APPENDIX D

Tidal Gate Removal Permit

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

79 Elm Street • Hartford, CT 06106-5127 www.ct.gov/deep Affirmative Action/Equal Opportunity Employer

June 7, 2012

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

City of Bridgeport
John Ricci
1000 Great Meadow Drive
Stratford, CT 06615

Subject: Certificate of Permission #201201271-KZ
Sikorsky Memorial Airport, 1000 Great Meadow Drive, Stratford

Dear Mr. Ricci:

Enclosed please find a copy of the certificate of permission ("certificate") which is being issued pursuant to your application of April 8, 2012. Your attention is directed to the conditions of the enclosed certificate. All work must conform to that which is specifically authorized by this certificate. Any work in tidal wetlands or waterward of the high tide line in tidal, navigable and coastal waters of the State which has not been authorized by a valid permit or certificate is a violation of state law and subject to enforcement action by the Department of Energy and Environmental Protection and the Office of the Attorney General.

Your initiation of authorized activities will be relied upon as your agreement to comply with the terms and conditions of the certificate. Please note that Appendix B of the certificate has been enclosed for your convenience to comply with Connecticut General Statutes Section 22a-363g. Also, the Permit Notice, found at the back of your authorization, must be posted at the work area while the work is being undertaken. Please refer to the SPECIAL TERMS AND CONDITIONS of your certificate for further details.

If you have not already done so, you should contact your local Planning and Zoning Office to determine local permit requirements for your project. Also, your activity may be eligible for General Permit authorization from the U.S. Army Corps of Engineers ("Corps"). Most maintenance and reconstruction activities require no further authorization from the Corps. Other activities, generally involving work in tidal wetlands or other special aquatic sites, and in or near a federal Navigation Project or involving filling, must receive written authorization from the Corps prior to beginning work. The State of Connecticut will automatically forward this certificate to the Corps for its determination of General Permit eligibility. You do not need to apply directly to the Corps unless they notify you. For more information regarding this federal process, you may write to the Corps New England Division, Regulatory Branch, 696 Virginia Road, Concord, Massachusetts, 02254 or call 978-318-8335 or 800-343-4789.

Sincerely,

Kevin Zawoy, Environmental Analyst
Office of Long Island Sound Programs
Bureau of Water Protection and Land Reuse

Enclosure – COP #201201271-KZ

cc: File #201201271-KZ
URS Corporation
Municipal CEO
ACOE
Harbor Master

Connecticut Department of

ENERGY &
ENVIRONMENTAL
PROTECTION

CERTIFICATE OF PERMISSION

Certificate No: 2012001271-KZ

Municipalities: Stratford

Site of Activity: Sikorsky Memorial Airport, 1000 Great Meadow Drive, earthen berm at western end of marine basin

Certificate Holder: City of Bridgeport
1000 Great Meadow Drive
Stratford, CT 06615

Pursuant to section 22a-363b of the Connecticut General Statutes ("CGS") and in accordance with CGS section 22a-98, CGS sections 22a-359 to 22a-363f, CGS sections 22a-28 through 22a-35, and the Connecticut Water Quality Standards effective February 25, 2011, a certificate of permission ("certificate") is hereby granted to remove an existing tide gate and berm for tidal wetlands restoration as is more specifically described below in the SCOPE OF AUTHORIZATION.

*****NOTICE TO CERTIFICATE HOLDER AND CONTRACTORS*****

UPON INITIATION OF ANY WORK AUTHORIZED HEREIN, THE CERTIFICATE HOLDER ACCEPTS AND AGREES TO COMPLY WITH ALL TERMS AND CONDITIONS OF THIS CERTIFICATE. FAILURE TO CONFORM TO THE TERMS AND CONDITIONS OF THIS CERTIFICATE MAY SUBJECT THE CERTIFICATE HOLDER AND ANY CONTRACTOR TO ENFORCEMENT ACTIONS, INCLUDING INJUNCTIONS AS PROVIDED BY LAW AND PENALTIES UP TO $1,000.00 PER DAY PURSUANT TO THE ADMINISTRATIVE CIVIL PENALTY POLICY DESCRIBED IN SECTIONS 22a-6b-1 THROUGH 22a-6b-15 OF THE REGULATIONS OF CONNECTICUT STATE AGENCIES ("RCSA").

SCOPE OF AUTHORIZATION

The Certificate Holder is hereby authorized to conduct the following work as described in application #201201271-KZ, including 9 sheets of plans, Figures 1 through 8, and one sheet entitled "Vicinity Map" dated September 2011 submitted by the Certificate Holder to the Commissioner of Energy and Environmental Protection ("Commissioner") and attached hereto:

1. remove an existing tidal gate and section of earthen berm located south of the existing gravel driveway located off Main Street, Route 113 as follows:

a. temporarily install a turbidity control curtain on the upstream and downstream sides of the area of proposed removed earthen berm as shown on Figure 4., of the plans attached hereto;

b. excavate approximately 525 cubic yards of earthen fill including removal of an existing reinforced concrete tide gate structure and pipe over an approximately 6,000 square foot area to a depth of -2.0' NGVD a 20 foot wide base and 3:1 side slopes terminating at elevation 5.75' NGVD; and with

c. place a minimum of 6 inches of a sandy loam if required on the 3:1 side slopes to enhance tidal wetland plant growth and cover the side slopes with a biodegradable matting.

SPECIAL TERMS AND CONDITIONS

1. Prior to the commencement of the work authorized herein, the Certificate Holder shall test the authorized excavated material to characterize contamination levels for proper disposal in accordance with state statutes. If Raymark waste is identified EPA and CT DEEP Remediation must be notified and any actions must be approved by EPA and the CT DEEP in writing.

2. Prior to the commencement of work authorized here, the Certificate Holder shall submit a stockpile and haul road location plan for the Commissioner's review and written approval to address potential adverse environmental impacts to a known state listed plant species which has been identified to exist at the site. Such stockpile area must be outside of the 100 year floodplain. The Certificate Holder shall follow any recommendations made by the Commissioner in writing

3. Prior to the commencement of the work authorized herein, the Certificate Holder shall submit to the Commissioner for review and written approval an up-dated hydraulic analysis to demonstrate that the work authorized herein will not result in increased flooding of existing or relocated Main Street (Route 113) located at the site.

4. Prior to the commencement of work authorized here, the Certificate Holder shall submit an on-site evaluation for the Commissioner's review and written approval which demonstrates that any contaminated areas that will be subject to tidal action once the work authorized herein is complete have been appropriately remediated to the Commissioner's satisfaction. The Certificate Holder shall follow any recommendations made by the Commissioner in writing.

5. Upon obtaining written permission for SPECIAL TERMS AND CONDITIONS paragraphs 1. through 4., above, the Certificate Holder shall complete all the work authorized in the SCOPE OF AUTHORIZATION within 90 calendar days.

6. Prior to the commencement of work authorized here, the Certificate Holder shall install and maintain the turbidity control curtain described in the SCOPE OF AUTHORIZATION paragraph 1.a., above, in good working condition until the work authorized herein is completed

and the site stabilized.

7. All excavated sediments shall be immediately placed within lined and sealed dump trucks and relocated to an upland stockpile/dewatering area that is outside the 100 year flood plain. All stockpile/dewatering areas shall be covered and bordered with straw bales or silt fence as shown on Figure 7., of the plans attached hereto.

8. Except as specifically authorized by this permit, no equipment or material including but not limited to, fill, construction materials, excavated material or debris, shall be deposited, placed or stored in any tidal wetland or watercourse, nor shall any tidal wetland or watercourse be used as a staging area or accessway other than as provided herein.

9. The Certificate Holder shall post the attached Permit Notice in a conspicuous place at the work area while the work authorized herein is undertaken.

10. All work authorized here shall be conducted during periods of low water conditions.

11. Upon excavation of the authorized 3:1 side slopes described in the SCOPE OF AUTHORIZATION paragraph 1.c., above, the Certificate Holder shall apply a minimum of a 6" sand loam to the surface of the over excavated side slopes. Upon approval of the Commissioner, the Certificate Holder may forego the 6" layer of sandy loam if a demonstration can be made that adequate plant soils are already present within the excavated area. In any event, the Certificate Holder shall apply the biodegradable matting shown on the plans. Such biodegradable matting must be maintained in good condition until the site has become stabilized.

12. Not later than two (2) weeks prior to the commencement of any work authorized herein, the Certificate Holder shall submit to the Commissioner, on the form attached hereto as Appendix A, the name(s) and address(es) of any contractor(s) employed to conduct such work and the expected date for commencement and completion of such work.

13. The Certificate Holder shall file Appendix B on the land records of the municipality in which the subject property is located not later than thirty (30) days after certificate issuance pursuant to CGS Section 22a-363g. A copy of Appendix B with a stamp or other such proof of filing with the municipality shall be submitted to the Commissioner no later than sixty (60) days after certificate issuance. Except as specifically authorized by this certificate, no equipment or material including, but not limited to, fill, construction materials, excavated material or debris, shall be deposited, placed or stored in any wetland or watercourse on or off-site, nor shall any wetland or watercourse be used as a staging area or accessway other than as provided herein.

14. The Certificate Holder shall give a copy of this permit to the contractor(s) who will be carrying out the activities authorized herein prior to the start of construction and shall receive a written receipt for such copy, signed and dated by such contractor(s). The Certificate Holder's contractor(s) shall conduct all operations at the site in full compliance with this permit and, to the extent provided by law, may be held liable for any violation of the terms and conditions of this permit. At the work area the contractor(s) shall, whenever work is being performed, make

available for inspection a copy of this permit and the final plans for the work authorized herein.

15. On or before ninety (90) days after completion of the work authorized herein, the Certificate Holder shall submit to the Commissioner "as-built" plans, including any proposed elevation views and cross sections included in the permit, prepared and sealed by a licensed engineer, licensed surveyor or licensed architect, as applicable, of the work area showing all tidal datums and structures.

GENERAL TERMS AND CONDITIONS

1. All work authorized by this certificate shall be completed within five years from date of issuance of this certificate ("work completion date") in accordance with all conditions of this certificate and any other applicable law.

    a. The Certificate Holder may request a one-year extension of the work completion date. Such request shall be in writing and shall be submitted to the Commissioner at least 30 days prior to said work completion date. Such request shall describe the work done to date, which work still needs to be completed and the reason for such extension. The Commissioner shall grant or deny such request in her sole discretion.

    b Any work authorized herein conducted after said work completion date or any authorized one year extension thereof is a violation of this certificate and may subject the Certificate Holder to enforcement action, including penalties, as provided by law.

2. In conducting the work authorized herein, the Certificate Holder shall not deviate from the attached plans, as may be modified by this certificate. The Certificate Holder shall not make de minimis changes from said plans without prior written approval of the Commissioner.

3. The Certificate Holder shall maintain all structures or other work authorized herein in good condition. Any such maintenance shall be conducted in accordance with applicable law including, but not limited to, CGS sections 22a-28 through 22a-35 and CGS sections 22a-359 through 22a-363f.

4. The Certificate Holder shall notify the Commissioner in writing of the commencement of any work and completion of all work authorized herein no later than three days prior to the commencement of such work and no later than seven days after the completion of such work.

5. In undertaking the work authorized hereunder, the Certificate Holder shall not cause or allow pollution of wetlands or watercourses, including pollution resulting from sedimentation and erosion. For purposes of this certificate, "pollution" means "pollution" as that term is defined by CGS section 22a-423.

6. Upon completion of any work authorized herein, the Certificate Holder shall restore all areas impacted by construction, or used as a staging area or accessway in connection with such work, to their condition prior to the commencement of such work.

7. Any document required to be submitted to the Commissioner under this certificate or any contact required to be made with the Commissioner shall, unless otherwise specified in writing by the Commissioner, be directed to:

   Permit Section
   Office of Long Island Sound Programs
   Department of Energy and Environmental Protection
   79 Elm Street
   Hartford, Connecticut 06106-5127
   (860) 424-3034
   Fax # (860) 424-4054

8. The date of submission to the Commissioner of any document required by this certificate shall be the date such document is received by the Commissioner. The date of any notice by the Commissioner under this certificate, including but not limited to notice of approval or disapproval of any document or other action, shall be the date such notice is personally delivered or the date three days after it is mailed by the Commissioner, whichever is earlier. Except as otherwise specified in this certificate, the word "day" as used in this certificate means calendar day. Any document or action which is required by this certificate to be submitted or performed by a date which falls on a Saturday, Sunday or a Connecticut or federal holiday shall be submitted or performed on or before the next day which is not a Saturday, Sunday, or a Connecticut or federal holiday.

9. The work specified in the SCOPE OF AUTHORIZATION is authorized solely for the purpose set forth in this certificate. No change in purpose or use of the authorization work or facilities as set forth in this certificate may occur without the prior written authorization of the Commissioner. The Certificate Holder shall, prior to undertaking or allowing any change in use or purpose from that which is authorized by this certificate, request authorization from the Commissioner for such change. Said request shall be in writing and shall describe the proposed change and the reason for the change.

10. This certificate may be revoked, suspended, or modified in accordance with applicable law.

11. This certificate is not transferable without prior written authorization of the Commissioner. A request to transfer a certificate shall be submitted in writing and shall describe the proposed transfer and the reason for such transfer. The Certificate Holder's obligations under this certificate shall not be affected by the passage of title to the certificate site to any other person or municipality until such time as a transfer is authorized by the Commissioner.

12. The Certificate Holder shall allow any representative of the Commissioner to inspect the work authorized hereunder at reasonable times to ensure that it is being or has been accomplished in accordance with the terms and conditions of this certificate.

13. In granting this certificate, the Commissioner has relied on all representations of the Certificate Holder, including information and data provided in support of the Certificate Holder's application. Neither the Certificate Holder's representations nor the issuance of this certificate shall constitute

an assurance by the Commissioner as to the structural integrity, the engineering feasibility or the efficacy of such design.

14. In the event that the Certificate Holder becomes aware that he did not or may not comply, or did not or may not comply on time, with any provision of this certificate or of any document required hereunder, the Certificate Holder shall immediately notify the Commissioner and shall take all reasonable steps to ensure that any noncompliance or delay is avoided or, if unavoidable, is minimized to the greatest extent possible. In so notifying the Commissioner, the Certificate Holder shall state in writing the reasons for the noncompliance or delay and propose, for the review and written approval of the Commissioner, dates by which compliance will be achieved, and the Certificate Holder shall comply with any dates which may be approved in writing by the Commissioner. Notification by the Certificate Holder shall not excuse noncompliance or delay and the Commissioner's approval of any compliance dates proposed shall not excuse noncompliance or delay unless specifically stated by the Commissioner in writing.

15. In evaluating the application for this certificate the Commissioner has relied on information and data provided by the Certificate Holder and on the Certificate Holder's representations concerning site conditions, design specifications and the proposed work authorized herein, including but not limited to representations concerning the commercial, public or private nature of the work or structures authorized herein, the water-dependency of said work or structures, its availability for access by the general public, and the ownership of regulated structures or filled areas. If such information proves to be false, deceptive, incomplete or inaccurate, this certificate may be modified, suspended or revoked, and any unauthorized activities may be subject to enforcement action.

16. The Certificate Holder may not conduct work waterward of the high tide line or in tidal wetlands at this certificate site other than the work authorized herein, unless otherwise authorized by the Commissioner pursuant to CGS section 22a-359 et. seq. and/or CGS section 22a-28 et. seq.

17. The issuance of this certificate does not relieve the Certificate Holder of his obligations to obtain any other approvals required by applicable federal, state and local law.

18. Any document, including but not limited to any notice, which is required to be submitted to the Commissioner under this certificate shall be signed by the Certificate Holder and by the individual or individuals responsible for actually preparing such document, each of whom shall certify in writing as follows: "I have personally examined and am familiar with the information submitted in this document and all attachments and certify that based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief, and I understand that any false statement made in this document or its attachments may be punishable as a criminal offense."

19. This certificate is subject to and does not derogate any present or future property rights or powers of the State of Connecticut, and conveys no property rights in real estate or material nor any exclusive privileges, and is further subject to any and all public and private rights and to any federal, state or local laws or regulations pertinent to the property or activity affected hereby.

Issued on June 4, 2012.

STATE OF CONNECTICUT
DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION

Brian P. Thompson, Director
Office of Long Island Sound Programs
Bureau of Water Protection & Land Reuse

Certificate of Permission No. 201201271-KZ, Stratford, City of Bridgeport

PERMIT NOTICE

This Certifies that Authorization to perform work below the High Tide Line and/or within Tidal Wetlands of coastal, tidal, or navigable waters of Connecticut

Has been issued to: City of Bridgeport

At this location: Sikorsky Memorial Airport, 1000 Great Meadow Drive

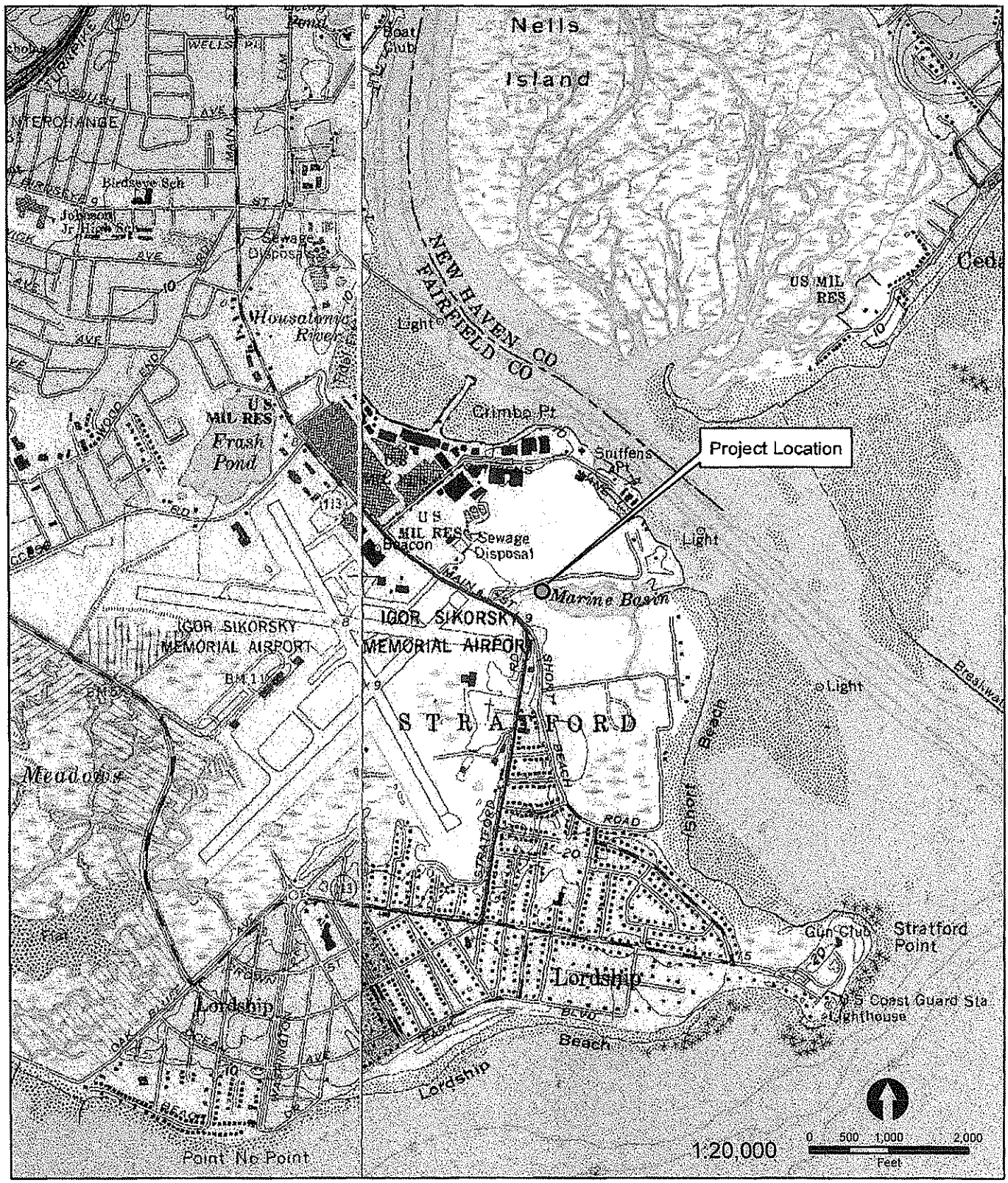
To conduct the following: remove a section of berm to restore tidal flow.

Permit #: 201201271-KZ Issued on: June 4, 2012

This Authorization expires on: June 4, 2017

This Notice must be posted in a conspicuous place on the job during the entire project.

Department of Energy and Environmental Protection
Office of Long Island Sound Programs
79 Elm Street • Hartford, CT 06106-5127
Phone: (860) 424-3034 Fax: (860) 424-4054
www.ct.gov/deep



Attachment A: USGS Topographical Quad. Vicinity Map

Igor I. Sikorsky Memorial Airport
NOV Activities, Stratford, CT

Dated September 2011

Original in Color FHI

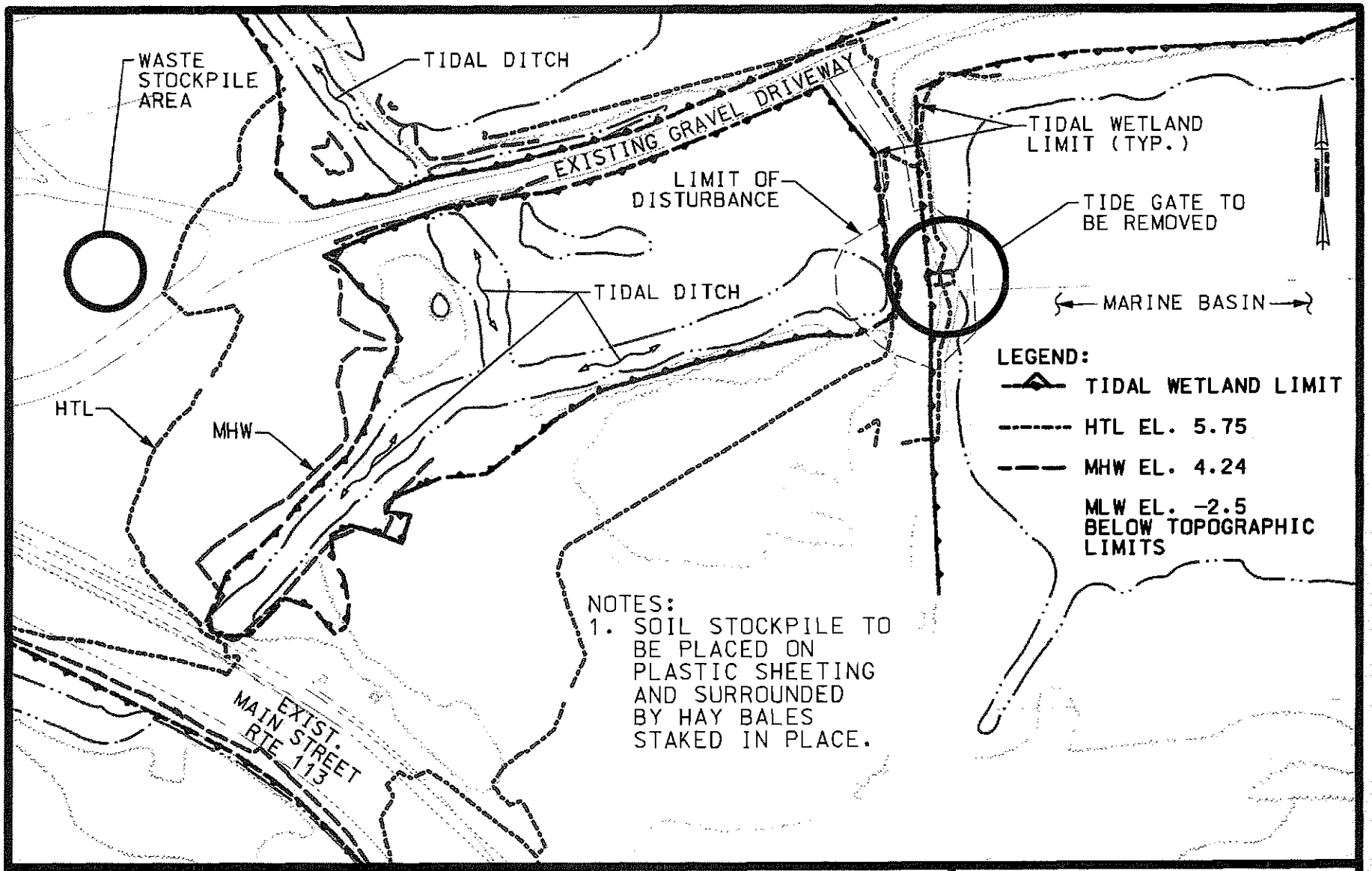
7/28/11

CERTIFICATE OF PERMISSION
FOR NOTICE OF VIOLATION #LIS-2008-159-V
CT DEPT. OF ENVIRONMENTAL PROTECTION
CITY OF BRIDGEPORT
IGOR I. SIKORSKY MEMORIAL AIRPORT

LOCATION PLAN 1

FIGURE 1

SEPTEMBER 2011

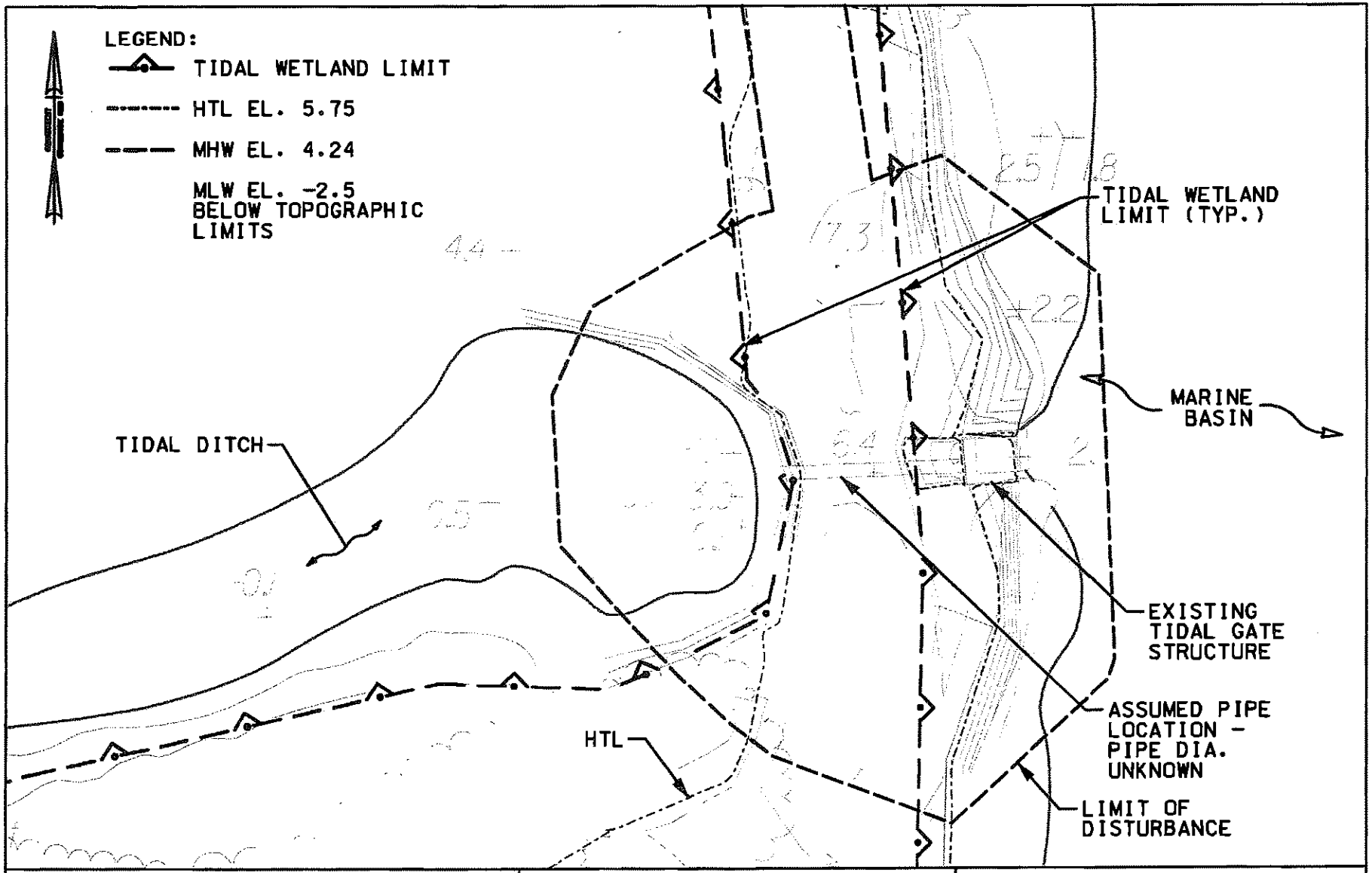


CERTIFICATE OF PERMISSION
FOR NOTICE OF VIOLATION #LIS-2008-159-V
CT DEPT. OF ENVIRONMENTAL PROTECTION
CITY OF BRIDGEPORT
IGOR I. SIKORSKY MEMORIAL AIRPORT

LOCATION PLAN 2

SCALE IN FEET
0 80 160

FIGURE 2 | SEPTEMBER 2011

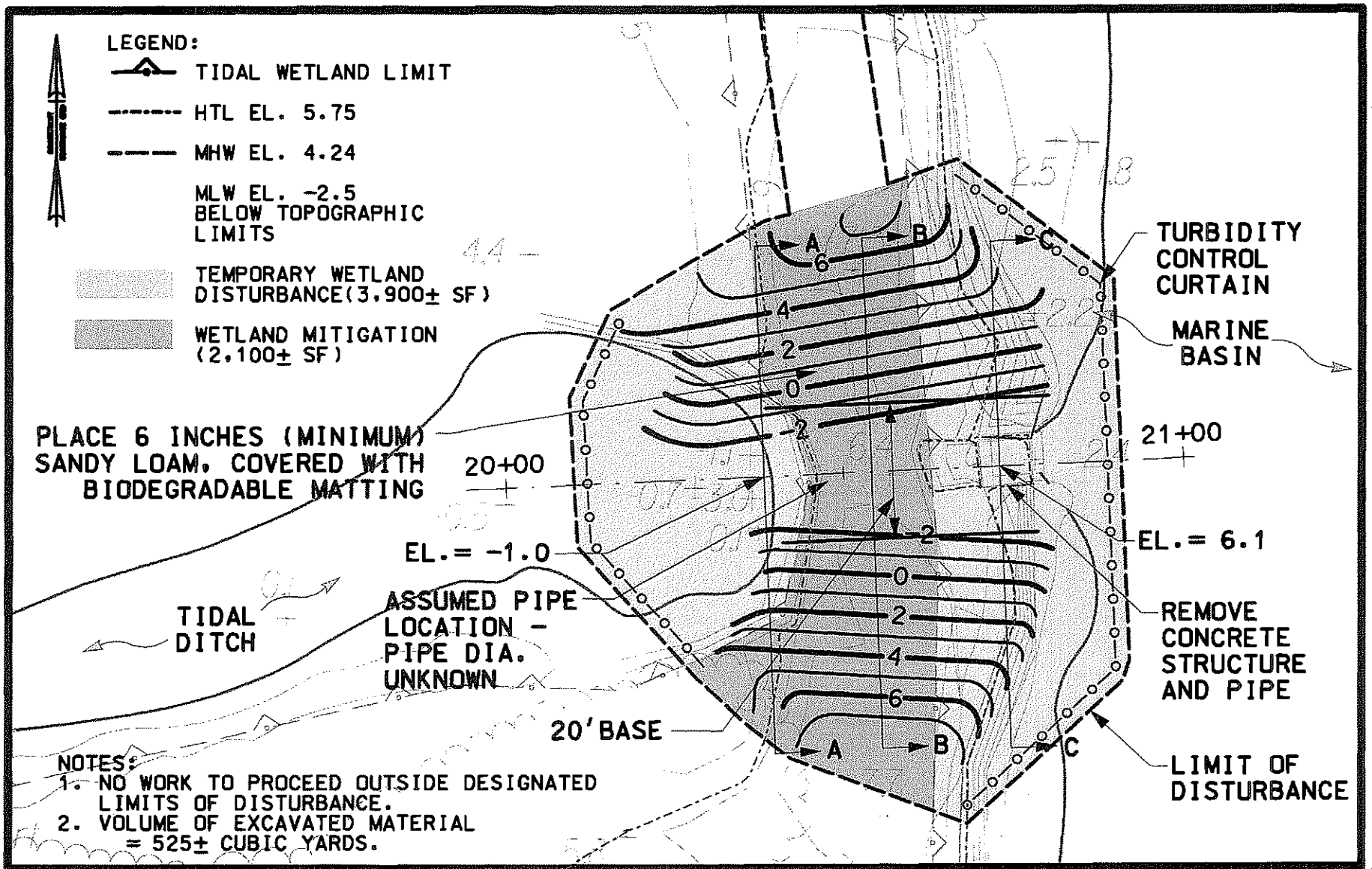


CERTIFICATE OF PERMISSION
FOR NOTICE OF VIOLATION #LIS-2008-159-V
CT DEPT. OF ENVIRONMENTAL PROTECTION
CITY OF BRIDGEPORT
IGOR I. SIKORSKY MEMORIAL AIRPORT

EXISTING CONDITIONS- BERM AND TIDE GATE AT MARINE BASIN

SCALE IN FEET
20 0 20

FIGURE 3 | SEPTEMBER 2011

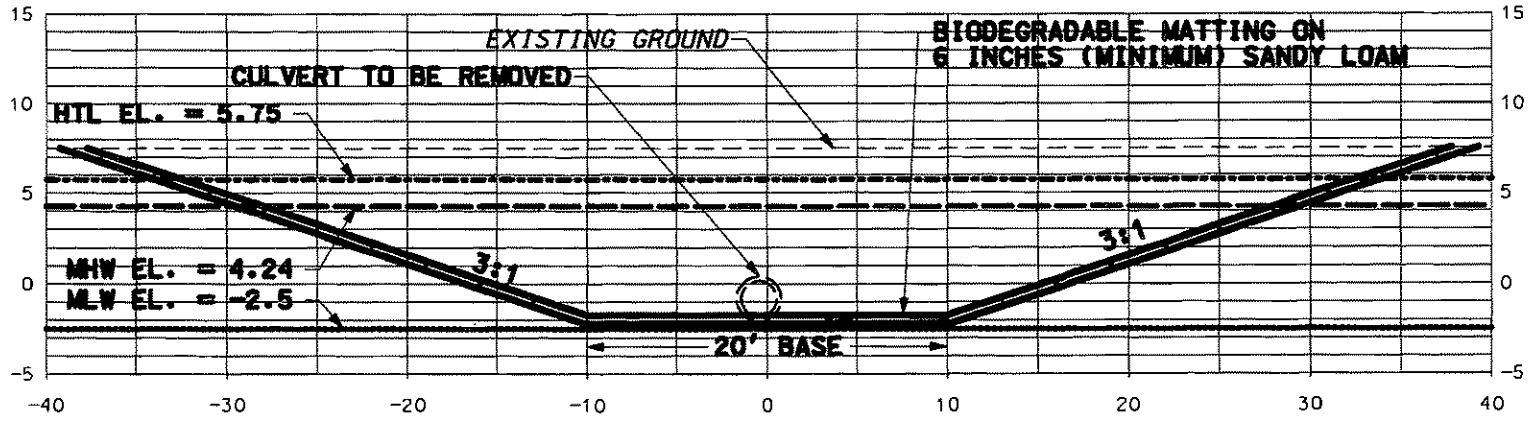


CERTIFICATE OF PERMISSION
FOR NOTICE OF VIOLATION #LIS-2008-159-V
CT DEPT. OF ENVIRONMENTAL PROTECTION
CITY OF BRIDGEPORT
IGOR I. SIKORSKY MEMORIAL AIRPORT

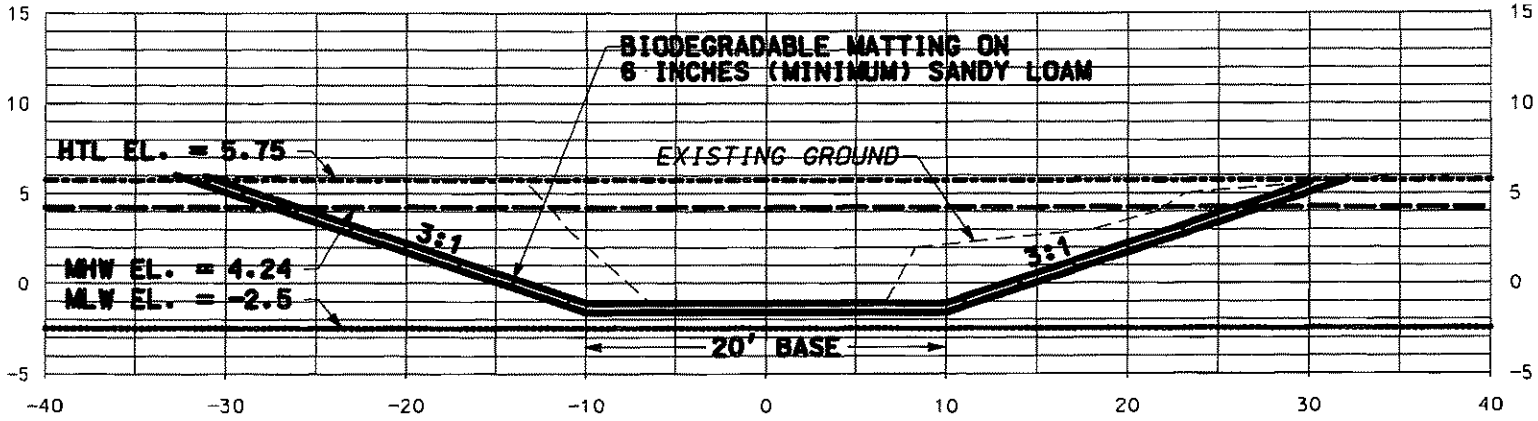
PROPOSED BERM AND TIDE GATE REMOVAL AT MARINE BASIN

SCALE IN FEET
20 0 20

FIGURE 4 | SEPTEMBER 2011



BERM REMOVAL
SECTION B-B



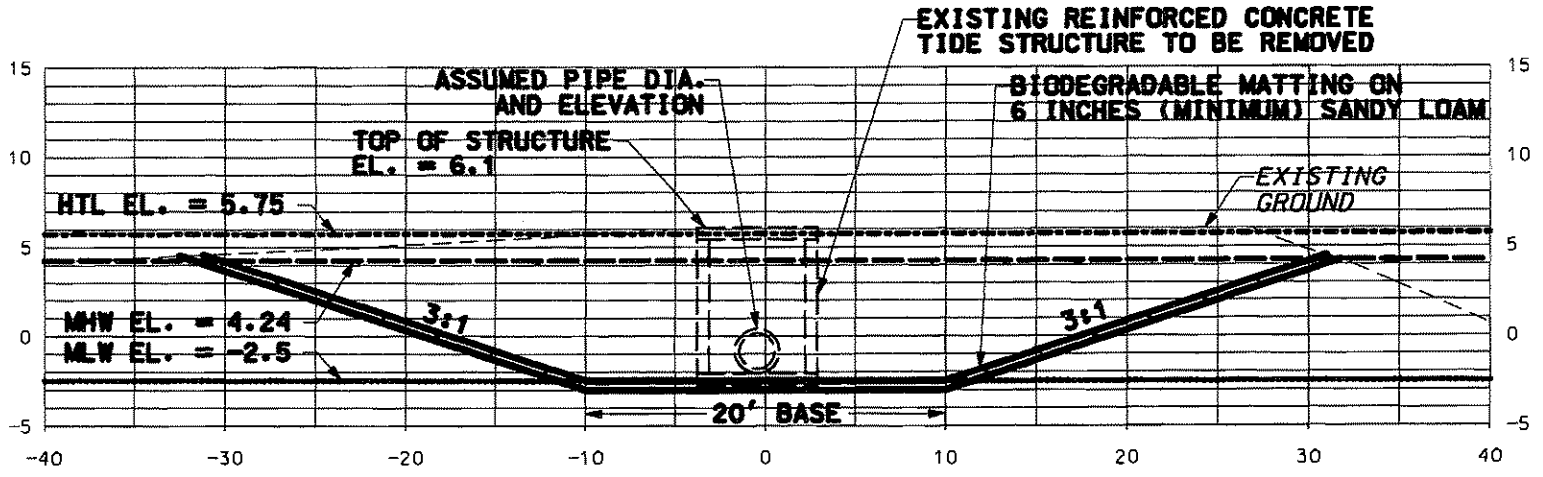
BERM REMOVAL
SECTION A-A

CERTIFICATE OF PERMISSION
FOR NOTICE OF VIOLATION #LIS-2008-159-V
CT DEPT. OF ENVIRONMENTAL PROTECTION
CITY OF BRIDGEPORT
IGOR I. SIKORSKY MEMORIAL AIRPORT

PROPOSED BERM AND TIDE GATE REMOVAL CROSS SECTIONS

SCALE IN FEET
10 5 0 10

FIGURE 5 | SEPTEMBER 2011



BERM REMOVAL
SECTION C-C

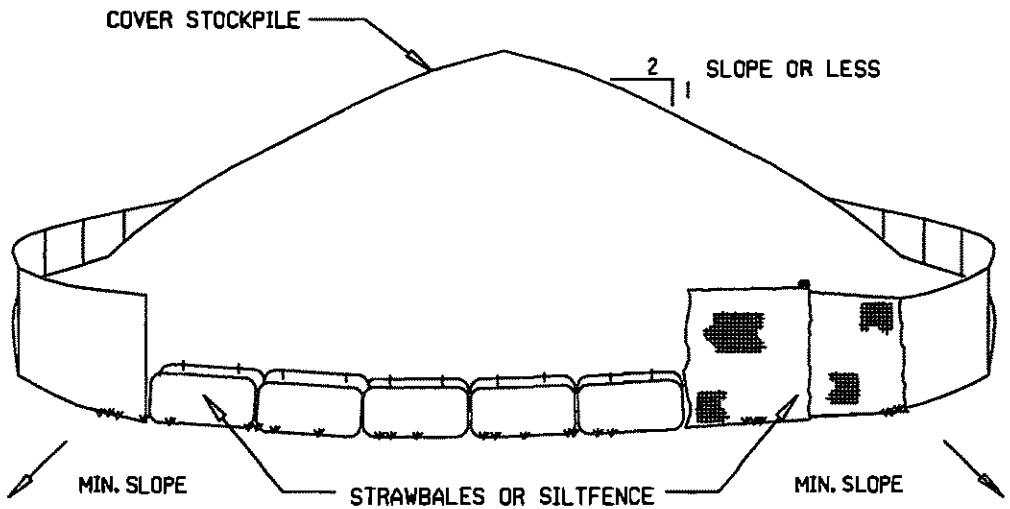
CERTIFICATE OF PERMISSION
FOR NOTICE OF VIOLATION #LIS-2008-159-V
CT DEPT. OF ENVIRONMENTAL PROTECTION
CITY OF BRIDGEPORT
IGOR I. SIKORSKY MEMORIAL AIRPORT

PROPOSED BERM AND TIDE GATE REMOVAL CROSS SECTIONS

SCALE IN FEET
10 5 0 10

FIGURE 6

SEPTEMBER 2011



NOTES:

1. CONTAMINATED MATERIALS SHALL NOT BE STOCKPILED. IF ENCOUNTERED, CONTAMINATED MATERIALS SHALL BE STORED AND TRANSPORTED OFF-SITE IN ROLL-OFF CONTAINERS.
2. GROUND BELOW STOCKPILE SHALL BE DRY, STABLE, AND LEVEL.
3. STOCKPILE SHALL BE LOCATED A MINIMUM OF 100' FROM WETLANDS.
4. MAXIMUM SLOPE OF STOKPILE SHALL BE 1:2.
5. STOCKPILE SHALL BE COVERED WHEN THE CONTRACTOR IS NOT ACTIVELY STOCKPILING MATERIAL.
6. STOCKPILED MATERIAL SHALL BE REMOVED FROM THE SITE AND LEGALLY DISPOSED OF PRIOR TO THE COMPLETION OF CONSTRUCTION ACTIVITIES. UPON REMOVAL OF STOCKPILE THE CONTRACTOR SHALL REGRADE, TOPSOIL, SEED AND MULCH THE DISTURBED AREA.

CERTIFICATE OF PERMISSION FOR NOTICE OF VIOLATION #LIS-2008-159-V CT DEPT. OF ENVIRONMENTAL PROTECTION CITY OF BRIDGEPORT IGOR I. SIKORSKY MEMORIAL AIRPORT	WASTE STOCKPILE DETAIL	NOT TO SCALE FIGURE 7 | SEPTEMBER 2011

SEQUENCE OF CONSTRUCTION
TIDE GATE AND BERM REMOVAL

GENERAL

1. PRIOR TO THE START OF CONSTRUCTION, AREA TO BE EXCAVATED SHALL BE TESTED FOR CONTAMINATION. IF CONTAMINATED MATERIALS ARE FOUND WITHIN THE LIMITS OF EXCAVATION, THEY WILL BE PLACED IN ROLL-OFF CONTAINERS AND LEGALLY DISPOSED OF OFF-SITE IN ACCORDANCE WITH ALL APPLICABLE STATE AND FEDERAL REGULATIONS. WET CONTAMINATED SOILS WILL FIRST BE DEWATERED BY PLACING ON PLASTIC SHEETING SURROUNDED BY HAY BALES. CONTAMINATED WATER WILL BE COLLECTED IN 50 GALLON DRUMS AND PROPERLY DISPOSED OF OFF-SITE IN ACCORDANCE WITH APPLICABLE FEDERAL AND STATE REGULATIONS. STOCKPILING OF CONTAMINATED MATERIALS ON-SITE WILL NOT BE ALLOWED. ALL PERSONNEL INVOLVED IN EXCAVATING AND/OR HANDLING WASTE MATERIALS WILL HAVE RECEIVED HAZARDOUS WASTE TRAINING IN ACCORDANCE WITH OSHA 1910.120 REQUIREMENTS. COORDINATE WITH EPA AND CTDEEP PRIOR TO EXCAVATION.

2. ALL CONSTRUCTION SHALL BE SEQUENCED SO AS TO MINIMIZE THE DURATION OF CONSTRUCTION ACTIVITIES.

3. ALL MATERIALS REQUIRED FOR CONSTRUCTION SHALL BE ON SITE PRIOR TO THE START OF THE ACTIVITY TO AVOID CONSTRUCTION DELAYS DUE TO MATERIALS DELIVERY.

4. THE CONTRACTOR SHALL PROVIDE ADVANCED NOTIFICATION OF THE CONSTRUCTION SCHEDULE TO THE CITY OF BRIDGEPORT, TOWN OF STRATFORD, THE CONNECTICUT DEPARTMENT OF TRANSPORTATION, THE ARMY ENGINE PLANT, AND THE RESIDENTS LOCATED ALONG THE DRIVEWAY USED TO ACCESS THE WORK AREA.

SPECIFIC

1. INSTALL THE TURBIDITY CURTAIN BARRIERS UPSTREAM AND DOWNSTREAM OF THE TIDE GATE STRUCTURE.

2. WORK WILL BE CONDUCTED IN THE WET DURING LOW TIDE. A BACKHOE OR SMALL EXCAVATOR WILL BE USED TO EXCAVATE AND REMOVE TIDE GATE STRUCTURE. THE SURROUNDING BERM WILL BE REMOVED, AS NECESSARY, IN ORDER TO FACILITATE REMOVAL OF THE TIDE GATE. IT IS ANTICIPATED THE EXCAVATED AREA WILL BE UP TO 20 FEET WIDE, WITH A 3:1 SLOPE.

3. WET EXCAVATED SOILS WILL BE DEWATERED BY PLACING ON PLASTIC SHEETING SURROUNDED BY HAY BALES.

4. WORKING FROM SOUTH TO NORTH IN 10-15 FOOT INCREMENTS, EXCAVATE BERM AND PIPE TO 6 INCHES (MINIMUM) BELOW FINISHED GRADE. INSTALL SANDY LOAM TO FINISHED GRADE. WORK AT LOWEST ELEVATIONS SHALL BE PERFORMED AS NEAR TO LOW TIDE AS POSSIBLE. EXCAVATED MATERIAL WILL BE TRANSPORTED ALONG THE TOP OF THE EARTHEN BERM, TO THE GRAVEL DRIVEWAY, WHERE IT WILL THEN BE TAKEN AND STOCKPILED ON PLASTIC SHEETING. THE STOCKPILE WILL BE LOCATED ON AN UPLAND AREA ON AIRPORT PROPERTY APPROXIMATELY 500 FEET WEST OF THE EXCAVATION SITE. THE STOCKPILED SOIL WILL BE SURROUNDED BY HALES BALES STAKED IN PLACE.

5. STABILIZE ALL DISTURBED AREAS WITH BIODEGRADABLE MATTING.

6. REMOVE TURBIDITY CONTROL CURTAIN BARRIERS.

7. ALLOW RE-VEGETATION OF THE SITE TO OCCUR NATURALLY.

CERTIFICATE OF PERMISSION FOR NOTICE OF VIOLATION #LIS-2008-159-V CT DEPT. OF ENVIRONMENTAL PROTECTION CITY OF BRIDGEPORT IGOR I. SIKORSKY MEMORIAL AIRPORT	SEQUENCE OF CONSTRUCTION	FIGURE 8 | FEBRUARY 2012

...\COP_Tide-Gate\figure08.dgn 2/7/2012 10:10:38 AM

Connecticut Department of

ENERGY &
ENVIRONMENTAL
PROTECTION

OFFICE OF LONG ISLAND SOUND PROGRAMS

APPENDIX A

TO: **Permit Section**
Department of Energy and Environmental Protection
Office of Long Island Sound Programs
79 Elm Street
Hartford, CT 06106-5127

Certificate Holder: City of Bridgeport
1000 Great Meadow Drive
Stratford, CT 06615

Certificate No: 201201271-KZ, Bridgeport

CONTRACTOR 1: _____

Address: _____

_____

Telephone #: _____

CONTRACTOR 2: _____

Address: _____

_____

Telephone #: _____

CONTRACTOR 3: _____

Address: _____

_____

Telephone #: _____

EXPECTED DATE OF COMMENCEMENT OF WORK: _____

EXPECTED DATE OF COMPLETION OF WORK: _____

CERTIFICATE HOLDER: _____

_____
(signature) (date)

Connecticut Department of

ENERGY &
ENVIRONMENTAL
PROTECTION

OFFICE OF LONG ISLAND SOUND PROGRAMS
APPENDIX B

CERTIFICATE OF PERMIT ISSUANCE

To: Stratford City Clerk

Signature and Date: 6-7-12

Subject: City of Bridgeport Sikorsky Memorial Airport, Marine Basin off Housatonic River located off property at 1000 Great Meadow Drive, Certificate of Permission #201201271-KZ

Pursuant to Section 22a-363g and Section 22a-363b of the Connecticut General Statutes, the Commissioner of Energy and Environmental Protection gives notice that a certificate has been issued to City of Bridgeport Sikorsky Memorial Airport:

1. remove an existing tidal gate and section of earthen berm located south of the existing gravel driveway located off Main Street, Route 113 as follows:

   a. temporarily install a turbidity control curtain on the upstream and downstream sides of the area of removed earthen berm as shown on Figure 4., of the plans attached hereto;

   b. excavate approximately 525 cubic yards of earthen fill including removal of an existing reinforced concrete tide gate structure and pipe over an approximately 6,000 square foot area to a depth of -2.0' NGVD for a 20 foot wide base with 3:1 side slopes terminating at elevation 5.75' NGVD;

   c. place 6 inches of a sandy loam if required on the 3:1 side slopes to enhance tidal wetland plant growth and cover the side slopes with a biodegradable matting.

If you have any questions pertaining to this matter, please contact the Office of Long Island Sound Programs at 860-424-3626.

APPENDIX E

Causeway Stative Load Analysis

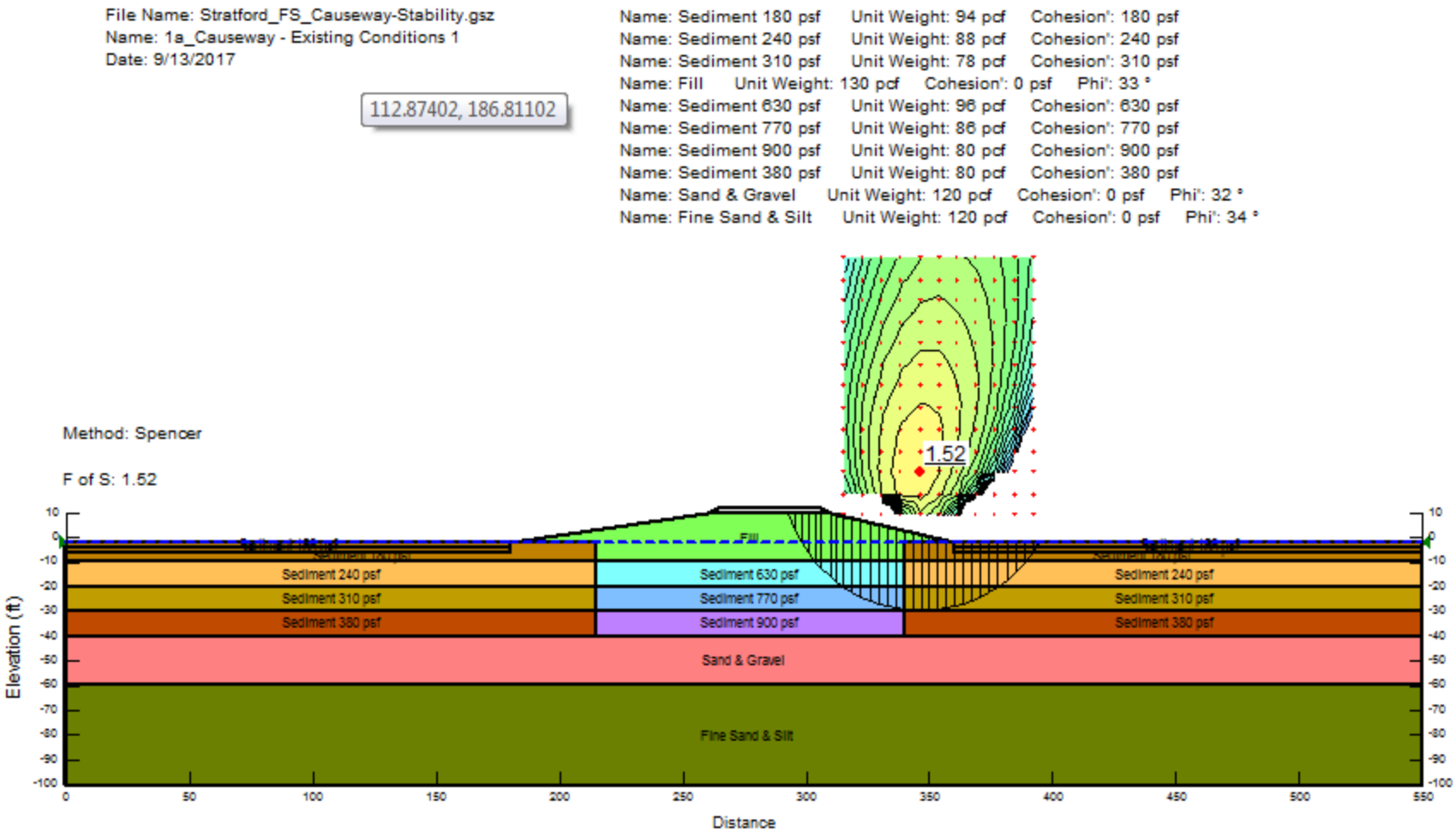


Figure 1 – Existing Conditions of Causeway

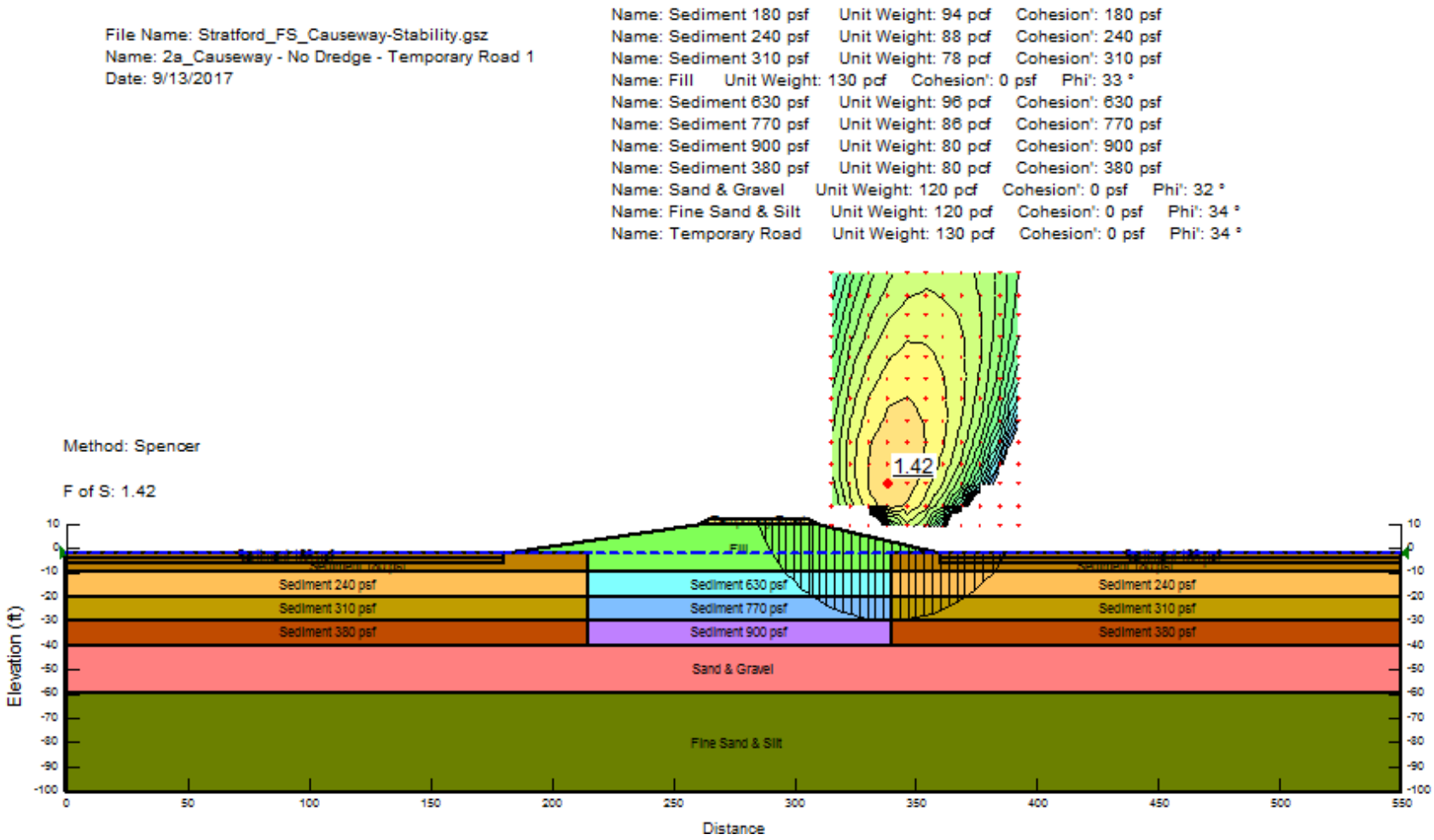


Figure 2 – Causeway with 2-foot Thick Construction Access Road

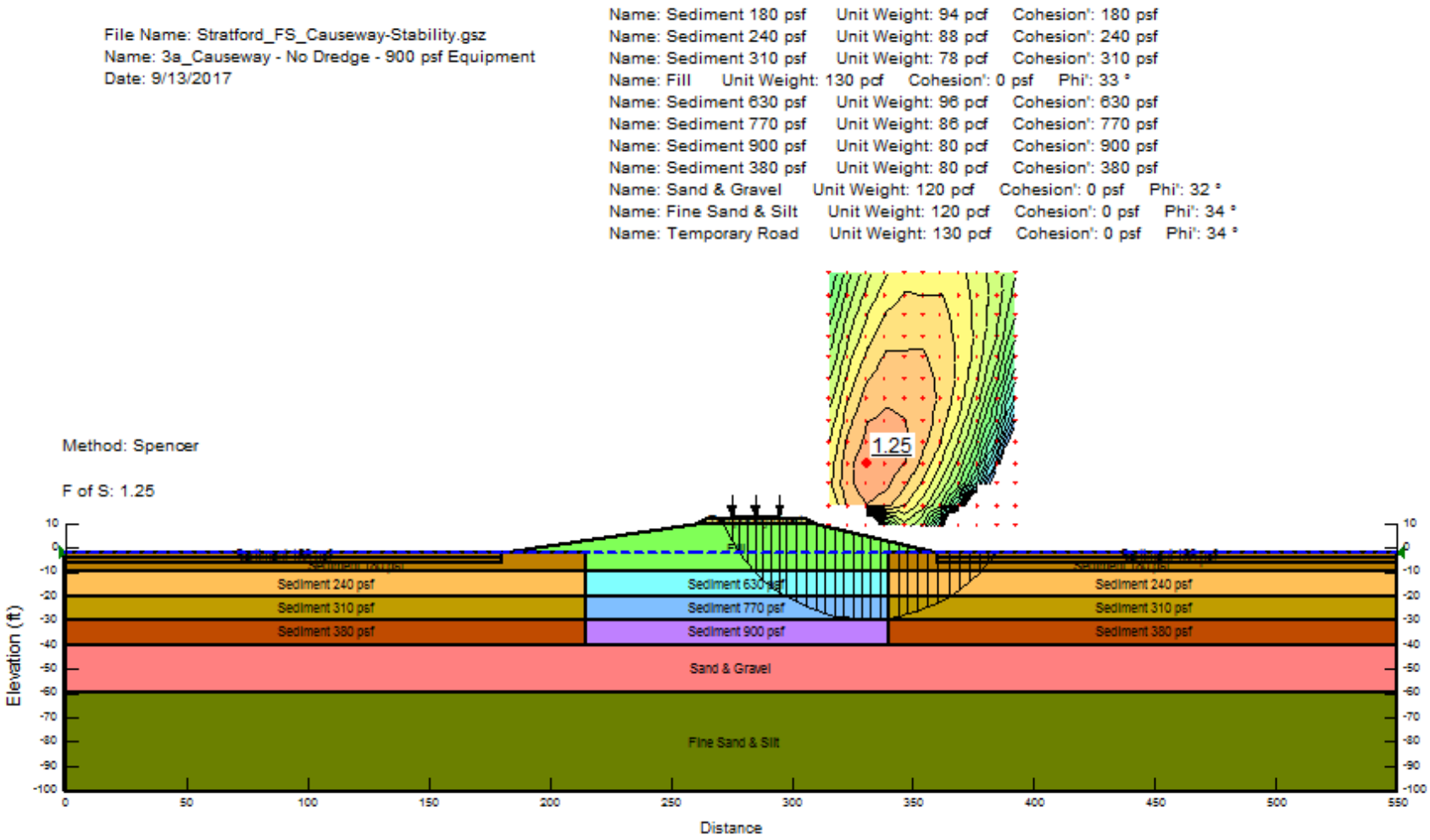


Figure 3 – Causeway with 20-foot Wide, 900 psf Equipment Surcharge Load (No Dredge)

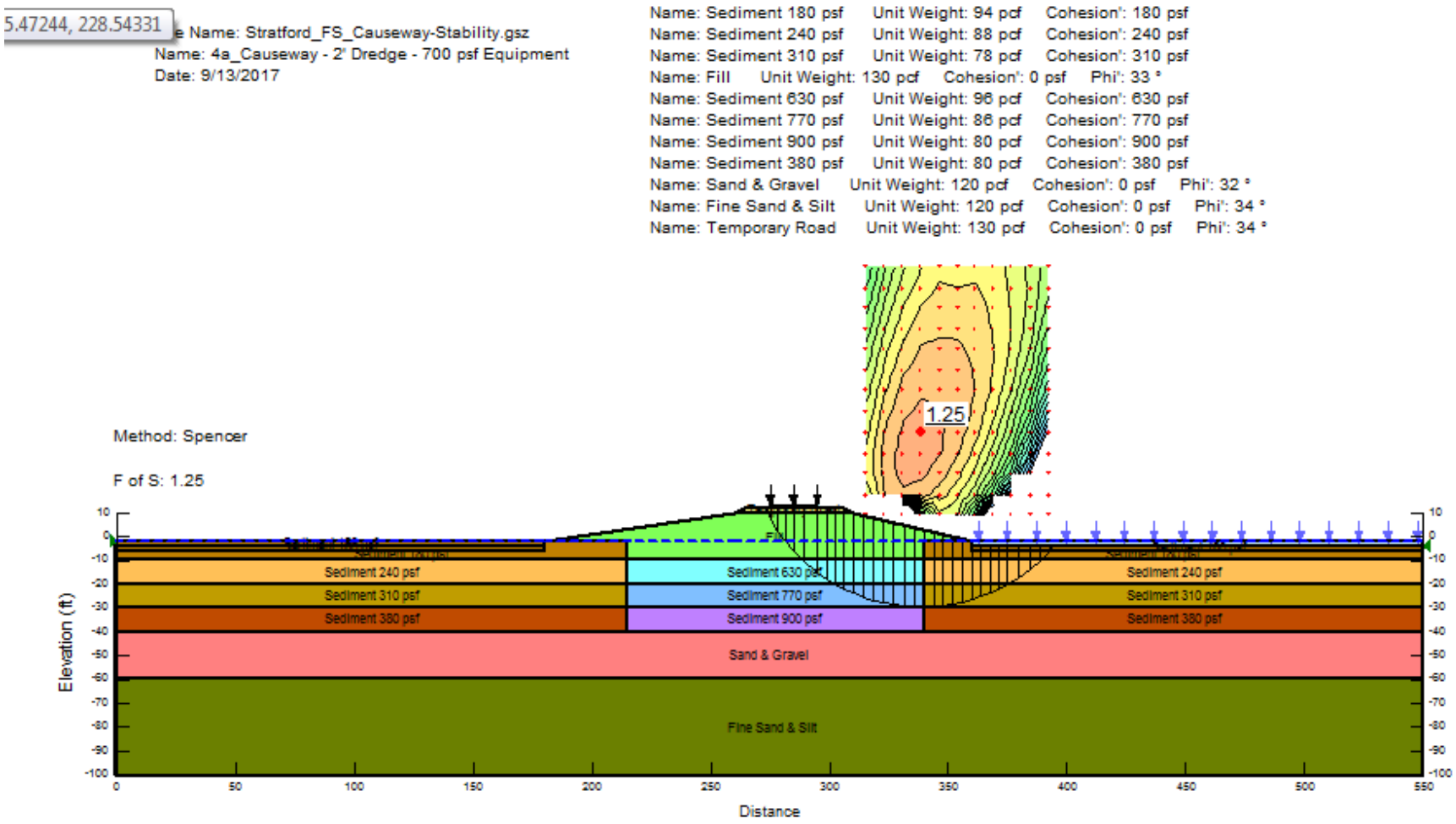


Figure 4 – Causeway with 20-foot Wide, 700 psf Equipment Surcharge Load (2-foot Dredge)

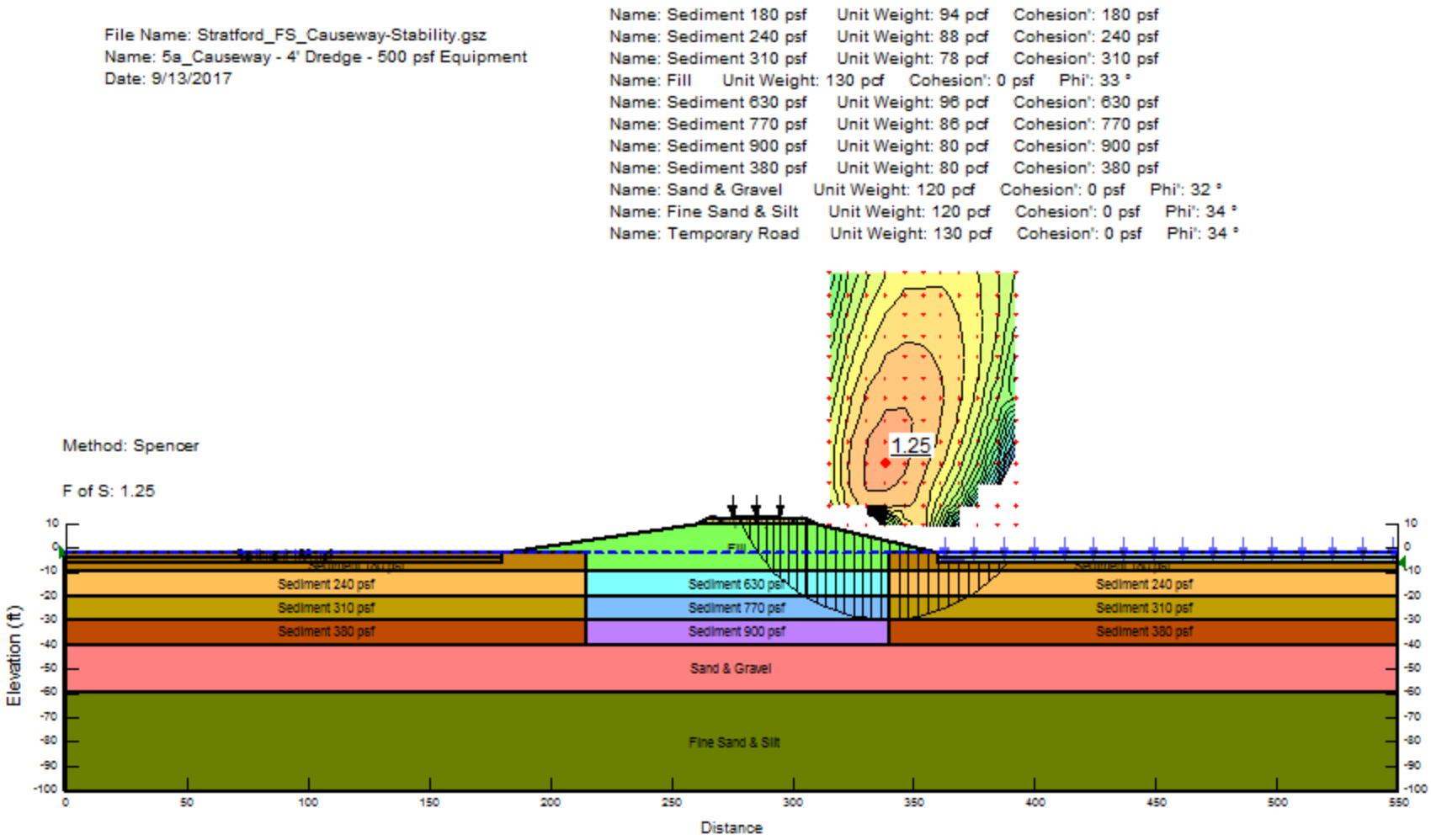


Figure 5 – Causeway with 20-foot Wide, 500 psf Equipment Surcharge Load (4-foot Dredge)

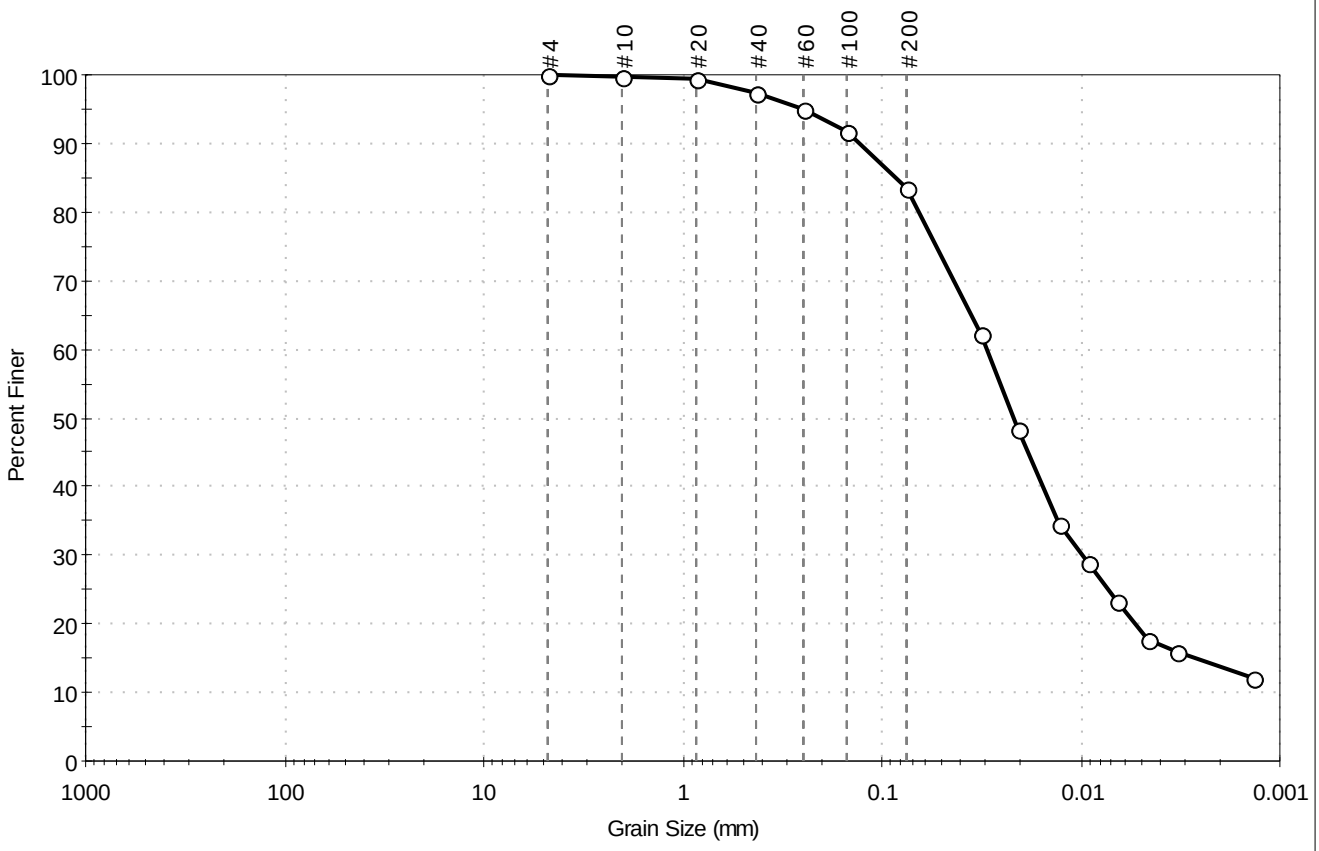
APPENDIX F

Grain-Size Test Results

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5010003	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-001	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431801		

Test Comment: ---
Visual Description: Wet, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	16.5	83.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	97		
#60	0.25	95		
#100	0.15	92		
#200	0.075	84		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0317	62		
---	0.0209	48		
---	0.0129	34		
---	0.0092	29		
---	0.0065	23		
---	0.0046	18		
---	0.0033	16		
---	0.0014	12		

Coefficients

D_{85} = 0.0849 mm D_{30} = 0.0099 mm
D_{60} = 0.0296 mm D_{15} = 0.0027 mm
D_{50} = 0.0220 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM Elastic SILT with Sand (MH)

AASHTO Clayey Soils (A-7-5 (41))

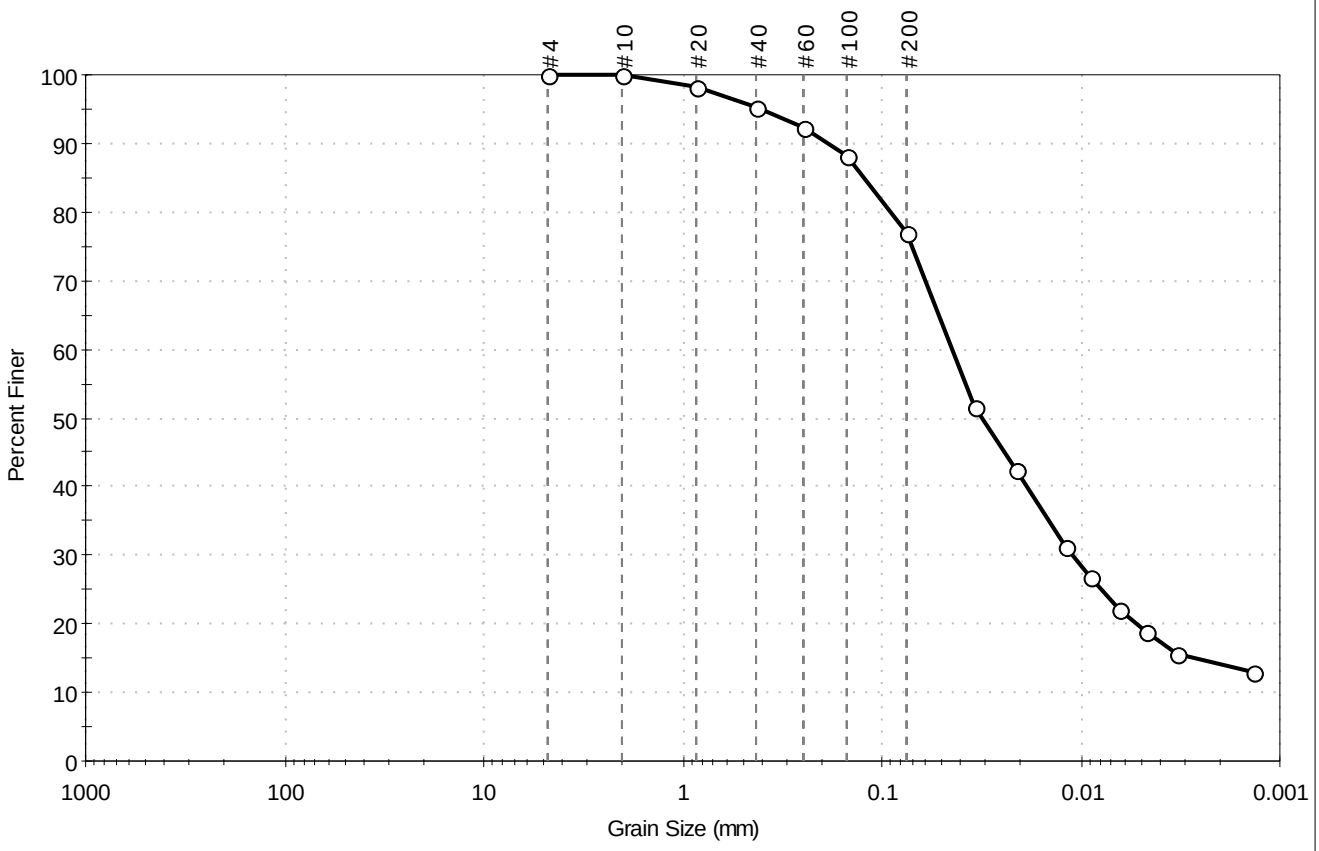
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5020001	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-002	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431802		

Test Comment: ---
Visual Description: Wet, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	23.1	76.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	98		
#40	0.42	95		
#60	0.25	92		
#100	0.15	88		
#200	0.075	77		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0341	52		
---	0.0211	43		
---	0.0120	31		
---	0.0090	27		
---	0.0065	22		
---	0.0047	19		
---	0.0033	16		
---	0.0014	13		

Coefficients

D_{85} = 0.1227 mm
D_{30} = 0.0111 mm
D_{60} = 0.0441 mm
D_{15} = 0.0027 mm
D_{50} = 0.0311 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM Elastic SILT with Sand (MH)

AASHTO Clayey Soils (A-7-5 (34))

Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

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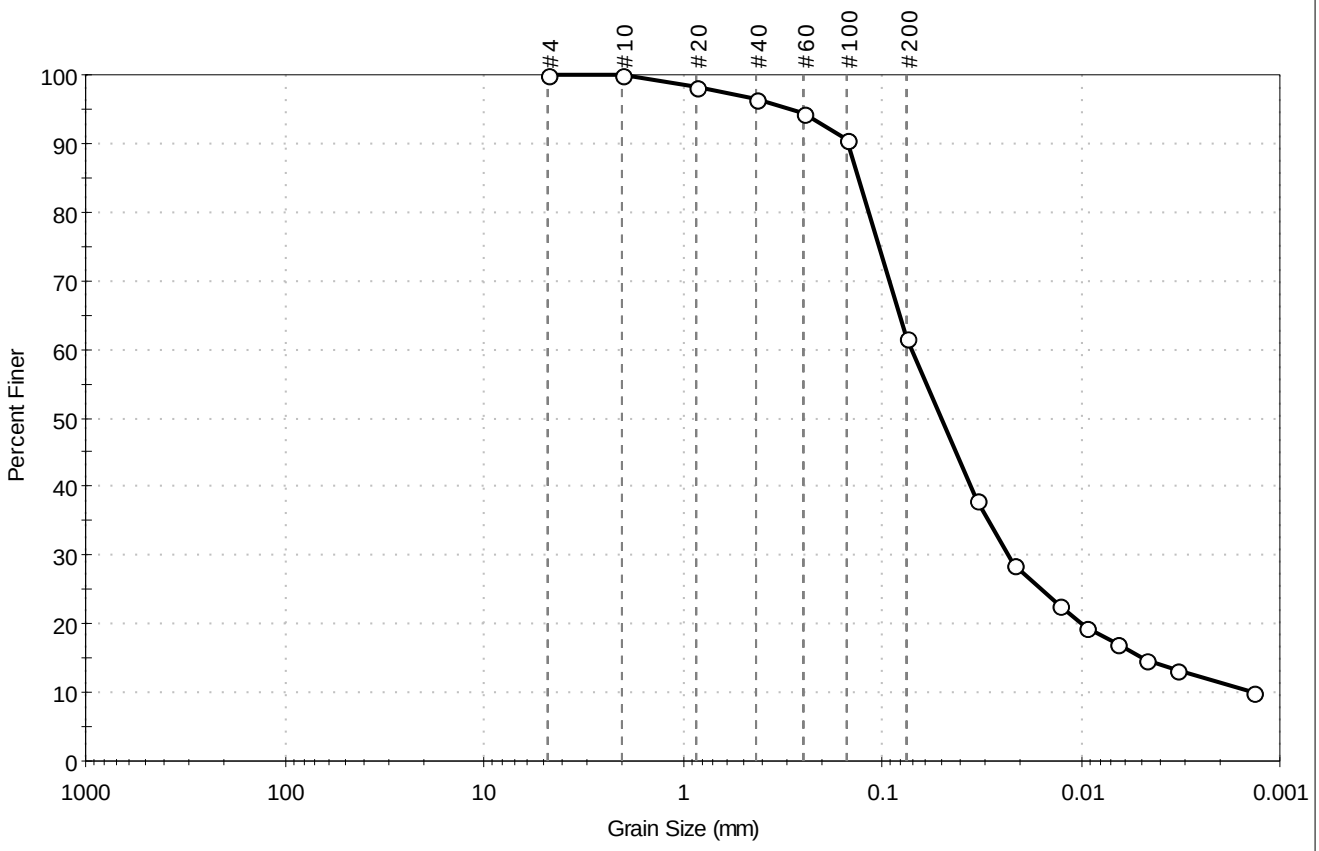
Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5030002	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-003	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431803		

Test Comment: ---
Visual Description: Wet, very dark gray sandy silt
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	38.4	61.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	98		
#40	0.42	96		
#60	0.25	95		
#100	0.15	91		
#200	0.075	62		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	38		
---	0.0219	29		
---	0.0130	23		
---	0.0093	19		
---	0.0066	17		
---	0.0047	15		
---	0.0033	13		
---	0.0014	10		

Coefficients

D_{85} = 0.1312 mm
D_{30} = 0.0233 mm
D_{60} = 0.0710 mm
D_{15} = 0.0049 mm
D_{50} = 0.0505 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM Sandy Elastic SILT (MH)

AASHTO Clayey Soils (A-7-5 (16))

Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: oo Sieve

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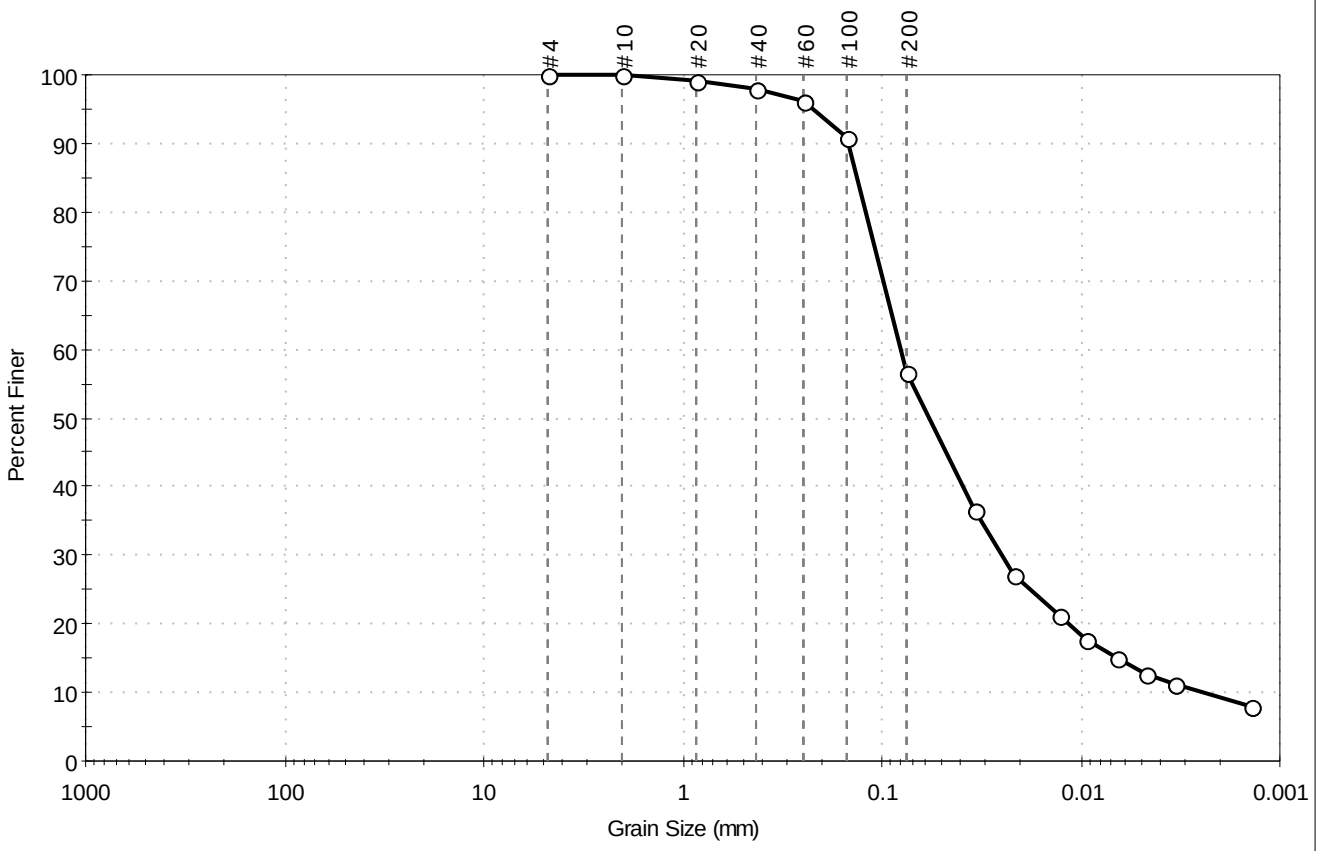
Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5040001	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-004	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431804		

Test Comment: ---
Visual Description: Wet, very dark gray sandy silt
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	43.3	56.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	96		
#100	0.15	91		
#200	0.075	57		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0340	37		
---	0.0215	27		
---	0.0129	21		
---	0.0094	18		
---	0.0067	15		
---	0.0047	13		
---	0.0033	11		
---	0.0014	8		

Coefficients

D_{85} = 0.1330 mm D_{30} = 0.0247 mm
D_{60} = 0.0802 mm D_{15} = 0.0065 mm
D_{50} = 0.0575 mm D_{10} = 0.0024 mm
C_u = 33.417 C_c = 3.170

Classification

ASTM Sandy Elastic SILT (MH)

AASHTO Clayey Soils (A-7-5 (8))

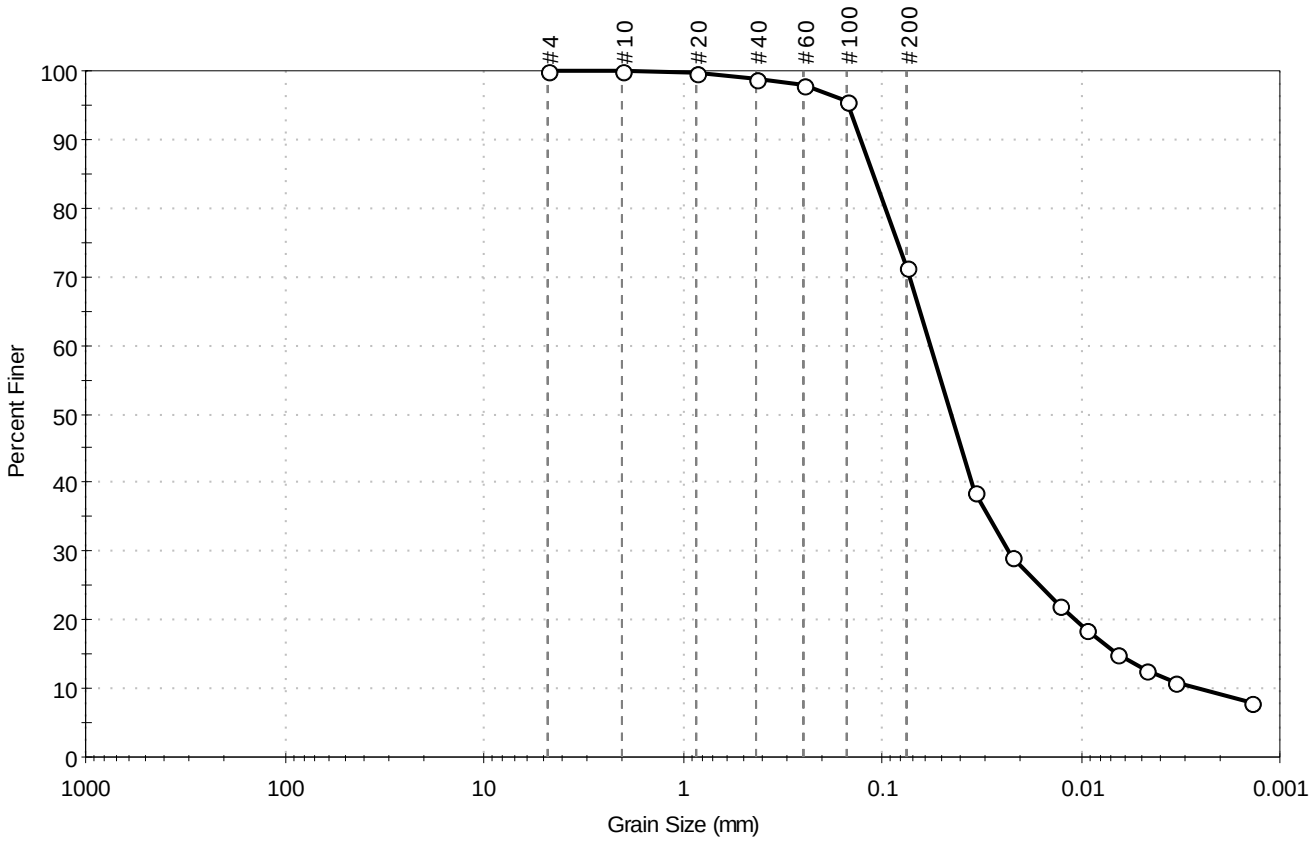
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5050002	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-005	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431805		

Test Comment: ---
Visual Description: Wet, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	28.6	71.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	98		
#100	0.15	96		
#200	0.075	71		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0345	39		
---	0.0220	29		
---	0.0130	22		
---	0.0093	19		
---	0.0066	15		
---	0.0047	13		
---	0.0033	11		
---	0.0014	8		

Coefficients

D_{85} = 0.1105 mm D_{30} = 0.0228 mm
D_{60} = 0.0572 mm D_{15} = 0.0066 mm
D_{50} = 0.0451 mm D_{10} = 0.0025 mm
C_u = 22.880 C_c = 3.635

Classification

ASTM Elastic SILT with Sand (MH)

AASHTO Clayey Soils (A-7-5 (14))

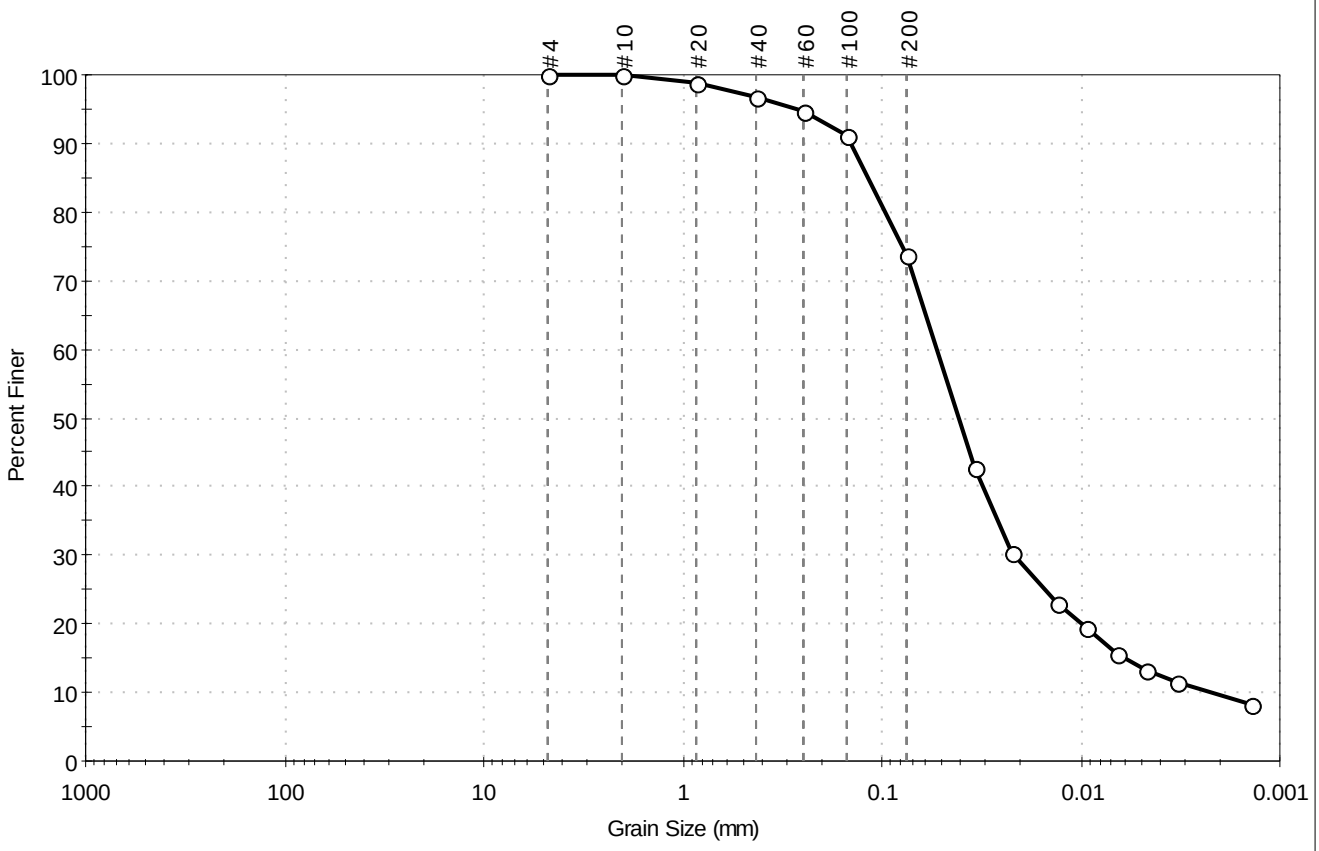
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5060001	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-006	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431806		

Test Comment: ---
Visual Description: Wet, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	26.1	73.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	97		
#60	0.25	95		
#100	0.15	91		
#200	0.075	74		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0341	43		
---	0.0220	31		
---	0.0131	23		
---	0.0093	19		
---	0.0066	16		
---	0.0047	13		
---	0.0033	12		
---	0.0014	8		

Coefficients

D_{85} = 0.1171 mm	D_{30} = 0.0212 mm
D_{60} = 0.0527 mm	D_{15} = 0.0060 mm
D_{50} = 0.0408 mm	D_{10} = 0.0022 mm
C_u = 23.955	C_c = 3.876

Classification

ASTM Elastic SILT with Sand (MH)

AASHTO Clayey Soils (A-7-5 (22))

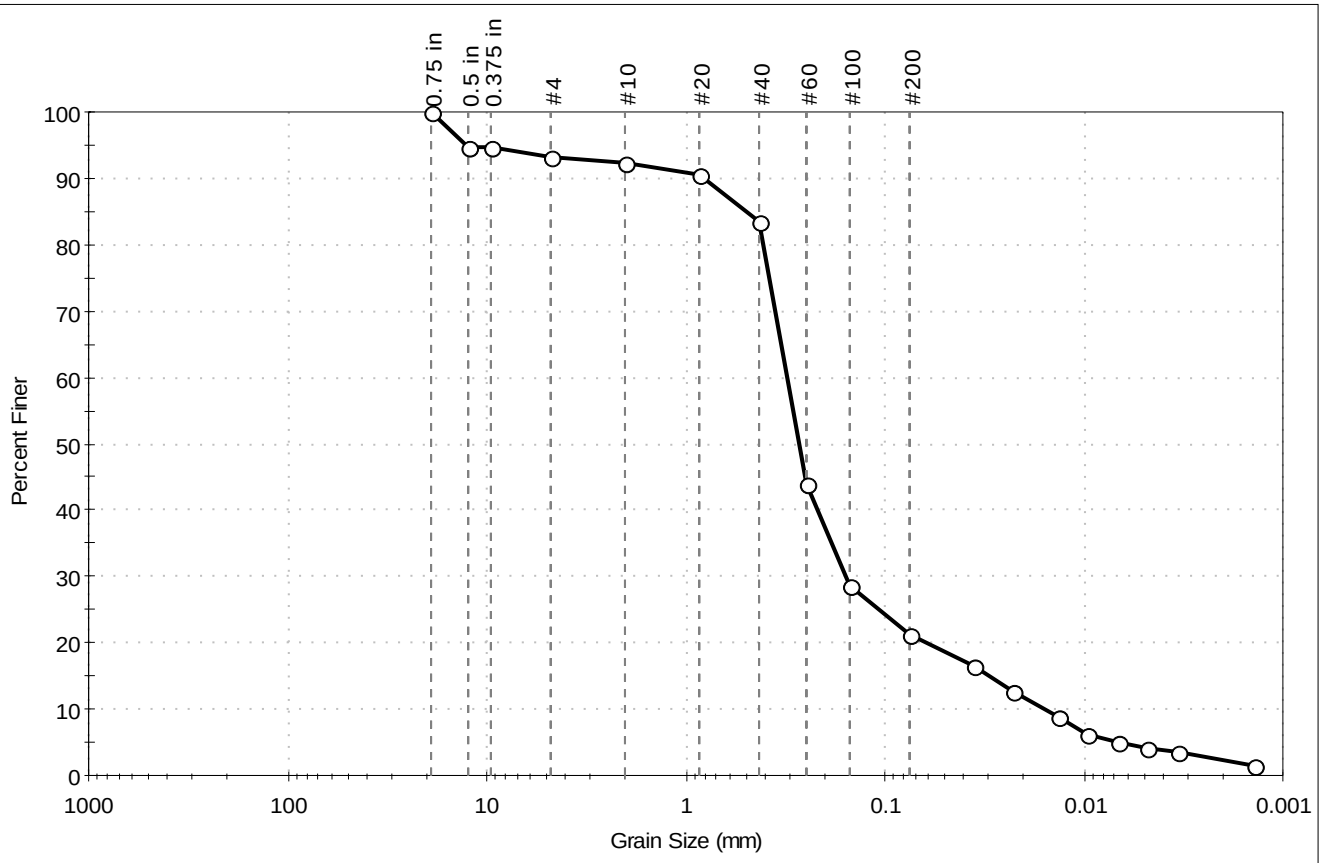
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5070004	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-007	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431807		

Test Comment: ---
Visual Description: Moist, very dark gray silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	6.7	71.9	21.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	95		
0.375 in	9.50	95		
#4	4.75	93		
#10	2.00	92		
#20	0.85	91		
#40	0.42	84		
#60	0.25	44		
#100	0.15	28		
#200	0.075	21		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0362	16		
---	0.0228	13		
---	0.0134	9		
---	0.0096	6		
---	0.0067	5		
---	0.0048	4		
---	0.0034	4		
---	0.0014	1		

Coefficients

D_{85} = 0.4898 mm	D_{30} = 0.1578 mm
D_{60} = 0.3101 mm	D_{15} = 0.0304 mm
D_{50} = 0.2713 mm	D_{10} = 0.0157 mm
C_u = 19.752	C_c = 5.115

Classification

ASTM Silty SAND (SM)

AASHTO Silty Gravel and Sand (A-2-4 (0))

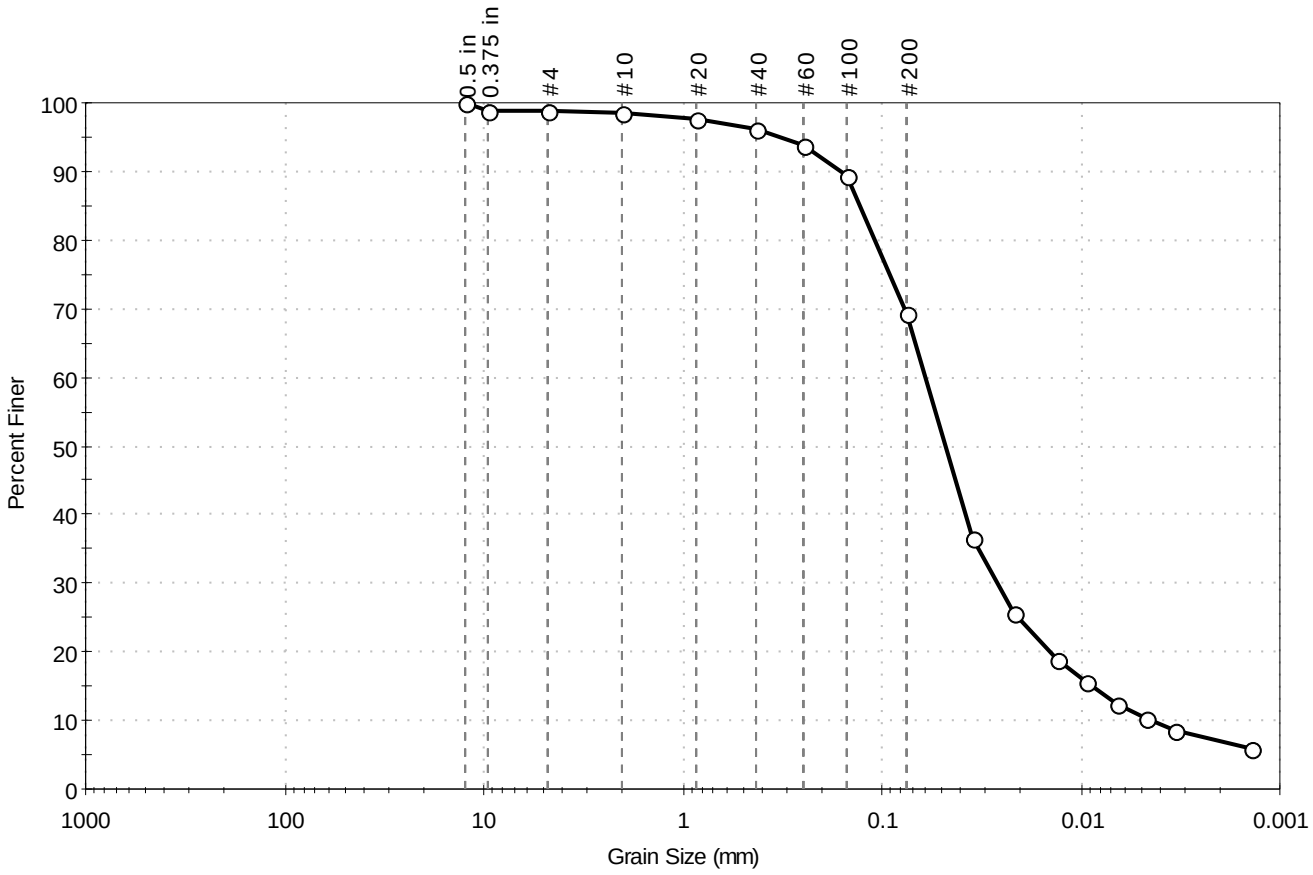
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5080001	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-008	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431808		

Test Comment: ---
Visual Description: Wet, very dark gray sandy silt
Sample Comment: ---

Particle Size Analysis - ASTM D422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	1.2	29.5	69.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	99		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	94		
#100	0.15	89		
#200	0.075	69		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0350	36		
---	0.0217	26		
---	0.0132	19		
---	0.0094	16		
---	0.0067	12		
---	0.0048	10		
---	0.0034	8		
---	0.0014	6		

Coefficients

D_{85} = 0.1288 mm	D_{30} = 0.0264 mm
D_{60} = 0.0605 mm	D_{15} = 0.0087 mm
D_{50} = 0.0480 mm	D_{10} = 0.0045 mm
C_u = 13.444	C_c = 2.560

Classification

ASTM Sandy Elastic SILT (MH)

AASHTO Clayey Soils (A-7-5 (16))

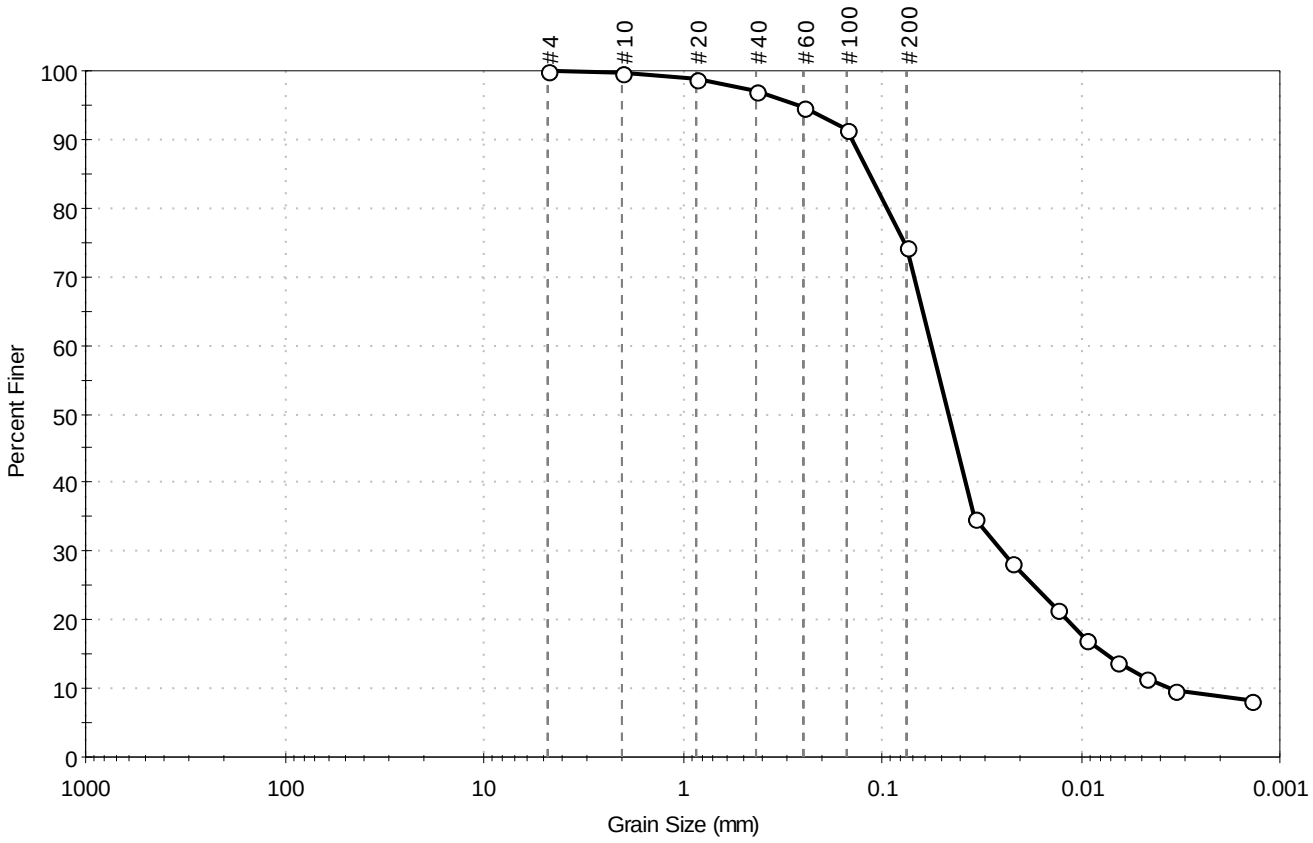
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5090002	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-009	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431809		

Test Comment: ---
Visual Description: Moist, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	25.7	74.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	97		
#60	0.25	95		
#100	0.15	92		
#200	0.075	74		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0345	35		
---	0.0222	28		
---	0.0132	22		
---	0.0093	17		
---	0.0066	14		
---	0.0048	12		
---	0.0033	10		
---	0.0014	8		

Coefficients

D_{85} = 0.1154 mm	D_{30} = 0.0249 mm
D_{60} = 0.0566 mm	D_{15} = 0.0074 mm
D_{50} = 0.0464 mm	D_{10} = 0.0035 mm
C_u = 16.171	C_c = 3.130

Classification

ASTM Elastic SILT with Sand (MH)

AASHTO Clayey Soils (A-7-5 (14))

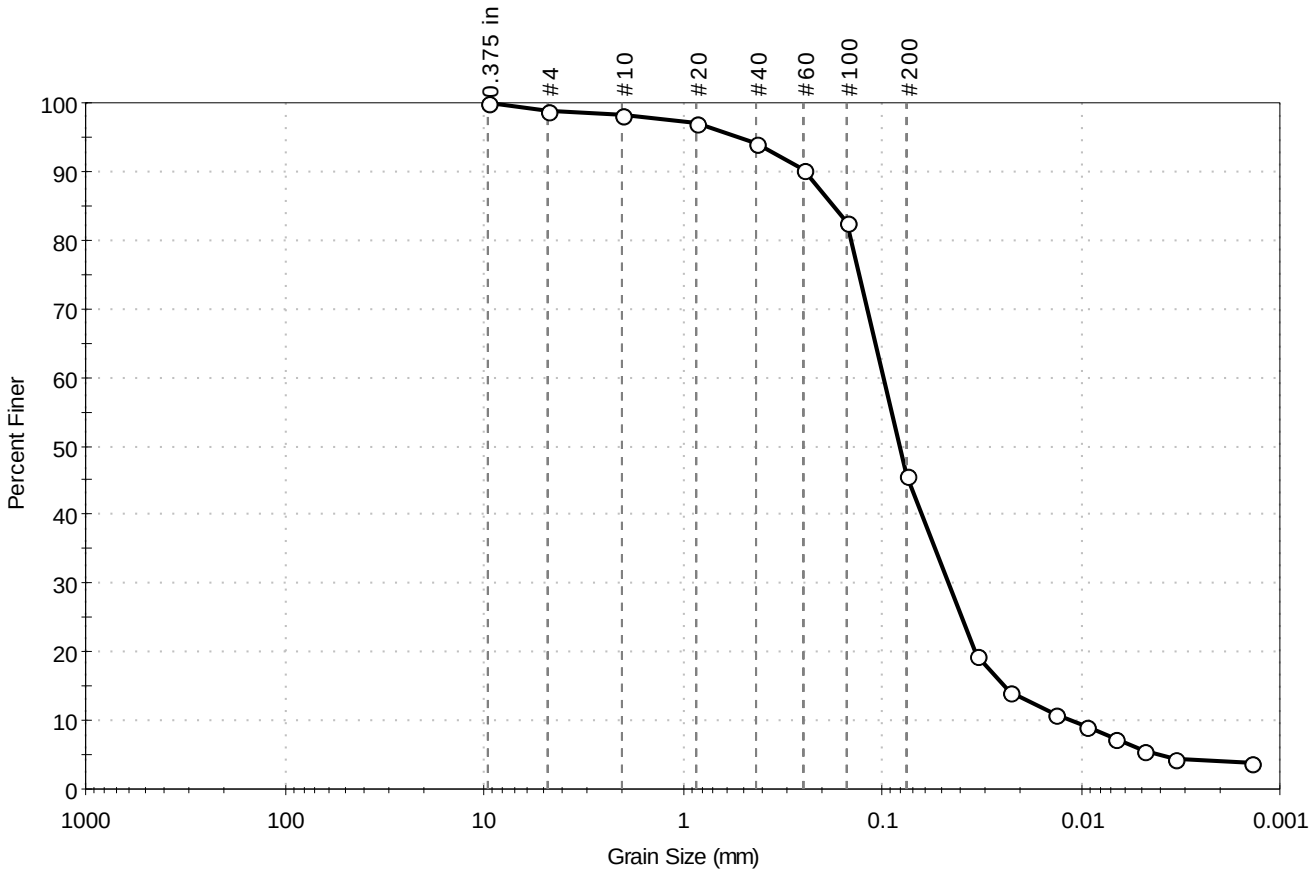
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29882				
Location:	---			Project No:	GTX-307249
Boring ID:	SDT5100001	Sample Type:	jar	Tested By:	GA
Sample ID:	29882-010	Test Date:	11/09/17	Checked By:	emm
Depth :	---	Test Id:	431810		

Test Comment: ---
Visual Description: Wet, very dark gray silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.2	53.0	45.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	97		
#40	0.42	94		
#60	0.25	90		
#100	0.15	83		
#200	0.075	46		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0337	19		
---	0.0226	14		
---	0.0133	11		
---	0.0095	9		
---	0.0067	7		
---	0.0048	6		
---	0.0034	5		
---	0.0014	4		

Coefficients

D_{85} = 0.1753 mm	D_{30} = 0.0465 mm
D_{60} = 0.0979 mm	D_{15} = 0.0240 mm
D_{50} = 0.0812 mm	D_{10} = 0.0113 mm
C_u = 8.664	C_c = 1.955

Classification

ASTM Silty SAND (SM)

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

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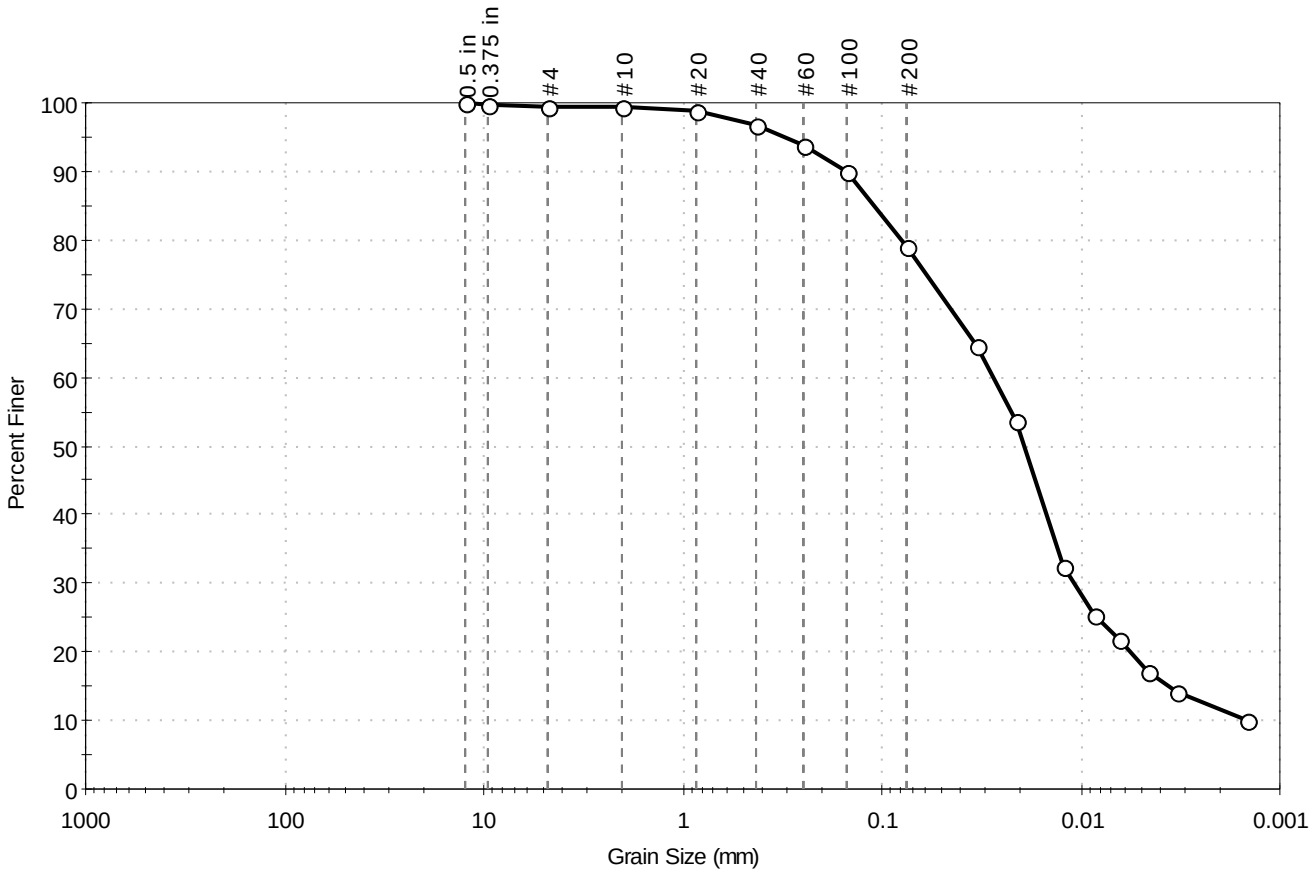
Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29543-006	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-01-COMP-002	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441168		

Test Comment: ---
Visual Description: Moist, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.5	20.3	79.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	99		
#20	0.85	99		
#40	0.42	97		
#60	0.25	94		
#100	0.15	90		
#200	0.075	79		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0334	65		
---	0.0212	54		
---	0.0123	33		
---	0.0087	25		
---	0.0065	22		
---	0.0046	17		
---	0.0033	14		
---	0.0015	10		

Coefficients

D_{85} = 0.1088 mm D_{30} = 0.0109 mm
D_{60} = 0.0275 mm D_{15} = 0.0036 mm
D_{50} = 0.0192 mm D_{10} = 0.0015 mm
C_u = 18.333 C_c = 2.880

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

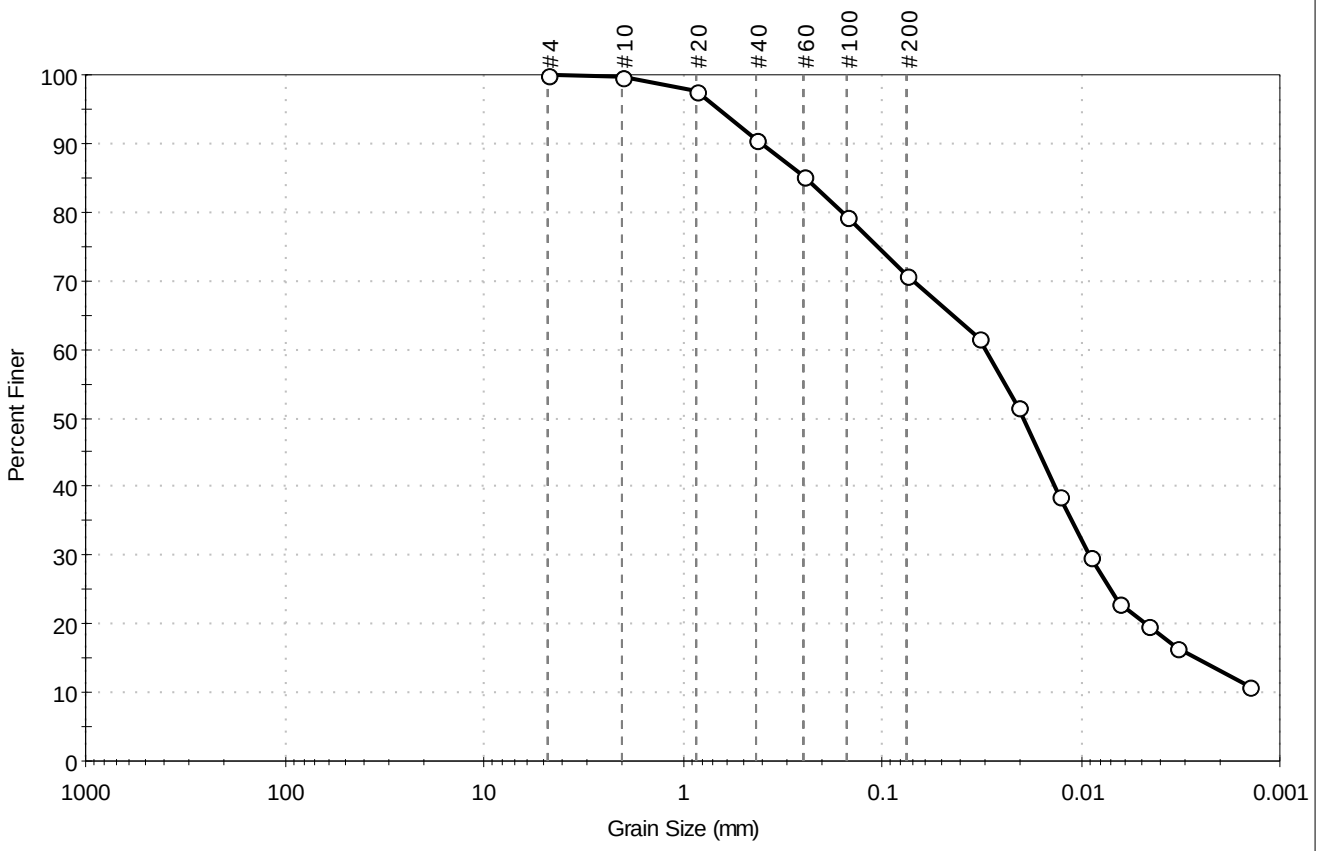
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29543-012	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-06-COMP-003	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441169		

Test Comment: ---
Visual Description: Moist, very dark gray silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	29.3	70.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	98		
#40	0.42	91		
#60	0.25	85		
#100	0.15	79		
#200	0.075	71		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0328	62		
---	0.0208	52		
---	0.0128	39		
---	0.0090	30		
---	0.0065	23		
---	0.0046	20		
---	0.0033	17		
---	0.0014	11		

Coefficients

D_{85} = 0.2460 mm
D_{30} = 0.0091 mm
D_{60} = 0.0304 mm
D_{15} = 0.0026 mm
D_{50} = 0.0195 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

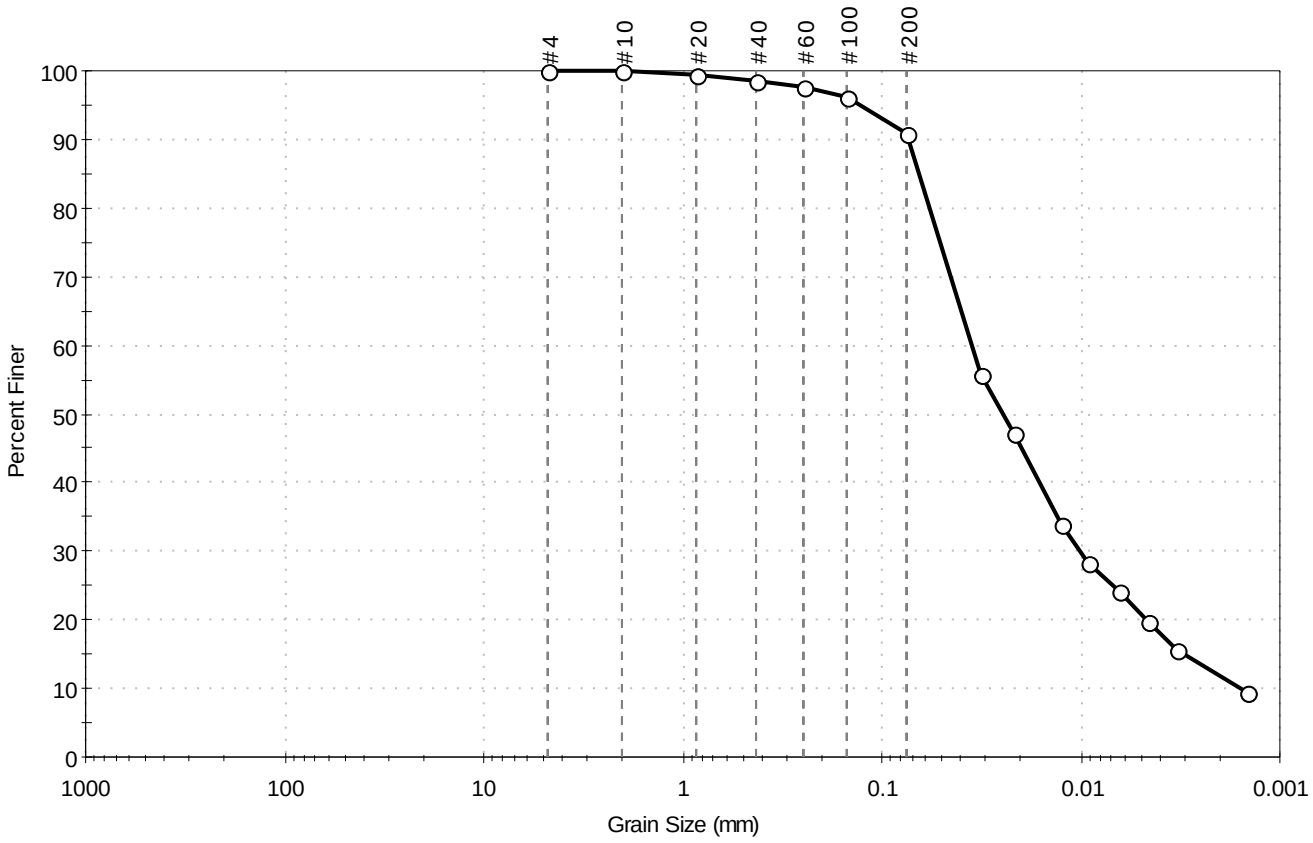
AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29543-020	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-08-COMP-004	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441170		
Test Comment:	---				
Visual Description:	Moist, dark gray silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
---	0.0	9.1	90.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	98		
#100	0.15	96		
#200	0.075	91		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0319	56		
---	0.0216	47		
---	0.0126	34		
---	0.0091	28		
---	0.0065	24		
---	0.0046	20		
---	0.0033	16		
---	0.0015	9		

Coefficients

D_{85} = 0.0650 mm	D_{30} = 0.0100 mm
D_{60} = 0.0354 mm	D_{15} = 0.0030 mm
D_{50} = 0.0246 mm	D_{10} = 0.0016 mm
C_u = 22.125	C_c = 1.766

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

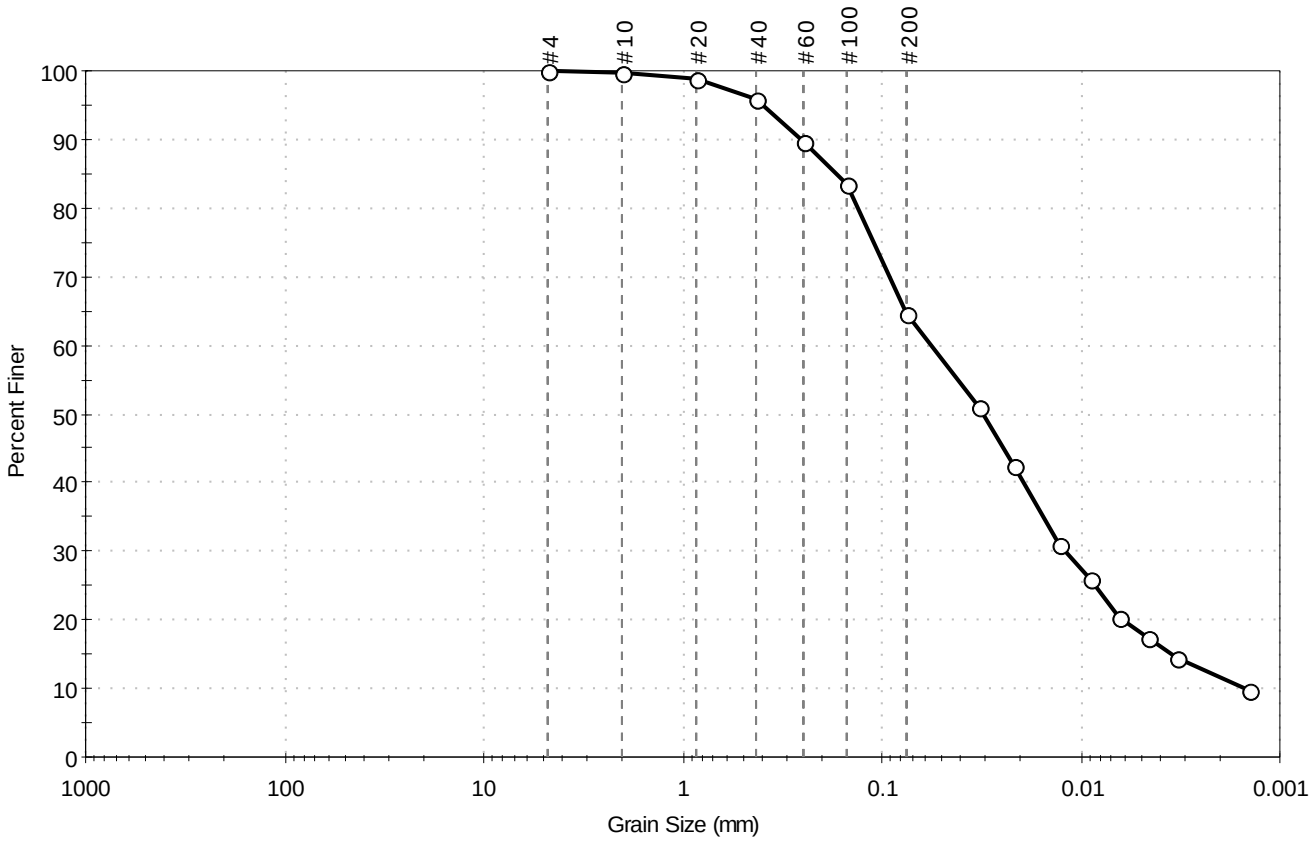
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29607-005	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-01-COMP-001	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441164		
Test Comment:	---				
Visual Description:	Moist, very dark gray sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	35.3	64.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	96		
#60	0.25	90		
#100	0.15	84		
#200	0.075	65		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0324	51		
---	0.0217	42		
---	0.0130	31		
---	0.0090	26		
---	0.0064	20		
---	0.0046	17		
---	0.0033	14		
---	0.0014	10		

Coefficients

D_{85} = 0.1681 mm	D_{30} = 0.0122 mm
D_{60} = 0.0561 mm	D_{15} = 0.0035 mm
D_{50} = 0.0308 mm	D_{10} = 0.0015 mm
C_u = 37.400	C_c = 1.769

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

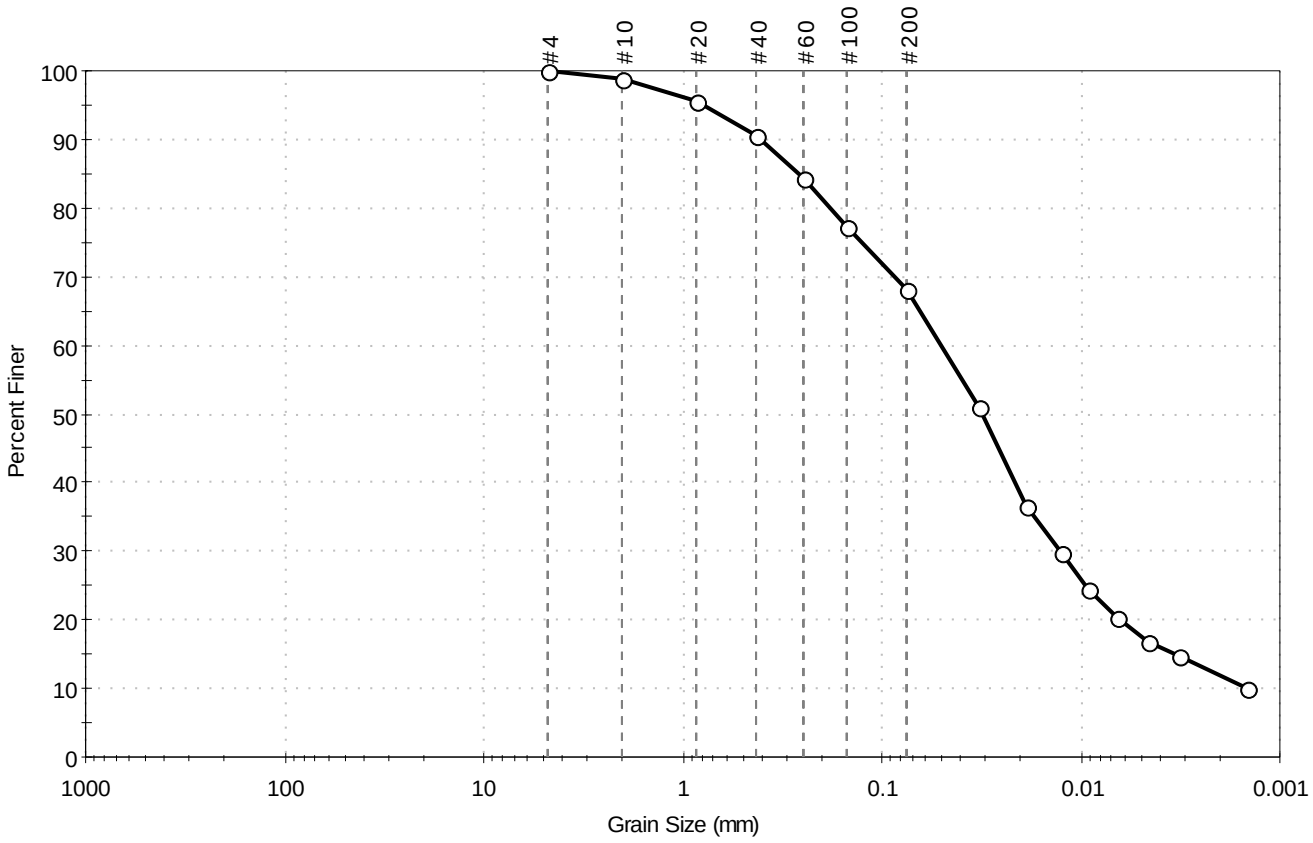
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29607-006	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-04-COMP-001	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441165		
Test Comment:	---				
Visual Description:	Moist, dark gray sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	31.9	68.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	96		
#40	0.42	91		
#60	0.25	84		
#100	0.15	77		
#200	0.075	68		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0325	51		
---	0.0188	37		
---	0.0125	30		
---	0.0092	24		
---	0.0065	20		
---	0.0047	17		
---	0.0032	15		
---	0.0015	10		

Coefficients

D_{85} = 0.2651 mm	D_{30} = 0.0126 mm
D_{60} = 0.0503 mm	D_{15} = 0.0034 mm
D_{50} = 0.0311 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

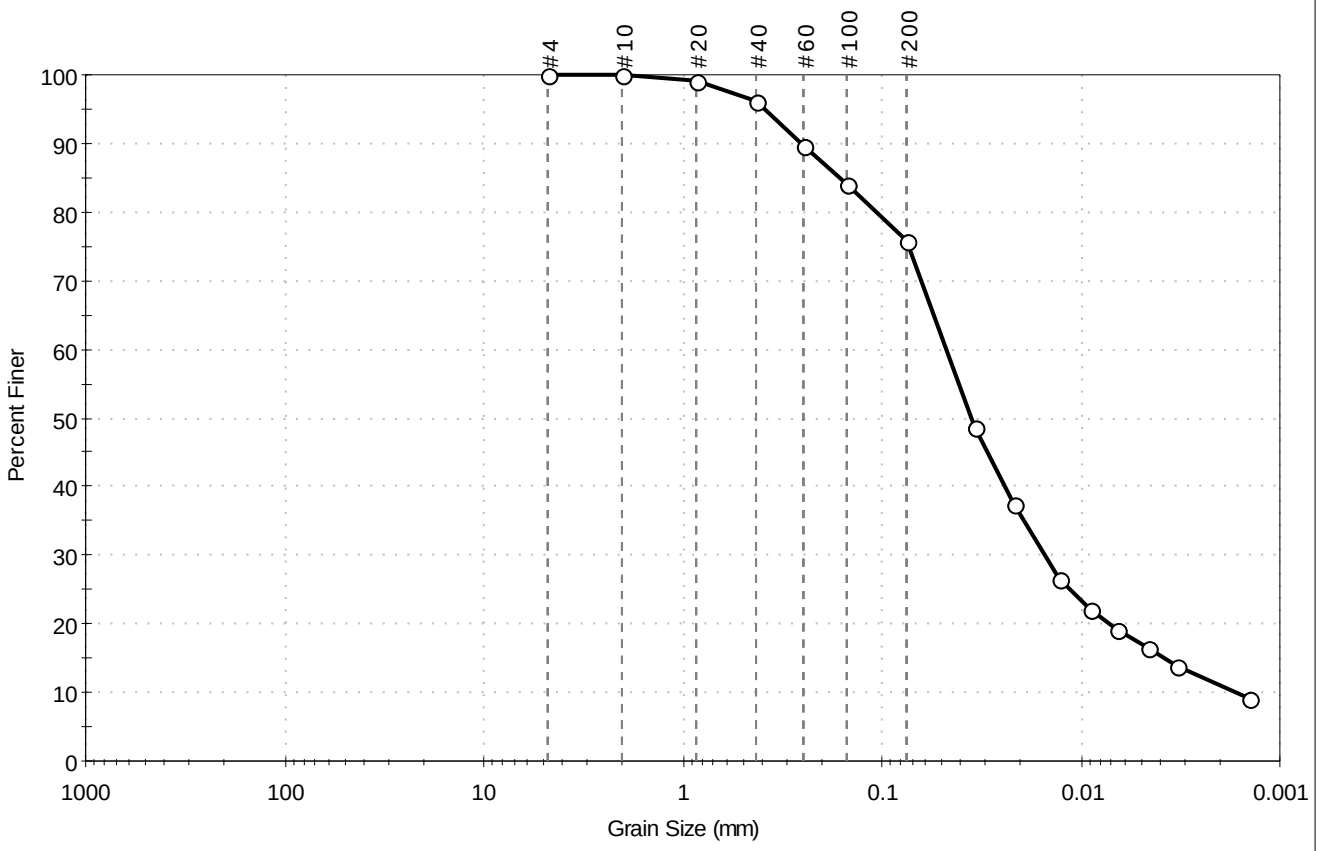
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29607-007	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-08-COMP-001	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441166		
Test Comment:	---				
Visual Description:	Moist, very dark gray silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	24.2	75.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	96		
#60	0.25	90		
#100	0.15	84		
#200	0.075	76		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0341	49		
---	0.0216	38		
---	0.0129	27		
---	0.0091	22		
---	0.0065	19		
---	0.0046	16		
---	0.0033	14		
---	0.0014	9		

Coefficients

D_{85} = 0.1628 mm	D_{30} = 0.0152 mm
D_{60} = 0.0475 mm	D_{15} = 0.0038 mm
D_{50} = 0.0356 mm	D_{10} = 0.0017 mm
C_u = 27.941	C_c = 2.861

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

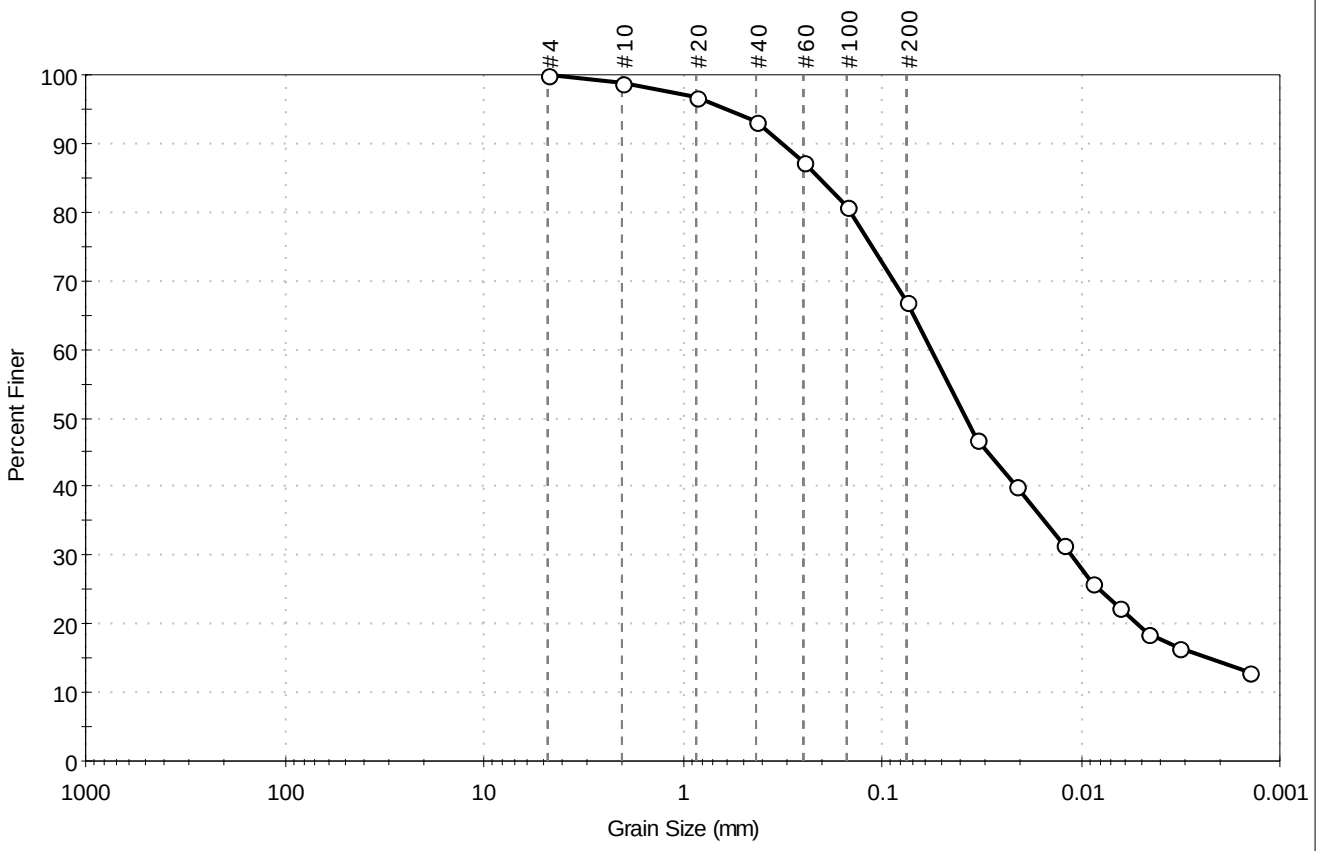
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	EnviroSystems, Inc.				
Project:	29607/29543				
Location:	---			Project No:	GTX-307602
Boring ID:	29607-019	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-xx -COMP-001	Test Date:	02/06/18	Checked By:	emm
Depth :	---	Test Id:	441167		

Test Comment: ---
Visual Description: Moist, very dark gray sandy silt
Sample Comment: Sample contains shells

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	33.1	66.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	97		
#40	0.42	93		
#60	0.25	87		
#100	0.15	81		
#200	0.075	67		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0330	47		
---	0.0212	40		
---	0.0123	31		
---	0.0087	26		
---	0.0064	22		
---	0.0046	18		
---	0.0033	17		
---	0.0014	13		

Coefficients

D_{85} = 0.2077 mm	D_{30} = 0.0112 mm
D_{60} = 0.0565 mm	D_{15} = 0.0023 mm
D_{50} = 0.0375 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

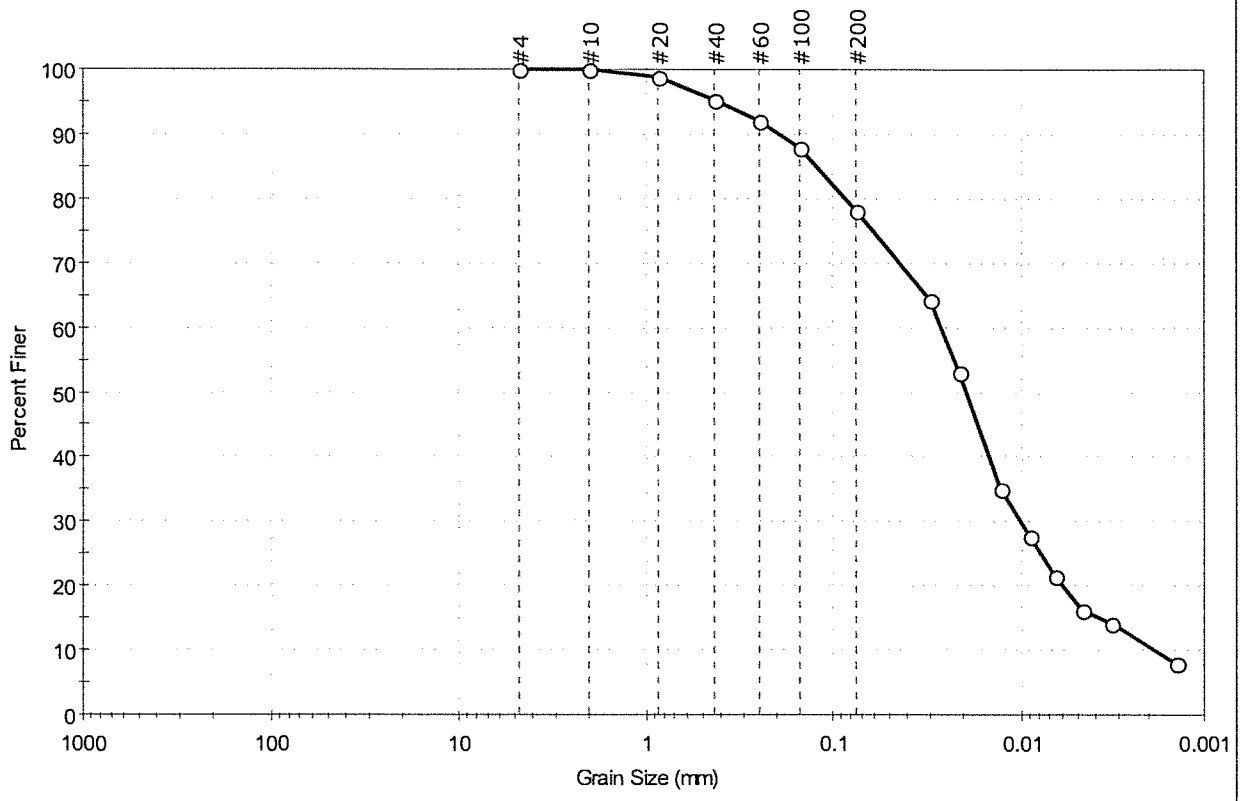
Sample / Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 013	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-06- COMP-003	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420355		
Test Comment:	---				
Visual Description:	Wet, dark gray silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	21.8	78.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	95		
#60	0.25	92		
#100	0.15	88		
#200	0.075	78		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0304	64		
---	0.0211	53		
---	0.0129	35		
---	0.0090	28		
---	0.0065	22		
---	0.0047	16		
---	0.0033	14		
---	0.0014	8		

Coefficients

D_{85} =0.1212 mm D_{30} =0.0100 mm
D_{60} =0.0264 mm D_{15} =0.0038 mm
D_{50} =0.0193 mm D_{10} =0.0018 mm
C_u =14.667 C_c =2.104

Classification

ASTM Elastic silt with sand (MH)

AASHTO Clayey Soils (A-7-5 (43))

Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Specific Gravity : 2.65
Separation of Sample: #200 Sieve

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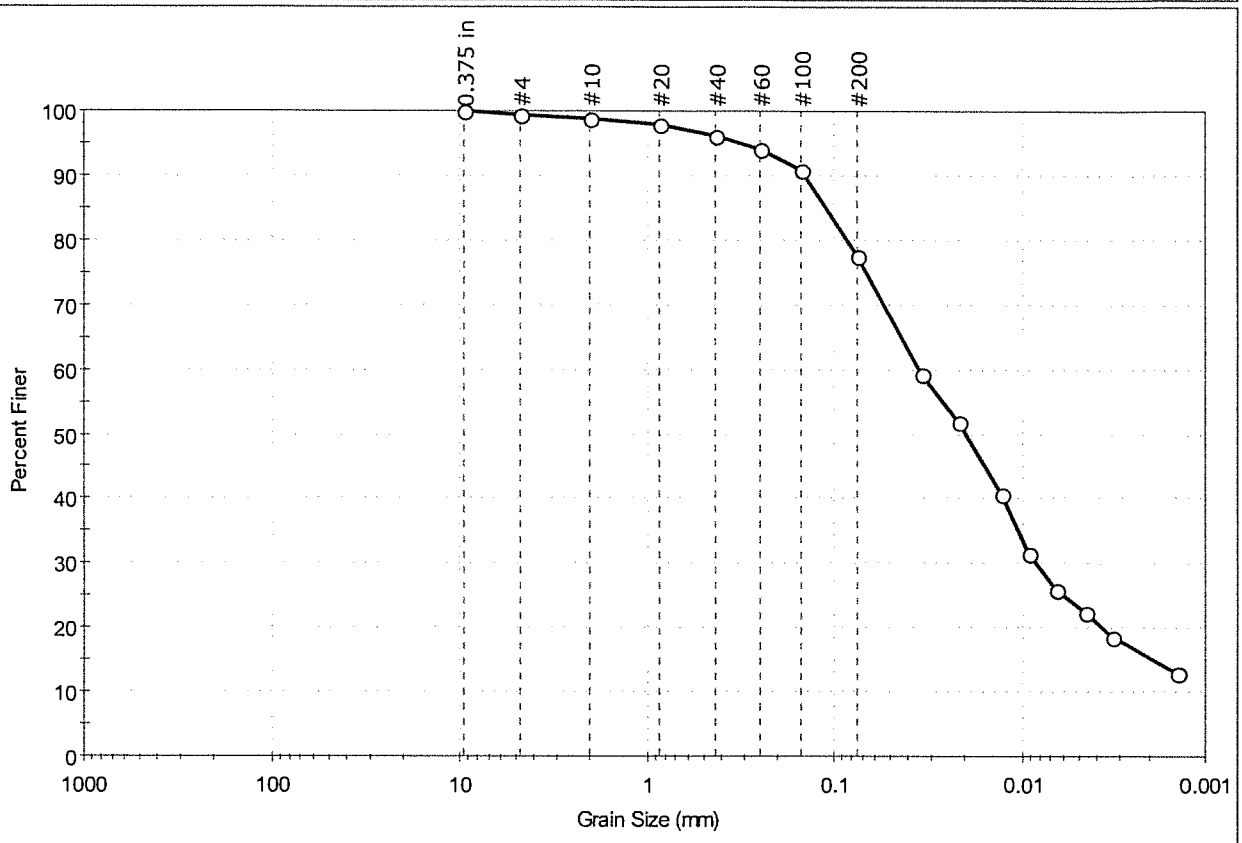
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 026	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-01- 019-0001	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420356		
Test Comment:	---				
Visual Description:	Wet, dark gray silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	21.8	77.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	94		
#100	0.15	91		
#200	0.075	78		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0346	59		
---	0.0216	52		
---	0.0129	41		
---	0.0092	32		
---	0.0066	26		
---	0.0047	22		
---	0.0033	19		
---	0.0014	13		

Coefficients

D_{85} =0.1106 mm	D_{30} =0.0084 mm
D_{60} =0.0355 mm	D_{15} =0.0019 mm
D_{50} =0.0197 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Elastic silt with sand (MH)

AASHTO Clayey Soils (A-7-5 (38))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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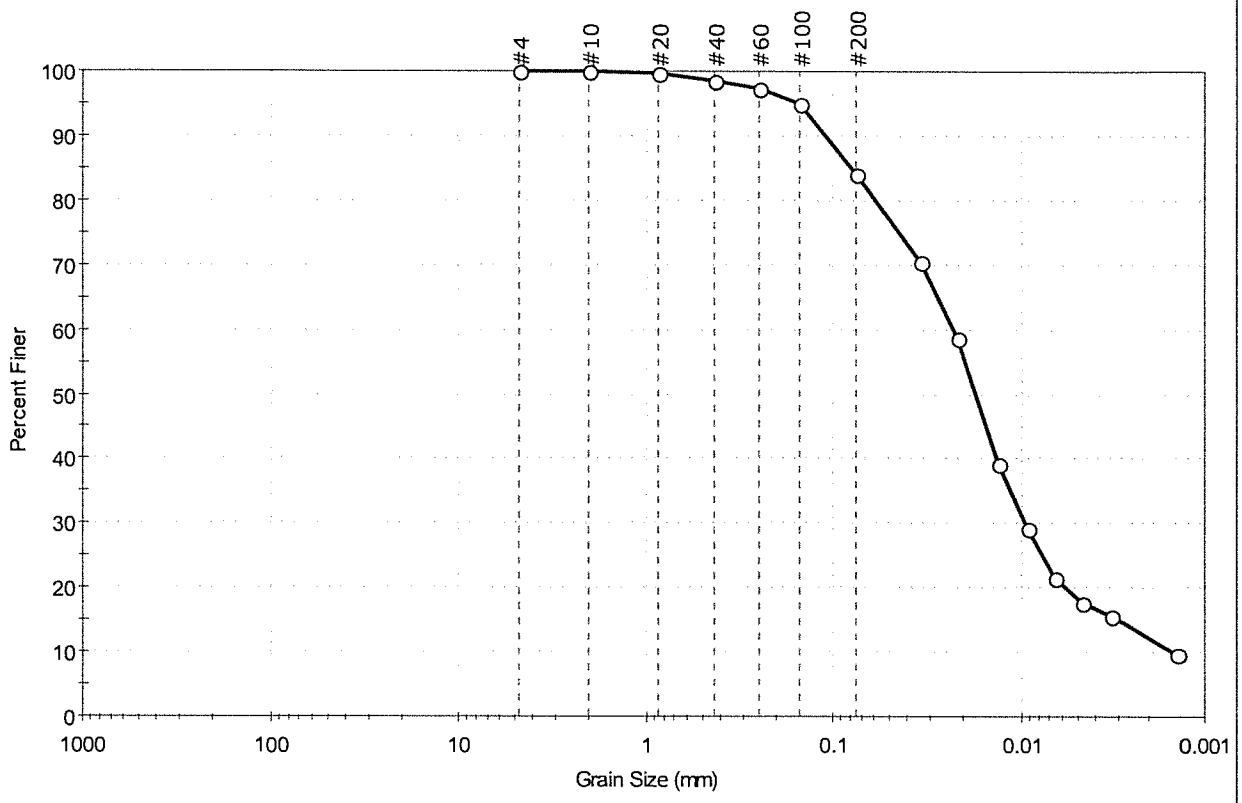
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 028	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-01- 019-0102	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420357		
Test Comment:	---				
Visual Description:	Wet, dark gray silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	16.1	83.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	97		
#100	0.15	95		
#200	0.075	84		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0344	70		
---	0.0218	59		
---	0.0130	39		
---	0.0093	29		
---	0.0066	22		
---	0.0047	18		
---	0.0033	16		
---	0.0014	10		

Coefficients

D_{85} =0.0802 mm	D_{30} =0.0095 mm
D_{60} =0.0229 mm	D_{15} =0.0030 mm
D_{50} =0.0173 mm	D_{10} =0.0014 mm
C_u =16.357	C_c =2.815

Classification

ASTM Elastic silt with sand (MH)

AASHTO Clayey Soils (A-7-5 (62))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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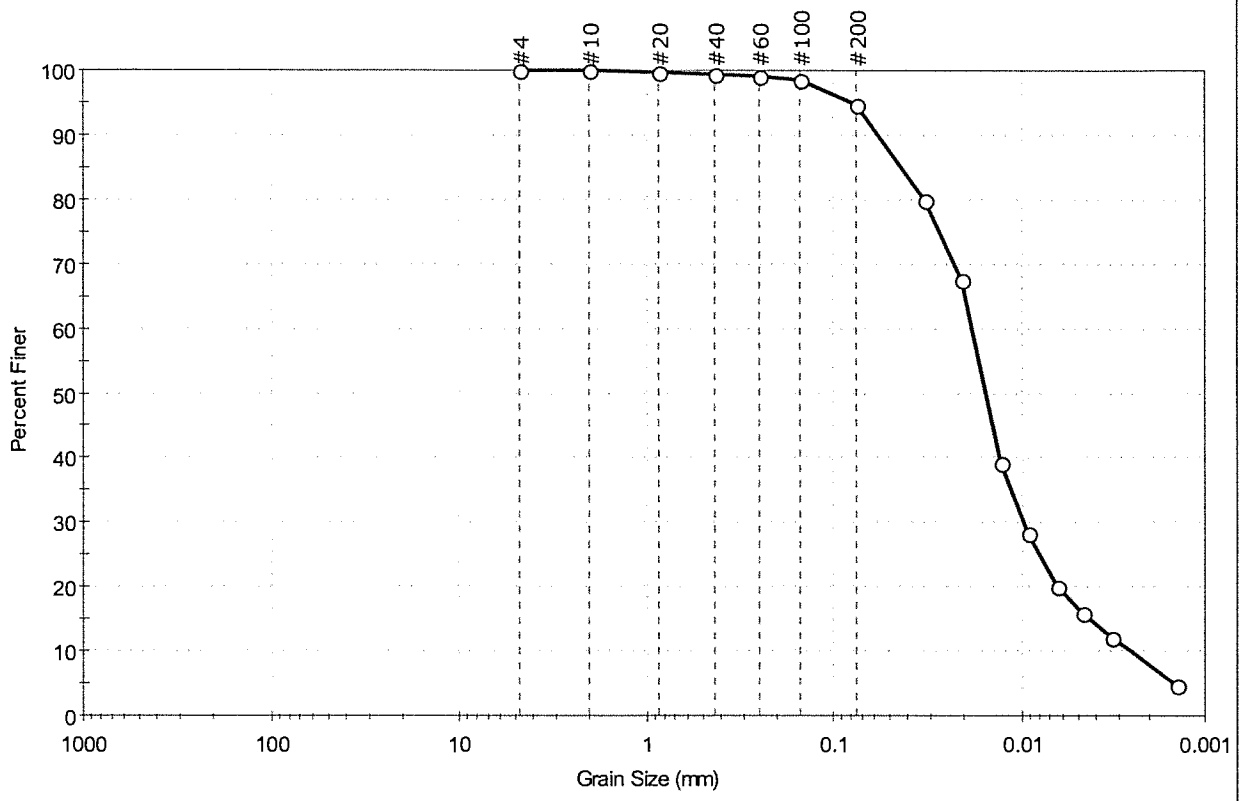
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 030	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-01- 019-0204	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420358		
Test Comment:	---				
Visual Description:	Wet, dark gray silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	5.2	94.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	98		
#200	0.075	95		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0323	80		
---	0.0207	68		
---	0.0128	39		
---	0.0092	28		
---	0.0064	20		
---	0.0047	16		
---	0.0033	12		
---	0.0014	5		

Coefficients

D_{85} =0.0432 mm D_{30} =0.0097 mm
D_{60} =0.0182 mm D_{15} =0.0043 mm
D_{50} =0.0153 mm D_{10} =0.0026 mm
C_u =7.000 C_c =1.988

Classification

ASTM Elastic silt (MH)

AASHTO Clayey Soils (A-7-5 (79))

Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Specific Gravity : 2.65
Separation of Sample: #200 Sieve

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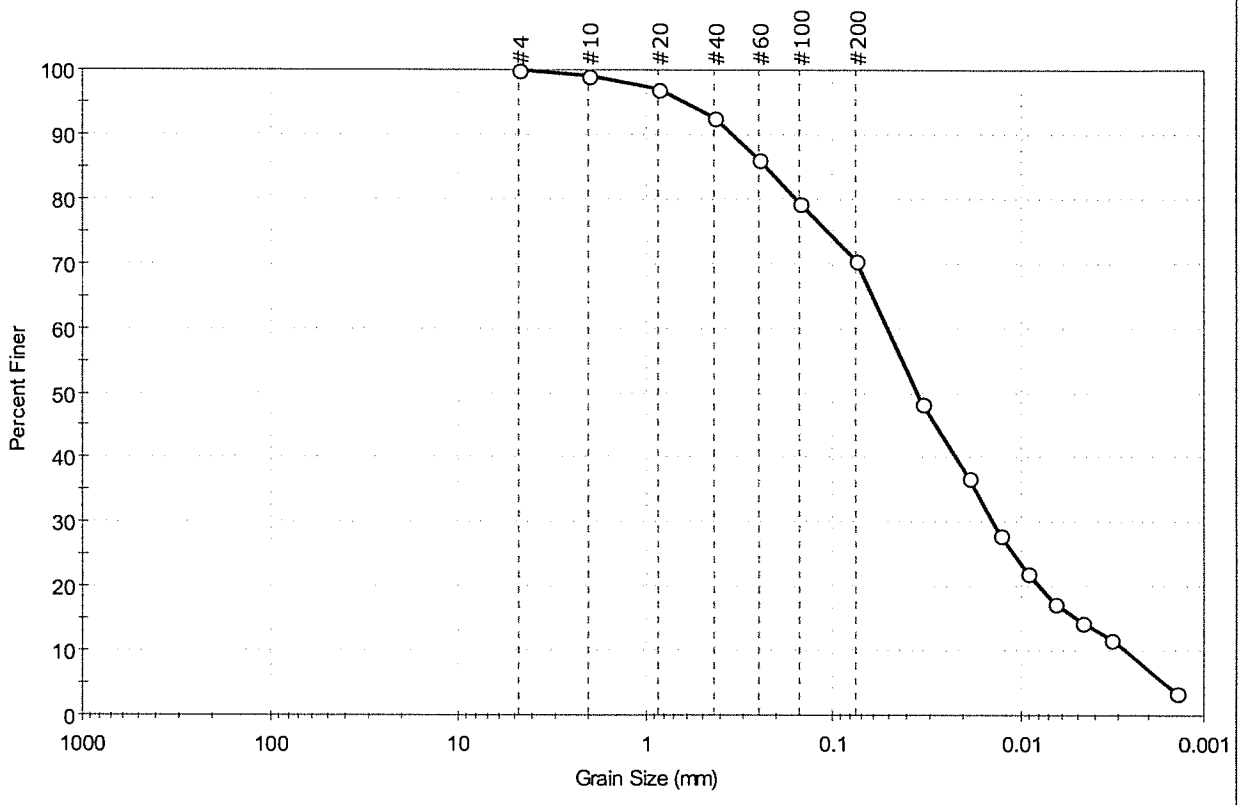
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 032	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-04- 051-0001	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420359		
Test Comment:	---				
Visual Description:	Wet, brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	29.5	70.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	97		
#40	0.42	92		
#60	0.25	86		
#100	0.15	79		
#200	0.075	70		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0333	49		
---	0.0190	37		
---	0.0129	28		
---	0.0092	22		
---	0.0066	17		
---	0.0047	14		
---	0.0033	12		
---	0.0014	3		

Coefficients

D_{85} =0.2276 mm	D_{30} =0.0140 mm
D_{60} =0.0509 mm	D_{15} =0.0050 mm
D_{50} =0.0352 mm	D_{10} =0.0028 mm
C_u =18.179	C_c =1.375

Classification

ASTM Elastic silt with sand (MH)

AASHTO Clayey Soils (A-7-5 (15))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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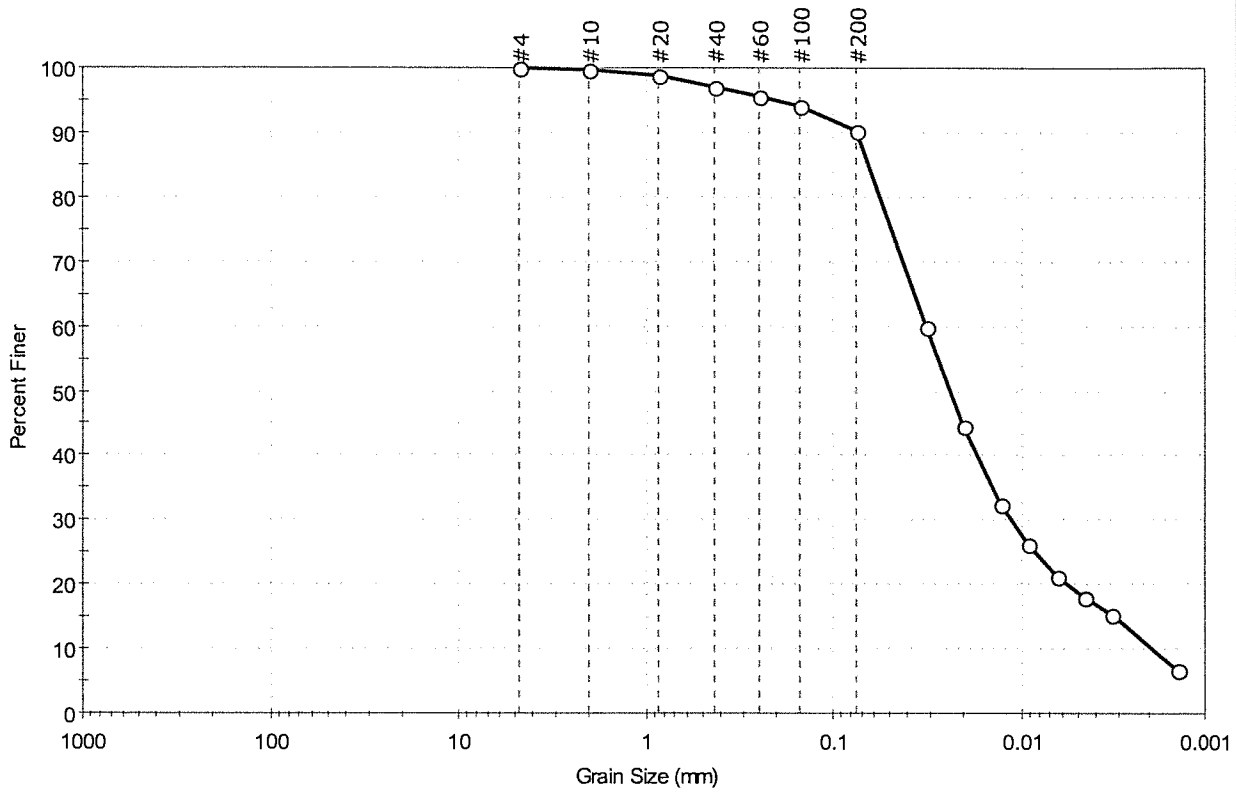
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 034	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-04- 051-0102	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420360		
Test Comment:	---				
Visual Description:	Moist, brown silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
–	0.0	9.7	90.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	97		
#60	0.25	96		
#100	0.15	94		
#200	0.075	90		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0316	60		
---	0.0204	45		
---	0.0128	32		
---	0.0091	26		
---	0.0065	21		
---	0.0046	18		
---	0.0033	15		
---	0.0014	7		

Coefficients

D_{85} =0.0645 mm	D_{30} =0.0112 mm
D_{60} =0.0317 mm	D_{15} =0.0032 mm
D_{50} =0.0238 mm	D_{10} =0.0019 mm
C_u =16.684	C_c =2.083

Classification

ASTM Elastic silt (MH)

AASHTO Clayey Soils (A-7-5 (49))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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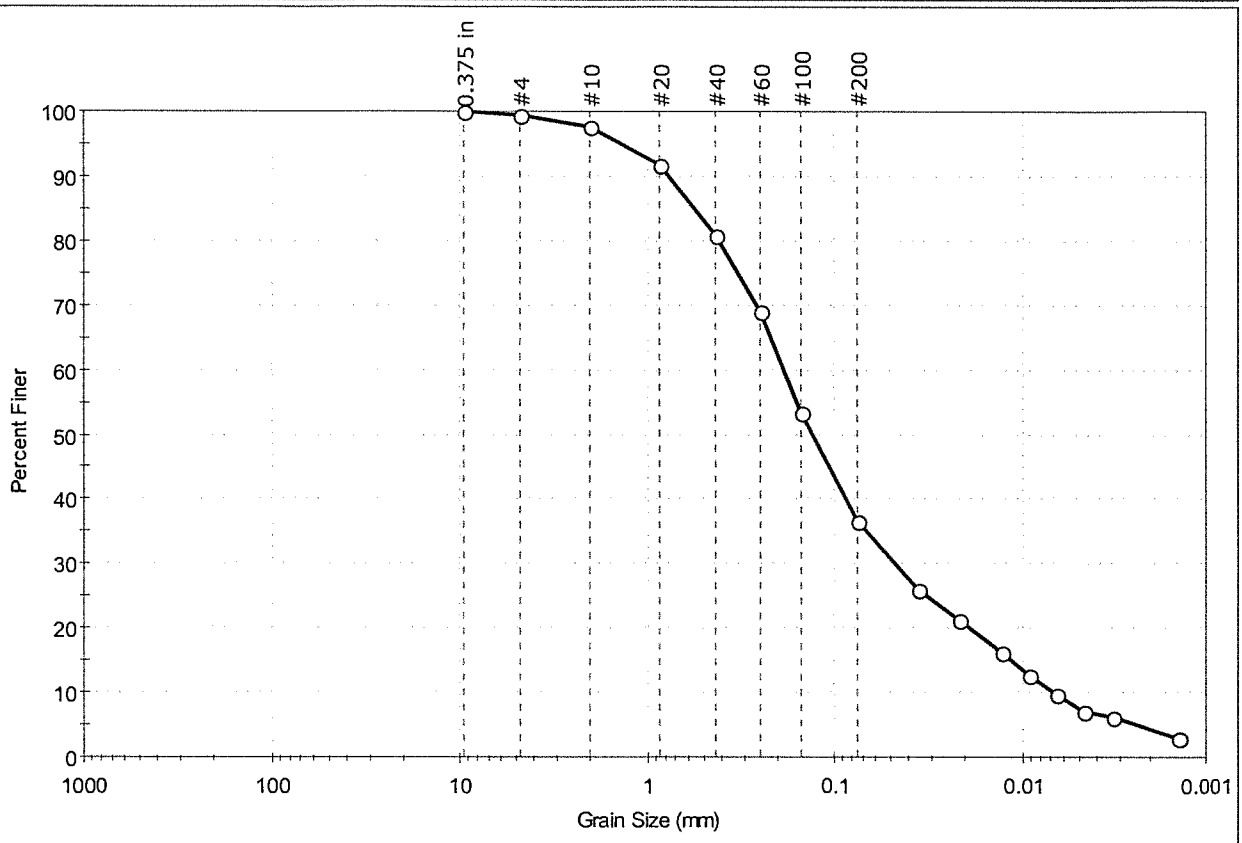
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 036	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-06- 055-0001	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420361		
Test Comment:	---				
Visual Description:	Wet, dark gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	62.8	36.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	92		
#40	0.42	81		
#60	0.25	69		
#100	0.15	53		
#200	0.075	37		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0359	26		
---	0.0218	21		
---	0.0128	16		
---	0.0092	13		
---	0.0066	10		
---	0.0047	7		
---	0.0033	6		
---	0.0014	3		

Coefficients

D_{85} =0.5524 mm	D_{30} =0.0473 mm
D_{60} =0.1859 mm	D_{15} =0.0115 mm
D_{50} =0.1304 mm	D_{10} =0.0069 mm
C_u =26.942	C_c =1.744

Classification

ASTM Silty sand (SM)

AASHTO Clayey Soils (A-7-5 (1))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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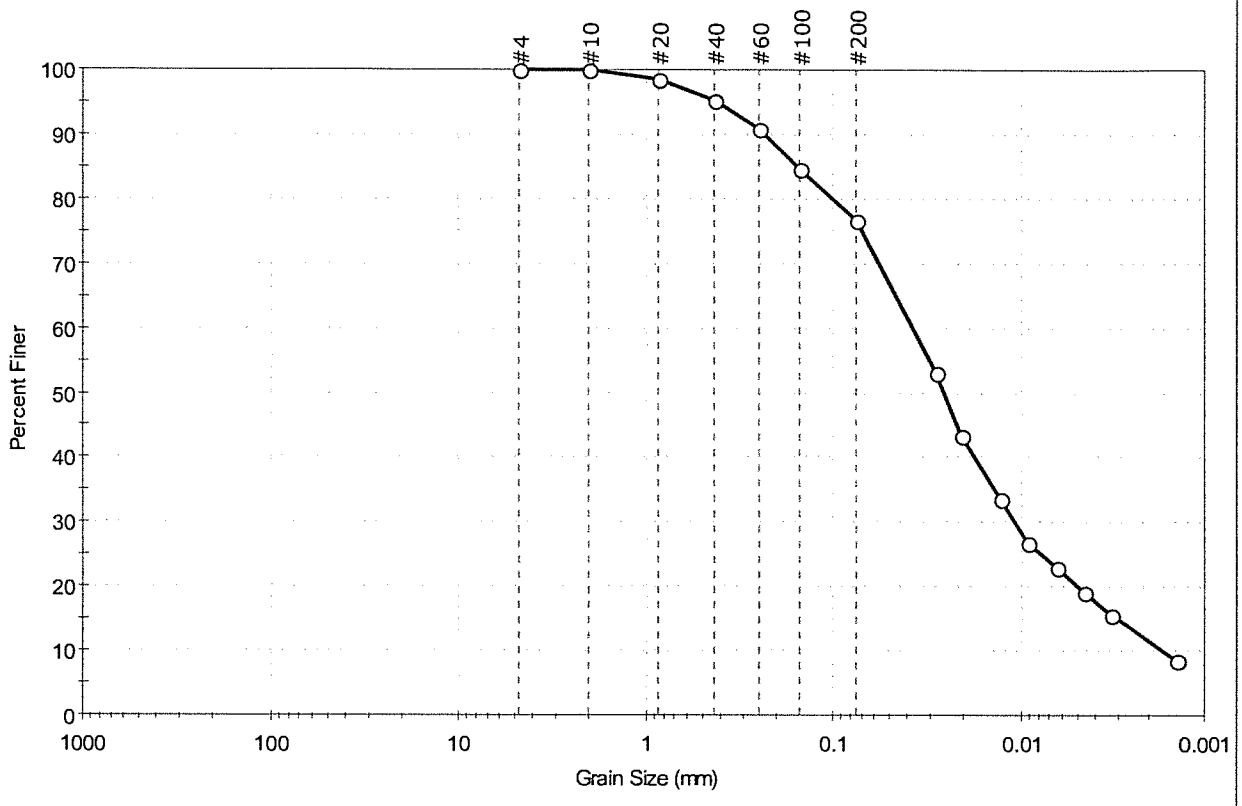
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 038	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-06- 055-0102	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420362		
Test Comment:	---				
Visual Description:	Wet, dark gray clay with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	23.3	76.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	95		
#60	0.25	91		
#100	0.15	85		
#200	0.075	77		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0283	53		
---	0.0207	43		
---	0.0130	34		
---	0.0091	27		
---	0.0065	23		
---	0.0047	19		
---	0.0033	16		
---	0.0014	8		

Coefficients

D_{85} =0.1552 mm	D_{30} =0.0107 mm
D_{60} =0.0377 mm	D_{15} =0.0031 mm
D_{50} =0.0257 mm	D_{10} =0.0017 mm
C_u =22.176	C_c =1.786

Classification

ASTM Fat clay with sand (CH)

AASHTO Clayey Soils (A-7-5 (33))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

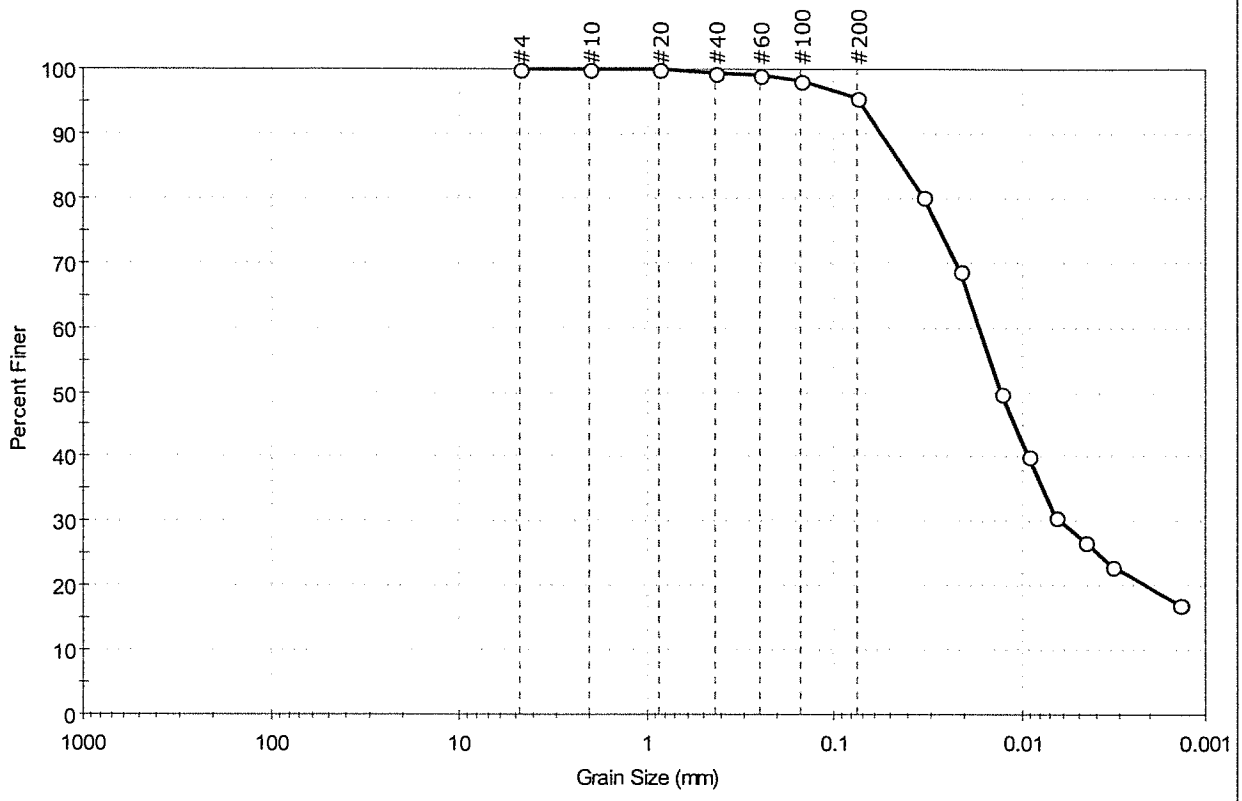
Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 040	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-06- 055-0204	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420363		
Test Comment:	---				
Visual Description:	Wet, brown silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
–	0.0	4.5	95.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	98		
#200	0.075	95		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0333	80		
---	0.0210	69		
---	0.0128	50		
---	0.0091	40		
---	0.0065	31		
---	0.0046	27		
---	0.0033	23		
---	0.0014	17		

Coefficients

D_{85} =0.0428 mm D_{30} =0.0062 mm
D_{60} =0.0167 mm D_{15} =N/A
D_{50} =0.0129 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM Elastic silt (MH)

AASHTO Clayey Soils (A-7-5 (69))

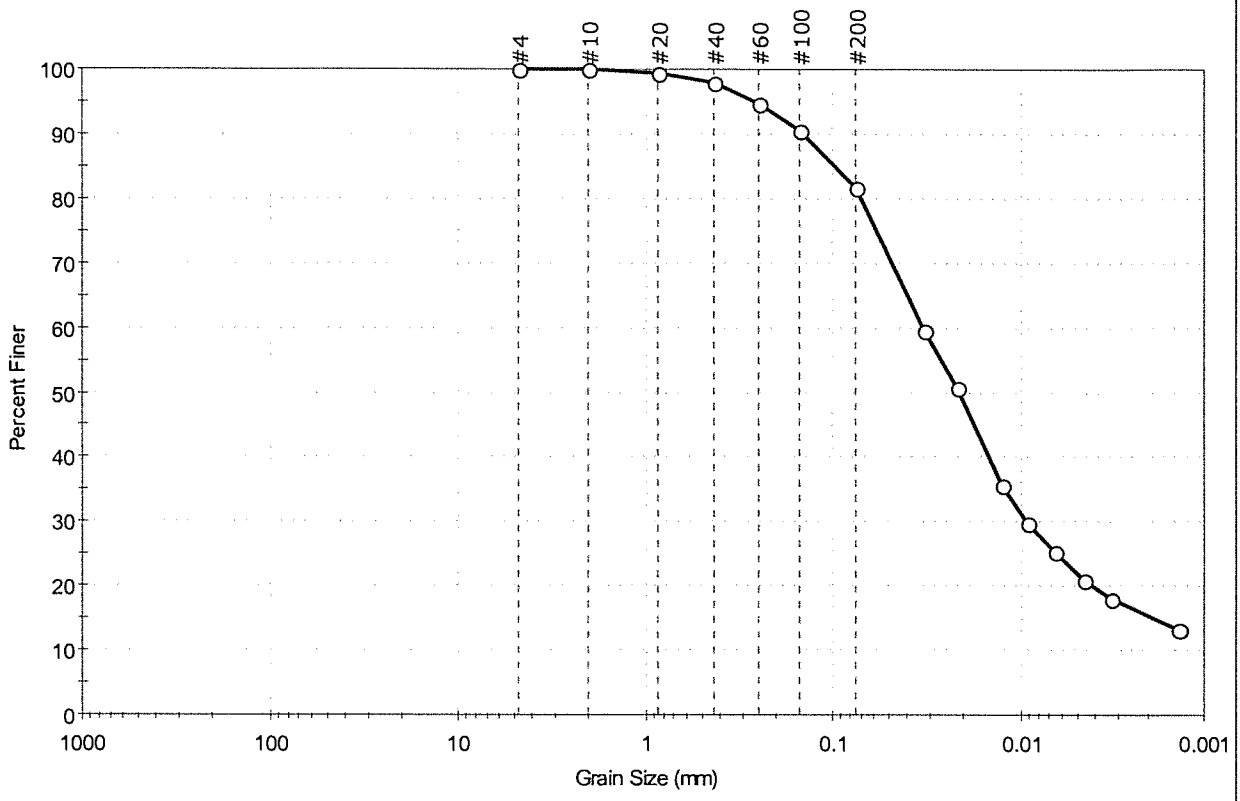
Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Specific Gravity : 2.65
Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 042	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-08- 081-0001	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420364		
Test Comment:	---				
Visual Description:	Wet, brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	18.3	81.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	98		
#60	0.25	95		
#100	0.15	90		
#200	0.075	82		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0327	60		
---	0.0218	51		
---	0.0126	36		
---	0.0092	30		
---	0.0065	25		
---	0.0046	21		
---	0.0033	18		
---	0.0014	13		

Coefficients

D_{85} =0.0973 mm	D_{30} =0.0093 mm
D_{60} =0.0332 mm	D_{15} =0.0019 mm
D_{50} =0.0213 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Elastic silt with sand (MH)

AASHTO Clayey Soils (A-7-5 (28))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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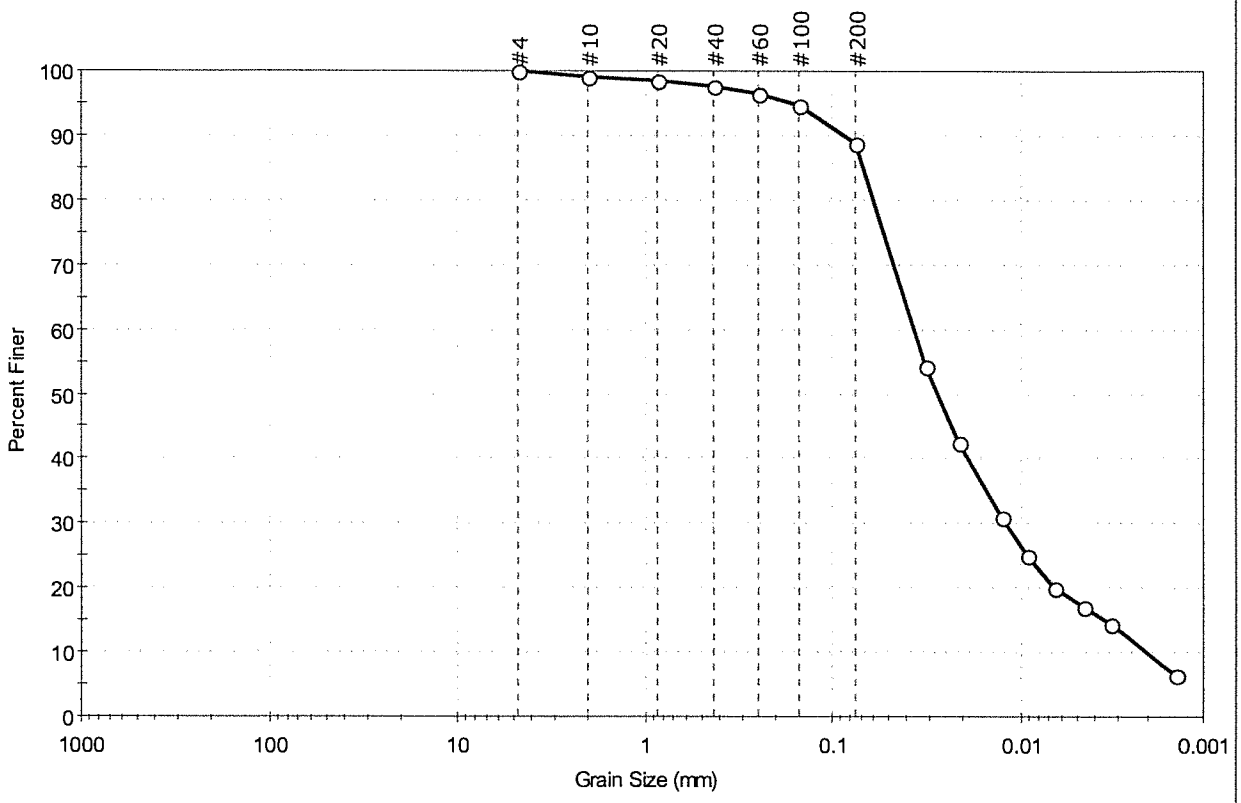
GeoTesting EXPRESS

Client:	EnviroSystems, Inc.				
Project:	29543				
Location:	---			Project No:	GTX-306857
Boring ID:	29543- 044	Sample Type:	jar	Tested By:	jbr
Sample ID:	SDT-08- 081-0102	Test Date:	08/21/17	Checked By:	emm
Depth :	---	Test Id:	420365		
Test Comment:	---				
Visual Description:	Wet, brown silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	11.2	88.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	98		
#60	0.25	97		
#100	0.15	95		
#200	0.075	89		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0322	54		
---	0.0213	43		
---	0.0125	31		
---	0.0092	25		
---	0.0065	20		
---	0.0046	17		
---	0.0033	15		
---	0.0014	6		

Coefficients

D_{85} = 0.0684 mm	D_{30} = 0.0119 mm
D_{60} = 0.0371 mm	D_{15} = 0.0035 mm
D_{50} = 0.0277 mm	D_{10} = 0.0020 mm
C_u = 18.550	C_c = 1.908

Classification

ASTM Elastic silt (MH)

AASHTO Clayey Soils (A-7-5 (33))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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APPENDIX G

Dredging Alternatives Evaluation

STRATFORD ARMY ENGINE PLANT, STRATFORD, CONNECTICUT
DREDGING ALTERNATIVES EVALUATION
FEASIBILITY STUDY

FINAL DRAFT

Prepared for:

Dba AMEC Foster Wheeler
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US Army Corps of Engineers ®

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March 2018

TABLE OF CONTENTS

TABLES

APPENDICES

Dredging Alternatives Evaluation
Stratford Army Engine Plant
Stratford, Connecticut

1.0 Introduction

Lally Consulting LLC (Lally) was tasked by Wood PLC dba AMEC Foster Wheeler (AMEC FW) to conduct a feasibility-level alternatives evaluation of dredging technologies for remediation of the Stratford Army Engine Plant (SAEP) site. The findings of these analyses, including proposed suitable alternative dredging technologies, are provided in this report.

2.0 Site Assessment and Data Review

To become familiar with site conditions and constraints, a site visit was conducted by John Lally at the SAEP property in Stratford, Connecticut on October 6, 2017, along with AMEC FW representatives Tony Delano and Danielle Ahern. After an introduction of the SAEP's historical activities and current operations by site representative Richard Barlow, Tikigao Construction LLC, shoreside visual assessment was made of the areas targeted for sediment remediation, including the Intertidal Flats (tidal flats), and, to a lesser degree, the Outfall 008 Drainage Ditch. The tidal flats shoreline and intertidal areas were viewed from the Causeway and central shoreline during mid- and low tide. A portion of the Outfall 008 Drainage Ditch was viewed at its west end through a chain link fence. Also viewed were the site's upland features including parking lots, roadways and buildings, that can potentially be employed for project access, staging areas, dredged material transport, dewatering and water treatment activities, cap material storage, and dredged material placement/beneficial use. Several photographs taken during the site visit are provided in Appendix A.

Further assessment was made through review of available site information. Several data sets were provided by AMEC FW or accessed through the additional efforts of Lally. These data and information include;

- *Geotechnical Investigation Summary Causeway Non-time Critical Removal Action Design* (Harding, 2000);
- Preliminary chemical analytical data and mapping of contaminants across the SAEP tidal flats;
- Preliminary geotechnical testing results for samples collected August and October 2017;
- Preliminary treatability study results;
- Preliminary dredge area delineation across the SAEP tidal flats and Outfall-008 Drainage Ditch remediation areas;
- National Oceanic and Atmospheric Administration (NOAA) tide data;
- Housatonic River Federal Navigation Project, Draft Environmental Assessment. (USACE, 2012);
- Historical aerial photography.

2.1 Proposed Remediation Plan

To address the sediment in the tidal flats, which has been determined to contain varying concentrations of primarily mercury, metals and PCBs, AMEC FW has developed a preliminary remediation plan. The plan currently involves the removal by dredging of approximately 58 acres of tidal flats sediment to depths of 1 ft. to 4 ft. below mudline. This would represent approximately 140,000 cy of dredged material to neatline elevation. Following dredging to target elevations, the dredged areas are proposed to be backfilled with clean material (i.e. sand) to original grades.

2.2 Shoreline Structures

The SAEP tidal flats site extends approximately 2,700 ft. along the right descending bank of the Housatonic River, with the downstream boundary roughly 7,700 ft. from the terminus of the outer breakwater at the river's entrance.

To protect the plant and property from wave-induced erosion and flooding, a dike and armor rock revetment approximately 2,300 ft. in length was installed along the facility's boundary with the tidal flats.

In the 2000s, an erosion control cover system consisting of geogrid marine mattresses was placed over the Causeway to prevent possible receptor contact with contaminated soil and overland transport of contaminated soil into the tidal flats.

Where the west tidal flats meet the Housatonic River, a quarrystone jetty extends approximately 1,200 ft. parallel with channel. The crest elevation of the jetty is set at approximately 0 ft. MSL.

Photos of the site setting, including these structures, are provided in Appendix A.

2.3 Sediment Characteristics

The physical characteristics of the surface sediments in the east and west tidal flats were observed from shore during the site visit to be dark brown silt with some sand and organic content. The sediments are generally very soft, exhibiting high water content and low bearing strength.

The report *Geotechnical Investigation Summary, Causeway Non-Time Critical Removal Action Design Stratford Army Engine Plant, Stratford, Connecticut* (Harding, 2000) documented the subsurface geotechnical characteristics of the Causeway for the purposes of designing the aforementioned erosion control cover system. Accordingly, most of the borings driven for the investigation were on the Causeway. Five (5) borings, however, GB-00-05, GB-00-06, GB-00-07, GB-00-08 and GB-00-09 were collected off the Causeway and provide an indication of the physical characteristics of the surface sediment to be encountered in the dredge prism. For this dredging evaluation, relevant physical characteristics were extracted from the report and boring logs and summarized in Table 1.

Table 1

Off-the-Causeway Sediment Physical Characteristics (from Harding, 2000)

Sample	Bed Surface Elevation (ft, MSL)	Field Description			USCS Group Symbol	SPT - N Value (Blows / Foot)
		0 - 2 ft. Below Surface	2 - 4 ft. Below Surface	4 - 6 ft. Below Surface		
GB-00-05	-1.9	Black mud flat muck, gritty w/ trace sand, trace silt, trace fiber, distinct hydrocarbon odors, non-plastic, very sticky, non-draining. PID=3	Black organic silt, trace fibers, trace shells, Sulphur odor, w/ slight organic odor, non-plastic, non-dilating, non-draining. PID=2.6	Vane Shear	MH	<1
GB-00-06	-1.7	Black organic silt. High Sulphur odor, very soft, some fibers - muck. PID=7	Blackish brown organic silt. Muck, high Sulphur odor, very soft, micaceous, w/ some plant fibers. PID=31	Vane Shear	OL	<1
GB-00-07	-2.7	Black silt, soft, non-plastic	Black silt, loose fine sand, non-plastic	Vane Shear		<1
GB-00-08	-1.3	Black muck, silt, very soft	Black to very gray silt, fine sand, muck, very soft	Fine sandy silt, wood, soft, trace peat, micaceous brown to gray	ML / OL	<1
GB-00-09	-2.1	No recovery	Black muck and silt. Very high Sulphur odor, very soft and sticky. PID =2	Black to very dark gray organic silt, micaceous - does not stick to fingers when squeezed, strong Sulphur odor. PID=7	OL	<1

As seen in the upper core intervals (0-2 ft., 2-4 ft., and 4-6 ft.), the surface layers of the tidal flats on either side of the Causeway are generally characterized as very soft, black to very dark gray organic silt, often with some sand, shell and fiber content.

Standard Penetration Test (SPT) sampling was performed with blow counts recorded for each 6-inch interval. At the 5 samples of interest off the Causeway, the blow counts where all weight of rod (N<1) in the upper core segments.

Vane shear testing (VST) was also performed on some of these samples in the field to characterize the shear strength of near surface sediments. For the off the Causeway samples, VST was undertaken at sample locations GB-00-05, GB-00-06, GB-00-07, at the 4-6 ft. interval. Based on VST results and analysis, the average undrained shear strength for the off the Causeway sediment was estimated to be 180 psf, while the saturated unit weight was estimated at 94 pcf, 0 - 10 ft. below mudline.

Based on the field sampling results and lab testing, strengths for the organic sediments were seen to increase with depth. Water contents are also reported to increase with depth. This is likely due to the increased organic contents observed with depth. (Harding, 2000)

As reported, the tidal flats sediment exhibits a high Sulphur odor. Photoionization detector (PID) testing was conducted on many samples, which registered readings as high as 31 ppm in GB-00-06, for example.

More recent field investigations and laboratory testing were initiated by AMEC FW in summer 2017 to yield a greater understanding of the physical properties of the contaminated sediment inventory in support of feasibility study development. Two sampling events, on August 22nd and October 19th, 2017 were undertaken.

For the August event, sampling was focused in four (4) discrete areas associated with some of the highest contaminant concentrations on the tidal flats. These areas were selected primarily for treatability testing and waste characterization analysis. From several of the coring locations, samples were collected to develop a treatability composite sediment sample. Of this master composite sample, 59.9% was silt and clay, with 38.4% sand, and 1.7% gravel, with a description of sandy silt (MH). LL was 72, PL was 43, and the PI was 29. Bulk (wet) density was 90.3 pcf and dry density was 50.1 pcf. Specific gravity was 2.61. Percent solids was 55.5%. (AMEC FW, 2018)

In the October event, ten (10) additional samples were collected from locations across the site. Samples were collected from borings advanced to the proposed depth of dredging (either 1, 2, 3, or 4 ft. below mudline) and composited across the depth of the recovered core. The October site-wide samples are more useful in assessing variability spatially and vertically across the site. A summary of the site-wide results is provided in Table 2.

For the ten (10) site-wide samples, silt content ranges from 17 to 66% and clay content ranges from 4 to 20%. Sand content ranges from 16.5 to 71.9% and descriptions include silt, silt with sand, sandy silt, and silty sand (MH, SM, and SM/ML). One sample was non-plastic. For plastic samples, LL ranged from 36 to 82, PL ranged from 33 to 41, and the PI ranged from 3 to 41. Bulk (wet) densities range from 81.5 to 112.5 pounds per cubic foot (pcf) and dry density ranges from 34.8 to 85.4 pcf. Specific gravity ranges from 2.5 to 2.68. Percent solids range from 50.4 to 75.9% and organic carbon ranges from 0.3 to 1.98%. (AMEC FW, 2018)

The results for the site-wide samples averaged 61.3% silt and clay, with 35.6% sand, and 0.9% gravel, with a description of sandy silt (MH). LL was 59.9, PL was 36.9, and the PI was 23. Bulk (wet) density was 101.1 pcf and dry density was 62.8 pcf. Specific gravity was 2.65. Percent solids was 61.6%. These results appear to provide a reasonable representation of overall geotechnical conditions at the site.

Table 2

Summary of Geotechnical Laboratory Testing Data

October 2017 Site-wide Samples

Sample Designation	Composite Depth Intervals (ft. bgs)	USCS Description	USCS Group Symbol	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	% Solids	Specific Gravity	Particle Size Analysis				Atterberg Limits			
									% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	LI
SDT-501-0003	0 -3	Dark gray silt with sand	MH	98.4	92.6	46.7	50.4%	2.62	0.0	16.5	83..5		82	41	41	1.4
SDT-502-0001	0 - 1	Dark gray silt with sand	MH	89.5	92.0	48.6	52.8%	2.62	0.0	23.1	76.9		78	39	39	1.3
SDT-503-0002	0 - 2	Dark gray sandy silt	MH	72.8	96.7	56.0	57.9%	2.67	0.0	38.4	61.6		60	33	27	1.5
SDT-504-0001	0 - 1	Dark gray sandy silt	MH	61.8	100.8	62.3	61.8%	2.64	0.0	43.3	56.7		51	35	16	1.7
SDT-505-0002	0 - 2	Dark gray silt with sand	MH	59.9	101.4	63.4	62.5%	2.63	0.0	28.6	71.4		54	36	18	1.3
SDT-506-0001	0 - 1	Dark gray silt with sand	MH	71.0	96.4	56.4	58.5%	2.65	0.0	26.1	73.9		64	37	27	1.3
SDT-507-0004	0 - 4	Dark gray silty sand	SM	31.8	112.5	85.4	75.9%	2.63	6.7	71.9	21.4		Non - Plastic			
SDT-508-0001	0 - 1	Dark gray silt with sand	MH	66.3	101.8	61.2	60.1%	2.64	1.2	29.5	69.3		59	39	20	1.4
SDT-509-0002	0 - 2	Dark gray silt with sand	MH	53.9	104.8	68.1	65.0%	2.68	0.0	25.7	74.3		55	39	16	0.9
SDT-510-0001	0 - 1	Dark gray silty sand / sandy silt	SM/ML	40.4	111.6	79.5	71.2%	2.68	1.2	53.0	45.8		36	33	3	2.5

Data extracted from Preliminary Summary of Geotechnical Laboratory Testing Data (AMEC FW, 2018)

pcf = pounds per cubic foot, LL = liquid Limit; PL = plastic limit; PI = plasticity index; LI = liquidity index

ASTM clay size particles are 0.005 mm or smaller and silt sized particles are 0.075 mm to 0.005 mm.

Hydrometer results have not yet been provided by the laboratory.

Debris, shellfish, organic matter, marsh grasses, etc. should also be characterized and accounted for in dredge and processing system design. Based on initial visual assessment, debris potentially to be encountered consists of loose riprap near the toe of the revetment and jetty, marsh grasses located along the western and southeastern shorelines of the tidal flat, and bivalves and mollusks within the sediment matrix. Anthropogenic debris from SAEP operations is unlikely to be encountered according to site personnel familiar with historic operations, but possible. One isolated pile of riprap was observed at roughly the - 3.5 ft. MSL contour in the east tide flat just off the Causeway that may require removal.

2.4 Bathymetry

The bathymetry of the tidal flats remediation area ranges from approximately 0.0 ft. MSL near the toe of the rock revetment, to -10 ft. MSL just channelward of the Causeway. The slope is gently sloping to flat across most of the tidal flats, with an average depth of roughly -2.0 ft. MSL on the west flat, and -3.0 ft. MSL on the east flat. Three primary rivulets (on the west flat) and many smaller rivulets drain the marshes and tidal flats.

2.5 Water Levels

Tides at the site are semi-diurnal, that is with two nearly equal high tides and low tides every lunar day (roughly 24 hours and 50 minutes). Tidal datums applicable to the project site were obtained from NOAA Tide Station 8467150, Bridgeport, the closest harmonic station to the project site. The tidal datums, with elevations converted from the station datum (NAVD88) to MLLW and MSL (project vertical datum), are provided in Table 3. Historic extreme water levels are also provided in Table 3.

Table 3
Water Level Data based on NOAA Tide Station 8467150

Water Level Data: NOAA Station 8467150 Bridgeport, CT	Elevation (ft., NAVD88)	Elevation (ft., MLLW)	Elevation (ft., MSL)
Mean Higher High Water (MHHW)	9.30	7.32	3.70
Mean High Water (MHW)	8.97	6.99	3.37
Mean Tide Level (MTL)	5.59	3.61	-0.01
Mean Sea Level (MSL)	5.6	3.62	0.00
Mean Low Water (MLW)	2.22	0.24	-3.38
Mean Lower-Low Water (MLLW)	1.98	0.00	-3.62
North American Vertical Datum of 1988 (NAVD88)	0.00	-1.98	-5.60
Highest Observed Water Level (Oct. 30, 2012)	15.02	13.04	9.42
Lowest Observed Water Level (Feb. 2, 1976)	-2.60	-4.58	-8.20

2.6 Wave Climate

The lower Housatonic River estuary near its confluence with Long Island Sound is generally protected from long period swell. The longest fetch distance over which wind-waves incident to the SAEP tide flats can form is slightly over a mile. Vessel wakes from heavy boat traffic in the adjacent navigation channel can generate wave energy across the tidal flats as well. In either case, it is unlikely that wave heights exceed 1.5 ft. and wavelengths exceed 10 ft.

3.0 Dredging Alternatives Evaluation

Informed by the site visit, preliminary geotechnical characterization, and initial physical processes evaluation, a shortlist of dredging technologies are proposed and evaluated in this section.

3.1 Key Considerations

3.1.1 Dredgeability

With regards to the dredgeability of the tidal flats surface sediments, the following observations are made based on the initial characterization information and prior experience;

- The material is diggable using hydraulic or mechanical dredging technology,
- The material is transportable by both hydraulic slurry pipeline or barge,
- The presence of clay provides for possible impacts to hydraulic slurry transport and mechanical dewatering processes,
- The potential for resuspension and residuals generation is considerable,
- The material does not have adequate bearing capacity to support terrestrial excavation/hauling equipment with or without matting, in *situ* conditions,
- The sediments do not appear suitable for in-place dewatering and excavation “in the dry”.

3.1.2 Production

The shallowness and expansiveness of the tidal flats site will limit access, and the size and production capacity of the dredging equipment to be employed. The site’s tidal regime will greatly influence remedial design decisions and the dredge production rates and cleanup efficiency to be achieved during construction implementation.

Based on the existing bathymetry, 0.0 ft. MSL provides an approximate elevation at which shallow draft dredging plant will be able to begin productively working the tidal flats. A tides analysis was developed to provide an idea of the time available above 0.0 ft MSL. The analysis was run for a typical construction window of 0600 hrs. - 1800 hrs. The percentage of time and average available hours per day above specific tide elevations is summarized in Table 4.

Table 4
Floating Plant Working Tides Analysis (based on NOAA Station Bridgeport, CT)

Tide Elevation (ft., MSL)	Average Hours above / Day	% Time above / Day
4.0	0.2	2%
3.0	1.7	15%
2.0	3.4	29%
1.0	4.3	36%
0.0	4.9	41%

Based on the analysis, for approximately 5 hours per day tide elevations will provide adequate flotation for dredging with shallow draft equipment (<3 ft.). While much of the time these working high tides would be continuous within a 12-hr work day, oftentimes they are split between early morning and late afternoon, which would further impact production efficiency. During lower tides the dredging equipment could be productive in deeper areas along the northern slopes of the tidal flats.

3.1.3 Accuracy

Measured at approximately 58 acres, the tidal flats site would significantly benefit from the application of precision dredging equipment, to minimize the unnecessary removal, transportation and processing of clean underlying sediments. To underscore the importance of dredging accuracy, Table 5 was developed to provide a simple estimate of realistic overdredge performance values for the SAEP tidal flats site, and associated volume and cost implications. The estimate assumes a total unit cost of $400/CY for dredging, processing and T&D, based on recent experience at other remedial dredging sites.

Table 5
Implications of Dredging Accuracy on Volume and Cost

SAEP Tide Flats Dredge Area (Acres)	SAEP Tide Flats Dredge Area (ft^2)	Overdredge (ft)	Overdredge Volume (ft^3)	Overdredge Volume (CY)	$/CY	Cost
58	2,526,000	0.1	252,600	9,000	$400	$3,600,000
		0.2	505,200	19,000		$7,600,000
		0.5	1,263,000	47,000		$18,800,000
		1.0	2,526,000	94,000		$37,600,000

As can be seen from these order of magnitude examples, there are significant cost and schedule implications driven by dredging accuracy performance. Accordingly, precision variants of both hydraulic and mechanical dredges are proposed for this project, as discussed below.

3.1.4 Resuspension and Residuals

To achieve cleanup goals cost effectively, dredging plant, support equipment and approaches should be applied to the SAEP site that minimize the generation of residual contamination. Both generated residuals and undredged inventory can lead to excessive, and expensive, returns to areas not meeting cleanup criteria. There can be many causes of generated residuals, including loss at the cutterhead / clamshell bucket, propwash, and sloughing. Undredged inventory is often a function of how accurately the contaminated inventory was sampled and delineated in the horizontal and vertical extent, modeled, and how effectively the dredge prism was designed.

Similarly, to meet project water quality requirements, and possibly allow for expanded construction windows, dredging plant, support equipment and approaches should be applied to the SAEP site that create minimal resuspension.

Table 6 was developed to summarize the resuspension and residuals generation 'footprint' of the proposed dredging alternatives, by operation.

3.1.5 Engineering Controls

It is appropriate to consider the need for engineering controls at this stage as they relate to the evaluation of dredging alternatives and project planning.

3.1.5.1 Cofferdam

A steel sheet pile cellular cofferdam extending from the shore connection of the jetty to the eastern boundary of east tidal flat could effectively isolate the tidal flats dredging areas from the Housatonic River during construction. Isolation of the dredging area by cofferdam allows for consideration of;

- Performing sediment removal in-the-dry, or
- Performing dredging with constant flotation, and
- Preventing water quality impacts outside the project.

As reported in the *Geotechnical Investigation Summary* (Harding, 2000), the water contents in the sediments increase with depth, which makes the prospect of in-place dewatering and excavation in-the-dry difficult. Possibly more feasible through construction of the cofferdam would be maintaining a constant water surface elevation over the dredge areas to provide adequate flotation at all times. This would allow for optimal dredging production, accuracy and residuals management by the floating dredge operation. Lastly, a cofferdam would allow for the isolation of the dredging project, and consequential water quality impacts during construction, from the Housatonic River estuary. This could open the possibility of dredging year-round and not being subject to environmental windows.

The potential advantages of the cofferdam described above are worth considering during the feasibility and remedial design stages and will need to be balanced against the cost of the installation and any impacts during and following construction. One other consideration would be the increase in flooding potential along adjacent shoreline properties caused by an ongoing high water surface elevation and storm-induced wind-waves. Accordingly, and based on detailed analysis of tidal flats shoreline topography, the cofferdam engineering control should not create a pool elevation exceeding a typical high tide elevation (i.e. MHW, or MHHW).

3.1.5.2 Wave Attenuator

To reduce potential impacts incident wind-waves and vessel wakes may have on dredging operations while underway in the tidal flats, a floating wave attenuator could be installed at strategic segments of the opening between the jetty and Causeway, and Causeway and eastern project shoreline. Again, the potential benefits in terms of production gains would need to be compared to the costs of installation and maintenance. It would also be important to consider that the larger, heavier dredge platforms would be less impacted by waves than the smaller plant.

3.1.5.3 Turbidity Curtain

The use of silt curtains and turbidity curtains to manage water quality impacts from dredging and support operations is common at contaminated sediment sites. For the SAEP tidal flats site it is anticipated that a Type II or Type III full length curtain could be required to contain plumes and manage

water quality and release to adjacent waters. The alignment and depth of the curtain will need to be determined to meet agency requirements and accommodate dredging operations. It's possible the curtain would need to enclose a large area, i.e. between the jetty and eastern project shoreline, and accommodate a large tidal flux. A solid understanding of the tidal regime, including velocities, is suggested.

3.2 Alternative Dredging Technologies

Informed by an initial understanding of site conditions, likely processing and disposal scenarios, and experience, a shortlist of five (5) dredging technologies are proposed as likely suitable alternatives to complete the SAEP dredging work;

- Hydraulic Swinging Ladder Cutterhead Dredge
- Precision (Mechanical) Excavator Dredge - Hydraulic Transport
- Precision (Mechanical) Excavator Dredge - Shallow Draft Barge Transport
- Amphibious Dredge (Mechanical / Hydraulic)
- Long Reach (Terrestrial) Excavator

Most of these dredging technologies have been demonstrated to be effective on other contaminated sediment sites and show potential for successful application on the conditions the SAEP tide flats site presents, to a degree they are evaluated here. Photos of each technology are provided in Appendix B.

3.2.1 Alternative 1 - Hydraulic Swinging Ladder Cutterhead Dredge

A hydraulic swinging ladder cutter suction dredge in the 8-in class is proposed as an appropriately sized and functioning shallow draft hydraulic pipeline dredge for the SAEP tidal flats.

The Dredge Supply Company (DSC) Moray SL and Ellicott 360 SL are versions of swinging ladder dredge, both 8-in discharge, with similar pumping characteristics, that are suitable for a shallow dredge cuts, pipeline conveyance over long distances, and feeding mechanical dewatering systems. The Moray has been used on more sediment remediation projects than the 360SL, in part likely due to customizations to their base model dredges for specific applications (i.e. shallow draft, precision cutting, and higher % solids). That said, the Ellicott 360 swinging ladder dredge has also been adapting to the needs of environmental dredging projects.

The swinging ladder dredge spuds down to stabilize the dredge platform while dredging, for improved accuracy, steadier state cutting and slurry concentrations, and consistent lane advance. Horizontal positioning is good, better than +/- 2 ft. typically, in using the walking spud system to advance in small increments (generally about one cutterhead width), before lowering the spuds again, to create a stable platform from which to swing the ladder and cutterhead. Both the Moray and 360SL can be operated in either swinging ladder mode, which swings that ladder and cutterhead into the bank whilst the barge is held stationary; or in conventional mode, where the entire dredge platform pivots off its stern spud. Conventional mode allows for wider swing widths, to about 40 ft., while swinging ladder provides closer to a 20 ft. swing width depending on pontoon configuration and ladder length and depth.

The dredges' cutterheads are designed to agitate and draw the targeted bank material closer to the influence of the suction intake immediately behind the cutter on the ladder. Options in cutterhead design, for improved accuracy, higher % solids, and reduced residuals, have been developed for the Moray dredge. Also, to orient the cutterhead and suction level with the cut bank to promote improved accuracy and higher solids, articulated ladders are available for both the Moray SL and 360 SL.

On a recent visit to the Lower Fox River project in Green Bay, Wisconsin the performance of swinging ladder dredge operations was observed. Three hydraulic dredges, including one (1) 12-in and two (2) 8-in swinging ladder dredges were being employed on the project to remove and transport PCB-contaminated sediment up to 10 miles to the project's sediment processing facility. System capacity is 6,500 GPM, with typical operating discharge of 5,000-6,000 GPM combined from the three dredges. The 8-in DSC Moray dredges, was producing on the order 25-30 cy/hr in high bank material, and as low as 5 cy/hr or less in thin face - cleanup pass mode. Corresponding slurry concentrations are reported to range from 8%-12% solids by weight for thick faces down to 2%-4% solids by weight for thin faces – cleanup passes. Dredging efficiencies (effective time) was reportedly maintained at 80% - 90%.

The Moray dredges can draw as little 1.5-2.0 ft and use both conventional and modified pontoons for shallow water operations. The contractor on the Fox River employs, and in some cases developed, several different cutter attachments, including the conventional rotating basket cutter for denser and thicker material, an environmental disk cutter, as well as a specialized straight vacuum for unconsolidated, high water content material removal overlying stiffer substrates. The Moray dredge is essentially self-propelled in lane advances through use of the kicker (traveling) spud. Project-averaged vertical dredging accuracies are reported to be 0.4-0.5 ft. using installed RTK-GPS and electronic dredge positioning system.

Conceptually, for the SAEP tidal flat project, one (1) or two (2) 8-in swinging ladder dredge systems, which are truckable, could be transported to the project site, and lifted or floated into the Housatonic or possibly mobilized off the Causeway. Depending on the required feed characteristics of the project dewatering system, and to optimize production, accuracy, and residuals management performance, it may be advisable to include automation controls (i.e. swing speed, cutter speed, flow rate) and a site-specific cutterhead design to minimize spillage and resuspension. The dredge would also be instrumented with RTK-GPS and dredge positioning and guidance system to implement a final, potentially tighter tolerance dredging plan. Shallower draft pontoons, articulated ladders, and advanced spud systems would also be considered as potential cost savings measures on a swinging ladder dredging alternative. Developing an operations plan that would leverage the swinging ladder's dredge pattern, to achieve cleanup with the greatest efficiency, would be done at the design phase.

3.2.2 Alternative 2 - Precision (Mechanical) Excavator Dredge - Shallow Draft Barge Transport

Based on prior experience with both hydraulic and mechanical dredge types, precision excavator dredges coupled with a latest generation level-cut sealed environmental clamshell bucket can offer the best available performance on contaminated sediment remediation sites in most key categories, including dredging accuracy, production, solids concentrations, and residuals management. These platforms are also versatile in their ability to easily convert to capping operations.

For shallower sites like the SAEP tide flats, the precision excavator dredges can be constructed on site by fabricating a barge platform, typically of modular barges (i.e. Flexifloat), lifting on deck plant (spud and winches/drums, genset, control rooms, etc.) with a shore-based crane, then rolling on the excavator.

The excavator is instrumented with RTK-DGPS and a dredge and bucket positioning system (DBPS), using a series of angle sensors (inclinometers) and rotation sensors mounted on the machine, boom, stick, and bucket for precise location and monitoring of the dredge and bucket. Operating from a relatively stable platform with 2-4 spuds, precision dredging, to better than 2-in. vertically, is achieved by placing the cutting edge of the bucket to target elevations monitored via a real-time heads-up display. For sites with high cost for T&D, use of the +/- 1-in. variance or better level-cut clamshell buckets is warranted to minimize further 'scallop' cuts into non-target sediments. Dredging progresses in defined set patterns, with consistent grab thicknesses and overlap to manage residuals and maintain planned production rates. For optimal solids concentrations and production rates, bucket grabs with consistently high fill efficiency are made. Barges provide the ability to transport dredge materials at highest possible solids concentrations, with the only water added that which is entrained in the bucket. To a large degree, clamshell buckets can also contend with debris better than hydraulic dredging systems.

Another potential advantage of mechanical dredging is the ability to leverage a 'visual' dredging approach. Developed on New Bedford Harbor during the Pre-Design Field Test in 2000, with the first excavator- mounted level-cut clamshell bucket used in the United States, this is the ability to make real time visual assessments of the material being dredged, to inform and tune core-based dredge target elevations. This approach is feasible where the contact between the contaminated inventory and 'clean' native material can be distinguished, either by color or consistency. Based on review of initial core logs from the east and west flat, the surface layers are predominantly homogenous black to dark gray organic silt (muck), very soft, with no distinguishing contact with native. The ability to apply the aforementioned approach in this case thus far appears limited.

For either the mechanical excavator with barge transport approach, or hybrid mechanical excavator – hydraulic transport approach, described in the next section, it is conceptualized that one (1) or two (2) shallow draft precision excavator dredges, would be employed to be able to work the tides efficiently, i.e. one working the east flat and one the west flat, or two working the west flat. These would use something like a CAT 3049MH long reach material handler or similar class excavator to operate an approximate 3.0 cy sealed level-cut environmental clamshell bucket. Deck barge platforms would be configured to provide greater flotation for optimal dredging production in the shallow conditions the tidal flats present. It is envisioned Flexifloat S-50 modular barges, which are 5 ft. high, would be used in the deck barge fabrication. Lane advances (stepping) and moves between areas would be accomplished using either an anchor and wire system or shallow draft push boat. These determinations would be based on balancing access, production, and residuals management on the tidal flats, while not sacrificing realized dredging accuracy.

To accommodate anticipated dredge production rates, depth limitations, and transport the mechanically dredge sediments from the point of dredging to shore, shallow draft barges would be needed for the mechanical dredging operations. Conceptually the barges would have capacities of roughly 60 cy, and not draw more than about 3 ft. To move the barges, shallow draft, truckable push boats would be employed. It is recognized that the push boats would be sources of resuspension, and their design and operations will need to be planned and managed carefully to keep water quality and residuals generation within acceptable ranges.

Another component that would need to be addressed with a mechanical dredging alternative (no hydraulic pipeline) at the SAEP, is transloading of dredged sediments to the presumed mechanical dewatering facility (i.e. east parking lot.). A likely scenario to transload dredged sediments under precision excavator and barge alternative would be to build a barge offloading area (BOA) on either the

northwest or northeast corner of the Causeway, or, near the channelside shore connection of the jetty. This would require construction of a pier-trestle capable of supporting a hydraulic offloader system and/or material offloading crane. Once installed, the BOA could be used for other site activities, including potentially residual cover and capping material conveyance to capping barges.

3.2.3 Alternative 3 - Precision (Mechanical) Excavator Dredge - Hydraulic Transport

This alternative combines the benefits of precision excavator dredging and hydraulic pipeline transport. Advantages and limitations are essentially the same as described for the precision excavator in the prior section. By the hybrid dredging approach, mechanical excavation removes material with a high degree of accuracy, typically better that 2-in below target elevation on average, at close to *in situ* concentrations, and places it in a hopper on board the dredge for initial screening of larger debris. Material that passes the debris screen, or grizzly, is slurried via a high efficiency, automated pump, with just enough makeup water to transport the material at maximum practical and steady-state concentrations. The makeup water can be sourced from a seachest along the dredge rail, or recirculated. The dredge material slurry would be received and processed in the same manner as hydraulically dredged sediment, at a presumed mechanical dewatering facility at the SAEP east parking lot.

During a pilot study in New Bedford Harbor in 2000, production averaged approximately 80 cy/hr, in deeper water, vertical dredging accuracy exceeded +/- 0.4 ft. with an average overdredge of -0.1 to -0.2 ft. below target elevation for the test area, and the visual dredging method was developed and applied to make real-time adjustments to the dredge plan. A similar system and approach has recently been setup at New Bedford and starting to achieve similar results, with improved accuracies. Additional details on the hybrid dredge system, can be reviewed in the Pre-Design Field Test study report, https://www3.epa.gov/region1/superfund/sites/newbedford/23751.pdf.

3.2.4 Alternative 4 - Amphibious Excavator

There are many variants of amphibious dredges, both mechanical and hydraulic. Mechanical models such as the Wilco marsh buggy are conventional excavator machines mounted on custom floating or low ground pressure (LGP) tracked pontoons. Hydraulic amphibious dredges such as the Amphibex or Waterking, use large sponsons and kicking spuds to traverse over ground. These platforms are also convertible to mechanical dredging mode.

While the production rates and accuracy of these dredges are not as high as Alternatives 1-3, the concept of employing amphibious dredges from floating to emergent conditions, to remain productive in the intertidal areas over the full tidal cycle, is attractive for this site. What would present a distinct disadvantage for these dredge types, however, is the problem of residuals generation and recontamination. Interaction of the tracks in the case of the marsh buggy and its support equipment (i.e. LGP trucks), or of the barge and sponsons in the case of the Amphibex type, would significantly disturb the bed surface, and cause mixing such that a ‘clean’ and organized removal sequencing would be difficult to achieve.

Examples of amphibious dredge types are provided in Figures 7 and 8 of Appendix B.

3.2.5 Alternative 5 - Long Reach (Terrestrial) Excavator

A long-reach excavator operated from stable ground close to the water's edge for the mechanical removal of near shore sediments is likely a suitable approach and cost effective for much of SAEP sediment site. Mechanically dredged material removed at close to *in situ* concentrations can provide savings in processing and disposal costs. Elimination of some of the shallowest areas, or areas where shoreline debris content may be high would also yield savings versus applying floating plant. Given the preliminary design slopes, a long reach excavator would also be a preferred technology for sediment removal and basin contouring in the Outfall 008 Drainage Ditch.

Long reach excavators are available from several manufacturers with various boom and stick configurations and aftermarket attachments. Reaches can extent to about 70 ft. from kingpin along the digging envelope. Smooth lipped, open faced buckets are typically used, however, with proper lifting capacity calculations, a sealed, level-cut clamshell bucket may be better applied, particularly if removing soft, high water content sediments, and on the tidal flats. An open bucket may be required in the Outfall 008 Drainage Ditch to accomplish slope sculpting. In either case, the dredged materials could be placed in dump trucks and presumably hauled to an onsite stabilization or processing facility.

Examples of long reach excavators working on shoreline and canal projects are provided in Figures 9 and 10 of Appendix B.

3.3 Summary

Specifications and estimated performance characteristics for the five alternative dredging technologies evaluated for this site are summarized in Table 6. Table 7 has been developed to provide the resuspension and residuals generation 'footprint' of each alternative, by operation. Table 7 does not yet attempt to quantify the various source mechanisms, nor propose mitigation measures or best management practices, of which there are many.

Based on the evaluations conducted, recommendation is made to retain Alternatives 1, 2, 3 and 5 for possible application on the SAEP project. To make a final determination on which technology or combination of technologies would be most effective in achieving project goals, detailed production and cost estimates for each system should be developed, cleanup goals better understood (i.e. backfilling to be carried out or not), and the site's dredged material disposal / beneficial use alternatives assessed further.

The estimates should incorporate reasonable performance value assumptions for production rates, dredging accuracy, equipment costs, added water, as well as construction schedules to assess the overall project cost for each dredging alternative. With this knowledge, determination of the most cost-effective dredging approach can be made, and developed during the remedial design phase.

TABLE 6
ALTERNATIVE DREDGING TECHNOLOGIES

Dredge Performance Parameter	Alternative 1 8-In. CUTTER SUCTION DREDGE , SWINGING LADDER, HYDRAULIC TRANSPORT	Alternative 2 PRECISION MECHANICAL DREDGE - SHALLOW DRAFT BARGE TRANSPORT	Alternative 3 HYBRID - PRECISION MECHANICAL DREDGE / HYDRAULIC TRANSPORT	Alternative 4 AMPHIBIOUS DREDGE (MECHANICAL / HYDRAULIC)	Alternative 5 LONG REACH TERRESTRIAL EXCAVATOR
Examples	DSC 8-In Moray	Hudson River Precision Excavator	New Bedford Harbor Hybrid Dredge	Wilco Marsh Buggy / Amphibex, Waterking	CAT 345D, CAT 352F, Komatsu PC200
Removal Method	Basket, Horizontal Disk or Viscous Cutterhead	Sealed, Level Cut Clamshell bucket, w/ Rotator	Sealed, Level Cut Clamshell bucket, w/ Rotator	Sealed Clamshell bucket, Open smooth bucket, or cutterhead	Sealed, Level Cut Clamshell bucket, w/ Rotator, or Open smooth edge bucket
Propulsion, lane advance	Traveling (Kicker) Spud	Winch & Wire Rope - Anchor, Skiff/Tug Assist	Winch & Wire Rope - Anchor, Skiff/Tug Assist	Tracks on ground, Sponson/kicking spud, Z-drive propeller	N/A
Propulsion, between areas	Skiff / Tug assist	Skiff / Tug assist	Skiff / Tug assist	Self Propelled	Self Propelled
Draft (ft.)	~2.5	~3.0	~3.0	~2.5	N/A
Weight (lbs.)	42,000 lbs	+ 200,000 lbs	+ 200,000 lbs	100,000 - 200,000 lbs	100,000 - 150,000 lbs
Positioning Method	Three-Four (3-4) 8-in Spuds	Two-Three (2-3) 20-in Spuds	Two-Three (2-3) 20-in Spuds	Two-Four Spuds, Sponson	N/A
Accuracy - Horizontal (ft.)	1.0 - 2.0	0.3 - 1.0	0.3 - 1.0	1.0 - 3.0	0.2 - 0.5
Accuracy - Vertical (ft.)	0.4 - 0.7	0.2 - 0.5	0.2 - 0.5	0.5 - 1.0	0.1 - 0.5
Visual Dredging Approach	No	Yes	Yes	Yes / No	Yes
Lane Width (ft.)	17 - 40	30 - 50	30 - 50	20 - 40	N/A
% Solids by Weight (Dry Solids)	2% - 12%	30% - 70%	10% - 20%	2% - 70%	30% - 70%
Production Rate (per dredge)	15 - 50 cy/hr	20 - 80 cy/hr	20 - 80 cy/hr	20 - 40 cy/hr	30 - 60 cy/hr
Operating Depth Range (ft.)	0 ft - 18 ft.	0 ft. - 25 ft.	0 ft. - 25 ft.	0 ft. - 15 ft.	0 ft. - 25 ft.
Convertible to Debris Removal Operations	No	Yes	Yes	Yes	Yes
Convertible to Capping Operations	No	Yes	Yes	Yes	Yes
Impact of Debris on Production	High	Low	Medium	High	Low
Residuals Footprint (See Table 7)	Medium	Medium	Medium	High	Low
Material Transport	HDPE Pipeline	Shallow Draft Hopper Barge	HDPE Pipeline	Shallow Draft Hopper Barge, LGP Truck, HDPE Pipeline	Dump Truck, LGP Truck
Barge Offloading Area Required	No	Yes	No	Yes / No	No
Adaptable to Mechanical Dewatering	Yes	No	Yes	Yes / No	No
Adaptable to Geotube Dewatering	Yes	No	Yes	Yes / No	No
Adaptable to Stabilization	No	Yes	No	Yes / No	Yes
Adaptable to Pneumatic Flow Tube Mixing	No	Yes	No	Yes / No	Yes

TABLE 7
RESUSPENSION AND RESIDUALS GENERATION PROCESSES

Potential Sources of Residuals and/or Resuspension	**Alternative 1** 8-In. CUTTER SUCTION DREDGE , SWINGING LADDER, HYDRAULIC TRANSPORT	**Alternative 2** PRECISION MECHANICAL DREDGE - SHALLOW DRAFT BARGE TRANSPORT	**Alternative 3** HYBRID - PRECISION MECHANICAL DREDGE / HYDRAULIC TRANSPORT	**Alternative 4** AMPHIBIOUS DREDGE (MECHANICAL / HYDRAULIC)	**Alternative 5** LONG REACH TERRESTRIAL EXCAVATOR
Anchor System	No anchor system required in swinging ladder mode. When dredging in conventional mode, to achieve wider cuts, an anchor and wire system is used to swing entire dredge. On SAEP a 3- or 4- wire system deployed up to 500 ft fore-aft and side-side of dredge, using shore connections when possible. Anchor setting and removal, with propwash and potential groundings of work boat and A-frame, and interaction of wires with bed, can cause resuspension and residuals.	No anchor system required for mechanical dredging operations, howver may be used to optimize access and production in shallow tide dependent areas of the SAEP. Likely a 3- or 4-point wire system could make use of shore anchors when possible. Anchor setting and removal, with propwash and potential groundings of work boat and A-frame, and interaction of wires with bed, can cause resuspension and residuals.	Anchor and wire system may be advisable for hybrid dredge to optimize access and production in shallows tidal dependent areas of the SAEP, likely a 4- or 5-point wire system could make use of shore anchors when possible. Anchor setting and removal, with propwash and potential groundings of work boat and A-frame, and interaction of wires with bed, can cause resuspension and residuals.	Anchor and wire system not suitable for amphibious dredge types.	N/A, land-based
Point of Dredging	Overloading of pump suction results in plowing, loss, and generated residuals. Overpenetration and mixing generates residuals and disturbed inventory. Evacuation of sediment slurry in discharge pipeline back to harbor to clear pump of debris, backflushing, and clearing plugged pipelines generates resuspension and residual contamination. Potential for grounding.	Resuspension with pressure wave as bucket approaches bed. Resuspension and residuals due to loss from grab closure through cycle to barge placement when bucket not sealed completely, or overfilled. Potential to cause generated residuals and undredged inventory if proper bucket overlap not achieved. Potential for grounding.	Resuspension with pressure wave as bucket approaches bed. Resuspension and residuals due to loss from grab closure through cycle to barge placement when bucket not sealed completely, or overfilled. Potential to cause generated residuals and undredged inventory if proper bucket overlap not achieved. Potential for grounding.	Grounding and traversing over bed surface is inherent in these dredge types. Significant residuals and resuspension likely. In addition, overloading of pump suction results in plowing, loss, and generated residuals. Overpenetration and mixing generates residuals and disturbed inventory. Evacuation of sediment slurry in discharge pipeline back to harbor to clear pump of debris, backflushing, and clearing plugged pipelines generates resuspension and residual contamination. In mechanical mode resuspension with pressure wave as bucket approaches bed. Resuspension and residuals due to loss from grab closure or open face bucket.	Resuspension with pressure wave as bucket approaches bed. Resuspension and residuals due to loss from grab closure or open face bucket.
Material Transport	Submerged and floating discharge pipeline interaction with bed surface. Periodic barge transits needed to transfer debris to shore.	Propwash and potential groundings from shallow draft barge operations. Barge transits from the dredges to the barge offloading area (BOA), oftentimes working the tides and with possibly less than 1 ft unkeel clearance.	Submerged and floating discharge pipeline interaction with bed surface. Periodic barge transits needed to transfer debris to shore.	By hydraulic method, submerged and floating discharge pipeline interaction with bed surface. Periodic barge transits needed to transfer debris to shore. By mechanical method LGP truck may be required, which would cause significant residuals. Propwash and potential groundings from shallow draft barge operations. Barge transits from the dredges to the barge offloading area (BOA).	N/A, land-based
Positioning and Lane Advance	Typically 1-2 passes required per 1 ft bank of material to remove. Uses traveling (kicker) spud to step forward in uniform increments, typically one cutterhead width. Each step requires resetting of the three (3) 8-in square spuds.	Typically 1 pass required per 1-2 ft bank of material to remove. Uses two (2) 20-in spuds to position dredge. Lane advance can be achieved by traveling spud, push boat assist, or anchor/wire, each with potential to generate resuspension and residual generation potential.	Typically 1 pass required per 1-2 ft bank of material to remove. Uses two (2) 20-in spuds to position dredge. Lane advance can be achieved by traveling spud, push boat assist, or anchor/wire, each with potential to generate resuspension and residual generation potential.	Typically 1 pass required per 1-2 ft bank of material to remove. Uses two (2) 8-10 in. spuds to position. Lane advance can be achieved by traveling spud, outboards, push boat assist, or tracking over bed surface, each generate resuspension and residuals.	N/A, land-based
Move between Areas	Moving dredges between areas upon completing an area, to accomodote bathy surveys and verfication sampling, or working the tides. Propeller wash from work boats and pipeline moves creates resuspension and potentially residuals.	Moving dredges between areas upon completing an area, to accomodate bathy surveys and verfication sampling, or working the tides. Propeller wash from work boats create resuspension and potentially residuals.	Moving dredges between areas upon completing an area, to accomodate bathy surveys and verfication sampling, or working the tides. Propeller wash from work boats and pipeline moves creates resuspension and potentially residuals.	Movements achieved by traveling spud, outboards, push boat assist, or tracking over bed surface, each generate resuspension and residuals.	N/A, land-based
Debris Management	Separate debris removal operation may be required, but not foreseen on SAEP.	Separate debris removal step not anticipated.	Separate debris removal step not anticipated.	Separate debris removal step not anticipated.	Separate debris removal step not anticipated.

4.0 References

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APPENDIX A
October 6, 2017 Site Visit Photographs

Photo 1. West end of Outfall 008 Drainage Ditch looking east from east parking lot. October 6, 2017.

Photo 2. East of Outfall 008 Drainage Ditch confluence with tidal lagoon, looking northwest. October 6, 2017.

Photo 3. South Causeway, looking north, mid-tide. October 6, 2017.

Photo 4. Head of Causeway looking east across east tide flat, dike and revetment, mid-tide. October 6, 2017.

Photo 5. Head of Causeway looking west across west tide flat, dike and revetment, mid-tide. October 6, 2017.

Photo 6. North Causeway looking east at Housatonic River confluence with Long Island Sound, mid-tide. October 6, 2017.

Photo 7. North Causeway looking north across Housatonic River at Nells Island, mid-tide. October 6, 2017.

Photo 8. North Causeway looking northwest across west tide flat boundary with Housatonic River and jetty light. Note jetty is submerged at mid-tide. Note USCG buoy tender managing vessel traffic. October 6, 2017.

Photo 9. Mid - Causeway looking northwest. Note vessel wake propagating into western tide flat, mid-tide. October 6, 2017.

Photo 10. Mid - Causeway on marine mattress erosion control cover system looking west across west tide flat, mid-tide. Note vessel wake has approximate 6 ft. wavelength, 0.5 ft. amplitude. October 6, 2017.

Photo 11. Mid - Causeway looking southeast across east tide flat to eastern end of dike and revetment, mid-tide. October 6, 2017.

Photo 12. South Causeway on rock revetment looking west across west tide flat, near low-tide. October 6, 2017.

Photo 13. Mid - Causeway looking east across east tide flat, near low-tide. Note isolated debris pile (riprap). October 6, 2017.

Photo 14. Mid - Causeway looking southeast across east tide flat, near low-tide. October 6, 2017.

Photo 15. Mid - Causeway on marine mattress erosion control cover system looking west across west tide flat, near low-tide. Note subtidal zone. Note emergent jetty. October 6, 2017.

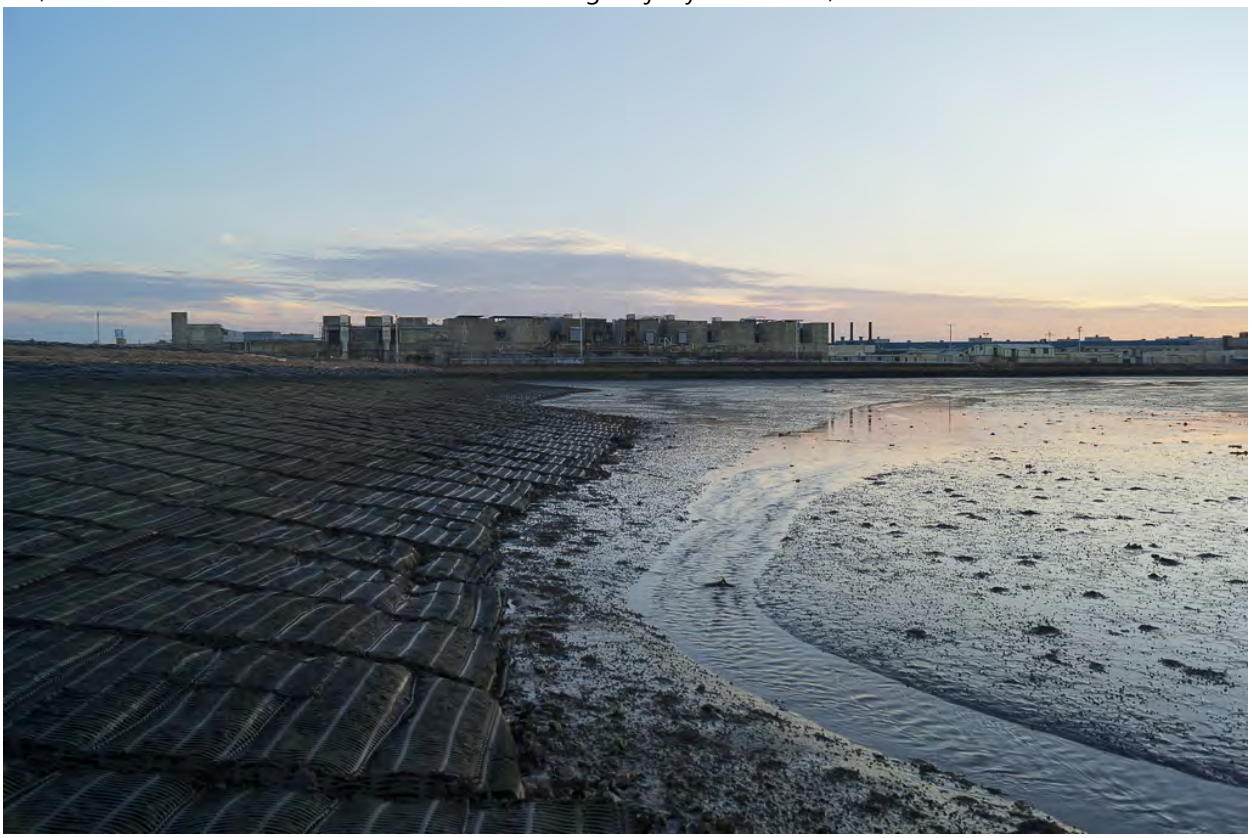

Photo 16. North Causeway on marine mattress erosion control cover system looking south with Building 19 in background, near low-tide. Note toe of marine mattress erosion control cover system. Note tidal rivulet running through surface sediment. October 6, 2017.

Photo 17. North Causeway looking north across Housatonic River towards Nells Island, near low-tide. Note shallow slope of marine mattress erosion control cover system extending to subtidal. October 6, 2017.

Photo 18. North Causeway looking south along east tide flat, near low-tide. October 6, 2017.

Photo 19. North Causeway looking west across entrance to west tide flat, near low-tide. Note subtidal area. Note fishermen practicing riparian rights. October 6, 2017.

Photo 20. South Causeway looking north. October 6, 2017.

APPENDIX B
Alternative Dredging Approaches

Figure 1. Alternative 1 - Swinging Ladder Dredge. Source: Dredge Supply Company

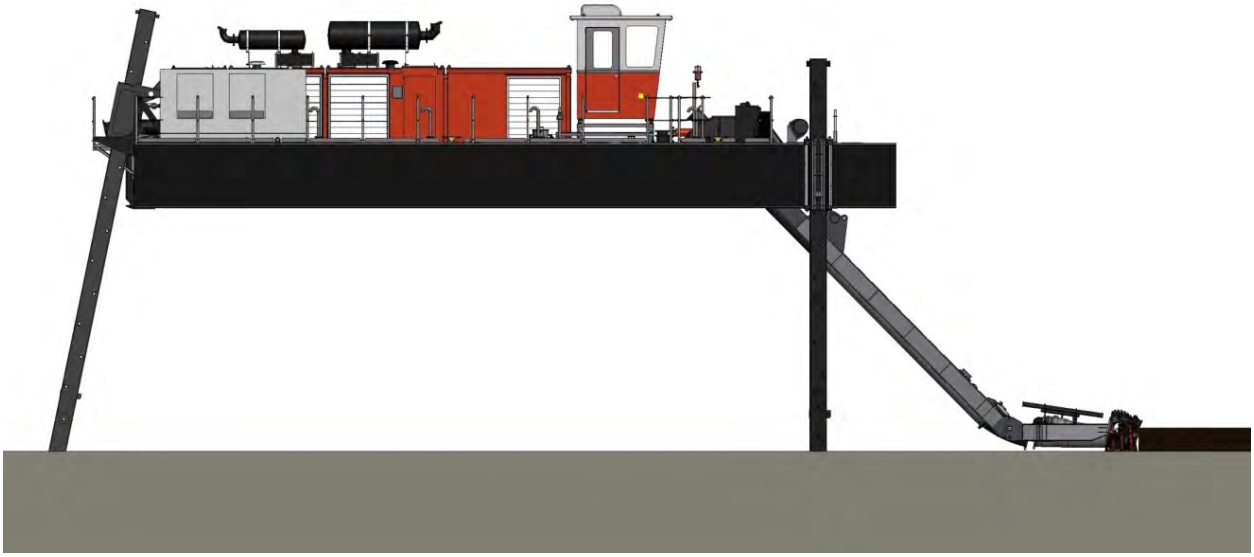

Figure 2. Alternative 1 - Swinging Ladder Dredge with Articulated Ladder. Source: Dredge Supply Co.

Figure 3. Alternative 2 - Precision Excavator Dredge, Shallow Draft Barge, Hudson River, NY, 2009.

Figure 4. Alternative 2 - Precision Excavator Dredge, Shallow Draft Barge, Push Boat, Hudson River, 2013

Figure 5. Alternative 3 - Hybrid Precision Excavator Hydraulic Transport Dredge, New Bedford, MA, 2000

Figure 6. Alternative 3 - Precision Excavator - Hydraulic Transport Dredge with 4.6 cy (3.5 m^3) Horizontal Profile Grab Level-Cut Environmental Clamshell Bucket, New Bedford, MA, 2000.

Figure 7. Alternative 4 – Amphibious Dredge - Mechanical. Source: BIG Dredging


Figure 8. Alternative 4 – Amphibious Dredge - Mechanical. Source: Amphibex

Figure 9. Alternative 5 – Long Reach Excavator. CAT 345B. Source: Pierce Pacific

Figure 10. Alternative 5 – Long Reach Excavator. CAT 352F. Source: CAT

Figure 11. Engineering Control - Cofferdam. Source: Pilebuck

Figure 12. Engineering Control – Wave Attenuator. Source: Kropf

Figure 13. Engineering Control – Silt Curtain, Type III. Source: Elastec


Figure 14. Engineering Control – Turbidity Barrier. Source: Layfield