Appendix 4.17-B

Station Stormwater Analyses

Stormwater Report

North Easton Station

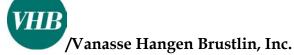
Town of Stoughton/Easton, Massachusetts

Prepared for

massDOT

Massachusetts Department of Transportation 10 Park Plaza Boston, Massachusetts

Prepared by



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June 2012



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Checklist for Stormwater Report



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Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.





A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals. This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

¹ The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

² For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.



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Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.	
Registered Professional Engineer Block and Signature	
Signature and Date	_
Checklist	_
Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?	
☐ New development	
Redevelopment	



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Checklist for Stormwater Report

Checklist (continued)

env	rironmentally sensitive design and LID Techniques were considered during the planning and design of project:
	No disturbance to any Wetland Resource Areas
	Site Design Practices (e.g. clustered development, reduced frontage setbacks)
	Reduced Impervious Area (Redevelopment Only)
	Minimizing disturbance to existing trees and shrubs
	LID Site Design Credit Requested:
	☐ Credit 1
	Credit 2
	☐ Credit 3
	Use of "country drainage" versus curb and gutter conveyance and pipe
\boxtimes	Bioretention Cells (includes Rain Gardens)
	Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
	Treebox Filter
	Water Quality Swale
\boxtimes	Grass Channel
	Green Roof
	Other (describe):
Sta	ndard 1: No New Untreated Discharges
\boxtimes	No new untreated discharges
	Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
	Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



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Checklist for Stormwater Report

Checklist (continued) Standard 2: Peak Rate Attenuation Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding. Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm. Calculations provided to show that post-development peak discharge rates do not exceed predevelopment rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24hour storm. Standard 3: Recharge Soil Analysis provided. Required Recharge Volume calculation provided. Required Recharge volume reduced through use of the LID site Design Credits. Sizing the infiltration, BMPs is based on the following method: Check the method used. Static
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 ☐ Simple Dynamic Dynamic Field¹ Runoff from all impervious areas at the site discharging to the infiltration BMP. Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume only to the maximum extent practicable for the following reason: Site is comprised solely of C and D soils and/or bedrock at the land surface Solid Waste Landfill pursuant to 310 CMR 19.000 Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable. Calculations showing that the infiltration BMPs will drain in 72 hours are provided. Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



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Checklist for Stormwater Report

Ch	necklist (continued)
Sta	ndard 3: Recharge (continued)
	The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
	Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.
Sta	ndard 4: Water Quality
•	e Long-Term Pollution Prevention Plan typically includes the following: Good housekeeping practices; Provisions for storing materials and waste products inside or under cover; Vehicle washing controls; Requirements for routine inspections and maintenance of stormwater BMPs; Spill prevention and response plans; Provisions for maintenance of lawns, gardens, and other landscaped areas; Requirements for storage and use of fertilizers, herbicides, and pesticides; Pet waste management provisions; Provisions for operation and management of septic systems; Provisions for solid waste management; Snow disposal and plowing plans relative to Wetland Resource Areas; Winter Road Salt and/or Sand Use and Storage restrictions; Street sweeping schedules; Provisions for prevention of illicit discharges to the stormwater management system; Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL; Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan; List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
	A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent. Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
	is within the Zone II or Interim Wellhead Protection Area
	is near or to other critical areas
	is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
	involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

applicable, the 44% TSS removal pretreatment requirement, are provided.

Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if



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Checklist (continued)

Checklist for Stormwater Report

	` '
Sta	andard 4: Water Quality (continued)
\boxtimes	The BMP is sized (and calculations provided) based on:
	∑ The ½" or 1" Water Quality Volume or
	☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
	The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
	A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.
Sta	ndard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)
	The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report. The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted <i>prioto</i> to the discharge of stormwater to the post-construction stormwater BMPs.
\boxtimes	The NPDES Multi-Sector General Permit does <i>not</i> cover the land use.
	LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
	All exposure has been eliminated.
	All exposure has <i>not</i> been eliminated and all BMPs selected are on MassDEP LUHPPL list.
\boxtimes	The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.
Sta	ndard 6: Critical Areas
	The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
	Critical areas and BMPs are identified in the Stormwater Report.



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Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
☐ Limited Project
 Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area. Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
☐ Bike Path and/or Foot Path
Redevelopment Project
Redevelopment portion of mix of new and redevelopment.
Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures:
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- · Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule:
- Maintenance Schedule;
- Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



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Checklist for Stormwater Report

Checklist (continued)

	Indard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control ntinued)
	The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has <i>not</i> been included in the Stormwater Report but will be submitted <i>before</i> land disturbance begins.
	The project is <i>not</i> covered by a NPDES Construction General Permit.
	The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
	The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.
Sta	ndard 9: Operation and Maintenance Plan
\boxtimes	The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
	☐ Name of the stormwater management system owners;
	Party responsible for operation and maintenance;
	☐ Schedule for implementation of routine and non-routine maintenance tasks;
	☐ Plan showing the location of all stormwater BMPs maintenance access areas;
	☐ Description and delineation of public safety features;
	☐ Estimated operation and maintenance budget; and
	Operation and Maintenance Log Form.
	The responsible party is <i>not</i> the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
	A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
	A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.
Sta	ndard 10: Prohibition of Illicit Discharges
\boxtimes	The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
	An Illicit Discharge Compliance Statement is attached;
	NO Illicit Discharge Compliance Statement is attached but will be submitted <i>prior to</i> the discharge of any stormwater to post-construction BMPs.



Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00).

Project Description

The Applicant, Massachusetts Bay Transportation Authority, is proposing to construct a train station located at 21 Washington Street Stoughton and Easton, Massachusetts. This station will be known as the North Easton Station and is proposed along the existing Stoughton Railroad Line (the Project). As proposed, the Project consists of approximately 10.0-acres of land acquisition, of which approximately 9-acres will be developed for the new station.

The Project will entail the construction of a center platform with canopy, a parking lot with 506 spaces, access driveway, a bus stop drop-off area, a center platform, sidewalks, stairs and ramps associated with access from the parking lot to the platform, bicycle parking facilities, retaining walls and stormwater infrastructure.

The site is considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 310 CMR 10.04 and 314 CMR 9.02 because it is a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Site Description

The Project Site is located at 21 Washington Street on the Stoughton/Easton Town line in Massachusetts. The Site is bounded by undeveloped land to the north, a wetland to the south, office buildings to the east, and the existing but abandoned Stoughton Line tracks to the west. See Figure 1, Site Locus Map.

Wetland Resource Areas on the Site, shown on Figures 3 and 4, are described in Table 1. For additional information regarding the wetland resource areas present on the site see the Abbreviated Notice of Resource Area Delineation prepared by VHB dated May 2011.

North Easton Station

Table 1: Wetland Resource Areas

<u>Name</u>	Critical Area	Zone 1 or Zone A	ORW or SRW	Zone II or IWPA	Description
Wetland ST-10 (100 Series)	No	No	No	No	PFO
Wetland ST-149.3	No	No	No	No	PFO
Wetland EA1 (100 Series)	No	No	No	No	PFO

Notes: Wetland Classifications: PEM = Palustrine Emergent, PFO = Palustrine Forested

According to the National Resources Conservation Service (NRCS), surface soils on the Site include Merrimac Fine Sandy Loam, Hinckley Sandy Loam, Woodbridge Fine Sandy Loam, Paxton Fine Sandy Loam, Scarboro and Birdsall, and Whitman Fine Sandy Loam. On-site soils are classified as Hydrologic Soil Groups (HSG) A, A, C, C, C, D, and D respectively.

The project is not located within the 100-year flood plain as shown on the FEMA Floodway Map, Town of Stoughton, Massachusetts Norfolk County, Community Panel Number 2502530004B, dated June 1, 1982 and the FEMA Floodway Map, Bristol County, Massachusetts (All Jurisdictions), Map Number 25005C0053F, dated July 7, 2009 included in Appendix B.

Existing Drainage Conditions

Under existing conditions, the Site is a vacant wooded area with a small paved area that is used to store construction equipment and material. For the existing conditions hydrologic analysis, the site was divided into four drainage areas that contribute to three design points. Additional there is an existing wetland onsite that acts as a detention pond for a portion of the site. The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This 1.55-acre area in the northern portion of the site consists mainly of an undeveloped wooded area. There is also a small area comprised of dirt cover. Runoff from this area flows in a northerly direction to Wetland ST-10 (100 Series) (Design Point 1). When the wetland overflows, runoff flows through a culvert under the tracks to the west.

<u>Drainage Area 2</u> - This 7.28-acre area in the center of the site consists mainly of paved area used to store construction equipment and materials. There are small wooded areas located among the pavement. Runoff from this area flows untreated in a westerly direction to Wetland ST-149.3 located on the western side of the site, between the site and the existing train tracks. This wetland acts as an existing pond that when overflows travel overland to the south into Wetland EA1 (100 Series) (Design Point 3).

<u>Drainage Area 3</u> – This 3.19-acre area in the southern portion of the site consists mainly of open space and woods. There are also small areas of gravel access drives



North Easton Station

and utility infrastructure. The existing detention basin, which takes runoff from the retail/office development, is not included in this analysis. Runoff from the basin is directed to the Wetland. Runoff from this area flows directly into Wetland EA1 (100 Series) (Design Point 3).

<u>Drainage Area 4</u> – This 0.65-acre area in the southern portion of the site consists mainly of open space and woods. Runoff from this area flows directly into Wetland EA1 (100 Series) (Design Point 4).

Figure 3 illustrates the existing drainage patterns on the Site. Table 2 below provides a summary of the existing conditions hydrologic data.

Table 2: Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland ST-10 (100 Series)	1	1.55	67	8.5
2	Wetland ST-149.3	3	7.28	75	9.2
3	Wetland EA1 (100 Series)	3	3.19	62	14.8
4	Wetland EA1 (100 Series)	4	0.65	81	5.0

Proposed Drainage Conditions

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into nine (9) drainage areas that discharge treated stormwater to the three existing Design Points. Existing drainage and grading patterns were maintained to the maximum extent possible. Stormwater management techniques have been incorporated into the design. These BMPs are focused on decentralizing stormwater management and reduce peak runoff rates, maximize groundwater recharge and treat for water quality. The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This 1.34-acre area in the northern portion of the site consists of an undeveloped wooded area. It will generally remain in its existing condition. Runoff from this area flows directly to Wetland ST-10 (Design Point 1).

<u>Drainage Area 2</u> – This 1.42-acre area in the northern portion of the site consists of a portion of the paved parking area for the station, some undeveloped wooded area, and Bioretention Basin 1 to the north of the parking. Runoff from this area sheet flows across the parking area and is then carried via a grassed channel to Bioretention Basin 1, which discharges to Wetland ST-10 (Design Point 1).



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<u>Drainage Area 3</u> – This 2.10-acre area in the central portion of the site consists of the eastern portion of the paved parking area for the station, some undeveloped wooded area, and some ancillary landscape areas. Runoff from the parking area will sheet flow into deep sump hooded catch basins and travel through the closed drainage system passing through a oil/grit separator prior to discharging to a sediment forebay, and terminating in Infiltration Basin 2. Basin 2 discharges to Wetland EA1 (Design Point 3).

<u>Drainage Area 4</u> - This 0.13-acre area in the central portion of the site consists of paved access drive for the station parking, some ancillary landscape areas and Infiltration Basin 2. Runoff from the access drive will flow into a deep sump hooded catch basin and travel through the closed drainage system passing through a oil/grit separator prior to discharging to a sediment forebay, and terminating in Infiltration Basin 2, which discharges to the rail swale to Wetland EA1 (Design Point 3).

<u>Drainage Area 5</u> – This 0.30-acre area in the southeastern portion of the site consists of a paved access drive for the station parking and some ancillary landscape area. Runoff from this area sheet flows to a deep sump hooded catch basin and travels through the closed drainage system prior to discharging to a sediment forebay and terminating in Infiltration Basin 3, which discharges through a closed drainage system to Wetland EA1 (Design Point 3).

<u>Drainage Area 6</u> - This 1.26-acre area in the south portion of the site consists of a paved exit drive for the station parking, some ancillary landscape area, and Infiltration Basin 4. Runoff from this area flows to a deep sump hooded catch basin and travels through the closed drainage system prior to discharging to a sediment forebay and terminating in Infiltration Basin 4, which discharges to the rail swale to Wetland EA1 (Design Point 3).

<u>Drainage Area 7</u> - This 2.80-acre area in the central portion of the site consists of the western portion of the paved parking area for the station, some undeveloped wooded area, and some ancillary landscape areas. Wetland 149.3 will be filled and replicated at an offsite location. Runoff from the parking area will sheet flow into deep sump hooded catch basins and travel through the closed drainage system passing through a oil/grit separator prior to discharging to a sediment forebay, and terminating in Infiltration Basin 5, which discharges directly to Wetland EA1 (Design Point 3).

<u>Drainage Area 8</u> – This 0.55-acre area in the southern portion of the site consists of landscape area and some undeveloped wooded areas. Runoff from this area flows directly to Wetland EA1 (Design Point 4).

<u>Drainage Area 9</u> – This 1.49-acre area in the southern portion of the site consists of landscape area, existing leaching basin, and Infiltration Basin 5. Runoff from this area flows directly to Infiltration Basin 5, which discharges directly to Wetland EA1 (Design Point 3).



North Easton Station

Table 3 below provides a summary of the proposed conditions hydrologic data.

Table 3: Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland ST-10	1	1.34	70	14.6
2	Wetland ST-10	1	1.42	75	15.0
3A	Wetland EA1	3	1.50	78	16.8
3B	Wetland EA1	3	0.60	98	5.0
4	Wetland EA1	3	0.13	82	5.0
5	Wetland EA1	3	0.30	92	5.0
6	Wetland EA1	3	1.26	77	5.0
7	Wetland EA1	3	2.80	95	5.0
8	Wetland EA1	4	0.55	81	6.7
9	Wetland EA1	3	1.49	68	7.3

Integrated into the site design is a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. Because the Project is located within an area of rapid infiltration and is considered a LUHPPL, the proposed stormwater management system has been designed to treat the one inch Water Quality Volume and provide 44% Total Suspended Solids (TSS) pretreatment prior to infiltration.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include:

- Infiltration basins
- Bioretention basin
- Minimal disturbance to existing trees and vegetation
- Grassed swales
- Oil/grit separator
- Light colored pavement sidewalks

In general stormwater runoff from the northern portion of the site sheet flows off of the impervious surface and is conveyed via a grassed swale to a Bioretention basin. Stormwater runoff from the southern portion of the site is collected in deep sump hooded catch basins and travels through the closed drainage system and passes through an oil/ grit separator prior to discharging to the sediment forebays, and terminating at the infiltration basins. Wooded areas in the northern portion of the property are to be maintained in their existing conditions as much as possible.

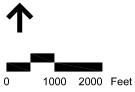


North Easton Station

Hydraulic Analysis

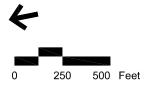
The closed drainage system was designed for the 25-year storm event, in accordance with the Massachusetts Bay Transportation Authority, Railroad Operations, Commuter Rail Design Standards Manual, Volume 1.

Drainage pipes were sized using Manning's Equation for full-flow capacity and the Rational Method. Pipe sizing calculations are included in Appendix A of this Stormwater Report.



Stoughton/Easton, Massachusets



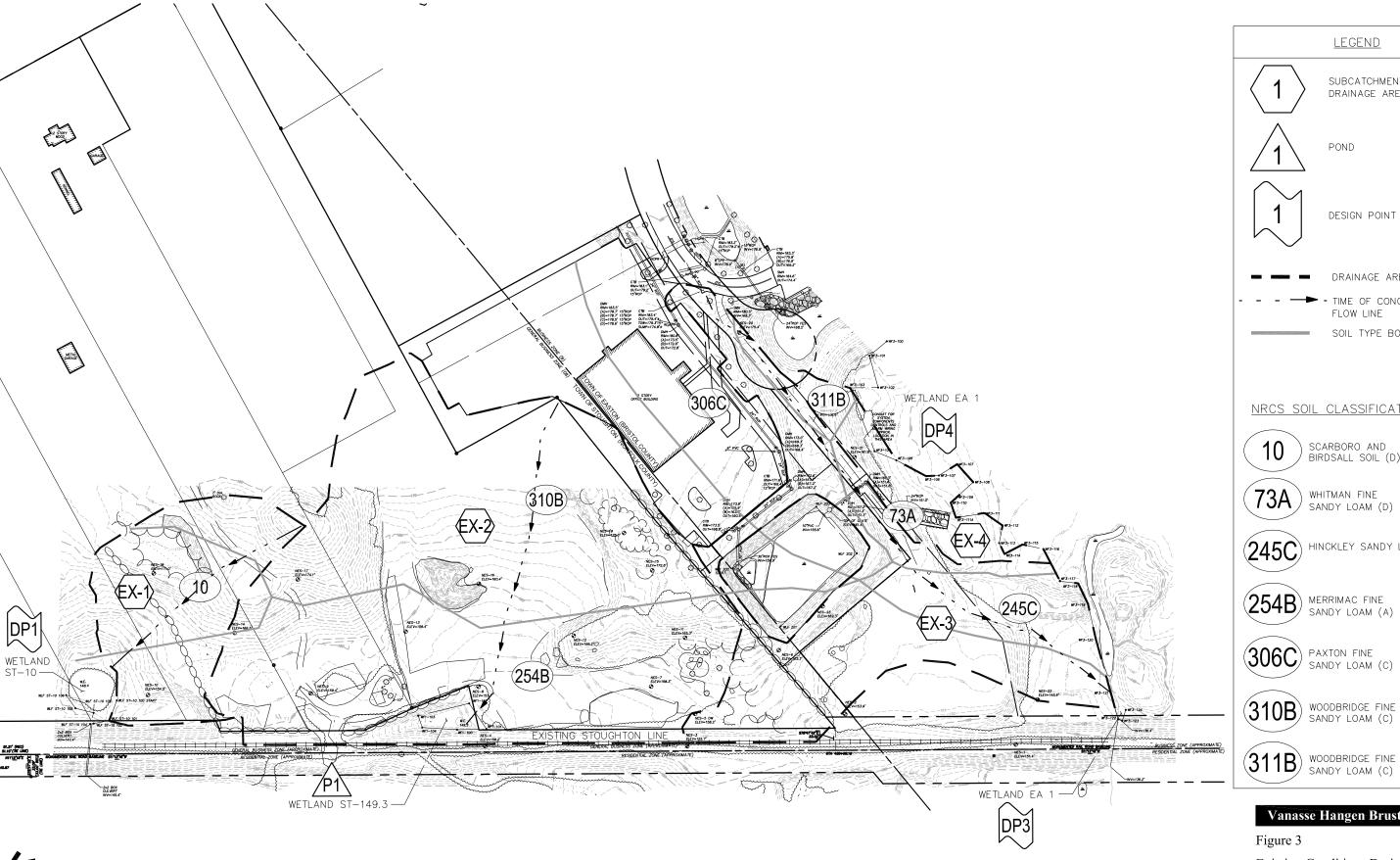


Site Aerial Map

North Easton Station South Coast Rail Stoughton/Easton, Massachusets

Figure 2 May 2012

140 Feet

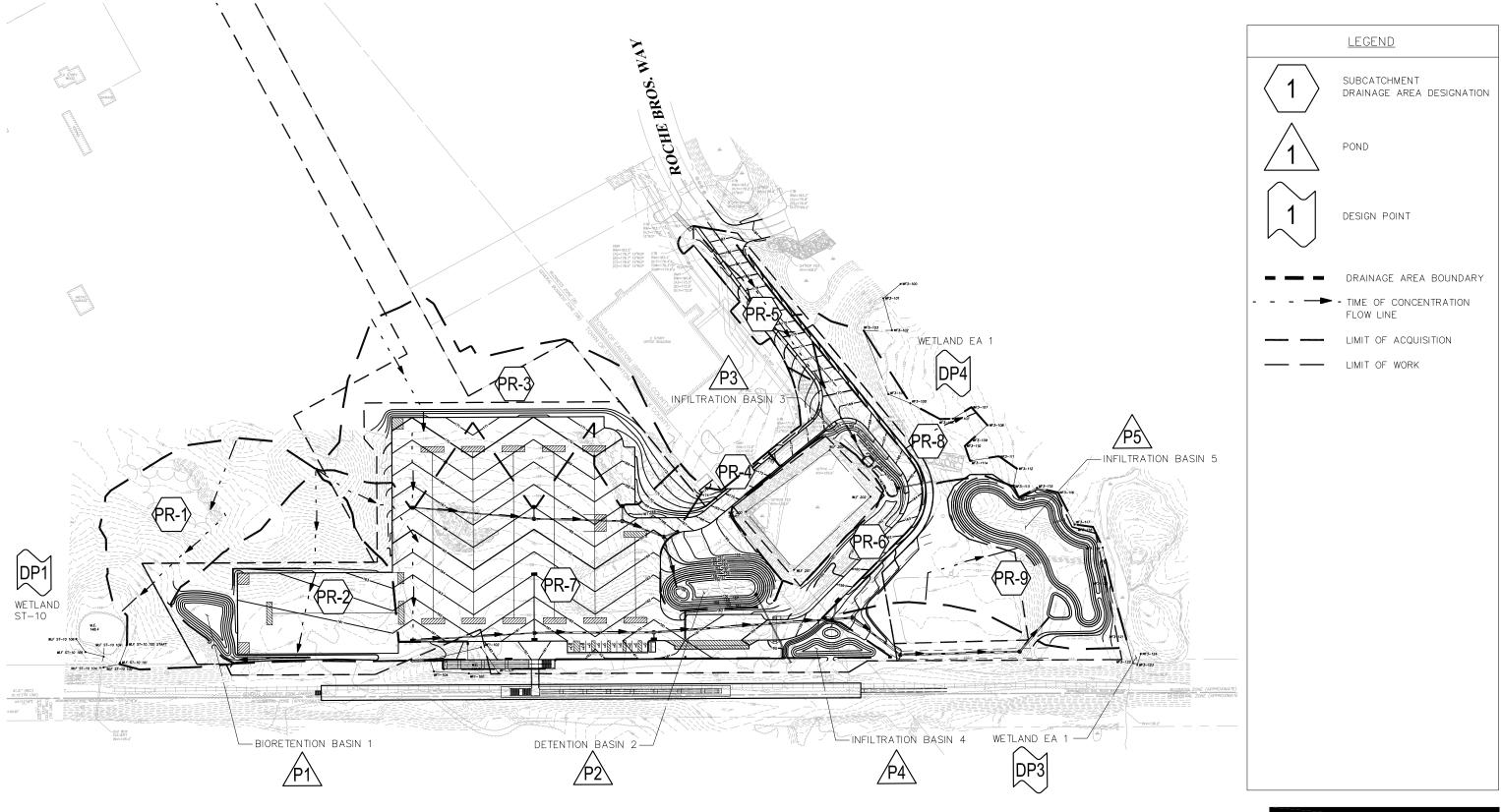


<u>LEGEND</u> SUBCATCHMENT DRAINAGE AREA DESIGNATION POND DESIGN POINT DRAINAGE AREA BOUNDARY - TIME OF CONCENTRATION FLOW LINE SOIL TYPE BOUNDARY NRCS SOIL CLASSIFICATIONS (HSG) SCARBORO AND BIRDSALL SOIL (D) 73A WHITMAN FINE SANDY LOAM (D) (245C) HINCKLEY SANDY LOAM (A) (254B) MERRIMAC FINE SANDY LOAM (A) 306C PAXTON FINE SANDY LOAM SANDY LOAM (C) WOODBRIDGE FINE SANDY LOAM (C)

Vanasse Hangen Brustlin, Inc.

May 2012

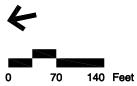
Existing Conditions Drainage Areas South Coast Rail North Easton Station Stoughton/Easton, Massachusetts



Vanasse Hangen Brustlin, Inc.

Figure 4 May 2012

Proposed Conditions Drainage Areas South Coast Rail North Easton Station Stoughton/Easton, Massachusetts





Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards at 310 CMR 10.05.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMP's that impound stormwater have been designed with stone to protect down gradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to fully comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 100-years. The results of the analysis, as summarized in Table 4 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

North Easton Station

Table 4: Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	100-year
Design Point 1: Wetland ST-10			
Existing	1.14	2.60	5.48
Proposed	1.03	2.16	4.34
Design Point 3: Wetland EA1			
Existing	1.17	3.28	8.97
Proposed	0.76	2.77	7.78
Design Point 4: Wetland EA1			
Existing	1.28	2.18	3.75
Proposed	1.03	1.76	3.01

^{*} cubic feet per second

Standard 3: Stormwater Recharge

The Project has been designed to fully comply with Standard 3.

In accordance with the Stormwater Handbook, the Required Recharge Volume for the Project is 6,926 cubic feet.

Recharge of stormwater has been provided through the use of infiltration basins which have been sized using the static method. Each infiltration BMP has been designed to drain completely within 72 hours. Table 5 below provides a summary of the proposed infiltration BMPs utilized for the Project.

Table 5
Summary of Recharge Calculations

Infiltration BMP	Provided Recharge Volume (cubic feet)
Bioretention Basin 1	7,829
Infiltration Basin 3	947
Infiltration Basin 4	5,356
Infiltration Basin 5	10,896
Total Provided Recharge	25,028
Total Required Recharge	6,926

A Geotechnical Report that describes subsurface soil conditions is included as an appendix to this report.

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.



North Easton Station

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide a minimum of 80% TSS removal for stormwater runoff from all proposed impervious surfaces as well as 44% pretreatment prior to infiltration BMPs.

Computations and supporting information are included in Appendix D.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is considered a LUHPPL as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is a parking lot with a high-intensity use (1,000 vehicle trips per day or more). Therefore has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and provide the pretreatment requirement of 44% TSS removal prior to infiltration. Proposed source controls and pollution prevention measures will be identified in the Long-Term Pollution Prevention Plan.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff from LUHPPLs, see Appendix D.

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is a redevelopment, but has still been designed to fully comply with all ten of the Stormwater Management Standards.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project would disturb approximately 9.0 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) would be developed and a Notice of Intent for the CGP would be submitted by the contractor and owner at least 14 days before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls were discussed in the DEIR/S. Appropriate controls will be prepared and implemented by the contractor and MassDOT (MBTA) during construction in accordance with the final design and NPDES SWPPP.



North Easton Station

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan will be developed by the MBTA during final design for the Project.

Standard 10: Prohibition of Illicit Discharges

The site was previously undeveloped and no sanitary sewer or storm drainage infrastructure is known to exist on the site. The design plans submitted with this report have been designed in full compliance with current standards. The Long-Term Pollution Prevention Plan will include measures to prevent illicit discharges.





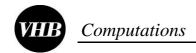
Appendix A Standard 1 Computations and Supporting Information



FEIS/FEIR Technical Report Stormwater North Easton Station

Stone Outlet Protection





Project: North Easton Station - SCR

Location: Stoughton, MA

Calculated by: CWF Date: April 23, 2012

Checked by: VHB Date:
Title: Riprap Outlet Protection Sizing

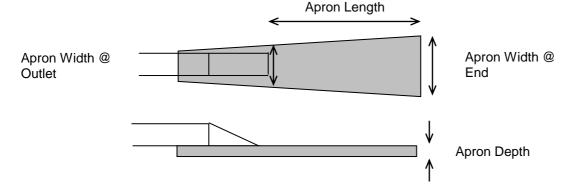
Sources: Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas

Massachusetts Department of Environmental Protection - Reprinted 2003 (pp. 118-120)

Erosion and Sediment Control Handbook - Third Edition 1992 (Chapter 3.18)

Virginia Department of Conservation and Recreation (DCR)

Attachments: Virginia DCR Erosion and Sediment Control Handbook Plate 3.18-3



Apron Width at Outlet: Width = $3 \times pipe dia$. (or width of channel)

Apron Length: Length = From Virginia DCR Handbook - Plate 3.18-3 if Tw depth is < 1/2 dia. Length = From Virginia DCR Handbook - Plate 3.18-4 if Tw dwpth is >= 1/2 dia.

Apron Width at End: Width = dia. + apron length if Tw depth is < 1/2 dia. Width = dia. + 0.4 x apron length if Tw dwpth is >= 1/2 dia.

or apron width = channel width if a well defined channel exists

Rock Riprap: Median Diameter (d₅₀) = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia = $1.5 \times d_{50}$

_	Outlet Description
Design Element	FES A2
Design Storm (yr):	25
Defined Channel (yes/no)	no
Pipe Dia (D), in	12
Tail Water (Tw), ft	Tw < 0.5D during low tide
Flow (Q), cfs	1.3
Apron Width (outlet), ft	3
Apron Length, ft	10
Apron Width (end), ft	11
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Project: North Easton Station - SCR

Location: Stoughton, MA

Calculated by: CWF Date: April 23, 2012

Checked by: VHB Date:
Title: Riprap Outlet Protection Sizing

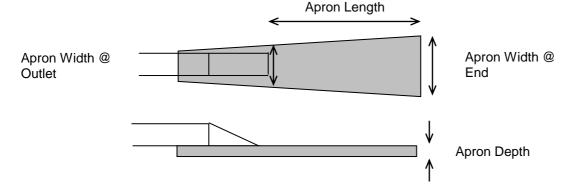
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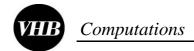
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Rock Riprap: Median Diameter (d_{50}) = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia = $1.5 \times d_{50}$

	Outlet Description
Design Element	FES B8
Design Storm (yr):	25
Defined Channel (yes/no)	no
Pipe Dia (D), in	15
Tail Water (Tw), ft	Tw < 0.5D during low tide
Flow (Q), cfs	5.8
Apron Width (outlet), ft	4
Apron Length, ft	10
Apron Width (end), ft	11
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Project: North Easton Station - SCR

Location: Stoughton, MA

Calculated by: CWF Date: April 23, 2012

Checked by: VHB Date:
Title: Riprap Outlet Protection Sizing

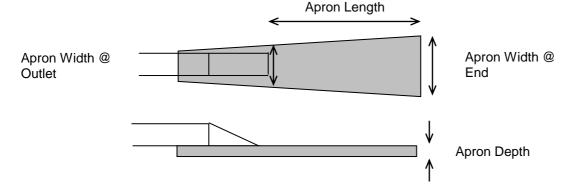
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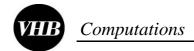
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Rock Riprap: Median Diameter (d_{50}) = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia = $1.5 \times d_{50}$

	Outlet Description
Design Element	<u>FES C10</u>
Design Storm (yr):	25
Defined Channel (yes/no)	no
Pipe Dia (D), in	21
Tail Water (Tw), ft	Tw < 0.5D during low tide
Flow (Q), cfs	11.7
Apron Width (outlet), ft	5
Apron Length, ft	10
Apron Width (end), ft	12
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Project: North Easton Station - SCR

Location: Stoughton, MA

Calculated by: CWF Date: April 23, 2012

Checked by: VHB Date:
Title: Riprap Outlet Protection Sizing

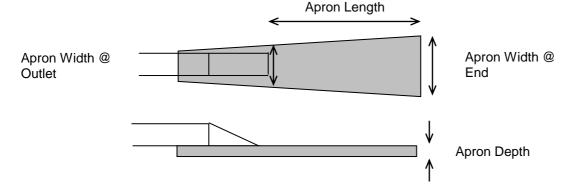
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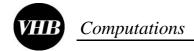
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Rock Riprap: Median Diameter (d_{50}) = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia = $1.5 \times d_{50}$

	Outlet Description
Design Element	FES D2
Design Storm (yr):	25
Defined Channel (yes/no)	no
Pipe Dia (D), in	12
Tail Water (Tw), ft	Tw < 0.5D during low tide
Flow (Q), cfs	3.7
Apron Width (outlet), ft	3
Apron Length, ft	10
Apron Width (end), ft	11
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Project: North Easton Station - SCR

Location: Stoughton, MA

Calculated by: CWF Date: April 23, 2012

Checked by: VHB Date:
Title: Riprap Outlet Protection Sizing

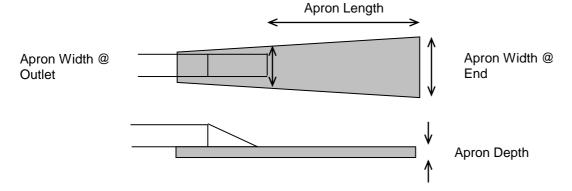
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	Outlet Description								
Design Element	FES E2								
Design Storm (yr):	25								
Defined Channel (yes/no)	no								
Pipe Dia (D), in	12								
Tail Water (Tw), ft	Tw < 0.5D during low tide								
Flow (Q), cfs	0.7								
Apron Width (outlet), ft	3								
Apron Length, ft	10								
Apron Width (end), ft	11								
Median Stone Dia., ft	0.50								
Median Stone Dia., in	6								
Largest Stone Dia., ft	0.75								
Largest Stone Dia., in	9								
Apron Depth, ft	1								
Apron Depth, in	14								





Project: North Easton Station - SCR

Location: Stoughton, MA

Calculated by: CWF Date: April 23, 2012

Checked by: VHB Date:
Title: Riprap Outlet Protection Sizing

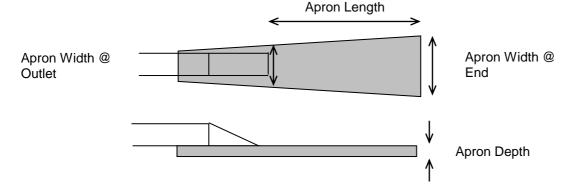
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Largest stone dia = $1.5 \times d_{50}$

	Outlet Description
Design Element	FES F2
Design Storm (yr): Defined Channel (yes/no) Pipe Dia (D), in	25 no 12
Tail Water (Tw), ft	Tw < 0.5D during low tide
Flow (Q), cfs	1.5
Apron Width (outlet), ft	3
Apron Length, ft	10
Apron Width (end), ft	11
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14



North Easton Station

Pipe Calculations



Vanasse Hangen Brustlin, Inc.
Transportation
Land Development
Environmental Services
101 Walnut St., Watertown, MA 02471
(617) 924-1770

Storm Drainage Computations

Name: MBTA SOUTH COAST RAIL STATION DESIGN

Easton, MA

Date:

Proj. No.:

10111.00 2/21/2012

ZZY

Design Parameters:

Year Storm Boston, MA

▼ IDF Curve

Client: MBTA Computed by:

Checked by: VHB $k_e=$ 0.5

LOCATION			AREA	С	CxA	SUM	FLOW TIME (MIN)		i*	DESIGN					С	APACITY	PROFILE						
DESCRIPTION	FROM	ТО	(AC.)			CxA	PIPE	CONC		Q	V	n	PIPE	SLOPE	Q full	V full	LENGTH	FALL	RIM	INV	INV	W.S.E.	Freeboard
								TIME		cfs	fps		SIZE		ft^3/s	ft/s	ft	ft		UPPER	LOWER	ft	ft
	CB A1	FES A2	0.30	0.71	0.21	0.21	0.40	5.0	6.0	1.3	5.3	0.013	12	0.0317	6.3	8.1	126	4.00	171.0	167.0	163.0	166.7	4.3
	CB B1	DMH B5	1.00	0.36	0.36	0.36	0.74	5.0	6.0	2.2	4.1	0.013	12	0.0105	3.7	4.6	181	1.90	166.0	162.0	160.1	161.8	4.2
	CB B2	DMH B5	0.72	0.49	0.36	0.36	0.66	5.0	6.0	2.1	4.2	0.013	12	0.0114	3.8	4.9	166	1.90	166.0	162.0	160.1	161.8	4.2
	DMH B5	DMH B6				0.72	0.45	5.0	6.0	4.3	4.9	0.013	15	0.0103	6.6	5.3	131	1.35	165.5	159.85	158.5	159.6	5.9
	CB B3	DMH B6	0.40	0.42	0.17	0.17	0.05	5.0	6.0	1.0	7.9	0.013	12	0.1556	14.1	17.9	23	3.50	167.0	163.0	159.5	162.2	4.8
	DMH B6	DMH B7				0.89	0.22	5.0	6.0	5.3	5.1	0.013	15	0.0091	6.2	5.0	66	0.60	166.3	158.4	157.8	158.1	8.2
	CB B4	DMH B7	0.13	0.66	0.08	0.08	0.14	5.0	6.0	0.5	2.6	0.013	12	0.0095	3.5	4.4	21	0.20	166.0	158.0	157.8	157.9	8.1
	DMH B7	FES B8				0.97	0.25	5.0	6.0	5.8	5.2	0.013	15	0.0091	6.2	5.0	77	0.70	164.0	157.7	157.0	157.4	6.6
	CB C1	DMH C5	0.86	0.76	0.66	0.66	0.54	5.0	6.0	3.9	5.6	0.013	12	0.0139	4.2	5.3	180	2.50	160.0	156.0	153.5	155.6	4.4
	CB C2	DMH C5	0.83	0.90	0.75	0.75	0.03	5.0	6.0	4.5	6.5	0.013	12	0.0200	5.0	6.4	10	0.20	160.0	156.00	155.8	155.5	4.5
	CB 2A	DMH C5	0.40	0.90	0.36	0.36	0.22	5.0	6.0	2.2	6.5	0.013	12	0.0368	6.8	8.7	87	3.20	163.0	159.0	155.8	158.5	4.5
	DMH C5	DMH C6				1.40	0.61	5.0	6.0	8.4	4.8	0.013	21	0.0065	12.8	5.3	177	1.15	160.4	152.75	151.6	152.5	7.9
	CB C3	DMH C6	0.69	0.79	0.55	0.55	0.03	5.0	6.0	3.3	5.8	0.013	12	0.0200	5.0	6.4	10	0.20	160.1	153.8	153.6	153.4	6.7
	DMH C6	DMH C7				1.95	0.85	5.0	6.0	11.7	5.9	0.013	21	0.0083	14.5	6.0	300	2.50	160.4	151.5	149.0	151.1	9.3
	DMH C7	DMH C8				1.95	0.23	5.0	6.0	11.7	5.9	0.013	21	0.0084	14.6	6.0	83	0.70	154.0	148.9	148.2	148.5	5.5
	DMH C8	DMH C9				1.95	0.53	5.0	6.0	11.7	5.5	0.013	21	0.0068	13.0	5.4	177	1.20	153.0	148.1	146.9	147.7	5.3
	DMH C9	FES C10				1.95	0.19	5.0	6.0	11.7	5.7	0.013	21	0.0076	13.8	5.7	66	0.50	150.0	146.8	146.3	146.4	3.6
	CB D1	FES D2	0.90	0.68	0.61	0.61	0.10	5.0	6.0	3.7	7.4	0.013	12	0.0364	6.8	8.7	44	1.60	158.0	155.6	154.0	154.9	3.1
	CB E1	HW E2			0.00	0.00	0.19	5.0	6.0	0.7	3.8	0.013	12	0.0227	5.4	6.8	44	1.00	162.4	155.0	154.0	154.8	7.6
	CB F1	FES F2			0.00	0.00	0.15	5.0	6.0	1.5	4.7	0.013	12	0.0205	5.1	6.5	44	0.90	160.9	153.4	152.5	153.1	7.8





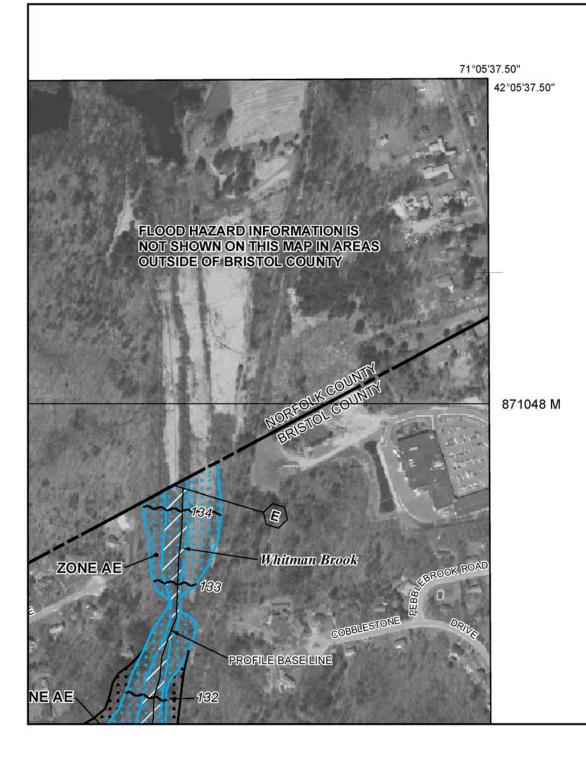
Appendix B Standard 2 Computations and Supporting Information

Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Norfolk County. Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.



FEIS/FEIR Technical Report Stormwater North Easton Station

FEMA Flood Maps





MAP SCALE 1" = 500'



PANEL 0053F

MILIM **FIRM** NATIONAL FLOOD INSURANCE PROGRAM FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, **MASSACHUSETTS** (ALL JURISDICTIONS)

PANEL 53 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY

EASTON, TOWN OF

SUFFIX NUMBER PANEL

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject

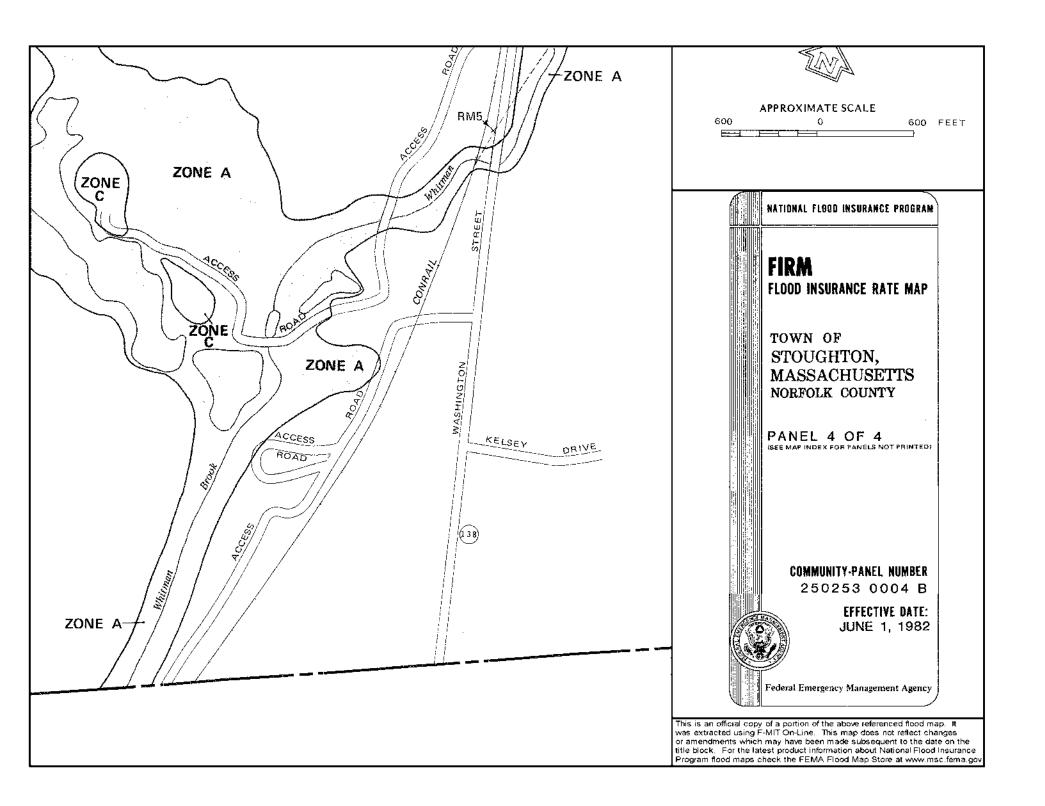


MAP NUMBER 25005C0053F

EFFECTIVE DATE JULY 7, 2009

Federal Emergency Management Agency

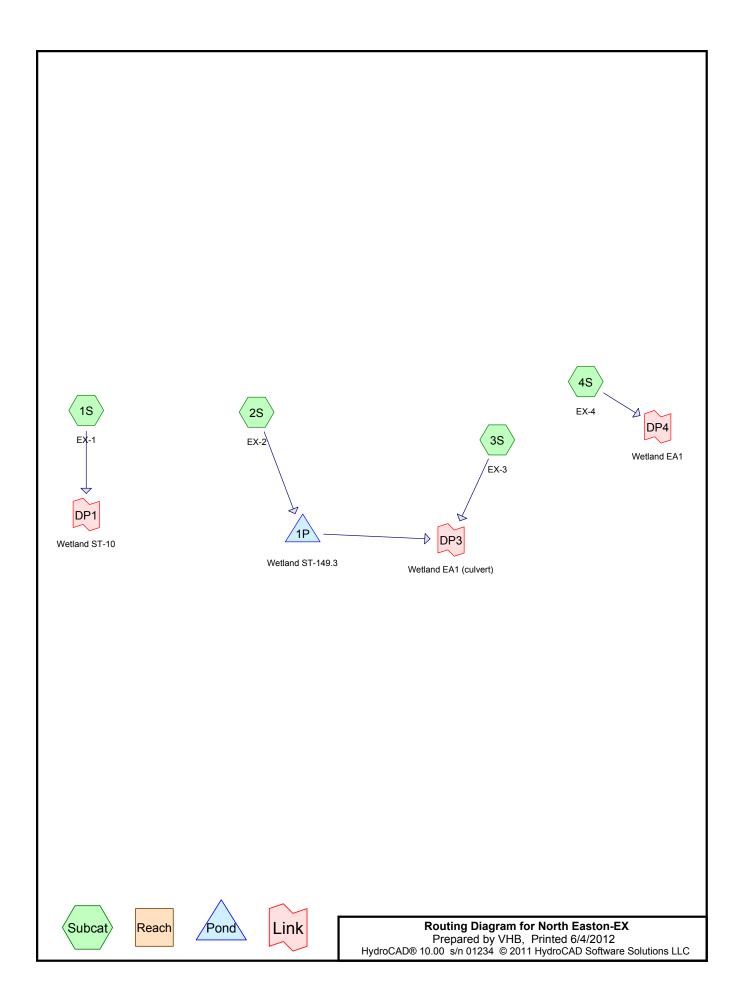
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov





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HydroCAD Analysis: Existing Conditions



North Easton-EX

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Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.050	36	Woods, Fair, HSG A (1S, 2S, 3S)
0.780	49	50-75% Grass cover, Fair, HSG A (3S)
0.160	68	<50% Grass cover, Poor, HSG A (2S)
0.370	72	Dirt roads, HSG A (2S)
1.491	73	Woods, Fair, HSG C (1S, 2S, 3S, 4S)
1.097	79	50-75% Grass cover, Fair, HSG C (3S, 4S)
1.143	79	Woods, Fair, HSG D (1S, 2S, 3S, 4S)
0.359	84	50-75% Grass cover, Fair, HSG D (3S, 4S)
0.320	86	<50% Grass cover, Poor, HSG C (2S)
0.880	87	Dirt roads, HSG C (2S)
0.160	89	Dirt roads, HSG D (1S)
0.070	89	Gravel roads, HSG C (3S)
0.050	91	Gravel roads, HSG D (3S)
1.010	98	Paved parking, HSG A (2S)
1.730	98	Paved parking, HSG C (2S)
12.670	71	TOTAL AREA



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2-Year Storm Event - Existing

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Page 3

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: EX-1 Runoff Area=1.550 ac 0.00% Impervious Runoff Depth>0.79"

Flow Length=350' Tc=8.5 min CN=67 Runoff=1.14 cfs 0.102 af

Subcatchment2S: EX-2 Runoff Area=7.280 ac 37.64% Impervious Runoff Depth>1.23"

Flow Length=514' Tc=9.2 min CN=75 Runoff=9.07 cfs 0.745 af

Subcatchment3S: EX-3 Runoff Area=3.190 ac 0.00% Impervious Runoff Depth>0.57"

Flow Length=885' Tc=14.8 min CN=62 Runoff=1.17 cfs 0.151 af

Subcatchment4S: EX-4 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth>1.63"

Tc=5.0 min CN=81 Runoff=1.28 cfs 0.088 af

Pond 1P: Wetland ST-149.3 Peak Elev=155.62' Storage=32,467 cf Inflow=9.07 cfs 0.745 af

Outflow=0.00 cfs 0.000 af

Link DP1: Wetland ST-10 Inflow=1.14 cfs 0.102 af

Primary=1.14 cfs 0.102 af

Link DP3: Wetland EA1 (culvert) Inflow=1.17 cfs 0.151 af

Primary=1.17 cfs 0.151 af

Link DP4: Wetland EA1 Inflow=1.28 cfs 0.088 af

Primary=1.28 cfs 0.088 af

Total Runoff Area = 12.670 ac Runoff Volume = 1.086 af Average Runoff Depth = 1.03" 78.37% Pervious = 9.930 ac 21.63% Impervious = 2.740 ac

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Type III 24-hr 2-Year Rainfall=3.40" Printed 6/4/2012

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Summary for Subcatchment 1S: EX-1

Runoff = 1.14 cfs @ 12.14 hrs, Volume= 0.102 af, Depth> 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 2-Year Rainfall=3.40"

	Area	(ac) C	CN Des	cription		
	0.	410	36 Woo	ods, Fair, F	ISG A	
	0.	320	73 Woo	ods, Fair, F	ISG C	
	0.	660	79 Woo	ods, Fair, F	ISG D	
_	0.	160	89 Dirt	roads, HS	G D	
	1.	550	67 Wei	ghted Avei	age	
	1.	550	100	.00% Pervi	ous Area	
	Tc	Length			Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	5.3	50	0.1600	0.16		Sheet Flow,
_	3.2	300	0.1000	1.58		Woods: Light underbrush n= 0.400 P2= 3.28" Shallow Concentrated Flow, Woodland Kv= 5.0 fps
	8.5	350	Total			

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Type III 24-hr 2-Year Rainfall=3.40" Printed 6/4/2012

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Summary for Subcatchment 2S: EX-2

Runoff = 9.07 cfs @ 12.14 hrs, Volume= 0.745 af, Depth> 1.23"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 2-Year Rainfall=3.40"

	Area	(ac) C	N Desc	cription		
	1.	920 3	36 Woo	ds, Fair, H	ISG A	
	0.	820 7	73 Woo	ds, Fair, H	ISG C	
	0.	070 7	79 Woo	ds, Fair, H	ISG D	
	1.	010	98 Pave	ed parking	, HSG A	
				ed parking		
					over, Poor,	
					over, Poor,	HSG C
				roads, HS0		
_				roads, HS0	G C	
			•	ghted Aver	0	
		540		6% Pervio		
	2.	740	37.6	4% Imper	ious Area	
	_		-			-
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	6.2	37	0.0600	0.10		Sheet Flow,
	0.5	4.4	0.0000	0.40		Woods: Light underbrush n= 0.400 P2= 3.28"
	0.5	14	0.0600	0.43		Sheet Flow,
	0.4	60	0.0000	0.45		Fallow n= 0.050 P2= 3.28"
	0.4	60	0.0600	2.45		Shallow Concentrated Flow,
	0.4	105	0.0600	4.97		Nearly Bare & Untilled Kv= 10.0 fps Shallow Concentrated Flow,
	0.4	105	0.0000	4.97		Paved Kv= 20.3 fps
	0.5	139	0.0500	4.54		Shallow Concentrated Flow,
	0.5	100	0.0000	т.от		Paved Kv= 20.3 fps
	0.4	92	0.0400	4.06		Shallow Concentrated Flow,
	0.1	٥ <u>ـ</u>	3.0 100	1.00		Paved Kv= 20.3 fps
	0.8	67	0.0700	1.32		Shallow Concentrated Flow,
						Woodland Kv= 5.0 fps
_	9.2	514	Total			

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Type III 24-hr 2-Year Rainfall=3.40" Printed 6/4/2012

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Summary for Subcatchment 3S: EX-3

Runoff = 1.17 cfs @ 12.26 hrs, Volume= 0.151 af, Depth> 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 2-Year Rainfall=3.40"

Area	(ac) C	N Desc	cription								
0.	780 4	9 50-7	5% Grass	cover, Fair	r, HSG A						
0.	990 7	'9 50-7	5% Grass	cover, Fair	; HSG C						
0.	160 8	34 50-7	5% Grass	cover, Fair	r, HSG D						
0.	720 3	36 Woo	ds, Fair, F	ISG A							
0.	350 7	'3 Woo	ds, Fair, F	ISG C							
0.	0.070 79 Woods, Fair, HSG D										
0.	0.070 89 Gravel roads, HSG C										
0.	050 9	1 Grav	/el roads, l	HSG D							
3.	190 6	32 Weig	ghted Aver	age							
3.	190	100.	00% Pervi	ous Area							
Tc	Length	Slope	Velocity	Capacity	Description						
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)							
5.5	35	0.0700	0.11		Sheet Flow,						
					Woods: Light underbrush n= 0.400 P2= 3.28"						
0.1	16	0.1250	2.01		Sheet Flow,						
					Smooth surfaces n= 0.011 P2= 3.28"						
1.6	443	0.0540	4.72		Shallow Concentrated Flow,						
					Paved Kv= 20.3 fps						
0.2	36	0.0300	3.52		Shallow Concentrated Flow,						
4.4	400		4.04		Paved Kv= 20.3 fps						
1.4	100	0.0300	1.21		Shallow Concentrated Flow,						
0.4	00	0.4500	4.70		Short Grass Pasture Kv= 7.0 fps						
0.1	22	0.4500	4.70		Shallow Concentrated Flow,						
1.0	02	0.0540	4.60		Short Grass Pasture Kv= 7.0 fps						
1.0	93	0.0540	1.63		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps						
4.9	140	0.0360	0.47		• • • • • • • • • • • • • • • • • • •						
4.9	140	0.0300	0.47		Shallow Concentrated Flow, Forest w/Heavy Litter Kv= 2.5 fps						
14.0	005	Total			i diest willeavy Liller INV- 2.3 ips						
14.8	885	Total									

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Summary for Subcatchment 4S: EX-4

Runoff = 1.28 cfs @ 12.08 hrs, Volume= 0.088 af, Depth> 1.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Area	(ac)	CN	Desc	Description							
	0.	107	79	50-7	50-75% Grass cover, Fair, HSG C							
	0.	199	84	50-7	50-75% Grass cover, Fair, HSG D							
	0.	001	73	Woo	Voods, Fair, HSG C							
_	0.	.343 79 Woods, Fair, HSG D										
	0.650 81 Weighted Average											
	0.650 100.			100.	00.00% Pervious Area							
	Tc	Leng		Slope	Velocity	Capacity	Description					
_	(min)	(fee	et)	(ft/ft)	(ft/sec)	(cfs)						
	E 0						Discot Fotos					

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Summary for Pond 1P: Wetland ST-149.3

Inflow Area = 7.280 ac, 37.64% Impervious, Inflow Depth > 1.23" for 2-Year event

Inflow = 9.07 cfs @ 12.14 hrs, Volume= 0.745 af

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 2 Peak Elev= 155.62' @ 24.00 hrs Surf.Area= 21,770 sf Storage= 32,467 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)

Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avai	I.Storage	Storage Description					
#1	151.00'	(62,400 cf	Custom Stage D	ata (Irregular)List	ed below (Recalc)			
Elevation	Çı.	ırf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
	St								
(feet)		(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>			
151.00		1,145	145.0	0	0	1,145			
152.00		1,956	207.0	1,533	1,533	2,891			
153.00		3,501	290.0	2,691	4,224	6,183			
154.00		6,555	401.0	4,949	9,173	12,296			
155.00		16,956	686.0	11,351	20,524	36,955			
156.00		25,041	784.0	20,868	41,391	48,442			
156.40		30,828	976.0	11,154	52,545	75,335			
156.70		34,911	1,014.0	9,855	62,400	81,360			
Dovice B	louting	رما	vort Outle	et Devices					
	outing								
#1 P	rimary	156				ed Rectangular Weir			
			Head	d (feet) 0.20 0.40	0.60 0.80 1.00	1.20 1.40 1.60 1.80 2.00			
			2.50	3.00 3.50 4.00	4.50 5.00 5.50				
			Coef	f. (English) 2.34 2	2.50 2.70 2.68 2.	68 2.66 2.65 2.65 2.65			
				2.67 2.66 2.68					

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=151.00' (Free Discharge)

1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

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Summary for Link DP1: Wetland ST-10

Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth > 0.79" for 2-Year event Inflow = 1.14 cfs @ 12.14 hrs, Volume= 0.102 af

Primary = 1.14 cfs @ 12.14 hrs, Volume= 0.102 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP3: Wetland EA1 (culvert)

Inflow Area = 10.470 ac, 26.17% Impervious, Inflow Depth > 0.17" for 2-Year event

Inflow = 1.17 cfs @ 12.26 hrs, Volume= 0.151 af

Primary = 1.17 cfs @ 12.26 hrs, Volume= 0.151 af, Atten= 0%, Lag= 0.0 min

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Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Link DP4: Wetland EA1

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth > 1.63" for 2-Year event

Inflow = 1.28 cfs @ 12.08 hrs, Volume= 0.088 af

Primary = 1.28 cfs @ 12.08 hrs, Volume= 0.088 af, Atten= 0%, Lag= 0.0 min



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10-Year Storm Event - Existing

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Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: EX-1 Runoff Area=1.550 ac 0.00% Impervious Runoff Depth>1.63"

Flow Length=350' Tc=8.5 min CN=67 Runoff=2.60 cfs 0.210 af

Subcatchment2S: EX-2 Runoff Area=7.280 ac 37.64% Impervious Runoff Depth>2.24"

Flow Length=514' Tc=9.2 min CN=75 Runoff=17.10 cfs 1.361 af

Subcatchment3S: EX-3 Runoff Area=3.190 ac 0.00% Impervious Runoff Depth>1.28"

Flow Length=885' Tc=14.8 min CN=62 Runoff=3.28 cfs 0.341 af

Subcatchment4S: EX-4 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth>2.76"

Tc=5.0 min CN=81 Runoff=2.18 cfs 0.150 af

Pond 1P: Wetland ST-149.3 Peak Elev=156.28' Storage=48,827 cf Inflow=17.10 cfs 1.361 af

Outflow=0.51 cfs 0.257 af

Link DP1: Wetland ST-10 Inflow=2.60 cfs 0.210 af

Primary=2.60 cfs 0.210 af

Link DP3: Wetland EA1 (culvert) Inflow=3.28 cfs 0.598 af

Primary=3.28 cfs 0.598 af

Link DP4: Wetland EA1 Inflow=2.18 cfs 0.150 af

Primary=2.18 cfs 0.150 af

Total Runoff Area = 12.670 ac Runoff Volume = 2.062 af Average Runoff Depth = 1.95" 78.37% Pervious = 9.930 ac 21.63% Impervious = 2.740 ac

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Type III 24-hr 10-Year Rainfall=4.75" Printed 6/4/2012

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Summary for Subcatchment 1S: EX-1

Runoff = 2.60 cfs @ 12.13 hrs, Volume= 0.210 af, Depth> 1.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

	Area	(ac) C	N Des	cription		
0.410 36 Woods, Fair, HSG A						
	0.	320 7	'3 Woo	ds, Fair, F	ISG C	
	0.	660 7	'9 Woo	ds, Fair, F	ISG D	
_	0.	160 8	9 Dirt	roads, HS	G D	
	1.	550 6	7 Weig	ghted Aver	age	
	1.550 100.00% Pervious Area				ous Area	
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	5.3	50	0.1600	0.16		Sheet Flow,
						Woods: Light underbrush n= 0.400 P2= 3.28"
	3.2	300	0.1000	1.58		Shallow Concentrated Flow,
						Woodland Kv= 5.0 fps
	8.5	350	Total			

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"75" [4.75] [ype III 24-hr 10-Year Rainfall 2012/Printed 6

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Summary for Subcatchment 2S: EX-2

Runoff = 17.10 cfs @ 12.13 hrs, Volume= 1.361 af, Depth> 2.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

Area	(ac) C	N Desc	cription						
1.	920 3	36 Woo	ds, Fair, H	ISG A					
0.	0.820 73 Woods, Fair, HSG C								
0.	0.070 79 Woods, Fair, HSG D								
1.	.010		ed parking						
			ed parking						
_				over, Poor,					
				over, Poor,	HSG C				
			roads, HS0						
			roads, HS0						
			ghted Aver						
	540		6% Pervio						
2.	740	37.6	4% Imper	ious Area					
То	مائده ما	Clana	\/alaaitu	Canacity	Description				
	Length	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description				
(min)	(feet)			(CIS)	Oh set Flour				
6.2	37	0.0600	0.10		Sheet Flow,				
0.5	14	0.0600	0.43		Woods: Light underbrush n= 0.400 P2= 3.28" Sheet Flow,				
0.5	14	0.0000	0.43		Fallow n= 0.050 P2= 3.28"				
0.4	60	0.0600	2.45		Shallow Concentrated Flow,				
0.4	00	0.0000	2.40		Nearly Bare & Untilled Kv= 10.0 fps				
0.4	105	0.0600	4.97		Shallow Concentrated Flow,				
0		0.0000			Paved Kv= 20.3 fps				
0.5	139	0.0500	4.54		Shallow Concentrated Flow,				
					Paved Kv= 20.3 fps				
0.4	92	0.0400	4.06		Shallow Concentrated Flow,				
					Paved Kv= 20.3 fps				
8.0	67	0.0700	1.32		Shallow Concentrated Flow,				
					Woodland Kv= 5.0 fps				
9.2	514	Total							

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"75" [4.75] [ype III 24-hr 10-Year Rainfall 2012/Printed 6

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Summary for Subcatchment 3S: EX-3

Runoff = 3.28 cfs @ 12.22 hrs, Volume= 0.341 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

_	Area	(ac) C	N Desc	cription							
	0.	780 4	9 50-7	5% Grass	cover, Fair	r, HSG A					
	0.	990 7	'9 50-7	5% Grass	cover, Fair	r, HSG C					
	0.	160 8	34 50-7	5% Grass	cover, Fair	r, HSG D					
	0.	720 3	36 Woo	ds, Fair, F	ISG A						
	0.350 73 Woods, Fair, HSG C										
	0.	070 7	'9 Woo	ds, Fair, F	ISG D						
	0.	070 8	39 Grav	el roads, l	HSG C						
_	0.	050 9	1 Grav	∕el roads, l	HSG D						
	3.	190 6	32 Weig	ghted Aver	age						
	3.	190	100.	00% Pervi	ous Area						
	Tc	Length	Slope	Velocity	Capacity	Description					
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)						
	5.5	35	0.0700	0.11		Sheet Flow,					
						Woods: Light underbrush n= 0.400 P2= 3.28"					
	0.1	16	0.1250	2.01		Sheet Flow,					
						Smooth surfaces n= 0.011 P2= 3.28"					
	1.6	443	0.0540	4.72		Shallow Concentrated Flow,					
						Paved Kv= 20.3 fps					
	0.2	36	0.0300	3.52		Shallow Concentrated Flow,					
						Paved Kv= 20.3 fps					
	1.4	100	0.0300	1.21		Shallow Concentrated Flow,					
						Short Grass Pasture Kv= 7.0 fps					
	0.1	22	0.4500	4.70		Shallow Concentrated Flow,					
	4.0	00	0.0540	4.00		Short Grass Pasture Kv= 7.0 fps					
	1.0	93	0.0540	1.63		Shallow Concentrated Flow,					
	4.0	140	0.0260	0.47		Short Grass Pasture Kv= 7.0 fps					
	4.9	140	0.0360	0.47		Shallow Concentrated Flow,					
_	446	007	T ()			Forest w/Heavy Litter Kv= 2.5 fps					
	14.8	885	Total								

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Type III 24-hr 10-Year Rainfall=4.75" Printed 6/4/2012

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Summary for Subcatchment 4S: EX-4

Runoff = 2.18 cfs @ 12.07 hrs, Volume= 0.150 af, Depth> 2.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

_	^					Discost Frates				
(mi	n) (fe	et)	(ft/ft)	(ft/sec)	(cfs)					
٦	c Lenç	gth	Slope	Velocity	Capacity	Description				
	0.650 100.00% Pervious Area									
	0.650	81		hted Aver	•					
	0.343									
	0.001	73		Voods, Fair, HSG C						
	0.199	84		50-75% Grass cover, Fair, HSG D						
				· · ·						
	0.107	79	50-7	5% Grass	cover, Fair	: HSG C				
Ar	ea (ac)	CN	Desc	Description						

5.0

Direct Entry,

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Type III 24-hr 10-Year Rainfall=4.75"

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Summary for Pond 1P: Wetland ST-149.3

Inflow Area = 7.280 ac, 37.64% Impervious, Inflow Depth > 2.24" for 10-Year event

Inflow = 17.10 cfs @ 12.13 hrs, Volume= 1.361 af

Outflow = 0.51 cfs @ 17.55 hrs, Volume= 0.257 af, Atten= 97%, Lag= 324.8 min

Primary = 0.51 cfs @ 17.55 hrs, Volume= 0.257 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 2 Peak Elev= 156.28' @ 17.55 hrs Surf.Area= 28,964 sf Storage= 48,827 cf

Plug-Flow detention time= 481.8 min calculated for 0.257 af (19% of inflow)

Center-of-Mass det. time= 339.3 min (1,178.4 - 839.1)

Volume	Inv	vert Ava	il.Storage	Storage Description					
#1	151.	00'	62,400 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)			
Elevation	on	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)			
151.0	00	1,145	145.0	0	0	1,145			
152.0	00	1,956	207.0	1,533	1,533	2,891			
153.0	00	3,501	290.0	2,691	4,224	6,183			
154.0	154.00 6,555 401.0		4,949	9,173	12,296				
155.0	00	16,956	686.0	11,351	20,524	36,955			
156.0	00	25,041	784.0	20,868	41,391	48,442			
156.4	40	30,828	976.0	11,154	52,545	75,335			
156.7	70	34,911	1,014.0	9,855	62,400	81,360			
Device	Routing	<u>In</u>	vert Outle	et Devices					
#1	Primary	156	5.20' 10.0	' long x 5.0' brea	dth Broad-Creste	ed Rectangular Weir			
	•					1.20 1.40 1.60 1.80 2	2.00		
			2.50	3.00 3.50 4.00	4.50 5.00 5.50				
			Coe	f. (English) 2.34 2	2.50 2.70 2.68 2.	68 2.66 2.65 2.65 2.6	i5		
			2.65	2.67 2.66 2.68	2.70 2.74 2.79 2	.88			

Primary OutFlow Max=0.49 cfs @ 17.55 hrs HW=156.28' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.49 cfs @ 0.64 fps)

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Summary for Link DP1: Wetland ST-10

Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth > 1.63" for 10-Year event

Inflow = 2.60 cfs @ 12.13 hrs, Volume= 0.210 af

Primary = 2.60 cfs @ 12.13 hrs, Volume= 0.210 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP3: Wetland EA1 (culvert)

Inflow Area = 10.470 ac, 26.17% Impervious, Inflow Depth > 0.69" for 10-Year event

Inflow = 3.28 cfs @ 12.22 hrs, Volume= 0.598 af

Primary = 3.28 cfs @ 12.22 hrs, Volume= 0.598 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP4: Wetland EA1

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth > 2.76" for 10-Year event

Inflow = 2.18 cfs @ 12.07 hrs, Volume= 0.150 af

Primary = 2.18 cfs @ 12.07 hrs, Volume= 0.150 af, Atten= 0%, Lag= 0.0 min



FEIS/FEIR Technical Report Stormwater North Easton Station

100-Year Storm Event - Existing

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Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: EX-1 Runoff Area=1.550 ac 0.00% Impervious Runoff Depth>3.30"

Flow Length=350' Tc=8.5 min CN=67 Runoff=5.48 cfs 0.426 af

Subcatchment2S: EX-2 Runoff Area=7.280 ac 37.64% Impervious Runoff Depth>4.14"

Flow Length=514' Tc=9.2 min CN=75 Runoff=31.74 cfs 2.513 af

Subcatchment3S: EX-3 Runoff Area=3.190 ac 0.00% Impervious Runoff Depth>2.79"

Flow Length=885' Tc=14.8 min CN=62 Runoff=7.77 cfs 0.742 af

Subcatchment4S: EX-4 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth>4.80"

Tc=5.0 min CN=81 Runoff=3.75 cfs 0.260 af

Pond 1P: Wetland ST-149.3 Peak Elev=156.57' Storage=57,956 cf Inflow=31.74 cfs 2.513 af

Outflow=5.57 cfs 1.397 af

Link DP1: Wetland ST-10 Inflow=5.48 cfs 0.426 af

Primary=5.48 cfs 0.426 af

Link DP3: Wetland EA1 (culvert) Inflow=8.97 cfs 2.139 af

Primary=8.97 cfs 2.139 af

Link DP4: Wetland EA1 Inflow=3.75 cfs 0.260 af

Primary=3.75 cfs 0.260 af

Total Runoff Area = 12.670 ac Runoff Volume = 3.941 af Average Runoff Depth = 3.73" 78.37% Pervious = 9.930 ac 21.63% Impervious = 2.740 ac

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Summary for Subcatchment 1S: EX-1

Runoff = 5.48 cfs @ 12.12 hrs, Volume= 0.426 af, Depth> 3.30"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Area	(ac) (CN D)esc	ription		
	0.	410	36 V	Voo	ds, Fair, H	ISG A	
	0.	320	73 V	Voo	ds, Fair, H	ISG C	
	0.	660	79 V	Voo	ds, Fair, H	ISG D	
_	0.	160	89 D	irt r	oads, HS	G D	
	1.	550	67 V	Veig	hted Aver	age	
	1.550 100.00% Pervious Area					ous Area	
	Tc	Length			Velocity	Capacity	Description
_	(min)	(feet)	(ft/	ft)	(ft/sec)	(cfs)	
	5.3	50	0.16	00	0.16		Sheet Flow,
							Woods: Light underbrush n= 0.400 P2= 3.28"
	3.2	300	0.10	00	1.58		Shallow Concentrated Flow,
_							Woodland Kv= 5.0 fps
	8.5	350	Tota				

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Summary for Subcatchment 2S: EX-2

Runoff = 31.74 cfs @ 12.13 hrs, Volume= 2.513 af, Depth> 4.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Area	(ac) C	N Desc	cription				
1.920 36 Woods, Fair, HSG A 0.820 73 Woods, Fair, HSG C								
	0.	820 7	73 Woo	ds, Fair, F	ISG C			
	0.	070 7	79 Woo	ds, Fair, F	ISG D			
	1.	010	98 Pave	ed parking	, HSG A			
				ed parking				
					over, Poor,			
					over, Poor,	HSG C		
0.370 72 Dirt roads, HSG A								
_				roads, HS	G C			
			•	ghted Aver	•			
		540		6% Pervio				
	2.	740	37.6	4% Imper	ious Area			
	_		-			-		
	_		Slope	Velocity	Capacity	Description		
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
	6.2 37 0		0.0600	0.10		Sheet Flow,		
0.5		0.0000	0.40		Woods: Light underbrush n= 0.400 P2= 3.28"			
0.5 14 0.4 60 0.4 105		14	0.0600	0.43		Sheet Flow,		
		60	0.0000	0.45		Fallow n= 0.050 P2= 3.28"		
		0.0600	2.45		Shallow Concentrated Flow,			
		105	0.0600	.0600 4.97		Nearly Bare & Untilled Kv= 10.0 fps Shallow Concentrated Flow,		
		105	0.0000			Paved Kv= 20.3 fps		
	0.5	139	0.0500	4.54		Shallow Concentrated Flow,		
	0.5	100	0.0000	т.от		Paved Kv= 20.3 fps		
	0.4	92	0.0400	4.06		Shallow Concentrated Flow,		
	0.1	٥ <u>ـ</u>	3.0 100	1.00		Paved Kv= 20.3 fps		
	0.8	67	0.0700	1.32		Shallow Concentrated Flow,		
						Woodland Kv= 5.0 fps		
_	9.2	514	Total					

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Type III 24-hr 100-Year Rainfall=7.00" Printed 6/4/2012

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Summary for Subcatchment 3S: EX-3

Runoff = 7.77 cfs @ 12.21 hrs, Volume= 0.742 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 100-Year Rainfall=7.00"

۸	() O	N Daa								
Area			Description 5 in 1100 A							
	0.780 49 50-75% Grass cover, Fair, HSG A									
	0.990 79 50-75% Grass cover, Fair, HSG C									
	0.160 84 50-75% Grass cover, Fair, HSG D									
_	0.720 36 Woods, Fair, HSG A									
_	0.350 73 Woods, Fair, HSG C									
	0.070 79 Woods, Fair, HSG D									
	0.070 89 Gravel roads, HSG C									
0.	0.050 91 Gravel roads, HSG D									
3.	3.190 62 Weighted Average									
3.	190	100.	00% Pervi	ous Area						
Tc	Length	Slope	Velocity	Capacity	Description					
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)						
5.5	35	0.0700	0.11		Sheet Flow,					
					Woods: Light underbrush n= 0.400 P2= 3.28"					
0.1	16	0.1250	2.01		Sheet Flow,					
					Smooth surfaces n= 0.011 P2= 3.28"					
1.6	443	0.0540	4.72		Shallow Concentrated Flow,					
					Paved Kv= 20.3 fps					
0.2	36	0.0300	3.52		Shallow Concentrated Flow,					
					Paved Kv= 20.3 fps					
1.4	100	0.0300	1.21		Shallow Concentrated Flow,					
					Short Grass Pasture Kv= 7.0 fps					
0.1	22	0.4500	4.70		Shallow Concentrated Flow,					
					Short Grass Pasture Kv= 7.0 fps					
1.0	93	0.0540	1.63		Shallow Concentrated Flow,					
					Short Grass Pasture Kv= 7.0 fps					
4.9	140	0.0360	0.47		Shallow Concentrated Flow,					
					Forest w/Heavy Litter Kv= 2.5 fps					
14.8	885	Total								

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Type III 24-hr 100-Year Rainfall=7.00" Printed 6/4/2012

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Summary for Subcatchment 4S: EX-4

Runoff = 3.75 cfs @ 12.07 hrs, Volume= 0.260 af, Depth> 4.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 100-Year Rainfall=7.00"

Area (ac) CN Description											
0.107 79 50-75% Grass cover, Fair, HSG C											
	0.	199	84	50-7	50-75% Grass cover, Fair, HSG D						
	0.	001	73	Woo	Woods, Fair, HSG C						
_	0.	343	79	Woo	ds, Fair, H	SG D					
0.650 81 Weighted Average											
	0.	0.650		100.	00% Pervi	ous Area					
	Tc	Leng		Slope	Velocity	Capacity	Description				
(min) (feet) (ft/ft) (ft/sec) (cfs)				(ft/sec)	(cfs)						
F O Dire							Discot Fotos				

5.0

Direct Entry,

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Pond 1P: Wetland ST-149.3

Inflow Area = 7.280 ac, 37.64% Impervious, Inflow Depth > 4.14" for 100-Year event

Inflow = 31.74 cfs @ 12.13 hrs, Volume= 2.513 af

Outflow = 5.57 cfs @ 12.65 hrs, Volume= 1.397 af, Atten= 82%, Lag= 31.5 min

Primary = 5.57 cfs @ 12.65 hrs, Volume= 1.397 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 2 Peak Elev= 156.57' @ 12.65 hrs Surf.Area= 33,101 sf Storage= 57,956 cf

Plug-Flow detention time= 229.6 min calculated for 1.397 af (56% of inflow)

Center-of-Mass det. time= 120.3 min (941.8 - 821.6)

Volume	Inv	vert Ava	il.Storage	Storage Descripti	ion			
#1	151.	00'	62,400 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)		
Elevation	on	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area		
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)		
151.0	00	1,145	145.0	0	0	1,145		
152.0	00	1,956	207.0	1,533	1,533	2,891		
153.0	00	3,501	290.0	2,691	4,224	6,183		
154.0	00	6,555	401.0	4,949	9,173	12,296		
155.0	00	16,956	686.0	11,351	20,524	36,955		
156.0	00	25,041	784.0	20,868	41,391	48,442		
156.4	40	30,828	976.0	11,154	52,545	75,335		
156.7	70	34,911	1,014.0	9,855	62,400	81,360		
Device	Routing	ln In	vert Outle	et Devices				
#1	Primary	156	6.20' 10.0	' long x 5.0' brea	dth Broad-Creste	ed Rectangular Weir		
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00								
2.50 3.00 3.50 4.00 4.50 5.00 5.50								
			Coe	f. (English) 2.34 2	2.50 2.70 2.68 2.	68 2.66 2.65 2.65 2.6	55	
			2.65	2.67 2.66 2.68	2.70 2.74 2.79 2	.88		

Primary OutFlow Max=5.56 cfs @ 12.65 hrs HW=156.57' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 5.56 cfs @ 1.50 fps)

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Summary for Link DP1: Wetland ST-10

Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth > 3.30" for 100-Year event

Inflow = 5.48 cfs @ 12.12 hrs, Volume= 0.426 af

Primary = 5.48 cfs @ 12.12 hrs, Volume= 0.426 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP3: Wetland EA1 (culvert)

Inflow Area = 10.470 ac, 26.17% Impervious, Inflow Depth > 2.45" for 100-Year event

Inflow = 8.97 cfs @ 12.52 hrs, Volume= 2.139 af

Primary = 8.97 cfs @ 12.52 hrs, Volume= 2.139 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP4: Wetland EA1

Inflow Area = 0.650 ac, 0.00% Impervious, Inflow Depth > 4.80" for 100-Year event

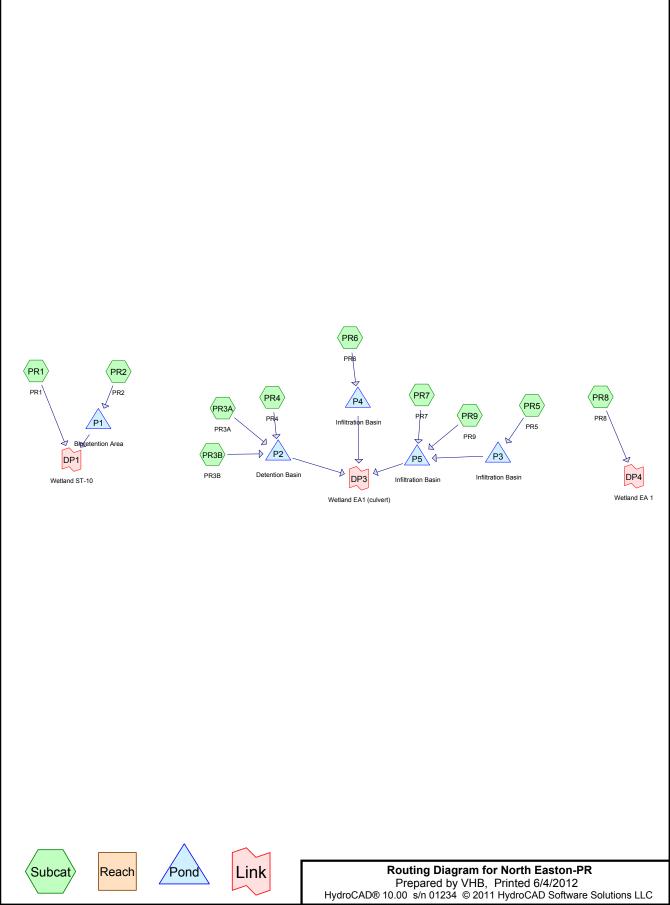
Inflow = 3.75 cfs @ 12.07 hrs, Volume= 0.260 af

Primary = 3.75 cfs @ 12.07 hrs, Volume= 0.260 af, Atten= 0%, Lag= 0.0 min



FEIS/FEIR Technical Report Stormwater North Easton Station

HydroCAD Analysis: Proposed Conditions



North Easton-PR

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Page 2

Area Listing (all nodes)

Aı	rea CN	Description			
(acre	es)	(subcatchment-numbers)			
0.3	367 36	Woods, Fair, HSG A (PR1, PR2, PR7)			
1.5	511 49	50-75% Grass cover, Fair, HSG A (PR2, PR4, PR6, PR7, PR9)			
0.9	922 73	Woods, Fair, HSG C (PR1, PR2, PR3A, PR7)			
0.0	36 76	Gravel roads, HSG A (PR9)			
2.4	116 79	50-75% Grass cover, Fair, HSG C (PR3A, PR4, PR5, PR6, PR7, PR8, PR9)			
0.9	914 79	Woods, Fair, HSG D (PR1, PR2, PR8)			
0.5	534 84	50-75% Grass cover, Fair, HSG D (PR2, PR6, PR8, PR9)			
0.1	157 89	Dirt roads, HSG D (PR1)			
0.0)10 89	Gravel roads, HSG C (PR9)			
2.3	348 98	Paved parking, HSG A (PR2, PR6, PR7)			
2.0)84 98	Paved parking, HSG C (PR3B, PR4, PR5, PR6, PR7)			
0.1	100 98	Paved parking, HSG D (PR6)			
11.3	399 81	TOTAL AREA			

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Pipe Listing (all nodes)

Line#	Node	In-Invert	Out-Invert	vert Length Slo		n	Diam/Width	Height	Inside-Fill
	Number	(feet)	(feet)	(feet)	(ft/ft)		(inches)	(inches)	(inches)
1	PR3A	0.00	0.00	181.0	0.0100	0.011	12.0	0.0	0.0
2	PR3A	0.00	0.00	131.0	0.0100	0.011	15.0	0.0	0.0
3	PR3A	0.00	0.00	66.0	0.0091	0.011	15.0	0.0	0.0
4	PR3A	0.00	0.00	75.0	0.0092	0.011	15.0	0.0	0.0
5	PR7	0.00	0.00	180.0	0.0139	0.013	12.0	0.0	0.0
6	PR7	0.00	0.00	177.0	0.0650	0.013	21.0	0.0	0.0
7	PR7	0.00	0.00	295.0	0.0102	0.013	21.0	0.0	0.0
8	PR7	0.00	0.00	90.0	0.0100	0.013	21.0	0.0	0.0
9	PR7	0.00	0.00	177.0	0.0136	0.013	21.0	0.0	0.0
10	PR7	0.00	0.00	66.0	0.0136	0.013	21.0	0.0	0.0
11	P2	153.40	152.50	112.0	0.0080	0.013	12.0	0.0	0.0
12	P3	155.00	154.00	49.0	0.0204	0.013	12.0	0.0	0.0
13	P5	144.00	143.50	50.0	0.0100	0.013	12.0	0.0	0.0



FEIS/FEIR Technical Report Stormwater North Easton Station

2-Year Storm Event - Proposed

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Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points Runoff by SCS TR-20 method, UH=SCS Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

i todoi i odimig by otor ind	
SubcatchmentPR1: PR1	Runoff Area=1.341 ac 0.00% Impervious Runoff Depth>0.94" Flow Length=410' Tc=14.6 min CN=70 Runoff=1.03 cfs 0.105 af
SubcatchmentPR2: PR2	Runoff Area=1.420 ac 42.25% Impervious Runoff Depth>1.23" Flow Length=455' Tc=15.0 min CN=75 Runoff=1.49 cfs 0.145 af
SubcatchmentPR3A: PR3A	Runoff Area=1.500 ac 0.00% Impervious Runoff Depth>1.42" Flow Length=757' Tc=16.8 min CN=78 Runoff=1.78 cfs 0.177 af
SubcatchmentPR3B: PR3B	Runoff Area=0.600 ac 100.00% Impervious Runoff Depth>3.16" Tc=5.0 min CN=98 Runoff=2.05 cfs 0.158 af
SubcatchmentPR4: PR4	Runoff Area=0.128 ac 62.50% Impervious Runoff Depth>1.70" Tc=5.0 min CN=82 Runoff=0.26 cfs 0.018 af
SubcatchmentPR5: PR5	Runoff Area=0.300 ac 66.67% Impervious Runoff Depth>2.54" Tc=5.0 min CN=92 Runoff=0.90 cfs 0.063 af
SubcatchmentPR6: PR6	Runoff Area=1.260 ac 43.65% Impervious Runoff Depth>1.36" Tc=5.0 min CN=77 Runoff=2.04 cfs 0.142 af
SubcatchmentPR7: PR7	Runoff Area=2.800 ac 89.36% Impervious Runoff Depth>2.84" Flow Length=1,318' Tc=5.0 min CN=95 Runoff=9.10 cfs 0.662 af
SubcatchmentPR8: PR8	Runoff Area=0.555 ac 0.00% Impervious Runoff Depth>1.63" Flow Length=117' Tc=6.7 min CN=81 Runoff=1.03 cfs 0.075 af
SubcatchmentPR9: PR9	Runoff Area=1.495 ac 0.00% Impervious Runoff Depth>0.84" Flow Length=175' Tc=7.3 min CN=68 Runoff=1.24 cfs 0.105 af
Pond P1: Bioretention Area Discarded=0.14	Peak Elev=156.43' Storage=2,897 cf Inflow=1.49 cfs 0.145 af cfs 0.129 af Primary=0.00 cfs 0.000 af Outflow=0.14 cfs 0.129 af
Pond P2: Detention Basin	Peak Elev=158.37' Storage=8,278 cf Inflow=3.30 cfs 0.353 af Outflow=0.46 cfs 0.275 af
Pond P3: Infiltration Basin Discarded=0.01	Peak Elev=162.50' Storage=872 cf Inflow=0.90 cfs 0.063 af cfs 0.009 af Primary=0.82 cfs 0.037 af Outflow=0.83 cfs 0.046 af

 Pond P4: Infiltration Basin
 Peak Elev=153.25'
 Storage=3,053 cf
 Inflow=2.04 cfs
 0.142 af

 Discarded=0.13 cfs
 0.115 af
 Primary=0.00 cfs
 0.000 af
 Outflow=0.13 cfs
 0.115 af

Pond P5: Infiltration Basin Peak Elev=144.29' Storage=14,390 cf Inflow=10.92 cfs 0.804 af Discarded=0.70 cfs 0.750 af Primary=0.30 cfs 0.052 af Outflow=1.00 cfs 0.803 af

Link DP1: Wetland ST-10Inflow=1.03 cfs 0.105 af

Primary=1.03 cfs 0.105 af

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\textbf{North Easton-PR} \tag{Type III 24-hr 2-Year Rainfall=3.40"} \\
\text{Prepared by VHB} \text{Printed 6/4/2012} \\
\text{HydroCAD} \text{8 10.00 s/n 01234 @ 2011 HydroCAD Software Solutions LLC} \text{Page 5} \\
\end{array}

Link DP3: Wetland EA1 (culvert) Inflow=0.76 cfs 0.328 af

Primary=0.76 cfs 0.328 af

Link DP4: Wetland EA 1 Inflow=1.03 cfs 0.075 af

Primary=1.03 cfs 0.075 af

Total Runoff Area = 11.399 ac Runoff Volume = 1.652 af Average Runoff Depth = 1.74" 60.24% Pervious = 6.867 ac 39.76% Impervious = 4.532 ac

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Summary for Subcatchment PR1: PR1

Runoff = 1.03 cfs @ 12.22 hrs, Volume= 0.105 af, Depth> 0.94"

Area	(ac) C	N Desc	cription						
0.	.278 3	6 Woo	ds, Fair, H	ISG A					
0.	.320 7	'3 Woo	ds, Fair, H	ISG C					
0.	.586 7	'9 Woo	ds, Fair, F	ISG D					
0.	0.157 89 Dirt roads, HSG D								
1.	.341 7	'0 Weig	ghted Aver	age					
1.	.341	100.	00% Pervi	ous Area					
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
9.2	50	0.1600	0.09		Sheet Flow,				
					Woods: Dense underbrush n= 0.800 P2= 3.28"				
3.7	190	0.0300	0.87		Shallow Concentrated Flow,				
					Woodland Kv= 5.0 fps				
0.3	34	0.1700	2.06		Shallow Concentrated Flow,				
					Woodland Kv= 5.0 fps				
1.4	136	0.1100	1.66		Shallow Concentrated Flow,				
					Woodland Kv= 5.0 fps				
14.6	410	Total							

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Summary for Subcatchment PR2: PR2

Runoff = 1.49 cfs @ 12.22 hrs, Volume= 0.145 af, Depth> 1.23"

Area	(ac) C	N Desc	cription						
0.	.080 3	6 Woo	ds, Fair, F	ISG A					
0.	.200 7	'3 Woo	Woods, Fair, HSG C						
0.	.100 7	'9 Woo	Woods, Fair, HSG D						
0.	.600 9		Paved parking, HSG A						
			50-75% Grass cover, Fair, HSG A						
0	.040 8	<u> 50-7</u>	5% Grass	cover, Fair	; HSG D				
			ghted Aver						
	.820	_	5% Pervio						
0.	.600	42.2	5% Imper	ious Area					
т.	1 41-	01	\	0 16 -	Describetion				
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
12.2	50	0.0800	0.07		Sheet Flow,				
0.5	70	0.0400	0.45		Woods: Dense underbrush n= 0.800 P2= 3.28"				
0.5	79	0.2400	2.45		Shallow Concentrated Flow,				
0.1	20	0.1500	2.71		Woodland Kv= 5.0 fps				
0.1	20	0.1500	2.71		Shallow Concentrated Flow,				
					Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps				
0.1 1.4	20 205	0.1500 0.0150	2.71 2.49		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps Shallow Concentrated Flow,				
1.4	205	0.0150	2.49		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps Shallow Concentrated Flow, Paved Kv= 20.3 fps				
					Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps Shallow Concentrated Flow, Paved Kv= 20.3 fps Shallow Concentrated Flow,				
1.4	205	0.0150	2.49		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps Shallow Concentrated Flow, Paved Kv= 20.3 fps				

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Summary for Subcatchment PR3A: PR3A

Runoff = 1.78 cfs @ 12.23 hrs, Volume= 0.177 af, Depth> 1.42"

Area	a (ac) C	N Des	cription		
	0.300 7	73 Woo	ds, Fair, F	ISG C	
	1.200 7			cover, Fair	, HSG C
	1.500 7	78 Weid	hted Aver	age	
	1.500		00% Pervi	•	
To	Length	Slope	Velocity	Capacity	Description
(min)	•	(ft/ft)	(ft/sec)	(cfs)	•
13.2	50	0.0650	0.06	, ,	Sheet Flow,
_					Woods: Dense underbrush n= 0.800 P2= 3.28"
1.4	104	0.0650	1.27		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
0.1	12	0.3300	2.87		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
0.7	138	0.0300	3.52		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
0.6	181	0.0100	5.36	4.21	
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.011 Concrete pipe, straight & clean
0.4	. 131	0.0100	6.22	7.63	
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
0.2	66	0.0091	5.93	7.28	
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
0.0		0.0000	5.07	7.00	n= 0.011 Concrete pipe, straight & clean
0.2	75	0.0092	5.97	7.32	
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
		-			n= 0.011 Concrete pipe, straight & clean
16.8	757	Total			

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Summary for Subcatchment PR3B: PR3B

Runoff = 2.05 cfs @ 12.07 hrs, Volume= 0.158 af, Depth> 3.16"

Area	(ac)	CN	Desc	Description						
0	0.600 98 Paved parking, HSG C									
0	0.600 100.00% Impervious Area									
Tc	Leng	ıth '	Slope	Velocity	Capacity	Description				
(min)	(fee		(ft/ft)	(ft/sec)	(cfs)	Description				
5.0						Direct Entry,				

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Summary for Subcatchment PR4: PR4

Runoff = 0.26 cfs @ 12.08 hrs, Volume= 0.018 af, Depth> 1.70"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Area	(ac)	CN	Desc	Description							
	0.011 79 50-75% Grass cover, Fair, HSG C											
	0.037 49 50-75% Grass cover, Fair, HSG A											
_	0.080 98 Paved parking, HSG C											
	0.128 82 Weighted Average											
	0.	048		37.5	37.50% Pervious Area							
	0.080			62.50% Impervious Area								
	_			01			B					
	Tc	Leng		Slope	Velocity	Capacity	Description					
_	(min)	min) (feet) (ft/ft) (ft/sec) (cfs)										
	E 0						Direct Frotm.					

5.0

Direct Entry,

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Summary for Subcatchment PR5: PR5

Runoff = 0.90 cfs @ 12.07 hrs, Volume= 0.063 af, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 2-Year Rainfall=3.40"

	5 0						Direct Entry						
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)							
	_	Length		Slope	,	. ,	Description						
	Тс	Longth	, 0	Slope	Velocity	Capacity	Description						
	0.200			00.00	70 imperv	ious Area							
	0.	100		33.33	3% Pervio	us Area							
	0.300 92 Weighted Average												
	0	200	02	Maia	btod Avor	2000							
	0.3	200	98	Pave	d parking,	, HSG C							
0.100 79 50-75% Grass cover, Fair, HSG C													
	0.400 70 F0.75% Cross source Fair LICC C												
	Area ((ac)	CN	Desc	Description								

5.0 Direct Entry,

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Summary for Subcatchment PR6: PR6

Runoff = 2.04 cfs @ 12.08 hrs, Volume= 0.142 af, Depth> 1.36"

	Area	(ac)	CN	Desc	Description								
	0.4	450	49	50-7	50-75% Grass cover, Fair, HSG A								
	0.200 79 50-75% Grass cover, Fair, HSG C												
	0.060 84 50-75% Grass cover, Fair, HSG D												
	0.300 98 Paved parking, HSG A												
	0.150 98 Paved parking, HSG C												
	0.	100	98	Pave	ed parking	, HSG D							
	1.:	260	77	Weig	ghted Aver	age							
	0.	710		56.3	5% Pervio	us Area							
	0.	550		43.6	5% Imper	ious Area							
	Tc	Leng	th	Slope	Velocity	Capacity	Description						
_	(min)	(fee	et)	(ft/ft)	(ft/sec)	(cfs)							
	5.0						Direct Entry.						

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Summary for Subcatchment PR7: PR7

Runoff = 9.10 cfs @ 12.07 hrs, Volume= 0.662 af, Depth> 2.84"

Area ((ac) C	N Desc	cription		
		'3 Woo	ds, Fair, H	ISG C	
		6 Woo	ds, Fair, H	ISG A	
				cover, Fair	
				cover, Fair	HSG C
			ed parking		
			ed parking		
	800 9 298		hted Aver 4% Pervio		
	290 502			ious Area	
۷.۶	30Z	09.5	o /o iiiipei v	nous Area	
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	'
0.5	50	0.0350	1.52		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.28"
0.4	53	0.2000	2.24		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
0.1	21	0.2200	3.28		Shallow Concentrated Flow,
					Short Grass Pasture Kv= 7.0 fps
1.0	209	0.0300	3.52		Shallow Concentrated Flow,
0.0	400	0.0400	5.05	4.00	Paved Kv= 20.3 fps
0.6	180	0.0139	5.35	4.20	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.013 Concrete pipe, straight & clean
0.2	177	0.0650	16.80	40.40	
0.2	177	0.0000	10.00	40.40	21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.7	295	0.0102	6.65	16.00	
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.2	90	0.0100	6.59	15.85	Pipe Channel,
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.4	177	0.0136	7.68	18.48	
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.8	00	0.0400	7.00	40.40	Direct Entry,
0.1	66	0.0136	7.68	18.48	
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
	4 040	Total			n= 0.013 Concrete pipe, straight & clean
5.0	1,318	Total			

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Summary for Subcatchment PR8: PR8

Runoff = 1.03 cfs @ 12.10 hrs, Volume= 0.075 af, Depth> 1.63"

_	Area	(ac) C	N Desc	escription							
	0.125 79 50-75% Grass cover, Fair, HSG C										
0.202 84 50-75% Grass cover, Fair, HSG D											
_	0.228 79 Woods, Fair, HSG D										
	0.555 81 Weighted Average										
0.555 100.00% Pervious Area											
	Тс	Length	Slope	Velocity	Capacity	Description					
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)						
	5.8	50	0.1300	0.14		Sheet Flow,					
						Woods: Light underbrush n= 0.400 P2= 3.28"					
	0.9	67	0.0600	1.22		Shallow Concentrated Flow,					
						Woodland Kv= 5.0 fps					
-	6.7	117	Total			•					

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Summary for Subcatchment PR9: PR9

Runoff = 1.24 cfs @ 12.12 hrs, Volume= 0.105 af, Depth> 0.84"

_	Area	(ac)	CN	Desc	cription		
	0.	590	49	50-7	5% Grass	cover, Fair	r, HSG A
	0.	627	79	50-7	5% Grass	cover, Fair	r, HSG C
	0.232 84 50-75% Grass cover, Fair						r, HSG D
	0.036 76 Gravel roads, HSG A						
	0.010 89 Gravel roads, HSG C						
	1.	495	68	Weig	hted Aver	age	
	1.	495		100.	00% Pervi	ous Area	
	Tc	Length	n S	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	5.6	50	0.0	0200	0.15		Sheet Flow,
							Grass: Short n= 0.150 P2= 3.28"
	1.7	125	5 0.0	0320	1.25		Shallow Concentrated Flow,
							Short Grass Pasture Kv= 7.0 fps
	7.3	175	5 To	otal			·

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Summary for Pond P1: Bioretention Area

Inflow Area = 1.420 ac, 42.25% Impervious, Inflow Depth > 1.23" for 2-Year event

Inflow = 1.49 cfs @ 12.22 hrs, Volume= 0.145 af

Outflow = 0.14 cfs @ 14.50 hrs, Volume= 0.129 af, Atten= 91%, Lag= 137.0 min

Discarded = 0.14 cfs @ 14.50 hrs, Volume= 0.129 af Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 156.43' @ 14.50 hrs Surf.Area= 2,518 sf Storage= 2,897 cf

Plug-Flow detention time= 240.7 min calculated for 0.129 af (89% of inflow)

Center-of-Mass det. time= 189.7 min (1,051.0 - 861.3)

Volume Inver		rt Avai	I.Storage	Storage Description					
#1	155.0	0'	11,957 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)			
Elevatior (feet	-	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)			
155.00	,	1,579	188.0	0	0	1,579			
156.00)	2,217	223.0	1,889	1,889	2,742			
157.00)	2,953	252.0	2,576	4,465	3,864			
158.00)	3,738	271.0	3,338	7,803	4,697			
158.50)	4,153	280.0	1,972	9,775	5,114			
159.00)	4,581	290.0	2,183	11,957	5,590			
Device	Routing	ln	vert Outle	et Devices					
#1	Primary	158	Head	tom Weir/Orifice, d (feet) 0.00 0.50 h (feet) 5.00 6.00	8)				
#2 Discard		d 155	5.00' 2.41	10 in/hr Exfiltration over Surface area					

Discarded OutFlow Max=0.14 cfs @ 14.50 hrs HW=156.43' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=155.00' (Free Discharge)
—1=Custom Weir/Orifice (Controls 0.00 cfs)

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Pond P2: Detention Basin

Inflow Area = 2.228 ac, 30.52% Impervious, Inflow Depth > 1.90" for 2-Year event

Inflow = 3.30 cfs @ 12.09 hrs, Volume= 0.353 af

Outflow = 0.46 cfs @ 13.12 hrs, Volume= 0.275 af, Atten= 86%, Lag= 62.1 min

Primary = 0.46 cfs @ 13.12 hrs, Volume= 0.275 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 158.37' @ 13.12 hrs Surf.Area= 4,672 sf Storage= 8,278 cf

Plug-Flow detention time= 261.0 min calculated for 0.275 af (78% of inflow)

Center-of-Mass det. time= 177.1 min (984.9 - 807.8)

Volume	Inve	ert Avail.Storage		Storage Description					
#1	156.00	00' 27,737		Custom Stage D	ata (Irregular)List	ed below (Recalc)			
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(feet	()	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>			
156.00	0	2,331	275.0	0	0	2,331			
157.00)	3,258	321.0	2,782	2,782	4,533			
157.50	0	3,896	289.0	1,786	4,568	6,094			
158.00)	4,338	299.0	2,058	6,625	6,584			
159.00	0	5,276	318.0	4,799	11,425	7,567			
160.00)	6,256	337.0	5,759	17,184	8,610			
161.00		7,298	356.0	6,770	23,954	9,714			
161.50		7,839	365.0	3,783	27,737	10,260			
Device	Routing	Inv	ert Outle	et Devices					
#1	Primary	153.	40' 12.0	" Round Culvert			_		
				= 112.0' RCP, sq.cut end projecting, Ke= 0.500					
						= 0.0080 '/' Cc= 0.900			
						ctions, Flow Area= 0.79 sf			
#2	Device 1	157.		Vert. Orifice/Grat		,			
#3	Device 1	160.			ice/Grate X 4.00 c	columns			
•		. 30.			4.0" x 24.0" Grate				
				ted to weir flow at I					

Primary OutFlow Max=0.46 cfs @ 13.12 hrs HW=158.37' (Free Discharge)

-1=Culvert (Passes 0.46 cfs of 6.21 cfs potential flow)

-2=Orifice/Grate (Orifice Controls 0.46 cfs @ 5.28 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Pond P3: Infiltration Basin

Inflow Area = 0.300 ac, 66.67% Impervious, Inflow Depth > 2.54" for 2-Year event 0.90 cfs @ 12.07 hrs, Volume= 0.063 af 0.83 cfs @ 12.11 hrs, Volume= 0.046 af, Atten= 8%, Lag= 2.0 min 0.01 cfs @ 12.11 hrs, Volume= 0.009 af 0.82 cfs @ 12.11 hrs, Volume= 0.037 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 162.50' @ 12.11 hrs Surf.Area= 1,201 sf Storage= 872 cf

Plug-Flow detention time= 140.3 min calculated for 0.046 af (73% of inflow) Center-of-Mass det. time= 52.2 min (846.4 - 794.2)

Volume	Inve	Invert Avail.Storage		Storage Description				
#1	161.5	0'	1,389 cf	Custom Stage D	ata (Irregular)List	ed below (Recalc)		
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
161.5		552	116.0	0	0	552		
162.00		879	170.0	355	355	1,783		
162.5	50	1,202	174.0	518	873	1,922		
162.9	90	1,379	179.0	516	1,389	2,080		
Device	Routing	In	vert Outle	et Devices				
#1	Primary	155	.00' 12.0	" Round Culvert				
	,		L= 4	9.0' RCP, sq.cut	end projecting, Ke	= 0.500		
			Inlet	/ Outlet Invert= 15	5.00' / 154.00' S=	= 0.0204 '/' Cc= 0.900		
			n= 0	.013 Concrete pip	e, straight & clean	, Flow Area= 0.79 sf		
#2	Device 1	162		x 4.0" Horiz. Orif				
			X 4 ı	rows C= 0.600 in 2	4.0" x 24.0" Grate			
				ted to weir flow at I	ow heads			
#3	Discarde	d 161	.50' 0.27	70 in/hr Exfiltration over Surface area				

Discarded OutFlow Max=0.01 cfs @ 12.11 hrs HW=162.50' (Free Discharge) 3=Exfiltration (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.82 cfs @ 12.11 hrs HW=162.50' (Free Discharge)
1=Culvert (Passes 0.82 cfs of 9.90 cfs potential flow)
2=Orifice/Grate (Weir Controls 0.82 cfs @ 1.03 fps)

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Pond P4: Infiltration Basin

Inflow Area = 1.260 ac, 43.65% Impervious, Inflow Depth > 1.36" for 2-Year event

Inflow = 2.04 cfs @ 12.08 hrs, Volume= 0.142 af

Outflow = 0.13 cfs @ 14.41 hrs, Volume= 0.115 af, Atten= 94%, Lag= 139.7 min

Discarded = 0.13 cfs @ 14.41 hrs, Volume= 0.115 af Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 153.25' @ 14.41 hrs Surf.Area= 2,345 sf Storage= 3,053 cf

Plug-Flow detention time= 270.1 min calculated for 0.115 af (81% of inflow)

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Center-of-Mass det. time= 192.5 min (1,039.9 - 847.4)

Volume	Inve	ert Avai	I.Storage	Storage Descript	ion					
#1	151.0	00'	6,847 cf	Custom Stage D	Data (Irregular)Lis	ted below (Recalc)				
Elevation	on	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area				
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)				
151.0	00	545	185.0	0	0	545				
152.0	00	1,210	238.0	856	856	2,342				
153.0	00	2,120	306.0	1,644	2,500	5,298				
154.0	00	3,095	343.0	2,592	5,092	7,236				
154.5	50	3,945	293.0	1,756	6,847	9,772				
Device	Routing	ln	vert Outle	et Devices						
#1	#1 Primary 154.00' Cu			Custom Weir/Orifice, Cv= 2.62 (C= 3.28)						
				d (feet) 0.00 0.50						
				Width (feet) 5.00 6.00						
#2 Discarded		d 151	.00' 2.41	10 in/hr Exfiltration over Surface area						

Discarded OutFlow Max=0.13 cfs @ 14.41 hrs HW=153.25' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.13 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=151.00' (Free Discharge) 1=Custom Weir/Orifice (Controls 0.00 cfs)

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Pond P5: Infiltration Basin

Inflow Area = 4.595 ac, 58.80% Impervious, Inflow Depth > 2.10" for 2-Year event

Inflow = 10.92 cfs @ 12.08 hrs, Volume= 0.804 af

Outflow = 1.00 cfs @ 13.00 hrs, Volume= 0.803 af, Atten= 91%, Lag= 55.5 min

Discarded = 0.70 cfs @ 13.00 hrs, Volume= 0.750 af Primary = 0.30 cfs @ 13.00 hrs, Volume= 0.052 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 144.29' @ 13.00 hrs Surf.Area= 12,548 sf Storage= 14,390 cf

Plug-Flow detention time= 170.6 min calculated for 0.802 af (100% of inflow)

Center-of-Mass det. time= 169.1 min (961.8 - 792.7)

Volume	Inve	rt Avai	I.Storage	Storage Description					
#1	143.0	0'	48,482 cf	Custom Stage Da	ata (Irregular)Liste	ed below (Recalc)			
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>			
143.0	00	9,980	601.0	0	0	9,980			
144.0	00	11,812	620.0	10,883	10,883	11,924			
145.0	00	14,463	744.0	13,115	23,998	25,401			
146.0	00	16,751	782.0	15,593	39,591	30,078			
146.	50	18,831	695.0	8,890	48,482	40,311			
Device	Routing	In	vert Outle	Outlet Devices					
#1	Primary			I2.0" Round Culvert _= 50.0' RCP, mitered to conform to fill, Ke= 0.700					
					The state of the s	: 0.0100 '/' Cc= 0.900			
				n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf					
#2	Primary	rimary 146.00'		tom Weir/Orifice,	Cv= 2.62 (C= 3.28	3)			
				Head (feet) 0.00 0.50 Width (feet) 6.00 7.00					
#3	Discarde	carded 143.00'		2.410 in/hr Exfiltration over Surface area					

Discarded OutFlow Max=0.70 cfs @ 13.00 hrs HW=144.29' (Free Discharge) **3=Exfiltration** (Exfiltration Controls 0.70 cfs)

Primary OutFlow Max=0.30 cfs @ 13.00 hrs HW=144.29' (Free Discharge)

1=Culvert (Inlet Controls 0.30 cfs @ 1.61 fps)

—2=Custom Weir/Orifice (Controls 0.00 cfs)

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North Easton-PR

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Link DP1: Wetland ST-10

Inflow Area = 2.761 ac, 21.73% Impervious, Inflow Depth > 0.46" for 2-Year event

Inflow = 1.03 cfs @ 12.22 hrs, Volume= 0.105 af

Primary = 1.03 cfs @ 12.22 hrs, Volume= 0.105 af, Atten= 0%, Lag= 0.0 min

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\textbf{North Easton-PR} \tag{Type III 24-hr} \text{2-Year Rainfall=3.40"} \\
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Summary for Link DP3: Wetland EA1 (culvert)

Inflow Area = 8.083 ac, 48.65% Impervious, Inflow Depth > 0.49" for 2-Year event

Inflow = 0.76 cfs @ 13.02 hrs, Volume= 0.328 af

Primary = 0.76 cfs @ 13.02 hrs, Volume= 0.328 af, Atten= 0%, Lag= 0.0 min

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North Easton-PR

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Summary for Link DP4: Wetland EA 1

Inflow Area = 0.555 ac, 0.00% Impervious, Inflow Depth > 1.63" for 2-Year event

Inflow = 1.03 cfs @ 12.10 hrs, Volume= 0.075 af

Primary = 1.03 cfs @ 12.10 hrs, Volume= 0.075 af, Atten= 0%, Lag= 0.0 min



FEIS/FEIR Technical Report Stormwater North Easton Station

10-Year Storm Event- Proposed

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Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

. todog by otoa	g 2, etceeu
SubcatchmentPR1: PR1	Runoff Area=1.341 ac 0.00% Impervious Runoff Depth>1.85" Flow Length=410' Tc=14.6 min CN=70 Runoff=2.16 cfs 0.206 af
SubcatchmentPR2: PR2	Runoff Area=1.420 ac 42.25% Impervious Runoff Depth>2.24" Flow Length=455' Tc=15.0 min CN=75 Runoff=2.81 cfs 0.265 af
SubcatchmentPR3A: PR3A	Runoff Area=1.500 ac 0.00% Impervious Runoff Depth>2.49" Flow Length=757' Tc=16.8 min CN=78 Runoff=3.18 cfs 0.312 af
SubcatchmentPR3B: PR3B	Runoff Area=0.600 ac 100.00% Impervious Runoff Depth>4.51" Tc=5.0 min CN=98 Runoff=2.89 cfs 0.226 af
SubcatchmentPR4: PR4	Runoff Area=0.128 ac 62.50% Impervious Runoff Depth>2.85" Tc=5.0 min CN=82 Runoff=0.44 cfs 0.030 af
SubcatchmentPR5: PR5	Runoff Area=0.300 ac 66.67% Impervious Runoff Depth>3.84" Tc=5.0 min CN=92 Runoff=1.33 cfs 0.096 af
SubcatchmentPR6: PR6	Runoff Area=1.260 ac 43.65% Impervious Runoff Depth>2.41" Tc=5.0 min CN=77 Runoff=3.70 cfs 0.253 af
SubcatchmentPR7: PR7	Runoff Area=2.800 ac 89.36% Impervious Runoff Depth>4.17" Flow Length=1,318' Tc=5.0 min CN=95 Runoff=13.07 cfs 0.973 af
SubcatchmentPR8: PR8	Runoff Area=0.555 ac 0.00% Impervious Runoff Depth>2.76" Flow Length=117' Tc=6.7 min CN=81 Runoff=1.76 cfs 0.128 af
SubcatchmentPR9: PR9	Runoff Area=1.495 ac 0.00% Impervious Runoff Depth>1.70" Flow Length=175' Tc=7.3 min CN=68 Runoff=2.75 cfs 0.212 af
Pond P1: Bioretention Area Discarded=0.19	Peak Elev=157.56' Storage=6,224 cf Inflow=2.81 cfs 0.265 af cfs 0.185 af Primary=0.00 cfs 0.000 af Outflow=0.19 cfs 0.185 af
Pond P2: Detention Basin	Peak Elev=159.41' Storage=13,693 cf Inflow=5.23 cfs 0.567 af Outflow=0.63 cfs 0.472 af
Pond P3: Infiltration Basin Discarded=0.01	Peak Elev=162.53' Storage=913 cf Inflow=1.33 cfs 0.096 af cfs 0.010 af Primary=1.27 cfs 0.069 af Outflow=1.28 cfs 0.079 af

Discarded=0.18 cfs 0.165 af Primary=0.27 cfs 0.025 af Outflow=0.44 cfs 0.190 af

Pond P4: Infiltration Basin

Peak Elev=154.06' Storage=5,288 cf Inflow=3.70 cfs 0.253 af

 Pond P5: Infiltration Basin
 Peak Elev=144.84'
 Storage=21,778 cf
 Inflow=16.79 cfs
 1.254 af

 Discarded=0.78 cfs
 0.859 af
 Primary=1.95 cfs
 0.330 af
 Outflow=2.73 cfs
 1.190 af

Link DP1: Wetland ST-10Inflow=2.16 cfs 0.206 af Primary=2.16 cfs 0.206 af

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Link DP3: Wetland EA1 (culvert) Inflow=2.77 cfs 0.827 af

Primary=2.77 cfs 0.827 af

Link DP4: Wetland EA 1 Inflow=1.76 cfs 0.128 af

Primary=1.76 cfs 0.128 af

Total Runoff Area = 11.399 ac Runoff Volume = 2.701 af Average Runoff Depth = 2.84" 60.24% Pervious = 6.867 ac 39.76% Impervious = 4.532 ac

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1 ype III 24-hr 10-Year Rainfall=4.75" 2011/Printed 6/4

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Summary for Subcatchment PR1: PR1

Runoff = 2.16 cfs @ 12.21 hrs, Volume= 0.206 af, Depth> 1.85"

Area	(ac) C	N Desc	cription		
0.	.278 3	6 Woo	ds, Fair, H	ISG A	
0.	.320 7	'3 Woo	ds, Fair, H	ISG C	
0.	.586 7	'9 Woo	ds, Fair, F	ISG D	
0.	.157 8	9 Dirt	roads, HS0	G D	
1.	.341 7	'0 Weig	ghted Aver	age	
1.	.341	100.	00% Pervi	ous Area	
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
9.2	50	0.1600	0.09		Sheet Flow,
					Woods: Dense underbrush n= 0.800 P2= 3.28"
3.7	190	0.0300	0.87		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
0.3	34	0.1700	2.06		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
1.4	136	0.1100	1.66		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
14.6	410	Total			

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Summary for Subcatchment PR2: PR2

Runoff = 2.81 cfs @ 12.21 hrs, Volume= 0.265 af, Depth> 2.24"

	A roo /	(20)	N Door	orintion				
	Area (cription	100 4			
				ds, Fair, F				
	_			ds, Fair, F				
	_			ds, Fair, F				
				ed parking		1100 4		
					cover, Fair	·		
0.040 84 50-75% Grass cover, Fair, HSG D								
1.420 75 Weighted Average								
		820		5% Pervio				
	0.0	600	42.2	5% Imper	ious Area			
	_		01			B		
,	Tc	Length	Slope	Velocity	Capacity	Description		
	min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
	12.2	50	0.0800	0.07		Sheet Flow,		
						Woods: Dense underbrush n= 0.800 P2= 3.28"		
	0.5	79	0.2400	2.45		Shallow Concentrated Flow,		
						Woodland Kv= 5.0 fps		
	0.1	20	0.1500	2.71		Shallow Concentrated Flow,		
						Short Grass Pasture Kv= 7.0 fps		
	1.4	205	0.0150	2.49		Shallow Concentrated Flow,		
						Paved Kv= 20.3 fps		
	8.0	101	0.0190	2.07		Shallow Concentrated Flow,		
						Grassed Waterway Kv= 15.0 fps		
	15.0	455	Total					

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Summary for Subcatchment PR3A: PR3A

Runoff = 3.18 cfs @ 12.23 hrs, Volume= 0.312 af, Depth> 2.49"

Area	(ac) C	N Des	cription		
0	.300 7	73 Woo	ds, Fair, F	ISG C	
1				cover, Fair	: HSG C
			ghted Aver	•	,
	.500 7	- ,	00% Pervi		
	.000	100.	00701 011	100071100	
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	2 dodnipilon
13.2	50	0.0650	0.06	(0.0)	Sheet Flow,
10.2	30	0.0000	0.00		Woods: Dense underbrush n= 0.800 P2= 3.28"
1.4	104	0.0650	1.27		Shallow Concentrated Flow,
1.7	104	0.0000	1.21		Woodland Kv= 5.0 fps
0.1	12	0.3300	2.87		Shallow Concentrated Flow,
0.1	12	0.0000	2.07		Woodland Kv= 5.0 fps
0.7	138	0.0300	3.52		Shallow Concentrated Flow,
0.7	100	0.0000	0.02		Paved Kv= 20.3 fps
0.6	181	0.0100	5.36	4.21	•
0.0	101	0.0100	3.30	7.21	12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.011 Concrete pipe, straight & clean
0.4	131	0.0100	6.22	7.63	
0.4	101	0.0100	0.22	7.00	15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
0.2	66	0.0091	5.93	7.28	· · · · · · · · · · · · · · · · · · ·
0.2	00	0.0031	0.00	7.20	15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
0.2	75	0.0092	5.97	7.32	
0.2	13	0.0032	5.31	1.52	15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
16.0	757	Total			11- 0.011 Concrete pipe, straight & clean
16.8	757	Total			

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Summary for Subcatchment PR3B: PR3B

Runoff = 2.89 cfs @ 12.07 hrs, Volume= 0.226 af, Depth> 4.51"

Area	(ac)	CN	Desc	cription					
0	0.600 98 Paved parking, HSG C								
0	.600		100.0	00% Impe	rvious Area	1			
Tc	Leng	ıth '	Slope	Velocity	Capacity	Description			
(min)	(fee		(ft/ft)	(ft/sec)	(cfs)	Description			
5.0						Direct Entry,			

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Summary for Subcatchment PR4: PR4

Runoff = 0.44 cfs @ 12.07 hrs, Volume= 0.030 af, Depth> 2.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

_	Area	(ac)	CN	Desc	cription					
	0.	0.011 79 50-75% Grass cover, Fair, HSG C								
	0.	0.037 49 50-75% Grass cover, Fair, HSG A								
_	0.080 98 Paved parking, HSG C									
0.128 82 Weighted Average										
	0.048 37.50% Pervious Area									
	0.	080		62.5	0% Imperv	vious Area				
	_			01			B			
	Tc	Leng		Slope	Velocity	Capacity	Description			
_	(min)	(fee	et)	(ft/ft)	(ft/sec)	(cfs)				
	E 0						Direct Frotm.			

5.0

Direct Entry,

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Summary for Subcatchment PR5: PR5

Runoff = 1.33 cfs @ 12.07 hrs, Volume= 0.096 af, Depth> 3.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

	Area	(ac)	CN I	Description							
	0.	100	79 !	50-75% Grass cover, Fair, HSG C							
	0.	200	98 I	Pave	d parking,	HSG C					
0.300 92 Weighted Average											
0.100 33.33% Pervious Area											
0.200			(66.67	7% Imperv	vious Area					
	_					_					
	Tc	Length		ope	Velocity	Capacity	Description				
	(min)	(feet)) (fl	t/ft)	(ft/sec)	(cfs)			_		
	5.0						Direct Entry				

5.0 Direct Entry,

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Summary for Subcatchment PR6: PR6

Runoff = 3.70 cfs @ 12.08 hrs, Volume= 0.253 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 10-Year Rainfall=4.75"

_	Area	(ac)	CN	Desc	Description								
	0.	450	49	50-7	50-75% Grass cover, Fair, HSG A								
0.200 79 50-75% Grass cover, Fair, HSG C													
0.060 84 50-75% Grass cover, Fair, HSG D													
0.300 98 Paved parking, HSG A													
0.150 98 Paved parking, HSG C													
0.100 98 Paved parking, HSG D													
	1.	260	77	Weig	ghted Aver	age							
	0.	710		56.3	56.35% Pervious Area								
0.550 43.65% Impervious Area													
	Tc	Leng	th	Slope	Velocity	Capacity	·						
_	(min)	(fee	et)	(ft/ft)	(ft/sec)	(cfs)							
	5.0						Direct Entry						

5.0 Direct Entry,

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Type III 24-hr 10-Year Rainfall=4.75" Printed 6/4/2012

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Summary for Subcatchment PR7: PR7

Runoff = 13.07 cfs @ 12.07 hrs, Volume= 0.973 af, Depth> 4.17"

Area ((ac) C	N Desc	cription				
		'3 Woo	ds, Fair, H	ISG C			
		6 Woo	ds, Fair, H	ISG A			
				cover, Fair			
				cover, Fair	HSG C		
			ed parking				
			ed parking				
			hted Aver				
0.298							
۷.۶	30Z	09.5	o /o iiiipei v	nous Area			
Tc	Length	Slope	Velocity	Capacity	Description		
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	'		
0.5	50	0.0350	1.52		Sheet Flow,		
					Smooth surfaces n= 0.011 P2= 3.28"		
0.4	53	0.2000	2.24		Shallow Concentrated Flow,		
					Woodland Kv= 5.0 fps		
0.1	21	0.2200	3.28		Shallow Concentrated Flow,		
					Short Grass Pasture Kv= 7.0 fps		
1.0	209	0.0300	3.52		Shallow Concentrated Flow,		
0.0	400	0.0400	5.05	4.00	Paved Kv= 20.3 fps		
0.6	180	0.0139	5.35	4.20	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'		
					n= 0.013 Concrete pipe, straight & clean		
0.2	177	0.0650	16.80	40.40			
0.2	177	0.0000	10.00	40.40	21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'		
					n= 0.013 Concrete pipe, straight & clean		
0.7	295	0.0102	6.65	16.00			
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'		
					n= 0.013 Concrete pipe, straight & clean		
0.2	90	0.0100	6.59	15.85	Pipe Channel,		
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'		
					n= 0.013 Concrete pipe, straight & clean		
0.4	177	0.0136	7.68	18.48			
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'		
					n= 0.013 Concrete pipe, straight & clean		
0.8	00	0.0400	7.00	40.40	Direct Entry,		
0.1	66	0.0136	7.68	18.48			
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'		
	4 040	Total			n= 0.013 Concrete pipe, straight & clean		
5.0	1,318	Total					

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Summary for Subcatchment PR8: PR8

Runoff = 1.76 cfs @ 12.10 hrs, Volume= 0.128 af, Depth> 2.76"

_	Area	(ac) C	N Des	cription						
	0.	125 7	' 9 50-7	0-75% Grass cover, Fair, HSG C						
	0.	202 8	34 50-7	50-75% Grass cover, Fair, HSG D						
	0.	228 7	'9 Woo	ds, Fair, H	ISG D					
	0.555 81 Weighted Average									
	0.	555	100.	00% Pervi	ous Area					
	Tc	Length	Slope	Velocity	Capacity	Description				
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	·				
	5.8	50	0.1300	0.14		Sheet Flow,				
						Woods: Light underbrush n= 0.400 P2= 3.28"				
	0.9	67	0.0600	1.22		Shallow Concentrated Flow,				
						Woodland Kv= 5.0 fps				
	6.7	117	Total			·				

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Type III 24-hr 10-Year Rainfall=4.75" Printed 6/4/2012

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Summary for Subcatchment PR9: PR9

Runoff = 2.75 cfs @ 12.11 hrs, Volume= 0.212 af, Depth> 1.70"

_	Area	(ac)	CN	Desc	cription						
	0.	590	49	50-7	5% Grass	cover, Fair	r, HSG A				
	0.	627	79	50-7	5% Grass	cover, Fair	r, HSG C				
	0.	232	84	50-7	9-75% Grass cover, Fair, HSG D						
	0.	036	76	Grav	el roads, l	HSG A					
	0.	010	89	Grav	el roads, l	HSG C					
	1.495 68 Weighted Average										
	1.	495		100.	00% Pervi	ous Area					
	Tc	Length	n S	Slope	Velocity	Capacity	Description				
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
	5.6	50	0.0	0200	0.15		Sheet Flow,				
							Grass: Short n= 0.150 P2= 3.28"				
	1.7	125	5 0.0	0320	1.25		Shallow Concentrated Flow,				
							Short Grass Pasture Kv= 7.0 fps				
	7.3	175	5 To	otal			·				

Type III 24-hr 10-Year Rainfall=4.75"

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Summary for Pond P1: Bioretention Area

Inflow Area = 1.420 ac, 42.25% Impervious, Inflow Depth > 2.24" for 10-Year event

Inflow = 2.81 cfs @ 12.21 hrs, Volume= 0.265 af

Outflow = 0.19 cfs @ 15.30 hrs, Volume= 0.185 af, Atten= 93%, Lag= 185.3 min

Discarded = 0.19 cfs @ 15.30 hrs, Volume= 0.185 af Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 157.56' @ 15.30 hrs Surf.Area= 3,378 sf Storage= 6,224 cf

Plug-Flow detention time= 299.2 min calculated for 0.184 af (70% of inflow)

Center-of-Mass det. time= 201.5 min (1,045.2 - 843.7)

Volume	Inve	rt Avai	I.Storage	Storage Description					
#1	155.0	0'	11,957 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)			
Elevatior (feet	-	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)			
155.00	,	1,579	188.0	0	0	1,579			
156.00)	2,217	223.0	1,889	1,889	2,742			
157.00)	2,953	252.0	2,576	4,465	3,864			
158.00)	3,738	271.0	3,338	7,803	4,697			
158.50)	4,153	280.0	1,972	9,775	5,114			
159.00)	4,581	290.0	2,183	11,957	5,590			
Device	Routing	ln	vert Outle	et Devices					
#1	Primary	158	Head	Custom Weir/Orifice, Cv= 2.62 (C= 3.28) Head (feet) 0.00 0.50 Width (feet) 5.00 6.00					
#2	Discarde	d 155	5.00' 2.41	0 in/hr Exfiltration	rea				

Discarded OutFlow Max=0.19 cfs @ 15.30 hrs HW=157.56' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=155.00' (Free Discharge) 1=Custom Weir/Orifice (Controls 0.00 cfs)

Type III 24-hr 10-Year Rainfall=4.75"

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Summary for Pond P2: Detention Basin

Inflow Area = 2.228 ac, 30.52% Impervious, Inflow Depth > 3.06" for 10-Year event

Inflow = 5.23 cfs @ 12.09 hrs, Volume= 0.567 af

Outflow = 0.63 cfs @ 13.32 hrs, Volume= 0.472 af, Atten= 88%, Lag= 73.8 min

Primary = 0.63 cfs @ 13.32 hrs, Volume= 0.472 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 159.41' @ 13.32 hrs Surf.Area= 5,672 sf Storage= 13,693 cf

Plug-Flow detention time= 288.5 min calculated for 0.472 af (83% of inflow)

Center-of-Mass det. time= 218.3 min (1,018.9 - 800.5)

Volume	Inve	rt Avail.	.Storage	Storage Description					
#1	156.0	0' 2	7,737 cf	Custom Stage Data (Irregular)Listed below (Recalc)					
Elevatio		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(feet	t)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)			
156.0	0	2,331	275.0	0	0	2,331			
157.0	0	3,258	321.0	2,782	2,782	4,533			
157.5	0	3,896	289.0	1,786	4,568	6,094			
158.0	0	4,338	299.0	2,058	6,625	6,584			
159.0	159.00 5,276 318		318.0	4,799	11,425	7,567			
160.0	0	6,256	337.0	5,759	17,184	8,610			
161.0	0	7,298	356.0	6,770	23,954	9,714			
161.5	0	7,839	365.0	3,783	27,737	10,260			
Device	Routing	Inv	ert Outle	Outlet Devices					
#1	Primary	153.	40' 12.0	12.0" Round Culvert					
	-		L= 1	.= 112.0' RCP, sq.cut end projecting, Ke= 0.500					
			Inlet	/ Outlet Invert= 15	53.40' / 152.50' S	= 0.0080 '/' Cc= 0.900			
			n= 0	.013 Concrete pip	e, bends & connec	ctions, Flow Area= 0.79 sf			
#2	Device 1	157.	00' 4.0"	Vert. Orifice/Grate C= 0.600					
#3	Device 1	vice 1 160.90'		4.0" x 4.0" Horiz. Orifice/Grate X 4.00 columns					
			X 4 r	rows C= 0.600 in 2	24.0" x 24.0" Grate				
			Limit	Limited to weir flow at low heads					

Primary OutFlow Max=0.63 cfs @ 13.32 hrs HW=159.41' (Free Discharge)

1=Culvert (Passes 0.63 cfs of 6.84 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.63 cfs @ 7.22 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

Volume

Invert

Type III 24-hr 10-Year Rainfall=4.75"

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Summary for Pond P3: Infiltration Basin

Inflow Area = 0.300 ac, 66.67% Impervious, Inflow Depth > 3.84" for 10-Year event Inflow = 1.33 cfs @ 12.07 hrs, Volume= 0.096 af Outflow = 1.28 cfs @ 12.09 hrs, Volume= 0.079 af, Atten= 4%, Lag= 1.4 min Discarded = 0.01 cfs @ 12.09 hrs, Volume= 0.010 af Primary = 1.27 cfs @ 12.09 hrs, Volume= 0.069 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 162.53' @ 12.09 hrs Surf.Area= 1,216 sf Storage= 913 cf

Plug-Flow detention time= 112.1 min calculated for 0.079 af (82% of inflow) Center-of-Mass det. time= 41.3 min (824.3 - 782.9)

Avail Storage Storage Description

volume	IIIVE	it Avaii.	Sidiaye	Storage Description					
#1	#1 161.50' 1,389 cf		Custom Stage Data (Irregular)Listed below (Recalc)						
Elevatio		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	:()	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)			
161.5	50	552	116.0	0	0	552			
162.0	00	879	170.0	355	355	1,783			
162.5	50	1,202	174.0	518	873	1,922			
162.9	90	1,379	179.0	516	1,389	2,080			
Device	Routing	Inv	ert Outle	et Devices					
#1	Primary	155.	00' 12.0	12.0" Round Culvert					
	,		L= 4 Inlet	L= 49.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 155.00' / 154.00' S= 0.0204 '/' C n= 0.013 Concrete pipe, straight & clean, Flow Area=					
#2	Device 1	162.	40' 4.0"	x 4.0" Horiz. Orif	ice/Grate X 4.00 c	olumns			
			X 4 ı	4 rows C= 0.600 in 24.0" x 24.0" Grate					
			Limi	ted to weir flow at low heads					
#3 Discarded 161.50' 0.270 in/hr Exfiltration over Surface area					ea				

Discarded OutFlow Max=0.01 cfs @ 12.09 hrs HW=162.53' (Free Discharge) 3=Exfiltration (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=1.27 cfs @ 12.09 hrs HW=162.53' (Free Discharge)
1=Culvert (Passes 1.27 cfs of 9.92 cfs potential flow)
2=Orifice/Grate (Weir Controls 1.27 cfs @ 1.19 fps)

Type III 24-hr 10-Year Rainfall=4.75"

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Summary for Pond P4: Infiltration Basin

Inflow Area = 1.260 ac, 43.65% Impervious, Inflow Depth > 2.41" for 10-Year event

Inflow = 3.70 cfs @ 12.08 hrs, Volume= 0.253 af

Outflow = 0.44 cfs @ 12.79 hrs, Volume= 0.190 af, Atten= 88%, Lag= 42.7 min

Discarded = 0.18 cfs @ 12.79 hrs, Volume= 0.165 af Primary = 0.27 cfs @ 12.79 hrs, Volume= 0.025 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 154.06' @ 12.79 hrs Surf.Area= 3,195 sf Storage= 5,288 cf

Plug-Flow detention time= 265.0 min calculated for 0.190 af (75% of inflow)

Avail Chanana Chanana Daganintian

Center-of-Mass det. time= 176.5 min (1,007.1 - 830.6)

Volume	Inve	ert Avai	I.Storage	Storage Description					
#1	151.0	00'	6,847 cf	Custom Stage D	Data (Irregular)Lis	ted below (Recalc)			
Elevation	on	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)			
151.0	00	545	185.0	0	0	545			
152.0	00	1,210	238.0	856	856	2,342			
153.0	00	2,120	306.0	1,644	2,500	5,298			
154.0	00	3,095	343.0	2,592	5,092	7,236			
154.5	50	3,945	293.0	1,756	6,847	9,772			
Device	Routing	ln	vert Outle	et Devices					
#1	Primary	154		Custom Weir/Orifice, Cv= 2.62 (C= 3.28)					
				d (feet) 0.00 0.50					
				h (feet) 5.00 6.00					
#2 Discarded 151.00' 2.410 in/h				0 in/hr Exfiltratio	n over Surface a	rea			

Discarded OutFlow Max=0.18 cfs @ 12.79 hrs HW=154.06' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=0.26 cfs @ 12.79 hrs HW=154.06' (Free Discharge) 1=Custom Weir/Orifice (Weir Controls 0.26 cfs @ 0.82 fps)

Type III 24-hr 10-Year Rainfall=4.75"

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Summary for Pond P5: Infiltration Basin

Inflow Area = 4.595 ac, 58.80% Impervious, Inflow Depth > 3.27" for 10-Year event

Inflow = 16.79 cfs @ 12.08 hrs, Volume= 1.254 af

Outflow = 2.73 cfs @ 12.56 hrs, Volume= 1.190 af, Atten= 84%, Lag= 28.9 min

Discarded = 0.78 cfs @ 12.56 hrs, Volume= 0.859 af Primary = 1.95 cfs @ 12.56 hrs, Volume= 0.330 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 144.84' @ 12.56 hrs Surf.Area= 14,032 sf Storage= 21,778 cf

Plug-Flow detention time= 157.6 min calculated for 1.189 af (95% of inflow)

Center-of-Mass det. time= 129.0 min (914.3 - 785.3)

Volume	Inve	<u>ert Avai</u>	il.Storage	Storage Description				
#1	143.0	0'	48,482 cf	f Custom Stage Data (Irregular)Listed below (Recalc)				
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area		
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)		
143.0	00	9,980	601.0	0	0	9,980		
144.0	00	11,812	620.0	10,883	10,883	11,924		
145.0	00	14,463	744.0	13,115	23,998	25,401		
146.0	00	16,751	782.0	15,593	39,591	30,078		
146.5	50	18,831	695.0	8,890	48,482	40,311		
Device	Routing	In	vert Outle	et Devices				
#1	Primary		4.00' 12.0 L= 5 Inlet	2.0" Round Culvert = 50.0' RCP, mitered to conform to fill, Ke= 0.700 nlet / Outlet Invert= 144.00' / 143.50' S= 0.0100'/' Cc= 0.900 = 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2	Primary	146	6.00' Cus Hea					
#3	Discarde	d 143		0 in/hr Exfiltration		ea		

Discarded OutFlow Max=0.78 cfs @ 12.56 hrs HW=144.84' (Free Discharge) **3=Exfiltration** (Exfiltration Controls 0.78 cfs)

Primary OutFlow Max=1.95 cfs @ 12.56 hrs HW=144.84' (Free Discharge)

1=Culvert (Inlet Controls 1.95 cfs @ 2.76 fps)

—2=Custom Weir/Orifice (Controls 0.00 cfs)

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Summary for Link DP1: Wetland ST-10

Inflow Area = 2.761 ac, 21.73% Impervious, Inflow Depth > 0.90" for 10-Year event

Inflow = 2.16 cfs @ 12.21 hrs, Volume= 0.206 af

Primary = 2.16 cfs @ 12.21 hrs, Volume= 0.206 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP3: Wetland EA1 (culvert)

Inflow Area = 8.083 ac, 48.65% Impervious, Inflow Depth > 1.23" for 10-Year event

Inflow = 2.77 cfs @ 12.68 hrs, Volume= 0.827 af

Primary = 2.77 cfs @ 12.68 hrs, Volume= 0.827 af, Atten= 0%, Lag= 0.0 min

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Summary for Link DP4: Wetland EA 1

Inflow Area = 0.555 ac, 0.00% Impervious, Inflow Depth > 2.76" for 10-Year event

Inflow = 1.76 cfs @ 12.10 hrs, Volume= 0.128 af

Primary = 1.76 cfs @ 12.10 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min



FEIS/FEIR Technical Report Stormwater North Easton Station

100-Year Storm Event – Proposed

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Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points Runoff by SCS TR-20 method, UH=SCS Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

r todom rodamig by otto mid	g 2, etceeu
SubcatchmentPR1: PR1	Runoff Area=1.341 ac 0.00% Impervious Runoff Depth>3.61" Flow Length=410' Tc=14.6 min CN=70 Runoff=4.34 cfs 0.403 af
SubcatchmentPR2: PR2	Runoff Area=1.420 ac 42.25% Impervious Runoff Depth>4.14" Flow Length=455' Tc=15.0 min CN=75 Runoff=5.22 cfs 0.490 af
SubcatchmentPR3A: PR3A	Runoff Area=1.500 ac 0.00% Impervious Runoff Depth>4.46" Flow Length=757' Tc=16.8 min CN=78 Runoff=5.69 cfs 0.558 af
SubcatchmentPR3B: PR3B	Runoff Area=0.600 ac 100.00% Impervious Runoff Depth>6.76" Tc=5.0 min CN=98 Runoff=4.27 cfs 0.338 af
SubcatchmentPR4: PR4	Runoff Area=0.128 ac 62.50% Impervious Runoff Depth>4.91" Tc=5.0 min CN=82 Runoff=0.75 cfs 0.052 af
SubcatchmentPR5: PR5	Runoff Area=0.300 ac 66.67% Impervious Runoff Depth>6.05" Tc=5.0 min CN=92 Runoff=2.05 cfs 0.151 af
SubcatchmentPR6: PR6	Runoff Area=1.260 ac 43.65% Impervious Runoff Depth>4.36" Tc=5.0 min CN=77 Runoff=6.66 cfs 0.458 af
SubcatchmentPR7: PR7	Runoff Area=2.800 ac 89.36% Impervious Runoff Depth>6.40" Flow Length=1,318' Tc=5.0 min CN=95 Runoff=19.62 cfs 1.494 af
SubcatchmentPR8: PR8	Runoff Area=0.555 ac 0.00% Impervious Runoff Depth>4.80" Flow Length=117' Tc=6.7 min CN=81 Runoff=3.01 cfs 0.222 af
SubcatchmentPR9: PR9	Runoff Area=1.495 ac 0.00% Impervious Runoff Depth>3.40" Flow Length=175' Tc=7.3 min CN=68 Runoff=5.69 cfs 0.424 af
Pond P1: Bioretention Area Discarded=0.22	Peak Elev=158.24' Storage=8,736 cf Inflow=5.22 cfs 0.490 af 2 cfs 0.225 af Primary=2.04 cfs 0.132 af Outflow=2.26 cfs 0.357 af
Pond P2: Detention Basin	Peak Elev=160.93' Storage=23,425 cf Inflow=8.60 cfs 0.948 af Outflow=0.97 cfs 0.742 af
Pond P3: Infiltration Basin Discarded=0.01	Peak Elev=162.58' Storage=968 cf Inflow=2.05 cfs 0.151 af cfs 0.011 af Primary=1.97 cfs 0.123 af Outflow=1.98 cfs 0.134 af

 Pond P4: Infiltration Basin
 Peak Elev=154.37'
 Storage=6,367 cf
 Inflow=6.66 cfs
 0.458 af

 Discarded=0.21 cfs
 0.186 af
 Primary=3.99 cfs
 0.188 af
 Outflow=4.19 cfs
 0.374 af

 Pond P5: Infiltration Basin
 Peak Elev=145.82' Storage=36,694 cf
 Inflow=26.82 cfs
 2.041 af

 Discarded=0.91 cfs
 0.982 af
 Primary=3.84 cfs
 0.907 af
 Outflow=4.75 cfs
 1.889 af

Link DP1: Wetland ST-10Inflow=4.34 cfs 0.535 af
Primary=4.34 cfs 0.535 af

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Link DP3: Wetland EA1 (culvert) Inflow=7.78 cfs 1.837 af

Primary=7.78 cfs 1.837 af

Link DP4: Wetland EA 1 Inflow=3.01 cfs 0.222 af

Primary=3.01 cfs 0.222 af

Total Runoff Area = 11.399 ac Runoff Volume = 4.590 af Average Runoff Depth = 4.83" 60.24% Pervious = 6.867 ac 39.76% Impervious = 4.532 ac

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Summary for Subcatchment PR1: PR1

Runoff 4.34 cfs @ 12.20 hrs, Volume= 0.403 af, Depth> 3.61"

Area	(ac) C	N Desc	cription			
0.	.278 3	6 Woo	ds, Fair, H	ISG A		
		'3 Woo	ds, Fair, H	ISG C		
			ds, Fair, H			
0.157 89 Dirt roads, HSG D						
1.341 70 Weighted Average						
1.	.341	100.	00% Pervi	ous Area		
_						
Tc	Length	Slope	Velocity	Capacity	Description	
(min)_	(feet)	(ft/ft)	(ft/sec)	(cfs)		
9.2	50	0.1600	0.09		Sheet Flow,	
					Woods: Dense underbrush n= 0.800 P2= 3.28"	
3.7	190	0.0300	0.87		Shallow Concentrated Flow,	
					Woodland Kv= 5.0 fps	
0.3	34	0.1700	2.06		Shallow Concentrated Flow,	
					Woodland Kv= 5.0 fps	
1.4	136	0.1100	1.66		Shallow Concentrated Flow,	
					Woodland Kv= 5.0 fps	
14.6	410	Total				

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Summary for Subcatchment PR2: PR2

Runoff = 5.22 cfs @ 12.21 hrs, Volume= 0.490 af, Depth> 4.14"

	A roo /	(aa) C	N Door	orintion							
	Area (cription	100 4						
				/oods, Fair, HSG A							
	_			Voods, Fair, HSG C							
				Noods, Fair, HSG D							
				ed parking		1100 4					
					cover, Fair	•					
					cover, Fair	T, HSG D					
			•	ghted Aver	•						
		820		5% Pervio							
	0.0	600	42.2	5% Imper	ious Area						
	_		01			B					
,	Tc	Length	Slope	Velocity	Capacity	Description					
	min)	(feet)	(ft/ft)	(ft/sec)	(cfs)						
	12.2	50	0.0800	0.07		Sheet Flow,					
						Woods: Dense underbrush n= 0.800 P2= 3.28"					
	0.5	79	0.2400	2.45		Shallow Concentrated Flow,					
						Woodland Kv= 5.0 fps					
	0.1	20	0.1500	2.71		Shallow Concentrated Flow,					
						Short Grass Pasture Kv= 7.0 fps					
	1.4	205	0.0150	2.49		Shallow Concentrated Flow,					
						Paved Kv= 20.3 fps					
	8.0	101	0.0190	2.07		Shallow Concentrated Flow,					
						Grassed Waterway Kv= 15.0 fps					
	15.0	455	Total								

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Summary for Subcatchment PR3A: PR3A

Runoff = 5.69 cfs @ 12.23 hrs, Volume= 0.558 af, Depth> 4.46"

Area	(ac) C	N Des	cription		
0	.300 7	73 Woo	ds, Fair, F	ISG C	
1				cover, Fair	: HSG C
			ghted Aver	•	,
	.500 7	- ,	00% Pervi		
	.000	100.	00701 011	100071100	
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	2 dodnipilon
13.2	50	0.0650	0.06	(0.0)	Sheet Flow,
10.2	30	0.0000	0.00		Woods: Dense underbrush n= 0.800 P2= 3.28"
1.4	104	0.0650	1.27		Shallow Concentrated Flow,
1.7	104	0.0000	1.21		Woodland Kv= 5.0 fps
0.1	12	0.3300	2.87		Shallow Concentrated Flow,
0.1	12	0.0000	2.07		Woodland Kv= 5.0 fps
0.7	138	0.0300	3.52		Shallow Concentrated Flow,
0.7	100	0.0000	0.02		Paved Kv= 20.3 fps
0.6	181	0.0100	5.36	4.21	•
0.0	101	0.0100	3.30	7.21	12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.011 Concrete pipe, straight & clean
0.4	131	0.0100	6.22	7.63	
0.4	101	0.0100	0.22	7.00	15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
0.2	66	0.0091	5.93	7.28	· · · · · · · · · · · · · · · · · · ·
0.2	00	0.0031	0.00	7.20	15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
0.2	75	0.0092	5.97	7.32	
0.2	13	0.0032	5.31	1.52	15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.011 Concrete pipe, straight & clean
16.0	757	Total			11- 0.011 Condicte pipe, straight & dean
16.8	757	Total			

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Summary for Subcatchment PR3B: PR3B

Runoff = 4.27 cfs @ 12.07 hrs, Volume= 0.338 af, Depth> 6.76"

Area	(ac)	CN	Desc	cription			
0.	0.600 98 Paved parking, HSG C						
0.	600		100.0	00% Impe	rvious Area	a	
Tc (min)	Leng		Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description	
5.0						Direct Entry,	

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Summary for Subcatchment PR4: PR4

Runoff = 0.75 cfs @ 12.07 hrs, Volume= 0.052 af, Depth> 4.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Area	(ac)	ac) CN Description								
	0.	0.011 79 50-75% Grass cover, Fair, HSG C									
	0.	0.037 49 50-75% Grass cover, Fair, HSG A									
_	0.	080	98								
0.128 82 Weighted Average											
	0.048 37.50% Pervious Area					us Area					
	0.080 62.50% Impervious Area					vious Area					
	_			01			B				
							Description				
_	(min)	(fee	et)	(ft/ft)	(ft/sec)	(cfs)					
	E 0						Direct Frotm.				

5.0

Direct Entry,

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Summary for Subcatchment PR5: PR5

Runoff = 2.05 cfs @ 12.07 hrs, Volume= 0.151 af, Depth> 6.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Type III 24-hr 100-Year Rainfall=7.00"

	Area	(ac)	CN I	Desc	ription			
	0.	100	79 !	50-7	5% Grass	cover, Fair	, HSG C	
	0.	200	98 I	Pave	d parking,	HSG C		
-	0.	300	92 \	Weig	hted Aver	age		
	0.100 33.33% Pervious Area							
	0.200 66.67% Impervious Area					vious Area		
	_					_		
	Tc	Length		ope	Velocity	Capacity	Description	
	(min) (feet) (ft/ft) (ft/sec) (cfs)							
	5.0						Direct Entry	

5.0 Direct Entry,

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Summary for Subcatchment PR6: PR6

Runoff = 6.66 cfs @ 12.07 hrs, Volume= 0.458 af, Depth> 4.36"

	Area	(ac)	CN	Desc	cription					
,	0.4	450	49	50-7	5% Grass	cover, Fair	, HSG A		,	
	0.200 79 50-75% Grass cover, Fai						, HSG C			
	0.060 84 50-75% Grass cover, Fair					, HSG D				
	0.	300	98	Pave	ed parking	HSG A				
	0.	150	98	Pave	ed parking	HSG C				
	0.	100	98	Pave	ed parking	HSG D				
	1.:	260	77	Weig	hted Aver	age				
	0.	710		56.3	5% Pervio	us Area				
	0.	550		43.6	5% Imper	ious Area				
	Тс	Lengt	h	Slope	Velocity	Capacity	Description			
(min)	(feet	t)	(ft/ft)	(ft/sec)	(cfs)				
	5.0						Direct Entry.			

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Summary for Subcatchment PR7: PR7

Runoff = 19.62 cfs @ 12.07 hrs, Volume= 1.494 af, Depth> 6.40"

Area ((ac) C	N Desc	cription		
		'3 Woo	ds, Fair, H	ISG C	
		6 Woo	ds, Fair, H	ISG A	
				cover, Fair	
				cover, Fair	HSG C
			ed parking		
			ed parking		
	800 9 298		hted Aver 4% Pervio		
	290 502			ious Area	
۷.۶	30Z	09.5	o /o iiiipei v	nous Area	
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	'
0.5	50	0.0350	1.52		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.28"
0.4	53	0.2000	2.24		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
0.1	21	0.2200	3.28		Shallow Concentrated Flow,
					Short Grass Pasture Kv= 7.0 fps
1.0	209	0.0300	3.52		Shallow Concentrated Flow,
0.0	400	0.0400	5.05	4.00	Paved Kv= 20.3 fps
0.6	180	0.0139	5.35	4.20	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.013 Concrete pipe, straight & clean
0.2	177	0.0650	16.80	40.40	
0.2	177	0.0000	10.00	40.40	21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.7	295	0.0102	6.65	16.00	
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.2	90	0.0100	6.59	15.85	Pipe Channel,
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.4	177	0.0136	7.68	18.48	
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
					n= 0.013 Concrete pipe, straight & clean
0.8	00	0.0400	7.00	40.40	Direct Entry,
0.1	66	0.0136	7.68	18.48	
					21.0" Round Area= 2.4 sf Perim= 5.5' r= 0.44'
	4 040	Total			n= 0.013 Concrete pipe, straight & clean
5.0	1,318	Total			

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Summary for Subcatchment PR8: PR8

Runoff = 3.01 cfs @ 12.10 hrs, Volume= 0.222 af, Depth> 4.80"

 Area	(ac) C	N Des	cription		
0.	125 7	⁷ 9 50-7	5% Grass	cover, Fair	HSG C
0.	202 8	34 50-7	5% Grass	cover, Fair	r, HSG D
 0.	228 7	79 Woo	ds, Fair, H	ISG D	
 0.	555 8	31 Weig	ghted Aver	age	
0.	555	100.	00% Pervi	ous Area	
Tc	Length	Slope	Velocity	Capacity	Description
 (min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
5.8	50	0.1300	0.14		Sheet Flow,
					Woods: Light underbrush n= 0.400 P2= 3.28"
0.9	67	0.0600	1.22		Shallow Concentrated Flow,
					Woodland Kv= 5.0 fps
6.7	117	Total			

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Summary for Subcatchment PR9: PR9

Runoff = 5.69 cfs @ 12.11 hrs, Volume= 0.424 af, Depth> 3.40"

_	Area	(ac) C	N Des	cription							
	0.590 49 50-75% Grass cover, Fair, HSG A										
	0.627 79 50-75% Grass cover, Fair, HSG C										
	0.232 84 50-75% Grass cover, Fair, HSG D										
0.036 76 Gravel roads, HSG A											
	0.010 89 Gravel roads, HSG C										
	1.	495 (38 Weig	ghted Aver	age						
	1.	495	100.	00% Pervi							
	Тс	Length	Slope	Velocity	Capacity	Description					
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)						
	5.6	50	0.0200	0.15		Sheet Flow,					
						Grass: Short n= 0.150 P2= 3.28"					
	1.7	125	0.0320	1.25		Shallow Concentrated Flow,					
						Short Grass Pasture Kv= 7.0 fps					
	7.3	175	Total								

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Summary for Pond P1: Bioretention Area

Inflow Area = 1.420 ac, 42.25% Impervious, Inflow Depth > 4.14" for 100-Year event Inflow = 5.22 cfs @ 12.21 hrs, Volume= 0.490 af

Outflow = 2.26 cfs @ 12.55 hrs, Volume= 0.357 af, Atten= 57%, Lag= 20.7 min

Discarded = 0.22 cfs @ 12.55 hrs, Volume= 0.225 af Primary = 2.04 cfs @ 12.55 hrs, Volume= 0.132 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 158.24' @ 12.55 hrs Surf.Area= 3,937 sf Storage= 8,736 cf

Plug-Flow detention time= 204.7 min calculated for 0.357 af (73% of inflow)

Center-of-Mass det. time= 115.3 min (941.5 - 826.2)

Volume	Inve	rt Avai	I.Storage	Storage Descripti	ion		
#1	155.0	0'	11,957 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)	
Elevatior (feet	-	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
155.00	,	1,579	188.0	0	0	1,579	
156.00)	2,217	223.0	1,889	1,889	2,742	
157.00)	2,953	252.0	2,576	4,465	3,864	
158.00)	3,738	271.0	3,338	7,803	4,697	
158.50)	4,153	280.0	1,972	9,775	5,114	
159.00)	4,581	290.0	2,183	11,957	5,590	
Device	Routing	ln	vert Outle	et Devices			
#1	Primary	158	Head	tom Weir/Orifice, d (feet) 0.00 0.50 h (feet) 5.00 6.00		8)	
#2	Discarde	d 155	5.00' 2.41	0 in/hr Exfiltratio	n over Surface ar	rea	

Discarded OutFlow Max=0.22 cfs @ 12.55 hrs HW=158.24' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=2.04 cfs @ 12.55 hrs HW=158.24' (Free Discharge)
—1=Custom Weir/Orifice (Weir Controls 2.04 cfs @ 1.60 fps)

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Summary for Pond P2: Detention Basin

Inflow Area = 2.228 ac, 30.52% Impervious, Inflow Depth > 5.10" for 100-Year event

Inflow = 8.60 cfs @ 12.10 hrs, Volume= 0.948 af

Outflow = 0.97 cfs @ 13.40 hrs, Volume= 0.742 af, Atten= 89%, Lag= 77.9 min

Primary = 0.97 cfs @ 13.40 hrs, Volume= 0.742 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 160.93' @ 13.40 hrs Surf.Area= 7,219 sf Storage= 23,425 cf

Plug-Flow detention time= 319.5 min calculated for 0.741 af (78% of inflow)

Center-of-Mass det. time= 239.2 min (1,030.7 - 791.5)

Volume	Inv	<u>ert Avai</u>	I.Storage	Storage Descript	ion		
#1	156.0	00'	27,737 cf	Custom Stage D	Data (Irregular)List	ed below (Recalc)	
Elevatio	on	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area	
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)	
156.0	00	2,331	275.0	0	0	2,331	
157.0	00	3,258	321.0	2,782	2,782	4,533	
157.5	50	3,896	289.0	1,786	4,568	6,094	
158.0	00	4,338	299.0	2,058	6,625	6,584	
159.0		5,276	318.0	4,799	11,425	7,567	
160.0		6,256	337.0	5,759	17,184	8,610	
161.0		7,298	356.0	6,770	23,954	9,714	
161.5	50	7,839	365.0	3,783	27,737	10,260	
Device	Routing	In	vert Outle	et Devices			
#1	Primary	153	.40' 12.0	" Round Culvert			
					it end projecting, k		
						= 0.0080 '/'	
						ctions, Flow Area= 0.79 sf	
#2	Device 1			Vert. Orifice/Gra			
#3	Device 1	l 160			fice/Grate X 4.00 c	columns	
					24.0" x 24.0" Grate		
			Limi	ted to weir flow at	low heads		

Primary OutFlow Max=0.93 cfs @ 13.40 hrs HW=160.93' (Free Discharge)

1=Culvert (Passes 0.93 cfs of 7.67 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.81 cfs @ 9.34 fps)

-3=Orifice/Grate (Weir Controls 0.12 cfs @ 0.54 fps)

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Summary for Pond P3: Infiltration Basin

Inflow Area = 0.300 ac, 66.67% Impervious, Inflow Depth > 6.05" for 100-Year event 2.05 cfs @ 12.07 hrs, Volume= 0.151 af

Outflow = 1.98 cfs @ 12.09 hrs, Volume= 0.134 af, Atten= 3%, Lag= 1.2 min 0.01 cfs @ 12.09 hrs, Volume= 0.011 af

Primary = 1.97 cfs @ 12.09 hrs, Volume= 0.123 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 162.58' @ 12.09 hrs Surf.Area= 1,236 sf Storage= 968 cf

Plug-Flow detention time= 88.9 min calculated for 0.134 af (88% of inflow) Center-of-Mass det. time= 35.2 min (806.6 - 771.3)

Volume	Inve	ert Avai	I.Storage	Storage Descripti	ion		
#1	161.5	50'	1,389 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)	_
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
161.5	50	552	116.0	0	0	552	
162.0	00	879	170.0	355	355	1,783	
162.5	50	1,202	174.0	518	873	1,922	
162.9	90	1,379	179.0	516	1,389	2,080	
Device	Routing	In	vert Outle	et Devices			
#1	Primary	155	5.00' 12.0	" Round Culvert			
				9.0' RCP, sq.cut			
						= 0.0204 '/' Cc= 0.900	
			n= 0	.013 Concrete pip	e, straight & clear	i, Flow Area= 0.79 sf	
#2	Device 1	162		x 4.0" Horiz. Orif			
				rows C= 0.600 in 2			
				ted to weir flow at			
#3	Discarde	d 161	.50' 0.27	0 in/hr Exfiltratio	n over Surface ar	rea	

Discarded OutFlow Max=0.01 cfs @ 12.09 hrs HW=162.58' (Free Discharge) **3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=1.97 cfs @ 12.09 hrs HW=162.58' (Free Discharge)
1=Culvert (Passes 1.97 cfs of 9.95 cfs potential flow)
2=Orifice/Grate (Weir Controls 1.97 cfs @ 1.38 fps)

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Summary for Pond P4: Infiltration Basin

Inflow Area = 1.260 ac, 43.65% Impervious, Inflow Depth > 4.36" for 100-Year event

Inflow = 6.66 cfs @ 12.07 hrs, Volume= 0.458 af

Outflow = 4.19 cfs @ 12.16 hrs, Volume= 0.374 af, Atten= 37%, Lag= 5.4 min

Discarded = 0.21 cfs @ 12.16 hrs, Volume= 0.186 af Primary = 3.99 cfs @ 12.16 hrs, Volume= 0.188 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 154.37' @ 12.16 hrs Surf.Area= 3,722 sf Storage= 6,367 cf

Plug-Flow detention time= 154.9 min calculated for 0.374 af (82% of inflow)

Center-of-Mass det. time= 82.4 min (896.0 - 813.6)

Volume	Inve	<u>ert Avai</u>	I.Storage	Storage Descript	ion		
#1	151.0	0'	6,847 cf	Custom Stage D	Data (Irregular)List	ted below (Recalc))
Elevatio	n	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area	
(fee	t)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)	
151.0	00	545	185.0	0	0	545	
152.0	0	1,210	238.0	856	856	2,342	
153.0	00	2,120	306.0	1,644	2,500	5,298	
154.0	0	3,095	343.0	2,592	5,092	7,236	
154.5	50	3,945	293.0	1,756	6,847	9,772	
Device	Routing	In	vert Outl	et Devices			
#1	Primary	154	Hea	tom Weir/Orifice, d (feet) 0.00 0.50 th (feet) 5.00 6.00		8)	
#2	Discarde	d 151			n over Surface a	rea	

Discarded OutFlow Max=0.21 cfs @ 12.16 hrs HW=154.37' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=3.98 cfs @ 12.16 hrs HW=154.37' (Free Discharge) 1=Custom Weir/Orifice (Weir Controls 3.98 cfs @ 1.98 fps)

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Summary for Pond P5: Infiltration Basin

Inflow Area = 4.595 ac, 58.80% Impervious, Inflow Depth > 5.33" for 100-Year event

Inflow = 26.82 cfs @ 12.08 hrs, Volume= 2.041 af

Outflow = 4.75 cfs @ 12.54 hrs, Volume= 1.889 af, Atten= 82%, Lag= 27.6 min

Discarded = 0.91 cfs @ 12.54 hrs, Volume= 0.982 af Primary = 3.84 cfs @ 12.54 hrs, Volume= 0.907 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs Peak Elev= 145.82' @ 12.54 hrs Surf.Area= 16,338 sf Storage= 36,694 cf

Plug-Flow detention time= 136.9 min calculated for 1.889 af (93% of inflow)

Center-of-Mass det. time= 97.6 min (874.7 - 777.1)

Volume	Inve	ert Avai	il.Storage	Storage Descripti	on		
#1	143.0	00'	48,482 cf	Custom Stage D	ata (Irregular)Listo	ed below (Recalc)	
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area	
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>	
143.0	00	9,980	601.0	0	0	9,980	
144.0	00	11,812	620.0	10,883	10,883	11,924	
145.0	00	14,463	744.0	13,115	23,998	25,401	
146.0	00	16,751	782.0	15,593	39,591	30,078	
146.5	50	18,831	695.0	8,890	48,482	40,311	
Device	Routing	In	vert Outle	et Devices			
#1	Primary	144	.00' 12.0	" Round Culvert			
	,		L= 5	0.0' RCP, mitered	d to conform to fill,	Ke= 0.700	
			Inlet	/ Outlet Invert= 14	4.00' / 143.50' S=	= 0.0100 '/' Cc= 0.900	
			n= 0	.013 Concrete pip	e, bends & connec	ctions, Flow Area= 0.79	sf
#2	Primary	146		tom Weir/Orifice,	•	3)	
				d (feet) 0.00 0.50			
				h (feet) 6.00 7.00			
#3	Discarde	d 143	3.00' 2.41	0 in/hr Exfiltration	n over Surface ar	ea	

Discarded OutFlow Max=0.91 cfs @ 12.54 hrs HW=145.82' (Free Discharge) **3=Exfiltration** (Exfiltration Controls 0.91 cfs)

Primary OutFlow Max=3.84 cfs @ 12.54 hrs HW=145.82' (Free Discharge)

-1=Culvert (Inlet Controls 3.84 cfs @ 4.89 fps)

—2=Custom Weir/Orifice (Controls 0.00 cfs)

\mabosdata\PROJECTS\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\North Easton\HydroC \\
\textbf{North Easton-PR} \tag{Type III 24-hr 100-Year Rainfall=7.00"} \\
\text{Prepared by VHB} \text{Printed 6/4/2012} \\
\text{HydroCAD} \text{8 10.00 s/n 01234 @ 2011 HydroCAD Software Solutions LLC} \text{Page 61} \\
\end{array}

Summary for Link DP1: Wetland ST-10

Inflow Area = 2.761 ac, 21.73% Impervious, Inflow Depth > 2.33" for 100-Year event

Inflow = 4.34 cfs @ 12.20 hrs, Volume= 0.535 af

Primary = 4.34 cfs @ 12.20 hrs, Volume= 0.535 af, Atten= 0%, Lag= 0.0 min

\mabosdata\PROJECTS\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\North Easton\HydroC \\
\textbf{North Easton-PR} \tag{Type III 24-hr 100-Year Rainfall=7.00"} \\
\text{Prepared by VHB} \text{Printed 6/4/2012} \\
\text{HydroCAD} \text{8 10.00 s/n 01234 @ 2011 HydroCAD Software Solutions LLC} \text{Page 62}

Summary for Link DP3: Wetland EA1 (culvert)

Inflow Area = 8.083 ac, 48.65% Impervious, Inflow Depth > 2.73" for 100-Year event

Inflow = 7.78 cfs @ 12.18 hrs, Volume= 1.837 af

Primary = 7.78 cfs @ 12.18 hrs, Volume= 1.837 af, Atten= 0%, Lag= 0.0 min

\mabosdata\PROJECTS\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\North Easton\HydroC \\
\textbf{North Easton-PR} \tag{Type III 24-hr 100-Year Rainfall=7.00"} \\
\text{Prepared by VHB} \text{Printed 6/4/2012} \\
\text{HydroCAD} \text{8 10.00 s/n 01234 @ 2011 HydroCAD Software Solutions LLC} \text{Page 63}

Summary for Link DP4: Wetland EA 1

Inflow Area = 0.555 ac, 0.00% Impervious, Inflow Depth > 4.80" for 100-Year event

Inflow = 3.01 cfs @ 12.10 hrs, Volume= 0.222 af

Primary = 3.01 cfs @ 12.10 hrs, Volume= 0.222 af, Atten= 0%, Lag= 0.0 min





Appendix C Standard 3 Computations and Supporting Information



FEIS/FEIR Technical Report Stormwater North Easton Station

Soil Evaluation and Analysis



Natural Resources Conservation Service A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants Custom Soil Resource
Report for
Bristol County,
Massachusetts, Northern
Part; and Norfolk and
Suffolk Counties,
Massachusetts



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app? agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

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Soil Information for All Uses	
Soil Properties and Qualities	
Soil Qualities and Features	
Hydrologic Soil Group	_

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Custom Soil Resource Report

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.



MAP LEGEND Area of Interest (AOI) Area of Interest (AOI) Soils Soil Map Units Soil Ratings Α A/D B/D С C/D D Not rated or not available **Political Features** Cities **Water Features** Streams and Canals **Transportation** +++ Rails Interstate Highways **US Routes** Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:4,990 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov Coordinate System: UTM Zone 19N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bristol County, Massachusetts, Northern Part

Survey Area Data: Version 5, Jul 27, 2010

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts Survey Area Data: Version 8, Jul 23, 2010

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 7/10/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Hydrologic	c Soil Group— Summary by Map Unit -	- Bristol County, M	assachusetts, Northern	Part (MA602)
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	С	0.3	0.4%
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	3.7	4.9%
245C	Hinckley sandy loam, 8 to 15 percent slopes	А	1.9	2.5%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	А	2.2	2.9%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	С	11.5	15.1%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	С	4.5	5.9%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	С	3.6	4.7%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	С	4.3	5.6%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	С	0.3	0.4%
413B	Charlton - Paxton fine sandy loams, 0 to 8 percent slopes, very stony	С	3.2	4.2%
902B	Charlton - Paxton fine sandy loams, 0 to 8 percent slopes, extremely stony	С	0.6	0.8%
Subtotals for Soil Su	irvey Area		36.1	47.4%
Totals for Area of Int	terest		76.2	100.0%

Hydrologic	Hydrologic Soil Group— Summary by Map Unit — Norfolk and Suffolk Counties, Massachusetts (MA616)		usetts (MA616)	
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10	Scarboro and Birdsall soils, 0 to 3 percent slopes	D	7.8	10.2%
71B	Ridgebury fine sandy loam, 2 to 8 percent slopes, extremely stony	С	1.3	1.7%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	А	8.6	11.3%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	С	22.4	29.4%
Subtotals for Soil Su	rvey Area		40.1	52.6%
Totals for Area of Int	erest		76.2	100.0%

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Custom Soil Resource Report

Tie-break Rule: Higher



FEIS/FEIR Technical Report Stormwater North Easton Station

Required and Provided Recharge Volumes



Recharge Calculations

Project Name: North Easton
Project Location: Stoughton, MA

Date: 31-May-12

Proj. No.: 10111.00

Calculated by: CWF

Checked by: EJM

Proposed Impervious Surface Summary

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
1	0.0	0.0	0.0	0.0	0.0
2	0.6	0.0	0.0	0.0	0.6
3	0.0	0.0	0.6	0.0	0.6
4	0.0	0.0	0.1	0.0	0.1
5	0.0	0.0	0.2	0.0	0.2
6	0.3	0.0	0.2	0.1	0.6
7	1.4	0.0	1.0	0.0	2.4
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
TOTAL	2.3	0.0	2.1	0.1	4.5

Required Recharge Volume (Cubic Feet)

HSG	Area	Recharge Depth *	Volume
	(acres)	(in.)	(c.f.)
Α	2.3	0.60	5,009
В	0.0	0.35	0
С	2.1	0.25	1,880
D	0.1	0.10	36
TOTAL			6,926

^{*} Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet - see attached sheets)

Basin 1	7,829	
Basin 3	947	
Basin 4	5,356	
Basin5	10,896	
Total	25,028	c.f



FEIS/FEIR Technical Report Stormwater North Easton Station

72-hour Drawdown Analysis



Drawdown Calculations

Project Name: North Easton Station **Proj. No.:** 10111.00

Date: 5/31/2012

Project Location: Stoughton/Easton, MA Calculated by: EJM

Bioretention Basin - 1

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
155.00	1,579	0
156.00	2,217	1,898
157.00	2,953	4,483
158.00	3,738	7,829
TOTAL		7,829

Assumptions:

Recharge Rate: 2.41 in/hr

Drawdown Time:	24.7 hours

Infiltration Basin - 3

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
161.50	552	0
162.00	879	358
162.50	1,202	878
TOTAL		878

Assumptions:

Recharge Rate: 0.27 in/hr

Drawdown Time:	70.7 hours

Infiltration Basin - 4

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
151.00	545	0
152.00	1,210	878
153.00	2,120	2,543
154.00	3,095	5,150
TOTAL		5,150

Assumptions:

Recharge Rate: 2.41 in/hr

Drawdown Time: 47.1	hours
---------------------	-------



Drawdown Calculations

Project Name: North Easton Station Proj. No.: 10111.00

Date: 5/31/2012

Project Location: Stoughton/Easton, MA Calculated by: EJM

Infiltration Basin - 5

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
143.00	9,980	0
144.00	11,812	10,896
TOTAL		10,896

Assumptions:

Recharge Rate: 2.41 in/hr

Drawdown Time: 5.4 hours





Appendix D Standard 4 Computations and Supporting Information



FEIS/FEIR Technical Report Stormwater North Easton Station

Water Quality Volume Calculations



Water Quality Volume Calculations

Project Name: North Easton Stati Proj. No.: 10111.00
Project Location: Easton, MA Date: 5/31/2012

Calculated by: CWF
Checked by: EJM

Bioretention Basin P1

(runoff from Area PR2)

Total Impervious Area = 0.60 Acres

Required:

Runoff Depth to Required be Treated (in.) Volume (c.f.)
Water Quality Volume

1 2,178

Provided:

Cumulative Infiltration Basin Elevation Area (s.f.) Volume (c.f.) 155.0 1,579 0 156.0 2,217 1,898 157.0 2,953 4,483 158.0 3,738 7,829

Infiltration Basin P2

(runoff from Area PR3, PR4)

Total Impervious Area = 0.68 Acres

Required:

Runoff Depth to be Treated (in.)
Forebay Volume

0.1

Volume (c.f.)

247

Water Quality Volume

1

Required
Volume (c.f.)

247

2,468

Provided:

Cumulative Elevation Area (s.f.) Volume (c.f.) **Sediment Forebay** 156.0 186 157.0 364 275 Infiltration Basin 156.0 2,331 0 3,258 2,795 157.0

Infiltration Basin P3

(runoff from Area PR5)

Total Impervious Area = 0.20 Acres

Required:

Runoff Depth to be Treated (in.)

Forebay Volume

0.1

Water Quality Volume

Required
Volume (c.f.)

73

726

Provided:

Cumulative Area (s.f.) Elevation Volume (c.f.) **Sediment Forebay** 161.5 0 0 146 37 162.0 162.5 220 <u>128</u> 0 Infiltration Basin 161.25 0 161.5 552 69 162.0 879 427 1,202 162.5 <u>947</u>



Water Quality Volume Calculations

Project Name: North Easton StatiProj. No.:10111.00Project Location: Easton, MADate:5/31/2012

Calculated by: CWF

Infiltration Basin P4

(runoff from Area PR6)

Total Impervious Area = 0.55 Acres

Required:

Runoff Depth to Required be Treated (in.) Volume (c.f.)
Forebay Volume 0.1 200
Water Quality Volume 1 1,997

Provided:

Sediment Forebay	Elevation 153.0 154.0	Area (s.f.) 168 346	Cumulative Volume (c.f.) 0 <u>257</u>
Infiltration Basin	150.5	280	0
	151.0	545	206
	152.0	1,210	1,084
	153.0	2,120	2,749
	154.0	3.095	5.356

Infiltration Basin P5

(runoff from Area PR7)

Total Impervious Area = 2.50 Acres

Required:

Runoff Depth to Required be Treated (in.) Volume (c.f.)
Forebay Volume 0.1 908
Water Quality Volume 1 9,075

Provided:

Sediment Forebay	Elevation 145.0 146.0	Area (s.f.) 761 1104	Cumulative Volume (c.f.) 0 <u>933</u>
Infiltration Basin	143.0	9,980	0
	144.0	11,812	10,896



FEIS/FEIR Technical Report Stormwater North Easton Station

TSS Removal Worksheets

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc. Consulting Engineers and Planners 101 Walnut Street Watertown, MA 02471 (617) 924-1770

Project Name: Project Number: Location:

Discharge Point:

Drainage Area(s):

North Easton Station 10111.00 Stoughton, MA PR1, PR2

Sheet: Date: Computed by:

1 of 3 11-Apr-2012 CWF

Checked by: VHB

1. Pre-Treatment prior to Infiltration

BMP*
Bioretention Area

TSS Removal Rate*
90%
0%
0%
-

Starting TSS Load**
100%
10%
10%

1 1	
	Amount Removed (B*C)
	(B C)
	90%
	0%
	0%

Remaining Load (D-E)
10%
10%
10%

Pre-Treatment TSS Removal =

90%

2. Total TSS Removal including Pretreatment 1.

BMP*
Bioretention Area

TSS Removal Rate*
90%
0%
0%
0%
Values from the MassDEP

Starting TSS Load**
100%
10%
10%
10%

Amount Removed (B*C)
90%
0%
0%
0%

Remaining Load (D-E)	
10%	
10%	
10%	
10%	

^{*} BMP and TSS Removal Rate Stormwater Handbook Vol. 1.

^{**} Equals remaining load from previous BMP (E)

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc. Consulting Engineers and Planners 101 Walnut Street Watertown, MA 02471 (617) 924-1770

Project Name: North
Project Number: 1011
Location: Stoug
Discharge Point: DP-3

Drainage Area(s):

North Easton Station
10111.00
Stoughton, MA
DP-3
PR 4, 5, 6, 8, 9

 Sheet:
 2 of 3

 Date:
 11-Apr-2012

 Computed by:
 CWF

 VHB

1. Pre-Treatment prior to Infiltration

BMP*
Deep Sump and Hooded Catch Basin
Sediment Forebay

or to illilitration
TSS Removal Rate*
25%
25%
0%

Starting TSS Load**	
100%	
75%	
56%	

Amount Removed (B*C)
25%
19%
0%
 _

Remaining Load (D-E)
75%
56%
56%
4.407

Pre-Treatment TSS Removal =

44%

2. Total TSS Removal including Pretreatment 1.

BMP*
Deep Sump and Hooded Catch Basin
Infiltration Basin

i including Pretrea
TSS Removal Rate*
25%
80%
0%
0%
Values from the MassDEP

Starting TSS Load**
100%
75%
15%
15%

Amount Removed (B*C)
25%
60%
0%
0%

Remaining Load (D-E)
75%
15%
15%
15%

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.

^{**} Equals remaining load from previous BMP (E)

TSS Removal Calculation Worksheet

DP-3

PR 3, 7

Discharge Point:

Drainage Area(s):



Vanasse Hangen Brustlin, Inc. Consulting Engineers and Planners 101 Walnut Street Watertown, MA 02471 (617) 924-1770

Project Name: North Easton Station Project Number: 10111.00 Location: Stoughton, MA

Sheet: Date: Computed by:

3 of 3 11-Apr-2012 CWF

Checked by: VHB

1. Pre-Treatment prior to Infiltration

BMP*
Deep Sump and Hooded Catch Basin
Sediment Forebay

n to minitration
TSS Removal Rate*
25%
25%
0%

Starting TSS Load**	
100%	
75%	
56%	

	Amount Removed (B*C)				
	25%				
	19%				
	0%				

Remaining Load (D-E) **75%** 56% 56%

Pre-Treatment TSS Removal =

44%

2. Total TSS Removal including Pretreatment 1.

BMP*
Deep Sump and Hooded Catch Basin
Oil Grit Separator
Infiltration Basin

i iliciaaliig i retiea				
TSS Removal Rate*				
25%				
25%				
80%				
0%				
Values from the MassDEP				

Starting TSS Load**	
100%	
75%	
56%	
11%	

Amount Removed (B*C)
25%
19%
45%
0%

Remaining Load (D-E)
75%
56%
11%
11%

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.

^{**} Equals remaining load from previous BMP (E)



FEIS/FEIR Technical Report Stormwater North Easton Station

Appendix E Geotechnical Report



Date January 23, 2012

To Rick Carey, Natasha Velickovic - VHB

From Paul Murphy, Da Ha, Peter Chou - Jacobs

 \mathbf{Cc}

Subject MBTA South Coast Rail (New Bedford/Fall River Commuter Rail Extension)

North Easton Station Geotechnical Design Memorandum

Easton, MA

Project No. E2347101

INTRODUCTION

The South Coast Rail project will restore passenger rail transportation from South Station in Boston to the cities of Fall River and New Bedford along an existing rail freight corridor running south from Taunton to Fall River and New Bedford. The project will include the construction of several existing and new passenger stations and two terminal layover facilities. This geotechnical design memorandum presents the foundation design considerations for the new station platform at the proposed North Easton Station in Easton, Massachusetts. The design recommendations presented in this report are based on the results of subsurface investigation performed by Jacobs in 2010.

Existing Conditions

The proposed North Easton Station is off Route 138 in Easton, behind the Roche Brothers Shopping Plaza (Figure 1). The station site is undeveloped and entirely vegetated, but has evidence of earthwork, most likely as a result of the construction of the shopping plaza. In addition to the shopping plaza to the east, the site is adjacent to forested land to the west and south. The shopping plaza contains six buildings in good condition as all are relatively new. A medical office building adjacent to the proposed station site is the newest building. Existing grades at the platform location range from elevations 160 to 154 feet (NGVD29 Datum), generally sloping downward from north to south.

Proposed Construction

A commuter parking lot, drop-off ramps and platform are currently proposed at this site. Current station plans are to construct a new parking area and a new drop-off area, and add an 800 foot long, 12 foot wide high level center platform adjacent to the existing tracks with some track relocation required, as well as the addition of a second track. Access to the platform will be from a new ramp/stair structure along the east side of the tracks with a bridge over the track to the platform. Approximately 375 feet of the platform will be under a new station canopy. The details of new track layout (including grading), associated sidewalks and ramps of the proposed station are still under development at the time of this report preparation. This report focuses on the foundations for the platform only.

Proj. No. E2347101

SCOPE OF WORK

This memorandum was prepared by Jacobs Engineering Group (Jacobs) in accordance with the scope of work under the contract between Jacobs and VHB for work on the New Bedford/Fall River Commuter Rail Line Extension Project for Massachusetts Bay Transportation Authority (MBTA). The geotechnical work included the following tasks:

- Perform a geotechnical exploration and laboratory testing program;
- Report and interpret the results of the exploration and laboratory testing program; and
- Provide geotechnical recommendations for design and construction of the platform foundations.

The Jacobs scope of work did not include environmental analyses to assess the potential presence of any hazardous materials at the project site or potential impacts to adjacent structures during construction.

LOCAL GEOLOGY

The soils at the site are underlain by the Dedham Granite. The Dedham Granite is Proterozoic in age, medium grained, and light gray, pinkish gray and greenish gray in color. The intact strength of the rock averages about 35,000 psi. The rock mass is sparsely fractured. The top of rock was encountered as shallow as five feet in some of the borings but extended deeper than 16 feet in others. The top of rock was typically sharp, with little or no residual soil. In some borings, there appeared to be a layer of granite, followed by a zone of soil, followed by granite. The intervening layer of soil was typically not sampled and described simply as material not recovered by rock coring. The most likely explanation is that exfoliation has caused large slabs of rock to pop off the top of the main body of rock. If this explanation is correct, then these slabs could extend laterally for tens of feet and could have open voids beneath them. Another possible explanation is that these layers are localized boulders in the glacial deposits overlying the rock. The similarity between the upper layer the underlying rock suggests that the first explanation is more likely. Heavily loaded foundations will need to pass through the upper slab and into the underlying, competent rock.

GEOTECHNICAL EXPLORATIONS

Jacobs Engineering Group planned the subsurface exploration program and retained the drilling contractor to perform the explorations. The geotechnical data reports were submitted in 2010. Five borings (NES-1, NES-2, NES-2A, NES-3 and NES-4) were conducted along the proposed station platform and eighteen borings (NES-6 to NES-9, NES-11, NES-11A, NES-12 to NES-17, NES-19, NES-19A and NES-20 to NES-23) were drilled in the general vicinity of the proposed parking lot and its driveways for the 2010 explorations. Boring locations are shown on the Subsurface Exploration Plan (Figure 2).

The 2010 borings were drilled by New Hampshire Boring of Brockton, Massachusetts using either a CME-550 or D-50 ATV mounted drill rig, a D-90 or D-120 track mounted drill rig, or a CME-75 truck mounted drill rig. The borings were advanced through the soil by wash boring methods using a 4-inch casing and roller bit with water. Standard penetration tests (SPT), consisting of a 140-pound hammer dropping 30 inches on a standard 2-inch-diameter (OD) split-spoon sampler, were performed with a safety hammer or automatic hammer to establish the consistency of the subsurface soils. The SPT's were typically performed at five foot intervals of depth. The obtained samples were sealed in glass jars to retain their natural moisture. Bedrock was not encountered during the explorations.

The borings were observed by a representative from Jacobs. The soil samples were classified in the field in accordance with ASTM D-2488, Standard Practice for Description and Identification of Soils (Visual-Manual

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Procedure) by Jacobs' representative, and appropriate stratum breaks were interpolated from drilling and sampling observations. The boring logs were prepared by Jacobs based on the field classifications and laboratory testing, and are presented in Appendix A.

LABORATORY TESTING

The results of the laboratory testing were previously submitted to VHB in a report entitled "South Coast Rail, Jacobs Geotechnical Data Report", dated November 2010.

Grain size distribution analyses were performed to evaluate the gradation of the natural granular soils for potential reuse as backfill, if needed, and to confirm sample classifications. The analyses are summarized in Table 1 below and are presented in Appendix B.

Table 1: Laboratory Soil Classification Summary

			· ·				
BORING NO.	SAMPLE NO.	ELEVATION (FEET)	USCS SOIL CLASSIFICATION	W (%)	GRAVEL (%)	SAND (%)	FINES (%)
NES-4	S4	144.0	Silty Clay (CL)	23.6	0.0	1.9	98.1
NES-5	S2	154.0	Silty Sand (SM)	1.1	13.3	68.3	18.4
NES-14	S2	162.0	Silty Sand w/ Gavel (SM)	NT	32.7	51.3	16.0
NES-21	S2	158.0	Gravel w/ Silt + Sand (GW-GM)	NT	56.9	34.1	9.0

Where: w = natural moisture content, NT = Not Tested.

SUBSURFACE CONDITIONS

The subsurface conditions at the site were inferred from the boring data collected for the South Coast Rail project, with some interpretations. The subsurface conditions encountered at the station platform area during our 2010 explorations generally consist of a layer of granular fill with thickness of about 4 to 9 feet, underlain by a sand and gravel layer with thickness ranging from 0 to 26 feet overlying bedrock. A 10 feet thick hard silty clay layer was encountered within the sand and gravel layer from about 14 to 24 feet below ground surface in boring NES-4. Boulders were encountered at borings NES-2, NES-3 and NES-5 within the upper 5 to 10 feet of the borings. Bedrock was encountered at a depth of about 5 to 35 feet in the platform area, corresponding to approximately elevations 123 to 151.5 feet.

Fill materials with thicknesses varying from 0 to 8 feet were also encountered in the vicinity of the proposed parking lot area. Bedrock was encountered at a depth about 4 to 18 feet (corresponding to elevations 133 to 169.5 feet) with generally shallower bedrock found on the south side of the parking lot and in the area of the proposed infiltration basin.

Subsurface soil conditions are summarized in Table 2 below.

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Table 2: Summary of Subsurface Conditions at Available Borings

Table 2: Summary of Subsurface Conditions at Available Borings							
BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
	Platform Borings						
NES - 2	154.0	0.5 (Top Soil)	153.5	153.5	153.5	NR	Obstruction encountered.
NES - 2A	154.0	4.0	150.0	148.5	146.0	NR	Offset ~5 ft from NES - 2.
NES - 3	156.0	0.3 (Top Soil)	155.7	144.0	138.5	NR	
NES - 4	158.0	9.0	149.0	123.0	122.0	148.0	
NES - 5 OW	158.0	4.0	154.0	141.0	131.0	140.5	
NES - 7	158.0	6.5	151.5	151.5	149.0	NR	
NES - 8	154.0	4.0	150.0	NE	138.0	150.5	Boring offset ~12 ft SE from staked location.
NES - 9	159.0	0	159.0	NE	143.0	154.0	
				Site Borings			
NES - 1 OW	151.0	8.0	143.0	133.0	127.5	135.5	Well screened from 18 to 23 ft.
NES - 6	163.0	0	163.0	157.5	152.5	159.5	
NES - 11	165.0	0	165.0	160.0	153.0	NR	
NES - 11A	162.0	0	162.0	156.5	142.0	NR	Boring offset ~25 ft W of NES-11, ~3 ft less elevation.
NES - 12	166.0	4.0	162.0	160.5	158.0	NR	
NES - 13	159.0	4.0	155.0	NE	143.0	NR	
NES - 14	166.0	0	166.0	151.0	150.0	NR	
NES - 15	173.0	0	173.0	169.0	169.0	NR	
NES - 16	160.0	4.0	156.0	NE	144.0	NR	
NES - 17	175.0	0	175.0	168.0	166.0	NR	
NES - 19	175.0	0	175.0	168.0	168.0	NR	Refusal at 7 ft, relocated boring.
NES - 19A	175.0	0	175.0	168.5	161.0	172.0	
NES - 20	175.0	0	175.0	169.5	165.0	NR	
NES - 21	162.0	0	162.0	NE	146.0	NR	
NES - 22	144.0	0.3 (Top Soil)	143.7	139.0	129.0	141.0	
NES - 23	162.0	8.0	154.0	153.0	145.0	NR	Boulder at 1 ft, relocated boring 5 ft south.
NE: Not encountered at the boring during drilling. NR: Not recorded.							

Fill: The fill layer typically consists of mostly granular, loose to very dense sand with up to about 15% silt and 15% gravel. The fill layer is generally about 0 to 4 feet thick but may be as thick as 9 feet in the area of the platform.

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Natural Granular Deposits: In the platform area, the natural soil deposits below the fill generally consist of predominantly sand with up to about 30% gravel and 20% silt. These deposits are loose to very dense with Standard Penetration Test (SPT) N-values ranging between 9 and in excess of 50 blows per foot (bpf). The numerous high N-values encountered may be caused by the presence of large pieces of gravel and cobbles or even boulders, which are common within this type of deposit.

An approximately 10 feet thick hard silty clay layer was encountered in boring NES-4 from about 14 to 24 feet below ground surface, corresponding to elevations 134 to 144 feet.

Bedrock: Granite bedrock was encountered in the platform area at depth of about 5 to 35 feet below existing ground surface, corresponding to approximately elevations 123 to 151.5 feet. The bedrock was generally hard, fresh to slightly weathered GRANITE.

Bedrock was encountered at elevations ranging from about 133 to 169.5 feet in other site areas. In the vicinity of borings NES-11 and NES-15, bedrock was encountered above the proposed grades at the site.

Groundwater: Groundwater levels were measured in the test borings using a weighted tape during and at completion of drilling. The data indicated the groundwater level ranged from approximate elevations 140.5 to 154.0 feet in the general area of the platform, and from elevations 135.5 to 172 feet in the general site area. The use of wash boring techniques for all soil borings may have artificially increased the water level readings due to the addition of water to the borings. Trapped/perched water is also commonly seen at a higher elevation within existing fill or silty materials. The longer term water level readings taken at Boring NES–1 OW on July 9, 2010 indicated the ground water level at a depth of about 17.0 feet (Elevation 134.0 feet). The longer term water level readings taken at Boring NES–5 OW on July 9, 2010 and September 12, 2011 indicated the water at a depth of about 17.5 feet (Elevation 140.5 feet) and 15.5 feet (Elevation 142.5 feet), respectively.

Groundwater levels should be expected to fluctuate with rainfall and other seasonal variations. Local and periodic variations of ground water elevations may also be influenced by local subsurface drainage and, leaking water or sewer pipes. More long-term observations would be required to evaluate true groundwater levels and their influence on planned construction. However, based upon these short-term observations and readings from the observation well at Boring NES-1 OW and NES-5 OW, it is anticipated that the groundwater could be at within 15 to 18 feet below existing grade at both the platform and the parking lot areas.

GEOTECHNICAL RECOMMENDATIONS

Based on our review of available subsurface information, the proposed station platforms can be supported on spread footings bearing directly within either competent natural soil or structural fill placed above suitable natural soils. Final platform and canopy design loads were not available at the time of this report preparation. However, it is anticipated that the station platform will be lightly (axially) loaded with limited horizontal forces from wind and seismic loads.

The following paragraphs provide project specific geotechnical recommendations for foundation soil preparation, structural fill/backfill placement, and design and construction of spread footings.

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Platform Foundation- Spread Footings

Spread footings are recommended for the platform foundations, bearing on compacted structure fill or natural granular deposits. The bottom of footing elevation should be at least 4 feet below final grades for frost protection. The existing fill is not suitable for support of the spread footings and should be removed within the zone of influence of the footing, defined by a line extending one foot horizontally from the bottom edge of footing and then down and away at a 1H:1V slope until natural granular soils are encountered.

The recommended allowable design bearing capacity for spread footings bearing on structural fill or natural sand and gravel deposits is 5 ksf, provided that subgrades are prepared as described herein. This provides an adequate factor of safety against bearing failure and limits the total estimated settlement to less than one inch and the differential settlement to less than ½ inch. All footings should be at least 4 feet wide.

The structural fill material, if needed, should be free from organics and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200 - Earthwork for Type B Gravel Borrow. The structural fill should be compacted to 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557).

All temporary open cuts required for footing construction should be in accordance with the related OSHA regulations and should have side slopes of no steeper than 1.5H:1V.

Seismic Consideration

The seismic design should comply with the requirements of the most current Massachusetts State Building Code 780 CMR and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface conditions encountered, the station site is classified as Seismic Site Class C soil profile in accordance with 780 CMR Chapter 1614.0 Section 9.4 Site Ground Motion. The structure could be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. The maximum considered earthquake ground motions shall be as represented by the spectral response acceleration at short periods (Ss) and at 1-sec (S₁) obtained from Table 1604.10 of the Massachusetts State Building Code and adjusted for Site Class effects using the site coefficients of Section 9.4.1.2.4.

For Site Class C Soils at the location of this station:

$$S_{MS} = 0.300$$
 and $S_{M1} = 0.109$

$$S_{\mathrm{DS}} = 0.200$$
 and $S_{\mathrm{D1}} = 0.073$

where:

- \bullet S_{MS} is the maximum consider earthquake spectral response acceleration for short periods adjusted for site class
- S_{M1} is the maximum consider earthquake spectral response acceleration at 1-sec adjusted for site class
- \bullet S_{DS} is the design earthquake spectral response acceleration for short periods adjusted for site class

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• S_{D1} is the design earthquake spectral response acceleration at 1-sec adjusted for site class

The building code also requires that the soil be evaluated for the following potential hazards: slope instability, soil liquefaction, or surface rupture due to faulting or lateral spreading. The proposed grading is relatively flat and we are not aware of any pre-existing slope instability in this area. The existing overburden soils do not appear to be subject to surface rupture due to faulting or lateral spreading.

Liquefaction

Based on the observed subsurface conditions, recorded water levels, percentage of fine contents and sample relative densities (high SPT N-values), the existing soils underlying the site are judged not susceptible to liquefaction.

CONSTRUCTION CONSIDERATIONS

Foundation Installation - Spread Footings

Following excavation to the base of the spread footing subgrade or to the bottom of existing fill layer, whichever is deeper, the exposed surface should be observed by an on-site representative of the project geotechnical engineer and proof-compacted with at least 10 passes of a large vibratory drum roller. Any yielding areas should be observed by geotechnical personnel to assess if additional localized undercutting is necessary. Footing inspections should include hand auger probes by the geotechnical personnel to identify soft/weak zones. The need for undercutting and backfilling with structural fill should be closely evaluated in the field based on encountered conditions.

If bedrock is encountered at the proposed bottom of footing elevation, the footing should either bear entirely on bedrock or entirely on soil. Where partial bedrock subgrade is encountered at the bottom of footing elevation, the bedrock should be over-excavated to a depth of at least 10 inches below the bottom of footing elevation and replaced with compacted Gravel Borrow to provide a uniform bearing surface.

In areas where seepage is encountered within footing excavations, the need for placing a 3" thick lean concrete mud mat or a layer of \(^3\)4-inch crushed stone to protect the bearing surface should be evaluated in the field. Crushed stone thicker than 4 inches shall be wrapped by non-woven filter fabric.

Following observation of the bearing soils by geotechnical personnel, reinforcing steel and concrete can be placed in the excavation. It is recommended that footing reinforcing steel and concrete be placed the same day as the footing excavation is made, where possible, to avoid significant moisture content changes in the bearing soils. No water should be allowed to pond within excavations and drainage should be maintained away from foundations both during and after construction. The footing excavation should be free of loose debris at the time of footing concrete placement.

Subgrade Preparation

Prior to performing any required grading operations and excavations in the proposed structure footprints, walkway and paved areas, these areas should be stripped of topsoil, vegetation, and existing pavement, if present. The topsoil should be placed in a designated area for reuse during final grading. Following site clearing and stripping, the exposed subgrade should be proof compacted with 10 passes of a large vibratory

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drum roller. Any pockets of excessively soft, wet or disturbed soil or unsuitable soils should be removed and replaced with properly compacted fill materials.

If additional rolling does not correct the unstable condition, the subgrade should be scarified to a depth of at least six inches but not exceeding eighteen inches, aerated, re-compacted, and retested to provide uniform compaction. Following satisfactory compaction of the subgrade, controlled compacted fill material should be placed to bring the site to the required grade.

Fill should not be placed over frozen soil. Soil subgrades should be protected against frost both during and after construction.

Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. Excavations should be made with as few passes of the backhoe bucket as possible to reduce disturbance of the subgrade. Also if possible, a backhoe bucket fitted with a smooth blade should be used during the final subgrade preparation, where necessary. The exposed base should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas. Construction traffic should be controlled to prevent excessive stresses and disturbance to the subgrade.

If pavements are not constructed immediately after grading, the subgrade should be shaped so as to prevent ponding. If there is a substantial lapse in time between grading and paving, or if the subgrade is disturbed, it should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during proof-rolling or initial construction should be removed and replaced with compacted granular fill.

Within the proposed paved areas, and extending a distance of five feet beyond the edge on all sides, excavate existing granular fill soils to a depth of two feet below existing site grades. It may be possible to reuse the existing granular fill, depending on the suitability of the material, as described herein.

Fill Placement and Compaction

Fill materials most likely will be obtained by importing granular fill materials from off-site borrow sources. However, it may be possible to reuse existing site granular fill material provided that it can be properly placed and compacted. The gradation shall be in accordance with MBTA Standard Specification Section 02200-Earthwork for Type B Gravel Borrow.

All structural fill should be free of organics, demolition debris or other deleterious substances. The fill material should have a plasticity index (PI) less than 4 and a liquid limit (LL) less than 10, and contain fragments less than 4 inches in maximum dimension. Each lift should be compacted to the specified density prior to placing any subsequent lift. All materials to be used as structural fill should be tested in the laboratory to determine their project suitability and compaction characteristics.

The fill should be systematically compacted to the following percentages of the maximum dry density:

Table 3: Fill Compaction Requirements

DESCRIPTION	MINIMUM PERCENT COMPACTION (ASTM D-1557)
General Site Fills, Structural Fill	95
(Below Footings and Slabs)	
Behind Retaining Walls	92
Landscape Area	90

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Soils which exhibit a well-defined moisture content—dry density relationship should be compacted to within plus or minus two percentage points of the optimum moisture content as determined by the Modified Proctor test (ASTM D-1557).

Where fill materials are placed against an existing embankment slope, the slope should be benched as the fill is brought up in layers. Benching should be of a sufficient width to permit placing and compaction of fill material upon the existing embankment materials. Typically, benches are between four to eight feet wide. Each bench cut should begin at the intersection of the existing embankment and the vertical side of the previous bench. Trench backfills over pipelines or utility structures should be performed so as not to adversely impact the underlying utilities. In fill areas, the backfill material, compaction method, and degree of compaction requirements should be similar to that for the fill adjacent to the trench.

Construction Dewatering

All excavations should be performed in the dry condition. Discharge of pumped water should be performed in accordance with all federal, state and/or local regulations which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

Permanent Slopes

Permanent slopes with loamed and seeded surfaces should not be steeper than 2-1/2 horizontal to 1 vertical (2-1/2H:1V) without slope protection to limit erosion and surficial sloughing of the slope. Additional analyses may be required to assess the stability of slopes steeper than 2-1/2H:1V as the station design is finalized.

Excavation Slopes and Shoring

The slopes of open cuts should be no steeper than 1-1/2H:1V. Open cuts should not be used below the water table because of the likelihood of soil sloughing into the excavation.

The temporary excavation support system, if needed, should be selected by the Contractor and designed by an experienced registered Professional Engineer in the Commonwealth of Massachusetts and retained by the Contractor. Where excavation sides can be sloped back, they should be performed in accordance with the Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

Protection of Existing Facilities

It is recommended that a geotechnical instrumentation and monitoring program be performed during construction of the project to evaluate impacts on adjacent structures. It is recommended that the program be developed to provide data for the following considerations:

- To monitor ground movements and vibration levels during construction.
- To provide early warning of potentially adverse trends by presenting sufficient data to determine the source of unanticipated ground movements, if present.
- If necessary, to plan remedial measures to limit damage to embankments and structures and to provide early warning when alternative means of protection are necessary.
- To document impacts of construction on adjacent facilities.
- To evaluate the performance and structural integrity of the constructed facilities.

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We recommend the following instrumentation program to measure:

- Ground surface settlement and lateral movement adjacent to proposed construction.
- Horizontal and vertical movement of any excavation support system, and existing structures.
- Vibrations as a result of construction activities.

Vertical and horizontal survey points should be established on the adjacent structures. The monitoring points should be surveyed prior to the start of construction and monitored during construction to detect movement.

Vibration monitoring shall be conducted within 100 feet of existing structures during construction activities.

We recommend conducting a pre-construction survey of structures and utilities within 100 feet of the site to document existing conditions prior to construction. Documentation should include photographs, video, sketches, and/or written comments.

Specific instrumentation and monitoring requirements shall be based on the proposed construction sequence, duration of construction, and performance criteria. Initial measurements should be established well in advance of construction so that baseline data can be developed. This information will be invaluable for providing early warning of adverse trends and for assessing the need for mitigating measures.

CLOSING

This report and the recommendations contained herein have been prepared for the exclusive use of MBTA and VHB and their representatives for specific application to the design and construction of the proposed North Easton Station in Easton, Massachusetts.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations available at the time of this report. Subsurface stratification variations between borings are anticipated. The reported groundwater levels only represent the water levels at the time noted on the logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

ATTACHMENTS

FIGURE 1 – SITE LOCATION PLAN

FIGURE 2 – SUBSURFACE EXPLORATION PLAN

FIGURE 3 – SUBSURFACE SOIL PROFILES

APPENDIX A - EXPLORATION LOGS

APPENDIX B – LABORATORY DATA

APPENDIX C – GEOTECHNICAL CALCULATIONS

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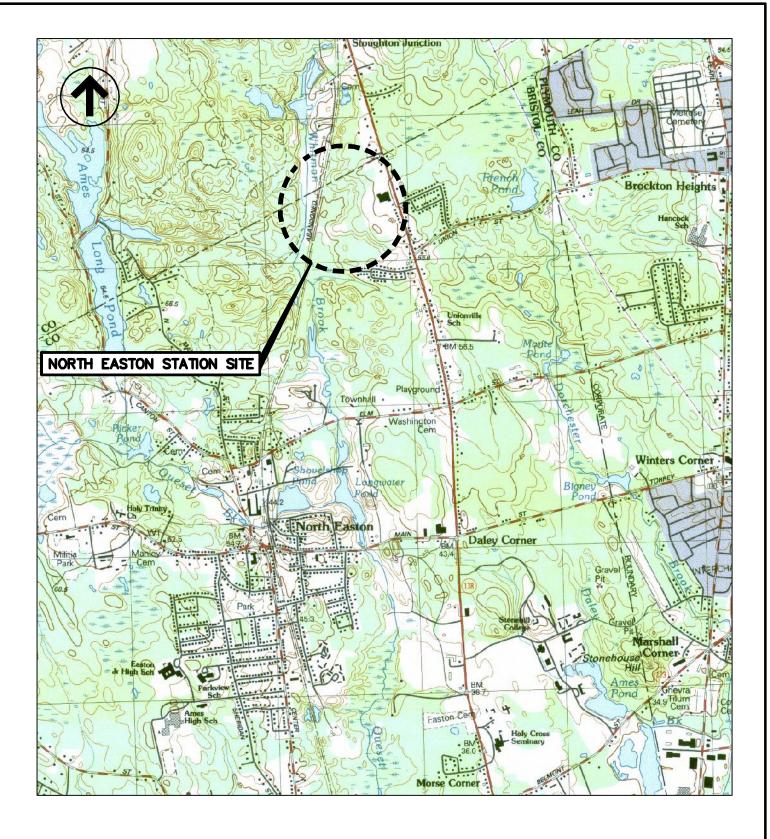
Memorandum



FIGURES

Figure 1: Site Location Plan

Figure 2: Subsurface Exploration Plan Figure 3: Subsurface Soil Profiles

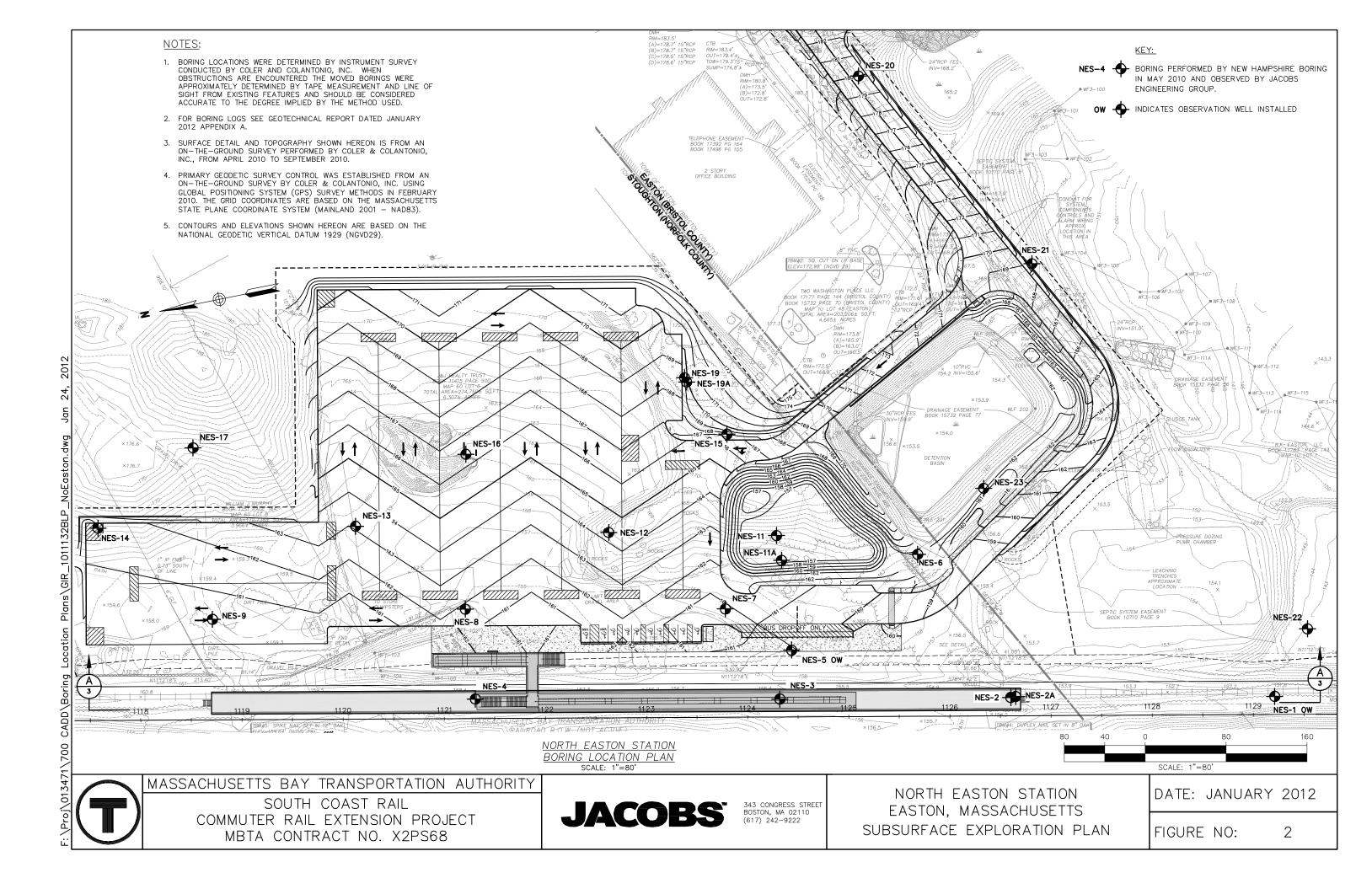


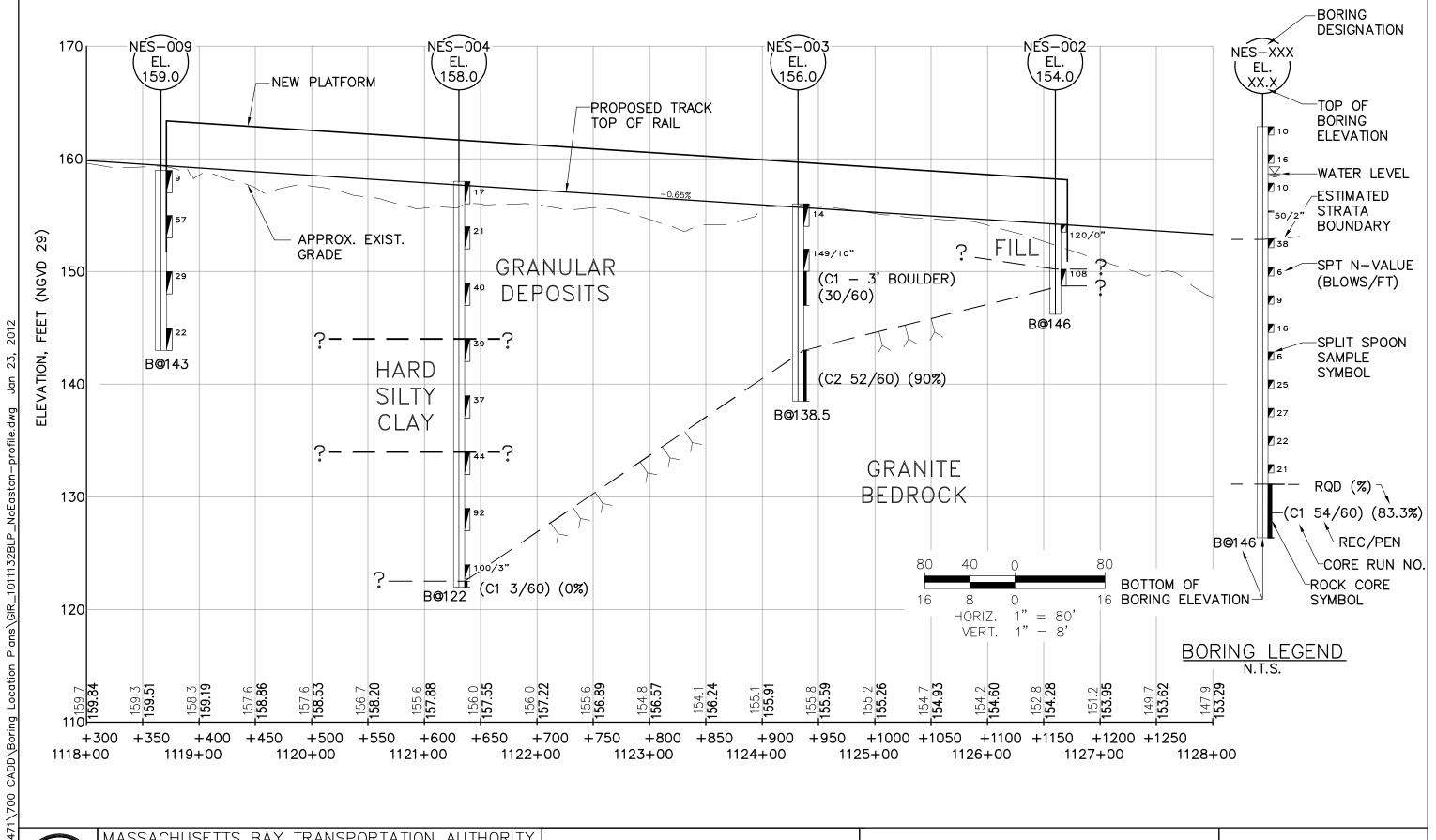
NORTH EASTON STATION
PROJECT LOCUS PLAN
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MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68 NORTH EASTON STATION EASTON, MASSACHUSETTS FIGURE 1





MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68

JACOBS

NORTH EASTON STATION EASTON, MASSACHUSETTS SUBSURFACE PROFILE A-A DATE: JANUARY 2012

3 FIGURE NO:

Memorandum

APPENDIX A: EXPLORATION LOGS

NES-1 TO NES-9 NES-11 TO NES-17 NES-19 TO NES-23

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23.5		rminated	· ·		7/8/2010		17		g Well Reading		DATE STA		5/19/10
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DEPTH (ft)	STRATA SYMBOL	SAMPL DATA		AMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
		Z 7	(OII	S1	0 - 0.5	5				D WITH SILT (SW-S	SM); fine to coars	e sand, trace no	n-plastic
-	\bowtie	120/	'0"						brown, moist	, FILL. at 0.5 feet; Boring NE	=C 2 terminated	Offact baring NE	=C 2A E #
-								south.	encountered a	at 0.5 leet, boiling Ni	_S-Z terrilinateu.	Oliset boiling NL	_3-2A 3 II
F													
L							150.0						
_		23 31 78 12		S2	4 - 5.5	10	130.0			RAVEL (SM); fine to			
-5		78	20 (0"				148.5			own, possible GLAC	•	of granite in tip o	or spoon.
-		17	20/0					l op of a	pparent Bedro	ock at 5.5 ft, roller bit	to 8 ft.		
-													
_							146.0						
								Bottom	of Hole at 8'.				
-10													
-													
Ļ													
- 15													
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-35	Page 1	: 0-35 feet.	Each sub	osequent p	page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
COHESIVE SOIL NON-COHESIVE SOIL RELATIVE										L	EGEND		
						OF SOIL CO	ORTIONS OMPONEN	NTS E Aug	ger Roo	ck Core (RC) Split-Spoon	Undisturbed	Jar V	Bag
BLOWS	/FT CONS	SISTENCY	BLOWS	/FT DI	ENSITY		S.T. OINEI	NTS Aug	mple and	I RQD (%) Sample (SS) C (%) and Blow Cou	unts (U)-Shelby Tube, (P)-Piston	Sample (JS)	Sample (B)
0 - 2 3 - 4		RY SOFT SOFT	0 - 4 5 - 10		RY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	.CE	_	per 6" REC (i			
5 - 8	MEDI	UM STIFF	11 - 3	0 MEDIL	UM DENSE	30 - 45%	SON	ME REI		ET ENTITLED "KEY TO CLASSIFICATION OF	DODIN!		
9 - 1: 16 - 3:		STIFF RY STIFF	31 - 5 51 +		DENSE RY DENSE	50 - 100%	MOS	ILY SUI		RIALS" FOR ADDITIONAL	BORING	NES -	2/2A
30 +		HARD						311	TIDOLOGI.		NO.		

ICOATION North Eastern No. SHEET 1 OF 1 SHEET 1 OF 1 No. SHEET 1 OF 1 S					PROJE		South	n Coast Rail				NEO 000
NOR NAMEER 2247/101 SAFET 1 OF SAFET		A		RS	LOCAT						_	NES - 003
INSPECTOR P. Chou									ortation Author	rity	⊣ NO.	SHEET 1 OF 1
Manual Prince Depth Dept	INISDI	ECTOR	P Choi	ı						DDILLED	S Hooley	
Wash Boring wCasing DATE/TIME DEPTH(t) REMARKS SPT HAMMER 140 Ib Safety GCORD E 782544					CONT				GS			
MX ROCK Core					a D							
DATE END STATE SAMPLE	13	1	-								•	
Page 1 1 1 1 1 1 1 1 1	17.5	Tei	minated									
RQD=90 C2 13 - 17.5 52 138.5												DATE END 5/11/10
Sample S		STRATA SYMBOL					ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S
8 8 8 9 1004* C1 6-9 30 150.0 WELL GRADED SAND WITH GRAVEL (SW); fine to coarse sand, some gravel, trace slit, brown, wet. GRANITE; loosing water at 8.5 ft, probable sand seams. Probable boulder. Break through at 9 ft, hit rock again at 12 ft. GRANITE; hard, fresh, joints spaced 4 - 44", joints angled at -0 degrees, white and black with gray. 138.5 Bottom of Hole at 17.5". Bottom of Hole at 17.5". Bottom of Hole at 17.5". SAMPLES (LASSIFED IN ACCORDANCE WITH ASTIM D-AMB UNLESS OTHERWISE NOTED. CONCEING SOIL NON-COMENCE		11/2 11/2	7	S1	0 - 2	12	155.7	Top 3" 1	OPSOIL.			
ROD=90 C2 13 - 17.5 52 Seek Each Intercent page digiting 49 Net Seek With gray	_	· ` .	8					(.25 - 2')	POORLY GR	ADED SAND (SP);	mostly fine sand	trace silt, brown, moist.
Section Sect	-	• • f	⊿ 8									
Section Sect	-	• •										
Table Tabl	-		63	S2	4 - 6	16	152.0	WELL	RADED SAN	D WITH GRAVEL (S	SW): fine to coars	se sand some gravel
150.0 GRANITE: loosing water at 8.5 ft, probable sand seams. Probable boulder.	-5		49		4-0	10		trace sil	t, brown, wet.	D WIIII OIVWEE (C	, inic to court	oc dana, donne graver,
RQD=90 C2 13 - 17.5 52 144.0 GRANITE: hard, fresh, joints spaced 4 - 44*, joints angled at ~0 degrees, white and black with gray.	L	**************************************	100/			00	150.0	CDANIT	·			
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RQD=90 C2 13 - 17.5 52 144.0	L											
RQD=90 C2 13 - 17.5 52 144.0 GRANITE; hard, fresh, joints spaced 4 - 44", joints angled at ~0 degrees, white and black with gray. Bottom of Hole at 17.5'. Bottom of Hole a	40							Break th	rough at 9 ft, I	hit rock again at 12 f	t.	
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black with gray. 138.5	-		DOD-0	C2	13 - 17.5	52		GRANIT	E; hard, fresh	, joints spaced 4 - 44	4", joints angled	at ~0 degrees, white and
Bottom of Hole at 17.5'. Page 1: 0-35 feet. Each subsequent page displays 40 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D_2488 UNLESS OTHERWISE NOTED.	-		RQD=9	00				black wi	th gray.	•		•
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Bottom of Hole at 17.5'. Bottom of Hole at	L	Ta The										
- 25 - 35 - 36 - 30 - 30 - 30 - 30 - 30 - 30 - 30 - 30	L		_				138.5					
- 25 - 35 - 36 - 30 - 30 - 30 - 30 - 30 - 30 - 30 - 30								Pottom	of Holo at 17 F	:·		
25 -35 -36 -37 -38 -38 -39 -38 -39 -39 -30 -30 -30 -30 -30 -30 -30 -30 -30 -30	20							Вошот	oi i iole at 17.5).		
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0 - 2								NTS Au			Undisturbed	Jar Bag
0 - 2 VERY SOFT 0 - 4 VERY LOOSE < 10% TRACE 15 - 25% SOFT 5 - 10 LOOSE 15 - 25% LITTLE SOME STIFF STIFF 31 - 50 DENSE DENSE 50 - 100% MOSTLY SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY. REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY. NES - 003					-					C (%) and Blow Cou	ınts (P)-Piston	Sample (JS) Sample (B)
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				51 +	/ERY DENSE					TANALO I OK ADDITIONAL		INES - 003

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		O OF DR		OONT			R READIN	GS	DRILL RIG	ATV D-50	DATUM	NGVD 29
			g w/Casing	n D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety		N 2858123
35.5		Rock Co		_	5/13/2010		10		letion (In Casing)			E 765304
36		rminated									DATE STAR	
											DATE END	5/13/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S	
		5 7 10 11	S1	0 - 2	10			GRADED SANI moist, FILL.	O WITH GRAVEL	(SW); fine to coars	se sand, little	fine gravel,
5		21 11 10 8	S2	4 - 6	17		SIMILAF	R TO S1.				
10		26 19 21 30	\$3	9 - 11	15	149.0	POORL	Y GRADED SA	AND (SP); mostly	medium sand, ligh	t brown, mois	t.
15		23 20 19 27	S4	14 - 16	17	144.0	SILTY (CLAY (CL); slig	htly-plastic clay, s	ome silt, grayish-b	rown, wet.	
20	_	18 21 16 21	S5	19 - 21	18		SIMILAF	R TO S4.				
25		23 21 23 21	S6	24 - 26	6	134.0	little fine		silt, grayish brown	O GRAVEL (SW-SM , wet.	И); fine to coa	rse sand,
30		46 42 50 49	S7	29 - 31	8			GRADED SANI gravel up to 1.5		(SW); fine to coars	se sand, some	e fine to
-35	Page 1:	11 0-35 feet. E	S8	34 - 35.25			WELL G			O GRAVEL (SW-SM		
						ATIVE				LEGEND		
COH LOWS	HESIVE SO		NON-COHE	DENSITY	PROP	ORTIONS OMPONENTS	S Aug	mple and	sk Core (RC) RQD (%) Sample (S	on Undisturbed (V)-Shelby Tube,	Jar Sample	Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30	VER S MEDIU 5 S 0 VER	Y SOFT SOFT JM STIFF STIFF Y STIFF	0 - 4 5 - 10 11 - 30 31 - 50	VERY LOOSE LOOSE EDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRACE LITTLE SOME MOSTL	REI Y SU	FER TO THE SHEE	T ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	Counts (P)-Piston	S NES	6 - 004

					PROJE								
	A		B	S	LOCATI OWNER			aston, MA ay Transportation Authority	BORING	NES - 004			
					JOB NU		E2347		NO.	SHEET 2 OF 2			
DEPTH	STRATA SYMBOL	SAMPLE	E SAI	MPLE	DEPTH (ft)	REC.	ELEV.	FIELD CLASSIFICATION	ON AND REMARKS				
(ft)		DATA		NO.	(ft)	(in)/(%)	123.0						
-		52 100 RQD	<u>)/3</u> " (C1	35.5 - 36	3	123.0	some fine gravel, trace silt, grayish-brown, GRANITE; very hard, fresh, single vertical f	wet, possible GL/ racture, white an	ACIAL TILL. d black.			
-		NQD	_0						·				
-								Bottom of Hole at 36'.					
-								Unable to complete the rock core due to a	siit blow in and be	ent casing.			
-40													
-													
-													
-45													
.													
-													
-													
-													
-50													
-													
-													
-55													
-													
-													
-													
-													
-60													
-													
-													
-65													
-													
-													
-													
-													
-70													
-													
-													
	Page 1:	0-35 feet. E	Each subs	sequent	page displays	40 feet.		SAMPLES CLASSIFIED IN ACCORDANCE		NLESS OTHERWISE NOTED.			
СОН	IESIVE SC	IL	NON-0	COHESI	IVE SOIL		ATIVE ORTIONS		GEND				
BLOWS/I	FT CONS	ISTENCY	BLOWS/F	FT [DENSITY	OF SOIL CO		(AS) REC (%) and Blow Cour	Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS) Bag Sample (B)			
0 - 2 3 - 4		Y SOFT OFT	0 - 4 5 - 10		RY LOOSE LOOSE	< 10% 15 - 25%	TRAC	E per 6 REC (III)	, , , , , , , , , , , , , , , , , , , ,				
5 - 8 9 - 15	MEDIU S	JM STIFF TIFF	11 - 30 31 - 50) MED	DENSE DENSE	30 - 45% 50 - 100%	SOME	REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF	BORING	NES 004			
16 - 30 30 +		Y STIFF ARD	51 +	VE	RY DENSE			SYMBOLOGY.	NO.	NES - 004			

					PROJE			Coast Rail	LOT DOI			NICO		^-	<u> </u>
	A		P	2 10	LOCAT			Easton, MA			BORING	NES	- 0	05	OW
					OWNE				ortation Author	ority	NO.		ırr	1.05.1	1
10.00	-o-c-	T - ·			JOB NU		E2347			DDU : ==				1 OF 1	l
	ECTOR METHOI				CONTR		NH Bo		G S	DRILLER DRILL RIG	S. Hooley	ELEVATION)N	158	
		sh Borin		ina	ח	GROUN ATE/TIME		R READIN	REMARKS	SPT HAMMER	ATV CME - 550 140 lb Safety	DATUM GRID	N	28578	
17		Rock Co	•	ıııy		7/8/2010	-	17.5		ng Well Reading	1 TO ID Galety	COORD	E	76528	
27		minated				9/12/2011		15.5		ng Well Reading		DATE STA		5/12/	
												DATE EN		5/12/	
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	E SAMI		DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK				
-		⁴ 3 ₂ 3			0 - 2 4 - 4.33	17	154.0		, ,	nostly fine sand, littl	·			L.	
-5 - - - - -10		□ 120/3'			8 - 8.25	0		NO REC	, ,		, g				
- - 15 -		26 28 25 94	S4	4	13 - 15	8	145.0			AVEL WITH SAND grayish brown, wet.	(GW); fine to coars	se gravel u	o to 2	", some	e
- - 20		RQD=	56 C	1	17 - 22	50	141.0 =	GRANIT weather	E; hard, joint ng, white and	s spaced 1 - 14", jc I black with gray.	oints angled at ~0 -	10 degrees	s, slig	ht	
- - 25		RQD=	68 C:	2	22 - 27	54		SIMILAF	R TO C1; joint	ts spaced 3 - 35".					
- - 30 -		_					131.0 -	Bottom (of Hole at 27'.						
_ - -35	Page 1:		Each subse		age displays	REL	ATIVE		SAMPLES CLA	ASSIFIED IN ACCORDAN	NCE WITH ASTM D-2488 LEGEND	UNLESS OTH	ERWIS	E NOTEI	D.
							ORTIONS	rs E Aug	ger Ro	ock Core (RC) Split-Spoo		Jar Sample	Γ,	Bag	
BLOWS		ISTENCY			NSITY			Sai (AS	nple an	d RQD (%) Sample (\$ EC (%) and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	X	Sample (B)	
0 - 2 3 - 4 5 - 8 9 - 1! 16 - 30	S MEDIL 5 S 0 VER	Y SOFT OFT JM STIFF TIFF Y STIFF ARD	0 - 4 5 - 10 11 - 30 31 - 50 51 +	MEDIU DI	Y LOOSE OOSE IM DENSE ENSE Y DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRAC LITTL SOM MOST	E REI	SCRIPTION AND	per 6" RE ET ENTITLED "KEY TO CLASSIFICATION OF ERIALS" FOR ADDITIONA	ROPINI	G NES	- 0	05 C)W

						_		EST BOR	KING				
_				PROJE		+	Coast Rail			PODING	NIE		വര
			RS	LOCAT			Easton, MA	ortation Author	rits /	BORING	INE	<u>.</u>	- 006
								ortation Author	ity	NO.	SI	HEET	1 OF 1
NCD	ECTOR	T. Telesc		JOB NU		NH Bo			DDILLED	C Knight			1
		D OF DRILI		CONTR			ER READIN	GS	DRILLER DRILL RIG	C. Knight ATV D-50	ELEVATI DATUM	OIN	163 NGVD 29
		ash Boring		D/	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2857666
5.5		Rock Core			5/17/2010		3.5		tion (Casing pulled		COORD	E	765357
3.5 10.5		rminated					0.0	Span compie	active (Cacing Pane)	<u> </u>	DATE ST		5/17/10
10.5	10.	mmatou									DATE EN		5/17/10
FPTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			EIELD CLASSIEIC	ATION AND REMARK			
(ft)	STRATA SYMBOL	DATA	NO.	(ft)	(in)/(%)				I ILLD CLASSII IC.	ATION AND INLINARIA	3		
	0 0	8 13 14	S1	0 - 2	10		SILTY S brown, i		e to coarse sand,	some non-plastic s	silt, trace fi	ne gra	avel,
		□ 14											
	Ψ•	7	S2	3 - 5	10	160.0	POORI	Y GRADED SA	AND (SP): mostly	fine sand, light bro	wn moist		
		9	02	3-3	10		1 OOKL	TOTABLE OF	AIND (OF), MOSHY	inic sand, light bro	wii, iiioist.		
5	• .	16 45											
•			C1	5.5 - 10.5	60	157.5	GRANIT	ΓF: hard_ioints	snaced 2 - 18" ic	oints angled at ~15	- 30 degre	ام دا	inht
		RQD=78					weather gray wit	ing, zone of m	oderate to severe	weathering at 9.5 -	10 ft, vert	ical fr	actures,
10						450.5							
		_				152.5							
							Bottom	of Hole at 10.5	j'.				
15													
15													
20													
25													
30													
35			1										
	Page 1:	0-35 feet. Each	n subsequen	t page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	HERWIS	E NOTED.
		DIL I	NON-COHE	SIVE SOIL		ATIVE				LEGEND			
	HESIVE SO				OF SOIL CO	ORTIONS OMPONEN	NTS Au Sa	iger Roc	ck Core (RC) Split-Spool		Jar Sample	Γ	Bag Sample (B)
COI		UOTENIS: (=		DENSITY			Sa (As		RQD (%) Sample (\$ and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston	(JS)	/X	Sample
COI	S/FT CONS		OWS/FT					-/	Der 6" DE	C. (in)	_	Ľ.	у (в)
COI _OWS 0 - 2	6/FT CONS	RY SOFT	0 - 4 V	ERY LOOSE	< 10% 15 - 25%	TRA	CE	_	per 6" RE	C (in)		·	<u>Л</u> (в)
COI _OWS 0 - 2 3 - 4 5 - 8	6/FT CONS	RY SOFT SOFT 5 UM STIFF 1	0 - 4 V 5 - 10 1 - 30 ME	ERY LOOSE LOOSE DIUM DENSE	15 - 25% 30 - 45%	LITT	CE LE ME RE	FER TO THE SHEE	per 6" RE	C (in)	_		
COI -OWS 0 - 2 3 - 4	S/FT CONS 2 VER 4 S 8 MEDIU 15 S	RY SOFT SOFT 5 UM STIFF 1 STIFF 3	0 - 4 V 5 - 10 1 - 30 ME 1 - 50	ERY LOOSE LOOSE	15 - 25%	LITT	CE TLE RE TLY SU	FER TO THE SHEE	per 6" RE	ROPINI	- S NE	 ES -	· 006

					PROJE		South	n Coast Rail				NEO 007
			B	3	LOCATI			Easton, MA			BORING	NES - 007
					OWNER				ortation Author	rity	NO.	SHEET 1 OF 1
INSDI	ECTOP	T. Tele	2800		JOB NU CONTRA		E234			DRILLER I	D. Dunklee	ELEVATION 158
			RILLING	\rightarrow	CONTRA			ER READIN	GS		TR D-90	DATUM NGVD 29
			ng w/Cas	ina	D/	ATE/TIME		DEPTH(ft)	REMARKS		40 lb Auto	GRID N 2857863
9		rminated						, ,		,		COORD E 765342
												DATE START 5/13/10
				\dashv								DATE END 5/13/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA	. NO		DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	5
		12 12 11	S1		0 - 2	6			RADED SANI	D (SW); fine to coars	se sand, trace fin	e gravel, brown, moist,
<u> </u>		111						FILL.				
<u> </u>		∐ 10	0									
-												
-		8	S2	,	4 - 6	22		POORL	Y GRADED S	AND (SP): mostly fir	ne sand trace fin	e gravel, light brown,
-5		8 5 12 2	02		4-0			moist, p	ossible FILL.	THE (OF), MOSHY III	ic dana, trade iii	o gravor, right brown,
-		2:	2									
L							151.5	Possible	bedrock enco	ountered at 6.5 ft, ro	ler bit to 9 ft.	
L												
L							149.0					
10							143.0					
- 10								Bottom	of Hole at 9'.			
<u> </u>												
-												
-												
- 15												
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-30												
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-												
-35												
	Page 1:	0-35 feet.	Each subsec	luent pag	ige displays		A T ! : -		SAMPLES CLA			UNLESS OTHERWISE NOTED.
COH	HESIVE SC	DIL	NON-CC	HESIVE	SOIL	PROP	ATIVE ORTIONS	AUTO E AUG	ger E Roo	ck Core (RC) Split-Spoon	EGEND Undisturbed	▼ Jar
BLOWS	/FT CONS	ISTENCY	BLOWS/FT	DEI	NSITY	OF SOIL CO	OMPONE	NTS Aug	nple and	I RQD (%) Sample (SS)	unts (U)-Shelby Tube, (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2 3 - 4		Y SOFT SOFT	0 - 4 5 - 10		LOOSE	< 10% 15 - 25%	TRA	CE	_	per 6" REC (i	n) —	
5 - 8	MEDI	JM STIFF	11 - 30	MEDIUN	M DENSE	30 - 45%	SO	ME REI	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF	BORING	<u></u>
9 - 19 16 - 30	0 VER	Y STIFF	31 - 50 51 +		ENSE / DENSE	50 - 100%	MOS	SUI		RIALS" FOR ADDITIONAL	NO.	NES - 007
30 +		IARD									INO.	

				DDQ 15	CT			E21 BOK	AING				
				PROJE			Coast Rail Easton, MA			BORING	NE	<u>S</u> _	800
			BS	OWNE				ortation Author	ritv	NO.	INL	<u> </u>	000
					JMBER	E2347					SH	EET ²	OF 1
INSP	ECTOR	T. Teles	sco		RACTOR	NH Boi			DRILLER	D. Dunklee	ELEVATIO	N	154
	METHO	OF DRI	ILLING		GROUN	IDWATE	R READIN	GS	DRILL RIG	TR D-90	DATUM		NGVD 29
			g w/Casin	-	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Auto	GRID		2858115
16	Ter	minated			5/13/2010		3.5	Upon Comp	letion (In Casing)		COORD	E .	765393
											DATE STA		5/13/10
											DATE END)	5/13/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPL NO.	.E DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	3		
		12	S1	0 - 2	16		WELL	RADED SANI) (SW): fine to co:	arse sand, trace fin	e aravel bro	own l	=11 1
		22	31	0-2	'0		WLLL (DIVADED OAN	5 (0vv), iiile to coe	arse saria, trace in	c graver, bre	Ovvii, i	ILL.
		12 22 27 14											
		_				150.0							
_	• •	9	S2	4 - 6	20	150.0	POORL	Y GRADED SA	AND (SP); mostly	medium sand, brow	vn, moist.		
-5	· · ·	9 11											
	• • • •	_											
	•												
	• •												
	•	5	S3	9 - 11	12	145.0	POORI	V GRADED SA	AND (SD): moetly	medium sand, trac	e non-nlaeti	c eilt	aravieh
10	• •	5	33	9-11	'2		brown, v		AIND (OI), IIIOSIIY	medium sand, trac	e non-piasti	C Siit,	grayisii
	 • ↑ •	5 4 5											
	••												
	•												
	<u>````</u>	5	S4	14 - 16	10	140.0	WELL C	RADED SANI	O WITH GRAVEL	(SW); fine to coars	e sand, son	ne fin	e to
15		21 23 24					coarse (gravel up to 2",	gray, wet.				
		24				138.0							
							Bottom	of Hole at 16'.					
20													
20													
25													
30													
35													
	Page 1:	0-35 feet. Ea	ach subsequ	ent page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHE	RWISE	NOTED.
	.===:				DEI	ATIVE				LEGEND			
COI	HESIVE SO	IL	NON-COH	IESIVE SOIL	PROP	ORTIONS		ger = -	de Cons (DO)		lor.	K 3	Pog
LOWS	/FT CONS	ISTENCY E	BLOWS/FT	DENSITY	OF SOIL C	OMPONENT	S Au Sa (As	mple and	k Core (RC) RQD (%) Sample (S and Blow	SS) (U)-Shelby Tube.	Jar Sample (JS)	M	Bag Sample (B)
0 - 2		Y SOFT		VERY LOOSE	< 10%	TRAC	E	-, EL REC	per 6" RE		(30)	Ľ	(1)
		OFT JM STIFF	5 - 10 11 - 30	LOOSE MEDIUM DENSE	15 - 25% 30 - 45%	LITTL	_ KE		T ENTITLED "KEY TO		_		
3 - 4 5 - 8		ANTO THEFT	11 - JU IIV	ULDION DENOE	JU - 1 370	1 3011	- I DE	CODIDTION AND O	LACCIFICATION OF	10000	~ I		
3 - 4 5 - 8 9 - 1 16 - 3	5 S	TIFF Y STIFF	31 - 50 51 +	DENSE VERY DENSE	50 - 100%	MOST			LASSIFICATION OF RIALS" FOR ADDITIONA	AL BORING NO.	j NI⊏	S _	800

INSPECTOR METHOD Was 16 Term DEPTH STRATA (ft) SYMBOL	A. Barbetta DF DRILLING DF Boring w/Casin inated SAMPLE SAMPLE	JOB NI CONTF	TION R JMBER RACTOR	North Mass. E2347 NH Bo	7101 oring	ortation Author	ity	BORING NO.	SH	EET	009
INSPECTOR METHOD Was 16 Term DEPTH STRATA (ft) SYMBOL	A. Barbetta DF DRILLING I Boring w/Casin inated	OWNE JOB NI CONTF	R JMBER RACTOR GROUN	Mass. E2347 NH Bo	Bay Transport 7101 Oring			NO.	SH	EET	1 OF 1
INSPECTOR METHOD Was 16 Term DEPTH STRATA SYMBOL	A. Barbetta DF DRILLING I Boring w/Casin inated	JOB NI CONTF	JMBER RACTOR GROUN	E2347 NH Bo	7101 oring	ortation Author					
METHOD Was 16 Term DEPTH STRATA (ft) SYMBOL	OF DRILLING n Boring w/Casin inated	CONTF	RACTOR GROUN	NH Bo	oring		חחוורם	1.04-1			
METHOD Was 16 Term DEPTH STRATA SYMBOL	OF DRILLING n Boring w/Casin inated	g D	GROUN				IDRIIIER	I J. STOKES	ELEVATIO	N	159
16 Term DEPTH STRATA (ft) SYMBOL	n Boring w/Casin inated				ER READIN	GS	DRILL RIG	TR D-120	DATUM		NGVD 29
DEPTH STRATA SYMBOL	inated		\frown \vdash		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2858362
(ft) SYMBOL	CAMDIE CAMDII		5/28/2010		5	Upon Comp	letion (In Casing)		COORD	Е	765433
(ft) SYMBOL	CAMPLE CAMPLE								DATE STA	RT	5/28/10
(ft) SYMBOL	CAMBLE CAMBLE								DATE END)	5/28/10
()			REC.	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S		
	DATA NO.	(ft)	(in)/(%)								
	12 6 3 3	0 - 2	4		SILTY S	SAND (SM); fin	e to coarse sand,	little silt, dark brow	n, dry, tops	oil.	
	3										
	3										
,	30 S2	4 - 6	5	155.0	WELL	PDADED CANI		(SW); fine to coars	o cond con	no fir	o to
-5	27	4-0	5				t, light brown, wet		se sariu, sui	116 111	le io
	30 S2 27 30 21										
0											
0 0	12 S3 13 16 21	9 - 11	18	150.0	WELL G	RADED SANI	O (SW); fine to coa	arse sand, trace sil	t, light brow	n, we	t.
-10	13 16										
	21										
0 0											
0											
0 0				145.0							
45 6 9	11 S4	14 - 16	16	145.0			AND WITH SILT (SP-SM); mostly fin	e sand, trac	e silt	light
15 • • • • • • • • • • • • • • • • •	11 8				brown/g	ray, wet.					
	0			143.0							
					Dettern	of I lolo of 101					
					BOLLOTTI	of Hole at 16'.					
-20											
25											
30											
35											
	35 feet. Each subseque	ent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHE	RWISI	NOTED.
				ATIVE				LEGEND			
	NON-COH	ESIVE SOIL		ATIVE PORTIONS							
COHESIVE SOIL		DENSITY	OF SOIL C			mple and	sk Core (RC) RQD (%) Sample (S	(U)-Shelby Tube,	Jar Sample	X	Bag Sample (B)
	TENCY BLOWS/FT				(AS	P) REC	C (%) and Blow		(JS)	V \	(B)
		VERY LOOSE	< 10%	TRA		_	per 6" RE	3 (in) —	_		
LOWS/FT CONSIS 0 - 2 VERY: 3 - 4 SOI	SOFT 0 - 4 T 5 - 10	VERY LOOSE LOOSE	15 - 25%	LITT	CE DE	FER TO THE SHEE	T ENTITLED "KEY TO	J (in)			
LOWS/FT CONSIS	SOFT 0 - 4 FT 5 - 10 STIFF 11 - 30 M	VERY LOOSE		LITT	CE LE REI	SCRIPTION AND C		BORING	- G NIC		009

					PROJE		South	n Coast Rail				NIEO 044			
			B	7	LOCAT			Easton, MA			BORING	NES - 011			
					OWNER				ortation Author	rity	NO.	SHEET 1 OF 1			
INISDI	ECTOR	T. Tele	2800		JOB NU	<u>IMBER</u> ACTOR	E234 NH B			DRILLER I	D. Dunklee	ELEVATION 165			
		D OF DF			CONTR			ER READIN	GS		TR D-90	DATUM NGVD 29			
			ng w/Cas	ing	D/	ATE/TIME		DEPTH(ft)	REMARKS		40 lb Auto	GRID N 2857799			
7	1	Rock C	-									COORD E 765403			
12	Те	rminated	d									DATE START 5/13/10			
												DATE END 5/13/10			
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA	NO		DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	5			
		2	S1		0 - 2	20		POORL	Y GRADED S	AND (SP); mostly fir	ne sand, brown, r	noist.			
- - - - - - - - - - - - - - - - - - -		22 33 33 70 120 RQD=	S2 0/2"		4 - 5.16 7 - 12	18	160.0	Top of b	edrock at 5 ft,	AND (SP); mostly m roller bit to 7 ft.					
- - - - - - - - - - - - - - - - - - -															
-35	Page 1	. ∩-35 foot	Fach subsec	uent na	age displays	40 feet		I	SAMDIES CLA	SSIFIED IN ACCORDANCE	= WITH ASTM D 2400	UNLESS OTHERWISE NOTED.			
COF	HESIVE SC		NON-CC			REL	ATIVE		OAIVIFLES GLA		EGEND	GIVELOG OTTERWISE NOTED.			
				1		PROP OF SOIL C	ORTIONS	NTS Au	ger Roo	ck Core (RC) Split-Spoon	Undisturbed	Jar Bag			
BLOWS			BLOWS/FT		ENSITY					Sample (SS) and Blow Coper 6" REC (i	unts (P)-Piston	Jar Sample (JS) Bag Sample (B)			
0 - 2 3 - 4		RY SOFT SOFT	0 - 4 5 - 10		Y LOOSE OOSE	< 10% 15 - 25%	TRA	TIF			,				
5 - 8 9 - 19 16 - 30 30 +	MEDI 5 S 0 VER	UM STIFF STIFF RY STIFF HARD	11 - 30 31 - 50 51 +	MEDIU Di	JM DENSE ENSE Y DENSE	30 - 45% 50 - 100%	SO MOS	ME DE:	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING NO.	NES - 011			

				PROJ		Soutl	n Coast Rail				NEO 044A
			BS	LOCA			Easton, MA			BORING	NES - 011A
								ortation Author	rity	NO.	SHEET 1 OF 1
INICO	ECTOR	T. Tele:	800		UMBER RACTOR	E234 NH B			DRILLER J	J. Stokes	ELEVATION 162
		D OF DR		CONT			ER READIN	GS		ATV CME - 550	DATUM NGVD 29
			g w/Casir	ıq [DATE/TIM		DEPTH(ft)			40 lb Safety	GRID N 2857799
7	1	Rock Co	-							•	COORD E 765403
20	Те	rminated									DATE START 5/26/10
											DATE END 5/27/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPL NO.	E DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICATI	ION AND REMARK	S
					() ()						
L	. * .										
L	• •										
	• •						Boring o	offset from NES	S - 011 and continue	d as NES - 011 <i>F</i>	١.
	• •										
	• •										
- 5	• •					156.5	Top of r	ook at E E ft m	allar bit to 7 ft		
<u> </u>							100 011	ock at 5.5 ft, ro	oller bit to 7 it.		
_		T	C1	7 - 11	20		Granite	Boulder			
-	na jiha										
-	1. "										
-10											
F		120/3"	C4	14 44 6			NO DEC	COVERY			
L	100	120/3	-	11 - 11.2				COVERY.			
		_	C2	12 - 13			Granite				
L		120/1"	S2	13 - 13.0	0 8		NO REC	COVERY; rolle	r bit to 15 ft.		
— 15		_									
15		RQD=7	70 C3	15 - 20	48		GRANIT	E; very hard,	joints spaced 2 - 12", ices, gray with black	, joints angled at	~0 - 15 degrees, fresh
	and the second						and sind	oun joint suna	ices, gray with black	and write.	
<u> </u>	na jiha										
†	1. Canal 1. C										
-20	4. 4	_				142.0					
-							Pottom	of Hole at 20'.			
-							Вошот	oi riole at 20 .			
-											
F											
-25											
-											
L											
L											
_											
-30											
_											
<u> </u>											
<u> </u>											
-35	Dec 1	0.25 for 5	ach cub	ont ness dissi	10 40 foot	1	1	CAMPLES OF	COLUMN ACCOUNTS	- VALITAL A OTAL D. O.C.	LINII EGG OTHEDIANGE NOTES
	rage 1:	u-so reet. E	acıı subsequ	ent page display				SAIVIPLES CLA			UNLESS OTHERWISE NOTED.
COF	HESIVE SC	DIL	NON-COF	ESIVE SOIL	1	LATIVE PORTIONS			_	EGEND	■ las □ □
BLOWS	/FT CONS	SISTENCY E	BLOWS/FT	DENSITY	OF SOIL O	COMPONE	NTS Au	mple and	ck Core (RC) I RQD (%) C (%) Split-Spoon Sample (SS) and Blow Cou	Undisturbed (U)-Shelby Tube, ints (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2		Y SOFT	0 - 4	VERY LOOSE	< 10%		ACE	, RE	per 6" REC (in	n)	(B)
3 - 4 5 - 8	MEDI	SOFT UM STIFF		LOOSE MEDIUM DENSE		so	ME RE		ET ENTITLED "KEY TO CLASSIFICATION OF	DODIN!	
9 - 1: 16 - 3:	0 VER	STIFF Y STIFF	31 - 50 51 +	DENSE VERY DENSE	50 - 100%	MOS	SILY SU		RIALS" FOR ADDITIONAL	BORING	NES - 011A
30 +	H	IARD								NO.	

					PROJEC	CT	South	Coast Rail					_
					LOCATI	ON	North	Easton, MA			BORING	NES - 01	2
J					OWNER				ortation Author	rity	NO.		
					JOB NUI	MBER	E234	7101				SHEET 1 OF 1	
INSP	ECTOR	T. Tele	sco		CONTRA		NH B			DRILLER	I. Stokes	ELEVATION 166	
	METHO	O OF DR	ILLING					ER READIN	GS		TR D-120	DATUM NGVD	
		ash Borin	g w/Cas	ing	DA	TE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER 1	40 lb Safety	GRID N 28579	
88	Те	rminated										COORD E 76543	
												DATE START 5/27/1	
												DATE END 5/27/1	10
	STRATA SYMBOL	SAMPLE DATA			DEPTH	REC.	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	3	
(ft)	STIVIBUL	DATA	NO	,. <u> </u>	(ft)	(in)/(%)							
		6	S1	1 c).33 - 1.5	7			ravel fill.	D (C)A(): fine to com		a amazzal limba bunazza	
		8 100						moist, F		D (SW), line to coars	se sand, trace in	e gravel, light brown,	
-		100	,0						encountered.				
-	\bowtie												
L		20			4 505		162.0	\A/ELL 6	DADED CAN		MA(). 6: 4		
_5		28 44	S2	<u>-</u>	4 - 5.25	9		coarse o	iravel up to 1 !	5", grayish-brown, w	et pieces of gran	e sand, some fine to	
	80010703	100	/3"				160.5	_		ck at 5.5 ft, got very			
								100016	pparent beard	ck at 5.5 it, got very	riard at 0 it, ione	i bit to o it.	
_													
_							158.0						
F													
-10								Bottom	of Hole at 8'.				
_													
-													
L													
<u> </u>													
'0													
-													
F													
L													
-20													
_													
-													
F													
-25													
<u> </u>													
<u> </u>													
F													
-30													
_													
<u> </u>													
-													
F													
—35													
	Page 1:	0-35 feet. E	ach subsec	quent pa	age displays 4	10 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	WITH ASTM D-2488	UNLESS OTHERWISE NOTED).
	•				·	DEI	ATIVE				EGEND		
COF	HESIVE SC	DIL	NON-CC	HESIV	ESOIL		ATIVE ORTIONS		=			— 1 —	
BLOWS	/FT CONS	SISTENCY E	BLOWS/FT	DE	ENSITY	OF SOIL C	OMPONE		nple and	ck Core (RC) Split-Spoon Sample (SS) and Blow Cou	Undisturbed (U)-Shelby Tube,	Jar Sample (JS) Bag Sample (B)	
0 - 2		Y SOFT	0 - 4		Y LOOSE	< 10%	TRA		REC	and Blow Couper 6" REC (in	ints (P)-Piston	(JS) [/] (B)	
3 - 4	8	OFT	5 - 10	L	OOSE	15 - 25%	LITT	LE BE	ER TO THE SHEE	ET ENTITLED "KEY TO			
5 - 8 9 - 1	5 S	JM STIFF STIFF	11 - 30 31 - 50	D	JM DENSE ENSE	30 - 45% 50 - 100%	SOI MOS	TIV DE	SCRIPTION AND C	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	NES - 012	,
16 - 30 +		Y STIFF IARD	51 +	VER	Y DENSE				MBOLOGY.	LO I OKADDITIONAL	NO.	INEO - 012	

					PROJEC	CT	South	n Coast Rail					
			D		LOCATI			Easton, MA			BORING	NES -	- 013
J	A		D		OWNER	}	Mass	.Bay Transp	ortation Autho	rity	NO.		
					JOB NU		E234	7101				SHEET	1 OF 1
	ECTOR				CONTRA		NH B			DRILLER	J. Stokes	ELEVATION	159
I	METHO	OF DR	RILLING	3		GROUN	1DWAT	ER READIN		DRILL RIG	TR CME 75	DATUM	NGVD 29
	Wa	sh Borir	ng w/Ca	asing	DA	ATE/TIME	<u>:</u>	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID N	2858205
16	Tei	minated										COORD E	765495
												DATE START	5/10/10
												DATE END	5/10/10
	STRATA SYMBOL	SAMPLI DATA		MPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
		42 68 72 87		S1	0 - 2	17		POORL	Y GRADED S.	AND WITH GRAV	EL (SP); mostly fin	e sand, some cr	ushed
F	\bowtie	68						stone, tr	ace silt, browr	n, moist, FILL.			
F		8	1										
L	\bowtie												
							455.0						
	0	12 19 34 18	;	S2	4 - 6	22	155.0	POORL	Y GRADED S	AND (SP); mostly	fine sand, trace gra	avel, brown, mois	st.
-5	。 () °	34											
-	>	18	3										
L	0 0												
	Ι'												
	∘ O °												
_	000	56 94	;	S3	9 - 10.42	17		POORL	Y GRADED S	AND WITH GRAV	/EL (SP); mostly fir	ne to medium sa	nd, some
 10	, 0	94 100)/5"					gravel, b	orown, wet.				
L		100	3,0										
	$ \circ \bigcirc \circ$												
	00												
_	00												
-	 	21		S4	14 - 16	13	145.0	WFII G	RADED SAN	D WITH GRAVEI	(SW); fine to coars	se sand some di	ravel
- 15		23		⁰	14 - 10			brown, v		D WITH GIVIVEE	(OVV), fille to obtain	oc odna, odnic gi	lavoi,
L		21 23 43 62	2				143.0						
							143.0						
								Bottom (of Hole at 16'.				
-								Dottoin	or riole at 10.				
L													
-20													
Γ													
F													
F													
L													
25													
25													
<u> </u>													
F													
L													
L													
-30													
-													
L													
L													
<u> </u>													
-35								<u> </u>					
	Page 1:	0-35 feet. E	Each subs	sequent p	page displays 4	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
001	HESIVE SO	MI.	NON	COLIEST	VE SOII	REL	ATIVE				LEGEND		
	ILGIVE 3U	"L	NUN-	·COHESI\	VL SUIL		ORTIONS	NTS E AU	ger I P~	ck Core (RC) Split-Spoo	on Undisturbed	Jar 📝	7 Bag
BLOWS	/FT CONS	ISTENCY	BLOWS/	FT D	DENSITY	OF SOIL CO	JMPONE!	NTS Aug	mple and	d RQD (%) Sample (S C (%) and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston		Bag Sample (B)
0 - 2		Y SOFT	0 - 4		RY LOOSE	< 10%	TRA	CE		per 6" RE	C (in)	-	′′ د
3 - 4 5 - 8		JM STIFF	5 - 10 11 - 30		LOOSE IUM DENSE	15 - 25% 30 - 45%	LIT1 SOI	ME REI		ET ENTITLED "KEY TO		_	
9 - 1	5 S	TIFF	31 - 50	o c	DENSE	50 - 100%	MOS	STLY SUI	BSURFACE MATE	CLASSIFICATION OF RIALS" FOR ADDITIONA	$_{\scriptscriptstyle{AL}}$ \mid BORIN(G NES -	.013
16 - 30 +		Y STIFF IARD	51 +	VEF	RY DENSE				MBOLOGY.		NO.	140	010

				PROJE	.CT	South	n Coast Rail					
	A		DC	LOCAT			Easton, MA			BORING	NES -	- 014
			BS	OWNER	R	Mass	.Bay Transp	ortation Autho	rity	NO.		
				JOB NU		E234					SHEET	
		T. Teles		CONTR	ACTOR	NH B			DRILLER	J. Stokes	ELEVATION	166
	METHOE	OF DRII	LLING				ER READIN		DRILL RIG	ATV CME - 550	DATUM	NGVD 29
			g w/Casing	D/	ATE/TIME	Ξ	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID N	2858455
16	Ter	minated									COORD E	765544
											DATE START	5/28/10
							<u> </u>				DATE END	5/28/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
	\$ •	3	S1	0 - 2	15		POORL	Y GRADED S	AND WITH SILT A	AND GRAVEL (SP-	SM); mostly fine	sand,
- - - -5 -		36 54 22 34 42 38	S2	4 - 6	17	162.0	SILTY S		evel, trace silt, dry,	to coarse sand, so	ome fine to coars	e gravel,
10 		19 28 31 33	S3	9 - 11	15		SIMILAF	R TO S2; mois	st.			
-		7 16	S4	14 - 14.75	5 4		SIMII AI	R TO S2; wet.				
- 15		16 100/3	" 34	14 - 14.73		151.0				:1 to 10 ft		
L						150.0	Top of a	pparent beard	ock at 15 ft, roller b	οιτ το 16 π.		
_ _ 20 _ _							Bottom (of Hole at 16'.				
-25												
F												
L												
L												
_												
-30												
F												
L												
L												
<u> </u>												
- 35				<u></u>			<u></u>					
	Page 1:	0-35 feet. Ea	ich subsequen	nt page displays	40 feet.			SAMPLES CLA	ASSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
COH	HESIVE SO	ıL	NON-COHES	SIVE SOIL		ATIVE PORTIONS				LEGEND	_	
BLOWS	_	ISTENCY B		DENSITY	OF SOIL C	OMPONE	NTS Aug	mple and	ck Core (RC) d RQD (%) C (%) Split-Spot Sample (s and Blow per 6" RE	SS) (U)-Shelby Tube, Counts (P)-Piston	Jar Sample (JS)	Bag Sample (B)
0 - 2 3 - 4		Y SOFT OFT	0 - 4 VI 5 - 10	ERY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	ACE TIE			⟨"""		
5 - 8 9 - 19 16 - 3	MEDIU 5 S		11 - 30 31 - 50	DIUM DENSE DENSE ERY DENSE	30 - 45% 50 - 100%	SOI	ME DES	SCRIPTION AND OBSURFACE MATE	ET ENTITLED "KEY TO CLASSIFICATION OF RIALS" FOR ADDITIONA		G NES -	014
30 +		ARD	J VI	52,102			SYI	MBOLOGY.		NO.	0	

					PROJEC		South	Coast Rail				NIEO 045
	A		BS	<u>_</u>	LOCATI			Easton, MA			BORING	NES - 015
					OWNER				ortation Autho	rity	NO.	SHEET 1 OF 1
INICO	ECTOR	P. Cho	NII.		JOB NUI CONTRA		E234			DRILLER T	T. Pentacost	ELEVATION 173
		D OF DR			JUNTRA			ER READIN	GS		TV D-50	DATUM NGVD 29
<u> </u>			ng w/Casii	าต	DA	TE/TIME		DEPTH(ft)	REMARKS		40 lb Safety	GRID N 2857827
4		rminated		·9				()			, , , , , ,	COORD E 765511
												DATE START 5/10/10
								T				DATE END 5/10/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA			DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICATI	ON AND REMARK	3
		3	S1	(0 - 2	12		SANDY	SILT (ML); mo	ostly silt, some sand,	trace clay, trace	gravel, brown, moist.
- - - -5		4 4 6 50/1"	S2	4	- 4.08	0	169.0		COVERY; split	-spoon refusal, propa	able bedrock.	
F												
-10												
L												
L												
L												
45												
 15												
-												
-												
-												
-20												
L												
L												
L												
 25												
_												
-												
<u> </u>												
-												
-30												
F												
L												
L												
L												
_ 25												
—35 ———	Page 1:	0-35 feet. I	Each subsequ	uent page	e displays 4	0 feet.			SAMPLES CLA			UNLESS OTHERWISE NOTED.
COF	HESIVE SC	DIL	NON-CO	HESIVE S	SOIL		ATIVE ORTIONS				EGEND	
BLOWS	FT CONS	SISTENCY	BLOWS/FT	DEN	SITY	OF SOIL CO		NTS Au	nple and	ck Core (RC) Split-Spoon Sample (SS)	Undisturbed (U)-Shelby Tube,	Jar Sample (JS) Bag Sample (B)
0 - 2		Y SOFT	0 - 4	VERY L		< 10%	TRA		RERE	and Blow Cou per 6" REC (in	nts (P)-Piston	(JS) (B)
3 - 4 5 - 8	8	SOFT UM STIFF	5 - 10	LOC		15 - 25% 30 - 45%	LIT	TLE RE		ET ENTITLED "KEY TO		
9 - 15 16 - 30 30 +	5 S	STIFF STIFF SY STIFF HARD	31 - 50 51 +	DEN VERY [NSE	50 - 45%	MOS	TLY SU		CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING NO.	9 NES - 015

				PROJE	ECT	South	n Coast Rail					0.4.0
			DG	LOCAT			Easton, MA			BORING	NES -	- 016
			BS	OWNE	:R	Mass	.Bay Transp	ortation Autho	rity	NO.		
					UMBER	E234					SHEET	1 OF 1
		P. Cho		CONTE	RACTOR	NH B			DRILLER	J. Stokes	ELEVATION	160
<u> </u>		OF DR		\perp			ER READIN		DRILL RIG	TR CME 75	DATUM	NGVD 29
		,	g w/Casing	<u>g</u> D	ATE/TIME	Ξ	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID N	2858084
16	Ter	minated		-							COORD E	765543
											DATE START	5/10/10
											DATE END	5/10/10
	STRATA SYMBOL	SAMPLE DATA	NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
		12 19 14 8	S1	0 - 2	16			SAND (SM); r	mostly fine sand, s	ome silt, trace dec	ayed wood piece	s, dark
_		8										
L												
		_				156.0						
_	0	11 12 16 28	S2	4 - 6	24	156.0	POORL	Y GRADED S	AND WITH GRAV	EL (SP); mostly fir	e to medium sar	nd, little
-5	。 () °	16					fine grav	vel, brown, mo	ist.			
-	000	∠ 28	i									
L												
L	0											
	$[\circ \bigcirc]$					151.0						
		47 100/3	S3	9 - 9.75	7	151.0				(SW); fine to coars	se sand, some fir	ne to
-10		100/3	,				coarse (gravel, gray, w	et.			
-												
L												
L												
Γ	P b	28	S4	14 - 16	17		SIMILAF	R TO S3.				
- 15		28 35 46 52										
-	×	52	<u>.</u>			144.0						
L												
							Bottom	of Hole at 16'.				
-												
-20												
L												
L												
Γ												
<u> </u>												
-25												
ļ.												
L												
 												
-30												
L												
<u> </u>												
F												
-35						<u> </u>	<u></u>					
	Page 1:	0-35 feet. E	ach subseque	ent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
					DEI	LATIVE				LEGEND		
COF	HESIVE SO	iL	NON-COHE	ESIVE SOIL		PORTIONS	,		— - :::		_	7 -
BLOWS	/FT CONS	ISTENCY E	BLOWS/FT	DENSITY	OF SOIL C		NTS Aug	mple and	ck Core (RC) Split-Spool Sample (S	SS) (U)-Shelby Tube,	Jar Sample (JS)	Bag Sample (B)
0 - 2		Y SOFT		VERY LOOSE	< 10%	TRA		RERE	C (%) and Blow per 6" RE	Counts (P)-Piston	(JS)	y (B)
3 - 4	s	OFT	5 - 10	LOOSE	15 - 25%	LITT	TLE DE	FER TO THE SHE	ET ENTITLED "KEY TO			
5 - 8 9 - 1		JM STIFF TIFF	11 - 30 MI 31 - 50	EDIUM DENSE DENSE	30 - 45% 50 - 100%		IVIE DES	SCRIPTION AND O	CLASSIFICATION OF RIALS" FOR ADDITIONA	BORIN	G NEO	046
16 - 30 30 +	0 VER	Y STIFF ARD		VERY DENSE			501	MBOLOGY.	NALO FUR ADDITIONA	NO.	NES -	טוט
1 50'	''				1	1	1			1	I	

				PRO	JECT	South	n Coast Rail				
			D	LOC	ATION		Easton, MA			BORING	NES - 017
J			B		NER			ortation Author	rity	NO.	
				JOB	NUMBER	E234					SHEET 1 OF 1
		A. Barb		CON	TRACTOR					. Stokes	ELEVATION 175
1		OF DR					ER READIN			R D-120	DATUM NGVD 29
			g w/Casi	ng	DATE/TIN	1E	DEPTH(ft)	REMARKS	SPT HAMMER 1	40 lb Safety	GRID N 2858347
9	Ter	minated									COORD E 765603
											DATE START 5/28/10
						1					DATE END 5/28/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMP NO.		H REC. (in)/(%)	ELEV.			FIELD CLASSIFICATI	ON AND REMARK	3
- (10)		_		. ,) N/ELL 6	DADED 04111	D (O)A() E 1		
	0 0	5 10 12 12	S1	0 - 2	2 7		dry.	SRADED SANI	D (SW); fine to coars	e sand, trace sil	t, roots, orange-brown,
	0 0	12	,				u. y.				
	°	_ 12									
-	0 0										
_	~.Q.,	41	S2	4 - 6	3 16	171.0	WELL	DADED SANI	D WITH CDAVEL (S	M): fine to coars	e sand, some fine to
_5		41 47 46 51	32	4-6) 10		coarse	aravel. trace si	It, light brown, dry.	vv), fille to coars	e sand, some line to
L	$\langle \circ, \cdot, \cdot \rangle, \circ$	46 51						, ,	, , , ,		
Γ		_ 0.									
F						168.0	Top of a	pparent bedro	ck at 7 ft, roller bit to	9 ft.	
_							,				
L						166.0					
-10											
'0							Bottom	of Hole at 9'.			
-											
-											
_											
4.5											
- 15											
<u> </u>											
F											
_											
-20											
-											
_											
L											
Γ											
-25											
-						1					
L						1					
L						1					
						1					
Γ						1					
-30						1					
F						1					
L						1					
						1					
						1					
						1					
-35	Page 1.	0-35 feet ⊏	ach subsec	uent page disp	lavs 40 feet	1	1	SAMPLES CLA	SSIFIED IN ACCORDANCE	WITH ASTM D 2400	UNLESS OTHERWISE NOTED.
						ELATIVE		O, WII LEG OLA		EGEND	S. LEGO OTTENVIOL NOTED.
COF	HESIVE SC	IL	NON-CO	HESIVE SOIL	PRO	PORTIONS	s	ner = -			■ lar ■ Por
BLOWS	/FT CONS	STENCY E	BLOWS/FT	DENSITY	OF SOIL	COMPONE	NTS Au Sa (As	mple and	ck Core (RC) Split-Spoon Sample (SS) C (%) Split-Spoon Sample (SS) and Blow Court	Undisturbed (U)-Shelby Tube,	Jar Bag Sample (JS) (B)
0 - 2	VER	Y SOFT	0 - 4	VERY LOOS	SE < 10%	TRA		REC	C (%) and Blow Coul per 6" REC (in	nts (P)-Piston	M (9.9)
3 - 4	S	OFT	5 - 10	LOOSE	15 - 259	6 LIT	TLE DE	FER TO THE SHEE	ET ENTITLED "KEY TO		
5 - 8 9 - 1	5 S	IM STIFF TIFF	31 - 50	MEDIUM DEN DENSE	50 - 100		IVIE DE	SCRIPTION AND C	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	NES - 017
16 - 30 30 +		STIFF ARD	51 +	VERY DENS	SE			MBOLOGY.	LO I ON ADDITIONAL	NO.	INEO - UT/

					PROJE		South	n Coast Rail				NEO 040
			B	2 10	LOCAT			Easton, MA			BORING	NES - 019
							_		ortation Autho	rity	NO.	QUEET 4 OF 4
11100		D OF			JOB NU		E234			DD# 1 50		SHEET 1 OF 1
		P. Cho			CONTR	ACTOR	NH B	onng ER READIN	GS		Γ. Pentacost ATV D-50	ELEVATION 175 DATUM NGVD 29
-			ng w/Cas	eina	D/	ATE/TIME		DEPTH(ft)			40 lb Safety	DATUM NGVD 29 GRID N 2857857
7		rminated		ing		~1 L/ 111VIL	-	DEI III(II)	REWARKO	OF THE WINNER	40 ib calcty	COORD E 765574
			<u> </u>									DATE START 5/10/10
												DATE END 5/10/10
DEPTH	STRATA	SAMPL			DEPTH	REC.	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S
(ft)	SYMBOL	DATA	. NO).	(ft)	(in)/(%)						
		8 4	S	1	0 - 2	10		SANDY	SILT (ML); mo	ostly silt, some sand	, little gravel, trad	e clay, brown, moist.
		11	_									
-		′ 17	'									
-												
-		38	S	2	4 - 6	16	171.0	WELL	RADED SAN	D WITH GRAVEL (S	SW): mostly fine t	o medium sand, some
-5	. 6	38 47 60		-	4-0	10		fine to c	oarse gravel, t	trace silt, brown, moi	st.	o mediam dana, dome
-		12	20									
L							168.0					
		120/	/0" S:	3	7 - 7			Refusal	on probable b	edrock, offset boring	to NES - 019A.	
Γ.,								Bottom	of Hole at 7'.			
- 10												
_												
-												
-												
-												
- 15												
_												
L												
<u> </u>												
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L												
—35												
35	Page 1:	0-35 feet. I	Each subse	quent p	age displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
							LATIVE				EGEND	-
COF	HESIVE SC	DIL	NON-CO	OHESIV	'E SOIL	PROF	PORTIONS		ger F Roo	ck Core (RC) Split-Spoon		Jar 📝 Bag
BLOWS	/FT CONS	SISTENCY	BLOWS/FT	DE	ENSITY	OF SOIL C	OMPONE	NTS Au Sa (As	mple and	d RQD (%) Sample (SS) C (%) and Blow Cou	Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS) Sample (B)
0 - 2		Y SOFT	0 - 4		RY LOOSE	< 10%	TRA	ACE		per 6" REC (ii	n) (7, 130	— —
3 - 4 5 - 8	MEDI	SOFT UM STIFF	5 - 10 11 - 30	MEDIL	OOSE UM DENSE	15 - 25% 30 - 45%	SO	ME RE		ET ENTITLED "KEY TO CLASSIFICATION OF	DODIN!	
9 - 19 16 - 30		STIFF Y STIFF	31 - 50 51 +		DENSE RY DENSE	50 - 100%	MOS	SILY SU		RIALS" FOR ADDITIONAL	BORIN	i NES - 019
30 +		IARD							*IDOLOG1.		NO.	

				DD0 :-	ОТ.			E21 BOF	MING				
_				PROJE			Coast Rail			BORING	NES		019A
			BS	LOCAT OWNE			Easton, MA	ortation Author	rity	NO.	INES	, –	UIJA
				IOP NI	JMBER	E234		Ortation Author	iity	- NO.	SHE	FT ·	I OF 1
INISDI	FCTOR	P. Chou			ACTOR	NH Bo			DRILLER	J. Stokes	ELEVATIO		175
		D OF DRIL	LING	CONTI		-	ER READIN	GS	DRILL RIG	TR CME 75	DATUM		NGVD 29
		ash Boring		n D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID		2857857
9		Rock Cor			5/10/2010		3		letion (In Casing)	1	COORD		765574
14		rminated									DATE STA		5/10/10
											DATE END		5/10/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	3		
-5	, 0	29 18	S1	4 - 5.83	12		POORL		S - 019, roller bit to	o 4 ft. EL (SP); mostly fin	e to medium	ı sanı	d, some
J) () °	38	/4"			168.5							
						100.0	Top of b	edrock at 6.5	ft, roller bit to 9 ft.				
-10		RQD=6	C1	9 - 14	50		GRANIT 10.5 ft, g	ΓE; very hard, α gray and pink.	coarse grained, joi	nts spaced 6 - 24",	high angle	fractu	ıre at
						161.0							
-15							Bottom	of Hole at 14'.					
-20													
20													
-25													
-30													
-35	Page 1:	0-35 feet. Eac	ch subseque	ent page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHER	RWISE	NOTED.
COF	HESIVE SC	DIL	NON-COHE	ESIVE SOIL		ATIVE PORTIONS				LEGEND			
LOWS		SISTENCY BL		DENSITY	OF SOIL C	OMPONE	NTS Aug	mple and	ck Core (RC) I RQD (%) C (%) Split-Spool Sample (S and Blow) per 6" REI	Counts (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)		Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 1! 16 - 30	MEDI 5 S 0 VER	UM STIFF	5 - 10 11 - 30 31 - 50	VERY LOOSE LOOSE EDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SOI MOS	TLE REI	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF RIALS" FOR ADDITIONA	BORING	NES	6 - ()19A

INSPECTOR T. Telesco						PROJEC		South	n Coast Rail			5 6 5 11 1 6	NEO 000
DOB NUMBER \$2347/01		A		R	3								NES - 020
INSPECTOR T. Telesco										ortation Author	rity	⊣ NO.	SHFFT 1 OF 1
METHOLO OF DRILLING	INISDI	CTOP	T Tala	SCO							DDII I ED	l Stokes	
Wash Boring w Casing DATE/TIME DEPTH(ft) REMARKS SPT HAMMER 140 Ib Safety GROUP R76832 COORD E 76832						CONTRA		-		GS			
Terminated					ina	DA							
DATE END DATE DAT	10								, ,				
Section Page													
STARPLE CASSIFIED N ACCORDANCE WITH ASTM D 2488 LPRESS OTHERWISE NOTED							т т						DATE END 5/25/10
126		STRATA SYMBOL						ELEV.			FIELD CLASSIFICAT	ION AND REMARK	5
171.0 171.		0 0	9	S	1	0 - 2	17			RADED SAN	D (SW); fine to coars	se sand, trace fin	e gravel, brown, moist,
171.0 171.		0 0	26	,					FILL.				
16 50 17 16 50 100/2* S2 4 - 5.16 6 171.0 169.5 100/2* S2 4 - 5.16 6 171.0 169.5 1			_	•									
16	ļ .												
169.5 Top of apparent bedrock at -5.5 ft, roller bit to 10 ft.	-	•	16	S2	2	4 - 5.16	6	171.0	SILTY S	AND WITH G	RAVEL (SM); fine to	coarse sand, litt	le non-plastic silt, little
Top of apparent bedrock at ~5.5 ft, roller bit to 10 ft. 165.0	-5		∕」 59 100	/2"				160.5	fine grav	el, brown, wet	t.	•	, ,
165.0	-							109.5	Ton of a	nnarent hedro	ck at ~5.5 ft roller h	it to 10 ft	
Bottom of Hole at 10*: Page 1: 0.95 feet. Each subsequent page displays 40 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.	-								1 op or a	pparent beare	ok at 0.0 it, roller b	it to To it.	
Bottom of Hole at 10*. Page 1: 0-35 feet. Each subsequent page displays 40 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.	-												
Bottom of Hole at 10*. Page 1: 0-35 feet. Each subsequent page displays 40 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.	_												
Bottom of Hole at 10*. Page 1: 0-35 feet. Each subsequent page displays 40 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.	10							165.0					
Page 1: 0-35 feet. Each subsequent page displays 40 feet. COHESIVE SOIL NON-COHESIVE SOIL NON-COHESIVE SOIL O-2 VERY SOFT 0-4 USEY LOOSE 1-5-27% LOOSE 30-40% SOIL O-3 VERY SOFT 0-4 WED LOOSE 30-40% SOIL O-3 VERY SOFT 1-0 WED LOOSE 30-40% SOIL O-3 VERY SOFT 1-0 WED LOOSE 30-40% SOIL O-3 VERY SOFT 1-0 WED LOOSE 30-40% SOIL O-4 WED LOOSE 30-40% SOIL O-5 COLOMPONENTS O-6 SOIL COMPONENTS O-7 SOIL COMPONENTS O-8 SOIL COMPONENTS O-9 SOIL C								100.0					
— 25 — 35 — 36 — 37 — 38 — 39 — 39 — 39 — 39 — 30									Bottom	of Hole at 10'.			
— 25 — 35 — 36 — 37 — 38 — 39 — 39 — 39 — 39 — 30	_												
— 25 — 35 — 36 — 37 — 38 — 39 — 39 — 39 — 39 — 30													
— 25 — 35 — 36 — 37 — 38 — 39 — 39 — 39 — 39 — 30	<u> </u>												
25 - 35 - 36 - 26 - 37 - 38 - 39 - 39 - 39 - 30 -	- 15												
25 - 35 - 36 - 26 - 37 - 38 - 39 - 39 - 39 - 30 -	-												
25 - 35 - 36 - 26 - 37 - 38 - 39 - 39 - 30 -	L												
25 - 35 - 36 - 26 - 37 - 38 - 39 - 39 - 30 -	L												
25 - 35 - 36 - 26 - 37 - 38 - 39 - 39 - 30 -	L												
25 - 35 - 36 - 26 - 37 - 38 - 39 - 39 - 30 -	_ 20												
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COHESIVE SOIL NON-COHESIVE SOIL RELATIVE PROPORTIONS OF SOIL COMPONENTS OF Sample (AS) REC (%) Split-Spoon Sample (U)-Shelby Tube, (U)-Shelby Tube, (P)-Piston Sample (S) Sample (S) Sample (S) Sample (P)-Piston OF SOIL COMPONENTS OF SOIL COMPONENTS OF SOIL COMPONENTS I Auger Sample (AS) Sample (AS) Sample (AS) September 1 - 30 December 1	-35												
BLOWS/FT CONSISTENCY BLOWS/FT DENSITY PROPORTIONS OF SOIL COMPONENTS Sample (AS) Sample (SS) and Blow Counts per 6" REC (III) OF SOIL COMPONENTS OF SOIL COMPONENTS Sample (AS) Sample (SS) and Blow Counts per 6" REC (III) OF SOIL COMPONENTS OF SOIL COMPONENTS Sample (AS) OF SOIL COMPONENTS OF SOIL COMPONENTS OF SOIL COMPONENTS OF SOIL COMPONENTS Sample (AS) Sample (AS) OF SOIL COMPONENTS OF SOIL COMPONENTS		Page 1:	0-35 feet. E	ach subsec	uent pa	age displays 4		A T. ! -		SAMPLES CLA			UNLESS OTHERWISE NOTED.
0 - 2						'E SOIL	PROP	ORTIONS	NTS Aug	ger Roo	ck Core (RC) Split-Spoon	Undisturbed	▼ Jar / / Bag
0-2 VERY SUF1 0-4 VERY LOOSE < 10% IRACE 3-4 SOFT 5-10 LOOSE 15-25% LITTLE 5-8 MEDIUM STIFF 11-30 MEDIUM DENSE 30-45% SOME 9-15 STIFF 31-50 DENSE 50-100% MOSTLY 16-30 VERY STIFF 51+ VERY DENSE 50-100% MOSTLY REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY. NES - 020								_		mple and	I RQD (%) Sample (SS) C (%) and Blow Cou	ints (U)-Shelby Tube, (P)-Piston	Sample Sample (JS)
5 - 8 MEDIUM STIFF 11 - 30 MEDIUM DENSE 9 - 15 STIFF 31 - 50 DENSE 16 - 30 VERY STIFF 51 + VERY DENSE VERY DENSE STIFF 51 + VERY DENSE STIFF STI									rie			"	
16-30 VERY STIFF 51+ VERY DENSE SYMBOLOGY	5 - 8	MEDI	JM STIFF	11 - 30	MEDIU	JM DENSE	30 - 45%	SO	ME REI	SCRIPTION AND C	CLASSIFICATION OF	BORING	ALEO COO
	16 - 30	VER	Y STIFF						501		NALO FUK ADDITIONAL		NES - 020

					PROJE		South	n Coast Rail			5 6 5 11 1 6	NEO 004
			E	3	LOCATI			Easton, MA	A .:		BORING	NES - 021
									ortation Author	rity	NO.	SHEET 1 OF 1
INICOL	CTOP	T. Tele	2900		JOB NU		E234			DRILLER	J. Stokes	ELEVATION 162
		D OF DE		G	CONTR			ER READIN	GS		ATV CME - 550	DATUM NGVD 29
		ash Borii			DA	ATE/TIME		DEPTH(ft)	REMARKS		40 lb Safety	GRID N 2857498
16		rminated									·	COORD E 765616
												DATE START 5/25/10
												DATE END 5/25/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA	.	AMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S
		28 75 10		S1	0 - 1.33	14			RADED SANI gravel, dry, br		W); fine to coars	se sand, some fine to
		10	0/4"					medium	graver, dry, bi	OWII.		
_	3	28 39 42 3		S2	4 - 6	19	158.0	GRAVE	WITH SILT	AND SAND (GW - G	M); fine to coars	e gravel, some fine to
-5	[• ¢ •	39 42						coarse s	and, trace silt	, gray, moist.		
-		□ 3	1									
-												
-	P. 4											
-		28		S3	9 - 11	16	153.0	WELLG	RADED SANI	D WITH GRAVEL (S	(W): fine to coars	se sand, some fine to
-10		28 41 39 2		33	9-11	10		coarse	ravel, moist, b	prown.	, fille to coars	se sand, some line to
L		2	1									
L												
L												
		_										
_ 15	D	29 41		S4	14 - 16	14		SIMILAF	R TO S3; wet.			
 15		41 87 2	,				4.40.0					
			'				146.0					
								Bottom	of Hole at 16'.			
_												
<u> </u>												
-20												
-												
-												
-												
-												
-25												
L												
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-30												
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†												
- 35	Page 1:	0-35 feet.	Each sub	bsequent r	page displays	1 40 feet.		I	SAMPLES CLA	SSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
COF	HESIVE SC			I-COHESI			ATIVE				EGEND	
						PROF OF SOIL C	ORTIONS	NTS E Aug	ger Roo	ck Core (RC) Split-Spoon	Undisturbed	Jar Bag
BLOWS		SISTENCY			DENSITY			Sai (AS	nple and	Sample (SS) and Blow Couper 6" REC (in	unts (U)-Shelby Tube, (P)-Piston	Sample (JS) Bag Sample (B)
0 - 2 3 - 4		Y SOFT SOFT	0 - 4 5 - 10		RY LOOSE LOOSE	< 10% 15 - 25%	TRA	rie			.,	
5 - 8 9 - 15	MEDI	UM STIFF	11 - 3 31 - 5	80 MEDI	UM DENSE DENSE	30 - 45% 50 - 100%	SO	ME REI	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF	BORING	ALEO COL
16 - 30 30 +	VER	Y STIFF IARD	51 +		RY DENSE	/0		501	BSURFACE MATE MBOLOGY.	RIALS" FOR ADDITIONAL	NO.	NES - 021

				DDC :=	O.T.			E21 BOK	MING				
		-		PROJECT LOCATION			Coast Rail			BORING	NI	S	022
	A		35	OWNER			Easton, MA	ortation Author	rity	NO.	INC	ა -	022
				JOB NU		E234		ortation Author	ity	NO.	SH	IFFT	1 OF 1
INSP	ECTOR	T. Telesco	0	CONTRA		NH B			DRILLER	C. Knight	ELEVATIO		144
		OF DRILL		OONTIV			ER READIN	GS	DRILL RIG	ATV D-50	DATUM	/IN	NGVD 29
		sh Boring v		D/A	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2857303
5		Rock Core			/19/2010		3		tion (Casing pulled		COORD	Е	765208
15		minated							, , ,	,	DATE STA		5/19/10
											DATE END		5/19/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	5		
	717 717	3 3 4	S1	0.33 - 2.33	16	143.7	Top 4" 7 SILT (M		silt, trace fine to o	coarse sand, light b	rown, dry.		
	[46											
		23	S2	3 - 5	9	141.0	SII TV S	SAND (SM): ma	netly fine sand litt	le non-plastic silt, g	ravish-hrov	vn m	niet
		23 65 57	32	3-3			OIL11 C	SAND (SIVI), IIIC	John Inic Sand, Int	ie non-plastic siit, g	iayisii-biov	vii, iii	oist.
-5		57 67				139.0							
		RQD=25	C1	5 - 10	30	100.0	moderat	te weathering,	spaced 2 - 9", joi zones of highly fra gray with black.	nts angled at ~10 - actured rock, some	60 degrees vertical frac	s, slig ctures	ht to s, sand
							Scarris,	ioss of water, t	gray with black.				
-10		_											
10		RQD=50	C2	10 - 15	42		GRANI1	TE; hard, joints	spaced 2 - 23", jo	oints angled at ~ 45 ctured and weather	degrees, s	light	io vortical
							fracture	s, loss of drill w	vater, gray with bla	ack.	eu iock at i	io it,	verticai
								,	, , , , , , , , , , , , , , , , , , , ,				
-15	1	L				129.0							
							Bottom	of Hole at 15'.					
-20													
-25													
-30													
-35													
	Page 1:	0-35 feet. Each	n subsequer	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHE	ERWIS	E NOTED.
CO	HESIVE SO		אטא כטייב	SIVE SOII	REL	ATIVE				LEGEND			
COI	ILOIVE SU		NON-COHE	SIVE SUIL	PROP	ORTIONS	NTS Au	ger 🔳 Poo	ck Core (RC) Split-Spoo	On Undisturbed	V Jar	Γ.	Bag
	FT CONS	STENCY BLC	DWS/FT	DENSITY	OF SOIL C	OMPONE!	NTS Au Sa	mple and	Split-Spool Sample (S and Blow	SS) (U)-Shelby Tube.	Sample (JS)	X	Bag Sample (B)
BLOWS		Y SOFT (0 - 4 V	ERY LOOSE	< 10%	TRA	CE	, E	per 6" RE		·/	V\	(-)
0 - 2	VER'						1						
0 - 2 3 - 4	S	OFT 5	5 - 10 1 - 30 ME	LOOSE DILIM DENSE	15 - 25% 30 - 45%	LITT	ME KE		T ENTITLED "KEY TO				
	MEDIU S S	OFT 5 IM STIFF 1: TIFF 3:	1 - 30 ME 1 - 50	LOOSE EDIUM DENSE DENSE PERY DENSE	15 - 25% 30 - 45% 50 - 100%	SOI MOS	ME DE	SCRIPTION AND C	ET ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BORING	3 NE	S	022

				DD0 :5	CT	1		E21 BOL	KING				
_				PROJE			Coast Rail Easton, MA			BORING	NE	S -	023
J			BS	OWNE				ortation Author	ritv	NO.	INL	- ر 	023
					JMBER	E234			,		SHE	ET 1	OF 1
INSPE	ECTOR	T. Teles	СО		RACTOR	NH Bo			DRILLER	C. Knight	ELEVATION	N	162
<u> </u>	МЕТНОГ	OF DRII	LLING		GROUN	IDWAT	ER READIN	GS	DRILL RIG	ATV D-50	DATUM		NGVD 29
		sh Boring		g D	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety			2857589
10		Rock Co	re										765408
17	Tei	rminated									DATE STAF		5/17/10 5/18/10
					T]						DATE END		3/10/10
	STRATA SYMBOL	SAMPLE DATA	SAMPLI NO.	E DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	5		
		5	S1	0 - 1.33	10		SILTY S	SAND (SM): fin	e to coarse sand.	some non-plastic s	ilt. trace fine	grav	el.
		16 100/-	4"					noist, FILL.	,	·	•	•	•
							Roulder	encountered a	at 1.5 ft, move bori	ing 5 ft south			
		5	S2	3 - 5	6			R TO S1; wet.	at 1.5 ft, 1110vc 50ff	ing 5 it 30dtii.			
		5 1 2	32	3-5	0		SIIVIILAI	K 10 31, Wel.					
-5		2											
						1540							
	0 0	13 48	S3	8 - 9.25	7	154.0		RADED SAN	D (SW); fine to coa	arse sand, trace fin	e gravel, ligh	nt bro	wn,
	1,11	120/	3"			153.0	moist.						
-10	and the second	RQD=9	C1	10 - 15	54		GRANIT	E; very hard,	fresh, one mechar	nical break, some h	igh angle fra	cture	s and
		NQD-9					intrusior	ns, gray with bl	lack and white.				
-15		-					/45 40	EI) ODANUTE				011	
	S		C2	15 - 17	10			.5') GRANITE; gray with black		ate weathering, hig	nly fractured,	, 6" S	eam at
		L				145.5 145.0		<u> </u>		eathering, highly fra	actured, blac	k.	
-						145.0							
							Bottom	of Hole at 17'.					
00							20110111						
-20													
•													
-25													
-30													
-35		0.05.5		1	10.5		<u> </u>						
	Page 1:	0-35 feet. Ea	ich subseque	ent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHER	RWISE	NOTED.
COF	HESIVE SO	olL	NON-COH	ESIVE SOIL		ATIVE				LEGEND			
OLOVAC.	/ET CONO	ISTENOV -			PROF OF SOIL C	ORTIONS OMPONE	ITS Au	ger Roo	ck Core (RC) Split-Spool		Jar Sample	M	Bag Sample (B)
BLOWS/		ISTENCY B		DENSITY					Sample (S and Blow per 6" RE	Counts (P)-Piston	(JS)	M	(B)
0 - 2 3 - 4	S	Y SOFT SOFT	5 - 10	VERY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	LE BE						
5 - 8 9 - 15		JM STIFF	11 - 30 M 31 - 50	EDIUM DENSE DENSE	30 - 45% 50 - 100%	SOM	ME DE:	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF	BORING	3	_	000
16 - 30	0 VER	Y STIFF		VERY DENSE	23 100/0	1,100	50	BSURFACE MATE MBOLOGY.	RIALS" FOR ADDITIONA	NO.	NES	5 -	023
30 +	Н	ARD								INO.			

Memorandum

APPENDIX B: LABORATORY DATA

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: NES-4 Sample Type: jar Tested By: jbr Sample ID:S-4 Test Date: 07/21/10 Checked By: jdt

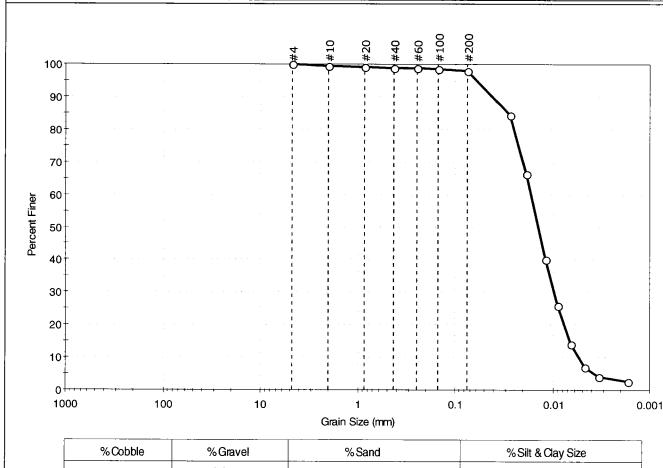
Depth: 14-16 ft Test Id: 185189

Test Comment: --

Sample Description: Moist, light olive brown silty sandy clay

Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



		% Gravel	% Sand	% Silt & Clay Size
L		0.0	1.9	98.1
ieve Name S	ieve Size, Percen	t Finer Spec. Percent Co	mplies	Coofficients

Sieve Itallie	mm	Percent Filler	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	99		
#60	0.25	99		
#100	0.15	98		
#200	0.075	98		
77 (4- 77, 77)	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0274	84		
	0.0186	66		
	0.0121	40		
	0.0089	26		
	0.0065	14		
	0.0047	7		
	0.0033	4		
	0.0017	3		
			-	
			1	

<u>Coefficients</u>				
D ₈₅ = 0.0285 mm	$D_{30} = 0.0097 \text{ mm}$			
D ₆₀ = 0.0168 mm	$D_{15} = 0.0067 \text{ mm}$			
D ₅₀ = 0.0142 mm	$D_{10} = 0.0054 \text{ mm}$			
Cu =N/A	$C_C = N/A$			

Project No:

GTX-9764

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description
Sand/Gravel Particle Shape: --Sand/Gravel Hardness: ---

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA Boring ID: NES-5 Sample Type: jar

Test Date: 07/21/10

Checked By: jdt

Project No:

Tested By:

GTX-9764

Depth: 4-4.33 ft Test Id: 185188

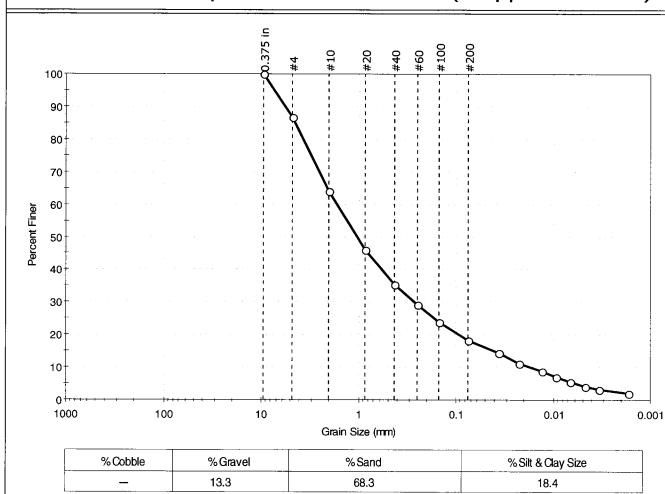
Test Comment:

Sample ID:S-2

Sample Description: Moist, light olive gray silty sand

Sample Comment:

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



	mm			
0.375 in	9.50	100		
#4	4.75	87		
#10	2.00	64	,	
#20	0.85	46		
#40	0.42	35		
. #60	0.25	29		
#100	0.15	24		
#200	0.075	18		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0363	14	<u> </u>	77.1.2.1.
	0.0229	11		
	0.0133	9		
	0.0095	7		
	0.0067	6		<u> </u>

Sieve Name | Sieve Size, | Percent Finer | Spec. Percent | Complies

<u>Coefficients</u>				
D ₈₅ =4.4610 mm	$D_{30} = 0.2696 \text{ mm}$			
D ₆₀ = 1.6488 mm	$D_{15} = 0.0399 \text{ mm}$			
D ₅₀ = 1.0270 mm	$D_{10} = 0.0174 \text{ mm}$			
Cu =N/A	$C_c = N/A$			

Classification **ASTM** N/A Stone Fragments, Gravel and Sand (A-1-b(0))

Sample/Test Description Sand/Gravel Particle Shape: ROUNDED Sand/Gravel Hardness: HARD

0.0047

0.0033 0.0017

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc.
Project: South Coast Rail

Location: MA

Boring ID: NES-14 Sample Type: jar

Sample Type: jar Tested By: jbr Test Date: 07/14/10 Checked By: jdt

Project No:

GTX-9764

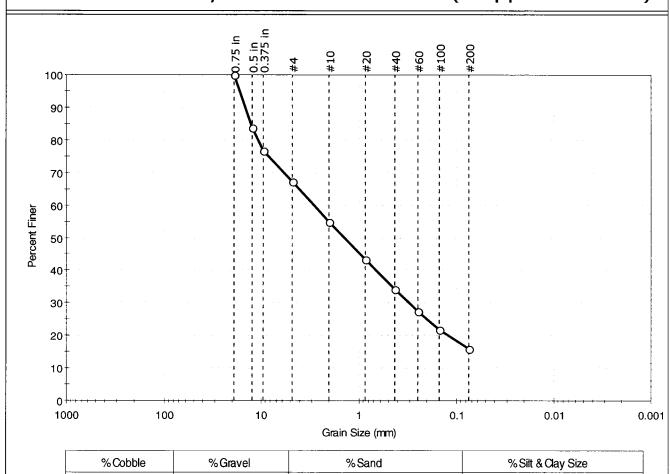
Sample ID:S-2 Test Date: 07/14/10 Depth: 4-6 ft Test Id: 185198

Test Comment: ---

Sample Description: Moist, olive silty sand with gravel

Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



51.3

Sieve Name	Sieve Size,	Percent Finer	Spec. Percent	Complies
	mm			
0.75 in	19.00	100		
0.5 in	12.50	84		
0.375 in	9.50	77		
#4	4.75	67		
#10	2.00	55		
#20	0.85	43		
#40	0.42	34		
#60	0.25	28		
#100	0.15	22		
#200	0.075	16		

32.7

<u>Coefficients</u>				
D ₈₅ = 12.9421 mm	$D_{30} = 0.3042 \text{ mm}$			
D ₆₀ = 2.8531 mm	$D_{15} = N/A$			
D ₅₀ = 1.3841 mm	$D_{10} = N/A$			
Cu =N/A	C _c =N/A			

16.0

<u>ASTM</u>	Classification N/A
<u>AASHTO</u>	Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description
Sand/Gravel Particle Shape: ANGULAR
Sand/Gravel Hardness: HARD

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA
Boring ID: NES-21 Sample Type: jar

Boring ID: NES-21 Sample Type: jar Tested By: jbr Sample ID:S-2 Test Date: 07/14/10 Checked By: jdt

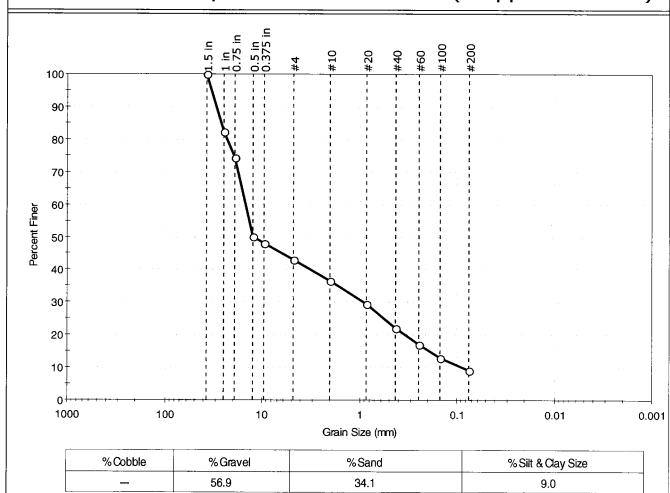
Depth: 4-6 ft Test Id: 185199

Test Comment: -

Sample Description: Moist, olive gray gravel with silt and sand

Sample Comment: sample jar received broken

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



Sieve Name	Sieve Size,	Percent Finer	Spec. Percent	Complies
	mm			
1.5 in	37.50	100		
1 in	25.00	82		
0.75 in	19.00	74		
0.5 in	12.50	50		
0.375 in	9.50	48		
#4	4.75	43		
#10	2.00	37		
#20	0.85	29		
#40	0.42	22		
#60	0.25	17		-
#100	0.15	13		
#200	0.075	9		

<u>Coefficients</u>				
D ₈₅ = 26.6354 mm	$D_{30} = 0.9130 \text{ mm}$			
D ₆₀ = 14.8269 mm	$D_{15} = 0.1950 \text{ mm}$			
D ₅₀ =12.1561 mm	$D_{10} = 0.0897 \text{ mm}$			
Cu =165.294	$C_c = 0.627$			

Classification

Project No:

GTX-9764

<u>ASTM</u>	N/A
<u>AASHTO</u>	Stone Fragments, Gravel and Sand (A-1-a (0))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape: ROUNDED

Sand/Gravel Hardness : HARD

Memorandum

APPENDIX C: GEOTECHNICAL CALCULATIONS

- Allowable Bearing Capacity and Estimated Settlement
- Seismic Site Class Evaluation





343 Congress Street Boston, MA 02210 617/242-9222

JOB	MBTA South Coast Rail		
SUBJECT	North Easton Station		
CALCULATED BY	DH	DATE	1/23/2012
CHECKED BY	PM	DATE	1/23/2012

PURPOSE: Evaluate bearing resistance for platform shallow foundations.

REFERENCE: AASHTO LRFD Bridge Design Specifications, 2010 AREMA Manual for Railway Engineering, 2011 Edition

ASSUMPTIONS: - Platform footing is 4 ft wide by 10 ft long.

- Bearing surface is well graded sand (SW) or silty sand (SM) w/ gravel.

- Footing embedment is at least 4 feet below ground surface.

- Groundwater level is at 15 feet below surface.

- Footing eccentricity is assumed to be zero.

- Estimated soil properties (experience, geotech literature, Table 10.4.6.2.4-1):

	γ (pcf)	ф
Sand or silty sand:	120	33

BEARING CAPACITY FACTORS (Table 10.6.3.1.2a-1):

Med. Dense Sand or Silty Sand with	ф	N _c	N_q	N_{γ}
gravel:	33	38.6	26.1	35.2

c = cohesion = 0

CALCULATE EFFECTIVE FOOTING WIDTH (B'):

where:

e < B/4(Section 10.6.3.3)

B = footing width (ft) = 4 where:

e = eccentricity (ft)

Assume no footing eccentricity, thus, e = 0

NOMINAL BEARING RESISTANCE (q_n):

 $q_n = cN_{cm} + \gamma D_f N_{qm}C_{wq} + 0.5\gamma B'N_{\gamma m}C_{w\gamma}$ (Eqn. 10.6.3.1.2a-1)

 γ = total unit weight 120

> D_f = depth of footing (ft) = 4 Assumed

B' = effective width of footing (ft) = 4 10

L = length of footing (ft) =

0.40 B'/L =

 $D_f/B' =$ 1.00

 $C_{wq} C_{w\gamma} = groundwater correction factors$ (using B')

 $C_{wq} =$ 1.0 (Table 10.6.3.1.2a-2)

 $C_{wy} =$ 1.0 (Table 10.6.3.1.2a-2)

 $N_{\text{cm}} \; N_{\text{qm}} \; N_{\text{ym}}$ = bearing capacity factors

 $N_{qm} = N_q s_q d_q i_q$ (Eqn. 10.6.3.1.2a-3)

> 1.26 (Table 10.6.3.1.2a-3)

 $d_q =$ 1.20 (Table 10.6.3.1.2a-4)

1.0 (see AASHTO p. 10-62)

39.5





343 Congress Street Boston, MA 02210 617/242-9222
 JOB
 MBTA South Coast Rail

 SUBJECT
 North Easton Station

 CALCULATED BY
 DH
 DATE
 1/23/2012

 CHECKED BY
 PM
 DATE
 1/23/2012

$$N_{\gamma m} = N_{\gamma} s_{\gamma} i_{\gamma}$$

$$s_{y} = 0.84$$
 (Table 10.6.3.1.2a-3)

$$i_v = 1$$
 (see AASHTO p. 10-62)

$$N_{ym} = 29.6$$

$$q_n = 26,035$$
 psf

ALLOWABLE BEARING RESISTANCE (qa):

$$q_a = q_n/FOS$$

where: FOS = factor of safety = 2.5 for sand

 $q_a = 10,414$ psf

use

q_a = 10.41 ksf strength limit value

Note: Based on the anticipated light loads and potentially small footing sizes, an allowable bearing capacity of 5 ksf is recommended.

Elastic Settlement Calculations:

$$S_{e} = \frac{\left(q_{o} (1 - v^{2})\sqrt{A'}\right)}{144E_{s}\beta_{z}}$$
 eqn. 10.6.2.4.2-1

where: $q_o = applied vert. stress (ksf)$

v = Poisson's Ratio

 E_s = Young's Modulus (ksi)

 β_z = Shape/Rigidity Factor

v = Poisson's Ratio =	0.25	(Table C10.4.6.3-1)
E _s = Young's Modulus (ksi) =	5.00	(Table C10.4.6.3-1)
β_z = Shape/Rigidity Factor =	1.11	(Table 10.6.2.4.2-1)

 $A' = (B'xL) = footing area (ft^2):$ 40

Settlement (S_e) for a given q_o:

q_o = applied vertical stress (ksf) = 5.00 ksf (assumed)

Se (inches) = 0.45 inches



North Easton Station Seismic Site Class Evaluation

Based on the platform boring with the deepest soil overburden (worst case)

Boring No.	Sample No.	N Value	Di	Di/N _i	N _{bar}
NES-4	S-1	17	4	0.24	
	S-2	21	5	0.24	
	S-3	40	5	0.13	59
	S-4	39	5	0.13	
	S-5	37	5	0.14	
	S-6	44	5	0.11	
	S-7	92	6	0.07	
	Weathered rock	100	65	0.65	
	Total Depth =	100			
De	epth to Bedrock =	35			

Per 9.4.1.2.1*, N_{bar} 50, Site Class C

9.4.1.2.1 Site Class Definitions. The site shall be classified as one of the following classes:

A = Hard rock with measured shear wavevelocity, $\overline{v}_s > 5000 \text{ft/s} (1500 \text{ m/s})$

 $B = \text{Rock with } 2500 \text{ ft/s} < \overline{\boldsymbol{v}}_{\boldsymbol{s}} \le 5000 \text{ ft/s} (760 \text{ m/s} < \overline{\boldsymbol{v}}_{\boldsymbol{s}} \le 1500 \text{ m/s})$

C= Very dense soil and soft rock with 1200 ft/s $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 2500$ ft/s (370 m/s $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 760$ m/s) or $\overline{\boldsymbol{N}}$ or $\overline{\boldsymbol{N}}_{\boldsymbol{ch}} \geq 50$ or $\overline{\boldsymbol{s}}_{\boldsymbol{u}} \geq 2000$ psf (100 kPa)

 $\begin{array}{ll} D = & \text{Stiff soil with 600 ft/s} \leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 1200 \text{ ft/s} \\ (180 \text{ m/s} \leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 370 \text{ m/s}) \text{ or with } 15 \leq \overline{\boldsymbol{N}} \text{ or } \\ \overline{\boldsymbol{N}}_{\boldsymbol{ch}} \leq 50 \text{ or } 1000 \text{ psf} \leq \overline{\boldsymbol{s}}_{\boldsymbol{u}} \leq 2000 \text{ psf} (50 \text{ kPa} \\ \leq \overline{\boldsymbol{s}}_{\boldsymbol{u}} \leq 100 \text{ kPa}) \end{array}$

 $E = \text{A soil profile with } \overline{\mathbf{v}}_{\mathbf{s}} < 600 \text{ ft/s } (180 \text{ m/s}) \text{ or any profile with more than } 10 \text{ ft } (3 \text{ m}) \text{ of soft clay. Soft clay is defined as soil with } Pl > 20, <math>w \ge 40\%$, and $s_u < 500 \text{ psf } (25 \text{ kPa})$

F =Soils requiring site-specific evaluations:

 Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. Potential for liquefaction shall be evaluated in accordance with 780 CMR 1804.6: Liquefaction.

Exception. None.

- 2. Peats and/or highly organic clays (H > 10 ft [3 m]) of peat and/or highly organic clay where H = thickness of soil).
- 3. Very high plasticity clays (H > 25 ft [7.6 m] with PI > 75).
- 4. Very thick soft/medium stiff clays (H>120 ft [37 m].

Exception. None.

Approx. Project Coordinates

Lat 42.088658 Long -71.098197

Seismic Coefficients

S_S = 0.25 (Table 1604.10*) S₁ = 0.064 (Table 1604.10*)

For Site Class C

 $F_A =$ 1.2 (See Table 9.4.1.2.4a*) $F_V =$ 1.7 (See Table 9.4.1.2.4b*)

Design Spectral Response Parameters

 $S_{MS} = Ss \times F_A = 0.300$ $S_{M1} = S_1 \times F_V = 0.109$

 $S_{DS} = 2/3 \times S_{MS} = 0.200$ $S_{D1} = 2/3 \times S_{M1} = 0.073$

Notes: * The Massachusetts State Building Code, 8th Edition (2010)

TABLE 9.4.1.2.4a VALUES OF F_a AS A FUNCTION OF SITE CLASS AND SHORT PERIOD MAXIMUM CONSIDERED EARTHQUAKE SPECTRAL ACCELERATION

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at Short Periods					
	$S_S \leq 0.26$	$0.27 \le S_S \le 0.29$	$0.30 \le S_S \le 0.32$	$0.33 \le S_s \le 0.35$	$0.36 \le S_S \le 0.38$	$S_{\rm S} \ge 0.39$
A	0.8	0.8	0.8	0.8	0.8	0.8
В	1.0	1.0	1.0	1.0	1.0	1.0
С	1.2	1.2	1.2	1.2	1.2	1.2
D	1.6	1.6	1.55	1.5	1.5	1.5
Е	2.5	2.4	2.3	2.2	2.1	2.0
F	Note a	Note a	Note a	Note a	Note a	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F₂ for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

TABLE 9.4.1.2.4b VALUES OF F, AS A FUNCTION OF SITE CLASS

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at 1-Second Periods			
	$S_1 \leq 0.1$			
A	0.8			
В	1.0			
C	1.7			
D	2.4			
E	3.5			
F	Note a			

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_v for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2

780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS THE MASSACHUSETTS STATE BUILDING CODE

TABLE 1604.10 GROUND SNOW LOADS; BASIC WIND SPEEDS; EARTHQUAKE DESIGN FACTORS

(For R-3 of three stories or less one- and two-family stand alone buildings, see 780 CMR 53.00 for snow and wind loads)

	Ground Snow	Basic Wind	Earthquake Design Factors		
City/Town	$\begin{array}{c} \textbf{Load} \\ \textbf{p}_{g,} \textbf{psf} \end{array}$	Speed V, MPH	Ss	$\mathbf{S_1}$	
Cambridge	45	105	0.28	0.068	
Canton	55	100	0.26	0.066	
Carlisle	55	100	0.29	0.071	
Carver	45	110	0.24	0.060	
Charlemont	65	100	0.22	0.068	
Charlton	55	100	0.23	0.065	
Chatham	35	120	0.17	0.050	
Chelmsford	55	100	0.30	0.073	
Chelsea	45	105	0.29	0.069	
Cheshire	65	90	0.22	0.068	
Chester	65	100	0.22	0.066	
Chesterfield	65	100	0.22	0.067	
Chicopee	55	100	0.23	0.066	
Chilmark	35	120	0.18	0.051	
Clarksburg	65	90	0.22	0.069	
Clinton	55	100	0.26	0.068	
Cohasset	45	110	0.27	0.066	
Colrain	65	100	0.23	0.069	
Concord	55	100	0.29	0.070	
Conway	65	100	0.22	0.068	
Cummington	65	100	0.22	0.067	
Dalton	65	90	0.22	0.067	
Danvers	45	110	0.32	0.073	
Dartmouth	45	110	0.23	0.058	
Dedham	55	100	0.26	0.066	
Deerfield	65	100	0.23	0.068	
Dennis	35	120	0.19	0.052	
Dighton	55	110	0.24	0.061	
Douglas	55	100	0.23	0.064	
Dover	55	100	0.26	0.066	
Dracut	55	100	0.33	0.075	
Dudley	55	100	0.23	0.064	
Dunstable	65	100	0.31	0.074	
Duxbury	45	110	0.25	0.062	
East Bridgewater	45	110	0.25	0.063	
East Brookfield	55	100	0.23	0.066	
East Longmeadow	55	100	0.23	0.065	
Eastham	35	120	0.19	0.052	
Easthampton	55	100	0.23	0.066	
Easton	55	110	0.25	0.064	
Edgartown	35	120	0.18	0.050	
Egremont	65	90	0.23	0.066	
Erving	65	100	0.23	0.069	
Essex	45	110	0.33	0.073	
Everett	45	105	0.29	0.069	
Fairhaven	45	110	0.22	0.057	
Fall River	45	110	0.23	0.059	
Falmouth	35	120	0.20	0.054	
Fitchburg	65	100	0.27	0.071	
Florida	65	90	0.22	0.069	

Stormwater Report

Raynham Park Station

Town of Raynham, Massachusetts

Prepared for

massDOT

Massachusetts Department of Transportation 10 Park Plaza Boston, Massachusetts





Transportation, Land Development, Environmental Services 99 High Street Boston, Massachusetts 02110 617 728 7777

June 2012



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Checklist for Stormwater Report



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.





A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals. This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

Raynham Park_DEP Stormwater Checklist • 04/01/08

¹ The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

² For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.



Massachusetts Department of Environmental Protection

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Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Stormwater Report accurately reflects conditions at the site as of the date of this permit application.
Registered Professional Engineer Block and Signature
Signature and Date
Checklist
Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?
☐ New development
□ Redevelopment
☐ Mix of New Development and Redevelopment



Massachusetts Department of Environmental ProtectionBureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

env	Measures: Stormwater Standards require LID measures to be considered. Document what vironmentally sensitive design and LID Techniques were considered during the planning and design of project:
	No disturbance to any Wetland Resource Areas
	Site Design Practices (e.g. clustered development, reduced frontage setbacks)
	Reduced Impervious Area (Redevelopment Only)
	Minimizing disturbance to existing trees and shrubs
	LID Site Design Credit Requested:
	☐ Credit 1
	☐ Credit 2
	☐ Credit 3
	Use of "country drainage" versus curb and gutter conveyance and pipe
	Bioretention Cells (includes Rain Gardens)
	Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
	Treebox Filter
	Water Quality Swale
	Grass Channel
	Green Roof
	Other (describe):
Sta	ndard 1: No New Untreated Discharges
\boxtimes	No new untreated discharges
	Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
	Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



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Checklist for Stormwater Report

Checklist (continued) Standard 2: Peak Rate Attenuation Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding. Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm. Calculations provided to show that post-development peak discharge rates do not exceed predevelopment rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24hour storm. Standard 3: Recharge Soil Analysis provided. Required Recharge Volume calculation provided. Required Recharge volume reduced through use of the LID site Design Credits. Sizing the infiltration, BMPs is based on the following method: Check the method used. ⊠ Static ☐ Simple Dynamic ☐ Dynamic Field¹ Runoff from all impervious areas at the site discharging to the infiltration BMP. Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason: Site is comprised solely of C and D soils and/or bedrock at the land surface M.G.L. c. 21E sites pursuant to 310 CMR 40.0000 Solid Waste Landfill pursuant to 310 CMR 19.000 Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable. Calculations showing that the infiltration BMPs will drain in 72 hours are provided. Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



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Checklist for Stormwater Report

Cł	necklist (continued)
Sta	andard 3: Recharge (continued)
	The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
	Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.
Sta	ndard 4: Water Quality
The	E Long-Term Pollution Prevention Plan typically includes the following: Good housekeeping practices; Provisions for storing materials and waste products inside or under cover; Vehicle washing controls; Requirements for routine inspections and maintenance of stormwater BMPs; Spill prevention and response plans; Provisions for maintenance of lawns, gardens, and other landscaped areas; Requirements for storage and use of fertilizers, herbicides, and pesticides; Pet waste management provisions; Provisions for operation and management of septic systems; Provisions for solid waste management; Snow disposal and plowing plans relative to Wetland Resource Areas; Winter Road Salt and/or Sand Use and Storage restrictions; Street sweeping schedules; Provisions for prevention of illicit discharges to the stormwater management system; Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL; Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan; List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
	A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent. Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge: is within the Zone II or Interim Wellhead Protection Area
	is near or to other critical areas
	is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
	involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

applicable, the 44% TSS removal pretreatment requirement, are provided.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if



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Checklist for Stormwater Report

Cł	necklist (continued)
Sta	andard 4: Water Quality (continued)
	The BMP is sized (and calculations provided) based on:
	☐ The ½" or 1" Water Quality Volume or
	☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
	The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
	A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.
Sta	ndard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)
	The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report. The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted <i>prior to</i> the discharge of stormwater to the post-construction stormwater BMPs.
	The NPDES Multi-Sector General Permit does <i>not</i> cover the land use.
	LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
	All exposure has been eliminated.
	All exposure has <i>not</i> been eliminated and all BMPs selected are on MassDEP LUHPPL list.
	The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.
Sta	ndard 6: Critical Areas
\boxtimes	The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
	Critical areas and BMPs are identified in the Stormwater Report.



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Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
☐ Limited Project
 Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area. Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
☐ Bike Path and/or Foot Path
□ Redevelopment Project
☐ Redevelopment portion of mix of new and redevelopment.
Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report. The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures:
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued) Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued) ☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has not been included in the Stormwater Report but will be submitted **before** land disturbance begins. ☐ The project is **not** covered by a NPDES Construction General Permit. The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report. The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins. Standard 9: Operation and Maintenance Plan The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information: ■ Name of the stormwater management system owners; Party responsible for operation and maintenance; Schedule for implementation of routine and non-routine maintenance tasks: Plan showing the location of all stormwater BMPs maintenance access areas; Description and delineation of public safety features; Estimated operation and maintenance budget; and Operation and Maintenance Log Form. The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions: A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs; A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions. Standard 10: Prohibition of Illicit Discharges The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges; An Illicit Discharge Compliance Statement is attached:

NO Illicit Discharge Compliance Statement is attached but will be submitted *prior to* the discharge of

any stormwater to post-construction BMPs.



Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00).

Project Description

The Applicant, MassDOT, is proposing to construct a train station at Raynham Park located at 1958 Broadway Street in Raynham, Massachusetts along the Stoughton Rail Road Line (the Project). The Project will involve a center platform with canopy, ancillary landscape improvements, 432 parking spaces, bicycle parking facilities, and utility improvements to support this use. The Project involves demolishing abandoned kennels and several small buildings that currently exist on the site.

The site is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is not a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Site Description

The Project Site is an 11.4-acre parcel of land (the Site) located at 1958 Broadway Street in Raynham, Massachusetts (see Figure 1, Site Locus Map and Figure 2, Site Aerial). The site is located to the south of the former Raynham Park Greyhound Track and is adjacent to industrial buildings to the south, Route 138 (Broadway) to the east, and the MBTA railroad right-of-way to the west.

Wetland Resource Areas on the Site, shown on Figures 3 and 4, are described in Table 1. For additional information regarding the wetland resource areas present on the site see the Abbreviated Notice of Resource Area Delineation (ANRAD) prepared by VHB dated May 2011.

Raynham Park Station

Table 1 Wetland Resource Areas

Name	Critical Area	Zone 1 or Zone A	ORW or SRW	Zone II or IWPA	Description
Wetland R62.1	No	No	No	No	PSS/PEM/OW
Wetland R4	No	No	No	No	PFO
Wetland R5	No	No	No	No	PFO

Notes: Wetland Classifications: OW = Open Water, PEM = Palustrine Emergent, PFO = Palustrine Forested, PSS = Palustrine Scrub/Shrub

According to the National Resources Conservation Service (NRCS), surface soils on the Site include Scarboro mucky loamy fine sand, Whitman fine sandy loam, and Urban land, and are all classified as Hydrologic Soil Groups (HSG) D. Based on the soil evaluation, the Site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour) and high bedrock is indicated. The poorly drained soils onsite have a very low potential for infiltration. According to 1982 Rawls Rates, infiltration rates for the soils will be approximately 0.09 inches per hour.

The project is not located within the 100-year flood plain as shown on the FEMA Floodway Map, Town of Raynham, Massachusetts Bristol County, Community Panel Number 25005C0152F dated July 7, 2009. This map is included in Appendix B.

Existing Drainage Conditions

Under existing conditions the Site is almost entirely developed, impervious land. For the existing conditions hydrologic analysis, the site was divided into four drainage areas that contribute to four separate design points. The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This 6.85-acre area in the northeast portion of the site consists mainly of urban land that includes both paved and dirt roads. This area sheet flows, untreated, to the existing parking lot to the north where it is captured by the closed drainage system on the adjacent parcel.

<u>Drainage Area 2</u> – This 1.63-acre area in the southeast portion of the site consists mainly of paved areas and some small dirt roads that sheet flows, untreated, to Wetland R5 east of the site.

<u>Drainage Area 3</u> – This 7.54-acre area in the northwest portion of the site consists predominantly of paved areas with small patches of grassed areas that sheet flows, untreated, to the parking area to the north where it is captured by a closed drainage system on the adjacent parcel.



Raynham Park Station

<u>Drainage Area 4</u> – This 3.94-acre area in the southwest portion of the site consists predominantly of urban land that includes paved parking areas and driveways and small buildings and kennels. This area sheet flows, untreated, to the west to Wetland R62.1 via an unnamed perennial stream that continues to flow to the north.

Figure 3 illustrates the existing drainage patterns on the Site. Table 2 below provides a summary of the existing conditions hydrologic data.

Table 2
Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Adjacent Parking Area	1	6.85	97	6.1
2	Wetland R5	2	1.63	94	3.7
	Adjacent Parking Area /				
3	Drainage System	3	7.54	94	19.6
	Wetland R62.1				
4	(Perennial Stream)	4	3.94	89	17.1

Proposed Drainage Conditions

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site would be divided into four drainage areas that discharge treated stormwater to the same four existing Design Points. Existing drainage and grading patterns were maintained to the maximum extent possible in proposed conditions. Low impact development stormwater management techniques have been incorporated into the design. These practices are focused on decentralizing stormwater management techniques into the design that will reduce peak runoff rates, maximize groundwater recharge and treat for water quality. The following is a summary of each drainage area.

<u>Drainage Areas 1 (1.1 & 1.2)</u> – These two drainage areas combined, are the 6.60-acre area in the northeast portion of the site that consists of existing landscaped and broken pavement area that would remain unchanged in proposed conditions and a paved driveway leading to the station. The paved driveway of this area will sheet flow into two new grassed swales and then conveyed into a bioretention basin for treatment. During large events the bioretention basin will overflow at a designed overflow weir and sheet flow across the adjacent parcel and be captured by the catch basins as it does in existing conditions. The landscaped and broken paved areas would continue to sheet flow as it does in existing conditions before being captured by catch basins and discharged to the existing closed drainage system on the adjacent parcel.

<u>Drainage Area 2</u> – This 2.03-acre area in the southeast portion of the site will be an entirely landscaped area and would sheet flow to Wetland R5 east of the site. Under existing conditions this area is predominantly pavement and discharges, untreated, to the same design point.



Raynham Park Station

<u>Drainage Area 3.1</u> – This 2.04-acre area in the northwest portion of the site will consist of paved parking areas for the station and landscaped islands. The paved parking areas for the station would be collected by two deep sump hooded catch basins that then discharge to a sediment forebay and bioretention area for further treatment. In larger storm events the bioretention basin would overflow at a designed overflow weir and sheet flow to the adjacent parcel before being captured by the existing catch basins as it does under existing conditions.

<u>Drainage Area 3.2</u> – This 5.71-acre area in the northwest portion of the site will consist of paved roadways and existing landscaped areas that would remain unchanged. This portion of the drainage area 3 would sheet flow, as it does in existing conditions, to the adjacent parcel before being captured by the existing catch basins as it does under existing conditions.

<u>Drainage Area 4</u> – This 4.20-acre area in the southwest portion of the site will consist predominantly of paved parking areas for the station which will sheet flow through a gravel and grass filter strip then into a bioretention swale before being discharged to a culvert beneath the rail tracks and then to the unnamed perennial stream, as it does in existing conditions.

Table 3 below provides a summary of the proposed conditions hydrologic data.

Table 3
Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Adjacent Parking Area	1	6.60	95	8.4
2	Wetland R5	2	2.03	89	10.4
	Adjacent Parking Area/Drainage				
3.1	System	3	2.04	96	14.1
	Adjacent Parking Area/Drainage				
3.2	System	3	5.71	91	15.1
	Wetland R62.1				
4	(Perennial Stream)	4	4.20	91	16.6

The site has been designed with a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. Although the site does not discharge directly to a critical area, the proposed stormwater management system has been designed to treat the 1.0 inch Water Quality Volume, because drainage from the site ultimately discharges to an Area of Critical Environmental Concern (ACEC).

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) incorporated in the site design include:



Raynham Park Station

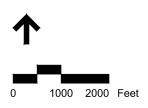
- Reduction of impervious area of 0.5 acres.
- Minimal disturbance to exiting trees and vegetation
- Grassed channel
- Gravel and grass filter strip
- Two bioretention basins and swales
- Bioretention swale

In general, stormwater runoff from all impervious surfaces in proposed conditions would receive some form of treatment for stormwater quality prior to discharge to the existing design points. Under existing conditions no such treatment is provided for stormwater runoff.

Hydraulic Analysis

The closed drainage system was designed for the 25-year storm event, in accordance with the Massachusetts Bay Transportation Authority, Railroad Operations, Commuter Rail Design Standards Manual, Volume 1.

Drainage pipes were sized using Manning's Equation for full-flow capacity and the Rational Method. Pipe sizing calculations are included in Appendix A of this report.



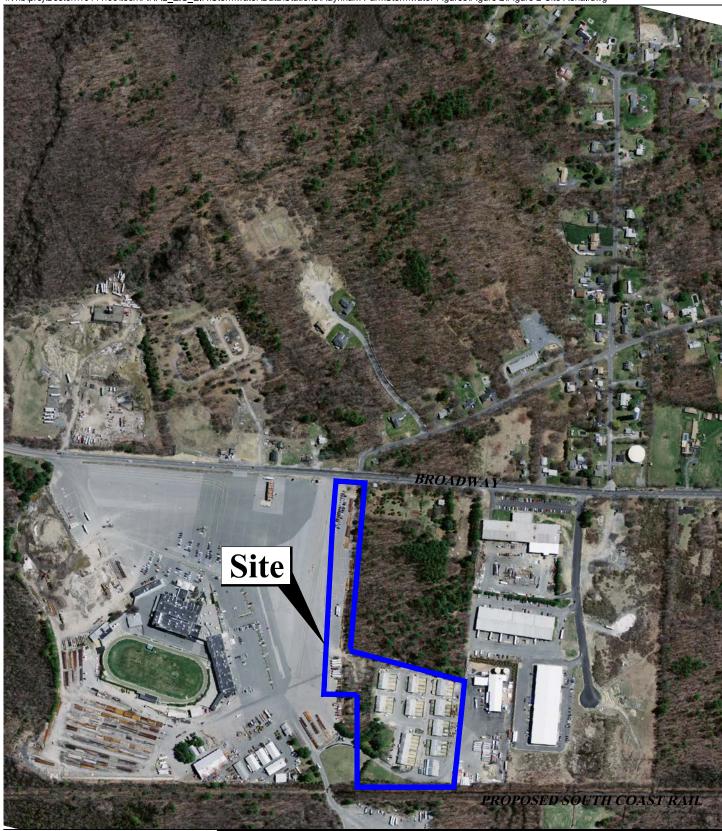
USGS Locus Map

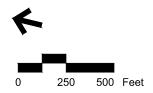
Raynham Park Station South Coast Rail Raynham, Massachusets

BM 25

Figure 1 May 2012

Vanasse Hangen Brustlin, Inc.



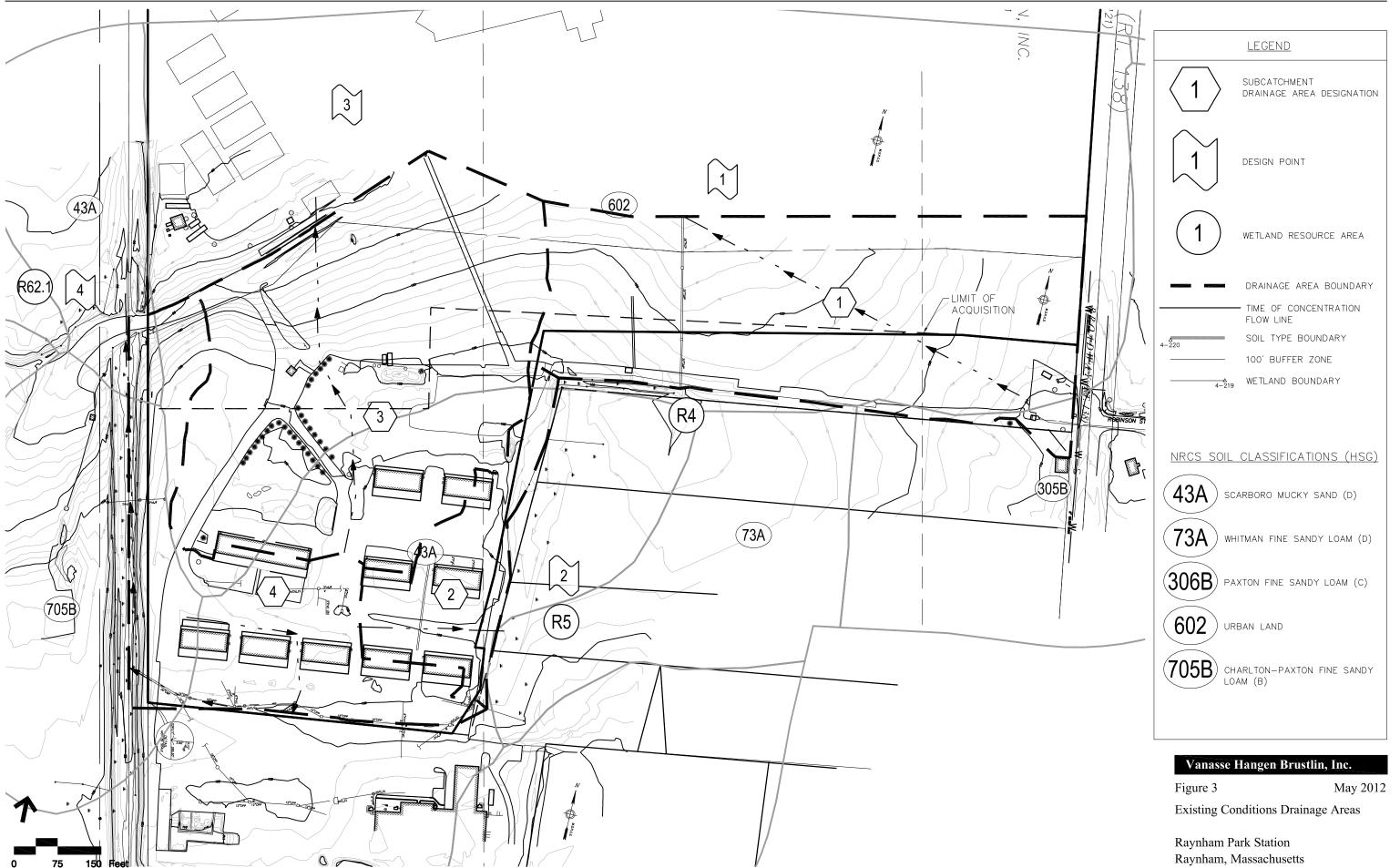


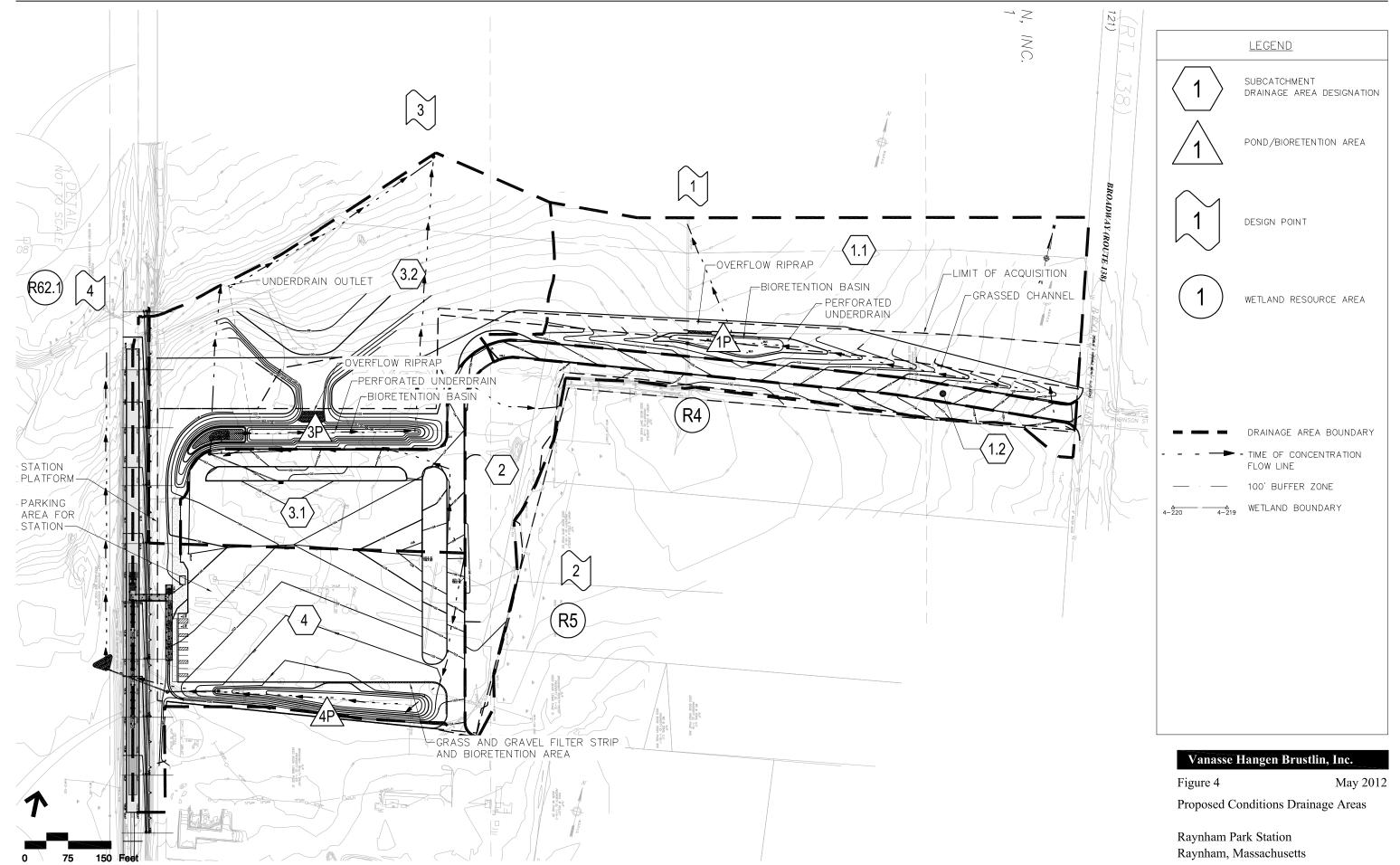
Site Aerial Map

Raynham Park Station South Coast Rail Raynham, Massachusets

Vanasse Hangen Brustlin, Inc.

Figure 2 May 2012







Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards at 310 CMR 10.05.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges would result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMPs that impound stormwater have been designed with stone to protect down gradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to fully comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 100-years. The results of the analysis, as summarized in Table 4 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Raynham Park Station

Table 4
Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	100-year
Design Point 1: Adjacent Parking Area			
Existing	21.8	31.1	45.7
Proposed	16.9	27.6	41.0
Design Point 2: Wetland R5			
Existing	5.3	7.8	11.6
Proposed	3.1	5.5	9.5
Design Point 3: Adjacent Parking			
Area/Drainage System			
Existing	15.8	23.2	34.7
Proposed	12.1	18.4	28.1
Design Point 4: Wetland R62.1			
Existing	7.4	11.6	18.0
Proposed	4.9	9.6	15.8

Standard 3: Stormwater Recharge

Due to the fact the site is comprised wholly of C and D soils and high bedrock as indicated in the geotechnical report, the project currently does not provide significant recharge and has been designed to infiltrate the required recharge volume to the maximum extent possible. The addition of pervious area and better subgrade soils in proposed basins will contribute to improved recharge.

Each infiltration BMP has been designed with an underdrain, due to the poor soils so it will drain completely within 72 hours.

A Geotechnical Report that describes subsurface soil conditions is included as an appendix to this report.

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide a minimum of 80% TSS removal for stormwater runoff from all proposed impervious surfaces. While not required, one-inch of water quality treatment for impervious surface runoff has been provided since the Site is in close proximity to the Hockomock Swamp Area of Critical Environmental Concern (ACEC).

Raynham Park Station

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is not considered a LUHPPL as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is not a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Standard 6: Critical Areas

The Project would discharge treated storm water near a critical area, the Hockomock Swamp Area of Critical Environmental Concern, via an unnamed stream and therefore has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and provide the pretreatment requirement of 44% TSS removal prior to infiltration. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan for the project.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff near or to critical areas, see Appendix D.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is a redevelopment, but has still been designed to fully comply with all ten of the Stormwater Management Standards.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project would disturb approximately 11.4 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) would be developed and a Notice of Intent for the CGP would be submitted by the contractor and owner at least 14 days before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls were discussed in the DEIR/S. Appropriate controls will be prepared and implemented by the contractor and MassDOT (MBTA) during construction in accordance with the final design and NPDES SWPPP

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan will be developed by the MBTA during final design for the Project.



Raynham Park Station

Standard 10: Prohibition of Illicit Discharges

Storm drainage structures remaining from the previous development which are part of the redevelopment area will be removed. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the site not included in the redevelopment project area. The Long-Term Pollution Prevention Plan will include measures to prevent illicit discharges.





Appendix A Standard 1 Computations and Supporting Information

Vanasse Han	Transportation	Land Develop	Fnvironmenta
	WHE)

Environmental Services 101 Walnut St., Watertown, MA 02471 (617) 924-1770 Hangen Brustlin, Inc. lopment ntal Services

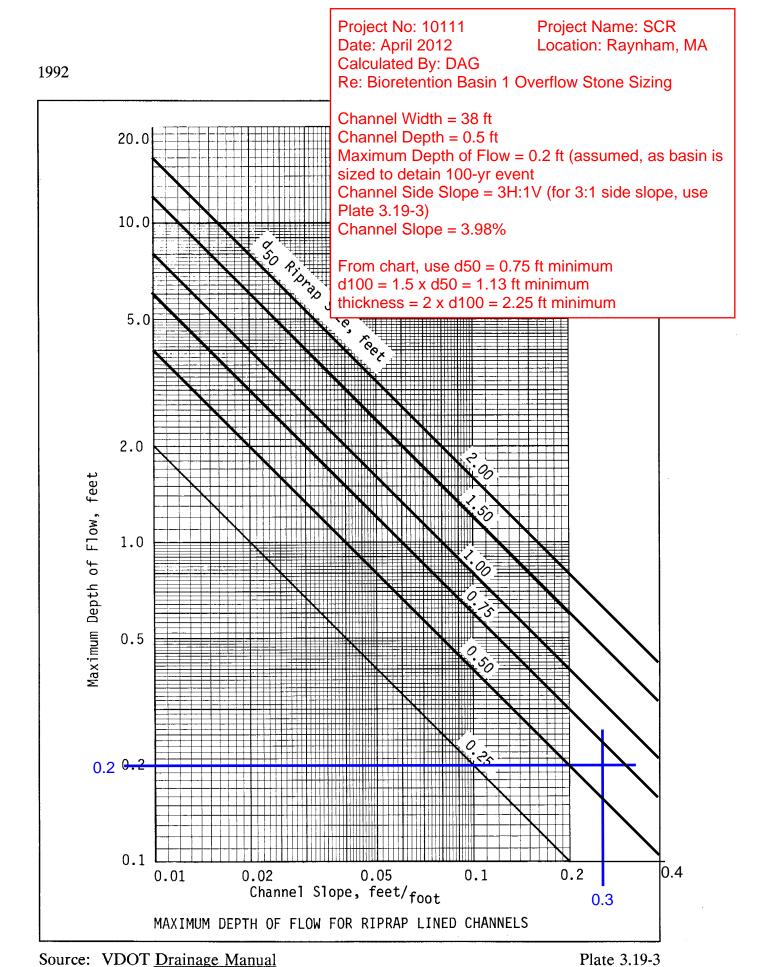
Name: Raynham Park Station Raynham, MA Client: MassDOT

Proj. No.: Date: Computed by: Checked by:

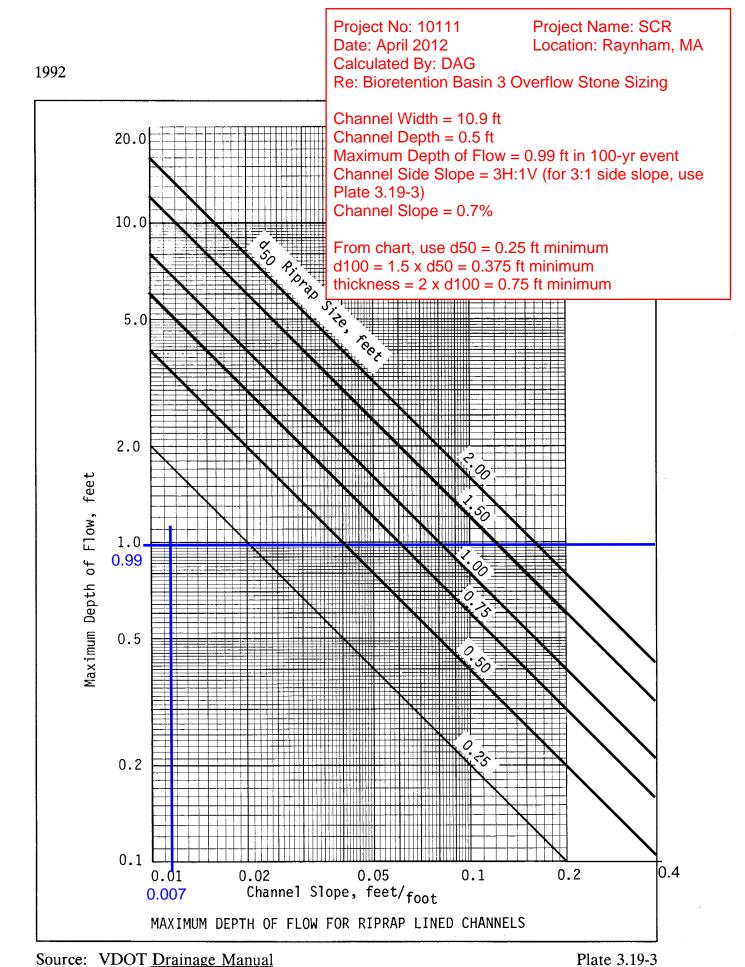
Design Parameters:
25
Year Storm
k_e 0.5 10111.00 5/21/2012 DAG EJM

Boston, MA IDF Curve

		OCATION	ABEA	Ċ	٥ × ٥	MI	TWO	IME (MIN)	*			NEWEN				CAPACITY				E HEORI			
	2)	3	8	- 1	(mm) = mm	-			- CECICIA								1			
DESCRIPTION	FROM	ТО	(AC.)			C×A	PIPE	CONC		Ø	>	c	PIPE	SLOPE	Ø fu∥	v full	LENGTH	FALL	RIM	ž	≥	W.S.E.	Freeboard
								TIME		cfs	fps		SIZE		ft^3/s	ft/s	Ħ	ft		UPPER	LOWER	ft	ft
ASERIES	CB A5	DMH A3	1.16	0.85	66:0	0.99	0.40	2.0	0.9	5.9	5.4	0.013	15	0.0100	6.5	5.3	130	1.30	102.4	99.4	98.1	0.66	3.4
	CB A4	DMH A3	06'0	0.72	0.64	0.64	0.57	2.0	0.9	3.9	3.8	0.013	15	0.0054	4.7	3.9	130	0.70	101.6	9.86	6'26	98.4	3.2
	DMH A3	FES A2	-	-	-	1.64	0.05	2.0	0.9	9.8	6.2	0.013	18	0.0100	10.5	5.9	20	0.20	102.7	2'26	97.5	97.2	5.5
B SERIES	OCS B3	DMH B2	3.15	0.85	2.68	2.68	0.22	2.0	0.9	16.1	6.8	0.013	24	0.0100	22.6	7.2	06	06.0	100.5	0.96	95.1	95.4	5.1
	DMH B2	FES B1	-	-	1	2.68	0.27	5.0	0.9	16.1	6.8	0.013	24	0.0100	22.6	7.2	110	1.10	105.5	0.36	93.9	94.4	11.1



*Sizing calculations represent minimum stone size. Larger stone may be required per detail plans.



*Sizing calculations represent minimum stone size. Larger stone may be required per detail plans.





Project #: 10111

Project: Raynham Park Station - SCR

Location: Raynham, MA

Calculated by: DAG Date: April 4, 2012 Checked by: VHB Date: April 4, 2012

Title: Riprap Outlet Protection Sizing

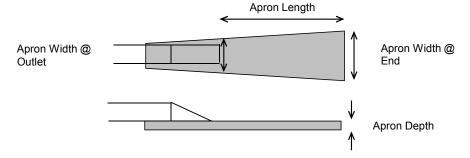
Sources: Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas

Massachusetts Department of Environmental Protection - Reprinted 2003 (pp. 118-120)

Erosion and Sediment Control Handbook - Third Edition 1992 (Chapter 3.18)

Virginia Department of Conservation and Recreation (DCR)

Attachments: Virginia DCR Erosion and Sediment Control Handbook Plate 3.18-3



Apron Width at Outlet: Width = $3 \times pipe dia$. (or width of channel)

Apron Length: Length = From Virginia DCR Handbook - Plate 3.18-3 if Tw depth is < 1/2 dia. Length = From Virginia DCR Handbook - Plate 3.18-4 if Tw dwpth is >= 1/2 dia.

Apron Width at End: Width = dia. + apron length if Tw depth is < 1/2 dia. Width = dia. + 0.4 x apron length if Tw dwpth is >= 1/2 dia.

or apron width = channel width if a well defined channel exists

Rock Riprap: Median Diameter (d_{50}) = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia = $1.5 \times d_{50}$

Apron Depth: 6" or 1.5 x largest stone dia

	Outlet Description
Design Element	FES C1
Design Storm (yr):	100
Defined Channel (yes/no)	no
Pipe Dia (D), in	22
Tail Water (Tw), ft	Tw < 0.5D during low tide
Flow (Q), cfs	17.4
Apron Width (outlet), ft	6
Apron Length, ft	17
Apron Width (end), ft	19
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Appendix B Standard 2 Computations and Supporting Information

Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Bristol County. Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.



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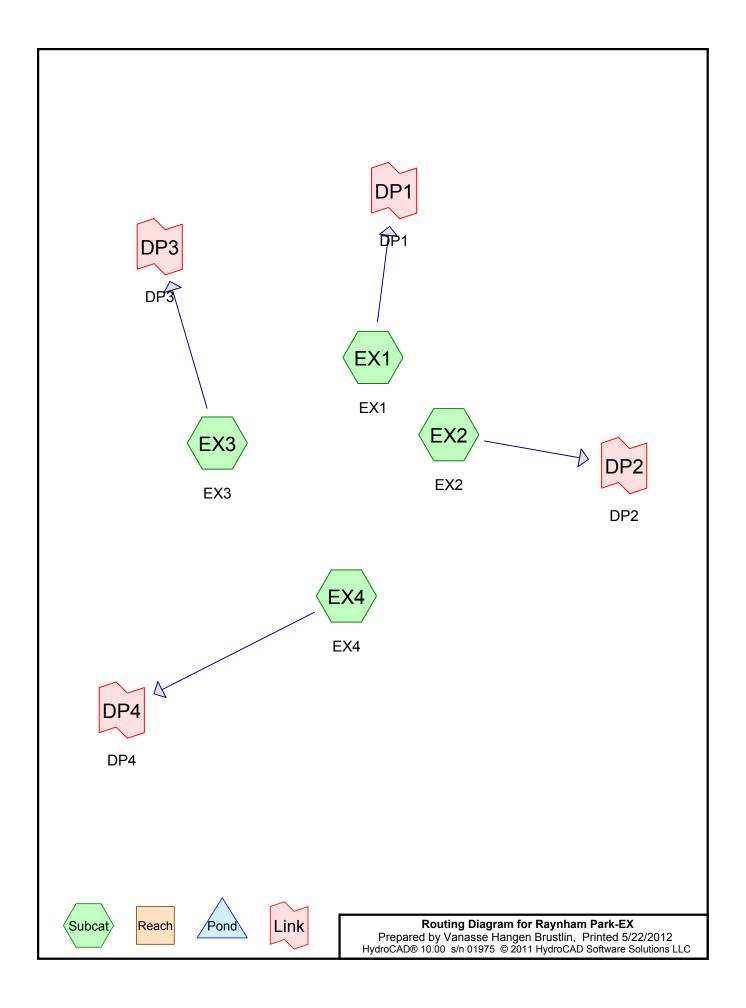
FEMA Flood Map





Raynham Park Station

HydroCAD Analysis: Existing Conditions



Raynham Park-EX

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Area Listing (all nodes)

Area	CN	Description
(acres)		(subcatchment-numbers)
0.491	60	Woods, Fair, HSG B (EX4)
0.126	69	50-75% Grass cover, Fair, HSG B (EX4)
0.038	73	Woods, Fair, HSG C (EX1)
0.261	79	Woods, Fair, HSG D (EX2, EX3, EX4)
0.013	82	Dirt roads, HSG B (EX4)
0.010	83	Woods, Poor, HSG D (EX4)
2.294	84	50-75% Grass cover, Fair, HSG D (EX2, EX3, EX4)
0.187	87	Dirt roads, HSG C (EX1)
1.384	89	Dirt roads, HSG D (EX1, EX2, EX3, EX4)
0.401	94	Fallow, bare soil, HSG D (EX1)
0.961	96	Gravel surface, HSG D (EX2, EX3)
0.011	98	Paved parking, HSG C (EX1)
10.951	98	Paved parking, HSG D (EX1, EX2, EX3)
1.582	98	Paved roads w/curbs & sewers, HSG D (EX4)
0.037	98	Roofs, HSG B (EX4)
1.048	98	Roofs, HSG D (EX2, EX3, EX4)
0.121	98	Water Surface, HSG B (EX4)
0.041	98	Water Surface, HSG D (EX4)
19.957	94	TOTAL AREA



FEIS/FEIR Technical Report Stormwater Raynham Park Station

2-Year Storm Event - Existing

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Raynham Park\HydroCAD\

Raynham Park-EX

Type III 24-hr 2-Year Rainfall=3.40"

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Page 1

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=6.849 ac 90.83% Impervious Runoff Depth>3.05"

Flow Length=777' Tc=6.1 min CN=97 Runoff=21.76 cfs 1.743 af

SubcatchmentEX2: EX2 Runoff Area=1.629 ac 54.33% Impervious Runoff Depth>2.74"

Flow Length=234' Tc=3.7 min CN=94 Runoff=5.30 cfs 0.372 af

SubcatchmentEX3: EX3 Runoff Area=7.543 ac 58.56% Impervious Runoff Depth>2.73"

Flow Length=659' Tc=19.6 min CN=94 Runoff=15.79 cfs 1.716 af

SubcatchmentEX4: EX4 Runoff Area=3.936 ac 57.62% Impervious Runoff Depth>2.26"

Flow Length=1,346' Tc=17.1 min CN=89 Runoff=7.42 cfs 0.741 af

Link DP1: DP1 Inflow=21.76 cfs 1.743 af

Primary=21.76 cfs 1.743 af

Link DP2: DP2 Inflow=5.30 cfs 0.372 af

Primary=5.30 cfs 0.372 af

Link DP3: DP3 Inflow=15.79 cfs 1.716 af

Primary=15.79 cfs 1.716 af

Link DP4: DP4 Inflow=7.42 cfs 0.741 af

Primary=7.42 cfs 0.741 af

Total Runoff Area = 19.957 ac Runoff Volume = 4.571 af Average Runoff Depth = 2.75" 30.90% Pervious = 6.166 ac 69.10% Impervious = 13.791 ac

Raynham Park-EX

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Subcatchment EX1: EX1

Runoff = 21.76 cfs @ 12.09 hrs, Volume= 1.743 af, Depth> 3.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Area	(ac) C	N Des	cription		
	0.	187	87 Dirt	roads, HS	G C	
	0.	002	89 Dirt	roads, HS	G D	
	0.	401		,	oil, HSG D	
	0.	011		ed parking		
				ed parking	•	
_	0.	038	73 Woo	ods, Fair, F	ISG C	
	6.	849	,	ghted Aver	•	
	0.	628	9.17	% Perviou	s Area	
	6.	221	90.8	3% Imper	vious Area	
	_		01			D
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	1.9	50	0.0320	0.44		Sheet Flow,
						Fallow n= 0.050 P2= 3.30"
	4.2	727	0.0199	2.86		Shallow Concentrated Flow,
_						Paved Kv= 20.3 fps
	6.1	777	Total			

Summary for Subcatchment EX2: EX2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 5.30 cfs @ 12.06 hrs, Volume= 0.372 af, Depth> 2.74"

Area (ac)	CN	Description
0.611	89	Dirt roads, HSG D
0.038	89	Dirt roads, HSG D
0.018	96	Gravel surface, HSG D
0.590	98	Paved parking, HSG D
0.068	84	50-75% Grass cover, Fair, HSG D
0.295	98	Roofs, HSG D
0.009	79	Woods, Fair, HSG D
0.000	79	Woods, Fair, HSG D
1.629	94	Weighted Average
0.744		45.67% Pervious Area
0.885		54.33% Impervious Area

Raynham Park-EX

Type III 24-hr 2-Year Rainfall=3.40"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
(111111)	(IEEL)	(11/11)	(10366)	(613)	
1.1	50	0.0060	0.75		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.30"
2.6	184	0.0034	1.18		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
3 7	234	Total			•

Summary for Subcatchment EX3: EX3

Runoff = 15.79 cfs @ 12.26 hrs, Volume= 1.716 af, Depth> 2.73"

Area	(ac)	CN I	Des	cription						
0.	0.131 89 Dirt roads, HSG D									
0.	.104	89	Dirt ı	roads, HS0	G D					
0.	.615	96	Grav	el surface	, HSG D					
0.	.328	96	Grav	el surface	, HSG D					
_	.548		Paved parking, HSG D							
	.603			ed parking						
	.241				cover, Fair					
	.509				cover, Fair	HSG D				
	.229			fs, HSG D						
	.037			fs, HSG D	100 0					
	.025			ds, Fair, H						
	.173			ds, Fair, F						
	.543			ghted Aver						
	.126			4% Pervio						
4.	.417	;	58.5	6% imperv	ious Area					
Tc	Length	SI	ope	Velocity	Capacity	Description				
(min)	(feet)		t/ft)	(ft/sec)	(cfs)	Description				
11.1	50			0.08	(010)	Sheet Flow,				
11.1	50	0.00	030	0.00		Grass: Dense n= 0.240 P2= 3.30"				
5.6	227	0.00	093	0.68		Shallow Concentrated Flow,				
0.0		0.00		0.00		Short Grass Pasture Kv= 7.0 fps				
1.3	155	0.07	774	1.95		Shallow Concentrated Flow,				
						Short Grass Pasture Kv= 7.0 fps				
1.3	159	0.0	107	2.10		Shallow Concentrated Flow,				
						Paved Kv= 20.3 fps				
0.3	68	0.04	485	4.47		Shallow Concentrated Flow,				
						Paved Kv= 20.3 fps				
19.6	659	Tota	al							

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Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Subcatchment EX4: EX4

Runoff = 7.42 cfs @ 12.23 hrs, Volume= 0.741 af, Depth> 2.26"

Area	(ac) C	N Des	cription							
0.	013	32 Dirt	roads, HS	G B						
0.	449	89 Dirt	Dirt roads, HSG D							
0.	049	89 Dirt	roads, HS	G D						
0.	275	98 Pave	ed roads w	//curbs & se	ewers, HSG D					
1.	202	98 Pave	Paved roads w/curbs & sewers, HSG D							
		98 Pave	Paved roads w/curbs & sewers, HSG D							
		69 50-7	50-75% Grass cover, Fair, HSG B							
		84 50-7	50-75% Grass cover, Fair, HSG D							
		84 50-7	50-75% Grass cover, Fair, HSG D							
			Roofs, HSG B							
			fs, HSG D							
			fs, HSG D							
			er Surface	•						
			er Surface	•						
			ds, Fair, F							
			Woods, Fair, HSG D							
			ds, Poor,							
			ghted Aver							
	668		8% Pervio							
2.	268	57.6	2% Imper	vious Area						
Тс	Length	Slope	Velocity	Capacity	Description					
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	'					
2.7	50	0.0140	0.31	, ,	Sheet Flow,					
					Fallow n= 0.050 P2= 3.30"					
1.8	141	0.0065	1.30		Shallow Concentrated Flow,					
					Unpaved Kv= 16.1 fps					
0.9	145	0.0159	2.56		Shallow Concentrated Flow,					
					Paved Kv= 20.3 fps					
3.2	285	0.0019	1.49	1.83	Pipe Channel, CMP_Round 15"					
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'					
					n= 0.020 Corrugated PE, corrugated interior					
0.1	78	0.0410	11.00	53.98	Pipe Channel, CMP_Round 30"					
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63'					
					n= 0.020 Corrugated PE, corrugated interior					
8.4	647	0.0073	1.28		Shallow Concentrated Flow,					
					Grassed Waterway Kv= 15.0 fps					
17.1	1,346	Total								

Raynham Park-EX

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Link DP1: DP1

Inflow Area = 6.849 ac, 90.83% Impervious, Inflow Depth > 3.05" for 2-Year event

Inflow = 21.76 cfs @ 12.09 hrs, Volume= 1.743 af

Primary = 21.76 cfs @ 12.09 hrs, Volume= 1.743 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP2: DP2

Inflow Area = 1.629 ac, 54.33% Impervious, Inflow Depth > 2.74" for 2-Year event

Inflow = 5.30 cfs @ 12.06 hrs, Volume= 0.372 af

Primary = 5.30 cfs @ 12.06 hrs, Volume= 0.372 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP3: DP3

Inflow Area = 7.543 ac, 58.56% Impervious, Inflow Depth > 2.73" for 2-Year event

Inflow = 15.79 cfs @ 12.26 hrs, Volume= 1.716 af

Primary = 15.79 cfs @ 12.26 hrs, Volume= 1.716 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP4: DP4

Inflow Area = 3.936 ac, 57.62% Impervious, Inflow Depth > 2.26" for 2-Year event

Inflow = 7.42 cfs @ 12.23 hrs, Volume= 0.741 af

Primary = 7.42 cfs @ 12.23 hrs, Volume= 0.741 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater Raynham Park Station

10-Year Storm Event - Existing

Raynham Park-EX
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Type III 24-hr 10-Year Rainfall=4.80"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=6.849 ac 90.83% Impervious Runoff Depth>4.44"

Flow Length=777' Tc=6.1 min CN=97 Runoff=31.09 cfs 2.537 af

Subcatchment EX2: EX2 Runoff Area=1.629 ac 54.33% Impervious Runoff Depth>4.11"

Flow Length=234' Tc=3.7 min CN=94 Runoff=7.77 cfs 0.558 af

SubcatchmentEX3: EX3 Runoff Area=7.543 ac 58.56% Impervious Runoff Depth>4.10"

Flow Length=659' Tc=19.6 min CN=94 Runoff=23.20 cfs 2.577 af

SubcatchmentEX4: EX4 Runoff Area=3.936 ac 57.62% Impervious Runoff Depth>3.57"

Flow Length=1,346' Tc=17.1 min CN=89 Runoff=11.55 cfs 1.171 af

Link DP1: DP1 Inflow=31.09 cfs 2.537 af

Primary=31.09 cfs 2.537 af

Link DP2: DP2 Inflow=7.77 cfs 0.558 af

Primary=7.77 cfs 0.558 af

Link DP3: DP3 Inflow=23.20 cfs 2.577 af

Primary=23.20 cfs 2.577 af

Link DP4: DP4 Inflow=11.55 cfs 1.171 af

Primary=11.55 cfs 1.171 af

Total Runoff Area = 19.957 ac Runoff Volume = 6.843 af Average Runoff Depth = 4.11" 30.90% Pervious = 6.166 ac 69.10% Impervious = 13.791 ac

Raynham Park-EX

Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Subcatchment EX1: EX1

Runoff = 31.09 cfs @ 12.09 hrs, Volume= 2.537 af, Depth> 4.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

_	Area	(ac)	CN	Desc	cription		
	0.	187	87	Dirt ı	roads, HS0	G C	
	0.	002	89	Dirt ı	roads, HS0	G D	
	0.	401	94	Fallo	w, bare so	oil, HSG D	
	0.	011	98	Pave	ed parking	, HSG C	
	6.	210	98	Pave	ed parking	, HSG D	
_	0.	038	73	Woo	ds, Fair, F	ISG C	
	6.	849	97	Weig	ghted Aver	age	
	0.	628		9.17	% Perviou	s Area	
	6.	221		90.8	3% Imperv	ious Area	
	Tc	Length		ope	Velocity	Capacity	Description
_	(min)	(feet)) (f	ft/ft)	(ft/sec)	(cfs)	
	1.9	50	0.0	320	0.44		Sheet Flow,
							Fallow n= 0.050 P2= 3.30"
	4.2	727	7 0.0	199	2.86		Shallow Concentrated Flow,
_							Paved Kv= 20.3 fps
	6.1	777	7 Tot	al			

Summary for Subcatchment EX2: EX2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 7.77 cfs @ 12.05 hrs, Volume= 0.558 af, Depth> 4.11"

 Area (ac)	CN	Description
0.611	89	Dirt roads, HSG D
0.038	89	Dirt roads, HSG D
0.018	96	Gravel surface, HSG D
0.590	98	Paved parking, HSG D
0.068	84	50-75% Grass cover, Fair, HSG D
0.295	98	Roofs, HSG D
0.009	79	Woods, Fair, HSG D
 0.000	79	Woods, Fair, HSG D
1.629	94	Weighted Average
0.744		45.67% Pervious Area
0.885		54.33% Impervious Area

Raynham Park-EX

Type III 24-hr 10-Year Rainfall=4.80"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
(111111)	(IEEL)	(11/11)	(10366)	(613)	
1.1	50	0.0060	0.75		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.30"
2.6	184	0.0034	1.18		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
3 7	234	Total			•

Summary for Subcatchment EX3: EX3

Runoff = 23.20 cfs @ 12.26 hrs, Volume= 2.577 af, Depth> 4.10"

Area	(ac)	CN I	Des	cription						
0.	0.131 89 Dirt roads, HSG D									
0.	.104	89	Dirt ı	roads, HS0	G D					
0.	.615	96	Grav	el surface	, HSG D					
0.	.328	96	Grav	el surface	, HSG D					
_	.548		Paved parking, HSG D							
	.603			ed parking						
	.241				cover, Fair					
	.509				cover, Fair	HSG D				
	.229			fs, HSG D						
	.037			fs, HSG D	100 0					
	.025			ds, Fair, H						
	.173			ds, Fair, F						
	.543			ghted Aver						
	.126			4% Pervio						
4.	.417	;	58.5	6% imperv	ious Area					
Tc	Length	SI	ope	Velocity	Capacity	Description				
(min)	(feet)		t/ft)	(ft/sec)	(cfs)	Description				
11.1	50			0.08	(010)	Sheet Flow,				
11.1	50	0.00	030	0.00		Grass: Dense n= 0.240 P2= 3.30"				
5.6	227	0.00	093	0.68		Shallow Concentrated Flow,				
0.0		0.00		0.00		Short Grass Pasture Kv= 7.0 fps				
1.3	155	0.07	774	1.95		Shallow Concentrated Flow,				
						Short Grass Pasture Kv= 7.0 fps				
1.3	159	0.0	107	2.10		Shallow Concentrated Flow,				
						Paved Kv= 20.3 fps				
0.3	68	0.04	485	4.47		Shallow Concentrated Flow,				
						Paved Kv= 20.3 fps				
19.6	659	Tota	al							

Raynham Park-EX

Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Subcatchment EX4: EX4

Runoff = 11.55 cfs @ 12.23 hrs, Volume= 1.171 af, Depth> 3.57"

Area	(ac) C	N Desc	cription							
0.	.013 8									
0.	.449 8	39 Dirt i	roads, HS	G D						
0.	.049 8	39 Dirt i	Dirt roads, HSG D							
0.	.275	8 Pave	Paved roads w/curbs & sewers, HSG D							
			Paved roads w/curbs & sewers, HSG D							
			Paved roads w/curbs & sewers, HSG D							
			50-75% Grass cover, Fair, HSG B							
			50-75% Grass cover, Fair, HSG D							
				cover, Fair	HSG D					
			fs, HSG B							
			fs, HSG D							
			fs, HSG D	LICC D						
			er Surface							
			er Surface ds, Fair, F	•						
			ids, Fair, F ids, Fair, F							
			ds, Faii, F ds, Poor, I							
			ghted Aver							
	.930 c		8% Pervio							
	.268	_		ious Area						
	.200	01.0	270 mmpon	7104071104						
Tc	Length	Slope	Velocity	Capacity	Description					
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	'					
2.7	50	0.0140	0.31	, ,	Sheet Flow,					
					Fallow n= 0.050 P2= 3.30"					
1.8	141	0.0065	1.30		Shallow Concentrated Flow,					
					Unpaved Kv= 16.1 fps					
0.9	145	0.0159	2.56		Shallow Concentrated Flow,					
					Paved Kv= 20.3 fps					
3.2	285	0.0019	1.49	1.83						
					15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'					
					n= 0.020 Corrugated PE, corrugated interior					
0.1	78	0.0410	11.00	53.98	Pipe Channel, CMP_Round 30"					
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63'					
0.4	0.47	0.0070	4.00		n= 0.020 Corrugated PE, corrugated interior					
8.4	647	0.0073	1.28		Shallow Concentrated Flow,					
47.4	4.040	T-4 !			Grassed Waterway Kv= 15.0 fps					
17.1	1,346	Total								

Raynham Park-EX

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Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Link DP1: DP1

Inflow Area = 6.849 ac, 90.83% Impervious, Inflow Depth > 4.44" for 10-Year event

Inflow = 31.09 cfs @ 12.09 hrs, Volume= 2.537 af

Primary = 31.09 cfs @ 12.09 hrs, Volume= 2.537 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP2: DP2

Inflow Area = 1.629 ac, 54.33% Impervious, Inflow Depth > 4.11" for 10-Year event

Inflow = 7.77 cfs @ 12.05 hrs, Volume= 0.558 af

Primary = 7.77 cfs @ 12.05 hrs, Volume= 0.558 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP3: DP3

Inflow Area = 7.543 ac, 58.56% Impervious, Inflow Depth > 4.10" for 10-Year event

Inflow = 23.20 cfs @ 12.26 hrs, Volume= 2.577 af

Primary = 23.20 cfs @ 12.26 hrs, Volume= 2.577 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP4: DP4

Inflow Area = 3.936 ac, 57.62% Impervious, Inflow Depth > 3.57" for 10-Year event

Inflow = 11.55 cfs @ 12.23 hrs, Volume= 1.171 af

Primary = 11.55 cfs @ 12.23 hrs, Volume= 1.171 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater Raynham Park Station

100-Year Storm Event - Existing

Raynham Park-EX
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Type III 24-hr 100-Year Rainfall=7.00"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=6.849 ac 90.83% Impervious Runoff Depth>6.64"

Flow Length=777' Tc=6.1 min CN=97 Runoff=45.66 cfs 3.789 af

SubcatchmentEX2: EX2 Runoff Area=1.629 ac 54.33% Impervious Runoff Depth>6.29"

Flow Length=234' Tc=3.7 min CN=94 Runoff=11.60 cfs 0.853 af

SubcatchmentEX3: EX3 Runoff Area=7.543 ac 58.56% Impervious Runoff Depth>6.27"

Flow Length=659' Tc=19.6 min CN=94 Runoff=34.70 cfs 3.942 af

SubcatchmentEX4: EX4 Runoff Area=3.936 ac 57.62% Impervious Runoff Depth>5.69"

Flow Length=1,346' Tc=17.1 min CN=89 Runoff=18.01 cfs 1.868 af

Link DP1: DP1 Inflow=45.66 cfs 3.789 af

Primary=45.66 cfs 3.789 af

Link DP2: DP2 Inflow=11.60 cfs 0.853 af

Primary=11.60 cfs 0.853 af

Link DP3: DP3 Inflow=34.70 cfs 3.942 af

Primary=34.70 cfs 3.942 af

Link DP4: DP4 Inflow=18.01 cfs 1.868 af

Primary=18.01 cfs 1.868 af

Total Runoff Area = 19.957 ac Runoff Volume = 10.452 af Average Runoff Depth = 6.28" 30.90% Pervious = 6.166 ac 69.10% Impervious = 13.791 ac

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Subcatchment EX1: EX1

Runoff = 45.66 cfs @ 12.09 hrs, Volume= 3.789 af, Depth> 6.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

	Area	(ac) (CN Des	cription		
	0.	187	87 Dirt	roads, HS	G C	
	0.	002	89 Dirt	roads, HS	G D	
	0.	401	94 Fall	ow, bare so	oil, HSG D	
	0.	011	98 Pav	ed parking	, HSG C	
	6.	210	98 Pav	ed parking	, HSG D	
_	0.	038	73 Wo	ods, Fair, F	ISG C	
	6.	849	97 We	ighted Avei	rage	
	0.	628	9.1	7% Perviou	ıs Area	
	6.	221	90.8	33% Imper	vious Area	
	Тс	Length			Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	1.9	50	0.0320	0.44		Sheet Flow,
						Fallow n= 0.050 P2= 3.30"
	4.2	727	0.0199	2.86		Shallow Concentrated Flow,
_						Paved Kv= 20.3 fps
	6.1	777	Total			

Summary for Subcatchment EX2: EX2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 11.60 cfs @ 12.05 hrs, Volume= 0.853 af, Depth> 6.29"

Area (ac)	CN	Description
0.611	89	Dirt roads, HSG D
0.038	89	Dirt roads, HSG D
0.018	96	Gravel surface, HSG D
0.590	98	Paved parking, HSG D
0.068	84	50-75% Grass cover, Fair, HSG D
0.295	98	Roofs, HSG D
0.009	79	Woods, Fair, HSG D
0.000	79	Woods, Fair, HSG D
1.629	94	Weighted Average
0.744		45.67% Pervious Area
0.885		54.33% Impervious Area

Raynham Park-EX

Type III 24-hr 100-Year Rainfall=7.00"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
(111111)	(IEEL)	(11/11)	(10366)	(613)	
1.1	50	0.0060	0.75		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.30"
2.6	184	0.0034	1.18		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
3 7	234	Total			•

Summary for Subcatchment EX3: EX3

Runoff = 34.70 cfs @ 12.26 hrs, Volume= 3.942 af, Depth> 6.27"

_	Area	(ac) C	N Des	cription				
	0.	131 8	39 Dirt	roads, HS	G D			
	0.	104 8	39 Dirt	roads, HS	G D			
				vel surface				
				vel surface	,			
	_			ed parking				
				ed parking				
					cover, Fair			
					cover, Fair	HSG D		
				fs, HSG D				
				fs, HSG D				
				ods, Fair, F				
_				ods, Fair, F				
				ghted Aver	•			
		126		41.44% Pervious Area				
	4.	417	58.5	6% Imper	vious Area			
	_		01		0 "			
	Tc	Length	Slope	Velocity	Capacity	Description		
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
	11.1	50	0.0090	0.08		Sheet Flow,		
	5 0	007	0.0000	0.00		Grass: Dense n= 0.240 P2= 3.30"		
	5.6	227	0.0093	0.68		Shallow Concentrated Flow,		
	4.0	155	0.0774	4.05		Short Grass Pasture Kv= 7.0 fps		
	1.3	155	0.0774	1.95		Shallow Concentrated Flow,		
	1.3	159	0.0107	2.10		Short Grass Pasture Kv= 7.0 fps		
	1.3	159	0.0107	2.10		Shallow Concentrated Flow, Paved Kv= 20.3 fps		
	0.3	68	0.0485	4.47		Shallow Concentrated Flow,		
	0.5	00	0.0400	7.7/		Paved Kv= 20.3 fps		
-	19.6	659	Total			1 4704 117 20.0 190		
	15.0	009	ı Ulai					

Raynham Park-EX

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Type III 24-hr 100-Year Rainfall=7.00" Printed 5/22/2012

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Summary for Subcatchment EX4: EX4

Runoff = 18.01 cfs @ 12.23 hrs, Volume= 1.868 af, Depth> 5.69"

Area ((ac) C	N Desc	cription		
			roads, HS		
			roads, HS		
			roads, HS		
					ewers, HSG D
					ewers, HSG D
					ewers, HSG D
				cover, Fair cover, Fair	
				cover, Fair	
			s, HSG B	cover, i ali	, 1100 D
			fs, HSG D		
			s, HSG D		
			er Surface	, HSG B	
0.0	041 9	98 Wate	er Surface	, HSG D	
			ds, Fair, F		
			ds, Fair, F		
			ds, Poor,		
			hted Aver		
	668		8% Pervio		
2.7	268	57.6	2% imper	vious Area	
Тс	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	·
2.7	50	0.0140	0.31		Sheet Flow,
					Fallow n= 0.050 P2= 3.30"
1.8	141	0.0065	1.30		Shallow Concentrated Flow,
	4.4=	0.0450	0.50		Unpaved Kv= 16.1 fps
0.9	145	0.0159	2.56		Shallow Concentrated Flow,
3.2	285	0.0019	1.49	1.83	Paved Kv= 20.3 fps
3.2	200	0.0019	1.49	1.03	Pipe Channel, CMP_Round 15" 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31'
					n= 0.020 Corrugated PE, corrugated interior
0.1	78	0.0410	11.00	53.98	Pipe Channel, CMP_Round 30"
0.1	, 5	0.0410	. 1.00	50.00	30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63'
					n= 0.020 Corrugated PE, corrugated interior
8.4	647	0.0073	1.28		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
17.1	1,346	Total		<u> </u>	

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Link DP1: DP1

Inflow Area = 6.849 ac, 90.83% Impervious, Inflow Depth > 6.64" for 100-Year event

Inflow = 45.66 cfs @ 12.09 hrs, Volume= 3.789 af

Primary = 45.66 cfs @ 12.09 hrs, Volume= 3.789 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP2: DP2

Inflow Area = 1.629 ac, 54.33% Impervious, Inflow Depth > 6.29" for 100-Year event

Inflow = 11.60 cfs @ 12.05 hrs, Volume= 0.853 af

Primary = 11.60 cfs @ 12.05 hrs, Volume= 0.853 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP3: DP3

Inflow Area = 7.543 ac, 58.56% Impervious, Inflow Depth > 6.27" for 100-Year event

Inflow = 34.70 cfs @ 12.26 hrs, Volume= 3.942 af

Primary = 34.70 cfs @ 12.26 hrs, Volume= 3.942 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP4: DP4

Inflow Area = 3.936 ac, 57.62% Impervious, Inflow Depth > 5.69" for 100-Year event

Inflow = 18.01 cfs @ 12.23 hrs, Volume= 1.868 af

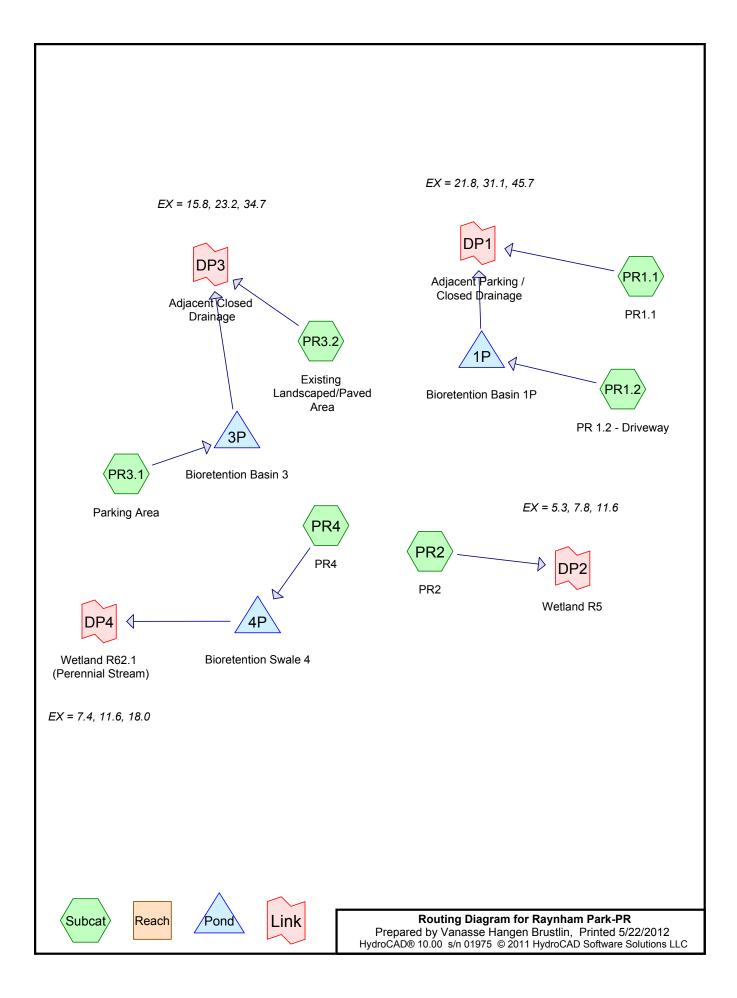
Primary = 18.01 cfs @ 12.23 hrs, Volume= 1.868 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater Raynham Park Station

HydroCAD Analysis: Proposed Conditions



Raynham Park-PR

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Area Listing (all nodes)

Area	CN	Description
(acres)		(subcatchment-numbers)
0.798	69	50-75% Grass cover, Fair, HSG B (PR3.2, PR4)
0.042	73	Woods, Fair, HSG C (PR1.1)
0.137	79	50-75% Grass cover, Fair, HSG C (PR1.1)
0.009	79	Woods, Fair, HSG D (PR2)
2.022	80	>75% Grass cover, Good, HSG D (PR2)
4.363	84	50-75% Grass cover, Fair, HSG D (PR1.1, PR3.1, PR3.2, PR4)
0.032	94	Fallow, bare soil, HSG D (PR1.1)
0.689	98	Paved parking, HSG A (PR1.2)
0.509	98	Paved parking, HSG B (PR3.2, PR4)
11.919	98	Paved parking, HSG D (PR1.1, PR3.1, PR3.2, PR4)
0.054	98	Paved roads w/curbs & sewers, HSG C (PR1.1)
20.574	92	TOTAL AREA



FEIS/FEIR Technical Report Stormwater Raynham Park Station

2-Year Storm Event - Proposed

Raynham Park-PR

Type III 24-hr 2-Year Rainfall=3.40"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR1.1: PR1.1 Runoff Area=5.908 ac 80.97% Impervious Runoff Depth>2.84"

Flow Length=682' Tc=8.4 min CN=95 Runoff=16.88 cfs 1.397 af

SubcatchmentPR1.2: PR 1.2 - Driveway Runoff Area=0.689 ac 100.00% Impervious Runoff Depth>3.17"

Tc=5.0 min CN=98 Runoff=2.29 cfs 0.182 af

SubcatchmentPR2: PR2 Runoff Area=2.031 ac 0.00% Impervious Runoff Depth>1.55"

Flow Length=162' Slope=0.0090 '/' Tc=10.4 min CN=80 Runoff=3.14 cfs 0.263 af

SubcatchmentPR3.1: Parking Area Runoff Area=2.040 ac 83.82% Impervious Runoff Depth>2.94"

Flow Length=1,335' Tc=14.1 min CN=96 Runoff=5.06 cfs 0.500 af

SubcatchmentPR3.2: Existing Runoff Area=5.706 ac 56.17% Impervious Runoff Depth>2.44"

Flow Length=646' Tc=15.1 min CN=91 Runoff=12.11 cfs 1.161 af

SubcatchmentPR4: PR4 Runoff Area=4.200 ac 66.26% Impervious Runoff Depth>2.44"

Flow Length=1,380' Tc=16.6 min CN=91 Runoff=8.60 cfs 0.854 af

Pond 1P: Bioretention Basin 1P Peak Elev=99.54' Storage=4,244 cf Inflow=2.29 cfs 0.182 af

Discarded=0.01 cfs 0.015 af Primary=0.98 cfs 0.073 af Outflow=0.99 cfs 0.088 af

Pond 3P: Bioretention Basin 3 Peak Elev=100.35' Storage=20,402 cf Inflow=5.06 cfs 0.500 af

Discarded=0.02 cfs 0.032 af Primary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.032 af

Pond 4P: Bioretention Swale 4 Peak Elev=100.03' Storage=15,341 cf Inflow=8.60 cfs 0.854 af

Discarded=0.02 cfs 0.024 af Primary=4.90 cfs 0.587 af Outflow=4.93 cfs 0.611 af

Link DP1: AdjacentParking / Closed Drainage Inflow=16.88 cfs 1.470 af

Primary=16.88 cfs 1.470 af

Link DP2: Wetland R5 Inflow=3.14 cfs 0.263 af

Primary=3.14 cfs 0.263 af

Link DP3: Adjacent Closed Drainage Inflow=12.11 cfs 1.161 af

Primary=12.11 cfs 1.161 af

Link DP4: Wetland R62.1 (Perennial Stream) Inflow=4.90 cfs 0.587 af

Primary=4.90 cfs 0.587 af

Total Runoff Area = 20.574 ac Runoff Volume = 4.357 af Average Runoff Depth = 2.54" 35.98% Pervious = 7.403 ac 64.02% Impervious = 13.171 ac

Raynham Park-PR

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Subcatchment PR1.1: PR1.1

Runoff = 16.88 cfs @ 12.12 hrs, Volume= 1.397 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

Area	(ac) C	N Desc	cription					
0.	032	94 Fallo	Fallow, bare soil, HSG D					
0.	054	98 Pave	Paved roads w/curbs & sewers, HSG C					
4.	730	98 Pave	ed parking	, HSG D				
0.	042	73 Woo	ds, Fair, F	ISG C				
0.	911 8	34 50-7	5% Grass	cover, Fair	r, HSG D			
0.	137	79 50-7	5% Grass	cover, Fair	r, HSG C			
0.	002 8	34 50-7	5% Grass	cover, Fair	r, HSG D			
5.	908	95 Weig	ghted Aver	age				
1.	124	19.0	3% Pervio	us Area				
4.	784	80.9	7% Imper	ious Area				
Tc	Length	Slope	Velocity	Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
4.8	50	0.0280	0.17		Sheet Flow,			
					Grass: Short n= 0.150 P2= 3.30"			
0.4	77	0.0200	2.87		Shallow Concentrated Flow,			
					Paved Kv= 20.3 fps			
2.4	330	0.0240	2.32		Shallow Concentrated Flow,			
					Grassed Waterway Kv= 15.0 fps			
0.5	103	0.0040	3.39	2.66	Pipe Channel, RCP_Round 12"			
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'			
					n= 0.011 Concrete pipe, straight & clean			
0.3	122	0.0254	6.92	33.99	Pipe Channel, CMP_Round 30"			
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63'			
					n= 0.025 Corrugated metal			
8.4	682	Total						

Summary for Subcatchment PR1.2: PR 1.2 - Driveway

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.29 cfs @ 12.07 hrs, Volume= 0.182 af, Depth> 3.17"

 Area (ac)	CN	Description
0.689	98	Paved parking, HSG A
0.689		100.00% Impervious Area

Raynham Park-PR

Type III 24-hr 2-Year Rainfall=3.40"

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Тс	-		,	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
5.0			Direct Entry,		

Summary for Subcatchment PR2: PR2

Runoff = 3.14 cfs @ 12.15 hrs, Volume= 0.263 af, Depth> 1.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Area	(ac) C	N Des	cription		
	2.	022	80 >75	% Grass c	over, Good	, HSG D
_	0.	009	79 Woo	ods, Fair, F	ISG D	
	2.	031	80 Wei	ghted Aver	rage	
	2.	031	100.	00% Pervi	ious Area	
	_					
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	7.6	50	0.0090	0.11		Sheet Flow,
						Grass: Short n= 0.150 P2= 3.30"
	2.8	112	0.0090	0.66		Shallow Concentrated Flow,
_						Short Grass Pasture Kv= 7.0 fps
	10.4	162	Total	•		

Summary for Subcatchment PR3.1: Parking Area

Runoff = 5.06 cfs @ 12.19 hrs, Volume= 0.500 af, Depth> 2.94"

Area (ac)	CN	Description
1.710	98	Paved parking, HSG D
0.330	84	50-75% Grass cover, Fair, HSG D
2.040	96	Weighted Average
0.330		16.18% Pervious Area
1.710		83.82% Impervious Area

Raynham Park-PR

Type III 24-hr 2-Year Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	8.1	50	0.0196	0.10		Sheet Flow,
						Grass: Dense n= 0.240 P2= 3.30"
	0.6	78	0.0196	2.10		Shallow Concentrated Flow,
						Grassed Waterway Kv= 15.0 fps
	8.0	50	0.0120	0.99		Sheet Flow,
						Smooth surfaces n= 0.011 P2= 3.30"
	2.4	318	0.0116	2.19		Shallow Concentrated Flow,
						Paved Kv= 20.3 fps
	0.1	34	0.0080	4.80	3.77	•
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.011 Concrete pipe, straight & clean
	0.5	329		11.35		Lake or Reservoir,
						Mean Depth= 4.00'
	1.6	476	0.0050	4.97	8.78	Pipe Channel,
						18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38'
_						n= 0.011 Concrete pipe, straight & clean
	14.1	1,335	Total			

Summary for Subcatchment PR3.2: Existing Landscaped/Paved Area

Runoff = 12.11 cfs @ 12.20 hrs, Volume= 1.161 af, Depth> 2.44"

Area	(ac) C	N Des	cription					
0.	025 9	98 Pave	Paved parking, HSG B					
3.	180		ed parking					
0.	251 6	59 50-7	5% Grass	cover, Fair	; HSG B			
2.	250 8	34 50-7	'5% Grass	cover, Fair	r, HSG D			
5.	706 9	91 Weig	ghted Aver	age				
2.	501	43.8	3% Pervio	us Area				
3.	205	56.1	7% Imperv	ious Area				
			-					
Tc	Length	Slope	Velocity	Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
9.9	50	0.0120	0.08		Sheet Flow,			
					Grass: Dense n= 0.240 P2= 3.30"			
8.0	171	0.0610	3.70		Shallow Concentrated Flow,			
					Grassed Waterway Kv= 15.0 fps			
3.5	300	0.0120	1.42		Sheet Flow,			
					Smooth surfaces n= 0.011 P2= 3.30"			
0.9	125	0.0120	2.22		Shallow Concentrated Flow,			
					Paved Kv= 20.3 fps			
15.1	646	Total						

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Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Subcatchment PR4: PR4

Runoff = 8.60 cfs @ 12.22 hrs, Volume= 0.854 af, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

Area	(ac) C	N Desc	cription		
0.	484 9	8 Pave	ed parking	, HSG B	
2.	127 9	8 Pave			
0.			ed parking		
_				cover, Fair	
0.			<u>5% Grass</u>	cover, Fair	; HSG D
			ghted Aver		
	417		4% Pervio		
2.	783	66.2	6% Imper	ious Area	
т.	1 41-	01	\	0	Describettes
Tc	Length	Slope		Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	01 (5)
0.5	33	0.0220	1.16		Sheet Flow,
0.0	160	0.0250	2.24		Smooth surfaces n= 0.011 P2= 3.30"
8.0	163	0.0250	3.21		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.6	40	0.0250	1.11		Shallow Concentrated Flow,
0.0	+0	0.0230	1.11		Short Grass Pasture Kv= 7.0 fps
5.7	240	0.0100	0.70		Shallow Concentrated Flow,
0.7	2.10	0.0100	0.70		Short Grass Pasture Kv= 7.0 fps
0.6	177	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12"
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.011 Concrete pipe, straight & clean
0.1	38	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12"
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.011 Concrete pipe, straight & clean
8.3	689	0.0085	1.38		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
16.6	1,380	Total			

Summary for Pond 1P: Bioretention Basin 1P

Inflow Area =	0.689 ac,100.00% Impervious, Inflow De	epth > 3.17" for 2-Year event
Inflow =	2.29 cfs @ 12.07 hrs, Volume=	0.182 af
Outflow =	0.99 cfs @ 12.27 hrs, Volume=	0.088 af, Atten= 57%, Lag= 12.1 min
Discarded =	0.01 cfs @ 12.27 hrs, Volume=	0.015 af
Primary =	0.98 cfs @ 12.27 hrs, Volume=	0.073 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 99.54' @ 12.27 hrs Surf.Area= 4,877 sf Storage= 4,244 cf

Plug-Flow detention time= 242.8 min calculated for 0.088 af (49% of inflow) Center-of-Mass det. time= 115.8 min (869.7 - 753.9)

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Type III 24-hr 2-Year Rainfall=3.40"

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Volume	Invert	Avail.	Storage	Storage Descripti	on		
#1	98.50'	(6,927 cf	Custom Stage D	ata (Irregular) List	ed below (Recalc)	
Elevatio		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.5	50	3,319	353.0	0	0	3,319	
99.0	00	4,106	413.0	1,853	1,853	6,981	
99.5	50	4,733	423.0	2,208	4,061	7,679	
100.0	00	6,793	591.0	2,866	6,927	21,237	
Device	Routing	Inve	ert Outle	et Devices			
#1	Primary	99.5		•	ted Rectangular	Weir 2 End Contraction	on(s)
#2	Discarded	98.5	1.0' Crest Height 50' 0.090 in/hr Exfiltration over Surface area		ea		

Discarded OutFlow Max=0.01 cfs @ 12.27 hrs HW=99.54' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.91 cfs @ 12.27 hrs HW=99.54' (Free Discharge) 1=Sharp-Crested Rectangular Weir (Weir Controls 0.91 cfs @ 0.63 fps)

Summary for Pond 3P: Bioretention Basin 3

Inflow Area =	2.040 ac, 83.82% Impervious, Inflow Depth > 2.94" for 2-Year event
Inflow =	5.06 cfs @ 12.19 hrs, Volume= 0.500 af
Outflow =	0.02 cfs @ 24.00 hrs, Volume= 0.032 af, Atten= 100%, Lag= 708.7 min
Discarded =	0.02 cfs @ 24.00 hrs, Volume= 0.032 af
Primary =	0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 100.35' @ 24.00 hrs Surf.Area= 11,945 sf Storage= 20,402 cf

Plug-Flow detention time= 510.8 min calculated for 0.031 af (6% of inflow) Center-of-Mass det. time= 164.1 min (942.7 - 778.6)

<u>Volume</u>	Invert	Avail.St	orage	Storage Description			
#1	98.00'	28,	805 cf	Custom Stage D	ata (Irregular) List	ted below (Recalc)	
Elevation (fee		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.0	00	5,654	805.6	0	0	5,654	
99.0	00	8,176	893.3	6,876	6,876	17,541	
100.0	00	10,935	891.3	9,522	16,398	18,477	
101.0	00	13,939	955.3	12,407	28,805	27,927	
Device	Routing	Inver	t Outle	et Devices			
#1	Discarded	98.00	0.09	0 in/hr Exfiltration	n over Surface ar	rea	
#2 Primary 100.70' 8.0'		long Sharp-Crested Rectangular Weir 2 End Contraction(s)					

Raynham Park-PR

Volume

Invert

Type III 24-hr 2-Year Rainfall=3.40"

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Discarded OutFlow Max=0.02 cfs @ 24.00 hrs HW=100.35' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=98.00' (Free Discharge) 2=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond 4P: Bioretention Swale 4

Inflow Area =	4.200 ac, 66.26% Impervious, Inflow D	epth > 2.44" for 2-Year event
Inflow =	8.60 cfs @ 12.22 hrs, Volume=	0.854 af
Outflow =	4.93 cfs @ 12.48 hrs, Volume=	0.611 af, Atten= 43%, Lag= 15.4 min
Discarded =	0.02 cfs @ 12.48 hrs, Volume=	0.024 af
Primary =	4.90 cfs @ 12.48 hrs, Volume=	0.587 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 100.03' @ 12.48 hrs Surf.Area= 10.833 sf Storage= 15,341 cf

Plug-Flow detention time= 160.6 min calculated for 0.610 af (71% of inflow) Center-of-Mass det. time= 72.4 min (880.7 - 808.4)

Avail Storage Storage Description

volume	invert	. Avali.Si	orage	Storage Description	on			
#1	#1 98.00' 29,092 °		092 cf	Custom Stage Data (Irregular)Listed below (Recalc)				
		Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)			
98.0	00	5,101	559.0	0	0	5,101		
99.0	00	7,395	693.0	6,213	6,213	18,466		
99.8	50	8,686	757.0	4,016	10,229	25,860		
100.0	00	10,672	776.0	4,831	15,060	28,209		
101.0	00	17,687	824.0	14,033	29,092	34,373		
Device	Routing	Inver	t Outl	et Devices				
#1	Primary	96.00	' 18.0	18.0" Round Culvert				
			Inlet	/ Outlet Invert= 96	ction conforming to .00' / 95.10' S= 0.0 e, bends & connect	•		
#2	Device 1	99.50	48.0	.0" W x 12.0" H Vert. Orifice/Grate C= 0.600				
#3	Device 1	100.50	' 4.0 "	x 4.0" Horiz. Orifi	ce/Grate X 4.00 co	olumns		
X 8 rows C= 0.600 in 24.0" x 48.0" Grate Limited to weir flow at low heads								
		0.09	0.090 in/hr Exfiltration over Surface area					

Discarded OutFlow Max=0.02 cfs @ 12.48 hrs HW=100.03' (Free Discharge) **4=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=4.88 cfs @ 12.48 hrs HW=100.03' (Free Discharge)

-1=Culvert (Passes 4.88 cfs of 14.80 cfs potential flow)

-2=Orifice/Grate (Orifice Controls 4.88 cfs @ 2.33 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

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Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Link DP1: Adjacent Parking / Closed Drainage

Inflow Area = 6.597 ac, 82.96% Impervious, Inflow Depth > 2.67" for 2-Year event

Inflow = 16.88 cfs @ 12.12 hrs, Volume= 1.470 af

Primary = 16.88 cfs @ 12.12 hrs, Volume= 1.470 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP2: Wetland R5

Inflow Area = 2.031 ac, 0.00% Impervious, Inflow Depth > 1.55" for 2-Year event

Inflow = 3.14 cfs @ 12.15 hrs, Volume= 0.263 af

Primary = 3.14 cfs @ 12.15 hrs, Volume= 0.263 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP3: Adjacent Closed Drainage

Inflow Area = 7.746 ac, 63.45% Impervious, Inflow Depth > 1.80" for 2-Year event

Inflow = 12.11 cfs @ 12.20 hrs, Volume= 1.161 af

Primary = 12.11 cfs @ 12.20 hrs, Volume= 1.161 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP4: Wetland R62.1 (Perennial Stream)

Inflow Area = 4.200 ac. 66.26% Impervious. Inflow Depth > 1.68" for 2-Year event

Inflow = 4.90 cfs @ 12.48 hrs, Volume= 0.587 af

Primary = 4.90 cfs @ 12.48 hrs, Volume= 0.587 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater

Raynham Park Station

10-Year Storm Event- Proposed

Raynham Park-PR
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Type III 24-hr 10-Year Rainfall=4.80"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR1.1: PR1.1 Runoff Area=5.908 ac 80.97% Impervious Runoff Depth>4.22"

Flow Length=682' Tc=8.4 min CN=95 Runoff=24.53 cfs 2.076 af

SubcatchmentPR1.2: PR 1.2 - Driveway Runoff Area=0.689 ac 100.00% Impervious Runoff Depth>4.56" Tc=5.0 min CN=98 Runoff=3.25 cfs 0.262 af

SubcatchmentPR2: PR2 Runoff Area=2.031 ac 0.00% Impervious Runoff Depth>2.71"

Flow Length=162' Slope=0.0090 '/' Tc=10.4 min CN=80 Runoff=5.53 cfs 0.459 af

SubcatchmentPR3.1: Parking Area Runoff Area=2.040 ac 83.82% Impervious Runoff Depth>4.33"

Flow Length=1,335' Tc=14.1 min CN=96 Runoff=7.29 cfs 0.735 af

SubcatchmentPR3.2: Existing Runoff Area=5.706 ac 56.17% Impervious Runoff Depth>3.78"

Flow Length=646' Tc=15.1 min CN=91 Runoff=18.39 cfs 1.797 af

SubcatchmentPR4: PR4 Runoff Area=4.200 ac 66.26% Impervious Runoff Depth>3.78"

Flow Length=1,380' Tc=16.6 min CN=91 Runoff=13.07 cfs 1.323 af

Pond 1P: Bioretention Basin 1P Peak Elev=99.58' Storage=4,462 cf Inflow=3.25 cfs 0.262 af

Discarded=0.01 cfs 0.016 af Primary=3.11 cfs 0.152 af Outflow=3.12 cfs 0.168 af

Pond 3P: Bioretention Basin 3 Peak Elev=100.75' Storage=25,460 cf Inflow=7.29 cfs 0.735 af

Discarded=0.03 cfs 0.036 af Primary=0.33 cfs 0.126 af Outflow=0.35 cfs 0.162 af

Pond 4P: Bioretention Swale 4 Peak Elev=100.32' Storage=18,810 cf Inflow=13.07 cfs 1.323 af

Discarded=0.03 cfs 0.027 af Primary=9.55 cfs 1.050 af Outflow=9.58 cfs 1.077 af

Link DP1: AdjacentParking / Closed Drainage Inflow=27.61 cfs 2.229 af

Primary=27.61 cfs 2.229 af

Link DP2: Wetland R5 Inflow=5.53 cfs 0.459 af

Primary=5.53 cfs 0.459 af

Link DP3: Adjacent Closed Drainage Inflow=18.39 cfs 1.923 af

Primary=18.39 cfs 1.923 af

Link DP4: Wetland R62.1 (Perennial Stream) Inflow=9.55 cfs 1.050 af

Primary=9.55 cfs 1.050 af

Total Runoff Area = 20.574 ac Runoff Volume = 6.653 af Average Runoff Depth = 3.88" 35.98% Pervious = 7.403 ac 64.02% Impervious = 13.171 ac

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Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Subcatchment PR1.1: PR1.1

Runoff = 24.53 cfs @ 12.11 hrs, Volume= 2.076 af, Depth> 4.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

Area	(ac) (ON Des	cription			
0.	0.032 94 Fallow, bare soil, HSG D					
0.	.054	98 Pav	ed roads w	//curbs & se	ewers, HSG C	
4.	.730	98 Pav	ed parking	, HSG D		
0.	.042	73 Woo	ods, Fair, F	ISG C		
0.	.911	84 50-7	'5% Grass	cover, Fair	r, HSG D	
0.	.137	79 50-7	'5% Grass	cover, Fair	r, HSG C	
0.	.002	84 50-7	'5% Grass	cover, Fair	r, HSG D	
5.	.908	95 Wei	ghted Aver	age		
1.	.124	19.0	3% Pervio	us Area		
4.	.784	80.9	7% Imper	vious Area		
Tc	Length	Slope	Velocity	Capacity	Description	
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)		
4.8	50	0.0280	0.17		Sheet Flow,	
					Grass: Short n= 0.150 P2= 3.30"	
0.4	77	0.0200	2.87		Shallow Concentrated Flow,	
					Paved Kv= 20.3 fps	
2.4	330	0.0240	2.32		Shallow Concentrated Flow,	
					Grassed Waterway Kv= 15.0 fps	
0.5	103	0.0040	3.39	2.66	Pipe Channel, RCP_Round 12"	
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'	
					n= 0.011 Concrete pipe, straight & clean	
0.3	122	0.0254	6.92	33.99	Pipe Channel, CMP_Round 30"	
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63'	
					n= 0.025 Corrugated metal	
8.4	682	Total				

Summary for Subcatchment PR1.2: PR 1.2 - Driveway

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.25 cfs @ 12.07 hrs, Volume= 0.262 af, Depth> 4.56"

 Area (ac)	CN	Description
0.689	98	Paved parking, HSG A
0.689		100.00% Impervious Area

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Type III 24-hr 10-Year Rainfall=4.80"

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Тс	-		,	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
5.0					Direct Entry,

Summary for Subcatchment PR2: PR2

Runoff = 5.53 cfs @ 12.15 hrs, Volume= 0.459 af, Depth> 2.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

_	Area	(ac) (CN Des	cription			
	2.	022	80 >75	% Grass c	over, Good	, HSG D	
_	0.	009	79 Woo	ods, Fair, F	ISG D		
	2.	031	80 Wei	ghted Aver	age		
	2.	031	100	.00% Pervi	ous Area		
	Tc	Length	•	Velocity	Capacity	Description	
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)		
	7.6	50	0.0090	0.11		Sheet Flow,	
						Grass: Short n= 0.150 P2= 3.30"	
	2.8	112	0.0090	0.66		Shallow Concentrated Flow,	
_						Short Grass Pasture Kv= 7.0 fps	
	10.4	162	Total				

Summary for Subcatchment PR3.1: Parking Area

Runoff = 7.29 cfs @ 12.19 hrs, Volume= 0.735 af, Depth> 4.33"

Area (ac)	CN	Description
1.710	98	Paved parking, HSG D
0.330	84	50-75% Grass cover, Fair, HSG D
2.040	96	Weighted Average
0.330		16.18% Pervious Area
1.710		83.82% Impervious Area

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Type III 24-hr 10-Year Rainfall=4.80"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0196	0.10		Sheet Flow,
					Grass: Dense n= 0.240 P2= 3.30"
0.6	78	0.0196	2.10		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
8.0	50	0.0120	0.99		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.30"
2.4	318	0.0116	2.19		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
0.1	34	0.0080	4.80	3.77	• •
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.011 Concrete pipe, straight & clean
0.5	329		11.35		Lake or Reservoir,
					Mean Depth= 4.00'
1.6	476	0.0050	4.97	8.78	Pipe Channel,
					18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38'
					n= 0.011 Concrete pipe, straight & clean
14.1	1,335	Total			

Summary for Subcatchment PR3.2: Existing Landscaped/Paved Area

Runoff = 18.39 cfs @ 12.20 hrs, Volume= 1.797 af, Depth> 3.78"

Area	(ac) C	N Des	cription				
0.025 98		98 Pave	Paved parking, HSG B				
3.180 98			Paved parking, HSG D				
0.251 69		59 50-7	50-75% Grass cover, Fair, HSG B				
		34 50-7	50-75% Grass cover, Fair, HSG D				
5.	706 9	91 Weig	Weighted Average				
2.	501	43.8	3% Pervio	us Area			
3.	205	56.1	7% Imperv	vious Area			
			·				
Tc	Length	Slope	Velocity	Capacity	Description		
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
9.9	50	0.0120	0.08		Sheet Flow,		
					Grass: Dense n= 0.240 P2= 3.30"		
0.8	171	0.0610	3.70		Shallow Concentrated Flow,		
					Grassed Waterway Kv= 15.0 fps		
3.5	300	0.0120	1.42		Sheet Flow,		
					Smooth surfaces n= 0.011 P2= 3.30"		
0.9	125	0.0120	2.22		Shallow Concentrated Flow,		
					Paved Kv= 20.3 fps		
15.1	646	Total					

Raynham Park-PR

Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Subcatchment PR4: PR4

Runoff = 13.07 cfs @ 12.22 hrs, Volume= 1.323 af, Depth> 3.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

Area	(ac) C	N Desc	cription						
0.	0.484 98 Paved parking, HSG B								
_	2.127 98 Paved parking, HSG D								
0.	0.172 98 Paved parking, HSG D								
0.	0.547 69 50-75% Grass cover, Fair, HSG B								
0.870 84 50-75% Grass cover, Fair, HSG D									
4.	4.200 91 Weighted Average								
1.	417	_	, 4% Pervio	•					
2.	783	66.2	6% Imper	ious Area					
Tc	Length	Slope		Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
0.5	33	0.0220	1.16		Sheet Flow,				
					Smooth surfaces n= 0.011 P2= 3.30"				
8.0	163	0.0250	3.21		Shallow Concentrated Flow,				
			40 0.0250 1.11		Paved Kv= 20.3 fps				
0.6	0.6 40 0		1.11		Shallow Concentrated Flow,				
- -	5.7		0.70		Short Grass Pasture Kv= 7.0 fps				
5.7	5.7 240 0		0.70		Shallow Concentrated Flow,				
0.6	177	0.0100	5.36	4.21	Short Grass Pasture Kv= 7.0 fps Pipe Channel, RCP_Round 12"				
0.0	177	0.0100	3.30	4.21	12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'				
					n= 0.011 Concrete pipe, straight & clean				
0.1	38	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12"				
0.1	00	0.0100	0.00		12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'				
					n= 0.011 Concrete pipe, straight & clean				
8.3	689	0.0085	1.38		Shallow Concentrated Flow,				
					Grassed Waterway Kv= 15.0 fps				
16.6	1,380	Total							

Summary for Pond 1P: Bioretention Basin 1P

Inflow Area =	0.689 ac,100.00% Impervious, Inflow I	Depth > 4.56" for 10-Year event
Inflow =	3.25 cfs @ 12.07 hrs, Volume=	0.262 af
Outflow =	3.12 cfs @ 12.10 hrs, Volume=	0.168 af, Atten= 4%, Lag= 1.9 min
Discarded =	0.01 cfs @ 12.10 hrs, Volume=	0.016 af
Primary =	3.11 cfs @ 12.10 hrs, Volume=	0.152 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 99.58' @ 12.10 hrs Surf.Area= 5,046 sf Storage= 4,462 cf

Plug-Flow detention time= 190.3 min calculated for 0.168 af (64% of inflow) Center-of-Mass det. time= 86.8 min (834.3 - 747.4)

Raynham Park-PR

#2

Primary

Type III 24-hr 10-Year Rainfall=4.80"

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Volume	Invert	Avail	l.Storage	Storage Description	on		
#1	98.50'		6,927 cf	Custom Stage D	ata (Irregular) List	ed below (Recalc)	
Elevatio		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.50		3,319	353.0	0	0	3,319	
99.0	00	4,106	413.0	1,853	1,853	6,981	
99.50		4,733	423.0	2,208	4,061	7,679	
100.00		6,793	591.0	2,866	6,927	21,237	
Device	Routing	Inv	vert Outle	et Devices			
#1	Primary	99		• .	ted Rectangular	Weir 2 End Contractio	n(s)
#2	Discarded	98		Crest Height 0 in/hr Exfiltratio r	n over Surface ar	ea	

Discarded OutFlow Max=0.01 cfs @ 12.10 hrs HW=99.58' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=3.09 cfs @ 12.10 hrs HW=99.58' (Free Discharge)
1=Sharp-Crested Rectangular Weir (Weir Controls 3.09 cfs @ 0.95 fps)

Summary for Pond 3P: Bioretention Basin 3

Inflow Area =	2.040 ac, 83.82% Impervious, Inflow De	epth > 4.33" for 10-Year event
Inflow =	7.29 cfs @ 12.19 hrs, Volume=	0.735 af
Outflow =	0.35 cfs @ 15.33 hrs, Volume=	0.162 af, Atten= 95%, Lag= 188.7 min
Discarded =	0.03 cfs @ 15.33 hrs, Volume=	0.036 af
Primary =	0.33 cfs @ 15.33 hrs, Volume=	0.126 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 100.75' @ 15.33 hrs Surf.Area= 13,163 sf Storage= 25,460 cf

Plug-Flow detention time= 486.6 min calculated for 0.162 af (22% of inflow) Center-of-Mass det. time= 272.5 min (1,042.2 - 769.6)

Volume	Inver	t Ava	il.Storage	Storage Descript	ion		
#1	98.00	'	28,805 cf	Custom Stage D	ata (Irregular) Lis	ted below (Recalc)
Elevation (fee		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.0	00	5,654	805.6	0	0	5,654	
99.0	00	8,176	893.3	6,876	6,876	17,541	
100.0	00	10,935	891.3	9,522	16,398	18,477	
101.0	00	13,939	955.3	12,407	28,805	27,927	
Device	Routing	Ir	vert Outl	et Devices			
#1	Discarded	98	3.00 ' 0.09	0 in/hr Exfiltratio	n over Surface a	rea	

100.70' **8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Ravnham Park-PR

Type III 24-hr 10-Year Rainfall=4.80"

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Discarded OutFlow Max=0.03 cfs @ 15.33 hrs HW=100.75' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.32 cfs @ 15.33 hrs HW=100.75' (Free Discharge) 2=Sharp-Crested Rectangular Weir (Weir Controls 0.32 cfs @ 0.75 fps)

Summary for Pond 4P: Bioretention Swale 4

Inflow Area = 4.200 ac, 66.26% Impervious, Inflow Depth > 3.78" for 10-Year event
Inflow = 13.07 cfs @ 12.22 hrs, Volume= 1.323 af
Outflow = 9.58 cfs @ 12.38 hrs, Volume= 1.077 af, Atten= 27%, Lag= 9.6 min
Discarded = 0.03 cfs @ 12.38 hrs, Volume= 0.027 af
Primary = 9.55 cfs @ 12.38 hrs, Volume= 1.050 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 100.32' @ 12.38 hrs Surf.Area= 12,731 sf Storage= 18,810 cf

Plug-Flow detention time= 128.5 min calculated for 1.077 af (81% of inflow) Center-of-Mass det. time= 57.4 min (853.8 - 796.4)

Volume	Inver	t Avail.St	orage	Storage Description	on	
#1	98.00)' 29,0	092 cf	Custom Stage Da	ata (Irregular)Liste	d below (Recalc)
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area
		· · ·				(sq-ft)
98.00		5,101 7,205	559.0	0	6 212	5,101
99.00		7,395	693.0	6,213	6,213	18,466
99.5		8,686	757.0	4,016	10,229	25,860
100.0		10,672	776.0	4,831	15,060	28,209
101.0	00	17,687	824.0	14,033	29,092	34,373
Device	Routing	Inver	t Outl	et Devices		
#1	Primary	96.00	' 18.0	" Round Culvert		
			L= 9	0.0' RCP, end-sed	ction conforming to	fill, Ke= 0.500
			Inlet	/ Outlet Invert= 96.	.00' / 95.10' S= 0.0	0100 '/' Cc= 0.900
			n=0	.013 Concrete pipe	e, bends & connect	ions, Flow Area= 1.77 sf
#2	Device 1	99.50	' 48.0	" W x 12.0" H Vert	:. Orifice/Grate C=	= 0.600
#3	Device 1	100.50	' 4.0"	x 4.0" Horiz. Orifi	ce/Grate X 4.00 co	olumns
			X 8	rows C= 0.600 in 24	4.0" x 48.0" Grate	
			Limi	ted to weir flow at lo	ow heads	
#4	Discarded	98.00	0.09	0 in/hr Exfiltration	over Surface are	a

Discarded OutFlow Max=0.03 cfs @ 12.38 hrs HW=100.32' (Free Discharge) **4=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=9.52 cfs @ 12.38 hrs HW=100.32' (Free Discharge)

—1=Culvert (Passes 9.52 cfs of 15.42 cfs potential flow)

2=Orifice/Grate (Orifice Controls 9.52 cfs @ 2.91 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

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Summary for Link DP1: Adjacent Parking / Closed Drainage

Inflow Area = 6.597 ac, 82.96% Impervious, Inflow Depth > 4.05" for 10-Year event

Inflow = 27.61 cfs @ 12.11 hrs, Volume= 2.229 af

Primary = 27.61 cfs @ 12.11 hrs, Volume= 2.229 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP2: Wetland R5

Inflow Area = 2.031 ac, 0.00% Impervious, Inflow Depth > 2.71" for 10-Year event

Inflow = 5.53 cfs @ 12.15 hrs, Volume= 0.459 af

Primary = 5.53 cfs @ 12.15 hrs, Volume= 0.459 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP3: Adjacent Closed Drainage

Inflow Area = 7.746 ac, 63.45% Impervious, Inflow Depth > 2.98" for 10-Year event

Inflow = 18.39 cfs @ 12.20 hrs, Volume= 1.923 af

Primary = 18.39 cfs @ 12.20 hrs, Volume= 1.923 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP4: Wetland R62.1 (Perennial Stream)

Inflow Area = 4.200 ac. 66.26% Impervious. Inflow Depth > 3.00" for 10-Year event

Inflow = 9.55 cfs @ 12.38 hrs, Volume= 1.050 af

Primary = 9.55 cfs @ 12.38 hrs, Volume= 1.050 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater

Raynham Park Station

100-Year Storm Event – Proposed

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR1.1: PR1.1 Runoff Area=5.908 ac 80.97% Impervious Runoff Depth>6.40"

Flow Length=682' Tc=8.4 min CN=95 Runoff=36.42 cfs 3.151 af

SubcatchmentPR1.2: PR 1.2 - Driveway Runoff Area=0.689 ac 100.00% Impervious Runoff Depth>6.76"

Tc=5.0 min CN=98 Runoff=4.76 cfs 0.388 af

SubcatchmentPR2: PR2 Runoff Area=2.031 ac 0.00% Impervious Runoff Depth>4.69"

Flow Length=162' Slope=0.0090 '/' Tc=10.4 min CN=80 Runoff=9.47 cfs 0.793 af

SubcatchmentPR3.1: Parking Area Runoff Area=2.040 ac 83.82% Impervious Runoff Depth>6.51"

Flow Length=1,335' Tc=14.1 min CN=96 Runoff=10.77 cfs 1.107 af

SubcatchmentPR3.2: Existing Runoff Area=5.706 ac 56.17% Impervious Runoff Depth>5.93"

Flow Length=646' Tc=15.1 min CN=91 Runoff=28.14 cfs 2.818 af

SubcatchmentPR4: PR4 Runoff Area=4.200 ac 66.26% Impervious Runoff Depth>5.92"

Flow Length=1,380' Tc=16.6 min CN=91 Runoff=20.01 cfs 2.074 af

Pond 1P: Bioretention Basin 1P Peak Elev=99.61' Storage=4,586 cf Inflow=4.76 cfs 0.388 af

Discarded=0.01 cfs 0.017 af Primary=4.60 cfs 0.278 af Outflow=4.61 cfs 0.294 af

Pond 3P: Bioretention Basin 3 Peak Elev=100.97' Storage=28,361 cf Inflow=10.77 cfs 1.107 af

Discarded=0.03 cfs 0.039 af Primary=3.61 cfs 0.493 af Outflow=3.64 cfs 0.531 af

Pond 4P: Bioretention Swale 4 Peak Elev=100.60' Storage=22,677 cf Inflow=20.01 cfs 2.074 af

Discarded=0.03 cfs 0.029 af Primary=15.76 cfs 1.795 af Outflow=15.79 cfs 1.824 af

Link DP1: AdjacentParking / Closed Drainage Inflow=40.95 cfs 3.428 af

Primary=40.95 cfs 3.428 af

Link DP2: Wetland R5 Inflow=9.47 cfs 0.793 af

Primary=9.47 cfs 0.793 af

Link DP3: Adjacent Closed Drainage Inflow=28.14 cfs 3.311 af

Primary=28.14 cfs 3.311 af

Link DP4: Wetland R62.1 (Perennial Stream) Inflow=15.76 cfs 1.795 af

Primary=15.76 cfs 1.795 af

Total Runoff Area = 20.574 ac Runoff Volume = 10.331 af Average Runoff Depth = 6.03" 35.98% Pervious = 7.403 ac 64.02% Impervious = 13.171 ac

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Subcatchment PR1.1: PR1.1

Runoff = 36.42 cfs @ 12.11 hrs, Volume= 3.151 af, Depth> 6.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

Area	(ac) C	N Des	cription				
0.032 94 Fallow, bare soil, HSG D							
0.054 98 Paved roads w/curbs & sewers, HSG C							
4.730 98 Paved parking, HSG D							
0.	.042	73 Woo	ds, Fair, F	ISG C			
0.	.911 8	34 50-7	5% Grass	cover, Fair	r, HSG D		
0.	.137	79 50-7	5% Grass	cover, Fair	r, HSG C		
0.	.002	34 50-7	5% Grass	cover, Fair	r, HSG D		
5.	.908	95 Weig	ghted Aver	age			
1.	.124	19.0	3% Pervio	us Area			
4.	.784	80.9	7% Imperv	ious Area			
Tc	Length		Velocity	Capacity	Description		
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
4.8	50	0.0280	0.17		Sheet Flow,		
					Grass: Short n= 0.150 P2= 3.30"		
0.4	77	0.0200	2.87		Shallow Concentrated Flow,		
					Paved Kv= 20.3 fps		
2.4	330	0.0240	0240 2.32		Shallow Concentrated Flow,		
					Grassed Waterway Kv= 15.0 fps		
0.5	103	0.0040	3.39	2.66			
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'		
					n= 0.011 Concrete pipe, straight & clean		
0.3	0.3 122 0.025		6.92	33.99	Pipe Channel, CMP_Round 30"		
					30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63'		
					n= 0.025 Corrugated metal		
8.4	682	Total					

Summary for Subcatchment PR1.2: PR 1.2 - Driveway

[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.76 cfs @ 12.07 hrs, Volume= 0.388 af, Depth> 6.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

 Area (ac)	CN	Description
0.689	98	Paved parking, HSG A
0.689		100.00% Impervious Area

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Tc	Length	Slope	Velocity	Capacity	Description
 (min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	<u> </u>
5.0					Direct Entry,

Summary for Subcatchment PR2: PR2

Runoff = 9.47 cfs @ 12.15 hrs, Volume= 0.793 af, Depth> 4.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

 Area	(ac)	CN D	escription				
2.	022	80 >7	>75% Grass cover, Good, HSG D				
 0.	009	79 W	Woods, Fair, HSG D				
2.	031	80 W	eighted Ave	erage			
2.	031	10	0.00% Per	ious Area			
Tc	Length	ı Slop	,		Description		
(min)	(feet	(ft/f	t) (ft/sec)	(cfs)			
7.6	50	0.009	0 0.11		Sheet Flow,		
					Grass: Short n= 0.150 P2= 3.30"		
2.8	112	0.009	0 0.66		Shallow Concentrated Flow,		
					Short Grass Pasture Kv= 7.0 fps		
 10.4	162	Total					

Summary for Subcatchment PR3.1: Parking Area

Runoff = 10.77 cfs @ 12.19 hrs, Volume= 1.107 af, Depth> 6.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
1.710	98	Paved parking, HSG D
0.330	84	50-75% Grass cover, Fair, HSG D
2.040	96	Weighted Average
0.330		16.18% Pervious Area
1.710		83.82% Impervious Area

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	8.1	50	0.0196	0.10		Sheet Flow,
						Grass: Dense n= 0.240 P2= 3.30"
	0.6	78	0.0196	2.10		Shallow Concentrated Flow,
						Grassed Waterway Kv= 15.0 fps
	8.0	50	0.0120	0.99		Sheet Flow,
						Smooth surfaces n= 0.011 P2= 3.30"
	2.4	318	0.0116	2.19		Shallow Concentrated Flow,
						Paved Kv= 20.3 fps
	0.1	34	0.0080	4.80	3.77	•
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
	0.5	000		44.05		n= 0.011 Concrete pipe, straight & clean
	0.5	329		11.35		Lake or Reservoir,
	4.0	470	0.0050	4.07	0.70	Mean Depth= 4.00'
	1.6	476	0.0050	4.97	8.78	• •
						18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38'
_						n= 0.011 Concrete pipe, straight & clean
	14.1	1,335	Total			

Summary for Subcatchment PR3.2: Existing Landscaped/Paved Area

Runoff = 28.14 cfs @ 12.20 hrs, Volume= 2.818 af, Depth> 5.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

Area	(ac) C	N Des	cription		
0.	025 9	98 Pave	ed parking	, HSG B	
3.	180 9		ed parking		
0.	251 6	59 50-7	5% Grass	cover, Fair	; HSG B
2.	250 8	34 50-7	'5% Grass	cover, Fair	r, HSG D
5.	706 9	91 Weig	ghted Aver	age	
2.	501	43.8	3% Pervio	us Area	
3.	205	56.1	7% Imperv	ious Area	
			-		
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
9.9	50	0.0120	0.08		Sheet Flow,
					Grass: Dense n= 0.240 P2= 3.30"
8.0	171	0.0610	3.70		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
3.5	300	0.0120	1.42		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.30"
0.9	125	0.0120	2.22		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
15.1	646	Total			

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Subcatchment PR4: PR4

Runoff = 20.01 cfs @ 12.22 hrs, Volume= 2.074 af, Depth> 5.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

Area	(ac) C	N Desc	cription					
0.	484 9	8 Pave	ed parking	, HSG B				
2.	127 9	8 Pave	Paved parking, HSG D					
0.			ed parking					
_				cover, Fair				
0.			<u>5% Grass</u>	cover, Fair	; HSG D			
			ghted Aver					
	417		4% Pervio					
2.	783	66.2	6% Imper	ious Area				
т.	1 41-	01	\	0	Describettes			
Tc	Length	Slope		Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	01 (5)			
0.5	33	0.0220	1.16		Sheet Flow,			
0.0	160	0.0250	2.24		Smooth surfaces n= 0.011 P2= 3.30"			
8.0	163	0.0250	3.21		Shallow Concentrated Flow, Paved Kv= 20.3 fps			
0.6	40	0.0250	1.11		Shallow Concentrated Flow,			
0.0	+0	0.0230	1.11		Short Grass Pasture Kv= 7.0 fps			
5.7	240	0.0100	0.70		Shallow Concentrated Flow,			
0.7	2.10	0.0100	0.70		Short Grass Pasture Kv= 7.0 fps			
0.6	177	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12"			
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'			
					n= 0.011 Concrete pipe, straight & clean			
0.1	38	0.0100	5.36	4.21	Pipe Channel, RCP_Round 12"			
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'			
					n= 0.011 Concrete pipe, straight & clean			
8.3	689	0.0085	1.38		Shallow Concentrated Flow,			
					Grassed Waterway Kv= 15.0 fps			
16.6	1,380	Total						

Summary for Pond 1P: Bioretention Basin 1P

Inflow Area =	0.689 ac,100.00% Imp	ervious, Inflow Do	epth > 6.76"	for 100-Year event
Inflow =	4.76 cfs @ 12.07 hrs,	Volume=	0.388 af	
Outflow =	4.61 cfs @ 12.10 hrs,	Volume=	0.294 af, Atte	en= 3%, Lag= 1.6 min
Discarded =	0.01 cfs @ 12.10 hrs,	Volume=	0.017 af	
Primary =	4.60 cfs @ 12.10 hrs,	Volume=	0.278 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 99.61' @ 12.10 hrs Surf.Area= 5,140 sf Storage= 4,586 cf

Plug-Flow detention time= 158.1 min calculated for 0.294 af (76% of inflow) Center-of-Mass det. time= 73.2 min (814.9 - 741.7)

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Raynham Park-PR

#2

Primary

Type III 24-hr 100-Year Rainfall=7.00"

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Volume	Invert	Avail	.Storage	Storage Descripti	on		
#1	98.50'		6,927 cf	Custom Stage D	ata (Irregular) List	ed below (Recalc)	
Elevatio		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.5	50	3,319	353.0	0	0	3,319	
99.0	00	4,106	413.0	1,853	1,853	6,981	
99.5	50	4,733	423.0	2,208	4,061	7,679	
100.0	00	6,793	591.0	2,866	6,927	21,237	
Device	Routing	Inv	vert Outle	et Devices			
#1	Primary	99.			ted Rectangular	Weir 2 End Contract	ion(s)
#2	Discarded	98.		Crest Height 0 in/hr Exfiltratio r	n over Surface ar	ea	

Discarded OutFlow Max=0.01 cfs @ 12.10 hrs HW=99.61' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=4.55 cfs @ 12.10 hrs HW=99.61' (Free Discharge)
—1=Sharp-Crested Rectangular Weir (Weir Controls 4.55 cfs @ 1.08 fps)

Summary for Pond 3P: Bioretention Basin 3

Inflow Area =	2.040 ac, 83.82% Impervious, Inflow I	Depth > 6.51" for 100-Year event
Inflow =	10.77 cfs @ 12.19 hrs, Volume=	1.107 af
Outflow =	3.64 cfs @ 12.57 hrs, Volume=	0.531 af, Atten= 66%, Lag= 23.3 min
Discarded =	0.03 cfs @ 12.57 hrs, Volume=	0.039 af
Primary =	3.61 cfs @ 12.57 hrs, Volume=	0.493 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 100.97' @ 12.57 hrs Surf.Area= 13,837 sf Storage= 28,361 cf

Plug-Flow detention time= 270.5 min calculated for 0.531 af (48% of inflow) Center-of-Mass det. time= 141.3 min (902.6 - 761.3)

Volume	Invert	t Ava	il.Storage	Storage Descript	ion		
#1	98.00	•	28,805 cf	Custom Stage D)ata (Irregular) List	ed below (Recalc)	
Elevatio		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.0	00	5,654	805.6	0	0	5,654	
99.0	00	8,176	893.3	6,876	6,876	17,541	
100.0	00	10,935	891.3	9,522	16,398	18,477	
101.0	00	13,939	955.3	12,407	28,805	27,927	
Device	Routing	In	vert Outle	et Devices			
#1	Discarded	98	3.00' 0.09	0 in/hr Exfiltratio	n over Surface a	ea	

100.70' **8.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Raynham Park-PR

Type III 24-hr 100-Year Rainfall=7.00"

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Discarded OutFlow Max=0.03 cfs @ 12.57 hrs HW=100.97' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=3.58 cfs @ 12.57 hrs HW=100.97' (Free Discharge) 2=Sharp-Crested Rectangular Weir (Weir Controls 3.58 cfs @ 1.69 fps)

Summary for Pond 4P: Bioretention Swale 4

Inflow Area = 4.200 ac, 66.26% Impervious, Inflow Depth > 5.92" for 100-Year event
Inflow = 20.01 cfs @ 12.22 hrs, Volume= 2.074 af
Outflow = 15.79 cfs @ 12.35 hrs, Volume= 1.824 af, Atten= 21%, Lag= 8.1 min
Discarded = 0.03 cfs @ 12.35 hrs, Volume= 0.029 af
Primary = 15.76 cfs @ 12.35 hrs, Volume= 1.795 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 100.60' @ 12.35 hrs Surf.Area= 14,692 sf Storage= 22,677 cf

Plug-Flow detention time= 102.9 min calculated for 1.821 af (88% of inflow) Center-of-Mass det. time= 49.1 min (833.8 - 784.7)

Invest Avail Charges Charges Description

Volume	Inver	t Avail.St	orage	Storage Description	n		
#1	98.00	' 29,0	092 cf	Custom Stage Da	ta (Irregular)Listed	below (Recalc)	
Elevation (fee		urf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
98.0		5,101 7,395	559.0 693.0	0 6,213	0 6,213	5,101 18,466	
99.5	50	8,686	757.0	4,016	10,229	25,860	
100.0 101.0		10,672 17,687	776.0 824.0	4,831 14,033	15,060 29,092	28,209 34,373	
Device	Routing	Inver	t Outl	et Devices			
#1	Primary	96.00	L= 9 Inlet	" Round Culvert 0.0' RCP, end-sect / Outlet Invert= 96.0 .013 Concrete pipe	00' / 95.10' S= 0.0°		sf
#2	Device 1	99.50		" W x 12.0" H Vert.			
#3	Device 1	100.50	X 8 I	x 4.0" Horiz. Orifice rows C= 0.600 in 24 ted to weir flow at lo	.0" x 48.0" Grate	umns	
#4	Discarded	98.00	' 0.09	0 in/hr Exfiltration	over Surface area		

Discarded OutFlow Max=0.03 cfs @ 12.35 hrs HW=100.60' (Free Discharge) **4=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=15.72 cfs @ 12.35 hrs HW=100.60' (Free Discharge)

—1=Culvert (Passes 15.72 cfs of 16.00 cfs potential flow)

2=Orifice/Grate (Orifice Controls 14.44 cfs @ 3.61 fps)

-3=Orifice/Grate (Weir Controls 1.28 cfs @ 1.05 fps)

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Summary for Link DP1: Adjacent Parking / Closed Drainage

Inflow Area = 6.597 ac, 82.96% Impervious, Inflow Depth > 6.24" for 100-Year event

Inflow = 40.95 cfs @ 12.11 hrs, Volume= 3.428 af

Primary = 40.95 cfs @ 12.11 hrs, Volume= 3.428 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP2: Wetland R5

Inflow Area = 2.031 ac, 0.00% Impervious, Inflow Depth > 4.69" for 100-Year event

Inflow = 9.47 cfs @ 12.15 hrs, Volume= 0.793 af

Primary = 9.47 cfs @ 12.15 hrs, Volume= 0.793 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP3: Adjacent Closed Drainage

Inflow Area = 7.746 ac, 63.45% Impervious, Inflow Depth > 5.13" for 100-Year event

Inflow = 28.14 cfs @ 12.20 hrs, Volume= 3.311 af

Primary = 28.14 cfs @ 12.20 hrs, Volume= 3.311 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link DP4: Wetland R62.1 (Perennial Stream)

Inflow Area = 4.200 ac. 66.26% Impervious. Inflow Depth > 5.13" for 100-Year event

Inflow = 15.76 cfs @ 12.35 hrs, Volume= 1.795 af

Primary = 15.76 cfs @ 12.35 hrs, Volume= 1.795 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater

Raynham Park Station



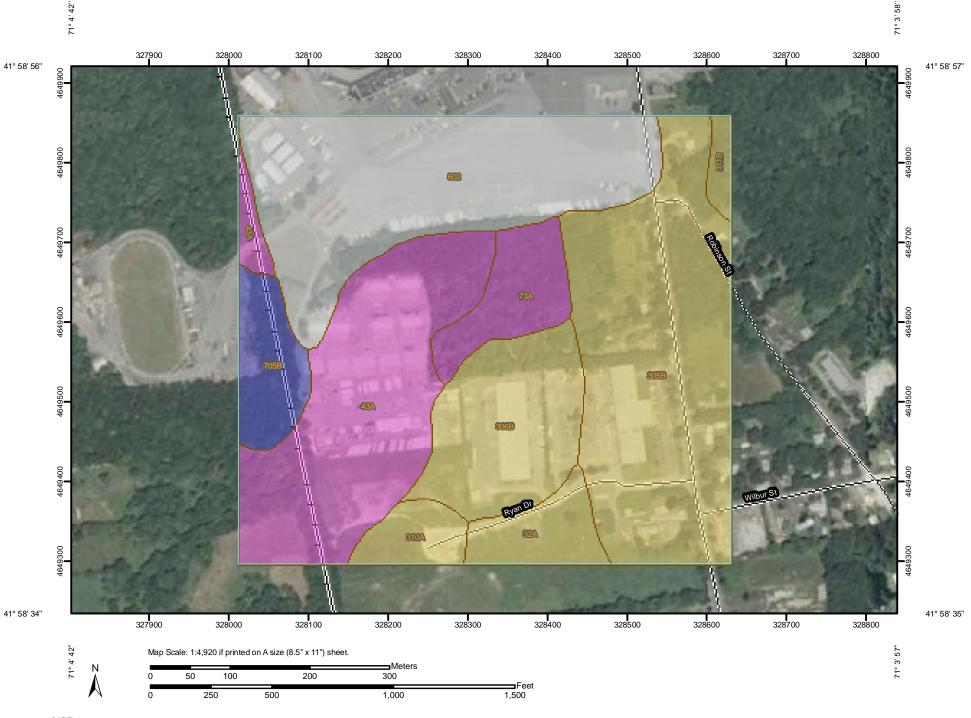


Appendix C Standard 3 Computations and Supporting Information



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Soil Evaluation and Analysis



MAP LEGEND

Area of Interest (AOI) Area of Interest (AOI) Soils Soil Map Units Soil Ratings Α A/D В B/D С C/D D Not rated or not available **Political Features** Cities **Water Features** Streams and Canals Transportation +++

Interstate Highways

US Routes

Major Roads

Local Roads

 \sim

MAP INFORMATION

Map Scale: 1:4,920 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov Coordinate System: UTM Zone 19N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bristol County, Massachusetts, Northern Part Survey Area Data: Version 5, Jul 27, 2010

Date(s) aerial images were photographed: 7/10/2003; 7/31/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bristol County, Massachusetts, Northern Part (MA602)						
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI		
32A	Wareham loamy sand, 0 to 3 percent slopes	С	3.2	3.8%		
43A	Scarboro mucky loamy fine sand, 0 to 3 percent slopes	D	18.5	21.5%		
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	4.3	4.9%		
305B	Paxton fine sandy loam, 3 to 8 percent slopes	С	22.9	26.6%		
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	С	9.4	11.0%		
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	С	2.3	2.7%		
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	С	0.9	1.0%		
602	Urban land		20.6	23.9%		
705B	Charlton - Paxton fine sandy loams, 3 to 8 percent slopes, rocky	В	3.9	4.5%		
Totals for Area of Int	terest		85.9	100.0%		

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

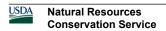
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher





FEIS/FEIR Technical Report Stormwater Raynham Park Station

Required and Provided Recharge Volumes



Recharge Calculations

Project Name: Raynham Park Station Proj. No.: 10111.00

Project Location: Raynham, MA Date: 18-May-12

Calculated by: DAG
Checked by: EJM

Proposed Impervious Surface Summary

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
1	0.0	0.0	0.1	5.4	5.5
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	1.7	1.7
4	0.0	0.0	0.0	2.3	2.3
TOTAL	0.0	0.0	0.1	9.4	9.5

Required Recharge Volume (Cubic Feet)

HSG	Area	Recharge Depth *	Volume
	(acres)	(in.)	(c.f.)
Α	0.0	0.60	0
В	0.0	0.35	61
С	0.1	0.25	49
D	9.4	0.10	3,422
TOTAL			3,533

^{*} Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet)

Pond 1P	741	
Pond 3P	1,699	
Pond 4P	1,263	
Total	3,703	c.f.



FEIS/FEIR Technical Report Stormwater Raynham Park Station

72-hour Drawdown Analysis



Drawdown Calculations

Project Name: Raynham Park Proj. No.:

Date: 5/18/2012

10111.00

Project Location: Raynham, MA Calculated by: EJM

Bioretention Basin - 1

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
98.50	3,319	0
99.00	4,106	1,856
99.50	4,733	4,066
TOTAL		4,066

Assumptions:

Recharge Rate: 1.00 in/hr* * Bioretention Basin Soil Media Infiltration Rate

Drawdown Time: 14.7 hours

Bioretention Basin - 3

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
98.00	5,654	0
99.00	8,176	6,915
100.00	10,935	16,471
101.00	13,939	28,908
TOTAL		28,908

Assumptions:

Recharge Rate: 1.00 in/hr* * Bioretention Basin Soil Media Infiltration Rate

Drawdown Time: 61.4 hours

Infiltration Basin - 4

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
98.00	5,101	0
99.00	7,395	6,248
99.50	8,686	10,268
TOTAL		10.268

Assumptions:

Recharge Rate: 1.00 in/hr* * Bioretention Basin Soil Media Infiltration Rate

Drawdown Time: 24.2 hours





Appendix D Standard 4 Computations and Supporting Information



FEIS/FEIR Technical Report Stormwater Raynham Park Station

Water Quality Volume Calculations



Water Quality Volume Calculations

Project Name: Raynham Park Station Proj. No.: 10111.00 Project Location: Raynham, MA Date: 5/18/2012 EJM

Calculated by:

Bioretention Basin 1P

(Runoff from Area DA-1 Driveway)

Total Impervious Area = 0.69 Acres

Required:

Forebay Volume

Water Quality Volume

Runoff Depth to Required be Treated (in.) Volume (c.f.) 250 0.1 2,501

Provided:

Cumulative **Bioretention Basin** Elevation Area (s.f.) Volume (c.f.) 98.5 3,319 0 99.0 4,106 1,856 99.5 4,733 4,066

Biofiltration Swale 3P

(Runoff from Parking Area DA-3)

Total Impervious Area = 4.96 Acres

Required:

Runoff Depth to Required be Treated (in.) Volume (c.f.) Forebay Volume 0.1 1,801 Water Quality Volume 18,012

Provided:

Cumulative Volume (c.f.) **Bioinfiltration Swale** Elevation Area (s.f.) 5,654 98.0 0 99.0 8,176 6,915 100.0 10,935 16,471 101.0 13,939 28,908

Bioretention Basin 4P

(Runoff from Parking Area DA-4)

Total Impervious Area = 2.39 Acres

Required:

Runoff Depth to Required Volume (c.f.) be Treated (in.) Forebay Volume 867 0.1 Water Quality Volume 8,675

Provided:

Cumulative **Bioretention Basin** Elevation Area (s.f.) Volume (c.f.) 98.0 5,101 0 99.0 7,395 6,248 99.5 8,686 10,268



FEIS/FEIR Technical Report Stormwater Raynham Park Station

TSS Removal Worksheets

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name: Raynham Park Station
Project Number: 10111.00
Location: Raynham, MA
Discharge Point: DP-1

DA-1

Drainage Area(s):

Sheet: 1 of 3
Date: 6-Apr-2012
Computed by: DAG
Checked by: VHB

Α	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Bioretention Area w/ Grassed Swale Pretreatment	90%	1.00	0.90	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

Treatment Train
TSS Removal =

90%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name: Raynham Park Station
Project Number: 10111.00

Location: Raynham, MA
Discharge Point: DP-3
Drainage Area(s): DA-3

Sheet: 2 of 3
Date: 6-Apr-2012
Computed by: DAG
Checked by: VHB

A B C D E

	BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Sedir	ention Area w/ ment Forebay etreatment	90%	1.00	0.90	0.10
		0%	0.10	0.00	0.10
		0%	0.10	0.00	0.10
		0%	0.10	0.00	0.10
		0%	0.10	0.00	0.10

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

90%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)

Treatment Train
TSS Removal =

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc. Consulting Engineers and Planners 101 Walnut Street Watertown, MA 02471 (617) 924-1770

Project Name: Raynham Park Station Project Number: 10111.00 Location: Raynham, MA **Discharge Point:** DP-4 Drainage Area(s): DA-4

Sheet: 3 of 3 6-Apr-2012 Date: Computed by: DAG Checked by: **VHB**

А	В		U	<u></u>
	T00 D	01 11 700		

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Bioretention Area w/ Grass and Gravel Filter Strip Pretreament	90%	1.00	0.90	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

Treatment Train TSS Removal =

90%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)



FEIS/FEIR Technical Report Stormwater Raynham Park Station

Appendix E Geotechnical Report



Date February 29, 2012

To Rick Carey, Natasha Velickovic - VHB

From Paul Murphy, Da Ha, Peter Chou - Jacobs

Subject MBTA South Coast Rail (New Bedford/Fall River Commuter Rail Extension)

Raynham Park Station Geotechnical Design Memorandum

Raynham, MA

Project No. E2347101

INTRODUCTION

The South Coast Rail project will restore passenger rail transportation from South Station in Boston to the cities of Fall River and New Bedford along an existing rail freight corridor running south from Taunton to Fall River and New Bedford. The project will include the construction of several existing and new passenger stations and two terminal layover facilities. This geotechnical design memorandum presents the foundation design considerations for the new station platform at the proposed Raynham Park Station in Raynham, Massachusetts. The design recommendations presented in this report are based on the results of subsurface investigation performed by Jacobs in 2010.

Existing Conditions

The proposed Raynham Park Station is at the site of the Raynham-Taunton Greyhound Track, off Route 138 in Raynham, MA (Figure 1). The station site itself is within a larger, developed site that contains industrial facilities, a telephone pole storage yard, the greyhound track and associated uses, and a parking area. Existing grades at the platform location range from elevations 92 to 96 feet (NGVD29 Datum), generally sloping downward from south to north. The existing buildings and their foundations will need to be removed.

Proposed Construction

Current station plans are to construct an 800 foot long, 12 foot wide high level center platform adjacent to the existing tracks with some track relocation required, as well as the addition of a second track, a new parking area, access roads, and a new drop-off area. Access to the platform will be from a new ramp/stair structure along the east side of the tracks with a bridge over the track to the platform. Approximately 400 feet of the platform will be under a canopy. The details of new track layout (including grading), associated sidewalks and ramps of the proposed station are still under development at the time of this report preparation. This report focuses on the foundations for the platform only.

SCOPE OF WORK

This memorandum was prepared by Jacobs in accordance with the scope of work under the contract between Jacobs and VHB for work on the New Bedford/Fall River Commuter Rail Line Extension Project for Massachusetts Bay Transportation Authority (MBTA). The geotechnical work included the following tasks:

- Perform a geotechnical exploration and laboratory testing program;
- Report and interpret the results of the exploration and laboratory testing program; and

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• Provide geotechnical recommendations for design and construction of the platform foundations.

The Jacobs scope of work did not include environmental analyses to assess the potential presence of any hazardous materials at the project site.

LOCAL GEOLOGY

The site is located in the Narragansett Basin of southeastern Massachusetts. The rocks in the Narragansett Basin consist mostly of lightly metamorphosed shale and sandstone of Pennsylvanian and Permian age. The Raynham Park Station is located in the area of the Rhode Island Formation. The rocks encountered in the borings include conglomerate, sandstone, greywacke and siltstone. These rocks are all similar in that they are strongly cemented mixtures of fine to coarse sand with silt. Conglomerate includes gravel; greywacke includes all grain sizes, including a high percentage of fines. Weathering in these rocks commonly involves the breakdown of the mineral cements leading to eventual disaggregation of the matrix and the formation of residual soil. The rocks in the borings had sub-horizontal joints that appear to follow the bedding in the rock. These joints are probably the result of vertical unloading following deglaciation.

The top of rock was encountered in the borings between elevation 103 feet and elevation 84 feet. The thickness of overburden above the rock ranged from 26 feet to less than one foot.

GEOTECHNICAL EXPLORATIONS

Jacobs planned the subsurface exploration program and retained the drilling contractor (New Hampshire Boring) to perform the explorations. The geotechnical data report was submitted in 2010. Seven borings (RPS-1 to RPS-7) were conducted in the general vicinity of the proposed station platform area and eighteen borings (RPS-8, RPS-10, RPS-12 to RPS-26 and RPS-28) were drilled in the general vicinity of the proposed parking lot and its access roads. Boring locations are shown on the Subsurface Exploration Plan (Figures 2 & 3).

The borings were drilled by New Hampshire Boring using either a CME-550 or D-50 ATV mounted drill rig, or a CME-75 truck mounted drill rig. The borings were advanced through the soil by hollow-stem auger or wash boring methods using a 4-inch casing and roller bit with water. Standard penetration tests (SPT), consisting of a 140-pound hammer dropping 30 inches on a standard 2-inch-diameter (OD) split-spoon sampler, were performed with a safety hammer or automatic hammer to establish the consistency of the subsurface soils. The SPT's were typically performed at five foot intervals of depth. The obtained samples were sealed in glass jars to retain their natural moisture. Bedrock was encountered and cored around the proposed platform area.

The borings were observed and logged by a representative from Jacobs. The soil samples were classified in the field in accordance with ASTM D-2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) by Jacobs' representative, and appropriate stratum breaks were interpolated from drilling and sampling observations. The boring logs were prepared by Jacobs based on the field classifications and laboratory testing, and are presented in Appendix A.

LABORATORY TESTING

The results of the laboratory testing were previously submitted to VHB in a report entitled "South Coast Rail, Jacobs Geotechnical Data Report", dated November 2010.

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Grain size distribution analyses were performed to evaluate the gradation of the natural granular soils for potential reuse as backfill, if needed, and to confirm sample classifications. The analyses are summarized in Table 1 below and are presented in Appendix B.

Table 1: Laboratory Soil Classification Summary

BORING NO.	SAMPLE NO.	ELEVATION (FEET)	USCS SOIL CLASSIFICATION	W (%)	GRAVEL (%)	SAND (%)	FINES (%)
RPS – 4 OW	S2	90.0	Silty Sand w/ Gravel (SM)	NT	37.7	45.2	17.1
RPS – 13 OW	S3	93.0	Silty Sand w/ Gravel (SM)	6.2	16.0	49.6	34.4
RPS - 16	S3	95.0	Silty Sand (SM)	11.6	4.9	74.8	20.3
RPS - 19	S4	92.0	Sandy Silt (ML)	2.7	6.0	44.4	49.6
RPS - 22	S3	97.0	Sandy Silt (ML)	14.5	6.0	40.0	54.0

Where: w = natural moisture content, NT = Not Tested.

SUBSURFACE CONDITIONS

The subsurface conditions at the site were inferred from the boring data collected for the Raynham Park Station project, with some interpretations. The subsurface conditions encountered at the station platform area generally consist of a relatively thin layer of granular fill with thickness of about 0 to 3 feet, underlain by a granular soil layer with thickness ranging from 0 to 10 feet overlying bedrock. Bedrock was encountered at a depth of about 0.7 to 10 feet in the platform area, corresponding to approximately elevations 86.0 to 103.0 feet.

Fill materials with thicknesses ranging from approximately 0 to 10 feet, were also encountered in the vicinity of the proposed parking lot and access roads area. Bedrock was encountered at a depth about 2 to 21 feet (corresponding to elevations 84.0 to 101.0 feet). Shallower bedrock was found on the north side of the parking lot and in the area of the proposed Pond 1.

Subsurface soil conditions are summarized in Table 2 and discussed below.

Table 2: Summary of Subsurface Conditions at Borings

Tuble 21 building of bubbuilded Collainons at Dollings								
BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS	
Platform Borings								
RPS - 1	96.0	0	96.0	86.0	79.0	96.5	Boring in flowing stream.	
RPS - 2	93.0	0	93.0	92.3	90.5	93.5	Boring in flowing stream.	
RPS - 3	92.0	0	92.0	89.0	87.5	92.5	Boring in flowing stream.	
RPS - 4 OW	93.0	3.0	90.0	89.5	77.0	89.5		
RPS - 5	106.0	0	106.0	103.0	85.0	104.0		
RPS - 6	105.0	3.0	102.0	98.0	93.0	100.5	Boring offset ~30 ft E.	
RPS - 7	107.0	3.0	104.0	91.0	81.5	NR		

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BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
Site Borings							
RPS - 8	106.0	0	106.0	95.0	92.0	NR	
RPS - 10	108.0	5.0	103.0	98.5	98.0	100.5	Auger Boring
RPS - 12	103.0	4.0	99.0	87.0	87.0	NR	
RPS - 13 OW	107.0	3.0	104.0	86.0	83.0	102.3	Well screened from 14 to 24 ft.
RPS - 14	104.0	0	104.0	98.6	98.6	NR	Auger Boring
RPS - 15	107.0	3.0	104.0	101.0	98.0	NR	
RPS - 16	107.0	4.0	103.0	NE	91.0	NR	
RPS - 17	106.0	3.0	103.0	NE	90.0	NR	
RPS - 18	105.0	3.0	102.0	98.0	98.0	NR	Boring offset ~18 ft S (utilities), Auger Boring
RPS - 19	106.0	10	96.0	NE	90.0	98.0	Boring offset ~8 ft E (utilities), Auger Boring
RPS - 20	106.0	3.0	103.0	NE	90.0	NR	
RPS - 21	105.0	3.0	102.0	91.0	88.0	99.0	
RPS - 22	105.0	3.0	102.0	84.0	81.0	100.0	
RPS - 23	106.0	4.0	102.0	NE	80.0	NR	
RPS - 24	103.0	2.0	101.0	101.0	100.5	101.0	Auger Boring
RPS - 25	103.0	4.0	99.0	99.0	98.5	NR	Boring offset ~5 ft W, Auger Boring
RPS – 26	104.0	0	104	99.0	97.5	NR	
RPS – 28	105.0	1.0	104.0	97.0	95.0	NR	
NE: Not encountered at the boring during drilling. NR: Not recorded							

Soil conditions in the platform area generally consisted of the following:

Fill: The fill layer typically consists of mostly granular, loose to medium dense sand or gravel with up to 10% silt. The fill layer is generally about 0 to 3 feet thick in the area of the platform.

Natural Granular Deposits: The natural soil deposits below the fill generally consist of predominantly sand with gravel. These deposits are medium dense to very dense with Standard Penetration Test (SPT) N-values ranging between 15 and more than 50 blows per foot (bpf).

Bedrock: Bedrock was encountered in the platform area near ground surface to a depth of 10 feet below existing ground surface, corresponding to approximately elevations 86.0 to 92.3 feet. The bedrock was fine grained, severely jointed and joint weathering SANDSTONE or highly jointed, moderately weathered CONGLOMERATE. Bedrock RQD values at the platform range from zero to 47.

Bedrock was encountered at elevations ranging from about 84.0 to 103.0 feet in other site areas.

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Groundwater: Groundwater levels were measured in the observation wells and in test borings using a weighted tape during and at completion of drilling. The data indicated the groundwater level ranged from approximate elevations 89.5 to 104 feet along the platform alignment, and from elevations 98 to 102 feet in the general area of the proposed parking lot. The use of wash boring techniques for some of the soil borings may have artificially increased the water level readings due to the addition of water to the borings. Trapped/perched water is also commonly seen at a higher elevation within existing fill and silty materials. The longer term water level readings taken at Boring RPS–04 OW on July 7, 2010 indicated the water at a depth of about 3.5 feet (Elevation 89.5 feet). The longer term water level readings taken at Boring RPS–13 OW on July 7, 2010 and September 12, 2011 indicated the water at a depth of about 7.5 feet (Elevation 99.5 feet) and 4.7 feet (Elevation 102.3 feet). Based upon these short-term observations and readings from the observation wells, it is anticipated that the groundwater could be within 3 to 4 feet below existing grade at the platform area and within 4 to 8 feet below grade in the parking lot area.

Groundwater levels should be expected to fluctuate with rainfall and other seasonal variations. More long-term observations would be required to evaluate true groundwater levels and their influence on planned construction. Local and periodic variations of ground water elevations may also be influenced by local subsurface drainage, leaking water or sewer pipes, and precipitation.

GEOTECHNICAL RECOMMENDATIONS

Based on the review of available subsurface conditions, the proposed station platforms can be supported on spread footings bearing directly within either competent natural soil, structural fill placed above suitable natural soils or on bedrock. Platform and canopy design loads were not available at the time of this report preparation. However, it is anticipated that the station platform will be lightly (axially) loaded with limited horizontal forces from wind and seismic loads.

The following paragraphs provide project specific geotechnical recommendations for foundation soil preparation, structural fill/backfill placement, and design and construction of spread footings.

Platform Foundations

Spread footings are recommended for the platform foundations, bearing on compacted structural fill, natural granular deposits, or bedrock. The existing fill is not suitable for support of the spread footings and should be removed within the zone of influence of the footing, defined by a line extending one foot horizontally from the bottom edge of footing and then down and away at a 1H:1V slope until natural granular soils or bedrock are encountered. The bottom of footing elevation should be at least 4 feet below final finished grades for frost protection for footings bearing on soil and at least 3 feet below final grade for footings bearing on bedrock.

The recommended allowable design bearing capacity for spread footings bearing on structural fill or natural sand and gravel deposits is 6 ksf, provided that subgrades are prepared as described herein. This provides an adequate factor of safety against bearing failure and limits the total estimated settlement to less than one inch and the differential settlement to less than ½ inch. For footings bearing directly on moderately weathered bedrock, we recommend an allowable bearing capacity of 16 ksf. However, since the actual bearing surface may not be known until construction, consideration should be given to designing all the footings for the 6 ksf bearing capacity. All footings should be at least 3 feet wide.

The structural fill material, if needed, should be free from organics and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200 - Earthwork for Type B Gravel Borrow. The structural fill should be compacted to 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557).

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All temporary open cuts required for footing construction should be in accordance with the related OSHA regulations and should have side slopes of no steeper than 1.5H:1V.

Seismic Consideration

The seismic design should comply with the requirements of the most current Massachusetts State Building Code 780 CMR and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface conditions encountered, the station site is classified as Seismic Site Class C soil profile in accordance with 780 CMR Chapter 1614.0 Section 9.4 Site Ground Motion. The structure could be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. The maximum considered earthquake ground motions shall be as represented by the spectral response acceleration at short periods (Ss) and at 1-sec (S₁) obtained from Table 1604.10 of the Massachusetts State Building Code and adjusted for Site Class effects using the site coefficients of Section 9.4.1.2.4.

For Site Class C Soils at the location of this station:

$$S_{MS} = 0.288$$
 and $S_{M1} = 0.105$

$$S_{DS} = 0.192$$
 and $S_{D1} = 0.070$

where:

- S_{MS} is the maximum consider earthquake spectral response acceleration for short periods adjusted for site class
- S_{M1} is the maximum consider earthquake spectral response acceleration at 1-sec adjusted for site class
- S_{DS} is the design earthquake spectral response acceleration for short periods adjusted for site class
- S_{D1} is the design earthquake spectral response acceleration at 1-sec adjusted for site class

The building code also requires that the soil be evaluated for the following potential hazards: slope instability, soil liquefaction, or surface rupture due to faulting or lateral spreading. The proposed grading is relatively flat and we are not aware of any pre-existing slope instability in this area. The existing overburden soils do not appear to be subject to surface rupture due to faulting or lateral spreading.

Liquefaction

Based on the observed subsurface conditions, recorded water levels, percentage of fine contents and sample relative densities, the existing soils underlying the site are judged not susceptible to liquefaction.

CONSTRUCTION CONSIDERATIONS

Platform Foundations - Spread Footings

The existing fill should be stripped off and removed from within the zone of influence of the platform and any walkway areas down to natural granular deposits or bedrock using a smooth edge excavation bucket, and replaced by compacted granular soils.

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Following excavation to the top of the natural granular deposits or bedrock, the exposed surface should be observed by an on-site representative of the project geotechnical engineer and soil subgrades shall be proof-compacted with at least 10 passes of a large vibratory drum roller. Any yielding areas should be observed by geotechnical personnel to assess if localized undercutting is necessary. Footing subgrade observations should include hand auger probes by the geotechnical personnel to check for soft/weak zones. The need for undercutting and backfilling with structural fill should be closely evaluated in the field based on encountered conditions.

If bedrock is encountered at the proposed bottom of footing elevation, the footing should either bear entirely on bedrock or entirely on soil. Where partial bedrock subgrade is encountered at the bottom of footing elevation, the bedrock should be over-excavated to a depth of at least 10 inches below the bottom of footing elevation and replaced with compacted Gravel Borrow to provide a uniform bearing surface.

In areas where seepage is encountered within footing excavations, the need for placing a 3" thick lean concrete mud mat or a layer of ¾-inch crushed stone to protect the bearing surface should be evaluated in the field. Crushed stone thicker than 4 inches shall be wrapped by non-woven filter fabric.

Following observation of the bearing soils by geotechnical personnel, reinforcing steel and concrete can be placed in the excavation. It is recommended that footing reinforcing steel and concrete be placed the same day as the footing excavation is made, where possible, to avoid significant moisture content changes in the bearing soils. No water should be allowed to pond within excavations and drainage should be maintained away from foundations both during and after construction. The footing excavation should be free of loose debris at the time of concrete placement.

Subgrade Preparation

Prior to performing any required grading operations and excavations in the proposed structure footprints, walkway and paved areas, these areas should be stripped of topsoil, vegetation, fill, former building foundations and existing pavement, if present. The topsoil should be placed in a designated area for reuse during final grading. Following site clearing and stripping, the exposed soil subgrade should be proof compacted with 10 passes of a large vibratory drum roller (minimum 10,000 pound static weight). Any pockets of excessively soft, wet or disturbed soil or unsuitable soils should be removed and replaced with properly compacted fill materials. Where subgrade soils are close to the existing groundwater level or where silty subgrade soils are encountered, proof-compaction using non-vibratory methods may be considered by the geotechnical engineer. Bedrock subgrades shall be free of all loose, fractured bedrock.

If additional rolling does not correct the unstable condition, the subgrade should be scarified to a depth of at least six inches but not exceeding eighteen inches, aerated, re-compacted, and retested to provide uniform compaction. Following satisfactory compaction of the subgrade, controlled compacted fill material should be placed to bring the site to the required grade.

Fill should not be placed over frozen soil. Soil subgrades should be protected against frost both during and after construction.

Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. Excavations should be made with as few passes of the backhoe bucket as possible to reduce disturbance of the subgrade. A backhoe bucket fitted with a smooth blade should be used during the final subgrade preparation, where necessary. The exposed base should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas. Construction traffic should be controlled to prevent excessive stresses and disturbance to the subgrade.

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If pavements are not constructed immediately after grading, the subgrade should be shaped so as to prevent water ponding. If there is a substantial lapse in time between grading and paving, or if the subgrade is disturbed, it should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during proof-rolling or initial construction should be removed and replaced with compacted granular fill.

Within the proposed paved areas, and extending a distance of five feet beyond the edge on all sides, excavate existing granular fill soils to a depth of two feet below existing site grades. It may be possible to reuse the existing granular fill, depending on the suitability of the material, as described herein.

Fill Placement and Compaction

Fill materials most likely will be obtained by importing granular fill materials from off-site borrow sources. However, it may be possible to reuse existing site granular fill material provided that it can be properly placed and compacted. The gradation shall be in accordance with MBTA Standard Specification Section 02200-Earthwork for Type B Gravel Borrow.

All structural fill should be free of organics, demolition debris or other deleterious substances. The fill material should have a plasticity index (PI) less than 4 and a liquid limit (LL) less than 10, and contain fragments less than 4 inches in maximum dimension. Each lift should be compacted to the specified density prior to placing any subsequent lift. All materials to be used as structural fill should be tested in the laboratory to determine their project suitability and compaction characteristics.

The fill should be systematically compacted to the following percentages of the maximum dry density:

Table 3: Fill Compaction Requirements

DESCRIPTION	MINIMUM PERCENT COMPACTION (ASTM D-1557)
General Site Fills, Structural Fill	95
(Below Footings and Slabs)	
Behind Retaining Walls	92
Landscape Area	90

Soils which exhibit a well-defined moisture content—dry density relationship should be compacted to within plus or minus two percentage points of the optimum moisture content as determined by the Modified Proctor test (ASTM D-1557).

Where fill materials are placed against an existing embankment slope, the slope should be benched as the fill is brought up in layers. Benching should be of a sufficient width to permit placing and compaction of fill material upon the existing embankment materials. Typically, benches are between four to eight feet wide. Each bench cut should begin at the intersection of the existing embankment and the vertical side of the previous bench. Trench backfills over pipelines or utility structures should be performed so as not to adversely impact the underlying utilities. In fill areas, the backfill material, compaction method, and degree of compaction requirements should be similar to that for the fill adjacent to the trench.

Construction Dewatering

All excavations should be performed in the dry condition. Pumped water should be discharged in accordance with all federal, state and/or local regulations which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

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Permanent Slopes

Permanent slopes with loamed and seeded surfaces should not be steeper than 2-1/2 horizontal to 1 vertical (2-1/2H:1V) without slope protection to limit erosion and surficial sloughing of the slope. Additional analyses may be required to assess the stability of slopes for Pond 1 as the station design is finalized.

Excavation Slopes and Shoring

The slopes of temporary open cuts should be no steeper than 1-1/2H:1V. Open cuts should not be used below the water table because of the likelihood of soil sloughing into the excavation.

The temporary excavation support system, if needed, should be selected by the Contractor and designed by an experienced registered Professional Engineer in the Commonwealth of Massachusetts and retained by the Contractor. Where excavation sides can be sloped back, they should be performed in accordance with the Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

Protection of Existing Facilities

It is recommended that a geotechnical instrumentation and monitoring program be performed during construction of the project to evaluate impacts on structures slated to remain adjacent to the station. It is recommended that the program be developed to provide data for the following considerations:

- To monitor ground movements and vibration levels during construction.
- To provide early warning of potentially adverse trends by presenting sufficient data to determine the source of unanticipated ground movements, if present.
- If necessary, to plan remedial measures to limit damage to embankments and structures and to provide early warning when alternative means of protection are necessary.
- To document impacts of construction on adjacent facilities.
- To evaluate the performance and structural integrity of the constructed facilities.

If needed, we recommend the following instrumentation program to measure:

- Ground surface settlement and lateral movement adjacent to proposed construction.
- Horizontal and vertical movement of any excavation support system, and existing structures.
- Vibrations as a result of construction activities.

Vertical and horizontal survey points should be established on the adjacent structures. The monitoring points should be surveyed prior to the start of construction and monitored during construction to detect movement.

Vibration monitoring shall be conducted within 100 feet of existing structures during construction activities.

We recommend conducting a pre-construction survey of structures and utilities within 100 feet of the site to document existing conditions prior to construction. Documentation should include photographs, video, sketches, and/or written comments.

Specific instrumentation and monitoring requirements shall be based on the proposed construction sequence, duration of construction, and performance criteria. Initial measurements should be established well in advance of construction so that baseline data can be developed. This information will be invaluable for providing early warning of adverse trends and for assessing the need for mitigating measures.

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CLOSING

This report and the recommendations contained herein have been prepared for the exclusive use of MBTA and VHB and their representatives for specific application to the design and construction of the proposed Raynham Park Station in Raynham, Massachusetts.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations available at the time of this report. Subsurface stratification variations between borings are anticipated. The reported groundwater levels only represent the water levels at the time noted on the logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

ATTACHMENTS

FIGURE 1 – SITE LOCATION PLAN
FIGURES 2&3 – SUBSURFACE EXPLORATION PLAN
FIGURE 4 – SUBSURFACE SOIL PROFILES
APPENDIX A – TEST BORING LOGS
APPENDIX B – LABORATORY DATA
APPENDIX C – GEOTECHNICAL CALCULATIONS

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Memorandum

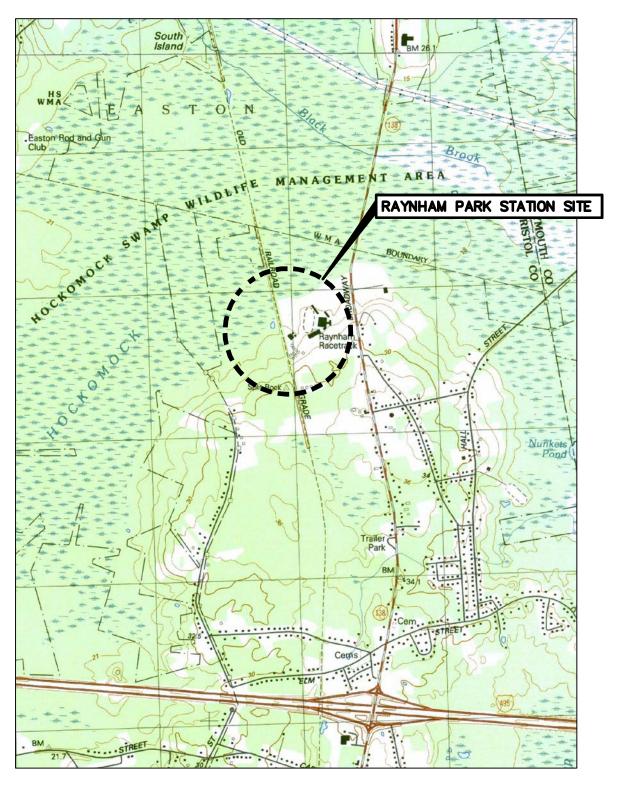
FIGURES

Figure 1: Site Location Plan

Figures 2&3: Subsurface Exploration Plan

Figure 4: Subsurface Soil Profiles



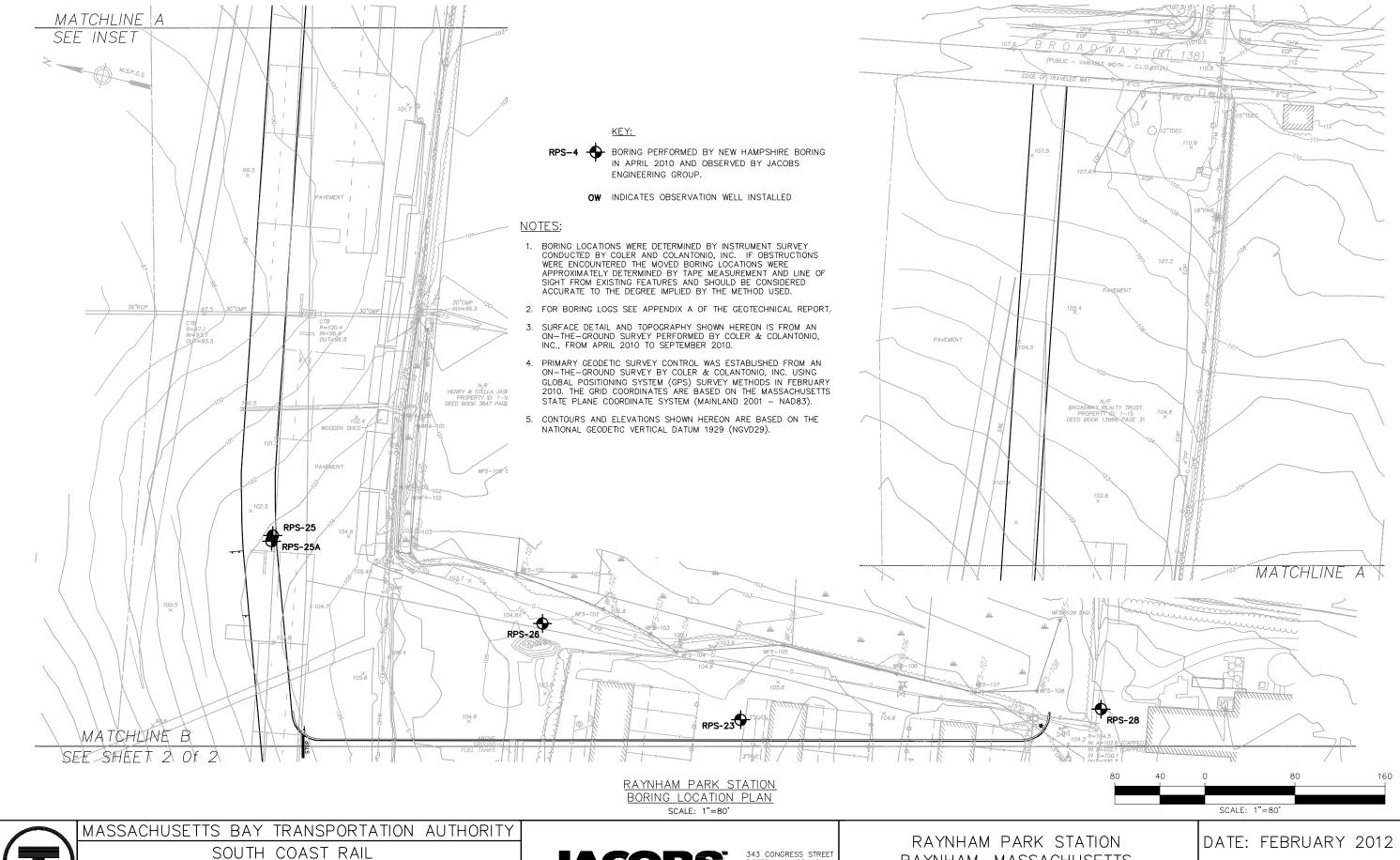


RAYNHAM PARK STATION
PROJECT LOCUS PLAN
NOT TO SCALE



MASSACHUSETTS BAY TRANSPORTATION AUTHORITY
SOUTH COAST RAII

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68 RAYNHAM PARK STATION RAYNHAM, MASSACHUSETTS FIGURE 1



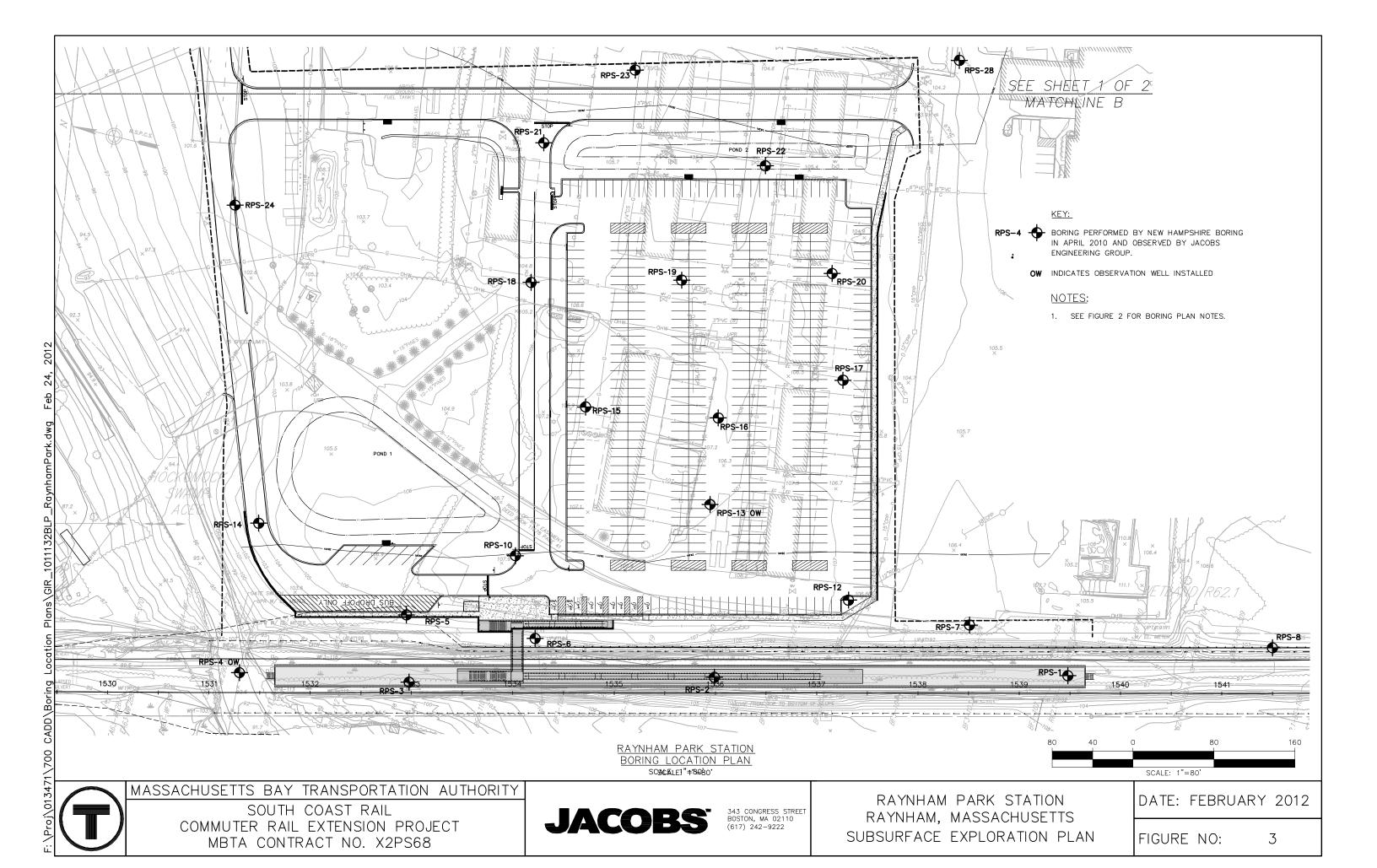
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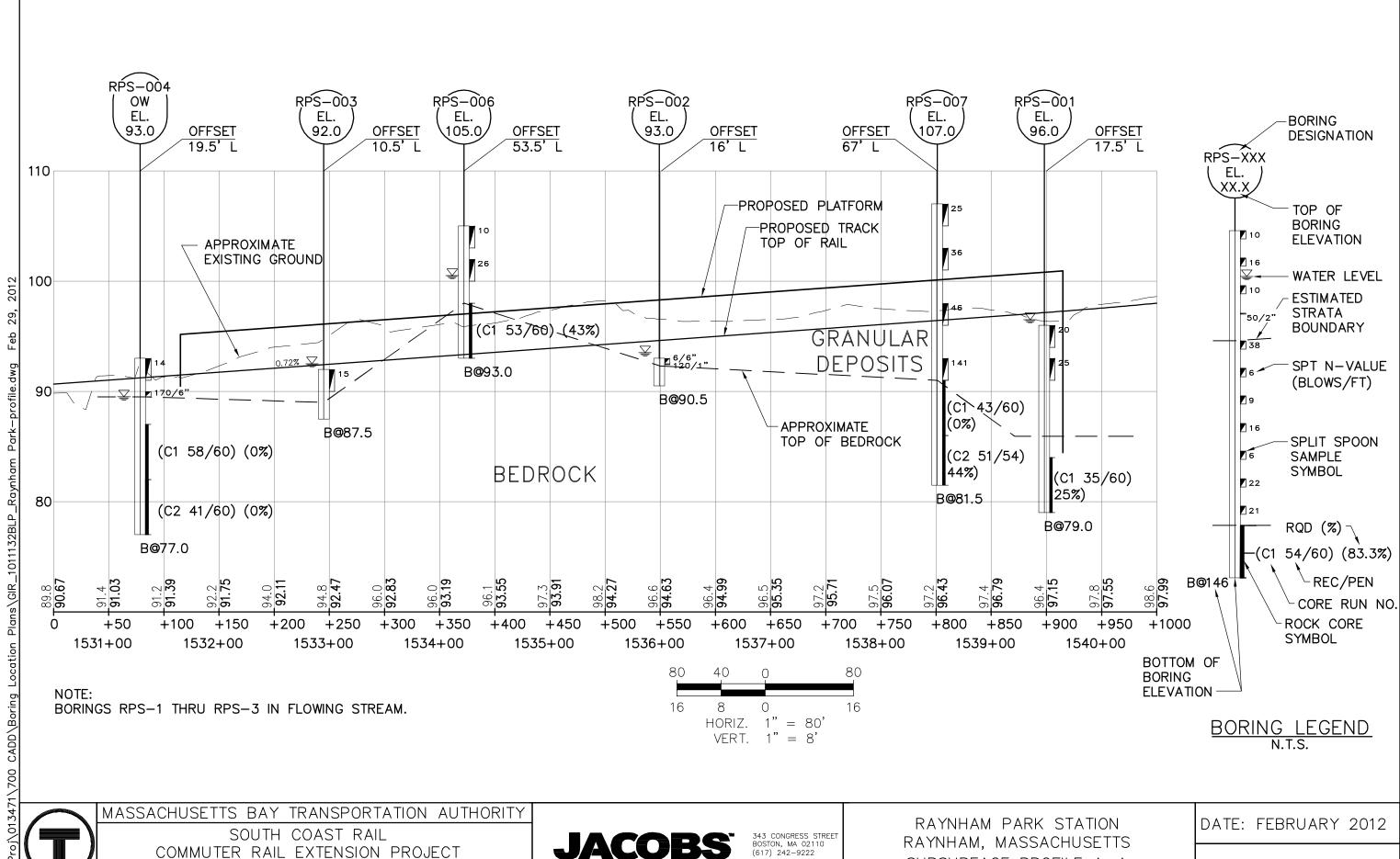
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RAYNHAM, MASSACHUSETTS SUBSURFACE EXPLORATION PLAN

FIGURE NO:





COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68

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SUBSURFACE PROFILE A-A

FIGURE NO: 4

Memorandum

APPENDIX A: BORING LOGS

RPS-1 TO RPS-8 RPS-10 RPS-12 TO RPS-26 RPS-28

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_				PROJ			Coast Rail			BORING	DDC	5 - 001
	A		BS	S LOCA OWNE			nam, MA Bay Transn	ortation Author	rity	NO.	NF C	- 001
					UMBER	E2347		ortation Author	ity		SHFI	ET 1 OF 1
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							l op of b	edrock at ~10	ft, roller bit to 12 f	t.		
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15						79.0						
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-20												
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-30												
-35				uent page display		ATIVE		SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHERV	VISE NOTED.
	CODESIVE SOIL NON-CORESIVE SOIL					ORTIONS	ITS Au	mple and	ck Core (RC) RQD (%) Sample (Sand Blow)	Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)	Bag Sample (B)
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J			D	-	OWNER	₹	Mass	.Bay Transp	ortation Autho	rity	NO.		
					JOB NU		E234					SHEET	
		T. Tele			CONTRA		NH Bo				C. Knight	ELEVATION	93
1	METHO	D OF DE	RILLING	3		GROUN	DWAT	ER READIN	GS		ATV CME - 550	DATUM	NGVD 29
0		ash Borir		asing		ATE/TIME		DEPTH(ft)	REMARKS		40 lb Auto	GRID N	2817750
2.5	Те	rminated			4	1/8/2010		-0.5	In	stream.		COORD E	771609
												DATE START	4/8/10
												DATE END	4/8/10
	STRATA SYMBOL	SAMPL DATA		MPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
(ft)	STIVIDOL					(111)/(%)							
	X///X	6 120/	_{'1"}	S1	0 - 0.58		92.3			VEL WITH SAND (C		se gravel up to 1	.5", some
		120/	'					Top of a	pparent bedro	ace silt, grayish brov ock at ∼8 in. Roller bi	t to 2.5 ft.		/
-							90.5						
F							00.0						
-								Bottom	of Hole at 2.5'.				
_5													
								Boring lo	ocated in smal	ll stream.			
_													
<u> </u>													
F													
-10													
_													
-													
L													
- 15													
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ļ.													
35													
	Page 1	0-35 feet. I	Each subs	sequent pa	age displays 4	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
00:	COHESIVE SOIL NON-COHESIVE SOIL						ATIVE			L	EGEND		
COF	HESIVE SC	JIL	NON-0	COHESIV	E SOIL	PROP	ORTIONS		ner = -			lar .	7 Bag
BLOWS	/FT CONS	SISTENCY	BLOWS/I	FT DE	ENSITY	OF SOIL CO	OMPONE	NTS Aug	nple and	ck Core (RC) I RQD (%) C (%) Split-Spoon Sample (SS) and Blow Cou	Undisturbed (U)-Shelby Tube,	Jar Sample (JS)	Bag Sample (B)
0 - 2	VEF	RY SOFT	0 - 4	VER	Y LOOSE	< 10%	TRA		, RE	C (%) and Blow Cou per 6" REC (i	n) (P)-Piston	(00)	y (D)
3 - 4 5 - 8		SOFT UM STIFF	5 - 10 11 - 30	L	OOSE JM DENSE	15 - 25% 30 - 45%	LITT	TLE REI		ET ENTITLED "KEY TO			
9 - 1	5 8	STIFF	31 - 50) 0	DENSE	50 - 45% 50 - 100%	MOS	TILL DES	SCRIPTION AND C	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	RPS -	.002
16 - 30 30 +		Y STIFF HARD	51 +	VER	Y DENSE				MBOLOGY.		NO.	111 0 -	00Z
L													

								EST BOF	KING				
	Λ		PROJECT South Countries LOCATION Raynha OWNER Mass.B							BORING	RF	s.	- 003
								ortation Author	rity	NO.	9	ПССТ	1 OF 1
INICD	ECTOR	T. Tele	200		UMBER RACTOR	E2347 NH Bo			DRILLER	C. Knight			92
		D OF DR		CONTR		-	ER READIN	GS	DRILL RIG	ATV CME - 550	ELEVATI DATUM	ION	NGVD 29
0		ash Borin		ina D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Auto	GRID	N	2818042
4.5		rminated		9	4/8/2010		-0.5		stream.	1	COORD	_	771534
											DATE ST		4/8/10
											DATE EN	ND.	4/8/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA			REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S		
		WOR 12 3		0 - 2	6		SILTY S fine grav	SAND WITH G vel, dark browr	RAVEL (SM); fine n, leaves, wet.	to coarse sand, so	me non-p	lastic s	silt, little
						89.0	Top of a	nnarent hedro	ck at ~3 ft. Roller	hit to 4.5 ft			
							100010	ipparent beare	ok at on. Roller	Dit 10 4.0 it.			
-5	,,,,,,					87.5							
								of Hole at 4.5'. ocated in smal					
-10													
15													
-20													
-25													
20													
-30													
-35	Page 1	: 0-35 feet. E	Each subseq	uent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDA	NCE WITH ASTM D-2488	UNLESS OT	HERWIS	E NOTED.
COI	HESIVE SO			HESIVE SOIL	REL	ATIVE			, , , , , , , , , , , , , , , , , , ,	LEGEND			•
	PROPORTIONS WS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENT						NTS Au	mple and	Split-Spot Sample (1 C (%)	SS) (U)-Shelby Tube, Counts (P)-Piston	Jar Sample (JS)		Bag Sample (B)
		RY SOFT	0 - 4	VERY LOOSE	< 10%	TRA		_	per 6" RE	··· (IN)			

								EST BOR	KING				
_				PROJE			Coast Rail			BORING	DDC	Γ	
	AC	OI	35	LOCAT			ham, MA Bay Transn	ortation Author	rity	NO.	INFO	- (10 4 01
					JMBER	E234		ortation Author	ity	INO.	SI	HEET	1 OF 1
NSPI	CTOR	T. Telesco)		RACTOR	NH B			DRILLER	C. Knight	ELEVATION		93
		OF DRILL		33.411			ER READIN	GS	DRILL RIG	ATV CME - 550	DATUM	J. •	NGVD 29
0		sh Boring w		D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Auto	GRID	N	2818207
6		Rock Core			7/7/2010		3.5	Monitorin	g Well Reading		COORD	E	771504
16	Terr	minated									DATE ST	ART	4/9/10
							T				DATE EN	D	4/12/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.				ATION AND REMARK			
		2 4 10 12	S1	0 - 2	10	00.0			VEL WITH SAND ark brown, wet, FIL	(GW); fine to coars L.	se gravel u	p to 1	.5", little
-5	0.00.0] 50 120/0"	S2	3 - 3.5	6	90.0 89.5	∖gravel, I	ittle silt, weath	RAVEL (SM); fine ered rock, gray, w 5 ft, roller bit to 6 f	to coarse sand, so et. t.	me fine to	medi	um
		RQD=0	C1	6 - 11	58		CONGL joints ge	OMERATE; hi enerally angled	ghly jointed, mode at 0 to 10 degree	erate weathering, jo s from horizontal, ç	ints space gray.	d <1 1	io 3",
-10		- RQD=0	C2	11 - 16	41		SIMILAF	R TO C1.					
15	0.000												
13	0.0.0	-				77.0							
							Bottom	of Hole at 16'.					
-20													
25													
30													
35													
	Page 1: 0	-35 feet. Each	subsequent	page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTH	IERWIS	SE NOTED.
	HESIVE SOIL		ION-COHESI			ATIVE ORTIONS	NTS E AU	ger Roo	ck Core (RC) Split-Spoo		Jar		Bag .
0 - 2 3 - 4	VERY	SOFT C) - 4 VE	RY LOOSE LOOSE	< 10% 15 - 25%	TRA	ACE I GAS	REC	Sample (S and Blow per 6" REC	Counts (P)-Piston	(JS)		Bag Sample (B)
5 - 8 9 - 15 16 - 30 30 +	ST VERY	IFF 31	- 50	IUM DENSE DENSE RY DENSE	30 - 45% 50 - 100%	MOS	STLY DE	SCRIPTION AND C	LASSIFICATION OF RIALS" FOR ADDITIONA	BORING NO.	RPS	- 0	04 OW

					OT.	1		E21 BOR	(III)			
_				PROJE LOCAT			Coast Rail			BORING	DDG	S - 005
		COL	35	OWNE			iam, MA Bay Transn	ortation Author	rity	NO.	T\F\	J - 000
				JOB NU		E2347		ortation Author	ity	NO.	SHE	ET 1 OF 1
INSPI	FCTOR	T. Telesco)		ACTOR	NH Bo			DRILLER	S. Bolduc	ELEVATION	
		D OF DRILL		OONTIN			ER READIN	GS	DRILL RIG	ATV D-50	DATUM	NGVD 29
0		ash Boring w		D.	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety		N 2818060
4		Rock Core			4/7/2010		2		letion (In Casing)			E 771598
21		rminated									DATE STAF	
											DATE END	4/7/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S	
		5 7 11 14	S1	0 - 2	15			Y GRADED SA t, brown, moist		EL (SP); mostly fin	e sand, little	fine gravel,
	• •					103.0						
	0 000					103.0	Top of b	edrock at 3 ft,	roller bit to 4 ft.			
-5		RQD=0	C1	4 - 9	14		CONGL	OMERATE; hi	ghly fractured, gra	y.		
	0000	-	C2	9 - 11	12		CONGL	OMERATE: m	oderate weatherin	g, highly fractured.		
-10	n. 00 n. 0	RQD=0					· · · · ·	· · · , · · ·		J. J. 17 11 22 Can 3 G.		
	0%0	-	C3	11 - 16	48		CONGL	OMEDATE: id	ninte enacod 2 8"	, joints angled at ~	15 dograde fi	rom
	0.0.0.	RQD=22		11 - 10	40		horizont	al, moderate jo	oint weathering, cla	, joints angled at ~ asts up to 1.5" in si	ze, gray.	OIII
	0000							-	-	·		
	0.80											
	0.0.0.											
15	, Q, , , , 0											
	0.000	-	C4	16 - 21	57		SIMII AF	R TO C3.				
	0.0.0.	RQD=47		10 - 21	"		OliviiLAi	(10 00.				
	n. 0. n. a											
	0000											
	0.0.0.											
20	D. O. O. O.											
						85.0						
							Bottom	of Hole at 21'.				
25												
. 20												
30												
-35												
JÜ	Page 1:	0-35 feet. Each	subsequent	page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHER	RWISE NOTED.
	. 290 1.	11.100. 2001		, .g. s.op.ayo				J LEG OLA				
COF	HESIVE SC	DIL N	ON-COHES	IVE SOIL		ATIVE ORTIONS				LEGEND		
LOWE	OWS/FT CONSISTENCY BLOWS/FT DEN				OF SOIL CO		ITS Aug	ger Roc	sk Core (RC) Split-Spool RQD (%) Sample (S		Jar Sample	Bag Sample (B)
LOWS				DENSITY					and Blow per 6" RE	Counts (P)-Piston	(JS)	Sample (B)
0 - 2 3 - 4				RY LOOSE LOOSE	< 10% 15 - 25%	TRAI LITT	IF	FED TO THE		. ,		
5 - 8	MEDI	UM STIFF 11	- 30 MED	IUM DENSE	30 - 45%	SON	ME RE	SCRIPTION AND C	ET ENTITLED "KEY TO LASSIFICATION OF	BORING		_
9 - 1				DENSE RY DENSE	50 - 100%	MOS	ILY SU		RIALS" FOR ADDITIONA	NO.	기 RPS	S - 005
16 - 30							ı əyi			N1/ \	1	

						1		E21 BOK	MING			
				PROJEC			Coast Rail			PODING	חחכ	006
			RS	LOCATI			nam, MA			BORING	RP3	5 - 006
								ortation Author	ity	NO.	CLIE	ET 1 OF 1
	F070-	T T .	_	JOB NU		E234				0 14 1 1 1		ET 1 OF 1
		T. Telesco		CONTRA		NH Bo		00	DRILLER	C. Knight	ELEVATION	
		OF DRILL					ER READIN		DRILL RIG	ATV D-50	DATUM	NGVD 29
0		sh Boring v			ATE/TIME 4/7/2010		DEPTH(ft) 4.5		SPT HAMMER letion (In Casing)	140 lb Safety		N 2817931 E 771605
7		Rock Core	;		+///2010		4.5	Орон Соттр	netion (in Casing)			
12	Ten	minated									DATE STAR	4/7/10
			1									4///10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	8	
		•				104.8	Ton 2" 7	- - -				
_		2 4	S1	0.16 - 2.16	14	101.0	Top 2" 1) WITH CDAVE	(SW); fine to coars	o cand come	fine gravel
		² 4 6						t, light brown, r		(SVV), line to coars	e sanu, sonie	e iiile gravei,
		7						. 6 .	,			
		3_	S2	3 - 5	10	102.0	SILT WI	TH SAND (ML	.); non-plastic silt,	some fine sand, lig	ht brown, we	<u> </u>
-		6 20						•		_		
-5		20 22										
-												
_		_				98.0	Top of h	edrock at 7 ft.				
	0000	RQD=43	C1	7 - 12	53	90.0			spaced 1 - 8". ioin	ts angled at ~0-45	degrees from	horizontal.
•	D. O. D.						moderat	e weathering a	and discoleration of	of joint surfaces, cla	sts up to 1",	gray.
-	0.00											
-10	0010											
	0.0.0											
	3.000					93.0						
		_				93.0						
							Rottom	of Hole at 12'.				
							Dottoili	or riole at 12.				
-15							Davina (NF4 20 F F-	4			
							Boring C	Offset ~30 ft Ea	ast.			
•												
-												
-												
-20												
_												
•												
•												
-												
-25												
-30												
-35			1									
50	Page 1: 0)-35 feet. Each	n subsequer	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHER	WISE NOTED.
			•			A TI) /C				LEGEND		
COF	HESIVE SOI	L 1	NON-COHE	SIVE SOIL		ATIVE ORTIONS				_	_	
BLOWS/	/FT CONSI	STENCY BLO	OWS/FT	DENSITY	OF SOIL CO		NTS Au	mple and	sk Core (RC) RQD (%) Sample (S	SS) (U)-Shelby Tube,	Jar Sample	Bag Sample (B)
0 - 2	_			ERY LOOSE	< 10%	TRA			and Blow per 6" RE	Counts (P)-Piston	(JS)	[∕] (B)
3 - 4	S	DFT 5	5 - 10	LOOSE	15 - 25%	LITT	LE BE	EED TO THE CHEF	T ENTITLED "KEY TO			
5 - 8 9 - 15			1 - 30 ME 1 - 50	DIUM DENSE DENSE	30 - 45% 50 - 100%	SOM	VIE DE	SCRIPTION AND C	LASSIFICATION OF	BORING	3 555	000
16 - 30	0 VERY	STIFF		ERY DENSE	50 100/0	IVIOG	50	BSURFACE MATEF MBOLOGY.	RIALS" FOR ADDITIONA	NO.	T RPS	5 - 006
30 +		NRD	1	I .		1	1			I INC.	1	

_				PROJE		South	Coast Rail	L01 D01		BORING	RPS - 007
J	A		BS	OWNE				ortation Autho	rity	NO.	
				JOB NI	JMBER	E2347					SHEET 1 OF 1
	ECTOR METHOD			CONTR	RACTOR	NH Bo	oring ER READIN	GS .	DRILLER DRILL RIG	P. Rosinha TR CME 75	ELEVATION 107 DATUM NGVD 29
0			g w/Casir	na D	ATE/TIME			REMARKS	SPT HAMMER	140 lb Safety	DATUM NGVD 29 GRID N 2817517
16		Rock Co	_	.g			\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		1-		COORD E 771718
25.5	Ter	minated									DATE START 4/9/10
											DATE END 4/9/10
OEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPL NO.	LE DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S
		10 15 10 5	S1	0 - 2	10	104.0		GRADED SAN own, moist, FIL		(SW); fine to coars	se sand, some fine gravel,
-5		12 17 19 19	S2	4 - 6	14	10 1.0			AND WITH SILT (ight brown, moist.		e sand, some non-plastic
-10	•	3 19 27 15	S3	9 - 11	9	99.0		SILT WITH G		-plastic silt, some f	ine to coarse sand, little
15		67 44 97 53 RQD	S4	14 - 16 16 - 21	43	93.0 91.0	SANDS inches,	joints angled a	ained, severe joint	ing and joint weath , soft, gray, at 20'6'	ering, joints spaced 0 - 2 ' rock becomes black and
20		RQD=4	44 C2	21 - 25.5	51	83.0	(21 - 24 spaced	r) SANDSTON 1 - 8 inches, jo	E; fine grained, m pints angled at ~0	- 60 degrees, soft,	d joint weathering, joints gray, loss of drill water.
25							(24 - 25) SILTSTONE	; joints spaced 1 -	8", soft, gray.	
-		L				81.5	Bottom	of Hole at 25.5	5'.		
-30											
-35	Page 1: (0-35 feet. E	ach subsequ	uent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
COL	HESIVE SOI	1	NON CO.	HESIVE SOU	REL	ATIVE				LEGEND	
	HESIVE SOI			HESIVE SOIL		PORTIONS	ITS Au	ger Ro	ck Core (RC) Split-Spoo Sample (S		Jar Sample Bag Sample
LOWS/			BLOWS/FT	DENSITY			—— 且 (AS	mple and RE	Sample (\$ and Blow per 6" RE	Counts (P)-Piston	Sample (JS) Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	SOMEDIU 5 ST 0 VERY	Y SOFT DFT M STIFF TIFF Y STIFF ARD	0 - 4 5 - 10 11 - 30 31 - 50 51 +	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SOM MOS	TLE RE ME DE TLY SU	SCRIPTION AND O	ET ENTITLED "KEY TO CLASSIFICATION OF RIALS" FOR ADDITION/	RODINI	G RPS - 007

					ROJE		South	n Coast Rail				DD0	000
	A		BS	L(OCATI			ham, MA			BORING	RPS ·	- 008
					WNEF		Mass E234		ortation Autho	rity	NO.	SHEET	1 OF 1
INSP	FCTOR	T. Teles	SCO			MBER ACTOR	NH B			DRILLER	C. Knight	ELEVATION	106
		OF DR			511110			ER READIN	GS		ATV CME - 550	DATUM	NGVD 29
0	Wa	sh Boring	g w/Casir	ng	DA	TE/TIME		DEPTH(ft)	REMARKS		140 lb Safety	GRID N	2817221
5	NX	Rock Co	re									COORD E	771766
_17	Tei	minated										DATE START	4/8/10
												DATE END	4/8/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPI NO.		PTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	TION AND REMARK	S	
	b	1	S1	0	- 2	19		SILTY S	SAND (SM): m	ostly fine sand, som	ne non-plastic silt.	trace fine grave	l. brown.
-	•	10 10			_			moist.		,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	and the grant	,,
-		19											
ļ-	φ	22	S2	9	3.67	6	103.0	SANDA	SII T WITH C	RAVEL (ML); non-p	lastic silt, somo f	no to coareo ea	ad little
L		22 120/2	2" 32	3-	3.07	0	102.3	fine grav	vel, gray, wet,	fractured rock in tip		THE TO COALSE SAI	iu, iittie
<u> </u>		_		_	4.0				edrock at 3.67				
L		RQD=3	30 C1	5 -	- 10	58		angled a	i ONE; mediui at ~15 degrees	m grained, hard, hig s from horizontal, sa	niy tractured, join ind seams. grav.	ts spaced 0 - 6",	joints
L								3		, , , , , , , ,	., 3 .,		
10													
- 10		_											
							95.0						
_		RQD=	C2	12	- 17	16		SILTST	ONE; fine grai	ned, soft, highly frac	ctured, vertical fra	ctures, loss of w	ater,
-		INQD-	-					gray.					
-							92.0						
- 15													
-													
F		L											
ļ-													
ļ.								Bottom	of Hole at 17'.				
-20													
L													
L													
L													
_ 25													
 25													
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Γ													
<u> </u>													
ļ .													
-30													
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H													
-													
F													
-35													
	Page 1:	0-35 feet. E	ach subsequ	ient page o	displays 4	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANC	E WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
COF	COHESIVE SOIL NON-COHESIVE S						_ATIVE			I	LEGEND		
BLOWS	/FT CONS	ISTENCY E	RI OWS/ET	DENSI	TV	OF SOIL C	ORTIONS OMPONE	NTS Au	mple and	ck Core (RC) Split-Spoon Sample (SS	Undisturbed (U)-Shelby Tube,	Jar Sample (JS)	Bag Sample
0 - 2		Y SOFT	0 - 4	VERY LO		< 10%	TRA			and Blow Co	ounts (P)-Piston	(JS)	(B)
3 - 4	S	OFT	5 - 10	LOOS	SE	15 - 25%	LIT	TLE DE	FER TO THE SHE	ET ENTITLED "KEY TO			
5 - 8 9 - 1	5 S	JM STIFF	31 - 50	MEDIUM D DENS	SE	30 - 45% 50 - 100%		IVIE DE	SCRIPTION AND O	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	G RPS -	. നവള
16 - 3 30 +		Y STIFF ARD	51 +	VERY DE	-NSE				MBOLOGY.		NO.	INFO.	000

				556	IFOT.			E21 BOF	MING			
				PROJ LOCA			Coast Rail			BORING	RPS	_ 010
	A		R	OWN			nam, MA Bay Transn	ortation Author	rity	NO.	NF3	- 010
					UMBER	E234		Ortation Author	iity	INO.	SHEET	1 OF 1
INSP	ECTOR	T Tele	esco		RACTOR	NH B			DRILLER	S. Bolduc	ELEVATION	108
	METHOD			00111			ER READIN	GS	DRILL RIG	ATV D-50	DATUM	NGVD 29
0			n Auger		DATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID N	2817969
10		minated			4/6/2010		7.5		letion (In Augers)	,	COORD E	771680
									, ,		DATE START	4/6/10
											DATE END	4/6/10
	STRATA	SAMPLI			REC.	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
(ft)	SYMBOL	DATA	NO	. (ft)	(in)/(%)							
		2 5	S1	0 - 2	19		POORL	Y GRADED S	AND (SP); mostly	fine sand, trace fin	e gravel, brown,	FILL.
		13 17	,									
		24	S2	2 4-6	16		(4 - 5')	SIMII AD TO S	1; some non-plast	c eilt moiet		
-5		24 44 66 90	32	4-0	10	103.0	` ,		•			
		J 66)				(5 - 6') V	WELL GRADE ine gravel trad	D SAND WITH GF ce silt, cobble enco	RAVEL (SW); tine to ountered light brow	to coarse sand, s vn_moist	some
								g,		,g	,	
						400.0						
						100.0						
		120/2	" sa	9 - 9.16	3 2	98.5	_ SANDY	SILT (ML); no	n-plastic silt, some	fine sand, trace fi	ne gravel, light b	orown, _
-10						98.0	─\\wet.	. , ,				/_
							\Top of a	apparent bedro	ock at ~ 9.5 ft.			
							Bottom	of Hole at 10'.				
-15												
-20												
-25												
20												
-30												
- •												
-35												
-35	Page 1:	0-35 feet. E	Each subseq	uent page displa	ys 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
						ATIVE		SAMPLES CLA	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
	Page 1:			uent page displa	REI PROF	_ATIVE				LEGEND		
	HESIVE SOI	IL			REI	PORTIONS	NTS Au	ger Roc mple and	ck Core (RC) Split-Spoo	LEGEND n Undisturbed (U)-Shelby Tube,		
COI	HESIVE SO	IL	NON-CO	HESIVE SOIL	REI PROF OF SOIL C	PORTIONS COMPONEI	NTS Au Sa (AS	ger Roc mple and	ck Core (RC) Split-Spoo	LEGEND n Undisturbed (U)-Shelby Tube, (P)-Piston	▼ Jar	
COI BLOWS 0 - 2 3 - 4	HESIVE SOI	ISTENCY Y SOFT OFT	NON-CO BLOWS/FT 0 - 4 5 - 10	DENSITY VERY LOOSE	REI PROF OF SOIL C < 10% 15 - 25%	PORTIONS COMPONEI TRA	NTS Sa Sa (AS	ger Roc and S) REC	ck Core (RC) Split-Spot Sample (S and Blow) per 6" REI	LEGEND I S Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)	
COI BLOWS 0 - 2	HESIVE SOLUTION SOLUT	IL ISTENCY Y SOFT	NON-CO BLOWS/FT 0 - 4 5 - 10	DENSITY VERY LOOSE	REI PROF OF SOIL C < 10% 15 - 25% 50 - 45% 50 - 100%	PORTIONS COMPONEI TRA LITT SOI	NTS Sa Sa CE (AS	ger mple and S) Rec	ck Core (RC) Sample (S and Blow per 6" REi	LEGEND In Signature (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)	Bag Sample (B)

_				PROJE LOCAT			Coast Rail			BORING	DDQ	- 012
	A		BS	OWNER			<u>nam, MA</u> Bay Transn	ortation Autho	rity	NO.	KFS	-012
				JOB NU		E2347		ortation / tatilo	iity		SHEET	1 OF 1
INSP	ECTOR	T. Teles	CO	CONTR		NH Bo			DRILLER	P. Rosinha	ELEVATION	103
		OF DRIL					ER READIN	GS	DRILL RIG	TR CME 75	DATUM	NGVD 29
0	Wa	sh Boring	w/Casing	g DA	ATE/TIME	Ξ	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID N	2817639
16	Ter	minated									COORD E	771714
											DATE START	
											DATE END	4/9/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
		8	S1	0.33 - 2.33	0	102.7		Asphaltic Cond				
		8 8					NO REC	COVERY; FILL	based on cutting	S.		
_		87										
-												
-	××××	10	S2	4 - 6	8	99.0	POORI.	Y GRADED S	AND (SP): mostly	fine sand, trace sil	light brown m	oist
-5	• •	10 25 66 50	02					. 0.0.222 0.	(0.),		.,g,	
-	• •	50										
L	• •											
	• •											
	• •					04.0						
		7	S3	9 - 11	10	94.0				plastic silt, some f	ne to coarse sa	nd, little
-10		12 30 33					fine to c	oarse gravel, (grayish brown, wet	i.		
-		33										
_												
L												
L		.				89.0						
<u> </u>		21 36 22 35	S4	14 - 16	6	00.0	WEATH	ERED ROCK	; completely weath	ered rock, gray, we	et.	
15		22				07.0						
		_ 55				87.0						
_												
_												
<u> </u>												
-20												
L												
_												
-25												
-												
F												
L							Bottom	of Hole at 26'.				
L												
-30												
30												
Γ												
_												
<u> </u>												
-												
-35												
	Page 1:	0-35 feet. Ea	ch subseque	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWI	SE NOTED.
COI	HESIVE SO		NON-COH	SIVE SOIL	REL	ATIVE				LEGEND		
				JIVE JUIL		OMBONE	ITS Aug	ger I Ro	ck Core (RC) Split-Spoo	on Undisturbed	Jar	7 Bag
BLOWS	/FT CONS	STENCY BI	LOWS/FT	DENSITY	OF SOIL C	OINIPONEN	ITS Aug	mple and	d RQD (%) Sample (S C (%) and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	Bag Sample (B)
0 - 2		SOFT		/ERY LOOSE	< 10%	TRA	CE	_	per 6" RE	C (in) —	'	
3 - 4 5 - 8	MEDIL			LOOSE EDIUM DENSE	15 - 25% 30 - 45%	LITT	ИE REI		ET ENTITLED "KEY TO CLASSIFICATION OF	DODINI		
9 - 1: 16 - 3		TIFF 'STIFF	31 - 50 51 +	DENSE /ERY DENSE	50 - 100%	MOS	ILY SUI		RIALS" FOR ADDITION	BORING	RPS	- 012
30 +		ARD					1 311			NO.		

								EST BOP	KING				
				PROJEC		+	Coast Rail			PODING	DDC	\wedge	12 (1)
	AC		RS	LOCATI			nam, MA	autation 6 ()	at 4	BORING	KY5	- U	13 UV
								ortation Author	rity	NO.	CI.	JEET	1 OF 1
INIODI	FOTOD	T Talaaa		JOB NU		E2347			DDII ED	D. Danisha			
		T. Telesc		CONTRA		NH BC	oring ER READIN	GS	DRILLER DRILL RIG	P. Rosinha TR CME 75	ELEVATION DATUM	אוע	107 NCVD 20
0		sh Boring		DΔ	TE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	NGVD 29 2817794
24		ninated	w/Casing		7/7/2010	-	7.5		g Well Reading	140 ib Galety	COORD	E	771774
27	1011	milatou			/12/2011		4.7		g Well Reading		DATE ST		4/8/10
									<u> </u>		DATE EN		4/8/10
DEPTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			FIELD CLASSIFIC	ATION AND REMARK			
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)				1122 02 10011 10	, thort, and reliving a tr	O .		
		9	S1	0.33 - 2.33	9	106.7	Top 4" A	Asphaltic Conc	rete.				
		6_	51	0.55 - 2.55						(SW); fine to coars	se sand, litt	le fine	e gravel,
		7					light bro	wn, moist, FIL	L.				
						104.0							
		40											
-5		18 23 21 17	S2	4 - 6	6		WELL G	RADED SANI	D WITH SILT (SW grayish brown, mo	/ - SM); fine to coa	rse sand, li	ttle no	n-plastic
0		21					ont, trao	e iiile gravei, g	jiayisii biowii, iiio	101.			
		- 17											
						98.0	Roulder	encountered f	rom 9 to 12 ft				
-10							Douldei	encountered i	10111 9 10 12 11.				
	A												
	H					05.0							
						95.0							
		23	S3	14 - 16	5		SII TV S	SAND WITH G	RAVEL (SM): mos	stly fine sand, some	non-nlast	ic eilt	little fine
-15		21		14 - 10				grayish brown,		ony mie dana, dom	o non-plast	io siit,	iittic iiiic
		23 21 16 15											
						00.0							
						89.0							
		32	S4	19 - 20	3		WELL G	RADED GRA	VEL WITH SAND	(GW); fine to coars	se gravel u	p to 1	.5", some
-20		120/6"					fine to c	oarse sand, tra	ace silt, gray, wet,	weathered rock.	Ū		
						86.0	Top of a	nnaront hadra	ck at 21 ft. Roller	hit to 24 ft			
							Top or a	ipparent bedro	ck at 21 it. Roller	DIL 10 24 IL.			
						00.0							
						83.0							
-25							Pottom /	of Hole at 24'.					
							Bollom	oi riole at 24 .					
20													
-30													
-35													
55	Page 1: 0	-35 feet. Eac	h subsequen	t page displays 4	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
	- 3			. 5		A T.I. "							
COF	HESIVE SOIL	-	NON-COHES	SIVE SOIL		ATIVE ORTIONS	_			LEGEND	_		
BLOWS	/FT CONSIS	STENCY BLO	OWS/FT	DENSITY	OF SOIL C		l 🖂 Jai	mple and	ck Core (RC) Split-Spoo RQD (%) Sample (\$	SS) (U)-Shelby Tube,	Jar Sample	X	Bag Sample (B)
0 - 2				ERY LOOSE	< 10%	TRA			and Blow per 6" RE	Counts (P)-Piston	(JS)	u	(B)
3 - 4	sc	OFT :	5 - 10	LOOSE	15 - 25%	LITT	LE BE	FER TO THE CHE	ET ENTITLED "KEY TO				
5 - 8 9 - 1			1 - 30 MEI 31 - 50	DIUM DENSE DENSE	30 - 45% 50 - 100%	SON MOS	TLV DE	SCRIPTION AND C	LASSIFICATION OF	BORING	GLDDG	^	40 0144
16 - 30	0 VERY	STIFF		ERY DENSE	5070	00	301	BSURFACE MATEI MBOLOGY.	RIALS" FOR ADDITION	BORING NO.	~ KPS	- 0	13 OW
30 +		RD	1	1		1	1			1 111	1		

					PROJE		South	n Coast Rail				DDO	044
			R	3	LOCATI			ham, MA		.,	BORING	RPS -	014
					OWNER JOB NU		Mass E234		ortation Author	rity	NO.	SHEET	1 OF 1
INSPI	FCTOR	T. Tele	esco		CONTRA		NH B			DRILLER :	S. Bolduc	ELEVATION	104
		D OF DF						ER READIN	GS		ATV D-50		NGVD 29
0	Нс	llow Ste	m Auger		D <i>F</i>	TE/TIME		DEPTH(ft)	REMARKS		40 lb Safety	GRID N	2818223
5.42	Те	rminated	l									COORD E	771652
												DATE START	4/6/10
						Т						DATE END	4/6/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA			DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
		8	S	1	0 - 2	14		SILTY S	AND (SM): m	ostly fine sand, some	e non-plastic silt.	trace gravel, bro	wn.
_		8 10 12						moist.	\ //	,	•	3	,
-		<u> </u>	2										
-													
F													
-5		120/5	" s	.,	5 - 5.42		99.0	\\/E\TU	ERED ROCK				
L		120/3	, 3	_	5 - 5.42	2	98.6	WLAIII	LNLD ROCK				
ļ.								Dattama	of Hole at 5.42	ni.			
_								Bottom	of Hole at 5.42	.			
L													
-10													
L													
L													
— 15													
_ 13													
Γ													
Ī													
-20													
-													
<u> </u>													
-25													
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-													
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+													
-30													
-													
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-													
-													
—35													
-	Page 1	: 0-35 feet. I	Each subse	equent pa	age displays	10 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWISE	NOTED.
COH	HESIVE SO	OIL	NON-C	OHESIV	/E SOIL		ATIVE			L	EGEND		
BLOWS	/FT CONS	SISTENCY		_	ENSITY	OF SOIL CO	ORTIONS OMPONEI	NTS Aug	nple and	ck Core (RC) Split-Spoon Sample (SS)	Undisturbed (U)-Shelby Tube,	Jar Sample (JS)	Bag Sample
0 - 2		RY SOFT	0 - 4		RY LOOSE	< 10%	TRA			and Blow Coper 6" REC (i	ınts (P)-Piston	(JS)	(B)
3 - 4 5 - 8	;	SOFT UM STIFF	5 - 10 11 - 30	L	LOOSE UM DENSE	15 - 25% 30 - 45%	LIT	TLE REI		ET ENTITLED "KEY TO			
9 - 1! 16 - 30	5 \$	STIFF RY STIFF	31 - 50 51 +	D	DENSE RY DENSE	50 - 100%	MOS	STLY SUI	BSURFACE MATE	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	GRPS -	014
30 +		HARD	JI +	VER	T DENSE			SYI	MBOLOGY.		NO.		

					PROJE	СТ	South	Coast Rail					
					LOCATI			nam, MA			BORING	RPS	- 015
J					OWNER		Mass	Bay Transp	ortation Author	rity	NO.		
					JOB NU	MBER	E234					SHEET	1 OF 1
INSP	ECTOR	T. Tele	esco		CONTRA	ACTOR	NH B	oring		DRILLER I	P. Rosinha	ELEVATION	107
	МЕТНО	D OF DF	RILLIN	G		GROUN	IDWAT	ER READIN	GS	DRILL RIG	TR CME 75	DATUM	NGVD 29
0	Wa	ash Borir	ng w/C	casing	DA	TE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER 1	140 lb Safety	GRID N	2817936
9	Те	rminated	<u> </u>									COORD E	771839
												DATE START	4/7/10
												DATE END	4/7/10
	STRATA	SAMPL		AMPLE	DEPTH	REC.	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
(ft)	SYMBOL	DATA	١	NO.	(ft)	(in)/(%)							
	****	7		S1	0.33 - 2.33	16	106.7	Top 4" A	Asphaltic Conc	rete			
-		11 12 13		01	0.00 - 2.00	'0				AND (SP); mostly fir	ne sand, trace fin	e gravel, light br	own,
-		12	3					moist, F	ILL.				
L							104.0						
		4		S2	4 - 5.83	12		SILT WI	TH SAND (ML	_); non-plastic silt, so	ome fine sand, gr	ay with brown, v	vet.
-5		4 25 12											
-		<u>'</u> 1:	20/2"				101.0	Ton of a	nnarent hedro	ck at 6 ft, roller bit to	9 ft		
L								100010	pparent bears	ok at o it, ioner bit to	7 0 It.		
							00.0						
							98.0						
-10								D-#	-f - + 0				
F								BOLLOITI	of Hole at 9'.				
L													
L													
<u> </u>													
- 15													
-													
L													
F													
-20													
L													
Γ													
<u> </u>													
-													
-25													
L													
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-													
-30													
<u> </u>													
H													
L													
—35													
33	Page 1	0-35 feet.	Each sub	bsequent	page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCI	E WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
CO	HESIVE SO	DIL	NON	N-COHES	IVE SOIL		ATIVE			L	EGEND		
DI C	VET 0.00	NOTEN S				OF SOIL CO	ORTIONS OMPONE!	NTS Au	ger Roo	ck Core (RC) Split-Spoon	Undisturbed	Jar Sample	Bag
BLOWS		SISTENCY			DENSITY			— ■ 🕮	mple and REG	Sample (SS) and Blow Coper 6" REC (i	unts (U)-Shelby Tube, (P)-Piston	Sample (JS)	Bag Sample (B)
0 - 2 3 - 4		RY SOFT SOFT	0 - 4 5 - 10		RY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	.CE		per o REC (I	,		
5 - 8	MEDI	UM STIFF	11 - 3	30 MED	DIUM DENSE	30 - 45%	SOI	ME RE		ET ENTITLED "KEY TO CLASSIFICATION OF	DODIN!		
9 - 1 16 - 3		STIFF RY STIFF	31 - 5 51 +		DENSE RY DENSE	50 - 100%	MOS	ILY SU		RIALS" FOR ADDITIONAL	BORING	RPS -	· 015
30 +		HARD						311			NO.		

					PROJEC	CT	South	n Coast Rail				
			D		LOCATION	ON		ham, MA			BORING	RPS - 016
J			B		OWNER		Mass	.Bay Transp	ortation Author	rity	NO.	
					JOB NU	MBER	E234	7101				SHEET 1 OF 1
INSP	ECTOR	T. Tele	esco		CONTRA	CTOR	NH B	oring		DRILLER	P. Rosinha	ELEVATION 107
	METHO	OF DF	RILLING			GROUN	IDWAT	ER READIN	GS	DRILL RIG	TR CME 75	DATUM NGVD 29
0	Wa	sh Borir	ng w/Cas	ing	DA	TE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER 1	140 lb Safety	GRID N 2817806
16	Ter	minated	d									COORD E 771859
												DATE START 4/7/10
												DATE END 4/8/10
DEPTH	STRATA	SAMPL			DEPTH	REC.	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S
(ft)	SYMBOL	DATA	. NO	0.	(ft)	(in)/(%)						
	XXXXX	10	S1		.33 - 2.33	16	106.7	Top 4" A	Asphaltic Conc	rete		
l-		10 10 8 7	3	'	.33 - 2.33	10		POORL	Y GRADED S	AND (SP); mostly fir	ne sand, grayish	orown, moist, FILL.
-		」 ⁸ 7										
L												
L		_					103.0					
	• •	6	S2	2	4 - 6	16	103.0				ne sand, trace no	n-plastic silt, trace fine
-5	•. •¶	6 13 19 1						gravel, g	grayish brown,	wet.		
-		J 17	7									
L	•]											
L	•											
	• •											
	*. *	10 15 15 19	S	3	9 - 11	16		SILTY S	SAND (SM); mo	ostly fine sand, little	non-plastic silt, g	rayish brown, wet.
- 10	•	15										
-	• • •	」 19	9									
_	الم الم						95.0					
L												
		12 9	S4	1	14 - 16	7		SANDY	SILT (ML); no	n-plastic silt, some f	fine to coarse sar	nd, trace fine gravel,
- 15		9						grayish	brown, wet.			
ļ.		11 11	5				91.0					
L												
								Bottom	of Hole at 16'.			
_												
-20												
L												
L												
Γ												
<u> </u>												
-25												
L												
L												
_												
-												
-30												
L												
Γ												
<u> </u>												
H												
-35												
	Page 1:	0-35 feet. I	Each subsec	quent p	age displays 4	0 feet.			SAMPLES CLA	SSIFIED IN ACCORDANC	E WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
	JEO. 75 -					RFI	ATIVE			L	.EGEND	
COI	HESIVE SO	IL	NON-CC	HESIV		PROP	ORTIONS		ner = 5			M lar M Dar
BLOWS	/FT CONS	STENCY	BLOWS/FT	DE	ENSITY	OF SOIL C	OMPONE	NTS Aug	mple and	ck Core (RC) I RQD (%) Sample (SS) and Blow Co		Jar Bag Sample (JS) (B)
0 - 2	VER	Y SOFT	0 - 4	VER	Y LOOSE	< 10%	TRA		REC	and Blow Co per 6" REC (i		<u> </u>
3 - 4 5 - 8	s	OFT JM STIFF	5 - 10 11 - 30	L	.OOSE	15 - 25% 30 - 45%	LITT	TLE RE		ET ENTITLED "KEY TO		
9 - 1	5 S	TIFF	31 - 50		JM DENSE DENSE	30 - 45% 50 - 100%	MOS	DE:	SCRIPTION AND C	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORIN	G RPS - 016
16 - 3 30 +		STIFF ARD	51 +	VER	Y DENSE				MBOLOGY.		NO.	175-010

COPPONE CONTROL Reportment NA						PROJEC	T	South	n Coast Rail					
NOR NUMBER 224/101 SHEET 1 OF SHEET		A		DG	TM							_	RPS .	- 017
NOR NUMBER 22347101	J									ortation Autho	rity	NO.		
METHOD OF DRILLING SACUNDWATER READINGS SPILL RIG TR CME 75 DATUM NOVD 29						JOB NUI	√BER	E234	7101				SHEET	1 OF 1
O						CONTRA						P. Rosinha	ELEVATION	106
Cock		METHO	OF DF	RILLING										
DATE START 48/10 DATE ST	0				ng	DA	TE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety		
DATE NO.	16	Ter	minated	l									•	
Sum														
STAPPORT CAPITA No. 00 enviso 103.0 103.7 105.7 Top 4' Asphablic Concrete Well CRADED SAND WITH GRAVEL (SW); fine to coarse sand, some fine gravel, graysh brown, moist Fill.						L							DATE END	4/8/10
Top 4" Asphaltic Concrete. WELL GRADED SAND WITH GRAVEL (SW); fine to coarse sand, some fine gravel, graysh brown, most, FILL. SILT Y SAND (SM); fine to coarse sand, some non-plastic silt, trace fine gravel, brown, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet. SILT WITH SAND (ML); non-plastic sile, little fine to coarse sand, dark gray, wet.		STRATA			.E			ELEV.			FIELD CLASSIFICAT	TION AND REMARK	S	
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BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS Auger Sample (J) Split-Spoon Sample (SS) and Blow Counts per 6" REC (ii) OF SOIL COMPONENTS IT Auger Sample (JS) and Blow Counts per 6" REC (ii) OF SOIL COMPONENTS		JESIVE SO		NON OC	ובטיי יי	E SOII	REL	ATIVE				LEGEND		
0 - 2	L COI				ıESIVI		PROP	ORTIONS	NTS F AU	ger I Ro	ck Core (RC) Split-Spoon	Undisturbed	Jar	Bag
0 - 2	BLOWS	/FT CONS	STENCY	BLOWS/FT	DE	NSITY	OF SUIL C	OIVIPUNE	Sa (A:	mple and	d RQD (%) Sample (SS) and Blow Co) (U)-Shelby Tube, ounts (P)-Piston	Sample (JS)	Sample
5 - 8 MEDIUM STIFF 11 - 30 MEDIUM DENSE 9 - 15 STIFF 31 - 50 DENSE 16 - 30 VERY STIFF 51 + VERY DENSE 17 OWN DENSE 18 OWN DENSE 18 OWN DENSE 18 OWN DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.									ACE		per 6" REC (in) — . ,		-
9 - 15 STIFF 31 - 50 DENSE 50 - 100% MOSTLY DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.									ME RE			505		
	9 - 1	5 S	ΠFF	31 - 50	D	ENSE			STLY SU	BSURFACE MATE			RPS -	017
				31.	v ∟IX	. DENOL			SY	WIBOLOGY.		NO.	0	

					PROJE	СТ	South	Coast Rail					0.4.0
			1		LOCAT			ham, MA			BORING	RPS ·	- 018
J			-		OWNER		Mass	.Bay Transp	ortation Author	rity	NO.		
					JOB NU		E234					SHEET	
		T. Tele			CONTR		NH B				P. Rosinha	ELEVATION	105
	1	D OF DE						ER READIN			TR CME 75	DATUM	NGVD 29
0		llow Ste		ger	D/	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER 1	40 lb Safety	GRID N	2818017
7	Те	rminated	<u> </u>									COORD E	771946
												DATE START	4/6/10
												DATE END	4/6/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA		SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
					()	(11)/(70)	4047						
		11 23 13		S1	0.33 - 2.33	18	104.7		Asphaltic Conc				
	\bowtie	13						moist, F		D (SW); fine to coars	se sano, trace in	e graver, grayisi	i brown,
		<u>'</u> 1:	5					,					
-							102.0						
F													
-5		11		00	5 0.7F	40		CII T W	THE CAND (MI	\			
L		15		S2	5 - 6.75	12		SILI WI	TH SAND (ML	.); non-plastic silt, so	ine line sand, gr	ay, wet.	
		11 15 52 1	00/3"				98.3						
			00.0				98.0	l op of a	pparent bedro	ck at 6.75 ft.			
<u> </u>													
-								Bottom	of Hole at 7'.				
- 10													
L													
<u> </u>													
-													
- 15													
_													
L													
<u> </u>													
l-													
-20													
L													
<u> </u>													
-25													
_													
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Γ													
<u> </u>													
-30													
L													
L													
Γ													
<u> </u>													
-35													
	Page 1:	0-35 feet.	Each su	ubsequent	t page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
COI	HESIVE SC	DIL	NO	N-COHES	SIVE SOIL		ATIVE			L	EGEND		
							ORTIONS	NTS E AU	ger Roo	ck Core (RC) Split-Spoon	Undisturbed	Jar .	Bag
BLOWS	/FT CONS	SISTENCY	BLOW	S/FT	DENSITY	OF SOIL C	OWITONE	NTS Aug	mple and	RQD (%) Sample (SS) and Blow Cou	unts (U)-Shelby Tube, (P)-Piston	Sample (JS)	Bag Sample (B)
0 - 2		RY SOFT	0		ERY LOOSE	< 10%	TRA	CE	_	per 6" REC (i	n) —		
3 - 4 5 - 8	MEDI	SOFT UM STIFF	5 - 1 11 - :	30 MEI	LOOSE DIUM DENSE	15 - 25% 30 - 45%	LIT	ME RE		ET ENTITLED "KEY TO ELASSIFICATION OF	DOD!!!		
9 - 1: 16 - 3		STIFF RY STIFF	31 - : 51 -		DENSE ERY DENSE	50 - 100%	MOS	SU	BSURFACE MATE	RIALS" FOR ADDITIONAL	BORIN	BPS -	018
30 +		HARD						SYI	MBOLOGY.		NO.		

					PROJEC		South	n Coast Rail			DODING	DD0 040
	A		B	11/1	LOCATIO			ham, MA			BORING	RPS - 019
					OWNER				ortation Author	ity	NO.	SHEET 1 OF 1
INSDI	ECTOR	T Told			JOB NUN		E234			DRILLER F	P. Rosinha	ELEVATION 106
			RILLING					ER READIN	GS		R CME 75	DATUM NGVD 29
0			m Auger			TE/TIME		DEPTH(ft)	REMARKS		40 lb Safety	GRID N 2817873
16		minated				/6/2010		8		letion (In Augers)	<u>,</u>	COORD E 771983
												DATE START 4/6/10
					<u> </u>			ı				DATE END 4/6/10
	STRATA SYMBOL	SAMPL DATA			DEPTH (ft)	REC.	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	3
(ft)	STIVIBOL			\perp	(11)	(in)/(%)						
	\bowtie	11 23 15	S1	0	0.33 - 2.33	18	105.7		sphaltic Conc			light hygun maigt FILL
	\bowtie	15	_					POURL	T GRADED SA	AND (SP), MOSHY IIII	e sand, trace sir	, light brown, moist, FILL.
		」 1:	5									
<u> </u>												
-5		10	S2		5 - 7	20		SIMILAF	R TO S1.			
-	\bowtie	10 14 16										
F		」 19	9									
ļ.												
L		40						(0.441)	D00DLV 0D	ADED CAND (OD)		
-10		10 15 66 30	S3		9 - 11	20	96.0	(9 - 11)	POURLY GRA	ADED SAND (SP); n	nostly fine sand,	trace silt, brown, wet.
	Ø	30	0									e to coarse sand, some
								fine to c	oarse gravel, t	race silt, grayish bro	wn, wet.	
							93.0					
<u> </u>		15	S4		14 - 16	22		SANDY	SILT (ML); no	n-plastic silt, some fi	ine sand, trace fi	ne gravel, grayish brown,
- 15		18 20 21						wet.				
-	1001	28	8				90.0					
-								5				
F								Bottom	of Hole at 16'.			
-												
-20												
L												
-25												
<u> </u>												
-												
H												
-												
-30												
L												
L												
[
<u> </u>												
-35	Pogs 4:	O 3E foot	Each outer:	Llent -	nage displays 1	0 fact		I	CAMPLEO OLA	POLETED IN ACCORDANCE	I WITH ACTAIN DOGGO	LINILEGO OTHERWISE MOTER
	raye 1:	o-၁၁ reet.	Lacii Subseqi	Jeni pa	page displays 4				SAIVIPLES CLA			UNLESS OTHERWISE NOTED.
COH	HESIVE SO	IL	NON-CO	HESIV	/E SOIL		ATIVE ORTIONS		=	_	EGEND	
BLOWS	/FT CONS	ISTENCY	BLOWS/FT	DF	ENSITY	OF SOIL CO	OMPONE	NTS Au	nple and	k Core (RC) RQD (%) Sample (SS) and Blow Cou	Undisturbed (U)-Shelby Tube, ints (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2		Y SOFT	0 - 4		RY LOOSE	< 10%	TRA	CE	, E REC	per 6" REC (in	n) (P)-Pision	<u>/</u> (5)
3 - 4 5 - 8		OFT JM STIFF	5 - 10 11 - 30		LOOSE UM DENSE	15 - 25% 30 - 45%	LIT	ME RE		T ENTITLED "KEY TO		
9 - 15 16 - 30	5 S	TIFF Y STIFF	31 - 50 51 +	D	DENSE RY DENSE	50 - 100%	MOS	STLY SU	SURFACE MATER	LASSIFICATION OF RIALS" FOR ADDITIONAL	BORIN	G RPS - 019
30 +		ARD		\				SYI	MBOLOGY.		NO.	

					PROJEC		South	n Coast Rail				DD0 00	$\overline{}$
	A		B		LOCATION			ham, MA			BORING	RPS - 020	J
					OWNER				ortation Author	rity	NO.	CUEET 1 OF 1	
INIOD	ECTOR	T 7-1	0000		JOB NUM		E234 NH B			DDII I ED	P. Rosinha	SHEET 1 OF 1	
			RILLING		CONTRA			ER READIN	GS		TR CME 75	ELEVATION 106 DATUM NGVD	20
0			ng w/Cas	ina	DA	TE/TIME		DEPTH(ft)	REMARKS		140 lb Safety	GRID N 28177;	
16		minated		mig			-	2 = 111(11)	T (EIVI) (I (I (O	0		COORD E 772024	
												DATE START 4/9/10	
												DATE END 4/9/10	
	STRATA	SAMPL			DEPTH	REC.	ELEV.			FIELD CLASSIFICAT	TION AND REMARK	3	
(ft)	SYMBOL	DATA). 	(ft)	(in)/(%)							
	\bowtie	8 10 8	s	1 0	0.33 - 2.33	10	105.7		Asphaltic Conc				_/
	\bowtie	10 8						WELLG	SRADED SAN	D (SW); fine to coar	rse sand, brown,	noist, FILL.	
Γ		1	5										
<u> </u>							103.0						
-		7	S	2	4 - 6	16		SANDY	SILT (ML); no	n-plastic silt, some	fine sand, light br	own, moist.	
-5		11 13 2							· //		, 0	,	
F		2	1										
F													
L													
L													
— 10		10 9	S	3	9 - 11	16		SANDY	SILT (ML); no	on-plastic silt, some	fine sand, gray, v	et.	
10		10 2	1										
<u> </u>							93.0						
-		32	S	4	14 - 16	8		SILTY S	SAND WITH G	RAVEL (SM): fine to	o coarse sand so	me non-plastic silt, little	
- 15		48		'	14 10					possible GLACIAL		mo non piaodo one, indo	
-	600	32 48 52 7	2				90.0						
L													
L								Bottom	of Hole at 16'.				
L													
200													
-20													
_													
-													
-													
-25													
ļ.													
L													
L													
L													
_ 20													
-30													
<u> </u>													
<u> </u>													
-													
-													
-35													
	Page 1:	0-35 feet.	Each subse	quent p	page displays 4	0 feet.			SAMPLES CLA	SSIFIED IN ACCORDANC	E WITH ASTM D-2488	UNLESS OTHERWISE NOTED.	
COH	HESIVE SC	IL	NON-CO	OHESI\	VE SOIL		ATIVE				LEGEND		
				1		PROP OF SOIL C	ORTIONS OMPONE	NTS Au	ger Roo	ck Core (RC) Split-Spoon Sample (SS	Undisturbed	Jar Sample Bag Sample	
BLOWS			BLOWS/F1		ENSITY					Sample (SS C (%) Sample (SS and Blow Co per 6" REC	ounts (P)-Piston	Jar Sample (JS) Bag Sample (B)	
0 - 2 3 - 4	S	Y SOFT OFT	0 - 4 5 - 10	L	LOOSE LOOSE	< 10% 15 - 25%	TRA	TLE DE					
5 - 8 9 - 1		JM STIFF TIFF	11 - 30 31 - 50		UM DENSE DENSE	30 - 45% 50 - 100%	SO MOS	DE:	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF	BORIN	B DDC 000	
16 - 3 30 +	0 VER	Y STIFF ARD	51 +		RY DENSE			50	MBOLOGY.	RIALS" FOR ADDITIONAL	NO.	RPS - 020	

				PROJEC	^т		Coast Rail	EST BUT	\ \				
							nam, MA			BORING	RP	<u>S</u> .	- 021
	A		BS	OWNER				ortation Author	ritv	NO.	1 71	<u> </u>	02 I
				JOB NU		E2347			-J	140.	SH	IEET	1 OF 1
INSPI	ECTOR	T. Teles	СО	CONTRA		NH Bo			DRILLER	P. Rosinha	ELEVATION	ON	105
	METHOD						ER READIN	GS	DRILL RIG	TR CME 75	DATUM		NGVD 29
0	Was	sh Boring	w/Casing	n DA	TE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2818037
17		minated	•		1/7/2010		6	Upon Comp	letion (In Casing)		COORD	Е	772083
											DATE ST	ART	4/7/10
											DATE EN	D	4/7/10
DEPTH	STRATA SYMBOL	SAMPLE	SAMPLE		REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
		4	S1	0.33 - 2.33	12	104.7		Asphaltic Conc					
		7					POORL'	Y GRADED S	AND (SP); mostly	fine sand, grayish-	brown, moi	st, FII	LL.
		1 4											
						102.0							
		14	00	4.0	10		CANDY	CILT (MIL): no	n nlaatia silt. sama	fine to ecores ee	ad traca fin	o aro	vol arov
-5		14 23 25 25	S2	4 - 6	18			wn, moist.	n-plastic silt, some	e line to coarse sai	iu, trace iii	ie gra	vei, gray
-		25 25						,					
						97.0							
		8	S3	9 - 11	6		WEII G	RADED SANI	D WITH GRAVEL	(SW); fine to coars	se sand so	me fir	ne gravel
-10		8 25 35 40						t, brown, wet.		(=), mio to ocare			5.0.01,
		40											
		100/5"	S4	14 - 14.52	0	91.0	NO REC	COVERY; top of	of apparent bedroo	k, roller bit to 17 ft			
15								•					
						88.0							
							Bottom (of Hole at 17'.					
-20													
- 25													
25													
-30													
35													
	Page 1: 0)-35 feet. Ea	ch subseque	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
COL	HESIVE SOII		NON-COHE	SIVE SOII	REL	ATIVE				LEGEND			
COF	ILUIVE SUII		INUIN-CUHE	JIVE SUIL	PROP	ORTIONS	ITS Aug	ger I R~	ck Core (RC) Split-Spoo	n Undisturbed	Jar	Λ.	Bag
LOWS	FT CONSI	STENCY BI	LOWS/FT	DENSITY	OF SOIL C	OMPONEN	ITS Aug Sar (AS	mple and	I RQD (%) Sample (S c (%) and Blow	(U)-Shelby Tube, Counts (P)-Piston		X	Sample (B)
0 - 2		SOFT		/ERY LOOSE	< 10%	TRA	CE		per 6" RE0	C (in)	- ` '	<u></u>	, ,
		DFT M STIFF	5 - 10 11 - 30 ME	LOOSE EDIUM DENSE	15 - 25% 30 - 45%	LITT	ΛE REF		T ENTITLED "KEY TO				
3 - 4 5 - 8	MEDIU												
3 - 4	5 ST		31 - 50	DENSE /ERY DENSE	50 - 100%	MOS	ILY SUE		CLASSIFICATION OF RIALS" FOR ADDITIONA	BORING NO.	اح ا ^ت	·S -	021

						_		EST BOP	KING			
	A		BS	PROJE LOCAT	ION	Raynh	Coast Rail			BORING	RPS	- 022
								ortation Author	rity	NO.	QUEE	T 1 OF 1
INICDI	ECTOR	T. Teleso	20	JOB NU		NH Bo			DRILLER	P. Rosinha	ELEVATION	105
		OF DRIL		CONTR			ER READIN	GS	DRILL RIG	TR CME 75	DATUM	NGVD 29
0			w/Casing	DA	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID N	
24		ninated			4/6/2010		5		oletion (In Casing)		COORD E	
											DATE START	4/6/10
											DATE END	4/6/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
		14 10 10 8	S1	0.33 - 2.33	12	104.7	WELL G			(SW); fine to coars	se sand, some	fine gravel,
	•					102.0						
5		7 11 14 16	S2	4 - 6	8			Y GRADED Sobrown, wet.	AND (SP); mostly	fine sand, trace no	n-plastic silt,	
		5	S3	8 - 10	12	97.0	SANDY	SILT (ML); sli	ghtly plastic silt, so	ome fine sand, trac	e gravel, gray,	wet.
10	<u></u>	5 5 5 6										
		16 31 120/4	S4 1"	13 - 14.33	12	92.0		TH SAND (ML et, possible GL		some fine to coars	e sand, trace f	ne gravel,
15		21 20 30 32	S5	18 - 20	10		SILT (M tip of sp	L); non-plastic oon, GLACIAL	silt, trace fine gra	vel, gray, wet, com	pletely weathe	red rock in
20		32				84.0			1 1018 5 11			
							l op of a	pparent bedro	ck at 21 ft. Roller	DIT TO 24 IT.		
	×//>>					81.0						
25							Bottom	of Hole at 24'.				
30												
35	Page 1: 0)-35 feet. Eac	ch subsequent	t page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERW	ISE NOTED.
	HESIVE SOII		NON-COHES			ATIVE ORTIONS	JTS E AU	ger Roo	ck Core (RC) Split-Spoo		Jar Samula	Bag .
0 - 2 3 - 4	VERY	SOFT		DENSITY ERY LOOSE LOOSE	< 10% 15 - 25%	TRA	CE Sai (AS	mple and	Sample (S and Blow per 6" RE	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	Bag Sample (B)
5 - 8 9 - 19 16 - 30	MEDIUI 5 ST 0 VERY	M STIFF	11 - 30 MEI 31 - 50	DIUM DENSE DENSE ERY DENSE	30 - 45% 50 - 100%	SOM	ME DES	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF RIALS" FOR ADDITIONA	BORING NO.	G RPS	- 022

				PROJE	CT	South	n Coast Rail				DD	000
			DG	LOCAT		Raynl	ham, MA			BORING	RPS -	- 023
J			BS	OWNER	₹	Mass	.Bay Transp	ortation Autho	rity	NO.		
				JOB NU	MBER	E234			T		SHEET	1 OF 1
		T. Tele		CONTR		NH Bo			DRILLER	P. Rosinha	ELEVATION	106
		D OF DE					ER READIN		DRILL RIG	TR CME 75	DATUM	NGVD 29
0			ng w/Casing	g D/	ATE/TIME	Ξ	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID N	2817966
26	Те	rminated									COORD E	772174
											DATE START	4/7/10
					1 1		<u> </u>				DATE END	4/7/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA		DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S	
(11)	OTIVIDOL	D/(I/(110.	(11)	(11)/(70)							
		7	S1	0.33 - 2.33	12	105.7		Asphaltic Cond		00.010		
	\bowtie	6 5 7							AND WITH SILT (grayish-brown, mo	SP-SM); mostly fin	e sand, little non	-plastic
_		7					ont, trao	o iiilo gravoi, s	grayion brown, mo	100, 1 122.		
-												
F		7	S2	4.6	18	102.0	POORI	V CDADED S	AND (SD): mostly	fine sand, trace no	n plactic cilt	
_5	. .	10	32	4 - 6	10			brown, moist.	AND (SP), mostly	ille saliu, trace no	iri-piastic siit,	
L	• •	14	6					,				
	• •	、										
_												
_	• . •											
L	• • •	11	00	0 11	10		DOODL	V CDADED C	AND WITH OUT /	CD CM); moothy fin	a aand little nam	nlastis
-10	· .	14	S3	9 - 11	16			Y GRADED 5. vn, moist.	AND WITH SILT (SP-SM); mostly fin	e sand, little non	-piastic
'	•	15	7				0, 2.0	,				
	• ['									
_	••											
-	. * .											
L	• •	- 40										
4.5	• •	13 16	S4	14 - 16	22	91.0	(14 - 15') POORLY GF	RADED SAND (SF	P); mostly fine sand	l, gray, wet.	
 15		13 16 25 40	_			91.0				lastic silt, some fin	e to medium san	id, trace
_		40	J				fine grav	/el, gray, wet,	possible GLACIAL	. TILL.		
F												
L												
L												
20		17 25 31 33	S5	19 - 21	14		SILT WI	TH SAND (ML	_); non-plastic silt,	some fine to coars	se sand, trace fin	e gravel,
-20		31	,				gray, we	et, GLACIAL T	ILL.			
-			3									
-												
L												
L												
		16 30	S6	24 - 26	8					me non-plastic silt,	trace fine grave	I, gray,
 25		42 33					wet, roc	k fragments in	tip of spoon, GLA	CIAL TILL.		
-	V_SX5//)	33	3			80.0						
-												
L							Bottom	of Hole at 26'.				
L												
-30						I						
F												
Ļ												
L						I						
<u> </u>						l						
<u> </u>												
- 35				1								
	Page 1:	0-35 feet. I	Each subseque	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
001	HESIVE SC	NI	NON-COHE	SIVE CO!	REL	ATIVE				LEGEND		
LUF	ILOIVE SC	/IL	INUIN-CUHE	JOIVE SUIL	PROP	PORTIONS	NITS Aug	ger F P~	ck Core (RC) Split-Spoo	on Undisturbed	Jar	7 Bag
BLOWS	FT CONS	SISTENCY	BLOWS/FT	DENSITY	OF SOIL C	OMPONEN	NTS Aug Sai (AS	mple and	RQD (%) Sample (S C (%) and Blow	Counts (U)-Shelby Tube, (P)-Piston	Sample (JS)	Bag Sample (B)
0 - 2		Y SOFT		/ERY LOOSE	< 10%	TRA	ACE	■ _ ∧∟	per 6" RE	C (in)		
3 - 4 5 - 8		SOFT UM STIFF	5 - 10 11 - 30 Mi	LOOSE EDIUM DENSE	15 - 25% 30 - 45%	LITT	ME REI		ET ENTITLED "KEY TO			
9 - 1	5 8	STIFF	31 - 50	DENSE	50 - 100%		STLY SUI	BSURFACE MATE	CLASSIFICATION OF RIALS" FOR ADDITIONA		G RPS -	.023
16 - 30 30 +		Y STIFF IARD	51 + \	/ERY DENSE			SYI	MBOLOGY.		NO.		320

					O.T.		Occasional						
_				PROJECT LOCATION			Coast Rail			BORING	DD	C	024
			35	OWNER			ham, MA Bay Transn	ortation Author	rity	NO.	ΠT	ა -	024
				JOB NU		E234		ortation Author	ity	INO.	SH	EET	1 OF 1
INISP	FCTOR	T. Telesco	<u> </u>	CONTRA		NH B			DRILLER	P. Rosinha	ELEVATIO		103
		D OF DRILL		OONTI		-	ER READIN	GS	DRILL RIG	TR CME 75	DATUM		NGVD 29
0		llow Stem A		D/	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2818319
2.5		rminated	ugci		4/6/2010	-	2		letion (In Augers)	· · · · · · · · · · · · · · · · · · ·	COORD	E	771952
2.0	1								(13-1)		DATE STA		4/6/10
											DATE END		4/6/10
DEDTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			FIELD OF ASSIERO	ATION AND REMARK			
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)	LLL V.			FIELD CLASSIFICA	TION AND REWARK	3		
_						102.7	Top 4" A	Asphaltic Conc	rete.				
-		8	S1	0.5 - 2.16	8		WELL	RADED SAN	O WITH SILT AND	GRAVEL (SW); fi			
-		8 120/2) II			101.0	of spoor		ittle non-plastic silt	, brown, moist, so	me weather	ed ro	ck in tip
_		120/2	4			100.5	\neg $$	•	ck at ~ 2 ft, roller b	oit to 2.5 ft.			
							(13)						
_							.						
-5							Bottom	of Hole at 2.5'.					
-													
-													
-													
, -													
-10													
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-													
-15													
_													
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-20													
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-25 -25 - - -													
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- - -													
· ·													
· ·					10.6								
	Page 1:	0-35 feet. Each	subsequen	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHE	RWISE	E NOTED.
- - - - - - - - - - - - - -	Page 1:		subsequen		REL	ATIVE		SAMPLES CLA	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488 LEGEND	UNLESS OTHE	RWISE	E NOTED.
-30 -30 -30 -35	HESIVE SC	DIL N	ION-COHE	SIVE SOIL	REI PROF	PORTIONS	NTS Au	ger T Roc	ck Core (RC)	LEGEND n Undisturbed	Jar		
-30 -30 -30 -35	HESIVE SC		ION-COHE		REL	PORTIONS	NTS Au (At	ger Roc mple and	k Core (RC) RQD (%) Split-Spoo Sample (S C (%) and Blow (LEGEND n Undisturbed (U)-Shelby Tube, (P)-Piston	Jar	RWISE	
30 30 5 COH	HESIVE SO	DIL NOSISTENCY BLC	NON-COHE:	SIVE SOIL DENSITY VERY LOOSE	REL PROF OF SOIL C	PORTIONS COMPONE TRA	NTS AU Sa (AS	ger Roc mple and	sk Core (RC) Split-Spoo RQD (%) Sample (S	LEGEND n Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample		
- 30 - 30 	HESIVE SO	DIL NOSISTENCY BLC RY SOFT (SOFT 5	NON-COHE: DWS/FT D - 4 V	SIVE SOIL DENSITY	REL PROF OF SOIL C	ORTIONS	NTS AUS AUS AUS AUS AUS AUS AUS AUS AUS AU	ger Roc and S) REC	k Core (RC) RQD (%) Split-Spoo Sample (S and Blow t per 6" REC	LEGEND O Si) Counts Undisturbed (I)-Shelby Tube, (P)-Piston	Jar Sample (JS)		
	HESIVE SC S/FT CONS 2 VER 4 S 8 MEDII 5 S	SISTENCY BLC RY SOFT (SOFT 1: STIFF 1: STIFF 3:	NON-COHES DWS/FT 0 - 4 V 1 - 10 1 - 30 ME 1 - 50	DENSITY VERY LOOSE LOOSE	REL PROF OF SOIL C < 10% 15 - 25%	PORTIONS COMPONE TRA LIT' SO	ACE TLE ME STLY Sa Sa (AS ACE FLE DE STLY SU	ger mple and Rec	k Core (RC) RQD (%) C (%) Sample (S and Blow t per 6" REC	LEGEND n S) Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)		

					PROJE	СТ	South	Coast Rail					
				TM .	LOCAT	ION		nam, MA			BORING	RPS -	- 025
			BS	3	OWNER		Mass	.Bay Transp	ortation Author	rity	NO.		
					JOB NU		E234					SHEET	1 OF 1
		T. Tele			CONTR		NH B				P. Rosinha	ELEVATION	103
			RILLING					ER READIN			TR CME 75	DATUM	NGVD 29
0			m Auger		D/	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER 1	40 lb Safety	GRID N	2818408
4.5	Те	rminated	1									COORD E	772236
												DATE START	4/6/10
				\dashv								DATE END	4/6/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA			DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
(11)				_	(/	(11)/(70)							
	$\times\!\!\times\!\!\times\!\!\times$	9	S1	10	0.5 - 2.5	6	102.5		sphaltic Conc			Im. [1] I	
	\bowtie	9						POURL	Y GRADED SA	AND (SP); mostly fir	ie sand, brown, c	iry, FILL.	
_		⁹ 9 ₅₆											
F	\bowtie												
-		120/0)" S2	,	4 - 4	0	99.0	NO REC	`OVERY: ton (of apparent bedrock	at ~ 4 ft roller hi	t to 4.5 ft	
-5		120/0	32		4-4		98.5	NOTIL	OVERT, top t	or apparent bedrock	at 4 it, ioliei bi	1 10 4.5 11.	
								Bottom	of Hole at 4.5'.				
_													
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	Page 1:	0-35 feet. I	Each subsequ	uent pa	age displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.
						DEI	ΔTI\/⊏			1	EGEND		
COF	HESIVE SC	DIL	NON-CO	HESIVE	E SOIL		ATIVE ORTIONS						7 -
BLOWS	FT CONS	SISTENCY	BLOWS/FT	DE	ENSITY	OF SOIL C	OMPONE		mple and	ck Core (RC) Split-Spoon Sample (SS) and Blow Col	Undisturbed (U)-Shelby Tube,	Jar Sample (JS)	Bag Sample (B)
0 - 2		Y SOFT	0 - 4		Y LOOSE	< 10%	TRA		REC	and Blow Couper 6" REC (i	unts (P)-Piston	(JS)	y (B)
3 - 4	8	SOFT	5 - 10	LC	OOSE	15 - 25%	LITT	TLE BEI	FER TO THE SHEF	ET ENTITLED "KEY TO			
5 - 8 9 - 15	5 S	UM STIFF	11 - 30 31 - 50	DE	IM DENSE ENSE	30 - 45% 50 - 100%	SOI MOS	TIV DE	SCRIPTION AND C	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	G DDC	025
16 - 30 30 +) VER	Y STIFF IARD	51 +		Y DENSE			501	MBOLOGY.	NALO I OR ADDITIONAL	NO.	RPS -	U25

						1		EST BOH	KING					
			De	PROJE LOCAT		Raynh	Coast Rail am, MA			BORING	RPS - 026			
J			BS			Mass.	Bay Transp	ortation Author	rity	NO.				
		T= = .			JMBER	E2347			DRILLER		SHEET 1 OF 1			
	NSPECTOR T. Telesco METHOD OF DRILLING				RACTOR	NH Bo			C. Knight	ELEVATI	ON	104		
0				- D	ATE/TIME		R READIN	REMARKS	DRILL RIG SPT HAMMER	ATV CME - 550 140 lb Auto	DATUM GRID	N	NGVD 29 2818157	
6.5		minated	g w/Casin	ig D	A I E/ I IIVIE		DEF ITI(II)	REWARKS	3FT HAWWINER	140 ID Auto	COORD	E	772216	
0.5	101	minatea									DATE ST		4/9/10	
											DATE EN		4/9/10	
DEPTH	STRATA	SAMPLE	SAMPL		REC.	ELEV.			FIELD CLASSIFIC	ATION AND REMARK				
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)					,				
		1	S1	0 - 2	18		SILT (M	L); non-plastic	silt, light brown, n	noist, pieces of woo	od.			
		1 2 2												
		」 2												
		2	S2	3 - 5	12	101.0	POORL	Y GRADED S	AND (SP): mostly	medium sand, trac	e fine grav	el. we	athered	
	• •	2	- I				rock in t	ip of spoon, gr	ayish brown, wet.	, , , , , , , , , , , , , , , , , , , ,	g	,		
-5	·//	1 28	•			99.0	Top of c	annarant hadra	ck at ~ 5ft, roller b	oit to 6 5 ft				
						98.0	ТОРОГА	apparent beuro	ock at ~ 5it, foller t	JII 10 0.5 II.				
							Rottom	of Hole at 6.5'.						
							בייוטווטם	oi i iole al 0.3.						
40														
-10														
15														
-20														
25														
-25														
-30														
35					12.6									
	Page 1:	0-35 feet. E	ach subsequ	ent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTI	HERWIS	E NOTED.	
COI	HESIVE SO	il	NON-COH	ESIVE SOIL		ATIVE				LEGEND				
					PROPORTIONS OF SOIL COMPONENTS			ger Roo	ck Core (RC) Split-Spot		Undisturbed			
LOWS			BLOWS/FT	DENSITY		_	— <u>■</u> (A)		Sample (\$ and Blow per 6" RE	Counts (P)-Piston	Sample (JS)	\triangleright	Bag Sample (B)	
0 - 2 3 - 4		Y SOFT SOFT	0 - 4 5 - 10	VERY LOOSE LOOSE	< 10% 15 - 25%	TRAC	F			\-'''				
5-8	MEDIL	JM STIFF	11 - 30 N	IEDIUM DENSE	30 - 45%	SOM	E RE		ET ENTITLED "KEY TO CLASSIFICATION OF	BORING	اد			
		TIFF	31 - 50	DENSE	50 - 100%	MOST			RIALS" FOR ADDITIONA		기 DI	20	026	
9 - 1 16 - 3 30 +	0 VER	Y STIFF IARD	51 +	VERY DENSE				MBOLOGY.	TUNES TOTT IDDITION	NO.	1 /1	- O -	. 020	

J	A		B	S		LOCATION Raynh		n Coast Rail nam, MA .Bay Transp	am, MA Bay Transportation Authority				RPS - 028		
					JOB NU		E234						SHEET 1 OF 1		
	ECTOR				CONTRA		NH B		00	DRILLER	C. Knight		ELEVATION		105
0	METHOD OF DRILLING Wash Boring w/Casing					TE/TIME		ER READIN DEPTH(ft)		DRILL RIG SPT HAMMER	140 lb Au		DATUM GRID		NGVD 29 2817657
10		rminate	-	asiriy		(1 <u>L</u> , 1 11V)L	-	DEI III(II)	TILIVIJ (TITO	OI I I II WWW.	11010710				772258
									DATE START 4/9/10						
						1 1							DATE END		4/9/10
DEPTH (ft)	STRATA SYMBOL	SAMPI DATA	۸ .	AMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.		FIELD CLASSIFICATION AND REMARKS						
_		16 19 16	3	S1	0.33 - 2.33	20	104.7 104.0	(0.33 - 1 fragmer	ıts, dark brown	DED SAND (SW);					/
-	•	15		S2	3 - 5	16	102.0	moist.	DOODLY OD	ADED CAND (CD	\		liadat busuus		,
-	• •	15 21 27 2	.				100.5	(3 - 4.5)	POURLY GR	ADED SAND (SP); mostly fir	ne sana,	light brown,	mois	ST.
<u>-</u> 5		′⊔ 2	3				100.0			WITH GRAVEL (ay, wet, possible			sand, some	non-	plastic
_							 •								
Ē		120/5	5"	S3	8 - 8.42	4	97.0	WEATH	IERED ROCK;	top of apparent b	edrock at ~	-8 ft, rolle	r bit to 10 ft	-	
- 10	X//X						95.0								
								Bottom	of Hole at 10'.						
_															
_ 15															
-															
_															
-20															
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-30															
- 30															
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-35	Page 1	0-35 feet	Each sub	sequent	page displays	10 feet.			SAMPLES CLA	SSIFIED IN ACCORDA	ICE WITH AST	TM D-2488 I	JNLESS OTHER	RWISF	NOTED.
COH	COHESIVE SOIL NON-COHESIV					REL	ATIVE				LEGEND				· ·
BLOWS	_	SISTENCY			DENSITY	OF SOIL C		NTS Au Sa (As	mple and	ck Core (RC) I RQD (%) C (%) Split-Spot Sample (5 and Blow per 6" RE	SS) (U)-S Counts (P)-P	listurbed Shelby Tube, Piston	Jar Sample (JS)		Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	MEDI 5 S	RY SOFT SOFT UM STIFF STIFF RY STIFF HARD	0 - 4 5 - 10 11 - 30 31 - 50 51 +	0 MED	RY LOOSE LOOSE IUM DENSE DENSE RY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SOI MOS	TLE RE ME DE TLY SU	SCRIPTION AND C	ET ENTITLED "KEY TO SLASSIFICATION OF RIALS" FOR ADDITION/	ВС	ORING NO.	RPS	S -	028

Memorandum

APPENDIX B: LABORATORY DATA

Table C.1 - Summary of Laboratory Soil Test Data South Coast Rail Project

Boring	Commis					Soil Classification								
Number	Sample Number	Sample Depth	Sample Elevation	Moisture Content	% Gravel	% Sand	% Fines	Organic Content	Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification System (ASTM D-2487)		
BCS - 01	S3	4.0	15.9	0.2	57.3	33.1	9.6					Well Graded Gravel w/ Sand (GW)		
	S9	38.0	-18.1	17.5	7.1	8.8	84.1					Silt (ML)		
BCS - 02	S5	18.0	9.7		29.3	47.3	23.4					Silty Sand w/ Gravel (SM)		
ECC - 02	S4	13.0	89.0	10					23	15	8	Clay (CL)		
EVS - 02	S4	11.0	132.0	24.3	0.6	46.2	53.2					Sandy Silt (ML)		
EVS - 03	S5	18.0	126.0		0.0	28.0	72.0					Silt w/ Sand (ML)		
FRD - 01	S2	4.0	34.0	6.5	47.7	41.1	11.2					Gravel w/ Silt + Sand (GW-GM)		
FRD - 03	S4	13.0	24.0	12.3	17.6	68.4	14.0					Silty Sand w/ Gravel (SM)		
FRD - 06	S2	4.0	22.0	7.2	44.4	47.1	8.5					Sand w/ Silt + Gravel (SW-SM)		
	S7	29.0	-3.0	20.1	0.0	88.0	12.0					Silty Sand (SM)		
FTS - 04	S2	4.0	63.6	42.4				4.7				Silt (ML)		
FTS - 11	S1	0.0	56.0	24	0	48.1	51.9					Sandy Śilt (ML)		
FTS - 13	S2	3.0	35.6	23.8	0	1	99					Silt (ML)		
KHS - 02	S3	8.0	82.8		27.0	47.9	25.1					Silty Sand w/ Gravel (SM)		
NES - 04	S4	14.0	144.0	23.6	0.0	1.9	98.1					Silty Clay (CL)		
NES - 05	S2	4.0	154.0	1.1	13.3	68.3	18.4					Silty Sand (SM)		
NES - 14	S2	4.0	162.0		32.7	51.3	16.0					Silty Sand w/ Gravel (SM)		
NES - 21	S2	4.0	158.0		56.9	34.1	9.0					Gravel w/ Silt + Sand (GW-GM)		
RPS - 04	S2	3.0	90.0		37.7	45.2	17.1					Silty Sand w/ Gravel (SM)		
RPS - 13	S3	14.0	93.0	6.2	16.0	49.6	34.4					Silty Sand w/ Gravel (SM)		
RPS - 16	S3	9.0	95.0	11.6	4.9	74.8	20.3					Silty Sand (SM)		
RPS - 19	S4	14.0	92.0	2.7	6.0	44.4	49.6					Sandy Silt (ML)		
RPS - 22	S3	8.0	97.0	14.5	6.0	40.0	54.0					Sandy Silt (ML)		
TD - 05	S2	3.0	33.9	<u> </u>	3.1	64.7	32.2					Silty Sand (SM)		
TS - 02	S3	9.0	9.0	32								Clay (CL)		
	S4	14.0	4.0	37	0	1.1	98.9		26	22	4	Silt (ML)		
TS - 03	S3	9.0	8.0	37.7			-					Clay (CL)		
TS - 07	S3	8.0	8.0	36.5	0	6.1	93.9		32	21	11	Clay (CL)		
	S4	13.0	3.0	32.8	· ·	0	33.3		02			Clay (CL)		
TS - 11	S2	3.0	14.0	26.1				7.8				Silt (ML)		
TS - 20	S3	8.0	6.0	41.4	0	5.6	94.4		33	24	9	Silt (ML)		
TS - 23	S3	8.0	5.0	35.8		5.0	J 1T		30			Clay (CL)		
TS - 24	S3	8.0	6.0	32.4								Clay (CL)		
WTS - 05	S4	14.0	-5.6	23.5				1.4				Silt (ML)		
WTS - 09	S5	20.0	-12.1	65.1					77	43	34	Silt (ML)		
WTS - 11	S6	20.0	-11.7	285.8				62.4	,,,	70		Organics (OL)		
WTS - 12	S4	10.0	-1.4	45.4				3				Silt (ML)		
	S5	15.0	-6.4	55.4				ĭ	73	31	42	Clay (CL)		

Notes:

1) Refer to the boring logs for the original sample descriptions based on visual-manual procedure (ASTM D-2488). For samples where no laboratory Atterberg Limit tests were performed, determinations of the type of fines was based on the visual-manual procedure.

GeoTesting express

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Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: RPS-4 Sample Type: jar Tested By: jbr Sample ID:S-2 Test Date: 07/14/10 Checked By: jdt

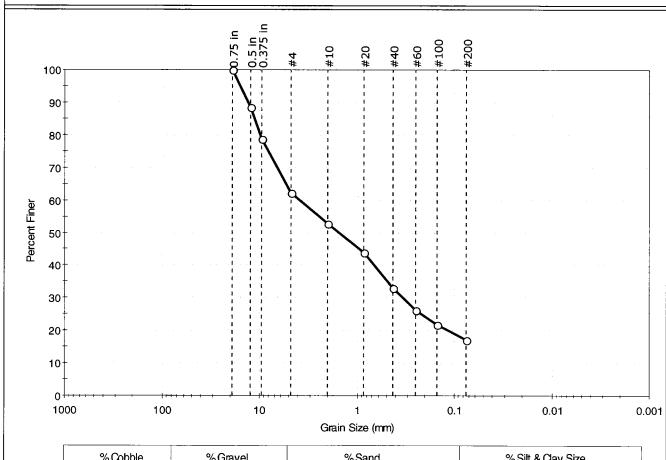
Depth: 3-5 ft Test Id: 185197

Test Comment: ---

Sample Description: Moist, light olive gray silty sand with gravel

Sample Comment: sample jar received broken

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	%Gravel	% Sand	% Silt & Clay Size
	37.7	45.2	17.1

Sieve Name	Sieve Size,	Percent Finer	Spec. Percent	Complies
	mm			
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	79		
#4	4.75	62	"	
#10	2.00	53		
#20	0.85	44		
#40	0.42	33		
#60	0.25	26		
#100	0.15	22		
#200	0.075	17		

<u>Coefficients</u>			
D ₈₅ = 11.2986 mm	$D_{30} = 0.3356 \text{ mm}$		
D ₆₀ = 3.8752 mm	$D_{15} = N/A$		
D ₅₀ = 1.5297 mm	$D_{10} = N/A$		
$C_u = N/A$	C _c =N/A		

Project No:

GTX-9764

ASTM	Classification N/A
<u>AASHTO</u>	Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description
Sand/Gravel Particle Shape: ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location:

Boring ID: RPS-13 Sample Type: jar

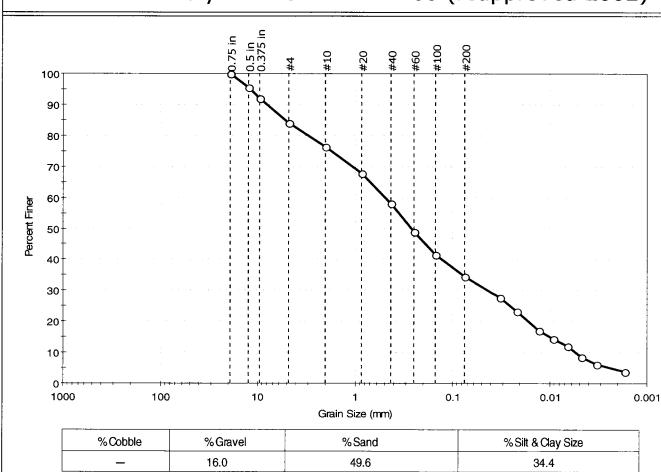
Sample ID:S-3 Test Date: 07/21/10 185186

Depth: 14-16 ft Test Id: Test Comment:

Sample Description: Moist, olive gray silty sand with gravel

Sample Comment:

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



9/	6 Cobble	%Gravel	%Sand	% Silt & Clay Size
	-	16.0	49.6	34.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100	den i Navarra Navarra Navarra	Line Land of the Carl
0.5 in	12.50	96		
0.375 in	9.50	92		
#4	4.75	84		
#10	2.00	77	-	
#20	0.85	68		
#40	0.42	58	-	
#60	0.25	49		
#100	0.15	41		
#200	0.075	34		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0328	28		<u>, 4 4 7 4 1, 7 4 1 4 7 4 7 4 9 4 4 </u>
	0.0216	23		
	0.0128	17		
	0.0092	15		
	0.0066	12		
	0.0047	9		
	0.0033	6		
	0.0017	4		

<u>Coefficients</u>			
D ₈₅ = 5.1894 mm	$D_{30} = 0.0439 \text{ mm}$		
$D_{60} = 0.4899 \text{ mm}$	$D_{15} = 0.0097 \text{ mm}$		
$D_{50} = 0.2641 \text{ mm}$	$D_{10} = 0.0053 \text{ mm}$		
$C_u = N/A$	$C_{c} = N/A$		

Project No:

Tested By:

Checked By: jdt

GTX-9764

jbr

Classification **ASTM** N/A Silty Gravel and Sand (A-2-4 (0))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape: ROUNDED Sand/Gravel Hardness: HARD

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location:

Boring ID: RPS-16 Sample Type: jar Tested By: jbr Test Date: Sample ID:S-3 Checked By: jdt 07/21/10

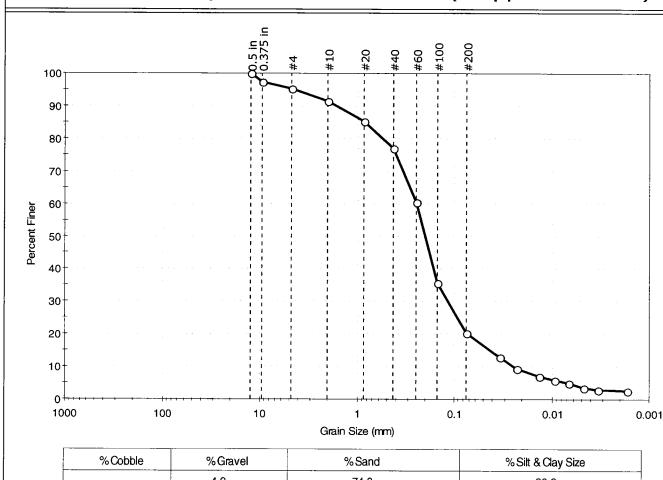
Depth: 9-11 ft Test Id: 185185

Test Comment:

Sample Description: Moist, olive silty sand

Sample Comment:

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	%Gravel	%Sand	% Silt & Clay Size
-	4.9	74.8	20.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	95		
#10	2.00	91		
#20	0.85	85		-
#40	0.42	77		-
#60	0.25	60		
#100	0.15	36		
#200	0.075	20		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0342	13		
	0.0226	9		
	0.0134	7		
	0.0094	6		
	0.0067	5		
	0.0047	4		
	0.0033	3		
	0.0017	3		

<u>Coefficients</u>			
D ₈₅ = 0.8261 mm	$D_{30} = 0.1157 \text{ mm}$		
D ₆₀ = 0.2479 mm	$D_{15} = 0.0423 \text{ mm}$		
D ₅₀ = 0.2015 mm	$D_{10} = 0.0242 \text{ mm}$		
Cu =N/A	$C_C = N/A$		

Project No:

Classification <u>ASTM</u> N/A AASHTO Silty Gravel and Sand (A-2-4 (0))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape: ROUNDED Sand/Gravel Hardness: HARD

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: RPS-19 Sample Type: jar

Sample Type: jar Tested By: jbr Test Date: 07/21/10 Checked By: jdt

Project No:

GTX-9764

Depth: 14-16 ft Test Id: 185187

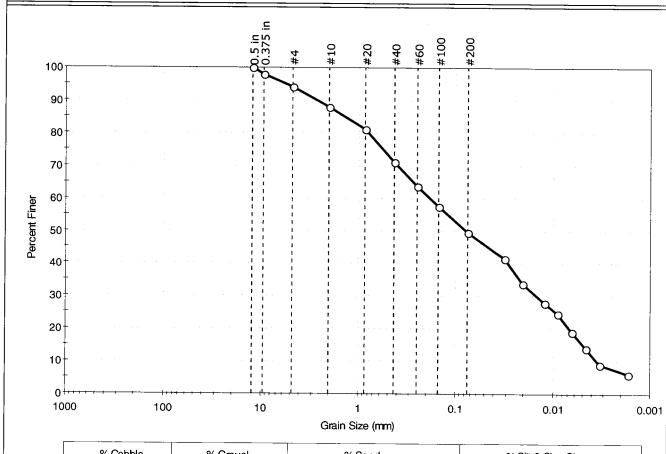
Test Comment: ---

Sample ID:S-4

Sample Description: Moist, olive sandy silt

Sample Comment: --

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	%Gravel	% Sand	% Silt & Clay Size
	6.0	44.4	49.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	98	-	
#4	4.75	94	-	
#10	2.00	88		
#20	0.85	81		
#40	0.42	71	· -	
#60	0.25	64		
#100	0.15	57		
#200	0.075	50		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0320	42		
	0.0207	34		
	0.0123	28		
	0.0089	25		
	0.0064	19		
	0.0046	14	-	
	0.0033	9		
	0.0017	6		
			-	-

	Coefficients				
	D ₈₅ = 1.3895 mm	$D_{30} = 0.0145 \text{ mm}$			
	D ₆₀ = 0.1857 mm	$D_{15} = 0.0048 \text{ mm}$			
	D ₅₀ = 0.0777 mm	$D_{10} = 0.0035 \text{ mm}$			
ĺ	$C_u = N/A$	C _c =N/A			

ASTM N/A

AASHTO Silty Soils (A-4 (0))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

GeoTesting express

a subsidiary of Geocomp Corporation

Jacobs Civil, Inc. Client: South Coast Rail Project:

Location: MA Boring ID: RPS-22 Sample Type: jar

Tested By: Test Date: 07/21/10 Checked By: jdt Sample ID:S-3

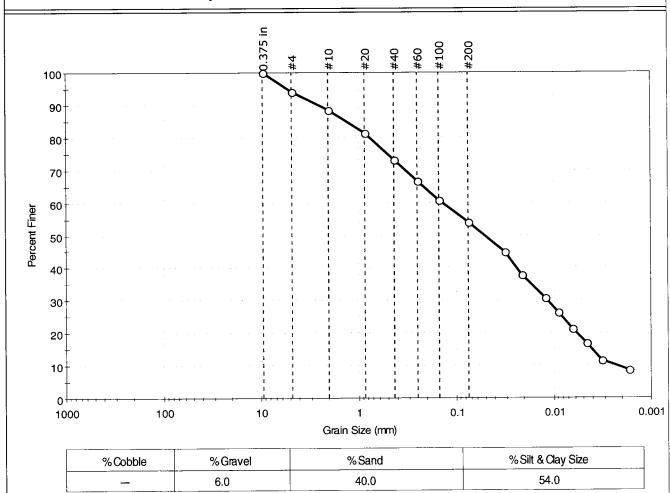
Depth: 8-10 ft Test Id: 185184

Test Comment:

Moist, dark olive gray sandy silt Sample Description:

Sample Comment:

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



Sieve Name	Sieve Size,	Percent Finer	Spec. Percent	Complies
	mm			
0.375 in	9.50	100		
#4	4.75	94		
#10	2.00	88		
#20	0.85	81		
#40	0.42	73		
#60	0.25	67		
#100	0.15	61		
#200	0.075	54		
- 444	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0318	45		
	0.0210	38		
	0.0123	31		
	0.0089	26		······································
	0.0064	21	<u> </u>	
	0.0046	17		
	0.0033	12	<u> </u>	
	0.0017	8	 	

<u>Coefficients</u>				
D ₈₅ = 1.3120 mm	$D_{30} = 0.0116 \text{ mm}$			
D ₆₀ = 0.1368 mm	$D_{15} = 0.0041 \text{ mm}$			
D ₅₀ = 0.0512 mm	$D_{10} = 0.0024 \text{ mm}$			
C _u =N/A	$C_c = N/A$			

GTX-9764

Project No:

Classification N/A **ASTM** AASHTO Silty Soils (A-4 (0))

<u>Sample/Test Description</u> Sand/Gravel Particle Shape: ROUNDED

Sand/Gravel Hardness: HARD

Memorandum

APPENDIX C: GEOTECHNICAL CALCULATIONS

- Allowable Bearing Capacity and Estimated Settlement
- Seismic Site Class Evaluation



343 Congress Street Boston, MA 02210 617/242-9222

CALCULATION WORKSHEET

JOB_	MDTA South Coast Kall				
SUBJECT	Raynham Park Station				
CALCULATED BY	DH	DATE	2/20/2012		
CHECKED BY	AH/PJM	DATE	2/29/2012		

Evaluate bearing resistance for platform shallow foundations. **PURPOSE:**

REFERENCE: AASHTO LRFD Bridge Design Specifications, 2010

ASSUMPTIONS: - Platform footing is 4 ft wide by 10 ft long.

- Bearing surface is compacted Gravel Borrow overlying sand or gravel.
- Footing embedment is at least 4 feet below final ground surface.
- Groundwater level is at 3 feet below surface.
- Footing eccentricity is assumed to be zero.
- Estimated soil properties (experience, geotech literature, Table 10.4.6.2.4-1):

	γ (pcf)	ф
Gravel Borrow:	125	34

BEARING CAPACITY FACTORS (Table 10.6.3.1.2a-1):

	ф	N _c	N_q	N _γ
Gravel Borrow:	34	42.2	29.4	41.1

CALCULATE EFFECTIVE FOOTING WIDTH (B'):

e < B/4(Section 10.6.3.3) B = footing width (ft) = 3 where: e = eccentricity (ft)

Assume no footing eccentricity, thus, e = 0

B' = B-2e

NOMINAL BEARING RESISTANCE (q_n):

where:

$$q_{n} = cN_{cm} + \gamma D_{f}N_{qm}C_{wq} + 0.5\gamma B'N_{\gamma m}C_{w\gamma}$$
 (Eqn. 10.6.3.1.2a-1)

3

c = cohesion = 0125 γ = total unit weight D_f = depth of footing (ft) = Assumed 4 B' = effective width of footing (ft) = 3 L = length of footing (ft) = 10 B'/L = 0.30 $D_f/B' =$ 1.33

> L/B' = 3.33 $C_{wq} C_{w\gamma}$ = groundwater correction factors (using B')

 $C_{wq} =$ 0.7 (Table 10.6.3.1.2a-2) $C_{w_{\gamma}} =$ 0.5 (Table 10.6.3.1.2a-2)

 $N_{cm} N_{qm} N_{vm}$ = bearing capacity factors

$$N_{qm} = N_q s_q d_q i_q$$
 (Eqn. 10.6.3.1.2a-3)

 $S_{\alpha} =$ 1.20 (Table 10.6.3.1.2a-3)

 $d_q =$ 1.23 (Table 10.6.3.1.2a-4)

(see AASHTO p. 10-62) 1.0

> 43.5 $N_{qm} =$

 $N_{\gamma m} = N_{\gamma} s_{\gamma} i_{\gamma}$

88.0 (Table 10.6.3.1.2a-3)

 $i_{\gamma} =$ 1 (see AASHTO p. 10-62)

 $N_{\gamma m} =$ 36.2



343 Congress Street Boston, MA 02210 617/242-9222

CALCULATION WORKSHEET

 JOB
 MBTA South Coast Rail

 SUBJECT
 Raynham Park Station

 CALCULATED BY
 DH
 DATE
 2/20/2012

 CHECKED BY
 AH/PJM
 DATE
 2/29/2012

 $q_0 = 18,609$ psf

ALLOWABLE BEARING RESISTANCE (qa):

 $q_a = q_n/FOS$

where: FOS = factor of safety =

q_a = 7,443 psf

use

q_a = 7.44 ksf strength limit value

Note: Based on the anticipated light loads and potentially small footing sizes, an allowable bearing capacity of 6 ksf is recommended.

Elastic Settlement Calculations:

$$S_e = \frac{\left(q_o (1 - v^2)\sqrt{A'}\right)}{144E_s \beta_z}$$
 eqn. 10.6.2.4.2-1

2.5

for sand

where: $q_o = applied vert. stress (ksf)$

v = Poisson's Ratio

 E_s = Young's Modulus (ksi)

 β_z = Shape/Rigidity Factor

where: B' = eff. width of footing (ft) =

L = length of footing (ft):

 $A' = (B'xL) = footing area (ft^2)$:

3	(from bearing resistance calcs)
10	(from bearing resistance calcs)
30	ft ²

Settlement (S_e) for a given q_o:

q_o = applied vertical stress (ksf) = 6.00 ksf (assumed)

Se (inches) = 0.36 inches



Raynham Park Station Seismic Site Class Evaluation

Based on the platform boring with the deepest soil overburden and lowest average blow counts (worst case)

Boring No.	Sample No.	N Value	Di	Di/N _i	N _{bar}
RPS-1	S-1	20	3	0.15	
	S-2	25	7	0.28	75
	Bedrock	100	90	0.90	
	Total Depth =	100			
De	pth to Bedrock =	10	Sum	1.33	

Per 9.4.1.2.1, N_{bar} > 50, Site Class C

9.4.1.2.1 Site Class Definitions. The site shall be classified as one of the following classes:

A = Hard rock with measured shear wavevelocity, $\overline{v}_s > 5000 \text{ft/s} (1500 \text{ m/s})$

 $B = \text{Rock with } 2500 \text{ ft/s} < \overline{\boldsymbol{v}}_{\boldsymbol{s}} \le 5000 \text{ ft/s} (760 \text{ m/s} < \overline{\boldsymbol{v}}_{\boldsymbol{s}} \le 1500 \text{ m/s})$

C= Very dense soil and soft rock with 1200 ft/s $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 2500$ ft/s (370 m/s $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 760$ m/s) or $\overline{\boldsymbol{N}}$ or $\overline{\boldsymbol{N}}_{\boldsymbol{ch}} \geq 50$ or $\overline{\boldsymbol{s}}_{\boldsymbol{u}} \geq 2000$ psf (100 kPa)

$$\begin{split} D &= \text{ Stiff soil with 600 ft/s} \leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 1200 \text{ ft/s} \\ (180 \text{ m/s} \leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 370 \text{ m/s}) \text{ or with } 15 \leq \overline{\boldsymbol{N}} \text{ or } \\ \overline{\boldsymbol{N}}_{\boldsymbol{ch}} \leq 50 \text{ or } 1000 \text{ psf} \leq \overline{\boldsymbol{s}}_{\boldsymbol{u}} \leq 2000 \text{ psf} (50 \text{ kPa} \\ \leq \overline{\boldsymbol{s}}_{\boldsymbol{u}} \leq 100 \text{ kPa}) \end{split}$$

E= A soil profile with $\overline{\mathbf{v}}_{\mathbf{s}} < 600$ ft/s (180 m/s) or any profile with more than 10 ft (3 m) of soft clay. Soft clay is defined as soil with Pl > 20, $w \ge 40\%$, and $s_u < 500$ psf (25 kPa)

F = Soils requiring site-specific evaluations:

 Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. Potential for liquefaction shall be evaluated in accordance with 780 CMR 1804.6: Liquefaction.

Exception. None.

- 2. Peats and/or highly organic clays (H > 10 ft [3 m] of peat and/or highly organic clay where H = thickness of soil).
- 3. Very high plasticity clays (H \geq 25 ft [7.6 m] with $PI \geq$ 75).
- 4. Very thick soft/medium stiff clays (H>120 ft [37 m].

Exception. None.

Approx. Project Coordinates

Lat 41.981442 Long -71.075919

Seismic Coefficients

 $S_S = 0.24 \text{ (Table 1604.10*)}$ $S_1 = 0.062 \text{ (Table 1604.10*)}$

For Site Class C

 $F_A = 1.2 \text{ (See Table 9.4.1.2.4a*)}$ $F_V = 1.7 \text{ (See Table 9.4.1.2.4b*)}$

Design Spectral Response Parameters

 $S_{MS} = Ss x F_A = 0.288$ $S_{M1} = S_1 x F_V = 0.105$

 $S_{DS} = 2/3 \times S_{MS} = 0.192$ $S_{D1} = 2/3 \times S_{M1} = 0.070$

Notes: * The Massachusetts State Building Code, 8th Edition (2010)

$TABLE~9.4.1.2.4a~VALUES~OF~F_{a}~AS~A~FUNCTION~OF~SITE~CLASS~AND~SHORT~PERIOD~MAXIMUM~CONSIDERED~EARTHQUAKE~SPECTRAL~ACCELERATION~$

Site Class			abulated Maximu ectral Response A			
	$S_s \le 0.26 \ 0.27 \le S_s \le 0.29 \ 0.30 \le S_s \le 0.29$	$0.30 \le S_S \le 0.32$	$0.33 \le S_S \le 0.35$	$0.36 \le S_S \le 0.38$	$S_{\rm S} \ge 0.39$	
A	0.8	0.8	0.8	0.8	0.8	0.8
В	1.0	1.0	1.0	1.0	1.0	1.0
С	1.2	1.2	1.2	1.2	1.2	1.2
D	1.6	1.6	1.55	1.5	1.5	1.5
E	2.5	2.4	2.3	2.2	2.1	2.0
F	Note a	Note a	Note a	Note a	Note a	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of $F_{\rm a}$ for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

TABLE 9.4.1.2.4b VALUES OF F, AS A FUNCTION OF SITE CLASS

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at 1-Second Periods
	$S_I \leq 0.1$
Α	0.8
В	1.0
C	1.7
D	2.4
E	3.5
F	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_v for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

TABLE 1604.10 GROUND SNOW LOADS; BASIC WIND SPEEDS; EARTHQUAKE DESIGN FACTORS

(For R-3 of three stories or less one- and two-family stand alone buildings, see 780 CMR 53.00 for snow and wind loads)

	Ground Snow	Basic Wind	Earthquake Design Factors		
City/Town	$\begin{array}{c} \textbf{Load} \\ \textbf{p}_{g}, \textbf{psf} \end{array}$	Speed V, MPH	Ss	\mathbf{S}_{1}	
Needham	55	100	0.27	0.067	
New Ashford	65	90	0.22	0.068	
New Bedford	45	110	0.23	0.058	
New Braintree	55	100	0.23	0.067	
New Marlborough	65	90	0.23	0.066	
New Salem	65	100	0.24	0.068	
Newbury	55	110	0.35	0.076	
Newburyport	55	110	0.35	0.077	
Newton	55	105	0.27	0.068	
Norfolk	55	100	0.25	0.065	
North Adams	65	90	0.22	0.069	
North Andover	55	110	0.33	0.075	
North Attleborough	55	110	0.24	0.063	
North Brookfield	55	100	0.23	0.066	
North Reading	55	105	0.32	0.073	
Northampton	55	100	0.22	0.066	
Northborough	55	100	0.25	0.067	
Northbridge	55	100	0.24	0.065	
Northfield	65	100	0.24	0.070	
Norton	55	110	0.24	0.063	
Norwell	45	110	0.26	0.064	
Norwood	55	100	0.26	0.065	
Oak Bluffs	35	120	0.18	0.051	
Oakham	55	100	0.24	0.067	
Orange	65	100	0.24	0.070	
Orleans	35	120	0.18	0.051	
Otis	65	90	0.23	0.066	
Oxford	55	100	0.23	0.065	
Palmer	55	100	0.23	0.066	
Paxton	55	100	0.24	0.067	
Peabody	45	110	0.31	0.072	
Pelham	55	100	0.23	0.067	
Pembroke	45	110	0.25	0.063	
Pepperell	65	100	0.30	0.073	
Peru	65	90	0.22	0.067	
Petersham	65	100	0.24	0.068	
Phillipston	65	100	0.24	0.069	
Pittsfield	65	90	0.22	0.067	
Plainfield	65	100	0.22	0.068	
Plainville	55	100	0.24	0.063	
Plymouth	45	110	0.24	0.060	
Pympton	45	110	0.24	0.061	
Princeton	65	100	0.25	0.069	
Provincetown	35	120	0.22	0.058	
Quincy	45	105	0.27	0.067	
Randolph	45	105	0.26	0.065	
Raynham	55	110	0.24	0.062	
Reading	55	105	0.31	0.072	
Rehoboth	55	110	0.24	0.062	
Revere	45	105	0.30	0.070	
Richmond	65	90	0.22	0.067	

Stormwater Report

Taunton Station

City of Taunton, Massachusetts

Prepared for

massDOT

Massachusetts Department of Transportation 10 Park Plaza Boston, Massachusetts





Transportation, Land Development, Environmental Services 99 High Street Boston, Massachusetts 02110 617 728 7777

June 2012



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Checklist for Stormwater Report



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.





A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals. This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

Taunton Station_DEP Stormwater Checklist • 04/01/08

¹ The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

² For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Stormwater Report accurately reflects conditions at the site as of the date of this permit application.
Registered Professional Engineer Block and Signature
Signature and Date
Checklist
Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?
☐ New development
□ Redevelopment
☐ Mix of New Development and Redevelopment



Massachusetts Department of Environmental ProtectionBureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

env	Measures: Stormwater Standards require LID measures to be considered. Document what rironmentally sensitive design and LID Techniques were considered during the planning and design of project:
	No disturbance to any Wetland Resource Areas
	Site Design Practices (e.g. clustered development, reduced frontage setbacks)
\boxtimes	Reduced Impervious Area (Redevelopment Only)
	Minimizing disturbance to existing trees and shrubs
	LID Site Design Credit Requested:
	☐ Credit 1
	☐ Credit 2
	☐ Credit 3
\boxtimes	Use of "country drainage" versus curb and gutter conveyance and pipe
\boxtimes	Bioretention Cells (includes Rain Gardens)
	Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
	Treebox Filter
	Water Quality Swale
\boxtimes	Grass Channel
	Green Roof
	Other (describe):
Sta	ndard 1: No New Untreated Discharges
\boxtimes	No new untreated discharges
	Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
	$Supporting\ calculations\ specified\ in\ Volume\ 3\ of\ the\ Massachusetts\ Stormwater\ Handbook\ included.$



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued) Standard 2: Peak Rate Attenuation Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding. Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm. Calculations provided to show that post-development peak discharge rates do not exceed predevelopment rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24hour storm. Standard 3: Recharge Soil Analysis provided. Required Recharge Volume calculation provided. Required Recharge volume reduced through use of the LID site Design Credits. Sizing the infiltration, BMPs is based on the following method: Check the method used. ⊠ Static ☐ Simple Dynamic ☐ Dynamic Field¹ Runoff from all impervious areas at the site discharging to the infiltration BMP. Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason: Site is comprised solely of C and D soils and/or bedrock at the land surface M.G.L. c. 21E sites pursuant to 310 CMR 40.0000 Solid Waste Landfill pursuant to 310 CMR 19.000 Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable. Calculations showing that the infiltration BMPs will drain in 72 hours are provided. Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



Massachusetts Department of Environmental ProtectionBureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Cł	necklist (continued)
Sta	ndard 3: Recharge (continued)
	The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
	Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.
Sta	ndard 4: Water Quality
The	E Long-Term Pollution Prevention Plan typically includes the following: Good housekeeping practices; Provisions for storing materials and waste products inside or under cover; Vehicle washing controls; Requirements for routine inspections and maintenance of stormwater BMPs; Spill prevention and response plans; Provisions for maintenance of lawns, gardens, and other landscaped areas; Requirements for storage and use of fertilizers, herbicides, and pesticides; Pet waste management provisions; Provisions for operation and management of septic systems; Provisions for solid waste management; Snow disposal and plowing plans relative to Wetland Resource Areas; Winter Road Salt and/or Sand Use and Storage restrictions; Street sweeping schedules; Provisions for prevention of illicit discharges to the stormwater management system; Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL; Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan; List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
	A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent. Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
	is within the Zone II or Interim Wellhead Protection Area
	is near or to other critical areas
	is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
	involves runoff from land uses with higher potential pollutant loads.
	The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if

applicable, the 44% TSS removal pretreatment requirement, are provided.



Massachusetts Department of Environmental ProtectionBureau of Resource Protection - Wetlands Program

Checklist (continued)

Checklist for Stormwater Report

Sta	ndard 4: Water Quality (continued)
\boxtimes	The BMP is sized (and calculations provided) based on:
	☐ The ½" or 1" Water Quality Volume or
	☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
	The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
	A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.
Sta	ndard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)
	The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report. The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted <i>prior</i> to the discharge of stormwater to the post-construction stormwater BMPs.
	The NPDES Multi-Sector General Permit does <i>not</i> cover the land use.
	LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
	All exposure has been eliminated.
	All exposure has <i>not</i> been eliminated and all BMPs selected are on MassDEP LUHPPL list.
	The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.
Sta	ndard 6: Critical Areas
	The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
П	Critical areas and BMPs are identified in the Stormwater Report.



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

\boxtimes	The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
	☐ Limited Project
	 Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area. Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
	☐ Bike Path and/or Foot Path
	□ Redevelopment Project
	Redevelopment portion of mix of new and redevelopment.
	Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
	The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative:
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures:
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Massachusetts Department of Environmental ProtectionBureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued) Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

(CO	nunuea)
	The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has <i>not</i> been included in the Stormwater Report but will be submitted <i>before</i> land disturbance begins.
	The project is <i>not</i> covered by a NPDES Construction General Permit.
	The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
	The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.
Sta	indard 9: Operation and Maintenance Plan
	The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
	☐ Name of the stormwater management system owners;
	☐ Party responsible for operation and maintenance;
	☐ Schedule for implementation of routine and non-routine maintenance tasks;
	☐ Plan showing the location of all stormwater BMPs maintenance access areas;
	☐ Description and delineation of public safety features;
	☐ Estimated operation and maintenance budget; and
	☐ Operation and Maintenance Log Form.
	The responsible party is not the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
	A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
	A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.
Sta	ndard 10: Prohibition of Illicit Discharges
\boxtimes	The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
	An Illicit Discharge Compliance Statement is attached;
	NO Illicit Discharge Compliance Statement is attached but will be submitted <i>prior to</i> the discharge of any stormwater to post-construction BMPs.



Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00).

Project Description

The Applicant, MassDOT, is proposing to construct a train station in Taunton, Massachusetts near the intersection of Arlington Street and the Belmont Street Extension (the Project). As proposed, the Project consists of a parking lot with 210 spaces, access driveway, a bus drop off area, a side platform, sidewalks, stairs and ramps associated with access from the parking lot to the train platform, bicycle parking facilities, a bioretention basin, and ancillary landscape improvements including the removal of the existing concrete building pads and existing broken pavement.

The site is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is not a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Site Description

The Project Site is a 12 acre parcel of land (the Site) located at the intersection of Arlington and the Belmont Street Extension in Taunton, Massachusetts. The Site lies within the surface watershed of Taunton River and is bounded by undeveloped land to the north, by Arlington Street to the south, a large wetland to the west, and the MBTA railroad ROW to the east (see Figure 1, Site Locus Map and Figure 2, Site Aerial). The site is previously developed, however the existing buildings have burned down, leaving only building foundations and paved driveways. Stormwater runoff currently sheet flows untreated, to the existing wetland.

One wetland Resource Area on the Site, shown on Figures 3 and 4, is described in Table 1. For additional information regarding the wetland resource area T41 present on the site see the Abbreviated Notice of Resource Area Delineation (ANRAD) prepared by VHB dated May 2011.

Taunton Station

Table 1
Wetland Resource Areas

Name	Critical Area	Zone 1 or Zone A	ORW or SRW	Zone II or IWPA	Description
Wetland T41	No	No	No	No	PFO

Notes: Wetland Classifications: PFO = Palustrine Forested

According to the National Resources Conservation Service (NRCS), surface soils on the Site are classified as Urban land. On-site soils are classified as fill. Based on the soil evaluation performed by Jacobs Engineering, included in Appendix C, the Site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour). Soil vary at the upper fill levels and are poor (silty/clay), HSG D soils at levels just below the surface.

The project is located within an area of 0.2% chance of flood as shown on the FEMA Floodway Map, Town of Taunton, Massachusetts Bristol County, Community Panel Number 25005C0162F and 25005CO164F dated July 7, 2009. These maps are included in Appendix B.

Existing Drainage Conditions

Under existing conditions, the 12 acre Site is developed with predominantly impervious surfaces with small areas of intermixed pervious ground, and generally has a flat topography with 8.7 acres developed area, and the remainder generally the wetland area to the west. This drainage area is described below.

<u>Drainage Area 1</u> - This 8.7-acre developed area of the site consist of concrete building foundations, paved driveways and parking areas, and small and large patches of pervious surfaces. This entire area sheet flows, untreated, to wetland T41 west of the site.

Figure 3 illustrates the existing drainage patterns on the Site. The Site was evaluated as a single drainage area because stormwater runoff flows to one Design Point. Table 2 below provides a summary of the existing conditions hydrologic data.

Taunton Station

Table 2
Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland T41	1	8.7	93	16.1

Proposed Drainage Conditions

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site would be divided into three sub-drainage areas that will discharge treated stormwater to the one existing Design Point. Existing grading and drainage patterns were maintained to the maximum extent possible in the proposed conditions. The existing building foundations and broken paved areas would be removed in the proposed conditions, and replaced with landscaping, or paved parking areas as shown on Figure 4. All runoff from impervious surfaces would sheet flow to a grassed swale and then be conveyed to a bioretention area for further treatment. Low impact development stormwater management techniques have been incorporated into the design. These practices are focused on decentralizing stormwater management techniques into the design that will reduce peak runoff rates, maximize groundwater recharge and treat for water quality. The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This 3.0-acre area consists of almost entirely pervious area that would sheet flow to Wetland T41. The existing building foundations and paved areas would be completely removed in the proposed conditions.

<u>Drainage Area 2</u> – This 4.1-acre area consists of both paved parking and drive aisle areas and landscaped islands. This area would sheet flow from the impervious surfaces into a grassed channel or a sediment forebay and then be conveyed to a bioretention area for treatment before it overflows to Wetland T41.

<u>Drainage Area 3</u> – This 1.8-acre area consist of almost entirely pervious surfaces that would sheet flow onto Arlington Street, as it does under existing conditions, before it is captured by a catch basin located in the street and connected to an existing culvert.

Table 3 below provides a summary of the proposed conditions hydrologic data.

Taunton Station

Table 3
Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland T41	1	3.03	84	12.8
2	Wetland T41	1	4.05	93	13.3
3	Wetland T41	1	1.83	85	5.6

The site has been designed with a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. The proposed stormwater management system has been designed to treat the 0.5 inch Water Quality Volume.

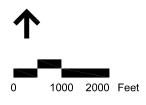
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Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include:

- Reduction in impervious area of 2.9 acres
- Grassed swale
- Bioretention basin
- Light colored pavement sidewalks

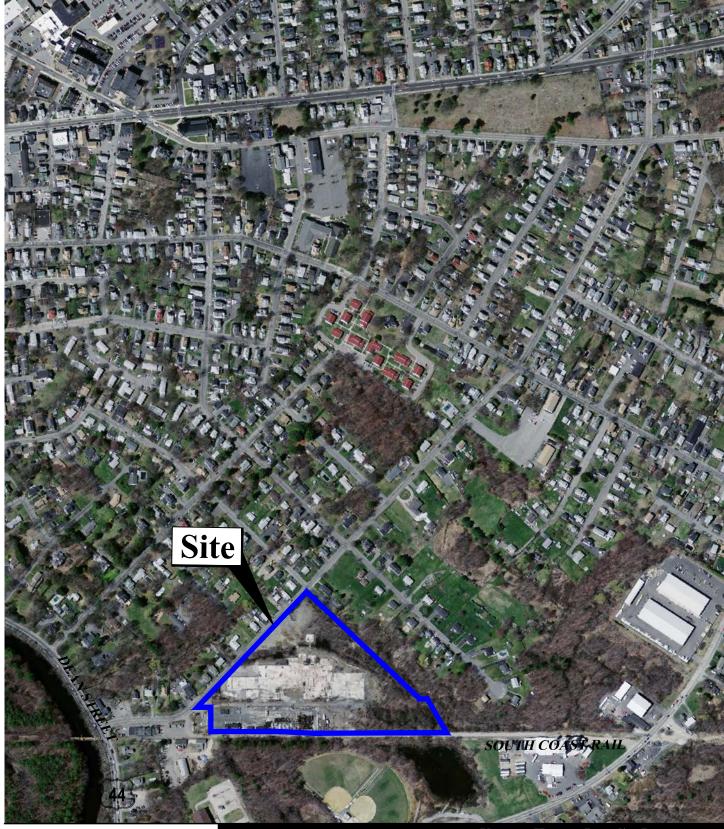
In general, stormwater from the proposed impervious surfaces will sheet flow into a grassed swale and conveyed to a large bioretention area for treatment and discharge to Wetland T41. Under existing conditions stormwater sheet flows from impervious surfaces, untreated, to the wetland.

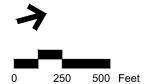


USGS Locus Map

Proposed Taunton Station South Coast Rail Taunton, Massachusets

Figure 1 May 2012





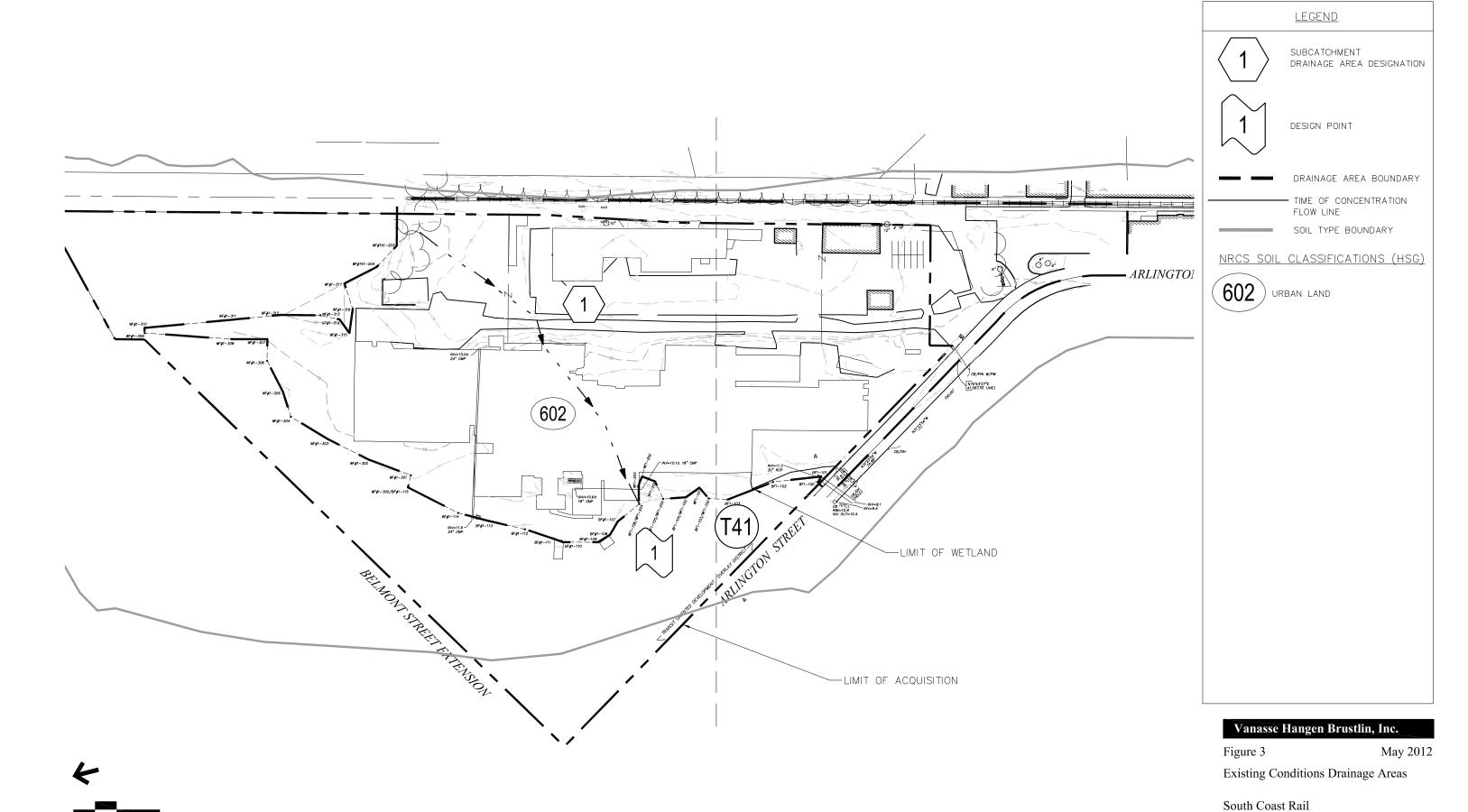
Site Aerial Map

Taunton Station South Coast Rail Taunton, Massachusets

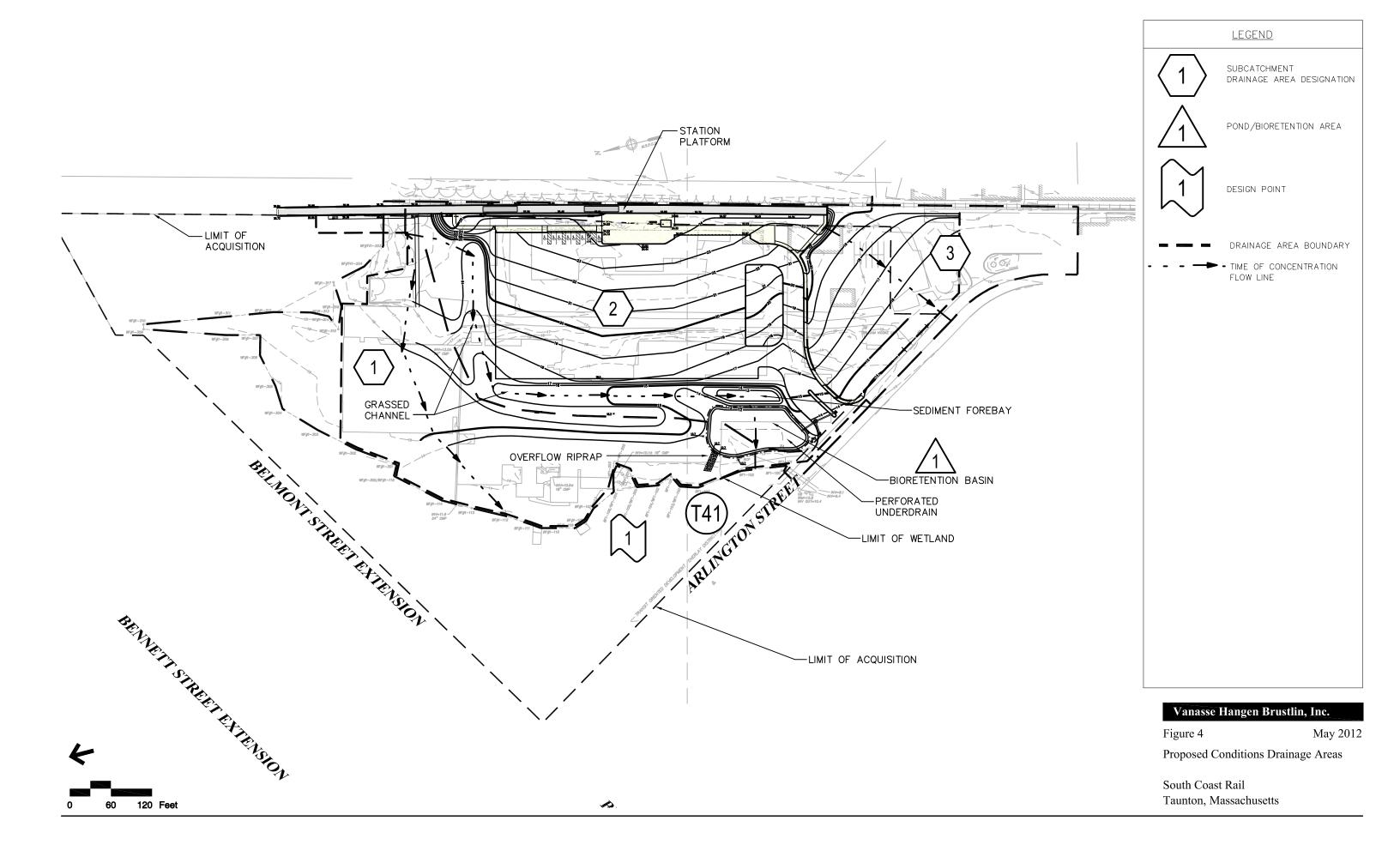
Vanasse Hangen Brustlin, Inc.

Figure 2 May 2012

120 Feet



Taunton, Massachusetts





Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards at 310 CMR 10.05.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMPs that impound stormwater have been designed with stone rip rap to protect down-gradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to fully comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 100-years. The results of the analysis, as summarized in Table 4 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions.

Taunton Station

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Table 4
Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	100-year
Design Point: Wetland T41			
Existing	19.1	28.4	42.8
Proposed	13.9	23.0	37.1

Standard 3: Stormwater Recharge

Due to the fact that the development portion of the site is comprised of fill, underlain by poorly draining soils, the project has been designed to promote infiltration of the required recharge volume only to the maximum extent practicable. The addition of pervious area in the proposed conditions will reduce runoff from the site as a whole. Currently the site runs off to the adjacent wetland and groundwater recharge is insignificant under existing conditions. If assuming there could be some infiltration, in the HSG D lower soils, according to the Stormwater Handbook, the Required Recharge Volume for the Project would be 970 cubic feet, a relatively small amount. Approximately 1,263 cubic feet of recharge is provided in the bioretention area.

This volume of storage has been provided through the use of a bioretention basin, which has been sized using the static method. It is hoped that the bioretention basin will promote some recharge and infiltrate, however it has been designed to drain completely within 72 hours by the incorporation of perforated underdrain. This is necessary due to the inconsistent and poor draining qualities of the subsurface soil conditions. A Geotechnical Report that describes subsurface soil conditions is included as an appendix to this report.

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide a minimum of 80% TSS removal for stormwater runoff from all proposed impervious surfaces.

Computations and supporting information are included in Appendix D.



Taunton Station

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is not considered a LUHPPL as defined in 310 CMR 10.04 and 314 CMR 9.02 because it is not parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is a redevelopment, but has still been designed to fully comply with all ten of the Stormwater Management Standards.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project would disturb approximately 8.9 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) would be developed and a Notice of Intent for the CGP would be submitted at least 14 days before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls were discussed in the DEIR/S. Appropriate controls will be prepared and implemented by the contractor and MassDOT (MBTA) during construction in accordance with the final design and NPDES SWPPP.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan will be developed by the MBTA during final design for the Project.



Taunton Station

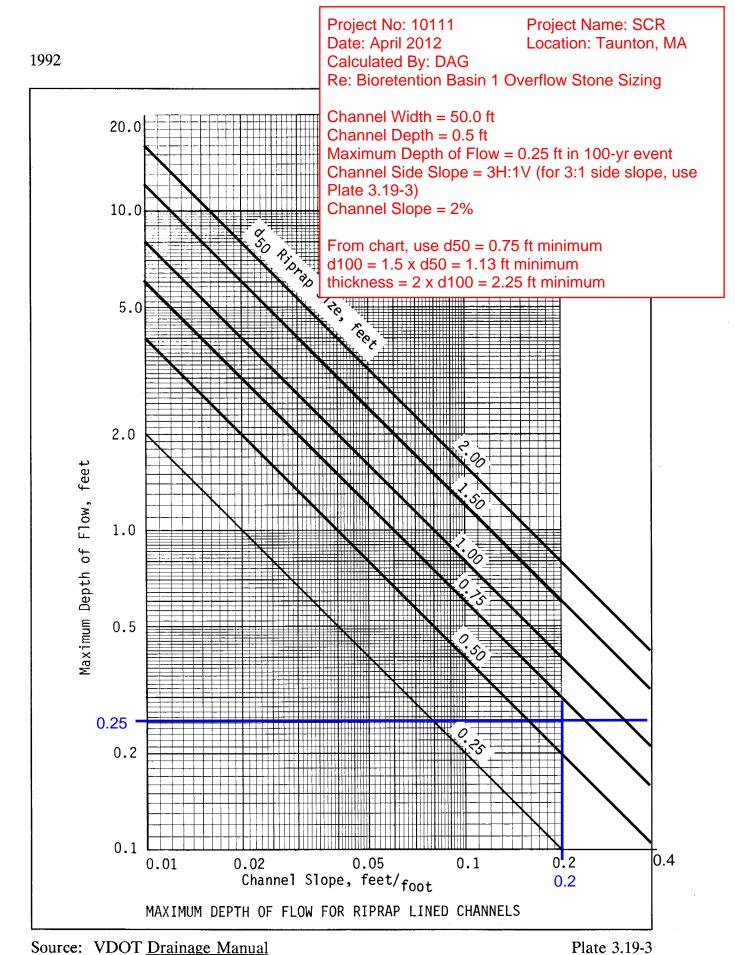
Standard 10: Prohibition of Illicit Discharges

Storm drainage structures remaining from the previous development which are part of the redevelopment area will be removed. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the site not included in the redevelopment project area. The Long-Term Pollution Prevention Plan will include measures to prevent illicit discharges.





Appendix A Standard 1 Computations and Supporting Information



*Sizing calculations represent minimum stone size. Larger stone may be required per detail plans.



Taunton Station





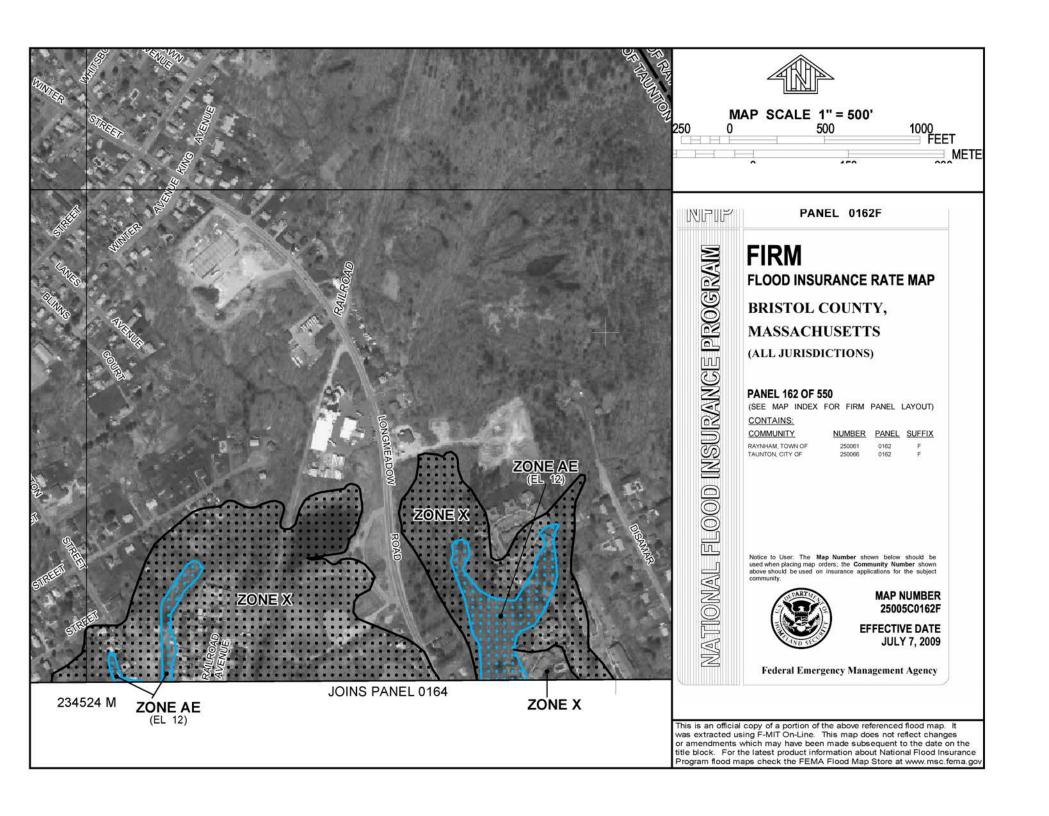
Appendix B Standard 2 Computations and Supporting Information

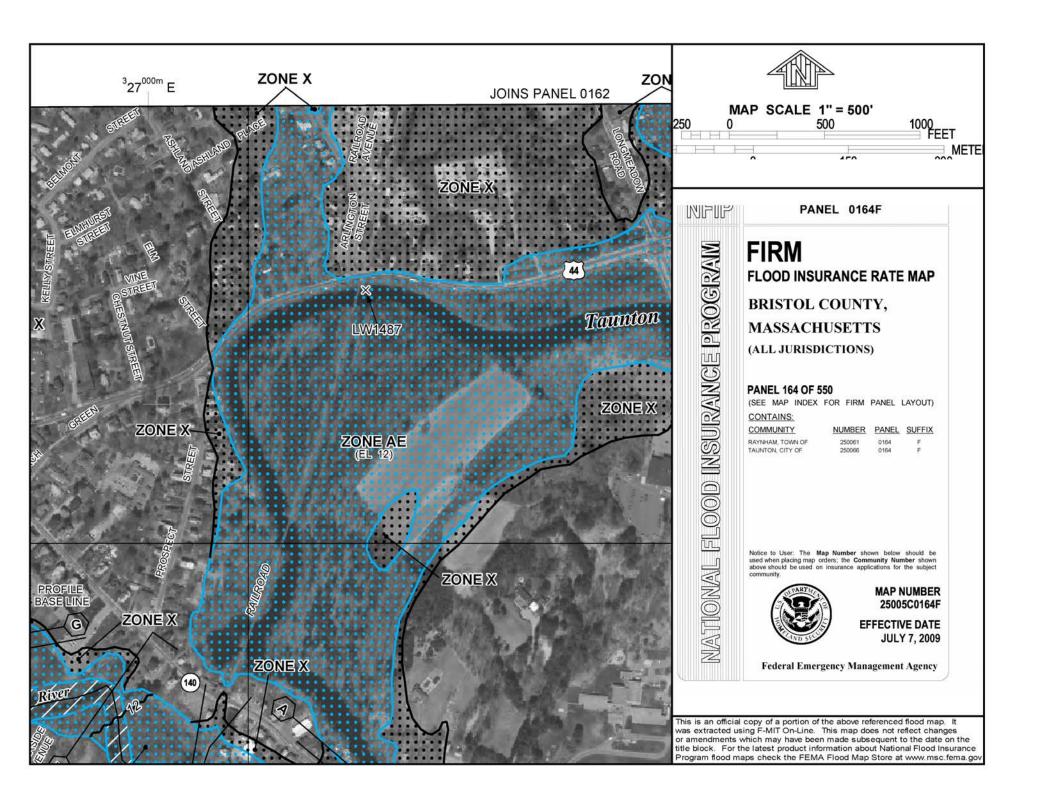
Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Bristol County. Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.



FEIS/FEIR Technical Report Stormwater Taunton Station

FEMA Flood Map







LEGEND



SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood

Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities

also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently

decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or

greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood

Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood

Elevations determined.



FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood

with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

11.11 OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary 0.2% annual chance floodplain boundary Floodway boundary

Zone D boundary

...... CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~~ 513 **~~~~~**

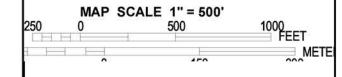
Base Flood Elevation line and value; elevation in feet*

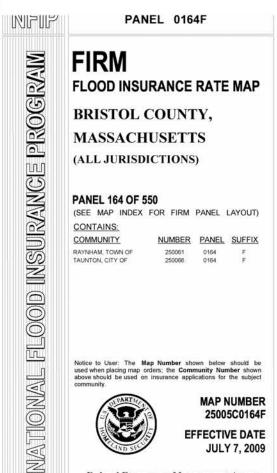
(EL 987)

Base Flood Elevation value where uniform within zone;

elevation in feet?







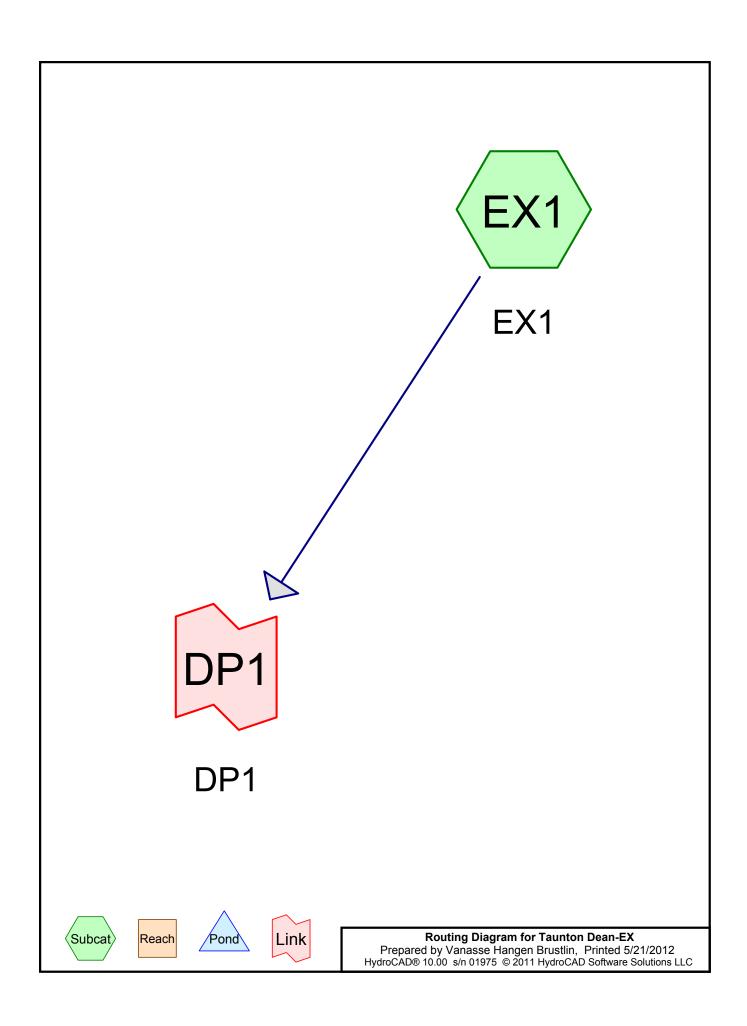
his is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes r amendments which may have been made subsequent to the date on the le block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.go

Federal Emergency Management Agency



FEIS/FEIR Technical Report Stormwater Taunton Station

HydroCAD Analysis: Existing Conditions



Taunton Dean-EX

Prepared by Vanasse Hangen Brustlin
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Page 2

Area Listing (all nodes)

Area	CN	Description
(acres)		(subcatchment-numbers)
3.249	84	50-75% Grass cover, Fair, HSG D (EX1)
5.324	98	Paved parking, HSG D (EX1)
0.112	98	Roofs, HSG D (EX1)
8.685	93	TOTAL AREA



FEIS/FEIR Technical Report Stormwater Taunton Station

2-Year Storm Event - Existing

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Dean\HydroCAD\\ **Taunton Dean-EX**Type III 24-hr 2-Year Rainfall=3.4

Prepared by Vanasse Hangen Brustlin

Type III 24-hr 2-Year Rainfall=3.40"
Printed 5/21/2012

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Page 1

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=8.685 ac 62.59% Impervious Runoff Depth>2.63"

Flow Length=597' Tc=16.1 min CN=93 Runoff=19.13 cfs 1.905 af

Link DP1: DP1 Inflow=19.13 cfs 1.905 af

Primary=19.13 cfs 1.905 af

Total Runoff Area = 8.685 ac Runoff Volume = 1.905 af Average Runoff Depth = 2.63" 37.41% Pervious = 3.249 ac 62.59% Impervious = 5.436 ac

Taunton Dean-EX

Type III 24-hr 2-Year Rainfall=3.40"

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Page 2

Summary for Subcatchment EX1: EX1

Runoff = 19.13 cfs @ 12.21 hrs, Volume= 1.905 af, Depth> 2.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

Area	(ac) C	N Desc	cription		
3.	.249 8	34 50-7	5% Grass	r, HSG D	
5					
			s, HSG D		
			ted Aver	0	
	.249	_	1% Pervio		
5.	.436	02.5	9% imperv	ious Area	
Тс	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	2 000.1.
6.8	50	0.0120	0.12	,	Sheet Flow,
					Grass: Short n= 0.150 P2= 3.32"
3.0	147	0.0140	0.83		Shallow Concentrated Flow,
0.4	00	0.0074	0.04		Short Grass Pasture Kv= 7.0 fps
0.1	38	0.0974	6.34		Shallow Concentrated Flow,
1.6	142	0.0056	1.52		Paved Kv= 20.3 fps Shallow Concentrated Flow,
1.0	142	0.0030	1.52		Paved Kv= 20.3 fps
3.8	130	0.0008	0.57		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
0.8	90	0.0089	1.92		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
16.1	597	Total			

Summary for Link DP1: DP1

Inflow Area = 8.685 ac, 62.59% Impervious, Inflow Depth > 2.63" for 2-Year event

Inflow = 19.13 cfs @ 12.21 hrs, Volume= 1.905 af

Primary = 19.13 cfs @ 12.21 hrs, Volume= 1.905 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Station

10-Year Storm Event - Existing

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Dean\HydroCAD\\ **Taunton Dean-EX**Type III 24-hr 10-Year Rainfall=4.80"

Prepared by Vanasse Hangen Brustlin

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Page 1

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=8.685 ac 62.59% Impervious Runoff Depth>3.99"

Flow Length=597' Tc=16.1 min CN=93 Runoff=28.40 cfs 2.890 af

Link DP1: DP1 Inflow=28.40 cfs 2.890 af

Primary=28.40 cfs 2.890 af

Total Runoff Area = 8.685 ac Runoff Volume = 2.890 af Average Runoff Depth = 3.99" 37.41% Pervious = 3.249 ac 62.59% Impervious = 5.436 ac

Taunton Dean-EX

Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Subcatchment EX1: EX1

Runoff = 28.40 cfs @ 12.21 hrs, Volume= 2.890 af, Depth> 3.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

Area	(ac) C	N Desc	cription		
3.	.249 8	34 50-7	5% Grass	r, HSG D	
5					
			s, HSG D		
			ted Aver	0	
	.249	_	1% Pervio		
5.	.436	02.5	9% imperv	ious Area	
Тс	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	2 000.1.
6.8	50	0.0120	0.12	,	Sheet Flow,
					Grass: Short n= 0.150 P2= 3.32"
3.0	147	0.0140	0.83		Shallow Concentrated Flow,
0.4	00	0.0074	0.04		Short Grass Pasture Kv= 7.0 fps
0.1	38	0.0974	6.34		Shallow Concentrated Flow,
1.6	142	0.0056	1.52		Paved Kv= 20.3 fps Shallow Concentrated Flow,
1.0	142	0.0030	1.52		Paved Kv= 20.3 fps
3.8	130	0.0008	0.57		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
0.8	90	0.0089	1.92		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
16.1	597	Total			

Summary for Link DP1: DP1

Inflow Area = 8.685 ac, 62.59% Impervious, Inflow Depth > 3.99" for 10-Year event

Inflow = 28.40 cfs @ 12.21 hrs, Volume= 2.890 af

Primary = 28.40 cfs @ 12.21 hrs, Volume= 2.890 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Station

100-Year Storm Event - Existing

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\textbf{Taunton Dean-EX} Type III 24-hr 100-Year Rainfall=7.00"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=8.685 ac 62.59% Impervious Runoff Depth>6.16"

Flow Length=597' Tc=16.1 min CN=93 Runoff=42.79 cfs 4.457 af

Link DP1: DP1Inflow=42.79 cfs 4.457 af
Primary=42.79 cfs 4.457 af

Total Runoff Area = 8.685 ac Runoff Volume = 4.457 af Average Runoff Depth = 6.16" 37.41% Pervious = 3.249 ac 62.59% Impervious = 5.436 ac

Taunton Dean-EX

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Subcatchment EX1: EX1

Runoff = 42.79 cfs @ 12.21 hrs, Volume= 4.457 af, Depth> 6.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Area	(ac) C	N Desc	cription		
3.249 84 50-75% Grass cover, Fair,						HSG D
	5.	324 9	8 Pave	ed parking	, HSG D	
	0.	.112 9	8 Roof	s, HSG D		
	8.	685 9	3 Weig	ghted Aver	age	
	3.	249	37.4	1% Pervio	us Area	
	5.	436	62.5	9% Imper	ious Area	
	_					
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	6.8	50	0.0120	0.12		Sheet Flow,
						Grass: Short n= 0.150 P2= 3.32"
	3.0	147	0.0140	0.83		Shallow Concentrated Flow,
	0.4	00	0.0074	0.04		Short Grass Pasture Kv= 7.0 fps
	0.1	38	0.0974	6.34		Shallow Concentrated Flow,
	4.0	4.40	0.0050	4.50		Paved Kv= 20.3 fps
	1.6	142	0.0056	1.52		Shallow Concentrated Flow,
	3.8	130	0.0008	0.57		Paved Kv= 20.3 fps
	3.0	130	0.0006	0.57		Shallow Concentrated Flow, Paved Kv= 20.3 fps
	0.8	90	0.0089	1.92		Shallow Concentrated Flow,
	0.0	90	0.0009	1.92		Paved Kv= 20.3 fps
-	16.1	597	Total			1 ανου 111- 20.0 1μο
	10.1	591	i Ulai			

Summary for Link DP1: DP1

Inflow Area = 8.685 ac, 62.59% Impervious, Inflow Depth > 6.16" for 100-Year event

Inflow = 42.79 cfs @ 12.21 hrs, Volume= 4.457 af

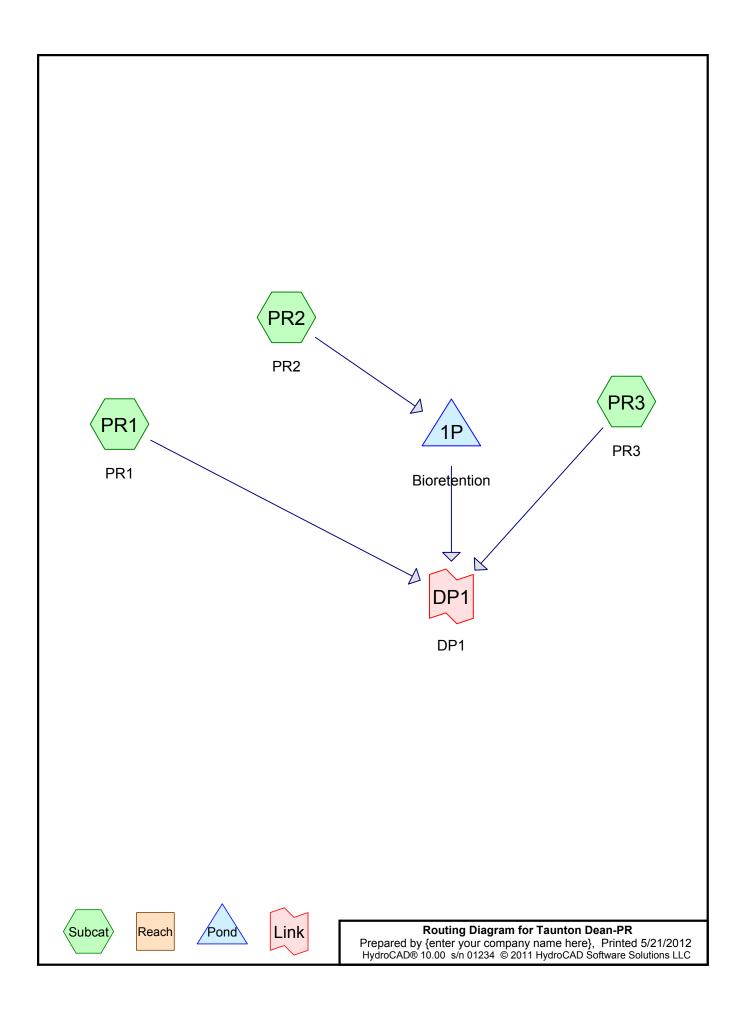
Primary = 42.79 cfs @ 12.21 hrs, Volume= 4.457 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



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HydroCAD Analysis: Proposed Conditions



Taunton Dean-PR

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Area Listing (all nodes)

Area	a CN	Description
(acres)	(subcatchment-numbers)
6.121	l 80	>75% Grass cover, Good, HSG D (PR1, PR2, PR3)
2.579	98	Paved parking, HSG D (PR1, PR2)
0.092	98	Paved roads w/curbs & sewers, HSG D (PR3)
0.119	98	Water Surface, HSG D (PR2)
8.91 ⁻	1 86	TOTAL AREA



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Taunton Station

2-Year Storm Event - Proposed

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Type III 24-hr 2-Year Rainfall=3.40"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR1: PR1 Runoff Area=3.025 ac 1.72% Impervious Runoff Depth>1.55"

Flow Length=461' Tc=12.8 min CN=80 Runoff=4.35 cfs 0.392 af

SubcatchmentPR2: PR2 Runoff Area=4.053 ac 65.28% Impervious Runoff Depth>2.54"

Flow Length=670' Tc=13.3 min CN=92 Runoff=9.25 cfs 0.857 af

SubcatchmentPR3: PR3 Runoff Area=1.833 ac 5.02% Impervious Runoff Depth>1.63"

Flow Length=208' Tc=5.6 min CN=81 Runoff=3.45 cfs 0.248 af

Peak Elev=13.16' Storage=9,345 cf Inflow=9.25 cfs 0.857 af

Discarded=0.02 cfs 0.025 af Primary=8.03 cfs 0.701 af Outflow=8.04 cfs 0.726 af

Link DP1: DP1 Inflow=13.87 cfs 1.341 af
Primary=13.87 cfs 1.341 af

Total Runoff Area = 8.911 ac Runoff Volume = 1.497 af Average Runoff Depth = 2.02" 68.69% Pervious = 6.121 ac 31.31% Impervious = 2.790 ac

Taunton Dean-PR

Type III 24-hr 2-Year Rainfall=3.40"

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Summary for Subcatchment PR1: PR1

Runoff = 4.35 cfs @ 12.18 hrs, Volume= 0.392 af, Depth> 1.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Area	(ac) C	N Desc	cription		
0.052 98 Paved parking, HSG D					, HSG D	
2.973 80 >75% Grass cover, Good, HS						, HSG D
	3.	025 8	30 Weig	ghted Aver	age	
	2.	973		8% Pervio		
	0.	052	1.72	% Impervi	ous Area	
	_		01			B
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	6.4	50	0.0140	0.13		Sheet Flow,
						Grass: Short n= 0.150 P2= 3.32"
	1.6	119	0.0327	1.27		Shallow Concentrated Flow,
						Short Grass Pasture Kv= 7.0 fps
	3.7	134	0.0075	0.61		Shallow Concentrated Flow,
						Short Grass Pasture Kv= 7.0 fps
	1.1	158	0.1266	2.49		Shallow Concentrated Flow,
_						Short Grass Pasture Kv= 7.0 fps
	12.8	461	Total			

Summary for Subcatchment PR2: PR2

Runoff = 9.25 cfs @ 12.18 hrs, Volume= 0.857 af, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

A	rea (ac)	CN	Description				
2.527 98 Paved parking, HSG D							
	1.407	80	>75% Grass cover, Good, HSG D				
	0.119	98	Water Surface, HSG D				
	4.053	92	Weighted Average				
	1.407		34.72% Pervious Area				
	2.646		65.28% Impervious Area				

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Type III 24-hr 2-Year Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	6.0	50	0.0160	0.14		Sheet Flow,
	0.0		0.0000	4.00		Grass: Short n= 0.150 P2= 3.32"
	0.9	55	0.0236	1.08		Shallow Concentrated Flow,
	4.4	00	0.0000	4.40		Short Grass Pasture Kv= 7.0 fps
	1.1	80	0.0063	1.19		Shallow Concentrated Flow,
	4.0	04	0.0400	4 57		Grassed Waterway Kv= 15.0 fps
	1.0	91	0.0109	1.57		Shallow Concentrated Flow,
	0.0	24	0.0400	4.70		Grassed Waterway Kv= 15.0 fps
	0.3	31	0.0129	1.70		Shallow Concentrated Flow,
	a -	0.4	0.0004			Grassed Waterway Kv= 15.0 fps
	0.7	64	0.0094	1.45		Shallow Concentrated Flow,
						Grassed Waterway Kv= 15.0 fps
	3.3	299	0.0100	1.50		Shallow Concentrated Flow,
_						Grassed Waterway Kv= 15.0 fps
	13.3	670	Total			

Summary for Subcatchment PR3: PR3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.45 cfs @ 12.09 hrs, Volume= 0.248 af, Depth> 1.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Area	(ac) (CN Des	cription			
	ewers, HSG D						
0.092 98 Paved roads w/curbs & sewers, HSG D 1.741 80 >75% Grass cover, Good, HSG D							
	1.	833	81 Wei	ghted Avei	rage		
	1.	741	94.9	98% Pervio	us Area		
	0.	092	5.02	2% Impervi	ous Area		
	Tc (min)	Length (feet)	•	Velocity (ft/sec)	Capacity (cfs)	Description	
	3.2	50	0.0800	0.26		Sheet Flow,	
_	2.4	158	0.0253	1.11		Grass: Short n= 0.150 P2= 3.32" Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps	
	5.6	208	Total				

Summary for Pond 1P: Bioretention

Inflow Area =	4.053 ac, 65.28% Impervious, Inflow De	epth > 2.54" for 2-Year event
Inflow =	9.25 cfs @ 12.18 hrs, Volume=	0.857 af
Outflow =	8.04 cfs @ 12.26 hrs, Volume=	0.726 af, Atten= 13%, Lag= 5.0 min
Discarded =	0.02 cfs @ 12.26 hrs, Volume=	0.025 af
Primary =	8.03 cfs @ 12.26 hrs, Volume=	0.701 af

Taunton Dean-PR

Type III 24-hr 2-Year Rainfall=3.40"

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Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 13.16' @ 12.26 hrs Surf.Area= 8,698 sf Storage= 9,345 cf

Plug-Flow detention time= 106.8 min calculated for 0.726 af (85% of inflow) Center-of-Mass det. time= 43.3 min (844.4 - 801.1)

Volume	Inve	rt Avail	.Storage	Storage Descripti	on			
#1	12.0	0' 1	14,203 cf	Custom Stage Data (Irregular)Listed below (Recalc)				
Elevatio		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area		
(fee	t)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>		
12.0	0	7,420	356.0	0	0	7,420		
12.7	0	8,181	369.0	5,458	5,458	8,212		
13.0	0	8,517	375.0	2,505	7,963	8,584		
13.7	0	9,318	388.0	6,240	14,203	9,417		
Device	Routing	Inv	ert Outle	Outlet Devices				
#1	Primary	12.	.70' 10.0 ')' long x 6.0' breadth Broad-Crested Rectangular Weir				
	- ,					1.20 1.40 1.60 1.80 2.00		
				3.00 3.50 4.00				
			Coef	f. (English) 2.37 2	2.51 2.70 2.68 2.	68 2.67 2.65 2.65 2.65		
			2.65	2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83				
#2	Discarde	d 12.	.00' 0.09	0 in/hr Exfiltration over Surface area				

Discarded OutFlow Max=0.02 cfs @ 12.26 hrs HW=13.16' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=7.95 cfs @ 12.26 hrs HW=13.16' (Free Discharge) 1=Broad-Crested Rectangular Weir (Weir Controls 7.95 cfs @ 1.74 fps)

Summary for Link DP1: DP1

Inflow Area = 8.911 ac, 31.31% Impervious, Inflow Depth > 1.81" for 2-Year event

Inflow = 13.87 cfs @ 12.22 hrs, Volume= 1.341 af

Primary = 13.87 cfs @ 12.22 hrs, Volume= 1.341 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



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Taunton Station

10-Year Storm Event- Proposed

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Type III 24-hr 10-Year Rainfall=4.80"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points Runoff by SCS TR-20 method, UH=SCS Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR1: PR1 Runoff Area=3.025 ac 1.72% Impervious Runoff Depth>2.71"

Flow Length=461' Tc=12.8 min CN=80 Runoff=7.66 cfs 0.684 af

SubcatchmentPR2: PR2 Runoff Area=4.053 ac 65.28% Impervious Runoff Depth>3.89"

Flow Length=670' Tc=13.3 min CN=92 Runoff=13.88 cfs 1.313 af

Runoff Area=1.833 ac 5.02% Impervious Runoff Depth>2.81" SubcatchmentPR3: PR3

Flow Length=208' Tc=5.6 min CN=81 Runoff=5.96 cfs 0.429 af

Pond 1P: Bioretention Peak Elev=13.30' Storage=10,554 cf Inflow=13.88 cfs 1.313 af

Discarded=0.02 cfs 0.027 af Primary=12.48 cfs 1.154 af Outflow=12.49 cfs 1.181 af

Link DP1: DP1 Inflow=22.99 cfs 2.267 af Primary=22.99 cfs 2.267 af

> Total Runoff Area = 8.911 ac Runoff Volume = 2.425 af Average Runoff Depth = 3.27" 68.69% Pervious = 6.121 ac 31.31% Impervious = 2.790 ac

Taunton Dean-PR

Type III 24-hr 10-Year Rainfall=4.80"

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Summary for Subcatchment PR1: PR1

Runoff = 7.66 cfs @ 12.18 hrs, Volume= 0.684 af, Depth> 2.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

_	Area	(ac) C	N Des	cription				
0.052 98 I			98 Pave	Paved parking, HSG D				
_	2.	973 8	30 >75°	% Grass co	over, Good	, HSG D		
	3.	025 8	30 Weig	ghted Aver	age			
	2.	973	98.2	8% Pervio	us Area			
	0.	052	1.72	% Impervi	ous Area			
	_					—		
	Tc	Length	Slope	Velocity	Capacity	Description		
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
	6.4	50	0.0140	0.13		Sheet Flow,		
						Grass: Short n= 0.150 P2= 3.32"		
	1.6	119	0.0327	1.27		Shallow Concentrated Flow,		
						Short Grass Pasture Kv= 7.0 fps		
	3.7	134	0.0075	0.61		Shallow Concentrated Flow,		
						Short Grass Pasture Kv= 7.0 fps		
	1.1	158	0.1266	2.49		Shallow Concentrated Flow,		
_						Short Grass Pasture Kv= 7.0 fps		
	12.8	461	Total					

Summary for Subcatchment PR2: PR2

Runoff = 13.88 cfs @ 12.18 hrs, Volume= 1.313 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

Are	ea (ac)	CN	Description				
	2.527	98	Paved parking, HSG D				
	1.407	80	>75% Grass cover, Good, HSG D				
	0.119	98	Water Surface, HSG D				
	4.053	92	Weighted Average				
	1.407 34.72% Pervious Area						
	2.646		65.28% Impervious Area				

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Type III 24-hr 10-Year Rainfall=4.80"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	50	0.0160	0.14		Sheet Flow,
					Grass: Short n= 0.150 P2= 3.32"
0.9	55	0.0236	1.08		Shallow Concentrated Flow,
					Short Grass Pasture Kv= 7.0 fps
1.1	80	0.0063	1.19		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
1.0	91	0.0109	1.57		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
0.3	31	0.0129	1.70		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
0.7	64	0.0094	1.45		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
3.3	299	0.0100	1.50		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
13.3	670	Total	·		

Summary for Subcatchment PR3: PR3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 5.96 cfs @ 12.09 hrs, Volume= 0.429 af, Depth> 2.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 10-Year Rainfall=4.80"

_	Area	(ac) (N Des	Description						
	0.	0.092 98 Paved roads w/curbs & sewers, HSG D								
_	1.	1.741 80 >75% Grass cover, Good, HSG D								
	1.833 81 Weighted Average									
	1.	741	94.9	8% Pervio	us Area					
	0.	092	5.02	2% Impervi	ous Area					
	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description				
	3.2	50	0.0800	0.26		Sheet Flow,				
_	2.4	158	0.0253	1.11		Grass: Short n= 0.150 P2= 3.32" Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps				
	5.6	208	Total		•					

Summary for Pond 1P: Bioretention

Inflow Area =	4.053 ac, 65.28% Impervious, Inflow	Depth > 3.89" for 10-Year event
Inflow =	13.88 cfs @ 12.18 hrs, Volume=	1.313 af
Outflow =	12.49 cfs @ 12.25 hrs, Volume=	1.181 af, Atten= 10%, Lag= 4.2 min
Discarded =	0.02 cfs @ 12.25 hrs, Volume=	0.027 af
Primary =	12.48 cfs @ 12.25 hrs, Volume=	1.154 af

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Type III 24-hr 10-Year Rainfall=4.80"

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Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 13.30' @ 12.25 hrs Surf.Area= 8,854 sf Storage= 10,554 cf

Plug-Flow detention time= 85.1 min calculated for 1.181 af (90% of inflow) Center-of-Mass det. time= 36.9 min (826.5 - 789.5)

<u>Volume</u>	Inve	<u>ert Avai</u>	I.Storage	Storage Descripti	on		
#1	12.0	00'	14,203 cf	Custom Stage D	ata (Irregular)List	ed below (Recalc)	
Elevatio		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area	
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>	
12.0	00	7,420	356.0	0	0	7,420	
12.7	' 0	8,181	369.0	5,458	5,458	8,212	
13.0	00	8,517	375.0	2,505	7,963	8,584	
13.7	70	9,318	388.0	6,240	14,203	9,417	
Device	Routing	In	vert Outle	et Devices			
#1	Primary	12	.70' 10.0	'long x 6.0' brea	dth Broad-Creste	ed Rectangular Weir	
	,					1.20 1.40 1.60 1.80 2.00	
			2.50	3.00 3.50 4.00	4.50 5.00 5.50		
			Coet	f. (English) 2.37 2	2.51 2.70 2.68 2.	68 2.67 2.65 2.65 2.65	
			2.65	2.66 2.66 2.67	2.69 2.72 2.76 2	.83	
#2	Discarde	ed 12	.00' 0.09	0 in/hr Exfiltration	n over Surface ar	ea	

Discarded OutFlow Max=0.02 cfs @ 12.25 hrs HW=13.30' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=12.48 cfs @ 12.25 hrs HW=13.30' (Free Discharge) 1=Broad-Crested Rectangular Weir (Weir Controls 12.48 cfs @ 2.09 fps)

Summary for Link DP1: DP1

Inflow Area = 8.911 ac, 31.31% Impervious, Inflow Depth > 3.05" for 10-Year event

Inflow = 22.99 cfs @ 12.20 hrs, Volume= 2.267 af

Primary = 22.99 cfs @ 12.20 hrs, Volume= 2.267 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



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100-Year Storm Event – Proposed

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Taunton Dean-PR

Type III 24-hr 100-Year Rainfall=7.00"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR1: PR1 Runoff Area=3.025 ac 1.72% Impervious Runoff Depth>4.68"

Flow Length=461' Tc=12.8 min CN=80 Runoff=13.18 cfs 1.181 af

SubcatchmentPR2: PR2 Runoff Area=4.053 ac 65.28% Impervious Runoff Depth>6.04"

Flow Length=670' Tc=13.3 min CN=92 Runoff=21.07 cfs 2.041 af

SubcatchmentPR3: PR3 Runoff Area=1.833 ac 5.02% Impervious Runoff Depth>4.80"

Flow Length=208' Tc=5.6 min CN=81 Runoff=10.06 cfs 0.733 af

Pond 1P: Bioretention Peak Elev=13.50' Storage=12,328 cf Inflow=21.07 cfs 2.041 af

Discarded=0.02 cfs 0.029 af Primary=19.04 cfs 1.878 af Outflow=19.06 cfs 1.907 af

Link DP1: DP1Inflow=37.13 cfs 3.793 af
Primary=37.13 cfs 3.793 af

Total Runoff Area = 8.911 ac Runoff Volume = 3.956 af Average Runoff Depth = 5.33"

68.69% Pervious = 6.121 ac 31.31% Impervious = 2.790 ac

Taunton Dean-PR

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Type III 24-hr 100-Year Rainfall=7.00"

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Summary for Subcatchment PR1: PR1

Runoff = 13.18 cfs @ 12.17 hrs, Volume= 1.181 af, Depth> 4.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Area	(ac) C	N Des	cription		
0.052 98 Paved parking, HSG D					, HSG D	
2.973 80 >75% Grass cover, Good, I						, HSG D
	3.	025 8	30 Weig	ghted Aver	age	
		973	98.2	8% Pervio	us Area	
	0.	052	1.72	% Impervi	ous Area	
	_		01			
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	6.4	50	0.0140	0.13		Sheet Flow,
						Grass: Short n= 0.150 P2= 3.32"
	1.6	119	0.0327	1.27		Shallow Concentrated Flow,
						Short Grass Pasture Kv= 7.0 fps
	3.7	134	0.0075	0.61		Shallow Concentrated Flow,
						Short Grass Pasture Kv= 7.0 fps
	1.1	158	0.1266	2.49		Shallow Concentrated Flow,
_						Short Grass Pasture Kv= 7.0 fps
	12.8	461	Total			

Summary for Subcatchment PR2: PR2

Runoff = 21.07 cfs @ 12.18 hrs, Volume= 2.041 af, Depth> 6.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

Are	ea (ac)	CN	Description				
	2.527	98	Paved parking, HSG D				
	1.407	80	>75% Grass cover, Good, HSG D				
	0.119	98	Water Surface, HSG D				
	4.053	92	Weighted Average				
	1.407 34.72% Pervious Area						
	2.646		65.28% Impervious Area				

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Type III 24-hr 100-Year Rainfall=7.00"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	50	0.0160	0.14		Sheet Flow,
					Grass: Short n= 0.150 P2= 3.32"
0.9	55	0.0236	1.08		Shallow Concentrated Flow,
					Short Grass Pasture Kv= 7.0 fps
1.1	80	0.0063	1.19		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
1.0	91	0.0109	1.57		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
0.3	31	0.0129	1.70		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
0.7	64	0.0094	1.45		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
3.3	299	0.0100	1.50		Shallow Concentrated Flow,
					Grassed Waterway Kv= 15.0 fps
 13.3	670	Total			

Summary for Subcatchment PR3: PR3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.06 cfs @ 12.08 hrs, Volume= 0.733 af, Depth> 4.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Type III 24-hr 100-Year Rainfall=7.00"

	Area	(ac) C	CN Des	Description						
	0.	092	2 98 Paved roads w/curbs & sewers, HSG D							
_	1.	1.741 80 >75% Grass cover, Good, HSG D								
	1.	833	81 Wei	ghted Aver	age					
	1.	741	94.9	8% Pervio	us Area					
	0.	092	5.02	% Impervi	ous Area					
				Velocity (ft/sec)	Capacity (cfs)	Description	_			
	3.2	50	0.0800	0.26		Sheet Flow,				
	2.4	158	0.0253	1.11		Grass: Short n= 0.150 P2= 3.32" Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps	_			
	5.6	208	Total							

Summary for Pond 1P: Bioretention

Inflow Area =	4.053 ac, 65.28% Impervious, Inflow I	Depth > 6.04" for 100-Year event	
Inflow =	21.07 cfs @ 12.18 hrs, Volume=	2.041 af	
Outflow =	19.06 cfs @ 12.24 hrs, Volume=	1.907 af, Atten= 10%, Lag= 4.1 mir	1
Discarded =	0.02 cfs @ 12.24 hrs, Volume=	0.029 af	
Primary =	19.04 cfs @ 12.24 hrs, Volume=	1.878 af	

Taunton Dean-PR

Type III 24-hr 100-Year Rainfall=7.00"

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Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs Peak Elev= 13.50' @ 12.24 hrs Surf.Area= 9,081 sf Storage= 12,328 cf

Plug-Flow detention time= 65.8 min calculated for 1.903 af (93% of inflow) Center-of-Mass det. time= 31.1 min (809.4 - 778.3)

Volume	Inve	rt Avai	I.Storage	Storage Descripti	on			
#1	12.0	0'	14,203 cf	Custom Stage D	ata (Irregular)Liste	ed below (Recalc)		
Elevatio		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
12.0	00	7,420	356.0	0	0	7,420		
12.7	' 0	8,181	369.0	5,458	5,458	8,212		
13.0	00	8,517	375.0	2,505	7,963	8,584		
13.7	70	9,318	388.0	6,240	14,203	9,417		
Device	Routing	In	vert Outle	et Devices				
#1	Primary	12	.70' 10.0	10.0' long x 6.0' breadth Broad-Crested Rectangular Weir				
- ,				ad (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00				
				3.00 3.50 4.00				
			Coe	f. (English) 2.37 2	2.51 2.70 2.68 2.6	88 2.67 2.65 2.65 2.65		
					2.69 2.72 2.76 2.			
#2	Discarde	d 12	.00' 0.09	0 in/hr Exfiltratio	n over Surface are	ea		

Discarded OutFlow Max=0.02 cfs @ 12.24 hrs HW=13.49' (Free Discharge) **T_2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=18.97 cfs @ 12.24 hrs HW=13.49' (Free Discharge) 1=Broad-Crested Rectangular Weir (Weir Controls 18.97 cfs @ 2.39 fps)

Summary for Link DP1: DP1

Inflow Area = 8.911 ac, 31.31% Impervious, Inflow Depth > 5.11" for 100-Year event

Inflow 37.13 cfs @ 12.19 hrs, Volume= 3.793 af

37.13 cfs @ 12.19 hrs, Volume= 3.793 af, Atten= 0%, Lag= 0.0 min Primary

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Station



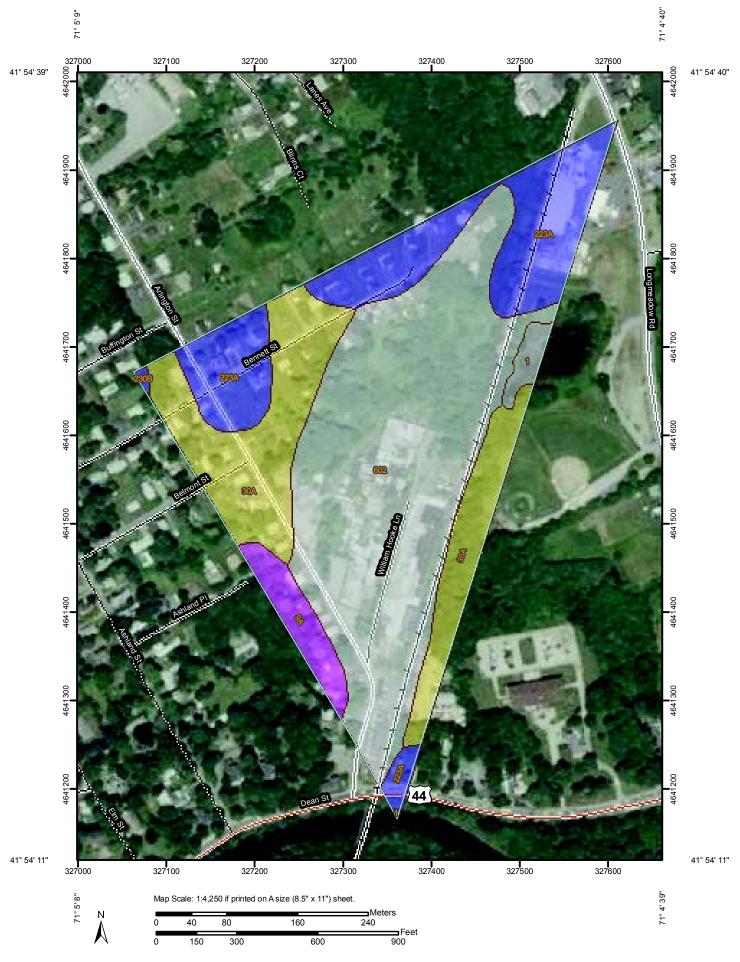


Appendix C Standard 3 Computations and Supporting Information



FEIS/FEIR Technical Report Stormwater Taunton Station

Soil Evaluation and Analysis



MAP LEGEND

Area of Interest (AOI) Area of Interest (AOI) Soils Soil Map Units Soil Ratings Α A/D В B/D С C/D D Not rated or not available **Political Features** Cities **Water Features** Streams and Canals Transportation +++ Interstate Highways **US Routes** Major Roads

Local Roads

 \sim

MAP INFORMATION

Map Scale: 1:4,250 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov Coordinate System: UTM Zone 19N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bristol County, Massachusetts, Northern Part Survey Area Data: Version 5, Jul 27, 2010

ourvey Area Data. Version 5, our 27, 2010

Date(s) aerial images were photographed: 7/10/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bristol County, Massachusetts, Northern Part (MA602)							
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI			
1	Water		0.6	1.4%			
9A	Birdsall silt loam, 0 to 3 percent slopes	D	1.7	3.8%			
30A	Raynham silt loam, 0 to 3 percent slopes	С	10.2	22.9%			
223A	Scio silt loam, 0 to 3 percent slopes	В	9.5	21.4%			
230B	Unadilla very fine sandy loam, 3 to 8 percent slopes	В	0.1	0.2%			
602	Urban land		22.3	50.3%			
Totals for Area of Inte	erest	44.4	100.0%				

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



FEIS/FEIR Technical Report Stormwater Taunton Station

Required and Provided Recharge Volumes



Recharge Calculations

Project Name:Taunton StationProj. No.:10111.00Project Location:Taunton, MADate:21-May-2012

Calculated by: DAG

Checked by: EJM

Proposed Impervious Surface Summary

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
1	0.0	0.0	0.0	0.1	0.1
2	0.0	0.0	0.0	2.5	2.5
3	0.0	0.0	0.0	0.1	0.1
TOTAL	0.0	0.0	0.0	2.7	2.7

Required Recharge Volume (Cubic Feet)

HSG	Area	Recharge Depth *	Volume
	(acres)	(in.)	(c.f.)
Α	0.0	0.60	0
В	0.0	0.35	0
С	0.0	0.25	0
D	2.7	0.10	970
TOTAL			970

^{*} Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet)

Basin 1	1,263	
Total	1,263	c.f.



FEIS/FEIR Technical Report Stormwater Taunton Station

72-hour Drawdown Analysis



Drawdown Calculations

Project Name: Taunton Station

Proj. No.: Date:

10111.00 5/18/2012

Project Location: Taunton, MA

Calculated by:

Check by:

PAC EJM

Bioretention Basin - 1

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Buom volumo Bo	Baom Volamo Bolow Gallot									
Elevation	Area	Incremental								
	(s.f.)	Volume (c.f.)								
12.00	7,420	0								
12.70	8,181	5,460								
TOTAL		5.460								

Assumptions:

Recharge Rate: 1.00 in/hr*

* Bioretention Basin Soil Media Infiltration Rate

Drawdown Time: 8.8 hours



FEIS/FEIR Technical Report Stormwater Taunton Station

Appendix D
Standard 4 Computations and
Supporting Information



FEIS/FEIR Technical Report Stormwater Taunton Station

Water Quality Volume Calculations



Water Quality Volume Calculations

Project Name: Taunton StationProj. No.:10111.00Project Location: Taunton, MADate:4/24/2012

Calculated by: DAG

Bioretention Basin 1P

(runoff from Area PR 2)

Total Impervious Area = 2.79 Acres

Required:

Forebay Volume

Water Quality Volume

Runoff Depth to Required be Treated (in.) Volume (c.f.)

0.1 1,013

0.5 5,064

Provided:



FEIS/FEIR Technical Report Stormwater Taunton Station

TSS Removal Worksheets

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name:	Taunton Station	Sheet:	1 of 1	
Project Number:	10111.00	 Date:	24-Apr-2012	
Location:	Taunton, MA	Computed by:	DAG	
Discharge Point:	1	Checked by:		

BMP*

Bioretention Area with
Grass Swale or sediment
forebay Pretreatment

TSS Removal Rate*
90%
0%
0%
0%
0%

Drainage Area(s):

<u> </u>
Starting TSS Load**
1.00
0.10
0.10
0.10
0.10

D

	E
d	Remaining Load (D-E)
	0.10
	0.10
	0.10
	0.10
	0.10

Treatment Train
TSS Removal =

90%

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol.

^{**} Equals remaining load from previous BMP (E)





Appendix E Geotechnical Report



Date February 17, 2012

To Rick Carey, Natasha Velickovic - VHB

From Paul Murphy, Da Ha, Peter Chou - Jacobs

Subject MBTA South Coast Rail (New Bedford/Fall River Commuter Rail Extension)

Taunton Station Geotechnical Design Memorandum

Taunton, MA

Project No. E2347101

INTRODUCTION

The South Coast Rail project will restore passenger rail transportation from South Station in Boston to the cities of Fall River and New Bedford along an existing rail freight corridor running south from Taunton to Fall River and New Bedford. The project will include the construction of several existing and new passenger stations and two terminal layover facilities. This geotechnical design memorandum presents the foundation design considerations for the new station platform at the proposed Taunton Station in Taunton, Massachusetts. The design recommendations presented in this report are based on the results of subsurface investigation performed by Jacobs in 2010.

Existing Conditions

The proposed Taunton Station, located off Arlington Street, is an approximately 3.8 acre site to the east of downtown Taunton (Figure 1). The site is a formerly developed parcel now containing vacant buildings and other derelict areas as a result of fire. Existing grades at the platform location range from approximately elevations 16 to 19 feet (NGVD29 Datum), generally sloping downward from north to south. A 20-inch diameter water main pipe is located along the proposed platform alignment and will need to be relocated. The remains of the buildings and their foundations will also have to be removed.

Proposed Construction

Current station plans are to construct an 800 foot long, 12 foot wide high level platform adjacent to the existing tracks, a new parking area and a new drop-off area. In addition, some track relocation is required. Access to the platform will be from a ramp/stair structure along the west side of the planned platform. Two 50-ft long platform canopies are also planned. The details of new track layout (including grading), associated sidewalks, ramps of the proposed station are still under development at the time of this report preparation. However, we anticipate that about 3 to 5 feet of fill will be placed at the site to raise the grade at the track level and platform area. This report focuses on the geotechnical design and recommendation for the platform only.

SCOPE OF WORK

This memorandum was prepared by Jacobs in accordance with the scope of work under the contract between Jacobs and VHB for work on the New Bedford/Fall River Commuter Rail Line Extension Project for Massachusetts Bay Transportation Authority (MBTA). The geotechnical work included the following tasks:

Proj. No. E2347101

- Perform a geotechnical exploration and laboratory testing program;
- Report and interpret the results of the exploration and laboratory testing program; and
- Provide geotechnical recommendations for design and construction of the platform foundations.

The Jacobs scope of work did not include environmental assessment of the potential presence of any hazardous materials at the project site. However, please note that potential contamination was observed in borings TS-5 (samples S2 and S3) from a depth of about 3 to 10 feet and TS-19 (samples S2 and S3) from a depth of about 3 to 10 feet (refer to boring logs in Appendix A).

LOCAL GEOLOGY

The site is located in the Narragansett Basin of southeastern Massachusetts. The rocks in the Narragansett Basin consist mostly of lightly metamorphosed shale and sandstone of Pennsylvanian and Permian age. The Taunton Station is located in the area of the Rhode Island Formation. The rocks encountered in the borings included coarse, weathered sandstone, dark gray shale, and dark gray siltstone. The weathered sandstone was sampled by Standard Penetration Tests with high blow counts. The shale and siltstone were cored but only partially recovered due to weathered seams. The rock contains joints oriented parallel to bedding, which typically dipped about 30 degrees. Based on the borings, the top of rock is likely to be between elevation -12 feet and elevation -30 feet over the site.

GEOTECHNICAL EXPLORATIONS

Jacobs planned the subsurface exploration program and retained the drilling contractor to perform the exploration. The geotechnical data report was submitted in 2010. Five borings (TS-1 to TS-5) were conducted along the proposed station platform and fourteen borings (TS-7, TS-9, TS-11, TS-13, TS-15, TS-17, and TS-19 to TS-26) were drilled in the general vicinity of the proposed parking lot and the access roads. Boring locations are shown on the Subsurface Exploration Plan (Figure 2).

The borings were drilled by New Hampshire Boring using either a CME-550 or D-50 ATV mounted drill rig, or a CME-75 truck mounted drill rig. The borings were advanced through the soil by wash boring methods using a 4-inch casing and roller bit with water. Standard penetration tests (SPT), consisting of a 140-pound hammer dropping 30 inches on a standard 2-inch-diameter (OD) split-spoon sampler, were performed with a safety hammer or an automatic hammer to establish the consistency of the subsurface soils. The SPT's were typically performed at five foot intervals of depth. The obtained samples were sealed in glass jars to retain their natural moisture. Bedrock was encountered and cored in some of the borings around the proposed platform area.

The borings were observed by a representative from Jacobs. The soil samples were classified in the field in accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) by Jacobs' representative, and appropriate stratum breaks were interpolated from drilling and sampling observations. The boring logs were prepared by Jacobs based on the field classifications and laboratory testing, and are presented in Appendix A.

LABORATORY TESTING

The results of the laboratory testing were previously submitted to VHB in report entitled "South Coast Rail, Jacobs Geotechnical Data Report", dated November 2010.

Proj. No. E2347101

Grain size distribution analyses were performed to evaluate the gradation of the natural granular soils for potential reuse as backfill, if needed, and to classify the soils. The graduation analyses are summarized in Table 1 below and are presented in Appendix B.

Table 1: Laboratory Soil Classification Summary

BORING	SAMPLE	MPLE ELEVATION	USCS SOIL CLASSIFICATION	W	ATTER LIM		GRAVEL	SAND (%)	FINES (%)	ORGANIC CONTENT
NO.	NO.	(FEET)		(%)	LL	PI	(%)			(%)
TS-2	S3	9.0	Clay (CL)	32	NT	NT	NT	NT	NT	NT
15 2	S4	4.0	Silt (ML)	37	26	4	0	1.1	98.9	NT
TS-3	S3	8.0	Clay (CL)	38	NT	NT	NT	NT	NT	NT
TS-7	S3	8.0	Clay (CL)	37	32	11	0	6.1	93.9	NT
15-7	S4	3.0	Clay (CL)	33	NT	NT	NT	NT	NT	NT
TS-11	S2	14.0	Silt (ML)	26	NT	NT	NT	NT	NT	7.8
TS-20	S3	6.0	Silt (ML)	41	33	9	0	5.6	94.4	NT
TS-24	S3	6.0	Clay (CL)	32	NT	NT	NT	NT	NT	NT

Where: w = natural moisture content, LL = Liquid Limit, PI = Plasticity Index, NT = Not Tested

SUBSURFACE CONDITIONS

The subsurface conditions at the site were inferred from the boring data collected for the South Coast Rail project, with some interpretations. The subsurface conditions encountered at the station platform generally consist of a layer of granular fill of up to 4-feet thickness, underlain by an intermittent sand layer, and a clayey silt layer with thickness ranging from about 20 feet to 30 feet overlying glacial till and weathered bedrock. A 5 to 10 feet thick lean clay layer was encountered within the clayey silt layer in borings TS-2 and TS-3. Weathered bedrock was encountered at a depth of about 28 to 38 feet in the platform area, corresponding to approximately elevations -12 to -21 feet.

Fill materials with thicknesses varying from 0.3 to 7 feet were also encountered in the vicinity of the proposed parking lot area. Bedrock was not encountered in this area due to shallow boring depths.

Subsurface soil conditions are summarized in Table 2 and discussed below.

Proj. No. E2347101

Table 2: Summary of Subsurface Conditions at Borings

		Table 2: S	Summary of S	ubsurface Cor	nditions at Bor	ings	
BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
			Pl	atform Borings			
TS-1	19.0	3	16.0	-18.0	-26.0	11.0	
TS-2	18.0	4	14.0	NE	-9.5	NE	
TS-3	17.0	4	13.0	-21.0	-23.0	14.0	
TS-4	16.0	4	12.0	-12.0	-32.5	5.0	
TS-5 OW	16.0	4	12.0	-21.0	-27.0	5.0	Potential Contamination encountered, Well screened from 33 to 43 ft
BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
				Site Borings			
TS-7	16.0	3	13.0	NE	1.0	13.0	
TS-9	18.0	3	15.0	NE	3.0	15.0	
TS-11	17.0	3	14.0	NE	2.0	NE	
TS-13	17.0	3	14.0	NE	2.0	13.0	
TS-15	15.0	7	8.0	NE	0.0	NE	
TS-17	13.0	0.3 (Concrete Slab)	12.7	NE	-2.0	13.0	
TS-19	14.0	3	11.0	NE	-1.0	NE	Potential Contamination encountered
TS-20 OW	14.0	1	13.0	NE	-11.0	12.0	Well screened from 15 to 20 ft
TS-21	15.0	3	12.0	NE	-10.0	12.0	
TS-22	14.0	3	11.0	NE	-11.0	NE	
TS-23	13.0	4	9.0	NE	-12.0	12.0	
TS-24	14.0	0.3 (Asphalt Concrete)	13.7	NE	-11.0	10.0	
TS-25	14.0	0.3 (Concrete Slab)	13.7	NE	-11.0	12.0	Boring offset ~8 f
TS-26	14.0	1	13.0	NE	-11.0	12.0	Boring offset ~10

Soil conditions in the platform area generally consisted of the following:

Fill: The fill layer typically consists of mostly granular, loose to medium dense sand with up to about 15% silt and 15% gravel. The fill layer is generally about 3 to 4 feet thick in the area of the platform.

Sand: Below the fill, an intermittent sand layer consisting of predominantly fine sand with up to about 40% silt was encountered. These deposits are medium dense with Standard Penetration Test (SPT) N-values ranging between 11 and 23 blows per foot (bpf).

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Clayey Silt: The clayey silt layer generally consists of silt with up to about 20% clay. This layer is typically soft to very stiff with SPT N-value ranging between 2 and 26 bpf.

An approximately 5 to 10 feet thick medium stiff to stiff lean clay layer was encountered in borings TS-2 and TS-3 from about 8 to 19 feet below ground surface, corresponding to elevations 10 to -2 feet.

Glacial Till: A thin layer of medium dense to dense glacial till was encountered in borings TS-3 and TS-5 overlying weathered bedrock.

Weathered Bedrock: Weathered bedrock was encountered in the platform area at depth of about 28 to 38 feet below existing ground surface, corresponding to approximately elevations -12 to -21 feet. The bedrock was generally weathered shale or slightly weathered soft siltstone.

Groundwater: Groundwater levels were measured in the test borings using a weighted tape during and at completion of drilling. The data indicated the groundwater level ranged from approximate elevations 16 to 19 feet along the platform alignment, and from elevations 13 to 18 feet in the general area of the proposed parking lot. The use of wash boring techniques for all soil borings may have artificially increased the water level readings due to the addition of water to the borings. Trapped/perched water is also commonly seen at a higher elevation within existing fill and silty materials. The longer term water level readings taken at Boring TS–05 OW on July 7, 2010 and September 12, 2011 indicated the water at a depth of about 22.5 feet (Elevation -6.5 feet) and 11.3 feet (Elevation 4.7 feet). The longer term water level readings taken at Boring TS–20 OW on July 7, 2010 and September 12, 2011 indicated the water at a depth of about 5.5 feet (Elevation 8.5 feet) and 2.0 feet (Elevation 12.0 feet). Based upon these short-term observations and readings from the observation wells, it is anticipated that the groundwater could be at approximately elevation 10 to 12 feet at the site.

Groundwater levels should be expected to fluctuate with rainfall and other seasonal variations. More long-term observations would be required to evaluate true groundwater levels and their influence on planned construction. Local and periodic variations of ground water elevations may also be influenced by local subsurface drainage, leaking water or sewer pipes, and precipitation.

GEOTECHNICAL RECOMMENDATIONS

Based on our review of available subsurface conditions, the proposed station platforms can be supported on shallow spread footings bearing directly on competent natural soil or structural fill placed above suitable natural soils. Platform and canopy design loads were not available at the time of this report preparation. However, it is anticipated that the station platform will be lightly (axially) loaded with limited horizontal forces from wind and seismic loads.

The following paragraphs provide project specific geotechnical recommendations for foundation soil preparation, structural fill/backfill placement, and design and construction of platform foundations.

Platform Foundations

Spread footings are recommended for the platform foundations, bearing on compacted structural fill or natural granular deposits. The bottom of footing elevation should be at least 4 feet below final grades for frost protection. Due to proposed site filling, bottom of footing is anticipated to be at approximately elevations 16 to 18 feet. The existing fill is not suitable for support of the spread footings and should be removed within the zone of influence of the footings, defined by a line extending one foot horizontally from the bottom edge of footing and then down and away at a 1H:1V slope until natural soils are encountered.

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The recommended allowable design bearing capacity for spread footings bearing on at least medium dense structural fill or natural sandy soil is 3 ksf, provided that subgrades are prepared as described herein. This provides an adequate factor of safety against bearing failure and limits the total estimated settlement to about 1.5 inches due to consolidation of the underlying clayey silt layer and the differential settlement to about 3/4 inch. It is recommended that footings should be at least 7 feet wide to limit bearing pressure and settlement impacts. Due to site filling to raise the track grade, we anticipate the track and platform will settle similarly over time. However, if these estimated settlements are not acceptable, alternative means of supporting the platform, such as drilled minipiles, can be developed.

The structural fill material, if needed, should be free from organics and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200 - Earthwork for Type B Gravel Borrow. The structural fill should be compacted to 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557).

All temporary open cuts required for footing construction should be in accordance with the related OSHA regulations and should have side slopes of no steeper than 1.5H:1V.

Seismic Consideration

The seismic design should comply with the requirements of the most current Massachusetts State Building Code 780 CMR and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface conditions encountered, the station site is classified as Seismic Site Class D soil profile in accordance with 780 CMR Chapter 1614.0 Section 9.4 Site Ground Motion. The structure could be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. The maximum considered earthquake ground motions shall be as represented by the spectral response acceleration at short periods (Ss) and at 1-sec (S₁) obtained from Table 1604.10 of the Massachusetts State Building Code and adjusted for Site Class effects using the site coefficients of Section 9.4.1.2.4.

For Site Class D Soils at the location of this station:

$$S_{MS} = 0.384$$
 and $S_{M1} = 0.149$

$$S_{DS} = 0.256$$
 and $S_{D1} = 0.099$

where:

- ullet S_{MS} is the maximum consider earthquake spectral response acceleration for short periods adjusted for site class
- S_{M1} is the maximum consider earthquake spectral response acceleration at 1-sec adjusted for site class
- S_{DS} is the design earthquake spectral response acceleration for short periods adjusted for site class
- S_{D1} is the design earthquake spectral response acceleration at 1-sec adjusted for site class

The building code also requires that the soil be evaluated for the following potential hazards: slope instability, soil liquefaction, or surface rupture due to faulting or lateral spreading. The proposed grading is relatively flat and we are not aware of any pre-existing slope instability in this area. The existing overburden soils do not appear to be subject to surface rupture due to faulting or lateral spreading.

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Liquefaction

Based on the observed subsurface conditions, recorded water levels, percentage of fine contents and sample relative densities the existing soils underlying the site are judged not susceptible to liquefaction.

CONSTRUCTION CONSIDERATIONS

Foundation Installation - Spread Footings

The existing fill, as well as any former building foundations should be stripped off and removed from within the zone of influence of the platform and any walkway areas down to natural soil deposits using a smooth edge excavation bucket, and replaced by compacted granular soils.

Following excavation to the top of the natural soil deposits, the exposed surface should be observed by an on-site representative of the project geotechnical engineer and be proof-compacted with at least 10 passes of a large vibratory drum roller. Any yielding areas should be observed by geotechnical personnel to assess if localized undercutting is necessary. Footing subgrade observations should include hand auger probes by the geotechnical personnel to check for soft/weak zones. The need for undercutting and backfilling with structural fill should be closely evaluated in the field based on encountered conditions.

In areas where seepage is encountered within footing excavations, the need for placing a 3" thick lean concrete mud mat or a layer of \(^34\)-inch crushed stone to protect the bearing surface should be evaluated in the field. Crushed stone thicker than 4 inches shall be wrapped by non-woven filter fabric.

Following observation of the bearing soils by geotechnical personnel, reinforcing steel and concrete can be placed in the excavation. It is recommended that footing reinforcing steel and concrete be placed the same day as the footing excavation is made, where possible, to avoid significant moisture content changes in the bearing soils. No water should be allowed to pond within excavations and drainage should be maintained away from foundations both during and after construction. The footing excavation should be free of loose debris at the time of footing concrete placement.

Subgrade Preparation

Prior to performing any required grading operations and excavations in the proposed structure footprints, walkway and paved areas, these areas should be stripped of topsoil, vegetation, fill, organic silt, former building foundations and existing pavement, if present. The topsoil should be placed in a designated area for reuse during final grading. Following site clearing and stripping, the exposed subgrade should be proof compacted with 10 passes of a large vibratory drum roller (minimum 10,000 pound static weight). Any pockets of excessively soft, wet or disturbed soil or unsuitable soils should be removed and replaced with properly compacted fill materials. Where subgrade soils are close to the existing groundwater level or where silty subgrade soils are encountered, proof-compaction using non-vibratory methods may be considered by the geotechnical engineer.

If additional rolling does not correct the unstable condition, the subgrade should be scarified to a depth of at least six inches but not exceeding eighteen inches, aerated, re-compacted, and retested to provide uniform compaction. Following satisfactory compaction of the subgrade, controlled compacted fill material should be placed to bring the site to the required grade.

Fill should not be placed over frozen soil. Soil subgrades should be protected against frost both during and after construction.

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Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. Excavations should be made with as few passes of the backhoe bucket as possible to reduce disturbance of the subgrade. A backhoe bucket fitted with a smooth blade should be used during the final subgrade preparation, where necessary. The exposed base should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas. Construction traffic should be controlled to prevent excessive stresses and disturbance to the subgrade.

If pavements are not constructed immediately after grading, the subgrade should be shaped so as to prevent ponding. If there is a substantial lapse in time between grading and paving, or if the subgrade is disturbed, it should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during proof-rolling or initial construction should be removed and replaced with compacted granular fill.

Within the proposed paved areas, and extending a distance of five feet beyond the edge on all sides, excavate existing granular fill soils to a depth of two feet below existing site grades. It may be possible to reuse the existing granular fill, depending on the suitability of the material, as described herein.

Fill Placement and Compaction

Fill materials most likely will be obtained by importing granular fill materials from off-site borrow sources. However, it may be possible to reuse existing site granular fill material provided that it can be properly placed and compacted. The gradation shall be in accordance with MBTA Standard Specification Section 02200-Earthwork for Type B Gravel Borrow.

All structural fill should be free of organics, demolition debris or other deleterious substances. The fill material should have a plasticity index (PI) less than 4 and a liquid limit (LL) less than 10, and contain fragments less than 4 inches in maximum dimension. Each lift should be compacted to the specified density prior to placing any subsequent lift. All materials to be used as structural fill should be tested in the laboratory to determine their project suitability and compaction characteristics.

The fill should be systematically compacted to the following percentages of the maximum dry density:

Table 3: Fill Compaction Requirements

Tuble 2.1 m Compaction Reduit ements										
DESCRIPTION	MINIMUM PERCENT COMPACTION (ASTM D-1557)									
General Site Fills, Structural Fill	95									
(Below Footings and Slabs)										
Behind Retaining Walls	92									
Landscape Area	90									

Soils which exhibit a well-defined moisture content–dry density relationship should be compacted to within plus or minus two percentage points of the optimum moisture content as determined by the Modified Proctor test (ASTM D-1557).

Where fill materials are placed against an existing embankment slope, the slope should be benched as the fill is brought up in layers. Benching should be of a sufficient width to permit placing and compaction of fill material upon the existing embankment materials. Typically, benches are between four to eight feet wide. Each bench cut should begin at the intersection of the existing embankment and the vertical side of the previous bench. Trench backfills over pipelines or utility structures should be performed so as not to adversely impact the underlying utilities. In fill areas, the backfill material, compaction method, and degree of compaction requirements should be similar to that for the fill adjacent to the trench.

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Construction Dewatering

All excavations should be performed in the dry condition. Discharge of pumped water should be performed in accordance with all federal, state and/or local regulations which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

Permanent Slopes

Permanent slopes with loamed and seeded surfaces should not be steeper than 2-1/2 horizontal to 1 vertical (2-1/2H:1V) without slope protection to limit erosion and surficial sloughing of the slope. Additional analyses may be required to assess the stability of slopes steeper than 2-1/2H:1V as the station design is finalized.

Excavation Slopes and Shoring

The slopes of temporary open cuts should be no steeper than 1-1/2H:1V. Open cuts should not be used below the water table because of the likelihood of soil sloughing into the excavation.

The temporary excavation support system, if needed, should be selected by the Contractor and designed by an experienced Professional Engineer registered in the Commonwealth of Massachusetts and retained by the Contractor. Where excavation sides can be sloped back, they should be performed in accordance with the Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

Protection of Existing Facilities

It is recommended that a geotechnical instrumentation and monitoring program be performed during construction of the project to evaluate impacts on adjacent structures. It is recommended that the program be developed to provide data for the following considerations:

- To monitor ground movements and vibration levels during construction.
- To provide early warning of potentially adverse trends by presenting sufficient data to determine the source of unanticipated ground movements, if present.
- If necessary, to plan remedial measures to limit damage to embankments and structures and to provide early warning when alternative means of protection are necessary.
- To document impacts of construction on adjacent facilities.
- To evaluate the performance and structural integrity of the constructed facilities.

We recommend the following instrumentation program to measure:

- Ground surface settlement and lateral movement adjacent to proposed construction.
- Horizontal and vertical movement of any excavation support system, and existing structures.
- Vibrations as a result of construction activities.

Vertical and horizontal survey points should be established on the adjacent structures. The monitoring points should be surveyed prior to the start of construction and monitored during construction to detect movement.

Vibration monitoring shall be conducted within 100 feet of existing structures during construction activities.

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We recommend conducting a pre-construction survey of structures and utilities within 100 feet of the site to document existing conditions prior to construction. Documentation should include photographs, video, sketches, and/or written comments.

Specific instrumentation and monitoring requirements shall be based on the proposed construction sequence, duration of construction, and performance criteria. Initial measurements should be established well in advance of construction so that baseline data can be developed. This information will be invaluable for providing early warning of adverse trends and for assessing the need for mitigating measures.

CLOSING

This report and the recommendations contained herein have been prepared for the exclusive use of MBTA and VHB and their representatives for specific application to the design and construction of the proposed Taunton Station in Taunton, Massachusetts.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations available at the time of this report. Subsurface stratification variations between borings are anticipated. The reported groundwater levels only represent the water levels at the time noted on the logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

ATTACHMENTS

FIGURE 1 – SITE LOCATION PLAN

FIGURE 2 – SUBSURFACE EXPLORATION PLAN

FIGURE 3 – SUBSURFACE SOIL PROFILES

APPENDIX A - EXPLORATION LOGS

APPENDIX B – LABORATORY DATA

APPENDIX C – GEOTECHNICAL CALCULATIONS

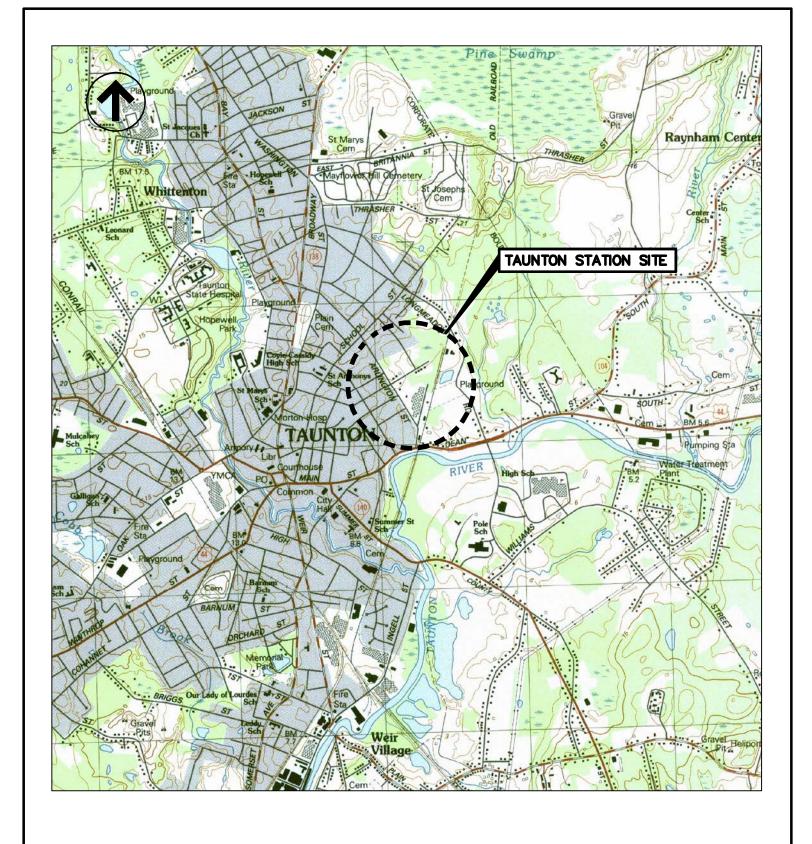
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FIGURES

Figure 1: Site Location Plan

Figure 2: Subsurface Exploration Plan Figure 3: Subsurface Soil Profiles

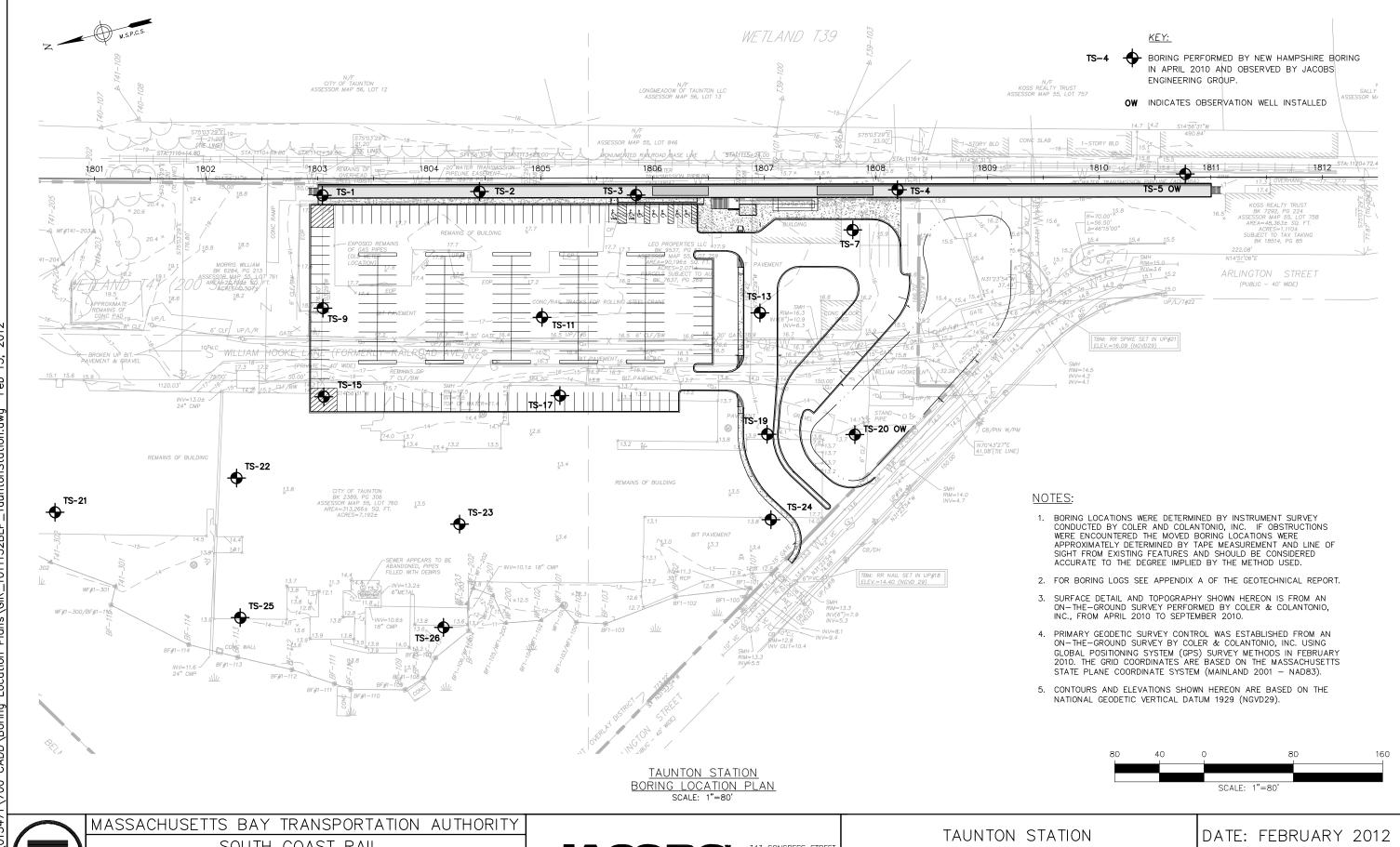


TAUNTON STATION
PROJECT LOCUS PLAN
NOT TO SCALE



MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68 TAUNTON STATION
TAUNTON, MASSACHUSETTS
FIGURE 1



SOUTH COAST RAIL

COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68

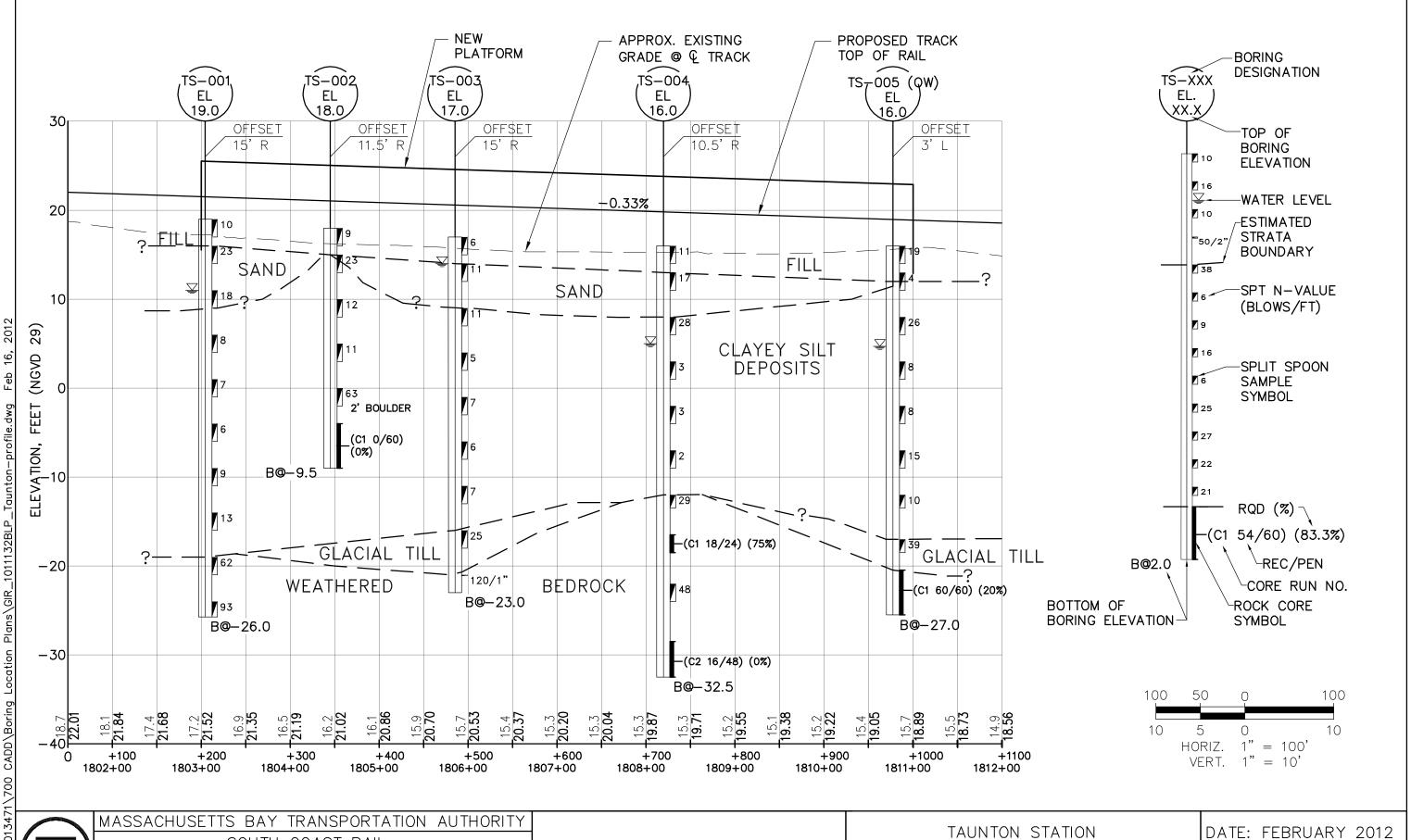
JACOBS

343 CONGRESS STREET BOSTON, MA 02110 (617) 242-9222

TAUNTON, MASSACHUSETTS SUBSURFACE EXPLORATION PLAN

FIGURE NO:

2



SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68

JACOBS

343 CONGRESS STREET BOSTON, MA 02110 (617) 242-9222

TAUNTON, MASSACHUSETTS SUBSURFACE PROFILE A-A

FIGURE NO:

3

APPENDIX A: EXPLORATION LOGS

TS-001 TO TS-005

TS-007

TS-009

TS-011

TS-013

TS-015

TS-017

TS-019 TO TS-026

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—10 - - -		3 6 8				8.0	(10 - 11) LEAN CLAY	(CL); slightly plas	tic clay, gray, wet.			
-15	<u> </u>	4 5 6 5	S4	14 - 16	17		SILT (M	L); slightly pla	stic silt, gray, wet,	PP = 1.0 TSF.			
-20		40 31 32 58	S5	19 - 21	14	-1.0 -3.0					-GM); mostly fine gravel tured rock in tip of spoon.		
-		-	C1	22.5 - 27.5	5 0				at 21 ft, roller bit to pable boulder, loss	22.5 ft. of drill water durin	g last 1 ft of core.		
-25 -						0.5							
- - -30 -		-				-9.5	Bottom	of Hole at 27.5	5'.				
- - -35	Page 1: 0)-35 feet. I	Each subseq	uent page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.		
COF	HESIVE SOIL	-	NON-CO	HESIVE SOIL		ATIVE PORTIONS				LEGEND			
BLOWS/FT CONSISTENCY BLOWS/FT			DENSITY	OF SOIL C	OMPONEN	Sa (As	mple and	ck Core (RC) d RQD (%) C (%) Split-Spot Sample (s and Blow per 6" RF	SS) (U)-Shelby Tube, Counts (P)-Piston	Jar Sample (JS) Bag Sample (B)			
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	SC MEDIUI 5 ST VERY	SOFT OFT M STIFF IFF STIFF	0 - 4 5 - 10 11 - 30 31 - 50 51 +	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	LITT	RACE TILE OME OSTLY REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY. BORING NO. TS						

					PROJE	СТ	1	Coast Rail	LOIDON							
		CO	R	3	LOCAT		Taunto				BORING					
	/				JOB NU		Mass. E2347		ortation Author	ity	NO.	SH	IFFT	1 OF 2		
INSPI	FCTOF	T. Tele	esco			RACTOR	NH Bo			DRILLER	T. Pentacost	ELEVATIO		17		
		D OF DE			001111			R READIN	GS	DRILL RIG	ATV D-50	DATUM	/11	NGVD 29		
0	W	ash Borii	ng w/Cas	sing	D	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	Ν	2791054		
40	Te	erminated	t		,	4/20/2010		3	Upon Complet	tion (Casing pulled	l)	COORD	E	770205		
												DATE STA		4/20/10 4/20/10		
EPTH (ft)	STRATA SYMBOL	SAMPL DATA	E SAM		DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S				
		² 2 ₄ 5	S	1	0 - 2	11			WELL GRADED SAND (SW); fine to coarse sand, trace non-plastic silt, dark brown, moist, FILL.							
-5		7 5 6	S	2	4 - 6	17	13.0	POORL	Y GRADED SA	AND (SP); mostly f	ine sand, gray, we	t.				
-10		8 ₅ 6 ₉	s	3	9 - 11	18	8.0	LEAN C	LAY (CL); mod	ray, wet, PP = 1.5 TSF.						
15			S	4	14 - 16	24		SIMILAF	R TO S3; medi	um stiff, PP = 1.25	STSF.					
20		23 ₄₄	S	5	19 - 21	24	-2.0	SILT (M	L); slightly plas	tic silt, trace clay,	medium stiff, gray	, wet, PP =	1.0 T	SF		
25		2 ₃ 34	S	6	24 - 26	24		SIMILAF	R TO S5; PP =	0.5 TSF.						
30		43 ₄₅	S	7	29 - 31	24		SIMILAF	R TO S5; PP =	0.5 TSF.						
-35		6	S	8	34 - 36	8	-17.0	SANDY	SILT WITH G	RAVEL (ML); sligh	tly plastic silt, som	e fine to co	arse	sand,		
	Page	1: 0-35 feet.	Each subse	equent pa	age displays	40 feet.			SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.							
COHESIVE SOIL NON-COHESI					E SOIL	PROP	ATIVE ORTIONS	🗏	ner I Desi	k Core (PC) Split-Spoor	LEGEND Undisturbed	V Jar		A Bag		
LOWS		SISTENCY			OF SOIL CO				Auger Sample Rock Core (RC) and RQD (%) REC (%) REC (%) Split-Spoon Sample (SS) and Blow Count per 6" REC (in)			Sample (JS)	X	Bag Sample (B)		
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	MED 5 VE	RY SOFT SOFT HUM STIFF STIFF RY STIFF HARD	TIFF 11 - 30				CE LE REI TLY DE: SUI	SCRIPTION AND CI	T ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BODING	G TS	S -	003			

				PROJEC	CT	South C	Coast Rail							
JACOBS		LOCATI	LOCATION		n, MA	BORING	TS - 003							
	JACOB5		OWNER			ay Transportation Authority	NO.	SHEET 2 OF 2						
				Т	JOB NUI									
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA	E SAM	IPLE O.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION	ON AND REMARKS					
	<i>6797X2</i> 3	8						little fine gravel, gray, wet, possible GLACIA	AL TILL					
_		8 17 1	2					male into graver, gray, wer, peccepte GE ten						
-			-											
_		120/1	1" S		20 20 00		-21.0	NO RECOVERY; top of apparent bedrock a	at 20 ft rollor bit to	40 ft				
_,		120/	' 3	9	38 - 38.08	0		NO RECOVERT, top of apparent bedrock a	at 36 it, ioliei bit to	140 II.				
 40							-23.0							
_														
_								Bottom of Hole at 40'.						
_														
_														
 45														
_														
_														
_														
-														
—50														
_														
_														
_														
_														
 55														
_														
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-														
 60														
_														
-														
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 65														
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_														
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 70														
-														
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_														
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Page 1: 0-35 feet. Each subsequent page displays 40 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE									ILESS OTHERWISE NOTED.					
COHESIVE SOIL NON-COHESIVE			VE SOIL		ATIVE ORTIONS		EGEND							
BLOWS/FT CONSISTEN		SISTENCY	BLOWS/F1	ТС	DENSITY	OF SOIL CO		and RQD (%)	Undisturbed (U)-Shelby Tube,	Jar Sample (JS) Bag Sample (B)				
0 - 2	VEI	RY SOFT	0 - 4	VE	RY LOOSE	< 10%	TRACE	per o REC (III	nts (P)-Piston	(JS) (B)				
3 - 4 5 - 8	MED	SOFT IUM STIFF	5 - 10 11 - 30	MEDI	LOOSE IUM DENSE	15 - 25% 30 - 45%	LITTLE	REFER TO THE SHEET ENTITLED "KEY TO	DODING					
9 - 1: 16 - 3:		STIFF RY STIFF	31 - 50 51 +		DENSE RY DENSE	50 - 100%	MOSTL	Y SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.	BORING	TS - 003				
30 +		HARD						STINDOLOGI.	NO.					

				PROJE	СТ		Coast Rail	LOT DON					
	A		BS	LOCAT		Tauntor				BORING	TS	3 -	004
				JOB NU		E23471		ortation Author	ity	NO.	SH	EET	1 OF 2
INSPE	ECTOR	A. Barbe	etta		ACTOR	NH Bori			DRILLER	T. Pentacost	ELEVATIO		16
		OF DRII					R READING		DRILL RIG	ATV D-50	DATUM		NGVD 29
0 44.5		sh Boring Rock Co	g w/Casing re		ATE/TIME 4/19/2010		DEPTH(ft) 11		SPT HAMMER letion (In Casing)	140 lb Safety	GRID COORD	N E	2790826 770151
48.5	Ter	minated									DATE STA		4/19/10 4/19/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
		⁷ 6 5 5	S1	0 - 2	10		WELL G FILL.	RADED SAND	O (SW); fine to coa	arse sand, trace fin	e gravel, as	sh, bli	ack, dry,
-5		4 8 9 13	S2	4 - 6	11	12.0		Y GRADED SA ish-brown, wet		SP-SM); mostly fin	e sand, son	ne no	n-plastic
10	· ·	12 17 11 12	S3	8 - 10	13	8.0	SILT (MI	L); slightly plas	tic silt, trace clay,	grayish-brown, we	et.		
-15		1 1 2 1	S4	13 - 15	15		SILT (MI	L); slightly plas	tic silt, trace clay,	soft, gray, wet.			
20		1 1 2 2	S5	18 - 20	21		SILT (MI	L); slightly plas	tic silt, trace clay,	soft, dark gray, we	et.		
25	<u></u>	² 112	S6	23 - 25	14		SIMILAF	R TO S5; very s	soft.				
30		4 15 14 100	S7 0/0"	28 - 29.5	10	-12.0	WEATH ft.	ERED SHALE	; some silt, dark g	ray, wet, possible l	bedrock, rol	ler bi	t to 32.5
0.5		RQD=7	, ₅ C1	32.5 - 34.5	5 18		SHALE;	joints spaced	5 - 13", slightly we	athered, gray, bro	ke through a	at 34.	5 ft.
35	Page 1:	0-35 feet. Ea	ach subseque	nt page displays	40 feet.	,		SAMPLES CLAS	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHE	RWIS	E NOTED.
COL	HESIVE SO		NON-COHE	SOIVE SOIL	REL	ATIVE				LEGEND			
LOWS		ISTENCY B		DENSITY		ORTIONS OMPONENT	S Aug Sar (AS	nple and	C Core (RC) RQD (%) Split-Spool Sample (S and Blow 0	S) (U)-Shelby Tube.	Jar Sample (JS)	X	Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	S MEDIL 5 S' 0 VER	Y SOFT OFT JM STIFF TIFF Y STIFF ARD	5 - 10 11 - 30 31 - 50	/ERY LOOSE LOOSE EDIUM DENSE DENSE /ERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRACE LITTLE SOME MOSTL	E REF	FER TO THE SHEE	per 6" REC T ENTITLED "KEY TO ASSIFICATION OF EIALS" FOR ADDITIONA	BORING			004

South Coast Rail **PROJECT** TS - 004 **BORING** LOCATION Taunton, MA NO. **OWNER** Mass.Bay Transportation Authority SHEET 2 OF 2 JOB NUMBER E2347101 DEPTH (ft) REC. (in)/(%) STRATA SYMBOL SAMPLE DATA SAMPLE NO. DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS (ft) 16 20 28 100/5 S8 38 - 40 14 WEATHERED SHALE; some silt, dark gray / black, possible weathered seam. 40 C2 44.5 - 48.5 16 SHALE; dark gray. 45 RQD=0 -32.5 50 Bottom of Hole at 48.5'. 55 60 65 70 SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Page 1: 0-35 feet. Each subsequent page displays 40 feet. LEGEND RELATIVE COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) Auger Sample (AS) Rock Core (RC) and RQD (%) REC (%) OF SOIL COMPONENTS BLOWS/FT CONSISTENCY BLOWS/FT DENSITY 0 - 2 VERY SOFT 0 - 4 VERY LOOSE < 10% TRACE LOOSE 15 - 25% LITTLE SOFT 5 - 10 REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY. 5 - 8 MEDIUM STIFF 11 - 30 MEDIUM DENSE 30 - 45% SOME **BORING** 9 - 15 16 - 30 31 - 50 STIFF DENSE 50 - 100% MOSTLY TS - 004 VERY STIFF VERY DENSE 51 + NO. 30 +

				T				E21 BOR	KIINO .				
				PROJEC			Coast Rail			BORING	TC	\cap	15 OW
			RS	LOCATI		Taunto	,	t - 4' A 41	eta.		13 -	. UC)5 OW
								ortation Author	rity	NO.	0		1 OF 2
		.		JOB NU		E2347			I	10.14.1.4			
		T. Telesc		CONTRA		NH Bo			DRILLER	C. Knight	ELEVATI	ON	16
		OF DRILL					R READIN		DRILL RIG	ATV D-50	DATUM	1	NGVD 29
0		sh Boring v	_		TE/TIME	:	DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2790573
38		Rock Core)		7/7/2010		22.5		g Well Reading		COORD	E	770100
43	Ter	minated		9	/12/2011		11.3	Monitorin	g Well Reading		DATE ST		4/22/10
											DATE EN	טו	4/22/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S		
(11)	OTWIDOL	Dittit	140.	(11)	(111)/(70)								
		9	S1	0.25 - 2.25	12	15.8		Asphaltic Conc					
•		13 6							ED SAND WITH (nents, moist, black	GRAVEL (SW); fine	to coarse	sand	, some
		5					(1 - 2') F	OORLY GRAI	DED SAND (SP);	mostly fine sand, b	rown, moi	st, FIL	L.
		3	S2	3 - 5	9		` ′		, ,	mostly fine sand, b			
-		3 2 2	32	3-3		12.0	(3 - 4) 1	OOKET OKA	DED SAND (SI),	mostly line sand, b	TOWIT, THOI	3t, 1 IL	L.
-5	<u> </u>	2					(4 - 5') S	SII T (ML): sliat	ntly plastic silt dar	rk brown, wet, mod	erate petro	leum	odor
5		_					(. 0)	··-· (···-), og.	, p.a.a.a a, a.a.	5.5, 1.51, 15	orato pour		0 0 0 1 1
-													
				0.40	,,		(O O) =	000DLV 0D 11	DED CAND (CC)	manadh (filir -		ادمد	
		9 15 11	S3	8 - 10	16		(8 - 9') F petroleu		DED SAND (SP);	mostly fine sand, g	ray, wet, n	nodera	ate
		11							ghtly plastic silt, w	et, grayish brown, i	noderate r	etrole	um odor.
-10		J 14					,	· //	,	, , , ,			
-													
-													
		_				3.0							
		3	S4	13 - 15	20	3.0	SILT (M	L); slightly plas	stic silt, trace clay,	, medium stiff, gray	, wet, PP :	= 1.0 7	SF.
	7	4 4 5											
-15		5											
•													
-		3	S5	18 - 20	18		SIMII AF	R TO S4; PP =	0.75 TSF				
		4		10 20	.0		O2. 11						
-20	<u> </u>	4 6											
20													
•													
-													
			00	00 05	10		CINALI AT	D TO C4: -4:ff					
		6	S6	23 - 25	16		SIIVIILAI	R TO S4; stiff.					
		9 7											
-25		_ <i>'</i>											
_		_											
		4_	S7	28 - 30	17		SIMILAF	R TO S4; stiff.					
		⁷ 5											
-30		6											
		16	S8	33 - 35	8	-17.0	SILTY S	AND WITH G	RAVEL (SM): fine	to coarse sand, so	me sliahth	/ plast	ic silt.
		18 21								y, wet, GLACIAL T		, ,	- *1
-35													
55	Page 1: ()-35 feet. Each	h subsequen	t page displays 4	10 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	HERWIS	E NOTED.
	J - · · ·	1	4. ***										
COF	HESIVE SOI	L 1	NON-COHES	SIVE SOIL		ATIVE ORTIONS				LEGEND			
21.01410	/FT OCNE	OTENOV 5	214/6/57	DENICITY	OF SOIL C		TS E Aug	ger Roo	sk Core (RC) Split-Spoo RQD (%) Sample (\$	On Undisturbed	Jar Sample	∇	Bag Sample
BLOWS		STENCY BLO		DENSITY			—		Sample (S and Blow per 6" RE	Counts (P)-Piston	(JS)	X	Bag Sample (B)
0 - 2 3 - 4			0 - 4 V 5 - 10	ERY LOOSE LOOSE	< 10% 15 - 25%	TRAC LITTI			pei o RE	~ ("")			
5 - 8	MEDIU	M STIFF 1	1 - 30 ME	DIUM DENSE	30 - 45%	SOM	IE KEI		T ENTITLED "KEY TO LASSIFICATION OF	DODIN	\neg		
	5 S1	TFF 3	1 - 50	DENSE	50 - 100%	MOST			RIALS" FOR ADDITIONA	BORING	J TC	\sim	5 OW
9 - 19 16 - 3		STIFF	51 + V	ERY DENSE				MBOLOGY.	NALO I ON ADDITION	NO.	1.0	- UU	O COV

_	_			PROJE		South Coa		BORING	TS - 005 OW
			R	LOCA		Taunton, I			13 - 005 000
							Transportation Authority	NO.	SHEET 2 OF 2
					UMBER	E2347101			SHEET 2 OF 2
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPL NO.		REC. (in)/(%)	ELEV.	FIELD CLASSIFIC	CATION AND REMARK	3
- - - - -40		17 RQD=20	0 C1	38 - 43			Top of apparent bedrock at ~37 ft. SILTSTONE; soft, joints spaced 0.5 - 6 norizontal and generally parallel to follia	", joints angled at ~₹ ition, thin bedding, s	30 - 45 degrees from light weathering, gray.
- 45 -						-27.0	Bottom of Hole at 43'.		
<u> </u>							Notes:		
_							Observation well screened 33 - 43 ft.		
 50									- 191
_							Contamination encountered between 3 gasoline, sheen on drill water.	and 10 it. Petroleum	i-like odor, possible
-									
_									
-									
55									
_									
_									
-									
F									
-60									
_									
F									
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	Page 1	: 0-35 feet. Ea	ch subsequ	uent page display	s 40 feet.		SAMPLES CLASSIFIED IN ACCORDA	NCE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
COL	HESIVE SO	OIL	NON-COL	HESIVE SOIL		ATIVE		LEGEND	
						ORTIONS OMPONENTS	Auger Rock Core (RC) Split-Spu Sample and RQD (%) Sample	Oon Undisturbed	Jar Bag
		SISTENCY BL		DENSITY			Auger Sample (AS) Rock Core (RC) Sample (AS) REC (%) REC (%) Split-Spc Sample and Bloop per 6° R	v Counts (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 1 16 - 3 30 +	MEDI 5 S		0 - 4 5 - 10 11 - 30 31 - 50 51 +	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRACE LITTLE SOME MOSTLY	REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITION SYMBOLOGY.	BODING.	G TS - 005 OW
30 +	'	""						110.	

								EST BOR	RING				
				PROJE			Coast Rail			PODING	т.	0	007
	AC		BS	LOCAT		Taunto		ambable - A ()	-14	BORING	13	S -	007
								ortation Author	rity	NO.	01		1 OF 1
INIOD	FOTOD	T Talaa		JOB NU		E2347 NH Bo			DDII ED	D. Danisha			
	ECTOR METHOD			CONTR			R READIN	00	DRILLER	P. Rosinha	ELEVATI DATUM	ON	16
0				D/	ATE/TIME		DEPTH(ft)		DRILL RIG SPT HAMMER	TR CME 75 140 lb Safety	GRID	N	NGVD 29 2790874
15		<u>sn Boring</u> ninated	g w/Casing		1/14/2010		3		eletion (In Casing)		COORD	E	770126
15	1611	IIIIaicu			11-112010			Opon comp	netion (in edoing)		DATE ST		4/14/10
											DATE EN		4/14/10
EDTU	STRATA	SAMPLE	SAMPLE	DEPTH	DEO	ELEV.		I.					1 11 11 10
(ft)	SYMBOL	DATA	NO.	(ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	5		
						15.7	→ Top 4" A	Asphaltic Conc	rete				
		5 10	S1	0.33 - 2.33	12					fine sand, trace fin	e gravel, b	rick fr	agments,
		10 13 15					black wi	th light brown,	FILL.				
						13.0							
		3	S2	3 - 5	16	10.0	SILT (M	L); non-plastic	silt, brown, moist	•			
_		3 4 9 11											
5		J 11											
		2	00	0 40	40	8.0	LEANC	1 AV (CL):		little electic cilt			
		5 __	S3	8 - 10	18		LEAN C	LAY (CL); mod	derately plastic cla	ay, little plastic silt,	orownish g	jray, w	et.
10		3 5 5											
10													
		6	S4	13 - 15	12		LEANC	I AV (CL): mo	derately plastic cla	ay, little plastic silt,	arav wet		
		7	34	13 - 13	12		LLANO	LAT (GL), IIIO	deratery plastic cia	ay, little plastic siit,	gray, wet.		
15		6 7 4 4				1.0							
10						1.0							
							Bottom	of Hole at 15'.					
20													
25													
30													
35													
ამ	Page 1: 0)-35 feet. Fa	ach subsequer	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	HERWIS	E NOTED
	. 490 1. 0		3000quoi	- F-32 arobidya				J. IVII ELO OLA					
COI	HESIVE SOII	_	NON-COHE	SIVE SOIL		ATIVE ORTIONS				LEGEND			
LOWS	/FT CONSI	STENCY B	sLOWS/FT	DENSITY	OF SOIL CO		<u>-</u> 3a	mple and	ck Core (RC) Split-Spool	SS) (U)-Shelby Tube.	Jar Sample	X	Bag Sample (B)
					z 400/	TDA			and Blow per 6" RE	Counts (P)-Piston	(JS)		(B)
0 - 2 3 - 4	sc	SOFT	0 - 4 V 5 - 10	ERY LOOSE LOOSE	< 10% 15 - 25%	TRAC LITTI	E BE						
5 - 8	MEDIU	M STIFF		DIUM DENSE DENSE	30 - 45% 50 - 100%	SOM	IE REI	SCRIPTION AND C	T ENTITLED "KEY TO LASSIFICATION OF	BORING	<u>ء</u> ا ۔	_	00-
	ادت بی				50 - 100%	IVIUSI	-' I SII	DOLIDEACE MATER	RIALS" FOR ADDITIONA		⊃⊢ T	٠.	ハハフ
9 - 1: 16 - 3 30 +	0 VERY	STIFF RD	51 + V	ERY DENSE				MBOLOGY.	INIALS TON ADDITION	NO.	1	S -	007

					O.T.			E21 BOK	MINO				
				PROJECT LOCATI			Coast Rail			BORING	т	. –	009
			BS	OWNER			on, MA Bav Transp	ortation Author	-itv	NO.		, - 	003
				JOB NU		E234		ortation Admor	ity		SH	EET	1 OF 1
INSPI	ECTOR	T. Teles	SCO	CONTRA		NH Bo			DRILLER	C. Knight	ELEVATIO		18
	METHOD					-	ER READIN	GS	DRILL RIG	ATV CME - 550	DATUM		NGVD 29
0	Wa	sh Boring	g w/Casing	L DA	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID	Ν	2791351
15	Ten	minated		4	/14/2010		3	Upon Comple	tion (Casing pulled	d)	COORD	Е	770177
											DATE STA		4/14/10
											DATE END)	4/14/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	3		
(11)	OTMBOL		110.	(11)	(111)/(70)	170							
_		20 15 6	S1	0.16 - 2.16	18	17.8		Asphaltic Conc				:14	little fine
		6_						plack with gray		stly fine sand, some	non-piasti	C SIII,	little fine
_		5					J ,	g,	,,				
-		6 1	S2	3 - 5	12	15.0 14.5	(3 - 3.5')	ORGANIC SI	LT (OH); slightly p	lastic silt, slight or	anic odor,	black	, wet.
-		4				14.0	(3.5 - 5')) LEAN (CL); m	noderately plastic	clay, little plastic si	t, medium s	stiff, I	orownish
-5		4					gray, we		, ,	, ,	•	,	
-													
_													
_		• •											
_		6 7 8 8	S3	8 - 10	16		LEAN C	CLAY (CL); mod	derately plastic cla	y, little plastic silt,	stiff, browni	sh gr	ay, wet.
40	Y/A	8 8											
 10													
_													
-													
-		6	S4	13 - 15	7		NO REC	COVERY.					
-		6 7 7	34	13-13	'		NOTIL	JOVENT.					
-15		J ′7				3.0							
-													
							Bottom	of Hole at 15'.					
_													
_													
_													
-20													
-													
_													
_													
0.5													
-25													
-													
-													
-													
-													
-30													
_													
_													
_													
•													
-													
-35							<u> </u>						
	Page 1: (0-35 feet. Ea	ach subsequer	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHE	RWIS	E NOTED.
COF	HESIVE SOI		NON-COHE	SIVE SOIL		ATIVE				LEGEND			
					PROP OF SOIL C	ORTIONS OMPONE	NTS E AU	ger Roc	sk Core (RC) Split-Spoo		Jar Samala	Γ.	Bag
BLOWS	_	STENCY B		DENSITY			Sa (As	mple and	RQD (%) Sample (S and Blow per 6" RE	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	X	Bag Sample (B)
0 - 2 3 - 4		/ SOFT OFT	0 - 4 5 - 10	'ERY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	1F			~ (···)			
5 - 8	MEDIU	IM STIFF	11 - 30 ME	DIUM DENSE	30 - 45%	SOI	ME DE	SCRIPTION AND C	T ENTITLED "KEY TO LASSIFICATION OF	BORING		_	
9 - 19 16 - 30 30 +	0 VERY	TIFF / STIFF	31 - 50 51 + V	DENSE ERY DENSE	50 - 100%	MOS	ILY SU		RIALS" FOR ADDITIONA		기 TS	S -	009
	1 100	ARD					311	552561.		NO.	1		

					PROJEC	CT	South	n Coast Rail					
			D	TM	LOCATION	NC	Taunt	ton, MA			BORING	TS -	011
J			BS		OWNER	<u> </u>	Mass	.Bay Transp	ortation Autho	rity	NO.		
					JOB NUM	MBER	E234	7101				SHEET	1 OF 1
INSP	ECTOR	T. Tele	esco		CONTRA	CTOR	NH B	oring		DRILLER	C. Knight	ELEVATION	17
	ИЕТНО	D OF DF	RILLING			GROUN	IDWAT	ER READIN	GS	DRILL RIG	ATV CME - 550	DATUM	NGVD 29
0	Wa	ash Borii	ng w/Casir	ng	DA	TE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER 1	140 lb Auto	GRID N	2791163
15		rminated										COORD E	770120
												DATE START	4/14/10
												DATE END	4/14/10
DEPTH	STRATA	SAMPL	.E SAMPI	.E	DEPTH	REC.	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	S	
(ft)	SYMBOL	DATA	NO.		(ft)	(in)/(%)						_	
		8	S1	0	.16 - 2.16	18	16.8	Top 2" /	Asphaltic Cond	crete.			
-		11		0	.10 - 2.10	10				AND WITH GRAVE	(SP); mostly fir	e sand, little fine	gravel,
-		12 8						dark bro	wn, FILL.				
L		_					14.0						
	///	2	S2		3 - 5	18	14.0	ORGAN	IIC SILT (ML);	slightly plastic silt, s	light organic odd	r, dark brown, m	ioist.
<u> </u>	///	17											
-5	///	□ 7											
L	V/A												
L	k / /												
	Y/A												
	r / /	⁶ 6 ₃	S3		8 - 10	15		SIMILA	R TO S2; wet,	1" lens of fine sand	at bottom of spo	on.	
-	/ / /	6											
-10	<u> </u>	3					7.0						
L													
-		7	S4		13 - 15	18		SILT (N	II): slightly pla	stic silt, dark gray, w	ret		
L		8	01		10 10			0.2.1 (ie), oligitay pla	one one, dank gray, n	Oi.		
- 15	ШШ	⁷ 8 8					2.0						
13							2.0						
								Bottom	of Hole at 15'.				
-								Bottom	or 11010 at 10.				
-													
L													
200													
-20													
<u> </u>													
F													
_													
L													
 25													
-													
F													
L													
L													
-30													
H													
L													
L													
<u> </u>													
-35													
	Page 1:	0-35 feet.	Each subsequ	ent pa	age displays 4	0 feet.			SAMPLES CLA	SSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWIS	SE NOTED.
CO1	HESIVE SC)II	NON-COH	IEGIV/	E SOII	REL	ATIVE				EGEND		
				١٢٥١٧			ORTIONS	NTC AL	ger Ro	ck Core (RC) Split-Spoon	Undisturbed	Jar	/ Bag
BLOWS	FT CONS	SISTENCY	BLOWS/FT	DE	ENSITY	OF SOIL CO	JIVIPUNEI	NTS AL Sa (A	mple and	d RQD (%) Sample (SS) C (%) and Blow Co	unts (U)-Shelby Tube,		Bag Sample (B)
0 - 2		RY SOFT	0 - 4		Y LOOSE	< 10%	TRA	ACE	■ _ //E	per 6" REC (i			J ' '
3 - 4 5 - 8		SOFT UM STIFF	5 - 10 11 - 30		OOSE JM DENSE	15 - 25% 30 - 45%	LIT	ME KE		ET ENTITLED "KEY TO			
9 - 1	5 8	STIFF	31 - 50	D	ENSE	50 - 100%	MOS	STLY SU	BSURFACE MATE	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORIN	G TS -	011
16 - 3 30 +		RY STIFF HARD	51 +	v⊏K	Y DENSE			SY	MBOLOGY.		NO.		~ ' '

						_		EST BOR	KING				
_				PROJEC			Coast Rail			BORING	т	9	013
	AC		BS	LOCATI OWNER			on, MA Bay Transn	ortation Author	rity	NO.	1	J -	013
				JOB NUI		E2347		ortation Author	ity	INO.	S	HEET	1 OF 1
INISDI	ECTOR	T. Teles	<u></u>	CONTRA		NH Bo			DRILLER	P. Rosinha	ELEVAT		17
		OF DRIL		CONTRA			R READIN	IGS	DRILL RIG	TR CME 75	DATUM	ON	NGVD 29
0			w/Casing	DΔ	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2790973
15		minated	wicasing		/14/2010		4		tion (Casing pulle		COORD	E	770075
_10	1011	miatou						- CP - C - C - C - C - C - C - C - C - C	(/	DATE S		4/14/10
											DATE EN		4/14/10
TEDTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.		'	FIELD OLASSIEIO	ATION AND REMARK			'
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)				FIELD CLASSIFIC	ATION AND REWARK	5		
_	***	10	-	0.00		16.7	Top 4" A	Asphaltic Conc	rete.				
		10	S1	0.33 - 2.33	6		WELL C	GRADED SANI	D (SW); fine to co	arse sand, trace fin	e gravel,	brick fr	agments,
		10 12 7 5					grayish	brown, wet, FI	LL.				
		_				14.0							
	• 1	5 5 10 9	S2	3 - 5	16		POORL	Y GRADED S	AND (SP); mostly	fine sand, grayish	orown, we	t.	
_	· : /	10											
-5	• •												
	• •												
	•												
		5	63	0 10	40	9.0 8.5	(0 OF) CII TV CAND	(SM): mostly fire	sand, some slightl	/ plantin =	ilt rod	dish
		5 6 3 5	S3	8 - 10	12	8.5	(8 - 8.5) brown, \		(SIVI), ITIOSTIY TINE	sanu, some siighti	y piastic s	п, геа	uisii
-10	V/I	$\begin{bmatrix} 3 \\ 5 \end{bmatrix}$							(CL); moderately	plastic clay, little s	ilt, gray, v	et.	
10	V/\sqrt{x}	-					-			÷ ·	- ·		
		2	S4	13 - 15	18		IFANC	CLAY (CL.): mo	derately plastic cla	ay, little silt, gray, w	et		
		² 236	54	13-13	"		LLANC) LAT (OL), 1110	deratery plastic cit	ay, nitic siit, gray, w	Ci.		
-15		³ 6				2.0							
10						0							
							Bottom	of Hole at 15'.					
-20													
-25													
-30													
35													
	Page 1: 0	0-35 feet. Ead	ch subsequen	t page displays 4	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OT	HERWIS	E NOTED.
COL	HESIVE SOI		NON-COHES	SIVE SOII	REL	ATIVE				LEGEND			
001			INDIN-CORE	J. V L GOIL		ORTIONS	TS E AU	iger Roo	ck Core (RC) Split-Spoo		Jar		Bag
LOWS	FT CONSI	STENCY BL	_OWS/FT	DENSITY	OF SOIL CO	JMPONEN	TS Au Sa (A:	ample and	RQD (%) Sample (3 and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	\rangle	Bag Sample (B)
0 - 2		SOFT		ERY LOOSE	< 10%	TRA	CE		per 6" RE	C (in)		<u>~</u>	u ' '
3 - 4			5 - 10 11 - 30 ME	LOOSE DIUM DENSE	15 - 25% 30 - 45%	LITT	ne RE		T ENTITLED "KEY TO				
			. 20 IVIL					SCIDIDTION AND C	LASSIFICATION OF		~		
5 - 8 9 - 19 16 - 30	5 ST	TIFF STIFF	31 - 50 51 + V	DENSE ERY DENSE	50 - 100%	MOS	ILY SU		RIALS" FOR ADDITION	AL BORING NO.	ס ∣כ	S-	013

					PROJEC		South	n Coast Rail				TO 045
			B	10	LOCATION			ton, MA			BORING	TS - 015
									ortation Autho	rity	NO.	SHEET 1 OF 1
INICO	ECTOR	T Tole	200		JOB NUM		E234 NH B			DRILLER (C. Knight	ELEVATION 15
			RILLING		CONTRA			ER READIN	GS		ATV CME - 550	DATUM NGVD 29
0			ng w/Casi	na	DA	TE/TIME		DEPTH(ft)			40 lb Auto	GRID N 2791370
15		minated		.9				(-7		1		COORD E 770100
												DATE START 4/14/10
												DATE END 4/14/10
DEPTH (ft)	STRATA SYMBOL	SAMPL DATA			DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICAT	ION AND REMARK	s
	2112	•					14.7	Top 4" (Concrete Slab.			
F		2	S1	0	.33 - 2.33	18		· ·			ine sand, pieces	of wood, dark brown,
-	\bowtie	² 232						moist, F		•	•	
L			I									
L		2	S2		3 - 5	12			SRADED SAN its, wet, FILL.	D (SW); fine to coars	se sand, trace no	on-plastic silt, brown, brick
5	\bowtie	² 2						liagilloi	10, 1101, 1 122.			
_5												
<u> </u>							8.0					
-		2	S3		8 - 10	13		SANDY	ORGANIC SO	OIL (OL); non-plastic	silt, some fine to	coarse sand, organic
-		² 3 ₃₂						materia	, dark brown,	wet.	.,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
- 10		2										
L	<u></u>						4.0					
	V//											
L	Y//1	_										
		2	S4		13 - 15	18		LEAN C	LAY (CL); mo	derately plastic clay,	some silt, gray,	wet.
		² 3 ₃₂										
 15							0.0					
-								Pottom	of Hole at 15'.			
-								BOLLOITI	oi noie at 15.			
-												
L												
-20												
<u> </u>												
-25												
F												
-												
L												
L												
_ 20												
-30												
Γ												
<u> </u>												
-												
-												
-35												
	Page 1:	0-35 feet. I	Each subsequ	uent pa	age displays 4	0 feet.			SAMPLES CLA	ASSIFIED IN ACCORDANCE	E WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
COF	COHESIVE SOIL NON-COHESIVE S						ATIVE ORTIONS	,		_	EGEND	
BLOWS	/FT CONS	ISTENCY	BLOWS/FT	DE	ENSITY	OF SOIL CO	OMPONE	NTS Au Sa	mple and	ck Core (RC) d RQD (%) Sample (SS) and Blow Cou	Undisturbed (U)-Shelby Tube,	Jar Sample (JS) Sample (B)
0 - 2		Y SOFT	0 - 4		RY LOOSE	< 10%	TRA	ACE	-, ■ RE	and Blow Cou per 6" REC (i	n) (P)-Piston	<u> </u>
3 - 4 5 - 8		OFT JM STIFF	5 - 10 11 - 30		LOOSE UM DENSE	15 - 25% 30 - 45%	LIT	ME RE		ET ENTITLED "KEY TO		
9 - 1: 16 - 3	5 S	TIFF Y STIFF	31 - 50 51 +	D	DENSE RY DENSE	50 - 100%	MOS	STLY SU	BSURFACE MATE	CLASSIFICATION OF RIALS" FOR ADDITIONAL	BORING	G TS - 015
30 +		IARD	J1 f	v ∟r<	DLINGE			SY	MBOLOGY.		NO.	. 5 5 15

				חחס יבי	`T			E21 BOR	IIIG				
_				PROJEC LOCATI			Coast Rail on, MA			BORING	т	S _	017
			BS	OWNER				ortation Author	ritv	NO.		<u> </u>	017
				JOB NUI		E2347			,		s	HEET	1 OF 1
INSPE	ECTOR	T. Teles	со	CONTRA		NH Bo			DRILLER	P. Rosinha	ELEVATI	ON	13
N	METHOD	OF DRIL	LING		GROUN	IDWATI	ER READIN	GS	DRILL RIG	TR CME 75	DATUM		NGVD 29
0			w/Casing		TE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2791165
15	Ter	minated		4,	/13/2010		0	Upon Comple	tion (Casing pulled	d)	COORD	E	770048
											DATE ST		4/13/10
											DATE EN	1D	4/13/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
	0 6 4 0	_		, ,	() ()	12.7	Top 4" (Concrete Clab					_
-		29 9	S1	0.33 - 2.33	6	12.1		Concrete Slab.	silt, gray, moist.				
_		4					OILT (III	iz), non plactic	one, gray, moles.				
_		_ 4											
		6 13	S2	3 - 5	12		SILT (M	L); non-plastic	silt, trace fine sar	nd, grayish brown, v	wet.		
_		13 11 7											
-5		/											
-													
-													
-		3	S3	8 - 10	15	5.0	I FAN C	LAY (CL): mor	derately plastic cla	ay, little silt, stiff, gr	av wet		
-		3 ₄ ₆	33	0-10	13		LLANO	(OL), IIIO(acratory piastic cia	,, nuic oni, ouii, yi	ay, WCL.		
-10		_											
	V/A												
		3_	S4	13 - 15	18		LEAN C	LAY (CL); mod	derately plastic cla	ay, little silt, stiff, gr	ay, wet, Pl	P = 0.7	75 TSF.
		3 5 4 6											
-15	//4	⊿ 6				-2.0							
-							5						
-							Bottom	of Hole at 15'.					
-													
_													
20													
-20													
-													
-													
-													
-													
-25													
-													
-30													
=													
_ 25													
-35	Page 1:	0-35 feet. Ead	ch subseauen	t page displays 4	10 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTI	HERWIS	E NOTED.
	-30	1		,		A TIV :-							
COF	HESIVE SOI	IL	NON-COHES	SIVE SOIL		ATIVE ORTIONS				LEGEND			
BLOWS/	/FT CONSI	STENCY BL	_OWS/FT	DENSITY	OF SOIL C			mple and	sk Core (RC) RQD (%) Sample (S	SS) (U)-Shelby Tube,	Jar Sample	X	Bag Sample (B)
0 - 2		Y SOFT		ERY LOOSE	< 10%	TRA			and Blow per 6" RE	Counts (P)-Piston	(JS)	Ľ	∬ (B)
3 - 4	S	OFT	5 - 10	LOOSE	15 - 25%	LITT	LE BE	FER TO THE SHEE	T ENTITLED "KEY TO				
5 - 8 9 - 15			11 - 30 ME	DIUM DENSE DENSE	30 - 45% 50 - 100%	SOM	VIE DE	SCRIPTION AND C	LASSIFICATION OF	BORING	G -		017
16 - 30	0 VERY	/ STIFF		ERY DENSE			30	BSURFACE MATER MBOLOGY.	RIALS" FOR ADDITIONA	NO.	~ I	5 -	017
30 +	H/	ARD								140.			

				PROJEC	^T	1	Coast Rail	LOT DOI	1110			
							on, MA			BORING	TS	- 019
J	AU		B 5	OWNER				ortation Author	rity	NO.		0.0
				JOB NU	MBER	E2347	7101				SHE	ET 1 OF 1
INSPI	CTOR	T. Telesc	o	CONTRA	ACTOR	NH Bo	oring		DRILLER	C. Knight	ELEVATION	N 14
I	METHOD	OF DRIL	LING		GROUN	IDWAT	ER READIN		DRILL RIG	ATV CME - 550	DATUM	NGVD 29
0		sh Boring	w/Casing	DA	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID	N 2790994
15	Terr	ninated										E 769968
											DATE STAF	
											DATE END	4/13/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S	
	202080					13.8	— T 011 /	N I It' - O				
		5 13	S1	0.25 - 2.25	12	13.0		Asphaltic Conc		arse sand, trace fin	o graval dar	k brown
		13 20 5					moist, F		D (SW), line to coa	arse sand, trace iii	e graver, dar	K DIOWII,
		. 5				44.0						
		6	S2	3 - 5	14	11.0				e fine sand, grayish	brown, wet,	strong
		10 10 11					naphtha	llene-like odor.				
5		11										
						6.0						
		3 3 5	S3	8 - 10	12	5.5	LEAN C	CLAY (CL); mo	derately plastic cla , PP = 0.5 TSF.	ay, little silt, mediun	n stiff, gray, v	vet, slight
		3,					парпипа	nene-like odor,	FF - U.D ISF.			
10		ຸ ວ										
		l o								Prof. 20 P		. 55
		4	S4	13 - 15	20		1.25 TS		derately plastic cla	ay, little silt, mediun	n stiff, gray, v	vet, PP =
45		2 4 4 4				4.0	1.23 10					
15		, ,				-1.0						
							Rottom	of Hole at 15'.				
							Dottom	or riole at 15.				
20												
25												
30												
0.5												
35	Page 1. C	L35 feet East	h subseques	t page displays	40 feet			SAMDI ES OLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	IINI EQQ OTUFF	NVISE NOTED
	i aye i. l	JO ICCL EdU	subscyueli	r page displays				ONIVIPLES ULA	OUI ILD IN ACCURDAN		UNLLOS UTTER	AVVIOL NOTED.
COF	IESIVE SOII	. 1	NON-COHE:	SIVE SOIL		ATIVE ORTIONS				LEGEND		
LOWS	ET CONSI	STENCY BLO	OWS/ET	DENSITY	OF SOIL CO		ITS Au Sa	mple and	ck Core (RC) Split-Spool	SS) (U)-Shelby Tube.	Jar Sample	Bag Sample
					- 4001		—— 且 (AS	S) RE	C (%) C (%) and Blow per 6" RE	Counts (P)-Piston	(JS)	Bag Sample (B)
0 - 2			0 - 4 V 5 - 10	ERY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	1F	EED TO THE OUT				
3 - 4				DIUM DENSE	30 - 45%	SON	ΛE RE	FER IO THE SHEE	ET ENTITLED "KEY TO	1	_	
5 - 8	MEDIU						TIV DE		CLASSIFICATION OF	R∪DINI	⊋l	
	ST VERY	TFF 3	31 - 50	DENSE ERY DENSE	50 - 100%	MOS	TLY SU		CLASSIFICATION OF RIALS" FOR ADDITIONA	AL BORING NO.	³ ⊤S	- 019

				PROJE		South	Coast Rail	LOT BOTTING		BODING	TC	00	
	AC		BS	LOCAT OWNER		Taunto		ortation Authority		BORING NO.	15 -	UZ	20 OW
				JOB NU		E2347		ortation Authority		INO.	SH	IEET	1 OF 1
INSPE	ECTOR	T. Tele	sco	CONTR		NH Bor		DRILLER	Р	. Rosinha	ELEVATION		14
	METHOD			00			R READIN			R CME 75	DATUM		NGVD 29
0	Was	sh Borin	g w/Casing	D/	ATE/TIME			REMARKS SPT HAMI		40 lb Safety	GRID	N	2790918
25	Terr	ninated			7/7/2010		5.5	Monitoring Well Read			COORD	E	769948
				9	9/12/2011		2	Monitoring Well Read	ling		DATE ST		4/13/10
											DATE EN	D	4/13/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.		FIELD CLA	SSIFICATION	ON AND REMARK	S		
	$\times\!\!\times\!\!\times$	6	S1	0.33 - 2.33	3 12	13.7		sphaltic Concrete.					/
	• •	7 7 8				13.0	√ (0 - 1') V moist, F	VELL GRADED SAND (SV	V); fine to	o coarse sand, t	race fine gi	avel,	brown,
	ľ. ' <i>þ</i>	8						OORLY GRADED SAND	(SP); mo	stly fine sand, to	race non-pl	astic	silt, gray,
	. •	6	S2	3 - 5	13		moist.		. ,	•			, 0 ,
	`. ' 	8					POORL	Y GRADED SAND (SP); n	nostly fine	e sand, gray, we	et.		
-5	· ./	10)										
	$ \cdot $												
	L					6.0							
		3 3 4 8	S3	8 - 10	16	6.0	SILT (M	L); slightly plastic silt, trace	e clay, gr	ay, wet.			
		4											
-10	<u> </u>	8											
		_											
		4	S4	13 - 15	10		SIMILAF	R TO S3; stiff.					
		⁴ 6 ₃											
-15		3											
		2 3 4	S5	18 - 20	6		SIMILAF	R TO S3; medium stiff.					
		4 3											
-20													
				00.05	40		OINAU AT	TO 00:					
		3	S6	23 - 25	18		SIMILA	R TO S3; medium stiff.					
25		² 3 ₅				11.0							
-25		_				-11.0							
							Bottom (of Hole at 25'.					
							Dottom						
							Notes:						
-30							Observa	tion well screened from 15	5 to 25 ft.				
-35													
	Page 1: 0)-35 feet. E	Each subsequer	nt page displays	40 feet.			SAMPLES CLASSIFIED IN ACC	CORDANCE	WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
	IEON /E 22:		No. c = :	00.45.00::	RFI	ATIVE			LE	EGEND			
COF	IESIVE SOIL		NON-COHE	SIVE SOIL	PROP	ORTIONS	F	ner Park Com (DO)			lar lar	K	7 Bag
LOWS/	FT CONSIS	STENCY	BLOWS/FT	DENSITY	OF SOIL CO	OMPONENT	S Aug	inple and RQD (%)	Split-Spoon Sample (SS) and Blow Cour	Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)	[χ	Bag Sample (B)
0 - 2	VERY	SOFT	0 - 4 V	ERY LOOSE	< 10%	TRAC		REC (%)	per 6" REC (in		(30)	V_	(D)
3 - 4 5 - 8	sc	OFT M STIFF	5 - 10	LOOSE DIUM DENSE	15 - 25% 30 - 45%	LITTL	E REI	FER TO THE SHEET ENTITLED "K					
		STIFF STIFF	31 - 50	DENSE	30 - 45% 50 - 100%	MOSTI	DE:	SCRIPTION AND CLASSIFICATION BSURFACE MATERIALS" FOR ADI	N OF	BORING	G Te	. กว	0 OW
9 - 15 16 - 30				ERY DENSE		1	, 501			i i			

				PROJE		South 0	Coast Rail			TO 004
	AC		DC	LOCATI		Taunto	1		BORING	TS - 021
J			BS			Mass.B	ay Transportation Auth	nority	NO.	
				JOB NU	MBER	E23471				SHEET 1 OF 1
	ECTOR			CONTRA		NH Bor		DRILLER	C. Knight	ELEVATION 15
	METHOD 						READINGS	DRILL RIG	ATV CME - 550	DATUM NGVD 29
0			ng w/Casing		ATE/TIME		DEPTH(ft) REMARKS		140 lb Auto	GRID N 2791629
25	Lern	ninated		4	/13/2010		3 Upon Comp	oletion (Casing pulled	1)	COORD E 770060
										DATE START 4/13/10
										DATE END 4/13/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	E SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.		FIELD CLASSIFICA	ATION AND REMARK	S
	2000				' ' '	44.7	T 411 O	. Ia		
		2	S1	0.33 - 2.33	13	14.7	Top 4" Concrete Sla	mostly fine sand, sor	no non plastic silt	brown dry EILI
		2					SILTT SAND (SIVI),	illostiy ilile sarid, soi	ne non-plastic siit,	DIOWII, UIY, I ILL.
		1								
	•	5	S2	3 - 5	16	12.0		SAND (SP); mostly f	ine sand, trace no	n-plastic silt, grayish
	· · /	4 8 8					brown, wet.			
5	• •	8								
	• •									
	• •									
	• •					- 0				
		5 7 6	S3	8 - 10	24	7.0	SILT (ML); non-plas	tic silt, gray, wet.		
		6								
10		6								
		6_	S4	13 - 15	18	2.0	LEAN CLAY (CL); n	noderately plastic clay	y, some silt, stiff, o	gray, wet.
		6 7 8								•
15		8								
		3 4 3	S5	18 - 20	24	-3.0	SILT (ML); slightly p	lastic silt, trace clay,	gray, wet.	
		3					, , , , , , , , , , , , , , , , , , , ,	•	•	
20		3								
		2	S6	23 - 25	11		SIMILAR TO S5.			
		² 9 5 5								
25		5				-10.0				
							Bottom of Hole at 25	5'.		
30										
35										
	Page 1: 0	-35 feet. E	Each subsequen	t page displays	40 feet.		SAMPLES C	CLASSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
CO1	HESIVE SOIL		NON COUR	SIVE SOII	REL	ATIVE			LEGEND	
COI	IESIVE SUIL		NON-COHE:	SIVE SUIL	PROP	ORTIONS	Auger T	Rock Core (RC) Split-Spoor	1 Undisturbed	Jar Bag
LOWS	/FT CONSIS	STENCY	BLOWS/FT	DENSITY	OF SOIL C	OMPONENT	Sample	and RQD (%) REC (%) Sample (Stand Blow Colors)	S) (U)-Shelby Tube, Counts (P)-Piston	Sample (B)
0 - 2				ERY LOOSE	< 10%	TRACI	<u> </u>	per 6" REC		
3 - 4 5 - 8		FT // STIFF	5 - 10 11 - 30 ME	LOOSE DIUM DENSE	15 - 25% 30 - 45%	LITTLE	REFER TO THE SE	HEET ENTITLED "KEY TO		_
9 - 1	5 ST	IFF	31 - 50	DENSE	50 - 100%	MOSTL	, DESCRIPTION AN	D CLASSIFICATION OF TERIALS" FOR ADDITIONA		G TS - 021
16 - 3	0 VEDV	STIFF	51 + V	ERY DENSE		1	SYMBOLOGY.		NO.	10-041

				DD0 :-	·OT			E21 BOR					
				PROJE LOCAT		South	Coast Rail			BORING	Т	\ -	022
			BS	OWNE				ortation Author	ritv	NO.	1	<u> </u>	022
					JMBER	E2347			,		SH	IEET	1 OF 1
INSP	ECTOR	T. Teles	sco		RACTOR	NH Bo			DRILLER	C. Knight	ELEVATIO	N	14
ı	МЕТНО	OF DR	ILLING			DWATE	R READIN	GS	DRILL RIG	ATV CME - 550	DATUM		NGVD 29
0			g w/Casin	g D	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID	N	2791464
25	Ter	minated									COORD	Е	770049
											DATE STA		4/13/10
											DATE ENI	ر	4/13/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLI NO.	E DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	3		
		6	S1	0 - 2	6		WELLG	RADED SANI) (SW): fine to co:	arse sand, trace sil	hrick frag	ment	s dark
		39	01	0-2				noist, FILL.	3 (011), mic to oot	aroc saria, trace on	, briok irag	1110110	o, dank
		39 32 43	3										
						11.0							
		13 16 14 14	S2	3 - 5	20		SILTYS	SAND (SM); mo	ostly fine sand, so	me non-plastic silt,	gray, wet.		
-5		∐ 14 ∐ 14	.										
5													
		3_	S3	8 - 10	20	6.0	SILT (M	L); slightly plas	stic silt, gray, wet,	PP = 1.25 TSF.			
	$ \ \ \ $	3 5 7					`	. 5 71 -					
-10		7											
		_				1.0							
		² 233	S4	13 - 15	16	1.0	LEAN C 1.0 TSF		derately plastic cla	ay, some silt, mediu	m stiff, gra	y, we	t, PP =
		3					1.0 15F	•					
15	Y//	_ 3											
	Y //												
		2	S5	18 - 20	22	-4.0	SILT (M	L): cliabtly plac	etic cilt. traco clav	, gray, wet, PP = 0.	75 TQE		
		² 2 ₂ 3	33	10 - 20	22		OILT (IVI	L), Slightly plac	siic siit, trace clay,	, gray, wet, i i = 0.	75 151 .		
-20	[3											
		1	S6	23 - 25	24		SIMILAF	R TO S5.					
		22											
25						-11.0							
							D-#	-					
							Rottom	of Hole at 25'.					
-30													
00													
35													
	Page 1:	0-35 feet. E	ach subseque	ent page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
COF	HESIVE SO	ou l	NON-COL	ESIVE SOIL	REL	ATIVE				LEGEND			
COF				LOIVE SUIL		ORTIONS	re 🗏 Aug	ger I Roo	ek Core (RC) Split-Spoo		Jar	Γ.	Bag
LOWS	/FT CONS	ISTENCY	BLOWS/FT	DENSITY	OF SOIL C	OMPONENT	S Aug Sai (AS	nple and	RQD (%) Sample (8 and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	X	Bag Sample (B)
0 - 2		Y SOFT		VERY LOOSE	< 10%	TRAC	E	_	per 6" RE	C (in) —			-
3 - 4 5 - 8	MEDIU	JM STIFF		LOOSE IEDIUM DENSE	15 - 25% 30 - 45%	LITTL	E REI		T ENTITLED "KEY TO LASSIFICATION OF	DODING	$\overline{}$		
9 - 1	5 S	TIFF Y STIFF	31 - 50	DENSE VERY DENSE	50 - 100%	MOST	^{LY} SUI		LASSIFICATION OF RIALS" FOR ADDITIONA	AL BORING NO.	T اخ	S -	022
16 - 3			~ i ·	DLINUL									

				DD 0 :-	ОТ.			E21 BOK					
				PROJE LOCAT			Coast Rail			BORING	Т	S _	023
			BS	OWNE			on, MA	ortation Author	ity	NO.	13	- ر	UZ3
				JOB NU		E234		ortation Author	ity	INO.	SH	HEET	1 OF 1
INSP	FCTOR	T. Teles	SCO SCO		ACTOR	NH B			P. Rosinha	ELEVATION		13	
		O OF DRII		CONTIN		-	ER READIN	GS	DRILLER DRILL RIG	TR CME 75	DATUM	וע	NGVD 29
0			w/Casing	ı D	ATE/TIME		DEPTH(ft) REMARKS SPT HAMMER 140 lb Safety				GRID	N	2791281
25		rminated	, w/odomig		4/13/2010		1		tion (Casing pulle		COORD	E	769959
	1								(-,	DATE ST		4/13/10
											DATE EN		4/13/10
DEPTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			FIELD CLASSIFIC	ATION AND REMARK			
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
	0 0 0 0						Top 11"	Concrete Slab	-				
		11	S1	1 - 3	6	12.0	WELL G	SRADED SAND	(SW); fine to co	arse sand, black, w	et, FILL.		
		11 6 3 6							, ,				
		6 18	S2	3 - 5	18		(3 - 4.5"	POORLY GR	ADED SAND (SD); mostly fine sand,	dark brow	n with	lancae
		18 10 12 11	52	3-3	'0			, wet, FILL.	ADED OAIVD (OI	, mostly line sand,	dark brow	ii vviti	1011303
-5		12				8.5	(4.5 - 5')) SILT (ML); no	n-plastic silt, trace	e fine sand, light br	own, wet.		
Ū							, ,	, ,,					
		3	S3	8 - 10	15	5.0	SILT (M	L); slightly plas	tic silt, trace clav	gray, wet, PP = 1.	25 TSF.		
	$ \mathbf{I} \mathbf{I} \mathbf{I} \mathbf{I} $	3 ₂ ₃₅					,	,, - 3) p.ac			- - •		
10		₅											
		3	S4	13 - 15	13		SIMILAF	R TO S3; PP =	1.0 TSF.				
		3 ₆ ₅						•					
15		5											
		2	S5	18 - 20	14		SIMILAF	R TO S3; PP =	1.25 TSF.				
		2 5 8 7											
20	│ ┃┃┃ ╏╏╏	7											
		2	S6	23 - 25	16		SIMILAF	R TO S3; PP =	0.5 TSF.				
		$\begin{bmatrix} 3\\3\\7 \end{bmatrix}$											
25		7				-12.0							
							Bottom	of Hole at 25'.					
30													
35													
	Page 1:	0-35 feet. Ea	ach subsequer	nt page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
COL	JE61/15 00	NI	NON COUR	SIVE SOU	REL	ATIVE				LEGEND			
COI	PROPE				ORTIONS	NITS Au	ger 🔳 📴	k Core (RC) Split-Spoo	On Indisturbed	Jar	K	Bag	
SLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL CON				OMPONE	NTS Au	mple and	k Core (RC) RQD (%) Sample (\$ and Blow	SS) (U)-Shelby Tube.	Sample (JS)	X	Bag Sample (B)		
0 - 2		Y SOFT		ERY LOOSE	< 10%	TRA	CE	, E REC	per 6" RE		\/	V_	y (<i>></i>)
3 - 4 5 - 8	8	OFT	5 - 10 11 - 30 ME	LOOSE DIUM DENSE	15 - 25% 30 - 45%	LITT SOI	ME KE		T ENTITLED "KEY TO				
			31 - 50 ME	DENSE	30 - 45% 50 - 100%		TLV DE	SCRIPTION AND C	LASSIFICATION OF	BORING	3 -	_	
9 - 1 16 - 3		Y STIFF		ERY DENSE	00 10070			BSURFACE MATER	RIALS" FOR ADDITIONA		_		023

								EST BOH	KING				
	Δ		BS	PROJECT LOCATION OWNER	ION	Taunt	on, MA	ortation Author	rity	BORING NO.	TS	S -	024
				JOB NU		E2347		Ortation Author	ity	NO.	Sł	HEET	1 OF 1
INSPI	ECTOR	T. Teles	SCO	CONTRA		NH Bo			DRILLER	P. Rosinha	ELEVATION 14		
	METHOD			0011110			ER READIN	GS	DRILL RIG	TR CME 75	DATUM	J11	NGVD 29
0	Was	sh Borine	g w/Casing	DA	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2791010
25		minated			/13/2010		4	Upon Comple	tion (Casing pulle	d)	COORD	E	769893
											DATE ST	ART	4/13/10
											DATE EN	D	4/13/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S		
		3	S1	0.33 - 2.33	12	13.7		Asphaltic Conc					
		2 4 4					SILT (M	IL); slightly plas	stic silt, trace fine	sand, dark brown,	moist.		
		4	S2	3 - 5	15		(3 - 4') \$	SIMILAR TO S	1.				
		16 24 13				10.0				astic clay, some silt	. grav. wet		
5							(. 0)-	(, g.u.,,		
		⁵ 6 ₅	S3	8 - 10	18		LEAN C	CLAY (CL); mod	derately plastic cla	ay, some silt, gray,	wet, PP =	1.0 TS	SF.
10		5											
		2	S4	13 - 15	24	1.0	SII T (M	II): eliabtly plac	etic silt trace clay	, gray, wet, PP = 1.	25 TSF		
15		2 2 2	04	13-13	24		OILT (W	ic), slightly plac	suc suc, trace clay	, gray, wei, i i – i.	20 101 .		
-20	<u> </u>	² 344	S5	18 - 20	19		SIMILAI	R TO S4; PP =	0.75 TSF.				
25		1 1 1 2	S6	23 - 25	24	-11.0	SIMILAI	R TO S4; PP =	0.5 TSF.				
23						-11.0	Bottom	of Hole at 25'.					
30													
35													
JJ	Page 1: 0)-35 feet. E	ach subsequen	t page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
COHESIVE SOIL NON-COHESIVE SOIL RELATIVE PROPORTIONS					orer = -	oli Cara (DC)	LEGEND	lor	k	A Pag			
LOWS			BLOWS/FT	DENSITY	OF SOIL CO		Sa (A:	imple and	ck Core (RC) RQD (%) Sample (3 and Blow per 6" RE	SS) (U)-Shelby Tube, Counts (P)-Piston	Jar Sample (JS)	\triangleright	Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	SC MEDIUI 5 ST VERY	Y SOFT DFT M STIFF TIFF Y STIFF ARD	5 - 10 11 - 30 31 - 50	ERY LOOSE LOOSE DIUM DENSE DENSE ERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SON MOS	TLE RE TLY SU	SCRIPTION AND C	ET ENTITLED "KEY TO CLASSIFICATION OF RIALS" FOR ADDITION	BODING.	ЭТ	S -	024

								EST BOH	KING				
				PROJECT LOCATI			Coast Rail on, MA			BORING	T	S-	025
J	AU		BS	OWNER				ortation Author	rity	NO.			
				JOB NU		E2347			DRILLER				1 OF 1
	ECTOR			CONTRA		NH Bo		100	C. Knight	ELEVATI	ON	14	
0	METHOD			D/	GROUN ATE/TIME		ER READIN DEPTH(ft)		DRILL RIG SPT HAMMER	ATV CME - 550 140 lb Auto	DATUM GRID	N	NGVD 29 2791492
25		minated	w/Casing		/13/2010		2		tion (Casing pulled		COORD	E	769927
20							_		(5	-,	DATE ST		4/13/10
											DATE EN		4/13/10
OEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC.	ATION AND REMARK	S		
		6 3 3	S1	0.33 - 2.33	14	13.7		Concrete Slab. IL); non-plastic	silt, gray with dar	k brown, moist.			/
-5		7 11 13 12	S2	3 - 5	20	11.0	SANDY	SILT (ML); no	n-plastic silt, some	e fine sand, grayish	n brown, w	et.	
-10		3 4 5 5	S3	8 - 10	24	6.0	SILT (M	IL); slightly plas	stic silt, trace clay,	gray, wet.			
·15	<u> </u>	2 3 3 4	S4	13 - 15	24		SIMILAI	R TO S3; PP =	1.0 TSF.				
20	<u> </u>	2 2 3 3	S5	18 - 20	24		SIMILAI	R TO S3; PP =	0.75 TSF.				
-25	 	3 3 4	S6	23 - 25	18	-11.0	SIMILAI	R TO S3; PP =	0.75 TSF.				
20						11.0	Bottom	of Hole at 25'.					
30													
-35	Page 1: 0	0-35 feet. Ea	ach subsequent	t page displays 4	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTI	HERWIS	E NOTED.
COH	HESIVE SOIL	L	NON-COHES	SIVE SOIL		ATIVE				LEGEND			
LOWS/				DENSITY	PROP OF SOIL C	ORTIONS OMPONEN	utc 🗎 Au	ample and	ck Core (RC) RQD (%) Split-Spot Sample (\$ and Blow	SS) (U)-Shelby Tube, Counts (P)-Piston	Jar Sample (JS)	\backslash	Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	SC MEDIUI 5 ST VERY		5 - 10 11 - 30 31 - 50	ERY LOOSE LOOSE DIUM DENSE DENSE ERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SOM MOS	CE TLE RE TLY SU	FER TO THE SHEE	T ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITION/	ROPINI	<u>-</u> · · ·		025

								EST BOH	KIING				
	Λ		BS	PROJE LOCAT	ΓΙΟΝ	Taunto	Coast Rail on, MA	ortotics Assts	ei 4. ,	BORING	TS	S -	026
					.K JMBER	E2347		ortation Author	rity	NO.	SH	IFFT	1 OF 1
INSPI	ECTOR	T Teles	SCO		RACTOR	NH Bo			DRILLER	P. Rosinha	ELEVATION		14
	METHOD			OONT			R READIN	GS	DRILL RIG	TR CME 75	DATUM	<i>2</i> 1 1	NGVD 29
0			g w/Casing	a D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2791318
25		minated			4/13/2010		2	Upon Comple	tion (Casing pulle	d)	COORD	Е	769873
											DATE STA	ART	4/13/10
											DATE ENI	D	4/13/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	6		
							Top 4" (Concrete Slab,	then ~8" base co	urse.			
	φ	21	S1	1 - 3	5	13.0	SILTY S	SAND (SM); fin	e to medium sand	d, some non-plastic	silt, gray, v	vet.	
		21 11 7						· //		•	, 0 ,,		
		3	S2	3 - 5	8	11.0	I FAN C	CLAY (CL.): plas	stic clay some silt	t, gray, wet, PP = 1	25 TSF		
		3 3 5 5	02					· · (0-), p.a.	J. J	,, g,			
5													
		_											
		2	S3	8 - 10	22		SIMILA	R TO S2; PP =	0.75 TSF.				
		² 3 ₄											
10		_ +				4.0							
		3	S4	13 - 15	0		NO REC	COVERY					
		3 4 3 4	34	13 - 13			NOTIL	SOVERT					
15	[3											
		3334	S5	18 - 20	15		SILT (M	IL); slightly plas	stic silt, trace clay	, gray, wet, PP = 0.	75 TSF.		
		33,											
20		4											
		1	C6	22 25	14		CIMII AI	R TO S5.					
		45	S6	23 - 25	14		SIMILA	K 10 55.					
25		5				-11.0							
							Bottom	of Hole at 25'.					
30													
35													
55	Page 1:	0-35 feet. E	ach subseque	nt page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
	IFO: := -				REI	ATIVE				LEGEND			
COF	HESIVE SO	IL	NON-COHE	SIVE SOIL	PROP	ORTIONS		ner = 5	ok Coro (BC)		lar	K	A Bac
LOWS	/FT CONS	ISTENCY E	BLOWS/FT	DENSITY	OF SOIL C	OMPONEN	TS Au Sa (A:	imple and	ck Core (RC) RQD (%) C (%) Split-Spool Sample (\$ and Blow	SS) (U)-Shelby Tube.	Jar Sample (JS)	\rangle	Bag Sample (B)
0 - 2		Y SOFT		/ERY LOOSE	< 10%	TRA	CE	, <u> </u>	per 6" RE		\==/	<u>V</u> _	y (=)
3 - 4 5 - 8		OFT JM STIFF	5 - 10 11 - 30 Mi	LOOSE EDIUM DENSE	15 - 25% 30 - 45%	LITT	ne RE		T ENTITLED "KEY TO				
	5 S	TIFF	31 - 50	DENSE VERY DENSE	50 - 100%	MOS	TLY SU	BSURFACE MATE	LASSIFICATION OF RIALS" FOR ADDITION		<i>3</i> ⊤9	2	026
9 - 1: 16 - 3:	() (/LL)	Y STIFF						MBOLOGY.		NO.			UZO

Design Memorandum

APPENDIX B: LABORATORY DATA



a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Depth:

Location: Boring ID: ---

Project No: Tested By:

GTX-9764

Sample Type: --mmd Test Date: 05/03/10 Checked By: jdt Sample ID:---Sample Id:

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
FTS-4	S-2	S-2 4-6 ft Moist, black silt		42.4
FTS-11	S-1	0-2 ft	Moist, yellowish brown sandy silt	24
FTS-13	S-2	3-5 ft	Moist, yellowish brown silt	23.8
TS-2	S-3	9-11 ft	Moist, gray clay	32
TS-2	S-4	14-16 ft	Wet, light gray silt	37
TS-3	S-3	9-11 ft	Moist, gray clay	37.7
TS-7	S-3	8-10 ft	Wet, yellowish brown clay	36.5
TS-7	S-4	13-15 ft	Moist, gray clay	32.8
TS-11	S-2	3-5 ft	Moist, black silt with organics	26.1
TS-20	S-3	8-10 ft	Wet, gray silt	41.4
	<u> </u>			<u> </u>

Notes: Temperature of Drying: 110° Celsius

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA Project No: GTX-9764

Boring ID: --- Sample Type: --- Tested By: mmd
Sample ID:--- Test Date: 04/28/10 Checked By: jdt

Depth: --- Test Id: 178378

Moisture, Ash, and Organic Matter - ASTM D 2974

Boring ID	Sample ID	Depth	Description	Moisture Content,%	Ash Content,%	Organic Matter,%
FTS-4	S-2	4-6 ft	Moist, black silt	42	95.3	4.7
TS-11	S-2	3-5 ft	Moist, black silt with	26	92.2	7.8



Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass; dried to a constant mass at temperature of 110° C Ash content and organic matter determined by Method C; dried to constant mass at temperature 440° C

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA Project No: GTX-9764

Boring ID: TS-2 Sample Type: jar Tested By: jbr Sample ID:S-4 Test Date: 04/28/10 Checked By: jdt

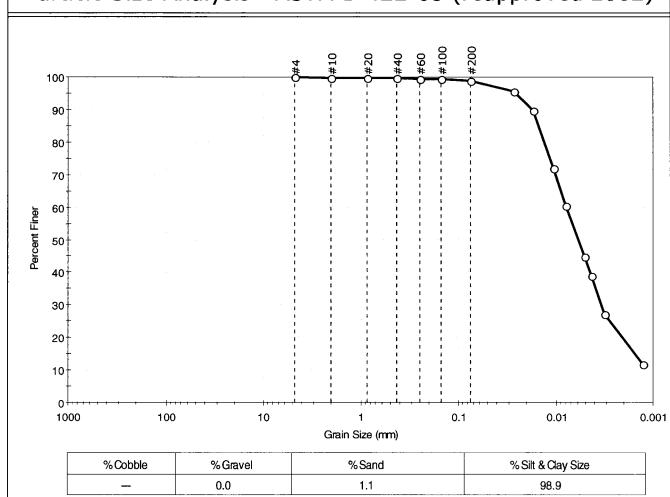
Depth: 14-16 ft Test Id: 178363

Test Comment: ---

Sample Description: Wet, light gray silt

Sample Comment: --

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100	 	
#60	0.25	100		
#100	0.15	99		
#200	0.075	99		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0266	95		
	0.0171	90		
	0.0106	72		
	0.0079	60		
	0.0051	45		
	0.0043	39		
	0.0031	27	T	

<u>Coefficients</u>							
D ₈₅ = 0.0151 mm	$D_{30} = 0.0034 \text{ mm}$						
D ₆₀ = 0.0078 mm	$D_{15} = 0.0015 \text{ mm}$						
D ₅₀ = 0.0059 mm	$D_{10} = 0.0012 \text{ mm}$						
$C_u = N/A$	C _c =N/A						

ASTM Silt (ML)

AASHTO Silty Soils (A-4 (3))

Sample/Test Description
Sand/Gravel Particle Shape: --Sand/Gravel Hardness: ---

0.0013



a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: TS-2 Sample Type: jar

Test Date: 04/29/10

Project No:

Tested By:

Checked By: jdt

GTX-9764

Depth: 14-16 ft Test Id: 178359

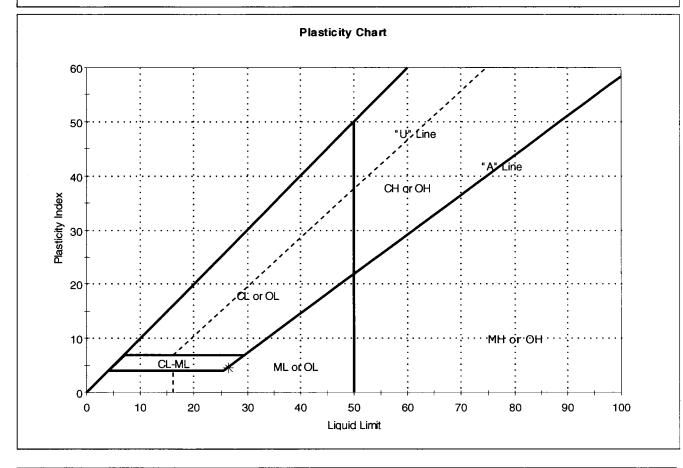
Test Comment: --

Sample ID:S-4

Sample Description: Wet, light gray silt

Sample Comment: ---

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-4	TS-2	14-16 ft	37	26	22	4	4	silt (ML)

Sample Prepared using the WET method

0% Retained on #40 Sieve Dry Strength: VERY HIGH

Dilentancy: SLOW Toughness: LOW

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. South Coast Rail Project:

Location:

Boring ID: TS-7 Sample Type: jar Tested By: jbr Sample ID:S-3 Test Date: 04/28/10 Checked By: jdt

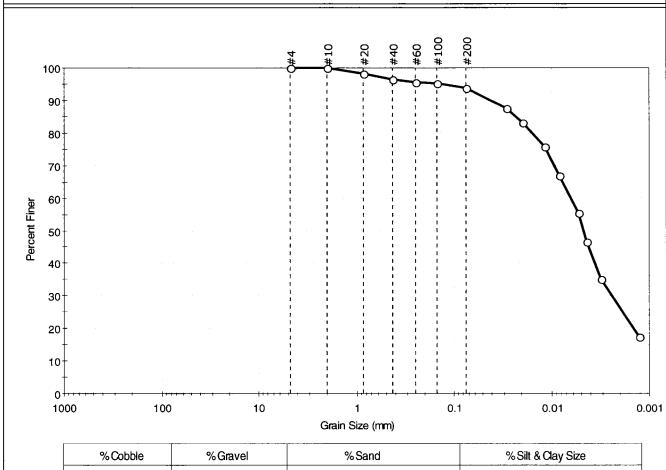
Depth: Test Id: 178364 8-10 ft

Test Comment:

Sample Description: Wet, yellowish brown clay

Sample Comment:

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	%Gravel	% Sand	% Silt & Clay Size
_	0.0	6.1	93.9

Sieve Name	Sieve Size,	Percent Finer	Spec. Percent	Complies
	mm			
#4	4.75	100		
#10	2.00	100		
#20	0.85	98		
#40	0.42	97		
#60	0.25	96		
#100	0.15	95		
#200	0.075	94		_
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0287	87		
	0.0198	83		
	0.0116	76		
	0.0084	67		
	0.0053	55		
	0.0044	47		
	0.0032	35		
	0.0013	17		

<u>Coefficients</u>				
D ₈₅ = 0.0233 mm	$D_{30} = 0.0024 \text{ mm}$			
D ₆₀ = 0.0063 mm	$D_{15} = N/A$			
D ₅₀ = 0.0047 mm	$D_{10} = N/A$			
Cu =N/A	$C_{c} = N/A$			

GTX-9764

Project No:

<u>Classification</u> lean clay (CL) <u>ASTM</u> AASHTO Clayey Soils (A-6 (11))

Sample/Test Description Sand/Gravel Particle Shape : -Sand/Gravel Hardness: ---



a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA
Boring ID: TS-7 Sample Type: jar

Sample ID:S-3 Test Date: 04/29/10 Checked By: jdt

Depth: 8-10 ft Test Id: 178360

Test Comment: ---

Sample Description: Wet, yellowish brown clay

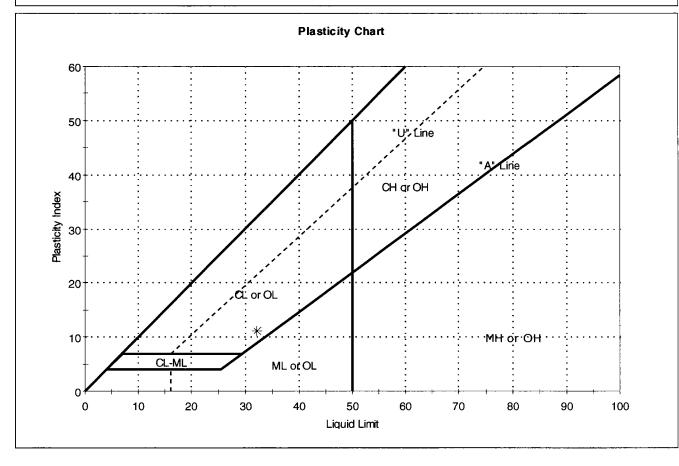
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

GTX-9764

Project No:

Tested By:



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-3	TS-7	8-10 ft	37	32	21	11	1	lean clay (CL)

Sample Prepared using the WET method

3% Retained on #40 Sieve Dry Strength: VERY HIGH

Dilentancy: SLOW Toughness: LOW

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: TS-20 Sample Type: jar Tested By: jbr Sample ID:S-3 Test Date: 04/28/10 Checked By: jdt

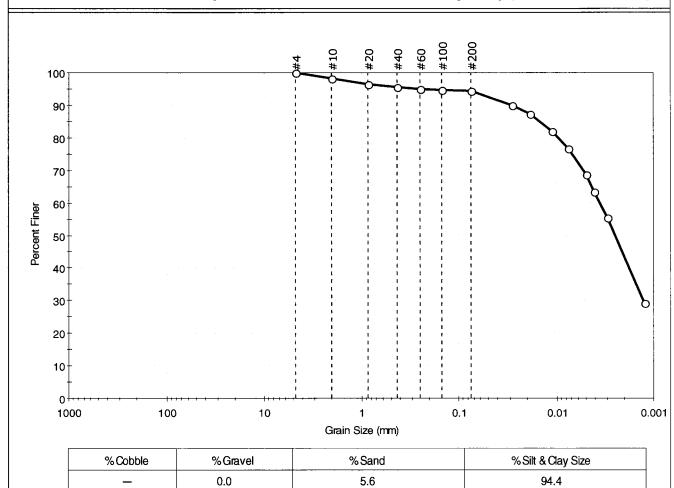
Depth: 8-10 ft Test Id: 178365

Test Comment: ---

Sample Description: Wet, gray silt

Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	98		
#20	0.85	96		
#40	0.42	95		
#60	0.25	95		
#100	0.15	95		
#200	0.075	94		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0291	90		
	0.0187	87		
	0.0112	82		
	0.0075	77		
	0.0049	69		
	0.0041	63		
	0.0030	56		
	0.0012	29		

<u>Coefficients</u>				
D ₈₅ = 0.0150 mm	$D_{30} = 0.0013 \text{ mm}$			
D ₆₀ = 0.0036 mm	$D_{15} = N/A$			
D ₅₀ = 0.0025 mm	$D_{10} = N/A$			
Cu =N/A	$C_C = N/A$			

Project No:

GTX-9764

<u>Classification</u> ASTM silt (ML)

AASHTO Silty Soils (A-4 (8))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape: --Sand/Gravel Hardness: ---

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location:

Boring ID: TS-20 Sample Type: jar Tested By: Sample ID:S-3 Test Date: 04/29/10 Checked By: jdt Depth: 8-10 ft Test Id:

Project No:

178361

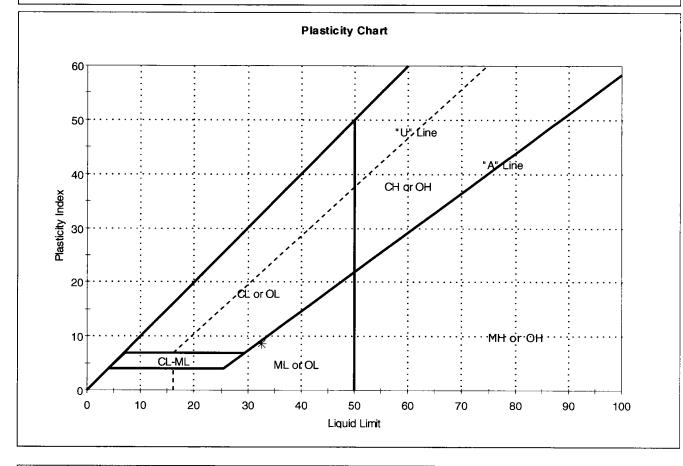
GTX-9764

Test Comment:

Sample Description: Wet, gray silt

Sample Comment:

Atterberg Limits - ASTM D 4318-05



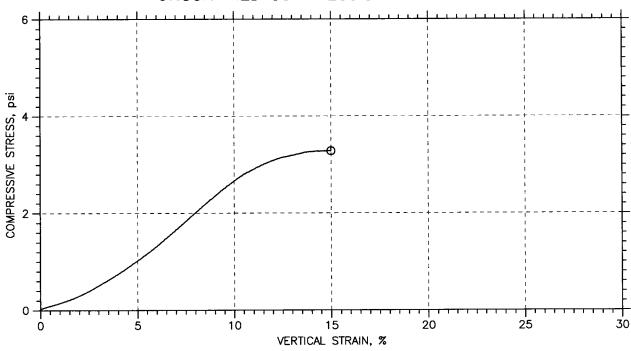
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-3	TS-20	8-10 ft	41	33	24	9	2	silt (ML)

Sample Prepared using the WET method

5% Retained on #40 Sieve Dry Strength: VERY HIGH

Dilentancy: SLOW Toughness: LOW

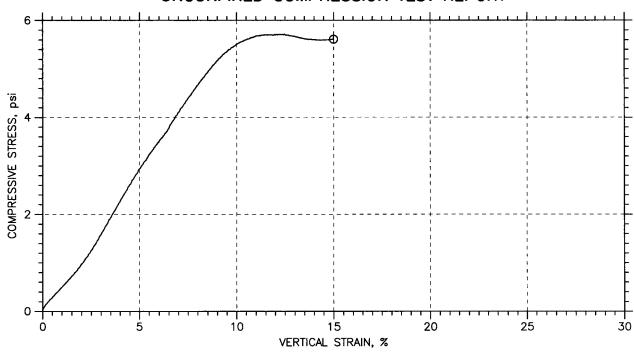
UNCONFINED COMPRESSION TEST REPORT - ASTM D 2166



Sy	mbol	0		
Те	st No.	UC-1		
	Diameter, in	1.5		
	Height, in	3.1		
<u>=</u>	Water Content, %	35.84		
Initial	Dry Density, pcf	83.57		
	Saturation, %	95.16		
	Void Ratio	1.02		
Ur	nconfined Compressive Strength, psi	3.285		
Ur	ndrained Shear Strength, psi	1.642		
Ti	ne to Failure, min	14.425		
St	rain Rate, %/min	1		
Es	timated Specific Gravity	2.70		
Li	quid Limit			
PI	astic Limit			
PI	asticity Index			
Fo	ilure Sketch			

	Project: South Coast Rail
	Location: MA
GeoTestina	Project No.: GTX-9764
express	Boring No.: TS-3
a subsidiary of Geocomp Corporation	Sample Type: tube
	Description: Moist, gray clay
	Remarks: System Q - Depth: 8-10 ft

UNCONFINED COMPRESSION TEST REPORT - ASTM D 2166



Sy	mbol	0		
Test No.		UC-2		
	Diameter, in	1.52		
	Height, in	3.29		
Initial	Water Content, %	32.39		
Ē	Dry Density, pcf	89.85		
	Saturation, %	99.83		
	Void Ratio	0.876		
Ur	confined Compressive Strength, psi	5.716		
Ur	ndrained Shear Strength, psi	2.858		
Tir	ne to Failure, min	14.091		
St	rain Rate, %/min	1		
Es	timated Specific Gravity	2.70		
Lic	quid Limit			
PΙ	astic Limit			
PΙ	asticity Index			
Fo	ilure Sketch			

	Project: South Coast Rail
	Location: MA
GeoTestina	Project No.: GTX-9764
express	Boring No.: TS-24
a subsidiary of Geocomp Corporation	Sample Type: tube
	Description: Moist, gray clay
	Remarks: System Q - Depth: 8-10 ft

Design Memorandum

APPENDIX C: GEOTECHNICAL CALCULATIONS

- Allowable Bearing Capacity and Estimated Settlement
- Seismic Site Class Evaluation





JOB	MBTA South Coast Rail				
SUBJECT	Taunton Station				
CALCULATED BY	DH	2/10/2012			
CHECKED BY	AH/PJM	2/14/2012			

PURPOSE: Evaluate bearing resistance for platform shallow foundations.

REFERENCE: AASHTO LRFD Bridge Design Specifications, 2010

ASSUMPTIONS: - Platform footing is 7 ft wide by 10 ft long.

- Bearing surface is compacted Gravel Borrow overlying poorly graded sand (SP) or sandy silt (ML).
- Footing embedment is at least 4 feet below ground surface.
- Groundwater level is at 6 feet below surface.Footing eccentricity is assumed to be zero.
- Estimated soil properties (experience, geotech literature, Table 10.4.6.2.4-1):

Gravel Borrow:

γ (pcf)	ф
125	34

BEARING CAPACITY FACTORS (Table 10.6.3.1.2a-1):

	ф	N _c	N_q	N_{γ}
Gravel Borrow:	34	42.2	29.4	41.1

CALCULATE EFFECTIVE FOOTING WIDTH (B'):

e < B/4 (Section 10.6.3.3)

where: B = footing width (ft) = 7

e = eccentricity (ft)

Assume no footing eccentricity, thus, e = 0

B' = B-2e 7

NOMINAL BEARING RESISTANCE (q_n):

 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B' N_{\gamma m} C_{w\gamma}$ (Eqn. 10.6.3.1.2a-1)

where: c = cohesion = 0

 γ = total unit weight 125

 D_f = depth of footing (ft) = 4 Assumed

 $B' = \text{effective width of footing (ft)} = \qquad \qquad 7$ $L = \text{length of footing (ft)} = \qquad \qquad 10$

B'/L = 0.70 $D_t/B' = 0.57$

 $C_{wq} C_{wv} = groundwater correction factors$ (using B')

 $C_{wq} = 1.0$ (Table 10.6.3.1.2a-2) $C_{wy} = 0.6$ (Table 10.6.3.1.2a-2)

 $N_{cm} N_{qm} N_{ym}$ = bearing capacity factors

 $N_{am} = N_a s_a d_a i_a$ (Eqn. 10.6.3.1.2a-3)

 $s_q = 1.47$ (Table 10.6.3.1.2a-3)

 $d_{q} = \frac{1.20}{\text{(Table 10.6.3.1.2a-4)}}$

 $i_q = 1.0$ (see AASHTO p. 10-62)

 $N_{qm} = 51.9$





 JOB
 MBTA South Coast Rail

 SUBJECT
 Taunton Station

 CALCULATED BY
 DH
 DATE
 2/10/2012

 CHECKED BY
 AH/PJM
 DATE
 2/14/2012

$$N_{\gamma m} = N_{\gamma} s_{\gamma} i_{\gamma}$$

$$s_{\gamma} = 0.72$$
 (Table 10.6.3.1.2a-3)

$$i_{\gamma}$$
 = 1 (see AASHTO p. 10-62)

$$N_{ym} = 29.6$$

$$q_n = 33,737$$
 psf

ALLOWABLE BEARING RESISTANCE (qa):

$$q_a = q_n/FOS$$

where: FOS = factor of safety = 2.5 for granular soil

 $q_a = 13,495$ psf

use

q_a = 13.49 ksf strength limit value

Note: Based on the existence of underlying clay/silt soils, an allowable bearing capacity of 3 ksf is recommended.

Elastic Settlement Calculations:

$$S_s = \frac{\left(q_o (1 - v^2)\sqrt{A'}\right)}{144E_s\beta_z}$$
 eqn. 10.6.2.4.2-1

where: $q_o = applied vert. stress (ksf)$

v = Poisson's Ratio

 E_s = Young's Modulus (ksi) β_z = Shape/Rigidity Factor

		_
v = Poisson's Ratio =	0.30	(Table C10.4.6.3-1)
E_s = Young's Modulus (ksi) =	6.00	(Table C10.4.6.3-1)
$\beta_z = \text{Shape/Rigidity Factor} =$	1.08	(Table 10.6.2.4.2-1)

where:B' = eff. width of footing (ft) =7(from bearing resistance calcs)L = length of footing (ft):10(from bearing resistance calcs)A' = (B'xL) = footing area (ft²):70ft²

Settlement (S_e) for a given q_o:

q_o = applied vertical stress (ksf) = 3.00 ksf (assumed)

Se (inches) = 0.29 inches



JOB_	MBTA South Coast Rail				
SUBJECT	Taunton Station				
CALCULATED BY	DH DATE 2/10/2012				
CHECKED BY	AH/PJM	DATE	2/14/2012		

Taunton Station - Consolidation Settlement Calculation

Platform Boring	TS-1	TS-2	TS-3	TS-4	TS-5	
Existing Ground Elevation (ft)	19	18	17	16	16	
Assumed Groundwater Elevation (ft)	13	12	11	10	10	
Assumed New Fill Height (ft)	3.2	3.9	4.6	5	4.3	
Assumed Final Ground Elevation (ft)	22.2	21.9	21.6	21	20.3	
Assumed Bottom of Footing Elevation (ft)	18.2	17.9	17.6	17	16.3	
Fill Surcharge (ksf)	0.38	0.47	0.55	0.60	0.52	
Soft Layer Top Elevation(ft)	9.5	8	8	6	3	
Soft Layer Bottom Elevation(ft)	-18	-1	-17	-12	-17	
Soft Layer Midpoint Elevation(ft)	-4.25	3.5	-4.5	-3	-7	
Thickness of Soft Layer (ft)	27.5	9	25	18	20	
Enlarged B (ft)	29.45	21.40	29.10	27.00	30.30	
Enlarged L (ft)	32.45	24.40	32.10	30.00	33.30	
Enlarged Compression Area (ft ²)	955.65	522.16	934.11	810.00	1008.99	
Footing Surcharge at the midpoint of soft layer (ksf)	0.12	0.22	0.12	0.14	0.12	
Initial Vertical Stress at Midpoint (ksf)	1.71	1.21	1.61	1.47	1.70	
Final Vertical Stress at Midpoint (ksf)	2.22	1.90	2.29	2.21	2.33 < P	Overconsolidated
RR	0.038	0.038	0.038	0.038	0.038	
Consolidation Settlement (inches)	1.42	0.81	1.74	1.47	1.26	

Assumptions:

- 1. Assume groundwater level is at 6 feet below existing ground surface.
- 2. Use 2:1 method to calculate the surcharge at the midpoint of the clay layer.
- 3. PI value from lab test data of TS-2, S4 was applied to all borings.
- 4. RR value based on lab test data of TS-2, S4 was applied to all borings.



Assumptions (Cont'd):

B' = effective width of footing =

L = length of footing =

P = vertical load at bottom of footing =

Weight of Excavated Soil =

Footing Surcharge at bottom of footing =

c_{min} = minimum cohesion =

PI = plasticity index =

PL = plastic limit =

w = water content =

P_c = preconsolidation pressure =

RR = recompression ratio =

Equations used in the calculations:

$$\delta_c = \frac{C_c}{1 + e_o} H \log \left(\frac{\sigma_{vf}}{\sigma_{vo}} \right)$$

$$C = \frac{1 + e_o}{C_o}$$

$$\delta_c = \frac{1}{C} H \log \left(\frac{\sigma_{vf}}{\sigma_{vo}} \right)$$

$$P_c = \frac{c}{0.1 + 0.004PI}$$

$$RR = 0.001598 + 0.0007160w + 0.0004613PL$$



Taunton Station Seismic Site Class Evaluation

Based on the platform boring with the deepest soil overburden and lowest average blow counts (worst case)

Boring No.	Sample No.	N Value	Di	Di/N _i	N_{bar}
TS-03	S-1	6	4	0.67	
	S-2	11	5	0.45	
	S-3	11	5	0.45	
	S-4	5	5	1.00	
	S-5	7	5	0.71	18
	S-6	6	5	0.83	
	S-7	7	5	0.71	
	S-8	25	4	0.16	
	Bedrock	100	62	0.62	
					-
					1
	Total Depth =	100			
De	epth to Bedrock =	38	Sum =	5.62	

Per 9.4.1.2.1, 15 < N_{bar} < 50, Site Class D

9.4.1.2.1 Site Class Definitions. The site shall be classified as one of the following classes:

A = Hard rock with measured shear wavevelocity, $\overline{v}_s > 5000 \text{ ft/s} (1500 \text{ m/s})$

 $B = \text{Rock with } 2500 \text{ ft/s} < \overline{\mathbf{v}}_{s} \le 5000 \text{ ft/s} (760 \text{ m/s} < \overline{\mathbf{v}}_{s} \le 1500 \text{ m/s})$

C = Very dense soil and soft rock with 1200 ft/s $\leq \overline{v}_g \leq 2500$ ft/s (370 m/s $\leq \overline{v}_g \leq 760$ m/s) or \overline{N} or $\overline{N}_{ch} \geq 50$ or $\overline{s}_u \geq 2000$ psf (100 kPa)

 $D = \text{Stiff soil with 600 ft/s} \le \overline{v}_s \le 1200 \text{ ft/s}$ $(180 \text{ m/s} \le \overline{v}_s \le 370 \text{ m/s}) \text{ or with } 15 \le \overline{N} \text{ or } \overline{N}_{ch} \le 50 \text{ or } 1000 \text{ psf} \le \overline{s}_u \le 2000 \text{ psf} (50 \text{ kPa} \le \overline{s}_u \le 100 \text{ kPa})$

E= A soil profile with $\overline{\mathbf{v}}_{s} < 600$ ft/s (180 m/s) or any profile with more than 10 ft (3 m) of soft clay. Soft clay is defined as soil with PI > 20, $w \ge 40\%$, and $s_u < 500$ psf (25 kPa)

F =Soils requiring site-specific evaluations:

 Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. Potential for liquefaction shall be evaluated in accordance with 780 CMR 1804.6: Liquefaction.

Exception. None.

- 2. Peats and/or highly organic clays (H > 10 ft [3 m] of peat and/or highly organic clay where H = thickness of soil).
- 3. Very high plasticity clays (H > 25 ft [7.6 m] with PI > 75).
- 4. Very thick soft/medium stiff clays (H>120 ft [37 m].

Exception. None.

Approx. Project Coordinates

Lat 41.905783 Long -71.080822

Seismic Coefficients

 $S_S = 0.24 \text{ (Table 1604.10*)}$ $S_1 = 0.062 \text{ (Table 1604.10*)}$

For Site Class D

 $F_A =$ 1.6 (See Table 9.4.1.2.4a*) $F_V =$ 2.4 (See Table 9.4.1.2.4b*)

Design Spectral Response Parameters

 $S_{MS} = Ss \times F_A = 0.384$ $S_{M1} = S_1 \times F_V = 0.149$

 $S_{DS=2/3} \times S_{MS} = 0.256$ $S_{D1=2/3} \times S_{M1} = 0.099$

Notes: * The Massachusetts State Building Code, 8th Edition (2010)

TABLE 9.4.1.2.4 α VALUES OF F $_a$ AS A FUNCTION OF SITE CLASS AND SHORT PERIOD MAXIMUM CONSIDERED EARTHQUAKE SPECTRAL ACCELERATION

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at Short Periods					
	$S_S \leq 0.26$	$0.27 \le S_S \le 0.29$	$0.30 \le S_S \le 0.32$	$0.33 \le S_S \le 0.35$	$0.36 \le S_S \le 0.38$	$S_{\rm S} \ge 0.39$
A	0.8	0.8	0.8	0.8	0.8	0.8
В	1.0	1.0	1.0	1.0	1.0	1.0
С	1.2	1.2	1.2	1.2	1.2	1.2
D	1.6	1.6	1.55	1.5	1.5	1.5
Е	2.5	2.4	2.3	2.2	2.1	2.0
F	Note a	Note a	Note a	Note a	Note a	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F₂ for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

TABLE 9.4.1.2.4b VALUES OF F, AS A FUNCTION OF SITE CLASS

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at 1-Second Periods
	$S_1 \leq 0.1$
A	0.8
В	1.0
C	1.7
D	2.4
E	3.5
F	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_{ν} for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS THE MASSACHUSETTS STATE BUILDING CODE

TABLE 1604.10 GROUND SNOW LOADS; BASIC WIND SPEEDS; EARTHQUAKE DESIGN FACTORS

(For R-3 of three stories or less one- and two-family stand alone buildings, see 780 CMR 53.00 for snow and wind loads)

	Ground Snow	Basic Wind	Earthquake Design Factors		
City/Town	$\begin{array}{c} \textbf{Load} \\ \textbf{p}_{g}, \textbf{psf} \end{array}$	Speed V, MPH	Ss	\mathbf{S}_1	
Rochester	45	110	0.23	0.059	
Rockland	45	110	0.26	0.064	
Rockport	45	110	0.33	0.073	
Rowe	65	100	0.22	0.069	
Rowley	55	110	0.34	0.075	
Royalston	65	100	0.25	0.070	
Russell	65	100	0.23	0.066	
Rutland	55	100	0.24	0.068	
Salem	45	110	0.31	0.071	
Salisbury	55	110	0.35	0.077	
Sandisfield	65	90	0.23	0.066	
Sandwich	35	120	0.22	0.058	
Saugus	45	110	0.30	0.070	
Savoy	65	90	0.22	0.068	
Scituate	45	110	0.27	0.065	
Seekonk	55	110	0.24	0.062	
Sharon	55	100	0.25	0.065	
Sheffield	65	90	0.23	0.066	
Shelburne	65	100	0.23	0.068	
Sherborn	55	100	0.26	0.066	
Shirley	65	100	0.28	0.072	
Shrewsbury	55	100	0.25	0.067	
Shutesbury	65	100	0.23	0.068	
Somerset	55	110	0.23	0.060	
Somerville	45	105	0.28	0.069	
South Hadley	55	100	0.23	0.066	
Southampton	55	100	0.23	0.066	
Southborough	55	100	0.26	0.067	
Southbridge	55	100	0.23	0.064	
Southwick	55	100	0.23	0.065	
Spencer	55	100	0.23	0.066	
Springfield	55	100	0.23	0.065	
Sterling	55	100	0.26	0.069	
Stockbridge	65	90	0.22	0.066	
Stoneham	45	105	0.30	0.071	
Stoughton	55	100	0.26	0.065	
Stow	55	100	0.27	0.069	
Sturbridge	55	100	0.23	0.065	
Sudbury	55	100	0.27	0.069	
Sunderland	65	100	0.23	0.068	
Sutton	55	100	0.24	0.065	
Swampscott	45	110	0.30	0.070	
Swansea	55	110	0.24	0.061	
Taunton Taunton	55	110	0.24	0.062	
Templeton	65	100	0.25	0.070	
Tewksbury	55	100	0.31	0.073	
Tisbury	35	120	0.18	0.052	
Tolland	65	100	0.23	0.066	
Topsfield	45	110	0.33	0.074	
Townsend	65	100	0.28	0.072	
Truro	35	120	0.22	0.057	

Stormwater Report

Taunton Depot Station

City of Taunton, Massachusetts

Prepared for

massDOT

Massachusetts Department of Transportation 10 Park Plaza Boston, Massachusetts





Transportation, Land Development, Environmental Services 99 High Street Boston, Massachusetts 02110 617 728 7777

June 2012



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Checklist for Stormwater Report



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.





A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals. This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

Taunton Depot_DEP Stormwater Checklist • 04/01/08

¹ The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

² For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

rmwater Report accurately reflects conditions at the site as of the date of this permit application.
gistered Professional Engineer Block and Signature
Signature and Date
Checklist
rject Type: Is the application for new development, redevelopment, or a mix of new and evelopment?
New development
Redevelopment
Mix of New Development and Redevelopment



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

\boxtimes	No disturbance to any Wetland Resource Areas
	Site Design Practices (e.g. clustered development, reduced frontage setbacks)
	Reduced Impervious Area (Redevelopment Only)
\boxtimes	Minimizing disturbance to existing trees and shrubs
	LID Site Design Credit Requested:
	☐ Credit 1
	☐ Credit 2
	☐ Credit 3
\boxtimes	Use of "country drainage" versus curb and gutter conveyance and pipe
\boxtimes	Bioretention Cells (includes Rain Gardens)
	Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
	Treebox Filter
	Water Quality Swale
\boxtimes	Grass Channel
	Green Roof
	Other (describe):
Sta	ndard 1: No New Untreated Discharges
\boxtimes	No new untreated discharges
	Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
	Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



Checklist for Stormwater Report

Checklist (continued)
Standard 2: Peak Rate Attenuation
 Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding. Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
□ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.
Standard 3: Recharge
☐ Soil Analysis provided.
Required Recharge Volume calculation provided.
Required Recharge volume reduced through use of the LID site Design Credits.
☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.
☐ Static ☐ Simple Dynamic ☐ Dynamic Field ¹
☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.
Runoff from all impervious areas at the site is <i>not</i> discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
Recharge BMPs have been sized to infiltrate the Required Recharge Volume <i>only</i> to the maximum extent practicable for the following reason:
☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
☐ Solid Waste Landfill pursuant to 310 CMR 19.000
Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



Checklist for Stormwater Report

Cł	necklist (continued)
Sta	ndard 3: Recharge (continued)
	The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
	Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.
Sta	ndard 4: Water Quality
The	E Long-Term Pollution Prevention Plan typically includes the following: Good housekeeping practices; Provisions for storing materials and waste products inside or under cover; Vehicle washing controls; Requirements for routine inspections and maintenance of stormwater BMPs; Spill prevention and response plans; Provisions for maintenance of lawns, gardens, and other landscaped areas; Requirements for storage and use of fertilizers, herbicides, and pesticides; Pet waste management provisions; Provisions for operation and management of septic systems; Provisions for solid waste management; Snow disposal and plowing plans relative to Wetland Resource Areas; Winter Road Salt and/or Sand Use and Storage restrictions; Street sweeping schedules; Provisions for prevention of illicit discharges to the stormwater management system; Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL; Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan; List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
	A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent. Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge: is within the Zone II or Interim Wellhead Protection Area
	is near or to other critical areas
	is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
	involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

applicable, the 44% TSS removal pretreatment requirement, are provided.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if



Checklist for Stormwater Report

Cł	necklist (continued)
Sta	andard 4: Water Quality (continued)
	The BMP is sized (and calculations provided) based on:
	☐ The ½" or 1" Water Quality Volume or
	☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
	The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
	A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.
Sta	ndard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)
	The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report. The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted <i>prior to</i> the discharge of stormwater to the post-construction stormwater BMPs.
	The NPDES Multi-Sector General Permit does <i>not</i> cover the land use.
	LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
	All exposure has been eliminated.
	All exposure has <i>not</i> been eliminated and all BMPs selected are on MassDEP LUHPPL list.
	The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.
Sta	ndard 6: Critical Areas
	The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
	Critical areas and BMPs are identified in the Stormwater Report.



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

	ndard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum ent practicable
Ш	The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
	☐ Limited Project
	☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
	Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
	Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
	☐ Bike Path and/or Foot Path
	☐ Redevelopment Project
	Redevelopment portion of mix of new and redevelopment.
	Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
	The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

	Indard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control ntinued)
	The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has <i>not</i> been included in the Stormwater Report but will be submitted <i>before</i> land disturbance begins.
	The project is <i>not</i> covered by a NPDES Construction General Permit.
	The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
	The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.
Sta	indard 9: Operation and Maintenance Plan
	The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
	☐ Name of the stormwater management system owners;
	☐ Party responsible for operation and maintenance;
	☐ Schedule for implementation of routine and non-routine maintenance tasks;
	☐ Plan showing the location of all stormwater BMPs maintenance access areas;
	☐ Description and delineation of public safety features;
	☐ Estimated operation and maintenance budget; and
	☐ Operation and Maintenance Log Form.
	The responsible party is <i>not</i> the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
	A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
	A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.
Sta	ndard 10: Prohibition of Illicit Discharges
\boxtimes	The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
	An Illicit Discharge Compliance Statement is attached;
	NO Illicit Discharge Compliance Statement is attached but will be submitted <i>prior to</i> the discharge of any stormwater to post-construction BMPs.



Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00).

Project Description

The Applicant, MassDOT, is proposing to construct a commuter rail station (the Project) at Taunton Depot Shopping Mall, Taunton Depot Drive in Taunton, Massachusetts along the New Bedford Main Line. As proposed, the Project will require approximately 13 acres of land acquisition, of which approximately 6 acres will be developed for the new station, with the remaining land mostly vegetated wetlands. The Project will involve a center platform with canopy, ancillary landscape improvements, 398 parking spaces, a pick up/drop off area, bicycle parking facilities, and utility improvements to support this use. The Project will also construct a sidewalk that connects the station to the existing sidewalk on Taunton Depot Drive and to the Taunton Gardens apartment complex.

The site is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is not a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Site Description

The Project Site consists of approximately 6 acres of land (the Site) located at Taunton Depot Drive in Taunton, Massachusetts (see Figure 1 & 2). Vegetated wetlands surround the Site on south, west, and north sides with the New Bedford Main Line tracks to the west of the wetlands. The Site is west of the Taunton Depot Shopping Center and is bound by retail buildings to the east and vegetated area and wetlands to the north, west, and south. The New Bedford Main Line tracks are on an elevated berm to the west, just beyond the wetlands. There is an existing stormwater basin for the shopping center drainage system located to the immediate southeast of the Site. A paved driveway leads to a pump station in the northwest corner of the Site and there are many dirt paths throughout the Site. See Figure 1, Site Locus Map.

Wetland Resource Areas on the Site, shown in Figures 3 and 4, are described in Table 1. For additional information regarding the wetland resource areas present on the site see the Abbreviated Notice of Resource Area Delineation (ANRAD) prepared by VHB dated May 2011.



Taunton Depot Station

Table 1 Wetland Resource Areas

Name	Critical Area	Zone 1 or Zone A	ORW or SRW	Zone II or IWPA	Description
Wetland 1 (TCM-7 East)	No	No	No	No	PFO/PEM
Wetland 3	No	No	No	No	Deep Marsh

Notes: Wetland Classifications: PEM = Palustrine Emergent, PFO = Palustrine Forested

According to the National Resources Conservation Service (NRCS), surface soils on the Site include Deerfield loamy sand, Scarboro mucky loamy fine sand, Whitman fine sandy loam, and Hinckley sandy loam, and are classified as Hydrologic Soil Groups (HSG) B, D, D, and A, respectively. Based on the soil evaluation, the Site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour). Most of the Site has A and B soils which, according to 1982 Rawls Rates, infiltration rates for the soils will be approximately 1.02 inches per hour.

The project is not located within the 100-year flood plain as shown on FEMA Floodway Map, City of Taunton, Massachusetts Bristol County, Community Panel number 25005C0164F dated July 7, 2009, included in Appendix B.

Existing Drainage Conditions

Under existing conditions, the Site consists of mostly cleared, undeveloped land, and is generally surrounded by vegetated wetlands. The Site is primarily dirt and gravel with some pockets of scrub shrubs and grass. There are dirt paths throughout the site and a paved driveway is in the northeast corner of the Site. Runoff sheet flows across the Site, resulting in considerable erosion and deposition into the wetlands. Groundwater is high throughout the Site, ranging from one to four feet below grade in the upland area. For the existing conditions hydrologic analysis, the site was divided into two drainage areas that contribute to two design points. The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This approximately 5.0-area comprises the majority of the Site and stretches from the northeast portion of the Site, across the northern and western parts, to the southwestern edge. The area consists of bare earth dirt and gravel with many pockets of sparse grass and a few clumps of saplings. Runoff from Drainage Area 1 flows in a westerly direction to Wetland 1 on the west side of the site.

<u>Drainage Area 2</u> – This approximately 1.0-acre area in the southeast portion of the Site consists of bare earth dirt and gravel with many pockets of sparsely grassed landscape. Lightly wooded areas are minimally present as well. Runoff from Drainage Area 2 flows in a southerly direction to Wetland 2 on the south side of the site.



Taunton Depot Station

Figure 3 illustrates the existing drainage patterns on the Site. Table 2 below provides a summary of the existing conditions hydrologic data.

Table 2
Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland 1	1	4.97	67	13.3
2	Wetland 3	2	0.99	63	9.1

Proposed Drainage Conditions

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into five drainage areas that discharge treated stormwater to the two existing Design Points. The runoff from the paved areas is split between three drainage areas that flow to three lined bioretention basins, used to control peak rates and treat the stormwater. Existing drainage and grading patterns were maintained to the maximum extent possible. Drainage Areas 1, 2, and 4 flow to Design Point 1 and Drainage Areas 3 and 5 flow to Design Point 2. Low impact development stormwater management techniques have been incorporated into the design. These practices are focused on decentralizing stormwater management techniques into the design that will reduce peak runoff rates and treat for water quality. Water quality basins are dispersed around the perimeter of the development area. The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This 1.99-acre area in the northern portion of the site consists of a paved parking area for the station and Bioretention Basin 1 to the north of the parking. Runoff from Drainage Area 1 is directed through drainage grates in the sidewalk to Bioretention Basin 1, which discharges to Wetland 1.

<u>Drainage Area 2</u> – This 1.35-acre area in the southern portion of the site consists of a paved parking area for the station and Bioretention Basin 2 to the south of the parking. Runoff from Drainage Area 2 is directed to Bioretention Basin 2, which discharges to Wetland 1.

<u>Drainage Area 3</u> – This 1.35-acre area in the east portion of the site consists of the entrance drive, some of the paved parking for the station, grassed landscape area, and Bioretention Basin 3 to the south of the parking. Runoff from Drainage Area 3 is directed to a grassed swale that flows to Bioretention Basin 3, which discharges to Wetland 3.



Taunton Depot Station

<u>Drainage Area 4</u> – This 1.00-acre area wraps around the perimeter of the site from the northeast corner, around the northwest portion of the Site, to the southwest corner. The area consists mostly of sloped grassed areas but also includes the new paved entranceway to the pump station. Runoff from the new pavement is captured by a grassed swale which flows to Wetland 1. Runoff from the rest of Drainage Arera 4 flows directly to Wetland 1.

<u>Drainage Area 5</u> – This 0.29-acre area wraps around the southeastern perimeter of the site and consists of sloped grassed areas. Runoff flows directly to Wetland 3.

Table 3 below provides a summary of the proposed conditions hydrologic data.

Table 3
Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland 1	1	1.99	92	5.0
2	Wetland 1	1	1.35	97	5.0
3	Wetland 3	2	1.35	77	5.3
4	Wetland 1	1	1.00	66	5.0
5	Wetland 3	2	0.29	65	8.9

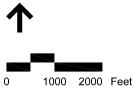
Integrated into the site design is a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. The proposed stormwater management system has been designed to treat the half inch Water Quality Volume.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include:

- Bioretention basins
- Light colored pavement sidewalks
- Grassed swale

Most of the runoff from Drainage Area 3 will sheet flow to a grass swale before it is connected to bioretention Basin 3. The bioretention basins have been designed with soils to mimic the hydrology of the existing conditions in the upland areas



Taunton, Massachusets



Site Aerial Map

Taunton Depot Station South Coast Rail Taunton, Massachusets

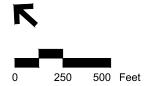


Figure 2 May 2012

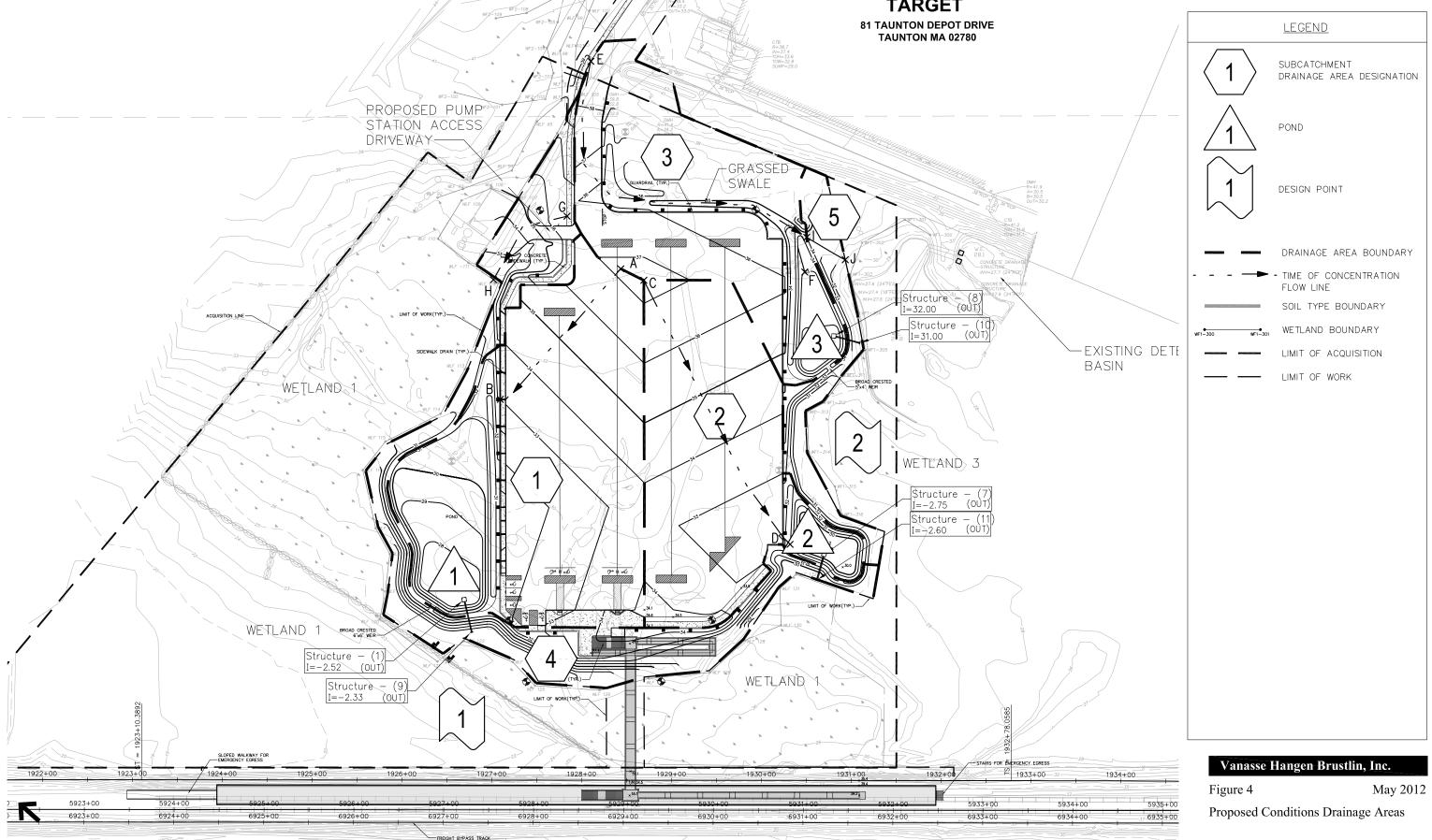
60 ___ 120 Feet

Figure 3

May 2012

Existing Conditions Drainage Areas

South Coast Rail Taunton, Massachusetts



(PXX)

100 Feet

South Coast Rail Taunton, Massachusetts



Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards at 310 CMR 10.05.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Drainage basin outlets have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMPs that impound stormwater have been designed with stone to protect downgradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to fully comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 100-years. The results of the analysis, as summarized in Table 4 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.



Taunton Depot Station

Table 4
Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	100-year
Design Point 1: Wetland 1			
Existing	3.1	7.2	15.2
Proposed	3.0	5.3	10.9
Design Point 2: Wetland 3			
Existing	0.5	1.3	3.0
Proposed	0.4	1.0	2.9

Standard 3: Stormwater Recharge

As described in the site description, the existing surface soils on the Site are comprised primarily of HSG B soils and provide an infiltration rate of approximately 1.02 inches per hour, according to 1982 Rawls Rates. In addition to the soil parameters, the Site has both a flat geography and a seasonal high groundwater table approximately one foot below existing grade that hinder the ability to provide the required two foot separation between the bottom of an infiltration structure and the seasonal high groundwater table. In existing conditions, however, infiltration on the site provides subsurface flow to wetland resource areas along the Site's border.

In an effort to mimic the Site's natural hydrology and meet the intent of the recharge requirements of Standard 3, the onsite bioretention basins have been oversized for treatment and exceed the Required Recharge Volume. The bioretention basins are required to be lined due to the elevation of the seasonal high groundwater table that does not allow for a separation of greater than two feet from the bottom of the bioretention basins. The soil within the bioretention basins however will be designed to approximate the infiltration rates of the existing soils (1.02 inches per hour) and provide two feet of depth in order to mimic the necessary separation from the seasonal high groundwater table and exceed that of existing conditions. After runoff is filtered through the two feet of biofiltration soil media, underdrains within the bioretention basins will slowly convey water to the wetland resource areas that surround the site, mimicking the base flows to the wetlands provided by the subsurface flows of the existing conditions.

A Geotechnical Report is included in Appendix E. The report indicates that the site has high groundwater so the basins will be lined.



Taunton Depot Station

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide a minimum of 80% TSS removal for stormwater runoff from all proposed impervious surfaces.

Computations and supporting information are included in Appendix D.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is not considered a LUHPPL as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is not a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is not a redevelopment.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project would disturb approximately 6.0 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPP) would be developed and a Notice of Intent for the CGP would be submitted by the contractor and owner at least 14 days before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls were discussed in the DEIR/S. Appropriate controls will be prepared and implemented by the contractor and MassDOT (MBTA) during construction in accordance with the final design and NPDES SWPPP.



Taunton Depot Station

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan will be developed by the MBTA during final design for the Project.

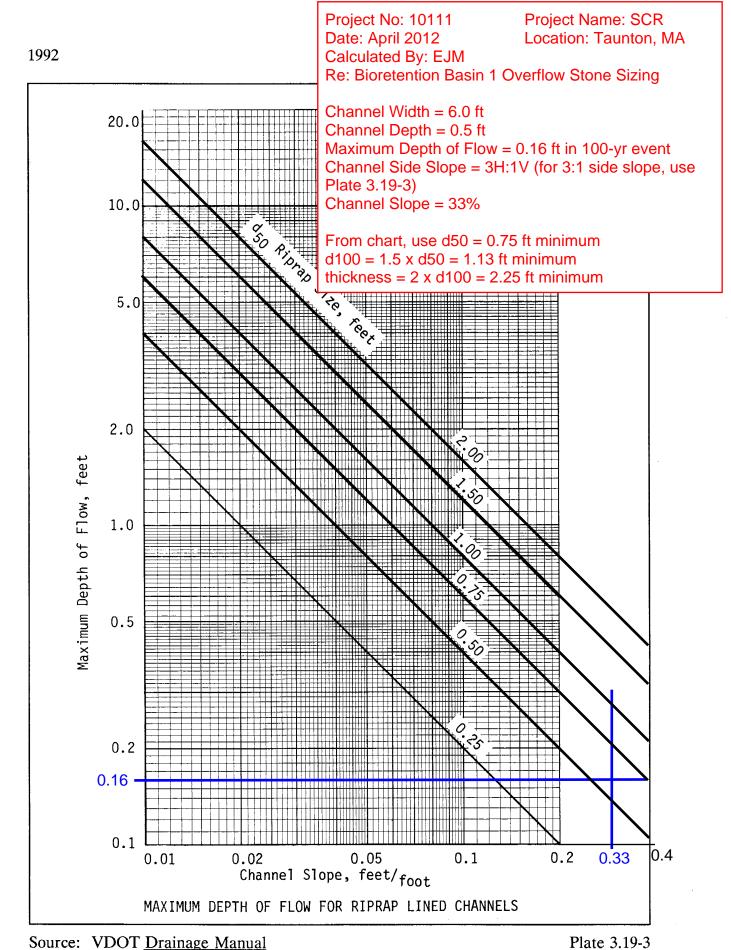
Standard 10: Prohibition of Illicit Discharges

The site was previously undeveloped and no sanitary sewer or storm drainage infrastructure is known to exist on the site. The design plans submitted with this report have been designed in full compliance with current standards. The Long-Term Pollution Prevention Plan will include measures to prevent illicit discharges.





Appendix A Standard 1 Computations and Supporting Information



*Sizing calculations represent minimum stone size. Larger stone may be required per detail plans.



Taunton Depot Station



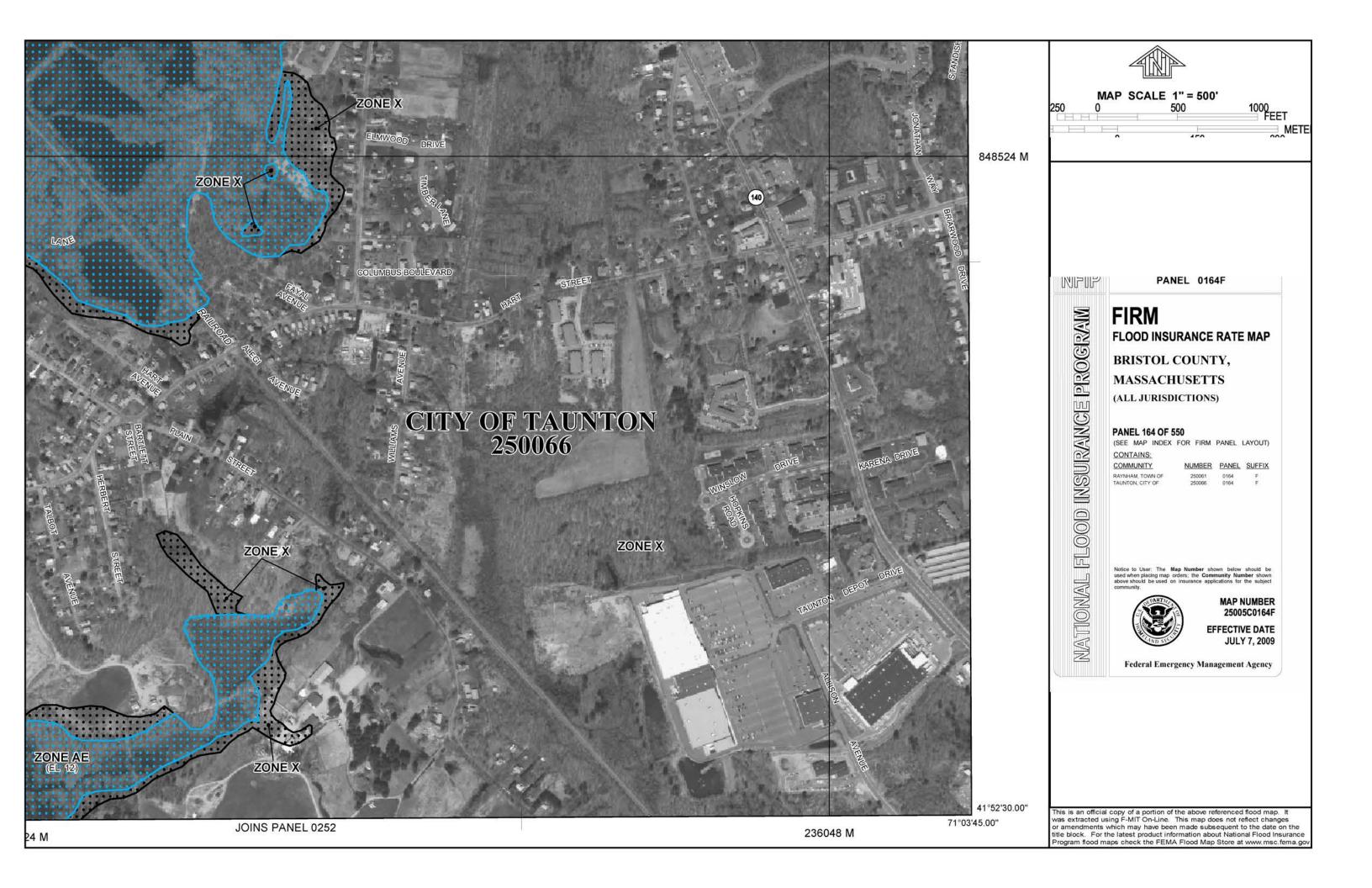
Appendix B Standard 2 Computations and Supporting Information

Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Bristol County. Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.



Taunton Depot Station

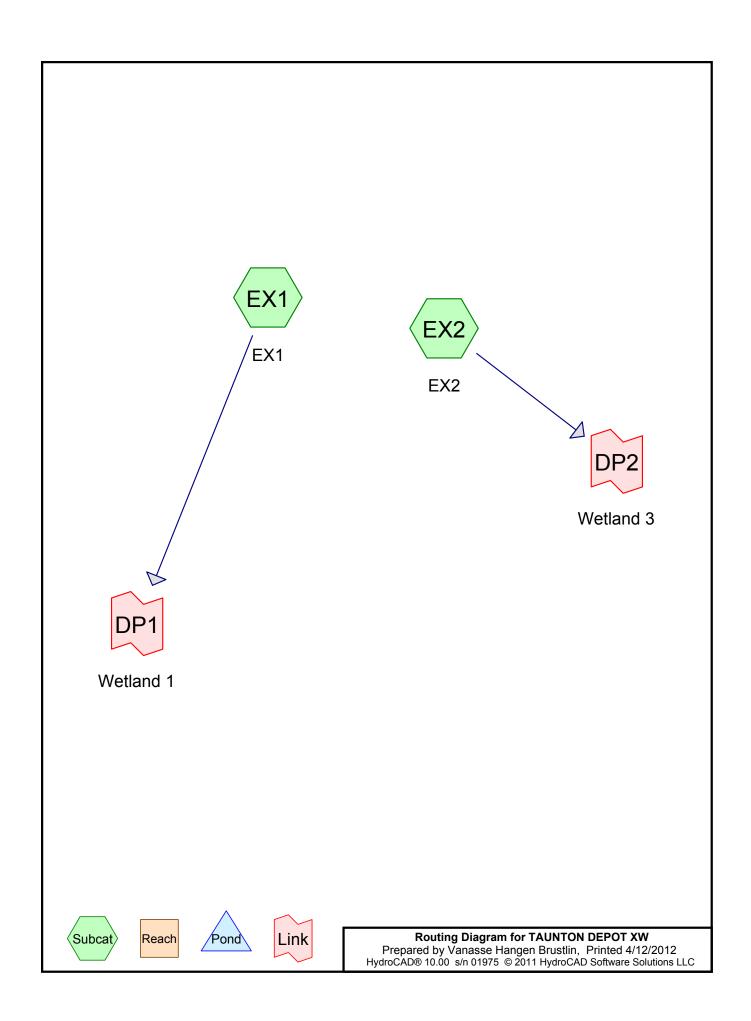
FEMA Flood Map





Taunton Depot Station

HydroCAD Analysis: Existing Conditions



TAUNTON DEPOT XW

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Area Listing (all nodes)

Area	CN	Description
(acres)		(subcatchment-numbers)
0.051	39	>75% Grass cover, Good, HSG A (EX1)
0.849	55	Woods, Good, HSG B (EX1, EX2)
3.261	61	>75% Grass cover, Good, HSG B (EX1, EX2)
0.010	72	Dirt roads, HSG A (EX1)
0.282	77	Woods, Good, HSG D (EX1, EX2)
0.151	80	>75% Grass cover, Good, HSG D (EX1, EX2)
1.243	82	Dirt roads, HSG B (EX1)
0.110	98	Paved parking, HSG B (EX1)
5.957	66	TOTAL AREA



Taunton Depot Station

2-Year Storm Event - Existing

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Depot\HydroCAD\\ \textbf{TAUNTON DEPOT XW} Type III 24-hr 2 yr storm Rainfall=3.4\)

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Type III 24-hr 2 yr storm Rainfall=3.40" Printed 4/12/2012

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=4.967 ac 2.21% Impervious Runoff Depth=0.79"

Flow Length=699' Tc=13.3 min CN=67 Runoff=3.12 cfs 0.329 af

SubcatchmentEX2: EX2 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=0.61"

Flow Length=337' Tc=9.1 min CN=63 Runoff=0.48 cfs 0.050 af

Link DP1: Wetland 1 Inflow=3.12 cfs 0.329 af

Primary=3.12 cfs 0.329 af

Link DP2: Wetland 3 Inflow=0.48 cfs 0.050 af

Primary=0.48 cfs 0.050 af

Total Runoff Area = 5.957 ac Runoff Volume = 0.379 af Average Runoff Depth = 0.76" 98.15% Pervious = 5.847 ac 1.85% Impervious = 0.110 ac

TAUNTON DEPOT XW

Type III 24-hr 2 yr storm Rainfall=3.40"

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Summary for Subcatchment EX1: EX1

Runoff 3.12 cfs @ 12.21 hrs, Volume= 0.329 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

Area	(ac) C	N Desc	cription		
0.			ed parking	, HSG B	
				over, Good,	
				over, Good,	
				over, Good,	HSG D
			ds, Good,		
			ds, Good,		
			roads, HS		
			roads, HS		
			hted Aver		
	.857	_	9% Pervio		
0.	.110	2.21	% Impervi	ous Area	
Тс	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Description
2.5	38	0.0790	0.25	(010)	Sheet Flow, Landscape B
2.0	30	0.0730	0.20		Grass: Short n= 0.150 P2= 3.40"
0.2	12	0.0420	1.25		Sheet Flow, Dirt B
0.2		0.0.20	0		Smooth surfaces n= 0.011 P2= 3.40"
0.2	37	0.0540	3.74		Shallow Concentrated Flow, Dirt B
					Unpaved Kv= 16.1 fps
0.5	44	0.0450	1.48		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.4	87	0.0230	1.06		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.6	75	0.0130	0.80		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
4.9	158	0.0060	0.54		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
0.2	37	0.0540	3.74		Shallow Concentrated Flow, Dirt B
4.4	400	0.0450	4.07		Unpaved Kv= 16.1 fps
1.1	136	0.0150	1.97		Shallow Concentrated Flow, Dirt B
0.7	75	0.0130	1.84		Unpaved Kv= 16.1 fps Shallow Concentrated Flow, Dirt B
0.7	13	0.0130	1.04		Unpaved Kv= 16.1 fps
12.2	600	Total			Οπράνου Κν- τυ. ττρο
13.3	699	Total			

TAUNTON DEPOT XW

Prepared by Vanasse Hangen Brustlin

Type III 24-hr 2 yr storm Rainfall=3.40" Printed 4/12/2012

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Summary for Subcatchment EX2: EX2

Runoff = 0.48 cfs @ 12.16 hrs, Volume= 0.050 af, Depth= 0.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

Area	(ac) C	N Des	cription			
0.	.275 5	55 Woo	ds, Good,	HSG B		
0.	0.174 77 Woods, Good, HSG D					
0.	0.475 61 >75% Grass cover, Good, HSG B					
0.066 80 >75% Grass cover, Good, HSG D						
0.990 63 Weighted Average						
	.990	,	00% Pervi	•		
Tc	Length	Slope	Velocity	Capacity	Description	
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	•	
3.5	50	0.0600	0.24	,	Sheet Flow, Landscape B	
					Grass: Short n= 0.150 P2= 3.40"	
1.1	75	0.0267	1.14		Shallow Concentrated Flow, Landscape B	
					Short Grass Pasture Kv= 7.0 fps	
2.5	104	0.0096	0.69		Shallow Concentrated Flow, Landscape B	
					Short Grass Pasture Kv= 7.0 fps	
1.2	54	0.0210	0.72		Shallow Concentrated Flow, Woods D	
					Woodland Kv= 5.0 fps	
0.2	14	0.0310	1.23		Shallow Concentrated Flow, Landscape D	
					Short Grass Pasture Kv= 7.0 fps	
0.5	28	0.0196	0.98		Shallow Concentrated Flow, Landscape D	
					Short Grass Pasture Kv= 7.0 fps	
0.1	12	0.0430	1.45		Shallow Concentrated Flow, Landscape D	
					Short Grass Pasture Kv= 7.0 fps	
9.1	337	Total				

Summary for Link DP1: Wetland 1

Inflow Are	ea =	4.967 ac,	2.21% Impervious,	Inflow Depth = $0.$	79" for 2 yr storm event
Inflow	=	3.12 cfs @	12.21 hrs, Volume	= 0.329 af	•
Primary	=	3.12 cfs @	12.21 hrs, Volume	0.329 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP2: Wetland 3

Inflow Area	a =	0.990 ac,	0.00% Impervious,	Inflow Depth = 0.6	61" for 2 yr storm event
Inflow	=	0.48 cfs @	12.16 hrs, Volume	= 0.050 af	-
Primary	=	0.48 cfs @	12.16 hrs. Volume	= 0.050 af.	Atten= 0%. Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

10-Year Storm Event - Existing

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Depot\HydroCAD\\ \textbf{TAUNTON DEPOT XW} Type III 24-hr 10 yr storm Rainfall=4.7

Prepared by Vanasse Hangen Brustlin

Type III 24-hr 10 yr storm Rainfall=4.75" Printed 4/12/2012

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX1: EX1 Runoff Area=4.967 ac 2.21% Impervious Runoff Depth=1.63"

Flow Length=699' Tc=13.3 min CN=67 Runoff=7.16 cfs 0.675 af

SubcatchmentEX2: EX2 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=1.35"

Flow Length=337' Tc=9.1 min CN=63 Runoff=1.29 cfs 0.112 af

Link DP1: Wetland 1 Inflow=7.16 cfs 0.675 af

Primary=7.16 cfs 0.675 af

Link DP2: Wetland 3 Inflow=1.29 cfs 0.112 af

Primary=1.29 cfs 0.112 af

Total Runoff Area = 5.957 ac Runoff Volume = 0.787 af Average Runoff Depth = 1.58" 98.15% Pervious = 5.847 ac 1.85% Impervious = 0.110 ac

TAUNTON DEPOT XW

Type III 24-hr 10 yr storm Rainfall=4.75"

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Summary for Subcatchment EX1: EX1

Runoff = 7.16 cfs @ 12.19 hrs, Volume= 0.675 af, Depth= 1.63"

Area	(ac) C	N Desc	cription		
0.			ed parking	, HSG B	
				over, Good,	
				over, Good,	
				over, Good,	HSG D
			ds, Good,		
			ds, Good,		
			roads, HS		
			roads, HS		
			hted Aver		
	.857	_	9% Pervio		
0.	.110	2.21	% Impervi	ous Area	
Тс	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Description
2.5	38	0.0790	0.25	(6.6)	Sheet Flow, Landscape B
2.0	30	0.0730	0.20		Grass: Short n= 0.150 P2= 3.40"
0.2	12	0.0420	1.25		Sheet Flow, Dirt B
0.2		0.0.20	0		Smooth surfaces n= 0.011 P2= 3.40"
0.2	37	0.0540	3.74		Shallow Concentrated Flow, Dirt B
					Unpaved Kv= 16.1 fps
0.5	44	0.0450	1.48		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.4	87	0.0230	1.06		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.6	75	0.0130	0.80		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
4.9	158	0.0060	0.54		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
0.2	37	0.0540	3.74		Shallow Concentrated Flow, Dirt B
4.4	400	0.0450	4.07		Unpaved Kv= 16.1 fps
1.1	136	0.0150	1.97		Shallow Concentrated Flow, Dirt B
0.7	75	0.0130	1.84		Unpaved Kv= 16.1 fps Shallow Concentrated Flow, Dirt B
0.7	13	0.0130	1.04		Unpaved Kv= 16.1 fps
42.2	600	Total			Olipaveu IXV- 10.1 lps
13.3	699	Total			

TAUNTON DEPOT XW

Type III 24-hr 10 yr storm Rainfall=4.75"

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Summary for Subcatchment EX2: EX2

Runoff = 1.29 cfs @ 12.14 hrs, Volume= 0.112 af, Depth= 1.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 10 yr storm Rainfall=4.75"

Area	(ac) C	N Des	cription					
0.	.275 5	55 Woo	ds, Good,	HSG B				
0.	.174 7	7 Woo	ds, Good,	HSG D				
0.475 61 >75% Grass cover, Good, HSG B								
0.066 80 >75% Grass cover, Good, HSG D								
0.	.990 6	3 Weig	hted Aver	age				
0.	.990	•	00% Pervi	•				
Tc	Length	Slope	Velocity	Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
3.5	50	0.0600	0.24		Sheet Flow, Landscape B			
					Grass: Short n= 0.150 P2= 3.40"			
1.1	75	0.0267	1.14		Shallow Concentrated Flow, Landscape B			
					Short Grass Pasture Kv= 7.0 fps			
2.5	104	0.0096	0.69		Shallow Concentrated Flow, Landscape B			
					Short Grass Pasture Kv= 7.0 fps			
1.2	54	0.0210	0.72		Shallow Concentrated Flow, Woods D			
					Woodland Kv= 5.0 fps			
0.2	14	0.0310	1.23		Shallow Concentrated Flow, Landscape D			
					Short Grass Pasture Kv= 7.0 fps			
0.5	28	0.0196	0.98		Shallow Concentrated Flow, Landscape D			
					Short Grass Pasture Kv= 7.0 fps			
0.1	12	0.0430	1.45		Shallow Concentrated Flow, Landscape D			
					Short Grass Pasture Kv= 7.0 fps			
9.1	337	Total						

Summary for Link DP1: Wetland 1

Inflow Area = 4.967 ac, 2.21% Impervious, Inflow Depth = 1.63" for 10 yr storm event Inflow = 7.16 cfs @ 12.19 hrs, Volume= 0.675 af

Primary = 7.16 cfs @ 12.19 hrs, Volume= 0.675 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP2: Wetland 3

Inflow Area = 0.990 ac, 0.00% Impervious, Inflow Depth = 1.35" for 10 yr storm event 1.29 cfs @ 12.14 hrs, Volume= 0.112 af 1.29 cfs @ 12.14 hrs, Volume= 0.112 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

100-Year Storm Event - Existing

Prepared by Vanasse Hangen Brustlin

Type III 24-hr 100 yr storm Rainfall=7.00"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points Runoff by SCS TR-20 method, UH=SCS Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Runoff Area=4.967 ac 2.21% Impervious Runoff Depth=3.31" SubcatchmentEX1: EX1

Flow Length=699' Tc=13.3 min CN=67 Runoff=15.15 cfs 1.369 af

Subcatchment EX2: EX2 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=2.90"

Flow Length=337' Tc=9.1 min CN=63 Runoff=2.97 cfs 0.239 af

Inflow=15.15 cfs 1.369 af Link DP1: Wetland 1

Primary=15.15 cfs 1.369 af

Link DP2: Wetland 3 Inflow=2.97 cfs 0.239 af

Primary=2.97 cfs 0.239 af

Total Runoff Area = 5.957 ac Runoff Volume = 1.608 af Average Runoff Depth = 3.24" 1.85% Impervious = 0.110 ac 98.15% Pervious = 5.847 ac

TAUNTON DEPOT XW

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Type III 24-hr 100 yr storm Rainfall=7.00"

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Summary for Subcatchment EX1: EX1

Runoff 15.15 cfs @ 12.19 hrs, Volume= 1.369 af, Depth= 3.31"

Area	(ac) C	N Desc	cription		
0.			ed parking	, HSG B	
				over, Good,	
				over, Good,	
				over, Good,	HSG D
			ds, Good,		
			ds, Good,		
			roads, HS		
			roads, HS		
			hted Aver		
	.857	_	9% Pervio		
0.	.110	2.21	% Impervi	ous Area	
Тс	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Description
2.5	38	0.0790	0.25	(6.6)	Sheet Flow, Landscape B
2.0	30	0.0730	0.20		Grass: Short n= 0.150 P2= 3.40"
0.2	12	0.0420	1.25		Sheet Flow, Dirt B
0.2		0.0.20	0		Smooth surfaces n= 0.011 P2= 3.40"
0.2	37	0.0540	3.74		Shallow Concentrated Flow, Dirt B
					Unpaved Kv= 16.1 fps
0.5	44	0.0450	1.48		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.4	87	0.0230	1.06		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.6	75	0.0130	0.80		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
4.9	158	0.0060	0.54		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
0.2	37	0.0540	3.74		Shallow Concentrated Flow, Dirt B
4.4	400	0.0450	4.07		Unpaved Kv= 16.1 fps
1.1	136	0.0150	1.97		Shallow Concentrated Flow, Dirt B
0.7	75	0.0130	1.84		Unpaved Kv= 16.1 fps Shallow Concentrated Flow, Dirt B
0.7	13	0.0130	1.04		Unpaved Kv= 16.1 fps
42.2	600	Total			Olipaveu IXV- 10.1 lps
13.3	699	Total			

TAUNTON DEPOT XW

Type III 24-hr 100 yr storm Rainfall=7.00"

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Summary for Subcatchment EX2: EX2

Runoff = 2.97 cfs @ 12.13 hrs, Volume= 0.239 af, Depth= 2.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 100 yr storm Rainfall=7.00"

Area	(ac) C	N Des	cription					
0.	.275 5	55 Woo	ds, Good,	HSG B				
0.	0.174 77 Woods, Good, HSG D							
0.	0.475 61 >75% Grass cover, Good, HSG B							
0.066 80 >75% Grass cover, Good, HSG D								
0.	.990 6	3 Wei	hted Aver	age				
	.990	,	00% Pervi	•				
Tc	Length	Slope	Velocity	Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	The state of the s			
3.5	50	0.0600	0.24	, ,	Sheet Flow, Landscape B			
0.0		0.000	J		Grass: Short n= 0.150 P2= 3.40"			
1.1	75	0.0267	1.14		Shallow Concentrated Flow, Landscape B			
					Short Grass Pasture Kv= 7.0 fps			
2.5	104	0.0096	0.69		Shallow Concentrated Flow, Landscape B			
					Short Grass Pasture Kv= 7.0 fps			
1.2	54	0.0210	0.72		Shallow Concentrated Flow, Woods D			
					Woodland Kv= 5.0 fps			
0.2	14	0.0310	1.23		Shallow Concentrated Flow, Landscape D			
					Short Grass Pasture Kv= 7.0 fps			
0.5	28	0.0196	0.98		Shallow Concentrated Flow, Landscape D			
					Short Grass Pasture Kv= 7.0 fps			
0.1	12	0.0430	1.45		Shallow Concentrated Flow, Landscape D			
					Short Grass Pasture Kv= 7.0 fps			
9.1	337	Total						

Summary for Link DP1: Wetland 1

Inflow Area = 4.967 ac, 2.21% Impervious, Inflow Depth = 3.31" for 100 yr storm event

Inflow = 15.15 cfs @ 12.19 hrs, Volume= 1.369 af

Primary = 15.15 cfs @ 12.19 hrs, Volume= 1.369 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP2: Wetland 3

Inflow Area = 0.990 ac, 0.00% Impervious, Inflow Depth = 2.90" for 100 yr storm event

Inflow = 2.97 cfs @ 12.13 hrs, Volume= 0.239 af

Primary = 2.97 cfs @ 12.13 hrs, Volume= 0.239 af, Atten= 0%, Lag= 0.0 min

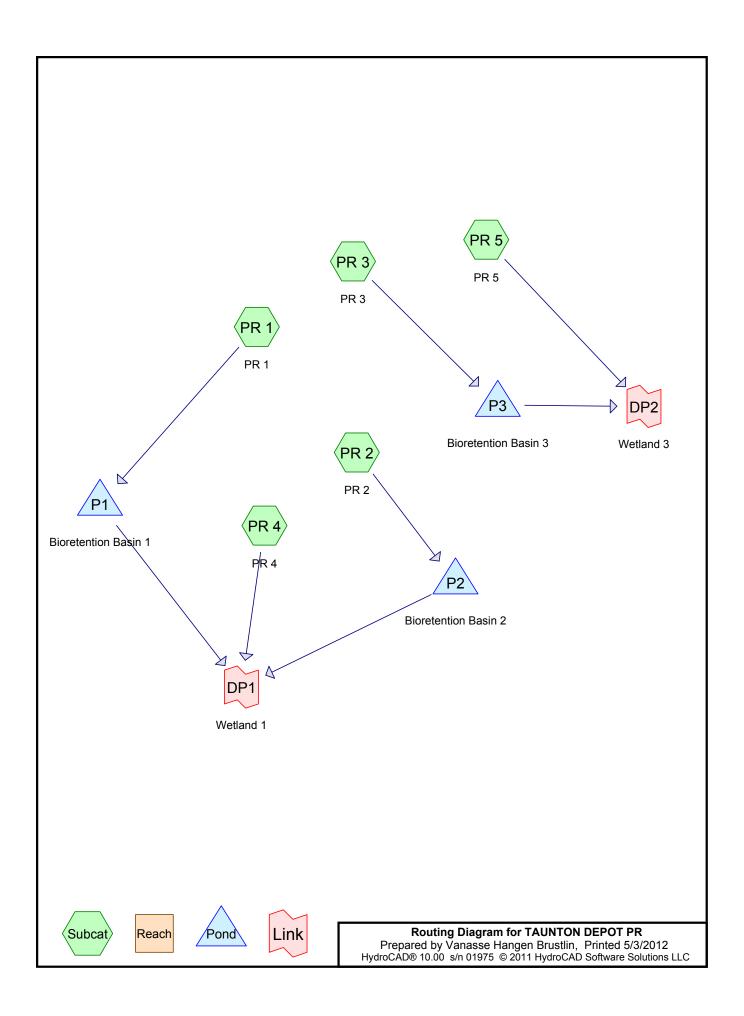
Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

HydroCAD Analysis: Proposed Conditions



TAUNTON DEPOT PR

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Area Listing (all nodes)

Area	CN	Description
(acres)		(subcatchment-numbers)
0.001	30	Woods, Good, HSG A (PR 4)
0.061	39	>75% Grass cover, Good, HSG A (PR 1, PR 4)
0.411	55	Woods, Good, HSG B (PR 4, PR 5)
1.554	61	>75% Grass cover, Good, HSG B (PR 1, PR 2, PR 3, PR 4, PR 5)
0.107	77	Woods, Good, HSG D (PR 4, PR 5)
0.082	80	>75% Grass cover, Good, HSG D (PR 2, PR 4, PR 5)
3.269	98	Paved parking, HSG B (PR 1, PR 2, PR 3, PR 4)
0.159	98	Paved parking, HSG D (PR 2)
0.242	98	Water Surface, 0% imp, HSG B (PR 1, PR 2)
0.077	98	Water Surface, 0% imp, HSG D (PR 2)
5.963	84	TOTAL AREA



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

2-Year Storm Event - Proposed

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Depot\HydroCAD\\ \textbf{TAUNTON DEPOT PR} \tag{Type III 24-hr 2 yr storm Rainfall=3.40"}

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR 1: PR 1	Runoff Area=1.985 ac 72.34% Impervious Runoff Depth=2.54" Flow Length=200' Tc=5.0 min CN=92 Runoff=5.96 cfs 0.420 af
SubcatchmentPR 2: PR 2	Runoff Area=1.348 ac 90.58% Impervious Runoff Depth=3.06" Flow Length=337' Tc=5.0 min CN=97 Runoff=4.55 cfs 0.343 af
SubcatchmentPR 3: PR 3	Runoff Area=1.348 ac 42.80% Impervious Runoff Depth=1.36" Flow Length=438' Tc=5.3 min CN=77 Runoff=2.16 cfs 0.152 af
SubcatchmentPR 4: PR 4	Runoff Area=0.996 ac 19.48% Impervious Runoff Depth=0.75" Flow Length=117' Tc=5.0 min CN=66 Runoff=0.76 cfs 0.062 af
SubcatchmentPR 5: PR 5	Runoff Area=0.286 ac 0.00% Impervious Runoff Depth=0.70" Flow Length=50' Tc=8.9 min CN=65 Runoff=0.17 cfs 0.017 af
Pond P1: Bioretention Basin 1	Peak Elev=30.07' Storage=17,870 cf Inflow=5.96 cfs 0.420 af Outflow=0.04 cfs 0.022 af
Pond P2: Bioretention Basin 2	Peak Elev=31.60' Storage=5,671 cf Inflow=4.55 cfs 0.343 af Outflow=2.48 cfs 0.288 af
Pond P3: Bioretention Basin 3	Peak Elev=32.87' Storage=2,902 cf Inflow=2.16 cfs 0.152 af Outflow=0.33 cfs 0.117 af
Link DP1: Wetland 1	Inflow=3.03 cfs 0.372 af Primary=3.03 cfs 0.372 af
Link DP2: Wetland 3	Inflow=0.39 cfs 0.134 af Primary=0.39 cfs 0.134 af

Total Runoff Area = 5.963 ac Runoff Volume = 0.995 af Average Runoff Depth = 2.00" 42.51% Pervious = 2.535 ac 57.49% Impervious = 3.428 ac

TAUNTON DEPOT PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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Summary for Subcatchment PR 1: PR 1

Runoff = 5.96 cfs @ 12.07 hrs, Volume= 0.420 af, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

Area	(ac)	CN Des	cription					
1.	1.436 98 Paved parking, HSG B							
0.	.014	39 > 75	% Grass c	over, Good	, HSG A			
0.	.300	61 > 75	% Grass c	over, Good	, HSG B			
0.	.235	98 Wat	er Surface	, 0% imp, H	HSG B			
1.	1.985 92 Weighted Average							
0.	.549	27.6	66% Pervio	us Area				
1.	.436	72.3	34% Imper	ious Area				
Tc	Length	•		Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
0.7	50	0.0180	1.18		Sheet Flow, Impervious B			
					Smooth surfaces n= 0.011 P2= 3.40"			
0.7	150	0.0270	3.34		Shallow Concentrated Flow, Impervious B			
					Paved Kv= 20.3 fps			
3.6					Direct Entry, <5 min Tc Adjustment			
5.0	200	Total						

Summary for Subcatchment PR 2: PR 2

Runoff = 4.55 cfs @ 12.07 hrs, Volume= 0.343 af, Depth= 3.06"

 Area (ac)	CN	Description
1.062	98	Paved parking, HSG B
0.159	98	Paved parking, HSG D
0.008	61	>75% Grass cover, Good, HSG B
0.035	80	>75% Grass cover, Good, HSG D
0.007	98	Water Surface, 0% imp, HSG B
 0.077	98	Water Surface, 0% imp, HSG D
 1.348	97	Weighted Average
0.127		9.42% Pervious Area
1.221		90.58% Impervious Area

TAUNTON DEPOT PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
0.8	50	0.0120	1.01		Sheet Flow, Impervious B
					Smooth surfaces n= 0.011 P2= 3.40"
1.7	287	0.0200	2.87		Shallow Concentrated Flow, Impervious B
					Paved Kv= 20.3 fps
2.5					Direct Entry, <5 min Tc Adjustment
5.0	337	Total			

Summary for Subcatchment PR 3: PR 3

Runoff = 2.16 cfs @ 12.08 hrs, Volume= 0.152 af, Depth= 1.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

Area	(ac) C	N Des	cription		
0.	577 9	8 Pave	ed parking	, HSG B	
0.	771 6	31 >75°	% Grass c	over, Good	, HSG B
			ghted Aver		
	771		0% Pervio		
0.	577	42.8	0% Imper	vious Area	
_		01		0 "	D
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
0.7	50	0.0200	1.23		Sheet Flow, Impervious B
					Smooth surfaces n= 0.011 P2= 3.40"
0.7	114	0.0180	2.72		Shallow Concentrated Flow, Impervious B
					Paved Kv= 20.3 fps
1.1	59	0.0170	0.91		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
2.3	159	0.0060	1.16		Shallow Concentrated Flow, Landscape B
					Grassed Waterway Kv= 15.0 fps
0.5	56	0.0180	2.01		Shallow Concentrated Flow, Landscape B
					Grassed Waterway Kv= 15.0 fps
5.3	438	Total			

Summary for Subcatchment PR 4: PR 4

Runoff = 0.76 cfs @ 12.09 hrs, Volume= 0.062 af, Depth= 0.75"

TAUNTON DEPOT PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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	A roo	(00)	N Doo	orintion		
_	Area			cription	1100 B	
				ed parking		
				ds, Good,		
				ds, Good,		
				ds, Good,		
					over, Good	
					over, Good	
	0.	036	30 >75°	% Grass c	over, Good	, HSG D
	0.	996	66 Weig	ghted Aver	age	
	0.	802	80.5	2% Pervio	us Area	
	0.	194	19.4	8% Imper	ious Area	
	Tc	Length	Slope	Velocity	Capacity	Description
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	3.0	38	0.0530	0.21		Sheet Flow, Landscape B
						Grass: Short n= 0.150 P2= 3.40"
	0.1	12	0.0540	1.38		Sheet Flow, Impervious B
						Smooth surfaces n= 0.011 P2= 3.40"
	0.3	47	0.0210	2.94		Shallow Concentrated Flow, Impervious B
						Paved Kv= 20.3 fps
	0.3	20	0.0250	1.11		Shallow Concentrated Flow, Landscape B
						Short Grass Pasture Kv= 7.0 fps
	1.3					Direct Entry, <5 min Tc Adjustment
_	5.0	117	Total			

Summary for Subcatchment PR 5: PR 5

Runoff = 0.17 cfs @ 12.15 hrs, Volume= 0.017 af, Depth= 0.70"

Area ((ac)	CN	Description
0.0	055	61	>75% Grass cover, Good, HSG B
0.0	011	80	>75% Grass cover, Good, HSG D
0.	118	55	Woods, Good, HSG B
0.	102	77	Woods, Good, HSG D
0.2	286	65	Weighted Average
0.2	286		100.00% Pervious Area

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Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	0.2	3	0.3300	0.27		Sheet Flow, Landscape B
						Grass: Short n= 0.150 P2= 3.40"
	1.4	11	0.0310	0.13		Sheet Flow, Landscape B
						Grass: Short n= 0.150 P2= 3.40"
	5.0	21	0.0310	0.07		Sheet Flow, Woods D
						Woods: Light underbrush n= 0.400 P2= 3.40"
	2.3	15	0.1100	0.11		Sheet Flow, Woods D
						Woods: Light underbrush n= 0.400 P2= 3.40"
	8.9	50	Total		·	

Summary for Pond P1: Bioretention Basin 1

Inflow Area = 1.985 ac, 72.34% Impervious, Inflow Depth = 2.54" for 2 yr storm event

Inflow = 5.96 cfs @ 12.07 hrs, Volume= 0.420 af

Outflow = 0.04 cfs @ 24.05 hrs, Volume= 0.022 af, Atten= 99%, Lag= 718.9 min

Primary = 0.04 cfs @ 24.05 hrs, Volume= 0.022 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 30.07' @ 24.05 hrs Surf.Area= 14,070 sf Storage= 17,870 cf

Plug-Flow detention time= 969.4 min calculated for 0.022 af (5% of inflow) Center-of-Mass det. time= 679.5 min (1,474.2 - 794.7)

Volume	Inv	vert Avail.Storage		Storage Description					
#1	28.0	00' 3	33,480 cf	Custom Stage D	oata (Irregular)Liste	ed below (Recalc)			
F. (:		0 (4	ъ.	. 01	0 01	NA			
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)			
28.0	00	3,790	237.0	0	0	3,790			
29.0	00	8,407	366.0	5,947	5,947	9,987			
30.0	00	13,678	468.0	10,936	16,883	16,770			
31.0	00	19,697	573.0	16,596	33,480	25,484			
Device	Routing	Inv	<u>/ert Outle</u>	et Devices					
#1	Primary	28.	.00' 12.0	12.0" Round RCP_Round 12"					
	•		L= 5	L= 50.0' RCP, sq.cut end projecting, Ke= 0.500					
				Inlet / Outlet Invert= 28.00' / 27.00' S= 0.0200 '/' Cc= 0.900					
			n= 0	n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf					
#2	Device 1	30.	.00' 8.0 "	· · · · · · · · · · · · · · · · · · ·					
#3	Primary	30.	.50' 6.0'	long x 6.0' bread	th Broad-Crested	Rectangular Weir			
	•		Head	d (feet) 0.20 0.40	0.60 0.80 1.00 1	1.20 1.40 1.60 1.80 2.00			
			2.50	3.00 3.50 4.00	4.50 5.00 5.50				
			Coef	f. (English) 2.37 2	2.51 2.70 2.68 2.6	88 2.67 2.65 2.65 2.65			
			2.65	2.66 2.66 2.67	2.69 2.72 2.76 2.	83			

TAUNTON DEPOT PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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Primary OutFlow Max=0.04 cfs @ 24.05 hrs HW=30.07' (Free Discharge)

-1=RCP Round 12" (Passes 0.04 cfs of 4.74 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.04 cfs @ 0.86 fps)

-3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond P2: Bioretention Basin 2

1.348 ac, 90.58% Impervious, Inflow Depth = 3.06" for 2 yr storm event Inflow Area =

Inflow 4.55 cfs @ 12.07 hrs, Volume= 0.343 af

Outflow 2.48 cfs @ 12.18 hrs, Volume= 0.288 af, Atten= 45%, Lag= 6.6 min

0.288 af Primary 2.48 cfs @ 12.18 hrs, Volume=

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 31.60' @ 12.18 hrs Surf.Area= 4,268 sf Storage= 5,671 cf

Plug-Flow detention time= 156.5 min calculated for 0.288 af (84% of inflow)

Center-of-Mass det. time= 89.9 min (853.5 - 763.6)

Volume	Inve	ert Ava	il.Storage	Storage Description				
#1	30.0	30.00' 7,		Custom Stage D	Custom Stage Data (Irregular)Listed below (Recalc)			
			Perim (feet			Wet.Area (sq-ft)		
30.0 31.0 32.0	00	2,881 3,690 4,673	246.0 371.0 320.0	0 3,277	0 3,277 7,449	2,881 9,026 11,852		
Device	Routing	In	vert Ou	tlet Devices				
#1	Primary			12.0" Round RCP_Round 12" L= 65.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 30.00' / 29.25' S= 0.0115 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2 #3	Device 1 Primary		0.75' 10 . 1.50' 6.0 He 2.5 Co	n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf 10.0" W x 9.0" H Vert. Orifice/Grate C= 0.600 6.0' long x 4.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32				

Primary OutFlow Max=2.48 cfs @ 12.18 hrs HW=31.60' (Free Discharge)

-1=RCP Round 12" (Passes 2.02 cfs of 3.89 cfs potential flow)

2=Orifice/Grate (Orifice Controls 2.02 cfs @ 3.23 fps)

-3=Broad-Crested Rectangular Weir (Weir Controls 0.47 cfs @ 0.76 fps)

TAUNTON DEPOT PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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Summary for Pond P3: Bioretention Basin 3

Inflow Area = 1.348 ac, 42.80% Impervious, Inflow Depth = 1.36" for 2 yr storm event

Inflow = 2.16 cfs @ 12.08 hrs, Volume= 0.152 af

Outflow = 0.33 cfs @ 12.64 hrs, Volume= 0.117 af, Atten= 85%, Lag= 33.5 min

Primary = 0.33 cfs @ 12.64 hrs, Volume= 0.117 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 32.87' @ 12.64 hrs Surf.Area= 4,579 sf Storage= 2,902 cf

Plug-Flow detention time= 218.8 min calculated for 0.117 af (77% of inflow)

Center-of-Mass det. time= 131.5 min (979.8 - 848.3)

Volume	Inve	ert Ava	il.Storage	Storage Description				
#1	32.0	00'	9,440 cf	Custom Stage D	Custom Stage Data (Irregular)Listed below (Recalc)			
			Perim (feet					
32.0 33.0 34.0)0)0	2,207 4,993 6,927	•	0 0 3,507	0 3,507 9,440	2,207 6,459 12,526		
Device	Routing	Ir	vert Ou	tlet Devices				
#1	v		L= Inle	12.0" Round RCP_Round 12" L= 35.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 32.00' / 31.00' S= 0.0286 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2 #3			2.50' 6.0 3.60' 5.0 He 2.5 Co	n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf 6.0" Vert. Orifice/Grate C= 0.600				

Primary OutFlow Max=0.33 cfs @ 12.64 hrs HW=32.87' (Free Discharge)

—1=RCP_Round 12" (Passes 0.33 cfs of 2.32 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.33 cfs @ 2.08 fps)

-3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Link DP1: Wetland 1

Inflow Area = 4.329 ac, 65.86% Impervious, Inflow Depth > 1.03" for 2 yr storm event

Inflow = 3.03 cfs @ 12.16 hrs, Volume= 0.372 af

Primary = 3.03 cfs @ 12.16 hrs, Volume= 0.372 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

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Type III 24-hr 2 yr storm Rainfall=3.40"

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Summary for Link DP2: Wetland 3

Inflow Area = 1.634 ac, 35.31% Impervious, Inflow Depth > 0.98" for 2 yr storm event

Inflow = 0.39 cfs @ 12.49 hrs, Volume= 0.134 af

Primary = 0.39 cfs @ 12.49 hrs, Volume= 0.134 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

10-Year Storm Event- Proposed

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Depot\HydroCAD\\ \textbf{TAUNTON DEPOT PR} Type III 24-hr 10 yr storm Rainfall=4.7

Prepared by Vanasse Hangen Brustlin

Type III 24-hr 10 yr storm Rainfall=4.75" Printed 4/16/2012

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR 1: PR 1	Runoff Area=1.985 ac 72.34% Impervious Runoff Depth=3.85" Flow Length=200' Tc=5.0 min CN=92 Runoff=8.83 cfs 0.636 af
SubcatchmentPR 2: PR 2	Runoff Area=1.348 ac 90.58% Impervious Runoff Depth=4.40" Flow Length=337' Tc=5.0 min CN=97 Runoff=6.44 cfs 0.494 af
SubcatchmentPR 3: PR 3	Runoff Area=1.348 ac 42.80% Impervious Runoff Depth=2.42" Flow Length=438' Tc=5.3 min CN=77 Runoff=3.91 cfs 0.271 af
SubcatchmentPR 4: PR 4	Runoff Area=0.996 ac 19.48% Impervious Runoff Depth=1.56" Flow Length=117' Tc=5.0 min CN=66 Runoff=1.79 cfs 0.129 af
SubcatchmentPR 5: PR 5	Runoff Area=0.286 ac 0.00% Impervious Runoff Depth=1.49" Flow Length=50' Tc=8.9 min CN=65 Runoff=0.42 cfs 0.035 af
Pond P1: Bioretention Basin 1	Peak Elev=30.28' Storage=20,873 cf Inflow=8.83 cfs 0.636 af Outflow=0.31 cfs 0.231 af
Pond P2: Bioretention Basin 2	Peak Elev=31.78' Storage=6,433 cf Inflow=6.44 cfs 0.494 af Outflow=4.53 cfs 0.439 af
Pond P3: Bioretention Basin 3	Peak Elev=33.31' Storage=5,146 cf Inflow=3.91 cfs 0.271 af Outflow=0.71 cfs 0.236 af
Link DP1: Wetland 1	Inflow=6.03 cfs 0.799 af Primary=6.03 cfs 0.799 af
Link DP2: Wetland 3	Inflow=0.97 cfs 0.271 af Primary=0.97 cfs 0.271 af

Total Runoff Area = 5.963 ac Runoff Volume = 1.566 af Average Runoff Depth = 3.15" 42.51% Pervious = 2.535 ac 57.49% Impervious = 3.428 ac

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Summary for Subcatchment PR 1: PR 1

Runoff = 8.83 cfs @ 12.07 hrs, Volume= 0.636 af, Depth= 3.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 10 yr storm Rainfall=4.75"

Area	(ac)	CN Des	cription									
1.	.436	98 Pav	aved parking, HSG B									
0.	.014	39 > 75	% Grass c	over, Good	, HSG A							
0.	.300	61 > 75	% Grass c	over, Good	, HSG B							
0.	.235	98 Wat	er Surface	, 0% imp, H	HSG B							
1.	.985	92 Wei	ghted Aver	age								
0.	.549	27.6	66% Pervio	us Area								
1.	.436	72.3	34% Imper	ious Area								
Tc	Length	•		Capacity	Description							
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)								
0.7	50	0.0180	1.18		Sheet Flow, Impervious B							
					Smooth surfaces n= 0.011 P2= 3.40"							
0.7	150	0.0270	3.34		Shallow Concentrated Flow, Impervious B							
					Paved Kv= 20.3 fps							
3.6					Direct Entry, <5 min Tc Adjustment							
5.0	200	Total										

Summary for Subcatchment PR 2: PR 2

Runoff = 6.44 cfs @ 12.07 hrs, Volume= 0.494 af, Depth= 4.40"

 Area (ac)	CN	Description
1.062	98	Paved parking, HSG B
0.159	98	Paved parking, HSG D
0.008	61	>75% Grass cover, Good, HSG B
0.035	80	>75% Grass cover, Good, HSG D
0.007	98	Water Surface, 0% imp, HSG B
 0.077	98	Water Surface, 0% imp, HSG D
 1.348	97	Weighted Average
0.127		9.42% Pervious Area
1.221		90.58% Impervious Area

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
0.8	50	0.0120	1.01		Sheet Flow, Impervious B
					Smooth surfaces n= 0.011 P2= 3.40"
1.7	287	0.0200	2.87		Shallow Concentrated Flow, Impervious B
					Paved Kv= 20.3 fps
2.5					Direct Entry, <5 min Tc Adjustment
5.0	337	Total			

Summary for Subcatchment PR 3: PR 3

Runoff = 3.91 cfs @ 12.08 hrs, Volume= 0.271 af, Depth= 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 10 yr storm Rainfall=4.75"

Area	(ac) C	N Des	cription						
0.	0.577 98 Paved parking, HSG B								
0.771 61 >75% Grass cover, Good, HSG B									
1.348 77 Weighted Average									
	.771		0% Pervio						
0.	.577	42.8	0% Imper	vious Area					
т.	l a .a a.tla	01	\/_l:	0	Description				
Tc (min)	Length	Slope	Velocity	Capacity	Description				
<u>(min)</u>	(feet)	(ft/ft)	(ft/sec)	(cfs)					
0.7	50	0.0200	1.23		Sheet Flow, Impervious B				
					Smooth surfaces n= 0.011 P2= 3.40"				
0.7	114	0.0180	2.72		Shallow Concentrated Flow, Impervious B				
		0.0470	0.04		Paved Kv= 20.3 fps				
1.1	59	0.0170	0.91		Shallow Concentrated Flow, Landscape B				
0.0	450	0.0000	4.40		Short Grass Pasture Kv= 7.0 fps				
2.3	159	0.0060	1.16		Shallow Concentrated Flow, Landscape B				
0.5	50	0.0400	0.04		Grassed Waterway Kv= 15.0 fps				
0.5	56	0.0180	2.01		Shallow Concentrated Flow, Landscape B				
					Grassed Waterway Kv= 15.0 fps				
5.3	438	Total							

Summary for Subcatchment PR 4: PR 4

Runoff = 1.79 cfs @ 12.08 hrs, Volume= 0.129 af, Depth= 1.56"

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Area	(ac) C	N Des	cription		
0	.194	98 Pave	ed parking	, HSG B	
0	.001		ds, Good,		
0	.293	55 Woo	ds, Good,	HSG B	
0	.005	77 Woo	ds, Good,	HSG D	
0	.047	39 >75	% Grass c	over, Good	, HSG A
0	.420	61 >75°	% Grass c	over, Good	, HSG B
0	.036	80 >75°	% Grass c	over, Good	, HSG D
0.	.996	66 Wei	ghted Avei	age	
0.	.802		2% Pervio		
0	.194	19.4	8% Imper	ious Area	
			•		
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
3.0	38	0.0530	0.21		Sheet Flow, Landscape B
					Grass: Short n= 0.150 P2= 3.40"
0.1	12	0.0540	1.38		Sheet Flow, Impervious B
					Smooth surfaces n= 0.011 P2= 3.40"
0.3	47	0.0210	2.94		Shallow Concentrated Flow, Impervious B
					Paved Kv= 20.3 fps
0.3	20	0.0250	1.11		Shallow Concentrated Flow, Landscape B
					Short Grass Pasture Kv= 7.0 fps
1.3					Direct Entry, <5 min Tc Adjustment
5.0	117	Total			

Summary for Subcatchment PR 5: PR 5

Runoff = 0.42 cfs @ 12.13 hrs, Volume= 0.035 af, Depth= 1.49"

Area ((ac)	CN	Description
0.0	055	61	>75% Grass cover, Good, HSG B
0.0	011	80	>75% Grass cover, Good, HSG D
0.	118	55	Woods, Good, HSG B
0.	102	77	Woods, Good, HSG D
0.2	286	65	Weighted Average
0.2	286		100.00% Pervious Area

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
_	0.2	3	0.3300	0.27		Sheet Flow, Landscape B
						Grass: Short n= 0.150 P2= 3.40"
	1.4	11	0.0310	0.13		Sheet Flow, Landscape B
						Grass: Short n= 0.150 P2= 3.40"
	5.0	21	0.0310	0.07		Sheet Flow, Woods D
						Woods: Light underbrush n= 0.400 P2= 3.40"
	2.3	15	0.1100	0.11		Sheet Flow, Woods D
						Woods: Light underbrush n= 0.400 P2= 3.40"
	8.9	50	Total			

Summary for Pond P1: Bioretention Basin 1

Inflow Area = 1.985 ac, 72.34% Impervious, Inflow Depth = 3.85" for 10 yr storm event

Inflow = 8.83 cfs @ 12.07 hrs, Volume= 0.636 af

Outflow = 0.31 cfs @ 15.40 hrs, Volume= 0.231 af, Atten= 96%, Lag= 199.7 min

Primary = 0.31 cfs @ 15.40 hrs, Volume= 0.231 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 30.28' @ 15.40 hrs Surf.Area= 15,231 sf Storage= 20,873 cf

Plug-Flow detention time= 481.9 min calculated for 0.231 af (36% of inflow) Center-of-Mass det. time= 346.2 min (1,129.6 - 783.4)

Volume	olume Invert Avail.Storage		Storage Description	on					
#1	28.0	00' 3	3,480 cf	Custom Stage Data (Irregular)Listed below (Recalc)					
- 14:		O A	Davis	la a Otana	0)			
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>			
28.0	00	3,790	237.0	0	0	3,790			
29.0	00	8,407	366.0	5,947	5,947	9,987			
30.0	00	13,678	468.0	10,936	16,883	16,770			
31.0	00	19,697	573.0	16,596	33,480	25,484			
Device	Routing	Inv	<u>ert Outle</u>	et Devices					
#1	Primary	28.0	00' 12.0	0" Round RCP_Round 12"					
	•			L= 50.0' RCP, sq.cut end projecting, Ke= 0.500					
			Inlet	t / Outlet Invert= 28.00' / 27.00' S= 0.0200 '/' Cc= 0.900					
			n= 0	= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf					
#2	Device 1	30.0	0. 8 '0 0	8.0" W x 4.0" H Vert. Orifice/Grate C= 0.600					
#3	Primary	30.	50' 6.0'	long x 6.0' bread	th Broad-Crested	Rectangular Weir			
	·		Head	d (feet) 0.20 0.40	0.60 0.80 1.00 1	.20 1.40 1.60 1.80 2.00			
			2.50	3.00 3.50 4.00 4	1.50 5.00 5.50				
			Coef	f. (English) 2.37 2	.51 2.70 2.68 2.6	8 2.67 2.65 2.65 2.65			
					2.69 2.72 2.76 2.8				

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Primary OutFlow Max=0.31 cfs @ 15.40 hrs HW=30.28' (Free Discharge)

_1=RCP_Round 12" (Passes 0.31 cfs of 5.04 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.31 cfs @ 1.69 fps)

-3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond P2: Bioretention Basin 2

Inflow Area = 1.348 ac. 90.58% Impervious, Inflow Depth = 4.40" for 10 yr storm event

Inflow = 6.44 cfs @ 12.07 hrs, Volume= 0.494 af

Outflow = 4.53 cfs @ 12.14 hrs, Volume= 0.439 af, Atten= 30%, Lag= 4.4 min

Primary = 4.53 cfs @ 12.14 hrs, Volume= 0.439 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 31.78' @ 12.14 hrs Surf.Area= 4,444 sf Storage= 6,433 cf

Plug-Flow detention time= 130.4 min calculated for 0.439 af (89% of inflow)

Center-of-Mass det. time= 77.2 min (833.1 - 755.9)

Volume	Inv	ert Ava	il.Stora	e St	orage Description				
#1	30.0	00'	7,449	cf Cı	Custom Stage Data (Irregular)Listed below (Recalc)				
Elevation (feet)		Surf.Area (sq-ft)	Per (fe		Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
30.0	00	2,881	24	5.0	0	0	2,881		
31.0	31.00		37	.0	3,277	3,277	9,026		
32.0	00	4,673	32	0.0	4,172	7,449	11,852		
Device	Routing				Devices				
#1	Primary	30		12.0" Round RCP_Round 12"					
			I	L= 65.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 30.00' / 29.25' S= 0.0115 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf					
#2	Device 1	30			0" W x 9.0" H Vert. Orifice/Grate C= 0.600				
#3	Primary	31	1.50' 6	.0' lon	g x 4.0' breadth	Broad-Crested Re	ectangular Weir		
			H	ead (fe	eet) 0.20 0.40 0.	.60 0.80 1.00 1.20	0 1.40 1.60 1.80 2.00		
			2	.50 3.	00 3.50 4.00 4.5	50 5.00 5.50			
				,	O ,		2.67 2.65 2.66 2.66		
			2	.68 2.	72 2.73 2.76 2.7	9 2.88 3.07 3.32			

Primary OutFlow Max=4.53 cfs @ 12.14 hrs HW=31.78' (Free Discharge)

-1=RCP Round 12" (Passes 2.39 cfs of 4.14 cfs potential flow)

2=Orifice/Grate (Orifice Controls 2.39 cfs @ 3.83 fps)

-3=Broad-Crested Rectangular Weir (Weir Controls 2.13 cfs @ 1.28 fps)

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Summary for Pond P3: Bioretention Basin 3

Inflow Area = 1.348 ac, 42.80% Impervious, Inflow Depth = 2.42" for 10 yr storm event

Inflow = 3.91 cfs @ 12.08 hrs, Volume= 0.271 af

Outflow = 0.71 cfs @ 12.55 hrs, Volume= 0.236 af, Atten= 82%, Lag= 28.0 min

Primary = 0.71 cfs @ 12.55 hrs, Volume= 0.236 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 33.31' @ 12.55 hrs Surf.Area= 5,560 sf Storage= 5,146 cf

Plug-Flow detention time= 164.7 min calculated for 0.236 af (87% of inflow)

Center-of-Mass det. time= 105.4 min (936.8 - 831.5)

Volume	Inve	ert Ava	il.Storage	Storage Descript	ion			
#1	32.0	00'	9,440 cf	Custom Stage D	Custom Stage Data (Irregular)Listed below (Recalc)			
Elevatio		Surf.Area (sq-ft)	Perim (feet		Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
32.0 33.0 34.0)0)0	2,207 4,993 6,927	•	0 0 3,507	0 3,507 9,440	2,207 6,459 12,526		
Device	Routing	Ir	vert Ou	tlet Devices				
#1			L= Inle	12.0" Round RCP_Round 12" L= 35.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 32.00' / 31.00' S= 0.0286 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2 Device 1 32.50' #3 Primary 33.60'		2.50' 6.0 3.60' 5.0 He 2.5 Co	" Vert. Orifice/Gra ' long x 4.0' bread ad (feet) 0.20 0.40 0 3.00 3.50 4.00 ef. (English) 2.38 2	te C= 0.600 lth Broad-Crested 0.60 0.80 1.00 1 4.50 5.00 5.50	Rectangular Weir .20 1.40 1.60 1.80 2.00 7 2.67 2.65 2.66 2.66			

Primary OutFlow Max=0.71 cfs @ 12.55 hrs HW=33.31' (Free Discharge)

—1=RCP_Round 12" (Passes 0.71 cfs of 3.41 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.71 cfs @ 3.61 fps)

-3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Link DP1: Wetland 1

Inflow Area = 4.329 ac, 65.86% Impervious, Inflow Depth > 2.22" for 10 yr storm event

Inflow = 6.03 cfs @ 12.12 hrs, Volume= 0.799 af

Primary = 6.03 cfs @ 12.12 hrs, Volume= 0.799 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

TAUNTON DEPOT PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Summary for Link DP2: Wetland 3

Inflow Area = 1.634 ac, 35.31% Impervious, Inflow Depth > 1.99" for 10 yr storm event

Inflow = 0.97 cfs @ 12.17 hrs, Volume= 0.271 af

Primary = 0.97 cfs @ 12.17 hrs, Volume= 0.271 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

100-Year Storm Event – Proposed

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Depot\HydroCAD\\ \textbf{TAUNTON DEPOT PR} Type III 24-hr 100 yr storm Rainfall=7.00"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentPR 1: PR 1	Runoff Area=1.985 ac 72.34% Impervious Runoff Depth=6.05" Flow Length=200' Tc=5.0 min CN=92 Runoff=13.55 cfs 1.002 af
SubcatchmentPR 2: PR 2	Runoff Area=1.348 ac 90.58% Impervious Runoff Depth=6.64" Flow Length=337' Tc=5.0 min CN=97 Runoff=9.55 cfs 0.746 af
SubcatchmentPR 3: PR 3	Runoff Area=1.348 ac 42.80% Impervious Runoff Depth=4.37" Flow Length=438' Tc=5.3 min CN=77 Runoff=7.05 cfs 0.490 af
SubcatchmentPR 4: PR 4	Runoff Area=0.996 ac 19.48% Impervious Runoff Depth=3.20" Flow Length=117' Tc=5.0 min CN=66 Runoff=3.85 cfs 0.266 af
SubcatchmentPR 5: PR 5	Runoff Area=0.286 ac 0.00% Impervious Runoff Depth=3.10" Flow Length=50' Tc=8.9 min CN=65 Runoff=0.93 cfs 0.074 af
Pond P1: Bioretention Basin 1	Peak Elev=30.66' Storage=27,117 cf Inflow=13.55 cfs 1.002 af Outflow=1.64 cfs 0.593 af
Pond P2: Bioretention Basin 2	Peak Elev=31.97' Storage=7,299 cf Inflow=9.55 cfs 0.746 af Outflow=7.71 cfs 0.691 af
Pond P3: Bioretention Basin 3	Peak Elev=33.84' Storage=8,389 cf Inflow=7.05 cfs 0.490 af Outflow=2.45 cfs 0.455 af
Link DP1: Wetland 1	Inflow=11.45 cfs 1.550 af Primary=11.45 cfs 1.550 af
Link DP2: Wetland 3	Inflow=2.94 cfs 0.529 af Primary=2.94 cfs 0.529 af

Total Runoff Area = 5.963 ac Runoff Volume = 2.578 af Average Runoff Depth = 5.19" 42.51% Pervious = 2.535 ac 57.49% Impervious = 3.428 ac

TAUNTON DEPOT PR

Type III 24-hr 100 yr storm Rainfall=7.00"

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Summary for Subcatchment PR 1: PR 1

Runoff = 13.55 cfs @ 12.07 hrs, Volume= 1.002 af, Depth= 6.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 100 yr storm Rainfall=7.00"

Area	(ac)	CN Des	cription					
1.	1.436 98 Paved parking, HSG B							
0.	.014	39 >75% Grass cover, Good, HSG A						
0.	0.300 61 >75% Grass cover, Good, HSG B							
0.	.235	98 Wat	er Surface	, 0% imp, H	HSG B			
1.	.985	92 Wei	ghted Aver	age				
0.	.549	27.6	66% Pervio	us Area				
1.	.436	72.3	34% Imper	ious Area				
Tc	Length	•		Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
0.7	50	0.0180	1.18		Sheet Flow, Impervious B			
					Smooth surfaces n= 0.011 P2= 3.40"			
0.7	150	0.0270	3.34		Shallow Concentrated Flow, Impervious B			
					Paved Kv= 20.3 fps			
3.6					Direct Entry, <5 min Tc Adjustment			
5.0	200	Total						

Summary for Subcatchment PR 2: PR 2

Runoff = 9.55 cfs @ 12.07 hrs, Volume= 0.746 af, Depth= 6.64"

	Area (ac)	CN	Description				
	1.062	98	Paved parking, HSG B				
	0.159	98	Paved parking, HSG D				
	0.008 61 >75% Grass cover, Good, HSG B						
	0.035	80	>75% Grass cover, Good, HSG D				
	0.007	98 Water Surface, 0% imp, HSG B					
	0.077	98	Water Surface, 0% imp, HSG D				
	Weighted Average						
	0.127		9.42% Pervious Area				
	1.221		90.58% Impervious Area				

TAUNTON DEPOT PR

Type III 24-hr 100 yr storm Rainfall=7.00"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
•	(111111)			(10000)	(010)	
	0.8	50	0.0120	1.01		Sheet Flow, Impervious B
						Smooth surfaces n= 0.011 P2= 3.40"
	1.7	287	0.0200	2.87		Shallow Concentrated Flow, Impervious B
						Paved Kv= 20.3 fps
_	2.5					Direct Entry, <5 min Tc Adjustment
•	5.0	337	Total			

Summary for Subcatchment PR 3: PR 3

Runoff = 7.05 cfs @ 12.08 hrs, Volume= 0.490 af, Depth= 4.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 100 yr storm Rainfall=7.00"

Area	(ac) C	N Des	cription		
0.	.577 9	98 Pave	ed parking	, HSG B	
0.	.771 6	61 >75°	% Grass c	over, Good	, HSG B
		77 Wei			
	.771		0% Pervio		
0.	.577	42.8	0% Imper	vious Area	
т.	l a .a a.tla	01	\/_l:	0	Description
Tc (min)	Length	Slope	Velocity	Capacity	Description
<u>(min)</u>	(feet)	(ft/ft)	(ft/sec)	(cfs)	
0.7	50	0.0200	1.23		Sheet Flow, Impervious B
					Smooth surfaces n= 0.011 P2= 3.40"
0.7	114	0.0180	2.72		Shallow Concentrated Flow, Impervious B
		0.0470	0.04		Paved Kv= 20.3 fps
1.1	59	0.0170	0.91		Shallow Concentrated Flow, Landscape B
0.0	450	0.0000	4.40		Short Grass Pasture Kv= 7.0 fps
2.3	159	0.0060	1.16		Shallow Concentrated Flow, Landscape B
0.5	50	0.0400	0.04		Grassed Waterway Kv= 15.0 fps
0.5	56	0.0180	2.01		Shallow Concentrated Flow, Landscape B
					Grassed Waterway Kv= 15.0 fps
5.3	438	Total			

Summary for Subcatchment PR 4: PR 4

Runoff = 3.85 cfs @ 12.08 hrs, Volume= 0.266 af, Depth= 3.20"

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Type III 24-hr 100 yr storm Rainfall=7.00"

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Area	(ac) C	N Desc	cription				
0.	194 9	8 Pave	ed parking	, HSG B			
0.	001 3	0 Woo	Woods, Good, HSG A				
0.	293 5	5 Woo	ds, Good,	HSG B			
0.	005 7	7 Woo	ds, Good,	HSG D			
0.	047 3	9 >759	% Grass co	over, Good,	HSG A		
0.	420 6	1 >759	% Grass c	over, Good,	HSG B		
0.	036 8	0 >759	% Grass co	over, Good,	HSG D		
0.	996 6	6 Weig	ghted Aver	age			
0.	802	80.5	2% Pervio	us Area			
0.	194	19.4	8% Imperv	ious Area			
Tc	Length	Slope		Capacity	Description		
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
2.0							
3.0	38	0.0530	0.21		Sheet Flow, Landscape B		
					Grass: Short n= 0.150 P2= 3.40"		
0.1		0.0530 0.0540	0.21 1.38		Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B		
0.1		0.0540	1.38		Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B Smooth surfaces n= 0.011 P2= 3.40"		
					Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B Smooth surfaces n= 0.011 P2= 3.40" Shallow Concentrated Flow, Impervious B		
0.1	12 47	0.0540 0.0210	1.38 2.94		Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B Smooth surfaces n= 0.011 P2= 3.40" Shallow Concentrated Flow, Impervious B Paved Kv= 20.3 fps		
0.1	12	0.0540	1.38		Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B Smooth surfaces n= 0.011 P2= 3.40" Shallow Concentrated Flow, Impervious B Paved Kv= 20.3 fps Shallow Concentrated Flow, Landscape B		
0.1 0.3 0.3	12 47	0.0540 0.0210	1.38 2.94		Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B Smooth surfaces n= 0.011 P2= 3.40" Shallow Concentrated Flow, Impervious B Paved Kv= 20.3 fps Shallow Concentrated Flow, Landscape B Short Grass Pasture Kv= 7.0 fps		
0.1	12 47	0.0540 0.0210	1.38 2.94		Grass: Short n= 0.150 P2= 3.40" Sheet Flow, Impervious B Smooth surfaces n= 0.011 P2= 3.40" Shallow Concentrated Flow, Impervious B Paved Kv= 20.3 fps Shallow Concentrated Flow, Landscape B		

Summary for Subcatchment PR 5: PR 5

Runoff = 0.93 cfs @ 12.13 hrs, Volume= 0.074 af, Depth= 3.10"

Area	(ac)	CN	Description
0	.055	61	>75% Grass cover, Good, HSG B
0	>75% Grass cover, Good, HSG D		
0	.118	55	Woods, Good, HSG B
0	.102	77	Woods, Good, HSG D
0	.286	65	Weighted Average
0	.286		100.00% Pervious Area

TAUNTON DEPOT PR

Type III 24-hr 100 yr storm Rainfall=7.00"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	3	0.3300	0.27		Sheet Flow, Landscape B
					Grass: Short n= 0.150 P2= 3.40"
1.4	11	0.0310	0.13		Sheet Flow, Landscape B
					Grass: Short n= 0.150 P2= 3.40"
5.0	21	0.0310	0.07		Sheet Flow, Woods D
					Woods: Light underbrush n= 0.400 P2= 3.40"
2.3	15	0.1100	0.11		Sheet Flow, Woods D
					Woods: Light underbrush n= 0.400 P2= 3.40"
8.9	50	Total			

Summary for Pond P1: Bioretention Basin 1

Inflow Area = 1.985 ac, 72.34% Impervious, Inflow Depth = 6.05" for 100 yr storm event

Inflow = 13.55 cfs @ 12.07 hrs, Volume= 1.002 af

Outflow = 1.64 cfs @ 12.61 hrs, Volume= 0.593 af, Atten= 88%, Lag= 32.4 min

Primary = 1.64 cfs @ 12.61 hrs, Volume= 0.593 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 30.66' @ 12.61 hrs Surf.Area= 17,514 sf Storage= 27,117 cf

Plug-Flow detention time= 343.4 min calculated for 0.593 af (59% of inflow) Center-of-Mass det. time= 238.0 min (1,009.8 - 771.8)

Volume	Inve	ert Avail.S	Storage	Storage Description				
#1	28.0	00' 33	3,480 cf	Custom Stage Data (Irregular)Listed below (Recalc)		below (Recalc)		
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area		
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)		
28.0	00	3,790	237.0	0	0	3,790		
29.0	00	8,407	366.0	5,947	5,947	9,987		
30.0	00	13,678	468.0	10,936	16,883	16,770		
31.0	00	19,697	573.0	16,596	33,480	25,484		
Device	Routing	Inve	ert Outle	et Devices				
#1	Primary	28.0		12.0" Round RCP_Round 12"				
				L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 28.00' / 27.00' S= 0.0200 '/' Cc= 0.900				
				= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2 Device		30.0		.0" W x 4.0" H Vert. Orifice/Grate C= 0.600				
#3	#3 Primary 30.50' 6		Head	.0' long x 6.0' breadth Broad-Crested Rectangular Weir lead (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 .50 3.00 3.50 4.00 4.50 5.00 5.50				

2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65

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Primary OutFlow Max=1.64 cfs @ 12.61 hrs HW=30.66' (Free Discharge)

1=RCP_Round 12" (Passes 0.75 cfs of 5.56 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.75 cfs @ 3.36 fps)

-3=Broad-Crested Rectangular Weir (Weir Controls 0.89 cfs @ 0.94 fps)

Summary for Pond P2: Bioretention Basin 2

Inflow Area = 1.348 ac, 90.58% Impervious, Inflow Depth = 6.64" for 100 yr storm event

Inflow = 9.55 cfs @ 12.07 hrs, Volume= 0.746 af

Outflow = 7.71 cfs @ 12.12 hrs, Volume= 0.691 af, Atten= 19%, Lag= 3.3 min

Primary = 7.71 cfs @ 12.12 hrs, Volume= 0.691 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 31.97' @ 12.12 hrs Surf.Area= 4,640 sf Storage= 7,299 cf

Plug-Flow detention time= 104.2 min calculated for 0.691 af (93% of inflow)

Center-of-Mass det. time= 64.4 min (812.8 - 748.4)

Volume	Inve	ert Ava	il.Storage	Storage Descript	ion	
#1 3		00'	7,449 cf	Custom Stage D	Data (Irregular)List	ed below (Recalc)
Elevatio		Surf.Area (sq-ft)	Perim (feet)		Cum.Store (cubic-feet)	Wet.Area (sq-ft)
30.0 31.0 32.0	00	2,881 3,690 4,673	246.0 371.0 320.0	3,277	0 3,277 7,449	2,881 9,026 11,852
Device	Routing	In	vert Ou	tlet Devices		
#1 Primary		L= 6 Inlet		0" Round RCP_Round 12" 65.0' RCP, sq.cut end projecting, Ke= 0.500 et / Outlet Invert= 30.00' / 29.25' S= 0.0115 '/' Cc= 0.900 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf		
#2 #3			0.75' 10. .50' 6.0 He: 2.5 Coo	"W x 9.0" H Vert. Orifice/Grate C= 0.600 long x 4.0' breadth Broad-Crested Rectangular Weir d (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 3.00 3.50 4.00 4.50 5.00 5.50 f. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.72 2.73 2.76 2.79 2.88 3.07 3.32		

Primary OutFlow Max=7.70 cfs @ 12.12 hrs HW=31.97' (Free Discharge)

1=RCP_Round 12" (Passes 2.74 cfs of 4.39 cfs potential flow)

2=Orifice/Grate (Orifice Controls 2.74 cfs @ 4.38 fps)

-3=Broad-Crested Rectangular Weir (Weir Controls 4.96 cfs @ 1.77 fps)

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Summary for Pond P3: Bioretention Basin 3

Inflow Area = 1.348 ac, 42.80% Impervious, Inflow Depth = 4.37" for 100 yr storm event

Inflow = 7.05 cfs @ 12.08 hrs, Volume= 0.490 af

Outflow = 2.45 cfs @ 12.36 hrs, Volume= 0.455 af, Atten= 65%, Lag= 16.8 min

Primary = 2.45 cfs @ 12.36 hrs, Volume= 0.455 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 33.84' @ 12.36 hrs Surf.Area= 6,606 sf Storage= 8,389 cf

Plug-Flow detention time= 132.1 min calculated for 0.455 af (93% of inflow)

Center-of-Mass det. time= 94.3 min (908.7 - 814.5)

Volume	Inve	ert Ava	il.Storag	Storage Descrip	tion			
#1	32.0	00'	9,440 c	Custom Stage	Data (Irregular) Lis	ted below (Recalc)	_	
Elevation (fee		Surf.Area (sq-ft)	Perir (fee			Wet.Area (sq-ft)		
32.0		2,207			•	2,207		
33.0 34.0	-	4,993 6,927	291 401		,	6,459 12,526		
01.0	,,	0,021	101	0,004	0,110	12,020		
Device	Routing	Ir	vert O	tlet Devices			_	
#1	Primary	32	L=	12.0" Round RCP_Round 12" L= 35.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 32.00' / 31.00' S= 0.0286 '/' Cc= 0.900				
						ections, Flow Area= 0.79 sf		
#2	Device 1	32	2.50' 6.	" Vert. Orifice/Gra	ate C= 0.600			
#3	Primary	33				d Rectangular Weir		
			2. C	3.00 3.50 4.00	4.50 5.00 5.50 2.54 2.69 2.68 2	1.20 1.40 1.60 1.80 2.00 .67 2.67 2.65 2.66 2.66 3.32		

Primary OutFlow Max=2.45 cfs @ 12.36 hrs HW=33.84' (Free Discharge)

-1=RCP_Round 12" (Passes 0.99 cfs of 4.39 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.99 cfs @ 5.04 fps)

-3=Broad-Crested Rectangular Weir (Weir Controls 1.46 cfs @ 1.19 fps)

Summary for Link DP1: Wetland 1

Inflow Area = 4.329 ac, 65.86% Impervious, Inflow Depth > 4.30" for 100 yr storm event

Inflow = 11.45 cfs @ 12.11 hrs, Volume= 1.550 af

Primary = 11.45 cfs @ 12.11 hrs, Volume= 1.550 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

\\Vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Taunton Depot\HydroCAD\

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Summary for Link DP2: Wetland 3

Inflow Area = 1.634 ac, 35.31% Impervious, Inflow Depth > 3.88" for 100 yr storm event

Inflow = 2.94 cfs @ 12.33 hrs, Volume= 0.529 af

Primary = 2.94 cfs @ 12.33 hrs, Volume= 0.529 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station





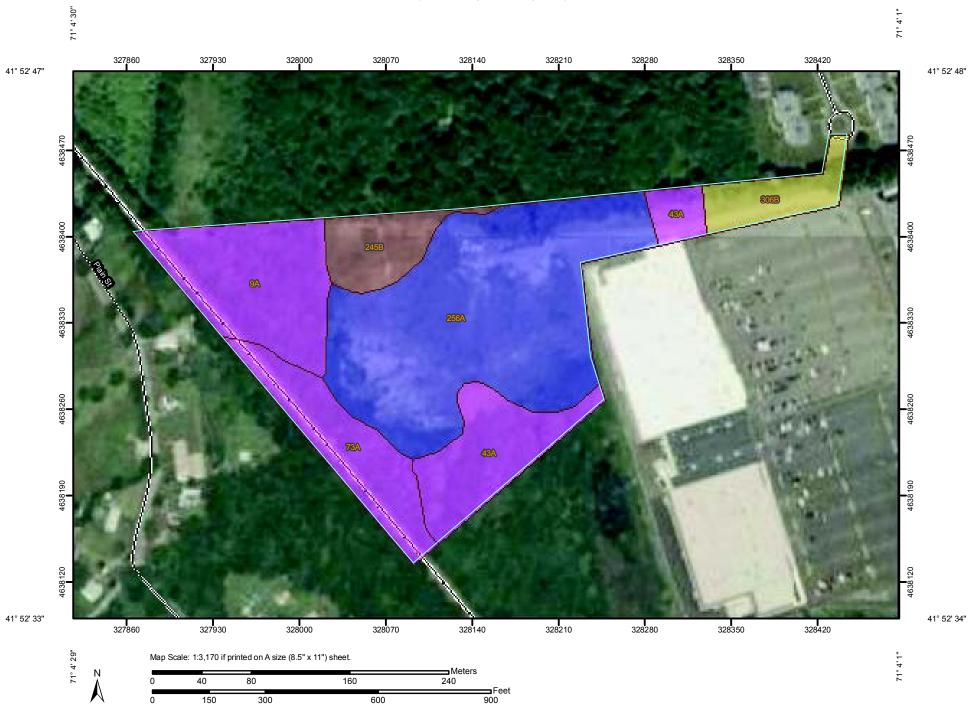
Appendix C Standard 3 Computations and Supporting Information



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Taunton Depot Station

Soil Evaluation and Analysis



MAP LEGEND MAP INFORMATION Map Scale: 1:3,170 if printed on A size (8.5" × 11") sheet. Area of Interest (AOI) Area of Interest (AOI) The soil surveys that comprise your AOI were mapped at 1:20,000. Soils Warning: Soil Map may not be valid at this scale. Soil Map Units Enlargement of maps beyond the scale of mapping can cause Soil Ratings misunderstanding of the detail of mapping and accuracy of soil line Α placement. The maps do not show the small areas of contrasting A/D soils that could have been shown at a more detailed scale. В Please rely on the bar scale on each map sheet for accurate map measurements. B/D С Source of Map: Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov C/D Coordinate System: UTM Zone 19N NAD83 D This product is generated from the USDA-NRCS certified data as of the version date(s) listed below. Not rated or not available **Political Features** Soil Survey Area: Bristol County, Massachusetts, Northern Part Survey Area Data: Version 5, Jul 27, 2010 Cities Date(s) aerial images were photographed: 8/14/2003; 7/10/2003; **Water Features** 8/15/2003 Streams and Canals The orthophoto or other base map on which the soil lines were Transportation compiled and digitized probably differs from the background +++ imagery displayed on these maps. As a result, some minor shifting Interstate Highways of map unit boundaries may be evident. **US Routes** Major Roads Local Roads \sim

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bristol County, Massachusetts, Northern Part (MA602)						
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI		
9A	Birdsall silt loam, 0 to 3 percent slopes	D	3.1	16.8%		
43A	Scarboro mucky loamy fine sand, 0 to 3 percent slopes	D	2.5	13.9%		
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	2.1	11.4%		
245B	Hinckley sandy loam, 3 to 8 percent slopes	А	1.2	6.6%		
256A	Deerfield loamy sand, 0 to 3 percent slopes	В	8.3	45.7%		
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	С	1.0	5.7%		
Totals for Area of Inte	erest	18.2	100.0%			

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



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Taunton Depot Station

Required and Provided Recharge Volumes



Recharge Calculations

Project Name: Taunton Depot StationProj. No.:10111.00Project Location: Taunton, MADate:12-Apr-12

Calculated by: PAC

Checked by:

Proposed Impervious Surface Summary

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
1	0.0	1.4	0.0	0.0	1.4
2	0.0	1.1	0.0	0.2	1.2
3	0.0	0.6	0.0	0.0	0.6
4	0.0	0.1	0.0	0.0	0.1
5	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	3.2	0.0	0.2	3.3

Required Recharge Volume (Cubic Feet)

HSG	Area	Recharge Depth *	Volume
	(acres)	(in.)	(c.f.)
Α	0.0	0.60	0
В	3.2	0.35	4,014
С	0.0	0.25	0
D	0.2	0.10	58
TOTAL		_	4,071

^{*} Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet)

Basin P1	17,141	
Basin P2	2,388	
Basin P3	1,452	
Total	20,981	c.f.



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Taunton Depot Station

72-hour Drawdown Analysis



Drawdown Calculations

Project Name: Taunton Depot Station

Proj. No.: 10111.00

Date: 5/18/2012

PAC

Project Location: Taunton, MA Calculated by:

Bioretention Basin - 1

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
28.00	3,790	0
29.00	8,407	6,099
30.00	13,678	17,141
TOTAL		17,141

Assumptions:

Recharge Rate: 1.00 in/hr

Drawdown Time: 54.3 hours

Bioretention Basin - 2

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
30.00	2,881	0
30.75	3,488	2,388
TOTAL		2,388

Assumptions:

Recharge Rate: 1.00 in/hr

Drawdown Time: 9.9 hours

Bioretention Basin - 3

Infiltration volumes provided in basin below lowest outlet.

Basin Volume Below Outlet

Elevation	Area (s.f.)	Incremental Volume (c.f.)
32.00	2,207	0
32.50	3,600	1,452
TOTAL		1,452

Assumptions:

Recharge Rate: 1.00 in/hr

Drawdown Time: 7.9 hours



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Taunton Depot Station





Appendix D Standard 4 Computations and Supporting Information



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

Water Quality Volume Calculations



Water Quality Volume Calculations

Project Name: Taunton Depot Station Proj. No.: 10111.00 Project Location: Taunton, MA Date: 4/13/2012 Calculated by: PAC

Bioretention	Basin	P1
---------------------	-------	-----------

(runoff from Area PR1)

Total Impervious Area = 1.44 Acres

Required:

Runoff Depth to Required be Treated (in.) Volume (c.f.) Forebay Volume 521 0.1 0.5 2,606

Provided:

Water Quality Volume

Cumulative **Bioretention Basin** Elevation Area (s.f.) Volume (c.f.) 28.0 3,790 0 29.0 8,407 6,099 30.0 13,678 17,141

Bioretention Basin P2

(runoff from Area PR2)

Total Impervious Area = 1.22 Acres

Required:

Runoff Depth to Required be Treated (in.) Volume (c.f.) 443 Forebay Volume 0.1 Water Quality Volume 0.5 2,216

Provided:

Cumulative **Bioretention Basin** Elevation Area (s.f.) Volume (c.f.) 2,881 30.0 0 3,488 30.75 2,388

Bioretention Basin P3

(runoff from Area PR3)

Total Impervious Area = 0.58 Acres

Required:

Runoff Depth to Required Volume (c.f.) be Treated (in.) Forebay Volume 209 0.1 Water Quality Volume 0.5 1,047

Provided:

Cumulative **Bioretention Basin** Elevation Area (s.f.) Volume (c.f.) 32.0 2,207 0 32.5 3,600 1,452



FEIS/FEIR Technical Report Stormwater

Taunton Depot Station

TSS Removal Worksheets

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name: Project Number: Location:

Discharge Point:

Drainage Area(s):

Taunton Depot Station
10111.00
Taunton, MA
DP1
PR 1, PR 2

Sheet: 1 of 3

Date: 12-Apr-2012 PAC

Computed by: PA

Α

В

С

D

Ε

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Bioretention Area	90%	1.00	0.90	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

Treatment Train
TSS Removal =

90%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc. Consulting Engineers and Planners 101 Walnut Street Watertown, MA 02471 (617) 924-1770

Project Name: Sheet: 2 of 3 **Taunton Depot Station Project Number:** 2-May-2012 10111.00 Date: Computed by: Location: Taunton, MA **PAC**

DP1 Drainage Area(s): PR 4 (Pump Station Access)

Discharge Point:

D Ε Α В

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Grass Channel	50%	1.00	0.50	0.50
	0%	0.50	0.00	0.50
	0%	0.50	0.00	0.50
	0%	0.50	0.00	0.50
	0%	0.50	0.00	0.50

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

Treatment Train TSS Removal =

Checked by:

50%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)

TSS Removal Calculation Worksheet



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name: Taunton Depot Station
Project Number: 10111.00
Location: Taunton, MA
Discharge Point: Drainage Area(s): PR 3

Sheet: 3 of 3
Date: 12-Apr-2012
Computed by: PAC
Checked by:

A B C D E

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Bioretention Area	90%	1.00	0.90	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

Treatment Train
TSS Removal =

90%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)



FEIS/FEIR Technical Report Stormwater Taunton Depot Station

Appendix E Geotechnical Report



Date March 29, 2012

To Rick Carey, Natasha Velickovic - VHB

From Paul Murphy, Da Ha, Peter Chou - Jacobs

Subject MBTA South Coast Rail (New Bedford/Fall River Commuter Rail Extension)

Taunton Depot Station Geotechnical Design Memorandum

Taunton, MA

Project No. E2347101

INTRODUCTION

The South Coast Rail project will restore passenger rail transportation from South Station in Boston to the cities of Fall River and New Bedford along an existing rail freight corridor running south from Taunton to Fall River and New Bedford. The project will include the construction of several existing and new passenger stations and two terminal layover facilities. This geotechnical design memorandum presents the foundation design considerations for the new station platform at the proposed Taunton Depot Station in Taunton, Massachusetts. The design recommendations presented in this report are based on the results of subsurface investigation performed by Jacobs in 2002 and 2010.

Existing Conditions

The proposed Taunton Depot Station site is behind the Target Plaza off of Route 140 in Taunton (Figure 1). Except for the two railroad tracks along the west side of the site, the site is currently undeveloped, with half the site cleared and half the site with forests and wetlands. Six large floor-plan retail buildings on the adjacent shopping plaza contain numerous retail establishments. Existing grades at the platform location range from elevations 38.6 to 32.9 feet (NGVD29 Datum), generally sloping downward from south to north.

Proposed Construction

Current station plans are to construct an 800 foot long, 12 foot wide high level center platform adjacent to the existing tracks with some track relocation required, as well as the addition of a third track, a new parking area (with access roads) and a new drop-off area. The tracks and the platform will be constructed on an embankment supported by 3 to 14 feet high retaining walls on both the west and east sides of the tracks.

Access to the platform will be from a new ramp/stair structure along the east side of the tracks with a pedestrian bridge over the wetland and northbound tracks to the platform. Approximately 320 feet of the platform will be under a new station canopy. The details of new track layout (including grading), associated sidewalks and ramps of the proposed station are still under development at the time of this report preparation. However, we anticipate that about 3-8 feet of fill will be placed at the site to raise the grade at the track level and platform area. This report focuses on the foundations for the platform, the ramp/stair structure and the pedestrian bridge.

Proj. No. E2347101

SCOPE OF WORK

This memorandum was prepared by Jacobs in accordance with the scope of work under the contract between Jacobs and VHB for work on the New Bedford/Fall River Commuter Rail Line Extension Project for Massachusetts Bay Transportation Authority (MBTA). The geotechnical work included the following tasks:

- Perform a geotechnical exploration and laboratory testing program;
- Report and interpret the results of the exploration and laboratory testing program; and
- Provide geotechnical recommendations for design and construction of the platform foundations.

The Jacobs scope of work did not include environmental analyses to assess the potential presence of any hazardous materials at the project site or potential impacts to adjacent structures during construction.

LOCAL GEOLOGY

The site is located in the Narragansett Basin of southeastern Massachusetts. The rocks in the Narragansett Basin consist mostly of lightly metamorphosed shale and sandstone of Pennsylvanian and Permian age. The Taunton Depot site is located in the area of the Rhode Island Formation. The rocks encountered in the borings included coarse grained, weathered sandstone and dark gray siltstone. The upper few feet of the rock has been weathered to soil and was sampled by Standard Penetration Tests in some borings. The less-weathered rock was cored with RQD values ranging from 18 to 50. The cored rock was partially weathered and had both high-angle and bedding-plane joints, which had a dip of about 10 to 20 degrees.

GEOTECHNICAL INVESTIGATION

Jacobs planned the subsurface exploration program and retained the drilling contractors to perform the explorations. The results of the explorations were presented in geotechnical data reports entitled "New Bedford Line – South of Weir Junction Geotechnical Data Report" and "South Coast Rail, Jacobs Geotechnical Data Report" submitted in 2002 and 2010, respectively. Six borings (TD-1 and NBA-12 to NBA-16) were conducted along the proposed station platform and fifteen borings (TD-2 to TD-6, NBS-1 to NBS-5 and NBS-8 to NBS-12) were drilled in the general vicinity of the proposed parking lot and access roads. Boring locations are shown on the Subsurface Exploration Plan (Figures 2 and 3).

The 2010 borings were drilled by New Hampshire Boring using either a D-50 ATV mounted drill or a CME-75 truck mounted drill rig. The borings were advanced through the soil by wash boring methods using a 4-inch casing and roller bit with water. Standard penetration tests (SPT), consisting of 140-pound hammer dropping 30 inches on a standard 2-inch-diameter (OD) split-spoon sampler, were performed with a safety hammer to establish the consistency of the subsurface soils. The SPT's were typically performed at five foot intervals of depth. The obtained samples were sealed in glass jars to retain their natural moisture. Bedrock was encountered and cored in some of the borings during exploration.

The borings were observed and logged by a representative from Jacobs. The soil samples were classified in the field in accordance with ASTM D-2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) by Jacobs' representative, and appropriate stratum breaks were interpolated from drilling and sampling observations. The boring logs were prepared by Jacobs based on the field classifications and laboratory testing, and are presented in Appendix A.

Note the vertical control datum of the 2002 borings was also the National Geodetic Vertical Datum (NGVD) of 1929, which is generally referred to as U.S. Coast Guard mean sea level.

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LABORATORY TESTING

The results of the laboratory testing were previously submitted to VHB in reports entitled "South Coast Rail, Jacobs Geotechnical Data Report", dated November 2010, and "New Bedford Line – South of Weir Junction Geotechnical Data Report", dated October 2002.

Grain size distribution analyses were performed to evaluate the gradation of the fill material and natural granular soils for potential reuse as backfill, if needed, and to confirm sample classifications. The graduation analyses are summarized in Table 1 below and are presented in Appendix B.

Table 1: Laboratory Soil Classification Summary

Table 1. Laboratory 5001 Classification Summary							
BORING NO.	SAMPLE NO.	ELEVATION (FEET)	USCS SOIL CLASSIFICATION	W (%)	GRAVEL (%)	SAND (%)	FINES (%)
TD-05	S2	33.9	Silty Sand (SM)	NT	3.1	64.7	32.2
NBA-12	SS-2 *	28.8	Silty sand (SM)	NT	0	58	42
	SS-4	18.8	Silt with sand (ML)	NT	0	25	75
	SS-5	13.8	Sandy silt (ML)	NT	0	43	57
	SS-2 *	29.9	Silty sand (SM)	NT	1	58	41
NBA-13 MW	SS-3 *	24.9	Sandy silt (ML)	NT	1	34	65
	SS-5	14.9	Sandy silt (ML)		1	28	71
NBA-15	SS-2 *	32.1	Silty sand with gravel (SM)	NT	29	56	15
SS-4		22.1	Silty sand with gravel (SM)	NT	23	43	34
SS-1 31.6		31.6	Silty sand with gravel (SM)	NT	39	42	19
NBS-03	SS-3	21.6	Poorly graded sand with gravel (SP)	NT	19	77	4
	SS-4	16.6	Sandy silt (ML)	NT	13	34	53
NBS-05 MW	SS-1	38.0	Silty sand (SM)	NT	4	62	34
	SS-2	33.0	Silty sand with gravel (SM)	NT	15	58	27
	SS-3	28.0	Silty sand (SM)	NT	13	41	46
NBS-12	SS-1	31.9	Silt with sand (ML)	NT	0	18	82
	SS-2	27.9	Silt (ML)	NT	0	7	93
	SS-3	22.9	Silty gravel with sand (GM)	NT	42	36	22

Where: w = natural moisture content, NT = Not Tested. * = Fill

SUBSURFACE CONDITIONS

The subsurface conditions at the site were inferred from the boring data collected for the Taunton Depot Station project, with some interpretations. The subsurface conditions encountered at the station platform area generally consist of a layer of granular fill with thickness of about 3 to 14 feet, underlain by a granular soil layer with thickness ranging from 4 to 14 feet overlying bedrock. Bedrock was encountered at a depth of about 14.5 to 22 feet in the platform area, corresponding to approximately elevations 20.1 to 11.0 feet.

In the vicinity of the proposed parking lot and access road areas, fill materials with thicknesses ranging from approximately 0 to 3 feet were encountered. Bedrock was encountered at a depth about 12.0 to 12.5 feet (corresponding to elevations 17.9 to 15.1 feet).

Subsurface soil conditions are summarized in Table 2 and discussed below.

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Table 2: Summary of Subsurface Conditions at Borings

Table 2: Summary of Subsurface Conditions at Borings							
BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
Platform Borings							
TD-1 OW	33.0	3.0	30.0	6.0	1.0	27.8	Well screened from 22 to 32 ft.
NBA-12	32.8	12	20.8	NE	7.3	23.3	Organic silty sand encountered from 12.0 to 15.5 ft.
NBA-13 MW	33.9	14	19.9	NE	8.4	20.5	Well screened from 12.8 to 22.8 ft.
NBA-14	34.6	11	23.6	20.1	5.6	23.9	Large boulders. Argillite rock may be bedrock or boulder.
NBA-15	36.1	12	24.1	10.6	10.6	27.1	Possible top of weathered rock at Elev. 13.1'.
NBA-16	38.6	11	27.6	NE	23.1	35.6	
Site Borings							
TD-2	30.6	3.0	27.6	NE	6.6	28.6	
TD-3	30.7	3.0	27.7	NE	17.4	28.2	
TD-4	32.8	3.0	29.8	NE	17.8	30.8	
TD-5	36.9	0	36.9	NE	21.9	32.9	
TD-6 OW	29.9	3.0	26.9	16.9	16.9	28.9	Well screened from 8 to 13 ft.
NBS-1	27.6	0	27.6	12.1	12.1	27.1	
NBS-2	38.0	0	38.0	NE	22.5	36.3	
NBS-3	31.6	0	31.6	NE	15.1	28.6	Auger Boring.
NBS-4	30.0	0	30.0	NE	5.0	29.5	
NBS-5 MW	38.0	0	38.0	NE	21.5	32.5	Auger Boring.
NBS-8, 8A	28.8	0	28.8	NE	12.3	23.8	Refusal @ 11'. Offset. Auger Boring.
NBS-9	36.7	0	36.7	NE	20.2	32.7	Auger Boring.
NBS-10,A,B,C	32.2	0	32.2	17.5	17.5	29.2	Many drilling refusals. Boulders. Refusal @ BOB. Auger Boring.
NBS-11	34.9	0	34.9	18.7	18.7	Dry	Boulders. Refusal@ BOB. Auger Boring.
NBS-12, 12A	31.9	0	31.9	7.9	7.9	27.9	Boulders. Refusal @ 16'. Offset. Refusal @ BOB.
NE: Not encountered at the boring during drilling. Dry: Dry borehole observed							

Soil conditions in the platform area generally consisted of the following:

Fill: The fill layer typically consists of mostly granular, loose to dense sand and gravel with trace silt. Top 2 feet of fill may contain slag. The fill layer is generally about 3 to 14 feet in the platform area, and 3 feet or less at all other areas.

Organic Silt: A 3.5 foot thick layer of organic silt was encountered from approximately elevation 12.0 to 15.5 feet at boring NBA-12 at the north side of the platform. Note boring NBA-12 is located adjacent to a wetland area. Organic soils may also exist near other wetland areas at the site.

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Natural Granular Deposits: In the platform area, the natural soil deposits below the fill generally consist of predominantly sandy silt and silty sand with up to 25% gravel. These deposits are loose to very dense with Standard Penetration Test (SPT) N-values ranging between 5 and 98 blows per foot (bpf).

Glacial Till: Dense glacial till was encountered at boring TD-1 at elevations ranging from 25.0 to 16.0 feet, and consisted of lean clay with up to 20% sand and gravel. Numerous boulders were encountered in the glacial till.

Bedrock: Bedrock was encountered in the platform area at a depth of about 14.5 to 22 feet below existing ground surface, corresponding to approximately elevations 20.1 to 11.0 feet. The bedrock was soft, jointed, slightly weathered SILTSTONE (TD-1) or moderately hard, very slightly weathered ARGILLITE (NBA-14). Bedrock RQD values at the platform range from 50% to 95%.

Hard, moderately weathered, moderately to highly fractured SANDSTONE (TD-2) was also encountered at elevation 22.6 feet in the pedestrian ramp area. Bedrock RQD values range from 18% to 27%.

Groundwater: Groundwater levels were measured in the observation wells and in test borings using a weighted tape during and at completion of drilling. The data indicated the groundwater level ranged from approximate elevations 35.6 to 23.3 feet along the platform alignment, and from elevations 36.3 to 23.8 feet in the general area of the proposed parking lot. The use of wash boring techniques for some of the soil borings may have artificially increased the water level readings due to the addition of water to the borings. Trapped/perched water is also commonly seen at a higher elevation within existing fill and silty materials. The longer term water level readings taken at Boring TD–1 OW on July 7, 2010 and September 12, 2011 indicated the water at a depth of about 8 feet (Elevation 25.0 feet) and 5.2 feet (Elevation 27.8 feet), respectively. The longer term water level readings taken at Boring TD–6 OW on July 7, 2010 and September 12, 2011 indicated the water at a depth of about 3.5 feet (Elevation 26.4 feet) and 1.0 feet (Elevation 28.9 feet), respectively. Based upon these short-term observations and readings from the observation wells, it is anticipated that the groundwater could be within 3 to 5 feet below existing grade at the platform area and within 1 to 3 feet below existing grade in the parking lot area.

Groundwater levels should be expected to fluctuate with rainfall and other seasonal variations. More long-term observations would be required to evaluate true groundwater levels and their influence on planned construction. Local and periodic variations of ground water elevations may also be influenced by local subsurface drainage, leaking water or sewer pipes, and precipitation.

GEOTECHNICAL RECOMMENDATIONS

Due to variable thickness and consistency of the fill materials within the platform area, it is recommended to use ground improvement techniques to minimize differential settlement and to improve bearing capacity of the foundation soils. The ground should be improved with aggregate stone columns or rammed aggregate piers (RAPs). Stone columns and RAPs create stiff reinforcing elements in the foundation soil mass, thereby improving the soil bearing capacity.

As an alternative, the proposed station platforms can be supported on drilled micropiles extending through unsuitable soils (i.e., existing deep uncontrolled fills and organic soil layers) and bearing into competent natural soils. The use of deep foundations can also minimize the construction impacts on the existing track considering the existing track is active. The same type of foundation should be used for the pedestrian bridge to minimize any differential settlement. Due to the relatively shallow depth to dense to very dense natural soils in the ramp/stair structure area, it may be possible to use shallow spread footings to support this structure.

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Platform and canopy design loads were not available at the time of this report preparation. However, it is anticipated that the station platform will be lightly (axially) loaded with limited horizontal forces from wind and seismic loads.

The following paragraphs provide project specific geotechnical recommendations for foundation soil preparation, structural fill/backfill placement, and design and construction of spread footings.

Ground Improvement

The stone column technique, also known as vibro-replacement or vibro-displacement, is a ground improvement process where vertical columns of compacted aggregate are formed through the soils to be improved. These columns result in considerable vertical load carrying capacity and improved shear resistance in the soil mass. The strength parameters of the stone columns-soil composite system can be estimated based on the reference FHWA/RD-83/026 and Priebe (1995). The rammed aggregate pier support elements are generally constructed by drilling a 18- to 36-inch diameter hole, removing or displacing the volume of soil, and then building a bottom bulb of clean, open-graded stone. The rammed aggregate pier is built on top of the bottom bulb, using well-graded highway base course stone placed in thin lifts (12-inches compacted thickness). The result of construction is a reinforced zone of soils directly beneath the foundations. Where subsurface conditions are such that an open hole is difficult to be maintained, the displacement rammed aggregate support elements (Impact System) can be used. In this method, the displacement rammed aggregate piers are installed by driving a variable-diameter mandrel into the soil, thereby displacing the soil laterally to form a cavity, and then filling the ensuing cavity by ramming thin lifts of open-graded aggregate within the cavity as the mandrel is retrieved from the hole.

Drilled Micropiles

Micropiles mainly rely on the grout/ground skin friction (bond) to transfer loads to the ground, since the pile displacement required to mobilize the frictional resistance is significantly less than that to mobilize end bearing. Micropiles should be designed to resist axial, lateral and eccentric loading conditions.

Based on our review of geological conditions and the split-spoon soil samples, it is our opinion that the skin friction within the existing fill and organic soils should be neglected. Type B pressure grouting or Types C and D post-grouting procedures should be required for micropile installation at this station for micropiles installed in soils. For micropiles installed in bedrock, Type A gravity grouting is acceptable. Side friction in soil should be neglected for micropiles bearing in rock. The allowable grout-to-ground bond strengths recommended for the materials encountered for this station are listed in Table 3 below.

Table 3: Summary of Micropile Design Parameters

SOIL/ROCK TYPE	BUOYANT UNIT WEIGHT (PCF)	ALLOWABLE SKIN ² FRICTION (BOND STRENGTH) TYPE A (PSI)	ALLOWABLE SKIN ² FRICTION (BOND STRENGTH) TYPES B AND C (PSI)	ALLOWABLE SKIN ² FRICTION (BOND STRENGTH) TYPE D (PSI)
Fill and Organic Soils	57.5		-	
Medium Dense to Very Dense Granular Soils	62.5		6	10
Competent Bedrock	82.5	35	-	

Notes: 1. Fill/organic thickness ranges from 8 to 20 feet, top of bearing soils shall be top of natural granular soils.

^{2.} Type A gravity grouting procedure is not recommended for micropiles in soil.

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For corrosion protection, permanent casing should be installed to a depth of at least 5 feet below the bottom of the encountered fill and organic soils. The permanent casing design should include a 1/8-inch corrosion allowance.

In general, we recommend that the micropiles not be spaced within a distance less than 3 times the drilled holes/grout diameters. This spacing is to eliminate group effect for axially loaded piles bearing within soils.

Spread Footings

Spread footings are recommended for the ramp and stair structure foundations. The footings should be placed on compacted structural fill or on dense natural granular soils. The existing fill appears to have been placed without control and must be removed within the zone of influence of the footing down to natural soils. The zone of influence is defined by a line extending one foot from the bottom edge of the footing and continuing at a 1H:1V slope down to the natural soils.

The recommended allowable design bearing capacity for spread footings bearing on at least medium dense structural fill is 5 ksf, provided that subgrades are prepared as described herein. This provides an adequate factor of safety against bearing failure and limits the total estimated settlement to less than one inch and the differential settlement to less than ½ inch. All footings should be at least 4 feet wide. The bottom of footing elevation should be at least 4 feet below final grades for frost protection.

The structural fill material should be free from organics and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200 - Earthwork for Type B Gravel Borrow. The exposed remaining fill and the structural fill should be compacted to 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557) and as described in the following sections.

All temporary open cuts required for footing construction should be in accordance with the related OSHA regulations and should have side slopes of no steeper than 1.5H:1V.

Seismic Consideration

The seismic design should comply with the requirements of the most current Massachusetts State Building Code 780 CMR and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface conditions encountered, the station site is classified as Seismic Site Class D soil profile in accordance with 780 CMR Chapter 1614.0 Section 9.4 Site Ground Motion. The structure could be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. The maximum considered earthquake ground motions shall be as represented by the spectral response acceleration at short periods (Ss) and at 1-sec (S₁) obtained from Table 1604.10 of the Massachusetts State Building Code and adjusted for Site Class effects using the site coefficients of Section 9.4.1.2.4.

For Site Class D Soils at the location of this station:

$$S_{MS} = 0.384$$
 and $S_{M1} = 0.149$

$$S_{DS} = 0.256$$
 and $S_{D1} = 0.099$

where:

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- \bullet S_{MS} is the maximum consider earthquake spectral response acceleration for short periods adjusted for site class
- S_{M1} is the maximum consider earthquake spectral response acceleration at 1-sec adjusted for site class
- S_{DS} is the design earthquake spectral response acceleration for short periods adjusted for site class
- S_{D1} is the design earthquake spectral response acceleration at 1-sec adjusted for site class

The building code also requires that the soil be evaluated for the following potential hazards: slope instability, soil liquefaction, or surface rupture due to faulting or lateral spreading. The proposed grading is relatively flat and we are not aware of any pre-existing slope instability in this area. The existing overburden soils do not appear to be subject to surface rupture due to faulting or lateral spreading.

Liquefaction

Based on the observed subsurface conditions, recorded water levels, percentage of fine contents and the recorded SPT N-values, the soil layers underlying the site are judged to be not susceptible to liquefaction.

Retaining Walls

The track embankment retaining walls can be a cantilevered sheet pile wall. Steel anchor bars could also be used to connect the top portion of the two sheet pile walls on the east and west sides if analyses indicate bracing is needed. If anchor bars under the tracks are not acceptable to the MBTA, another option for the retaining walls is a soldier pile wall with precast concrete panels. Alternatively, if construction of the walls can be sequenced to limit excavation impacts on the existing tracks, use of Mechanically Stabilized Earth (MSE) walls may be possible.

CONSTRUCTION CONSIDERATIONS

Ground Improvement - Rammed Aggregate Piers/ Stone Columns

If a spread footing foundation option is desired by the designer but mass foundation over-excavation is not cost-effective or feasible, then ground improvement measures (such as rammed aggregate piers or stone columns) below foundation areas can be considered as a foundation alternative. The rammed aggregate piers/stone columns can improve soil bearing capacity characteristics of the existing fill, transfer (portions of) axial loads, and reduce potential foundation settlement. Rammed aggregate pier design and construction is typically provided by a specialty contractor based on a performance criteria, but should be reviewed by the Geotechnical Engineer.

Stone columns and rammed aggregate piers are constructed by excavating a hole (typically 18 to 36 inches in diameter) to the specified design depth (typically to competent soils) by augering or using a mandrel. The soil at the bottom of the hole is then densified with a high impact densification system having a rated energy of 250,000 ft.-lbs. to 1,200,000 ft.-lbs. Thin lifts (6- to 12-inches thick) of dense-grade aggregate or crushed stone are then compacted in the cavity. The proposed platform can then be supported on shallow foundation bearing on soils improved with rammed aggregate piers or stone columns. The footings can be designed based on a higher "composite" soil bearing capacity.

Stone columns and rammed aggregate pier elements are typically installed at about 6 to 8 feet center to center spacing. The length and spacing of the elements will depend on the foundation loads and settlement tolerance.

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Drilled Micropiles

The drill rig should have adequate torque and downward pressure to facilitate drilling or coring through any obstruction and drilling into bedrock. A temporary or permanent casing is typically required to provide full length side support within soil embedment especially when drilling through sandy granular soils. The steel casing can provide high shear and bending capacity to resist lateral loads.

Water or polymer drilling mud (for flushing the hole during drilling) can also be used in addition to the casing to provide temporary side support during pile installation. Bentonite slurry may impair grout/ground bond capacity and therefore, it is not recommended.

Grouting under pressure should be performed through a tremie pipe from the bottom to the top of the casing in full until fresh grout tops out. No significant loss of grout from the pile should be observed. Re-grouting (post-grouting) after set of the initial grout may be necessary to improve the grout and ground bond strength within soil embedment. Suitable centralizers should be firmly fixed to maintain the specified grout cover. We recommend that the drilling, installation of the reinforcement, and grouting of a particular pile be completed in a short and continuous processes.

Field load testing including both performance and proof testing should be performed for production micropiles. The pile load test program and proof tests during installation should be conducted as described in the project specifications. Testing procedures and results should be observed and reviewed by the Geotechnical Engineer, and are subject to MBTA approval. In general, the compression load test should be performed in accordance with ASTM D1143 and tension load test in accordance with ASTM D3689.

Spread Footings

The existing fill should be stripped off and removed from within the zone of influence of the walkway area footings using a smooth edge excavation bucket. Following excavation, the exposed surface should be proof compacted with at least 10 passes of a large vibratory drum roller (minimum 10,000 pound static weight). All excavated areas should be backfilled with gravel borrow and compacted to 95% of the maximum dry density (ASTM D1557). Footing inspections should include hand auger probes by the geotechnical personnel to check for soft/weak zones. The need for undercutting and backfilling with structural fill should be closely evaluated in the field based on encountered conditions.

In areas where seepage is encountered within footing excavations, the need for placing a 3" thick lean concrete mud mat or a layer of \(^3\)4-inch crushed stone to protect the bearing surface should be evaluated in the field. Crushed stone thicker than 4 inches shall be wrapped by non-woven filter fabric.

Following observation of the bearing soils by geotechnical personnel, reinforcing steel and concrete can be placed in the excavation. It is recommended that footing reinforcing steel and concrete be placed the same day as the footing excavation is made, where possible, to avoid significant moisture content changes in the bearing soils. No water should be allowed to pond within excavations and drainage should be maintained away from foundations both during and after construction. The footing excavation should be free of loose debris at the time of footing concrete placement.

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MSE Wall Construction

Wall Subgrade Preparation

Remove existing soil from the area to be occupied by the MSE wall structure, including facing and reinforcing strips, to the required grade, and extending at least 5 feet beyond the edge of structures on all sides. Where practical, final excavation should be undertaken using a smooth edged bucket to limit disturbance of the subgrade.

The exposed subgrade soils should be proof-compacted with a minimum of 10 passes of a minimum 10,000-lb (static weight) heavy vibratory roller. Loose or soft zones observed during proof-compaction should be over-excavated to firm and stable ground and replaced with compacted Gravel Borrow. Where exposed soil subgrades are at or near the groundwater level, static proof-compaction methods may be recommended in lieu of vibratory methods by the geotechnical engineer. Exposed subgrade soils should be protected from disturbance.

Existing fill may remain in place below the undercut zone of the MSE wall; however, if organic soils or soft or disturbed soils are observed, they should be completely removed from within the bearing influence zone of the retaining wall and reinforced soil mass. The bearing influence zone is defined by a one horizontal to one vertical (1H:1V) line sloping down and out from one foot outside the bottom exterior edge of the footing/reinforced soil zone to the exposed subgrade.

Once proof-compaction is complete, a layer of non-woven heavy duty geotextile, in accordance with MassDOT M9.50.0, Type I Separation, or Type II Stabilization geotextile fabric, should be placed at the bottom of excavation. The geotextile should have an Equivalent Opening Size (EOS) suitable to act as a filter to prevent loss of material from the new structural fill (Gravel Borrow) into the underlying existing fill materials (overlap roll ends and sides a minimum of 12 inches).

We recommend that a qualified geotechnical engineer evaluate the bearing subgrade and observe fill placement.

Leveling Pad

We recommend that a minimum 12 inch wide, 6 inch thick leveling pad consisting of reinforced concrete be provided as a leveling pad below the facing panels.

Backfill Material

MSE walls require placement of well-graded, granular soil (i.e. Gravel Borrow, MassDOT M1.03.0, Type a) in order to allow for drainage and to provide resistance to pullout of the reinforcing strips. Fill should be placed in loose lifts no greater than 8 inches thick and compacted to 95% of maximum density as determined by ASTM D1557 up to each layer of reinforcement. The reinforcing strips can be connected to the facing prior to placing subsequent lifts of backfill and reinforcing, or the strips can be wrapped around the subsequent lift, allowing the facing to be installed upon completion of backfilling. The method of construction should be provided by the MSE wall specialty designer and reviewed by the engineer.

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Subgrade Preparation

Prior to performing any required grading operations and excavations in the proposed structure footprints, walkway and paved areas, these areas should be stripped of topsoil, vegetation, loose fill, and existing pavement, if present. The topsoil should be placed in a designated area for reuse during final grading. Following site clearing and stripping, the foundation areas should be prepared as discussed above. The exposed soil subgrade should be proof rolled with at least 10 passes of a minimum 10,000-lb (static weight) heavy vibratory roller. Any pockets of excessively soft, wet or disturbed soil or unsuitable soils should be removed and replaced with properly compacted fill materials. Where subgrade soils are close to the existing groundwater level or where silty subgrade soils are encountered, proof-compaction using non-vibratory methods may be considered by the geotechnical engineer.

If additional rolling does not correct the unstable condition, the subgrade should be scarified to a depth of at least six inches but not exceeding eighteen inches, aerated, re-compacted, and retested to provide uniform compaction. Following satisfactory compaction of the subgrade, controlled compacted fill material should be placed to bring the site to the required grade.

Fill should not be placed over frozen soil. Soil subgrades should be protected against frost both during and after construction.

Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. Excavations should be made with as few passes of the backhoe bucket as possible to reduce disturbance of the subgrade. A backhoe bucket fitted with a smooth blade should be used during the final subgrade preparation, where necessary. The exposed base should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas. Construction traffic should be controlled to prevent excessive stresses and disturbance to the subgrade.

If pavements are not constructed immediately after grading, the subgrade should be shaped so as to prevent ponding. If there is a substantial lapse in time between grading and paving, or if the subgrade is disturbed, it should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during proof-rolling or initial construction should be removed and replaced with compacted granular fill.

Within the proposed paved areas, and extending a distance of five feet beyond the edge on all sides, excavate existing granular fill soils to a depth of two feet below existing site grades. It may be possible to reuse the existing granular fill, depending on the suitability of the material, as described herein.

Fill Placement and Compaction

Fill materials most likely will be obtained by importing granular fill materials from off-site borrow sources. However, it may be possible to reuse existing site granular fill material provided that it can be properly placed and compacted. The gradation shall be in accordance with MBTA Standard Specification Section 02200-Earthwork for Type B Gravel Borrow.

All structural fill should be free of organics, demolition debris or other deleterious substances. The fill material should have a plasticity index (PI) less than 4 and a liquid limit (LL) less than 10, and contain fragments less than 4 inches in maximum dimension. Each lift should be compacted to the specified density prior to placing any subsequent lift. All materials to be used as structural fill should be tested in the laboratory to determine their project suitability and compaction characteristics.

The fill should be systematically compacted to the following percentages of the maximum dry density:

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Table 3: Fill Compaction Requirements

DESCRIPTION	MINIMUM PERCENT COMPACTION (ASTM D-1557)		
General Site Fills, Structural Fill	95		
(Below Footings and Slabs)			
Behind Retaining Walls	92		
Landscape Area	90		

Soils which exhibit a well-defined moisture content—dry density relationship should be compacted to within plus or minus two percentage points of the optimum moisture content as determined by the Modified Proctor test (ASTM D-1557).

Where fill materials are placed against an existing embankment slope, the slope should be benched as the fill is brought up in layers. Benching should be of a sufficient width to permit placing and compaction of fill material upon the existing embankment materials. Typically, benches are between four to eight feet wide. Each bench cut should begin at the intersection of the existing embankment and the vertical side of the previous bench. Trench backfills over pipelines or utility structures should be performed so as not to adversely impact the underlying utilities. In fill areas, the backfill material, compaction method, and degree of compaction requirements should be similar to that for the fill adjacent to the trench.

Construction Dewatering

All excavations should be performed in the dry condition. Discharge of pumped water should be performed in accordance with all federal, state and/or local regulations which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

Permanent Slopes

Permanent slopes with loamed and seeded surfaces should not be steeper than 2-1/2 horizontal to 1 vertical (2-1/2H:1V) without slope protection to limit erosion and surficial sloughing of the slope. Additional analyses may be required to assess the stability of slopes steeper than 2-1/2H:1V as the station design is finalized.

Excavation Slopes and Shoring

The slopes of open cuts should be no steeper than 1-1/2H:1V. Open cuts should not be used below the water table because of the likelihood of soil sloughing into the excavation.

The temporary excavation support system, if needed, should be selected by the Contractor and designed by an experienced registered Professional Engineer in the Commonwealth of Massachusetts and retained by the Contractor. Where excavation sides can be sloped back, they should be performed in accordance with the Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

Permanent Retaining Walls

If sheet pile walls or soldier pile walls with precast concrete panels are used for permanent retaining walls, pre-trenching or pre-drilling may be required to remove obstructions and to install piles to sufficient depths into underlying dense soils and bedrock. A minimum of 3 feet of free draining Gravel Borrow should be placed behind the walls and the walls should also have weep holes installed for drainage.

Proj. No. E2347101

Protection of Existing Facilities

It is recommended that a geotechnical instrumentation and monitoring program be performed during construction of the project to evaluate impacts on adjacent structures. It is recommended that the program be developed to provide data for the following considerations:

- To monitor ground movements and vibration levels during construction.
- To provide early warning of potentially adverse trends by presenting sufficient data to determine the source of unanticipated ground movements, if present.
- If necessary, to plan remedial measures to limit damage to embankments and structures and to provide early warning when alternative means of protection are necessary.
- To document impacts of construction on adjacent facilities.
- To evaluate the performance and structural integrity of the constructed facilities.

We recommend the following instrumentation program to measure:

- Ground surface settlement and lateral movement adjacent to proposed construction.
- Horizontal and vertical movement of any excavation support system, and existing structures.
- Vibrations as a result of construction activities.

Vertical and horizontal survey points should be established on the adjacent structures. The monitoring points should be surveyed prior to the start of construction and monitored during construction to detect movement.

Vibration monitoring should be conducted within 100 feet of existing structures during construction activities.

We recommend conducting a pre-construction survey of structures and utilities within 100 feet of the site to document existing conditions prior to construction. Documentation should include photographs, video, sketches, and/or written comments.

Specific instrumentation and monitoring requirements shall be based on the proposed construction sequence, duration of construction, and performance criteria. Initial measurements should be established well in advance of construction so that baseline data can be developed. This information will be invaluable for providing early warning of adverse trends and for assessing the need for mitigating measures.

CLOSING

This report and the recommendations contained herein have been prepared for the exclusive use of MBTA and VHB and their representatives for specific application to the design and construction of the proposed Taunton Depot Station in Taunton, Massachusetts.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations available at the time of this report. Subsurface stratification variations between borings are anticipated. The reported groundwater levels only represent the water levels at the time noted on the logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

Proj. No. E2347101

ATTACHMENTS

FIGURE 1 – SITE LOCATION PLAN FIGURES 2&3 – SUBSURFACE EXPLORATION PLANS FIGURES 4&5 – SUBSURFACE SOIL PROFILES APPENDIX A – EXPLORATION LOGS APPENDIX B – LABORATORY DATA APPENDIX C – GEOTECHNICAL CALCULATIONS

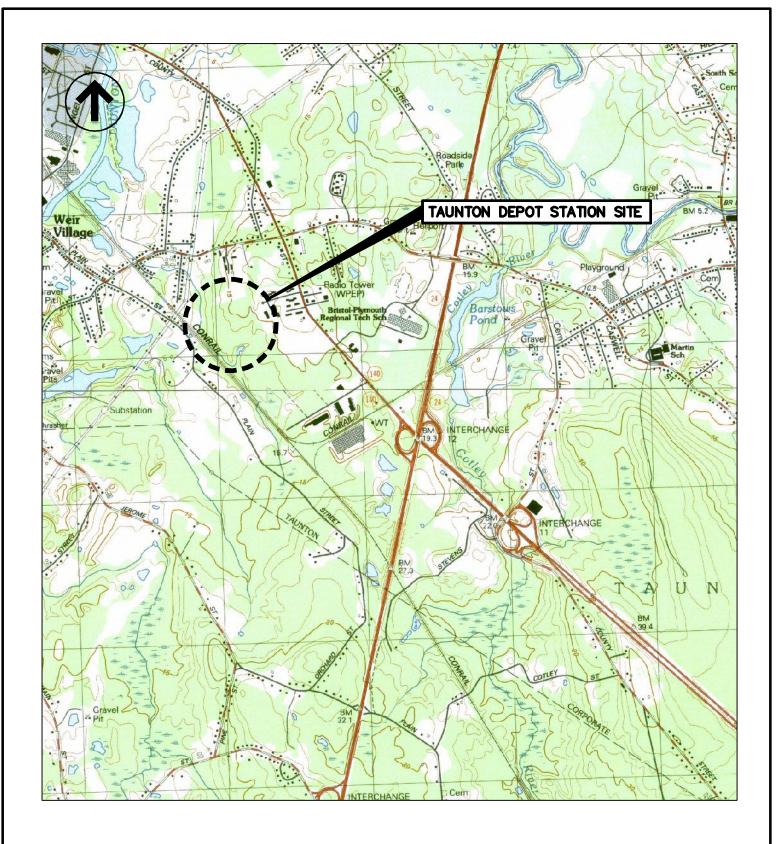
Memorandum



FIGURES

Figure 1: Site Location Plan

Figures 2 and 3: Subsurface Exploration Plan Figures 4 and 5: Subsurface Soil Profiles

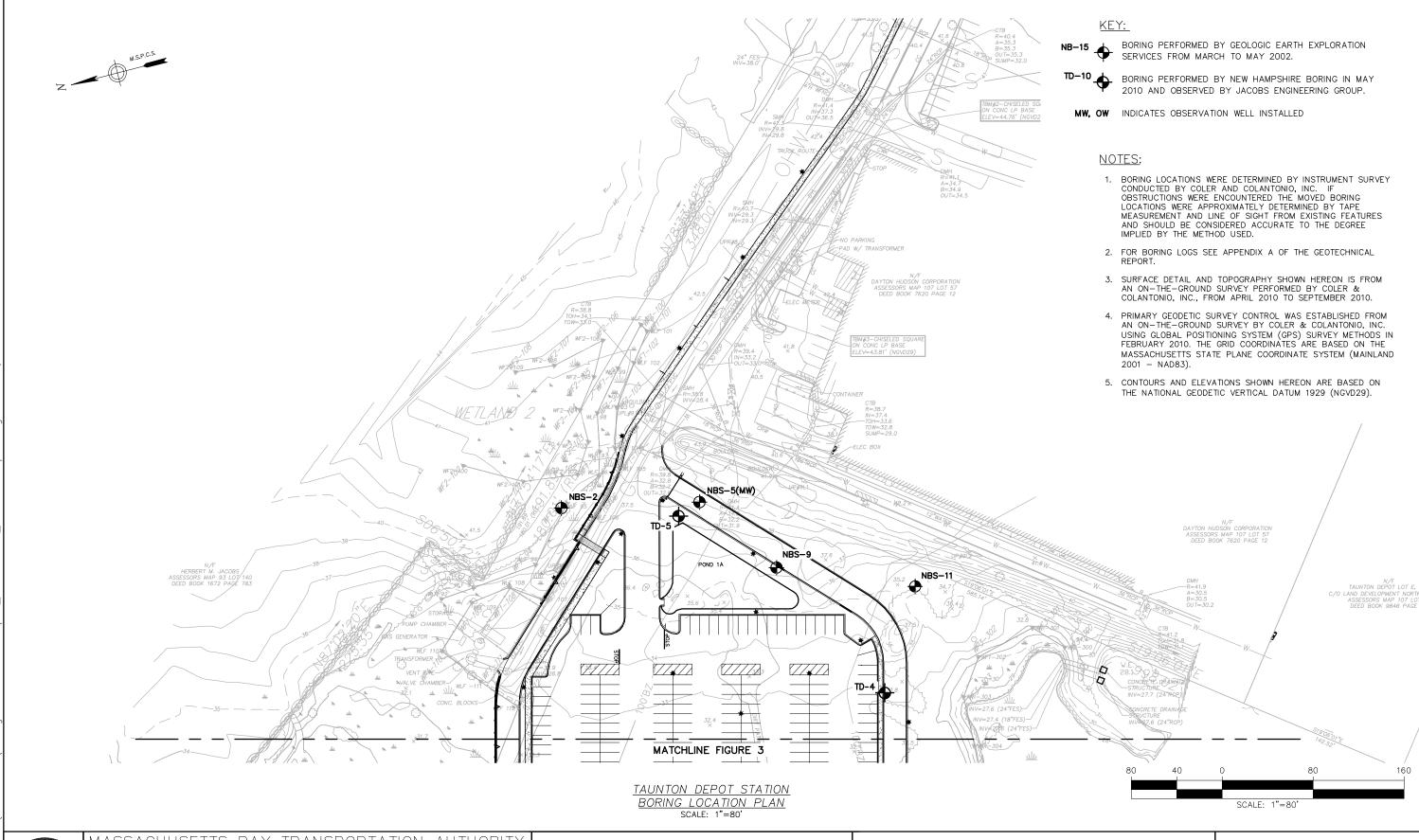


TAUNTON DEPOT STATION
PROJECT LOCUS PLAN
NOT TO SCALE



MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68 TAUNTON DEPOT STATION TAUNTON, MASSACHUSETTS FIGURE 1



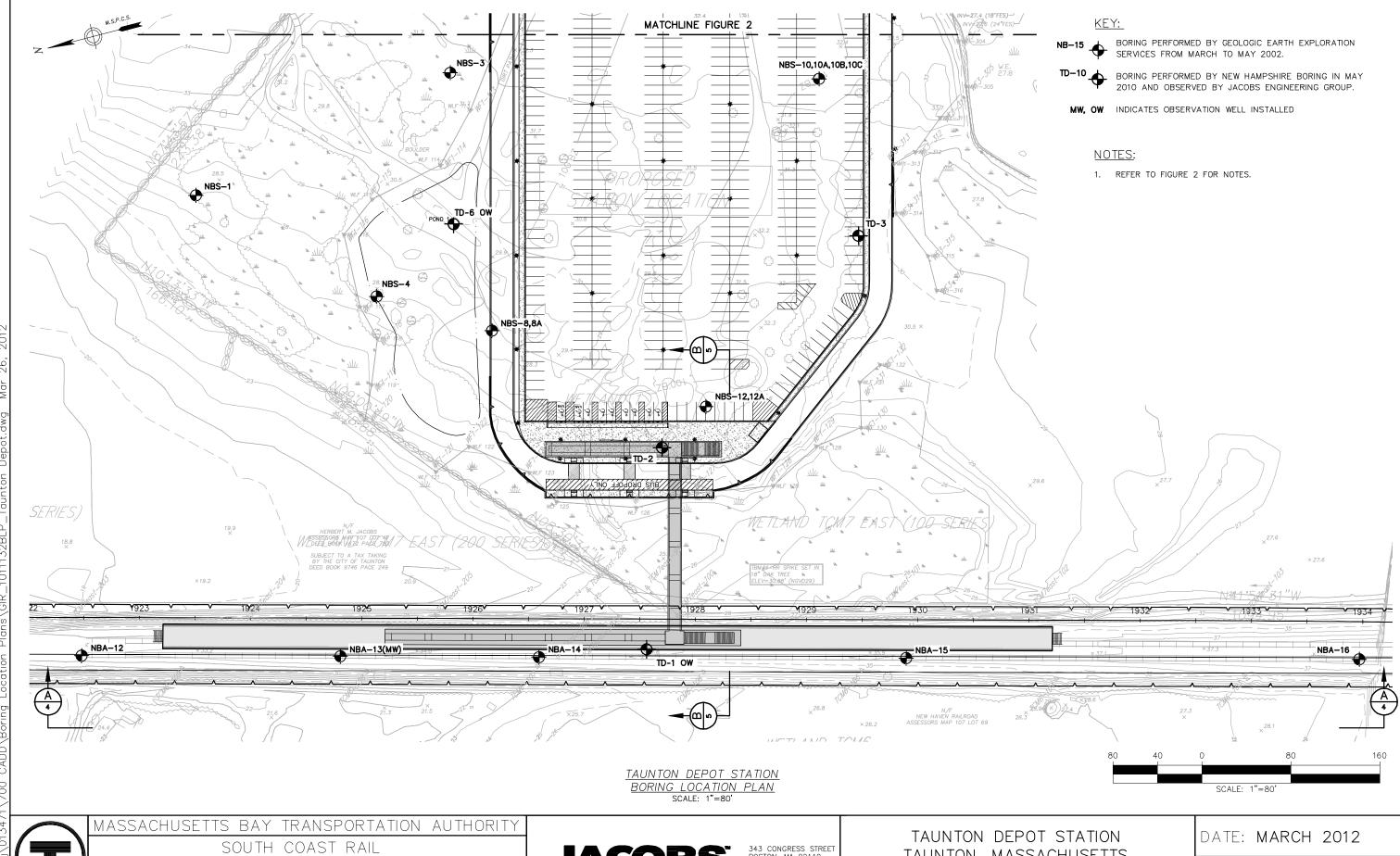
MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL
COMMUTER RAIL EXTENSION PROJECT
MBTA CONTRACT NO. X2PS68

JACOBS

343 CONGRESS STREET BOSTON, MA 02110 (617) 242-9222 TAUNTON DEPOT STATION
TAUNTON, MASSACHUSETTS
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

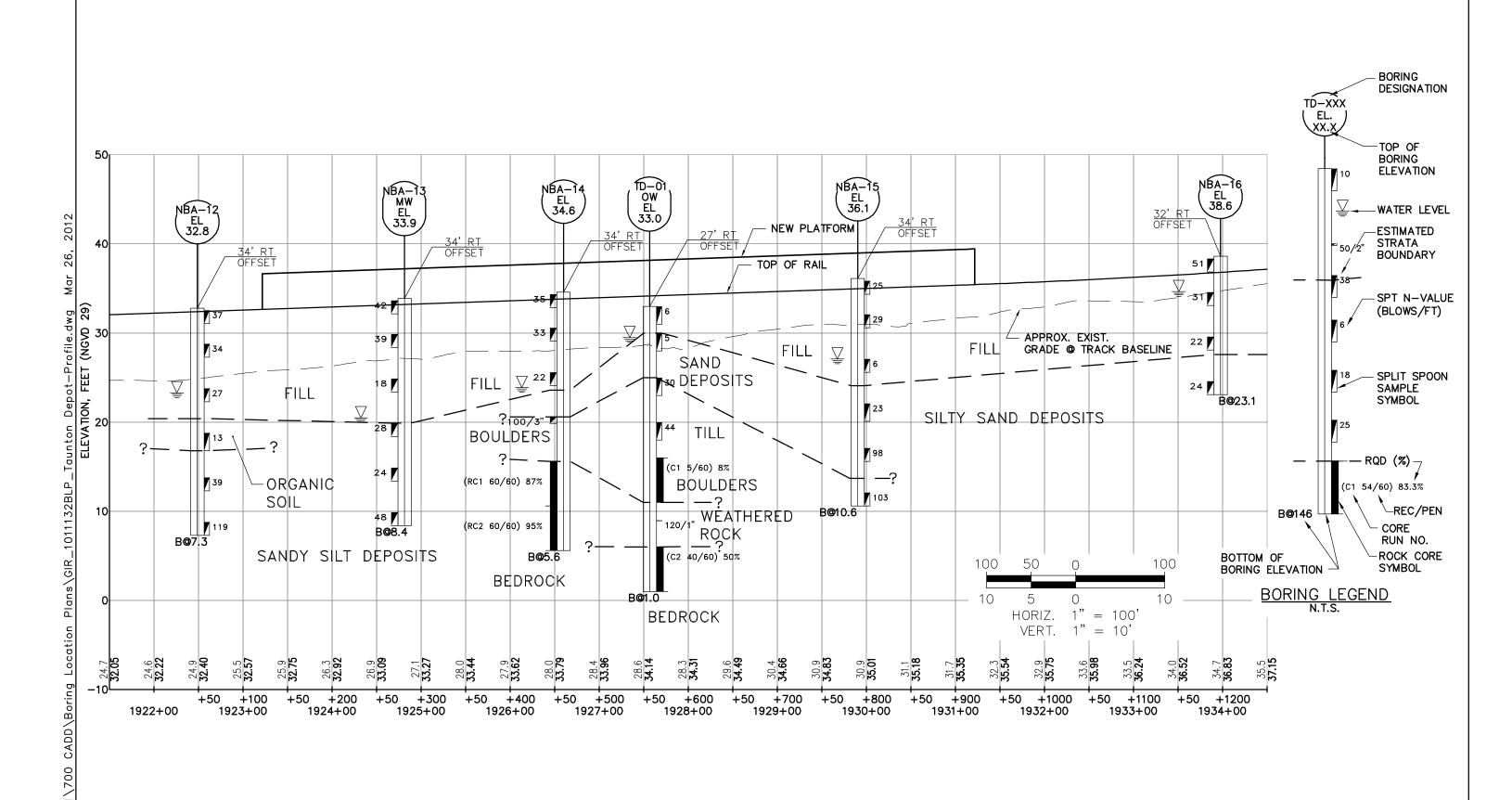


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SOUTH COAST RAIL
COMMUTER RAIL EXTENSION PROJECT
MBTA CONTRACT NO. X2PS68

JACOBS

343 CONGRESS STREET BOSTON, MA 02110 (617) 242-9222 TAUNTON DEPOT STATION
TAUNTON, MASSACHUSETTS
SUBSURFACE EXPLORATION PLAN





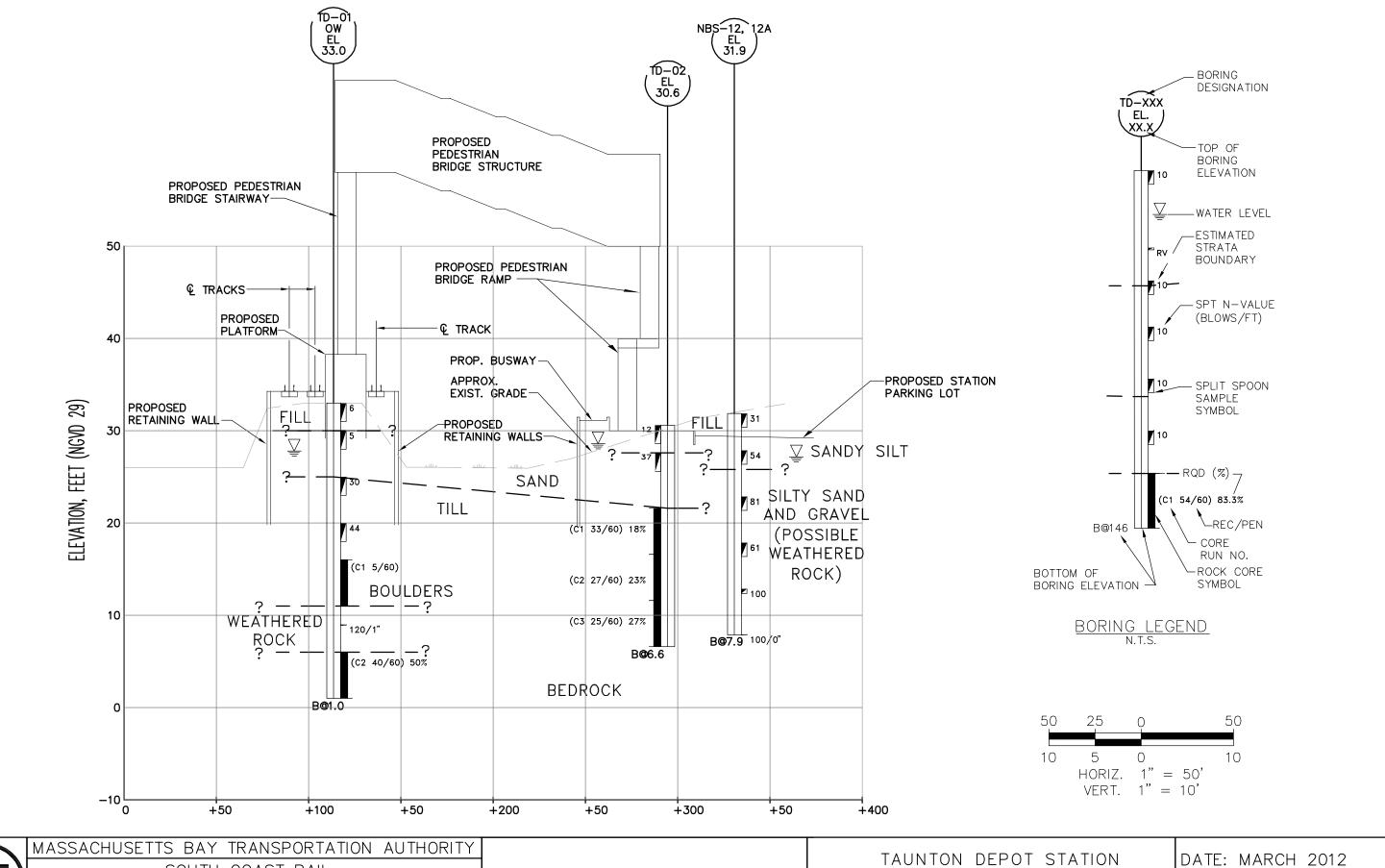
MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68

JACOBS

343 CONGRESS STREET BOSTON, MA 02110 (617) 242-9222 TAUNTON DEPOT STATION TAUNTON, MASSACHUSETTS SUBSURFACE PROFILE A-A

DATE: MARCH 2012



SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68

JACOBS

TAUNTON, MASSACHUSETTS SUBSURFACE PROFILE B-B

Memorandum

APPENDIX A: EXPLORATION LOGS

TD-1 TO TD-6 NBA-12 TO NBA-16 NBS-1 TO NBS-5 NBS-8 TO NBS-12

				PROJE	CT	South	Coast Rail			505010	TD 004 014
	AC		BS	LOCAT		Taunto	,			BORING	TD - 001 OW
								rtation Author	ity	NO.	SUEET 1 OF 1
INICDI	ECTOR	D. Chau			JMBER	E2347			DDILLED	C Knimht	SHEET 1 OF 1
	METHOD			CONTR	RACTOR		r READING	38	DRILLER DRILL RIG	C. Knight ATV D-50	ELEVATION33DATUMNGVD 29
0			w/Casing	, D	ATE/TIME				SPT HAMMER	140 lb Safety	GRID N 2780610.2
27		Rock Cor		, , , , , , , ,	5/4/2010		3.5		letion (In Casing)	· · · · · · · · · · · · · · · · · · ·	COORD E 772564.6
32		ninated		_	7/7/2010		8		Well Reading		DATE START 5/4/10
					9/12/2011		5.2	Monitoring	Well Reading		DATE END 5/4/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	as .
		5 4 2 1	S1	0 - 2	0					RADED GRAVEL nd, trace silt, gray,	WITH SAND (GW); fine moist, FILL.
-5		8 4 1 1	S2	3 - 5	4	30.0	POORLY brown, w		ND (SP); mostly t	fine to medium sa	nd, trace gravel, trace silt,
		24 17 13	S3	8 - 10	18	25.0	LEAN CI	_AY (CL); moo P = 4.5 TSF, G	lerately plastic cla BLACIAL TILL.	y, some silt, trace	sand, trace gravel, gray,
10		17 13 14									
15		14 31 13 21	S4	13 - 15	13			·	ent wet sand sean	ns, PP = 4.5 TSF.	
20			C1	17 - 22	5	16.0	BOULDE				
		120/1"	S5	23 - 23.1	2	11.0	WEATH	ERED ROCK;	gray.		
25						6.0					
-30	X	RQD=5	0 C2	27 - 32	40	0.0	SILTSTC high ang	DNE; soft, joint le fractures, sl	s spaced 3 - 16", ightly weathered,	joints angled at ∼1 greenish-gray.	10 - 20 degrees, some
	* * *					1.0	Bottom o	of Hole at 32'.			
-35	Page 1: 0	-35 feet. Ea	ch subseque	nt page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
COF	HESIVE SOIL		NON-COHE	SIVE SOIL		ATIVE ORTIONS	_		_	LEGEND	
LOWS	FT CONSIS	TENCY BI	LOWS/FT	DENSITY	OF SOIL CO		S Aug San (AS	nple and	C Core (RC) RQD (%) Sample (S and Blow)	(U)-Shelby Tube Counts (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30	SO MEDIUM 5 ST	FT // STIFF FF STIFF	5 - 10 11 - 30 31 - 50	/ERY LOOSE LOOSE EDIUM DENSE DENSE /ERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRAC LITTL SOMI MOSTI	E REF E DES LY SUE	ER TO THE SHEE	per 6" REC T ENTITLED "KEY TO ASSIFICATION OF IIALS" FOR ADDITIONA	ROPINI	

				PROJE		South 0	Coast Rail			TD 000
	A		26	LOCAT		Tauntor	,		BORING	TD - 002
							ay Transportation Aut	hority	NO.	CUEET 1 OF 1
				JOB NU		E23471		1		SHEET 1 OF 1
		A. Barbe		CONTR	ACTOR	NH Bori	ng R READINGS	DRILLER DRILL RIG	C. Knight ATV D-50	ELEVATION 30.6 DATUM NGVD 29
0		sh Boring			ATE/TIME		DEPTH(ft) REMARKS		140 lb Safety	DATUM NGVD 29 GRID N 2780721.2
9		Rock Core			5/5/2010			pletion (Casing pulled		COORD E 772708.7
24		minated	•		0.0.20.0		Z Gpan aann	producti (Galoring parios	-,	DATE START 5/5/10
	101	milatou								DATE END 5/5/10
DEPTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.		FIELD CLASSIFICA	ATION AND REMARK	
(ft)	STRATA SYMBOL	DATA	NO.	(ft)	(in)/(%)			TILLE OLYGON TO	THOIR THE INCIDENT	O
		2	S1	0 - 2	16		WELL GRADED SA	ND (SW); fine to coa	rse sand, trace gr	avel, trace silt, light
	\bowtie	8 8					brown, dry, FILL.			
		8								
		10		0 5	1 45	27.6	CIL TV CAND (CM).	mostly fine sand, little		inht hansen sont
		10 15 22 23	S2	3 - 5	15		SILIT SAND (SIVI),	mostly line sand, little	e non-piastic siit, i	igni brown, wet.
-5		」 22 23								
3										
						22.6	Top of bedrock at 8	ft, roller bit to 9 ft.		
		Γ	. C1	9 - 14	33		•	l, coarse grained, mo	derate weathering	gray/blue
-10		RQD=18	3 0	3 - 14			Critico Torte, nare	, oodroc grained, mo	derate weathering	, gray/blac.
		POD-00	C2	14 - 19	27		SIMILAR TO C1.			
15		RQD=23	'							
00		RQD=27	, C3	19 - 24	25		SIMILAR TO C1.			
-20										
		L				6.6				
-25										
							Bottom of Hole at 2	4'.		
-30										
-35										
-	Page 1:	0-35 feet. Eac	h subsequent	page displays	40 feet.		SAMPLES (CLASSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
	.=		·		DEI	ATIVE			LEGEND	
COH	HESIVE SOI	L	NON-COHES	IVE SOIL	PROP	ORTIONS	E Auger	Book Coro (BC)		lar Dan
LOWS	/FT CONSI	STENCY BL	OWS/FT I	DENSITY	OF SOIL CO	OMPONENT	Auger Sample (AS)	Rock Core (RC) and RQD (%) REC (%) Split-Spool Sample (S and Blow 0	S) (U)-Shelby Tube	Jar Bag Sample (JS)
0 - 2				RY LOOSE	< 10%	TRACE	<u> </u>	per 6" REC		(D)
3 - 4 5 - 8				LOOSE IUM DENSE	15 - 25% 30 - 45%	LITTLE	REFER TO THE ST	HEET ENTITLED "KEY TO		
9 - 1	5 S	TIFF 3	31 - 50	DENSE RY DENSE	50 - 100%	MOSTL	Y SUBSURFACE MA	D CLASSIFICATION OF TERIALS" FOR ADDITIONA		G TD - 002
16 - 30	VER	1 3 HFF	51 + VE	IVI DEM2E			SYMBOLOGY.		NO.	10 002

								EST BOH	KING				
				PROJE LOCAT			Coast Rail on, MA			BORING	ТГ) -	003
			BS	OWNE				ortation Author	rity	NO.	1 L	<i></i>	500
				JOB NU		E2347			,		SH	HEET	1 OF 1
INSPI	ECTOR	A. Barl	betta		ACTOR	NH Bo			DRILLER	C. Knight	ELEVATIO	ON	30.7
1	METHO	D OF DR	RILLING		GROUN	IDWAT	ER READIN		DRILL RIG	ATV D-50	DATUM		NGVD 29
0			ng w/Casin	-	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2780717.4
13.33	3 Te	rminated			5/5/2010		2.5	Upon Comple	tion (Casing pulled	d)	COORD	E	772968.5
											DATE STA		5/5/10 5/5/10
	OTDATA	0.445	- OALADI	5 555711		E1 E) (DATE EN	ט	3/3/10
(ft)	STRATA SYMBOL	SAMPLI DATA		E DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S		
-		2 5 10 12	S1 2	0 - 2	12		WELL (silt, trac	GRADED SANI e gravel, brow	D WITH SILT (SW n, dry, FILL.	/-SM); fine to coars	e sand, littl	e nor	-plastic
-5		12 13 13 15	S2	3 - 5	8	27.7	SILTY	SAND (SM); fin	e to coarse sand,	little non-plastic sil	t, brown, w	et.	
- - - -10		15 26 19 22	S3	8 - 10	9		SIMLAF	R TO S2; gray,	wet.				
- - - 15 -	0 0	1 20/4	" S4	13 - 13.33	3 4	17.4	weather	SAND (SM); fin red rock in tip o of Hole at 13.3	of spoon.	little non-plastic sil	t, dark gray	/, wet	
20													
-25													
- -30 -													
- - -35	Page 1:	0-35 feet. E	Each subseque	ent page displays	40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
COH	HESIVE SC	DIL	NON-COH	ESIVE SOIL		ATIVE				LEGEND			
					PROP OF SOIL CO	ORTIONS OMPONEN	NTS Au Sa	nger Roo	ck Core (RC) Split-Spoo RQD (%) Sample (\$	On Undisturbed (U)-Shelby Tube,	Jar Sample	∇	Bag Sample (B)
BLOWS			BLOWS/FT	DENSITY					and Blow per 6" RE	Counts (P)-Piston	(JS)	X	(B)
0 - 2 3 - 4 5 - 8 9 - 1! 16 - 30 30 +	MEDI 5 S	RY SOFT SOFT UM STIFF STIFF RY STIFF	5 - 10 11 - 30 31 - 50	VERY LOOSE LOOSE IEDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SOM MOS	TLE RE TLY SU	SCRIPTION AND C	ET ENTITLED "KEY TO ELASSIFICATION OF RIALS" FOR ADDITION/	BODING.	G TI	D -	003

				DDO IS	CT			E21 BOK	AII VO				
_				PROJE LOCAT			Coast Rail on, MA			BORING	TI	D -	004
	AC		35	OWNE				ortation Author	itv	NO.	!!	- ر	
				JOB NU		E2347		Ortation Author	ity	INO.	S	HEET	1 OF 1
INISPE	CTOR	A. Barbet	ta		ACTOR	NH Bo			DRILLER	C. Knight	ELEVATI		32.8
		OF DRILL		CONTR		-	ER READIN	GS	DRILL RIG	ATV D-50	DATUM	UIN.	NGVD 29
0		sh Boring v		D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2780857.5
15		ninated	w Casing		5/5/2010	_	2		tion (Casing pulled		COORD	E	773140.5
									(J	- /	DATE ST		5/5/10
											DATE EN		5/5/10
EDTH	STRATA	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			FIELD OF ACCIDIO	ATION AND REMARK			
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)	LLL V.			FIELD CLASSIFICA	ATION AND REWARK	3		
		1	S1	0 - 2	16		WELL C	SRADED SAND	O (SW): fine to coa	arse sand, trace sil	t. reddish-	brown	. drv.
		9					FILL.		,,,	•	,		, ,,
		10											
						29.8							
	9	15 20	S2	3 - 5	18		WELL G		O WITH SILT (SW	'-SM); fine to coars	e sand, litt	le nor	n-plastic
_	0 0 0	15 20 19 20					ont, brov	WII, WOL					
-5													
	$ \circ ^{\circ}$												
	٦٠					25.8	Boulder	encountered.					
	W.	46	S3	8 - 10	12	04.0			J BOLLI DED				
		46 17 20 18	33	0 - 10	12	24.3) WEATHERE		de mana e const			
-10		18					(8.5 - 10	リ) SILI (ML); N	ion-plastic silt, dar	к gray, wet.			
.0													
		17	S4	13 - 15	14		SILT (M	II): non-plastic	silt, dark gray, we	et.			
		17 23 21 40		10 10	'-		0.21 (iz), non piaodo	ont, dank gray, we				
-15		40				17.8							
							Bottom	of Hole at 15'.					
-20													
-25													
-30													
35	Pogs 1: 0	35 foot Fail	auboog::art	nage disals:	40 feet			CAMPI TO OL 11	POLETED IN ACCOUNT	ICE WITH ACTA D 0400	LINIL ECO OT	JEDV4/10	E NOTED
	rage 1: 0)-35 feet. Each	i subsequent	page displays	+∪ 1 00 1.			SAMPLES CLAS	SSIFIED IN ACCURDAN	ICE WITH ASTM D-2488	UNLESS UT	TERWIS	E NOTED.
COF	IESIVE SOIL	_ N	NON-COHES	IVE SOIL		ATIVE				LEGEND			
					PROP OF SOIL C	ORTIONS OMPONEN	NTS Au	ger Roc mple and	k Core (RC) Split-Spoo	Undisturbed	Jar Sample	∇	Bag
LOWS/		STENCY BLC		DENSITY			—— <u> </u>		Sample (S and Blow per 6" RE	Counts (P)-Piston	Sample (JS)	X	Bag Sample (B)
0 - 2 3 - 4				RY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	CE			(□1)			
5 - 8	MEDIUI	M STIFF 1	1 - 30 MED	IUM DENSE	30 - 45%	SON	ME RE		T ENTITLED "KEY TO LASSIFICATION OF	DODINA	_		
9 - 15 16 - 30				DENSE RY DENSE	50 - 100%	MOS	ILY SU	BSURFACE MATER	RIALS" FOR ADDITIONA		기 T	D -	004
30 +		RD .		52,102			SY	MBOLOGY.		NO.	1 .	_	

					-0-			E21 BOK				
				PROJE			Coast Rail			BORING	TD	- 005
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INSP	ECTOR	P. Chou	1		RACTOR	NH Bo			DRILLER	S. Bolduc	ELEVATION	36.9
		O OF DRI		OONT			R READIN	GS	DRILL RIG	TR CME 75	DATUM	NGVD 29
0			g w/Casin	n D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID N	
15		minated	<u> </u>	9	5/4/2010		4		letion (In Casing)	,	COORD E	
											DATE STAR	
											DATE END	5/4/10
	STRATA	SAMPLE			REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	3	
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)							
	• 1	12 50 41 22	S1	0 - 2	12		POORL	Y GRADED SA	AND WITH SILT (SP-SM); mostly fin	e to mediuim s	sand, some
		41					non-pias	stic siit, trace g	ravel, brown, mois	St.		
		8	S2	3 - 5	14		SII TY S	SAND (SM): mo	ostly fine to mediu	im sand, some nor	-plastic silt_tra	ace gravel
	•	14	I		''		olive, we			ca.ra, cocc.	, p.a.o o,	acc g.a.c.,
-5		14 14 18										
	• •											
	• ·											
	1. 4											
		12 14 19 22	S3	8 - 10	12		SIMILAF	R TO S2; occa	sional clay seams	i.		
	•_\ •	19										
-10		□ 22										
	• [•											
	• •											
		• ••				23.9						
		22 17 20 24	S4	13 - 15	12		LEAN C	LAY (CL); mod	derately plastic cla	y, little sand, trace	silt, gray, moi	st, PP = 3
45		20				21.9	101.					
15						21.9						
							Bottom	of Hole at 15'.				
							Bottom	or riolo at 10.				
-20												
-25												
20												
-30												
35												
	Page 1:	0-35 feet. Ea	ach subseque	ent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTHERW	VISE NOTED.
	UEO" /E 2 -		Nov	FON /F 3 3	RFI	ATIVE				LEGEND		
CONESIVE SOIL NON-CONESIVE SOIL PRO				PROP	ORTIONS	=	ner 🔳 🕞	ck Core (RC) Split-Spoo		Jar	∏ Bag	
LOWS	/FT CONS	ISTENCY B	BLOWS/FT	DENSITY	OF SOIL C	OMPONEN [*]	S Au	mple and	RQD (%) Sample (8 and Blow	Counts (U)-Shelby Tube, (P)-Piston	Sample (JS)	Bag Sample (B)
0 - 2		YSOFT		VERY LOOSE	< 10%	TRAC	E	. REC	per 6" RE		• ''	
3 - 4 5 - 8		OFT JM STIFF	5 - 10 11 - 30 M	LOOSE EDIUM DENSE	15 - 25% 30 - 45%	LITTL	F KE		T ENTITLED "KEY TO			
9 - 1	5 S	TIFF Y STIFF	31 - 50	DENSE VERY DENSE	50 - 100%		LY SU		LASSIFICATION OF RIALS" FOR ADDITIONA	BORING NO.	G TD	- 005
16 - 3						1					111	

								E21 BOK	IIIG				
_				PROJE			Coast Rail			BORING	TD	$\cap \cap$	6 OW
			BS	LOCAT OWNE		Taunto		ortation Author	-itv	NO.	יטי	UU	
					JMBER	E2347		ortation Author	ity	INO.	SH	IEET 1	OF 1
INSPI	FCTOR	A. Barbe	etta		RACTOR	NH Bo			DRILLER	P. Rosinha	ELEVATIO		29.9
		O OF DRI		CONTI			R READIN	GS	DRILL RIG	TR CME 75	DATUM		NGVD 29
0		sh Boring		n D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID		2780995.1
13		minated	, w. oao		5/5/2010		1.5		tion (Casing pulled		COORD		772732.7
					7/7/2010		3.5		g Well Reading	,	DATE STA		5/5/10
					9/12/2011		1	Monitoring	g Well Reading		DATE EN		5/5/10
DEPTH	STRATA	SAMPLE	SAMPL	E DEPTH	REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)						-		
		5	S1	0 - 2	10		WELL G	RADED SANI	O WITH GRAVEL	(SW); fine to coars	e sand, soi	me fine	e to
-		6					coarse g	gravel, trace sil	t, brownish gray, o	dry, FILL.			
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LOG OF TEST BORING **PROJECT** New Bedford/FallRiver Commuter Rail NBA-12 **II** JACOBS BORING LOCATION New Bedford Line - Taunton NO. CLIENT Mass. Bay Transportation Authority SHEET I OF I JOB NUMBER 013471 T.Galvin 32.8 Earth Exploration, Inc DRILLER **ELEVATION** CONTRACTOR INSPECTOR C.Nagata **B57-TR** DATUM FT MSL GROUNDWATER READINGS DRILL RIG METHOD OF DRILLING REMARKS SPT HAMMER 140 Ib. Safety GRID 2780984 DEPTH (ft) N 0.0 Wash Boring w/Casing DATE/TIME COORD E 772220 3/12/02 Upon Completion (Casing pulled) 4.0 Wash Boring-Open Hole 3/12/02 DATE START 24.0 Split Spoon Sample 3/12/02 DATE END 25.5 Terminated SAMPLE SAMPLE REC. DEPTH STRATA FIELD CLASSIFICATION AND REMARKS ELEV. SYMBOL DATA (In)/(%) NO. (ft) 3° of ballast 32.50 14 18 19 10 SS-1 Wellgraded sand with gravel(SW) - mostly fine to medium sand, some fine to coarse gravel, light brown, dry (FILL) Top 2° of sample contains slag, dark brown/black (Possibly used as subballast) Slity sand (SM) - mostly fine to medium sand, some silt, trace fine 27 19 15 18 SS-2 to coarse gravel, trace coarse sand, brown, wet (FILL) 5 Wellgraded sand with silt and gravel(SW-SM) - mostly fine 13 14 13 SS-3 18 to coarse sand, little fine to coarse gravel, trace to little 10 silt, brown, wet (FILL) 20.80 (Organic soillayer from 12.0 to 15.5 ft) Top 12': Organic soil with sand (OL/OH) - mostly organics, little 5 5 18 SS-4 fine sand, trace medium to coarse sand, dark brown, moist 15 8 17.30 24 Bot 6': Wellaraded sand with silt (SW-SM) - mostly fine to 0000 medium sand, trace to little silt, gray, wet 0 14.80 Sandy silt (ML) - mostly silt, some fine sand, trace medium **SS-5** 21 18 12 27 20 sand, aray, wet 10 **SS-6** Sandy silt (ML) - mostly silt, some fine sand, trace medium 41 58 61 25 sand, gray, wet 7.300 Boring Terminated at 25.5 ft. REMARKS: Boring located at centerline of existing tracks. Test boring performed by GeoLogic, Inc. 30 35 Page to 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL PROPORTIONS ROCK CORE (RC) BAG (B) BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED AUGER (U)-SHELBY TUBE. (US) (SS) AND BLOW (AS) AND ROD (%) 0 - 2**VERY SOFT** 0 - 4 (P)-PISTON **VERY LOOSE** COUNTS PER 6° REC (2) < 10% TRACE 3 - 4 SOFT 5 - 10 LOOSE LITTLE 5 - 8 MEDIUM STIFF 15 - 25% u - 30 MEDIUM DENSE 9 - 15 30 - 45% SOME REFER TO THE SHEET ENTITLED "KEY TO BORING STIFF 31 - 50 DENSE NBA-12 DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 16 - 30 VERY STIFF 50 - 100% MOSTLY 51+ VERY DENSE NO. MATERIALS' FOR ADDITIONAL SYMBOLOGY. 30 + HARD

TEST BORING/MONITORING WELL LOG OF **PROJECT** New Bedford/FallRiver Commuter Rail **II** JACOBS NBA-I3 MW BORING New Bedford Line - Taunton LOCATION Mass. Bay Transportation Authority CLIENT NO. SHEET I OF I JOB NUMBER 013471 CONTRACTOR Earth Exploration, Inc DRILLER T.Galvin **ELEVATION** 33.9 INSPECTOR C.Nagata B57-TR DATUM FT MSL DRILL RIG METHOD OF DRILLING GROUNDWATER READINGS SPT HAMMER 140 lb. Safety GRID 2780811 Ν Wash Boring w/Casing DATE/TIME DEPTH (ft) REMARKS 772376 COORD Ε 4.0 Wash Boring-Open Hole 3/13/02 1330 8.0 Upon Completion (In Casing) 3/13/02 DATE START 24.0 5/21/02 1415 13.4 Monitoring wellreading Split Spoon Sample DATE END 3/13/02 25.5 Terminated SAMPLE REC. SAMPLE DEPTH|STRATA ELEV. FIELD CLASSIFICATION AND REMARKS WELL LOG IN. T. S.) SYMBOL (f+) DATA (1n)/(2)NO. 3° of ballast WELL COVER INFORMATION 33.60 **SS-1** 8 18 24 Wellgraded sand with gravel(SW) -☐ STANDPIPE XROADBOX mostly fine to medium sand, some fine to coarse gravel, tan, dry (FILL) (Slag in shoe) Silty sand (SM) - mostly fine to medium 13 22 17 12 **SS-2** sand, some silt, trace coarse sand, 5 0.2 gray, moist (FILL) TOP OF RISER PIPE Sandy silt (ML) - mostly silt, little fine sand, SS-3 14 9 9 trace medium to coarse sand, brown, wet 10 (FILL) 19.90 Sandy silt (ML) - mostly silt, little to some 12 13 15 10 SS-4 15 fine sand, trace medium sand, gray, wet воттом GROUT LO ft 7.5 ft TOP SEAL Sandy silt (ML) - mostly silt, little to some 18 SS-5 3 8 16 10.0 ft 20 fine sand, trace medium sand, gray, wet SAND 12.8 ft TOP SCREEN Sandy silt with gravel(ML) - mostly silt, little SLOT SIZE fine sand, little fine to coarse gravel, 23 22 26 6 SS-6 0.25 25 gray, wet 8.40 Boring Terminated at 25.5 ft. **REMARKS:** HOTTOM Boring located at centerline of SCREEN existing tracks. 22.8 ft Test boring performed by GeoLogic. Inc. BOTTOM 23.0 ft1 30 SAND Monitoring well installed (2° Dia. PVC pipe) BOTTOM SEDIMENT 24.0 ft TRAP 25.5 ft воттом 4 BORING INCH DIA 35 Page & D-35 feet, Page 2: 35-80 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. RELATIVE LEGEND NON-COHESIVE SOIL COHESIVE SOIL PROPORTIONS OF SOIL COMPONENTS BAC (B) BLOWS/FT CONSISTENCY BLOWS/FT DENSITY SPLIT-SPOON UNDISTURBED AUGER ROCK CORE (RC) (D)-SHELBY TUBE, ANO ROO (%) (SS) AND BLOW (AS) VERY SOFT 0 - 4 VERY LOOSE COUNTS PER 6° REC (%) < 10% TRACE 3 - 4 SOFT 5 - 10 LOOSE 15 - 25% 30 - 45% REC ((n) LITTLE 5 - 8 MEDIUM STIFF H = 30MEDIUM DENSE REFER TO THE SHEET ENTITLED "KEY TO SOME BORING 9 - 15 STIFF 31 - 50 DENSE MOSTLY 16 - 30 VERY STIFF 50 - 100% DESCRIPTION AND CLASSIFICATION OF SUBSURFACE NBA-I3 MW 51+ VERY DENSE MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO. 30 + HARD

LOG OF TEST BORING **PROJECT** New Bedford/Foll River Commuter Rail NBA-14 BORING **III** JACOBS New Bedford Line - Taunton LOCATION Mass. Bay Transportation Authority NO. CLIENT SHEET I OF I JOB NUMBER 013471 T.Galvin ELEVATION 34.6 CONTRACTOR Earth Exploration, Inc DRILLER C.Nagata INSPECTOR 857-TR DRILL RIG DATUM FT MSL METHOD OF DRILLING GROUNDWATER READINGS REMARKS SPT HAMMER 140 lb. Safety GRID N 2780678 Wash Boring w/Casing DATE/TIME DEPTH (ft) 772495 COORD E 3/14/02 0900 10.7 Prior to resumption of drilling 4.0 Wash Boring-Open Hole DATE START 3/13/02 NX Rock Core (Hole depth at 18 ft) 19.0 3/14/02 DATE END Terminated 29.0 SAMPLE SAMPLE STRATA REC. DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS SYMBOL DATA (In)/(%) NO. (ft) 3° of ballast 34.30 9 **SS-1** 18 17 Wellgraded sand with gravel(SW) - mostly fine to medium sand, some fine to coarse gravel, light brown, dry (FILL) (Sand with slag in shoe tip) (Layer containing slag from 1.5 to 3.0 ft) Weilgraded sand with sit (SW-SM) - mostly fine to medium 15 17 SS-2 18 sand, trace to little slit, trace fine gravel, brown, wet 16 5 Wellgraded sand with slit (SW-SM) - mostly fine to medium 5 **SS-3** 10 12 sand, trace to little slit, trace fine gravel, brown, wet 10 (FILL) 23.60 รูร์-4 Silty sand (SM) - mostly fine sand, some silt, gray, wet 13 4 20.10 100/3 (Gravel/rock lodged in shoe) 15 (Rollerbit from i4.5 to 19.0 ft, drop 3° casing down hole and begin rock core) 87 87 RC-1 Argilite: moderately hard, very slightly weathered, sound, gray, fine grained, moderately close horizontal to moderately 20 RQD REC dipping joints (왕) (왕) RC-2 Argillite: moderately hard, very slightly weathered, sound, 95 97 gray, fine grained, close horizontal joints 25 ROD REC (왕) (왕) 5.60 Boring Terminated at 29.0 ft. 30 **REMARKS:** Very large boulders observed in surrounding area. Boring located at centerline of existing tracks. Test boring performed by GeoLogic.inc. 35 Page I: 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS UNDISTURBED ROCK CORE IRC) SPLIT-SPOON NBAG (B) ALIGER (LI)-SHELBY TUBE, X (JS) (SS) AND BLOW AND ROD (%) 0 - 2 (AS) VERY SOFT 0 - 4 VERY LOOSE (P)-PISTON REC (%) COUNTS PER 6° TRACE SOFT C 10% 5 - 10 LOOSE RFC (In) LITTLE 15 - 25% 30 - 45% 5 - 8 MEDIUM STIFF B - 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED TKEY TO 9 - 6 SOME BORING STIFF 31 - 50 DENSE 16 - 30 DESCRIPTION AND CLASSIFICATION OF SUBSURFACE VERY STIFF 50 - 100% MOSTLY NBA-14 51+ VERY DENSE 30 + HARD MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO.

LOG OF TEST BORING PROJECT New Bedford/Fall River Commuter Rail NBA-15 BORING **III** JACOBS LOCATION New Bedford Line - Tounton Mass. Bay Transportation Authority NO. CLIENT SHEET I OF I JOB NUMBER 013471 Earth Exploration, Inc T.Galvin **ELEVATION** 36.1 DRILLER CONTRACTOR C.Nagata INSPECTOR B57-TR FT MSL **DATUM** GROUNDWATER READINGS DRILL RIG METHOD OF DRILLING REMARKS SPT HAMMER 140 Ib. Safety **GRID** 2780431 N Wash Boring w/Casing DATE/TIME DEPTH (ft) 772715 Ε 3/14/02 1400 9.0 Upon Campletion (In Casing) COORD Wash Boring-Open Hole 4.0 3/14/02 DATE START 24.0 Split Spoon Sample DATE END 3/14/02 25.5 Terminated SAMPLE DEPTH STRATA SAMPLE REC. FIELD CLASSIFICATION AND REMARKS ELEV. NO. SYMBOL DATA (In)/(%) (ft) 3° of ballast 35.80 **SS-1** 6 12 13 Well graded sand (SW) - mostly fine to medium sand, trace fine to coarse gravel, light brown, dry (FILL) (Sand with slag in shoe tip) Silty sond with grovel(SM) - mostly fine to coarse sand. **SS-2** 9 17 12 10 some fine to coarse gravel, little silt, brown, wet (FILL) 5 Well graded sand with silt and grovel (SW-SM) - mostly fine 2 **SS-3** to medium sond, little fine to coarse gravel, trace to little 2 10 silt. brown, wet (FILL) 24.10 Silty sand with gravel(SM) - mostly fine to medium sand, some II 9 ₁₄ 8 **SS-4** slit, little coarse gravel, troce coarse sand, light brown, wet 15 (Hard drilling from 17.5 to 18.5 ft) Silty sand with gravel(SM) - mostly fine to coarse sand, **SS-5** 37 47 51 6 some fine to coarse gravel, little silt, gray, wet 20 13.10 Clayey sand with gravel (SC) - mostly fine to coorse sand, some clay, ⁴⁹ 52 51 8 **SS-6** little fine to coarse gravel, gray, wet (possible weathered rock) 25 10.60 Boring Terminoted at 25.5 ft. REMARKS: Boring located at centerline of existing tracks. Test boring performed by GeoLogic, inc. 30 35 Page & 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. LEGEND RELATIVE CDHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT ROCK CORE (RC) SPL(T-SPOON UNDISTURBED DENSITY OF SOIL COMPONENTS **₩**BAG UNDISTURBED

UI-SHELBY TUBE. | JAR
(US) AUGER (SS) AND BLOW AND ROO (%) (AS) 0 - 2 **VERY SOFT** 0 - 4 L (P)-PISTON **VERY LOOSE** COUNTS PER 6° REC (%) < 10% TRACE SOFT 5 - 10 LOOSE 15 - 25% 30 - 45% 5 - 8 LITTLE MEDIUM STIFF 1 - 30 MEDIUM DENSE BORING REFER TO THE SHEET ENTITLED TKEY TO SOME 9 - 15 STIFF 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE NBA-15 50 - (00% 16 - 30 MOSTLY VERY STIFF 51+ VERY DENSE MATERIALS FOR ADDITIONAL SYMBOLOGY. NO. 30 + HARD

LOG OF TEST BORING **PROJECT** New Bedford/Fall River Commuter Rail II JACOBS NBA-16 BORING **LOCATION** New Bedford Line - Tounton Mass. Bay Transportation Authority CLIENT NO. SHEET I OF I JOB NUMBER 013471 T.Galvin 38.6 INSPECTOR C.Nagata CONTRACTOR Earth Exploration, Inc DRILLER **ELEVATION B57-TR** METHOD OF DRILLING GROUNDWATER READINGS DRILL RIG **DATUM** FT MSL SPT HAMMER 140 lb. Safety GRID 2780128 Wash Boring w/Casing DATE/TIME DEPTH (f+) REMARKS N 0.0 772987 3/14/02 1500 COORD Ε 4.0 Wash Boring-Open Hole 3.0 Upon Completion (Casing pulled) 3/14/02 DATE START 14.0 Split Spoon Sample 15.5 Terminated 3/14/02 DATE END SAMPLE STRATA SAMPLE REC. DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS SYMBOL DATA NO. (ft) ((n)/(%) 38.30 3° of ballast SS-1 13 23 29 ß Wellgraded sand (SW) - mostly fine to medium sand, brown, dry (FILL) Wellgraded sand with silt and gravel(SW-SM) - mostly fine 17 7 4 SS-2 5 24 to medium sand, little fine to coarse gravel, trace to little silt, brown, wet (FILL) Wellgraded sand with silt and gravel(SW-SM) - mostly fine 10 11 11 6 **SS-3** 10 to medium sand, little fine to coarse gravei, trace to little silt, brown, wet (FILL) 27.60 Silty sand (SM) - mostly fine sand, some silt, brown, wet **SS-4** 12 1 6 18 15 23.10 Boring Terminated at 15.5 ft. **REMARKS:** 20 Boring located at centerline of existing tracks. Test boring performed by GeoLogic, Inc. 25 30 35 Page ti 0-35 feet, Page 2i 35-80 feet, Each subsequent page displays 45 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS BAG (B) RDCK CORE (RC) SPLIT-SPOON UNDISTURBED **AUGER** (U)-SHELBY TUBE. X (US) (SS) AND BLOW 0 - 2 AND ROD (%) **VERY SOFT** (AS) 0 - 4VERY LOOSE (P)-PISTON REC (%) COUNTS PER 6" TRACE SOFT (IDZ 5 - 10 LOOSE 5 - 8 REC ((n) 15 - 25% 30 - 45% LITTLE MEDIUM STIFF H - 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED KEY TO SOME STIFF BORING 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE VERY STIFF 50 - 100% MOSTLY NBA-16 51+ VERY DENSE 30 + MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO.

LOG OF TEST BORING **PROJECT** New Bedford/Foll River Commuter Roll NBS-I II JACOBS BORING LOCATION New Bedford Line - Taunton Mass. Bay Transportation Authority OWNER NO. SHEET I OF I JOB NUMBER 013471 Earth Exploration, inc CONTRACTOR INSPECTOR C.Nagata DRILLER B. Forget **ELEVATION** 27.6 METHOD OF DRILLING GROUNDWATER READINGS DRILL RIG Bombadier DATUM FT MSL Wash Boring w/Casing DATE/TIME DEPTH (ft) REMARKS SPT HAMMER 140 lb Safety GRID 2781185 N 5/24/02 1445 0.5 COORD Wash Boring-Open Hole Upon Completion (Casing Pulled) Ε 772597 9.0 5/24/02 12.5 NX Rock Core DATE START 15.5 Terminated 5/24/02 DATE END SAMPLE STRATA SAMPLE REC. DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS **SYMBOL** DATA (In)/(%) NO. (ft) **SS-1** Wellgraded sond with silt (SW-SM) - mostly fine to medium 6 sand, trace to little silt, brown, moist (Very hard drilling from 1.5 to 3.0 ft, probable boulder) 24.60 Poorly graded sand (SP) - mostly fine sand, trace medium 15 10 SS-2 18 20 5 sand, brown, wet 20.60 Silty sand with gravel (SM) - mostly fine to medium sand. 12 16 55 **SS-3** 10 some fine gravel, little silt, gray, wet (Very hard drilling from 10.5 to 12.5 ft) (Attempt rock core at 12.5 ft) 15.10 RC-I 14 14 Diobase - moderately hard, very slightly weathered, light gray to black, fine to medium grained (Probable boulder, lean cloy in core barrelabave and below RQD REC rock recovery) (왕) (왕) 15 (Care barreljammed at 15.5 ft) 12.10 Boring Terminated at 15.5 ft. **REMARKS:** Test boring performed by GeoLogic, Inc. 20 25 30 35 Page & 0-35 feet, Page 2: 35-80 feet, Each subsequent page displays 45 feet SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. RELATIVE COHESIVE SOIL NON-COHESIVE SOIL LEGEND **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT ROCK CORE (RC) DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED BAG (B) 6 (SS) AND BLOW COUNTS PER 6° (U)-SHELBY TUBE. MISSI 0 - 2 3 - 4 **VERY SOFT** AND ROD (%) REC (%) (AS) 0 - 4**VERY LOOSE** SOFT < 10% TRACE 5 - 10 E - 30 LOOSE MEDIUM STIFE 15 - 25% 30 - 45% LITTLE MEDIUM DENSE DENSE 9 - 15 STIFF SOME REFER TO THE SHEET ENTITLED KEY TO 31 - 50 BORING 16 - 30 VERY STEF 50 - 100% MOSTLY DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 51+ NBS-I VERY DENSE 30 + HARD MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO.

New Bedford/Fall River Commuter Rail PROJECT NBS-2 **BORING** LOCATION New Bedford Line - Tounton **JACOBS** NO. Mass. Bay Transportation Authority OWNER SHEET I OF I JOB NUMBER 013471 B. Forget **ELEVATION** 38.0 Earth Exploration, inc DRILLER CONTRACTOR C.Nogata INSPECTOR **DATUM** GROUNDWATER READINGS Bombadier FT MSL DRILL RIG METHOD OF DRILLING **GRID** 140 lb Safety N 2781178 DATE/TIME DEPTH (ft) REMARKS SPT HAMMER Wash Boring w/Casing Ε Upon Completion (Casing Pulled) COORD 773071 1030 1.7 5/24/02 Wash Boring-Open Hole 9.0 5/24/02 DATE START Split Spoon Sample 14.0 DATE END 5/24/02 Terminated 15.5 SAMPLE REC. SAMPLE STRATA FIELD CLASSIFICATION AND REMARKS DEPTH ELEV. DATA (in)/(%) NO. (ft) SYMBOL Wellgraded sand with silt and gravel(SW-SM) - mostly fine 15 19 32 18 SS-1 to coarse sand, little fine gravel, trace to little silt, 00 Maht brown, moist 0 35.00 Silty sand (SM) - mostly fine sand, some silt, light 9 18 **SS-2** 11 .12 brown-gray, wet Silty sand with gravel (SM) - mostly fine to medium sand, little silt, 15 19 17 14 **SS-3** 10 little fine gravel, trace clay, gray, wet Silty sand with gravel(SM) - mostly fine to medium sand, little silt, 18 **SS-4** 20 24 24 little fine gravel, trace clay, gray, wet 15 22.50 Boring Terminated at 15.5 ft. REMARKS: Test boring performed by GeoLogic, Inc. 20 25 30 35 Page is 0-35 feet, Page 2: 35-80 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM 0-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** N8AG (B) ROCK CORE (RC) UNDISTURBED BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED
(U)-SHELBY TUBE, (US) AUGER AND ROD (%) (SS) AND BLOW COUNTS PER 6° (AS) VERY SOFT (P)-PISTON 0 - 4 **VERY LOOSE** REC (%) < 10% TRACE 3 - 4 SOFT 5 - 10 REC (In) LOOSE 15 - 25% 30 - 45% LITTLE 5 - 8 MEDIUM STIFF #- 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED KEY TO SOME BORING 9 - 15 STIFF 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 50 - 100% NBS-2 MOSTLY 16 - 30 VERY STIFF 51+ VERY DENSE MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO.

30

HARD

PROJECT New Bedford/FollRiver Commuter Rall NBS-3 **BORING** II JACOBS LOCATION New Bedford Line - Tounton OWNER Mass. Bay Transportation Authority NO. SHEET I OF I JOB NUMBER 013471 T.Galvin CONTRACTOR Earth Exploration, Inc. DRILLER **ELEVATION** 31.6 C.Nagata INSPECTOR GROUNDWATER READINGS B-57 TR **DATUM** FT MSL DRILL RIG METHOD OF DRILLING SPT HAMMER 140 lb Safety GRID 2781088 REMARKS N DEPTH (ft) Hollow Stem Augers DATE/TIME 0.0 COORD E 772832 4/18/02 1010 4.8 During Drilling (In Augers) Split Spoon Sample 15.0 4/18/02 3.0 4/18/02 MO Upon Completion (Augers Pulled) DATE START Terminated 16.5 DATE END 4/18/02 SAMPLE SAMPLE REC. STRATA DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS NO. SYMBOL DATA (In)/(Z) (ft) Silty sand with gravel(SM) - mostly fine to coarse sand, 12 SS-1 some fine to coarse gravel, little silt, olive brown, moist 28.60 Silty gravel with sand (GM) - mostly fine gravel, some fine 30 37 22 3 **SS-2** to coarse sand, little sllt, gray, wet 23.60 (Blow-in sands caused 6' drillrod of stickup prior to SS-3 sample) 10 Poorly graded sand with gravel(SP) - mostly fine to medium sand, 15 40 48 18 **SS-3** little fine gravel, trace coarse sand, trace fines, gray, wet 18.60 15 Sandy silt (ML) - mostly silt, some fine to coarse sand, trace to 10 **SS-4** 12 13 22 fine gravel, gray, wet 15.10 Boring Terminated at 16.5 ft. REMARKS: Test boring performed by GeoLogic. Inc. 20 25 30 35 Page & 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. RELATIVE COHESIVE SOIL LEGEND NON-COHESIVE SOIL PROPORTIONS BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS ROCK CORE (RC) SPLIT-SPOON UNOISTURBED AUGER OUT-SHELBY TUBE, X (JS) COUNTS PER 6 (AS) AND ROD (X) VERY SOFT 0 - 4**VERY LOOSE** (P)-PISTON REC (2) < 10% TRACE SOFT 5 - 10 LOOSE 15 - 25% 30 - 45% REC (In) 5 - 8 WEDIUM STIFF LITTLE 1- 30 MEDIUM DENSE 9 - 15 STIFF SOME REFER TO THE SHEET ENTITLED TKEY TO BORING 31 - 50 16 - 30 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE VERY STIFF 50 - 100% MOSTLY NBS-3 51+ VERY DENSE 30 MATERIALS' FOR ADDITIONAL SYMBOLOGY.

HARD

NO.

LOG OF TEST BORING **PROJECT** New Bedford/FallRiver Commuter Rail NBS-4 **BORING** II JACOBS LOCATION New Bedford Line - Tounton Mass. Bay Transportation Authority NO. OWNER SHEET 1 OF I JOB NUMBER 013471 **ELEVATION** 30.0 B. Forget DRILLER CONTRACTOR Earth Exploration, Inc INSPECTOR C.Nagata FT MSL Bombodier DATUM GROUNDWATER READINGS DRILL RIG METHOD OF DRILLING SPT HAMMER 140 1b Safety **GRID** N 2781003 DEPTH (ft) REMARKS Wash Boring w/Casing DATE/TIME 0.0 COORD Ε 772638 Upon Completion (Casing Pulled) Wash Boring-Open Hole 5/28/02 0.5 19.0 5/28/02 DATE START 24.0 Split Spoon Sample 5/28/02 DATE END 25.0 Spoon Refusal SAMPLE REC. SAMPLE STRATA DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS DATA NO. SYMBOL (In)/(2)(ft) Silty sand (SM) - mostly fine sand, some silt, light brown, 55-1 12 7 10 moist 27.00 00 o Well graded sand with grave! (SW) - mostly fine to coarse 21 25 22 10 **SS-2** 00 sand, some fine gravel, trace silt, light brown, wet 5 0 0 0 0 23.00 Silty sand with gravel(SM) - mostly fine sand, some silt. **SS-3** 9 37 20 26 little fine gravel, trace coarse sand, beige, wet 10 (Very hard drilling from 11 to 13.5 ft) 16.50 Silty gravel(GM) - mostly fine gravel, some silt, trace fine **SS-4** 5 sand, beige, wet 15 100/0 (Very hard drilling from 14 to 19 ft) 3 16 **SS-5** Silty gravel (GM) - mostly fine gravel, some silt, trace fine 100/31 sand, beige, wet 20 (Very hard drilling from 19 to 22.5 ft) Silty gravel (GM) - mostly fine gravel, some silt, trace fine SS-6 6 sand, beige, wet 100 25 5.00 Split Spoon Refusalat 25.0 ft. Boring Terminated. **REMARKS:** Test boring performed by GeoLogic, Inc. Survey coordinates and elevations are approximate. 30 35 Page is 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. LEGEND REI ATIVE COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** ROCK CORE (RC) BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED AUGER (U)-SHELBY TUBE. X (JS) (SSI AND BLOW AND ROO (%) (AS) 0 - 2 VERY SOFT (PI-PISTON 0 - 4 COUNTS PER 6º **VERY LOOSE** < 10% TRACE REC (%) SOFT 5 - 10 LOOSE REC ((n) (5 - 25% LITTLE 5 - 8 MEDIUM STIFF 11 - 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED "KEY TO 30 - 45% SOME BORING 9 - 15 STIFF 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE NBS-4 50 - 100% MOSTLY **VERY STIFF** 16 - 30 51+ VERY DENSE NO. MATERIALS' FOR ADDITIONAL SYMBOLOGY.

30 +

HARO

LOG OF TEST BORING/MONITORING WELL New Bedford/FallRiver Commuter Rail PROJECT NBS-5 MW BORING New Bedford Line - Taunton **III** JACOBS LOCATION Mass. Boy Transportation Authority NO. CLIENT SHEET 1 OF I 013471 JOB NUMBER ELEVATION T_aGolvin 38.0 Earth Exploration, Inc DRILLER CONTRACTOR INSPECTOR C.Nagata B-57 TR **DATUM** FT MSL DRILL RIG GROUNDWATER READINGS METHOD OF DRILLING GRID N 2781091 140 lb Safety SPT HAMMER DEPTH (ft) REMARKS DATE/TIME Hollow Stem Augers COORD Ε 773156 4/17/02 5.5 During Orilling (in Augers) 0954 15.0 Split Spoon Sample 4/17/02 DATE START 16.5 Terminated DATE END 4/17/02 SAMPLE REC. DEPTH STRATA SAMPLE WELL LOG (N. T. S.) ELEV. FIELD CLASSIFICATION AND REMARKS NO. (in)/(2)SYMBOL DATA (ft) WELL COVER INFORMATION Silty sand (SM) - mostly fine to medium sand. SS-1 18 14 10 some silt, trace coarse sand, trace fine ☐ ST ANDPIPE X ROADBOX gravel, organics, brown, dry 5 Silty sond with gravel (SM) - mostly fine 0.2 31 28 34 SS-2 12 to medium sond, little to some silt, little fine TOP OF gravel, trace coorse sand, beige, wet RISER PIPE 10 Silty sand (SM) - mostly fine to coorse sand. 16 22 22 10 **SS-3** some silt, trace to little fine gravel, gray. wet 15 Silty sand (SM) - mostly fine to coorse sand, 13 **SS-4** 13 BOTTOM 15 17 some silt, trace to little fine gravel, gray, wet GROUT 21.50 Baring Terminated at 16.5 ft. 2.0 ft 2.0 f1 SEAL TOF 20 REMARKS: TOP Test boring performed by GeoLogic. Inc. Monitoring well installed (2° Dia. PVC pipe) TOP SCREEN SLOT SIZE 0.25 25 ММ ROTTOM SCREEN 13.8 ft BOTTOM H.0 ft SAND 30 BOTTOM SEDIMENT 5.0 ft TRAP 16.5 ft BOTTOM 4 INCH DIA. 35 Page is 0-35 feet, Page 2: 35-80 feet, Each subsequent page displays 45 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-24BB UNLESS OTHERWISE NOTED. LEGEND RELATIVE COKESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** ROCK CORE (RC) BAC (B) UNDISTURBED BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON (P)-PISTON AUGER SS) AND BLOW AND ROD (%) (AS) - 2 **VERY SOFT** 0 0 - 4 VERY LOOSE COUNTS PER 6" REC (%) C IOZ TRACE 3 - 4 SOFT 5 - 10 LOOSE REC (In) 15 - 25% LITTLE 5 - 8 MEDIUM STIFF H - 30 MEDIUM CENSE REFER TO THE SHEET ENTITLED TKEY TO BORING 9 - 6 30 - 452 SOME STIFF NBS-5 31 - 50 OENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MW 16 - 30 50 - 100% VERY STIFF MOSTLY VERY DENSE 5(+ NO. MATERIALS' FOR ADDITIONAL SYMBOLOGY. 30 + HARD

PROJECT New Bedford/Fall River Commuter Roll NBS-8, 8A II JACOBS BORING LOCATION New Bedford Line - Taunton OWNER Mass. Bay Transportation Authority NO. SHEET I OF I JOB NUMBER 013471 T.Galvin 28.8 **ELEVATION** CONTRACTOR Earth Exploration, Inc. DRILLER INSPECTOR C.Nagata **B-57 TR** DATUM GROUNDWATER READINGS FT MSL METHOD OF DRILLING DRILL RIG SPT HAMMER 140 ID Sofety GRID DATE/TIME DEPTH (f+) REMARKS 2780905 Hollow Stem Augers COORD E 772685 Split Spoon Sample 5.0 Upon Completion (Augers Pulled) 4/18/02 1400 15.0 4/18/02 DATE START 16.5 Terminated 4/18/02 DATE END SAMPLE SAMPLE REC. DEPTH STRATA ELEV. FIELD CLASSIFICATION AND REMARKS SYMBOL DATA (In)/(Z) NO. (f+) Poorly graded sand (SP) - mostly fine sand, trace slit, tan, 13 20 20 SS-1 25.80 Slity sand (SM) - mostly fine sand, little silt, brown to 18 14 17 12 SS-2 gray, wet 13 _{100/3}. 10 Silty sand with gravel (SM) - mostly fine sand, some silt, 7 **SS-3** little fine gravel, gray, wet (Auger refusal at 11.0 ft. offset hole 10 ft to NBS-8A, soil probe to (ft) 15.80 Silty gravel with sand (GM) - mostly fine gravel, some fine 10 **SS-4** 13 22 to coarse sand, little silt, gray, wet 12.30 Boring Terminated at 16.5 ft. REMARKS: Test boring performed by GeaLogic, Inc. 20 25 30 35 Page k 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 feet. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED CUI-SHELBY TUBE, (JS)
(P)-PISTON ROCK CORE (RC) " (SS) AND BLOW AND ROD (%) REC (%) (AS) **YERY SOFT** (P)-PISTON 0 - 4 **VERY LOOSE** COUNTS PER 6º TRACE < 10% 3 - 4 SOFT LOOSE REC (In) 15 - 25% 30 - 45% LITTLE 5 - 8 MEDIUM STIFF #- 30 MEDIUM DENSE SOME REFER TO THE SHEET ENTITLED KEY TO **BORING** 9 - 15 STIFF 31 - 50 DENSE NBS-8, 8A DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 16 - 30 50 - 100% **VERY STIFF** MOSTLY 51+ VERY DENSE

MATERIALS" FOR ADDITIONAL SYMBOLOGY.

NO.

30 +

HARD

New Bedford/Fall River Commuter Roll **PROJECT** NBS-9 BORING II JACOBS LOCATION New Bedford Line - Tounton NO. OWNER Moss. Boy Transportation Authority SHEET I OF I JOB NUMBER 013471 T.Galvin Earth Exploration, Inc **ELEVATION** 36.7 CONTRACTOR DRILLER C.Nagata INSPECTOR B-57 TR GROUNDWATER READINGS **DATUM** FT MSL DRILL RIG METHOD OF DRILLING GRID 2781002 140 lb Safety Hollow Stem Augers DATE/TIME DEPTH (f+) REMARKS ISPT HAMMER N 0.0 4/17/02 1151 5.7 COORD E 773159 During Drilling (In augers) Split Spoon Sample 15.0 6.0 DATE START 4/17/02 4/17/02 1230 Upon Completion (in augers) 16.5 Terminated 1250 4.0 Upon Completion (Augers pulled) DATE END 4/17/02 4/17/02 SAMPLE SAMPLE REC. DEPTH STRATA ELEV. FIELD CLASSIFICATION AND REMARKS NO. SYMBOL DATA (ln)/(%) (ft) Wellgraded sand (SW) - mostly fine to medium sand, trace SS-I fines, brown, top 2° of sample contains organic soil (topsoil), dry 00 0 0 0 0 00 0 Well graded sand (SW) - mostly fine to medium sand, trace **SS-2** 30 10 27 20 0 fine gravel, trace silt, brown, wet 0 00 27.70 10 Silty sond (SM) - mostly fine to medium sond, little 10 14 12 **SS-3** 5 silt, beige, wet 15 Silty sand with gravel(SM) - mostly fine to medium sand, **SS-4** 8 20 25 12 some fine gravel, little slit, gray, wet 20.20 Boring Terminated at 16.5 ft. REMARKS: Test boring performed by GeoLogic, Inc. 20 25 30 35 Page & 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS DTHERWISE NOTED. subsequent page displays 45 feet. REI ATIVE COHESIVE SOIL LEGEND NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS ROCK CORE (RC) SPLIT-SPOON UNDISTURBED AUGER I JAK 0 - 2 AND ROD (%) 6 (SS) AND BLOW (U)-SHELBY TUBE, VERY SOFT (AS) 0 - 4 **VERY LOOSE** 3 - 4 < 10% TRACE REC (%) COUNTS PER 6" SOFT 5 - 10 LOOSE 5 - 8 REC (In) 15 - 25% LITTLE MEDIUM STIFF R- 30 MEDIUM DENSE 9 - 15 STEF 30 - 45% SOME REFER TO THE SHEET ENTITLED KEY TO **BORING** 31 - 50 DENSE 16 - 30 VERY STIFF 50 - 100% MOSTLY DESCRIPTION AND CLASSIFICATION OF SUBSURFACE NBS-9 51+ VERY DENSE 30

MATERIALS' FOR ADDITIONAL SYMBOLOGY.

NO.

HARD

LOG OF TEST BORING PROJECT New Bedford/Fall River Commuter Rail BORING NBS-10,10A.B.C **JACOBS** LOCATION New Bedford Line - Taunton OWNER Mass. Bay Transportation Authority NO. SHEET I OF I JOB NUMBER 013471 B.Forget CONTRACTOR Earth Exploration, Inc DRILLER **ELEVATION** 32.2 INSPECTOR C.Nagata GROUNDWATER READINGS DRILL RIG Bombadier DATUM FT MSL METHOD OF DRILLING SPT HAMMER 140 Ib Safety GRID N 2780838 DEPTH (ft) REMARKS DATE/TIME 0.0 Hollow Stem Augers/Wash Boring COORD Ε 773050 4/18/02 0810 5.0 During Ollling (In augers) 9.0 Wash Boring-Open Hole 4/18/02 3.0 DATE START 5/29/02 1045 Upon Completion (Casing pulled) 14.0 Split Spoon Sample Spoon Refusal DATE END 5/29/02 14.7 SAMPLE STRATA SAMPLE REC. DEPTH ELEV. FIELD CLASSIFICATION AND REMARKS DATA (In)/(%) NO. SYMBOL (ft) Wellgraded sand with silt (SW-SM) - mostly fine to medium 10 SS-1 16 18 sand, trace to little slit, trace fine gravel, brown, dry (Very hard drilling 0 to 5 ft) 29,20 Slity gravel with sand (GM) - mostly fine to coarse gravel. some fine to medium sand, little silt, light brown, wet (Auger refusalet 5 ft, boring offset 5 ft to NBS-IOA) = 100/2° 1 **SS-2** (Auger refusal at 4 ft, boring offset 5 ft to NBS-10B) (Auger refusal at 9 ft. offset 10 ft to NBS-10C, switchover from augers to wash boring with casing) = 100/3° 0 No recovery **SS-3** 10 (Very hard drilling from 9 to 10.5 ft) (Very hard drilling from II.5 to I3.5 ft) (High drill water loss while drilling from 13.5 to 14.0 ft) 18.70 Poorly graded gravel(GP) - mostly fine gravel, trace coarse gravel, gray, wet 55 100/2 **SS-4** 1 17.50 15 Split Spoon Refusalat 14.7 ft. Boring Terminated. 20 REMARKS: Test boring performed by GeoLogic, Inc. 25 30 35 Page & 0-35 feet, Page 2: 35-80 feet, Each subsequent page displays 45 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** ROCK CORE (RC) BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED BAG (B) AUGER UNDISTURBED
(U)-SHELBY TUBE, (US) (SS) AND BLOW COUNTS PER 6" AND ROD (%) (AS) VERY SOFT 0 - 2 (P)-PISTON 0 - 4 **VERY LOOSE** < 10% TRACE REC (X) 3 - 4 SOFT 5 - 10 LOOSE REC (In) 15 - 25% 30 - 45% LITTLE 5 - 8 9 - 15 MEDIUM STIFF H - 30 MEDIUM DENSE SOME REFER TO THE SHEET ENTITLED TKEY TO BORING STIFF 31 - 50 DENSE 50 - 100% DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 16 - 30 VERY STIFF MOSTLY NBS-10,10A,B,C VERY DENSE 51+ NO. MATERIALS' FOR ADDITIONAL SYMBOLOGY. 30 HARD

LOG OF TEST BORING **PROJECT** New Bedford/FollRiver Commuter Rail NBS-II BORING **III** JACOBS LOCATION New Bedford Line - Taunton NO. Mass. Bay Transportation Authority OWNER SHEET I OF I JOB NUMBER 013471 34.9 T.Galvin **ELEVATION** Earth Exploration, Inc DRILLER CONTRACTOR INSPECTOR C.Nagata B-57 TR DATUM FT MSL METHOD OF DRILLING GROUNDWATER READINGS DRILL RIG GRID SPT HAMMER 140 Ib Sofety 2780900 N DATE/TIME DEPTH (ft) REMARKS Hollow Stem Augers 0.0 COORD Ε 773228 4/17/02 Upon Completion (In Augers) 1440 Dry 15.0 Split Spoon Sample 4/17/02 Augers pulled (hole coved to 12 ft) DATE START Dry 1500 4/17/02 16.2 Spoon Refusal DATE END 4/17/02 SAMPLE DEPTH STRATA SAMPLE REC. ELEV. FIELD CLASSIFICATION AND REMARKS DATA NO. SYMBOL (In)/(X) (ft) Silty sand (SM) - mostly fine sand, some silt, tan-light 18 SS-1 brown, moist Sity sand with gravel (SM) - mostly fine sand, some sit, some gravel 33 34 47 **SS-2** 14 (crushed rock fragments), tan-light brown, moist (Very hard drilling from 5 to 10 ft) 10 Silty sand with gravel(SM) - mostly fine to medium sand, 22 _{32 25} **SS-3** 5 some fine gravel, little silt, trace clay, gray, moist 15 Silty sand (SM) - mostly fine sand, little silt, trace clay, 47 **SS-4** 4 trace fine gravel, gray, moist 100/2 18.69 Split Spoon Refusalat 16.2 ft. Boring Terminated. **REMARKS:** Test boring performed by GeoLogic, Inc. 20 25 30 35 Page & 0-35 feet, Page 2: 35-80 feet. Each subsequent page displays 45 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** ROCK CORE (RC) N BAC BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS UNDISTURBED SPLIT-SPOON **AUGER** CUT-SHELBY TUBE, WUST S (SS) AND BLOW (AS) AND ROD (%) 0 - 2 **VERY SOFT** (P)-PISTON 0 - 4 VERY LOOSE COUNTS PER 6º < 10% TRACE REC (%) SOFT 5 - 10 LOOSE REC ((n) 15 - 25% 30 - 45% LITTLE MEDIUM STIFF 5 - 8 #- 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED "KEY TO SOME BORING 9 - 15 STIFF 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 16 - 30 VERY STIFF 50 - 100% MOSTLY NBS-II VERY DENSE 51+ MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO. 30

HARD

PROJECT New Bedford/FollRiver Commuter Rail NBS-12, 12A **II** JACOBS BORING LOCATION New Bedford Line - Tauntan OWNER Mass. Bay Transportation Authority NO. SHEET OF I JOB NUMBER 013471 T.Galvin **ELEVATION** INSPECTOR C.Nagata CONTRACTOR Earth Exploration, Inc DRILLER 31.9 METHOD OF DRILLING B-57 TR DATUM GROUNDWATER READINGS DRILL RIG FT MSL REMARKS SPT HAMMER 140 Ib Safety GRID 2780717 Wash Baring w/Casing DATE/TIME DEPTH (ft) Ν COORD 772762 Ε 4/22/02 1400 24.0 Split Spoon Refusol 4.0 Upon Completion of N85-12 (Casing Pulled) 4/22/02 DATE START 5/28/02 4.7 Upon Completion of NBS-I2A (Casing Pulled) DATE END 5/28/02 DEPTHISTRATA SAMPLE SAMPLE REC. ELEV. FIELD CLASSIFICATION AND REMARKS SYMBOL DATA NO. (ft) (In)/(Z) Silt with sand (ML) - mostly silt, little fine to medium sand, trace 14 17 **SS-1** coarse sand, light brown, dry Silt (ML) - mostly silt, trace fine sand, light brown, SS-2 18 27 27 8 5 wet (fine to medium sand in shoe) 24.90 27 _{51 30} 7 **SS-3** Silty gravel with sand (GM) - mostly fine to coarse gravel, 10 same fine to coarse sand, little silt, gray, wet (Very hard drilling from 9 to 14 ft. possible boulder blocking spoon sampler. add 10 ft of casing and continue drilling) 10 20 41 Slity gravel with sand (GM) - mostly fine to coarse gravel, 4 **SS-4** 15 some fine to coarse sand, little slit, gray, wet (Difficulty in drilling, affset boring to NBS-I2A and resume sompling of 19 ft) **100 SS-5** 2 Silty gravel with sand (GM) - mostly fine to coarse gravel, 20 some fine to coorse sand, little silt, gray, wet (Very hard drilling from 19 to 24 ft) No recovery 100/0 **SS-6** 0 7.90 Split Spoon Refusalat 24.0 ft. Boring Terminated. 25 **REMARKS:** Test boring performed by GeoLogic, Inc. 30 35 Page k 0-35 feet, Page 2: 35-80 feet, SAMPLES CLASSIFED IN ACCORDANCE WITH ASTM 0-2488 UNLESS OTHERWISE NOTED. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON UNDISTURBED MBAG (B) AUGER ROCK CORE (RC) * G CLIT-SHELBY TUBE, (JS) ISSI AND BLOW (AS) AND ROD (%) REC (%) **VERY SOFT VERY LOOSE** L (P)-PISTON COUNTS PER 6º < 102 TRACE 5 - 10 LOOSE LITTLE REC (In) 5 - 8 15 - 25% 30 - 45% MEDIUM STIFF # - 30 MEDIUM DENSE SOME REFER TO THE SHEET ENTITLED KEY TO 9 - 6 STEF BORING 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 16 - 30 VERY STIFF 50 - 100% MOSTLY NBS-12. 12A 51+ VERY DENSE 30 HARD MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO.

Memorandum

APPENDIX B: LABORATORY DATA

GeoTesting express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: TD-5 Sample Type: jar Tested By: jbr Sample ID:S-2 Test Date: 07/14/10 Checked By: jdt

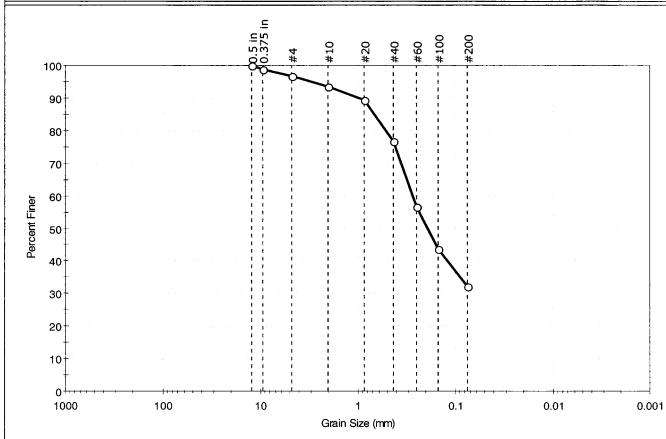
Depth: 3-5 ft Test Id: 185193

Test Comment: ---

Sample Description: Moist, olive silty sand

Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



 % Cobble
 % Gravel
 % Sand
 % Silt & Clay Size

 —
 3.1
 64.7
 32.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		<u> </u>
0.375 in	9.50	99		
#4	4.75	97		
#10	2.00	93		
#20	0.85	89		
#40	0.42	77		
#60	0.25	57		
#100	0.15	44		
#200	0.075	32		

<u>Coefficients</u>									
D ₈₅ = 0.6733 mm	$D_{30} = N/A$								
D ₆₀ = 0.2726 mm	$D_{15} = N/A$								
D ₅₀ = 0.1922 mm	$D_{10} = N/A$								
$C_u = N/A$	$C_c = N/A$								

Project No:

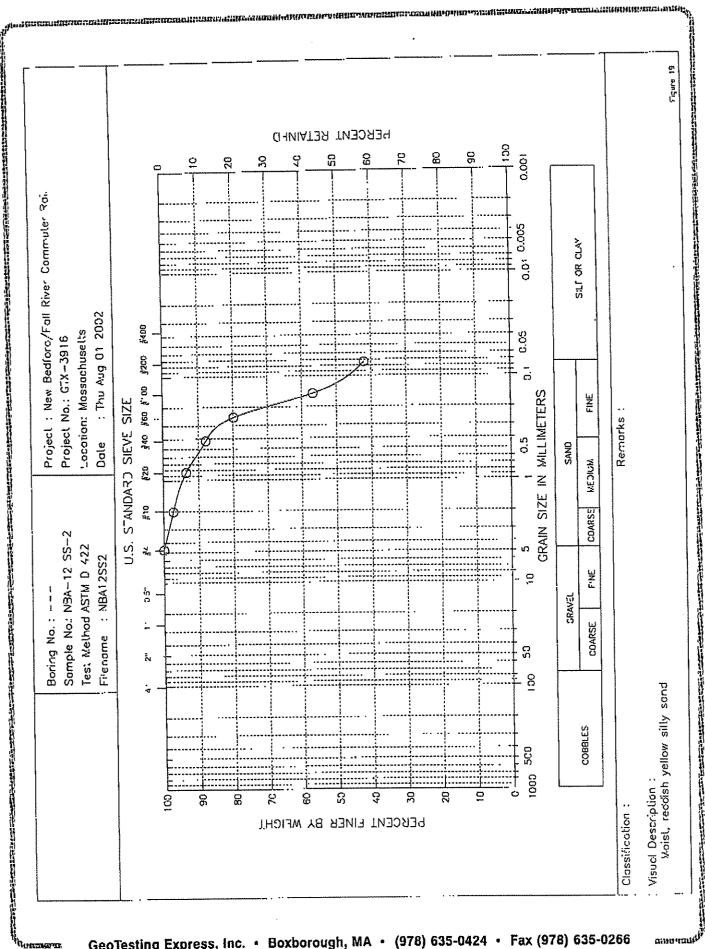
GTX-9764

Classification
ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape: ROUNDED

Sand/Gravel Hardness: HARD



Plevation : ---

Checked by : jdt

Tosted by : srp/jx

Page: 1

Depth : --Project No. : GTX-3916

YouL Date : 07/26/02 Boring No. : ---

Test Method : ASTM D 422 Sample No. : NBA-12 SS-2

Location : Massachusetts Soil Description : Moist, reddish yellow silty mand

Sicve	Sieve O		Moidhr Moidhr	Cumulativo Woight Retained	Percent Finer (%)	
Mesh	Tnch≐s	m;llimeters	Retained (gm)	(gm)		
#4	0.287	4.75	0.00	0.00	300	
#1C	0.079	2.00	2.20	2.20	9)	
#20	0.033	0.84	3.04	5.24	54	
	0.017	0.42	4.58	9.82	R.P	
#40	0.017	0.25	6.51	16.33	មព	
#60	0.006	0.15	18,72	35.05	57	
#100		0.15	11.96	47.01	42	
#200 5	0.003	0.07	34.09	81.10	ō	

Total Dry Weight of Sample = 89.19

D85 : 0.3484 mm

D60 : 0.1601 mm

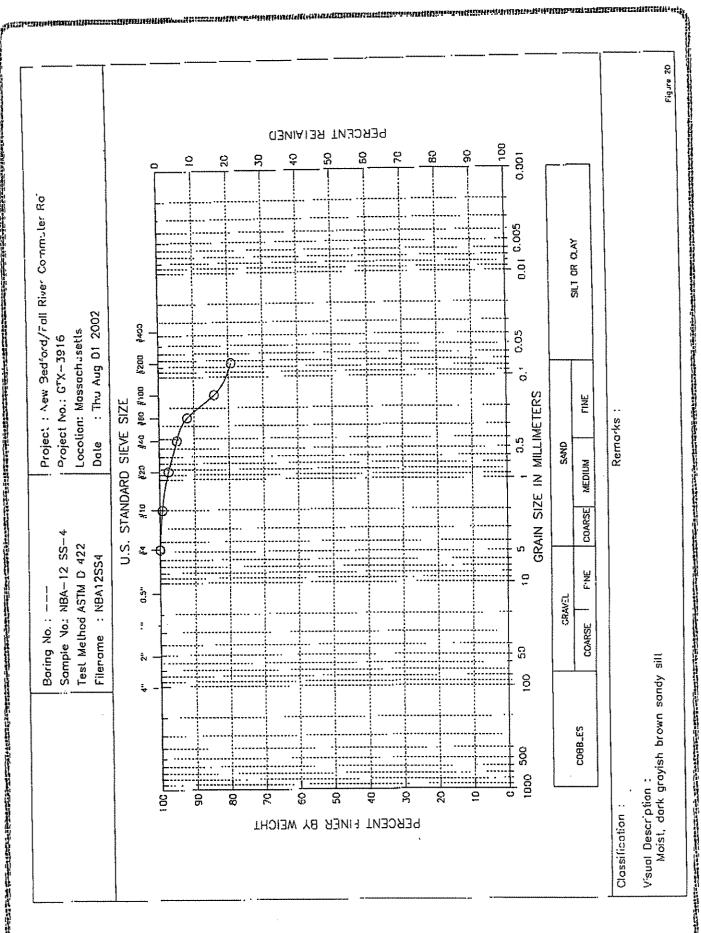
D50 : 0.1080 mm

D30 : N/A

D15 : N/A D10 : N/A

Soil Classification

ASTM Group Symbol : N/A ASTM Group Name : N/A AASHTO Group Symbol : A-4(0) AASHTO Group Name : Silty Soils



Page: 1

Pilenamo : NBA12SS4

Tested by : srp/jx

Chacked by : jdt

Elevation : "-"

Thu Aug 01 16:11:44 2002

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford/Fall River Communer Rail Depth : --

Project No. : GTX-3916 Test Unite : 07/26/02 Horing No. : ---Test Method : ASTM D 422 Sample No. : NBA-13 88-4

1.ocation : Massachusetts

Soil Description : Moist, dark grayish brown sandy silt

Sievo Mesh	Sievo Op Inches	pėnings Millimeters	FINE SIRVE SET Weight Recarred (ym)	(gm) (gm)	Parcent Pinat (%)	

"4	0.187	4.75	0.00	0.00	100	
#4		2.00	0.28	0.28	99	
#T0	0.079		0.74	1.02	97	
作とり	0.033	0.84	* *	2.00	95	
#40	0.017	0.42	0.98	3.19	92	
#60	0.010	0.25	1.15		84	
#100	0.006	0.15	3.10	6.29		
	0.003	0.07	1,96	8.25	79	
#300	8.005	0.0.	31.41	39.66	0	

Total Dry Weight of Sample - 47.81

D05 : 0.1577 mm

DG0 : N/A

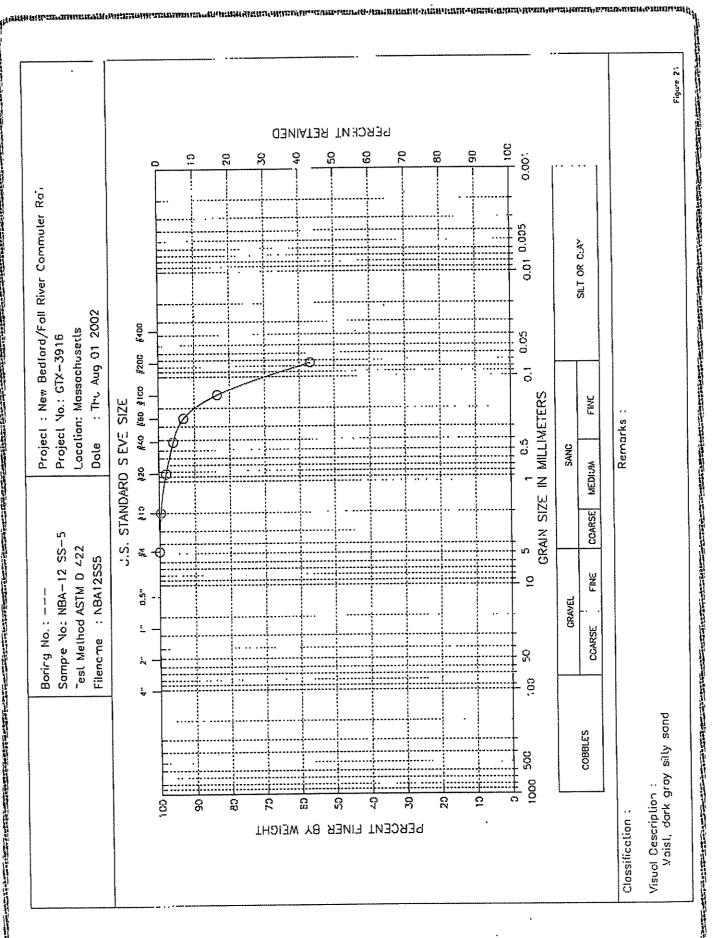
pso : N/A

D30 : N/A D15 : N/A

D10 : N/A

Soil Classification

ASTM Group Symbol : N/A : N/A ASTM Croup Name AASHTO Group Symbol : A 4 (0) AASHTO Group Name : Silry Souls



^Nokan milaning menggung dang dinikan dari milikan mining menggung menggung menggung menggung mining menggung menggung

The Aug 01 36:11:44 2002

Packe: J

GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford/Pail River Commuter Rail

Project No. : CTX-3516 Depth : ---

Boring No. : --

Elevation : ---Tosted by : srp/jx Test Date : 07/26/02 Checked by : jdr Test Method : ASIM D 422

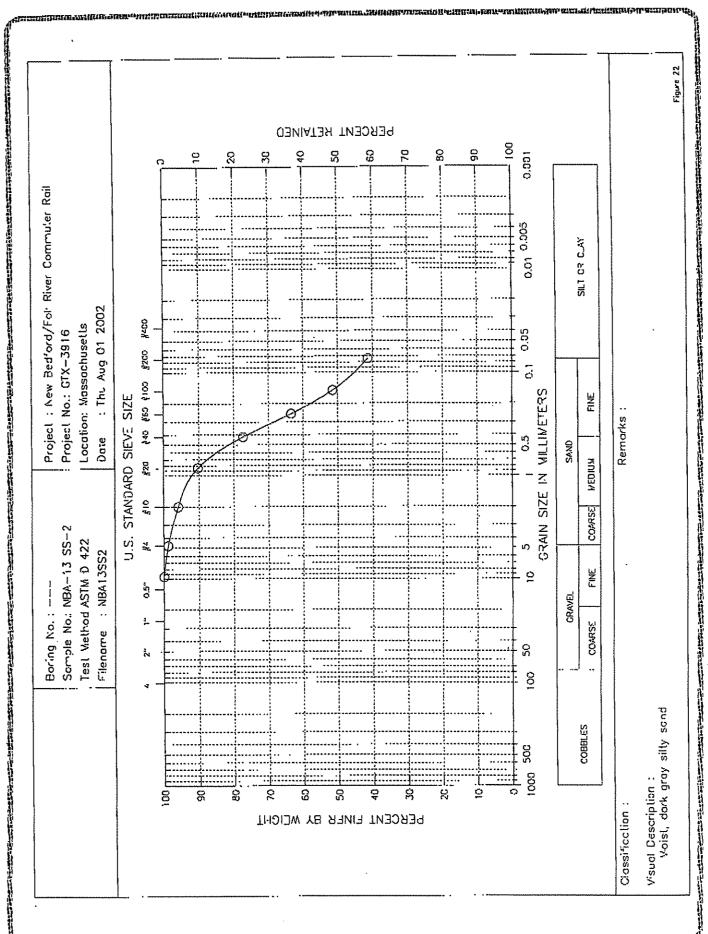
Filename : NBA12885

Sample No. : NBA-12 SS-5 Location : Massachusetts

Soil Description : Moist, dark gray salty sand

Remarks :

	Sieve Mash	Sieve Og Inches		NE SIEVE SOT Weight Relained (gm)	Cumulative Weight Rocain (gm)	Percent (%)
}					U.	
į	#4	0.187	4.75	0.00	0.1	
	110	0.079	2.00	0.56	2.	
	#30	0.033	0.84	1.96		
1	#40	0.017	0.42	2.54	5.	
	#60	0.010	0.35	3.67	8.	
	1, 11700	0.006	0.15	12.08	\$0.	
1	#200	0.003	0.07	33.66	54.	
	Daire			71.65	126.	13 0
: .	Total DAS: 0.1 D60: 0. D50: N/	l Dry Weight	of Sample - 134	.28		
	ปี บลร : 0.:	1616 mm				
	D60 : 0.	080S mm				
	D50 : N/					
	D30 : N/	A				
	D15 . N/	A				
	មី pio : N/. អ៊ី	A				
	A A	ssification STM Group Sym STM Group Nau ASHTO Group S ASHTO Group N	e · N/λ lymbol : A-4(0)	Goils		
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·		GeoTestin	g Express, Ir	ic. • Boxbo	orough, MA •	(978) 635-04



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GEOTECHNICAL LABORATORY TEST DATA

Project : New Hodford/rall River Commuter Rail

Project No. : CFX-3916 Boring No. : ---

Depth : ---

Test Dace : 07/25/02

Test Mathod : ASTM D 422

Filename : NBA13SS2 Elevation : -Tested by : srp/jx Checked by : jdt

Sample No. : NBA-13 6S-2 Location : Massachusetts

Soil Description : Moist, dark gray salty sand

Remarks :

Sieve Mesh	Sieve Op Inchos	penings MillimeLef8	FIME SIEVE SET Weight Retained (qm)	Cumulative Weight Ronained (gm)	Percent Finer (%)
					100
0.375"	0.374	9.51	0.00	0,00	100
	0,187	4.75	1.68	1.68	99
#4			3.93	5.61	96
#10	0.079	3.00	7.81.	13.42	90
#20	0.033	0.84		31.36	77
#40	0.017	0.42	17.94		ຣີ່
#an	0.010	0.25	19.20	50.56	
	0.006	0.15	16.68	67.24	51
1100			13.93	81,16	- 41
#200	0.003	0.07	57.25	138.41	0

Total Dry Weight of Sample - 146.62

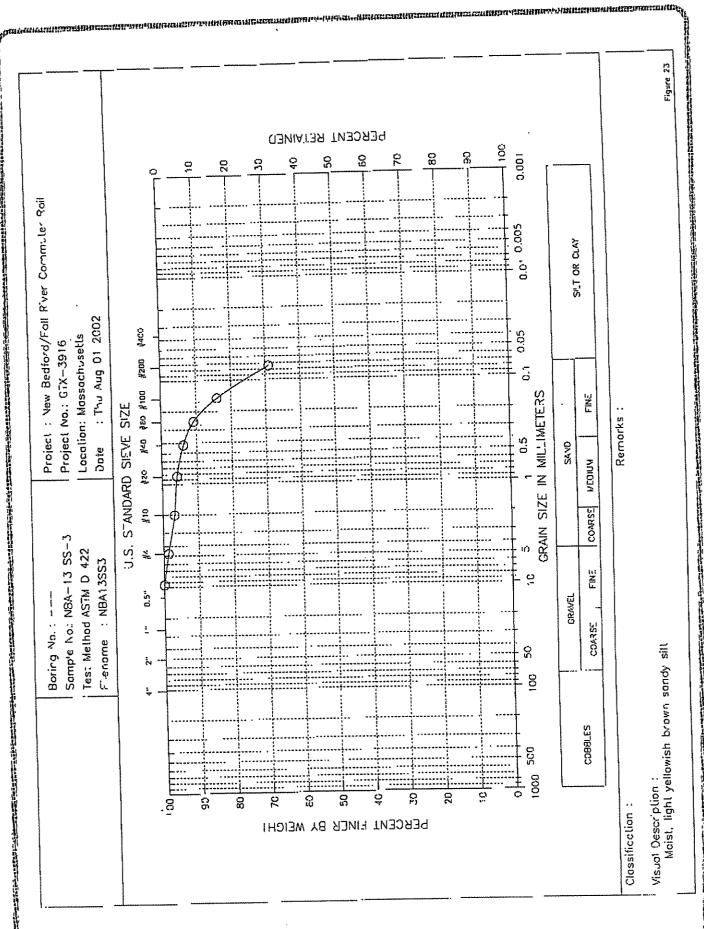
DB5 : 0.6330 mm D60 : 0.2154 mm

D50 : 0.1350 mm D30 : N/A

D15 : N/A 010 : N/A

Soul Classification

ASTM Group Symbol : N/A ASTM Group Name : N/A AASHTO Group Symbol : A-4(0) AASHTO Group Name : Silty Soils



Filename : NBA13583

Tested by : srp/jx

Checked by : jdt

Elevation : --

Project : New Bedford/Fail River Commuter Rail

Depth : ---Project No. : CYX-3916

Boring No. : ---

'ComL Date : 07/26/03

Sample No. : NBA-13 SS-3

Yest Method : ASIM D 422

Location : Massachusetts

Soil Description : Moist, light yellowish brown sandy sill

sicve Mesh	Sievo Og Inches	enipgs Millimeters	FINE SIEVE SET Wolght Retained	Cumulative Weight Katained (gm)	Fercent Finer (%)
0.375" #1 #10 #20 #4 #160 #100 #200	0.374 0.187 0.079 0.033 0.017 0.010 0.006	9.51 4.75 2.00 0.84 0.42 0.25 0.15	0.00 1.53 2.16 1.07 2.30 3.47 7.75 17.31	0.00 1.53 3.71 4.78 7.08 10.55 18.30 35.61	100 99 , 97 96 94 91 84 69

Total Dry Weight of Sample - 122.94

D85 ; 0.1602 mm

DG0 : N/A

D50 : N/A

D30 : N/A

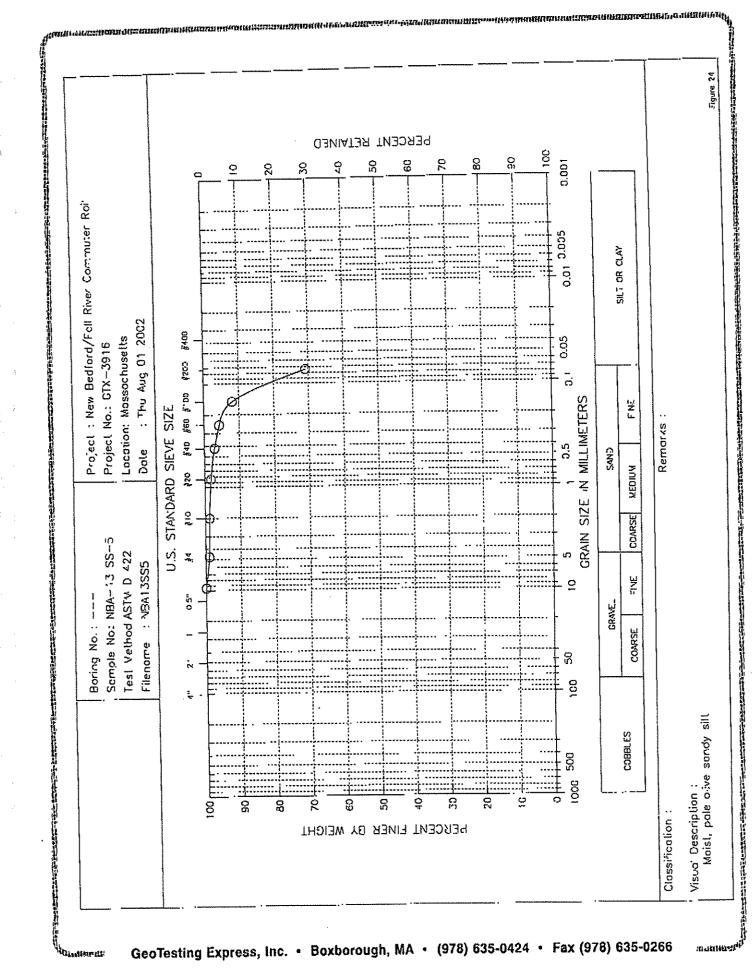
D15 : N/A

D10 : N/A

Soil Classification

ASTM Group Symbol : N/A ASTM Group Name : N/A

AASHTO Group Symbol : A-4(0)



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GEOTECHNICAL LABORATORY THAT DATA

Project : New Bedford/Fall River Commuter Rail

Project No. : GTX-3916

Depth : ---

Boring No. : ---

Test Dane : 07/36/02

Sample No. : NDA-13 55-5

Test Mothod : ASTM D 422

Elevation : ---Tested by : srp/jx Checked by ; jdt.

Pilename : NBA13555

Location : Massachusetts

Soil Description : Moist, pale offive sandy silt

Sieve	Sieve O	panings	FINE SIEVE SET Weight	Cumulacivo	Percent Finer
Mesh	Inches	Millimeters	(gm)	Weight Retained (gm)	(\$)
			~~~~	*** ********	
0.375"	0.374	9.51	0,00	0.00	100
	0.187	4.75	0.90	0.90	99
#4		2.00	0.23	1.13	99
#10	0.079	0.84	0.49	1.62	98
#20	0.033	* *	1.05	2.67	97
₩4O	0.017	0.43		4.00	96
#60	0.010	0.25	1.34	7,52	92
#100	0.006	0.15	3.51		/1
#200	0.003	0.07	19.68	37.20	•
The contract of the contract o			66.05	93.25	0

Total Dry Weight of Sample - 101.42

DB5 : 0.1184 mm

D60 : N/A

D5G : N/A

D30 : N/A

DIS : N/A

D10 : N/A

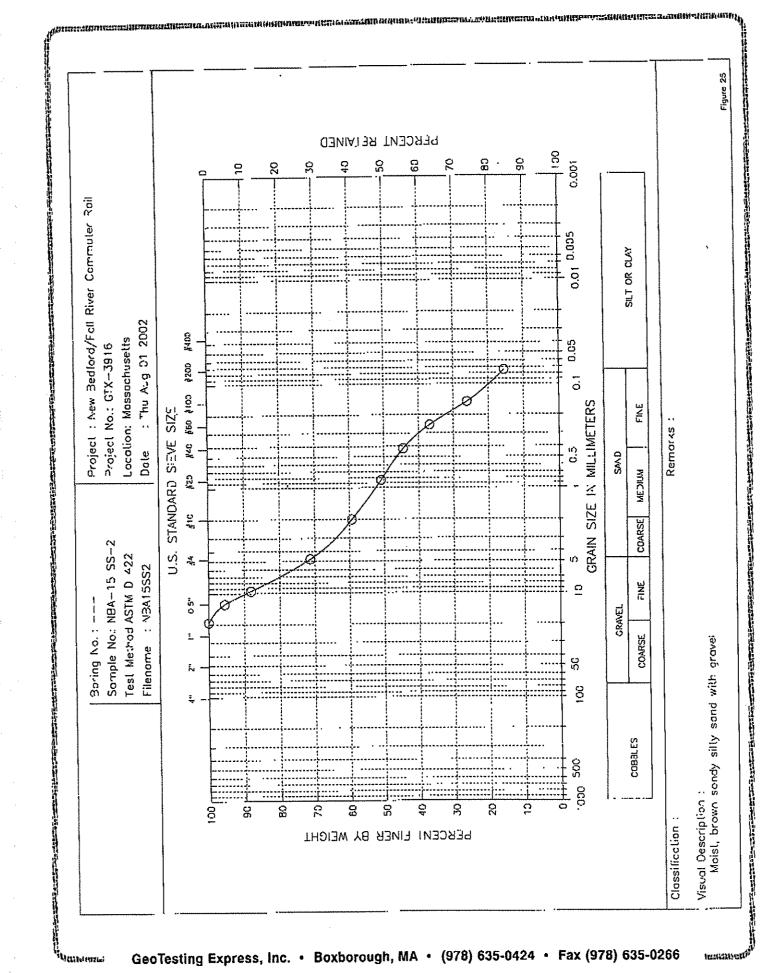
Soil Classification

: N/Y ASTM Group Symbol

ASTM Group Name : N/A

AASHTO Group Symbol : A-4(0)

AASHTO Group Name : Silky Soils



Manten description des la company de la comp

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Pilename : NBA15882

Tested by : srp/jx

Checked by : jdt

Elevation : ---

## GEOTECHNICAL LABORATORY TEST DATA

Project : New Bedford/Pali River Commuter Rail

Depth : ---Project No. : CTX-3916

Test Date : 07/26/02 Soring No. : ---

Test Method : ASTM D 422 Sample No. ; NBA-15 SS-2

Location : Massachusetts

Soil Description : Moist, brown sandy silty sand with gravel

Sieve	Sieve O		FINS SIEVE SET Woight	Cumulative	Percent Finer
Weep	Inches	Millimecorn	Ropained (gm)	woight Retained (gm)	(\$)
0.75"	0.748	19.00	0.00	0.00	100
	0.500	12.70	3.80	3.80	96
0.5"		9.51	6.39	10.09	86
0.375"	0.374	4.75	14.24	24.33	71
#4	0.187		10.17	34.50	G 9
#10	0.079	2.00	7.24	41.74	51
#20	0.043	U.84		47.16	44
#40	0.017	0.42	5.42	53.64	37
1160	0.010	0.25	6.48		26
#10D	0.006	0.15	9.10	62.74	
**	0,003	0.07	9.01	71.75	15
#200 Pan			13.12	84.87	0

Total Dry Weight of Sample - 92.93

mm F136.8 : 200 D60 : 2.0961 mm D50 : 0.7694 mm

D30 : 0.1801 mm DIS : N/A

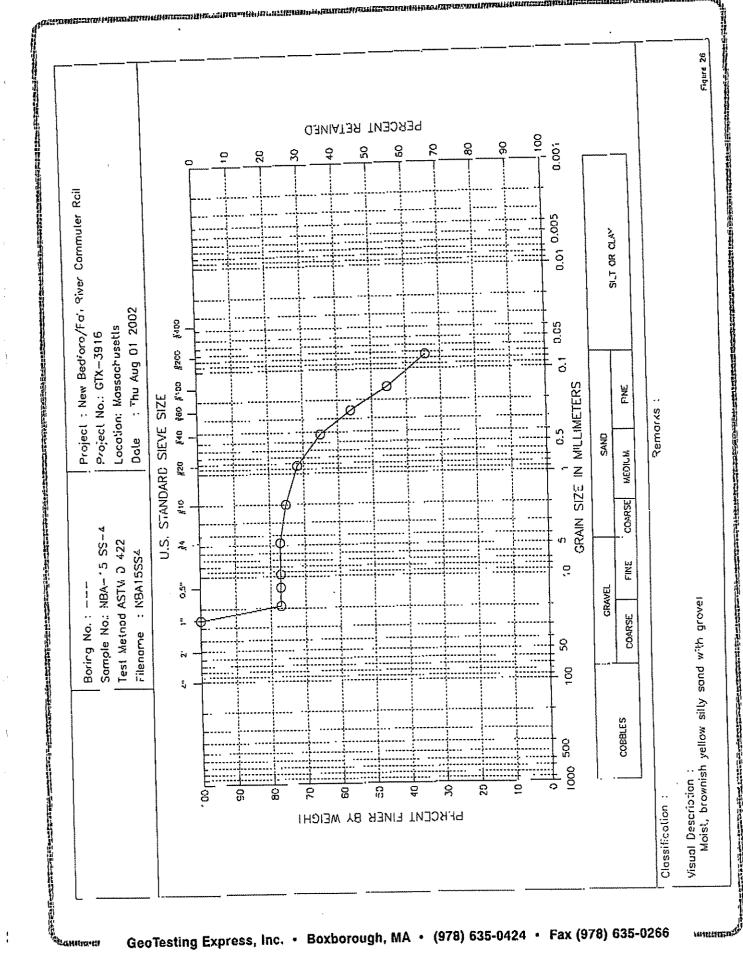
Dio : N/A

Soil Classification

ASTM Group Symbol : N/A : N/A ASTM Group Name

AASHTO Group Symbol : A-l-b(0)

AASHTO Group Name : Slone Fragments, Gravel and Sand



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### CECTECHNICAL LABORATORY TEST DATA

Project : New Bedford/Fall River Commuter Rail

Project No. : GTX-3916

Horing No. : ---

Depth: ---

Test Date : 07/26/02

Tost Mothod : ASTM D 422

Alevation : ---Tested by : erp/jx Checked by : jdt

Filonomo : NBA15884

Sample No. : NEA-15 SS-4 Location : Massachusetts

Soil Description : Moist, brownish yellow silty sand with gravel

Remarks :

			FINE SIEVE SET		
Sleve	Sieve O	penings	Weight	Cumulative	Percent
Mesh	Inches	Millimeters	Rétained (gm)	Weight Retained (gm)	Finer (%)
14	1.012	25.70	0.00	0.00	100
0.75%	0.748	19.00	22.04	22.04	77
0.5"	0.500	12.70	0.00	22.04	77
0.375"	0.374	9.51	0.00	23.04	77
#4	0.187	4.75	0.00	22.04	77
110	0.079	2.00	1.77	23.81	75
#20	0.033	0.84	3.32	27.13	72
#40	0.017	0.42	6.54	33.67	65
1160	0.010	0.25	8.51	42.38	56
#100	0.006	0.15	10.22	52.40	46
#200	0.003	0.07	F8.01	63.23	34
Pan			32.98	96.21	Q

Total Dry Weight of Sample - 104.33

DOS : 21.0882 mm

D60 : 0.3132 mm D50 : 0.1852 mm

D30 : N/A

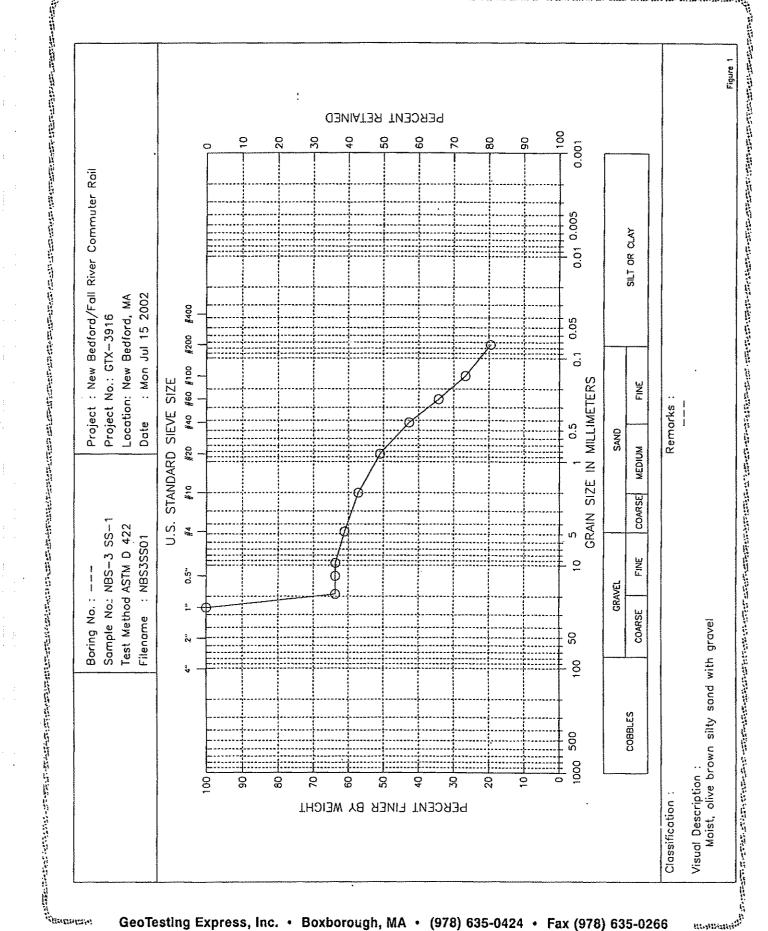
D15 : N/A D10 : N/A

Soul Classification

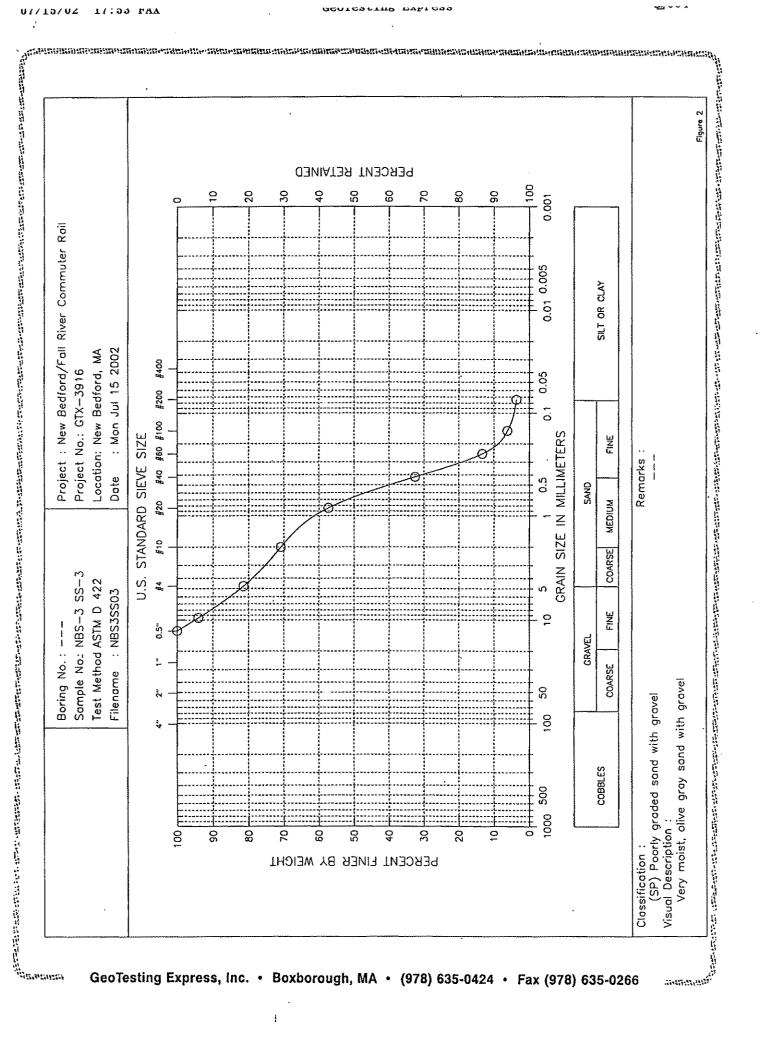
ASIM Group Symbol : N/A ASTM Group Name : N/A

AASHTO Group Symbol : A-2-4(0)

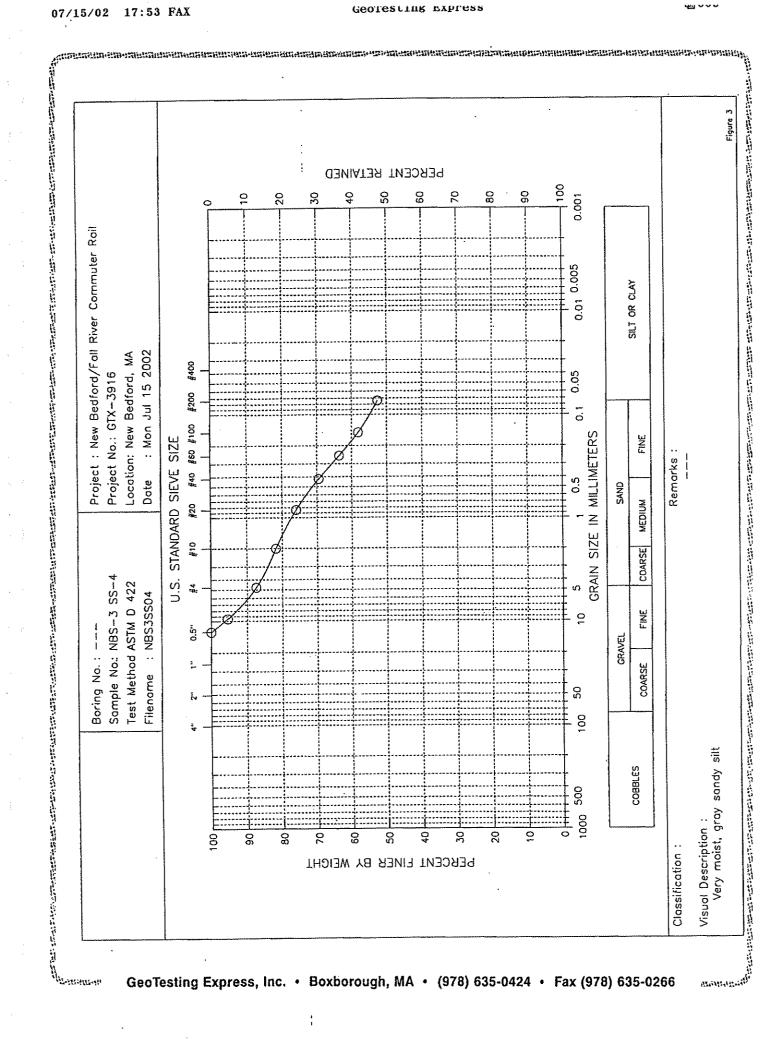
AASHTO Group Name : Slity Gravel and Sand



Mon Jul 15	18:09:20 2002		. 1	•		Page : 1
		GE	OTECHNICAL LAB	SORATORY TEST DATA		
Project : Ne Project No. Boring No.	ew Bedford/Fa : GTX-3916 :	ll River Comm	nuter Rail Depth : Test Date : 07/	10/02	Filename : NBS3SS01 Elevation : Tested by : jx	
Sample No. : Location : I Soil Descrip	: NBS-3 SS-1 New Bedford, otion : Moist	MA , olive brown	est Method : A silty sand wi	STM D 422 th gravel	Checked by : jdt	
Remarks :	• •	_				
Sieve Mesh	Sieve Ope Inches	nings Millimeters	'INE SIEVE SET Weight Retained	Cumulative Weight Retained	Percent Finer	
******	*	~~===	(gm)	(gm)	(%)	
1 k	1.012	25.70	0.00	0.00	100	
0.75" 0.5"	0.748	19.00	40.60	40.60	64	
0.375"	0.374	9.51	0.00	40.60	. 64 64	
#4	0.187	4.75	2.91	43.51	61	
#10	0.079	2.00	4.41	47.92	57	
#20 #4n	0.033	0.84	6.96	54.88	<b>51</b>	
#60	0.010	0.4%	9.40	64.14 73 SE	43 34	
#100	0.006	0.15	8.52	82.08	27	
#200	0.003	0.07	8.03	90.11	19	
Pan Takal F	lwe Wajehr of	Ca-ala - 120	21.82	111.93	0	
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM ASTM AASH AASH	fication Group Symbol Group Name TO Group Name TO Group Nam	l : N/A : N/A bol : A-l-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM AASH AASH	fication Group Symbol Group Name TO Group Name	1 : N/A : N/A bol: A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM AASH AASH	fication Group Symbol Group Name TO Group Name	1 : N/A : N/A bol : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand	Filename: NBS3SS01 Blevation: Tested by: jx Checked by: jdt  Percent Finer (*)  100 64 64 64 61 57 51 43 34 27 19 0	
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM AASH AASH	fication Group Symbol Group Name TO Group Name	1 : N/A : N/A bo1 : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM ASTM AASH	fication  fication  Group Symbol  Group Name  TO Group Symi	l : N/A : N/A bol : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM ASTM AASH	3 mm 9 mm fication Group Symbol Group Name TO Group Name	l : N/A : N/A bol : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM ASSM AASH	3 mm 9 mm fication Group Symbol Group Name TO Group Name	l : N/A : N/A bol : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM ASTM AASH	3 mm 9 mm fication Group Symbol Group Name TO Group Name	1 : N/A : N/A bol : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM AASH AASH	fication Group Symbol Group Name TO Group Name	1 : N/A : N/A bol: A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM AASH AASH	fication Group Symbol Group Name TO Group Symi	1 : N/A : N/A bol: A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30: 0.186 D15: N/A D10: N/A Soil Classi ASTM AASH AASH	fication Group Symbol Group Name TO Group Symi	l : N/A : N/A bol : A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
D30: 0.186 D15: N/A D10: N/A Soil Classi ASTM AASH AASH	fication  fication  Group Symbol  Group Name  TO Group Symi	l : N/A : N/A bol: A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		·
D30 : 0.186 D15 : N/A D10 : N/A Soil Classi ASTM ASSM AASH	fication Group Symbol Group Name TO Group Name TO Group Name	l : N/A : N/A bol: A-1-b(0 e : Stone F	) ragments, Grave	el and Sand		
					635-0424 • Fax (978)	

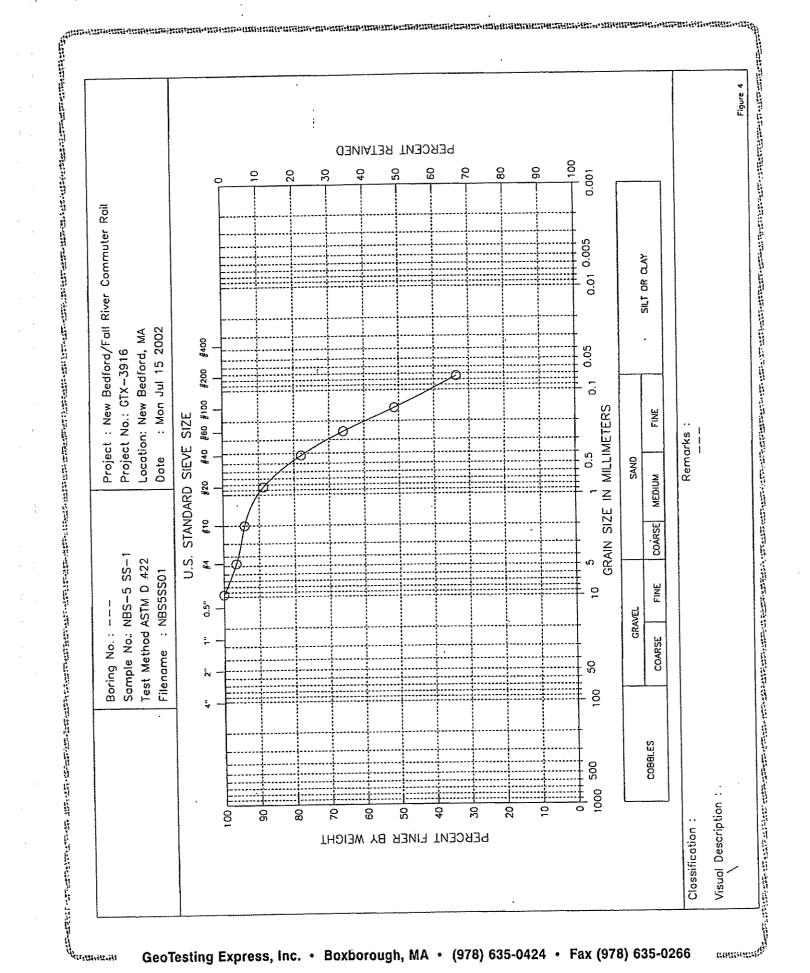


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e el e			EOTECHNICAL LAE	ORATORY TEST DATA		Page : 1
Project : Project No Boring No Sample No Location	New Bedford/1 o.: GTX-3916 .: .: NBS-3 SS-3 : New Bedford,	Fall River Com	muter Rail Depth : Test Date : 07/ Test Method : A	/10/02 ASTM D 422	Filename: NBS3SS03 Elevation: Tested by: jx Checked by: jdt  Percent Finer (%)  100 94 81 71 57 33 13 6 4 0	
Soil Desci Remarks :	ription : Very	y moist, olive	gray sand with	gravel		
Sieve Mesh	Sieve Op Inches	penings Millimeters	FINE SIEVE SET Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)	
0.5"	0.500	12.70	0.00	0.00	100	
, U.375" , #4	0.187	9.51 4.75	8.10 17.33	8.10 25.43	94 81	
#10	0.079	2.00	14.54	39.97	71	
#20	0.033	0.84	18.54	58.51	57	
#40	0.017 8.016	0.42 n 25	34.01	92.52	33 .	
#100	0.006	0.15	9.72	118.92 128.64	1.3	
#200	0,003	0.07	3.47	132.11	4	
Pan manana			5.05	137.16	o	
Total	r Dry Weight o	or Sample = 145	5.21			
DIO : 0.1	.965 mm					
	sification TTM Group Symb TTM Group Name SHTO Group Sy SHTO Group Na		graded sand wi )} Pragments, Grave			
AA						
AA						
AA						

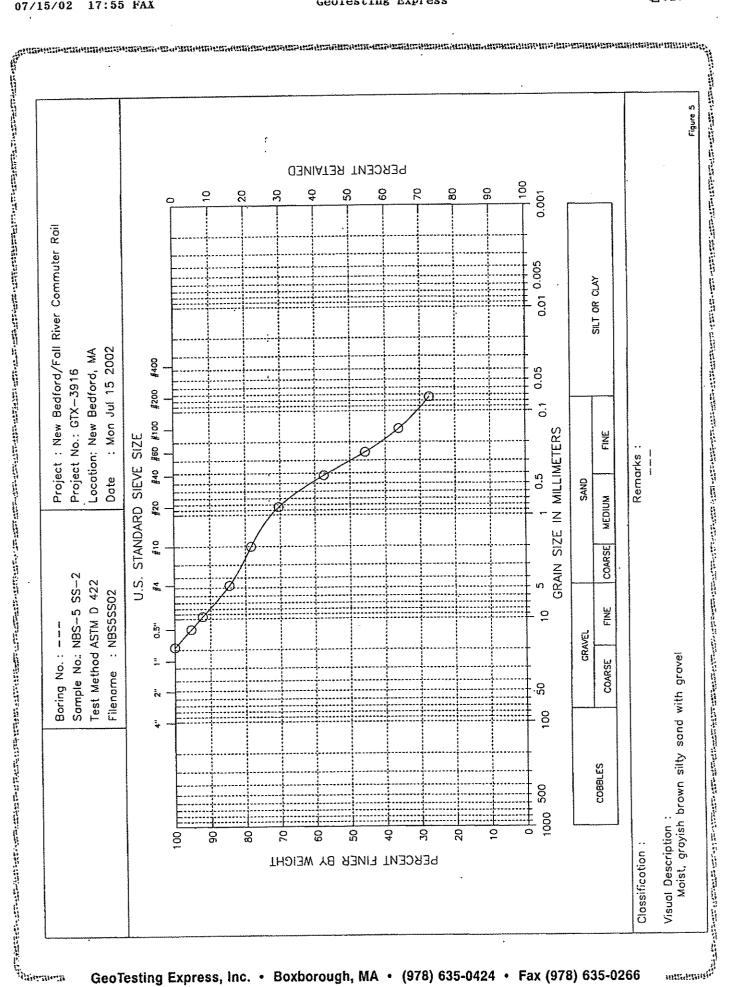


Mon Jul 15 18						
	:09:21 200	32	•		•	Page : 1
		GE	OTECHNICAL LAB	ORATORY TEST DATA		
Project : New Project No. : Boring No. :	Bedford/E GTX-3916	7all River Comm E T	outer Rail Pepth : Pest Date : 07/	10/02	Filename: NBS3SS04 Elevation: Tested by: jx Checked by: jdt  Percent Finer (%)  100 95 87 82 76 69 64 58 53	,
Sample No. : Location : Ne Soil Descript Remarks :	w Bedford, ion : Very	! , MA , moist, gray s	est Method : A	STM D 422	Checked by : jdt	
		r	THE STRUE SET			
Sieve Mesh	Sieve Op Inches	enings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)	
0.5"	0.500	12.70	0.00	0.00	100	
0.375"	0.374	9.51	4.83	4.83	95	
#4 #10	0.187	4.75	8.57	13.40	87	
#20	0.079	⊿.₩ 0.84	ზ. US წ. 22	19.45 25.67	82 76	
#40	0.017	0.42	6.97	32.64	69	
#60	0.010	0.25	. 6.26	38.90	. 64	•
#100 #200	0.006	0.15	5.87 5.94	44.77	58	
#200 Pan	0.003	0.07	5.94 56.19	50.71 106.90	53 0	
	y Weight c	of Sample = 115			-	
ASTM	Group Symb Group Name	: N/A				
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name	≥ : N/A vmbol : A-4(0)	oils			
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name O Group Sy	≥ : N/A vmbol : A-4(0)	oils			
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name O Group Sy	≥ : N/A vmbol : A-4(0)	oils			
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name O Group Sy	≥ : N/A vmbol : A-4(0)	oils			
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name O Group Sy	≥ : N/A vmbol : A-4(0)	oils			
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name O Group Sy	≥ : N/A vmbol : A-4(0)	oils			
D10 : N/A Soil Classif ASTM ASTM ASSM	Group Symb Group Name O Group Sy	≥ : N/A vmbol : A-4(0)	oils			

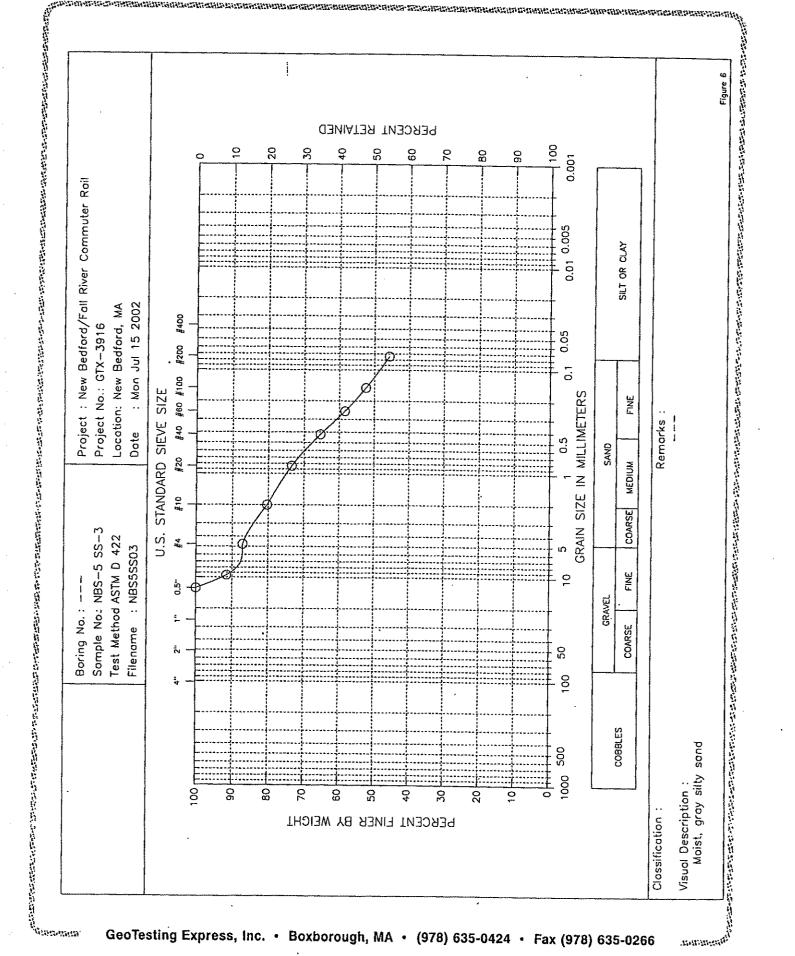
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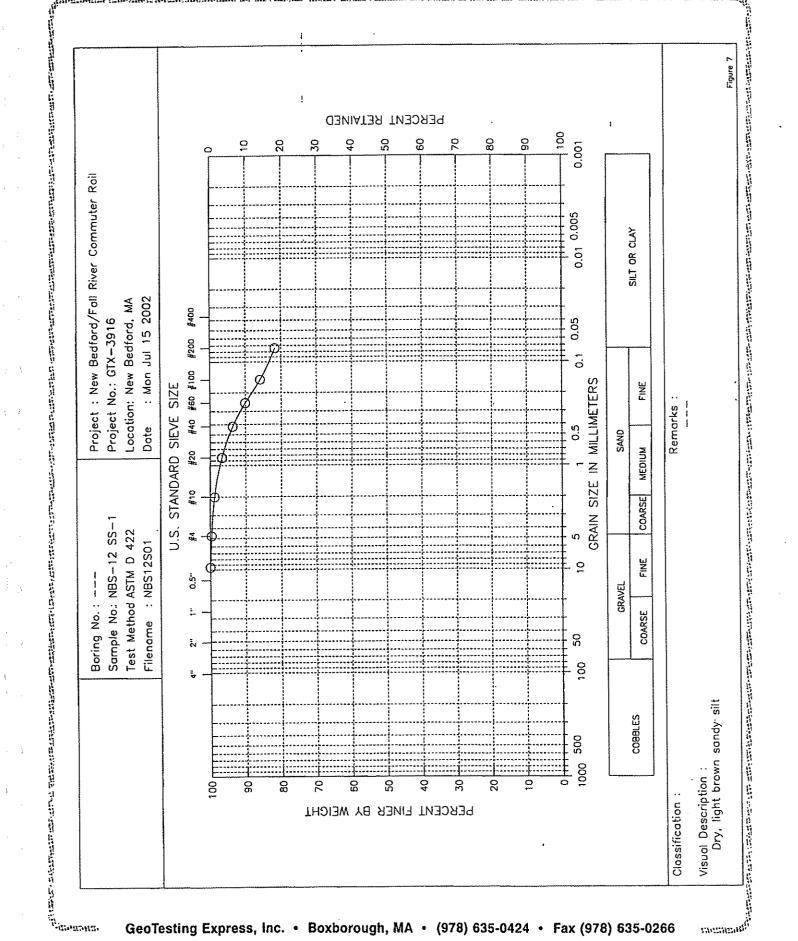
Mon Jul 15	18:09:21 200	)2	. !			Page: 1
		GE	OTECHNICAL LAB	ORATORY TEST DATA		
Project : No. Project No. Boring No. Sample No. Location : Soil Descri Remarks :	ew Bedford/F : GTX-3916 : : NBS-5 SS-1 New Bedford, ption : \	all River Comm I I I MA	muter Rail Depth : Test Date : 07/ Test Method : A	110/02 STM D 422	Filename: NBS5SS01 Blevation: Tested by: jx Checked by: jdt  Percent Finer (*) 100 96	
		1	PINE SIEVE SET			
Sieve Mesh	Sieve Op Inches	penings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)	
0.375"	0.374	9.51	0.00	0.00	100	
#4						
#10 #20	0.079	2.00 0.84	1.93 4.27	4.73 9.00	94 89	
#20 #40	0,033 0.017	0.84	8.60	17.60	78	
#60	0.010	0.25	9.61	27,21	66	
#100	0.006	0.15 0.07	11.71 14.17	38.92 53.09	51 34 .	,
#200 Pan	0.003	0.07	26.86	79.95	0	
	Dry Weight (	of Sample = 88				
D15 : N/A D10 : N/A						
D10 : N/A Soil Class AST AST	sification IM Group Sym IM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	d.		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	d .		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	O) Gravel and Sand	<b>a</b>	·	
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	<b>d</b>		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	<b>d</b> 		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand		·	
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	a ·	·	
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	d		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	<b>d</b>		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand			
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	i		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	d		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	d		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	a		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	d		
D10 : N/A Soil Class AST AST	TM Group Sym TM Group Nam SHTO Group S	e : N/A ymbol : A-2-4(	0) Gravel and Sand	<b>d</b>		



######################################	GEOTECHNICAL LABORATORY TEST DATA  Bedford/Fall River Commuter Rail Filename: NBSSSS02 GTX-3916 Depth: Elevation: Test Date: 07/10/02 Tested by: jx NBS-5 SS-2 Test Method: ASTM D 422 Checked by: jdt  W Bedford, MA ion: Moist, grayish brown silty sand with gravel  FINE SIEVE SET  Sieve Openings Weight Cumulative Percent Inches Millimeters Retained Weight Retained Finer (gm) (gm) (%)  0.748 19.00 0.00 0.00 100 0.500 12.70 6.99 6.99 95 0.374 9.51 4.93 11.92 92 0.187 4.75 11.61 23.53 85 0.079 2.00 9.51 33.04 78 0.033 0.84 12.17 45.21 70 0.017 0.42 19.81 65.02 57 0.010 0.25 17.98 83.00 46	GEOTECHNICAL Toject: New Bedford/Fall River Commuter Rail Troject No.: GTX-3916 Toring No.: Test Date: Test Date: Test Method Tocation: New Bedford, MA Toil Description: Moist, grayish brown silty stemarks:  FINE SIEVE Test Method Test Date: Test Method Test Date: Test Method Test Date: Test Method Test Date: Test Method Test Date: Test Method Test Date: Test Method Test Method Test Date: Test Date: Test Date: Test Date: Test Date: Test Date: Test Method Test Date: Test Method Test Date: Test Date: Test Date: Test Method Test Date:
Copect : New Bedford/Fall River Commuter, Rail   Filename : NBSSSS92   Elevation :   Copect No. : GTX-3916   Elevation :   Elevation :   Copect No. : GTX-3916   Elevation :   Copec	Bedford/Fall River Commuter Rail Filename : NBSSSS02  GTX-3916 Depth : Elevation : Test Date : 07/10/02 Tested by : jx  NBS-5 SS-2 Test Method : ASTM D 422 Checked by : jdt  W Bedford, MA ion : Moist, grayish brown silty sand with gravel  FINE SIEVE SET  Sieve Openings Weight Cumulative Percent Inches Millimeters Retained Weight Retained (gm) (gm) (%)  0.748 19.00 0.00 0.00 100 0.500 12.70 6.99 6.99 95 0.374 9.51 4.93 11.92 92 0.187 4.75 11.61 23.53 85 0.079 2.00 9.51 33.04 78 0.033 0.84 12.17 45.21 70 0.017 0.42 19.81 65.02 57 0.010 0.25 17.98 83.00 46	GEOTECHNICAL  Project: New Bedford/Fall River Commuter, Rail Project No.: GTX-3916 Depth: Foring No.: Test Date: Sample No.: NBS-5 SS-2 Test Method Accation: New Bedford, MA Coil Description: Moist, grayish brown silty s  Temarks:  FINE SIEVE  Sieve Openings Weight  Heather Retaine  (gm)  1.5" 0.748 19.00 0.0  1.5" 0.500 12.70 6.9  1.375" 0.374 9.51 4.9  1.4 0.187 4.75 11.6
Filename   NBSSS02   Filename   Fi	## Bedford/Fall River Commuter Rail	Project: New Bedford/Fall River Commuter Rail Project No.: GTX-3916 Depth: Foring No.: Test Date: imple No.: NBS-5 SS-2 Test Method cocation: New Bedford, MA icil Description: Moist, grayish brown silty stemarks:  FINE SIEVE Sieve Openings Weight Inches Millimeters Retaine (gm)  1.75" 0.748 19.00 0.0 1.375" 0.500 12.70 6.9 1.375" 0.374 9.51 4.9 1.0 0.079 2.00 9.5
ample No.: NBS-5 SS-2 coation: Now Bedford, NA oil Description: Moist, grayish brown silty sand with gravel emarks:  FINE SIEVE SET ieve Sieve Openings Weight Cumulative Piner (gm) (gm) (t)  7.5* 0.748 19.00 0.00 0.00 100  .5" 0.500 12.70 6.99 6.99 95 .375* 0.374 9.51 4.93 11.92 92 4 0.187 4.75 11.61 23.53 85 10 0.079 2.00 9.51 33.04 78 20 0.033 0.84 12.17 45.21 70 40 0.017 0.42 19.81 65.02 57 60 0.010 0.25 17.98 83.00 46 100 0.006 0.15 14.62 97.62 36 100 0.003 0.07 13.43 111.05 27 an Total Dry Weight of Sample * 160.89  DBS: 4.9251 mm DGO: 0.4813 mm DSO: 0.4813 mm DSO: 0.4813 mm DSO: 0.3023 mm D10: N/A  Soil Classification  ASTM Group Symbol: N/A ASSMT Group Symbol: N/A ASSMT Group Symbol: N/A ASSMT Group Symbol: A-2-4(0) AASHT Group Symbol: A-2-4(0) AASH	### Bedford, MA ion: Moist, grayish brown silty sand with gravel    FINE SIEVE SET	Sieve   Sieve   Openings   Weight
PINE SIEVE SET	FINE SIEVE SET  Sieve Openings Weight Cumulative Percent Inches Millimeters Retained Weight Retained Finer  (gm) (gm) (%)  0.748 19.00 0.00 0.00 100 0.500 12.70 6.99 6.99 95 0.374 9.51 4.93 11.92 92 0.187 4.75 11.61 23.53 85 0.079 2.00 9.51 33.04 78 0.033 0.84 12.17 45.21 70 0.017 0.42 19.81 65.02 57 0.010 0.25 17.98 83.00 46	Soil Description : Moist, grayish brown silty stemarks :   FINE SIEVE
Sieve Openings   Weight   Cumulative   Percent	FINE SIEVE SET  Sieve Openings Weight Cumulative Percent Inches Millimeters Retained (gm) (%)  0.748 19.00 0.00 0.00 100 0.500 12.70 6.99 6.99 95 0.374 9.51 4.93 11.92 92 0.187 4.75 11.61 23.53 85 0.079 2.00 9.51 33.04 78 0.033 0.84 12.17 45.21 70 0.017 0.42 19.81 65.02 57 0.010 0.25 17.98 83.00 46	FINE SIEVE Sieve Openings Weight Mesh Inches Millimeters Retaine (gm)  1.75" 0.748 19.00 0.0 1.5" 0.500 12.70 6.9 1.375" 0.374 9.51 4.9 14 0.187 4.75 11.6 110 0.079 2.00 9.5
Sieve Openings	Sieve Openings Weight Cumulative Percent Finer (gm) (gm) (%)  0.748 19.00 0.00 0.00 100 0.500 12.70 6.99 6.99 95 0.374 9.51 4.93 11.92 92 0.187 4.75 11.61 23.53 85 0.079 2.00 9.51 33.04 78 0.033 0.84 12.17 45.21 70 0.017 0.42 19.81 65.02 57 0.010 0.25 17.98 83.00 46	Sieve Openings Weight  Millimeters Retaine  (gm)  1.75" 0.74B 19.00 0.0  1.5" 0.500 12.70 6.9  1.375" 0.374 9.51 4.9  14 0.187 4.75 11.6  110 0.079 2.00 9.5
.75" 0.748 19.00 0.00 0.00 100 .5" 0.500 12.70 6.99 6.99 95 .375" 0.374 9.51 4.93 11.92 92 4 0.187 4.75 11.61 23.53 85 10 0.079 2.00 9.51 33.04 78 20 0.033 0.84 12.17 45.21 70 40 0.017 0.42 19.81 65.02 57 60 0.010 0.25 17.99 83.00 46 100 0.006 0.15 14.62 97.62 36 100 0.003 0.07 13.43 111.05 27 20	0.748     19.00     0.00     0.00     100       0.500     12.70     6.99     6.99     95       0.374     9.51     4.93     11.92     92       0.187     4.75     11.61     23.53     85       0.079     2.00     9.51     33.04     78       0.033     0.84     12.17     45.21     70       0.017     0.42     19.81     65.02     57       0.010     0.25     17.98     83.00     46	0.75" 0.74B 19.00 0.0 0.5" 0.500 12.70 6.9 1.375" 0.374 9.51 4.9 14 0.187 4.75 11.6 110 0.079 2.00 9.5
1.5	0.500     12.70     6.99     6.99     95       0.374     9.51     4.93     11.92     92       0.187     4.75     11.61     23.53     85       0.079     2.00     9.51     33.04     78       0.033     0.84     12.17     45.21     70       0.017     0.42     19.81     65.02     57       0.010     0.25     17.98     83.00     46	0.5" 0.500 12.70 6.9 0.375" 0.374 9.51 4.9 4 0.187 4.75 11.6 110 9.079 2.00 9.5
1.375" 0.374 9.51 4.93 11.92 92 4 0.187 4.75 11.61 23.53 85 10 0.079 2.00 9.51 33.04 78 20 0.033 0.84 12.17 45.21 70 40 0.017 0.42 19.81 65.02 57 60 0.010 0.25 17.98 83.00 46 100 0.006 0.15 14.62 97.62 36 200 0.003 0.07 13.43 111.05 27 Van  Total Dry Weight of Sample = 160.89  D85 : 4.9251 mm D50 : 0.4813 mm D50 : 0.3023 mm D15 : N/A D10 : N/A ASTM Group Symbol : N/A ASTM Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and Sand	0.374     9.51     4.93     11.92     92       0.187     4.75     11.61     23.53     85       0.079     2.00     9.51     33.04     78       0.033     0.84     12.17     45.21     70       0.017     0.42     19.81     65.02     57       0.010     0.25     17.98     83.00     46	0.375° 0.374 9.51 4.9 4 0.187 4.75 11.6 10 9.079 2.00 9.5
10	0.079     2.00     9.51     33.04     78       0.033     0.84     12.17     45.21     70       0.017     0.42     19.81     65.02     57       0.010     0.25     17.98     83.00     46	in 0.079 2.00 9.5
20	0.033     0.84     12.17     45.21     70       0.017     0.42     19.81     65.02     57       0.010     0.25     17.98     83.00     46	,—-
140 0.017 0.42 19.81 65.02 57 160 0.010 0.25 17.98 83.00 46 1100 0.006 0.15 14.62 97.62 36 1200 0.003 0.07 13.43 111.05 27 1200 Total Dry Weight of Sample = 160.89  D85 : 4.9251 mm D60 : 0.4813 mm D50 : 0.3023 mm D10 : 0.0915 mm D15 : N/A D10 : N/A  Soi) Classification  ASTM Group Symbol : N/A ASTM Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and Sand	0.017 0.42 19.81 05.02 57 0.010 0.25 17.98 83.00 46	20 0.033 0.84 12.1
100	TITE AND	140 0.017 0.42 19.8 160 0.010 0.25 17.9
13.43	0.006 0.15 14.62 97.62 36	100 0.006 0.15 14.6
Total Dry Weight of Sample = 160.89  D85: 4.9251 mm D60: 0.3023 mm D50: 0.3023 mm D15: N/A D10: N/A  Soil Classification ASTM Group Symbol : N/A ASTM Group Name : N/A AASHTO Group Symbol: A-2-4(0) AASHTO Group Name : Silty Gravel and Sand	0_003	†200 0.003 0.07 <b>13.4</b>
D85 : 4.9251 mm D60 : 0.4813 mm D50 : 0.3029 mm D30 : 0.0915 mm D15 : N/A D10 : N/A Soil Classification	y Weight of Sample = 160.89	Total Dry Weight of Sample * 160.89
	O Group Name : Silty Gravel and Sand .	ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0)
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
	•	ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
•		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and
		ASTM Group Name : N/A AASHTO Group Symbol : A-2-4(0) AASHTO Group Name : Silty Gravel and



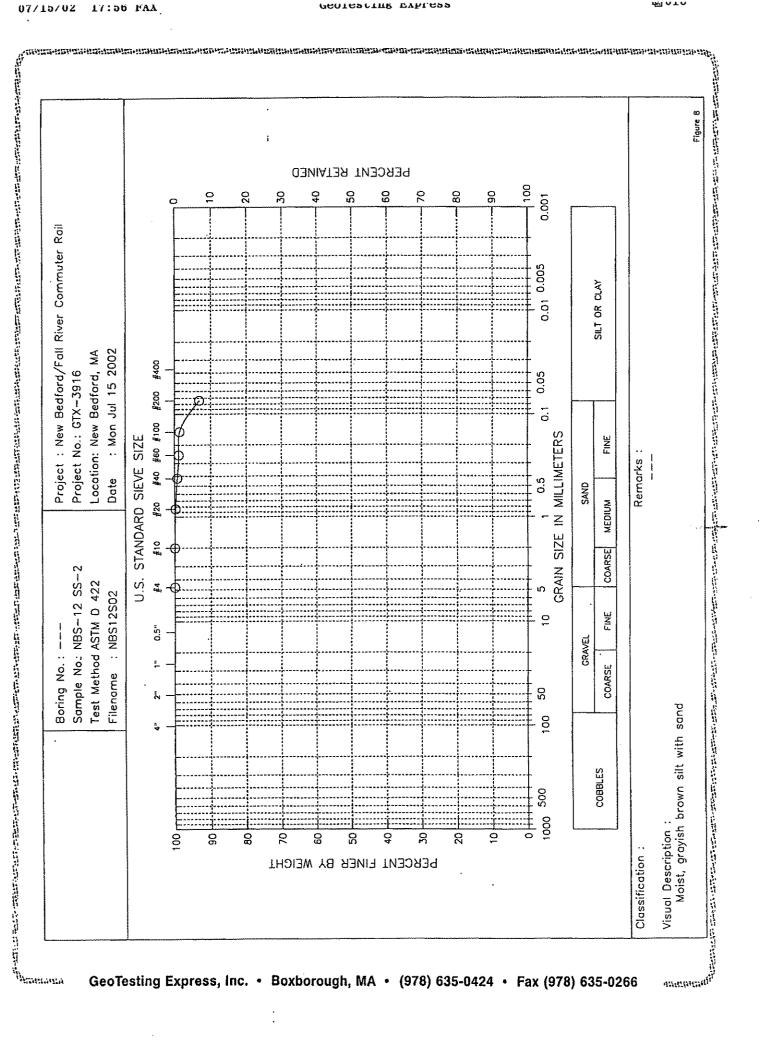
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Mon Jul 15 1	18:09:21 200	2	•			Page : 1
		GE	OTECHNICAL LAB	ORATORY TEST DATA		
Project : Ne Project No. Boring No. :	ew Bedford/F : GTX-3916	'all River Comm De Te	uter Rail epth: est Date : 07/	10/02	Filename: NBS5SS03 Elevation: Tested by: jx	
Sample No. : Location : I Soil Descrip Remarks :	: NBS-5 SS-3 Wew Bedford, otion : Mois	MA st, gray silty :	est Method : A sand	STM D 422	спескей ву : јас	
		. F	ine sieve set			
Sieve Mesh	Sieve Op 'Inches	enings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)	
0.5*	0.500	12.70	0.00	0.00	100	
0.375"	0.374	9.51	12.17	12.17	92	
#4	0.187	4.75	6.39 a an	18.56 20 36	87 80	
#10 #20	0.079 0.033	2.00 0.84	9.80 9.94	38.30	73	
#40	0.017	0.42	11.62	49.92	65	
#60	0.010	0.25	10.07	59.99	58	
#100	0.006	0.15	; 8.60	68,59 78.26	52 46	
#200 Pan	0.003	0.07	65.89	144.15	0	
Total 1	Dry Weight o	of Sample = 152	.31			
D50 : 0.11 D30 : N/A D15 : N/A D10 : N/A	58 mm					
AST						
TZA ZAA ZAA	M Group Symb M Group Name HTO Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			
tea Raa Raa	M Group Symi M Group Name HTO Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils		·	
ast Aas Aas	M Group Symi M Group Name HTO Group Sy HTO Group Na	ool : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils		·	Page : 1
ast Aas Aas	M Group Symi M Group Name HTO Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			
ast aas	M Group Symi M Group Name HTO Group Sy HTO Group Na	ool : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			
AST AAS	M Group Symi M Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			
AST AAS	M Group Symi M Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			
AST AAS AAS	M Group Symi M Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils		·	
AST AAS AAS	M Group Symi M Group Name HTO Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			
AST AAS AAS	M Group Symi M Group Name HTO Group Sy HTO Group Na	bol : N/A e : N/A ymbol : A-4(0) ame : Silty S	oils			



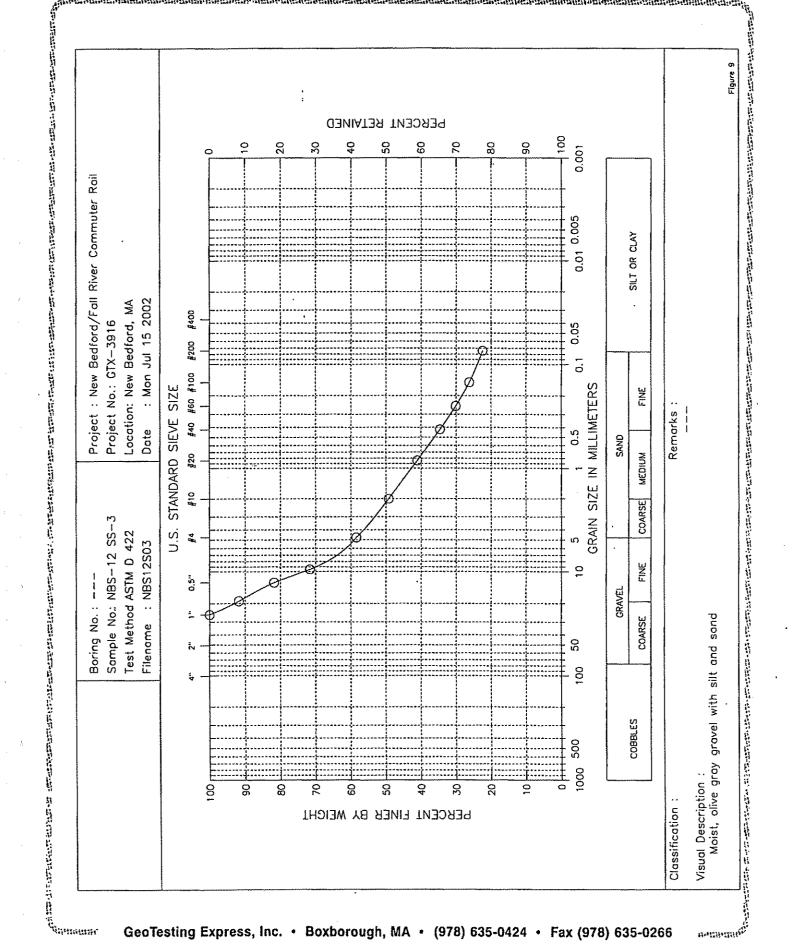
Mon Jul 15	18:09:20 200	02					Page :	1
		GE	OTECHNICAL LAB	ORATORY TEST DATA				
Project : No. Boring No. Sample No.	ew Bedford/F : GTX-3916 : : NBS-12 SS-	Pall River Comm r 7	muter Rail Depth : Test Date : 07/ Test Method : A	10/02 STM D 422	Filename : Elevation Tested by Checked by	NBS12S01 : : jx : jdt		
Location : 1 Soil Descri Remarks : -	New Bedford, ption : Dry, 	, MA , light brown s	andy silt	·				
Sieve Mesh	Sieve Op Inches	penings Millimeters	FINE SIEVE SET Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)			
0.375"	0.374	9.51	0.00	0.00	100			
#4	0.187	4.75	0.32	0.32	100			
#10	0.079	2.00	0.78	1.10	99 07			
#20 #40	0.033 0.017	0.84	2.79	5.79	94			
#60	0.010	0.25	3.24	9.03	90			
#100	0.006	0.15	3.82	12.85	86			
#200 Pag	0.003	0.07	, 3.82 74 F4	16.67 91.21	92 0			
Total	Dry Weight	of Sample = 99	.35	,,,,,				
DRE . 0 17	79 mm		•					
D60 : N/A								
D50 : N/A								
A\M : 0EG			·					
D15 : N/A								
D10 . N/3			:					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam	bol : N/A e : N/A ymbol : A-4(0)	:					٠
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	: Soils					·
D10 : N/A Soil Class AST AST AAS	iffication M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	: Soils					·
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	: Soils	ORATORY TEST DATA  10/02 STM D 422  Cumulative Weight Retained (gm)  0.00 0.32 1.10 3.00 5.79 9.03 12.85 16.67 91.21				•
D10 : N/A Soil Class AST AST ASS	ification M Group Sym M Group Nam HTO Group S HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	: Soils		·	·.		
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	: Soils		4			
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	: Soils		i.			
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	: Soils			•		
D10 : N/A Soil Class AST AST AAS	iffication M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils			.,		
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils			·		
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	: Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	: Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils			**		
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils			·		
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	Soils					
D10 : N/A Soil Class AST AST AAS	ification M Group Sym M Group Nam HTO Group S HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	Soils					
D10 : N/A Soil Class AST AST AAS AAS	ification M Group Sym M Group Nam HTO Group S HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty :	Soils					
D10 : N/A Soil Class AST AST AAS AAS	ification M Group Sym M Group Nam HTO Group S	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils					
Dio: N/A Soil Class AST AST AAS AAS	ification M Group Sym M Group Nam HTO Group N	bol : N/A e : N/A ymbol : A-4(0) ame : Silty	Soils			••		

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		GE	TECHNICAL LABO	ORATORY TEST DATA		
Project : Ne Project No. Boring No. : Sample No. : Location : N Soil Descrip	w Bedford/Fal : GTX-3916  NBS-12 SS-2 ew Bedford, M tion : Moist,	l River Comm Do To To A grayish bro	epth : est Date : 07/ est Method : A wn silt with.s	10/02 STM D 422 and	Filename: NBS12S02 Elevation: Tested by: jx Checked by: jdt	
Remarks :	He	-				
Sieve Mesh	Sieve Open Inches M	r. ings illimeters	INE SIEVE SET Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)	
#4	0.187	4.75	0.00	0.00	100	
#10 #20	0.079 0.033	2.00 0.84	0.02 0.17	· 0.82	100	
#40	0.017	0.42	0.40	0.59	99	
#60 #100	0.010 0.006	0.25 0.15	0.34 0.17	0.93 1,10	99 29	
#200	0.003	0.07	4.18	5.28	93	
Pan Total I	ory Weight of	Sample = 85.	72.06 53	77.34	U	
D85 : N/A D60 : N/A D50 : N/A D30 : N/A D15 : N/A D10 : N/A				-	Filename: NBS12S02 Elevation: Tested by: jx Checked by: jdt  Percent Finer (%)  100 100 99 99 99 99 90 0	
				.nd		
			•			



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		GE	OTECHNICAL LAN	BORATORY TEST DATA			
Project : N	ew Bedford/F	all River Comm	uter Rail		Filename : NBS12S03		
Project No. Boring No.	:	T	est Date : 07/	/10/02	Tested by : jx		
Sample No.	: NBS-12 SS- New Bedford.	3 T MA	est Method : /	ASTM D 422	Checked by : jdt		
Soil Descri	ption : Mois	t, olive gray	gravel with si	ilt and sand			
Remarks : -	~	2	THE CTUIT COT				
Sieve	Sieve Op	enings	Weight	Cumulative	Percent		
Mesh	Inches	Millimeters	Retained (qm)	Weight Retained (gm)	Finer (%)		
	*		0.00	0.00	100		
1* 0.75*	1.012 0.748	25.70 19.00	10.48	10.48	92		
0.5"	0.500	12.70	12.80	23.28	82		
0.375"	0.374	9.51	13.03	36.31	72		
#4	0.187	4.75	16.81	53.12	58		
#3.0	0.079	2.00	11.85	54.97 75.42	43		
#20	0.033	0.44	8.27	83.69	35		
#40 #60	0.010	0.25	5.76	89.45	30		
#100	0.006	0.15	4,93	94.38	26		
#200	0.003	0.07	4.88	99.26	22		
Pan	Danie Wadalah	of Comple - 136	28.12	127,30	v		
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AS3 AA5	183 mm 183 mm 165 mm  Sification TM Group Sym TM Group Nam SHTO Group N	bol : N/A e : N/A ymbol : A-i-b{: ame : Stone i	) Fragments, Gra	wel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class ASC ASC ASC	137 mm 183 mm 165 mm 165 mm  Sification 1M Group Sym 1M Group Nam 1HTO Group N	bol : N/A e : N/A ymbol : A-1-b( ame : Stone i	D) Fragments, Gra	vel and Sand	Filename: NBS12S03 Blevation: Tested by: jx Checked by: jdt  Percent Finer (*) 100 92 82 72 58 49 41 35 30 26 22 0		
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class ASC ASC AAS	183 mm 183 mm 165 mm 166 Group Sym 166 Group Nam 167 Group S	bol : N/A e : N/A ymbol : A-i-b( ame : Stone I	0) Fragments, Gra	ivel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class ASC ASC ASS	183 mm 183 mm 165 mm 165 mm 18ification 19 Group Sym 19 Group Nam 19HTO Group N	bol : N/A e : N/A ymbol : A-i-b( ame : Stone I	0) Fragme <u>n</u> ts, Gra	ivel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AST AAS	137 mm 183 mm 165 mm 165 mm  Sification 1M Group Sym 1M Group Nam 1HTO Group S 1HTO Group N	bol : N/A e : N/A ymbol : A-i-b(i ame : Stone i	0) Fragments, Gra	vel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AS3 AA5	183 mm 183 mm 165 mm 165 mm 18 Group Sym 18 Group Nam 18HTO Group N	bol : N/A e : N/A ymbol : A-i-b( ame : Stone I	0) Fragments, Gra	ivel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AST AAS	137 mm 183 mm 165 mm  Sification TM Group Sym TM Group Nam SHTO Group N	bol : N/A e : N/A ymbol : A-i-b(i ame : Stone i	0) Fragments, Gra	wel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AS3 AA5	183 mm 183 mm 165 mm 16	bol : N/A e : N/A ymbol : A-i-b( ame : Stone i	0) Fragments, Gra	wel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AST AAS	137 mm 183 mm 165 mm  Sification TM Group Sym TM Group Nam SHTO Group N	bol : N/A e : N/A ymbol : A-i-b( ame : Stone i	0) Fragments, Gra	vel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AST ASS AAS	183 mm 183 mm 165 mm 16	bol : N/A e : N/A ymbol : A-i-b( ame : Stone i	0) Fragments, Gra	evel and Sand			
D60 : 5.14 D50 : 2.14 D30 : 0.24 D15 : N/A D10 : N/A Soil Class AS5 AA5 AA5	183 mm 183 mm 165 mm 165 mm  Sification 1M Group Sym 1M Group Nam 1HTO Group S 1HTO Group N	bol : N/A e : N/A ymbol : A-i-b( ame : Stone i	0) Fragments, Gra	evel and Sand			

## Memorandum

## APPENDIX C: GEOTECHNICAL CALCULATIONS

- Allowable Bearing Capacity and Estimated Settlement
- Seismic Site Class Evaluation



343 Congress Street Boston, MA 02210 617/242-9222

#### CALCULATION WORKSHEET

JOB_	MBTA South Coast Rail				
SUBJECT	Taunton Depot Station				
CALCULATED BY	DH	DATE	3/28/2012		
CHECKED BY	PC	DATE	3/29/2012		

**PURPOSE:** Evaluate bearing resistance for ramp/stair structure shallow foundations.

REFERENCE: AASHTO LRFD Bridge Design Specifications, 2010/AREMA Manual for Railway Engineering, 2004

ASSUMPTIONS: - Ramp/Stair structure footing is 4 ft wide by 6 ft long.

- Bearing surface is silty sand (SM).
- Footing embedment is at least 4 feet below ground surface.
- Groundwater level is at 1 feet below surface.
- Footing eccentricity is assumed to be zero.
- Estimated soil properties (experience, geotech literature, AASHTO Table 10.4.6.2.4-1):

	γ (pcf)	ф
Silty Sand:	125	32

#### BEARING CAPACITY FACTORS (Table 10.6.3.1.2a-1):

	ф	N _c	$N_{q}$	$N_{\gamma}$
Silty Sand:	32	35.5	23.2	30.2

#### **CALCULATE EFFECTIVE FOOTING WIDTH (B'):**

e < B/4 (AASHTO Section 10.6.3.3)

where: B = footing width (ft) = 4

e = eccentricity (ft)

Assume maximum footing eccentricity, thus, e =

B' = B-2e 2

### NOMINAL BEARING RESISTANCE (qn):

 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B' N_{\gamma m} C_{w\gamma}$  (AASHTO Eqn. 10.6.3.1.2a-1)

where: c = cohesion = 0

 $\gamma$  = total unit weight 125

 $D_f$  = depth of footing (ft) = 4 Assumed

B' = effective width of footing (ft) = 2

L = length of footing (ft) = 6

B'/L = 0.33

 $D_f/B' = 2.00$ 

L/B' = 3.00

 $C_{wq} \; C_{w\gamma} \! = \; \text{groundwater correction factors} \qquad \qquad \text{(using B')}$ 

 $C_{wq} = 0.6$  (AASHTO Table 10.6.3.1.2a-2)  $C_{w\gamma} = 0.5$  (AASHTO Table 10.6.3.1.2a-2)

 $N_{\text{cm}} \; N_{\text{qm}} \, N_{\text{ym}}$  = bearing capacity factors

 $N_{qm} = N_q s_q d_q i_q \tag{AASHTO Eqn. 10.6.3.1.2a-3} \label{eq:AASHTO}$ 

s_q = 1.21 (AASHTO Table 10.6.3.1.2a-3)

d_q = 1.30 (AASHTO Table 10.6.3.1.2a-4)

i_q = 1.0 (see AASHTO p. 10-62)

36.4

 $N_{ym} = N_y s_y i_y$ 

 $s_{\gamma} = 0.87$  (AASHTO Table 10.6.3.1.2a-3)

 $i_{y} = 1$  (see AASHTO p. 10-62)

 $N_{ym} = 26.2$ 

 $q_n = 12,568$  psf



343 Congress Street Boston, MA 02210 617/242-9222

#### CALCULATION WORKSHEET

JOB_	MBTA South Coast Rail			
SUBJECT	Taunton Depot Station			
CALCULATED BY	DH	DATE	3/28/2012	
CHECKED BY	PC	DATE	3/29/2012	

### ALLOWABLE BEARING RESISTANCE (qa):

 $q_a = q_n/FOS$ 

where: FOS = factor of safety = 3 for primary loads (see AREMA 3.4.2)

 $q_a = 4,189$  psf

use

q_a = 4.19 ksf strength limit value

Note: Based on the anticipated light loads and potentially small footing sizes, an allowable bearing capacity of 4 ksf is recommended.

#### **Elastic Settlement Calculations:**

$$S_e = \frac{\left(q_o \left(1-v^2\right) \sqrt{A'}\right)}{144 E_s \beta_z}$$

AASHTO eqn. 10.6.2.4.2-1

where:  $q_0 = applied vert. stress (ksf)$ 

v = Poisson's Ratio

 $E_s$  = Young's Modulus (ksi)  $\beta_z$  = Shape/Rigidity Factor

where: B' = eff. width of footing (ft) =

L = length of footing (ft):

 $A' = (B'xL) = footing area (ft^2)$ :

2 (from bearing resistance calcs)
6 (from bearing resistance calcs)
12 ft²

Settlement (S_e) for a given q_o:

 $q_o = applied vertical stress (ksf) = 4.00 ksf (assumed)$ 

S_e (inches) = 0.19 inches



#### Taunton Depot Station Seismic Site Class Evaluation

Based on the platform boring with the lowest average blow counts (worst case)

Boring No.	Sample No.	N Value	Di	Di/N _i	$N_{bar}$
TD-1	S-1	6	3	0.50	
	S-2	5	5	1.00	
	S-3	30	5	0.17	38
	S-4	44	5	0.11	
	C1	100	5	0.05	
	S-5	100	4	0.04	
	Bedrock	100	73	0.73	
	Total Depth =	100			
De	pth to Bedrock =	27	sum	2.60	

#### Per 9.4.1.2.1, 15 < N_{bar} < 50, Site Class D

9.4.1.2.1 Site Class Definitions. The site shall be classified as one of the following classes:

A = Hard rock with measured shear wavevelocity,  $\overline{v}_s > 5000 \text{ft/s} (1500 \text{ m/s})$ 

 $B = \text{Rock with } 2500 \text{ ft/s} < \overline{\boldsymbol{v}}_{\boldsymbol{s}} \le 5000 \text{ ft/s} (760 \text{ m/s} < \overline{\boldsymbol{v}}_{\boldsymbol{s}} \le 1500 \text{ m/s})$ 

C = Very dense soil and soft rock with 1200 ft/s  $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 2500 \text{ ft/s}$  (370 m/s  $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 760 \text{ m/s}$ ) or  $\overline{\boldsymbol{N}}$  or  $\overline{\boldsymbol{N}}_{\boldsymbol{ch}} > 50 \text{ or } \overline{\boldsymbol{s}}_{\boldsymbol{u}} \geq 2000 \text{ psf}$  (100 kPa)

 $D = \text{Stiff soil with } 600 \text{ ft/s} \le \overline{\boldsymbol{v}_{\boldsymbol{s}}} \le 1200 \text{ ft/s}$   $(180 \text{ m/s} \le \overline{\boldsymbol{v}_{\boldsymbol{s}}} \le 370 \text{ m/s}) \text{ or with } 15 \le \overline{\boldsymbol{N}} \text{ or }$   $\overline{\boldsymbol{N}_{\boldsymbol{ch}}} \le 50 \text{ or } 1000 \text{ psf} \le \overline{\boldsymbol{s}_{\boldsymbol{u}}} \le 2000 \text{ psf} (50 \text{ kPa})$   $\le \overline{\boldsymbol{s}_{\boldsymbol{u}}} \le 100 \text{ kPa}$ 

E = A soil profile with  $\overline{\mathbf{v}}_{g} < 600 \text{ ft/s}$  (180 m/s) or any profile with more than 10 ft (3 m) of soft clay. Soft clay is defined as soil with Pl > 20,  $w \ge 40\%$ , and  $s_{u} < 500 \text{ psf}$  (25 kPa)

F =Soils requiring site-specific evaluations:

 Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. Potential for liquefaction shall be evaluated in accordance with 780 CMR 1804.6: Liquefaction.

#### Exception. None.

- 2. Peats and/or highly organic clays (H > 10 ft [3 m] of peat and/or highly organic clay where H = thickness of soil).
- 3. Very high plasticity clays (H > 25 ft [7.6 m] with PI > 75).
- 4. Very thick soft/medium stiff clays (H>120 ft [37 m].

Exception. None.

#### Approx. Project Coordinates

Lat 41.877953 Long -71.073333

Seismic Coefficients

 $S_S = 0.24 \text{ (Table 1604.10*)}$  $S_1 = 0.062 \text{ (Table 1604.10*)}$ 

For Site Class D

 $F_A =$  1.6 (See Table 9.4.1.2.4a*)  $F_V =$  2.4 (See Table 9.4.1.2.4b*)

Design Spectral Response Parameters

 $S_{MS} = Ss \times F_A = 0.384$  $S_{M1} = S_1 \times F_V = 0.149$ 

 $S_{DS=} 2/3 \times S_{MS} = 0.256$  $S_{D1=} 2/3 \times S_{M1} = 0.099$ 

Notes: * The Massachusetts State Building Code, 8th Edition (2010)

## TABLE 9.4.1.2.4a VALUES OF F_a AS A FUNCTION OF SITE CLASS AND SHORT PERIOD MAXIMUM CONSIDERED EARTHQUAKE SPECTRAL ACCELERATION

Site Class		Tabulated Maximum Considered Earthquake Spectral Response Acceleration at Short Periods							
1	$S_{\rm S} \le 0.26 \   0.27 \le S_{\rm S} \le 0.29 \   0.30 \le S_{\rm S} \le 0.32 \   0.33 \le S_{\rm S} \le 0.35 \   0.36 \le S_{\rm S} \le 0.38 $								
A	0.8	0.8	0.8	0.8	0.8	0.8			
В	1.0	1.0	1.0	1.0	1.0	1.0			
С	1.2	1.2	1.2	1.2	1.2	1.2			
D	1.6	1.6	1.55	1.5	1.5	1.5			
Е	2.5	2.4	2.3	2.2	2.1	2.0			
F	Note a	Note a	Note a	Note a	Note a	Note a			

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_a for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

### TABLE 9.4.1.2.4b VALUES OF F, AS A FUNCTION OF SITE CLASS

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at 1-Second Periods
	$S_1 \leq \theta.1$
Α	0.8
В	1.0
C	1.7
D	2.4
E	3.5
F	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of  $F_{\nu}$  for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

# 780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS THE MASSACHUSETTS STATE BUILDING CODE

# TABLE 1604.10 GROUND SNOW LOADS; BASIC WIND SPEEDS; EARTHQUAKE DESIGN FACTORS

(For R-3 of three stories or less one- and two-family stand alone buildings, see 780 CMR 53.00 for snow and wind loads)

		and wind loads)	E a uth ava a la a	Darion Factors	
C!4/T	Ground Snow	Basic Wind	Earthquake Design Factors		
City/Town	$\begin{array}{c} \textbf{Load} \\ \textbf{p}_{g,}  \textbf{psf} \end{array}$	Speed V, MPH	Ss	$\mathbf{S_i}$	
Rochester	45	110	0.23	0.059	
Rockland	45	110	0.26	0.064	
Rockport	45	110	0.33	0.073	
Rowe	65	100	0.22	0.069	
Rowley	55	110	0.34	0.075	
Royalston	65	100	0.25	0.070	
Russell	65	100	0.23	0.066	
Rutland	55	100	0.24	0.068	
Salem	45	110	0.31	0.071	
Salisbury	55	110	0.35	0.077	
Sandisfield	65	90	0.23	0.066	
Sandwich	35	120	0.22	0.058	
Saugus	45	110	0.30	0.070	
Savoy	65	90	0.22	0.068	
Scituate	45	110	0.27	0.065	
Seekonk	55	110	0.24	0.062	
Sharon	55	100	0.25	0.065	
Sheffield	65	90	0.23	0.066	
Shelburne	65	100	0.23	0.068	
Sherborn	55	100	0.26	0.066	
Shirley	65	100	0.28	0.072	
Shrewsbury	55	100	0.25	0.067	
Shutesbury	65	100	0.23	0.068	
Somerset	55	110	0.23	0.060	
Somerville	45	105	0.28	0.069	
South Hadley	55	100	0.23	0.066	
Southampton	55	100	0.23	0.066	
Southborough	55	100	0.26	0.067	
Southbridge	55	100	0.23	0.064	
Southwick	55	100	0.23	0.065	
Spencer	55	100	0.23	0.066	
Springfield	55	100	0.23	0.065	
Sterling	55	100	0.26	0.069	
Stockbridge	65	90	0.22	0.066	
Stoneham	45	105	0.30	0.071	
Stoughton	55	100	0.26	0.065	
Stow	55	100	0.27	0.069	
Sturbridge	55	100	0.23	0.065	
Sudbury	55	100	0.27	0.069	
Sunderland	65	100	0.23	0.068	
Sutton	55	100	0.24	0.065	
Swampscott	45	110	0.30	0.070	
Swansea	55	110	0.24	0.061	
Taunton	55	110	0.24	0.062	
Templeton	65	100	0.25	0.070	
Tewksbury	55	100	0.31	0.073	
Tisbury	35	120	0.18	0.052	
Tolland	65	100	0.23	0.066	
Topsfield	45	110	0.33	0.074	
Townsend	65	100	0.28	0.072	
Truro	35	120	0.22	0.057	

## **Stormwater Report**

# Freetown Station

## Town of Freetown, Massachusetts

Prepared for

## massDOT

Massachusetts Department of Transportation 10 Park Plaza Boston, Massachusetts





Transportation, Land Development, Environmental Services 99 High Street Boston, Massachusetts 02110 617 728 7777

June 2012



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## **FEIS/FEIR Technical Report** Freetown Station

# **Checklist for Stormwater Report**



### **Massachusetts Department of Environmental Protection**

Bureau of Resource Protection - Wetlands Program

### **Checklist for Stormwater Report**

### A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.





A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals. This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

¹ The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

² For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.



### **Massachusetts Department of Environmental Protection**

Bureau of Resource Protection - Wetlands Program

### **Checklist for Stormwater Report**

### **B. Stormwater Checklist and Certification**

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

### **Registered Professional Engineer's Certification**

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Stormwater Report accurately reflects conditions at the site as of the date of this permit application.
Registered Professional Engineer Block and Signature
Signature and Date
Checklist
<b>Project Type:</b> Is the application for new development, redevelopment, or a mix of new and redevelopment?
New development     New development
Redevelopment
Mix of New Development and Redevelopment



# **Massachusetts Department of Environmental Protection**Bureau of Resource Protection - Wetlands Program

# **Checklist for Stormwater Report**

### Checklist (continued)

env	<b>Measures:</b> Stormwater Standards require LID measures to be considered. Document what ironmentally sensitive design and LID Techniques were considered during the planning and design of project:
	No disturbance to any Wetland Resource Areas
	Site Design Practices (e.g. clustered development, reduced frontage setbacks)
	Reduced Impervious Area (Redevelopment Only)
$\boxtimes$	Minimizing disturbance to existing trees and shrubs
	LID Site Design Credit Requested:
	☐ Credit 1
	☐ Credit 2
	☐ Credit 3
$\boxtimes$	Use of "country drainage" versus curb and gutter conveyance and pipe
$\boxtimes$	Bioretention Cells (includes Rain Gardens)
	Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
	Treebox Filter
	Water Quality Swale
$\boxtimes$	Grass Channel
	Green Roof
	Other (describe):
Sta	ndard 1: No New Untreated Discharges
$\boxtimes$	No new untreated discharges
	Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
	Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



### **Massachusetts Department of Environmental Protection**

Bureau of Resource Protection - Wetlands Program

### **Checklist for Stormwater Report**

Checklist (continued) Standard 2: Peak Rate Attenuation Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding. Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm. Calculations provided to show that post-development peak discharge rates do not exceed predevelopment rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24hour storm. Standard 3: Recharge Soil Analysis provided. Required Recharge Volume calculation provided. Required Recharge volume reduced through use of the LID site Design Credits. Sizing the infiltration, BMPs is based on the following method: Check the method used. ⊠ Static ☐ Simple Dynamic ☐ Dynamic Field¹ Runoff from all impervious areas at the site discharging to the infiltration BMP. Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason: Site is comprised solely of C and D soils and/or bedrock at the land surface M.G.L. c. 21E sites pursuant to 310 CMR 40.0000 Solid Waste Landfill pursuant to 310 CMR 19.000 Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable. Calculations showing that the infiltration BMPs will drain in 72 hours are provided. Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



# **Massachusetts Department of Environmental Protection**Bureau of Resource Protection - Wetlands Program

### **Checklist for Stormwater Report**

Cł	necklist (continued)
Sta	ndard 3: Recharge (continued)
	The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
	Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.
Sta	ndard 4: Water Quality
The	E Long-Term Pollution Prevention Plan typically includes the following: Good housekeeping practices; Provisions for storing materials and waste products inside or under cover; Vehicle washing controls; Requirements for routine inspections and maintenance of stormwater BMPs; Spill prevention and response plans; Provisions for maintenance of lawns, gardens, and other landscaped areas; Requirements for storage and use of fertilizers, herbicides, and pesticides; Pet waste management provisions; Provisions for operation and management of septic systems; Provisions for solid waste management; Snow disposal and plowing plans relative to Wetland Resource Areas; Winter Road Salt and/or Sand Use and Storage restrictions; Street sweeping schedules; Provisions for prevention of illicit discharges to the stormwater management system; Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL; Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan; List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
	A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.  Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
	is within the Zone II or Interim Wellhead Protection Area
	is near or to other critical areas
	is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
	involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

applicable, the 44% TSS removal pretreatment requirement, are provided.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if



# **Massachusetts Department of Environmental Protection**Bureau of Resource Protection - Wetlands Program

# **Checklist for Stormwater Report**

Cł	necklist (continued)
Sta	ndard 4: Water Quality (continued)
	The BMP is sized (and calculations provided) based on:
	☐ The ½" or 1" Water Quality Volume or
	☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
	The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
	A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.
Sta	ndard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)
	The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.  The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted <i>prior to</i> the discharge of stormwater to the post-construction stormwater BMPs.
	The NPDES Multi-Sector General Permit does <i>not</i> cover the land use.
	LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
	All exposure has been eliminated.
	All exposure has <i>not</i> been eliminated and all BMPs selected are on MassDEP LUHPPL list.
	The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.
Sta	ndard 6: Critical Areas
	The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
	Critical areas and BMPs are identified in the Stormwater Report.



### **Massachusetts Department of Environmental Protection**

Bureau of Resource Protection - Wetlands Program

### **Checklist for Stormwater Report**

### Checklist (continued)

ndard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum ent practicable
The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
☐ Limited Project
<ul> <li>Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.</li> <li>Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area</li> <li>Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff</li> </ul>
☐ Bike Path and/or Foot Path
☐ Redevelopment Project
☐ Redevelopment portion of mix of new and redevelopment.
Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.  The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

#### Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



# **Massachusetts Department of Environmental Protection**Bureau of Resource Protection - Wetlands Program

# **Checklist for Stormwater Report**

Checklist (continued)

	andard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control ntinued)
	The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has <i>not</i> been included in the Stormwater Report but will be submitted <i>before</i> land disturbance begins.
	The project is <i>not</i> covered by a NPDES Construction General Permit.
	The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
	The project is covered by a NPDES Construction General Permit but no SWPPP been submitted.  The SWPPP will be submitted BEFORE land disturbance begins.
Sta	andard 9: Operation and Maintenance Plan
	The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
	☐ Name of the stormwater management system owners;
	☐ Party responsible for operation and maintenance;
	☐ Schedule for implementation of routine and non-routine maintenance tasks;
	☐ Plan showing the location of all stormwater BMPs maintenance access areas;
	☐ Description and delineation of public safety features;
	Estimated operation and maintenance budget; and
	☐ Operation and Maintenance Log Form.
	The responsible party is <i>not</i> the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
	A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
	A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.
Sta	andard 10: Prohibition of Illicit Discharges
$\boxtimes$	The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
	An Illicit Discharge Compliance Statement is attached;
	NO Illicit Discharge Compliance Statement is attached but will be submitted <i>prior to</i> the discharge or any stormwater to post-construction BMPs.



### Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00).

### **Project Description**

The Applicant, MassDOT, is proposing to construct a commuter rail station along the existing Fall River Secondary tracks in Freetown, Massachusetts (the Project). As proposed, the Project requires the acquisition of approximately 7 acres of land at 165 South Main Street of which approximately 4 acres will be developed for the new station. The Project will involve a platform with canopy, ancillary landscape improvements, 173 parking spaces, a pick up/drop off area, bicycle parking facilities, and utility improvements to support this use.

The station is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because it is not a parking lot with a high-intensity use (1,000 vehicle trips per day or more).

### **Site Description**

The project development area (the Site) consists of approximately 4 acres of currently undeveloped land (see Figures 1 and 2). The Site is bound by Assonet Mini Storage to the west, South Main Street to the northwest, woods and wetlands to the north, grassed pasture to the northeast, the Fall River Secondary tracks to the southeast, and woods and wetlands to the southwest. A telecommunications tower abuts the mini storage and is in the southwest corner of the Site. Brightman Lumber Co. is located nearby south of the Site and the Stop and Shop Distribution Center is located to the north, across South Main Street. See Figure 1, Site Locus Map and Figure 2, Site Aerial.

The wetland Resource Areas on the Site as, shown on Figures 3 and 4, are described in Table 1. The wetlands ultimately flow to the Taunton River. For additional information regarding the wetland resource areas present on the site see the Abbreviated Notice of Resource Area Delineation (ANRAD) prepared by VHB dated January 2012.

Freetown Station

Table 1
Wetland Resource Areas

Name	Critical Area	Zone 1 or Zone A	ORW or SRW	Zone II or IWPA	Description
Wetland 1	No	No	No	No	PFO
Wetland 1A	No	No	No	No	PEM

Notes: Wetland Classifications: PEM = Palustrine Emergent, PFO = Palustrine Forested

According to the National Resources Conservation Service (NRCS), surface soils on the Site include Merrimac fine sandy loam, Scarboro muck, Ridgebury fine sandy loam, and Sudbury fine sandy loam, and are classified as Hydrologic Soil Groups (HSG) A, D, C, B, respectively. The majority of the soil on the Site is classified as HSG A. Based on the soil evaluation included in Appendix C, the Site is considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour. According to 1982 Rawls Rates, infiltration rates for the soils will be approximately 2.41 inches per hour.).

The project is not located within the 100-year flood plain as shown on FEMA Floodway Map, Town of Freetown, Massachusetts Bristol County, Community Panel numbers 25005C0263F and 25005C0264F dated July 7, 2009, included in Appendix B.

### **Existing Drainage Conditions**

Under existing conditions, the Site consists of mostly cleared, but undeveloped land. The Site is primarily grass pasture and dirt with some dirt mounds and a few scattered trees. There is also a gravel road that goes around the mini storage to provide access to the communications tower. For existing conditions hydrologic analysis, the drainage area including the Site and the mini storage was divided into four sub drainage areas. The existing mini storage was included because site drainage flows on to this property under current conditions. All four drainage areas contribute to a single design point (Wetland 1). The following is a summary of each drainage area.

<u>Drainage Area 1</u> – This 2.45-acre area comprises the portion of the Site between the mini storage lot and Wetland 1, extending from South Main Street to the existing Fall River Line track. The area consists of grassy pasture with some areas of dirt, gravel, and brush. Runoff from Drainage Area 1 sheet flows in a northerly direction to Wetland 1, on the north side of the Site.



Freetown Station

<u>Drainage Area 2</u> – This 0.95-acre area consist of grassy pasture with some sections of dirt, gravel, and brush. The area is located in the center of the Site, between the Fall River Line track and the mini storage. Runoff from this area sheet flows into Drainage Area 3 and sheet flows across the gravel lot. Runoff from Drainage Area 2 flows to Wetland 1.

<u>Drainage Area 3</u> – This 3.34-acre area consists of the developed land that the Assonet Mini Storage occupies. The area is split between a paved portion with storage buildings, a gravel lot, and some grassed sections along South Main Street. There is a drainage system for paved area, while the gravel lot and grassed area sheet flows, untreated, to Wetland 1.

<u>Drainage Area 4</u> – This 1.79-acre area consist of grassy pasture with some sections of dirt, gravel, and brush. The area is located on the south side of the Site, between the Fall River Line track and the mini storage. Runoff from this area sheet flows into Drainage Area 3 and is captured by the drainage system. Runoff from Drainage Area 4 flows to Wetland 1.

Figure 3 illustrates the existing drainage patterns on the Site. Table 2 below provides a summary of the existing conditions hydrologic data.

Table 2
Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland 1	1	2.45	51	6.9
2	Wetland 1	1	0.95	42	8.5
3	Wetland 1	1	3.34	89	5.0
4	Wetland 1	1	1.79	71	7.4

### **Proposed Drainage Conditions**

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into five drainage areas that discharge treated stormwater to the one existing Design Point. Existing drainage and grading patterns were maintained to the maximum extent possible. The drainage from the paved areas will be captured and treated in three infiltration basins. These basins are designed to decentralize stormwater management and reduce peak runoff rates, maximize groundwater recharge and treat for water quality. The following is a summary of each drainage area.



Freetown Station

<u>Drainage Area 1</u> – This 0.99-acre area comprises the eastern portion of the parking lot and consists of a paved parking area for the station, grassed swale, and Infiltration Basin 1 to the east of the parking. Runoff from Drainage Area 1 is directed to Basin 1, which discharges to Wetland 1.

<u>Drainage Area 2</u> – This 1.70-acre area in the southern portion of the Site consists of grassy pasture with some sections of dirt, gravel, and brush. The majority of Drainage Area 2 is unchanged from existing conditions. Part of the area will remain occupied by an existing telecommunications tower and gravel access drive. Runoff from Drainage Area 2 sheet flows to Drainage Area 3, the existing mini storage area, where is it captured by the existing drainage system and discharged to Wetland 1.

<u>Drainage Area 3</u> – This 3.50-acre area comprises the existing mini storage area. Runoff from Drainage Area 3 discharges to Wetland 1.

<u>Drainage Area 4</u> – This 0.71-acre area comprises the site access road and consists of a paved roadway, grassed swale, and Infiltration Basin 3 to the northeast of the roadway. Runoff from Drainage Area 4 is directed a grassed swale that leads to a sediment forebay and Basin 3, which discharges to Wetland 1.

<u>Drainage Area 5</u> – This 1.63-acre area comprises the southwestern portion of the parking lot and consists of a paved parking area for the station, grassed swale, and Infiltration Basin 2 to the northeast of the parking. Runoff from Drainage Area 5 is directed to a swale, then through a pipe under the access drive to Basin 2, which discharges to Wetland 1.

Table 3 below provides a summary of the proposed conditions hydrologic data.

Table 3
Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1	Wetland 1	1	0.99	83	5.0
2	Wetland 1	1	1.70	71	7.4
3	Wetland 1	1	3.50	87	5.0
4	Wetland 1	1	0.71	90	5.0
5	Wetland 1	1	1.63	83	5.0

The site has been designed with a comprehensive stormwater management system in accordance with the Massachusetts Stormwater Handbook. The proposed



Freetown Station

stormwater management system has been designed to treat the half inch Water Quality Volume.

# **Environmentally Sensitive and Low Impact Development (LID) Techniques**

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include:

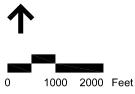
- Minimal disturbance to existing trees and vegetation
- Infiltration basins
- Light colored pavement sidewalks
- Grassed swales

In general, stormwater runoff from impervious surfaces in the proposed drainage areas will receive treatment for stormwater quality in grassed swales and infiltration basins prior to discharge to the existing design point.

### **Hydraulic Analysis**

The closed drainage system was designed for the 25-year storm event, in accordance with the Massachusetts Bay Transportation Authority, Railroad Operations, Commuter Rail Design Standards Manual, Volume 1.

Drainage pipes were sized using Manning's Equation for full-flow capacity and the Rational Method. Pipe sizing calculations are included in Appendix A of this report.

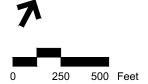


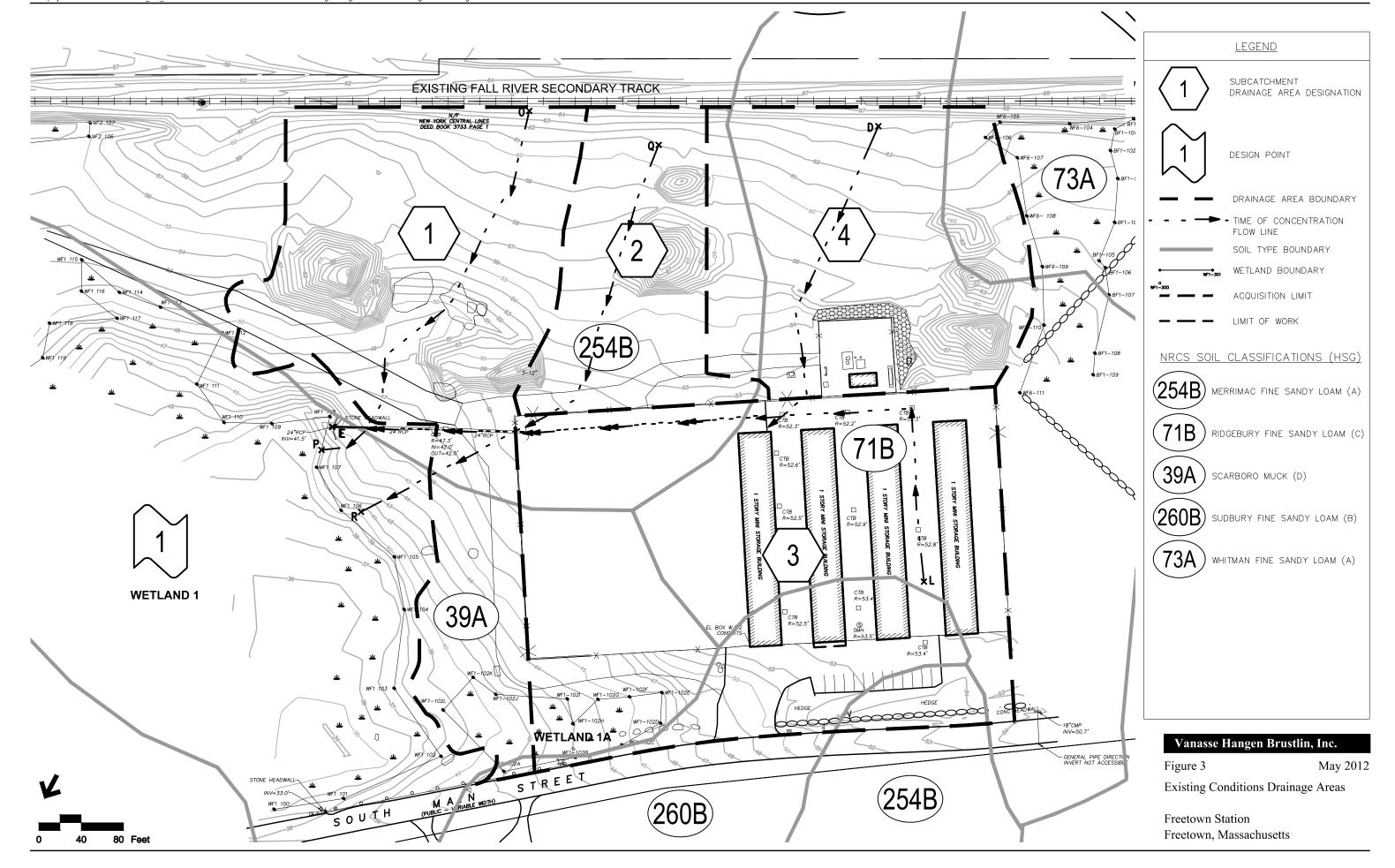
Freetown Station South Coast Rail Freetown, Massachusetts

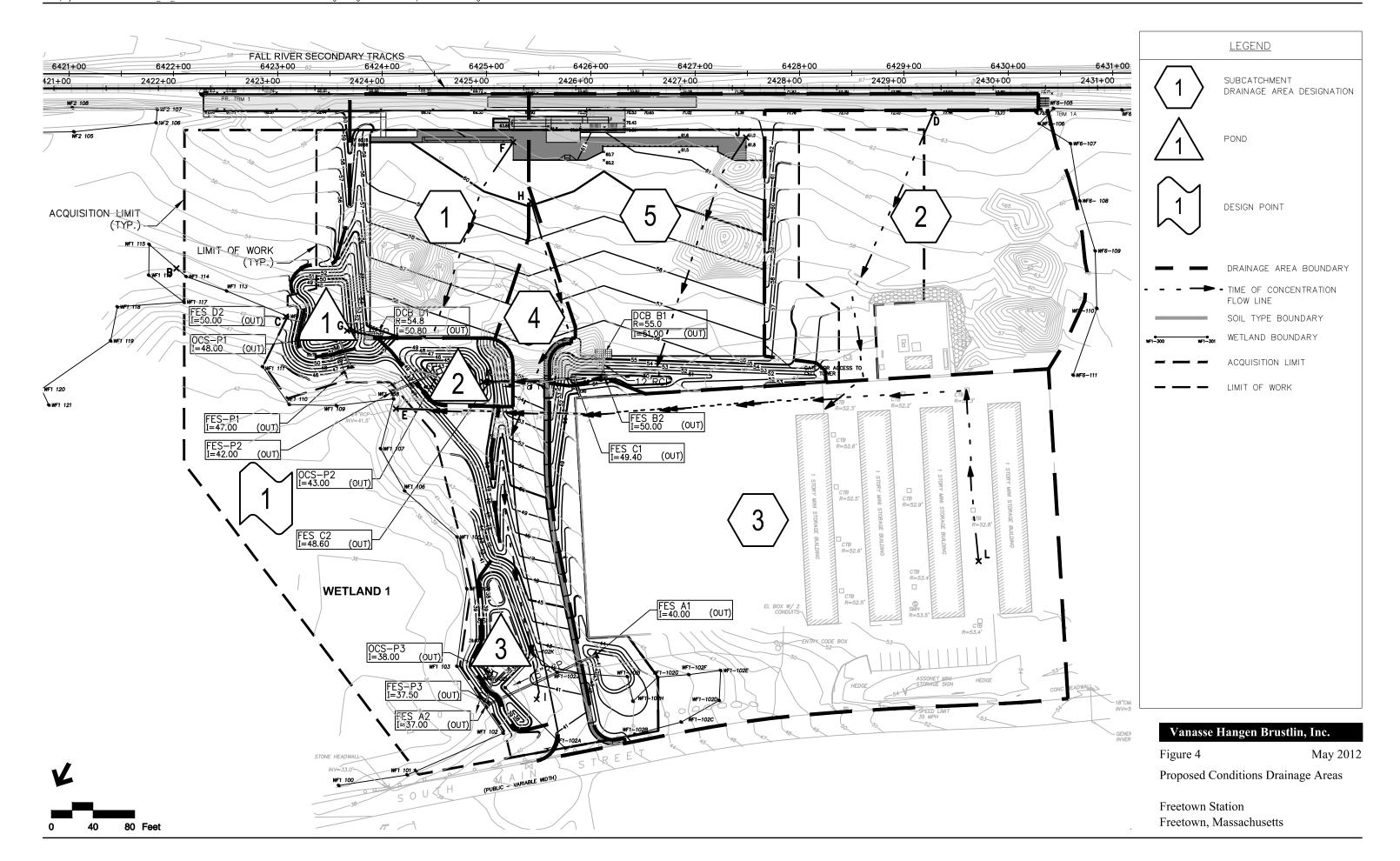


Site Aerial Map

Freetown Station South Coast Rail Freetown, Massachusetts Figure 2 May 2012









### **Regulatory Compliance**

# Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards at 310 CMR 10.05.

### Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMPs that impound stormwater have been designed with stone to protect down gradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

#### Standard 2: Peak Rate Attenuation

The Project has been designed to fully comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 100-years. The results of the analysis, as summarized in Table 4 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Freetown Station

Table 4
Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	100-year
Design Point 1: Wetland 1			
Existing	10.8	18.3	33.4
Proposed	10.4	17.3	31.8

#### Standard 3: Stormwater Recharge

The Project has been designed to fully comply with Standard 3.

In accordance with the Stormwater Handbook, the Required Recharge Volume for the Project is 4,676 cubic feet.

Recharge of stormwater has been provided through the use of infiltration basins, which has been sized using the static method. Each infiltration BMP has been designed to drain completely within 72 hours. Table 5 below provides a summary of the proposed infiltration BMPs utilized for the Project.

Table 5
Summary of Recharge Calculations

Infiltration BMP	Provided Recharge Volume (cubic feet)
Infiltration Basin P1	1,955
Infiltration Basin P2	5,205
Infiltration Basin P3	<u>4,403</u>
Total Provided Recharge	11,563

A Geotechnical Report is included in Appendix E.

#### Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide a minimum of 80% TSS removal for stormwater runoff from all proposed impervious surfaces.

Computations and supporting information are included in Appendix D.



Freetown Station

# Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is not considered a LUHPPL as defined in 3.10 CMR 10.04 and 314 CMR 9.02 because the parking lot is not classified as a high-intensity use (1,000 vehicle trips per day or more).

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is not a redevelopment.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project would disturb approximately 3.9 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) would be developed and a Notice of Intent for the CGP would be submitted by the contractor and owner at least 14 days before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls were discussed in the DEIR/S. Appropriate controls will be prepared and implemented by the contractor and MassDOT (MBTA) during construction in accordance with the final design and NPDES SWPPP.

#### **Standard 9: Operation and Maintenance Plan**

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan will be developed by the MBTA during final design for the Project.

Standard 10: Prohibition of Illicit Discharges

The site was previously undeveloped and no sanitary sewer or storm drainage infrastructure is known to exist on the site. The design plans submitted with this report have been designed in full compliance with current standards. The Long-Term Pollution Prevention Plan will include measures to prevent illicit discharges.



### FEIS/FEIR Technical Report Stormwater Freetown Station

# Appendix A Standard 1 Computations and Supporting Information





Project #: 10111.34

Project: Freetown Station - SCR

Location: Freetown, MA

Calculated by: PAC Date: April 30, 2012 Checked by: - Date: April 30, 2012

Title: Riprap Outlet Protection Sizing

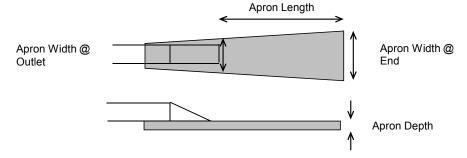
Sources: Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas

Massachusetts Department of Environmental Protection - Reprinted 2003 (pp. 118-120)

Erosion and Sediment Control Handbook - Third Edition 1992 (Chapter 3.18)

Virginia Department of Conservation and Recreation (DCR)

Attachments: Virginia DCR Erosion and Sediment Control Handbook Plate 3.18-3



Apron Width at Outlet: Width =  $3 \times pipe dia$ . (or width of channel)

Apron Length: Length = From Virginia DCR Handbook - Plate 3.18-3 if Tw depth is < 1/2 dia.

Length = From Virginia DCR Handbook - Plate 3.18-4 if Tw dwpth is >= 1/2 dia. Width = dia. + apron length if Tw depth is < 1/2 dia.

Width = dia. + 0.4 x apron length

if Tw dwpth is  $\geq 1/2$  dia.

or apron width = channel width if a well defined channel exists

Median Diameter  $(d_{50})$  = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia =  $1.5 \times d_{50}$ 

Apron Depth: 6" or 1.5 x largest stone dia

Apron Width at End:

Rock Riprap:

_	Outlet Description
Design Element	FES - Pond 1
Design Storm (yr):	100
Defined Channel (yes/no)	no
Pipe Dia (D), in	15
Tail Water (Tw), ft	Tw < 0.5D
Flow (Q), cfs	1.7
Apron Width (outlet), ft	4
Apron Length, ft	17
Apron Width (end), ft	18
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Project #: 10111.34

Project: Freetown Station - SCR

Location: Freetown, MA

Calculated by: PAC Date: April 30, 2012 Checked by: - Date: April 30, 2012

if Tw dwpth is  $\geq 1/2$  dia.

Title: Riprap Outlet Protection Sizing

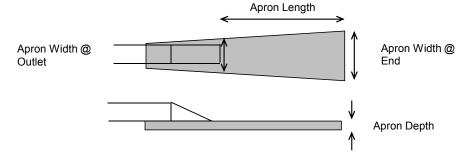
Sources: Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas

Massachusetts Department of Environmental Protection - Reprinted 2003 (pp. 118-120)

Erosion and Sediment Control Handbook - Third Edition 1992 (Chapter 3.18)

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Attachments: Virginia DCR Erosion and Sediment Control Handbook Plate 3.18-3



Apron Width at Outlet: Width =  $3 \times pipe dia$ . (or width of channel)

 $Apron \ Length = From \ Virginia \ DCR \ Handbook - Plate \ 3.18-3 \qquad if \ Tw \ depth \ is < 1/2 \ dia.$ 

Length = From Virginia DCR Handbook - Plate 3.18-4 if Tw dwpth is >= 1/2 dia. Width = dia. + apron length if Tw depth is < 1/2 dia.

Width = dia. + 0.4 x apron length if or apron width = channel width if a well defined channel exists

Rock Riprap: Median Diameter  $(d_{50})$  = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia =  $1.5 \times d_{50}$ 

Apron Depth: 6" or 1.5 x largest stone dia

Apron Width at End:

	Outlet Description
Design Element	FES - Pond 2
Design Storm (yr):	100
Defined Channel (yes/no)	no
Pipe Dia (D), in	12
Tail Water (Tw), ft	Tw < 0.5D
Flow (Q), cfs	2.2
Apron Width (outlet), ft	3
Apron Length, ft	17
Apron Width (end), ft	18
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14





Project #: 10111.34

Project: Freetown Station - SCR

Location: Freetown, MA

Calculated by: PAC Date: April 30, 2012 Checked by: Date: April 30, 2012

Title: Riprap Outlet Protection Sizing

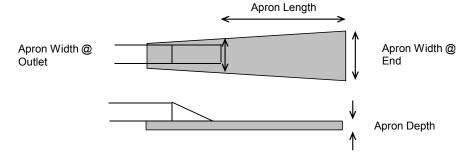
Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas Sources:

Massachusetts Department of Environmental Protection - Reprinted 2003 (pp. 118-120)

Erosion and Sediment Control Handbook - Third Edition 1992 (Chapter 3.18)

Virginia Department of Conservation and Recreation (DCR)

Attachments: Virginia DCR Erosion and Sediment Control Handbook Plate 3.18-3



Apron Width at Outlet: Width =  $3 \times \text{pipe dia.}$  (or width of channel)

Length = From Virginia DCR Handbook - Plate 3.18-3 Apron Length:

if Tw depth is < 1/2 dia. Length = From Virginia DCR Handbook - Plate 3.18-4 if Tw dwpth is  $\geq 1/2$  dia. Width = dia. + apron length

Width = dia. + 0.4 x apron length

if Tw depth is < 1/2 dia. if Tw dwpth is  $\geq 1/2$  dia.

or apron width = channel width if a well defined channel exists

Rock Riprap: Median Diameter  $(d_{50})$  = From Virginia DCR Handbook - Plate 3.18-3 or 4

Largest stone dia =  $1.5 \times d_{50}$ 

Apron Depth: 6" or 1.5 x largest stone dia

Apron Width at End:

	Outlet Description
Design Element	FES - Pond 3
Design Storm (yr):	100
Defined Channel (yes/no)	no
Pipe Dia (D), in	24
Tail Water (Tw), ft	Tw < 0.5D
Flow (Q), cfs	4.8
Apron Width (outlet), ft	6
Apron Length, ft	17
Apron Width (end), ft	19
Median Stone Dia., ft	0.50
Median Stone Dia., in	6
Largest Stone Dia., ft	0.75
Largest Stone Dia., in	9
Apron Depth, ft	1
Apron Depth, in	14



Environmental Services 99 High St., Boston, MA 02110 (617) 728-7777

Storm Drainage Computations

Name: South Coast Rail Freetown MA Client: MassDOT

Proj. No.: Date:

10111.00 5/21/2012 Design Parameters: 25

Year Storm Boston, MA

Computed by: Checked by:

PAC EJM

0.5 k_e=

	LOCA	ATION	AREA	С	CxA	SUM	FLOW	TIME (MIN)	i* DESIGN			C	APACITY	PROFILE									
DESCRIPTION	FROM	TO	(AC.)			CxA	PIPE	CONC		Q	V	n	PIPE	SLOPE	Q full	V full	LENGTH	FALL	RIM	INV	INV	W.S.E.	Freeboard
								TIME		cfs	fps		SIZE		ft^3/s	ft/s	ft	ft		UPPER	LOWER	ft	ft
	FES A1	FES A2	1.65	0.71	1.18	1.18	0.26	5.0	6.0	7.1	7.7	0.013	15	0.0250	10.2	8.3	120	3.00	40.0	40.0	37.0	39.3	0.7
	DCB B1	FES B2	0.63	0.85	0.53	0.53	0.04	5.0	6.0	3.2	8.1	0.013	12	0.0500	8.0	10.1	20	1.00	55.0	51.0	50.0	50.2	4.8
	FES C1	FES C2	1.34	0.78	1.04	1.04	0.26	5.0	6.0	6.2	5.1	0.013	24	0.0100	22.6	7.2	80	0.80	49.4	49.4	48.6	49.1	0.3
	DCB D1	FES D2	0.40	0.90	0.36	0.36	0.05	5.0	6.0	2.2	6.7	0.013	12	0.0400	7.1	9.1	20	0.80	54.8	50.8	50.0	50.2	4.6



Freetown Station



### FEIS/FEIR Technical Report Stormwater Freetown Station

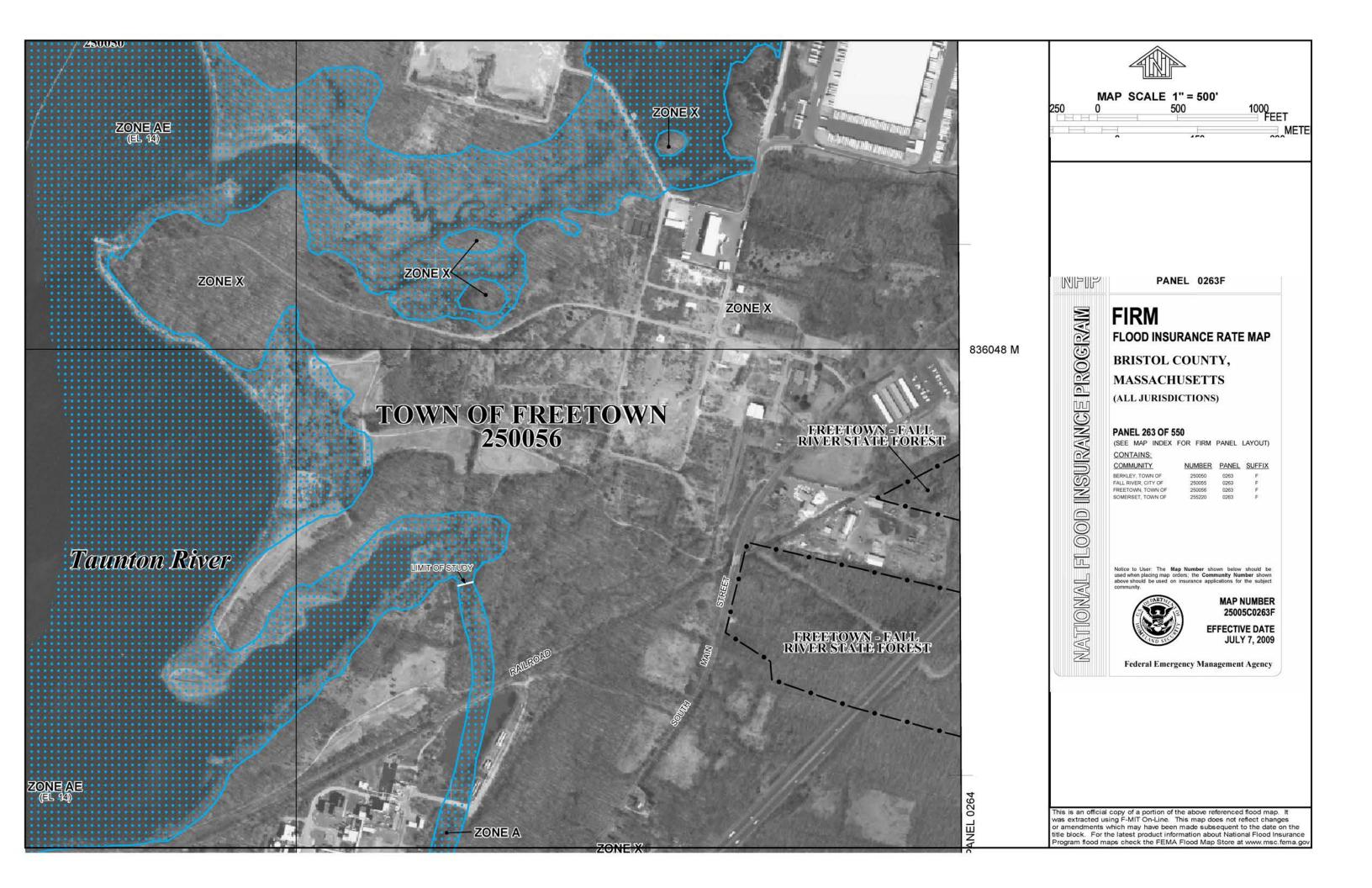
# Appendix B Standard 2 Computations and Supporting Information

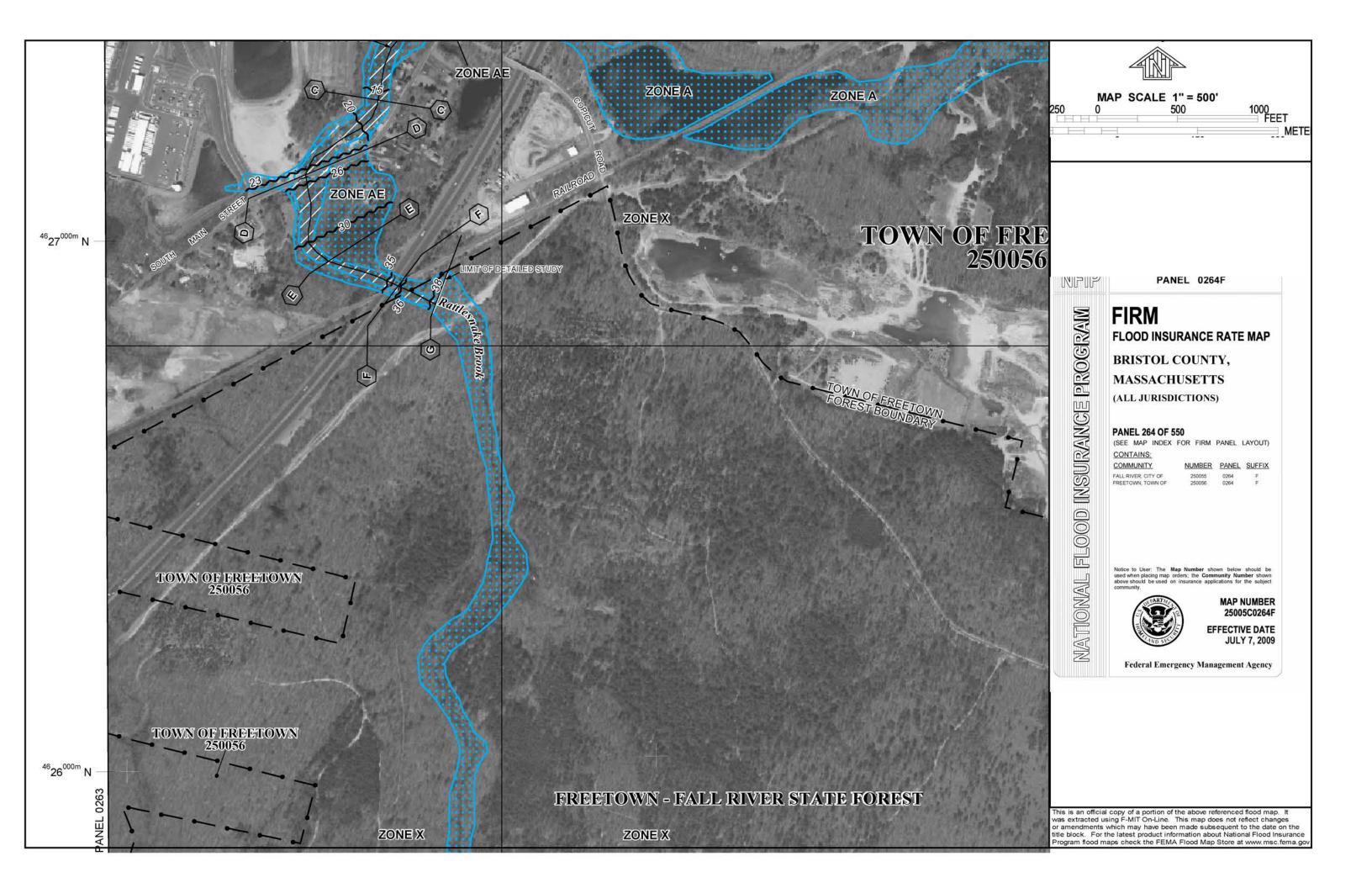
Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Bristol County. Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.



Freetown Station

FEMA Flood Maps

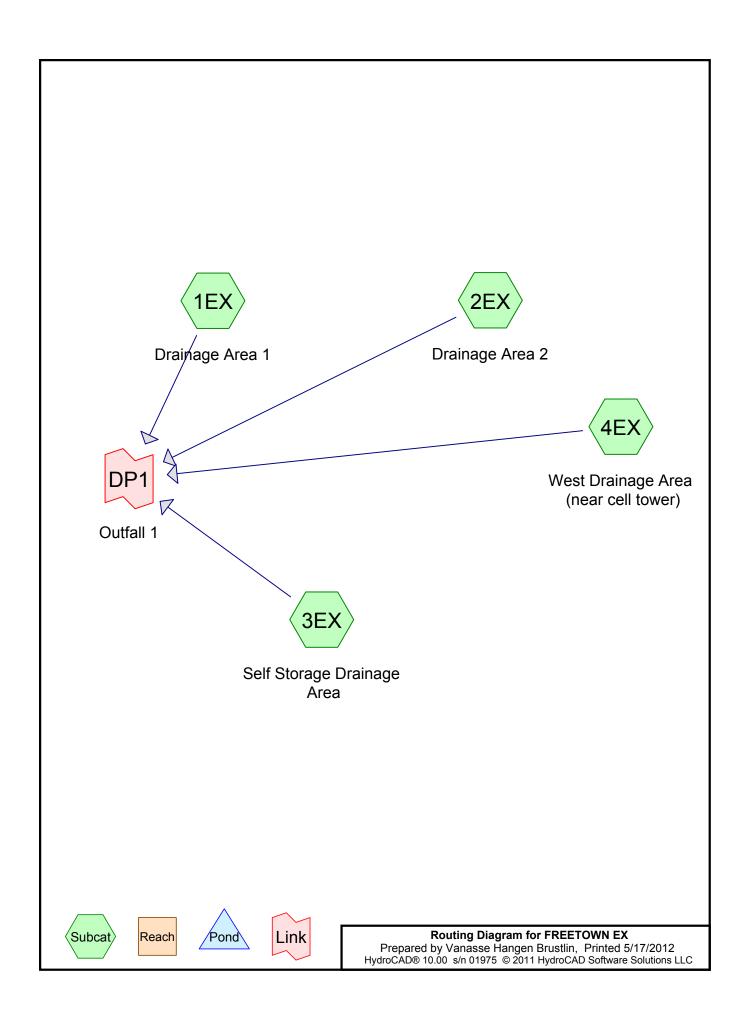






Freetown Station

HydroCAD Analysis: Existing Conditions



### FREETOWN EX

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### **Area Listing (all nodes)**

Area	CN	Description
(acres)		(subcatchment-numbers)
3.006	39	>75% Grass cover, Good, HSG A (1EX, 2EX, 3EX, 4EX)
0.155	61	>75% Grass cover, Good, HSG B (1EX, 3EX)
1.261	74	>75% Grass cover, Good, HSG C (2EX, 3EX, 4EX)
0.571	76	Gravel roads, HSG A (1EX, 2EX, 3EX, 4EX)
0.012	77	Woods, Good, HSG D (1EX)
0.649	80	>75% Grass cover, Good, HSG D (1EX, 3EX, 4EX)
0.023	85	Gravel roads, HSG B (3EX)
0.418	89	Gravel roads, HSG C (3EX, 4EX)
0.641	91	Gravel roads, HSG D (1EX, 3EX)
0.023	98	Paved parking, HSG A (3EX)
0.350	98	Paved parking, HSG B (3EX)
0.606	98	Paved parking, HSG C (3EX)
0.111	98	Roofs, HSG B (3EX)
0.458	98	Roofs, HSG C (3EX)
0.014	98	Unconnected roofs, HSG C (4EX)
0.011	98	Water Surface, 0% imp, HSG B (1EX, 3EX)
0.220	98	Water Surface, 0% imp, HSG D (1EX, 3EX)
8.530	69	TOTAL AREA



Freetown Station

2-Year Storm Event - Existing

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Stations\Freetown\HydroCAD\

FREETOWN EX

Type III 24-hr 2 yr storm Rainfall=3.40"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1EX: Drainage Area 1 Runoff Area=106,520 sf 0.00% Impervious Runoff Depth=0.20"

Flow Length=395' Tc=6.9 min CN=51 Runoff=0.15 cfs 0.040 af

Subcatchment2EX: Drainage Area 2 Runoff Area=41,350 sf 0.00% Impervious Runoff Depth=0.03"

Flow Length=505' Tc=8.5 min CN=42 Runoff=0.00 cfs 0.002 af

Subcatchment3EX: Self Storage Runoff Area=145,620 sf 46.31% Impervious Runoff Depth=2.26"

Flow Length=715' Tc=5.0 min CN=89 Runoff=9.12 cfs 0.631 af

Subcatchment4EX: West Drainage Area Runoff Area=78,080 sf 0.80% Impervious Runoff Depth=1.00"

Flow Length=720' Tc=7.4 min UI Adjusted CN=71 Runoff=1.85 cfs 0.149 af

**Link DP1: Outfall 1**Inflow=10.77 cfs 0.823 af

Primary=10.77 cfs 0.823 af

Total Runoff Area = 8.530 ac Runoff Volume = 0.823 af Average Runoff Depth = 1.16" 81.68% Pervious = 6.968 ac 18.32% Impervious = 1.562 ac

#### FREETOWN EX

Area (sf)

6.9

395 Total

Type III 24-hr 2 yr storm Rainfall=3.40"

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### **Summary for Subcatchment 1EX: Drainage Area 1**

Tc is minimum recommended by tr-55 = 6 min

CN

Runoff = 0.15 cfs @ 12.41 hrs, Volume=

Description

0.040 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

A	iea (Si)	CIN L	rescription									
	3,867	76 Gravel roads, HSG A										
	4,856	91 (	91 Gravel roads, HSG D									
	78,081	39 >	· · · · · · · · · · · · · · · · · · ·									
	355		>75% Grass cover, Good, HSG B									
	14,435		>75% Grass cover, Good, HSG D									
	263		Water Surface, 0% imp, HSG B									
	4,148			ace, 0% imp								
	515	77 V	<u>Voods, Go</u>	od, HSG D								
1	06,520		Veighted A									
1	06,520	1	00.00% P	ervious Are	a							
Tc	Length	Slope	Velocity	Capacity	Description							
<u>(min)</u>	(feet)	(ft/ft)	(ft/sec)	(cfs)								
2.9	50	0.0960	0.29		Sheet Flow, Sheet							
					Grass: Short n= 0.150 P2= 3.40"							
1.0	80	0.0330	1.27		Shallow Concentrated Flow, SGP 3.3%							
0.5		0.4070	0.00		Short Grass Pasture Kv= 7.0 fps							
0.5	75	0.1070	2.29		Shallow Concentrated Flow, SGP 10.7%							
0.0	4.40	0.0040	4.04		Short Grass Pasture Kv= 7.0 fps							
2.3	140	0.0210	1.01		Shallow Concentrated Flow, SGP 2.1%							
0.0	ΕO	0.4000	171		Short Grass Pasture Kv= 7.0 fps							
0.2	50	0.1000	4.74		Shallow Concentrated Flow, Grassed Waterway							
-					Grassed Waterway Kv= 15.0 fps							

### **Summary for Subcatchment 2EX: Drainage Area 2**

Runoff = 0.00 cfs @ 16.97 hrs, Volume= 0.002 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

 Area (sf)	CN	Description
3,606	76	Gravel roads, HSG A
37,545	39	>75% Grass cover, Good, HSG A
 199	74	>75% Grass cover, Good, HSG C
 41,350	42	Weighted Average
41,350		100.00% Pervious Area

**FREETOWN EX** 

Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
-	3.8	50	0.0500	0.22	(010)	Sheet Flow, Sheet
						Grass: Short n= 0.150 P2= 3.40"
	2.5	195	0.0350	1.31		Shallow Concentrated Flow, SGP
	0.0	105	0.0070	0.65		Short Grass Pasture Kv= 7.0 fps
	0.9	135	0.0270	2.65		Shallow Concentrated Flow, Gravel Drive & Lot Unpaved Kv= 16.1 fps
	1.1	100	0.0500	1.57		Shallow Concentrated Flow, SGP
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.1000	2.21		Shallow Concentrated Flow, SGP
_						Short Grass Pasture Kv= 7.0 fps
	8.5	505	Total			

## **Summary for Subcatchment 3EX: Self Storage Drainage Area**

Runoff = 9.12 cfs @ 12.07 hrs, Volume= 0.631 af, Depth= 2.26"

Area (sf)	CN	Description
16,640	76	Gravel roads, HSG A
1,002	85	Gravel roads, HSG B
13,155	89	Gravel roads, HSG C
23,087	91	Gravel roads, HSG D
1,002	98	Paved parking, HSG A
15,246	98	Paved parking, HSG B
26,397	98	Paved parking, HSG C
5,401	39	>75% Grass cover, Good, HSG A
6,403	61	>75% Grass cover, Good, HSG B
2,962	74	>75% Grass cover, Good, HSG C
3,877	80	>75% Grass cover, Good, HSG D
218	98	Water Surface, 0% imp, HSG B
5,445	98	Water Surface, 0% imp, HSG D
4,835	98	Roofs, HSG B
19,950	98	Roofs, HSG C
145,620	89	Weighted Average
78,190		53.69% Pervious Area
67,430		46.31% Impervious Area

**FREETOWN EX** 

Type III 24-hr 2 yr storm Rainfall=3.40"

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(	Tc min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	0.9	50	0.0100	0.94	, ,	Sheet Flow, pavement
						Smooth surfaces n= 0.011 P2= 3.40"
	0.6	115	0.0050	3.21	2.52	
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
	0.4	125	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.5	320	0.0200	10.18	31.99	_ · · · · · · · · · · · · · · · · · · ·
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	2.3					Direct Entry, <5 min adjustment
	5.0	715	Total			

## **Summary for Subcatchment 4EX: West Drainage Area (near cell tower)**

Runoff = 1.85 cfs @ 12.12 hrs, Volume= 0.149 af, Depth= 1.00"

Area (sf)	CN	Description
776	76	Gravel roads, HSG A
5,049	89	Gravel roads, HSG C
626	98	Unconnected roofs, HSG C
9,897	39	>75% Grass cover, Good, HSG A
51,756	74	>75% Grass cover, Good, HSG C
9,976	80	>75% Grass cover, Good, HSG D
78,080	72	Weighted Average, UI Adjusted CN = 71
77,454		99.20% Pervious Area
626		0.80% Impervious Area
626		100.00% Unconnected

FREETOWN EX

Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0480	0.22		Sheet Flow, Grass
						Grass: Short n= 0.150 P2= 3.40"
	2.0	180	0.0470	1.52		Shallow Concentrated Flow, Grass 4.7%
						Short Grass Pasture Kv= 7.0 fps
	0.1	10	0.0400	3.22		Shallow Concentrated Flow, Gravel Drive
						Unpaved Kv= 16.1 fps
	0.5	30	0.0170	0.91		Shallow Concentrated Flow, Grass 1.7%
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.0080	1.82		Shallow Concentrated Flow, Paved 0.8%
						Paved Kv= 20.3 fps
	0.5	320	0.0200	10.18	31.99	· · · · · · · · · · -
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
_						n= 0.013 Concrete pipe, bends & connections
	7.4	720	Total			

#### **Summary for Link DP1: Outfall 1**

Inflow Area = 8.530 ac, 18.32% Impervious, Inflow Depth = 1.16" for 2 yr storm event

Inflow = 10.77 cfs @ 12.08 hrs, Volume= 0.823 af

Primary = 10.77 cfs @ 12.08 hrs, Volume= 0.823 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



# FEIS/FEIR Technical Report Stormwater

Freetown Station

10-Year Storm Event - Existing

FREETOWN EX

Type III 24-hr 10 yr storm Rainfall=4.75"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1EX: Drainage Area 1 Runoff Area=106,520 sf 0.00% Impervious Runoff Depth=0.64"

Flow Length=395' Tc=6.9 min CN=51 Runoff=1.09 cfs 0.131 af

Subcatchment2EX: Drainage Area 2 Runoff Area=41,350 sf 0.00% Impervious Runoff Depth=0.25"

Flow Length=505' Tc=8.5 min CN=42 Runoff=0.07 cfs 0.020 af

Subcatchment3EX: Self Storage Runoff Area=145,620 sf 46.31% Impervious Runoff Depth=3.53"

Flow Length=715' Tc=5.0 min CN=89 Runoff=13.98 cfs 0.984 af

Subcatchment4EX: West Drainage Area Runoff Area=78,080 sf 0.80% Impervious Runoff Depth=1.93"

Flow Length=720' Tc=7.4 min UI Adjusted CN=71 Runoff=3.79 cfs 0.288 af

**Link DP1: Outfall 1**Inflow=18.27 cfs 1.423 af

Primary=18.27 cfs 1.423 af

Total Runoff Area = 8.530 ac Runoff Volume = 1.423 af Average Runoff Depth = 2.00" 81.68% Pervious = 6.968 ac 18.32% Impervious = 1.562 ac

#### **FREETOWN EX**

6.9

395 Total

Type III 24-hr 10 yr storm Rainfall=4.75"

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#### **Summary for Subcatchment 1EX: Drainage Area 1**

Tc is minimum recommended by tr-55 = 6 min

Runoff = 1.09 cfs @ 12.14 hrs, Volume=

0.131 af, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 10 yr storm Rainfall=4.75"

A	rea (sf)	CN D	escription		
	3,867	76 G	ravel road	ls, HSG A	
	4,856	91 G	ravel road	ls, HSG D	
	78,081	39 >	75% Gras	s cover, Go	ood, HSG A
	355				ood, HSG B
	14,435				ood, HSG D
	263			ace, 0% im	
	4,148			ace, 0% im	
	515	77 V	loods, Go	od, HSG D	
	06,520		Veighted A		
1	06,520	1	00.00% Pe	ervious Are	ea
_		-		• "	<b>—</b>
Tc	Length	Slope	•	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
2.9	50	0.0960	0.29		Sheet Flow, Sheet
					Grass: Short n= 0.150 P2= 3.40"
1.0	80	0.0330	1.27		Shallow Concentrated Flow, SGP 3.3%
		0.40=0	0.00		Short Grass Pasture Kv= 7.0 fps
0.5	75	0.1070	2.29		Shallow Concentrated Flow, SGP 10.7%
0.0	4.40	0.0040	4.04		Short Grass Pasture Kv= 7.0 fps
2.3	140	0.0210	1.01		Shallow Concentrated Flow, SGP 2.1%
0.0	ΕO	0.4000	171		Short Grass Pasture Kv= 7.0 fps
0.2	50	0.1000	4.74		Shallow Concentrated Flow, Grassed Waterway
					Grassed Waterway Kv= 15.0 fps

# **Summary for Subcatchment 2EX: Drainage Area 2**

Runoff = 0.07 cfs @ 12.46 hrs, Volume= 0.020 af, Depth= 0.25"

Area (sf)	CN	Description			
3,606	76	Gravel roads, HSG A			
37,545	39	>75% Grass cover, Good, HSG A			
199	74	>75% Grass cover, Good, HSG C			
41,350	42	Weighted Average			
41,350		100.00% Pervious Area			

**FREETOWN EX** 

Type III 24-hr 10 yr storm Rainfall=4.75"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0500	0.22		Sheet Flow, Sheet
						Grass: Short n= 0.150 P2= 3.40"
	2.5	195	0.0350	1.31		Shallow Concentrated Flow, SGP
						Short Grass Pasture Kv= 7.0 fps
	0.9	135	0.0270	2.65		Shallow Concentrated Flow, Gravel Drive & Lot
						Unpaved Kv= 16.1 fps
	1.1	100	0.0500	1.57		Shallow Concentrated Flow, SGP
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.1000	2.21		Shallow Concentrated Flow, SGP
_						Short Grass Pasture Kv= 7.0 fps
	8.5	505	Total			

## **Summary for Subcatchment 3EX: Self Storage Drainage Area**

Runoff = 13.98 cfs @ 12.07 hrs, Volume= 0.984 af, Depth= 3.53"

Area (sf)	CN	Description
16,640	76	Gravel roads, HSG A
1,002	85	Gravel roads, HSG B
13,155	89	Gravel roads, HSG C
23,087	91	Gravel roads, HSG D
1,002	98	Paved parking, HSG A
15,246	98	Paved parking, HSG B
26,397	98	Paved parking, HSG C
5,401	39	>75% Grass cover, Good, HSG A
6,403	61	>75% Grass cover, Good, HSG B
2,962	74	>75% Grass cover, Good, HSG C
3,877	80	>75% Grass cover, Good, HSG D
218	98	Water Surface, 0% imp, HSG B
5,445	98	Water Surface, 0% imp, HSG D
4,835	98	Roofs, HSG B
19,950	98	Roofs, HSG C
145,620	89	Weighted Average
78,190		53.69% Pervious Area
67,430		46.31% Impervious Area

**FREETOWN EX** 

Type III 24-hr 10 yr storm Rainfall=4.75"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
-	0.9	50	0.0100	0.94	, ,	Sheet Flow, pavement
	0.6	115	0.0050	3.21	2.52	
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Concrete pipe, bends & connections
	0.4	125	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.5	320	0.0200	10.18	31.99	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
_	2.3					Direct Entry, <5 min adjustment
_	5.0	715	Total			

## **Summary for Subcatchment 4EX: West Drainage Area (near cell tower)**

Runoff = 3.79 cfs @ 12.11 hrs, Volume= 0.288 af, Depth= 1.93"

Area (sf)	CN	Description
776	76	Gravel roads, HSG A
5,049	89	Gravel roads, HSG C
626	98	Unconnected roofs, HSG C
9,897	39	>75% Grass cover, Good, HSG A
51,756	74	>75% Grass cover, Good, HSG C
9,976	80	>75% Grass cover, Good, HSG D
78,080	72	Weighted Average, UI Adjusted CN = 71
77,454		99.20% Pervious Area
626		0.80% Impervious Area
626		100.00% Unconnected

FREETOWN EX

Type III 24-hr 10 yr storm Rainfall=4.75"

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To (min)	•	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	50	0.0480	0.22	, ,	Sheet Flow, Grass
					Grass: Short n= 0.150 P2= 3.40"
2.0	180	0.0470	1.52		Shallow Concentrated Flow, Grass 4.7%
					Short Grass Pasture Kv= 7.0 fps
0.1	10	0.0400	3.22		Shallow Concentrated Flow, Gravel Drive
					Unpaved Kv= 16.1 fps
0.5	30	0.0170	0.91		Shallow Concentrated Flow, Grass 1.7%
					Short Grass Pasture Kv= 7.0 fps
0.2	25	0.0080	1.82		Shallow Concentrated Flow, Paved 0.8%
					Paved Kv= 20.3 fps
0.5	320	0.0200	10.18	31.99	· · · · · · · · · · · · · · · · · · ·
					24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
					n= 0.013 Concrete pipe, bends & connections
0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
					24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
					n= 0.013 Concrete pipe, bends & connections
7.4	720	Total			

#### **Summary for Link DP1: Outfall 1**

Inflow Area = 8.530 ac, 18.32% Impervious, Inflow Depth = 2.00" for 10 yr storm event

Inflow = 18.27 cfs @ 12.08 hrs, Volume= 1.423 af

Primary = 18.27 cfs @ 12.08 hrs, Volume= 1.423 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



# FEIS/FEIR Technical Report Stormwater

Freetown Station

100-Year Storm Event - Existing

FREETOWN EX

Type III 24-hr 100 yr storm Rainfall=7.00"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1EX: Drainage Area 1 Runoff Area=106,520 sf 0.00% Impervious Runoff Depth=1.76"

Flow Length=395' Tc=6.9 min CN=51 Runoff=4.31 cfs 0.358 af

Subcatchment2EX: Drainage Area 2 Runoff Area=41,350 sf 0.00% Impervious Runoff Depth=1.00"

Flow Length=505' Tc=8.5 min CN=42 Runoff=0.64 cfs 0.079 af

Subcatchment3EX: Self Storage Runoff Area=145,620 sf 46.31% Impervious Runoff Depth=5.71"

Flow Length=715' Tc=5.0 min CN=89 Runoff=22.02 cfs 1.590 af

Subcatchment4EX: West Drainage Area Runoff Area=78,080 sf 0.80% Impervious Runoff Depth=3.72"

Flow Length=720' Tc=7.4 min UI Adjusted CN=71 Runoff=7.45 cfs 0.556 af

**Link DP1: Outfall 1**Inflow=33.37 cfs 2.583 af
Primary=33.37 cfs 2.583 af

Total Runoff Area = 8.530 ac Runoff Volume = 2.583 af Average Runoff Depth = 3.63" 81.68% Pervious = 6.968 ac 18.32% Impervious = 1.562 ac

#### **FREETOWN EX**

6.9

395 Total

Type III 24-hr 100 yr storm Rainfall=7.00"

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### **Summary for Subcatchment 1EX: Drainage Area 1**

Tc is minimum recommended by tr-55 = 6 min

Runoff = 4.31 cfs @ 12.11 hrs, Volume=

0.358 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 100 yr storm Rainfall=7.00"

		-			
Α	rea (sf)	CN E	Description		
	3,867	76 C	Gravel road	ls, HSG A	
	4,856	91 (	Gravel road	ls, HSG D	
	78,081	39 >	75% Gras	s cover, Go	ood, HSG A
	355	61 >	·75% Gras	s cover, Go	ood, HSG B
	14,435			,	ood, HSG D
	263			ace, 0% im	
	4,148			ace, 0% im	
	515	77 V	Voods, Go	od, HSG D	
	06,520		Veighted A	0	
1	06,520	1	00.00% Pe	ervious Are	ea
_		01			B
Tc	Length	Slope	Velocity	Capacity	Description
<u>(min)</u>	(feet)	(ft/ft)	(ft/sec)	(cfs)	
2.9	50	0.0960	0.29		Sheet Flow, Sheet
					Grass: Short n= 0.150 P2= 3.40"
1.0	80	0.0330	1.27		Shallow Concentrated Flow, SGP 3.3%
0.5		0.4070	0.00		Short Grass Pasture Kv= 7.0 fps
0.5	75	0.1070	2.29		Shallow Concentrated Flow, SGP 10.7%
2.2	140	0.0040	1.01		Short Grass Pasture Kv= 7.0 fps
2.3	140	0.0210	1.01		Shallow Concentrated Flow, SGP 2.1%
0.2	50	0.4000	171		Short Grass Pasture Kv= 7.0 fps
0.2	50	0.1000	4.74		Shallow Concentrated Flow, Grassed Waterway Grassed Waterway Kv= 15.0 fps
					Grassed Waterway NV- 10.0 Ips

# **Summary for Subcatchment 2EX: Drainage Area 2**

Runoff = 0.64 cfs @ 12.16 hrs, Volume= 0.079 af, Depth= 1.00"

Area (sf)	CN	Description			
3,606	76	Gravel roads, HSG A			
37,545	39	>75% Grass cover, Good, HSG A			
199	74	>75% Grass cover, Good, HSG C			
41,350	42	Weighted Average			
41,350		100.00% Pervious Area			

**FREETOWN EX** 

Type III 24-hr 100 yr storm Rainfall=7.00"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0500	0.22		Sheet Flow, Sheet
						Grass: Short n= 0.150 P2= 3.40"
	2.5	195	0.0350	1.31		Shallow Concentrated Flow, SGP
						Short Grass Pasture Kv= 7.0 fps
	0.9	135	0.0270	2.65		Shallow Concentrated Flow, Gravel Drive & Lot
						Unpaved Kv= 16.1 fps
	1.1	100	0.0500	1.57		Shallow Concentrated Flow, SGP
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.1000	2.21		Shallow Concentrated Flow, SGP
						Short Grass Pasture Kv= 7.0 fps
_	8.5	505	Total			

## **Summary for Subcatchment 3EX: Self Storage Drainage Area**

Runoff = 22.02 cfs @ 12.07 hrs, Volume= 1.590 af, Depth= 5.71"

Area (sf)	CN	Description
16,640	76	Gravel roads, HSG A
1,002	85	Gravel roads, HSG B
13,155	89	Gravel roads, HSG C
23,087	91	Gravel roads, HSG D
1,002	98	Paved parking, HSG A
15,246	98	Paved parking, HSG B
26,397	98	Paved parking, HSG C
5,401	39	>75% Grass cover, Good, HSG A
6,403	61	>75% Grass cover, Good, HSG B
2,962	74	>75% Grass cover, Good, HSG C
3,877	80	>75% Grass cover, Good, HSG D
218	98	Water Surface, 0% imp, HSG B
5,445	98	Water Surface, 0% imp, HSG D
4,835	98	Roofs, HSG B
19,950	98	Roofs, HSG C
145,620	89	Weighted Average
78,190		53.69% Pervious Area
67,430		46.31% Impervious Area

**FREETOWN EX** 

Type III 24-hr 100 yr storm Rainfall=7.00"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
-	0.9	50	0.0100	0.94	, ,	Sheet Flow, pavement
	0.6	115	0.0050	3.21	2.52	
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Concrete pipe, bends & connections
	0.4	125	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.5	320	0.0200	10.18	31.99	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
_	2.3					Direct Entry, <5 min adjustment
_	5.0	715	Total			

## **Summary for Subcatchment 4EX: West Drainage Area (near cell tower)**

Runoff = 7.45 cfs @ 12.11 hrs, Volume= 0.556 af, Depth= 3.72"

Area (sf)	CN	Description
776	76	Gravel roads, HSG A
5,049	89	Gravel roads, HSG C
626	98	Unconnected roofs, HSG C
9,897	39	>75% Grass cover, Good, HSG A
51,756	74	>75% Grass cover, Good, HSG C
9,976	80	>75% Grass cover, Good, HSG D
78,080	72	Weighted Average, UI Adjusted CN = 71
77,454		99.20% Pervious Area
626		0.80% Impervious Area
626		100.00% Unconnected

**FREETOWN EX** 

Type III 24-hr 100 yr storm Rainfall=7.00"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0480	0.22	, ,	Sheet Flow, Grass
						Grass: Short n= 0.150 P2= 3.40"
	2.0	180	0.0470	1.52		Shallow Concentrated Flow, Grass 4.7%
						Short Grass Pasture Kv= 7.0 fps
	0.1	10	0.0400	3.22		Shallow Concentrated Flow, Gravel Drive
						Unpaved Kv= 16.1 fps
	0.5	30	0.0170	0.91		Shallow Concentrated Flow, Grass 1.7%
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.0080	1.82		Shallow Concentrated Flow, Paved 0.8%
		000		40.40	0.4.00	Paved Kv= 20.3 fps
	0.5	320	0.0200	10.18	31.99	· · · · · · · · · · · · · · · · · · ·
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
	0.0	405	0.0050	5.00	40.00	n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
_						n= 0.013 Concrete pipe, bends & connections
	7.4	720	Total			

#### **Summary for Link DP1: Outfall 1**

Inflow Area = 8.530 ac, 18.32% Impervious, Inflow Depth = 3.63" for 100 yr storm event

Inflow = 33.37 cfs @ 12.08 hrs, Volume= 2.583 af

Primary = 33.37 cfs @ 12.08 hrs, Volume= 2.583 af, Atten= 0%, Lag= 0.0 min

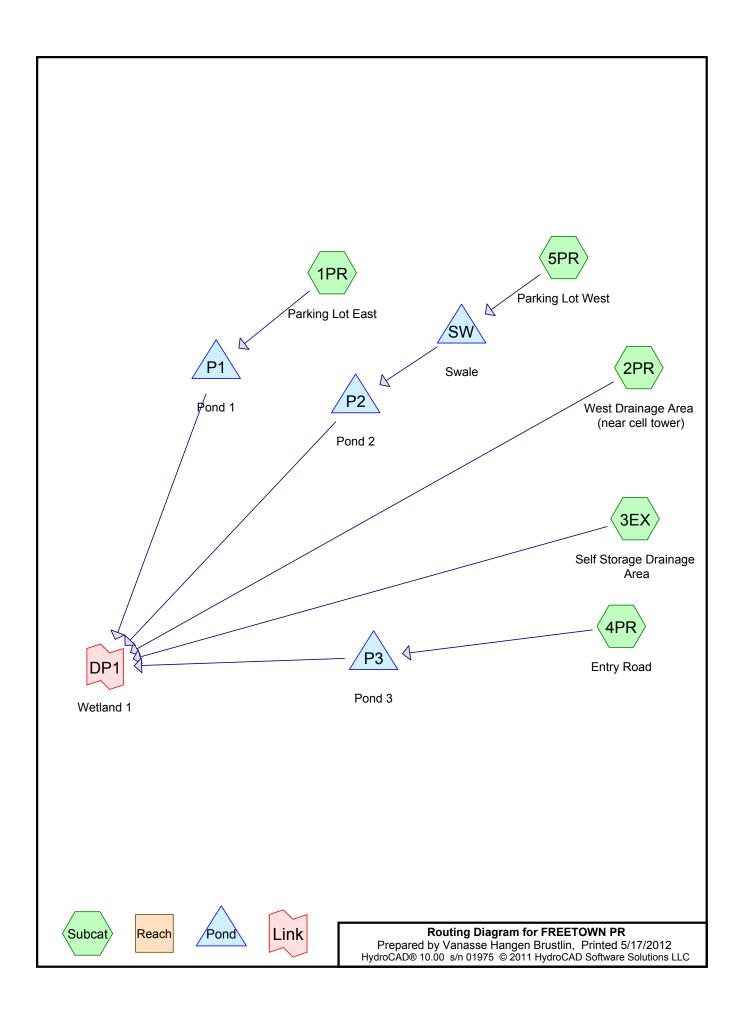
Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



# FEIS/FEIR Technical Report Stormwater

Freetown Station

**HydroCAD Analysis: Proposed Conditions** 



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## **Area Listing (all nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
1.111	39	>75% Grass cover, Good, HSG A (1PR, 2PR, 3EX, 4PR, 5PR)
0.146	61	>75% Grass cover, Good, HSG B (3EX)
1.184	74	>75% Grass cover, Good, HSG C (2PR, 3EX, 5PR)
0.400	76	Gravel roads, HSG A (2PR, 3EX)
0.802	80	>75% Grass cover, Good, HSG D (1PR, 2PR, 3EX, 4PR)
0.013	85	Gravel roads, HSG B (3EX)
0.417	89	Gravel roads, HSG C (2PR, 3EX)
0.503	91	Gravel roads, HSG D (3EX)
2.090	98	Paved parking, HSG A (1PR, 3EX, 4PR, 5PR)
0.379	98	Paved parking, HSG B (3EX, 4PR)
0.606	98	Paved parking, HSG C (3EX)
0.209	98	Paved parking, HSG D (4PR)
0.111	98	Roofs, HSG B (3EX)
0.548	98	Roofs, HSG C (2PR, 3EX, 5PR)
0.013	98	Roofs, HSG D (5PR)
8.532	83	TOTAL AREA



# FEIS/FEIR Technical Report Stormwater

Freetown Station

2-Year Storm Event - Proposed

FREETOWN PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1PR: Parking Lot East

Runoff Area=43,318 sf 72.89% Impervious Runoff Depth=1.77"

Runoff Area=43,318 sf 72.89% Impervious Runoff Depth=1.77"

Flow Length=285' Tc=5.0 min CN=83 Runoff=2.14 cfs 0.147 af

Subcatchment2PR: West Drainage Area Runoff Area=73,919 sf 0.85% Impervious Runoff Depth=1.00"

Flow Length=720' Tc=7.4 min CN=71 Runoff=1.75 cfs 0.142 af

Subcatchment3EX: Self Storage Runoff Area=152,330 sf 44.55% Impervious Runoff Depth=2.09"

Flow Length=715' Tc=5.0 min CN=87 Runoff=8.87 cfs 0.610 af

Subcatchment4PR: Entry Road Runoff Area=0.714 ac 63.45% Impervious Runoff Depth=2.35"

Flow Length=515' Tc=5.0 min CN=90 Runoff=2.02 cfs 0.140 af

Subcatchment5PR: Parking Lot West Runoff Area=70,993 sf 73.96% Impervious Runoff Depth=1.77"

Flow Length=430' Tc=5.0 min CN=83 Runoff=3.51 cfs 0.241 af

**Pond P1: Pond 1** Peak Elev=49.30' Storage=2,653 cf Inflow=2.14 cfs 0.147 af

Discarded=0.14 cfs 0.129 af Primary=0.10 cfs 0.018 af Outflow=0.23 cfs 0.147 af

Pond P2: Pond 2 Peak Elev=47.22' Storage=5,691 cf Inflow=3.27 cfs 0.223 af

Discarded=0.13 cfs 0.170 af Primary=0.05 cfs 0.013 af Outflow=0.19 cfs 0.183 af

Pond P3: Pond 3 Peak Elev=39.33' Storage=4,670 cf Inflow=2.02 cfs 0.140 af

Outflow=0.08 cfs 0.039 af

Pond SW: Swale Peak Elev=50.19' Storage=393 cf Inflow=3.51 cfs 0.241 af

Discarded=0.04 cfs 0.018 af Primary=3.27 cfs 0.223 af Outflow=3.31 cfs 0.241 af

Link DP1: Wetland 1 Inflow=10.44 cfs 0.821 af

Primary=10.44 cfs 0.821 af

Total Runoff Area = 8.532 ac Runoff Volume = 1.280 af Average Runoff Depth = 1.80" 53.64% Pervious = 4.577 ac 46.36% Impervious = 3.956 ac

Type III 24-hr 2 yr storm Rainfall=3.40"

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### **Summary for Subcatchment 1PR: Parking Lot East**

Runoff = 2.14 cfs @ 12.08 hrs, Volume= 0.147 af, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 2 yr storm Rainfall=3.40"

A	rea (sf)	CN D	escription		
31,576 98 Paved parking, HSG A					
	11,096	39 >	75% Gras	s cover, Go	ood, HSG A
	646	80 >	75% Gras	s cover, Go	ood, HSG D
	43,318	83 V	Veighted A	verage	
	11,742	2	7.11% Per	rvious Area	
	31,576	7	2.89% lmp	pervious Ar	ea
_					
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
0.7	50	0.0182	1.19		Sheet Flow, grass
					Smooth surfaces n= 0.011 P2= 3.40"
0.7	155	0.0316	3.61		Shallow Concentrated Flow, Paved
					Paved Kv= 20.3 fps
0.5	55	0.0087	1.89		Shallow Concentrated Flow, Paved
0.4	0.5	0.0044	0.00	0.00	Paved Kv= 20.3 fps
0.1	25	0.0311	8.00	6.28	Pipe Channel, RCP_Round 12"
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
0.0					n= 0.013 Concrete pipe, bends & connections
3.0					Direct Entry, <5 min adjustment
5.0	285	Total			

#### **Summary for Subcatchment 2PR: West Drainage Area (near cell tower)**

Runoff = 1.75 cfs @ 12.12 hrs, Volume= 0.142 af, Depth= 1.00"

Area (sf)	CN	Description			
804	76	Gravel roads, HSG A			
5,049	5,049 89 Gravel roads, HSG C				
626	98	Roofs, HSG C			
9,557	39	>75% Grass cover, Good, HSG A			
48,441 74 >75% Grass cover, Good, HSG C					
9,442	80	>75% Grass cover, Good, HSG D			
73,919	71	Weighted Average			
73,293		99.15% Pervious Area			
626		0.85% Impervious Area			

FREETOWN PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0480	0.22		Sheet Flow, Grass
						Grass: Short n= 0.150 P2= 3.40"
	2.0	180	0.0470	1.52		Shallow Concentrated Flow, Grass 4.7%
						Short Grass Pasture Kv= 7.0 fps
	0.1	10	0.0400	3.22		Shallow Concentrated Flow, Gravel Drive
						Unpaved Kv= 16.1 fps
	0.5	30	0.0170	0.91		Shallow Concentrated Flow, Grass 1.7%
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.0080	1.82		Shallow Concentrated Flow, Paved 0.8%
						Paved Kv= 20.3 fps
	0.5	320	0.0200	10.18	31.99	· · · · · · · · · · -
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
_						n= 0.013 Concrete pipe, bends & connections
	7.4	720	Total			

## **Summary for Subcatchment 3EX: Self Storage Drainage Area**

Runoff = 8.87 cfs @ 12.07 hrs, Volume= 0.610 af, Depth= 2.09"

Area (sf)	CN	Description
16,640	76	Gravel roads, HSG A
566	85	Gravel roads, HSG B
13,112	89	Gravel roads, HSG C
21,911	91	Gravel roads, HSG D
1,002	98	Paved parking, HSG A
15,682	98	Paved parking, HSG B
26,397	98	Paved parking, HSG C
8,625	39	>75% Grass cover, Good, HSG A
6,360	61	>75% Grass cover, Good, HSG B
2,962	74	>75% Grass cover, Good, HSG C
14,288	80	>75% Grass cover, Good, HSG D
4,835	98	Roofs, HSG B
19,950	98	Roofs, HSG C
152,330	87	Weighted Average
84,464		55.45% Pervious Area
67,866		44.55% Impervious Area

FREETOWN PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
_	0.9	50	0.0100	0.94	, ,	Sheet Flow, storage lot
						Smooth surfaces n= 0.011 P2= 3.40"
	0.6	115	0.0050	3.21	2.52	
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
	0.4	125	0.0050	5.09	16.00	· · · · · · · · · · · · · · · · · · ·
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.5	320	0.0200	10.18	31.99	· · · · · · · · · · · · · · · · · · ·
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
_	2.3					Direct Entry, <5 min adjustment
	5.0	715	Total			

### **Summary for Subcatchment 4PR: Entry Road**

Runoff = 2.02 cfs @ 12.07 hrs, Volume= 0.140 af, Depth= 2.35"

_	Area (ac)	CN	Description
	0.225	98	Paved parking, HSG A
	0.019	98	Paved parking, HSG B
	0.209	98	Paved parking, HSG D
	0.019	39	>75% Grass cover, Good, HSG A
	0.242	80	>75% Grass cover, Good, HSG D
	0.714	90	Weighted Average
	0.261		36.55% Pervious Area
	0.453		63.45% Impervious Area

FREETOWN PR

Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
_	0.6	50	0.0320	1.49	(0.0)	Sheet Flow, Lot (sheet)
	0.0		0.0020			Smooth surfaces n= 0.011 P2= 3.40"
	0.4	85	0.0320	3.63		Shallow Concentrated Flow, Lot (SCF)
						Paved Kv= 20.3 fps
	0.3	50	0.0140	2.40		Shallow Concentrated Flow, along curb
						Paved Kv= 20.3 fps
	0.2	60	0.0500	4.54		Shallow Concentrated Flow, Driveway 5%
						Paved Kv= 20.3 fps
	0.0	10	0.3300	4.02		Shallow Concentrated Flow, swale slope
						Short Grass Pasture Kv= 7.0 fps
	1.3	240	0.0450	3.18		Shallow Concentrated Flow, swale
						Grassed Waterway Kv= 15.0 fps
	0.1	20	0.0250	2.37		Shallow Concentrated Flow, end of swale
						Grassed Waterway Kv= 15.0 fps
_	2.1					Direct Entry, <5 min adjustment
	5.0	515	Total			

#### **Summary for Subcatchment 5PR: Parking Lot West**

Runoff = 3.51 cfs @ 12.08 hrs, Volume= 0.241 af, Depth= 1.77"

Area (sf)	CN	Description					
48,651	98	Paved parking, HSG A					
3,305	98	Roofs, HSG C					
552	98	Roofs, HSG D					
18,305	39	>75% Grass cover, Good, HSG A					
180	74	>75% Grass cover, Good, HSG C					
70,993	83	Weighted Average					
18,485		26.04% Pervious Area					
52,508		73.96% Impervious Area					

Type III 24-hr 2 yr storm Rainfall=3.40"

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	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	1.0	50	0.0080	0.86		Sheet Flow, Impervious
						Smooth surfaces n= 0.011 P2= 3.40"
	0.9	180	0.0300	3.52		Shallow Concentrated Flow, impervious parking lot
						Paved Kv= 20.3 fps
	0.1	20	0.3300	4.02		Shallow Concentrated Flow, 3:1 ditch slope
						Short Grass Pasture Kv= 7.0 fps
	0.6	80	0.0250	2.37		Shallow Concentrated Flow, ditch
						Grassed Waterway Kv= 15.0 fps
	0.4	100	0.0100	4.54	3.56	Pipe Channel, RCP_Round 12"
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
_	2.0					Direct Entry, <5 min adjustment
	5.0	430	Total			

# **Summary for Pond P1: Pond 1**

Inflow Area =	0.994 ac, 72.89% Impervious, Inflow De	epth = 1.77" for 2 yr storm event
Inflow =	2.14 cfs @ 12.08 hrs, Volume=	0.147 af
Outflow =	0.23 cfs @ 12.88 hrs, Volume=	0.147 af, Atten= 89%, Lag= 48.2 min
Discarded =	0.14 cfs @ 12.88 hrs, Volume=	0.129 af
Primary =	0.10 cfs @ 12.88 hrs, Volume=	0.018 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 49.30' @ 12.88 hrs Surf.Area= 2,422 sf Storage= 2,653 cf

Plug-Flow detention time= 167.2 min calculated for 0.147 af (100% of inflow) Center-of-Mass det. time= 167.2 min (996.3 - 829.2)

Volume	Inve	ert Avai	I.Storage	Storage Description	on			
#1	48.0	0'	7,713 cf	Custom Stage Da	Custom Stage Data (Irregular)Listed below (Recalc)			
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
48.0 49.0	)0 )0	1,670 2,240	180.0 199.0	0 1,948	0 1,948	1,670 2,274		
50.0 51.0		2,870 3,575	219.0 241.0	2,549 3,216	4,497 7,713	2,971 3,808		
Device	Routing	In	vert Outle	et Devices				
#1			L= 1 Inlet	15.0" Round RCP_Round 15" L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 48.00' / 47.00' S= 0.0100' /' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf				
#2 #3 #4	Device 1 Device 1 Primary	e 1 49.00' <b>3.</b> 0 e 1 50.25' <b>12</b> ry 50.75' <b>5.</b> 0 He		"' Vert. Orifice/Grate C= 0.600  O" W x 6.0" H Vert. Orifice/Grate C= 0.600  O' long x 5.0' breadth Broad-Crested Rectangular Weir  ad (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00  O 3.00 3.50 4.00 4.50 5.00 5.50				

Volume

Invert

Type III 24-hr 2 yr storm Rainfall=3.40"

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Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65

2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

#5 Discarded 48.00' 2.410 in/hr Exfiltration over Surface area

**Discarded OutFlow** Max=0.14 cfs @ 12.88 hrs HW=49.30' (Free Discharge) **5=Exfiltration** (Exfiltration Controls 0.14 cfs)

**Primary OutFlow** Max=0.10 cfs @ 12.88 hrs HW=49.30' (Free Discharge)

**_1=RCP_Round 15"** (Passes 0.10 cfs of 4.86 cfs potential flow)

**1**—2=Orifice/Grate (Orifice Controls 0.10 cfs @ 2.03 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

-4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

### **Summary for Pond P2: Pond 2**

Inflow Area = 1.630 ac, 73.96% Impervious, Inflow Depth = 1.64" for 2 yr storm event
Inflow = 3.27 cfs @ 12.10 hrs, Volume= 0.223 af
Outflow = 0.19 cfs @ 14.32 hrs, Volume= 0.183 af, Atten= 94%, Lag= 133.0 min
Discarded = 0.05 cfs @ 14.32 hrs, Volume= 0.170 af
Primary = 0.05 cfs @ 14.32 hrs, Volume= 0.013 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 47.22' @ 14.32 hrs Surf.Area= 2,414 sf Storage= 5,691 cf

Plug-Flow detention time= 414.0 min calculated for 0.183 af (82% of inflow) Center-of-Mass det. time= 345.7 min (1,168.1 - 822.4)

Avail.Storage Storage Description

				- 10.13					
#1 43.0		00'	11,053 cf	Custom Stage D	oata (Irregular)List	ed below (Recalc)			
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area			
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	<u>(sq-ft)</u>			
43.0	00	510	93.0	0	0	510			
44.0	00	840	118.0	668	668	943			
45.0	00	1,245	141.0	1,036	1,704	1,434			
46.0	00	1,725	164.0	1,478	3,183	2,013			
47.0	00	2,280	188.0	1,996	5,179	2,708			
48.0	00	2,925	212.0	2,596	7,774	3,498			
49.0	00	3,645	237.0	3,278	11,053	4,419			
Device	Routing	In	vert Outle	et Devices					
#1	Primary	43	.00' <b>12.0</b>	12.0" Round RCP_Round 12"					
			L= 6	L= 60.0' RCP, sq.cut end projecting, Ke= 0.500					
			Inlet	Inlet / Outlet Invert= 43.00' / 42.00' S= 0.0167 '/' Cc= 0.900					
			n= 0	= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf					
#2 Device 1		47		.0" W x 12.0" H Vert. Orifice/Grate C= 0.600					
#3 Device 1		48		2.0" W x 6.0" H Vert. Orifice/Grate C= 0.600					
#4	Primary	48		l' long x 4.0' breadth Broad-Crested Rectangular Weir					
				` ,		1.20 1.40 1.60 1.80 2.00			
			2.50	3.00 3.50 4.00	4.50 5.00 5.50				

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Type III 24-hr 2 yr storm Rainfall=3.40"

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Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66

2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

#5 Discarded 43.00' 2.410 in/hr Exfiltration over Surface area

**Discarded OutFlow** Max=0.13 cfs @ 14.32 hrs HW=47.22' (Free Discharge) **5=Exfiltration** (Exfiltration Controls 0.13 cfs)

**Primary OutFlow** Max=0.05 cfs @ 14.32 hrs HW=47.22' (Free Discharge)

**_1=RCP_Round 12"** (Passes 0.05 cfs of 7.04 cfs potential flow)

**2=Orifice/Grate** (Orifice Controls 0.05 cfs @ 1.50 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

-4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

### **Summary for Pond P3: Pond 3**

Inflow Area = 0.714 ac, 63.45% Impervious, Inflow Depth = 2.35" for 2 yr storm event

Inflow = 2.02 cfs @ 12.07 hrs, Volume= 0.140 af

Outflow = 0.08 cfs @ 15.29 hrs, Volume= 0.039 af, Atten= 96%, Lag= 193.0 min

Primary = 0.08 cfs @ 15.29 hrs, Volume= 0.039 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 39.33' @ 15.29 hrs Surf.Area= 3,471 sf Storage= 4,670 cf

Plug-Flow detention time= 444.0 min calculated for 0.039 af (28% of inflow)

Center-of-Mass det. time= 303.8 min (1,107.4 - 803.6)

Volume	Inv	ert Avail.Storage		Storage Description	on			
#1	37.	50'	7,234 cf	Custom Stage Da	Custom Stage Data (Irregular)Listed below (Recalc)			
Elevation (fee	_	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
37.5	50	1,708	226.0	0	0	1,708		
38.0 39.0 40.0	00	2,140 3,114 4,240	280.0 312.0 366.0	960 2,612 3,663	960 3,572 7,234	3,886 5,422 8,355		
Device	Routing	,		et Devices	7,234	6,333		
#1	Primary		.00' <b>12.0</b>	12.0" Round RCP_Round 12" L= 25.0' RCP, sq.cut end projecting, Ke= 0.500				
			n= 0	Inlet / Outlet Invert= 38.00' / 37.50' S= 0.0200 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2 #3	Device 1							
#3 Primary 39.		5.60' 5.0' long x 4.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32						

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Primary OutFlow Max=0.08 cfs @ 15.29 hrs HW=39.33' (Free Discharge)

-1=RCP_Round 12" (Passes 0.08 cfs of 3.45 cfs potential flow)

**1**—2=Orifice/Grate (Orifice Controls 0.08 cfs @ 0.93 fps)

-3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

#### **Summary for Pond SW: Swale**

Inflow Area = 1.630 ac, 73.96% Impervious, Inflow Depth = 1.77" for 2 yr storm event

Inflow = 3.51 cfs @ 12.08 hrs, Volume= 0.241 af

Outflow = 3.31 cfs @ 12.10 hrs, Volume= 0.241 af, Atten= 6%, Lag= 1.6 min

Discarded = 0.04 cfs @ 12.10 hrs, Volume= 0.018 af

Primary = 3.27 cfs @ 12.10 hrs, Volume= 0.223 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 50.19' @ 12.10 hrs Surf.Area= 782 sf Storage= 393 cf

Plug-Flow detention time= 5.5 min calculated for 0.241 af (100% of inflow) Center-of-Mass det. time= 5.5 min (834.7 - 829.2)

Volume	Inve	ert Avail	.Storage	Storage Descripti	on		
#1	49.0	00'	1,290 cf	Custom Stage D	ata (Irregular)Listo	ed below (Recalc)	
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
49.0 50.0 51.0	00	16 653 1,466	22.0 203.0 293.0	0 257 1,032	0 257 1,290	16 3,259 6,820	
Device	Routing	Inv	ert Outle	et Devices			
#1 Primary			L= 5 Inlet n= 0	7" Round Culvert 50.0' RCP, sq.cut end projecting, Ke= 0.500 t / Outlet Invert= 49.40' / 48.90' S= 0.0100 '/' Cc= 0.900 0.013 Concrete pipe, bends & connections, Flow Area= 3.14 sf			
#2	Discarde	d 49.	.00' <b>2.41</b>	0 in/hr Exfiltration over Surface area			

**Discarded OutFlow** Max=0.04 cfs @ 12.10 hrs HW=50.19' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=3.26 cfs @ 12.10 hrs HW=50.19' (Free Discharge) 1=Culvert (Barrel Controls 3.26 cfs @ 4.20 fps)

### Summary for Link DP1: Wetland 1

Inflow Area = 8.532 ac, 46.36% Impervious, Inflow Depth = 1.15" for 2 yr storm event

Inflow = 10.44 cfs @ 12.08 hrs, Volume= 0.821 af

Primary = 10.44 cfs @ 12.08 hrs, Volume= 0.821 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



# FEIS/FEIR Technical Report Stormwater

Freetown Station

10-Year Storm Event- Proposed

FREETOWN PR

Type III 24-hr 10 yr storm Rainfall=4.75"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1PR: Parking Lot East Runoff Area=43,318 sf 72.89% Impervious Runoff Depth=2.95"

Flow Length=285' Tc=5.0 min CN=83 Runoff=3.55 cfs 0.244 af

Subcatchment2PR: West Drainage Area Runoff Area=73,919 sf 0.85% Impervious Runoff Depth=1.93"

Flow Length=720' Tc=7.4 min CN=71 Runoff=3.59 cfs 0.273 af

Subcatchment3EX: Self Storage Runoff Area=152,330 sf 44.55% Impervious Runoff Depth=3.33"

Flow Length=715' Tc=5.0 min CN=87 Runoff=13.94 cfs 0.971 af

Subcatchment4PR: Entry Road Runoff Area=0.714 ac 63.45% Impervious Runoff Depth=3.64"

Flow Length=515' Tc=5.0 min CN=90 Runoff=3.05 cfs 0.216 af

Subcatchment5PR: Parking Lot West Runoff Area=70,993 sf 73.96% Impervious Runoff Depth=2.95"

Flow Length=430' Tc=5.0 min CN=83 Runoff=5.82 cfs 0.400 af

Pond P1: Pond 1 Peak Elev=50.04' Storage=4,619 cf Inflow=3.55 cfs 0.244 af

Discarded=0.16 cfs 0.169 af Primary=0.23 cfs 0.075 af Outflow=0.39 cfs 0.244 af

Pond P2: Pond 2 Peak Elev=48.12' Storage=8,140 cf Inflow=5.41 cfs 0.379 af

Discarded=0.17 cfs 0.195 af Primary=0.76 cfs 0.132 af Outflow=0.92 cfs 0.327 af

**Pond P3: Pond 3** Peak Elev=39.55' Storage=5,430 cf Inflow=3.05 cfs 0.216 af

Outflow=0.48 cfs 0.116 af

Pond SW: Swale Peak Elev=50.46' Storage=631 cf Inflow=5.82 cfs 0.400 af

Discarded=0.06 cfs 0.022 af Primary=5.41 cfs 0.379 af Outflow=5.47 cfs 0.400 af

Link DP1: Wetland 1 Inflow=17.31 cfs 1.567 af

Primary=17.31 cfs 1.567 af

Total Runoff Area = 8.532 ac Runoff Volume = 2.105 af Average Runoff Depth = 2.96" 53.64% Pervious = 4.577 ac 46.36% Impervious = 3.956 ac

Type III 24-hr 10 yr storm Rainfall=4.75"

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### **Summary for Subcatchment 1PR: Parking Lot East**

Runoff = 3.55 cfs @ 12.07 hrs, Volume= 0.244 af, Depth= 2.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 10 yr storm Rainfall=4.75"

A	rea (sf)	CN D	escription					
	31,576 98 Paved parking, HSG A							
	ood, HSG A							
646 80 >75% Grass cover, Good, HSG D								
	43,318	83 V	Veighted A	verage				
	11,742	2	7.11% Per	rvious Area				
	31,576	7	2.89% lmp	pervious Ar	ea			
_								
Tc	Length	Slope	Velocity	Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
0.7	50	0.0182	1.19		Sheet Flow, grass			
					Smooth surfaces n= 0.011 P2= 3.40"			
0.7	155	0.0316	3.61		Shallow Concentrated Flow, Paved			
					Paved Kv= 20.3 fps			
0.5	55	0.0087	1.89		Shallow Concentrated Flow, Paved			
0.4	0.5	0.0044	0.00	0.00	Paved Kv= 20.3 fps			
0.1	25	0.0311	8.00	6.28	Pipe Channel, RCP_Round 12"			
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'			
0.0					n= 0.013 Concrete pipe, bends & connections			
3.0					Direct Entry, <5 min adjustment			
5.0	285	Total						

#### **Summary for Subcatchment 2PR: West Drainage Area (near cell tower)**

Runoff = 3.59 cfs @ 12.11 hrs, Volume= 0.273 af, Depth= 1.93"

Area (sf)	CN	Description					
804	76	Gravel roads, HSG A					
5,049	89	Gravel roads, HSG C					
626	626 98 Roofs, HSG C						
9,557	>75% Grass cover, Good, HSG A						
48,441	74	>75% Grass cover, Good, HSG C					
9,442	80	>75% Grass cover, Good, HSG D					
73,919	71	Weighted Average					
73,293		99.15% Pervious Area					
626		0.85% Impervious Area					

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Type III 24-hr 10 yr storm Rainfall=4.75"

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0480	0.22		Sheet Flow, Grass
						Grass: Short n= 0.150 P2= 3.40"
	2.0	180	0.0470	1.52		Shallow Concentrated Flow, Grass 4.7%
						Short Grass Pasture Kv= 7.0 fps
	0.1	10	0.0400	3.22		Shallow Concentrated Flow, Gravel Drive
						Unpaved Kv= 16.1 fps
	0.5	30	0.0170	0.91		Shallow Concentrated Flow, Grass 1.7%
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.0080	1.82		Shallow Concentrated Flow, Paved 0.8%
						Paved Kv= 20.3 fps
	0.5	320	0.0200	10.18	31.99	· · · · · · · · · · · · · · · · · · ·
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
_						n= 0.013 Concrete pipe, bends & connections
	7.4	720	Total			

# **Summary for Subcatchment 3EX: Self Storage Drainage Area**

Runoff = 13.94 cfs @ 12.07 hrs, Volume= 0.971 af, Depth= 3.33"

Area (sf)	CN	Description
16,640	76	Gravel roads, HSG A
566	85	Gravel roads, HSG B
13,112	89	Gravel roads, HSG C
21,911	91	Gravel roads, HSG D
1,002	98	Paved parking, HSG A
15,682	98	Paved parking, HSG B
26,397	98	Paved parking, HSG C
8,625	39	>75% Grass cover, Good, HSG A
6,360	61	>75% Grass cover, Good, HSG B
2,962	74	>75% Grass cover, Good, HSG C
14,288	80	>75% Grass cover, Good, HSG D
4,835	98	Roofs, HSG B
19,950	98	Roofs, HSG C
152,330	87	Weighted Average
84,464		55.45% Pervious Area
67,866		44.55% Impervious Area

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
-	0.9	50	0.0100	0.94	(0.0)	Sheet Flow, storage lot
						Smooth surfaces n= 0.011 P2= 3.40"
	0.6	115	0.0050	3.21	2.52	Pipe Channel, RCP_Round 12"
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
	0.4	125	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.5	320	0.0200	10.18	31.99	
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
	0.0	405	0.0050	F 00	40.00	n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24" 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	2.3					Direct Entry, <5 min adjustment
-						Direct Entry, so min adjustment
	5.0	715	Total			

## **Summary for Subcatchment 4PR: Entry Road**

Runoff = 3.05 cfs @ 12.07 hrs, Volume= 0.216 af, Depth= 3.64"

 Area (ac)	CN	Description
0.225	98	Paved parking, HSG A
0.019	98	Paved parking, HSG B
0.209	98	Paved parking, HSG D
0.019	39	>75% Grass cover, Good, HSG A
 0.242	80	>75% Grass cover, Good, HSG D
0.714	90	Weighted Average
0.261		36.55% Pervious Area
0.453		63.45% Impervious Area

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
_	0.6	50	0.0320	1.49	(0.0)	Sheet Flow, Lot (sheet)
	0.0		0.0020			Smooth surfaces n= 0.011 P2= 3.40"
	0.4	85	0.0320	3.63		Shallow Concentrated Flow, Lot (SCF)
						Paved Kv= 20.3 fps
	0.3	50	0.0140	2.40		Shallow Concentrated Flow, along curb
						Paved Kv= 20.3 fps
	0.2	60	0.0500	4.54		Shallow Concentrated Flow, Driveway 5%
						Paved Kv= 20.3 fps
	0.0	10	0.3300	4.02		Shallow Concentrated Flow, swale slope
						Short Grass Pasture Kv= 7.0 fps
	1.3	240	0.0450	3.18		Shallow Concentrated Flow, swale
						Grassed Waterway Kv= 15.0 fps
	0.1	20	0.0250	2.37		Shallow Concentrated Flow, end of swale
						Grassed Waterway Kv= 15.0 fps
_	2.1					Direct Entry, <5 min adjustment
	5.0	515	Total			

#### **Summary for Subcatchment 5PR: Parking Lot West**

Runoff = 5.82 cfs @ 12.07 hrs, Volume= 0.400 af, Depth= 2.95"

Area (sf)	CN	Description
48,651	98	Paved parking, HSG A
3,305	98	Roofs, HSG C
552	98	Roofs, HSG D
18,305	39	>75% Grass cover, Good, HSG A
180	74	>75% Grass cover, Good, HSG C
70,993	83	Weighted Average
18,485		26.04% Pervious Area
52,508		73.96% Impervious Area
70,993 18,485		Weighted Average 26.04% Pervious Area

Type III 24-hr 10 yr storm Rainfall=4.75"

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	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	1.0	50	0.0080	0.86		Sheet Flow, Impervious
						Smooth surfaces n= 0.011 P2= 3.40"
	0.9	180	0.0300	3.52		Shallow Concentrated Flow, impervious parking lot
						Paved Kv= 20.3 fps
	0.1	20	0.3300	4.02		Shallow Concentrated Flow, 3:1 ditch slope
						Short Grass Pasture Kv= 7.0 fps
	0.6	80	0.0250	2.37		Shallow Concentrated Flow, ditch
						Grassed Waterway Kv= 15.0 fps
	0.4	100	0.0100	4.54	3.56	Pipe Channel, RCP_Round 12"
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
	2.0					Direct Entry, <5 min adjustment
	5.0	430	Total			

## **Summary for Pond P1: Pond 1**

Inflow Area =	0.994 ac, 72.89% Impervious, Inflow D	epth = 2.95" for 10 yr storm event
Inflow =	3.55 cfs @ 12.07 hrs, Volume=	0.244 af
Outflow =	0.39 cfs @ 12.81 hrs, Volume=	0.244 af, Atten= 89%, Lag= 44.4 min
Discarded =	0.16 cfs @ 12.81 hrs, Volume=	0.169 af
Primary =	0.23 cfs @ 12.81 hrs, Volume=	0.075 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 50.04' @ 12.81 hrs Surf.Area= 2,898 sf Storage= 4,619 cf

Plug-Flow detention time= 172.7 min calculated for 0.244 af (100% of inflow) Center-of-Mass det. time= 172.7 min ( 987.3 - 814.6 )

Volume	Inv	ert Avai	I.Storage	Storage Description	on			
#1	48.0	00'	7,713 cf	Custom Stage Da	<b>ata (Irregular)</b> List	ed below (Recalc)		
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
48.0		1,670	180.0	0	0	1,670		
49.0 50.0		2,240 2,870	199.0 219.0	1,948 2,549	1,948 4,497	2,274 2,971		
51.0	00	3,575	241.0	3,216	7,713	3,808		
Device	Routing	In	vert Outl	et Devices				
#1	Primary	48	L= 1 Inlet	L= 100.0' RCP_Round 15" L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 48.00' / 47.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23				
#2	Device 1			3.0" Vert. Orifice/Grate C= 0.600				
#3	Device 1			<b>12.0" W x 6.0" H Vert. Orifice/Grate</b> C= 0.600				
#4	Primary	50	Hea		0.60 0.80 1.00	Rectangular Weir 1.20 1.40 1.60 1.80 2.00		

Type III 24-hr 10 yr storm Rainfall=4.75"

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Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65

2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

#5 Discarded 48.00' 2.410 in/hr Exfiltration over Surface area

**Discarded OutFlow** Max=0.16 cfs @ 12.81 hrs HW=50.04' (Free Discharge) **5=Exfiltration** (Exfiltration Controls 0.16 cfs)

**Primary OutFlow** Max=0.23 cfs @ 12.81 hrs HW=50.04' (Free Discharge)

**_1=RCP_Round 15"** (Passes 0.23 cfs of 6.74 cfs potential flow)

-2=Orifice/Grate (Orifice Controls 0.23 cfs @ 4.61 fps)

-3=Orifice/Grate (Controls 0.00 cfs)

-4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

#### **Summary for Pond P2: Pond 2**

Inflow Area = 1.630 ac, 73.96% Impervious, Inflow Depth = 2.79" for 10 yr storm event Inflow = 5.41 cfs @ 12.10 hrs, Volume= 0.379 af Outflow = 0.92 cfs @ 12.58 hrs, Volume= 0.327 af, Atten= 83%, Lag= 28.7 min O.17 cfs @ 12.58 hrs, Volume= 0.195 af O.76 cfs @ 12.58 hrs, Volume= 0.132 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 48.12' @ 12.58 hrs Surf.Area= 3,009 sf Storage= 8,140 cf

Plug-Flow detention time= 283.5 min calculated for 0.327 af (86% of inflow) Center-of-Mass det. time= 225.2 min (1,037.0 - 811.7)

Volume	Inv	ert Ava	il.Storage	Storage Description				
#1	43.0	00'	11,053 cf	Custom Stage D	ata (Irregular)List	ed below (Recalc)		
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
43.0		510	93.0	0	0	510		
44.0		840	118.0	668	668	943		
45.0		1,245	141.0	1,036	1,704	1,434		
46.0	00	1,725	164.0	1,478	3,183	2,013		
47.0	00	2,280	188.0	1,996	5,179	2,708		
48.0		2,925		2,596	7,774	3,498		
49.0	00	3,645	237.0	3,278	11,053	4,419		
Device	Routing	In	vert Outl	et Devices				
#1	Primary	43	3.00' <b>12.0</b>	" Round RCP_R	ound 12"			
					end projecting, Ke			
						0.0167 '/' Cc= 0.900		
				n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2	Device 1			2.0" W x 12.0" H Vert. Orifice/Grate C= 0.600				
#3	Device 1			12.0" W x 6.0" H Vert. Orifice/Grate C= 0.600				
#4	Primary	48	Hea	•	0.60 0.80 1.00	d Rectangular Weir 1.20 1.40 1.60 1.80 2.00		

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Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66

2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

43.00' 2.410 in/hr Exfiltration over Surface area #5 Discarded

Discarded OutFlow Max=0.17 cfs @ 12.58 hrs HW=48.12' (Free Discharge) **-5=Exfiltration** (Exfiltration Controls 0.17 cfs)

**Primary OutFlow** Max=0.75 cfs @ 12.58 hrs HW=48.12' (Free Discharge)

-1=RCP Round 12" (Passes 0.75 cfs of 7.76 cfs potential flow)

**-2=Orifice/Grate** (Orifice Controls 0.61 cfs @ 3.68 fps)

-3=Orifice/Grate (Orifice Controls 0.14 cfs @ 1.13 fps)

-4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

## **Summary for Pond P3: Pond 3**

Inflow Area = 0.714 ac, 63.45% Impervious, Inflow Depth = 3.64" for 10 yr storm event

Inflow 3.05 cfs @ 12.07 hrs, Volume= 0.216 af

0.48 cfs @ 12.54 hrs, Volume= Outflow 0.116 af, Atten= 84%, Lag= 28.1 min

0.48 cfs @ 12.54 hrs, Volume= 0.116 af Primary

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 39.55' @ 12.54 hrs Surf.Area= 3,707 sf Storage= 5,430 cf

Plug-Flow detention time= 262.0 min calculated for 0.116 af (53% of inflow)

Center-of-Mass det. time= 152.7 min (944.3 - 791.5)

Volume	Volume Invert Avail.Storage		e Storage Description					
#1	37.	50'	7,234 cf	Custom Stage D	Custom Stage Data (Irregular)Listed below (Recalc)			
Elevation	<b>.</b> n	Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area		
			_					
(fee		(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)		
37.5	50	1,708	226.0	0	0	1,708		
38.0	00	2,140	280.0	960	960	3,886		
39.0	00	3,114	312.0	2,612	3,572	5,422		
40.0	00	4,240	366.0	3,663	7,234	8,355		
Device Routing Invert Outlet Devices								
#1	Primary	38	.00' <b>12.0</b>	12.0" Round RCP_Round 12"				
	•		L= 2	L= 25.0' RCP, sq.cut end projecting, Ke= 0.500				
				Inlet / Outlet Invert= 38.00' / 37.50' S= 0.0200 '/' Cc= 0.900				
		n= 0		n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf				
#2	Device '	l 39		12.0" W x 3.0" H Vert. Orifice/Grate C= 0.600				
#3	Primary 39.60'		.60' <b>5.0'</b>	5.0' long x 4.0' breadth Broad-Crested Rectangular Weir				
	-		Hea	Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00				
			2.50	3.00 3.50 4.00	4.50 5.00 5.50			
						67 2.67 2.65 2.66 2.66		
				` ' '	2.79 2.88 3.07 3.			

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Volume

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Primary OutFlow Max=0.48 cfs @ 12.54 hrs HW=39.55' (Free Discharge)

-1=RCP_Round 12" (Passes 0.48 cfs of 3.87 cfs potential flow)

**1.94** T—2=Orifice/Grate (Orifice Controls 0.48 cfs @ 1.94 fps)

-3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

### **Summary for Pond SW: Swale**

Inflow Area = 1.630 ac, 73.96% Impervious, Inflow Depth = 2.95" for 10 yr storm event

Inflow = 5.82 cfs @ 12.07 hrs, Volume= 0.400 af

Outflow = 5.47 cfs @ 12.10 hrs, Volume= 0.400 af, Atten= 6%, Lag= 1.7 min

Discarded = 0.06 cfs @ 12.10 hrs, Volume= 0.022 af Primary = 5.41 cfs @ 12.10 hrs, Volume= 0.379 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 50.46' @ 12.10 hrs Surf.Area= 986 sf Storage= 631 cf

Plug-Flow detention time= 4.3 min calculated for 0.400 af (100% of inflow)

Avail.Storage Storage Description

Center-of-Mass det. time= 4.3 min (818.9 - 814.6)

Invert

VOIGITIE	1117	71741	i.Otorage	Ctorage Decomption	711				
#1	49.0	00'	1,290 cf	Custom Stage Da	ata (Irregular)Listed	below (Recalc)			
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft <u>)</u>			
49.0		16	22.0	0	0	16			
50.0 51.0		653 1,466	203.0 293.0	257 1,032	257 1,290	3,259 6,820			
Device	Device Routing Invert Outle			et Devices					
#1	Primary	49	L= 5 Inlet	' 24.0" Round Culvert L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 49.40' / 48.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 3.14 sf					
#2	Discarde	ed 49	49.00' 2.410 in/hr Exfiltration over Surface area						

**Discarded OutFlow** Max=0.05 cfs @ 12.10 hrs HW=50.46' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=5.41 cfs @ 12.10 hrs HW=50.46' (Free Discharge)
1=Culvert (Barrel Controls 5.41 cfs @ 4.66 fps)

## Summary for Link DP1: Wetland 1

Inflow Area = 8.532 ac. 46.36% Impervious, Inflow Depth = 2.20" for 10 yr storm event

Inflow = 17.31 cfs @ 12.08 hrs, Volume= 1.567 af

Primary = 17.31 cfs @ 12.08 hrs, Volume= 1.567 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



# FEIS/FEIR Technical Report Stormwater

Freetown Station

100-Year Storm Event – Proposed

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Type III 24-hr 100 yr storm Rainfall=7.00"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1PR: Parking Lot East

Runoff Area=43,318 sf 72.89% Impervious Runoff Depth=5.03"

Runoff Area=43,318 sf 72.89% Impervious Runoff Depth=5.03"

Flow Length=285' Tc=5.0 min CN=83 Runoff=5.96 cfs 0.417 af

**Subcatchment2PR: West Drainage Area** Runoff Area=73,919 sf 0.85% Impervious Runoff Depth=3.72"

Flow Length=720' Tc=7.4 min CN=71 Runoff=7.06 cfs 0.527 af

Subcatchment3EX: Self Storage Runoff Area=152,330 sf 44.55% Impervious Runoff Depth=5.48"

Flow Length=715' Tc=5.0 min CN=87 Runoff=22.40 cfs 1.597 af

Subcatchment4PR: Entry Road Runoff Area=0.714 ac 63.45% Impervious Runoff Depth=5.82"

Flow Length=515' Tc=5.0 min CN=90 Runoff=4.76 cfs 0.346 af

Subcatchment5PR: Parking Lot West Runoff Area=70,993 sf 73.96% Impervious Runoff Depth=5.03"

Flow Length=430' Tc=5.0 min CN=83 Runoff=9.76 cfs 0.683 af

Pond P1: Pond 1 Peak Elev=50.80' Storage=7,007 cf Inflow=5.96 cfs 0.417 af

Discarded=0.19 cfs 0.212 af Primary=1.70 cfs 0.205 af Outflow=1.89 cfs 0.417 af

Pond P2: Pond 2 Peak Elev=48.84' Storage=10,485 cf Inflow=8.98 cfs 0.656 af

Discarded=0.20 cfs 0.219 af Primary=5.26 cfs 0.373 af Outflow=5.46 cfs 0.593 af

Pond P3: Pond 3 Peak Elev=39.88' Storage=6,714 cf Inflow=4.76 cfs 0.346 af

Outflow=2.61 cfs 0.246 af

Peak Elev=50.85' Storage=1,075 cf Inflow=9.76 cfs 0.683 af

Discarded=0.07 cfs 0.027 af Primary=8.98 cfs 0.656 af Outflow=9.05 cfs 0.683 af

Link DP1: Wetland 1 Inflow=31.84 cfs 2.947 af

Primary=31.84 cfs 2.947 af

Total Runoff Area = 8.532 ac Runoff Volume = 3.569 af Average Runoff Depth = 5.02" 53.64% Pervious = 4.577 ac 46.36% Impervious = 3.956 ac

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## **Summary for Subcatchment 1PR: Parking Lot East**

Runoff = 5.96 cfs @ 12.07 hrs, Volume= 0.417 af, Depth= 5.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Type III 24-hr 100 yr storm Rainfall=7.00"

A	rea (sf)	CN D	escription					
	31,576	98 P	98 Paved parking, HSG A					
	11,096	39 >	39 >75% Grass cover, Good, HSG A					
	646	80 >	75% Gras	s cover, Go	ood, HSG D			
	43,318	83 V	Veighted A	verage				
	11,742	2	7.11% Per	rvious Area				
	31,576	7	2.89% lmp	pervious Ar	ea			
_								
Tc	Length	Slope	Velocity	Capacity	Description			
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)				
0.7	50	0.0182	1.19		Sheet Flow, grass			
					Smooth surfaces n= 0.011 P2= 3.40"			
0.7	155	0.0316	3.61		Shallow Concentrated Flow, Paved			
					Paved Kv= 20.3 fps			
0.5	55	0.0087	1.89		Shallow Concentrated Flow, Paved			
0.4	0.5	0.0044	0.00	0.00	Paved Kv= 20.3 fps			
0.1	25	0.0311	8.00	6.28	Pipe Channel, RCP_Round 12"			
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'			
0.0					n= 0.013 Concrete pipe, bends & connections			
3.0					Direct Entry, <5 min adjustment			
5.0	285	Total						

## **Summary for Subcatchment 2PR: West Drainage Area (near cell tower)**

Runoff = 7.06 cfs @ 12.11 hrs, Volume= 0.527 af, Depth= 3.72"

Area (sf)	CN	Description
804	76	Gravel roads, HSG A
5,049	89	Gravel roads, HSG C
626	98	Roofs, HSG C
9,557	39	>75% Grass cover, Good, HSG A
48,441	74	>75% Grass cover, Good, HSG C
9,442	80	>75% Grass cover, Good, HSG D
73,919	71	Weighted Average
73,293		99.15% Pervious Area
626		0.85% Impervious Area

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	3.8	50	0.0480	0.22		Sheet Flow, Grass
						Grass: Short n= 0.150 P2= 3.40"
	2.0	180	0.0470	1.52		Shallow Concentrated Flow, Grass 4.7%
						Short Grass Pasture Kv= 7.0 fps
	0.1	10	0.0400	3.22		Shallow Concentrated Flow, Gravel Drive
						Unpaved Kv= 16.1 fps
	0.5	30	0.0170	0.91		Shallow Concentrated Flow, Grass 1.7%
						Short Grass Pasture Kv= 7.0 fps
	0.2	25	0.0080	1.82		Shallow Concentrated Flow, Paved 0.8%
						Paved Kv= 20.3 fps
	0.5	320	0.0200	10.18	31.99	· · · · · · · · · · -
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
_						n= 0.013 Concrete pipe, bends & connections
	7.4	720	Total			

## **Summary for Subcatchment 3EX: Self Storage Drainage Area**

Runoff = 22.40 cfs @ 12.07 hrs, Volume= 1.597 af, Depth= 5.48"

Area (sf)	CN	Description
16,640	76	Gravel roads, HSG A
566	85	Gravel roads, HSG B
13,112	89	Gravel roads, HSG C
21,911	91	Gravel roads, HSG D
1,002	98	Paved parking, HSG A
15,682	98	Paved parking, HSG B
26,397	98	Paved parking, HSG C
8,625	39	>75% Grass cover, Good, HSG A
6,360	61	>75% Grass cover, Good, HSG B
2,962	74	>75% Grass cover, Good, HSG C
14,288	80	>75% Grass cover, Good, HSG D
4,835	98	Roofs, HSG B
19,950	98	Roofs, HSG C
152,330	87	Weighted Average
84,464		55.45% Pervious Area
67,866		44.55% Impervious Area

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1)	Tc min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	0.9	50	0.0100	0.94	, ,	Sheet Flow, storage lot
						Smooth surfaces n= 0.011 P2= 3.40"
	0.6	115	0.0050	3.21	2.52	
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
	0.4	125	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.5	320	0.0200	10.18	31.99	_ · · · · · · · · · · · · · · · · · · ·
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	0.3	105	0.0050	5.09	16.00	Pipe Channel, RCP_Round 24"
						24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
						n= 0.013 Concrete pipe, bends & connections
	2.3					Direct Entry, <5 min adjustment
	5.0	715	Total			

# **Summary for Subcatchment 4PR: Entry Road**

Runoff = 4.76 cfs @ 12.07 hrs, Volume= 0.346 af, Depth= 5.82"

Are	ea (ac)	CN	Description
	0.225	98	Paved parking, HSG A
	0.019	98	Paved parking, HSG B
	0.209	98	Paved parking, HSG D
	0.019	39	>75% Grass cover, Good, HSG A
	0.242	80	>75% Grass cover, Good, HSG D
	0.714	90	Weighted Average
	0.261		36.55% Pervious Area
	0.453		63.45% Impervious Area

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	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
_	0.6	50	0.0320	1.49	(0.0)	Sheet Flow, Lot (sheet)
	0.0		0.0020			Smooth surfaces n= 0.011 P2= 3.40"
	0.4	85	0.0320	3.63		Shallow Concentrated Flow, Lot (SCF)
						Paved Kv= 20.3 fps
	0.3	50	0.0140	2.40		Shallow Concentrated Flow, along curb
						Paved Kv= 20.3 fps
	0.2	60	0.0500	4.54		Shallow Concentrated Flow, Driveway 5%
						Paved Kv= 20.3 fps
	0.0	10	0.3300	4.02		Shallow Concentrated Flow, swale slope
						Short Grass Pasture Kv= 7.0 fps
	1.3	240	0.0450	3.18		Shallow Concentrated Flow, swale
						Grassed Waterway Kv= 15.0 fps
	0.1	20	0.0250	2.37		Shallow Concentrated Flow, end of swale
						Grassed Waterway Kv= 15.0 fps
_	2.1					Direct Entry, <5 min adjustment
	5.0	515	Total			

## **Summary for Subcatchment 5PR: Parking Lot West**

Runoff = 9.76 cfs @ 12.07 hrs, Volume= 0.683 af, Depth= 5.03"

Area (sf)	CN	Description
48,651	98	Paved parking, HSG A
3,305	98	Roofs, HSG C
552	98	Roofs, HSG D
18,305	39	>75% Grass cover, Good, HSG A
180	74	>75% Grass cover, Good, HSG C
70,993	83	Weighted Average
18,485		26.04% Pervious Area
52,508		73.96% Impervious Area

Type III 24-hr 100 yr storm Rainfall=7.00"

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	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	1.0	50	0.0080	0.86		Sheet Flow, Impervious
						Smooth surfaces n= 0.011 P2= 3.40"
	0.9	180	0.0300	3.52		Shallow Concentrated Flow, impervious parking lot
						Paved Kv= 20.3 fps
	0.1	20	0.3300	4.02		Shallow Concentrated Flow, 3:1 ditch slope
						Short Grass Pasture Kv= 7.0 fps
	0.6	80	0.0250	2.37		Shallow Concentrated Flow, ditch
						Grassed Waterway Kv= 15.0 fps
	0.4	100	0.0100	4.54	3.56	Pipe Channel, RCP_Round 12"
						12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
						n= 0.013 Concrete pipe, bends & connections
	2.0					Direct Entry, <5 min adjustment
	5.0	430	Total			

# **Summary for Pond P1: Pond 1**

Inflow Area =	0.994 ac, 72.89% Impervious, Inflow D	Depth = 5.03" for 100 yr storm event
Inflow =	5.96 cfs @ 12.07 hrs, Volume=	0.417 af
Outflow =	1.89 cfs @ 12.37 hrs, Volume=	0.417 af, Atten= 68%, Lag= 17.8 min
Discarded =	0.19 cfs @ 12.37 hrs, Volume=	0.212 af
Primary =	1.70 cfs @ 12.37 hrs, Volume=	0.205 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 50.80' @ 12.37 hrs Surf.Area= 3,427 sf Storage= 7,007 cf

Plug-Flow detention time= 151.0 min calculated for 0.417 af (100% of inflow) Center-of-Mass det. time= 151.0 min ( 950.5 - 799.5 )

Volume	Inve	rt Avail	.Storage	Storage Descriptio	n	
#1	48.00	)'	7,713 cf	<b>Custom Stage Da</b>	ta (Irregular)Listed	below (Recalc)
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
48.0	00	1,670	180.0	0	0	1,670
49.0	00	2,240	199.0	1,948	1,948	2,274
50.0	00	2,870	219.0	2,549	4,497	2,971
51.0	00	3,575	241.0	3,216	7,713	3,808
Device	Routing	Inv	ert Outle	et Devices		
#1	Primary	48.	L= 1 Inlet	" Round RCP_Ro 00.0' RCP, sq.cut / Outlet Invert= 48.0 .013 Concrete pipe	end projecting, Ke= 00' / 47.00' S= 0.0	
#2	Device 1	49.		Vert. Orifice/Grate	•	,
#3	Device 1	50.		" W x 6.0" H Vert.		0.600
#4	Primary	50.	Head	long x 5.0' breadtl d (feet) 0.20 0.40 3.00 3.50 4.00 4	0.60 0.80 1.00 1.2	Rectangular Weir 20 1.40 1.60 1.80 2.00

Type III 24-hr 100 yr storm Rainfall=7.00"

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Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65

2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

#5 48.00' 2.410 in/hr Exfiltration over Surface area Discarded

Discarded OutFlow Max=0.19 cfs @ 12.37 hrs HW=50.80' (Free Discharge) **5=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=1.70 cfs @ 12.37 hrs HW=50.80' (Free Discharge)

**-1=RCP Round 15"** (Passes 1.58 cfs of 8.03 cfs potential flow)

**2=Orifice/Grate** (Orifice Controls 0.31 cfs @ 6.23 fps)

-3=Orifice/Grate (Orifice Controls 1.27 cfs @ 2.54 fps)

-4=Broad-Crested Rectangular Weir (Weir Controls 0.13 cfs @ 0.52 fps)

## **Summary for Pond P2: Pond 2**

Inflow Area =	1.630 ac, 73.96% Impervious, Inflow De	epth = 4.83" for 100 yr storm event
Inflow =	8.98 cfs @ 12.10 hrs, Volume=	0.656 af
Outflow =	5.46 cfs @ 12.22 hrs, Volume=	0.593 af, Atten= 39%, Lag= 6.9 min
Discarded =	0.20 cfs @ 12.22 hrs, Volume=	0.219 af
Primary =	5.26 cfs @ 12.22 hrs, Volume=	0.373 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 48.84' @ 12.22 hrs Surf.Area= 3,526 sf Storage= 10,485 cf

Plug-Flow detention time= 185.1 min calculated for 0.592 af (90% of inflow) Center-of-Mass det. time= 138.9 min ( 938.0 - 799.1 )

Volume	Inve	ert Ava	il.Storage	Storage Descripti	on	
#1	43.0	00'	11,053 cf	Custom Stage D	ata (Irregular)List	ed below (Recalc)
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)
43.0	00	510	93.0	0	0	510
44.0	00	840	118.0	668	668	943
45.0	00	1,245	141.0	1,036	1,704	1,434
46.0	00	1,725	164.0	1,478	3,183	2,013
47.0	00	2,280	188.0	1,996	5,179	2,708
48.0	00	2,925	212.0	2,596	7,774	3,498
49.0	00	3,645	237.0	3,278	11,053	4,419
Device	Routing	Ir	vert Outle	et Devices		
#1	Primary	43	3.00' <b>12.0</b>	" Round RCP_R	ound 12"	
	- ,			0.0' RCP, sq.cut		e= 0.500
					. ,	.0167 '/' Cc= 0.900
			n= 0	.013 Concrete pip	e, bends & connec	ctions, Flow Area= 0.79 sf
#2	Device 1	47		W x 12.0" H Vert.		
#3	Device 1	48	3.00' <b>12.0</b>	" W x 6.0" H Vert.	Orifice/Grate C=	= 0.600
#4	Primary	48	3.50' <b>5.0'</b>	long x 4.0' bread	th Broad-Crested	l Rectangular Weir
	•		Hea	d (feet) 0.20 0.40	0.60 0.80 1.00	1.20 1.40 1.60 1.80 2.00
			2.50	3.00 3.50 4.00	4.50 5.00 5.50	

Type III 24-hr 100 yr storm Rainfall=7.00"

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Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66

2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

43.00' 2.410 in/hr Exfiltration over Surface area #5 Discarded

**Discarded OutFlow** Max=0.20 cfs @ 12.22 hrs HW=48.84' (Free Discharge) **-5=Exfiltration** (Exfiltration Controls 0.20 cfs)

**Primary OutFlow** Max=5.25 cfs @ 12.22 hrs HW=48.84' (Free Discharge)

-1=RCP Round 12" (Passes 2.76 cfs of 8.28 cfs potential flow)

**-2=Orifice/Grate** (Orifice Controls 0.92 cfs @ 5.54 fps)

-3=Orifice/Grate (Orifice Controls 1.84 cfs @ 3.67 fps)

-4=Broad-Crested Rectangular Weir (Weir Controls 2.49 cfs @ 1.46 fps)

## **Summary for Pond P3: Pond 3**

Inflow Area = 0.714 ac, 63.45% Impervious, Inflow Depth = 5.82" for 100 yr storm event

Inflow 4.76 cfs @ 12.07 hrs, Volume= 0.346 af

2.61 cfs @ 12.18 hrs, Volume= Outflow 0.246 af, Atten= 45%, Lag= 6.6 min

2.61 cfs @ 12.18 hrs, Volume= Primary 0.246 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 39.88' @ 12.18 hrs Surf.Area= 4,090 sf Storage= 6,714 cf

Plug-Flow detention time= 191.5 min calculated for 0.246 af (71% of inflow)

Center-of-Mass det. time= 101.1 min (880.0 - 779.0)

Volume	Inv	ert Ava	il.Storage	Storage Descript	ion	
#1	37.	50'	7,234 cf	Custom Stage D	Data (Irregular)List	ted below (Recalc)
<b>-</b> 14:		O	Danina	la a Otana	0	10/-1 0
Elevation		Surf.Area	Perim.	Inc.Store	Cum.Store	Wet.Area
(fee	et)	(sq-ft)	(feet)	(cubic-feet)	(cubic-feet)	(sq-ft)
37.5	50	1,708	226.0	0	0	1,708
38.0	00	2,140	280.0	960	960	3,886
39.0	00	3,114	312.0	2,612	3,572	5,422
40.0	00	4,240	366.0	3,663	7,234	8,355
ъ.	D "					
Device	Routing	ın	vert Outle	et Devices		
#1	Primary	38	3.00' <b>12.0</b>	" Round RCP_R	ound 12"	
			L= 2	5.0' RCP, sq.cut	end projecting, Ke	e= 0.500
						0.0200 '/' Cc= 0.900
			n= 0	.013 Concrete pip	be, bends & conne	ctions, Flow Area= 0.79 sf
#2	Device '	1 39	).25' <b>12.0</b>	" W x 3.0" H Vert	. Orifice/Grate C:	= 0.600
#3	Primary	39	0.60' <b>5.0'</b>	long x 4.0' bread	Ith Broad-Crested	d Rectangular Weir
	•		Hea	d (feet) 0.20 0.40	0.60 0.80 1.00	1.20 1.40 1.60 1.80 2.00
			2.50	3.00 3.50 4.00	4.50 5.00 5.50	
						67 2.67 2.65 2.66 2.66
					2.79 2.88 3.07 3	

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FREETOWN PR

Volume

Type III 24-hr 100 yr storm Rainfall=7.00"

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**Primary OutFlow** Max=2.61 cfs @ 12.18 hrs HW=39.87' (Free Discharge)

-1=RCP_Round 12" (Passes 0.85 cfs of 4.43 cfs potential flow)

**1**—2=Orifice/Grate (Orifice Controls 0.85 cfs @ 3.40 fps)

-3=Broad-Crested Rectangular Weir (Weir Controls 1.76 cfs @ 1.28 fps)

### **Summary for Pond SW: Swale**

Inflow Area = 1.630 ac, 73.96% Impervious, Inflow Depth = 5.03" for 100 yr storm event

Inflow = 9.76 cfs @ 12.07 hrs, Volume= 0.683 af

Outflow = 9.05 cfs @ 12.10 hrs, Volume= 0.683 af, Atten= 7%, Lag= 1.8 min

Discarded = 0.07 cfs @ 12.10 hrs, Volume= 0.027 af Primary = 8.98 cfs @ 12.10 hrs, Volume= 0.656 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs Peak Elev= 50.85' @ 12.10 hrs Surf.Area= 1,320 sf Storage= 1,075 cf

Plug-Flow detention time= 3.4 min calculated for 0.683 af (100% of inflow)

Avail.Storage Storage Description

Center-of-Mass det. time= 3.5 min ( 803.0 - 799.5 )

Invert

VOIGITIC	1117	ort /war	i.Otorage	Otorage Description		
#1	49.0	00'	1,290 cf	Custom Stage Da	<b>ta (Irregular)</b> Listed	below (Recalc)
Elevation (fee		Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft <u>)</u>
49.0	00	16	22.0	0	0	16
50.0	00	653	203.0	257	257	3,259
51.0	00	1,466	293.0	1,032	1,290	6,820
Device	Routing	In	vert Outl	et Devices		
#1	Primary	49	.40' <b>24.0</b>	" Round Culvert		
	•		Inlet	50.0' RCP, sq.cut ei c/Outlet Invert= 49.4 0.013 Concrete pipe	40' / 48.90' S= 0.0	
#2	Discarde	ed 49	.00' <b>2.41</b>	0 in/hr Exfiltration	over Surface area	

**Discarded OutFlow** Max=0.07 cfs @ 12.10 hrs HW=50.84' (Free Discharge) **2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=8.97 cfs @ 12.10 hrs HW=50.84' (Free Discharge)
—1=Culvert (Barrel Controls 8.97 cfs @ 5.16 fps)

## Summary for Link DP1: Wetland 1

Inflow Area = 8.532 ac, 46.36% Impervious, Inflow Depth = 4.14" for 100 yr storm event

Inflow = 31.84 cfs @ 12.09 hrs, Volume= 2.947 af

Primary = 31.84 cfs @ 12.09 hrs, Volume= 2.947 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



# FEIS/FEIR Technical Report Stormwater

Freetown Station



## FEIS/FEIR Technical Report Stormwater Freetown Station

# Appendix C Standard 3 Computations and Supporting Information



# FEIS/FEIR Technical Report Stormwater

Freetown Station

Soil Evaluation and Analysis



#### MAP LEGEND MAP INFORMATION Map Scale: 1:2,200 if printed on A size (8.5" × 11") sheet. Area of Interest (AOI) Area of Interest (AOI) The soil surveys that comprise your AOI were mapped at 1:20,000. Soils Warning: Soil Map may not be valid at this scale. Soil Map Units Enlargement of maps beyond the scale of mapping can cause Soil Ratings misunderstanding of the detail of mapping and accuracy of soil line Α placement. The maps do not show the small areas of contrasting A/D soils that could have been shown at a more detailed scale. В Please rely on the bar scale on each map sheet for accurate map measurements. B/D С Source of Map: Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov C/D Coordinate System: UTM Zone 19N NAD83 D This product is generated from the USDA-NRCS certified data as of the version date(s) listed below. Not rated or not available **Political Features** Soil Survey Area: Bristol County, Massachusetts, Southern Part Survey Area Data: Version 6, Jul 23, 2010 Cities Date(s) aerial images were photographed: 8/14/2003 **Water Features** Streams and Canals The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background Transportation imagery displayed on these maps. As a result, some minor shifting +++ of map unit boundaries may be evident. Interstate Highways **US Routes** Major Roads Local Roads $\sim$

# **Hydrologic Soil Group**

Hydrologic Soil Group— Summary by Map Unit — Bristol County, Massachusetts, Southern Part (MA603)					
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI	
39A	Scarboro muck, 0 to 1 percent slopes	D	2.4	19.9%	
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	С	3.2	26.4%	
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	0.3	2.7%	
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	А	5.3	43.1%	
260A	Sudbury fine sandy loam, 0 to 3 percent slopes	В	0.0	0.1%	
260B	Sudbury fine sandy loam, 3 to 8 percent slopes	В	1.0	7.9%	
Totals for Area of Int	erest	12.3	100.0%		

## **Description**

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

# **Rating Options**

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



# FEIS/FEIR Technical Report Stormwater

Freetown Station

Required and Provided Recharge Volumes



# **Recharge Calculations**

Project Name: Freetown StationProj. No.:10111.00Project Location: Freetown, MADate:30-Apr-12

Calculated by: PAC

Checked by:

#### **Proposed Impervious Surface Summary**

### Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
2	0.0	0.0	0.0	0.0	0.0
3	0.7	0.0	0.0	0.0	0.7
4	0.2	0.0	0.0	0.2	0.5
5	1.1	0.0	0.1	0.0	1.2
3EX	0.0	0.0	0.0	0.0	0.0
TOTAL	2.1	0.0	0.1	0.2	2.4

## **Required Recharge Volume (Cubic Feet)**

HSG	Area	Recharge Depth *	Volume
	(acres)	(in.)	(c.f.)
Α	2.1	0.60	4,502
В	0.0	0.35	24
С	0.1	0.25	69
D	0.2	0.10	81
TOTAL			4,676

^{*} Per 2008 Massachusetts DEP Recharge Requirement

#### **Provided Recharge Volume (Cubic Feet)**

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet)

Total 11.5		.f.
Basin P3	1,403	
Basin P2	5,205	
Basin P1	1,955	



# FEIS/FEIR Technical Report Stormwater

Freetown Station

72-hour Drawdown Analysis



## **Drawdown Calculations**

Project Name: Freetown Station

**Proj. No.:** 10111.00

**Date:** 5/18/2012

EJM

Project Location: Freetown, MA

Calculated by:

#### Infiltration Basin - 1

Infiltration volumes provided in basin below lowest outlet.

#### **Basin Volume Below Outlet**

Elevation	Area	Incremental
	(s.f.)	Volume (c.f.)
48.00	1,670	0
49.00	2,240	1,955
TOTAL		1,955

#### Assumptions:

Recharge Rate: 2.41 in/hr

#### Infiltration Basin - 2

Infiltration volumes provided in basin below lowest outlet.

#### **Basin Volume Below Outlet**

Elevation	Area (s.f.)	Incremental Volume (c.f.)
43.00	510	0
44.00	840	675
45.00	1,245	1,718
46.00	1,725	3,203
47.00	2,280	5,205
TOTAL		5.205

#### **Assumptions:**

Recharge Rate: 2.41 in/hr

Į	Drawdown Time:	50.8 hours

#### Infiltration Basin - 3

Infiltration volumes provided in basin below lowest outlet.

#### **Basin Volume Below Outlet**

Elevation	Area (s.f.)	Incremental Volume (c.f.)
37.50	1,708	0
38.00	2,140	962
39.00	3,114	3,589
39.25	3,396	4,403
TOTAL		4,403

#### **Assumptions:**

Recharge Rate: 2.41 in/hr

Drawdown Time: 12.8 hours	
---------------------------	--



## FEIS/FEIR Technical Report Stormwater Freetown Station

# Appendix D Standard 4 Computations and Supporting Information



# FEIS/FEIR Technical Report Stormwater

Freetown Station

**Water Quality Volume Calculations** 



# Water Quality Volume Calculations

Project Name: Freetown StationProj. No.:10111.00Project Location: Freetown, MADate:4/30/2012

Calculated by: PAC

### Infiltration Basin P1

(runoff from Area 3PR)

Total Impervious Area = 0.72 Acres

Required:

Forebay Volume

Water Quality Volume

Runoff Depth to Bequired be Treated (in.) Volume (c.f.)

0.1 263

0.5 1,316

Provided:

| Cumulative | Bioretention Basin P1 | Elevation | Area (s.f.) | Volume (c.f.) | 48.00 | 1,670 | 0 | 49.00 | 2,240 | 1.955 |

#### **Infiltration Basin P2**

(runoff from Area 5PR)

Total Impervious Area = 1.21 Acres

Required:

Runoff Depth to be Treated (in.)
Forebay Volume
0.1
Water Quality Volume
0.5
Required
Volume (c.f.)
438
2,188

Provided:

Cumulative Bioretention Basin P2 Elevation Area (s.f.) Volume (c.f.) 43.00 510 0 44.00 840 675 45.00 1,245 1,718 46.00 1,725 3,203 47.00 2,280 5,205

#### **Infiltration Basin P3**

(runoff from Area 4PR)

Total Impervious Area = 0.45 Acres

Required:

Runoff Depth to be Treated (in.)
Forebay Volume
0.1
Water Quality Volume
0.5
Required
Volume (c.f.)
164
822

Provided:

Cumulative Bioretention Basin P3 Elevation Area (s.f.) Volume (c.f.) 37.50 1,708 0 38.00 2,140 962 39.00 3,114 3,589 3,396 39.25 4,403



# **FEIS/FEIR Technical Report** Stormwater Freetown Station

**TSS Removal Worksheets** 

# **TSS Removal Calculation Worksheet**



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name: Freetown Station

Project Number: 10111.00

Location: Freetown, MA

Discharge Point: Drainage Area(s): PR-3, PR-4, PR-5

Sheet: 1 of 2
Date: 28-Apr-2012
Computed by: PAC
Checked by:

Α	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Grass Channel	50%	1.00	0.50	0.50
Infiltration Basin	80%	0.50	0.40	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10
	0%	0.10	0.00	0.10

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

90%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)

Treatment Train
TSS Removal =

# **TSS Removal Calculation Worksheet**



Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name: Freetown Station Sheet: 2 of 2
Project Number: 10111.00 Date: 28-Apr-2012
Location: Freetown, MA Computed by: PAC

Discharge Point: - Checked by:

A B C D E

	BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Dee	ep Sump and Hooded Catch Basin	25%	1.00	0.25	0.75
	Infiltration Basin	80%	0.75	0.60	0.15
		0%	0.15	0.00	0.15
		0%	0.15	0.00	0.15
		0%	0.15	0.00	0.15

^{*} BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

Drainage Area(s):

Treatment Train
TSS Removal =

85%

^{**} Equals remaining load from previous BMP (E)

^{***} Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)



## FEIS/FEIR Technical Report Stormwater Freetown Station

# Appendix E Geotechnical Report



**Date** January 31, 2012

To Rick Carey, Natasha Velickovic - VHB

**From** Paul Murphy, Da Ha, Peter Chou - Jacobs

**Subject** MBTA South Coast Rail (New Bedford/Fall River Commuter Rail Extension)

Freetown Station Geotechnical Design Memorandum

Freetown, MA

**Project No.** E2347101

#### INTRODUCTION

The South Coast Rail project will restore passenger rail transportation from South Station in Boston to the cities of Fall River and New Bedford along an existing rail freight corridor running south from Taunton to Fall River and New Bedford. The project will include the construction of several existing and new passenger stations and two terminal layover facilities. This geotechnical design memorandum presents the foundation design considerations for the new station platform at the proposed Freetown Station in Freetown, Massachusetts. The design recommendations presented in this report are based on the results of subsurface investigations performed by Jacobs in 2001 and 2010.

#### **Existing Conditions**

The proposed Freetown Station site is located off the south side of South Main Street in Freetown (Figure 1). The site is currently an undeveloped gravel lot with associated soil stockpiles on the site and some wetland areas are also present adjacent to the platform area. A self-storage facility with associated parking is located along the north side of the site, a telecommunication tower is located west of the site, and the remaining site area is surrounded by open and forested land. Existing grades at the platform location range from approximately elevation 61 to 67.6 feet (NGVD29 Datum), generally sloping downward from west to east.

#### **Proposed Construction**

Current station plans are to construct a new parking area, a new drop-off area, and an 800 foot long, 12 foot wide high level platform adjacent to the existing tracks. In addition, some track relocation is required. Access to the platform will be from a new ramp/stair structure along the north side of the tracks. Two 50-ft long platform canopies are also planned. The details of new track layout (including grading), associated sidewalks and ramps, and parking lot of the proposed station are still under development at the time of this report preparation. However, we anticipate that about 6 to 8 feet of fill is proposed at the site to raise the grade at the track level and platform area. This report focuses on the geotechnical design and recommendation for the platform only.

#### SCOPE OF WORK

This memorandum was prepared by Jacobs in accordance with the scope of work under the contract between Jacobs and VHB for work on the New Bedford/Fall River Commuter Rail Line Extension Project for Massachusetts Bay Transportation Authority (MBTA). The geotechnical work included the following tasks:

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- Perform a geotechnical exploration and laboratory testing program;
- Report and interpret the results of the exploration and laboratory testing program; and
- Provide geotechnical recommendations for design and construction of the platform foundations.

The Jacobs scope of work did not include environmental assessment of the potential presence of any hazardous materials at the project site or potential impacts to adjacent structures during construction.

#### LOCAL GEOLOGY

The geologic map of Massachusetts shows the Freetown Station to be located in the Milford-Dedham zone, just south of the Narragansett Basin. The bedrock in the Milford-Dedham zone is mostly granite of Proterozoic age. The bedrock in the Narragansett Basin is lightly metamorphosed shale and sandstone of Pennsylvanian and Permian age. Bedrock was not sampled at the Freetown site. Two of the borings encountered SPT refusal at a depth of 47 and 48 feet, but the refusal could possibly be a large boulder or true bedrock. The deepest boring at the site extended to a depth of 49 feet. The bedrock is typically overlain by hard till or very dense sand and gravel.

#### GEOTECHNICAL EXPLORATIONS

Jacobs planned the subsurface exploration programs and retained the drilling contractors to perform the explorations. The geotechnical data reports were submitted in 2001 and 2010, respectively. Nine borings (FTS-1, FTS-4, FTS-5 to FTS-8, FR-79 MW, FR-80 and FR-81) were conducted along the proposed station platform and nine borings (FTS-09 to FTS-17) were drilled in the general vicinity of the proposed parking lot and the access road. Boring locations are shown on the Subsurface Exploration Plan (Figure 2).

The recent 2010 borings were drilled by New Hampshire Boring with either a CME-550 or D-50 ATV mounted drill rig. The 2001 borings were drilled by Earth Explorations, Inc. and NFE, Inc. with a B-57 ATV mounted drill rig. The 2010 borings were advanced through the soil by hollow-stem auger or wash boring methods using a 4-inch casing and roller bit with water. Standard penetration tests (SPT), consisting of 140-pound hammer dropping 30 inches on a standard 2-inch-diameter (OD) split-spoon sampler, were performed with a safety hammer to establish the consistency of the subsurface soils. The SPT's were typically performed at five foot intervals of depth. The obtained samples were sealed in glass jars to retain their natural moisture. Bedrock was not cored during the explorations. (Borings performed in 2001 were summarized in our previous data reports.)

The borings were observed by a representative from Jacobs. The soil samples were classified in the field in accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) by Jacobs' representative, and appropriate stratum breaks were interpolated from drilling and sampling observations. The boring logs were prepared by Jacobs based on the field classifications and laboratory testing, and are presented in Appendix A.

#### LABORATORY TESTING

The results of the laboratory testing were previously submitted to VHB in reports entitled "South Coast Rail, Jacobs Geotechnical Data Report", dated November 2010, and "Fall River Line, Jacobs Geotechnical Data Report", dated October 2001.

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Grain size distribution analyses were performed to evaluate the gradation of the natural granular soils for potential reuse as backfill, if needed, and to classify the soils. The graduation analyses are summarized in Table 1 below and are presented in Appendix B.

**Table 1: Laboratory Soil Classification Summary** 

BORING NO.	SAMPLE NO.	ELEVATION (FEET)	USCS SOIL CLASSIFICATION	W (%)	GRAVEL (%)	SAND (%)	FINES (%)	ORGANIC CONTENT (%)
FTS-04	S2	63.6	moist, black Silt (ML)	42.4	NT	NT	NT	4.7
FTS-11	S1	55.0	Sandy Silt (ML)	24	0	48.1	51.9	NT
FTS-13	S2	34.6	Silt (ML)	23.8	0	1.0	99.0	NT

Where: w = natural moisture content, NT = Not Tested

#### SUBSURFACE CONDITIONS

The subsurface conditions at the site were inferred from the boring data collected for the South Coast Rail project, with some interpretations. The subsurface conditions encountered at the station area during our 2001 and 2010 explorations generally consist of a layer of granular fill with thickness of about 0 to 3 feet, underlain by natural, loose to dense stratified silt and sand deposits, and very dense glacial till. Boulders were encountered at borings FTS-1 and FTS-6 at depths of 31 feet and 24 feet below ground surface, respectively. Apparent bedrock was encountered at a depth of about 48 feet (El. 14.2 feet) in boring FTS-1 and at a depth of about 45 feet (El. 20.6 feet) in boring FTS-4.

Organic silt was encountered at boring FTS-4 along the proposed platform at a depth of 3 to 5 feet (elevations 64.6 to 62.6 feet).

Fill materials with thicknesses varying from 0 to 7 feet were also encountered in the vicinity of the proposed parking lot area. Bedrock was not encountered in this area.

Subsurface soil conditions are summarized in Table 2 below.

**Table 2: Summary of Subsurface Conditions at Borings** 

BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
			PI	atform Borings			
FTS – 1	62.4	3.0	59.4	14.2	14.2	54.4	Boring offset 18 ft SW along tracks.
FTS – 4	67.6	3.0	64.6	20.6	18.6	62.6	
FTS – 5	61.3	0	61.3	NE	45.3	53.3	Auger Boring
FTS – 6	60.2	0	60.2	NE	33.7	57.2	Auger Boring
FTS - 7	57.4	0	57.4	NE	40.4	52.9	Auger Boring
FTS – 8	58.6	0	58.6	NE	42.6	54.1	Auger Boring
FR-79 MW	61.5	7.0	54.5	NE	41.0	49.0	Well screened from 9.2 to 19.2 ft.
FR-80	64.9	3.0	61.9	NE	44.4	52.8	
FR-81	70.2	3.0	67.2	NE	49.7	59.8	

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BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. FILL THICKNESS (FT)	TOP OF NATURAL SOIL ELEV. (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
				Site Borings			
FTS – 9 OW	57.6	0	57.6	NE	32.1	52.6	Well screened from 10 to 25 ft.
FTS – 10	56.9	4.0	52.9	NE	39.9	46.9	Auger Boring
FTS – 11	56.0	0	56.0	NE	41.0	54	
FTS - 12	50.2	0	50.2	NE	33.2	42.2	Auger Boring
FTS – 13	38.6	2.0	36.6	NE	23.6	35.6	
FTS – 14	55.6	0	55.6	NE	30.6	49.6	
FTS – 15 OW	46.7	0	46.7	NE	21.7	41.7	Well screened from 10 to 20 ft.
FTS – 16 OW	37.6	0	37.6	NE	12.6	36.6	Well screened from 10 to 20 ft.
FTS – 17	60.7	0	60.7	NE	35.7	50.7	Auger Boring
NE: Not encour	ntered at the boring	g during drilling.		•	•	•	-

*Fill:* The fill layer, where encountered, typically consists of railroad ballast, and granular, loose to medium dense sand and gravel. Clay fill was encountered at boring FR-81. The fill layer is generally about 0 to 3 feet thick in the area of the platform.

*Organic Silt:* A two foot thick layer of organic silt was encountered from approximately elevation 64.5 to 62.5 feet at boring FTS-4 at the west side of the platform. Boring FTS-4 is located adjacent to a wetland area. Organic soils may also be located near other wetland areas at the site.

*Natural Granular Deposits:* In the platform area, the natural soil deposits below the fill generally consist of predominantly silt, sandy silt and silty sand with up to 30% gravel. These deposits are loose to very dense with Standard Penetration Test (SPT) N-values ranging between 6 and 58 blows per foot (bpf).

Glacial Till: Very dense glacial till was encountered in the platform area at elevations ranging from 31.4 to 40.6 feet, and consisted of silt with 10 to 30% sand and 10 to 20% gravel.

Groundwater: Groundwater levels were measured in the test borings using a weighted tape during and at completion of drilling. The data indicated the groundwater level ranged from approximate elevations 49 to 62.6 feet along the platform alignment, and from elevations 35.6 to 54 feet in the general site area. The use of wash boring techniques for some of the borings may have artificially increased the water level readings due to the addition of water to the borings. Trapped/perched water is also commonly seen at a higher elevation within existing fill and silty materials. The longer term water level readings taken at boring FTS–09 OW on July 7, 2010 and September 13, 2011 indicated the groundwater at a depth of about 6 feet (elevation 51.6 feet) and 5 feet (elevation 52.6 feet), respectively. The longer term readings taken at borings FTS–15 OW and FTS–16 OW on July 7, 2010 indicated groundwater at a depth of about 8 feet (elevation 38.7 feet) and 1.4 feet (elevation 36.2 feet), respectively.

Groundwater levels should be expected to fluctuate with rainfall and other seasonal variations. Local and periodic variations of groundwater elevations may also be influenced by local subsurface drainage and leaking water or sewer pipes. More long-term observations would be required to evaluate true groundwater levels and their influence on planned construction. However, based upon these short-term observations and readings from the observation wells, it is anticipated that the groundwater could be within 5 to 12 feet below

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existing grade at the platform area and within 1 to 8 feet below existing grade in the parking lot and roadway area.

#### GEOTECHNICAL RECOMMENDATIONS

Based on our review of available subsurface conditions, the proposed station platforms can be supported on shallow spread footings bearing directly within either competent natural soil or structural fill placed above suitable natural soils. Platform and canopy design loads were not available at the time of this report preparation. However, it is anticipated that the station platform will be lightly (axially) loaded with limited horizontal forces from wind and seismic loads.

The following paragraphs provide project specific geotechnical recommendations for foundation soil preparation, structural fill/backfill placement, and design and construction of spread footings.

#### <u>Platform Foundations - Spread Footings</u>

Spread footings are recommended for the platform foundations, bearing on compacted structure fill or natural granular deposits. The bottom of footing elevation should be at least 4 feet below final grades for frost protection. Due to proposed site filling, bottom of footing is anticipated to be at elevations 66 to 70 feet. The existing fill and organic silt deposits are not suitable for support of the spread footings and should be removed within the zone of influence of the footings, defined by a line extending one foot horizontally from the bottom edge of footing and then down and away at a 1H:1V slope until natural soils are encountered.

The recommended allowable design bearing capacity for spread footings bearing on at least medium dense structural fill or natural silt, sandy silt or silty sand deposits is 6 ksf, provided that subgrades are prepared as described herein. This provides an adequate factor of safety against bearing failure and limits the total estimated settlement to less than one inch and the differential settlement to less than ½ inch. All footings should be at least 4 feet wide.

The structural fill material, if needed, should be free from organics and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200 - Earthwork for Type B Gravel Borrow. The structural fill should be compacted to 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557).

All temporary open cuts required for footing construction should be in accordance with the related OSHA regulations and should have side slopes of no steeper than 1.5H:1V.

### Seismic Consideration

The seismic design should comply with the requirements of the most current Massachusetts State Building Code 780 CMR and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface conditions encountered, the station platform site is classified as Seismic Site Class D soil profile in accordance with 780 CMR Chapter 1614.0 Section 9.4 Site Ground Motion. The structure could be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. The maximum considered earthquake ground motions shall be as represented by the spectral response acceleration at short periods (Ss) and at 1-sec (S₁) obtained from Table 1604.10 of the Massachusetts State Building Code and adjusted for Site Class effects using the site coefficients of Section 9.4.1.2.4.

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For Site Class D Soils at the location of this station:

$$S_{MS} = 0.368$$
 and  $S_{M1} = 0.144$ 

$$S_{DS} = 0.245$$
 and  $S_{D1} = 0.096$ 

#### where:

- S_{MS} is the maximum consider earthquake spectral response acceleration for short periods adjusted for site class
- S_{M1} is the maximum consider earthquake spectral response acceleration at 1-sec adjusted for site class
- $\bullet$  S_{DS} is the design earthquake spectral response acceleration for short periods adjusted for site class
- S_{D1} is the design earthquake spectral response acceleration at 1-sec adjusted for site class

The building code also requires that the soil be evaluated for the following potential hazards: slope instability, soil liquefaction, or surface rupture due to faulting or lateral spreading. The proposed grading is relatively flat and we are not aware of any pre-existing slope instability in this area. The existing overburden soils do not appear to be subject to surface rupture due to faulting or lateral spreading.

#### **Liquefaction**

Based on the observed subsurface conditions, recorded water levels, percentage of fine contents and sample relative densities, the existing soils underlying the site are judged not susceptible to liquefaction.

#### CONSTRUCTION CONSIDERATIONS

### Foundation Installation - Spread Footings

The existing fill and organic silt should be stripped off and removed from within the zone of influence of the platform and walkway areas down to natural granular deposits using a smooth edge excavation bucket, and replaced by compacted granular soils.

Following excavation to the top of the natural granular deposits, the exposed surface should be observed by an on-site representative of the project geotechnical engineer and be proof-compacted with at least 10 passes of a large vibratory drum roller. Any yielding areas should be observed by geotechnical personnel to assess if localized undercutting is necessary. Footing inspections should include hand auger probes by the geotechnical personnel to check for soft/weak zones. The need for undercutting and backfilling with structural fill should be closely evaluated in the field based on encountered conditions.

In areas where seepage is encountered within footing excavations, the need for placing a 3" thick lean concrete mud mat or a layer of \(^34\)-inch crushed stone to protect the bearing surface should be evaluated in the field. Crushed stone thicker than 4 inches shall be wrapped by non-woven filter fabric.

Following observation of the bearing soils by geotechnical personnel, reinforcing steel and concrete can be placed in the excavation. It is recommended that footing reinforcing steel and concrete be placed the same day as the footing excavation is made, where possible, to avoid significant moisture content changes in the bearing soils. No water should be allowed to pond within excavations and drainage should be maintained

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away from foundations both during and after construction. The footing excavation should be free of loose debris at the time of footing concrete placement.

#### Subgrade Preparation

Prior to performing any required grading operations and excavations in the proposed structure footprints, walkway and paved areas, these areas should be stripped of topsoil, vegetation, fill, organic silt, and existing pavement, if present. The topsoil should be placed in a designated area for reuse during final grading. Following site clearing and stripping, the exposed subgrade should be proof compacted with 10 passes of a large vibratory drum roller (minimum 10,000 pound static weight). Any pockets of excessively soft, wet or disturbed soil or unsuitable soils should be removed and replaced with properly compacted fill materials. Where subgrade soils are close to the existing groundwater level or where silty subgrade soils are encountered, proof-compaction using non-vibratory methods may be considered by the geotechnical engineer.

If additional rolling does not correct the unstable condition, the subgrade should be scarified to a depth of at least six inches but not exceeding eighteen inches, aerated, re-compacted, and retested to provide uniform compaction. Following satisfactory compaction of the subgrade, controlled compacted fill material should be placed to bring the site to the required grade.

Fill should not be placed over frozen soil. Soil subgrades should be protected against frost both during and after construction.

Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. Excavations should be made with as few passes of the backhoe bucket as possible to reduce disturbance of the subgrade. A backhoe bucket fitted with a smooth blade should be used during the final subgrade preparation, where necessary. The exposed base should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas. Construction traffic should be controlled to prevent excessive stresses and disturbance to the subgrade.

If pavements are not constructed immediately after grading, the subgrade should be shaped so as to prevent ponding. If there is a substantial lapse in time between grading and paving, or if the subgrade is disturbed, it should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during proof-rolling or initial construction should be removed and replaced with compacted granular fill.

Within the proposed paved areas, and extending a distance of five feet beyond the edge on all sides, excavate existing granular fill soils to a depth of two feet below existing site grades. It may be possible to reuse the existing granular fill, depending on the suitability of the material, as described herein.

#### Fill Placement and Compaction

Fill materials most likely will be obtained by importing granular fill materials from off-site borrow sources. However, it may be possible to reuse existing site granular fill material provided that it can be properly placed and compacted. The gradation shall be in accordance with MBTA Standard Specification Section 02200-Earthwork for Type B Gravel Borrow.

All structural fill should be free of organics, demolition debris or other deleterious substances. The fill material should have a plasticity index (PI) less than 4 and a liquid limit (LL) less than 10, and contain fragments less than 4 inches in maximum dimension. Each lift should be compacted to the specified density prior to placing any subsequent lift. All materials to be used as structural fill should be tested in the laboratory to determine their project suitability and compaction characteristics.

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The fill should be systematically compacted to the following percentages of the maximum dry density:

**Table 3: Fill Compaction Requirements** 

DESCRIPTION	MINIMUM PERCENT COMPACTION (ASTM D-1557)
General Site Fills, Structural Fill	95
(Below Footings and Slabs)	
Behind Retaining Walls	92
Landscape Area	90

Soils which exhibit a well-defined moisture content–dry density relationship should be compacted to within plus or minus two percentage points of the optimum moisture content as determined by the Modified Proctor test (ASTM D-1557).

Where fill materials are placed against an existing embankment slope, the slope should be benched as the fill is brought up in layers. Benching should be of a sufficient width to permit placing and compaction of fill material upon the existing embankment materials. Typically, benches are between four to eight feet wide. Each bench cut should begin at the intersection of the existing embankment and the vertical side of the previous bench. Trench backfills over pipelines or utility structures should be performed so as not to adversely impact the underlying utilities. In fill areas, the backfill material, compaction method, and degree of compaction requirements should be similar to that for the fill adjacent to the trench.

#### **Construction Dewatering**

All excavations should be performed in the dry condition. Discharge of pumped water should be performed in accordance with all federal, state and/or local regulations which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

#### Permanent Slopes

Permanent slopes with loamed and seeded surfaces should not be steeper than 2-1/2 horizontal to 1 vertical (2-1/2H:1V) without slope protection to limit erosion and surficial sloughing of the slope. Additional analyses may be required to assess the stability of slopes steeper than 2-1/2H:1V as the station design is finalized.

#### **Excavation Slopes and Shoring**

The slopes of temporary open cuts should be no steeper than 1-1/2H:1V. Open cuts should not be used below the water table because of the likelihood of soil sloughing into the excavation.

The temporary excavation support system, if needed, should be selected by the Contractor and designed by an experienced Professional Engineer registered in the Commonwealth of Massachusetts and retained by the Contractor. Where excavation sides can be sloped back, they should be performed in accordance with the Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

#### **Protection of Existing Facilities**

It is recommended that a geotechnical instrumentation and monitoring program be performed during construction of the project to evaluate impacts on adjacent structures. It is recommended that the program be developed to provide data for the following considerations:

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- To monitor ground movements and vibration levels during construction.
- To provide early warning of potentially adverse trends by presenting sufficient data to determine the source of unanticipated ground movements, if present.
- If necessary, to plan remedial measures to limit damage to embankments and structures and to provide early warning when alternative means of protection are necessary.
- To document impacts of construction on adjacent facilities.
- To evaluate the performance and structural integrity of the constructed facilities.

We recommend the following instrumentation program to measure:

- Ground surface settlement and lateral movement adjacent to proposed construction.
- Horizontal and vertical movement of any excavation support system, and existing structures.
- Vibrations as a result of construction activities.

Vertical and horizontal survey points should be established on the adjacent structures. The monitoring points should be surveyed prior to the start of construction and monitored during construction to detect movement.

Vibration monitoring shall be conducted within 100 feet of existing structures during construction activities.

We recommend conducting a pre-construction survey of structures and utilities within 100 feet of the site to document existing conditions prior to construction. Documentation should include photographs, video, sketches, and/or written comments.

Specific instrumentation and monitoring requirements shall be based on the proposed construction sequence, duration of construction, and performance criteria. Initial measurements should be established well in advance of construction so that baseline data can be developed. This information will be invaluable for providing early warning of adverse trends and for assessing the need for mitigating measures.

#### **CLOSING**

This report and the recommendations contained herein have been prepared for the exclusive use of MBTA and VHB and their representatives for specific application to the design and construction of the proposed Freetown Station in Freetown, Massachusetts.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations available at the time of this report. Subsurface stratification variations between borings are anticipated. The reported groundwater levels only represent the water levels at the time noted on the logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

#### **ATTACHMENTS**

FIGURE 1 – SITE LOCATION PLAN

FIGURE 2 – SUBSURFACE EXPLORATION PLAN

FIGURE 3 – SUBSURFACE SOIL PROFILES

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APPENDIX A – EXPLORATION LOGS APPENDIX B – LABORATORY DATA APPENDIX C – GEOTECHNICAL CALCULATIONS

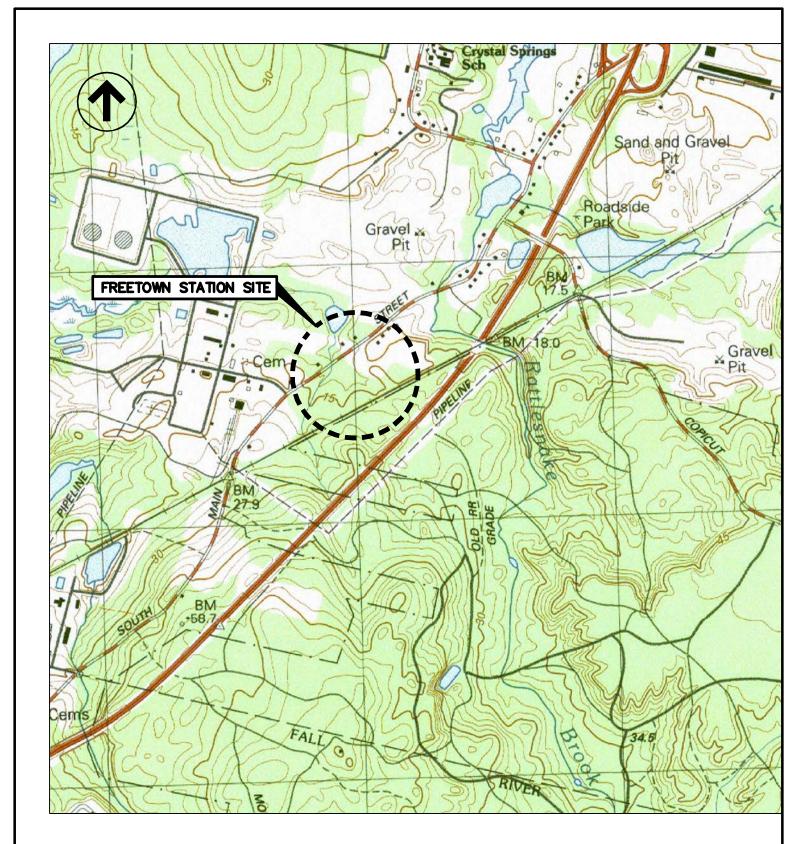
### Memorandum



#### **FIGURES**

Figure 1: Site Location Plan

Figure 2: Subsurface Exploration Plan Figure 3: Subsurface Soil Profiles

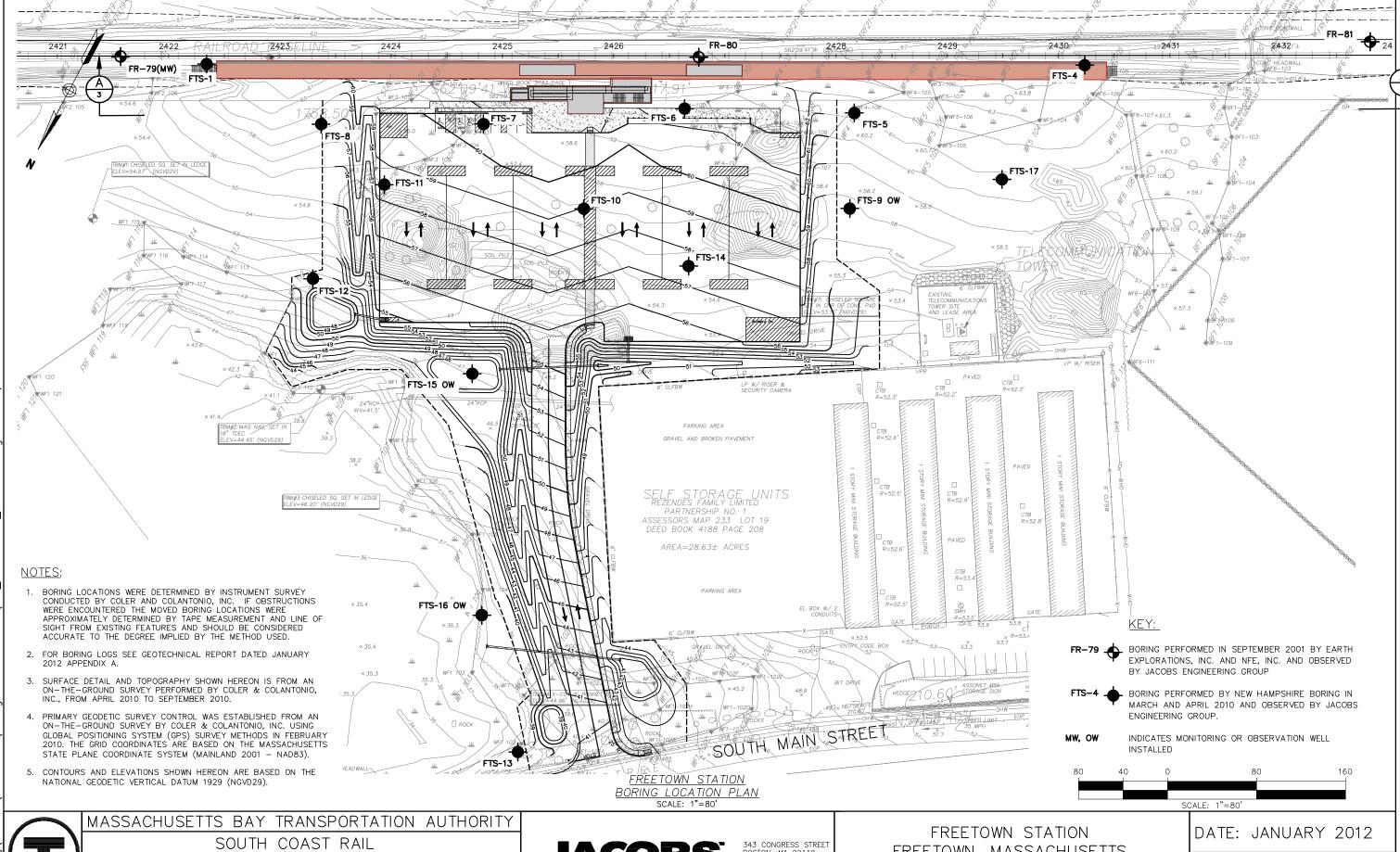


FREETOWN STATION
PROJECT LOCUS PLAN
NOT TO SCALE



MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68 FREETOWN STATION FREETOWN, MASSACHUSETTS FIGURE 1

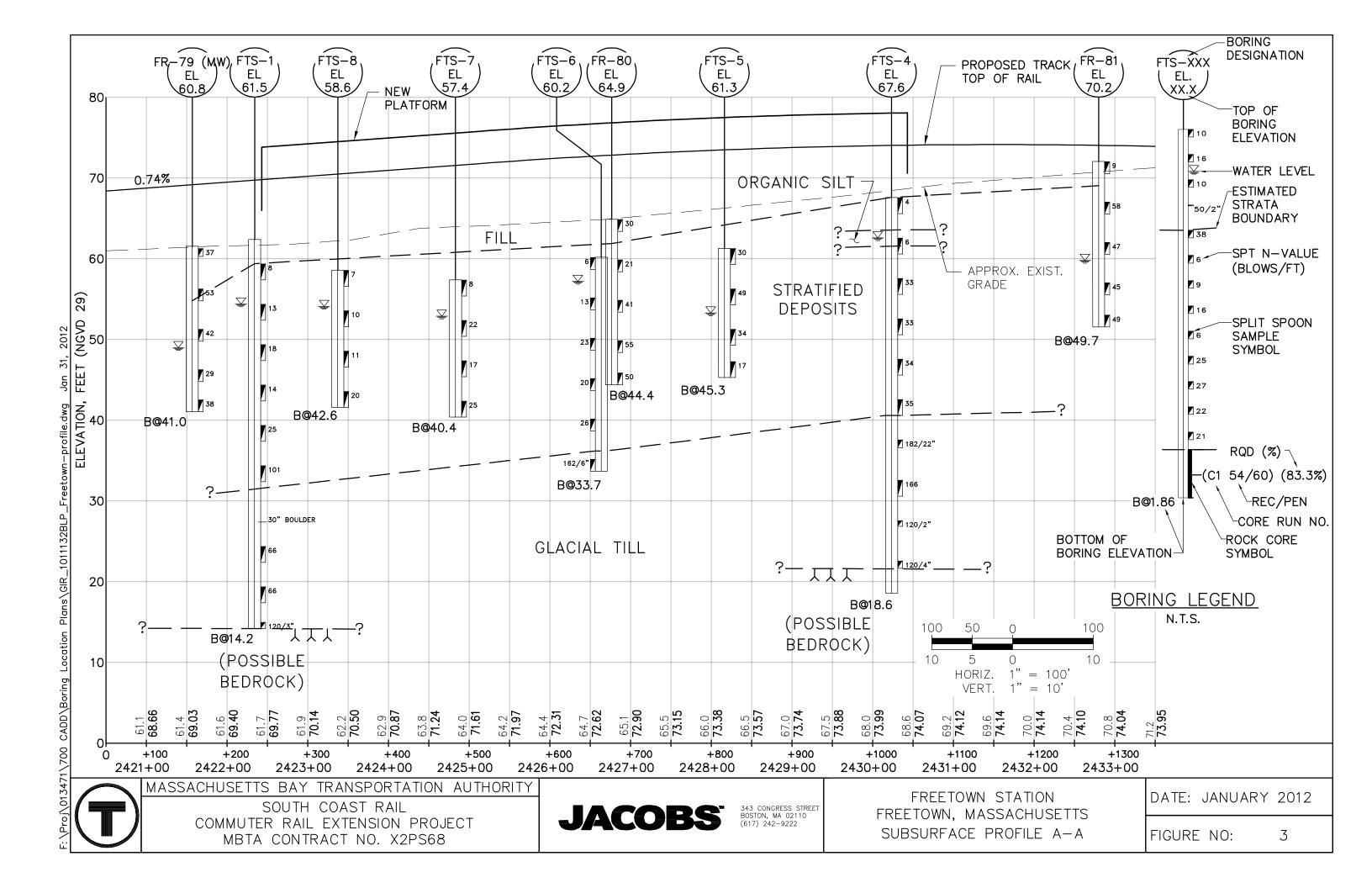


SOUTH COAST RAIL
COMMUTER RAIL EXTENSION PROJECT
MBTA CONTRACT NO. X2PS68

**JACOBS** 

343 CONGRESS STREET BOSTON, MA 02110 (617) 242-9222 FREETOWN STATION
FREETOWN, MASSACHUSETTS
SUBSURFACE EXPLORATION PLAN

FIGURE NO:



### Memorandum

#### **APPENDIX A: EXPLORATION LOGS**

FTS-1 FTS-4 TO FTS-17 FR-79 MW FR-80 AND FR-81

				550:-	-OT	1		EQ1 BOR	VII VO				
_				PROJE			Coast Rail wn, MA			BORING	ĘΤ	2	001
			BS	OWNE				ortation Author	ritv	NO.	' '	၂ _	001
				JOB NU		E2347		ortation Author	nty	NO.	SH	HEET	1 OF 2
INSPI	FCTOR	T. Tele	esco		RACTOR	NH Bo			DRILLER	C. Knight	ELEVATION		62.4
		D OF DR		00			R READIN	GS	DRILL RIG	ATV CME - 550	DATUM		NGVD 29
	Wa	ash Borin	ng w/Casii	ng D	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Auto	GRID	N	
48.25	5 Te	rminated			4/5/2010		8	Upon Comp	eletion (In Casing)		COORD	E	
											DATE ST	ART	4/5/10
											DATE EN	D	4/5/10
	STRATA	SAMPLE			REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
-5		² 356	S1	3 - 5	8	59.4		railroad ballas		some fine sand, lit	tle gravel, l	ight b	rown,
10	0 0 0	6 7 6	S2	8 - 10	8	55.4 -	WELL GRADED SAND (SW); fine to coarse sand, trace silt, gray, wet.						
15	0 0	4 7 11 14	S3	13 - 15	14	50.4	POORLY GRADED SAND (SP); fine sand, trace non-plastic silt, grayish-brown, wet.						
-20		6 7 7	S4	18 - 20	0	41.4	NO REC	COVERY: push	n spoon, still no re	covery.			
-25		5 10 15 12	S5	23 - 25	16		SILT (M	L); non-plastic	silt, grayish-browi	n, wet.			
30		22 36 65 12	S6 20/0"	28 - 29.5	18		SILT WI	TH SAND (ML	_); non-plastic silt,	little fine sand, gra	y, wet.		
			C1	31 - 33.5	18	31.4	CONGL	OMERATE BO	DULDER; rounded	to sub rounded cla	asts, gray.		
-35	Page 1	0-35 feet	Fach subsect	uent page displays	40 feet	28.9		SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	LINI ESS OTU	EB/V/IC	E NOTED
	raye I.	. J-JJ 1661. E	_acri subseqi	John page displays				JAWIFLES ULA	OOII ILD IN ACCURDAN		UNLEGO UTH	LIKWIS	L INOTED.
COF	HESIVE SC	DIL	NON-CO	HESIVE SOIL		ATIVE ORTIONS				LEGEND			
LOWS	/FT CONS	SISTENCY	BLOWS/FT	DENSITY	OF SOIL C		TS Au Sai	mple and	Split-Spool Sample (S and Blow	Counts (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)	X	Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30	MEDI 5 S	RY SOFT SOFT UM STIFF STIFF RY STIFF HARD	0 - 4 5 - 10 11 - 30 31 - 50 51 +	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	0% TRACE 25% LITTLE REFER TO THE SHEET ENTITLED "KEY TO 45% SOME DESCRIPTION AND CLASSIFICATION OF DODANG							

_	_					oast Rail	BORING	FTS - 001	
			BS	OWNER		Freetowr	n, MA ny Transportation Authority	NO. –	F13-001
				JOB NUM		E234710		INO.	SHEET 2 OF 2
DEPTH	STRATA SYMBOL	SAMPLE	E SAMPLE	DEPTH (ft)	REC.	ELEV.	FIELD CLASSIFICATI	ON AND REMARKS	
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)				
- - - - 40		22 31 35 32	S7	38 - 40	10		SANDY SILT WITH GRAVEL (ML); non-pla mostly fine gravel, grayish-brown, wet, GLA	nstic silt, some find	e to coarse sand, little
- - - 45		32 31 35 36	S8	43 - 45	12		SIMILAR TO S7.		
_		<b>120/3</b> '	" S9	48 - 48.25	3	14.2	SIMILAR TO S7; some pieces of rock in tip	of spoon, possibl	e top of bedrock.
- 50							D. // (11.1 40.05)		
-							Bottom of Hole at 48.25'.		
-									
-									
<del></del> 55							Boring offset from stake ~18 ft SW along ex	xisting track.	
-									
- 60									
-									
<del></del> 65									
-									
- 70									
─70 -									
_									
[	Page 1:	0-35 feet. E	 Each subsequer	nt page displays 4	0 feet.		SAMPLES CLASSIFIED IN ACCORDANCE	WITH ASTM D-2488 U	NLESS OTHERWISE NOTED.
СОН	IESIVE SC	)IL	NON-COHE:	SIVE SOIL		ATIVE ORTIONS	LE	EGEND	
BLOWS/	FT CONS	SISTENCY	BLOWS/FT	DENSITY		OMPONENTS	(AS) REC (%) and Blow Cour	Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	MEDI 5 S	RY SOFT SOFT UM STIFF STIFF RY STIFF	5 - 10 11 - 30 31 - 50	ERY LOOSE LOOSE DIUM DENSE DENSE ERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRACE LITTLE SOME MOSTLY	REFER TO THE SHEET ENTITLED "KEY TO	BORING NO.	

				1				EST BOR	KING				
				PROJE			Coast Rail			PODING	ГТ	·C	004
	AC		R	LOCAT			wn, MA			BORING	FI	5 -	004
								ortation Author	nty	NO.		ırr	1.05.0
					UMBER	E2347			I <b></b>	10.0			1 OF 2
	ECTOR			CONTE	RACTOR	NH Bo		00	DRILLER	S. Bolduc	ELEVATION	NC	67.6
	METHOD						R READIN		DRILL RIG	ATV D-50	DATUM		NGVD 29
			g w/Casi	ng D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742213.6
49	Terr	ninated			4/5/2010		5	Upon Comp	letion (In Casing)		COORD	E	766673.1
											DATE ST		4/5/10
											DATE EN	D	4/5/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMP NO.		REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
							Top 1 ft	railroad ballas	t.				
		2 1 3	S1	1 - 3	7	04.0	POORL moist.	Y GRADED SA	AND (SP); mostly	fine sand, trace no	n-plastic si	ilt, dar	k brown,
						64.6							
		3	S2	4 - 6	12		(4 - 5') 5	SILT (ML): sliat	ntly plastic silt trad	ce organics, dark b	rown. wet		
-5		2,	32		'-	62.6							
		3 2 4 4					(5 - 6') \$	SILT WITH SAI	ND (ML); non-plas	stic silt, little fine to	coarse sar	nd, gra	ay, wet.
		14	00	0.44	,,	58.6	CANDY	OII T WITH O	DANEL (MIN	plantia silt same f	ino to see	00.00	nd little
-10		14 16 17 19	S3	9 - 11	14				RAVEL (ML); non- se gravel up to 1",	-plastic silt, some f	ine to coars	se sar	ia, little
10	Paloly	17					iiio gia	voi, il acc coalc	o glavor ap to 1,	giay, wot.			
	P   P	19											
	[: 9° _												
		15 17	S4	14 - 16	8		SIMILAF	R TO S3.					
15		17											
		16 19											
	[000]												
00		16 17	S5	19 - 21	6					silt, little fine gravel	trace fine	to coa	arse
20		17					sand, gr	rayish-brown, v	vet.				
	9 10 1	24				46.6							
		17	S6	24 - 26	16		SILT (M	L); non-plastic	silt, grayish brown	n, wet.			
25		17 19		5			(***	,, p. ac. ac.	., 5 ,	. ==			
	<u> </u>	16 21											
						400							
						40.6							
		00					A = ·	ou =					
20		66 82	S7	29 - 30.42	2   12					e fine to coarse sar	nd, trace fir	ne gra	vel,
30		100/	/5"				graish b	rown, wet, GL	ACIAL TILL.				
		71	S8	34 - 36	17		SIMII AF	R TO S7.					
35	VØ/JØ/J			0. 00	.,		J						
	Page 1: 0	)-35 feet. Ea	ach subseq	uent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	IERWIS	E NOTED.
					סרי	ATIVE				LEGEND			
COF	HESIVE SOII	-	NON-CO	HESIVE SOIL		ORTIONS	_						-
1 0 1 1 0	FT CONSI	STENCY E	BLOWS/FT	DENSITY	OF SOIL C			mple and	sk Core (RC) RQD (%) Sample (S	SS) (U)-Shelby Tube,	Jar Sample	X	Bag Sample (B)
LOVV	_			VERY LOOSE	< 10%	TRA			and Blow per 6" RE	Counts (P)-Piston	(JS)	<u>L</u>	(B)
BLOWS		SOFT	0 - 4			LITT							
0 - 2 3 - 4		)FT	5 - 10	LOOSE	15 - 25%	LIII		FED TO THE OVER	T ENITITI ED III CONTO				
0 - 2 3 - 4 5 - 8	SC MEDIU	M STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SON	ME RE	SCRIPTION AND C	T ENTITLED "KEY TO LASSIFICATION OF	B∪DINI	<u> </u>		
0 - 2 3 - 4	SC MEDIU					SON	ME DE:	SCRIPTION AND C		BORING	G F1	ſS -	004

# LOG OF TEST BORING South Coast Rail

					PROJEC			oast Rail		DODINO	FTC 004
	A		B	S	LOCATION OWNER		Freetow Mass B	n, MA ay Transportation Authority		BORING NO.	FTS - 004
					JOB NUI		E23471	· · · · · · · · · · · · · · · · · · ·		NO.	SHEET 2 OF 2
DEPTH	STRATA SYMBOL	SAMPL DATA	E SA	MPLE NO.	DEPTH (ft)	REC.	ELEV.	FIEI	LD CLASSIFICATION	N AND REMARKS	
(π)	STIVIBUL XXXXXXX			<b>10</b> .	(11)	(in)/(%)					
-40		74 92 10		S9	39 - 39.16	0		NO RECOVERY			
-45		98 120/	/4" S	310	44 - 44.83	6	20.6	SANDY SILT WITH GRAVE mostly fine gravel, grayish-b	orown, wet, GLAC	tic silt, some fir CIAL TILL.	ne to coarse sand, little
								Top of apparent Bedrock, ro	olier dit to 49 ft.		
							18.6				
-50								Bottom of Hole at 49'.			
								Dottom of Flore at 49.			
-55											
55											
-60											
-65											
03											
-70											
				$\perp$							
	Page 1:	0-35 feet. I	Each subs	equent	page displays 4	0 feet.		SAMPLES CLASSIFIE	D IN ACCORDANCE W	/ITH ASTM D-2488 U	JNLESS OTHERWISE NOTED.
COF	HESIVE SC	DIL	NON-C	COHES	SIVE SOIL		ATIVE ORTIONS				
BLOWS/	FT CONS	ISTENCY	BLOWS/F	FT [	DENSITY		OMPONENTS	Auger Sample Rock Core (in and RQD (% REC (%))	Sample (SS) and Blow Counts	Undisturbed (U)-Shelby Tube, (P)-Piston	Jar Sample (JS) Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30	MEDII 5 S	Y SOFT SOFT UM STIFF STIFF Y STIFF	0 - 4 5 - 10 11 - 30 31 - 50 51 +	MED	ERY LOOSE LOOSE DIUM DENSE DENSE ERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRACE LITTLE SOME MOSTL	REFER TO THE SHEET ENT	per 6" REC (in)  TITLED "KEY TO FICATION OF	BORING NO.	_
30 +		IARD								140.	

				DDQ :-	·OT			E21 BOK	IIIG				
				PROJE  LOCAT			Coast Rail own, MA			BORING	FT	<u>S</u> -	005
			BS	OWNE				ortation Author	itv	NO.		0	000
					JMBER	E234				110.	SH	IEET	1 OF 1
INSP	ECTOR	T. Teles	SCO		ACTOR	NH Bo			DRILLER	C. Knight	ELEVATIO	N	61.3
1	METHOD	OF DRI	LLING		GROUN	IDWAT	ER READIN	GS	DRILL RIG	ATV D-50	DATUM		NGVD 29
		low Stem	Auger		ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742348.2
16	Ter	minated			3/31/2010		8	Upon Complet	tion (Augers pulled	d)	COORD	E	766836.2
											DATE STA		3/31/10
											DATE ENI	)	3/31/10
OEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	3		
		2	S1	0 - 2	24		SILT (M	II ): non-nlastic	silt, brown, wet, to	neoil			
		3	0.	" -			0.2. (	,, p.aa	o, 2.0, 1.0., 10				
		1 2											
		_				57.3							
_		15 21 28 29	S2	4 - 6	16	37.3	SILT W	ITH SAND (ML	.); non-plastic silt,	little fine to coarse	sand, trace	fine	gravel,
-5		28					gray, mo	DISI,.					
		_ 29											
	1011					53.3							
	600	9	S3	9 - 11	19		SILTW	ITH GRAVEL (	MI ): non-plastic s	ilt, some fine to co	arse aravel	un to	1 5"
10		21 13 20	33	9-11	19				d, grayish-brown,		aise giavei	up ic	, 1.5 ,
	[.0.]	20											
	Palol												
	1909												
		7_	S4	14 - 16	8				ML); non-plastic s	ilt, little fine gravel,	trace sand	l,	
15		5 12 19					grayish-	brown, wet.					
	9 0	<b>」</b> 19				45.3							
							5.4						
							Bottom	of Hole at 16'.					
-20													
25													
30													
-													
35				1			<u> </u>						
	Page 1:	0-35 feet. Ea	ach subseque	nt page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
COH	HESIVE SO	ıL	NON-COHE	SIVE SOIL		ATIVE				LEGEND			
					PROP OF SOIL C	ORTIONS	JTS E A	ger Roc	k Core (RC) Split-Spoo		Jar	Γ.	Bag
LOWS		STENCY B		DENSITY			Sa (As	mple and	Sample (S and Blow oper 6" REC	SS) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	X	Bag Sample (B)
0 - 2 3 - 4		Y SOFT OFT	0 - 4 5 - 10	/ERY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	1 F			~ (···)			
5 - 8	MEDIL	JM STIFF	11 - 30 ME	EDIUM DENSE	30 - 45%	SOI	ME DE	SCRIPTION AND C	T ENTITLED "KEY TO LASSIFICATION OF	BORING	<u> </u>		
9 - 1: 16 - 3:	0 VER	TIFF / STIFF	31 - 50 51 + \	DENSE /ERY DENSE	50 - 100%	MOS	ILY SU		RIALS" FOR ADDITIONA	NO.	≺  FT	S-	005
30 +	H	ARD								INU.			

PROJEC				СТ	South	Coast Rail				
			BS	LOCAT		Freetov	,		BORING	FTS - 006
							ay Transportation A	uthority	NO.	011557 4 05 4
				JOB NU	MBER	E2347				SHEET 1 OF 1
		T. Teles		CONTR		NH Bor	_	DRILLER	T. Pentacost	ELEVATION 60.2
N		O OF DRIL					READINGS	DRILL RIG	ATV D-50	DATUM NGVD 29
		llow Stem	Auger		ATE/TIME		DEPTH(ft) REMAR		140 lb Safety	GRID N 2742415.9
26.5	l er	minated		3	3/31/2010		3 Upon Co	mpletion (Augers pulle	a)	COORD E 766973
										DATE START 3/31/10  DATE END 3/31/10
										DATE END   3/31/10
OEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.		FIELD CLASSIFIC	ATION AND REMARK	S
-		1		0 0			CILT (MI ): non n	lastic silt trace aand b	rough west	
		3	S1	0 - 2	9		SILT (IVIL); non-p	astic silt, trace sand, b	rown, wet.	
		¹ 3 ₃								
		_								
						56.2				
-5	o l	3	S2	5 - 7	16		WELL GRADED	SAND WITH GRAVEL	(SW): fine to coars	se sand some fine to
	0	3 7 10	32	3-7	'0			to 1", trace silt, brown,		se sand, some line to
	0 0	13								
	0 4									
	0 0									
	<del>ф</del>					51.2				
10		11	S3	10 - 12	10		SILTY SAND (SI	1); fine to medium sand	d some non-plastic	silt_trace fine gravel
		11 14 9		10 - 12	'0		brown, wet.	i), iiiie to iiiedidiii odiic	a, some non plastic	ont, trace into graver,
		13								
15		9	S4	15 - 17	14		SIMILAR TO S3.			
	•	10		10 17	'		5 <u>2</u> 6 66.			
	•	9 10 10 12								
	<b> </b>					41.2				
00						41.2				
-20		24	S5	20 - 22	8					e non-plastic silt, little fine
	•	14 12					to coarse gravel	up to 1.5", grayish brow	vn, wet.	
		25								
							Cabbles / baulds	ro oncountered		
						36.2	Cobbles / boulde	s encountered.		
25										
25		35 52	S6	25 - 26.5	18			O(ML); non-plastic silt,	little mostly fine sa	and, trace fine gravel,
		110/6	6"			33.7	grayish brown, w	<b>ฮเ</b> .		
							Bottom of Hole a	26.5'.		
30										
35										
	Page 1:	0-35 feet. Ea	ch subsequent	page displays	40 feet.		SAMPLE	S CLASSIFIED IN ACCORDA	NCE WITH ASTM D-2488	UNLESS OTHERWISE NOTED.
COL	JEON/E OO		NON COUR	N/E SO!!	REL	ATIVE			LEGEND	
COF	HESIVE SO	71L	NON-COHES	OIVE SUIL	PROP	ORTIONS	Auger I	Rock Core (RC) Split-Spor	on Indisturbed	■ Jar ■ Bag
LOWS/	/FT CONS	ISTENCY BI	_OWS/FT	DENSITY	OF SOIL C	OMPONENT	S Auger Sample (AS)	Rock Core (RC) and RQD (%) REC (%)  Split-Spot Sample (in and Blow)	SS) (U)-Shelby Tube	
0 - 2		Y SOFT		ERY LOOSE	< 10%	TRAC	≣	per 6" RE		<u> </u>
3 - 4 5 - 8	S	OFT	5 - 10	LOOSE DIUM DENSE	15 - 25% 30 - 45%	LITTL	REFER TO THE	SHEET ENTITLED "KEY TO		
J - Q		TIFF	31 - 50	DENSE ERY DENSE	30 - 45% 50 - 100%	MOST	DESCRIPTION	AND CLASSIFICATION OF MATERIALS" FOR ADDITIONA	AL BORIN	G FTS - 006
9 - 15 16 - 30			51 +   VE				SYMBOLOGY.			

				DDO IS	CT	_	Coast Rail	LOIDON	10				
				PROJE LOCAT			own, MA			BORING	FT	<u>S</u> -	007
	A			OWNE				ortation Author	itv	NO.	1 1	<u> </u>	001
				JOB NU		E2347		ortation / tatrior	ity	INO.	SH	IEET	1 OF 1
INSPI	-CTOR	T. Teleso	CO		ACTOR	NH Bo			DRILLER	T. Pentacost	ELEVATIO		57.4
		O OF DRIL		00		_	ER READIN	GS	DRILL RIG	ATV D-50	DATUM		NGVD 29
		llow Stem		D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742512.4
17		rminated			4/1/2010		4.5		ion (Augers pulled		COORD	Е	767126.5
											DATE STA	ART	4/1/10
											DATE EN	D	4/1/10
DEPTH	STRATA SYMBOL	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			FIELD CLASSIFICA	TION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
	• •	2	S1	0 - 2	15		POORL	Y GRADED SA	AND (SP); fine san	d, brown, moist.			
	ľ. ' <i> </i>	² 3 ₅₆											
	•	<b>」</b> 6											
	`.												
	<u></u>					53.4							
-5		<b>-</b> 0											
		10	S2	5 - 7	18		SILI (M	L); non-plastic	silt, gray, wet.				
	$ \  \  \  $	8 10 12 9											
	$ \  \  \  $												
	$ \  \  \  $												
-10		4	S3	10 - 12	12		SILT (M	L); non-plastic	silt, grav. wet.				
		48 ₉ 10					(···		, g,,				
	[	<u> </u>											
-15		12 11 14 23	S4	15 - 17	18		SILT (M	L); non-plastic	silt, gray, wet.				
		11											
ŀ	<del>                                     </del>	23				40.4							
							5						
							Bottom	of Hole at 17'.					
-20													
-25													
-30													
50													
-35													
	Page 1:	0-35 feet. Eac	ch subsequen	nt page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
	IEON /E 0.0	NI	NON COU	01) /5 00"	RFI	ATIVE				LEGEND			
COH	HESIVE SO	)IL	NON-COHE:	SIVE SOIL	PROP	ORTIONS		ner 🔳 🕞	(Core (RC) Split-Spoor	_	<b>V</b> Jar	K	A Ban
BLOWS/	FT CONS	SISTENCY BL	OWS/FT	DENSITY	OF SOIL C	OMPONEN	ITS Aug	mple and	RQD (%) Sample (S	<ul><li>S) (U)-Shelby Tube.</li></ul>		X	Bag Sample (B)
	1,450	Y SOFT		ERY LOOSE	< 10%	TRA	CE	, EC	per 6" REC		(==/	V_	y (5)
0 - 2					45 050/	LITT	1 = 1						
3 - 4	s		5 - 10 11 - 30 ME	LOOSE DIUM DENSE	15 - 25% 30 - 45%		AF   KE		T ENTITLED "KEY TO		_		
	MEDIU S S	JM STIFF	11 - 30 ME 31 - 50	LOOSE DIUM DENSE DENSE ERY DENSE	30 - 45% 50 - 100%	SON	ME DE:	SCRIPTION AND C	T ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BORING NO.	G FT	·s -	007

				550:-	-OT			E21 BOK	MINO				
_				PROJE			Coast Rail			BORING	FT	2	800
			BS	LOCAT OWNE			own, MA Bay Transn	ortation Author	ity	NO.	1- 1	J -	. 000
				IOR NI	JMBER	E2347		Ortation Author	ity	INO.	SH	IEET	1 OF 1
INSPI	FCTOR	T. Tele	SCO		RACTOR	NH Bo			DRILLER	T. Pentacost	ELEVATIO		58.6
		OF DR		JOINT			ER READIN	GS	DRILL RIG	ATV D-50	DATUM	×11	NGVD 29
		low Sten		D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742580.5
17		minated			4/1/2010		4.5		tion (Augers pulled		COORD	Е	767255.5
									, , ,		DATE STA		4/1/10
											DATE ENI		4/1/10
DEPTH	STRATA	SAMPLE	SAMPL	E DEPTH	REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
	• •	3	S1	0 - 2	19		POORL	Y GRADED SA	AND (SP); mostly	fine sand, trace silt	, brown, m	oist.	
	<b>`.       </b>	3 4 5											
	•	<b>□</b> 5											
	`. •												
	· .												
-5	•					53.6							
Ü		4	S2	5 - 7	10	00.0			AND WITH SILT (	SP-SM); mostly fin	e sand, trac	ce no	n-plastic
	• • •	⁴ 6					silt, gray	y, wet.					
		_ 0											
	• •												
-10	• • • <u> </u>	8	S3	10 - 12	14		CIMII AI	R TO S2.					
	•  •	5	33	10 - 12	14		SIIVIILAI	K 10 32.					
	•  ••	8 5 6 5											
						45.6							
						45.6							
-15		5 9	S4	15 - 17	16		SILT (M	L); non-plastic	silt, gray, wet.				
		9				42.6	`						
		11 13	•										
							Bottom	of Hole at 17'.					
20													
-20													
-25													
-30													
-35		0.051 : =			40.5	1	<u> </u>	041-5	201515D *** * 2	IOE MITH 1071			- NOT
	Page 1:	บ-35 feet. E	acn subsequ	ent page displays	s 40 reet.			SAMPLES CLA	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTH	EKWIS	E NOTED.
COH	HESIVE SO	ıL	NON-COH	HESIVE SOIL		LATIVE				LEGEND			
SI OWO	/ET CONO	ISTENCY E	DI OMO/ET	DENOTA	OF SOIL C	PORTIONS COMPONEN	NTS Au Sai (As	ger Roc	k Core (RC) Split-Spool RQD (%) Sample (S	n Undisturbed (S) (U)-Shelby Tube,	Jar Sample	$\nabla$	Bag Sample (B)
BLOWS				DENSITY					and Blow per 6" REG	Counts (P)-Piston	(JS)	X	(B)
0 - 2 3 - 4		Y SOFT OFT	0 - 4 5 - 10	VERY LOOSE LOOSE	< 10% 15 - 25%	TRA LITT	1F			. ,			
5 - 8 9 - 1	MEDIL	JM STIFF TIFF		MEDIUM DENSE DENSE	30 - 45% 50 - 100%	SON	ME DE	SCRIPTION AND C	T ENTITLED "KEY TO LASSIFICATION OF	BORING	ન		000
16 - 3	0 VER	Y STIFF	51 +	VERY DENSE	55 - 10070	IVIOS	30	BSURFACE MATER MBOLOGY.	RIALS" FOR ADDITIONA	NO.	~  FT	S-	800
30 +	l H	ARD								INO.			

				PROJE	СТ		Coast Rail	LOIDON					
							own, MA			BORING	FTS	- O	09  OW
J			<b>B</b> 5	OWNER				ortation Author	ity	NO.			
				JOB NU	IMBER	E234	7101		-		SH	IEET	1 OF 1
		T. Telesc		CONTR	ACTOR	NH B	oring		DRILLER	C. Knight	ELEVATIO	ON	57.6
ı	METHO	D OF DRIL	LING				ER READIN		DRILL RIG	ATV D-50	DATUM		NGVD 29
		llow Stem /	-		ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742426.1
17		ash Boring	w/Casing	_	3/31/2010		2		letion (In Augers)		COORD	E	766799.8
25.42	2 le	rminated			7/7/2010 9/13/2011		6 5		g Well Reading g Well Reading		DATE STA		3/31/10 3/31/10
				T '			5	INIOIIIIOIII	g Well Reading		DATE ENI	D	3/3 1/ 10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
		2	S1	0 - 2	8		SILT (M	l ): non plactic	silt, trace fine san	d light brown moi	et		
-		4	31	0-2			SILT (IVI	L), Horr-plastic	Siit, trace iirie sair	a, light brown, moi	St.		
-		6 21											
						54.6							
						54.6							
		9	S2	4 - 6	20		(4 - 5') S	SANDY SILT (N	/L); non-plastic sil	t, some fine sand,	light brown	, wet.	
-5	44	9 27 25 19				52.6	(F 6') C		Γ (ML); non-plastic	ailt sama fina ta	ooroo aray	ol un	to 1"
	699	<b>∐</b> 19						nd, gray, wet.	(IVIL), HOH-plastic	Siit, Some line to	Joanse grav	ei up	ιο ι ,
	90					50.6							
-													
10		15 17	S3	9 - 11	13		SILT WI	TH SAND (ML	); non-plastic silt, l	ittle fine to coarse	sand, gray	ish br	own, wet.
-10		18 22											
•													
		2	0.4	44 40	40		CANDY	OH T (MIL)					
-15		³ 6 7	S4	14 - 16	12		brown, v		n-plastic silt, some	mostly fine sand,	trace fine g	gravei	, grayısn
.0		7 8					, .						
		_ •											
•	0 0					40.6							
-	19/14	43	S5	18 - 19	12		SILT WI	TH GRAVEL (	ML); non-plastic si	It, some fine to co	arse gravel	up to	1", trace
-	699	120/6"					sand, gr	ayish brown, w	vet.			·	
-20	600												
-	90					36.6							
	•												
		_											
		<b>100/4</b> "	S6	23 - 23.33	0		NO REC	COVERY					
	•												
-25		100/5"	S7	25 - 25.42	3	32.2	POORL	Y GRADED GI	RAVEL WITH SAN	ID (GP); mostly fir	ne gravel, s	ome f	ine to _
								sand, gray, wet					
							Bottom o	of Hole at 25.4	2'.				
20													
-30													
•													
-													
-													
-35													
55	Page 1:	0-35 feet. Eac	h subsequen	t page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTH	ERWISI	E NOTED.
					DEI	ATIVE				LEGEND			
COH	HESIVE SC	OIL	NON-COHES	SIVE SOIL		ORTIONS							
BLOWS	/FT CONS	SISTENCY BL	OWS/FT	DENSITY	OF SOIL C	OMPONE	<u> </u> Sai	mple and	k Core (RC) Split-Spoor RQD (%) Sample (S	<ul><li>S) (U)-Shelby Tube,</li></ul>	Jar Sample (JS)	X	Bag Sample
0 - 2				ERY LOOSE	< 10%	TRA		S) REC	and Blow 0 per 6" REC	Counts (P)-Piston	(12)	<u> </u>	(B)
3 - 4	.   8	SOFT	5 - 10	LOOSE	15 - 25%	LIT	TLE DE	FER TO THE SHEE	T ENTITLED "KEY TO				
5 - 8 9 - 1	5 S	STIFF 3	31 - 50	DIUM DENSE DENSE	30 - 45% 50 - 100%	MOS	VIE DES	SCRIPTION AND C	LASSIFICATION OF RIALS" FOR ADDITIONA	BORING	3 ETC	_ ^	9 OW
16 - 3 30 +		Y STIFF IARD	51 + V	ERY DENSE				MBOLOGY.	LO I OR ADDITIONA	NO.	1,19	- 00	DO OVV
JU +		,,,,,								1,10.			

									EST BOR	KING						
	Λ	ACOBS LOCATION Freet OWNER Mass					Freeto	own, MA	ortation Author	rity	BORING NO.	FT	S-	010		
						MBER	E234		Ortation Author	ity	NO.	SH	HEET	1 OF 1		
INSPE	ECTO	R T. Tel	esco			ACTOR	NH B			DRILLER	T. Pentacost	ELEVATION		56.9		
		DD OF DI			<u> </u>			ER READIN	GS	DRILL RIG	ATV D-50	DATUM	J. 1	NGVD 29		
		lollow Ste			D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742537.7		
17		erminated				4/1/2010		10	Upon Comple	tion (Augers pulle	d)	COORD	Е	767011.2		
												DATE ST	ART	4/1/10		
								I				DATE EN	D	4/1/10		
	STRAT				PTH	REC.	ELEV.			FIELD CLASSIFIC	ATION AND REMARK	S				
(ft)	SYMBO				(ft)	(in)/(%)										
		2 4 4 3	S	1 0	- 2	8	52.9	SILTY S	SAND WITH G vel, grayish bro	RAVEL (SM); fine wn, moist, FILL.	to coarse sand, so	me non-pla	astic s	silt, little		
-5		11 10 12 1	2	2 5	- 7	11	48.9	SANDY SILT (ML); non-plastic silt, some fine to coarse sand, grayish brown, moist.								
-10		14 12 17 1	8 Si	3 10	- 12	16		SILT (ML); non-plastic silt, gray, wet.								
-15		10 13 13 1	S-	4 15	- 17	15	39.9	SIMILAR TO S3.								
-20								Bottom	of Hole at 17'.							
-25																
-30																
-35	Page	1: 0-35 feet.	Each subse	quent page	displays				SAMPLES CLA	SSIFIED IN ACCORDA	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.		
COF	HESIVE S	SOIL	NON-CO	OHESIVE S	OIL		ATIVE ORTIONS				LEGEND					
BLOWS		NSISTENCY		-		OF SOIL CO	OMPONE	NTS Au Sa	imple and	ck Core (RC) RQD (%) Split-Spot Sample (5 and Blow per 6" RE	SS) (U)-Shelby Tube, Counts (P)-Piston	Jar Sample (JS)	X	Bag Sample (B)		
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	MEI 5 VE	ERY SOFT SOFT DIUM STIFF STIFF ERY STIFF HARD	0 - 4 5 - 10 11 - 30 31 - 50 51 +	VERY LO LOOS MEDIUM D DENS VERY DE	SE DENSE SE	< 10% 15 - 25% 30 - 45% 50 - 100%	LIT1 SOI	TRACE LITTLE SOME MOSTLY  REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.  BORING NO. FTS - 010								

				PROJECT South Coast Rail											
			DG	LOCA		_	own, MA			BORING	FTS -	- 011			
J			BS	OWNE	-R	Mass	.Bay Transp	ortation Author	rity	NO.					
				JOB N	UMBER	E2347			1		SHEET				
	ECTOR			CONTE	RACTOR	NH Bo			DRILLER	C. Knight	ELEVATION	56.0			
I	METHO	OF DR	ILLING		GROUN	IDWAT	ER READIN		DRILL RIG	ATV D-50	DATUM	NGVD 29			
	Wa	sh Borin	ng w/Casin	ıg C	DATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID N	2742602.2			
15	Ter	minated			4/1/2010		2	Upon Comple	tion (Augers pulled	i)	COORD E	767180			
				$\longrightarrow$							DATE START	4/1/10			
	ļ .										DATE END	4/1/10			
	STRATA SYMBOL	SAMPLI DATA		E DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S				
		2 2 3 6	S1	0 - 2	13		SANDY	SILT (ML); no	n-plastic silt, some	fine sand, brown,	moist.				
		3													
_															
L		10 11 15 10	S2	3 - 5	15		SILT (M	L); non-plastic	silt, trace fine san	d, gray, wet.					
5		15 10	)												
_5		,													
_															
-															
-		9	S3	8 - 10	24	48.0	CILT (M	SILT (ML); non-plastic silt, gray, wet.							
L		9 15 18 21	33	0 - 10	24		SILI (IVI	SILT (ML); non-plastic silt, gray, wet.							
10		18	1												
10															
-															
ļ.		7	0.4	40 45			CINALLAL	D TO 62							
L		12	S4	13 - 15	24		SIMILA	R TO S3.							
4-		7 12 12 15	_			44.0									
<del></del> 15			´			41.0									
-							Pottom	of Hole at 15'.							
F							BOLLOTT	oi noie at 15.							
L															
Ī															
-20															
-															
ļ-															
L															
-25															
-															
F															
L															
_															
-30															
F															
L															
ſ															
<b> </b>															
-35							<u> </u>								
	Page 1:	0-35 feet. E	Each subseque	ent page displays	s 40 feet.			SAMPLES CLA	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHERWIS	E NOTED.			
COL	HESIVE SO		NON COLL	IESIVE SOII	REL	LATIVE				LEGEND					
	ILOIVE SU	ı.	INUIN-CUH	IESIVE SOIL	PROP	PORTIONS	NTO F AII	ger <b>F</b> P~	ck Core (RC) Split-Spool	n Undisturbed	Jar Sample (JS)	7 Bag			
BLOWS	/FT CONS	ISTENCY	BLOWS/FT	DENSITY	OF SOIL C	Auger Soil COMPONENTS Sample (AS) REC (%) FISHON Sample (S) Significance (JS) Sample (SS) Sample (SS) Sample (SS) Significance (JS) REC (%) REC (%) Sample (SS) Significance (JS) Sample (SS) Sample (						Bag Sample (B)			
0 - 2		Y SOFT		VERY LOOSE	< 10%	TRA	ACE		per 6" REC	C (in)					
3 - 4 5 - 8		OFT JM STIFF	5 - 10 11 - 30 M	LOOSE MEDIUM DENSE	15 - 25% 30 - 45%	LITT	ME   REI		ET ENTITLED "KEY TO						
9 - 1	5 S	TIFF	31 - 50	DENSE VERY DENSE	50 - 100%		STLY SUI	BSURFACE MATE	CLASSIFICATION OF RIALS" FOR ADDITIONA		G FTS -	011			
16 - 30 +		Y STIFF ARD	51 +	VERT DENSE			SYI	MBOLOGY.		NO.	10-	<b>5</b> 1 1			

				555	-0.			E21 BOK	MING			
_				PROJE			Coast Rail			BORING	ETC	- 012
			BS	OWNE			own, MA Bay Transn	ortation Author	rity	NO.	113	- 012
					UMBER	E2347		ortation AuthOl	ıty	INO.	SHEE	T 1 OF 1
INSPI	FCTOR	T. Tele	esco		RACTOR	NH Bo			DRILLER	T. Pentacost	ELEVATION	50.2
		D OF DF		OON		-	ER READIN	GS	DRILL RIG	ATV D-50	DATUM	NGVD 29
			m Auger	Г	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID N	
17		rminated			4/1/2010		8		tion (Augers pulled		COORD E	
									, , ,	,	DATE STAR	
											DATE END	4/1/10
	STRATA SYMBOL	SAMPL DATA			REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S	
		² 435	S1	0 - 2	7			Y GRADED SA wn, moist.	AND WITH SILT (\$	SP-SM); mostly fin	e sand, some	non-plastic
-5		14 14 11 10	S2 0	5 - 7	10	41.2	POORL silt, trac	Y GRADED SA e fine gravel, g	AND WITH SILT ( rayish brown, wet	SP-SM); mostly fin	e sand, some	non-plastic
-10		9899	S3	10 - 12	4		SILT (M	IL); non-plastic	silt, brown, wet, c	obble in tip of spoc	n.	
-15		8 8 9	S4 0	15 - 17	10	33.2	SILT (M	L); non-plastic	silt, gray, wet.			
-20							Bottom	of Hole at 17'.				
-25												
-30												
-35	Page 1:	0-35 feet. I	Each subseq	uent page display	s 40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHERW	/ISE NOTED.
CUL	HESIVE SC	)II	NON CO	HESIVE SOIL	REL	ATIVE				LEGEND		
LOWS			BLOWS/FT	DENSITY	PROF OF SOIL C	ORTIONS	NTS Au Sa (As	mple and	k Core (RC) RQD (%) Sample (S and Blow)	Counts (U)-Shelby Tube, (P)-Piston	Jar Sample (JS)	Bag Sample (B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	MEDI 5 S	RY SOFT SOFT UM STIFF STIFF RY STIFF	0 - 4 5 - 10 11 - 30 31 - 50 51 +	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRA LITT SOM MOS	CE TLE RE TLY SU	FER TO THE SHEE	T ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BORING	_	- 012

				DD 0 :-	OT			E21 BOK	MING				
				PROJE LOCAT			Coast Rail			BORING	ĘT	2	- 013
			BS	OWNE			wn, MA Ray Transn	ortation Author	rity	NO.	ГІ	<b>J</b> -	- 013
				JOB NU		E2347		Ortation Author	ity	NO.	S	HEET	1 OF 1
NSPI	FCTOR	T. Teles	SCO		RACTOR	NH Bo			DRILLER	C. Knight	ELEVATI		38.6
		OF DRI		OONTI			R READIN	GS	DRILL RIG	ATV D-50	DATUM	011	NGVD 29
			w/Casing	n D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742997.3
15		minated	,		4/1/2010		3		tion (Augers pulled		COORD	E	766836
									, , ,		DATE ST		4/1/10
											DATE EN		4/1/10
EPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
	1/ 1/1/ 1/1/	2 1 2	S1	0 - 2	4		TOPSO	IL; organic ma	terial, brown, mois	st.			
	<u> </u>	1 2				36.6							
		10 13 14 16	S2	3 - 5	20		SILT (M	L); non-plastic	silt, grayish brown	n, wet.			
	7	14											
5		10											
		10					011411	D TO 00					
		10 11	S3	8 - 10	24		SIMILA	R TO S2.					
10		11 10											
10	[	0											
						26.6							
		16	0.4	40.45	10		OII TV C	SAND WITH O	DAVEL (CM), fine	t		4:	-:14 1:441 -
		16	S4	13 - 15	10			vel, gray, wet.	RAVEL (SM); fine	to coarse sand, so	me non-p	astic s	silt, little
45		16 15 16 18				23.6	iiio gia	vei, gray, wet.					
15		0				23.0							
							Rottom	of Hole at 15'.					
							Dottom	or riole at 13.					
20													
20													
25													
20													
30													
35													
	Page 1:	0-35 feet. Ea	ach subseque	ent page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	HERWIS	E NOTED.
	IEON/E 0.2		NON CO.	-01\/F 00''	RFI	ATIVE				LEGEND			
COL	HESIVE SO	IL	NON-COHE	ESIVE SOIL	PROP	ORTIONS	- A	ner <b>=</b> -	ok Cara (BC) Salit Cara		lar	K	7 Bac
COF		ISTENCY B	LOWS/FT	DENSITY	OF SOIL C	OMPONEN'	TS Au Sa (As	mple and	ck Core (RC) RQD (%) Sqlit-Spool Sample (\$ and Blow	SS) (U)-Shelby Tube,	Jar Sample (JS)	X	Bag Sample (B)
	/FT  CONS							REC	C (%) and Blow per 6" RE		(30)	V	у (D)
		Y SOFT	0 - 4	VERY LOOSE	< 10%	TRAC	)E						
0 - 2 3 - 4	VER'	OFT	5 - 10	LOOSE	15 - 25%	LITTL	E   BE	FER TO THE SHEE	ET ENTITLED "KEY TO				
LOWS	VER' S MEDIL 5 S'		5 - 10 11 - 30 31 - 50			LITTL	.E RE	SCRIPTION AND C	ET ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BORING	G	гe	013

				DDO IT	CT		Coast Rail	LOIDON	10				
				PROJE LOCAT			wn, MA			BORING	FT	S -	014
			35	OWNE				ortation Author	itv	NO.	1 1		U 1 <del>T</del>
					JMBER	E2347				_ NO.	SHI	EET	1 OF 1
INSPE	ECTOR	T. Telesc	:0		RACTOR	NH Bo			DRILLER	C. Knight	ELEVATIO	N	55.6
		O OF DRILI				-	R READIN	GS	DRILL RIG	ATV D-50	DATUM		NGVD 29
		sh Boring		D	ATE/TIME		DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2742539.3
25		minated			4/1/2010		6	Upon Comp	letion (In Casing)		COORD	Е	766903.9
											DATE STA	.RT	4/1/10
											DATE END	)	4/1/10
DEPTH	STRATA SYMBOL	SAMPLE	SAMPLE	DEPTH	REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
		3	S1	0 - 2	10		SILT WI	TH SAND (ML	); non-plastic silt, l	little fine sand, bro	wn, moist.		
		2 2 8											
		<b>⊿</b> 8											
	•	9	S2	3 - 5	12	52.6	POORL'	Y GRADED SA	ND (SP): mostly i	medium sand, trac	e silt. brown	. moi	ist.
	• •	13 16							(0. ),	,		,	
-5	• •	13 16 18											
	• •												
	•					48.6							
	9					₹0.0							
		22 16 25 28	S3	8 - 10	4					-SM); fine to coars	e sand, som	ne no	n-plastic
	0 0	25					silt, trac	e gravel, gray,	wet.				
-10	$ \circ ^{\circ} _{\bullet}$	28											
	°	6 8	S4	13 - 15	10		SIMILAF	R TO S3.					
		13 18											
15		18											
	9 0	<b>-</b> 40			l l								
	0	23	S5	18 - 20	11		SIMILA	R TO S3.					
20		10 23 24 10											
-20		_ 10											
	8 0												
						33.6							
	•   • •	20	S6	23 - 25	1		POORI.	Y GRADED SA	ND WITH SILT (S	SP-SM); mostly co	arse sand li	ttle	
	•   •	16 6		20 - 20	'			stic silt, grayish		or civi), incomy co	aroc oaria, ii	ttic	
25	•	11				30.6							
							Bottom	of Hole at 25'.					
30													
35	D 1	0.055	h auk	negg die 1	40 fc - t			0410150000	OOIEIED IN ACCESS	OF WITH ACTAIN STATE	LINII E00 07: :-	D)4"2"	NOTES
	Page 1:	0-35 feet. Eacl	n subsequent	page displays	4U TEET.			SAMPLES CLAS	SSIFIED IN ACCORDAN	CE WITH ASTM D-2488	UNLESS OTHE	KWISE	NOTED.
COF	HESIVE SO	olL   I	NON-COHES	IVE SOIL		ATIVE				LEGEND			
1.014:5	/FT 05::-				PROP OF SOIL CO	ORTIONS OMPONEN	TS     Aug	ger Roci	Core (RC) Split-Spoor Sample (S		Jar Sample	$\bigvee$	Bag Sample
LOWS		ISTENCY BLO		DENSITY			— 目 (AS	nple and REC		Counts   (P)-Piston	(JS)	M	(B)
0 - 2 3 - 4			0 - 4 VE 5 - 10	RY LOOSE LOOSE	< 10% 15 - 25%	TRAC	F			- \/			
	MEDIL	JM STIFF 1	1 - 30 MED	DIUM DENSE	30 - 45%	SOM	E DE	SCRIPTION AND CI	T ENTITLED "KEY TO ASSIFICATION OF	BODIN/	اء	_	
5 - 8		TIFF 3	31 - 50	DENSE	50 - 100%	MOST	Lr   SUI	BSURFACE MATER	IALS" FOR ADDITIONA	L BORING	ラ  FT®	<b>S</b> _	014
9 - 15 16 - 30 30 +	0 VER		51 + VE	RY DENSE				MBOLOGY.		NO.	11,	<b>-</b>	U 1 <del>4</del>

				550:	-от			E21 BOK	MINO				
_				PROJE			Coast Rail			BORING	ETC	_ ^	15 <b>^</b> \/
			BS	LOCAT		Freeto		ortation Author	-itv	NO.	113	- 0	10 01
				IOR NI	JMBER	E2347		Sitation Author	ity	INO.	SH	HEET	1 OF 1
INISPI	FCTOR	T. Teles	sco		RACTOR	NH Bor			DRILLER	C. Knight	ELEVATION		46.7
		O OF DRI		CONT			R READIN	GS	DRILL RIG	ATV D-50	DATUM	וע	NGVD 29
·			g w/Casing	n D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742715.6
25		minated	g w/odomi		4/2/2010		5		g Well Reading	111111111111111111111111111111111111111	COORD	Е	767030.8
					7/7/2010		8		g Well Reading		DATE ST		4/2/10
							-		<u> </u>		DATE EN		4/2/10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK			
-		7 12 4	S1	0 - 2	18		SILT (M	L); non-plastic	silt, trace fine gra	vel, brown, moist.			
		」 10 ■ 12	S2	3 - 5	7	43.7	WELLG	RADED SANI	) WITH GRAVEI	(SW); fine to coars	e sand litt	le fine	gravel
- -5	0 0	12 14 16 15	I				trace silf	r, brown, moist		(317), 1110 to obtain	o oarra, ma		gravoi,
<del>.</del>	0 0												
	0 0	10 11 12 10	S3	8 - 10	4		SIMILAF	R TO S2.					
10 	0 0	_ 10				34.7							
		6 ₇₈₇	S4	13 - 15	12	34.7	SILT (M	L); non-plastic	silt, trace fine sar	nd, grayish brown, v	vet.		
-15	<u>_</u>	8 7											
	<u> </u>	7 7 6	S5	18 - 20	15		SILT (M	L); non-plastic	silt, gray, wet.				
-20		_ 0											
-25		5 8 9 11	S6	23 - 25	16	21.7	SIMILAF	R TO S5.					
							Bottom	of Hole at 25'.					
-30													
- -35		0.054 : 5			40.6			0.44.5.5.5.	0015150	IOF MITH.			- NOT
	Page 1:	υ-35 feet. Ea	ach subseque	nt page displays	s 40 teet.			SAMPLES CLA	SSIFIED IN ACCORDAN	NCE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
	HESIVE SO	ISTENCY E	NON-COHE		PROP	ATIVE ORTIONS OMPONENT	rs Aug	ger Roc	sk Core (RC) Split-Spoo RQD (%) Sample (S	DI Undisturbed (U)-Shelby Tube,	Jar Sample		Bag Sample (B)
BLOWS/				DENSITY	- 400/	TD 4.0			and Blow per 6" RE	Counts (P)-Piston	(JS)	X	(B)
0 - 2 3 - 4 5 - 8 9 - 15 16 - 30 30 +	MEDIU 5 S 0 VER	Y SOFT SOFT JM STIFF STIFF Y STIFF	5 - 10 11 - 30 31 - 50	VERY LOOSE LOOSE EDIUM DENSE DENSE VERY DENSE	< 10% 15 - 25% 30 - 45% 50 - 100%	TRAC LITTL SOMI MOSTI	E REI E DE: LY SUI	SCRIPTION AND C	ET ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BODING.	FTS	- 0 ⁻	15 OW

				PROJE	CT		Coast Rail	LOIDON					
							wn, MA			BORING	FTS	- O	16 OW
			BS	OWNE				ortation Author	itv	NO.	1 10 01001		
					JMBER	E2347			-7	110.	SH	IEET	1 OF 1
INSPE	ECTOR	T. Teles	SCO		RACTOR	NH Bo			DRILLER	C. Knight	ELEVATIO		37.6
		D OF DRI		00			R READIN	GS	DRILL RIG	ATV D-50	DATUM		NGVD 29
	Wa	ash Borino	g w/Casing	D	ATE/TIME		DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742903.5
25	Те	rminated			4/2/2010		1	Monitoring	g Well Reading		COORD	E	766922
					7/7/2010		1.4	Monitoring	g Well Reading		DATE STA	ART	4/2/10
											DATE EN	D	4/2/10
	STRATA	SAMPLE		DEPTH	REC.	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
(ft)	SYMBOL	DATA	NO.	(ft)	(in)/(%)								
		2	S1	0 - 2	12		SANDY	SILT (ML); no	n-plastic silt, some	e fine sand, light br	own, moist		
		4 2 .											
		5											
		11	S2	3 - 5	16		SANDY	SILT (ML): no	n-nlastic silt some	e fine sand, light br	own wet		
		15	1 - 1	3-3	'0		OANDI	OILT (IVIL), HO	n-piastic siit, soine	o inic sand, light bi	OWII, WCL.		
-5		14											
						31.6							
	$ \cdot \cdot $					51.0							
	$ \  \  \  $												
		5_	S3	8 - 10	14		SILT (M	L); slightly plas	stic silt, gray, wet,	PP = 1 TSF.			
	$ \  \  \  $	5 8 9 7		-				Penetrometer =					
-10		∐											
	$ \  \  \  $												
		6 8 12 9	S4	13 - 15	15			R TO S3, PP =					
		12					Pocket F	Penetrometer =	= 0.75 tsf.				
-15		9											
	ЩН					21.6	Doring	allanaaa with s	and at 16 ft				
							Boring o	ollapses with s	sand at 16 ft.				
	9 9	11 10	S5	18 - 20	5					'-SM); fine to coars	e sand, littl	e non	-plastic
		16					Siit, trace	e fine gravei, g	rayish brown, wet	•			
-20	ا ا	18											
						15.6							
	• Ť .•	<b>-</b> 04								T (0D 011)			
	•	94 78	S6	23 - 25	3			WLY GRADEL stic silt, gray, w		T (SP-SM); mostly	/ fine sand,	little	
25	•	76 58				40.0	non plac	one, gray, n					
-25		_ 00				12.6							
							Bottom (	of Hole at 25'.					
							Dottoill						
-30													
-													
-35													
	Page 1	: 0-35 feet. Ea	ach subsequent	page displays	s 40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTH	ERWIS	E NOTED.
001	JEON/E 00		NON COUR	IVE CO!	REL	ATIVE				LEGEND			
COF	HESIVE SO	ЛL	NON-COHES	IVE SOIL	PROP	ORTIONS		ner <b>F</b> D	k Core (RC) Split-Spoo		<b>V</b> Jar	Κ.	A Ban
BLOWS/	FT CONS	SISTENCY B	BLOWS/FT	DENSITY	OF SOIL C	OMPONEN'	TS Aug Sai (AS	mple and	RQD (%) Sample (S	SS) (U)-Shelby Tube.		X	Bag Sample (B)
0 - 2	VEF	RY SOFT	0 - 4 VE	RY LOOSE	< 10%	TRAC		REC	and Blow of per 6" REG		(33)	<u> </u>	(b)
3 - 4 5 - 8	5	SOFT UM STIFF	5 - 10	LOOSE	15 - 25% 30 - 45%	LITTL	LE REI		T ENTITLED "KEY TO				
9 - 15	5   8	STIFF	31 - 50	DENSE DENSE	30 - 45% 50 - 100%	MOST	E DES	SCRIPTION AND C	LASSIFICATION OF RIALS" FOR ADDITIONA	BORING	GETS	_ 0′	16 OW
16 - 30 30 +		RY STIFF HARD	51 + VE	RY DENSE				MBOLOGY.	5551115147	NO.	1-13	- 0	10 000

				PROJE	CT	1	Coast Rail	LOIDON	10				
						Freetov				BORING	FT	S-	017
J			35	OWNER				ortation Author	ity	NO.			<u> </u>
				JOB NU		E23471					SH	IEET	1 OF 1
INSP	ECTOR	T. Telesc	0	CONTRA	ACTOR	NH Bor	ing		DRILLER	T. Pentacost	ELEVATIO	N	60.7
	METHO	O OF DRILL	LING				R READIN		DRILL RIG	ATV D-50	DATUM		NGVD 29
		llow Stem A	Auger		ATE/TIME	] [	DEPTH(ft)		SPT HAMMER	140 lb Safety	GRID	N	2742339.1
25	Ter	minated		3	/31/2010		10	Upon Comp	letion (In Augers)		COORD	E	766691
											DATE STA		3/31/10
					I I								3/3 1/ 10
DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.			FIELD CLASSIFICA	ATION AND REMARK	S		
		3	S1	0 - 2	15		(0 - 5')	TOPSOIL : root	s, brown, moist.				
		6		• -			(.5 - 2')	SILT WITH SA	ND (ML); non-plas	stic silt, little fine sa	and, gray, m	noist.	
		14 27											
-						56.7							
_						30.7							
-5	1	30 22 52 100/3	S2	5 - 6.75	12		SILT WI	TH GRAVEL (	ML); non-plastic si	ilt, some fine to co	arse gravel	up to	1", little
		52					fine to co	oarse sand, gr	ay, moist, cobble e	encountered.			
	1919	100/.	3"										
	600												
-10		22	60	10 - 12			SIMILAF	2 TO 62					
		22 12 10 10	S3	10 - 12	9		SIIVIILAF	R 10 32.					
	Paloly	10											
-15	69.6	31	S4	15 - 17	6		SILT WI	TH GRAVEL (	ML); non-plastic si	ilt, some fine grave	el up to 1.5"	, trac	e sand,
		46 100/2'					grayish l	orown, wet.		_			
	[.0.]												
-20	Palola	40						. = 0 0 /					
	9.9	13 46	S5	20 - 21.42	17		SIMILAF	R 10 S4.					
		100/5'	"										
	69.9												
-25		100/0"	S6	25 - 25	0	35.7	NO REC	OVERY; bould	der encountered.				
								,					
							Bottom (	of Hole at 25'.					
							ביייים וווייים	JI I I I I I I I I I I I I I I I I I I					
-30													
00							Cobbles	and boulders	encountered from	6 to 25 ft.			
-35			1										
	Page 1:	0-35 feet. Each	n subsequen	t page displays	40 feet.			SAMPLES CLAS	SSIFIED IN ACCORDAN	ICE WITH ASTM D-2488	UNLESS OTHE	ERWIS	E NOTED.
COL	HESIVE SO	oll N	NON-COHES	SIVE SOIL		ATIVE				LEGEND			
						ORTIONS OMPONENT	S   Aug	ger Roc	Core (RC) Split-Spool		Jar		Bag
BLOWS	/FT CONS	ISTENCY BLO	DWS/FT	DENSITY	OI SOIL O	ONEIN I	S Aug Sar (AS	nple and REC	RQD (%) Sample (S and Blow (	(S) (U)-Shelby Tube, Counts (P)-Piston	Sample (JS)	X	Sample (B)
		1	0 - 4 VI	ERY LOOSE	< 10%	TRACI	E	_	per 6" REC	· (III)			
0 - 2					15 - 25%	I ITTI I	FI						
0 - 2 3 - 4 5 - 8	MEDIL	OFT 5 JM STIFF 1	5 - 10 1 - 30 ME	LOOSE DIUM DENSE	15 - 25% 30 - 45%	SOME	E RE		T ENTITLED "KEY TO ASSIFICATION OF	DODIN!			
0 - 2 3 - 4	MEDIU 5 S 0 VER	OFT 5 JM STIFF 1 TIFF 3	5 - 10 1 - 30 1 - 50	LOOSE			E REF DES Y SUE	SCRIPTION AND CI	T ENTITLED "KEY TO LASSIFICATION OF RIALS" FOR ADDITIONA	BORING NO.	G FT	S-	017

TEST BORING/MONITORING WELL LOG OF **PROJECT** New Bedford/Fall River Commuter Rail FR-79 MW **BORING** LOCATION Fall River Line - Freetown **JACOBS** NO. OWNER Mass. Bay Transportation Authority SHEET I OF I 013471 JOB NUMBER J.Galvin **ELEVATION** 61.5 DRILLER CONTRACTOR Earth Exploration, Inc C.Nagata INSPECTOR B-57 ATV DATUM FT MSL GROUNDWATER READINGS DRILL RIG METHOD OF DRILLING REMARKS SPT HAMMER 140 Ib Safety **GRID** N 2742611 DATE/TIME DEPTH (f+) Wash Boring w/Casing 0.0 Ε 767443 COORD Upon completion (In casing) 9/07/01 1030 12.5 Wash Boring-Open Hole 9.0 9/07/01 DATE START Monitoring wellreading 12.4 Split Spoon Sample 5/21/02 1335 19.0 DATE END 9/07/01 Terminated 20.5 SAMPLE REC. SAMPLE DEPTH STRATA WELL LOG (N. T. S.) FIELD CLASSIFICATION AND REMARKS ELEV. SYMBOL DATA (In)/(%) NO. WELL COVER INFORMATION 3° of ballast 61.20 14 23 7 SS-1 Wellgraded sand (SW) - mostly fine to medium STANDPIPE **X** ROADBOX sand with slag, trace fine to coarse subangular gravel, dark brown/black, dry (FILL) (Possibly used as subballast) Wellgraded sand (SW) - mostly fine to 14 SS-2 18 35 medium sand, trace silt, brown, 0.25 ft wet (FILL) TOP OF I RISER PIPE 54.50 Poorly graded sand (SP) - mostly fine 12 20 22 14 **SS-3** sand, light brown, wet 10 Poorly graded sand (SP) - mostly fine **SS-4** 10 14 15 sand, light brown, wet 15 **BOTTOM** GROUT 2.0 ft SEAL Poorly graded sand (SP) - mostly fine 9 **SS-5** 7.2 ft TOP SAND 19 16 22 sand, light brown, wet 20 . . 41.00 Boring Terminated at 20.5 ft. TOP SCREEN Remarks: Boring located at centerline of existing tracks. SLOT SIZE Test boring performed by GeoLogic, Inc. 0.25 Monitoring well installed (2" Dia. PVC pipe) 25 BOTTOM SCREEN 19.2 ft **BOTTOM** 19.5 ft SANO 30 BOTTOM SEDIMENT 20.5 ft TRAP 20.5 ft BOTTOM 4 BORING INCH DIA 35 Page & 0-35 ft., Page 2: 35-80 ft. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM 0-2488 UNLESS OTHERWISE NOTED. Each subsequent page displays 45 ft. RELATIVE LEGEND NON-COHESIVE SOIL COHESIVE SOIL **PROPORTIONS** ROCK CORE (RC) UNDISTURBED BAG (B) BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS SPLIT-SPOON ALICER (U)-SHELBY TUBE, (JS) 56 AND ROO (%) (SS) AND BLOW (AS) VERY SOFT 0 - 2 0 - 4 **VERY LOOSE** COUNTS PER 6º REC (%) C 10% TRACE SOFT REC (In) 5 - 10 1.00SF LITTLE 15 - 25% 30 - 45% 5 - 8 MEDIUM STIFI H - 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED KEY TO 9 - 15 BORING STIFF SOME 31 - 50 DESCRIPTION AND CLASSIFICATION OF SUBSURFACE OENSE FR-79 MW MOSTLY 50 - 100% 16 - 30 VERY STIFF VERY DENSE MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO. 30 + HARD

**PROJECT** New Bedford/Fall River Commuter Rail FR-80 **III** JACOBS BORING LOCATION Fall River Line - Freetown Mass. Bay Transportation Authority NO. CLIENT SHEET I OF I JOB NUMBER 013471 64.9 J.Galvin **ELEVATION** NFE. Inc. DRILLER CONTRACTOR C.Nagata INSPECTOR B-57 ATV DATUM FT MSL METHOD OF DRILLING GROUNDWATER READINGS DRILL RIG GRID 2742369 REMARKS SPT HAMMER 140 Ib Safety DATE/TIME DEPTH (ft) N Wash Boring w/Casing COORD Ε 766983 9/07/01 1315 Upon completion (in casing) 4.0 Wash Boring-Open Hole 9/07/01 DATE START 19.0 Split Spoon Sample 9/07/01 DATE END 20.5 Terminated SAMPLE REC. SAMPLE DEPTH STRATA ELEV. FIELD CLASSIFICATION AND REMARKS DATA (ft) SYMBOL (In)/(%) NO. Wellgraded sand (SW) - mostly fine to medium sand with slag, SS-1 18 6 12 18 trace fine to coarse subrounded gravel, dark brown/black, dry (FILL) (Possibly used as subballast) 61.90 Silty sand (SM) - mostly fine sand, little to some silt, **SS-2** 18 11 10 brown, wet Silty sand (SM) - mostly fine sand, little to some slit, **SS-3** 18 23 18 11 brown, wet 10 51.90 Silt (ML) - homogeneous, non-plastic, light brown, wet **SS-4** 15 17 38 12 (Gravellodged in shoe) 15 48.90 Silty sand (SM) - Mostly fine to coarse sand, little to some **SS-5** 6 31 19 silt, trace fine to coarse subangular gravel, beige, wet 20 44.40 Boring Terminated at 20.5 ft. Remarks: Boring located at centerline of existing tracks. Test boring performed by GeoLogic, Inc. 25 30 35 Page & 0-35 feet, Page 2: 35-80 feet. Each subsequent page displays 45 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. REI ATIVE LECEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT DENSITY OF SOIL COMPONENTS ROCK CORE (RC) BAG (B) SPLIT-SPOON (SS) AND BLOW UNDISTURBED **AUGER** (U)-SHELBY TUBE. X (JS) AND ROD (%) (AS) VERY SOFT 0 - 4 **VERY LOOSE** COUNTS PER 6º (P)-PISTON REC (Z) < 10% TRACE SOFT - 10 LOOSE 15 - 25% LITTLE 5 - 8 MEDIUM STIFF H- 30 MEDIUM DENSE REFER TO THE SHEET ENTITLED KEY TO 30 - 45% SOME BORING 9 - 15 STIFF 31 - 50 DENSE DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 50 - 100% MOSTLY FR-80 16 - 30 **VERY STIFF** VERY DENSE 51+ MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO. 30 +

**PROJECT** New Bedford/FallRiver Commuter Roil FR-81 BORING **III** JACOBS LOCATION Fall River Line - Freetown CLIENT Mass. Bay Transportation Authority NO. OF I SHEET I JOB NUMBER 013471 J.Galvin CONTRACTOR NFE, Inc. DRILLER **ELEVATION** 70.2 INSPECTOR C.Nagoto B-57 ATV DATUM METHOD OF DRILLING **GROUNDWATER READINGS** DRILL RIG FT MSL Wash Boring w/Cosing GRID DATE/TIME DEPTH (ft) REMARKS SPT HAMMER 140 Ib Safety N 2742075 Split Spoon Sample 9/10/01 0705 10.4 COORD E 766456 Upon completion (In casing) 19.0 7.9 DATE START 9/07/01 9/10/01 0720 Upon completion (Casing pulled) Terminoted 20.5 9/10/01 DATE END DEPTH STRATA SAMPLE SAMPLE REC. ELEV. FIELD CLASSIFICATION AND REMARKS SYMBOL DATA (In)/(%) NO. Clay (CL) - homogeneous, medium plasticity, trace roots, 18 SS-1 5 brown, dry (FILL) 67.20 10 Poorly groded sond with silt (SP-SM) - mostly fine sand, **SS-2** 32 ₂₆ trace to little silt, trace fine to coorse grovel, light brown, wet 62.20 00 0 54 33 14 Wellgraded sand (SW) - mostly fine to medium sond, brown, 6 **SS-3** 10 wet 0 00 00 0 00 ٥ Wellgroded sand with gravel(SW) - mostly fine to coarse 5 **SS-4** 25 20 sond, some fine to coarse subongular gravel, trace silt, 15 0 00 light brown, wet 00 0 00 0 0 00 0 Wellgroded sand with gravel(SW) - mostly fine to coarse sand, 43 28 21 5 **SS-5** 00 0 20 some fine to coarse subangular grovel, trace silt, light brown, wet 49.70 Boring Terminated at 20.5 ft. Remarks: Boring offset 12 ft east of centerline of trocks. Test boring performed by GeoLogic. Inc. 25 30 35 Page is 0-35 feet, Page 2: 35-80 feet, Each subsequent page displays 45 feet. SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED. RELATIVE LEGEND COHESIVE SOIL NON-COHESIVE SOIL **PROPORTIONS** BLOWS/FT CONSISTENCY BLOWS/FT **OENSITY** OF SOIL COMPONENTS BAG (B) UNDISTURBED AUGER ROCK CORE (RC) SPLIT-SPOON (U)-SHELBY TUBE. (US) AND ROD (%) (SS) AND BLOW 0 - 2 **VERY SOFT** (AS) 0 - 4 VERY LOOSE (P)-PISTON COUNTS PER 6º REC (%) < 10% TRACE SOFT 5 - 10 LOOSE 15 - 25% 30 - 45% REC (in) LITTLE 5 - 8 MEDIUM STIFF II - 30 MEDIUM DENSE 9 - 15 SOME REFER TO THE SHEET ENTITLED KEY TO BORING STIFF 31 - 50 DENSE 50 - 100% MOSTLY DESCRIPTION AND CLASSIFICATION OF SUBSURFACE 16 - 30 VERY STIFF FR-81 51+ VERY DENSE 30 + MATERIALS' FOR ADDITIONAL SYMBOLOGY. NO.

### Memorandum

**APPENDIX B: LABORATORY DATA** 



a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA Sample Type: --- Project No:

GTX-9764

Boring ID: ---Test Date: Sample ID:---

Tested By: 05/03/10 Checked By: jdt

mmd

Sample Id: Depth:

### Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
FTS-4	S-2	4-6 ft	Moist, black silt	42.4
FTS-11	S-1 0-2 ft		Moist, yellowish brown sandy silt	24
FTS-13	TS-13 S-2		Moist, yellowish brown silt	23.8
TS-2	S-3	9-11 ft	Moist, gray clay	32
TS-2	S-4	14-16 ft	Wet, light gray silt	37
TS-3	S-3	9-11 ft	Moist, gray clay	37.7
TS-7	S-3	8-10 ft	Wet, yellowish brown clay	36.5
TS-7	S-4	13-15 ft Moist, gray clay		32.8
TS-11	S-2	3-5 ft	Moist, black silt with organics	26.1
TS-20	S-3	8-10 ft	Wet, gray silt	41.4

Notes: Temperature of Drying: 110° Celsius



a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA Project No: GTX-9764

Boring ID: --- Sample Type: --- Tested By: mmd Sample ID:--- Test Date: 04/28/10 Checked By: jdt

Depth: --- Test Id: 178378

## Moisture, Ash, and Organic Matter - ASTM D 2974

Boring ID	Sample ID	Depth	Description	Moisture Content,%	Ash Content,%	Organic Matter,%
FTS-4	S-2	4-6 ft	Moist, black silt	42	95.3	4.7
TS-11	S-2	3-5 ft	Moist, black silt with organics	26	92.2	7.8

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass; dried to a constant mass at temperature of 110° C Ash content and organic matter determined by Method C; dried to constant mass at temperature 440° C

# **GeoTesting** express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

Location: MA

Boring ID: FTS-11 Sample Type: jar Tested By: jbr Sample ID:S-1 Test Date: 04/28/10 Checked By: jdt

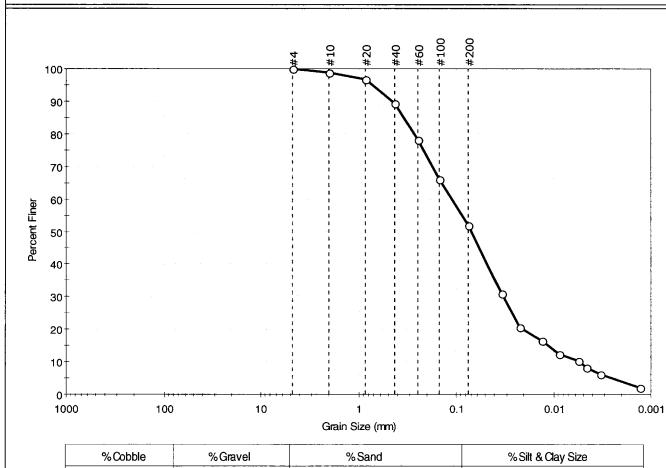
Depth: 0-2 ft Test Id: 178366

Test Comment: ---

Sample Description: Moist, yellowish brown sandy silt

Sample Comment: ---

### Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	%Sand	% Silt & Clay Size
-	0.0	48.1	51.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	97		
#40	0.42	89		
#60	0.25	78		
#100	0.15	66		-
#200	0.075	52		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0340	31		
	0.0220	21		
	0.0131	17		-
	0.0087	12		
	0.0056	10		
	0.0047	8		,
	0.0033	6		
	0.0013	2		

<u>Coefficients</u>						
D ₈₅ = 0.3453 mm	$D_{30} = 0.0326 \text{ mm}$					
D ₆₀ = 0.1116 mm	$D_{15} = 0.0112 \text{ mm}$					
D ₅₀ = 0.0698 mm	$D_{10} = 0.0054 \text{ mm}$					
C _u =N/A	$C_C = N/A$					

GTX-9764

Project No:

ASTM N/A

AASHTO Silty Soils (A-4 (0))

<u>Sample/Test Description</u>
Sand/Gravel Particle Shape : --Sand/Gravel Hardness : ---

#### **Geo**Testing express

a subsidiary of Geocomp Corporation

Client: Jacobs Civil, Inc. Project: South Coast Rail

GTX-9764 Location: Project No:

Sample Type: jar Boring ID: FTS-13 Tested By: Test Date: 04/28/10 Checked By: jdt Sample ID:S-2

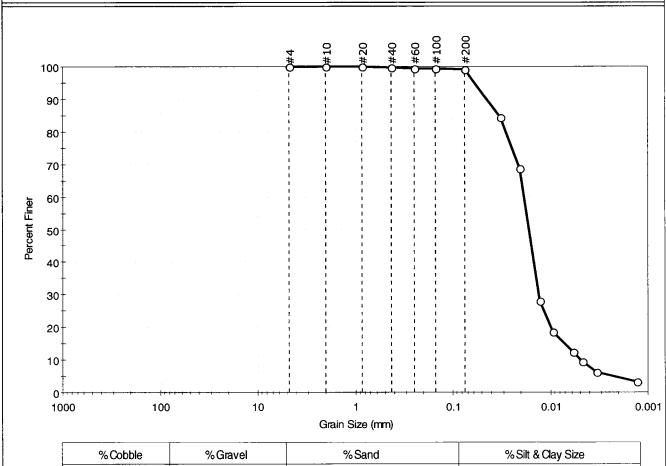
Depth: 3-5 ft Test Id: 178367

Test Comment:

Moist, yellowish brown silt Sample Description:

Sample Comment:

### Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	%Gravel	%Sand	% Silt & Clay Size
	0.0	1.0	99.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		V 1
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	99		
#200	0.075	99		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
	0.0325	84		
	0.0209	69		
	0.0130	28		
	0.0093	19		
	0.0058	12		
	0.0047	9		
	0.0034	6		
	0.0013	3		

<u>Coefficients</u>				
D ₈₅ = 0.0338 mm	$D_{30} = 0.0133 \text{ mm}$			
$D_{60} = 0.0189 \text{ mm}$	$D_{15} = 0.0071 \text{ mm}$			
D ₅₀ = 0.0168 mm	$D_{10} = 0.0049 \text{ mm}$			
Cu =N/A	$C_c = N/A$			

Classification silt (ML) **ASTM** AASHTO Silty Soils (A-4 (0))

Sample/Test Description Sand/Gravel Particle Shape: --Sand/Gravel Hardness: ---

### Memorandum

#### APPENDIX C: GEOTECHNICAL CALCULATIONS

- Allowable Bearing Capacity and Estimated Settlement
- Seismic Site Class Evaluation





343 Congress Street Boston, MA 02210 617/242-9222

JOB	MBTA South Coast Rail		
SUBJECT	Freetown Station		
CALCULATED BY	DH	DATE	1/31/2012
CHECKED BY	PM	DATE	1/31/2012

**PURPOSE:** Evaluate bearing resistance for platform shallow foundations.

REFERENCE: AASHTO LRFD Bridge Design Specifications, 2010
AREMA Manual for Railway Engineering, 2011 Edition

ASSUMPTIONS: - Platform footing is 4 ft wide by 10 ft long.

- Bearing surface is compacted Gravel Borrow overlying silt with sand (ML), silty sand and sand.
- Footing embedment is at least 4 feet below ground surface.
- Groundwater level is about 10 feet below bottom of foundation.
- Footing eccentricity is assumed to be zero.
- Estimated soil properties (experience, geotech literature, Table 10.4.6.2.4-1):

 γ (pcf)
 φ

 Gravel Borrow:
 125
 34

#### BEARING CAPACITY FACTORS (Table 10.6.3.1.2a-1):

	ф	N _c	$N_q$	$N_{\gamma}$
Gravel Borrow:	34	42.2	29.4	41.1

#### **CALCULATE EFFECTIVE FOOTING WIDTH (B'):**

e < B/4 (Section 10.6.3.3)

where: B = footing width (ft) = 4

e = eccentricity (ft)

Assume no footing eccentricity, thus, e = 0

B' = B-2e 4

#### NOMINAL BEARING RESISTANCE (q_n):

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B' N_{\gamma m} C_{w\gamma}$$
 (Eqn. 10.6.3.1.2a-1)

 $D_f$  = depth of footing (ft) = 4 Assumed

B' = effective width of footing (ft) = 4 L = length of footing (ft) = 10

B'/L = 0.40 $D_f/B' = 1.00$ 

 $C_{wq} C_{wy} = groundwater correction factors$  (using B')

 $C_{wq} = 1.0$  (Table 10.6.3.1.2a-2)  $C_{wy} = 1.0$  (Table 10.6.3.1.2a-2)

 $N_{cm} N_{qm} N_{\gamma m}$  = bearing capacity factors

$$N_{qm} = N_q s_q d_q i_q$$
 (Eqn. 10.6.3.1.2a-3)

 $s_q = 1.27$  (Table 10.6.3.1.2a-3)

 $d_q = \frac{1.20}{\text{(Table 10.6.3.1.2a-4)}}$ 

 $i_q = 1.0$  (see AASHTO p. 10-62)

 $N_{cm} = 44.8$ 





343 Congress Street Boston, MA 02210 617/242-9222

JOB	MBTA South Coast Rail			
SUBJECT	Freetown Station			
CALCULATED BY	DH <b>DATE</b> 1/31/201:			
CHECKED BY	PM <b>DATE</b> 1/31/2012			

$$N_{\gamma m} = N_{\gamma} s_{\gamma} i_{\gamma}$$

$$s_{y} = 0.84$$
 (Table 10.6.3.1.2a-3)

$$i_y = 1$$
 (see AASHTO p. 10-62)

$$N_{ym} = 34.5$$

$$q_n = 31,030$$
 psf

#### ALLOWABLE BEARING RESISTANCE (qa):

$$q_a = q_n/FOS$$

where: FOS = factor of safety = 2.5 for granular soil

12.412  $q_a =$ psf

use

 $q_a =$ 12.41 ksf strength limit value

Note: Based on the anticipated light loads and potentially small footing sizes, an allowable bearing capacity of 6 ksf is recommended.

#### **Elastic Settlement Calculations:**

$$S_{e} = \frac{\left(q_{o} (1 - v^{2})\sqrt{A'}\right)}{144 E_{s} \beta_{z}}$$
 eqn. 10.6.2.4.2-1

where: q_o = applied vert. stress (ksf)

v = Poisson's Ratio

E_s = Young's Modulus (ksi)

 $\beta_z$  = Shape/Rigidity Factor

v = Poisson's Ratio =	0.30	(Table C10.4.6.3-1)
E _s = Young's Modulus (ksi) =		(Table C10.4.6.3-1)
$\beta_z$ = Shape/Rigidity Factor =	1.11	(Table 10.6.2.4.2-1)

B' = eff. width of footing (ft) = where:

L = length of footing (ft):

 $A' = (B'xL) = footing area (ft^2)$ :

4	(from bearing resistance calcs)
10	(from bearing resistance calcs)
40	ft ²

#### Settlement (S_e) for a given q_o:

6.00 qo = applied vertical stress (ksf) = ksf (assumed)

> 0.43 Se (inches) = inches



#### Freetown Station Seismic Site Class Evaluation

Based on the platform boring with the deepest soil overburden and the lowest average blow counts (worst case)

Boring No.	Sample No.	N Value	Di	Di/N _i	N _{bar}
FTS-1	S-1	8	6	0.75	
	S-2	13	5	0.38	
	S-3	18	5	0.28	33
	S-4	14	5	0.36	
	S-5	25	5	0.20	
	S-6	100	5	0.05	
	S-7	66	10	0.15	
	S-8	66	7.25	0.11	
Assum	ned Weathered rock	66	51.75	0.78	
	Total Depth =	100			
Depth to A	ssumed Bedrock =	48.25	Sum	3.06	

#### Per 9.4.1.2.1, $15 < N_{bar} < 50$ , Site Class D

**9.4.1.2.1** Site Class Definitions. The site shall be classified as one of the following classes:

A = Hard rock with measured shear wavevelocity,  $\overline{\mathbf{v}}_s > 5000 \text{ ft/s} (1500 \text{ m/s})$ 

 $B = \text{Rock with } 2500 \text{ ft/s} < \overline{\mathbf{v}}_{s} \le 5000 \text{ ft/s} (760 \text{ m/s} < \overline{\mathbf{v}}_{s} \le 1500 \text{ m/s})$ 

C = Very dense soil and soft rock with 1200 ft/s  $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 2500$  ft/s (370 m/s  $\leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 760$  m/s) or  $\overline{\boldsymbol{N}}$  or  $\overline{\boldsymbol{N}}_{\boldsymbol{ch}} > 50$  or  $\overline{\boldsymbol{s}}_{\boldsymbol{u}} \geq 2000$  psf (100 kPa)

$$\begin{split} D &= \text{ Stiff soil with 600 ft/s} \leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 1200 \text{ ft/s} \\ (180 \text{ m/s} \leq \overline{\boldsymbol{v}}_{\boldsymbol{s}} \leq 370 \text{ m/s}) \text{ or with } 15 \leq \overline{\boldsymbol{N}} \text{ or } \\ \overline{\boldsymbol{N}}_{\boldsymbol{ch}} \leq 50 \text{ or } 1000 \text{ psf} \leq \overline{\boldsymbol{s}}_{\boldsymbol{u}} \leq 2000 \text{ psf} (50 \text{ kPa} \\ \leq \overline{\boldsymbol{s}}_{\boldsymbol{u}} \leq 100 \text{ kPa}) \end{split}$$

 $E = \text{A soil profile with } \overline{\mathbf{v}_s} < 600 \text{ ft/s } (180 \text{ m/s}) \text{ or any profile with more than } 10 \text{ ft } (3 \text{ m}) \text{ of soft clay. Soft clay is defined as soil with } Pl > 20, <math>w \ge 40\%$ , and  $s_u < 500 \text{ psf } (25 \text{ kPa})$ 

F =Soils requiring site-specific evaluations:

 Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. Potential for liquefaction shall be evaluated in accordance with 780 CMR 1804.6: Liquefaction.

#### Exception. None.

- 2. Peats and/or highly organic clays (H > 10 ft [3 m]) of peat and/or highly organic clay where H = thickness of soil).
- 3. Very high plasticity clays (H  $\geq$  25 ft [7.6 m] with  $PI \geq$  75).
- 4. Very thick soft/medium stiff clays (H>120 ft [37 m].

Exception. None.

#### Approx. Project Coordinates

Lat 41.772592 Long -71.093589

Seismic Coefficients

S_S = 0.230 (Table 1604.10*) S₁ = 0.060 (Table 1604.10*)

For Site Class D

 $F_A =$  1.6 (See Table 9.4.1.2.4a*)  $F_V =$  2.4 (See Table 9.4.1.2.4b*)

Design Spectral Response Parameters

 $S_{MS} = Ss x F_A = 0.368$  $S_{M1} = S_1 x F_V = 0.144$ 

 $S_{DS=} 2/3 \times S_{MS} = 0.245$  $S_{D1=} 2/3 \times S_{M1} = 0.096$ 

Notes: * The Massachusetts State Building Code, 8th Edition (2010)

TABLE 9.4.1.2.4a VALUES OF  $F_a$  AS A FUNCTION OF SITE CLASS AND SHORT PERIOD MAXIMUM CONSIDERED FARTHOUAKE SPECTRAL ACCELERATION

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at Short Periods						
	$S_s \le 0.26 \   0.27 \le S_s \le 0.29 \   0.30 \le S_s \le 0.32 \   0.33 \le S_s \le 0.35 \   0.36 \le S_s \le 0.38 $ $S_s \ge 0.35 \   0.36 \le S_s \le 0.38 $						
A	0.8	0.8	0.8	0.8	0.8	0.8	
В	1.0	1.0	1.0	1.0	1.0	1.0	
С	1.2	1.2	1.2	1.2	1.2	1.2	
D	1.6	1.6	1.55	1.5	1.5	1.5	
E	2.5	2.4	2.3	2.2	2.1	2.0	
F	Note a	Note a	Note a	Note a	Note a	Note a	

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_a for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

#### TABLE 9.4.1.2.4b VALUES OF F, AS A FUNCTION OF SITE CLASS

Site Class	Tabulated Maximum Considered Earthquake Spectral Response Acceleration at 1-Second Periods
	$S_1 \leq \theta.1$
Α	0.8
В	1.0
C	1.7
D	2.4
E	3.5
F	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of  $\Gamma_v$  for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

# TABLE 1604.10 GROUND SNOW LOADS; BASIC WIND SPEEDS; EARTHQUAKE DESIGN FACTORS

(For R-3 of three stories or less one- and two-family stand alone buildings, see 780 CMR 53.00 for snow and wind loads)

	Ground Snow	Basic Wind	Earthquake Design Factors		
City/Town	Load p _g , psf	Speed V, MPH	Ss	S ₁	
Foxborough	55	100	0.25	0.064	
Framingham	55	100	0.26	0.067	
Franklin	55	100	0.24	0.064	
Freetown	45	110	0.23	0.060	
Gardner	65	100	0.26	0.070	
Gay Head (a.k.a Aquinnah)	35	120	0.18	0.051	
Georgetown	55	110	0.34	0.075	
Gill	65	100	0.23	0.069	
Gloucester	45	110	0.33	0.073	
Goshen	65	100	0.22	0.067	
Gosnold	35	120	0.19	0.053	
Grafton	55	100	0.24	0.066	
Granby	55	100	0.23	0.066	
Granville	65	100	0.23	0.066	
Great Barrington	65	90	0.22	0.066	
Greenfield	65	100	0.23	0.069	
Groton	65	100	0.30	0.073	
Groveland	55	110	0.34	0.076	
Hadley	55	100	0.23	0.067	
Halifax	45	110	0.25	0.062	
Hamilton	45	110	0.33	0.074	
Hampden	55	100	0.23	0.065	
Hancock	65	90	0.22	0.068	
Hanover	45	110	0.26	0.064	
Hanson	45	110	0.25	0.063	
Hardwick	55	100	0.23	0.067	
Harvard	55	100	0.28	0.070	
Harwich	35	120	0.18	0.051	
Hatfield	55	100	0.22	0.067	
Haverhill	55	110	0.35	0.077	
Hawley	65	100	0.22	0.068	
Heath	65	100	0.22	0.069	
Hingham	45	110	0.27	0.066	
Hinsdale	65	90	0.22	0.067	
Holbrook	45	105	0.26	0.065	
Holden	55	100	0.25	0.068	
Holland	55	100	0.23	0.064	
Holliston	55	100	0.25	0.066	
Holyoke	55	100	0.23	0.066	
Hopedale	55	100	0.24	0.065	
Hopkinton	55	100	0.25	0.066	
Hubbardston	65	100	0.25	0.069	
Hudson	55	100	0.26	0.068	
Hull	45	110	0.28	0.067	
Huntington	65	100	0.22	0.066	
Ipswich	45	110	0.34	0.074	
Kingston	45	110	0.24	0.061	
Lakeville	45	110	0.24	0.061	
Lancaster	55	100	0.27	0.070	
Lanesborough	65	90	0.22	0.068	



#### **FEIS/FEIR Technical Report** Stormwater

Freetown Station