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Environmental Assessment of the Marion Wastewater Treatment Plant Sewage Lagoons

Marion, MA

April 29, 2011

Prepared for:
The Coalition For Buzzards Bay
114 Front Street
New Bedford, MA 02740

Prepared by:
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Table of Contents

List of Tables

List of Figures

Appendices

Introduction

The Town of Marion Wastewater Treatment Plant (WWTP) is located at the end of Benson Brook Road in Marion, Massachusetts (Figure 1). As part of the everyday operation of the WWTP, three sewage lagoons are used to equalize the flow of effluent into the WWTP. The sewage lagoons were constructed in 1971 and have a combined area of approximately 20.2 acres. According to the 1969 design plans for the sewage lagoons, the sewage lagoons appear to be unlined (no impermeable geotextile membrane or clay layer under the sewage lagoons). The sewage lagoons have a maximum depth of eight feet, with normal operating depths in the lagoons of four to five feet.

The WWTP is permitted for the following design flows: an average flow of 0.58 million gallons per day (MGD), a maximum flow of 1.54 MGD, and a peak flow of 2.33 MGD. The WWTP facility accepts wastewater from the sewage lagoons, treats it through the sequencing batch reactor (SBR) system and ultraviolet disinfection (UV) system, and discharges treated wastewater to Effluent Brook, via an 18-inch diameter outfall. Effluent Brook is located south of the facility and ultimately discharges into Aucoot Cove. Sewage flow increases during precipitation events due to infiltration/inflow (I/I) into the sewage collection system.

On behalf of the Coalition for Buzzards Bay (Coalition), Horsley Witten Group, Inc. (HW) conducted an environmental assessment of the Town's WWTP sewage lagoons to determine the potential impacts to groundwater and to the nearby coastal estuaries that may be caused by the potential leakage of untreated effluent through the base of the sewage lagoons. The following tasks were conducted to aid in this assessment:

- Monitoring wells were installed at various locations and depths in the vicinity of the WWTP;
- Staff gages were installed at various streams and ponds in the vicinity of the WWTP;
- Water samples were collected and water level readings were taken (consisting of three rounds: spring, summer, and winter) at the monitoring wells and staff gage locations;
- The water table was mapped and hydrogeological cross sections were prepared to analyze local geological and groundwater flow conditions; and
- Laboratory water quality results were analyzed to evaluate potential impacts to groundwater and surface water quality.

In addition to the above tasks, results were presented to the Town staff and Board of Selectmen (BOS) throughout the process.

Methodology

Installation of Monitoring Wells & Staff Gages

HW installed a total of 17 two–inch PVC monitoring wells at various screen depths at and in the vicinity of the WWTP to determine the groundwater elevation and direction of flow (Figure 2). Boring logs for all the monitoring wells are attached in Appendix A. In areas near the WWTP, several monitoring wells were installed in clusters at varying depths (shallow, medium, and/or deep) to determine where potential pollutants may be travelling in groundwater.

Six cluster and four individual monitoring wells (HWMW 1 – 7) were drilled in April 2010 by New England Geotech, LLC. They utilized a Geoprobe machine to collect soil samples and install the monitoring wells. HW witnessed these well installations, characterized the soils, and determined the best depths to set the well screen.

The Geoprobe machine encountered some difficulties due to the soils encountered in the field during the first phase of drilling (generally hard packed till). Therefore, the remainder of the wells (HWMW 8 – 10) were drilled by Desmond Well Drilling, Inc. from Orleans, Massachusetts. They utilized a hollow stem auger drilling rig which was better suited for the soils encountered at the site. HWMW 8S, 8M, and 8D were drilled in September 2010 and HWMW 9 and 10 were drilled in February 2011.

Five staff gage (HWSG 1 – 3, and 5a and 5b) locations were identified and staff gages were installed in April 2010. These locations were selected at streams and ponds located around the WWTP (Figure 2). A topographical survey of all the monitoring wells and staff gages was conducted by HW. The survey was tied to the NAVD 88 (vertical datum) and to the Massachusetts Grid Coordinate System 1983 (horizontal datum).

Water Level Reading and Water Quality Sampling

Water quality sampling and water (groundwater and surface water) level readings were collected from the monitoring wells and staff gages discussed above. An electronic water level tape was used to collect water level readings in the monitoring wells, and water levels were read directly from staff gages. Water level readings were taken prior to any well purging and water quality sampling. Water quality samples were collected for field and laboratory analysis. ESS Laboratory in Cranston, Rhode Island was contracted to do the laboratory analysis for all the collected water samples. ESS Laboratory analyzed the samples for boron, pH, conductance, and a series of nutrients (total nitrogen, nitrate, nitrite, Total Kjeldahl Nitrogen, orthophosphorus, and total phosphorus). HW used an In-Situ™ Sonde multi-parameter meter for field water quality analysis. These field parameters include: pH, temperature, conductance, dissolved oxygen, and oxygen reduction potential.

A total of three rounds of water quality sampling and water level readings were conducted: once each in the spring, summer, and winter (May 2010, August 2010, and February 2011, respectively). These months were selected as representative of the season, and the tests were run to determine if there would be any significant changes in groundwater elevations and water quality during the different seasons.

In addition to monitoring the HW installed monitoring wells and staff gage locations, HW collected water quality samples from existing nearby monitoring wells around the Town owned landfill area. A single round of water quality sampling was conducted from three existing landfill monitoring wells (ECE 1, 2R, and 4). This provided background water quality data near the landfill.

Groundwater Table Mapping and Cross Sections

Based on the water level readings collected from all the monitoring wells and staff gage locations, a water table map was produced. Groundwater contours were developed with the aid of a surface mapping software (Surfer, version 6.04) and modified to represent existing hydrologic features, such as streams and wetlands. Cross sections were developed to show how groundwater moves vertically as well as horizontally. Boring logs and topographical maps were used to create these cross sections.

Results

Groundwater and water quality results will be discussed in more detail below. In addition, further discussion on travel times, nitrogen loading, and impacts to nearby resource areas are also included.

Groundwater Flow Directions

The WWTP sewage lagoons are located at a natural geographic high point, which corresponds to an underlying natural groundwater mound. At the peak of the mound, groundwater will travel radially in all directions (radial) and will eventually reach down gradient surface water bodies (resource areas). Evidence of this mound can be seen on the water table map (Figure 3). The probable effect from the day to day use of the sewage lagoons on the underlying groundwater mound is an increase of the mound height due to leakage from the lagoons. The resource areas that are down gradient of the WWTP are the following:

- Benson Brook/Sippican – Weweantic River to the north;
- Sippican Harbor to the east; and
- Aucoot Cove to the south.

Based on groundwater mapping, approximately 50% of the groundwater is estimated to migrate to Aucoot Cove, 30% to Sippican Harbor, and 20% to Benson Brook/Sippican – Weweantic River. The percent of contribution to the three different resource areas were estimated based on the contributing area between the groundwater divide boundaries (Figure 4) relative to the overall area.

The bottom of the sewage lagoons is located approximately between 46.5 to 47.7 feet in elevation (according to the 1969 design plans). During the seasonal high groundwater period (February 2011), the highest groundwater elevation observed in the monitoring wells is approximately 43.5 feet in HWMW 6S and 6D (Appendix B). This condition represents approximately three feet of separation between the bottom of the sewage lagoons and the seasonal high groundwater table. Therefore, the sewage lagoons are not directly connected to the underlying aquifer. This suggests that wastewater from the sewage lagoons is infiltrating into the ground and contributing to the groundwater mound beneath it. Figure 5 depicts a cross section through the WWTP sewage lagoons, showing how groundwater migrates in horizontal and vertical directions.

Water Quality

Water quality samples were collected from the available monitoring well and staff gage locations during the three sampling rounds (May, August, and February). Detailed tables of these water quality results, including the landfill wells, can be found in Appendix B.

Typical total nitrogen (TN) concentration in groundwater for undeveloped areas is approximately 0.05 milligrams per liter (mg/L) (Cape Cod Commission, 1992). The laboratory results have shown all the wells and staff gages have TN concentrations greater than 0.05 mg/L at least once during the monitoring period (Table 1). TN concentrations found in the nearby monitoring wells and staff gage locations range from non-detectable to as high as 10.2 mg/L. The highest TN concentrations were found closest to the sewage lagoons at monitoring well clusters HWMW 8 and HWMW 4 (Figure 6). Surface water from the site of Staff gage HWSG 5a had a TN concentration of 7.0 mg/L in February. Staff gage HWMW 5a is located at a stream running under Benson Brook Road, which drains an existing wetland nearest to the sewage lagoons, and ultimately drains to Benson Brook/Sippican – Weweantic River.

Table 1. Summary of Total Nitrogen Concentrations

Well/Staff Gage	May 2010 TN (mg/L)	August 2010 TN (mg/L)	February 2011 TN (mg/L)
HWMW 1S	0.98	DRY[1]	1.80
HWMW 1D	0.26	ND[2]	0.41
HWMW 2	<0.23	3.76	5.00
HWMW 3	0.65	DRY	0.84
HWMW 4S	2.28	DRY	10.2
HWMW 4D	1.42	3.01	4.86
HWMW 5S	0.64	DRY	0.47
HWMW 5D	0.89	1.14	0.80
HWMW 6S	0.54	DRY	0.57
HWMW 6D	<0.53	ND	0.61
HWMW 7S	0.34	0.19	0.93
HWMW 7D	1.09	1.43	1.38
HWMW 8S	----	----	1.95
HWMW 8M	----	----	6.40
HWMW 8D	----	----	3.62
HWMW 9	----	----	1.45
HWMW 10	----	----	2.47
HWSG 1	2.21	2.87	2.68
HWSG 2	0.58	1.18	0.73
HWSG 3	0.54	0.49	0.53
HWSG 5A	3.74	1.88	7.04
HWSG 5B	1.12	DRY	0.77

Notes:
1. DRY = no water in the monitoring well
2. ND = non detect (below detection limit)

Boron is a constituent used to determine if high TN concentrations are a result of the wastewater from the sewage lagoons. Boron is found in nature at very low concentrations (less than 0.02 mg/L) and any concentration greater than this typically represents the presence of detergents found in wastewater (J. Bundschuh et al., 1993). The highest boron concentration found during the monitoring periods was approximately 0.26 mg/L at HWSG 5a, an order of magnitude greater than what would be expected to naturally occur. Table 2 summarizes the boron concentrations found throughout the monitoring period at all the monitoring wells and staff gage locations.

Table 2. Summary of Boron Concentrations

Well/Staff Gage	May 2010 Boron (mg/L)	August 2010 Boron (mg/L)	February 2011 Boron (mg/L)
HWMW 1S	<0.05[1]	DRY[2]	<0.05
HWMW 1D	<0.05	0.09	<0.05
HWMW 2	0.14	0.18	<0.05
HWMW 3	<0.05	DRY	<0.05
HWMW 4S	0.14	DRY	0.11
HWMW 4D	0.18	0.19	0.10
HWMW 5S	0.13	DRY	<0.05
HWMW 5D	0.19	0.16	<0.05
HWMW 6S	0.13	DRY	<0.05
HWMW 6D	<0.05	<0.05	<0.05
HWMW 7S	0.06	0.09	<0.05
HWMW 7D	0.06	0.09	<0.05
HWMW 8S	----	----	<0.05
HWMW 8M	----	----	0.09
HWMW 8D	----	----	0.08
HWMW 9	----	----	<0.05
HWMW 10	----	----	<0.05
HWSG 1	0.09	0.20	<0.05
HWSG 2	<0.05	<0.05	<0.05
HWSG 3	<0.05	<0.05	<0.05
HWSG 5A	0.15	0.26	0.08
HWSG 5B	0.06	DRY	<0.05

Notes:

1. <0.05 = non detect (below detection limit)
2. DRY = no water in the monitoring well

At monitoring well and staff gage locations with high TN concentrations, boron was also detected (Appendix B). Figures 6a – 6c, show a relatively good correlation between TN and boron concentrations at each monitoring well and staff gage during the monitoring period, indicating that the source of the nitrogen in groundwater and surface water is likely wastewater from the lagoons.

Groundwater Travel Time

The WWTP sewage lagoons are approximately 0.9 miles (4,700 feet) away from Sippican Harbor. HW estimated the travel time for groundwater underneath the sewage lagoons to reach Sippican Harbor. Travel times in groundwater can be estimated by dividing the travel distance by the seepage velocity (Eqn. 1). Darcy's Law defines the seepage velocity (V) as the average velocity flowing through the pores of the soils. Seepage velocity is a function of the hydraulic gradient (i) of the groundwater and the porosity (n) of the soil (Eqn. 2).

The subsurface geologic conditions encountered during the well installation ranged from silty sand to till. The subsurface conditions at this site are highly variable, so a range of horizontal hydraulic conductivity (K) was used for the travel time analysis. Hydraulic conductivity is a measure of the soil's ability to transmit water. The corresponding horizontal Ks for silty sand and till are 12.5 to 50 feet per day (ft/d), respectively (Todd, 1980). Based on the water table map (Figure 3) the hydraulic gradient is approximately (0.006 ft/ft) and based on the soils encountered the porosity is 30%. Table 3 summarizes the travel time to Sippican Harbor based on the varying K values. See Appendix C for sample calculation.

$$Travel\ Time = \frac{Distance}{V} \quad \text{(Eqn. 1)}$$

$$V = \frac{Ki}{n} \quad \text{(Eqn. 2)}$$

Table 3. Summary of Travel Times to Sippican Harbor

Distance to Sippican Harbor (ft)	Seepage Velocity (ft/d)	Estimated Travel Time (yrs)
4,700	0.25	52
4,700	0.50	26
4,700	1.00	13

The estimated travel times vary from 13 to 52 years depending on the K encountered. These travel times are not exact and may be longer considering that vertical travel time through the aquifer, and vertical travel time from the lagoons down to the water table were not considered. Groundwater flows down into the aquifer near the sewage lagoons and then back upwards as it discharges into a surface water body, as shown on the cross section (Figure 5), therefore, the travel times are likely to be longer than those presented in Table 3.

The WWTP sewage lagoons were constructed in 1971, almost 40 years ago. Recent water quality sampling in Sippican Harbor has shown elevated levels of nutrients (including TN). The estimated travel times in Table 3 are consistent with the detection of elevated nitrogen in Sippican Harbor. However, other sources of nitrogen also likely have contributed to the observed nitrogen increases in Sippican Harbor.

Based on the groundwater migration time, even if the Town stopped the leakage from the lagoons, groundwater containing effluent from the lagoons will continue to migrate to Benson Brook/Sippican – Weweantic River, Sippican Harbor, and Aucoot Cove for many years into the future.

Nitrogen Loading

Nitrogen loading is an important consideration for the health of nearby aquatic resource areas (Benson Brook/Sippican – Weweantic River, Sippican Harbor, and Aucoot Cove). To estimate the nitrogen loading to these resource areas, the nitrogen concentration in the sewage lagoons and the leakage rate through the bottom of the sewage lagoons were estimated. The typical nitrogen concentration found in wastewater is 35 mg/L (Cape Cod Commission, 1992). The Town sewage collection system is old and has significant inflow from groundwater into the sewage pipes during storms and periods of high groundwater, further diluting the nitrogen concentration. HW therefore, assumed a nitrogen concentration of 20 mg/L for the wastewater in the sewage lagoons to account for dilution due to sewer line inflow.

For discussion purposes, the leakage rate through the bottom of the sewage lagoons was estimated to be one inch per day (in/d). This leakage rate is typical for clay loam soils (C.W. Fetter, 1994). The WWTP sewage lagoons are approximately 20 acres in area. Based on the assumptions made above, HW estimated the sewage lagoons to contribute 33,400 pounds of nitrogen per year (lbs of N/yr), see Appendix C for detailed calculations.

Assuming nitrogen loading from typical home septic systems to be 17 lbs of N/yr (165 gpd and 35 mg/L), the loading from the sewage lagoons is equivalent to approximately 1,965 homes. According to the U.S. Census Bureau, 2005 – 2009, the Town of Marion has approximately 1,700 single family homes.

In addition, if 30% (based on the contributing area) of the groundwater under the sewage lagoons migrates to Sippican Harbor, then the sewage lagoons contribute 9,700 lbs of N/yr to Sippican Harbor, equivalent to 570 homes. Table 4 summarizes the estimated nitrogen loading to the three resource areas.

Table 4. Summary of Nitrogen Loading from WWTP to Resource Areas

Resource Areas	Nitrogen Loading (lbs of N/yr)	Equivalent # of Homes
Aucoot Cove	16,700	982
Sippican Harbor	10,020	590
Benson Brook / Sippican – Weweantic River	6,680	393
Total	***33,400***	***1,965***

Conclusions & Recommendations

Based on the results of the environmental assessment (groundwater mapping, groundwater mound elevation, water sampling results, etc.), effluent from the Marion WWTP sewage lagoons appears to be infiltrating into underlying groundwater. The nearby monitoring wells, particularly the HWMW 8 and 4 clusters indicate high TN and boron concentrations near the sewage lagoons. At staff gage HWSG 5a, the stream that drains the wetland nearest to the sewage lagoons also has exhibited high TN and boron concentrations throughout the monitoring period. HW recommends the sewage lagoons be lined with an impermeable geotextile membrane to prevent further leaking from the bottom and the sides of the sewage lagoons.

The sewage lagoons are approximately 20 acres in area and can hold over 26 million gallons of wastewater (assuming operating depth of 4 feet in the lagoons). The cost to line the sewage lagoons is estimated to be approximately $3.2 million dollars. This estimated cost does not include the cost to design and permit this type of work.

In order to keep the WWTP in operation, the construction can be done in phases, since there are three separate sewage lagoons in operation at all times. One of the three lagoons can be taken off line and be worked on while the other two are left in operation.

Another option to consider is if the existing volume or areas of the sewage lagoons are required. HW understands that the Town of Marion is working on reducing their I/I problem in the town by replacing sections of old sewage pipes. By doing this, over time the volume of inflow from the town into the WWTP would be greatly reduced, therefore, the size of the sewage lagoons could potentially be reduced. This would similarly reduce the cost to line the sewage lagoons.

The analysis described in this report indicates that nitrogen from the lagoons is likely leaching into groundwater, and then flowing towards Marion's coastal estuaries. One solution to this problem could be provided by lining the lagoons. However, it also makes sense to analyze the need for, and the future use of these lagoons before an investment is made to line all 20.2 acres of lagoon. With the ongoing work funded by the Town to minimize infiltration of groundwater and stormwater into the sewer system, the ongoing need to use all three lagoons to equalize flows into the wastewater treatment plant should be evaluated. If one of more of the lagoons is no longer needed, then the cost to solve this problem can be minimized.

As mentioned earlier, even if discharge of effluent from the sewage lagoons was prevented, the plume underneath the sewage lagoons will continue to migrate to Benson Brook/Sippican – Weweantic River, Sippican Harbor, and Aucoot Cove for many years to come. This is an issue to consider in the future water quality planning for the harbor. It may be possible to consider the use of a permeable reactive barrier placed within groundwater to treat nitrogen in groundwater before it reaches the harbor. This approach has been demonstrated in Rhode Island and on Cape Cod. It involves digging a trench into the water table and filling it with wood chips that denitrify groundwater, converting dissolved nitrate-nitrogen into nitrogen gas. The feasibility of this option for Marion will depend on the ability to site a nitrogen treatment trench in areas where groundwater is near the land surface such that a trench can be easily installed. It will also depend on whether or not possible trench locations will capture nitrogen-rich groundwater. Detailed hydrogeologic investigations would be needed to fully evaluate this option.

References

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Cape Cod Commission Water Resources Office, *Nitrogen Loading*, Technical Bulletin 91-001, 1992.

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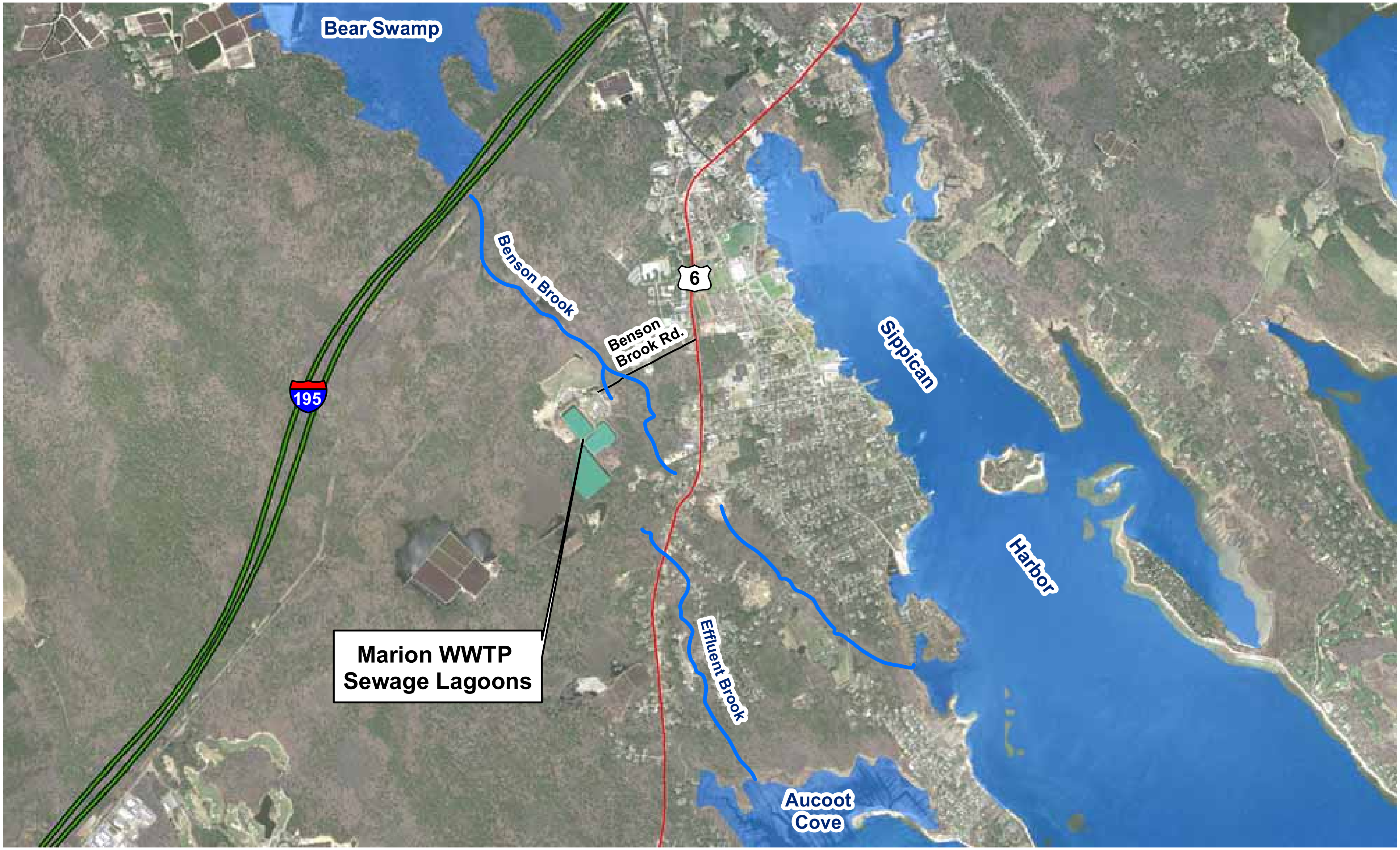

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N

Feet

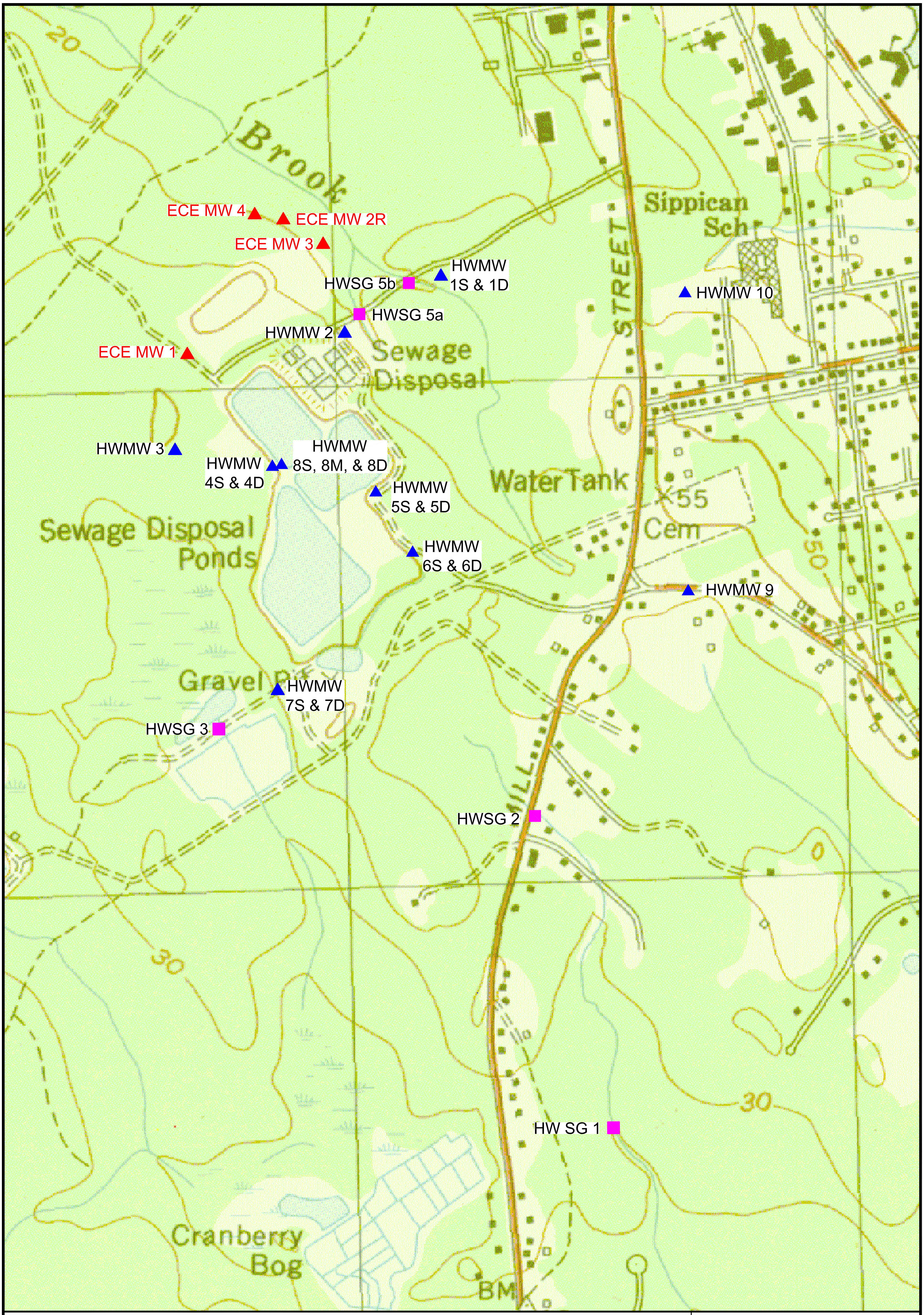
2,700

Site Map
Marion WWTP
Marion, MA

Date: 3/29/2011

Figure 1

Path: H:\Projects\2009\9065 Coalition Buzzards Bay - Marion Sewage Storage\GIS\Maps\Figure 1 - Site Map.mxd



Legend

- ▲ HW Monitoring Well (MW)
- ■ HW Staff Gage (SG)
- ▲ Existing Monitoring Well

North

0 600

Scale in Feet

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Monitoring Well & Staff Gage Locations

Marion WWTP, Marion, MA

03/29/11 TW 100630_Monitoring Map_9065.dwg

Figure 2

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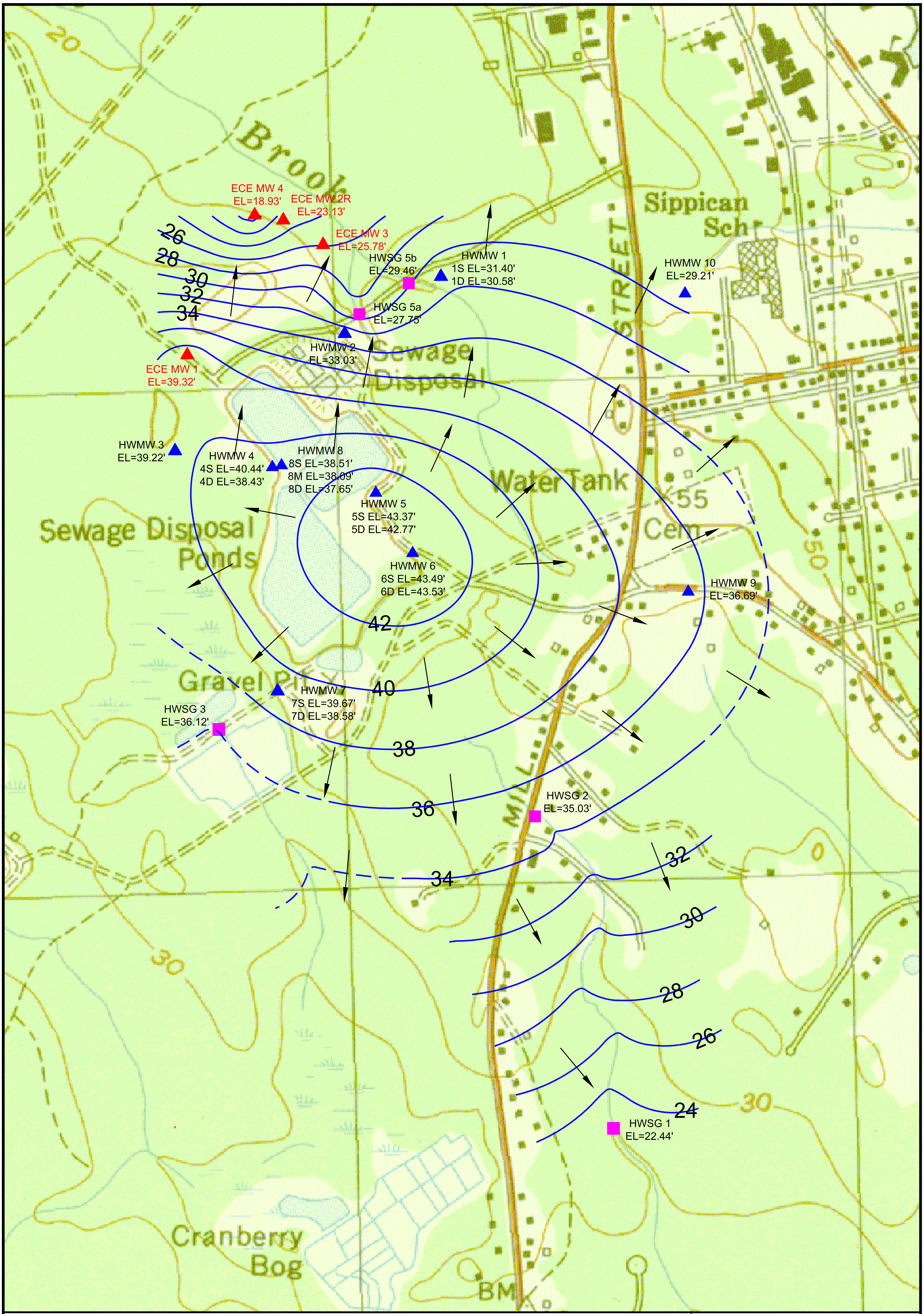

Legend

- ▲ HW Monitoring Well (MW)
- ■ HW Staff Gage (SG)
- ▲ Existing Monitoring Well
- Groundwater Contour
- Groundwater Contour (Inferred)
- → Groundwater Flow Direction

North

0 — 600

Scale in Feet

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Groundwater Contours (Feb 2011)
Marion WWTP
Marion, MA

03/29/11 TW 100630_Monitoring Map_9065.dwg

Figure 3

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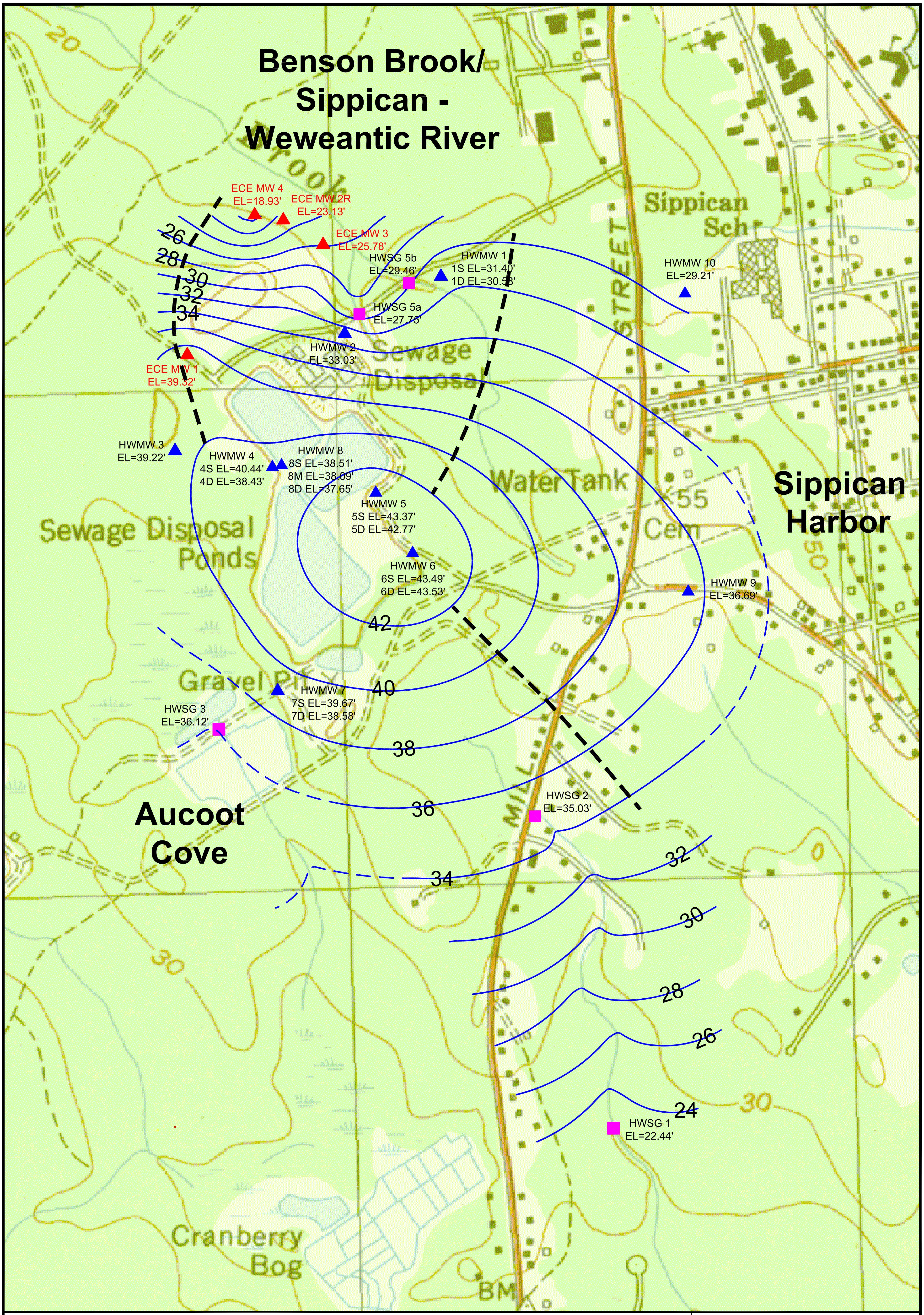

Legend

- ▲ HW Monitoring Well (MW)
- ■ HW Staff Gage (SG)
- ▲ Existing Monitoring Well
- Groundwater Contour
- Groundwater Contour (Inferred)
- Groundwater Divide Boundary

North

0 600

Scale in Feet

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Resource Areas
Marion WWTP
Marion, MA

03/29/11 TW 100630_Monitoring Map_9065.dwg

Figure 4

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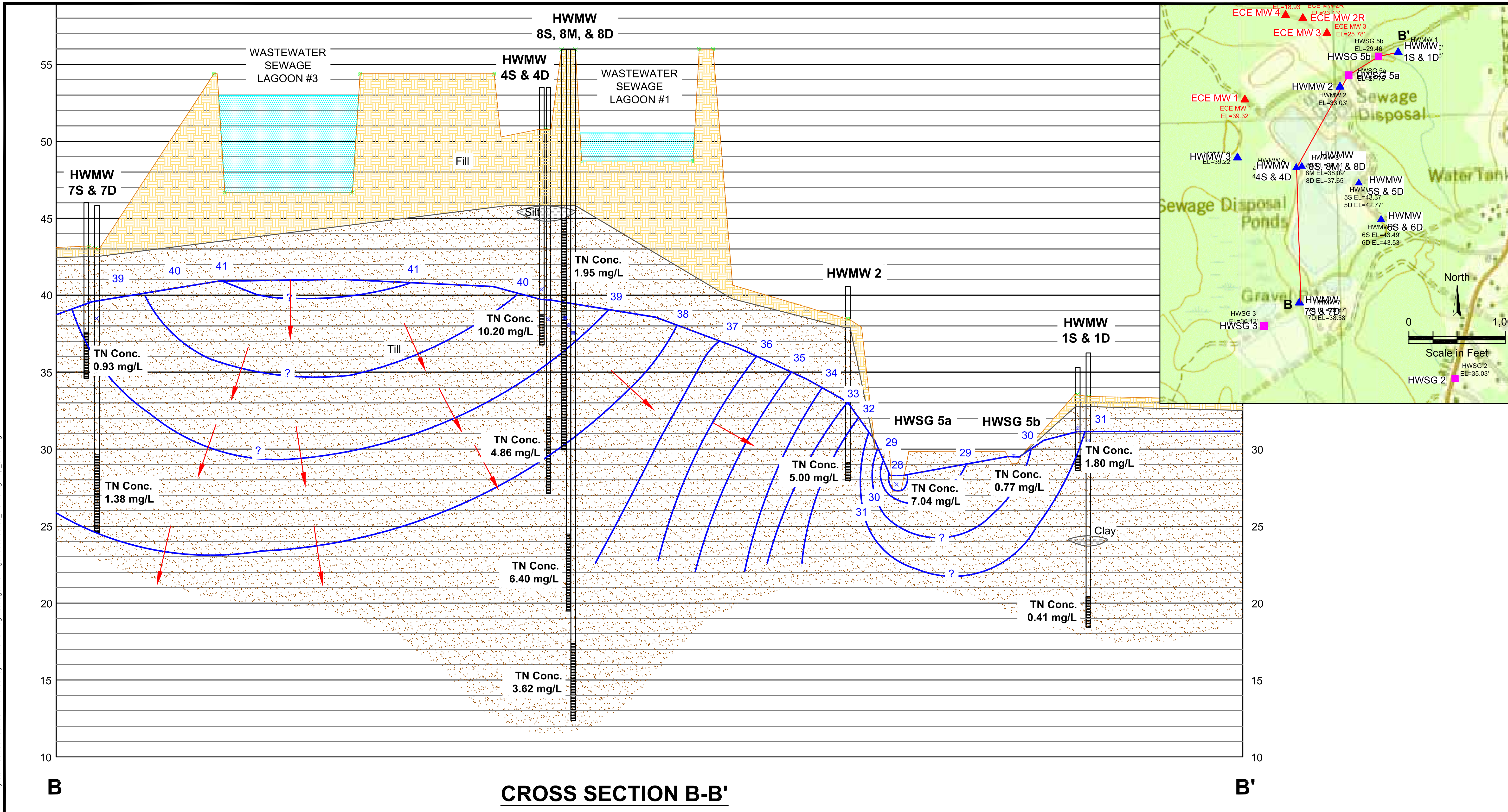

CROSS SECTION B-B'

Legend

- ▲ HW Monitoring Well (MW)
- ■ HW Staff Gage (SG)
- ▲ Existing Monitoring Well
- Groundwater Contour
- Groundwater Contour (Inferred)
- Groundwater Flow Direction

0 300
Horizontal Scale in Feet

0 6
Vertical Scale in Feet

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Cross Section B-B'
Marion WWTP
Marion, MA

03/29/11 TW 100630_Monitoring Map_9065.dwg

Figure 5

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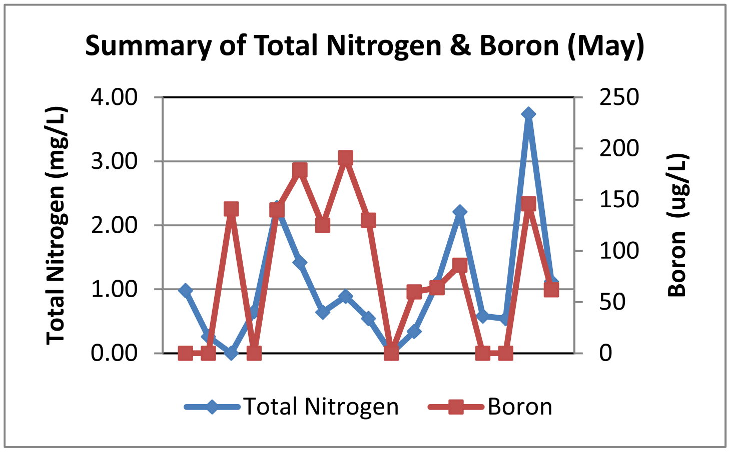

Figure 6a. Summary of Total Nitrogen & Boron (May)

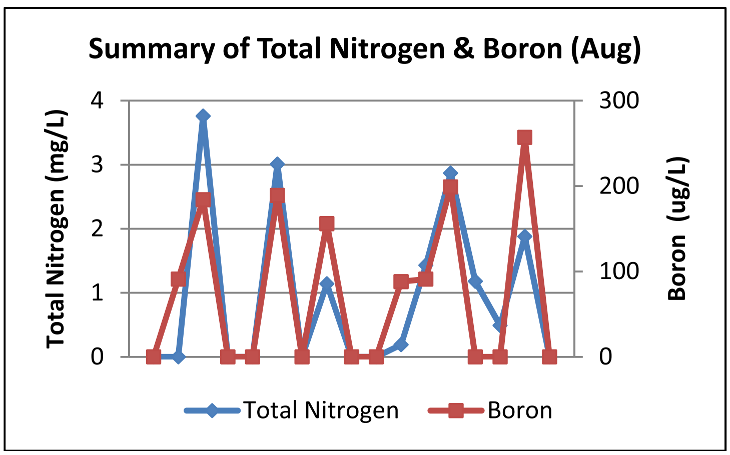

Figure 6b. Summary of Total Nitrogen & Boron (August)

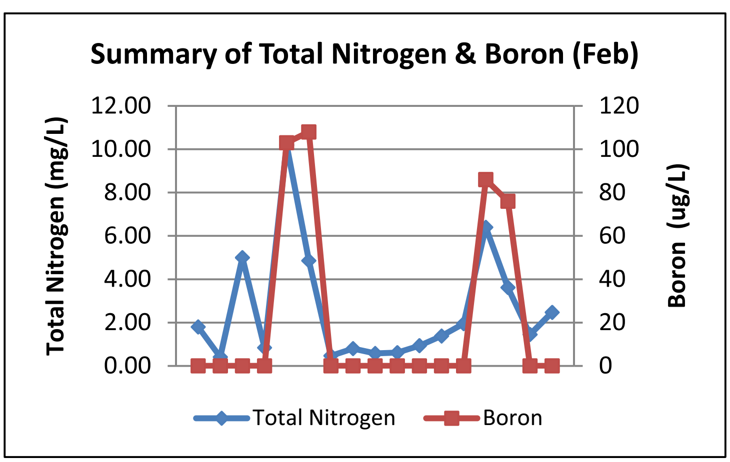

Figure 6c. Summary of Total Nitrogen & Boron (February)

APPENDIX A

Boring Logs

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MONITORING WELL BORING LOG

Boring No. HWMW 1S

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: New England Geotech
Boring Equipment: Direct Push, 2" casing

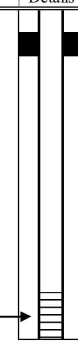
Date: 4/28/2010
Completion Depth: 3.89
Elevation:
Inspector: TW

Proportions Used:

trace (trc)	0 - 10%
little (li)	10 - 20%
some (so)	20 - 35%
and	35 - 50%

Abbreviations:

Color		Angular	Misc.	Size	
Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
			Poorly-Graded Gravel (GP)		
			Below Land Surface (BLS)		
			Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						2.80' stick up		
0	0"-9" Organic Material	5'	30"	ang	dk Br			0
	9"-21" f-Sand, wet			ang	dk Br			
	21"-30" m-Sand, so c-Sand, tr Gravel			ang	dk Br			
5	0"-16" m-Sand, so c-Sand (wet)	5'	48"	ang	dk Br			5
	16"-27" m-Sand, so Gravel (dry)			ang	Br	.010 Slot PVC Screen		
	27"-42" f-Sand, so Clay (dry)			ang	lt Br			
	42"-48" Clay (wet at 44")			ang	Gy			
						Total depth: 6.69 btoc		
						DTW: 4.68 btoc		
						Screen Interval: 5.69-6.69 btoc		
10		5'	60"					10
13	0"-32" m-Sand			ang	dk Br			
	32"-44" m-Sand, tr Gravel			ang	dk Br			
	44"-60" c-Sand, so Gravel, tr Clay			ang	Gy			
15		5'	40"					15
18								

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MONITORING WELL BORING LOG

Boring No. HWMW 1D

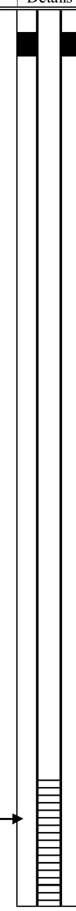
Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: New England Geotech
Boring Equipment: Direct Push, 2" casing

Date: 4/28/2010
Completion Depth: 15.03
Elevation:
Inspector: TW

Proportions Used:

			Abbreviations:			
	Color		Angular	Misc.	Size	
trace (trc) 0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li) 10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so) 20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and 35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
	Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
				Poorly-Graded Gravel (GP)		
				Below Land Surface (BLS)		
				Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Depth Feet
						2.80' stick up	
0	0"-9" Organic Material	5'	30"	ang	dk Br		0
	9"-21" f-Sand, wet			ang	dk Br		
	21"-30" m-Sand, so c-Sand, tr Gravel			ang	dk Br		
5	0"-16" m-Sand, so c-Sand (wet)	5'	48"	ang	dk Br		5
	16"-27" m-Sand, so Gravel (dry)			ang	Br		
	27"-42" f-Sand, so Clay (dry)			ang	lt Br		
	42"-48" Clay (wet at 44")			ang	Gy		
10		5'	60"				10
						Total depth: 17.83 btoc	
						DTW: 6.5 btoc	
						Screen Interval: 16.83-17.83 btoc	
13	0"-32" m-Sand			ang	dk Br		
	32"-44" m-Sand, tr Gravel			ang	dk Br		
	44"-60" c-Sand, so Gravel, tr Clay			ang	Gy		
15		5'	40"				15
						.010 Slot PVC Screen	
18							



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MONITORING WELL BORING LOG

Boring No. HWMW 2

Project:	9065	**Date:**	4/28/2010
Client:	Coalition for Buzzards Bay	**Completion Depth:**	9.83
Boring Contractor:	New England Geotech	**Elevation:**	
Boring Equipment:	Direct Push, 2" casing	**Inspector:**	TW

Proportions Used:

trace (trc)	0 - 10%
little (li)	10 - 20%
some (so)	20 - 35%
and	35 - 50%

Abbreviations:

Color		Angular	Misc.	Size	
Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
			Poorly-Graded Gravel (GP)		
			Below Land Surface (BLS)		
			Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						2.75' stick up		
0		5'	36"					0
	0"-6" Topsoil			ang	Blk			
	6"-18" Loamy Sand			ang	Br			
	18"-36" Sand and Silt, bottom 6" wet			ang	Br			
5		5'	40"					5
	0"-13" Sand and Silt, so m-sand			ang	Br			
	13"-22" c-m Sand			ang	lt Br			
	22"-40" f-m Sand, tr gravel			ang	lt Br			
						Total depth: 12.53 btoc		
						DTW: 8.02 btoc		
						Screen Interval: 11.53-12.53 btoc		
10								10
						.010 Slot PVC Screen		

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MONITORING WELL BORING LOG

Boring No. HWMW 3

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: New England Geotech
Boring Equipment: Direct Push, 2" casing
Date: 4/28/2010
Completion Depth: 9.17
Elevation:
Inspector: TW/GH

Proportions Used:

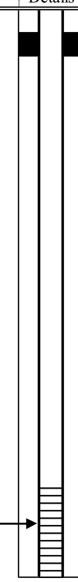
trace (trc)	0 - 10%
little (li)	10 - 20%
some (so)	20 - 35%
and	35 - 50%

Abbreviations:

Color		Angular	Misc.	Size	
Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
			Poorly-Graded Gravel (GP)		
			Below Land Surface (BLS)		
			Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Depth Feet
						2.63' stick up	
0	0"-6": Organic material	5'	40"	ang	Blk		0
	6"-40": Silt some f sand			ang	Br		
5	0" - 18" m-c Sand	5'	40"	ang	Br		5
	18" - 40" Cobbles			ang			
10						.010 Slot PVC Screen	10
						Total depth: 11.8 btoc	
						DTW: 9.1' btoc	
						Screen Interval: 8.8 - 11.8 btoc	

Well Details



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MONITORING WELL BORING LOG

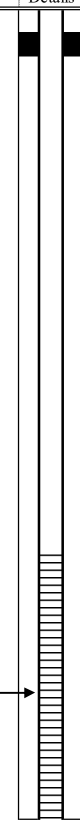
Boring No. HWMW 4S

Project:	9065	**Date:**	4/28/2010
Client:	Coalition for Buzzards Bay	**Completion Depth:**	13.9
Boring Contractor:	New England Geotech	**Elevation:**	
Boring Equipment:	Direct Push, 2" casing	**Inspector:**	GH

Proportions Used:

		Color		**Angular**	**Abbreviations:** **Misc.**	**Size**	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description		Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
							2.75' stick up		
0			5'	16"					0
	Loose fill from transfer station								
5			5'	36"					5
	0"-12": Clay and F Sand, trc silt				ang	Gy			
	12"-36": Gravel and C Sand, trc f sand				ang	Br			
10			5'	40"					10
	0"-6": C SAND and f sand /silt				ang	Br			
	6"-18": C SAND, some grey f sand/silt				ang	Gy			
	18"-40": grey C SAND, wet at 14				ang	Gy			
							.010 Slot PVC Screen		
15			5'	40"					15
	0"-46": C SAND trc clay				ang	Gy			
20							Total depth: 16.65 btoc DTW: 12.40 btoc Screen Interval: 11.65-16.65 btoc		20
	0"-6": Cobble								
	6"-18": C SAND, trc f sand/silt				ang	Gy			
	18"-40": C SAND, trc f sand/silt, trc clay				ang	Gy			
	Effective refusal at 24.5' bgs								
25									25



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MONITORING WELL BORING LOG

Boring No. HWMW 4D

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: New England Geotech
Boring Equipment: Direct Push, 2" casing

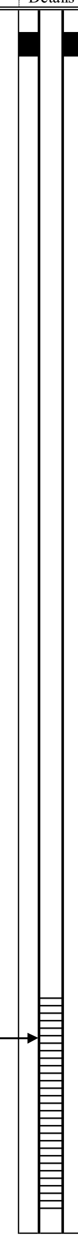
Date: 4/28/2010
Completion Depth: 23.55
Elevation:
Inspector: GH

Proportions Used:

		Color		Angular	Abbreviations: Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Depth Feet
						2.75' stick up	
0		5'	16"				0
	Loose fill from transfer station						
5		5'	36"				5
	0"-12": Clay and F Sand, trc silt			ang	Gy		
	12"-36": Gravel and C Sand, trc f sand			ang	Br		
10		5'	40"				10
	0"-6": C SAND and f sand /silt			ang	Br		
	6"-18": C SAND, some grey f sand/silt			ang	Gy		
	18"-40": grey C SAND, wet at 14			ang	Gy		
15		5'	40"				15
	0"-46": C SAND trc clay			ang	Gy		
20							20
						.010 Slot PVC Screen	
	0"-6": Cobble						
	6"-18": C SAND, trc f sand/silt			ang	Gy		
	18"-40": C SAND, trc f sand/silt, trc clay			ang	Gy		
	Effective refusal at 24.5' bgs						
						Total depth: 26.30 btoc	
25						DTW: 14.58 btoc	25
						Screen Interval: 21.3-26.3 btoc	

Well Details



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MONITORING WELL BORING LOG

Boring No. HWMW 5S

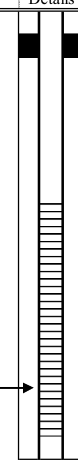
Project:	9065	**Date:**	4/29/2010
Client:	Coalition for Buzzards Bay	**Completion Depth:**	6.1
Boring Contractor:	New England Geotech	**Elevation:**	
Boring Equipment:	Direct Push, 2" casing	**Inspector:**	GH

Proportions Used: / **Abbreviations:**

		Color		Angular	Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Depth Feet
						1.75' stick up	
0		5'	50"				0
	0"-2": Organic Material						
	2"-20": C SAND, some gravel, trc f sand/silt (wet)_			ang	Br		
	20"-28": F SAND			ang	Gy		
	28"-34": C SAND and gravel (wet)			ang	Gy		
	34"-48": M-C SAND			ang	Br		
	48"-50": C SAND			ang	Br		
	Effective refusal at 8' bgs or less in five locations						
5		5'	36"			Total depth: 7.85' btoc	5
						DTW: 3.55' btoc	
						Screen Interval: 3.85'-7.85	
	0"-6": C SAND and gravel			ang	Gy		
	6"-10": F SAND and gravel			ang	Gy	.010 Slot PVC Screen	
	10"-22": C SAND and gravel			ang	Br		
	22"-36": C SAND and gravel, trc f sand			ang	Br		
10		5'	48"				10
	0"-8": F SAND and gravel			ang	Lt		
	8"-14": Cobble						
	14"-20": C SAND and gravel			ang	Br		
	20"-22": C SAND and grey clay			ang	Br		
	22"-24": C SAND and gravel			ang	Br		
	24"-48": F-C SAND and gravel			ang	Br		
15							15

Well Details:



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MONITORING WELL BORING LOG

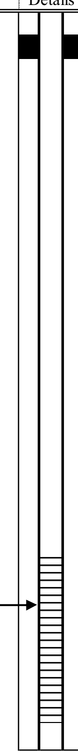
Boring No. HWMW 5D

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: New England Geotech
Boring Equipment: Direct Push, 2" casing

Date: 5/20/2010
Completion Depth: 12.35
Elevation:
Inspector: GH

Proportions Used: / **Abbreviations:**

Proportions Used		Color		Angular	Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						1.75' stick up		
0		5'	50"					0
	0"-2": Organic Material							
	2"-20": C SAND, some gravel, trc f sand/silt			ang	Br			
	20"-28": F SAND			ang	Gy			
	28"-34": C SAND and gravel			ang	Gy			
	34"-48": M-C SAND			ang	Br			
	48"-50": C SAND			ang	Br			
	Effective refusal at 8' bgs or less in five locations							
5		5'	36"					5
	0"-6": C SAND and gravel			ang	Gy			
	6"-10": F SAND and gravel			ang	Gy			
	10"-22": C SAND and gravel			ang	Br			
	22"-36": C SAND and gravel, trc f sand			ang	Br			
10		5'	48"					10
	0"-8": F SAND and gravel			ang	Lt	.010 Slot PVC Screen		
	8"-14": Cobble							
	14"-20": C SAND and gravel			ang	Br			
	20"-22": C SAND and grey clay			ang	Br			
	22"-24": C SAND and gravel			ang	Br			
	24"-48": F-C SAND and gravel			ang	Br			
						Total depth: 14.1 btoc		
15						DTW: 2.40 btoc		15
						Screen Interval: 11.1 - 14.1 btoc		

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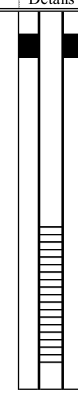
MONITORING WELL BORING LOG

Boring No. HWMW 6S

Project:	9065	**Date:**	4/29/2010
Client:	Coalition for Buzzards Bay	**Completion Depth:**	4.95
Boring Contractor:	New England Geotech	**Elevation:**	
Boring Equipment:	Direct Push, 2" casing	**Inspector:**	GH

Proportions Used: | **Abbreviations:**

Proportions		Color		Angular	Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description		Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
							2.65' stick up		
0			5'	34"					0
	0"-4": Organic Material								
	4"-6": F SAND and silt (wet)				ang	Br			
	6"-16": M-C SAND				ang	Br			
	16"-34": M SAND and gravel				ang	Gy			
							.010 Slot PVC Screen		
5			5'	44"					5
							Total depth: 7.6' btoc		
							DTW: 4.6' btoc		
	0"-38": M SAND and gravel				ang	Br	Screen Interval: 2.6'-7.6' btoc		
	38"-44": M SAND and gravel				ang	Gy			
10			5'	40"					10
	M SAND and gravel, trc f sand				ang	Br			
	Effective refusal at 15' bgs in cobble								
15									15

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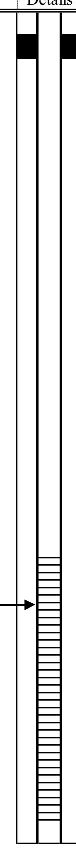
MONITORING WELL BORING LOG

Boring No. HWMW 6D

Project:	9065	**Date:**	4/29/2010
Client:	Coalition for Buzzards Bay	**Completion Depth:**	14.55
Boring Contractor:	New England Geotech	**Elevation:**	
Boring Equipment:	Direct Push, 2" casing	**Inspector:**	GH

Proportions Used: / **Abbreviations:**

Proportions		Color		Angular	Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						2.85' stick up		
0		5'	34"					0
	0"-4": Organic Material							
	4"-6": F SAND and silt (wet)			ang	Br			
	6"-16": M-C SAND			ang	Br			
	16"-34": M SAND and gravel			ang	Gy			
5		5'	44"					5
	0"-38": M SAND and gravel			ang	Br			
	38"-44": M SAND and gravel			ang	Gy			
10		5'	40"					10
						.010 Slot PVC Screen		
	M SAND and gravel, trc f sand			ang	Br			
	Effective refusal at 15 in cobble							
						Total depth: 17.4' btoc		
15						DTW: 7.2' btoc		15
						Screen Interval: 12.4'-17.4' btoc		

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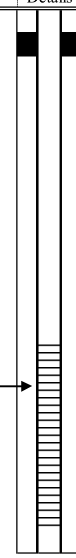
MONITORING WELL BORING LOG

Boring No. HWMW 7S

Project:	9065	**Date:**	4/29/2010
Client:	Coalition for Buzzards Bay	**Completion Depth:**	8.6
Boring Contractor:	New England Geotech	**Elevation:**	
Boring Equipment:	Direct Push, 2" casing	**Inspector:**	GH

Proportions Used: / **Abbreviations:**

Proportions		Color		Angular	Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						2.7 stick up		
0		5'	45"					0
	0"-6": Organic material							
	6"-18": M SAND			ang	Br			
	18"-34": M SAND, trc gravel			ang	Br			
	34"-36": Cobble							
	36"-45": Cobble, rust stained							
5		5'	60"					5
	0"-24": M-C SAND			ang	Br			
	24"-28": M SAND and clay, trc f sand			ang	Gy			
	28"-42": C SAND and gravel			ang	Br	.010 Slot PVC Screen		
	42"-46": M SAND and gravel			ang	Gy			
	46"-50": Cobble			ang	Br			
	Refused at 11' in four locations							
10		5'	60"					10
						Total depth: 11.3' btoc		
						DTW: 6.2' btoc		
	M-C SAND and gravel, trc f sand					Screen Interval: 6.3'-11.3' btoc		
	*core barrel jammed							
15		5'	60"					15
	M-C SAND and gravel, trc f sand							
	*core barrel jammed							
20								20

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MONITORING WELL BORING LOG

Boring No. HWMW 7D

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: New England Geotech
Boring Equipment: Direct Push, 2" casing

Date: 4/29/2010
Completion Depth: 18.5
Elevation:
Inspector: GH

Proportions Used:

trace (trc)	0 - 10%
little (li)	10 - 20%
some (so)	20 - 35%
and	35 - 50%

Abbreviations:

Color		Angular	Misc.	Size	
Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
			Poorly-Graded Gravel (GP)		
			Below Land Surface (BLS)		
			Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						2.7 stick up		
0		5'	45"					0
	0"-6": Organic material							
	6"-18": M SAND			ang	Br			
	18"-34": M SAND, trc gravel			ang	Br			
	34"-36": Cobble							
	36"-45": Cobble, rust stained							
5		5'	60"					5
	0"-24": M-C SAND			ang	Br			
	24"-28": M SAND and clay, trc f sand			ang	Gy			
	28"-42": C SAND and gravel			ang	Br			
	42"-46": M SAND and gravel			ang	Gy			
	46"-50": F SAND and gravel			ang	Br			
	Refused at 11' in four locations							
10		5'	60"					10
	M-C SAND and gravel, trc f sand							
	*core barrel jammed							
15		5'	60"					15
	M-C SAND and gravel, trc f sand					.010 Slot PVC Screen		
	*core barrel jammed							
						Total depth: 21.2' btoc		
						DTW: 6.2' btoc		
						Screen Interval: 16.2'-21.2' btoc		
20								20

MONITORING WELL BORING LOG

Boring No. HWMW 8S, 8M, 8D

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: Desmond Well Drilling
Boring Equipment: Auger, 4" casing

Date: 9/29/2010
Completion Depth: 39.4
Elevation:
Inspector: TW

Proportions Used:

			Color		Angular	Abbreviations: Misc.	Size	
trace (trc)	0 - 10%		Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%		Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%		Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%		Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
			Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
						Poorly-Graded Gravel (GP)		
						Below Land Surface (BLS)		
						Not Available (N/A)		

Depth Feet	Description		Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
							2.7 stick up		
0									0
	Hand auger down to 5 feet bgs								
5									5
7			2'	17"	ang	Br			
	f-m sand, so c sand, tr gravel								
9									
10									10
12		11-9-13-2	2'	14"	ang	Br			
	6-inch tree root, Dense f-m sand,						HWMW 8S		
14							Total depth: 24.4' btoc		
							DTW: 19' btoc		
							Screen Interval: 9.4'-24.4' btoc		15
17		11-21-18-21	2'	18"	ang	Gy			
	3-inch tree root, f sand, so clay, wet								
19									
									20
22		22-18-24-14	2'	12"	ang	Gy			
	f-m sand, so clay, tr gravel								
24									
									25
27		10-12-12-9	2'	16"	ang	Gy			

MONITORING WELL BORING LOG

Boring No. HWMW 8S, 8M, 8D

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Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: Desmond Well Drilling
Boring Equipment: Auger, 4" casing

Date: 9/29/2010
Completion Depth: 39.4
Elevation:
Inspector: TW

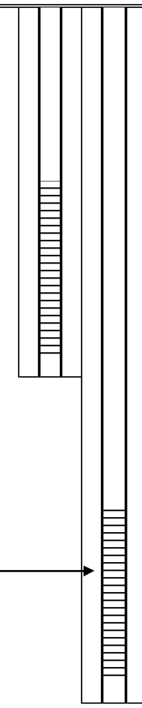
Proportions Used:

trace (trc)	0 - 10%
little (li)	10 - 20%
some (so)	20 - 35%
and	35 - 50%

Abbreviations:

Color		Angular	Misc.	Size	
Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
			Poorly-Graded Gravel (GP)		
			Below Land Surface (BLS)		
			Not Available (N/A)		

	m-c sand, so clay, tr gravel							
29								
								30
32		1-1-17-30	2'	12"	ang	Br	HWMW 8M Total depth: 34.6' btoc DTW: 19' btoc Screen Interval: 29.6"-34.6' btoc	
	Top 6-inch, m-c sand, bot 6-inch m-c sand, so gravel, tr clay							
34								
								35
37			2'	6"	ang	Br	HWMW 8D Total depth: 42.1' btoc DTW: 19.9' btoc Screen Interval: 37'-42' btoc	
	m-c sand, tr silt, bottom rock							
39							.010 Slot PVC Screen	
								40
42			2'		ang	Br		
	m-c sand, so gravel, tr silt (hard pan)							
44								
								45



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MONITORING WELL BORING LOG

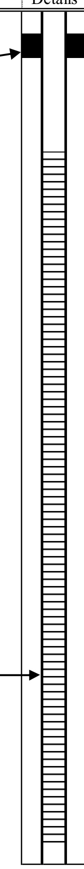
Boring No. HWMW 9

Project:	9065	**Date:**	2/22/2011
Client:	Coalition for Buzzards Bay	**Completion Depth:**	17.00
Boring Contractor:	Desmond Well Drilling	**Elevation:**	
Boring Equipment:	4" H.S.A., SS Sampling	**Inspector:**	GH

Proportions Used: / **Abbreviations:**

Proportions Used		Color		Angular	Misc.	Size	
trace (trc)	0 - 10%	Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
little (li)	10 - 20%	Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
some (so)	20 - 35%	Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
and	35 - 50%	Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
		Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
					Poorly-Graded Gravel (GP)		
					Below Land Surface (BLS)		
					Not Available (N/A)		

Depth Feet	Description		Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
							Flush mount roadbox		
0							Bentonite seal from 12"-24" btoc		0
	Split-spoon sampler refused at 3.5' bgs, no recovery Characterization based on auger cuttings		8"	0"	ang	Br			
5									5
	0"- 16": C SAND and gravel, trc silt Split-spoon sample and auger cuttings wet at 7' bgs		2'	16"	ang	Br			
10									10
	0"- 4": C SAND and gravel, trc f sand, wet		12"	4"	ang	Br	.010 Slot PVC Screen		
15									15
	Split-spoon sampler refused at 6" penetration Split-spoon shoe packed with very dense c sand, f sand, gravel, and silt, wet.		6"	4"			Total depth: 17.00' btoc DTW: 2.96' btoc Screen Interval: 2.0'-17.0' btoc		
20	Auger refusal at 19', 2,000 lb downpressure for 5 minutes								20



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MONITORING WELL BORING LOG

Boring No. HWMW 10

Project: 9065
Client: Coalition for Buzzards Bay
Boring Contractor: Desmond Well Drilling
Boring Equipment: 4" H.S.A., SS Sampling

Date: 2/22/2011
Completion Depth: 10.20
Elevation:
Inspector: GH

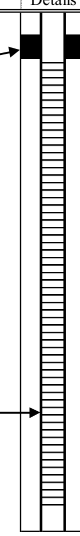
Proportions Used:

trace (trc)	0 - 10%
little (li)	10 - 20%
some (so)	20 - 35%
and	35 - 50%

Abbreviations:

Color		Angular	Misc.	Size	
Blue (Bl)	Green (Gr)	Round (rnd.)	Fragments (frag.)	Fine = (f)	Fine to Coarse = (f-c)
Red (R)	Gray (Gy)	Angular (ang.)	Cement (cem.)	Medium = (m)	Very = (v)
Light (lt)	Brown (Br)		Well-Graded Sand (SW)	Coarse = (c)	More/Less = (+/-)
Dark (dk)	Orange (Or)		Poorly-Graded Sand (SP)	Dark = (dk)	
Rust (Ru)	Black (Blk)		Well-Graded Gravel (GW)		
			Poorly-Graded Gravel (GP)		
			Below Land Surface (BLS)		
			Not Available (N/A)		

Depth Feet	Description	Penetration	Recovery	USCS Code	USCS Color	Comments	Well Details	Depth Feet
						Flush mount roadbox		
0								0
						Bentonite seal from 4"-16" btoc		
	F-M topsoil, dk brn sand, trc gravel	24"	18"	ang	Br			
5								5
	F-M sand, trc silt, trc gravel, wet throughout	24"	20"	ang	Br	.010 Slot PVC Screen		
10								10
						Total depth: 10.20' btoc DTW: 2.40' btoc Screen Interval: 1.3'-10.2' btoc		
	F-M sand, trc gravel, wet throughout Heavy blue clay in auger cuttings	24"	18"	ang	Br			
15								15
	Refusal at 6" outside H.S.A., hard and dry blue clay and gravel in split-spoon shoe. Heavy blue clay in auger cuttings	6"	3"					
20								20



APPENDIX B

Water Levels & Water Quality Summary Tables

Marion WWTP Water Level Readings at All Monitoring Well and Staff Gage Locations

MW Well / SG Name	Coordinates		Measuring Point Elevation (ft)	Notes	Total Depth of Well (ft)	Elev. Of Btm of Well (ft)	Length of Screen (ft)	Stick Up Height (ft)	Ground Elevation (ft)	Depth to Water (ft)				Water Elevation (ft)			
	X	Y								5/26/2010	5/27/2010	8/5/2010	2/23/2011	5/26/2010	5/27/2010	8/5/2010	2/23/2011
ECEMW 1	852305.4	2717508	42.33	---	13.1	29.23	---	---	---	---	5.30	6.60	3.01	---	37.03	35.73	39.32
ECEMW 2R	852942.3	2718391	28.03	---	13.66	14.37	---	---	---	---	5.75	7.21	4.90	---	22.28	20.82	23.13
ECEMW 3	853176.7	2718226	30.78	---	17.45	13.33	---	---	---	---		8.55	5.00	---	----	22.23	25.78
ECEMW 4	852733.2	2718423	26.61	---	14.7	11.91	---	---	---	---	8.73	10.44	7.68	---	17.88	16.17	18.93
HWMW 1S	854006.1	2718065	35.29	Top of PVC Casing	6.69	28.6	1	1.74	33.55	4.68	---	DRY	3.89	30.61	---	DRY	31.4
HWMW 1D	854014.7	2718065	36.21	Top of PVC Casing	17.83	18.38	2	2.8	33.41	6.50	---	8.63	5.63	29.71	---	27.58	30.58
HWMW 2	853328.4	2717667	40.45	Top of PVC Casing	12.53	27.92	1	2	38.45	8.02	---	9.08	7.42	32.43	---	31.37	33.03
HWMW 3	852119.3	2717086	48.34	Top of PVC Casing	11.79	36.55	2	2.6	45.74	10.46	---	DRY	9.12	37.88	---	DRY	39.22
HWMW 4S	852891.5	2716781	53.48	Top of PVC Casing	16.65	36.83	2	2.7	50.78	14.34	---	DRY	13.04	39.14	---	DRY	40.44
HWMW 4D	852894.4	2716775	53.49	Top of PVC Casing	26.3	27.19	5	2.75	50.74	15.83	---	18.05	15.06	37.66	---	35.44	38.43
HWMW 5S	853517.7	2716609	48.13	Top of PVC Casing	7.85	40.28	3	1.75	46.38	---	4.80	DRY	4.76	---	43.33	DRY	43.37
HWMW 5D	853507.9	2716592	47.61	Top of PVC Casing	15.95	31.66	3	2	45.61	---	4.90	7.28	4.84	---	42.71	40.33	42.77
HWMW 6S	853877.7	2716158	48.3	Top of PVC Casing	7.6	40.7	5	2.65	45.65	5.45	---	DRY	4.81	42.85	---	DRY	43.49
HWMW 6D	853888.7	2716145	48.43	Top of PVC Casing	17.4	31.03	5	2.85	45.58	5.51	---	8.24	4.90	42.92	---	40.19	43.53
HWMW 7S	852920.9	2715397	46.02	Top of PVC Casing	11.3	34.72	3	2.7	43.32	---	7.05	8.98	6.35	---	38.97	37.04	39.67
HWMW 7D	852909.4	2715397	45.77	Top of PVC Casing	21.2	24.57	5	2.7	43.07	---	7.43	9.00	7.19	---	38.34	36.77	38.58
HWMW 8S	852921.9	2716771	54.06	Top of PVC Casing	24.3	29.76	15	-0.5	54.56	---	---	---	15.55	---	---	---	38.51
HWMW 8M	852909.2	2716781	54.13	Top of PVC Casing	34.6	19.53	5	-0.5	54.63	---	---	---	16.04	---	---	---	38.09
HWMW 8D	852899.1	2716792	54.34	Top of PVC Casing	42.1	12.24	5	-0.5	54.84	---	---	---	16.69	---	---	---	37.65
HWMW 9	855586.5	2715980	39.64	Top of PVC Casing	17.35	22.29	15	-0.5	40.14	---	---	---	2.95	---	---	---	36.69
HWMW 10	855599.2	2717925	31.56	Top of PVC Casing	9.65	21.91	10	-0.5	32.06	---	---	---	2.35	---	---	---	29.21
HWSG 1	855129.4	2712444	25.25	Top of RCP Flared End	---	22.05	---	---	---	2.80	---	3.20	2.81	22.45	---	22.05	22.44
HWSG 2	854585.0	2714526	36.33	Top of Headwall	---	31.68	---	---	---	4.25	---	4.65	1.30	32.08	---	31.68	35.03
HWSG 3	852515.8	2715130	38.7	Top of Board -0.75 to 3.0' on Staff Gauge	---	35.62	---	---	---	1.00	---	0.67	1.17	35.95	---	35.62	36.12
HWSG 5a	853411.2	2717821	29.25	Top of RCP Culvert to Measuring Pt -0.17	---	27.52	---	---	---	1.46	---	1.73	1.50	27.62	---	27.52	27.75
HWSG 5b	853109.0	2718030	30.91	Top of RCP Culvert to Measuring Pt -0.15	---	29.46	---	---	---	1.20	---	DRY	1.30	29.56	---	DRY	29.46

Water Quality Summary (May) for the Marion WWTP Monitoring Program

Water Quality Samples Collected on 5/26/10 - 5/28/10														
Well / Staff Gage	Total Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Total Phosporus (mg/L)	Ortho Phosporus (mg/L)	Boron (ug/L)	pH (S.U.)	Conductance (uhoms/cm)	Field pH (S.U.)	Field Temperature (deg C)	Field Conductance (uS/cm)	Field Dissolved Oxygen (mg/L)	Field ORP (mV)
ECEMW 1	1.31	1.23	0.08	<0.010	<0.10	<0.10	<50	4.72	174	5.29	11.13	154	0.28	194
ECEMW 2R	4.30	4.30	<0.030	<0.010	<0.10	<0.10	252	6.31	1020	6.33	10.94	651	0.20	-27
ECEMW 4	0.45	0.45	<0.030	<0.010	<0.10	<0.10	66	5.83	528	5.92	13.42	374	2.56	42
HWMW 1S	0.98	0.98	<0.210	<0.010	<0.10	<0.10	<50	5.65	593	N/A	N/A	N/A	N/A	N/A
HWMW 1D	0.26	0.26	<0.030	<0.010	<0.10	<0.10	<50	6.17	849	7.23	10.75	528	0.06	-160
HWMW 2	<0.23	0.19	<0.210	<0.010	<0.10	<0.10	141	6.21	494	6.39	13.98	381	4.79	-24
HWMW 3	0.65	0.65	<0.030	0.01	<0.10	<0.10	<50	5.43	67	N/A	N/A	N/A	N/A	N/A
HWMW 4S	2.28	2.28	<0.210	<0.010	<0.10	<0.10	140	6.08	573	6.03	11.95	411	3.55	52
HWMW 4D	1.42	1.42	<0.210	<0.010	<0.10	1.90	179	5.87	503	7.06	13.24	366	2.24	-35
HWMW 5S	0.64	0.64	<0.110	<0.010	<0.10	<0.10	125	5.99	129	6.27	12.31	187	1.49	-35
HWMW 5D	0.89	0.89	<0.510	<0.010	<0.10	<0.10	191	5.91	366	6.05	10.68	248	2.33	-12
HWMW 6S	0.54	0.50	<0.110	<0.010	<0.10	<0.10	130	5.39	64	6.73	14.06	82	1.22	-123
HWMW 6D	<0.53	0.15	<0.110	<0.010	<0.10	<0.10	<50	6.02	145	7.15	9.95	118	0.42	-259
HWMW 7S	0.34	0.34	<0.110	<0.010	<0.10	<0.10	60	6.25	133	6.15	12.31	121	6.28	14
HWMW 7D	1.09	1.09	<0.110	<0.010	<0.10	<0.10	64	6.50	255	6.67	9.96	172	0.58	-153
HWSG 1	2.21	0.52	1.66	0.02	0.98	1.49	86	6.70	543	6.74	17.55	427	7.44	115
HWSG 2	0.58	0.49	0.07	0.02	<0.10	<0.10	<50	5.24	263	5.8	16.72	248	4.10	138
HWSG 3	0.54	0.54	<0.110	0.01	<0.10	<0.10	<50	5.61	93	5.96	21.76	108	6.05	177
HWSG 5a	3.74	3.74	<0.030	0.01	<0.10	<0.10	146	6.76	568	6.53	18.73	453	5.94	-24
HWSG 5b	1.12	1.12	<0.110	0.02	<0.10	<0.10	62	5.73	112	6.17	18.76	118	5.83	115

mg/L = milligrams per liter ug/L = microgram per liter S.U. = standard unit uhoms/cm = microhoms per centimeter deg C = degree Celcius Dry = dry well or stream

uS/cm = microseimens per centimeter ORP - oxidation reduction potential mV = millivolt N/A = not available

Water Quality Summary (August) for the Marion WWTP Monitoring Program

Water Quality Samples Collected on 8/5/10														
Well / Staff Gage	Total Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Total Phosporus (mg/L)	Ortho Phosporus (mg/L)	Boron (ug/L)	pH (S.U.)	Conductance (uhoms/cm)	Field pH (S.U.)	Field Temperature (deg C)	Field Conductance (uS/cm)	Field Dissolved Oxygen (mg/L)	Field DO% or *Field ORP
ECEMW 1	N/A													
ECEMW 2R	N/A													
ECEMW 4	N/A													
HWMW 1S	DRY													
HWMW 1D	ND	ND	ND	ND	ND	ND	91	5.77	349	5.07	14.8	365.4	1.9	19.8
HWMW 2	3.76	3.76	ND	ND	ND	ND	184	6.3	576	5.75	20.79	638.1	1.42	16.5
HWMW 3	DRY													
HWMW 4S	DRY													
HWMW 4D	3.01	3.01	ND	ND	ND	ND	189	5.81	464	5.09	15.05	487.3	1.38	15.2
HWMW 5S	DRY													
HWMW 5D	1.14	1.14	ND	ND	ND	ND	156	5.91	379	5.25	15.32	394.5	1.39	16.5
HWMW 6S	DRY													
HWMW 6D	ND	ND	ND	ND	ND	ND	ND	5.37	112	4.76	13.35	144.5	1.42	14.1
HWMW 7S	0.19	0.19	ND	ND	ND	ND	88	6.17	165	5.77	21.44	227.2	2.79	33.7
HWMW 7D	1.43	1.43	ND	ND	ND	ND	91	6.65	232	5.97	14.82	262.7	0.95	9.6
HWSG 1	2.87	0.78	2.08	0.012	1.97	2.08	199	7.37	801	7.43	22.09	672.2	6.68	*87
HWSG 2	1.18	0.22	0.905	0.057	ND	ND	ND	5.97	926	6.15	22.68	767.3	2.09	*125
HWSG 3	0.49	0.49	ND	0.014	ND	ND	ND	5.75	121	6.42	25.71	155.8	4.37	*129
HWSG 5a	1.88	1.79	0.077	0.017	ND	ND	257	6.58	774	6.78	21.49	672.3	2.02	*-75
HWSG 5b	DRY													

mg/L = milligrams per liter ug/L = microgram per liter S.U. = standard unit uhoms/cm = microhoms per centimeter deg C = degree Celcius Dry = dry well or stream

uS/cm = microseimens per centimeter DO - dissolved oxygen ORP - oxidation reduction potential mV = millivolt N/A = not available

Water Quality Summary (February) for the Marion WWTP Monitoring Program

Water Quality Samples Collected on 2/23/11 - 2/24/11														
Well / Staff Gage	Total Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Total Phosporus (mg/L)	Ortho Phosporus (mg/L)	Boron (ug/L)	pH (S.U.)	Conductance (uhoms/cm)	Field pH (S.U.)	Field Temperature (deg C)	Field Conductance (uS/cm)	Field Dissolved Oxygen (mg/L)	Field DO% or *Field ORP
ECEMW 1	N/A													
ECEMW 2R	N/A													
ECEMW 4	N/A													
HWMW 1S	1.80	1.73	0.03	0.04	<0.10	<0.10	<50	6.42	197	N/A	N/A	N/A	N/A	N/A
HWMW 1D	0.41	0.41	<0.03	<0.01	<0.10	<0.10	<50	6.06	325	6.27	7.87	214	5.37	87
HWMW 2	5.00	4.56	0.44	<0.01	<0.10	<0.10	<50	6.33	510	6.63	5.67	280	5.61	82
HWMW 3	0.84	0.80	0.04	<0.01	<0.10	<0.10	<50	6.34	124	N/A	N/A	N/A	N/A	N/A
HWMW 4S	10.20	10.20	<0.03	0.01	<0.10	<0.10	103	6.71	1,100	6.73	9.62	710	5.95	54
HWMW 4D	4.86	4.73	0.13	<0.01	<0.10	<0.10	108	6.01	687	6.42	10.74	427	5.55	146
HWMW 5S	0.47	0.44	<0.03	<0.01	<0.10	<0.10	<50	5.77	145	6.62	5.55	127	8.72	36
HWMW 5D	0.80	0.80	<0.03	<0.01	<0.10	<0.10	<50	5.79	333	6.36	6.22	220	2.32	67
HWMW 6S	0.57	0.55	<0.03	<0.01	<0.10	<0.10	<50	5.13	45	5.32	4.84	52	7.27	168
HWMW 6D	0.61	0.61	<0.03	<0.01	<0.10	<0.10	<50	5.17	145	5.66	7.19	123	4.34	161
HWMW 7S	0.93	0.78	0.14	0.02	<0.10	<0.10	<50	5.94	124	6.36	5.59	79	6.94	111
HWMW 7D	1.38	1.24	0.14	<0.01	<0.10	<0.10	<50	6.04	148	6.56	7.42	122	4.81	117
HWMW 8S	1.95	1.93	<0.03	<0.01	<0.10	<0.10	<50	5.75	260	6.28	9.83	198	5.55	77
HWMW 8M	6.40	6.40	<0.03	<0.01	<0.10	<0.10	86	6.42	359	6.89	11.15	254	5.33	11
HWMW 8D	3.62	3.62	<0.03	<0.01	<0.10	<0.10	76	6.63	404	7.03	11.65	315	2.96	-60
HWMW 9	1.45	0.25	1.20	<0.01	<0.10	<0.10	<50	5.99	82	6.16	7.41	76	7.84	65
HWMW 10	2.47	0.39	2.06	0.02	<0.10	<0.10	<50	6.69	1,820	7.40	6.97	1,046	3.65	-90
HWSG 1	2.68	1.35	1.01	0.32	0.49	0.44	<50	6.66	655	7.02	7.16	404	9.23	192
HWSG 2	0.73	0.43	0.30	<0.01	<0.10	<0.10	<50	5.60	325	5.83	3.21	325	10.93	206
HWSG 3	0.53	0.53	<0.03	<0.01	<0.10	<0.10	<50	4.96	64	5.67	2.55	57	9.75	221
HWSG 5a	7.04	7.04	<0.03	<0.01	<0.10	<0.10	81	6.42	343	7.05	1.22	206	6.67	52
HWSG 5b	0.77	0.69	0.08	<0.01	<0.10	<0.10	<50	5.62	104	6.34	2.87	81	8.86	208

mg/L = milligrams per liter ug/L = microgram per liter S.U. = standard unit uhoms/cm = microhoms per centimeter deg C = degree Celcius

uS/cm = microseimens per centimeter DO - dissolved oxygen ORP - oxidation reduction potential mV = millivolt N/A = not available

APPENDIX C
Calculations

Calculations

1. Travel Time

Assumptions:

- Distance from WWTP to Sippican Harbor = 0.9 miles
- Horizontal Hydraulic Conductivity (K) = 12.5 feet per day (ft/d)
- Hydraulic Gradient (i) = 0.006 ft/ft
- Porosity (n) = 30%

$$Travel\ Time = \frac{distance}{V}$$

Where V = seepage velocity

$$V = \frac{Ki}{n}$$

$$V = \frac{12.5\frac{ft}{d} \times 0.006 ft/ft}{0.30}$$

$$V = 0.25\ ft/d$$

$$Travel\ Time = \frac{0.9\ \cancel{miles}}{0.25\ \cancel{ft}/d} \times \frac{5{,}280\ \cancel{ft}}{1\ \text{mile}}$$

$$Travel\ Time = 19{,}008\ \cancel{day} \times \frac{1\ yr}{365\ \cancel{day}}$$

$$Travel\ Time = 52\ yrs$$

2. Total Loading

Assumptions:

- Leakage Rate = 1 inch per day (in/d)
- WWTP Sewage Lagoon Area = 20.2 acres
- Concentration of Nitrogen in Sewage Lagoons = 20 milligram per Liter (mg/L)

$$Nutrient\ Loading = Concentration\ \times Volume$$
$$Nutrient\ Loading = Concentration\ \times (Leakage\ Rate\ \times Surface\ Area)$$

$$Nutrient\ Loading:$$
$$= \left(\frac{20\ \cancel{mg}}{\cancel{L}} \times \frac{1\ lbs\ of\ N}{453{,}592\ \cancel{mg}} \times \frac{28.32\ \cancel{L}}{1\ ft^3}\right) \times \left(\frac{1\ \cancel{in}}{\cancel{day}} \times \frac{365\ \cancel{day}}{yr} \times \frac{1\ ft}{12\ \cancel{in}}\right) \times \left(20.2\ \cancel{ac} \times \frac{43{,}560\ ft^2}{1\ \cancel{ac}}\right)$$

$$Nutrient\ Loading = \left(\frac{0.00125\ lbs\ of\ N}{\cancel{ft^3}}\right) \times \left(\frac{30.42\ \cancel{ft}}{yr}\right) \times (879{,}912\cancel{ft^2})$$

$$Nutrient\ Loading = 33{,}400\ \frac{lbs\ of\ N}{yr}$$

3. Equivalent # of Homes

Assumptions:

- Loading from Typical Home on Septic = 17 lbs of N per year (lbs of N/yr)

$$Equivalent\ \#\ of\ Homes = \frac{33{,}400\ \frac{lbs\ of\ N}{yr}}{17\ \frac{lbs\ of\ N}{yr}}$$

$$Equivalent\ \#\ of\ Homes = 1{,}965\ homes$$

4. Contribution to Resource Areas

Assumptions:

- 50% to Aucoot Cove
- 30% to Sippican Harbor
- 20% to Benson Brook/Sippican – Weweantic River

$$Loading\ to\ Aucoot\ Cove = 0.50 \times\ 33{,}400\ \frac{lbs\ of\ N}{yr}$$

$$Loading\ to\ Aucoot\ Cove = 16{,}700\ \frac{lbs\ of\ N}{yr}$$

$$Equivalent\ \#\ of\ Homes = \frac{16{,}700\ \frac{lbs\ of\ N}{yr}}{17\ \frac{lbs\ of\ N}{yr}}$$

$$Equivalent\ \#\ of\ Homes = 982\ homes$$