

**GROUNDWATER DISCHARGE  
HYDROGEOLOGIC EVALUATION  
32 AND 43 LOTS HOLLOW ROAD  
TOWN OF ORLEANS, MASSACHUSETTS**

*Prepared for:*

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## 1. INTRODUCTION AND BACKGROUND

The Hydrogeologic Evaluation Technical Memorandum documents the approach used to evaluate 32 and 43 Lots Hollow Road (Figure 1) for a groundwater discharge from the proposed Downtown Area wastewater treatment facility (WWTF). This report includes the following:

- Description of the initial steps taken in the process of evaluating groundwater discharge sites;
- Summary of existing data that is available to help evaluate the 32 and 43 Lots Hollow Road site;
- Summary of field investigations conducted at 32 and 43 Lots Hollow Road site;
- Evaluation of field investigations and other available data;
- Results of groundwater flow modeling and groundwater mounding analysis; and
- Recommended maximum discharge capacity for the 32 and 43 Lots Hollow Road site.

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## **2. PROPOSED COLLECTION, TREATMENT, AND DISCHARGE FACILITIES**

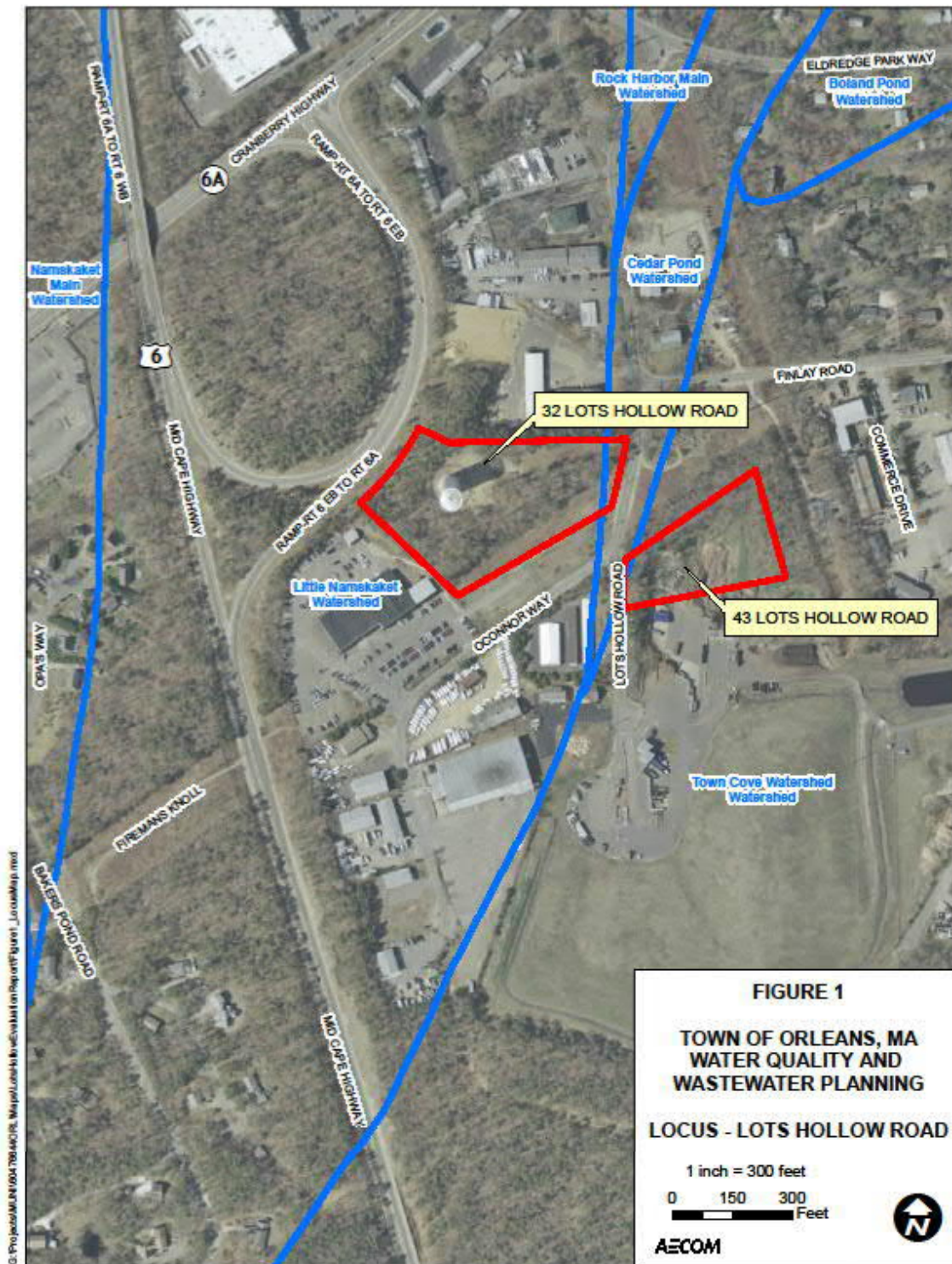
### **2.1. Collection Area and WWTF**

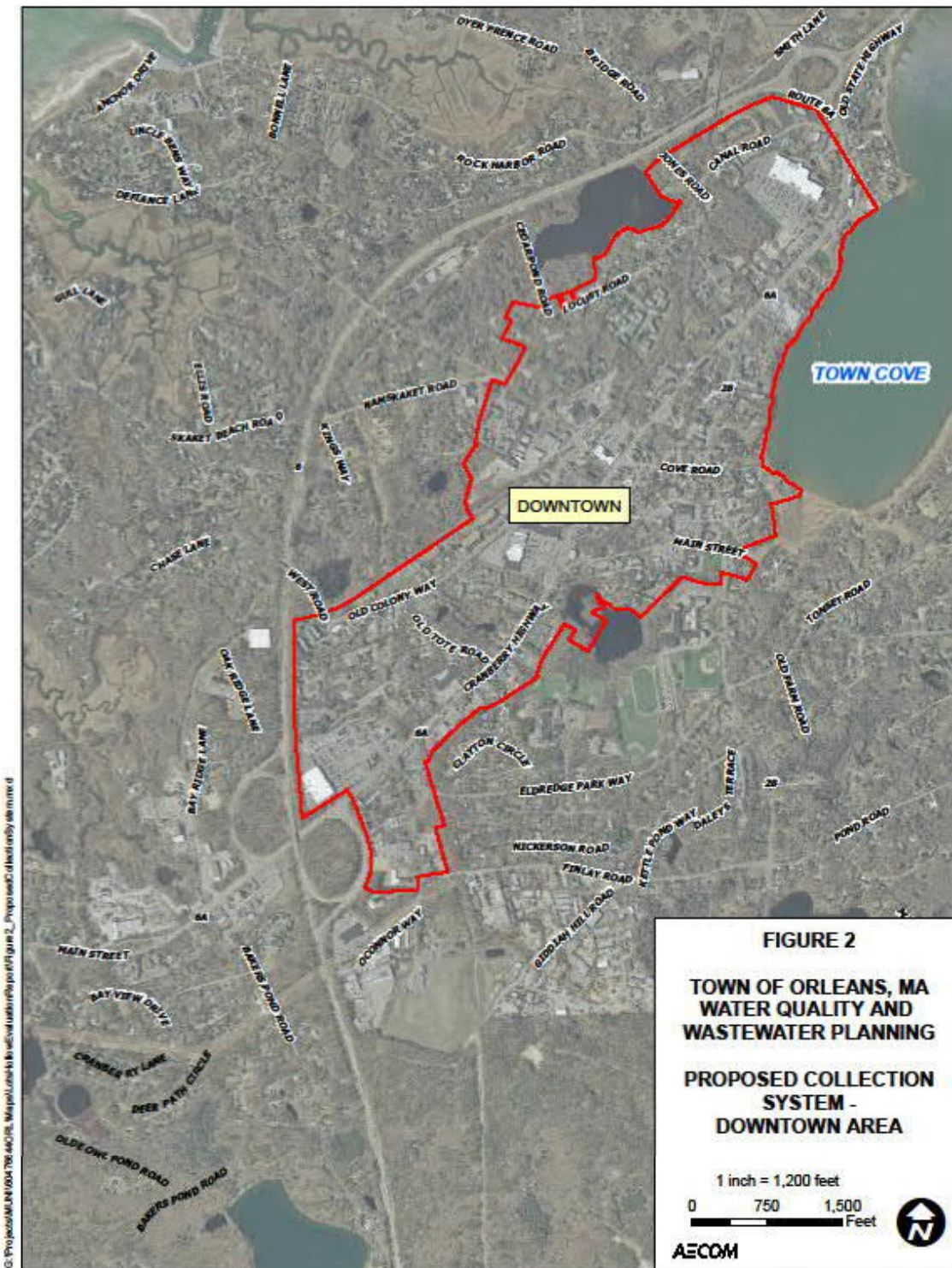
The Massachusetts Estuaries Project (MEP) estimates that approximately 7,000 kilograms per year (kg/yr) of nitrate load from existing and future septic load will need to be removed from the Town Cove Watershed to meet the nutrient load reduction target for Town Cove. The Orleans Water Quality Advisory Panel (OWQAP) evaluated traditional and non-traditional nutrient reduction technologies for nitrate removal within the watershed. Due to the significant nitrate load removal within the Town Cove Watershed, the OWQAP proposed to manage a significant portion of the nitrate load through the construction of wastewater collection, treatment, and disposal facilities in the Consensus Plan. Flow from the collection area will be primarily residential and commercial. Flows are estimated at 150,000 gallons per day (gpd) initially and approximately 250,000 gpd at build out. The proposed collection area is shown on Figure 2. The method of treatment is also being evaluated although a sequencing batch reactor (SBR) facility is considered likely.

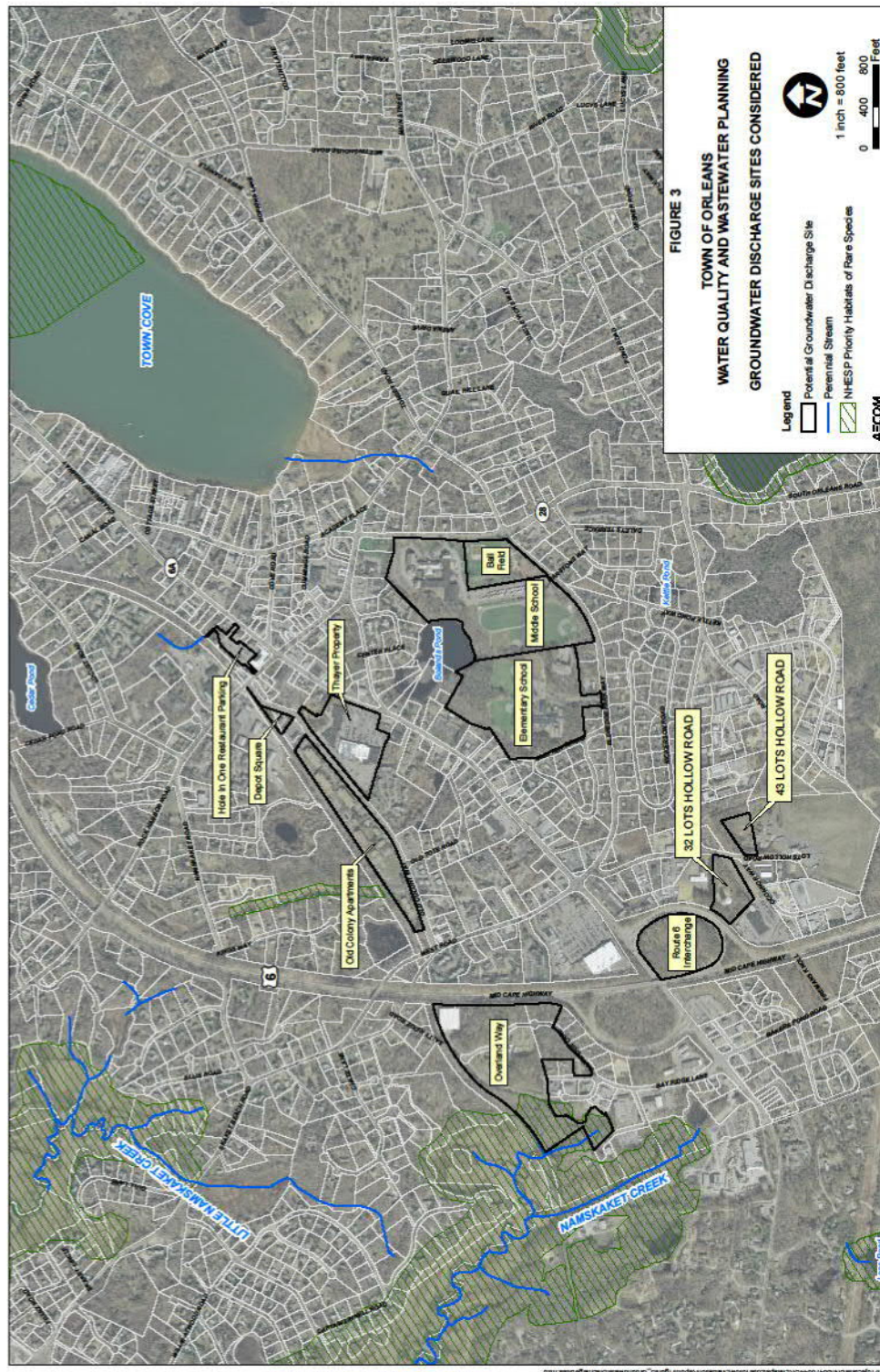
### **2.2. Initial Discharge Sites Considered**

Nine potential locations (Figure 3) for groundwater discharge of wastewater treatment facility effluent were considered in 2016. These sites include:

- Overland Way (Parcels 1/1A);
- Route 6 (Exit 12);
- Thayer Property (Orleans Market Place);
- Old Colony Apartments (Old Colony Way);
- Hole in One Restaurant Parking (Cranberry Highway);
- Depot Square (Old Colony Way);
- Orleans Elementary (46 Eldredge Park Way);
- Nauset Regional Middle School (70 Eldredge Park Way); and
- Orleans Firebirds Baseball Field (80 Eldredge Park Way).







A Site Selection Matrix was developed for the Town by AECOM for objective evaluation of selected discharge sites. The Matrix includes criteria for site suitability, permitting, project evaluation and other/overriding considerations. Site suitability criteria address environmental, land use and implementation features of the proposed discharge locations. Permitting criteria assess regulatory requirements and potential conflicts related to the proposed discharge locations. Project evaluation criteria evaluate the benefits gained from a proposed discharge site. The site selection screening was based on data available at the time of the screening process.

AECOM collected site specific information for each, conducted site visits, and evaluated the potential performance effectiveness. A rating system was then developed to quantify how well each site met a specific criterion. The point-based system used is as follows.

The Site Selection Matrix includes the following criteria that can be understood from currently available information and excluding hydrogeology which will be the subject of the investigations:

#### **2.2.1. Site Suitability**

- Property Ownership – Town owned, open space, privately owned, developed, undeveloped,
- Distance from wastewater treatment facility – The length of the force main and route it would follow must be installed significantly affecting overall costs.
- Ease of Access/Use of Property – Whether the discharge area is in an open area, under an existing parking lot, or in a developed area can affect the size and cost of the discharge area as well as installation and maintenance costs.
- Site Topography - Significant changes in elevation may affect construction and monitoring.
- Present Use of Site – Developed sites may be difficult to gain an easement agreement or right-of-way for a groundwater discharge.
- Potential Use of Site – Sites that are zoned or slated for future development may be more difficult to get permission to access and can impact the purchase price of parcel or alter the value of Town owned land.
- Depth to Groundwater - Deeper water table increases costs and may affect feasibility.
- Subsurface Soils Profile – Finer, lower transitivity soils (silt and clay) between the ground surface and 20 feet or so below the groundwater table can limit the amount of groundwater that can be discharged as well as the method of discharge (open bed, subsurface, wick, etc.).
- Area Available for Groundwater Discharge – Smaller discharge areas limit the amount of groundwater discharge potentially requiring discharge infrastructure at several locations.
- Downgradient Water Use – Public water supply or potable water supply wells are located nearby or down gradient.

#### **2.2.2. Permitting**

- Potential for Watershed/Estuary Impacts - Distance from surface water and wetland resource areas/water use considerations.
- Potential Impacts to Areas of Critical Environmental Concern (ACEC).
- Presence of Rare and Endangered species.

### 2.2.3. Project Evaluation

- Watershed total maximum daily load (TMDL) – Discharging to a watershed with a nitrate total maximum daily load may require higher treatment levels at the wastewater treatment facility significantly increasing capital and O&M costs.
- Conclusion of Previous Studies – The quality and conclusion of previous studies can impact the tasks necessary to perform the required Massachusetts Department of Environmental Protection (MassDEP) Hydrogeologic Evaluation.
- Required Effluent Discharge Quality – Site specific and surrounding conditions can impact required wastewater treatment facility discharge quality such as disinfection, nitrate levels, etc.
- Groundwater Discharge Method(s) – Capital and O&M costs for groundwater discharge methods vary. Site conditions can impact what discharge methods can be used.

### 2.2.4. Site Review and Shortlisted Sites

Site review and the site suitability evaluation process resulted in the following ranking of sites:

- Overland Way (Sites 1/1A) – 13 Points
- Route 6 (Exit 12) – 8 Points
- Depot Square (Old Colony Way) – 5 Points
- Old Colony Apartments (Old Colony Way) – 5 Points
- Thayer Property (Orleans Market Place) – 1 Point
- Hole in One Restaurant Parking (Cranberry Highway) – 1 Point

The above groundwater discharge sites were reviewed by the Town of Orleans Selectmen at an open meeting on Wednesday December 14, 2016. Two locations were initially shortlisted for hydrogeologic evaluation; Route 6 (Exit 12) and Overland Way. Reports on these sites were submitted to MassDEP in October and June of 2017, respectively.

## 2.3. Subsequent Discharge Sites Considered - Lots Hollow Road

This document reviews 32 and 43 Lots Hollow Road for potential groundwater discharge sites (Figure 1). These sites were not being considered at the time of the Site Selection Matrix was developed and were thus not scored and ranked.

The 32 and 43 Lots Hollow Road sites are being considered for two primary reasons. First, the site is located relatively close to the proposed WWTF at Overland Way; second, the 32 Lots Hollow site is located outside the Town Cove Watershed allowing for removal of the nitrate load from that nitrate impacted watershed under most discharge scenarios. The focus of this report is the hydrogeologic evaluation that was performed at the 32 and 43 Lots Hollow Road sites including the groundwater model results resulting from the calibrated groundwater model.

On January 12, 2018 a proposed scope of work to conduct a Hydrogeologic Site Evaluation was submitted to MassDEP for review and comment. The notification of the proposed scope of work was published in Volume 89, Issue 6 on January 24, 2018 of the Environmental Monitor and was open to public comment. Copies of the proposed Hydrogeologic Evaluation scope of work and Environmental Monitor Notification are provided in Appendix A.

The following Technical Memorandum reports on the scope of work, methodology, findings, conclusions, and recommendations of the 32 and 43 Lots Hollow Road Hydrogeologic Evaluation.

### 3. HYDROGEOLOGIC INVESTIGATION

Results of the hydrogeologic investigation of 32 and 43 Lots Hollow Road are included in the following sections. AECOM's investigations included the installation of soil borings and monitoring wells, grain-size analysis of soil samples, the installation of pumping wells to perform aquifer pumping tests, and the installation and testing of a small diameter "test" wick. The data obtained were used to evaluate subsurface conditions (i.e. soils), estimate the groundwater flow direction, estimate hydraulic conductivity values, and to characterize the aquifer's response to loading the test wick. Results of the field investigations and data analysis were then used to modify the USGS Monomoy Lens groundwater model. Once modified, the groundwater flow model was used to simulate groundwater flow across the site and regionally, estimate groundwater mounding, and estimate the nitrate load to watersheds under various discharge scenarios (Section 5). A summary of these investigations follows.

#### 3.1. Previous Subsurface Investigations

Prior to AECOM's hydrogeologic evaluation, few detailed site investigations had been performed at the site. Regionally, in the early 1990s, the Cape Cod Commission (CCC) investigated soils, water level and water quality data across the Town of Orleans. The CCC gathered existing soil boring and water level data from numerous previous investigations. The CCC also installed numerous additional soil borings and monitoring wells to evaluate soil and groundwater elevations throughout Orleans. Once collected, data was summarized in a report titled "Orleans Water Table Mapping Project, Orleans Massachusetts", dated May 1995. Soil boring logs, water level and groundwater elevation data, well location maps, geologic cross-sections and groundwater contour maps are included in the report. At 43 Lots Hollow Road, the Town of Orleans installed several monitoring wells to evaluate groundwater quality originating from the capped refuse, former septage lagoons, and compost area at the Town's landfill. Historic water level and water quality data from the monitoring wells was used to evaluate groundwater quality and to estimate the groundwater flow direction at and near 32 and 43 Lots Hollow Road.

#### 3.2. Test Pit Excavation and Percolation Tests

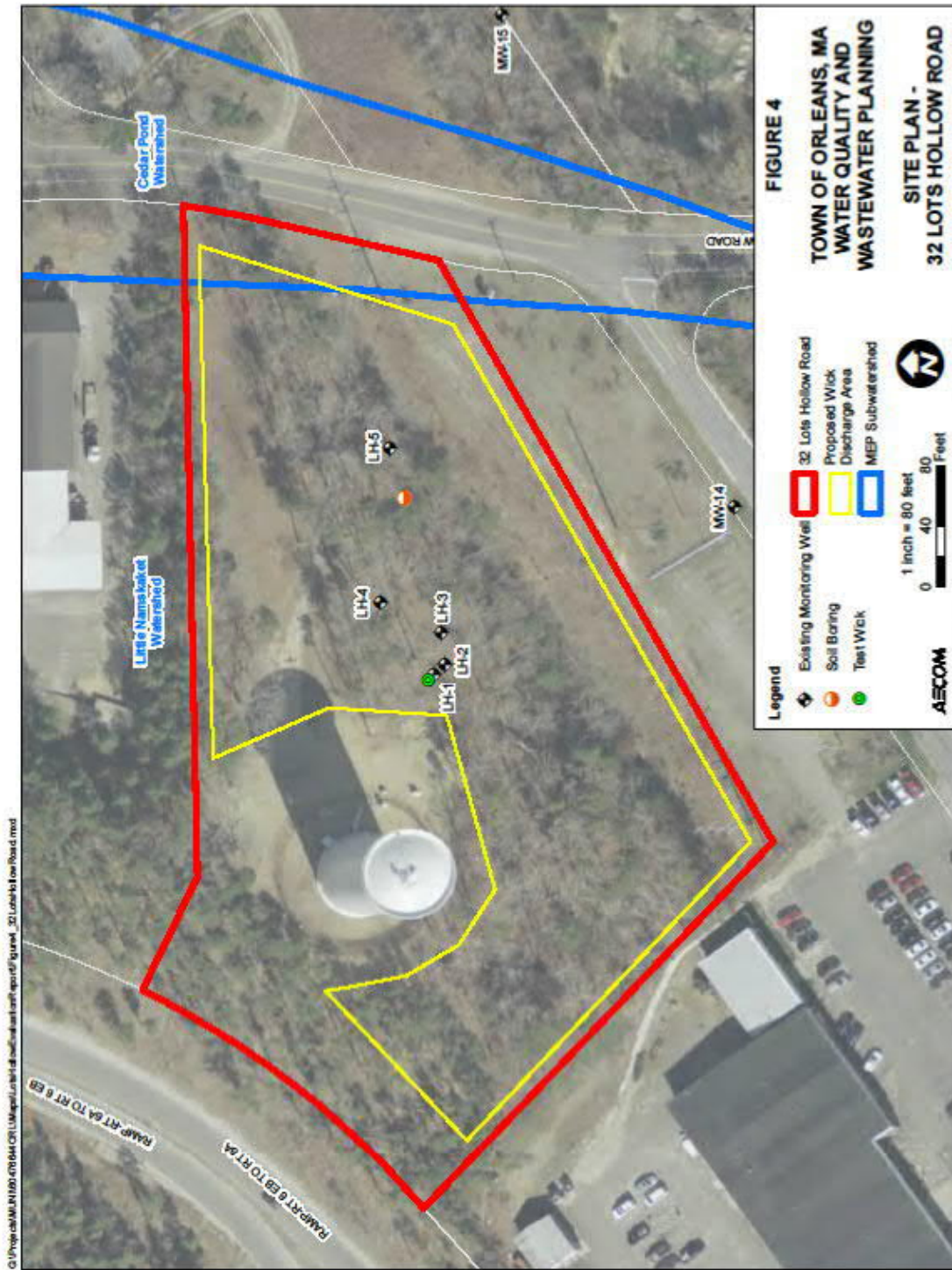
At the January 29, 2018 Site Visit, MassDEP stated that test pit excavations and Title 5 percolation tests were not required as part of the Hydrogeologic Evaluation. Test pit excavations generally expose soils to depths no greater than 15 feet. A permanent wick would likely not utilize the top 15 feet of the soil column for infiltration of the WWTF effluent. In addition, AECOM proposed a 30-day loading test was conducted at the site. The loading test is considered a better indicator of the site's capacity to discharge to groundwater through a wick.

#### 3.3. Soil Boring and Monitoring Well Installation

##### 3.3.1. 32 Lots Hollow

Five monitoring wells were installed by AECOM from December 2017 through February 2018, including LH-1, LH-2, LH-3, LH-4, and LH-5. Continuous sampling was conducted from the ground surface to depths of between 129 and 134 feet at locations LH-2, and LH-5 (Figure 4). Borings were installed with an AMS 9400 direct push rig, and soil core samples were collected for soil type characterization. Due to the depth to the water table, the direct push rig could not collect soil samples below 88 feet. A CME auger rig was used to collect split spoon samples below 88 feet. At all locations, an attempt to collect continuous soil samples to a minimum of 20 feet below the water table were made. Soils generally consisted of medium and fine sands, with occasional discontinuous lenses of silt or clay, no more than one to three inches thick.

Each monitoring well consisted of 10-foot sections of schedule 40 PVC riser pipe attached to 10-foot sections of 10-slot well screen. Natural sand pack was used between the well screen and the formation from the base of the well to approximately 2 feet above the well screen. The sand pack was then capped by approximately 2 feet of bentonite pellets and allowed to hydrate. Natural sand pack was allowed to collapse from above the bentonite to the surface.



### 3.3.2. 43 Lots Hollow

A total of seven monitoring wells were installed by AECOM from January 2017 through August 2017, including MW-2 (236-246), MW-5 (140-150), MW-9, MW-15 (115-125), MW-15 (145-155), MW-16S (110-120), and MW-16D (140-150). Monitoring wells that were installed in a cluster of two or more wells include the depth of the screen interval (in parentheses) in the well name. Six monitoring wells were drilled with a truck-mounted CME auger rig. Continuous split spoon samples were collected at MW-5 (140-150). At all other augered locations, general soil descriptions were determined from drill cuttings removed from auger flights. MW-2 (236-246) was drilled with a truck-mounted sonic rig, which provided continuous sampling to a depth of approximately 246 feet below ground surface (bgs).

Each monitoring well consisted of 10-foot sections of schedule 40 PVC riser pipe attached to 10-foot sections of 10-slot well screen. Natural sand pack was used between the well and the formation from the base of the well to approximately 2 feet above the well screen. The sand pack was then capped by approximately 2 feet of bentonite pellets and allowed to hydrate. Natural sand pack was allowed to collapse from above the bentonite to the surface.

The monitoring wells were used to determine the water table elevation and collect water quality sample. All wells were surveyed for location and elevation relative to NAVD 1988. Water table elevations were used to estimate groundwater flow patterns. Copies of the boring logs with monitoring well details are provided in Appendix B. A summary of the well construction details is provided in Table 1.

### 3.4. Grain-Size Analysis

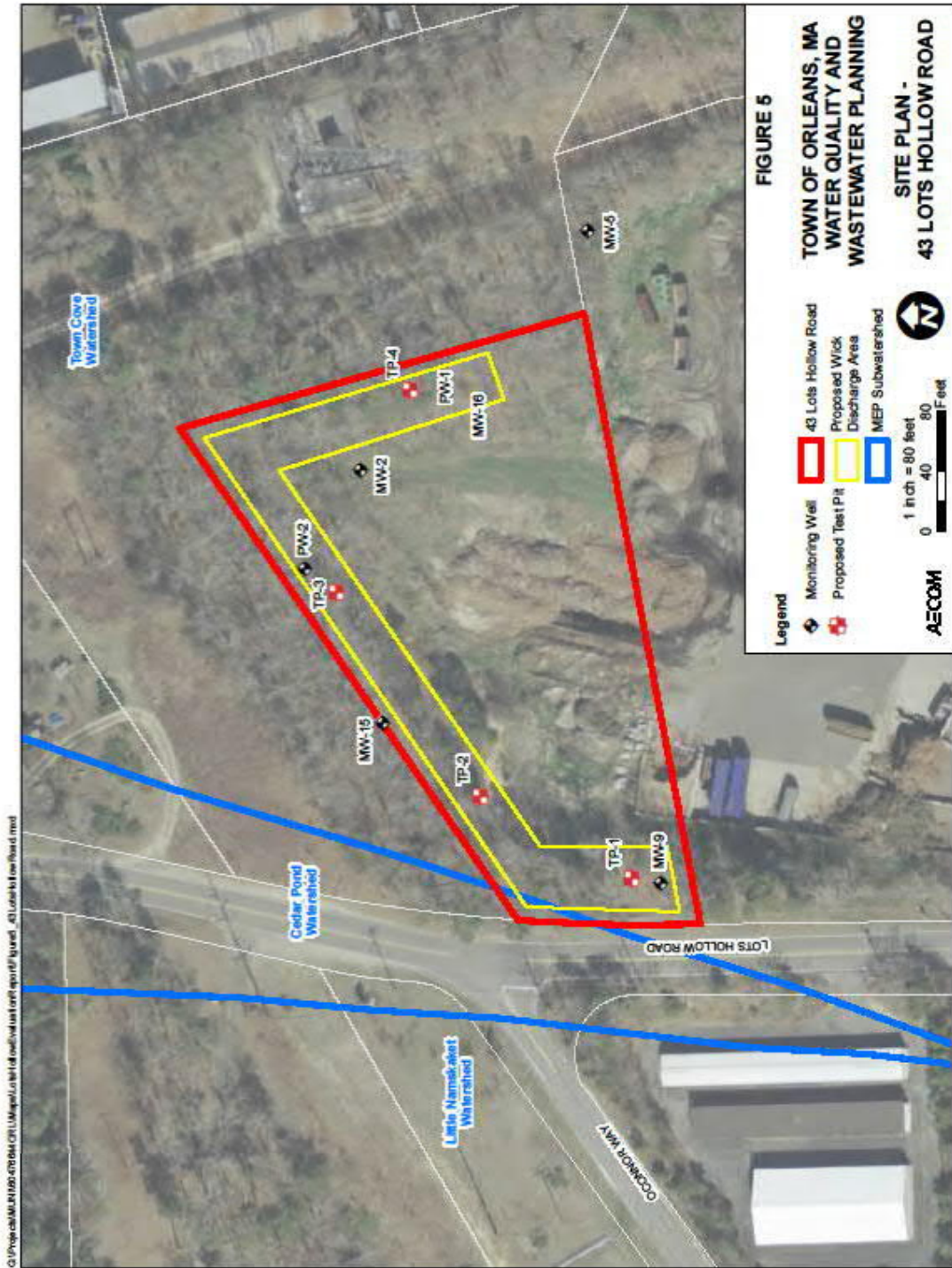
Soil samples were collected during the installation of the soil borings. Selected samples were submitted to a laboratory for grain size analysis. Copies of the laboratory grain-size analysis reports are provided in Appendix C. Results of the soils analysis are discussed in Section 4.2.1.

### 3.5. Pumping Tests

In July and August 2017, four 4-inch diameter PVC pumping wells were installed downgradient of the landfill at 43 Lots Hollow Road. Four pumping tests (one at each well) were then conducted to evaluate water quality and aquifer characteristics in the vicinity of the Orleans Landfill.

Each well was installed using a truck-mounted CME hollow-stem auger rig. Well PW-1S was installed to a depth of 125 feet below ground, with a 30 foot screen stretching from 95 to 125 feet below ground. Well PW-1D was installed to a depth of 160 feet below ground, with a 30 foot screen stretching from 130 to 160 feet below ground. Well PW-2S was installed to a depth of 130 feet below ground, with a 30 foot screen stretching from 100 to 130 feet below ground. Well PW-2D was installed to a depth of 154 feet below ground, with a 24 foot screen stretching from 130 to 154 feet below ground. The wells were installed in fine to medium sands. All wells were installed with 20-slot, continuously wound stainless steel well screen. Each well was developed with air until the water was clear. The deep and shallow wells at locations PW-1 and PW-2 were installed approximately 10 feet apart. The well locations are shown on Figure 5.

All wells were surveyed for location and elevation relative to NAVD 1988. The pumping and monitoring wells referenced in this section are shown on Figure 5. Well and groundwater elevation data are summarized in Table 1.



**TABLE 1  
SUMMARY OF WELL CONSTRUCTION DATA**

Observation Well	Diameter (inches)	Borehole Depth	Depth of Screened Interval	Ground Elevation	Northing	Easting	Top of PVC Elevation (ft msl)	Depth to Water Table (4 25 17)	Groundwater Elevation (NAVD 88)
<b>32 Lots Hollow St.</b>									
LH-1	2.0	128	118 - 128	122.43	2747103.768	1065269.699	124.27	106.94	17.33
LH-2	2.0	129	119 - 129	121.78	2747096.171	1065276.156	123.81	106.45	17.36
LH-3	2.0	129	119 - 129	121.20	2747098.958	1065296.917	123.00	105.65	17.35
LH-4	2.0	124	114 - 124	122.30	2747139.563	1065317.244	123.79	106.45	17.34
LH-5	2.0	124	114 - 124	118.15	2747133.158	1065419.554	119.81	102.53	17.28
Test Wick	8.0	105	25 - 105	122.58	2747107.796	1065265.909	123.33	NA	NA
<b>43 Lots Hollow St.</b>									
MW-2S (84-94)	2.0	94	84 - 94	103.45*	2747083.146	1065868.116	101.4	86.33	15.07
MW-2D (124-134)	2.0	134	124 - 134	103.61*	2747082.25	1065873.604	101.6	87.28	14.32
MW-2 (140-150)	2.0	150	140 - 150	102.80	2747072.948	1065874.231	101.3	86.50	14.80
MW-2 (160-170)	2.0	170	160 - 170	102.90	2747074.158	1065866.368	101.42	86.6*	14.82
MW-5D	2.0	150	140 - 150	101.70	2746922.228	1066033.688	103.6	86.32	17.28
MW-9	2.0	102	92 - 102	105.50	2746873.731	1065600.504	107.32	89.85	17.47
MW-14	2.0	160	150 - 160	105.40	2746904.287	1065380.336	105.15	87.89	17.26
MW-15S	2.0	125	115 - 125	107.40	2747058.283	1065707.528	109.17	91.92	17.25
MW-15D	2.0	155	145 - 155	107.30	2747060.145	1065711.291	108.87	92.42	16.45
MW-16S	2.0	120	110 - 120	101.28	2746994.936	1065935.913	103.38	86.18	17.20
MW-16D	2.0	150	140 - 150	101.50	2746999.446	1065935.174	103.36	86.74	16.62
Pumping Well 1S	4.0	125	95 - 125	102.10	2747030	1065939	103.66	86.6*	17.06
Pumping Well 1D	4.0	160	130 - 160	102.20	2747049	1065933	104.29	87.9*	16.39
Pumping Well 2S	4.0	130	100 - 130	99.10	2747107	1065801	100.75	83.9*	16.85
Pumping Well 1D	4.0	160	130 - 160	99.30	2747110	1065809	101.11	85.4*	15.71
<b>USGS Wells</b>									
OSW-22	2.0	52	52	39.00	Lat Long (NAD 27) 41°47'26"	69°58'16"	39.1	34.64	4.46
BMW-22	1.25	52	49	50.45	41°46'30"	70°01'49"	50.4	28.36	22.08
Notes:	All depths in feet below ground level (bgl)								
	All elevations in feet (NAVD 88)								
	ft = feet								
	* - Estimated value								

### 3.5.1. Pumping Wells PW-1S and PW-1D

The 4-inch diameter test well at PW-1S was pumped continuously for 24 hours from 2:00 pm on July 31, 2017 to 2:00 pm on August 1, 2017. The well was pumped to obtain water quality samples as well as drawdown data. During the test, the pumping rate was held constant at approximately 80 gallons per minute (gpm). Groundwater samples and water level data were collected prior to, during and at the conclusion of the pumping test.

The 4-inch diameter test well at PW-1D was pumped continuously for 24 hours from 10:00 am on August 3, 2017 to 10:00 am on August 4, 2017. During this time, the pumping rate was held constant at 80 gpm. Water level stabilization in each of the 4-inch diameter pumping wells was not achieved during either pumping test.

During the PW-1S pumping test water quality samples were collected after two, three, seven, eleven, fifteen, nineteen, twenty-two, and twenty-four hours of pumping. During the PW-1D pumping test water quality samples were collected after six, ten, fourteen, eighteen, twenty-one, and twenty-four hours of pumping. Samples were chilled on ice, picked up by courier, and transported under chain of custody for analysis at ESS Laboratory of Cranston, Rhode Island.

#### 3.5.1.1. Pumping Test Operation – PW-1S

The 4-inch diameter test well at PW-1S was pumped at a constant rate of 80 gpm from 2:00 pm on July 31, 2017 to 2:00 pm on August 1, 2017. Prior to the startup of the pumping test, antecedent water levels were measured in selected observation wells. A copy of the pumping test data is provided in Appendix D.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells MW-2(84-94), MW-2(140-150), MW-5(130-140), MW-16S, PW-16D, and PW-1D during the 24-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOBO electronic data loggers, and were used for aquifer analysis. Drawdown after 24 hours of pumping is shown in Table 2.

**TABLE 2  
DRAWDOWN PW-1S – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
MW-2 (84-94)	83	1.66
MW-2 (140-150)	77	0.30
MW-16S	33	0.74
PW-16D	29	0.72
PW-1D	23	0.23

At 2:00 pm on August 1, 2017 pumping was discontinued and water levels in the above-mentioned observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery progressed as shown on Table 3.

**TABLE 3  
RECOVERY PW-1S – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
MW-2 (84-94)	83	43
MW-2 (140-150)	77	13
MW-16S	33	81
PW-16D	29	10
PW-1D	23	17

**3.5.1.2. Pumping Test Operation – PW-1D**

The 4-inch diameter test well at PW-1D was pumped at a constant rate of 80 gpm from 10:00 am on August 3, 2017 to 10:00 am on August 4, 2017. Prior to the startup of the pumping test, antecedent water levels were measured in selected observation wells.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells PW-1S, MW-2(124-134), MW-2(140-150), MW-5(130-140), MW-16S, AND PW-1D during the 24-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOB0 electronic data loggers, and were used for aquifer analysis. Drawdown after 24 hours of pumping is shown in Table 4 below.

**TABLE 4  
DRAWDOWN PW-1D – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
PW-1D	0 (pumping well)	No Data
MW-2 (124-134)	66	0.81
MW-2 (140-150)	60	0.86
MW-5 (130-140)	27	0.15
MW-16S	44	0.14
PW-1S	23	0.11

At 10:00 am on August 4, 2017 pumping of the well was discontinued and water levels in the above-mentioned observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery occurred as shown in Table 5.

**TABLE 5**  
**RECOVERY PW-1D – 43 LOTS HOLLOW ROAD**

<b>Well ID</b>	<b>Distance from Pumping Well (feet)</b>	<b>Percent Recovery 2 hours (%)</b>
<b>PW-1D</b>	0 (pumping well)	N/A
<b>MW-2 (124-134)</b>	66	91
<b>MW-2 (140-150)</b>	60	87
<b>MW-5 (130-140)</b>	27	13
<b>MW-16S</b>	44	21
<b>PW-1S</b>	23	18

### 3.5.2. Pumping Wells PW-2S and PW-2D

Pumping well PW-2S was pumped continuously for 8 hours from 8:00 am to 4:00 pm on August 17, 2017 to obtain drawdown data and collect water quality samples. During this time, the pumping rate was held constant at 80 gallons per minute (gpm).

The 4-inch diameter test well at PW-2D was pumped continuously for 8 hours from 8:00 am to 4:00 pm on August 24, 2017 to collect water quality samples and obtain drawdown data. During this time, the pumping rate was held constant at 80 gpm. Water level stabilization in the 4-inch diameter pumping wells was not achieved during either pumping test.

During both the PW-2S and PW-2D pumping tests water quality sample were collected after two, four, and seven and a half hours of pumping. Samples were chilled on ice, picked up by courier, and transported under chain of custody for analysis at ESS Laboratory of Cranston, Rhode Island.

#### 3.5.2.1. Pumping Test Operation – PW-2S

The 4-inch diameter test well at PW-2S was pumped at a constant rate of 80 gpm from 8:00 am to 4:00 pm on August 17, 2017. Prior to the startup of the pumping test, static water levels were measured in selected observation wells.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells MW-2S, MW-15S, MW-15D, MW-2D, PW-2D, and PW-1S during the 8-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOB0 electronic data loggers, and were used for aquifer analysis. Drawdown after 8 hours of pumping is provided in Table 6.

**TABLE 6**  
**DRAWDOWN PW-2S – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
MW-2 (84-94)	83	1.66
MW-2 (140-150)	77	0.3
MW-5 (124-134)	159	NA
MW-16S	33	0.74
PW-16D	29	0.72
PW-1D	23	0.23

At 4:00 pm on August 17, 2017 pumping was discontinued and water levels in the above-mentioned observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery readings are summarized in Table 7.

**TABLE 7**  
**RECOVERY PW-2S – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
MW-2 (84-94)	83	43
MW-2 (140-150)	77	13
MW-5 (124-134)	159	NA
MW-16S	33	81
PW-16D	29	10
PW-1D	23	17

**3.5.2.2. Pumping Test Operation – PW-2D**

The 8-inch diameter test well at PW-2D was pumped at a constant rate of 80 gpm from 8:00 am to 4:00 pm on August 24, 2017. Prior to the startup of the constant-rate pumping test, antecedent water levels were measured in selected observation wells.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells MW-2, MW-15D, PW-2S, PW-1D, and MW-16D during the 8-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOBO electronic data loggers. Drawdown after 8 hours of pumping is summarized in Table 8.

**TABLE 8  
 DRAWDOWN PW-2D – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
PW-2D	0 (pumping well)	12.11
MW-2	69	0.67
MW-15D	113	0.48
PW-2S	68	0.38
PW-1D	141	0.48
MW-16D	168	0.36

At 4:00 pm on August 24, 2017 pumping was discontinued and water levels in the observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery progressed as summarized in Table 9.

**TABLE 9  
 RECOVERY PW-2D – 43 LOTS HOLLOW ROAD**

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
PW-2D	0 (pumping well)	100
MW-2	69	96
MW-15D	113	104
PW-2S	68	92
PW-1D	141	94
MW-16D	168	94

### **3.5.3. Observation Wells**

Water levels were measured before, during, and after each pumping test in the 4-inch diameter pumping wells and surrounding observation wells. Observation wells were also used to measure water-level drawdown and recovery due to pumping. Drawdown data was then used to compute aquifer hydraulic characteristics.

### **3.5.4. Precipitation**

No precipitation was recorded during any of the pumping tests.

### **3.5.5. Pumping Test Discharge**

Water was pumped from each of the 4-inch diameter pumping wells using an electrical submersible pumps driven by a single diesel-powered generator. Water was conveyed from the 4-inch diameter test well through temporary, 2-inch diameter hosing and discharged to the edge of the on-site stormwater retention basin located approximately 600 feet southeast of the pumping wells. The rate of flow from the 2-inch pumping wells was measured with an electronic flow meter on the discharge hose.

## **3.6. Slug Tests**

On March 1, 2018, rising-head slug testing was performed at wells LH-1, LH-3, LH-5, MW-15S, MW-15D, and MW-16S. Wells were tested using a Midwest Geosciences “Pneumatic Hi-K Slug” slug testing apparatus. Each well was tested three times, to check for data reliability. Water levels were recorded with an In-Situ LevelTroll 700 pressure transducer. Water levels were allowed to stabilize after each test. Data was analyzed using Aqtesolv software. All slug tests were completed on the same day.

## **3.7. Water Quality**

On August 8 and 9, 2017, water quality sampling was performed at 43 Lots Hollow Road and just upgradient of 32 Lots Hollow Road. Groundwater samples were collected from monitoring wells installed by AECOM: MW-2S, MW-2D, MW-2 (140-150), MW-2 (160-170), MW-9, MW-14, MW-15S, MW-15D, MW-16S, and MW-16D. Additionally, pumping wells PW-1S, PW-1D, PW-2S, and PW-2D were sampled during their respective pumping tests in July and August 2018. The samples were submitted for inorganic and organic analyses to ESS Laboratory of Cranston, Rhode Island, a Massachusetts certified analytical laboratory. In addition, water quality was tested in the field using an YSI water quality meter. Results of the water quality analysis are summarized in Section 4.3.

## **3.8. Test Wick and Loading Test – 32 Lots Hollow Road**

On January 12 2018, AECOM submitted a Proposed Hydrogeologic Evaluation to MassDEP. The proposed scope of work proposed the design of the “test” wick, the installation of five monitoring wells, and a 30-day loading test. The 30-day loading test was conducted to evaluate whether the 32 Lots Hollow Road site could accommodate the groundwater discharge associated the discharge from the proposed WWTF.

### **3.8.1. Test Wick**

One “test” wick was installed at 32 Lots Hollow Road, from February 6 through 7, 2018. A CME auger rig with 14-inch outside diameter (OD), 8-inch inside diameter (ID) augers was used to drill to a depth of 105 feet. A 2-inch diameter PVC well with 80 feet of screen was set inside the drilled hole and 3/8-inch diameter washed gravel was placed around the 2-inch well from a depth of 105 feet to ground surface. A plastic 6-foot diameter culvert pipe was set four feet into the ground as a protective cover for the test wick. PVC piping was inserted through the side of the culvert pipe. The piping was fitted with a firehose on the end outside the culvert pipe, and terminated inside a 90-degree bend which directed water downward into the wick. The “test” wick log is attached in Appendix B.

### 3.8.2. Loading Test Operation

Loading of the wick began at 12:00 pm on February 9, 2018 and was completed at 1:15 pm on March 14, 2018. Water discharged into the wick was supplied by the Town of Orleans water system, delivered via an on-site hydrant. Water use volume was determined by taking daily readings at a passive in-line meter installed at the hydrant. Loading rate was also calculated using the meter. Approximately 3.4 million gallons were discharged into the wick over the course of the 34 day loading test.

During the loading test, water levels were measured at on-site wells LH-1 through LH-5, and off-site wells MW-14, MW-9, MW-15S, CL-1, MW-2D, MW-16S, CL-2, MW-5, and CL-3. Water levels were measured twice daily at all wells for the first four days of the loading test, and thereafter once daily at the on-site wells and two to three times a week at the off-site wells. A copy of water level data recorded during the loading test is included in Appendix E.

USGS well BMW 22, located approximately 1.5 miles west of the 32 and 43 Lots Hollow Road site, was used to establish ambient water levels. Downloaded daily water levels are included in the water-level graphs on Figure 6. Monitoring well BMW-22 has been monitored since 1967, and is screened in a similar formation and hydrogeologic setting as the 32 Lots Hollow Road Site. A copy of the water level data at the ambient well is provided in Appendix F.

Precipitation data was provided by the Town of Orleans Water Department and is included in Appendix G along with detailed water level readings. Notable rain events of more than a half-inch were recorded on February 11 and 25, and March 2, 7, 12, and 14.

The loading test took place during a very wet winter. Over 8.82 inches of rain was recorded during the test. Groundwater levels at BMW-22 rose approximately 1.67 feet between the beginning and the conclusion of the loading test. Similar water table increases were noted across 32, and 43 Lots Hollow Road. Figure 6 shows cumulative rainfall and water level trends in all wells monitored during the loading test. Water levels rose across the entire study area during the loading test, including ambient well BMW 22, likely due to the 8.82 inches of rain received over the course of the loading test. The record high water level at BMW-22 was recorded on April 4, 2018, shortly after the conclusion of the loading test. Initial wick loading took place at 20 gpm, and was increased over the course of the test to a final loading rate of 88 gpm. Loading rates over time are summarized in Table 10. Wick mounding and analysis are discussed in Section 4.5.

**TABLE 10  
WICK LOADING TEST SUMMARY – 32 LOTS HOLLOW ROAD**

Loading Rate		Loading Duration		Water-Level Rise, Feet								Efficiency	
gpm	gpd	Days at Rate	Total Days	LH-1 (5)*	LH-2 (15)*	LH-3 (30)*	LH-4 (60)*	LH-5 (125)*	MW-14 (250)*	MW-9 (415)*	Wick (0)*	Wick Efficiency (gpm/ft)	Wick Efficiency (gpd/ft)
20	28,800	1	1	0.03	0.03	0.02	0.03	0.03	-0.06	0.02	3.55	5.63	8,113
33	47,520	5	6	1.03	0.90	0.72	0.56	0.33	0.15	0.11	14.38	2.29	3,305
59	84,960	4	10	1.85	1.60	1.31	1.04	0.48	0.11	0.07	17.95	3.29	4,733
88	126,720	23	33	3.10	2.85	2.38	2.00	1.07	0.08	0.13	42.40	2.08	2,989
Average												3.32	4,785

\* Distance from test wick in feet.

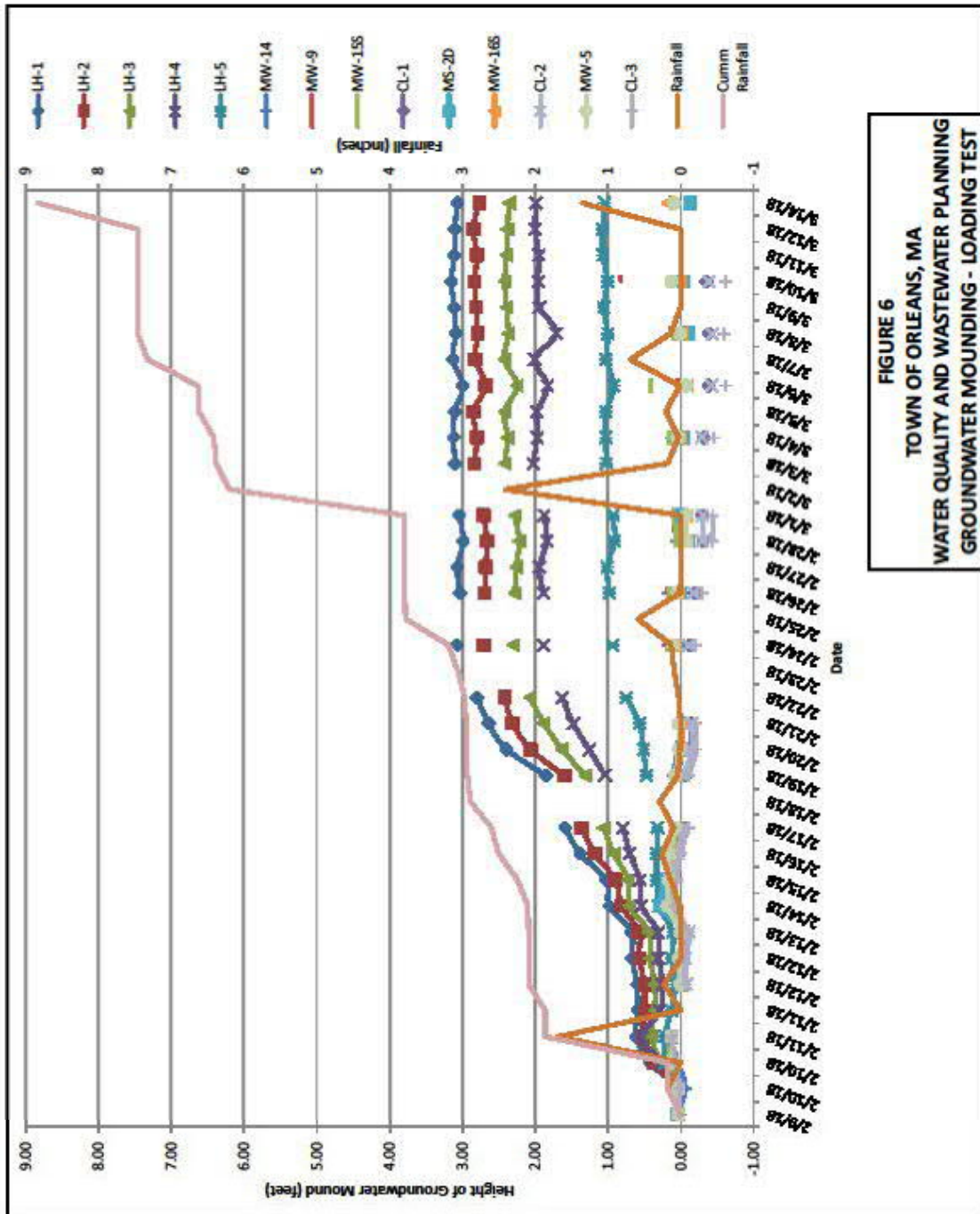


FIGURE 6  
TOWN OF ORLEANS, MA  
WATER QUALITY AND WASTEWATER PLANNING  
GROUNDWATER MOUNDING - LOADING TEST

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#### 4. HYDROGEOLOGIC CONDITIONS AND DATA ANALYSIS

##### 4.1. Geology, Groundwater Flow and Boundary Conditions

Orleans is underlain by glacially derived sediments deposited 15,000 or so years ago during the waning stages of continental glaciation. The sediments consist of outwash deposited from the melting of the Cape Cod Bay and South Channel Lobes of the glacier (Wordsworth and Wigglesworth, 1934). The Harwich Outwash Plain deposits were derived from the Cape Cod Bay Lobe, while the Nauset Heights and Eastham plain deposits were derived from the South Channel Lobe (Oldale et.al., 1971).

According to Koteff and Cotton (1962), coarse sand and gravel deposits (Harwich Outwash Plain Deposits) are underlain by coarse sands to clayey silts followed by compact basal till directly overlying bedrock. The relatively thin layer of basal till indicates that the soils were deposited as the result of a single glaciation. Previous seismic investigations in the Orleans beach area indicate the bedrock surface at about 400 feet below sea level (Oldale and Tuttle, 1964).

The 32 and 43 Lots Hollow Road parcel is underlain by Harwich Outwash Plan Deposits, as mapped by Oldale et.al (1971). According to Oldale, these deposits consist primarily of medium to very coarse sand and pebble to cobble gravel. In general, these deposits are fairly well sorted and very permeable. Till and boulders can be found shallow or overlying the deposits. Clayey silt can also be found in the deposits.

Due west and north of the site, lake deposits and lake bottom deposits from the Cape Cod Bay proglacial lake are mapped by Oldale et.al. (1971). The deposits due west of the site are described as being gravelly sand, pebble and gravel cobble gravel. Clayey silt and till can also be found. Deposits further to the northwest and north of the outwash deposits are described as being more gravelly and clayey silt.

Geologic conditions found at the 32 and 43 Lots Hollow Road site through AECOM's field investigations are consistent with the deposits described above. In general, the soils encountered at 32 Lots Hollow were tan to brown fine-to-medium or medium sand with low percentages of silt to the full depths of the wells. Within this interval, occasional thin layers of silty sand, silt and silt with varying amounts of clay were encountered. These layers appeared to be discontinuous across the site and were no more than one to three inches thick.

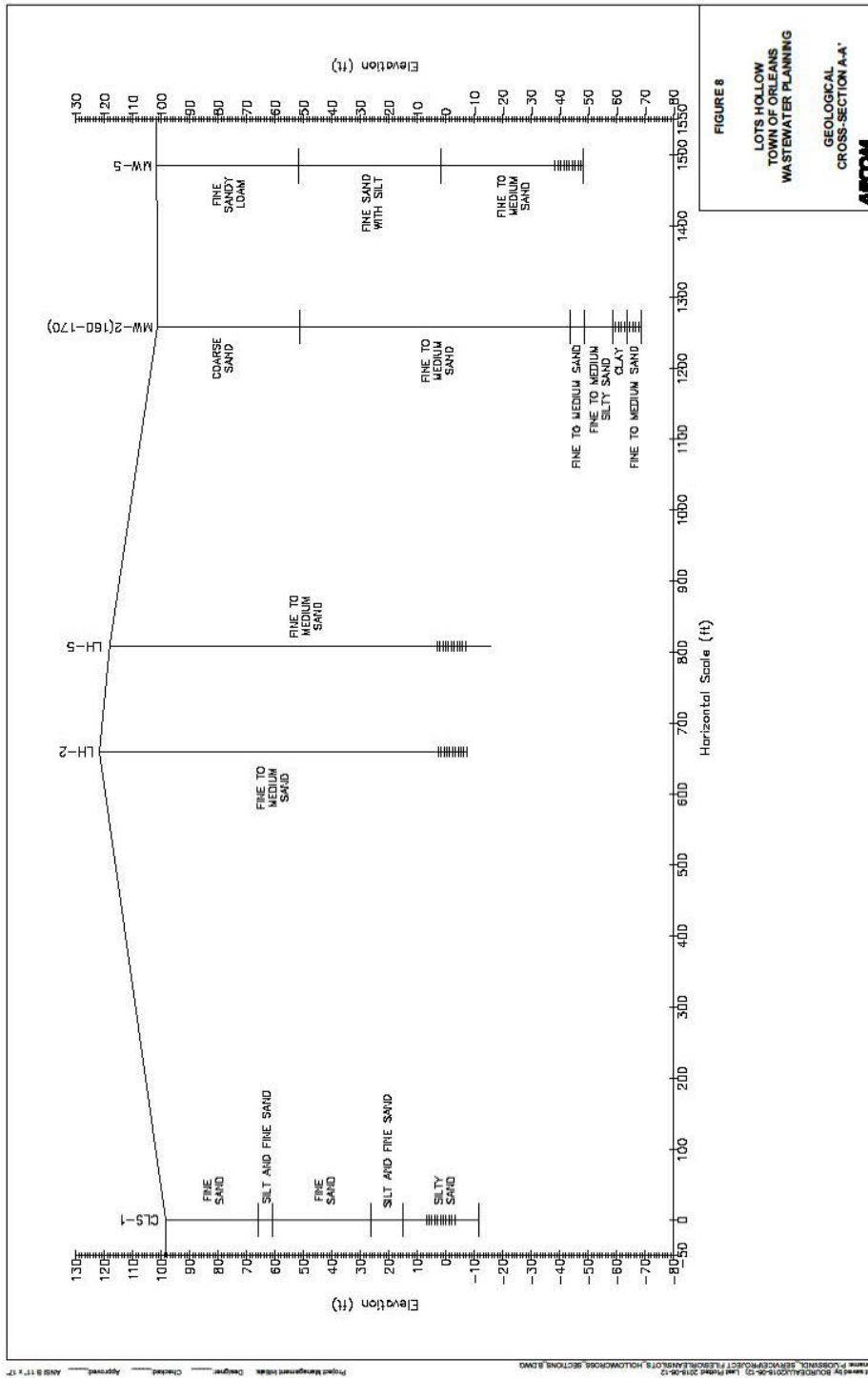
The soils at 43 Lots Hollow were tan to brown fine-to-medium or medium sand, with low percentages of silt. Within this interval, occasional thin layers of silty sand, silt and silt with varying amounts of clay were encountered. Brown to grey clay was encountered in some locations below a depth of approximately 154 feet. The clay appeared to be discontinuous across the site but in the area of PW-1D and MW-2(236-246) was thick.

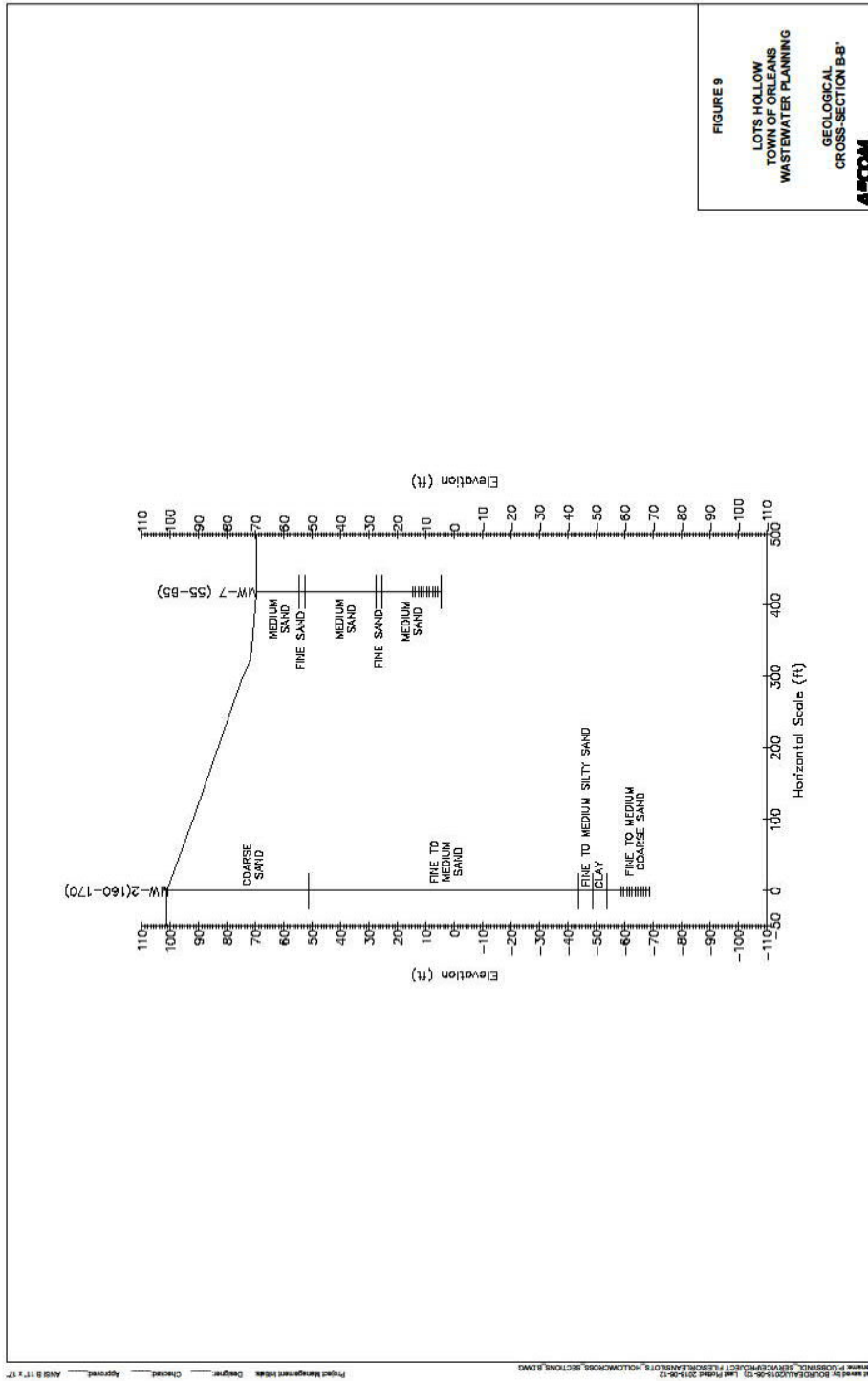
Groundwater was measured in the monitoring wells at a depth of approximately 88 to 108 feet below ground surface at the time of drilling.

The lines of geologic cross-section are shown on Figure 7. The geologic cross-sections A-A' and B-B' (Figure 8 and Figure 9, respectively) graphically depict geologic conditions locally and regionally. Well logs used to construct the geologic cross-sections are in Appendix B.

According to MEP water table maps, groundwater flows north northwesterly across the site toward the Namskaket and Little Namskaket Creeks (USGS, 2005). The drainage divide between the Namskaket and Little Namskaket Creek watersheds is located approximately 700 feet west of the 32 Lots Hollow site.







## **4.2. Calculated Aquifer Hydraulic Conductivity**

Aquifer conductivity values were estimated through laboratory grain-size analysis and slug tests. Details follow in this section.

### **4.2.1. Grain-Size Analysis**

Samples collected from selected soil borings were submitted to a laboratory for grain-size analysis. In total, 12 soil samples were submitted: three samples each from soil borings at LH-2 and LH-5, and six samples from a soil boring at MW-2.

Hydraulic conductivity (K) and porosity (n) values for each of the 12 samples were estimated using several numerical methods including Kozeny-Carman (Carman, 1937), Shepards (1989), Hazen (1892), and Slitcher (1992).

At 32 Lots Hollow conductivity values ranged from 2 ft/day to 83 ft/day. The average value for the sampled described as “poorly graded sand” and “sand with silt” was 40 ft. Soils of this description make up the majority of the soils underlying the site. The average value for the thin (6-inches or less) and likely discontinuous layers of finer soils described as “silt with sand”, “silty sand”, and “silt samples” was 5 ft/day.

At 43 Lots Hollow conductivity values ranged from 2 ft/day to 150 ft/day. The average value for poorly graded sand and sand with silt samples, the majority of the soils underlying the site, was 58 ft/day. The average value for the thin layers of finer soils (silt with sand, silty sand, and silt samples) was 16 ft/day.

### **4.2.2. Pumping Test Analysis**

Aquifer analysis was performed on both drawdown and recovery data from selected observation wells monitored during pumping tests PW-1S, PW-1D, PW-2S, and PW-2D, located at 43 Lots Hollow. Water level data was obtained with Onset HOBO pressure transducers and was analyzed using Aqtesolv software. Due to the distance between the pumping and monitoring wells, drawdown observed in the observation wells was generally a half foot or less, with only one well (MW-16S, monitoring during pumping of PW-1S) having drawdown exceeding a foot.

Due to this muted response, analysis of drawdown data did not yield meaningful values for transmissivity and conductivity. The small amount of drawdown observed during eight-hour and 24-hour tests, all at 80 gpm, is a very good indicator that the aquifer underlying 43 Lots Hollow is quite transmissive. As with 32 Lots Hollow, the high transmissivity of the aquifer underlying 43 Lots hollow will transmit a large quantity of water without significant drawdown or mounding. To obtain improved drawdown data in a future pumping test, observation wells would need to be located closer (within 30 feet) to the pumping wells, and screened in the same interval as the pumping well. Aqtesolv plots are included in Appendix I for reference.

### **4.2.3. Slug Test Analysis**

At 32 Lots Hollow (LH-1, LH-3, and LH-5) average conductivity values ranged from 54 ft/day to 78 ft/day. These wells had not been previously developed, sampled, or otherwise pumped, and at each well the first slug test has a poor response, with a more robust, repeatable response occurring during the second and third tests. It is likely that the first slug test displaced some of the fines around the well screen, and as such, tests two and three are considered more representative of the conductivity of the formation around the well. All wells showed a very rapid response, with initial displacement and return to stabilized conditions occurring within 10-20 seconds.

At 43 Lots Hollow (MW-15S, MW-15D, MW-16S) conductivity values ranged from 29 ft/day to 86 ft/day. MW-15S and MW-16S exhibited similar behavior to the wells at 32 Lots Hollow Road, with rapid rise in head and stabilization within 10-20 seconds. MW-15D exhibited unusual behavior, in which head rapidly rose, and then oscillated several time before stabilizing. The data is a poor fit for analysis with type curves, and meaningful conductivity values were not able to be obtained.

#### **4.3. Groundwater**

The study area, which includes 32 and 43 Lots Hollow Road sites is located at the groundwater divide between the Little Namskaket Creek, Cedar Pond (Rock Harbor River), and Town Cove Watersheds (Figure 1). Locally, groundwater flows north. Water levels measured on May 29, 2018 from 11 observation wells were used to estimate the groundwater flow direction across the study area. Each well was surveyed relative to NAVD 1988. Using the survey data, the water levels obtained at each location were converted to elevation in NAVD 1988. A summary of groundwater elevation data is provided in Table 1.

The static groundwater elevations were plotted on a map and approximated contours of the potentiometric surface were drawn. The resulting contours are shown on Figure 10. Contours were inferred between monitoring well locations. Based on the contours, groundwater flow across the site is 0.0032 ft/ft to the north-northeast. The hydraulic gradient was calculated between the 16 and 17 foot contour at a distance of approximately 316 ft. The groundwater contours are shown on Figure 10.

In general, elevated nitrate levels above the Massachusetts drinking water standard are detected across the site. Higher nitrate is observed in the more shallow wells, with deeper wells having relatively low or non-detect nitrate levels. Chloride levels and sulfide levels are elevated above the Massachusetts guidance values. Results of the field and laboratory testing are summarized in Table 11. Copies of the laboratory reports are provided in Appendix K.

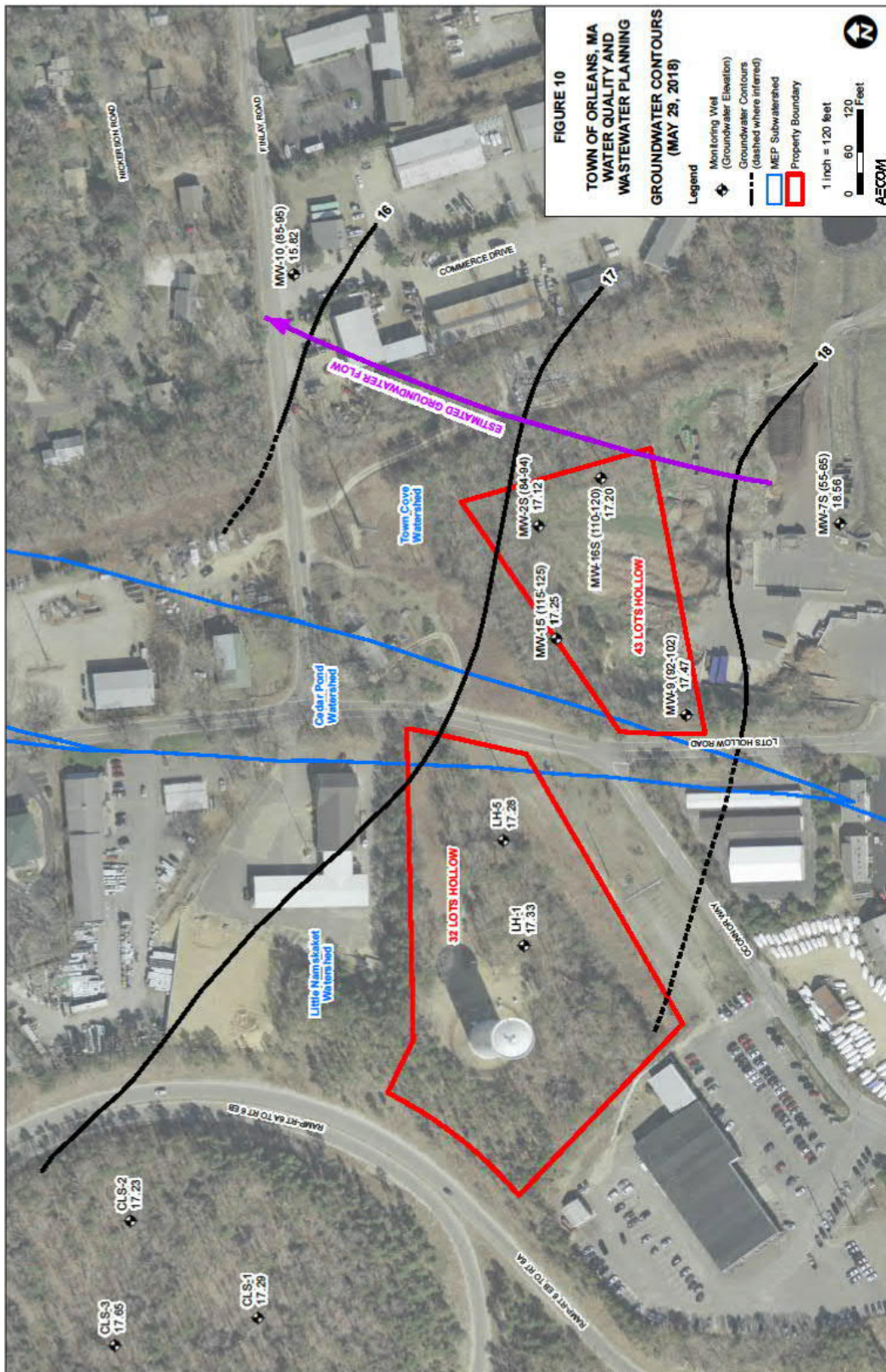
#### **4.4. Surface Water**

The nearest surface water body is the upper reaches of Namskaket Creek, approximately 1,800 feet to the west. However, groundwater flows is north northwest towards Little Namskaket Creek, Rock Harbor, Boat Meadow River, and Town Cove which are approximately 4,900, 6,300, 8,300 and 5,600 feet respectively from the discharge.

#### **4.5. Loading Test Analysis**

As described in Section 3.8.1, a 2-inch diameter PVC well was installed inside the 12-inch diameter test wick to monitor water levels during the loading test. Water levels in the test wick were digitally monitored throughout the loading test using an Onset Hobo data logger. Manual water level readings were also collected periodically. Table 10 summarizes the loading rates, high water levels (within the wick and monitoring wells) noted during each loading rate, and the number of days of loading at each rate.

To evaluate the test wick's performance, each loading rate was divided by the mound height (in feet). The resulting value is referred to as the wick efficiency and is expressed as gallon per day of discharge per foot of mounding within the test wick (gpd/ft)..



**TABLE 11  
SUMMARY OF WATER-QUALITY RESULTS**

Parameter	Units	MRL	Drinking Water Standard <sup>1</sup>	MMW-2S 2/6/2017	MMW-2D(124-134) 2/6/2017	MMW-2(140-160) 2/6/2017	MMW-2(160-170) 3/25/2017	MMW-5 3/27/2017	MMW-9 2/8/2017	MMW-14 8/14/2017	MMW-15S 8/4/2017	MMW-15D 8/4/2017	MMW-16S 8/8/2017	MMW-16D 8/8/2017	PW-1S 8/1/2017	PW-1D 8/4/2017	PW-2S 8/17/2017	PW-2D 8/24/2017
<b>Field Results:</b>																		
pH	S.U.	NA	6.5-8.5 <sup>2</sup>	4.8	6.0	5.7	6.1	6.1	5.0	1.9	4.1	4.5	6.1	6.3	4.9	5.6	6.1	6.0
Specific Conductance	µmho/cm	0	NE	751	800.0	637.0	620.0	377	297	223	366	430	581	503	689	616	465	544
Turbidity	NTU	0.25	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Temperature	°C	0.01	NE	16.0	15.5	15.2	14.4	14.6	15.9	14.8	14.5	14.8	15.6	15.5	15.0	14.8	16.6	18.4
ORP	mV	0.1	NE	129.8	54.5	65.1	57.5	195.9	139.1	672.7	517.9	554.9	7.5	40.8	-87.1	59.2	137.0	103.8
Dissolved Oxygen	mg/L	2.5	NE	1.6	0.1	0.1	0.0	0.17	7.4	3.3	6.3	7.8	0.2	0.2	0.55	0.3	0.88	0.21
<b>Laboratory Results:</b>																		
Chloride	mg/L	3.0	2502	88.8	97.7	49.0	43.6	39.6	65.5	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	mg/L	0.03	10	18.8	0.208	0.03	-0.03	-0.03	20.20	8.44	2.20	0.46	<0.03	<0.03	2.12	<0.03	0.17	0.19
Nitrite-N	mg/L	0.01	1	0.0	0.014	0.01	<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 as N	mg/L	0.50	NE	0.14	11.5	11.9	13.7	9.34	0.34	0.16	0.55	0.80	10.30	7.39	7.18	11.1	4.89	4.96
VOCs	µg/L	0.5	0.5															
1,4-dioxane	µg/L	0.25	0.3 <sup>3</sup>	<0.25	1.84	2.05	NS	<0.25	<0.25	NS	NS	NS	NS	NS	NS	NS	NS	NS
NA = not applicable																		
ND = not detected																		
NE = not established																		
NTU = Nephelometric turbidity units																		
µg/L = microgram per liter																		
µmho/cm = micromho per centimeter																		
MRL = Minimum Reporting Limit																		
1Mass. Maximum Contaminant Level																		
2Mass. Secondary Maximum Contaminant Level																		
3Mass. DEP Office Research and Standards Goal																		

The mound height within the wick is dependent on several factors: the loading rate, the permeability of the artificial-gravel pack within the wick, the permeability of the surrounding soils, and the amount of surface area between the wick and the surrounding soils per foot of wick. In the full scale wick, the permeability of the artificial-gravel pack will be great enough that the pack's impact on mounding is negligible. This will leave the loading rate, the permeability of the surrounding soils and the surface area of the wick as the primary factors in wick mounding. A larger diameter wick, which creates more surface area with the formation per foot of wick, will also produce less mounding.

Using the test wick as an example, at a discharge rate of 88 gpm (126,000 gpd) a wick efficiency of 3,000 gpd/ft of wick mounding was calculated (Table 12). Using this wick efficiency and assuming that the formation above the wick mound has the same permeability, the 1-foot diameter test wick could potentially discharge 300,000 gpd or 3,000 gpd/ft times 100 feet.

**TABLE 12  
SUMMARY OF ESTIMATED WICK MOUNDING**

Discharge Rate	Estimated Wick Mound					
	1-foot Diameter Test Wick Wick Surface Area (314 sqft/ft)			3-foot Diameter Final Wick Wick Surface Area (942 sqft/ft)		
	Wick Efficiency (gpd/ft)	Mound Height	Depth to Mound*	Wick Efficiency (gpd/ft)	Mound Height	Depth to Mound*
150,000	3,000	50	50	9,000	17	83
200,000	3,000	67	33	9,000	22	78
350,000	3,000	117	-17	9,000	39	61
400,000	3,000	133	-33	9,000	44	56
450,000	3,000	150	-50	9,000	50	50
500,000	3,000	167	-67	9,000	56	44

To estimate wick mounding and the potential discharge capacity of a larger diameter wick, the efficiency of the test wick (3,000 gpd/ft) was multiplied by the increase in the surface area per foot between the test and full scale wick. For example, if the wick diameter is increased from 1 to 3 feet, the surface area between the wick and surrounding formation would increase by a factor of 3. Assuming the same formation and infiltration rate, the wick efficiency should also increase by a factor of three. Using the test wick location as an example, the wick efficiency of the 1-foot diameter test wick was 3,000 gpd/ft, if a 3-foot diameter wick were installed at the same location the wick efficiency should increase to approximately 9,000 gpd. Therefore, a 100-foot deep 3-foot diameter wick installed at the same location as the test wick, should discharge approximately 500,000 gpd with a wick mound height of approximately 56 feet (Table 12). This would place the top of the mound approximately 44 feet below the ground surface at the test wick site.

Based on soil borings drilled at 32 and 43 Lots Hollow Road, the subsurface soils appear to be fairly uniform across the sites. However, variations in soil conditions and in the assumptions outlined above will lead to wick efficiencies differing at each wick location. To account for these variations, a borehole will be installed at each proposed wick location to collect soil samples. Each full scale wick will also be load tested once installed to verify the wick efficiency and discharge capacity of each wick.

The anticipated discharge from the WWTF from the Downtown Area is not expected to exceed 150,000 gpd initially and 250,000 gpd at build-out. The WWTF flow could increase to 350,000 gpd if flow from the Meetinghouse Pond Area is tied into the WWTF. . Mound heights at these flows at wick efficiency of 9,000 gpd/ft are summarized in Table 12.

At this time, it is anticipated that three to four wicks will initially be installed at 32 Lots Hollow Road. Each wick will be designed to discharge between 350,000 and 500,000 gpd at a minimum. Once installed, each wick will be load tested using potable water to evaluate wick mounding, wick efficiency, and wick capacity. Details of the wick design and testing will be submitted with the WWTF design.

## **5. GROUNDWATER MODELING EVALUATION**

Groundwater modeling was performed by AECOM as a part of the evaluation of disposal options to provide feedback on potential designs; this feedback can then be used to help make design decisions. Specifically for this project, numerical groundwater flow modeling was used by AECOM to predict changes in groundwater elevations and flow directions based on the volume of discharge.

More specifically, the purpose of the groundwater modeling was to: (1) evaluate the potential impacts of the groundwater discharge on ambient groundwater flow and water levels; (2) evaluate where the effluent originating from the discharge at 32 and 43 Lots Hollow Road site discharges; and (3) estimate the nitrate load discharging to each watershed.

### **5.1. Modeling Method**

A regional three-dimensional groundwater flow model of the Monomoy Lens was developed by the USGS as a tool for understanding the groundwater flow system and water budget in this region of Cape Cod (USGS, 2004). This regional groundwater flow model formed the basis of the model modified by AECOM for the purpose of performing groundwater discharge simulations.

MODFLOW was used by AECOM for this analysis (MacDonald and Harbaugh, 1988). The three-dimensional groundwater flow model was coupled with a particle tracking model called MODPATH (Pollack, 2004) in order to illustrate the potential movement of groundwater over time. Both of these models were used on the GMS platform, Version 10.3.

### **5.2. Conceptual Model of the Aquifer System**

A conceptual site model (CSM) of a groundwater flow system is a representation of how an aquifer functions based on available data. Geologic maps and cross-sections, groundwater flow maps, and the generalized water balance (the volume of water entering and leaving the aquifer) are common elements of a conceptual aquifer model. AECOM's understanding of how the regional groundwater flow system functions is based on the geological and hydrological data presented in Sections 3.0 and 4.0; additionally the CSM is based on the work done and reported on by the USGS (2004).

The CSM for hydrogeology and groundwater flow in the Monomoy Lens is well documented in the USGS (2004) report. Overall, the CSM documented in the USGS (2004) report is the same as is used for AECOM's modeling effort. However, AECOM's investigation of the 32 and 43 Lots Hollow Road site completed in March 2018 was used to compare actual site conditions to the USGS's CSM. AECOM's work included new wells and hydraulic testing of the aquifer to estimate the aquifer's hydraulic conductivity (K) in the vicinity of the Lots Hollow Sites. These results of the investigation and data analysis are discussed in Sections 3.0 and 4.0 of this document.

In general, the aquifer in the Town of Orleans is a water table aquifer composed of sand with varying amounts of silt and trace amounts of gravel. The bottom of the aquifer is assumed to coincide with the bottom of the numerical model, around 350 feet elevation below sea level.

According to the USGS's CSM, water enters the aquifer system primarily in the form of rainfall recharge. Groundwater then leaves the aquifer system through surface water features, such as lakes, streams, wetlands, estuaries, marshes, and the ocean. A small portion is withdrawn from the aquifer through public and private water-supply wells.

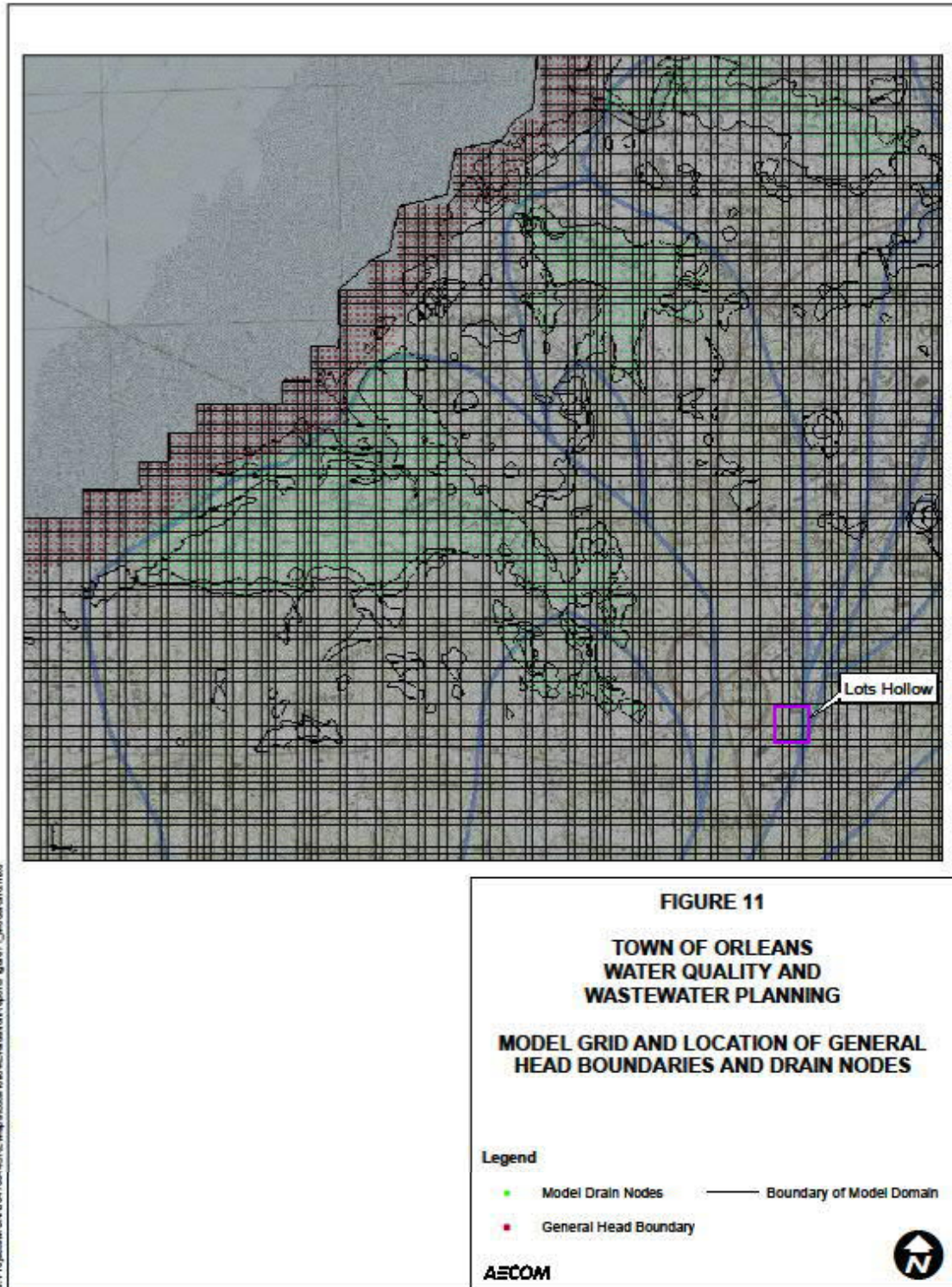
### **5.3. Model Design and Updates**

AECOM's numerical groundwater flow modeling was completed using the USGS numerical groundwater flow model of the Monomoy Lens as a basis. This model is documented in "Simulated Water Sources and Effects of Pumping on Surface and Ground Water, Sagamore and Monomoy Flow Lenses, Cape Cod, Massachusetts" (USGS, 2005). Modeling files were received from the USGS and were imported by AECOM into the GMS 10.3 platform. GMS is a pre- and post-processor for MODFLOW-2000 that facilitates data input, and depiction and interpretation of output.

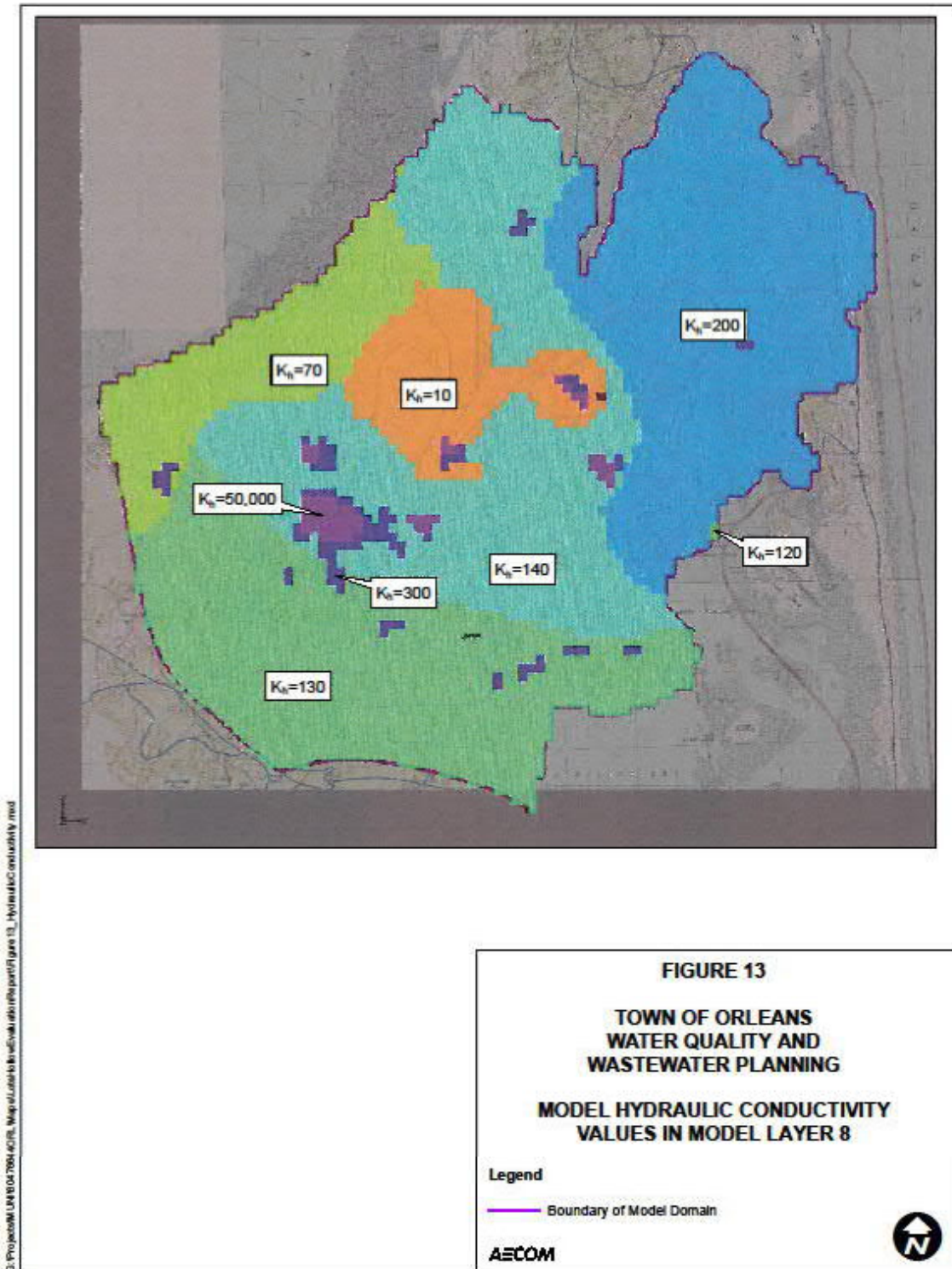
### 5.3.1. Model design

The model prepared by the USGS, and modified by AECOM, is structured as follows:

- The USGS model runs as a steady-state model, which incorporates long-term average conditions.
- The USGS model domain includes the entire Monomoy Lens. A map of this domain is included in Appendix 1 (USGS, 2004) Figure 1-1A. The model domain updated by AECOM is bounded primarily by surface water features (streams, marshes, inlets, estuaries, and ocean). AECOM adjusted the southwestern limit of the model domain from the full regional model; a no-flow boundary was assigned there to coincide with the groundwater divide.
- The original USGS model and AECOM modified model are both 20 layers. In this area of the Monomoy Lens, the groundwater table is low enough such that many of the upper layers go dry. The uppermost layer that is wet over the entire model domain is layer 8. The bottom of the USGS and AECOM's updated model domain ranges from approximately 300 to 400 feet below sea level. With the exception of the lowest model layer, the model layers are uniform thickness across the model domain, see Appendix 1 (USGS, 2004) Figure 1-1B.
- AECOM changed the model grid from 400 by 400 foot nodes to 100 by 100 foot nodes across the model domain (Figure 11). Drain nodes and boundary conditions are shown on Figure 11.
- USGS assigned rainfall recharge using a variable array for the model domain. The USGS rainfall recharge rate ranges from 0 to 33.7 in/year, with a model wide average of 22.9 inches per year. Lesser rates or zero rainfall recharge rates were assigned to wetlands, open water, and/or oceans. Figure 12 shows rainfall recharge distribution across the model domain. In the calibration process, AECOM increased the recharge, discussed in section 5.3.2.
- USGS simulated surface-water features in a variety of ways:
  - Streams, wetlands, marshes, estuaries and other drainages features were simulated using the drain (DRN) package.
  - The Atlantic Ocean and Cape Cod Bay were simulated with a general head boundary (GHB).
  - Lakes were simulated with horizontal flow boundaries (HFB) and high hydraulic conductivity.
  - The USGS model included using the stream (STR) package for some surface water drainages, but when the model domain was made smaller, those features were outside of the new domain and therefore excluded. For that reason, AECOM's model does not use the stream package.
- Hydraulic conductivity values used in the USGS model range from 10 ft/day for sandy silts to 300 ft/day for sand and gravel deposits. The distributions of horizontal hydraulic conductivity values ( $k_h$ ) in ft/day for layer 8 (the layer representing the water table aquifer) in the USGS model are shown in Figure 13. High hydraulic conductivities (50,000 ft/day) were used for lakes. AECOM's recent site investigations completed at the 32 and 43 Lots Hollow Road site indicated that the soils were fine- to coarse-grained sediments, resulting in hydraulic conductivity values ranging from 2 to 86 ft/day for the sandy soils underlying the site. The average conductivity also decreased with depth. These values were consistent with the USGS model for these areas; therefore AECOM made no changes to horizontal or vertical hydraulic conductivity in the model.







- The original USGS model included groundwater extraction consistent with water usage from production wells using the well (WEL) package. Extraction rates are summarized in Appendix 1 of the USGS (2004) report Table 1-3. Most simulations of discharge were completed with 2002 pumping rates. One simulation used USGS estimated future 2020 pumping rates (Walter & Whealan, 2005) to evaluate changes to flow originating from the landfill given future water usage. AECOM simulated wastewater discharge by adding recharge in select cells within the model at the locations of 32 and 43 Lots Hollow Road. This is discussed in the Model Simulations section below.

### 5.3.2. AECOM Model Updates

AECOM made a number of changes to the model to meet model objectives. They are as follows:

- AECOM converted the solver package to the PCG2 package from the LMG (Link Multi-Grid) package based on a recommendation from the USGS in the model documentation that accompanied the model files (“...due to licensing restrictions, the USGS is no longer able to publicly distribute the Algebraic Multi-Grid (AMG) solver, on which the Link-AMG (LMG) Package relies. There are two possible solutions: 1) use a standard solver publicly available from USGS, such as SIP or PCG2 or 2) obtain the AMG/LMG solver from Fraunhofer-Institute for Algorithms and Scientific Computing (SCAI).”).
- AECOM converted the USGS model grid from 400 by 400-foot to 100 by 100-foot cells over the entire domain. This was completed to provide better resolution on the model inputs (i.e., discharge areas) and outputs.
- In refining the grid, AECOM updated some model features:
  - Drain cell conductances were adjusted to reflect the new dimensions of the grid cells.
  - General Head boundary conductances were adjusted to reflect the new dimensions of the grid cells.
  - Horizontal flow barrier segments were added as needed to surround the ponds/lakes in the model domain.

Figure 11 shows a portion of AECOM’s updated model grid, general head boundaries and drain nodes. The distribution of recharge is shown in Figure 12. The hydraulic conductivity values used by the USGS and AECOM are shown in Figure 13.

After AECOM made the changes above, the model was verified to be a good representation of the original USGS model in the following ways:

- A comparison of steady-state groundwater elevations was made in select cells/areas to demonstrate that AECOM’s new version of the model-predicted groundwater elevations similar to those predicted by the USGS model. Generally, the differences were less than 0.5 feet and lower in many instances. There are a handful of cells where AECOM model predictions exceed USGS-model predictions by more than 1 foot, but these are far from the areas of interest and so should not impact model predictions.
- A comparison of groundwater flow directions was made using particle tracking. Particles were seeded in select areas to verify that AECOM’s groundwater flow paths and divides are similar to those mapped by the USGS. In general, the AECOM version of the model was the same or similar to the particle tracking under ambient conditions from the USGS version of the model.

- AECOM made a comparison of mass balance generated by the two models. Specifically, recharge, well, general head boundary, drain boundary volumes were compared to verify that the water balances were the same or similar to the USGS model. Table 13 summarizes the comparison. The percent differences on the water budget components are very small; most differences can be attributed, in part, to the regriding and resulting changes to conductances of the drain and general head boundaries.
- The change in the model solver (from LMG to PCG2) may also have resulted in a slightly different solution.

In summary, AECOM made a number of changes to the original USGS model domain and structure to better meet the project objectives. Despite the changes, the AECOM model replicated the USGS output adequately; differences can be explained and are not expected to impact model predictions. Overall, AECOM considers this model a good tool to complete a preliminary evaluation of effluent disposal scenarios at the Lots Hollow Road Sites.

#### 5.4. Model Calibration

USGS calibrated the full Monomoy Lens model and this process is described in Appendix 1 of the USGS report (2004). In accordance with our scope, AECOM verified that the calibration was maintained after the domain and grid were updated as discussed above. In summary:

- Simulated groundwater elevations from the USGS model compared favorably to the simulated groundwater elevations generated in the AECOM model.
- Simulated groundwater flow paths from the USGS model compared favorably to the simulated groundwater flow paths generated in the AECOM model.
- The water budget of the USGS model (for the area of interest) compared favorably with the water budget for the AECOM model.

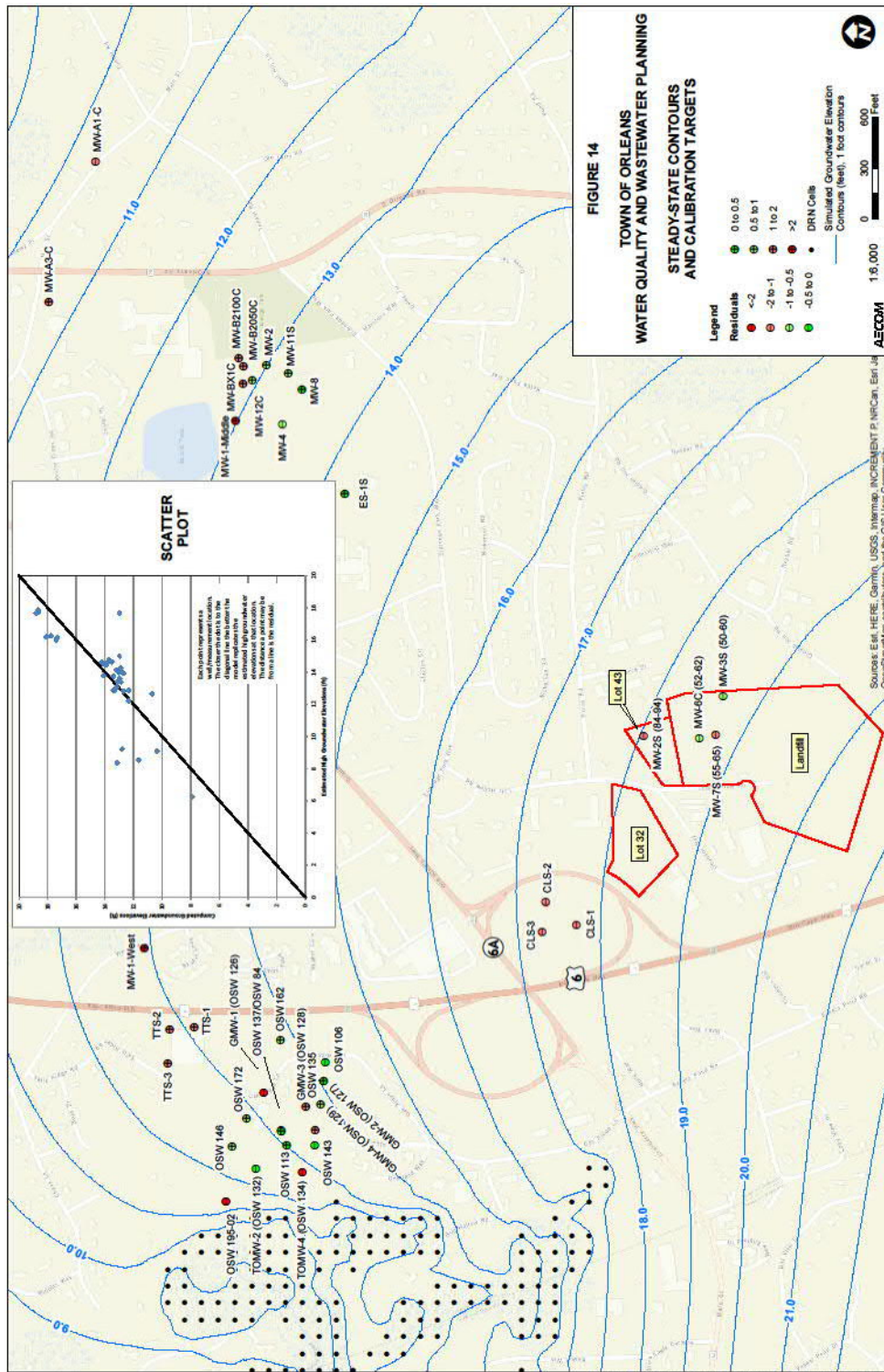
Regionally, the updated model was able to reproduce the results from the original USGS model very closely.

On April 25, 2017, AECOM measured groundwater levels at numerous wells in Orleans. An estimate of high groundwater levels across the town was made based on the differences between the high and April 2017 groundwater levels at OSW-22. In this case, the historic high groundwater level at OSW-22 was 1.8 feet higher than that observed by AECOM on April 25, 2017. The estimated high groundwater elevations (measured plus adjusted based on OSW-22) were higher than the simulated groundwater levels at the target locations predicted by the model. Therefore, the model was further calibrated to better simulate the estimated high water table conditions.

To achieve this, numerous model runs were performed, varying several parameters, including rainfall recharge, hydraulic conductivity values, the drain node elevation, and the drain node elevations. As a result of the calibration process, the following changes were made:

- Rainfall recharge was increased by 25 percent across the model grid. Overall, the USGS average rainfall recharge rate of 22.9 inches was increased to 28.6 inches;
- The location of the Namskaket Creek drain nodes, were changed to better simulate the geometry of the marsh boundary; and,
- The Namskaket Creek drain node elevations and conductivity values were made consistent.

At the conclusion of the calibration process, the model was considered a good tool for conducting predictive simulations. The AECOM simulated groundwater elevations compared favorably to our estimates for high groundwater elevation conditions. The results of the calibrated steady-state model output for Layer 8 are shown in Figure 14. Table 14 summarizes the estimated high water table and model-simulated elevations



**TABLE 13  
COMPARISON OF MASS BALANCE**

	Subset of USGS Regional Model <sup>1</sup>	AECOM (Updated) Model <sup>2</sup>	Difference	Percent Difference from Original
<b>IN (ft<sup>3</sup>/day):</b>				
<b>CONSTANT HEAD</b>	0.00	0.00		
<b>WELLS</b>	0.00	0.00		
<b>DRAINS</b>	0.00	0.00		
<b>GENERAL HEAD</b>	0.00	0.00		
<b>RECHARGE</b>	3,899,661.85	3,906,112.50	-6,450.64	-0.17%
<b>STREAM LEAKAGE</b>	0.00	NA		
<b>Zone 1 to zone 2</b>	192,978.09	0.00	192,978.09	
<b>Total IN</b>	4,092,639.94	3,906,112.50	186,527.44	
<b>OUT (ft<sup>3</sup>/day):</b>				
<b>CONSTANT HEAD</b>	0.00	0.00		
<b>WELLS</b>	239,703.00	239,703.00	0.00	
<b>DRAINS</b>	2,137,289.64	2,152,853.94	-15,564.31	-0.73%
<b>GENERAL HEAD</b>	1,472,953.97	1,513,555.55	-40,601.58	-2.76%
<b>RECHARGE</b>	0.00	0.00		
<b>STREAM LEAKAGE</b>	0.00	NA		

Notes:

- 1 - Using Zonebudget, calculated based on approximate same domain as the Updated Model
- 2 - Using Zonebudget.

**TABLE 14  
COMPARISON OF HIGH WATER TABLE CONDITIONS**

Location	Estimated High Groundwater Elevations (feet)	Simulated Groundwater Elevations (feet)	Residuals (feet)	Average Residual
MW-2S (84-94)-Shallow	16.21	18.10	-1.89	-0.007
MW-3S (50-60)-Shallow	17.72	18.68	-0.96	
MW-6C (52-62) -Shallow	17.87	18.66	-0.79	
MW-7S (55-65)-Shallow	17.68	18.81	-1.13	
MW-1-Middle-Shallow	15.01	12.99	2.02	
MW-2-Shallow	13.99	12.99	1.00	
MW-4-Shallow	12.84	13.41	-0.57	
MW-8-Shallow	13.74	13.41	0.33	
MW-11S-Shallow	14.13	13.21	0.92	
MW-12C-Shallow	13.6	12.95	0.65	
MW-B2050C-Shallow	14.02	12.81	1.21	
MW-BX1C-Shallow	14.24	12.89	1.35	
MW-B2100C-Shallow	13.98	12.73	1.25	
ES-1S-Shallow	14.62	14.24	0.38	
CLS-1-Shallow	16.27	17.76	-1.49	
CLS-2-Shallow	16.02	17.40	-1.38	
CLS-3-Shallow	16.13	17.34	-1.21	
TTS-1-Shallow	14.14	13.13	1.01	
TTS-2-Shallow	14.26	12.91	1.35	
TTS-3-Shallow	13.94	12.69	1.25	
OSW 137-Shallow	13.08	13.19	-0.11	
OSW 84-	13.41	13.08	0.33	
OSW 135-Shallow	14.64	13.49	1.15	
OSW 146-Shallow	12.85	12.34	0.51	
OSW 143-Shallow	12.85	13.31	-0.46	
OSW 162-Shallow	8.35	13.31	-4.96	
OSW 172-Shallow	13.4	12.89	0.51	
OSW 113-Shallow	12.82	12.7	0.12	
OSW 106-Shallow	13.8	14.09	-0.29	
OSW 195-02-Shallow	8.53	11.63	-3.10	
OSW 132-Shallow	12.22	12.36	-0.14	
OSW 134-Shallow	9.23	12.79	-3.56	
GMW-2 (OSW 127)-Shallow	14.56	14.12	0.44	
GMW-3 (OSW 128)-Shallow	14.77	13.72	1.05	
GMW-4 (OSW 129)-Shallow	14.45	13.91	0.54	
OSW 126-Shallow	14.52	13.88	0.64	
MW-1-West-Shallow	17.67	12.98	4.69	
MW-A1-C-Shallow	9.09	10.35	-1.26	
MW-A3-C-Shallow	12.64	10.70	1.94	
OSW-22-Shallow	6.26	7.88	-1.62	

The model generated contours shown on Figure 14 represent high water table conditions across the area of interest. The monitoring well locations shown on the figure are where water level data was collected on April 25, 2017 and high water table conditions were estimated. The residuals (Table 14) are the calculated difference between the model-simulated and the estimated high water table condition at each monitoring well location.

Well locations where the model-predicted water-table elevation is within 0.5 feet of the estimated high water-table elevation is indicated by dark green. Lighter green symbols indicate that the simulated water-table elevation is between 0.5 and on 1.0 feet of the calculated high water-table. Light and dark red symbols represent locations where the residual is between 1.0 and 2.0 feet, and is greater than 2.0 feet, respectively. Monitoring-well symbols with a "+" are locations where the model-simulated water-table elevation is higher than the estimate water-table conditions for that site. A negative ("-") indicate that the simulated water-table is lower than the estimated high water-table elevation.

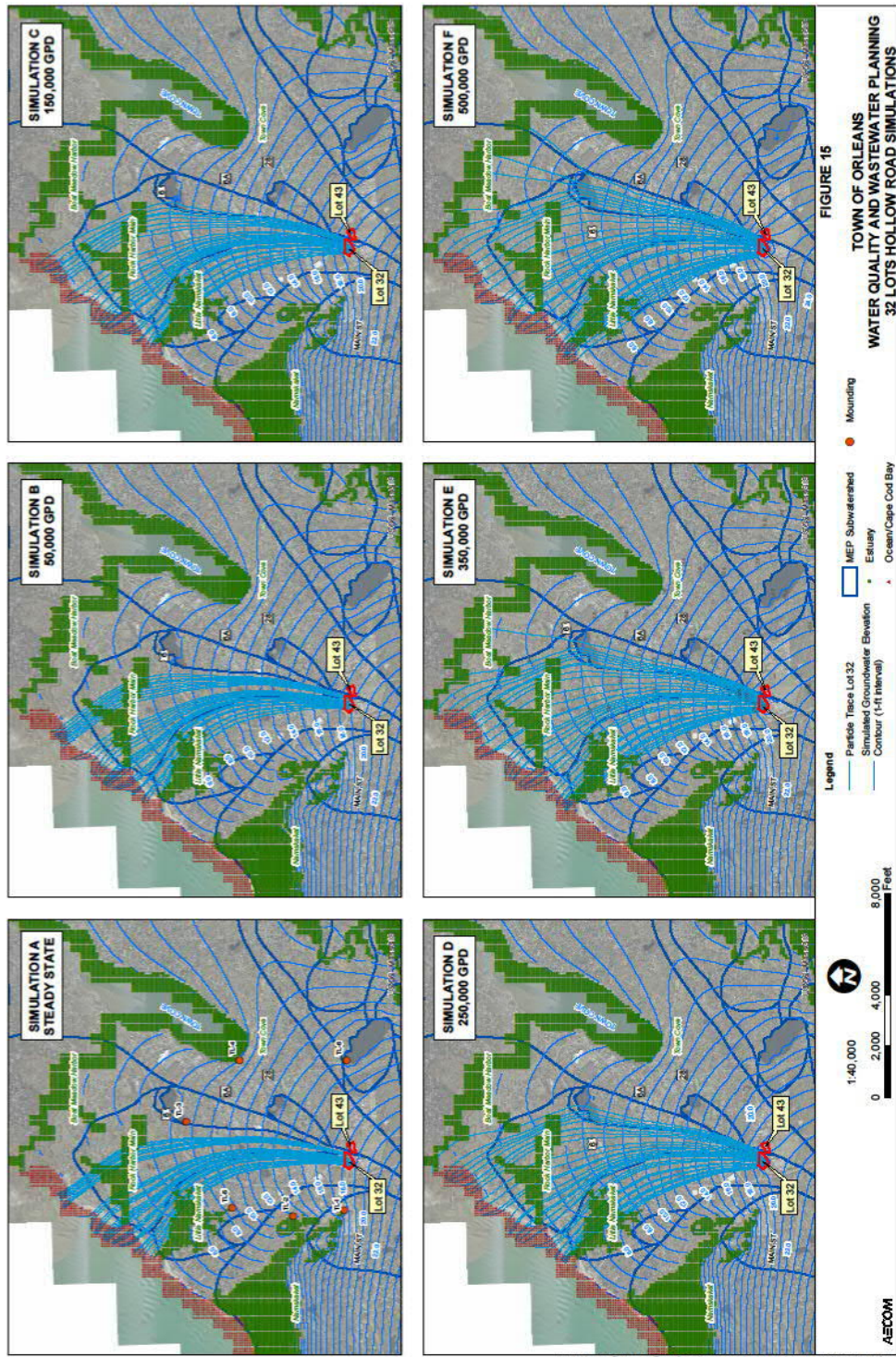
Also shown on Figure 14 is a graph plotting model-simulated and estimated high water-table elevations at each monitoring well location. The residual at each location is the distance between the diagonal line and point plotted. The closer the point to the diagonal line, the lower the residual and the closer the model is simulating the AECOM estimated high water-table conditions. As indicated by the scatter plot, the points are fairly evenly distributed above and below the diagonal line and the residuals are also relatively close to the line. Both indicate that the model is reasonably well calibrated to the estimated high water-table conditions.

## **5.5. Predictive Simulations**

AECOM's calibrated groundwater flow model was used to simulate fifteen discharge scenarios to predict groundwater mounding and the flow of groundwater (particle tracking) from the discharge sites. The 32 Lots Hollow Road site has been designated the primary discharge area by the Town while 43 Lots Hollow Road has been designated a reserve discharge area. Model scenarios were performed simulating a groundwater discharge at 32 Lots Hollow Road only, 43 Lots Hollow Road only, and the with the discharge taking place over both sites. Five discharge volumes (50,000 gpd, 150,000 gpd, 250,000 gpd, 350,000 gpd, and 500,000 gpd) were simulated and compared to a zero discharge scenario (base case).

### **5.5.1. 32 Lots Hollow Road Groundwater Discharge**

Figure 15 compares the no-discharge (base case) simulated groundwater flow contours and particle pathlines with five scenarios at increasing groundwater discharge rates at 32 Lots Hollow Road. A close inspection of groundwater contours indicates that as the discharge rate increases a mound develops. The estimated maximum mound height under 32 Lots Hollow Road at various flow rates is provided in Table 15. The mound heights are all sufficiently low so as to keep the required separation between the groundwater mound under high water-table conditions and the land surface of the groundwater discharge.



**TABLE 15**  
**ESTIMATED SITE GROUNDWATER MOUND – 32 LOTS HOLLOW ROAD**

32 Lots Hollow Road Discharge (gpd)	32 Lots Hollow Road Maximum Simulated Mound (ft)
0	--
50,000	0.98
150,000	2.82
250,000	4.41
350,000	5.86
500,000	7.86

Groundwater mounding at several additional locations (TL-1, TL-2, TL-3, TL-4, TL-5, and TL-6) were also noted (Simulation A, Figure 15). Table 16 summarizes the model estimated groundwater mounding at each location.

**TABLE 16**  
**ESTIMATED REGIONAL GROUNDWATER MOUND – 32 LOTS HOLLOW ROAD**

Discharge (gpd)	Watershed (mounding in feet)					
	Namskaket (TL-1)	Namskaket (TL-2)	Cedar Pond (TL-3)	Town Cove (TL-4)	Little Namskaket (TL-5)	Crystal Lake (TL-6)
150,000	0.303	0.191	0.094	0.066	0.082	0.150
250,000	0.504	0.319	0.157	0.110	0.136	0.250
350,000	0.705	0.446	0.220	0.155	0.190	0.350
500,000	1.007	0.637	0.315	0.221	0.272	0.499

Particle tracks were started at the same cells where the discharge was simulated; MODPATH then simulated the particle trajectories (pathlines) until they end at a discharge point (estuary (drain) or ocean/Cape Cod Bay (general head boundary)). As the discharge rates increase the particles tend to spread out. The trajectories are three-dimensional and a significant part of their near-discharge trajectory is downward, deep into the aquifer, followed by horizontal movement, followed by upward flow to discharge points. The flow downward, through deep layers of the aquifer and then back to the surface, results in relatively long travel times. Table 17 summarizes the minimum, maximum, range, and average travel times for particles from 32 Lots Hollow Road to the discharge point (estuary, Cape Cod Bay).

**TABLE 17**  
**ESTIMATED TRAVEL TIME – 32 LOTS HOLLOW ROAD**

Discharge (gpd)	Travel Time (years) to Discharge Boundary			
	Minimum	Maximum	Range	Average
0	65	144	79	114
50,000	60	290	230	129
150,000	60	401	341	155
250,000	61	337	277	157
350,000	64	477	413	186
500,000	77	910	833	262

Figure 16 shows an oblique view of the particle pathlines originating from 32 Lots Hollow Road under the 500,000 gpd discharge scenario. Based on the particle pathlines, discharge of the effluent is predominantly to Cape Cod Bay with a lesser component of discharge to estuaries.

Table 18 compares the water budget with different discharge scenarios to the base case. This table demonstrates that as the discharge rate increases so does the relative discharge to each of the watersheds.

**TABLE 18**  
**ESTIMATED FRESH WATER FLOW TO WATERSHEDS – 32 LOTS HOLLOW ROAD**

Watershed	Discharge (gpd)					
	0	50,000	150,000	250,000	350,000	500,000
<b>Namskaket Creek</b>	572,161	574,345	578,714	583,075	587,439	594,004
Difference		2,185	6,553	10,914	15,278	21,843
Percent change		0.4	1.1	1.9	2.7	3.8
<b>Little Namskaket Creek</b>	86,230	86,673	87,562	88,449	89,338	90,675
Difference		444	1,332	2,219	3,109	4,445
Percent change		0.5	1.5	2.6	3.6	5.2
<b>Rock Harbor</b>	93,543	93,812	94,350	94,887	95,426	96,234
Difference		269	807	1,344	1,883	2,691
Percent change		0.3	0.9	1.4	2.0	2.9
<b>Boat Meadow River</b>	102,240	102,545	103,153	103,759	104,368	105,283
Difference		304	912	1,519	2,128	3,042
Percent change		0.3	0.9	1.5	2.1	3.0
<b>Town Cove</b>	486,482	487,583	489,787	491,986	494,189	497,496
Difference		1,102	3,305	5,504	7,707	11,014
Percent change		0.2	0.7	1.1	1.6	2.3
<b>Other</b>	1,321,133	1,323,169	1,327,250	1,331,327	1,335,407	1,341,536
Difference		2,037	6,117	10,194	14,274	20,404
Percent change		0.2	0.5	0.8	1.1	1.5
<b>Cape Cod Bay</b>	933,856	934,986	937,235	939,513	941,770	945,135
Difference		1,130	3,379	5,656	7,913	11,279
Percent change		0.1	0.4	0.6	0.8	1.2
<b>Pleasant Bay</b>	970,763	971,721	973,650	975,570	977,493	980,387
Difference		958.4	2,887.4	4,807.3	6,730.5	9,624.7
Percent change		0.1	0.3	0.5	0.7	1.0

Finally, based on the flow field generated with each discharge scenario, MT3D, a fate and transport model was run to make a prediction of nitrate loading to each discharge boundary. For each fate and transport simulation, nitrate was assumed to be discharged at a concentration of 10 mg/L from 32 Lots Hollow Road and the simulation was run for 40,000 days or just under 110 years. Nitrate was assumed to be a conservative element, meaning there was no retardation or degradation. Longitudinal dispersion was set to 10.

In order to calculate the flow to each of the boundaries, AECOM used the USGS “flow budget” tool included in the GMS pre and post processor. This tool reports on the flow in and out of selected cells and boundary conditions. For example, AECOM selected a set of cells that represent Namskaket Creek and the flow budget tool reported the flow through those drain cells. This was completed separately for the drain cells representing Little Namskaket and Rock Harbor. Flow through the general head boundary cells, representing Cape Cod flow into Cape Cod Bay, was similarly used using the flow budget tool.

Table 19 summarizes the nitrate load to each estuary or Cape Cod Bay under different discharge scenarios. Based on the travel times predicted by the particle pathlines, the simulation time of 40,000 days may not have been sufficient to reach steady state conditions. As a result, the mass load estimates maybe be underestimates. However the results do indicate the relative increase in load for the different discharge scenarios.

**TABLE 19  
ESTIMATED NITRATE LOAD TO WATERSHEDS – 32 LOTS HOLLOW ROAD**

		50,000	150,000	250,000	350,000	500,000
<b>Estimated Nitrate Load (kg/year)</b>	Discharge (gpd)	50,000	150,000	250,000	350,000	500,000
	Cape Cod Bay	298	853	1,499	2,099	2,809
	Namskaket Creek	0	0	48	235	808
	Little Namskaket Creek	217	565	765	898	1,047
	Rock Harbor	114	233	300	355	422
	Boat Meadow River	1	7	16	26	47
	Town Cove	0	91	438	1,018	2,112
	Other*	0	0	0	0	0
	<b>Total Nitrate Load</b>	<b>630</b>	<b>1,749</b>	<b>3,066</b>	<b>4,631</b>	<b>7,245</b>
	<b>Nitrate Load Summary</b>	Nitrate Load to Cape Cod Bay	47%	49%	49%	45%
Nitrate Load to an Estuary		48%	39%	31%	26%	22%
Nitrate Load to Town Cove		0%	5%	14%	22%	29%

Notes:

- The model simulations were run to 40,000 days under steady-state conditions.
- \* Atlantic Ocean, Pleasant Bay, and other surface waters not included above.

**5.5.2. 43 Lots Hollow Road Groundwater Discharge**

Similar to Figure 15, Figure 17 shows the groundwater contours and particle pathlines for different discharge scenarios for 43 Lots Hollow Road. The mound heights are shown in Table 20 and are sufficiently low that there is enough separation to the land surface.

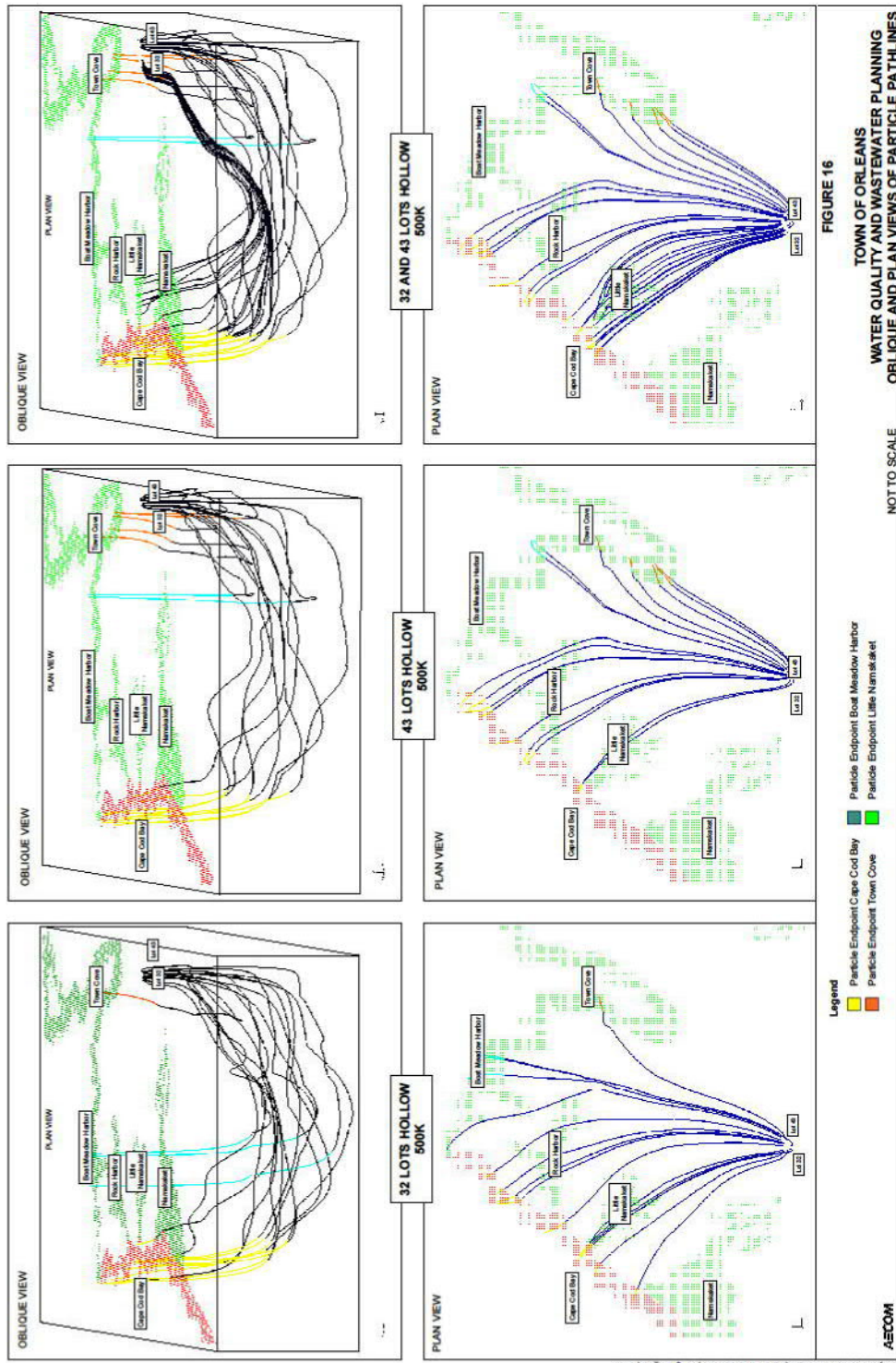
**TABLE 20  
ESTIMATED SITE GROUNDWATER MOUND – 43 LOTS HOLLOW ROAD**

<b>43 Lots Hollow Road Discharge (gpd)</b>	<b>43 Lots Hollow Road Maximum Simulated Mound (ft)</b>
<b>0</b>	--
<b>50,000</b>	1.03
<b>150,000</b>	2.95
<b>250,000</b>	4.60
<b>350,000</b>	6.11
<b>500,000</b>	8.20

Mounding was also observed at the far-afield locations shown on Figure 17. Table 21 summarizes the mounding at a number of locations.

**TABLE 21  
ESTIMATED REGIONAL GROUNDWATER MOUND – 43 LOTS HOLLOW ROAD**

<b>Discharge (gpd)</b>	<b>Watershed (mounding in feet)</b>					
	<b>Namskaket (TL-1)</b>	<b>Namskaket (TL-2)</b>	<b>Cedar Pond (TL-3)</b>	<b>Town Cove (TL-4)</b>	<b>Little Namskaket (TL-5)</b>	<b>Crystal Lake (TL-6)</b>
<b>150,000</b>	0.258	0.171	0.067	0.087	0.090	0.168
<b>250,000</b>	0.430	0.285	0.112	0.144	0.150	0.280
<b>350,000</b>	0.602	0.399	0.157	0.202	0.209	0.392
<b>500,000</b>	0.860	0.57	0.224	0.289	0.299	0.559



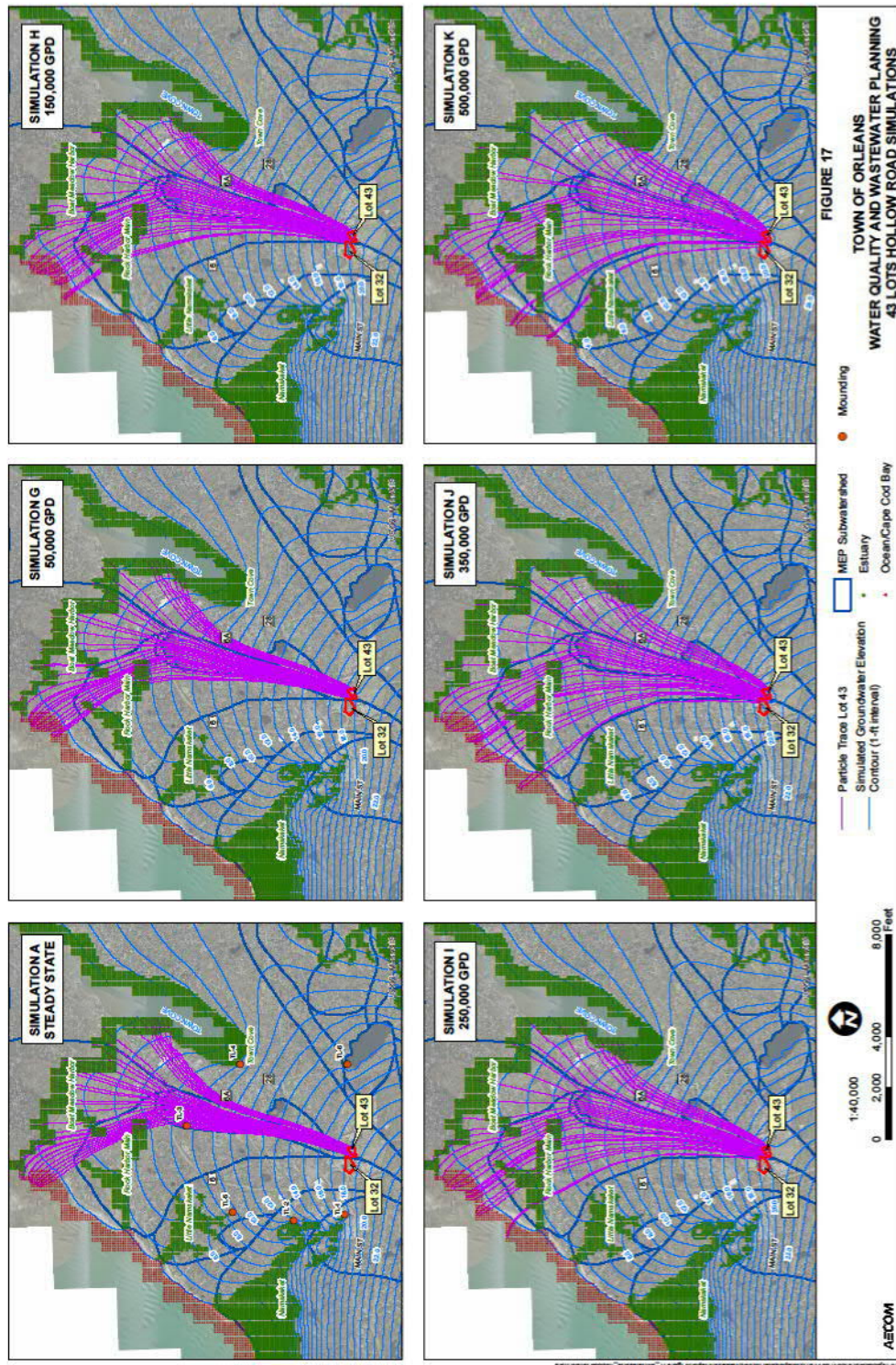


Table 22 summarizes the minimum, maximum, range, and average travel times for particles to travel between 43 Lots Hollow Road and the discharge point (estuary, Cape Cod Bay).

**TABLE 22  
ESTIMATED TRAVEL TIME – 43 LOTS HOLLOW ROAD**

Discharge (gpd)	Travel Time (years) to Discharge Boundary			
	Minimum	Maximum	Range	Average
0	90	368	278	196
50,000	54	322	268	167
150,000	45	756	711	190
250,000	44	1,005	961	200
350,000	41	1,010	969	213
500,000	40	894	854	220

Figure 16 shows an oblique view of the particle pathlines originating from 43 Lots Hollow Road under the 500,000 gpd discharge scenario. Based on the particle pathlines, discharge is predominantly to Cape Cod Bay with a lesser component of discharge to estuaries. Table 23 compares the water budget with different discharge scenarios to the base case. This table demonstrates that as the discharge rate increases so does the relative discharge to each of the watersheds.

Finally, based on the flow field generated with each discharge scenario, MT3D, a fate and transport model was run to make a prediction of nitrate loading to each watershed.

Table 24 summarizes the nitrate load to each watershed under different discharge scenarios. Similar to above the transport simulations were set to around 110 years which is less time than it takes for all the particles to reach a discharge boundary. For that reason the nitrate loadings may be slight under-estimates, however are sufficient to understand the relative differences in loading rates for different discharge scenarios.

**TABLE 23**  
**ESTIMATED FRESH WATER FLOW TO WATERSHEDS – 43 LOTS HOLLOW ROAD**

Watershed	Discharge (gpd)					
	0	50,000	150,000	250,000	350,000	500,000
Namskaket Creek	572,161	574,120	578,032	581,951	587,822	591,737
Difference		1,959	5,871	9,790	15,661	19,576
Percent change		0.3	1.0	1.7	2.7	3.4
Little Namskaket Creek	86,230	86,658	87,515	88,372	89,659	90,518
Difference		428	1,286	2,142	3,430	4,288
Percent change		0.5	1.5	2.5	4.0	5.0
Rock Harbor	93,543	93,812	94,352	94,890	95,698	96,236
Difference		269	809	1,347	2,155	2,693
Percent change		0.3	0.9	1.4	2.3	2.9
Boat Meadow River	102,240	102,550	103,169	103,786	104,714	105,332
Difference		309	928	1,546	2,474	3,092
Percent change		0.3	0.9	1.5	2.4	3.0
Town Cove	486,482	487,656	490,004	492,350	495,871	498,219
Difference		1,174	3,522	5,869	9,389	11,738
Percent change		0.2	0.7	1.2	1.9	2.4
Other	1,321,133	1,323,353	1,327,798	1,332,247	1,336,693	1,343,373
Difference		2,220	6,665	11,115	15,560	22,241
Percent change		0.2	0.5	0.8	1.2	1.7
Cape Cod Bay	933,856	934,941	937,100	939,254	942,502	944,659
Difference		1,085	3,244	5,398	8,646	10,803
Percent change		0.1	0.3	0.6	0.9	1.2
Pleasant Bay	970,763	971,744	973,716	975,692	978,645	980,622
Difference		981.4	2,953.1	4,929.6	7,882.4	9,859.6
Percent change		0.1	0.3	0.5	0.8	1.0

**TABLE 24**  
**ESTIMATED NITRATE LOAD TO WATERSHEDS – 43 LOTS HOLLOW ROAD**

	Discharge (gpd)	50,000	150,000	250,000	350,000	500,000
	<b>Estimated Nitrate Load (kg/year)</b>	<b>Cape Cod Bay</b>	6	190	456	775
<b>Namskaket Creek</b>		0	0	0	0	1
<b>Little Namskaket Creek</b>		0	28	235	515	841
<b>Rock Harbor</b>		109	229	296	353	427
<b>Boat Meadow River</b>		5	13	24	38	64
<b>Town Cove</b>		320	1,151	2,067	3,018	4,477
<b>Other*</b>		0	0	0	0	0
<b>Total Nitrate Load</b>		441	1,611	3,077	4,699	7,264
<b>Nitrate Load Summary</b>		<b>Nitrate Load to Cape Cod Bay</b>	1%	12%	15%	16%
	<b>Nitrate Load to an Estuary</b>	26%	17%	18%	19%	18%
	<b>Nitrate Load to Town Cove</b>	73%	71%	67%	64%	62%

**5.5.3. 32 and 43 Lots Hollow Road Groundwater Discharge**

This set of simulations considers the situation where both Lots Hollow sites are used and the groundwater discharge is distributed equally between the two. Figure 18 shows the groundwater contours and particle pathlines for different discharge scenarios for 43 Lots Hollow Road. The mound heights at the site are shown in Table 25 and are sufficiently low that there is enough separation to the ground surface.

**TABLE 25**  
**ESTIMATED SITE GROUNDWATER MOUND – 32 AND 43 LOTS HOLLOW ROAD**

<b>32/43 Lots Hollow Road Discharge (gpd)</b>	<b>Lot 32/43 Lots Hollow Road Maximum Simulated Mound (ft)</b>
<b>0</b>	--
<b>50,000</b>	0.67
<b>150,000</b>	1.95
<b>250,000</b>	3.15
<b>350,000</b>	4.26
<b>500,000</b>	5.82

Mounding was also observed at far-field locations. Table 26 summarizes the mounding at a number of locations, shown on Figure 18.

**TABLE 26**  
**ESTIMATED REGIONAL GROUNDWATER MOUND – 32 AND 43 LOTS HOLLOW ROAD**

<b>Discharge (gpd)</b>	<b>Watershed (mounding in feet)</b>					
	<b>Namskaket (TL-1)</b>	<b>Namskaket (TL-2)</b>	<b>Cedar Pond (TL-3)</b>	<b>Town Cove (TL-4)</b>	<b>Little Namskaket (TL-5)</b>	<b>Crystal Lake (TL-6)</b>
<b>150,000</b>	0.280	0.181	0.092	0.067	0.084	0.159
<b>250,000</b>	0.467	0.302	0.153	0.111	0.140	0.265
<b>350,000</b>	0.654	0.423	0.215	0.156	0.196	0.371
<b>500,000</b>	0.933	0.604	0.307	0.223	0.280	0.529

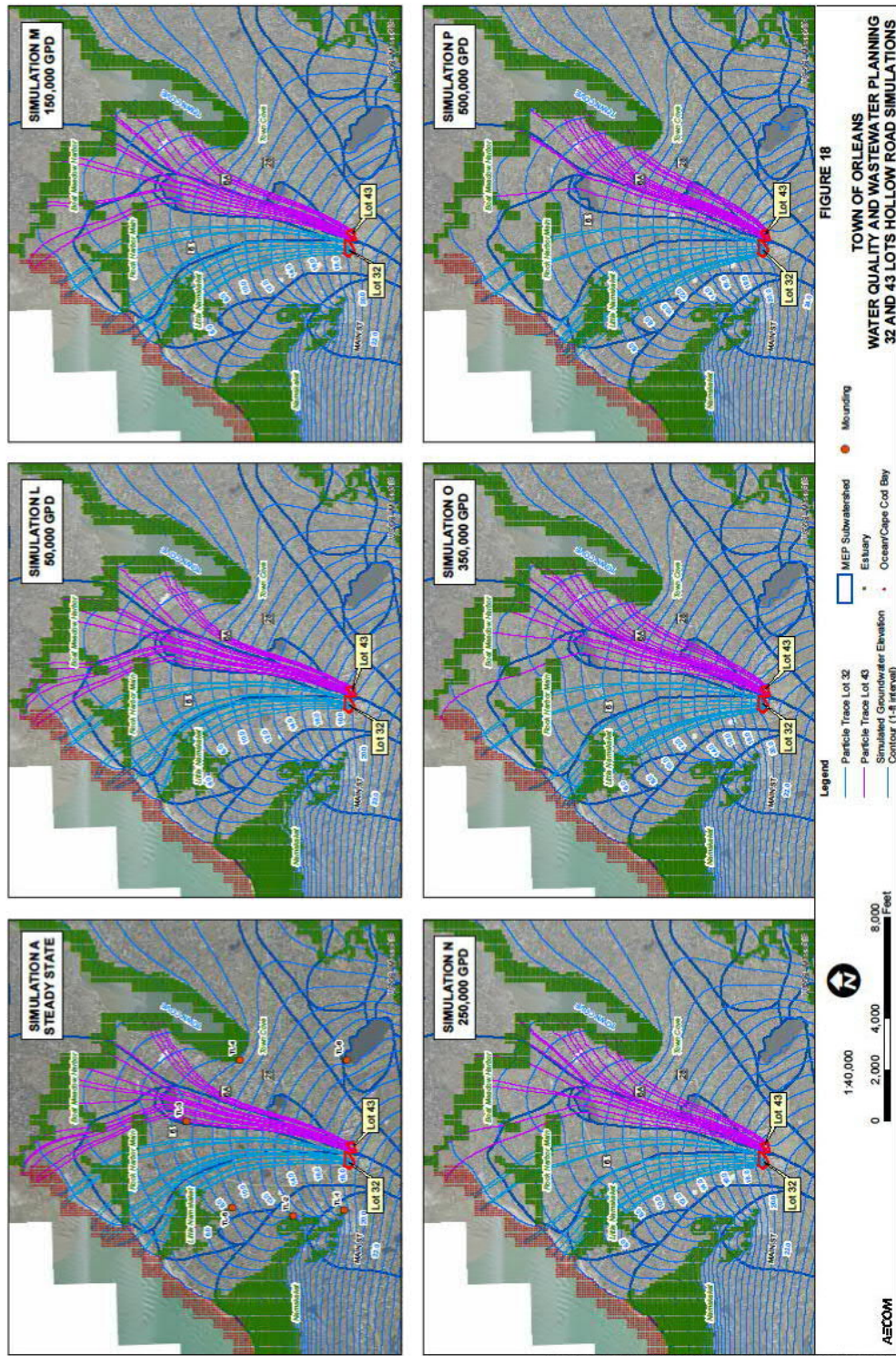


Table 27 summarizes the minimum, maximum, range, and average travel times for particles to travel between 43 Lots Hollow Road and the discharge point (estuary, Cape Cod Bay).

**TABLE 27**  
**ESTIMATED TRAVEL TIME – 32 AND 43 LOTS HOLLOW ROAD**

Discharge (gpd)	Travel Time (years) to Discharge Boundary			
	Minimum	Maximum	Range	Average
0	71	408	337	168
50,000	65	421	355	155
150,000	61	505	444	160
250,000	56	673	617	165
350,000	53	664	611	161
500,000	50	638	587	140

Figure 16 shows an oblique view of the particle traces originating from 43 Lots Hollow Road under the 500,000 gpd discharge scenario. Based on the particle traces, discharge is predominantly to Cape Cod Bay with a lesser component of discharge to estuaries. Table 28 compares the water budget with different discharge scenarios to the base case. This table demonstrates that as the discharge rate increases so does the relative discharge to each of the watersheds.

Finally, based on the flow field generated with each discharge scenario, MT3D, a fate and transport model was run to make a prediction of nitrate loading to each watershed. Table 29 summarizes the nitrate load to each watershed under different discharge scenarios. Similar to above the transport simulations were set to around 110 years which is less time than it takes for all the particles to reach a discharge boundary. For that reason the nitrate loadings may be slight under-estimates, however are sufficient to understand the relative differences in loading rates for different discharge scenarios.

**TABLE 28**  
**ESTIMATED FRESH WATER FLOW TO WATERSHEDS – 32 AND 43 LOTS HOLLOW ROAD**

Flow (ft <sup>3</sup> /day)	Watershed	Discharge (gpd)					
		0	50,000	150,000	250,000	350,000	500,000
	Namskaket Creek	572,161	574,234	578,376	582,513	586,651	592,875
	Difference		2,073	6,215	10,352	14,490	20,714
	Percent change		0.4	1.1	1.8	2.5	3.6
	Little Namskaket Creek	86,230	86,666	87,539	88,411	89,284	90,596
	Difference		436	1,309	2,181	3,055	4,367
	Percent change		0.5	1.5	2.5	3.5	5.1
	Rock Harbor	93,543	93,812	94,351	94,889	95,427	96,236
	Difference		269	808	1,346	1,884	2,693
	Percent change		0.3	0.9	1.4	2.0	2.9
	Boat Meadow River	102,240	102,547	103,161	103,774	104,387	105,307
	Difference		307	920	1,533	2,146	3,067
	Percent change		0.3	0.9	1.5	2.1	3.0
	Town Cove	486,482	487,620	489,896	492,169	494,443	497,858
	Difference		1,138	3,414	5,687	7,961	11,376
	Percent change		0.2	0.7	1.2	1.6	2.3
	Other	1,321,133	1,323,262	1,327,526	1,331,787	1,336,049	1,342,455
	Difference		2,130	6,394	10,655	14,917	21,322
	Percent change		0.2	0.5	0.8	1.1	1.6
	Cape Cod Bay	933,856	934,965	937,164	939,371	941,595	944,897
	Difference		1,109	3,308	5,515	7,739	11,041
	Percent change		0.1	0.4	0.6	0.8	1.2
	Pleasant Bay	970,763	971,733	973,686	975,632	977,575	980,504
	Difference		970.1	2,923.0	4,869.6	6,812.1	9,741.4
	Percent change		0.1	0.3	0.5	0.7	1.0

**TABLE 29**  
**ESTIMATED NITRATE LOAD TO WATERSHEDS – 32 AND 43 LOTS HOLLOW ROAD**

		50,000	150,000	250,000	350,000	500,000
<b>Estimated Nitrate Load (kg/year)</b>	Discharge (gpd)					
	Cape Cod Bay	298	853	1,499	2,099	2,809
	Namskaket Creek	0	0	48	235	808
	Little Namskaket Creek	217	565	765	898	1,047
	Rock Harbor	114	233	300	355	422
	Boat Meadow River	1	7	16	26	47
	Town Cove	0	91	438	1,018	2,112
	Other*	0	0	0	0	0
	<b>Total Nitrate Load</b>	<b>630</b>	<b>1,749</b>	<b>3,066</b>	<b>4,632</b>	<b>7,245</b>
<b>Nitrate Load Summary</b>	Nitrate Load to Cape Cod Bay	47%	49%	49%	45%	39%
	Nitrate Load to an Estuary	67%	71%	69%	68%	69%

**5.5.4. Landfill Plume**

In addition to the previous scenarios, selected flow fields generated for the above-discussed simulations were used to consider potential impacts to flow originating from the landfill. Figure 19 shows the flow field generated from discharging 250,000 gpd from 32 Lots Hollow Road, 43 Lots Hollow Road, and across both sites. In addition to showing the particles that originate from the groundwater discharge, these figures also show the particles that originate from the perimeter of the landfill.

In the no-discharge (steady-state) simulation, landfill particle traces tend to move due north or north-northeast with some particles discharging to Town Cove and further north at Boat Meadow Harbor. With the addition of a groundwater discharge at 32 Lots Hollow, groundwater from the landfill moves to the north-northeast such that all particles originating from the landfill appear to discharge to Town Cove. With the discharge at 43 Lots Hollow, most groundwater from the landfill moves slightly further to the east, with a few flowpaths ending in Boat Meadow Harbor. When the discharge is divided among both sites, flow from the landfill is similar to the 32 Lots Hollow simulations except the flow is slightly further to the north-northeast.

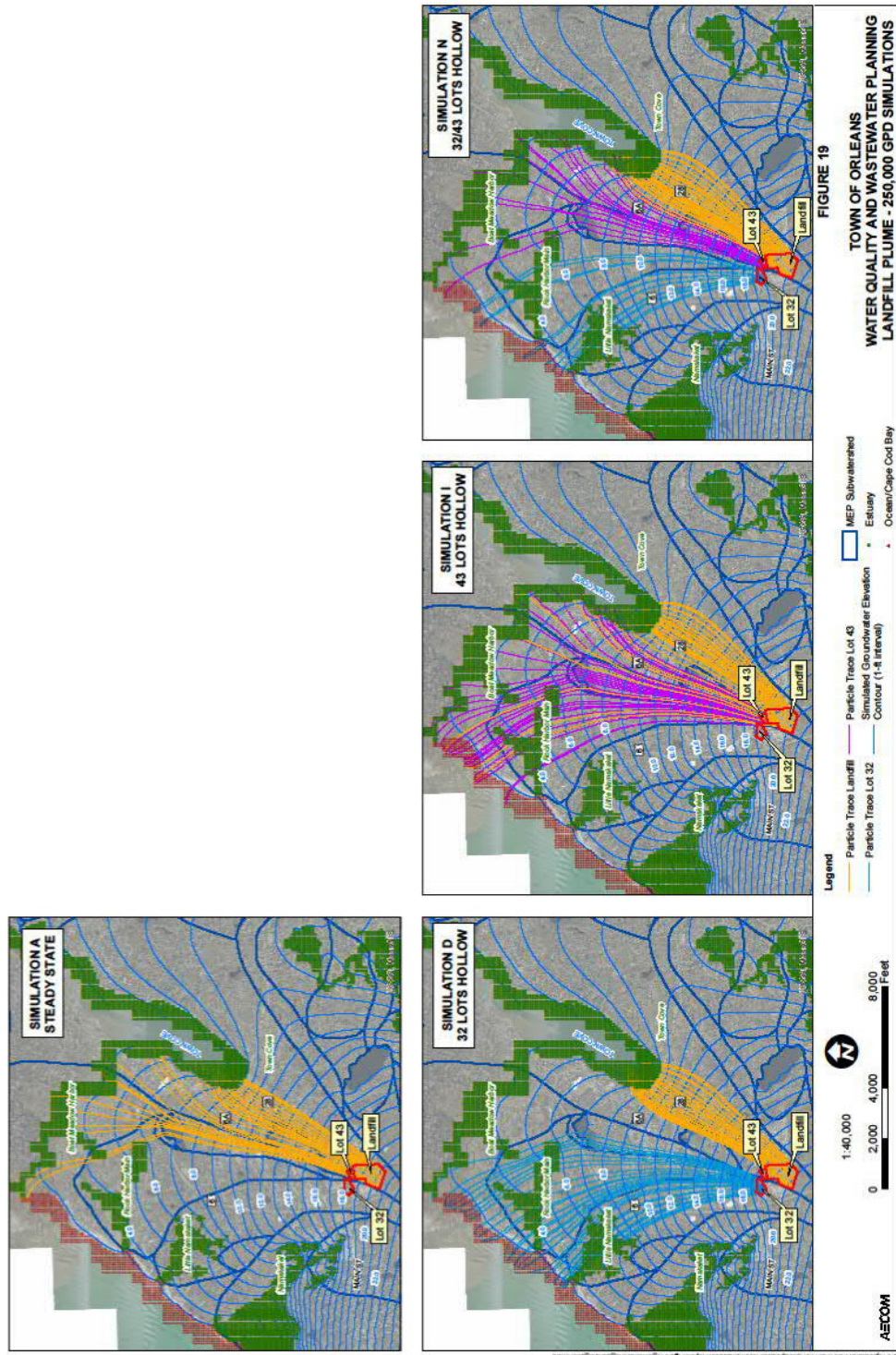


Figure 20 shows model simulations similar to Figure 19, except for the discharge rate being increased to 500,000 gpd. With the additional discharge to 32 Lots Hollow Road, particles originating from the landfill are deflected further to the northeast with all the landfill flow entering Town Cove. When the 500,000 gpd is shifted to 43 Lots Hollow Road, the majority of the particle traces originating from the landfill flow to the north-northeast while a few isolated particles are diverted northwest to Cape Cod Bay. In this scenario, a few isolated particles head east to the headwaters of Pleasant Bay. Finally discharging to both 32 and 43 Lots Hollow Road, particles originating from the landfill are deflected northeastward indicating that the landfill plume discharges to the south and east of Town Cove.

#### **5.5.5. Public Water Supplies**

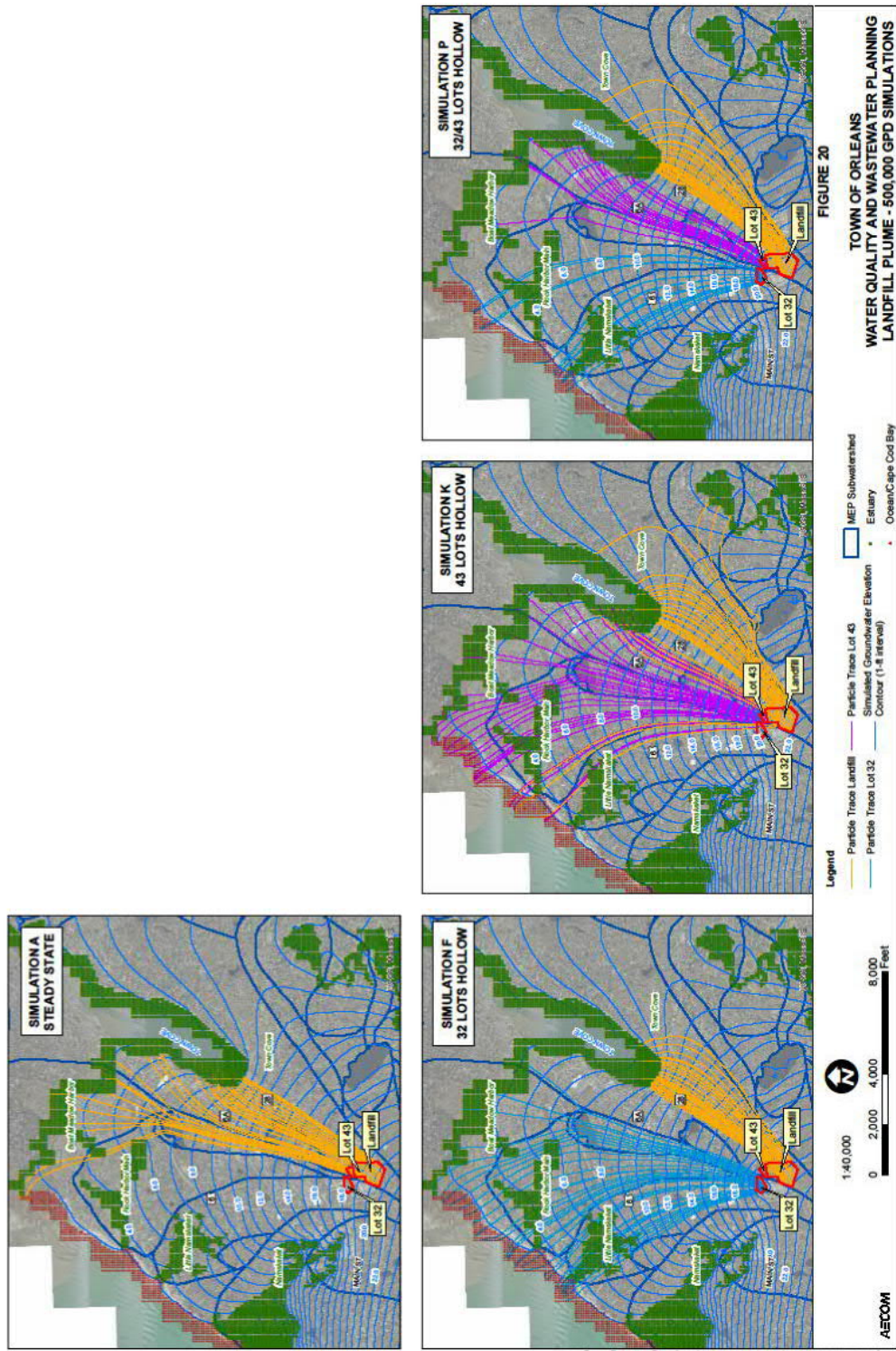
Figure 21 presents an analysis of the proposed groundwater discharge on the water supply wells of Orleans and Harwich. The first scenario (Simulation A) on Figure 21 shows steady-state baseline conditions with the wells pumping steady-state baseline conditions with the wells pumping at 2002 average pumping conditions, with no groundwater discharge at any of the Lots Hollow Road sites. The zones of contribution for the Town wells are illustrated using grey reverse particle traces. Particle traces estimating the path of the landfill plume are yellow while particle traces from 32 Lots Hollow Road (no discharge) are shown in blue.

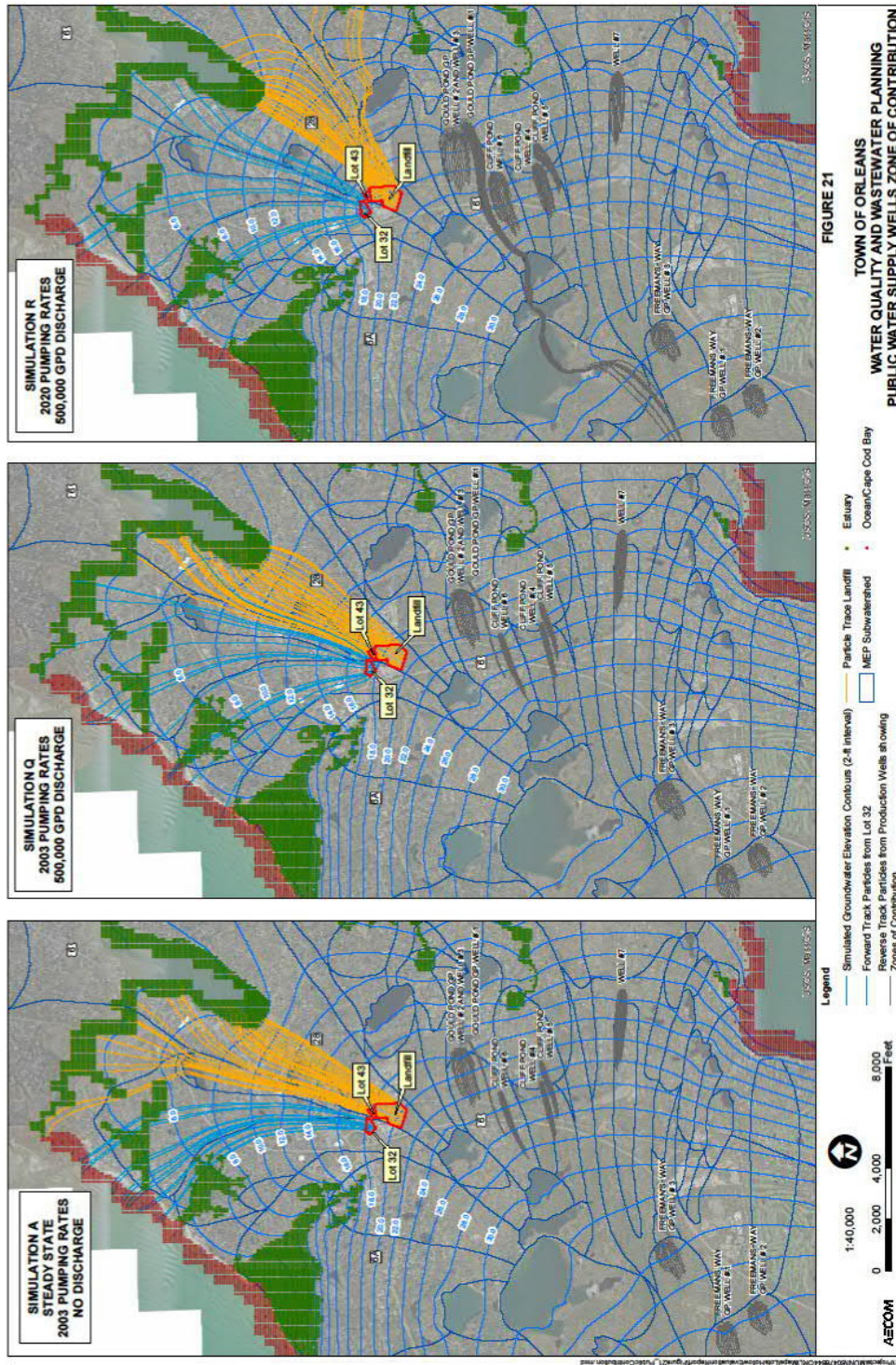
All of the water supply wells are located outside the subwatersheds of the landfill and proposed groundwater discharge sites. The supply wells are located in subwatersheds of Pleasant Bay, while the landfill and 32 Lots Hollow Road are located in the Town Cove and Little Namskaket Creek subwatersheds, respectively. The 43 Lots Hollow Road site is located in the Town Cove Watershed.

The distance between the proposed discharge at 32 Lots hollow and the closest water supply well (Town of Orleans's Goulds Pond Well #2) is approximate 4,400 feet to the southwest. The distance between Goulds Pond Well #2 and the closest point of the Landfill is approximately 2,900 feet.

The second scenario (Simulation Q) is identical to the first with the exception of a 500,000 gpd discharge at 32 Lots Hollow. As discussed in Section 5.5.4, the groundwater discharge influences the path of the landfill plume by it moving further to the east and north. However, the particle traces from the discharge and landfill plume do not move south or southeast towards the water supply wells or zones of contribution.

Scenario R simulates the water supply wells pumping at higher rates (USGS projected 2020 pumping rates) with the 500,000 gpd discharge. As with Scenario Q, the discharge with the increased pumping appears to have no noticeable impact on any of the water supply well's zones of contribution. The zones of contribution are slightly larger in this simulation, however this is due to the increased pumping rates of the wells. A few particle traces from the landfill appear to flow into a subwatershed of Pleasant Bay. This did not occur at a discharge rate of 250,000 gpd which is the anticipated buildout flow for the Downtown Area.





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## 6. POTENTIAL IMPACTS

The potential impacts resulting from the proposed groundwater discharge fall into two general categories: 1) potential water quality impacts and 2) potential groundwater mounding impacts. Although the discharge will be treated to high levels, the discharge may contain slightly higher levels of nutrients and other constituents compared to the ambient groundwater. Potential mounding impacts include the discharge of groundwater in areas where groundwater does not presently discharge and the rise of water levels adjacent to the wick and on surrounding properties.

Groundwater mounding and water quality impacts were modeled using worst-case input parameters. These included using high water-table conditions, a discharge rate that will likely exceed the actual discharge rate of the WWTF, and a nitrate effluent concentration of 10 mg/L. The actual discharge concentration would likely be closer to 3 to 6 mg/L depending on the MassDEP discharge permit and daily plant operations.

### 6.1. Potential Groundwater Mounding Impacts

The primary site of proposed discharge is at 32 Lots Hollow Road, with the reserve discharge location being 43 Lots Hollow Road. Based on groundwater model simulations, groundwater mounding would not impact any structures or nearby properties. In general, the average or high water level elevations from groundwater mounding is insignificant and well below surrounding surface elevations.

The groundwater mounding simulation indicates that a rise of approximately 0.3 feet at a discharge of 150,000 gpd, and a rise of up to 1.0 foot at discharge of 500,000 gpd, may occur at the eastern/southeastern boundary of Namskaket Creek (Figure 15). Similarly, the groundwater model predicts a potential rise of approximately one (150,000 gpd discharge) to four (500,000 gpd discharge) inches at Little Namskaket and north of Namskaket Creek. Details of the groundwater mounding scenarios are discussed in Section 5.5.

Although this groundwater mound prediction is only an approximation, the increase in groundwater elevation in the vicinity of Namskaket and Little Namskaket Creek has the potential to alter the hydrology of the marsh sufficiently that a vegetation change may occur. The portion of the Namskaket Creek that is within the area of the predicted groundwater mound is an area which includes both a saltmarsh as well as a brackish plant community associated with Hurley's Bog (Figure 15, Simulation A, TL-1) on the south side of the Cape Cod Rail Trail (SMAST, 2016).

Typically, the hydrology driving the presence of hydrophytic plant species is located within the top 12-inches of the soil; therefore, a change in this regime of 3 to 12 inches could result in a substantial change to the hydrological conditions experienced by plant species present. Since the discharge would represent an increase in freshwater input to the marsh, it is possible that a shift from salt marsh to freshwater plant species could occur. These conditions would be particularly favorable to an increase in extent of Phragmites, which already exists in the area (SMAST, 2016). The extent of any vegetation shift is difficult to predict. Therefore, monitoring of the plant species distribution within the eastern/southeastern portion of Namskaket Creek is recommended just prior to and once the discharge commences, in order to document any shifts in plant cover from salt water to freshwater species, including Phragmites.

Similar to the previous study conducted by SMAST, it is recommended that long-term permanent monitoring plots be established in Namskaket Creek in the vicinity of the predicted mound in order to annually monitor plant community composition, and thereby document any changes over time. If any changes to the salt marsh community were to occur, such as expansion in Phragmites cover, mitigation measures such as restoration or replication of a salt marsh in the vicinity or payment to the Commonwealth's in-lieu fee administered by the Massachusetts Department of Fish and Game should occur.

It should be noted that a recent study conducted by USGS (USGS, 2016) indicated that as a result of sea level rise, groundwater levels on Cape Cod are predicted to rise as high as 2.11 feet, with a more nominal rise of 0.1 foot near inland streams. Given these predictions, it is likely that any effect of the groundwater mounding predicted to occur as a result of the proposed groundwater discharge would be more than offset by changes likely to occur as a result of sea level rise over a longer time period.

It is possible that floodplains may be slightly affected as the water table may slightly increase in elevation in some low elevation areas around the marshes. It is also possible that floodplain extent may increase nominally as a result of the groundwater mounding predicted, although any increase would be unlikely to raise the floodplain elevation by a half foot or more, which would trigger a modification to the mapped floodplain. However, any increase is likely to be dwarfed by predicted sea level rise.

The groundwater mounding simulation also predicts a rise in groundwater elevations below Cedar Pond and Crystal Lake, ranging from less than one to approximately four inches, depending on the discharge volume. The locations of groundwater mounding are shown on Figure 15, Simulation A, at locations TL-3 and TL-6, respectively. As indicated above, this increase is likely to be offset by sea level rise. However monitoring may be appropriate to document any vegetation changes due to changes in the water levels of these water bodies.

## **6.2. Potential Water Quality Impacts**

### **6.2.1. Discharge Water Quality**

Discharge from the WWTF is expected to be within water quality standards set by the state. As noted in the model simulations, the effluent discharged will be widely distributed across several watersheds. This is primarily due to the relatively flat water table.

### **6.2.2. Watershed Nitrate Loads**

The elimination of septic systems will result in long-term improvements in groundwater quality due to the removal of septic systems and their high nitrate discharge. No significant short-term impacts on surface water quality are expected. It is likely that improvement in groundwater quality will eventually lead to better surface water quality, as groundwater moves from inland areas to coastal discharge areas, or toward ponds from tributary areas. When most of the effluent-impacted groundwater eventually emerges in coastal waters, it would do so offshore, and in sufficiently well-mixed areas. Water quality improvements to estuaries would occur by removing septic systems whose discharge flows to salt marshes, tidal creeks and/or nitrate impacted estuaries, treating the wastewater, and discharging the effluent further upgradient in the watershed where the effluent impacted groundwater would flow deep in the aquifer below the estuaries to coastal waters that would not be impacted by the discharge. The discharge to coastal waters would not occur until many years after the initiation of treatment and disposal activities.

The modelling results indicate that freshwater flow and nitrate load from the discharged effluent will eventually reach Cape Cod Bay, Little Namskaket Creek (MA 96-26), Namskaket Creek (MA 96-27), and Town Cove (MA 96-68), as well as a smaller proportion discharging to Rock Harbor (MA 96-16) and Boat Meadow River (MA 95-15). However, the discharge will not reach these receiving water bodies for approximately 100 years. Rock Harbor Creek (MA 96-16) is not identified as impaired for nitrogen in either the MassDEP 2014 303(d) list of impaired waters, nor in the draft 2016 303(d) list of impaired waters. Namskaket Creek, Little Namskaket Creek, Rock Harbor Creek, Boat Meadow River, and Town Cove are all listed as impaired for fecal coliform in the current 303(d) list, and covered under a TMDL for this water quality constituent. However, the draft 2016 303(d) list proposes removing the fecal coliform impairment associated with Town Cove. The proposed groundwater discharge from the WWTF is expected to be within water quality standards set by the Commonwealth and would therefore comply with TMDL requirements.

Cape Cod Bay and Boat Meadow River have not been evaluated by MEP. Namskaket and Little Namskaket Creek, Rock Harbor, and Town Cove are all evaluated in MEP reports that identify nitrogen loading thresholds based on hydrodynamic and water quality modelling of these estuarine systems (Howes et. al. 2007a, b and c; Howes et. al. 2012). The MEP modelling analysis of both the Namskaket and Little Namskaket Creek marsh systems indicates that they are still able to assimilate additional nitrogen, without adverse water quality and benthic habitat impacts. The MEP analysis indicates that Rock Harbor and Town Cove cannot assimilate additional nitrogen without adverse water quality and benthic habitat impacts, and that the existing nitrogen loads are already in excess of the target watershed loads that would maintain a healthy aquatic ecosystem. The residual nitrogen remaining after treatment will increase the nitrogen loading to both Namskaket Creek and Little Namskaket Creek, but the loading would still be below their respective MEP nitrogen load target (Table 30).

The nitrogen loading to the Town Cove and Rock Harbor sub-watersheds will be reduced as a result of the proposed discharge (Table 29), which will benefit these receiving waters that are already impaired for nutrients and adversely affect by current nitrogen loading. Although Boat Meadow River is listed as impaired for estuarine bio assessments on the current 303(d) list, which typically is related to excess nitrogen, there is no TMDL established or MEP report for Boat Meadow River, so it is not possible to quantitatively evaluate the change in nitrogen loading on this receiving water body. However, the nitrate load to Boat Meadow River that will occur as a result of the discharge is only slightly greater than the current nitrate load, and is expected to result in minimal if any change on the receiving water quality. Overall, the proposed discharge at Lots Hollow Road is anticipated to be within the MEP recommended nitrogen loading for all receiving watersheds and will reduce nitrogen loading to two receiving waterbodies (Rock Harbor and Town Cove) and consequently is not expected to result in an adverse effect on water quality or benthic habitat. Because Cape Cod Bay experiences a tremendous amount of daily flushing, it is not anticipated that the additional nitrogen loading to the Bay would result in adverse water quality or benthic habitat impacts, particularly when coupled with lowered nitrogen loading as a result of discontinued use of septic systems. Table 29 summarizing load removed, returned, added, TMDL, and balance by watershed.

**TABLE 30  
ESTIMATED WATERSHED NITRATE LOADS**

Location	Present Watershed Nitrate Load ((kg/yr)			Estimated Buildout Watershed Nitrate Load ((kg/yr)				
	Present Watershed Load <sup>1</sup>	Target Threshold Watershed Load <sup>1</sup>	Allowable Additional Watershed Load <sup>2</sup>	Watershed Nitrate Load to WWTF	Watershed Nitrate Load from WWTF	Net Increase / (Decrease) in Watershed Nitrate Load	Watershed Load with WWTF	Future Allowable Additional Watershed Load
Cape Cod Bay	ND	ND	ND	ND	2,809	ND	ND	ND
Namskaket Creek	3,446	16,750	13,304	470	808	338	3,784	12,966
Little Namskaket Creek	2,797	4,650	1,853	825	1,047	222	3,019	1,631
Rock Harbor	9,066	3,721	ND	3,000	422	(2,578)	6,488	0
Boat Meadow River	ND	ND	ND	36	47	ND	ND	ND
Town Cove	31,595	11,968	0	3,536	2,112	(1,424)	30,171	0

### 6.2.3. Landfill Nitrogen

As described in Section 5.5.4, model simulations shown on Figures 19 and 20 indicate that the path of the landfill nitrate plume could be influenced by a discharge at either of the Lots Hollow Road sites. Under the no discharge scenario (Simulation A, Figure 19), the model results indicate that most of the landfill plume discharges into Town Cove along the south and west side of the estuary. The model also indicates that most of the remaining plume discharges to Boat Meadow Harbor and Cape Cod Bay.

Model Simulations D and F (Figures 19 and 20, respectively) indicates that discharging at 250,000 or 500,000 gpd at 32 Lots Hollow Road the landfill plume moves to the east resulting in the plume entering Town Cove to the south and southeast.

Discharging at 32 Lots Hollow Road may result in additional nitrate from the landfill entering the Town Cove Watershed and ultimately Town Cove. The additional nitrate load would likely be relatively small compared to the nitrate load removed by the sewerage of the Downtown area.

Distributing the discharge to both 32 and 43 Lots Hollow Road (Simulations I and K), the model results are similar to discharging at 32 Lots Hollow Road. The most significant difference is that the plume takes a more easterly path and enters Town Cove to the south and east.

Model scenarios simulating all of the WWTF flow discharging to 43 Lots Hollow Road (Simulations N and P) indicates that the landfill plume moves further to the east, north and west than under steady-state conditions (Simulation A). The plume appears to discharge across the Little Namskaket Creek, Rock Harbor, Boat Meadow Harbor, Meetinghouse Pond, and Cape Cod Bay watersheds. The plume that cross the Little Namskaket Creek and Rock Harbor Watershed divides flows under the estuaries, discharging directly to Cape Cod Bay. The wider distribution of the landfill plume is the result of the WWTF effluent discharging directly over the western portion of the plume.

Historic monitoring at the landfill (Section 4.3) indicates that groundwater downgradient of the landfill contains nitrogen in the forms of nitrate and ammonia. In general, the landfill plume below 43 Lots Hollow Road contains nitrate in the upper 15 to 20 feet of the aquifer. Below the nitrate, most of the groundwater nitrogen is in the form of ammonia (AECOM, 2018).

In the presence of more oxygenated water, such as a WWTF discharge, ammonia can convert to nitrate. Studies have shown that nitrate travels significantly faster through an aquifer than ammonia (Barbaro, 2013). If a significant portion of the landfill ammonia plume is converted to nitrate, the receiving watersheds could receive the converted landfill nitrogen sooner than if the nitrogen remained ammonia.

Based on the model simulations discussed in this section, discharging at 32 Lots Hollow Road would appear to have the least chance of the oxygenated WWTF discharge mixing with the ammonia from the landfill. Simulations D and F show that the particle traces representing the discharge and landfill plume are a significant distance from each other and discharge into separate watersheds. This separation indicates that the conversion of ammonia to nitrate is not likely. The 32 Lots Hollow discharge is located furthest from the plume and is located in a different watershed than the landfill. The groundwater divided between the watersheds likely contributes to this separation.

The particle traces representing a discharge at 32 and 43 Lots Hollow Road (Simulations I and K) indicate less distance between the discharge and plume particle traces increasing the likelihood of mixing and ammonia converting to nitrate. In scenarios where the groundwater discharge take place only at 43 Lots Hollow Road (Simulations N and P), the WWTF effluent discharges directly over a portion of the landfill plume moving it into several watersheds. Under this scenario the mixing of the landfill plume and the more oxygenated discharge is most likely.

As discussed in Section 4.3, ammonia exists 15 to 20 below the water table at 43 Lots Hollow Road. With the discharge taking place above the water table, the groundwater mounding would have the tendency to move the landfill plume deeper into the aquifer. Even though the discharge takes place above the water table and direct mixing may not take place below the wick, it is likely that downgradient of the discharge, mixing of the more oxygen rich discharge with ammonia may result in some ammonia converting to nitrate. The ammonia load converted to nitrate could not be estimated using the AECOM modified USGS model. Estimating the fate and transport of nitrate and ammonia would require the application of a different model.

At this time, the Town has designates 32 Lots Hollow Road as the primary discharge site. If in the future, the Town were to choose to discharge all or a portion of the WWTF effluent at 43 Lots Hollow Road, further evaluation the impact of the discharge on the landfill nitrogen load may be required.

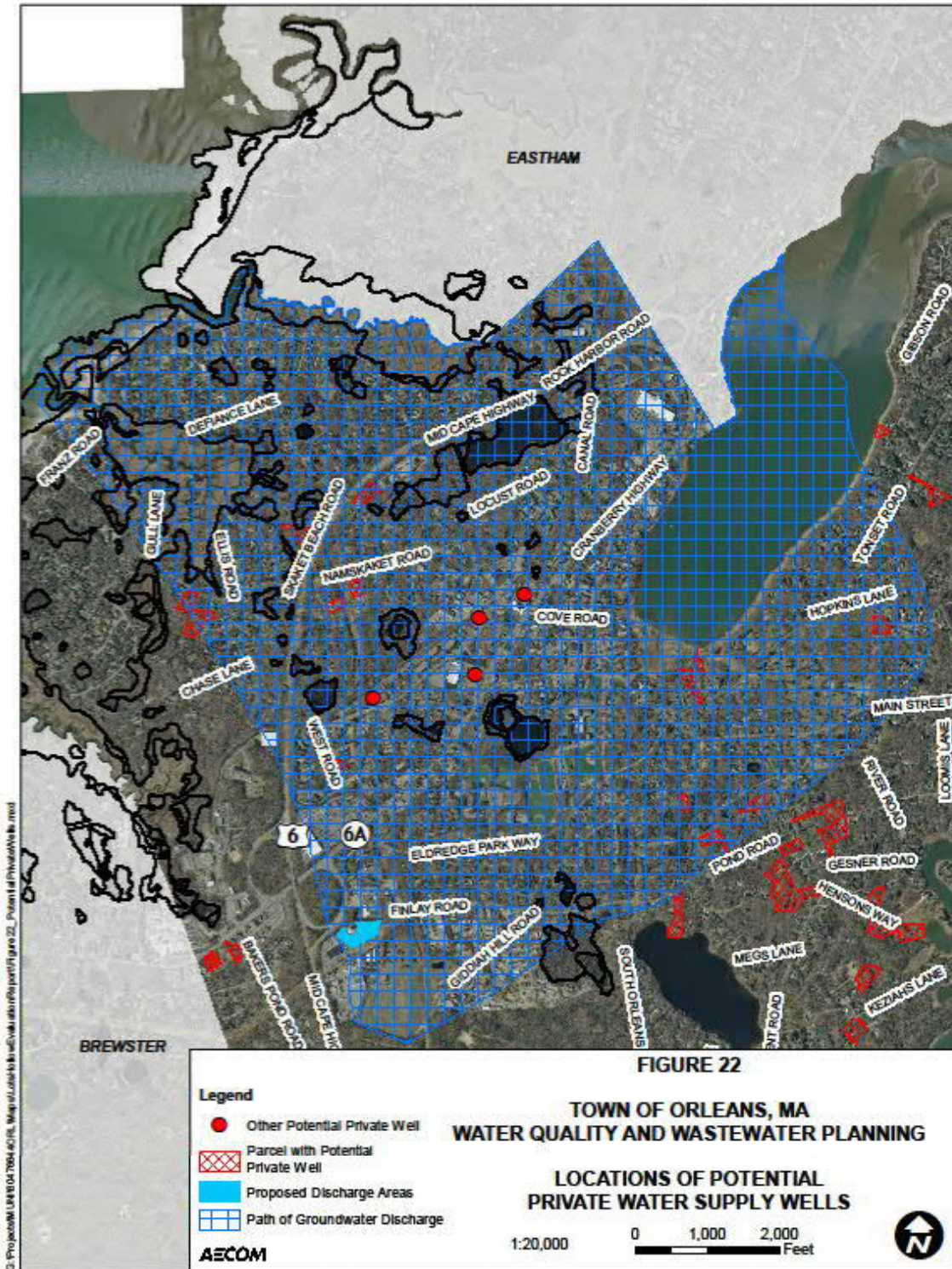
#### **6.2.4. Private Wells**

There are no known sensitive receptors directly downgradient of the discharge with the exception of potential private water supply wells. According to Town records, there are several potential private water supply wells located downgradient of the discharge. According to Town records, there are properties on Old Colony Way, West Road, Kings Road, Namskaket Way, Bevan Way, and Skaket Beach Road that may have private wells (Figure 22). If wells exist and they are used for drinking water or irrigation supply, the Town should consider offering to connecting any property to the public water supply as the well may be located within the influence of the discharge.

#### **6.2.5. Public Water Supplies**

As outlined in Section 5.5.5, Figure 21 presents simulations of the proposed groundwater discharge on the zones of contribution of the Towns of Orleans and Harwich groundwater supplies. As noted on Figure 21, the water supply wells, landfill, and the proposed discharge at 32 Lots Hollow Road are located in different watersheds. The distance between the nearest water supply well (Town of Orleans's Goulds Pond Well #2), the discharge location and the closest point of the landfill are approximately 4,400 and 2,900 feet, respectively.

The scenarios performed indicate that with a 500,000 gpd discharge and the water supply wells pumping at 2002 average rates or 2020 projected rates, that neither particle traces representing the landfill plume nor the groundwater discharge moves towards the pumping water supply wells. The proposed groundwater discharge is therefore not expected to have an impact on the groundwater supplies of Orleans or Harwich.



### **6.3. Potential Impacts to Coastal Resources**

Coastal resources in the area of groundwater mounding and eventual effluent discharge include beaches and associated swimming areas, commercial and recreational shellfishing areas, and marine/estuarine habitat. The groundwater mound and effluent discharge would occur within the Inner Cape Cod Bay Area of Critical Environmental Concern (ACEC), which includes Cape Cod Bay, both Namskaket and Little Namskaket Creeks, Boat Meadow River, and Rock Harbor up to the 10-foot elevation contour. Because of the depth of effluent disposal the majority of effluent will travel beneath these coastal resources to be mixed with waters sufficiently offshore where substantial tidal flushing will occur. As discussed above, the treatment and disposal of sewage through the proposed groundwater discharge rather than the continued use of on-site septic systems is expected to result in an overall improvement to water quality which would benefit all coastal resources. Thus the discharge is not expected to adversely affect the ACEC functions.

### **6.4. Potential Impacts to Wetlands**

As discussed above, the western extent of the simulated groundwater mound will intercept with the eastern/southeastern boundary of Namskaket Creek. The mound may result in a shift in plant composition with more freshwater species and fewer salt marsh species, with a potential expansion in extent of Phragmites in the short-term. Over a longer time frame these changes may be dwarfed as a result of sea level rise. AECOM recommends monitoring of Namskaket Creek to document the long-term plant community stability as well as any potential changes. If adverse changes are documented, compensatory mitigation should be implemented.

### **6.5. Potential Impacts to Rare and Endangered Species**

According to the MassGIS datalayers, Cape Cod Bay, the area of Namskaket and Little Namskaket Creek marshes and adjacent streams, Rock Harbor and Town Cove are all mapped as Priority Habitat (polygon PH 945). In addition, Town Cove is also mapped as Estimated Habitat. The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has not been contacted to determine which species are present in the areas of groundwater mounding and eventual effluent discharge. However, as discussed above, no adverse water quality impacts are anticipated to occur to any of these receiving waters, and therefore there are not expected to be any water quality impacts to any protected species. In addition, the groundwater effluent is not expected to reach the estuaries for approximately 100 years.

As discussed above, the proposed discharge would result in a groundwater mound that may intercept the eastern edge of Namskaket Creek. During consultation with NHESP during the preparation and submittal of the 2010 Comprehensive Wastewater Management Plan (CWMP), it was determined that Priority Habitat for four species protected under the Massachusetts Endangered Species Act (MESA) was present at the Tri-Town Septage Treatment Facility site, which is relatively close to the proposed discharge at Lots Hollow. The four species identified were: the Eastern Box Turtle (*Terrapene carolina*), the Diamond-backed Terrapin (*Malaclemys terrapin*), Salt Reedgrass (*Spartina cynosuroides*), and Mitchell's Sedge (*Carex mitchelliana*). During more recent discussions pertaining to the demolition of the compost shed associated with the Tri-Town site, MA NHESP indicated that the area west of the site was potential habitat for two state listed plant species. Thus, the predicted mound from a discharge at the Lots Hollow site may extend to areas including habitat for any of these species and potentially others.

Additional consultation with NHESP is needed to determine the species potentially present at the discharge site and mounding locations. Mitigation measures could include pre-discharge surveys to document the location of protected plant species and ongoing monitoring to evaluate any impacts on these species. However, monitoring may be necessary to confirm presence and any impacts on protected species. Salt Reedgrass occurs at the upper fringes of salt marsh, while Mitchell's sedge occurs in freshwater areas adjacent to salt marsh. These species would be particularly susceptible to changes in salinity and hydrology that may occur as a result of the groundwater mound. Thus, additional consultation with NHESP is necessary to confirm any necessary mitigation measures.

#### **6.6. Increased Flow to Watersheds**

Additional fresh-water flow to each of the estuaries is summarized in Tables 18, 23, and 28. The percentage of increased flow is also summarized in these tables. Due to the nature of marsh soils, a majority of the increased flow would likely enter the marshes through the stream channels where the greatest stream flow occurs due to tidal flux. The percentage of increased flow to the estuaries is relatively low. The estuaries with the greatest flow are tidal creeks that would discharge most of the additional freshwater with each tidal cycle. Outside the potential for groundwater mounding impacts discussed in Section 6.1, the additional freshwater flow is not expected to impact on the estuaries.

#### **6.7. Soils near Water Tank**

One of the goals of the loading test was to evaluate groundwater mounding near the wick. The loading test demonstrated that at a loading rate of 126,000 gpd (88 gpm), minimal groundwater mounding occurred across the site. At monitoring well LH-1, five feet from the wick, groundwater mounding was approximately 3.1 feet. The mound remained relatively stable over the final nineteen days of the loading test. The mound decreased with distance from the test wick. In monitoring wells located 15, 32, 60, 156, and 233 from the test wick, the maximum mound noted during the 32 days of loading was 2.85, 2.38, 2.00, 1.07, and 0.08 feet respectively.

Based on the groundwater model scenarios, test results and the groundwater model scenario, groundwater mounding at the site is expected to be no greater than 1.0, 2.8, 4.4, 5.9, and 7.9 feet at flow rates of 50,000, 150,000, 250,000, 350,000, and 500,000 gpd, respectively.

The proposed wicks will be installed a minimum of 40 feet from the water tank and foundation. A slight increase in the water table is expected below the water tank and foundation during discharge, though the fluctuation in groundwater levels will be similar to the seasonal rising and falling water table due to changes in precipitation. At the buildout discharge rate of 250,000 gpd, the water table will be an estimated four feet higher than if no discharge were taking place. However, this water table rise will be minimal compared to the over 100 feet of unsaturated soils below the tank.

During wick construction, a 3- to 6-foot diameter vertical column of artificial gravel will be installed at each wick location. A 3- to 6- foot diameter drill casing will be used to drill a borehole for the wick. Once the borehole has been drilled, the gravel pack will be installed as the casing is removed. At no time during installation will the formation be allowed to collapse into the borehole.

Once the drill casing has been removed, the gravel will support the surrounding soils with no settling of the surrounding soils expected. Construction and operation of the proposed wicks should have no impact on the water tank or surrounding infrastructure.

## **7. PRIMARY AND RESERVE DISCHARGE LOCATIONS**

### **7.1. Primary Discharge Location**

As previously mentioned, the Town of Orleans has selected 32 Lots Hollow as the primary discharge location and is seeking MassDEP approval to discharge 500,000 gpd at the site. The request to discharge WWTF effluent at the site will be included as part of the Groundwater Discharge Permit application. The proposed discharge area is shown on Figure 23.

Based on site conditions, subsurface soils encountered, the wick loading test, and groundwater model scenario results, the Town is proposing to install a series of wicks at the 32 Lots Hollow to discharge 500,000 gpd of WWTF effluent. Groundwater modeling indicates that a minimum of 500,000 gpd can be discharged at the site. The Town plans to convey and discharge all of the WWTF effluent at 32 Lots Hollow Road.

### **7.2. Reserve Discharge Locations**

Three reserve discharge locations have been identified. The locations are 43 Lots Hollow Road, Route 6 (Exit 12), and 223 Beach Road. The reserve discharge location details are shown on Figure 23.

#### **7.2.1. 43 Lots Hollow Road**

The Hydrogeologic Evaluation for 43 Lots Hollow Road is included herein. The Town is seeking MassDEP approval for a 500,000 gpd discharge at the site. The discharge would take place within the discharge area shown on Figure 5. As with 32 Lots Hollow Road, the groundwater discharge would take place through the installation of a series of wicks.

#### **7.2.2. Route 6 (Exit 12)**

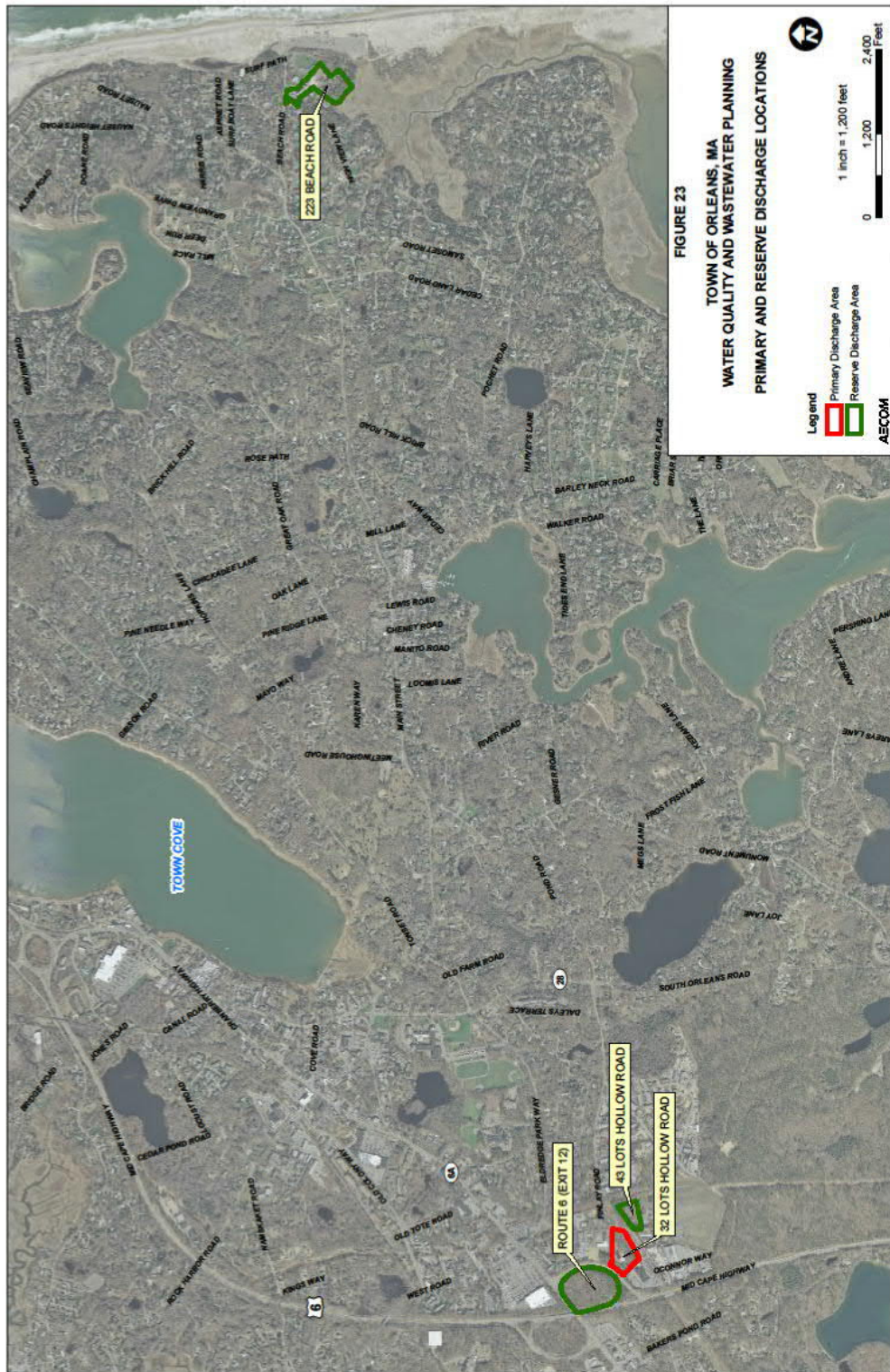
MassDEP has approved a discharge of 140,000 gpd at the Route 6, Exit 12 site. The Town has proposed a wick loading test at the site and will be submitting an updated Hydrogeologic Evaluation for the site to MassDEP requesting approval for a wick discharge be allowed at the site. The site is controlled by MassDOT. The Town of Orleans and MassDOT are working on an agreement to allow the Town to use the site for a groundwater discharge.

#### **7.2.3. 223 Beach Road**

AECOM completed a Hydrogeologic Evaluation for 223 Beach Road in June 2016. In February 2017, MassDEP approved 223 Beach Road for a 200,000 gpd discharge through subsurface leaching trenches. A copy of the approval letter is provided in Appendix A.

The Hydrogeologic Evaluation concluded that 223 Beach Road site is suitable for a groundwater discharge greater than 200,000 gpd. However, the approved discharge was based on a discharge rate where all of the WWTF discharge would flow directly to the Atlantic Ocean without no flow, and associated nitrate load, going to a nitrate impacted estuary. As part of the 2016 Hydrogeologic Evaluation, groundwater model scenarios indicated that at discharge rates greater than 200,000 gpd, a portion of the WWTF discharge may flow into the Pochet River, a subwatershed of the nitrate impacted Pleasant Bay Watershed.

If the Town planned to discharge at 223 Beach Road at a rate greater than the approved 200,000 gpd, additional nitrate reduction measures within the Pleasant Bay Watershed may be required by MassDEP. The purpose of the nitrate reduction measures would be to offset the additional WWTF nitrate load to the Pochet River subwatershed. Prior to increasing the discharge over 200,000 gpd, the Town would be required to submit a request to MassDEP for the proposed discharge rate. At a minimum, the request would need to include the anticipated discharge rate at the site, an estimate of the nitrate load from the WWTF discharge to the Pochet River subwatershed, and supporting documentation.



## **8. GROUNDWATER DISCHARGE – 32 LOTS HOLLOW ROAD**

Based on site conditions, subsurface soils encountered, the wick loading test, and groundwater model scenario results, the Town is proposing to install a series of wicks at 32 Lots Hollow Road to discharge up to 500,000 gpd or WWTF effluent. The estimated number of wicks, preliminary wick design, and proposed discharge areas are discussed in the following sections.

### **8.1. Preliminary Wick Design and Capacity**

The proposed wick is essentially a column of gravel that is installed vertically from the ground surface through the unsaturated portion of the aquifer to a specified depth above the water table. Once online, effluent from the WWTF will be conveyed from the WWTF and discharged over the gravel at the surface of the wick. Once discharged, the effluent will flow downward through the gravel in the wick, discharging outward into the aquifer. This will first occur at the base of the wick or once the discharge reaches the temporary mound created by effluent discharging into the aquifer for the WWTF.

Based on the site soils, depth to water table, and wick loading test results, it is expected that a full scale wick would range in diameter between three and six feet. The total depth of the wick would be between 50 and 100 feet. The final wick design including the diameter, total depth, gravel selection, etc. will be included as part of the GWDP application. Wick operations and maintenance (O&M) will also be proposed as part of the application.

As discussed in Section 4.5, the capacity of each wick is expected to be in excess of 500,000 gpd. It is anticipated that three to four wicks will be installed within the discharge area at 32 Lots Hollow Road (Figure 4). The number of wicks installed will allow for redundancy in the discharge capacity and for proper operation and maintenance of the wicks.

### **8.2. Preliminary Wick Locations**

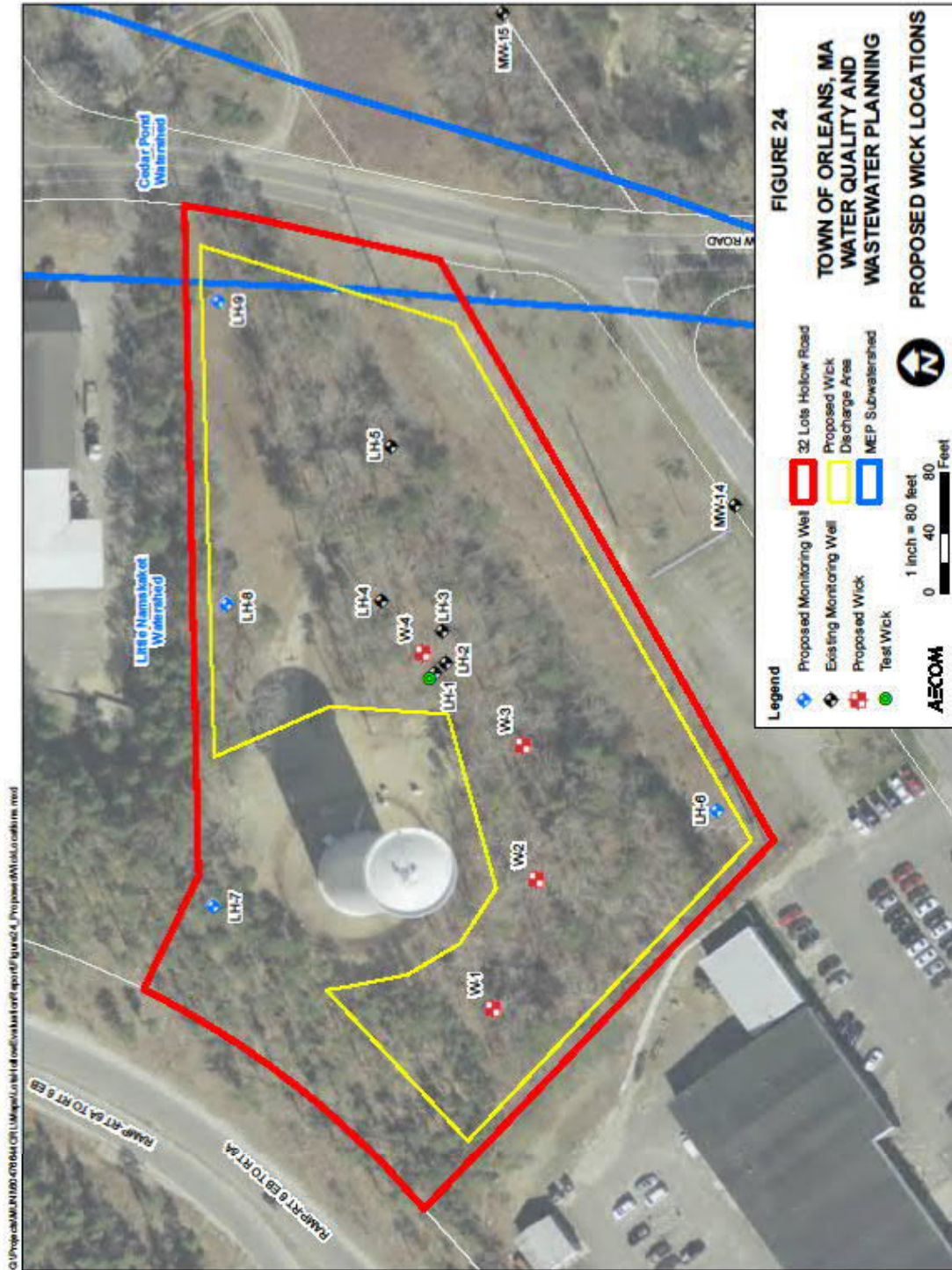
Preliminary wick locations are shown on Figure 24. These locations may be adjusted based on discussion with the Town, Water Department and site conditions. The final locations will be submitted with the final wick design as part of the GWDP application.

At this time, the wicks are proposed to be installed on the western portion of the discharge area. This is primarily due to overhead utilities and topography. Installing the wicks in the western portion of the discharge area will have the added benefit of providing additional separation between the discharge and the landfill plume. The discharge locations will also be further west of the groundwater divide for Town Cove which should decrease the amount of effluent nitrate that flows into the Town Cove Watershed.

### **8.3. Groundwater Monitoring Plan**

A groundwater monitoring plan will be implemented to assess both baseline and compliance groundwater quality in the vicinity of the proposed discharge. The number and location of the compliance monitoring wells will be based on the final wick locations. Preliminary monitoring locations (LH-6, LH-7, LH-8, LH-9, and MW-14) are shown on Figure 24. A detailed compliance monitoring plan will be submitted as part of the GWDP application.

Prior to discharging, two rounds of groundwater samples will be collected at the compliance monitoring wells and sent to a laboratory for analysis. As required by MassDEP, water samples will be analyzed in the field for temperature, pH and specific conductance. Groundwater samples collected from each of the monitoring wells will also be sent to a MassDEP certified laboratory for analysis. At a minimum, laboratory analysis will include nitrate-nitrogen, total nitrogen, total phosphorus, sodium, and volatile organic compounds (VOCs). Groundwater sampling will be conducted in accordance with MassDEP guidance. A round of water levels will also be collected during each round of sampling. The water level data and water quality results will be submitted to the MassDEP for review.



Once the WWTF is operational, samples from the compliance monitoring wells will be collected and analyzed to demonstrate that the groundwater quality meets the standards specified by MassDEP. Groundwater sampling and water level monitoring will be performed at the locations, frequency, and for the parameters stipulated in the GWDP.

Groundwater samples collected during each sampling round will be sent to a MassDEP certified laboratory for analysis. Groundwater sampling will be conducted in accordance with MassDEP's guidelines. After each round of sampling, the water level data and water quality results will be submitted to the MassDEP for review.

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**Appendix A**  
**Correspondence**

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PUBLIC NOTICE

NOTICE OF HYDROGEOLOGIC EVALUATION

SCOPE OF WORK

PURSUANT TO 314 CMR 5.09(1)(b)

Downtown Area WWTF Discharge - Town of Orleans

Pursuant to 314 CMR 5.09(1)(b), public notice is hereby given that a Scope of Work for a Hydrogeologic Evaluation has been prepared and will be submitted to the Massachusetts Department of Environmental Protection at its Southeast Regional Office, 20 Riverside Drive, Lakeville, MA 02347. The Scope of Work was prepared on behalf of the Town of Orleans in support of a future Groundwater Discharge Permit to regulate proposed wastewater infrastructure for "Downtown Area" of Orleans.

Additional information regarding the Scope of Work may be obtained by contacting Mark Owen or Tom Parece from AECOM (9 Jonathan Bourne Drive, Pocasset, MA) at 978-905-2100; ([mark.owen@aecom.com](mailto:mark.owen@aecom.com)), [Tom.Parece@AECOM.com](mailto:Tom.Parece@AECOM.com).

Welcome to the *Environmental Monitor* page. In order to access previous issues of the *Environmental Monitor* published since the launch of the new MEPA website on September 23, 2009, please select the year and publication date from the following drop-down lists.

In order to access issues of the *Environmental Monitor* published from 2002 through September 9, 2009, please click on the Environmental Monitor Archives link.

Select Year: 2018 ▼  
 Select Publication Date: 01/24/2018 ▼

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## MEPA Environmental Monitor

Jan 24, 2018  
 Volume 89, Issue 06

The Environmental Monitor  
 a publication of the  
 Massachusetts Executive Office of Energy and Environmental Affairs  
 Charlie Baker, Governor  
 William F. Galvin, Secretary

The **Environmental Monitor** provides information on projects under review by the Massachusetts Environmental Policy Act (MEPA) office, recent MEPA decisions of the Secretary of Energy & Environmental Affairs, and public notices from environmental agencies. Please note that the links on this page require the use of Adobe Acrobat Reader®, which is available free of charge at <http://www.adobe.com/products/acrobat/readstep.html>.

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## Projects Submitted Jan 3, 2018 - Jan 16, 2018

### Environmental Notification Forms

EEA No.	Project Name	Location	Comments Due	For Copies	MEPA Analyst
15794	<a href="#">Mass Audubon/Wachusett Meadow Wildlife Pond Accessible Trail</a>	Princeton	02/13/2017	Cindy Dunn (978) 464-2712	Eve Schluter (617) 626-1131
15796	<a href="#">The Preserve at Abbyville and Abbyville Commons</a>	Norfolk	02/13/2018	Mary Ellen Radovanic (617) 896-4506	Erin Flaherty (617) 626-1128
15797	<a href="#">Squamantum Point Pier &amp; Ferry Dock Improvements Project</a>	Quincy	Withdrawn	Tracy Adamski (413) 572-3256	Page Czepiga (617) 626-1021
15798	<a href="#">White Cap Shoreline Stabilization Project</a>	Sandwich	02/13/2018	Jack Vaccaro (978) 897-7100	Erin Flaherty (617) 626-1128
15799	<a href="#">Fairfield Commons Development</a>	Somerset	03/13/2018	Joseph Freeman (781) 255-1982	Page Czepiga (617) 626-1021

### Environmental Notification Forms - Site Visits

EEA No.	Date	Time	Location
15794	02/02/2016	10:00 AM	Meet at Crocker House mtg. rm.,@ Wachusett Meadow Sanctuary, 113 Goodnow Rd., Princeton
15796	02/02/2018	10:00 AM	Meet at Norfolk Public Library, 139 Main St., Norfolk - Follow by Site Visit
15798	02/01/2018	1:00 PM	Meet at end of White Cap Path, Sandwich
15799	02/06/201	10:00 AM	Meet at Somerset Public Library (Large meeting room 1st flr.) 1464 County St. (adjacent to Town Hall) somerset

### Environmental Impact Reports

EEA No.	Project Name	Location	Document Type	Comments Due	For Copies	MEPA Analyst
15273	Eastham Water System - Phase 2	Eastham	Supplemental Draft Environmental Impact Report	02/23/2018	Mark White (617) 657-0200	Purvi Patel (617) 626-1029

### Notices of Project Change

No Data Found.

## Other Projects Under Review

### Environmental Notification Forms

EEA No.	Project Name	Location	Comments Due	For Copies	MEPA Analyst
15783	<a href="#">Suffolk Downs Redevelopment</a>	Boston and Revere	01/19/2018	Lauren DeVoe (617) 607-0091	Page Czepiga (617) 626-1021
15787	<a href="#">Vineyard Wind Connector</a>	Barnstable	01/30/2018	Holly Carlson (978) 897-7100	Purvi Patel (617) 626-1029
15788	<a href="#">Conveyance of Tenean St. Parcel to Sullivan McLaughlin Companies Inc.</a>	Boston (Dorchester)	01/19/2018	Michael Brodigan (617) 542-1871	Anne Canaday (617) 626-1035
15789	<a href="#">Fairhaven Development</a>	Fairhaven	01/30/2018	Colleen Medeiros (508) 823-2245	Purvi Patel (617) 626-1029
15792	<a href="#">S&amp;J Exco-MSW Facility Expansion</a>	Dennis	01/30/2018	Gregory Wirsen (508) 888-6034	Erin Flaherty (617) 626-1128
15793	<a href="#">Northeastern University MSC Seawater Intake</a>	Nahant	WITHDRAWN	Briscoe Lang	Alex Stryksy (617)

	<a href="#">Replacement</a>			(401) 334-4100	626-1025
15794	<a href="#">Mass Audubon/Wachusett Meadow Wildlife Pond Accessible Trail</a>	Princeton	02/13/2018	Cindy Dunn (978) 464-2712	Eve Schluter (617) 626 1131
15795	<a href="#">Middle Pond Beach Maintenance Project</a>	Taunton	WITHDRAWN	Alex Patterson (401) 330-1233	Purvi Patel (617) 626-1029

**Environmental Impact Reports**

EEA No.	Project Name	Location	Document Type	Comments Due	For Copies	MEPA Analyst
11202	MassDot Snow and Ice Control	Statewide	Final Environmental Impact Report	02/23/2018	Laurene Poland (857) 368-8821	Alex Strysky (617) 626-1025
15278	I-90 Allston Interchange Project	Boston	Draft Environmental Impact Report	02/9/2018	James Cerbone (857) 368-8792	Alex Strysky (617) 626-1025
15610	115 Winthrop Square	Boston	Draft Environmental Impact Report	02/09/2018	Corrine Snowdon (978) 897-7100	Page Czepiga (617) 626-1021

**Notices of Project Change**

EEA No.	Project Name	Location	Comments Due	For Copies	MEPA Analyst
13897	<a href="#">EIR &amp; CWMP/Main Lift Pumping Station Improvements</a>	Taunton	01/30/2018	Michael Andrus (401) 333-2382	Page Czepiga (617) 626-1021

**Secretary's Certificates Jan 3,2018 - Jan 16,2018****Environmental Notification Forms**

EEA No.	Project Name	Location	Action	Action Date
15781	<a href="#">Milford Power</a>	Milford	Does not Require an Environmental Impact Report	01/05/2018
15784	<a href="#">Snow Fields Estates</a>	Mattapoisett	Does not Require an Environmental Impact Report	01/05/2018
15785	<a href="#">Fames Mill Pond Dam Repair Project</a>	Paxton	Requires a Mandatory Environmental Impact Report	01/12/2018
15786	<a href="#">Lowell Area Gas Modernization Project</a>	Lowell, Chelmsford and Tewksbury	Requires an Environmental Impact Report	01/05/2018
15790	<a href="#">Masconomo Park and Morss Pier Improvements</a>	Manchester - By-The-Sea	Does not Require an Environmental Impact Report	01/19/2018
15791	<a href="#">Reconstruction of Main Street (Route 30)</a>	Southborough	Does not Require an Environmental Impact Report	01/19/2018

**Environmental Impact Reports**

EEA No.	Project Name	Location	Document Type	Action	Action Date
15355	<a href="#">Route 20 Reconstruction Project</a>	Charlton and Oxford	Draft Environmental Impact Report	Adequately and Properly complies	01/12/2018

**Notices of Project Change**

EEA No.	Project Name	Location	Action	Action Date
11333	<a href="#">Bourne Intergrated Solid Waste Management Facility</a>	Bourne	Requires a Mandatory Environmental Impact Report	01/12/2018
15745	<a href="#">Cochituate State Park Boat Ramp</a>	Natick	Does not Require an Environmental Impact Report	01/05/2018
4959	<a href="#">Lakeshore Center</a>	Bridgewater and Raynham	Does not Require a Supplemental Environmental Impact Report	01/19/2018
8161	<a href="#">Boston Marine Industrial Park Master Plan /a.k.a Raymond L.Flynn Marine</a>	Boston	Adequately and properly complies	01/19/2018

**Records of Decision**

EEA No.	Project Name	Location	Comments Due	Action	Action Date
15771	<a href="#">Field Pond Dam and Dike Rehabilitation</a>	Andover	01/30/2018	Propose to Grant a Waiver	11/29/2017

**Special Review Procedures**

No Data Found.

**Public Benefits Determinations**

EEA No.	Project Name	Location	Action	Action Date
15575	<a href="#">254-272 and 282R Lynnway</a>	Lynn	Determined to have public benefit	01/19/2018

**Advisory Opinions**

No Data Found.

**Requests for Advisory Opinion**

No Data Found.

**Public Notices**

Agency	Notice Type	Location
Ashburnham Conservation Commission	<a href="#">Notice of Intent to Initiate an Aquatic Management Program for Billy Ward Pond</a>	Ashburnham
CZM	<a href="#">Notice of Extension of the City of Boston's Consultation Session for the Downtown Waterfront District Municipal Harbor Plan</a>	Boston Harbor
CZM	<a href="#">Notice of Federal Consistency Reviews</a>	Boston, Dennis and Yarmouth
DCAMM	<a href="#">Notice of Public Hearing on Reuse Restrictions for Sale of Land</a>	Medford
DEP	<a href="#">Notice of Scope of Work for a Hydrogeological Evaluation</a>	Orleans
DEP	<a href="#">Notice of Application for a Combined Chapter 91 and 401 Water Quality Certification for the Bass River Marina</a>	Dennis
DEP	<a href="#">Notice of Application for a Combined Chapter 91 and 401 Water Quality Certification for Eversource Energy</a>	Boston
DEP	<a href="#">Notice of Application and Draft Groundwater Discharge Permit</a>	Norton
DEP	<a href="#">Notice of Application and Wastewater Management Program</a>	Statewide
DEP	<a href="#">Notice of a Draft Scope of Work and Public Meeting for Preparation of a Resource Management Plan</a>	Brockton
Groveland	<a href="#">Notice of Intent to Initiate an Ecological Restoration Project for Johnson's Pond</a>	Groveland

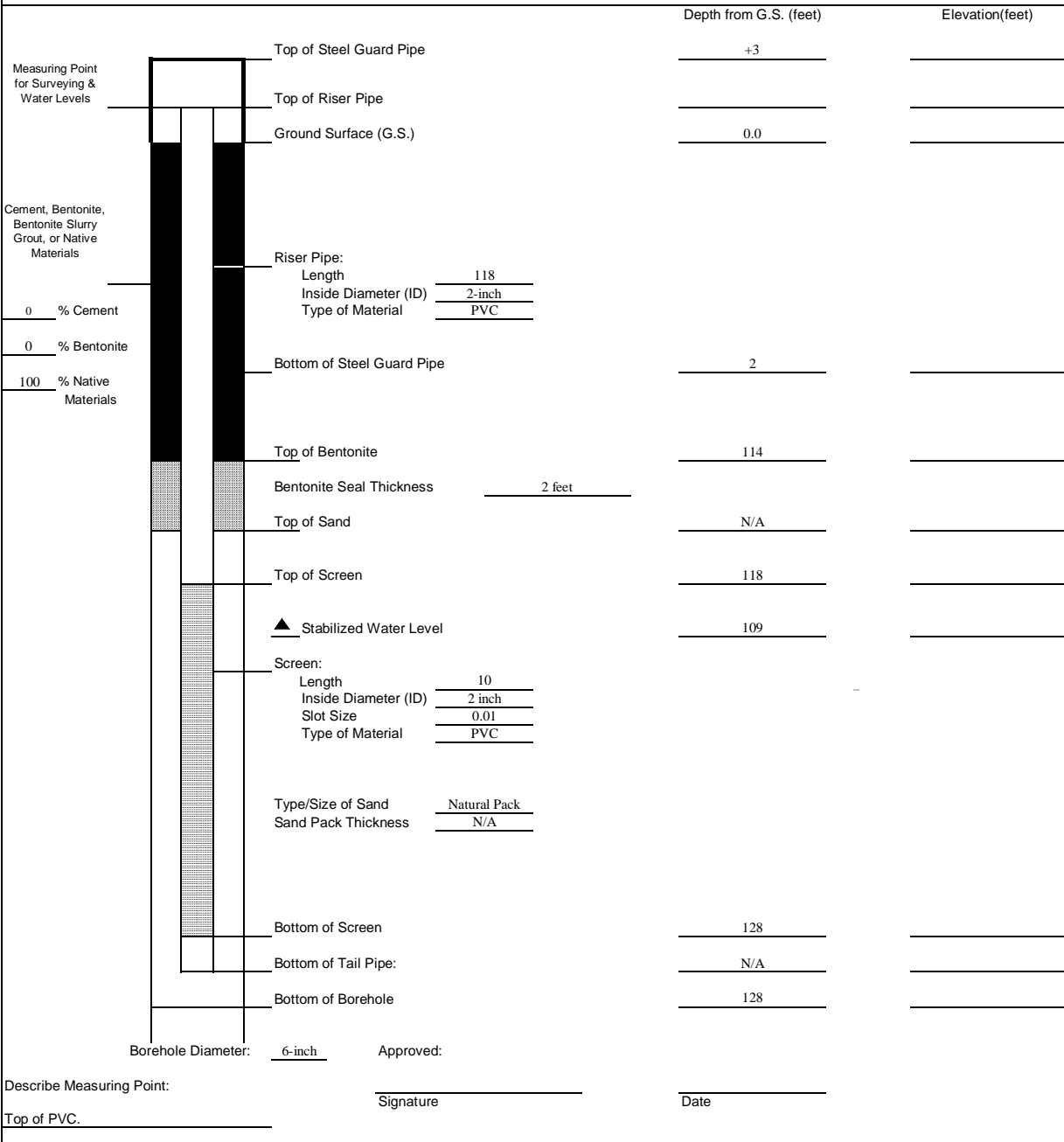
Conservation Commission		
MDAR	<a href="#">Notice of Public Hearing for Vegetation Management Plan and Yearly Operational Plan</a>	Eastern and Southeastern MA.
MDAR	<a href="#">Notice of Submission of a (YOP) Yearly Operational Plan</a>	Western MA
MDAR	<a href="#">Notice of Public Hearing for Vegetation Management Plan and Yearly Operational Plan</a>	Cape Cod and Martha's Vineyard
MDAR	<a href="#">Notice of Submission of a (YOP) Yearly Operational Plan</a>	Wilmington
Needham Conservation Commission	<a href="#">Notice of Intent to Initiate an Aquatic Plant Management Program for Forbes Pond</a>	Needham
Yarmouth Conservation Commission	<a href="#">Notice of Intent to Initiate an Ecological Restoration Project</a>	Yarmouth
Yarmouth Conservation Commission	<a href="#">Notice of Intent to Initiate an Aquatic Management Program for Perera Pond</a>	Yarmouth

**Appendix B**  
**Soil Boring, Monitoring Well and Wick Logs**

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<b>AECOM</b>	<i>Client: Town of Orleans</i>	<b>WELL ID: LH-1</b>	
	<i>Project Number: 60476644</i>		
	<i>Site Location: Orleans, MA</i>		<i>Date Installed: 01/03/2018</i>
	<i>Well Location: 32 Lots Hollow</i> <i>Coords:</i>		<i>Inspector: Erika Amir-Lin</i>
	<i>Method: CME truck mounted hollow-stem auger</i>		<i>Contractor: Desmond Drilling</i>

**MONITORING WELL CONSTRUCTION DETAIL**



Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-2**

Boring Number: 2  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 129 feet  
 Screen Depth: 119-129 feet  
 Screen length: 10 feet  
 Water Level: ~107 feet

Project Manager: M. Owen  
 Field Tech: E. Amir-Lin  
 Drilling Contractor: Desmond  
 Driller: Tommy/Josh  
 Date Started: 12/13/2017  
 Date Completed: 12/22/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	Fill Mat	Tube	Fill Mat	Depth
		0-6	6-12	12-18	18-24								
1									Well completed with 3 foot metal standpipe and concrete pad				1
2						27	dry	2" Dark brown loam/topsoil 3" Grey M SAND, little C sand, trace F sand. 22" Dark tan M SAND, little F sand, trace C sand.					2
3													3
4													4
5													5
6						47	dry	24" Tan F SAND, little M sand, trace C sand. 23" Light tan M SAND, some F sand, trace C sand.					6
7													7
8													8
9													9
10						26	dry	15" Tan M SAND, little F sand, trace C sand. 6" Brown F SAND. 5" Tan M SAND, little F sand, trace C sand.					10
11													11
12													12
13													13
14						41	moist	41" Orange-tan M SAND, little F sand, little C sand.	Schedule 40 PVC riser to surface Natural formation pack				14
15													15
16													16
17		No Blow Counts Collected - Drilled Direct Push to 88 feet											17
18						40	moist	Same as above; increasingly orange/Fe stained.					18
19													19
20													20
21													21
22						32	moist	28" Tan M SAND, little F sand, trace C sand. 4" Orange M SAND, little F sand, trace C sand.					22
23													23
24													24
25													25
26						26	moist	26" Light tan-buff M SAND, little C sand, trace F sand.					26
27													27
28													28
29													29
30						37	moist	16" Tan/brown mottled M SAND, occasional stringers of dark brown, F sand. 21" Tan-orange C SAND, little M sand, trace F sand.					30
31													31
32													32
33													33

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-2**

Boring Number: 2  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 129 feet  
 Screen Depth: 119-129 feet  
 Screen length: 10 feet  
 Water Level: ~107 feet

Project Manager: M. Owen  
 Field Tech: E. Amir-Lin  
 Date Started: 12/13/2017  
 Drilling Contractor: Desmond  
 Driller: Tommy/Josh  
 Date Completed: 12/22/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	Fill Mat	Tube	Fill Mat	Depth
		0-6	6-12	12-18	18-24								
34						41	moist	41" Tan M SAND, little F sand, trace C sand.				34	
35												35	
36												36	
37												37	
38						42	moist	42" Tan M SAND, little F sand, one 2" piece of subrounded C gravel.				38	
39												39	
40												40	
41												41	
42						37	moist	26" Tan M and C SAND, little F sand, trace F subrounded gravel. 11" Tan M SAND, some F sand, trace C sand.				42	
43												43	
44												44	
45												45	
46						36	moist	36" Light brown M SAND, clean.				46	
47												47	
48									Schedule 40 PVC riser to surface Natural formation pack			48	
49						36	moist	6" Orange-brown M SAND, some C sand, little F sand, trace F rounded gravel. 30" Tan M SAND, little F sand, coarse lens at 50.5 feet, at 50 feet a lens of F rounded gravel.				49	
50		No Blow Counts Collected - Drilled Direct Push to 88 feet										50	
51												51	
52												52	
53												53	
54						36	moist	8" Tan M SAND, some C sand, little F sand, trace F gravel. 2" Brown/grey mottled SILT. 26" Tan F SAND, one lens F gravel/C sand.				54	
55												55	
56												56	
57												57	
58						48	moist	14" Orange-tan-brown C SAND, little M sand, little F sand, little F subrounded to subangular gravel. 34" Tan F SAND, clean.				58	
59												59	
60												60	
61												61	
62						37	moist	8" Orange/tan mottled M SAND, some C sand, little F sand, trace F subrounded gravel. 23" Tan/orange mottled M SAND. 6" Tan F SAND, clean.				62	
63												63	
64												64	
65						39	moist	39" Tan F SAND, clean. Orange to dark brown lens at 65.5 feet.				65	
66												66	

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-2**

Boring Number: 2  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 129 feet  
 Screen Depth: 119-129 feet  
 Screen length: 10 feet  
 Water Level: ~107 feet

Project Manager: M. Owen  
 Field Tech: E. Amir-Lin  
 Date Started: 12/13/2017  
 Drilling Contractor: Desmond  
 Driller: Tommy/Josh  
 Date Completed: 12/22/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	Fill Mat	Tube	Fill Mat	Depth
		0-6	6-12	12-18	18-24								
67													67
68													68
69													69
70						29	moist	29" Tan-light brown F SAND. Orange mottling. Two lenses of brown SILT, 2" thick each, at 71 and 72 feet.					70
71													71
72													72
73													73
74						31	moist	6" Light brown F SAND. 25" Tan M SAND, slight Fe stain and mottling.					74
75													75
76													76
77													77
78						42	moist	42" Tan M SAND, trace F sand. Orange Fe mottling.	Schedule 40 PVC riser to surface Natural formation pack				78
79													79
80													80
81													81
82						47	moist	47" Light brown M SAND, little F sand.					82
83													83
84													84
85													85
86						41	moist	Same as above.					86
87													87
88													88
89						12		12" Tan-buff M SAND, some F sand.					89
90													90
91						15		15" Buff F SAND, clean.					91
92													92
93						19		19" Tan F SAND, clean.					93
94													94
95						22		22" Tan F SAND, clean.					95
96													96
97						21		16" Tan F SAND, clean, slight Fe mottling. 5" Buff M SAND, little F sand.					97
98													98
99						22	moist	22" Tan F SAND, little M sand, slight Fe mottling.					99

No Blow Counts Collected - Drilled Direct Push to 88 feet, then downhole hammer employed

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-2**

Boring Number: 2  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 129 feet  
 Screen Depth: 119-129 feet  
 Screen length: 10 feet  
 Water Level: ~107 feet

Project Manager: M. Owen  
 Drilling Contractor: Desmond  
 Field Tech: E. Amir-Lin  
 Driller: Tommy/Josh  
 Date Started: 12/13/2017  
 Date Completed: 12/22/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	FILM	Tube	FILM	Depth
		0-6	6-12	12-18	18-24								
100													100
101						22	moist	19" Light brown F SAND, little M sand. 3" Grey SILT, trace clay, little F-M sand.	Schedule 40 PVC riser to surface Natural formation pack				101
102						19	moist	19" Tan-light brown F SAND.		102			
103										103			
104						18	moist	11" Light brown F SAND. 4" Brown SILTY SAND, F sand. 3" Grey/brown mottled SILT, medium stiff.		104			
105										105			
106						24	moist-wet	3" Same as above; SILT. 21" Brown F SAND, some silt.		106			
107										107			
108						24	wet	24" Brown F SAND, little silt, Fe mottling, stiff.		108			
109										109			
110						18	wet	18" Brown F and M SAND, Fe staining, dense.		110			
111										111			
112						22	wet	22" Brown F and M SAND, dense.		112			
113										113			
114						18	wet	18" Brown F and M SAND, micaceous, dense.	114				
115									115				
116						17	wet	17" Brown M SAND, some F sand, lenses of reddish-brown M sand, dense.	116				
117									117				
118						14	wet	14" Brown M and F SAND, dense.	118				
119									119				
120						24	wet	25" Brown M SAND, little F sand, dense. 2" lens grey/brown mottled SILT at 121.5 feet.	120				
121									121				
122						24	wet	24" Brown M SAND, little F sand, dense.	122				
123									123				
124						21	wet	18" Brown M SAND, little F sand, dense. 3" Grey/brown mottled SILT, little clay, stiff.	124				
125									125				
126						24	wet	Brown M SAND, little F sand, dense.	126				
127									127				
128									128				
129								Bottom of Boring at 129 feet	129				
130									130				
131									131				
132									132				

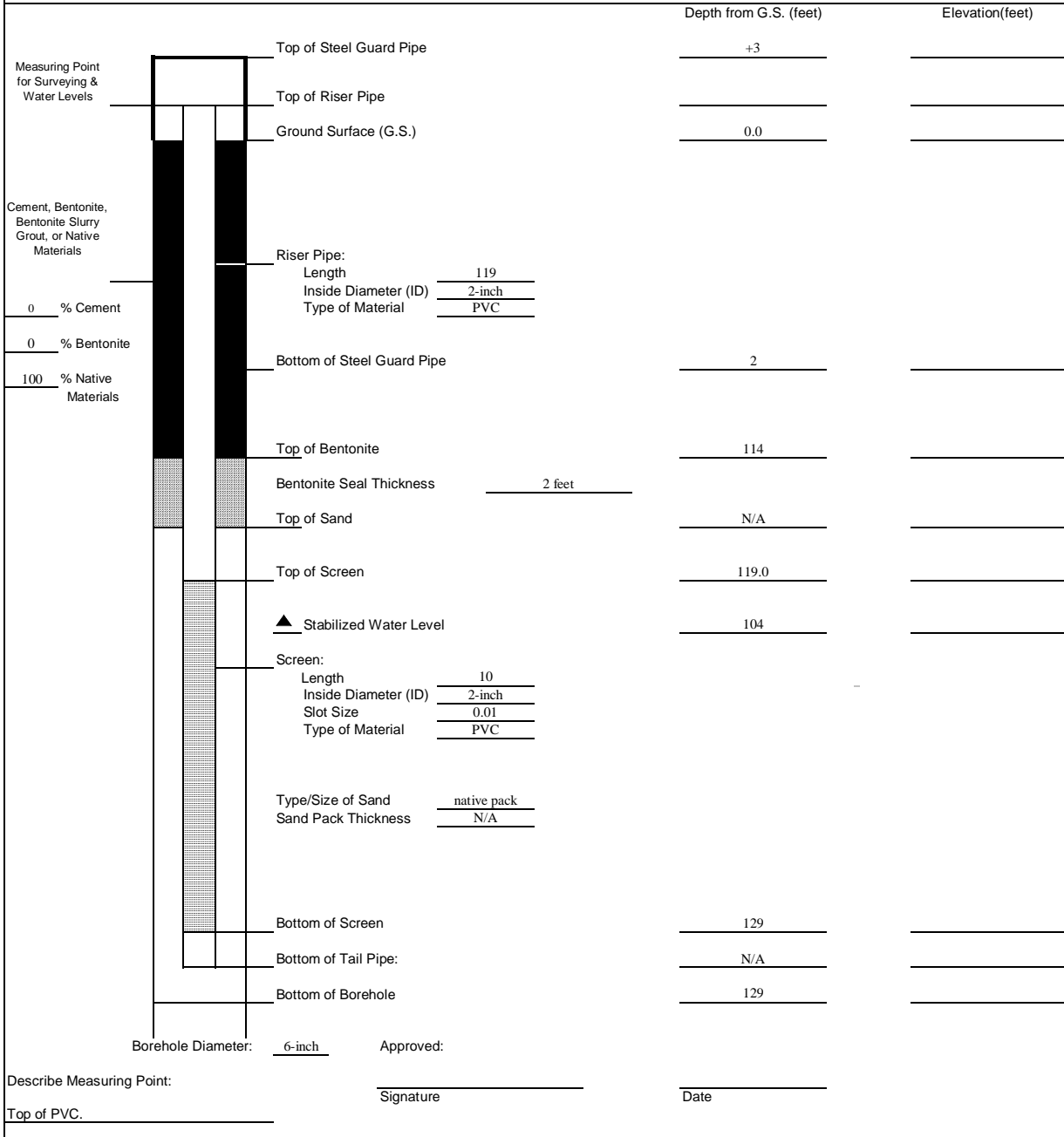
No Blow Counts Collected - Drilled Direct Push to 88 feet, then downhole hammer employed

.010 slot PVC screen

Notes: F=Fine, M=Medium, C=Coarse

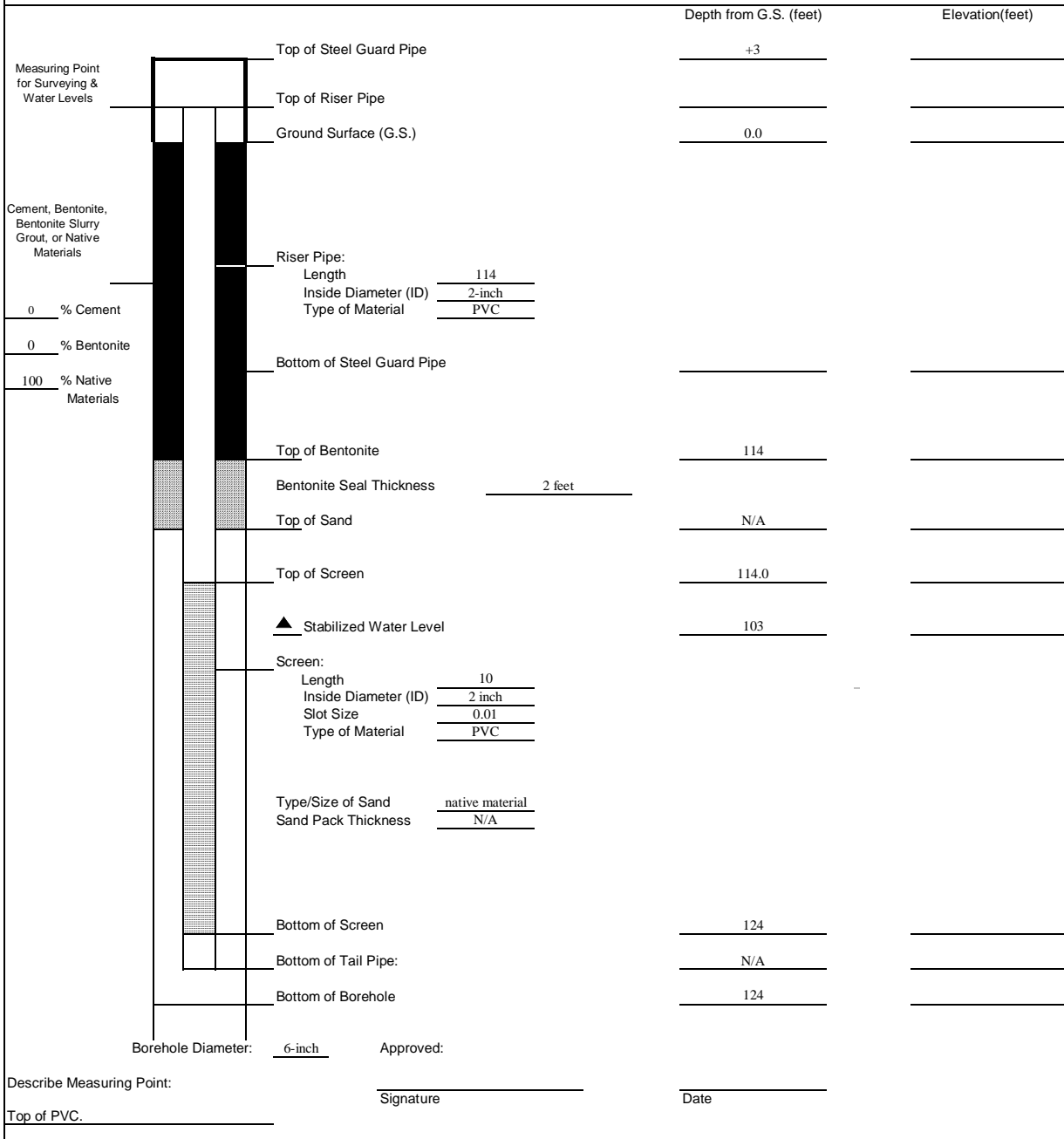
<b>AECOM</b>	<i>Client: Town of Orleans</i>	<b>WELL ID: LH-3</b>	
	<i>Project Number: 60476644</i>		
	<i>Site Location: Orleans, MA</i>		<i>Date Installed: 02/06/2018</i>
	<i>Well Location: 32 Lots Hollow</i> <i>Coords:</i>		<i>Inspector: Erika Amir-Lin</i>
	<i>Method: CME truck mounted hollow-stem auger</i>		<i>Contractor: Desmond Drilling</i>

**MONITORING WELL CONSTRUCTION DETAIL**



<b>AECOM</b>	Client: <i>Town of Orleans</i>	<b>WELL ID: LH-4</b>	
	Project Number: <i>60476644</i>		
	Site Location: <i>Orleans, MA</i>		Date Installed: <i>01/04/2018</i>
	Well Location: <i>32 Lots Hollow</i> Coords:		Inspector: <i>Erika Amir-Lin</i>
	Method: <i>CME truck mounted hollow-stem auger</i>		Contractor: <i>Desmond Drilling</i>

**MONITORING WELL CONSTRUCTION DETAIL**



Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-5**

Boring Number: 5  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 134 feet  
 Screen Depth: 115-125 feet  
 Screen length: 10 feet  
 Water Level: ~104 feet

Project Manager: M. Owen  
 Drilling Contractor: Desmond  
 Field Tech: E. Amir-Lin  
 Driller: Tommy/Josh  
 Date Started: 12/15/2017  
 Date Completed: 12/19/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	FILMat	Tube	FILMat	Depth	
		0-6	6-12	12-18	18-24									
1									Well completed with 3 foot metal standpipe and concrete pad				1	
2						25	dry	2" Brown loam.					2	
3								24" Yellow-brown M SAND, little F sand, trace C sand, trace F rounded gravel.					3	
4													4	
5													5	
6						21	dry	21" Light brown M SAND, intermittent Fe stained bands.					6	
7													7	
8													8	
9													9	
10						40	dry	18" Light brown M SAND, little C sand, Fe staining. 6" Light brown F SAND. 16" Light brown M SAND, little C sand, Fe staining.					10	
11													11	
12													12	
13													13	
14						22	dry	22" Light brown to orange-brown M SAND, some C sand, little F sand, trace F rounded gravel.					14	
15										Schedule 40 PVC riser to surface Natural formation pack			15	
16														16
17		No Blow Counts Collected - Drilled Direct Push to 80 feet												17
18						23	dry	23" Light brown M SAND, little F sand, trace C sand, trace F rounded gravel, mottled Fe stain.					18	
19													19	
20													20	
21													21	
22						28	dry	28" Light brown M SAND, some C sand, little F sand, trace F subrounded gravel, Fe staining.					22	
23													23	
24													24	
25													25	
26						34	dry	26" Tan M SAND, little C sand, trace F sand, trace F rounded gravel, occasional Fe stain. 8" Reddish brown C SAND, little F gravel, one piece C angular gravel, little M sand, trace F sand.					26	
27													27	
28													28	
29													29	
30						30	moist	30" Light brown M SAND, some C sand, little F sand, little F-C gravel.					30	
31													31	
32													32	
33													33	

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-5**

Boring Number: 5  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 134 feet  
 Screen Depth: 115-125 feet  
 Screen length: 10 feet  
 Water Level: ~104 feet

Project Manager: M. Owen  
 Field Tech: E. Amir-Lin  
 Date Started: 12/15/2017  
 Drilling Contractor: Desmond  
 Driller: Tommy/Josh  
 Date Completed: 12/19/2017

Depth	Sample Depth	Blow Counts (24")				Rec (')	Moisture	Field Identification	Description	Fill Mat	Tube	Fill Mat	Depth
		0-6	6-12	12-18	18-24								
34						30	moist	8" Light brown M SAND, some C sand, little F sand, little F-C gravel.	Schedule 40 PVC riser to surface Natural formation pack				34
35								22" Brown/tan mottled M SAND, little fine sand.					35
36													36
37													37
38						29'	moist	29" Brown-tan M SAND, little F sand, trace C sand.					38
39													39
40													40
41													41
42						42'	moist	42" Light brown-tan M SAND, little F sand, little C sand, lens of brown M and C sand at 43.3 feet.					42
43													43
44													44
45													45
46						40'	moist	40" Light brown-tan M SAND, little F, trace C, Fe staining.					46
47												47	
48												48	
49												49	
50						32'	moist	Same as above, decreasing Fe staining.				50	
51												51	
52												52	
53												53	
54						26'	moist	26" Tan M SAND, little F sand, little C sand, trace F subangular gravel.				54	
55												55	
56												56	
57												57	
58						30'	moist	10" Tan M SAND, occasional Fe staining. 3" Grey/brown mottled SILT. 5" Tan F SAND, Fe stain. 12" Tan M SAND, some F sand, occasional Fe staining.				58	
59												59	
60												60	
61												61	
62						31'	moist	31" Tan M SAND, little F sand, occasional dark brown bands.				62	
63												63	
64												64	
65												65	
66						36'	moist	36" Tan-light brown M SAND, little F sand, occasional Fe stain.				66	

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644  
 Client:  
 City of Orleans  
 Orleans, MA  
 Site Location:  
 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-5**

Boring Number: 5  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 134 feet  
 Screen Depth: 115-125 feet  
 Screen length: 10 feet  
 Water Level: ~104 feet

Project Manager: M. Owen  
 Field Tech: E. Amir-Lin  
 Date Started: 12/15/2017  
 Drilling Contractor: Desmond  
 Driller: Tommy/Josh  
 Date Completed: 12/19/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	Fill Mat	Tube	Fill Mat	Depth
		0-6	6-12	12-18	18-24								
67													67
68													68
69													69
70						38	moist	38" Tan-light brown M SAND, little F sand, trace Fe stain.					70
71													71
72													72
73													73
74						25	moist	21" Same as above, two C gravel pieces. 4" Brown F SAND with SILT.					74
75													75
76									Schedule 40 PVC riser to surface Natural formation pack				76
77													77
78						24	moist	24" Tan-light brown M SAND, little F sand, Fe staining.					78
79													79
80													80
81						22	moist	22" Tan M SAND, little F sand, clean.					81
82													82
83						22	moist	22" Light brown M SAND, little F sand, clean.					83
84													84
85						21	moist	21" Same as above.					85
86													86
87						19	moist	19" Tan M SAND, little F sand, clean.					87
88													88
89						20	moist	20" Light brown to tan M SAND, little F sand.					89
90													90
91						21	moist	21" Light brown M SAND, little F sand.					91
92													92
93						24	moist	24" Same as above.					93
94													94
95						24	moist	24" Same as above.					95
96													96
97						11	moist	11" Tan M SAND, little F sand.					97
98													98
99						24	moist	24" Light brown M SAND, little F sand, faint Fe staining.					99

No Blow Counts Collected - Drilled Direct Push to 80 feet, then downhole hammer employed

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644  
 Client: City of Orleans  
 Orleans, MA  
 Site Location: 32 Lots Hollow Road; Water Tower  
 Orleans, MA



250 Apollo Drive  
 Chelmsford, Massachusetts  
 (978) 905-2100

**Boring Log LH-5**

Boring Number: 5  
 Sheet: 1 of 4  
 Surface Elevation (ft-asl):  
 Equipment: CME  
 Inside Diameter:

**Well Data**

Boring Depth: 134 feet  
 Screen Depth: 115-125 feet  
 Screen length: 10 feet  
 Water Level: ~104 feet

Project Manager: M. Owen  
 Field Tech: E. Amir-Lin  
 Date Started: 12/15/2017  
 Drilling Contractor: Desmond  
 Driller: Tommy/Josh  
 Date Completed: 12/19/2017

Depth	Sample Depth	Blow Counts (24")				Rec (")	Moisture	Field Identification	Description	Fill Mat	Tube	Fill Mat	Depth
		0-6	6-12	12-18	18-24								
100													100
101						19	moist	19" Tan M SAND, some F sand, faint Fe staining.					101
102													102
103						24	moist	24" Light brown M SAND, little F sand.					103
104													104
105						24	moist - wet	24" Brown M sand, some F sand.	Time-release bentonite chip seal.				105
106													106
107						19	wet	19" Same as above.					107
108													108
109						22	wet	22" Brown M and F SAND.					109
110									Schedule 40 PVC riser to surface Natural formation pack				110
111						24	wet	24" Same as above.					111
112													112
113						18	wet	24" Same as above.					113
114													114
115						22	wet	22" Brown M SAND, some F sand.					115
116		No Blow Counts Collected - Drilled Direct Push to 80 feet, then downhole hammer employed											116
117						24	wet	19" Brown M SAND, some F sand. 5" Brown SANDY SILT.					117
118													118
119						24	wet	24" Brown M and F SAND, becoming M with some F at bottom of spoon.	0.010 slot PVC screen				119
120													120
121						24	wet	5" Brown M and F SAND. 1" Brown SILT. 18" Light brown M SAND, little F sand.					121
122													122
123						24	wet	3" Same as above. 21" Brown F and M SAND.					123
124													124
125						24	wet	24" Brown F SAND, little M sand.					125
126													126
127						21	wet	21" Same as above.					127
128													128
129						24	wet	24" Brown F SAND, trace M sand, clean.					129
130													130
131						20	wet	20" Same as above.					131
132													132
133						18	wet	18" Brown M SAND, some F sand.					133
134		<b>Bottom of Boring at 134 feet</b>											134
135													135

Notes: F=Fine, M=Medium, C=Coarse

<b>AECOM</b>	<i>Client: Town of Orleans</i>	<b>Test Wick - 32 Lots Hollow</b>	
	<i>Project Number: 60476644</i>		
	<i>Site Location: Orleans, MA</i>		<i>Date Installed: 02/06/2018</i>
	<i>Well Location: 32 Lots Hollow</i> <i>Coords:</i>		<i>Inspector: Erika Amir-Lin</i>
	<i>Method: CME truck mounted hollow-stem auger</i>		<i>Contractor: Desmond Drilling</i>

**WICK DISCHARGE CONSTRUCTION DETAIL**

		Depth from G.S. (feet)	Elevation(feet)
Measuring Point for Surveying & Water Levels	Top of Plastic Culvert Pipe (6-foot diameter)	+2	
	Top of PVC well	+1	
	Ground Surface (G.S.)	0.0	
Cement, Bentonite, Bentonite Slurry Grout, or Native Materials	Well Riser Pipe: Length <u>25</u> Inside Diameter (ID) <u>2-inch</u> Type of Material <u>PVC</u>		
	Bottom of Plastic Culvert Pipe	4	
	Note: PVC well set in center of the wick.	N/A	
		N/A	
0 % Cement			
0 % Bentonite			
100 % Native Materials			
	Top of Screen	25	
	▲ Stabilized Water Level	above water table	
	Screen: Length <u>80</u> Inside Diameter (ID) <u>2 inch</u> Slot Size <u>0.01</u> Type of Material <u>PVC</u>		
	Type/Size of Sand <u>3/8" gravel -</u> Sand Pack Thickness <u>5 inches</u>		
	Bottom of Screen	105	
	Bottom of Tail Pipe:	N/A	
	Bottom of Borehole	105	
	Borehole Diameter: <u>12-inch</u> Approved: _____		
Describe Measuring Point:	Signature _____	Date _____	
Top of PVC.			

**Appendix C**  
**Laboratory Reports - Soils**

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**SOILS LABORATORY TESTING ASSIGNMENT SHEET**



401-467-6454

195 Frances Ave., Cranston, RI 02910

Project Name Orleans - GWDP

Client Town of Orleans

Assigned By \_\_\_\_\_

CTS Project No. 60476644.01.01

Site Location LH 37 Lots Hollow

Collected By Mark Owen

ESS Project No. \_\_\_\_\_

Date Assigned \_\_\_\_\_

Received By \_\_\_\_\_

Project Manager T. Parece

Date Received \_\_\_\_\_

Date Required None

Sample Information			Lab No.	Identification Tests						Permeability			Compaction		Strength		Consol.	Notes				
Boring/ Test Pit No.	Sample No.	Depth Ft.		Sample Date	ESS SAMPLE ID	Water Cont. %	LL & PL %	Org. %	Sieve -200 %	Hyd -2µ %	G <sub>s</sub>	γ <sub>t</sub> pcf	Sand	Clay	Mod.	Std.			CBR	Tor- vane	Type Test σ <sub>c</sub> or σ <sub>c</sub>	
LH-2	1	36-40	12/14/17					X				D2434	D5084	D1557	D698	D1883			D21667/D4767/ D2850	Cc/ I+eo	D2435	
LH-5	1	80-96	12/18/17					X														
LH-2	2	106	12/20/17					X	X													
LH-5	2	118	12/19/17					X	X													
LH-5	3	124-132	12/19/17					X														
LH-2	3	106-108	12/20/17					X														
MW-2 (235-245)	1	36	7/20/17					X														
MW-2 (235-245)	2	66	7/20/17					X														
MW-2 (235-245)	3	101	7/20/17					X	X													
MW-2 (235-245)	4	165	7/20/17					X	X													
MW-2 (235-245)	5	186-196	7/21/17					X														
MW-2 (235-245)	6	226	7/21/17					X														

Notes: Sampler with LH Designation = 37 Lots Hollow, Sampler with MW Designation = 43 Lots Hollow

# THIELSCH

## ENGINEERING

195 Frances Avenue  
Cranston RI, 02910  
Phone: (401)-467-6454  
Fax: (401)-467-2398  
<http://www.thielsch.com>  
Let's Build a Solid Foundation

Client Information:  
AECOM / Town Of Orleans  
Boston, MA  
PM: Tom Parece  
Collected By: Mark Owen  
Client Project #: 60476644.01.01

Project Information:  
Orleans - GWDP  
Orleans, MA  
TEI Project Number: 60476644.01.01  
Summary Page: 1 of 1  
Report Date: 02.23.18

### LABORATORY TESTING DATA SHEET

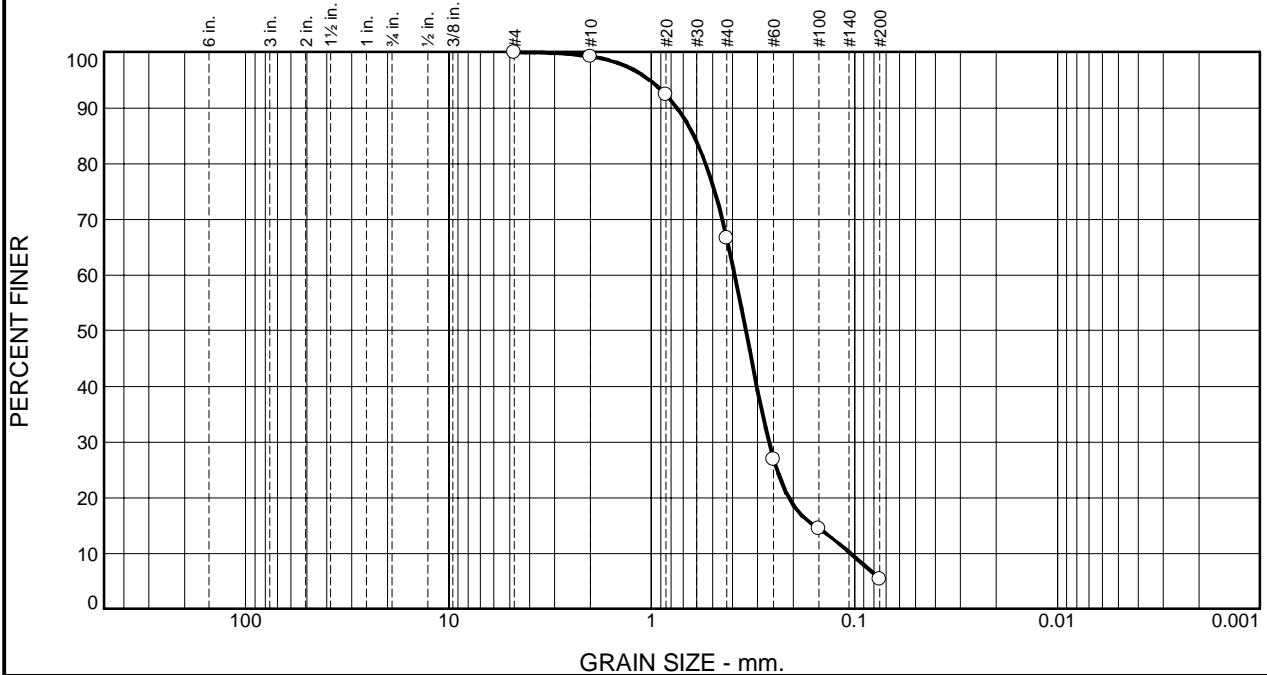
Boring ID / Source	Sample No. / Material	Depth (ft)	CTS Laboratory No.	Identification Tests						Corrosivity Tests						Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Sulfide (mg/kg)	Redox Potential (mv)	Electrical Resist. As Received Ohm-cm	
LH-2	1	30-40	18-S-163				0.0	94.6	5.4							Brown poorly graded sand with silt (SP - SM)
LH-5	1	80-96	18-S-164				0.0	97.2	2.8							Brown poorly graded sand (SP)
LH-2	2	106	18-S-165				0.0	20.4	79.6							Grey-brown silt with sand (ML)
LH-5	2	118	18-S-166				0.0	22.0	78.0							Brown silt with sand (ML)
LH-5	3	124-132	18-S-167				0.0	96.7	3.3							Brown poorly graded sand (SP)
LH-2	3	106-108	18-S-168				0.0	76.6	23.4							Brown silty sand (SM)
MW-2 (235-245)	1	36	18-S-169				0.0	78.6	21.4							Brown silty sand (SM)
MW-2 (235-245)	2	66	18-S-170				0.0	97.0	3.0							Brown poorly graded sand (SP)
MW-2 (235-245)	3	101	18-S-171				0.0	7.2	92.8							Brown silt (ML)
MW-2 (235-245)	4	165	18-S-172				0.0	58.3	41.7							Grey sandy silt (SM)
MW-2 (235-245)	5	186-196	18-S-173				0.0	94.4	5.6							Gray poorly graded sand with silt (SP - SM)
MW-2 (235-245)	6	226	18-S-174				0.0	95.0	5.0							Gray poorly graded sand with silt (SP - SM)

Reviewed By

Date Reviewed

02.26.18

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	32.6	61.2	5.4	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.2		
#20	92.4		
#40	66.6		
#60	26.9		
#100	14.5		
#200	5.4		

\* (no specification provided)

**Material Description**

Brown poorly graded sand with silt (SP - SM)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP-SM    AASHTO (M 145)= A-3

**Coefficients**

D<sub>90</sub>= 0.7483              D<sub>85</sub>= 0.6191              D<sub>60</sub>= 0.3887  
D<sub>50</sub>= 0.3433              D<sub>30</sub>= 0.2636              D<sub>15</sub>= 0.1577  
D<sub>10</sub>= 0.1044              C<sub>u</sub>= 3.72                      C<sub>c</sub>= 1.71

Remarks


---

Date Received: 02.20.18              Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples  
Sample Number: LH-2 / S-1

Depth: 30-40'

Date Sampled: 12.14.17

**Thielsch Engineering Inc.**

**Cranston, RI**

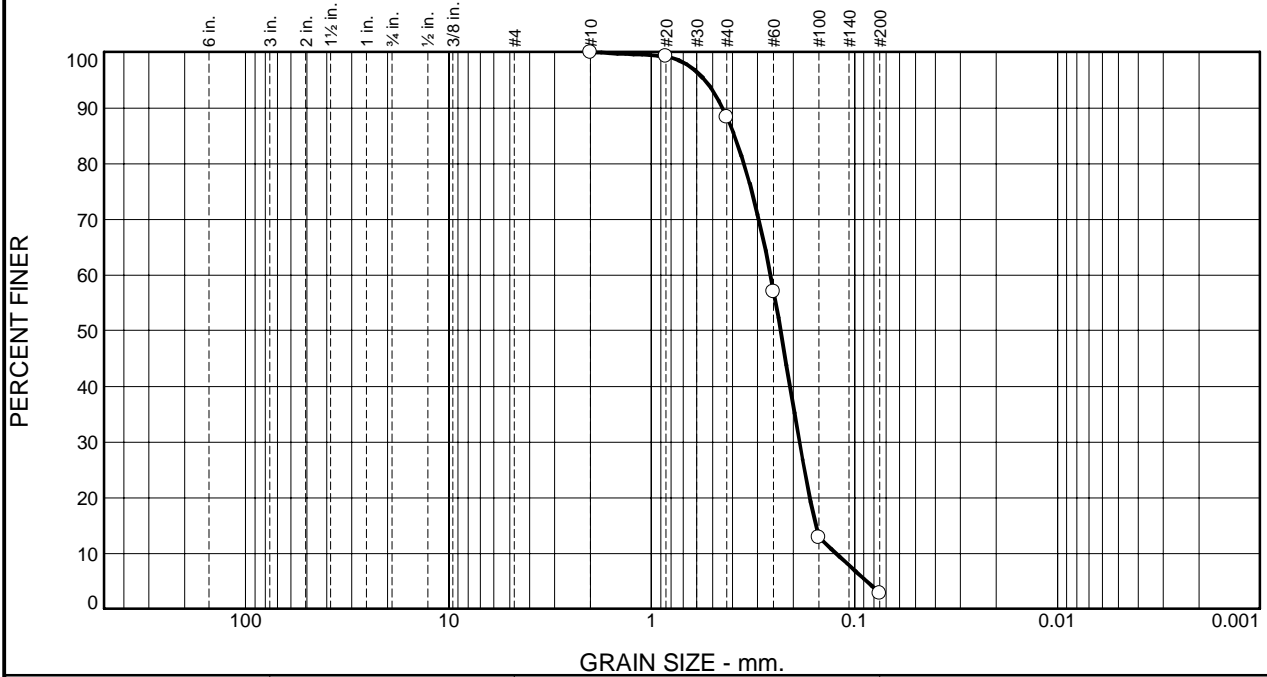
Client: AECOM / Town Of Orleans

Project: Orleans-GWDP  
Orleans, MA

Project No: 06476644.01.01

Figure 18-S-163

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	11.7	85.5	2.8	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.3		
#40	88.3		
#60	57.0		
#100	12.9		
#200	2.8		

**Material Description**

Brown poorly graded sand (SP)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP                      AASHTO (M 145)= A-3

**Coefficients**

D<sub>90</sub>= 0.4468                      D<sub>85</sub>= 0.3902                      D<sub>60</sub>= 0.2592  
 D<sub>50</sub>= 0.2310                      D<sub>30</sub>= 0.1866                      D<sub>15</sub>= 0.1550  
 D<sub>10</sub>= 0.1231                      C<sub>u</sub>= 2.11                      C<sub>c</sub>= 1.09

Remarks

---

Date Received: 02.20.18                      Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

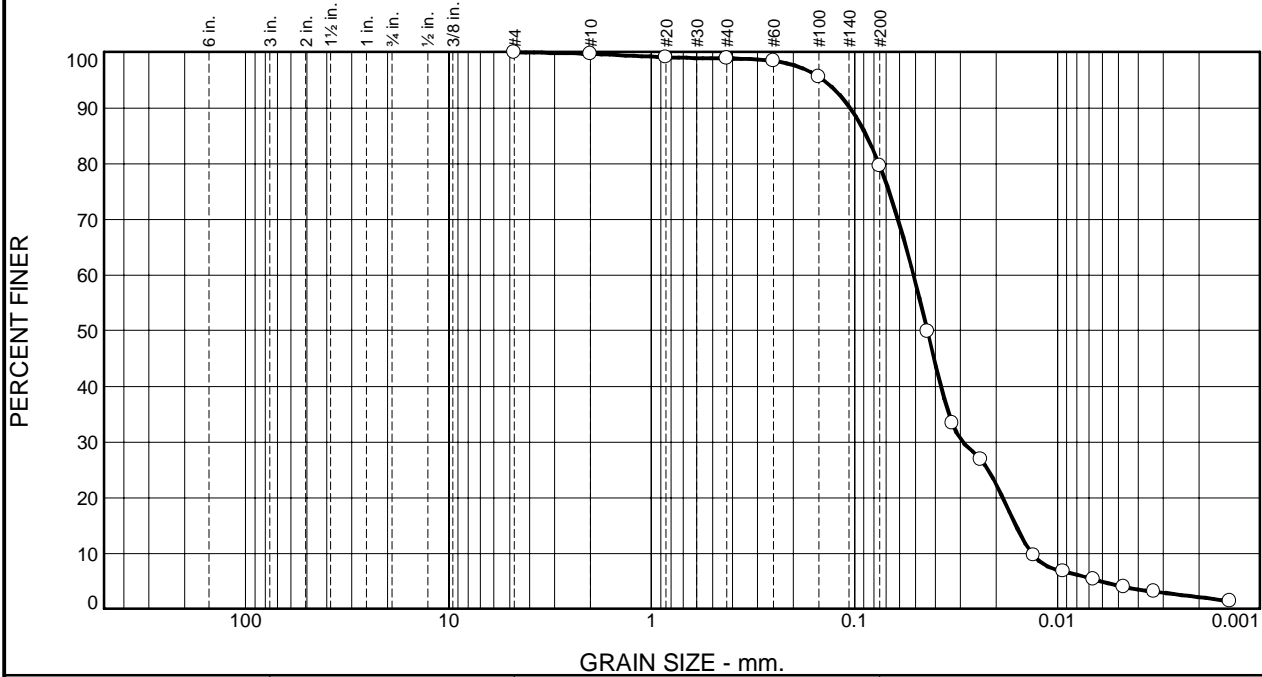
Title: Laboratory Manager

\* (no specification provided)

Source of Sample: Exploratory Samples                      Depth: 80-96'                      Date Sampled: 12.18.17  
 Sample Number: LH-5 / S-1

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	Client: AECOM / Town Of Orleans Project: Orleans-GWDP Orleans, MA Project No: 06476644.01.01
<b>Figure 18-S-164</b>	

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	0.8	19.3	77.5	2.1

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.7		
#20	99.1		
#40	98.9		
#60	98.4		
#100	95.6		
#200	79.6		
0.0436 mm.	49.9		
0.0330 mm.	33.4		
0.0239 mm.	26.9		
0.0131 mm.	9.6		
0.0093 mm.	6.8		
0.0066 mm.	5.3		
0.0047 mm.	4.0		
0.0033 mm.	3.1		
0.0014 mm.	1.4		

\* (no specification provided)

**Material Description**

Grey-brown silt with sand (ML)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= ML                      AASHTO (M 145)= A-4(0)

**Coefficients**

D<sub>90</sub>= 0.1051                      D<sub>85</sub>= 0.0872                      D<sub>60</sub>= 0.0511  
D<sub>50</sub>= 0.0437                      D<sub>30</sub>= 0.0292                      D<sub>15</sub>= 0.0160  
D<sub>10</sub>= 0.0133                      C<sub>u</sub>= 3.84                      C<sub>c</sub>= 1.25

**Remarks**

Material was visually checked for plasticity and rolled to approximately 3/16" thread diameter.

Date Received: 02.20.18                      Date Tested: 02.23.18

Tested By: MN

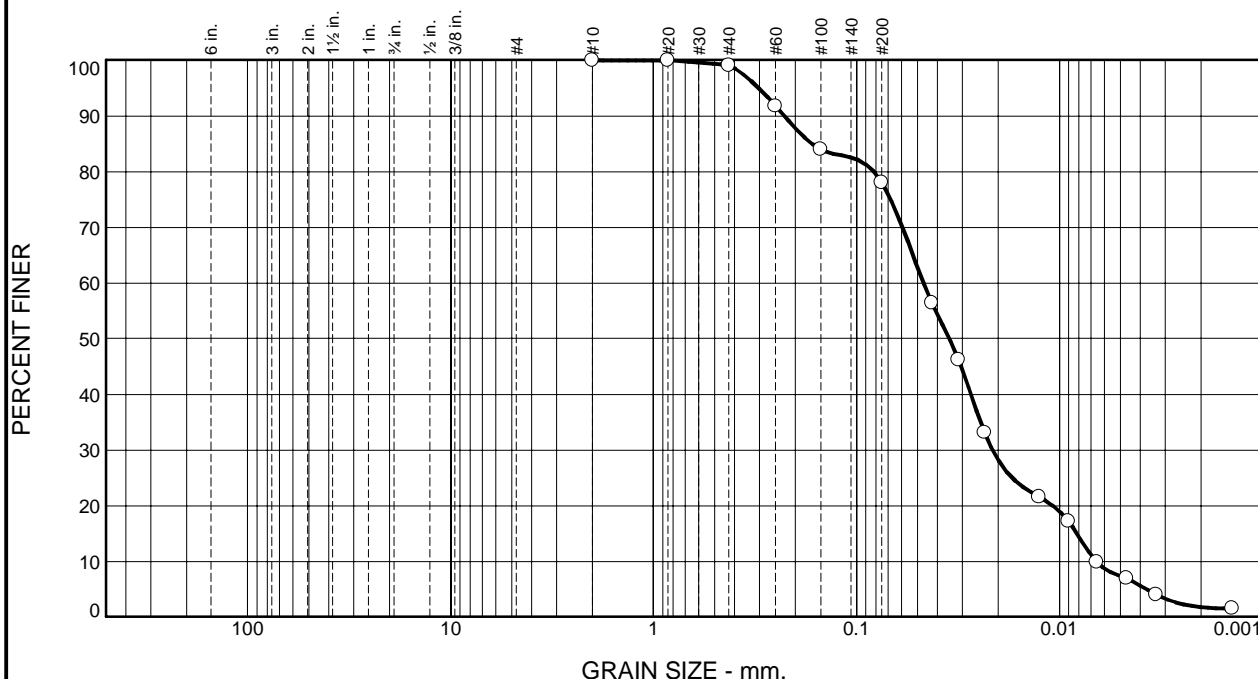
Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples                      Depth: 106'                      Date Sampled: 12.20.17  
Sample Number: LH-2 / S-2

<b>Thielsch Engineering Inc.</b>	Client: AECOM / Town Of Orleans
<b>Cranston, RI</b>	Project: Orleans-GWDP Orleans, MA
	Project No: 06476644.01.01                      Figure 18-S-165

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.9	21.1	76.2	1.8

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	99.1		
#60	91.8		
#100	84.0		
#200	78.0		
0.0425 mm.	56.4		
0.0314 mm.	46.2		
0.0234 mm.	33.1		
0.0126 mm.	21.5		
0.0090 mm.	17.2		
0.0065 mm.	9.9		
0.0047 mm.	6.9		
0.0033 mm.	4.0		
0.0014 mm.	1.5		

\* (no specification provided)

**Material Description**

Brown silt with sand (ML)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= ML                      AASHTO (M 145)= A-4(0)

**Coefficients**

D<sub>90</sub>= 0.2269                      D<sub>85</sub>= 0.1658                      D<sub>60</sub>= 0.0467  
D<sub>50</sub>= 0.0348                      D<sub>30</sub>= 0.0213                      D<sub>15</sub>= 0.0082  
D<sub>10</sub>= 0.0066                      C<sub>u</sub>= 7.10                      C<sub>c</sub>= 1.48

**Remarks**

Material was visually checked for plasticity and rolled to 3/16 thread diameter.

---

Date Received: 02.20.18                      Date Tested: 02.23.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples  
Sample Number: LH-5 / S-2

Depth: 118'

Date Sampled: 12.19.17

**Thielsch Engineering Inc.**

**Cranston, RI**

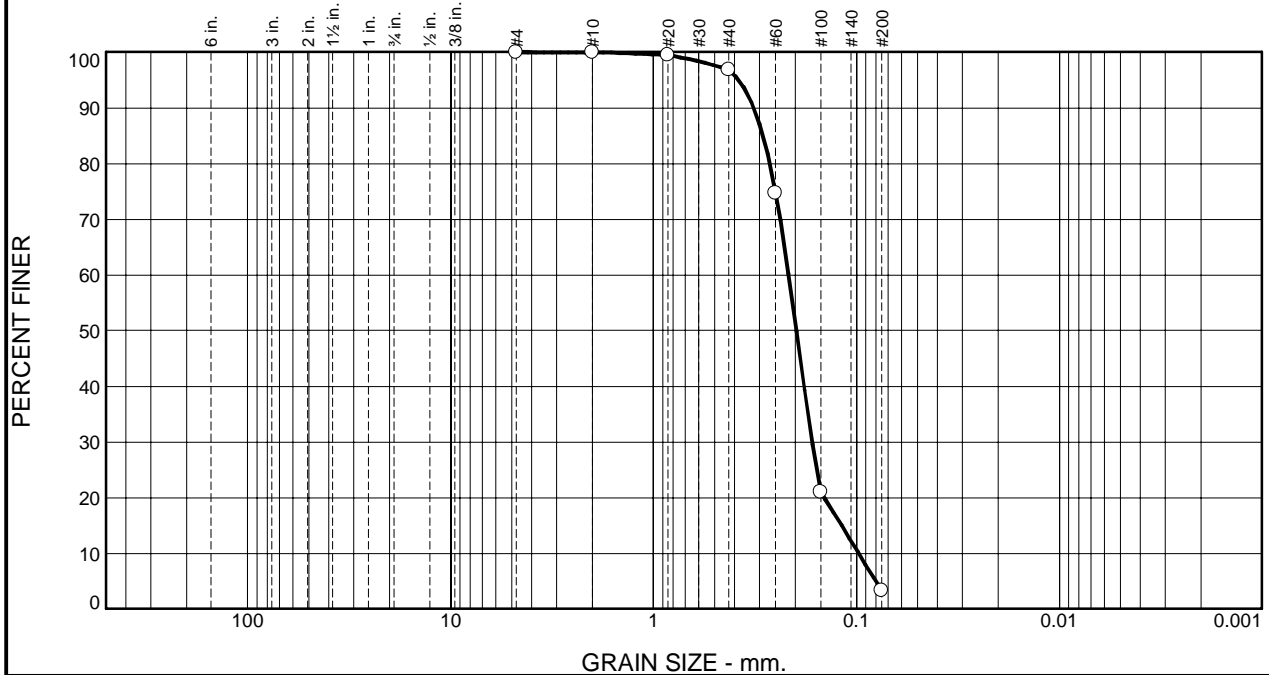
Client: AECOM / Town Of Orleans

Project: Orleans-GWDP  
Orleans, MA

Project No: 06476644.01.01

Figure 18-S-166

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.2	93.5	3.3	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	99.5		
#40	96.8		
#60	74.7		
#100	21.0		
#200	3.3		

**Material Description**  
Brown poorly graded sand (SP)

**Atterberg Limits (ASTM D 4318)**  
 PL= NP      LL= NV      PI= NP

**Classification**  
 USCS (D 2487)= SP      AASHTO (M 145)= A-3

**Coefficients**  
 D<sub>90</sub>= 0.3207      D<sub>85</sub>= 0.2889      D<sub>60</sub>= 0.2159  
 D<sub>50</sub>= 0.1977      D<sub>30</sub>= 0.1652      D<sub>15</sub>= 0.1185  
 D<sub>10</sub>= 0.0974      C<sub>u</sub>= 2.22      C<sub>c</sub>= 1.30

Remarks

---

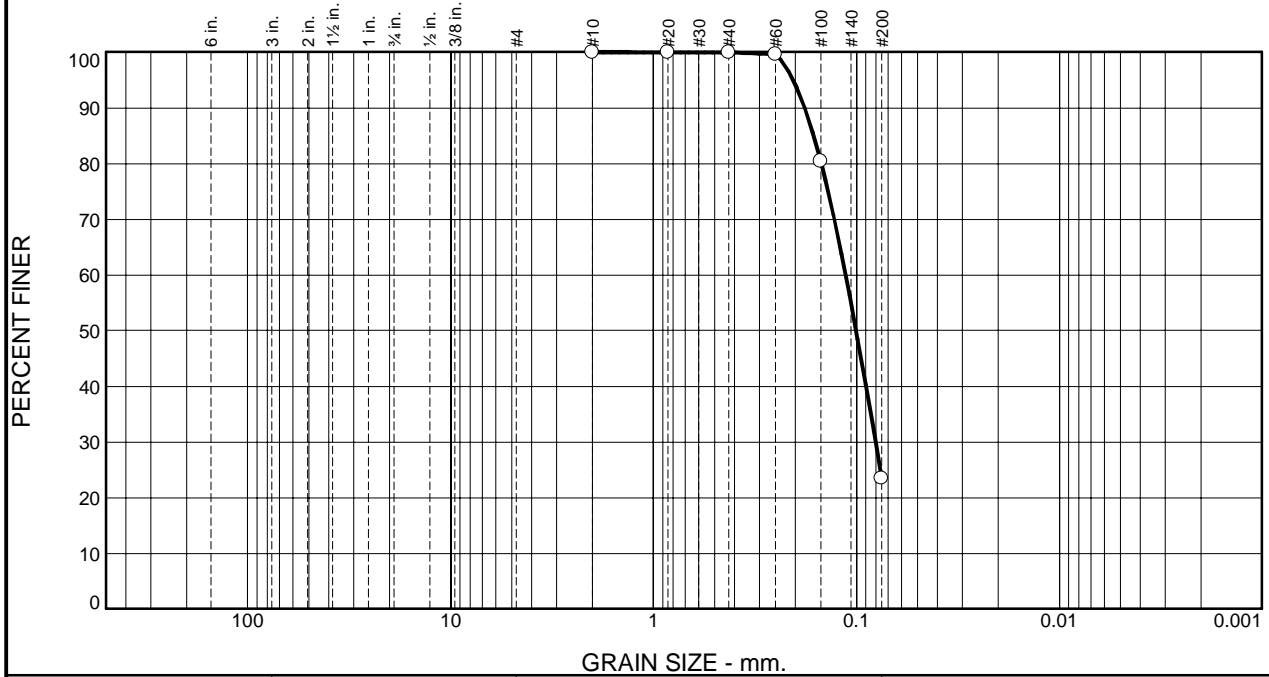
Date Received: 02.20.18      Date Tested: 02.22.18  
 Tested By: MN  
 Checked By: Matthew Colman P.E.  
 Title: Laboratory Manager

\* (no specification provided)

Source of Sample: Exploratory Samples      Depth: 124-132'      Date Sampled: 12.19.18  
 Sample Number: LH-5 / S-3

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> AECOM / Town Of Orleans
	<b>Project:</b> Orleans-GWDP Orleans, MA
	<b>Project No:</b> 06476644.01.01
	<b>Figure</b> 18-S-167

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	76.6	23.4	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.6		
#100	80.4		
#200	23.4		

**Material Description**

Brown silty sand (SM)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SM                      AASHTO (M 145)= A-2-4(0)

**Coefficients**

D<sub>90</sub>= 0.1801                      D<sub>85</sub>= 0.1625                      D<sub>60</sub>= 0.1130  
D<sub>50</sub>= 0.1004                      D<sub>30</sub>= 0.0805                      D<sub>15</sub>=  
D<sub>10</sub>=                                      C<sub>u</sub>=                                      C<sub>c</sub>=

**Remarks**

Material was visually checked for plasticity and appeared non-plastic.

---

Date Received: 02.20.18                      Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

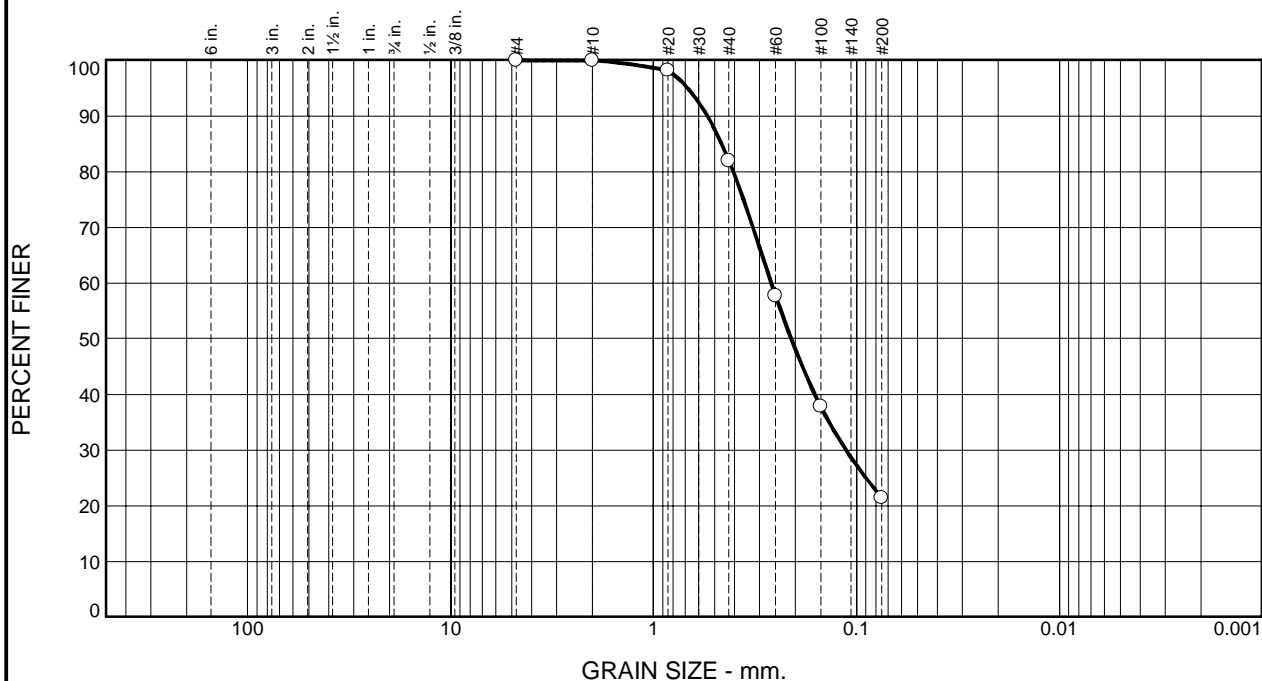
Title: Laboratory Manager

\* (no specification provided)

Source of Sample: Exploratory Samples                      Depth: 106-108'                      Date Sampled: 12.20.17  
Sample Number: LH-2 / S-3

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> AECOM / Town Of Orleans <b>Project:</b> Orleans-GWDP Orleans, MA <b>Project No:</b> 06476644.01.01
---	--

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	18.1	60.5	21.4	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	98.2		
#40	81.9		
#60	57.7		
#100	37.8		
#200	21.4		

\* (no specification provided)

**Material Description**

Brown silty sand (SM)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SM                      AASHTO (M 145)= A-2-4(0)

**Coefficients**

D<sub>90</sub>= 0.5430                      D<sub>85</sub>= 0.4618                      D<sub>60</sub>= 0.2628  
D<sub>50</sub>= 0.2097                      D<sub>30</sub>= 0.1126                      D<sub>15</sub>=  
D<sub>10</sub>=                                      C<sub>u</sub>=                                      C<sub>c</sub>=

**Remarks**

Material was visually checked for plasticity and appeared non-plastic.

---

Date Received: 02.20.18                      Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples  
Sample Number: MW-2 / S-1

Depth: 36'

Date Sampled: 07.20.17

**Thielsch Engineering Inc.**

**Cranston, RI**

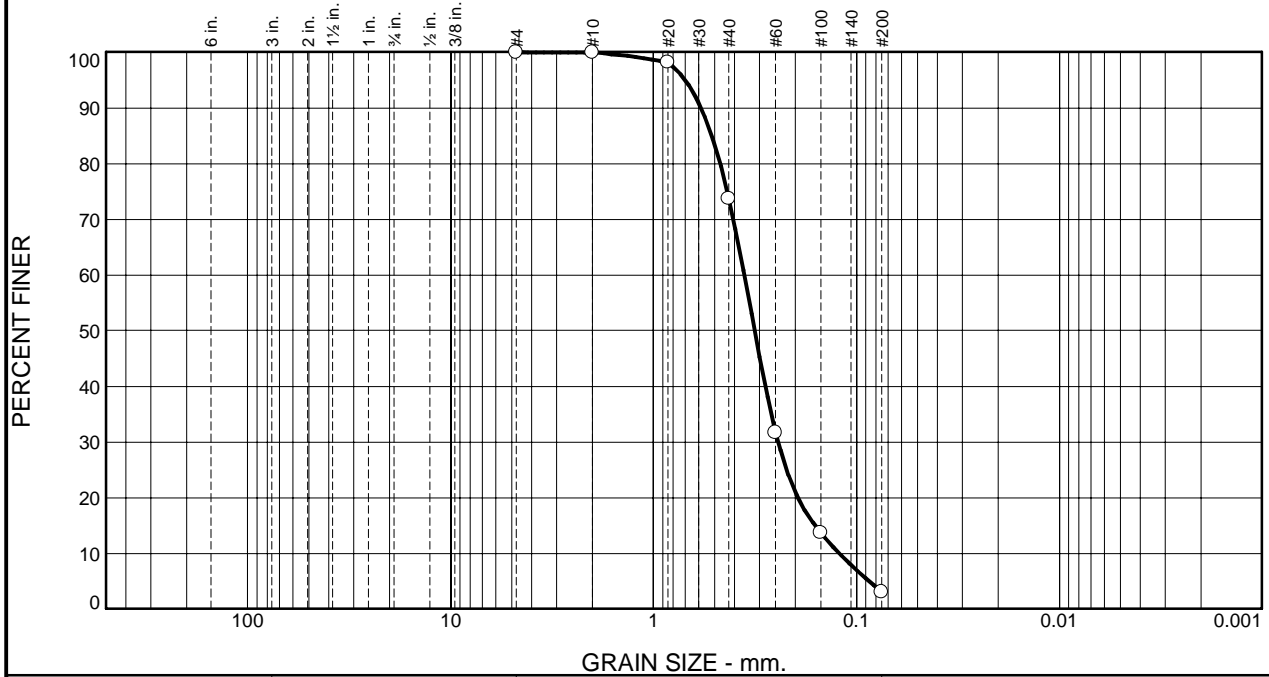
Client: AECOM / Town Of Orleans

Project: Orleans-GWDP  
Orleans, MA

Project No: 06476644.01.01

Figure 18-S-169

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	26.2	70.7	3.0	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	98.2		
#40	73.7		
#60	31.7		
#100	13.7		
#200	3.0		

**Material Description**

Brown poorly graded sand (SP)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI=

**Classification**

USCS (D 2487)= SP                      AASHTO (M 145)=

**Coefficients**

D<sub>90</sub>= 0.5840                      D<sub>85</sub>= 0.5166                      D<sub>60</sub>= 0.3570  
D<sub>50</sub>= 0.3175                      D<sub>30</sub>= 0.2433                      D<sub>15</sub>= 0.1602  
D<sub>10</sub>= 0.1215                      C<sub>u</sub>= 2.94                      C<sub>c</sub>= 1.36

Remarks

---

Date Received: 02.20.17                      Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman, P.E.

Title: Laboratory Manager

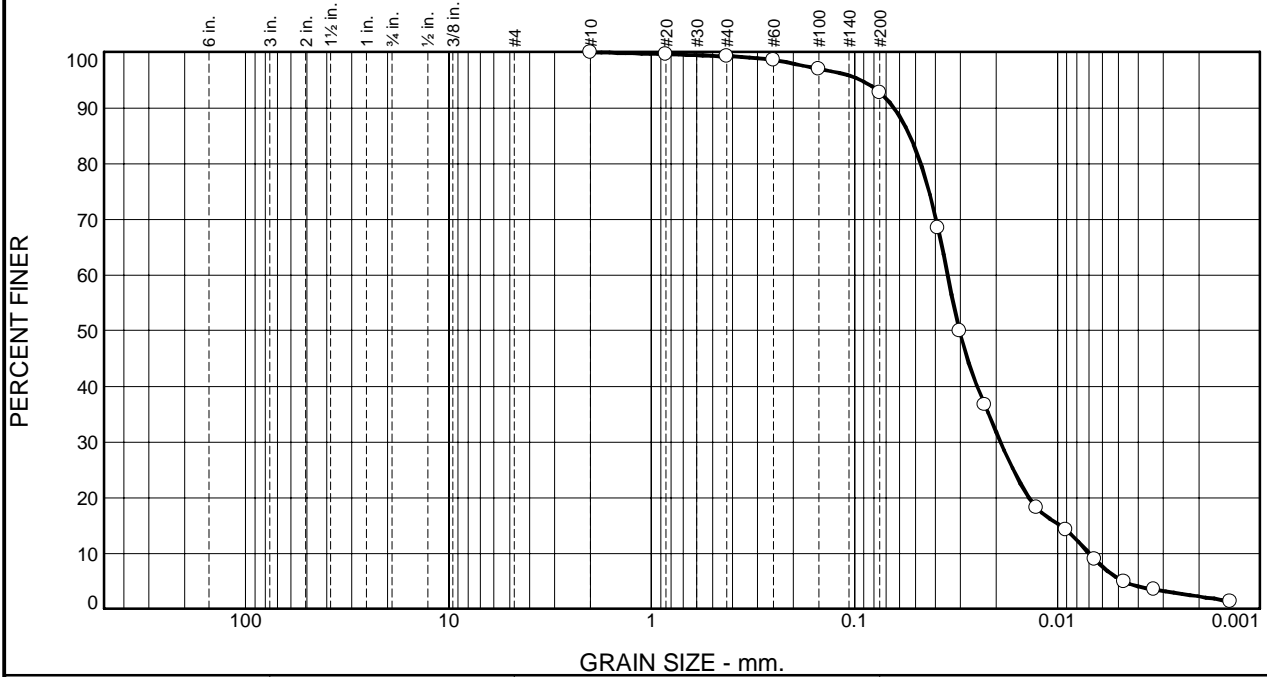
\* (no specification provided)

Source of Sample: Exploratory Samples                      Depth: 66'                      Date Sampled: 07.20.17  
Sample Number: MW-2 / S-2

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> AECOM / Town Of Orleans <b>Project:</b> Orleans-GWDP Orleans, MA <b>Project No:</b> 06476644.01.01
---	--

**Figure 18-S-170**

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.7	6.5	90.5	2.3

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.7		
#40	99.3		
#60	98.6		
#100	97.0		
#200	92.8		
0.0388 mm.	68.4		
0.0303 mm.	49.9		
0.0228 mm.	36.7		
0.0126 mm.	18.2		
0.0091 mm.	14.2		
0.0065 mm.	8.9		
0.0047 mm.	4.9		
0.0033 mm.	3.5		
0.0014 mm.	1.4		

\* (no specification provided)

**Material Description**

Brown silt (ML)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= ML                      AASHTO (M 145)= A-4(0)

**Coefficients**

D<sub>90</sub>= 0.0638                      D<sub>85</sub>= 0.0533                      D<sub>60</sub>= 0.0347  
D<sub>50</sub>= 0.0303                      D<sub>30</sub>= 0.0190                      D<sub>15</sub>= 0.0097  
D<sub>10</sub>= 0.0070                      C<sub>u</sub>= 4.98                      C<sub>c</sub>= 1.50

**Remarks**

Material was visually checked for plasticity and appeared non-plastic.

Date Received: 02.20.18                      Date Tested: 02.23.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples  
Sample Number: MW-2 / S-3

Depth: 101'

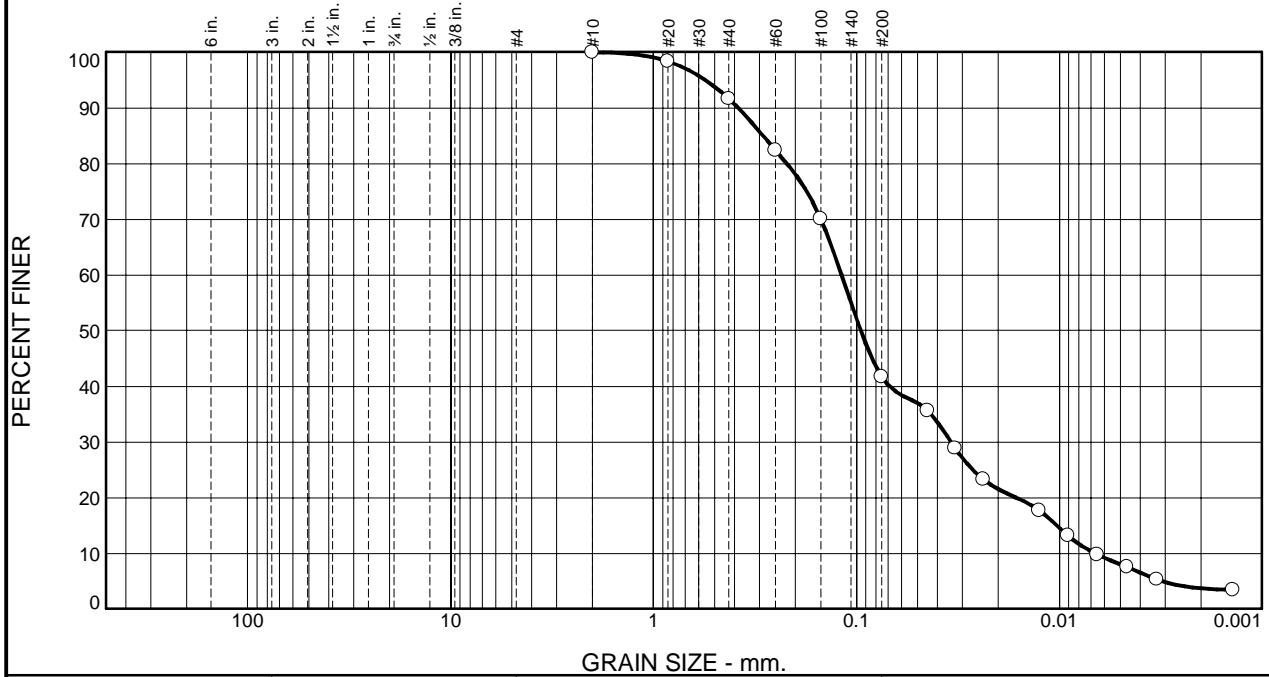
Date Sampled: 07.20.17

**Thielsch Engineering Inc.**  
  
**Cranston, RI**

Client: AECOM / Town Of Orleans  
Project: Orleans-GWDP  
Orleans, MA  
Project No: 06476644.01.01

Figure 18-S-171

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	8.4	49.9	38.0	3.7

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	98.3		
#40	91.6		
#60	82.4		
#100	70.1		
#200	41.7		
0.0445 mm.	35.6		
0.0326 mm.	28.9		
0.0237 mm.	23.3		
0.0125 mm.	17.7		
0.0090 mm.	13.2		
0.0065 mm.	9.8		
0.0046 mm.	7.6		
0.0033 mm.	5.3		
0.0014 mm.	3.4		

\* (no specification provided)

**Material Description**

Grey silty sand (SM)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SM                      AASHTO (M 145)= A-4(0)

**Coefficients**

D<sub>90</sub>= 0.3830                      D<sub>85</sub>= 0.2886                      D<sub>60</sub>= 0.1185  
D<sub>50</sub>= 0.0952                      D<sub>30</sub>= 0.0342                      D<sub>15</sub>= 0.0103  
D<sub>10</sub>= 0.0067                      C<sub>u</sub>= 17.72                      C<sub>c</sub>= 1.48

**Remarks**

Material was visually checked for plasticity and appeared non-plastic.

Date Received: 02.20.18                      Date Tested: 02.23.18

Tested By: MN

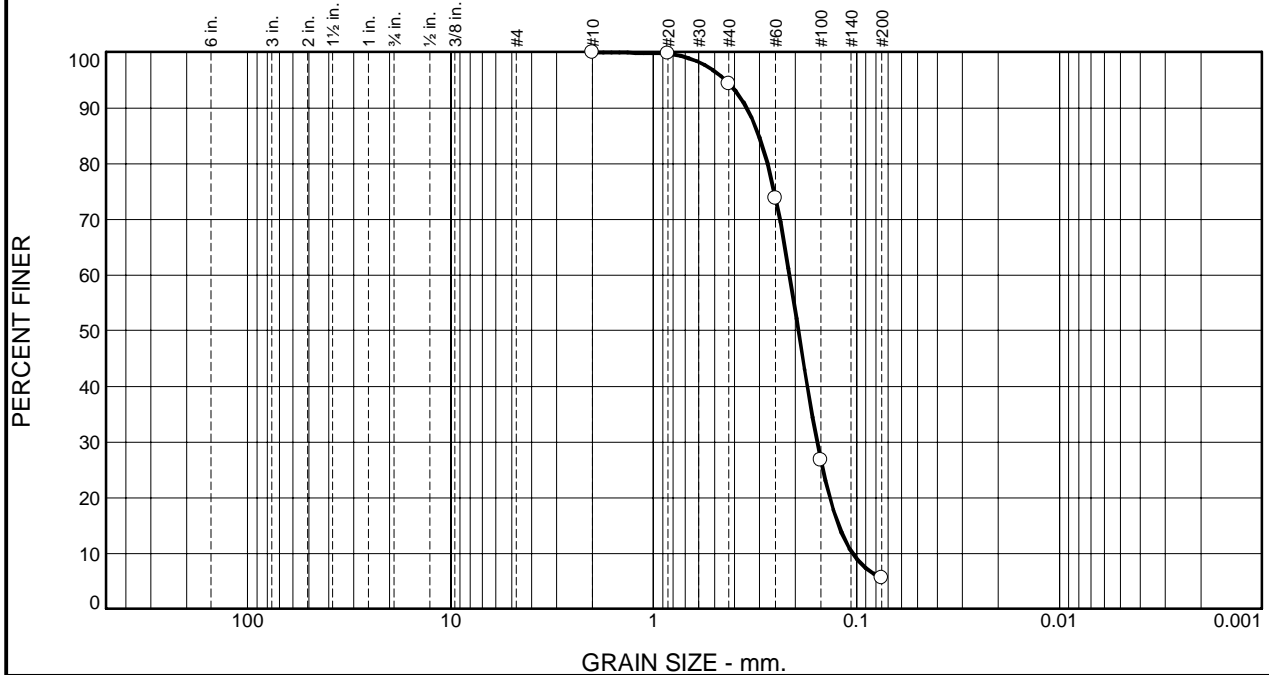
Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples                      Depth: 165'                      Date Sampled: 07.20.17  
Sample Number: MW-2 / S-4

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> AECOM / Town Of Orleans <b>Project:</b> Orleans-GWDP Orleans, MA <b>Project No:</b> 06476644.01.01
<b>Figure</b> 18-S-172	

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	5.7	88.7	5.6	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	94.3		
#60	73.8		
#100	26.8		
#200	5.6		

\* (no specification provided)

**Material Description**

Gray poorly graded sand with silt (SP - SM)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP-SM      AASHTO (M 145)= A-3

**Coefficients**

D <sub>90</sub> = 0.3469	D <sub>85</sub> = 0.3022	D <sub>60</sub> = 0.2137
D <sub>50</sub> = 0.1932	D <sub>30</sub> = 0.1563	D <sub>15</sub> = 0.1222
D <sub>10</sub> = 0.1045	C <sub>u</sub> = 2.04	C <sub>c</sub> = 1.09

Remarks

Date Received: 02.20.18      Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples  
Sample Number: MW-2 / S-5

Depth: 186-196'

Date Sampled: 07.21.18

**Thielsch Engineering Inc.**

**Cranston, RI**

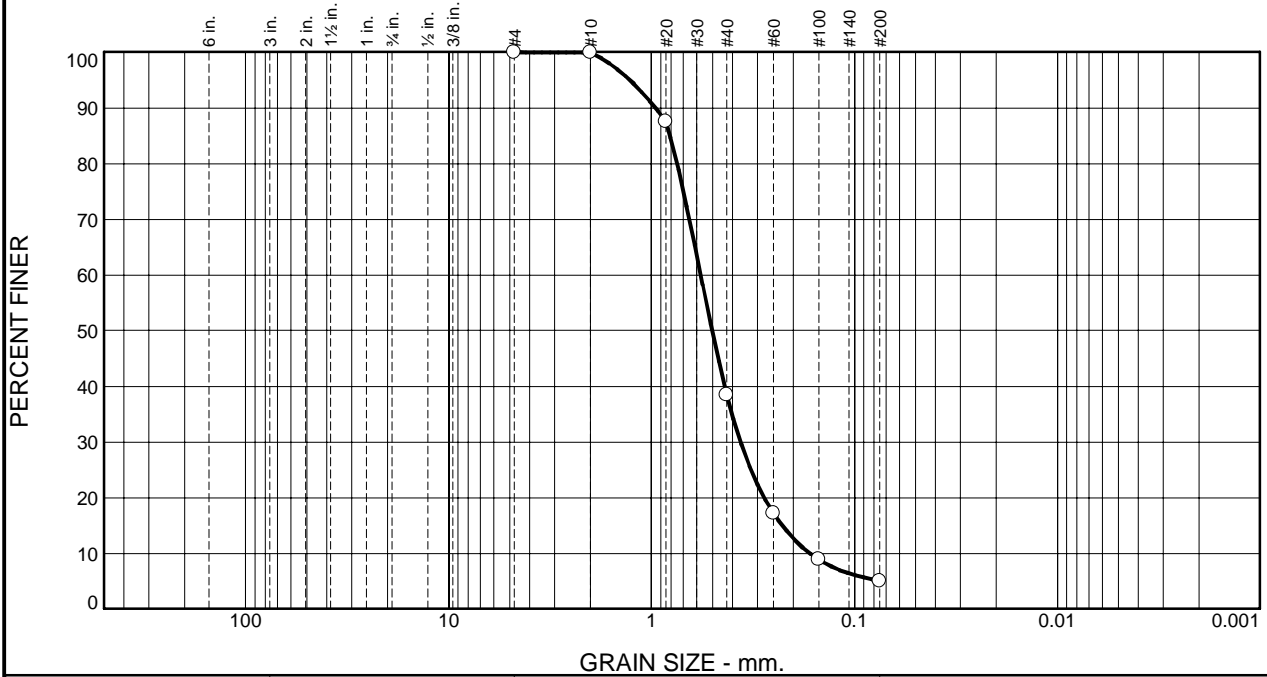
Client: AECOM / Town Of Orleans

Project: Orleans-GWDP  
Orleans, MA

Project No: 06476644.01.01

Figure 18-S-173

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	61.5	33.4	5.0	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	87.5		
#40	38.4		
#60	17.2		
#100	8.9		
#200	5.0		

\* (no specification provided)

**Material Description**

Gray poorly graded sand with silt (SP - SM)

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP-SM    AASHTO (M 145)= A-1-b

**Coefficients**

D <sub>90</sub> = 0.9576	D <sub>85</sub> = 0.8116	D <sub>60</sub> = 0.5720
D <sub>50</sub> = 0.5023	D <sub>30</sub> = 0.3639	D <sub>15</sub> = 0.2267
D <sub>10</sub> = 0.1660	C <sub>u</sub> = 3.45	C <sub>c</sub> = 1.39

Remarks

Date Received: 02.20.18      Date Tested: 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples      Depth: 226'      Date Sampled: 07.21.17  
 Sample Number: MW-2 / S-6

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	Client: AECOM / Town Of Orleans Project: Orleans-GWDP Orleans, MA Project No: 06476644.01.01
Figure 18-S-174	

**Appendix D**  
**Pumping Test Water Level Data**

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**Client: AECOM/Town of Orleans**  
**Job location: Orleans Landfill - Well PW1 (130-160)**

**24 hour pump test results and notes**

Date/Time	GPM	Water level (ft) top of poly sleeve		Date/Time	GPM	Water level (ft)
8/3/17 10:00 AM	83	89.95				
8/3/17 10:01 AM	83	96.50				
8/3/17 10:02 AM	83	101.39				
8/3/17 10:03 AM	83	101.52				
8/3/17 10:04 AM	83	101.61				
8/3/17 10:05 AM	83	101.66				
8/3/17 10:06 AM	83	101.68				
8/3/17 10:07 AM	83	101.70				
8/3/17 10:08 AM	83	101.75				
8/3/17 10:09 AM	83	101.75				
8/3/17 10:10 AM	83	101.75				
8/3/17 10:11 AM	83	101.75				
8/3/17 10:12 AM	83	101.75				
8/3/17 10:20 AM	83	101.78				
8/3/17 10:30 AM	83	101.78				
8/3/17 10:40 AM	83	101.78				
8/3/17 10:50 AM	83	101.78				
8/3/17 11:00 AM	83	101.78				
8/3/17 11:10 AM	83	101.78				
8/3/17 11:20 AM	83	101.78				
8/3/17 12:20 PM	83	101.78				
8/3/17 2:20 PM	83	101.76				
8/3/17 4:20 PM	83					

Well depth: 160'                      Top of pipe  
 Static: 87.9'                         Top of pipe  
 Well screen: 4"x30"x.012 st/st  
 Pump length: 42.8"  
 Motor length: 27.7"

5 Rayber Road  
 P.O. Box 2783  
 Orleans, MA 02653

(508) 240-1000  
 (508) 240-1003 Fax

info@desmondwelldrilling.com  
 www.desmondwelldrilling.com



**Client: AECOM/Town of Orleans**  
**Job location: Orleans Landfill - Well PW1 (95 to 125)**

**24 hour pump test results and notes**

Date/Time	GPM	Water level (ft) top of poly sleeve		Date/Time	GPM	Water level (ft)
7/31/17 1:10 PM	85	89.95		7/31/17 11:40 PM	85	95.90
7/31/17 1:11 PM	85	95.44		8/1/17 3:40 AM	85	95.90
7/31/17 1:12 PM	85	95.50		8/1/17 7:40 AM	85	95.93
7/31/17 1:13 PM	85	95.50		8/1/17 9:45 AM	85	95.95
7/31/17 1:14 PM	85	95.50				
7/31/17 1:15 PM	85	95.50				
7/31/17 1:16 PM	85	95.50		<b>Recovery</b>		
7/31/17 1:17 PM	85	95.50		8/1/17 1:10 PM		95.95
7/31/17 1:18 PM	85	95.50		8/1/17 1:11 PM		91.00
7/31/17 1:19 PM	85	95.50		8/1/17 1:12 PM		90.98
7/31/17 1:20 PM	85	95.54		8/1/17 1:13 PM		90.95
7/31/17 1:30 PM	85	95.60		8/1/17 1:14 PM		90.93
7/31/17 1:40 PM	85	95.64		8/1/17 1:15 PM		90.92
7/31/17 1:50 PM	85	95.65		8/1/17 1:16 PM		90.91
7/31/17 2:00 PM	85	95.70		8/1/17 1:17 PM		90.90
7/31/17 2:10 PM	85	95.70		8/1/17 1:18 PM		90.89
7/31/17 2:20 PM	85	95.73		8/1/17 1:19 PM		90.88
7/31/17 2:30 PM	85	95.75		8/1/17 1:20 PM		90.88
7/31/17 2:40 PM	85	95.77		8/1/17 1:21 PM		90.87
7/31/17 2:50 PM	85	95.78		8/1/17 1:22 PM		90.82
7/31/17 5:50 PM	85	95.85		8/1/17 2:00 PM		90.78
7/31/17 8:35 PM	85	95.90		8/1/17 2:15 PM		90.70

Well depth: 126.55'      Top of pipe  
 Static: 86.4'      Top of pipe  
 Well screen: 4"x30"x.012 st/st  
 Pump length: 42.8"  
 Motor length: 27.7"

5 Rayber Road  
 P.O. Box 2783  
 Orleans, MA 02653

(508) 240-1000  
 (508) 240-1003 Fax

info@desmondwelldrilling.com  
 www.desmondwelldrilling.com



**Client: AECOM/Town of Orleans**  
**Job location: Orleans Landfill - Well PW2 (131-155)**

**8 hour pump test results and notes**

Date/Time	GPM	Water level (ft)		Date/Time	GPM	Water level (ft)
8/24/17 8:00 AM	85	95.18		8/24/17 2:40 PM	85	95.40
8/24/17 8:01 AM	85	95.29		8/24/17 3:40 PM	85	95.40
8/24/17 8:02 AM	85	95.31				
8/24/17 8:03 AM	85	95.31				
8/24/17 8:04 AM	85	95.31				
8/24/17 8:05 AM	85	95.35		<b>Recovery</b>		
8/24/17 8:06 AM	85	95.35		8/24/17 4:00 PM		95.15
8/24/17 8:07 AM	85	95.35		8/24/17 4:01 PM		95.06
8/24/17 8:08 AM	85	95.35		8/24/17 4:02 PM		95.08
8/24/17 8:09 AM	85	95.35		8/24/17 4:03 PM		94.98
8/24/17 8:10 AM	85	95.35		8/24/17 4:04 PM		94.97
8/24/17 8:20 AM	85	95.36		8/24/17 4:05 PM		94.95
8/24/17 8:30 AM	85	95.37		8/24/17 4:06 PM		94.95
8/24/17 8:40 AM	85	95.38		8/24/17 4:07 PM		94.93
8/24/17 8:50 AM	85	95.38		8/24/17 4:08 PM		94.92
8/24/17 9:00 AM	85	95.38		8/24/17 4:09 PM		94.92
8/24/17 9:10 AM	85	95.37		8/24/17 4:10 PM		94.91
8/24/17 9:20 AM	85	95.39		8/24/17 4:11 PM		94.91
8/24/17 9:30 AM	85	95.39		8/24/17 4:21 PM		94.91
8/24/17 9:40 AM	85	95.39		8/24/17 4:22 PM		94.91
8/24/17 10:40 AM	85	95.40		8/24/17 4:32 PM		94.91
8/24/17 11:40 PM	85	95.40		8/24/17 4:42 PM		94.91
8/24/17 12:40 PM	85	95.40		8/24/17 4:52 PM		94.90
8/24/17 1:40 PM	85	95.40		8/24/17 5:02 PM		94.90

Well depth: 155'                      Top of pipe  
 Static: 84.7'                        Top of pipe  
 Well screen: 4"x30'x.012 st/st  
 Pump length: 42.8"  
 Motor length: 27.7"

5 Rayber Road  
 P.O. Box 2783  
 Orleans, MA 02653

(508) 240-1000  
 (508) 240-1003 Fax

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**Appendix E**  
**Wick Loading Test Water Level Data**

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32 Los Hollow Loading Test  
(BMWZ2 Reference)  
30-Day Loading Test  
Orleans, MA

Well ID	Distances from Wick (ft.)	Elevation (ft.MSL)*	(State) Friday		Saturday		Sunday		Monday		Tuesday	
			2/9/2018 15:00	2/10/2018 8:00	2/10/2018 8:00	2/10/2018 18:00	2/11/2018 9:30	2/11/2018 20:00	2/11/2018 9:30	2/12/2018 8:00	2/12/2018 17:00	2/12/2018 17:00
Day Meter		101,000	Start Load Test									
WKR Well	0	123.3	20	39.45	20	33	91.32	33	91.41	33	92.68	33
LH-1	5	124.3	109.39	109.37	109.33	108.83	108.72	108.74	108.74	108.74	108.71	108.64
LH-2	15	123.8	108.89	108.87	108.83	108.48	108.31	108.33	108.33	108.33	108.31	108.24
LH-3	30	123.0	108.08	108.06	108.03	107.78	107.62	107.66	107.66	107.66	107.64	107.58
LH-4	60	123.8	108.91	108.88	108.85	108.61	108.32	108.57	108.57	108.57	108.53	108.30
LH-5	125	119.8	104.99	104.96	104.92	104.75	104.71	104.80	104.80	104.80	104.84	104.79
MW-14	250	105.2	99.16	99.12	99.19	98.99	98.95	99.19	99.19	99.19	99.10	98.99
MW-9	415	107.3	99.26	99.22	99.19	98.99	98.95	99.19	99.19	99.19	99.10	98.99
MW-15S	550	109.2	94.31	94.29	94.25	94.15	94.09	94.24	94.24	94.24	94.22	94.16
CL-1	600	98.5	86.22	86.21	86.17	86.11	86.02	86.14	86.14	86.14	86.18	86.18
MW-2D	640	103.6	89.52	89.48	89.45	89.40	89.33	89.33	89.33	89.33	89.46	89.46
MW-16S	725	103.4	88.51	88.49	88.45	88.40	88.32	88.32	88.32	88.44	88.44	88.42
CL-2	735	85.4	72.80	72.77	72.73	72.68	72.61	72.61	72.61	72.80	72.80	72.78
MW-5	825	103.6	88.63	88.61	88.56	88.51	88.44	88.44	88.44	88.55	88.55	88.53
MW-6	840	103.6	88.63	88.61	88.56	88.51	88.44	88.44	88.44	88.55	88.55	88.53
(Local Avr*)	860	85.8	73.14	73.13	73.09	73.04	72.99	73.11	73.11	73.12	73.12	73.11
BMW Z2 (Ambient)	8,275		30.34	30.35	30.31	30.31	30.28	30.28	30.28	30.28	30.26	30.26
Rainfall (in.)			0.00	0.18	0.18		1.68				0.23	
Rainfall (cum.)			0.00	0.18	0.36		1.68				2.09	

Notes:	Notes:	Notes:	Notes:	Notes:
* MSL = mean sea level				
** Average of closest, most distant wells. Likely outside of influence of flooding.				
*** http://forecast.weather.gov/MapClick.php?lat=41.7821&lon=-83.9776&WorkUnit=K1				
**** http://forecast.weather.gov/MapClick.php?lat=41.7821&lon=-83.9776&WorkUnit=K1				

Estimated WL in Wick

Loading Test	gpm	gpd	Days	Days Cumulative	Estimated WL in Wick													
					LH-1 (ft)	LH-2 (15ft)	LH-3 (30ft)	LH-4 (60ft)	LH-5 (75ft)	MW-9 (415 ft)	MW-14 (250 ft)	MW-15 (415 ft)	Wick Mound (ft.Rise)	Wick Efficiency (gpd/ft)				
Loading	20	28,800	1	1	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.02	3.55	8.113	6,000	25	75
	33	47,520	5	6	1.03	0.90	0.72	0.56	0.33	0.15	0.11	0.11	0.11	14.38	3,305	6,000	33	67
	56	80,640	4	10	1.85	1.60	1.31	1.04	0.48	0.11	0.07	0.07	0.07	17.95	4,482	6,000	58	42
	88	1,26,720	23	33	3.10	2.85	2.38	2.00	1.07	0.08	0.13	0.13	0.13	42.40	2,989	6,000	67	33
Recovery	0		2	35												6,000	75	25
Total																6,000	83	17

\* Assumes wick installed to 100ft depth and depth to water a minimum of 100 ft.

32. Los Hollow Loading Test  
(BMWZZ Reference)  
30-Day Loading Test  
Orleans, MA

Tuesday		Wednesday		Thursday		Friday		Saturday		Monday		Tuesday		Wednesday	
2/13/2018 15:30	Water Level Increase	2/14/2018 14:00	Water Level Increase	2/15/2018 13:30	Water Level Increase	2/16/2018 9:30	Water Level Increase	2/17/2018 8:00	Water Level Increase	2/19/2018 8:30	Water Level Increase	2/20/2018 8:00	Water Level Increase	2/21/2018 7:00	Water Level Increase
Mound Height		Mound Height		Mound Height		Mound Height		Mound Height		Mound Height		Mound Height		Mound Height	
5	0.79	6	0.36	7	0.37	8	0.41	9	0.36	11	0.46	12	0.54	13	0.62
33	0.09	33	0.30	34	0.33	59	0.39	56	0.38	59	0.45	89	0.51	87	0.57
93.44	0.09	90.25	0.30	86.62	0.33	85.10	0.39	85.05	0.38	86.50	0.45	76.20	0.51	72.20	0.57
	-12.75		-1.14		-14.38		-17.90		-17.95		-16.50		-26.80		-30.80
106.20	0.68	108.25	1.14	108.14	1.25	107.73	1.66	107.48	1.91	107.16	2.23	106.50	2.89	106.20	3.19
0.69	0.58	0.87	0.81	0.77	1.12	0.90	1.46	1.07	1.36	1.88	1.98	1.60	2.56	2.06	2.31
0.55	0.44	0.70	0.70	0.74	0.94	0.72	1.20	0.92	1.06	1.31	1.69	1.31	2.13	1.63	2.31
0.42	0.31	0.54	0.54	0.56	0.78	0.56	0.88	0.70	0.79	1.07	1.42	1.04	1.76	1.26	2.03
0.42	0.11	0.46	0.30	0.44	0.55	0.33	0.61	0.33	0.64	0.86	0.86	0.48	1.01	0.51	1.12
0.09	-0.04	0.80	0.36	0.97	0.37	0.75	0.41	0.33	0.38	0.67	0.49	0.11	0.54	0.04	0.62
0.09	-0.02	0.94	0.30	0.91	0.33	0.85	0.39	0.86	0.38	0.97	0.45	0.07	0.51	0.01	0.62
0.10	-0.01	0.91	0.30	0.93	0.34	0.93	0.38	0.93	0.37	0.99	0.46	0.08	0.52	0.01	0.60
0.02	-0.09	0.25	0.09	0.30	0.30	0.08	0.31	0.03	0.05	0.30	0.46	0.08	0.37	0.13	0.41
0.07	-0.04	0.44	0.28	0.41	0.41	0.19	0.38	0.10	0.35	0.42	0.42	0.08	0.48	-0.02	0.53
0.10	-0.01	0.33	0.17	0.35	0.35	0.13	0.40	0.12	0.38	0.44	0.44	0.04	0.48	-0.02	0.52
0.00	-0.11	0.15	0.15	0.12	0.34	0.12	0.32	0.04	0.28	0.34	0.34	0.04	0.35	-0.15	0.40
0.11	0.00	0.34	0.18	0.25	0.39	0.16	0.43	0.08	0.40	0.46	0.46	0.08	0.52	0.02	0.58
0.13	-0.10	0.26	0.09	0.27	0.27	0.05	0.35	0.00	0.32	0.37	0.36	0.08	0.41	0.04	0.54
0.06	0.06	0.29	0.29	0.32	0.32	0.05	0.35	0.00	0.31	0.37	0.36	0.08	0.41	0.04	0.46
0.11	0.11	0.16	0.16	0.22	0.22	0.28	0.28	0.28	0.32	0.38	0.38	0.50	0.50	0.55	0.55
0.00	0.01	0.01	0.01	0.14	0.14	0.26	0.26	0.10	0.10	0.33	0.33	0.01	0.01	0.00	0.00
2.09	2.09	2.10	2.10	2.24	2.24	2.50	2.50	2.60	2.60	2.93	2.93	2.94	2.94	2.94	2.94

**Notes:**  
Notes: Increase Discharge Rate to 60 gpm Add Gravel  
Notes: Increase Discharge Rate to 90 gpm Add Gravel  
Notes: Download Loggers Logger caught in stone in Gravel in 2" PVC  
Notes: Add Gravel  
Notes: Move logger from MW-1S5 to wick Gravel in 2" PVC at 63.81ft Gravel in 8-inch 2.90 ft  
Notes: Gravel appears to be moving from 10.2" PVC  
Gravel in 8-inch 2.90 ft  
Notes: Gravel in 2" PVC at 77.7 ft Gravel in 8-inch @ 3.30 ft Gravel washing from outside of 2-inch PVC to inside

32. Los Hollow Loading Test  
 (BMWZZ Reference)  
 30-Day Loading Test  
 Orleans, MA

Thursday		Friday		Saturday		Sunday		Monday		Tuesday		Wednesday		Thursday		Friday				
2/22/2018 16:30	Water Level Increase	Mound Height	2/23/2018 10:00	Water Level Increase	Mound Height	2/25/2018 9:50	Water Level Increase	Mound Height	2/26/2018 16:00	Water Level Increase	Mound Height	2/27/2018 6:30	Water Level Increase	Mound Height	3/1/2018	Water Level Increase	Mound Height	3/2/2018	Water Level Increase	Mound Height
14 1,057.400 87 NM			16 1,318.300 87 66.72	-30.28		17 1,452.200 87 NM			18 1,569.000 88 NM			19 1,689.400 88 67.50	-35.50		21 1,968.800 88.00 67.20	-35.80		22 2,114.300 89.00		
106.00 105.88 105.42 106.69 103.65	3.39 3.01 2.66 2.22 1.34	2.80 2.42 2.07 1.63 0.75	105.68 105.54 105.14 106.39 103.41	3.71 3.35 2.84 2.52 1.59	3.07 2.71 2.30 1.88 0.94	105.59 105.42 105.02 106.24 103.23	3.81 3.47 3.06 2.67 1.76	3.03 2.69 2.28 1.89 0.99	105.50 105.39 105.00 106.15 103.16	3.89 3.50 3.08 2.76 1.83	3.07 2.68 2.26 1.94 1.01	105.54 105.37 105.00 106.21 103.22	3.85 3.52 3.08 2.70 1.77	2.99 2.66 2.22 1.84 0.91	89.20 88.20 89.20 89.35 91.31	0.96 0.99 0.98 0.83 0.07	0.06 0.05 0.08 0.08 0.03	29.38 29.44	0.96 0.90	
28.75 0.03 2.97	0.59		29.70 0.22 3.19	0.64		29.60 0.59 3.76	0.74		29.56 0.01 3.79	0.78		29.52 0.00 3.79	0.82		29.44 0.00 3.79	0.90		29.38 2.41 6.20	0.96	
<b>Notes:</b> Gravel in 8-inch @ 3.30 ft		<b>Notes:</b> Gravel in 8-inch @ 3.80 ft		<b>Notes:</b> Gravel in 8-inch @ 3.80 ft		<b>Notes:</b> Gravel in 8-inch @ 3.80 ft		<b>Notes:</b> Gravel in 8-inch @ 3.80 ft		<b>Notes:</b> Gravel in 8-inch @ 3.80 ft		<b>Notes:</b> Gravel in 8-inch @ 3.80 ft		<b>Notes:</b> Gravel in 8-inch @ 4.60 ft		<b>Notes:</b> Gravel in 2" PVC at 76.9 ft Gravel in 8-inch @ 4.60 ft		<b>Notes:</b>		

32. Los Hills Hollow Loading Test  
(BMWZZ Reference)  
30-Day Loading Test  
Orleans, MA

Saturday		Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday	
3/3/2018	3/4/2018	3/5/2018	3/6/2018	3/7/2018	3/8/2018	3/9/2018	3/10/2018	3/11/2018	3/12/2018	3/13/2018	3/14/2018	3/15/2018	3/16/2018	3/17/2018	3/18/2018
Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase	Water Level Increase
Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height	Mound Height
23 2,214.600 89.00 67.50	24 63.95	25 2,466.900 89	26 2,605.800 88	27 2,717.200 88	28 62.30	29 2,974.000 88	30 3,133.600	31 65.50	32 65.50	33 65.50	34 65.50	35 65.50	36 65.50	37 65.50	38 65.50
4.11	4.19	4.23	4.18	4.18	4.38	4.07	4.38	4.38	4.38	4.38	4.42	4.42	4.50	4.50	4.59
3.85	3.87	3.98	3.87	3.87	3.87	3.87	3.87	3.87	3.87	3.87	3.87	3.87	3.87	3.87	3.87
3.43	3.45	3.55	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44	3.44
3.04	3.04	3.10	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02
2.03	2.10	2.15	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11
NM	0.13	NM	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
NM	1.20	NM	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
NM	0.17	NM	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
NM	1.23	NM	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
NM	0.76	NM	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
NM	-0.31	NM	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
NM	-0.04	NM	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39
NM	1.03	NM	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
NM	0.02	NM	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
NM	-0.29	NM	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
NM	1.11	NM	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
NM	0.04	NM	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
NM	-0.45	NM	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
29.33	29.27	29.21	29.15	29.09	29.09	29.09	29.09	29.09	29.09	29.09	29.01	29.01	29.01	29.01	29.01
1.01	1.07	1.13	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.33	1.33	1.39	1.44	1.44
0.18	0.03	0.21	0.01	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.14	0.14	0.14	0.14	0.14
6.36	6.41	6.62	6.63	7.32	7.32	7.32	7.32	7.32	7.32	7.32	7.46	7.46	7.46	7.46	7.46
Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:	Notes:



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**Appendix F**  
**Ambient Well Water Level Data**

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# ----- WARNING -----
# Some of the data that you have obtained from this U.S. Geological Survey database
# may not have received Director's approval. Any such data values are qualified
# as provisional and are subject to revision. Provisional data are released on the
# condition that neither the USGS nor the United States Government may be held liable
# for any damages resulting from its use.
#
# Additional info: https://help.waterdata.usgs.gov/policies/provisional-data-statement
#
# File-format description: https://help.waterdata.usgs.gov/faq/about-tab-delimited-output
# Automated-retrieval info: https://help.waterdata.usgs.gov/faq/automated-retrievals
#
# Contact: gs-w_support_nwisweb@usgs.gov
# retrieved: 2018-06-06 06:22:08 EDT (caww01)
#
# Data for the following 1 site(s) are contained in this file
# USGS 414630070014901 MA-BMW 22 BREWSTER, MA
# -----
#
# Data provided for site 414630070014901
# TS parameter statistic Description
# 65166 72019 00003 Depth to water level, feet below land surface (Mean)
# 00 72019 00011 Depth to water level, feet below land surface (Instantaneous)
#
# Data-value qualification codes included in this output:
#
# A Approved for publication -- Processing and review completed.
# P Provisional data subject to revision.
#
# Discrete groundwater status codes included in this output:
# '00_72019_00011_cd'
#
# "" The reported water-level measurement represents a static level
#
# A Approved for publication -- Processing and review completed.
# P Provisional data subject to revision.
#
agency_cd site_no datetime tz_cd 65166_72019_00003 65166_72019_00003_cd 00_72019_00011 00_72019_00011_cd
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USGS	414630070014901	2018-05-31	28.39	P
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USGS	414630070014901	2018-06-02	28.41	P
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**Appendix G**  
**Precipitation Data**

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I

MONTHLY CLIMATOLOGICAL SUMMARY for FEB. 2018

NAME: rain history CITY: STATE:  
 ELEV: 54 ft LAT: 41° 07' 01" N LONG: 69° 09' 01" W

TEMPERATURE (°F), RAIN (in), WIND SPEED (mph)

DAY	MEAN TEMP	HIGH	TIME	LOW	TIME	HEAT DEG DAYS	COOL DEG DAYS	RAIN	AVG WIND SPEED	HIGH	TIME	DOM DIR
1	39.9	45.4	2:00p	33.8	12:30a	25.1	0.0	0.03	2.5	22.0	12:30p	SSW
2	29.5	41.2	4:30a	16.6	12:00m	35.5	0.0	0.13	5.5	26.0	11:00p	W
3	21.6	30.4	12:00m	13.6	5:00a	43.4	0.0	0.00	3.6	21.0	1:00a	W
4	41.0	47.5	7:30p	30.4	12:30a	24.0	0.0	0.69	5.9	25.0	3:00p	SSE
5	39.9	51.7	3:00a	29.1	12:00m	25.1	0.0	0.26	4.8	26.0	3:30a	W
6	30.5	35.0	3:30p	25.5	4:00a	34.5	0.0	0.00	0.1	11.0	2:30p	W
7	37.9	52.0	5:30p	24.4	7:00a	27.1	0.0	0.76	3.9	32.0	5:30p	ESE
8	28.7	37.1	12:30a	23.2	8:00p	36.3	0.0	0.02	4.1	24.0	4:00a	W
9	29.8	34.7	12:00m	25.4	7:00a	35.2	0.0	0.00	1.7	15.0	2:00p	W
10	47.8	54.0	11:30p	34.6	12:30a	17.2	0.0	0.18	5.3	25.0	12:30p	SSE
11	50.2	55.6	5:30p	44.5	3:00p	14.8	0.0	1.68	1.4	25.0	9:00p	SSW
12	42.3	54.7	2:00a	29.9	9:30p	22.7	0.0	0.23	1.1	26.0	2:00a	W
13	30.7	34.8	12:30a	27.9	7:00a	34.3	0.0	0.00	1.2	18.0	5:00a	W
14	38.9	47.9	2:30p	29.7	12:30a	26.1	0.0	0.01	0.8	17.0	1:30p	SSW
15	43.4	46.7	4:30p	38.6	1:00a	21.6	0.0	0.14	0.9	17.0	10:30p	SSW
16	46.4	52.4	12:30p	36.1	12:00m	18.6	0.0	0.26	2.5	23.0	12:00m	W
17	34.4	37.6	12:00m	29.9	6:30a	30.6	0.0	0.10	2.9	25.0	12:30a	SE
18	36.8	41.5	5:00a	28.7	11:30p	28.2	0.0	0.29	3.4	28.0	8:00a	W
19	41.8	49.1	10:00p	26.7	3:00a	23.2	0.0	0.04	2.7	21.0	10:30p	SSE
20	50.3	57.0	2:30p	47.3	7:30p	14.7	0.0	0.01	4.4	26.0	1:00p	SSW
21	51.5	57.2	10:00p	48.8	11:30p	13.5	0.0	0.00	3.2	26.0	2:00a	SSW
22	40.6	51.1	1:00a	33.4	7:30p	24.4	0.0	0.03	1.1	18.0	5:30p	NE
23	39.0	43.0	11:00p	34.9	1:30a	26.0	0.0	0.09	3.6	20.0	8:30p	SE
24	46.1	53.1	1:30p	39.9	1:00a	18.9	0.0	0.13	2.1	19.0	6:00a	W
25	41.4	44.3	7:30p	38.8	7:30a	23.6	0.0	0.59	4.4	26.0	2:30p	ESE
26	41.2	47.4	4:00p	37.5	7:00a	23.8	0.0	0.01	1.3	15.0	4:00a	W
27	41.0	48.9	3:30p	35.5	5:30a	24.0	0.0	0.00	1.1	14.0	11:30p	W
28	45.7	53.1	1:00p	40.0	6:00a	19.3	0.0	0.00	3.5	31.0	12:30p	SSW
	39.6	57.2	21	13.6	3	711.7	0.0	5.68	2.8	32.0	7	W

Max >= 90.0: 0  
 Max <= 32.0: 1  
 Min <= 32.0: 14  
 Min <= 0.0: 0

Max Rain: 1.68 ON 02/11/18

Days of Rain: 18 (>.01 in) 12 (>.1 in) 1 (>1 in)

Heat Base: 65.0 Cool Base: 65.0 Method: Integration

SNOW = 0.50"  
 $\bar{T}_H = 46.6^\circ$   
 $\bar{T}_L = 32.3^\circ$

MONTHLY CLIMATOLOGICAL SUMMARY for JAN. 2018

NAME: rain history CITY: STATE:  
 ELEV: 54 ft LAT: 41° 07' 01" N LONG: 69° 09' 01" W

TEMPERATURE (°F), RAIN (in), WIND SPEED (mph)

DAY	MEAN TEMP	HIGH	TIME	LOW	TIME	HEAT DEG DAYS	COOL DEG DAYS	RAIN	AVG WIND SPEED	HIGH	TIME	DOM DIR
1	11.9	15.1	3:30p	8.8	7:30a	53.1	0.0	0.00	6.6	21.0	9:30p	W
2	15.2	18.8	12:00m	12.8	12:30a	49.8	0.0	0.00	3.8	20.0	9:30a	W
3	25.0	32.6	3:00p	14.7	7:00a	40.0	0.0	0.00	1.1	16.0	1:00p	SSE
4	36.3	43.1	7:30a	25.4	12:00m	28.7	0.0	1.01	7.5	40.0	6:00p	NE
5	17.3	25.6	1:00a	9.8	10:30p	47.7	0.0	0.00	8.0	27.0	6:00p	W
6	11.5	15.6	2:30p	8.8	7:00a	53.5	0.0	0.00	8.3	28.0	7:00p	W
7	12.1	25.2	12:00m	6.5	4:00a	52.9	0.0	0.00	3.5	23.0	2:00a	W
8	34.9	41.3	7:00p	25.2	12:30a	30.1	0.0	0.02	5.6	30.0	8:00p	SSW
9	35.8	41.0	12:30p	31.0	12:00m	29.2	0.0	0.01	3.7	19.0	12:30a	W
10	33.7	39.4	12:30p	26.3	7:30a	31.3	0.0	0.00	1.5	14.0	12:30a	SSE
11	46.4	53.4	11:00a	35.4	12:30a	18.6	0.0	0.00	3.8	27.0	10:30p	SSE
12	54.4	58.1	1:00p	51.3	1:00a	10.6	0.0	0.19	9.0	33.0	1:00p	SSE
13	44.4	56.3	2:30a	27.6	12:00m	20.6	0.0	0.14	7.2	37.0	4:30a	SSE
14	26.4	27.8	2:00p	24.5	6:00p	38.6	0.0	0.00	2.5	15.0	2:00a	W
15	31.7	35.0	11:00a	27.4	12:30a	33.3	0.0	0.00	1.5	18.0	8:00a	NE
16	32.0	38.2	1:00p	28.7	7:00p	33.0	0.0	0.03	0.1	10.0	12:30a	NNW
17	35.1	38.5	4:00p	31.2	12:30a	29.9	0.0	0.36	0.4	12.0	10:00a	NW
18	31.1	33.4	12:30a	29.0	5:00p	33.9	0.0	0.00	1.5	16.0	5:00p	W
19	29.4	33.6	12:30p	25.8	7:30a	35.6	0.0	0.00	1.8	12.0	12:30a	W
20	42.2	50.6	3:00p	29.7	2:00a	22.8	0.0	0.00	2.5	38.0	9:30a	W
21	38.5	45.9	2:30p	31.5	9:30p	26.5	0.0	0.00	0.5	12.0	12:00p	W
22	38.9	42.5	12:00m	32.3	2:30a	26.1	0.0	0.02	1.6	18.0	8:30p	SE
23	49.2	54.6	4:30p	42.5	12:30a	15.8	0.0	0.63	7.4	32.0	4:30p	SSE
24	37.8	45.0	12:30a	28.8	12:00m	27.2	0.0	0.00	2.9	18.0	11:00a	W
25	26.5	29.4	3:30p	23.0	6:00a	38.5	0.0	0.00	6.6	24.0	9:00p	W
26	25.4	30.5	3:00p	20.6	9:00p	39.6	0.0	0.00	3.8	28.0	4:00a	W
27	41.1	48.8	2:30p	26.2	12:30a	23.9	0.0	0.00	5.1	31.0	10:00p	SSE
28	45.3	47.9	12:00p	39.5	12:00m	19.7	0.0	0.21	1.5	23.0	2:00a	SSW
29	39.5	42.3	11:00a	36.4	7:30p	25.5	0.0	0.03	3.4	28.0	11:00p	NE
30	29.2	37.0	12:30a	25.7	3:00p	35.8	0.0	0.04	5.3	27.0	2:00a	W
31	25.6	33.8	12:00m	21.6	6:30a	39.4	0.0	0.02	3.9	22.0	1:00a	W
	32.4	58.1	12	6.5	7	1011.2	0.0	2.71	3.9	40.0	4	W

Max >= 90.0: 0

Max <= 32.0: 8

Min <= 32.0: 25

Min <= 0.0: 0

Max Rain: 1.01 ON 01/04/18

Days of Rain: 12 (>.01 in) 6 (>.1 in) 1 (>1 in)

Heat Base: 65.0 Cool Base: 65.0 Method: Integration

$$\bar{X} H = 38.1^{\circ}$$

$$\bar{X} L = 26^{\circ}$$

$$SNOW = 8.75''$$

MONTHLY CLIMATOLOGICAL SUMMARY for MAR. 2018

NAME: rain history CITY: STATE:  
 ELEV: 54 ft LAT: 41° 07' 01" N LONG: 69° 09' 01" W

TEMPERATURE (°F), RAIN (in), WIND SPEED (mph)

DAY	MEAN TEMP	HIGH	TIME	LOW	TIME	HEAT DEG DAYS	COOL DEG DAYS	RAIN	AVG WIND SPEED	HIGH	TIME	DOM DIR
1	46.6	57.3	1:30p	41.7	8:30p	18.4	0.0	0.00	0.8	17.0	11:30p	NE
2	42.6	47.1	9:30a	37.5	11:30p	22.4	0.0	2.41	8.4	45.0	5:30p	NE
3	40.4	42.2	9:30a	36.9	1:00a	24.6	0.0	0.18	6.2	40.0	2:00a	NE
4	38.1	41.1	1:30a	35.9	11:30p	26.9	0.0	0.03	2.6	26.0	1:30a	NE
5	38.7	41.4	2:30p	35.0	3:00a	26.3	0.0	0.21	4.4	31.0	9:30a	NE
6	36.6	41.0	12:00p	34.4	8:30a	28.4	0.0	0.01	1.5	19.0	12:30a	NE
7	39.6	44.3	12:00m	35.4	12:30a	25.4	0.0	0.69	3.8	36.0	10:30p	ESE
8	37.9	44.3	12:30a	33.4	10:00a	27.1	0.0	0.14	3.0	26.0	9:00a	W
9	34.9	39.5	11:00a	29.6	6:00a	30.1	0.0	0.00	1.4	18.0	11:00a	W
10	37.3	42.2	12:30p	33.5	4:30a	27.7	0.0	0.00	5.1	22.0	12:30p	W
11	37.5	42.4	2:30p	32.6	6:00a	26.3	0.0	0.00	3.2	18.0	11:00a	W
12	38.1	45.2	2:30p	28.8	7:00a	26.9	0.0	0.00	1.2	21.0	11:30p	ESE
13	33.8	40.3	12:30a	32.2	12:00m	31.2	0.0	0.76	6.5	31.0	2:00a	NE
14	33.9	38.2	3:00p	29.3	4:30a	31.1	0.0	0.62	2.5	30.0	12:30p	SSW
15	36.8	42.3	4:30p	31.7	6:30a	28.3	0.0	0.10	4.0	20.0	10:00a	W
16	34.4	37.0	12:30a	30.2	12:00m	30.6	0.0	0.00	6.9	25.0	8:30p	W
17	31.8	40.9	4:30p	25.3	12:00m	33.2	0.0	0.00	6.3	23.0	12:30a	W
18	27.0	31.5	4:30p	22.8	7:00a	38.1	0.0	0.00	4.4	24.0	4:30p	W
19	30.2	35.8	5:30p	25.3	7:00a	34.8	0.0	0.00	5.6	25.0	10:00a	W
20	33.2	37.9	3:00p	27.9	7:00a	31.8	0.0	0.00	1.3	15.0	12:30a	W
21	37.3	39.1	3:00a	35.0	2:00p	27.7	0.0	0.26	4.4	29.0	11:00p	NE
22	35.7	38.6	9:30p	33.9	7:00a	29.3	0.0	0.50	4.6	27.0	6:00a	NE
23	37.4	43.2	1:30p	29.9	12:00m	27.6	0.0	0.00	1.2	13.0	3:00p	W
24	37.8	46.0	3:30p	28.2	5:00a	27.2	0.0	0.00	0.9	16.0	11:00a	W
25	35.8	38.5	3:30p	32.9	6:30p	29.2	0.0	0.02	2.5	25.0	3:00p	NE
26	36.0	39.8	1:00p	33.9	7:30p	29.0	0.0	0.00	2.9	22.0	4:30p	NE
27	38.9	44.8	1:00p	34.4	1:00a	26.1	0.0	0.00	1.8	19.0	11:30a	NE
28	42.1	50.5	3:30p	37.4	12:00m	23.0	0.0	0.00	1.1	15.0	2:00p	W
29	44.8	54.4	1:30p	35.1	7:00a	20.2	0.0	0.00	1.8	17.0	11:00p	SSE
30	50.3	53.9	12:00p	44.2	11:00p	14.7	0.0	0.02	3.2	27.0	5:30a	SSW
31	42.3	48.1	2:00p	39.2	10:30p	22.7	0.0	0.01	3.1	21.0	8:00p	W
	37.7	57.3	1	22.8	18	846.3	0.0	5.96	3.4	45.0	2	W

Max >= 90.0: 0  
 Max <= 32.0: 1  
 Min <= 32.0: 11  
 Min <= 0.0: 0

Max Rain: 2.41 ON 03/02/18

Days of Rain: 13 (>.01 in) 9 (>.1 in) 1 (>1 in)

Heat Base: 65.0 Cool Base: 65.0 Method: Integration

$\bar{x}_H = 42.9^\circ$   
 $\bar{x}_L = 33.0^\circ$

DAY	WEATHER	TEMP: F	WIND		BAROMETER inches	RAINFALL inches	SNOW inches	RELATIVE HUMIDITY %	REMARKS
			speed	direction					
1		57.0						APRIL 2018	
2		40.5	24			.25		H-53.0 L-39.2	
3		43.2	12			.34		H-40.5 L-30.2	
4		56.4	20			.08		H-49.2 L-37.5	
5		43.3	31			.20		H-56.2 L-41.2	
6		49.3	25			.04		H-43.3 L-33.1	
7		49.3	29			.04		H-49.3 L-38.7	
8		48.9	16					H-48.9 L-36.8	
9		41.2	22					H-46.2 L-34.0	
10		42.5	20			.05		H-42.5 L-32.1	
11		40.8	13			.01		H-42.3 L-30.9	
12		44.6	15			.02		H-42.6 L-29.5	
13		52.8	21			.01		H-52.8 L-36.8	
14		54.3	39					H-54.3 L-47.3	
15		52.8	22					H-52.8 L-46.7	
16	Cldy	38.0	3	NE	30.41		67	H-40.7 L-35	
17	Cldy	41.1	13	ESE	30.16		77	H-52 L-36	
18	PC	43.6	<1	SW	29.98		94	H-53 L-42	
19	Clear	57.9	2	WSW	29.64		80	H-51 L-37	
20	RAIN	42	18	SW	29.76	.24	90	H-42.7 L-37.8	
21	MC	38	4	ANW	29.89	.01	82	H-41.7 L-38.1	
22	Clear	41	4	W	30.25		76	H-52 L-38	
23	Clear	41	13	SSW	30.30		87	H-58 L-33	
24	Clear	42	<1	NW	30.43		78	H-60 L-32	
25	Clear	42	18	SSE	30.42		94	H-57 L-32	
26	Cldy	49	6	SSE	30.12	.66	90	H-56.5 L-48.4	
27	Open	51	21	S	29.56	.01	98	H-59.3 L-41.2	
28	Clear	47	18	W	29.89	.14	95	H-57 L-41	
29	Cldy	50	19	W	29.79		98	H-64 L-49	
30	PC	48	13	W	29.98	.01	97	H-57 L-41	
31	Clear	47	13	SW	29.90	.07	85	H-50 L-38	

$\bar{x} = 50.7 \quad \bar{y} = 36.9$

2.14"

**Appendix H**  
**Grain Size Analysis Reports**

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**Hydraulic Conductivity Approximation**  
Orleans, MA

**Summary of Equations:**

Vukovic and Soro  
 $n = 0.255 \left[ 1 + 0.83 \sqrt{U} \right]$   
 $n = 0.255 (1 + 0.83 \sqrt{U})$        $U = (d_{60}/d_{10})$

Shepards  
 $K_{sat} = b * (d_{50})^c$

b and c are read from Shepards Chart

Hazen  
 $K_{sat} = c(d_{10})^2$ ; c=1.0 to 1.5; d10 (mm)

$$K = \frac{g}{\nu} \times 6 \times 10^{-4} \left[ 1 + 10 \left( \frac{n}{n-0.26} \right)^2 \right] \frac{d_{10}^2}{10}$$

Kozeny-Carman  
 $K_{sat} = g / \text{viscosity} * 0.370 * 0.0018 \ln^3 \left( \frac{1-n}{n} \right)^2 / d_{10}^2$

$$K = \frac{g}{\nu} \times 8.3 \times 10^{-3} \left[ \left( \frac{n}{1-n} \right)^3 \right] \frac{d_{10}^2}{10}$$

Slitcher  
 $K = \frac{g}{\nu} \times 1 \times 10^{-2} n^{3.287} / d_{10}^2$

g  
 viscosity  
 9.81 m/s<sup>2</sup>  
 1.004E-06 m<sup>2</sup>/s

**Summary of Results**

Soil sample	CTS Sample No./ Laboratory Material	Depth (ft)	D10 (mm)	D50 (mm)	D80 (mm)	U(d60/d10)	(porosity)	n	Classification	Fines(%)	Kozeny-Carman Keat (ft/day)	Shepards Keat (ft/day)	Hazen Keat (ft/day)	Slitcher Keat (ft/day)	Sample Average (FT/day)
LH-2	1 18-S-163	30-40	0.1044	0.3433	0.3887	3.72	0.38	0.02	Poorly graded SAND with Silt	36.76	79.95	40.29	12.82	42.46	
LH-5	1 18-S-164	80-96	0.1231	0.231	0.2592	2.11	0.43	0.03	Poorly graded SAND	82.67	41.60	67.25	25.61	54.28	
LH-2	2 18-S-165	106	0.0133	0.0437	0.0511	3.84	0.38	0.44	SILT with SAND	2.67	2.67			2.67	
LH-5	2 18-S-166	118	0.0066	0.0348	0.0467	7.1	0.32	0.06	SILT with SAND	1.83	1.83			1.83	
LH-5	3 18-S-167	124-132	0.0974	0.1977	0.2159	2.22	0.42	0.96	Poorly graded SAND	32.18	32.18		15.61	23.89	
LH-2	3 18-S-168	106-108	0.1004	0.113	0.113		0.51	0.47	Silty SAND	10.52	10.52			10.52	
WW-2(235-245)	1 18-S-169	36	0.2097	0.2628			0.51	0.68	Silty SAND	35.46	35.46			35.46	
WW-2(235-245)	2 18-S-170	66	0.1215	0.3175	0.357	2.94	0.40	0.11	Poorly graded SAND	61.93	70.31	59.46	20.52	53.06	
WW-2(235-245)	3 18-S-171	101	0.007	0.0303	0.0347	4.98	0.36	0.14	SILT	1.46	1.46			1.46	
WW-2(235-245)	4 18-S-172	165	0.0067	0.0652	0.1185	17.72	0.26	0.43	Silty SAND	9.64	9.64			9.64	
WW-2(235-245)	5 18-S-173	186-196	0.1045	0.1932	0.2137	2.04	0.43	0.10	Poorly graded SAND with Silt	61.01	30.98	48.87	16.78	39.91	
WW-2(235-245)	6 18-S-174	226	0.186	0.6023	0.572	3.45	0.39	0.02	Poorly graded SAND with Silt	99.94	149.87	104.88	34.28	97.24	

Most widely accepted, fine sand with d10 between 0.1 to 3mm  
 (see Shepards Equation chart)  
 Uniformly graded sand and fine sand with d10 between 0.1 to 3mm, and U<5  
 Applicable for grain-size between 0.075mm and 5mm

Grain size outside the equation applicability range  
 Insufficient grain size data

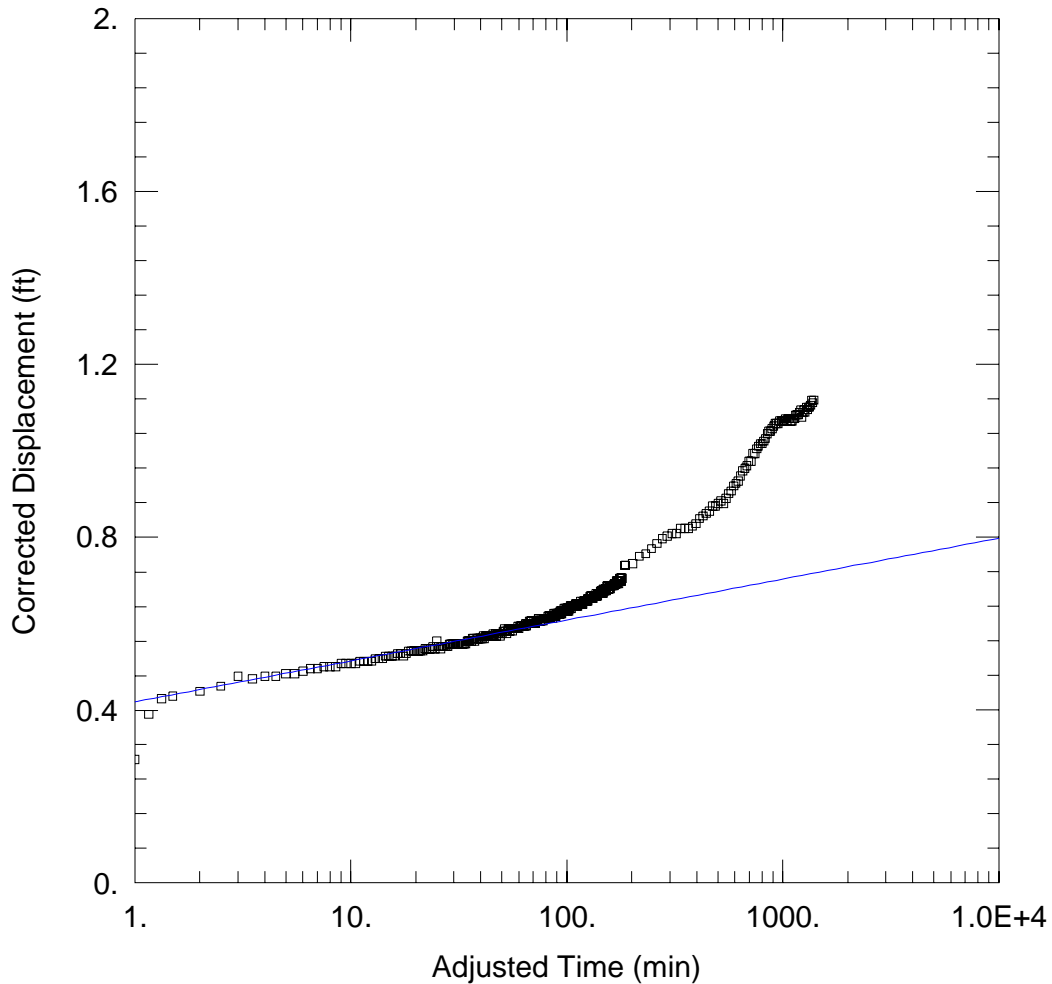
Poorly graded SAND - (ft/day)	Poorly graded SAND with Silt - Ksat (ft/day)	SILT with SAND - Ksat (ft/day)	Silty SAND - Ksat (ft/day)	SILT - Ksat (ft/day)
54.28	42.46	2.67	10.52	1.46
23.89	39.91	1.83	35.46	
53.06	97.24	9.64		
43.74	99.87	2.25	18.34	1.46

Average per soil class

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**Appendix I**  
**Pumping Test Analysis Reports**

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WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-1S PPTMW-16(110-120) pumping.aqt  
 Date: 09/14/17 Time: 14:24:13

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1S  
 Test Date: 8/1/17

AQUIFER DATA

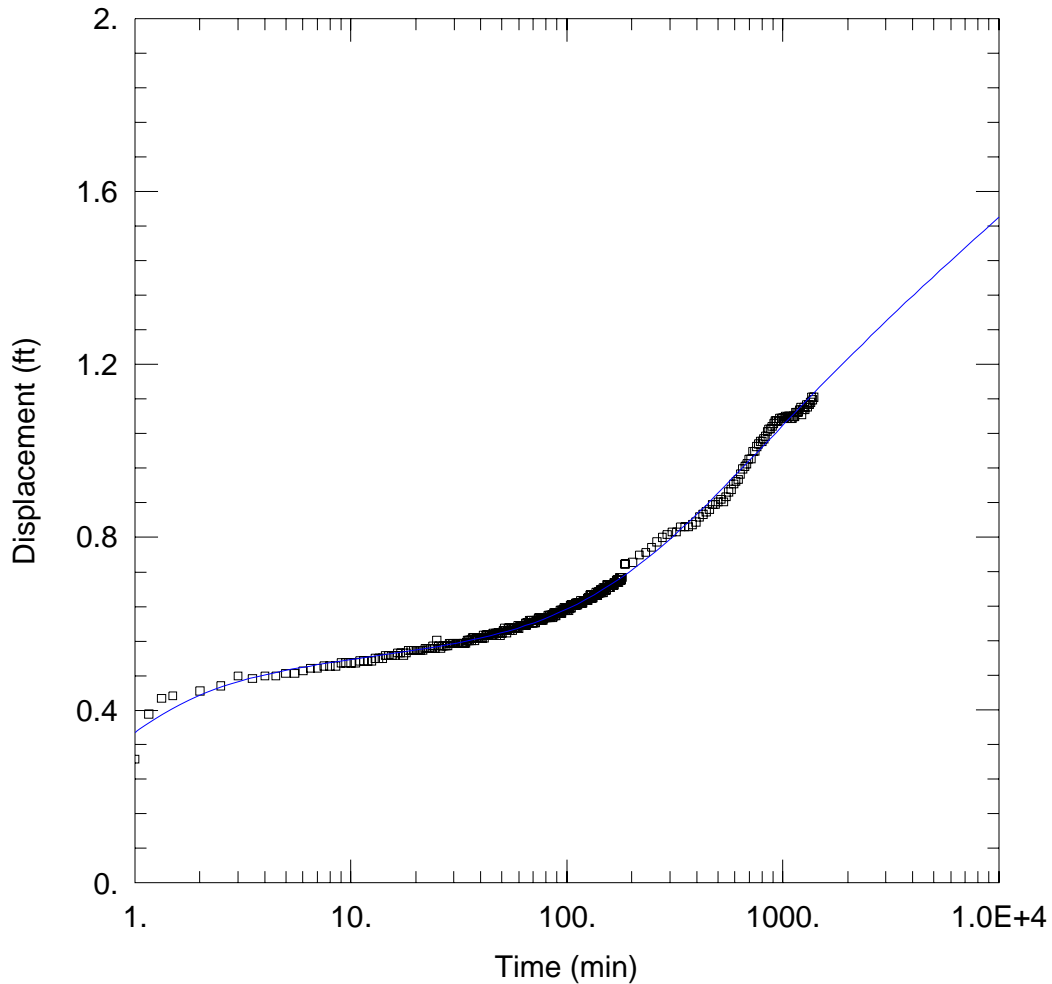
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.2948

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-1S	0	0	□ MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob  
 T = 2.976E+4 ft<sup>2</sup>/day S = 1.447E-6



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-1S PPTMW-16(110-120) pumping.aqt  
 Date: 09/13/17 Time: 14:08:50

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1S  
 Test Date: 8/1/17

AQUIFER DATA

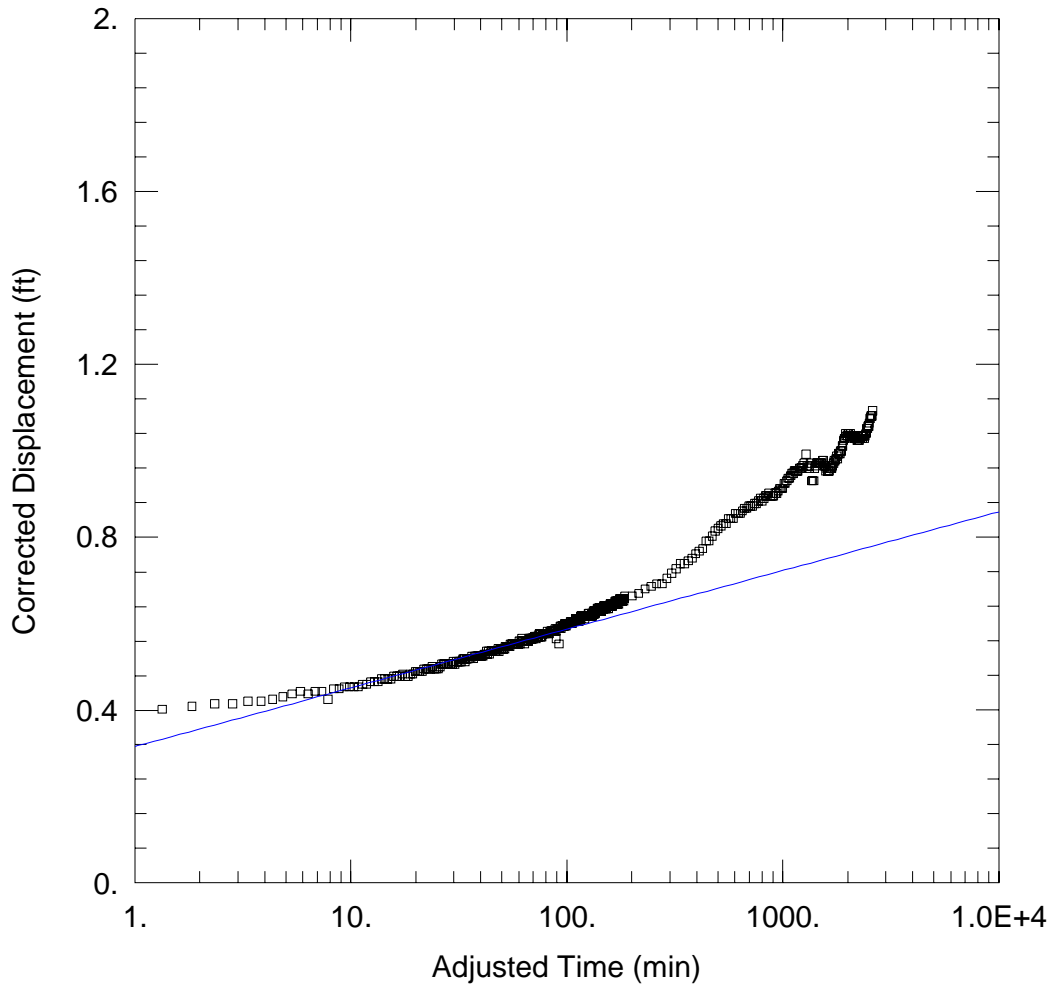
Saturated Thickness: 100. ft

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-1S	0	0	□ MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman  
 T = 6461.7 ft<sup>2</sup>/day S = 0.003835  
 Sy = 0.146 β = 0.03611



WELL TEST ANALYSIS

Data Set: C:\...\MW-16(110-120) recovery.aqt

Date: 09/14/17

Time: 14:29:47

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1S  
 Test Date: 8/1/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 0.06865

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1S	0	0

Well Name	X (ft)	Y (ft)
□ MW-16(110-120)	35	0

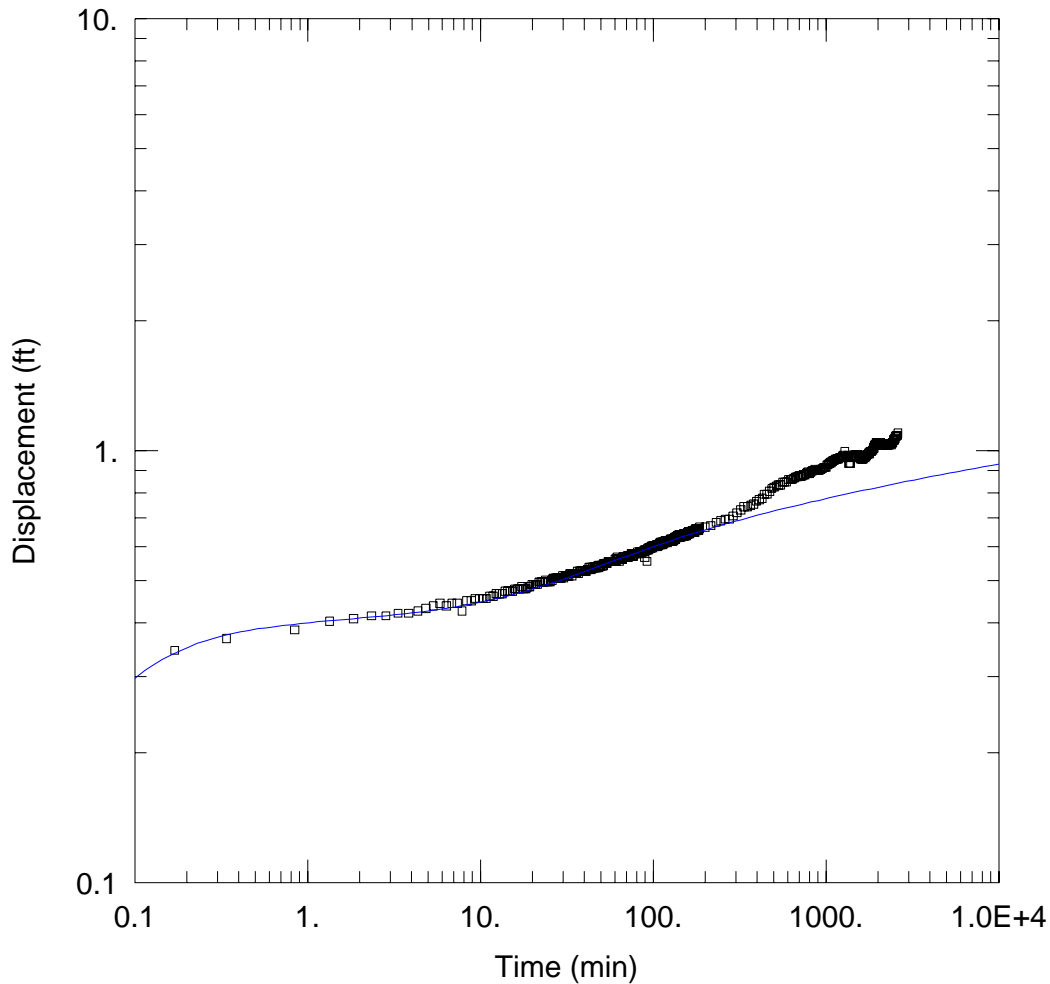
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

T = 2.076E+4 ft<sup>2</sup>/day

S = 0.0001265



WELL TEST ANALYSIS

Data Set: C:\...\MW-16(110-120) recovery.aqt

Date: 09/13/17

Time: 16:56:13

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1S  
 Test Date: 8/1/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1S	0	0

Well Name	X (ft)	Y (ft)
□ MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined

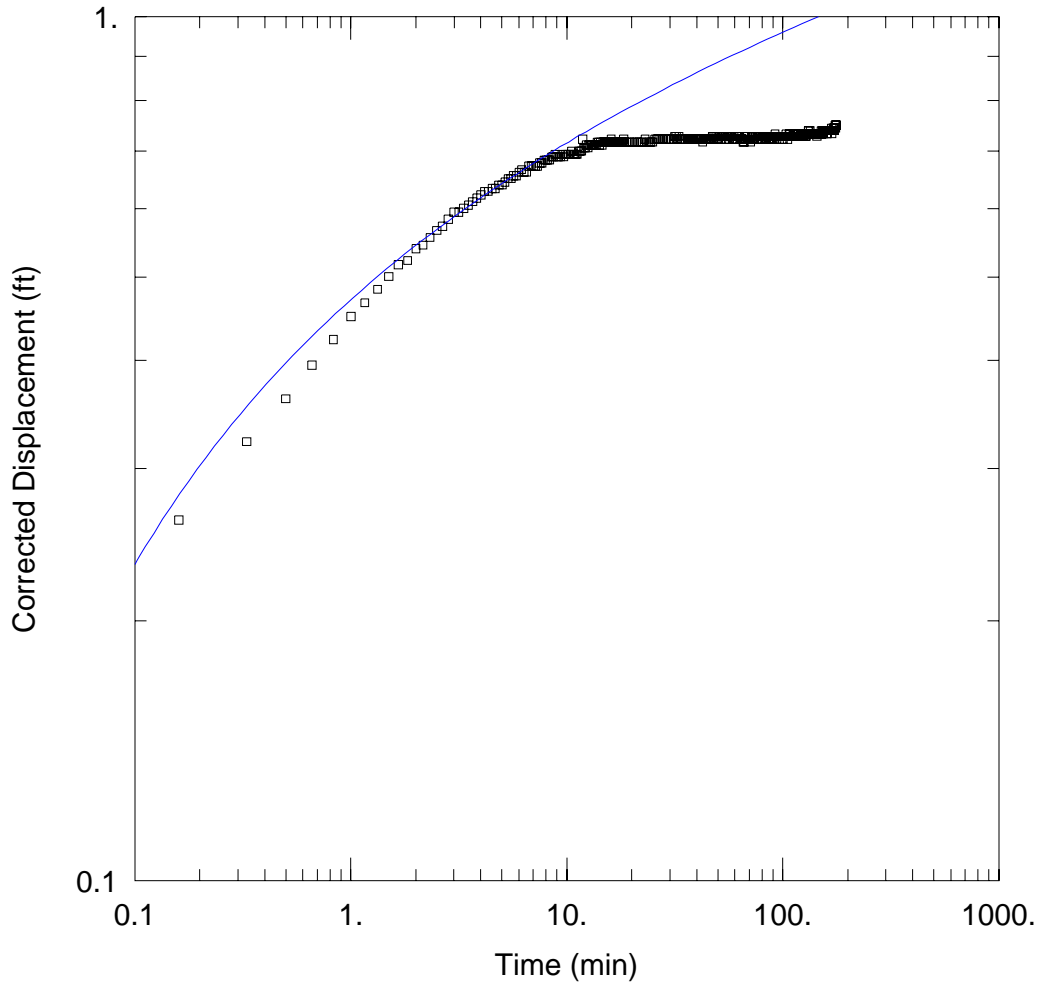
Solution Method: Neuman

T = 1.814E+4 ft<sup>2</sup>/day

S = 0.0004143

Sy = 0.01147

β = 0.008409



WELL TEST ANALYSIS

Data Set:

Date: 09/14/17

Time: 16:53:15

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1D  
 Test Date: 8/3/17

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined

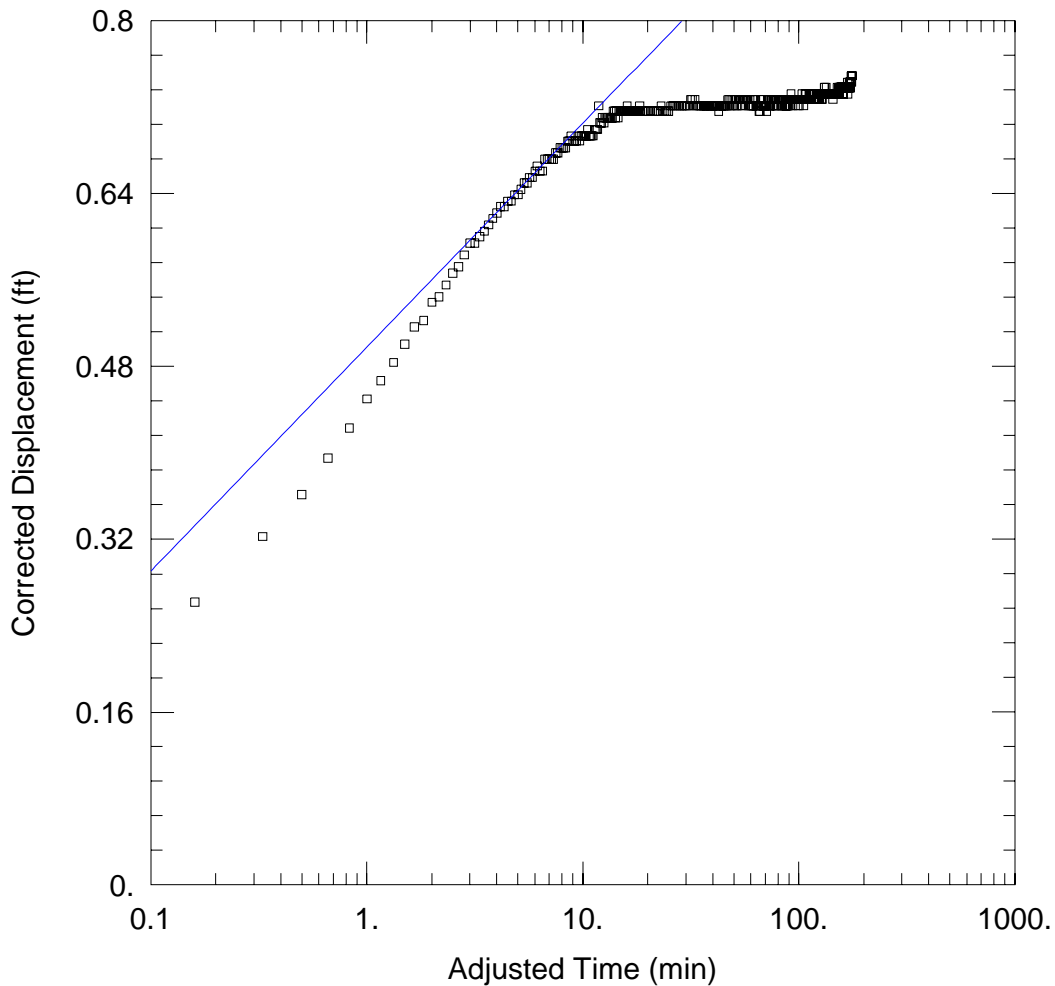
Solution Method: Theis

T = 8.203 ft<sup>2</sup>/min

S = 6.081E-5

Kz/Kr = 1.

b = 100. ft



WELL TEST ANALYSIS

Data Set:

Date: 09/14/17

Time: 16:54:46

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1D  
 Test Date: 8/3/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	62	0

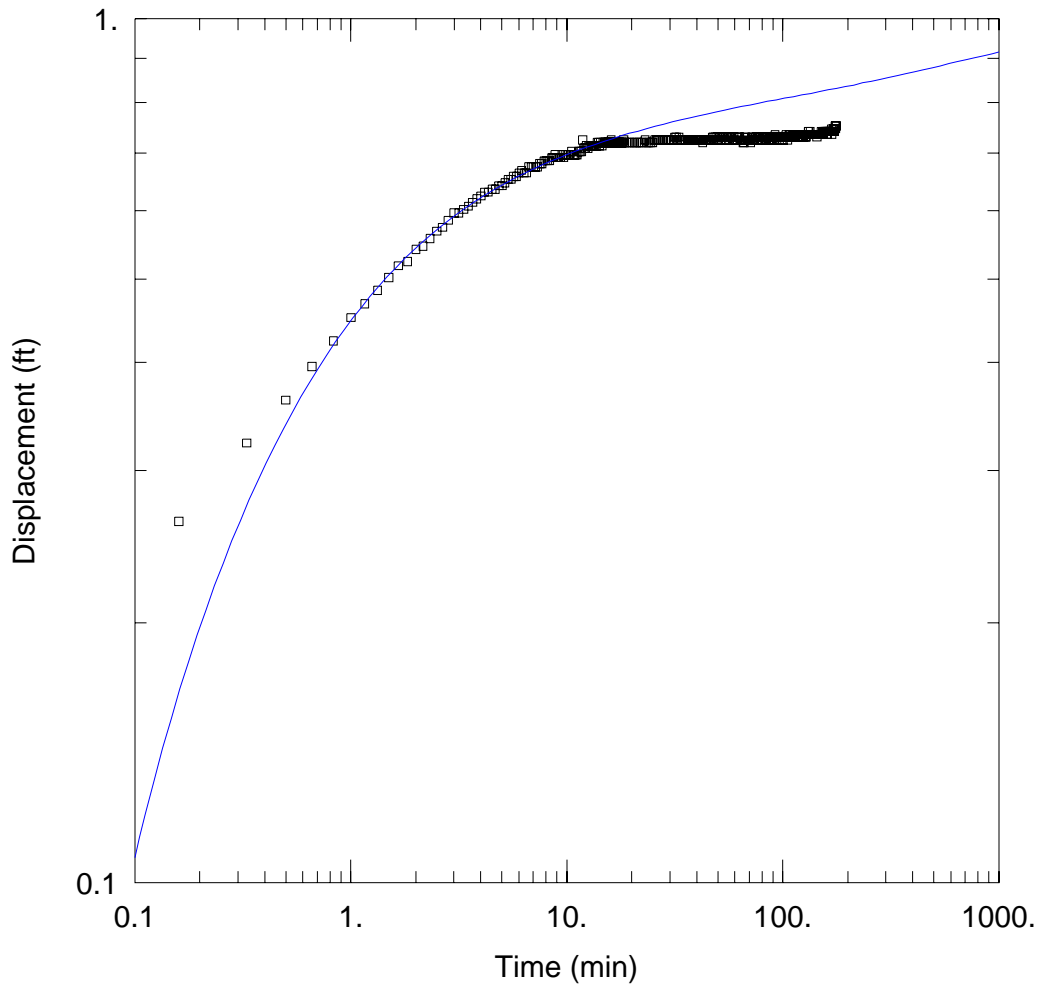
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

T = 9.69 ft<sup>2</sup>/min

S = 2.244E-5



WELL TEST ANALYSIS

Data Set:

Date: 09/14/17

Time: 16:57:53

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1D  
 Test Date: 8/3/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined

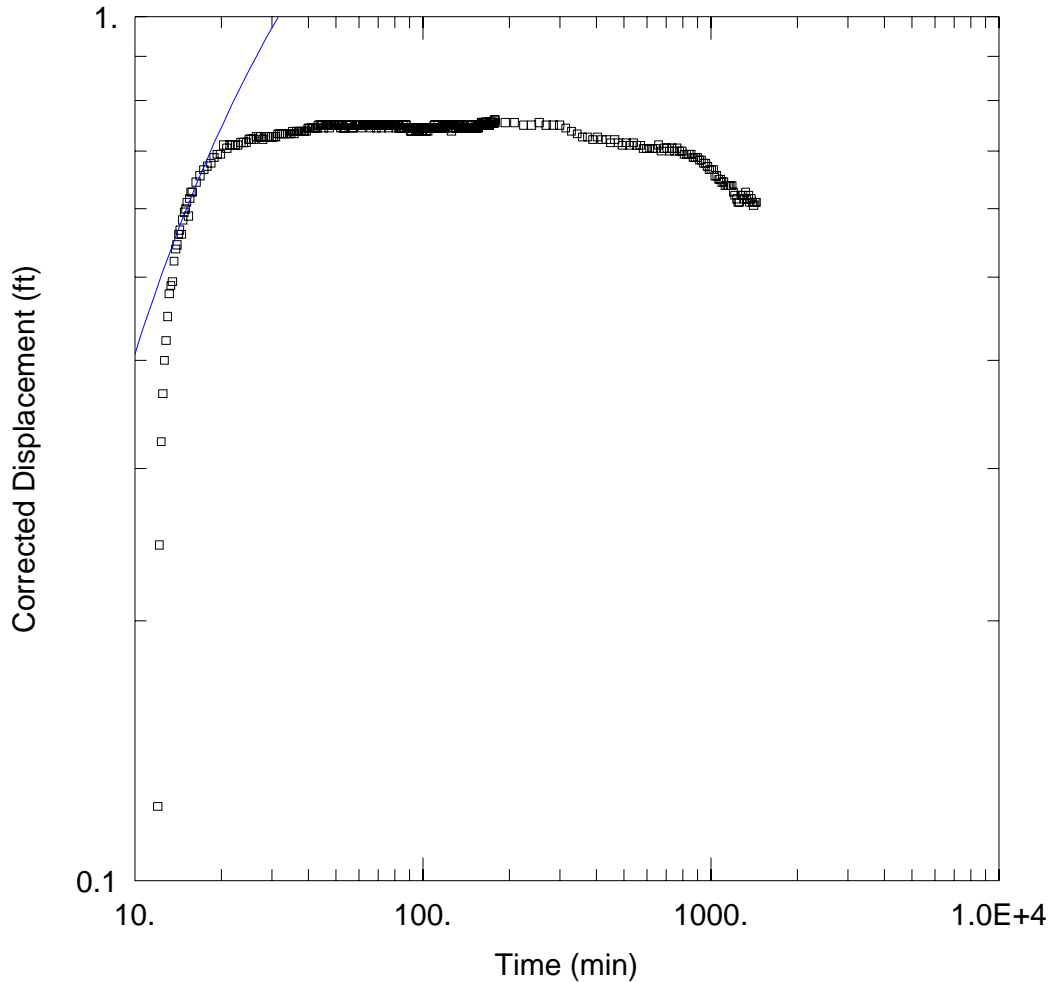
Solution Method: Neuman

T = 15.62 ft<sup>2</sup>/min

S = 0.0007936

Sy = 0.001

β = 0.001



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt

Date: 09/14/17

Time: 17:22:29

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1D  
 Test Date: 8/3/17

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined

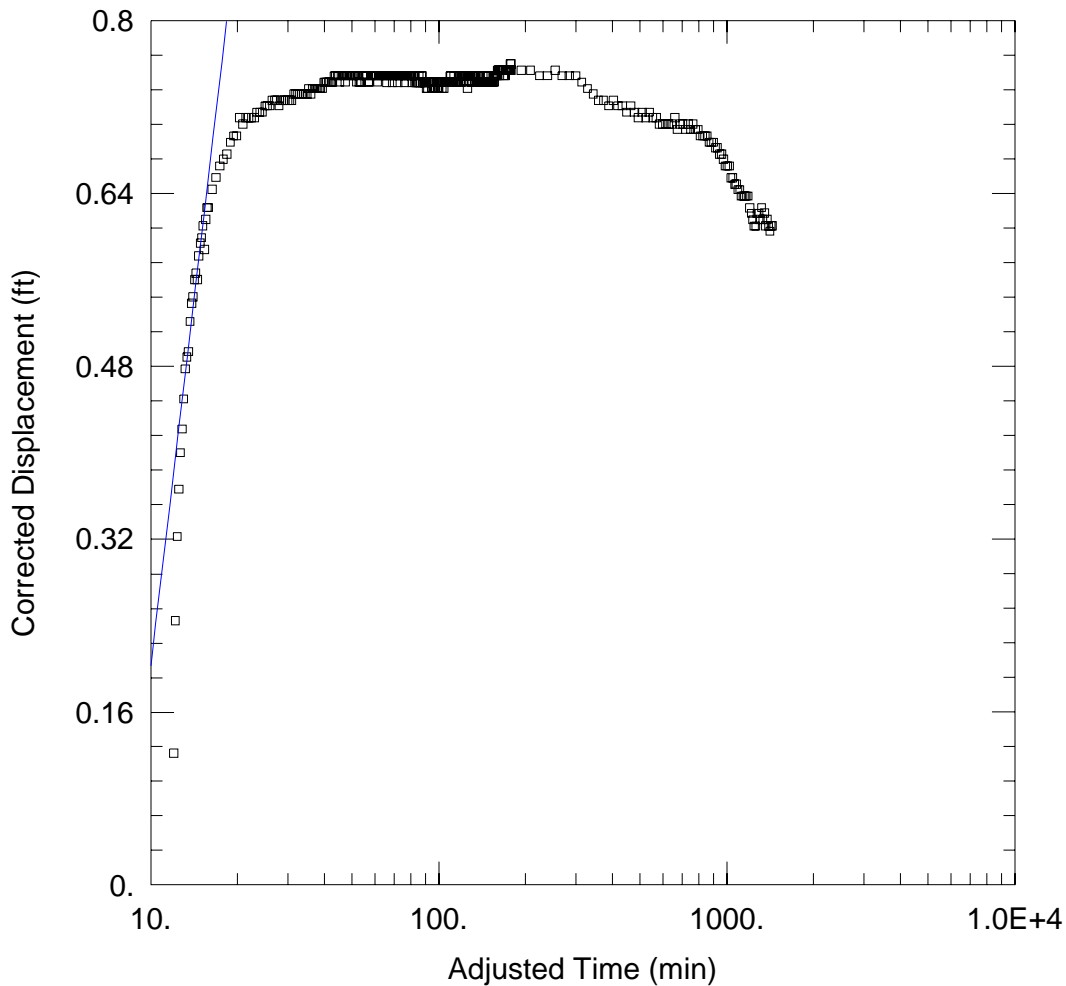
Solution Method: Theis

T = 4.215 ft<sup>2</sup>/min

S = 0.02088

Kz/Kr = 0.002601

b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt

Date: 09/14/17

Time: 17:23:32

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-1D  
 Test Date: 8/3/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 0.002601

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	62	0

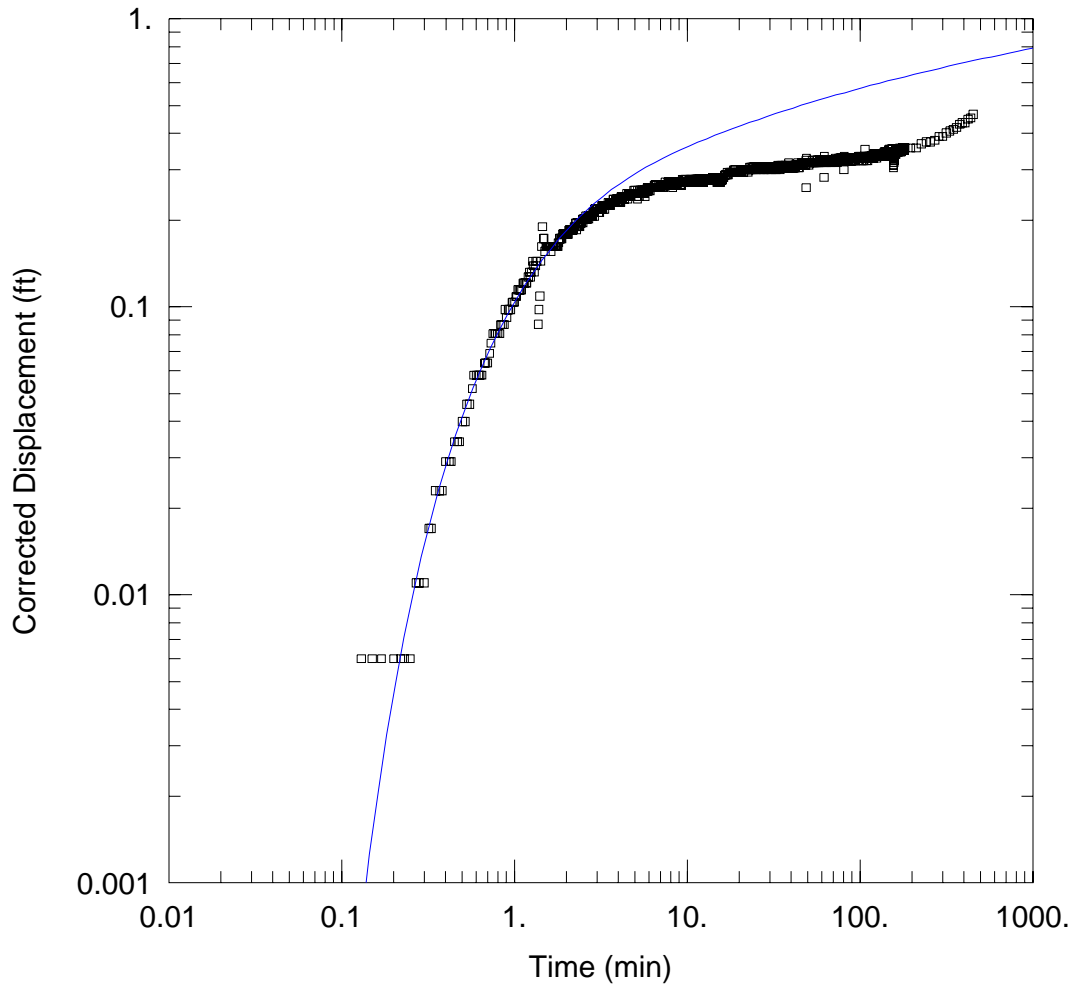
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

T = 0.8863 ft<sup>2</sup>/min

S = 0.004215



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPTMW-15S pumping.aqt  
 Date: 09/12/17 Time: 16:03:05

PROJECT INFORMATION

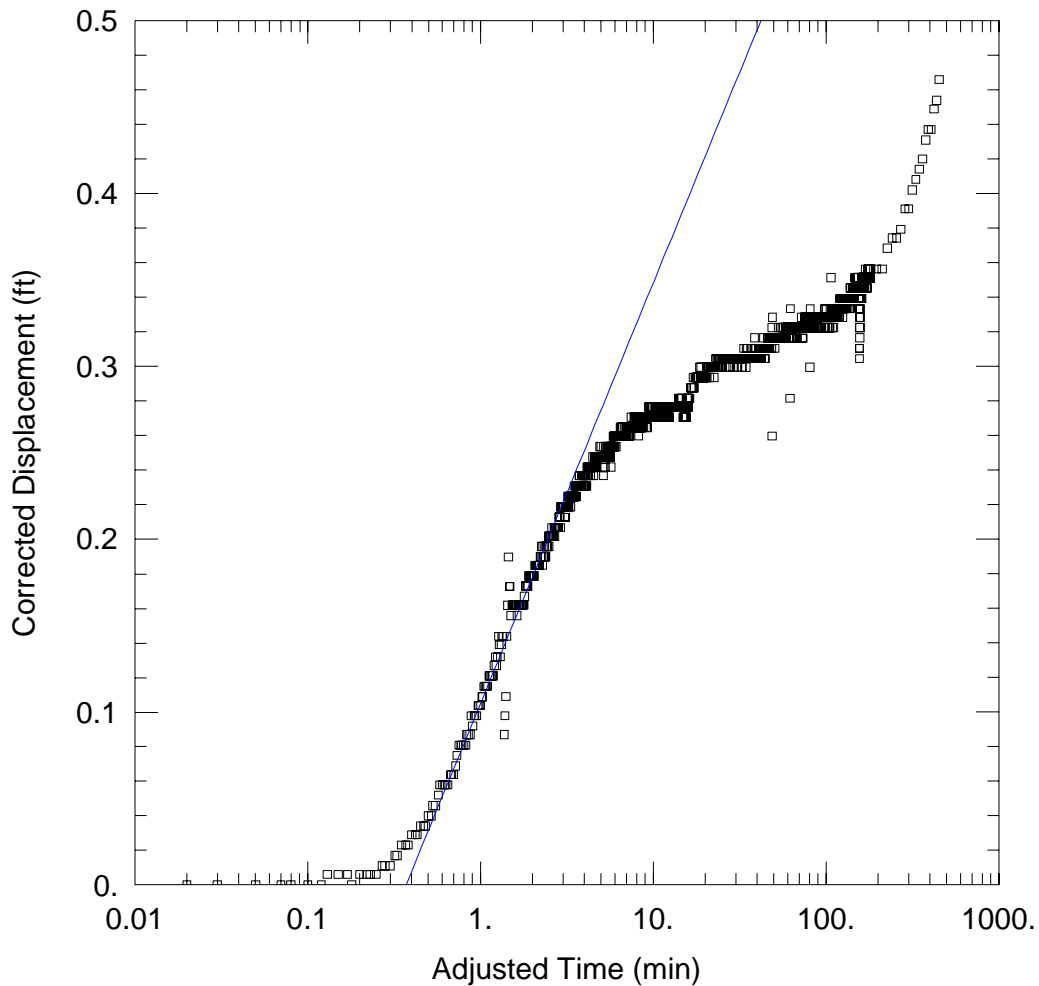
Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-2S  
 Test Date: 8/17/17

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2S	0	0	□ MW-15S	106	0

SOLUTION

Aquifer Model: <u>Unconfined</u>	Solution Method: <u>Theis</u>
T = <u>9.229 ft<sup>2</sup>/min</u>	S = <u>0.001849</u>
Kz/Kr = <u>0.06691</u>	b = <u>103.5 ft</u>



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPTMW-15S pumping.aqt  
 Date: 09/12/17 Time: 16:02:26

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-2S  
 Test Date: 8/17/17

### AQUIFER DATA

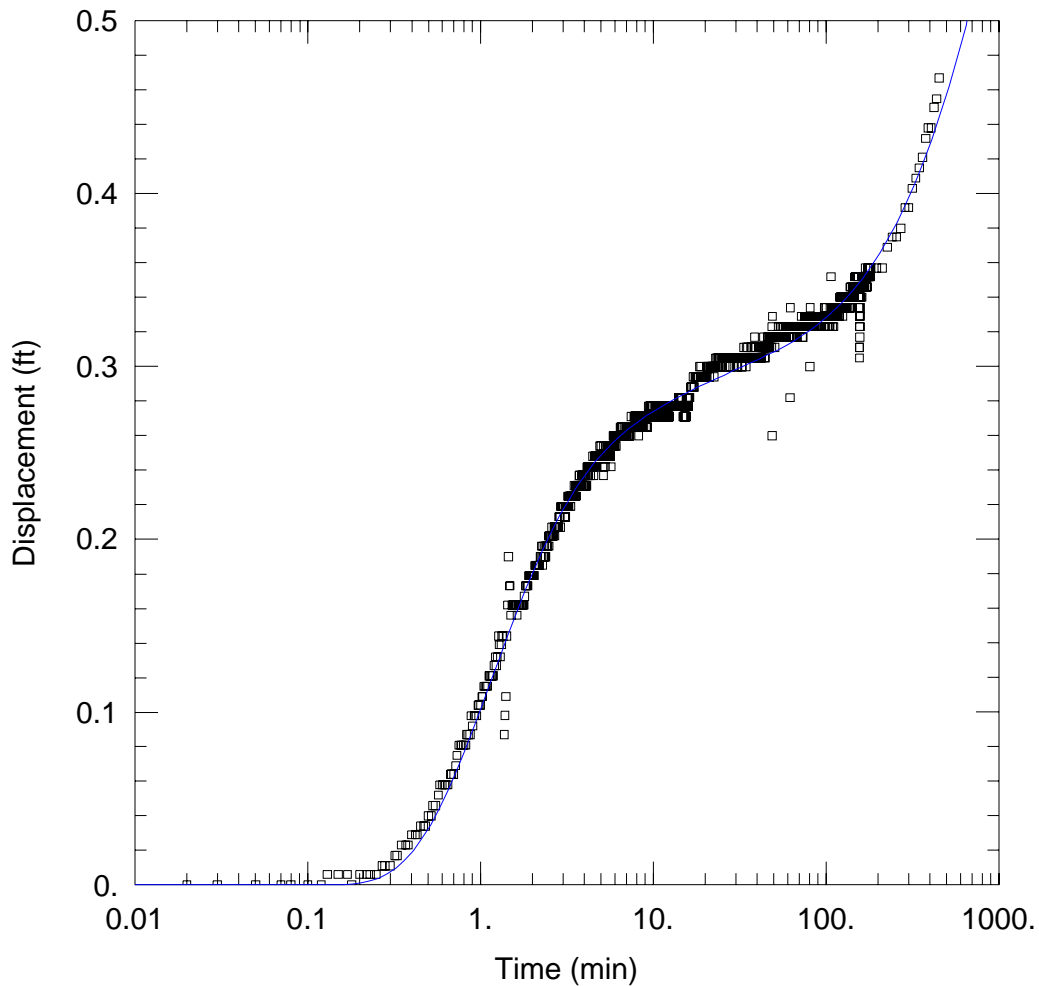
Saturated Thickness: 103.5 ft Anisotropy Ratio (Kz/Kr): 0.06691

### WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2S	0	0	□ MW-15S	106	0

### SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob  
 T = 8.247 ft<sup>2</sup>/min S = 0.0006118



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPTMW-15S pumping.aqt  
 Date: 09/12/17 Time: 12:33:24

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-2S  
 Test Date: 8/17/17

AQUIFER DATA

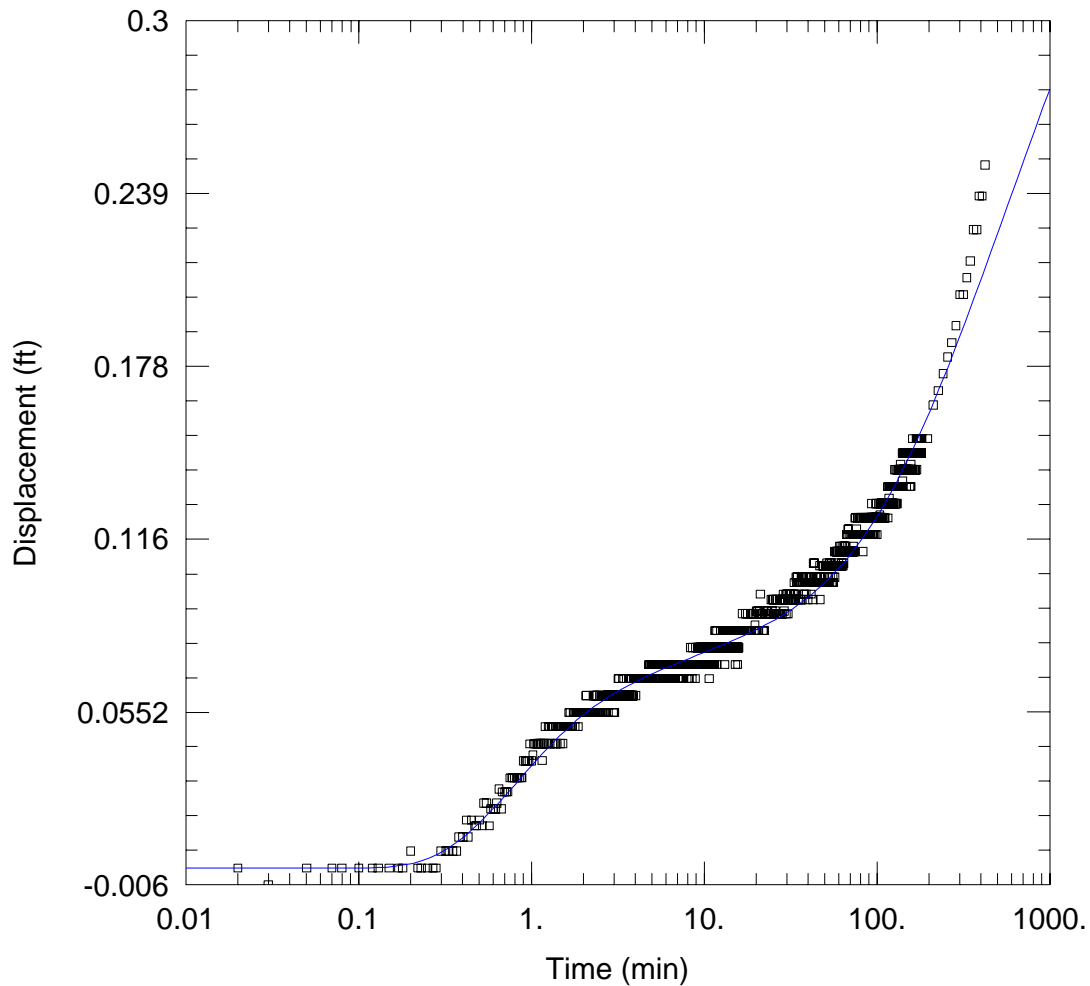
Saturated Thickness: 103.5 ft

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2S	0	0	□ MW-15S	106	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman  
 $T = 4.524 \text{ ft}^2/\text{min}$   $S = 0.001443$   
 $Sy = 0.105$   $\beta = 0.07014$



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPT\PW-1S pumping.aqt  
 Date: 09/12/17 Time: 12:36:36

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-2S  
 Test Date: 8/17/17

### AQUIFER DATA

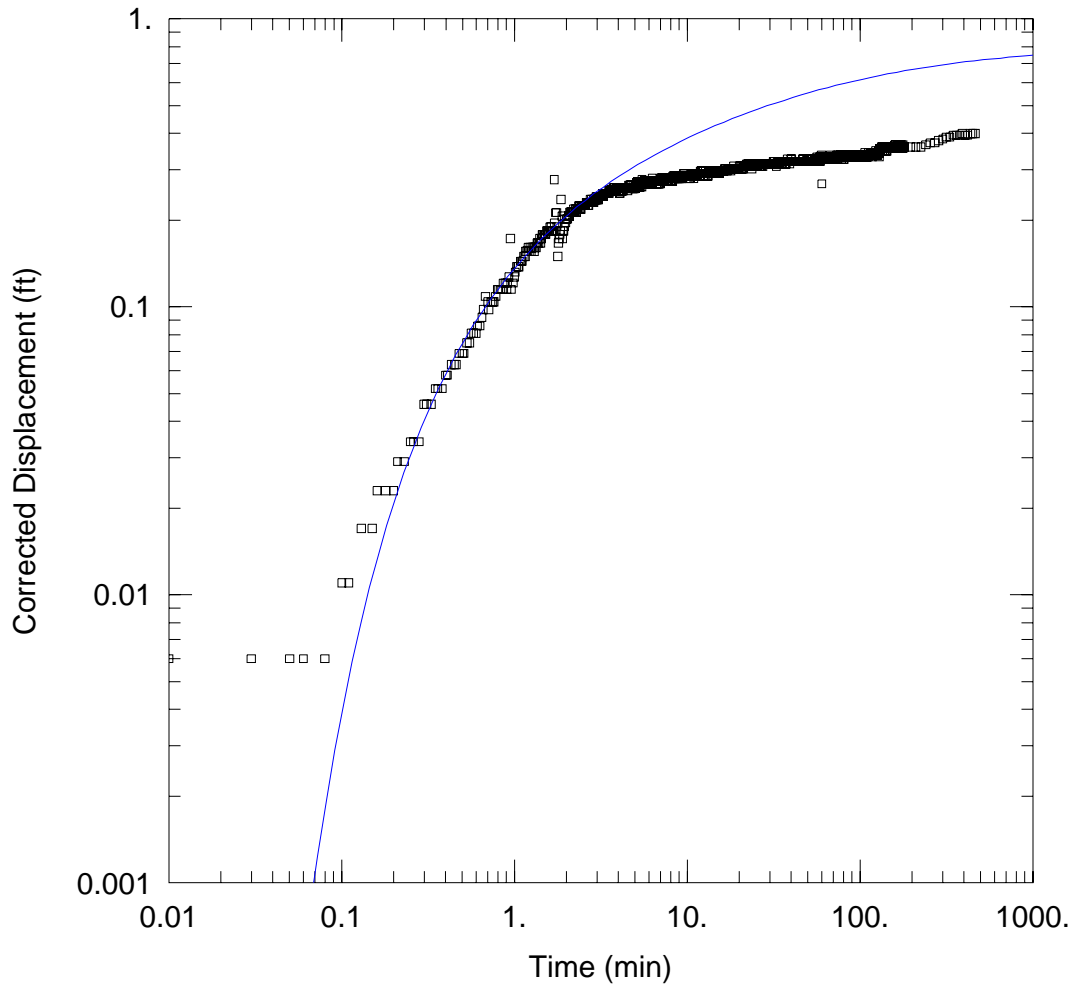
Saturated Thickness: 103.5 ft

### WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2S	0	0	□ PW-1S	160	0

### SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman  
 $T = 13.98 \text{ ft}^2/\text{min}$   $S = 0.001387$   
 $S_y = 0.03174$   $\beta = 0.09565$



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S Recovery\MW-15S Recovery.aqt  
 Date: 09/12/17 Time: 11:43:45

PROJECT INFORMATION

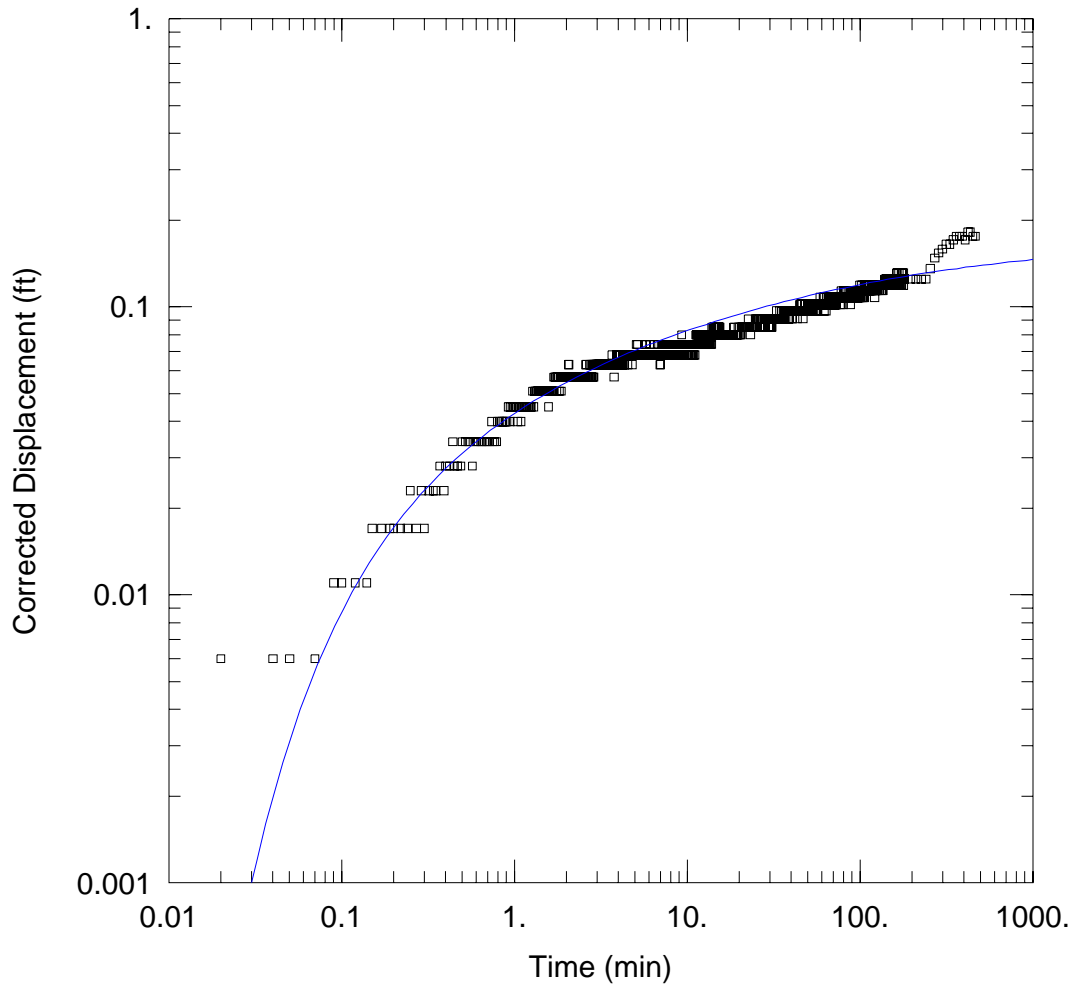
Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-2S  
 Test Date: 8/17/17

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
<u>PW-2S</u>	0	0	□ <u>MW-15S</u>	106	0
<u>MW-15S</u>	106	0			

SOLUTION

Aquifer Model: Unconfined Solution Method: Theis  
 $T = 68.74 \text{ ft}^2/\text{min}$   $S = 714.5$   
 $Kz/Kr = 1.$   $b = 100. \text{ ft}$



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S Recovery\PW-1S Recovery.aqt  
 Date: 09/12/17 Time: 11:44:21

### PROJECT INFORMATION

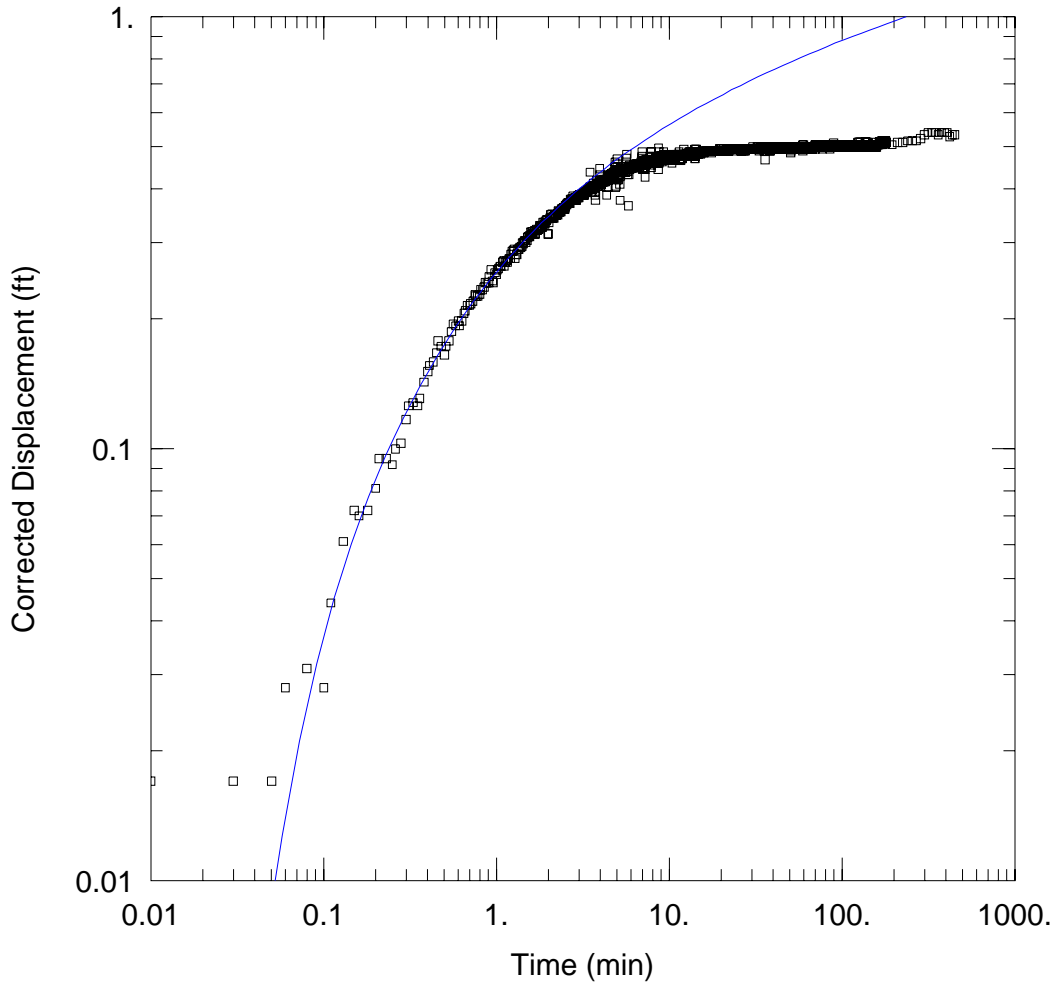
Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-2S  
 Test Date: 8/17/17

### WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
<u>PW-2S</u>	0	0	□ <u>PW-1S</u>	160	0
<u>PW-1S</u>	160	0			

### SOLUTION

Aquifer Model: <u>Unconfined</u>	Solution Method: <u>Theis</u>
T = <u>156.3 ft<sup>2</sup>/min</u>	S = <u>404.4</u>
Kz/Kr = <u>1.</u>	b = <u>100. ft</u>



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-15(140-150).aqt  
 Date: 09/12/17 Time: 14:41:06

PROJECT INFORMATION

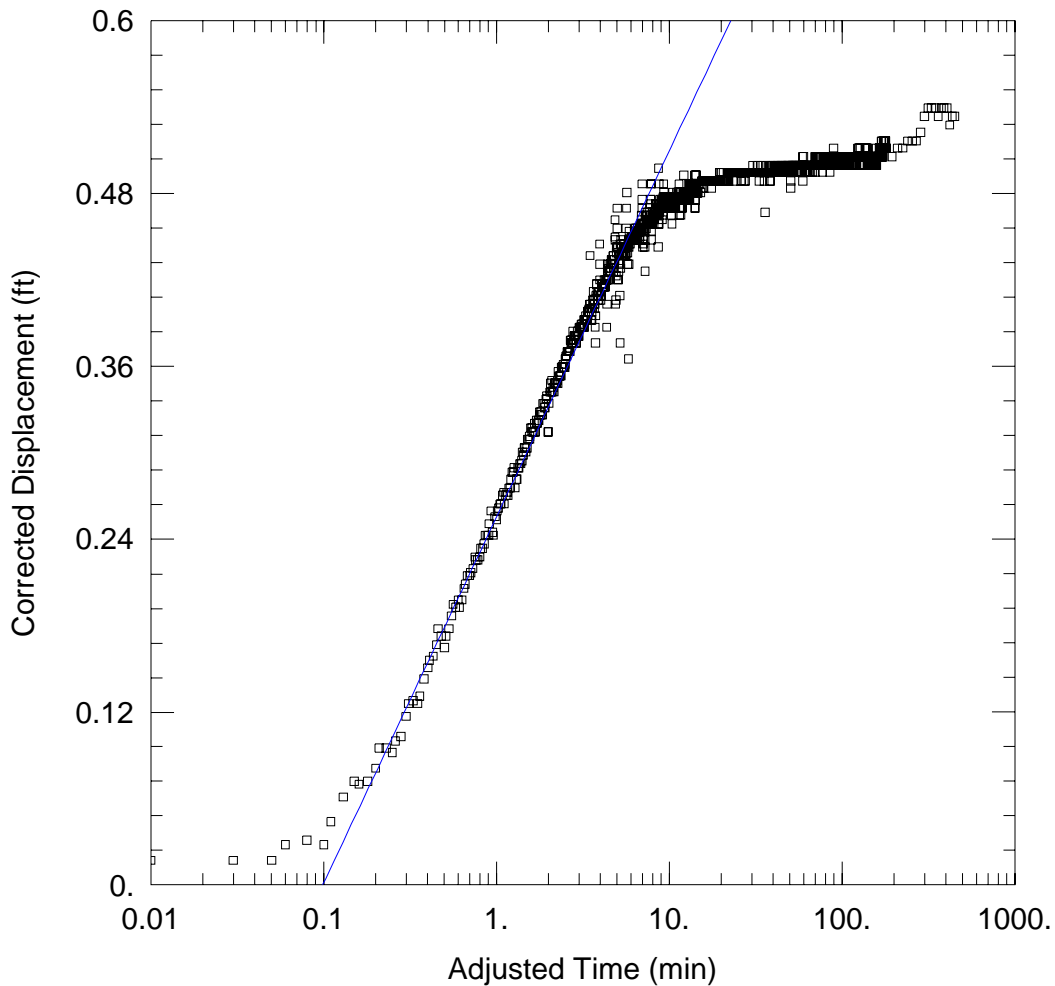
Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ MW-15(140-150)	108	0

SOLUTION

Aquifer Model: <u>Unconfined</u>	Solution Method: <u>Theis</u>
T = <u>6.278 ft<sup>2</sup>/min</u>	S = <u>0.0002402</u>
Kz/Kr = <u>0.1826</u>	b = <u>100. ft</u>



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-15(140-150).aqt  
 Date: 09/12/17 Time: 14:41:43

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

AQUIFER DATA

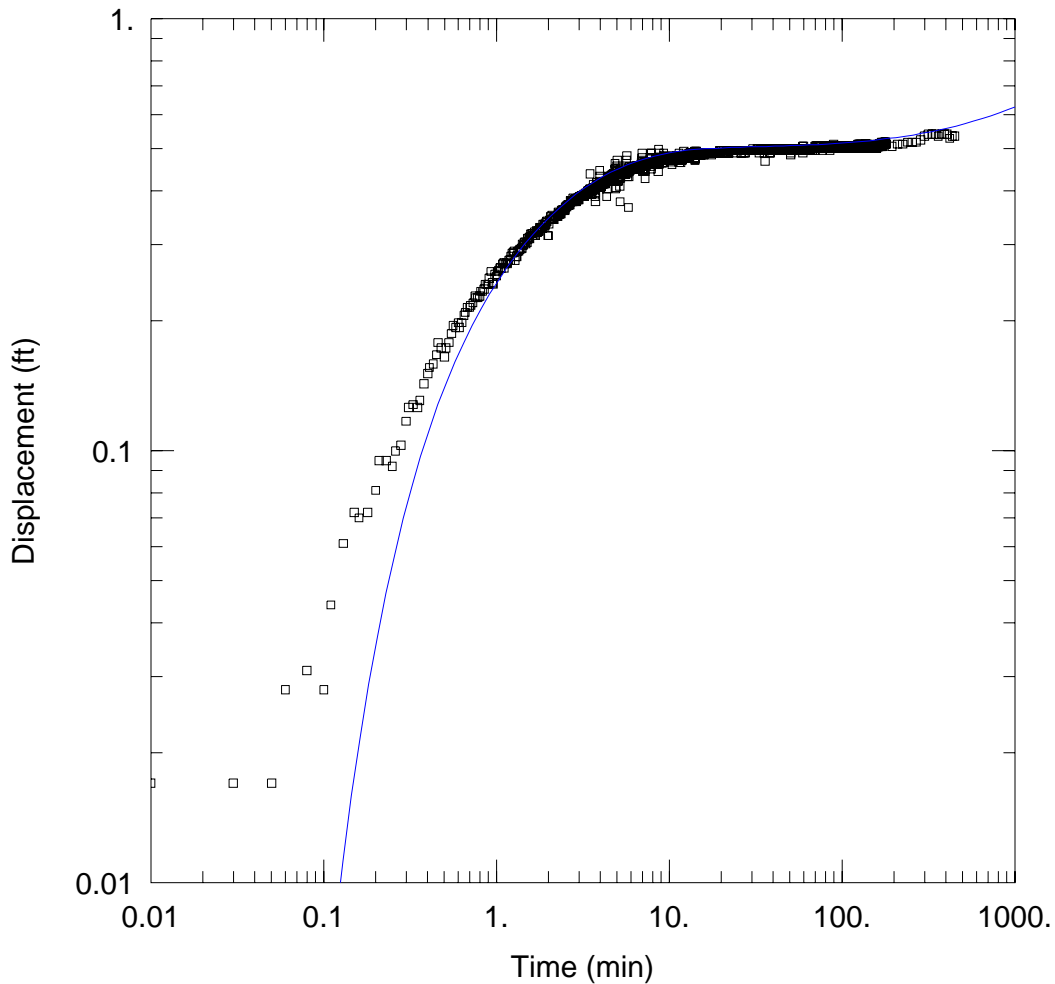
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.1826

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob  
 T = 7.9 ft<sup>2</sup>/min S = 0.0001504



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPTMW-15(140-150).aqt  
 Date: 09/12/17 Time: 14:42:32

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

AQUIFER DATA

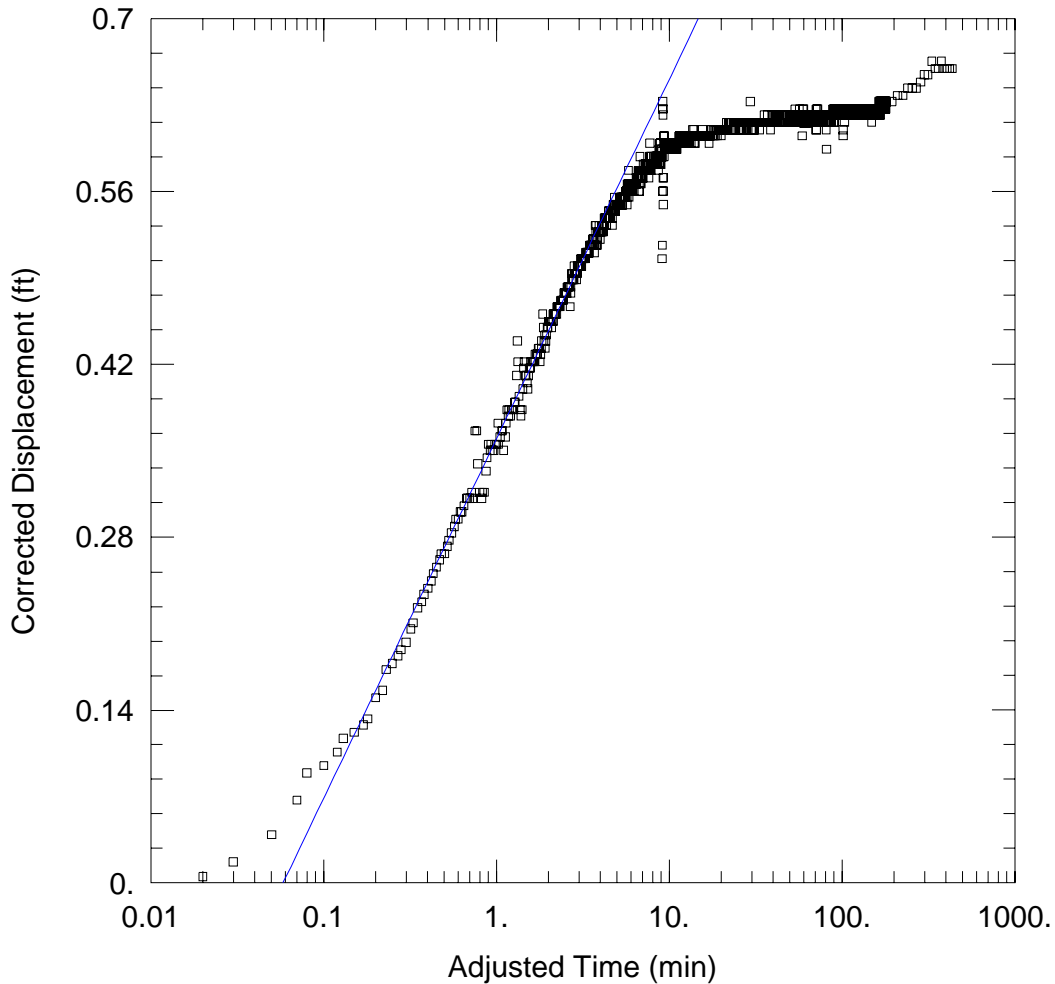
Saturated Thickness: 100. ft

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman  
 $T = 4.207 \text{ ft}^2/\text{min}$   $S = 0.0004757$   
 $S_y = 0.1$   $\beta = 0.1$



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-2(140-150).aqt  
 Date: 09/12/17 Time: 14:32:36

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

### AQUIFER DATA

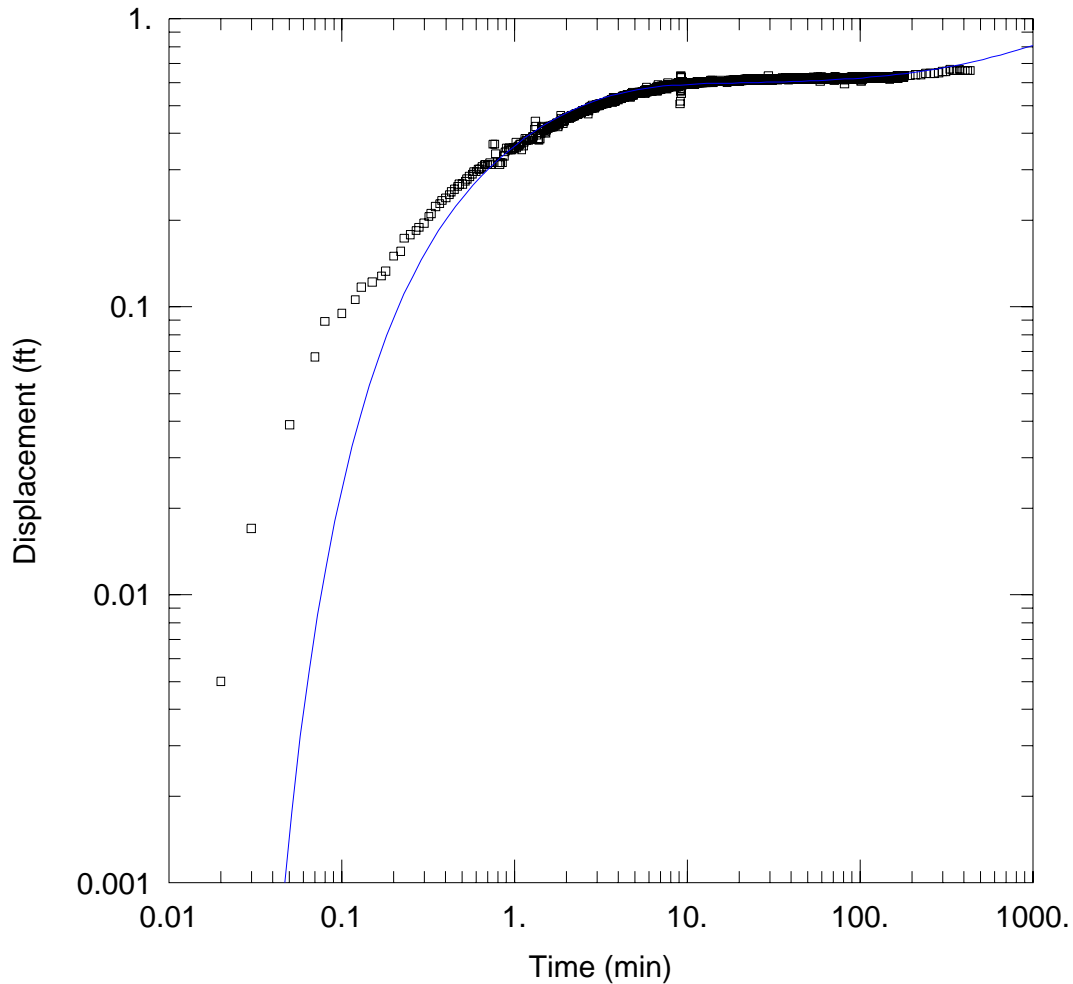
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.1826

### WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ MW-2(140-150)	74	0

### SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob  
 T = 6.895 ft<sup>2</sup>/min S = 0.0001648



WELL TEST ANALYSIS

Data Set:  
Date: 09/12/17

Time: 14:31:36

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined

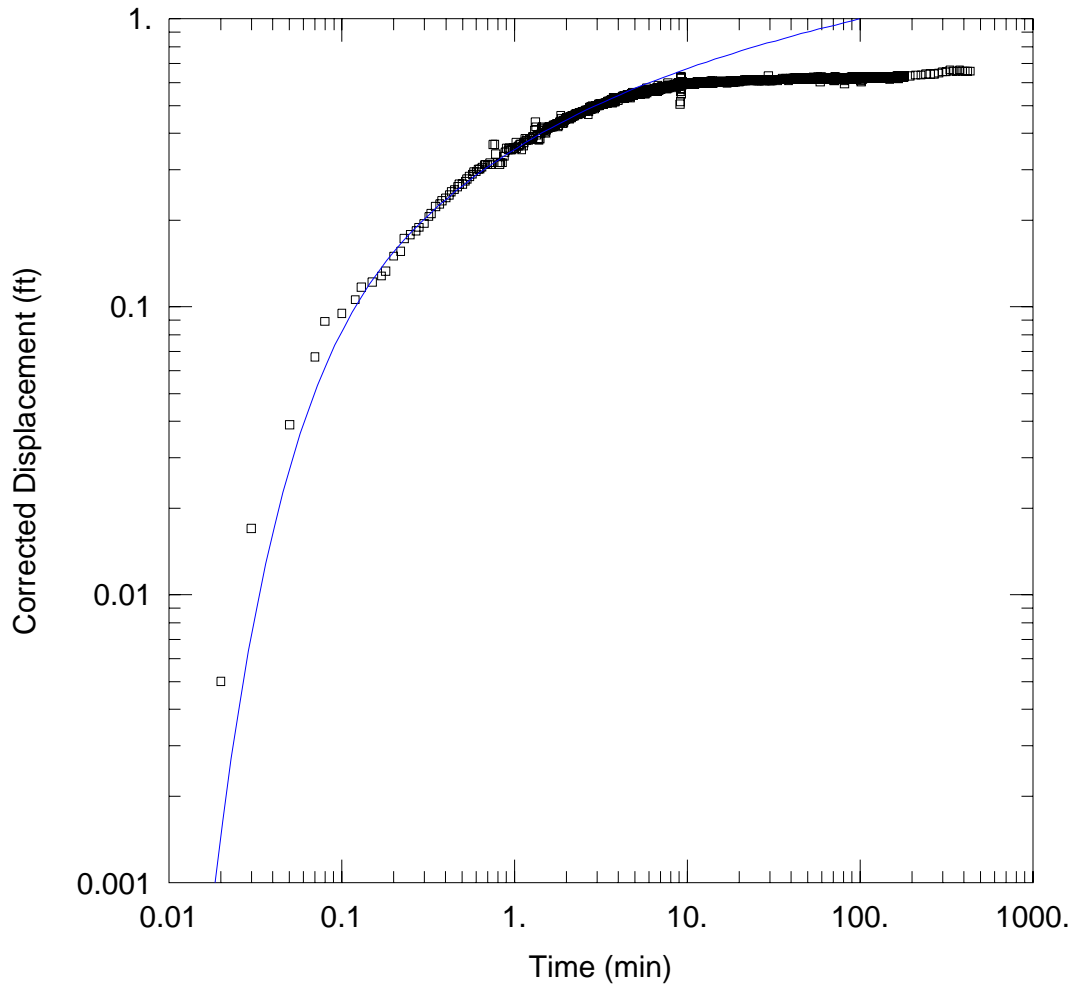
Solution Method: Neuman

T = 3.774 ft<sup>2</sup>/min

S = 0.0005887

Sy = 0.1

β = 0.1



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-2(140-150).aqt  
 Date: 09/12/17 Time: 14:33:22

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined

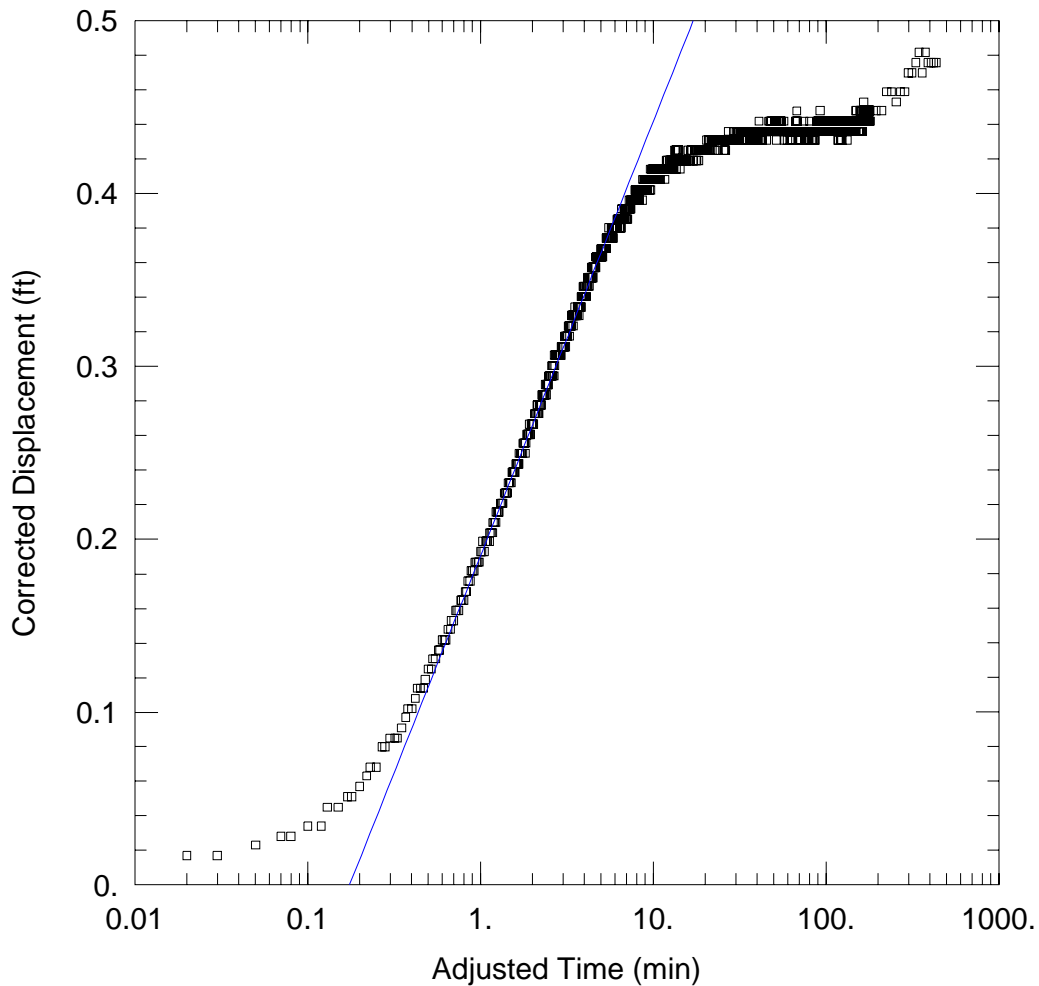
Solution Method: Theis

T = 6.092 ft<sup>2</sup>/min

S = 0.0003581

Kz/Kr = 0.1826

b = 100. ft



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\PW-1D.aqt  
 Date: 09/12/17 Time: 14:57:13

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

### AQUIFER DATA

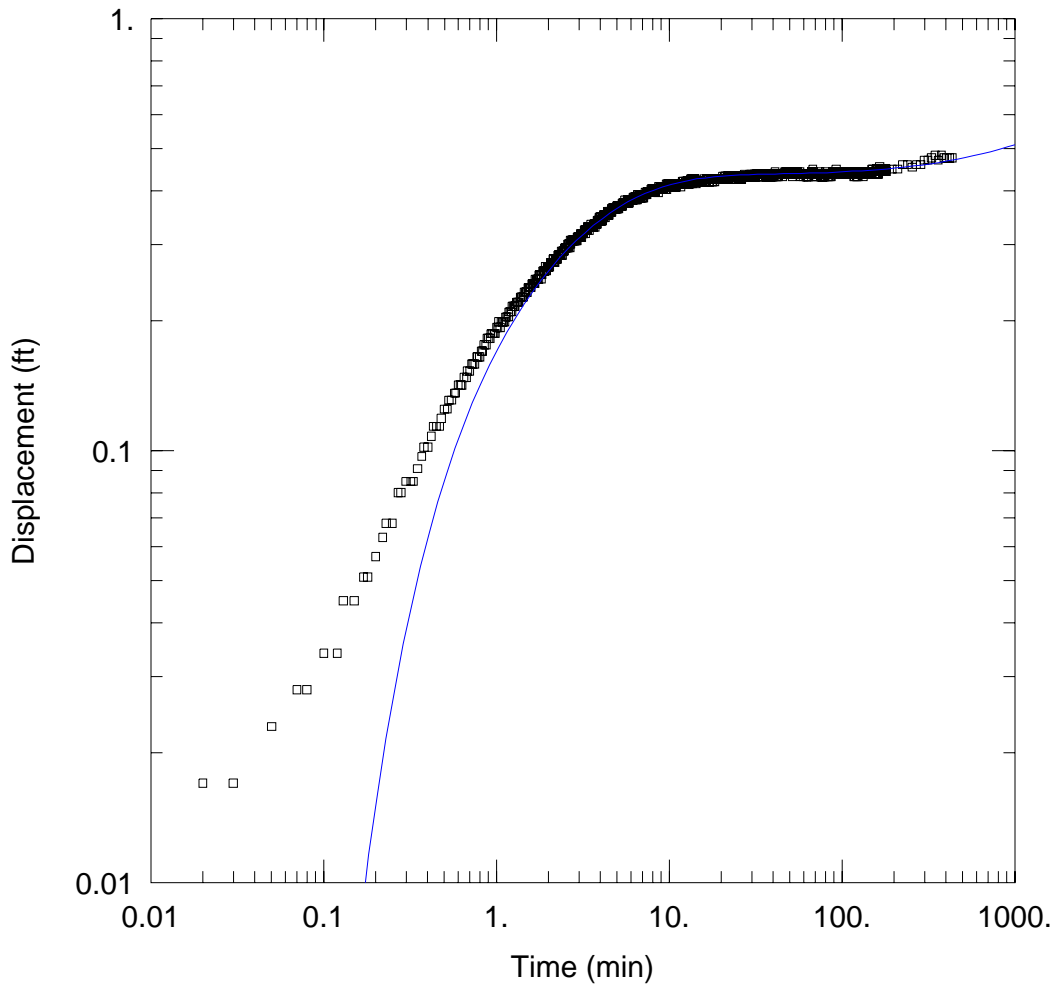
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.05251

### WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ PW-1D	138	0

### SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob  
 T = 7.989 ft<sup>2</sup>/min S = 0.0001647



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\PW-1D.aqt  
 Date: 09/12/17 Time: 14:56:15

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ PW-1D	138	0

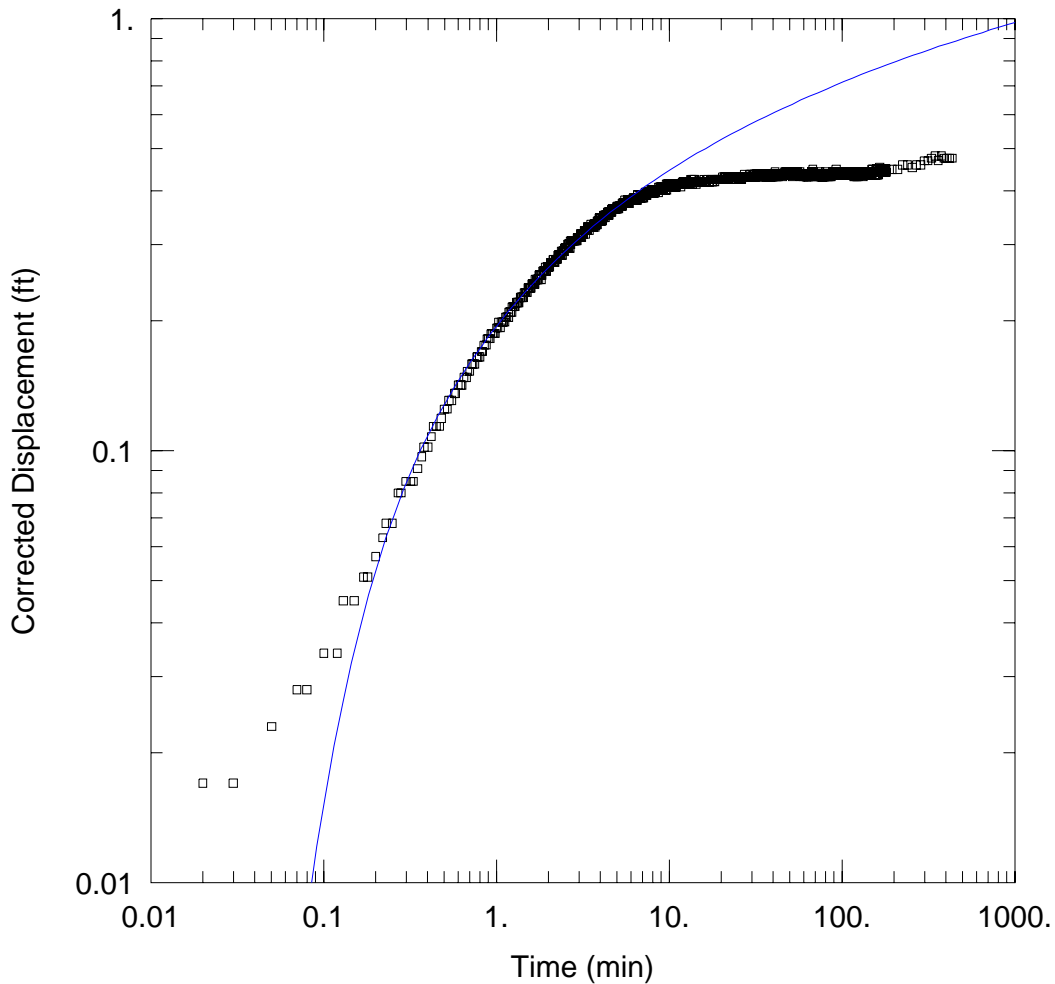
SOLUTION

Aquifer Model: Unconfined

Solution Method: Neuman

T = 4.962 ft<sup>2</sup>/min  
 Sy = 0.1

S = 0.0004494  
 β = 0.1



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\PW-1D.aqt  
 Date: 09/12/17 Time: 14:57:49

PROJECT INFORMATION

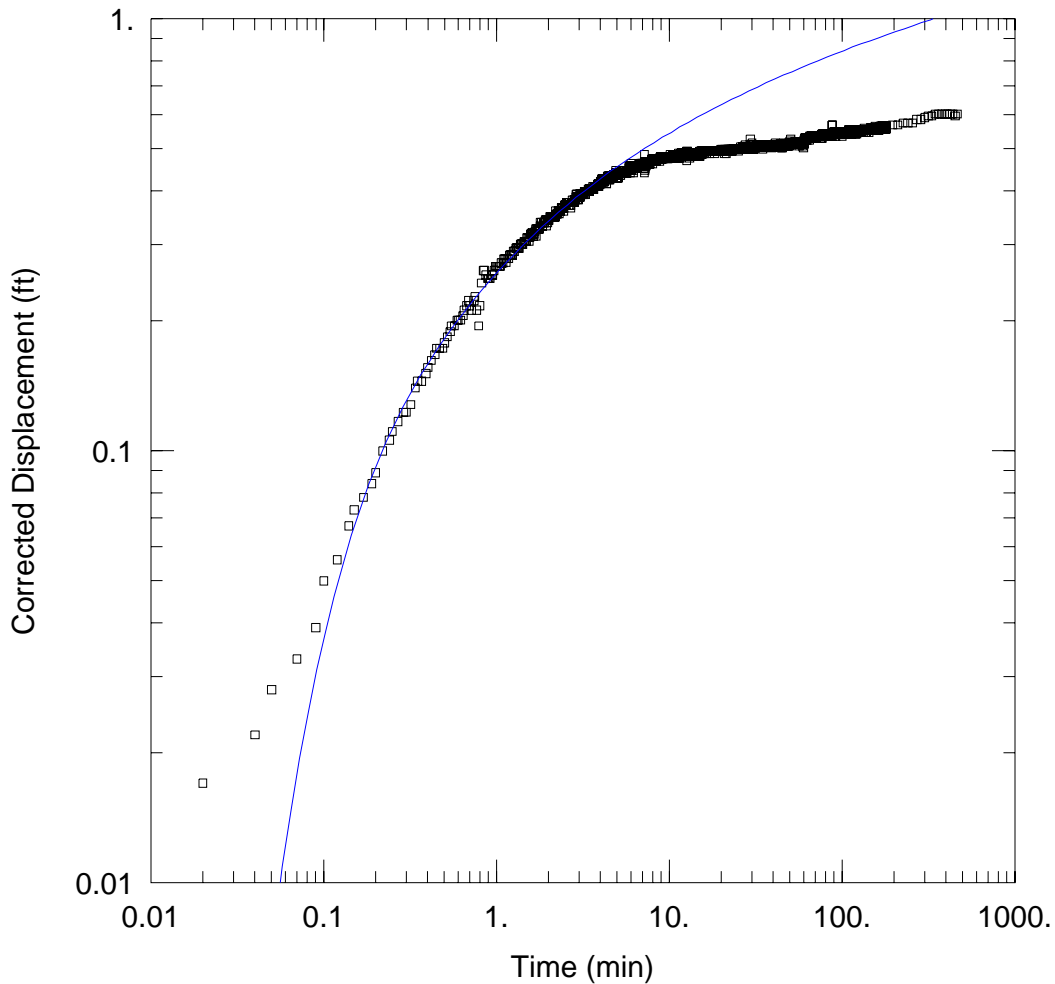
Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ PW-1D	138	0

SOLUTION

Aquifer Model: <u>Unconfined</u>	Solution Method: <u>Theis</u>
T = <u>7.468 ft<sup>2</sup>/min</u>	S = <u>0.0002859</u>
Kz/Kr = <u>0.05251</u>	b = <u>100. ft</u>



WELL TEST ANALYSIS

Data Set: C:\...\MW-15(140-150) recovery.aqt

Date: 09/12/17

Time: 15:27:03

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined

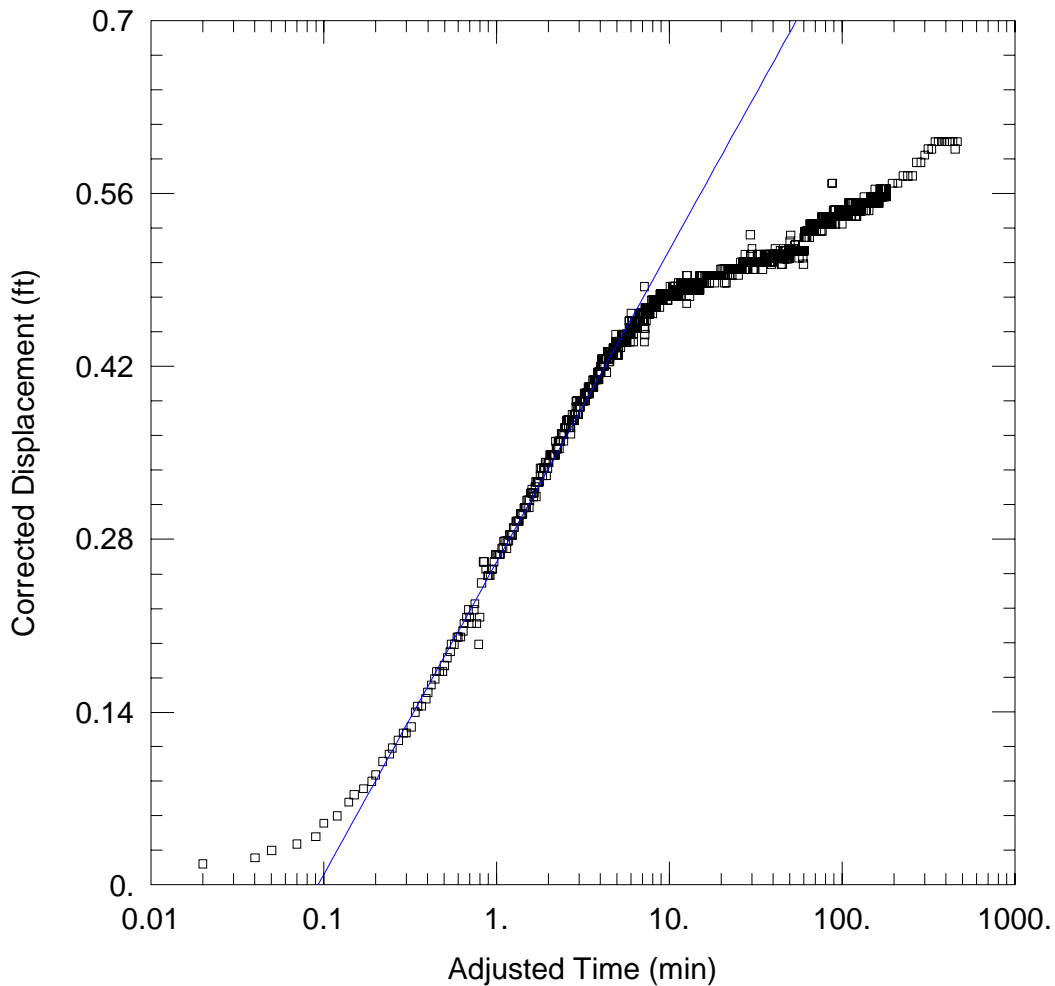
Solution Method: Theis

T = 6.698 ft<sup>2</sup>/min

S = 0.000291

Kz/Kr = 0.08573

b = 100. ft



### WELL TEST ANALYSIS

Data Set: C:\...\MW-15(140-150) recovery.aqt

Date: 09/12/17

Time: 15:27:56

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 0.08573

### WELL DATA

#### Pumping Wells

#### Observation Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Well Name	X (ft)	Y (ft)
□ MW-15(140-150)	108	0

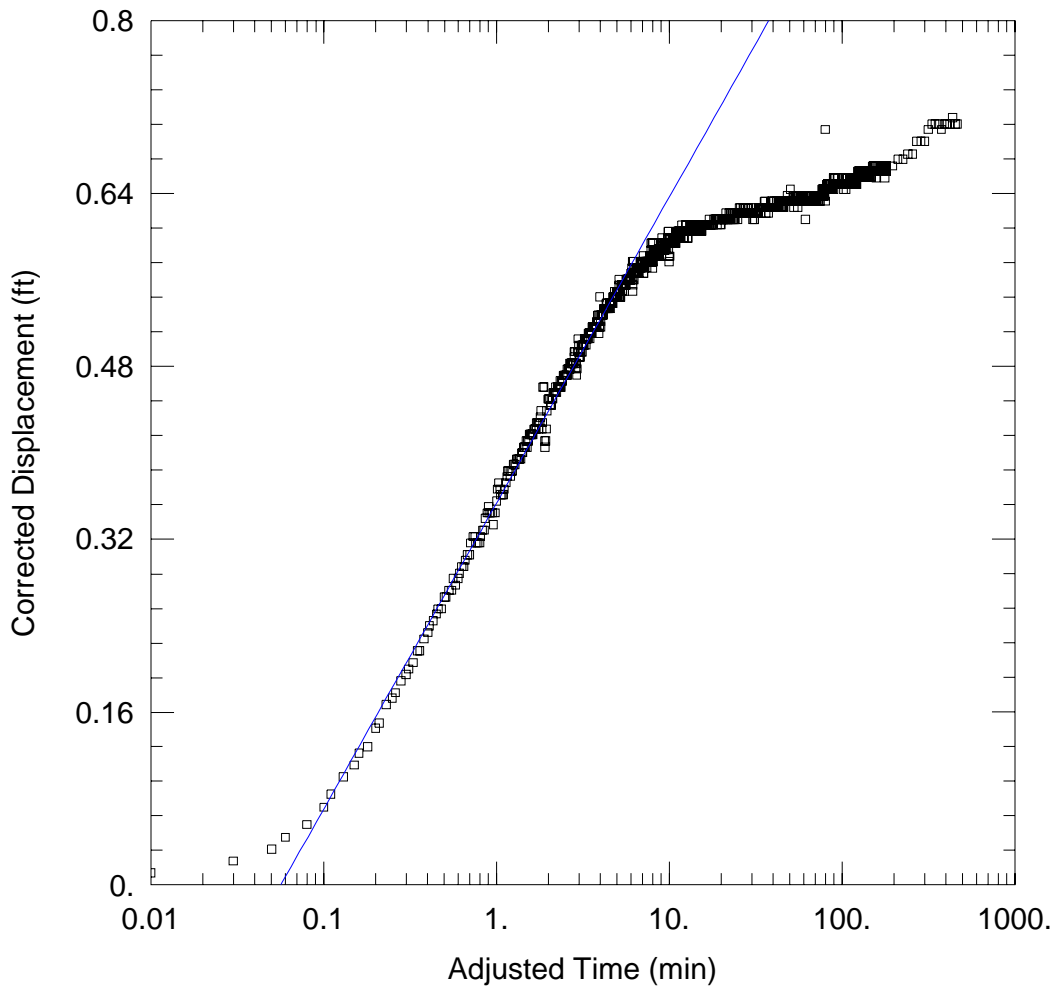
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

T = 7.94 ft<sup>2</sup>/min

S = 0.0001418



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt

Date: 09/12/17

Time: 15:13:01

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 0.1826

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	74	0

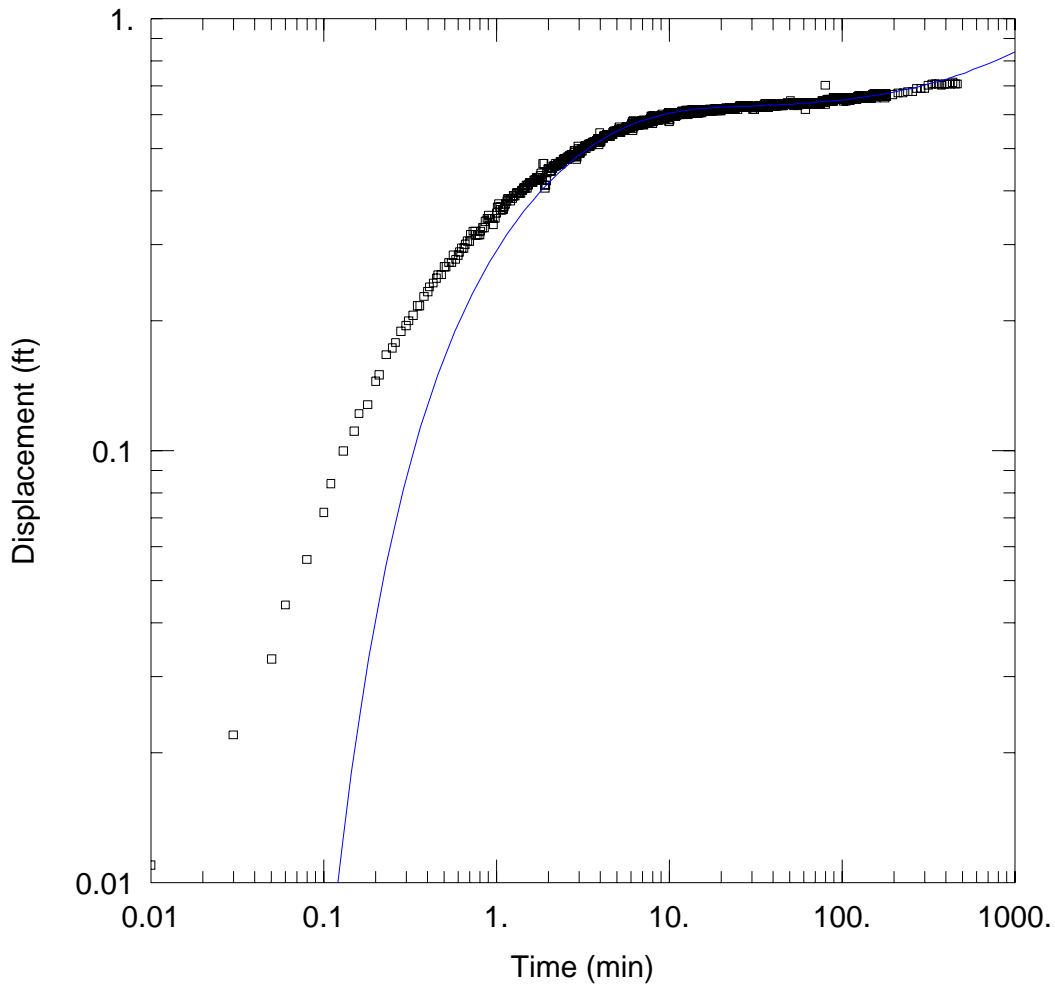
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

T = 7.089 ft<sup>2</sup>/min

S = 0.0001645



### WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt

Date: 09/12/17

Time: 15:20:27

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

### AQUIFER DATA

Saturated Thickness: 100. ft

### WELL DATA

#### Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

#### Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	74	0

### SOLUTION

Aquifer Model: Unconfined

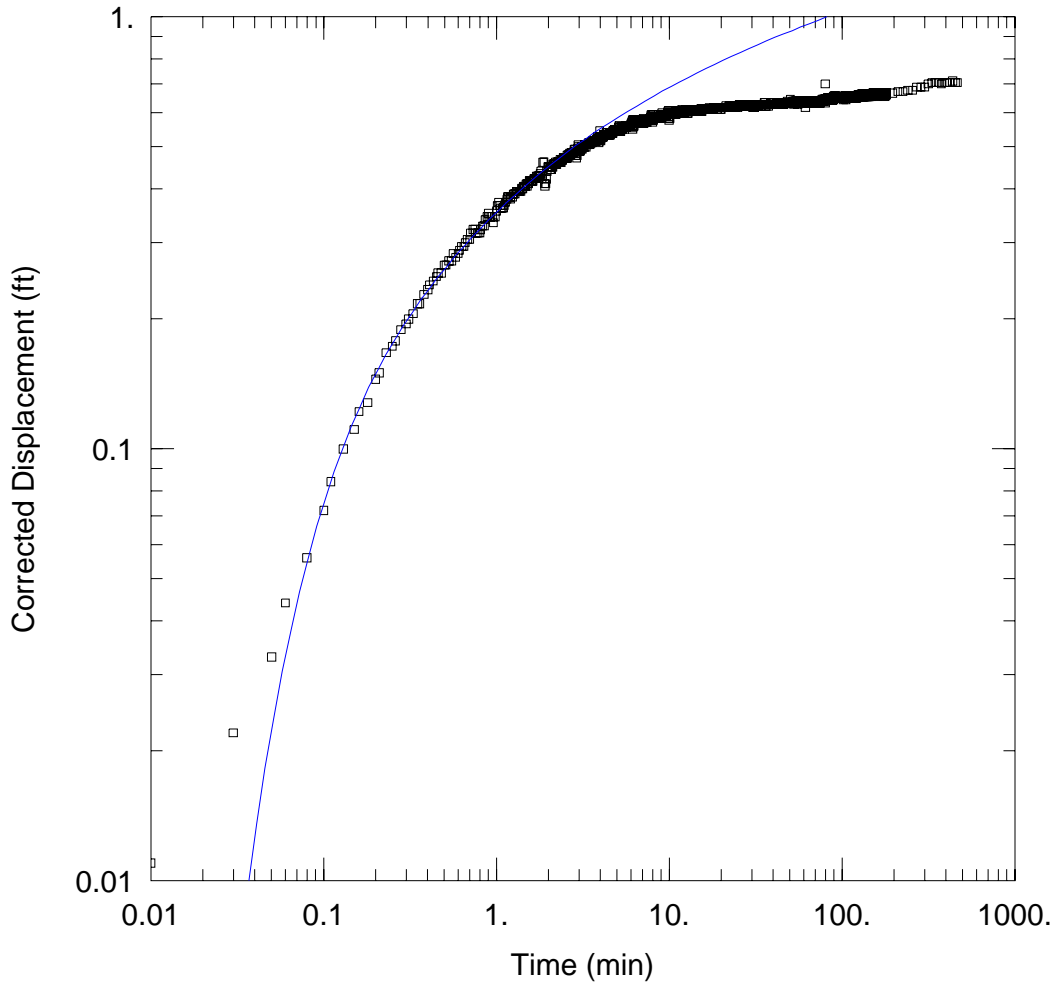
Solution Method: Neuman

T = 3.609 ft<sup>2</sup>/min

S = 0.0009061

Sy = 0.1

β = 0.1



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt

Date: 09/12/17

Time: 15:12:33

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Well Name	X (ft)	Y (ft)
□ MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined

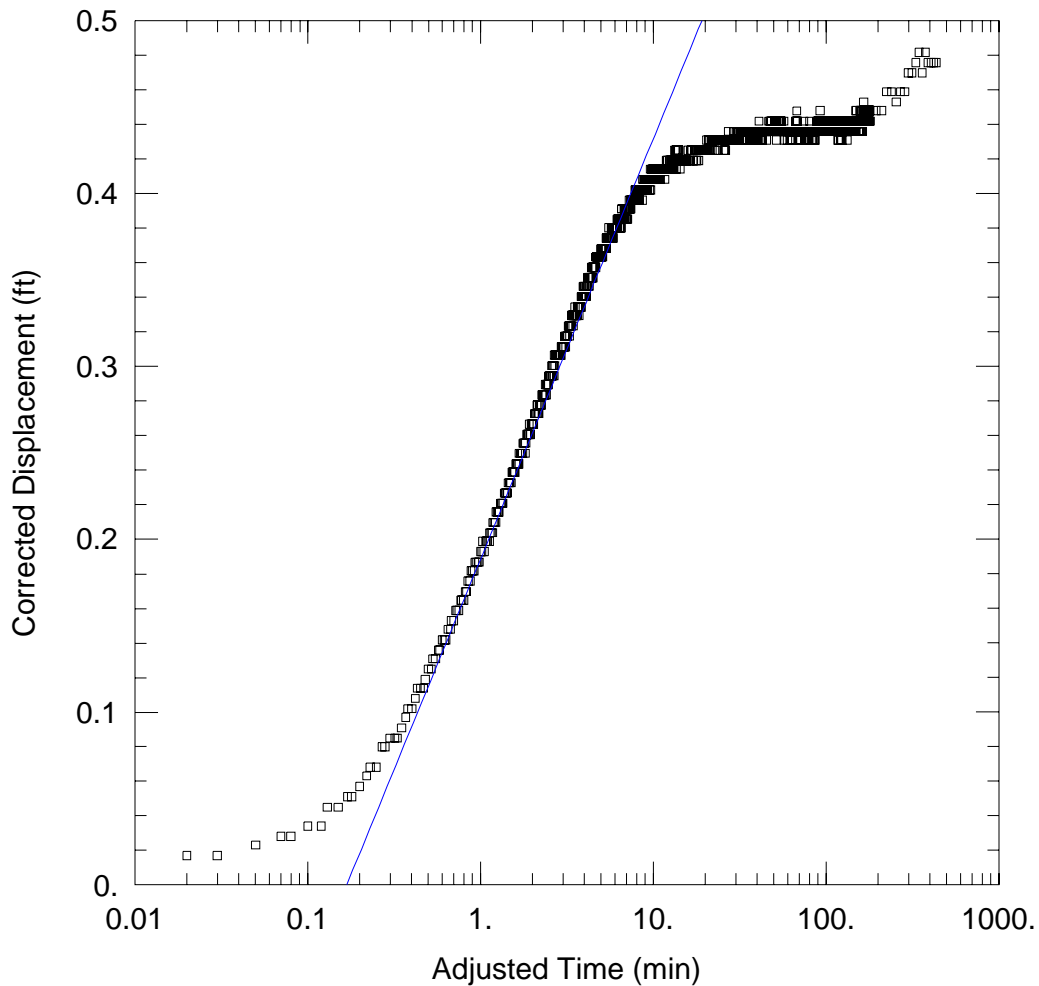
Solution Method: Theis

T = 5.824 ft<sup>2</sup>/min

S = 0.0003832

Kz/Kr = 0.1826

b = 100. ft



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D Recovery\PW-1D recovery.aqt  
 Date: 09/12/17 Time: 15:34:12

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

### AQUIFER DATA

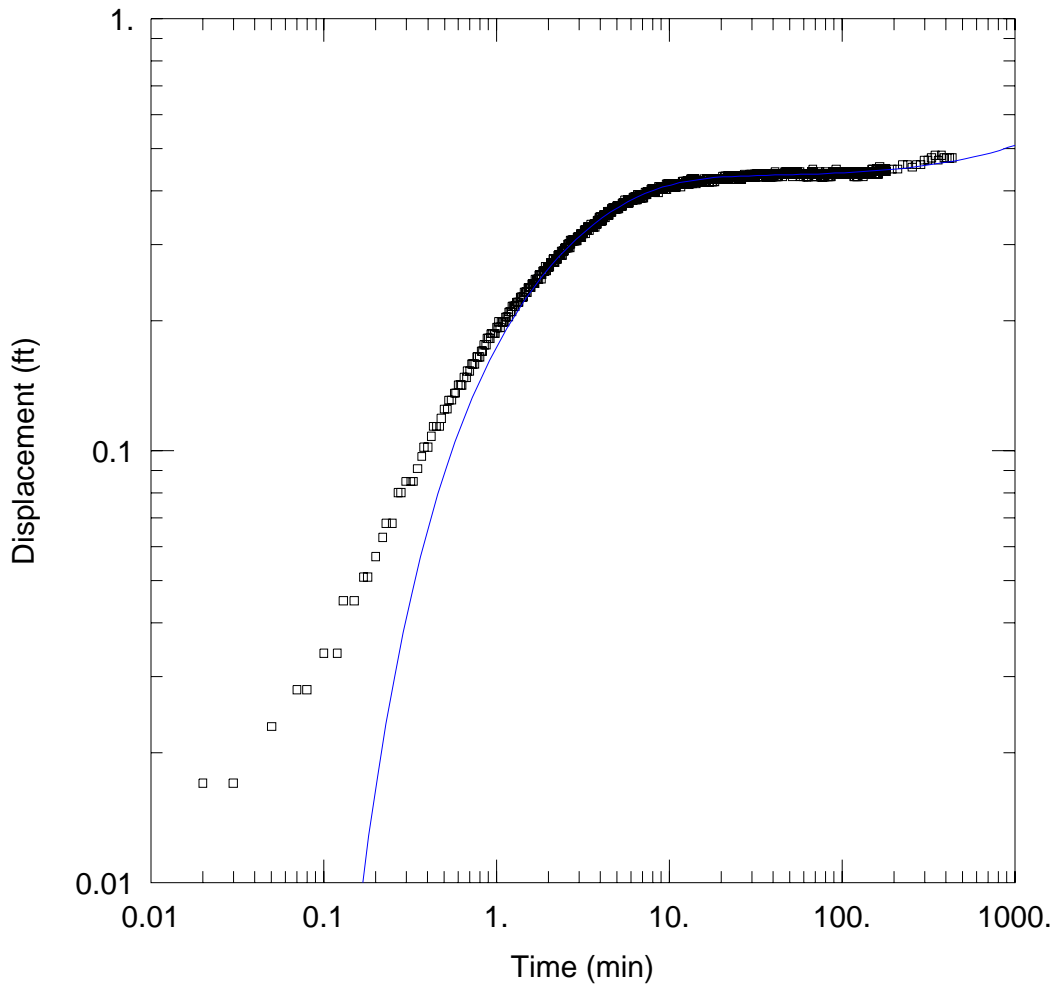
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.05251

### WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ PW-1D	138	0

### SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob  
 T = 8.253 ft<sup>2</sup>/min S = 0.0001639



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D Recovery\PW-1D recovery.aqt  
 Date: 09/12/17 Time: 15:34:43

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

AQUIFER DATA

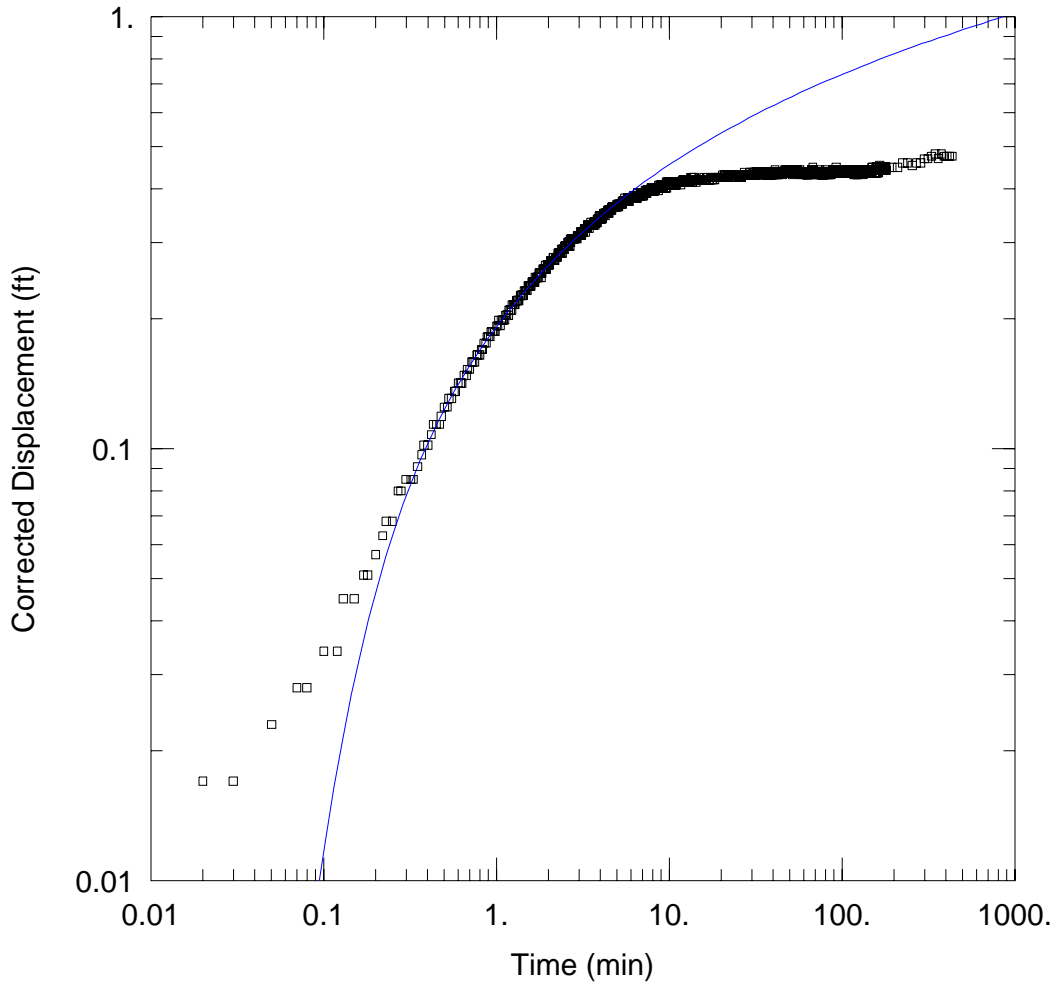
Saturated Thickness: 100. ft

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman  
 $T = 4.993 \text{ ft}^2/\text{min}$   $S = 0.0004361$   
 $S_y = 0.1$   $\beta = 0.1$



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D Recovery\PW-1D recovery.aqt  
 Date: 09/12/17 Time: 15:33:32

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60306595  
 Location: Orleans, MA  
 Test Well: PW-  
 Test Date: 8/24/17

WELL DATA

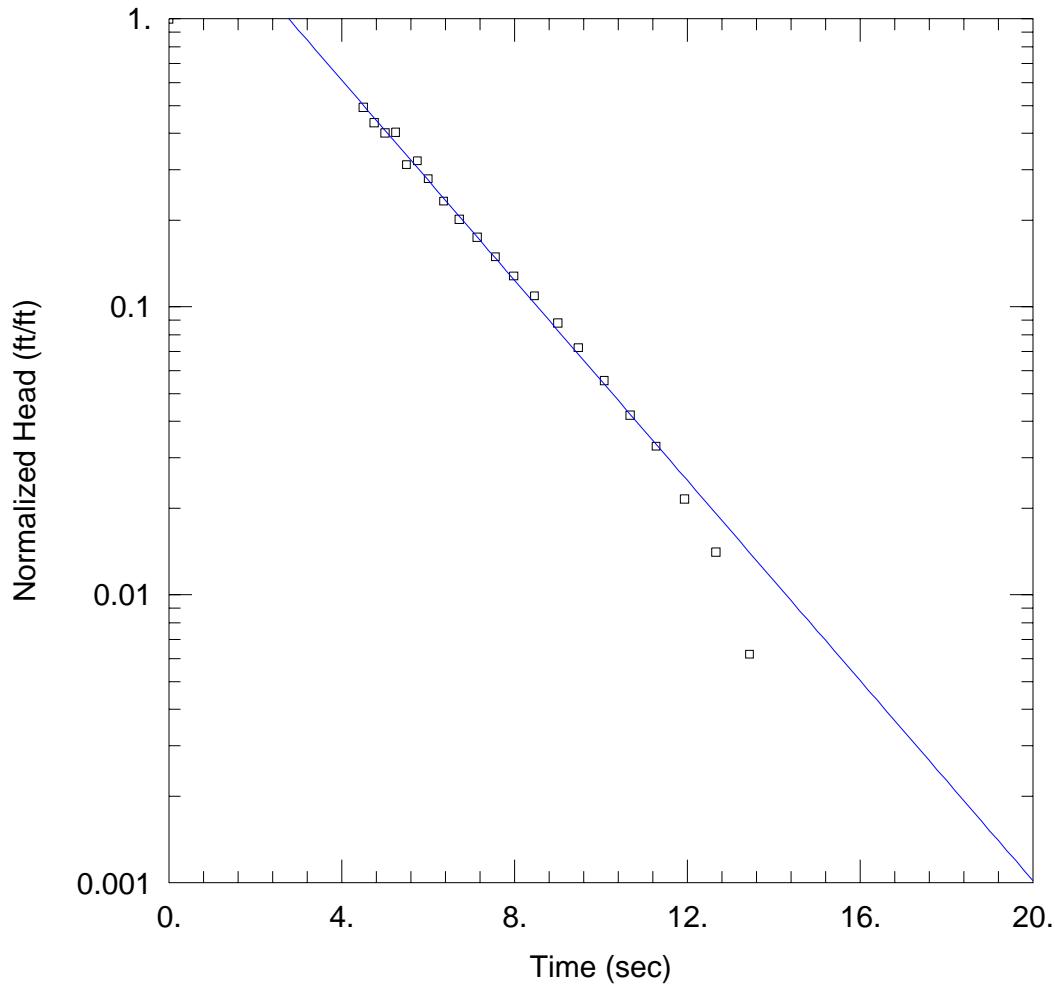
Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2D	0	0	□ PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Theis  
 $T = 7.086 \text{ ft}^2/\text{min}$   $S = 0.0003077$   
 $Kz/Kr = 0.05251$   $b = 100. \text{ ft}$

**Appendix J**  
**Slug Test Analysis Reports**

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### WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run1 normalized.aqt

Date: 05/24/18

Time: 11:47:10

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (LH-1)

Initial Displacement: 2.03 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

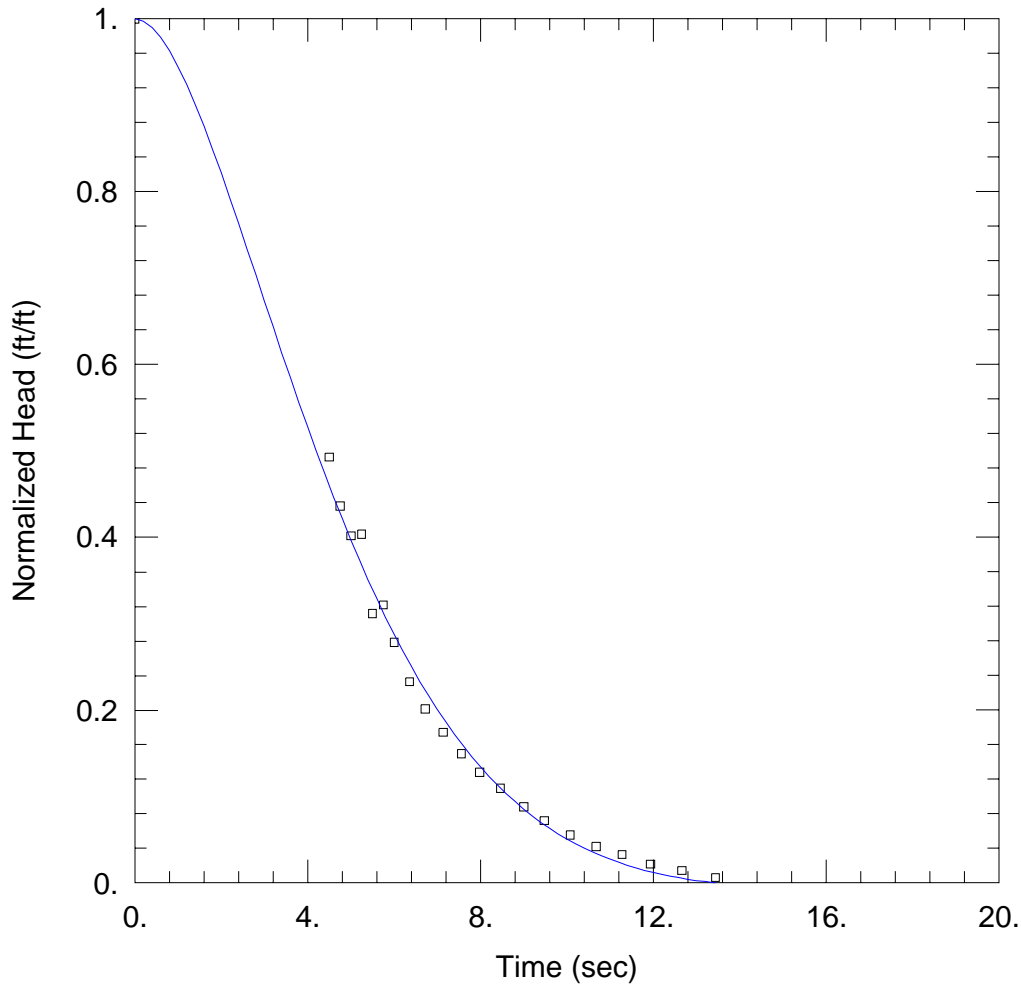
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 59.68 ft/day

y0 = 6.171 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run1 normalized.aqt  
 Date: 05/24/18

Time: 11:47:29

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

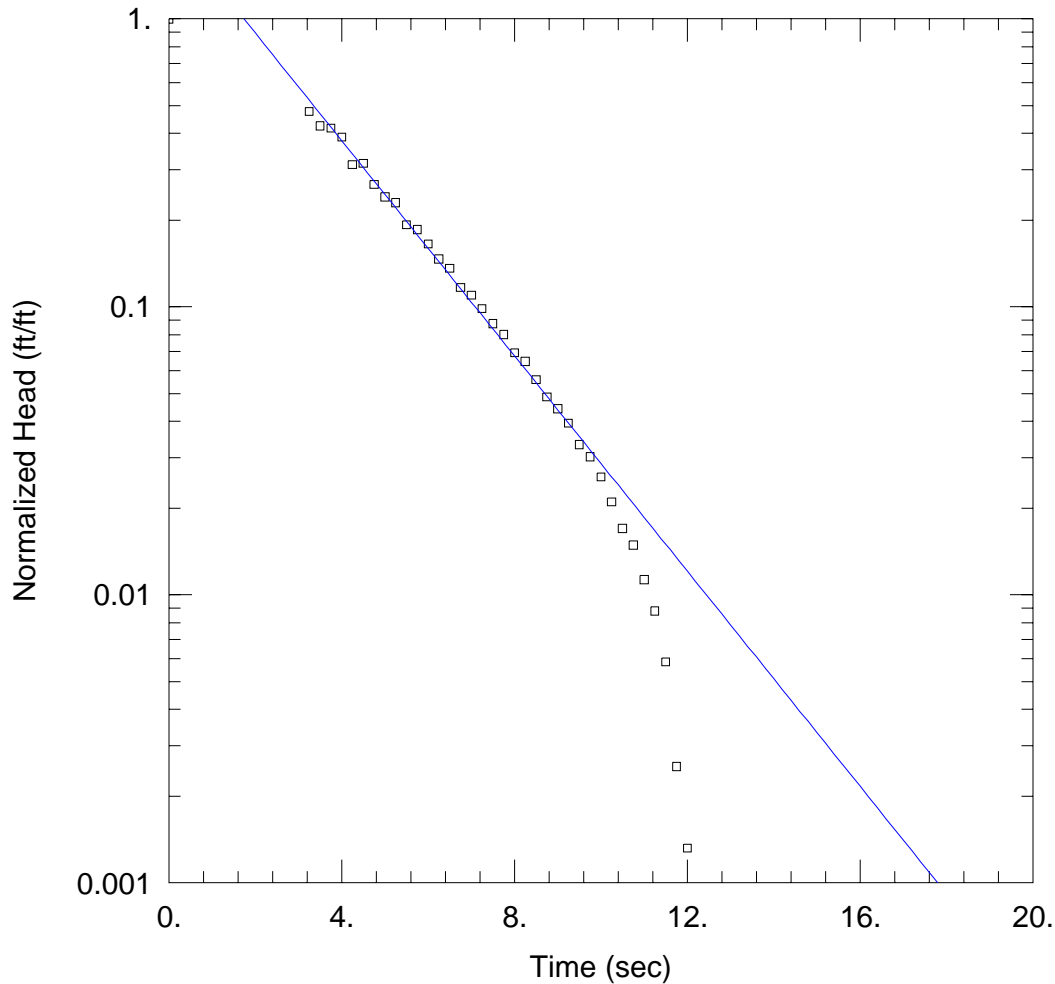
Initial Displacement: 2.03 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 32.24 ft/day

Solution Method: Springer-Gelhar  
 Le = 237.2 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run2 normalized.aqt  
 Date: 05/24/18

Time: 11:45:37

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

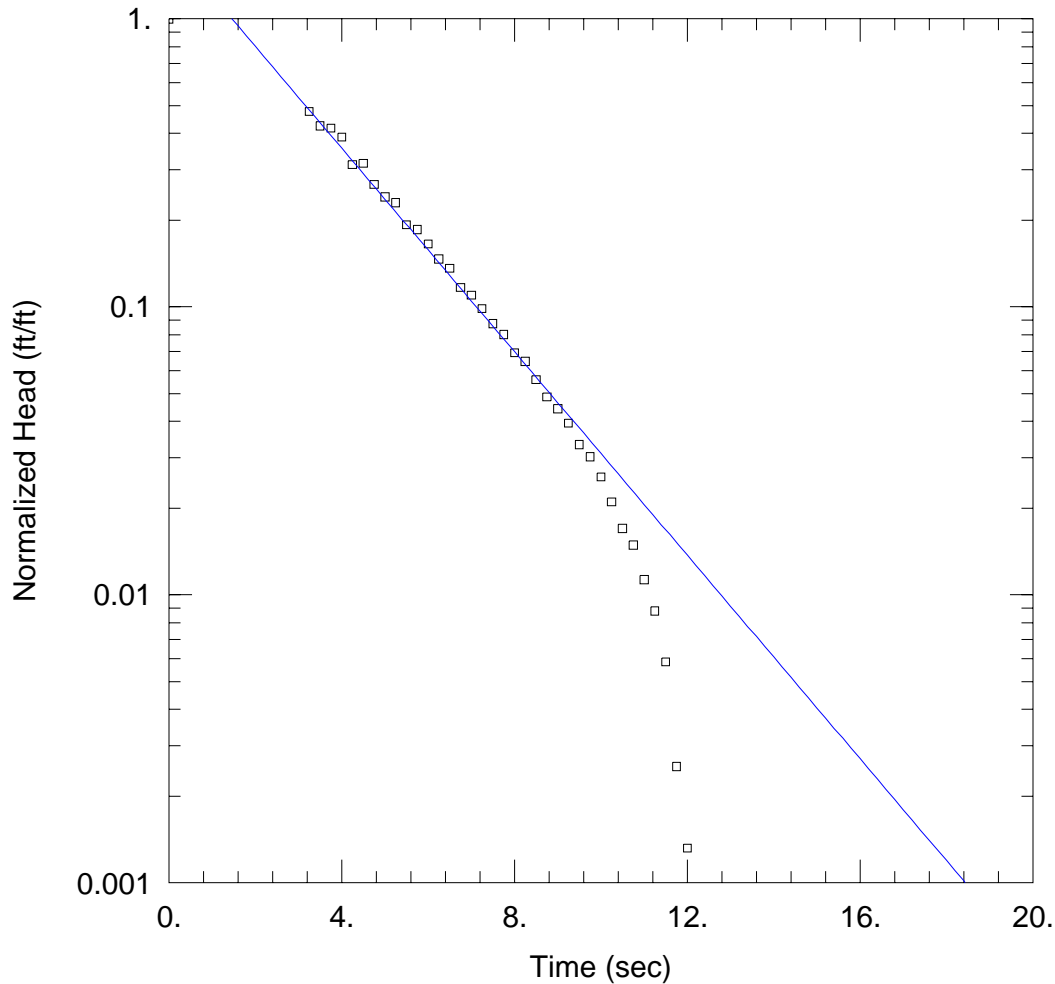
Initial Displacement: 2.1 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 64.18 ft/day

Solution Method: Bowser-Rice  
 y0 = 4.439 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run2 normalized.aqt  
 Date: 05/24/18

Time: 11:46:08

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

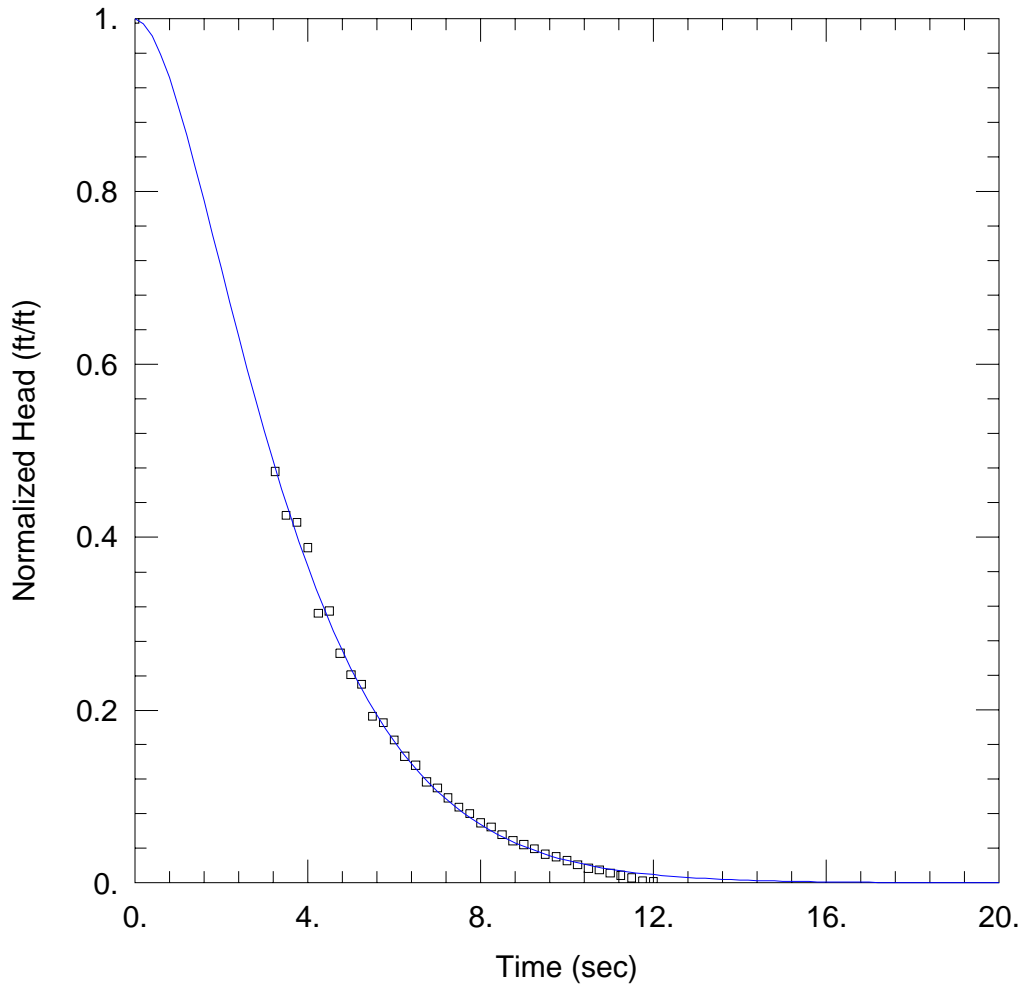
Initial Displacement: 2.1 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 80.94 ft/day

Solution Method: Hvorslev  
 y0 = 3.806 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run2 normalized.aqt  
 Date: 05/24/18

Time: 11:45:11

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

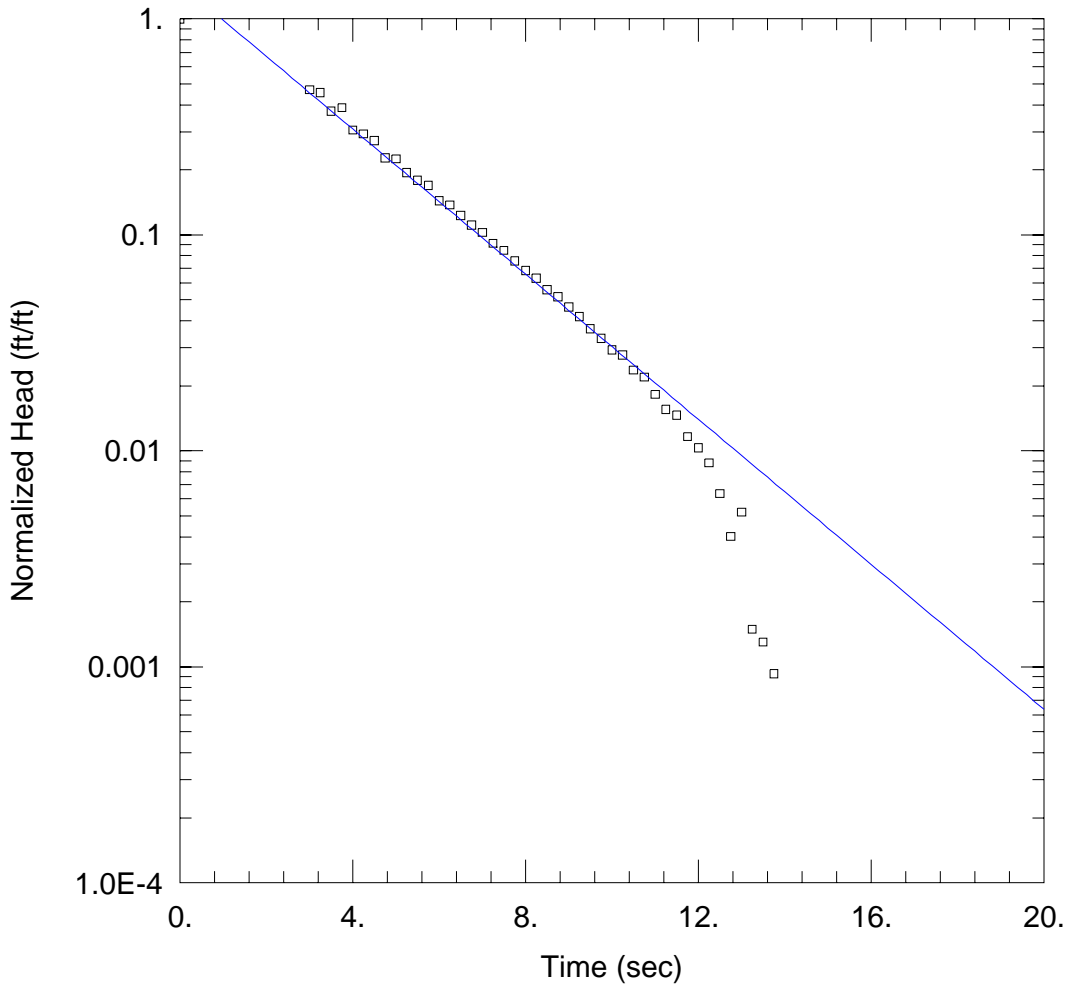
Initial Displacement: 2.1 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 40.38 ft/day

Solution Method: Springer-Gelhar  
 Le = 115. ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run3 normalized.aqt

Date: 05/24/18

Time: 11:48:15

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.13 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

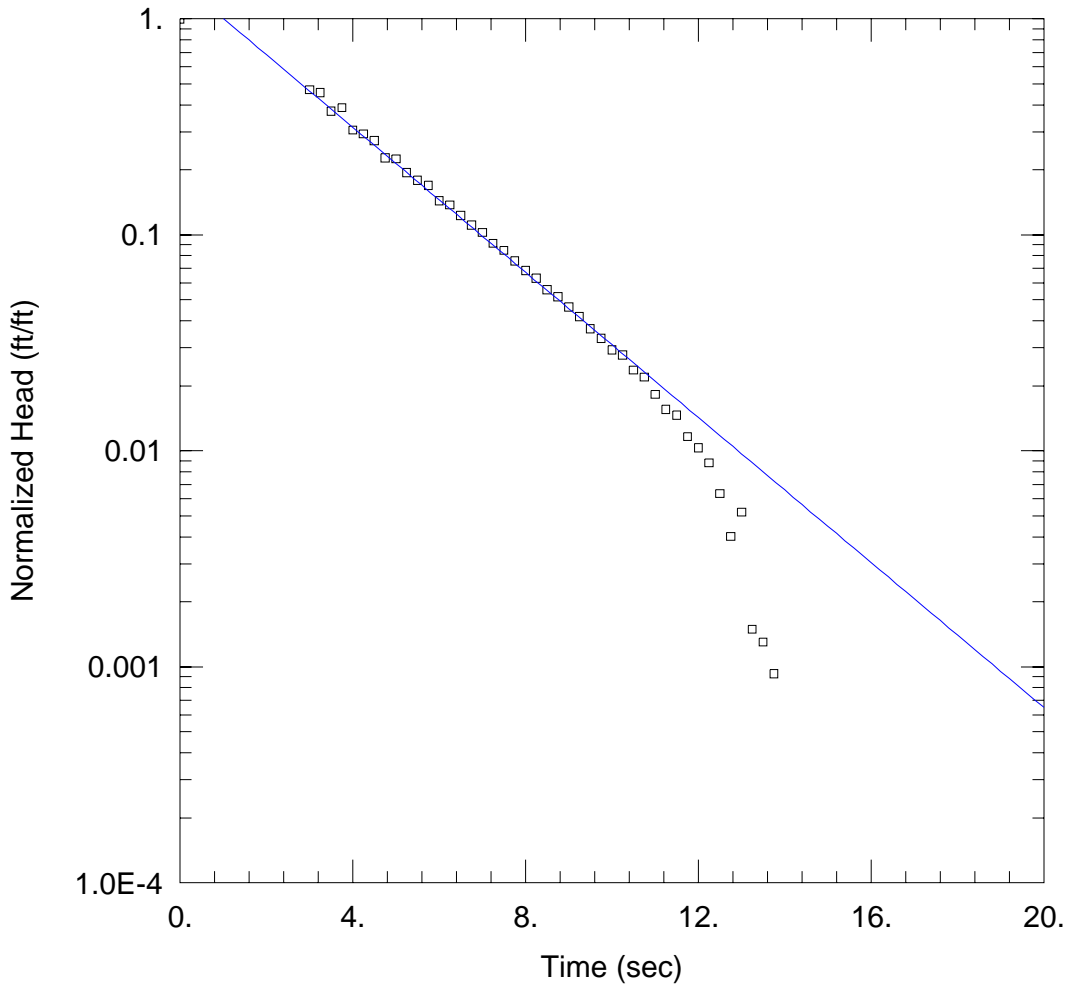
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 57.68 ft/day

y0 = 3.095 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run3 normalized.aqt

Date: 05/24/18

Time: 11:47:56

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.13 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

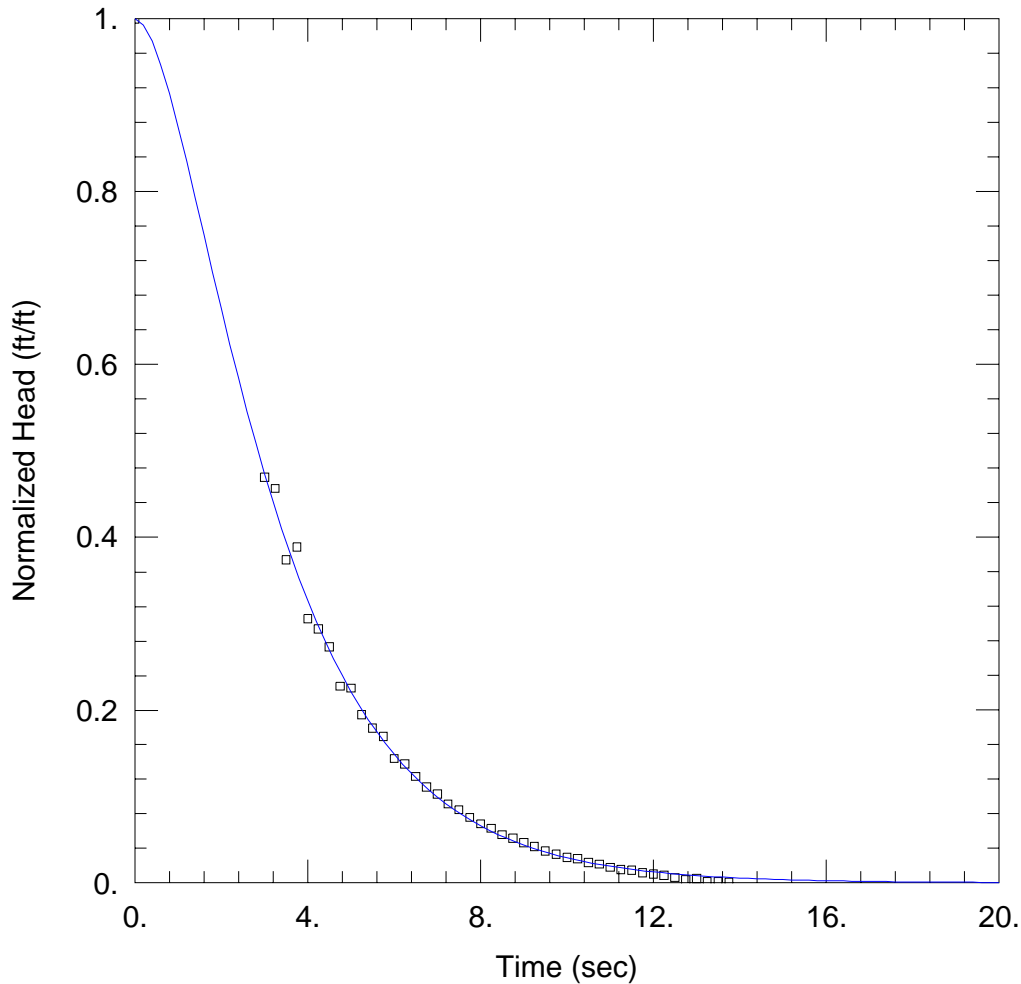
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 76.95 ft/day

y0 = 3.158 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run3 normalized.aqt  
 Date: 05/24/18

Time: 11:48:51

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-1  
 Test Date: 6/7/17

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

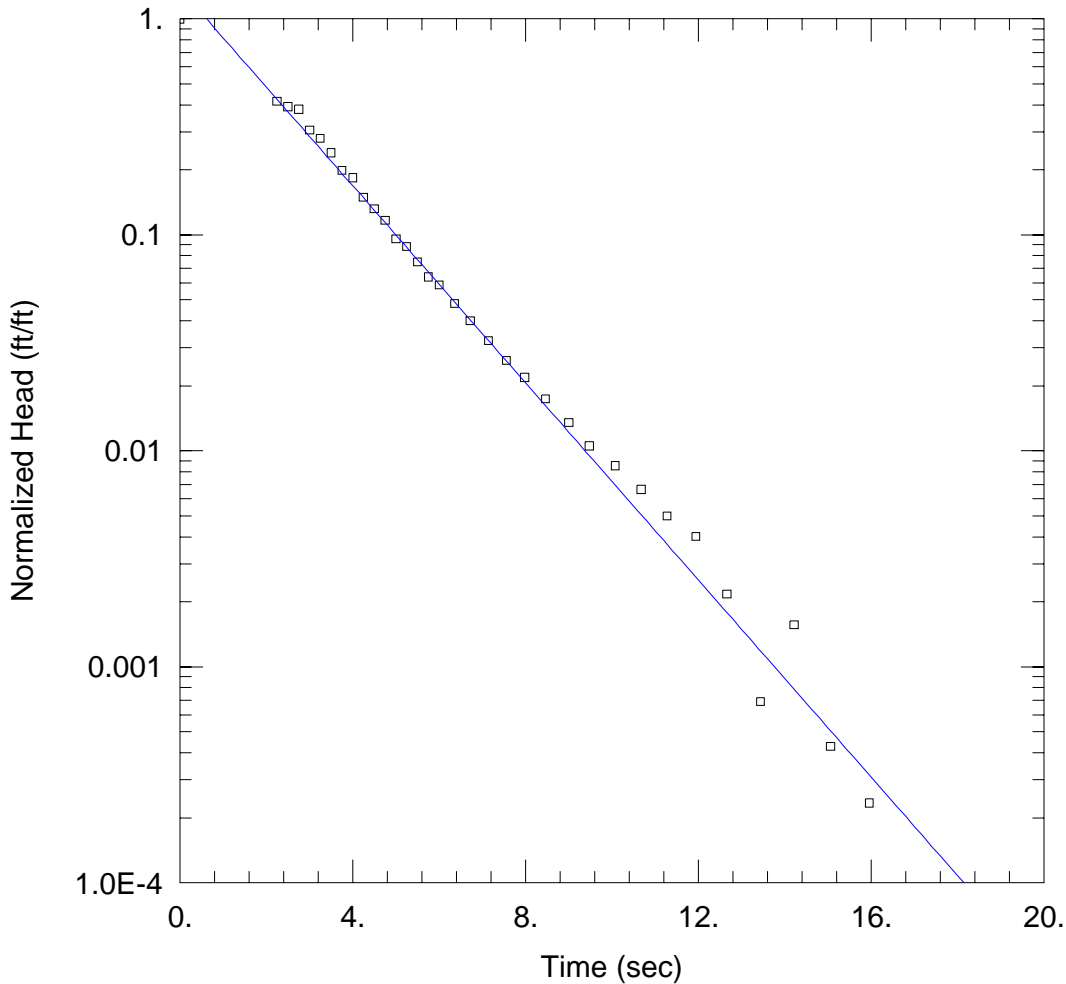
Initial Displacement: 2.13 ft  
 Total Well Penetration Depth: 23. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 23. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 42.53 ft/day

Solution Method: Springer-Gelhar  
 Le = 84.64 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run1 normalizd.aqt

Date: 05/24/18

Time: 11:52:20

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.41 ft  
 Total Well Penetration Depth: 24. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 24. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

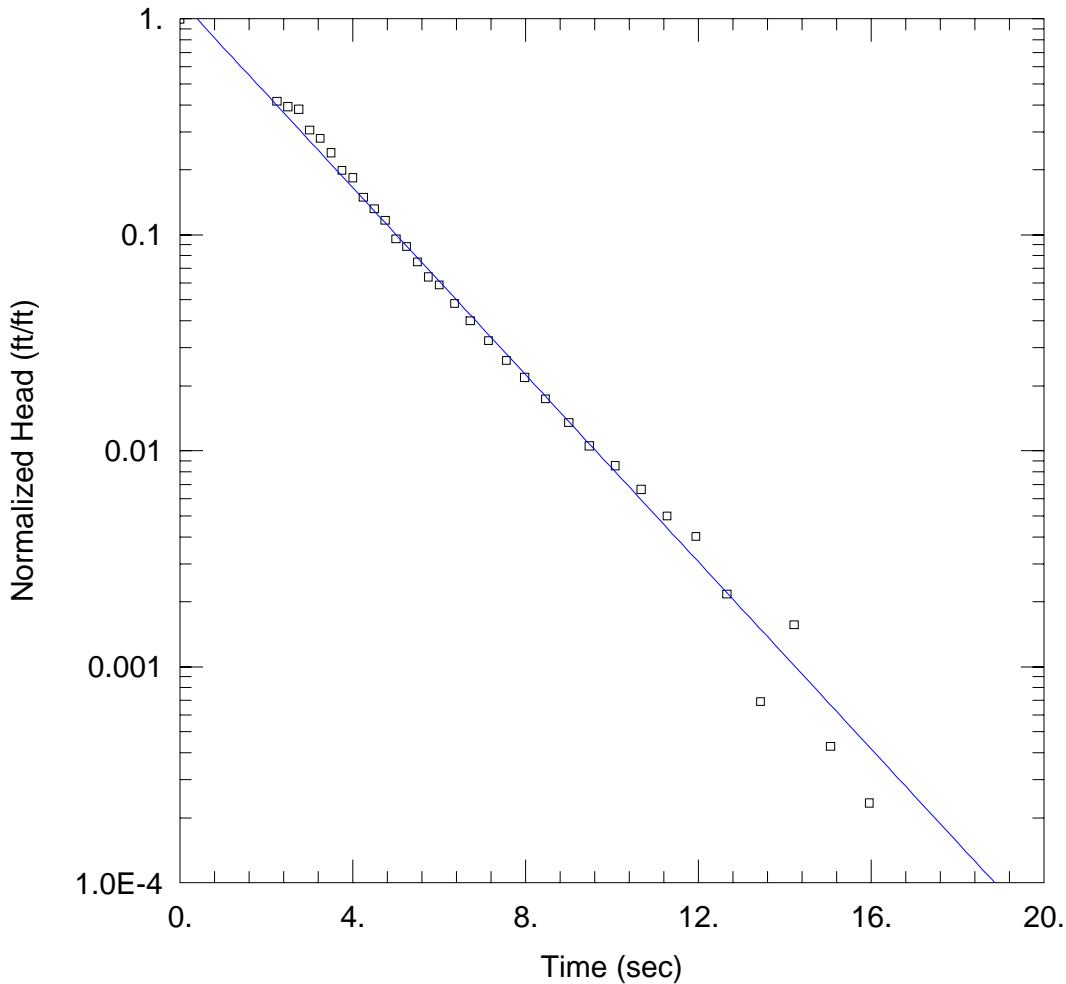
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 78.8 ft/day

y0 = 3.334 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run1 normalizd.aqt

Date: 05/24/18

Time: 11:52:40

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.41 ft  
 Total Well Penetration Depth: 24. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 24. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

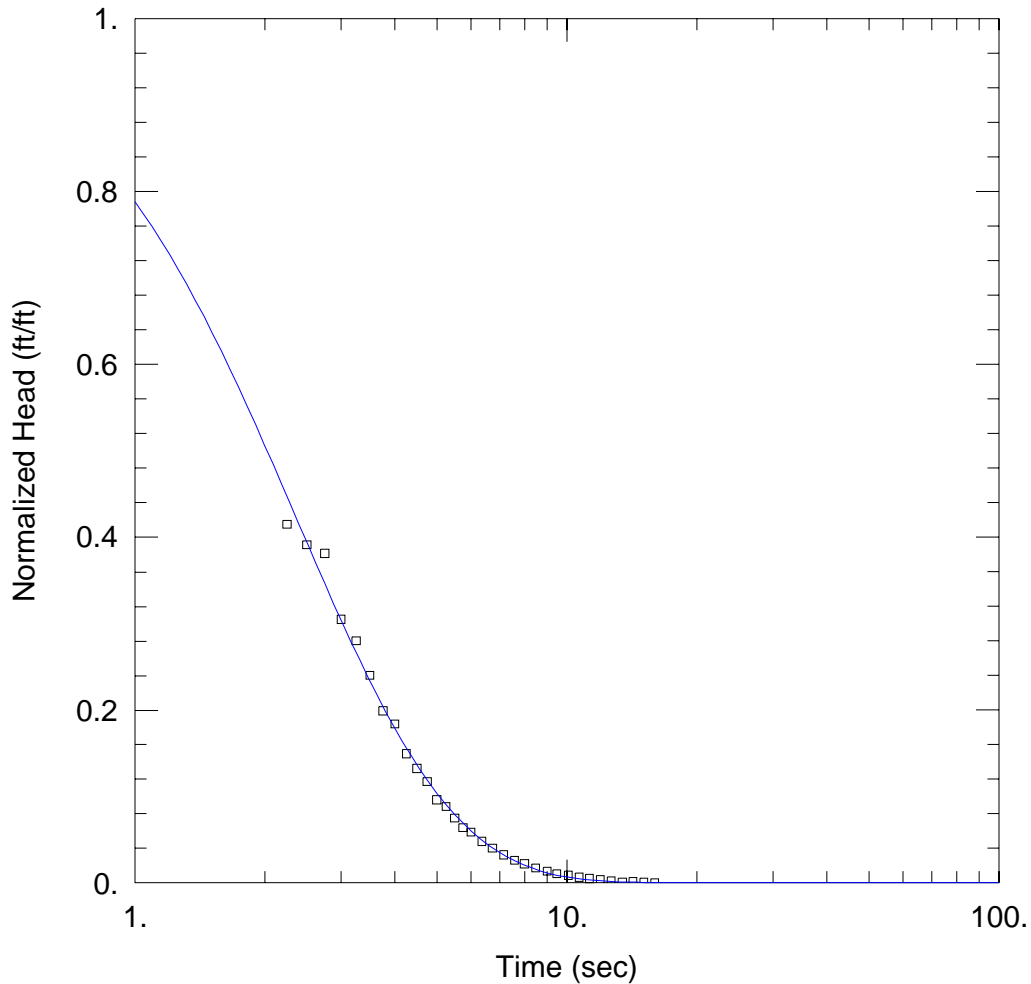
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 99.22 ft/day

y0 = 2.938 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run1 normalizd.aqt  
 Date: 05/24/18

Time: 11:51:46

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

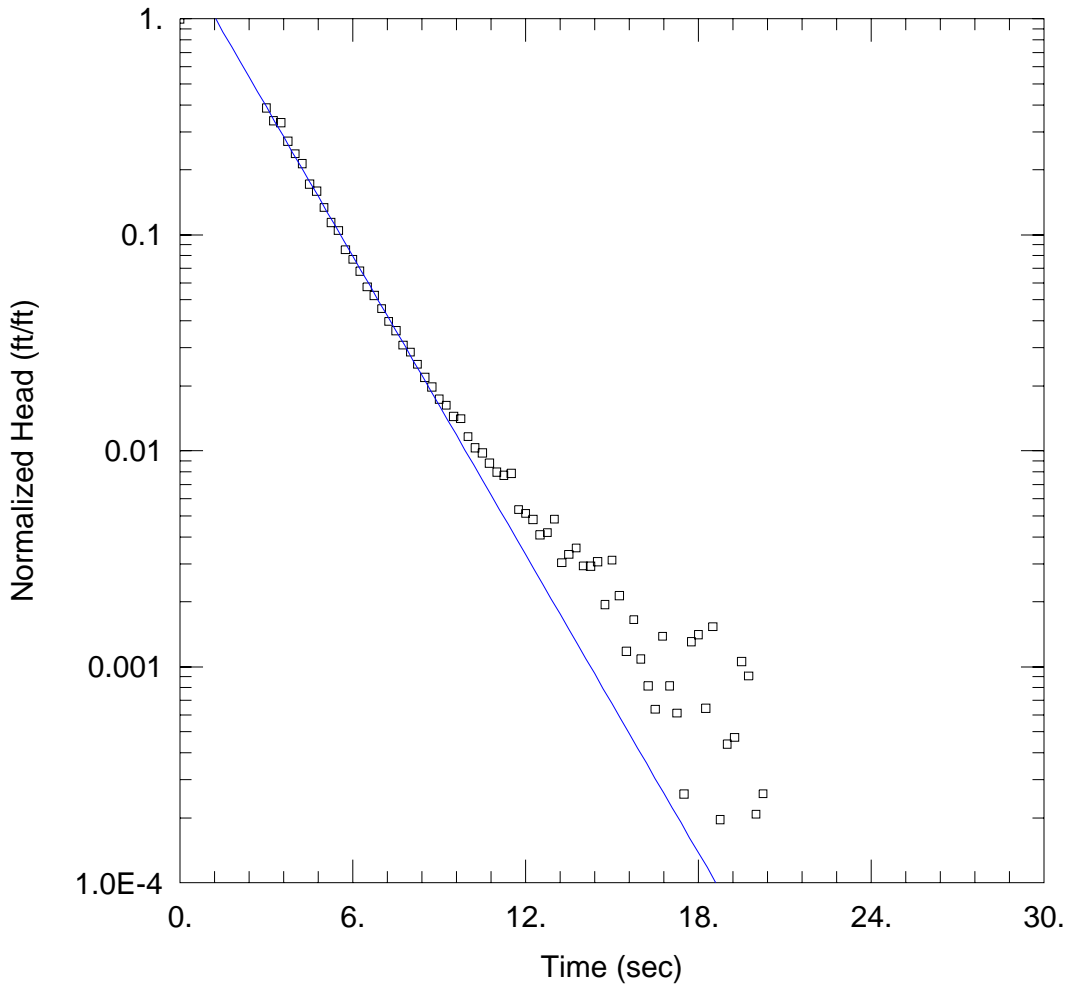
Initial Displacement: 2.41 ft  
 Total Well Penetration Depth: 24. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 24. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 59.46 ft/day

Solution Method: Springer-Gelhar  
 Le = 41.1 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run2 normalized.aqt

Date: 05/24/18

Time: 11:53:31

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.59 ft  
 Total Well Penetration Depth: 24. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 24. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

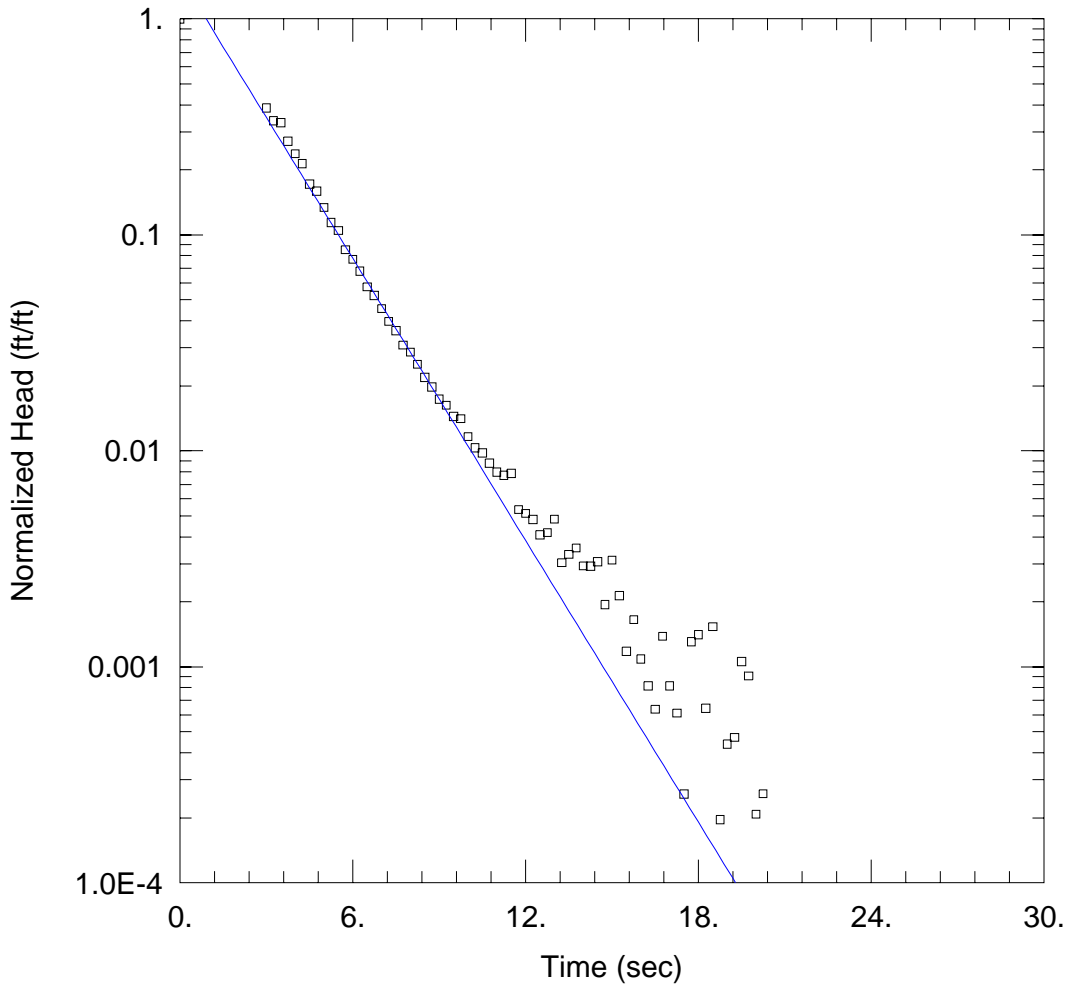
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 79.52 ft/day

y0 = 4.987 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run2 normalized.aqt

Date: 05/24/18

Time: 11:54:16

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.59 ft  
 Total Well Penetration Depth: 24. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 24. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

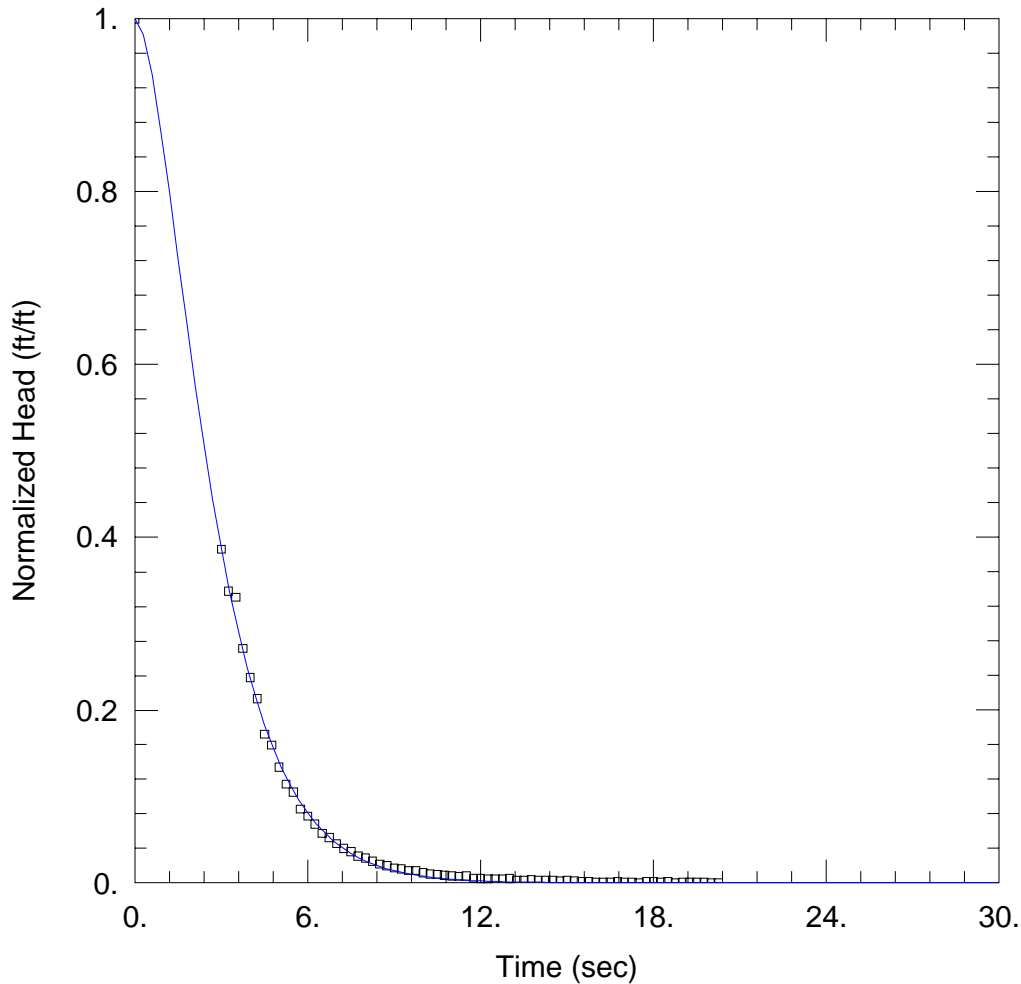
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 99.67 ft/day

y0 = 4.088 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run2 normalized.aqt

Date: 05/24/18

Time: 11:53:11

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.59 ft  
 Total Well Penetration Depth: 24. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 24. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

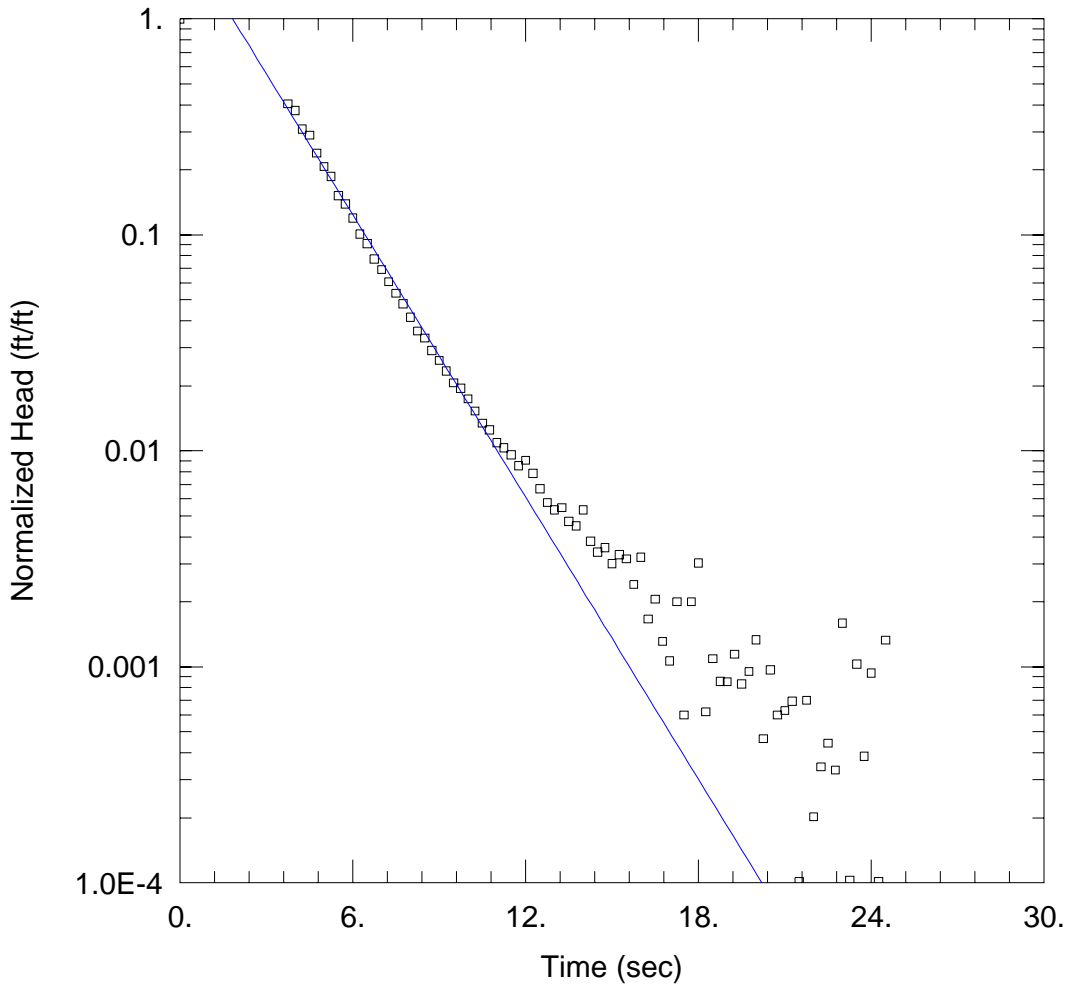
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 51.81 ft/day

Le = 68. ft



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\Slug Tests\Feb 2018\LH-3\LH-3 Run3.aqt  
 Date: 05/24/18 Time: 11:54:42

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

### AQUIFER DATA

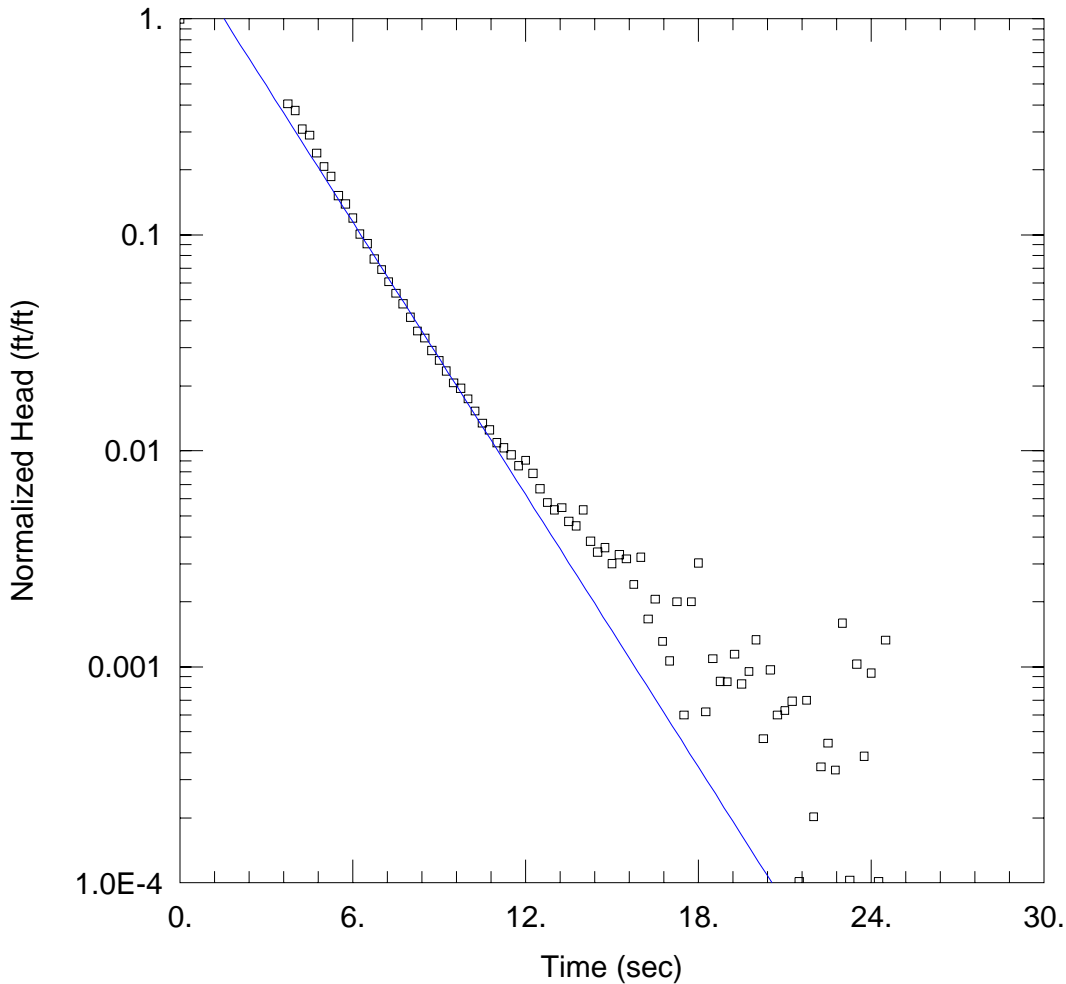
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (LH-3)

Initial Displacement: 2.47 ft Static Water Column Height: 24. ft  
 Total Well Penetration Depth: 24. ft Screen Length: 10. ft  
 Casing Radius: 0.1 ft Well Radius: 0.1 ft

### SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-Rice  
 K = 75.2 ft/day y0 = 6.21 ft



### WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\Slug Tests\Feb 2018\LH-3\LH-3 Run3.aqt  
 Date: 05/24/18 Time: 11:55:04

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

### AQUIFER DATA

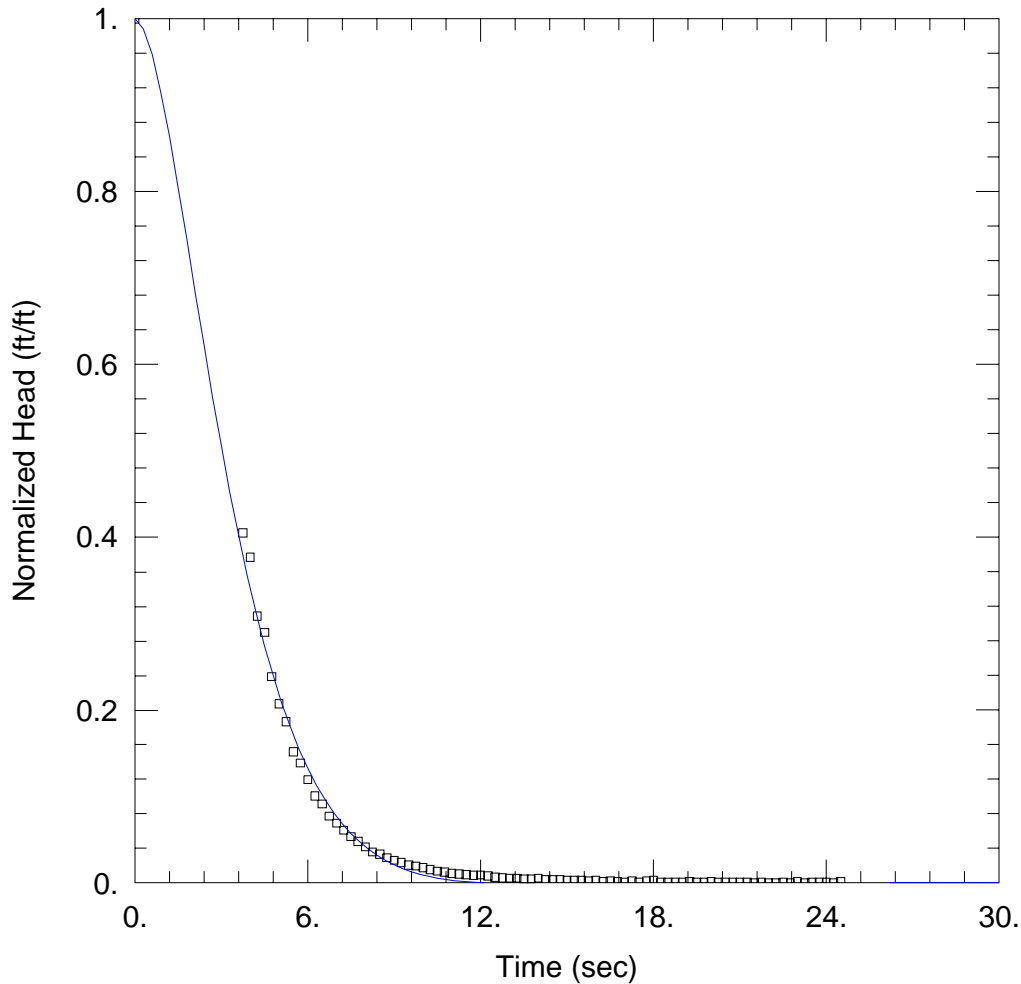
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (LH-3)

Initial Displacement: 2.47 ft Static Water Column Height: 24. ft  
 Total Well Penetration Depth: 24. ft Screen Length: 10. ft  
 Casing Radius: 0.1 ft Well Radius: 0.1 ft

### SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev  
 K = 96.32 ft/day y0 = 5.185 ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\Slug Tests\Feb 2018\LH-3\LH-3 Run3.aqt  
 Date: 05/24/18 Time: 11:55:27

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

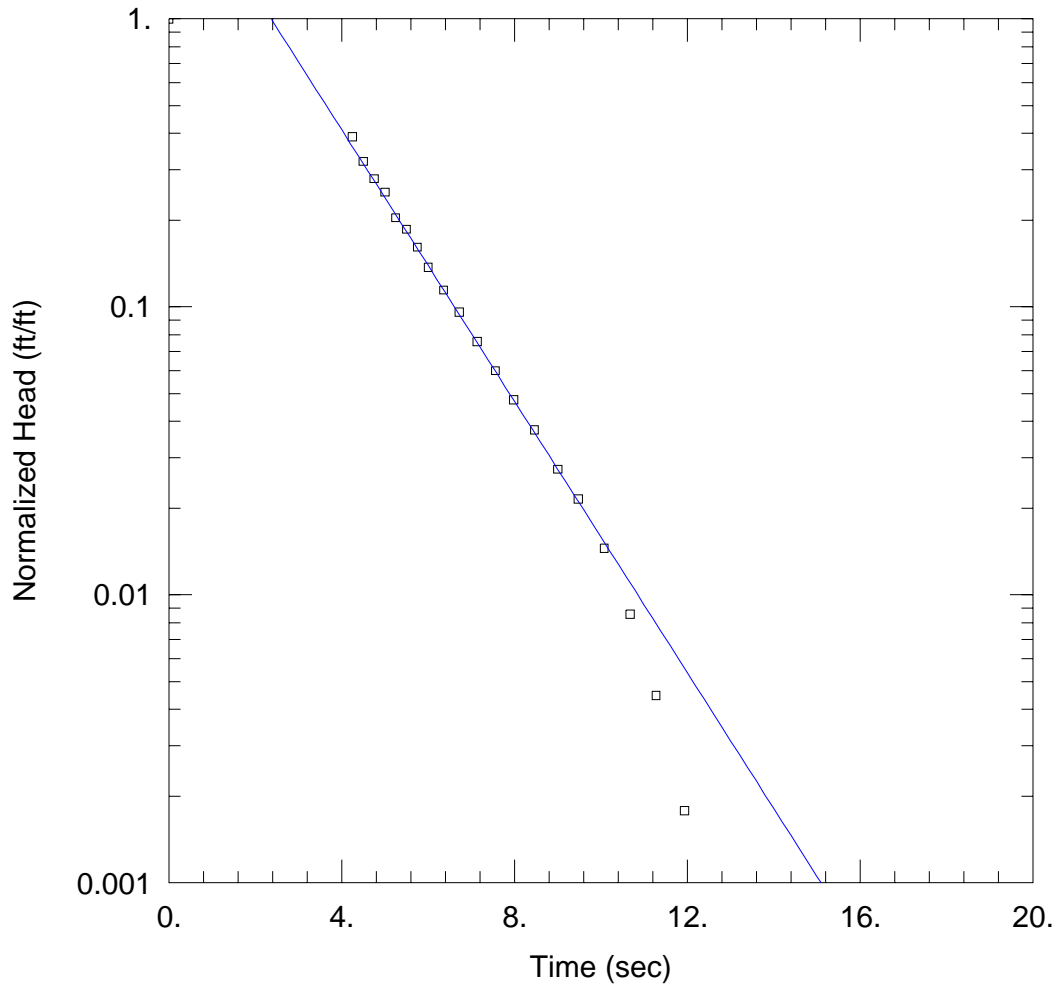
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.47 ft Static Water Column Height: 24. ft  
 Total Well Penetration Depth: 24. ft Screen Length: 10. ft  
 Casing Radius: 0.1 ft Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar  
 K = 43.49 ft/day Le = 116.7 ft



### WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run1 normalized.aqt

Date: 05/24/18

Time: 11:56:59

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (LH-5)

Initial Displacement: 2.57 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

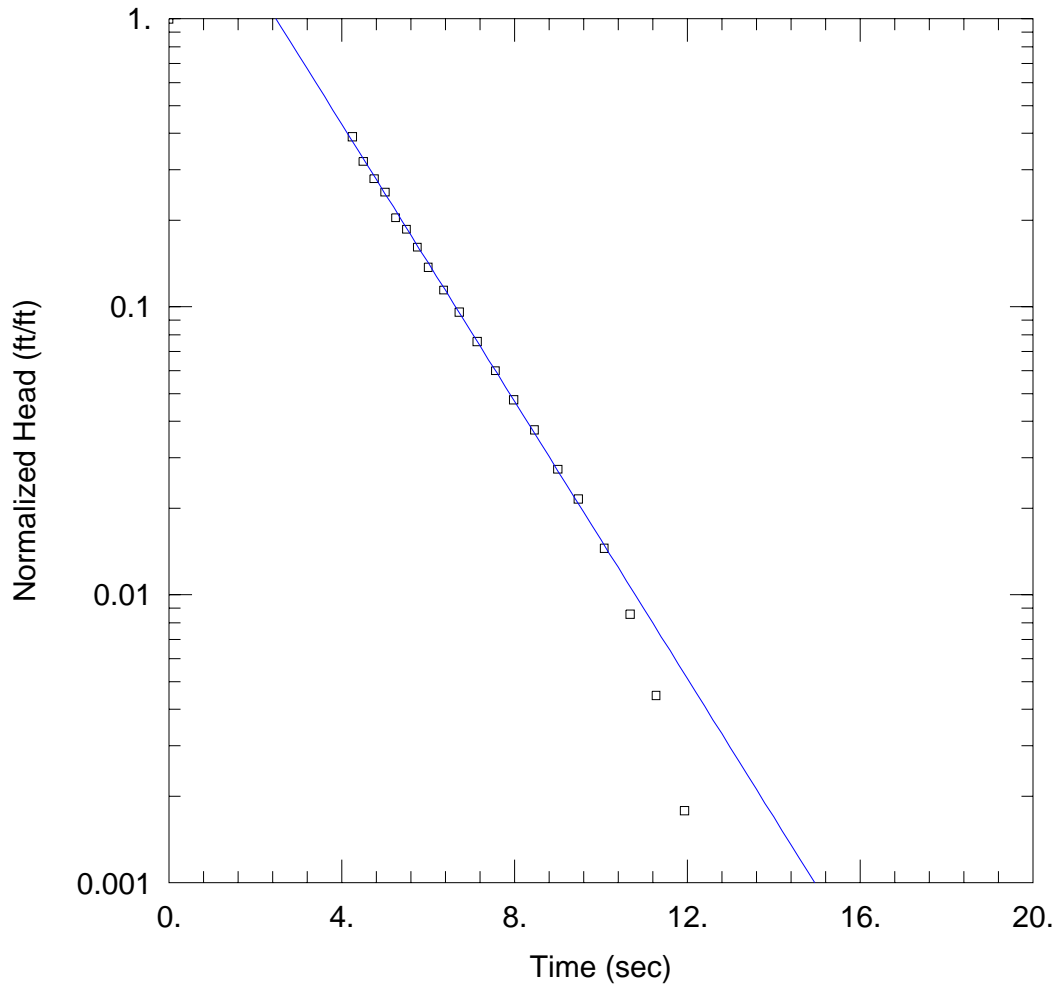
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 79.99 ft/day

y0 = 9.286 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run1 normalized.aqt

Date: 05/24/18

Time: 11:57:22

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

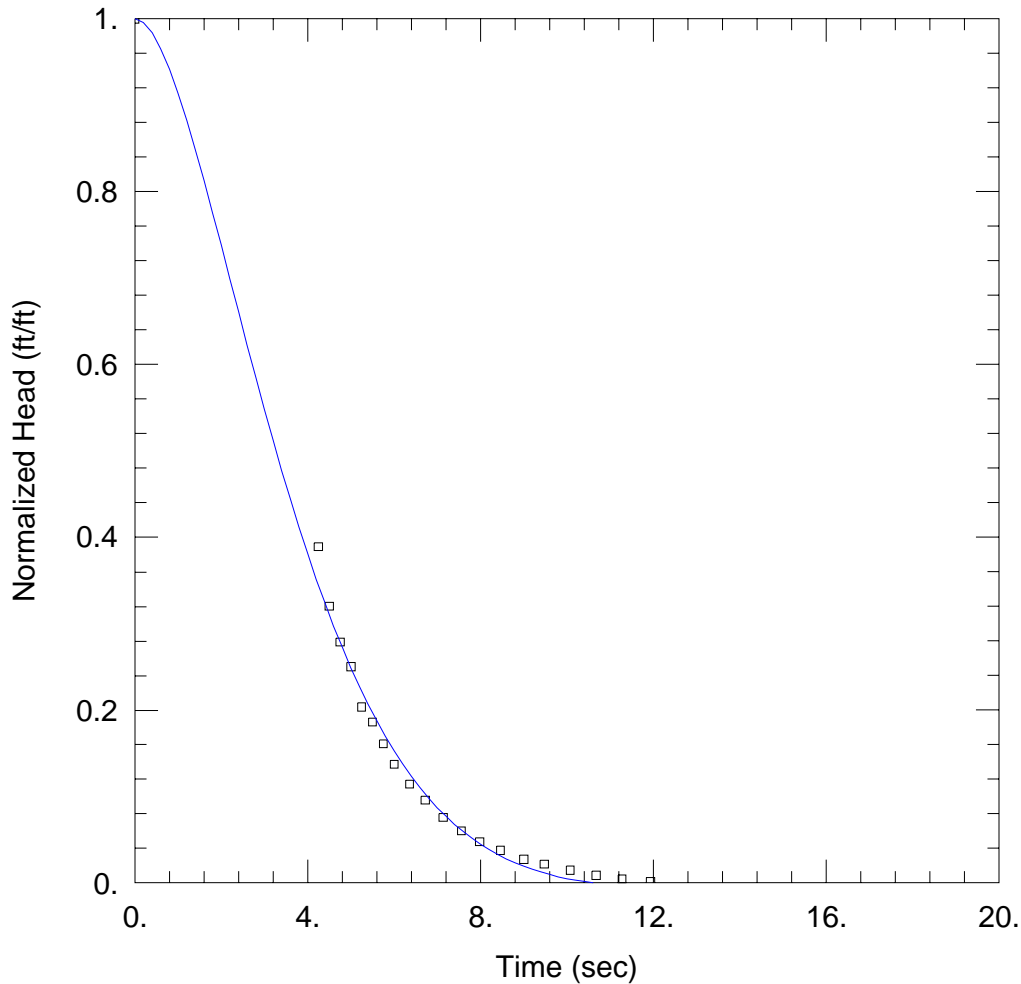
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 110.2 ft/day

y0 = 10.18 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run1 normalized.aqt

Date: 05/24/18

Time: 11:58:36

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

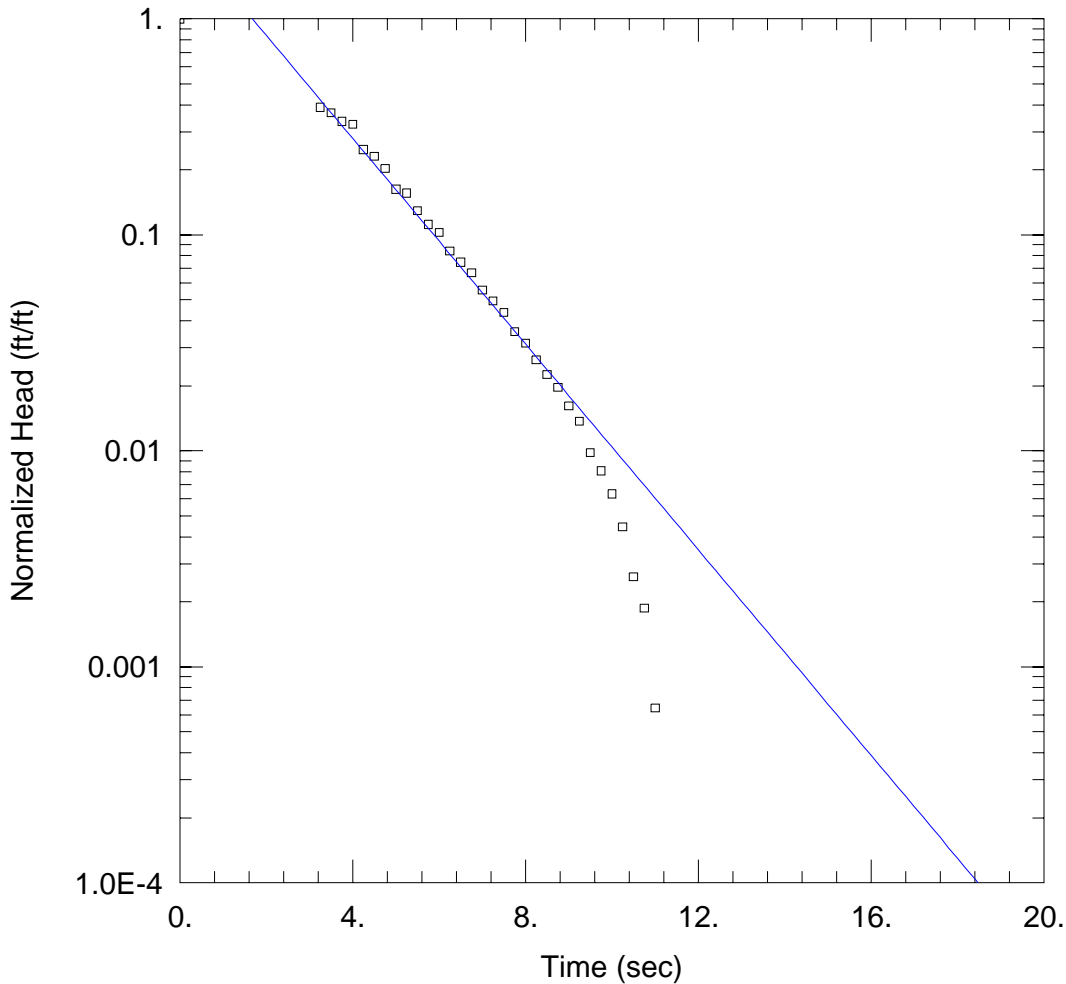
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 40.83 ft/day

Le = 143. ft



### WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run2 normalized.aqt

Date: 05/24/18

Time: 11:59:18

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (LH-5)

Initial Displacement: 2.57 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

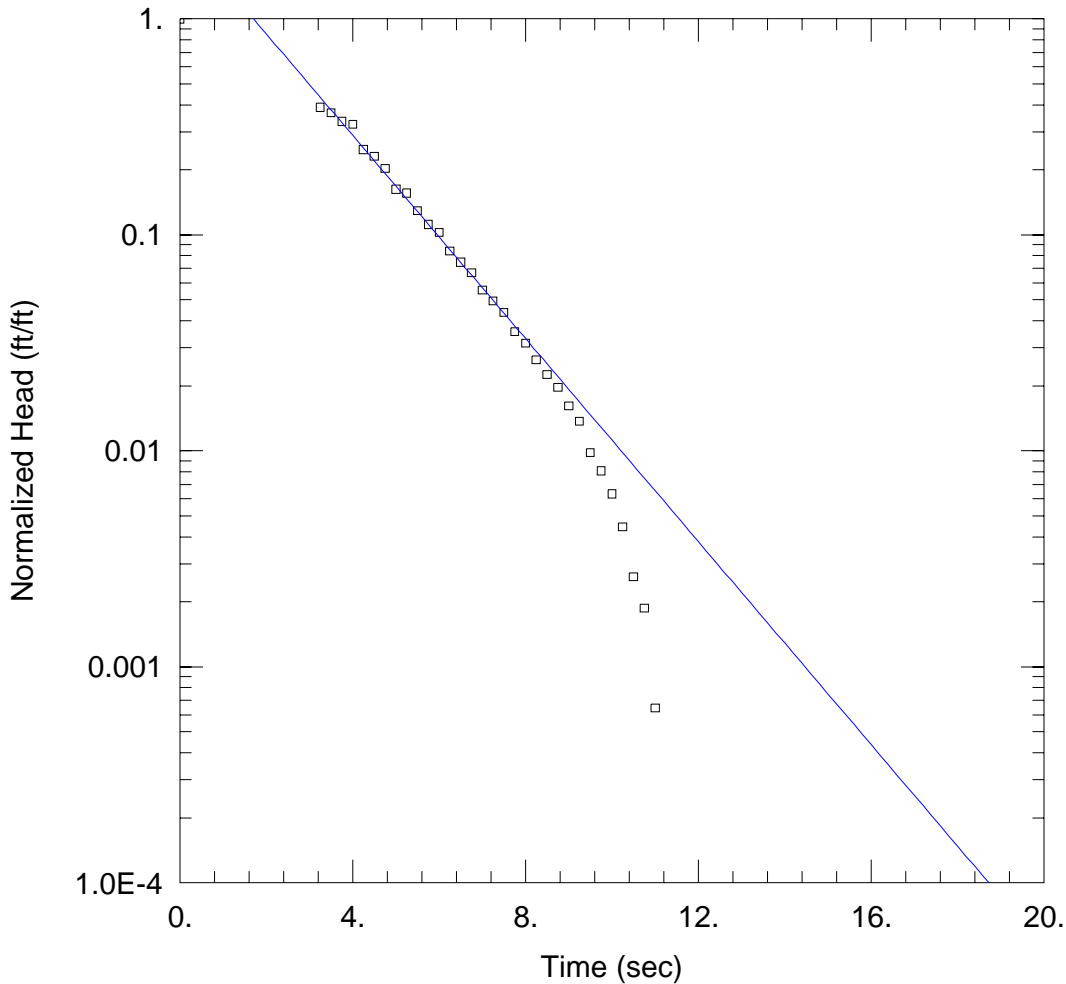
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 80.81 ft/day

y0 = 6.449 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run2 normalized.aqt

Date: 05/24/18

Time: 11:59:40

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

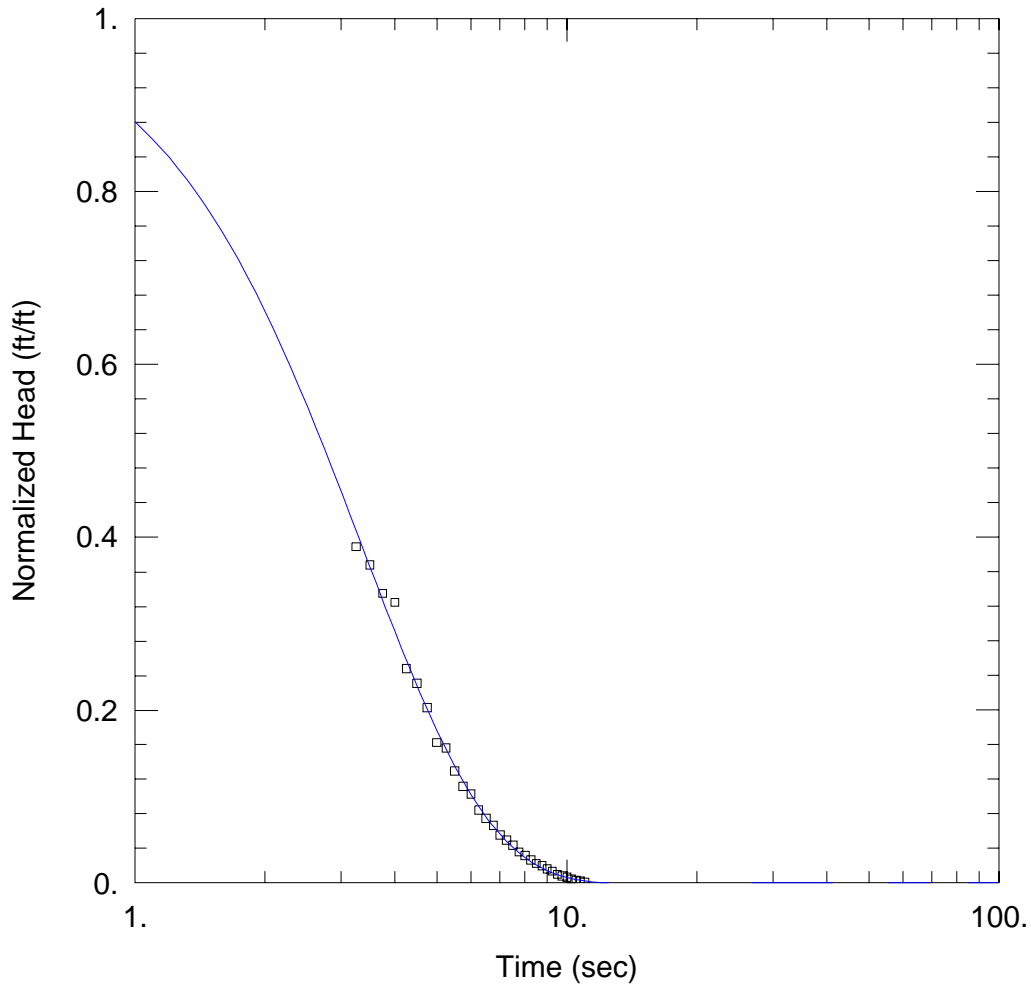
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 107.7 ft/day

y0 = 6.473 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run2 normalized.aqt

Date: 05/24/18

Time: 11:58:52

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

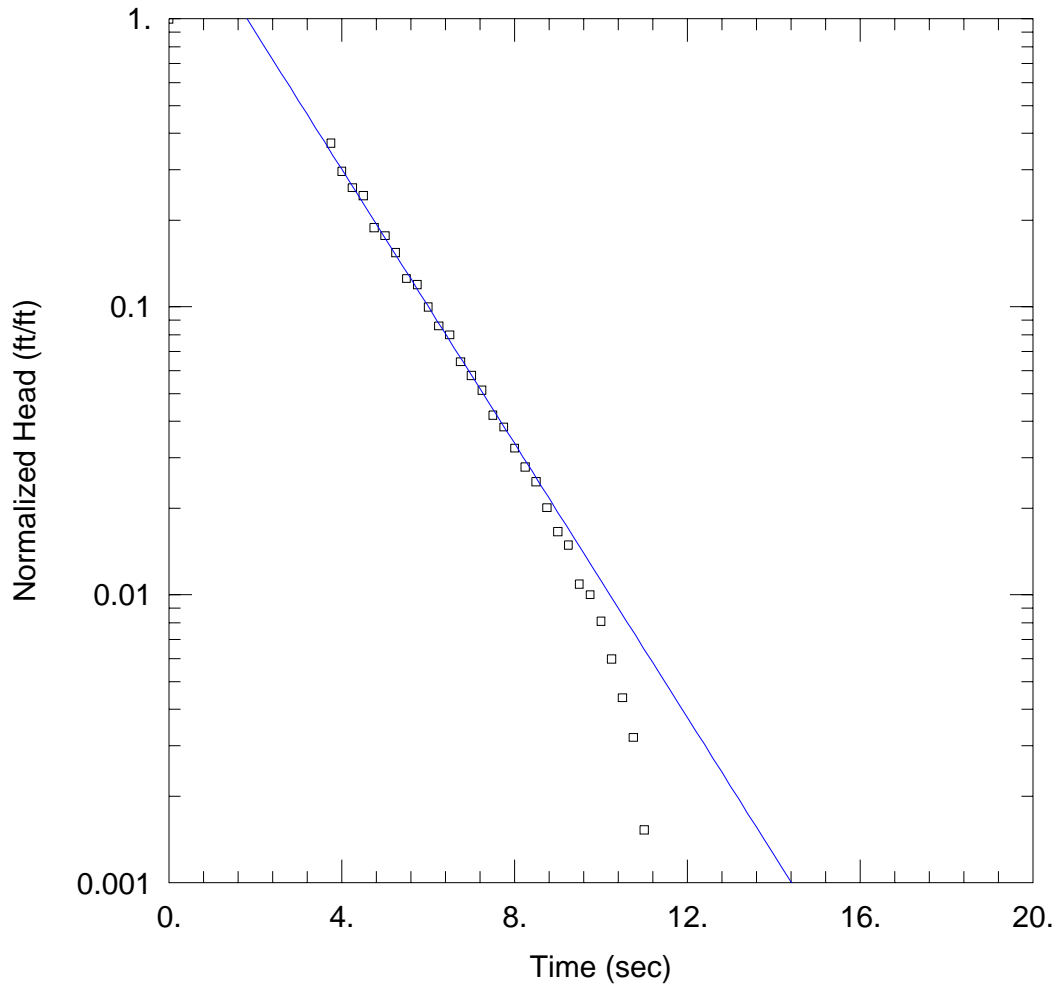
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 46.47 ft/day

Le = 94.49 ft



### WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run3 normalized.aqt

Date: 05/24/18

Time: 12:01:13

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (LH-5)

Initial Displacement: 2.7 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

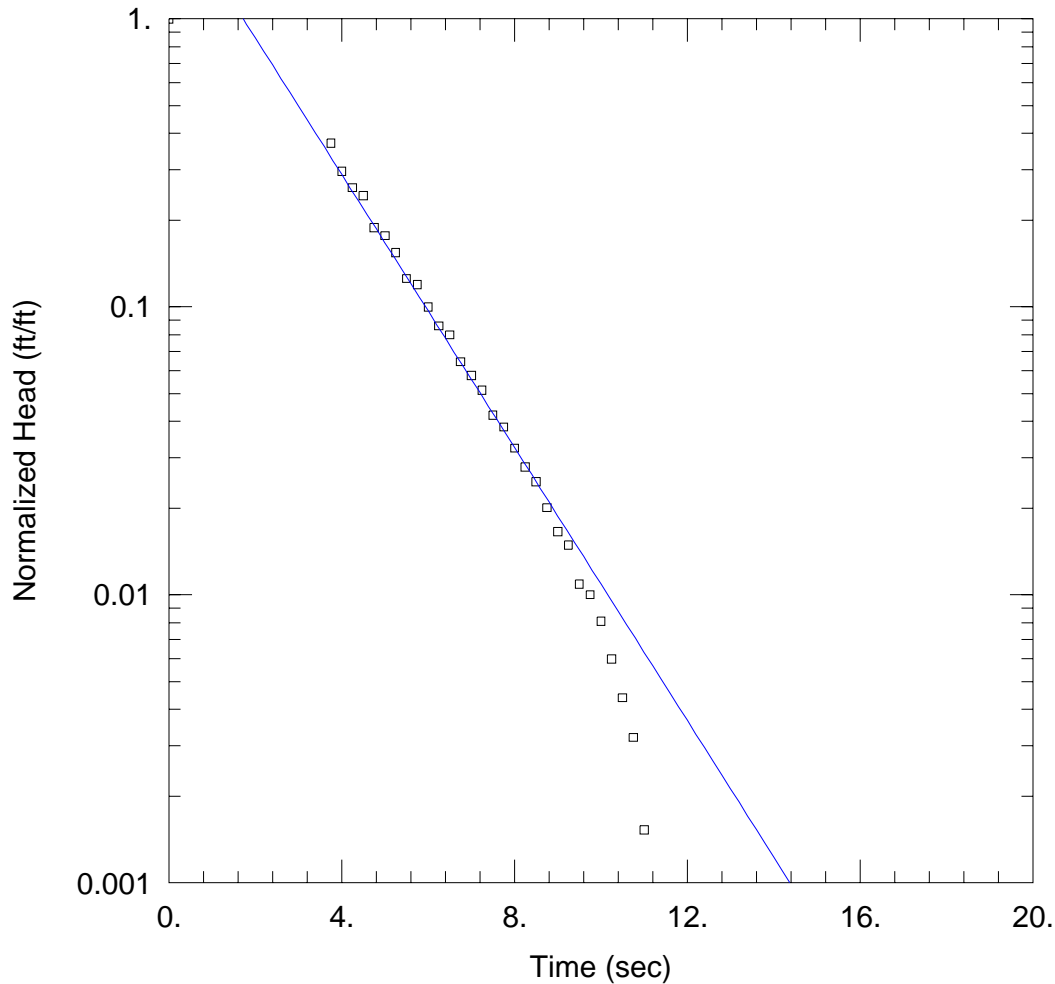
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 80.78 ft/day

y0 = 7.275 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run3 normalized.aqt

Date: 05/24/18

Time: 12:01:38

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.7 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

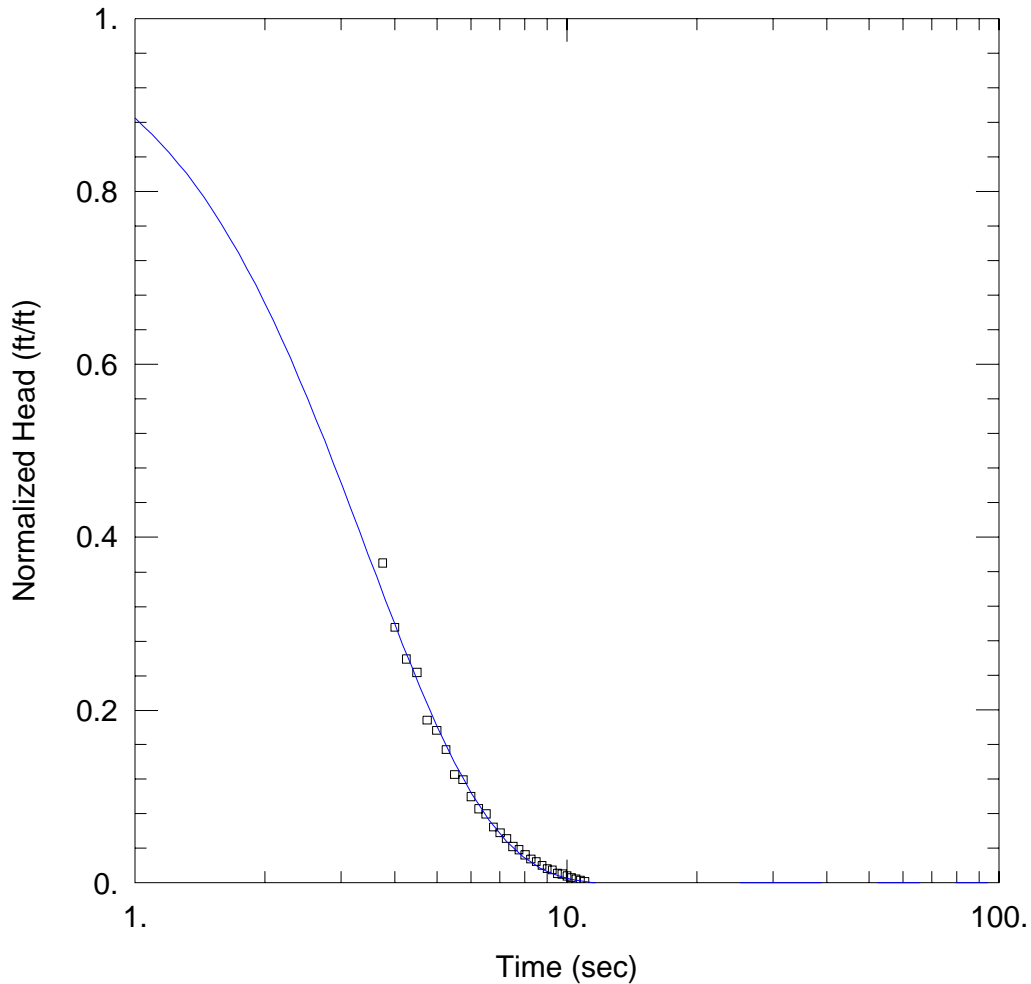
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 108.6 ft/day

y0 = 6.916 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run3 normalized.aqt

Date: 05/24/18

Time: 12:00:00

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: LH-3  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.7 ft  
 Total Well Penetration Depth: 21. ft  
 Casing Radius: 0.1 ft

Static Water Column Height: 21. ft  
 Screen Length: 10. ft  
 Well Radius: 0.1 ft

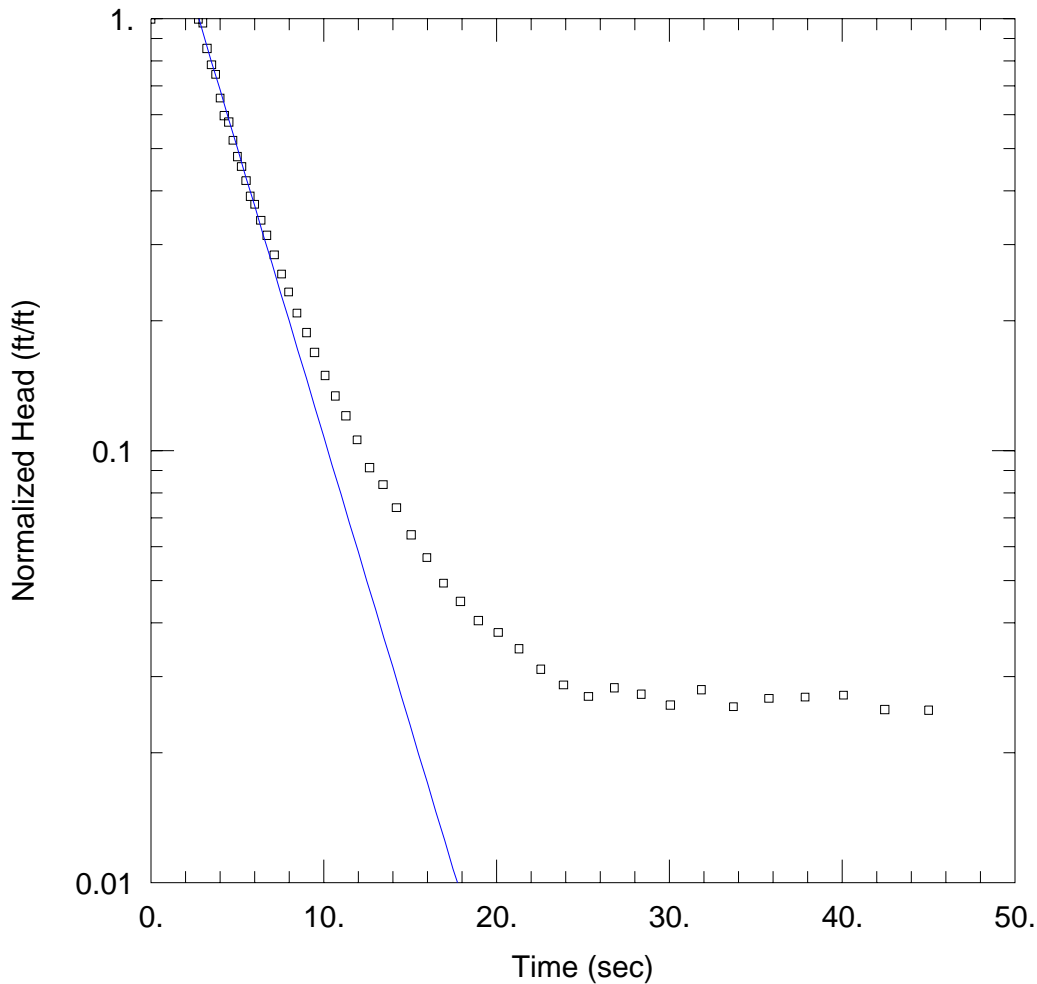
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 45.98 ft/day

Le = 99.45 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run1 normalized.aqt

Date: 05/24/18

Time: 12:07:02

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

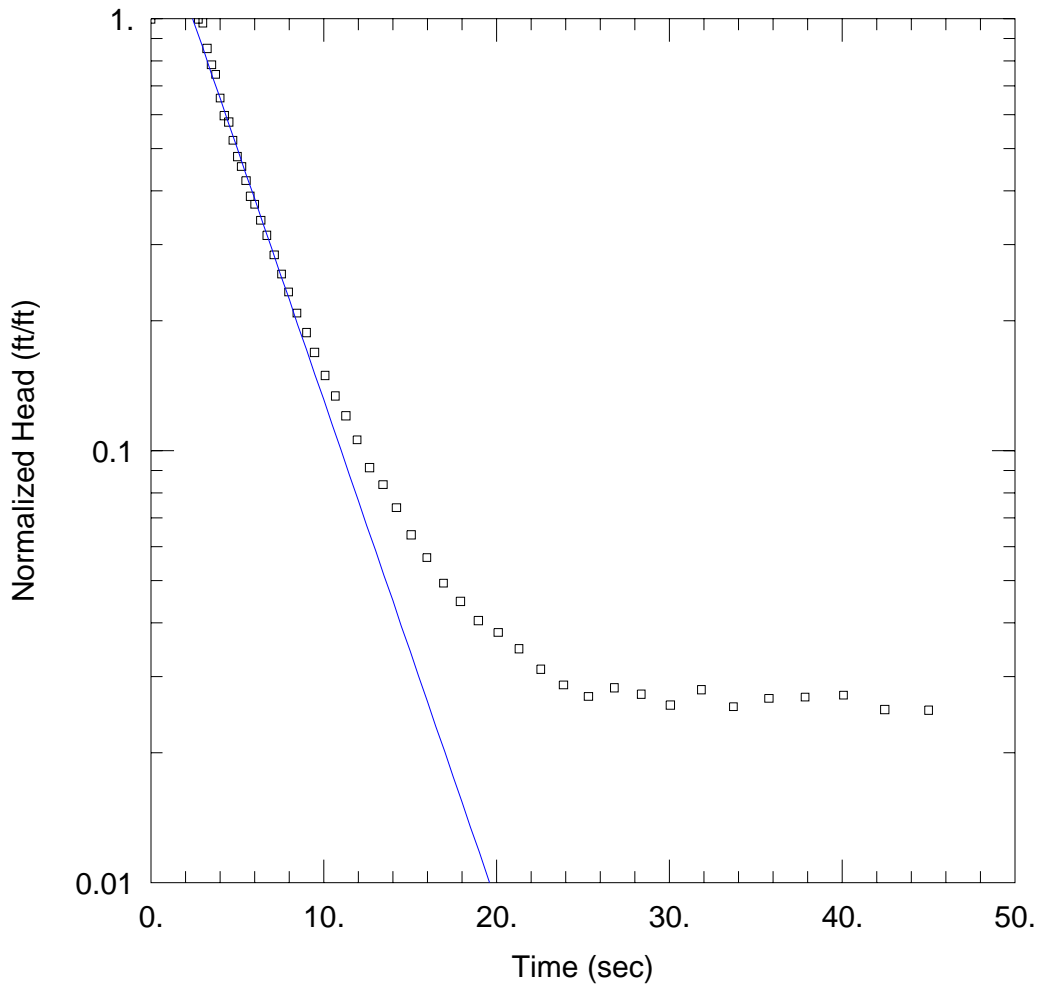
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 34.45 ft/day

y0 = 2.345 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run1 normalized.aqt

Date: 05/24/18

Time: 12:07:43

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

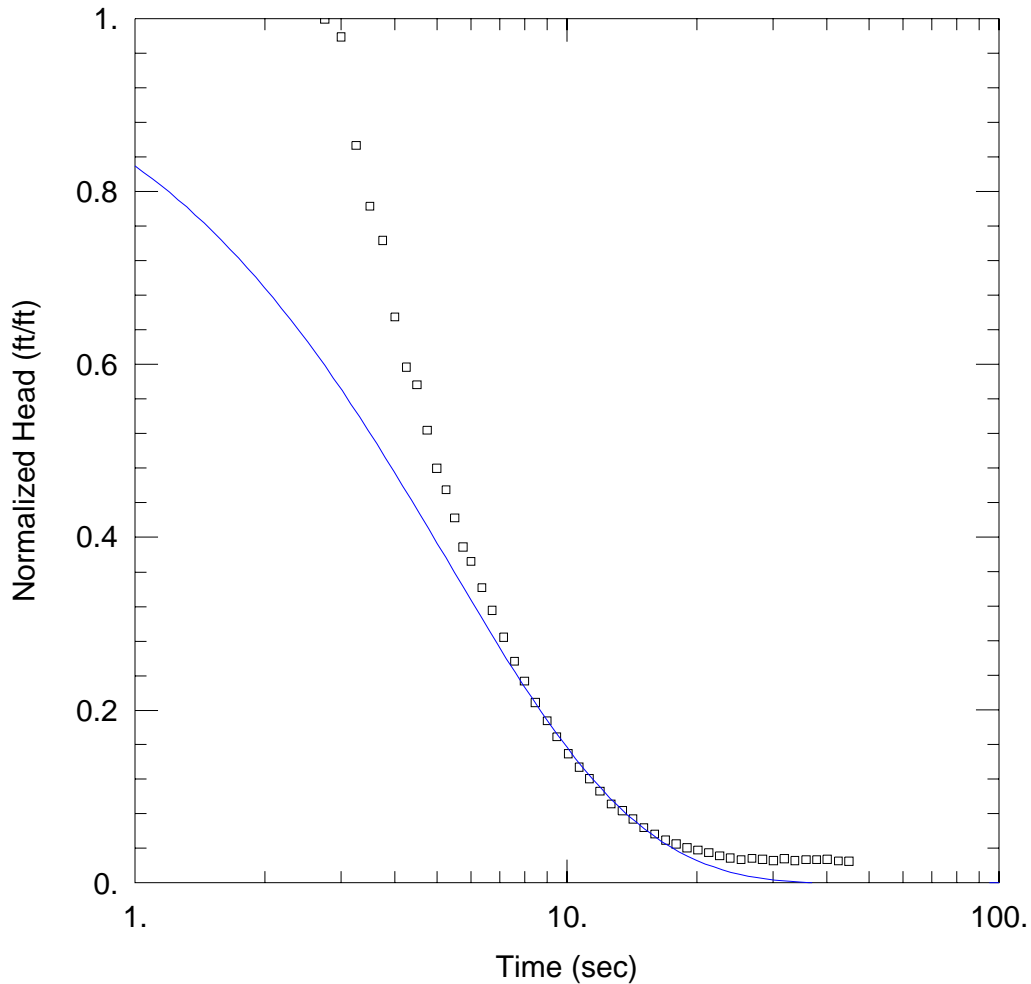
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 38.21 ft/day

y0 = 1.916 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run1 normalized.aqt

Date: 05/24/18

Time: 12:08:27

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

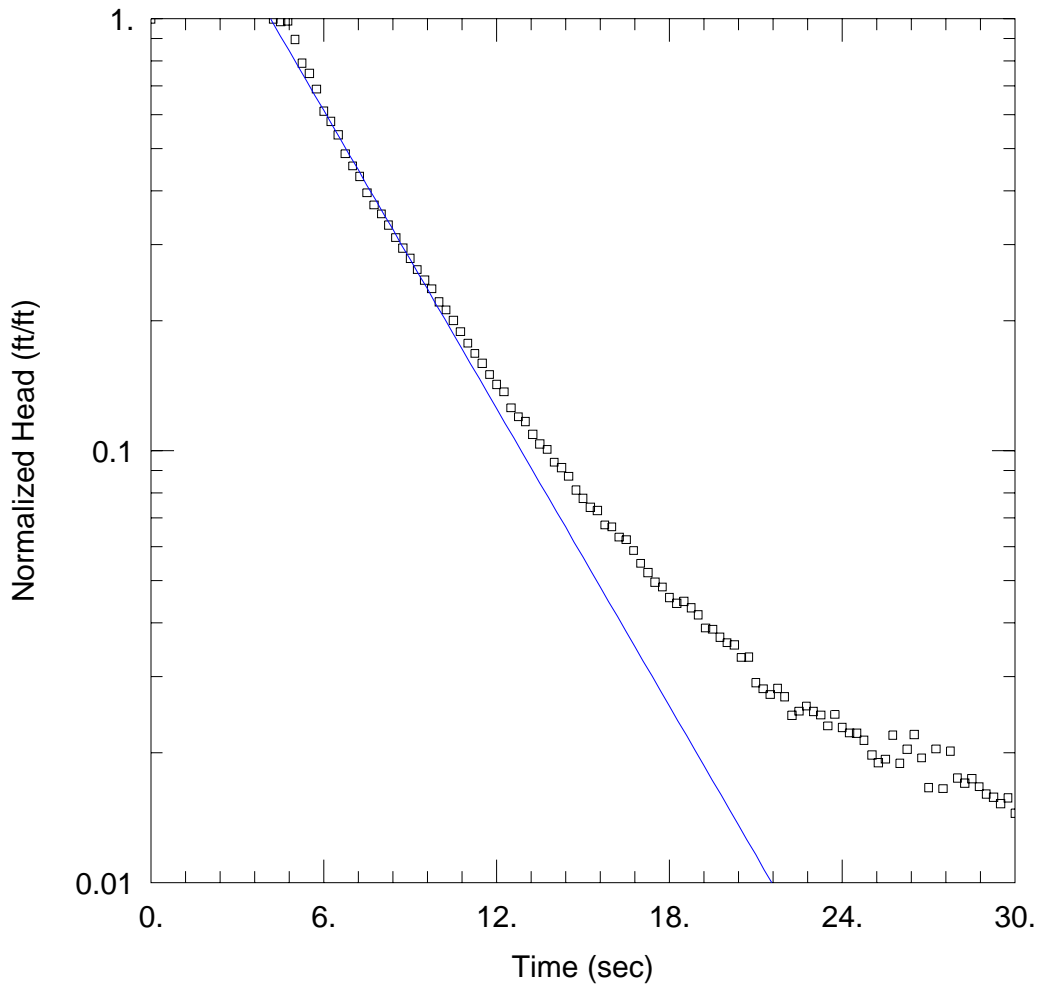
Saturated Thickness: 100. ft

WELL DATA (MW-15S)

Initial Displacement: <u>1. ft</u>	Static Water Column Height: <u>31.61 ft</u>
Total Well Penetration Depth: <u>31.61 ft</u>	Screen Length: <u>10. ft</u>
Casing Radius: <u>0.083 ft</u>	Well Radius: <u>0.083 ft</u>

SOLUTION

Aquifer Model: <u>Unconfined</u>	Solution Method: <u>KGS Model</u>
Kr = <u>24.35 ft/day</u>	Ss = <u>1.0E-12 ft<sup>-1</sup></u>
Kz/Kr = <u>1.</u>	



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt

Date: 05/24/18

Time: 12:10:36

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

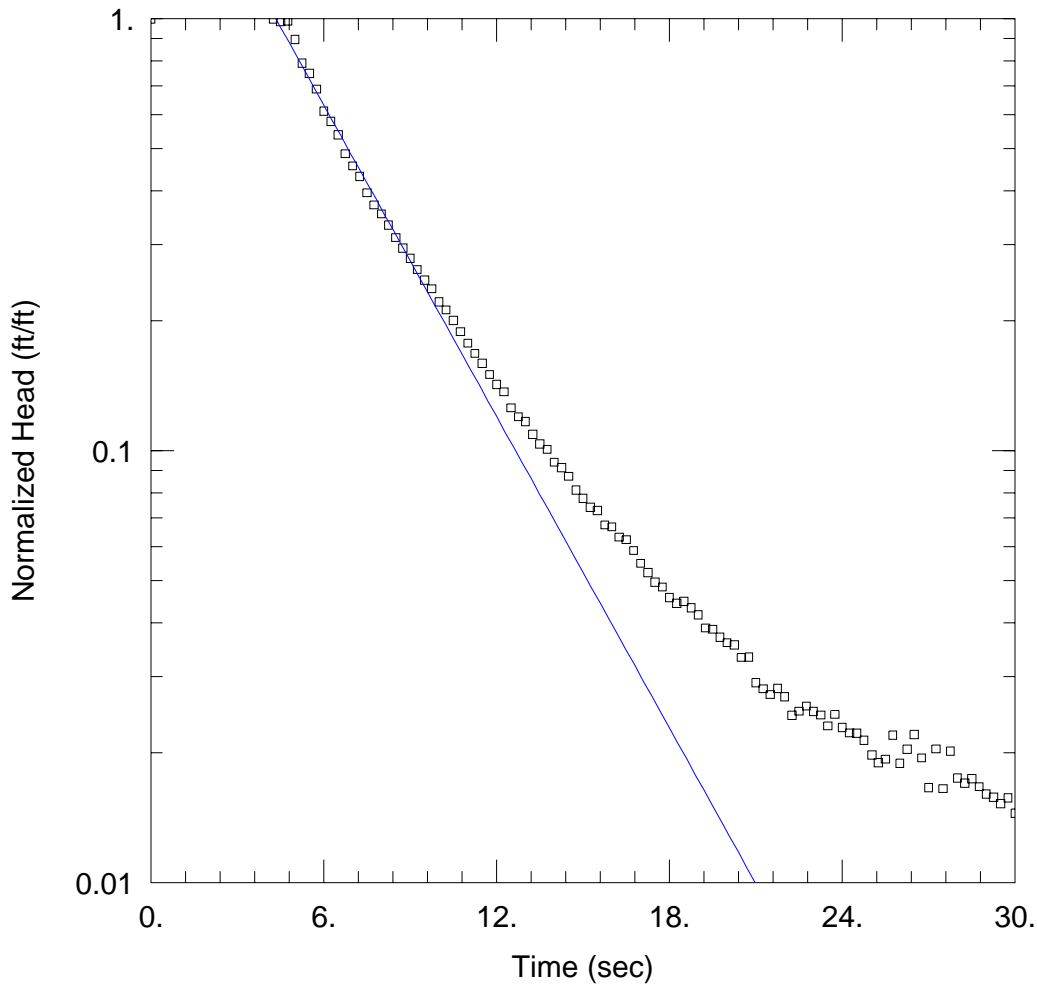
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 29.62 ft/day

y0 = 3.005 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt

Date: 05/24/18

Time: 12:11:05

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

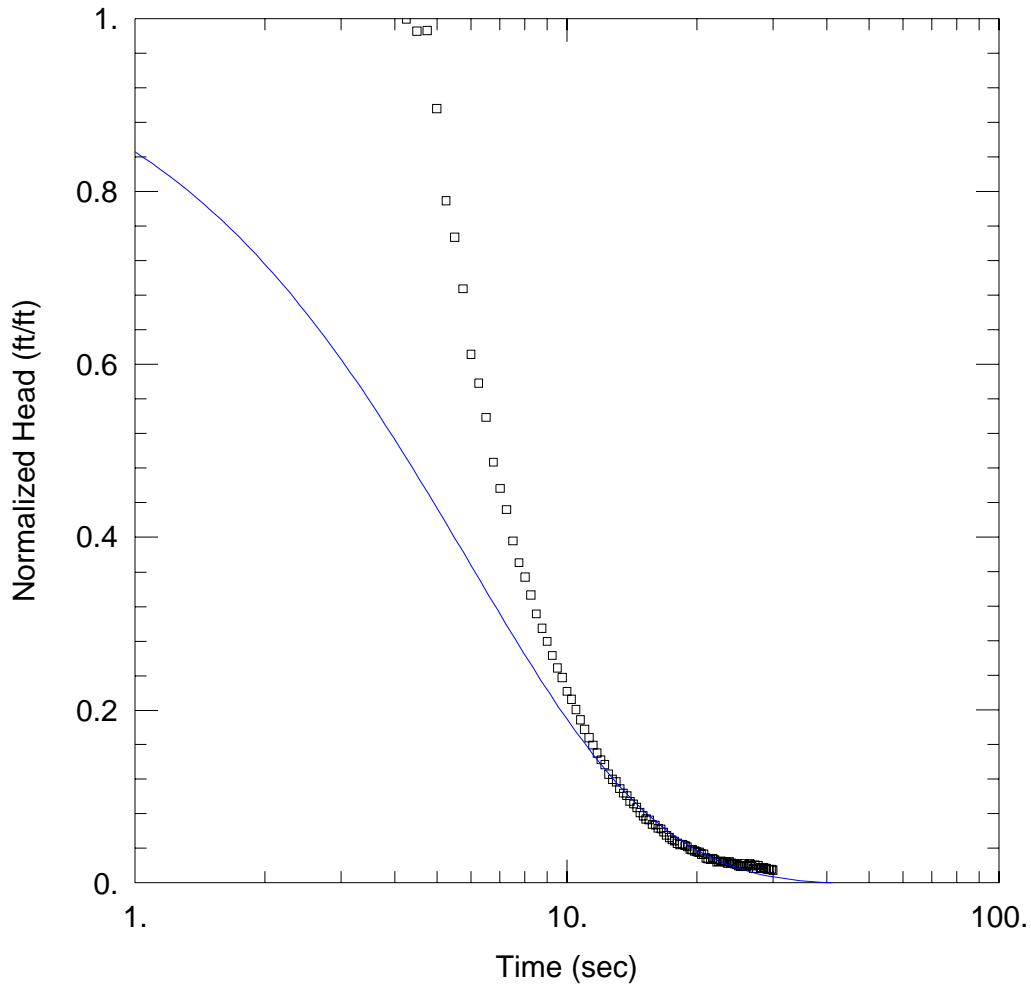
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 39.46 ft/day

y0 = 3.33 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt

Date: 05/24/18

Time: 12:09:50

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

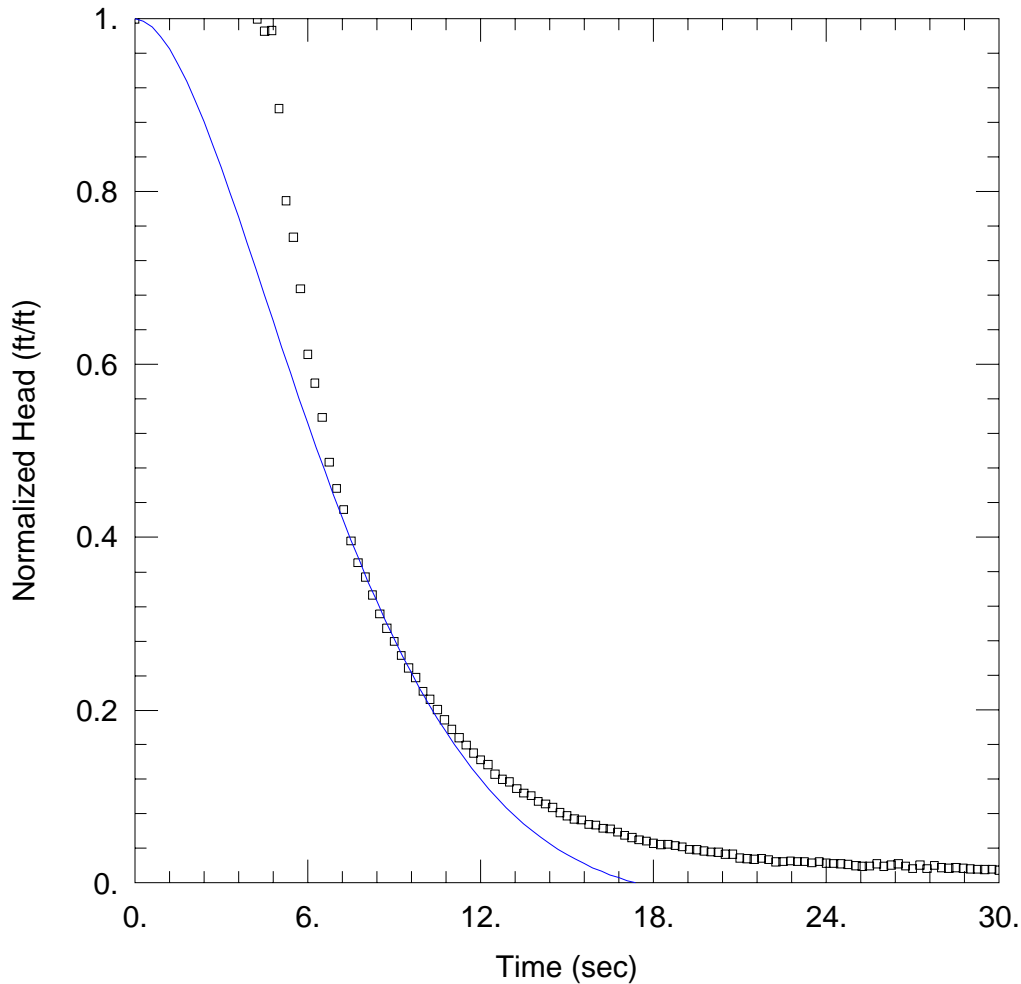
Saturated Thickness: 100. ft

WELL DATA (MW-15S)

Initial Displacement: <u>1. ft</u>	Static Water Column Height: <u>31.61 ft</u>
Total Well Penetration Depth: <u>31.61 ft</u>	Screen Length: <u>10. ft</u>
Casing Radius: <u>0.083 ft</u>	Well Radius: <u>0.083 ft</u>

SOLUTION

Aquifer Model: <u>Unconfined</u>	Solution Method: <u>KGS Model</u>
Kr = <u>21.81 ft/day</u>	Ss = <u>1.0E-12 ft<sup>-1</sup></u>
Kz/Kr = <u>1.</u>	



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt

Date: 05/24/18

Time: 12:09:20

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

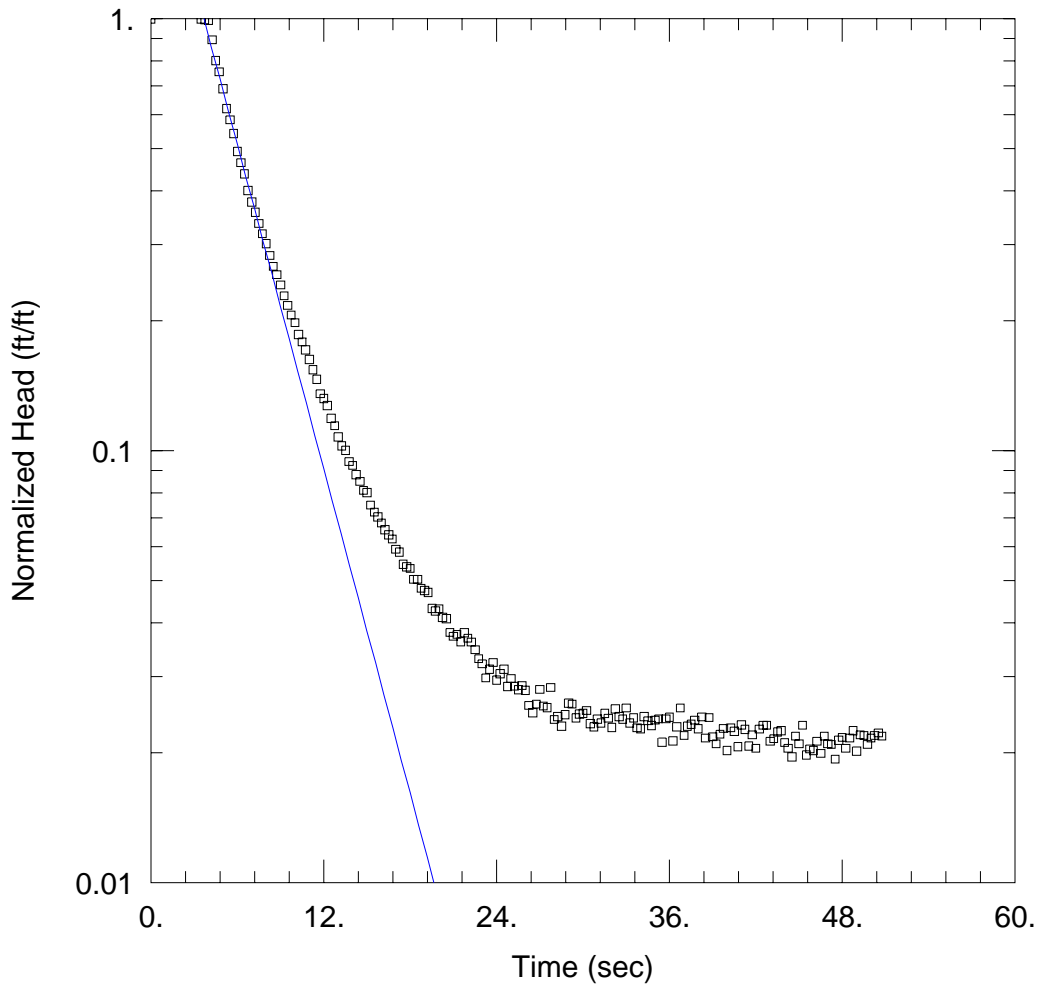
Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined  
 K = 16.65 ft/day

Solution Method: Springer-Gelhar  
 Le = 573.9 ft



### WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt

Date: 05/24/18

Time: 12:12:07

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

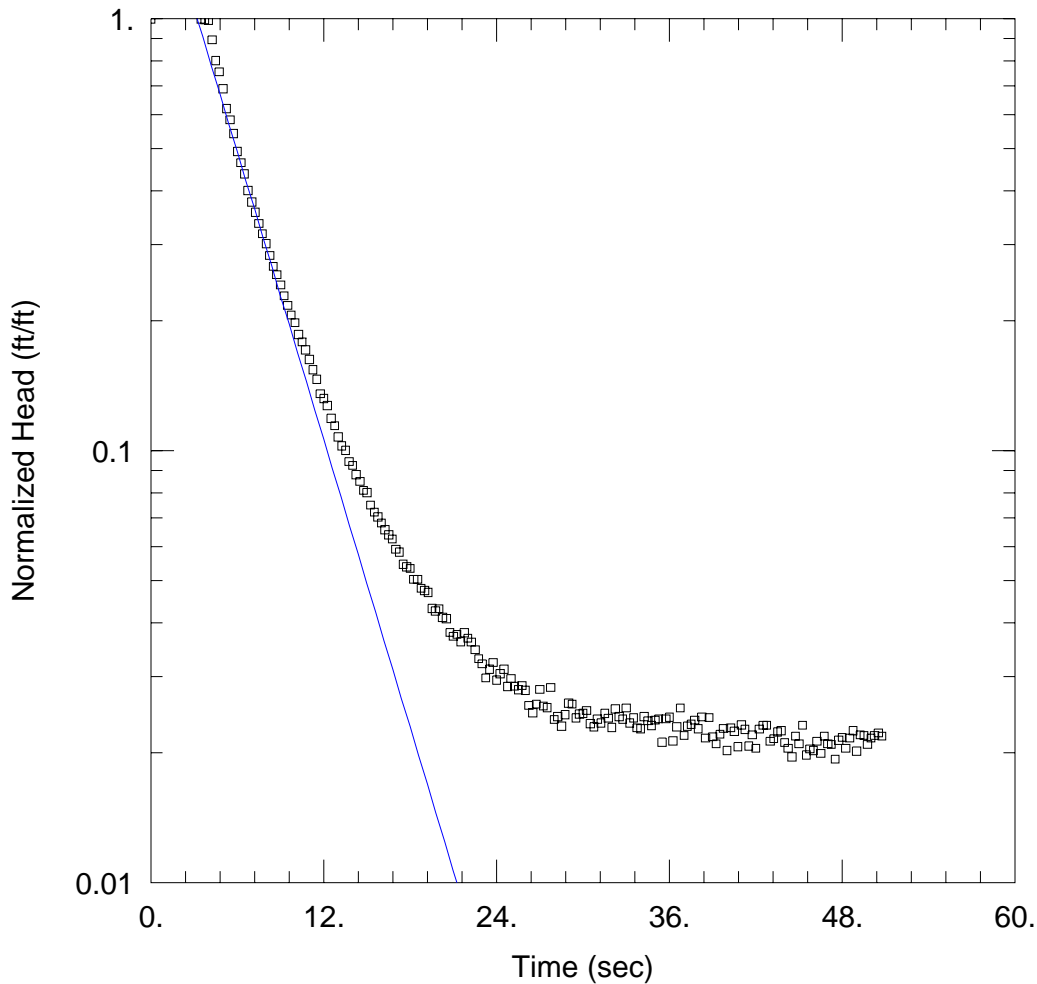
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 32.26 ft/day

y0 = 2.894 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt

Date: 05/24/18

Time: 12:12:34

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

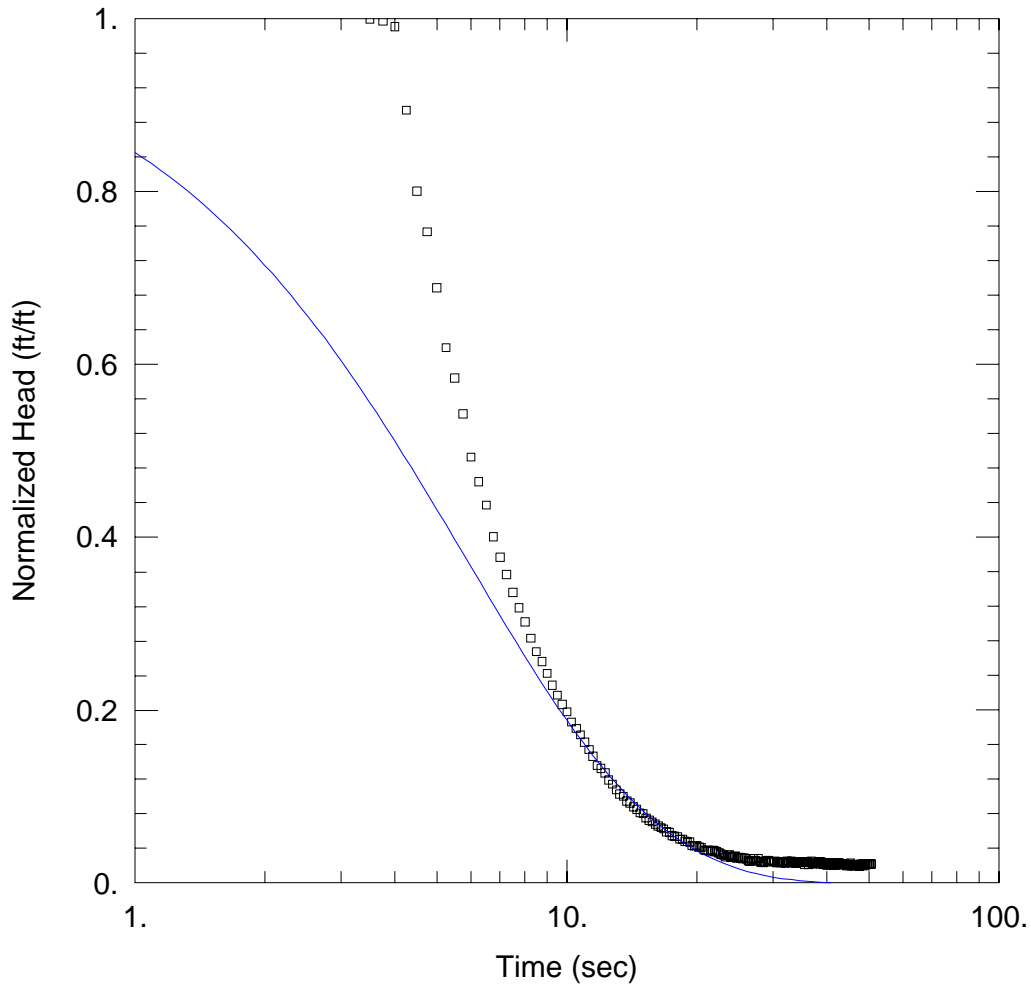
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 36.44 ft/day

y0 = 2.284 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt

Date: 05/24/18

Time: 12:11:44

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

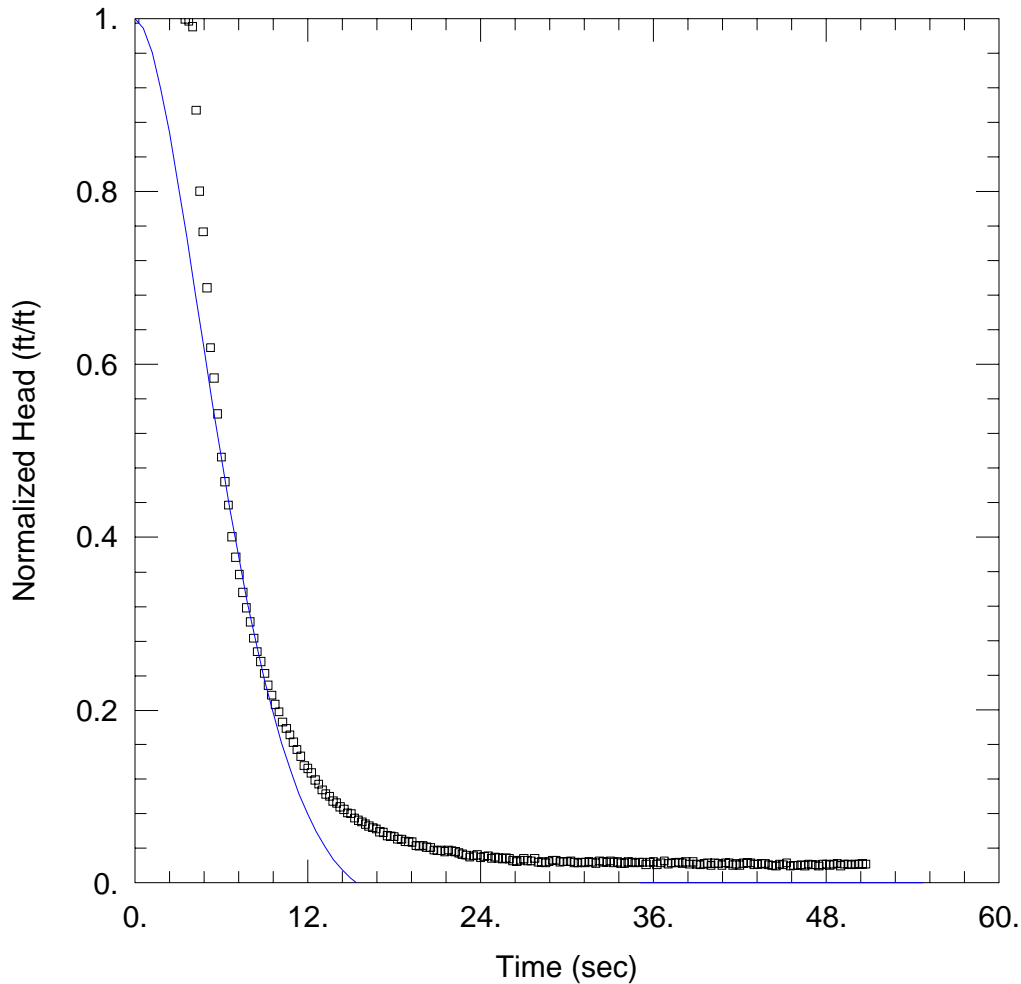
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 21.92 ft/day  
 Kz/Kr = 1.

Ss = 1.0E-12 ft<sup>-1</sup>



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt

Date: 05/24/18

Time: 12:11:23

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-15S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 31.61 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 31.61 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

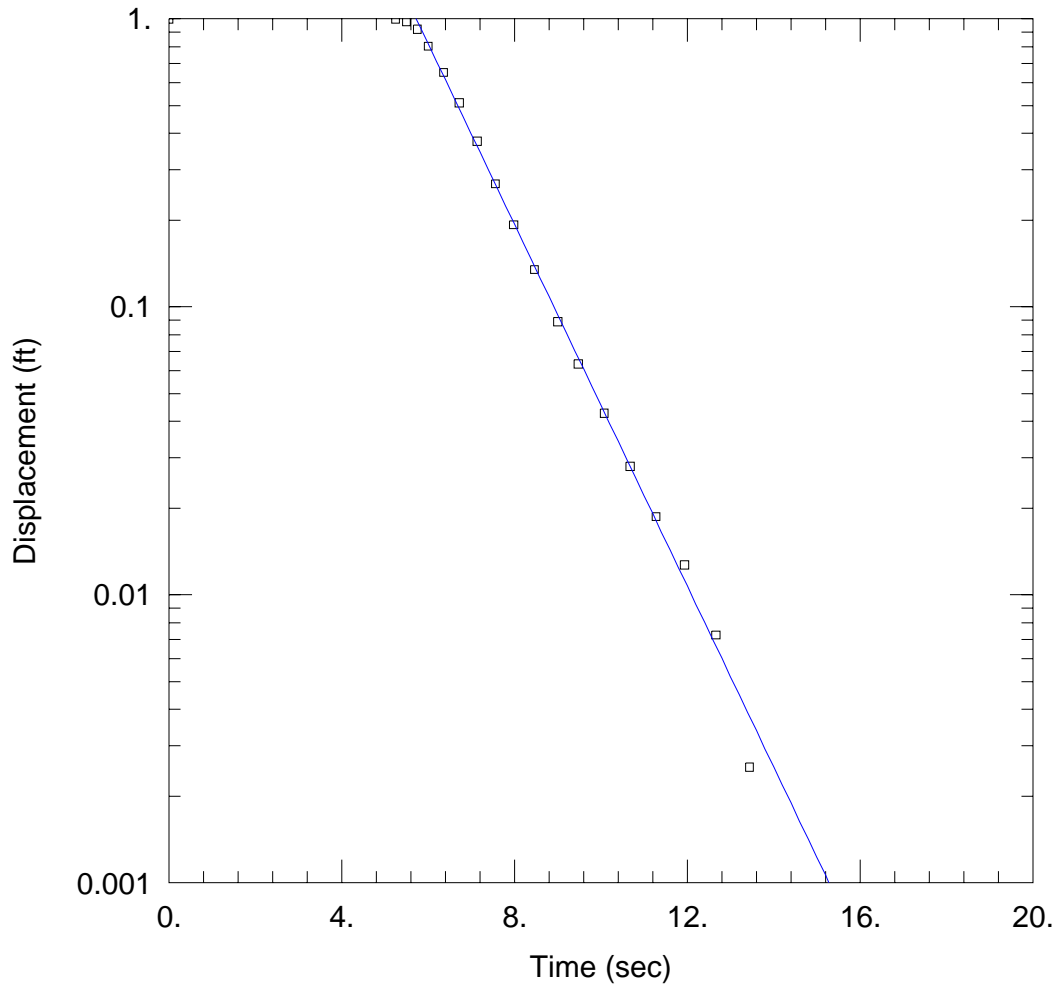
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 18.17 ft/day

Le = 514.8 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run1 normalized.aqt

Date: 05/24/18

Time: 12:13:51

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-16S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 32.32 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 32.32 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

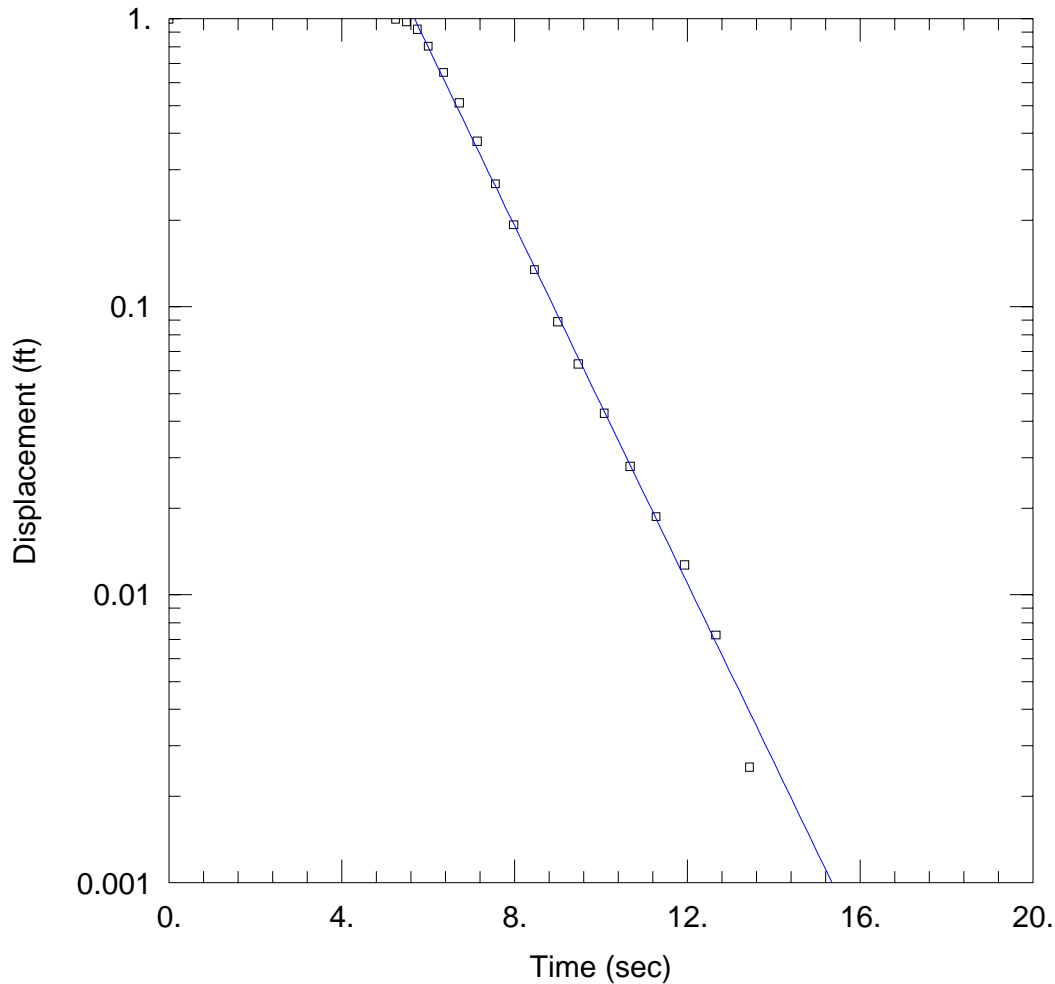
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 81.16 ft/day

y0 = 62.95 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run1 normalized.aqt

Date: 05/24/18

Time: 12:14:16

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-16S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 32.32 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 32.32 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

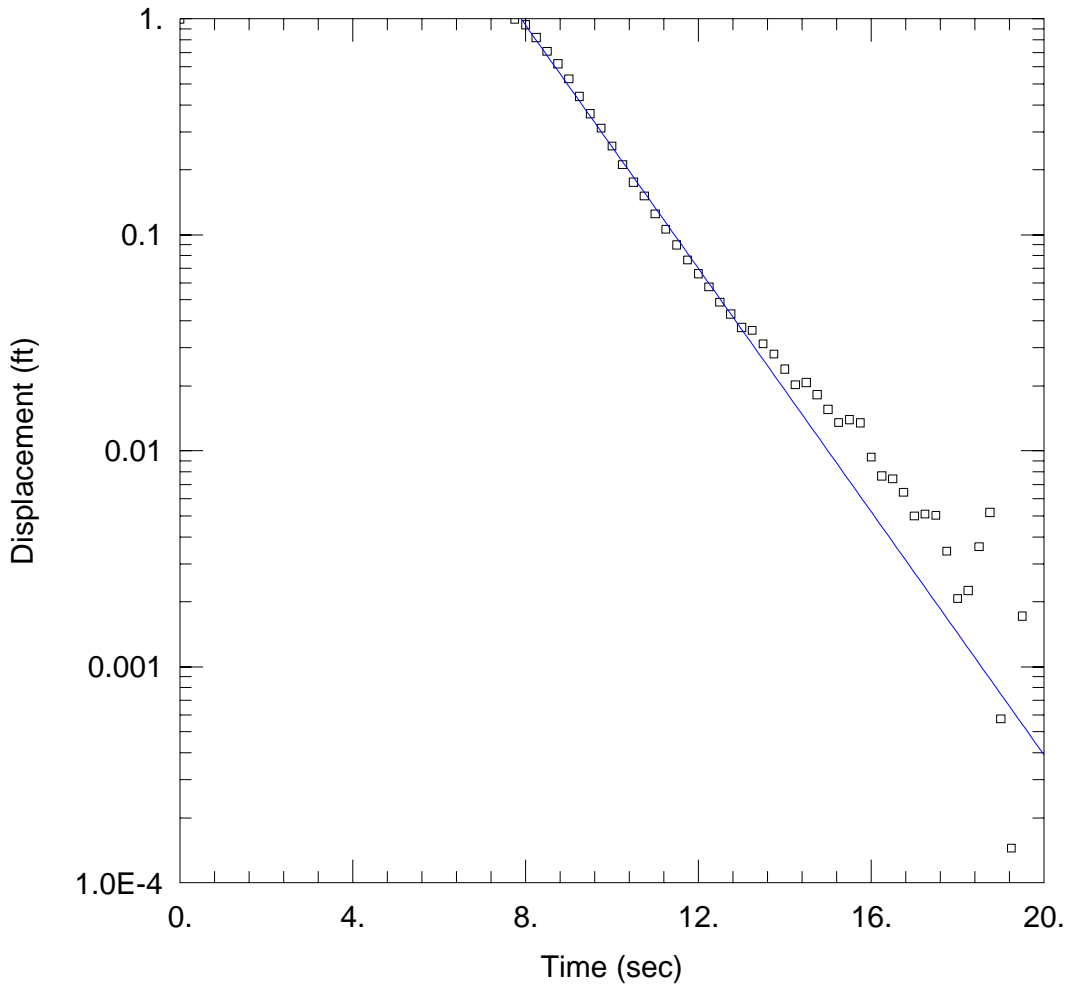
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 101.9 ft/day

y0 = 58.22 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run2 normalized.aqt

Date: 05/24/18

Time: 12:15:30

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-16S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 32.32 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 32.32 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

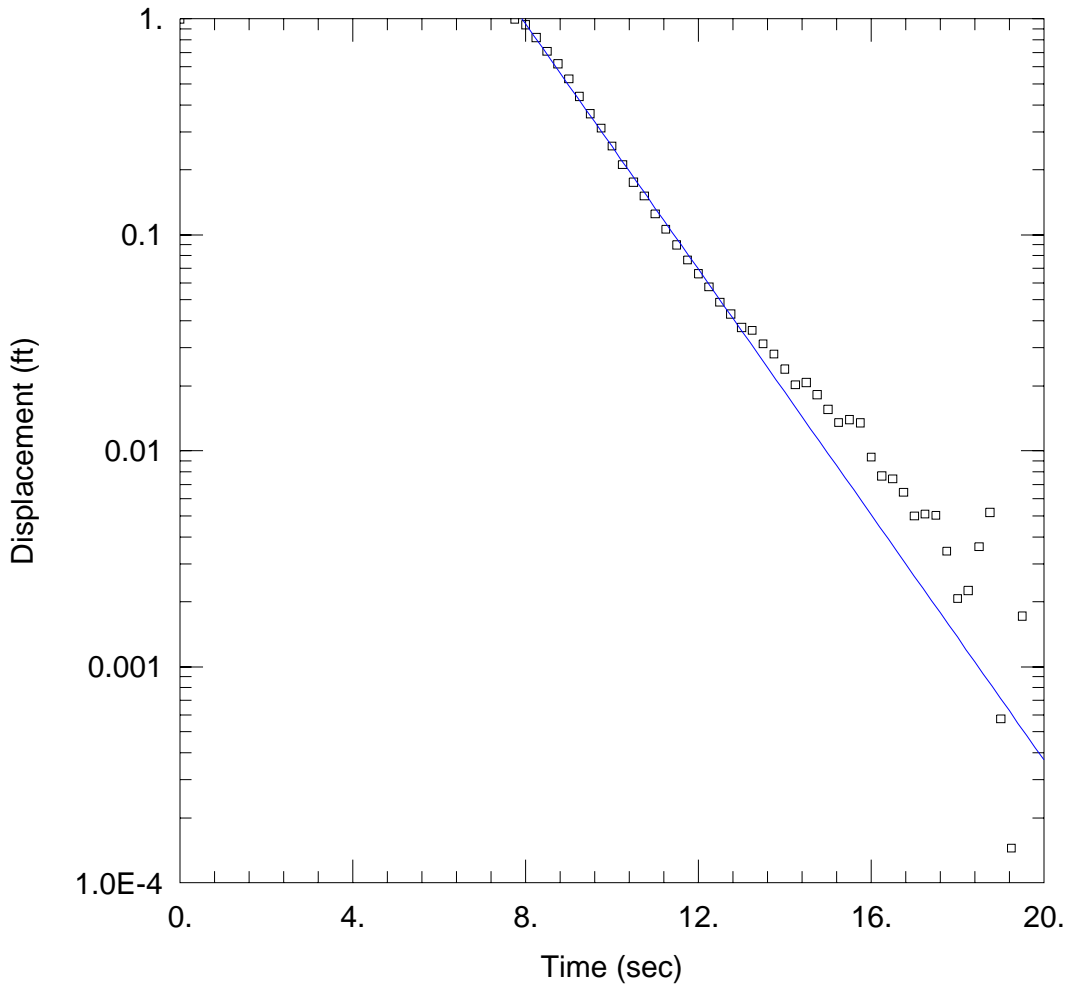
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 72.77 ft/day

y0 = 167.2 ft



### WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run2 normalized.aqt

Date: 05/24/18

Time: 12:15:03

### PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-16S  
 Test Date: 3/1/18

### AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (MW-16S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 32.32 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 32.32 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

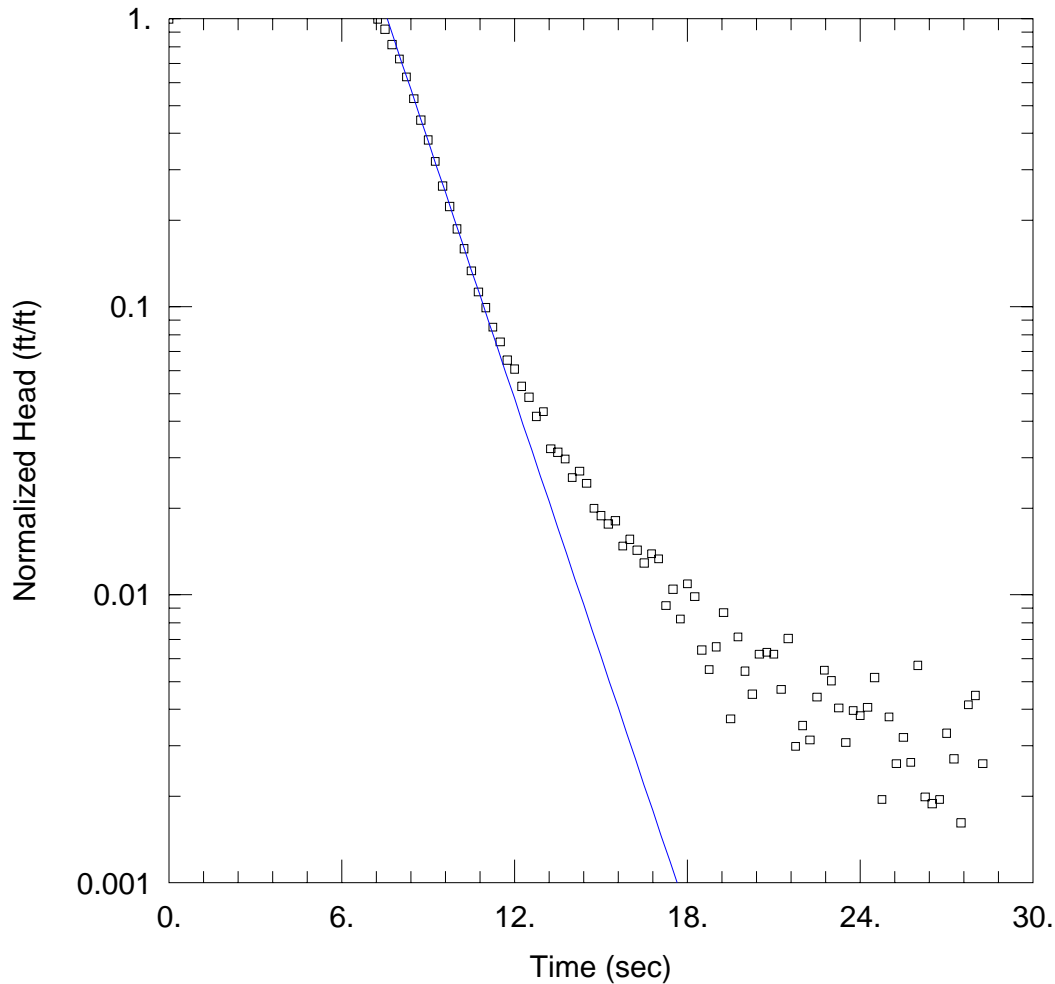
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 93.27 ft/day

y0 = 177.9 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run3 normalized.aqt

Date: 05/24/18

Time: 12:16:11

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-16S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 32.32 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 32.32 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

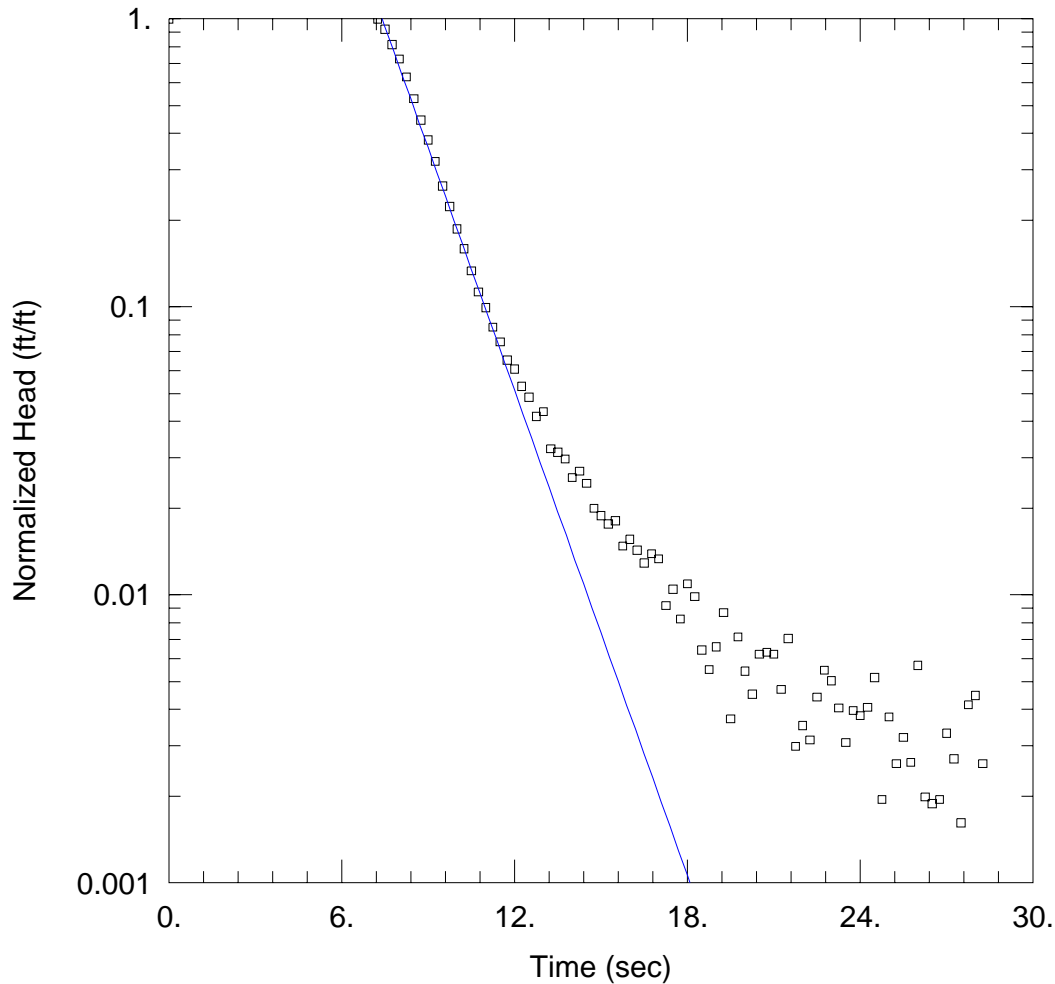
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bower-Rice

K = 77.05 ft/day

y0 = 181.8 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run3 normalized.aqt

Date: 05/24/18

Time: 12:16:30

PROJECT INFORMATION

Company: AECOM  
 Client: Town of Orleans  
 Project: 60476644  
 Location: Orleans, MA  
 Test Well: MW-16S  
 Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft  
 Total Well Penetration Depth: 32.32 ft  
 Casing Radius: 0.083 ft

Static Water Column Height: 32.32 ft  
 Screen Length: 10. ft  
 Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 92.15 ft/day

y0 = 120. ft

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**Appendix K**  
**Laboratory Reports – Groundwater Quality**

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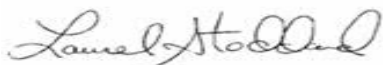
I

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1702113**

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



Laurel Stoddard  
Laboratory Director

**REVIEWED**

By ESS Laboratory at 5:08 pm, Feb 15, 2017

**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: 1702113

**SAMPLE RECEIPT**

The following samples were received on February 06, 2017 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>
1702113-01	MW-2S (84-94)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-02	MW-2D (124-134)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-03	MW-2D (124-134) DUP	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-04	MW-5S (78-88)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702113-05	MW-5D (124-134)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702113-06	MW-6A (64-74)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-07	MW-6B (54-64)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-08	MW-6 (88-98)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-09	MW-7S (55-65)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-10	MW-7D (115-125)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-11	MW-2 (140-150)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-12	MW-7S (55-65) DUP	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702113

**PROJECT NARRATIVE**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**  
C7B0084-TUN1 [DDT breakdown > 20%](#)

**No other observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

[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: 1702113

**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-2S (84-94)  
Date Sampled: 02/06/17 14:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-01  
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	02/07/17 22:29	10	10	CB70703
Manganese	0.545 (0.020)		200.7		1	KJK	02/07/17 22:29	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 02/06/17 14:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-01  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.281 (0.050)		200.7		1	KJK	02/07/17 20:34	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 02/06/17 14:55  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-01  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 18:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 1:40	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	54 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 02/06/17 14:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-01  
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	02/08/17 18:37	mg/L	CB70721
Chloride	88.8 (3.0)		9250		1	JLK	02/10/17 16:03	mg/L	CB71038
Dissolved Organic Carbon (Average)	9.49 (0.500)		5310B		1	DEL	02/07/17 18:47	mg/L	[CALC]
Nitrate as N	18.8 (1.01)		353.2		50	JLK	02/07/17 19:53	mg/L	[CALC]
Nitrite as N	0.041 (0.010)		353.2		1	JLK	02/07/17 17:26	mg/L	CB70728
Sulfate	77.0 (50.0)		9038		10	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	2.13 (0.20)		351.2		1	EEM	02/08/17 15:12	mg/L	CB70707
Total Nitrogen	21.0 (1.20)		4500N		50	EEM	02/08/17 15:12	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 02/06/17 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-02  
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	02/07/17 22:33	10	10	CB70703
Manganese	5.12 (0.020)		200.7		1	KJK	02/07/17 22:33	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 02/06/17 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-02  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.259 (0.050)		200.7		1	KJK	02/07/17 20:39	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 02/06/17 14:20  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-02  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 18:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	1.84 (0.250)		8270D SIM		1	02/08/17 2:16	C7B0106	CB70742
		<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>				
<i>Surrogate: 1,4-Dioxane-d8</i>		64 %		15-115				



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 02/06/17 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-02  
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	11.5 (1.00)		350.1		10	JLK	02/08/17 18:51	mg/L	CB70721
Chloride	97.7 (3.0)		9250		1	JLK	02/10/17 16:05	mg/L	CB71038
Dissolved Organic Carbon (Average)	7.20 (0.500)		5310B		1	DEL	02/07/17 19:51	mg/L	[CALC]
Nitrate as N	0.208 (0.030)		353.2		1	JLK	02/07/17 19:54	mg/L	[CALC]
Nitrite as N	0.014 (0.010)		353.2		1	JLK	02/07/17 17:02	mg/L	CB70728
Sulfate	52.5 (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	13.7 (1.00)		351.2		5	EEM	02/08/17 16:38	mg/L	CB70707
Total Nitrogen	13.9 (1.02)		4500N		5	EEM	02/08/17 16:38	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134) DUP  
Date Sampled: 02/06/17 14:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-03  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.113 (0.100)		200.7		1	KJK	02/07/17 22:37	10	10	CB70703
Manganese	5.10 (0.020)		200.7		1	KJK	02/07/17 22:37	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134) DUP  
Date Sampled: 02/06/17 14:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-03  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.254 (0.050)		200.7		1	KJK	02/07/17 20:43	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134) DUP  
Date Sampled: 02/06/17 14:25  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-03  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 18:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	1.70 (0.250)		8270D SIM		1	02/08/17 2:52	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	67 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134) DUP  
Date Sampled: 02/06/17 14:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-03  
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	11.2 (1.00)		350.1		10	JLK	02/08/17 18:55	mg/L	CB70721
Chloride	99.2 (3.0)		9250		1	JLK	02/10/17 16:06	mg/L	CB71038
Dissolved Organic Carbon (Average)	8.61 (0.500)		5310B		1	DEL	02/07/17 20:03	mg/L	[CALC]
Nitrate as N	0.180 (0.030)		353.2		1	JLK	02/07/17 19:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:03	mg/L	CB70728
Sulfate	52.0 (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	14.7 (1.00)		351.2		5	EEM	02/08/17 16:39	mg/L	CB70707
Total Nitrogen	14.8 (1.02)		4500N		5	EEM	02/08/17 16:39	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5S (78-88)  
Date Sampled: 02/06/17 16:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-04  
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	0.101 (0.100)		200.7		1	KJK	02/07/17 22:41	10	10	CB70703
Manganese	0.112 (0.020)		200.7		1	KJK	02/07/17 22:41	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5S (78-88)  
Date Sampled: 02/06/17 16:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-04  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.108 (0.050)		200.7		1	KJK	02/07/17 20:47	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5S (78-88)  
Date Sampled: 02/06/17 16:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-04  
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	0.12 (0.10)		350.1		1	JLK	02/08/17 18:41	mg/L	CB70721
Chloride	63.5 (3.0)		9250		1	JLK	02/10/17 16:06	mg/L	CB71038
Nitrate as N	17.3 (1.01)		353.2		50	JLK	02/07/17 19:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:04	mg/L	CB70728
Sulfate	55.0 (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	2.19 (0.20)		351.2		1	EEM	02/08/17 15:15	mg/L	CB70707
Total Nitrogen	19.5 (1.20)		4500N		50	EEM	02/08/17 15:15	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5D (124-134)  
Date Sampled: 02/06/17 16:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-05  
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	0.622 (0.100)		200.7		1	KJK	02/07/17 22:58	10	10	CB70703
Manganese	0.524 (0.020)		200.7		1	KJK	02/07/17 22:58	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5D (124-134)  
Date Sampled: 02/06/17 16:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-05  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.056 (0.050)		200.7		1	KJK	02/07/17 21:04	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5D (124-134)  
Date Sampled: 02/06/17 16:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-05  
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	12.7 (1.00)		350.1		10	JLK	02/08/17 18:56	mg/L	CB70721
Chloride	66.1 (3.0)		9250		1	JLK	02/10/17 16:07	mg/L	CB71038
Nitrate as N	0.046 (0.030)		353.2		1	JLK	02/07/17 20:02	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:06	mg/L	CB70728
Sulfate	24.0 (5.0)		9038		1	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	13.9 (1.00)		351.2		5	EEM	02/08/17 16:40	mg/L	CB70707
Total Nitrogen	13.9 (1.02)		4500N		5	EEM	02/08/17 16:40	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 02/06/17 12:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-06  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.147 (0.100)		200.7		1	KJK	02/07/17 23:02	10	10	CB70703
Manganese	0.053 (0.020)		200.7		1	KJK	02/07/17 23:02	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 02/06/17 12:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-06  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.100 (0.050)		200.7		1	KJK	02/07/17 21:08	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
 Client Project ID: Orleans MA  
 Client Sample ID: MW-6A (64-74)  
 Date Sampled: 02/06/17 12:15  
 Percent Solids: N/A  
 Initial Volume: 500  
 Final Volume: 0.5  
 Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
 ESS Laboratory Sample ID: 1702113-06  
 Sample Matrix: Ground Water  
 Units: ug/L  
 Analyst: VSC  
 Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 3:28	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	65 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 02/06/17 12:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-06  
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	02/08/17 18:44	mg/L	CB70721
Chloride	280 (15.0)		9250		5	JLK	02/10/17 16:17	mg/L	CB71038
Dissolved Organic Carbon (Average)	8.07 (0.500)		5310B		1	DEL	02/07/17 20:16	mg/L	[CALC]
Nitrate as N	7.20 (0.210)		353.2		10	JLK	02/07/17 20:03	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:07	mg/L	CB70728
Sulfate	34.4 (10.0)		9038		2	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	1.70 (0.20)		351.2		1	EEM	02/08/17 15:17	mg/L	CB70707
Total Nitrogen	8.90 (0.40)		4500N		10	EEM	02/08/17 15:17	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 02/06/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-07  
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	0.158 (0.100)		200.7		1	KJK	02/07/17 23:06	10	10	CB70703
Manganese	0.038 (0.020)		200.7		1	KJK	02/07/17 23:06	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 02/06/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-07  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.109 (0.050)		200.7		1	KJK	02/07/17 21:12	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 02/06/17 11:40  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-07  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 18:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 4:05	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	67 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 02/06/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-07  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.11 (0.10)		350.1		1	EEM	02/15/17 15:31	mg/L	CB71417
Chloride	151 (6.0)		9250		2	JLK	02/10/17 16:18	mg/L	CB71038
Dissolved Organic Carbon (Average)	6.68 (0.500)		5310B		1	DEL	02/07/17 20:53	mg/L	[CALC]
Nitrate as N	16.3 (1.01)		353.2		50	JLK	02/07/17 20:04	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:08	mg/L	CB70728
Sulfate	41.5 (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	1.50 (0.20)		351.2		1	EEM	02/08/17 15:17	mg/L	CB70707
Total Nitrogen	17.8 (1.20)		4500N		50	EEM	02/08/17 15:17	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6 (88-98)  
Date Sampled: 02/06/17 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-08  
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	18.4 (0.100)		200.7		1	KJK	02/07/17 23:10	10	10	CB70703
Manganese	2.49 (0.020)		200.7		1	KJK	02/07/17 23:10	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6 (88-98)  
Date Sampled: 02/06/17 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-08  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.241 (0.050)		200.7		1	KJK	02/07/17 21:16	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6 (88-98)  
Date Sampled: 02/06/17 11:10  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-08  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 18:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	0.687 (0.250)		8270D SIM		1	02/08/17 4:40	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	35 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6 (88-98)  
Date Sampled: 02/06/17 11:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-08  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.12 (0.10)		350.1		1	JLK	02/08/17 18:45	mg/L	CB70721
Chloride	173 (6.0)		9250		2	JLK	02/10/17 16:18	mg/L	CB71038
Dissolved Organic Carbon (Average)	8.75 (0.500)		5310B		1	DEL	02/07/17 21:05	mg/L	[CALC]
Nitrate as N	0.051 (0.030)		353.2		1	JLK	02/07/17 20:05	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:09	mg/L	CB70728
Sulfate	22.5 (5.0)		9038		1	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	24.1 (2.00)		351.2		10	EEM	02/08/17 16:41	mg/L	CB70707
Total Nitrogen	24.2 (2.02)		4500N		10	EEM	02/08/17 16:41	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 02/06/17 10:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-09  
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	0.342 (0.100)		200.7		1	KJK	02/07/17 23:14	10	10	CB70703
Manganese	0.024 (0.020)		200.7		1	KJK	02/07/17 23:14	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 02/06/17 10:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-09  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.078 (0.050)		200.7		1	KJK	02/07/17 21:20	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 02/06/17 10:10  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-09  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 19:00

All methods used are in accordance with 40 CFR 136.

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 5:16	C7B0106	CB70742
		<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>				
<i>Surrogate: 1,4-Dioxane-d8</i>		56 %		15-115				



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 02/06/17 10:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-09  
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	0.34 (0.10)		350.1		1	JLK	02/08/17 18:46	mg/L	CB70721
Chloride	127 (6.0)		9250		2	JLK	02/10/17 16:19	mg/L	CB71038
Dissolved Organic Carbon (Average)	16.0 (0.500)		5310B		1	DEL	02/07/17 21:18	mg/L	[CALC]
Nitrate as N	8.68 (0.210)		353.2		10	JLK	02/07/17 19:46	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:10	mg/L	CB70728
Sulfate	29.6 (5.0)		9038		1	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	1.92 (0.20)		351.2		1	EEM	02/08/17 15:25	mg/L	CB70707
Total Nitrogen	10.6 (0.40)		4500N		10	EEM	02/08/17 15:25	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 02/06/17 09:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-10  
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	18.3 (0.100)		200.7		1	KJK	02/07/17 23:19	10	10	CB70703
Manganese	3.21 (0.020)		200.7		1	KJK	02/07/17 23:19	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 02/06/17 09:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-10  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.138 (0.050)		200.7		1	KJK	02/07/17 21:24	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 02/06/17 09:40  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-10  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 19:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	1.70 (0.250)		8270D SIM		1	02/08/17 5:52	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	43 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 02/06/17 09:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-10  
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	2.74 (0.10)		350.1		1	JLK	02/08/17 18:47	mg/L	CB70721
Chloride	55.3 (3.0)		9250		1	JLK	02/10/17 16:11	mg/L	CB71038
Dissolved Organic Carbon (Average)	5.83 (0.500)		5310B		1	DEL	02/07/17 21:30	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	02/07/17 19:47	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:13	mg/L	CB70728
Sulfate	36.2 (10.0)		9038		2	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	3.17 (0.20)		351.2		1	EEM	02/08/17 15:26	mg/L	CB70707
Total Nitrogen	3.17 (0.22)		4500N		1	EEM	02/08/17 15:26	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 02/06/17 10:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-11  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.107 (0.100)		200.7		1	KJK	02/07/17 23:23	10	10	CB70703
Manganese	5.46 (0.020)		200.7		1	KJK	02/07/17 23:23	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 02/06/17 10:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-11  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.281 (0.050)		200.7		1	KJK	02/07/17 21:29	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 02/06/17 10:15  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-11  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 19:00

All methods used are in accordance with 40 CFR 136.

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	2.05 (0.250)		8270D SIM		1	02/08/17 6:27	C7B0106	CB70742

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	49 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 02/06/17 10:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-11  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	11.9 (1.00)		350.1		10	JLK	02/08/17 18:57	mg/L	CB70721
Chloride	49.0 (3.0)		9250		1	JLK	02/10/17 16:12	mg/L	CB71038
Dissolved Organic Carbon (Average)	6.95 (0.500)		5310B		1	DEL	02/07/17 21:43	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	02/07/17 19:48	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:14	mg/L	CB70728
Sulfate	62.0 (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	12.8 (1.00)		351.2		5	EEM	02/08/17 16:42	mg/L	CB70707
Total Nitrogen	12.8 (1.02)		4500N		5	EEM	02/08/17 16:42	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65) DUP  
Date Sampled: 02/06/17 13:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-12  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.271 (0.100)		200.7		1	KJK	02/07/17 23:27	10	10	CB70703
Manganese	0.024 (0.020)		200.7		1	KJK	02/07/17 23:27	10	10	CB70703



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65) DUP  
Date Sampled: 02/06/17 13:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-12  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.084 (0.050)		200.7		1	KJK	02/07/17 21:33	50	25	CB70701



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65) DUP  
Date Sampled: 02/06/17 13:45  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-12  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/7/17 19:00

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 7:03	C7B0106	CB70742
		<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>				
<i>Surrogate: 1,4-Dioxane-d8</i>		<i>48 %</i>		<i>15-115</i>				



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65) DUP  
Date Sampled: 02/06/17 13:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1702113  
ESS Laboratory Sample ID: 1702113-12  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.13 (0.10)		350.1		1	JLK	02/08/17 18:49	mg/L	CB70721
Chloride	124 (6.0)		9250		2	JLK	02/10/17 16:19	mg/L	CB71038
Dissolved Organic Carbon (Average)	14.1 (0.500)		5310B		1	DEL	02/08/17 17:11	mg/L	[CALC]
Nitrate as N	12.8 (1.01)		353.2		50	JLK	02/07/17 20:12	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:15	mg/L	CB70728
Sulfate	33.6 (10.0)		9038		2	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	2.38 (0.20)		351.2		1	EEM	02/08/17 15:27	mg/L	CB70707
Total Nitrogen	15.2 (1.20)		4500N		50	EEM	02/08/17 15:27	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1702113

**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 CB70703 - 200.7/6010BNoDigest**

**Blank**

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

**LCS**

Iron	2.44		mg/L	2.500		98	80-120			
Manganese	0.490		mg/L	0.5000		98	80-120			

Total Metals

**Batch CB70701 - 3005A**

**Blank**

Boron	ND	0.050	mg/L							
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**LCS**

Boron	0.241	0.050	mg/L	0.2500		96	85-115			
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8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

**Batch CB70742 - 3535A**

**Blank**

1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	3.71		ug/L	5.000		74	15-115			

**LCS**

1,4-Dioxane	10.8	0.250	ug/L	10.00		108	40-140			
Surrogate: 1,4-Dioxane-d8	3.37		ug/L	5.000		67	15-115			

**LCS Dup**

1,4-Dioxane	10.5	0.250	ug/L	10.00		105	40-140	3	20	
Surrogate: 1,4-Dioxane-d8	3.39		ug/L	5.000		68	15-115			

Classical Chemistry

**Batch CB70707 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	18.9	2.00	mg/L	18.80		101	80-120			
Total Kjeldahl Nitrogen as N	18.9	2.00	mg/L	18.80		101	80-120			
Total Nitrogen	18.9	2.00	mg/L							

**Batch CB70718 - General Preparation**

**Blank**

Sulfate	ND	5.0	mg/L							
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**LCS**

Sulfate	9.6		mg/L	9.988		96	85-115			
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CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1702113

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CB70721 - NH4 Prep</b>										
<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.10	0.10	mg/L	0.09994		100	80-120			
<b>LCS</b>										
Ammonia as N	1.04	0.10	mg/L	0.9994		104	80-120			
<b>Batch CB70728 - [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	0.248		mg/L	0.2497		100	90-110			
Nitrite as N	0.248		mg/L	0.2497		100	90-110			
<b>Batch CB70729 - [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	0.02	mg/L							
<b>LCS</b>										
Nitrate as N	0.462		mg/L							
Nitrate/Nitrite as N	0.462		mg/L	0.5000		92	90-110			
Nitrate/Nitrite as N	0.462		mg/L	0.5000		92	90-110			
Total Nitrogen	0.462		mg/L							
<b>Batch CB70741 - 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	0.500	mg/L							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.47	0.500	mg/L	5.000		89	80-120			
Dissolved Organic Carbon (2)	4.55	0.500	mg/L	5.000		91	80-120			
Dissolved Organic Carbon (Average)	4.51	0.500	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.55	0.500	mg/L	5.000		91	80-120	2	200	
Dissolved Organic Carbon (2)	4.60	0.500	mg/L	5.000		92	80-120	1	200	
Dissolved Organic Carbon (Average)	4.57	0.500	mg/L							
<b>Batch CB71038 - General Preparation</b>										
<b>Blank</b>										
Chloride	ND	3.0	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702113

**Quality Control Data**

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

**Batch CB71038 - General Preparation**

**LCS**

Chloride	30.4		mg/L	30.00		101	90-110			
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**Batch CB71417 - General Preparation**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.09	0.10	mg/L	0.09994		91	80-120			
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**LCS**

Ammonia as N	0.95	0.10	mg/L	0.9994		95	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702113

**Notes and Definitions**

- U Analyte included in the analysis, but not detected
- DDT DDT breakdown > 20%
- 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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702113

**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 - KPB/MM

ESS Project ID: 1702113

Date Received: 2/6/2017

Shipped/Delivered Via: ESS Courier

Project Due Date: 2/13/2017

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: 4.1 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	102849	Yes	No	Yes	VOA Vial - HCl	HCl	
01	102850	Yes	No	Yes	VOA Vial - HCl	HCl	
01	102877	Yes	NA	Yes	1L Amber - Unpres	NP	
01	102878	Yes	NA	Yes	1L Amber - Unpres	NP	
01	102888	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
01	102898	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	102908	Yes	NA	Yes	500 mL Poly - Unpres	NP	
01	102918	Yes	NA	Yes	250 mL Amber - Unpres	NP	
01	102928	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	102847	Yes	No	Yes	VOA Vial - HCl	HCl	
02	102848	Yes	No	Yes	VOA Vial - HCl	HCl	
02	102875	Yes	NA	Yes	1L Amber - Unpres	NP	
02	102876	Yes	NA	Yes	1L Amber - Unpres	NP	
02	102887	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
02	102897	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	102907	Yes	NA	Yes	500 mL Poly - Unpres	NP	
02	102917	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	102927	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	102845	Yes	No	Yes	VOA Vial - HCl	HCl	
03	102846	Yes	No	Yes	VOA Vial - HCl	HCl	
03	102873	Yes	NA	Yes	1L Amber - Unpres	NP	
03	102874	Yes	NA	Yes	1L Amber - Unpres	NP	
03	102886	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
03	102896	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1702113

Date Received: 2/6/2017

03	102906	Yes	NA	Yes	500 mL Poly - Unpres	NP
03	102916	Yes	NA	Yes	250 mL Amber - Unpres	NP
03	102926	Yes	NA	Yes	250 mL Poly - Unpres	NP
04	102852	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
04	102854	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
04	102856	Yes	NA	Yes	500 mL Poly - Unpres	NP
04	102858	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	102851	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
05	102853	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
05	102855	Yes	NA	Yes	500 mL Poly - Unpres	NP
05	102857	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	102843	Yes	No	Yes	VOA Vial - HCl	HCl
06	102844	Yes	No	Yes	VOA Vial - HCl	HCl
06	102871	Yes	NA	Yes	1L Amber - Unpres	NP
06	102872	Yes	NA	Yes	1L Amber - Unpres	NP
06	102885	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
06	102895	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
06	102905	Yes	NA	Yes	500 mL Poly - Unpres	NP
06	102915	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	102925	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	102841	Yes	No	Yes	VOA Vial - HCl	HCl
07	102842	Yes	No	Yes	VOA Vial - HCl	HCl
07	102869	Yes	NA	Yes	1L Amber - Unpres	NP
07	102870	Yes	NA	Yes	1L Amber - Unpres	NP
07	102884	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
07	102894	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
07	102904	Yes	NA	Yes	500 mL Poly - Unpres	NP
07	102914	Yes	NA	Yes	250 mL Amber - Unpres	NP
07	102924	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	102839	Yes	No	Yes	VOA Vial - HCl	HCl
08	102840	Yes	No	Yes	VOA Vial - HCl	HCl
08	102867	Yes	NA	Yes	1L Amber - Unpres	NP
08	102868	Yes	NA	Yes	1L Amber - Unpres	NP
08	102883	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
08	102893	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
08	102903	Yes	NA	Yes	500 mL Poly - Unpres	NP
08	102913	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	102923	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	102837	Yes	No	Yes	VOA Vial - HCl	HCl
09	102838	Yes	No	Yes	VOA Vial - HCl	HCl
09	102865	Yes	NA	Yes	1L Amber - Unpres	NP
09	102866	Yes	NA	Yes	1L Amber - Unpres	NP
09	102882	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
09	102892	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
09	102902	Yes	NA	Yes	500 mL Poly - Unpres	NP
09	102912	Yes	NA	Yes	250 mL Amber - Unpres	NP
09	102922	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	102835	Yes	No	Yes	VOA Vial - HCl	HCl
10	102836	Yes	No	Yes	VOA Vial - HCl	HCl
10	102863	Yes	NA	Yes	1L Amber - Unpres	NP
10	102864	Yes	NA	Yes	1L Amber - Unpres	NP
10	102881	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
10	102891	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
10	102901	Yes	NA	Yes	500 mL Poly - Unpres	NP
10	102911	Yes	NA	Yes	250 mL Amber - Unpres	NP
10	102921	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	102833	Yes	No	Yes	VOA Vial - HCl	HCl
11	102834	Yes	No	Yes	VOA Vial - HCl	HCl
11	102861	Yes	NA	Yes	1L Amber - Unpres	NP
11	102862	Yes	NA	Yes	1L Amber - Unpres	NP
11	102880	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
11	102890	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
11	102900	Yes	NA	Yes	500 mL Poly - Unpres	NP
11	102910	Yes	NA	Yes	250 mL Amber - Unpres	NP
11	102920	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	102831	Yes	No	Yes	VOA Vial - HCl	HCl
12	102832	Yes	No	Yes	VOA Vial - HCl	HCl
12	102859	Yes	NA	Yes	1L Amber - Unpres	NP
12	102860	Yes	NA	Yes	1L Amber - Unpres	NP
12	102879	Yes	NA	Yes	250 mL Poly - HNO3	HNO3

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1702113

Date Received: 2/6/2017

12	102889	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
12	102899	Yes	NA	Yes	500 mL Poly - Unpres	NP
12	102909	Yes	NA	Yes	250 mL Amber - Unpres	NP
12	102919	Yes	NA	Yes	250 mL Poly - Unpres	NP

**2nd Review**

Are barcode labels on correct containers?

Yes/ No

Completed

By: [Signature]

Date & Time: 2/6/17 2029

Reviewed

By: [Signature]

Date & Time: 2/6/17 2040

Delivered

By: [Signature]

Date & Time: 2/6/17 2040

# ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211

Tel. (401) 461-7181 Fax (401) 461-4486

www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time Standard Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)

MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

ESS Lab # **1702113**

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

Co. Name **AECOM** Project # \_\_\_\_\_ Project Name **ONEBUS LANDFILL**

Contact Person **JULIANNE MARRON** Address **250 APOLLON** PO # \_\_\_\_\_

City **Chelmsford** State **MA** Zip \_\_\_\_\_

Tel. **781-561-5558** Fax \_\_\_\_\_ email: \_\_\_\_\_

ESS Lab ID	Date	Collection Time	Grab-G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis
1	02/06/17	<del>1455</del> 1455	G	GW	MW-2S(84-94)		7			NH <sub>4</sub> N NO <sub>2</sub> -NO <sub>3</sub> -SO <sub>4</sub> -CL DISS F METALS LH DISS F DOC Boron
2	02/06/17	<del>1420</del> 1420	G	GW	MW-2D(124-134)		7			X X X X X X X
3	02/06/17	<del>1425</del> 1425	G	GW	MW-2DU(124-134) DUP		7			X X X X X X X
4	02/06/17	1015	G	GW	MW-5S(78-88)		4			X X X X
5	02/06/17	1030	G	GW	MW-5D(124-134)		4			X X X X
6	02/06/17	1215	G	GW	MW-6A(64-74)		7			X X X X X X X
7	02/06/17	1140	G	GW	MW-UB(54-64)		7			X X X X X X X
8	02/06/17	1110	G	GW	MW-6(88-98)		7			X X X X X X X
9	02/06/17	1010	G	GW	MW-7S(55-65)		7			X X X X X X X
10	02/06/17	0940	G	GW	MW-7D(115-125)		7			X X X X X X X

Container Type: P-Poly G-Glass AG-Amber Glass & Sterile V-VOA Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present  Yes  No Internal Use Only  Pickup  Technician

Seals Intact  Yes  No NA: \_\_\_\_\_

Cooler Temperature: Ice cube 9:50

Comments: \_\_\_\_\_

Relinquished by: (Signature, Date & Time) Julianne Marron 2/6/17 14:12

Relinquished by: (Signature, Date & Time) [Signature] 2/6/17 14:50

Received by: (Signature, Date & Time) [Signature] 2/6/17 14:57

Received by: (Signature, Date & Time) \_\_\_\_\_

Received by: (Signature, Date & Time) \_\_\_\_\_

Received by: (Signature, Date & Time) \_\_\_\_\_

Received by: (Signature, Date & Time) \_\_\_\_\_

1 (White) Lab Copy  
2 (Yellow) Client Receipt

Please fax to the laboratory all changes to Chain of Custody

\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

**ESS Laboratory**

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 www.esslaboratory.com

**CHAIN OF CUSTODY**

ESS Lab # 1702113

Turn Time \_\_\_\_\_ Standard \_\_\_\_\_ Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CTDEP Other \_\_\_\_\_

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

Co. Name AECOM  
 Contact Person JULIANNE MANN  
 City Chelseaford State MA  
 Tel. 781-561-5550 Fax \_\_\_\_\_  
 Project Name \_\_\_\_\_  
 Address 250 Apollo Dr PO # \_\_\_\_\_  
 Zip \_\_\_\_\_ email: \_\_\_\_\_

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis
11	01/01/17	1015	G	GW	MW-26140-190		7			X NH <sub>4</sub> N X NO <sub>2</sub> -N X NO <sub>3</sub> -S X DISINFECTANTS X LHM DEXANE X DOC X BOREN
12	01/01/17	1345	G	GW	MW-75155-650P		7			X NH <sub>4</sub> N X NO <sub>2</sub> -N X NO <sub>3</sub> -S X DISINFECTANTS X LHM DEXANE X DOC X BOREN
<del>_____</del>										

Container Type: P-Poly G-Class AG-Amber Glass S-Sterile V-VOA  
 Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filler  
 Cooler Present Yes \_\_\_\_\_ No \_\_\_\_\_  
 Cooler Intact Yes \_\_\_\_\_ No NA: \_\_\_\_\_  
 Cooler Temperature: Ice 1.50 2/17/17  
 Internal Use Only  Pickup  Technician \_\_\_\_\_  
 Sampled by: \_\_\_\_\_  
 Comments: \_\_\_\_\_

Received by: (Signature, Date & Time) [Signature] 2/17/17 1557  
 Reinquished by: (Signature, Date & Time) \_\_\_\_\_  
 Received by: (Signature, Date & Time) [Signature] 2/17/17 1557  
 Reinquished by: (Signature, Date & Time) \_\_\_\_\_

Please fax to the laboratory for changes to Chain of Custody

1 (White) Lab Copy  
 2 (Yellow) Client Receipt

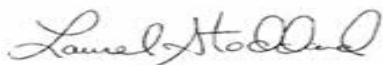
\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1702186**

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



Laurel Stoddard  
Laboratory Director

**REVIEWED**

By ESS Laboratory at 3:43 pm, Feb 16, 2017

**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: 1702186

**SAMPLE RECEIPT**

The following samples were received on February 08, 2017 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>
1702186-01	Stormwater 1	Surface Water	350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702186-02	Stormwater 2	Surface Water	350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702186

**PROJECT NARRATIVE**

**No unusual observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

[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: 1702186

**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: Stormwater 1  
Date Sampled: 02/08/17 11:00  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702186  
ESS Laboratory Sample ID: 1702186-01  
Sample Matrix: Surface Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/13/17 18:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 0:24	C7B0188	CB71341

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	58 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: Stormwater 1  
Date Sampled: 02/08/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1702186  
ESS Laboratory Sample ID: 1702186-01  
Sample Matrix: Surface 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	0.67 (0.10)		350.1		1	JLK	02/13/17 17:27	mg/L	CB71005
Chloride	455 (30.0)		9250		10	JLK	02/10/17 16:20	mg/L	CB71038
Dissolved Organic Carbon (Average)	39.6 (5.00)		5310B		10	DEL	02/10/17 18:13	mg/L	[CALC]
Nitrate as N	0.424 (0.030)		353.2		1	JLK	02/08/17 22:35	mg/L	[CALC]
Nitrite as N	0.026 (0.010)		353.2		1	JLK	02/08/17 20:43	mg/L	CB70837
Sulfate	ND (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	4.05 (0.20)		351.2		1	EEM	02/14/17 16:26	mg/L	CB71332
Total Nitrogen	4.50 (0.22)		4500N		1	EEM	02/14/17 16:26	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: Stormwater 2  
Date Sampled: 02/08/17 10:45  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702186  
ESS Laboratory Sample ID: 1702186-02  
Sample Matrix: Surface Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/13/17 18:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 0:58	C7B0188	CB71341

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	59 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: Stormwater 2  
Date Sampled: 02/08/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1702186  
ESS Laboratory Sample ID: 1702186-02  
Sample Matrix: Surface 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	2.92 (0.10)		350.1		1	JLK	02/13/17 17:43	mg/L	CB71005
Chloride	188 (15.0)		9250		5	JLK	02/10/17 16:21	mg/L	CB71038
Dissolved Organic Carbon (Average)	175 (5.00)		5310B		10	DEL	02/10/17 18:51	mg/L	[CALC]
Nitrate as N	10.5 (1.01)		353.2		50	JLK	02/08/17 23:05	mg/L	[CALC]
Nitrite as N	0.150 (0.010)		353.2		1	JLK	02/08/17 20:44	mg/L	CB70837
Sulfate	5.9 (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	16.4 (2.00)		351.2		10	EEM	02/14/17 16:57	mg/L	CB71332
Total Nitrogen	27.1 (3.00)		4500N		50	EEM	02/14/17 16:57	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1702186

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

**Batch CB71341 - 3535A**

**Blank**

1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	3.11		ug/L	5.000		62	15-115			

**LCS**

1,4-Dioxane	10.9	0.250	ug/L	10.00		109	40-140			
Surrogate: 1,4-Dioxane-d8	3.41		ug/L	5.000		68	15-115			

**LCS Dup**

1,4-Dioxane	10.7	0.250	ug/L	10.00		107	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	3.46		ug/L	5.000		69	15-115			

Classical Chemistry

**Batch CB70837 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.247		mg/L	0.2497		99	90-110			
Nitrite as N	0.247		mg/L	0.2497		99	90-110			

**Batch CB70838 - [CALC]**

**Blank**

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	0.02	mg/L							

**LCS**

Nitrate as N	0.483		mg/L							
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Total Nitrogen	0.483		mg/L							

**Batch CB71005 - General Preparation**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		103	80-120			
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**LCS**

Ammonia as N	1.10	0.10	mg/L	0.9994		110	80-120			
--------------	------	------	------	--------	--	-----	--------	--	--	--

**Batch CB71037 - General Preparation**

**Blank**

Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702186

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CB71037 - [CALC]</b>										
Dissolved Organic Carbon (Average)	ND	0.500	mg/L							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.70	0.500	mg/L	5.000		94	80-120			
Dissolved Organic Carbon (2)	4.86	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (Average)	4.78	0.500	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	2	200	
Dissolved Organic Carbon (2)	4.84	0.500	mg/L	5.000		97	80-120	0.3	200	
Dissolved Organic Carbon (Average)	4.82	0.500	mg/L							
<b>Batch CB71038 - General Preparation</b>										
<b>Blank</b>										
Chloride	ND	3.0	mg/L							
<b>LCS</b>										
Chloride	30.4		mg/L	30.00		101	90-110			
<b>Batch CB71323 - 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 CB71332 - TKN Prep</b>										
<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
<b>LCS</b>										
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.8	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702186

**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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702186

**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 - KPB/MM

ESS Project ID: 1702186

Date Received: 2/8/2017

Shipped/Delivered Via: ESS Courier

Project Due Date: 2/15/2017

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>3.1</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? Yes / <input checked="" type="checkbox"/> No               |

- |  |   |
|--|---|
| 11. Any Subcontracting needed? Yes / <input checked="" type="checkbox"/> No          | 12. Were VOAs received? <input checked="" type="checkbox"/> Yes / No                      |
| ESS Sample IDs: _____  | a. Air bubbles in aqueous VOAs? Yes / <input checked="" type="checkbox"/> 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:

500 ml poly unpres. for sample 1 was acid with lid from 500ml poly H2SO4 - raised sample pH to 3.  
Rec'd 2 bottles for dissolved lab filtered metals for sample 2 not on COC. RL z/s/h  
No collection dates on COC.

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	103564	Yes	No	Yes	VOA Vial - HCl	HCl	
01	103565	Yes	No	Yes	VOA Vial - HCl	HCl	
01	103568	Yes	NA	Yes	1L Amber - Unpres	NP	
01	103569	Yes	NA	Yes	1L Amber - Unpres	NP	
01	103571	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	103573	Yes	NA	Yes	500 mL Poly - Unpres	NP	
01	103575	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	103562	Yes	No	Yes	VOA Vial - HCl	HCl	
02	103563	Yes	No	Yes	VOA Vial - HCl	HCl	
02	103566	Yes	NA	Yes	1L Amber - Unpres	NP	
02	103567	Yes	NA	Yes	1L Amber - Unpres	NP	
02	103570	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	103572	Yes	NA	Yes	500 mL Poly - Unpres	NP	
02	103574	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	103576	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	103623	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review  
 Are barcode labels on correct containers?  Yes / No

Completed By: RHT Date & Time: 2/8/17 1822

Reviewed

# ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KP/BB ESS Project ID: 1702186  
By: [Signature] Date Received: 2/8/2017  
Delivered Date & Time: 2/8/17 1830  
By: [Signature] 2/8/17 1830

# ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time  Standard Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)

MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Project # 60476644 Project Name Oceansland Fill Phase 1

Address 250 Apollo Dr

City Chelsea State MA Zip 01824 PO # 17915

Contact Person Julianne Mamon email: Julianne.Mamon@acem.com

Tel. 978-905-2419

ESS Lab ID \_\_\_\_\_

Collection Time \_\_\_\_\_

Date \_\_\_\_\_

Grab-G Composite-C \_\_\_\_\_

Matrix \_\_\_\_\_

Sample ID \_\_\_\_\_

Pres Code \_\_\_\_\_

# of Containers \_\_\_\_\_

Type of Container \_\_\_\_\_

Vol of Container \_\_\_\_\_

Analysis \_\_\_\_\_

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ESS Lab # 1702186

Reporting Limits - MCL

Electronic Deliverables  Excel  Access  PDF

Analysis

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Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix: S-Soil SP-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filler

Cooler Present  Yes  No Internal Use Only

Seals Intact  Yes  No NA:

Cooler Temperature: 2.8 <sup>3.1</sup> 2.6 ice RB

Sampled by: J. B. S. J. C. H. J.

Comments: SN = STORMWATER

Relinquished by: (Signature, Date & Time)

Relinquished by: (Signature, Date & Time)

Relinquished by: (Signature, Date & Time)

Relinquished by: (Signature, Date & Time)

1 (White) Lab Copy  
 2 (Yellow) Client Receipt

# ESS Laboratory

Division of Thielsch Engineering, Inc.

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 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time  Standard  Other \_\_\_\_\_  
 Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_  
 Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

ESS Lab # 1702186

Reporting Limits - MCL

Electronic Deliverables  Excel  Access  PDF

Co. Name AECOM  
 Project # 60476644  
 Project Name Oceanslandfill phase 1  
 Contact Person JULIANNE MAMON  
 Address 250 Apollo Dr  
 State MA  
 Zip 01824  
 PO # 17915  
 email: julianne.mamon@aecom.com

ESS Lab ID	Date	Collection Time	Grab - G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container
1	02/17/17	11:00	G	SW	STORMWATER 1		5		
2	02/17/17	10:45	G	SW	STORMWATER 2		5		
<del>3</del>	<del>02/17/17</del>	<del></del>	<del>G</del>	<del>SW</del>	<del>STORMWATER 3</del>		<del>5</del>		
<del>4</del>	<del>02/17/17</del>	<del></del>	<del>G</del>	<del>SW</del>	<del>STORMWATER 4</del>		<del>5</del>		
<del>5</del>	<del>02/17/17</del>	<del></del>	<del>G</del>	<del>SW</del>	<del>STORMWATER 5</del>		<del>5</del>		

Analysis  
 NH<sub>4</sub><sup>+</sup> TN  
 NO<sub>2</sub> NO<sub>3</sub> SO<sub>4</sub> CL<sup>-</sup> TN  
 1,4-DIOXANE  
 hpc

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix: S-Soil SP-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filler

Cooler Present  Yes  No  
 Seals Intact  Yes  No NA: \_\_\_\_\_  
 Cooler Temperature: 2.8 <sup>3.1</sup> 2.6 ice RB  
 Internal Use Only  
 Pickup  
 Technician

Sampled by: J. Begley, C. H. Lee  
 Comments: SN = STORMWATER

Relinquished by: (Signature, Date & Time) <u>Chayden 2/17/17</u>	Relinquished by: (Signature, Date & Time) <u>Julia 2/18/17</u>	Relinquished by: (Signature, Date & Time) <u>Julia 2/18/17 17:50</u>	Relinquished by: (Signature, Date & Time) <u>Julia 2/18/17</u>
Received by: (Signature, Date & Time) <u>2/17/17</u>	Received by: (Signature, Date & Time) <u>2/18/17</u>	Received by: (Signature, Date & Time) <u>2/18/17</u>	Received by: (Signature, Date & Time) <u>2/18/17</u>

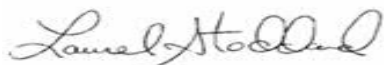
1 (White) Lab Copy  
 2 (Yellow) Client Receipt  
 Please fax to the laboratory all changes to Chain of Custody

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1702187**

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



Laurel Stoddard  
Laboratory Director

**REVIEWED**

By ESS Laboratory at 3:22 pm, Feb 21, 2017

**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: 1702187

**SAMPLE RECEIPT**

The following samples were received on February 08, 2017 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>
1702187-01	MW-1S (56-66)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 8270D SIM, 9038, 9250
1702187-02	MW-1D (99-109)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 8270D SIM, 9038, 9250
1702187-03	MW-3S (50-60)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702187-04	MW-3D (84-94)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702187-05	MW-8 (36-46)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702187-06	MW-9 (92-102)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702187-07	MW-10 (85-95)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702187

**PROJECT NARRATIVE**

**No unusual observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

[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: 1702187

**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-1S (56-66)  
Date Sampled: 02/08/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-01  
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	02/17/17 14:41	10	10	CB71501
Manganese	<b>0.369</b> (0.020)		200.7		1	KJK	02/17/17 14:41	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-1S (56-66)  
Date Sampled: 02/08/17 11:40  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-01  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/13/17 18:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 1:33	C7B0188	CB71341

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	68 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-1S (56-66)  
Date Sampled: 02/08/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-01  
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	02/13/17 17:44	mg/L	CB71005
Chloride	13.2 (3.0)		9250		1	JLK	02/10/17 16:41	mg/L	CB71039
Nitrate as N	3.60 (0.110)		353.2		5	JLK	02/08/17 22:56	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:45	mg/L	CB70837
Sulfate	6.7 (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	1.24 (0.20)		351.2		1	EEM	02/14/17 16:33	mg/L	CB71332
Total Nitrogen	4.84 (0.30)		4500N		5	EEM	02/14/17 16:33	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-1D (99-109)  
Date Sampled: 02/08/17 12:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-02  
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	02/17/17 14:45	10	10	CB71501
Manganese	<b>0.083</b> (0.020)		200.7		1	KJK	02/17/17 14:45	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-1D (99-109)  
Date Sampled: 02/08/17 12:05  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-02  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/13/17 18:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 2:08	C7B0188	CB71341
		<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>				
<i>Surrogate: 1,4-Dioxane-d8</i>		57 %		15-115				



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-1D (99-109)  
Date Sampled: 02/08/17 12:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-02  
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	0.51 (0.10)		350.1		1	JLK	02/13/17 17:45	mg/L	CB71005
Chloride	32.5 (3.0)		9250		1	JLK	02/10/17 16:43	mg/L	CB71039
Nitrate as N	3.28 (0.110)		353.2		5	JLK	02/08/17 22:57	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:46	mg/L	CB70837
Sulfate	8.7 (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	1.21 (0.20)		351.2		1	EEM	02/14/17 16:34	mg/L	CB71332
Total Nitrogen	4.48 (0.30)		4500N		5	EEM	02/14/17 16:34	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3S (50-60)  
Date Sampled: 02/08/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-03  
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	02/17/17 14:50	10	10	CB71501
Manganese	<b>0.180</b> (0.020)		200.7		1	KJK	02/17/17 14:50	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3S (50-60)  
Date Sampled: 02/08/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-03  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	ND (0.050)		200.7		1	KJK	02/18/17 17:10	50	25	CB71337



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3S (50-60)  
Date Sampled: 02/08/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-03  
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	02/13/17 17:46	mg/L	CB71005
<b>Chloride</b>	<b>324</b> (30.0)		9250		10	JLK	02/10/17 16:43	mg/L	CB71039
<b>Nitrate as N</b>	<b>0.601</b> (0.030)		353.2		1	JLK	02/08/17 22:40	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:47	mg/L	CB70837
Sulfate	ND (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
<b>Total Kjeldahl Nitrogen as N</b>	<b>0.61</b> (0.20)		351.2		1	EEM	02/14/17 16:35	mg/L	CB71332
<b>Total Nitrogen</b>	<b>1.21</b> (0.22)		4500N		1	EEM	02/14/17 16:35	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3D (84-94)  
Date Sampled: 02/08/17 10:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-04  
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	34.6 (0.100)		200.7		1	KJK	02/17/17 14:54	10	10	CB71501
Manganese	2.66 (0.020)		200.7		1	KJK	02/17/17 14:54	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3D (84-94)  
Date Sampled: 02/08/17 10:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-04  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	ND (0.050)		200.7		1	KJK	02/18/17 17:26	50	25	CB71337



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3D (84-94)  
Date Sampled: 02/08/17 10:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-04  
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	4.63 (0.10)		350.1		1	JLK	02/13/17 17:47	mg/L	CB71005
Chloride	159 (15.0)		9250		5	JLK	02/10/17 16:44	mg/L	CB71039
Nitrate as N	ND (0.030)		353.2		1	JLK	02/08/17 22:41	mg/L	[CALC]
Nitrite as N	0.014 (0.010)		353.2		1	JLK	02/08/17 20:48	mg/L	CB70837
Sulfate	14.1 (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	5.75 (0.40)		351.2		2	EEM	02/14/17 16:58	mg/L	CB71332
Total Nitrogen	5.75 (0.42)		4500N		2	EEM	02/14/17 16:58	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-8 (36-46)  
Date Sampled: 02/08/17 15:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-05  
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	02/17/17 15:10	10	10	CB71501
Manganese	<b>0.095</b> (0.020)		200.7		1	KJK	02/17/17 15:10	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-8 (36-46)  
Date Sampled: 02/08/17 15:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-05  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	0.090 (0.050)		200.7		1	KJK	02/18/17 17:30	50	25	CB71337



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-8 (36-46)  
Date Sampled: 02/08/17 15:05  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-05  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/14/17 15:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 2:43	C7B0188	CB71341

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	54 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-8 (36-46)  
Date Sampled: 02/08/17 15:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-05  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	0.11 (0.10)		350.1		1	JLK	02/13/17 17:49	mg/L	CB71005
Chloride	55.1 (3.0)		9250		1	JLK	02/10/17 16:45	mg/L	CB71039
Dissolved Organic Carbon (Average)	4.42 (0.500)		5310B		1	DEL	02/10/17 19:03	mg/L	[CALC]
Nitrate as N	5.52 (0.210)		353.2		10	JLK	02/08/17 23:06	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:49	mg/L	CB70837
Sulfate	37.8 (10.0)		9038		2	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	2.03 (0.20)		351.2		1	EEM	02/14/17 16:36	mg/L	CB71332
Total Nitrogen	7.55 (0.40)		4500N		10	EEM	02/14/17 16:36	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-9 (92-102)  
Date Sampled: 02/08/17 13:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-06  
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	02/17/17 15:14	10	10	CB71501
Manganese	<b>0.491</b> (0.020)		200.7		1	KJK	02/17/17 15:14	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-9 (92-102)  
Date Sampled: 02/08/17 13:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-06  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	ND (0.050)		200.7		1	KJK	02/18/17 17:34	50	25	CB71337



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-9 (92-102)  
Date Sampled: 02/08/17 13:20  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-06  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/14/17 15:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 3:18	C7B0188	CB71341

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	48 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-9 (92-102)  
Date Sampled: 02/08/17 13:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-06  
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	0.34 (0.10)		350.1		1	JLK	02/13/17 17:50	mg/L	CB71005
Chloride	65.5 (3.0)		9250		1	JLK	02/10/17 16:45	mg/L	CB71039
Dissolved Organic Carbon (Average)	1.55 (0.500)		5310B		1	DEL	02/10/17 19:15	mg/L	[CALC]
Nitrate as N	20.2 (2.01)		353.2		100	JLK	02/08/17 23:09	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:51	mg/L	CB70837
Sulfate	15.5 (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	2.83 (0.20)		351.2		1	EEM	02/14/17 16:37	mg/L	CB71332
Total Nitrogen	23.0 (2.20)		4500N		100	EEM	02/14/17 16:37	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 02/08/17 14:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-07  
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	02/17/17 15:18	10	10	CB71501
Manganese	0.072 (0.020)		200.7		1	KJK	02/17/17 15:18	10	10	CB71501



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 02/08/17 14:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-07  
Sample Matrix: Ground Water  
Units: mg/L

Extraction Method: 3005A  
**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	ND (0.050)		200.7		1	KJK	02/18/17 17:39	50	25	CB71337



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 02/08/17 14:10  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-07  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 2/14/17 15:30

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 3:54	C7B0188	CB71341

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	62 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 02/08/17 14:10  
Percent Solids: N/A

ESS Laboratory Work Order: 1702187  
ESS Laboratory Sample ID: 1702187-07  
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	02/13/17 17:51	mg/L	CB71005
<b>Chloride</b>	<b>42.9</b> (3.0)		9250		1	JLK	02/10/17 16:47	mg/L	CB71039
Dissolved Organic Carbon (Average)	ND (0.500)		5310B		1	DEL	02/10/17 19:27	mg/L	[CALC]
<b>Nitrate as N</b>	<b>2.44</b> (0.110)		353.2		5	JLK	02/08/17 23:01	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:52	mg/L	CB70837
Sulfate	ND (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
<b>Total Kjeldahl Nitrogen as N</b>	<b>0.85</b> (0.20)		351.2		1	EEM	02/14/17 16:38	mg/L	CB71332
<b>Total Nitrogen</b>	<b>3.29</b> (0.30)		4500N		5	EEM	02/14/17 16:38	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1702187

**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 CB71501 - 200.7/6010BNoDigest**

<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
<b>LCS</b>										
Iron	2.33		mg/L	2.500		93	80-120			
Manganese	0.455		mg/L	0.5000		91	80-120			

Total Metals

**Batch CB71337 - 3005A**

<b>Blank</b>										
Boron	ND	0.050	mg/L							
<b>LCS</b>										
Boron	0.251	0.050	mg/L	0.2500		100	85-115			
<b>LCS Dup</b>										
Boron	0.259	0.050	mg/L	0.2500		103	85-115	3	20	

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

**Batch CB71341 - 3535A**

<b>Blank</b>										
1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	3.11		ug/L	5.000		62	15-115			
<b>LCS</b>										
1,4-Dioxane	10.9	0.250	ug/L	10.00		109	40-140			
Surrogate: 1,4-Dioxane-d8	3.41		ug/L	5.000		68	15-115			
<b>LCS Dup</b>										
1,4-Dioxane	10.7	0.250	ug/L	10.00		107	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	3.46		ug/L	5.000		69	15-115			

Classical Chemistry

**Batch CB70837 - [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	0.247		mg/L	0.2497		99	90-110			
Nitrite as N	0.247		mg/L	0.2497		99	90-110			

**Batch CB70838 - [CALC]**

<b>Blank</b>										
Nitrate as N	ND	0.020	mg/L							



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1702187

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CB70838 - General Preparation</b>										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
<b>LCS</b>										
Nitrate as N	0.483		mg/L							
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Total Nitrogen	0.483		mg/L							
<b>Batch CB71005 - General Preparation</b>										
<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.10	0.10	mg/L	0.09994		103	80-120			
<b>LCS</b>										
Ammonia as N	1.10	0.10	mg/L	0.9994		110	80-120			
<b>Batch CB71037 - 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	0.500	mg/L							
<b>LCS</b>										
Dissolved Organic Carbon (1)	4.70	0.500	mg/L	5.000		94	80-120			
Dissolved Organic Carbon (2)	4.86	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (Average)	4.78	0.500	mg/L							
<b>LCS Dup</b>										
Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	2	200	
Dissolved Organic Carbon (2)	4.84	0.500	mg/L	5.000		97	80-120	0.3	200	
Dissolved Organic Carbon (Average)	4.82	0.500	mg/L							
<b>Batch CB71039 - General Preparation</b>										
<b>Blank</b>										
Chloride	ND	3.0	mg/L							
<b>LCS</b>										
Chloride	31.4		mg/L	30.00		105	90-110			
<b>Batch CB71323 - 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 CB71332 - TKN Prep</b>										
<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702187

**Quality Control Data**

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

**Batch CB71332 - TKN Prep**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.8	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702187

**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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1702187

**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

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211

Tel. (401) 461-7181 Fax (401) 461-4486

www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time \_\_\_\_\_ Standard \_\_\_\_\_ Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)

MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Project # 6047604 Project Name Olefiens Landfill Phase I

Address 250 Apple DR PO # 170115

City Chelmsford Zip 01824

State MA email: Julianne.Mahoney@comcast.com

Tel. 978-905-2419 Fax \_\_\_\_\_

ESS Lab # 1702187

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

ESS Lab ID	Date	Collection Time	Grab-G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Analysis	Vol of Container
1	02/8/17	1140	G	GW	MW-1S(56-66)				NH <sub>4</sub> -TN	X
2	02/8/17	1205	G	GW	MW-1D(98-109)				NH <sub>4</sub> -NO <sub>3</sub> -NO <sub>2</sub> -SO <sub>4</sub> -CLN	X
3	02/8/17	0955	G	GW	MW-3S(50-60)				Diss LF Metals	X
4	02/8/17	1025	G	GW	MW-3D(84-94)				1,4 Dioxane	X
5	02/8/17	1505	G	GW	MW-8(36-46)				DOC	X
6	02/8/17	1320	G	GW	MW-9(92-102)					X
7	02/8/17	1410	G	GW	MW-10(85-95)					X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present  Yes  No

Internal Use Only  Internal Use Only  Pick up

Seals Intact  Yes  No NA: 3.1

Sampled by: C. Hayden

Cooler Temperature: 2.8 2.6 ice  Technician \_\_\_\_\_

Comments: \_\_\_\_\_

Received by: (Signature, Date & Time) C. Hayden 2/8/17 / 10:25

Received by: (Signature, Date & Time) [Signature] 2/8/17 17:50

Received by: (Signature, Date & Time) \_\_\_\_\_

Received by: (Signature, Date & Time) \_\_\_\_\_

\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy  
2 (Yellow) Client Receipt

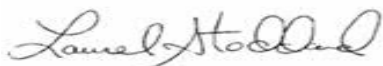


*CERTIFICATE OF ANALYSIS*

Julianne Marrion  
AECOM Environment - ENSR  
9 Jonathan Bourne Dr  
Pocasset, MA 02559

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1703684**

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



**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: 1703684

**SAMPLE RECEIPT**

The following samples were received on March 29, 2017 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>
1703684-01	MW-7S (55-65)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-02	MW-7D (115-125)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-03	MW-7 (90-100)	Ground Water	200.7, 350.1, 353.2, 4500N, 8270D SIM, 9038, 9250, RSK175
1703684-04	MW-6A (64-74)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-05	MW-6B (54-64)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-06	MW-E6 (88-98)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-07	MW-2 (140-150)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-08	MW-2 (160-170)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-09	MW-2S (84-94)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-10	MW-2D (124-134)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-11	MW-10 (85-95)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-12	LS-1	Ground Water	350.1, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**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: 1703684

**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-7S (55-65)  
Date Sampled: 03/28/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-01  
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	0.216 (0.100)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946
Manganese	0.031 (0.020)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 03/28/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-01  
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	0.15 (0.10)		350.1		1	EEM	03/31/17 14:51	mg/L	CC73019
Chloride	369 (30.0)		9250		10	EEM	03/30/17 15:48	mg/L	CC73028
Nitrate as N	4.96 (0.210)		353.2		10	JLK	03/30/17 19:22	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	03/29/17 17:38	mg/L	CC72951
Sulfate	15.5 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	8.67 (0.40)		4500N		10	JLK	04/03/17 21:26	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 03/28/17 09:55  
Percent Solids: N/A  
Initial Volume: 1  
Final Volume: 1  
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-01  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: ZLC  
Prepared: 4/4/17 8:39

**All methods used are in accordance with 40 CFR 136.**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

<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>Sequence</u>	<u>Batch</u>
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:46	C7D0026	CD70409



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 03/28/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-02  
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	17.5 (0.100)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946
Manganese	2.72 (0.020)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 03/28/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-02  
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	2.59 (0.10)		350.1		1	EEM	04/04/17 12:25	mg/L	CD70303
Chloride	57.2 (3.0)		9250		1	EEM	03/30/17 15:28	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:40	mg/L	CC72951
Sulfate	34.2 (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	0.57 (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 03/28/17 10:00  
Percent Solids: N/A  
Initial Volume: 1  
Final Volume: 1  
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-02  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: ZLC  
Prepared: 4/4/17 8:39

**All methods used are in accordance with 40 CFR 136.**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

<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>Sequence</u>	<u>Batch</u>
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:52	C7D0026	CD70409



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
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	7.51 (0.100)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946
Manganese	0.331 (0.020)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 3/30/17 17:20

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	03/31/17 14:14	C7C0505	CC72972
		<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>				
<i>Surrogate: 1,4-Dioxane-d8</i>		<i>44 %</i>		<i>15-115</i>				



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
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	0.19 (0.10)		350.1		1	EEM	04/04/17 12:26	mg/L	CD70303
Chloride	428 (60.0)		9250		20	EEM	03/30/17 15:55	mg/L	CC73028
Nitrate as N	0.154 (0.030)		353.2		1	JLK	03/30/17 19:26	mg/L	[CALC]
Nitrite as N	0.015 (0.010)		353.2		1	JLK	03/29/17 17:41	mg/L	CC72951
Sulfate	18.7 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	1.06 (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A  
Initial Volume: 1  
Final Volume: 1  
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: ZLC  
Prepared: 4/4/17 8:39

**All methods used are in accordance with 40 CFR 136.**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

<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>Sequence</u>	<u>Batch</u>
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 10:08	C7D0026	CD70409



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 03/28/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-04  
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	0.107 (0.100)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946
Manganese	0.050 (0.020)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 03/28/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-04  
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	EEM	04/04/17 12:27	mg/L	CD70303
<b>Chloride</b>	<b>331</b> (30.0)		9250		10	EEM	03/30/17 15:56	mg/L	CC73028
<b>Nitrate as N</b>	<b>2.61</b> (0.110)		353.2		5	JLK	03/30/17 19:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:42	mg/L	CC72951
<b>Sulfate</b>	<b>27.8</b> (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
<b>Total Nitrogen</b>	<b>3.94</b> (0.30)		4500N		5	JLK	04/03/17 21:28	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 03/28/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-05  
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	03/29/17 17:44	10	10	CC72946
Manganese	0.026 (0.020)		200.7		1	KJK	03/29/17 17:44	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 03/28/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-05  
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	EEM	04/04/17 12:30	mg/L	CD70303
<b>Chloride</b>	<b>167</b> (30.0)		9250		10	EEM	03/30/17 15:58	mg/L	CC73028
<b>Nitrate as N</b>	<b>8.27</b> (0.210)		353.2		10	JLK	03/30/17 19:28	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:43	mg/L	CC72951
<b>Sulfate</b>	<b>43.5</b> (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
<b>Total Nitrogen</b>	<b>36.3</b> (2.20)		4500N		10	JLK	04/03/17 21:51	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-E6 (88-98)  
Date Sampled: 03/28/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-06  
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	13.5 (0.100)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946
Manganese	2.39 (0.020)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-E6 (88-98)  
Date Sampled: 03/28/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-06  
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	22.6 (1.00)		350.1		10	EEM	04/04/17 13:00	mg/L	CD70303
Chloride	196 (30.0)		9250		10	EEM	03/30/17 15:59	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:31	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:44	mg/L	CC72951
Sulfate	21.5 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	13.6 (1.02)		4500N		5	JLK	04/03/17 21:51	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 03/28/17 15:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-07  
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	0.908 (0.100)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946
Manganese	5.12 (0.020)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 03/28/17 15:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-07  
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	11.2 (1.00)		350.1		10	EEM	04/04/17 13:01	mg/L	CD70303
Chloride	46.1 (3.0)		9250		1	EEM	03/30/17 15:34	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:50	mg/L	CC72951
Sulfate	63.5 (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	17.2 (1.02)		4500N		5	JLK	04/03/17 21:52	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (160-170)  
Date Sampled: 03/28/17 14:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-08  
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	0.647 (0.100)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946
Manganese	6.72 (0.020)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (160-170)  
Date Sampled: 03/28/17 14:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-08  
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	13.7 (1.00)		350.1		10	EEM	04/04/17 13:02	mg/L	CD70303
Chloride	43.6 (3.0)		9250		1	EEM	03/30/17 15:39	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:51	mg/L	CC72951
Sulfate	32.8 (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	2.45 (0.22)		4500N		1	JLK	04/03/17 21:31	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 03/28/17 15:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-09  
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	03/29/17 20:19	10	10	CC72946
Manganese	<b>0.528</b> (0.020)		200.7		1	KJK	03/29/17 20:19	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 03/28/17 15:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-09  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:42	mg/L	CD70303
Chloride	<b>94.8</b> (3.0)		9250		1	EEM	03/30/17 15:40	mg/L	CC73028
Nitrate as N	<b>1.05</b> (0.050)		353.2		2	JLK	03/30/17 20:23	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:52	mg/L	CC72951
Sulfate	<b>81.0</b> (50.0)		9038		10	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	<b>14.7</b> (1.04)		4500N		5	JLK	04/03/17 21:53	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 03/28/17 15:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-10  
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	0.107 (0.100)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946
Manganese	4.48 (0.020)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 03/28/17 15:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-10  
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	10.9 (1.00)		350.1		10	EEM	04/04/17 13:12	mg/L	CD70303
Chloride	134 (30.0)		9250		10	EEM	03/30/17 16:00	mg/L	CC73028
Nitrate as N	2.32 (0.110)		353.2		5	JLK	03/30/17 20:24	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:53	mg/L	CC72951
Sulfate	51.0 (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	2.89 (0.30)		4500N		5	JLK	04/03/17 21:35	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 03/28/17 17:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-11  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.375 (0.100)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946
Manganese	0.028 (0.020)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 03/28/17 17:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-11  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:44	mg/L	CD70303
Chloride	39.1 (3.0)		9250		1	EEM	03/30/17 15:42	mg/L	CC73028
Nitrate as N	2.50 (0.110)		353.2		5	JLK	03/30/17 20:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Sulfate	6.1 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	2.83 (0.30)		4500N		5	JLK	04/04/17 18:23	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: LS-1  
Date Sampled: 03/28/17 09:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-12  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	4.94 (0.10)		350.1		1	EEM	04/04/17 12:45	mg/L	CD70303
Nitrate as N	1.20 (0.110)		353.2		5	JLK	03/30/17 20:26	mg/L	[CALC]
Nitrite as N	0.428 (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Total Nitrogen	98.5 (10.1)		4500N		50	JLK	04/04/17 18:42	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1703684

**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 CC72946 - 200.7/6010BNoDigest**

**Blank**

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

**LCS**

Iron	2.49		mg/L	2.500		100	80-120			
Manganese	0.502		mg/L	0.5000		100	80-120			

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

**Batch CC72972 - 3535A**

**Blank**

1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	2.46		ug/L	5.000		49	15-115			

**LCS**

1,4-Dioxane	11.1	0.250	ug/L	10.00		111	40-140			
Surrogate: 1,4-Dioxane-d8	2.86		ug/L	5.000		57	15-115			

**LCS Dup**

1,4-Dioxane	11.4	0.250	ug/L	10.00		114	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	3.04		ug/L	5.000		61	15-115			

Classical Chemistry

**Batch CC72951 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.248		mg/L	0.2497		99	90-110			
Nitrite as N	0.248		mg/L	0.2497		99	90-110			

**Batch CC73019 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.09	0.10	mg/L	0.09994		91	80-120			
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**LCS**

Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
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**Batch CC73028 - General Preparation**

**Blank**

Chloride	ND	3.0	mg/L							
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**LCS**

Chloride	31.0		mg/L	30.00		103	90-110			
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CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1703684

**Quality Control Data**

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

**Batch CC73032 - General Preparation**

**Blank**

Sulfate	ND	5.0	mg/L							
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**LCS**

Sulfate	9.6		mg/L	9.988		96	85-115			
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**Batch CC73050 - [CALC]**

**Blank**

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	0.02	mg/L							

**LCS**

Nitrate as N	0.506		mg/L							
Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
Total Nitrogen	0.506		mg/L							

**Batch CC73110 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	20.9	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.9	2.00	mg/L							

**Batch CD70303 - General Preparation**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		98	80-120			
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**LCS**

Ammonia as N	1.03	0.10	mg/L	0.9994		103	80-120			
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**Batch CD70351 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	15.9	2.00	mg/L	18.80		85	80-120			
Total Nitrogen	15.9	2.00	mg/L							

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

**Batch CD70409 - No Prep**

**Blank**

Methane	ND	2.0	ug/L							
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**Quality Control Data**

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

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

**Batch CD70409 - No Prep**

**LCS**

Methane	24.8		ug/L	36.00		69	60-140			
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**LCS Dup**

Methane	22.0		ug/L	36.00		61	60-140	12	30	
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**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>



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

***Items for Project Management Review***

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

**Classical Chemistry**

1703684-01	Sampled->Prepared > 2.00 days
1703684-02	Sampled->Prepared > 2.00 days
1703684-03	Sampled->Prepared > 2.00 days
1703684-04	Sampled->Prepared > 2.00 days
1703684-05	Sampled->Prepared > 2.00 days
1703684-06	Sampled->Prepared > 2.00 days
1703684-07	Sampled->Prepared > 2.00 days
1703684-08	Sampled->Prepared > 2.00 days
1703684-09	Sampled->Prepared > 2.00 days
1703684-10	Sampled->Prepared > 2.00 days
1703684-11	Sampled->Prepared > 2.00 days
1703684-12	Sampled->Prepared > 2.00 days

**Dissolved Metals**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

1703684-01	Missing Ethene
	Missing Ethane
1703684-02	Missing Ethene
	Missing Ethane
1703684-03	Missing Ethene
	Missing Ethane



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**PROJECT COMPLETION CHECKLIST**

All Reports:

- |  |     |    |     |
|--|-----|----|-----|
| 1. Has Report been Paginated?                              | Yes | No |     |
| 2. Has Report been Digitally Signed?                       | Yes | No |     |
| 3. Has MCP/PC Sheet been filled out?                       | Yes | No | N/A |
| 4. Have PRM and Fax Sheet been removed from the Project?   | Yes | No |     |
| 5. Is the correct Chain of Custody attached to the Report? | Yes | No |     |
| 6. Is the correct Cooler Receipt attached to the Report?   | Yes | No | N/A |

Contact Person: \_\_\_\_\_

EDD: \_\_\_\_\_

E-Mail: \_\_\_\_\_

- |  |     |    |     |
|--|-----|----|-----|
| 1. Does e-mail address in Element match the COC/CSR?           | Yes | No |     |
| 1a. If No, did you contact Customer Service?                   | Yes | No | N/A |
| 2. Are there any CCs for the report?                           | Yes | No |     |
| 3a If Yes, did you include them?                               | Yes | No | N/A |
| 4. Did you save a copy of the e-mail in the Work Order Folder? | Yes | No |     |

Client Connect: \_\_\_\_\_

- |   |     |    |     |
|---|-----|----|-----|
| 1. Did you save Report in CORRECT ClientConnect Folder? | Yes | No | N/A |
| 2. Did you save EDD in CORRECT ClientConnect Folder?    | Yes | No | N/A |

Fax: \_\_\_\_\_

- |  |     |    |     |
|--|-----|----|-----|
| 1. Does fax number in Element match the COC? | Yes | No |     |
| 1a. Did you contact Customer Service?        | Yes | No | N/A |
| 2. Was the fax "rejected" for any reason?    | Yes | No |     |
| 2a. Was the project re-faxed?                | Yes | No | N/A |
| 2b. Was Customer Service notified?           | Yes | No | N/A |

Updated to Faxed:      Yes      No      N/A      Initials: \_\_\_\_\_      Date: \_\_\_\_\_

# ESS Laboratory

Division of Thielsch Engineering, Inc.



## FAX

Date: \_\_\_\_\_

To: Julianne Marrion

Company: AECOM Environment - ENSR

Project Name: Orleans MA

ESS Work Order: 1703684

Fax: (978) 589-3100

### Comments:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Our certified laboratory provides a full range of services, including the following:

- Soil Characterization
- Petroleum Fingerprinting
- Priority Pollutant Analysis
- Groundwater, Wastewater and Drinking Water Analyses
- PCBs and Pesticides Analysis
- Trace Metals (ICAP/Furnace) Analysis
- Inorganic Analysis by Classic Methods, Flow Analyzer, and Ion Chromatography
- Organics by GC/Mass Spectroscopy
- Microbiology Analysis
- Massachusetts EPH/VPH Analysis
- Siloxanes
- Field Screening and Sample Technician Services

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Number of pages (including this cover): \_\_\_\_\_

Date: \_\_\_\_\_ Faxed: \_\_\_\_\_ Initials: \_\_\_\_\_ Time: \_\_\_\_\_

## CERTIFICATE OF ANALYSIS

Julianne Marrion  
AECOM Environment - ENSR  
9 Jonathan Bourne Dr  
Pocasset, MA 02559

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1703684**

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 9:29 am, May 02, 2017

**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: 1703684

**SAMPLE RECEIPT**

The following samples were received on March 29, 2017 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 May 2, 2017: This report has been revised to include TKN for sample 1703684-12.**

<u>Lab Number</u>	<u>Sample Name</u>	<u>Matrix</u>	<u>Analysis</u>
1703684-01	MW-7S (55-65)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-02	MW-7D (115-125)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-03	MW-7 (90-100)	Ground Water	200.7, 350.1, 353.2, 4500N, 8270D SIM, 9038, 9250, RSK175
1703684-04	MW-6A (64-74)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-05	MW-6B (54-64)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-06	MW-E6 (88-98)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-07	MW-2 (140-150)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-08	MW-2 (160-170)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-09	MW-2S (84-94)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-10	MW-2D (124-134)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-11	MW-10 (85-95)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-12	LS-1	Ground Water	350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**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: 1703684

**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-7S (55-65)  
Date Sampled: 03/28/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-01  
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	0.216 (0.100)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946
Manganese	0.031 (0.020)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 03/28/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-01  
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	0.15 (0.10)		350.1		1	EEM	03/31/17 14:51	mg/L	CC73019
Chloride	369 (30.0)		9250		10	EEM	03/30/17 15:48	mg/L	CC73028
Nitrate as N	4.96 (0.210)		353.2		10	JLK	03/30/17 19:22	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	03/29/17 17:38	mg/L	CC72951
Sulfate	15.5 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	8.67 (0.40)		4500N		10	JLK	04/03/17 21:26	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7S (55-65)  
Date Sampled: 03/28/17 09:55  
Percent Solids: N/A  
Initial Volume: 1  
Final Volume: 1  
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-01  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: ZLC  
Prepared: 4/4/17 8:39

**All methods used are in accordance with 40 CFR 136.**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

<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>Sequence</u>	<u>Batch</u>
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:46	C7D0026	CD70409



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 03/28/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-02  
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	17.5 (0.100)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946
Manganese	2.72 (0.020)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 03/28/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-02  
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	2.59 (0.10)		350.1		1	EEM	04/04/17 12:25	mg/L	CD70303
Chloride	57.2 (3.0)		9250		1	EEM	03/30/17 15:28	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:40	mg/L	CC72951
Sulfate	34.2 (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	0.57 (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7D (115-125)  
Date Sampled: 03/28/17 10:00  
Percent Solids: N/A  
Initial Volume: 1  
Final Volume: 1  
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-02  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: ZLC  
Prepared: 4/4/17 8:39

**All methods used are in accordance with 40 CFR 136.**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

<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>Sequence</u>	<u>Batch</u>
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:52	C7D0026	CD70409



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
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	7.51 (0.100)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946
Manganese	0.331 (0.020)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A  
Initial Volume: 500  
Final Volume: 0.5  
Extraction Method: 3535A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: VSC  
Prepared: 3/30/17 17:20

**All methods used are in accordance with 40 CFR 136.**

**8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,4-Dioxane	ND (0.250)		8270D SIM		1	03/31/17 14:14	C7C0505	CC72972

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,4-Dioxane-d8</i>	44 %		15-115



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
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	0.19 (0.10)		350.1		1	EEM	04/04/17 12:26	mg/L	CD70303
Chloride	428 (60.0)		9250		20	EEM	03/30/17 15:55	mg/L	CC73028
Nitrate as N	0.154 (0.030)		353.2		1	JLK	03/30/17 19:26	mg/L	[CALC]
Nitrite as N	0.015 (0.010)		353.2		1	JLK	03/29/17 17:41	mg/L	CC72951
Sulfate	18.7 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	1.06 (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 03/28/17 10:45  
Percent Solids: N/A  
Initial Volume: 1  
Final Volume: 1  
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-03  
Sample Matrix: Ground Water  
Units: ug/L  
Analyst: ZLC  
Prepared: 4/4/17 8:39

**All methods used are in accordance with 40 CFR 136.**

**Methane / Ethane / Ethene by Headspace GCFID (RSK175)**

<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>Sequence</u>	<u>Batch</u>
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 10:08	C7D0026	CD70409



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 03/28/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-04  
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	0.107 (0.100)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946
Manganese	0.050 (0.020)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6A (64-74)  
Date Sampled: 03/28/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-04  
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	EEM	04/04/17 12:27	mg/L	CD70303
<b>Chloride</b>	<b>331</b> (30.0)		9250		10	EEM	03/30/17 15:56	mg/L	CC73028
<b>Nitrate as N</b>	<b>2.61</b> (0.110)		353.2		5	JLK	03/30/17 19:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:42	mg/L	CC72951
<b>Sulfate</b>	<b>27.8</b> (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
<b>Total Nitrogen</b>	<b>3.94</b> (0.30)		4500N		5	JLK	04/03/17 21:28	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 03/28/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-05  
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	03/29/17 17:44	10	10	CC72946
Manganese	0.026 (0.020)		200.7		1	KJK	03/29/17 17:44	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6B (54-64)  
Date Sampled: 03/28/17 11:40  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-05  
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	EEM	04/04/17 12:30	mg/L	CD70303
Chloride	167 (30.0)		9250		10	EEM	03/30/17 15:58	mg/L	CC73028
Nitrate as N	8.27 (0.210)		353.2		10	JLK	03/30/17 19:28	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:43	mg/L	CC72951
Sulfate	43.5 (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	36.3 (2.20)		4500N		10	JLK	04/03/17 21:51	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-E6 (88-98)  
Date Sampled: 03/28/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-06  
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	13.5 (0.100)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946
Manganese	2.39 (0.020)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-E6 (88-98)  
Date Sampled: 03/28/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-06  
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	22.6 (1.00)		350.1		10	EEM	04/04/17 13:00	mg/L	CD70303
Chloride	196 (30.0)		9250		10	EEM	03/30/17 15:59	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:31	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:44	mg/L	CC72951
Sulfate	21.5 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	13.6 (1.02)		4500N		5	JLK	04/03/17 21:51	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 03/28/17 15:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-07  
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	0.908 (0.100)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946
Manganese	5.12 (0.020)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 03/28/17 15:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-07  
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	11.2 (1.00)		350.1		10	EEM	04/04/17 13:01	mg/L	CD70303
Chloride	46.1 (3.0)		9250		1	EEM	03/30/17 15:34	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:50	mg/L	CC72951
Sulfate	63.5 (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	17.2 (1.02)		4500N		5	JLK	04/03/17 21:52	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (160-170)  
Date Sampled: 03/28/17 14:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-08  
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	0.647 (0.100)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946
Manganese	6.72 (0.020)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (160-170)  
Date Sampled: 03/28/17 14:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-08  
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	13.7 (1.00)		350.1		10	EEM	04/04/17 13:02	mg/L	CD70303
Chloride	43.6 (3.0)		9250		1	EEM	03/30/17 15:39	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:51	mg/L	CC72951
Sulfate	32.8 (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	2.45 (0.22)		4500N		1	JLK	04/03/17 21:31	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 03/28/17 15:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-09  
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	03/29/17 20:19	10	10	CC72946
Manganese	<b>0.528</b> (0.020)		200.7		1	KJK	03/29/17 20:19	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S (84-94)  
Date Sampled: 03/28/17 15:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-09  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:42	mg/L	CD70303
Chloride	<b>94.8</b> (3.0)		9250		1	EEM	03/30/17 15:40	mg/L	CC73028
Nitrate as N	<b>1.05</b> (0.050)		353.2		2	JLK	03/30/17 20:23	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:52	mg/L	CC72951
Sulfate	<b>81.0</b> (50.0)		9038		10	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	<b>14.7</b> (1.04)		4500N		5	JLK	04/03/17 21:53	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 03/28/17 15:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-10  
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	0.107 (0.100)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946
Manganese	4.48 (0.020)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2D (124-134)  
Date Sampled: 03/28/17 15:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-10  
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	10.9 (1.00)		350.1		10	EEM	04/04/17 13:12	mg/L	CD70303
Chloride	134 (30.0)		9250		10	EEM	03/30/17 16:00	mg/L	CC73028
Nitrate as N	2.32 (0.110)		353.2		5	JLK	03/30/17 20:24	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:53	mg/L	CC72951
Sulfate	51.0 (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	2.89 (0.30)		4500N		5	JLK	04/03/17 21:35	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 03/28/17 17:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-11  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.375 (0.100)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946
Manganese	0.028 (0.020)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-10 (85-95)  
Date Sampled: 03/28/17 17:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-11  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:44	mg/L	CD70303
Chloride	39.1 (3.0)		9250		1	EEM	03/30/17 15:42	mg/L	CC73028
Nitrate as N	2.50 (0.110)		353.2		5	JLK	03/30/17 20:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Sulfate	6.1 (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	2.83 (0.30)		4500N		5	JLK	04/04/17 18:23	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: LS-1  
Date Sampled: 03/28/17 09:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1703684  
ESS Laboratory Sample ID: 1703684-12  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

**Classical Chemistry**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>Units</u>	<u>Batch</u>
Ammonia as N	4.94 (0.10)		350.1		1	EEM	04/04/17 12:45	mg/L	CD70303
Nitrate as N	1.20 (0.110)		353.2		5	JLK	03/30/17 20:26	mg/L	[CALC]
Nitrite as N	0.428 (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Total Kjeldahl Nitrogen as N	96.8 (10.0)		351.2		50	JLK	04/04/17 18:42	mg/L	CD70351
Total Nitrogen	98.5 (10.1)		4500N		50	JLK	04/04/17 18:42	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1703684

**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 CC72946 - 200.7/6010BNoDigest**

**Blank**

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

**LCS**

Iron	2.49		mg/L	2.500		100	80-120			
Manganese	0.502		mg/L	0.5000		100	80-120			

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

**Batch CC72972 - 3535A**

**Blank**

1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	2.46		ug/L	5.000		49	15-115			

**LCS**

1,4-Dioxane	11.1	0.250	ug/L	10.00		111	40-140			
Surrogate: 1,4-Dioxane-d8	2.86		ug/L	5.000		57	15-115			

**LCS Dup**

1,4-Dioxane	11.4	0.250	ug/L	10.00		114	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	3.04		ug/L	5.000		61	15-115			

Classical Chemistry

**Batch CC72951 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.248		mg/L	0.2497		99	90-110			
Nitrite as N	0.248		mg/L	0.2497		99	90-110			

**Batch CC73019 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.09	0.10	mg/L	0.09994		91	80-120			
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**LCS**

Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
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**Batch CC73028 - General Preparation**

**Blank**

Chloride	ND	3.0	mg/L							
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**LCS**

Chloride	31.0		mg/L	30.00		103	90-110			
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CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1703684

**Quality Control Data**

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

**Batch CC73032 - General Preparation**

**Blank**

Sulfate	ND	5.0	mg/L							
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**LCS**

Sulfate	9.6		mg/L	9.988		96	85-115			
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**Batch CC73050 - [CALC]**

**Blank**

Nitrate as N	ND	0.020	mg/L							
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Nitrate/Nitrite as N	ND	0.020	mg/L							
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Nitrate/Nitrite as N	ND	0.020	mg/L							
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Total Nitrogen	ND	0.02	mg/L							
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**LCS**

Nitrate as N	0.506		mg/L							
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Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
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Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
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Total Nitrogen	0.506		mg/L							
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**Batch CC73110 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
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Total Nitrogen	ND	0.20	mg/L							
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**LCS**

Total Kjeldahl Nitrogen as N	20.9	2.00	mg/L	18.80		111	80-120			
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Total Nitrogen	20.9	2.00	mg/L							
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**Batch CD70303 - General Preparation**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		98	80-120			
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**LCS**

Ammonia as N	1.03	0.10	mg/L	0.9994		103	80-120			
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**Batch CD70351 - [CALC]**

**Blank**

Total Nitrogen	ND	0.20	mg/L							
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**LCS**

Total Nitrogen	15.9	2.00	mg/L							
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Methane / Ethane / Ethene by Headspace GCFID (RSK175)

**Batch CD70409 - No Prep**

**Blank**

Methane	ND	2.0	ug/L							
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**LCS**

Methane	24.8		ug/L	36.00		69	60-140			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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Methane / Ethane / Ethene by Headspace GCFID (RSK175)

**Batch CD70409 - No Prep**

**LCS Dup**

Methane	22.0		ug/L	36.00		61	60-140	12	30	
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1703684

**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: 1703684

**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: 1703684

Date Received: 3/29/2017

Shipped/Delivered Via: ESS Courier

Project Due Date: 4/5/2017

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>5.7</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"/> No</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 <b>short holds &amp; rushes</b>? <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>12. Were VOAs received? <input checked="" type="checkbox"/> Yes / No<br/>a. Air bubbles in aqueous VOAs? Yes / <input checked="" type="checkbox"/> No<br/>b. Does methanol cover soil completely? Yes / No / NA</p> |
|---|--|

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:

COC = MW-2(160-170) label = MW-2(161-171) WK 3/29/17

14. Was there a need to contact Project Manager?  Yes /  No 3/29/17
- 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	113626	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	113638	Yes	NA	Yes	500 mL Poly - Unpres	NP	
01	113649	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	113656	Yes	No	Yes	VOA Vial - HCl	HCl	
01	113657	Yes	No	Yes	VOA Vial - HCl	HCl	
02	113625	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	113637	Yes	NA	Yes	500 mL Poly - Unpres	NP	
02	113648	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	113654	Yes	No	Yes	VOA Vial - HCl	HCl	
02	113655	Yes	No	Yes	VOA Vial - HCl	HCl	
03	113624	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	113636	Yes	NA	Yes	500 mL Poly - Unpres	NP	
03	113647	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	113650	Yes	NA	Yes	1L Amber - Unpres	NP	
03	113651	Yes	NA	Yes	1L Amber - Unpres	NP	
03	113652	Yes	No	Yes	VOA Vial - HCl	HCl	
03	113653	Yes	No	Yes	VOA Vial - HCl	HCl	
04	113623	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	113635	Yes	NA	Yes	500 mL Poly - Unpres	NP	
04	113646	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	113622	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
05	113634	Yes	NA	Yes	500 mL Poly - Unpres	NP	
05	113645	Yes	NA	Yes	250 mL Poly - Unpres	NP	
06	113621	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1703684

Date Received: 3/29/2017

06	113633	Yes	NA	Yes	500 mL Poly - Unpres	NP
06	113644	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	113620	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
07	113632	Yes	NA	Yes	500 mL Poly - Unpres	NP
07	113643	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	113619	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
08	113631	Yes	NA	Yes	500 mL Poly - Unpres	NP
08	113642	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	113618	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
09	113630	Yes	NA	Yes	500 mL Poly - Unpres	NP
09	113641	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	113617	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
10	113629	Yes	NA	Yes	500 mL Poly - Unpres	NP
10	113640	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	113616	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
11	113628	Yes	NA	Yes	500 mL Poly - Unpres	NP
11	113639	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	113615	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
12	113627	Yes	NA	Yes	500 mL Poly - Unpres	NP

**2nd Review**

Are barcode labels on correct containers?

Yes  No

Completed

By: [Signature]

Date & Time: 3/29/17 0825

Reviewed

By: [Signature]

Date & Time: 3/29/17 0840

Delivered

By: [Signature]

Date & Time: 3/29/17 0840

**ESS Laboratory**

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

**CHAIN OF CUSTODY**

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

ESS Lab # 1703684  
 Reporting Limits \_\_\_\_\_  
 Electronic Deliverables  Limit Checker  Standard Excel  
 Other (Please Specify ->)

Project # \_\_\_\_\_ Project Name Oneas LE  
 Address 9 Jonathan Burner Dr  
 City MA State MA PO # \_\_\_\_\_  
 Telephone Number \_\_\_\_\_ FAX Number \_\_\_\_\_  
 Email Address Julianne.Mannon@ess.com Sample ID \_\_\_\_\_

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Analysis
1	03/28/17	0955	G	W	TD, Ammonia
2	03/28/17	1000	G	GW	NO <sub>2</sub> , NO <sub>x</sub> Sp4, DISS Metals
3	03/28/17	1045	G	GW	X X X Methane
4	03/28/17	1100	G	GW	X X X
5	03/28/17	1140	G	GW	X X X
6	03/28/17	1200	G	GW	X X X
7	03/28/17	1535	G	GW	X X X
8	03/28/17	1425	G	GW	X X X
9	03/28/17	1515	G	GW	X X X
10	03/28/17	1545	G	GW	X X X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubittainer G-Glass O-Other P-Poly S-Sterile V-Vial  
 Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other\*  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2SO3 8-ZnAc, NaOH 9-NH4Cl 10-DI-H2O 11-Ascorbic Acid 12-Other\*  
 Number of Containers per Sample: \_\_\_\_\_

Cooler Present:  \_\_\_\_\_  
 Seals Intact: NA  
 Cooler Temperature: 5.7/5.6°C 11.03 3/28/17  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_

Relinquished By: (Signature, Date & Time) [Signature] 3/28/17 0730  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_

Relinquished By: (Signature, Date & Time) [Signature] 3/28/17 1930  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_

Relinquished By: (Signature, Date & Time) [Signature] 3/28/17  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_

Relinquished By: (Signature, Date & Time) [Signature] 3/28/17  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_

Comments: Please specify "Other" preservative and containers types in this space  
 Sampled by: \_\_\_\_\_  
 Received By: (Signature, Date & Time) [Signature] 3/28/17  
 Received By: (Signature, Date & Time) [Signature] 3/28/17  
 Received By: (Signature, Date & Time) [Signature] 3/28/17  
 Received By: (Signature, Date & Time) [Signature] 3/28/17

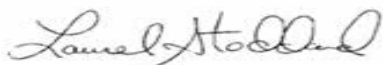


## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1707480**

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 10:50 am, Jul 28, 2017

**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: 1707480

**SAMPLE RECEIPT**

The following samples were received on July 21, 2017 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>
1707480-01	MW-2 (186-196)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1707480-02	MW-2 (206-216)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707480

**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: 1707480

**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

ESS Laboratory Work Order: 1707480

**Dissolved Metals**

Client Sample ID: MW-2 (186-196)  
Date Sampled: 07/21/17 09:35  
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-01  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>
Iron	0.411	mg/L	0.100	200.7	1	BJV	07/24/17 20:53	10	10
Manganese	0.119	mg/L	0.020	200.7	1	BJV	07/24/17 20:53	10	10

Client Sample ID: MW-2 (206-216)  
Date Sampled: 07/21/17 11:57  
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-02  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>
Iron	2.56	mg/L	0.100	200.7	1	BJV	07/24/17 21:21	10	10
Manganese	0.057	mg/L	0.020	200.7	1	BJV	07/24/17 21:21	10	10

**Classical Chemistry**

Client Sample ID: MW-2 (186-196)  
Date Sampled: 07/21/17 09:35  
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-01  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>
Ammonia as N	ND	mg/L	0.10	350.1	1	EEM	07/27/17 15:58
Nitrate as N	0.135	mg/L	0.030	353.2	1	JLK	07/27/17 20:39
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	07/21/17 20:34
Total Kjeldahl Nitrogen as N	0.38	mg/L	0.20	351.2	1	EEM	07/25/17 12:26
Total Nitrogen	0.52	mg/L	0.22	4500N	1	EEM	07/27/17 20:39

Client Sample ID: MW-2 (206-216)  
Date Sampled: 07/21/17 11:57  
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-02  
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>
Ammonia as N	ND	mg/L	0.10	350.1	1	EEM	07/27/17 15:59
Nitrate as N	0.116	mg/L	0.030	353.2	1	JLK	07/27/17 20:42
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	07/21/17 20:35
Total Kjeldahl Nitrogen as N	0.45	mg/L	0.20	351.2	1	EEM	07/25/17 12:33
Total Nitrogen	0.57	mg/L	0.22	4500N	1	EEM	07/27/17 20:42



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1707480

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CG72137 - [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 CG72441 - TKN Prep</b>										
<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
<b>LCS</b>										
Total Kjeldahl Nitrogen as N	15.8	2.00	mg/L	14.20		111	80-120			
Total Kjeldahl Nitrogen as N	15.8	2.00	mg/L	14.20		111	80-120			
Total Nitrogen	15.8	2.00	mg/L							
<b>Batch CG72513 - 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		120	80-120			
<b>LCS</b>										
Ammonia as N	0.97	0.10	mg/L	0.9994		97	80-120			
<b>Batch CG72731 - [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	0.02	mg/L							
<b>LCS</b>										
Nitrate as N	0.520		mg/L							
Nitrate/Nitrite as N	0.520		mg/L	0.5000		104	90-110			
Nitrate/Nitrite as N	0.520		mg/L	0.5000		104	90-110			
Total Nitrogen	0.520		mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707480

**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: 1707480

**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: 1707480

Date Received: 7/21/2017

Shipped/Delivered Via: ESS Courier

Project Due Date: 7/28/2017

Days for Project: 5 Day

1. Air bill manifest present?  No  
Air No.: NA

6. Does COC match bottles?  Yes

2. Were custody seals present?  No

7. Is COC complete and correct?  Yes

3. Is radiation count <100 CPM?  Yes

8. Were samples received intact?  Yes

4. Is a Cooler Present?  Yes  
Temp: 3.5 Iced with: Ice

9. Were labs informed about short holds & rushes?  Yes /  No /  NA

5. Was COC signed and dated by client?  Yes

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	149935	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	149937	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	149939	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	149934	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	149936	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	149938	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review  
Are barcode labels on correct containers?  Yes / No

Completed By: [Signature] Date & Time: 7/21/17 1459  
Reviewed By: [Signature] Date & Time: 7/21/17 1513  
Delivered By: [Signature] Date & Time: 7/21/17 1513



8 Walkup Drive  
Westboro, MA 01581  
Tel: 508-898-9220

320 Forbes Blvd  
Mansfield, MA 02048  
Tel: 508-822-9300

# CHAIN OF CUSTODY

PAGE 1 OF 1

Date Rec'd in Lab:

ALPHA Job #: 1707480

## Project Information

Project Name: Orleans Landfill

Project Location: Orleans, MA

Project #: 687766044

Project Manager: Mark Owen

ALPHA Quote #:

## Turn-Around Time

Standard  RUSH (only confirmed if pre-approved)

Date Due:

Additional Project Information:

## Client Information

Client: AECOM

Address: 9 Jonathan Bourne Drive

Roxasheet, MA

Phone: 508-833-6964

Email: Mark.Owen@acom.com

## Report Information - Data Deliverables

ADEX  EMAIL

Same as Client info  PO #:

## Regulatory Requirements & Project Information Requirements

- Yes  No MA MCP Analytical Methods
- Yes  No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
- Yes  No GW1 Standards (Info Required for Metals & EPH with Targets)
- Yes  No NPDES RGP
- Other State / Fed Program

Criteria

ANALYSIS	VOC: <input type="checkbox"/> 8260 <input type="checkbox"/> 624 <input type="checkbox"/> 524.2	METALS: <input type="checkbox"/> MCP 13 <input type="checkbox"/> ABN <input type="checkbox"/> PAH	METALS: <input type="checkbox"/> RCRAS <input type="checkbox"/> MCP 14 <input type="checkbox"/> RCP 15	EPH: <input type="checkbox"/> Ranges & Targets <input type="checkbox"/> RCRAS <input type="checkbox"/> PPT3	VPH: <input type="checkbox"/> Ranges & Targets <input type="checkbox"/> Ranges Only	TPH: <input type="checkbox"/> Quant Only <input type="checkbox"/> Fingerprint	SAMPLE INFO	TOTAL # BOTTLES
1	MW-2 (186-196)						Filtration <input type="checkbox"/> Field <input type="checkbox"/> Lab to do Preservation <input type="checkbox"/> Lab to do	3
2	MW-2 (206-216)							3
	MW-13 / 4-8' (SB-1)							
	MW-13 / 8-9' (SB-1)							
	MW-13 / 10-16' (SB-1)							
	MW-13 / 16-24' (SB-1)							

Handwritten notes in table:  
 Nitrate, Nitrite, Ammonia, TP, Mn  
 Dissolved Fe, Mn  
 Sieve Analysis

- Container Type**  
 P= Plastic  
 A= Amber glass  
 V= Vial  
 G= Glass  
 B= Bacteria cup  
 C= Cube  
 O= Other  
 E= Encore  
 D= BOD Bottle
- Preservative**  
 A= None  
 B= HCl  
 C= HNO<sub>3</sub>  
 D= H<sub>2</sub>SO<sub>4</sub>  
 E= NaOH  
 F= MeOH  
 G= NaHSO<sub>4</sub>  
 H= Na<sub>2</sub>S<sub>2</sub>O<sub>8</sub>  
 I= Ascorbic Acid  
 J= NH<sub>4</sub>Cl  
 K= Zn Acetate  
 O= Other

Relinquished By:

Date/Time

Received By:

Date/Time

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1707481**

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 11:17 am, Jul 28, 2017

**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.

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**Subcontracted Analyses**

CTS - Cranston, RI

Sieve Analysis



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707481

**SAMPLE RECEIPT**

The following samples were received on July 21, 2017 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>
1707481-01	MW-13 / 4-8' (SB-1)	Soil	§
1707481-02	MW-13 / 8-9' (SB-1)	Soil	§
1707481-03	MW-13 / 10-16' (SB-1)	Soil	§
1707481-04	MW-13 / 16-24' (SB-1)	Soil	§



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707481

**PROJECT NARRATIVE**

**No unusual observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

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[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: 1707481

**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

ESS Laboratory Work Order: 1707481

**Subcontracted Analysis**

Client Sample ID: MW-13 / 4-8' (SB-1)  
Date Sampled: 07/20/17 12:00

ESS Laboratory Sample ID: 1707481-01  
Sample Matrix: Soil

**All methods used are in accordance with 40 CFR 136.**

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>
Sieve Analysis	See Attached								

Client Sample ID: MW-13 / 8-9' (SB-1)  
Date Sampled: 07/20/17 12:02

ESS Laboratory Sample ID: 1707481-02  
Sample Matrix: Soil

**All methods used are in accordance with 40 CFR 136.**

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>
Sieve Analysis	See Attached								

Client Sample ID: MW-13 / 10-16' (SB-1)  
Date Sampled: 07/20/17 12:04

ESS Laboratory Sample ID: 1707481-03  
Sample Matrix: Soil

**All methods used are in accordance with 40 CFR 136.**

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>
Sieve Analysis	See Attached								

Client Sample ID: MW-13 / 16-24' (SB-1)  
Date Sampled: 07/20/17 12:06

ESS Laboratory Sample ID: 1707481-04  
Sample Matrix: Soil

**All methods used are in accordance with 40 CFR 136.**

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>
Sieve Analysis	See Attached								



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707481

**Quality Control Data**

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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707481

**Notes and Definitions**

- Z-08 See Attached
- 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: 1707481

**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>

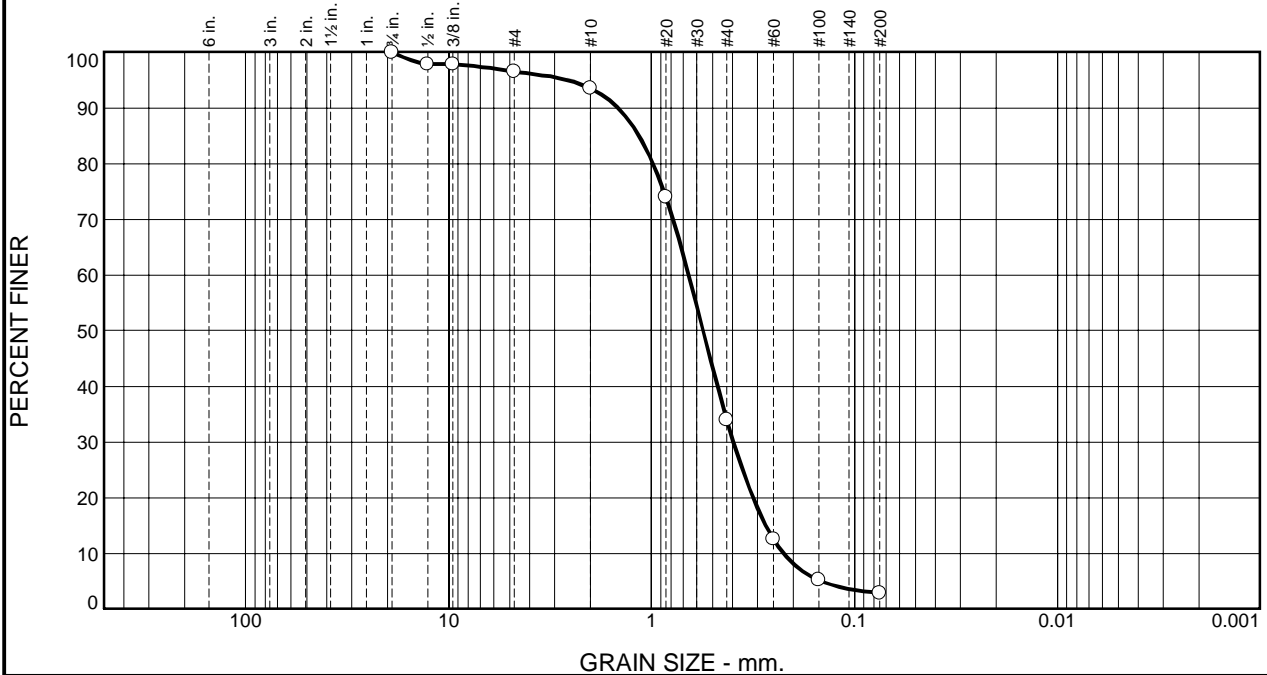
New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006  
[http://datamine2.state.nj.us/DEP\\_OPRA/OpraMain/pi\\_main?mode=pi\\_by\\_site&sort\\_order=PI\\_NAMEA&Select+a+Site:=58715](http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715)

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>



# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.5	3.0	59.6	31.0	2.9	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	97.8		
0.375"	97.8		
#4	96.5		
#10	93.5		
#20	74.0		
#40	33.9		
#60	12.5		
#100	5.2		
#200	2.9		

**Material Description**

Light Brown poorly graded sand

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP                      AASHTO (M 145)= A-1-b

**Coefficients**

D<sub>90</sub>= 1.4621                      D<sub>85</sub>= 1.1529                      D<sub>60</sub>= 0.6562  
D<sub>50</sub>= 0.5572                      D<sub>30</sub>= 0.3945                      D<sub>15</sub>= 0.2732  
D<sub>10</sub>= 0.2235                      u = 2.94                      C<sub>c</sub>= 1.06

**Remarks**

Split Sample

---

Date Received: 07.21.17                      Date Tested: 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

\* (no specification provided)

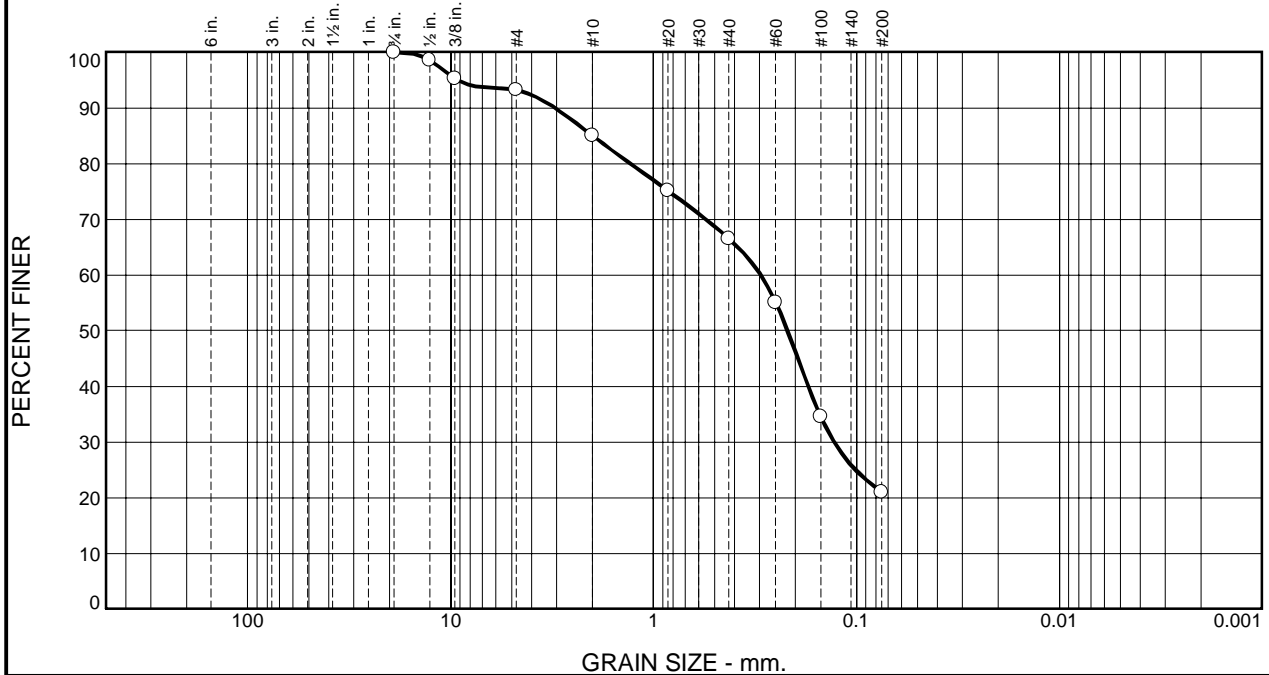
Source of Sample: Soil Samples                      Depth: 4-8'  
Sample Number: MW-13 / 1707481-01

Date Sampled: 07.20.17

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> ESS / AECOM <b>Project:</b> Orleans Landfill Orleans, MA <b>Project No:</b> 1707481
---	---

**Figure 17-S-1056**

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.8	8.2	18.5	45.5	21.0	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	98.6		
0.375"	95.3		
#4	93.2		
#10	85.0		
#20	75.1		
#40	66.5		
#60	55.1		
#100	34.6		
#200	21.0		

**Material Description**

Brown silty sand

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SM                      AASHTO (M 145)= A-2-4(0)

**Coefficients**

D<sub>90</sub>= 3.0637                      D<sub>85</sub>= 1.9939                      D<sub>60</sub>= 0.2965  
D<sub>50</sub>= 0.2187                      D<sub>30</sub>= 0.1289                      D<sub>15</sub>=  
D<sub>10</sub>=                                      C<sub>u</sub>=                                      C<sub>c</sub>=

Remarks

---

Date Received: 07.21.17                      Date Tested: 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

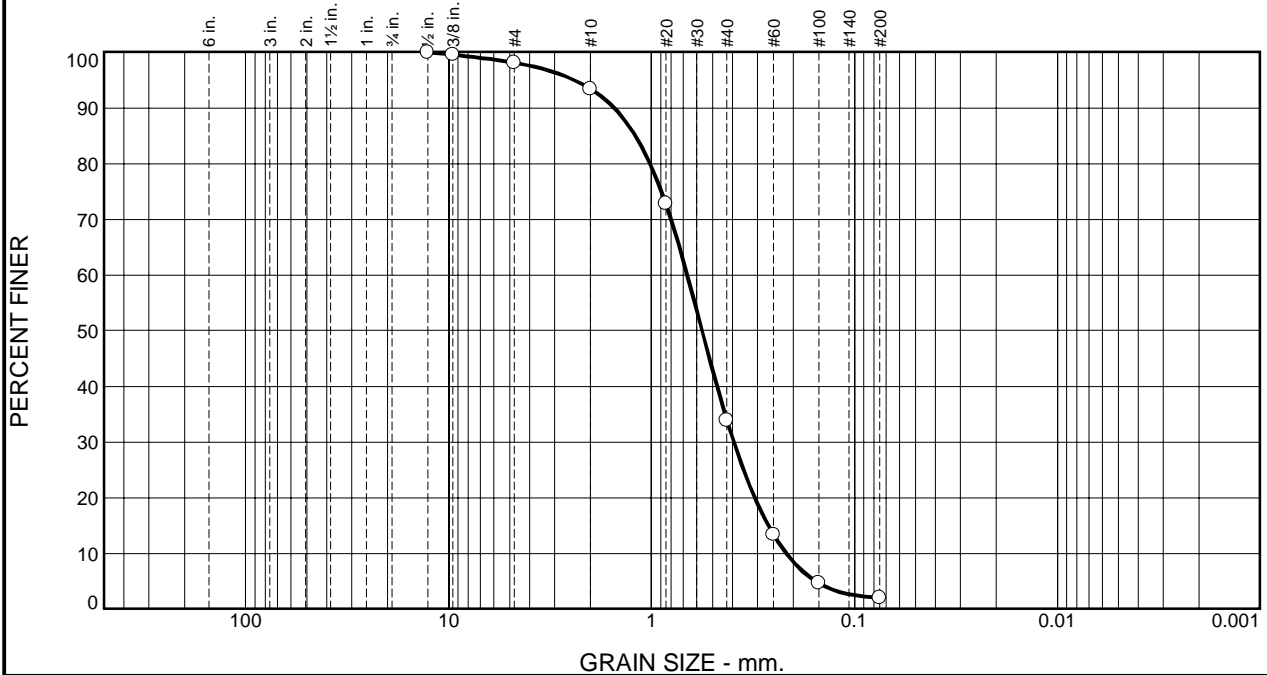
\* (no specification provided)

Source of Sample: Soil Samples                      Depth: 8-9'                      Date Sampled: 07.20.17  
Sample Number: MW-13 / 1707481-02

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> ESS / AECOM <b>Project:</b> Orleans Landfill Orleans, MA <b>Project No:</b> 1707481
---	---

**Figure 17-S-1057**

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	4.7	59.5	31.9	2.0	

TEST RESULTS (D6913)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.5"	100.0		
0.375"	99.6		
#4	98.1		
#10	93.4		
#20	72.8		
#40	33.9		
#60	13.3		
#100	4.7		
#200	2.0		

**Material Description**

Light Brown poorly graded sand

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP                      AASHTO (M 145)= A-1-b

**Coefficients**

D<sub>90</sub>= 1.5296                      D<sub>85</sub>= 1.2009                      D<sub>60</sub>= 0.6671  
D<sub>50</sub>= 0.5635                      D<sub>30</sub>= 0.3931                      D<sub>15</sub>= 0.2654  
D<sub>10</sub>= 0.2167                      u = 3.08                      C<sub>c</sub>= 1.07

**Remarks**

Split Sample

---

Date Received: 07.21.17                      Date Tested: 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

\* (no specification provided)

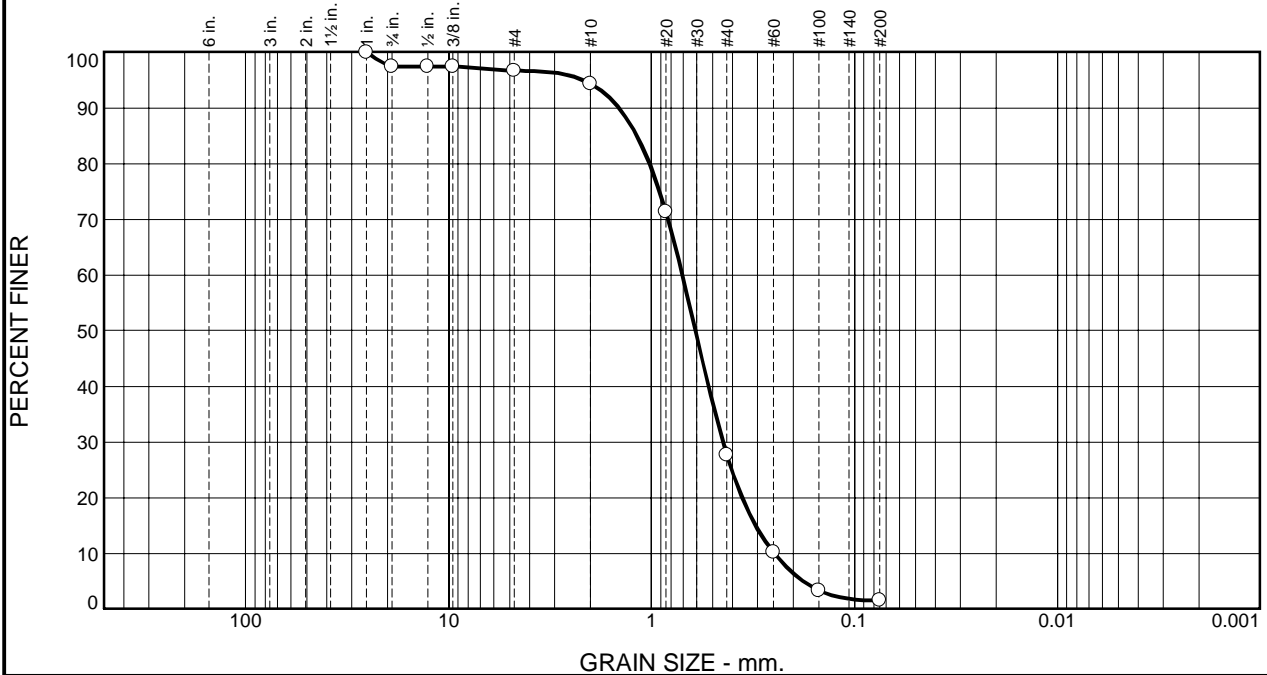
Source of Sample: Soil Samples                      Depth: 10-16'  
Sample Number: MW-13 / 1707481-03

Date Sampled: 07.20.17

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> ESS / AECOM <b>Project:</b> Orleans Landfill Orleans, MA <b>Project No:</b> 1707481
---	---

**Figure 17-S-1058**

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.6	0.7	2.4	66.6	26.1	1.6	

Test Results (D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	97.4		
0.5"	97.4		
0.375"	97.4		
#4	96.7		
#10	94.3		
#20	71.3		
#40	27.7		
#60	10.2		
#100	3.3		
#200	1.6		

\* (no specification provided)

**Material Description**

Light Brown poorly graded sand

**Atterberg Limits (ASTM D 4318)**

PL= NP                      LL= NV                      PI= NP

**Classification**

USCS (D 2487)= SP                      AASHTO (M 145)= A-1-b

**Coefficients**

D<sub>90</sub>= 1.4478                      D<sub>85</sub>= 1.1817                      D<sub>60</sub>= 0.7049  
D<sub>50</sub>= 0.6074                      D<sub>30</sub>= 0.4439                      D<sub>15</sub>= 0.3065  
D<sub>10</sub>= 0.2476                      u = 2.85                      C<sub>c</sub>= 1.13

**Remarks**

Split Sample

Date Received: 07.21.17                      Date Tested: 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Soil Samples                      Depth: 16-24'  
Sample Number: MW-13 / 1707481-04

Date Sampled: 07.20.17

<b>Thielsch Engineering Inc.</b>  <b>Cranston, RI</b>	<b>Client:</b> ESS / AECOM <b>Project:</b> Orleans Landfill Orleans, MA <b>Project No:</b> 1707481
<b>Figure 17-S-1059</b>	





*CERTIFICATE OF ANALYSIS*

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1707666**

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 9:28 am, Aug 02, 2017*

**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: 1707666

**SAMPLE RECEIPT**

The following samples were received on July 31, 2017 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>
1707666-01	PW-1 (95-128)	Ground Water	350.1, 351.2, 353.2, 4500N
1707666-02	PW-1 (95-128)	Ground Water	350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707666

**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: 1707666

**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

ESS Laboratory Work Order: 1707666

**Classical Chemistry**

Client Sample ID: PW-1 (95-128)  
Date Sampled: 07/31/17 14:45  
Percent Solids: N/A

ESS Laboratory Sample ID: 1707666-01  
Sample Matrix: Ground Water

**All methods used are in accordance with 40 CFR 136.**

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>
Ammonia as N	9.44	mg/L	1.00	350.1	10	EEM	08/01/17 14:43
Nitrate as N	0.121	mg/L	0.030	353.2	1	JLK	08/01/17 17:23
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	08/01/17 16:47
Total Kjeldahl Nitrogen as N	10.1	mg/L	1.00	351.2	5	JLK	08/01/17 19:20
Total Nitrogen	10.2	mg/L	1.02	4500N	5	JLK	08/01/17 19:20

Client Sample ID: PW-1 (95-128)  
Date Sampled: 07/31/17 16:00  
Percent Solids: N/A

ESS Laboratory Sample ID: 1707666-02  
Sample Matrix: Ground Water

**All methods used are in accordance with 40 CFR 136.**

<u>Analyte</u>	<u>Results</u>	<u>Units</u>	<u>MRL</u>	<u>Method</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>
Ammonia as N	8.76	mg/L	1.00	350.1	10	EEM	08/01/17 14:43
Nitrate as N	0.212	mg/L	0.030	353.2	1	JLK	08/01/17 17:24
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	08/01/17 16:48
Total Kjeldahl Nitrogen as N	9.51	mg/L	1.00	351.2	5	JLK	08/01/17 19:21
Total Nitrogen	9.72	mg/L	1.02	4500N	5	JLK	08/01/17 19:21



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1707666

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
<b>Classical Chemistry</b>										
<b>Batch CG73113 - NH4 Prep</b>										
<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.10	0.10	mg/L	0.09994		100	80-120			
<b>LCS</b>										
Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
<b>Batch CH70109 - TKN Prep</b>										
<b>Blank</b>										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
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	15.4	2.00	mg/L	14.20		109	80-120			
Total Kjeldahl Nitrogen as N	15.4	2.00	mg/L	14.20		109	80-120			
Total Nitrogen	15.4	2.00	mg/L							
<b>Batch CH70135 - [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	0.261		mg/L	0.2497		104	90-110			
Nitrite as N	0.261		mg/L	0.2497		104	90-110			
<b>Batch CH70136 - [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	0.468		mg/L							
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Total Nitrogen	0.468		mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1707666

**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: 1707666

**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

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

CHAIN OF CUSTODY

Turn Time 5-Day Rush 24 HA

Regulatory State

Is this project for any of the following?:

CT RCP  MA MCP  GP

Reporting Limits

Electronic Deliverables  Limit Checker  Other (Please Specify ->)

Standard Excel

ESS Lab # 1707666

Company Name  
 Contact Person  
 City  
 State  
 Telephone Number  
 FAX Number

Project #  
 Address  
 Zip Code  
 Email Address  
 PO #  
 Project Name

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis
1	7-31-17	2:45	Groundwater	H <sub>2</sub> O	PW-1 (95-128)	X
1		2:45				X
2		4:00				X
2		4:00				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	9-4 oz	10-8 oz	11-Other*
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAcce, Nat	9-NH4Cl	10-DI H2O	11-Other*
Number of Containers per Sample:											

Laboratory Use Only

Cooler Present:  N

Seals Intact:  N

Cooler Temperature: Ice cool 31 °C 7-31-17 18:05

Received by: (Signature, Date & Time) [Signature] 7/31/17 24:00

Relinquished by: (Signature, Date & Time) [Signature] 7-31-17 18:00

Received By: (Signature, Date & Time) [Signature] 7-31-17 18:00

Relinquished By: (Signature, Date & Time) [Signature] 7-31-17 18:00

Comments: Please specify "Other" preservative and containers types in this space

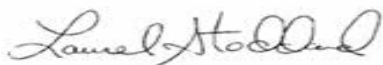
Sampled by: Mark Owen

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708022**

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



Laurel Stoddard  
Laboratory Director

**REVIEWED****By ESS Laboratory at 3:25 pm, Aug 03, 2017****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: 1708022

**SAMPLE RECEIPT**

The following samples were received on August 01, 2017 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>
1708022-01	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-02	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-03	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-04	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-05	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-06	PW-1 (95-125)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708022

**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: 1708022

**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: PW-1 (95-125)  
Date Sampled: 07/31/17 20:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-01  
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	8.33 (0.50)		350.1		5	JLK	08/02/17 18:08	mg/L	CH70221
Nitrate as N	0.701 (0.030)		353.2		1	JLK	08/01/17 20:39	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	08/01/17 20:21	mg/L	CH70135
Total Kjeldahl Nitrogen as N	10.2 (1.00)		351.2		5	JLK	08/02/17 16:58	mg/L	CH70215
Total Nitrogen	10.9 (1.02)		4500N		5	JLK	08/02/17 16:58	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (95-125)  
Date Sampled: 08/01/17 00:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-02  
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	8.40 (0.50)		350.1		5	JLK	08/02/17 18:16	mg/L	CH70221
Nitrate as N	1.18 (0.050)		353.2		2	JLK	08/01/17 20:46	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	08/01/17 20:21	mg/L	CH70135
Total Kjeldahl Nitrogen as N	10.0 (1.00)		351.2		5	JLK	08/02/17 17:00	mg/L	CH70215
Total Nitrogen	11.2 (1.04)		4500N		5	JLK	08/02/17 17:00	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (95-125)  
Date Sampled: 08/01/17 04:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-03  
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	7.67 (0.50)		350.1		5	JLK	08/02/17 18:17	mg/L	CH70221
Nitrate as N	1.62 (0.110)		353.2		5	JLK	08/01/17 20:47	mg/L	[CALC]
Nitrite as N	0.013 (0.010)		353.2		1	JLK	08/01/17 20:22	mg/L	CH70135
Total Kjeldahl Nitrogen as N	9.95 (1.00)		351.2		5	JLK	08/02/17 17:00	mg/L	CH70215
Total Nitrogen	11.6 (1.10)		4500N		5	JLK	08/02/17 17:00	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (95-125)  
Date Sampled: 08/01/17 08:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-04  
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	7.19 (0.50)		350.1		5	JLK	08/02/17 18:20	mg/L	CH70221
Nitrate as N	1.90 (0.110)		353.2		5	JLK	08/01/17 20:47	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	08/01/17 20:23	mg/L	CH70135
Total Kjeldahl Nitrogen as N	9.69 (1.00)		351.2		5	JLK	08/02/17 17:01	mg/L	CH70215
Total Nitrogen	11.6 (1.10)		4500N		5	JLK	08/02/17 17:01	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (95-125)  
Date Sampled: 08/01/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-05  
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	7.24 (0.50)		350.1		5	JLK	08/02/17 18:21	mg/L	CH70221
Nitrate as N	2.06 (0.110)		353.2		5	JLK	08/01/17 20:48	mg/L	[CALC]
Nitrite as N	0.013 (0.010)		353.2		1	JLK	08/01/17 20:24	mg/L	CH70135
Total Kjeldahl Nitrogen as N	9.52 (1.00)		351.2		5	JLK	08/02/17 17:02	mg/L	CH70215
Total Nitrogen	11.6 (1.10)		4500N		5	JLK	08/02/17 17:02	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (95-125)  
Date Sampled: 08/01/17 13:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-06  
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	19.6 (0.100)		200.7		1	KJK	08/02/17 10:56	10	10	CH70220
Manganese	2.59 (0.020)		200.7		1	KJK	08/02/17 10:56	10	10	CH70220



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (95-125)  
Date Sampled: 08/01/17 13:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708022  
ESS Laboratory Sample ID: 1708022-06  
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	7.18 (0.50)		350.1		5	JLK	08/02/17 18:21	mg/L	CH70221
Nitrate as N	2.12 (0.110)		353.2		5	JLK	08/01/17 20:54	mg/L	[CALC]
Nitrite as N	0.012 (0.010)		353.2		1	JLK	08/01/17 20:25	mg/L	CH70135
Total Kjeldahl Nitrogen as N	9.71 (1.00)		351.2		5	JLK	08/02/17 17:03	mg/L	CH70215
Total Nitrogen	11.8 (1.10)		4500N		5	JLK	08/02/17 17:03	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708022

**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 CH70220 - 200.7/6010BNoDigest**

**Blank**

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

**LCS**

Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.501		mg/L	0.5000		100	80-120			

Classical Chemistry

**Batch CH70135 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.261		mg/L	0.2497		104	90-110			
Nitrite as N	0.261		mg/L	0.2497		104	90-110			

**Batch CH70136 - [CALC]**

**Blank**

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							

**LCS**

Nitrate as N	0.468		mg/L							
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Total Nitrogen	0.468		mg/L							

**Batch CH70215 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	14.9	2.00	mg/L	14.20		105	80-120			
Total Kjeldahl Nitrogen as N	14.9	2.00	mg/L	14.20		105	80-120			
Total Nitrogen	14.9	2.00	mg/L							

**Batch CH70221 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.11	0.10	mg/L	0.09994		114	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708022

**Quality Control Data**

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

Classical Chemistry

**Batch CH70221 - NH4 Prep**

**LCS**

Ammonia as N	0.86	0.10	mg/L	0.9994		86	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708022

**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: 1708022

**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

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time: Standard 24 Hr Other \_\_\_\_\_  
 Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_  
 Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

ESS Lab # 1708022

Reporting Limits - \_\_\_\_\_

Electronic Deliverables: Excel Access PDF

Co. Name: AFECOM  
 Contact Person: Mark Owen  
 City: Barnat State: MA  
 Project # 60476644 Project Name: Orleans LF  
 Address: 9 Jonathan Borat Pl PO # \_\_\_\_\_  
 Zip: 02559  
 email: mark.owen@afecom.com

Analysis	Vol of Container	Signature, Date & Time
<u>NO<sub>2</sub> NO<sub>x</sub></u>		
		<u>Dis Iron &amp; Manganese, TN, TP</u>

ESS Lab ID	Date	Collection Time	Grab-G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container
1	7-31-17	8:00 pm	G	H <sub>2</sub> O	PW-1 (95-125)	3	1	P	1L
2	8-1-17	12:15 am	G	H <sub>2</sub> O		3	1	P	1L
3	8-1-17	4:15 am	G	H <sub>2</sub> O		3	1	P	1L
4	8-1-17	9:00 am	G	H <sub>2</sub> O		3	1	P	1L
5	8-1-17	11:00 am	G	H <sub>2</sub> O		3	1	P	1L
6	8-1-17	13:00	G	H <sub>2</sub> O		3	1	P	1L
1	7-31-17	8:00 pm	G			1	1	P	250
2	8-1-17	12:15 am	G			1	1	P	250
3		4:15 am	G			1	1	P	250
4		8:00 am	G			1	1	P	250

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present: Yes  No  Internal Use Only: Yes  No  Pickups: Yes  No

Seals Intact: Yes  No

Cooler Temperature: 6.0150 m

Relinquished by: (Signature, Date & Time) Mark Owen 8/1/17 14:30

Relinquished by: (Signature, Date & Time) Mark Owen 8/1/17 17:10

Relinquished by: (Signature, Date & Time) Mark Owen 8/1/17 17:16

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy  
 2 (Yellow) Client Receipt

# ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211

Tel. (401) 461-7181 Fax (401) 461-4486

www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time Standard Other 24 HR

Regulatory State MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)

MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Co. Name AFCOM Project Name Olearys 6F  
 Contact Person Mark Owey Address 9 Jonathan Bourne PO # \_\_\_\_\_  
 City \_\_\_\_\_ State MA Zip 02559  
 Tel. 978-204-0983 email: \_\_\_\_\_

ESS Lab # 17080022

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

ESS Lab ID	Date	Collection Time	Grab-G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis
5	8-1-17	11:00	E	H <sub>2</sub> O	PM-1 (95-123)	1	1	P	250	X
6	8-1-17	13:00	E	H <sub>2</sub> O	↓	1	1	P	250	X
6	8-1-17	13:00	E	H <sub>2</sub> O		1	1	P	250	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present  Yes  No No NA: 0  
 Seals Intact  Yes  No NA: 0  
 Cooler Temperature: 6.0 16 m

Sampled by: Mark Owey  
 Comments: \_\_\_\_\_  
 Relinquished by: (Signature, Date & Time) [Signature] 8/1/17 12:30  
 Relinquished by: (Signature, Date & Time) [Signature] 8/1/17 12:30  
 Received by: (Signature, Date & Time) [Signature] 8/1/17 12:30  
 Received by: (Signature, Date & Time) [Signature] 8/1/17 12:30

1 (White) Lab Copy  
 2 (Yellow) Client Receipt

Please fax to the laboratory all changes to Chain of Custody

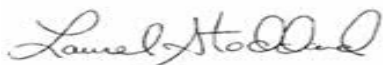
\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708095**

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 1:24 pm, Aug 07, 2017

**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: 1708095

**SAMPLE RECEIPT**

The following samples were received on August 03, 2017 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>
1708095-01	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708095-02	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708095

**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: 1708095

**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: PW-1 (130-160)  
Date Sampled: 08/03/17 12:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1708095  
ESS Laboratory Sample ID: 1708095-01  
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	12.3 (0.50)		350.1		5	JLK	08/04/17 21:30	mg/L	CH70405
Nitrate as N	ND (0.030)		353.2		1	JLK	08/03/17 21:15	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/03/17 20:32	mg/L	CH70340
<b>Total Kjeldahl Nitrogen as N</b>	<b>14.7 (2.00)</b>		351.2		10	EEM	08/04/17 11:53	mg/L	CH70352
<b>Total Nitrogen</b>	<b>14.7 (2.02)</b>		4500N		10	EEM	08/04/17 11:53	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
 Client Project ID: Orleans MA  
 Client Sample ID: PW-1 (130-160)  
 Date Sampled: 08/03/17 16:00  
 Percent Solids: N/A

ESS Laboratory Work Order: 1708095  
 ESS Laboratory Sample ID: 1708095-02  
 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	11.8 (0.50)		350.1		5	JLK	08/04/17 21:31	mg/L	CH70405
Nitrate as N	ND (0.030)		353.2		1	JLK	08/03/17 21:16	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/03/17 20:32	mg/L	CH70340
<b>Total Kjeldahl Nitrogen as N</b>	<b>14.8 (2.00)</b>		351.2		10	EEM	08/04/17 11:54	mg/L	CH70352
<b>Total Nitrogen</b>	<b>14.8 (2.02)</b>		4500N		10	EEM	08/04/17 11:54	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708095

**Quality Control Data**

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

**Batch CH70340 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.259		mg/L	0.2497		104	90-110			
Nitrite as N	0.259		mg/L	0.2497		104	90-110			

**Batch CH70341 - [CALC]**

**Blank**

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	0.02	mg/L							

**LCS**

Nitrate as N	0.482		mg/L							
Nitrate/Nitrite as N	0.482		mg/L	0.5000		96	90-110			
Nitrate/Nitrite as N	0.482		mg/L	0.5000		96	90-110			
Total Nitrogen	0.482		mg/L							

**Batch CH70352 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	14.0	2.00	mg/L	14.20		98	80-120			
Total Kjeldahl Nitrogen as N	14.0	2.00	mg/L	14.20		98	80-120			
Total Nitrogen	14.0	2.00	mg/L							

**Batch CH70405 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		105	80-120			
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**LCS**

Ammonia as N	0.99	0.10	mg/L	0.9994		99	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708095

**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: 1708095

**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

Division of Thielsch Engineering, Inc.  
 185 Frances Avenue, Cranston, RI 02910-2211  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time 24hr Standard Other \_\_\_\_\_  
 Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_  
 Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_  
 Project # 60476644 Project Name O'Brien's Landfill  
 Address 9 Jonathan Bourne Drive PO # \_\_\_\_\_  
 Zip 02559 email: MARK.OWEN@ACCOM.COM

ESS Lab # D08095

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

Co. Name AECOM State MA  
 Contact Person Mark Owen  
 City Pocasset Fax \_\_\_\_\_  
 Tel. 508-833-9782-204-0983

ESS Lab ID	Date	Collection Time	Grab - G Composite - C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis
1	8-3-17	12:05pm	G	H <sub>2</sub> O	PW-1 (130-160)	1	2	P	250ml	X
1	8-3-17	12:05pm	G	H <sub>2</sub> O	PW-1 (130-160)	3	1	P	1000ml	X
2	8-3-17	4:00pm	G	H <sub>2</sub> O	PW-1 (130-160)	1	2	P	250ml	X
2	8-3-17	4:00pm	G	H <sub>2</sub> O	PW-1 (130-160)	3	2	P	1000ml	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix: S-Soil SD-Solid D-Sludge WM-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Preservation Code: 1-NP, 2-HCl, 3-H<sub>2</sub>SO<sub>4</sub>, 4-HNO<sub>3</sub>, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9- \_\_\_\_\_

Cooler Present  Yes  No Internal Use Only   Pickup

Seals Intact  Yes  No NA: D

Cooler Temperature: 2-5 (ice in)

Relinquished by (Signature, Date & Time) [Signature] 8/3/17 1537  
 Relinquished by (Signature, Date & Time) [Signature] 8/3/17 1537  
 Relinquished by (Signature, Date & Time) [Signature] 8/3/17 1500  
 Relinquished by (Signature, Date & Time) [Signature] 8/3/17 1500

Comments: SC  
 Relinquished by (Signature, Date & Time) \_\_\_\_\_  
 Relinquished by (Signature, Date & Time) \_\_\_\_\_

1 (White) Lab Copy  
 2 (Yellow) Client Receipt

Please fax to the laboratory all changes to Chain of Custody

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708128**

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 11:35 am, Aug 08, 2017*

**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: 1708128

**SAMPLE RECEIPT**

The following samples were received on August 04, 2017 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>
1708128-01	MW-15 (155-145)	Ground Water	350.1, 351.2, 353.2, 4500N
1708128-02	MW-15 (125-115)	Ground Water	350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708128

**PROJECT NARRATIVE**

**No unusual observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

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[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: 1708128

**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-15 (155-145)  
Date Sampled: 08/04/17 08:51  
Percent Solids: N/A

ESS Laboratory Work Order: 1708128  
ESS Laboratory Sample ID: 1708128-01  
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	0.80 (0.10)		350.1		1	JLK	08/07/17 17:34	mg/L	CH70708
Nitrate as N	0.456 (0.030)		353.2		1	JLK	08/04/17 19:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:11	mg/L	CH70432
Total Kjeldahl Nitrogen as N	1.49 (0.20)		351.2		1	EEM	08/07/17 14:58	mg/L	CH70709
Total Nitrogen	1.95 (0.220)		4500N		1	EEM	08/07/17 14:58	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-15 (125-115)  
Date Sampled: 08/04/17 09:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708128  
ESS Laboratory Sample ID: 1708128-02  
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	0.55 (0.10)		350.1		1	JLK	08/07/17 17:35	mg/L	CH70708
Nitrate as N	2.20 (0.110)		353.2		5	JLK	08/04/17 20:09	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:13	mg/L	CH70432
Total Kjeldahl Nitrogen as N	1.38 (0.20)		351.2		1	EEM	08/07/17 15:01	mg/L	CH70709
Total Nitrogen	3.58 (0.300)		4500N		5	EEM	08/07/17 15:01	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708128

**Quality Control Data**

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

Classical Chemistry

**Batch CH70432 - [CALC]**

**Blank**

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

**LCS**

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

**Batch CH70433 - [CALC]**

**Blank**

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							

**LCS**

Nitrate as N	0.477		mg/L							
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Total Nitrogen	0.477		mg/L							

**Batch CH70708 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		99	80-120			
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**LCS**

Ammonia as N	1.19	0.10	mg/L	0.9994		119	80-120			
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**Batch CH70709 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Nitrogen	17.0	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708128

**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: 1708128

**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 - KPB/MM

ESS Project ID: 1708128  
 Date Received: 8/4/2017  
 Project Due Date: 8/7/2017  
 Days for Project: 1 Day

Shipped/Delivered Via: ESS Courier

- 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: 5.3 Iced with: Ice
- 5. Was COC signed and dated by client?  Yes

- 6. Does COC match bottles?  No
- 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:

COC = MW-15(155-14) , Label = MWK(145-155)      8/4/17

- 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	152599	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	152601	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	152598	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	152600	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	

- 2nd Review  
 Are barcode labels on bottles/containers?  Yes /  No
- Completed By: [Signature] Date & Time: 8/4/17 1716  
 Reviewed By: [Signature] Date & Time: 8/4/17 1732  
 Delivered By: [Signature] Date & Time: 8/4/17 1732

# ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211

Tel. (401) 461-7181 Fax (401) 461-4486

www.esslaboratory.com

Co. Name **AECOM**

Contact Person **Mark Owen**

City **Pocasset**

Tel. **978-204-0983**

State **MA**

Fax

email: **mark.owen@aecom.com**

## CHAIN OF CUSTODY

Turn Time 24 Standard Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Project Name Orleons Landfill

Address 9 Johnston Bourne Drive

PO # \_\_\_\_\_

Zip 02559

ESS Lab # 1708128

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

Analysis Ammonia Nitrogen

Vol of Container

Type of Container

# of Containers

Pres Code

Sample ID

Matrix

Grab-G Composite-C

Collection Time

Date

ESS Lab ID

1

8-4-17

851

G

H<sub>2</sub>O

MW-15 (155-145)

1

P

250 ml

X

2

8-4-17

851

G

H<sub>2</sub>O

MW 15 (155-145)

1

P

250 ml

X

2

8-4-17

920

G

H<sub>2</sub>O

MW 15 (125-115)

3

P

1000 ml

X

2

8-4-17

920

G

H<sub>2</sub>O

MW 15 (125-115)

3

P

1000 ml

X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9- \_\_\_\_\_

Cooler Present Yes No \_\_\_\_\_

Seals Intact Yes No NAY

Cooler Temperature: 5-31ccm

Internal Use Only

Sampled by: SC

Comments:

Received by: (Signature, Date & Time) 8/4/17 1600

Relinquished by: (Signature, Date & Time) 8/4/17 1703

Received by: (Signature, Date & Time) 8/4/17 1600

Relinquished by: (Signature, Date & Time) 8/4/17 1703

Received by: (Signature, Date & Time) \_\_\_\_\_

Relinquished by: (Signature, Date & Time) \_\_\_\_\_

1 (White) Lab Copy

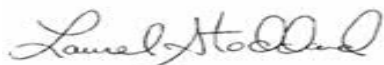
2 (Yellow) Client Receipt

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708129**

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 2:47 pm, Aug 08, 2017****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: 1708129

**SAMPLE RECEIPT**

The following samples were received on August 04, 2017 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>
1708129-01	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-02	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-03	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-04	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-05	PW-1 (130-160)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708129

**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: 1708129

**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: PW-1 (130-160)  
Date Sampled: 08/03/17 20:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708129  
ESS Laboratory Sample ID: 1708129-01  
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	11.8 (1.00)		350.1		10	JLK	08/07/17 17:49	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 19:58	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:14	mg/L	CH70432
<b>Total Kjeldahl Nitrogen as N</b>	<b>15.4 (2.00)</b>		351.2		10	EEM	08/07/17 15:11	mg/L	CH70709
<b>Total Nitrogen</b>	<b>15.4 (2.02)</b>		4500N		10	EEM	08/07/17 15:11	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (130-160)  
Date Sampled: 08/04/17 00:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708129  
ESS Laboratory Sample ID: 1708129-02  
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	12.0 (1.00)		350.1		10	JLK	08/07/17 17:55	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 19:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:15	mg/L	CH70432
<b>Total Kjeldahl Nitrogen as N</b>	<b>15.3 (2.00)</b>		351.2		10	EEM	08/07/17 15:12	mg/L	CH70709
<b>Total Nitrogen</b>	<b>15.3 (2.02)</b>		4500N		10	EEM	08/07/17 15:12	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (130-160)  
Date Sampled: 08/04/17 04:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708129  
ESS Laboratory Sample ID: 1708129-03  
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	11.3 (1.00)		350.1		10	JLK	08/07/17 17:56	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 20:00	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:16	mg/L	CH70432
<b>Total Kjeldahl Nitrogen as N</b>	<b>14.9 (2.00)</b>		351.2		10	EEM	08/07/17 15:13	mg/L	CH70709
<b>Total Nitrogen</b>	<b>14.9 (2.02)</b>		4500N		10	EEM	08/07/17 15:13	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (130-160)  
Date Sampled: 08/04/17 07:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708129  
ESS Laboratory Sample ID: 1708129-04  
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	13.3 (1.00)		350.1		10	JLK	08/07/17 17:57	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 20:01	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:17	mg/L	CH70432
<b>Total Kjeldahl Nitrogen as N</b>	<b>15.1 (2.00)</b>		351.2		10	EEM	08/07/17 15:14	mg/L	CH70709
<b>Total Nitrogen</b>	<b>15.1 (2.02)</b>		4500N		10	EEM	08/07/17 15:14	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (130-160)  
Date Sampled: 08/04/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1708129  
ESS Laboratory Sample ID: 1708129-05  
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	2.46 (0.100)		200.7		1	BJV	08/07/17 12:32	10	10	CH70722
Manganese	3.48 (0.020)		200.7		1	BJV	08/07/17 12:32	10	10	CH70722



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-1 (130-160)  
Date Sampled: 08/04/17 09:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1708129  
ESS Laboratory Sample ID: 1708129-05  
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	11.1 (1.00)		350.1		10	JLK	08/07/17 17:57	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 20:07	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:23	mg/L	CH70432
<b>Total Kjeldahl Nitrogen as N</b>	<b>15.2 (2.00)</b>		351.2		10	EEM	08/07/17 15:15	mg/L	CH70709
<b>Total Nitrogen</b>	<b>15.2 (2.02)</b>		4500N		10	EEM	08/07/17 15:15	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708129

**Quality Control Data**

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

Dissolved Metals

**Batch CH70722 - 200.7/6010BNoDigest**

**Blank**

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

**Blank**

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

**LCS**

Iron	2.44		mg/L	2.500		98	80-120			
Manganese	0.491		mg/L	0.5000		98	80-120			

Classical Chemistry

**Batch CH70432 - [CALC]**

**Blank**

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

**LCS**

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

**Batch CH70433 - [CALC]**

**Blank**

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							

**LCS**

Nitrate as N	0.477		mg/L							
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Total Nitrogen	0.477		mg/L							

**Batch CH70708 - NH4 Prep**

**Blank**

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

**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		99	80-120			
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**LCS**

Ammonia as N	1.19	0.10	mg/L	0.9994		119	80-120			
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**Batch CH70709 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708129

**Quality Control Data**

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

**Batch CH70709 - [CALC]**

Total Nitrogen	ND	0.200	mg/L							
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**LCS**

Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Nitrogen	17.0	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708129

**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: 1708129

**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: 1708129

Shipped/Delivered Via: ESS Courier

Date Received: 8/4/2017

Project Due Date: 8/8/2017

Days for Project: 2 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: 5.3 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	152606	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	152611	Yes	NA	Yes	1L Poly - H2SO4	NP	
02	152605	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	152610	Yes	NA	Yes	1L Poly - H2SO4	NP	
03	152604	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	152609	Yes	NA	Yes	1L Poly - H2SO4	NP	
04	152603	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	152608	Yes	NA	Yes	1L Poly - H2SO4	NP	
05	152602	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	152607	Yes	NA	Yes	1L Poly - H2SO4	NP	
05	152622	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review  
Are barcode labels on correct containers?  Yes / No

Completed By: [Signature] Date & Time: 8/4/17 1726  
Reviewed By: [Signature] Date & Time: 8/4/17 1742  
Delivered By: [Signature] Date & Time: 8/4/17 1742

# ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time 48 Standard Other \_\_\_\_\_  
 Regulatory State MA RI CT NH NJ NY ME Other \_\_\_\_\_  
 Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

ESS Lab # 1708129

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

Co. Name AECOM Project Name Orleans Landfill  
 Contact Person Mark Owen Address 9 Jonathan Bourne Drive  
 City Pocasset State MA Zip 02559  
 Tel. 978-204-0983 email: mark.owen@aecom.com

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis	
										NO <sub>3</sub> NO <sub>2</sub>	PM <sub>10</sub> TSP TKN
1	8-3-17	8:00 PM	G	H <sub>2</sub> O	PW-1 (130-160)	1	1	P	250 ml	X	
1	8-3-17	8:00 PM	G	H <sub>2</sub> O	PW-1 (130-160)	3	1	P	1000 ml		X
2	8-4-17	12:00 AM	G	H <sub>2</sub> O	PW-1 (130-160)	1	1	P	250 ml	X	
2	8-4-17	12:00 AM	G	H <sub>2</sub> O	PW-1 (130-160)	3	1	P	1000 ml		X
3	8-4-17	4:00 AM	G	H <sub>2</sub> O	PW-1 (130-160)	1	1	P	250 ml	X	
3	8-4-17	4:00 AM	G	H <sub>2</sub> O	PW-1 (130-160)	3	1	P	1000 ml		X
4	8-4-17	7:00 AM	G	H <sub>2</sub> O	PW-1 (130-160)	1	1	P	250 ml	X	
4	8-4-17	7:00 AM	G	H <sub>2</sub> O	PW-1 (130-160)	3	1	P	1000 ml		X
5	8-4-17	9:55 AM	G	H <sub>2</sub> O	PW1 (130-160)	1	1	P	250 ml	X	
5	8-4-17	9:55 AM	G	H <sub>2</sub> O	PW1 (130-160)	3	1	P	1000 ml		X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix: S-Soil SD-Solid D-Sludge WM-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filler

Cooler Present  Yes  No  Internal Use Only  Preservation Code: 1-NP, 2-HCl, 3-H<sub>2</sub>SO<sub>4</sub>, 4-HNO<sub>3</sub>, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-\_\_\_\_\_

Seals Intact  Yes  No NA:   Pickup  Technician \_\_\_\_\_

Cooler Temperature: 5.3 ICE in Comments: added Diss Lab Filtered Feb 17  
per m.o. on 8/17

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
<i>[Signature]</i> 8/4/17 1600	<i>[Signature]</i> 8/17 1600
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
<i>[Signature]</i> 8/4/17 1716	<i>[Signature]</i> 8/17 1716

\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

1 (White) Lab Copy  
 2 (Yellow) Client Receipt


Please fax to the laboratory all changes to Chain of Custody

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708202**

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 2:43 pm, Aug 16, 2017****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: 1708202

**SAMPLE RECEIPT**

The following samples were received on August 08, 2017 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>
1708202-01	MW-16D	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708202-02	MW-16S	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708202-03	MW-2 (140-150)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708202-04	MW-2 (124-131)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708202

**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: 1708202

**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-16D  
Date Sampled: 08/08/17 09:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-01  
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	4.77 (0.100)		200.7		1	KJK	08/09/17 20:51	10	10	CH70919
Manganese	3.26 (0.020)		200.7		1	KJK	08/09/17 20:51	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-16D  
Date Sampled: 08/08/17 09:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-01  
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	7.39 (0.20)		350.1		2	JLK	08/10/17 18:06	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 18:29	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:46	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>9.09 (0.40)</b>		351.2		2	JLK	08/11/17 19:49	mg/L	CH71005
<b>Total Nitrogen</b>	<b>9.09 (0.42)</b>		4500N		2	JLK	08/11/17 19:49	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-16S  
Date Sampled: 08/08/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-02  
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	2.32 (0.100)		200.7		1	KJK	08/09/17 20:55	10	10	CH70919
Manganese	1.72 (0.020)		200.7		1	KJK	08/09/17 20:55	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-16S  
Date Sampled: 08/08/17 10:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-02  
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	10.3 (0.50)		350.1		5	JLK	08/10/17 18:06	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 18:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:49	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>12.3 (1.00)</b>		351.2		5	JLK	08/11/17 19:50	mg/L	CH71005
<b>Total Nitrogen</b>	<b>12.3 (1.02)</b>		4500N		5	JLK	08/11/17 19:50	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 08/08/17 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-03  
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	08/09/17 20:59	10	10	CH70919
Manganese	4.59 (0.020)		200.7		1	KJK	08/09/17 20:59	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (140-150)  
Date Sampled: 08/08/17 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-03  
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	11.0 (0.50)		350.1		5	JLK	08/10/17 18:14	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 18:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:50	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>12.5 (1.00)</b>		351.2		5	JLK	08/11/17 19:51	mg/L	CH71005
<b>Total Nitrogen</b>	<b>12.5 (1.02)</b>		4500N		5	JLK	08/11/17 19:51	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (124-131)  
Date Sampled: 08/08/17 16:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-04  
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	0.148 (0.100)		200.7		1	KJK	08/09/17 21:04	10	10	CH70919
Manganese	4.62 (0.020)		200.7		1	KJK	08/09/17 21:04	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (124-131)  
Date Sampled: 08/08/17 16:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1708202  
ESS Laboratory Sample ID: 1708202-04  
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	10.9 (0.50)		350.1		5	JLK	08/10/17 18:15	mg/L	CH70905
Nitrate as N	0.154 (0.030)		353.2		1	JLK	08/09/17 18:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:51	mg/L	CH70924
Total Kjeldahl Nitrogen as N	13.1 (1.00)		351.2		5	JLK	08/11/17 19:51	mg/L	CH71005
Total Nitrogen	13.2 (1.02)		4500N		5	JLK	08/11/17 19:51	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708202

**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 CH70919 - 200.7/6010BNoDigest**

<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	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	0.489		mg/L	0.5000		98	80-120			

Classical Chemistry

**Batch CH70905 - NH4 Prep**

<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.11	0.10	mg/L	0.09994		111	80-120			
<b>LCS</b>										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			

**Batch CH70924 - [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	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			

**Batch CH70925 - [CALC]**

<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	0.02	mg/L							
<b>LCS</b>										
Nitrate as N	0.492		mg/L							
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Total Nitrogen	0.492		mg/L							

**Batch CH71005 - TKN Prep**

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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708202

**Quality Control Data**

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

**Batch CH71005 - [CALC]**

Total Nitrogen	ND	0.20	mg/L							
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**LCS**

Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Nitrogen	15.7	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708202

**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: 1708202

**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

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time Standard Other \_\_\_\_\_  
 Regulatory State MA RI CT NH NJ NY ME Other \_\_\_\_\_  
 Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Co. Name: MARK OWEN / AECOM  
 Contact Person: MARK OWEN  
 City: Pocasset State: MA  
 Project Name: ORLEANS, MA  
 Address: Lot Hollow Rd PO #: \_\_\_\_\_  
 Zip: 02559  
 email: mark.owen@aecom.com

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis
1	08/08/17	0945	G	GW	MW-16D	3	3	P	3	Total Nitrogen TKN Ammonia Nitrogen Nitrate Nitrogen Nitrite Nitrogen Dissolved Fe/Mn
2	08/08/17	1045	G	GW	MW-16S	3	3	P	3	Total Nitrogen TKN Ammonia Nitrogen Nitrate Nitrogen Nitrite Nitrogen Dissolved Fe/Mn
3	08/08/17	1530	G	GW	MW-2 (140-150)	3	3	P	3	Total Nitrogen TKN Ammonia Nitrogen Nitrate Nitrogen Nitrite Nitrogen Dissolved Fe/Mn
4	08/08/17	1635	G	GW	MW-2 (124-131)	3	3	P	3	Total Nitrogen TKN Ammonia Nitrogen Nitrate Nitrogen Nitrite Nitrogen Dissolved Fe/Mn

Container Type: P-Poly G-Glass AG-Amber Glass S-Stdale-VVOA  
 Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filler  
 Cooler Present  Yes  No  
 Seals Intact  Yes  No NA:   
 Cooler Temperature: 5.5 1.2 m  
 Sampled by: ERIKA AMIR-LIN  
 Comments: \_\_\_\_\_  
 Relinquished by: (Signature, Date & Time) [Signature] 8/17/17  
 Received by: (Signature, Date & Time) [Signature] 8/17/17  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_  
 Received by: (Signature, Date & Time) \_\_\_\_\_

ESS Lab # 1708202

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

1 (White) Lab Copy  
 2 (Yellow) Client Receipt

Please fax to the laboratory all changes to Chain of Custody

\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708238**

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 1:14 pm, Aug 17, 2017****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: 1708238

**SAMPLE RECEIPT**

The following samples were received on August 09, 2017 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>
1708238-01	MW-6 (88-98)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-02	MW-7 (90-100)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-03	MW-7 (115-125)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-04	MW-13 (117-127)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-05	MW-13 (74-84)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-06	MW-8 (84-94)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-07	MW-9 (92-102)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708238

**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: 1708238

**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-6 (88-98)  
Date Sampled: 08/09/17 09:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-01  
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	16.6 (0.100)		200.7		1	BJV	08/11/17 3:27	10	10	CH71031
Manganese	1.95 (0.020)		200.7		1	BJV	08/11/17 3:27	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-6 (88-98)  
Date Sampled: 08/09/17 09:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-01  
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	24.5 (1.00)		350.1		10	JLK	08/10/17 18:16	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:35	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:42	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>26.0 (2.00)</b>		351.2		10	JLK	08/11/17 19:52	mg/L	CH71005
<b>Total Nitrogen</b>	<b>26.0 (2.02)</b>		4500N		10	JLK	08/11/17 19:52	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 08/09/17 10:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-02  
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	9.30 (0.100)		200.7		1	BJV	08/11/17 3:44	10	10	CH71031
Manganese	0.749 (0.020)		200.7		1	BJV	08/11/17 3:44	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (90-100)  
Date Sampled: 08/09/17 10:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-02  
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	0.12 (0.10)		350.1		1	JLK	08/10/17 17:44	mg/L	CH70905
Nitrate as N	3.04 (0.110)		353.2		5	JLK	08/09/17 21:54	mg/L	[CALC]
Nitrite as N	0.032 (0.010)		353.2		1	JLK	08/09/17 20:43	mg/L	CH70924
Total Kjeldahl Nitrogen as N	0.93 (0.20)		351.2		1	JLK	08/11/17 19:03	mg/L	CH71005
Total Nitrogen	4.00 (0.30)		4500N		5	JLK	08/11/17 19:03	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (115-125)  
Date Sampled: 08/09/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-03  
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	17.0 (0.100)		200.7		1	BJV	08/11/17 3:48	10	10	CH71031
Manganese	2.40 (0.020)		200.7		1	BJV	08/11/17 3:48	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-7 (115-125)  
Date Sampled: 08/09/17 11:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-03  
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	2.01 (0.10)		350.1		1	JLK	08/10/17 17:47	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:37	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:44	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>2.65 (0.20)</b>		351.2		1	JLK	08/11/17 19:04	mg/L	CH71005
<b>Total Nitrogen</b>	<b>2.65 (0.22)</b>		4500N		1	JLK	08/11/17 19:04	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-13 (117-127)  
Date Sampled: 08/09/17 12:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-04  
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	BJV	08/11/17 3:52	10	10	CH71031
Manganese	0.131 (0.020)		200.7		1	BJV	08/11/17 3:52	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-13 (117-127)  
Date Sampled: 08/09/17 12:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-04  
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	08/10/17 17:48	mg/L	CH70905
Nitrate as N	<b>1.45</b> (0.110)		353.2		5	JLK	08/09/17 21:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:45	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>0.45</b> (0.20)		351.2		1	JLK	08/11/17 19:05	mg/L	CH71005
<b>Total Nitrogen</b>	<b>1.90</b> (0.30)		4500N		5	JLK	08/11/17 19:05	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-13 (74-84)  
Date Sampled: 08/09/17 14:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-05  
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	4.10 (0.100)		200.7		1	BJV	08/11/17 3:56	10	10	CH71031
Manganese	0.163 (0.020)		200.7		1	BJV	08/11/17 3:56	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-13 (74-84)  
Date Sampled: 08/09/17 14:05  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-05  
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	08/10/17 17:56	mg/L	CH70905
Nitrate as N	<b>1.48</b> (0.110)		353.2		5	JLK	08/09/17 21:56	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:45	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>0.56</b> (0.20)		351.2		1	JLK	08/11/17 19:05	mg/L	CH71005
<b>Total Nitrogen</b>	<b>2.04</b> (0.30)		4500N		5	JLK	08/11/17 19:05	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-8 (84-94)  
Date Sampled: 08/09/17 15:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-06  
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	BJV	08/11/17 4:13	10	10	CH71031
Manganese	<b>0.104</b> (0.020)		200.7		1	BJV	08/11/17 4:13	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-8 (84-94)  
Date Sampled: 08/09/17 15:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-06  
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	08/10/17 17:57	mg/L	CH70905
Nitrate as N	11.5 (0.410)		353.2		20	JLK	08/09/17 21:56	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:46	mg/L	CH70924
Total Kjeldahl Nitrogen as N	1.91 (0.20)		351.2		1	JLK	08/11/17 19:06	mg/L	CH71005
Total Nitrogen	13.4 (0.60)		4500N		20	JLK	08/11/17 19:06	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-9 (92-102)  
Date Sampled: 08/09/17 16:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-07  
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	BJV	08/11/17 4:17	10	10	CH71031
Manganese	<b>0.031</b> (0.020)		200.7		1	BJV	08/11/17 4:17	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-9 (92-102)  
Date Sampled: 08/09/17 16:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708238  
ESS Laboratory Sample ID: 1708238-07  
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	08/10/17 17:58	mg/L	CH70905
Nitrate as N	<b>5.66</b> (0.210)		353.2		10	JLK	08/09/17 21:57	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:47	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>1.03</b> (0.20)		351.2		1	JLK	08/11/17 19:07	mg/L	CH71005
<b>Total Nitrogen</b>	<b>6.69</b> (0.40)		4500N		10	JLK	08/11/17 19:07	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708238

**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 CH71031 - 200.7/6010BNoDigest**

<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
<b>LCS</b>										
Iron	2.38		mg/L	2.500		95	80-120			
Manganese	0.498		mg/L	0.5000		100	80-120			

Classical Chemistry

**Batch CH70905 - NH4 Prep**

<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.11	0.10	mg/L	0.09994		111	80-120			
<b>LCS</b>										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			

**Batch CH70924 - [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	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			

**Batch CH70925 - [CALC]**

<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	0.02	mg/L							
<b>LCS</b>										
Nitrate as N	0.492		mg/L							
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Total Nitrogen	0.492		mg/L							

**Batch CH71005 - TKN Prep**

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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708238

**Quality Control Data**

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

**Batch CH71005 - [CALC]**

Total Nitrogen	ND	0.20	mg/L							
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**LCS**

Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Nitrogen	15.7	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708238

**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: 1708238

**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: 1708238

Date Received: 8/9/2017

Project Due Date: 8/17/2017

Days for Project: 5 Day

Shipped/Delivered Via: ESS Courier

- |  |  |
|--|--|
| <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>2.4</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? <input checked="" type="checkbox"/> Yes / No</p> |
|--|--|

- |  |  |
|--|--|
| <p>11. Any Subcontracting needed? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/><br/>ESS Sample IDs: _____<br/>Analysis: _____<br/>TAT: _____</p> | <p>12. Were VOAs received? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/><br/>a. Air bubbles in aqueous VOAs? Yes / No / NA<br/>b. Does methanol cover soil completely? Yes / No / NA</p> |
|--|--|

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:  
No project name as 8/17

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	153591	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	153604	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	153605	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153590	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	153602	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153603	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153589	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	153600	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153601	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153588	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	153598	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153599	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	153613	Yes	NA	Yes	1L Amber - H2SO4	H2SO4	
05	153618	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	153619	Yes	NA	Yes	250 mL Poly - Unpres	NP	
06	153612	Yes	NA	Yes	1L Amber - H2SO4	H2SO4	
06	153616	Yes	NA	Yes	250 mL Poly - Unpres	NP	
06	153617	Yes	NA	Yes	250 mL Poly - Unpres	NP	
07	153611	Yes	NA	Yes	1L Amber - H2SO4	H2SO4	
07	153614	Yes	NA	Yes	250 mL Poly - Unpres	NP	
07	153615	Yes	NA	Yes	250 mL Poly - Unpres	NP	

# ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1708238

Date Received: 8/9/2017

Are barcode labels on correct containers?

Yes /  No

Completed By: [Signature]

Date & Time: 8/9/17 1957

Reviewed By: [Signature]

Date & Time: 8/9/17 2016

Delivered By: [Signature]

Date & Time: 8/9/17 2016

ESS Laboratory

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

CHAIN OF CUSTODY

Turn Time 5-Day Rush

Regulatory State

Is this project for any of the following?:

OCT RCP  MA MCP  I-SP  Standard Excel

ESS Lab # 108838

Reporting Limits

Electronic Deliverables  Limit Checker  Other (Please Specify ->)

Company Name  
AECOM

Project #  
00476644

ORLEANS

Project No. 10/17

Contact Person  
Julianne Mamon

Address

PO #

City  
Charlottesville

State  
MA

Zip Code

PO #

Telephone Number  
978-905-2419

FAX Number

Email Address

Julianne.Mamon@aecom.com

ESS Lab ID

Collection Date

Collection Time

Sample Matrix

Sample ID

Analysis

1 08/09/17 0925 G GW MW-6(88-98)

2 08/09/17 1020 G GW MW-7(90-100)

3 08/09/17 1100 G GW MW-7(115-125)

4 08/09/17 1235 G GW MW-13(117-127)

5 08/09/17 1405 G GW MW-13(74-84)

6 08/09/17 1515 G GW MW-8(84-94)

7 08/09/17 1625 G GW MW-9(92-102)

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other\*

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAc2, NaCl 9-NH4Cl 10-DI H2O 11-Other

Number of Containers per Sample:

Analysis: TN, TRV, Ammonia, NO2, NO3, DISSIC, Mn

Laboratory Use Only

Cooler Present:   
 Seals Intact:   
 Cooler Temperature: 0.5-2.0°C  
 Relinquished by: (Signature, Date & Time) [Signature] 8/9/17 17:05  
 Relinquished by: (Signature, Date & Time) [Signature] 8/9/17 17:05

Sampled by: BKM

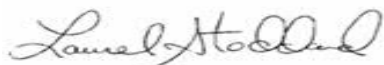
Comments: Please specify "Other" preservative and containers types in this space  
 Relinquished By: (Signature, Date & Time) [Signature] 8/9/17 19:26  
 Relinquished By: (Signature, Date & Time) [Signature] 8/9/17 19:45

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708239**

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 2:07 pm, Aug 17, 2017

**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: 1708239

**SAMPLE RECEIPT**

The following samples were received on August 09, 2017 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>
1708239-01	MW-2S	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708239-02	MW-2 (160-170)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708239-03	MW-2 (236-246)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708239-04	MW-2 (236-246) DUP	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708239

**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: 1708239

**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-2S  
Date Sampled: 08/09/17 08:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-01  
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	BJV	08/10/17 23:38	10	10	CH70919
Manganese	<b>0.514</b> (0.020)		200.7		1	BJV	08/10/17 23:38	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2S  
Date Sampled: 08/09/17 08:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-01  
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	0.11 (0.10)		350.1		1	JLK	08/10/17 17:58	mg/L	CH70905
Nitrate as N	16.6 (0.410)		353.2		20	JLK	08/09/17 21:58	mg/L	[CALC]
Nitrite as N	0.025 (0.010)		353.2		1	JLK	08/09/17 20:48	mg/L	CH70924
Total Kjeldahl Nitrogen as N	2.02 (0.20)		351.2		1	JLK	08/11/17 19:08	mg/L	CH71005
Total Nitrogen	18.7 (0.60)		4500N		20	JLK	08/11/17 19:08	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (160-170)  
Date Sampled: 08/09/17 09:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-02  
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	1.15 (0.100)		200.7		1	BJV	08/10/17 23:43	10	10	CH70919
Manganese	6.72 (0.020)		200.7		1	BJV	08/10/17 23:43	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (160-170)  
Date Sampled: 08/09/17 09:35  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-02  
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	13.2 (0.50)		350.1		5	JLK	08/10/17 18:17	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:43	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:49	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>17.1 (2.00)</b>		351.2		10	JLK	08/11/17 19:53	mg/L	CH71005
<b>Total Nitrogen</b>	<b>17.1 (2.02)</b>		4500N		10	JLK	08/11/17 19:53	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (236-246)  
Date Sampled: 08/09/17 16:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-03  
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	10.6 (0.100)		200.7		1	BJV	08/10/17 23:47	10	10	CH70919
Manganese	4.97 (0.020)		200.7		1	BJV	08/10/17 23:47	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (236-246)  
Date Sampled: 08/09/17 16:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-03  
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	4.52 (0.10)		350.1		1	JLK	08/10/17 18:00	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:44	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:50	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>5.23 (0.40)</b>		351.2		2	JLK	08/11/17 19:54	mg/L	CH71005
<b>Total Nitrogen</b>	<b>5.23 (0.42)</b>		4500N		2	JLK	08/11/17 19:54	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (236-246) DUP  
Date Sampled: 08/09/17 16:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-04  
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	10.6 (0.100)		200.7		1	BJV	08/10/17 23:51	10	10	CH70919
Manganese	5.00 (0.020)		200.7		1	BJV	08/10/17 23:51	10	10	CH70919



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-2 (236-246) DUP  
Date Sampled: 08/09/17 16:45  
Percent Solids: N/A

ESS Laboratory Work Order: 1708239  
ESS Laboratory Sample ID: 1708239-04  
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	4.77 (0.10)		350.1		1	JLK	08/10/17 18:01	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:49	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:56	mg/L	CH70924
<b>Total Kjeldahl Nitrogen as N</b>	<b>5.54 (0.40)</b>		351.2		2	JLK	08/11/17 19:54	mg/L	CH71005
<b>Total Nitrogen</b>	<b>5.54 (0.42)</b>		4500N		2	JLK	08/11/17 19:54	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708239

**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 CH70919 - 200.7/6010BNoDigest**

<b>Blank</b>										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	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	0.489		mg/L	0.5000		98	80-120			

Classical Chemistry

**Batch CH70905 - NH4 Prep**

<b>Blank</b>										
Ammonia as N	ND	0.10	mg/L							
<b>LCS</b>										
Ammonia as N	0.11	0.10	mg/L	0.09994		111	80-120			
<b>LCS</b>										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			

**Batch CH70924 - [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	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			

**Batch CH70925 - [CALC]**

<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	0.02	mg/L							
<b>LCS</b>										
Nitrate as N	0.492		mg/L							
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Total Nitrogen	0.492		mg/L							

**Batch CH71005 - TKN Prep**

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



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708239

**Quality Control Data**

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

**Batch CH71005 - [CALC]**

Total Nitrogen	ND	0.20	mg/L							
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**LCS**

Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Nitrogen	15.7	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708239

**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: 1708239

**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: Environment - ENSR  
AECOM - Earth Tech - KPB/MM  
*to 8/9/17*

ESS Project ID: 1708239  
 Date Received: 8/9/2017  
 Project Due Date: 8/17/2017  
 Days for Project: 5 Day

Shipped/Delivered Via: Client - ESS Courier

- |  |   |
|--|---|
| 1. Air bill manifest present? <input type="checkbox"/> No<br>Air No.: <u>NA</u><br>2. Were custody seals present? <input type="checkbox"/> No<br>3. Is radiation count <100 CPM? <input type="checkbox"/> Yes<br>4. Is a Cooler Present? <input type="checkbox"/> Yes<br>Temp: <u>2.9</u> Iced with: <u>Ice</u><br>5. Was COC signed and dated by client? <input type="checkbox"/> Yes | 6. Does COC match bottles? <input type="checkbox"/> Yes<br>7. Is COC complete and correct? <input type="checkbox"/> Yes<br>8. Were samples received intact? <input type="checkbox"/> Yes<br>9. Were labs informed about <b>short holds &amp; rushes</b> ? <input type="checkbox"/> Yes / <input type="checkbox"/> No / <input type="checkbox"/> NA<br>10. Were any analyses received outside of hold time? <input type="checkbox"/> Yes / <input type="checkbox"/> No |
|--|---|

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

Sample Receiving Notes:

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

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	153623	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	153630	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	153631	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153622	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	153628	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153629	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153621	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	153626	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153627	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153620	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	153624	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153625	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review

Are barcode labels on correct containers?  Yes /  No

Completed By: [Signature] Date & Time: 8/9/17 2006  
 Reviewed By: [Signature] Date & Time: 8/9/17 2012  
 Delivered By: [Signature] Date & Time: 8/9/17 2012

# ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time Standard Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Co. Name AECOM Project Name OPELANS, MA  
 Contact Person MARK OWEN Address 9 Jonathan Bouene Dr. PO # \_\_\_\_\_  
 City Rocasset State MA Zip 01359  
 Tel. 508-833-6950 Fax 508-833-6951 email: MARK.OWEN@aec.com

ESS Lab # 1708239

Reporting Limits - \_\_\_\_\_

Electronic Deliverables Excel Access PDF

ESS Lab ID	Date	Collection Time	Grab-G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Analysis						
									Total Nitrogen	Ammonia Nitrogen	TKN	Nitrate Nitrogen	Nitrite Nitrogen	Dissolved Fe/ln	
1	08/09/17	0825	G	GW	MW-2.5	3	3	P	X	X	X	X	X	X	X
2	08/09/17	0935	G	GW	MW-2(160-170)	3	3	P	X	X	X	X	X	X	X
3	08/09/17	1045	G	GW	MW-2(236-246)	3	3	P	X	X	X	X	X	X	X
4	08/09/17	1045	G	GW	MW-2(236-246) DUP	3	3	P	X	X	X	X	X	X	X

Container Type: P-Poly G-Glass AG-Ambey/Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present  Yes  No

Internal Use Only

Seals Intact  Yes  No NA: ATV/Pickup

Sampled by: ERIKA AMIR-LIN

Cooler Temperature: 0.72.97

Comments:

Delivered by: (Signature/Date & Time) [Signature] 8/9/17

Received by: (Signature, Date & Time) [Signature] 8/9/17

Relinquished by: (Signature) Date & Time

Received by: (Signature, Date & Time) [Signature] 8/9/17

Relinquished by: (Signature, Date & Time)

Received by: (Signature, Date & Time) [Signature] 8/9/17

\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIII

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy  
 2 (Yellow) Client Receipt



*CERTIFICATE OF ANALYSIS*

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708290**

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 7:15 pm, Aug 18, 2017*

**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: 1708290

**SAMPLE RECEIPT**

The following samples were received on August 10, 2017 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>
1708290-01	MW-5S	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708290-02	MW-5	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708290

**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: 1708290

**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-5S  
Date Sampled: 08/10/17 10:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1708290  
ESS Laboratory Sample ID: 1708290-01  
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	08/11/17 11:15	10	10	CH71031
Manganese	0.053 (0.020)		200.7		1	KJK	08/11/17 11:15	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5S  
Date Sampled: 08/10/17 10:55  
Percent Solids: N/A

ESS Laboratory Work Order: 1708290  
ESS Laboratory Sample ID: 1708290-01  
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	EEM	08/15/17 14:55	mg/L	CH71110
Nitrate as N	<b>9.54</b> (0.410)		353.2		20	JLK	08/11/17 21:26	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/11/17 20:27	mg/L	CH71130
<b>Total Kjeldahl Nitrogen as N</b>	<b>2.06</b> (0.20)		351.2		1	EEM	08/17/17 15:23	mg/L	CH71602
<b>Total Nitrogen</b>	<b>11.6</b> (0.600)		4500N		20	EEM	08/17/17 15:23	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5  
Date Sampled: 08/10/17 12:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1708290  
ESS Laboratory Sample ID: 1708290-02  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.120 (0.100)		200.7		1	KJK	08/11/17 11:31	10	10	CH71031
Manganese	1.39 (0.020)		200.7		1	KJK	08/11/17 11:31	10	10	CH71031



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5  
Date Sampled: 08/10/17 12:15  
Percent Solids: N/A

ESS Laboratory Work Order: 1708290  
ESS Laboratory Sample ID: 1708290-02  
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	9.40 (0.20)		350.1		2	EEM	08/15/17 15:07	mg/L	CH71110
Nitrate as N	ND (0.030)		353.2		1	JLK	08/11/17 21:15	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/11/17 20:28	mg/L	CH71130
<b>Total Kjeldahl Nitrogen as N</b>	<b>10.4 (2.00)</b>		351.2		10	EEM	08/17/17 15:36	mg/L	CH71602
<b>Total Nitrogen</b>	<b>10.4 (2.02)</b>		4500N		10	EEM	08/17/17 15:36	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708290

**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 CH71031 - 200.7/6010BNoDigest**

**Blank**

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

**Blank**

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

**LCS**

Iron	2.38		mg/L	2.500		95	80-120			
Manganese	0.498		mg/L	0.5000		100	80-120			

Classical Chemistry

**Batch CH71110 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.11	0.10	mg/L	0.09994		114	80-120			
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**LCS**

Ammonia as N	0.95	0.10	mg/L	0.9994		95	80-120			
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**Batch CH71130 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.256		mg/L	0.2497		102	90-110			
Nitrite as N	0.256		mg/L	0.2497		102	90-110			

**Batch CH71131 - [CALC]**

**Blank**

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							

**LCS**

Nitrate as N	0.496		mg/L							
Nitrate/Nitrite as N	0.496		mg/L	0.5000		99	90-110			
Nitrate/Nitrite as N	0.496		mg/L	0.5000		99	90-110			
Total Nitrogen	0.496		mg/L							

**Batch CH71602 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708290

**Quality Control Data**

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

**Batch CH71602 - [CALC]**

Total Nitrogen	ND	0.200	mg/L							
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**LCS**

Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Nitrogen	16.7	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR

Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

**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: 1708290

**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

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211

Tel. (401) 461-7181 Fax (401) 461-4486

www.esslaboratory.com

# CHAIN OF CUSTODY

Turn Time Standard Other \_\_\_\_\_

Regulatory State: MA RI CT NH NJ NY ME Other \_\_\_\_\_

Is this project for any of the following: (please circle)  
 MA-MCP Navy USACE CT DEP Other \_\_\_\_\_

Project # 60476644 Project Name Orleans, MA

Address 9 Jonathan Bourne Dr. PO # \_\_\_\_\_

City POLARSETT State MA Zip 02559

Tel. 508-833-6464 Fax 508-833-6451 email: mark.owen@aecom.com

ESS Lab ID \_\_\_\_\_ Date \_\_\_\_\_ Collection Time \_\_\_\_\_

Grab-G Composite-C \_\_\_\_\_ Matrix \_\_\_\_\_ Sample ID \_\_\_\_\_

Pres Code \_\_\_\_\_ # of Containers \_\_\_\_\_ Type of Container \_\_\_\_\_

Vol of Container \_\_\_\_\_

Analysis \_\_\_\_\_

Electronic Deliverables Excel Access PDF

Reporting Limits - \_\_\_\_\_

ESS Lab # 1708290

Ammonia Nitrogen

Total Nitrogen

TKN

Nitrate

Nitrite

Dissolved Fe/m

14.25L

14.25L

3 P

3 P

3 B

3 B

MW-55

MW-5

GW

GW

G

G

08/10/17

1055

08/10/17

1215

X

X

X

X

X

X

X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA Matrix S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present  Yes  No Internal Use Only  Yes  No

Seals Intact  Yes  No NA: P

Cooler Temperature: 4.2°C

Sampled by: ERIKA AMIR-LIN

Comments: \_\_\_\_\_

Relinquished by: (Signature, Date & Time) [Signature] 8/10/17

Relinquished by: (Signature, Date & Time) [Signature] 8/10/17

Received by: (Signature, Date & Time) [Signature] 8/10/17

Received by: (Signature, Date & Time) [Signature] 8/10/17

1 (White) Lab Copy

2 (Yellow) Client Receipt

Please fax to the laboratory all changes to Chain of Custody

\* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIII



*CERTIFICATE OF ANALYSIS*

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708336**

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



**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: 1708336

**SAMPLE RECEIPT**

The following samples were received on August 15, 2017 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>
1708336-01	MW-5D	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708336-02	MW-3D	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708336-03	MW-14	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708336

**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: 1708336

**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-5D  
Date Sampled: 08/14/17 11:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708336  
ESS Laboratory Sample ID: 1708336-01  
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	0.820 (0.100)		200.7		1	KJK	08/15/17 12:04	10	10	CH71523
Manganese	0.664 (0.020)		200.7		1	KJK	08/15/17 12:04	10	10	CH71523



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-5D  
Date Sampled: 08/14/17 11:25  
Percent Solids: N/A

ESS Laboratory Work Order: 1708336  
ESS Laboratory Sample ID: 1708336-01  
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	13.7 (0.50)		350.1		5	JLK	08/17/17 17:28	mg/L	CH71614
Nitrate as N	ND (0.030)		353.2		1	JLK	08/15/17 21:20	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/15/17 20:31	mg/L	CH71537
<b>Total Kjeldahl Nitrogen as N</b>	<b>16.4 (2.00)</b>		351.2		10	EEM	08/17/17 15:38	mg/L	CH71602
<b>Total Nitrogen</b>	<b>16.4 (2.02)</b>		4500N		10	EEM	08/17/17 15:38	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3D  
Date Sampled: 08/14/17 13:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708336  
ESS Laboratory Sample ID: 1708336-02  
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	33.7 (0.100)		200.7		1	KJK	08/15/17 12:08	10	10	CH71523
Manganese	2.42 (0.020)		200.7		1	KJK	08/15/17 12:08	10	10	CH71523



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-3D  
Date Sampled: 08/14/17 13:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708336  
ESS Laboratory Sample ID: 1708336-02  
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	3.83 (0.10)		350.1		1	JLK	08/17/17 17:18	mg/L	CH71614
Nitrate as N	ND (0.030)		353.2		1	JLK	08/15/17 21:22	mg/L	[CALC]
Nitrite as N	0.015 (0.010)		353.2		1	JLK	08/15/17 20:34	mg/L	CH71537
Total Kjeldahl Nitrogen as N	5.26 (0.40)		351.2		2	EEM	08/17/17 15:39	mg/L	CH71602
Total Nitrogen	5.26 (0.42)		4500N		2	EEM	08/17/17 15:39	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-14  
Date Sampled: 08/14/17 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708336  
ESS Laboratory Sample ID: 1708336-03  
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	08/15/17 12:13	10	10	CH71523
Manganese	<b>0.050</b> (0.020)		200.7		1	KJK	08/15/17 12:13	10	10	CH71523



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: MW-14  
Date Sampled: 08/14/17 14:20  
Percent Solids: N/A

ESS Laboratory Work Order: 1708336  
ESS Laboratory Sample ID: 1708336-03  
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	0.16 (0.10)		350.1		1	JLK	08/17/17 17:19	mg/L	CH71614
Nitrate as N	8.44 (0.410)		353.2		20	JLK	08/15/17 21:37	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/15/17 20:35	mg/L	CH71537
Total Kjeldahl Nitrogen as N	1.11 (0.20)		351.2		1	EEM	08/17/17 15:35	mg/L	CH71602
Total Nitrogen	9.56 (0.60)		4500N		20	EEM	08/17/17 15:35	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708336

**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 CH71523 - 200.7/6010BNoDigest**

**Blank**

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

**LCS**

Iron	2.41		mg/L	2.500		96	80-120			
Manganese	0.485		mg/L	0.5000		97	80-120			

Classical Chemistry

**Batch CH71537 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
Nitrite as N	0.258		mg/L	0.2497		103	90-110			

**Batch CH71538 - [CALC]**

**Blank**

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	0.02	mg/L							

**LCS**

Nitrate as N	0.477		mg/L							
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Total Nitrogen	0.477		mg/L							

**Batch CH71602 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Nitrogen	16.7	2.00	mg/L							

**Batch CH71614 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.08	0.10	mg/L	0.09994		82	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708336

**Quality Control Data**

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

Classical Chemistry

**Batch CH71614 - NH4 Prep**

**LCS**

Ammonia as N	0.99	0.10	mg/L	0.9994		99	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708336

**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: 1708336

**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 - KPB/MM

ESS Project ID: 1708336

Date Received: 8/14/2017

Project Due Date: 8/21/2017

Days for Project: 5 Day

Shipped/Delivered Via: ESS Courier

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: 2.2 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	154650	Yes	NA	Yes	1L Poly - H2SO4	NP	
01	154655	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	154656	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	154649	Yes	NA	Yes	1L Poly - H2SO4	NP	
02	154653	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	154654	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	154648	Yes	NA	Yes	1L Poly - H2SO4	NP	
03	154651	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	154652	Yes	NA	Yes	250 mL Poly - Unpres	NP	

**2nd Review**

Are barcode labels on correct containers?  Yes / No

Completed By: [Signature] Date & Time: 8/15/17 0824

Reviewed By: [Signature] Date & Time: 8/15/17 0838

Delivered By: [Signature] 8/15/17 0838





**ESS Laboratory**  
*Division of Thielsch Engineering, Inc.*

**BAL Laboratory**  
*The Microbiology Division  
of Thielsch Engineering, Inc.*



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708336

***Items for Project Management Review***

**Classical Chemistry  
Dissolved Metals**



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708336

**PROJECT COMPLETION CHECKLIST**

All Reports:

- |  |     |    |     |
|--|-----|----|-----|
| 1. Has Report been Paginated?                              | Yes | No |     |
| 2. Has Report been Digitally Signed?                       | Yes | No |     |
| 3. Has MCP/PC Sheet been filled out?                       | Yes | No | N/A |
| 4. Have PRM and Fax Sheet been removed from the Project?   | Yes | No |     |
| 5. Is the correct Chain of Custody attached to the Report? | Yes | No |     |
| 6. Is the correct Cooler Receipt attached to the Report?   | Yes | No | N/A |

Contact Person: \_\_\_\_\_

EDD: \_\_\_\_\_

E-Mail: \_\_\_\_\_

- |  |     |    |     |
|--|-----|----|-----|
| 1. Does e-mail address in Element match the COC/CSR?           | Yes | No |     |
| 1a. If No, did you contact Customer Service?                   | Yes | No | N/A |
| 2. Are there any CCs for the report?                           | Yes | No |     |
| 3a If Yes, did you include them?                               | Yes | No | N/A |
| 4. Did you save a copy of the e-mail in the Work Order Folder? | Yes | No |     |

Client Connect: \_\_\_\_\_

- |   |     |    |     |
|---|-----|----|-----|
| 1. Did you save Report in CORRECT ClientConnect Folder? | Yes | No | N/A |
| 2. Did you save EDD in CORRECT ClientConnect Folder?    | Yes | No | N/A |

Fax: \_\_\_\_\_

- |  |     |    |     |
|--|-----|----|-----|
| 1. Does fax number in Element match the COC? | Yes | No |     |
| 1a. Did you contact Customer Service?        | Yes | No | N/A |
| 2. Was the fax "rejected" for any reason?    | Yes | No |     |
| 2a. Was the project re-faxed?                | Yes | No | N/A |
| 2b. Was Customer Service notified?           | Yes | No | N/A |

Updated to Faxed:      Yes      No      N/A      Initials: \_\_\_\_\_      Date: \_\_\_\_\_

# ESS Laboratory

Division of Thielsch Engineering, Inc.



## FAX

Date: \_\_\_\_\_

To: Mark Owen \_\_\_\_\_

Company: AECOM Environment - ENSR \_\_\_\_\_

Project Name: Orleans MA \_\_\_\_\_

ESS Work Order: 1708336 \_\_\_\_\_

Fax: (978) 589-3100 \_\_\_\_\_

### Comments:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Our certified laboratory provides a full range of services, including the following:

- Soil Characterization
- Petroleum Fingerprinting
- Priority Pollutant Analysis
- Groundwater, Wastewater and Drinking Water Analyses
- PCBs and Pesticides Analysis
- Trace Metals (ICAP/Furnace) Analysis
- Inorganic Analysis by Classic Methods, Flow Analyzer, and Ion Chromatography
- Organics by GC/Mass Spectroscopy
- Microbiology Analysis
- Massachusetts EPH/VPH Analysis
- Siloxanes
- Field Screening and Sample Technician Services

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Number of pages (including this cover): \_\_\_\_\_

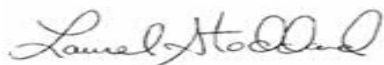
Date: \_\_\_\_\_ Faxed: \_\_\_\_\_ Initials: \_\_\_\_\_ Time: \_\_\_\_\_

## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708433**

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 4:48 pm, Aug 24, 2017

**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: 1708433

**SAMPLE RECEIPT**

The following samples were received on August 17, 2017 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>
1708433-01	PW-2S-2Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708433-02	PW-2S-4Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708433-03	PW-2S-7.5Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708433

**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: 1708433

**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: PW-2S-2Hr  
Date Sampled: 08/17/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708433  
ESS Laboratory Sample ID: 1708433-01  
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	BJV	08/21/17 15:34	10	10	CH71723
Manganese	4.20 (0.020)		200.7		1	KJK	08/18/17 14:06	10	10	CH71723



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2S-2Hr  
Date Sampled: 08/17/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708433  
ESS Laboratory Sample ID: 1708433-01  
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	7.37 (0.20)		350.1		2	JLK	08/22/17 21:40	mg/L	CH72115
Nitrate as N	0.412 (0.030)		353.2		1	JLK	08/17/17 22:17	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/17/17 21:13	mg/L	CH71740
Total Kjeldahl Nitrogen as N	10.2 (2.00)		351.2		10	EEM	08/21/17 15:59	mg/L	CH71806
Total Nitrogen	10.6 (2.02)		4500N		10	EEM	08/21/17 15:59	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2S-4Hr  
Date Sampled: 08/17/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708433  
ESS Laboratory Sample ID: 1708433-02  
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	BJV	08/21/17 15:38	10	10	CH71723
Manganese	4.17 (0.020)		200.7		1	KJK	08/18/17 14:11	10	10	CH71723



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2S-4Hr  
Date Sampled: 08/17/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708433  
ESS Laboratory Sample ID: 1708433-02  
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	7.11 (0.20)		350.1		2	JLK	08/22/17 21:42	mg/L	CH72115
Nitrate as N	0.519 (0.030)		353.2		1	JLK	08/17/17 22:18	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/17/17 21:13	mg/L	CH71740
Total Kjeldahl Nitrogen as N	8.87 (2.00)		351.2		10	EEM	08/21/17 16:00	mg/L	CH71806
Total Nitrogen	9.39 (2.02)		4500N		10	EEM	08/21/17 16:00	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2S-7.5Hr  
Date Sampled: 08/17/17 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1708433  
ESS Laboratory Sample ID: 1708433-03  
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	BJV	08/21/17 15:43	10	10	CH71723
Manganese	4.00 (0.020)		200.7		1	KJK	08/18/17 14:15	10	10	CH71723



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2S-7.5Hr  
Date Sampled: 08/17/17 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1708433  
ESS Laboratory Sample ID: 1708433-03  
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	6.74 (0.20)		350.1		2	JLK	08/22/17 21:43	mg/L	CH72115
Nitrate as N	0.626 (0.030)		353.2		1	JLK	08/17/17 22:19	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/17/17 21:14	mg/L	CH71740
Total Kjeldahl Nitrogen as N	8.62 (2.00)		351.2		10	EEM	08/21/17 16:01	mg/L	CH71806
Total Nitrogen	9.25 (2.02)		4500N		10	EEM	08/21/17 16:01	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708433

**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 CH71723 - 200.7/6010BNoDigest**

**Blank**

Iron ND 0.100 mg/L

**Blank**

Iron ND 0.100 mg/L

Manganese ND 0.020 mg/L

**LCS**

Iron 2.51 mg/L 2.500 101 80-120

Manganese 0.497 mg/L 0.5000 99 80-120

Classical Chemistry

**Batch CH71740 - [CALC]**

**Blank**

Nitrate as N ND 0.010 mg/L

Nitrite as N ND 0.010 mg/L

Nitrite as N ND 0.010 mg/L

**LCS**

Nitrate as N ND mg/L

Nitrite as N 0.252 mg/L 0.2497 101 90-110

Nitrite as N 0.252 mg/L 0.2497 101 90-110

**Batch CH71741 - [CALC]**

**Blank**

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 0.02 mg/L

**LCS**

Nitrate as N 0.472 mg/L

Nitrate/Nitrite as N 0.472 mg/L 0.5000 94 90-110

Nitrate/Nitrite as N 0.472 mg/L 0.5000 94 90-110

Total Nitrogen 0.472 mg/L

**Batch CH71806 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N ND 0.20 mg/L

Total Kjeldahl Nitrogen as N ND 0.20 mg/L

Total Nitrogen ND 0.20 mg/L

**LCS**

Total Kjeldahl Nitrogen as N 16.0 2.00 mg/L 14.20 113 80-120

Total Kjeldahl Nitrogen as N 16.0 2.00 mg/L 14.20 113 80-120

Total Nitrogen 16.0 2.00 mg/L

**Batch CH72115 - NH4 Prep**

**Blank**

Ammonia as N ND 0.10 mg/L



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708433

**Quality Control Data**

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

**Batch CH72115 - NH4 Prep**

**LCS**

Ammonia as N	0.12	0.10	mg/L	0.09994		117	80-120			
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**LCS**

Ammonia as N	0.99	0.10	mg/L	0.9994		99	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708433

**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: 1708433

**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 - KPB/MM

ESS Project ID: 1708433

Date Received: 8/17/2017

Project Due Date: 8/24/2017

Days for Project: 5 Day

Shipped/Delivered Via: ESS Courier

- 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: 4.5 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	155482	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	155487	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	155488	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	155481	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	155485	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	155486	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	155480	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	155483	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	155484	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review  
Are barcode labels on correct containers?  Yes / No

Completed By: [Signature] Date & Time: 8/17/17 1843

Reviewed By: [Signature] Date & Time: 8/17/17 1948

Delivered By: [Signature] Date & Time: 8/17/17 1948




## CERTIFICATE OF ANALYSIS

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

**RE: Orleans MA (60476644)**  
**ESS Laboratory Work Order Number: 1708620**

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 1:19 pm, Aug 31, 2017****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: 1708620

**SAMPLE RECEIPT**

The following samples were received on August 24, 2017 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>
1708620-01	PW-2D-2Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708620-02	PW-2D-4Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708620-03	PW-2D-7.5Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708620

**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: 1708620

**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: PW-2D-2Hr  
Date Sampled: 08/24/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708620  
ESS Laboratory Sample ID: 1708620-01  
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	0.306 (0.100)		200.7		1	KJK	08/25/17 21:20	10	10	CH72523
Manganese	4.49 (0.020)		200.7		1	KJK	08/25/17 21:20	10	10	CH72523



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2D-2Hr  
Date Sampled: 08/24/17 10:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708620  
ESS Laboratory Sample ID: 1708620-01  
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	4.89 (0.10)		350.1		1	JLK	08/29/17 17:58	mg/L	CH72907
Nitrate as N	0.167 (0.030)		353.2		1	JLK	08/24/17 21:41	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/24/17 21:41	mg/L	CH72431
Total Kjeldahl Nitrogen as N	6.47 (1.00)		351.2		5	JLK	08/30/17 17:55	mg/L	CH72908
Total Nitrogen	6.64 (1.02)		4500N		5	JLK	08/30/17 17:55	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2D-4Hr  
Date Sampled: 08/24/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708620  
ESS Laboratory Sample ID: 1708620-02  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.369 (0.100)		200.7		1	KJK	08/25/17 21:36	10	10	CH72523
Manganese	4.47 (0.020)		200.7		1	KJK	08/25/17 21:36	10	10	CH72523



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2D-4Hr  
Date Sampled: 08/24/17 12:00  
Percent Solids: N/A

ESS Laboratory Work Order: 1708620  
ESS Laboratory Sample ID: 1708620-02  
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	5.08 (0.20)		350.1		2	JLK	08/29/17 18:20	mg/L	CH72907
Nitrate as N	0.188 (0.030)		353.2		1	JLK	08/24/17 21:42	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/24/17 21:42	mg/L	CH72431
Total Kjeldahl Nitrogen as N	5.77 (1.00)		351.2		5	JLK	08/30/17 17:57	mg/L	CH72908
Total Nitrogen	5.96 (1.02)		4500N		5	JLK	08/30/17 17:57	mg/L	[CALC]



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2D-7.5Hr  
Date Sampled: 08/24/17 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1708620  
ESS Laboratory Sample ID: 1708620-03  
Sample Matrix: Ground Water  
Units: mg/L

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

**Dissolved Metals**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyst</u>	<u>Analyzed</u>	<u>I/V</u>	<u>F/V</u>	<u>Batch</u>
Iron	0.350 (0.100)		200.7		1	KJK	08/25/17 21:41	10	10	CH72523
Manganese	4.38 (0.020)		200.7		1	KJK	08/25/17 21:41	10	10	CH72523



*CERTIFICATE OF ANALYSIS*

Client Name: AECOM Environment - ENSR  
Client Project ID: Orleans MA  
Client Sample ID: PW-2D-7.5Hr  
Date Sampled: 08/24/17 15:30  
Percent Solids: N/A

ESS Laboratory Work Order: 1708620  
ESS Laboratory Sample ID: 1708620-03  
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	4.96 (0.10)		350.1		1	JLK	08/29/17 18:11	mg/L	CH72907
Nitrate as N	0.186 (0.030)		353.2		1	JLK	08/24/17 21:43	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/24/17 21:43	mg/L	CH72431
Total Kjeldahl Nitrogen as N	5.83 (1.00)		351.2		5	JLK	08/30/17 17:58	mg/L	CH72908
Total Nitrogen	6.02 (1.02)		4500N		5	JLK	08/30/17 17:58	mg/L	[CALC]



CERTIFICATE OF ANALYSIS

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

ESS Laboratory Work Order: 1708620

**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 CH72523 - 200.7/6010BNoDigest**

**Blank**

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

**LCS**

Iron	2.48		mg/L	2.500		99	80-120			
Manganese	0.517		mg/L	0.5000		103	80-120			

Classical Chemistry

**Batch CH72431 - [CALC]**

**Blank**

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

**LCS**

Nitrate as N	ND		mg/L							
Nitrite as N	0.263		mg/L	0.2497		105	90-110			
Nitrite as N	0.263		mg/L	0.2497		105	90-110			

**Batch CH72432 - [CALC]**

**Blank**

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							

**LCS**

Nitrate as N	0.464		mg/L							
Nitrate/Nitrite as N	0.464		mg/L	0.5000		93	90-110			
Nitrate/Nitrite as N	0.464		mg/L	0.5000		93	90-110			
Total Nitrogen	0.464		mg/L							

**Batch CH72907 - NH4 Prep**

**Blank**

Ammonia as N	ND	0.10	mg/L							
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**LCS**

Ammonia as N	0.10	0.10	mg/L	0.09994		103	80-120			
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**LCS**

Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
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**Batch CH72908 - TKN Prep**

**Blank**

Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							

**LCS**

Total Kjeldahl Nitrogen as N	15.0	2.00	mg/L	14.20		105	80-120			
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*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708620

**Quality Control Data**

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

**Batch CH72908 - TKN Prep**

Total Kjeldahl Nitrogen as N	15.0	2.00	mg/L	14.20		105	80-120			
Total Nitrogen	15.0	2.00	mg/L							



*CERTIFICATE OF ANALYSIS*

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

ESS Laboratory Work Order: 1708620

**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: 1708620

**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: 1708620

Shipped/Delivered Via: ESS Courier

Date Received: 8/24/2017

Project Due Date: 8/31/2017

Days for Project: 5 Day

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

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

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

12. Were VOAs received? Yes  No  
a. Air bubbles in aqueous VOAs? Yes / No  
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	157232	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	157235	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	157236	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	157231	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	157233	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	157234	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	157237	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	157238	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	157239	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	

2nd Review  
Are barcode labels on correct containers?  Yes / No

Completed By: [Signature] Date & Time: 8/24/17 2005

Reviewed By: [Signature] Date & Time: 8/24/17 2034

Delivered By: [Signature] Date & Time: 8/24/17 2034

