EWB

New Bedford Regional Airport

RECONSTRUCT TERMINAL AREA APRONS – PHASE I
STORMWATER MANAGEMENT REPORT

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STORMWATER MANAGEMENT REPORT

1. INTRODUCTION

The New Bedford Regional Airport, located in New Bedford, MA seeks to reconstruct the Terminal Area Aprons that serve the Airport's Fixed Base Operators and its Terminal Building. The Terminal Area Aprons will be reconstructed in three separate phases. This report will deal with Phase I only. The aprons will be redesigned according to the following FAA regulations:

- FAA Advisory Circular 150/5300-13 (Airport Design), and
- MassDOT Aeronautics approved aeronautical rules and regulations for public use airports (pursuant to 702 CMR, as amended; for airports subject to MassDOT Aeronautics certification pursuant to M.G.L. c.90, Section 39B).

The proposed stormwater management system described herein has been designed to comply with MASS DEP's stormwater management standards that were incorporated into the Wetlands Protection Act Regulations on January 2, 2008 (see 310 CMR 10.05(6)(k)). This plan also addresses Special Condition Nos. 49 and 51 of MASS DEP's Wetland and Water Quality Certification Variance ("Variance Order") (DEP File No. SE 049-0635) issued on February 26, 2010 for the separate Runway 5-23 Safety Improvement Projects.

As explained in further detail below and in the accompanying Notice of Intent prepared by Epsilon Associates, Inc., work associated with reconstructing Phase I of the terminal area aprons is characterized as a redevelopment project relative to collecting and treating stormwater runoff. More specifically, according to MASS DEP Stormwater Standard 7:

> *A redevelopment project is required to meet the following Stormwater Management Standard only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5 and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.*

The Regulations require documentation demonstrating that runoff from the existing developed portion of the Phase I portion of the Terminal Area Aprons meets the Stormwater Standards to the maximum extent practicable and improves existing conditions. Maximum extent practicable is defined at 310 CMR 10.05(6)(0) and is summarized as follows: all reasonable efforts have been made to meet each of the Standards; a complete evaluation has been conducted of possible stormwater management measures including (in part) environmentally sensitive site design and low impact development techniques that minimize land disturbance and impervious surfaces, structural stormwater best management practices, pollution prevention, erosion and sedimentation control and proper operation and maintenance; and if full compliance with the Standards cannot be achieved, the highest practicable level of stormwater management is implemented. The measures described herein comply with the Standards to the maximum extent practicable and will improve existing stormwater runoff conditions consistent with the requirements of Standard 7. Additional detail describing existing and proposed conditions is provided below.

Per Nitsch Engineering's comments on the previous submission the Stormwater Management Report has been revised to incorporate these comments.

2. METHODOLOGY

The existing and proposed watersheds were modeled utilizing HydroCad stormwater software, version 9.10. The watersheds were analyzed utilizing the SCS TR-20 methodology for hydrograph development and the TR-55 methodology for Time of Concentration (Tc) determination. Type III, 24-hour hydrographs were developed for the 2-year, 10-year, and 100-year storm events corresponding to 3.4", 4.8", and 7.0" rainfall storm events respectively as directed by the SCS *Technical Paper 40* (TP-40) and the MASS DEP *Hydrology Handbook for Conservation Commissioners*.

Existing topography and site features were obtained through a combination of aerial topography, on-ground topography, the MASS GIS system, and USGS Topographical Maps. Existing soil conditions were derived from a combination of geotechnical investigation performed by R.W. Gillespie & Associates, test pits performed by ASG, MASS GIS soils, and the Natural Resources Conservation Services (NRCS) Web Soil Service Mapping Tool. The wetland resource area boundaries depicted on the enclosed drawings were reviewed and approved under MASS DEP File No. 049-0635 and remain valid.

3. EXISTING CONDITIONS

In the previous version of this report the entire Airport watershed was analyzed. The majority of the closed stormwater drainage systems on Airport drain to outfalls located along drainage ditches that eventually collect at a single analysis point. In their review of the report, Nitsch Engineering wanted to see the analysis of the single watershed containing the Phase I Apron Reconstruction.

The existing 26+ acres sub-watershed containing the Phase I apron work has been analyzed. The existing watershed contains a mixture of impervious surfaces, grass, brush and open water wetlands. Watershed soils were determined to be Hydrologic Soil Group (HSG) "A". All wetlands were classified HSG "D". Runoff curve numbers associated with developed areas are based upon land usage.

The southwestern portion of the existing apron, servicing Colonial Air, does not have a closed drainage system. Stormwater runoff generated on this portion of the ramp sheet flows over the pavement and into the drainage ponds west and south of the Colonial Air Hangar.

The remaining portion of the existing apron uses a completely closed drainage system comprised of catch basins with sumps, manholes and small diameter drainage pipe to convey stormwater runoff. Stormwater runoff is captured in catch basins and conveyed to an outfall that drains to a closed drainage pond south of Colonial Air.

Existing Drainage Areas and Analysis Points are depicted on Sheet D-1.1.

This drainage study utilizes three Analysis Points (AP-1, AP-2 and AP-3) in the calculations.

- Analysis Point #1 (AP-1) is defined as the point where runoff from the Colonial Air apron discharges to the adjacent wetlands.
- Analysis Point #2 (AP-2) is defined as the closed drainage pond west of the existing Colonial Air apron.
- Analysis Point #3 (AP-3) is defined as the closed drainage pond south of the existing Colonial Air apron.

For analysis purposes, the 26 acre watershed was divided into five (5) sub-watersheds.

- "EX-RW5-E1" contains 21.912 acres along the east side of Runway 5. Runoff from this watershed is collected in the infield storage area located between Runway 5 and Taxiway "A, is collected in the Existing Drainage System "B" and is discharged to the adjacent wetlands to the Colonial Air apron.
- "EX-COLONIAL-1" contains 0.588 acres southwest of the Colonial Air apron. Runoff from this watershed enters the adjacent wetlands.
- "EX-COLONIAL-2" contains 2.458 acres southwest of the Colonial Air apron and part of the paved apron and includes a closed drainage pond, Analysis Point #2. Runoff from this watershed enters the closed drainage pond.
- "EX-COLONIAL-3" contains 0.098 acres south of the Colonial Air apron off the back of the existing pavement. Runoff of from this watershed enters the closed drainage pond, Analysis Point #3.
- "EX-COLONIAL-4" contains 0.989 acres northwest of the Colonial Air Hangar and includes the apron pavement. Runoff from this watershed enters a closed drainage system and is discharged to the closed drainage pond, Analysis Point #3 south of the Colonial Air Apron.

EXISTING DRAINAGE SUMMARY (Pre-development)			
	RETURN PERIOD		
	2-YR	10-YR	100 YR
ANALYSIS POINT	EXISTING PEAK DISCHARGE (CFS)	EXISTING PEAK DISCHARGE (CFS)	EXISTING PEAK DISCHARGE (CFS)
AP-1	0.94	4.61	6.68
AP-2	3.34	6.17	10.96
AP-3	2.99	4.31	6.39

4. PROPOSED CONDITIONS

The proposed analysis points are as indicated in the Existing Conditions Section. As part of this project an existing culvert will be replaced that will restore hydraulic conductivity from the closed drainage pond to the south of the Colonial Air apron to the adjacent wetlands, Analysis Point #1.

Proposed Drainage Areas and Analysis Points are depicted on Sheet D2.1.

Work associated with reconstructing the Terminal Area Aprons includes the construction of a new drainage system at the southwestern end of the apron servicing Colonial Air that conforms to the maximum extent practicable with MASS DEP's Stormwater Management Standards. The main reason a new closed drainage system is being constructed, along with a new outfall, is that this area is considered a LUHPLL area. Colonial Air maintains and services aircraft on this portion of the ramp. The apron will be regraded to separate the Colonial Air apron drainage from the rest of the Phase I apron reconstruction. Deep sump catch basins will be installed to capture stormwater runoff and the runoff will be conveyed to a proprietary separator before being discharged to a new outfall. The proposed deep sump catch basins function as underground retention systems and in this particular case have the ability to remove primarily sediment from stormwater runoff. The proprietary separator will then remove additional pollutants from the runoff before being discharged into the existing wetland complex.

Another drainage improvement that is being proposed is the complete separation of the Taxiway A drainage from the apron drainage. The Taxiway A drainage system in this area is currently tied into "Existing Drainage System B". The existing catch basin that the Taxiway A drainage currently ties into will be converted to a manhole and the casting will be raised to facilitate positive drainage to other portions of the apron.

The remaining portion of the apron will reuse the existing drainage system. An additional proprietary separator will be installed on the outlet pipe that connects Phase I to Phase II of the apron reconstruction to treat the remaining portion of the Phase I apron.

Collectively, these proposed measures will improve existing stormwater runoff conditions consistent with the requirements of Standard 7.

For analysis purposes, the 26 acre watershed was reanalyzed for the proposed conditions and has been subdivided into ten (10) sub-watersheds.

- "EX-RW5-E1" contains 21.912 acres along the east side of Runway 5. Runoff from this watershed is collected in the infield storage area located between Runway 5 and Taxiway "A, is collected in the Existing Drainage System "B" and is discharged to the adjacent wetlands to the Colonial Air apron.
- "PR-COLONIAL-1" contains 0.757 acres southwest of the Colonial Air apron. Runoff from this watershed enters the adjacent wetlands.
- "PR-COLONIAL-2" contains 0.547 acres southwest of the Colonial Air apron and a closed drainage pond, Analysis Point #2. Runoff from this watershed enters the closed drainage pond.

- “PR-COLONIAL-3” contains 0.771 acres northwest of the Colonial Air hangar and includes the apron expansion. Runoff from this watershed enters a closed drainage system and is discharged to the adjacent wetlands.
- “PR-COLONIAL-4” contains 0.466 acres west of the Colonial Air hangar and includes the paved apron surface. Runoff from this watershed enters a closed drainage system and is discharged to the adjacent wetlands.
- “PR-COLONIAL-5” contains 0.336 acres west of the Colonial Air hangar and includes the paved apron surface. Runoff from this watershed enters a closed drainage system and is discharged to the adjacent wetlands.
- “PR-COLONIAL-6” contains 0.238 acres west of the Colonial Air hangar and includes the paved apron surface. Runoff from this watershed enters a closed drainage system and is discharged to the adjacent wetlands.
- “PR-COLONIAL-7” contains 0.031 acres south of the Colonial Air apron off the back of the existing pavement. Runoff of from this watershed enters the closed drainage pond, Analysis Point #3.
- “PR-COLONIAL-8” contains 0.412 acres northwest of the Colonial Air hangar and includes the paved apron surface. Runoff from this watershed enters a closed drainage system and is discharged to the adjacent wetlands.
- “PR-COLONIAL-9” contains 0.575 acres northwest of the Colonial Air hangar and includes the paved apron surface. Runoff from this watershed enters a closed drainage system and is discharged to the adjacent wetlands.

PROPOSED DRAINAGE SUMMARY
(Post-development)

	RETURN PERIOD		
	2-YR	10-YR	100 YR
ANALYSIS POINT	PEAK DISCHARGE (CFS)	PEAK DISCHARGE (CFS)	PEAK DISCHARGE (CFS)
AP-1	8.11	11.58	18.37
AP-2	0.41	0.94	1.90
AP-3	N/A	N/A	N/A

5. COMPLIANCE WITH MASSDEP STORMWATER STANDARDS:

Standard #1: *No new stormwater conveyance (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.*

One new outfall is being proposed as part of this project. The outfall will discharge stormwater runoff generated at the Colonial Air apron to the existing wetland complex adjacent to the hangar site. All stormwater runoff in this portion of the apron will be treated via the use of deep sump catch basins and a proprietary separator to the maximum extent practicable.

All other areas being reconstructed will be treated via the use of a proprietary separator.

Standard #2: *Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.*

As detailed in the following table, the post-development peak discharge rates have increased for Analysis Point #1 as a result of the complete collection and treatment of the stormwater runoff generated by the Colonial Air apron. In the pre-development condition a significant amount of stormwater runoff generated by the Colonial Air apron runs overland into a closed drainage pond to the west of the apron, Analysis Point #2. In the post-development condition all of this stormwater is captured and rerouted to the adjacent wetlands, Analysis Point #1 thus causing an increase in the peak discharge rate.

The peak discharge rate for Analysis Point #2 is significantly decreased due to the re-grading and installation of a closed drainage system in the Colonial Air apron.

Stormwater runoff that was being discharged to Analysis Point #3 is now being routed to Analysis Point #1 after the existing culvert is replaced.

The overall peak discharge rate from the pre-development versus post-development conditions has been reduced for this watershed.

The following is a comparison of the Pre-development versus the Post-development peak stormwater discharge rates for the 2, 10 and 100 year storm events.

	RETURN PERIOD					
	2-YR		10-YR		100 YR	
ANALYSIS POINT	PRE	POST	PRE	POST	PRE	POST
AP-1	0.94	8.11	4.61	11.58	6.68	18.37
AP-2	3.34	0.41	6.17	0.94	10.96	1.90
AP-3	2.99	N/A	4.31	N/A	6.39	N/A

Standard #3: *Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices and good operation and maintenance. At a minimum, the annual recharge from the post development site shall approximate the annual recharge from the pre-development conditions based on soil type. This*

Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Any stormwater runoff generated by the reconstructed areas must be pre-treated before being discharged to groundwater. While the treatment of stormwater runoff will be achieved, the area available to infiltrate runoff is not capable of infiltrating the required amount necessitated by the apron expansion. The existing foot print of the apron allowed for little to no groundwater recharge.

To account for the recharge volume required by the apron expansion an infiltration basin, infiltration trench and proprietary infiltration structures were analyzed. The land available for infiltration measures would not be capable of infiltrating the full amount required by the Standards, but would be suitable to infiltrate a portion of the required volume. Groundwater is approximately 3.5 feet below existing grade according to the soil boring nearest the infiltration site. After designing the drainage system to provide minimum pipe cover and pipe slope the invert of the outlet pipe would be at or below existing groundwater depth. This would preclude an infiltration basin or trench, or even proprietary infiltration structures from being built in this area. Additional areas for infiltration are unavailable because the apron is surrounded by wetlands, drainage ponds and additional Airport pavement.

Standard #4: *Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when (a) Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained; (b) Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with Massachusetts Stormwater Handbook; and (c) Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.*

The new Colonial Air apron drainage system has been designed to remove TSS from stormwater runoff with the use of deep sump catch basins and a proprietary separator. The proprietary separator has been designed to remove 80% of TSS. This portion of the apron will be reconstructed and regraded to separate this runoff from the remaining portion of the apron.

The remaining areas of reconstruction will use the existing drainage system. The existing drainage system is comprised of catch basins with sumps, manholes and drainage pipe of various sizes and types. A proprietary separator will be installed on the pipe that leaves the study area to treat the remaining runoff and achieve 80% TSS removal.

TSS removal calculations are included in Appendix A.

Standard #5: *Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pre-treatment is prohibited.*

Typical airports include land that is considered Land Use with Higher Potential Pollutant Loads (LUHPPL). These areas are defined as apron and plane storage and maintenance areas. Phase I of the apron reconstruction will be treated with proprietary separators before being discharged.

Standard #6: *Stormwater discharges to critical areas must utilize certain stormwater BMPs approved for critical areas. Critical areas are Oustanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries, and recharge areas for public water supplies.*

This Standard is not applicable.

Standard #7: *A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5 and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.*

As described above, work associated with reconstructing the Terminal Area Aprons is considered to be a redevelopment and meets Stormwater Management Standards 2 and 3 and the pre-treatment and structural BMP requirements of Standards 4, 5 and 6 to the maximum extent practicable as follows:

Standard #2: The overall post-development stormwater discharge rate does not exceed the pre-development discharge rate.

Standard #3: Please see the discussion above relating to groundwater recharge.

Standard #4: 80% TSS removal has been achieved for each sub-watershed affected by the reconstruction of the Terminal Area Aprons by using deep sump catch basins and proprietary separators.

Standard #5: The Terminal Area Aprons are considered LUHPPL areas and will be treated with proprietary separators.

Standard #6: This Standard is not applicable.

The project complies with all other standards and improves existing conditions.

Standard #8: *A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.*

Erosion control has been incorporated into the construction plan set. A General Permit Construction Phase SWPPP will be developed by the Contractor for this construction project. A construction SWPPP will be prepared prior to the start of construction.

Standard #9: *A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.*

ASG has prepared a long-term operation and maintenance plan titled "New Bedford Regional Airport – Storm Water Operations and Maintenance Plan" for the New Bedford Regional Airport. This Operations and Maintenance plan has been updated and a copy of the Plan is attached.

Standard #10: *All illicit discharges to the stormwater management system are prohibited.*

All existing illicit discharges associated with the Airport were removed / eliminated as part of the Variance Order issued by MASS DEP (e.g. , floor drains at various hangar facilities).

6. DRAINAGE SUMMARY

Watershed Area Comparison

Pre-dev Conditions		Post-dev Conditions	
Watershed	Area (AC)	Watershed	Area (AC)
EX-RW-E1	21.912	EX-RW5-E1	21.912
EX-COLONIAL-1	0.588	PR-COLONIAL-1	0.757
EX-COLONIAL-2	2.458	PR-COLONIAL-2	0.547
EX-COLONIAL-3	0.098	PR-COLONIAL-3	0.771
EX-COLONIAL-4	0.989	PR-COLONIAL-4	0.466
		PR-COLONIAL-5	0.336
		PR-COLONIAL-6	0.238
		PR-COLONIAL-7	0.031
		PR-COLONIAL-8	0.412
		PR-COLONIAL-9	0.575
Total	26.045		26.045

Soils Comparison

HSG	Pre-dev Area (AC)	Post-dev Area (AC)
A	26.045	26.045
B	0.00	0.00
C	0.00	0.00
D	0.00	0.00
Total	26.045	26.045

Peak Discharge Comparison (cfs)

	2 YR		10 YR		100 YR	
	PRE	POST	PRE	POST	PRE	POST
AP-1	0.94	8.11	4.61	11.58	6.68	18.37
AP-2	3.34	0.41	6.17	0.94	10.96	1.90
AP-3	2.99	N/A	4.31	N/A	6.39	N/A

APPENDIX A

EXISTING DRAINAGE CALCULATIONS

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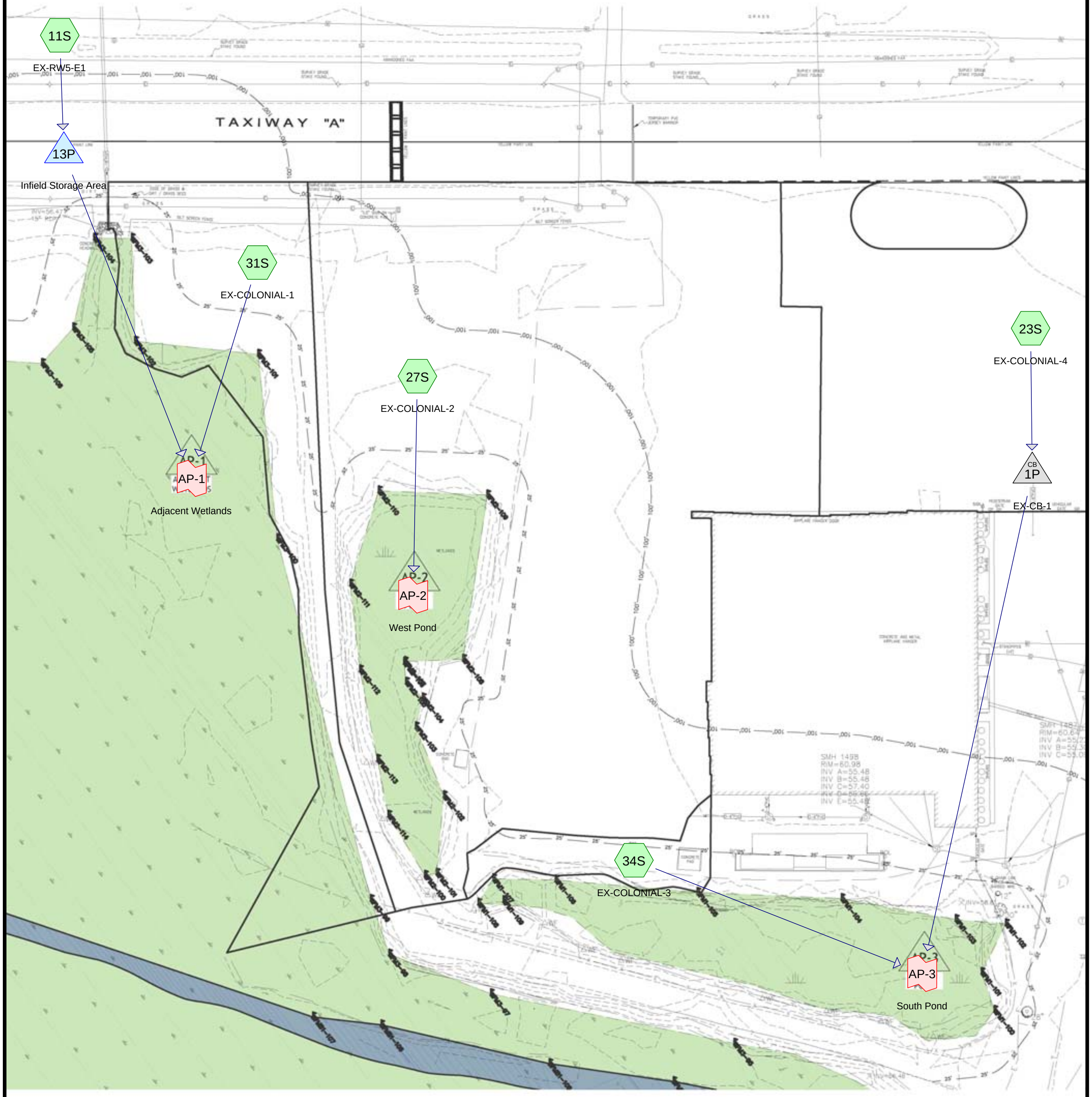

Routing Diagram for 103-032 Existing Drainage Colonial_Only
Prepared by Hewlett-Packard Company, Printed 12/14/2016
HydroCAD® 10.00-14 s/n 06680 © 2015 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
17.515	39	>75% Grass cover, Good, HSG A (11S, 27S, 31S)
0.421	35	Brush, Fair, HSG A (31S)
0.339	30	Brush, Good, HSG A (27S, 34S)
0.126	76	Gravel roads, HSG A (11S)
0.169	96	Gravel surface, HSG A (27S, 31S)
7.226	98	Paved parking, HSG A (11S, 23S, 27S, 34S)
0.249	98	Water Surface, HSG A (27S)
26.045	**56**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
26.045	HSG A	11S, 23S, 27S, 31S, 34S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
26.045		**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: EX-RW5-E1 Runoff Area=21.912 ac 22.13% Impervious Runoff Depth=0.22"
Flow Length=1,467' Tc=45.0 min CN=52 Runoff=1.06 cfs 0.409 af

Subcatchment 23S: EX-COLONIAL-4 Runoff Area=43,093 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=403' Tc=10.0 min CN=98 Runoff=2.87 cfs 0.261 af

Subcatchment 27S: EX-COLONIAL-2 Runoff Area=107,069 sf 63.83% Impervious Runoff Depth=1.36"
Flow Length=328' Tc=10.0 min CN=77 Runoff=3.34 cfs 0.278 af

Subcatchment 31S: EX-COLONIAL-1 Runoff Area=25,593 sf 0.00% Impervious Runoff Depth=0.07"
Flow Length=50' Slope=0.0593 '/' Tc=10.0 min CN=45 Runoff=0.01 cfs 0.003 af

Subcatchment 34S: EX-COLONIAL-3 Runoff Area=4,257 sf 68.17% Impervious Runoff Depth=1.29"
Flow Length=28' Slope=0.0897 '/' Tc=10.0 min CN=76 Runoff=0.13 cfs 0.011 af

Pond 1P: EX-CB-1 Peak Elev=106.64' Inflow=2.87 cfs 0.261 af
6.0" Round Culvert n=0.010 L=273.0' S=0.0022 '/' Outflow=2.87 cfs 0.261 af

Pond 13P: Infield Storage Area Peak Elev=59.56' Storage=785 cf Inflow=1.06 cfs 0.409 af
Outflow=0.93 cfs 0.409 af

Link AP-1: Adjacent Wetlands Inflow=0.94 cfs 0.412 af
Primary=0.94 cfs 0.412 af

Link AP-2: West Pond Inflow=3.34 cfs 0.278 af
Primary=3.34 cfs 0.278 af

Link AP-3: South Pond Inflow=2.99 cfs 0.272 af
Primary=2.99 cfs 0.272 af

Total Runoff Area = 26.045 ac Runoff Volume = 0.962 af Average Runoff Depth = 0.44"
71.30% Pervious = 18.570 ac 28.70% Impervious = 7.475 ac

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: EX-RW5-E1 Runoff Area=21.912 ac 22.13% Impervious Runoff Depth=0.72"
Flow Length=1,467' Tc=45.0 min CN=52 Runoff=6.07 cfs 1.308 af

Subcatchment 23S: EX-COLONIAL-4 Runoff Area=43,093 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=403' Tc=10.0 min CN=98 Runoff=4.07 cfs 0.376 af

Subcatchment 27S: EX-COLONIAL-2 Runoff Area=107,069 sf 63.83% Impervious Runoff Depth=2.46"
Flow Length=328' Tc=10.0 min CN=77 Runoff=6.17 cfs 0.503 af

Subcatchment 31S: EX-COLONIAL-1 Runoff Area=25,593 sf 0.00% Impervious Runoff Depth=0.38"
Flow Length=50' Slope=0.0593 '/' Tc=10.0 min CN=45 Runoff=0.09 cfs 0.019 af

Subcatchment 34S: EX-COLONIAL-3 Runoff Area=4,257 sf 68.17% Impervious Runoff Depth=2.37"
Flow Length=28' Slope=0.0897 '/' Tc=10.0 min CN=76 Runoff=0.24 cfs 0.019 af

Pond 1P: EX-CB-1 Peak Elev=154.78' Inflow=4.07 cfs 0.376 af
6.0" Round Culvert n=0.010 L=273.0' S=0.0022 '/' Outflow=4.07 cfs 0.376 af

Pond 13P: Infield Storage Area Peak Elev=60.03' Storage=5,744 cf Inflow=6.07 cfs 1.308 af
Outflow=4.57 cfs 1.308 af

Link AP-1: Adjacent Wetlands Inflow=4.61 cfs 1.326 af
Primary=4.61 cfs 1.326 af

Link AP-2: West Pond Inflow=6.17 cfs 0.503 af
Primary=6.17 cfs 0.503 af

Link AP-3: South Pond Inflow=4.31 cfs 0.396 af
Primary=4.31 cfs 0.396 af

Total Runoff Area = 26.045 ac Runoff Volume = 2.225 af Average Runoff Depth = 1.03"
71.30% Pervious = 18.570 ac 28.70% Impervious = 7.475 ac

Summary for Subcatchment 11S: EX-RW5-E1

Runoff = 6.07 cfs @ 12.76 hrs, Volume= 1.308 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description	Land Use
4.850	98	Paved parking, HSG A	Pavement
16.936	39	>75% Grass cover, Good, HSG A	Open Space
0.126	76	Gravel roads, HSG A	Roadway
21.912	52	Weighted Average	
17.062		77.87% Pervious Area	
4.850		22.13% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0143	1.08		**Sheet Flow, Over Pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.2	28	0.0143	2.43		**Shallow Concentrated Flow, Over Pavement** Paved Kv= 20.3 fps
39.3	1,081	0.0043	0.46		**Shallow Concentrated Flow, Over Grass** Short Grass Pasture Kv= 7.0 fps
4.7	308	0.0005	1.10	0.86	**Pipe Channel, Pipe Reach** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
45.0	1,467	Total			

Summary for Subcatchment 23S: EX-COLONIAL-4

Minimum Tc of 10 min. used for calculations.

Runoff = 4.07 cfs @ 12.13 hrs, Volume= 0.376 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
43,093	98	Paved parking, HSG A	Pavement
43,093		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0057	0.75		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.8	75	0.0057	1.53		**Shallow Concentrated Flow, Over pavement** Paved Kv= 20.3 fps
1.4	278	0.0079	3.30	0.65	**Pipe Channel, Through pipe to isolated wetland** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.010 PVC, smooth interior

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  3.3      403   Total,  Increased to minimum Tc = 10.0 min
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Summary for Subcatchment 27S: EX-COLONIAL-2

Minimum Tc of 10 mins. used for calculations.

Runoff = 6.17 cfs @ 12.14 hrs, Volume= 0.503 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
3,223	96	Gravel surface, HSG A	Roadway
10,853	98	Water Surface, HSG A	Open Water
22,078	39	>75% Grass cover, Good, HSG A	Open Space
57,489	98	Paved parking, HSG A	Pavement
13,426	30	Brush, Good, HSG A	Brush
107,069	77	Weighted Average	
38,727		36.17% Pervious Area	
68,342		63.83% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0090	0.90		**Sheet Flow, Over Pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.3	38	0.0147	2.46		**Shallow Concentrated Flow, Over Pavement** Paved Kv= 20.3 fps
6.9	198	0.0047	0.48		**Shallow Concentrated Flow, Through grass** Short Grass Pasture Kv= 7.0 fps
1.1	42	0.0158	0.63		**Shallow Concentrated Flow, Through brush** Woodland Kv= 5.0 fps
9.2	328	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 31S: EX-COLONIAL-1

Minimum Tc of 10 min. used for calculations.

Runoff = 0.09 cfs @ 12.39 hrs, Volume= 0.019 af, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
4,128	96	Gravel surface, HSG A	Roadway
18,327	35	Brush, Fair, HSG A	Brush
3,138	39	>75% Grass cover, Good, HSG A	Open Space
25,593	45	Weighted Average	
25,593		100.00% Pervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.0593	0.11		**Sheet Flow, Through brush** Woods: Light underbrush n= 0.400 P2= 3.40"
7.7	50	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 34S: EX-COLONIAL-3

Min. Tc of 10 min. used in calculations.

Runoff = 0.24 cfs @ 12.14 hrs, Volume= 0.019 af, Depth= 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
2,902	98	Paved parking, HSG A	Pavement
1,355	30	Brush, Good, HSG A	Brush
4,257	76	Weighted Average	
1,355		31.83% Pervious Area	
2,902		68.17% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	28	0.0897	0.11		**Sheet Flow, Through brush to open water** Woods: Light underbrush n= 0.400 P2= 3.40"
4.1	28	Total, Increased to minimum Tc = 10.0 min			

Summary for Pond 1P: EX-CB-1

Inflow Area = 0.989 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 4.07 cfs @ 12.13 hrs, Volume= 0.376 af
Outflow = 4.07 cfs @ 12.13 hrs, Volume= 0.376 af, Atten= 0%, Lag= 0.0 min
Primary = 4.07 cfs @ 12.13 hrs, Volume= 0.376 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 154.78' @ 12.13 hrs
Flood Elev= 61.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	59.40'	**6.0" Round Culvert** L= 273.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 59.40' / 58.81' S= 0.0022 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=4.07 cfs @ 12.13 hrs HW=154.61' (Free Discharge)
└─**1=Culvert** (Barrel Controls 4.07 cfs @ 20.73 fps)

Summary for Pond 13P: Infield Storage Area

Inflow Area = 21.912 ac, 22.13% Impervious, Inflow Depth = 0.72" for 10-Year event
Inflow = 6.07 cfs @ 12.76 hrs, Volume= 1.308 af
Outflow = 4.57 cfs @ 13.12 hrs, Volume= 1.308 af, Atten= 25%, Lag= 21.9 min
Primary = 4.57 cfs @ 13.12 hrs, Volume= 1.308 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 60.03' @ 13.12 hrs Surf.Area= 18,388 sf Storage= 5,744 cf
Flood Elev= 61.00' Surf.Area= 114,236 sf Storage= 56,686 cf

Plug-Flow detention time= 16.5 min calculated for 1.307 af (100% of inflow)
Center-of-Mass det. time= 16.5 min (962.7 - 946.2)

Volume	Invert	Avail.Storage	Storage Description
#1	59.29'	56,686 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.29	290	0	0
60.00	14,422	5,223	5,223
60.80	114,236	51,463	56,686

Device	Routing	Invert	Outlet Devices
#1	Device 2	57.03'	**18.0" Round 18" Round Culvert** L= 303.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 57.03' / 56.51' S= 0.0017 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Primary	59.29'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 0.5' Crest Height

Primary OutFlow Max=4.57 cfs @ 13.12 hrs HW=60.03' (Free Discharge)
└─**2=Sharp-Crested Rectangular Weir** (Weir Controls 4.57 cfs @ 3.33 fps)
  └─**1=18" Round Culvert** (Passes 4.57 cfs of 4.90 cfs potential flow)

Summary for Link AP-1: Adjacent Wetlands

Inflow Area = 22.500 ac, 21.56% Impervious, Inflow Depth = 0.71" for 10-Year event
Inflow = 4.61 cfs @ 13.12 hrs, Volume= 1.326 af
Primary = 4.61 cfs @ 13.12 hrs, Volume= 1.326 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Link AP-2: West Pond

Runoff from this sub-watershed runs overland and into an isolated wetland with standing water.

Inflow Area = 2.458 ac, 63.83% Impervious, Inflow Depth = 2.46" for 10-Year event
Inflow = 6.17 cfs @ 12.14 hrs, Volume= 0.503 af
Primary = 6.17 cfs @ 12.14 hrs, Volume= 0.503 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Link AP-3: South Pond

Runoff from this sub-watershed enters into a closed drainage system and is discharged into an isolated wetland with standing water.

```
Inflow Area =          1.087 ac,  97.14% Impervious,  Inflow Depth =   4.37"    for  10-Year event
Inflow       =         4.31 cfs @   12.13 hrs,  Volume=             0.396 af
Primary      =         4.31 cfs @   12.13 hrs,  Volume=             0.396 af,  Atten= 0%,  Lag= 0.0 min
```

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 11S: EX-RW5-E1 Runoff Area=21.912 ac 22.13% Impervious Runoff Depth=1.85"
Flow Length=1,467' Tc=45.0 min CN=52 Runoff=19.73 cfs 3.372 af

Subcatchment 23S: EX-COLONIAL-4 Runoff Area=43,093 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=403' Tc=10.0 min CN=98 Runoff=5.96 cfs 0.557 af

Subcatchment 27S: EX-COLONIAL-2 Runoff Area=107,069 sf 63.83% Impervious Runoff Depth=4.37"
Flow Length=328' Tc=10.0 min CN=77 Runoff=10.96 cfs 0.894 af

Subcatchment 31S: EX-COLONIAL-1 Runoff Area=25,593 sf 0.00% Impervious Runoff Depth=1.24"
Flow Length=50' Slope=0.0593 '/' Tc=10.0 min CN=45 Runoff=0.55 cfs 0.061 af

Subcatchment 34S: EX-COLONIAL-3 Runoff Area=4,257 sf 68.17% Impervious Runoff Depth=4.26"
Flow Length=28' Slope=0.0897 '/' Tc=10.0 min CN=76 Runoff=0.43 cfs 0.035 af

Pond 1P: EX-CB-1 Peak Elev=263.74' Inflow=5.96 cfs 0.557 af
6.0" Round Culvert n=0.010 L=273.0' S=0.0022 '/' Outflow=5.96 cfs 0.557 af

Pond 13P: Infield Storage Area Peak Elev=60.63' Storage=39,410 cf Inflow=19.73 cfs 3.372 af
Outflow=6.59 cfs 3.372 af

Link AP-1: Adjacent Wetlands Inflow=6.68 cfs 3.432 af
Primary=6.68 cfs 3.432 af

Link AP-2: West Pond Inflow=10.96 cfs 0.894 af
Primary=10.96 cfs 0.894 af

Link AP-3: South Pond Inflow=6.39 cfs 0.592 af
Primary=6.39 cfs 0.592 af

Total Runoff Area = 26.045 ac Runoff Volume = 4.919 af Average Runoff Depth = 2.27"
71.30% Pervious = 18.570 ac 28.70% Impervious = 7.475 ac

APPENDIX B

PROPOSED DRAINAGE CALCULATIONS

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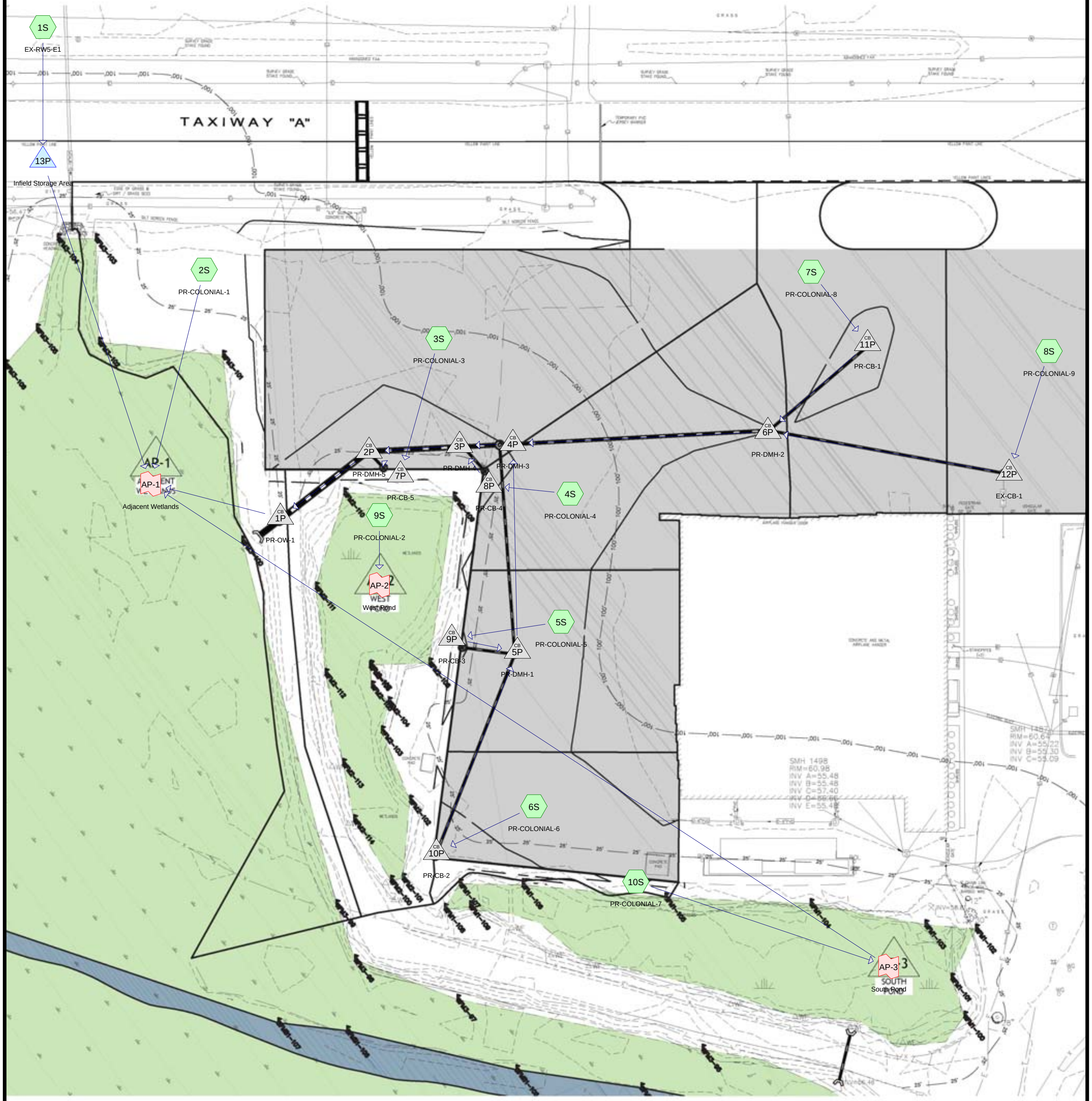

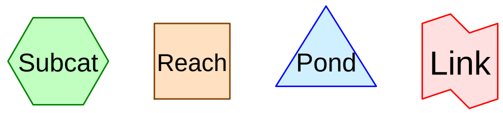

Routing Diagram for 103-032 Proposed Drainage Colonial_Only
Prepared by Hewlett-Packard Company, Printed 12/14/2016
HydroCAD® 10.00-14 s/n 06680 © 2015 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
17.285	39	>75% Grass cover, Good, HSG A (1S, 2S, 9S, 10S)
0.438	35	Brush, Fair, HSG A (2S)
0.197	30	Brush, Good, HSG A (9S)
0.126	76	Gravel roads, HSG A (1S)
0.103	96	Gravel surface, HSG A (2S, 9S)
7.647	98	Paved parking, HSG A (1S, 3S, 4S, 5S, 6S, 7S, 8S)
0.249	98	Water Surface, HSG A (9S)
26.045	**57**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
26.045	HSG A	1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
26.045		**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: EX-RW5-E1 Runoff Area=21.912 ac 22.13% Impervious Runoff Depth=0.22"
Flow Length=1,467' Tc=45.0 min CN=52 Runoff=1.06 cfs 0.409 af

Subcatchment 2S: PR-COLONIAL-1 Runoff Area=32,985 sf 0.00% Impervious Runoff Depth=0.02"
Flow Length=50' Slope=0.0593 '/' Tc=10.0 min CN=41 Runoff=0.00 cfs 0.001 af

Subcatchment 3S: PR-COLONIAL-3 Runoff Area=33,588 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=257' Tc=10.0 min CN=98 Runoff=2.24 cfs 0.203 af

Subcatchment 4S: PR-COLONIAL-4 Runoff Area=20,285 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=444' Tc=10.0 min CN=98 Runoff=1.35 cfs 0.123 af

Subcatchment 5S: PR-COLONIAL-5 Runoff Area=14,631 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=449' Tc=10.0 min CN=98 Runoff=0.97 cfs 0.089 af

Subcatchment 6S: PR-COLONIAL-6 Runoff Area=10,352 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=582' Tc=10.0 min CN=98 Runoff=0.69 cfs 0.063 af

Subcatchment 7S: PR-COLONIAL-8 Runoff Area=17,934 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=652' Tc=10.0 min CN=98 Runoff=1.19 cfs 0.109 af

Subcatchment 8S: PR-COLONIAL-9 Runoff Area=25,059 sf 100.00% Impervious Runoff Depth=3.17"
Flow Length=753' Tc=10.0 min CN=98 Runoff=1.67 cfs 0.152 af

Subcatchment 9S: PR-COLONIAL-2 Runoff Area=23,826 sf 45.55% Impervious Runoff Depth=0.84"
Flow Length=42' Tc=10.0 min CN=68 Runoff=0.41 cfs 0.038 af

Subcatchment 10S: PR-COLONIAL-7 Runoff Area=1,370 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=28' Slope=0.0897 '/' Tc=10.0 min CN=39 Runoff=0.00 cfs 0.000 af

Pond 1P: PR-OW-1 Peak Elev=57.74' Inflow=8.11 cfs 0.738 af
30.0" x 18.0" Box Culvert n=0.012 L=15.0' S=0.0013 '/' Outflow=8.11 cfs 0.738 af

Pond 2P: PR-DMH-5 Peak Elev=58.03' Inflow=8.11 cfs 0.738 af
30.0" x 18.0" Box Culvert n=0.012 L=68.0' S=0.0009 '/' Outflow=8.11 cfs 0.738 af

Pond 3P: PR-DMH-4 Peak Elev=58.25' Inflow=5.88 cfs 0.535 af
24.0" x 18.0" Box Culvert n=0.012 L=58.0' S=0.0010 '/' Outflow=5.88 cfs 0.535 af

Pond 4P: PR-DMH-3 Peak Elev=58.42' Inflow=4.53 cfs 0.412 af
18.0" x 18.0" Box Culvert n=0.012 L=22.0' S=0.0009 '/' Outflow=4.53 cfs 0.412 af

Pond 5P: PR-DMH-1 Peak Elev=58.50' Inflow=1.66 cfs 0.151 af
18.0" Round Culvert n=0.012 L=124.0' S=0.0010 '/' Outflow=1.66 cfs 0.151 af

Pond 6P: PR-DMH-2 Peak Elev=58.64' Inflow=2.86 cfs 0.260 af
18.0" Round Culvert n=0.012 L=163.0' S=0.0010 '/' Outflow=2.86 cfs 0.260 af

Pond 7P: PR-CB-5 Peak Elev=58.10' Inflow=2.24 cfs 0.203 af
18.0" Round Culvert n=0.012 L=14.0' S=0.0014 '/' Outflow=2.24 cfs 0.203 af

Pond 8P: PR-CB-4 Peak Elev=58.37' Inflow=1.35 cfs 0.123 af
12.0" Round Culvert n=0.012 L=17.0' S=0.0012 '/' Outflow=1.35 cfs 0.123 af

Pond 9P: PR-CB-3 Peak Elev=58.56' Inflow=0.97 cfs 0.089 af
12.0" Round Culvert n=0.012 L=32.0' S=0.0009 '/' Outflow=0.97 cfs 0.089 af

Pond 10P: PR-CB-2 Peak Elev=58.55' Inflow=0.69 cfs 0.063 af
12.0" Round Culvert n=0.012 L=132.0' S=0.0010 '/' Outflow=0.69 cfs 0.063 af

Pond 11P: PR-CB-1 Peak Elev=58.67' Inflow=1.19 cfs 0.109 af
18.0" Round Culvert n=0.012 L=80.0' S=0.0010 '/' Outflow=1.19 cfs 0.109 af

Pond 12P: EX-CB-1 Peak Elev=58.72' Inflow=1.67 cfs 0.152 af
18.0" Round Culvert n=0.012 L=144.0' S=0.0010 '/' Outflow=1.67 cfs 0.152 af

Pond 13P: Infield Storage Area Peak Elev=59.56' Storage=786 cf Inflow=1.06 cfs 0.409 af
Outflow=0.93 cfs 0.409 af

Link AP-1: Adjacent Wetlands Inflow=8.11 cfs 1.148 af
Primary=8.11 cfs 1.148 af

Link AP-2: West Pond Inflow=0.41 cfs 0.038 af
Primary=0.41 cfs 0.038 af

Link AP-3: South Pond Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 26.045 ac Runoff Volume = 1.187 af Average Runoff Depth = 0.55"
69.68% Pervious = 18.149 ac 30.32% Impervious = 7.896 ac

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: EX-RW5-E1 Runoff Area=21.912 ac 22.13% Impervious Runoff Depth=0.72"
Flow Length=1,467' Tc=45.0 min CN=52 Runoff=6.07 cfs 1.308 af

Subcatchment 2S: PR-COLONIAL-1 Runoff Area=32,985 sf 0.00% Impervious Runoff Depth=0.23"
Flow Length=50' Slope=0.0593 '/' Tc=10.0 min CN=41 Runoff=0.04 cfs 0.014 af

Subcatchment 3S: PR-COLONIAL-3 Runoff Area=33,588 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=257' Tc=10.0 min CN=98 Runoff=3.18 cfs 0.293 af

Subcatchment 4S: PR-COLONIAL-4 Runoff Area=20,285 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=444' Tc=10.0 min CN=98 Runoff=1.92 cfs 0.177 af

Subcatchment 5S: PR-COLONIAL-5 Runoff Area=14,631 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=449' Tc=10.0 min CN=98 Runoff=1.38 cfs 0.128 af

Subcatchment 6S: PR-COLONIAL-6 Runoff Area=10,352 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=582' Tc=10.0 min CN=98 Runoff=0.98 cfs 0.090 af

Subcatchment 7S: PR-COLONIAL-8 Runoff Area=17,934 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=652' Tc=10.0 min CN=98 Runoff=1.70 cfs 0.157 af

Subcatchment 8S: PR-COLONIAL-9 Runoff Area=25,059 sf 100.00% Impervious Runoff Depth=4.56"
Flow Length=753' Tc=10.0 min CN=98 Runoff=2.37 cfs 0.219 af

Subcatchment 9S: PR-COLONIAL-2 Runoff Area=23,826 sf 45.55% Impervious Runoff Depth=1.74"
Flow Length=42' Tc=10.0 min CN=68 Runoff=0.94 cfs 0.079 af

Subcatchment 10S: PR-COLONIAL-7 Runoff Area=1,370 sf 0.00% Impervious Runoff Depth=0.16"
Flow Length=28' Slope=0.0897 '/' Tc=10.0 min CN=39 Runoff=0.00 cfs 0.000 af

Pond 1P: PR-OW-1 Peak Elev=58.06' Inflow=11.52 cfs 1.064 af
30.0" x 18.0" Box Culvert n=0.012 L=15.0' S=0.0013 '/' Outflow=11.52 cfs 1.064 af

Pond 2P: PR-DMH-5 Peak Elev=58.46' Inflow=11.52 cfs 1.064 af
30.0" x 18.0" Box Culvert n=0.012 L=68.0' S=0.0009 '/' Outflow=11.52 cfs 1.064 af

Pond 3P: PR-DMH-4 Peak Elev=58.79' Inflow=8.35 cfs 0.771 af
24.0" x 18.0" Box Culvert n=0.012 L=58.0' S=0.0010 '/' Outflow=8.35 cfs 0.771 af

Pond 4P: PR-DMH-3 Peak Elev=59.13' Inflow=6.43 cfs 0.593 af
18.0" x 18.0" Box Culvert n=0.012 L=22.0' S=0.0009 '/' Outflow=6.43 cfs 0.593 af

Pond 5P: PR-DMH-1 Peak Elev=59.22' Inflow=2.36 cfs 0.218 af
18.0" Round Culvert n=0.012 L=124.0' S=0.0010 '/' Outflow=2.36 cfs 0.218 af

Pond 6P: PR-DMH-2 Peak Elev=59.45' Inflow=4.07 cfs 0.375 af
18.0" Round Culvert n=0.012 L=163.0' S=0.0010 '/' Outflow=4.07 cfs 0.375 af

```
Pond 7P: PR-CB-5                                         Peak Elev=58.60'   Inflow=3.18 cfs  0.293 af
                      18.0"  Round Culvert  n=0.012  L=14.0'  S=0.0014 '/'   Outflow=3.18 cfs  0.293 af

Pond 8P: PR-CB-4                                         Peak Elev=59.04'   Inflow=1.92 cfs  0.177 af
                      12.0"  Round Culvert  n=0.012  L=17.0'  S=0.0012 '/'   Outflow=1.92 cfs  0.177 af

Pond 9P: PR-CB-3                                         Peak Elev=59.34'   Inflow=1.38 cfs  0.128 af
                      12.0"  Round Culvert  n=0.012  L=32.0'  S=0.0009 '/'   Outflow=1.38 cfs  0.128 af

Pond 10P: PR-CB-2                                        Peak Elev=59.33'   Inflow=0.98 cfs  0.090 af
                     12.0"  Round Culvert  n=0.012  L=132.0'  S=0.0010 '/'   Outflow=0.98 cfs  0.090 af

Pond 11P: PR-CB-1                                        Peak Elev=59.48'   Inflow=1.70 cfs  0.157 af
                      18.0"  Round Culvert  n=0.012  L=80.0'  S=0.0010 '/'   Outflow=1.70 cfs  0.157 af

Pond 12P: EX-CB-1                                        Peak Elev=59.54'   Inflow=2.37 cfs  0.219 af
                     18.0"  Round Culvert  n=0.012  L=144.0'  S=0.0010 '/'   Outflow=2.37 cfs  0.219 af

Pond 13P: Infield Storage Area           Peak Elev=60.03'  Storage=5,747 cf   Inflow=6.07 cfs  1.308 af
                                                                             Outflow=4.57 cfs  1.308 af

Link AP-1: Adjacent Wetlands                                                 Inflow=11.58 cfs  2.386 af
                                                                            Primary=11.58 cfs  2.386 af

Link AP-2: West Pond                                                          Inflow=0.94 cfs  0.079 af
                                                                             Primary=0.94 cfs  0.079 af

Link AP-3: South Pond                                                         Inflow=0.00 cfs  0.000 af
                                                                             Primary=0.00 cfs  0.000 af

          Total Runoff Area = 26.045 ac   Runoff Volume = 2.465 af   Average Runoff Depth = 1.14"
                                    69.68% Pervious = 18.149 ac     30.32% Impervious = 7.896 ac
```

Summary for Subcatchment 1S: EX-RW5-E1

Runoff = 6.07 cfs @ 12.76 hrs, Volume= 1.308 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description	Land Use
4.850	98	Paved parking, HSG A	Pavement
16.936	39	>75% Grass cover, Good, HSG A	Open Space
0.126	76	Gravel roads, HSG A	Roadway
21.912	52	Weighted Average	
17.062		77.87% Pervious Area	
4.850		22.13% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0143	1.08		**Sheet Flow, Over Pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.2	28	0.0143	2.43		**Shallow Concentrated Flow, Over Pavement** Paved Kv= 20.3 fps
39.3	1,081	0.0043	0.46		**Shallow Concentrated Flow, Over Grass** Short Grass Pasture Kv= 7.0 fps
4.7	308	0.0005	1.10	0.86	**Pipe Channel, Pipe Reach** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
45.0	1,467	Total			

Summary for Subcatchment 2S: PR-COLONIAL-1

Minimum Tc of 10 min. used for calculations.

Runoff = 0.04 cfs @ 12.50 hrs, Volume= 0.014 af, Depth= 0.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
2,242	96	Gravel surface, HSG A	Roadway
19,060	35	Brush, Fair, HSG A	Brush
11,683	39	>75% Grass cover, Good, HSG A	Open Space
32,985	41	Weighted Average	
32,985		100.00% Pervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.0593	0.11		**Sheet Flow, Through brush** Woods: Light underbrush n= 0.400 P2= 3.40"
7.7	50	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 3S: PR-COLONIAL-3

Min. Tc of 10 min. used in calculations.

Runoff = 3.18 cfs @ 12.13 hrs, Volume= 0.293 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
33,588	98	Paved parking, HSG A	Pavement
33,588		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.94		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.8	113	0.0135	2.36		**Shallow Concentrated Flow, Over pavement** Paved Kv= 20.3 fps
0.1	14	0.0044	3.26	2.56	**Pipe Channel, From CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.4	80	0.0017	3.22	10.10	**Pipe Channel, DMH to HW** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
2.2	257	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 4S: PR-COLONIAL-4

Min. Tc of 10 min. used in calculations.

Runoff = 1.92 cfs @ 12.13 hrs, Volume= 0.177 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
20,285	98	Paved parking, HSG A	Pavement
20,285		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0059	0.76		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
3.7	239	0.0065	1.08		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.1	17	0.0044	3.26	2.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	58	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	80	0.0017	3.22	10.10	**Pipe Channel, DMH to HW** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
5.6	444	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 5S: PR-COLONIAL-5

Min. Tc of 10 min. used in calculations.

Runoff = 1.38 cfs @ 12.13 hrs, Volume= 0.128 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
14,631	98	Paved parking, HSG A	Pavement
14,631		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0108	0.96		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
1.2	83	0.0138	1.18		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.2	32	0.0044	3.26	2.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.6	124	0.0044	3.26	2.56	**Pipe Channel, DMH to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	22	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.3	58	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	80	0.0017	3.22	10.10	**Pipe Channel, DMH to HW** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'

Tc (min)	Length (feet)	Description
		n= 0.012 Concrete pipe, finished
3.7	449	Total, Increased to minimum Tc = 10.0 min

Summary for Subcatchment 6S: PR-COLONIAL-6

Min. Tc of 10 min. used in calculations.

Runoff = 0.98 cfs @ 12.13 hrs, Volume= 0.090 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
10,352	98	Paved parking, HSG A	Pavement
10,352		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0127	1.03		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
1.7	116	0.0111	1.15		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.7	132	0.0044	3.26	2.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.6	124	0.0044	3.26	2.56	**Pipe Channel, DMH to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	22	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.3	58	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	80	0.0017	3.22	10.10	**Pipe Channel, DMH to HW** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
4.6	582	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 7S: PR-COLONIAL-8

Min. Tc of 10 min. used in calculations.

Runoff = 1.70 cfs @ 12.13 hrs, Volume= 0.157 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
17,934	98	Paved parking, HSG A	Pavement
17,934		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0110	0.97		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
1.8	75	0.0039	0.70		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.4	80	0.0044	3.26	2.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.8	163	0.0044	3.26	2.56	**Pipe Channel, DMH to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.6	124	0.0044	3.26	2.56	**Pipe Channel, DMH to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	22	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.3	58	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	80	0.0017	3.22	10.10	**Pipe Channel, DMH to HW** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
5.3	652	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 8S: PR-COLONIAL-9

Min. Tc of 10 min. used in calculations.

Runoff = 2.37 cfs @ 12.13 hrs, Volume= 0.219 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
25,059	98	Paved parking, HSG A	Pavement
25,059		100.00% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0066	0.79		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
1.8	112	0.0082	1.02		**Sheet Flow, Over pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.7	144	0.0044	3.26	2.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.8	163	0.0044	3.26	2.56	**Pipe Channel, DMH to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.6	124	0.0044	3.26	2.56	**Pipe Channel, DMH to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	22	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.3	58	0.0026	3.28	5.80	**Pipe Channel, DMH to DMH** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	80	0.0017	3.22	10.10	**Pipe Channel, DMH to HW** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
5.8	753	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 9S: PR-COLONIAL-2

Minimum Tc of 10 mins. used for calculations.

Runoff = 0.94 cfs @ 12.15 hrs, Volume= 0.079 af, Depth= 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
2,242	96	Gravel surface, HSG A	Roadway
10,853	98	Water Surface, HSG A	Open Water
2,129	39	>75% Grass cover, Good, HSG A	Open Space
8,602	30	Brush, Good, HSG A	Brush
23,826	68	Weighted Average	
12,973		54.45% Pervious Area	
10,853		45.55% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	13	0.0090	0.69		**Sheet Flow, Over Pavement** Smooth surfaces n= 0.011 P2= 3.40"
0.7	21	0.0047	0.48		**Shallow Concentrated Flow, Through grass** Short Grass Pasture Kv= 7.0 fps
0.2	8	0.0158	0.63		**Shallow Concentrated Flow, Through brush** Woodland Kv= 5.0 fps
1.2	42	Total, Increased to minimum Tc = 10.0 min			

Summary for Subcatchment 10S: PR-COLONIAL-7

Min. Tc of 10 min. used in calculations

Runoff = 0.00 cfs @ 13.72 hrs, Volume= 0.000 af, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description	Land Use
1,370	39	>75% Grass cover, Good, HSG A	Pavement
1,370		100.00% Pervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	28	0.0897	0.11		**Sheet Flow, Through brush to open water** Woods: Light underbrush n= 0.400 P2= 3.40"
4.1	28	Total, Increased to minimum Tc = 10.0 min			

Summary for Pond 1P: PR-OW-1

Inflow Area = 2.797 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 11.52 cfs @ 12.13 hrs, Volume= 1.064 af
Outflow = 11.52 cfs @ 12.13 hrs, Volume= 1.064 af, Atten= 0%, Lag= 0.0 min
Primary = 11.52 cfs @ 12.13 hrs, Volume= 1.064 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 58.06' @ 12.13 hrs
Flood Elev= 60.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	56.52'	**30.0" W x 18.0" H Box Culvert** L= 15.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 56.52' / 56.50' S= 0.0013 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.75 sf

Primary OutFlow Max=11.51 cfs @ 12.13 hrs HW=58.05' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 11.51 cfs @ 4.00 fps)

Summary for Pond 2P: PR-DMH-5

Inflow Area = 2.797 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 11.52 cfs @ 12.13 hrs, Volume= 1.064 af
Outflow = 11.52 cfs @ 12.13 hrs, Volume= 1.064 af, Atten= 0%, Lag= 0.0 min
Primary = 11.52 cfs @ 12.13 hrs, Volume= 1.064 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 58.46' @ 12.14 hrs
Flood Elev= 60.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	56.59'	**30.0" W x 18.0" H Box Culvert** L= 68.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 56.59' / 56.53' S= 0.0009 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.75 sf

Primary OutFlow Max=11.45 cfs @ 12.13 hrs HW=58.46' TW=58.05' (Dynamic Tailwater)
⬑**1=Culvert** (Inlet Controls 11.45 cfs @ 3.05 fps)

Summary for Pond 3P: PR-DMH-4

Inflow Area = 2.026 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 8.35 cfs @ 12.13 hrs, Volume= 0.771 af
Outflow = 8.35 cfs @ 12.13 hrs, Volume= 0.771 af, Atten= 0%, Lag= 0.0 min
Primary = 8.35 cfs @ 12.13 hrs, Volume= 0.771 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 58.79' @ 12.14 hrs
Flood Elev= 60.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	56.75'	**24.0" W x 18.0" H Box Culvert** L= 58.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 56.75' / 56.69' S= 0.0010 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.00 sf

Primary OutFlow Max=8.12 cfs @ 12.13 hrs HW=58.77' TW=58.46' (Dynamic Tailwater)
⬑**1=Culvert** (Inlet Controls 8.12 cfs @ 2.71 fps)

Summary for Pond 4P: PR-DMH-3

Inflow Area = 1.561 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 6.43 cfs @ 12.13 hrs, Volume= 0.593 af
Outflow = 6.43 cfs @ 12.13 hrs, Volume= 0.593 af, Atten= 0%, Lag= 0.0 min
Primary = 6.43 cfs @ 12.13 hrs, Volume= 0.593 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Peak Elev= 59.13' @ 12.15 hrs
Flood Elev= 61.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	56.87'	**18.0" W x 18.0" H Box Culvert** L= 22.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 56.87' / 56.85' S= 0.0009 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 2.25 sf

Primary OutFlow Max=6.08 cfs @ 12.13 hrs HW=59.09' TW=58.77' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 6.08 cfs @ 2.70 fps)

Summary for Pond 5P: PR-DMH-1

Inflow Area = 0.574 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 2.36 cfs @ 12.13 hrs, Volume= 0.218 af
Outflow = 2.36 cfs @ 12.13 hrs, Volume= 0.218 af, Atten= 0%, Lag= 0.0 min
Primary = 2.36 cfs @ 12.13 hrs, Volume= 0.218 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 59.22' @ 12.16 hrs
Flood Elev= 60.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.10'	**18.0" Round Culvert** L= 124.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 57.10' / 56.97' S= 0.0010 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=1.38 cfs @ 12.13 hrs HW=59.12' TW=59.09' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.38 cfs @ 0.78 fps)

Summary for Pond 6P: PR-DMH-2

Inflow Area = 0.987 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 4.07 cfs @ 12.13 hrs, Volume= 0.375 af
Outflow = 4.07 cfs @ 12.13 hrs, Volume= 0.375 af, Atten= 0%, Lag= 0.0 min
Primary = 4.07 cfs @ 12.13 hrs, Volume= 0.375 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 59.45' @ 12.16 hrs
Flood Elev= 61.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.14'	**18.0" Round Culvert** L= 163.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 57.14' / 56.97' S= 0.0010 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=3.67 cfs @ 12.13 hrs HW=59.36' TW=59.09' (Dynamic Tailwater)
↰**1=Culvert** (Outlet Controls 3.67 cfs @ 2.07 fps)

Summary for Pond 7P: PR-CB-5

Inflow Area = 0.771 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 3.18 cfs @ 12.13 hrs, Volume= 0.293 af
Outflow = 3.18 cfs @ 12.13 hrs, Volume= 0.293 af, Atten= 0%, Lag= 0.0 min
Primary = 3.18 cfs @ 12.13 hrs, Volume= 0.293 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 58.60' @ 12.15 hrs
Flood Elev= 60.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	56.71'	**18.0" Round Culvert** L= 14.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 56.71' / 56.69' S= 0.0014 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=2.97 cfs @ 12.13 hrs HW=58.58' TW=58.46' (Dynamic Tailwater)
↰**1=Culvert** (Inlet Controls 2.97 cfs @ 1.68 fps)

Summary for Pond 8P: PR-CB-4

Inflow Area = 0.466 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 1.92 cfs @ 12.13 hrs, Volume= 0.177 af
Outflow = 1.92 cfs @ 12.13 hrs, Volume= 0.177 af, Atten= 0%, Lag= 0.0 min
Primary = 1.92 cfs @ 12.13 hrs, Volume= 0.177 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 59.04' @ 12.15 hrs
Flood Elev= 61.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	56.87'	**12.0" Round Culvert** L= 17.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 56.87' / 56.85' S= 0.0012 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Primary OutFlow Max=1.77 cfs @ 12.13 hrs HW=58.99' TW=58.77' (Dynamic Tailwater)
↰**1=Culvert** (Inlet Controls 1.77 cfs @ 2.26 fps)

Summary for Pond 9P: PR-CB-3

Inflow Area = 0.336 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 1.38 cfs @ 12.13 hrs, Volume= 0.128 af
Outflow = 1.38 cfs @ 12.13 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min
Primary = 1.38 cfs @ 12.13 hrs, Volume= 0.128 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 59.34' @ 12.17 hrs
Flood Elev= 61.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.23'	**12.0" Round Culvert** L= 32.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 57.23' / 57.20' S= 0.0009 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Primary OutFlow Max=0.79 cfs @ 12.13 hrs HW=59.16' TW=59.12' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.79 cfs @ 1.01 fps)

Summary for Pond 10P: PR-CB-2

Inflow Area = 0.238 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 0.98 cfs @ 12.13 hrs, Volume= 0.090 af
Outflow = 0.98 cfs @ 12.13 hrs, Volume= 0.090 af, Atten= 0%, Lag= 0.0 min
Primary = 0.98 cfs @ 12.13 hrs, Volume= 0.090 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 59.33' @ 12.17 hrs
Flood Elev= 61.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.33'	**12.0" Round Culvert** L= 132.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 57.33' / 57.20' S= 0.0010 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Primary OutFlow Max=0.50 cfs @ 12.13 hrs HW=59.15' TW=59.12' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.50 cfs @ 0.64 fps)

Summary for Pond 11P: PR-CB-1

Inflow Area = 0.412 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 1.70 cfs @ 12.13 hrs, Volume= 0.157 af
Outflow = 1.70 cfs @ 12.13 hrs, Volume= 0.157 af, Atten= 0%, Lag= 0.0 min
Primary = 1.70 cfs @ 12.13 hrs, Volume= 0.157 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Peak Elev= 59.48' @ 12.17 hrs
Flood Elev= 61.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.32'	**18.0" Round Culvert** L= 80.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 57.32' / 57.24' S= 0.0010 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=0.00 cfs @ 12.13 hrs HW=59.31' TW=59.36' (Dynamic Tailwater)
└─**1=Culvert** (Controls 0.00 cfs)

Summary for Pond 12P: EX-CB-1

Inflow Area = 0.575 ac,100.00% Impervious, Inflow Depth = 4.56" for 10-Year event
Inflow = 2.37 cfs @ 12.13 hrs, Volume= 0.219 af
Outflow = 2.37 cfs @ 12.13 hrs, Volume= 0.219 af, Atten= 0%, Lag= 0.0 min
Primary = 2.37 cfs @ 12.13 hrs, Volume= 0.219 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 59.54' @ 12.16 hrs
Flood Elev= 61.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.38'	**18.0" Round Culvert** L= 144.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 57.38' / 57.24' S= 0.0010 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=0.81 cfs @ 12.13 hrs HW=59.37' TW=59.36' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.81 cfs @ 0.46 fps)

Summary for Pond 13P: Infield Storage Area

Inflow Area = 21.912 ac, 22.13% Impervious, Inflow Depth = 0.72" for 10-Year event
Inflow = 6.07 cfs @ 12.76 hrs, Volume= 1.308 af
Outflow = 4.57 cfs @ 13.12 hrs, Volume= 1.308 af, Atten= 25%, Lag= 21.9 min
Primary = 4.57 cfs @ 13.12 hrs, Volume= 1.308 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 60.03' @ 13.12 hrs Surf.Area= 18,410 sf Storage= 5,747 cf
Flood Elev= 61.00' Surf.Area= 114,236 sf Storage= 56,686 cf

Plug-Flow detention time= 16.5 min calculated for 1.307 af (100% of inflow)
Center-of-Mass det. time= 16.5 min (962.7 - 946.2)

Volume	Invert	Avail.Storage	Storage Description
#1	59.29'	56,686 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.29	290	0	0
60.00	14,422	5,223	5,223
60.80	114,236	51,463	56,686

Device	Routing	Invert	Outlet Devices
#1	Device 2	57.03'	**18.0" Round 18" Round Culvert** L= 303.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 57.03' / 56.51' S= 0.0017 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Primary	59.29'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 0.5' Crest Height

Primary OutFlow Max=4.57 cfs @ 13.12 hrs HW=60.03' TW=0.00' (Dynamic Tailwater)
└─**2=Sharp-Crested Rectangular Weir** (Weir Controls 4.57 cfs @ 3.33 fps)
  └─**1=18" Round Culvert** (Passes 4.57 cfs of 4.90 cfs potential flow)

Summary for Link AP-1: Adjacent Wetlands

Inflow Area = 25.498 ac, 29.99% Impervious, Inflow Depth = 1.12" for 10-Year event
Inflow = 11.58 cfs @ 12.13 hrs, Volume= 2.386 af
Primary = 11.58 cfs @ 12.13 hrs, Volume= 2.386 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Link AP-2: West Pond

Runoff from this sub-watershed runs overland and into an isolated wetland with standing water.

Inflow Area = 0.547 ac, 45.55% Impervious, Inflow Depth = 1.74" for 10-Year event
Inflow = 0.94 cfs @ 12.15 hrs, Volume= 0.079 af
Primary = 0.94 cfs @ 12.15 hrs, Volume= 0.079 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Link AP-3: South Pond

Runoff from this sub-watershed enters into a closed drainage system and is discharged into an isolated wetland with standing water.

Inflow Area = 0.031 ac, 0.00% Impervious, Inflow Depth = 0.16" for 10-Year event
Inflow = 0.00 cfs @ 13.72 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 13.72 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: EX-RW5-E1 Runoff Area=21.912 ac 22.13% Impervious Runoff Depth=1.85"
Flow Length=1,467' Tc=45.0 min CN=52 Runoff=19.73 cfs 3.372 af

Subcatchment 2S: PR-COLONIAL-1 Runoff Area=32,985 sf 0.00% Impervious Runoff Depth=0.92"
Flow Length=50' Slope=0.0593 '/' Tc=10.0 min CN=41 Runoff=0.42 cfs 0.058 af

Subcatchment 3S: PR-COLONIAL-3 Runoff Area=33,588 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=257' Tc=10.0 min CN=98 Runoff=4.65 cfs 0.434 af

Subcatchment 4S: PR-COLONIAL-4 Runoff Area=20,285 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=444' Tc=10.0 min CN=98 Runoff=2.81 cfs 0.262 af

Subcatchment 5S: PR-COLONIAL-5 Runoff Area=14,631 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=449' Tc=10.0 min CN=98 Runoff=2.02 cfs 0.189 af

Subcatchment 6S: PR-COLONIAL-6 Runoff Area=10,352 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=582' Tc=10.0 min CN=98 Runoff=1.43 cfs 0.134 af

Subcatchment 7S: PR-COLONIAL-8 Runoff Area=17,934 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=652' Tc=10.0 min CN=98 Runoff=2.48 cfs 0.232 af

Subcatchment 8S: PR-COLONIAL-9 Runoff Area=25,059 sf 100.00% Impervious Runoff Depth=6.76"
Flow Length=753' Tc=10.0 min CN=98 Runoff=3.47 cfs 0.324 af

Subcatchment 9S: PR-COLONIAL-2 Runoff Area=23,826 sf 45.55% Impervious Runoff Depth=3.41"
Flow Length=42' Tc=10.0 min CN=68 Runoff=1.90 cfs 0.155 af

Subcatchment 10S: PR-COLONIAL-7 Runoff Area=1,370 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=28' Slope=0.0897 '/' Tc=10.0 min CN=39 Runoff=0.01 cfs 0.002 af

Pond 1P: PR-OW-1 Peak Elev=58.50' Inflow=16.86 cfs 1.576 af
30.0" x 18.0" Box Culvert n=0.012 L=15.0' S=0.0013 '/' Outflow=16.86 cfs 1.576 af

Pond 2P: PR-DMH-5 Peak Elev=59.37' Inflow=16.86 cfs 1.576 af
30.0" x 18.0" Box Culvert n=0.012 L=68.0' S=0.0009 '/' Outflow=16.86 cfs 1.576 af

Pond 3P: PR-DMH-4 Peak Elev=60.07' Inflow=12.21 cfs 1.142 af
24.0" x 18.0" Box Culvert n=0.012 L=58.0' S=0.0010 '/' Outflow=12.21 cfs 1.142 af

Pond 4P: PR-DMH-3 Peak Elev=60.81' Inflow=9.41 cfs 0.879 af
18.0" x 18.0" Box Culvert n=0.012 L=22.0' S=0.0009 '/' Outflow=9.41 cfs 0.879 af

Pond 5P: PR-DMH-1 Peak Elev=61.00' Inflow=3.46 cfs 0.323 af
18.0" Round Culvert n=0.012 L=124.0' S=0.0010 '/' Outflow=3.46 cfs 0.323 af

Pond 6P: PR-DMH-2 Peak Elev=61.49' Inflow=5.95 cfs 0.556 af
18.0" Round Culvert n=0.012 L=163.0' S=0.0010 '/' Outflow=5.95 cfs 0.556 af

Pond 7P: PR-CB-5
Peak Elev=59.66' Inflow=4.65 cfs 0.434 af
18.0" Round Culvert n=0.012 L=14.0' S=0.0014 '/' Outflow=4.65 cfs 0.434 af

Pond 8P: PR-CB-4
Peak Elev=60.61' Inflow=2.81 cfs 0.262 af
12.0" Round Culvert n=0.012 L=17.0' S=0.0012 '/' Outflow=2.81 cfs 0.262 af

Pond 9P: PR-CB-3
Peak Elev=61.26' Inflow=2.02 cfs 0.189 af
12.0" Round Culvert n=0.012 L=32.0' S=0.0009 '/' Outflow=2.02 cfs 0.189 af

Pond 10P: PR-CB-2
Peak Elev=61.24' Inflow=1.43 cfs 0.134 af
12.0" Round Culvert n=0.012 L=132.0' S=0.0010 '/' Outflow=1.43 cfs 0.134 af

Pond 11P: PR-CB-1
Peak Elev=61.57' Inflow=2.48 cfs 0.232 af
18.0" Round Culvert n=0.012 L=80.0' S=0.0010 '/' Outflow=2.48 cfs 0.232 af

Pond 12P: EX-CB-1
Peak Elev=61.69' Inflow=3.47 cfs 0.324 af
18.0" Round Culvert n=0.012 L=144.0' S=0.0010 '/' Outflow=3.47 cfs 0.324 af

Pond 13P: Infield Storage Area
Peak Elev=60.63' Storage=39,413 cf Inflow=19.73 cfs 3.372 af
Outflow=6.59 cfs 3.372 af

Link AP-1: Adjacent Wetlands
Inflow=18.37 cfs 5.008 af
Primary=18.37 cfs 5.008 af

Link AP-2: West Pond
Inflow=1.90 cfs 0.155 af
Primary=1.90 cfs 0.155 af

Link AP-3: South Pond
Inflow=0.01 cfs 0.002 af
Primary=0.01 cfs 0.002 af

Total Runoff Area = 26.045 ac Runoff Volume = 5.163 af Average Runoff Depth = 2.38"
69.68% Pervious = 18.149 ac 30.32% Impervious = 7.896 ac

APPENDIX C

TSS REMOVAL CALCULATIONS

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INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: PR-COLONIAL-3

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	**1.00**	0.25	0.75
Hydrodynamic Separator	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 103-030 EWB

Prepared By: Mark K. Ottariano

Date: 15-Dec-16

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Non-automated: Mar. 4, 2008

INSTRUCTIONS:
1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: PR-COLONIAL-4

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	**1.00**	0.25	0.75
Hydrodynamic Separator	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 103-030 EWB
Prepared By: Mark K. Ottariano
Date: 15-Dec-16

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

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2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: PR-COLONIAL-5

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	**1.00**	0.25	0.75
Hydrodynamic Separator	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 103-030 EWB
Prepared By: Mark K. Ottariano
Date: 15-Dec-16

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

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2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: PR-COLONIAL-6

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	**1.00**	0.25	0.75
Hydrodynamic Separator	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 103-030 EWB
Prepared By: Mark K. Ottariano
Date: 15-Dec-16

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: PR-COLONIAL-8

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	**1.00**	0.25	0.75
Hydrodynamic Separator	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 103-030 EWB

Prepared By: Mark K. Ottariano

Date: 15-Dec-16

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: PR-COLONIAL-9

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump and Hooded Catch Basin	0.25	**1.00**	0.25	0.75
Hydrodynamic Separator	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 103-030 EWB
Prepared By: Mark K. Ottariano
Date: 15-Dec-16

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

[1] *From MassDEP Stormwater Handbook Vol. 1*

Mass. Dept. of Environmental Protection

APPENDIX D

EXHIBITS

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EXISTING AND PROPOSED DRAINAGE PLANS

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MARK K. OTTAVIANO
CIVIL
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NO.	DATE	DESCRIPTION	BY
1	12/14/16	REVISED DRAINAGE AREAS	MKO

PROJECT
RECONSTRUCT TERMINAL APRONS
PHASE I

OWNER
NEW BEDFORD AIRPORT COMMISSION
NEW BEDFORD REGIONAL AIRPORT
NEW BEDFORD, MASSACHUSETTS

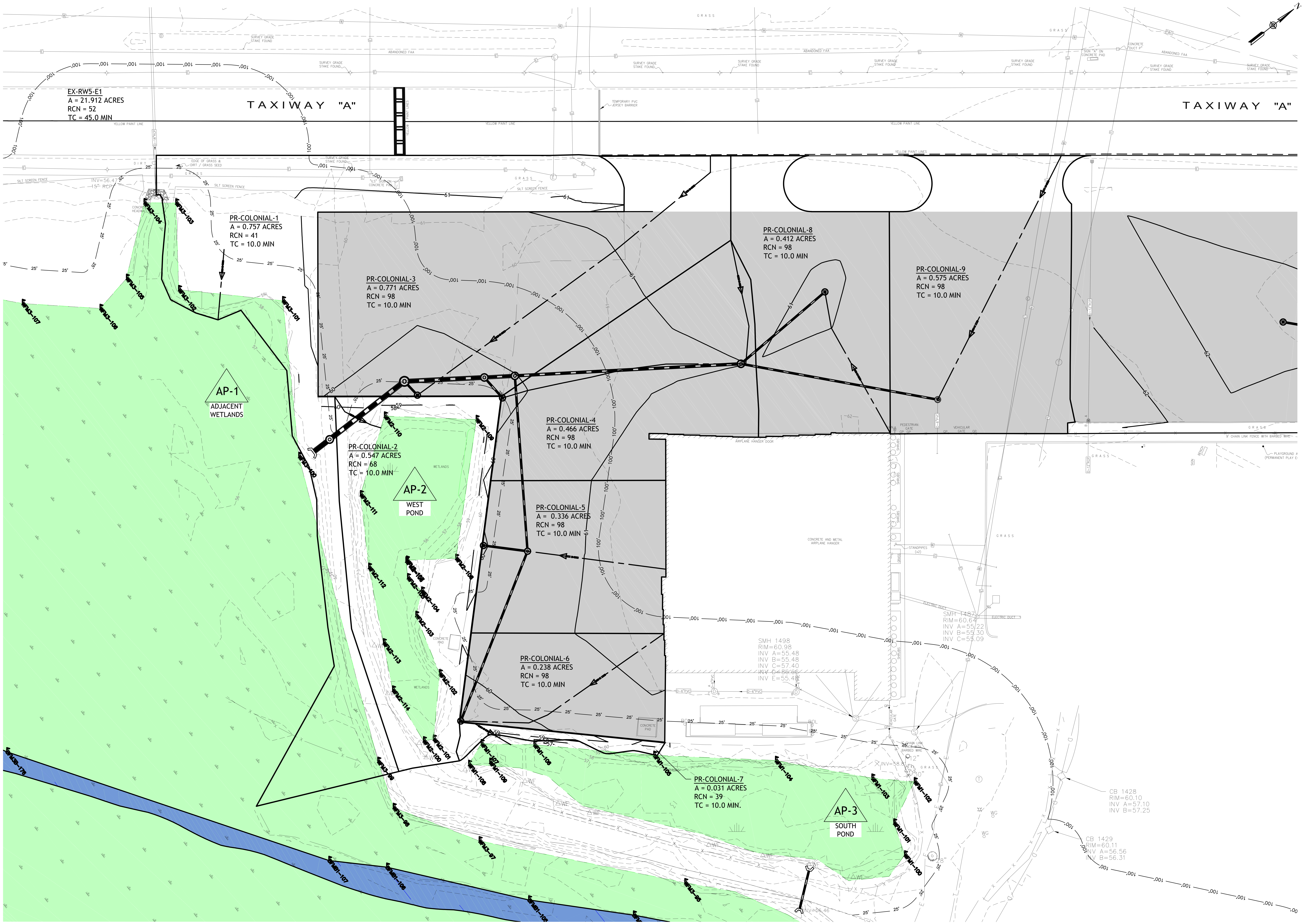
PROJECT NO.	103-032
CADD FILE	SHEET_DRAINAGE
DESIGNED BY	MKO
DRAWN BY	MKO
CHECKED BY	RAL
DATE	SEPTEMBER 2016
DRAWING SCALE	1" = 30'

SHEET TITLE
EXISTING DRAINAGE PLAN

GRAPHIC SCALE
0 15 30 60

DRAWING NO.
D1.1
1 OF 2

2016-09-26 NOI SUBMISSION



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MARK K. OTTAVIANO

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PHONE (781) 491-0083 FAX (781) 491-0360

NO.	DATE	DESCRIPTION	BY
1	12/14/16	REVISED DRAINAGE AREAS	MKO

PROJECT
RECONSTRUCT TERMINAL APRONS
PHASE I

OWNER
NEW BEDFORD AIRPORT COMMISSION
NEW BEDFORD REGIONAL AIRPORT
NEW BEDFORD, MASSACHUSETTS

PROJECT NO.	103-032
CADD FILE	SHEET_DRAINAGE
DESIGNED BY	MKO
DRAWN BY	MKO
CHECKED BY	RAL
DATE	SEPTEMBER 2016
DRAWING SCALE	1" = 30'

SHEET TITLE
PROPOSED DRAINAGE PLAN

GRAPHIC SCALE
0 15 30 60

DRAWING NO.
D2.1
2 OF 2

2016-09-26 NOI SUBMISSION

TEST PIT AND BORING LOCATIONS

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R. W. Gillespie & Associates, Inc.
Geotechnical Engineering • Geohydrology • Materials Testing Services

18 November 2009

Michael L Bramhall, P.E.
Airport Solutions Group, LLC
390 Main Street, Suite 100
Woburn, MA 01801

Subject: Geotechnical Evaluation
Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport
New Bedford, Massachusetts
RWG&A Project No. 1229-01

Dear Mr. Bramhall:

In accordance with Airport Solutions Group, LLC (ASG)'s request and authorization, R. W. Gillespie & Associates, Inc., (RWG&A) has completed a subsurface investigation and laboratory testing program for the subject project. Our work was completed in general accordance with our proposal to you dated 21 July 2009 (note: RWG&A Proposal No. P-7255GI). Preliminary copies of laboratory testing and the exploration logs were provided to you via email on 02 and 05 November 2009. Our work scope included the following:

1. Drilled, logged, and sampled thirty-eight (38) borings (B-1 to B-36 and TP-1 and TP-2) at locations provided by ASG.
2. Completed sieve/hydrometer analyses of sixty-two (62) soil samples, Atterberg Limit determinations on sixteen (16) soil samples, and extraction, gradation, and abson tests on twelve (12) asphaltic pavement core samples. Delivered the remaining asphaltic pavement core samples and recovered liquid asphalt to the UMass-Dartmouth laboratory.
3. Performed twelve (12) field California Bearing Ratio (CBR) tests at locations selected by Airport Solutions Group, LLC.

4. Prepared this summary of the work, together with the final exploration logs.

The project location is shown on Figure 1, *Locus Map*. The general location of the borings and field CBRs are shown on Figure 2, *Exploration Location Plan*. The boring and CBR locations were selected and marked in the field by ASG prior to drilling. The explorations were drilled by Great Works Pump & Test Boring, Inc., of Rollinsford, New Hampshire, using a track-mounted drill rig during the time period from 21 to 28 September 2009. Exploration activities were coordinated and monitored by RWG&A personnel who prepared the exploration logs. The soils were described in general accordance with *ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).*

Laboratory and field results have been summarized in tabular form; field CBR results are also presented in graphical format, and individual exploration logs are presented in Appendix A. A summary of the data is as follows:

TABLE I. Summary of Sieve Analyses
TABLE II. Summary of Field CBR Values
APPENDIX A. Exploration Logs
APPENDIX B. Sieve / Hydrometer Tests and Atterberg Limits
APPENDIX C. Field CBR Tests
APPENDIX D. Asphalt Extraction/Gradation Tests

Asphaltic pavement was encountered at each of the exploration locations; thicknesses ranged from 2 to 6 inches. Concrete pavement was encountered below asphaltic pavement in borings B-13 and B-14, with thicknesses of 6 and 5 inches, respectively. Subsoils at the project site generally consist of fill over naturally deposited sand and silty sand. Organic silt was encountered in a few explorations, generally at the fill/naturally deposited soil interface. The fill soils generally consisted of coarse to fine sand with little silt and have USCS classifications of GP-GM, GW-GM, SW-SM, SP-SM and SM. The underlying naturally deposited soils generally consisted of interbedded layers of sand and silty sand, with USCS classifications of SP, SP-SM, SW-SM, and SM. Groundwater was observed in several of the explorations at depths of 2.5 to 7 feet below current ground surface. Field CBR values ranged from 1.6 to 72.6, with most values in the range of 3 to 7.5.

Comparison of grain size distribution tests to frost susceptibility criteria suggests moderate to high susceptibility, although observation of existing pavement did not reveal evidence of frost heaving or ice lense formation. ASG should evaluate a design governed by frost, as well as one which is based on aircraft for comparative purposes.

Proximity of groundwater to pavement section subgrade could be problematic with respect to compaction of subgrade and/or subbase materials; test sections at the start of construction might be advantageous. Dewatering in areas of shallow groundwater should be anticipated in the design, and construction documents.

We trust the foregoing meets your present needs, and if you have any questions, please contact us.

Very truly yours,
R. W. GILLESPIE & ASSOCIATES, INC.

Marc R. Grenier, P.E.
Project Geotechnical Engineer

Robert W. Gillespie, P. E.
Principal Geotechnical Engineer

MRG/RWG:md
In quadruplicate

Attachments:
Figure 1, Locus Map
Figure 2, Exploration Location Plan
Table I, Summary of Sieve Analyses
Table II, Summary of Field CBR Values
Appendix A, Exploration Logs
Appendix B. Sieve / Hydrometer Tests and Atterberg Limits
Appendix C. Field CBR Tests
Appendix D. Asphalt Extraction/Gradation Tests

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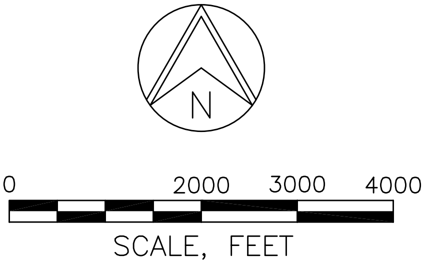

SOURCE:
USGS 7.5-MINUTE TOPOGRAPHIC QUADRANGLE
OF NEW BEDFORD NORTH, DATED 1990.

FIGURE 1
LOCUS MAP
PAVEMENT REHABILITATION STRATEGIES FOR RAMPS
NEW BEDFORD REGIONAL AIRPORT
NEW BEDFORD, MASSACHUSETTS

NOVEMBER 2009 PROJECT NO. 1229-01

R.W Gillespie & Associates, Inc.
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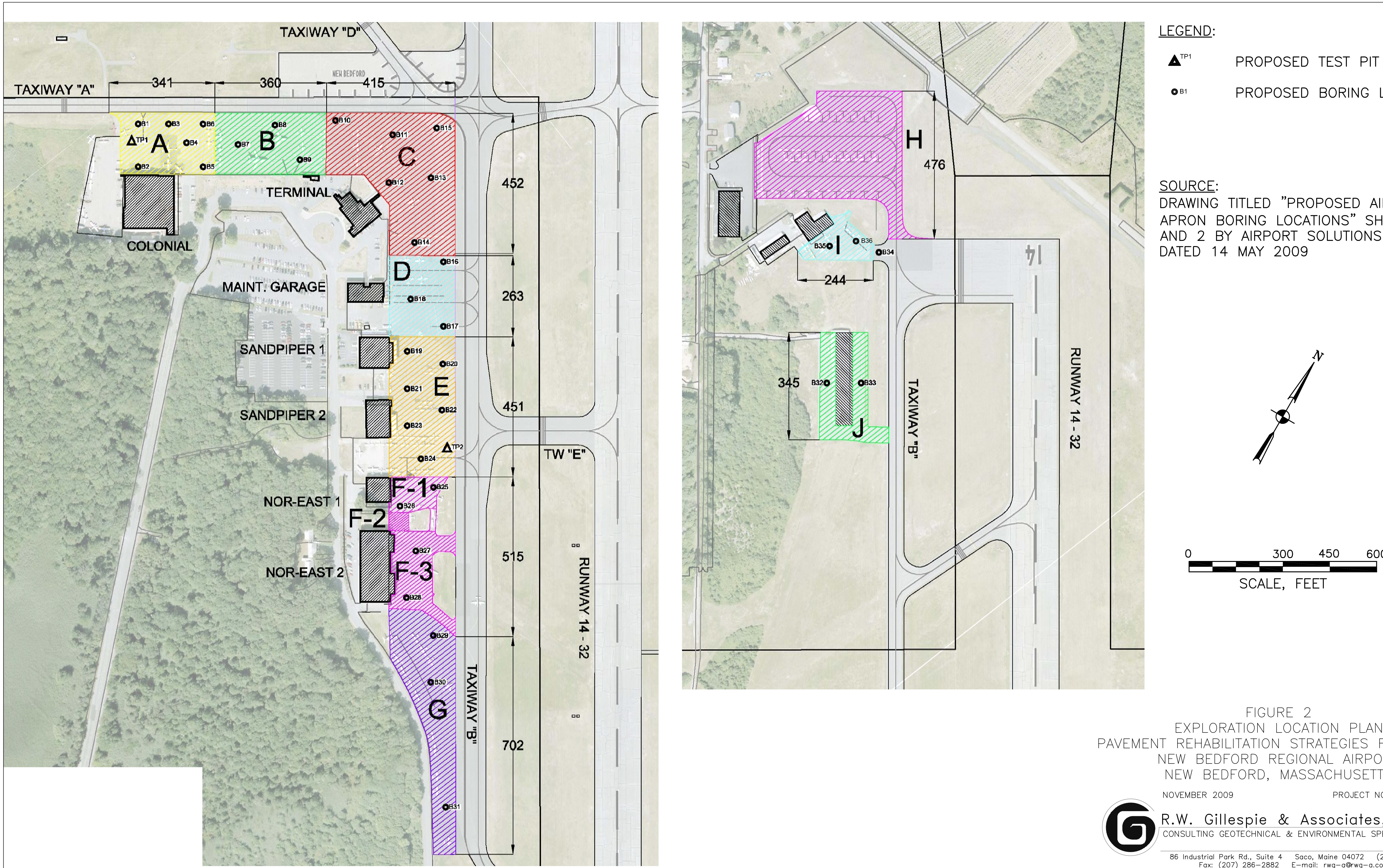

LEGEND:

▲TP1 PROPOSED TEST PIT LOCATION

●B1 PROPOSED BORING LOCATION

SOURCE:
DRAWING TITLED "PROPOSED AIRCRAFT APRON BORING LOCATIONS" SHEETS 1 AND 2 BY AIRPORT SOLUTIONS GROUP, DATED 14 MAY 2009

FIGURE 2
EXPLORATION LOCATION PLAN
PAVEMENT REHABILITATION STRATEGIES FOR RAMPS
NEW BEDFORD REGIONAL AIRPORT
NEW BEDFORD, MASSACHUSETTS

NOVEMBER 2009 PROJECT NO. 1229-01

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TABLE I

Summary of Sieve Analyses
Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport, New Bedford, Massachusetts

Sieve Analysis														
Boring Number	Depth of Sample, ft	Percent Passing Screen or Sieve Size											% Finer than 0.005 mm	USCS
		1"	3/4"	1/2"	3/8"	4	10	20	40	80	140	200		
B-1, S-1	0.3 - 2.3	100.0	90.5	86.4	81.7	75.1	63.7	50.5	37.8	21.7	16.5	14.2	3.7	SM
B-2, S-1	0.3 - 2.3	89.2	89.2	87.1	86.3	83.3	76.0	64.5	51.8	25.2	13.6	9.6	2.3	SP-SM
B-2, S-3	4.3 - 6.3			100.0	98.4	93.4	89.0	83.9	69.6	33.5	14.2	10.4	2.4	SP-SM
B-3, S-1	0.4 - 2.4	90.6	90.6	78.7	70.4	60.6	50.8	40.0	28.0	14.3	10.1	8.4	2.4	SP-SM
B-4, S-1	0.3 - 2.3		100.0	98.5	96.0	89.8	80.1	76.4	51.2	29.5	21.4	17.5	5.0	SM
B-5, S-1	0.3 - 2.3	100.0	87.7	73.7	67.5	57.4	47.0	35.9	26.0	14.9	10.2	7.9	2.4	SP-SM
B-5, S-3	4.3 - 6.3				100.0	96.3	92.0	83.1	67.5	37.1	27.1	22.4	2.2	SM
B-6, S-1	0.4 - 2.4	100.0	83.6	78.2	77.1	70.1	59.2	46.0	33.3	17.9	13.1	10.9	3.4	SP-SM
B-6, S-3	4.5 - 6.5		100.0	98.0	96.7	92.6	69.9	38.9	19.7	9.4	6.7	5.5	1.3	SW-SM
B-7, S-1	0.4 - 2.4	85.9	85.9	81.4	79.2	73.3	61.5	49.3	36.7	22.4	17.0	14.1	4.1	SM
B-8, S-1	0.5 - 2.5		100.0	92.7	86.6	76.8	61.9	45.9	32.3	15.9	11.3	9.5	2.5	SP-SM
B-8, S-3	4.5 - 6.5		100.0	97.4	97.4	92.9	82.7	57.7	22.2	7.4	5.7	4.8	1.4	SP
B-9, S-1	0.5 - 2.5	100.0	91.8	82.4	75.8	72.2	64.8	55.8	42.5	23.7	18.3	15.0	4.1	SM

<u>TABLE I, Continued</u>
Summary of Sieve Analyses
Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport, New Bedford, Massachusetts

		Sieve Analysis												
		Percent Passing Screen or Sieve Size											% Finer than 0.02 mm	
Boring Number	Depth of Sample, ft	1"	3/4"	1/2"	3/8"	4	10	20	40	80	140	200		USCS
B-10, S-1	0.4 - 2.4	100.0	61.7	54.8	51.4	48.2	45.1	40.9	37.0	15.8	6.4	5.0	1.5	GP-GM
B-10, S-3	4.4 - 6.4					100.0	97.5	88.9	73.1	49.4	37.9	29.2	0.5	SM
B-11, S-1	0.4 - 2.4	100.0	93.5	84.2	76.6	66.7	55.6	43.5	33.3	21.6	16.5	14.0	3.2	SM
B-12, S-1	0.4 - 2.4	100.0	94.3	77.6	62.5	47.6	35.5	25.3	17.2	10.5	8.3	7.2	1.6	GW-GM
B-12, S-3	4.4 - 6.4	100.0	81.2	70.6	67.3	56.5	45.5	33.3	24.6	15.5	12.2	10.6	1.6	SW-SM
B-12, S-4	6.4 - 8.4					100.0	99.9	89.2	66.1	30.5	20.7	17.5	2.0	SM
B-13, S-1	1.0 - 3.0	83.8	83.8	70.1	66.3	57.3	46.8	36.0	25.1	13.0	9.4	7.6	1.2	SP-SM
B-14, S-1	0.7 - 2.7	83.7	83.7	77.8	71.2	63.1	51.1	35.4	22.3	11.1	8.2	7.0	1.5	SP-SM
B-14, S-3	4.7 - 6.7			100.0	99.2	93.9	77.2	50.8	22.1	6.1	4.5	3.8	0.9	SP
B-15, S-1	0.4 - 2.4	89.5	85.1	80.2	72.9	59.8	45.3	33.3	24.8	16.4	12.9	11.3	2.7	SW-SM
B-16, S-1	0.3 - 2.3	86.9	70.7	67.8	63.7	56.3	45.9	36.5	24.6	13.6	10.5	9.0	2.2	SP-SM
B-16, S-3	4.3 - 6.3			100.0	97.3	88.7	71.3	38.0	13.9	5.2	3.9	3.3	0.5	SP
B-17, S-1	0.5 - 2.5		100.0	94.2	87.2	81.1	71.5	58.1	39.1	17.0	12.2	10.5	2.9	SW-SM

TABLE I. Continued

Summary of Sieve Analyses

Pavement Rehabilitation Strategies for Ramps

New Bedford Regional Airport, New Bedford, Massachusetts

Boring Number	Depth of Sample, ft	Sieve Analysis												USCS
		Percent Passing Screen or Sieve Size											% Finer than 0.02 mm	
		1"	3/4"	1/2"	3/8"	4	10	20	40	80	140	200		
B-18, S-1	0.5 - 2.5	100.0	92.9	80.6	80.6	73.7	62.6	50.5	34.7	18.6	13.5	11.0	3.7	SW-SM
B-19, S-1	0.2 - 2.2	78.5	78.5	70.1	67.2	59.4	48.2	37.5	27.5	16.4	12.0	9.8	2.4	SP-SM
B-19, S-3	4.0 - 6.0		100.0	89.4	87.8	74.1	53.5	33.5	20.4	10.4	7.2	5.6	1.9	SW-SM
B-19, S-4	6.0 - 8.0				100.0	99.7	96.1	86.8	76.3	52.5	39.3	29.8	1.4	SM
B-20, S-1	0.2 - 2.2		100.0	93.2	92.1	88.5	80.6	73.0	62.8	41.4	29.3	23.6	6.9	SM
B-20, S-3	4.2 - 6.2						100.0	99.9	99.9	76.2	26.3	14.2	1.9	SM
B-20, S-4	6.0 - 8.0					100.0	99.5	97.3	93.3	54.1	20.0	9.9	1.9	SP-SM
B-21, S-1	0.5 - 2.5				100.0	99.1	96.3	91.3	77.1	42.0	24.6	18.1	7.0	SM
B-21, S-4	6.5 - 8.5				100.0	99.3	96.1	85.6	68.7	24.9	10.8	7.3	1.4	SP-SM
B-22, S-1	0.3 - 2.3	81.0	81.0	81.0	78.6	74.4	66.4	53.8	40.2	23.6	17.1	14.0	3.9	SM
B-22, S-3	4.3 - 6.3					100.0	99.8	94.4	81.2	36.9	14..5	8.0	1.5	SP-SM
B-23, S-1	0.3 - 2.3			100.0	94.6	89.1	75.9	56.4	39.2	22.3	16.6	14.0	2.5	SM
B-24, S-1	0.4 - 2.4		100.0	98.3	96.9	90.2	79.0	65.0	48.2	22.8	16.2	14.0	1.3	SM

TABLE I, Continued

Summary of Sieve Analyses
Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport, New Bedford, Massachusetts

Sieve Analysis														
Boring Number	Depth of Sample, ft	Percent Passing Screen or Sieve Size											% Finer than 0.02 mm	USCS
		1"	3/4"	1/2"	3/8"	4	10	20	40	80	140	200		
B-24, S-3	4.4 - 6.4				100.0	99.5	95.7	89.2	76.8	34.3	16.3	10.1	1.6	SP-SM
B-25, S-1	0.3 - 2.3	100.0	87.2	87.2	83.6	75.6	65.0	53.7	41.5	26.6	20.5	17.4	1.8	SM
B-26, S-1	0.2 - 2.2			100.0	96.1	82.1	81.8	69.0	54.4	34.4	25.0	20.2	2.5	SM
B-26, S-3	4.2 - 6.2				100.0	98.3	90.9	67.5	28.5	6.7	4.7	4.1	2.0	SP
B-27, S-1	0.3 - 2.3		100.0	95.4	92.9	79.3	60.5	42.7	28.1	15.6	11.3	9.3	2.5	SW-SM
B-28, S-1	0.5 - 2.5	100.0	87.6	82.8	76.4	66.6	56.1	43.9	30.4	12.9	8.5	7.1	2.4	SP-SM
B-28, S-2	2.5 - 4.5		100.0	92.2	88.4	79.9	70.8	62.1	52.1	33.0	21.7	16.4	3.3	SM
B-28, S-4	6.0 - 8.0							100.0	99.7	83.5	57.9	44.5	3.3	SM
B-29, S-1	0.3 - 2.3	79.8	75.7	70.1	61.7	52.6	42.8	35.1	26.1	16.4	12.4	10.2	3.4	GP-GM
B-30, S-1	0.3 - 2.3		100.0	83.9	70.9	62.5	49.9	38.9	29.1	18.5	14.0	12.0	4.3	SW-SM
B-30, S-3	4.5 - 6.5		100.0	96.9	94.9	89.0	78.6	67.3	56.1	39.8	30.5	23.3	5.7	SM
B-31, S-1	0.5 - 2.5	82.8	77.3	76.0	73.9	64.8	56.7	47.1	35.8	13.1	17.9	15.1	5.3	SM
B-32, S-1	0.2 - 2.2		100.0	90.5	86.2	80.4	70.5	60.9	51.4	39.9	33.7	30.3	5.0	SM

TABLE I, Continued

Summary of Sieve Analyses
Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport, New Bedford, Massachusetts

		Sieve Analysis												
		Percent Passing Screen or Sieve Size											% Finer than 0.02 mm	
Boring Number	Depth of Sample, ft	1"	3/4"	1/2"	3/8"	4	10	20	40	80	140	200		USCS
B-32, S-3	4.2 - 6.2			100.0	97.9	92.2	80.3	62.7	43.4	24.9	19.7	16.6	3.3	SM
B-32, S-4	6.2 - 8.2				100.0	98.8	96.8	95.3	93.1	61.6	29.1	17.1	2.3	SM
B-33, S-1	2.0 - 4.0	100.0	91.6	85.8	81.2	68.6	50.7	34.9	18.7	9.8	7.7	6.5	2	SP-SM
B-34, S-1	0.2 - 2.2		100.0	98.3	94.6	80.6	85.6	77.9	67.3	42.8	27.4	20.3	5.3	SM
B-34, S-3	4.0 - 6.0	100.0	86.3	65.1	64.0	56.2	46.7	35.9	26.4	16.8	12.4	10.0	2.2	SP-SM
B-35, S-1	0.2 - 2.2		100.0	90.8	85.6	73.3	57.3	40.5	27.5	13.0	8.0	6.0	2.9	SP-SM
B-36, S-1	0.2 - 2.2				100.0	90.4	75.4	62.3	51.6	36.2	27.6	22.6	4.1	SM
B-36, S-3	4.2 - 6.2		100.0	92.3	86.0	72.4	52.7	33.9	20.0	10.3	7.4	6.0	1.7	SW-SM
TP-1, S-1	0.3 - 2.3	100.0	93.1	84.3	77.7	68.4	58.3	46.5	33.3	17.2	12.3	10.3	2.7	SP-SM
TP-2, S-1	0.3 - 2.3	93.2	93.2	92.7	91.0	85.1	75.5	63.9	49.9	29.0	19.1	15.4	3.5	SM

TABLE II

Summary of Field CBR Values

Project: Pavement Rehabilitation Strategies for Ramps   Client: Airport Solutions Group, LLC
RWG&A Project No: 1229-01   Date: September 2009
Location: New Bedford Regional Airport, New Bedford, Massachusetts

Location	Depth	CBR Value at 0.1" penetration
B-6	27"	7.0
B-8	30"	31.6
B-15	26"	72.6
B-18	26"	4.3
B-20	26"	1.6
B-25	27"	7.5
B-27	27"	33.0
B-30	28"	14.8
B-33	16"	2.8
B-35	24"	11.5
TP-1	27"	4.1
TP-2	28"	4.4

APPENDIX A

EXPLORATION LOGS

Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport
New Bedford, Massachusetts

RWG&A Project No. 1229-01

17 November 2009

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering • Geohydrology • Materials Testing Services

Boring Log: B-1
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/21/09
Date Completed: 09/21/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	S-1	ASPHALTIC PAVEMENT (3 inches). FILL; Gravelly silty sand, medium dense, moist, fine to medium sand, few gravel, few to trace coarse sand, light brown to gray.	13	9 10 6 2	16	9	GS
2.5	S-2	ORGANIC SILT (OL); Soft, moist, silt with sand, little organics, dark brown.	14	3 2 2 3	4		
5	S-3	SILTY SAND (SM); Very loose, wet, fine to medium sand, little silt, few coarse sand, gray.	6	2 2 5 12	7		
7.5	S-4		12	12 19 19 17	38		
		Bottom of Exploration at 8'; Not refusal.					
10							
12.5							
15							

Notes:

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering • Geohydrology • Materials Testing Services

Boring Log: B-2
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: Not Obs.

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/21/09
Date Completed: 09/21/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (3.5 inches). FILL; Sand with silt, medium dense, moist, fine to medium sand, few silt, trace coarse sand, light brown then dark brown. FILL; Sand, medium dense, moist, fine medium sand, trace coarse sand, light brown.	10	12 10 9 5	19	11	GS
2.5			S-2		12	2 3 7 7	10		
				ORGANIC SILT (OL); Soft, moist, silt with sand, trace organics, organic odor, dark brown to black. SILTY SAND (SP-SM); Dense, moist, fine to medium sand, few coarse sand, few silt, trace gravel, gray.					
			S-3		16	9 18 25 24	42	16	GS
5									
			S-4		18	15 19 20 20	39		
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering• Geohydrology•Materials Testing Services

Boring Log: B-3
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/21/09
Date Completed: 09/21/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4 inches).					
			S-1	FILL; Sand with gravel, medium dense, moist, fine to medium sand, little gravel, light brown.	6	9 12 4 4	16	6	GS
2.5			S-2	FILL; Sand with silt, loose, moist, fine sand, few medium sand, few silt, trace organics, dark brown to black.	20	3 3 3 8	6		
▽									
			S-3		12	10 13 12 13	25		
5				SILTY SAND (SP-SM); Medium dense, wet, fine sand, little silt, light brown.					
			S-4	SAND (SP); Medium dense, wet, fine to medium sand, trace coarse sand, light brown.	20	8 9 10 12	19		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

R.W. Gillespie & Associates, Inc.

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Boring Log: B-4
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/21/09
Date Completed: 09/21/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (3.5 inches). FILL; Sand, medium dense, moist, fine to medium sand, few silt, trace coarse sand, dark brown.	15	12 10 18 7	28	14	GS
2.5			S-2		0	5 4 7 12	11		
5 ▽			S-3	SAND (SP); Dense, wet, fine to medium sand, trace coarse sand, trace silt, gray.	1	23 26 22 17	48		
7.5			S-4		7	11 12 13 17	25		
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering• Geohydrology •Materials Testing Services

Boring Log: B-5
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/21/09
Date Completed: 09/21/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (3 inches). FILL; Gravelly sand, medium dense, moist, fine to medium sand, little gravel, few coarse sand, trace silt, light brown.	12	7 14 12 8	26	6	GS
2.5			S-2	FILL; Silty sand medium dense, moist, fine sand, few silt, trace medium sand, dark brown. FILL; Silty sand with gravel, dense, moist, fine to medium sand, little silt, few gravel, gray.	7	11 22 27 25	49		
▽ 5			S-3	SAND (SP); Medium dense, wet, fine to medium sand, little silt, gray.	21	9 12 13 13	25	28	GS
7.5			S-4		20	7 8 9 9	17	12	AL
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

R.W. Gillespie & Associates, Inc.
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Boring Log: B-6
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/18/09
Date Completed: 09/18/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (3.5 inches).					
			S-1	FILL; Gravelly sand, loose, moist, fine to medium sand, few gravel, dark brown to light brown.	6	2 5 4 3	9	12	GS
				FILL; Sand with silt, loose, moist, fine to medium sand, little to few coarse sand, few silt, moist, dark brown.					
2.5			S-2		6	4 4 5 9	9		
				SAND (SW-SM); Loose, moist then wet, fine to medium sand, few coarse sand, trace silt, light brown.					
5			S-3		16	12 12 12 8	24	12	GS
			S-4		20	5 3 4 3	7		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-7
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/18/09
Date Completed: 09/18/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4.5 inches).					
			S-1	FILL; Gravelly sand, medium dense, moist, fine to medium sand, little gravel to coarse sand, dark brown.	17	13 17 12 16	29	7	GS
				FILL; Sand, medium dense, moist, fine to medium sand, few coarse sand, trace gravel, light brown.					
2.5			S-2	FILL; Sand with silt, medium dense, moist, fine to medium sand, few silt, trace gravel, dark brown then gray. Fill grades finer.	14	18 23 27 15	50	12	AL
▽			S-3	SAND (SP); Medium dense, wet, fine to medium sand, little to few coarse sand, light brown.	14	16 13 10 10	23		
5									
			S-4		10	6 7 6 7	13		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-8
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/18/09
Date Completed: 09/18/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (5.5 inches).					
			S-1	FILL; Gravelly sand, very dense, moist, fine to medium sand, little gravel to coarse sand, few silt, dark brown.	17	25 35 21 25	56	5	GS
				FILL; Sand, very dense, moist, fine to medium sand, few coarse sand, light brown.					
2.5			S-2		16	13 16 15 12	31		
	▽			SAND (SP); Medium dense to loose, wet, fine to medium sand, few coarse sand, light brown.					
5			S-3		14	7 7 6 7	13	16	GS
			S-4		20	5 4 3 4	7		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-9
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/18/09
Date Completed: 09/18/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (6 inches).					
			S-1	FILL; Sandy gravel, dense, moist, fine gravel, little fine to medium sand, dark brown.	17	20 20 13 18	33	9	GS
				FILL; Sandy gravel, medium dense, moist, fine gravel, little fine to medium few silt, sand, dark brown.					
2.5			S-2		11	20 21 24 22	45	6	AL
5			S-3	SAND (SP); Medium dense, wet, fine to medium sand, trace coarse sand, light brown.	10	16 12 9 8	21		
			S-4		10	7 7 6 6	13		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-10
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: Not Obs.

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/18/09
Date Completed: 09/18/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4.5 inches).					
			S-1	FILL; Gravelly sand, dense, moist, fine to medium sand, some gravel, dark brown. FILL; Sand, dense, moist, fine sand, trace silt, light brown.	13	18 21 18 23	39	4	GS
2.5			S-2	FILL; Sand, dense, moist, fine to medium sand, few coarse sand, light brown.	16	19 17 19 17	36		
			S-3	SAND (SP); Medium dense to loose, moist, fine sand, few medium sand, little silt, light brown.	12	13 11 9 9	20	17	GS
5									
			S-4		16	5 5 5 10	10	16	AL
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-11
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/17/09
Date Completed: 09/17/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4.5 inches).					
			S-1	FILL; Gravelly sand, very dense, moist, fine to medium sand, few gravel, few coarse sand, dark brown.	12	28 32 26 27	58	6	GS
				FILL; Sand, very dense, moist, fine sand, few medium to coarse sand, trace gravel, few silt, light brown.					
2.5			S-2		8	21 21 11 12	32	5	AL
▽			S-3	SAND (SP); Medium densse to dense, wet, fine sand, trace medium sand and silt, light brown.	10	11 10 9 9	19		
5									
			S-4		8	21 21 11 12	32		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-12
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/17/09
Date Completed: 09/17/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4.5 inches).					
			S-1	FILL; Gravelly sand, dense, moist, fine to medium sand, few gravel, few coarse sand, dark brown.	13	22 24 17 17	41	3	GS
				FILL; Sand, dense, moist, fine sand, few medium to coarse sand, trace gravel, few silt, light brown.					
2.5			S-2		8	19 24 34 28	58		
			S-3	SAND (SW-SM); Dense, moist, fine to medium sand, few coarse sand, light brown.	6	28 22 21 19	43	6	GS
5 ▽				SILTY SAND (SM); Medium dense, wet, fine sand, little to few silt, light brown.					
			S-4		6	7 8 11 10	19	17	GS
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-13
Total Depth (ft): 9
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/17/09
Date Completed: 09/17/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (5.5 inches).					
				CONCRETE (6 inches).					
			S-1	FILL; Gravelly sand, medium dense, moist, fine to medium sand, few gravel and coarse sand, trace silt, brown.	10	8 13 15 23	28	5	GS
2.5									
			S-2		12	13 16 13 9	29		
▽									
5			S-3	SAND (SP); Dense to medium dense, wet, fine to medium sand, trace coarse sand, light brown.	13	12 18 16 11	34	12	AL
			S-4		20	9 6 7 7	13		
7.5									
				Bottom of Exploration at 9'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-14
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/17/09
Date Completed: 09/17/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (3.5 inches).					
				CONCRETE (5 inches).					
			S-1	FILL; Sand, medium dense, moist, fine to coarse sand, trace gravel, light brown.	12	6 15 12 11	27	5	GS
2.5			S-2			14 21 23 17	44		
				FILL; Gravelly sand, dense, fine to coarse sand, few gravel, moist to wet, light brown.					
5	▽		S-3	SAND (SP); Medium dense, wet, fine to medium sand, few coarse sand, trace gravel, light brown.	21	11 15 15 16	30	14	GS
			S-4		20	17 15 13 10	28		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-15
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: Chris Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/17/09
Date Completed: 09/17/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (4.5 inches).	14	27 31 20 25	51	5	GS
				FILL; Gravelly sand, very dense, moist, fine to medium sand, few gravel, few to trace coarse sand, few silt, dark brown.					
				FILL; Sand, very dense, moist, fine sand, few medium to coarse sand, trace gravel, trace silt, light brown.					
2.5			S-2		12	11 17 18 18	35		
	▽		S-3		7	14 10 7 7	17		
5				SAND (SP); Medium dense, wet, fine to medium sand, trace coarse sand, light brown.					
			S-4		10	6 6 7 5	13		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-16
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4 inches).					
			S-1	FILL; Gravelly sand, dense, moist, fine to medium sand, little gravel, trace silt, orange-brown.	11	16 18 20 17	38	4	GS
2.5			S-2	SAND (SP); Dense, moist then wet, fine to medium sand, trace coarse sand, yellow-brown.	6	14 17 16 13	33		
▽			S-3		20	10 11 13 12	24	14	GS
5									
			S-4		22	14 15 14 11	29		
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-17
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (5 inches).					
			S-1	FILL; Sand, dense, moist, fine to medium sand, trace, gravel and coarse sand, few silt, orange-brown.	12	16 20 18 20	38	9	GS
2.5			S-2		20	14 15 12 10	27		
	▽			ORGANIC SILT (OL); Medium dense, wet, silt, organic odor, red-brown.					
				SAND (SP-SM); Medium dense, wet, fine to medium sand, few silt, trace coarse sand, gray then brown.					
5			S-3		18	10 13 10 8	23	20	AL
			S-4		11	5 5 7 8	12		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-18
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (5 inches).					
			S-1	FILL; Sand, dense, moist, fine to medium sand, trace coarse sand, few silt, dark brown to orange.	15	17 18 21 10	39	9	GS
2.5			S-2	FILL; Silty sand, medium dense, moist, fine sand, few silt, trace medium sand, dark brown.	11	3 3 10 9	13	33	AL
	▽			SAND (SP); Medium dense, wet, fine to medium sand, light brown.					
5			S-3		1	17 14 15 11	29		
			S-4		16	13 19 18 20	37		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-19
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (2.5 inches). FILL; Sand with silt, dense, moist, fine to medium sand, few silt, fine to medium sand, few silt, trace gravel.	3	10 25 11 6	36	7	GS
2.5			S-2	FILL; Silty sand, loose, moist, fine sand, little silt, few medium sand, dark brown.	15	2 3 3 4	6		
▽ 5			S-3	SAND (SW-SM); Dense, wet, fine to medium sand, trace coarse sand, gray.	13	6 14 17 16	31	14	GS
7.5			S-4	SILTY SAND (SM); Medium dense, wet, fine sand, little silt, gray.	16	11 13 14 24	27	21	GS
10 12.5 15				Bottom of Exploration at 8'; Not refusal.					

Notes:

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Boring Log: B-20
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	S-1	ASPHALTIC PAVEMENT (2.5 inches). FILL; Gravelly silty sand, loose, moist, medium to coarse sand, few gravel, little silt, brown FILL; Silty sand, loose, moist, fine sand, little to few silt, trace medium sand, gray-brown.	9	8 5 1 1	6	22	GS
2.5	S-2	SILTY SAND (SM); Medium dense, moist, fine sand, few silt, gray.	16	4 6 6 7	12	24	AL
	S-3		21	7 10 14 14	24	25	GS
5							
	S-4		18	8 9 7 8	16	26	GS
7.5							
		Bottom of Exploration at 8'; Not refusal.					
10							
12.5							
15							

Notes:

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Boring Log: B-21
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (6 inches).					
			S-1	FILL; Sand, very loose, moist, fine to medium sand, trace silt, orange-brown.	20	4 1 1 1	2	32	GS
				FILL; Silty sand, very loose, moist to wet, fine sand, little silt, trace medium to coarse sand, dark brown.					
2.5	▽		S-2	FILL; Gravelly sand, medium dense, wet, medium coarse sand, few gravel, trace fine sand, light brown.	13	3 5 7 10	12		
5			S-3	SILTY SAND (SP-SM); Medium dense, wet, fine sand, little silt, brown-gray.	15	9 10 11 9	21		
			S-4		16	7 20 14 6	34	19	GS
7.5				SAND WITH SILT (SM); Dense, wet, fine to medium sand, few to trace silt, orange-brown.					
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-22
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (3 inches). FILL; Sand with silt, medium dense, moist, fine to medium sand, few silt, trace gravel, dark brown.	6	6 5 10 16	15	12	GS
2.5	∇		S-2	SAND (SP-SM); Medium dense, moist then wet, fine to medium sand, trace silt, light brown.	16	11 12 14 12	26		
5			S-3		14	9 9 13 14	22	21	GS
			S-4		12	7 7 7 9	14		
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-23
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (3 inches).					
			S-1	FILL; Sand, medium dense, moist fine to medium sand, few coarse sand, few silt, orange-brown.	13	5 11 11 17	22	6	GS
2.5			S-2	SAND (SP); Medium dense to loose, moist then wet, fine to medium sand, few coarse sand, trace silt, light brown.	15	17 11 10 8	21		
			S-3		17	6 5 6 7	11		
5									
			S-4		20	5 4 4 4	8	23	AL
7.5				SILTY SAND (SP-SM); Loose, wet, fine sand, little silt, light brown.					
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-24
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4.5 inches).					
			S-1	FILL; Sand, medium dense, moist, fine to medium sand, trace gravel and coarse sand, few silt, yellow-brown.	12	6 11 15 15	26	6	GS
2.5			S-2		11	15 14 14 12	28		
▽			S-3	SAND (SP-SM); Medium dense, wet, fine to medium sand, trace gravel and coarse sand, yellow-brown.	16	15 9 9 7	18	21	GS
5									
			S-4		10	3 3 3 3	6	24	AL
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-25
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	S-1	ASPHALTIC PAVEMENT (3 inches). FILL; Sand, very dense, moist, fine to medium sand, few to trace silt, dark brown.	1	16 28 28 33	56	11	GS
2.5	S-2	FILL; Gravelly sand, very dense, moist, fine to medium sand, few gravel, trace coarse sand, orange-brown.	16	18 14 8 7	22		
5	S-3	SAND (SP); Medium dense to loose, wet, fine to medium sand, trace coarse sand, yellow-brown.	12	5 6 5 4	11		
7.5	S-4		18	4 4 5 6	9		
		Bottom of Exploration at 8'; Not refusal.					
10							
12.5							
15							

Notes:

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Boring Log: B-26
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (2.5 inches). FILL; Sand with silt, medium dense, moist, fine sand, few silt, dark brown.	8 20	10 11 8 10	19	17	GS
2.5			S-2	FILL; Sand, medium dense, moist, fine to medium sand, trace silt, orange-brown.	8	12 10 11 12	21	9	AL
				SAND (SP); Medium dense, wet, fine to medium sand, trace coarse sand, light brown.					
▽			S-3		8	4 8 8 10	16	18	GS
5									
			S-4		20	6 12 6 7	18		
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

Boring Log: B-27
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	■			ASPHALTIC PAVEMENT (3 inches).					
	▨	▼	S-1	FILL; Sand, dense, fine to medium sand, few coarse sand, trace gravel, light brown.	14	16 22 24 18	46	4	GS
2.5	▨	▼	S-2		14	4 8 14 12	22		
	░			SAND (SP); Medium dense, moist, fine to medium sand, trace coarse sand, brown.					
▽	░	▼	S-4		18	9 8 8 7	16		
5	░								
	░	▼	S-4		24	6 5 5 6	10		
7.5	░								
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-28
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (3 inches).					
			S-1	FILL; Gravelly sand, very dense, fine to medium sand, little gravel, few coarse sand, few silt, brown.	11	7 23 34 33	57	6	GS
2.5			S-2	FILL; Sand, dense, moist, fine sand, little silt, light brown.	10	20 16 17 14	33	9	GS
▽				SAND (SP); Dense, wet, fine to coarse sand, trace gravel, trace silt, gray.					
5			S-3		0	18 12 50/1"	62+		
			S-4	SILTY SAND (SP-SM); Dense, wet, fine sand, little silt, gray.	14	12 22 20 17	42	27	GS
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-29
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 3'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (4 inches). FILL; Gravelly sand, very dense, moist, fine to medium sand, little gravel, few silt, gray-brown.	12	15 26 27 23	53	4	GS
2.5			S-2	FILL; Sand, dense, moist, fine to medium sand, trace coarse sand, trace silt, brown.	14	14 16 15 12	31		
▽									
			S-3	SAND (SP); Dense, wet, fine to medium sand, few coarse sand, trace silt, gray.	12	14 19 16 14	35	14	AL
5									
			S-4		14	5 5 8 7	13		
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-30
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 2.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (4 inches). FILL; Gravelly sand, dense, to very dense, moist, fine to medium sand, little gravel and coarse sand, few silt, gray to brown.	13	14 25 25 29	50	5	GS
2.5 ▽			S-2	SAND WITH GRAVEL (SP); Dense, wet, fine to coarse sand, trace gravel, gray.	16	11 16 20 40	36		
5			S-3	SILTY SAND (SP-SM); Medium dense, wet, fine sand, little silt, gray. SAND WITH GRAVEL (SP); Medium dense, wet, fine to coarse sand, trace gravel, gray.	12	8 8 4 8	12	44	GS
7.5			S-4	ORGANIC SILT (OL); Medium dense, wet, organic odor, wood fragments, some silt, red-brown. SILTY SAND (SM); Dense, wet, fine sand, little silt, gray.	10	19 25 22 16	47	26	AL
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-31
Total Depth (ft): 6
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 4'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (5 inches).					
			S-1	FILL; Gravelly sand with silt, very dense, moist, fine to medium sand, little gravel and coarse sand, trace silt, gray.	14	18 25 32 35	57	8	GS
2.5			S-2		15	14 20 24 20	44		
				SAND (SP); Dense, moist to wet, fine to medium sand, few silt, gray.					
∇									
5			S-3		5	5 8 50/4"	58+		
				Bottom of Exploration at 6'; Auger and spoon refusal, possible bedrock.					
7.5									
10									
12.5									
15									

Notes:

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Boring Log: B-32
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 5.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (2.5 inches). FILL; Sand, dense, moist, fine to medium sand, trace gravel and coarse sand, trace silt, light brown	15	7 13 25 20	38	7	GS
2.5			S-2		14	18 20 22 30	42		
5			S-3	SAND (SP); Dense, moist, fine sand, trace medium sand, light brown.	18	15 16 17 20	33	8	GS
▽				SAND WITH SILT (SM); Dense, wet, fine sand, few to trace silt, trace fine gravel, orange-brown with mottling.					
7.5			S-4	SILTY SAND (SM); Medium dense, wet, fine sand, few silt, light brown.	14	10 10 11 7	21	24	GS
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-33
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (3 inches).					
				FILL; Gravelly sand, moist, fine to medium sand, little gravel, trace cobbles, light brown.					
2.5			S-1	FILL; Sand, very dense, moist, fine to medium sand, few gravel, yellow-brown..	13	12 21 50/5"	71+	2	GS
5 ∇			S-2	SILTY SAND (SM); Dense, moist to wet, fine sand, little silt, gray-brown.	9	12 16 25 19	41	23	AL
			S-3		7	8 8 6 6	14		
7.5				SAND (SP); Medium dense, wet, fine to medium sand, trace silt, gray-brown.					
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-34
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 6'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/14/09
Date Completed: 09/14/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	■ ▨		S-1	ASPHALTIC PAVEMENT (2.5 inches). FILL; Silty sand, medium dense, moist, fine to medium sand, trace gravel, little silt, orange-brown.	14	7 8 8 6	16	10	GS
2.5	▨		S-2		15	14 22 28 42	50		
5	▨		S-3		9	28 35 50/5"	85+	3	GS
▽	░		S-4	SAND (SP); Dense, wet, fine sand, few silt, brown.	15	8 15 15 17	30		
7.5	░								
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-35
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 6'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/14/09
Date Completed: 09/14/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (2 inches). FILL; Sand, medium dense, moist, fine sand, trace medium sand, trace silt, dark brown. FILL; Sand, medium dense, moist, fine to medium sand, trace coarse sand and gravel, yellow-brown.	12	6 12 12 10	24	5	GS
2.5			S-2		16	3 3 14 28	17		
5			S-3		13	31 31 30 25	61		
			S-4	SAND (SP-SM); Very dense, moist, fine sand, few to trace silt, yellow-brown.	12	21 18 17 17	35		
7.5									
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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Boring Log: B-36
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 7'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/15/09
Date Completed: 09/15/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	■ ▨	◣	S-1	ASPHALTIC PAVEMENT (2 inches). FILL; Gravelly sand with silt, medium dense, moist, fine to medium sand, few gravel and coarse sand, little silt, dark gray.	12	5 6 9 8	15	9	GS
2.5	▨	◣	S-2	FILL; Silty sand, medium dense, moist, fine sand, little silt, orange and dark brown.	11	5 11 31 33	42	3	AL
5	▨	◣	S-3	FILL; Gravelly sand, dense, moist, fine to medium sand, few gravel, light brown.	14	25 27 19 18	46	2	GS
▽ 7.5	░	◣	S-4	SAND (SP); Medium dense, moist to wet, fine sand, few silt, light brown.	16	16 12 11 11	23		
				Bottom of Exploration at 8'; Not refusal.					
10									
12.5									
15									

Notes:

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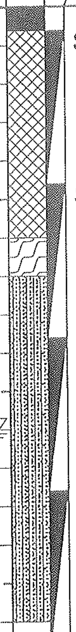
Boring Log: TP-1
Total Depth (ft): 8
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 5.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/21/09
Date Completed: 09/21/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a



DEPTH, FT.	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0	S-1	ASPHALTIC PAVEMENT (3 inches). FILL; Sand, medium dense, moist, fine to medium sand, few coarse sand, trace gravel, trace silt, light brown.	4	9 12 18 16	30	5	GS
2.5	S-2		2	4 4 3 1	7		
		ORGANIC SILT (OL); Soft, moist, silt, little sand, trace organics, organic odor, dark brown.					
	S-3	SILTY SAND (SP-SM); Loose then dense, moist then wet, fine to medium sand, little to few silt, few coarse sand, gray-brown.	0	2 2 1 15	3		
5							
	S-4		2	10 14 30 36	44		
7.5							
		Bottom of Exploration at 8'; Not refusal.					
10							
12.5							
15							

Notes:

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering• Geohydrology•Materials Testing Services

Boring Log: TP-2
Total Depth (ft): 8.5
Sheet 1 of 1

Project Name: Pavement Rehabilitation Strategies for Ramps
RWG&A Project No. 1229-01
Location: New Bedford, MA
Client: Airport Solutions Group, LLC
RWG&A Representative: C. Morrell
Boring Location: As marked
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 2.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: Mobile Acker
Driller Rep.: Jeff & Will
Date Started: 09/16/09
Date Completed: 09/16/09
Surface Elevation: ()
Drilling Method: 2 1/4" HSA
Casing Type: n/a

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (3.5 inches). FILL; Gravelly sand with silt, medium dense, moist, fine to medium sand, few gravel, little silt, dark brown.	16	7 5 10 8	15	11	GS
2.5 ▽			S-2	SAND (SP-SM); Loose, moist, medium to fine sand, few silt, trace coarse sand, yellow-brown.	17	5 5 6 11	11		
5			S-3		21	3 4 4 4	8		
			S-4		20	4 5 4 4	9		
7.5									
				Bottom of Exploration at 8.5'; Not refusal.					
10									
12.5									
15									

Notes:

APPENDIX B

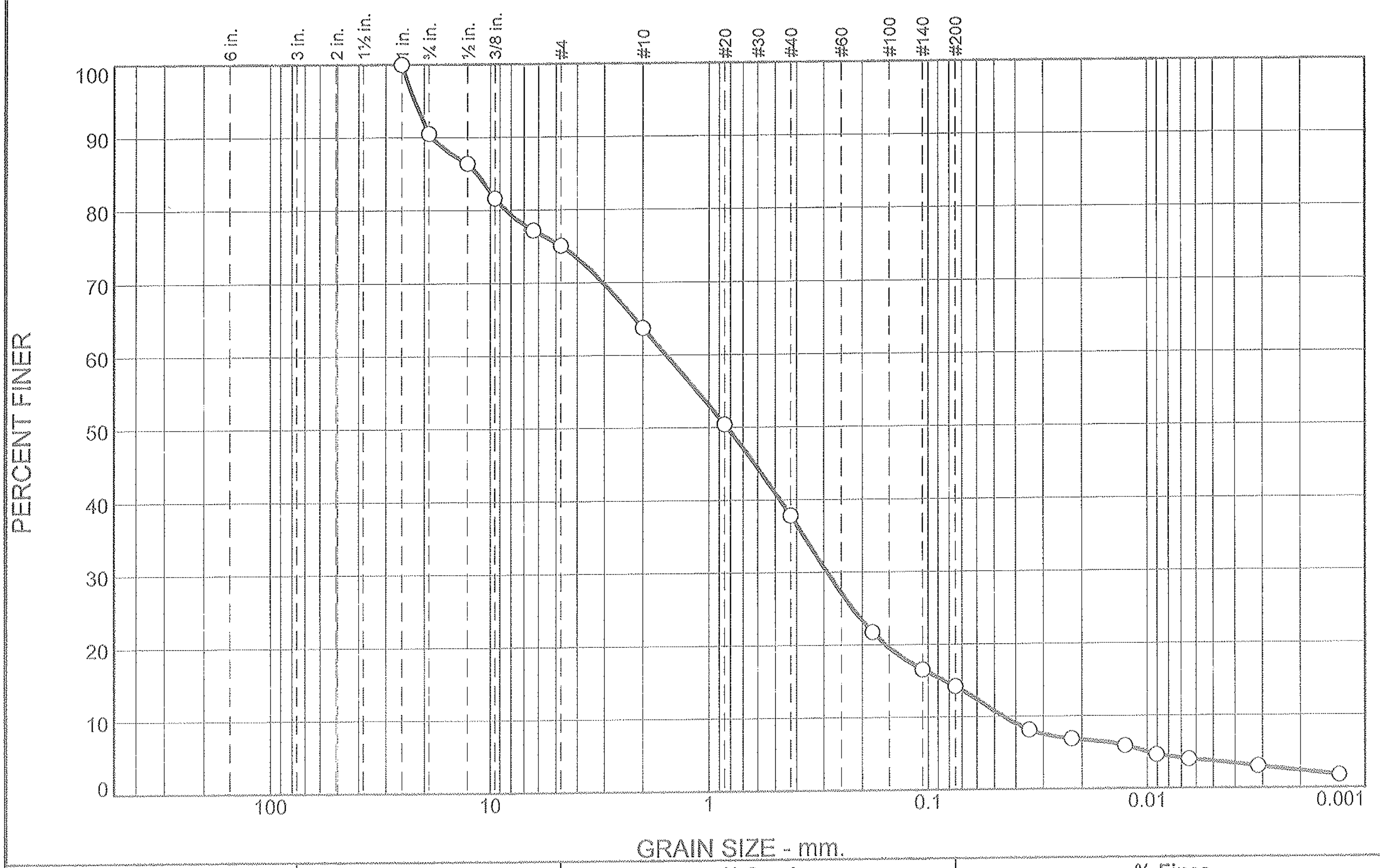
SIEVE / HYDROMETER TESTS AND ATTERBERG LIMITS

Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport
New Bedford, Massachusetts

RWG&A Project No. 1229-01

17 November 2009

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.5	15.4	11.4	25.9	23.6	10.5	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	90.5		
1/2"	86.4		
3/8"	81.7		
1/4"	77.2		
#4	75.1		
#10	63.7		
#20	50.5		
#40	37.8		
#80	21.7		
#140	16.5		
#200	14.2		
0.0347 mm.	8.1		
0.0222 mm.	6.9		
0.0127 mm.	5.9		
0.0091 mm.	4.7		
0.0065 mm.	4.0		
0.0031 mm.	3.0		
0.0013 mm.	1.8		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 11.4951 D_{60}= 1.5627 D_{50}= 0.8266

D_{30}= 0.2891 D_{15}= 0.0840 D_{10}= 0.0456

C_u= 34.31 C_c= 1.17

Classification

USCS= SM AASHTO=

Remarks

Moisture Content:9.4%

Sample No.: S-1 **Source of Sample:** B-1 **Date:** 10/3/09

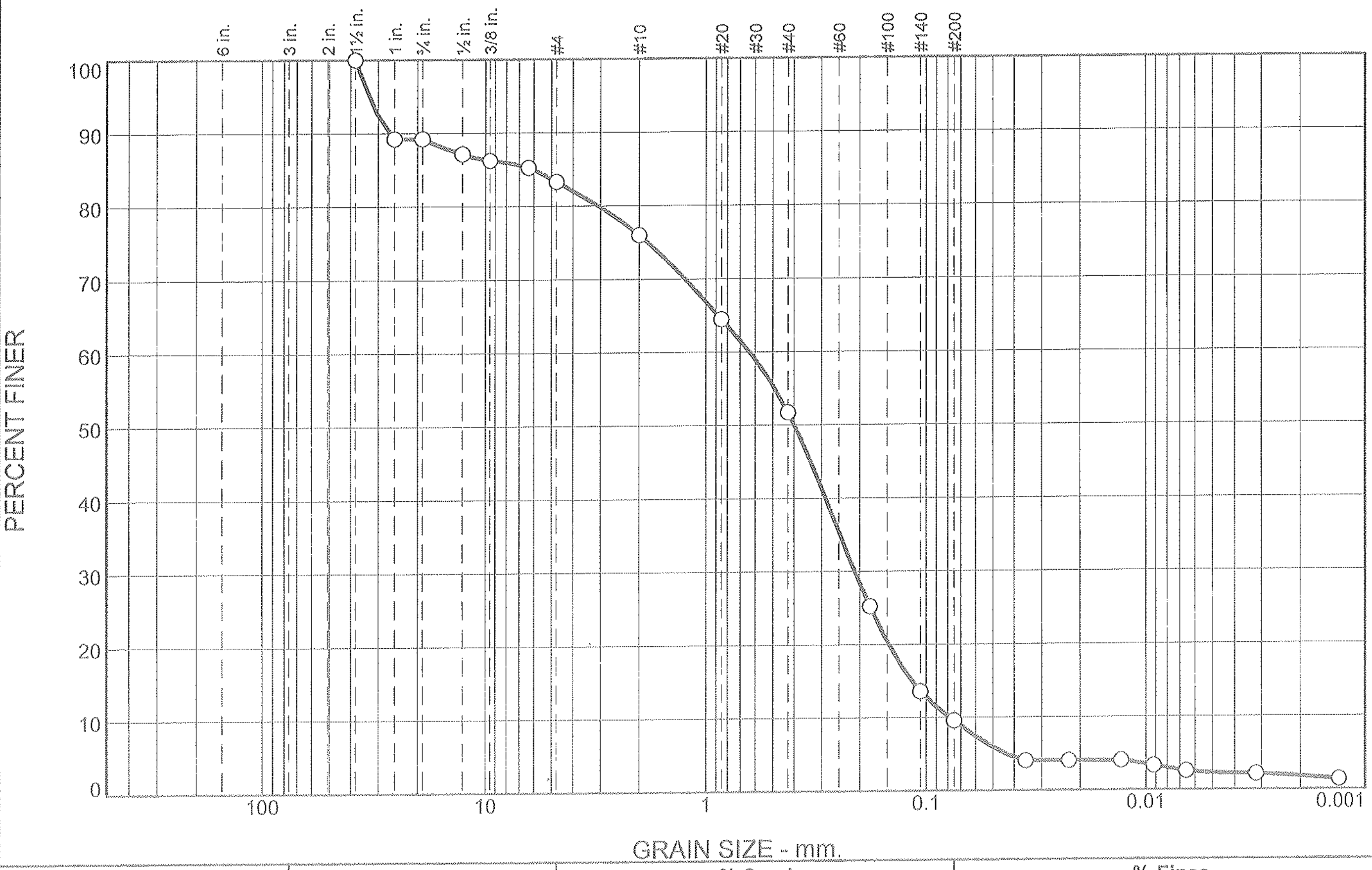
Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions group
Project: Pavement Rehabilitation Strategies for ramps
Project No: 1229-01 **Figure** 10972A

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.8	5.9	7.3	24.2	42.2	7.3	2.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	89.2		
3/4"	89.2		
1/2"	87.1		
3/8"	86.3		
1/4"	85.3		
#4	83.3		
#10	76.0		
#20	64.5		
#40	51.8		
#80	25.2		
#140	13.6		
#200	9.6		
0.0355 mm.	4.1		
0.0224 mm.	4.1		
0.0130 mm.	4.1		
0.0092 mm.	3.3		
0.0066 mm.	2.6		
0.0032 mm.	2.1		
0.0013 mm.	1.4		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 6.0520 D_{60}= 0.6357 D_{50}= 0.3976

D_{30}= 0.2109 D_{15}= 0.1159 D_{10}= 0.0785

C_u= 8.10 C_c= 0.89

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture Content:10.8%

Sample No.: S-1 **Source of Sample:** B-2 **Date:** 10/3/09

Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

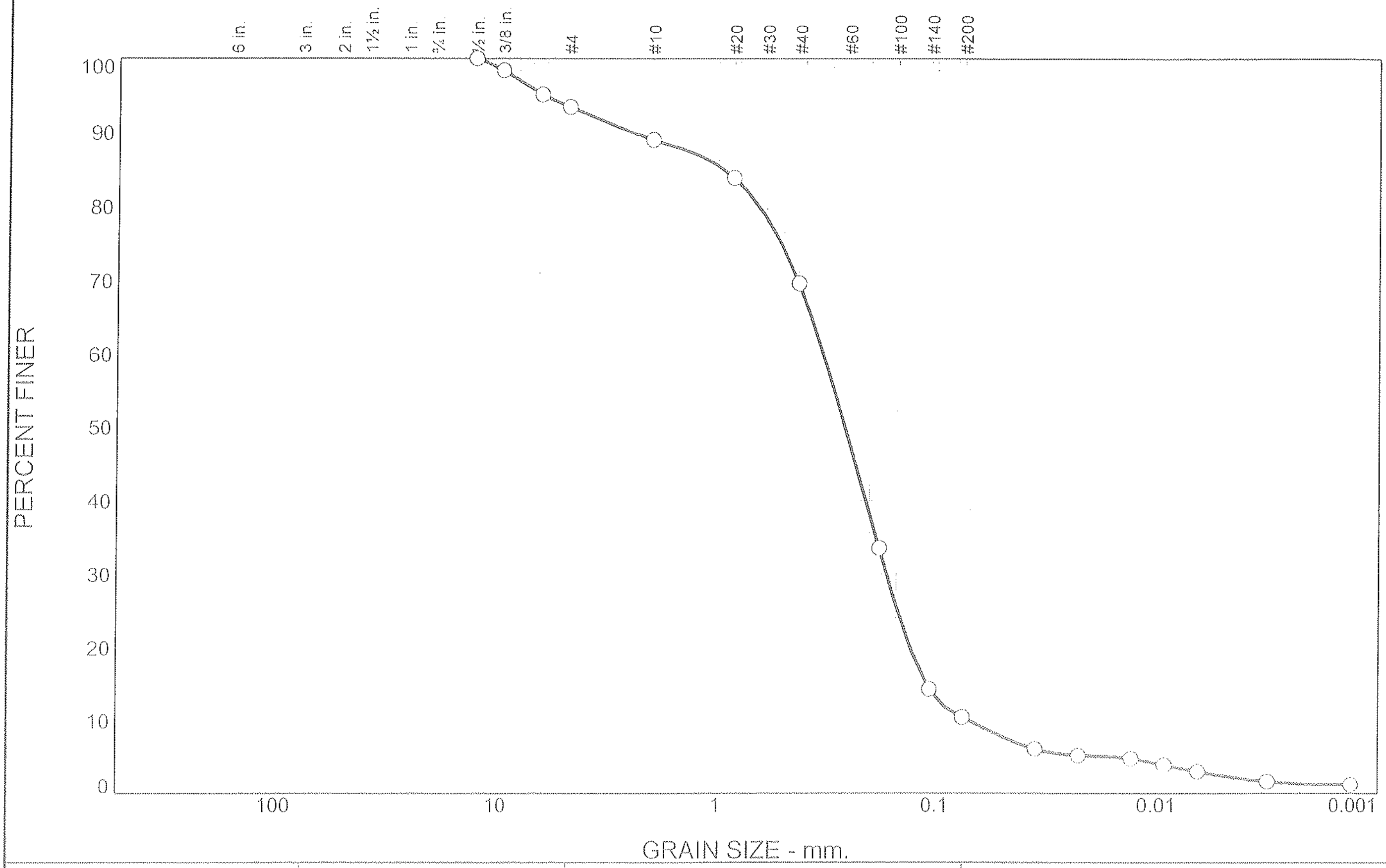
Client: Airport Solutions group

Project: Pavement Rehabilitation Strategies for ramps

Project No: 1229-01 **Figure** 10972B

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.6	4.4	19.4	59.2	8.0	2.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	98.4		
1/4"	95.1		
#4	93.4		
#10	89.0		
#20	83.9		
#40	69.6		
#80	33.5		
#140	14.2		
#200	10.4		
0.0352 mm.	6.1		
0.0224 mm.	5.2		
0.0130 mm.	4.8		
0.0092 mm.	3.9		
0.0066 mm.	3.0		
0.0032 mm.	1.6		
0.0013 mm.	1.2		

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.9447 D_{60}= 0.3268 D_{50}= 0.2584
D_{30}= 0.1663 D_{15}= 0.1097 D_{10}= 0.0701
C_u= 4.66 C_c= 1.21

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Moisture Content:15.8%

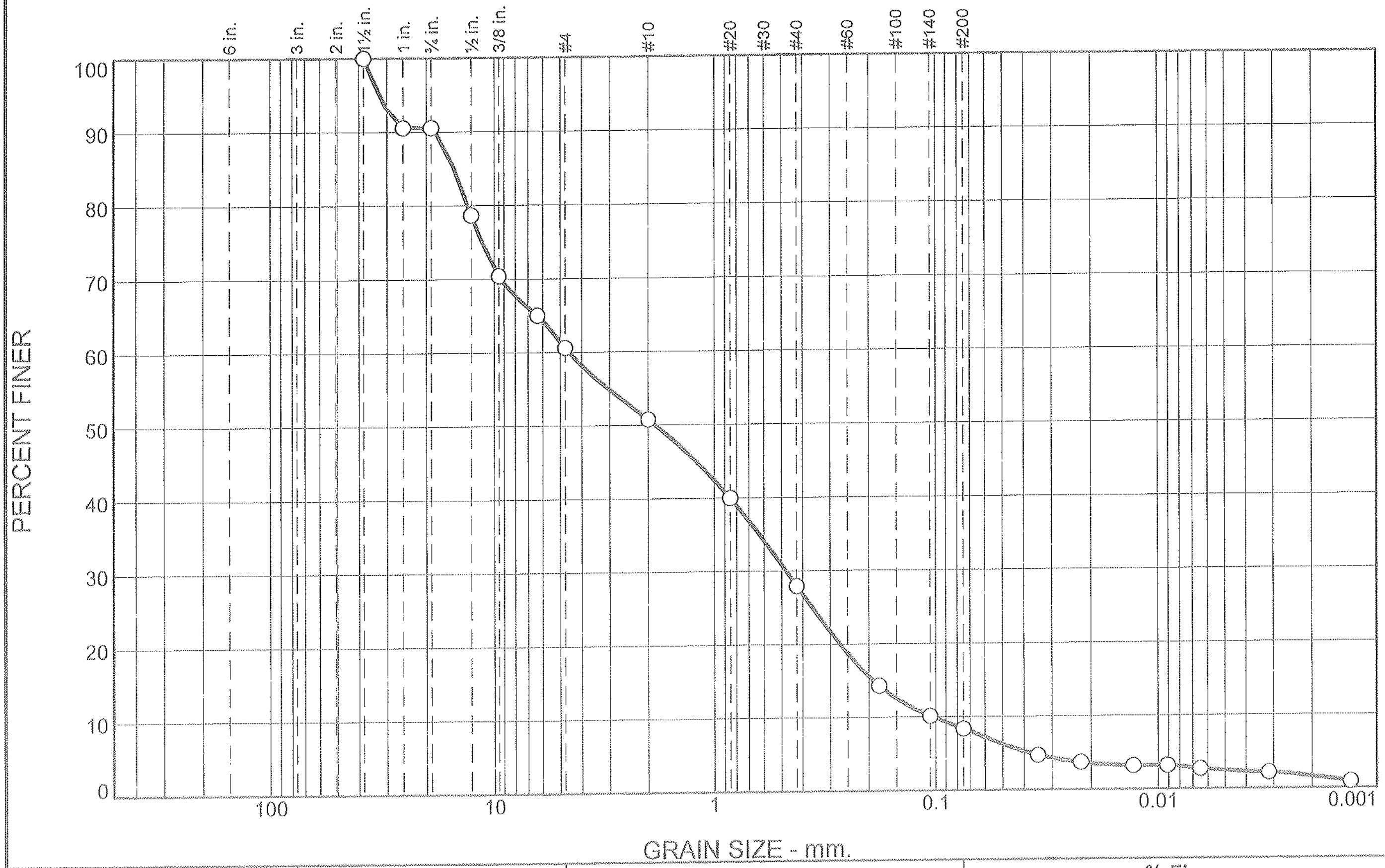
Sample No.: S-3 **Source of Sample:** B-2 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972C

Tested By: JJH **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.4	30.0	9.8	22.8	19.6	6.0	2.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	90.6		
3/4"	90.6		
1/2"	78.7		
3/8"	70.4		
1/4"	65.1		
#4	60.6		
#10	50.8		
#20	40.0		
#40	28.0		
#80	14.3		
#140	10.1		
#200	8.4		
0.0347 mm.	4.7		
0.0222 mm.	3.7		
0.0129 mm.	3.2		
0.0091 mm.	3.2		
0.0065 mm.	2.7		
0.0031 mm.	2.1		
0.0013 mm.	0.9		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 15.1200 D_{60}= 4.5604 D_{50}= 1.8565
D_{30}= 0.4753 D_{15}= 0.1915 D_{10}= 0.1034
C_u= 44.12 C_c= 0.48

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture Content:6.1%

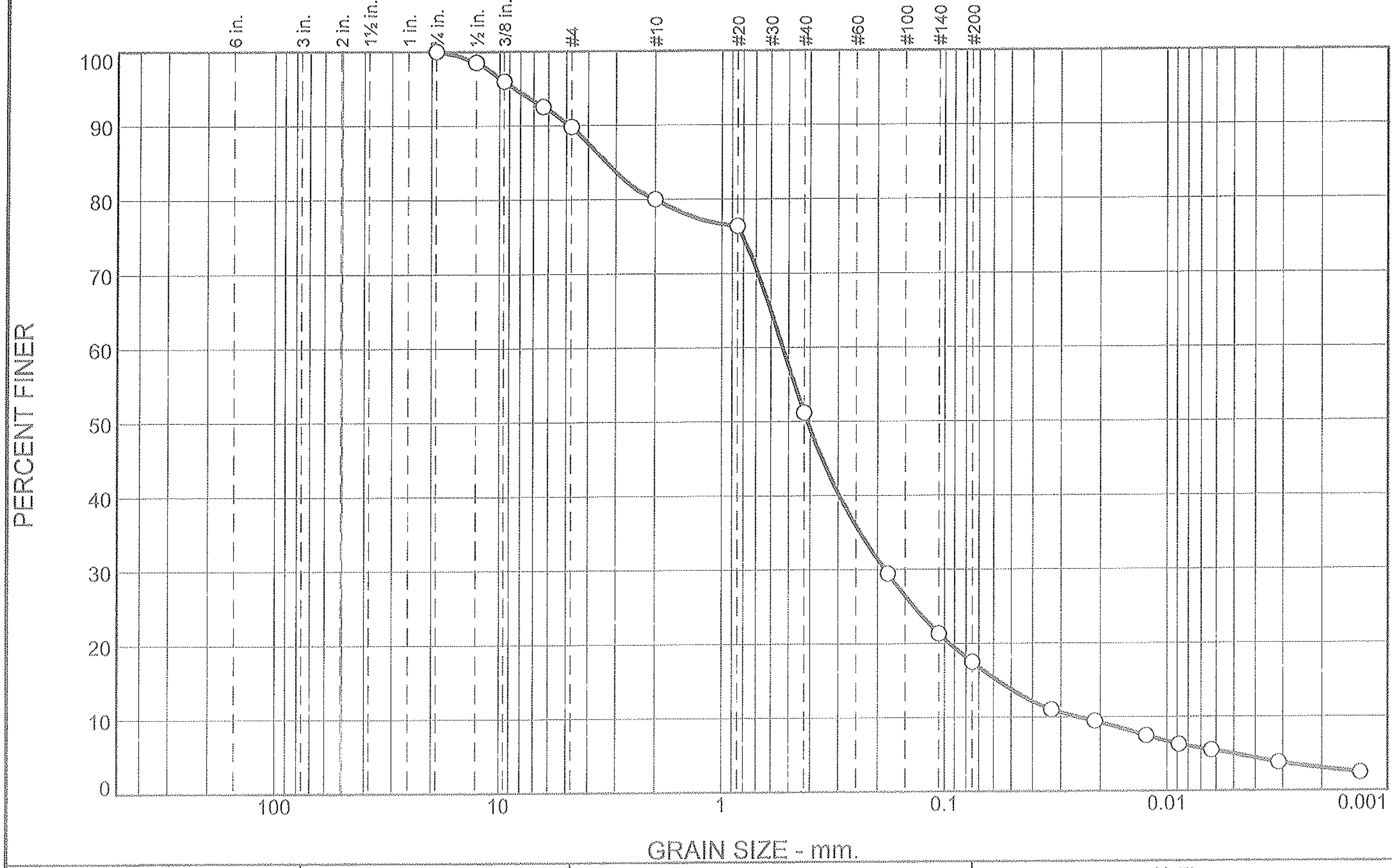
Sample No.: S-1 **Source of Sample:** B-3 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.4'-2.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions group
Project: Pavement Rehabilitation Strategies for ramps
Project No: 1229-01 **Figure** 10972D

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.2	9.7	28.9	33.7	12.5	5.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	98.5		
3/8"	96.0		
1/4"	92.6		
#4	89.8		
#10	80.1		
#20	76.4		
#40	51.2		
#80	29.5		
#140	21.4		
#200	17.5		
0.0330 mm.	11.0		
0.0211 mm.	9.5		
0.0124 mm.	7.5		
0.0088 mm.	6.3		
0.0063 mm.	5.5		
0.0031 mm.	3.8		
0.0013 mm.	2.4		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.3037 D_{60}= 0.5300 D_{50}= 0.4112
D_{30}= 0.1855 D_{15}= 0.0579 D_{10}= 0.0251
C_u= 21.12 C_c= 2.59

Classification

USCS= SM AASHTO=

Remarks

Moisture Content:14.4%

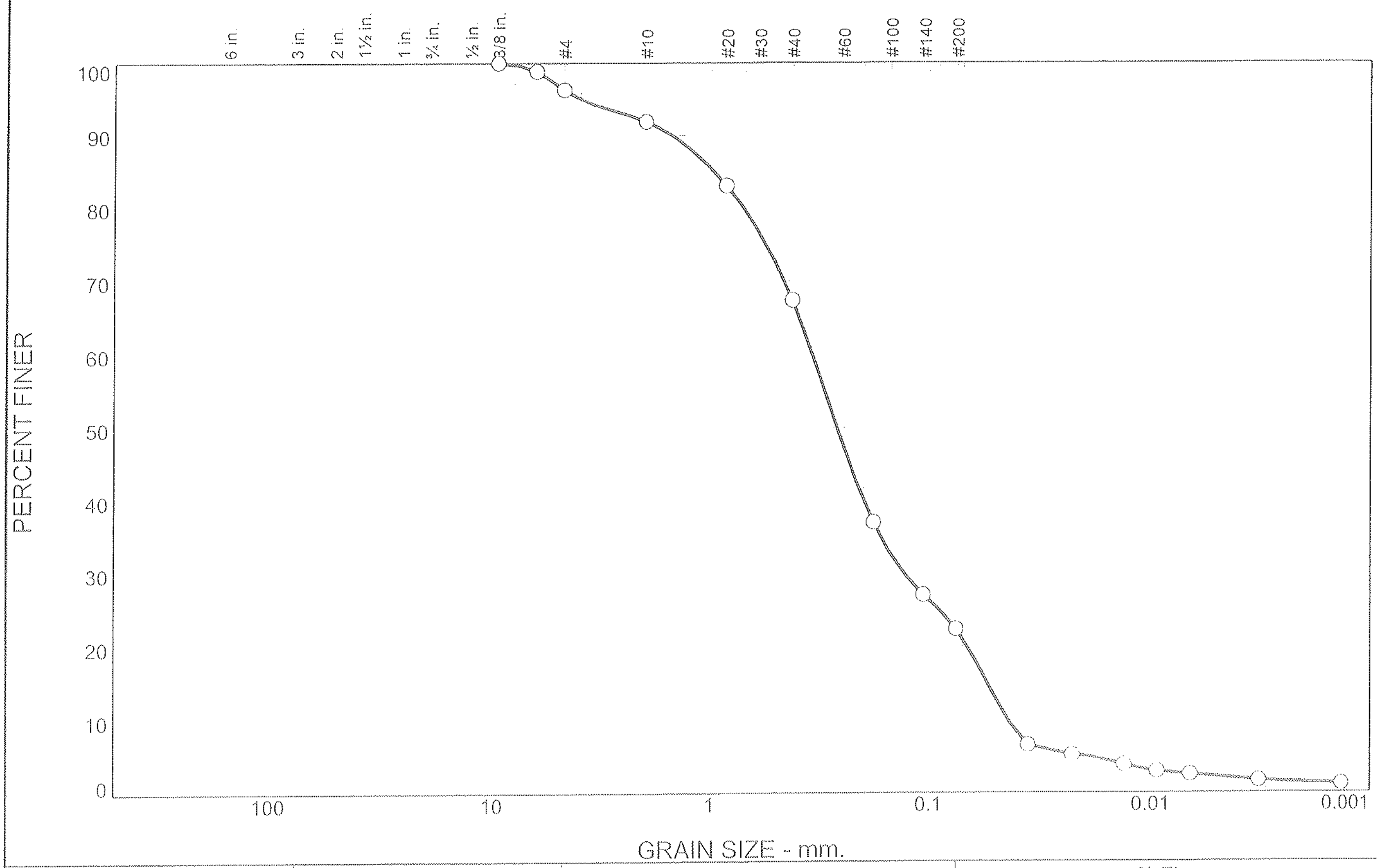
Sample No.: S-1 **Source of Sample:** B-4 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions group
Project: Pavement Rehabilitation Strategies for ramps
Project No: 1229-01 **Figure** 10972E

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.7	4.3	24.5	45.1	20.2	2.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	98.8		
#4	96.3		
#10	92.0		
#20	83.1		
#40	67.5		
#80	37.1		
#140	27.1		
#200	22.4		
0.0354 mm.	6.5		
0.0226 mm.	5.2		
0.0131 mm.	3.8		
0.0094 mm.	2.9		
0.0066 mm.	2.5		
0.0032 mm.	1.7		
0.0014 mm.	1.2		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.9641 D_{60}= 0.3432 D_{50}= 0.2638

D_{30}= 0.1300 D_{15}= 0.0541 D_{10}= 0.0436

C_u= 7.87 C_c= 1.13

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 27.5%

Sample No.: S-3 **Source of Sample:** B-5 **Date:** 10/22/09

Location: New Bedford, MA **Elev./Depth:** 4.3'-6.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

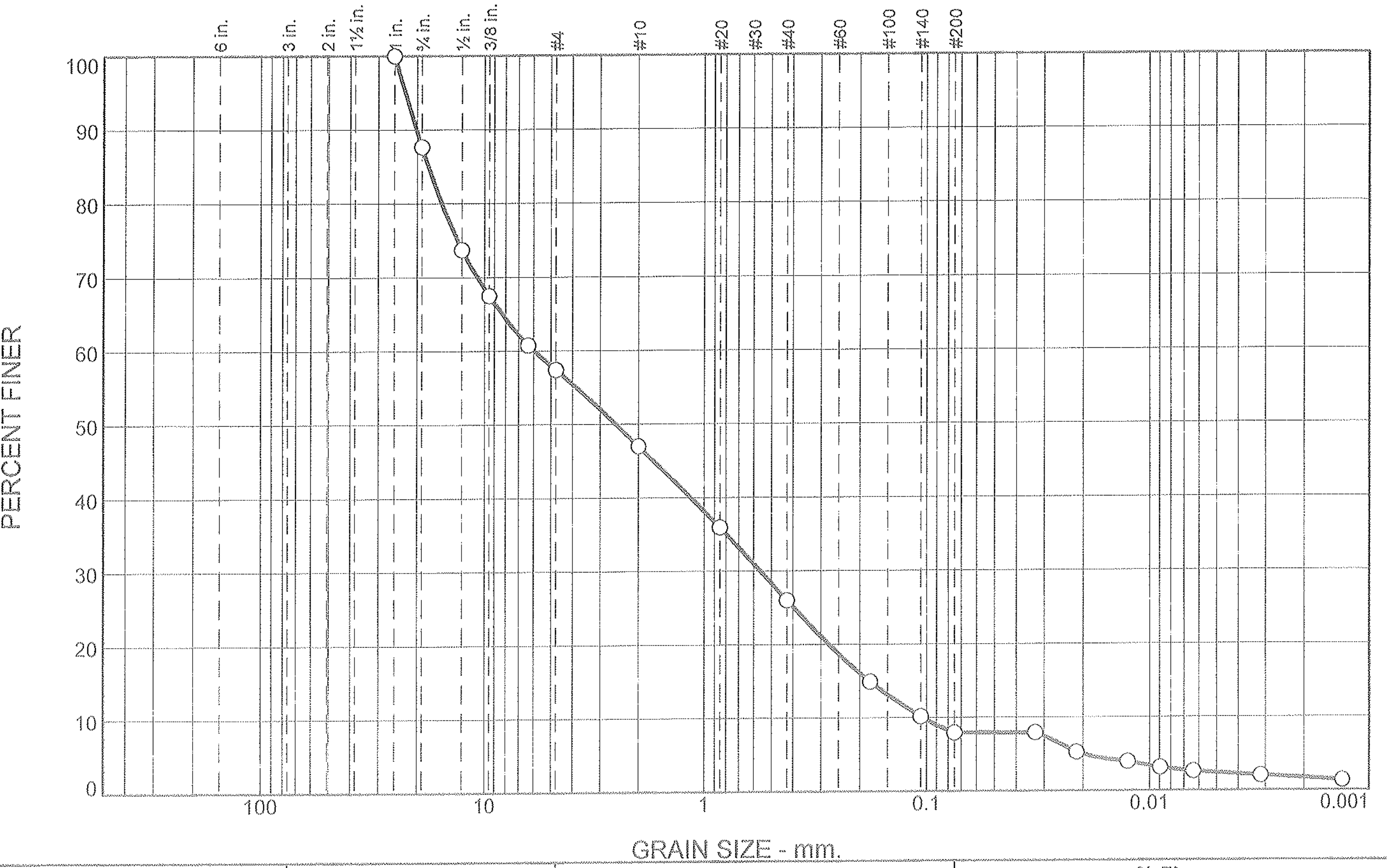
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972F

Tested By: JJH/DCH **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	12.3	30.3	10.4	21.0	18.1	5.5	2.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	87.7		
1/2"	73.7		
3/8"	67.5		
1/4"	60.8		
#4	57.4		
#10	47.0		
#20	35.9		
#40	26.0		
#80	14.9		
#140	10.2		
#200	7.9		
0.0328 mm.	7.9		
0.0214 mm.	5.3		
0.0125 mm.	3.9		
0.0089 mm.	3.2		
0.0064 mm.	2.6		
0.0031 mm.	2.0		
0.0013 mm.	1.4		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 17.8175 D_{60}= 5.9736 D_{50}= 2.5385
D_{30}= 0.5598 D_{15}= 0.1819 D_{10}= 0.1038
C_u= 57.54 C_c= 0.51

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture Content:5.9%

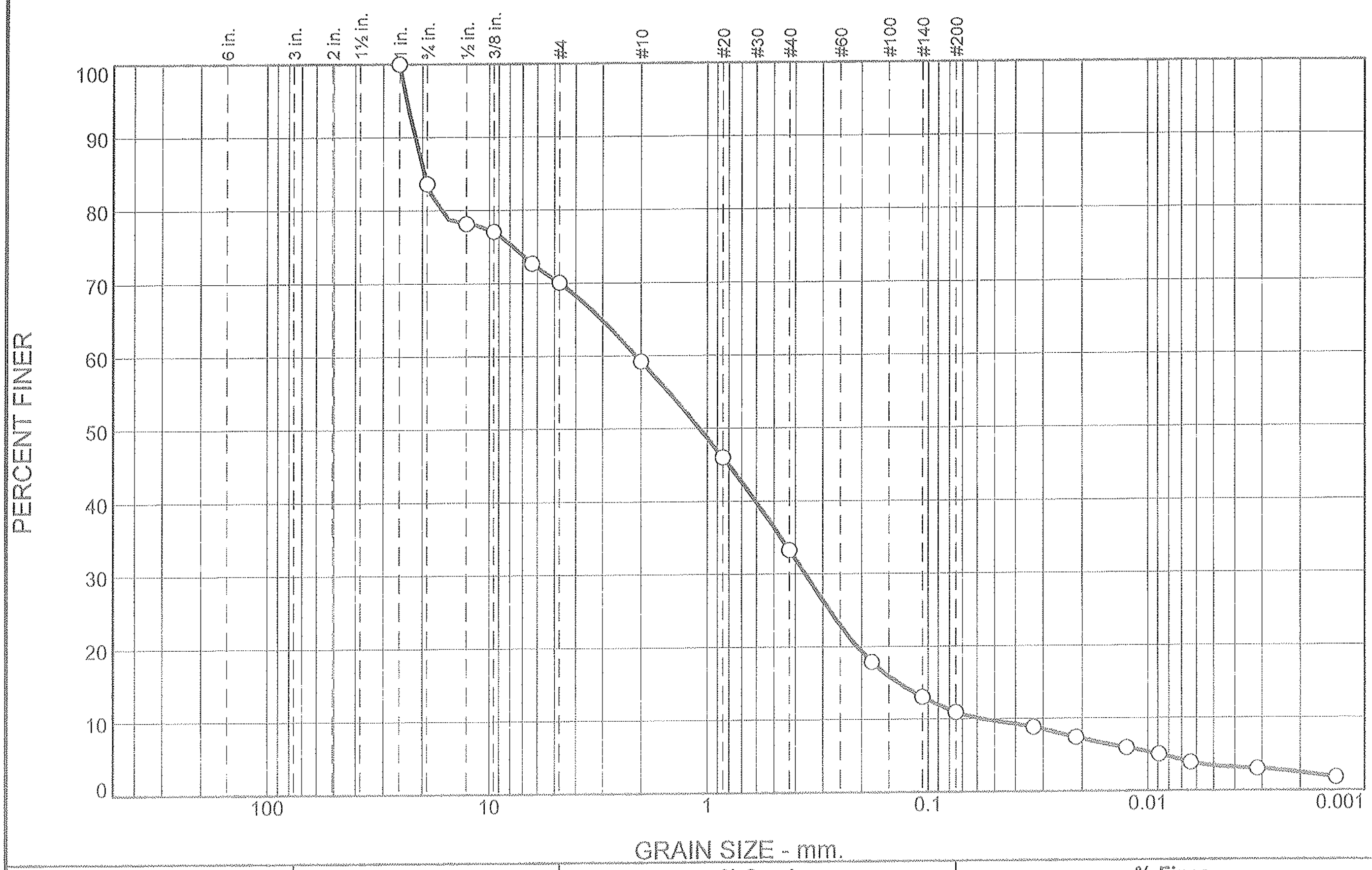
Sample No.: S-1 **Source of Sample:** B-5 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions group
Project: Pavement Rehabilitation Strategies for ramps
Project No: 1229-01 **Figure** 10972G

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.4	13.5	10.9	25.9	22.4	7.5	3.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	83.6		
1/2"	78.2		
3/8"	77.1		
1/4"	72.7		
#4	70.1		
#10	59.2		
#20	46.0		
#40	33.3		
#80	17.9		
#140	13.1		
#200	10.9		
0.0331 mm.	8.8		
0.0213 mm.	7.4		
0.0125 mm.	5.9		
0.0089 mm.	5.1		
0.0064 mm.	3.9		
0.0031 mm.	3.0		
0.0014 mm.	1.8		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 19.6806 D_{60}= 2.1071 D_{50}= 1.0838
D_{30}= 0.3602 D_{15}= 0.1368 D_{10}= 0.0579
C_u= 36.39 C_c= 1.06

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture Content:11.7%

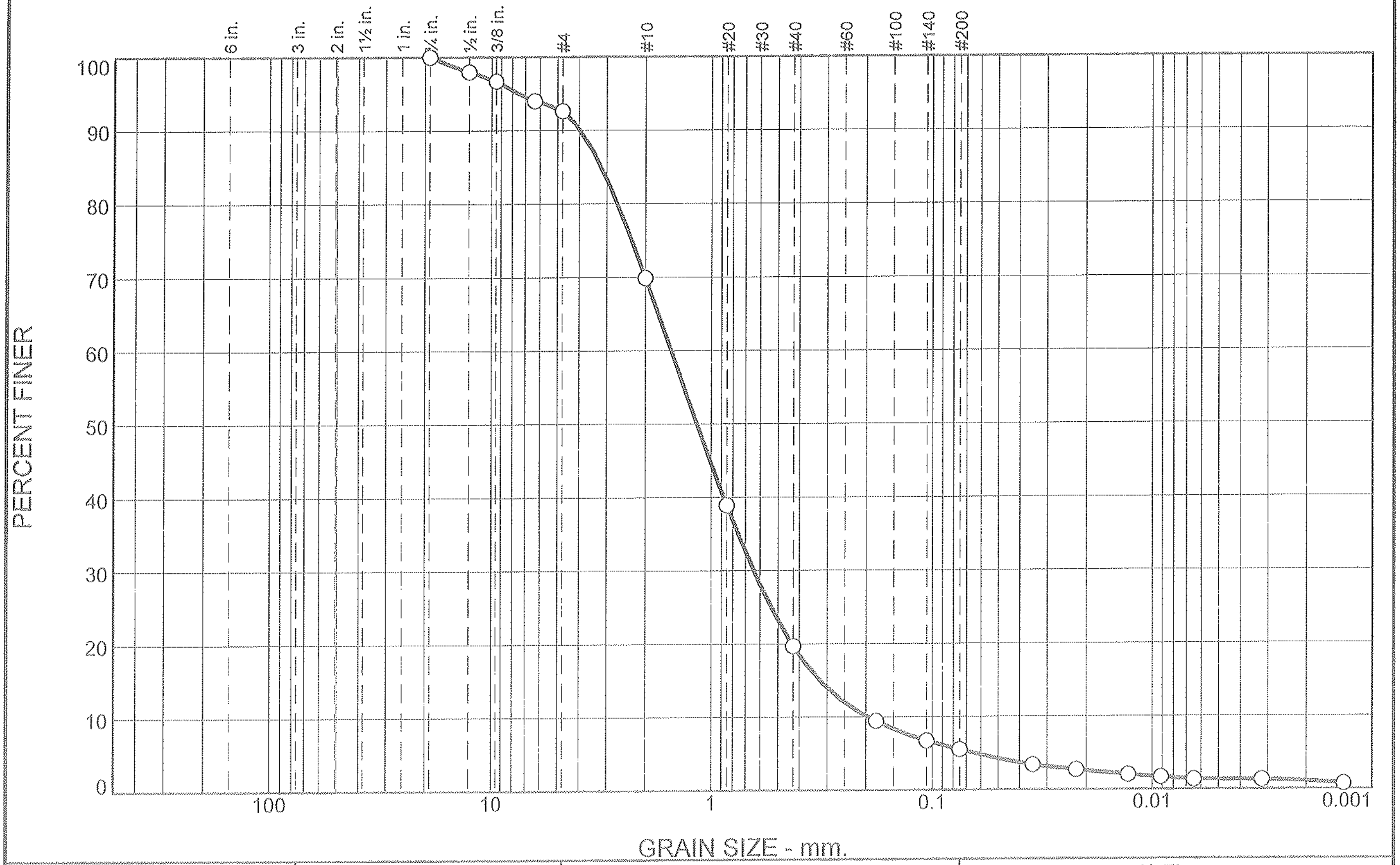
Sample No.: S-1 **Source of Sample:** B-6 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.4'-2.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Figure** 10972H

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.4	22.7	50.2	14.2	4.2	1.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	98.0		
3/8"	96.7		
1/4"	94.0		
#4	92.6		
#10	69.9		
#20	38.9		
#40	19.7		
#80	9.4		
#140	6.7		
#200	5.5		
0.0348 mm.	3.4		
0.0222 mm.	2.7		
0.0129 mm.	2.0		
0.0091 mm.	1.7		
0.0065 mm.	1.3		
0.0032 mm.	1.3		
0.0013 mm.	0.7		

* (no specification provided)

Soil Description

well-graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.1736 D_{60}= 1.5282 D_{50}= 1.1647

D_{30}= 0.6408 D_{15}= 0.3228 D_{10}= 0.1962

C_u= 7.79 C_c= 1.37

Classification

USCS= SW-SM AASHTO=

Remarks

Moisture Content:12.0%

Sample No.: S-3 **Source of Sample:** B-6 **Date:** 10/3/09

Location: New Bedford, MA **Elev./Depth:** 4.5'-6.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

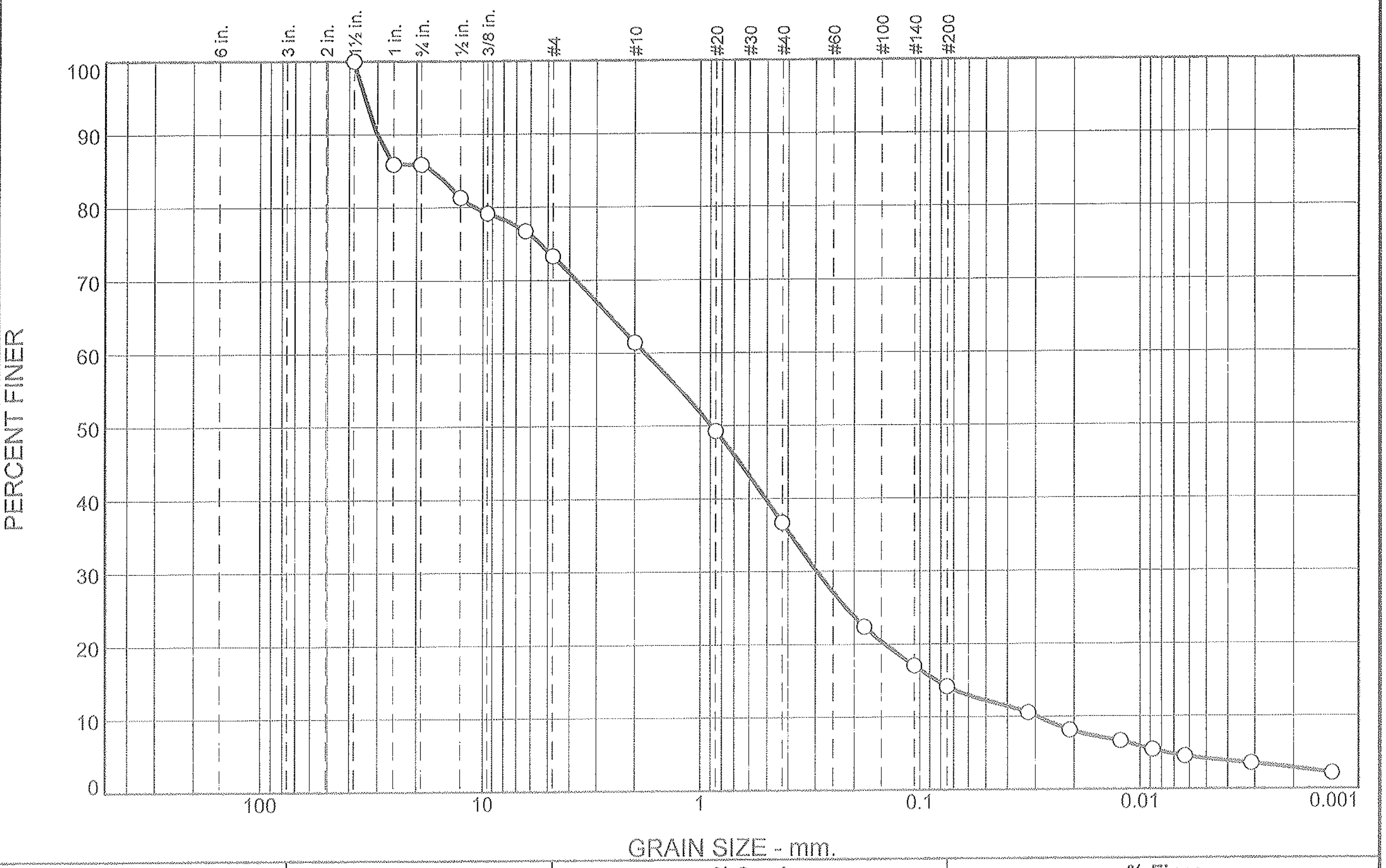
Client: Airport Solutions group

Project: Pavement Rehabilitation Strategies for ramps

Project No: 1229-01 **Figure** 10972I

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	14.1	12.6	11.8	24.8	22.6	10.0	4.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	85.9		
3/4"	85.9		
1/2"	81.4		
3/8"	79.2		
1/4"	76.7		
#4	73.3		
#10	61.5		
#20	49.3		
#40	36.7		
#80	22.4		
#140	17.0		
#200	14.1		
0.0323 mm.	10.5		
0.0209 mm.	8.1		
0.0123 mm.	6.6		
0.0088 mm.	5.4		
0.0063 mm.	4.5		
0.0031 mm.	3.5		
0.0013 mm.	2.2		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 16.6202 D_{60}= 1.7932 D_{50}= 0.8874
D_{30}= 0.2953 D_{15}= 0.0840 D_{10}= 0.0293
C_u= 61.30 C_c= 1.66

Classification

USCS= SM AASHTO=

Remarks

Moisture Content:6.9%

Sample No.: S-1 **Source of Sample:** B-7 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.4'-2.4'

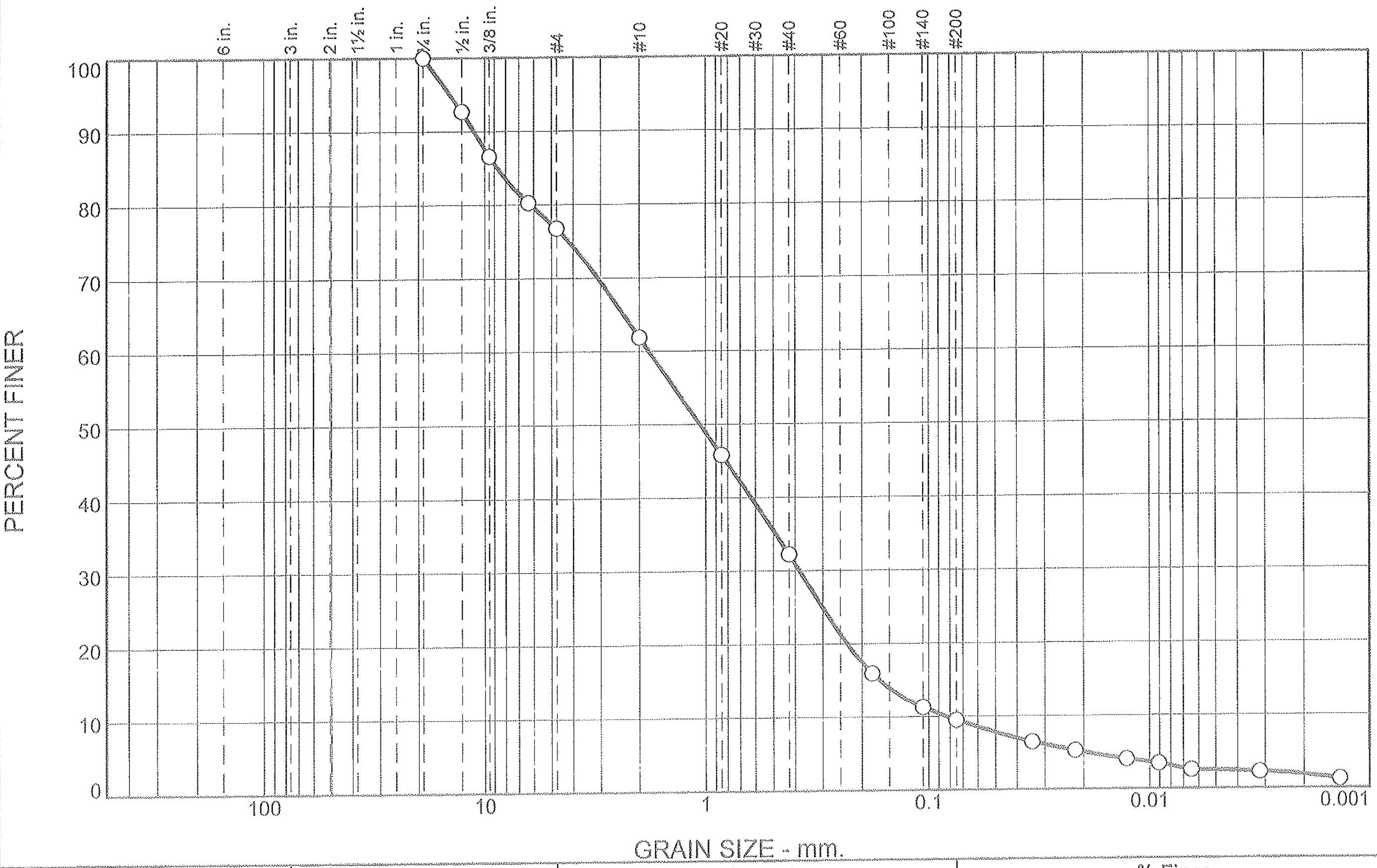
R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions group
Project: Pavement Rehabilitation Strategies for ramps
Project No: 1229-01 **Figure** 10972J

Tested By: JJH **Checked By:** MTG

MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	23.2	14.9	29.6	22.8	7.0	2.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	92.7		
3/8"	86.6		
1/4"	80.3		
#4	76.8		
#10	61.9		
#20	45.9		
#40	32.3		
#80	15.9		
#140	11.3		
#200	9.5		
0.0341 mm.	6.5		
0.0218 mm.	5.3		
0.0127 mm.	4.1		
0.0091 mm.	3.5		
0.0065 mm.	2.5		
0.0032 mm.	2.2		
0.0014 mm.	1.3		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 8.7407 D_{60}= 1.8106 D_{50}= 1.0604
D_{30}= 0.3817 D_{15}= 0.1672 D_{10}= 0.0828
C_u= 21.86 C_c= 0.97

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture Content:4.6%

Sample No.: S-1 **Source of Sample:** B-8 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 0.5'-2.5'

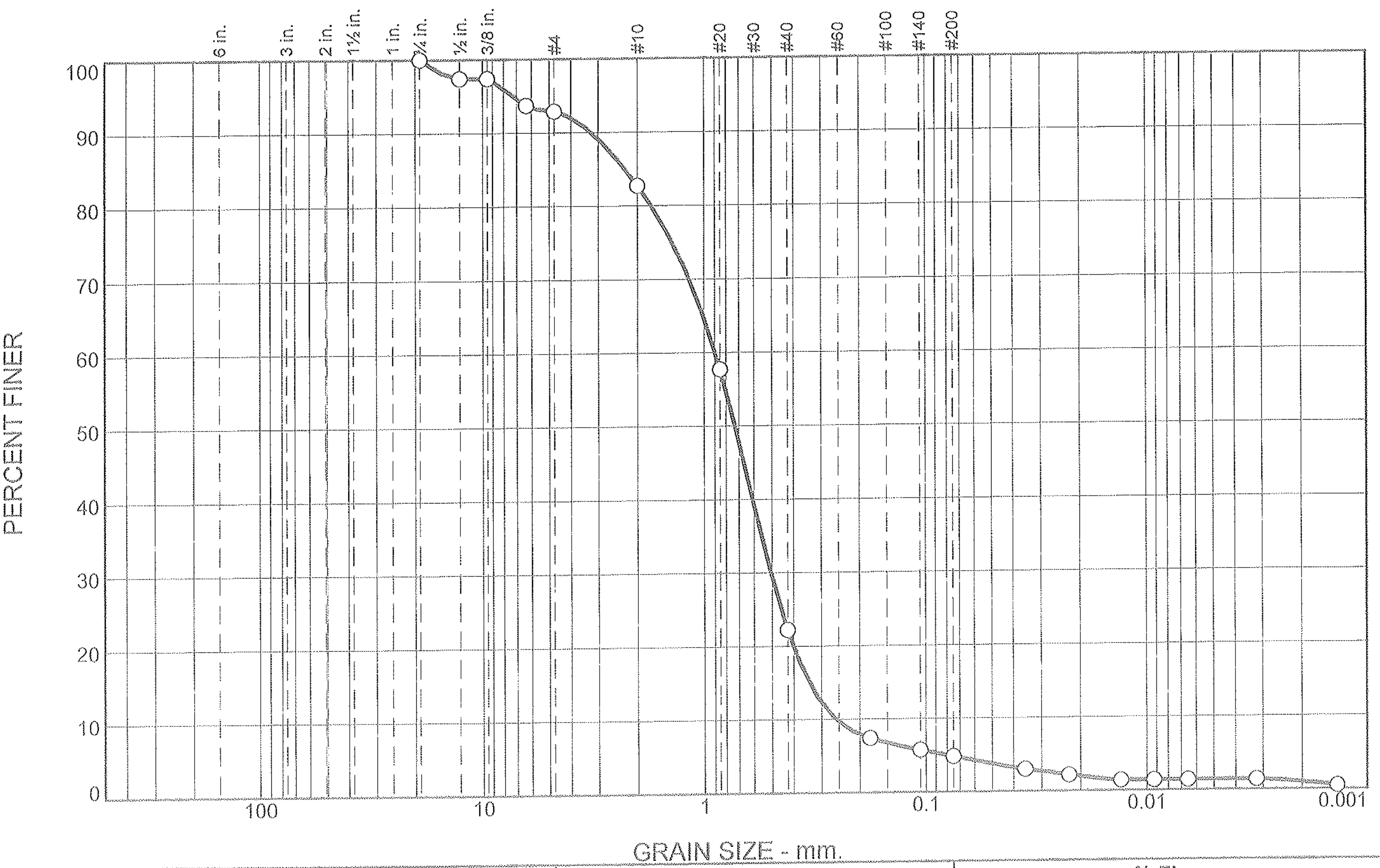
R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Figure** 10972K

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.1	10.2	60.5	17.4	3.4	1.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	97.4		
3/8"	97.4		
1/4"	93.7		
#4	92.9		
#10	82.7		
#20	57.7		
#40	22.2		
#80	7.4		
#140	5.7		
#200	4.8		
0.0355 mm.	3.0		
0.0226 mm.	2.2		
0.0131 mm.	1.4		
0.0093 mm.	1.4		
0.0066 mm.	1.4		
0.0032 mm.	1.4		
0.0014 mm.	0.5		

* (no specification provided)

Soil Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.2759 D_{60}= 0.8935 D_{50}= 0.7294
D_{30}= 0.5039 D_{15}= 0.3396 D_{10}= 0.2567
C_u= 3.48 C_c= 1.11

Classification

USCS= SP AASHTO=

Remarks

Moisture Content:15.5%

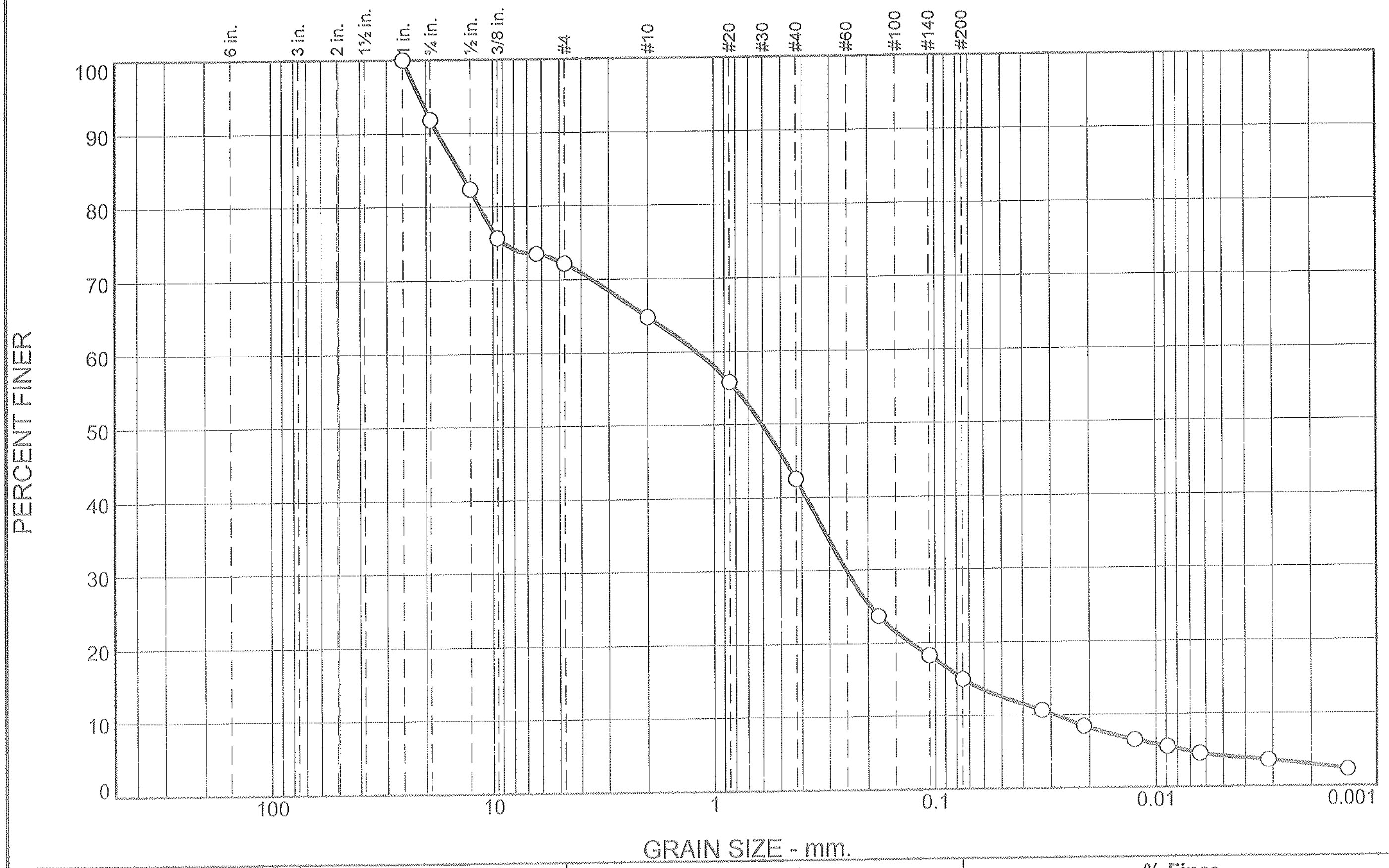
Sample No.: S-3 **Source of Sample:** B-8 **Date:** 10/3/09
Location: New Bedford, MA **Elev./Depth:** 4.5'-6.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Figure** 10972L

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.2	19.6	7.4	22.3	27.5	10.9	4.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	91.8		
1/2"	82.4		
3/8"	75.8		
1/4"	73.6		
#4	72.2		
#10	64.8		
#20	55.8		
#40	42.5		
#80	23.7		
#140	18.3		
#200	15.0		
0.0328 mm.	10.6		
0.0212 mm.	8.4		
0.0125 mm.	6.5		
0.0089 mm.	5.5		
0.0064 mm.	4.6		
0.0031 mm.	3.6		
0.0014 mm.	2.3		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 14.1490 D_{60}= 1.1942 D_{50}= 0.6028

D_{30}= 0.2510 D_{15}= 0.0749 D_{10}= 0.0289

C_u= 41.35 C_c= 1.83

Classification

USCS= SM AASHTO=

Remarks

Moisture Content:8.7%

Sample No.: S-1 **Source of Sample:** B-9 **Date:** 10/3/09

Location: New Bedford, MA **Elev./Depth:** 0.5'-2.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

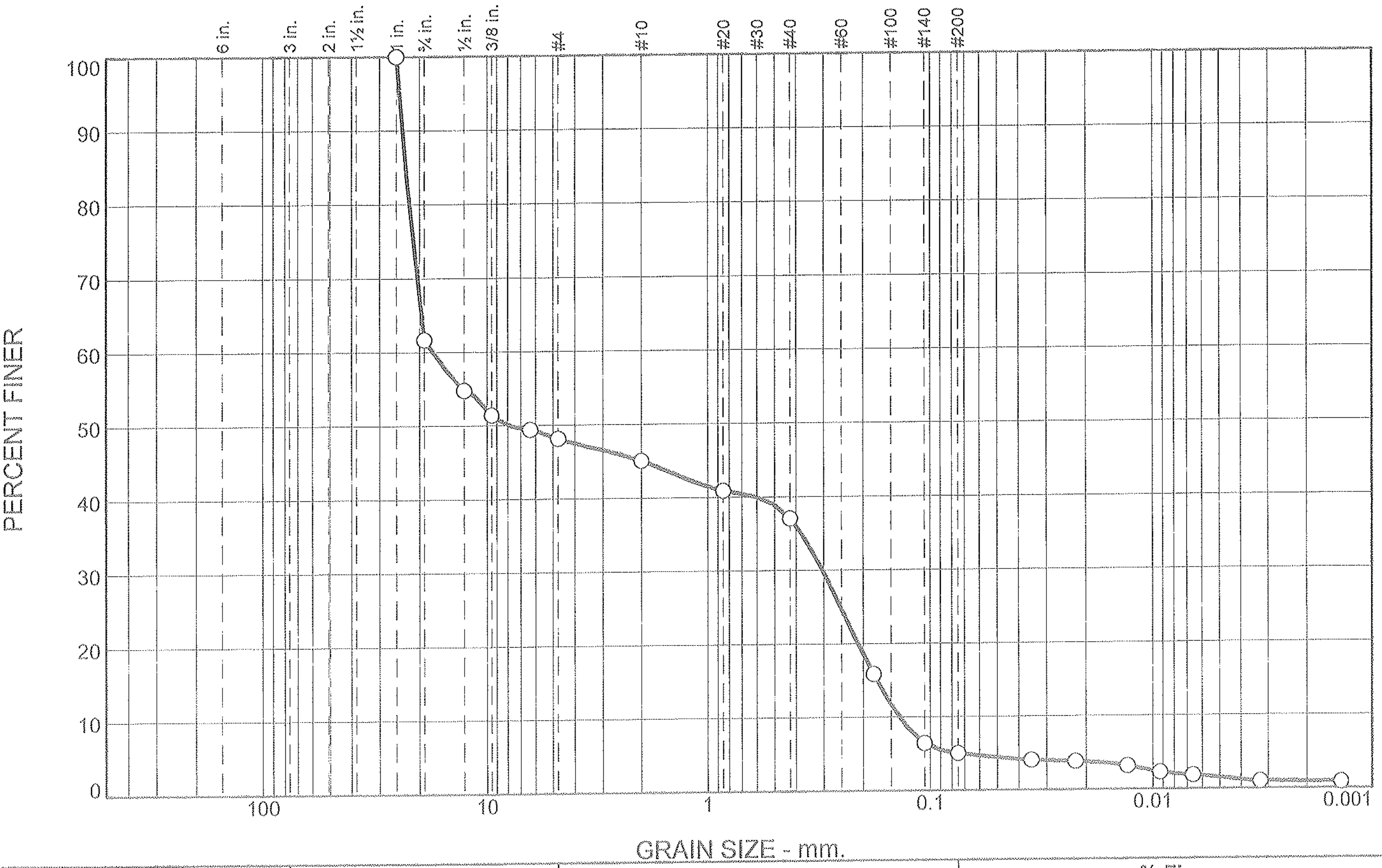
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Figure** 10972M

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	38.3	13.5	3.1	8.1	32.0	3.5	1.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	61.7		
1/2"	54.8		
3/8"	51.4		
1/4"	49.4		
#4	48.2		
#10	45.1		
#20	40.9		
#40	37.0		
#80	15.8		
#140	6.4		
#200	5.0		
0.0351 mm.	4.1		
0.0223 mm.	3.8		
0.0130 mm.	3.2		
0.0093 mm.	2.3		
0.0066 mm.	1.9		
0.0033 mm.	1.0		
0.0014 mm.	0.9		

* (no specification provided)

Soil Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 23.0798 D_{60}= 17.4692 D_{50}= 7.9178
D_{30}= 0.3034 D_{15}= 0.1739 D_{10}= 0.1377
C_u= 126.83 C_c= 0.04

Classification

USCS= GP-GM AASHTO=

Remarks

Moisture content:4.0%

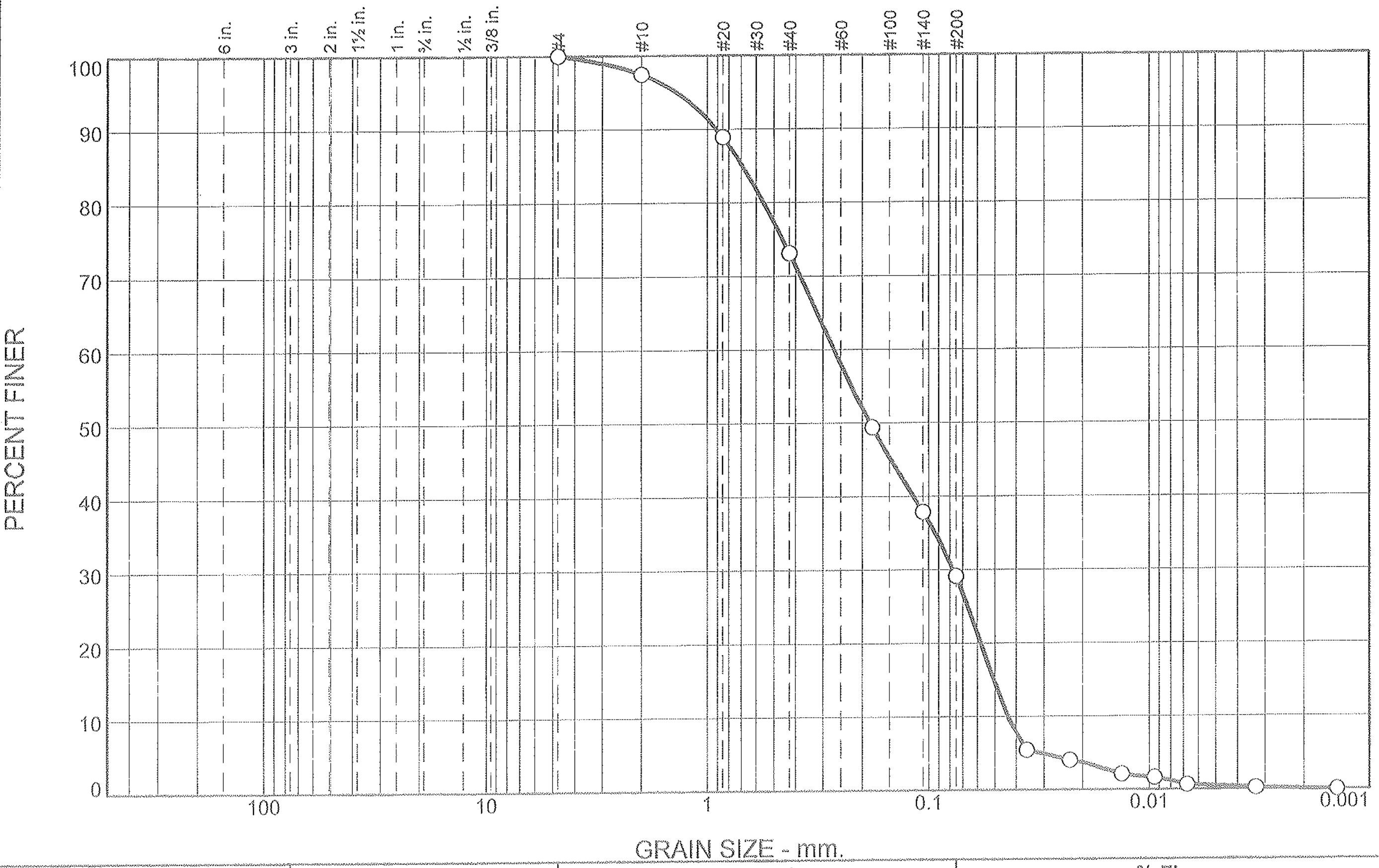
Sample No.: S-1 **Source of Sample:** B-10 **Date:** 10/8/09
Location: New Bedford, MA **Elev./Depth:** 0.4'-2.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Figure** 10972N

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.5	24.4	43.9	28.7	0.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	97.5		
#20	88.9		
#40	73.1		
#80	49.4		
#140	37.9		
#200	29.2		
0.0358 mm.	5.4		
0.0229 mm.	4.0		
0.0133 mm.	2.1		
0.0095 mm.	1.6		
0.0067 mm.	0.7		
0.0033 mm.	0.2		
0.0014 mm.	0.0		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.6905 D_{60}= 0.2676 D_{50}= 0.1843
D_{30}= 0.0771 D_{15}= 0.0507 D_{10}= 0.0436
C_u= 6.13 C_c= 0.51

Classification

USCS= SM AASHTO=

Remarks

Moisture content:17.3%

Sample No.: S-3 **Source of Sample:** B-10 **Date:** 10/8/09
Location: New Bedford, MA **Elev./Depth:** 4.4'-6.4'

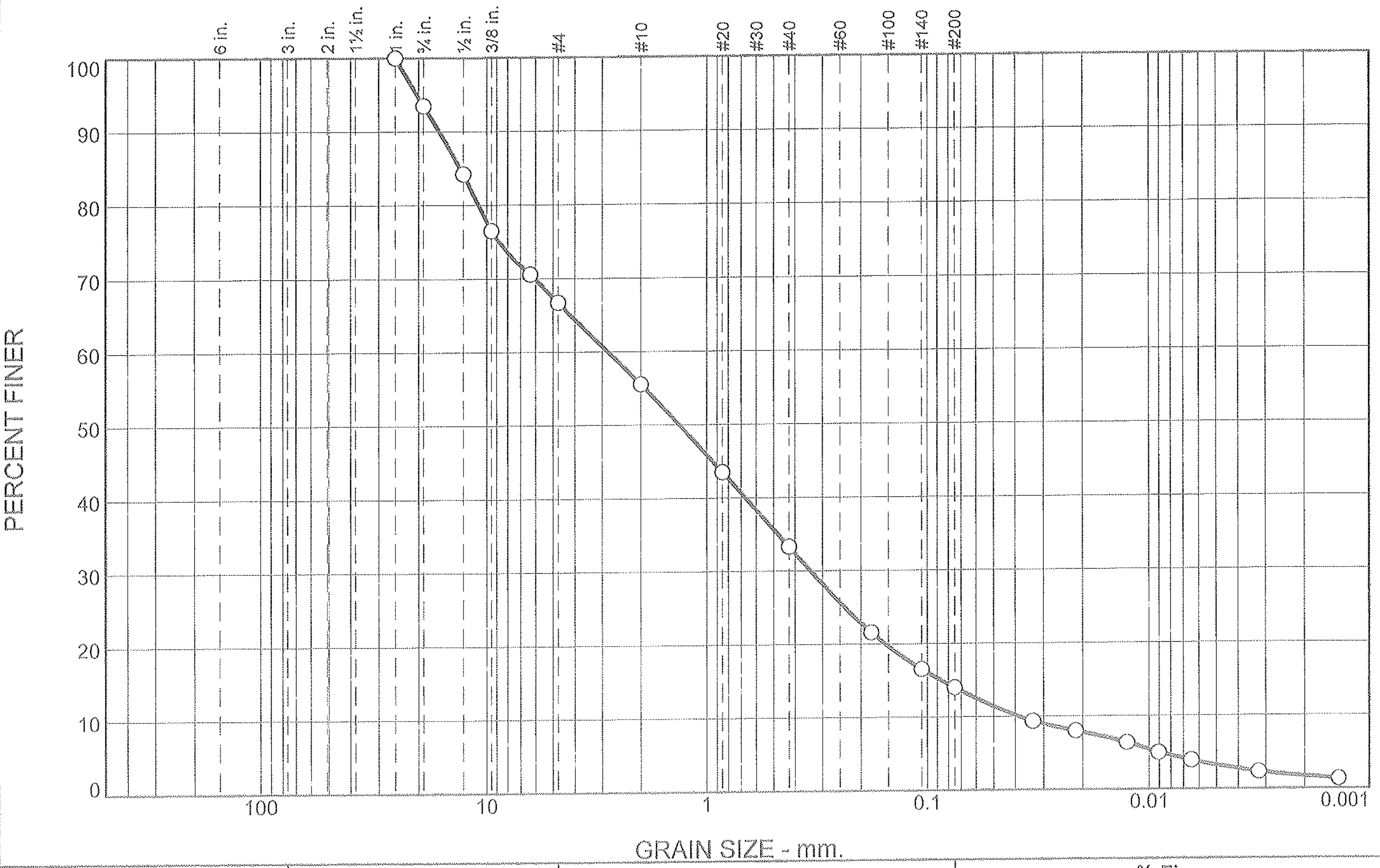
R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Figure** 109720

Tested By: JJH **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.5	26.8	11.1	22.3	19.3	10.8	3.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	93.5		
1/2"	84.2		
3/8"	76.6		
1/4"	70.6		
#4	66.7		
#10	55.6		
#20	43.5		
#40	33.3		
#80	21.6		
#140	16.5		
#200	14.0		
0.0334 mm.	9.4		
0.0215 mm.	8.0		
0.0126 mm.	6.4		
0.0091 mm.	5.0		
0.0065 mm.	3.9		
0.0032 mm.	2.3		
0.0014 mm.	1.4		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 13.0727 D_{60}= 2.8246 D_{50}= 1.3329
D_{30}= 0.3391 D_{15}= 0.0865 D_{10}= 0.0386
C_u= 73.22 C_c= 1.06

Classification

USCS= SM AASHTO=

Remarks

Moisture content:5.5%

Sample No.: S-1 **Source of Sample:** B-11 **Date:** 10/8/09
Location: New Bedford, MA **Elev./Depth:** 0.4'-2.4'

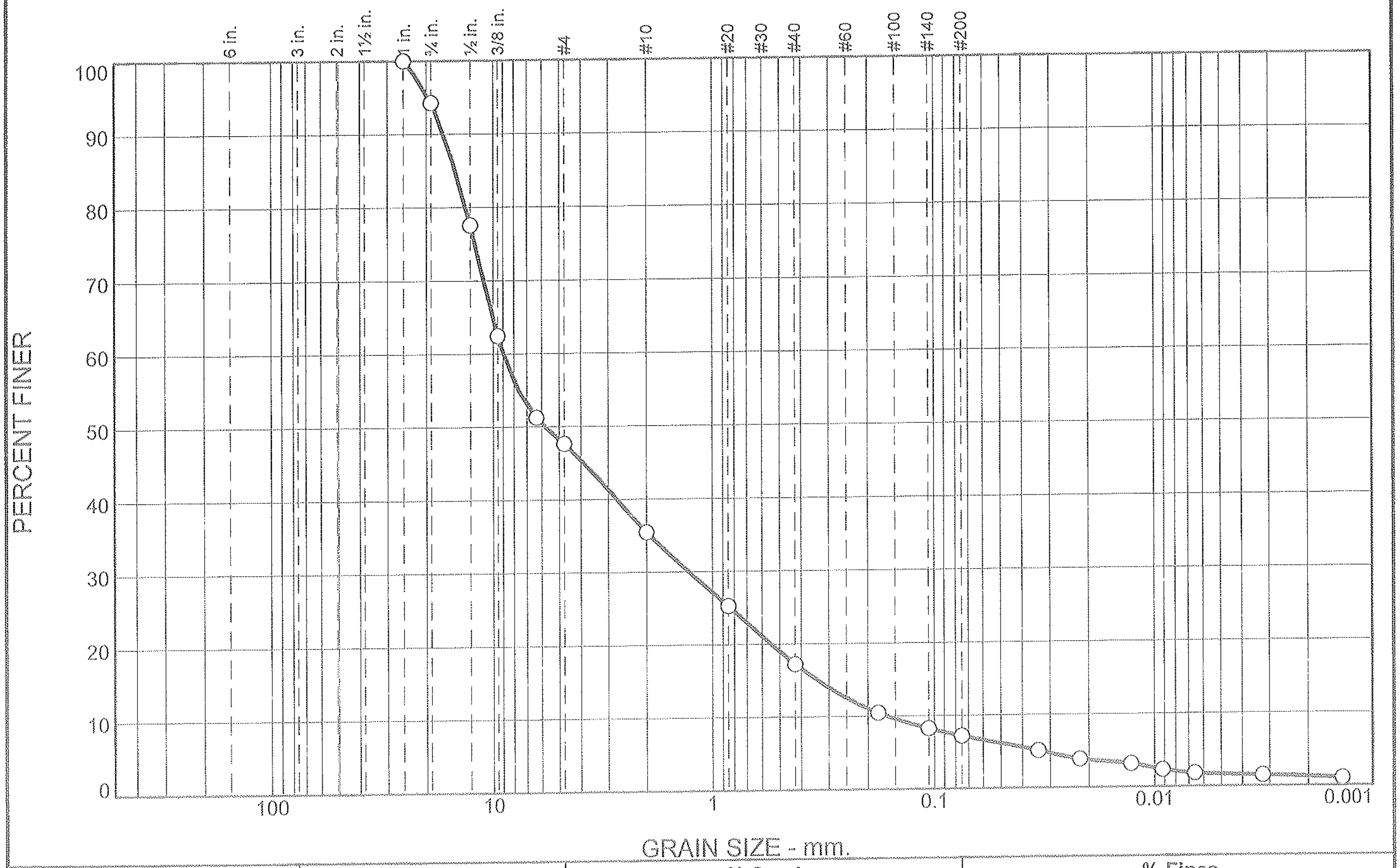
R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Figure** 10972P

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.7	46.7	12.1	18.3	10.0	5.6	1.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	94.3		
1/2"	77.6		
3/8"	62.5		
1/4"	51.3		
#4	47.6		
#10	35.5		
#20	25.3		
#40	17.2		
#80	10.5		
#140	8.3		
#200	7.2		
0.0339 mm.	5.1		
0.0219 mm.	3.9		
0.0128 mm.	3.2		
0.0092 mm.	2.3		
0.0066 mm.	1.8		
0.0032 mm.	1.5		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

well-graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 14.7829 D_{60}= 8.9715 D_{50}= 5.7964

D_{30}= 1.2853 D_{15}= 0.3380 D_{10}= 0.1640

C_u= 54.70 C_c= 1.12

Classification

USCS= GW-GM AASHTO=

Remarks

Moisture Content:3.1%

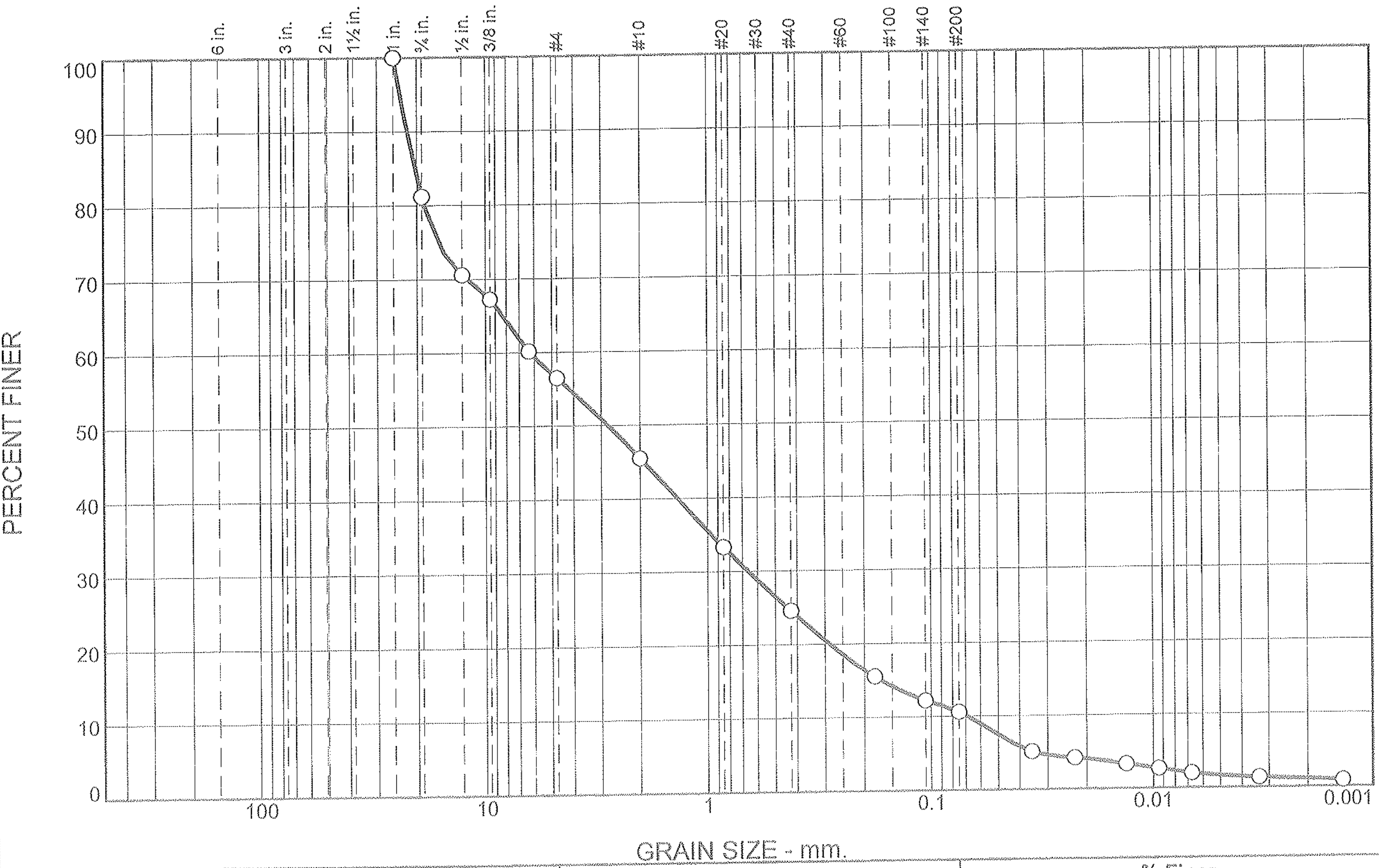
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-12
Date: 10/8/09
Elev./Depth: 0.4'-2.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Figure 10972Q

Tested By: JJH
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	18.8	24.7	11.0	20.9	14.0	9.0	1.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	81.2		
1/2"	70.6		
3/8"	67.3		
1/4"	60.2		
#4	56.5		
#10	45.5		
#20	33.3		
#40	24.6		
#80	15.5		
#140	12.2		
#200	10.6		
0.0353 mm.	5.1		
0.0226 mm.	4.2		
0.0132 mm.	3.3		
0.0094 mm.	2.7		
0.0067 mm.	2.0		
0.0033 mm.	1.3		
0.0014 mm.	0.9		

* (no specification provided)

Soil Description

well-graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 20.4015 D_{60}= 6.2751 D_{50}= 2.7890
D_{30}= 0.6610 D_{15}= 0.1683 D_{10}= 0.0686
C_u= 91.53 C_c= 1.02

Classification

USCS= SW-SM AASHTO=

Remarks

Moisture content:6.3%

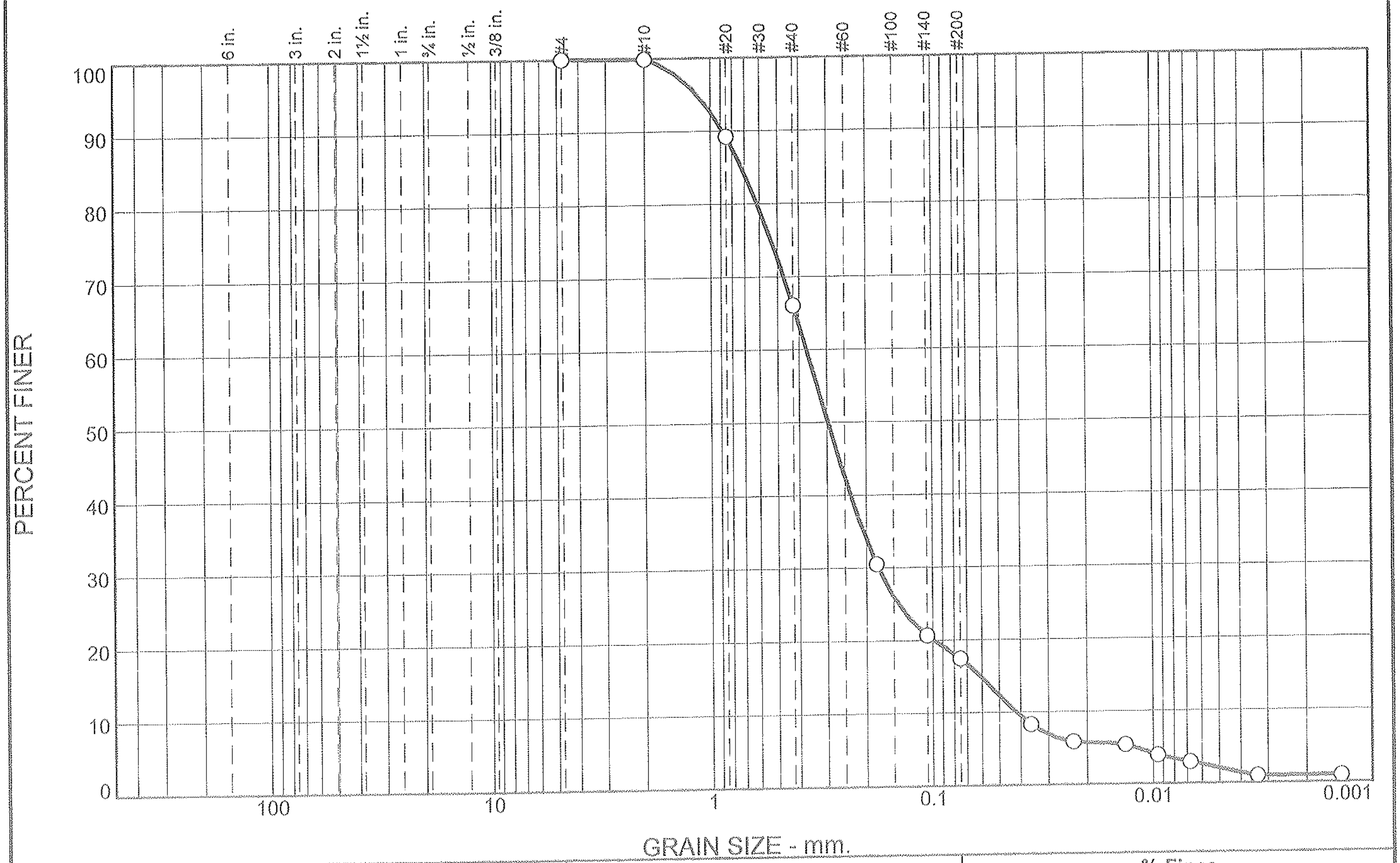
Sample No.: S-3 **Source of Sample:** B-12 **Date:** 10/8/09
Location: New Bedford, MA **Elev./Depth:** 4.4'-6.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Figure** 10972R

Tested By: JJH **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	33.8	48.6	15.5	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	89.2		
#40	66.1		
#80	30.5		
#140	20.7		
#200	17.5		
0.0359 mm.	8.3		
0.0231 mm.	5.9		
0.0134 mm.	5.4		
0.0095 mm.	3.9		
0.0068 mm.	2.9		
0.0034 mm.	1.0		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.7226 D_{60}= 0.3696 D_{50}= 0.2962
D_{30}= 0.1768 D_{15}= 0.0610 D_{10}= 0.0419
C_u= 8.82 C_c= 2.02

Classification

USCS= SM AASHTO=

Remarks

Moisture content:17.2%

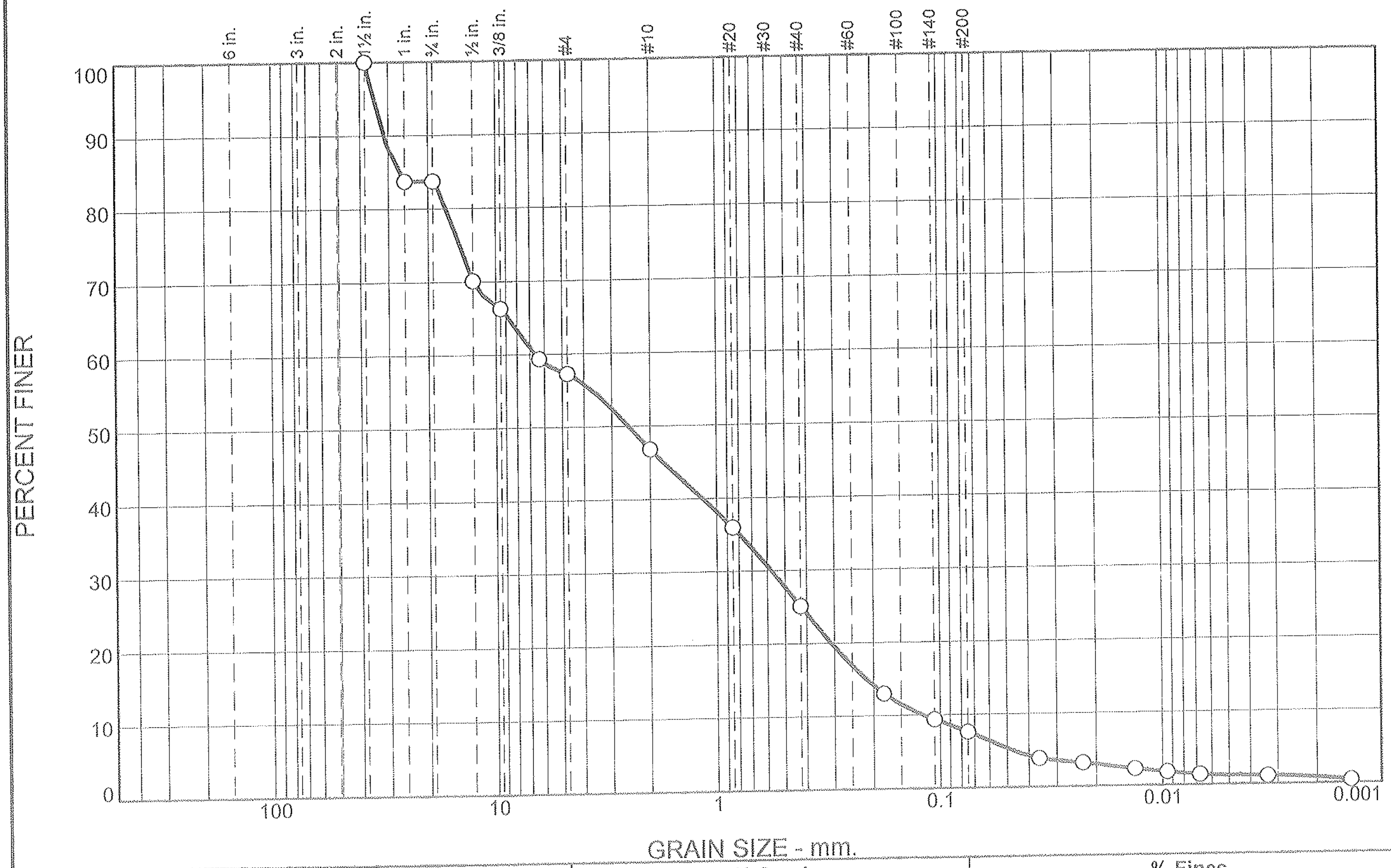
Sample No.: S-4
Location: New Bedford, MA
Source of Sample: B-12
Date: 10/8/09
Elev./Depth: 6.4'-8.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Figure 10972S

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.2	26.5	10.5	21.7	17.5	6.4	1.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	83.8		
3/4"	83.8		
1/2"	70.1		
3/8"	66.3		
1/4"	59.4		
#4	57.3		
#10	46.8		
#20	36.0		
#40	25.1		
#80	13.0		
#140	9.4		
#200	7.6		
0.0359 mm.	3.9		
0.0229 mm.	3.2		
0.0134 mm.	2.3		
0.0095 mm.	1.8		
0.0068 mm.	1.4		
0.0033 mm.	1.1		
0.0014 mm.	0.5		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 27.2747 D_{60}= 6.6391 D_{50}= 2.5082
D_{30}= 0.5735 D_{15}= 0.2156 D_{10}= 0.1187
C_u= 55.91 C_c= 0.42

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture content:5.3%

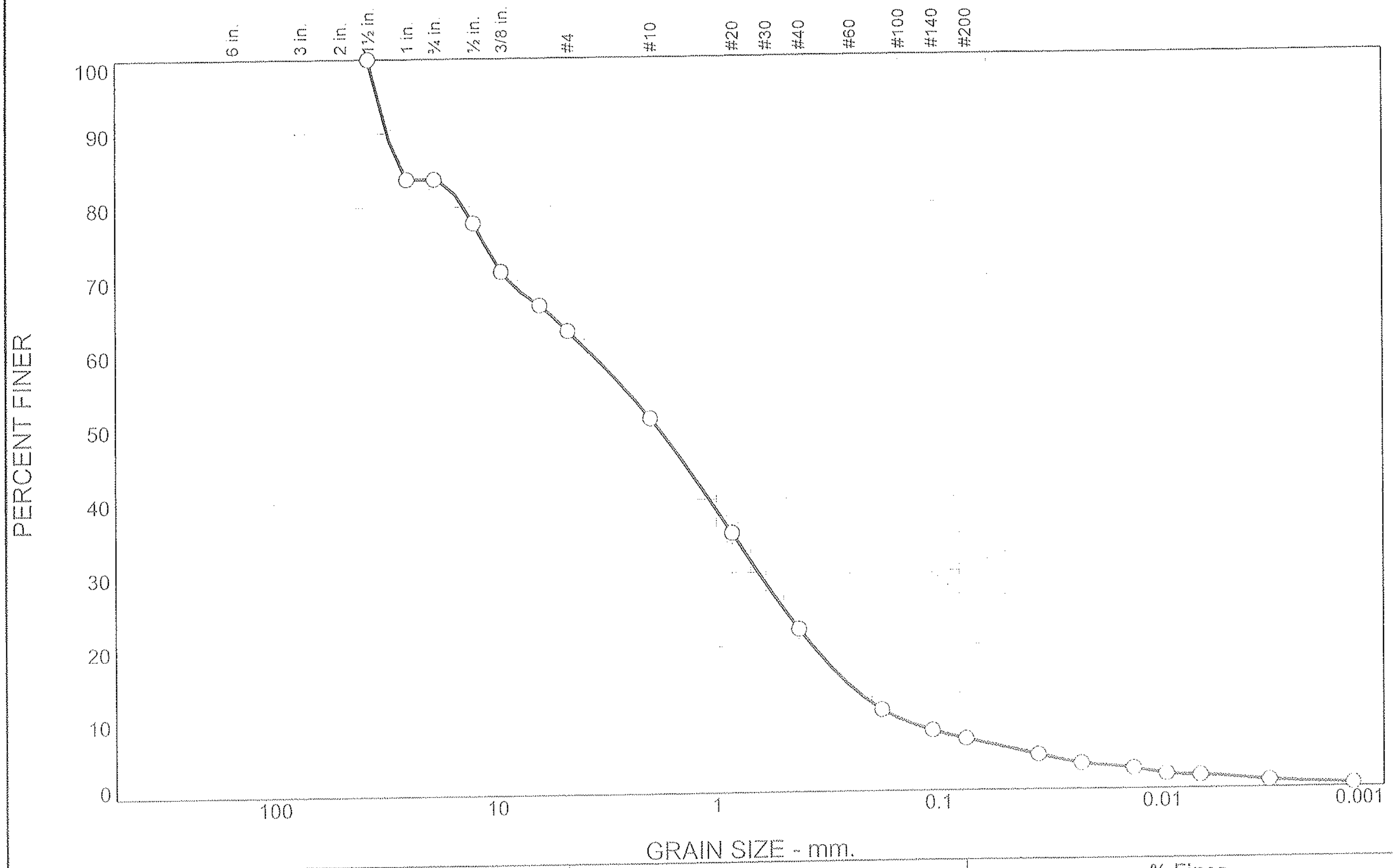
Sample No.: S-1 **Source of Sample:** B-13 **Date:** 10/8/09
Location: New Bedford, MA **Elev./Depth:** 1'-3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Figure** 10972T

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.3	20.6	12.0	28.8	15.3	5.5	1.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	83.7		
3/4"	83.7		
1/2"	77.8		
3/8"	71.2		
1/4"	66.6		
#4	63.1		
#10	51.1		
#20	35.4		
#40	22.3		
#80	11.1		
#140	8.2		
#200	7.0		
0.0357 mm.	4.7		
0.0229 mm.	3.5		
0.0134 mm.	2.7		
0.0095 mm.	2.0		
0.0068 mm.	1.7		
0.0033 mm.	1.0		
0.0014 mm.	0.5		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 27.0818 D_{60}= 3.7487 D_{50}= 1.8692
D_{30}= 0.6461 D_{15}= 0.2622 D_{10}= 0.1548
C_u= 24.22 C_c= 0.72

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Moisture content: 4.7%

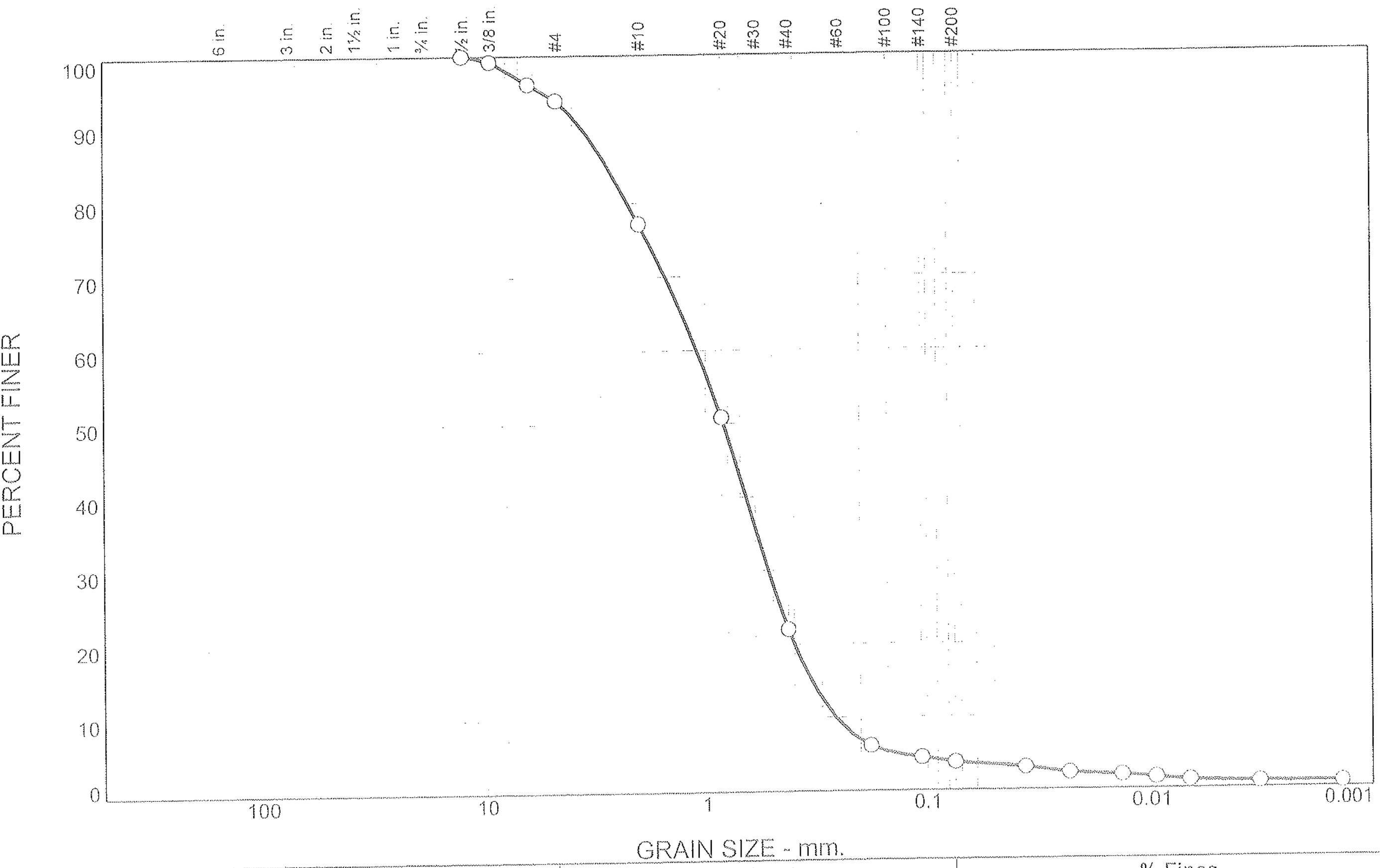
Sample No.: S-1 **Source of Sample:** B-14 **Date:** 10/16/09
Location: New Bedford, MA **Elev./Depth:** 0.7'-2.7'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972U

Tested By: JJH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.1	16.7	55.1	18.3	2.9	0.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	99.2		
1/4"	96.1		
#4	93.9		
#10	77.2		
#20	50.8		
#40	22.1		
#80	6.1		
#140	4.5		
#200	3.8		
0.0365 mm.	3.0		
0.0232 mm.	2.3		
0.0134 mm.	1.9		
0.0095 mm.	1.5		
0.0068 mm.	1.1		
0.0033 mm.	0.8		
0.0014 mm.	0.8		

* (no specification provided)

Soil Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.7812 D_{60}= 1.0922 D_{50}= 0.8328
D_{30}= 0.5229 D_{15}= 0.3337 D_{10}= 0.2590
C_u= 4.22 C_c= 0.97

Classification

USCS= SP AASHTO=

Remarks

Moisture content: 14.0%

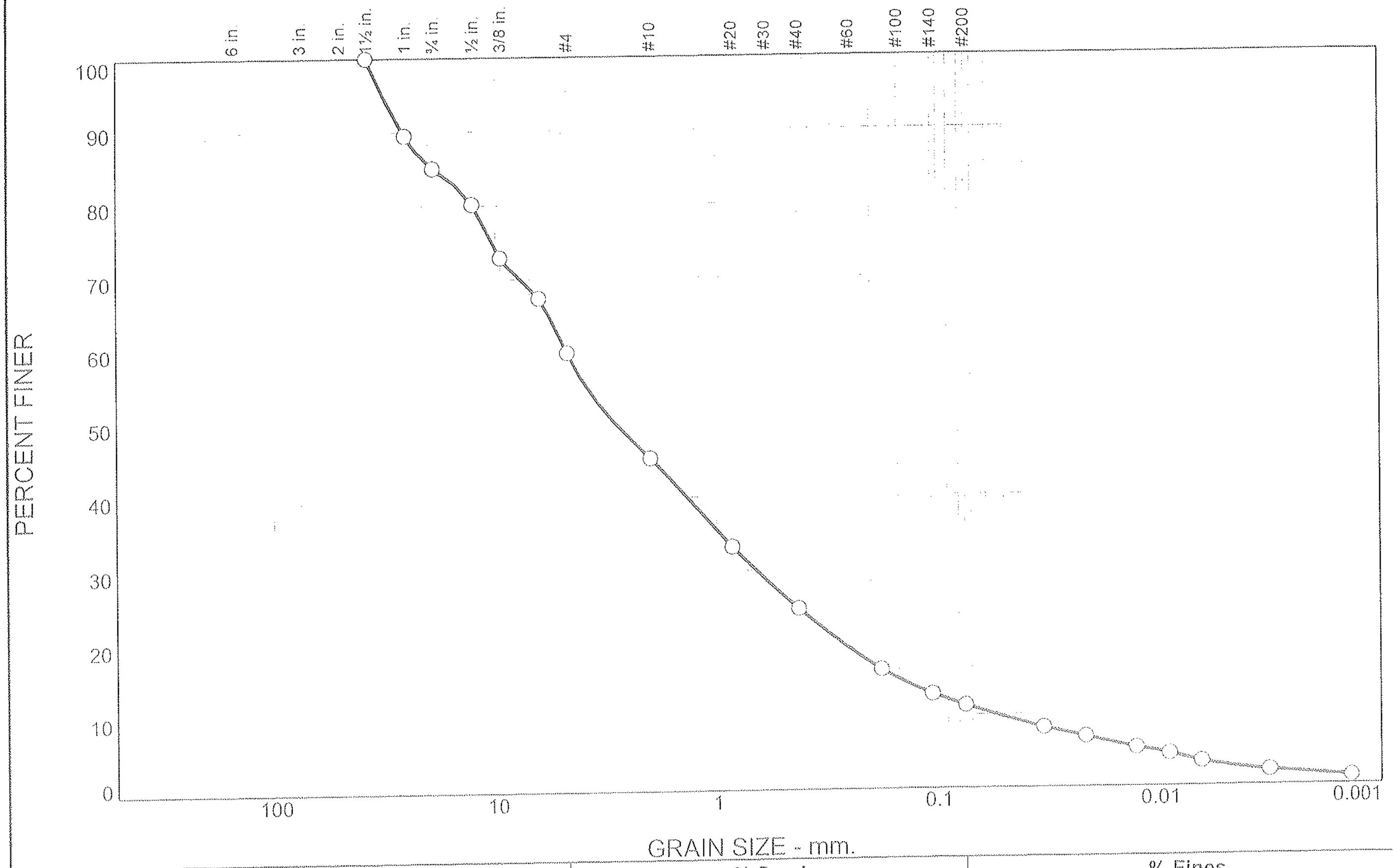
Sample No.: S-3
Location: New Bedford, MA
Source of Sample: B-14
Date: 10/16/09
Elev./Depth: 4.7'-6.7'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972V

Tested By: JJH
Checked By: MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	14.9	25.3	14.5	20.5	13.5	8.6	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	89.5		
3/4"	85.1		
1/2"	80.2		
3/8"	72.9		
1/4"	67.3		
#4	59.8		
#10	45.3		
#20	33.3		
#40	24.8		
#80	16.4		
#140	12.9		
#200	11.3		
0.0334 mm.	8.2		
0.0215 mm.	6.9		
0.0127 mm.	5.3		
0.0091 mm.	4.4		
0.0065 mm.	3.3		
0.0032 mm.	2.0		
0.0014 mm.	1.1		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 18.9464 D_{60}= 4.7818 D_{50}= 2.8554

D_{30}= 0.6620 D_{15}= 0.1496 D_{10}= 0.0544

C_u= 87.91 C_c= 1.68

Classification

USCS= SW-SM AASHTO= A-1-a

Remarks

Moisture content: 5.0%

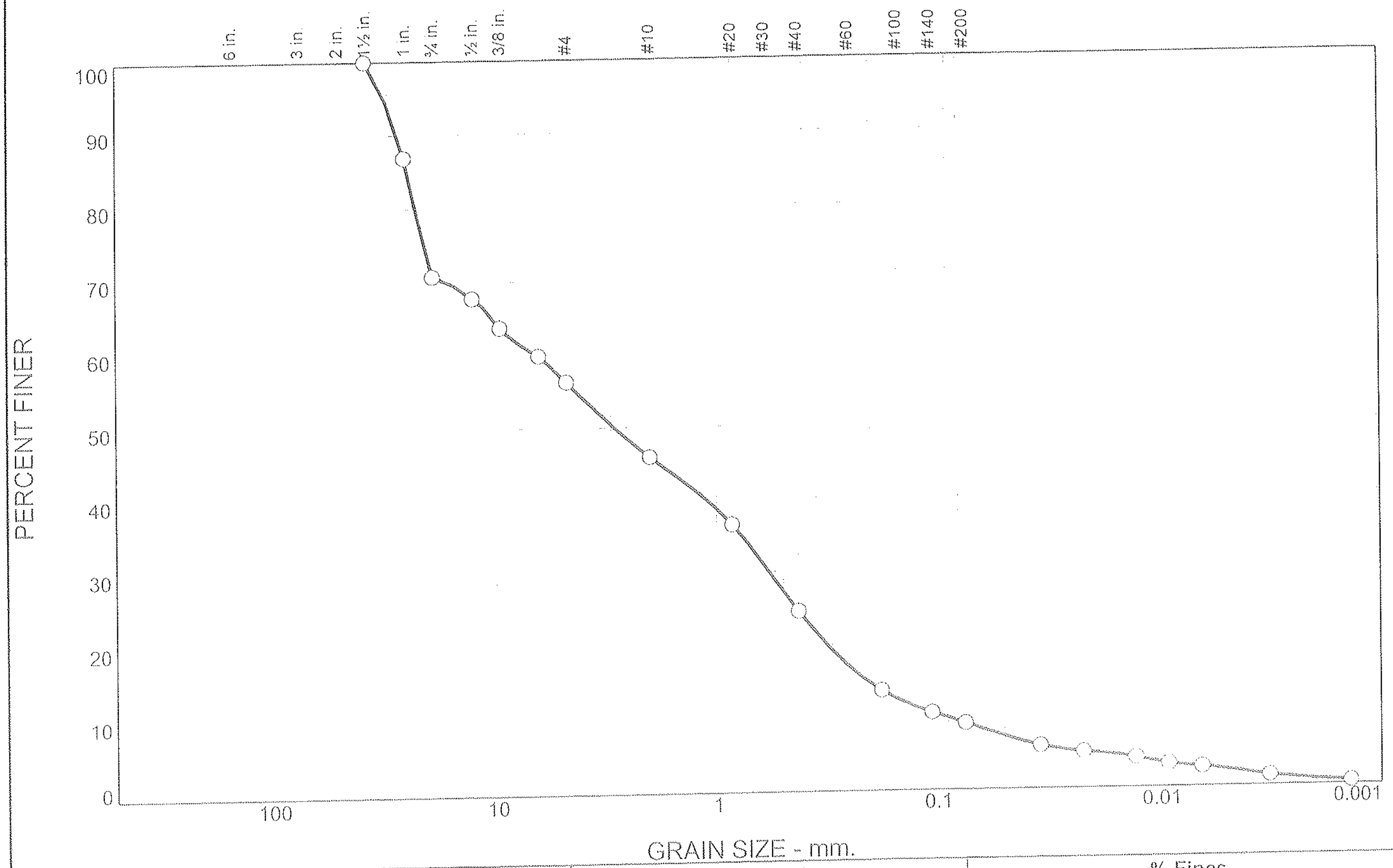
Sample No.: S-1
Source of Sample: B-15
Date: 10/16/09
Location: New Bedford, MA
Elev./Depth: 0.4'-2.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972W

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	29.3	14.4	10.4	21.3	15.6	6.8	2.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	86.9		
3/4"	70.7		
1/2"	67.8		
3/8"	63.7		
1/4"	59.9		
#4	56.3		
#10	45.9		
#20	36.5		
#40	24.6		
#80	13.6		
#140	10.5		
#200	9.0		
0.0346 mm.	5.8		
0.0222 mm.	4.9		
0.0130 mm.	4.0		
0.0093 mm.	3.1		
0.0066 mm.	2.7		
0.0033 mm.	1.4		
0.0014 mm.	0.4		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 24.5771
D_{60}= 6.4375
D_{50}= 2.8920
D_{30}= 0.5770
D_{15}= 0.2093
D_{10}= 0.0941
C_u= 68.37
C_c= 0.55

Classification

USCS= SP-SM
AASHTO= A-1-a

Remarks

Moisture content: 4.2%

Sample No.: S-1
Source of Sample: B-16
Date: 10/16/09
Location: New Bedford, MA
Elev./Depth: 0.3'-2.3'

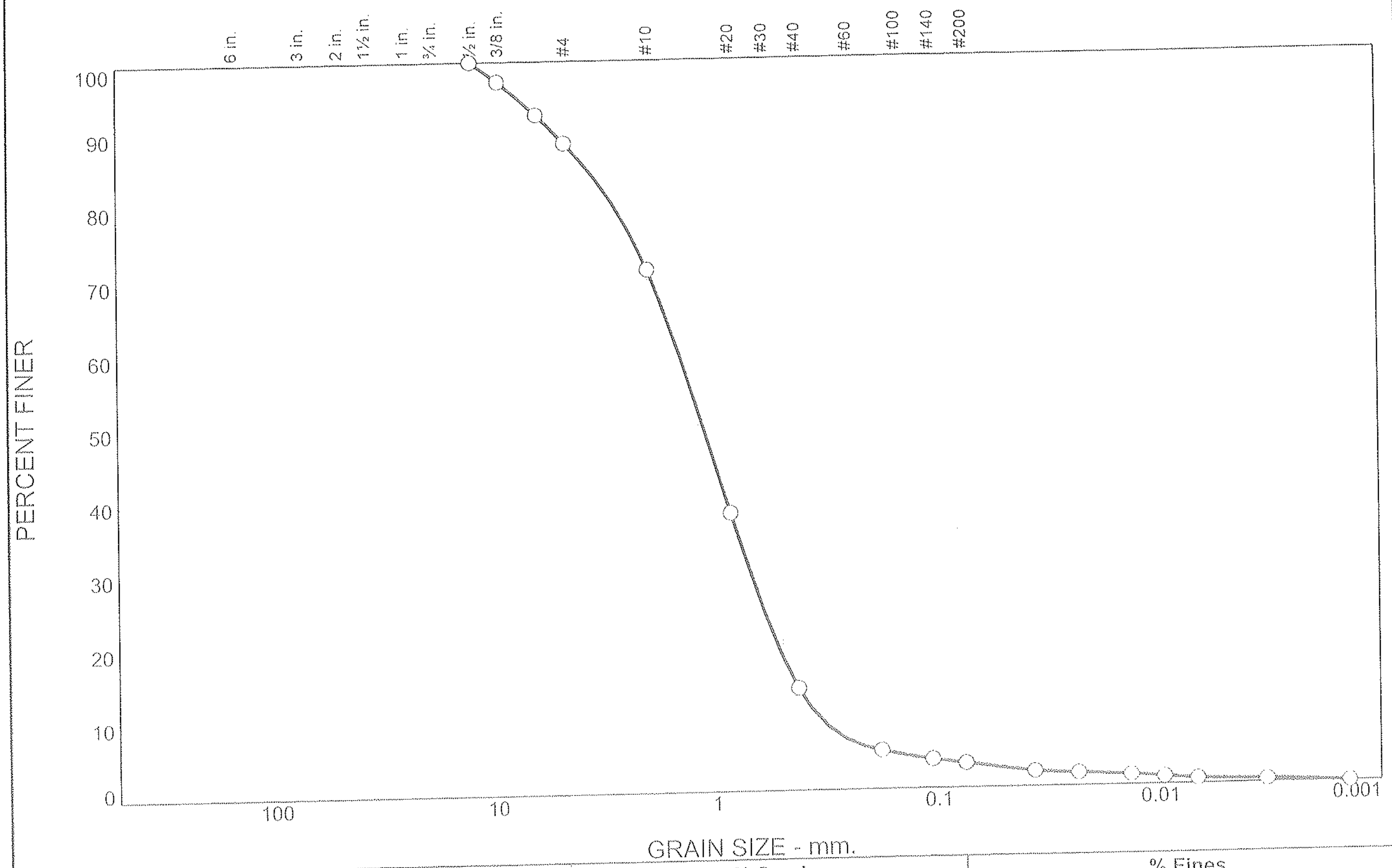
R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01
Lab No. 10972X

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.3	17.4	57.4	10.6	2.8	0.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	97.3		
1/4"	92.7		
#4	88.7		
#10	71.3		
#20	38.0		
#40	13.9		
#80	5.2		
#140	3.9		
#200	3.3		
0.0367 mm.	2.1		
0.0233 mm.	1.7		
0.0135 mm.	1.4		
0.0096 mm.	1.0		
0.0068 mm.	0.7		
0.0033 mm.	0.4		
0.0014 mm.	0.0		

* (no specification provided)

Soil Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.7065 D_{60}= 1.4469 D_{50}= 1.1312
D_{30}= 0.6985 D_{15}= 0.4439 D_{10}= 0.3454
C_u= 4.19 C_c= 0.98

Classification

USCS= SP AASHTO=

Remarks

Moisture content: 14.3%

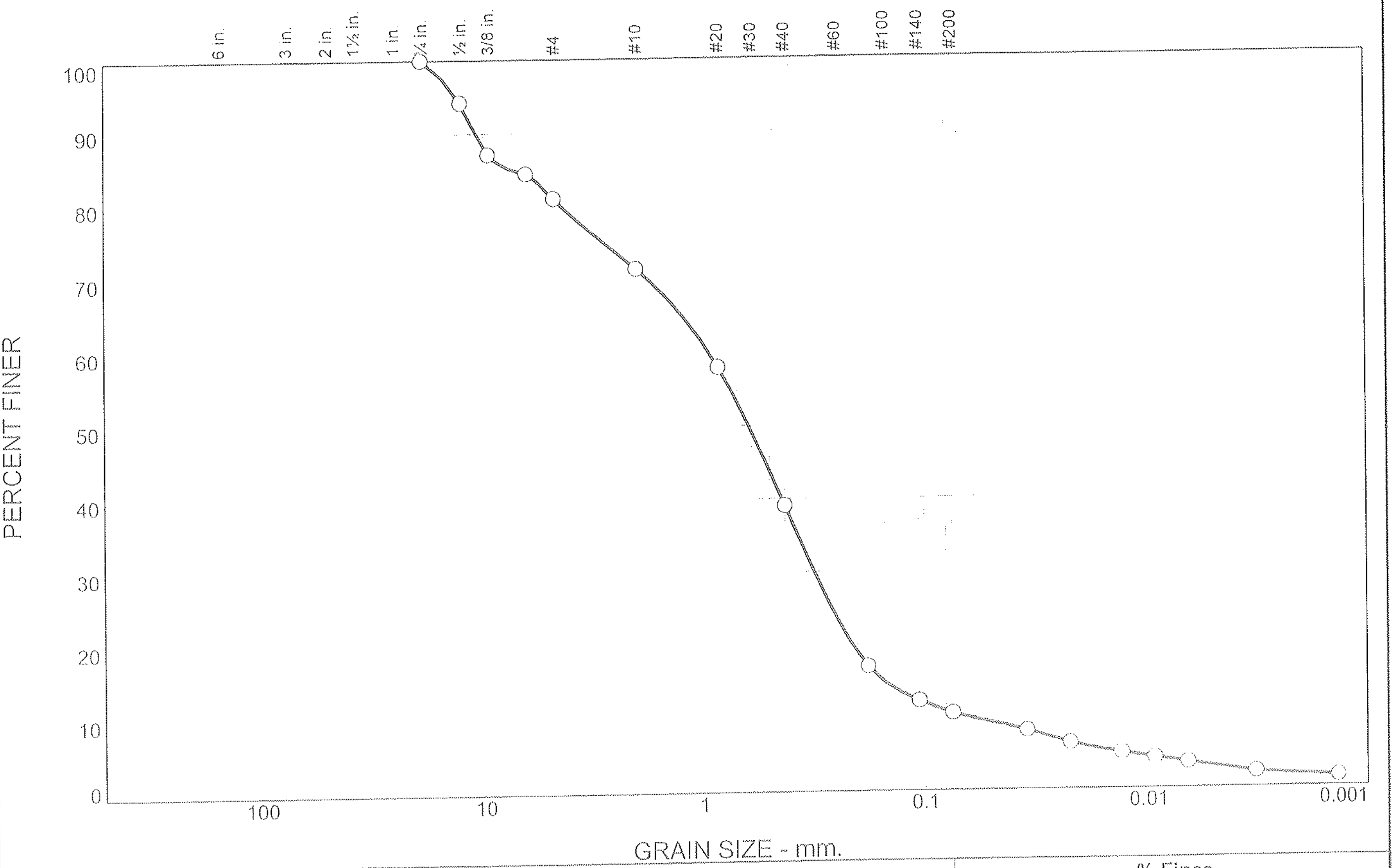
Sample No.: S-3
Location: New Bedford, MA
Source of Sample: B-16
Date: 10/16/09
Elev./Depth: 4.3'-6.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972Y

Tested By: JJH/MCS Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	18.9	9.6	32.4	28.6	7.6	2.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	94.2		
3/8"	87.2		
1/4"	84.5		
#4	81.1		
#10	71.5		
#20	58.1		
#40	39.1		
#80	17.0		
#140	12.2		
#200	10.5		
0.0350 mm.	8.0		
0.0225 mm.	6.3		
0.0131 mm.	4.9		
0.0093 mm.	4.2		
0.0066 mm.	3.5		
0.0033 mm.	2.1		
0.0014 mm.	1.4		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 7.1439 D_{60}= 0.9298 D_{50}= 0.6172

D_{30}= 0.3135 D_{15}= 0.1542 D_{10}= 0.0658

C_u= 14.13 C_c= 1.61

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

Moisture content: 9.0%

Sample No.: S-1 **Source of Sample:** B-17 **Date:** 10/16/09

Location: New Bedford, MA **Elev./Depth:** 0.5'-2.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

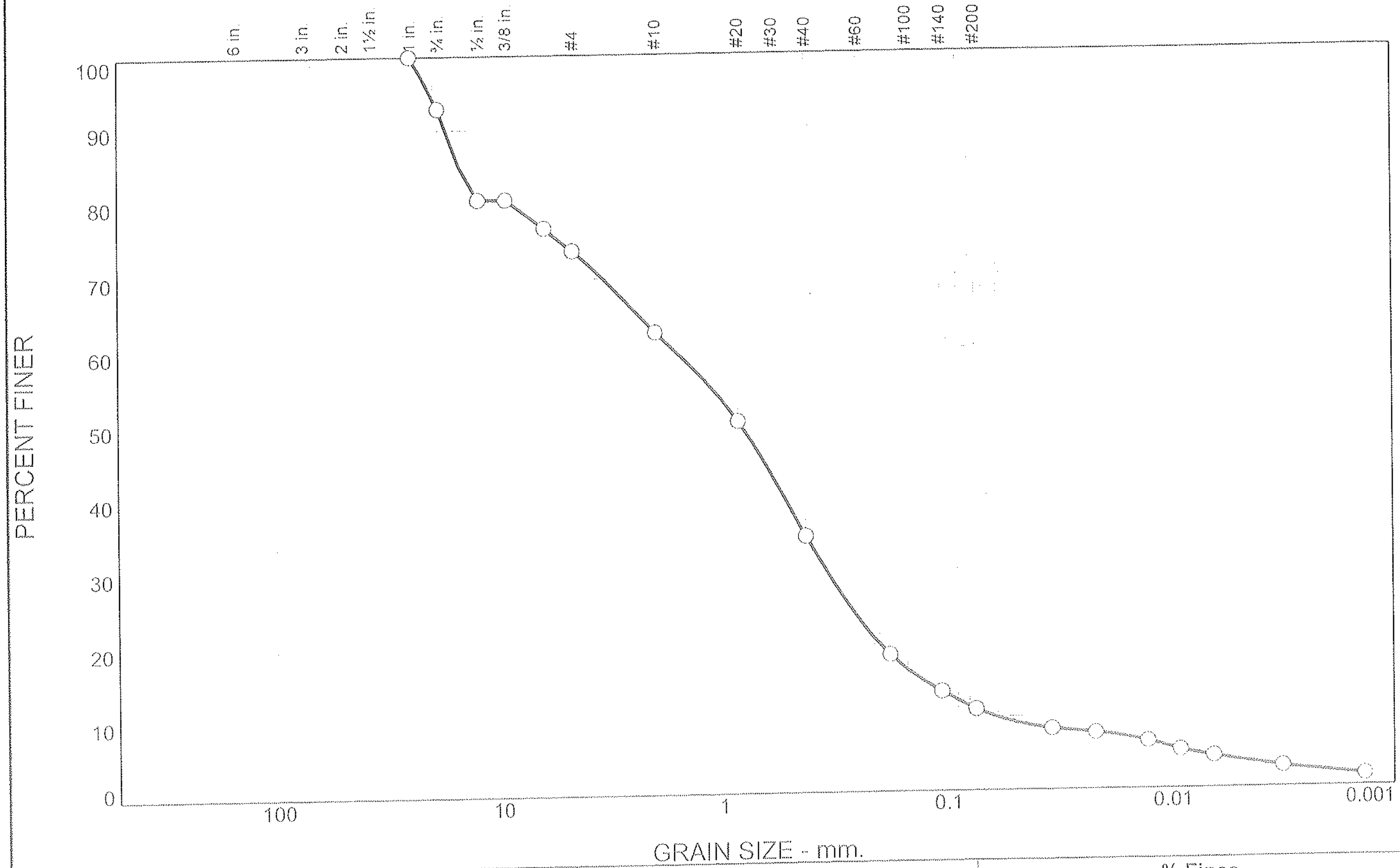
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972Z

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.1	19.2	11.1	27.9	23.7	7.3	3.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	92.9		
1/2"	80.6		
3/8"	80.6		
1/4"	76.8		
#4	73.7		
#10	62.6		
#20	50.5		
#40	34.7		
#80	18.6		
#140	13.5		
#200	11.0		
0.0346 mm.	8.3		
0.0220 mm.	7.7		
0.0129 mm.	6.4		
0.0092 mm.	5.2		
0.0066 mm.	4.3		
0.0032 mm.	2.8		
0.0014 mm.	1.6		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 15.2010
D_{60}= 1.6279
D_{50}= 0.8299
D_{30}= 0.3447
D_{15}= 0.1279
D_{10}= 0.0615
C_u= 26.46
C_c= 1.19

Classification

USCS= SW-SM
AASHTO= A-1-b

Remarks

Moisture content: 8.9%

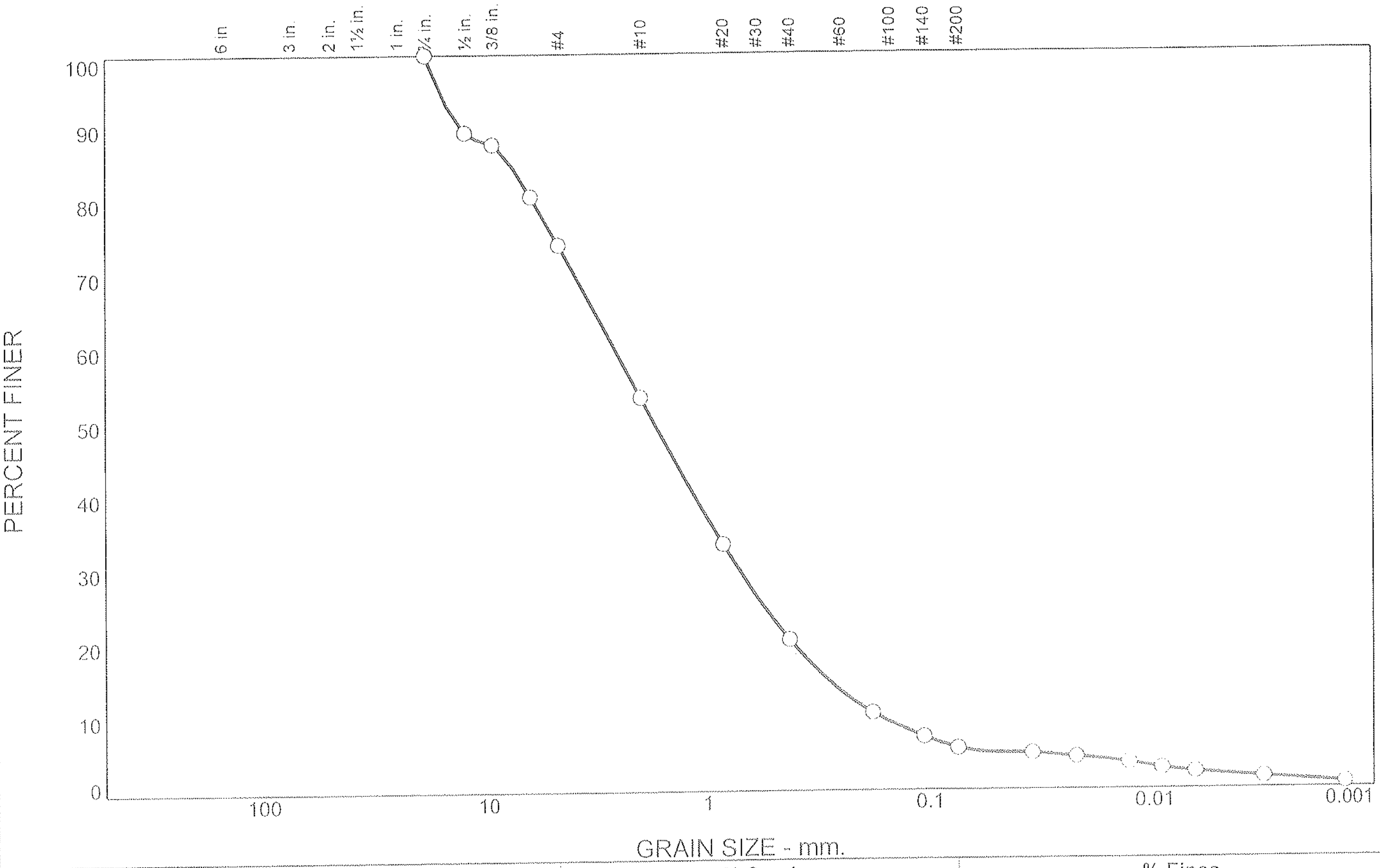
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-18
Date: 10/16/09
Elev./Depth: 0.5'-2.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972AA

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	25.9	20.6	33.1	14.8	3.7	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	89.4		
3/8"	87.8		
1/4"	80.7		
#4	74.1		
#10	53.5		
#20	33.5		
#40	20.4		
#80	10.4		
#140	7.2		
#200	5.6		
0.0350 mm.	4.9		
0.0223 mm.	4.3		
0.0130 mm.	3.6		
0.0092 mm.	2.8		
0.0066 mm.	2.2		
0.0032 mm.	1.5		
0.0014 mm.	0.7		

* (no specification provided)

Soil Description

well-graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 7.7688 D_{60}= 2.6163 D_{50}= 1.7329
D_{30}= 0.7208 D_{15}= 0.2873 D_{10}= 0.1694
C_u= 15.44 C_c= 1.17

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

Moisture content: 14.0%

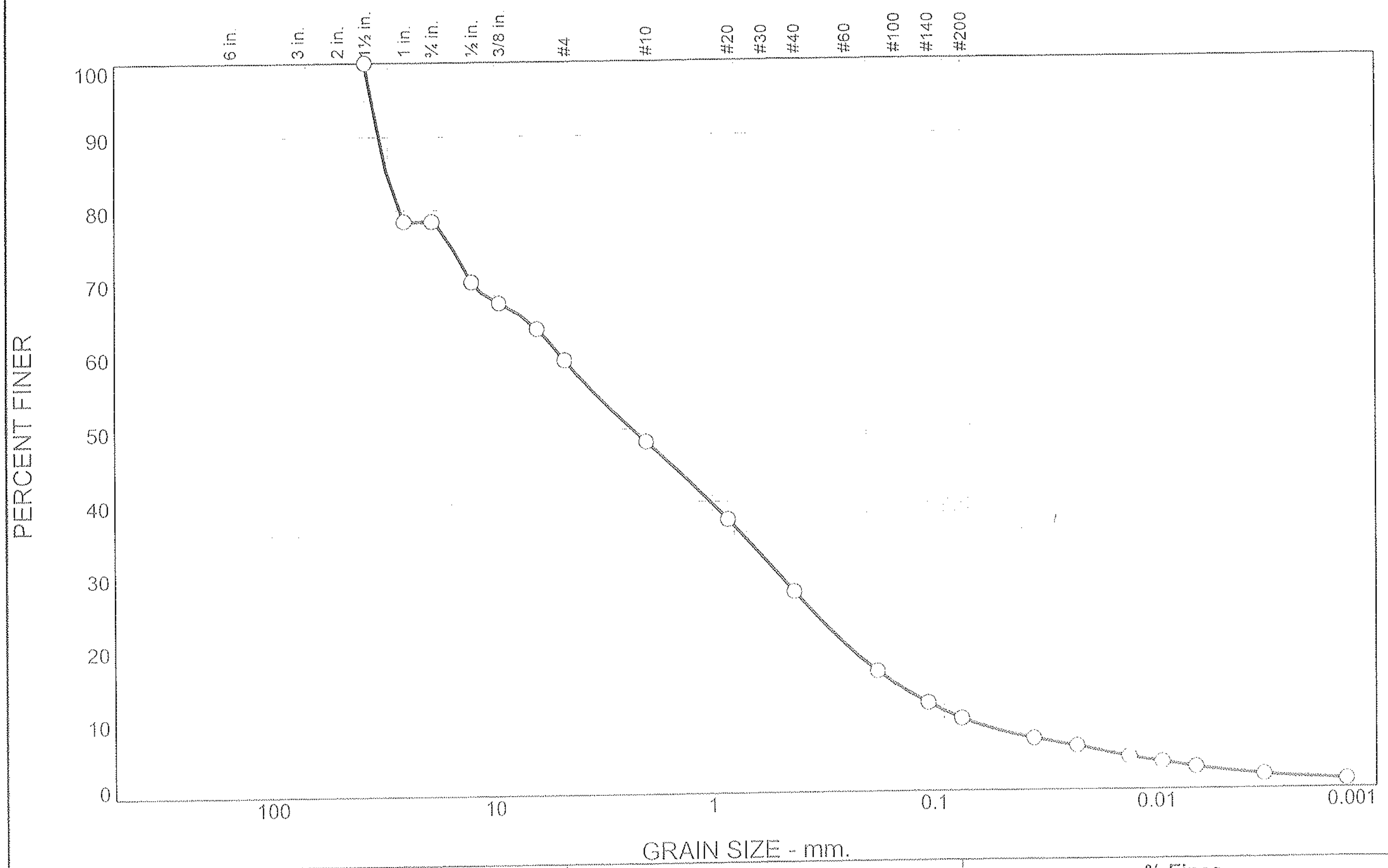
Sample No.: S-3 **Source of Sample:** B-19 **Date:** 10/22/09
Location: New Bedford, MA **Elev./Depth:** 4'-6'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972BB

Tested By: JJH/DCH **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	21.5	19.1	11.2	20.7	17.7	7.4	2.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	78.5		
3/4"	78.5		
1/2"	70.1		
3/8"	67.2		
1/4"	63.6		
#4	59.4		
#10	48.2		
#20	37.5		
#40	27.5		
#80	16.4		
#140	12.0		
#200	9.8		
0.0355 mm.	7.0		
0.0226 mm.	5.9		
0.0132 mm.	4.4		
0.0094 mm.	3.7		
0.0067 mm.	3.0		
0.0033 mm.	1.9		
0.0014 mm.	1.1		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np   LL= nv   PI=

Coefficients

D_{85}= 30.2845 D_{60}= 4.9506 D_{50}= 2.3203
D_{30}= 0.5033 D_{15}= 0.1555 D_{10}= 0.0773
C_u= 64.07 C_c= 0.66

Classification

USCS= SP-SM   AASHTO= A-1-a

Remarks

Moisture content: 6.5%

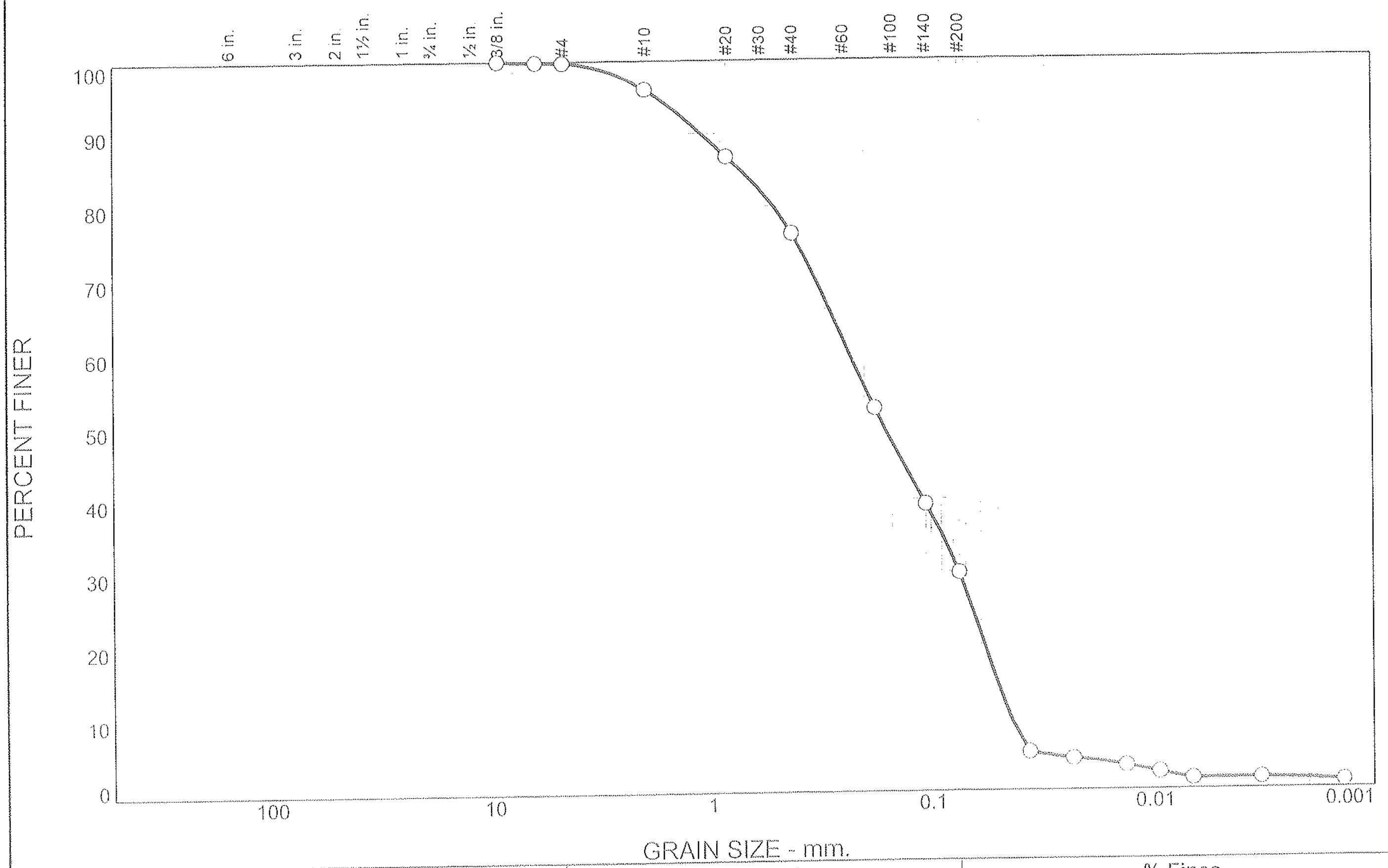
Sample No.: S-1   **Source of Sample:** B-19   **Date:** 10/16/09
Location: New Bedford, MA   **Elev./Depth:** 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01   **Lab No.** 10972CC

Tested By: JJH/MCS   **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	3.6	19.8	46.5	28.4	1.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	99.8		
#4	99.7		
#10	96.1		
#20	86.8		
#40	76.3		
#80	52.5		
#140	39.3		
#200	29.8		
0.0363 mm.	5.2		
0.0231 mm.	4.2		
0.0134 mm.	3.3		
0.0095 mm.	2.3		
0.0068 mm.	1.4		
0.0033 mm.	1.5		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.7310 D_{60}= 0.2337 D_{50}= 0.1641

D_{30}= 0.0754 D_{15}= 0.0510 D_{10}= 0.0443

C_u= 5.28 C_c= 0.55

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 20.6%

Sample No.: S-4 **Source of Sample:** B-19 **Date:** 10/16/09

Location: New Bedford, MA **Elev./Depth:** 6'-8'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

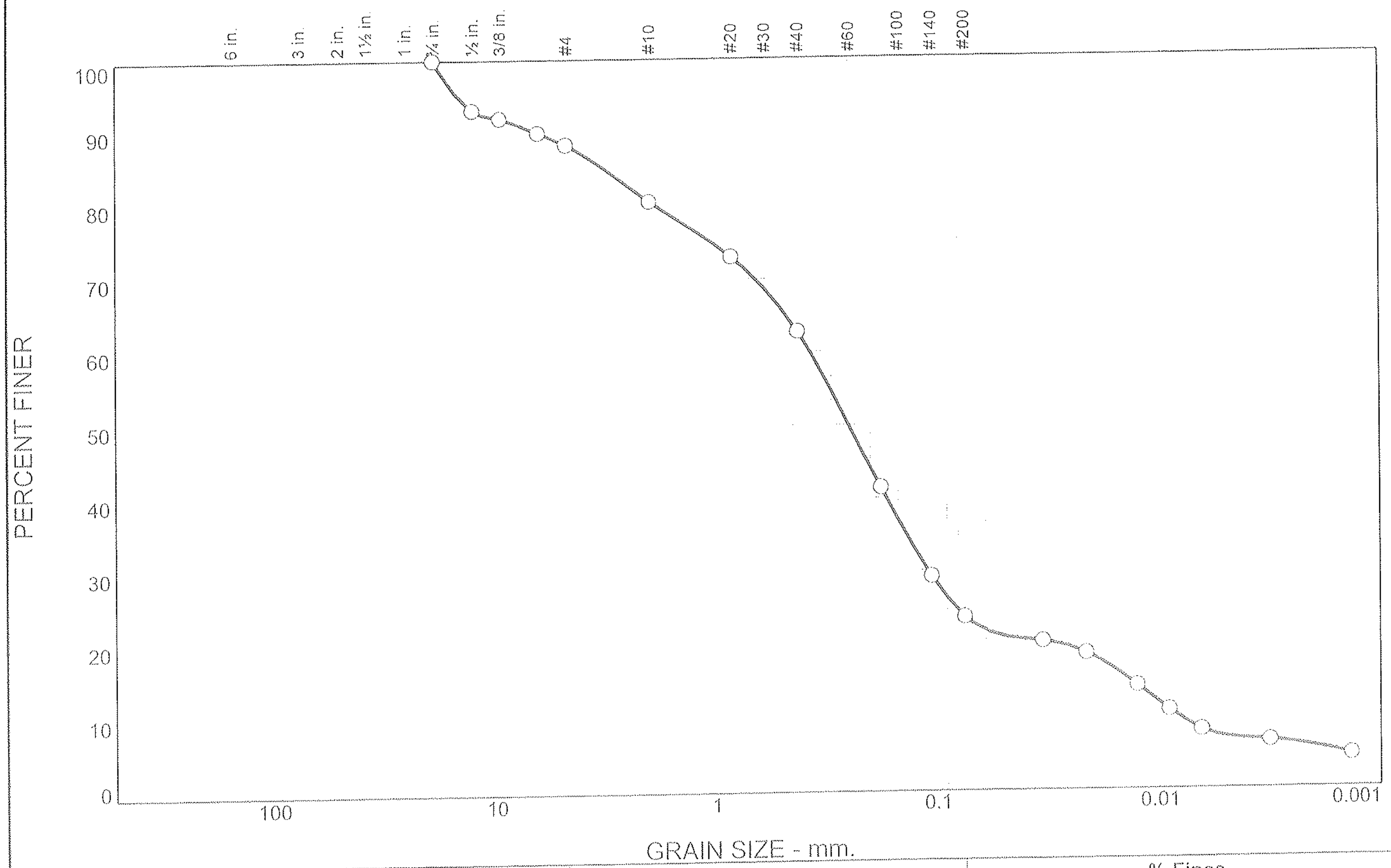
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972DD

Tested By: JJH/MCS Checked By: MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.5	7.9	17.8	39.2	16.7	6.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	93.2		
3/8"	92.1		
1/4"	90.1		
#4	88.5		
#10	80.6		
#20	73.0		
#40	62.8		
#80	41.4		
#140	29.3		
#200	23.6		
0.0332 mm.	20.2		
0.0212 mm.	18.5		
0.0126 mm.	14.1		
0.0091 mm.	10.7		
0.0065 mm.	8.0		
0.0032 mm.	6.4		
0.0014 mm.	4.4		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 3.1364
D_{60}= 0.3737
D_{50}= 0.2499
D_{30}= 0.1100
D_{15}= 0.0138
D_{10}= 0.0084
C_u= 44.52
C_c= 3.86

Classification

USCS= SM
AASHTO= A-2-4(0)

Remarks

Moisture content: 22.0%

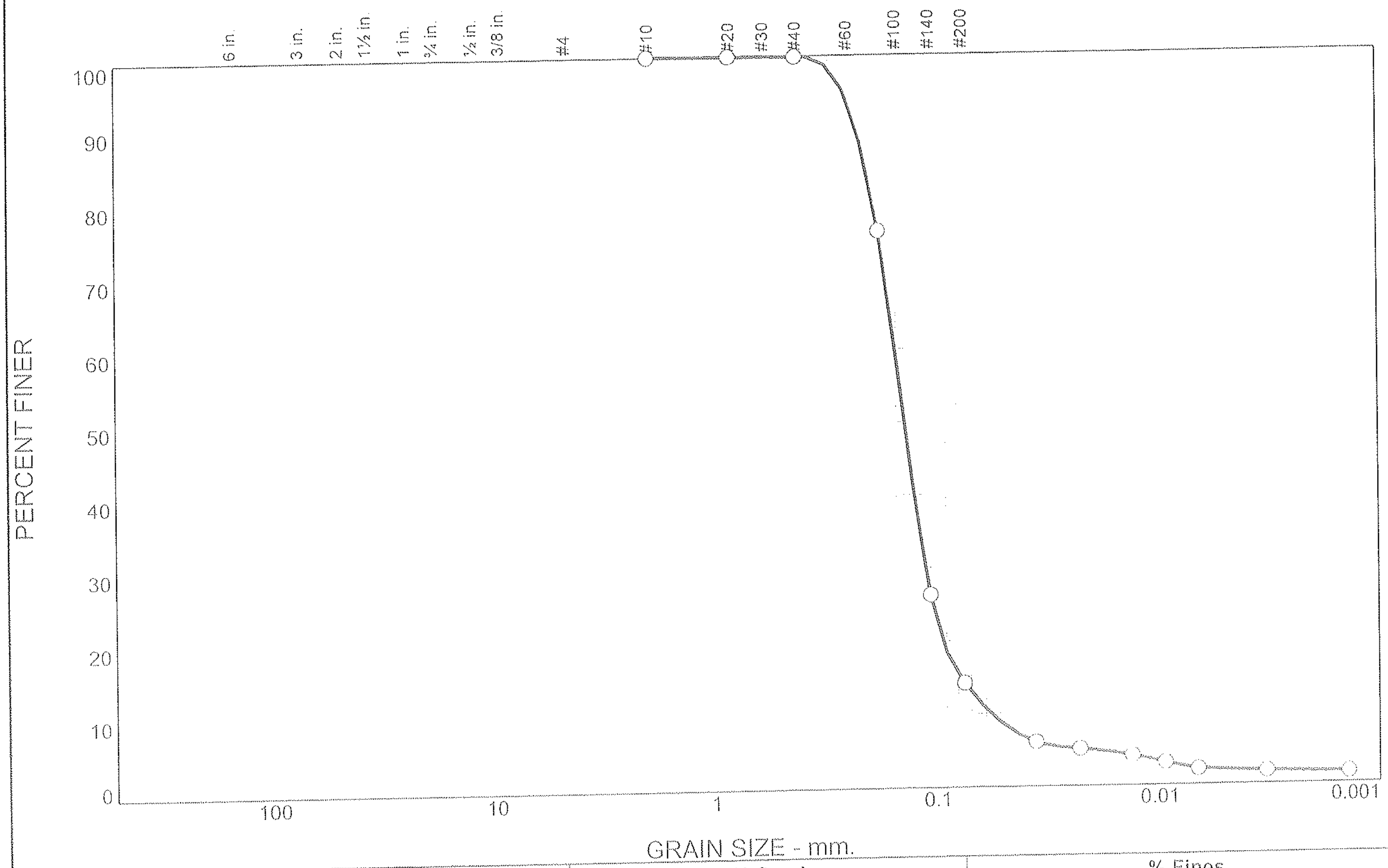
Sample No.: S-1
Source of Sample: B-20
Date: 10/16/09
Location: New Bedford, MA
Elev./Depth: 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972EE

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	85.7	12.3	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.9		
#80	76.2		
#140	26.3		
#200	14.2		
0.0358 mm.	6.0		
0.0228 mm.	5.0		
0.0132 mm.	4.1		
0.0094 mm.	3.1		
0.0067 mm.	2.1		
0.0033 mm.	1.7		
0.0014 mm.	1.5		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.2037 D_{60}= 0.1519 D_{50}= 0.1380
D_{30}= 0.1116 D_{15}= 0.0783 D_{10}= 0.0569
C_u= 2.67 C_c= 1.44

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 24.5%

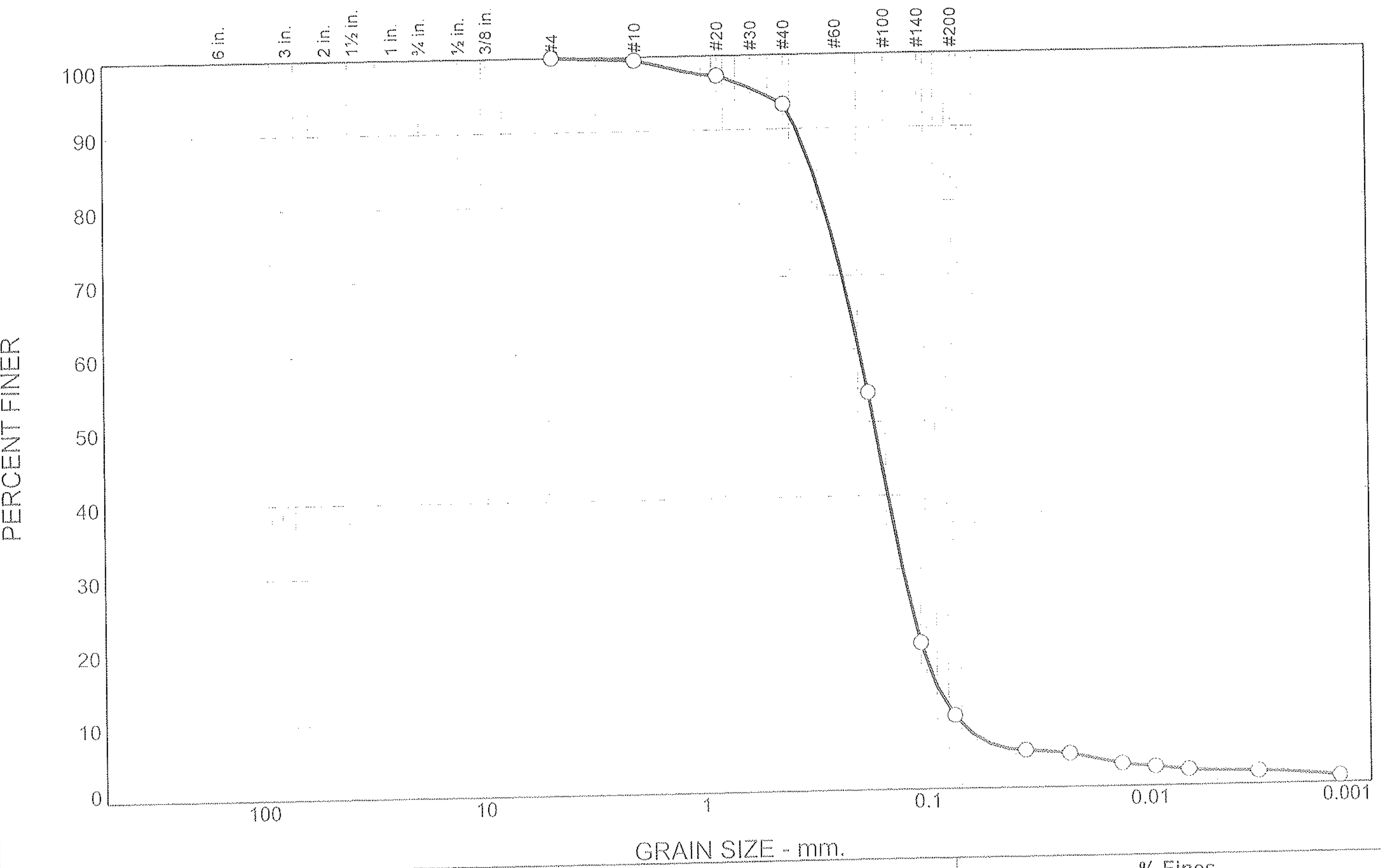
Sample No.: S-3 **Source of Sample:** B-20 **Date:** 10/16/09
Location: New Bedford, MA **Elev./Depth:** 4.2'-6.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972FF

Tested By: JJH/MCS Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	6.2	83.4	8.0	1.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.5		
#20	97.3		
#40	93.3		
#80	54.1		
#140	20.0		
#200	9.9		
0.0360 mm.	5.0		
0.0229 mm.	4.5		
0.0133 mm.	3.1		
0.0094 mm.	2.6		
0.0067 mm.	2.1		
0.0033 mm.	1.7		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.3201 D_{60}= 0.1970 D_{50}= 0.1697
D_{30}= 0.1269 D_{15}= 0.0931 D_{10}= 0.0753
C_u= 2.62 C_c= 1.09

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Moisture content: 25.6%

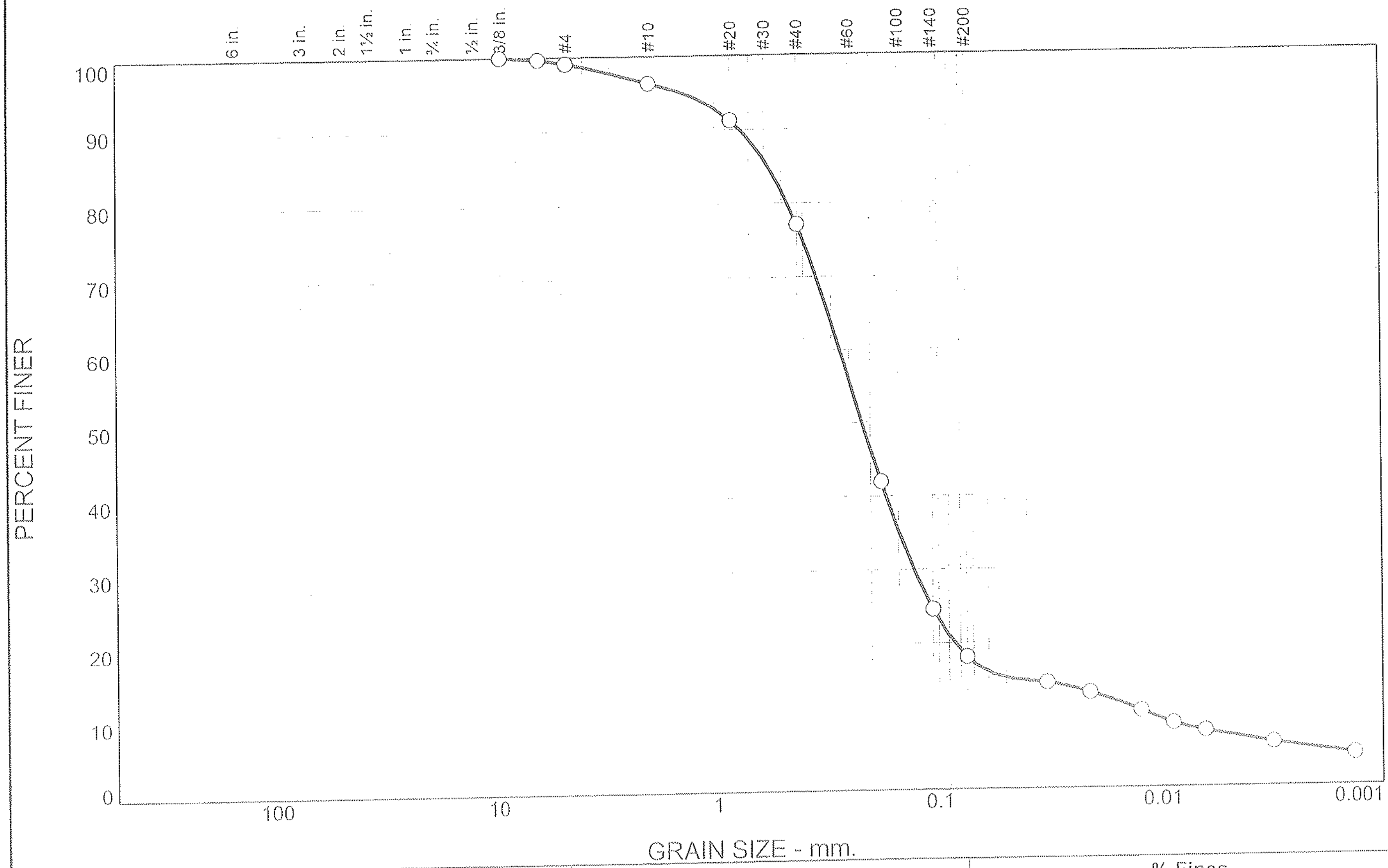
Sample No.: S-4 **Source of Sample:** B-20 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 6'-8'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972GG

Tested By: JJH/MCS Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	2.8	19.2	59.0	11.1	7.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	99.6		
#4	99.1		
#10	96.3		
#20	91.3		
#40	77.1		
#80	42.0		
#140	24.6		
#200	18.1		
0.0328 mm.	14.5		
0.0210 mm.	13.0		
0.0124 mm.	10.5		
0.0089 mm.	8.7		
0.0064 mm.	7.7		
0.0031 mm.	6.0		
0.0014 mm.	4.3		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.5714 D_{60}= 0.2740 D_{50}= 0.2180
D_{30}= 0.1288 D_{15}= 0.0469 D_{10}= 0.0113
C_u= 24.17 C_c= 5.34

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 32.3%

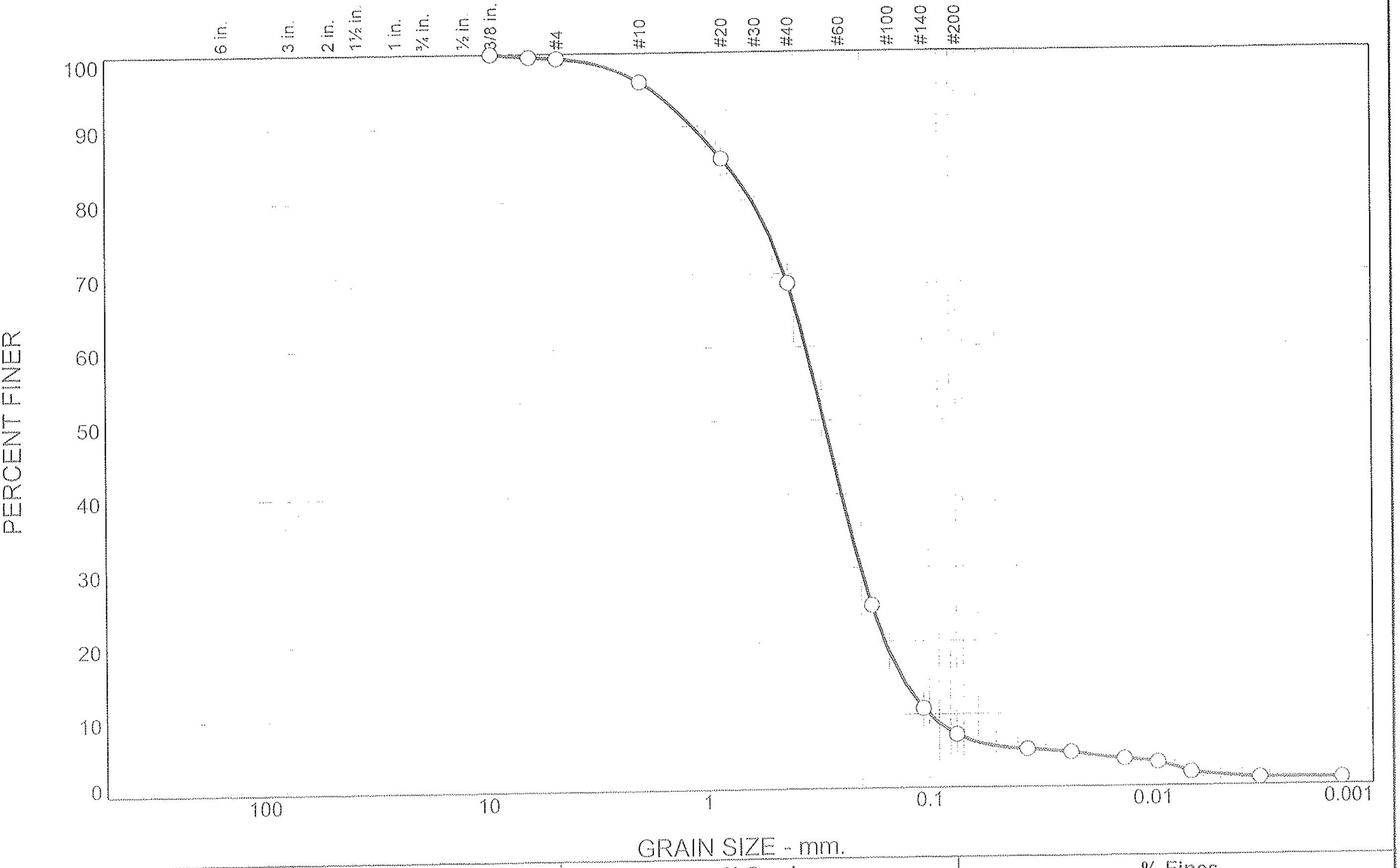
Sample No.: S-1 **Source of Sample:** B-21 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 0.5'-2.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972HH

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	3.2	27.4	61.4	5.9	1.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	99.5		
#4	99.3		
#10	96.1		
#20	85.6		
#40	68.7		
#80	24.9		
#140	10.8		
#200	7.3		
0.0363 mm.	5.2		
0.0230 mm.	4.7		
0.0134 mm.	3.8		
0.0095 mm.	3.3		
0.0068 mm.	1.9		
0.0033 mm.	1.0		
0.0014 mm.	0.9		

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.8160 D_{60}= 0.3525 D_{50}= 0.2926
D_{30}= 0.2015 D_{15}= 0.1321 D_{10}= 0.1000
C_u= 3.52 C_c= 1.15

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Moisture content: 18.8%

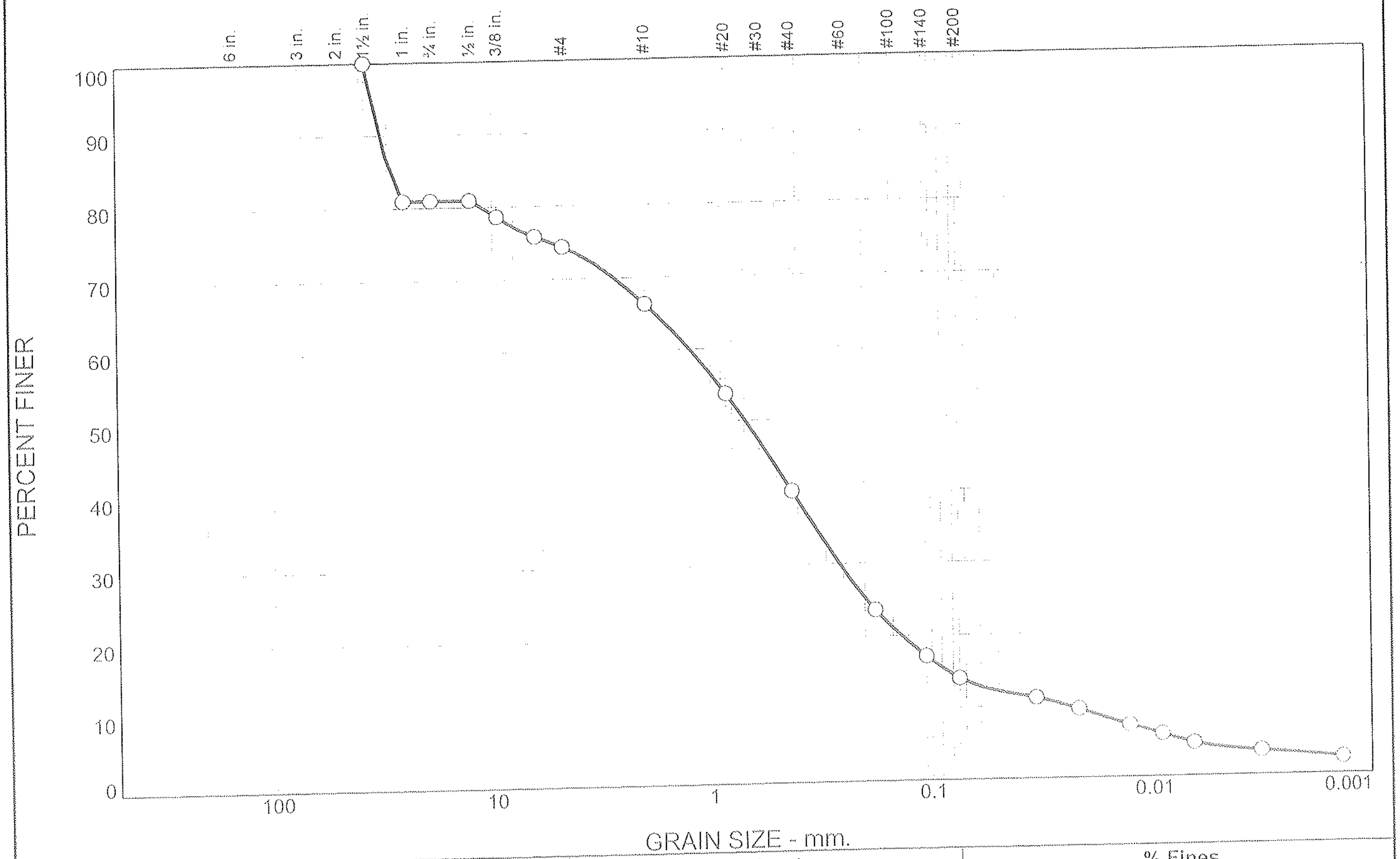
Sample No.: S-4
Location: New Bedford, MA
Source of Sample: B-21
Date: 10/19/09
Elev./Depth: 6.5'-8.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972II

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.0	6.6	8.0	26.2	26.2	10.1	3.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	81.0		
3/4"	81.0		
1/2"	81.0		
3/8"	78.6		
1/4"	75.9		
#4	74.4		
#10	66.4		
#20	53.8		
#40	40.2		
#80	23.6		
#140	17.1		
#200	14.0		
0.0338 mm.	11.1		
0.0217 mm.	9.5		
0.0128 mm.	7.2		
0.0092 mm.	5.9		
0.0066 mm.	4.6		
0.0032 mm.	3.3		
0.0014 mm.	2.3		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 28.9620 D_{60}= 1.2476 D_{50}= 0.6924
D_{30}= 0.2595 D_{15}= 0.0850 D_{10}= 0.0244
C_u= 51.11 C_c= 2.21

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture content: 12.0%

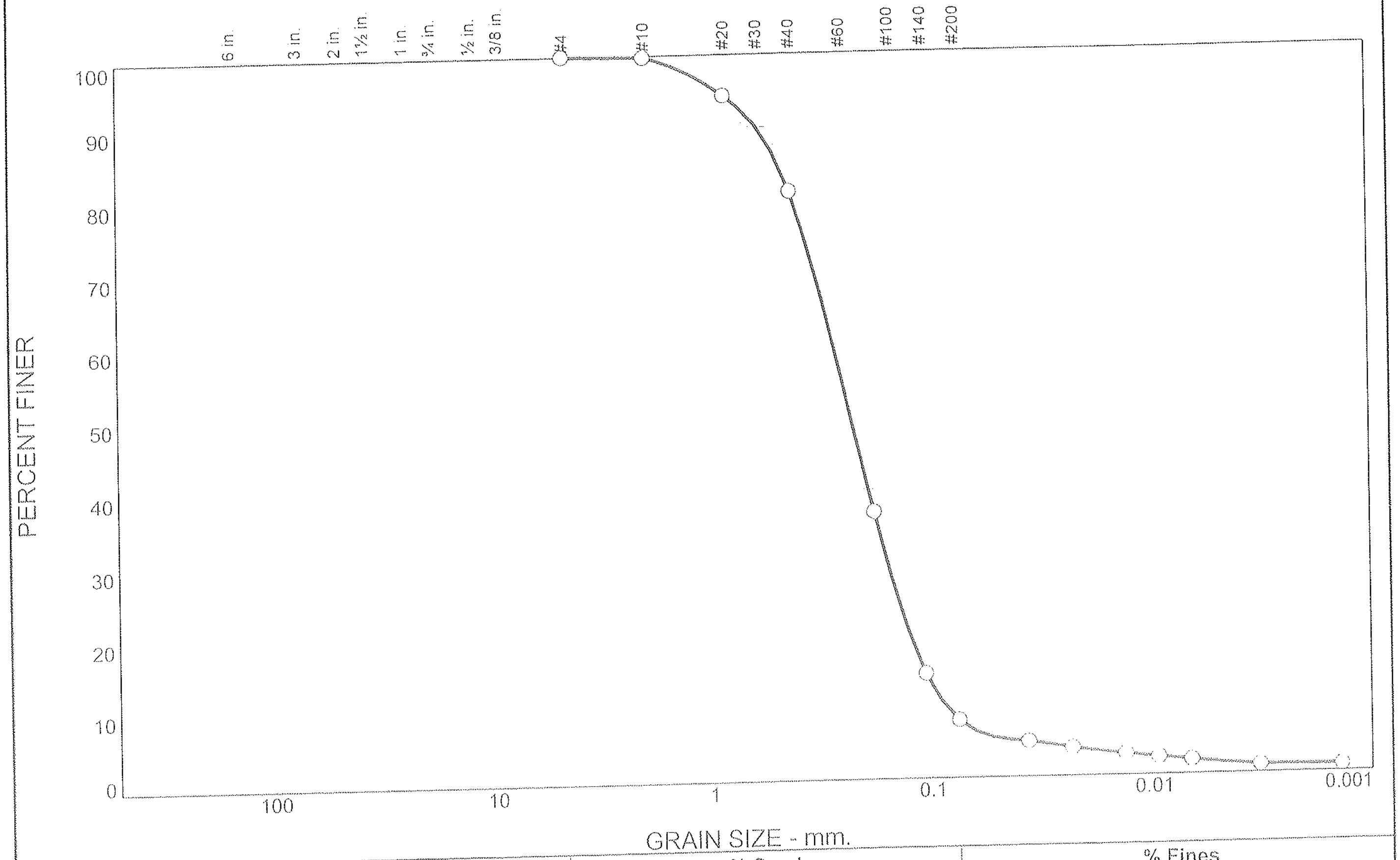
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-22
Date: 10/19/09
Elev./Depth: 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972JJ

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	18.6	73.2	6.5	1.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	94.4		
#40	81.2		
#80	36.9		
#140	14.5		
#200	8.0		
0.0364 mm.	4.9		
0.0231 mm.	3.9		
0.0134 mm.	2.9		
0.0095 mm.	2.4		
0.0068 mm.	1.9		
0.0033 mm.	1.1		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.4789 D_{60}= 0.2721 D_{50}= 0.2279
D_{30}= 0.1573 D_{15}= 0.1078 D_{10}= 0.0864
C_u= 3.15 C_c= 1.05

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Moisture content: 21.2%

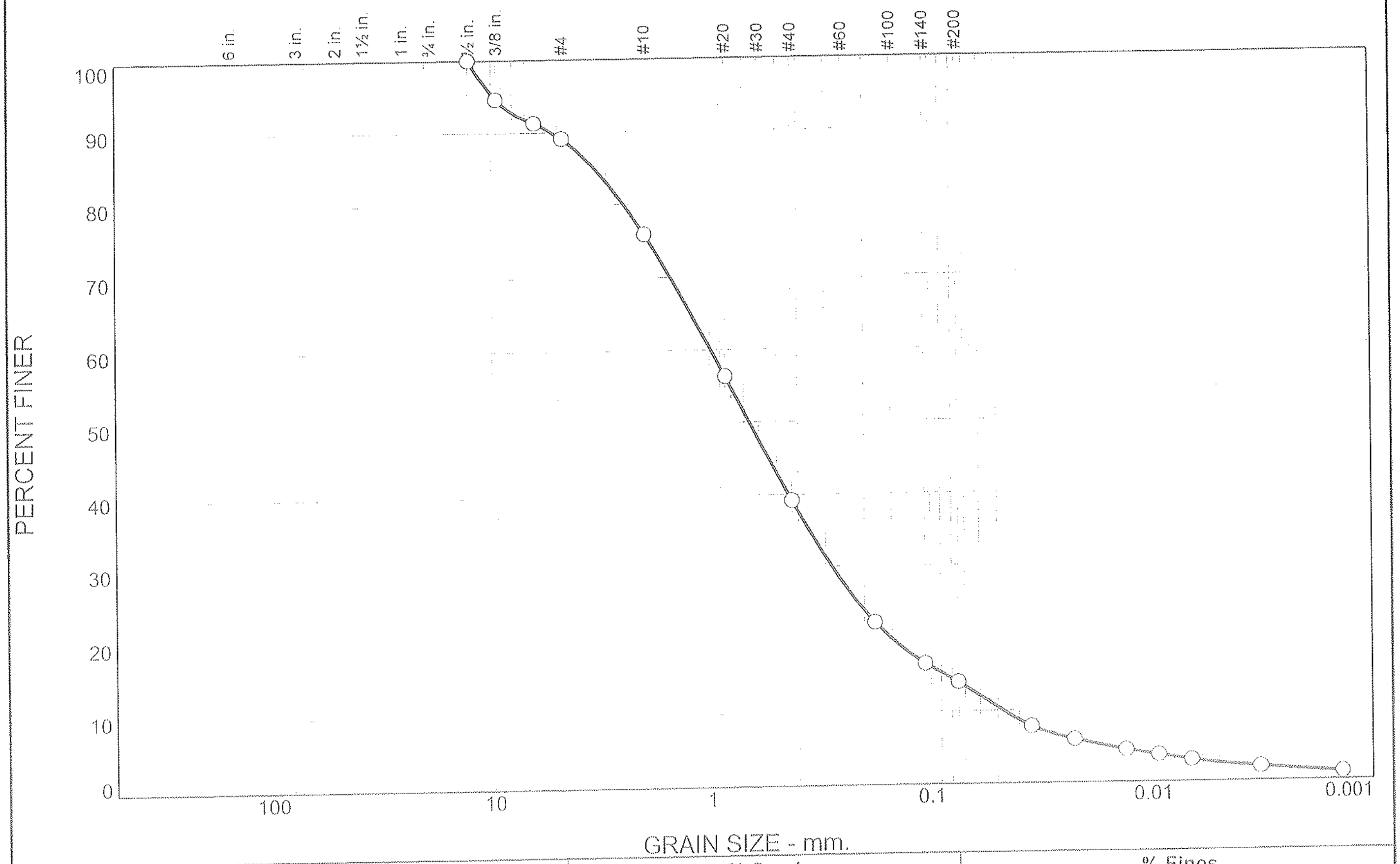
Sample No.: S-3 **Source of Sample:** B-22 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 4.3'-6.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972KK

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.9	13.2	36.7	25.2	11.5	2.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	94.6		
1/4"	91.3		
#4	89.1		
#10	75.9		
#20	56.4		
#40	39.2		
#80	22.3		
#140	16.6		
#200	14.0		
0.0352 mm.	7.8		
0.0226 mm.	5.9		
0.0132 mm.	4.5		
0.0094 mm.	3.7		
0.0067 mm.	3.0		
0.0033 mm.	1.9		
0.0014 mm.	1.1		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np   LL= nv   PI=

Coefficients

D_{85}= 3.3664 D_{60}= 0.9847 D_{50}= 0.6592
D_{30}= 0.2805 D_{15}= 0.0858 D_{10}= 0.0472
C_u= 20.85 C_c= 1.69

Classification

USCS= SM   AASHTO= A-1-b

Remarks

Moisture content: 6.4%

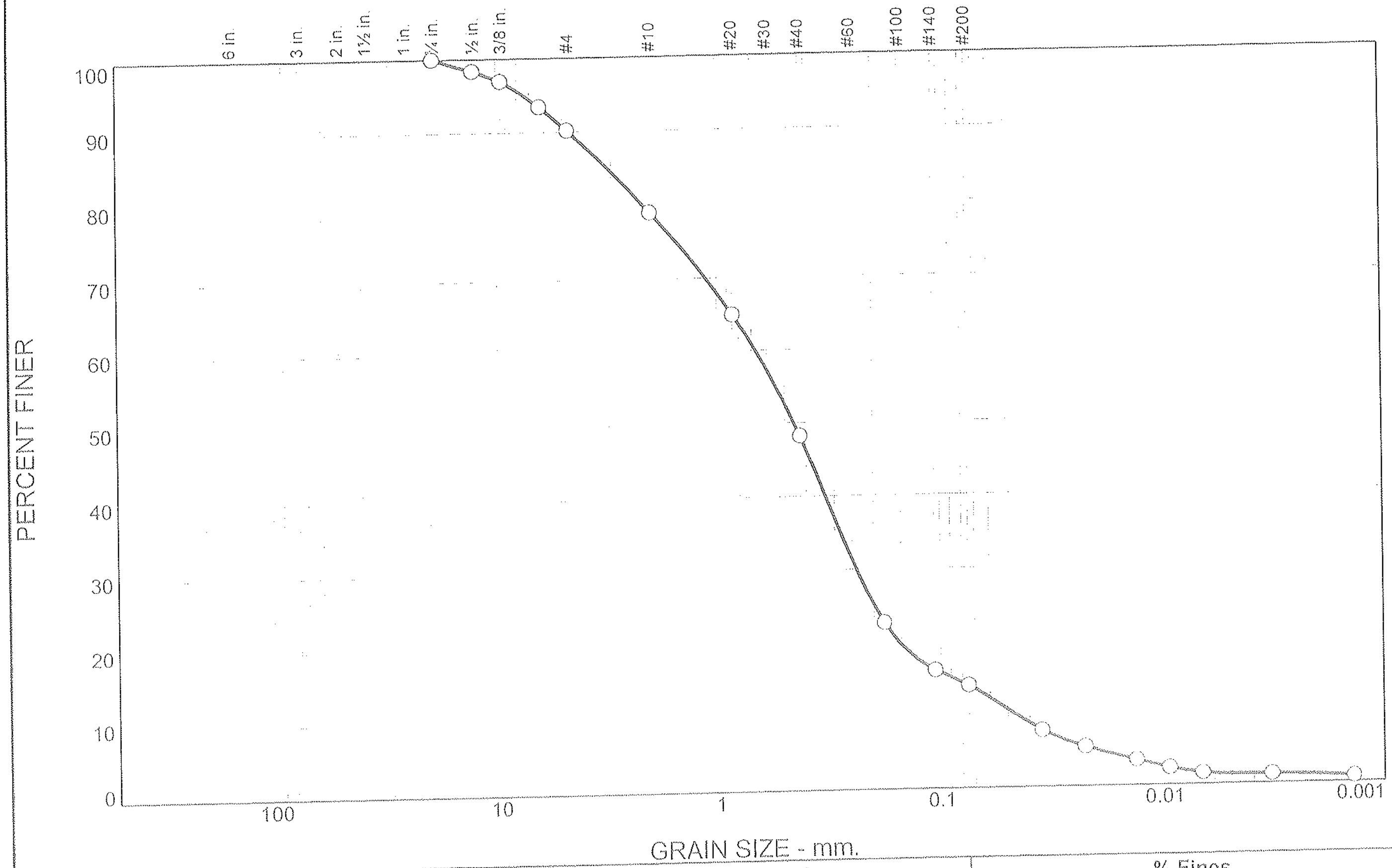
Sample No.: S-1   **Source of Sample:** B-23   **Date:** 10/19/09
Location: New Bedford, MA   **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01   **Lab No.** 10972LL

Tested By: JJH/MCS   **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.8	11.2	30.8	34.2	12.7	1.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	98.3		
3/8"	96.9		
1/4"	93.4		
#4	90.2		
#10	79.0		
#20	65.0		
#40	48.2		
#80	22.8		
#140	16.2		
#200	14.0		
0.0353 mm.	7.7		
0.0227 mm.	5.4		
0.0133 mm.	3.5		
0.0095 mm.	2.3		
0.0068 mm.	1.5		
0.0033 mm.	1.2		
0.0014 mm.	0.8		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 3.0971
D_{60}= 0.6709
D_{50}= 0.4520
D_{30}= 0.2388
D_{15}= 0.0879
D_{10}= 0.0467
C_u= 14.38
C_c= 1.82

Classification

USCS= SM
AASHTO= A-1-b

Remarks

Moisture content: 6.4%

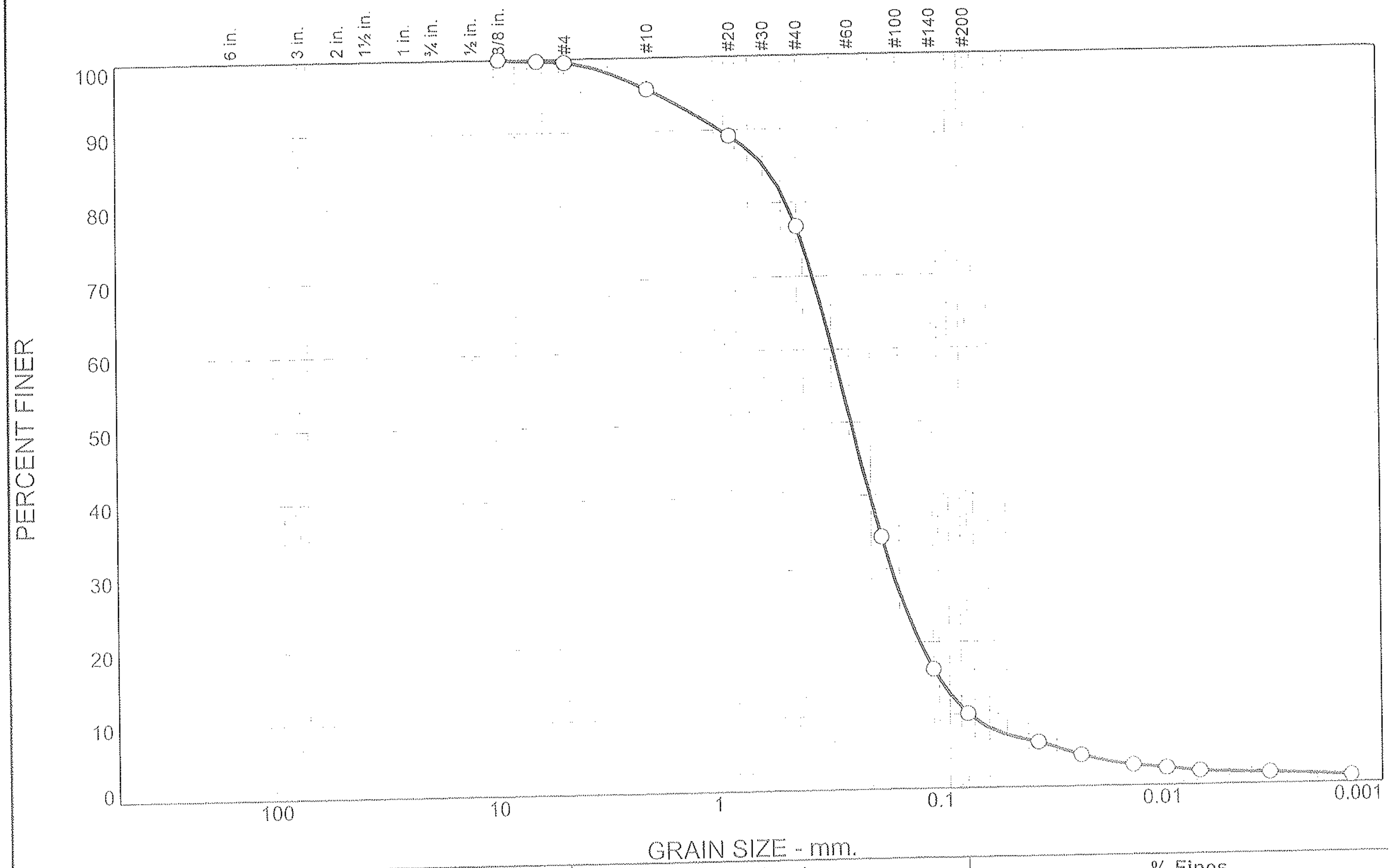
Sample No.: S-1
Source of Sample: B-24
Date: 10/19/09
Location: New Bedford, MA
Elev./Depth: 0.4'-2.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972MM

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	3.8	18.9	66.7	8.5	1.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	99.7		
#4	99.5		
#10	95.7		
#20	89.2		
#40	76.8		
#80	34.3		
#140	16.3		
#200	10.1		
0.0360 mm.	6.1		
0.0231 mm.	4.2		
0.0134 mm.	2.8		
0.0095 mm.	2.3		
0.0068 mm.	1.9		
0.0033 mm.	1.5		
0.0014 mm.	0.9		

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.5903 D_{60}= 0.2943 D_{50}= 0.2445

D_{30}= 0.1629 D_{15}= 0.1001 D_{10}= 0.0741

C_u= 3.97 C_c= 1.22

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Moisture content: 20.5%

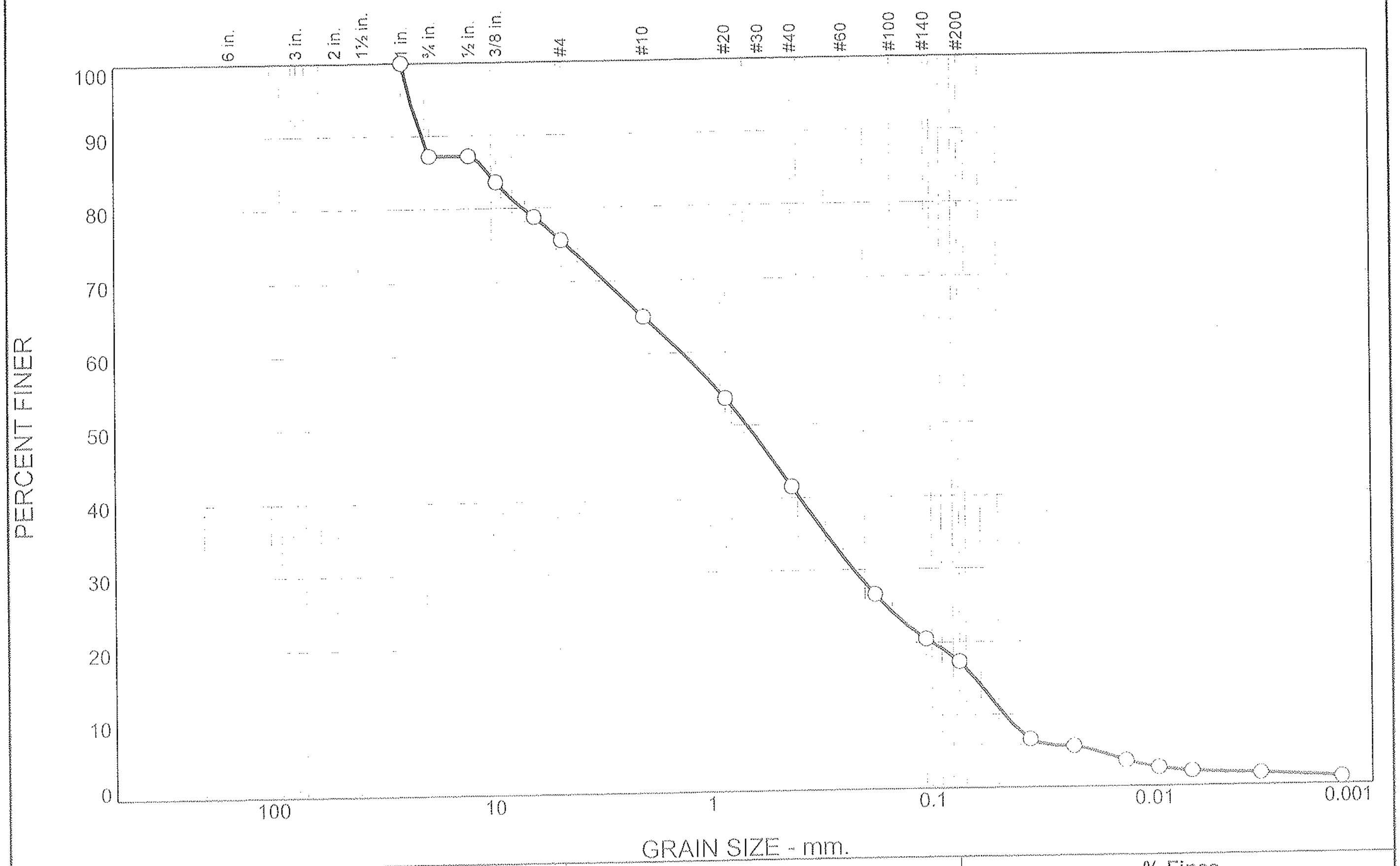
Sample No.: S-3
Location: New Bedford, MA
Source of Sample: B-24
Date: 10/19/09
Elev./Depth: 4.4'-6.4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972NN

Tested By: JJH/MCS Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	12.8	11.6	10.6	23.5	24.1	15.6	1.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	87.2		
1/2"	87.2		
3/8"	83.6		
1/4"	78.8		
#4	75.6		
#10	65.0		
#20	53.7		
#40	41.5		
#80	26.6		
#140	20.5		
#200	17.4		
0.0360 mm.	6.6		
0.0229 mm.	5.6		
0.0134 mm.	3.6		
0.0095 mm.	2.5		
0.0068 mm.	2.0		
0.0033 mm.	1.6		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 10.3865 D_{60}= 1.3320 D_{50}= 0.6775

D_{30}= 0.2236 D_{15}= 0.0636 D_{10}= 0.0473

C_u= 28.18 C_c= 0.79

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture content: 10.7%

Sample No.: S-1 **Source of Sample:** B-25 **Date:** 10/19/09

Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

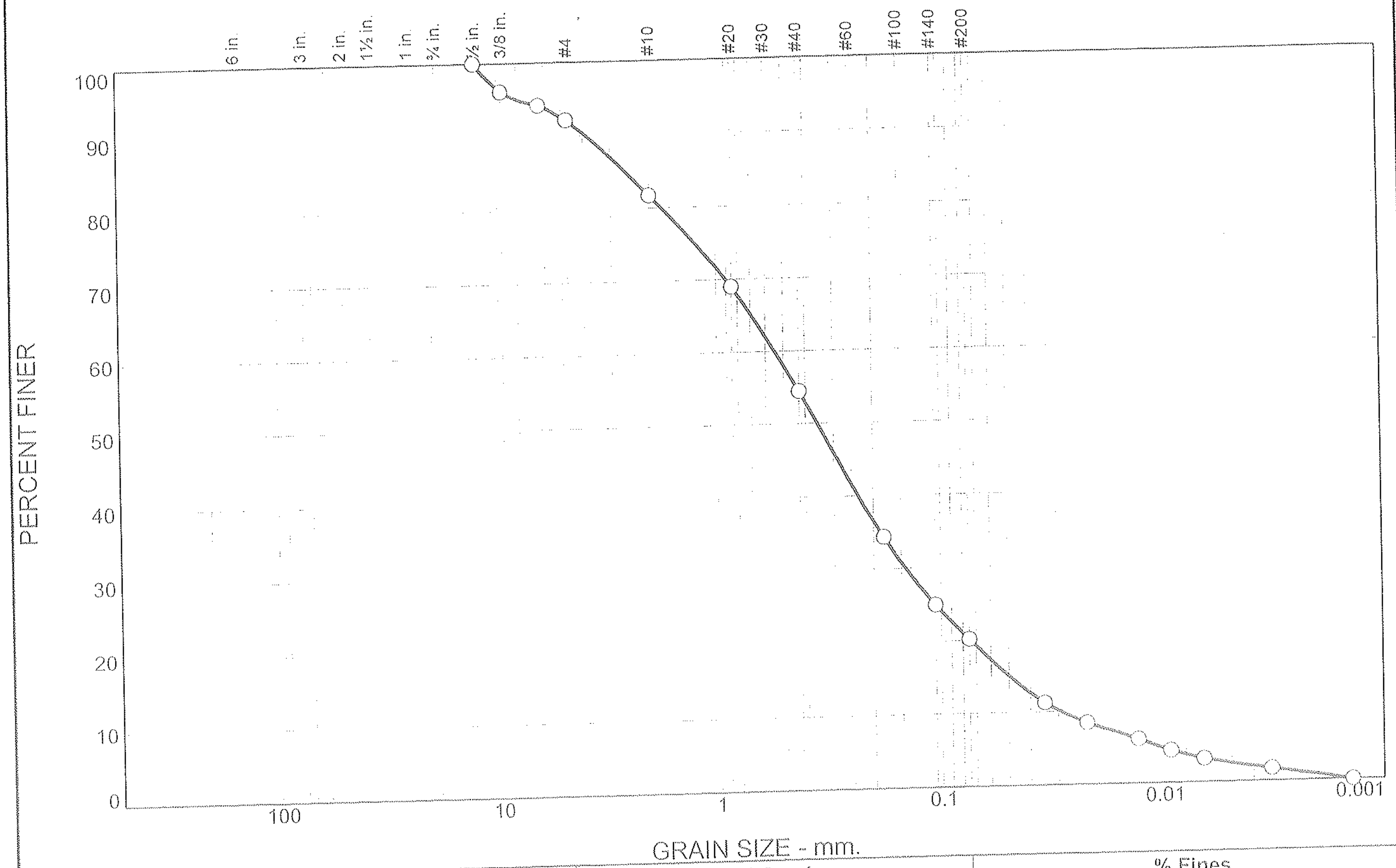
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972QQ

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.9	10.3	27.4	34.2	17.7	2.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	96.1		
1/4"	94.2		
#4	92.1		
#10	81.8		
#20	69.0		
#40	54.4		
#80	34.4		
#140	25.0		
#200	20.2		
0.0344 mm.	11.2		
0.0223 mm.	8.4		
0.0131 mm.	6.0		
0.0094 mm.	4.4		
0.0067 mm.	3.2		
0.0033 mm.	1.7		
0.0014 mm.	0.0		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 2.5521 D_{60}= 0.5428 D_{50}= 0.3528
D_{30}= 0.1438 D_{15}= 0.0498 D_{10}= 0.0293
C_u= 18.54 C_c= 1.30

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 16.8%

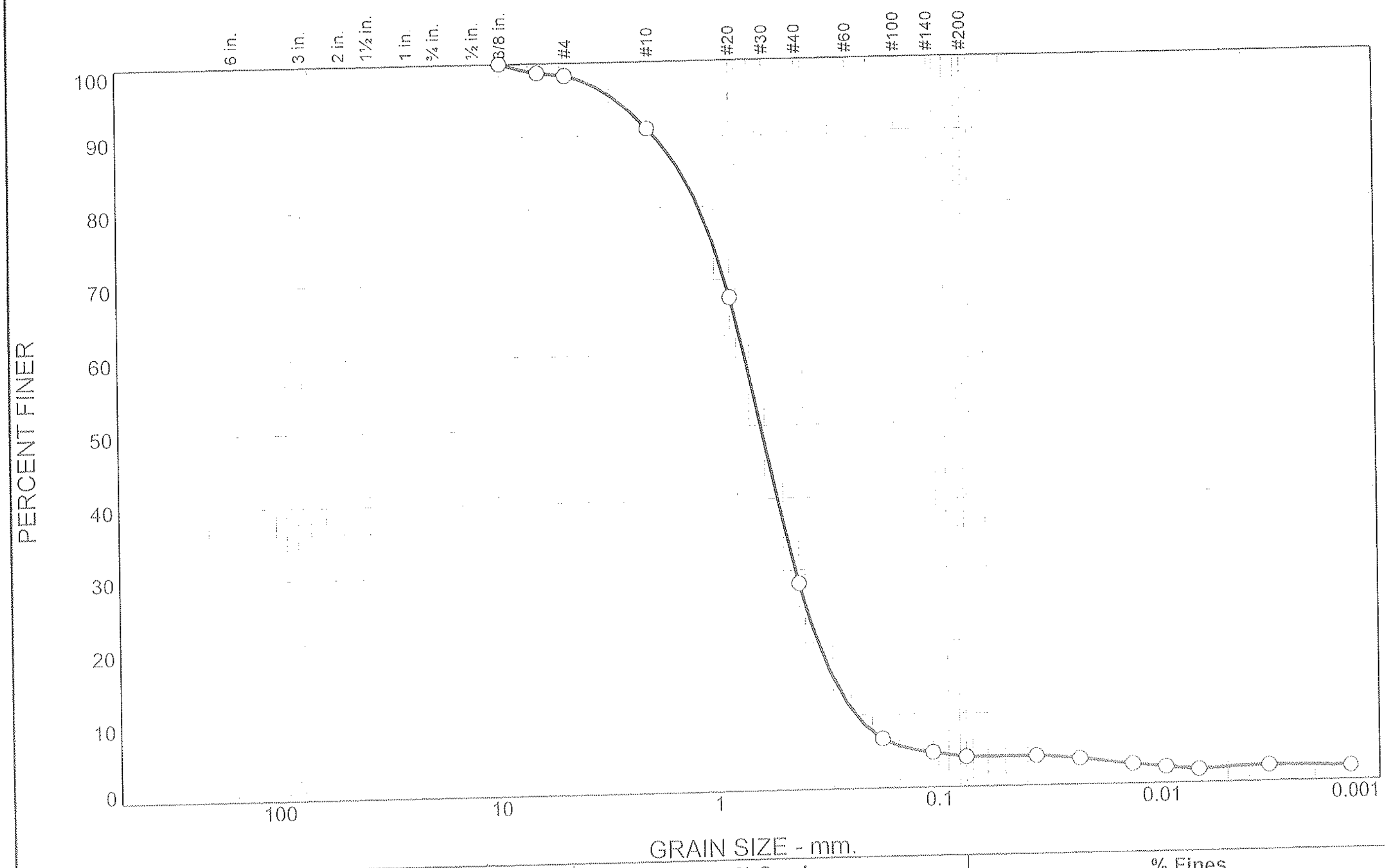
Sample No.: S-1 **Source of Sample:** B-26 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972PP

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.7	7.4	62.7	24.1	2.1	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	98.7		
#4	98.3		
#10	90.9		
#20	67.5		
#40	28.2		
#80	6.7		
#140	4.7		
#200	4.1		
0.0365 mm.	4.0		
0.0231 mm.	3.6		
0.0134 mm.	2.7		
0.0095 mm.	2.2		
0.0068 mm.	1.8		
0.0032 mm.	2.1		
0.0014 mm.	1.9		

* (no specification provided)

Soil Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.4240 D_{60}= 0.7373 D_{50}= 0.6226
D_{30}= 0.4405 D_{15}= 0.2982 D_{10}= 0.2366
C_u= 3.12 C_c= 1.11

Classification

USCS= SP AASHTO=

Remarks

Moisture content: 17.9%

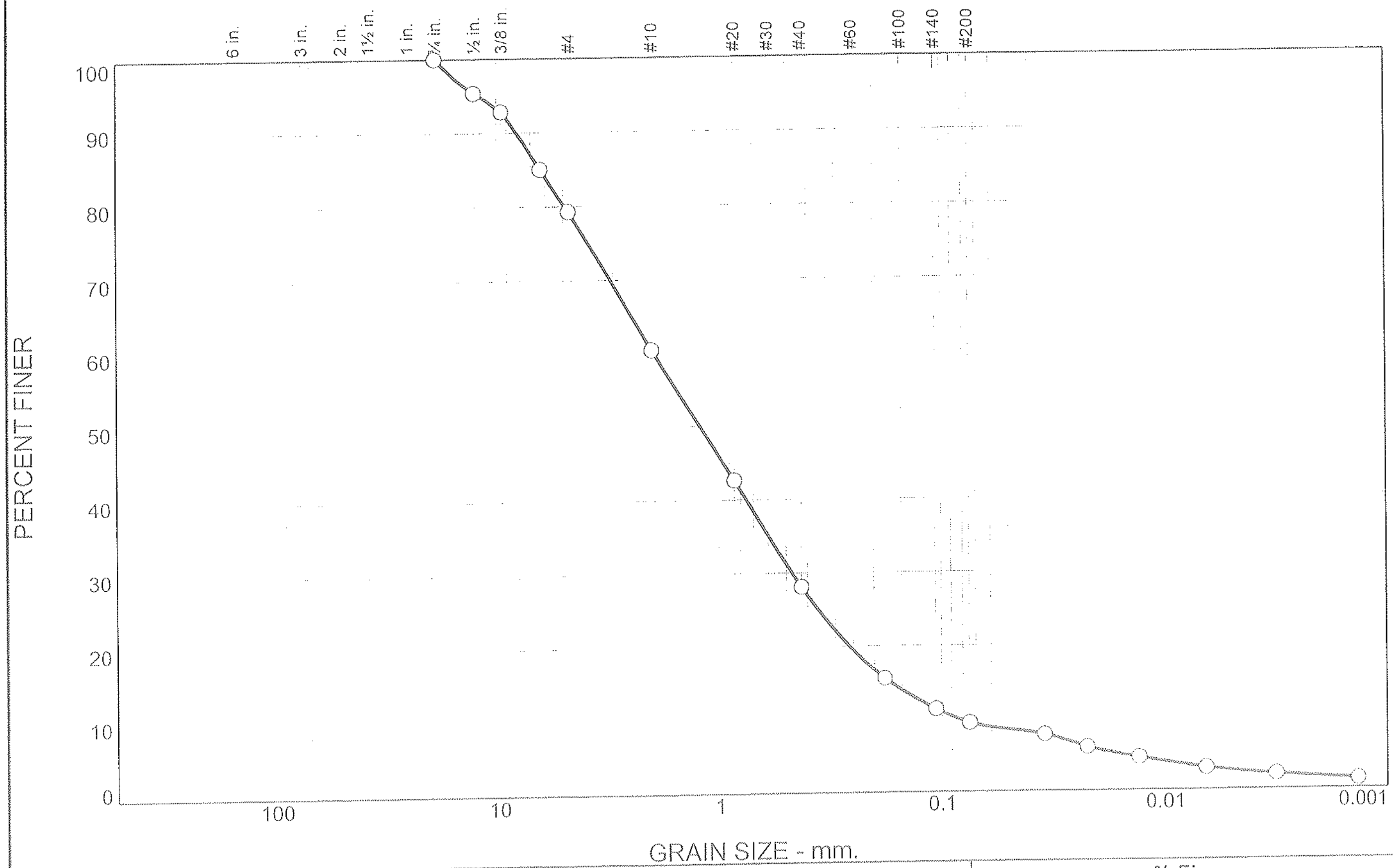
Sample No.: S-3
Source of Sample: B-26
Date: 10/19/09
Location: New Bedford, MA
Elev./Depth: 4.2'-6.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972QQ

Tested By: JJH/MCS
Checked By: MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	20.7	18.8	32.4	18.8	6.8	2.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	95.4		
3/8"	92.9		
1/4"	85.0		
#4	79.3		
#10	60.5		
#20	42.7		
#40	28.1		
#80	15.6		
#140	11.3		
#200	9.3		
0.0347 mm.	7.7		
0.0223 mm.	5.9		
0.0131 mm.	4.4		
0.0066 mm.	3.0		
0.0032 mm.	2.0		
0.0014 mm.	1.3		

* (no specification provided)

Soil Description

well-graded sand with silt and gravel

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 6.3523
D_{60}= 1.9553
D_{50}= 1.2099
D_{30}= 0.4678
D_{15}= 0.1699
D_{10}= 0.0861
C_u= 22.72
C_c= 1.30

Classification

USCS= SW-SM
AASHTO= A-1-b

Remarks

Moisture content: 3.8%

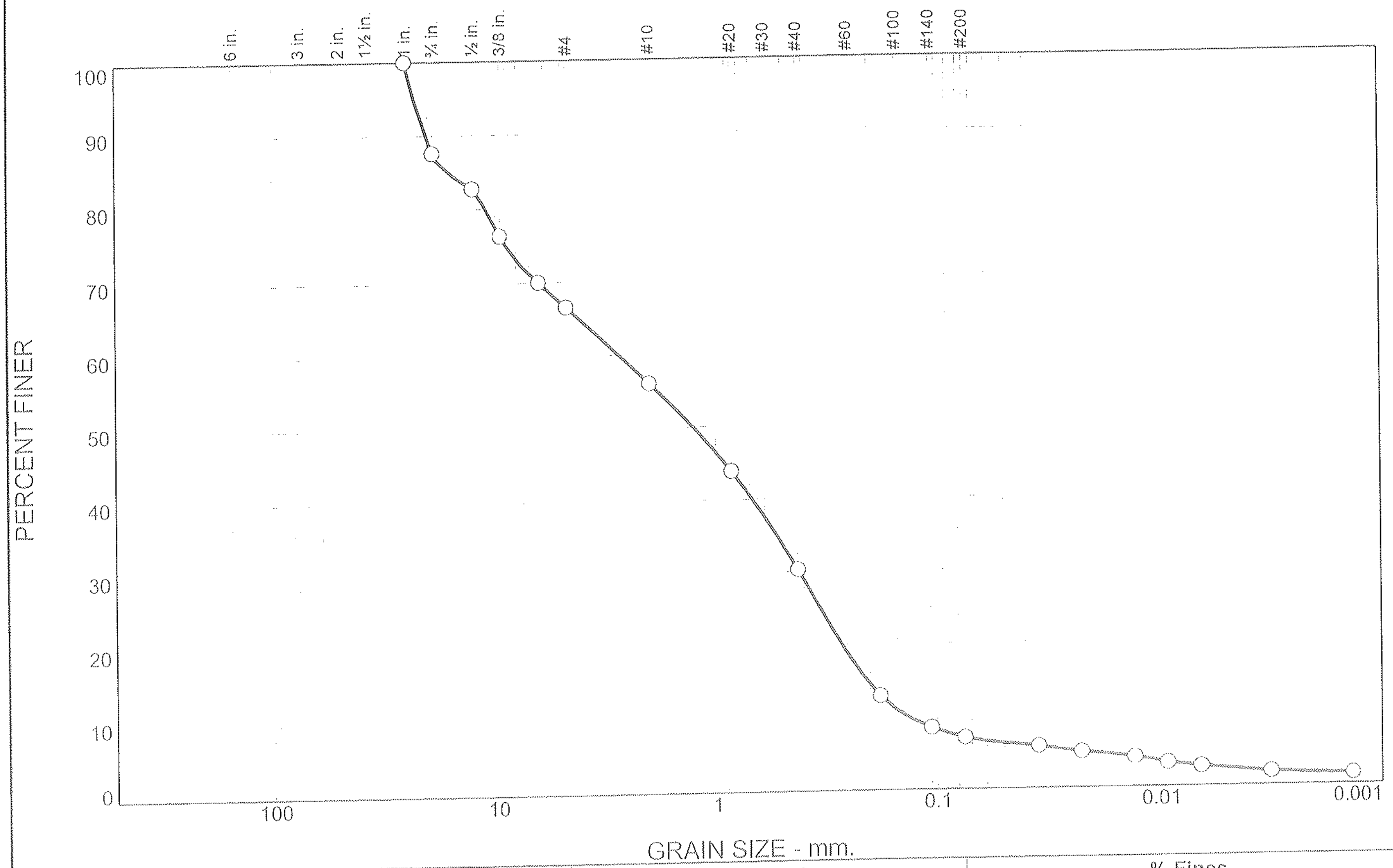
Sample No.: S-1
Source of Sample: B-27
Date: 10/19/09
Location: New Bedford, MA
Elev./Depth: 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972RR

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	12.4	21.0	10.5	25.7	23.3	4.7	2.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	87.6		
1/2"	82.8		
3/8"	76.4		
1/4"	70.0		
#4	66.6		
#10	56.1		
#20	43.9		
#40	30.4		
#80	12.9		
#140	8.5		
#200	7.1		
0.0352 mm.	5.8		
0.0225 mm.	4.9		
0.0131 mm.	4.1		
0.0093 mm.	3.3		
0.0066 mm.	2.7		
0.0032 mm.	1.9		
0.0014 mm.	1.5		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 16.3717 D_{60}= 2.7405 D_{50}= 1.2633
D_{30}= 0.4182 D_{15}= 0.2065 D_{10}= 0.1357
C_u= 20.19 C_c= 0.47

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Moisture content: 6.0%

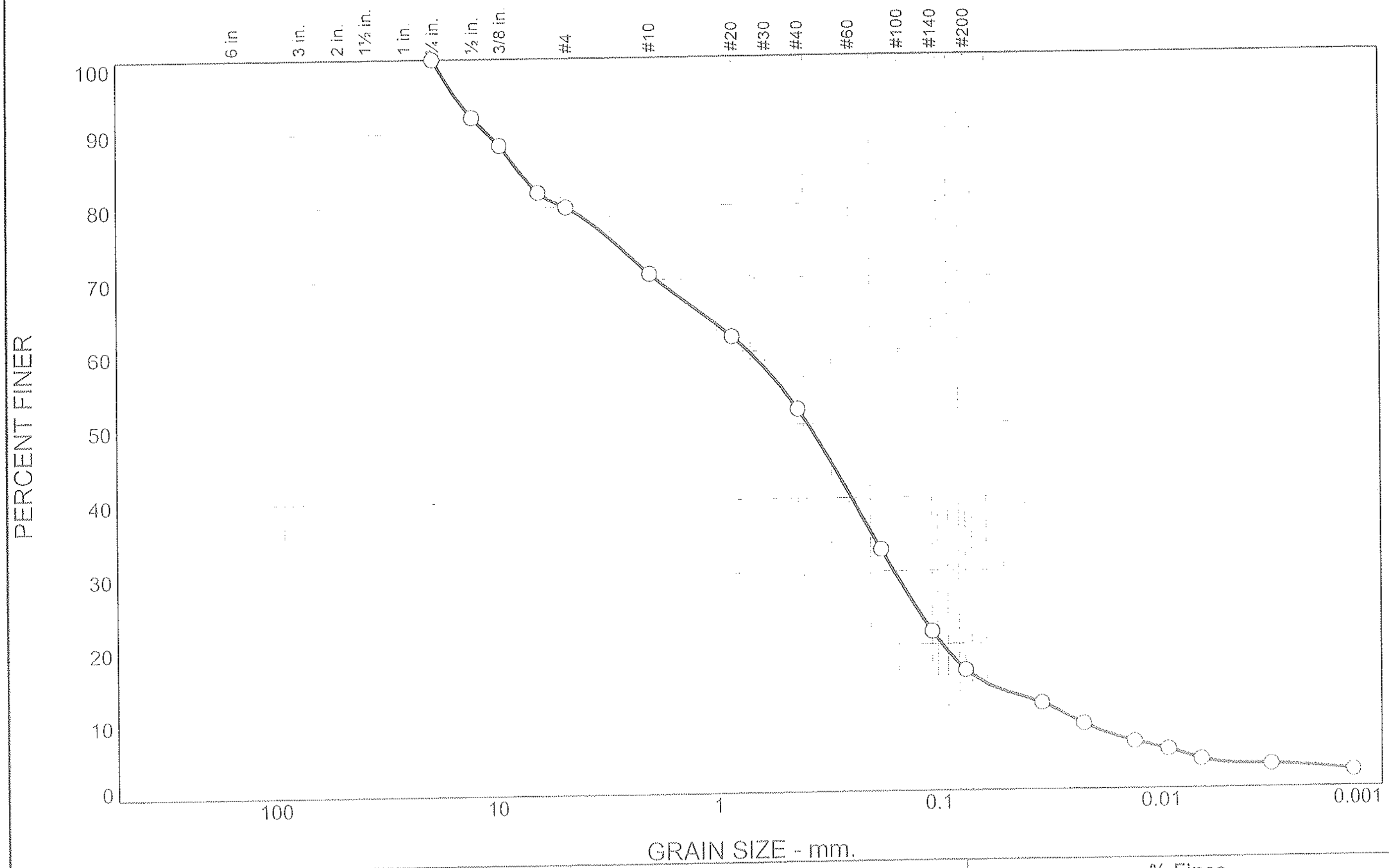
Sample No.: S-1 **Source of Sample:** B-28 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 0.5'-2.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972SS

Tested By: JJH/MCS Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	20.1	9.1	18.7	35.7	13.1	3.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	92.2		
3/8"	88.4		
1/4"	81.9		
#4	79.9		
#10	70.8		
#20	62.1		
#40	52.1		
#80	33.0		
#140	21.7		
#200	16.4		
0.0339 mm.	11.8		
0.0220 mm.	8.9		
0.0130 mm.	6.4		
0.0093 mm.	5.4		
0.0066 mm.	3.9		
0.0032 mm.	3.2		
0.0014 mm.	2.3		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 7.7878 D_{60}= 0.7127 D_{50}= 0.3813
D_{30}= 0.1580 D_{15}= 0.0648 D_{10}= 0.0257
C_u= 27.71 C_c= 1.36

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 8.8%

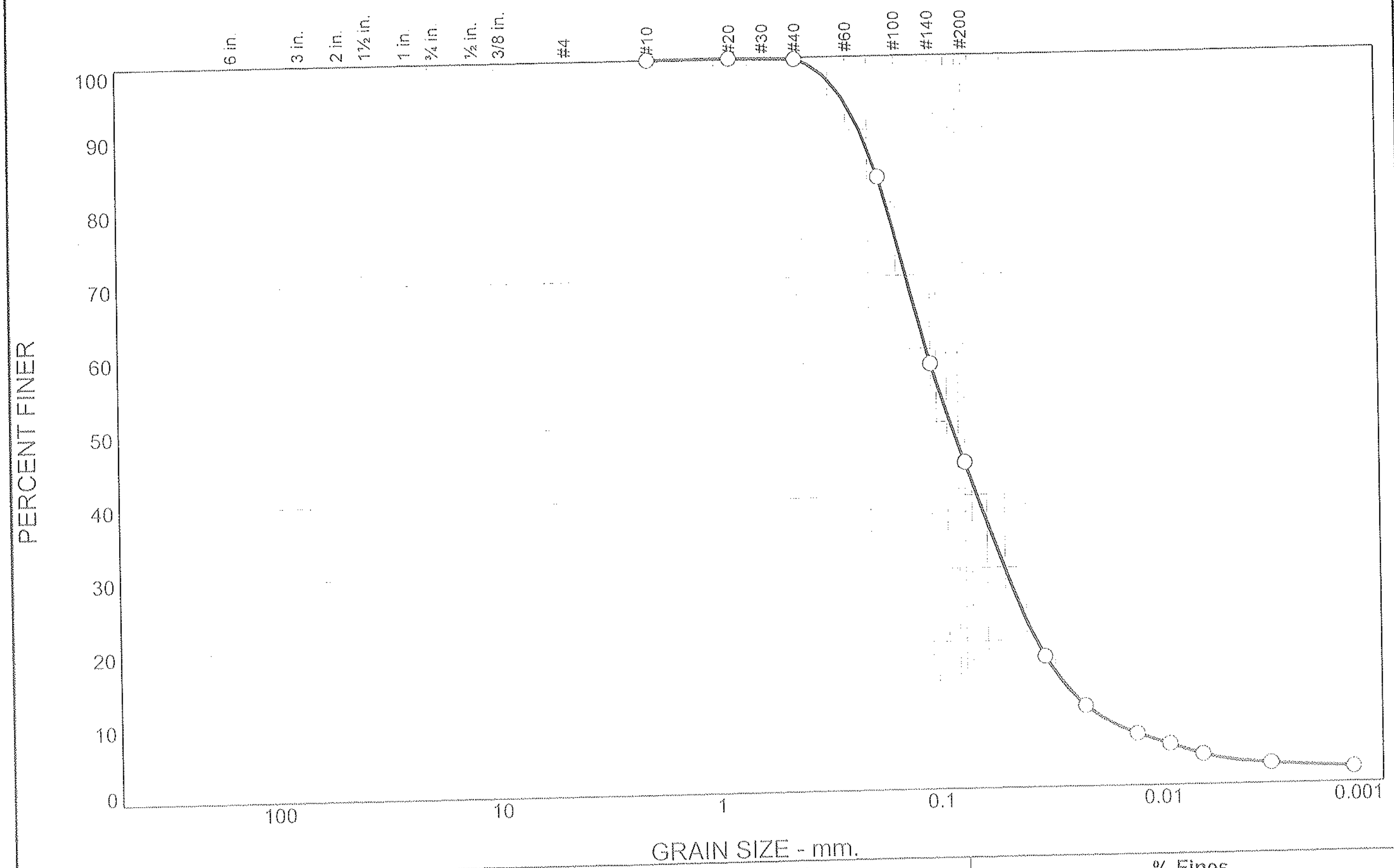
Sample No.: S-2
Location: New Bedford, MA
Source of Sample: B-28
Date: 10/19/09
Elev./Depth: 2.5'-4.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972TT

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	55.2	41.2	3.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.7		
#80	83.5		
#140	57.9		
#200	44.5		
0.0332 mm.	17.8		
0.0220 mm.	10.9		
0.0130 mm.	7.0		
0.0093 mm.	5.5		
0.0066 mm.	4.1		
0.0032 mm.	2.7		
0.0014 mm.	2.1		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.1868 D_{60}= 0.1108 D_{50}= 0.0872
D_{30}= 0.0502 D_{15}= 0.0291 D_{10}= 0.0201
C_u= 5.51 C_c= 1.13

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Moisture content: 26.5%

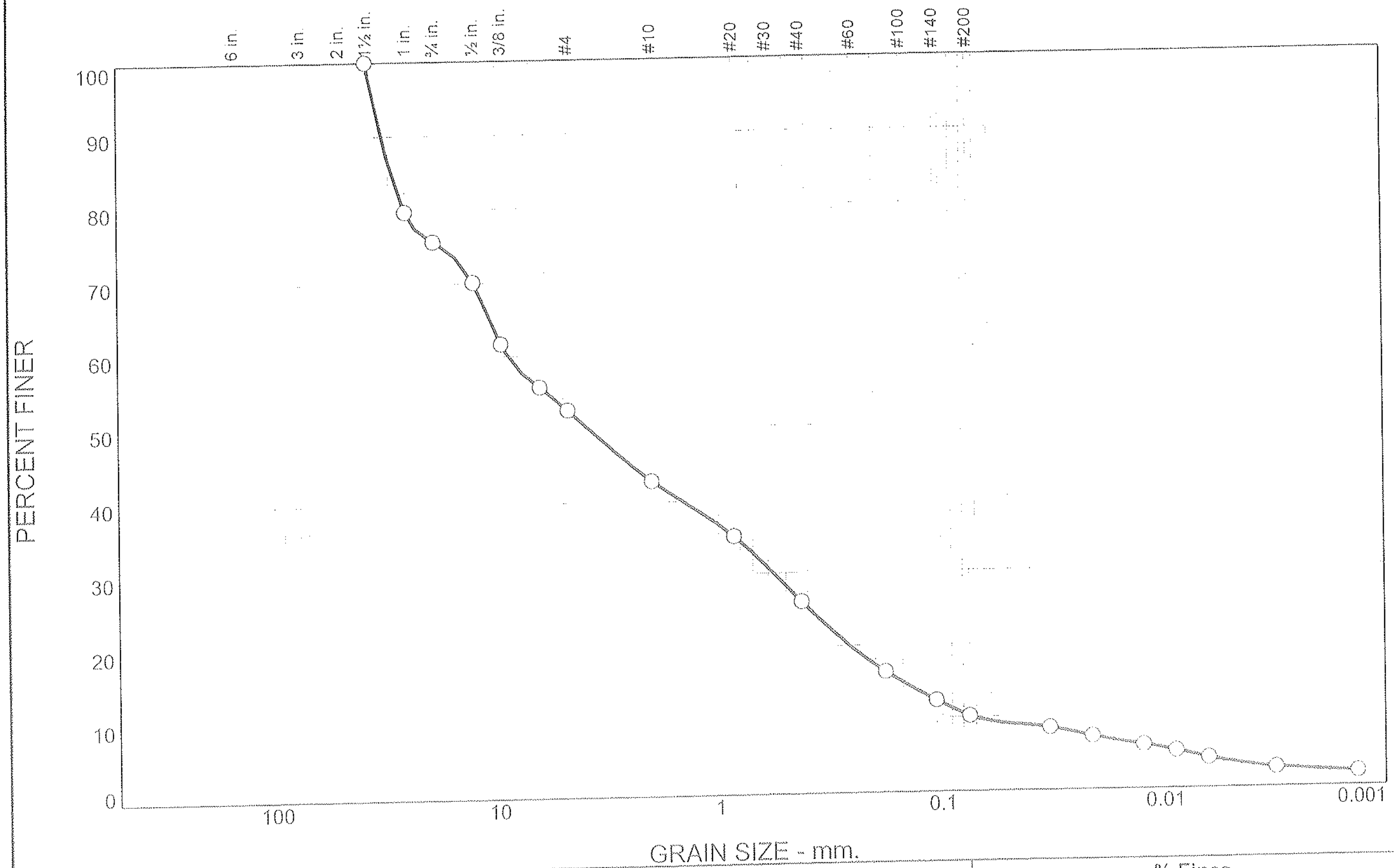
Sample No.: S-4
Location: New Bedford, MA
Source of Sample: B-28
Date: 10/19/09
Elev./Depth: 6'-8'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972UU

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	24.3	23.1	9.8	16.7	15.9	6.8	3.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	79.8		
3/4"	75.7		
1/2"	70.1		
3/8"	61.7		
1/4"	55.7		
#4	52.6		
#10	42.8		
#20	35.1		
#40	26.1		
#80	16.4		
#140	12.4		
#200	10.2		
0.0328 mm.	8.4		
0.0211 mm.	7.2		
0.0124 mm.	5.9		
0.0089 mm.	5.1		
0.0064 mm.	4.0		
0.0032 mm.	2.6		
0.0013 mm.	1.9		

* (no specification provided)

Soil Description

poorly graded gravel with silt and sand

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 29.1211
D_{60}= 8.8347
D_{50}= 3.8267
D_{30}= 0.5661
D_{15}= 0.1525
D_{10}= 0.0724
C_u= 122.11
C_c= 0.50

Classification

USCS= GP-GM
AASHTO= A-1-a

Remarks

Moisture content: 4.1%

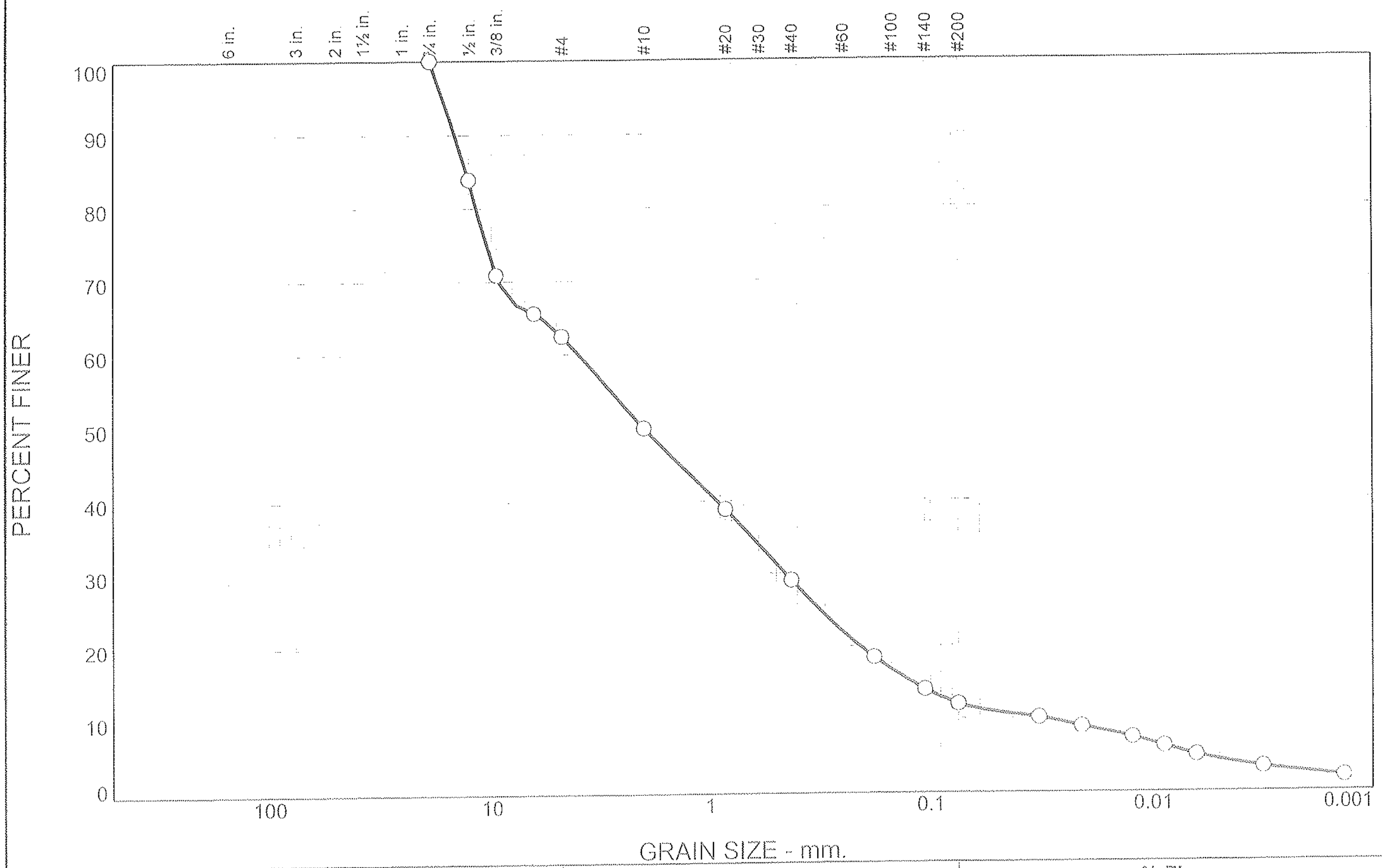
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-29
Date: 10/19/09
Elev./Depth: 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972VV

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	37.5	12.6	20.8	17.1	7.7	4.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	83.9		
3/8"	70.9		
1/4"	65.6		
#4	62.5		
#10	49.9		
#20	38.9		
#40	29.1		
#80	18.5		
#140	14.0		
#200	12.0		
0.0326 mm.	10.1		
0.0210 mm.	8.9		
0.0124 mm.	7.4		
0.0089 mm.	6.2		
0.0064 mm.	5.0		
0.0032 mm.	3.3		
0.0014 mm.	2.0		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 12.9947 D_{60}= 3.9714 D_{50}= 2.0073

D_{30}= 0.4542 D_{15}= 0.1209 D_{10}= 0.0312

C_u= 127.29 C_c= 1.67

Classification

USCS= SW-SM AASHTO= A-1-a

Remarks

Moisture content: 4.5%

Sample No.: S-1 **Source of Sample:** B-30 **Date:** 10/19/09

Location: New Bedford, MA **Elev./Depth:** 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

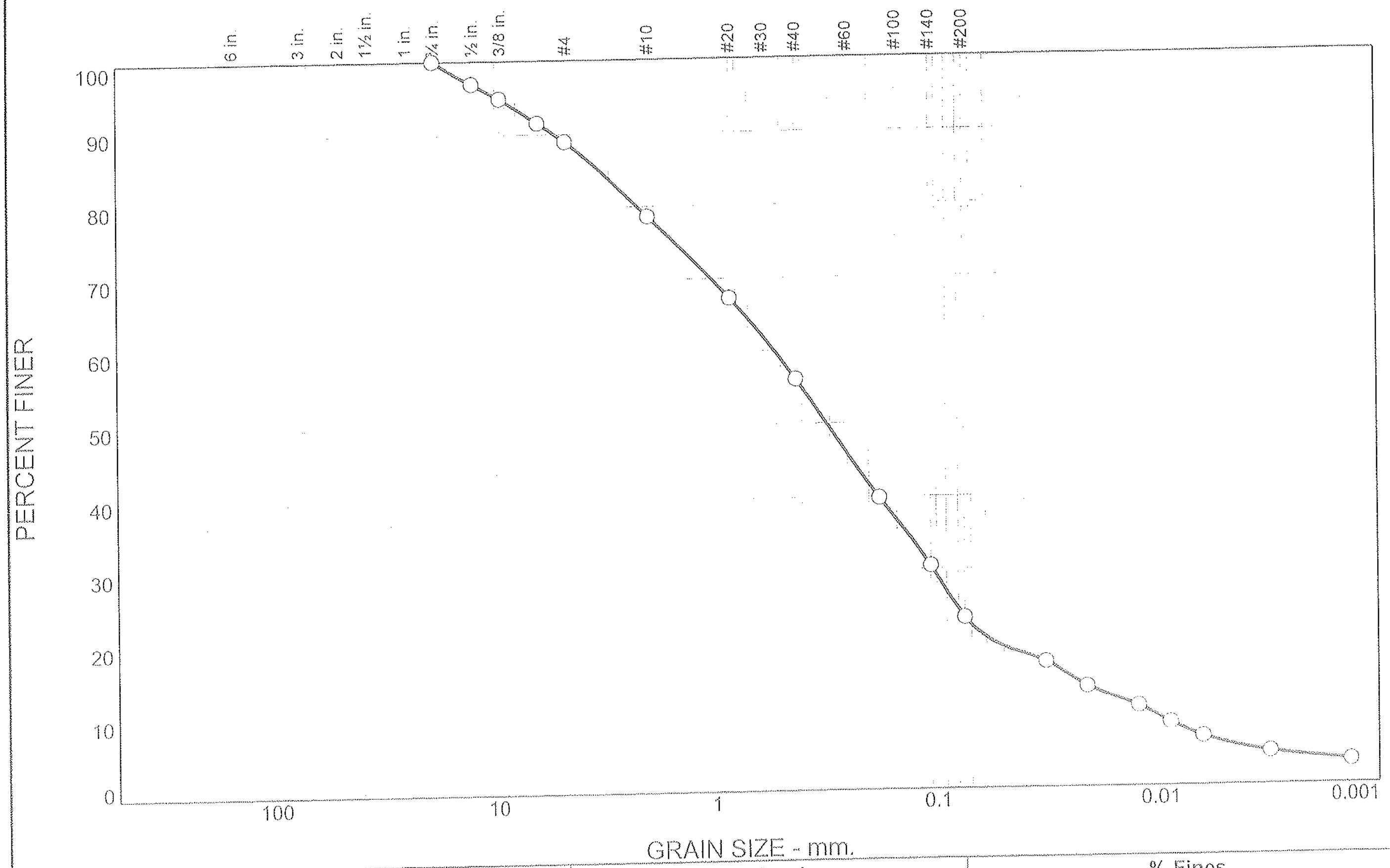
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972WW

Tested By: JJH/MCS **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.0	10.4	22.5	32.8	17.6	5.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	96.9		
3/8"	94.9		
1/4"	91.6		
#4	89.0		
#10	78.6		
#20	67.3		
#40	56.1		
#80	39.8		
#140	30.5		
#200	23.3		
0.0323 mm.	17.1		
0.0211 mm.	13.6		
0.0124 mm.	10.9		
0.0090 mm.	8.6		
0.0064 mm.	6.7		
0.0032 mm.	4.5		
0.0014 mm.	3.2		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 3.3033 D_{60}= 0.5299 D_{50}= 0.3081
D_{30}= 0.1037 D_{15}= 0.0250 D_{10}= 0.0108
C_u= 48.92 C_c= 1.87

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 44.2%

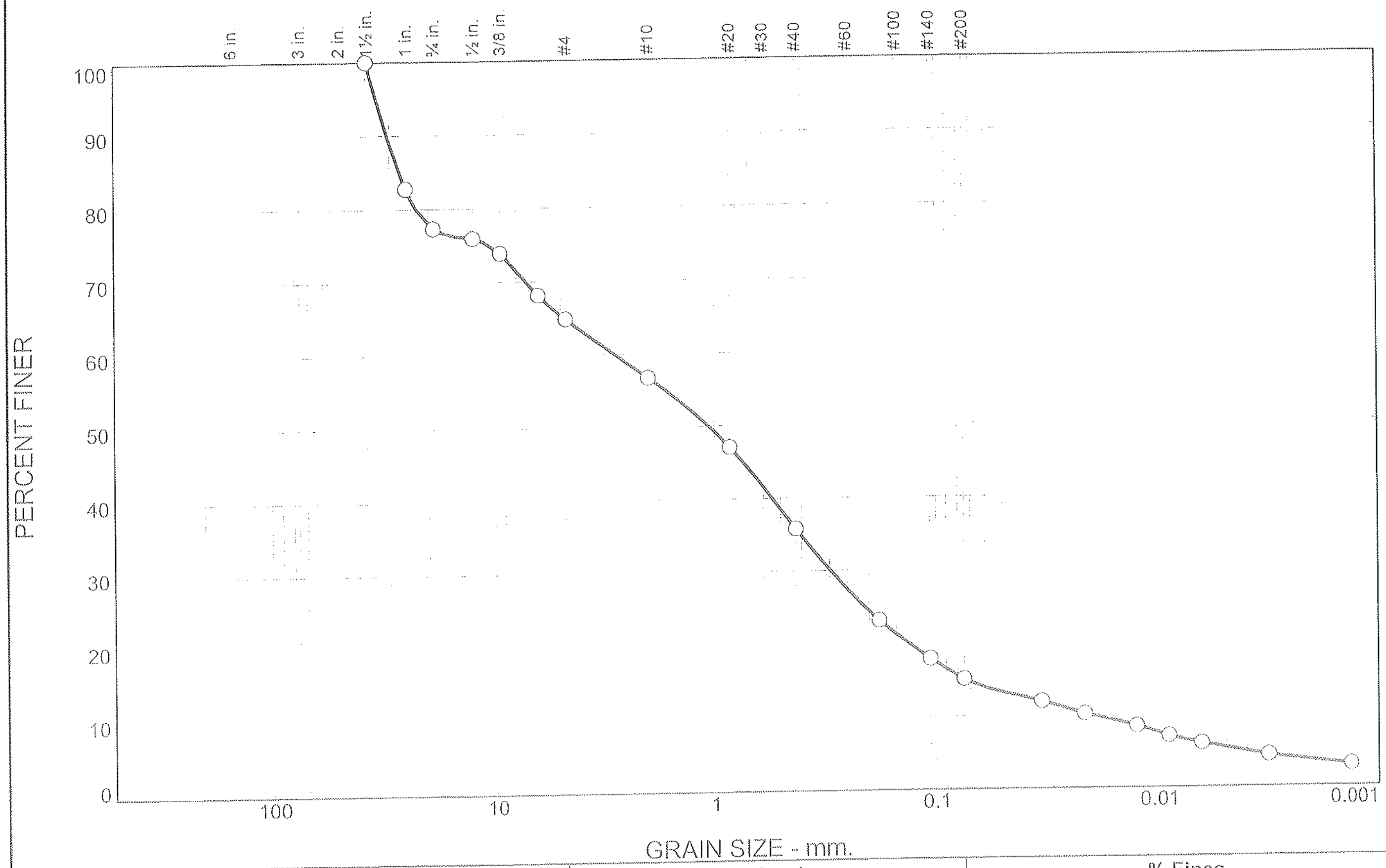
Sample No.: S-3 **Source of Sample:** B-30 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 4.5'-6.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972XX

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	22.7	12.5	8.1	20.9	20.7	9.8	5.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	82.8		
3/4"	77.3		
1/2"	76.0		
3/8"	73.9		
1/4"	68.1		
#4	64.8		
#10	56.7		
#20	47.1		
#40	35.8		
#80	23.1		
#140	17.9		
#200	15.1		
0.0335 mm.	11.9		
0.0215 mm.	10.1		
0.0126 mm.	8.4		
0.0090 mm.	7.0		
0.0064 mm.	6.0		
0.0032 mm.	4.3		
0.0013 mm.	2.9		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 27.1497 D_{60}= 2.8521 D_{50}= 1.0570

D_{30}= 0.2970 D_{15}= 0.0741 D_{10}= 0.0207

C_u= 138.05 C_c= 1.50

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture content: 7.7%

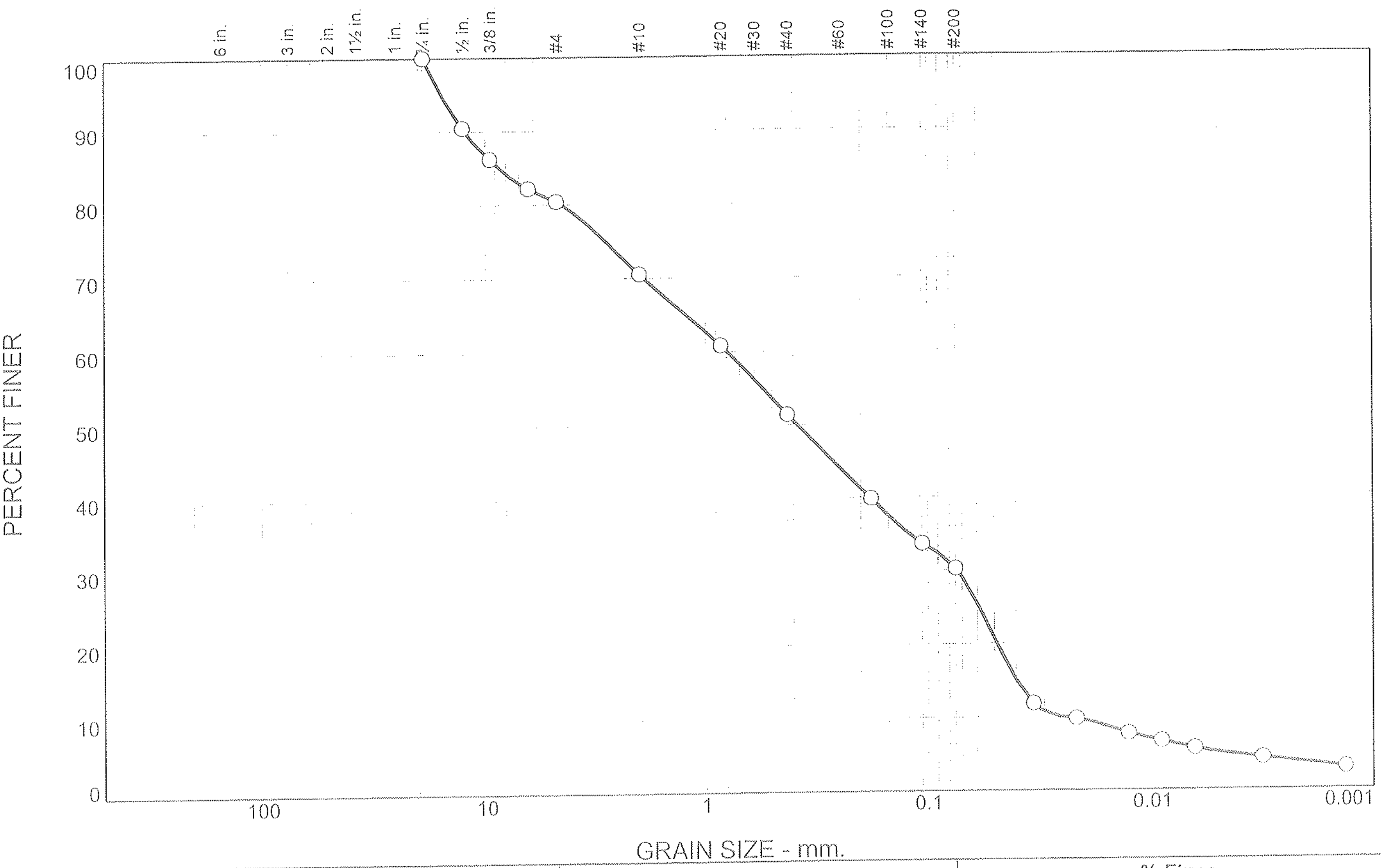
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-31
Date: 10/09/09
Elev./Depth: 0.5'-2.5'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972YY

Tested By: JJH/MCS **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	19.6	9.9	19.1	21.1	25.3	5.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	90.5		
3/8"	86.2		
1/4"	82.2		
#4	80.4		
#10	70.5		
#20	60.9		
#40	51.4		
#80	39.9		
#140	33.7		
#200	30.3		
0.0335 mm.	11.8		
0.0216 mm.	9.8		
0.0127 mm.	7.7		
0.0091 mm.	6.7		
0.0065 mm.	5.6		
0.0032 mm.	4.3		
0.0013 mm.	2.9		

* (no specification provided)

Soil Description

silty sand with gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 8.5950 D_{60}= 0.7927 D_{50}= 0.3843

D_{30}= 0.0738 D_{15}= 0.0398 D_{10}= 0.0249

C_u= 31.80 C_c= 0.28

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 7.2%

Sample No.: S-1 **Source of Sample:** B-32 **Date:** 10/19/09

Location: New Bedford, MA **Elev./Depth:** 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

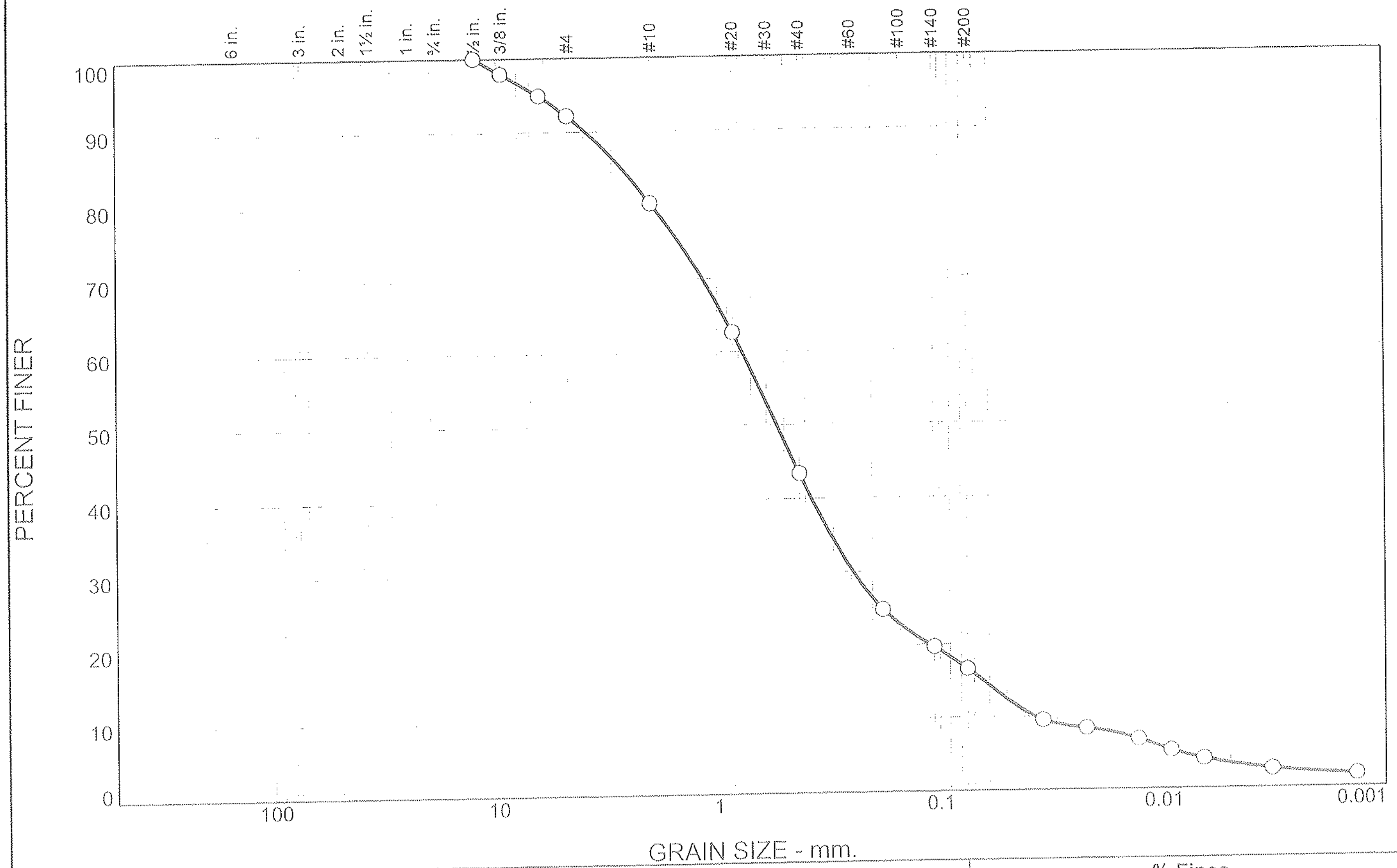
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972ZZ

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.8	11.9	36.9	26.8	13.3	3.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	97.9		
1/4"	94.9		
#4	92.2		
#10	80.3		
#20	62.7		
#40	43.4		
#80	24.9		
#140	19.7		
#200	16.6		
0.0346 mm.	9.5		
0.0221 mm.	8.4		
0.0129 mm.	6.8		
0.0092 mm.	5.2		
0.0066 mm.	4.0		
0.0032 mm.	2.5		
0.0014 mm.	1.8		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 2.6875 D_{60}= 0.7672 D_{50}= 0.5374
D_{30}= 0.2439 D_{15}= 0.0638 D_{10}= 0.0374
C_u= 20.54 C_c= 2.07

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture content: 7.6%

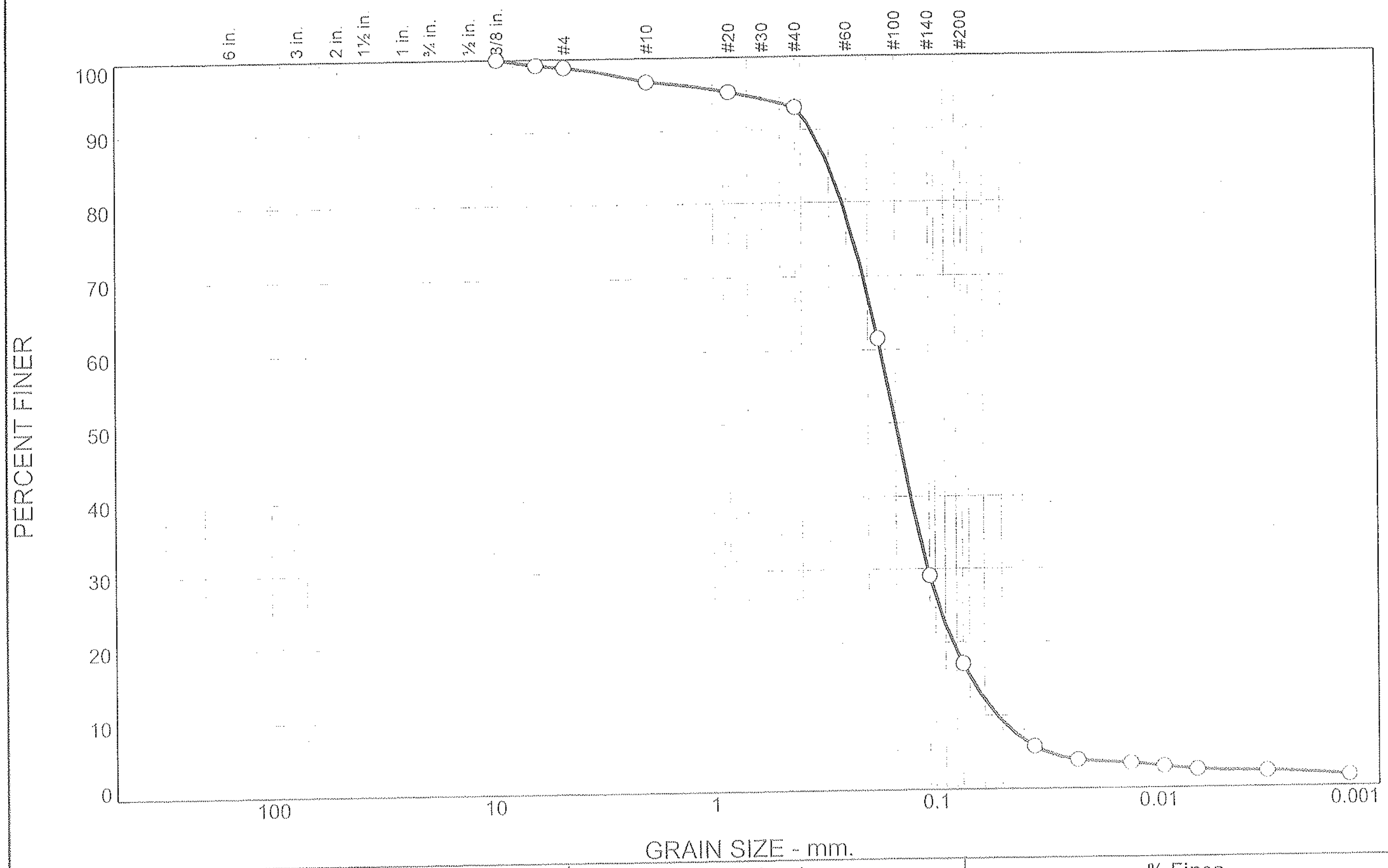
Sample No.: S-3 **Source of Sample:** B-32 **Date:** 10/19/09
Location: New Bedford, MA **Elev./Depth:** 4.2'-6.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972AAA

Tested By: JJH/MCS **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.2	2.0	3.7	76.0	14.8	2.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	99.2		
#4	98.8		
#10	96.8		
#20	95.3		
#40	93.1		
#80	61.6		
#140	29.1		
#200	17.1		
0.0359 mm.	5.8		
0.0230 mm.	3.9		
0.0133 mm.	3.4		
0.0094 mm.	2.9		
0.0067 mm.	2.5		
0.0033 mm.	2.2		
0.0014 mm.	1.5		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 0.2993 D_{60}= 0.1754 D_{50}= 0.1502
D_{30}= 0.1080 D_{15}= 0.0687 D_{10}= 0.0526
C_u= 3.33 C_c= 1.26

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 23.6%

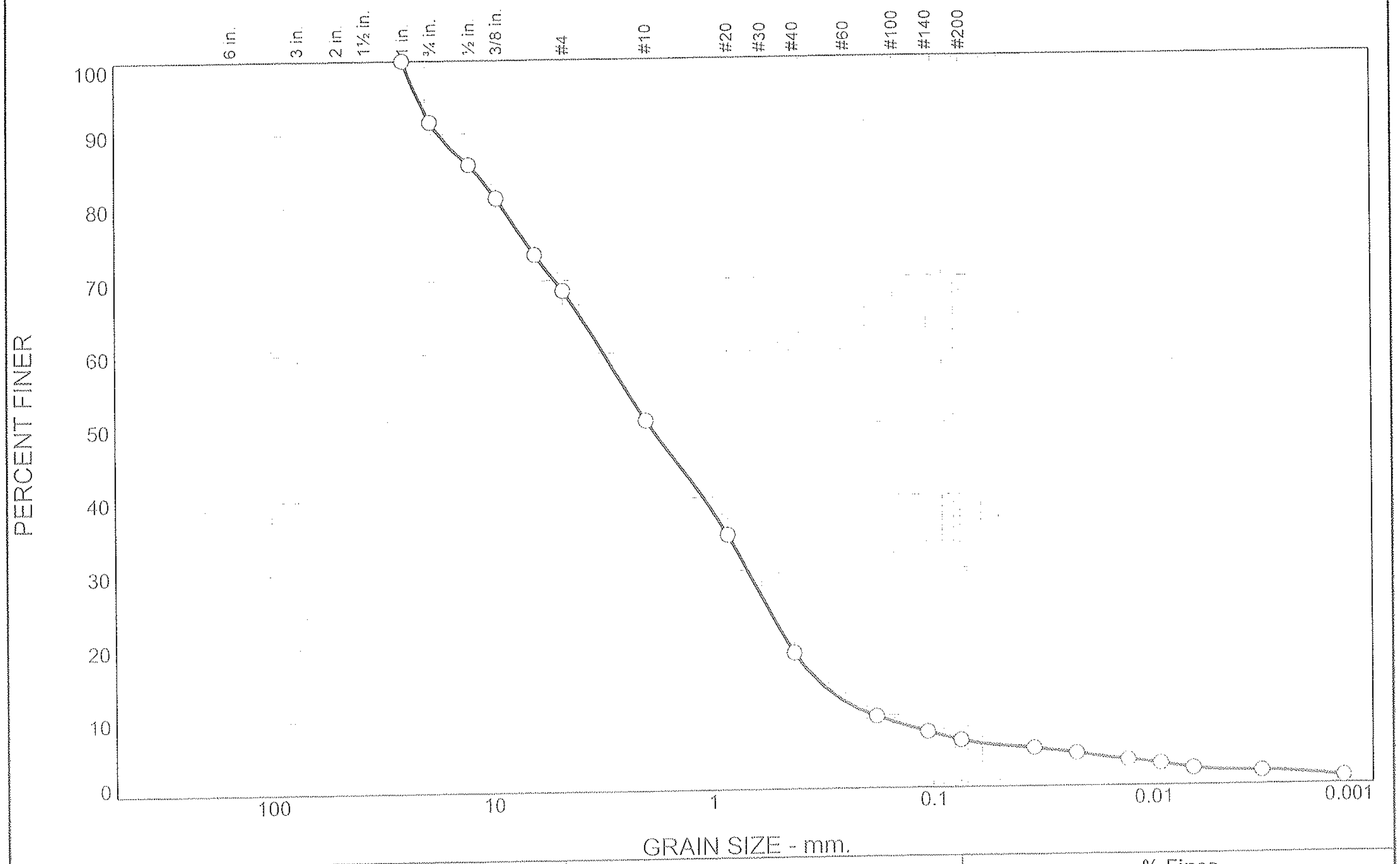
Sample No.: S-4
Location: New Bedford, MA
Source of Sample: B-32
Date: 10/20/09
Elev./Depth: 6.2'-8.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972BBB

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.4	23.0	17.9	32.0	12.2	4.5	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	91.6		
1/2"	85.8		
3/8"	81.2		
1/4"	73.5		
#4	68.6		
#10	50.7		
#20	34.9		
#40	18.7		
#80	9.8		
#140	7.7		
#200	6.5		
0.0350 mm.	5.2		
0.0223 mm.	4.5		
0.0130 mm.	3.5		
0.0093 mm.	3.0		
0.0066 mm.	2.3		
0.0032 mm.	1.9		
0.0014 mm.	1.0		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 12.0045 D_{60}= 3.1091 D_{50}= 1.9317
D_{30}= 0.6912 D_{15}= 0.3366 D_{10}= 0.1857
C_u= 16.74 C_c= 0.83

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Moisture content: 1.6%

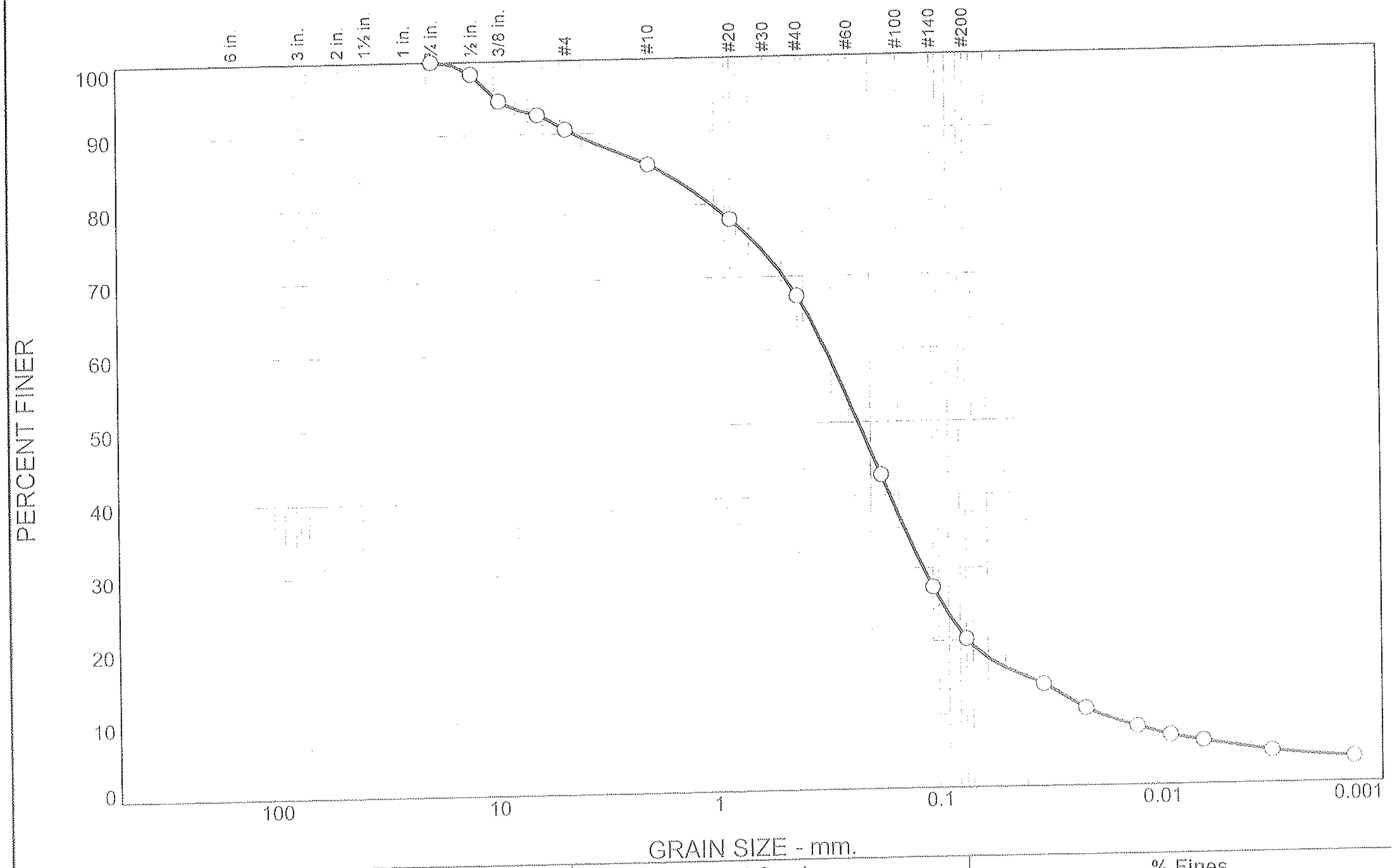
Sample No.: S-1 **Source of Sample:** B-33 **Date:** 10/20/09
Location: New Bedford, MA **Elev./Depth:** 2'-4'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972CCC

Tested By: JJH/MCS Checked By: MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.4	5.0	18.3	47.0	15.0	5.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	98.3		
3/8"	94.6		
1/4"	92.6		
#4	90.6		
#10	85.6		
#20	77.9		
#40	67.3		
#80	42.8		
#140	27.4		
#200	20.3		
0.0337 mm.	13.9		
0.0218 mm.	10.5		
0.0128 mm.	8.0		
0.0092 mm.	6.8		
0.0065 mm.	5.9		
0.0032 mm.	4.4		
0.0014 mm.	3.4		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np
LL= nv
PI=

Coefficients

D_{85}= 1.8179
D_{60}= 0.3166
D_{50}= 0.2260
D_{30}= 0.1172
D_{15}= 0.0406
D_{10}= 0.0200
C_u= 15.80
C_c= 2.16

Classification

USCS= SM
AASHTO= A-2-4(0)

Remarks

Moisture content: 9.5%

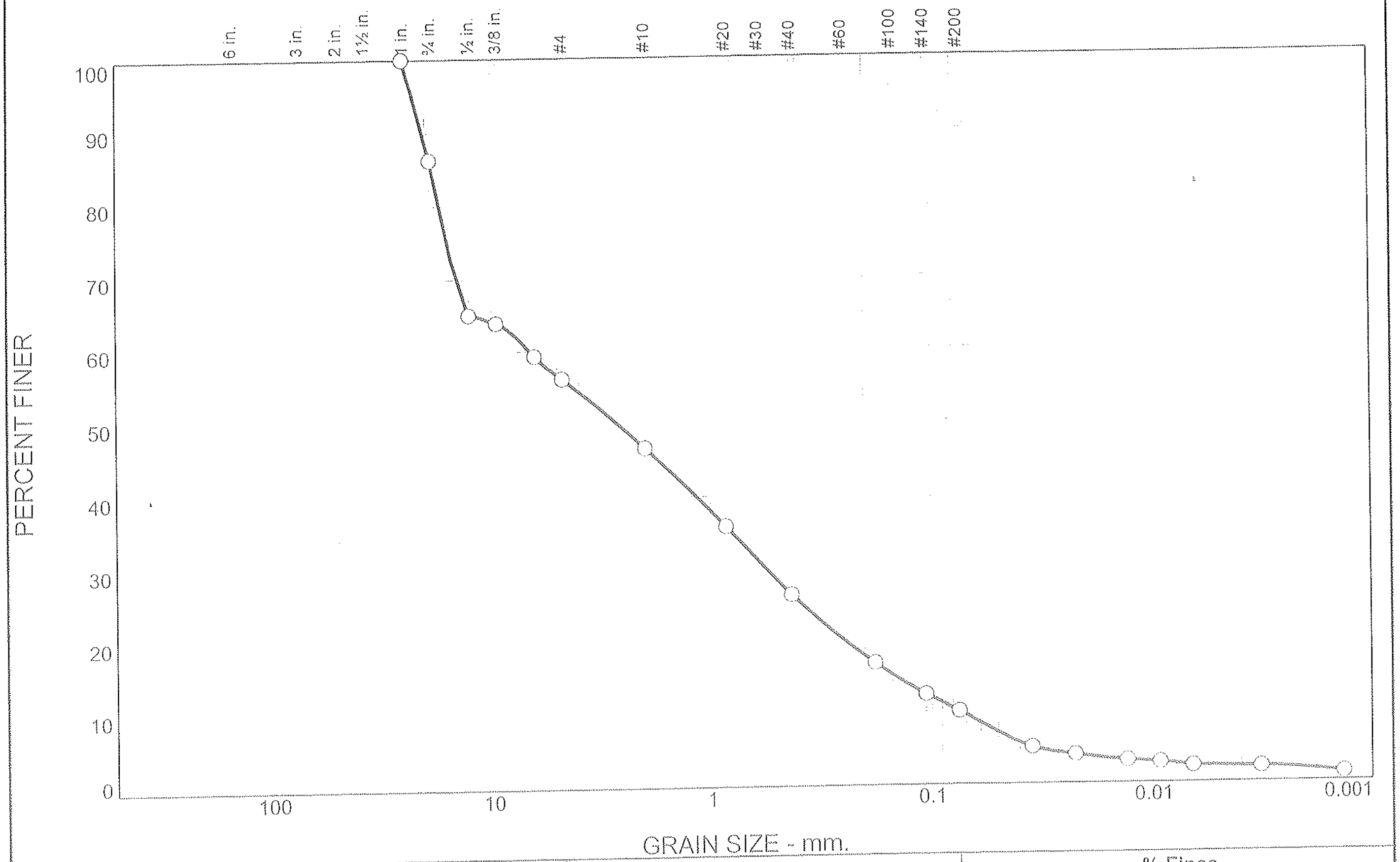
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-34
Date: 10/20/09
Elev./Depth: 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972DDD

Tested By: JJH/MCS
Checked By: MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	13.7	30.1	9.5	20.3	16.4	7.8	2.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	86.3		
1/2"	65.1		
3/8"	64.0		
1/4"	59.3		
#4	56.2		
#10	46.7		
#20	35.9		
#40	26.4		
#80	16.8		
#140	12.4		
#200	10.0		
0.0352 mm.	4.9		
0.0225 mm.	3.9		
0.0131 mm.	3.1		
0.0093 mm.	2.8		
0.0066 mm.	2.2		
0.0032 mm.	2.0		
0.0014 mm.	1.2		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 18.6113 D_{60}= 6.6596 D_{50}= 2.6497

D_{30}= 0.5554 D_{15}= 0.1470 D_{10}= 0.0745

C_u= 89.40 C_c= 0.62

Classification

USCS= SP-SM AASHTO= A-1-a

Remarks

Moisture content: 3.0%

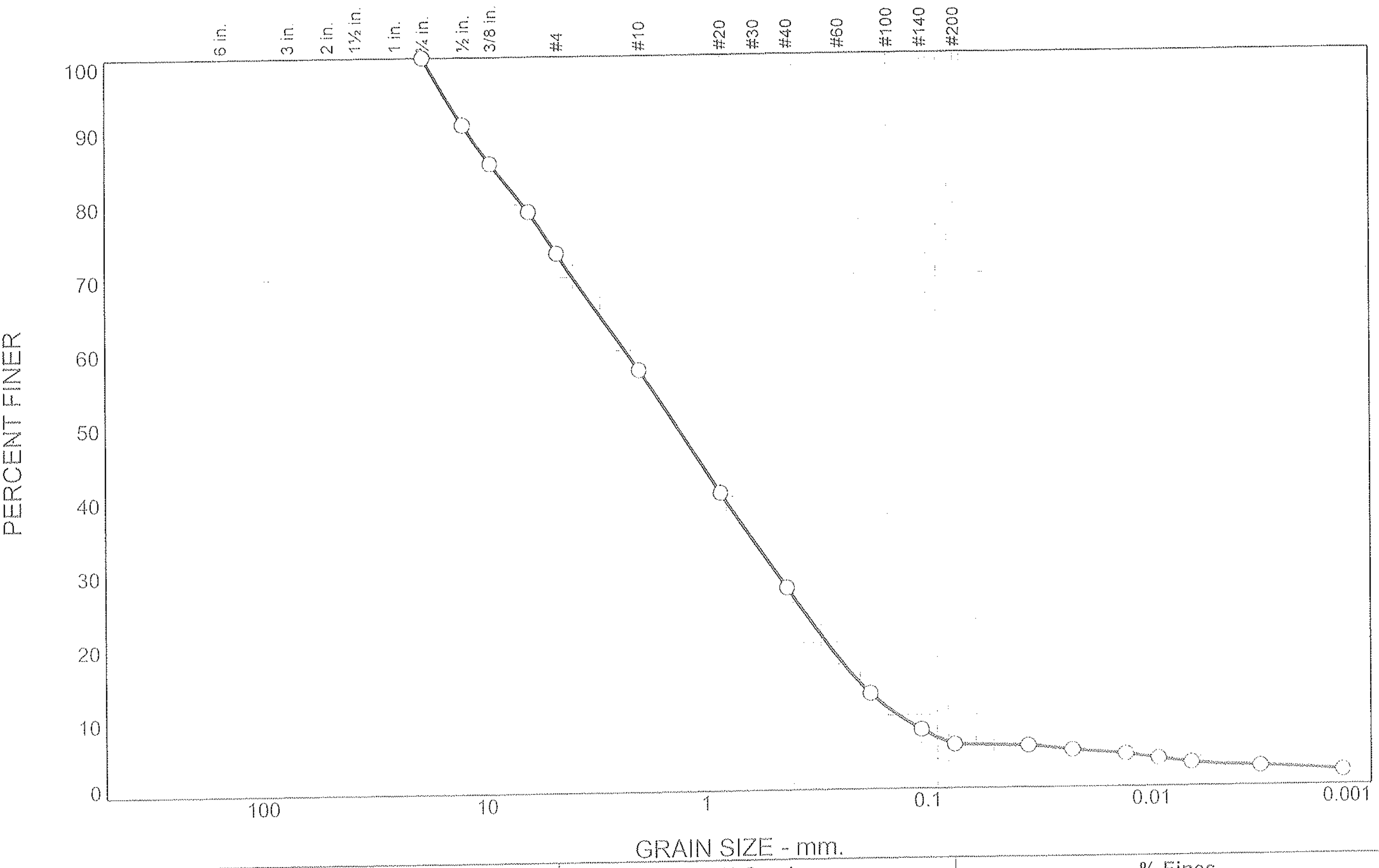
Sample No.: S-3
Location: New Bedford, MA
Source of Sample: B-34
Date: 10/21/09
Elev./Depth: 4'-6'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972EEE

Tested By: JJH/MCS **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	26.7	16.0	29.8	21.5	3.1	2.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	90.8		
3/8"	85.6		
1/4"	79.0		
#4	73.3		
#10	57.3		
#20	40.5		
#40	27.5		
#80	13.0		
#140	8.0		
#200	6.0		
0.0352 mm.	5.7		
0.0224 mm.	5.1		
0.0130 mm.	4.5		
0.0093 mm.	3.8		
0.0066 mm.	3.2		
0.0032 mm.	2.7		
0.0014 mm.	2.0		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 9.1926 D_{60}= 2.3132 D_{50}= 1.3717

D_{30}= 0.4860 D_{15}= 0.2082 D_{10}= 0.1352

C_u= 17.11 C_c= 0.76

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Moisture content: 5.3%

Sample No.: S-1 **Source of Sample:** B-35 **Date:** 10/21/09

Location: New Bedford, MA **Elev./Depth:** 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

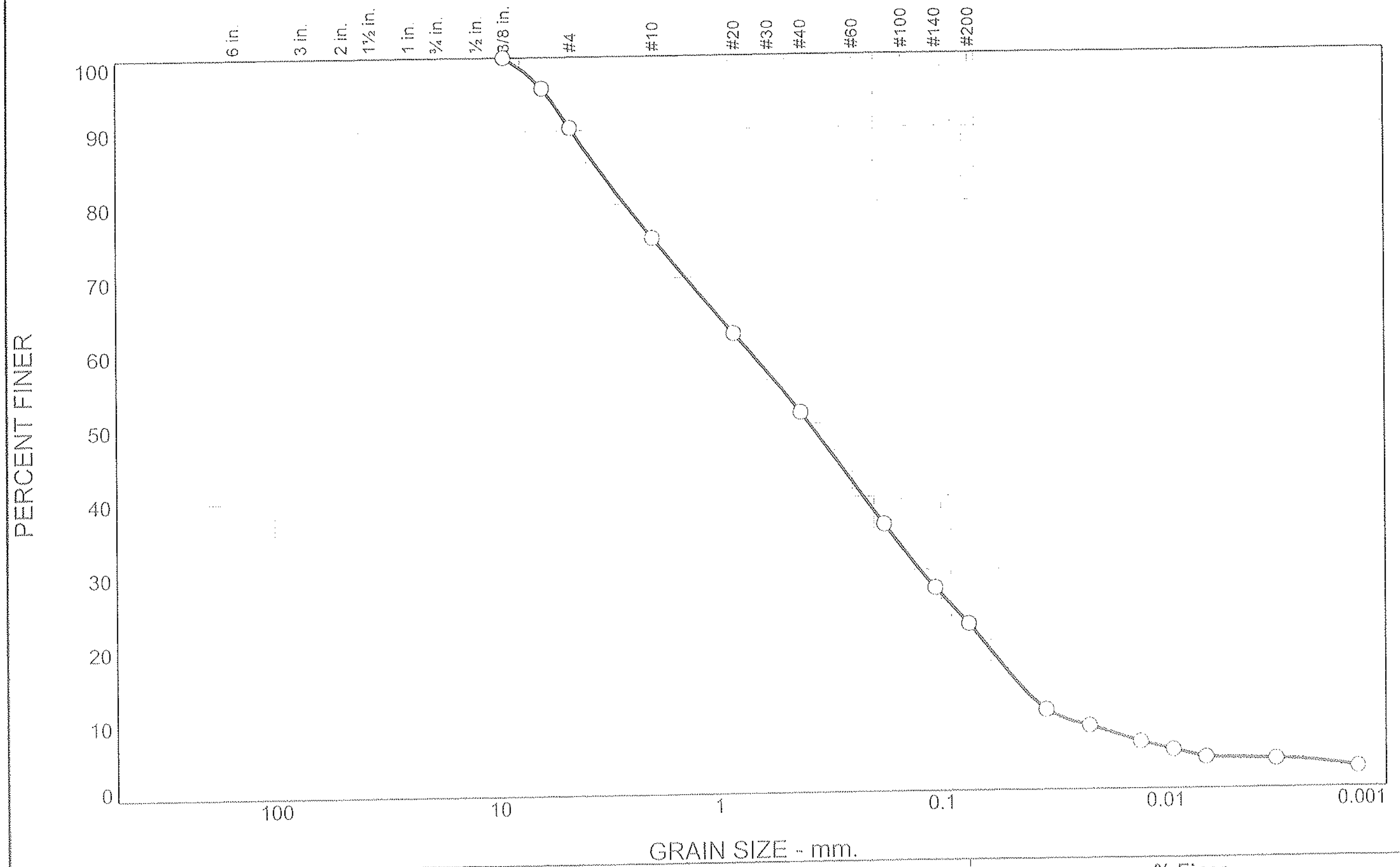
Client: Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

Project No: 1229-01 **Lab No.** 10972FFF

Tested By: JJH/MCS **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.6	15.0	23.8	29.0	18.5	4.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	95.8		
#4	90.4		
#10	75.4		
#20	62.3		
#40	51.6		
#80	36.2		
#140	27.6		
#200	22.6		
0.0340 mm.	10.8		
0.0219 mm.	8.6		
0.0129 mm.	6.4		
0.0092 mm.	5.3		
0.0066 mm.	4.2		
0.0032 mm.	3.9		
0.0014 mm.	2.7		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 3.5618 D_{60}= 0.7272 D_{50}= 0.3878
D_{30}= 0.1244 D_{15}= 0.0472 D_{10}= 0.0305
C_u= 23.84 C_c= 0.70

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture content: 8.7%

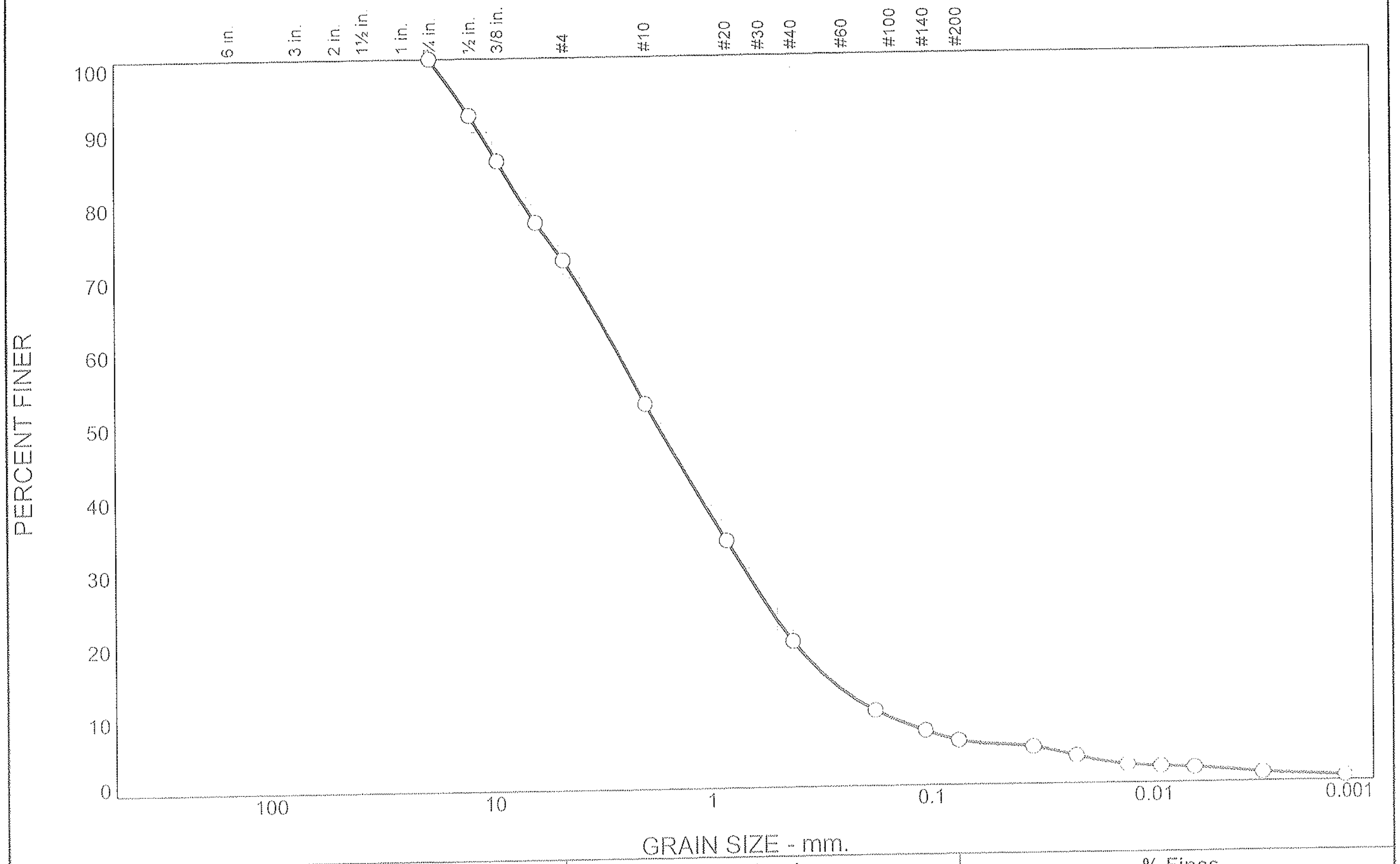
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: B-36
Date: 10/21/09
Elev./Depth: 0.2'-2.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972GGG

Tested By: JJH/MCS **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	27.6	19.7	32.7	14.0	4.3	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	92.3		
3/8"	86.0		
1/4"	77.6		
#4	72.4		
#10	52.7		
#20	33.9		
#40	20.0		
#80	10.3		
#140	7.4		
#200	6.0		
0.0348 mm.	5.0		
0.0224 mm.	3.8		
0.0131 mm.	2.5		
0.0093 mm.	2.2		
0.0066 mm.	2.0		
0.0032 mm.	1.2		
0.0014 mm.	0.7		

* (no specification provided)

Soil Description

well-graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 9.0928 D_{60}= 2.7157 D_{50}= 1.7833
D_{30}= 0.7098 D_{15}= 0.3004 D_{10}= 0.1724
C_u= 15.75 C_c= 1.08

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

Moisture content: 1.7%

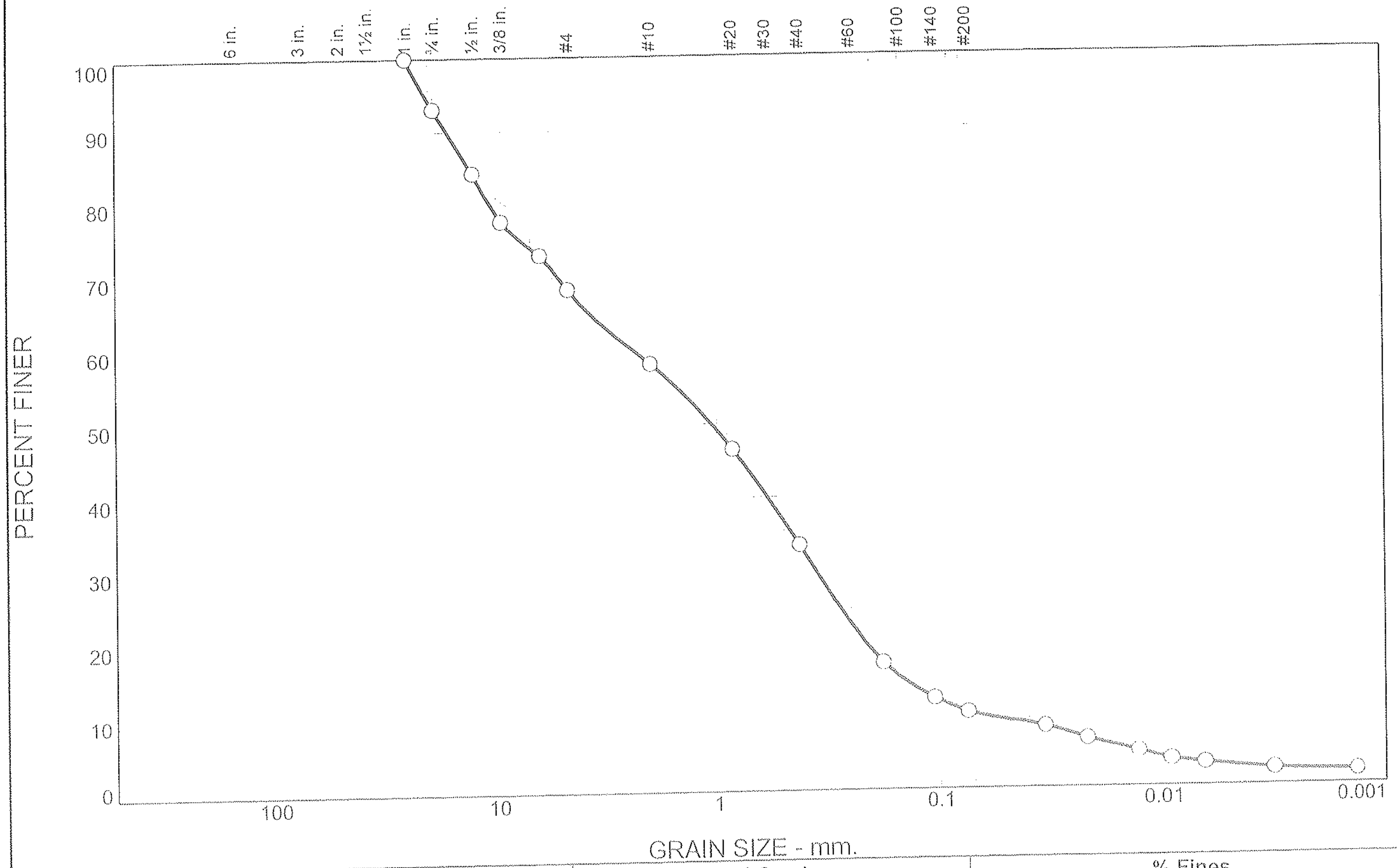
Sample No.: S-3 **Source of Sample:** B-36 **Date:** 10/22/09
Location: New Bedford, MA **Elev./Depth:** 4.2'-6.2'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972HHH

Tested By: JJH/DCH **Checked By:** MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.9	24.7	10.1	25.0	23.0	7.6	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	93.1		
1/2"	84.3		
3/8"	77.7		
1/4"	73.1		
#4	68.4		
#10	58.3		
#20	46.5		
#40	33.3		
#80	17.2		
#140	12.3		
#200	10.3		
0.0340 mm.	8.3		
0.0219 mm.	6.5		
0.0129 mm.	4.8		
0.0092 mm.	3.6		
0.0065 mm.	3.1		
0.0032 mm.	2.2		
0.0014 mm.	1.8		

* (no specification provided)

Soil Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 13.0766 D_{60}= 2.3644 D_{50}= 1.0558
D_{30}= 0.3622 D_{15}= 0.1488 D_{10}= 0.0687
C_u= 34.39 C_c= 0.81

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Moisture content: 4.7%

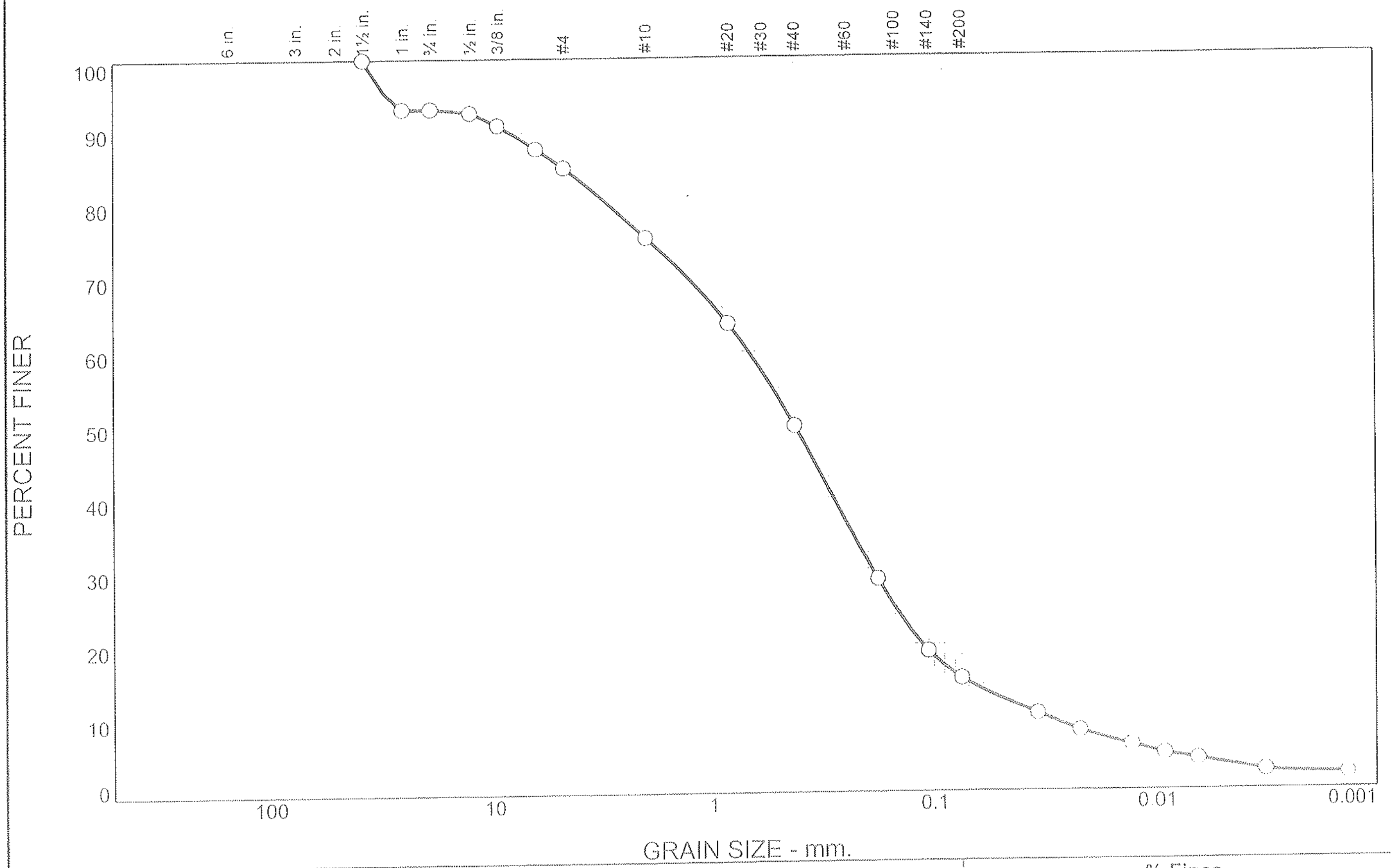
Sample No.: S-1
Source of Sample: TP-1
Date: 11/9/09
Location: New Bedford, MA
Elev./Depth: 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01
Lab No. 10972III

Tested By: DCH/JJH **Checked By:** MTG MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.8	8.1	9.6	25.6	34.5	11.9	3.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	93.2		
3/4"	93.2		
1/2"	92.7		
3/8"	91.0		
1/4"	87.7		
#4	85.1		
#10	75.5		
#20	63.9		
#40	49.9		
#80	29.0		
#140	19.1		
#200	15.4		
0.0342 mm.	10.5		
0.0220 mm.	8.1		
0.0129 mm.	6.2		
0.0092 mm.	5.0		
0.0065 mm.	4.2		
0.0032 mm.	2.6		
0.0014 mm.	2.1		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= np LL= nv PI=

Coefficients

D_{85}= 4.6785 D_{60}= 0.6849 D_{50}= 0.4277
D_{30}= 0.1882 D_{15}= 0.0716 D_{10}= 0.0312
C_u= 21.97 C_c= 1.66

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture content: 11.4%

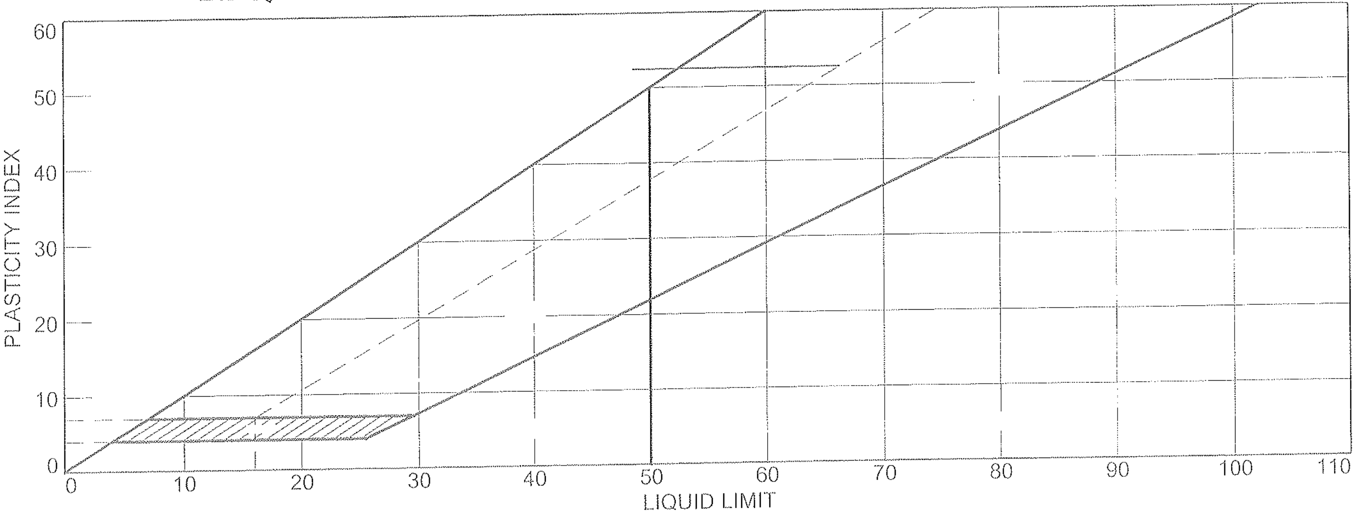
Sample No.: S-1
Location: New Bedford, MA
Source of Sample: TP-2
Date: 11/9/09
Elev./Depth: 0.3'-2.3'

R.W. Gillespie
& Associates, Inc.
Saco, Maine

Client: Airport Solutions Group
Project: Pavement Rehabilitation Strategies for Ramps
Project No: 1229-01 **Lab No.** 10972JJJ

Tested By: DCH/JJH **Checked By:** MTG MTG

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	silty sand	16	NP	NP			
■	silty sand with gravel	16	NP	NP			
▲	silty sand with gravel	16	NP	NP			
◆	silty sand	18	NP	NP			
▼	silty sand with gravel	17	NP	NP			

Project No. 1229-01 **Client:** Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

● **Source of Sample:** B-5 **Depth:** 6.3'-8.3' **Sample Number:** S-4

■ **Source of Sample:** B-7 **Depth:** 2.4'-4.4' **Sample Number:** S-2

▲ **Source of Sample:** B-9 **Depth:** 2.5'-4.5' **Sample Number:** S-2

◆ **Source of Sample:** B-10 **Depth:** 6.4'-8.4' **Sample Number:** S-4

▼ **Source of Sample:** B-11 **Depth:** 2.4'-4.4' **Sample Number:** S-2

Remarks:
● Moisture content: 12.2%
■ Moisture content: 12.3%
▲ Moisture content: 6.5%
◆ Moisture content: 15.5%
▼ Moisture content: 5.1%

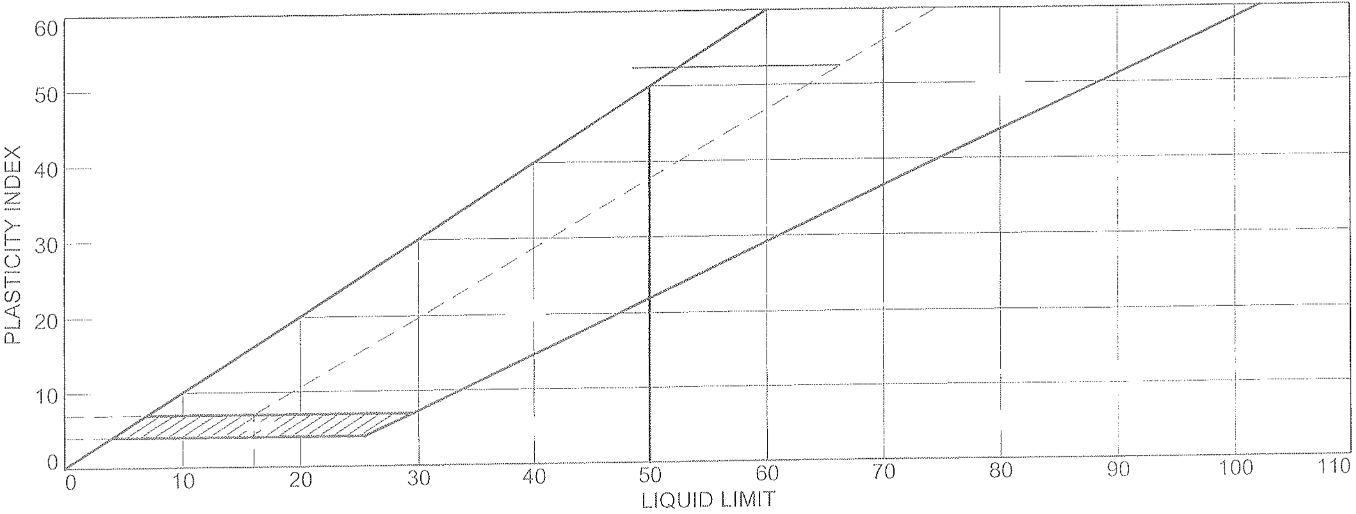
R.W. Gillespie & Associates, Inc.

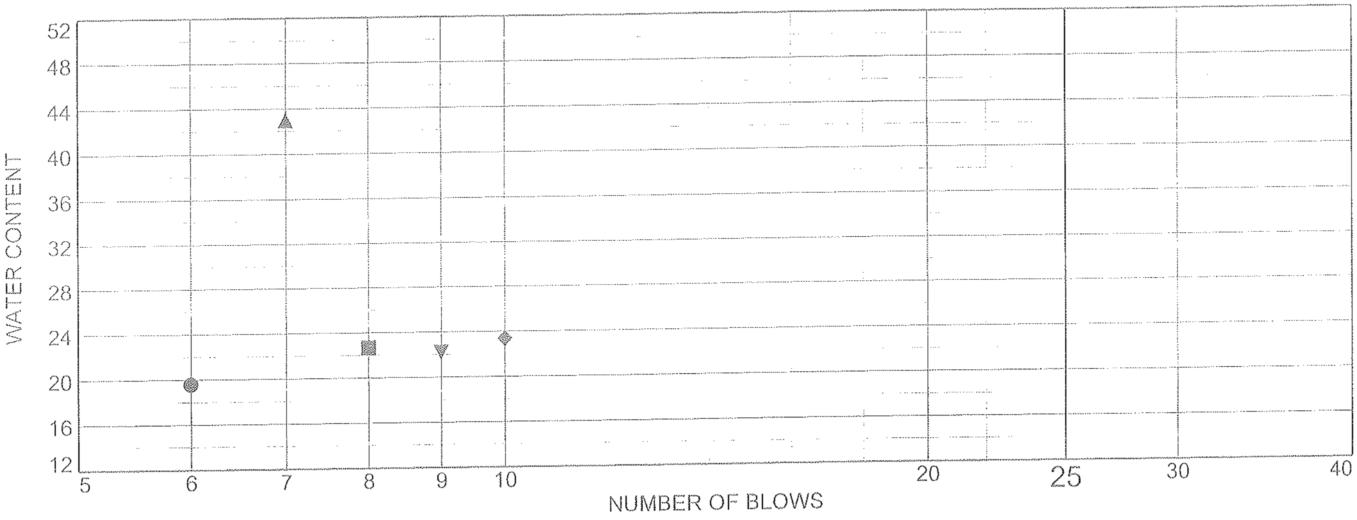
Saco, Maine

Lab No. 11025a

Tested By: DCH **Checked By:** MTG MTG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	poorly graded sand with silt and gravel	16	NP	NP			
■	poorly graded sand with silt and gravel	20	NP	NP			
▲	poorly graded sand with silt and gravel	37	NP	NP			
◆	silty sand	21	NP	NP			
▼	silty sand	20	NP	NP			

Project No. 1229-01 **Client:** Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

● **Source of Sample:** B-13 **Depth:** 5'-7' **Sample Number:** S-3
■ **Source of Sample:** B-17 **Depth:** 4.5'-6.5' **Sample Number:** S-3
▲ **Source of Sample:** B-18 **Depth:** 2.5'-4.5' **Sample Number:** S-2
◆ **Source of Sample:** B-20 **Depth:** 2.2'-4.2' **Sample Number:** S-2
▼ **Source of Sample:** B-23 **Depth:** 6'-8' **Sample Number:** S-4

Remarks:
● Moisture content: 11.6%
■ Moisture content: 20.1%
▲ Moisture content: 32.5%
◆ Moisture content: 23.8%
▼ Moisture content: 23.1%

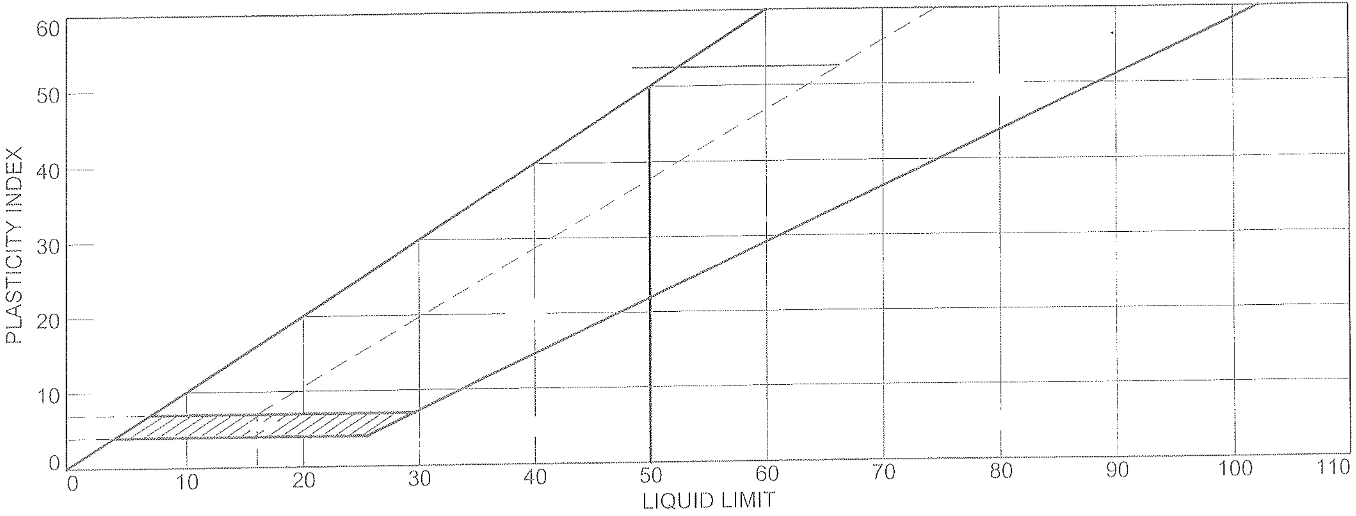
R.W. Gillespie & Associates, Inc.

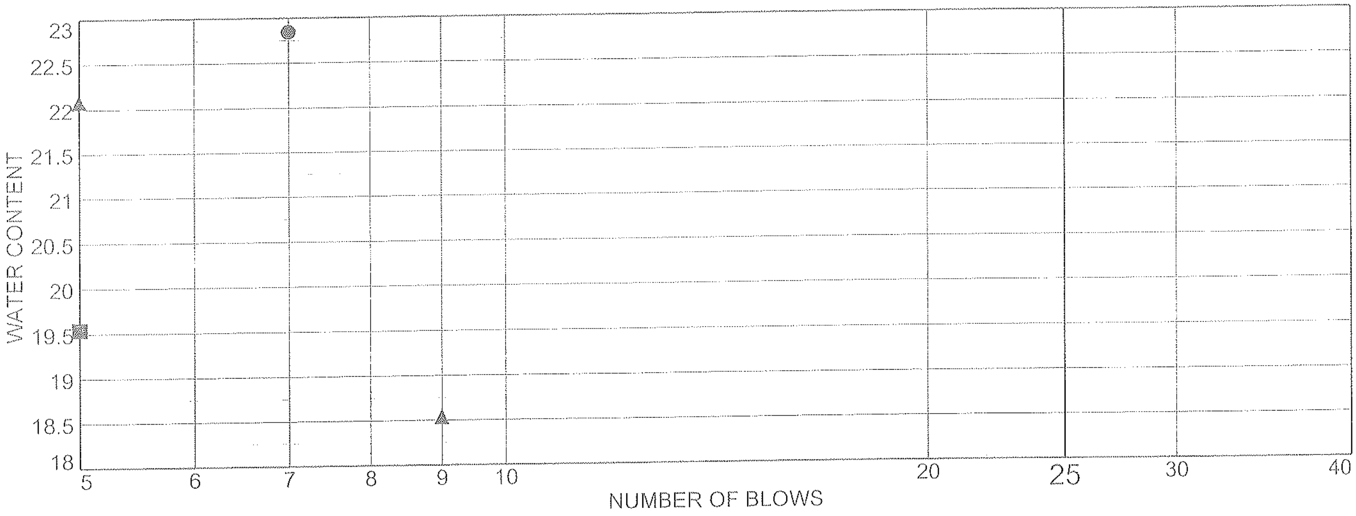
Saco, Maine

Lab No. 11025b

Tested By: DCH **Checked By:** MTG MTG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	poorly graded sand with silt	20	NP	NP			
■	poorly graded sand	16	NP	NP			
▲	poorly graded gravel with silt and sand	17	NP	NP			

Project No. 1229-01 **Client:** Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

● **Source of Sample:** B-24 **Depth:** 6.4'-8' **Sample Number:** S-4

■ **Source of Sample:** B-26 **Depth:** 2.2'-4.2' **Sample Number:** S-2

▲ **Source of Sample:** B-29 **Depth:** 4.3'-6.3' **Sample Number:** S-3

Remarks:

● Moisture content: 24.0%

■ Moisture content: 8.8%

▲ Moisture content: 13.7%

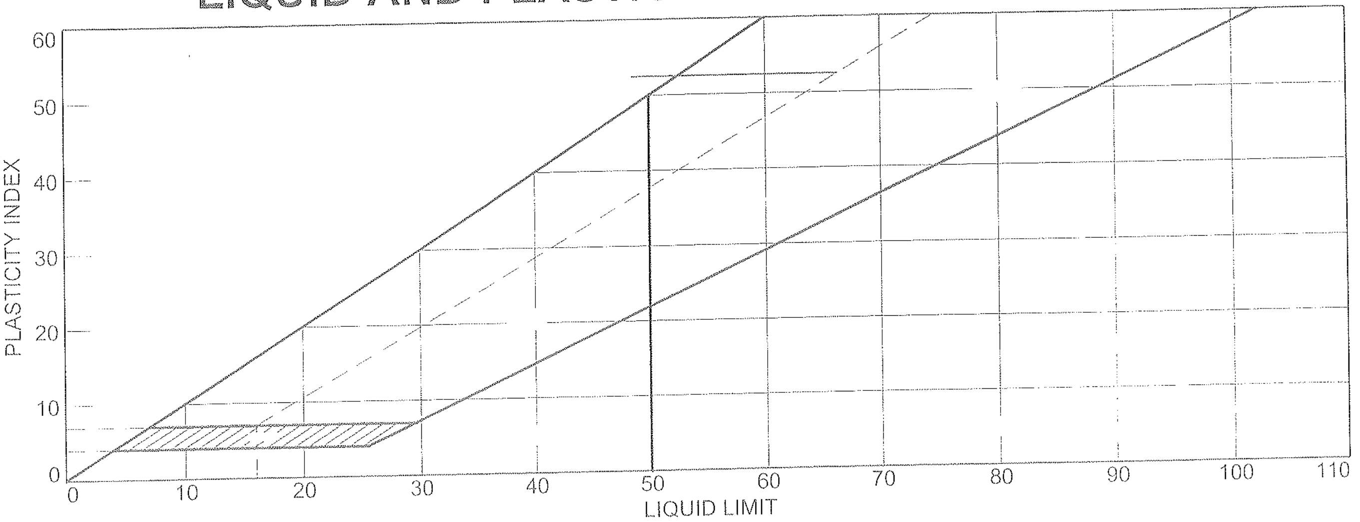
R.W. Gillespie & Associates, Inc.

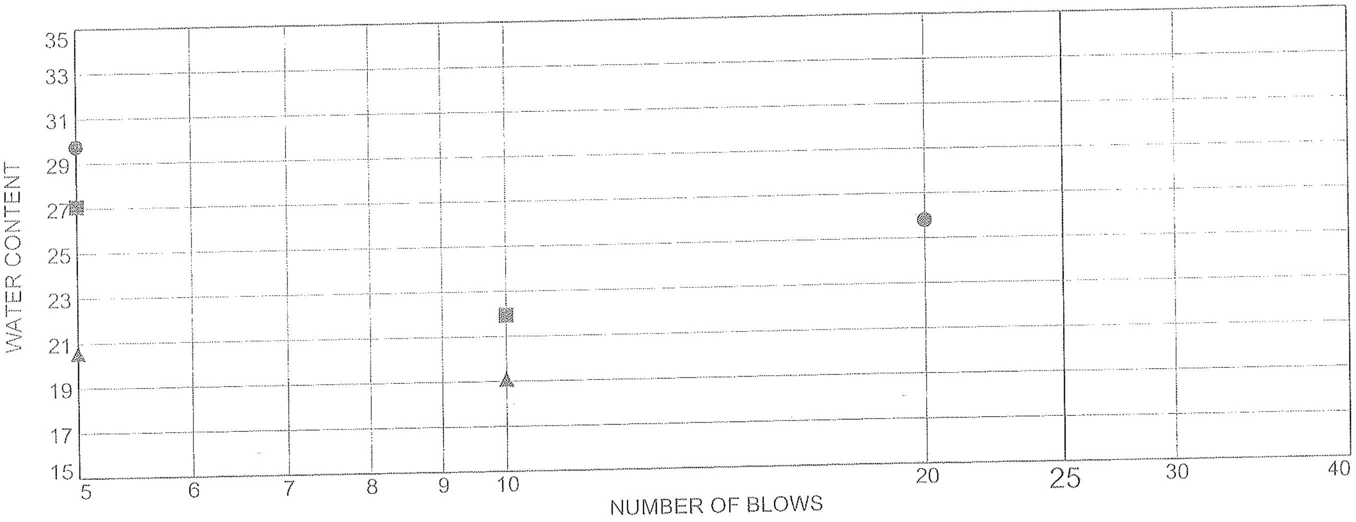
Saco, Maine

Lab No. 11025c

Tested By: DCH **Checked By:** MTG MTG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	silty sand	25	NP	NP			
■	poorly graded sand with silt and gravel	21	NP	NP			
▲	silty sand	17	NP	NP			

Project No. 1229-01 **Client:** Airport Solutions Group

Project: Pavement Rehabilitation Strategies for Ramps

● **Source of Sample:** B-30 **Depth:** 6.5'-8.5' **Sample Number:** S-4

■ **Source of Sample:** B-33 **Depth:** 4'-6' **Sample Number:** S-2

▲ **Source of Sample:** B-36 **Depth:** 2.2'-4.2' **Sample Number:** S-2

Remarks:

● Moisture content: 26.0%

■ Moisture content: 22.6%

▲ Moisture content: 3.3%

R.W. Gillespie & Associates, Inc.

Saco, Maine

Lab No. 11025d

Tested By: DCH **Checked By:** MTG MTG

APPENDIX C

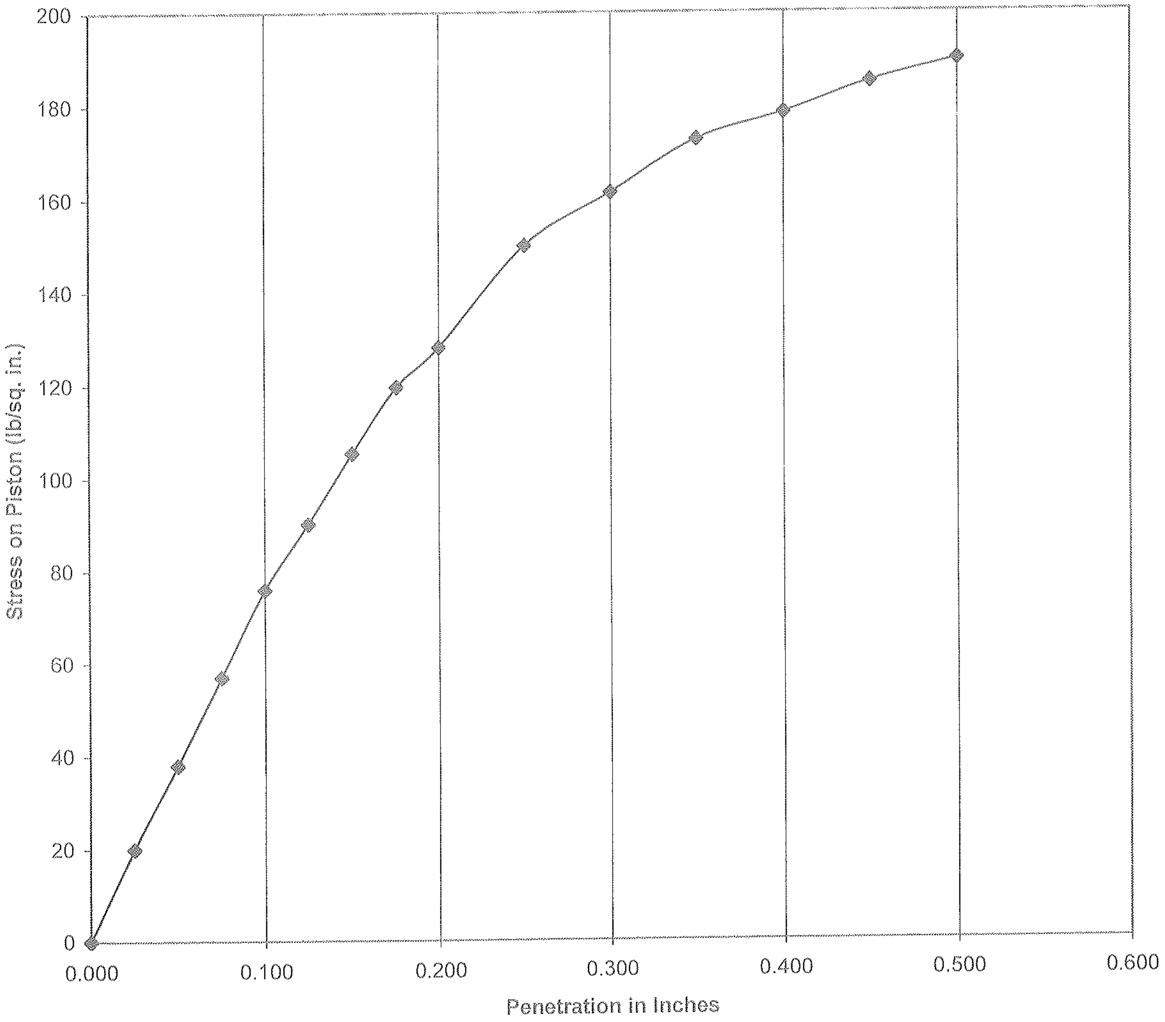
FIELD CBR TESTS

Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport
New Bedford, Massachusetts

RWG&A Project No. 1229-01

17 November 2009

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 7.6

Test Location:	B-6	Test Depth:	27"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01
Client: Airport Solutions Group
Location: New Bedford, MA
Date: 18-Sep-2009

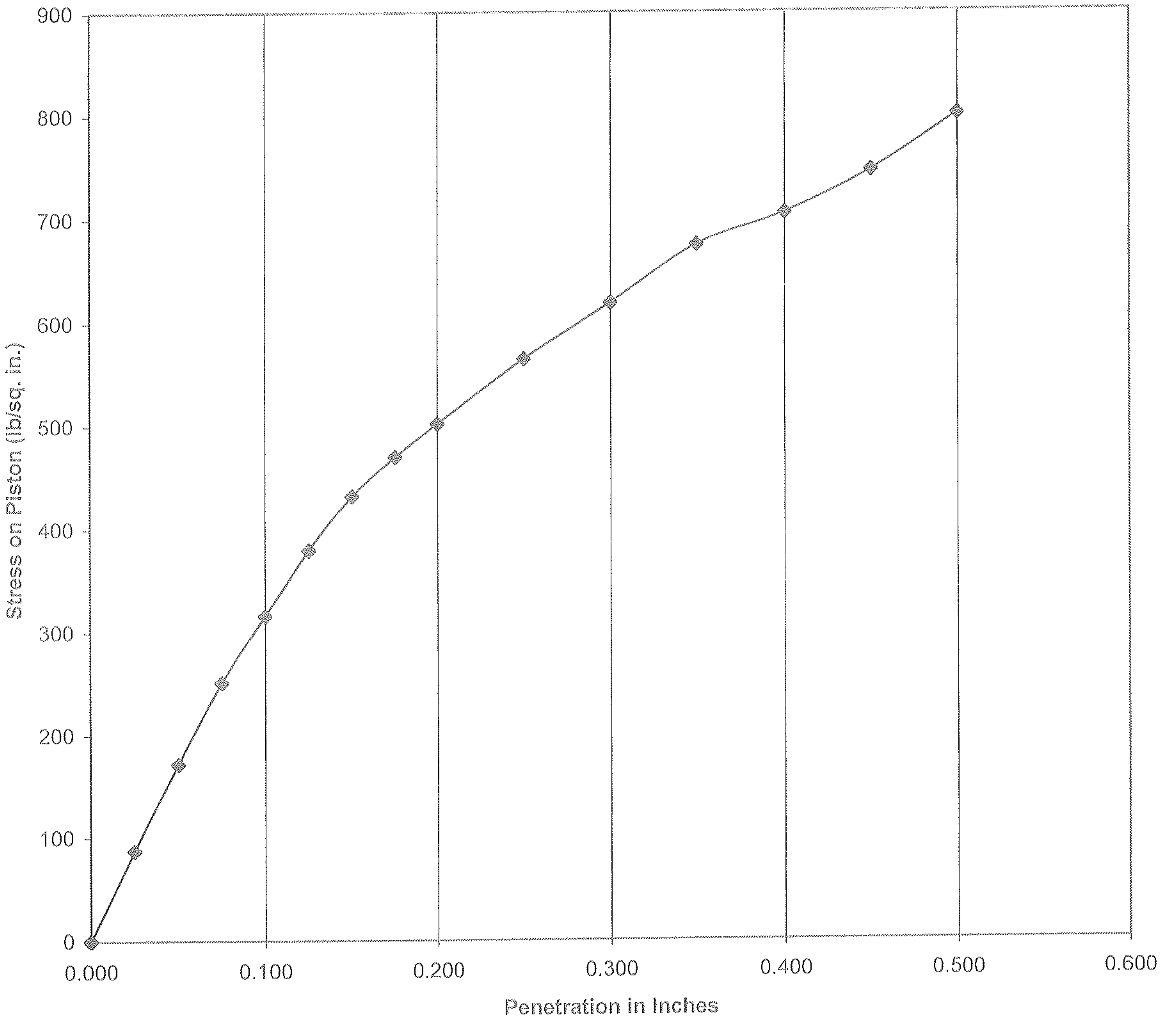
R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio

ASTM D4429



Bearing Ratio at 0.1 inch penetration = 31.6

Test Location:	B-8	Test Depth:	30"

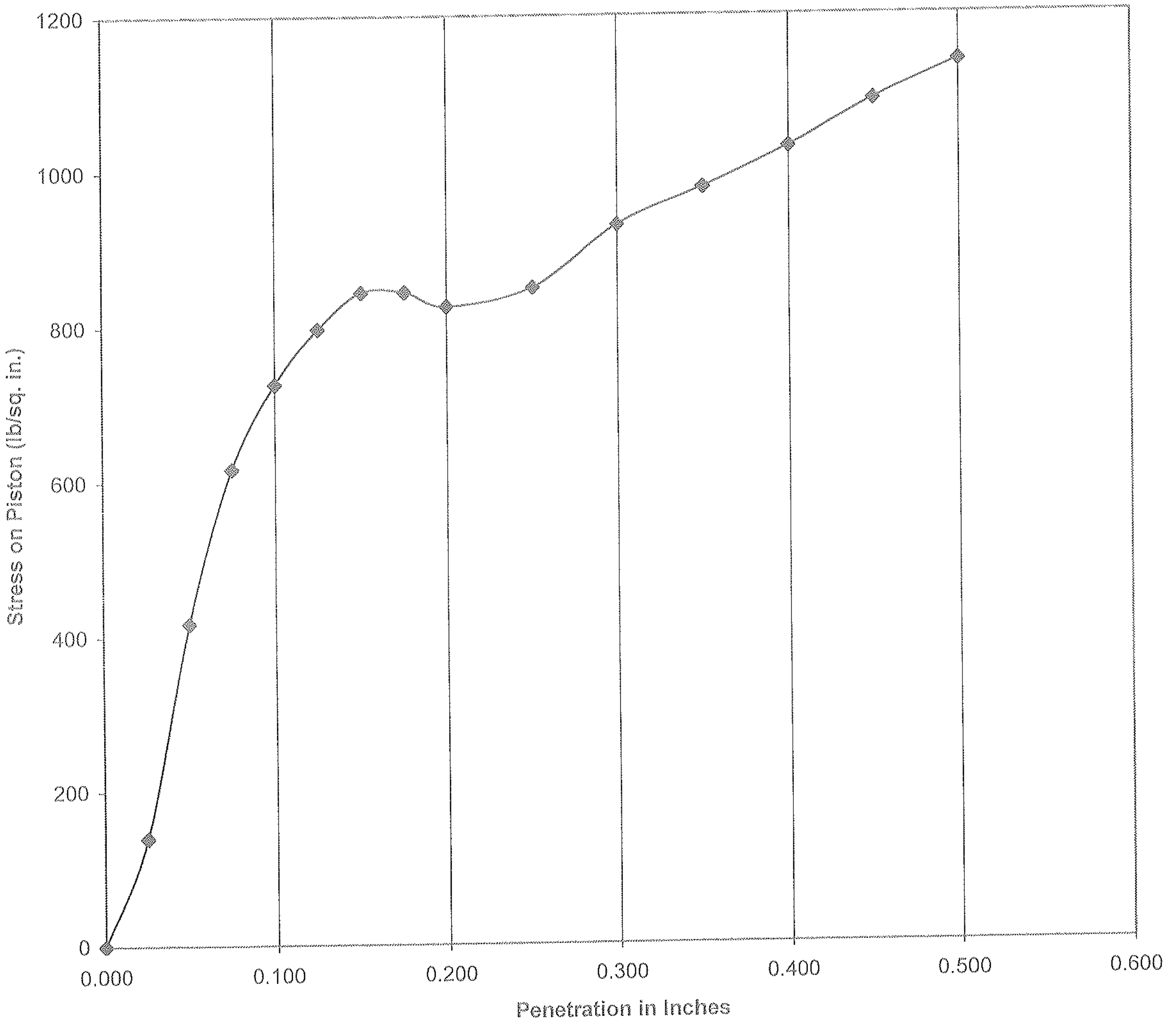
Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01 Client: Airport Solutions Group
Location: New Bedford, MA Date: 18-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 72.6

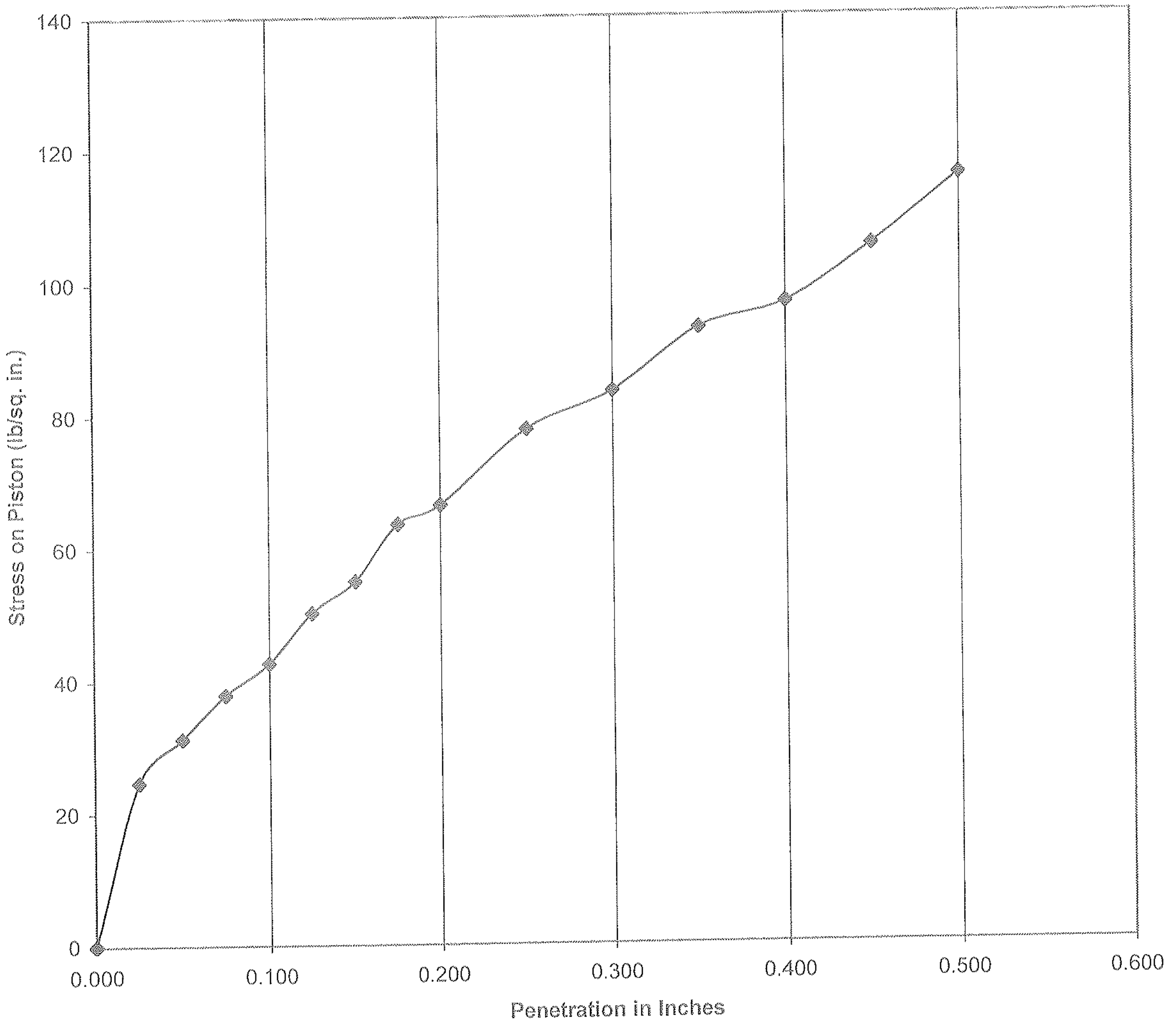
Test Location: B-15 Test Depth: 26"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01 Client: Airport Solutions Group
Location: New Bedford, MA Date: 17-Sep-2009

R. W. Gillespie & Associates
86 Industrial Park Road, Suite 4
Saco, ME 04072
200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio

ASTM D4429



Bearing Ratio at 0.1 inch penetration = **4.3**

Test Location: B-18 Test Depth: 26"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport

RWG&A Project No: 1229-01 Client: Airport Solutions Group

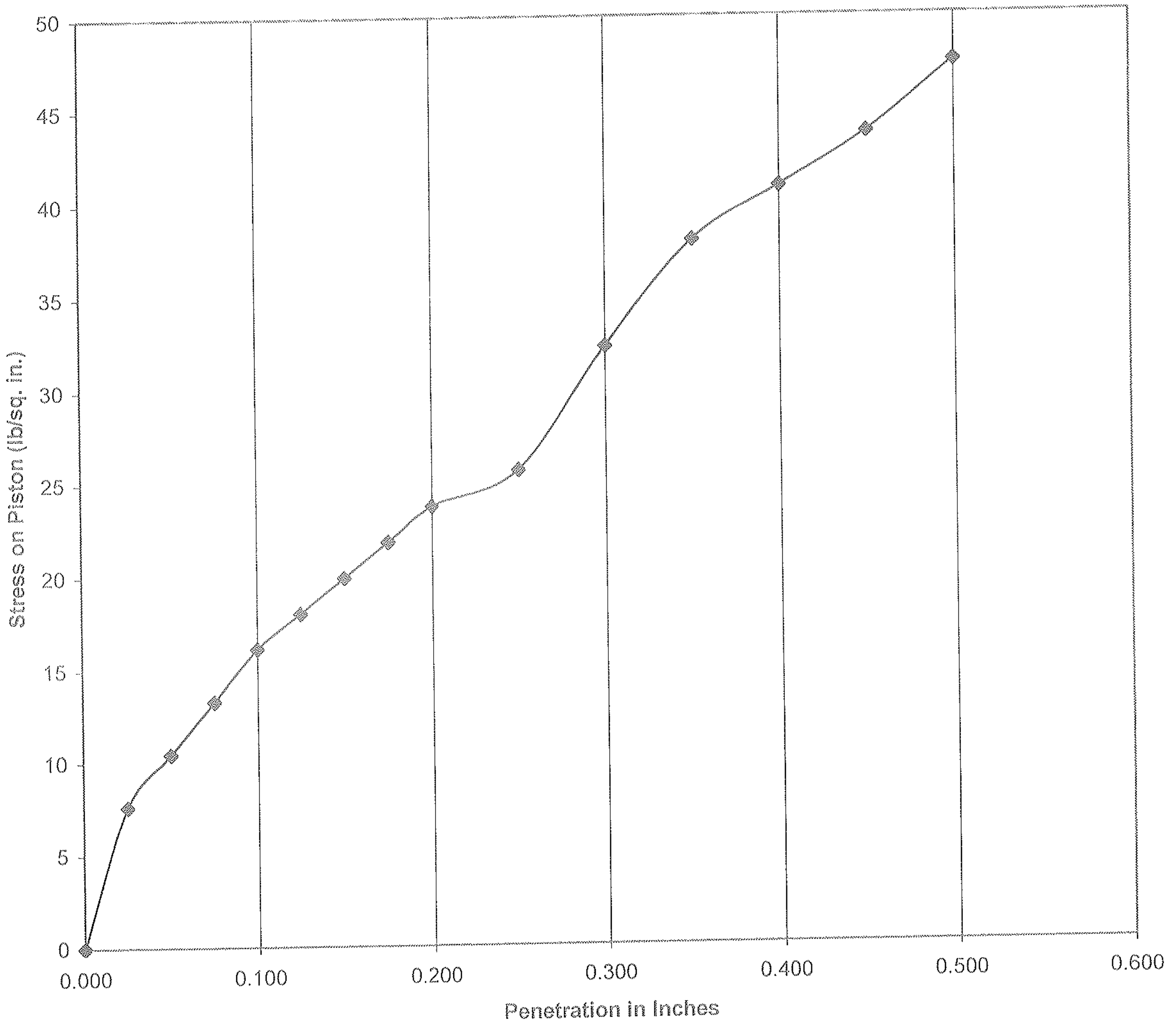
Location: New Bedford, MA Date: 16-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = **1.6**

Test Location:	B-20	Test Depth:	26"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01
Client: Airport Solutions Group
Location: New Bedford, MA
Date: 16-Sep-2009

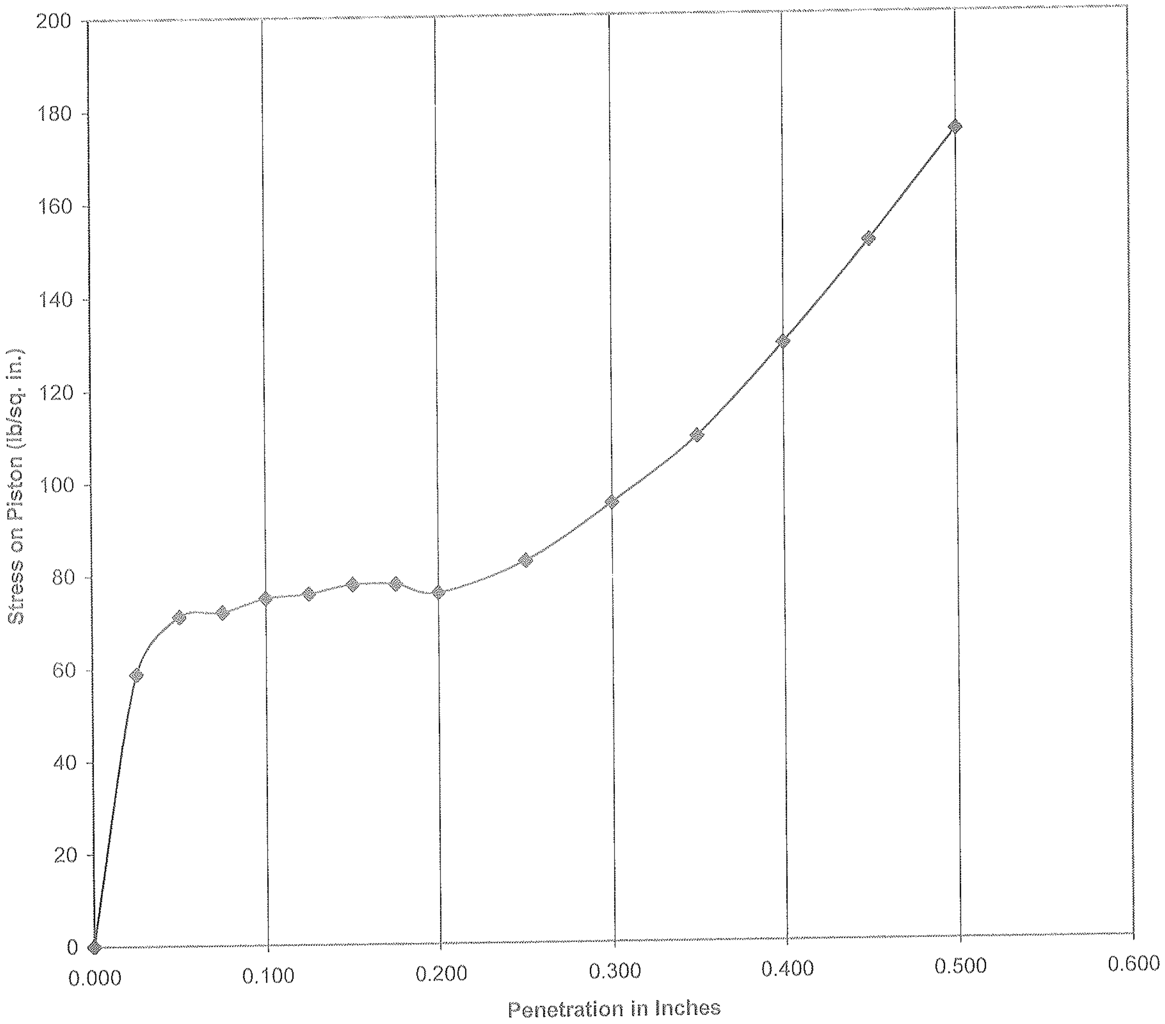
R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio

ASTM D4429



Bearing Ratio at 0.1 inch penetration = 7.5

Test Location:	B-25	Test Depth:	27"

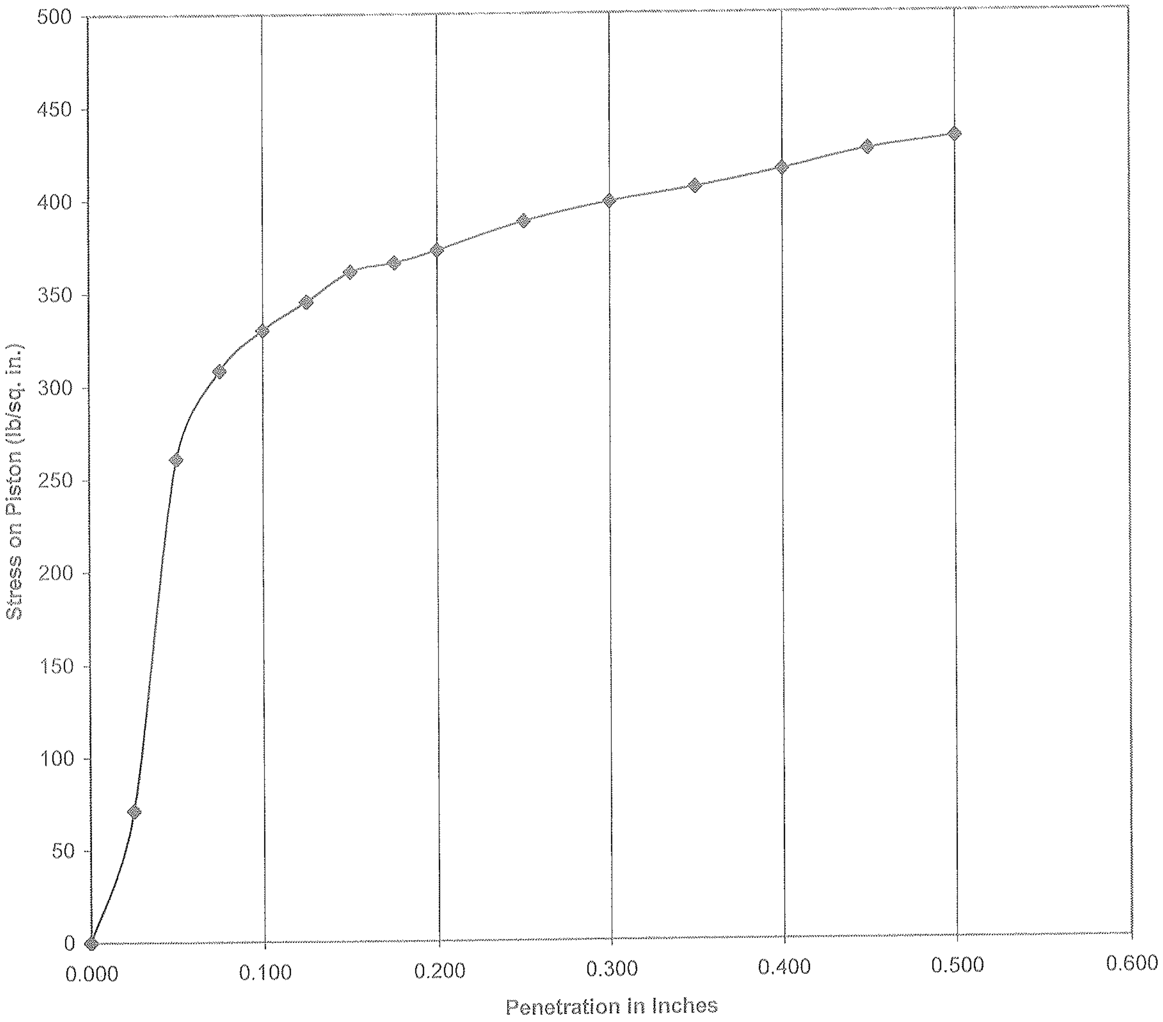
Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01 Client: Airport Solutions Group
Location: New Bedford, MA Date: 16-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 33.0

Test Location:	B-27	Test Depth:	27"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport

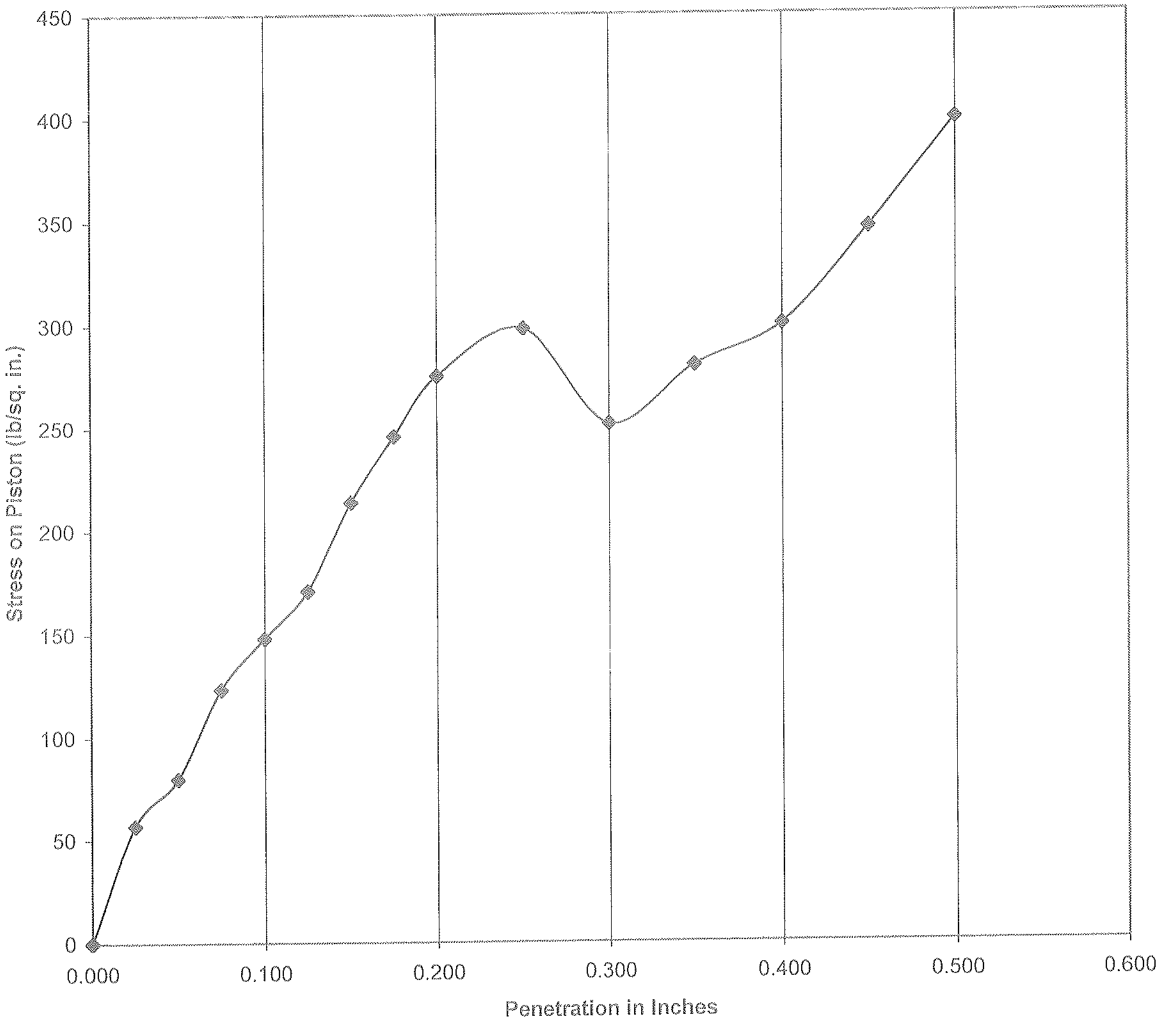
RWG&A Project No:	1229-01	Client:	Airport Solutions Group
Location:	New Bedford, MA	Date:	15-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 14.8

Test Location: B-30
Test Depth: 28"

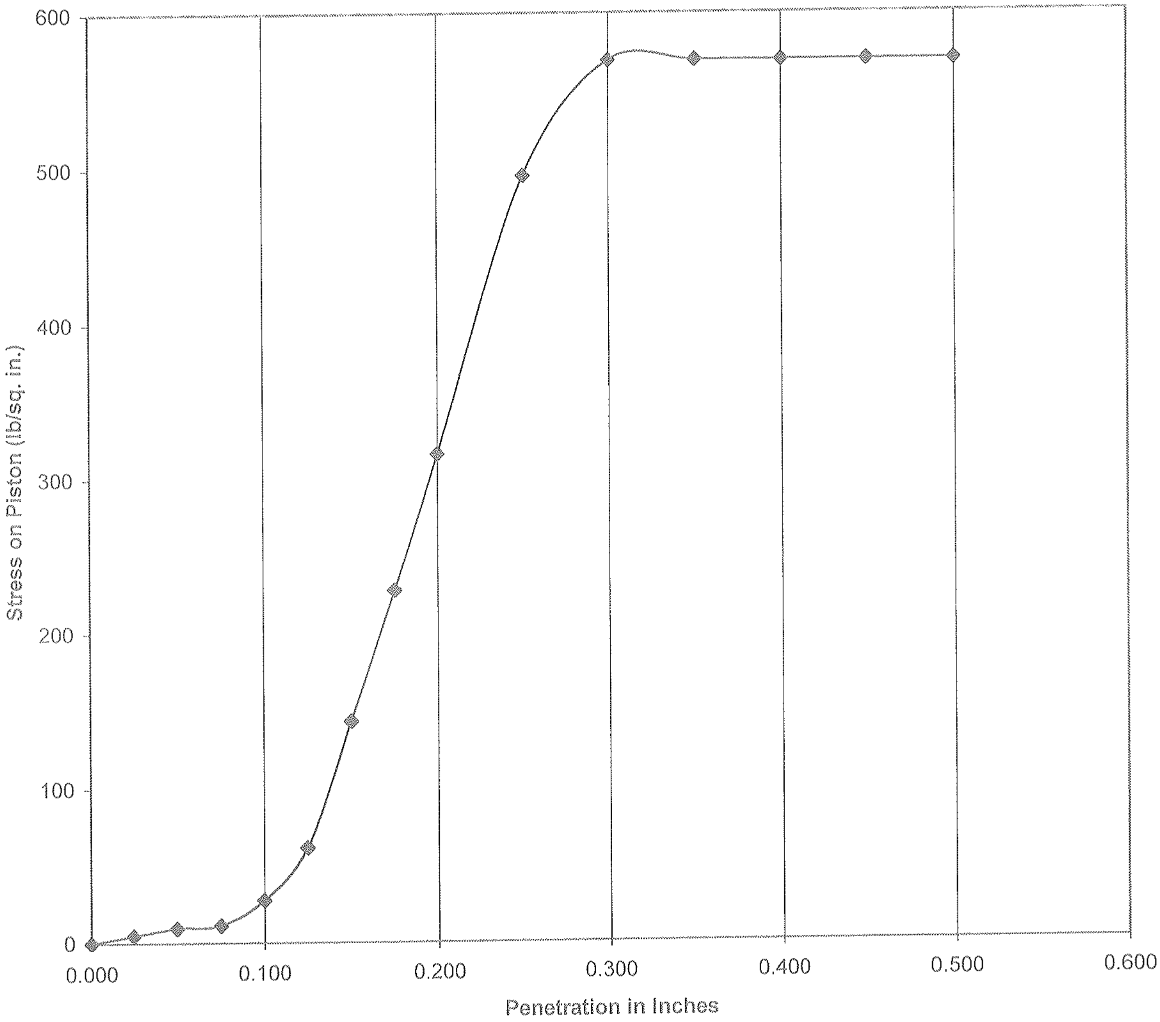
Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01
Client: Airport Solutions Group
Location: New Bedford, MA
Date: 15-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 2.8

Test Location: B-33 Test Depth: 16"

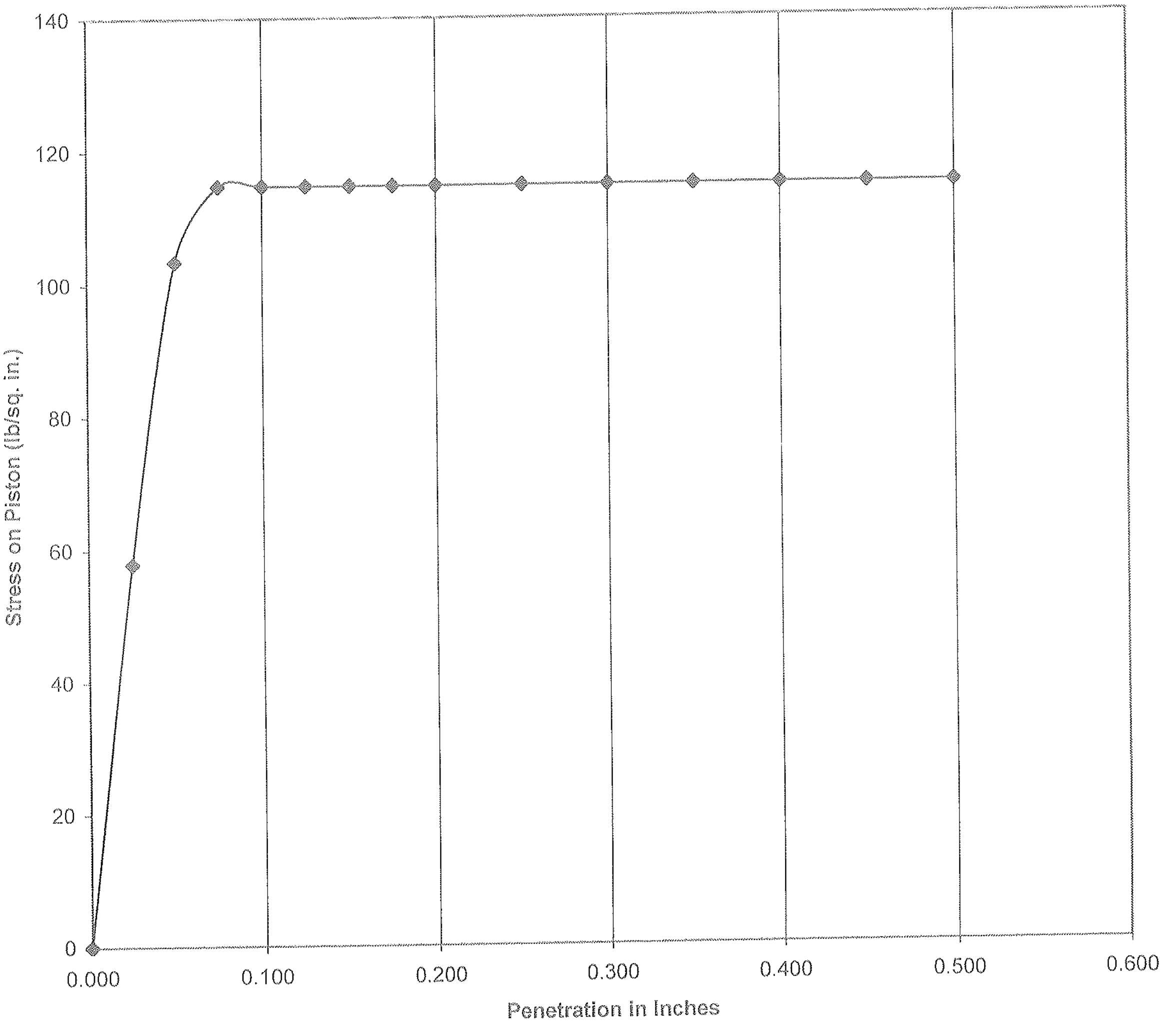
Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01 Client: Airport Solutions Group
Location: New Bedford, MA Date: 15-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 11.5

Test Location: B-35 Test Depth: 24"

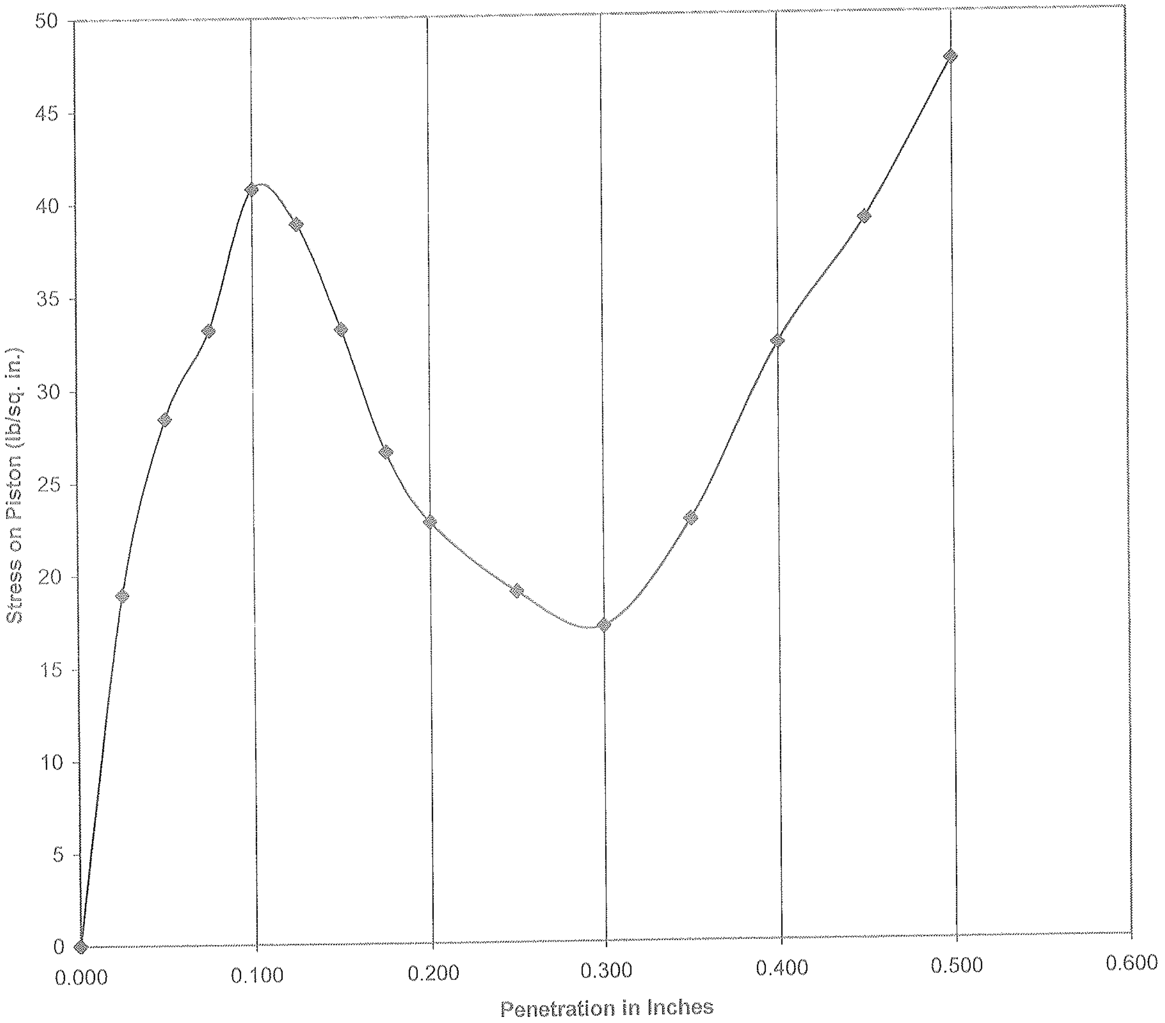
Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport
RWG&A Project No: 1229-01 Client: Airport Solutions Group
Location: New Bedford, MA Date: 14-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = 4.1

Test Location:	TP-1	Test Depth:	27"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport

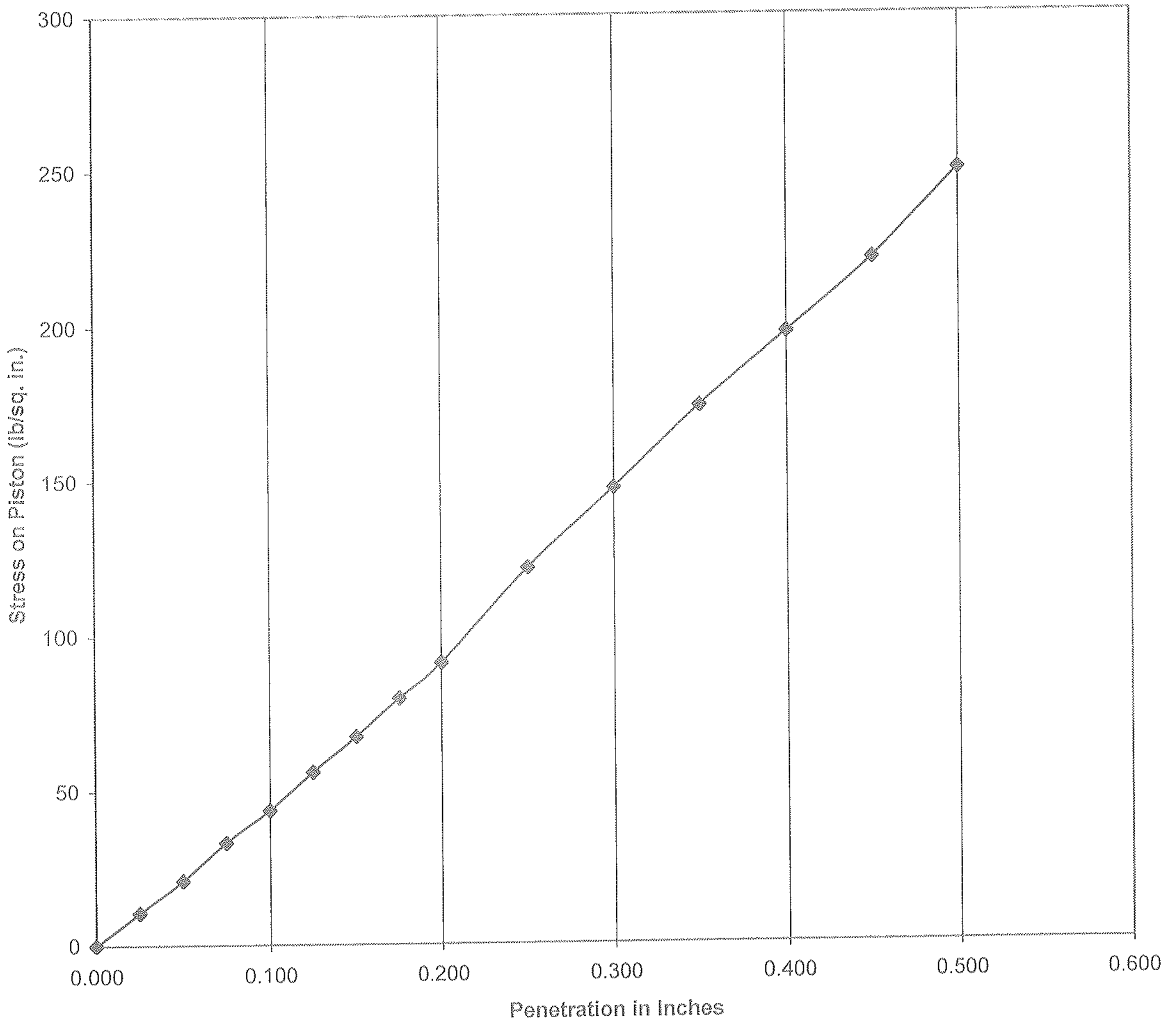
RWG&A Project No:	1229-01	Client:	Airport Solutions Group
Location:	New Bedford, MA	Date:	21-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

Field California Bearing Ratio
ASTM D4429



Bearing Ratio at 0.1 inch penetration = **4.4**

Test Location:	TP-2	Test Depth:	28"

Project: Pavement Rehabilitation Strategies for Ramps - New Bedford Regional Airport

RWG&A Project No:	1229-01	Client:	Airport Solutions Group
Location:	New Bedford, MA	Date:	16-Sep-2009

R. W. Gillespie & Associates

86 Industrial Park Road, Suite 4
Saco, ME 04072

200 International Drive, Suite 170
Portsmouth, NH 03801

APPENDIX D

ASPHALTIC PAVEMENT EXTRACTION/GRADATION TESTS

Pavement Rehabilitation Strategies for Ramps
New Bedford Regional Airport
New Bedford, Massachusetts

RWG&A Project No. 1229-01

17 November 2009

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/20/09 Lab/Location: Belmont, NH

Weather: Date Rec'd #: 9-Oct Random Sample: No

Project: Pavement Rehab.Strategies for Ramps Lab Login #: 99-2279 Lot #:

Contract #: Material ID: B-4 (1.5" Base) Sublot #:

Contractor: Material #: Sample Location:

Pay Item #: Sample #: Station:

Source: New Bedford MA Airport Sample Type: QC Offset:

Plant Type: Sampled By/Cert. #:

Moisture Content (T 110)		**Asphalt Content of HMA by Extraction Method (T 164)**			
Sample Wet Mass (A):		Initial Sample Mass (W_1i):	1790.3	Extracted Agg.+ Pan (W_3p):	2058.0
Sample Dry Mass (B):		Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	1790.3	Pan Tare Mass (P):	248.6
Water Mass (C): (A - B)				Extracted Agg. (W_3): (W_3p-P)	1709.4
% Moisture (M): (100*((A-B)/B))	0	Initial Filter Mass (Fi):	19.3	Total Agg. Mass: ($W_3 + W_4$)	1714.1
		Final Filter Mass (Ff):	21.5	PG Binder Mass (Wpg): ($W_1 - (W_3 + W_4)$)	76.2
Continuous Centrifuge		Fines on Filter (W_4f): (Ff - Fi)	2.2		
Tare Weight of Flask 0.01g	241.51	Ash Correction (W_4a):	2.5	**%PG Binder (Pb):** ((Wpg/W_1)*100)	4.26
End Weight of Flask 0.01g	244.051	Mineral Matter Mass (W_4): ($W_4f + W_4a$)	4.7		
Mineral Matter	2.54			PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)						
Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm	29.4	1.7	**98.3**			
12.5 mm	298.6	17.4	**80.9**			
9.5 mm	232.8	13.6	**67.3**			
4.75 mm	324.5	18.9	**48.4**			
2.36 mm	215.0	12.5	**35.9**			
1.18 mm	148.6	8.7	**27.2**			
600 µm	99.5	5.8	**21.4**			
300 µm	84.8	4.9	**16.5**			
150 µm	78.1	4.6	**11.9**			
75 µm	69.2	4.0	**7.9**			
PAN	133.6	7.9				
TOTAL:	1714.1					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain Reviewed by:

Certification #: 559m Certification #:

Date: 10/20/2009 Date:

Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/21/09 Lab/Location: Belmont, NH
Weather: Date Rec'd #: 9-Oct Random Sample: No
Project: Pavement Rehab.Strategies for Ramps Lab Login #: 99-2280 Lot #:
Contract #: Material ID: B-8 (5" Top & base) Sublot #:
Contractor: Material #: Sample Location:
Pay Item #: Sample #: Station:
Source: New Bedford MA Airport Sample Type: QC Offset:
Plant Type: Sampled By/Cert. #:

Moisture Content (T 110)	
Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0
Continuous Centrifuge	
Tare Weight of Flask 0.01g	240.43
End Weight of Flask 0.01g	249.89
Mineral Matter	9.46

Asphalt Content of HMA by Extraction Method (T 164)			
Initial Sample Mass (W_1i):	4729.6	Extracted Agg.+ Pan (W_3p):	5104.1
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	4729.6	Pan Tare Mass (P):	683.6
		Extracted Agg. (W_3): (W_3p-P)	4420.5
Initial Filter Mass (Fi):	37.7	Total Agg. Mass: (W_3 + W_4)	4434.2
Final Filter Mass (Ff):	41.9	PG Binder Mass (Wpg): (W_1 - (W_3 + W_4))	295.4
Fines on Filter (W_4f): (Ff - Fi)	4.2		
Ash Correction (W_4a):	9.5	**%PG Binder (Pb):** ((Wpg/W_1)*100)	6.25
Mineral Matter Mass (W_4): (W_4f + W_4a)	13.7	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm	37.3	0.8	**99.2**			
12.5 mm	384.3	8.7	**90.5**			
9.5 mm	256.6	5.8	**84.7**			
4.75 mm	724.0	16.3	**68.4**			
2.36 mm	622.4	14.0	**54.4**			
1.18 mm	795.5	17.9	**36.5**			
600 µm	530.6	12.0	**24.5**			
300 µm	383.4	8.6	**15.9**			
150 µm	277.6	6.3	**9.6**			
75 µm	173.3	3.9	**5.7**			
PAN	249.2	5.7				
TOTAL:	4434.2					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain 559m
Certification #: 559m Certification #:
Date: 10/21/2009 Date:
Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

Rev. 02/25/1999 CT MA ME NH RI VT T164

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/21/09 Lab/Location: Belmont, NH
Weather: Date Rec'd #: 9-Oct Random Sample: No
Project: Pavement Rehab.Strategies for Ramps Lab Login #: 99-2281 Lot #:
Contract #: Material ID: B-11 (2.125 Top) Sublot #:
Contractor: Material #: Sample Location:
Pay Item #: Sample #: Station:
Source: New Bedford MA Airport Sample Type: QC Offset:
Plant Type: Sampled By/Cert. #:

Moisture Content (T 110)

Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0

Continuous Centrifuge

Tare Weight of Flask 0.01g	274.96
End Weight of Flask 0.01g	276.478
Mineral Matter	1.52

Asphalt Content of HMA by Extraction Method (T 164)

Initial Sample Mass (W_1i):	2091.1	Extracted Agg.+ Pan (W_3p):	2316.1
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	2091.1	Pan Tare Mass (P):	340.3
		Extracted Agg. (W_3): (W_3p-P)	1975.8
Initial Filter Mass (Fi):	18.7	Total Agg. Mass: ($W_3 + W_4$)	1979.8
Final Filter Mass (Ff):	21.2	PG Binder Mass (Wpg): ($W_1 - (W_3 + W_4)$)	111.3
Fines on Filter (W_4f): (Ff - Fi)	2.5		
Ash Correction (W_4a):	1.5	**%PG Binder (Pb):** ((Wpg/W_1)*100)	5.32
Mineral Matter Mass (W_4): ($W_4f + W_4a$)	4.0	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	Percent Passing	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			100.0			
25 mm			100.0			
19 mm			100.0			
12.5 mm	50.9	2.6	97.4			
9.5 mm	339.9	17.2	80.2			
4.75 mm	437.1	22.1	58.1			
2.36 mm	268.1	13.5	44.6			
1.18 mm	308.9	15.6	29.0			
600 µm	179.4	9.1	19.9			
300 µm	114.4	5.8	14.1			
150 µm	93.5	4.7	9.4			
75 µm	73.6	3.7	5.7			
PAN	114.0	5.7				
TOTAL:	1979.8					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain Reviewed by:
Certification #: 559m Certification #:
Date: 10/21/2009 Date:
Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/20/09	Lab/Location: Belmont, NH	
Weather:	Date Rec'd #: 9-Oct	Random Sample: No
Project: Pavement Rehab.Strategies for Ramps	Lab Login #: 99-2282	Lot #:
Contract #:	Material ID: B 11 (2.125" base)	Sublot #:
Contractor:	Material #:	Sample Location:
Pay Item #:	Sample #:	Station:
Source: New Bedford MA Airport	Sample Type: QC	Offset:
Plant Type:	Sampled By/Cert. #:	

Moisture Content (T 110)	
Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0
Continuous Centrifuge	
Tare Weight of Flask 0.01g	240.415
End Weight of Flask 0.01g	242.47
Mineral Matter	2.06

Asphalt Content of HMA by Extraction Method (T 164)			
Initial Sample Mass (W_1i):	2103.3	Extracted Agg.+ Pan (W_3p):	2335.1
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	2103.3	Pan Tare Mass (P):	347.5
		Extracted Agg. (W_3): (W_3p-P)	1987.6
Initial Filter Mass (Fi):	20.2	Total Agg. Mass: (W_3 + W_4)	1991.3
Final Filter Mass (Ff):	21.8	PG Binder Mass (Wpg): (W_1 - (W_3 + W_4))	112.0
Fines on Filter (W_4f): (Ff - Fi)	1.6		
Ash Correction (W_4a):	2.1	**%PG Binder (Pb):** ((Wpg/W_1)*100)	5.32
Mineral Matter Mass (W_4): (W_4f + W_4a)	3.7	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	Percent Passing	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm			**100.0**			
12.5 mm	78.6	3.9	**96.1**			
9.5 mm	288.8	14.5	**81.6**			
4.75 mm	447.9	22.5	**59.1**			
2.36 mm	231.9	11.6	**47.5**			
1.18 mm	294.9	14.8	**32.7**			
600 µm	186.7	9.4	**23.3**			
300 µm	134.3	6.7	**16.6**			
150 µm	113.8	5.7	**10.9**			
75 µm	83.9	4.2	**6.7**			
PAN	130.5	6.7				
TOTAL:	1991.3					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain

Reviewed by:

Certification #: 559m

Certification #:

Date: 10/20/2009

Date:

Results Within Specification Limits: ☐

Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/21/09	Lab/Location: Belmont, NH	
Weather:	Date Rec'd #: 9-Oct	Random Sample: No
Project: Pavement Rehab.Strategies for Ramps	Lab Login #: 99-2283	Lot #:
Contract #:	Material ID: B-18 (2.125 Top)	Sublot #:
Contractor:	Material #:	Sample Location:
Pay Item #:	Sample #:	Station:
Source: New Bedford MA Airport	Sample Type: QC	Offset:
Plant Type:	Sampled By/Cert. #:	

Moisture Content (T 110)	
Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0
Continuous Centrifuge	
Tare Weight of Flask 0.01g	240.427
End Weight of Flask 0.01g	243.646
Mineral Matter	3.22

Asphalt Content of HMA by Extraction Method (T 164)			
Initial Sample Mass (W_1i):	2119.7	Extracted Agg.+ Pan (W_3p):	2335.8
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	2119.7	Pan Tare Mass (P):	338.3
		Extracted Agg. (W_3): (W_3p-P)	1997.5
Initial Filter Mass (Fi):	18.7	Total Agg. Mass: ($W_3 + W_4$)	2003.0
Final Filter Mass (Ff):	21.0	PG Binder Mass (Wpg): (W_1 - ($W_3 + W_4$))	116.7
Fines on Filter (W_4f): (Ff - Fi)	2.3		
Ash Correction (W_4a):	3.2	**%PG Binder (Pb):** ((Wpg/W_1)*100)	5.51
Mineral Matter Mass (W_4): ($W_4f + W_4a$)	5.5	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm	24.6	1.2	**98.8**			
12.5 mm	110.5	5.5	**93.3**			
9.5 mm	301.3	15.0	**78.3**			
4.75 mm	483.7	24.1	**54.2**			
2.36 mm	247.3	12.3	**41.9**			
1.18 mm	242.4	12.1	**29.8**			
600 µm	159.2	7.9	**21.9**			
300 µm	122.3	6.1	**15.8**			
150 µm	111.5	5.6	**10.2**			
75 µm	82.7	4.1	**6.1**			
PAN	117.5	6.1				
TOTAL:	2003.0					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain	Reviewed by:
Certification #: 559m	Certification #:
Date: 10/21/2009	Date:

Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/21/09	Lab/Location: Belmont, NH	
Weather:	Date Rec'd #: 9-Oct	Random Sample: No
Project: Pavement Rehab.Strategies for Ramps	Lab Login #: 99-2284	Lot #:
Contract #:	Material ID: B-18 (2.375 Base)	Sublot #:
Contractor:	Material #:	Sample Location:
Pay Item #:	Sample #:	Station:
Source: New Bedford MA Airport	Sample Type: QC	Offset:
Plant Type:	Sampled By/Cert. #:	

Moisture Content (T 110)		Asphalt Content of HMA by Extraction Method (T 164)			
Sample Wet Mass (A):		Initial Sample Mass (W_1i):	2258.4	Extracted Agg.+ Pan (W_3p):	2477.6
Sample Dry Mass (B):		Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	2258.4	Pan Tare Mass (P):	342.6
Water Mass (C): (A - B)				Extracted Agg. (W_3): (W_3p-P)	2135.0
% Moisture (M): (100*((A-B)/B))	0	Initial Filter Mass (Fi):	18.7	Total Agg. Mass: (W_3 + W_4)	2138.6
		Final Filter Mass (Ff):	20.6	PG Binder Mass (Wpg): (W_1 - (W_3 + W_4))	119.8
Continuous Centrifuge		Fines on Filter (W_4f): (Ff - Fi)	1.9		
Tare Weight of Flask 0.01g	240.414	Ash Correction (W_4a):	1.7	**%PG Binder (Pb):** ((Wpg/W_1)*100)	5.30
End Weight of Flask 0.01g	242.118	Mineral Matter Mass (W_4): (W_4f + W_4a)	3.6		
Mineral Matter	1.70			PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm	37.0	1.7	**98.3**			
12.5 mm	191.2	8.9	**89.4**			
9.5 mm	211.1	9.9	**79.5**			
4.75 mm	408.5	19.1	**60.4**			
2.36 mm	286.2	13.4	**47.0**			
1.18 mm	332.6	15.6	**31.4**			
600 μm	198.6	9.3	**22.1**			
300 μm	136.3	6.4	**15.7**			
150 μm	121.4	5.7	**10.0**			
75 μm	93.4	4.4	**5.6**			
PAN	122.3	5.7				
TOTAL:	2138.6					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain	559m
Certification #: 559m	Certification #:
Date: 10/21/2009	Date:

Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/20/09
Lab/Location: Belmont, NH
Weather:
Date Rec'd #: 9-Oct
Random Sample: No
Project: Pavement Rehab.Strategies for Ramps
Lab Login #: 99-2285
Lot #:
Contract #:
Material ID: B-21 (3" Base)
Sublot #:
Contractor:
Material #:
Sample Location:
Pay Item #:
Sample #:
Station:
Source: New Bedford MA Airport
Sample Type: QC
Offset:
Plant Type:
Sampled By/Cert. #:

Moisture Content (T 110)	
Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0

Continuous Centrifuge	
Tare Weight of Flask 0.01g	240.447
End Weight of Flask 0.01g	242.991
Mineral Matter	2.54

Asphalt Content of HMA by Extraction Method (T 164)			
Initial Sample Mass (W_1i):	2344.2	Extracted Agg.+ Pan (W_3p):	2618.3
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	2344.2	Pan Tare Mass (P):	342.5
		Extracted Agg. (W_3): (W_3p-P)	2275.8
Initial Filter Mass (Fi):	18.9	Total Agg. Mass: (W_3 + W_4)	2280.3
Final Filter Mass (Ff):	20.9	PG Binder Mass (Wpg): (W_1 - (W_3 + W_4))	63.9
Fines on Filter (W_4f): (Ff - Fi)	2.0		
Ash Correction (W_4a):	2.5	**%PG Binder (Pb):** ((Wpg/W_1)*100)	2.73
Mineral Matter Mass (W_4): (W_4f + W_4a)	4.5	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+/- Tolerance	Variance
31.5 mm	223.8	9.8	**90.2**			
25 mm	41.9	1.8	**88.4**			
19 mm	323.2	14.2	**74.2**			
12.5 mm	219.6	9.6	**64.6**			
9.5 mm	61.6	2.7	**61.9**			
4.75 mm	169.8	7.4	**54.5**			
2.36 mm	208.5	9.1	**45.4**			
1.18 mm	293.1	12.9	**32.5**			
600 µm	248.5	10.9	**21.6**			
300 µm	216.5	9.5	**12.1**			
150 µm	136.9	6.0	**6.1**			
75 µm	47.0	2.1	**4.0**			
PAN	89.9	4.0				
TOTAL:	2280.3					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain
Reviewed by:
Certification #: 559m
Certification #:
Date: 10/20/2009
Date:

Results Within Specification Limits: ☐
Results Outside Specification Limits: ☐

Rev. 02/25/1999

CT MA ME NH RI VT

T164

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/21/09	Lab/Location: Belmont, NH	
Weather:	Date Rec'd #: 9-Oct	Random Sample: No
Project: Pavement Rehab.Strategies for Ramps	Lab Login #: 99-2286	Lot #:
Contract #:	Material ID: B-26 (2.125 Top & Base)	Sublot #:
Contractor:	Material #:	Sample Location:
Pay Item #:	Sample #:	Station:
Source: New Bedford MA Airport	Sample Type: QC	Offset:
Plant Type:	Sampled By/Cert. #:	

Moisture Content (T 110)

Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0

Continuous Centrifuge

Tare Weight of Flask 0.01g	241.536
End Weight of Flask 0.01g	243.404
Mineral Matter	1.87

Asphalt Content of HMA by Extraction Method (T 164)

Initial Sample Mass (W_1i):	2325.4	Extracted Agg.+ Pan (W_3p):	2547.4
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	2325.4	Pan Tare Mass (P):	352.2
		Extracted Agg. (W_3): (W_3p-P)	2195.2
Initial Filter Mass (Fi):	18.9	Total Agg. Mass: ($W_3 + W_4$)	2198.9
Final Filter Mass (Ff):	20.7	PG Binder Mass (Wpg): (W_1 - ($W_3 + W_4$))	126.5
Fines on Filter (W_4f): (Ff - Fi)	1.8		
Ash Correction (W_4a):	1.9	**%PG Binder (Pb):** ((Wpg/W_1)*100)	5.44
Mineral Matter Mass (W_4): ($W_4f + W_4a$)	3.7	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	Percent Passing	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			100.0			
25 mm			100.0			
19 mm			100.0			
12.5 mm	87.3	4.0	96.0			
9.5 mm	218.3	9.9	86.1			
4.75 mm	683.3	31.1	55.0			
2.36 mm	319.0	14.5	40.5			
1.18 mm	258.8	11.8	28.7			
600 µm	176.4	8.0	20.7			
300 µm	141.3	6.4	14.3			
150 µm	123.1	5.6	8.7			
75 µm	78.9	3.6	5.1			
PAN	112.5	5.1				
TOTAL:	2198.9					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain

Reviewed by:

Certification #: 559m

Certification #:

Date: 10/21/2009

Date:

Results Within Specification Limits: ☐

Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/21/09 Lab/Location: Belmont, NH
Weather: Date Rec'd #: 9-Oct Random Sample: No
Project: Pavement Rehab.Strategies for Ramps Lab Login #: 99-2287 Lot #:
Contract #: Material ID: B-30 (1.75 Top) Sublot #:
Contractor: Material #: Sample Location:
Pay Item #: Sample #: Station:
Source: New Bedford MA Airport Sample Type: QC Offset:
Plant Type: Sampled By/Cert. #:

Moisture Content (T 110)		**Asphalt Content of HMA by Extraction Method (T 164)**			
Sample Wet Mass (A):		Initial Sample Mass (W_1i):	1741.1	Extracted Agg.+ Pan (W_3p):	1970.4
Sample Dry Mass (B):		Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	1741.1	Pan Tare Mass (P):	347.3
Water Mass (C): (A - B)				Extracted Agg. (W_3): (W_3p-P)	1623.1
% Moisture (M): (100*((A-B)/B))	0	Initial Filter Mass (Fi):	19.0	Total Agg. Mass: (W_3 + W_4)	1639.4
		Final Filter Mass (Ff):	21.8	PG Binder Mass (Wpg): (W_1 - (W_3 + W_4))	101.7
Continuous Centrifuge		Fines on Filter (W_4f): (Ff - Fi)	2.8		
Tare Weight of Flask 0.01g	241.542	Ash Correction (W_4a):	13.5	**%PG Binder (Pb):** ((Wpg/W_1)*100)	5.84
End Weight of Flask 0.01g	255.02	Mineral Matter Mass (W_4): (W_4f + W_4a)	16.3		
Mineral Matter	13.48			PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+/- Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm			**100.0**			
12.5 mm	168.9	10.3	**89.7**			
9.5 mm	283.5	17.3	**72.4**			
4.75 mm	292.2	17.8	**54.6**			
2.36 mm	148.7	9.1	**45.5**			
1.18 mm	138.5	8.4	**37.1**			
600 µm	177.0	10.8	**26.3**			
300 µm	203.0	12.4	**13.9**			
150 µm	96.6	5.9	**8.0**			
75 µm	37.6	2.3	**5.7**			
PAN	93.4	5.7				
TOTAL:	1639.4					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain Reviewed by:
Certification #: 559m Certification #:
Date: 10/21/2009 Date:
Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

Rev. 02/25/1999 CT MA ME NH RI VT T164

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/20/09
Lab/Location: Belmont, NH
Weather:
Date Rec'd #: 9-Oct
Random Sample: No
Project: Pavement Rehab.Strategies for Ramps
Lab Login #: 99-2288
Lot #:
Contract #:
Material ID: B30 (2" Base)
Sublot #:
Contractor:
Material #:
Sample Location:
Pay Item #:
Sample #:
Station:
Source: New Bedford MA Airport
Sample Type: QC
Offset:
Plant Type:
Sampled By/Cert. #:

Moisture Content (T 110)

Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0

Continuous Centrifuge

Tare Weight of Flask 0.01g	274.968
End Weight of Flask 0.01g	285.404
Mineral Matter	10.44

Asphalt Content of HMA by Extraction Method (T 164)

Initial Sample Mass (W_1i):	1724.6	Extracted Agg.+ Pan (W_3p):	1948.0
Corrected Sample Mass (W_1): ($W_1i / (1+(.01*M))$)	1724.6	Pan Tare Mass (P):	342.7
		Extracted Agg. (W_3): (W_3p-P)	1605.3
Initial Filter Mass (Fi):	19.3	Total Agg. Mass: ($W_3 + W_4$)	1618.8
Final Filter Mass (Ff):	22.4	PG Binder Mass (Wpg): ($W_1 - (W_3 + W_4)$)	105.8
Fines on Filter (W_4f): (Ff - Fi)	3.1		
Ash Correction (W_4a):	10.4	**%PG Binder (Pb):** ((Wpg/W_1)*100)	6.13
Mineral Matter Mass (W_4): ($W_4f + W_4a$)	13.5	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm			**100.0**			
12.5 mm	139.6	8.6	**91.4**			
9.5 mm	260.0	16.1	**75.3**			
4.75 mm	314.6	19.4	**55.9**			
2.36 mm	159.4	9.8	**46.1**			
1.18 mm	144.6	8.9	**37.2**			
600 μm	166.7	10.3	**26.9**			
300 μm	173.2	10.7	**16.2**			
150 μm	101.5	6.3	**9.9**			
75 μm	51.5	3.2	**6.7**			
PAN	107.7	6.7				
TOTAL:	1618.8					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain
Reviewed by:
Certification #: 559m
Certification #:
Date: 10/20/2009
Date:

Results Within Specification Limits: ☐
Results Outside Specification Limits: ☐

Rev. 02/25/1999

CT MA ME NH RI VT

T164

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/20/09
Lab/Location: Belmont, NH
Weather:
Date Rec'd #: 9-Oct
Random Sample: No
Project: Pavement Rehab.Strategies for Ramps
Lab Login #: 99-2289
Lot #:
Contract #:
Material ID: B32 (1.625 Base)
Sublot #:
Contractor:
Material #:
Sample Location:
Pay Item #:
Sample #:
Station:
Source: New Bedford MA Airport
Sample Type: QC
Offset:
Plant Type:
Sampled By/Cert. #:

Moisture Content (T 110)

Sample Wet Mass (A):	
Sample Dry Mass (B):	
Water Mass (C): (A - B)	
% Moisture (M): (100*((A-B)/B))	0
Continuous Centrifuge	
Tare Weight of Flask 0.01g	274.957
End Weight of Flask 0.01g	277.981
Mineral Matter	3.02

Asphalt Content of HMA by Extraction Method (T 164)

Initial Sample Mass (W_1i):	1544.7	Extracted Agg.+ Pan (W_3p):	1821.6
Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	1544.7	Pan Tare Mass (P):	351.0
		Extracted Agg. (W_3): (W_3p-P)	1470.6
Initial Filter Mass (Fi):	18.7	Total Agg. Mass: ($W_3 + W_4$)	1476.4
Final Filter Mass (Ff):	21.5	PG Binder Mass (Wpg): ($W_1 - (W_3 + W_4)$)	68.3
Fines on Filter (W_4f): (Ff - Fi)	2.8		
Ash Correction (W_4a):	3.0	**%PG Binder (Pb):** ((Wpg/W_1)*100)	4.42
Mineral Matter Mass (W_4): ($W_4f + W_4a$)	5.8	PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm	83.7	5.7	**94.3**			
12.5 mm	239.0	16.2	**78.1**			
9.5 mm	196.1	13.3	**64.8**			
4.75 mm	222.1	15.0	**49.8**			
2.36 mm	157.1	10.6	**39.2**			
1.18 mm	117.4	8.0	**31.2**			
600 µm	107.8	7.3	**23.9**			
300 µm	123.3	8.4	**15.5**			
150 µm	94.2	6.4	**9.1**			
75 µm	45.7	3.1	**6.0**			
PAN	90.0	6.0				
TOTAL:	1476.4					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain
Reviewed by:
Certification #: 559m
Certification #:
Date: 10/20/2009
Date:

Results Within Specification Limits: ☐
Results Outside Specification Limits: ☐

New England Transportation Technician Certification Program

HMA Asphalt Content and Gradation Test Report (T 110, T 164, T 30)

Date/Time: 10/20/09 Lab/Location: Belmont, NH

Weather: Date Rec'd #: 9-Oct Random Sample: No

Project: Pavement Rehab.Strategies for Ramps Lab Login #: 99-2290 Lot #:

Contract #: Material ID: B-35 (1" Base) Sublot #:

Contractor: Material #: Sample Location:

Pay Item #: Sample #: Station:

Source: New Bedford MA Airport Sample Type: QC Offset:

Plant Type: Sampled By/Cert. #:

Moisture Content (T 110)		**Asphalt Content of HMA by Extraction Method (T 164)**			
Sample Wet Mass (A):		Initial Sample Mass (W_1i):	1059.9	Extracted Agg.+ Pan (W_3p):	1361.3
Sample Dry Mass (B):		Corrected Sample Mass (W_1): (W_1i / (1+(.01*M)))	1059.9	Pan Tare Mass (P):	351.2
Water Mass (C): (A - B)				Extracted Agg. (W_3): (W_3p-P)	1010.1
% Moisture (M): (100*((A-B)/B))	0	Initial Filter Mass (Fi):	19.1	Total Agg. Mass: ($W_3 + W_4$)	1013.6
		Final Filter Mass (Ff):	21.7	PG Binder Mass (Wpg): ($W_1 - (W_3 + W_4)$)	46.3
Continuous Centrifuge		Fines on Filter (W_4f): (Ff - Fi)	2.6		
Tare Weight of Flask 0.01g	241.531	Ash Correction (W_4a):	0.9	**%PG Binder (Pb):** ((Wpg/W_1)*100)	4.37
End Weight of Flask 0.01g	242.393	Mineral Matter Mass (W_4): ($W_4f + W_4a$)	3.5		
Mineral Matter	0.86			PG Binder JMF:	

Mechanical Analysis of Extracted Aggregate (T 30)

Sieve	Mass Retained	Percent Retained	**Percent Passing**	Job Mix Formula	+ / - Tolerance	Variance
37.5 mm			**100.0**			
25 mm			**100.0**			
19 mm	24.0	2.4	**97.6**			
12.5 mm	298.4	29.4	**68.2**			
9.5 mm	126.8	12.5	**55.7**			
4.75 mm	106.1	10.5	**45.2**			
2.36 mm	79.9	7.9	**37.3**			
1.18 mm	88.2	8.7	**28.6**			
600 µm	59.8	5.9	**22.7**			
300 µm	57.0	5.6	**17.1**			
150 µm	51.8	5.1	**12.0**			
75 µm	41.9	4.1	**7.9**			
PAN	79.7	7.9				
TOTAL:	1013.6					

Comments:

☑ Washed Gradation

Tested by: DB Chamberlain Reviewed by:

Certification #: 559m Certification #:

Date: 10/20/2009 Date:

Results Within Specification Limits: ☐ Results Outside Specification Limits: ☐

STORMWATER OPERATIONS AND MAINTENANCE PLAN

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NEW BEDFORD REGIONAL AIRPORT
NEW BEDFORD, MASSACHUSETTS

STORMWATER MANAGEMENT SYSTEM OPERATION AND MAINTENANCE PLAN

City of New Bedford

OCTOBER 2016

Prepared For:

City of New Bedford Airport Commission
1569 Airport Road
New Bedford, Massachusetts

Prepared By:

Airport Solutions Group
39 Winn Street
Burlington, Massachusetts
(P) 780.491.0083

Table of Contents

1. Introduction

The New Bedford Regional Airport, owned and operated by the City of New Bedford through the New Bedford Airport Commission, is located in southeastern Massachusetts approximately fifty-five miles south of Boston. The airport just completed a multiphase project to improve the safety of Runway 5-23, its main runway. Included in that project was the rebuilding of the existing stormwater management system associated with Runway 5-23. The Airport recently reconstructed Taxiway A (the Airport's main parallel taxiway) which included a closed drainage system to capture and treat stormwater runoff before it is discharged into the existing drainage system and also reused existing outfalls to drain the taxiway. The Operation and Maintenance Plan was updated during the design process for Taxiway A. The Plan is being updated again as a result of another Airport project. The Airport wishes to reconstruct the Terminal Area Aprons that serve the Airport's FBO's and Terminal Building and as part of this project new stormwater BMPs will be constructed.

Pursuant to New Bedford Regional Airport Massachusetts Department of Environmental Protection (MassDEP) Wetland Variance Decision / Order of Conditions (DEP file no: SE-049-0635) and Stormwater Standard No. 9 of the MassDEP's Stormwater Management Policy, with any new development or redevelopment, "a Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function by design." Moreover, Special Condition 58 of the Variance requires the following:

> *Post Construction Stormwater Operation and Maintenance Plan: A written operation and maintenance plan (O/M Plan) shall be submitted by Applicant to MassDEP for its review and written approval for all post construction man-made stormwater structures including, but not limited to, extended detention basins, water quality swales, deep sump catch basins, pipes, and outlets. Said O/M Plan shall include a schedule for implementation and shall be provided to the Commission for review and to MassDEP for review and written approval at least ninety (90) days prior to disturbance of any Resource Area or BZ*

The airport, and any future responsible parties, shall be accountable for implementing this plan following the completion of the project's construction and the termination of the contractor's interim Storm Water Pollution Prevention Plan (SWPPP) per the National Pollutant Discharge Elimination System (NPDES) General Permit.

2. Purpose and Need

This document prescribes the methods required for the New Bedford Regional Airport to properly maintain the airport-wide stormwater management system. A program of regular stormwater drainage system field reviews and assessments, scheduled maintenance and repairs, as-needed, will be necessary. The program will be conducted by trained airport staff and/or licensed contractors, as required, familiar with the airport facility.

Included in this document is a list of Best Management Practices (BMP's) incorporated into the design of the stormwater management system, a summary of requirements and procedures for reviewing the BMP's, and a drainage system review checklist. It is understood that documentation of routine and non-routine maintenance of the system is not only required by the Massachusetts Stormwater Regulations, but is an important tool for the airport to access future maintenance requirements and improvements.

3. Stormwater Management System Owner

The New Bedford Regional Airport is publicly owned by the City of New Bedford, Massachusetts under the care, custody, and control of the New Bedford Airport Commission. The Airport Commission currently appoints a full time Airport Manager who is responsible for the management and operation of the airport.

New Bedford Regional Airport Commission
1569 Airport Road
New Bedford, MA 02746
Phone: 508.991.6161

Airport Manager
New Bedford Regional Airport
1569 Airport Road
New Bedford, MA 02746

4. Parties Responsible for Operation and Maintenance

The New Bedford Regional Airport is under the direct authority of the airport manager and the policies of the New Bedford Regional Airport Commission, for the maintenance of the airport and the airport's stormwater management systems. Therefore, the responsible party of this O & M Plan will be referred to collectively as the Airport.

The Airport keeps on file record plans of the Airport's stormwater management system, O & M plans developed during previous improvement projects, routine drainage system, review and maintenance reports, and the facilities Stormwater Pollution Prevention Plan per the EPA NPDES Multi-Sector General Permit.

In the event that the New Bedford Regional Airport was to change ownership, the above mentioned stormwater management system documentation and EPA NPDES Multi-Sector SWPPP would remain on file at the Airport.

This O & M plan shall be located in the Airport Manager's office. The O&M Plan located in the Airport Manager's office shall be the O&M plan of record and shall be maintained up-to-date at all times. Any changes to the stormwater system, runways, taxiways, or any stormwater BMP's shall be recorded in this O&M plan and all drawings or exhibits shall be updated to reflect said changes.

5. Routine and Non-Routine Maintenance Tasks

The New Bedford Regional Airport's stormwater management system has been designed to comply with the Massachusetts Stormwater Management Standards that were incorporated into the Wetlands Protection Act Regulations on January 2, 2008 (see 310 CMR 10.05(6)(k)). To ensure the proposed stormwater management systems are functioning adequately, routine and non-routine maintenance, system reviews, and preventative measures are necessary. The system utilizes Best Management Practices (BMP) source controls including the following:

1. Vegetative Filter Strips
   Description: Grassed Area
   Location: Adjacent to Runway or Taxiway edge of pavement.
   Purpose: Pre-treat stormwater run-off from asphalt surfaces prior to discharging to catch basins or infiltration trenches.

Review: At least once a year (every six months during first year) the edge of pavement and toe-of-slope shall be checked for sediment build up and vegetation reviewed for signs of erosion and bare spots.
Maintenance: Mowing to occur on routine basis. Sediment, debris and trash removal from edge of pavement and reseeded as necessary to fill in bare spots.

2. <u>Drainage Channels</u>
   Description: Grass Channels
   Location: Various locations throughout the airport property.
   Purpose: To provide for non-erosive conveyance of stormwater to inlets, infiltration trenches and other bodies of water.
   Review: At least twice per year review channels for adequate vegetation growth, rilling or gullying.
   Maintenance: Mowing to occur on routine basis. Sediment, debris and trash removal shall occur at least once per year or as necessary. Repair of any erosion and reseeding shall occur as necessary.

3. <u>Grassed Channels</u>
   Description: Grass Channels
   Location: Along construction access road.
   Purpose: To provide for pre-treatment for and conveyance of stormwater to inlets, infiltration trenches, sediment forebays, and other bodies of water
   Review: At least once per year review channels for adequate vegetation growth, rilling or gullying.
   Maintenance: Mowing to occur once a month during growing season. Sediment, debris and trash removal shall occur at least once per year or as necessary. Repair of any erosion and reseeding shall occur as necessary, but no less than once a year.

4. <u>Catch Basin (Deep Sump Hooded)</u>
   Description: Underground Retention Basins.
   Location: Various locations throughout the airport property.
   Purpose: Designed to remove trash debris and coarse sediment from stormwater runoff. Also serve as temporary spill containment devices for oils and grease.
   Review: At least four times per year, and at the end of foliage and snow-removal seasons, review structures for sedimentation, debris build-up, floatables and structural damage.
   Maintenance: Remove sediment debris at least four times per year or whenever depth of deposits is greater than or equal to one half the depth from the bottom of the sump to the invert of the lowest pipe in the basin. Remove trash and floatables as required. Replace structure as necessary.

5. <u>Infiltration Trenches</u>
   Description: Shallow Excavations Filled with Stone.
   Location: At the toe of slope of vegetative filter strips, typically at the edge of Runway and Taxiway Safety Area.
   Purpose: The stone provides underground storage for stormwater runoff which gradually exfiltrates through the bottom and/or sides of the trench into the subsoil and eventually into the water table.
   Review: At least two times per year review for sedimentation, debris, trash and grass clippings within trench. Check pre-treatment BMP's as required, to maximize infiltration trench useable lifetime.

Maintenance: At least two times per year remove sedimentation, debris, trash and grass clipping from trench and pretreatment BMP's. Rehabilitate the trench when required.

6. Proprietary Separator
Description: Underground Storage Tanks with Three Chambers.
Location: Adjacent to Aircraft Aprons or Hangars.
Purpose: Removes heavy particulates, floating debris and hydrocarbons from stormwater.
Review: At least once a month (and after every major storm) review for sediments and debris.
Maintenance: At least twice per year, by qualified personnel, the unit shall be cleaned of oil, grease and sediments using a specialized vacuum truck.

7. Infiltration Basin
Description: Stormwater runoff impoundment constructed over permeable soils.
Location: Adjacent to Northwest Ramp and along construction access road.
Purpose: Stormwater runoff is stored until it exfiltrates through the soil of the basin floor, typically within 72 hours.
Review: At least twice per year review for sediments and debris. Review pre-treatment BMP's, as specified, to reduce maintenance for basin.
Maintenance: At least twice per year mow buffer area, side slopes and basin bottom (if grass) or rake (if stone bottom). Remove grass clippings, accumulated organic matter, trash and debris and eradicate any invasive plant species. Note: Remove sediment from basin as necessary, but wait until basin floor is dry. Use light equipment to remove the top layer so as not to compact the underlying soil.

8. Leaching Catch Basin
Description: Pre-cast concrete structure with an open bottom.
Location: Main Ramp Apron Area
Purpose: To permit runoff to infiltrate into the ground.
Review: At once per year, and at the end of foliage and snow-removal seasons, review structures for sedimentation, debris build-up, floatables, grass clippings and structural damage.
Maintenance: Remove sediment debris at once per year, 50% full or whenever deposits impact exfiltration. Replace structure as necessary.

9. Outlet Erosion Control Protection
Description: Devices that controls the flow of stormwater from an outlet device (i.e. Rip-Rap)
Location: Downstream of headwalls or any outlet.
Purpose: To dissipate energy from stormwater runoff to control erosion as it enters streams and wetland areas.
Review: At least two times per year review for erosion sedimentation, vegetation debris, trash and grass clippings. Review pre-treatment BMP's to reduce maintenance.
Maintenance: At least two times per year remove sedimentation, debris, trash and grass clipping from outlet erosion control device and pretreatment BMP's.

10. Check Dams
Description: A small earthen or stone dam constructed across a drainage ditch, swale or channel.
Location: Various locations throughout the airport property.
Purpose: To lower the velocity of flow to reduce erosion and gullying in a channel and allow sediments to settle out.
Review: After every significant rainfall event review the check dams.

Maintenance: Repair damage and remove sediment as necessary.

11. Catch Basin Inlet Controls (Temporary during construction)
Description: Filter media insert that fits into a catch basin opening.
Location: Currently none at the airport.
Purpose: To remove a range of pollutants including debris, trash, fine sediments, oil/grease and metals depending on type of filter media.
Review: Per manufacturer's schedule, review inserts for effectiveness and structural integrity. Must be OSHA certified to enter the structure.
Maintenance: Per manufacturer's requirements, replace inserts as necessary or when ineffective.

12. Drain Manholes
Description: Underground chambers with access from surface.
Location: Various locations throughout the airport property.
Purpose: Used for pipe connections, flow diversions and review access.
Review: At least four times per year, and at the end of foliage and snow-removal seasons, review structures for sedimentation, debris build-up, floatables and structural damage. Must be OSHA certified to enter the structure.
Maintenance: Remove sediment debris at least four times per year or whenever depth of deposits is greater than or equal to one half the depth from the bottom of the sump to the invert of the lowest pipe in the basin. Remove trash and floatables as required. Replace structure as necessary.

13. Drainage Pipe
Description: Hollow cylindrical conduit of varying material such as steel, concrete, plastic and clay.
Location: Throughout stormwater system, typically between catch basins, manholes and outfalls.
Purpose: To convey stormwater throughout the system.
Review: At least four times per year, and at the end of foliage and snow-removal seasons, review pipes for sedimentation, debris build-up, floatables and structural damage.
Maintenance: Remove sediment debris at least four times per year or whenever depth of deposits is impeding stormwater conveyance. Remove trash and floatables as required. Replace pipe as necessary if structural failure is apparent.

14. Culverts
Description: A covered channel that crosses under a roadway or other paved airport surface.
Location: West Ditch under RW 5 End Localizer access road; Along Taxiway "A" (3)
Purpose: To convey stormwater under a roadway crossing.
Review: At least four times per year review structures for sedimentation, debris build-up, floatables and structural damage.
Maintenance: Remove sediment debris at least four times per year or as required. Replace structure as necessary.

Table 1 includes a summary all BMP's associated with the Airport's stormwater management system and routine and non-routine maintenance required:

Table 1 – Operation and Maintenance Requirements

BMP	Approx. Quantity	Maintenance Required	Frequency
Vegetative Filter Strips	*TBD* LF	Review edge of pavement and toe-of-slope for sediment build up. Review vegetation for signs of erosion, bare spots and overall health.	**1 Time/Year**; Every six months during first year.
		Mowing	**As Needed**
		Remove sediment from the tow of slope or edge of pavement. Reseed bare spots.	**As Needed**
Drainage Channels	*TBD* LF	Review Channels to ensure adequate vegetation growth and no rilling or gullying. Repair rills, gullies and dead vegetation.	**2 Times/Year**; and first few months after construction.
		Mowing	**As Necessary**; Grass height shall not exceed 6 inches.
		Manually remove sediment and debris	**1 Time/Year** (Minimum)
		Reseed	**As necessary**; Deicing will necessitate yearly reseeding in the spring.
Grassed Channels	*TBD* LF	Review Channels to ensure adequate vegetation growth and no rilling or gullying. Repair rills, gullies and dead vegetation.	**1 Time/Year** (Minimum)
		Mowing	**Once a month during growing season**
		Manually remove sediment and debris	**1 Time/Year** (Minimum)
		Reseed	**As necessary**; Deicing will necessitate yearly reseeding in the spring.
Catch Basins (deep sump hooded)	*TBD* EA	Review Units	**4 Times/Year**; And at the end of foliage and snow-removal seasons.
		Clean Units	**4 Times/Year**; Or whenever depth of deposits is greater than or equal to one half the depth from the bottom of the sump to the invert of the lowest pipe in the basin.
Infiltration Trench	*TBD* LF	Review units and remove debris.	**2 Times/Year; and after every major storm**
		Remove sediment from pretreatment BMP's	**2 Times/Year; and after every major storm**

BMP	Approx. Quantity	Maintenance Required	Frequency
Proprietary Separator	*TBD* EA	Review Units	**1 Time/Month**; and after every major storm
		Clean Units	**2 Times/Year**
Infiltration Basins	1 EA	Preventative Maintenance	**2 Times/Year**
		Review to ensure proper functioning	**2 Times/Year**; After every major storm for first 3 months of operation; after discharges through high outlet orifice.
		Mow the buffer area, side slopes, and basin bottom if grass; Rake if stone bottom	**2 Times/Year**
Infiltration Basin (Cont'd)	1 EA	Remove trash, debris, grass clippings and accumulated organic matter from unit	**2 Times/Year**
		Review and clean pretreatment devices	**2 Times/Year (Minimum)**; Every Two Months (Recommended); After Every Major Storm.
Leaching Catch Basin	2 EA	Review Units	**1 Time/Year**; And at the end of foliage and snow-removal seasons.
		Clean Units	**1 Times/Year;** 50% Full; As required
Outlet Erosion Control	N/A	Review and clean sedimentation, debris, trash and **grass clippings**. Review pre-treatment BMP's.	**2 Times/Year**
Check Dams	N/A	Review and repair or remove sediment.	**Following significant rainfall**
Catch Basin Inlet Controls	All CB's	Review and Replace per manufacturer's requirements	**Per Manufacturer**
Drain Manhole	*TBD* EA	Review Units	**2 Times/Year**
		Clean Units	**As Required**
Drainage Pipe	*TBD* LF	Review Pipes	**2 Times/Year**
		Clean/Repair Pipes	**As Required**
Open Box Culvert	4 EA	Review Structure	**2 Times/Year**
		Clean/Repair	**As Required**
Invasive Species Removal		Review for the presence of invasive species.	**1 Time/Year**
		Mechanical removal preferred (i.e., hand tools); apply herbicides as necessary.	**As Required**

For reference, MassDEP Specifications from the Stormwater Management Standards have been included in **Appendix B** for all BMP's associated with the Airport's stormwater system.

6. Plan of Stormwater BMP's

Maps of the New Bedford Regional Airport's existing stormwater management system can be found in earlier versions of this Plan. Existing and Proposed Drainage Plans for the current project can be found in the Stormwater Management Report for "Construct Gravel Access Road."

7. Public Safety Features

The proposed stormwater management system will be constructed entirely within the Airport's restricted and fenced-in areas. These areas are controlled by the Airport and are closed to public access.

The proposed systems have been, and will be designed to manage any changes in the existing rate of runoff due to airport improvements. System designs to control increases in runoff include infiltration trenches and basins that will be designed to infiltrate stormwater runoff quickly to prevent water retention and eliminate the migration of wildlife such as water fowl and the infestation of insects.

8. Estimated Operations and Maintenance Budget

The City of New Bedford owns and operates the Airport through the New Bedford Airport Commission. The Airport has a maintenance staff of municipal employees who are responsible for the maintenance of the Airport's facilities. The additional cost associated with reviewing and maintaining proposed Gravel Access Road drainage improvements would not add any significant burden onto the current maintenance budget for the entire Airport facility.

9. O & M Compliance Statement

The Airport shall report compliance with the following statements during all drainage system reviews and maintenance activities:

> The site has been reviewed for erosion and appropriate steps have been taken to permanently stabilize any eroded areas;

1. All aspects of the stormwater BMP's have been reviewed for damage, wear and malfunction, and appropriate steps have been taken to repair or replace the system or portions of the system so that the stormwater at the site may be managed in accordance with the Stormwater Management Standards;
2. Future responsible parties must be notified of their continuing legal responsibility to operate and maintain the structure; and
3. The Operation and Maintenance Plan for the stormwater BMP's is being implemented.

10. Maintenance Log Book

All stormwater BMP's shall be operated and maintained in accordance with the design plans and this O&M Plan. The Airport will report on all drainage system reviews, repairs, replacement, and disposal (for disposal, the log shall indicate the type of material and the disposal location) activities. These reports will be kept on file for a minimum of three (3) years and will be made available to the MassDEP and the City of New Bedford Conservation Commission upon request. In addition, the Airport will escort members of the MassDEP and the City of New Bedford Conservation Commission onto the Airport premises to review, evaluate, and ensure compliance with this O&M Plan during regular business hours.

A 24-hour advanced notice is requested to ensure proper escort is available and to prevent interference with airport operations.

An example copy of the drainage system review worksheet for use by Airport Maintenance Staff is included in **Appendix C**.

11. Snow Removal

Snow shall not be plowed, deposited, or dumped into any Wetland Resource Area or buffer zone. Snow shall not be plowed, deposited, or dumped into stormwater management structures including infiltration trenches. Snow removal shall be directed away from these areas to the extent practicable.

Excess snow shall be stored in prescribed areas. Prescribed snow storage areas include:

a.) infield areas between taxiways and runways a minimum of 50’ from infiltration trenches,
b.) east of Taxiway “B” south of Runway 32,
c.) west of the Bridgewater State apron, and
d.) west of the T-hangar adjacent to the west end of Taxiway “B”.

Winter conditions and rates of accumulations of precipitation vary widely. Wind speed and direction, available equipment, and conditions may require special equipment and techniques collectively for snow storage. Snow shall be positioned off the movement area surfaces so all airplane propellers, engine pods, rotors, and wing tips will clear any snowdrift and snow bank as the airplane’s landing gear traverses any portion of the movement area.

Snow storage sites shall not compromise airplane operations, airport NAVAIDS, airport traffic, and ATCT operations such as ATCT line-of-sight requirements.

Depending on the amount of snow cleared and the size of the ramp, ramp signage directing pilots toward the runway could become obscured (covered with snow), and the resulting height of snow stockpiles could cause clearance issues between taxiing airplanes and the snow stockpile. Snow banks piled adjacent to paved Aircraft Operating Areas shall be in accordance with the FAA AC 150/5200-30B Airport Winter Safety and Operations.

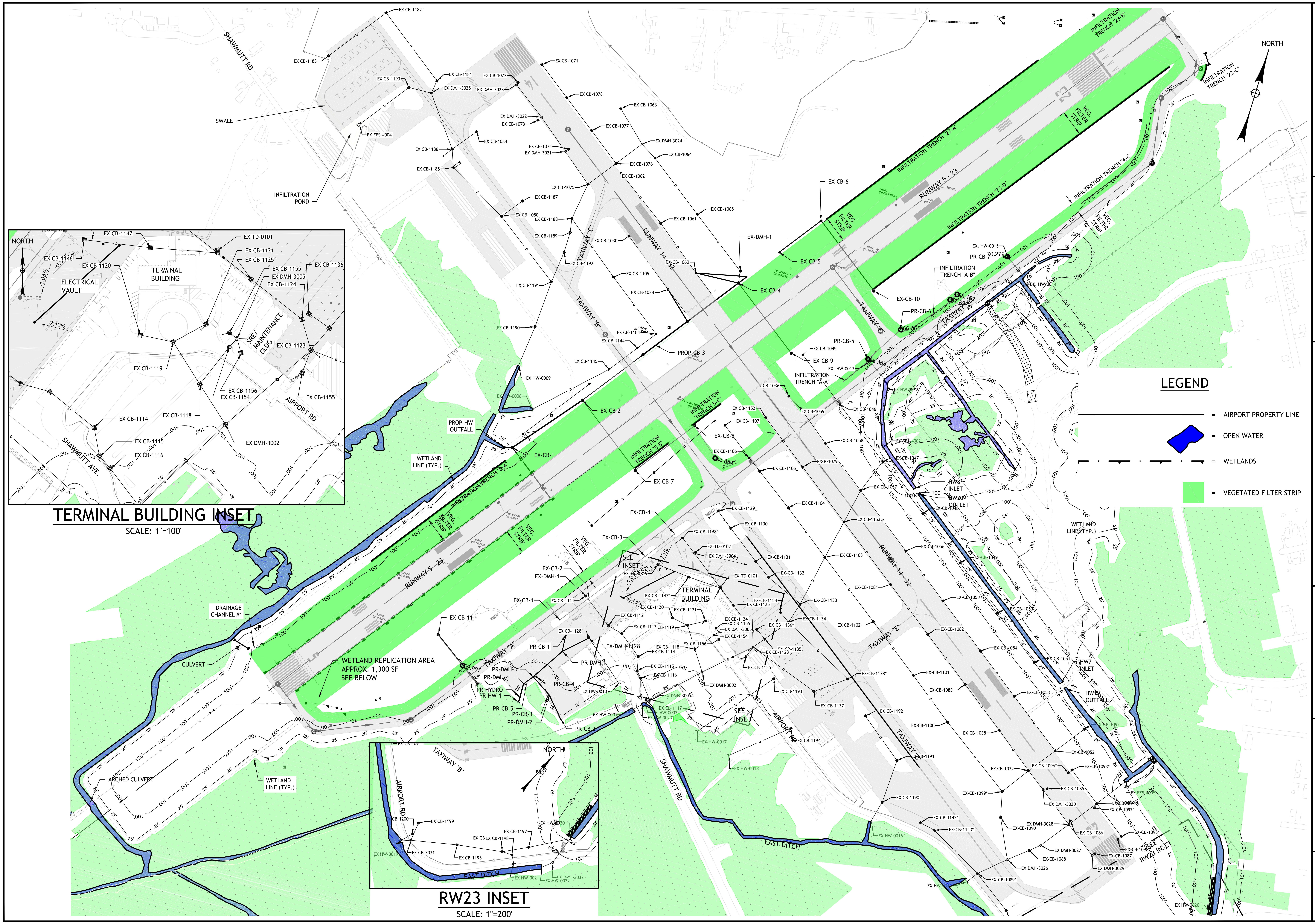
12. Pollution Prevention

A stormwater pollution prevention plan (SWPPP) was previously developed for the New Bedford Regional Airport. This SWPPP contains helpful information regarding pollution prevention, spill containment, and maintenance procedures to be enacted to limit the pollution potential from the Airport.

Operators and Maintenance Staff shall thoroughly read, understand, and enact all procedures as indicated in the SWPPP. Operators and Staff shall pay special attention to Section 3 – Stormwater Control Measures. The SWPPP shall be kept and maintained in the Airport Manager’s office. Any questions regarding the SWPPP shall be directed to the Airport Manager, or his/her designate.

Appendix A

Stormwater Management System Plans



SHEET TITLE

DRAINAGE SYSTEM DIAGRAM

GRAPHIC SCALE 0 100 200 400

PROJECT NO.	103-032
CADD FILE	DRAINAGE DIAGRAM
DESIGNED BY	MKO
DRAWN BY	MKO
CHECKED BY	RAL
DATE	OCTOBER 2016
DRAWING SCALE	1" = 200'

PROJECT

NEW BEDFORD REGIONAL AIRPORT
OPERATIONS AND MAINTENANCE PLAN

OWNER

NEW BEDFORD AIRPORT COMMISSION
NEW BEDFORD REGIONAL AIRPORT
NEW BEDFORD, MASSACHUSETTS

NO.	DATE	DESCRIPTION	BY

AIRPORT SOLUTIONS GROUP
INNOVATIVE AIRPORT DEVELOPMENT SPECIALISTS
AIRPORT CONSULTANTS • WOBURN, MASSACHUSETTS
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DRAWING NO.

Fig. 1

Appendix B

BMP Specifications

Massachusetts Stormwater Management Policy

Vegetated Filter Strips

Description: Vegetated filter strips, also known as filter strips, grass buffer strips and grass filters, are uniformly graded vegetated surfaces (i.e., grass or close-growing native vegetation) that receive runoff from adjacent impervious areas. Vegetated filter strips typically treat sheet flow or small concentrated flows that can be distributed along the width of the strip using a level spreader. Vegetated filter strips are designed to slow runoff velocities, trap sediment, and promote infiltration, thereby reducing runoff volumes.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides some peak flow attenuation but usually not enough to achieve compliance with Standard 2
3 - Recharge	No recharge credit
4 - TSS Removal	If greater than or equal to 25' and less than 50' wide, 10% TSS removal. If greater than or equal to 50' wide, 45% TSS removal.
5 - Higher Pollutant Loading	May be used as part of a pretreatment train if lined
6 - Discharges near or to Critical Areas	May be used as part of a pretreatment train if lined. May be used near cold-water fisheries.
7 - Redevelopment	Suitable for pretreatment or as a stand-alone practice if sufficient land is available.

Advantages/Benefits:

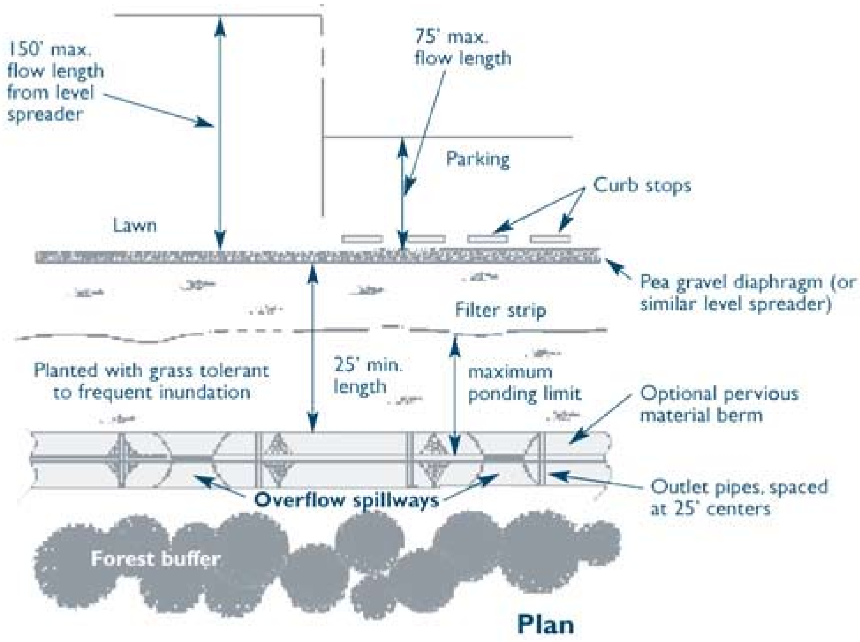
- Reduces runoff volumes and peak flows.
- Slows runoff velocities and removes sediment.
- Low maintenance requirements.
- Serves as an effective pretreatment for bioretention cells
- Can mimic natural hydrology
- Small filter strips may be used in certain urban settings.
- Ideal for residential settings and to treat runoff from small parking lots and roads.
- Can be used as part of runoff conveyance system in combination with other BMPs
- Little or no entrapment hazard for amphibians or other small creatures

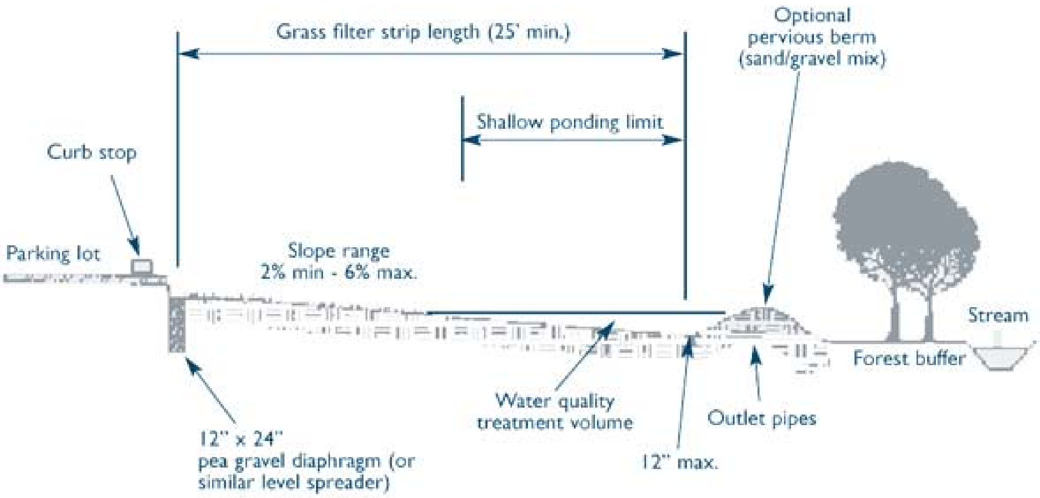
Disadvantages/Limitations:

- Variability in removal efficiencies, depending on design
- Little or no treatment is provided if the filter strip is short-circuited by concentrated flows.
- Often a poor retrofit option due to large land requirements.
- Effective only on drainage areas with gentle slopes (less than 6 percent).
- Improper grading can greatly diminish pollutant removal.

Pollutant Removal Efficiencies

• TSS (if filter strip is 25 feet wide)	10% assumed (Regulatory)
• TSS (if filter strip is 50 feet wide)	45% assumed (Regulatory)
• Nutrients (Nitrogen, phosphorus)	Insufficient data
• Metals (copper, lead, zinc, cadmium)	Insufficient data
• Pathogens (coliform, e coli)	Insufficient data





adapted from the "Design of Stormwater Systems" 1996

Maintenance

Activity	Frequency
Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health.	Every six months during the first year. Annually thereafter.
Regularly mow the grass.	As needed
Remove sediment from the toe of slope or level spreader and reseed bare spots.	As needed

Special Features

Include an impermeable liner and underdrain for discharges from Land Use with Higher Potential Pollutant Loads and for discharges within Zone IIs and Interim Wellhead Protection Areas; for discharges near or to other critical areas or in soils with rapid infiltration rates greater than 2.4 inches per hour.

Vegetated Filter Strips

Applicability

Vegetated filter strips are used to pretreat sheet flow from roads, highways, and small parking lots. In residential settings, they are useful in pretreating sheet flow from driveways. They provide effective pretreatment, especially when combined with bioretention areas and stream buffers. Urban areas can sometimes accommodate small filter strips depending on available land area, making them potential retrofit options in certain urban settings. Vegetated filter strips can also be used as side slopes of grass channels or water quality swales to enhance infiltration and remove sediment.

Effectiveness

Variable TSS removal efficiencies have been reported for filter strips, depending on the size of the contributing drainage area, the width of the filter strip, the underlying parent soil, the land slope, the type of vegetation, how well the vegetation is established, and maintenance practices. Vegetated filter strips may remove nutrients and metals depending on the length and slope of the filter, soil permeability, size and characteristics of the drainage area, type of vegetative cover, and runoff velocity.

Planning Considerations

Vegetated filter strips may be used as a stand-alone practice for redevelopments, only where other practices are not feasible. Vegetated filter strips can be designed to fit within the open space and rights of way that are available along roads and highways. Do not design vegetated filter strips to accept runoff from land uses with higher potential pollutant loads (LUHHPL) without a liner. Vegetated filter strips function best for drainage areas of one acre or less with gentle slopes.

Design

Do not locate vegetated filter strips in soils with high clay content that have limited infiltration or in soils that cannot sustain grass cover.

The filter strip cannot extend more than 50 feet into a Buffer Zone to a wetland resource area.

The contributing drainage area to a vegetated filter strip is limited to one acre of less.

Design vegetated filter strips with slopes between 2 and 6 percent. Steeper slopes tend to create concentrated flows. Flatter slopes can cause ponding and create mosquito-breeding habitat.

Design the top and toe of the slope to be as flat as possible. Use a level spreader at the top of the slope to evenly distribute overland flows or concentrated runoff across the entire length of the filter strip. Many variations of level spreader designs may be used including level trenches, curbing and concrete weirs. The key to any level spreader design is creating a continuous overflow elevation along the entire width of the filter strip.

Velocity dissipation (e.g. by using riprap) may be required for concentrated flows.

Design the filter strip to drain within 24 hours after a storm. The design flow depth must not exceed 0.5 inches.

To recieve TSS removal credit, make the filter strip at least 25 feet long and generally as wide as the area draining to the strip. To prevent high-velocity concentrated flows, the length of the flow path must be limited to 75 feet if the filter strip handles runoff from impervious surfaces, and 150 feet if the filter strip handles runoff from pervious surfaces. The minimum width of the filter strip must be 20% of the length of the flow path or 8 feet, whichever is greater.

To prevent groundwater contamination, the filter strip must be constructed at least 2 feet above seasonal high groundwater and 2 to 4 feet above bedrock.

The filter strip must be planted with grasses that are relatively salt-tolerant. Select grasses to withstand high flow velocities under wet weather conditions.

A vegetated filter strip may be used as a qualifying pervious area for purposes of the LID Site Design Credits for disconnecting rooftop and nonroof top runoff.

Construction

Proper grading is essential to establish sheet flow from the level spreader and throughout the filter strip.

Implement soil stabilization measures until permanent vegetation is established.

Protect the area to be used for the filter strip by using upstream sediment traps.

Use as much of the existing topsoil on the site as possible to enhance plant growth.

Maintenance

Regular maintenance is critical for filter strips to be effective and to ensure that flow does not short-circuit the system. Conduct semi-annual inspections during the first year (and annually thereafter). Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health. Regular, frequent mowing of the grass is required. Remove sediment from the toe of slope or level spreader, and reseed bare spots as necessary. Periodically, remove sediment that accumulates near the top of the strip to maintain the appropriate slope and prevent formation of a "berm" that could impede the distribution of runoff as sheet flow.

When the filter strip is located in the buffer zone to a wetland resource area, the operation and maintenance plan must include strict measures to ensure that maintenance operations do not alter the wetland resource areas. Please note, filter strips are restricted to the outer 50 feet of the buffer zone.

Cold Climate Considerations

In cold climates such as Massachusetts, the depth of soil media that serves as the planting bed must extend below the frost line to minimize the effects of freezing. Avoid using peat and compost media, which retain water and freeze during the winter, and become impermeable and ineffective.

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Virginia Department of Conservation and Recreation, Chapter 3, Minimum Standard 3.14, Vegetated Filter Strip, Pp. 3.14-1 to 3.14.-14, http://dcr.state.va.us/soil_&_water/documents/Chapter_3-14.pdf

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Drainage Channels

Description: Drainage channels are traditional vegetated open channels that are designed to provide for non-erosive conveyance. They receive no infiltration or TSS removal credit (Standards 3 and 4).

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides negligible groundwater recharge.
4 - TSS Removal	0% TSS removal credit.
5 - Higher Pollutant Loading	Use as conveyance.
6 - Discharges near or to Critical Areas	May be used to achieve temperature reduction for runoff discharging to cold-water fisheries.
7 - Redevelopment	Limited applicability

Advantages/Benefits:

- Conveys stormwater
- Generally less expensive than curb and gutter systems.
- Accents natural landscape.
- Compatible with LID design practices
- Roadside channels reduce driving hazards by keeping stormwater flows away from street surfaces during storms

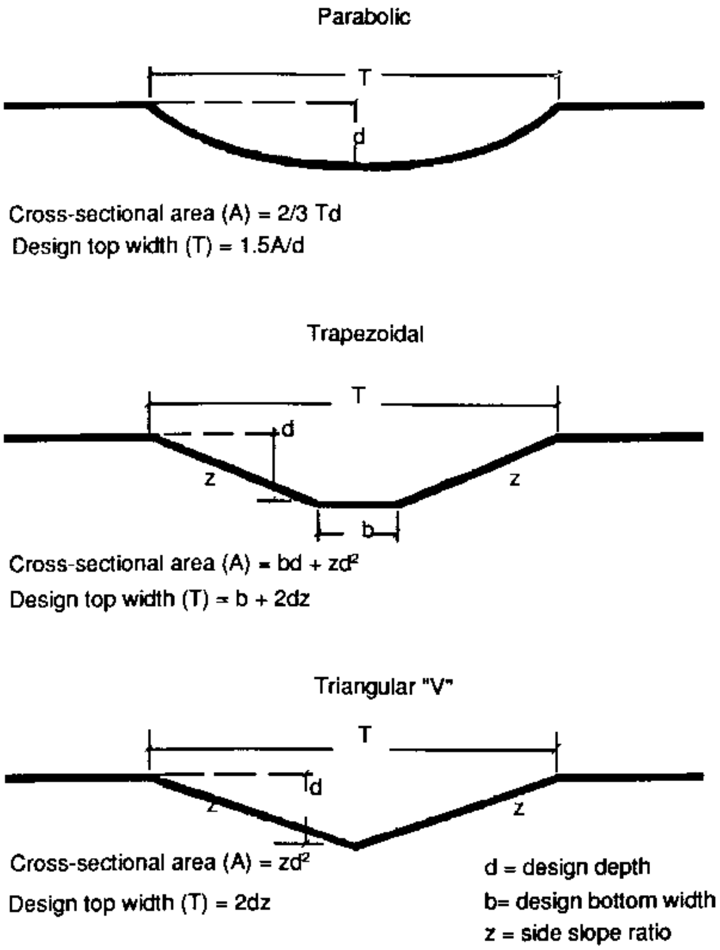
Disadvantages/Limitations:

- Higher degree of maintenance required than for curb and gutter systems.
- Roadside channels are subject to damage from off-street parking and snow removal.
- Provides limited pollutant removal compared to water quality swales
- May be impractical in areas with flat grades, steep topography or poorly drained soils
- Large area requirements for highly impervious sites.

Pollutant Removal Efficiencies

- Total Suspended Solids (TSS) - 0%
- Nutrients (Nitrogen, phosphorus) - Insufficient data
- Metals (copper, lead, zinc, cadmium) - Insufficient data
- Pathogens (coliform, e coli) - Insufficient data

Figure DC 1



adapted from the University of New Hampshire

Maintenance

Activity	Frequency
Inspect channels to make sure vegetation is adequate and for signs of rilling and gullying. Repair any rills or gullies. Replace dead vegetation.	The first few months after construction and twice a year thereafter.
Mow	As necessary. Grass height shall not exceed 6 inches.
Remove sediment and debris manually	At least once a year
Reseed	As necessary. Use of road salt or other deicers during the winter will necessitate yearly reseeding in the spring.

Special Features

Drainage channels cannot be used to meet the Stormwater Management Standards. They are a component of a larger stormwater management system and serve to convey runoff from impervious surfaces to or from stormwater treatment BMPs.

Drainage Channels

Drainage Channels versus Water Quality Swales

The distinction between drainage channels and water quality swales lies in the design and planned use of the open channel conveyance. Drainage channels are designed to have sufficient capacity to convey runoff safely during large storm events without causing erosion. Drainage channels typically have a cross-section with sufficient hydraulic capacity to handle the peak discharge for the 10-year storm. The dimensions (slope and bottom width) of a drainage channel must not exceed a critical erosive velocity during the peak discharge. They must be vegetated with grasses to maintain bank and slope integrity. Other than basic channel size and geometry, there are no other design modifications to enhance pollutant removal capabilities. Therefore, pollutant removal efficiency is typically low for drainage channels.

Water quality swales and grass channels, on the other hand, are designed for the required water quality volume and incorporate specific features to enhance their stormwater pollutant removal effectiveness. Pollutant removal rates are significantly higher for water quality swales and grass channels. A water quality swale or grass channel must be used in place of the drainage channel when a water quality treatment credit is sought.

Applicability

Drainage channels are suitable for residential and institutional areas of low to moderate density. The percentage of impervious cover in the contributing areas must be relatively small. Drainage channels can also be used in parking lots to break up areas of impervious cover.

Along the edge of roadways, drainage channels can be used in place of curb and gutter systems. However, the effectiveness of drainage channels may decrease as the number of driveway culverts increases. They are also generally not compatible with extensive sidewalk systems. When using drainage channels in combination with roadways and sidewalks, it is most appropriate to place the channel between the two impervious covers (e.g., between the sidewalk and roadway).

The topography of the site should allow for the design of a drainage channel with sufficient slope and cross-sectional area to maintain non-erosive flow velocities. The longitudinal slope of the swale should be as close to zero as possible and not greater than 5%.

Planning Considerations

The two primary considerations when designing a drainage channel are maximizing channel capacity and minimizing erosion. Use the maximum expected retardance when checking drainage channel capacity. Usually the greatest flow retardance occurs when vegetation is at its maximum growth for the year. This usually occurs during the early growing season and dormant periods.

Other factors to be considered when planning for the drainage channel are land availability, maintenance requirements and soil characteristics. The topography of the site should allow for the design of a drainage channel with sufficient slope and cross-sectional area to maintain a non-erosive flow velocity, generally less than five feet per second.

The shape of the cross-sectional channel is also an important planning consideration. Figure DC 1 shows three different design shapes. The V-shaped or triangular cross-section can result in higher velocities than other shapes, especially when combined with steeper side slopes, so use this design only if the quantity of flow is relatively small. The parabolic cross-section results in a wide shallow channel that is suited to handling larger flows and blends in well with natural settings. Use trapezoidal channels when deeper channels are needed to carry larger flows and conditions require relatively high velocities. Select a grass type for the channel lining that is appropriate for site conditions, including one that is able to resist shear from the design flow, is shade tolerant, is drainage tolerant, and has low maintenance requirements. Use vegetation that is water tolerant and has a dense root system. Alternatively, the drainage channel may be lined with stone.

Design

See the following for complete design references: Site Planning for Urban Stream Protection. 1995. Schueler. Center for Watershed Protection.

The length of the drainage channel depends on the slope, contributing impervious surface area, and runoff volume. Because drainage channels with low velocities can act as sediment traps, add extra capacity to address sediment accumulation without reducing design capacity. Add an extra 0.3 to 0.5

feet of freeboard depth, if sediment accumulation is expected. Use side slopes of 3:1 or flatter to prevent side slope erosion. Make the longitudinal slope of the channel as flat as possible and not greater than 5%.

Install check dams in drainage channels when necessary to achieve velocities of 5 feet per second or less. Do not use earthen check dams because they tend to erode on the downstream side, and it is difficult to establish and maintain grass on the dams. The maximum ponding time behind the check dam should not exceed 24 hours. Use outlet protection at discharge points from a drainage channel to prevent scour at the outlet.

The design for the drainage channel must include access for maintenance. When located along a highway, provide a breakdown lane with a width of 15 feet. When located along a street, off-street parking can be doubled up as the access, provided signs are posted indicating no parking is allowed during maintenance periods. When locating drainage channels adjacent to pervious surfaces, include a 15-foot wide grass strip to provide access for maintenance trucks.

Construction

Use temporary erosion and sediment controls during construction. Soil amendments, such as aged compost that contains no biosolids, may be needed to encourage vegetation growth. Select a vegetation mix that suits the characteristics of the site. Seeding will require mulching with appropriate materials, such as mulch matting, straw, wood chips, other natural blankets, or synthetic blankets. Anchor blanket immediately after seeding. Provide new seedlings with adequate water until they are well established. Refer to the “Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers, and Municipal Officials” for information regarding seeding, mulching, and use of blankets.

Maintenance

The maintenance and inspection schedule should take into consideration the effectiveness of the drainage channel. Inspect drainage channels the first few months after construction to make sure that there is no rilling or gullying, and that vegetation in the channels is adequate. Thereafter, inspect the channel twice a year for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, soil erosion, ponding, and sediment accumulation.

Regular maintenance tasks include mowing, fertilizing, liming, watering, pruning, weeding, and pest control. Mow channels at least once per year. Do not cut the grass shorter than three to four inches. Keep grass height under 6 inches to maintain the design depth necessary to serve as a conveyance. Do not mow excessively, because it may increase the design flow velocity.

Remove sediment and debris manually at least once per year. Re-seed periodically to maintain the dense growth of grass vegetation. Take care to protect drainage channels from snow removal procedures and off-street parking. When drainage channels are located on private residential property, the operation and maintenance plan must clearly specify the private property owner who is responsible for carrying out the required maintenance. If the operation and maintenance plan calls for maintenance of drainage channels on private properties to be performed by a public entity or an association (e.g. homeowners association), maintenance easements must be obtained.

Grassed Channel (Biofilter Swale)

Description: Grassed Channels (formerly known as Biofilter swales) are treatment systems with a longer hydraulic residence time than drainage channels. The removal mechanisms are sedimentation and gravity separation, rather than filtration. To receive TSS credit, a sediment forebay or equivalent must be provided for pretreatment. Note that the sediment forebay does not receive a separate TSS removal credit.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	No infiltration credit
4 - TSS Removal	50% TSS with adequate pretreatment
5 - Higher Pollutant Loading	N/A
6 - Discharges near or to Critical Areas	Not suitable for vernal pools or bathing beaches. At other critical areas, may be used as a pretreatment device.
7 - Redevelopment	Typically not suited for retrofits.

Advantages/Benefits:

- Provides pretreatment if used as the first part of a treatment train.
- Open drainage system aids maintenance
- Accepts sheet or pipe flow
- Compatible with LID design measures.
- Little or no entrapment hazard for amphibians or other small animals

Disadvantages/Limitations:

- Short retention time does not allow for full gravity separation·
- Limited biofiltration provided by grass lining.· Cannot alone achieve 80% TSS removal
- Must be designed carefully to achieve low flow rates for Water Quality Volume purposes (<1.0 fps)
- Mosquito control considerations

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	50%[1] for Regulatory Purposes (47%)[2]
• Total phosphorus (TP)	-121%[2]
• Total Nitrogen	Insufficient Data
• Metals (copper, lead, zinc, cadmium)	Insufficient Data
• Pathogens (coliform, e. coli)	Insufficient Data

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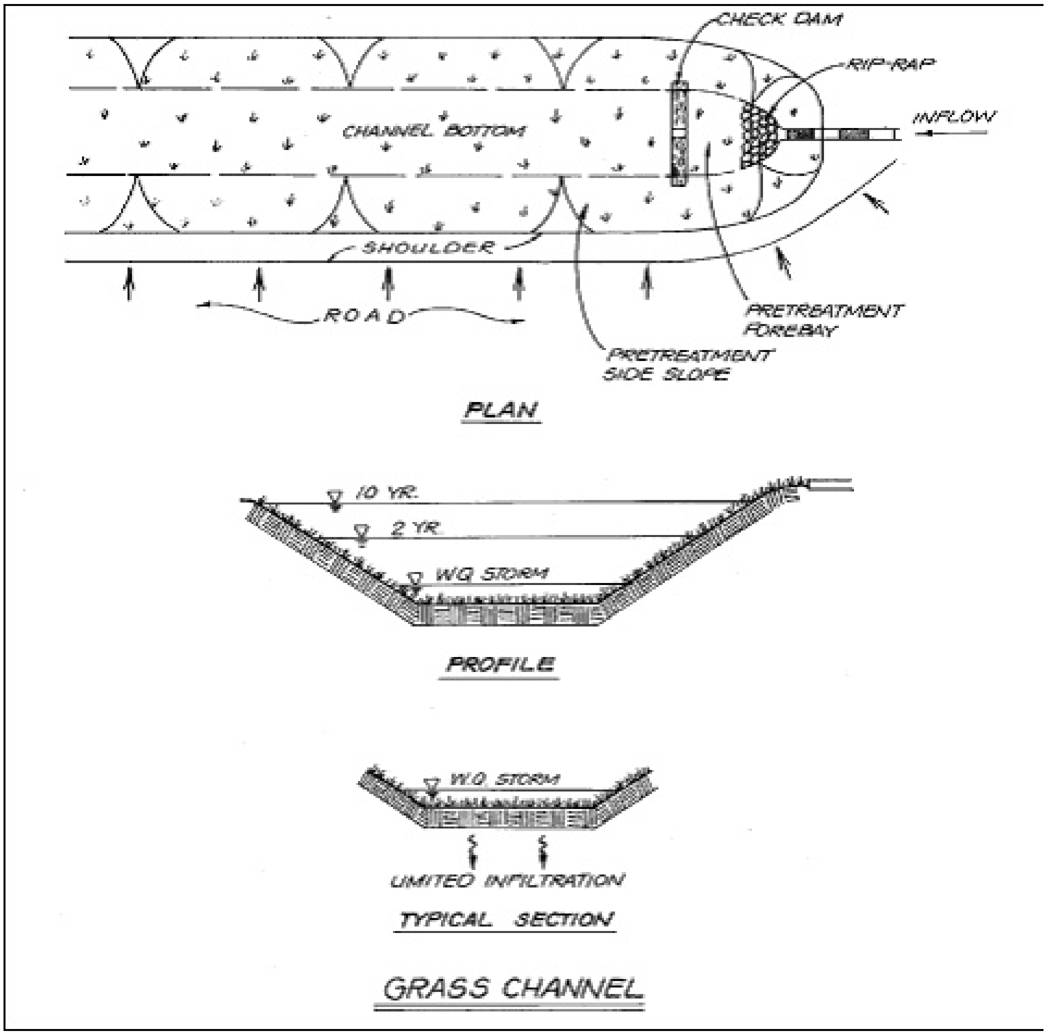
[1] Atlanta Regional Commission et al, 2001, Georgia Stormwater Manual, Volume 2, Section 3-3-2, http://georgiastormwater.com/vol2/3-3-2.pdf

[2] International Stormwater Database, based on MassDEP analysis of raw influent & effluent values reported in 2005.



adapted from the Vermont Stormwater Manual

Maintenance

Activity	Frequency
Remove sediment from forebay	Annually
Remove sediment from grass channel	Annually
Mow	Once a month during growing season
Repair areas of erosion and revegetate	As needed, but no less than once a year

Special Features

Reduces volume and rate of runoff.

Grass Channels

Grass channels convey and treat stormwater. Grass channels were referred to as biofilter swales in the 1996 MassDEP/CZM Stormwater Handbook, based on the nomenclature coined by the Center for Watershed Protection (CWP). The CWP is now referring to biofilter swales as grass channels – so MassDEP is adopting the same name as the CWP to minimize confusion.

Properly designed grass channels are ideal when used adjacent to roadways or parking lots, where runoff from the impervious surfaces can be directed to the channel via sheet flow. Runoff can also be piped to the channel. If piped, locate the sediment forebay at the pipe outlet and include a check dam separating the forebay from the channel. For sheet flow, use a vegetated filter strip on a gentle slope or a pea gravel diaphragm. Make the longitudinal slope as flat as possible. This increases the Hydraulic Residence Time (HRT) and allows gravity separation of solids and maximizes sediment removal. Install check dams to further increase the HRT.

Review of the International Stormwater Database, updated in 2005, indicates lower TSS removal when compared to similar treatment practices (dry water quality swales, wet water quality swales, and bioretention areas). The information in the International Stormwater Database indicates grass channels are likely to export phosphorus (hence the negative removal efficiency cited above). Grass channels are not a practice suitable for treating stormwater that discharges to waters impaired by phosphorus or for waters where phosphorus TMDLs have been established.

Differences from dry water quality swales, wet water quality swales, bioretention cells, and drainage channels: Dry water quality swales contain a specific soil media mix and underdrain, providing greater treatment than grass channels. Wet water quality swales are designed with a permanent wet channel, whereas grass channels must be designed to completely drain between storms. Bioretention areas, including rain gardens, are designed solely as a treatment practice, and not for conveyance. Lastly, drainage channels act solely as a conveyance, in contrast to properly designed grass channels where runoff flow is deliberately lagged to provide treatment.

Design Considerations

Sizing:

Water Quality Volume: Design grass channels to maximize contact with vegetation and soil surface to promote greater gravity separation of solids during the storm associated with the water quality event (either ½ inch or 1-inch runoff). Design the channel such that the velocity does not exceed 1 foot per second during the 24-hour storm associated with the water quality event. Do not allow the water depth during the storm associated with the water quality event to exceed 4 inches (for design purposes). Make sure the selected design storm provides at least 9 minutes of HRT within the channel. Increasing the HRT beyond 9 minutes increases the likelihood of achieving the 50% TSS removal efficiency. Adding meanders to the swale increases its length and may increase the HRT.

2-year and 10-year conveyance capacity: Design grass channels to convey both the 2-year and 10-year 24-hour storms. Provide a minimum of 1-foot freeboard above the 10-year storm. Make sure that the runoff velocities during the 2-year 24-hour storm do not cause erosion problems.

Channel Length: Length depends on design factors to achieve the minimum 9-minute residence time for the storm associated with the water quality event.

Channel Crossings: In residential settings, driveways will cross over the channel, typically via culverts (pre-cast concrete, PVC, or corrugated metal pipe).

Soils: Grass channels may be constructed from most parent soils, unless the soils are highly impermeable. Soils must be able to support a dense grass growth. MassDEP recommends sandy loams, with an organic content of 10 to 20%, and no more than 20% clay. Highly impermeable soils, such as clays, are not suitable for grass channels, because they do not support dense grass stands. Similarly, gravelly and coarse soils may not be suitable due to their lower moisture retention capability, leading to potential die-back of the grass lining during the summer when the inter-event period between storms is longer than during other times of the year.

Grasses: The grasses serve to stabilize the channel, and promote conditions suitable for sedimentation, such as offering resistance to flow, which reduces water velocities and turbulence. Select a grass height of 6 inches or less. Grasses over that height tend to flatten when water flows over them, inhibiting sedimentation. Select grasses that produce a fine, uniform and dense cover that can withstand varying moisture conditions. Regularly mow the channel to ensure that the grass height does not exceed 6 inches. Select grasses that are salt tolerant to withstand winter deicing of roadways. In the spring, replant any areas where grasses died off due to deicing. (Franklin 2002 and Knoxville 2003 provide recommendations for the best grass species.)

Pea Gravel Diaphragm: Use clean bank-run gravel, conforming to ASTM D 448, varying in size from 1/8 inch to 3/8 inch (No. 6 stone).

Outlet Protection: Must be used at discharge points to prevent scour downstream of the outlet.

Construction Considerations: Stabilize the channel after it is shaped before permanent turf is established, using natural or synthetic blankets. Never allow grass channels to receive construction period runoff.

Site Constraints

A proponent may not be able to install a grass channel swale because of:

- High groundwater;
- Presence of utilities; or
- Other site conditions that limit depth of excavation because of stability.

Maintenance

Access: Maintenance access must be designed as part of the grass channel. If located adjacent to a roadway, make the maintenance access at least 15 feet wide, which can also be combined with a breakdown lane along a highway or on-street parking along a residential street. When combined with on-street parking, post signs prohibiting parking when the swale is to be inspected and cleaned. Do not use travel lanes along highways and streets as the required maintenance access.

Mowing: Set the mower blades no lower than 3 to 4 inches above the ground. Do not mow beneath the depth of the design flow during the storm associated with the water quality event (e.g., if the design flow is no more than 4 inches, do not cut the grass shorter than 4 inches). Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches.

Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring.

Trash/Debris Removal: Remove accumulated trash and debris prior to mowing.

Sediment Removal: Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils. Sediment build-up in the grass channel reduces its capacity to treat and convey the water quality event, 2-year and 10-year 24-hour storm.

References:

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Deep Sump Catch Basin

Description: Deep sump catch basins, also known as oil and grease or hooded catch basins, are underground retention systems designed to remove trash, debris, and coarse sediment from stormwater runoff, and serve as temporary spill containment devices for floatables such as oils and greases.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	25% TSS removal credit when used for pretreatment. Because of their limited effectiveness and storage capacity, deep sump catch basins receive credit for removing TSS only if they are used for pretreatment and designed as off-line systems.
5 - Higher Pollutant Loading	Recommended as pretreatment BMP. Although provides some spill control capability, a deep sump catch basin may not be used in place of an oil grit separator or sand filter for land uses that have the potential to generate runoff with high concentrations of oil and grease such as: high-intensity-use parking lots, gas stations, fleet storage areas, vehicle and/or equipment maintenance and service areas.
6 - Discharges near or to Critical Areas	May be used as pretreatment BMP. not an adequate spill control device for discharges near or to critical areas.
7 - Redevelopment	Highly suitable.

Advantages/Benefits:

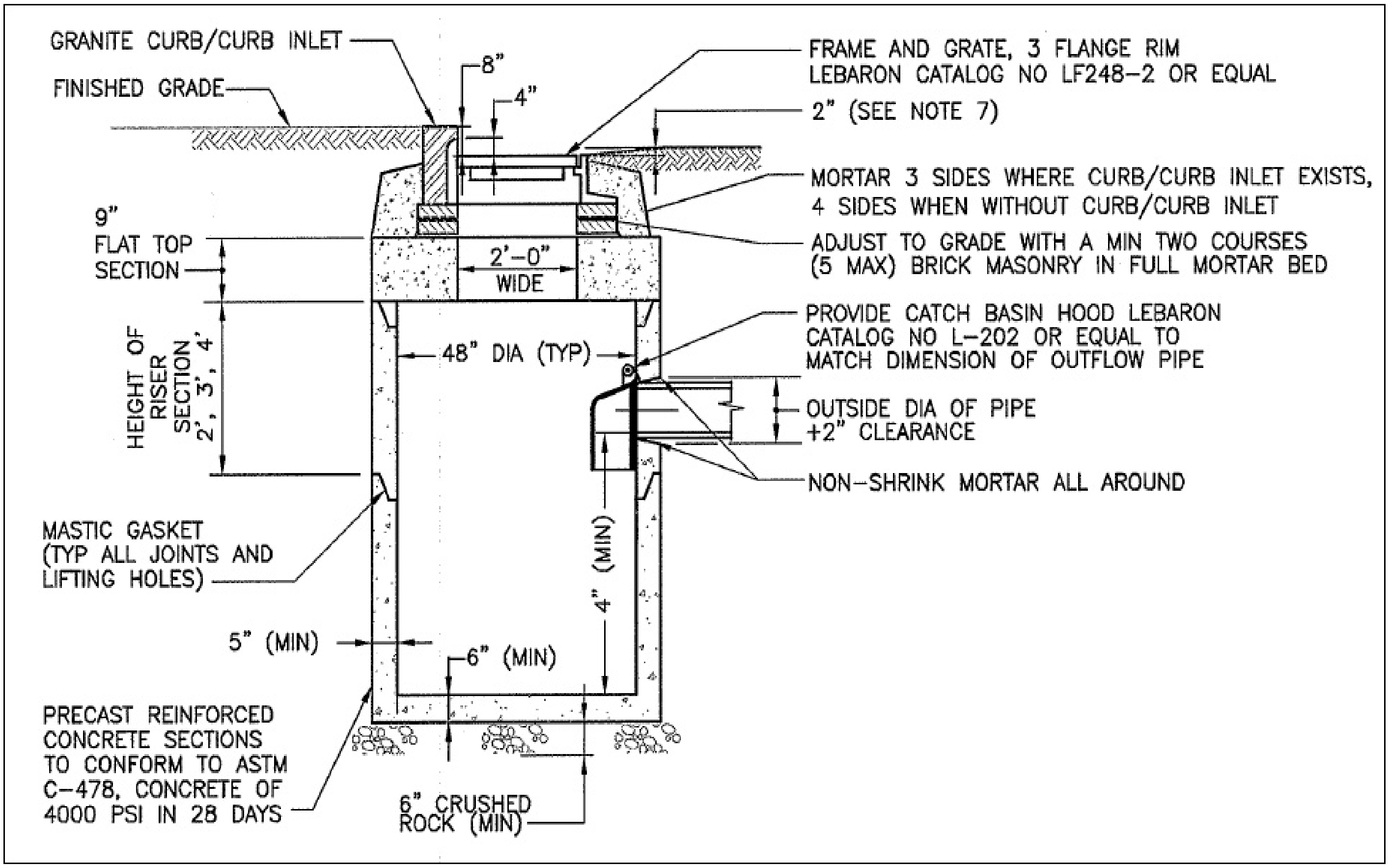
- Located underground, so limited lot size is not a deterrent.
- Compatible with subsurface storm drain systems.
- Can be used for retrofitting small urban lots where larger BMPs are not feasible.
- Provide pretreatment of runoff before it is delivered to other BMPs.
- Easily accessed for maintenance.
- Longevity is high with proper maintenance.

Disadvantages/Limitations:

- Limited pollutant removal.
- Expensive to install and maintain, resulting in high cost per unit area treated.
- No ability to control volume of stormwater
- Frequent maintenance is essential
- Requires proper disposal of trapped sediment and oil and grease
- Entrapment hazard for amphibians and other small animals

Pollutant Removal Efficiencies

- Total Suspended Solids (TSS) - 25% (for regulatory purposes)
- Nutrients (Nitrogen, phosphorus) - Insufficient data
- Metals (copper, lead, zinc, cadmium) - Insufficient data
- Pathogens (coliform, e coli) - Insufficient data



adapted from the University of New Hampshire

Maintenance

Activity	Frequency
Inspect units	Four times per year
Clean units	Four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

Special Features

All deep sump catch basins must include hoods. For MassHighway projects, consult the Stormwater Handbook for Highways and Bridges for hood requirements.

LID Alternative

Reduce Impervious Surface
Disconnect rooftop and non-rooftop runoff
Vegetated Filter Strip

Deep Sump Catch Basin

Suitable Applications

- Pretreatment
- Residential subdivisions
- Office
- Retail

Design Considerations

- The contributing drainage area to any deep sump catch basin should not exceed ¼ acre of impervious cover.
- Design and construct deep sump catch basins as off-line systems.
- Size the drainage area so that the flow rate does not exceed the capacity of the inlet grate.
- Divert excess flows to another BMP intended to meet the water quantity requirements (peak rate attenuation) or to a storm drain system. An off-line design enhances pollutant removal efficiency, because it prevents the resuspension of sediments in large storms.

Make the sump depth (distance from the bottom of the outlet pipe to the bottom of the basin) at least four feet times the diameter of the outlet pipe and more if the contributing drainage area has a high sediment load. The minimum sump depth is 4 feet. Double catch basins, those with 2 inlet grates, may require deeper sumps. Install the invert of the outlet pipe at least 4 feet from the bottom of the catch basin grate.

The inlet grate serves to prevent larger debris from entering the sump. To be effective, the grate must have a separation between the grates of one square inch or less. The inlet openings must not allow flows greater than 3 cfs to enter the deep sump catch basin. If the inlet grate is designed with a curb cut, the grate must reach the back of the curb cut to prevent bypassing. The inlet grate must be constructed of a durable material and fit tightly into the frame so it won't be dislodged by automobile traffic. The inlet grate must not be welded to the frame so that sediments may be easily removed. To facilitate maintenance, the inlet grate must be placed along the road shoulder or curb line rather than a traffic lane.

Note that within parking garages, the State Plumbing Code regulates inlet grates and other stormwater management controls. Inlet grates inside parking garages are currently required to have much smaller openings than those described herein.

To receive the 25% removal credit, hoods must be used in deep sump catch basins. Hoods also help contain oil spills. MassHighway may install catch basins without hoods provided they are designed, constructed, operated, and maintained in accordance with the Mass Highway Stormwater Handbook.

Install the weep hole above the outlet pipe. Never install the weep hole in the bottom of the catch basin barrel.

Site Constraints

A proponent may not be able to install a deep sump catch basin because of:

- Depth to bedrock;
- High groundwater;
- Presence of utilities; or
- Other site conditions that limit depth of excavation because of stability.

Maintenance

Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. One study found that once 50% of the sump volume is filled, the catch basin is not able to retain additional sediments.

Inspect or clean deep sump basins at least four times per year and at the end of the foliage and snow-removal seasons. Sediments must also be removed four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. If handling runoff from land uses with higher potential pollutant loads or discharging runoff near or to a critical area, more frequent cleaning may be necessary.

Clamshell buckets are typically used to remove sediment in Massachusetts. However, vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

Always consider the safety of the staff cleaning deep sump catch basins. Cleaning a deep sump catch basin within a road with active traffic or even within a parking lot is dangerous, and a police detail may be necessary to safeguard workers.

Although catch basin debris often contains concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal. Contaminated catch basin cleanings must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

In the absence of evidence of contamination, catch basin cleanings may be taken to a landfill or other facility permitted by MassDEP to accept solid waste, without any prior approval by MassDEP. However, some landfills require catch basin cleanings to be tested before they are accepted.

With prior MassDEP approval, catch basin cleanings may be used as grading and shaping materials at landfills undergoing closure (see Revised Guidelines for Determining Closure Activities at Inactive Unlined Landfill Sites) or as daily cover at active landfills. MassDEP also encourages the beneficial reuse of catch basin cleanings whenever possible. A Beneficial Reuse Determination is required for such use.

MassDEP regulations prohibit landfills from accepting materials that contain free-draining liquids. One way to remove liquids is to use a hydraulic lift truck during cleaning operations so that the material can be decanted at the site. After loading material from several catch basins into a truck, elevate the truck so that any free-draining liquid can flow back into the structure. If there is no free water in the truck, the material may be deemed to be sufficiently dry. Otherwise the catch basin cleanings must undergo a Paint Filter Liquids Test. Go to www. Mass.gov/dep/recycle/laws/cafacts.doc for information on all of the MassDEP requirements pertaining to the disposal of catch basin cleanings.

Proprietary Separators

Description: A proprietary separator is a flow-through structure with a settling or separation unit to remove sediments and other pollutants. They typically use the power of swirling or flowing water to separate floatables and coarser sediments, are typically designed and manufactured by private businesses, and come in different sizes to accommodate different design storms and flow conditions. Some rely solely on gravity separation and contain no swirl chamber. Since proprietary separators can be placed in almost any location on a site, they are particularly useful when either site constraints prevent the use of other stormwater techniques or as part of a larger treatment train. The effectiveness of proprietary separators varies greatly by size and design, so make sure that the units are sized correctly for the site's soil conditions and flow profiles, otherwise the unit will not work as designed.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	Varies by unit. Must be used for pretreatment and be placed first in the treatment train to receive TSS removal credit. Follow procedures described in Chapter 4 to determine TSS credit.
5 - Higher Pollutant Loading	Suitable as pretreatment device.
6 - Discharges near or to Critical Areas	Suitable as pretreatment device or potentially a spill control device
7 - Redevelopment	Suitable as pretreatment device or treatment device if it is not possible to provide other BMPs.

Advantages/Benefits:

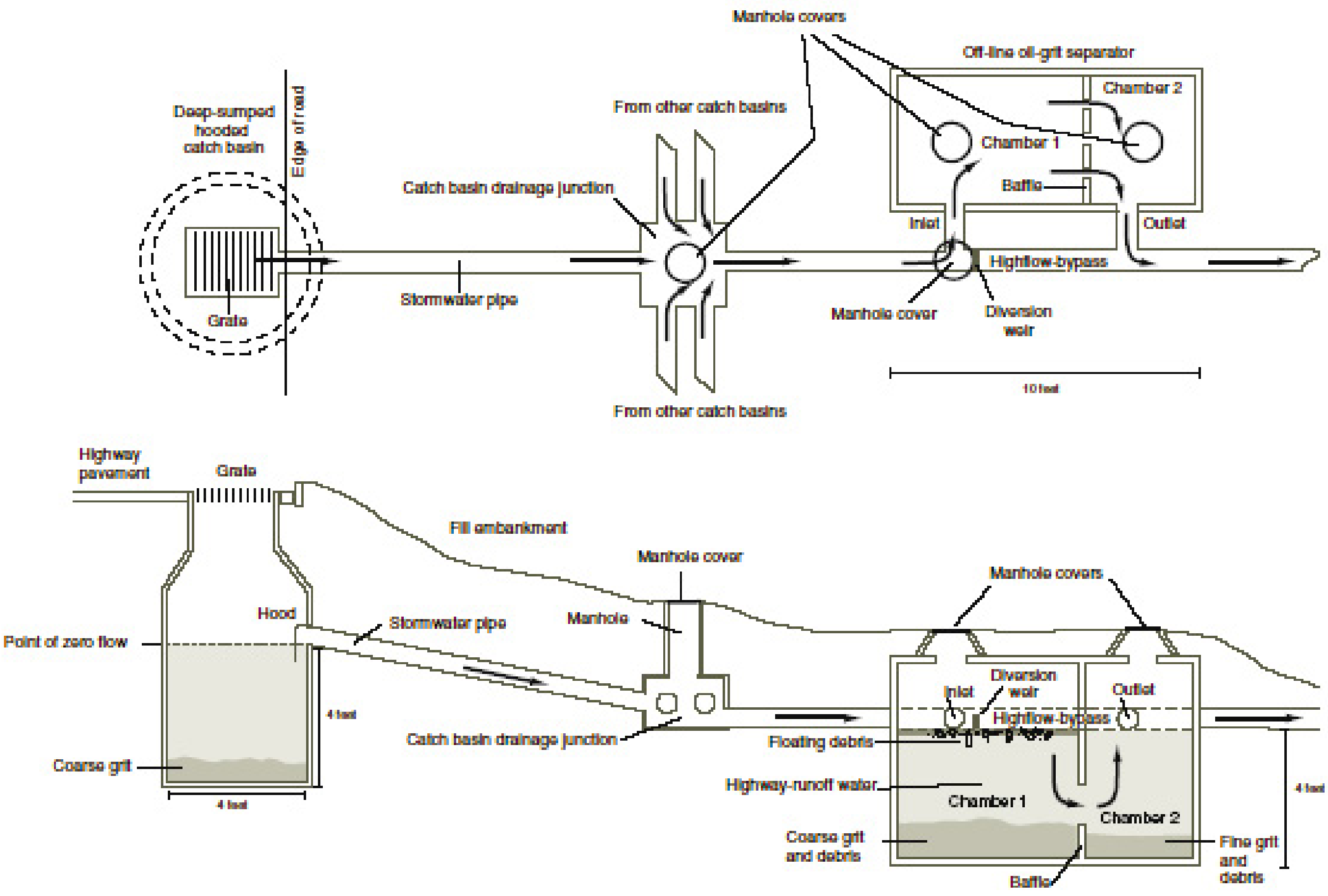
- Removes coarser sediment.
- Useful on constrained sites.
- Can be custom-designed to fit specific needs of a specific site.

Disadvantages/Limitations:

- Removes only coarse sediment fractions
- Provides no recharge to groundwater
- No control of the volume of runoff
- Frequent maintenance is essential

Pollutant Removal Efficiencies

- Total Suspended Solids (TSS) - Varies.
- Nutrients (Nitrogen, phosphorus) - Insufficient data
- Metals (copper, lead, zinc, cadmium) - Insufficient data
- Pathogens (coliform, e coli) - Insufficient data



Schematic section of a deep-sump hooded catch basin and a 1,500-gallon off-line water quality inlet.

adapted from the MassHighway Storm Water Handbook for Highways

Maintenance

Activity	Frequency
Inspect in accordance with manufacturer requirements, but no less than twice a year following installation, and no less than once a year thereafter.	See activity
Remove sediment and other trapped pollutants at frequency or level specified by manufacturer.	See manufacturer information

Special Features

Can be custom-designed to fit specific needs at a specific site.

LID Alternative

Reduce impervious surfaces

Disconnect runoff from non-metal roofs, roadways, and driveways

Proprietary Separators

Applicability

Because they have limited pollutant removal and storage capacity, proprietary separators must be used for pretreatment only. Because they are placed underground, proprietary separators may be the only structural pretreatment BMPs feasible on certain constrained redevelopment sites where space or storage is not available for more effective BMPs. They may be especially useful in ultra-urban settings such as Boston or Worcester. Some proprietary separators may be used for spill control.

Effectiveness

Proprietary separators have a wide range of TSS efficiencies. To assess the ability of proprietary separators to remove TSS and other pollutants, a proponent should follow the procedures set forth in Chapter 4. The specific units proposed for a particular project cannot be effective unless they are sized correctly. Proprietary separators are usually sized based on flow rate. A proprietary separator must be sized to treat the required water quality volume. To be effective at removing TSS and other pollutants the system must be designed, constructed, and maintained in accordance with the manufacturer's specifications and the specifications in this Handbook.

Planning Considerations

To receive TSS removal credit, proprietary separators must be used for pretreatment and placed at the beginning of a stormwater treatment train. They can be configured either in-line or if subject to higher flows, off-line to reduce scouring. They must be sized in accordance with the manufacturer's specifications and the specifications in this Handbook. Proprietary separators used as spill control devices may have to be sized differently than those used for TSS removal.

Design

The design of proprietary separators varies by manufacturer. Units are typically precast concrete, but larger systems may be cast in place. Units may have baffles or other devices to direct incoming water into and through a series of chambers, slowing the water down to allow sediment to drop out into internal storage areas, then directing this pre-treated water to exit to other treatment or infiltration devices. In some cases, flow will be introduced tangentially, to induce swirl or vortex. Units may include skirts or weirs, to keep trapped sediments from becoming re-entrained. Some units combine a catch basin with the treatment function, providing off-line rather than in-line treatment.

Generally they are placed below ground on a gravel or stone base. Make sure all units contain inspection and access ports so that they may be inspected and cleaned. During design, take care to place the inspection and access ports where they will be accessible. Do not place the ports in locations such as travel lanes of roadways/highways and parking stalls.

Construction

Install construction barriers around the excavation area to prevent access by pedestrians. Use diversions and other soil erosion practices up-slope of the proprietary separator to prevent runoff from entering the site before construction of the units is complete. Implement practices to prevent construction period runoff from being discharged to the units until construction is complete and the soil is stabilized. Stabilize all surrounding area and any established outlets. Remove temporary structures after vegetation is established.

Maintenance

Inspect and clean these units in strict accordance with manufacturers' recommendations and requirements. Clean the units using the method specified by the manufacturer. Vactor trucks are typically used to clean these units. Clamshell buckets typically used for cleaning catch basins are almost never allowed by manufacturers. Sometimes it will be necessary to remove sediment manually.

Adapted from:
MassHighway. Storm Water Handbook for Highways and Bridges. May 2004.

Infiltration Trenches

Description: Infiltration trenches are shallow excavations filled with stone. They can be designed to capture sheet flow or piped inflow. The stone provides underground storage for stormwater runoff. The stored runoff gradually exfiltrates through the bottom and/or sides of the trench into the subsoil and eventually into the water table.

Ability to meet specific standards

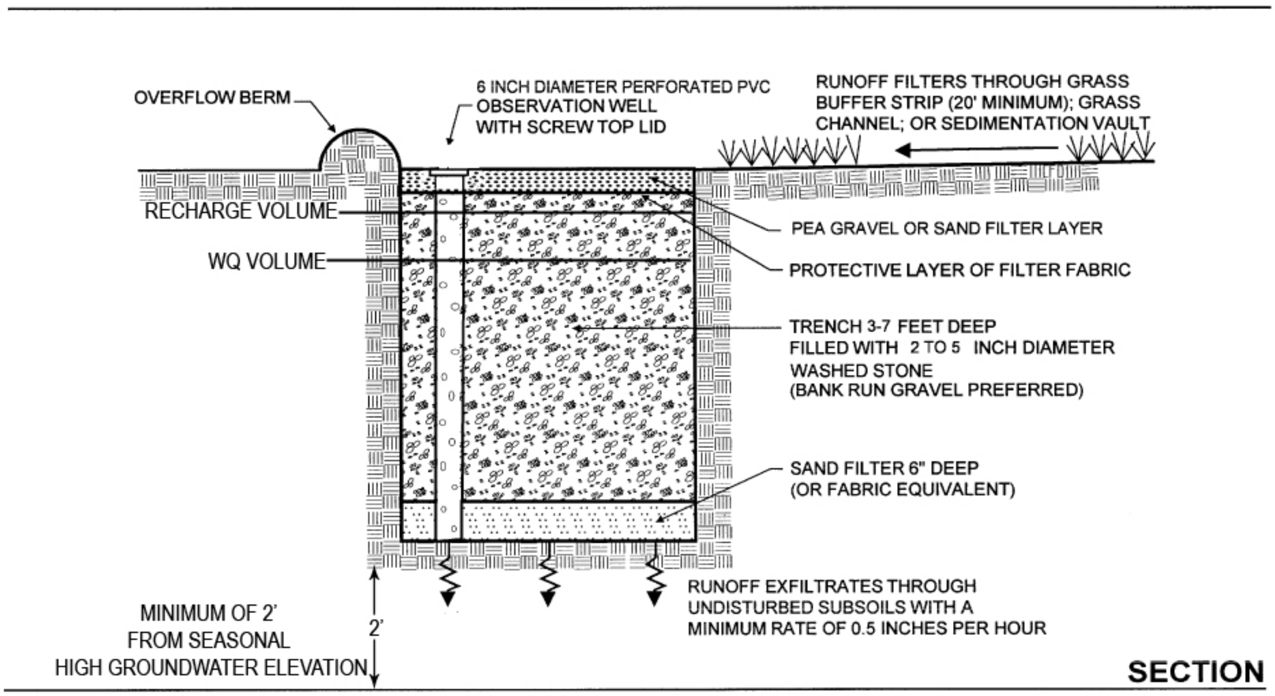
Standard	Description
2 - Peak Flow	Full exfiltration trench systems may be designed for peak rate attenuation
3 - Recharge	Provides groundwater recharge.
4 - TSS Removal	80% TSS removal credit when combined with one or more pretreatment BMPs.
5 - Higher Pollutant Loading	May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. For some land uses with higher potential pollutant load an oil grit separator or equivalent must be used prior to discharge to the infiltration structure. Infiltration must be done in compliance with 314 CMR 5.00.
6 - Discharges near or to Critical Areas	Highly recommended with pretreatment to remove at least 44% TSS removal prior to discharge.
7 - Redevelopment	Suitable with pretreatment.

Advantages/Benefits:
- Provides groundwater recharge.
- Reduces downstream flooding and protects stream bank integrity for small storms.
- Preserves the natural water balance of the site.
- Provides a high degree of runoff pollution control when properly designed and maintained.
- Reduces the size and cost of downstream stormwater control facilities and/or storm drain systems by infiltrating stormwater in upland areas.
- Suitable where space is limited.

Disadvantages/Limitations:
- High failure rates due to improper siting, inadequate pollution prevention and pretreatment, poor design, construction and maintenance.
- Use restricted to small drainage areas.
- Depending on runoff quality, potential risk of groundwater contamination.
- Requires frequent maintenance.
- Susceptible to clogging with sediment.

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	80% with pretreatment
• Total Nitrogen	40% to 70%
• Total Phosphorus	40% to 70%
• Metals (copper, lead, zinc, cadmium)	85% to 90%
• Pathogens (coliform, e coli)	Up to 90%



Example of Infiltration Trench

adapted from the University of New Hampshire

Maintenance

Activity	Frequency
Inspect units and remove debris	Every 6 months and after every major storm
Remove sediment from pretreatment BMPs	Every 6 months and after every major storm

Special Features:

High failure rate without adequate pretreatment and regular maintenance

LID Alternative:

Reduce impervious areas
Bioretention areas

Infiltration Trenches

Infiltration trenches can be designed for complete exfiltration or partial exfiltration, where a portion of the runoff volume is directed to the trench and the remainder is conveyed to other BMPs.

Full Exfiltration Trench Systems

Infiltration trenches must be sized to provide storage and exfiltration of the required water quality volume. Full exfiltration systems also provide control of peak discharges and water quality treatment for all storm events equal to or less than the design storm selected. In selecting the design storm, the minimum peak rate attenuation storm event must include the 2- and 10-year 24-hour storm events and may include the 100-year 24-hour storm event, if the runoff from that storm will increase flooding up- or downstream of the site. An emergency overflow channel is required to discharge runoff volumes in excess of the design storm. Economic and physical constraints can restrict the use of full exfiltration systems. Generally, it is not practical to provide storage for large infrequent storms, such as the 100-year storm.

Partial or Water Quality Exfiltration Trench Systems

These systems exfiltrate a portion of the runoff, while the remainder is conveyed to other BMPs. At a minimum, they must be sized to exfiltrate the recharge volume required by Stormwater Management Standard 3. There are two methods of partial infiltration. The first relies on off-line treatment where a portion of the runoff, or the “first-flush,” is routed from the main channel to the trench by means of a weir or other diversion structure. The second method is on-line, and uses a perforated pipe at the top of the trench. This underdrain must be placed near the top of the trench. Refer to the design section below. After the trench fills to capacity, excess runoff is discharged through the perforated pipe and directed to other BMPs.

Applicability

Infiltration trenches always require a pretreatment BMP. For sheet flow, pretreatment BMP structures that may be used include vegetated filter strips and pea stone gravel diaphragms. For piped flow, a sediment forebay should be used.

Infiltration trenches are feasible at sites with gentle slopes, permeable soils, and where seasonal high groundwater levels are at least two feet below the bottom of the trench. MassDEP recommends providing greater depths from the bottom of the trench to seasonal high groundwater elevation to reduce the potential for failure. Depth to bedrock will need to be evaluated to determine if use of an infiltration trench is feasible.

Contributing drainage areas must be relatively small and not exceed 5 acres. Infiltration trenches are suitable for parking lots, rooftop areas, local roads, highways, and small residential developments.

Infiltration trenches are adaptable to many sites because of their thin profile. Table IT.1 lists the recommended site criteria. Infiltration trenches can be used in upland areas of larger sites to reduce the overall amount of runoff and improve water quality while reducing the size and costs of downgradient BMPs.

Infiltration trenches are effective at mimicking the natural, pre-development hydrological regime at a site. Full exfiltration systems that have been carefully designed may be capable of controlling peak discharges from the 2-year and 10-year 24-hour storm.

Planning Considerations

MassDEP highly recommends using infiltration trenches near Critical Areas. They may be used to treat stormwater discharges from areas of higher potential pollutant loads, provided 44% of TSS is removed prior to infiltration. For some land uses with higher potential pollutant load, an oil grit separator or equivalent device may be required prior to discharge to the infiltration trench. When an oil/grit separator is used, pipe the runoff to the infiltration trench. Discharges from land uses with higher potential pollutant loads require compliance with 314 CMR 5.00.

Before planning infiltration trenches, carefully evaluate the subsurface of the site including soils, depth to bedrock, and depth to the water table. Make sure soils have a minimum percolation rate of 0.17 inches per hour.

Make the slopes of the contributing drainage area less than 5%. Infiltration trenches have extremely high failure rates, usually due to clogging, so pretreatment is essential. Infiltration trenches are not intended to remove coarse particulate pollutants, and generally are difficult to rehabilitate once clogged. Typical pretreatment BMPs for infiltration trenches

Table IT.1 - Site Criteria for Infiltration Trenches

1. The contributing drainage area to any individual infiltration trench should be restricted to 5 acres or less.
2. The minimum depth to the seasonal high water table, bedrock, and/or impermeable layer should be 2 ft. from the bottom of the trench.
3. The minimum acceptable soil infiltration rate is 0.17 inches per hour. Infiltration trenches must be sized in accordance with the procedures set forth in Volume 3.
4. A minimum of 2 soil borings should be taken for each infiltration trench. Infiltration trenches over 100 ft. in length should include at least one additional boring location for each 50 ft. increment. Borings should be taken at the actual location of the proposed infiltration trench so that any localized soil conditions are detected.
5. Infiltration trenches should not be used at sites where soils have 30% or greater clay content, or 40% or greater silt clay content. Infiltration trenches will not function adequately in areas with hydrologic soils in group D and infiltration will be limited for hydrologic soils in group C.
6. Infiltration trenches should not be placed over fill materials.
7. The following setback requirements apply to infiltration trench installations:
    - Distance from any slope greater than 5% to any surface exposed trench: minimum of 100 ft.
    - Distance from any slope greater than 20% to any underground trench: minimum of 100 ft.
    - Distance from septic system soil absorption system: minimum of 50 ft.
    - Distance from any private well: minimum of 100 feet, additional setback distance may be required depending on hydrogeological conditions.
    - Distance from any public groundwater drinking water supplies: Zone I radius, additional setback distance may be required depending on hydrogeological conditions.
    - Distance from any surface water supply and its tributaries: Zone A
8. Distance from any surface water of the Commonwealth (other than surface drinking water supplies and their tributaries): minimum of 150 ft downslope and 100 ft upslope.
9. Distance from any building foundations including slab foundations without basements: minimum of 20 ft.

include oil grit separators, deep sump catch basins, vegetated filter strips, pea stone gravel diaphragms, or sediment forebays.

Clogging can be an issue even when infiltrating uncontaminated rooftop runoff as well, so it is important to implement some form of pretreatment to remove sediments, leaf litter, and debris to ensure the proper functioning of the trench and allow for longer periods between maintenance.

Consider the impacts of infiltrating stormwater on nearby resources. Infiltration trenches need to be set back outside Zone Is and Zone As for public drinking water supplies. Finally, avoid creating groundwater mounds near Chapter 21e sites that could alter subsurface flow patterns and spread groundwater pollution.

Design

See the following for complete design references:
Maryland Stormwater Design Manual, Volumes I and II. October 2000. Maryland Department of Environment. Baltimore, MD.

The volume and surface area of an infiltration trench relate to the quantity of runoff entering the trench from the contributing area, the void space, and the infiltration rate. Because the infiltration trench is filled with stone, only the space between the stone is available for runoff storage. Effective designs call for infiltration trenches to be filled with 1.5-inch to 3.0-inch diameter clean washed stone. Conduct a geotechnical study to determine the final soil infiltration rate below the trench. For sizing purposes, assume a void ratio of 0.4.

Take a minimum of two borings or observation pits for each infiltration trench. For trenches over 100 feet long, include at least one additional boring or pit for each 50-foot increment. Take borings or dig observation pits at the actual location of the proposed infiltration trench to determine localized soil conditions.

Base the design of the infiltration trench on the soil evaluation set forth in Volume 3. The minimum acceptable rate is 0.17 inches per hour. Never use the results of a Title 5 percolation test to estimate an infiltration rate, as these tend to greatly overestimate the rate that water will infiltrate into the subsurface.

Place the maximum depth of the trench at least two feet above the seasonal high water table or bedrock, and below the frost line.

Include vegetated buffers (20-foot minimum) around surface trenches. Place permeable filter fabric 6 to 12 inches below the surface of the trench, along the sides, and at the bottom of the trench. Use filter fabric, especially at the surface to prevent clogging; if failure does occur, it can be alleviated without reconstructing the infiltration trench. Another option is to place twelve inches of sand at the bottom of the trench.

Install an observation well at the center of the trench to monitor how quickly runoff is clearing the system. Use a well-anchored, vertical perforated PVC pipe with a lockable above-ground cap.

The visible surface of the trench may either be stone or grassed. Stone is easier to rake out when clogged. If it is vegetated with grasses, use fabric above the stone to keep the soil that serves as the planting medium from clogging the stone. When trenches are designed to accept sheet flow, take into account the grass surface when determining how much of the runoff will exfiltrate into the trench.

A perforated pipe underdrain is sometimes used as part of the design. The purpose of the underdrain is to facilitate exfiltration into the parent soil. Except for underdrains placed between different trench cells, MassDEP does not allow underdrains placed near the bottom of the trench. Placement of an underdrain near the bottom of the trench reduces the amount of treatment and exfiltration, because more water is conveyed through the underdrain to the outlet point when it rains than exfiltrates into the surrounding soils.

Construction

Table IT.2 presents the minimum construction criteria for infiltration trenches. Take precautions before and during construction to minimize the risk of premature failure of the infiltration trench. First, prevent heavy equipment from operating at the locations where infiltration trenches are planned. Heavy equipment will compact soil and adversely affect the performance of the trench. Isolate the areas where the trenches will be located by roping them off and flagging them.

Construct infiltration trenches only after the site has been stabilized. Never use trenches as temporary sediment traps during construction. Use diversion berms or staked and lined hay bales around the perimeter of the trenches during their construction. Excavate and build the trench manually or with light earth-moving equipment. Deposit all excavated material downgradient of the trench to prevent re-deposition during runoff events.

Line the sides and bottom of the trench with permeable geotextile fabric. Twelve inches of sand (clean, fine aggregate) may be substituted or used in addition on the bottom. Place one to three inches of clean, washed stone in the lined trench and lightly compact the stone with plate compactors, to within approximately one foot of the surface. Place fabric filter over the top, with at least a 12-inch overlap on both sides. An underground trench may be filled with topsoil and planted. A surface trench may be filled with additional aggregate stone.

Divert drainage away from the infiltration trench until the contributing drainage area is fully stabilized, including full establishment of any vegetation.

Table IT.2 - Construction Criteria for Infiltration Trenches
1. Infiltration trenches should never serve as temporary sediment traps for construction.
2. Before the development site is graded, the area of the infiltration trench should be roped off and flagged to prevent heavy equipment from compacting the underlying soils.
3. Infiltration trenches should not be constructed until the entire contributing drainage area has been stabilized. Diversion berms should be placed around the perimeter or the infiltration trench during all phases of construction. Sediment and erosion controls should be used to keep runoff and sediment away from the trench area.
4. During and after excavation, all excavated materials should be placed downstream, away from the infiltration trench, to prevent redeposition of these materials during runoff events. These materials should be properly handled and disposed of during and after construction.
Light earth-moving equipment should be used to excavate the infiltration trench. Use of heavy equipment causes compaction of the soils in the trench floor, resulting in reduced infiltration capacity.

Maintenance

Because infiltration trenches are prone to failure due to clogging, it is imperative that they be aggressively maintained on a regular schedule. Using pretreatment BMPs will significantly reduce the maintenance requirements for the trench itself. Removing accumulated sediment from a deep sump catch basin or a vegetated filter strip is considerably less difficult and less costly than rehabilitating a trench. Eventually, the infiltration trench will have to be rehabilitated, but regular maintenance will prolong its operational life and delay the day when rehabilitation is needed. With appropriate design and aggressive maintenance, rehabilitation can be delayed for a decade or more. Perform preventive maintenance at least twice a year.

Inspect and clean pretreatment BMPs every six months and after every major storm event (2 year return frequency). Check inlet and outlet pipes to determine if they are clogged. Remove accumulated sediment, trash, debris, leaves and grass clippings from mowing. Remove tree seedlings, before they become firmly established.

Inspect the infiltration trench after the first several rainfall events, after all major storms, and on regularly scheduled dates every six months. If the top of the trench is grassed, it must be mowed on a seasonal basis. Grass height must be maintained to be no more than four inches. Routinely remove grass clippings leaves and accumulated sediment from the surface of the trench.

Inspect the trench 24 hours or several days after a rain event, to look for ponded water. If there is ponded water at the surface of the trench, it is likely that the trench surface is clogged. To address surface clogging, remove and replace the topsoil or first layer of stone aggregate and the filter fabric. If water is ponded inside the trench, it may indicate that the bottom of the trench has failed. To rehabilitate a failed trench, all accumulated sediment must be stripped from the bottom, the bottom of the trench must be scarified and tilled to induce infiltration, and all of the stone aggregate and filter fabric or media must be removed and replaced.

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Infiltration Basins

Description: Infiltration basins are stormwater runoff impoundments that are constructed over permeable soils. Pretreatment is critical for effective performance of infiltration basins. Runoff from the design storm is stored until it exfiltrates through the soil of the basin floor.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Can be designed to provide peak flow attenuation.
3 - Recharge	Provides groundwater recharge.
4 - TSS Removal	80% TSS removal, with adequate pretreatment
5 - Higher Pollutant Loading	May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. For some land uses with higher potential pollutant loads, use an oil grit separator, sand filter or equivalent for pretreatment prior to discharge to the infiltration basin. Infiltration must be done in compliance with 314 CMR 5.00
6 - Discharges near or to Critical Areas	Highly recommended, especially for discharges near cold-water fisheries. Requires 44% removal of TSS prior to discharge to infiltration basin
7 - Redevelopment	Typically not an option due to land area constraints

Advantages/Benefits:

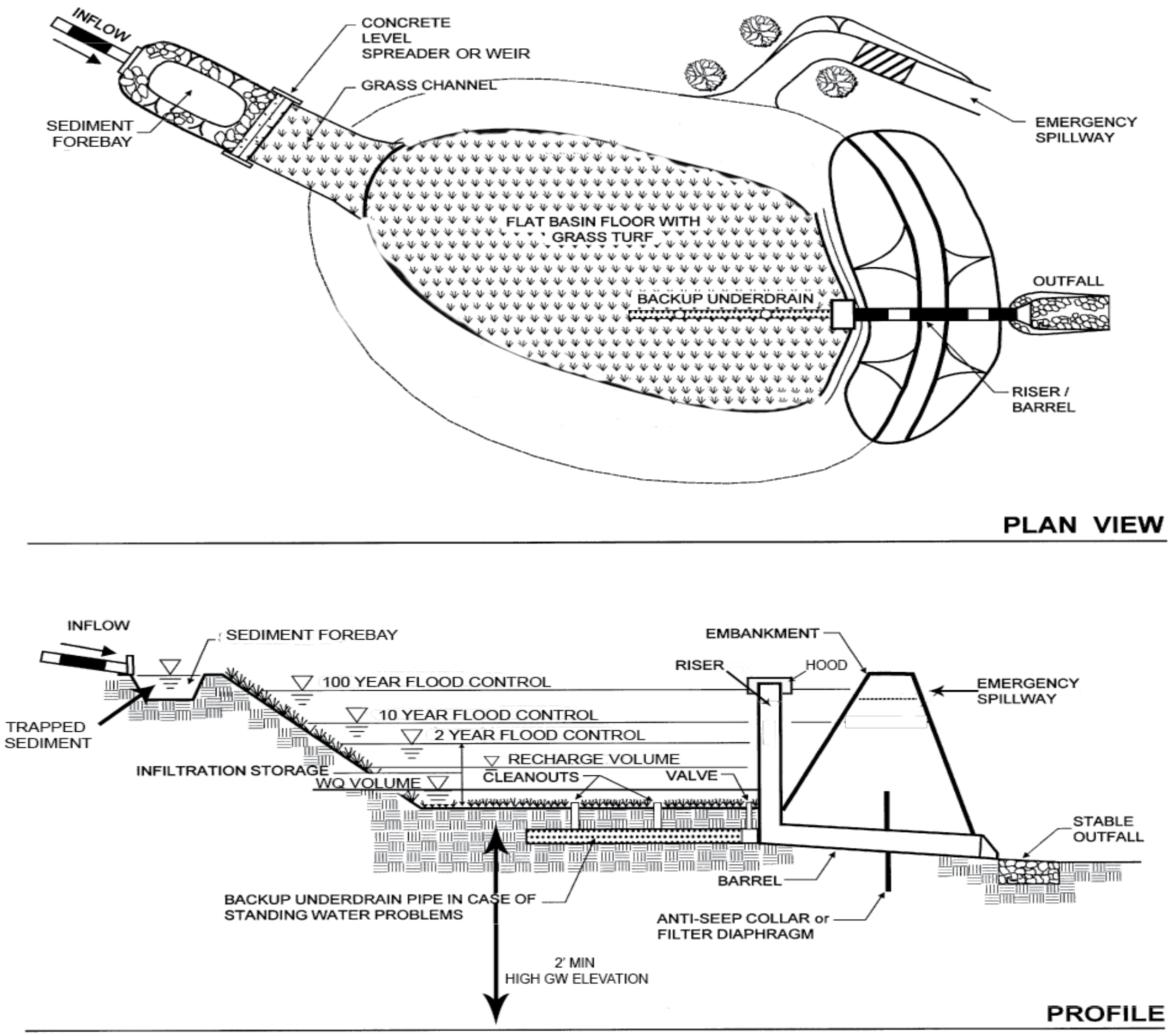
- Provides groundwater recharge.
- Reduces local flooding.
- Preserves the natural water balance of the site.
- Can be used for larger sites than infiltration trenches or structures.

Disadvantages/Limitations:

- High failure rates due to improper siting, inadequate pretreatment, poor design and lack of maintenance.
- Restricted to fairly small drainage areas.
- Not appropriate for treating significant loads of sediment and other pollutants.
- Requires frequent maintenance.
- Can serve as a “regional” stormwater treatment facility

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	80% with pretreatment
• Total Nitrogen	50% to 60%
• Total Phosphorus	60% to 70%
• Metals (copper, lead, zinc, cadmium)	85% to 90%
• Pathogens (coliform, e coli)	90%



adapted from the Vermont Stormwater Manual

Maintenance

Activity	Frequency
Preventative maintenance	Twice a year
Inspect to ensure proper functioning	After every major storm during first 3 months of operation and twice a year thereafter and when there are discharges through the high outlet orifice.
Mow the buffer area, side slopes, and basin bottom if grassed floor; rake if stone bottom; remove trash and debris; remove grass clippings and accumulated organic matter	Twice a year
Inspect and clean pretreatment devices	Every other month recommended and at least twice a year and after every major storm event.

Special Features: High failure rate without adequate pretreatment and regular maintenance.

LID Alternative: Reduce impervious surfaces. Bioretention areas

Infiltration Basins

The following are variations of the infiltration basin design.

Full Exfiltration Basin Systems

These basin systems are sized to provide storage and exfiltration of the required recharge volume and treatment of the required water quality volume. They also attenuate peak discharges. Designs typically include an emergency overflow channel to discharge runoff volumes in excess of the design storm.

Partial or Off-line Exfiltration Basin Systems

Partial basin systems exfiltrate a portion of the runoff (usually the first flush or the first half inch), with the remaining runoff being directed to other BMPs. Flow splitters or weirs divert flows containing the first flush into the infiltration basin. This design is useful at sites where exfiltration cannot be achieved by downstream detention BMPs because of site condition limitations.

Applicability

The suitability of infiltration basins at a given site is restricted by several factors, including soils, slope, depth to water table, depth to bedrock, the presence of an impermeable layer, contributing watershed area, proximity to wells, surface waters, and foundations. Generally, infiltration basins are suitable at sites with gentle slopes, permeable soils, relatively deep bedrock and groundwater levels, and a contributing watershed area of approximately 2 to 15 acres. Table IB.1 presents the recommended site criteria for infiltration basins.

Pollution prevention and pretreatment are particularly important at sites where infiltration basins are located. A pollution prevention program that separates contaminated and uncontaminated runoff is essential. Uncontaminated runoff can be infiltrated directly, while contaminated runoff must be collected and pretreated using an appropriate combination of BMPs and then rerouted to the infiltration basin. This approach allows uncontaminated stormwater to be infiltrated during and immediately after the storm and permits the infiltration of contaminated stormwater after an appropriate detention time. The Pollution Prevention and Source Control Plan required by Stormwater Standard 4 must take these factors into account. For land uses with higher potential pollutant loads, provide a bypass to divert contaminated stormwater from the infiltration basin in storms larger than the design storm.

Table IB.1 - Site Criteria for Infiltration Basins
1. The contributing drainage area to any individual infiltration basin should be restricted to 15 acres or less.
2. The minimum depth to the seasonal high water table, bedrock, and/or impermeable layer should be 2 ft. from the bottom of the basin.
3. The minimum infiltration rate is 0.17 inches per hour. Infiltration basins must be sized in accordance with the procedures set forth in Volume 3.
4. One soil sample for every 5000 ft. of basin area is recommended, with a minimum of three samples for each infiltration basin. Samples should be taken at the actual location of the proposed infiltration basin so that any localized soil conditions are detected.
5. Infiltration basins should not be used at sites where soil have 30% or greater clay content, or 40% or greater silt clay content.
6. Infiltration basins should not be placed over fill materials.
7. The following setback requirements should apply to infiltration basin installations: • Distance from any slope greater than 15% - Minimum of 50 ft. • Distance from any soil absorption system- Minimum of 50 ft. • Distance from any private well - Minimum of 100 ft., additional setback distance may be required depending on hydrogeological conditions. • Distance from any public groundwater drinking supply wells - Zone I radius, additional setback distance may be required depending on hydrogeological conditions. • Distance from any surface drinking water supply - Zone A • Distance from any surface water of the commonwealth (other than surface water supplies and their tributaries) - Minimum of 50 ft. • Distance from any building foundations including slab foundations without basements - Minimum of 10 ft. downslope and 100 ft. upslope.

Prior to pretreatment, implement the pollution prevention and source control program specified in the Pollution Prevention and Source Control Plan to reduce the concentration of pollutants in the discharge. Program components include careful management of snow and deicing chemicals, fertilizers, herbicides, and pest control. The Plan must prohibit snow disposal in the basin and include measures to prevent runoff of stockpiled snow from entering the basin. Stockpiled snow contains concentrations of sand and deicing chemicals. At industrial sites, keep raw materials and wastes from being exposed to precipitation. Select pretreatment BMPs that remove coarse sediments, oil and grease, and floatable organic and inorganic materials, and soluble pollutants.

Effectiveness

Infiltration basins are highly effective treatment systems that remove many contaminants, including TSS. However, infiltration basins are not intended to remove coarse particulate pollutants. Use a pretreatment device to remove them before they enter the basin. The pollutant removal efficiency of the basin depends on how much runoff is exfiltrated by the basin.

Infiltration basins can be made to control peak discharges by incorporating additional stages in the design. To do this, design the riser outlet structure or weir with multiple orifices, with the lowest orifice set to achieve storage of the full recharge volume required by Standard 3. Design the upper orifices using the same procedures as extended detention basins. The basins can also be designed to achieve exfiltration of storms greater than the required recharge volume. However, in such cases, make sure the soils are permeable enough to allow the basin to exfiltrate the entire volume in a 72-hour period. This may necessitate increasing the size of the floor area of the basin. Generally, it is not economically feasible to provide storage for large infrequent storms, such as the 100-year 24-hour storm.

Planning Considerations

Carefully evaluate sites before planning infiltration basins, including investigating soils, depth to bedrock, and depth to water table. Suitable parent soils should have a minimum infiltration rate of 0.17 inches per hour. Infiltration basis must be sized in accordance with the procedures set forth in Volume 3. The slopes of the contributing drainage area for the infiltration basin must be less than 5%.

Design

Infiltration basins are highly effective treatment and disposal systems when designed properly. The first step before design is providing source control and implementing pollution prevention measures to minimize sediment and other contaminants in runoff discharged to the infiltration basin. Next, consider the appropriate pretreatment BMPs.

Design pretreatment BMPs to pretreat runoff before stormwater reaches the infiltration basin. For Critical Areas, land uses with potentially higher pollutant loads, and soils with rapid infiltration rates (greater than 2.4 inches/hour), pretreatment must remove at least 44% of the TSS. Proponents may comply with this requirement by proposing two pretreatment BMPs capable of removing 25% TSS. However, the issuing authorities (i.e., Conservation Commissions or MassDEP) may require additional pretreatment for other constituents beyond TSS for land uses with higher potential pollutant loads. If the land use has the potential to generate stormwater runoff with high concentrations of oil and grease, treatment by an oil grit separator or equivalent is required before discharge to the infiltration basin.

For discharges from areas other than Critical Areas, land uses with potentially higher pollutant loads, and soils with rapid infiltration rates, MassDEP also requires some TSS pretreatment. Common pretreatment for infiltration basins includes aggressive street sweeping, deep sump catch basins, oil/grit separators, vegetated filter strips, water quality swales, or sediment forebays. Fully stabilize all land surfaces contributing drainage to the infiltration practice after construction is complete to reduce the amount of sediment in runoff that flows to the pretreatment devices.

Always investigate site conditions. Infiltration basins must have a minimum separation from seasonal high groundwater of at least 2 feet. Greater separation is necessary for bedrock. If there is bedrock on the site, conduct an analysis to determine the appropriate vertical separation. The greater the distance from the bottom of the basin media to the seasonal high groundwater elevation, the less likely the basin will fail to drain in the 72-hour period following precipitation.

Determine soil infiltration rates using samples collected at the proposed location of the basin. Take one soil boring or dig one test pit for every 5,000 feet of basin area, with a minimum of three borings for each infiltration basin. Conduct the borings or test pits in the layer where infiltration is proposed. For example, if the A and B horizons are to be removed and the infiltration will be through the C horizon, conduct the borings or test pits through the C horizon. MassDEP requires that borings be at least 20 feet deep or extend to the depth of the limiting layer.

For each bore hole or test pit, evaluate the saturated hydraulic conductivity of the soil, depth to seasonal high groundwater, NRCS soil textural class, NRCS Hydrologic Soil Group, and the presence of fill materials in accordance with Volume 3. Never locate infiltration basins above fill. Never locate infiltration basins in Hydrologic Soil Group "D" soils. The minimum acceptable final soil infiltration rate is 0.17 inches per hour. Design the infiltration basin based on the soil evaluation set forth in Volume 3.

If the proposed basin is determined to be in Hydrologic Soil Group "C" soils, incorporate measures in the design to reduce the potential for clogging, such as providing more pretreatment or greater media depth to provide additional storage. Never use the results of a Title 5 percolation test to estimate a saturated hydraulic conductivity rate, because it tends to greatly overestimate the rate that water will infiltrate into the subsurface.

Estimate seasonal high groundwater based on soil mottles or through direct observation when borings are conducted in April or May, when groundwater levels are likely to be highest. If it is difficult to determine the seasonal high groundwater elevation from the borings or test pits, then use the Frimpter method developed by the USGS (Massachusetts/ Rhode Island District Office) to estimate seasonal high groundwater. After estimating the seasonal high groundwater using the Frimpter method, re-examine the bore holes or test pits to determine if there are any field indicators that corroborate the Frimpter method estimate.

Stabilize inlet channels to prevent incoming flow velocities from reaching erosive levels, which can scour the basin floor. Riprap is an excellent inlet stabilizer. Design the riprap so it terminates in a broad apron, thereby distributing runoff more evenly over the basin surface to promote better infiltration.

At a minimum, size the basin to hold the required recharge volume. Determine the required recharge volume using either the static or dynamic methods set forth in Volume 3. Remember that the required storage volume of an infiltration basin is the sum of the quantity of runoff entering the basin from the contributing area and the precipitation directly entering the basin. Include one foot of freeboard above the total of the required recharge volume and the direct precipitation volume to account for design uncertainty. When applying the dynamic method to size the basin, use only the bottom of the basin (i.e., do not include side wall exfiltration) for the effective infiltration area.

Design the infiltration basin to exfiltrate in no less than 72 hours. Consider only the basin floor as the effective infiltration area when determining whether the basin meets this requirement.

Design the basin floor to be as flat as possible to provide uniform ponding and exfiltration of the runoff. Design the basin floor to have as close to a 0% slope as possible. In no case shall the longitudinal slope exceed 1%. Enhanced deposition of sediment in low areas may clog the surface soils, resulting in reduced infiltration and wet areas. Design the side slopes of the basin to be no steeper than 3:1 (horizontal: vertical) to allow for proper vegetative stabilization, easier mowing, easier access, and better public safety.

For basins with a 1% longitudinal slope, it will be necessary to incorporate cells into the design, making sure that the depth of ponded water does not exceed 2 feet, because sloped basin floors cause water to move downhill, thereby decreasing the likelihood of infiltration. Make lateral slopes flat (i.e., 0% slope).

After the basin floor is shaped, place soil additives on the basin floor to amend the soil. The soil additives shall include compost, properly aged to kill any seed stock contained within the compost. Do not put biosolids in the compost. Mix native soils that were excavated from the A or B horizons to create the basin with the compost, and then scarify the native materials and compost into the parent material using a chisel plow or rotary device to a depth of 12 inches. Immediately after constructing the basin, stabilize its bottom and side slopes with a dense turf of water-tolerant grass. Use low-maintenance, rapidly germinating grasses, such as fescues. The selected grasses must be capable of surviving in both wet and dry conditions. Do not use sod, which can prevent roots from directly contacting the underlying soil. During the first two months, inspect the newly established vegetation several times to determine if any remedial actions (e.g., reseeding, irrigating) are necessary.

Never plant trees or shrubs within the basin or on the impounding embankments as they increase the chance of basin failure due to root decay or subsurface disturbance. The root penetration and thatch formation of the turf helps to maintain and may even enhance the original infiltration capacity. Soluble nutrients are taken up by the turf for growth, improving the pollutant removal capacity. Dense turf will impede soil erosion and scouring of the basin floor.

In place of turf, use a basin liner of 6 to 12 inches of fill material, such as coarse sand. Clean and replace this material as needed. Do not use loose stone, riprap, and other irregular materials requiring hand removal of debris and weeds.

Design embankments and spillways to conform to the regulatory guidelines of the state's Office of Dam Safety (302 CMR 10.00). Design infiltration basins to be below surrounding grade to avoid issues related to potential embankment failure. All infiltration basins must have an emergency spillway capable of bypassing runoff from large storms without damage to the impounding structure. Design the emergency spillway to divert the storm associated with brimful conditions without impinging upon the structural integrity of the basin. The brimful condition could be the required recharge volume or a design storm (such as the 2-year, 10-year, or 100-year storm if the basin is designed to provide peak rate attenuation in addition to exfiltration). The storm associated with the brimful conditions should not include the one foot of freeboard required to account for design uncertainty. Design the emergency spillway to shunt water toward a location where the water will not damage wetlands or buildings. A common error is to direct the spillway runoff toward an adjoining property not owned by an applicant. If the emergency spillway is designed to drain the emergency overflow toward an adjoining property, obtain a drainage easement and submit it to the Conservation Commission as part of the Wetlands NOI submission. Place vegetative buffers around the perimeter of the basin for erosion control and additional sediment and nutrient removal.

Monitoring wells: Install one monitoring well in the basin floor per every 5,000 square feet of basin floor. Make sure the monitoring well(s) extend 20 feet beneath the basin floor or to the limiting layer, whichever is higher.

Access: Include access in the basin design. The area at the top of the basin must provide unimpeded vehicular access around the entire basin perimeter. The access area shall be no less than 15 feet.

Inlet Structures: Place inlet structures at one longitudinal end of the basin, to maximize the flow path from the inlet to the overflow outlet. A common error is to design multiple inlet points around the entire basin perimeter.

Outlet structures: Infiltration basins must include an overflow outlet in addition to an emergency spillway. Whether using a single orifice or multiple orifices in the design, at a minimum, set the lowest orifice at or above the required recharge volume.

Drawdown device: Include a device to draw the basin down for maintenance purposes. If the basin includes multiple cells, include a drawdown device for each cell.

Fences: Do not place fences around basins located in Riverfront Areas, as required by 310 CMR 10.58(4)(d)1.d. to avoid impeding wildlife movement. In such cases, consider including a safety bench as part of the design.

Construction

Prior to construction, rope or fence off the area selected for the infiltration basin. Never allow construction equipment to drive across the area intended to serve as the infiltration basin.

Never use infiltration basins as temporary sediment traps for construction activities.

To limit smearing or compacting soils, never construct the basin in winter or when it is raining. Use light earth-moving equipment to excavate the infiltration basin because heavy equipment compacts the soils beneath the basin floor and side slopes and reduces infiltration capacity. Because some compaction of soils is inevitable during construction, add the required soil amendments and deeply till the basin floor with a rotary tiller or a disc harrow to a depth of 12 inches to restore infiltration rates after final grading.

Use proper erosion/sediment control during construction. Immediately following basin construction, stabilize the floor and side slopes of the basin with a dense turf of water-tolerant grass. Use low maintenance, rapidly germinating grasses, such as fescues. Do not sod the basin floor or side slopes. After the basin is completed, keep the basin roped or fenced off while construction proceeds on other parts of the site. Never direct construction period drainage to the infiltration basin. After construction is completed, do not direct runoff into the basin until the bottom and side slopes are fully stabilized.

Maintenance

Infiltration basins are prone to clogging and failure, so it is imperative to develop and implement aggressive maintenance plans and schedules. Installing the required pretreatment BMPs will significantly reduce maintenance requirements for the basin.

The Operation and Maintenance Plan required by Standard 9 must include inspections and preventive maintenance at least twice a year, and after every time drainage discharges through the high outlet orifice. The Plan must require inspecting the pretreatment BMPs in accordance with the minimal requirements specified for those practices and after every major storm event. A major storm event is defined as a storm that is equal to or greater than the 2-year, 24-hour storm (generally 2.9 to 3.6 inches in a 24-hour period, depending in geographic location in Massachusetts).

Once the basin is in use, inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary take corrective action. Note how long water remains standing in the basin after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging (such as upland sediment erosion, excessive compaction of soils, or low spots).
Thereafter, inspect the infiltration basin at least twice per year. Important items to check during the inspection include:

- Signs of differential settlement,
- Cracking,
- Erosion,
- Leakage in the embankments
- Tree growth on the embankments
- Condition of riprap,
- Sediment accumulation and
- The health of the turf.

At least twice a year, mow the buffer area, side slopes, and basin bottom. Remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Use deep tilling to break up clogged surfaces, and revegetate immediately.

Remove sediment from the basin as necessary, but wait until the floor of the basin is thoroughly dry. Use light equipment to remove the top layer so as to not compact the underlying soil. Deeply till the remaining soil, and revegetate as soon as possible. Inspect and clean pretreatment devices associated with basins at least twice a year, and ideally every other month.

References:

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Center for Watershed Protection, http://www.stormwatercenter.net/Manual_Builder/Performance%20Criteria/Infiltration.htm

Center for Watershed Protection, Stormwater Management Fact Sheet, Infiltration Basin,
http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool6_Stormwater_Practices/Infiltration%20Practice/Infiltration%20Basin.htm

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Leaching Catch Basins

Description: A leaching catch basin is pre-cast concrete barrel and riser with an open bottom that permits runoff to infiltrate into the ground. There are two configurations:

1. Stand-alone barrel/riser and
2. Barrel/riser combined with a deep sump catch basins that provides pretreatment.

80% TSS removal is awarded to the deep sump catch basin/leaching catch basin pretreatment combination provided the system is off-line.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	May provide some peak rate attenuation if sufficient number of leaching catch basins are provided to control 10-year storm
3 - Recharge	Provides groundwater recharge
4 - TSS Removal	80% TSS removal providing a deep sump catch basin is used for pretreatment and provided it is designed to be off-line
5 - Higher Pollutant Loading	May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. For land uses that have the potential to generate runoff with high concentrations of oil and grease, an oil grit separator or equivalent may be required for pretreatment prior to discharge to the leaching catch basin. Infiltration must be done in compliance with 314 CMR 5.00.
6 - Discharges near or to Critical Areas	Not suitable except as terminal treatment for discharges to or near cold-water fisheries.
7 - Redevelopment	May be a good retrofit for sites with existing catch basins

Advantages/Benefits:

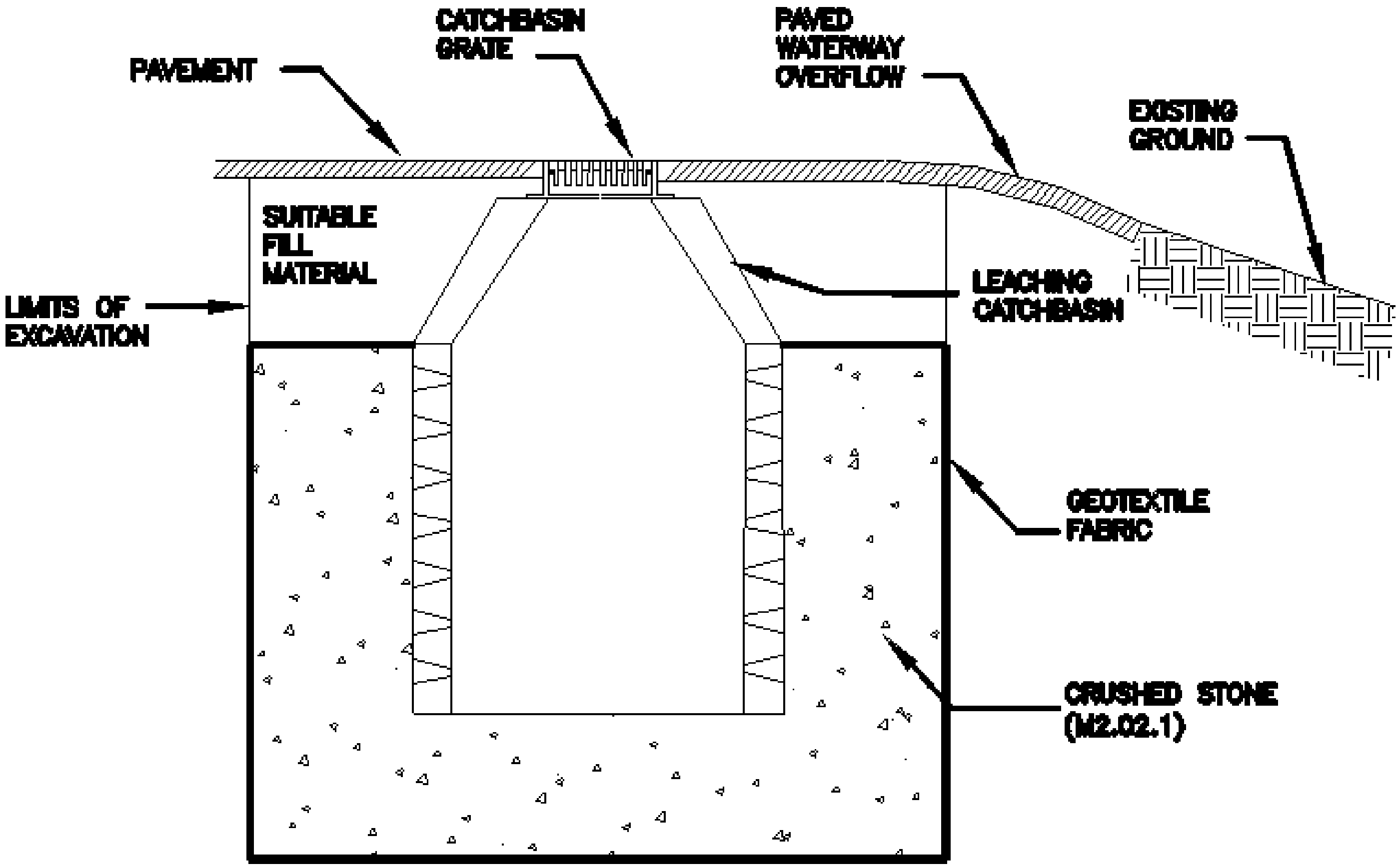
- Provide groundwater recharge.
- Remove coarse sediment

Disadvantages/Limitations:

- Need frequent maintenance. Can become a source of pollutants via resuspension if not properly maintained.
- Cannot effectively remove soluble pollutants or fine particles.
- Do not provide adequate treatment of runoff unless combined with deep sump catch basin
- Entrapment hazard for amphians and other small animals.

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	80% if combined with deep sump catch basin and if designed to be off-line
• Nutrients (Nitrogen, phosphorus)	Insufficient data
• Metals (copper, lead, zinc, cadmium)	Insufficient data
• Pathogens (coliform, e coli)	Insufficient data



adapted from the MassHighway Department

Maintenance

Activity	Frequency
Inspect units and remove debris	Inspect annually or more frequently as indicated by structure performance
Remove sediment	When the basin is 50% filled
Rehabilitate the basin if it fails due to clogging	As needed

Special Features:

Use as off-line device

LID Alternative:

Reduce pervious areas
Bioretention areas and rain gardens

Leaching Catch Basins

Planning Considerations

Use leaching catch basins as off-line devices in areas with highly permeable soils. Provide for the safe overflow from these devices in severe storm events, or in the event of clogging of the soils surrounding the device. Because leaching catch basins discharge runoff to groundwater, do not use them in areas of higher potential pollutant loadings (such as gas stations) without adequate pretreatment such as an oil grit separator.

Design

Leaching catch basins are typically set in an excavation lined with a geotextile liner to prevent fine soil particles from migrating into the void spaces of the stone. The basin is placed on a pad of free-draining crushed stone, with the excavation around the basin back-filled with similar material. The base and barrel of the basin are perforated so that water entering the basin can enter the surrounding stone fill and infiltrate into the ground.

Use stone material with a void ratio of 0.39 or less. Make the depth to groundwater at least 2 feet below the bottom of the leaching catch basin. When designing structural components, design for dead and live loads as appropriate. Include provisions for overflows such as redundant devices and paved chutes.

The basin inlet cover is an important component. The openings must be no larger than 1 inch square to prevent coarse debris larger than 1 inch from entering the basin. The inlet grate must fit tightly into the underlying steel frame to prevent it from being dislodged by traffic. Do not weld the inlet grate to the underlying frame.

The riser section shall be mortared, grouted, gasketed, or otherwise sealed, to prevent exfiltration through the joint. Leaching catch basins shall contain no weep holes. Do not perforate the barrel section.

Make sure leaching catch basins contain no outlet pipes. The only pipe that is allowed in a leaching catch basin is an inlet pipe from an off-line deep sump catch basin paired with that leaching catch basin. Seal all pipe joints.

Construction

Install construction barriers around the excavation area to prevent access by pedestrians. Use diversions and other erosion control practices up-slope of the leaching catch basin to prevent runoff from entering the site before catch basins are complete. Stabilize the surrounding area and any established outlet. Put controls in place to prevent any drainage from being discharged to the leaching catch basin until the contributing drainage area is fully stabilized. Remove all temporary structures after the contributing drainage area and vegetation is stabilized.

Maintenance

- Inspect annually or more frequently as indicated by structure performance
- Remove sediment when the basin is 50% filled.
- Rehabilitate the basin if it fails due to clogging

Adapted from:
MassHighway. Storm Water Handbook for Highways and Bridges. May 2004.

BMP Accessories: Level Spreaders, Check Dams, Outlet Structures, Catch Basin Inserts

BMP accessories are not BMPs themselves but are required to facilitate the operation and function of BMPs. This section presents four of the most common and important BMP accessories: level spreaders, check dams, outlet structures, and catch basin inserts.

Level Spreaders

Description

A level spreader receives concentrated flow from channels, outlet structures, or other conveyance structures, and converts it to sheet flow where it can disperse uniformly across a stable slope. A level spreader is not a pollutant reduction device. It improves the efficiency of other BMPs, such as vegetated swales, filter strips, or infiltration systems that depend on sheet flow to operate properly.

Applicability and Planning Considerations

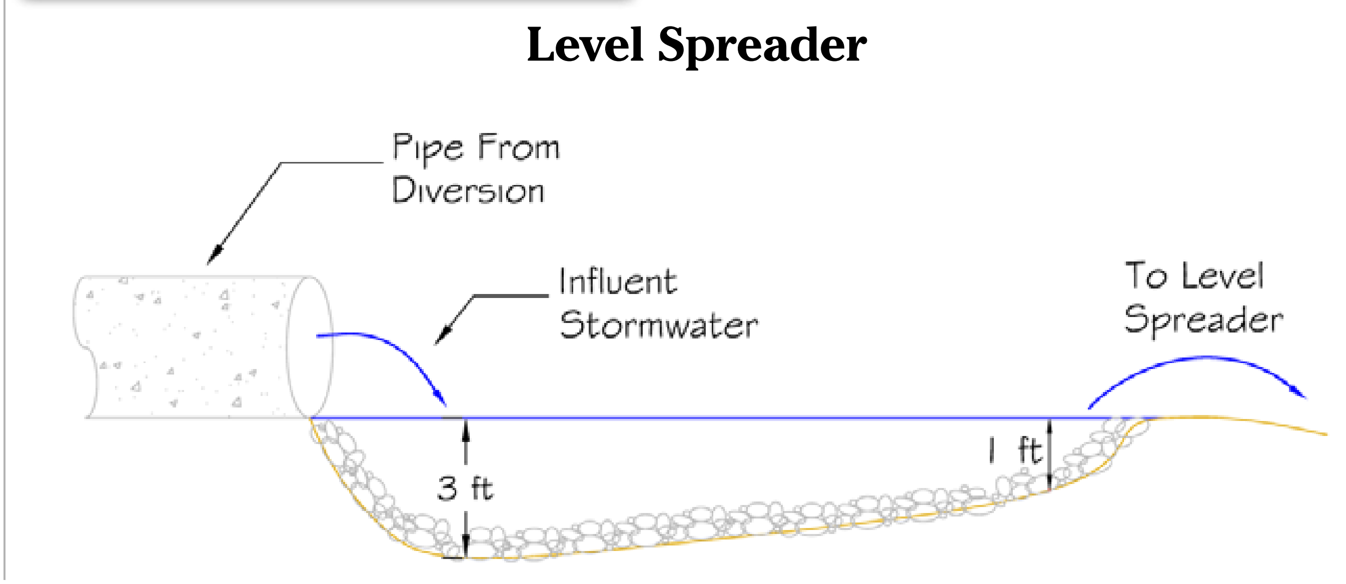
Level spreaders are used in wide, level areas where concentrated runoff occurs. They should be placed on undisturbed soil that has been stabilized with vegetation. Disturbed soils are more erodible. If the spreader is not absolutely level, flow will concentrate at the low point and may worsen erosion problems. Flows to the level spreader should be relatively free of sediment, or the level spreader could be quickly overwhelmed by sediment and lose its effectiveness.

Design and Construction

Level spreaders are usually made of rocks, lumber, or concrete. Typical depths of flow behind each spreader range from 6 to 12 inches.

Construct level spreaders to be absolutely level. Small variations in height of even 0.25 inches can cause water to quickly concentrate and create erosion problems. A 4-inch variation in ground elevation across the entire length of the level spreader can make level construction difficult.

The height of the spreader is based on design flow, allowing for sediment and debris deposition. Design the length of the spreader based on the 10-year design flow for the site or the sheet flow path width, whichever is greater. When designing for the 10-year design flow, use the following table:



adapted from the North Carolina State University

Drainage Area	Minimum spreader length
1 acre	10 feet
2 acres	10 feet
3 acres	15 feet
4 acres	18 feet
5 acres	20 feet

The slope leading to the level spreader should be less than 1% for at least 20 feet immediately upstream, to keep runoff velocities less than 2 feet per second during the 10-year storm event. The slope at the outlet of the spreader should be 6% or less.

Maintenance

Inspect level spreaders regularly, especially after large rainfall events. Note and repair any erosion or low spots in the spreader.

Adapted from:
Idaho Department of Environmental Quality. Catalog of Stormwater BMPs for Cities and Counties, 209-210.
MassDEP, Massachusetts Nonpoint Source Pollution Management Manual, 2006.
http://www.mass.gov/dep/water/laws/policies.htm#storm
Additional Resources:
Hunt, W.F. et al. Designing Level Spreaders to Treat Stormwater Runoff. North Carolina State University, as presented at North Carolina Department of Transportation Level Spreader Workshop, February 19, 2001, Raleigh, NC.

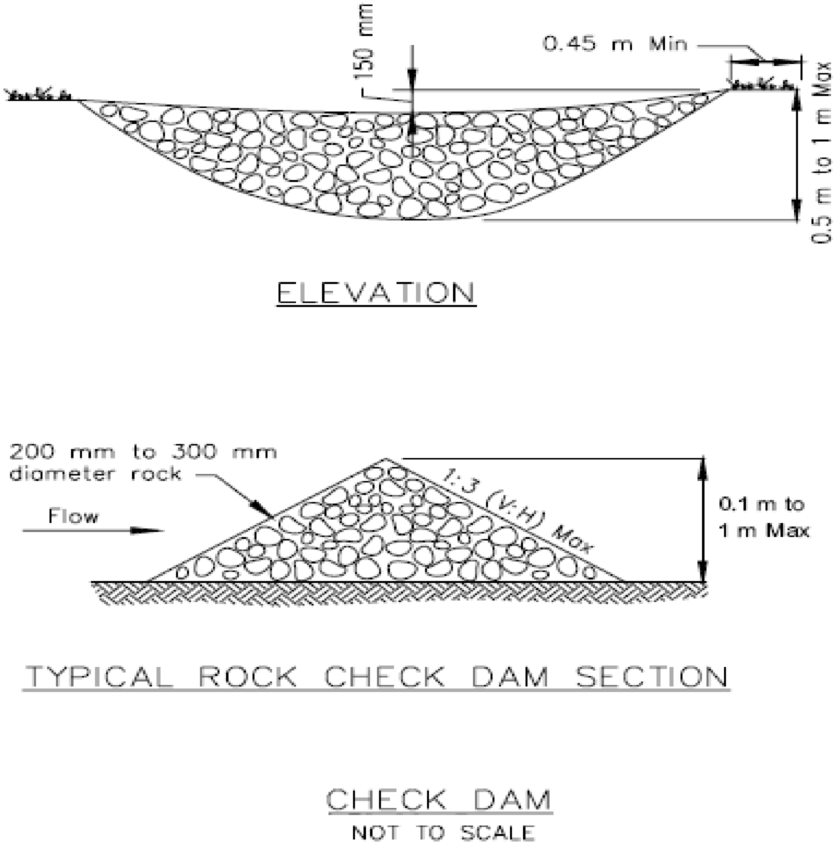
Check Dams

Description

A check dam is a small dam constructed across a drainage ditch, swale, or channel to lower the velocity of flow. Reduced runoff velocity reduces erosion and gullying in the channel and allows sediments to settle out. A check dam may be built from stone, sandbags (filled with pea gravel), logs, or concrete. Check dams are relatively easy and inexpensive to construct. Permanent check dams should be constructed from stone or concrete. Sandbag dams filled with pea gravel or logs are suitable only as temporary practices. Never use a filter fence or a hay bale as a check dam, either on a temporary or permanent basis.

Applicability

Use check dams where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, where velocity checks are needed, or to induce stormwater exfiltration into the ground within a BMP such as a dry water quality swale. Check dams may also be used as a temporary or emergency measure to limit erosion by reducing flow in small open channels. Other uses for



adapted from Caltrans Stormwater Handbooks check dams include:

- To reduce flow in small temporary channels that are presently undergoing degradation,
- Where permanent stabilization is impractical due to the temporary nature of the problem,
- To reduce flow in small eroding channels where construction delays or weather conditions prevent timely installation of non-erosive liners.

Check dams can be installed in small open channels that drain 10 acres or less, or channels where stormwater velocities exceed 5 feet per second. Note that some BMPs such as grass channels require flows to not exceed 1 foot per second for the water quality volume. Check dams cause water to pond. Under low-flow situations, water ponds behind the structure and then slowly seeps through the check dam and/or exfiltrates into the underlying soil, depending on the soil permeability. Under high-flow situations, water flows over and/or through the structure.

Advantages

- Inexpensive and easy to install.
- Reduces velocity and may provide aeration of the water.
- Prevents gully erosion from occurring before vegetation is established, and also causes a high proportion of the sediment load in runoff to settle out.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading, etc.
- They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to capture sediment coming off that site.
- They must be constructed in dry water quality swales to reduce velocity and induce exfiltration.

Disadvantages

- May kill grass linings in channels if the water level remains high after rainstorms or if there is significant sedimentation.
- Clogging by leaves in the fall may be a problem.
- Should not be used in live streams
- Promotes sediment trapping but resuspension can occur during subsequent storms
- Require extensive maintenance following high velocity flows
- Should not be made from straw bales or silt fences

Design

Install check dams at a distance and a height to allow small pools to form behind them. Install the first check dam about 15 feet from the outfall device and at regular intervals after that, depending on slope and soil type. In multiple check dam installations, design the system so that backwater from the downstream check dam reaches the toe of the next upstream dam. High flows (typically a 2-year or larger storm) should flow over the check dam without increasing upstream flooding or damaging the dam. Form check dams by hand or mechanically. Never dump rock directly into the channel or swale. Rock check dams should consist of well-graded stone consisting of a mixture of rock sizes.

When used in dry water quality swales, the height of the check dam shall be no less than the elevation associated with the Water Quality Volume (1/2 inch or 1-inch times contributing impervious surface).

Exercise care in designing the ends of a check dam to ensure that it is long enough and adequately anchored to prevent ponded water from scouring the soil at the ends, and flowing around the dam.

Some check dam designs may require weirs. For example, if the same check dam is used for water quality treatment (for the water quality volume), and to lag the peak rate of runoff (for the velocity associated with runoff from the 2-year storm), a weir must be included as part of the check dam design. In instances where a permanent check dam is to be used for both water quality treatment and lag peak flows with a weir, use a durable material such as concrete. If the check dam is constructed from stone such as pea gravel, the weir would most likely lose its shape when higher velocities occur.

Maintenance

Inspect check dams after every significant rainfall event. Repair damage as needed. Remove sediment as needed.

Adapted from:
Caltrans, Storm Water Quality Handbooks. Section 4. SC-4 P.
MassDEP, Massachusetts Nonpoint Source Pollution Management Manual, 2006.
http://www.mass.gov/dep/water/laws/policies.htm#storm

OUTLET STRUCTURES

Description

Outlets of BMPs are devices that control the flow of stormwater out of the BMP to the conveyance system.

Outlet Protection Design in Relation to Receiving Wetlands

This section describes the various types of common outlets such as flared end structures, risers, single-stage outlets, and multi-stage outlets. Considerations include setting back the outlet from a brook, providing appropriate energy dissipation, and orientating the outlet to reduce scour effects on the opposite bank.

Alignment of Outlets into Regulatory Streams

The Wetlands and 401 regulations require that stormwater treatment be provided prior to discharge into wetland resource areas such as vegetated wetlands (BVW, IVW, salt marshes), land under water (streams, lakes, rivers, ponds, ocean), and other resource areas, except for Riverfront Areas ILSF, BLSF, and land subject to coastal zone flowage, where such practices may be sited, provided the structures meet the performance standards specified in the Wetland regulations applicable to all projects.

The impact of new pipe outfalls on wetlands can be significantly reduced by locating the outfall point back from the receiving stream, using a flared-end structure, installing riprap or bio-engineered splash pad, and either digging a channel from the outfall to the stream or designing the splash pad to act as a level spreader to sheet the discharged stormwater to the stream.

In addition to not placing the outfall and energy dissipation in a wetland resource area such as a BVW or LUW, care must be exercised in the outlet design to ensure its orientation is such to reduce scour at the entry point and opposite bank. The preferred approach is to end the outlet pipe at a headwall or flared-end structure with a riprap or bio-engineered splash pad, discharging to a manmade drainage swale that is aligned at no more than a 45 degree angle to a stream channel. Design the outlet point and riprap or bio-engineered splash pad to reduce the energy sufficiently to eliminate a need to install riprap on the bank opposite the outfall point to protect it from scour.

References for BMP Accessories:

Note that sections of the Massachusetts Stormwater Update were adapted from a variety of manuals, checklists and other references in the public domain previously developed by other states and federal agencies, including:

Caltrans, Storm Water Quality Handbooks. 2003. (http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm)

Connecticut Department of Environmental Protection. Connecticut Stormwater Quality Manual. 2004. (http://dep.state.ct.us/wtr/stormwater/strmwtrman.htm)

Idaho Department of Environmental Quality. Catalog of Stormwater BMPs for Cities and Counties. March 2003. (http://www.google.com/u/DEQ?q=stormwater&domains=www.deq.idaho.gov&sitesearch=www.deq.idaho.gov)

Maine Department of Environmental Protection. Maine Stormwater Best Management Practices Manual. January 2006. (http://www.maine.gov/dep/blwq/docstand/stormwater/stormwaterbmps/index.htm)

Maryland Department of the Environment. Maryland Stormwater Design Manual, Volumes I and II, October 2000. (http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp)

New Jersey Department of Environmental Protection. New Jersey Stormwater Best Management Practices Manual. April 2004. http://www.state.nj.us/dep/stormwater/bmp_manual2.htm

U.S. Department of Transportation. Federal Highway Administration. Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring. (Undated). (http://www.fhwa.dot.gov/environment/ultraurb/index.htm)

U.S.Environmental Protection Agency. Office of Research and Development. The Use of Best Management Practices (BMPs) in Urban Watersheds. EPA/600/R-04/184. September 2004.

Vermont Agency of Natural Resources. The Vermont Stormwater Management Manual. April 2002. (http://www.vtwaterquality.org/stormwater.htm)

Catch Basin Inserts

Description

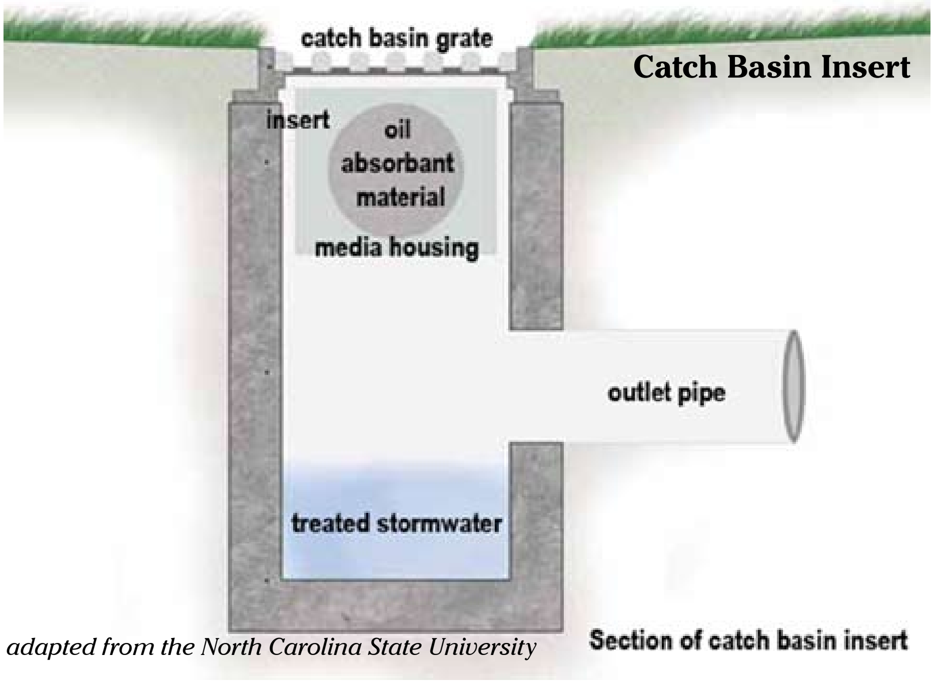
Catch Basin Inserts are a BMP accessory recently developed to add filtering efficiency to traditional catch basins. These proprietary BMPs are capable of removing a range of pollutants, from trash and debris to fine sediments and oil/grease and metals depending upon the filtering medium used. They typically have three components:

- an insert that fits in into the catch basin
- absorbent material (can be a single unit or a series of filters)
- a housing to hold the absorbent material

Applicability and Planning Considerations

Catch Basin Inserts can be useful for specialized applications, such as targeting specific pollutants other than TSS, at Land Uses with Higher Potential Pollution Loads, for oil control at small sites, for retrofits of existing catch basins with no or undersized sumps, to add TSS capability to areas with higher sediment loading, or to improve existing conditions at size-constrained sites (e.g., catch basins near bathing beaches).

If using a proprietary Catch Basin Insert, the manufacturer's specifications must be followed, which may include modifications to the catch basin. Such modifications may include a high flow bypass or other feature to handle clogging or larger storm events.



adapted from the North Carolina State University

Catch Basin Inserts are typically designed for and used for smaller volume applications. Additionally, larger sized sediment can clog and significantly reduce the effectiveness of some Catch Basin Insert filtering media. Therefore it is important to ensure that flow rates, sediment removal, and the frequency of inspection and maintenance are evaluated.

Design and Construction

Since Catch Basin Inserts are usually proprietary devices, the manufacturer should be asked to ensure that the device will work in the type of catch basin in which it is installed. Flow characteristics and sediment loading should be evaluated and any resulting modifications to the catch basin made before installation of the insert.

Maintenance

Inspect Catch Basin Inserts per the manufacturer's schedule, and especially after large rainfall events. Whoever is responsible for maintenance should explicitly agree to conduct the maintenance per the manufacturer's recommendation and to lawfully dispose of the cleanings or used filtration media.

Appendix C

Stormwater Management Review Reports

Name: Date:

General Notes/Comments: (Describe weather and general drainage system conditions)

Structure	Current Condition	Maintenance Performed
Vegetative Filter Strip:		
Review (Grass height, sediment, and debris)		
Drainage Channels:		
Review (Vegetated condition, sediment, and debris)		
Grassed Channels:		
Review (Vegetated condition, sediment, and debris)		
Catch Basin/Manhole:		
Review (Overall structure conditions, hood, sediment depth, and debris)		
Leaching Basin:		
Review (Overall structure condition, sediment depth, and debris)		
Infiltration Trench:		
Review (Signs of effective operation, sediment, and debris)		
Infiltration Basins:		
Review (Grass height, sediment, debris, signs of effective operation)		
Proprietary Separator:		
Review (Oil depth and debris)		
Outlets/Headwalls:		
Review (Structure integrity and debris)		
Pipes/Open Box Culvert:		
Review (structural integrity, silting, and clogging)		

CHECKLIST FOR STORMWATER REPORT

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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.[1] 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 8[2]
- 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.

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[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.

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.

Registered Professional Engineer Block and Signature

MARK K. OTTARIANO
CIVIL
No. 48698

9/26/2016
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

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:

☒ 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): ____________________

Standard 1: No New Untreated Discharges

☒ 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 (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 *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.

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

Checklist (continued)

Standard 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.

Standard 4: Water Quality

The 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.

Checklist (continued)

Standard 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.

Standard 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 ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** 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 ***not*** 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.

Standard 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.

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.

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.