APPENDIX I: EROSION TEST RESULTS ON NEW ORLEANS LEVEE SAMPLES

I.1 THE EFA: EROSION FUNCTION APPARATUS

The EFA (Briaud et al. 1999, Briaud et al., 2001a) was conceived by Dr. Briaud in 1991, designed in 1992, and built in 1993 (Fig. 1). The sample of soil, fine-grained or not, is taken in the field by pushing an ASTM standard Shelby tube with a 76.2 mm outside diameter(ASTMD1587). One end of the Shelby tube full of soil is placed through a circular opening in the bottom of a rectangular cross section pipe. A snug fit and an O-ring establish a leak proof connection. The cross section of the rectangular pipe is 101.6 mm by 50.8 mm. The pipe is 1.22 m long and has a flow straightener at one end. The water is driven through the pipe by a pump. A valve regulates the flow and a flow meter is used to measure the flow rate. The range of mean flow velocities is 0.1 m/s to 6 m/s. The end of the Shelby tube is held flush with the bottom of the rectangular pipe. A piston at the bottom end of the sampling tube pushes the soil until it protrudes 1 mm into the rectangular pipe at the other end. This 1 mm protrusion of soil is eroded by the water flowing over it.

I.1.1 EFA test procedure

The procedure for the EFA test consists of

1. Place the sample in the EFA, fill the pipe with water, and wait one hour.
2. Set the velocity to 0.3 m/s.
3. Push the soil 1 mm into the flow.
4. Record how much time it takes for the 1 mm soil to erode (visual inspection)
5. When the 1 mm of soil is eroded or after 30 minutes of flow whichever comes first, increase the velocity to 0.6 m/s and bring the soil back to a 1 mm protrusion.
6. Repeat step 4.
7. Then repeat steps 5 and 6 for velocities equal to 1.0 m/s, 1.5 m/s, 2 m/s, 3 m/s, 4.5 m/s, and 6 m/s. The choice of velocity can be adjusted as needed.

I.1.2 EFA test data reduction

The test result consists of the erosion rate dz/dt versus shear stress τ curve (Fig. 1). For each flow velocity v, the erosion rate dz/dt (mm/hr) is simply obtained by dividing the length of sample eroded by the time required to do so.

$$dz/dt = h/t \quad (1)$$

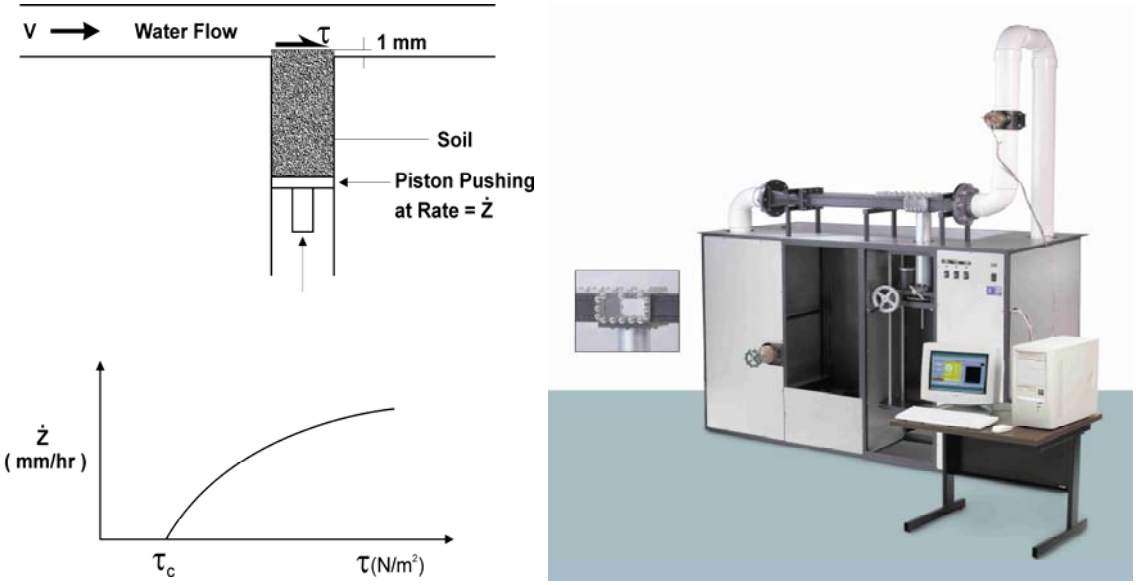


Fig. 1 - EFA (Erosion Function Apparatus) from Briaud et al. (2001)

where h is the length of soil sample eroded in a time t. The length h is 1 mm and the time t is the time required for the sample to be eroded flush with the bottom of the pipe (visual inspection through a Plexiglas window). After several attempts at measuring the shear stress τ in the apparatus it was found that the best way to obtain τ was by using the Moody Chart (Moody, 1944) for pipe flows.

$$\tau = f \rho v^2/8 \qquad (2)$$

Where τ is the shear stress on the wall of the pipe, f is the friction factor obtained from Moody Chart (Fig. 2), ρ is the mass density of water (1000 kg/m3), and v is the mean flow velocity in the pipe. The friction factor f is a function of the pipe Reynolds number Re and the pipe roughness ε/D. The Reynolds number is $Re = vD/\nu$ where D is the pipe diameter and ν is the kinematic viscocity of water (10^{-6} m^2/s at 20^0C). Since the pipe in the EFA has a rectangular cross section, D is taken as the hydraulic diameter $D = 4A/P$ (Munson et al., 1990) where A is the cross sectional flow area, P is the wetted perimeter, and the factor 4 is used to ensure that the hydraulic diameter is equal to the diameter for a circular pipe. For a rectangular cross section pipe:

$$D = 2ab/(a + b) \qquad (3)$$

where a and b are the dimensions of the sides of the rectangle. The relative roughness ε/D is the ratio of the average height of the roughness elements on the pipe surface over the pipe diameter D. The average height of the roughness elements ε is taken equal to $0.5D_{50}$ where D_{50} is the mean grain size for the soil. The factor 0.5 is used because it is assumed that the top half of the particle protrudes into the flow while the bottom half is buried into the soil mass. During the test, it is possible for the soil surface to become rougher than just 0.5 D_{50}; this occurs when the soil erodes block by block rather than particle by particle. In this case the value used for ε is estimated by the operator on the basis of inspection through the test window.

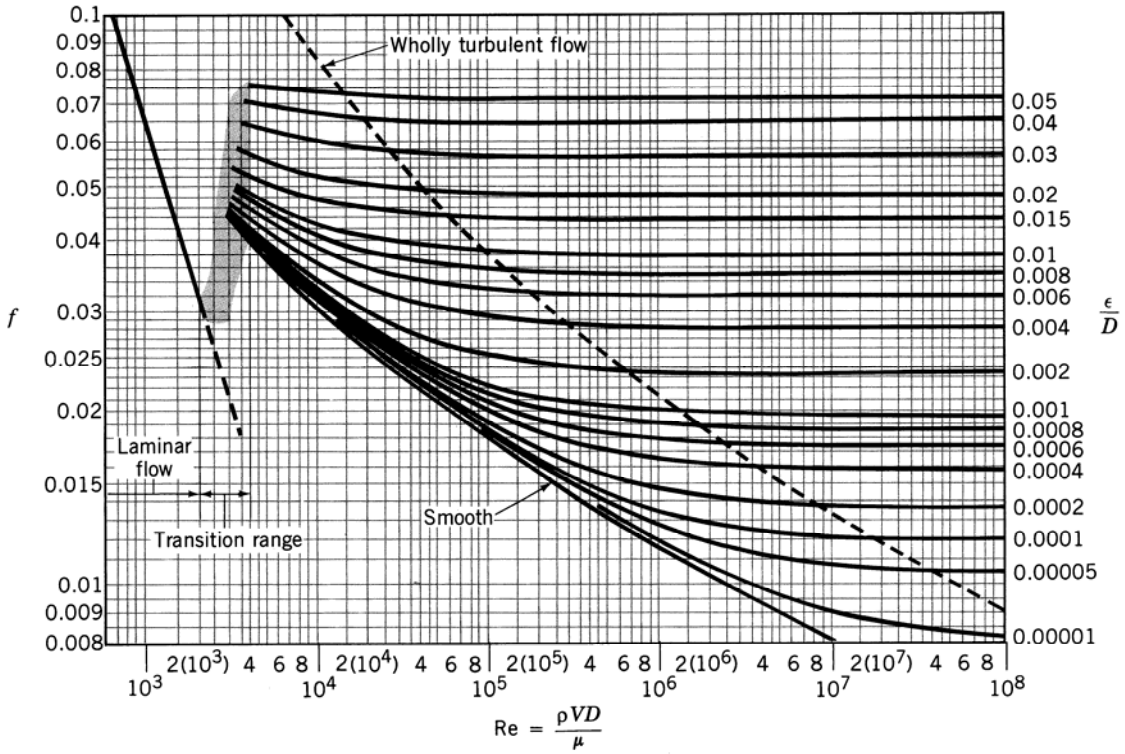


Fig. 2 - Moody Chart (reprinted with permission from Munson et al. 1990)

I.2 SOIL AND WATER SAMPLES USED FOR EROSION TESTS

A total of 11 locations were identified for studying the erosion resistance of the levee soils. Emphasis was placed on levees which were very likely overtopped. These locations are labeled S1 through S15 for Site 1 through Site 15 on Fig. 3. The samples were taken by pushing a Shelby tube when possible or using a shovel to retrieve soil samples into a plastic bag. For example at Site S1, the drilling rig was driven on top of the levee, stopped at the location of Site 1, a first Shelby tube was pushed with the drilling rig from 0 to 2 ft depth and then a second Shelby tube was pushed from 2 to 4 ft depth in the same hole. These two Shelby tubes belonged to boring B1. The drilling rig advanced a few feet and a second location B2 at Site S1 was chosen; then two more Shelby tubes were collected in the same way as for B1. This process at Site S1 generated 4 Shelby tube samples designated

- S1-B1-(0-2ft)
- S1-B1-(2-4ft)
- S1-B2-(0-2ft)
- S1-B2-(2-4ft)

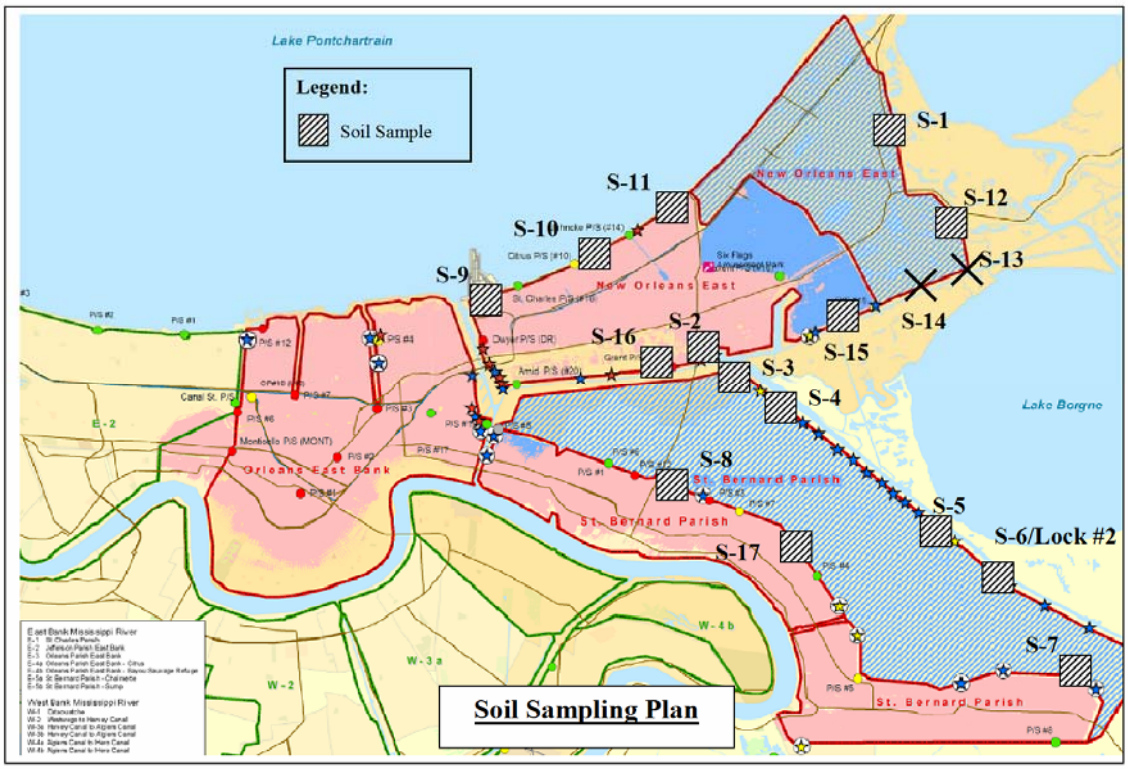


Fig. 3 – Location of samples

Four such Shelby tubes were collected from sites S1, S2, S3, S7, S8, and S12. In a number of cases, Shelby tube samples could not be obtained because access for the drilling rig was not possible (e.g.: access by light boat for the MRGO levee) or pushing a Shelby tube did not yield any sample (clean sands). In these cases, grab samples were collected by using a shovel and filling a plastic bag. The number of bags collected varied from 1 to 4. Plastic bag samples were collected from sites S4, S5, S6, S11, and S15. The total number of sites sampled for erosion testing was therefore 11. These 11 sites generated a total of 23 samples. One of the samples, S8-B1-(2-4ft), exhibited two distinct layers during the EFA tests and therefore led to two EFA curves. All in all 24 EFA curves were obtained from these 23 samples: 14 performed on Shelby tube samples and 10 on bag samples. The reconstitution of the bag samples in the EFA is discussed later.

Water salinity has an effect on erosion. The salinity of the water was determined by using the soil samples collected at the sites. Samples S11 and S15 were selected because one was on the Lake Pontchartrain side and the other on the Lake Borgne side. The procedure consisted of:

1. Dry the soil (about 70 g) in an oven for 12 hr
2. Weigh a quantity of soil, e.g. 10 g and place it in a PE bottle
3. Add deionized (DI) water in the ratio of 2 ml water for one sample and 5 ml water for another sample to each gram of soil

4. Soil: DI water = 10 g: 20 ml or 10g: 50 ml
5. Shake the bottle to thoroughly mix the soil and water
6. Allow the soil to settle for 12 hr
7. Use a pH meter (Orion model 420 A) to measure the pH and a calibrated conductivity meter (Corning model 441) to measure the conductivity of the water.
8. Perform a calibration of the conductivity meter by using known concentrations of salt.
9. Use the conductivity to salinity calibration curve to obtain the salinity of the water created in steps 1 to 7.

Then it becomes necessary to correct the salinity of this water because the amount of water added to the soil for the salinity determination test does not correspond to the amount of water available in the soil pores in its natural state (in the levee). This is done by calculating the amount of water available in the pores of the samples in its natural state. This requires the use of the void ratio and the degree of saturation of the samples calculated using simple phase diagram relationships. The results obtained are shown in Table 1.

Table 1 – Salinity and pH of water associated with the samples

	pH	Salinity (ppm)
Sample S11	8.61	3287
Sample S15	8.09	4199
Typical sea water	7.9	30000 to 35000
Typical tap water	7.0	500

I.3 EROSION FUNCTION APPARATUS (EFA) TEST RESULTS

I.3.1 Sample preparation

No special sample preparation was necessary for the samples which were in Shelby tubes. The Shelby tube was simply inserted in the hole on the bottom side of the rectangular cross section pipe of the FEA (described previously).

For bag samples obtained by using a shovel to collect the soil, there was a need to reconstruct the sample. These samples were prepared by re-compacting the soil in the Shelby tube (Fig. 4). The same process as the one used to prepare a sample for a Proctor compaction test was used. Since it was not known what the compaction level was in the field, two extreme levels of compaction energy were used to recompact the samples. The goal was to bracket the erosion response of the intact soil.

For the high compaction effort (100% of Modified Proctor compaction effort), the sample was compacted in an 18-inch long Shelby tube as follows:

1) The total sample height was 6 inches. The sample was compacted in eight layers.
2) To form each layer, the soil was poured into the Shelby tube from a height of 1 inch above the top of the tube.
3) The soil was compacted using a 10 lb hammer (Modified Proctor hammer) with a drop height of 1.5 feet. Each layer was compacted by 8 hammer blows, i.e. 8 blows/layer.
4) This process was repeated until a 6 inch sample was obtained.
5) The corresponding compaction energy was equal to the Standard Modified Proctor Compaction energy.

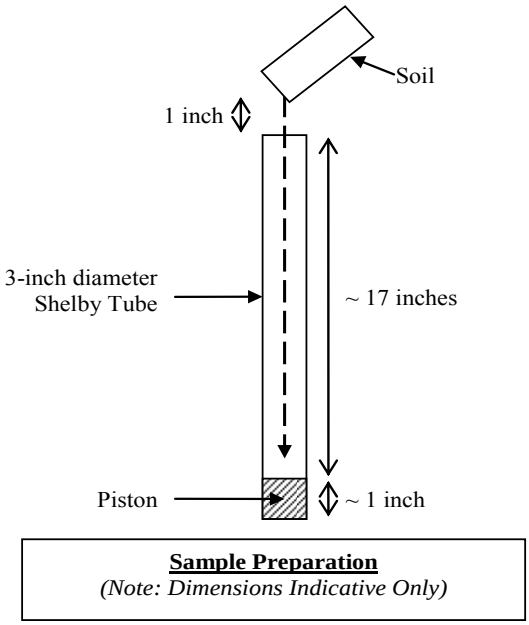


Fig. 4 – Soil preparation by re-compaction for bag samples

For the low compaction effort (1.63% of Modified Proctor compaction effort), the sample was compacted in an 18-inch long Shelby tube as follows.

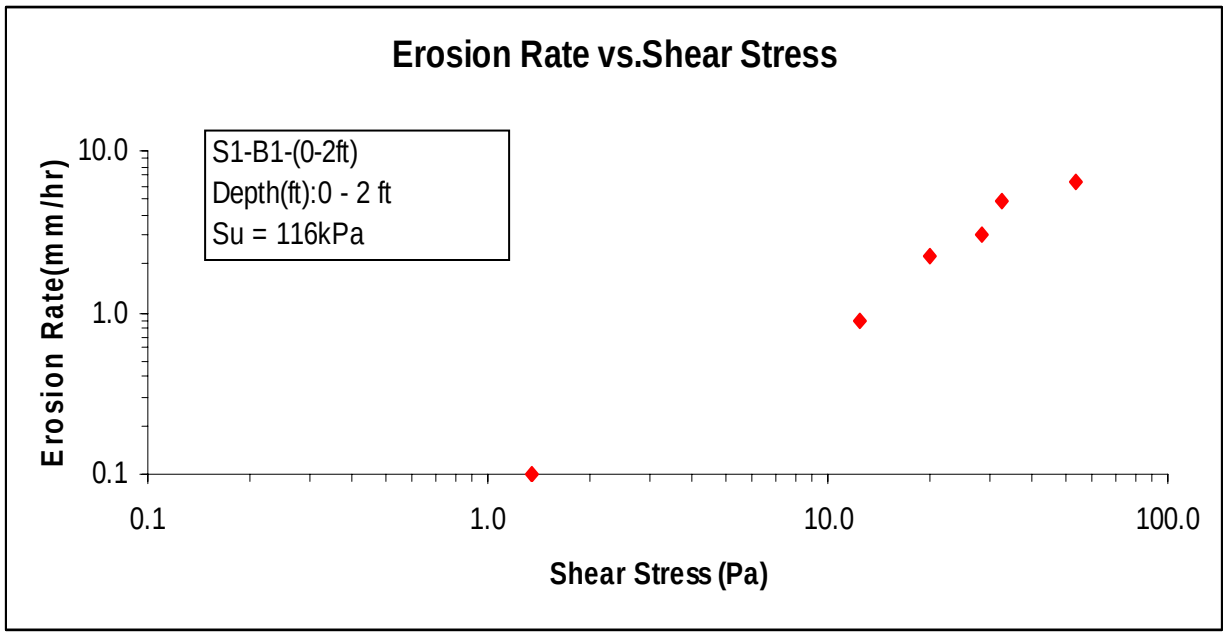
1. The total sample height was 6 inches. The sample was compacted in eight layers.
2. To form each layer, the soil was poured into the Shelby tube from a height of 1 inch above the top of the tube.
3. The soil was compacted using a 10 lb hammer (Modified Proctor hammer) with a drop height of 1 inch. Each layer was compacted by 3 hammer blows, i.e. 3 blows/layer.
4. This process was repeated until a 6 inch sample was obtained.
5. The corresponding compaction energy was 1.63% of the Standard Modified Proctor Compaction energy.

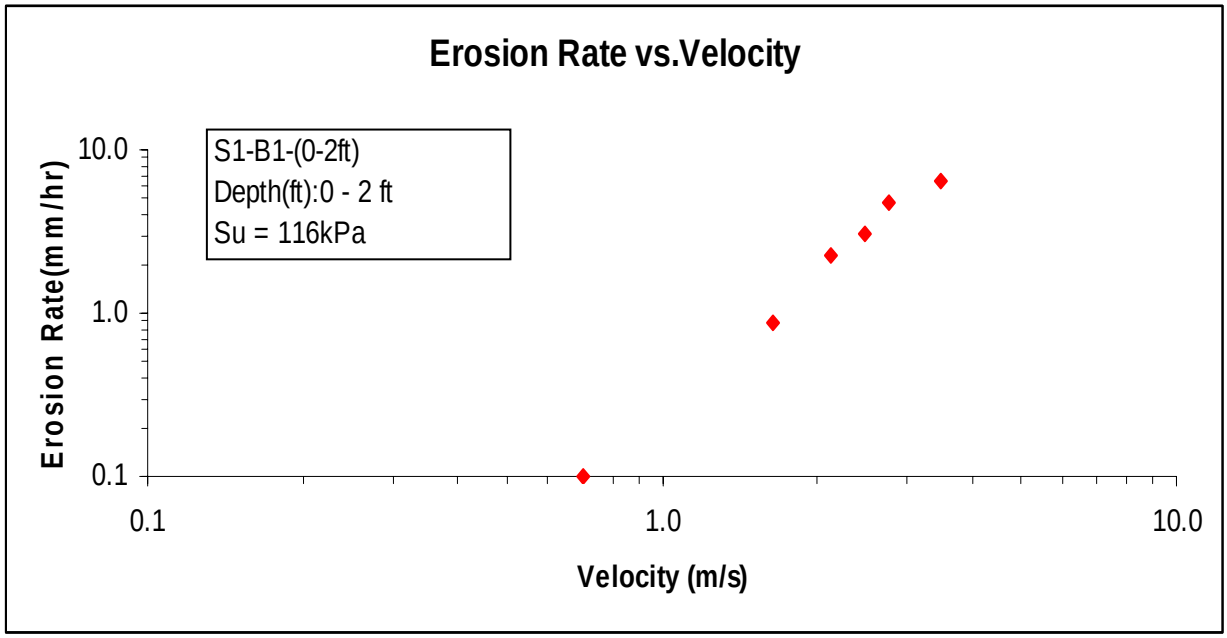
Summary test data for all erosion samples are presented in the following section.

EFA TEST RESULTS

EFA Test Results for Sample No. S1-B1-(0-2ft)-TW

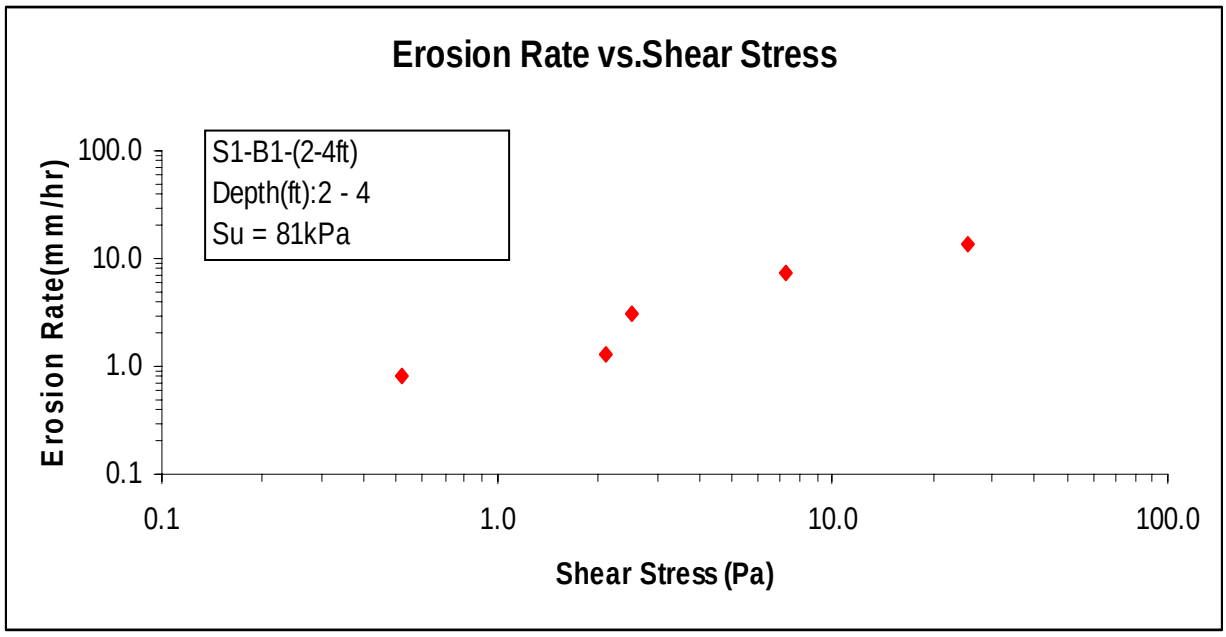
Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

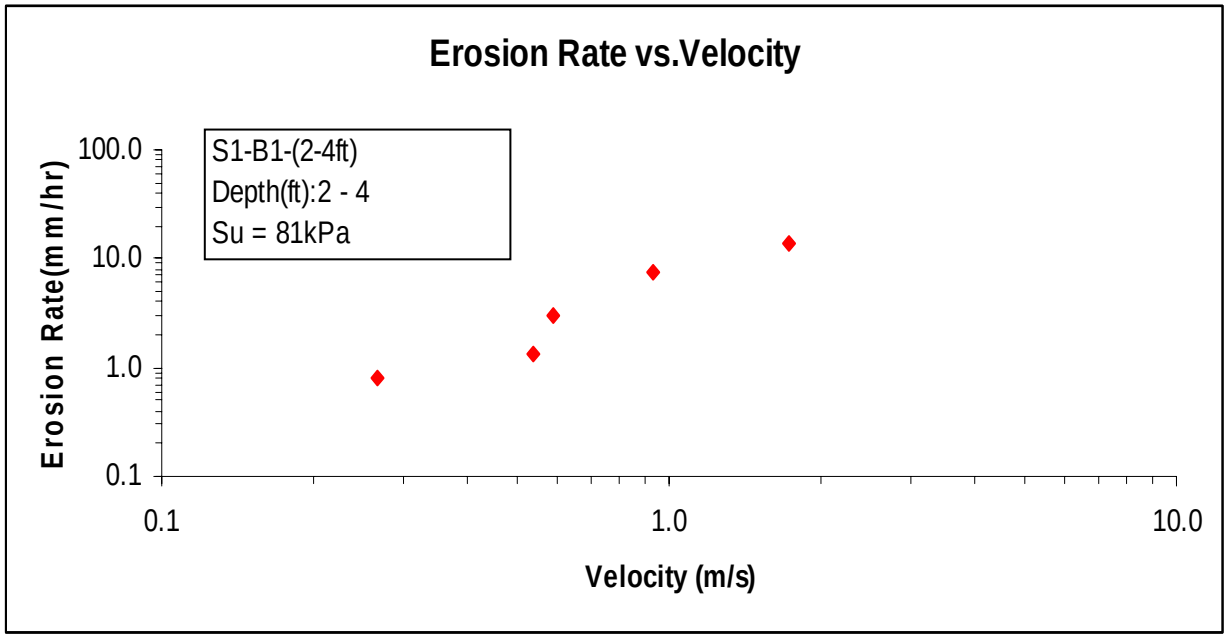




EFA Test Results for Sample No. S1-B1-(2-4ft)-SW

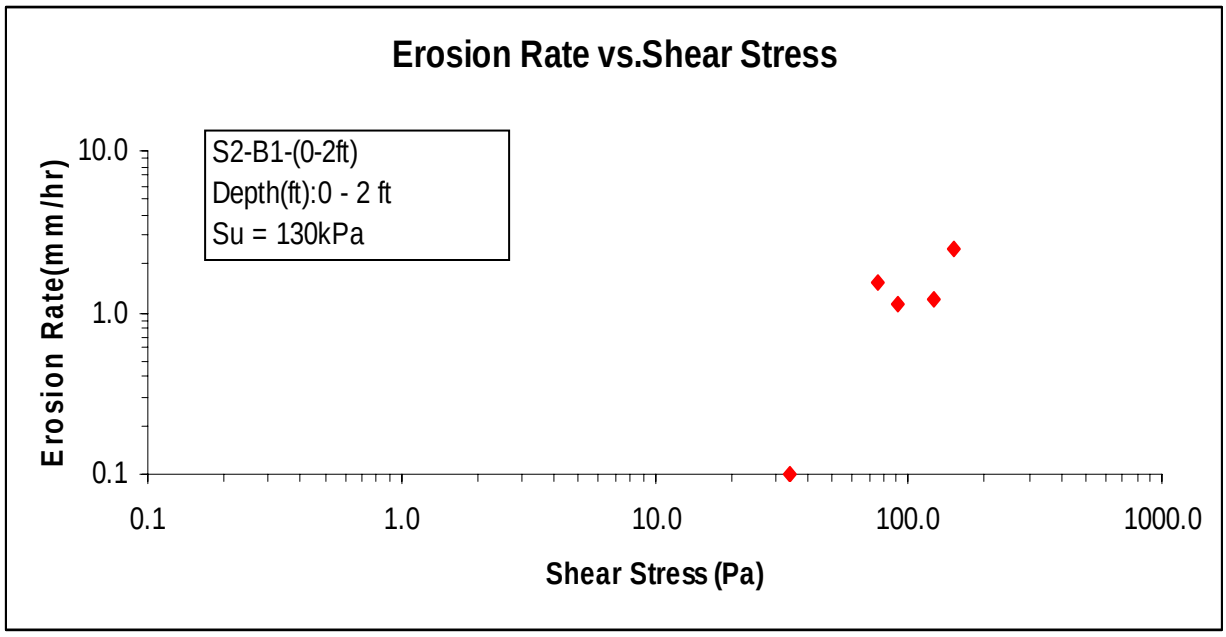
Sample Type: Shelby Tube
Water Salinity: 35.6 PPT (Salt Water)
Compaction Effort: N/A

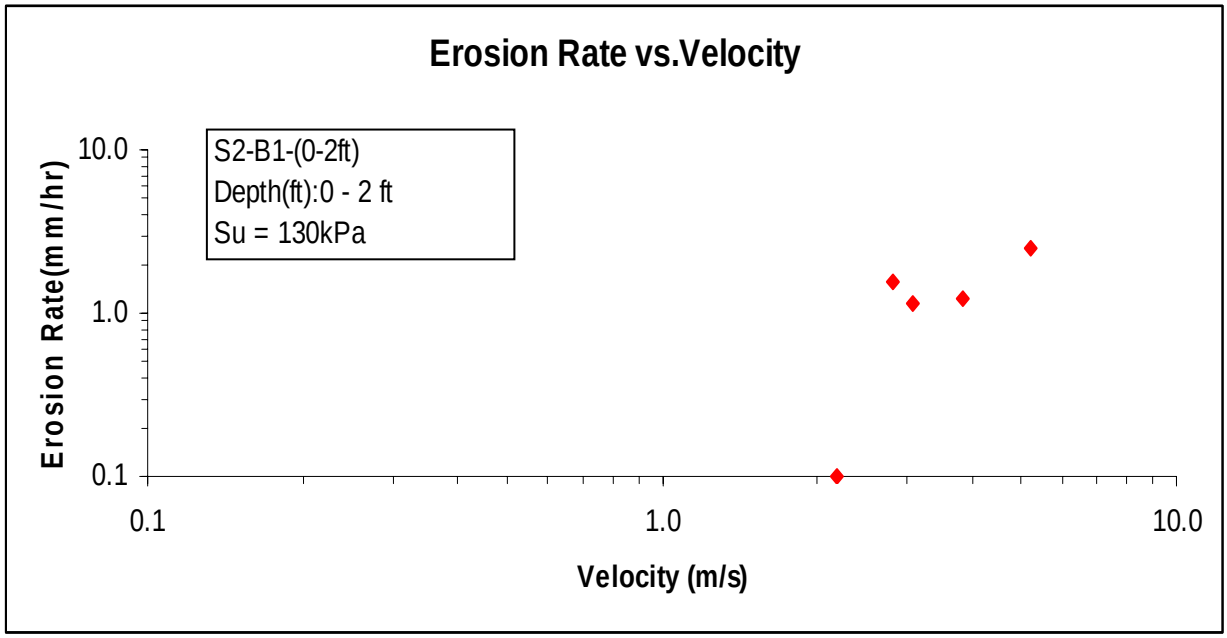




EFA Test Results for Sample No. S2-B1-(0-2ft)-TW

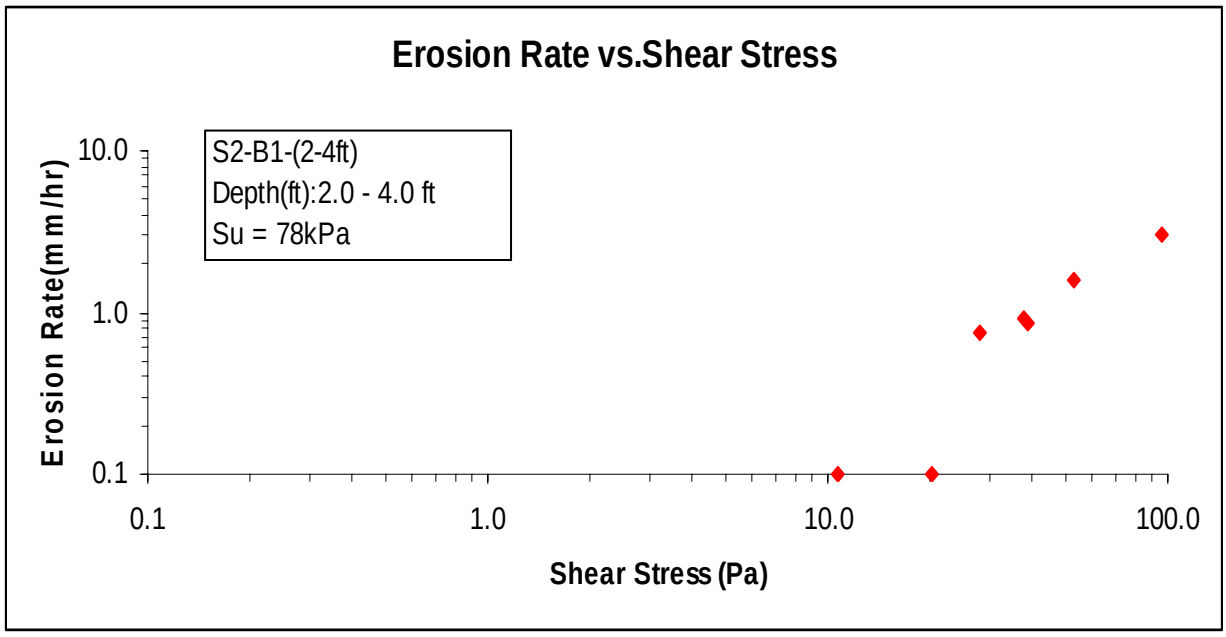
Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

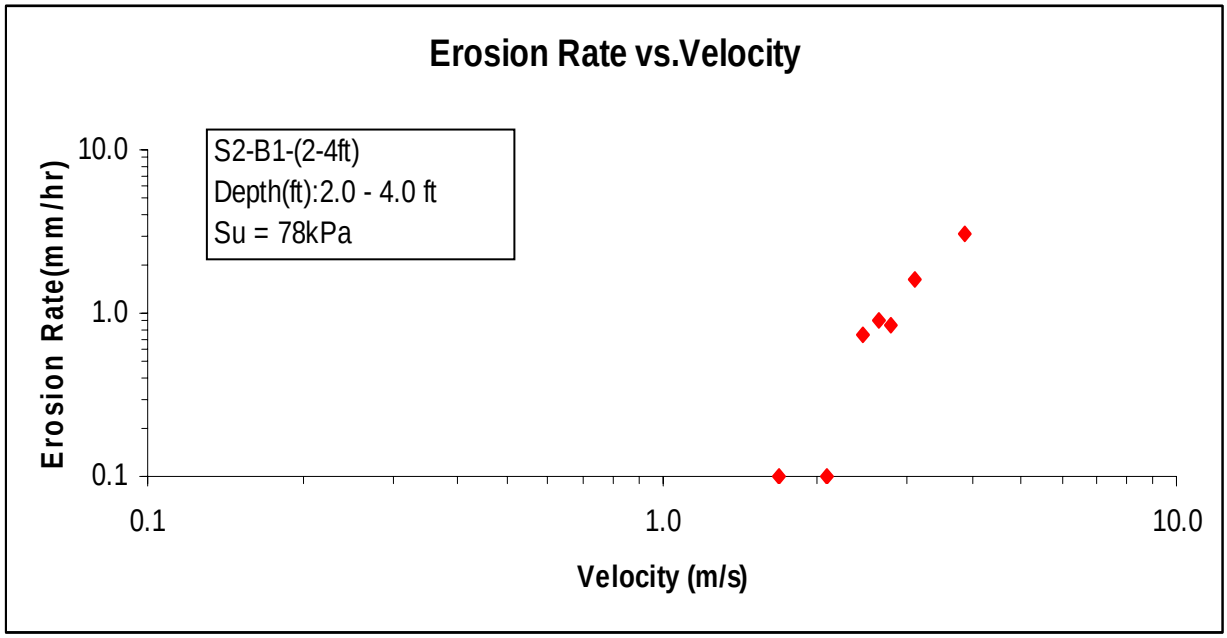




EFA Test Results for Sample No. S2-B1-(2-4ft)-SW

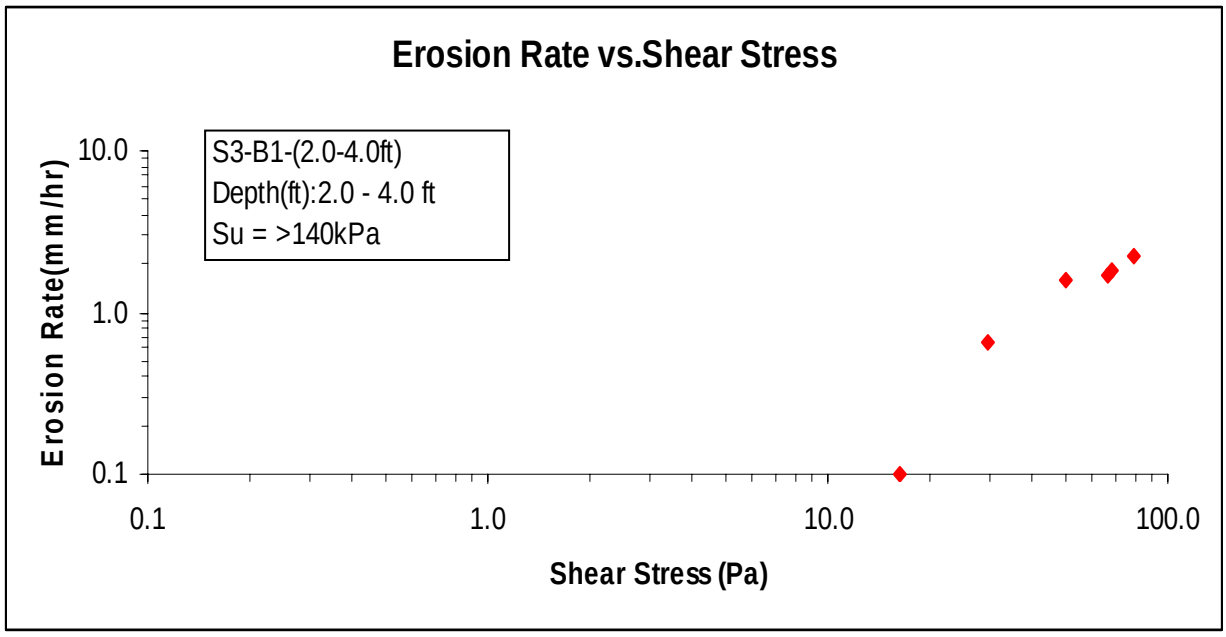
Sample Type: Shelby Tube
Water Salinity: 36.9 PPT (Salt Water)
Compaction Effort: N/A

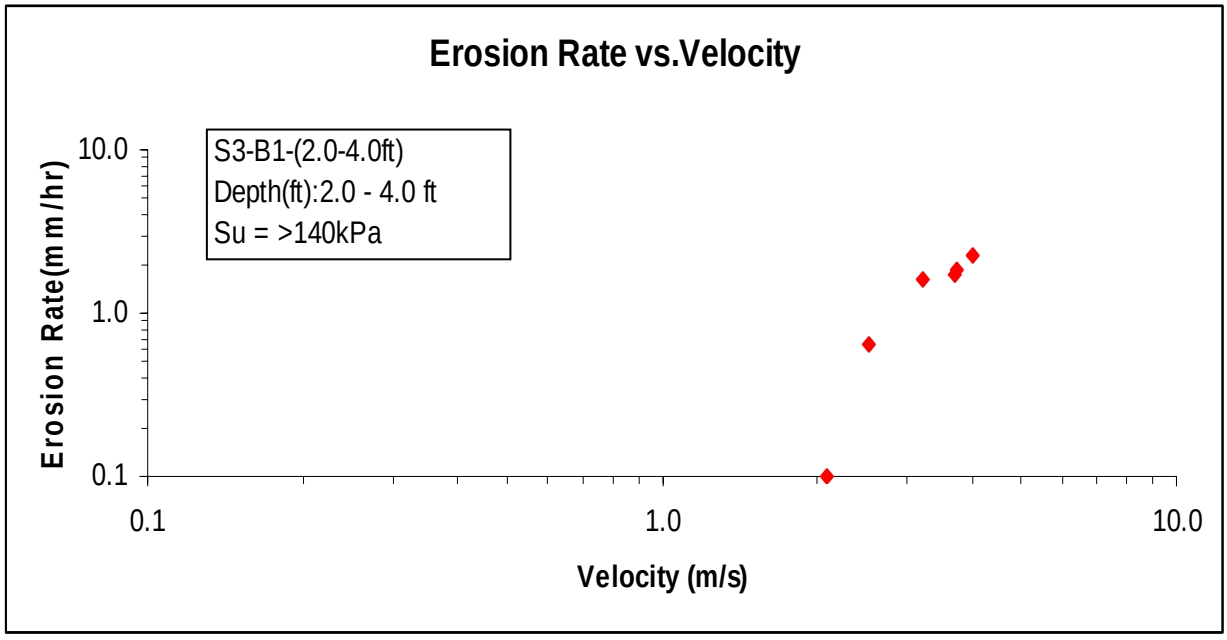




EFA Test Results for Sample No. S3-B1-(2-4ft)-SW

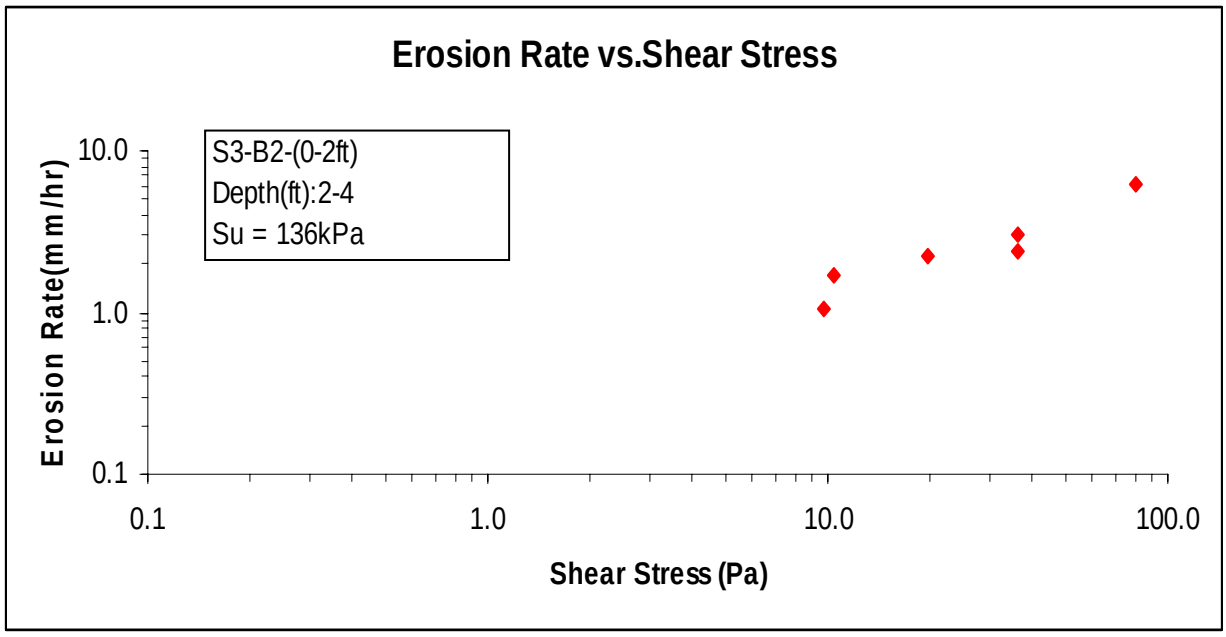
Sample Type: Shelby Tube
Water Salinity: 35.8 PPT (Salt Water)
Compaction Effort: N/A

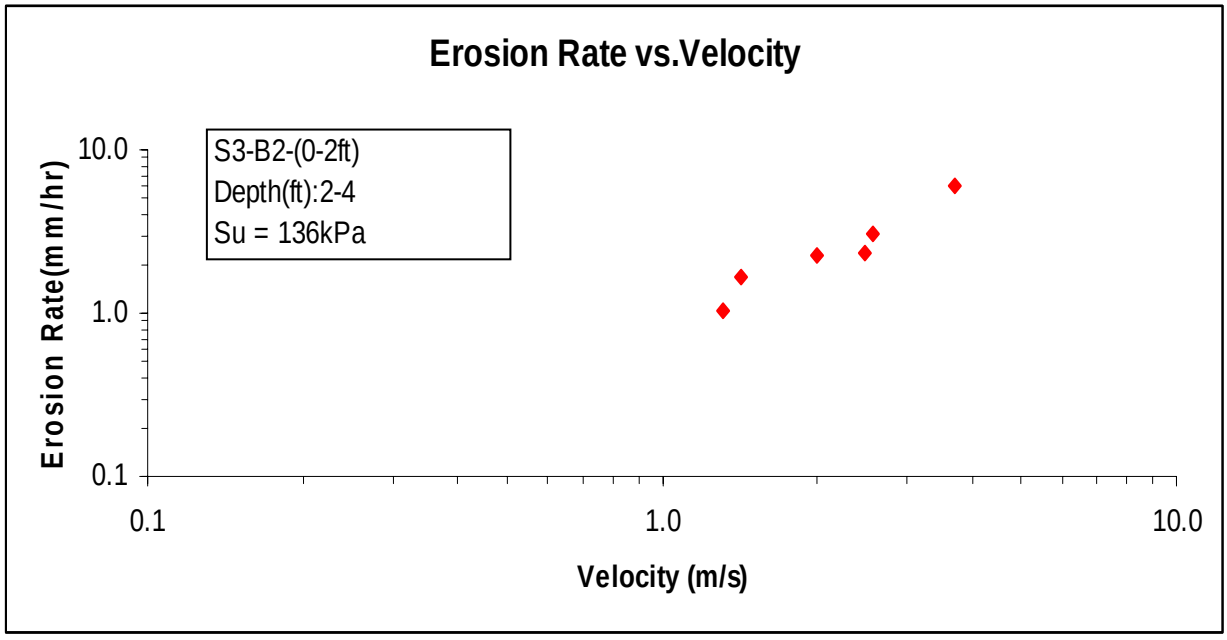




EFA Test Results for Sample No. S3-B2-(0-2ft)-SW

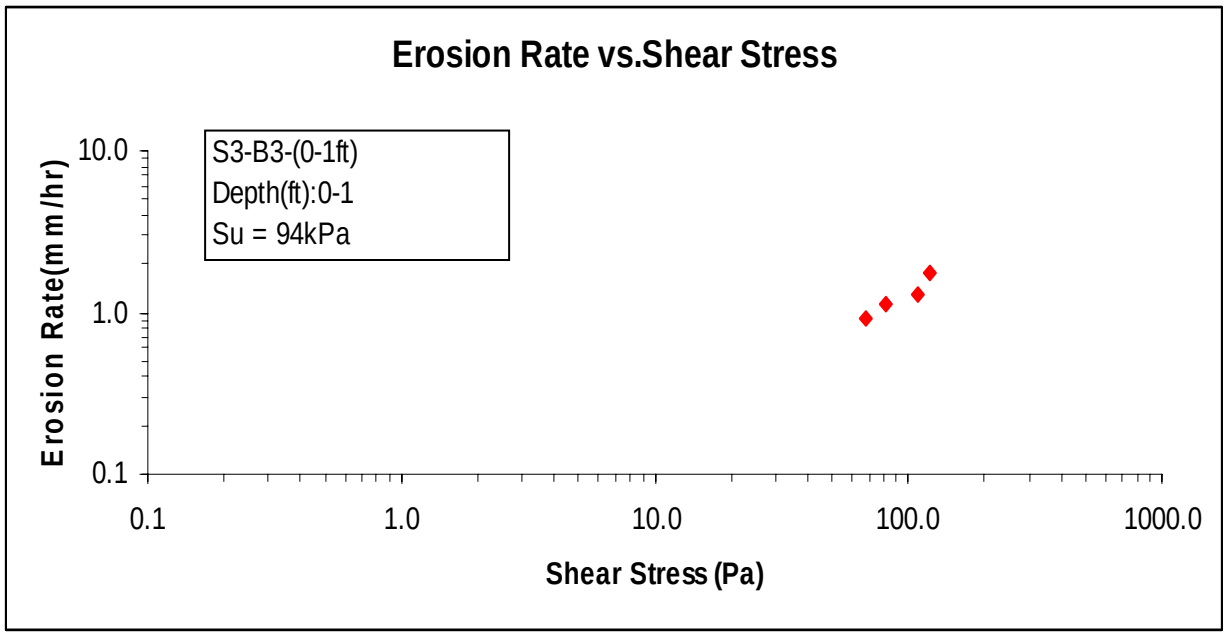
Sample Type: Shelby Tube
Water Salinity: 36.5 PPT (Salt Water)
Compaction Effort: N/A

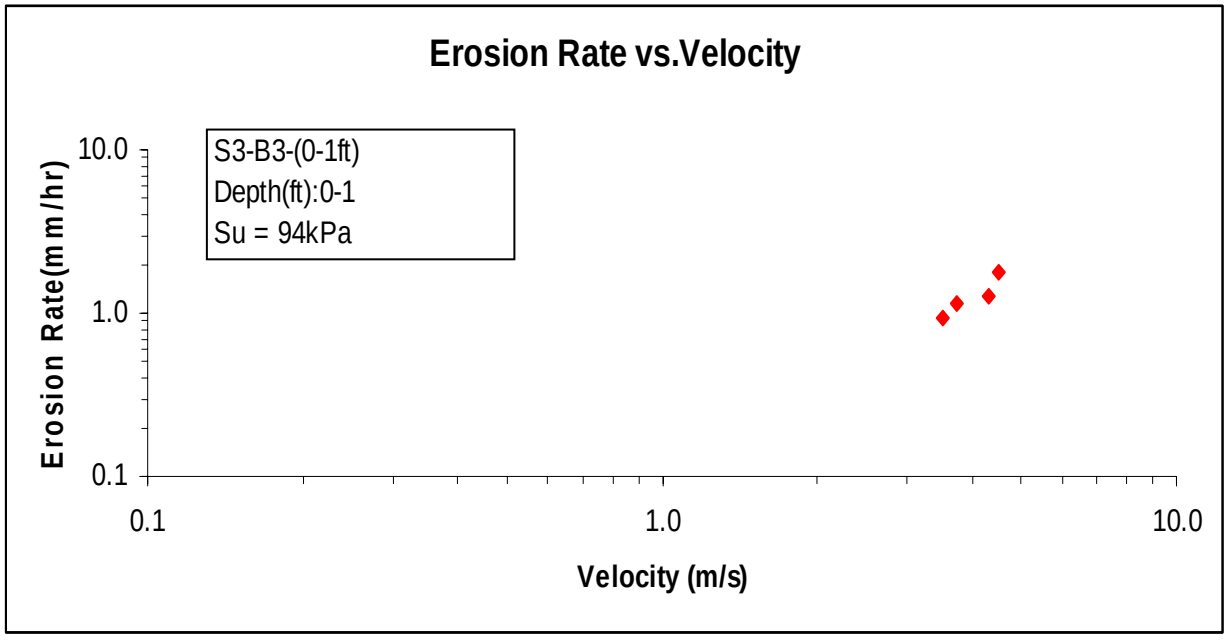




EFA Test Results for Sample No. S3-B3-(0-1ft)-SW

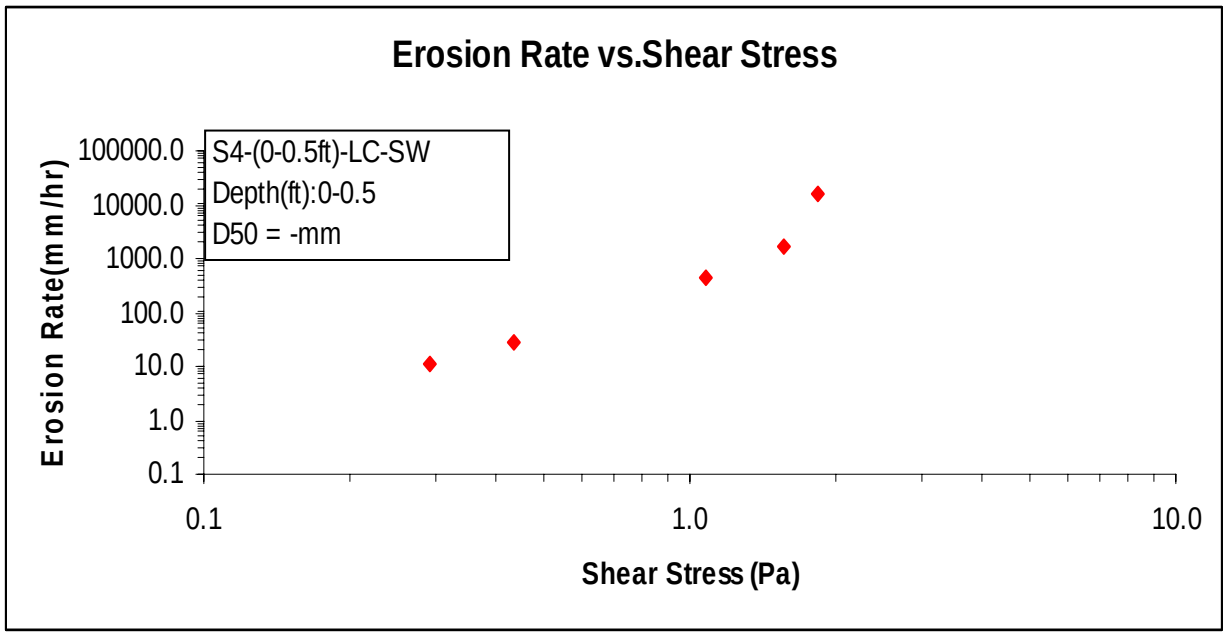
Sample Type: Shelby Tube
Water Salinity: 36.4 PPT (Salt Water)
Compaction Effort: N/A

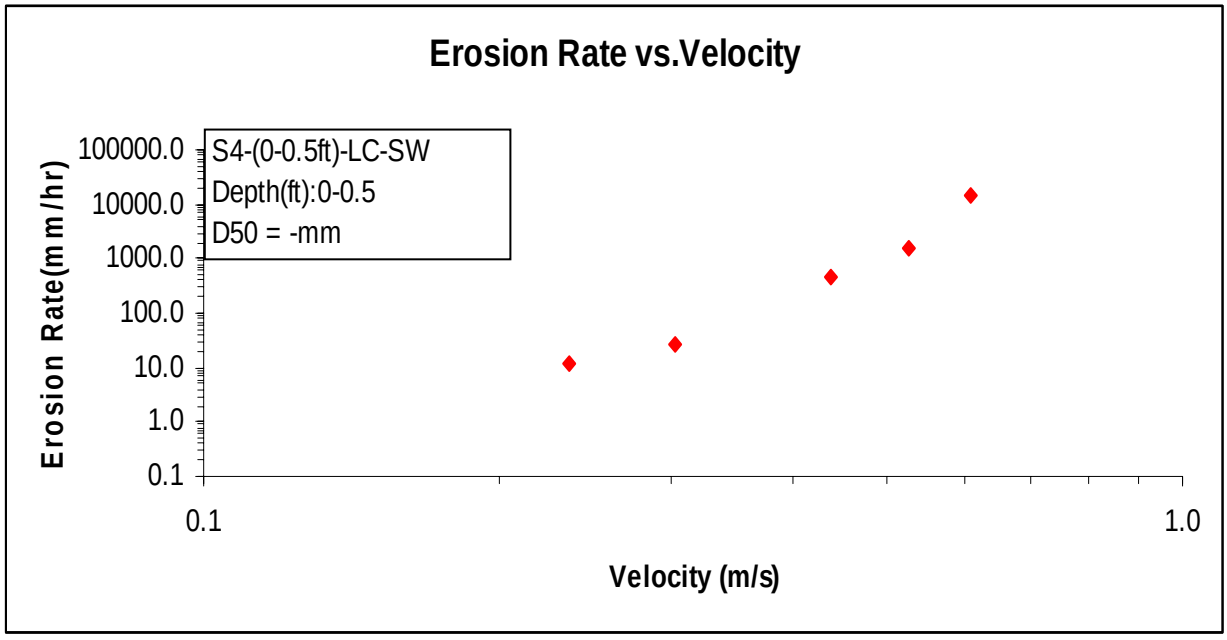




EFA Test Results for Sample No. S4-(0-0.5ft)-LC-SW

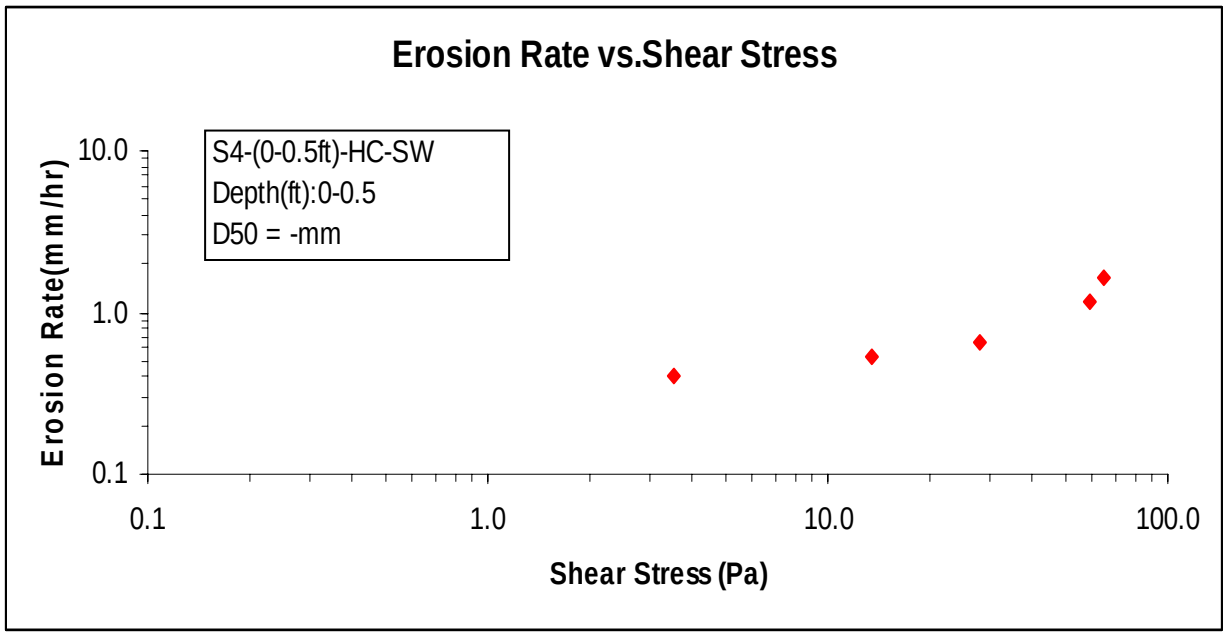
Sample Type: Bulk Sample
Water Salinity: 36.1 PPT (Salt Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction

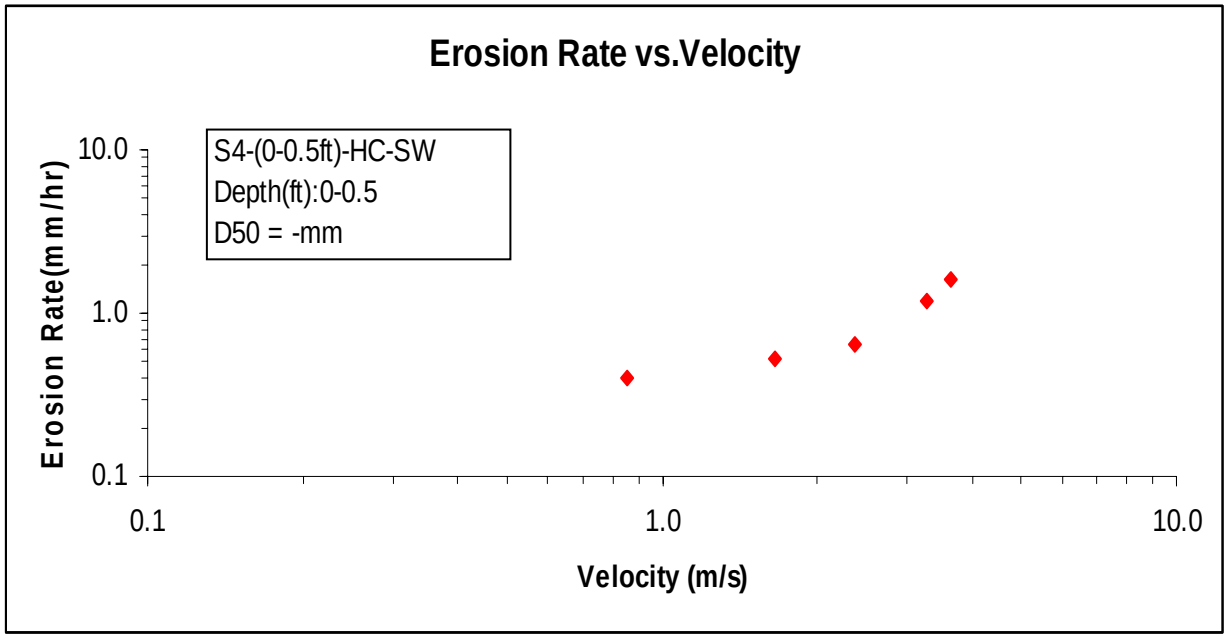




EFA Test Results for Sample No. S4-(0-0.5ft)-HC-SW

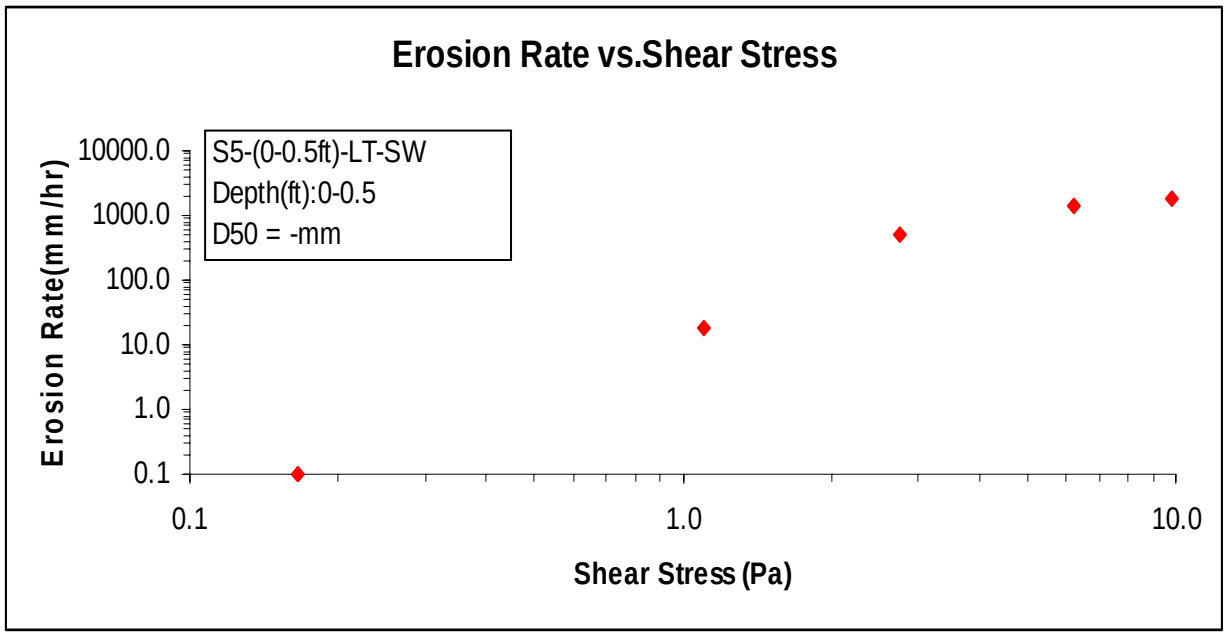
Sample Type: Bulk Sample
Water Salinity: 35.7 PPT (Salt Water)
Compaction Effort: High = 100% Modified Proctor Compaction

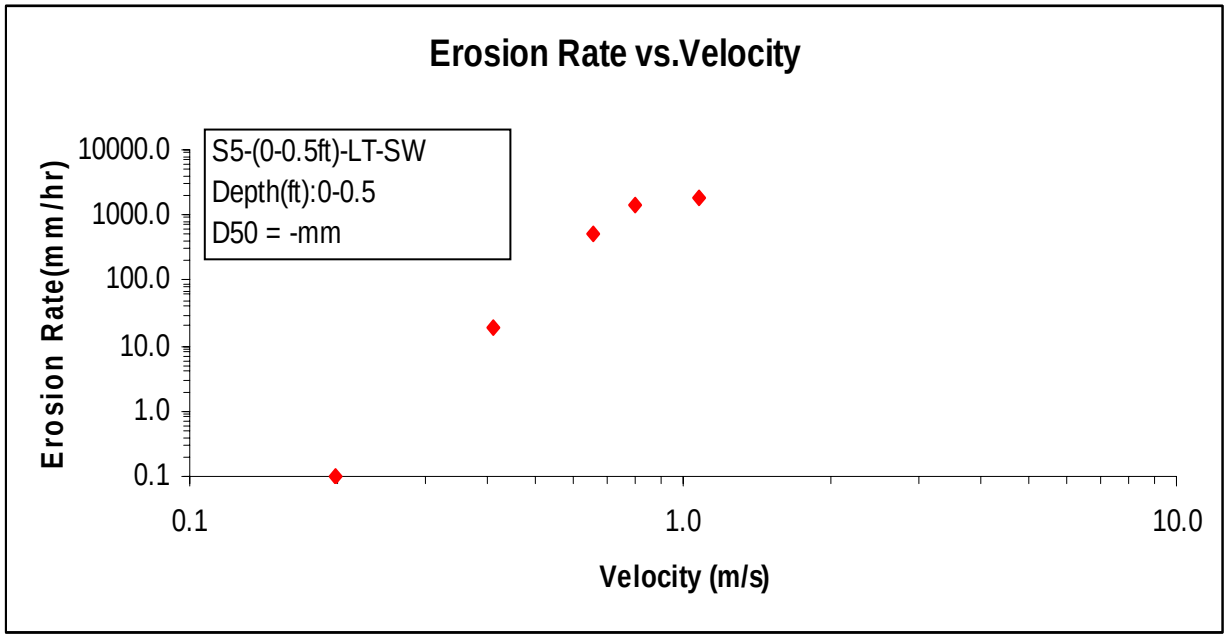




EFA Test Results for Sample No. S5-(0-0.5ft)-LT-SW

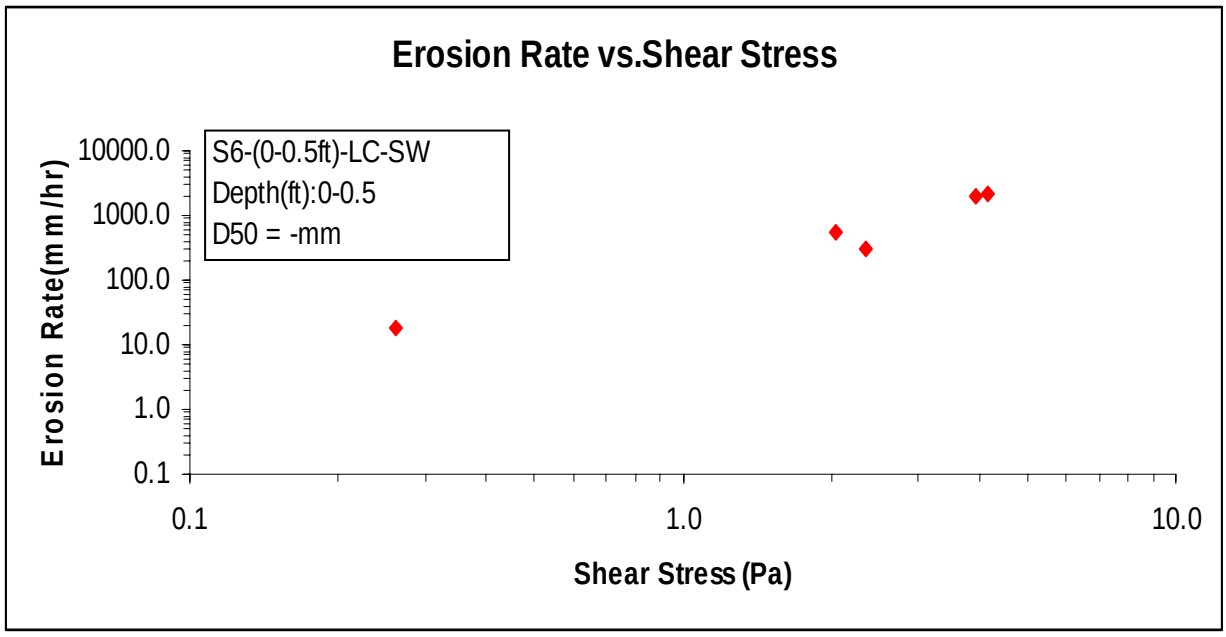
Sample Type: Bulk Sample
Water Salinity: 36.2 PPT (Salt Water)
Compaction Effort: Light Tamping

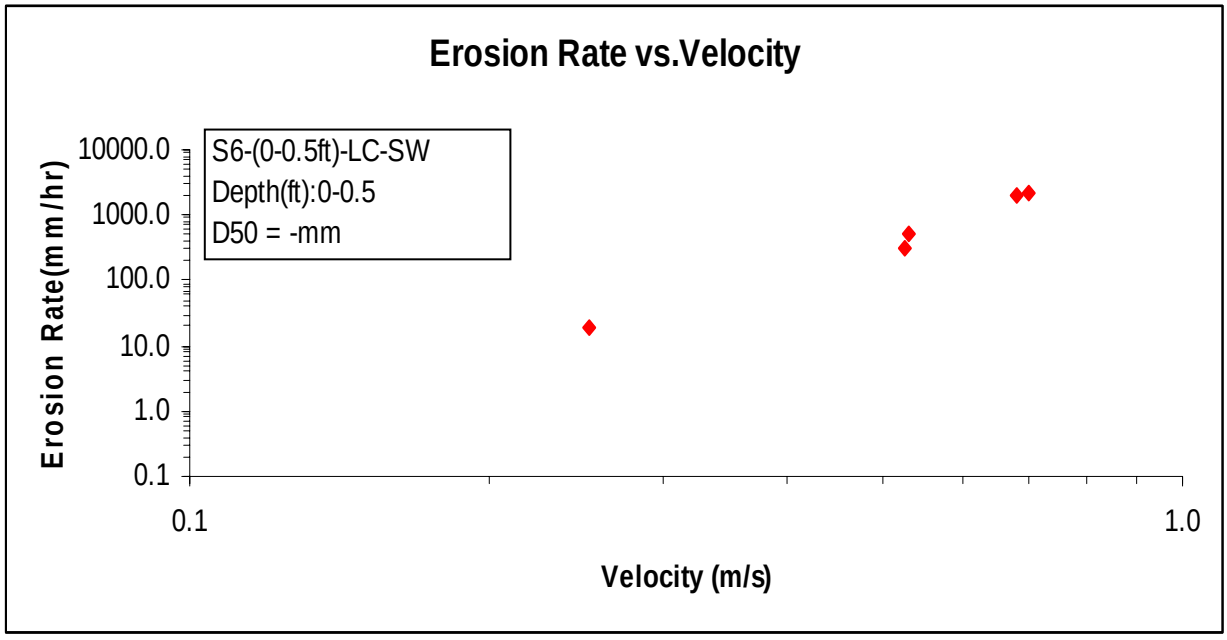




EFA Test Results for Sample No. S6-(0-0.5ft)-LC-SW

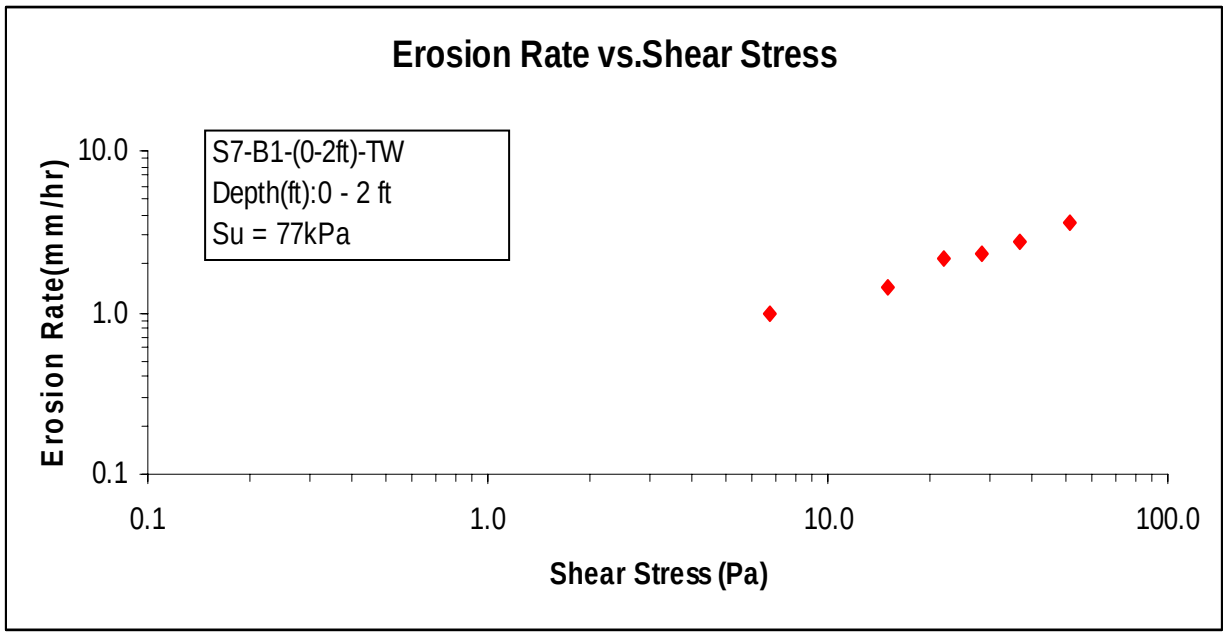
Sample Type: Bulk Sample
Water Salinity: 36.5 PPT (Salt Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction

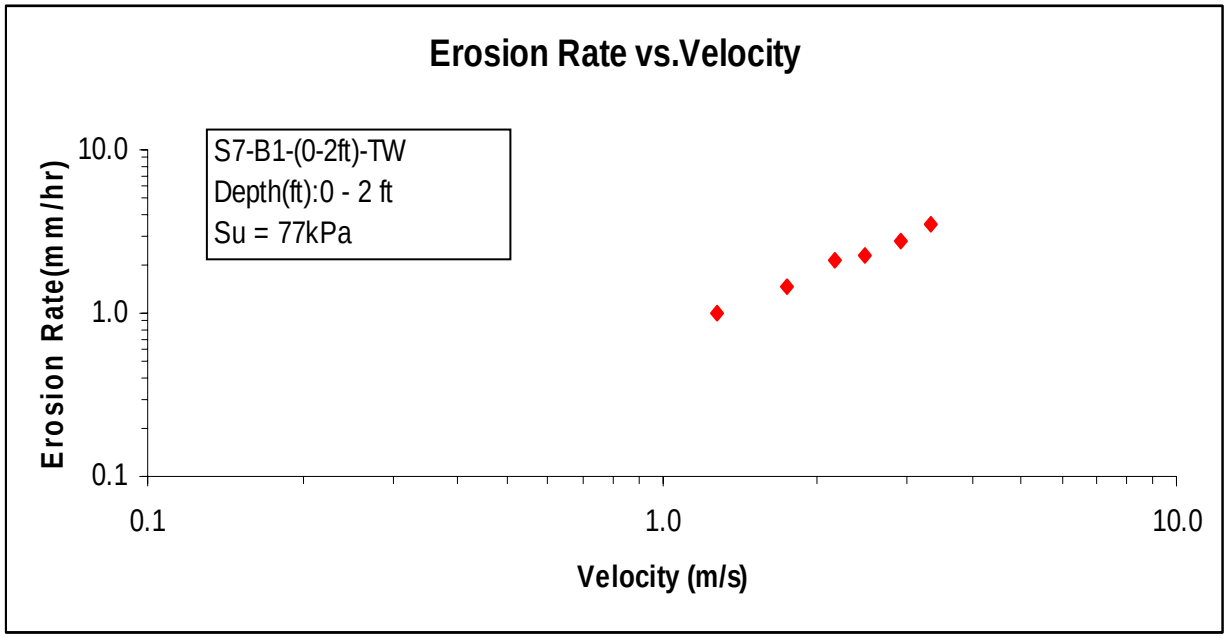




EFA Test Results for Sample No. S7-B1-(0-2ft)-TW

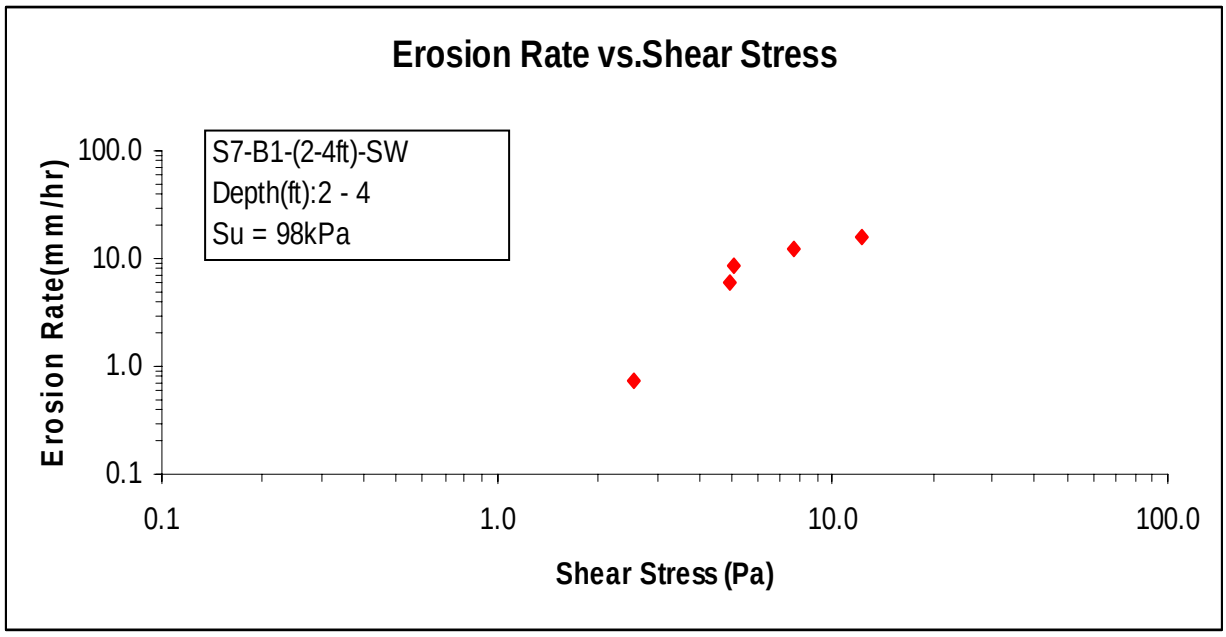
Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

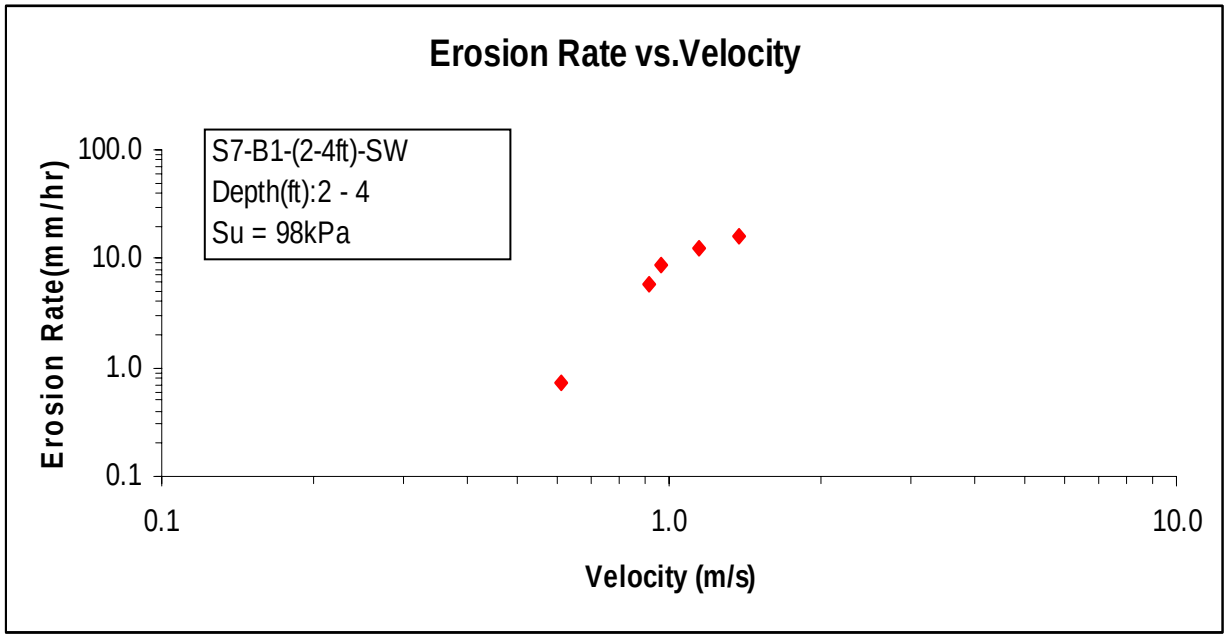




EFA Test Results for Sample No. S7-B1-(2-4ft)-SW

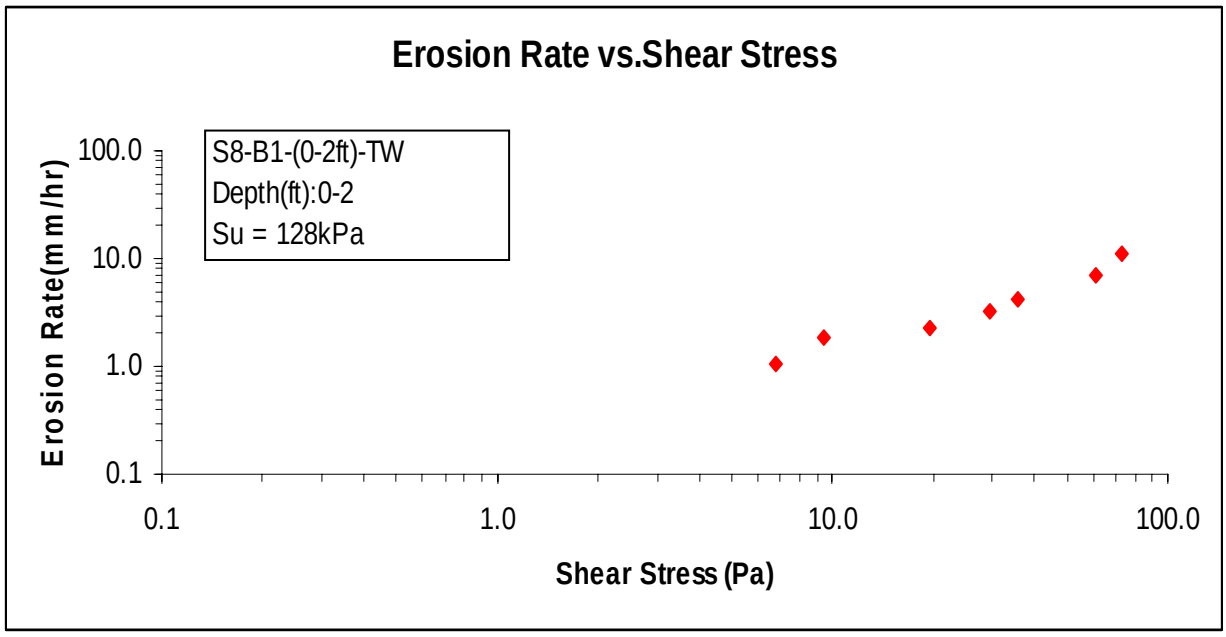
Sample Type: Shelby Tube
Water Salinity: 36.9 PPT (Salt Water)
Compaction Effort: N/A

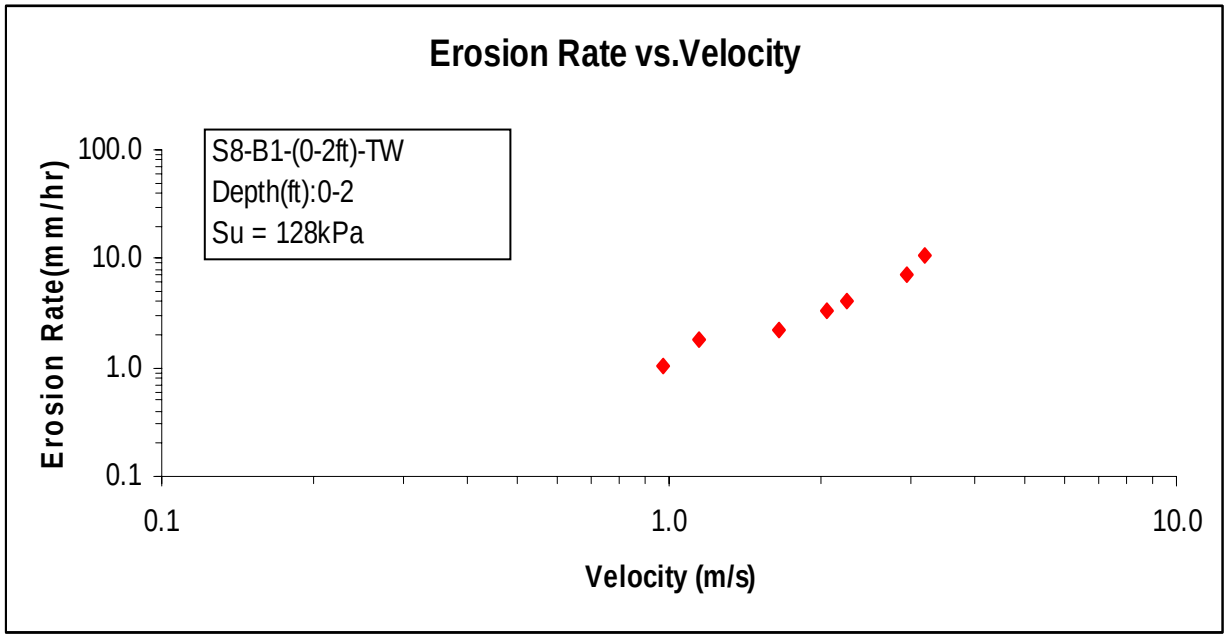




EFA Test Results for Sample No. S8-B1-(0-2ft)-TW

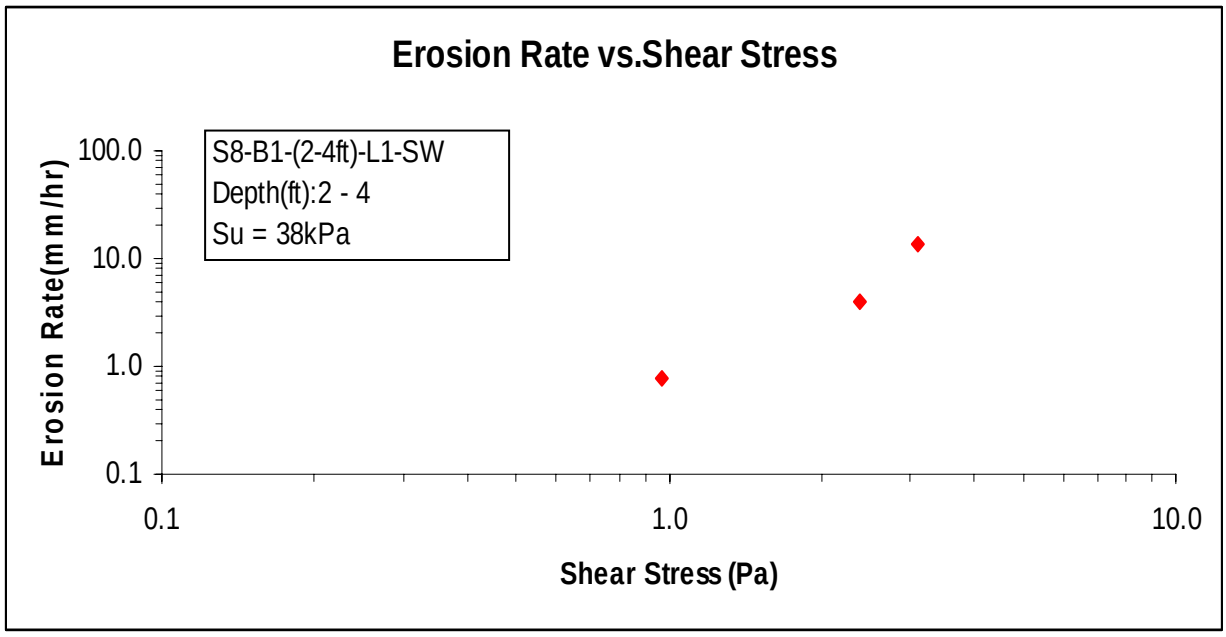
Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

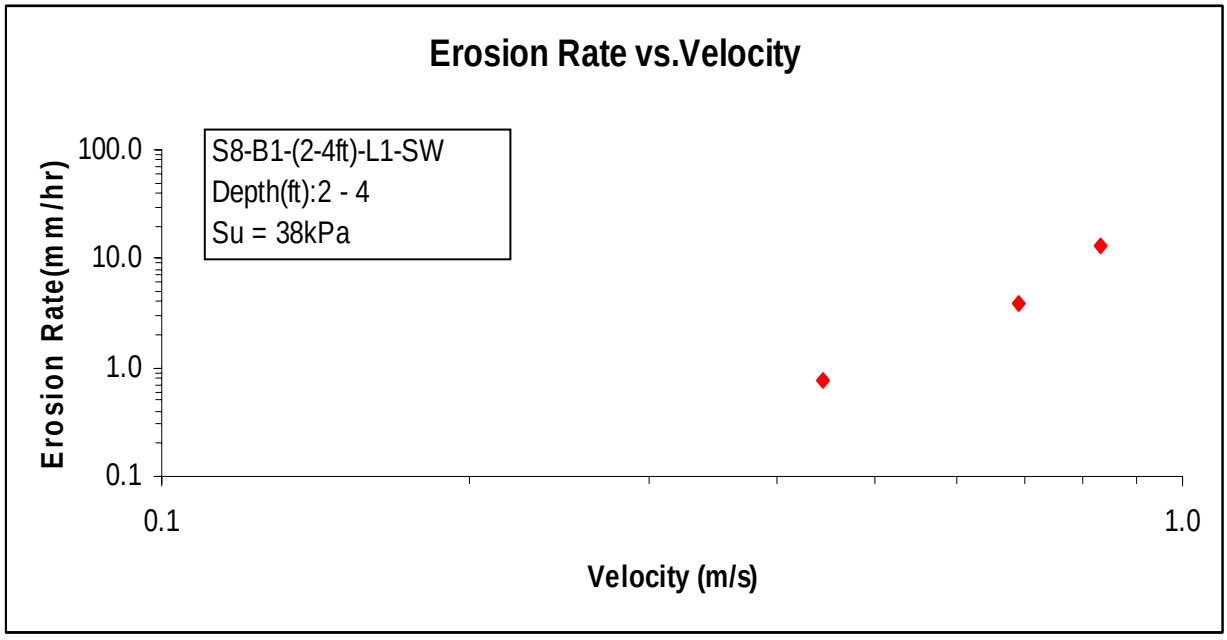




EFA Test Results for Sample No. S8-B1-(2-4ft)-L1-SW

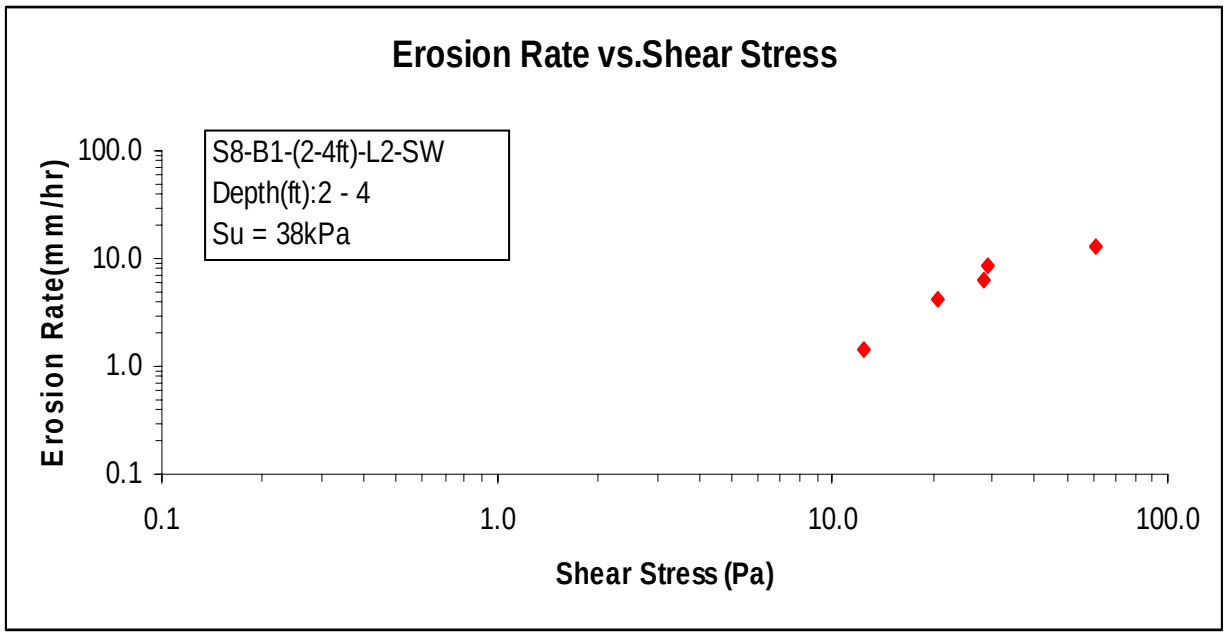
Sample Type: Shelby Tube
Water Salinity: 38.3 PPT (Salt Water)
Compaction Effort: N/A

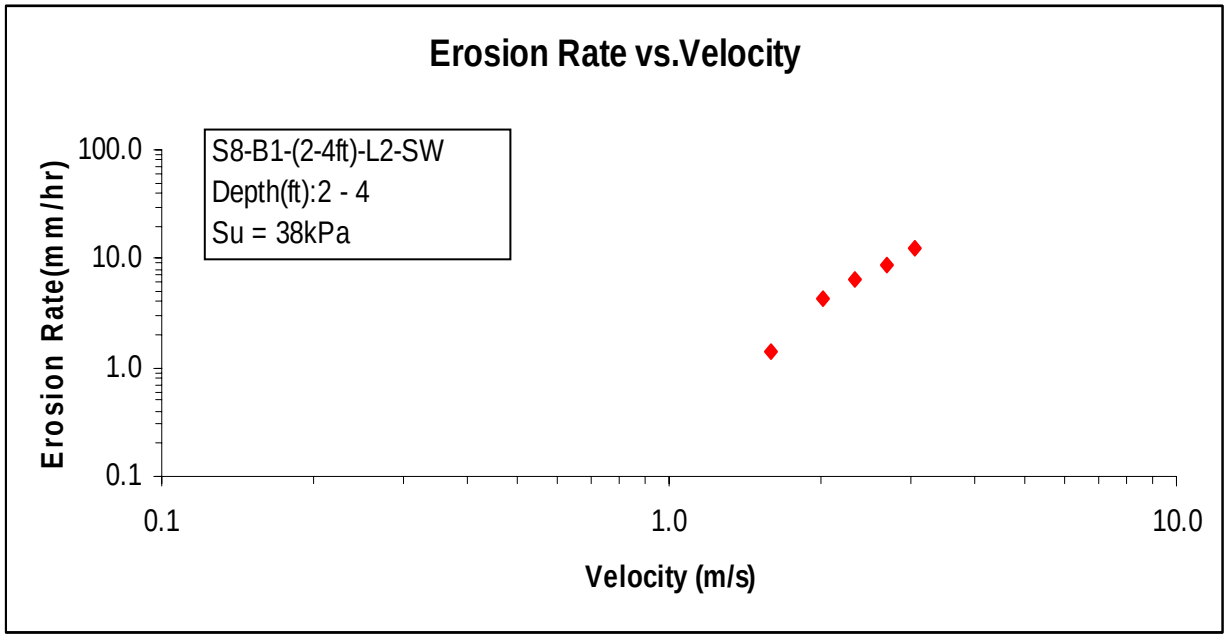




EFA Test Results for Sample No. S8-B1-(2-4ft)-L2-SW

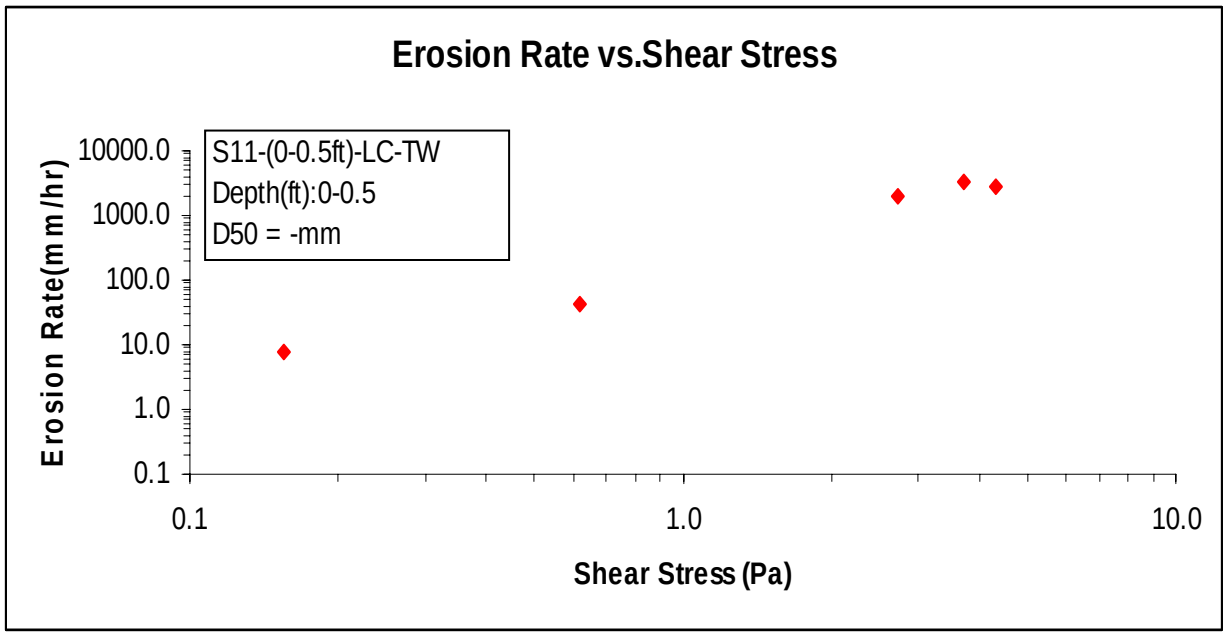
Sample Type: Shelby Tube
Water Salinity: 38.3 PPT (Salt Water)
Compaction Effort: N/A

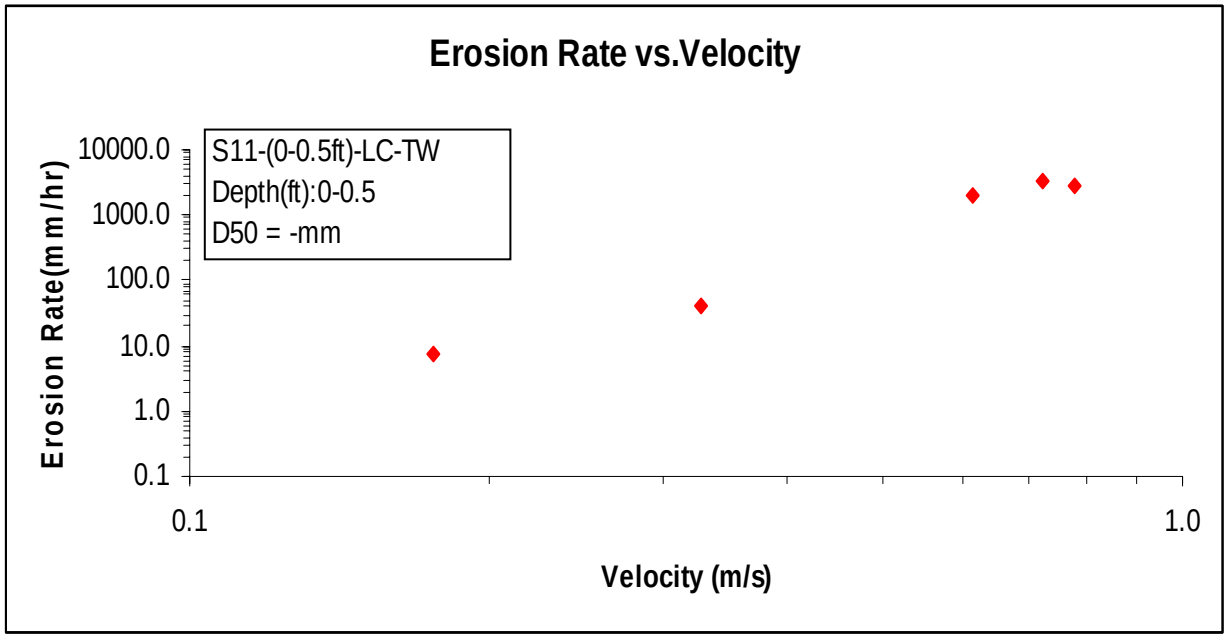




EFA Test Results for Sample No. S11-(0-0.5ft)-LC-TW

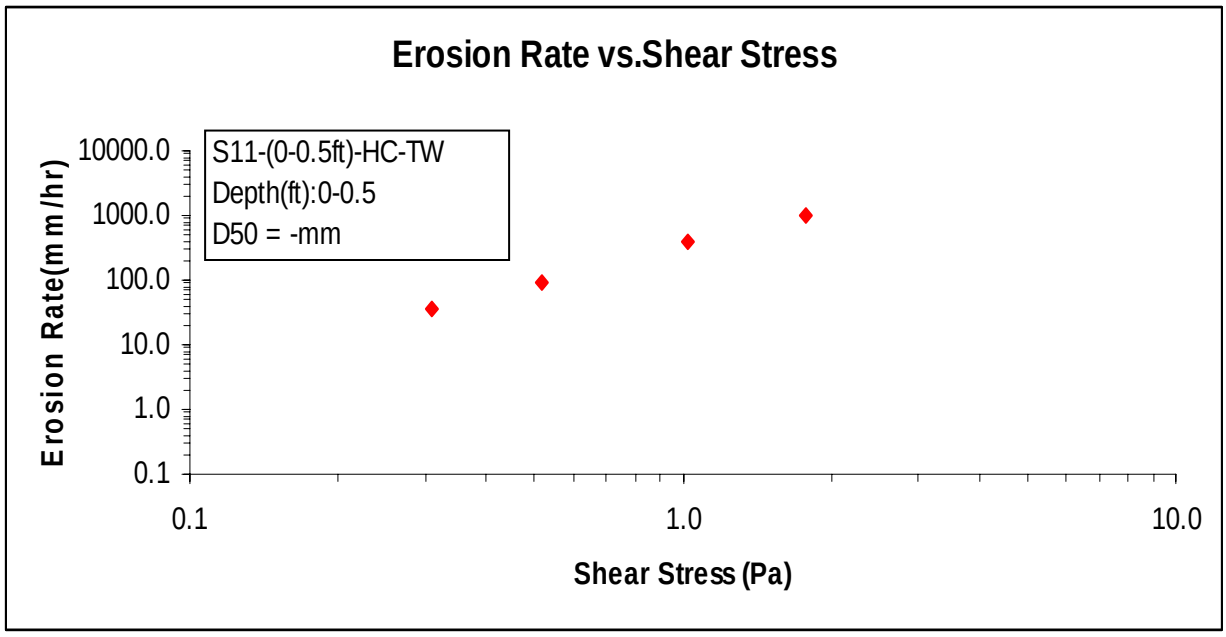
Sample Type: Bulk Sample
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction

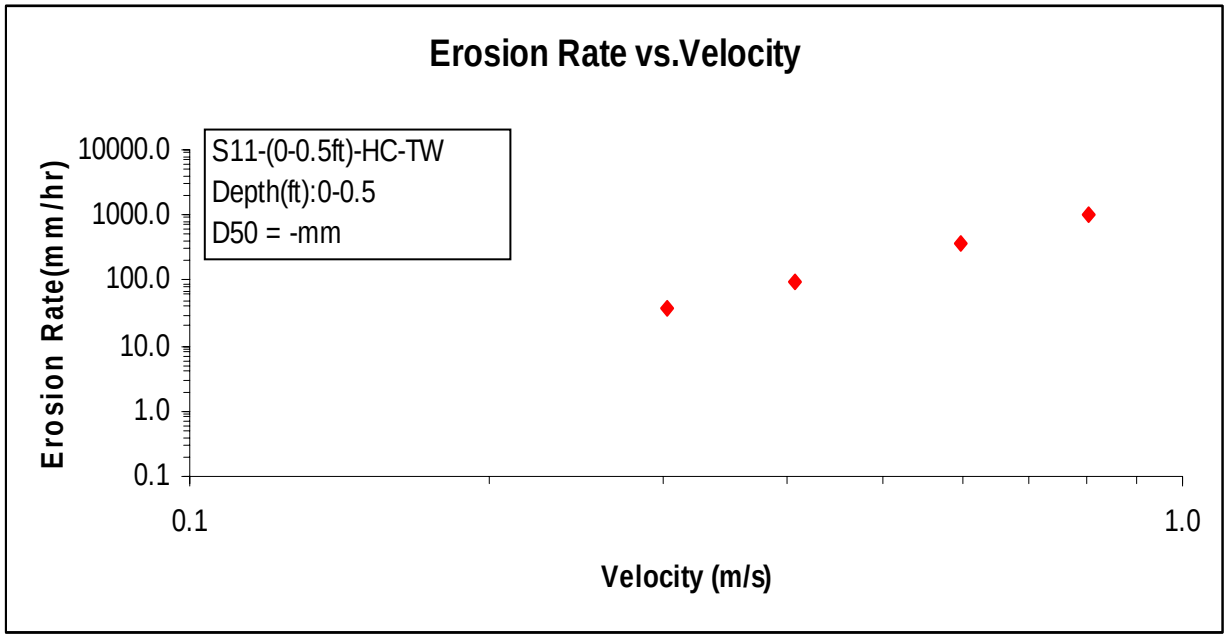




EFA Test Results for Sample No. S11-(0-0.5ft)-HC-TW

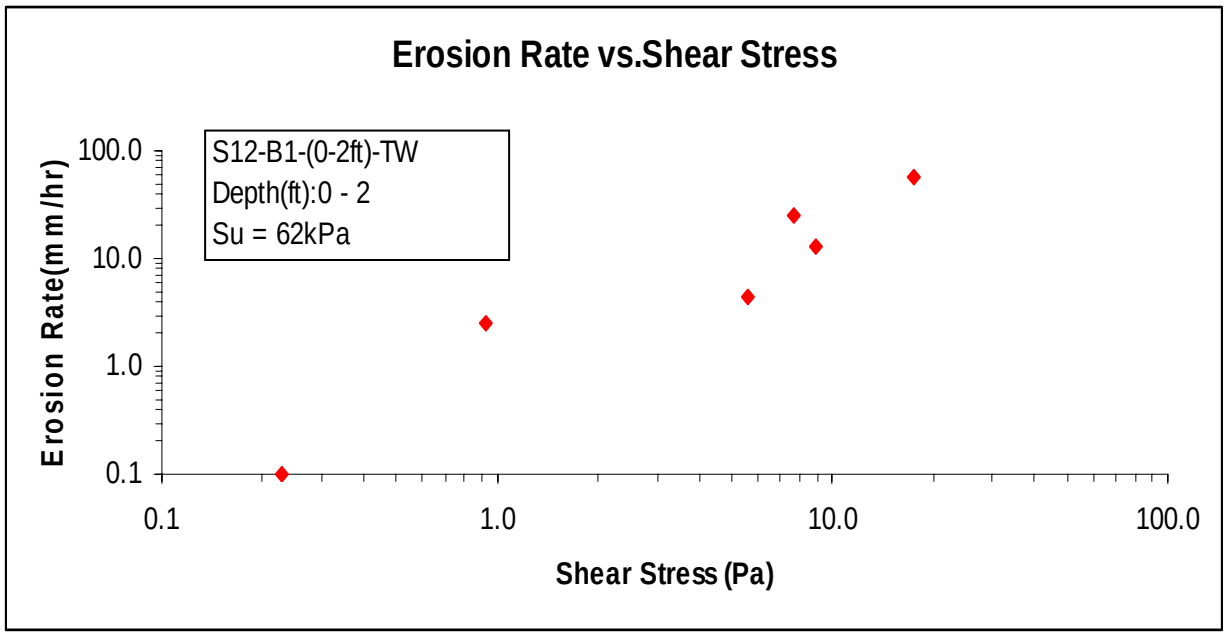
Sample Type: Bulk Sample
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: High = 100% Modified Proctor Compaction

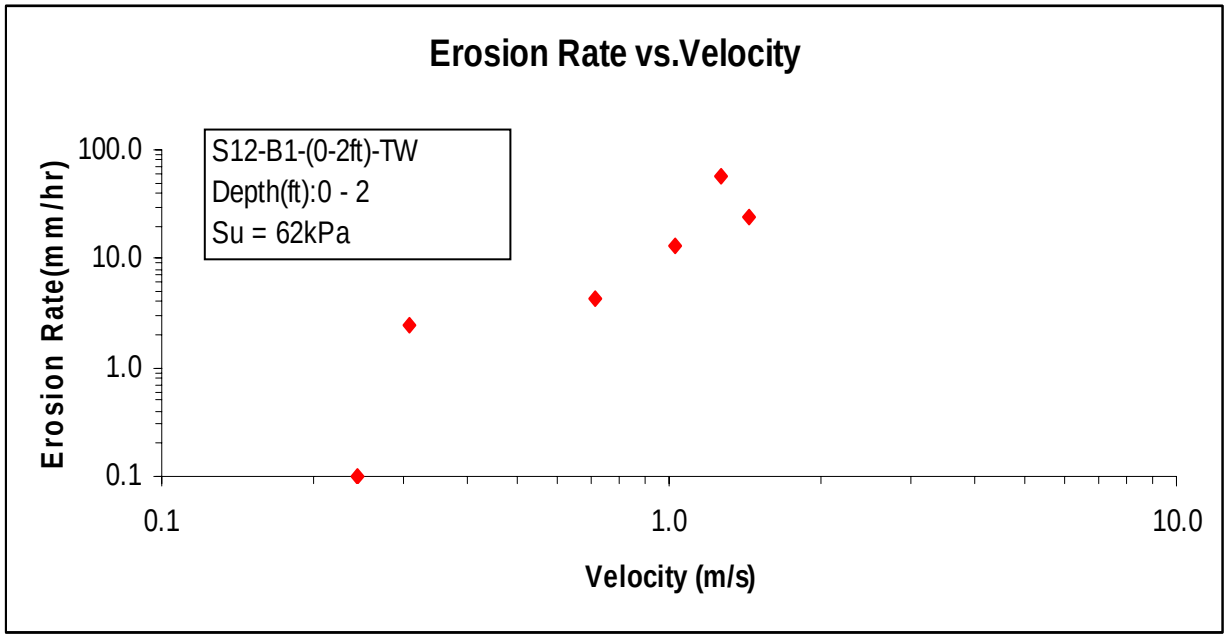




EFA Test Results for Sample No. S12-B1-(0-2ft)-TW

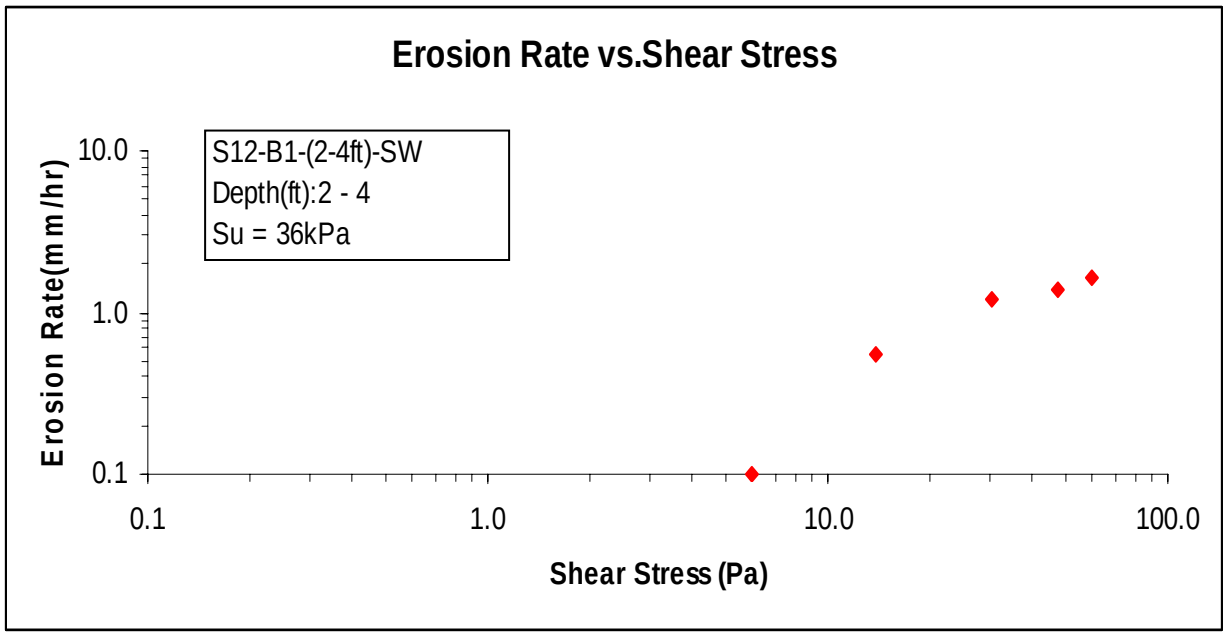
Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

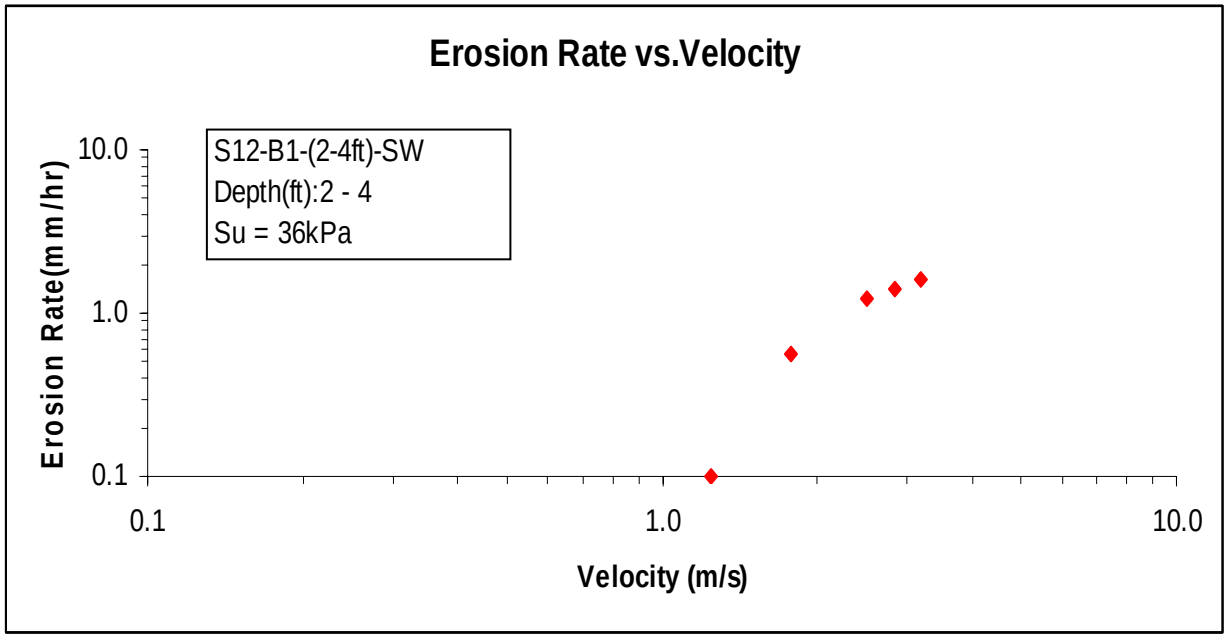




EFA Test Results for Sample No. S12-B1-(2-4ft)-SW

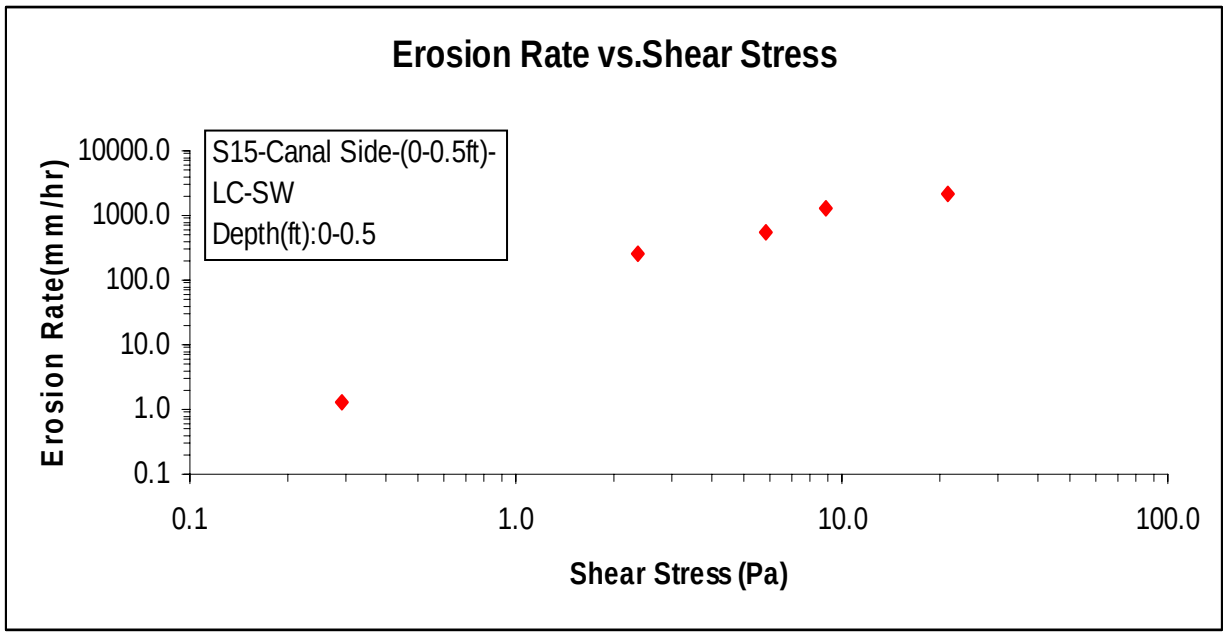
Sample Type: Shelby Tube
Water Salinity: 36.0 PPT (Salt Water)
Compaction Effort: N/A

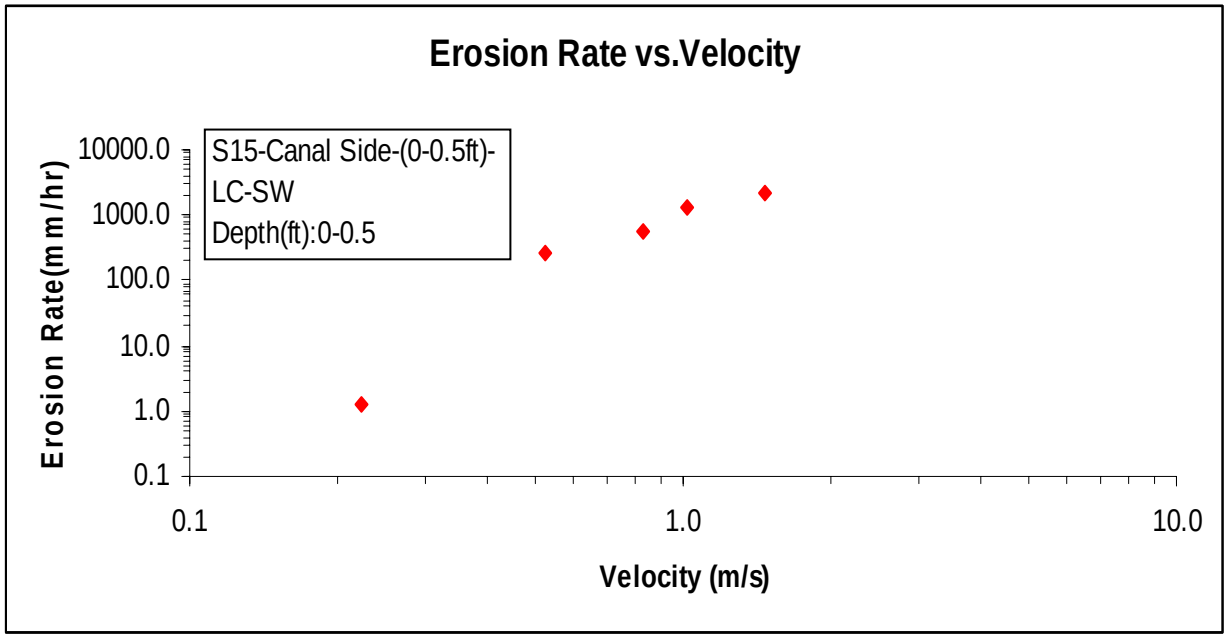




EFA Test Results for Sample No. S15-Canal Side-(0-0.5ft)-LC-SW

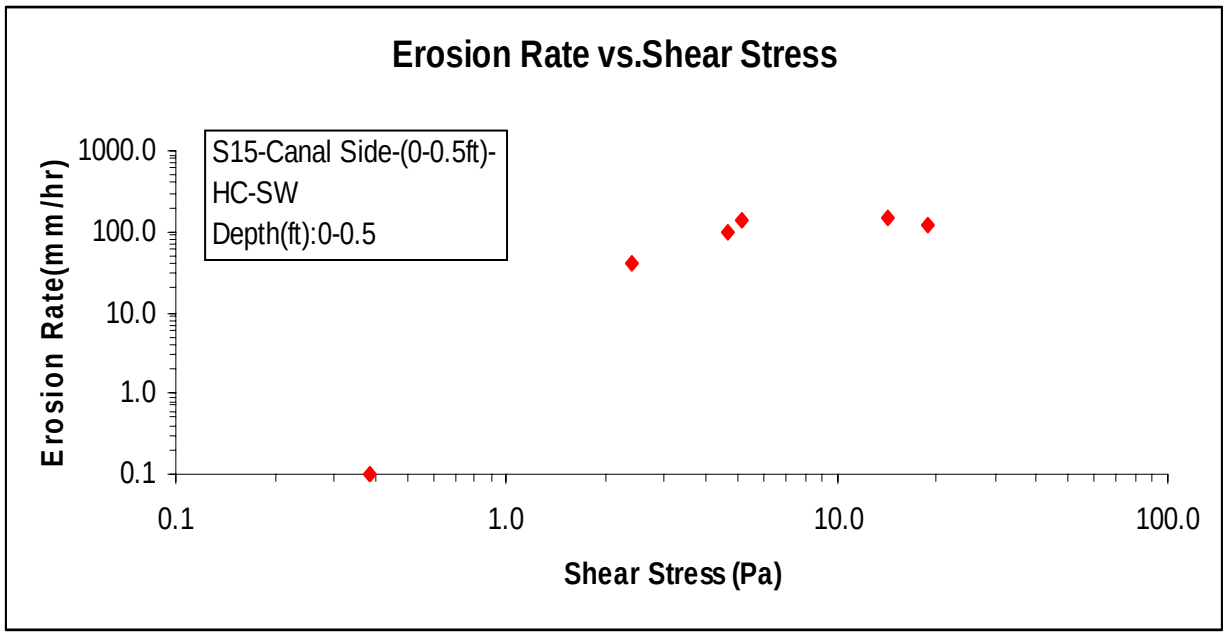
Sample Type: Bulk Sample
Water Salinity: 36.4 PPT (Salt Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction

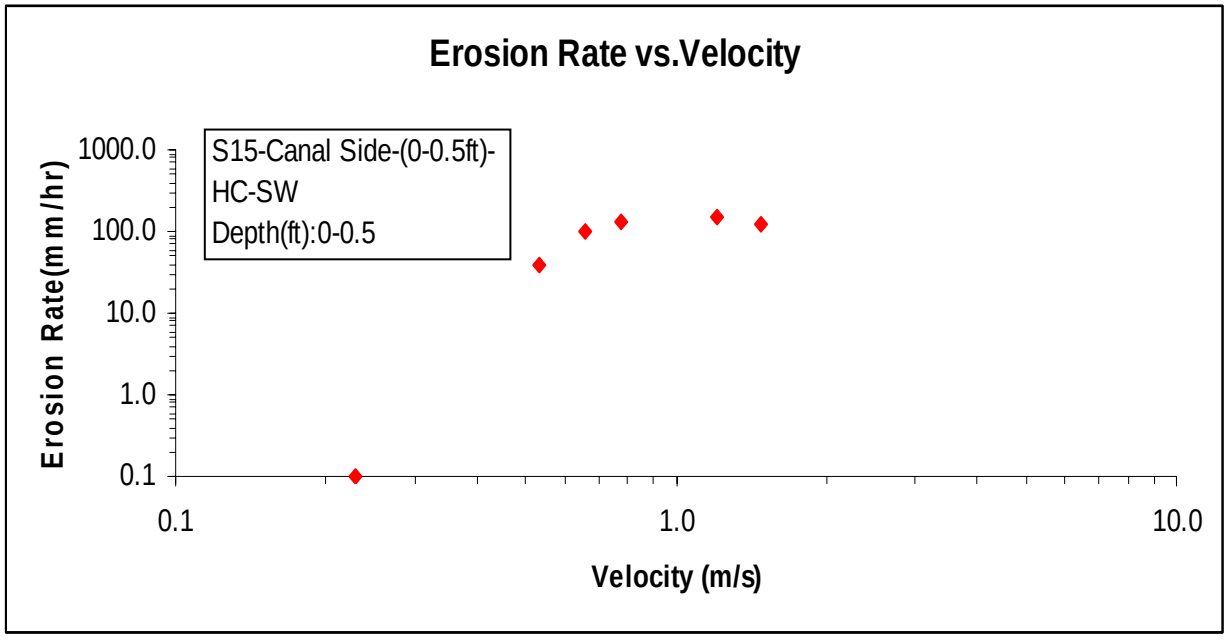




EFA Test Results for Sample No. S15-Canal Side-(0-0.5ft)-HC-SW

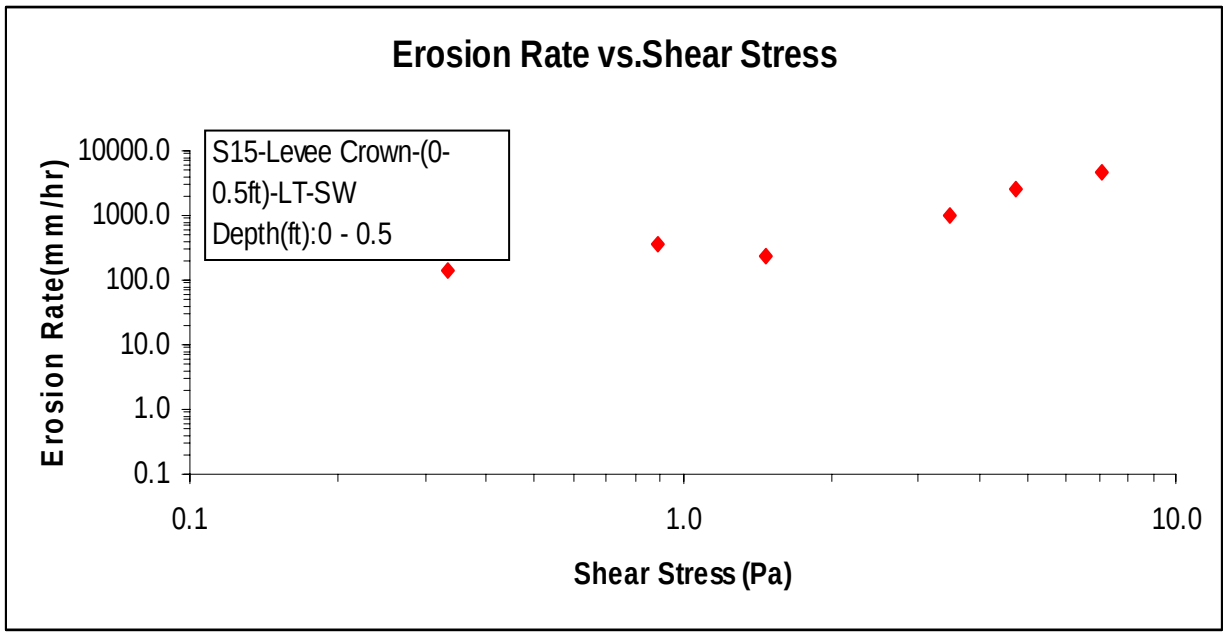
Sample Type: Bulk Sample
Water Salinity: 36.5 PPT (Salt Water)
Compaction Effort: High = 100% Modified Proctor Compaction

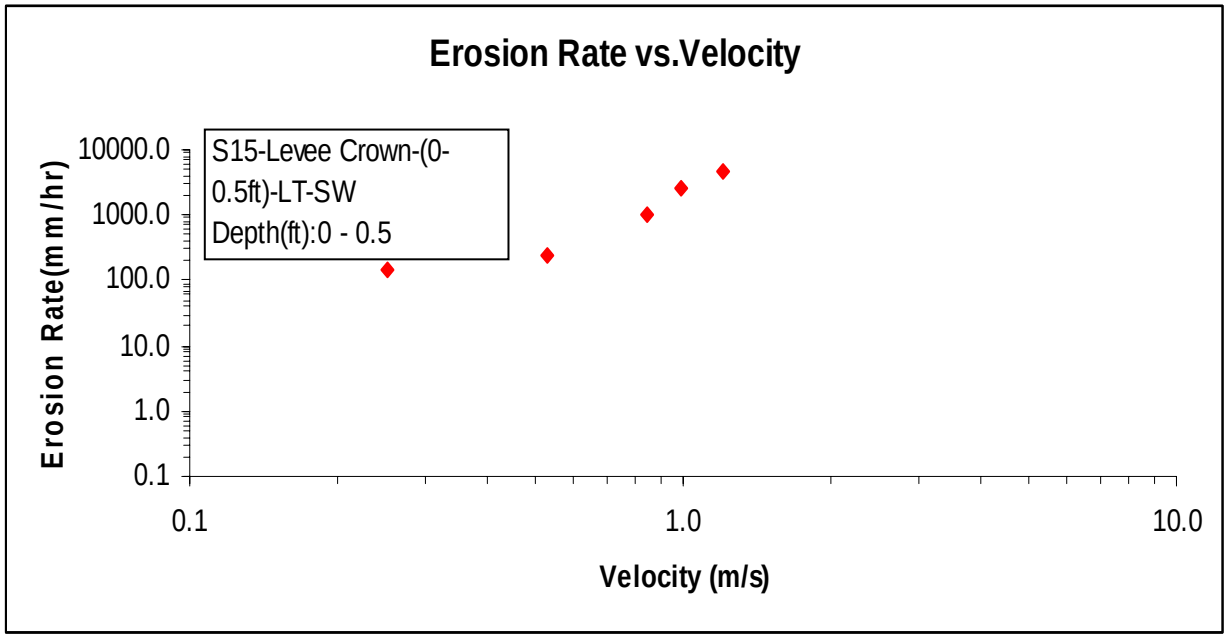




EFA Test Results for Sample No. S15-Levee Crown-(0-0.5ft)-LT-SW

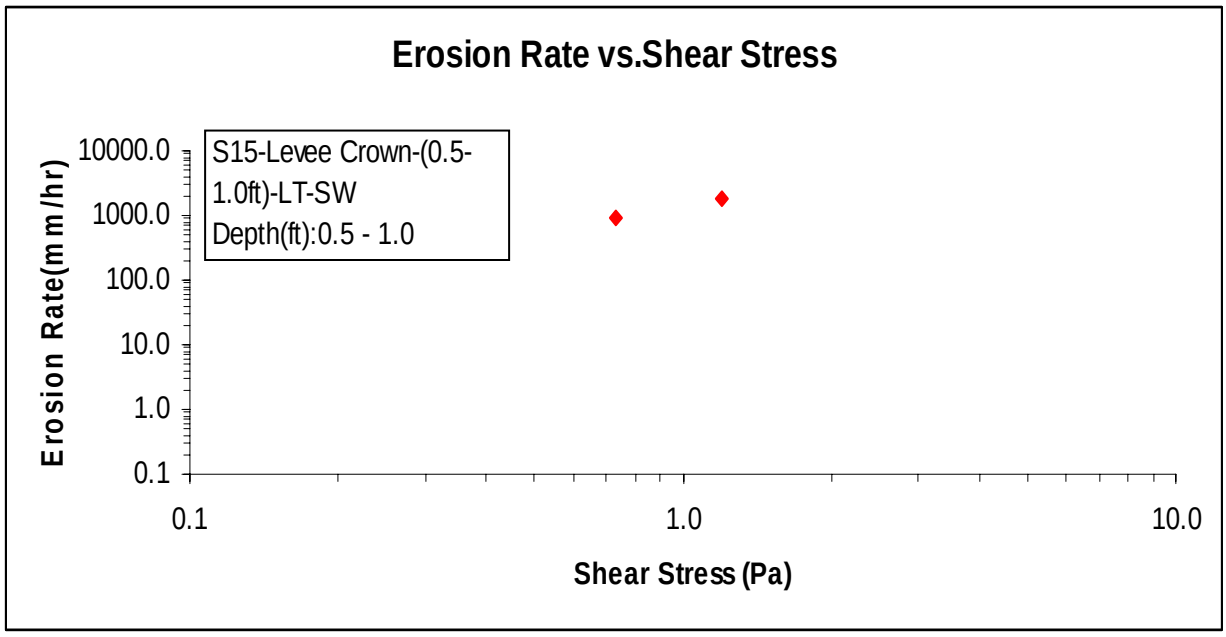
Sample Type: Bulk Sample
Water Salinity: 36.7 PPT (Salt Water)
Compaction Effort: Light Tamping

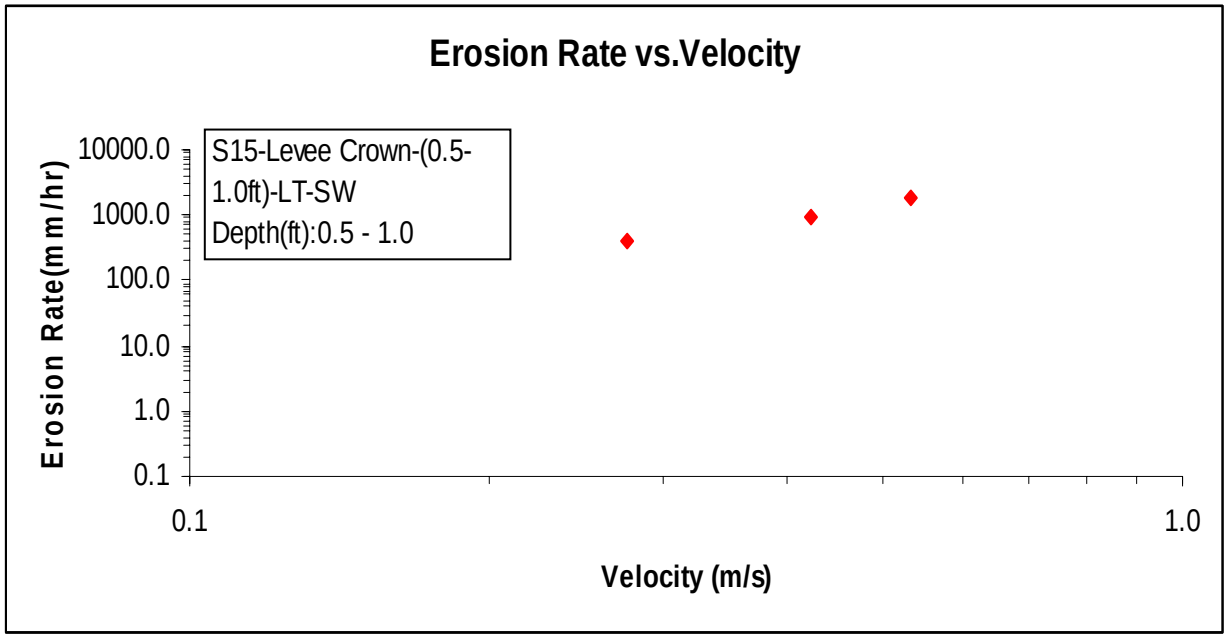




EFA Test Results for Sample No. S15-Levee Crown-(0.5-1.0ft)-LT-SW

Sample Type: Bulk Sample
Water Salinity: 35.9 PPT (Salt Water)
Compaction Effort: Light Tamping

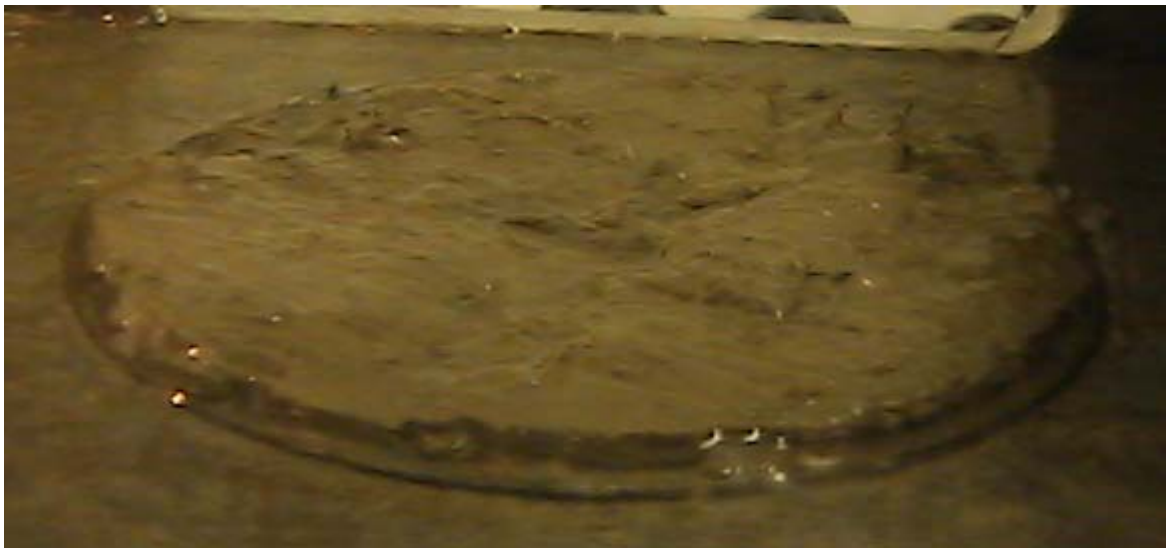




PHOTOS OF THE SAMPLES

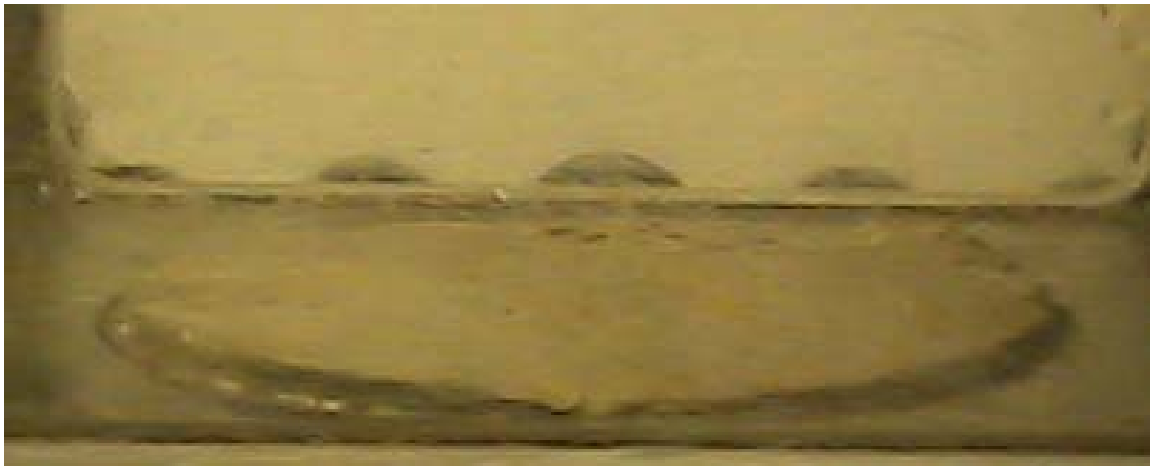
EFA Test Results for Sample No. S1-B1-(2-4ft)-SW

Sample Type: Shelby Tube
Water Salinity: 35.6 PPT (Salt Water)
Compaction Effort: N/A



EFA Test Results for Sample No. S2-B1-(2-4ft)-SW

Sample Type: Shelby Tube
Water Salinity: 36.9 PPT (Salt Water)
Compaction Effort: N/A



EFA Test Results for Sample No. S3-B1-(2-4ft)-SW

Sample Type: Shelby Tube
Water Salinity: 35.8 PPT (Salt Water)
Compaction Effort: N/A

EFA Test Results for Sample No. S5-(0-0.5ft)-LT-SW

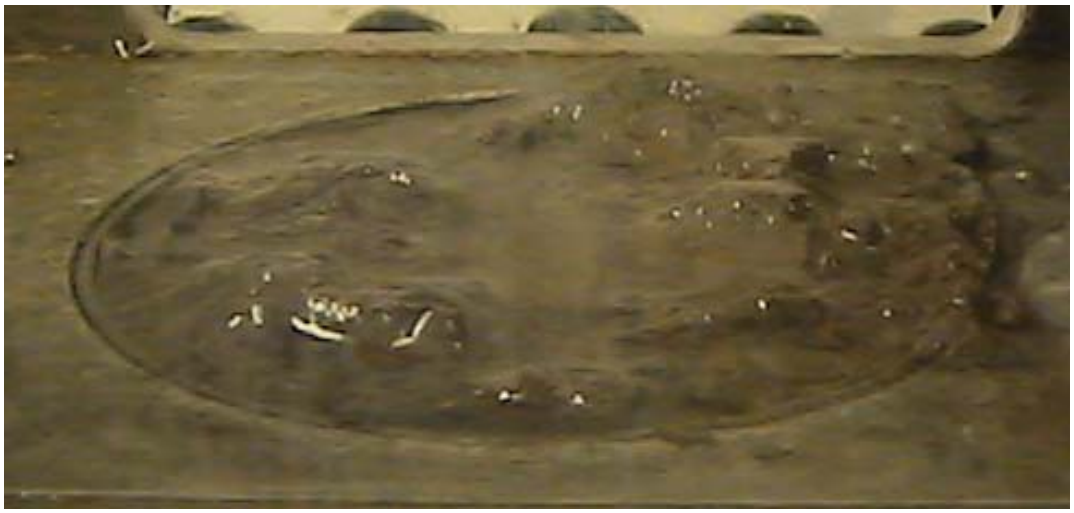
Sample Type: Bulk Sample
Water Salinity: 36.2 PPT (Salt Water)
Compaction Effort: Light Tamping

EFA Test Results for Sample No. S6-(0-0.5ft)-LC-SW

Sample Type: Bulk Sample
Water Salinity: 36.5 PPT (Salt Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction

EFA Test Results for Sample No. S7-B1-(2-4ft)-SW

Sample Type: Shelby Tube
Water Salinity: 36.9 PPT (Salt Water)
Compaction Effort: N/A



EFA Test Results for Sample No. S8-B1-(0-2ft)-TW

Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

EFA Test Results for Sample No. S11-(0-0.5ft)-LC-TW

Sample Type: Bulk Sample
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction

EFA Test Results for Sample No. S12-B1-(0-2ft)-TW

Sample Type: Shelby Tube
Water Salinity: 0.4 PPT (Tap Water)
Compaction Effort: N/A

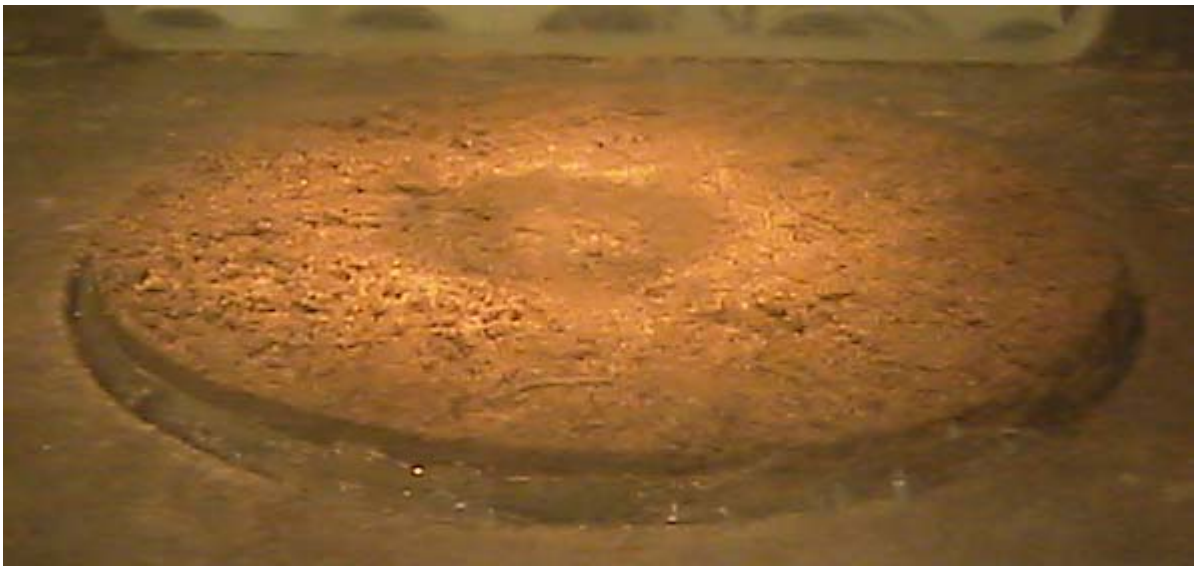
EFA Test Results for Sample No. S12-B1-(2-4ft)-SW

Sample Type: Shelby Tube
Water Salinity: 36.0 PPT (Salt Water)

Compaction Effort: N/A

EFA Test Results for Sample No. S15-Canal Side-(0-0.5ft)-LC-SW

Sample Type: Bulk Sample
Water Salinity: 36.4 PPT (Salt Water)
Compaction Effort: Low = 1.6% Modified Proctor Compaction



EFA Test Results for Sample No. S15-Canal Side-(0-0.5ft)-HC-SW

Sample Type: Bulk Sample
Water Salinity: 36.5 PPT (Salt Water)

Compaction Effort: High = 100% Modified Proctor Compaction

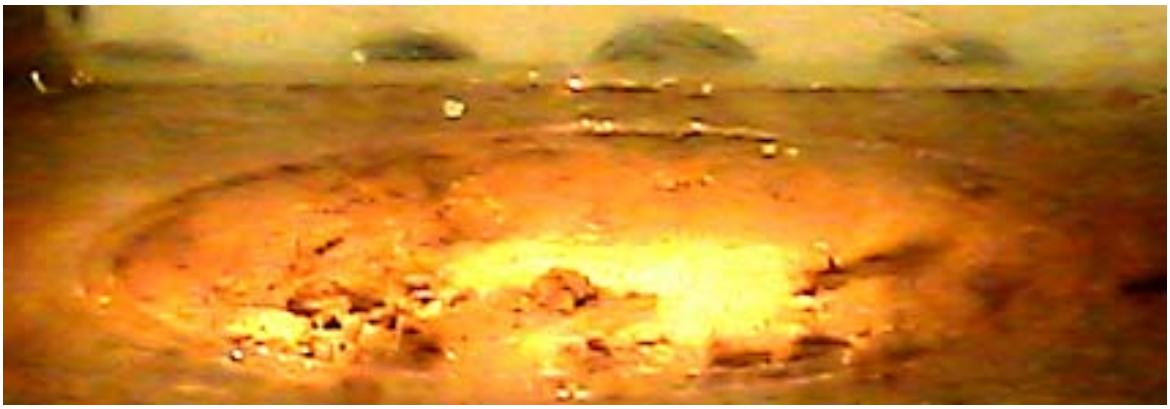
EFA Test Results for Sample No. S15-Levee Crown-(0-0.5ft)-LT-SW

Sample Type: Bulk Sample
Water Salinity: 36.7 PPT (Salt Water)
Compaction Effort: Light Tamping

EFA Test Results for Sample No. S15-Levee Crown-(0.5-1.0ft)-LT-SW

Sample Type: Bulk Sample
Water Salinity: 35.9 PPT (Salt Water)

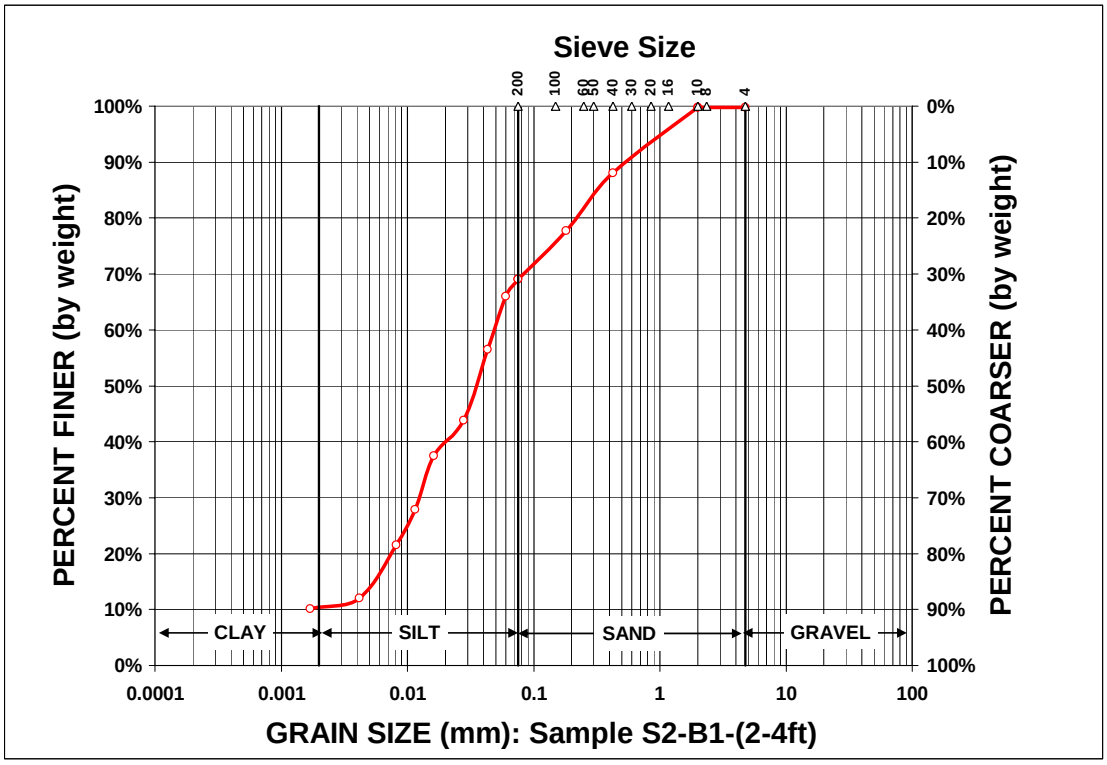
Compaction Effort: Light Tamping

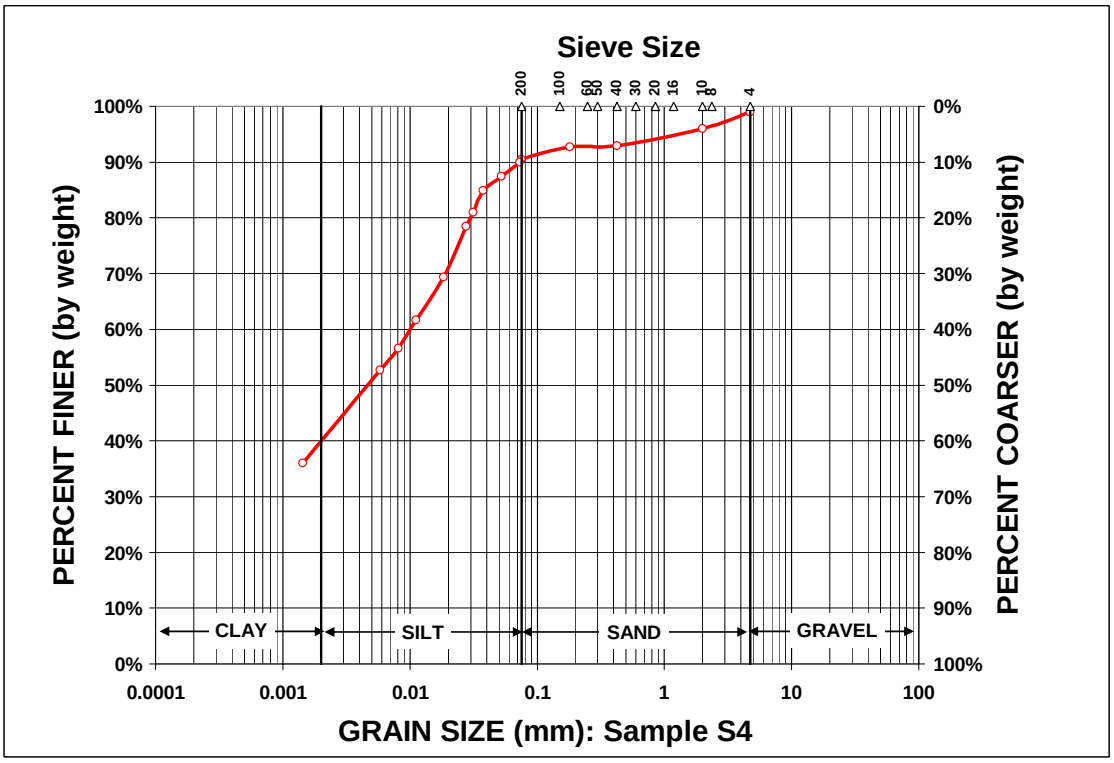


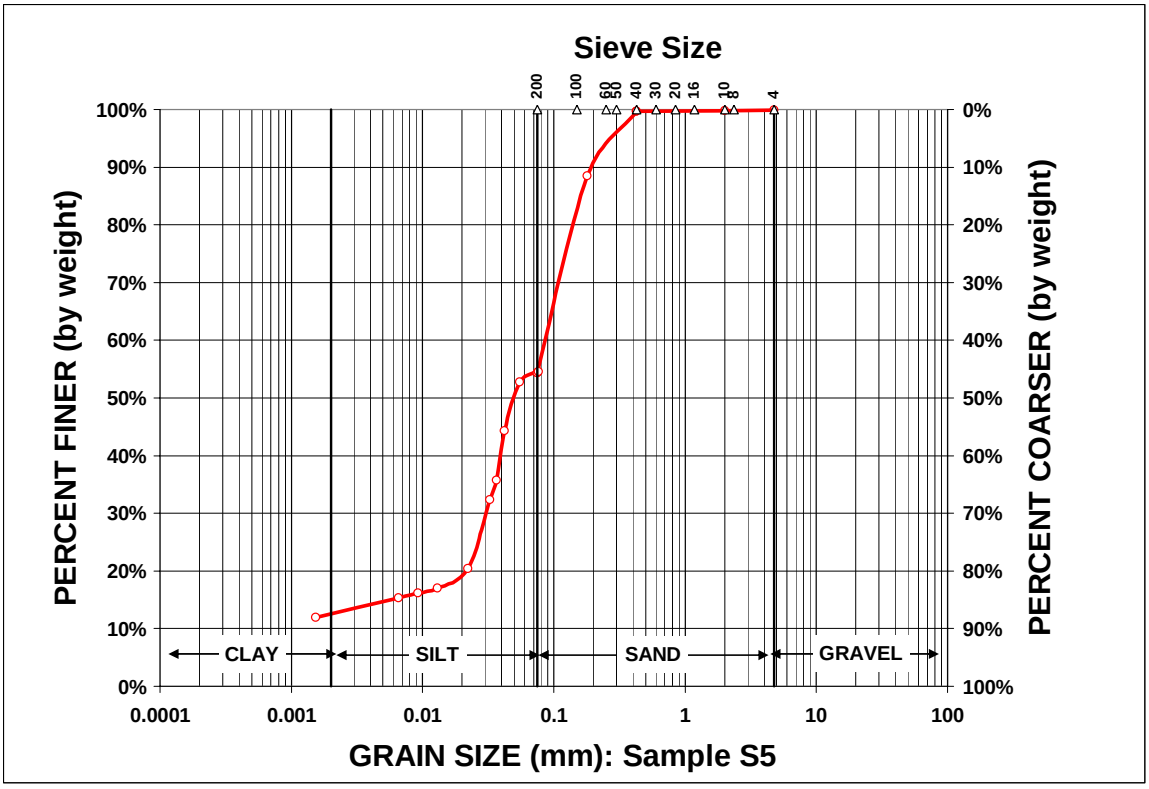
INDEX PROPERTIES OF SOIL SAMPLES

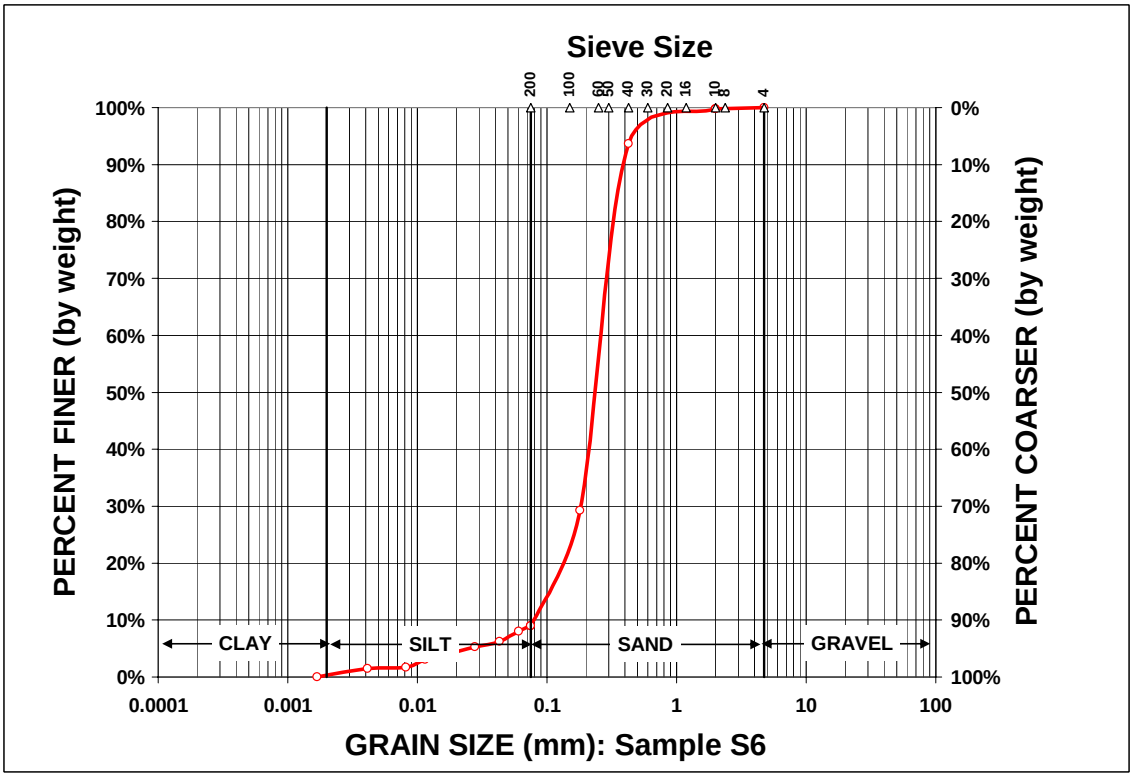
Sample	Soil Description	Classification	γ_t (kN/m3)	γ_{dry} (kN/m3)	w (%)	Tested at Texas A&M University					Tests Performed by STE			
						% fines	LL	PL	PI	Organic Content%	% fines	LL	PL	PI
S1-B1-(0-2ft)-TW	Clay with hard clay grain mixture	CH	20.23	15.37	31.66	-	71	25	46	3.09	89.9	65	22	43
S1-B1-(2-4ft)-SW	Clay with rootlets	CH	19.10	15.69	21.77	-	56	19	37	1.91				
S2-B1-(0-2ft)-TW	Clay with rootlets	CL	19.74	17.00	16.11	-	46	17	29	16.94	67.2	49	17	32
S2-B1-(2-4ft)-SW	Clay	CL	20.26	16.71	21.23	69.1	41	16	25	1.62				
S3-B1-(2-4ft)-SW	Clay	CL-CH	17.60	13.86	27.00	-	48	17	31	2.50	90.3	54	19	35
S3-B2-(0-2ft)-SW	Clay with some sand	CH	20.20	17.26	31.66	-	69	23	46	-				
S3-B3-(0-1ft)-SW	Clay	CL-CH	17.16	13.95	23.00	-	32	12	20	2.60				
S4-(0-0.5ft)-LC-SW	Clat with some sand	CL	13.87	10.42	33.14	90.5	60	30	30	8.16	-	-	-	-
S4-(0-0.5ft)-HC-SW	Clay with some sand		17.69	13.23	33.14									
S5-(0-0.5ft)-LT-SW	Silt-Clay		21.85	18.15	20.40	54.4	-	-	-	0.69	-	-	-	-
S6-(0-0.5ft)-LC-SW	Sand w/Some Clay	SP	13.45	12.79	5.21	8.9	-	-	-	0.71				
S7-B1-(0-2ft)-TW	Clay	CH	17.39	13.73	26.65	-	68	24	44	3.78	90.1	78	32	46
S7-B1-(2-4ft)-SW	Clay with hard clay grain mixture	CH	16.52	13.42	23.04	-	-	-	-	7.14				
S8-B1-(0-2ft)-TW	Clay with 1.5" thick grass on top of sample	CH	17.71	13.38	32.34	-	-	-	-	-	97.3	85	36	49
S8-B1-(2-4ft)-L1-SW	Clay with 2 layers	CH	18.74	14.00	33.87	-	-	-	-	2.28				
S8-B1-(2-4ft)-L2-SW	Clay with 2 layers	CH	18.74	14.00	33.87	-	54	21	33	15.37				
S11-(0-0.5ft)-LC-TW	Sand	SP	12.30	12.23	1.02	0.1	-	-	-	0.32	-	-	-	-
S11-(0-0.5ft)-HC-TW	Sand	SP	13.26	13.12	1.02		-	-	-	0.35				
S12-B1-(0-2ft)-TW	Clay with decomposed wood	CH	14.77	10.19	44.94	-	67	27	40	16.91	92	67	21	46
S12-B1-(2-4ft)-SW	Clay	MH-CH	17.56	12.64	38.94	-	58	32	26	5.28				
S15-CanalSide-(0-0.5ft)-LC-SW	Sand w/Some Clay	SM	13.85	12.21	13.43	29.9	-	-	-	1.28	-	-	-	-
S15-CanalSide-(0-0.5ft)-HC-SW	Sand w/some clay		19.63	17.31	13.43		-	-	-					
S15-LeveeCrown-(0-0.5ft)-LT-SW	Sand w/Some Clay		13.29	11.94	11.29		-	-	-	2.16				
S15-LeveeCrown-(0.5-1ft)-LT-SW	Sand w/Some Clay		13.57	12.46	8.93		-	-	-	1.01				

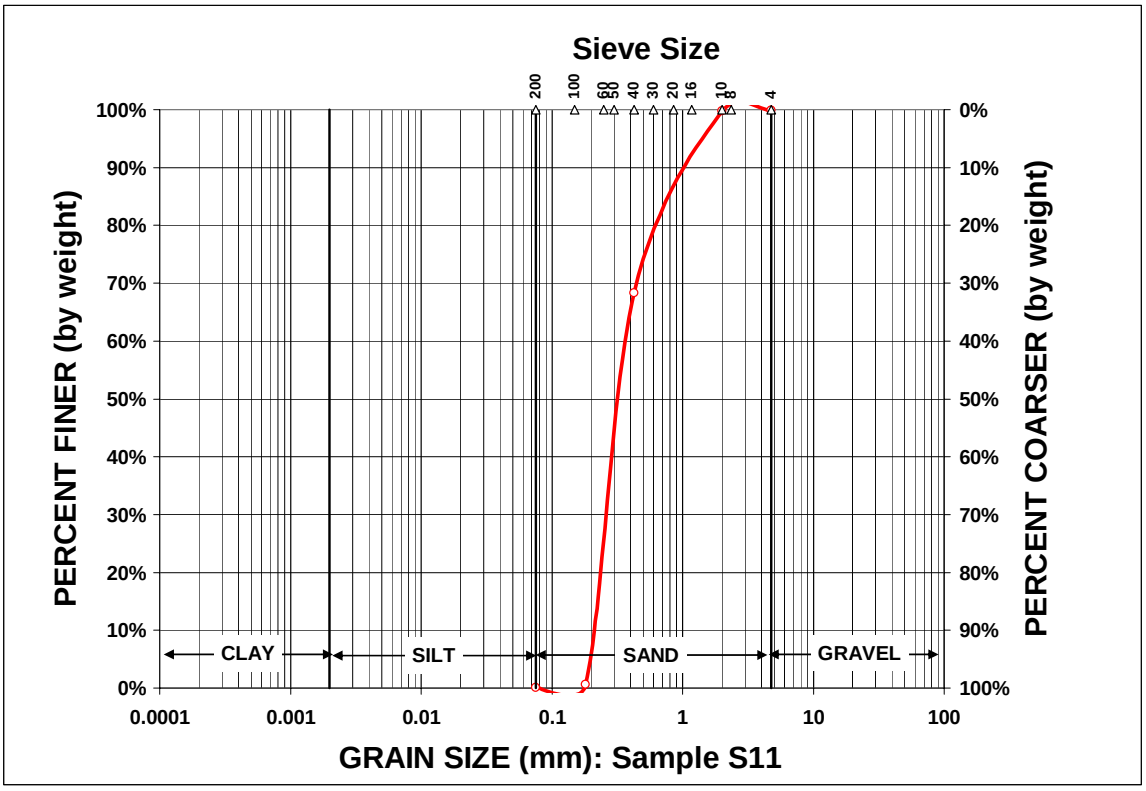
GRAIN SIZE ANALYSIS CARRIED OUT AT TEXAS A&M UNIVERSITY

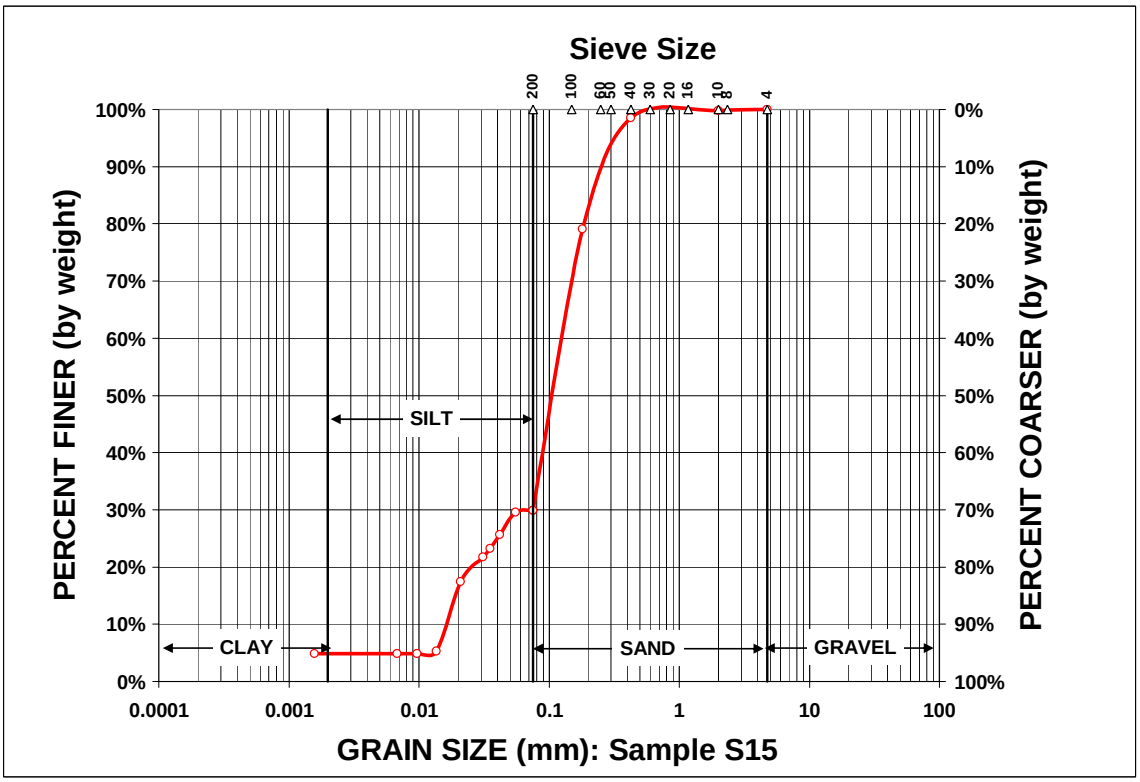




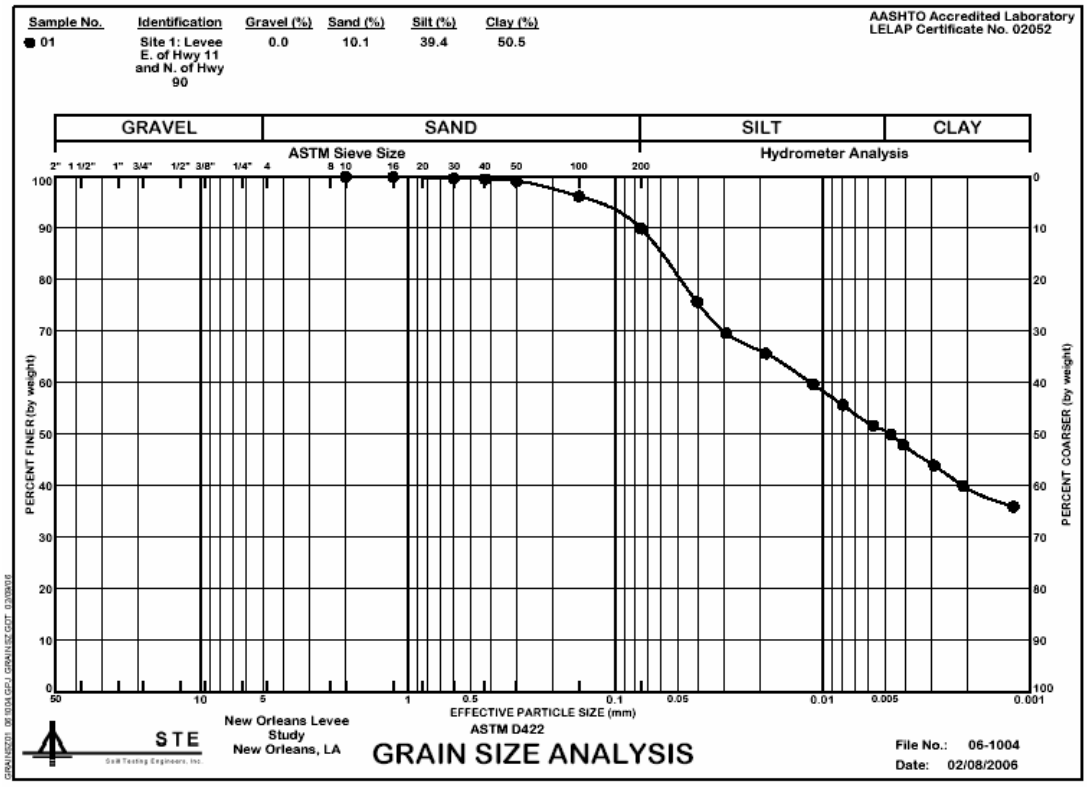

Sieve Size
200
100
60
50
40
30
20
16
10
8
4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
CLAY
SILT
SAND
GRAVEL
0.0001
0.001
0.01
0.1
1
10
100
GRAIN SIZE (mm): Sample S5

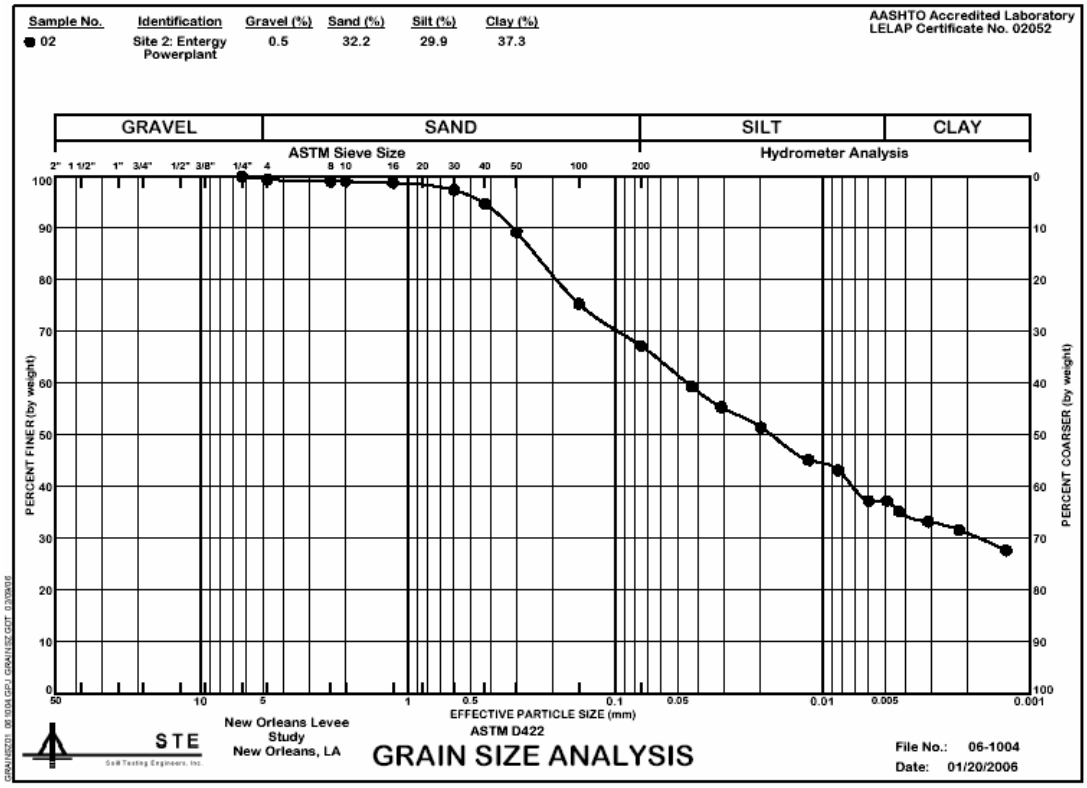

Sieve Size
200
100
60
50
40
30
20
16
10
8
4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
CLAY
SILT
SAND
GRAVEL
0.0001
0.001
0.01
0.1
1
10
100
GRAIN SIZE (mm): Sample S6

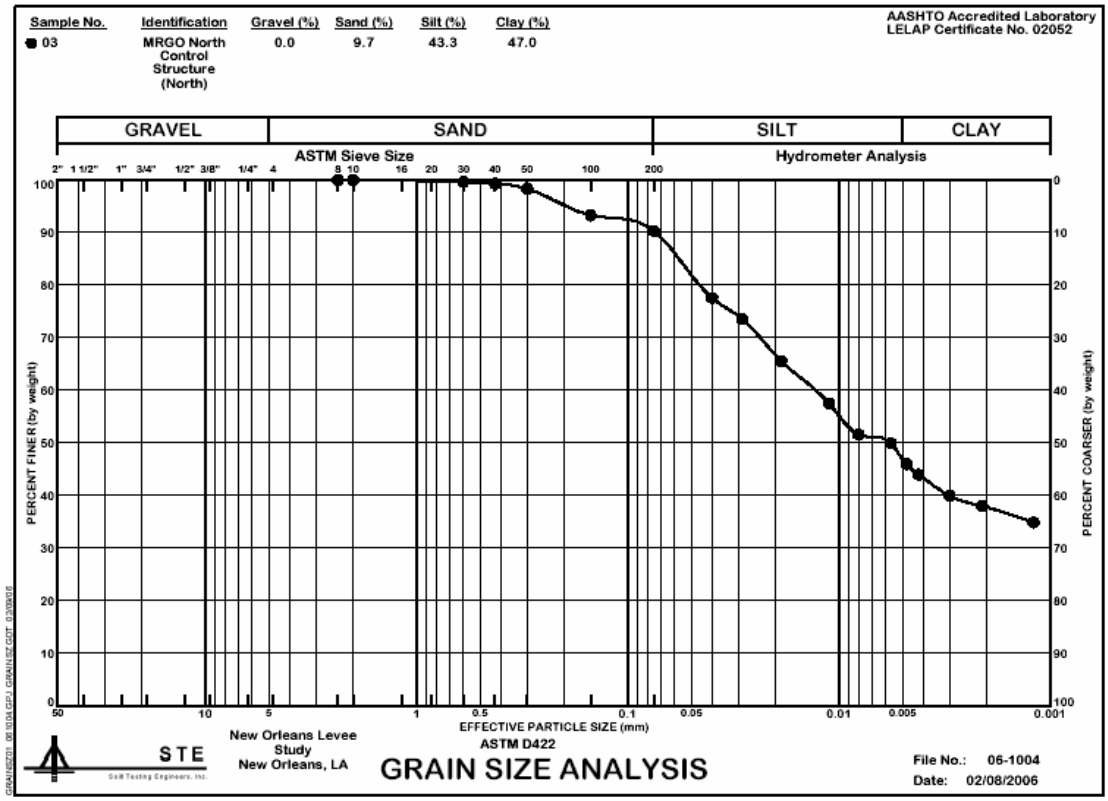

Sieve Size
200
100
60
50
40
30
20
16
10
8
4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
CLAY
SILT
SAND
GRAVEL
0.0001
0.001
0.01
0.1
1
10
100
GRAIN SIZE (mm): Sample S11

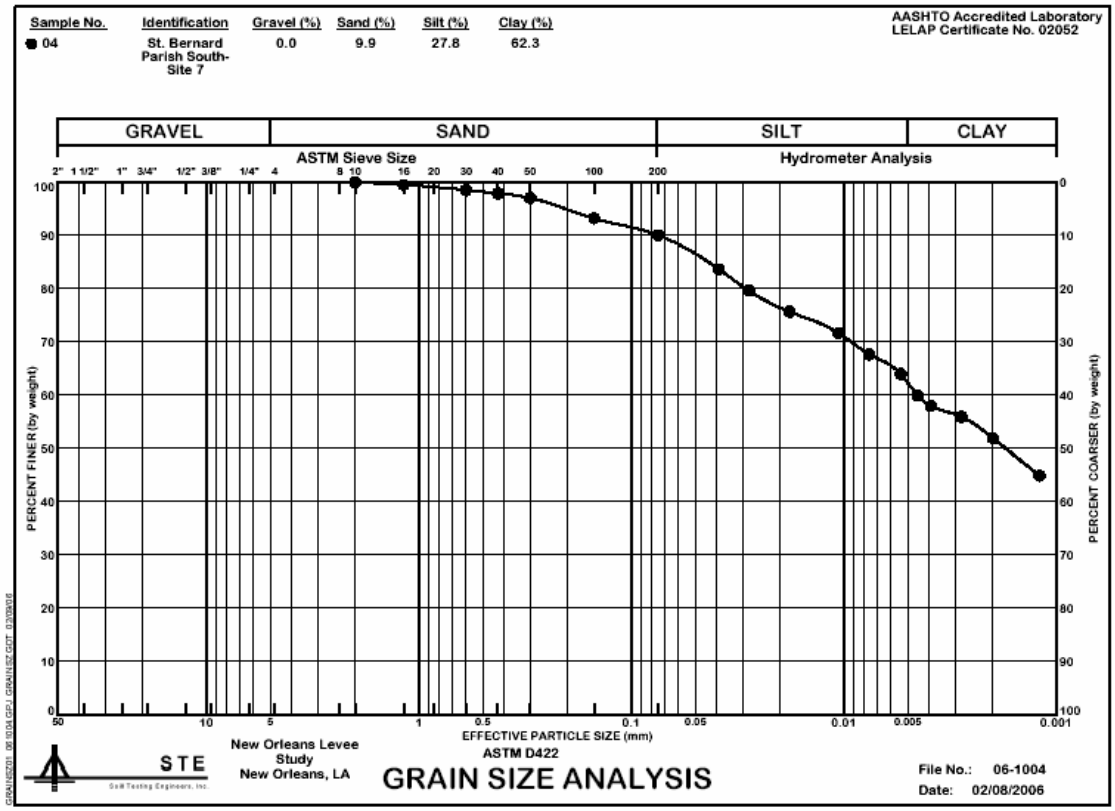

Sieve Size
200
100
60
50
40
30
20
16
10
8
4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
SILT
CLAY
SAND
GRAVEL
0.0001
0.001
0.01
0.1
1
10
100
GRAIN SIZE (mm): Sample S15

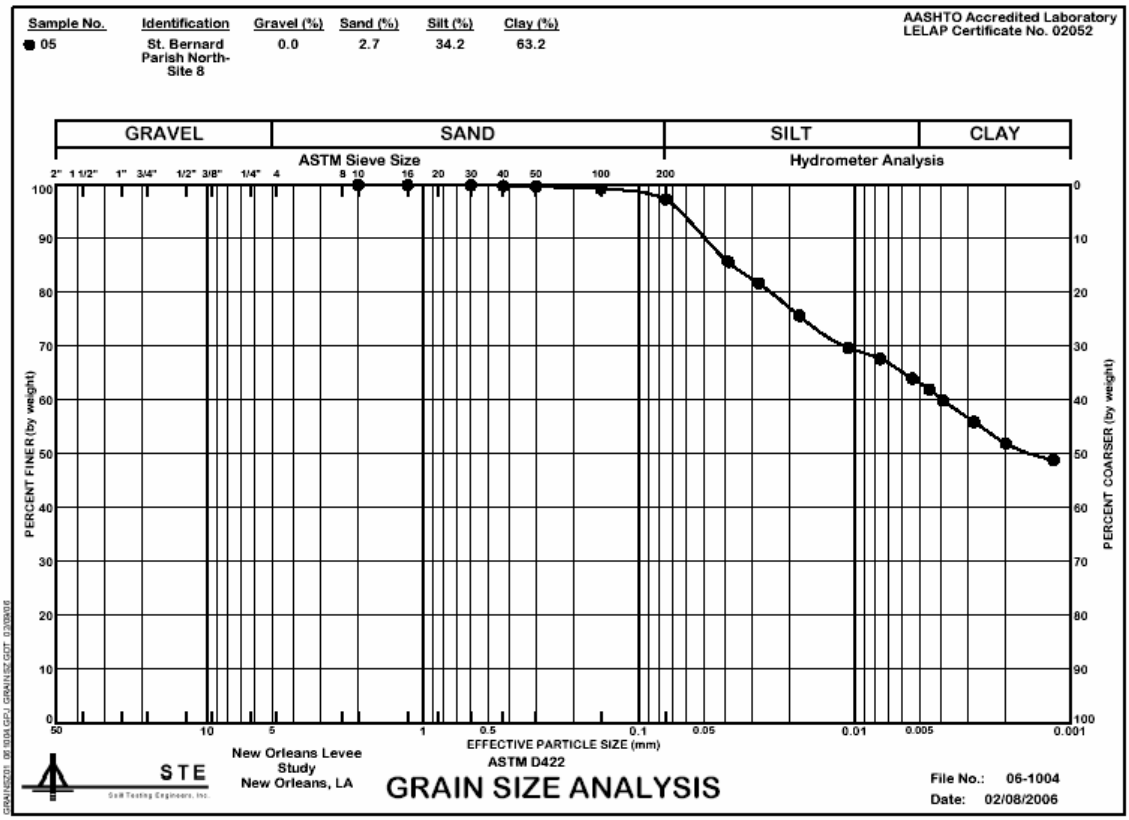
GRAIN SIZE ANALYSIS CARRIED OUT BY SOIL TESTING ENGINEERS, INC.




Sample No. 02
Identification: Site 2: Entergy Powerplant
Gravel (%): 0.5
Sand (%): 32.2
Silt (%): 29.9
Clay (%): 37.3
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
ASTM D422
New Orleans Levee Study
New Orleans, LA
GRAIN SIZE ANALYSIS
File No.: 06-1004
Date: 01/20/2006


Sample No. 03
Identification: MRGO North Control Structure (North)
Gravel (%): 0.0
Sand (%): 9.7
Silt (%): 43.3
Clay (%): 47.0
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
ASTM D422
New Orleans Levee Study
New Orleans, LA
GRAIN SIZE ANALYSIS
File No.: 06-1004
Date: 02/08/2006


Sample No. Identification Gravel (%) Sand (%) Silt (%) Clay (%)
04 St. Bernard Parish South-Site 7 0.0 9.9 27.8 62.3
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
ASTM D422
New Orleans Levee Study
New Orleans, LA
GRAIN SIZE ANALYSIS
File No.: 06-1004
Date: 02/08/2006


Sample No. Identification Gravel (%) Sand (%) Silt (%) Clay (%)
05 St. Bernard Parish North-Site 8 0.0 2.7 34.2 63.2
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
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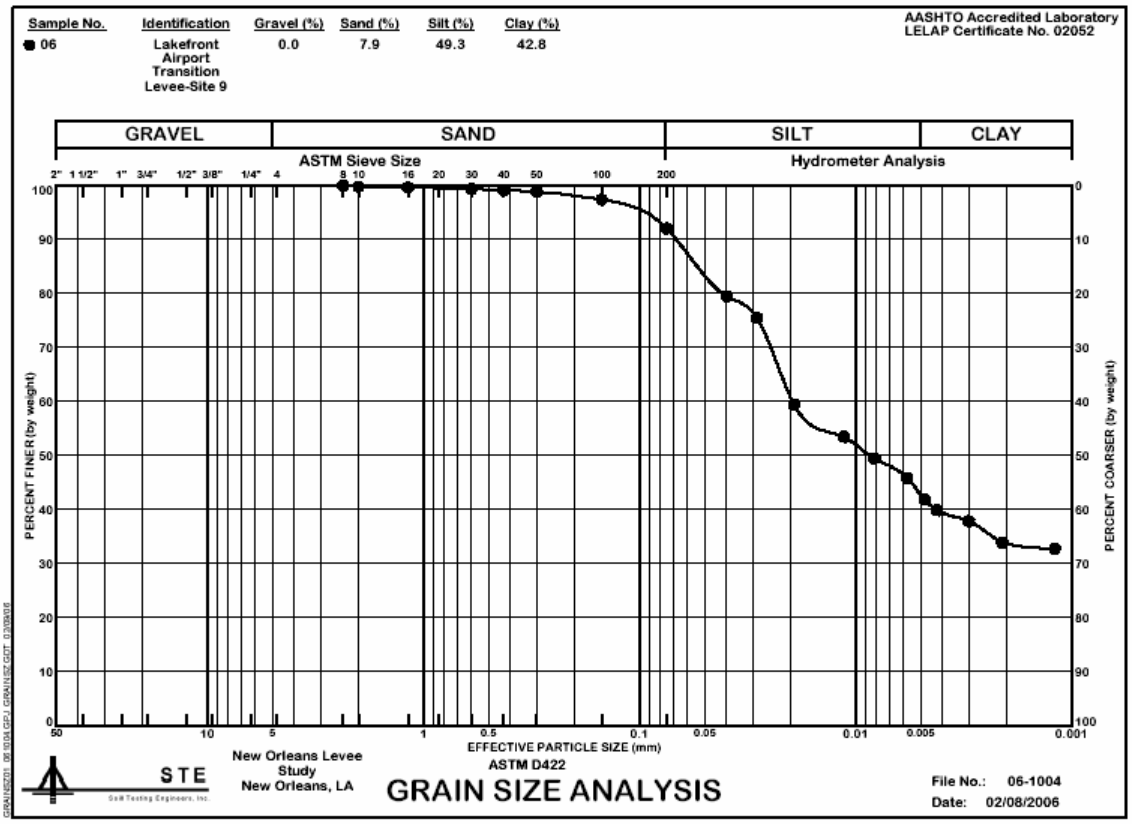
Sample No. 06
Identification: Lakefront Airport Transition Levee-Site 9
Gravel (%): 0.0
Sand (%): 7.9
Silt (%): 49.3
Clay (%): 42.8
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
ASTM D422
New Orleans Levee Study
New Orleans, LA
GRAIN SIZE ANALYSIS
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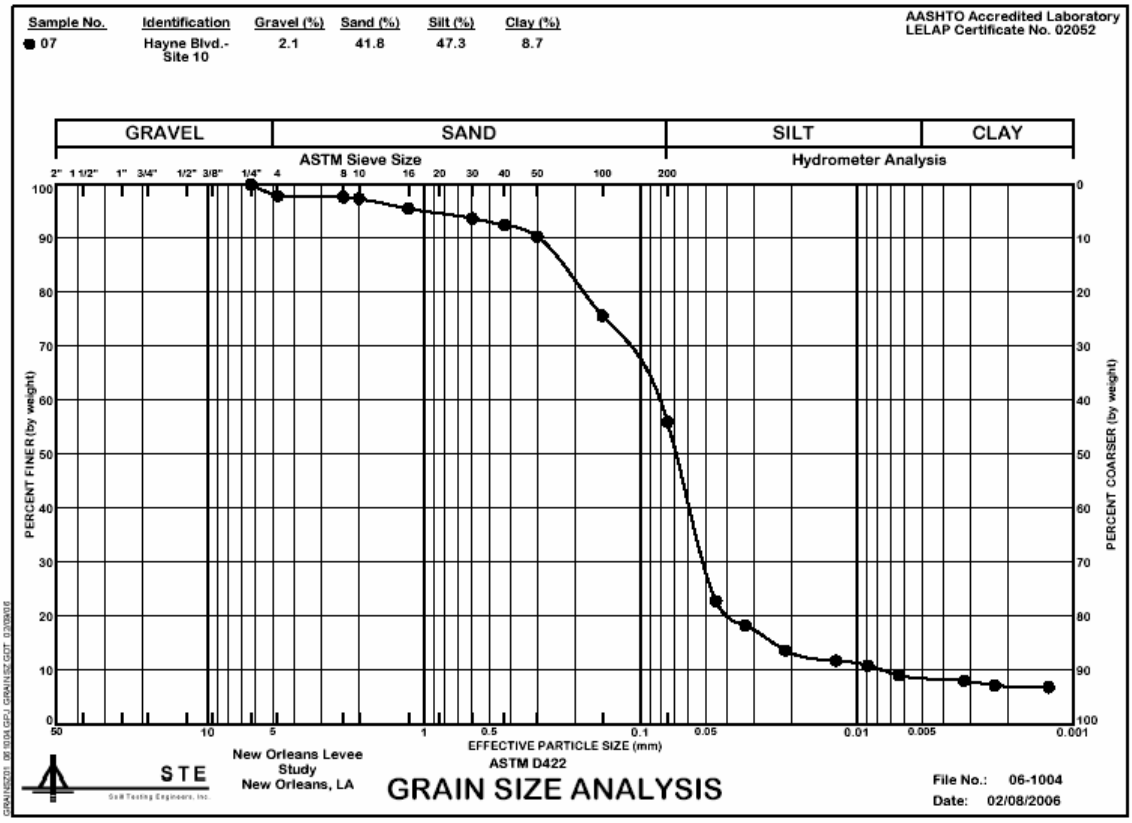
Sample No. 07
Identification: Hayne Blvd.- Site 10
Gravel (%): 2.1
Sand (%): 41.8
Silt (%): 47.3
Clay (%): 8.7
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
ASTM D422
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Sample No.	Identification	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
08	Site 12- Orleans East, Southeast RR Transition	0.0	8.0	33.2	58.8

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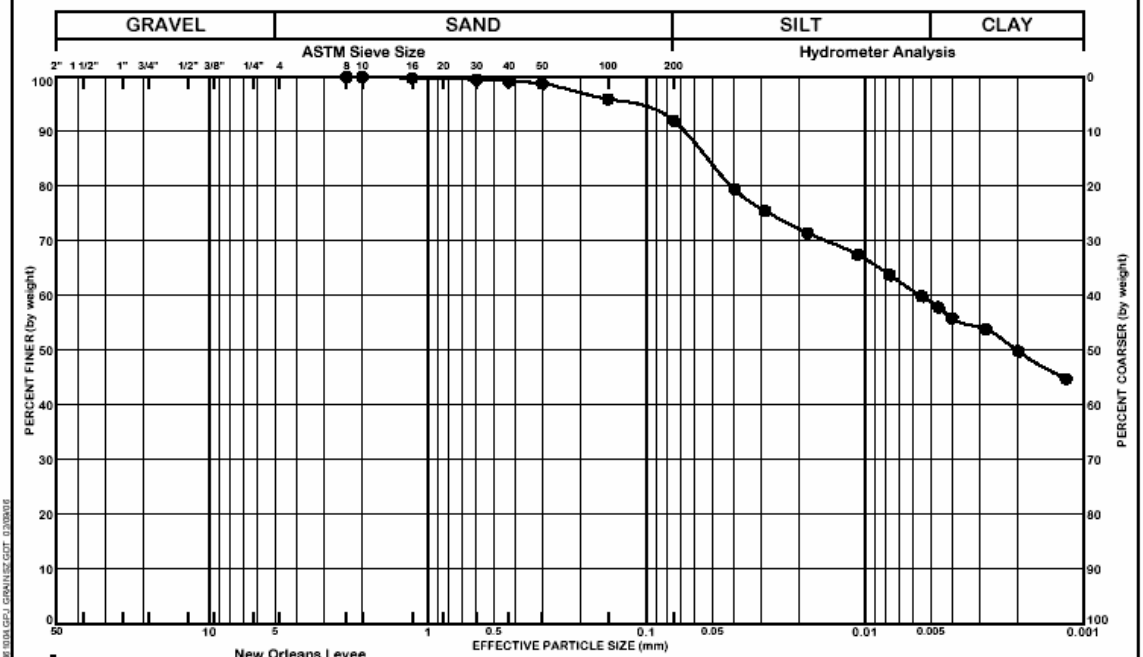

STE Soil Testing Engineers, Inc.

New Orleans Levee Study
New Orleans, LA

ASTM D422

GRAIN SIZE ANALYSIS

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Sample No.	Identification	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
09	Levee West of Entergy Plant Site 16	0.0	25.5	36.0	38.4

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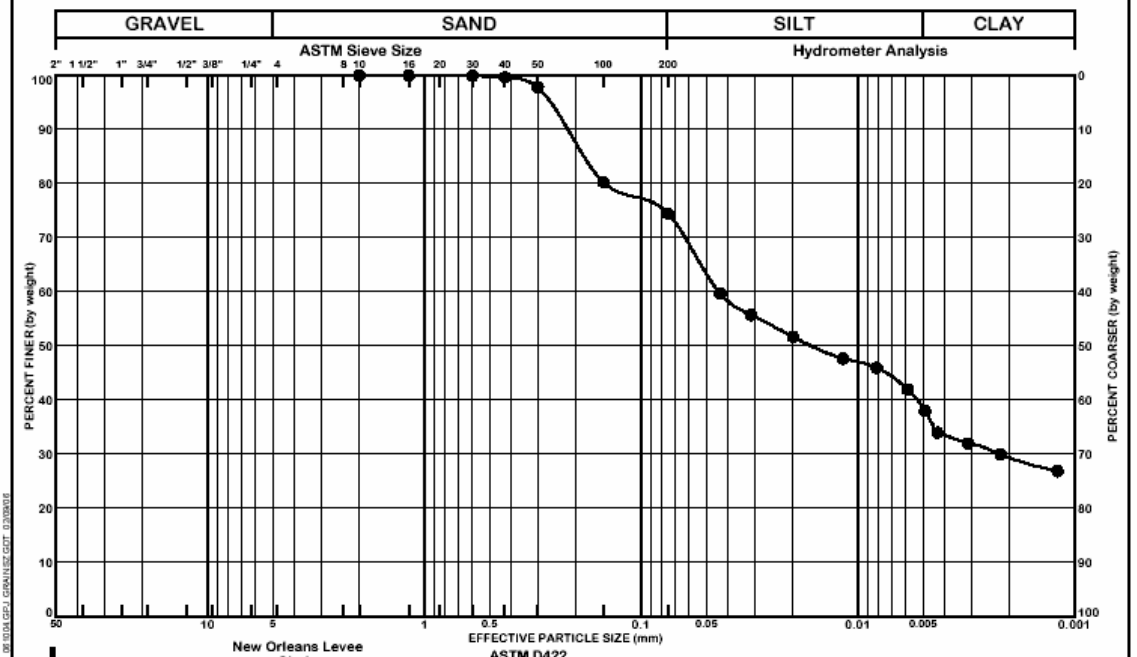

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New Orleans Levee Study
New Orleans, LA

ASTM D422

GRAIN SIZE ANALYSIS

File No.: 06-1004
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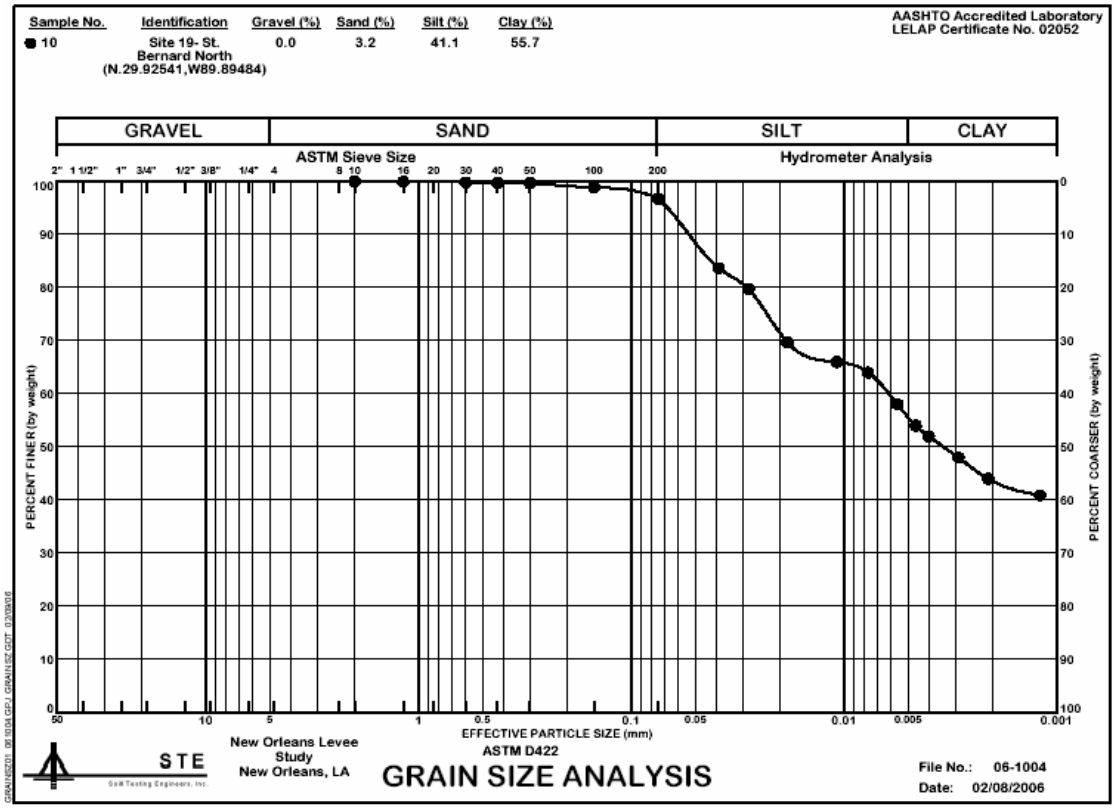
Sample No.
Identification
Gravel (%)
Sand (%)
Silt (%)
Clay (%)
10
Site 19- St. Bernard North (N.29.92541,W89.89484)
0.0
3.2
41.1
55.7
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
2" 1 1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 30 40 50 100 200
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
ASTM D422
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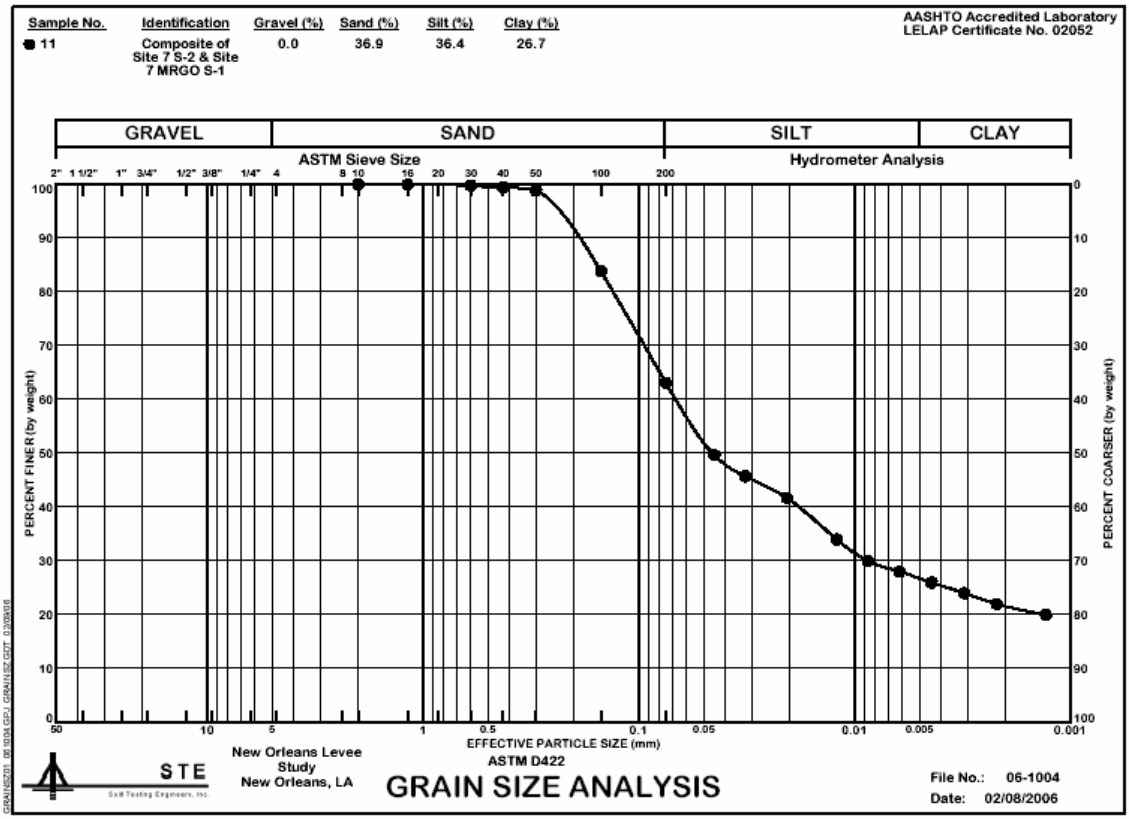
Sample No.
Identification
Gravel (%)
Sand (%)
Silt (%)
Clay (%)
11
Composite of Site 7 S-2 & Site 7 MRGO S-1
0.0
36.9
36.4
26.7
AASHTO Accredited Laboratory
LELAP Certificate No. 02052
GRAVEL
SAND
SILT
CLAY
ASTM Sieve Size
Hydrometer Analysis
2" 1 1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 30 40 50 100 200
PERCENT FINER (by weight)
PERCENT COARSER (by weight)
EFFECTIVE PARTICLE SIZE (mm)
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