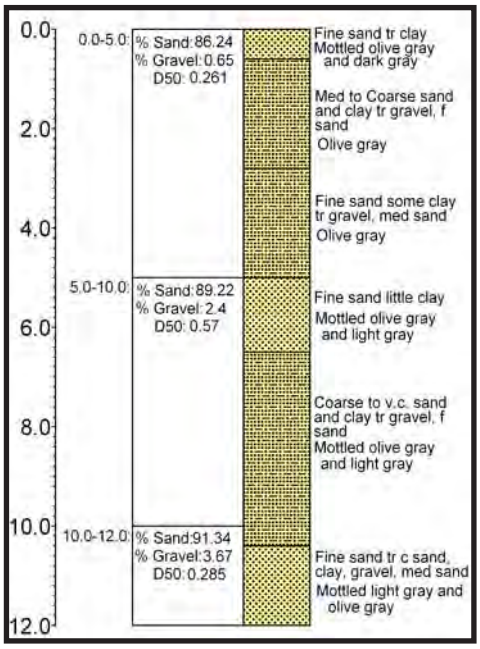
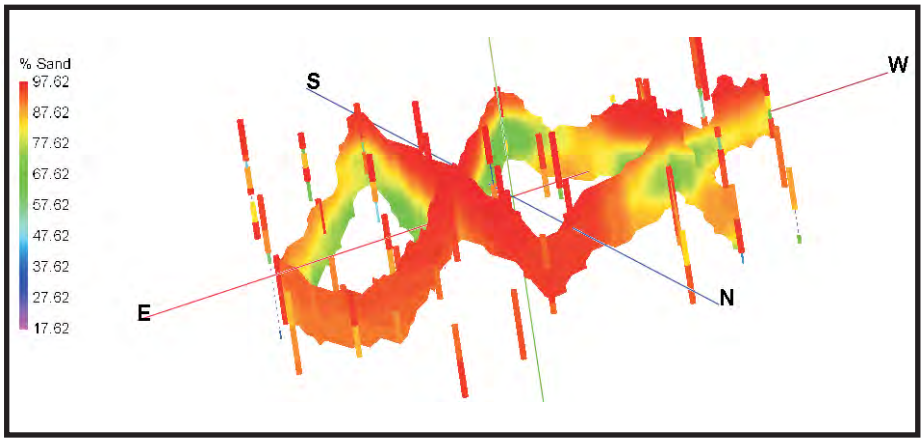
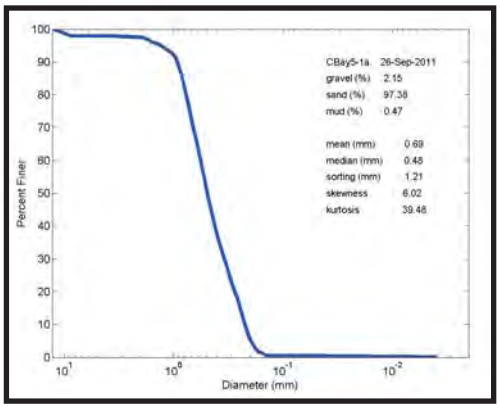
A Geotechnical Evaluation of Chesapeake Beach Shoal for Beach Quality Sand







Shoreline Studies Program
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December 2011

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Introduction

Chesapeake Beach Shoal is located along the southern coast of Chesapeake Bay in Virginia Beach, Virginia (Figure 1-1). Chesapeake Beach, which is nearly adjacent, has a history of chronic beach erosion which threatens upland infrastructure. Beach nourishment occurs on Ocean Park Beach to the east from intermittent dredging of Lynnhaven Inlet (Figure 1-2), but the effects do not always translate westward to Chesapeake Beach. The general alongshore sand movement is east to west. The purpose of this project is to establish a reliable source of beach sand for Chesapeake Beach via the nearshore shoal.

Many issues, including identifying the location and volume of suitable material, cost effectiveness, permitting requirements (marine habitat impacts) and impacts to the local wave climate, must be addressed before mining sand from offshore shoals. Permits for sand mining for beach nourishment in the Bay have been granted for the Buckroe and Factory Point areas, but extensive environmental assessments are required. First, the sand resource must be identified in order to develop a dredging/mining plan.

A single core, taken by VIMS in 1981(Hobbs *et al.*, 1981), showed that the first 20 feet of material in the subbottom was at least 97% sand (Figure 1-2). According to results from Hobbs *et al.* (1981), the surface sediments in Chesapeake Beach Shoal are mostly very fine grained silty-sands, grading to gray medium sand near the beach. The core shows a sand horizon starting at the beach which has an overburden of inorganic clays and silts that thickens to the north and west. However, a surface deposit has a thickness of between 7 and 20 ft and an estimated volume of material with an overfill ratio of less than 2.0 is about 3.0 million cubic yards (Hobbs *et al.*, 1981). According to the Army Corps of Engineers (1990) the average mean grainsize of the beach sands along Ocean Park is 0.35 mm (medium-grained). This analysis is no doubt influenced by recent beach fill projects. Hobbs *et al.* (1992) found the sediments in the nearshore to be between 0.2 mm and 0.35 mm.

This report focuses on the acquisition of short cores and site data in order to establish the extent of the sand resource and provide data for developing a sand-mining plan. Athena Technologies took 42 vibracores in August 2011. These were analyzed to determine grain size characteristics which would define the location and suitability of beach quality material in the nearshore off Chesapeake Beach. In addition, a selected storm wave was modeled to determine the effect of the proposed dredging in the nearshore.

Methods

Cores

Field Sampling

Athena deployed their 35 foot research vessel, *Artemis*, as the primary sampling platform. It utilized a Trimble DGPS (sub-meter accuracy) interfaced through HYPACK® and a Sitex CVS-106 fathometer (accurate to 0.1 ft) for basic horizontal and vertical positioning. Final elevations were derived using tidal data provided by the National Oceanic and Atmospheric Association (NOAA) for station 8638863, Chesapeake Bay Bridge Tunnel (http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8638863%20Chesapeake%20Bay%20Bridge%20Tunnel%20VA&cype=Tide%20Data).

The coordinates of the sample stations were provided to Athena by VIMS (Figure 1-2). A three-point anchoring system secured the vessel during the deployment of Athena's custom designed and built vibracoring system. This system consists of a mechanical vibrator attached directly to the sampler apparatus. The sample barrel was a three inch, 16 gauge steel tube. The sample barrel was lowered to the sea-floor through a moon pool in the deck by attaching lengths of drill stem. The vibrator was then turned on and drove the sample barrel until it reached the target depth or refusal. Jetting was required at station VIMS-37. This involved attaching a jet pump to the sample barrel and lowering it to the sea floor. The pump was then turned on and the sample barrel was advanced to one foot above the previously penetrated depth. The vibrator was then turned on driving the barrel further into the bottom. The sample barrel was then retrieved using an electric winch. Once the sample was on deck, the sample barrel was cut into five foot sections, capped, labeled, and measured.

A video camera recorded penetration as the vibracore system advanced into the bottom. The equipment is marked in half-foot increments, and advancement is determined in the office by calculating the amount of time passing for each one-foot interval of insertion.

The completed cores were opened, transferred to PVC pipe, wrapped in plastic wrap and then placed into heavy-duty plastic tubing. They were then transferred to VIMS for processing. (From "Field Sampling Methodologies Used for the Collection of Vibracore Samples Offshore of Virginia Beach, Virginia in the Vicinity of the Chesapeake Bay Bridge Tunnel," Athena Technologies, Inc. report, Appendix A)

Description and Sampling

At VIMS, each five foot section was opened and photographed in one-foot intervals on a 17% gray background (Appendix B). The sections then were systematically logged from top down (Appendix C). The descriptions included color, major and minor constituents, foreign/miscellaneous material, and soil types. Color was determined using the Geotechnical Gauge card manufactured by McCollough. Major and minor constituents specified grain size using the Wentworth Classification: very coarse sand (1.0-2.0 mm), coarse sand (0.50-1.0 mm), medium sand (.25-.50 mm), fine sand (0.125-0.25 mm), very fine sand (0.0625-0.125 mm), silt (0.0039-0.0625 mm), and clay (0-0.0039 mm). Minor constituents included the qualifiers trace (1-10%), little (10-20%), some (20-35%), and (35-50%). Foreign/miscellaneous material consisted of shell fragments, wood fragments, and organics. Unified Soil Classification System (USCS) soil types were assigned to the sediment. These included SP (poorly graded clean sand), SW (well graded clean sand), SM (silty sand), SC (clayey sand), ML (inorganic silts with v.f. sand or clay), and CL (inorganic clays with sand or silt). In addition, clays were described as very soft, soft, medium stiff, stiff, very stiff, or hard.

A channel sample collected down center of each section of core provided a representative sample. If a core section contained substantially different lenses of sediment, each was sampled separately. The sediment sample was homogenized. Samples were sent to the sediment lab to determine grain-size distribution. Sediments were sieved to determine percent gravel, sand, silt and clay (Appendix D). The sand fraction was analyzed with VIMS' Rapid Sediment Analyzer. These data were combined to calculate entire sample statistics, including the D50, using a custom Matlab® program created as per Blott and Pye's (2001) description of the arithmetic method of moments. Each sample's frequency curve and sample statistics are presented in Appendix D.

Data Compilation and Analysis

The program RockWorks, a software for downhole data by RockWare®, was used to store and analyze the core data. Information entered into RockWorks included location, sediment descriptions, color, soil type, sample statistics, and core photographs. 2D strip logs were created for each core depicting sediment description and color (Appendix C). Sample statistics of % gravel (>2 mm), % sand (2mm>sand<0.0625 mm), % silt (0.0625mm<silt>0.0039mm), % clay (<0.0039mm), total % fines (%silt + %clay) and total sand and gravel (%gravel + %sand) were used to generate models of the shoal depicting the location of acceptable material content (>90% material is sand and the D50 >0.25 mm). Because the channel samples had varying lengths down the core, the weighted mean was calculated with the individual

sample statistics of percent sand and gravel and the D50 in order to summarize the overall core statistics.

Nearshore Modeling

The Coastal Engineering Design & Analysis System (CEDAS) modeling system (Veri-tech, Inc., 2012) was used to model potential changes to waves due to dredging. It consist of the Nearshore Evolution MOdeling System (NEMOS) and STWAVE. NEMOS is a set of computer codes that operates as a system to simulate the long-term evolution of the planform of the beach in response to wave conditions, coastal structures, and other engineering activity (*e.g.*, beach nourishment). Within NEMOS, grids and spectral wave data are created for STWAVE . STWAVE uses a 2-D finite-difference representation of a simplified form of the spectral balance equation to simulate near-coast, time-independent spectral wave energy propagation.

Data from several sources were used to create a nearshore modeling grid that was as accurate as possible. The data sources include shore zone survey by Shoreline Studies Program personnel (Jun-Aug 2006) and the U.S. Army Corps of Engineers (January 2007) at Little Creek Naval Amphibious base during several Shoreline Studies projects, and nearshore survey in September 2010 by Waterways Survey and Engineering, LTD for the City of Virginia Beach (Figure 2-1). The data for the rest of the grid came the Navy's contour map dated August 2003 and from the NOAA's Tsunami Inundation DEMs (http://www.ngdc.noaa.gov/mgg/inundation). These data were converted from various vertical datums to mean high water (MHW). The mean tide range at the Chesapeake Bay Bridge Tunnel is 2.55 ft and the diurnal tide range is 2.90 ft (Table 1). Two grids were created to model effect of nearshore dredging, one for north and northeast waves, and the second for waves coming through the mouth of the Bay (Figure 2-2).

The same storm condition was modeled for both grids (Table 2). A wave gage was deployed in March 2006 in the southern Chesapeake Bay in 22 m of water approximately 1 mile off Norfolk's shoreline and 6 miles west of the Chesapeake Bay Bridge Tunnel (CBBT) (Puckette and Gray, 2008). This gage recorded a significant wave height (H_s) of 8.7 ft on November 22, 2006. This was greater than the 7.7 ft H_s during Tropical Storm Ernesto on September 1, 2006. Data from the CBBT on November 22, 2006 shows a maximum storm surge of 3 ft with sustained winds averaging 40 mph.

Two dredging scenarios were modeled for their effect on waves. The first scenario was a 5 ft dredge cut across the entire sampling area (Figure 2-3). The second scenario was dredging 10 ft in the offshore area only. In order to

model these scenarios, the existing bathymetry was modified to reflect the proposed changes in bottom elevation due to the dredging. Because of the restricted zone near the bridge where no dredging will occur, the bathymetry was not modified in this area. Transformation of storm waves was modeled on the existing bathymetry and on the modified bathymetry.

The results for predicted wave height and wave angle from the modeling runs for selected stations for all three scenarios (existing, 5 ft, and 10 ft) were compared. For wave height, positive differences indicate that the wave height is larger, while negative differences indicate a reduction in wave height. For wave angle, positive values indicate that the wave will have a more westerly heading while negative values indicate the waves become more easterly.

Table 1. Tide datum elevations for Chesapeake Bay Bridge Tunnel relative to mean lower low water for the 1983-2001 tidal epoch (NOAA, 2011).

Tidal Datum	Elevation (ft MLLW)
Mean higher high water	2.90
Mean high water	2.68
Mean sea level	1.42
Mean low water	0.13
Mean lower low water	0
NAVD88*	1.65

*Elevation at Sewells Point

Table 2. Summary of input wave conditions to STWAVE.

Orientation	Hs (m)	T(s)	angle	Wind (mph)	Surge (ft)
North	2.650	5.000	5° TN	40	3
Northeast	2.650	5.000	45° TN	40	3
East	2.650	5.000	90° TN	40	3

Results and Discussion

Cores

Analysis of the vibracores indicates that the shoal area offshore of Virginia Beach consists of sand suitable for dredging and placement on the beach. Cross-sections along the coring grid show that sediments with a suitably high combined percent of sand and gravel are thick throughout the study area (Appendix E).

The percent of sand and gravel sample statistics were mean-weighed with sample length to determine the overall statistics in the first five feet of each core and was plotted to determine suitability for the 5 ft dredging scenario (Figure 3-1). Most of the study area is greater than 90% sand and gravel with D_{50}s greater than 0.25 mm in the first five feet below the bottom. When the mean-weighed percent sand and gravel for the first 10 ft of each core is plotted, the nearshore region at depth is finer than the first 5 ft (Figure 3-2). The offshore area has suitable material for the 10 ft dredging scenario.

The proposed dredge scenarios are shown in Figure 3-3. The 5 ft scenario includes the area in green dredged on both sides of CBBT. If just the east side of the study area were dredged, approximately 3.8 million cubic yards (cy) of material with an average D_{50} of medium sand would be available (Table 3). If only the offshore area, as depicted by the cross-hatching, is dredged on the east side, approximately 4.1 million cy of material would be available for placement.

Table 3. Projected volume (cubic yards) for six dredge scenarios as shown in Figure 3-3.

Case	Dredge Scenario	Side	Volume (cy)	Average D_{50} (mm)
1	5 ft	East	3,810,000	0.41
2	5 ft	West	1,080,000	0.51
3	10 ft	East	4,140,000	0.37
4	10 ft	West	980,000	0.51
5	5 ft & 10 ft	East	5,890,000	0.46
6	5 ft & 10 ft	West	1,570,000	0.44

Nearshore Modeling

Nearshore modeling indicates little change to the wave height or direction as a result of either dredging scenario (Appendix F). For waves from the north, only two sites have a change in wave height greater than 0.1 m and only 3 sites have wave angles that varied by more than 5 degrees. The largest change occurred at station #82 which went from 0.8 m on the existing bathymetry to 1.1 m on both dredge scenarios. Several sites had wave heights reduced by as much as -0.1 m. The angle varied less than 10 degrees. Results at stations #60 through #82 indicated that the waves may approach the shoreline in a more easterly direction. However, the average change in the angle was -1.7 degrees with a range of 0 to -6 deg.

For the northeast waves modeled, only two sites had wave height change larger than 0.1 m while several sites had wave heights reduced by as much as -0.1 m for both the 5 ft and 10 ft scenarios (Appendix F). The northeast had more wave variation under the 5 ft and 10 ft scenarios than the north. At thirty four stations (5 ft scenario) and 78 stations (10 ft scenario) wave angle varied more than 1 degree. With the exception of stations #29 and #32, all the large changes in angle (greater than 10 degrees toward the west) are along the shoreline.

Not all of the output stations were included in the analysis for the storm wave condition from the east. Stations, along the shoreline and across the proposed dredge area, were included (Appendix F). This analysis showed that wave height did not change by more than $\pm$0.1 m for both scenarios. Wave angle was more variable, but only 3 stations (#31, #61, and #82 changed by more than $\pm$5 degrees under the 5 ft dredge scenario and no stations changed by more than 5 degrees under the 10 ft scenario.

Conclusions

Suitable material is available offshore of Chesapeake Beach for beach nourishment purposes. Much of the area has greater than 90% sand and gravel-sized material with an average D_{50} greater than 0.25 mm. Case 3, the 10 ft dredging scenario on the east side of CBBT, will provide the most material for beach nourishment. Getting permission to dredge on the west side of the CBBT may be difficult since it is a military restricted area, but the material is suitable for beach nourishment. The limited analysis of wave climate performed for this project indicates that minor alterations to the wave climate could occur during storms. However, they generally will tend to drive more material westward.

Acknowledgments

Thanks to Carl Hobbs, III and Lyle Varnell for serving on the contract committee and editing this report. Thanks to Cynthia Harris for helping us navigate the contract process.

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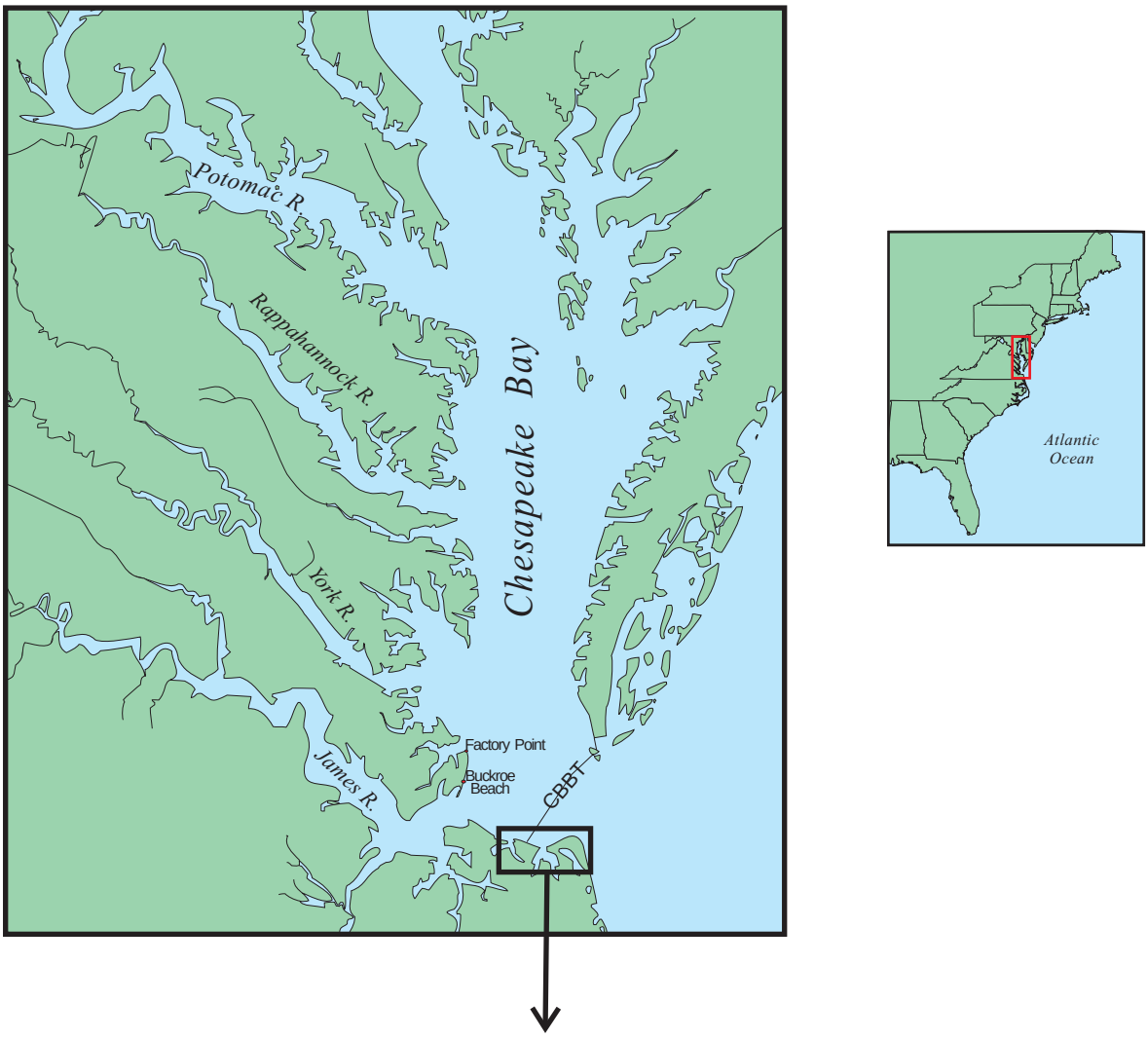


Figure 1-1. Location of Chesapeake Beach on Chesapeake Bay.

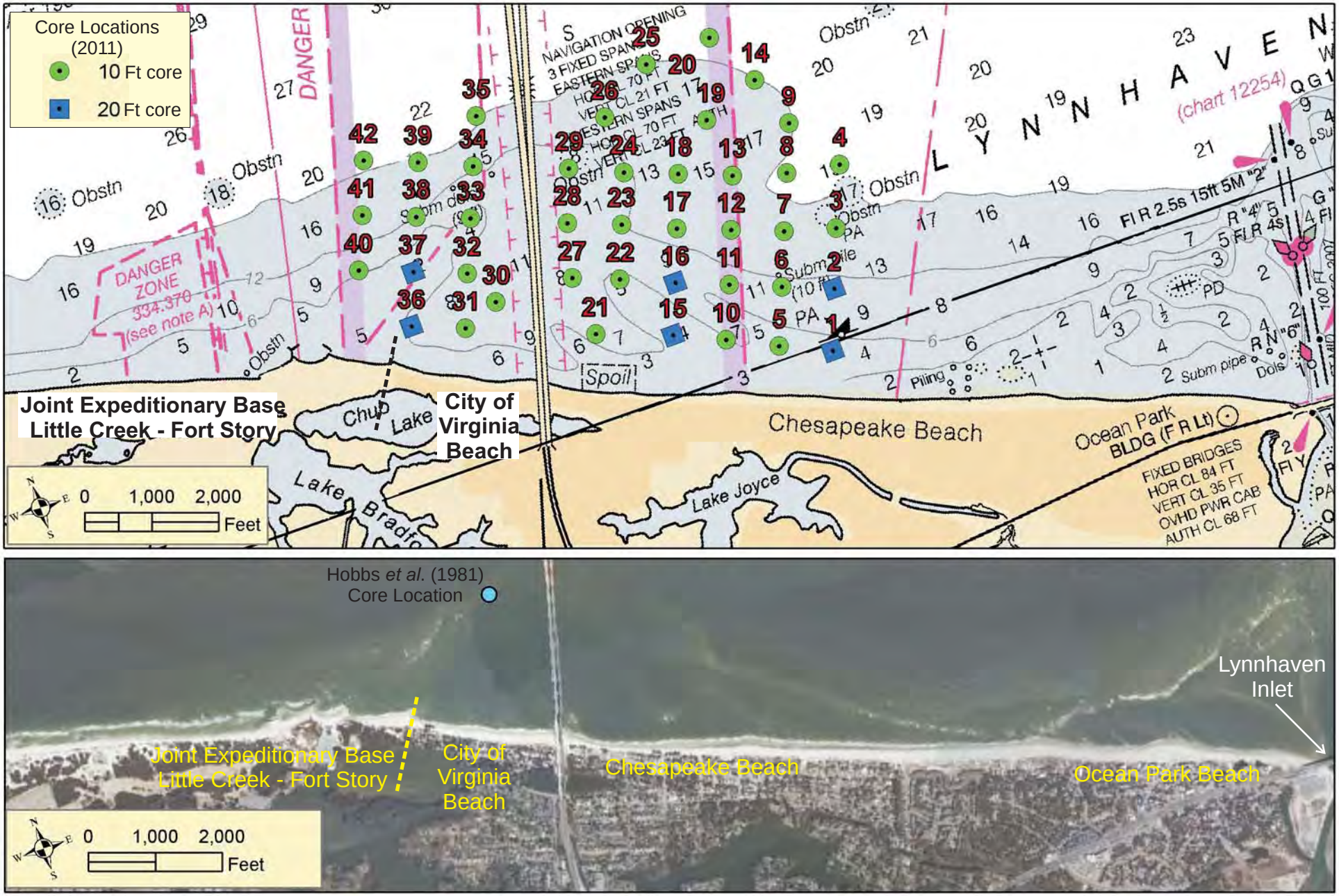
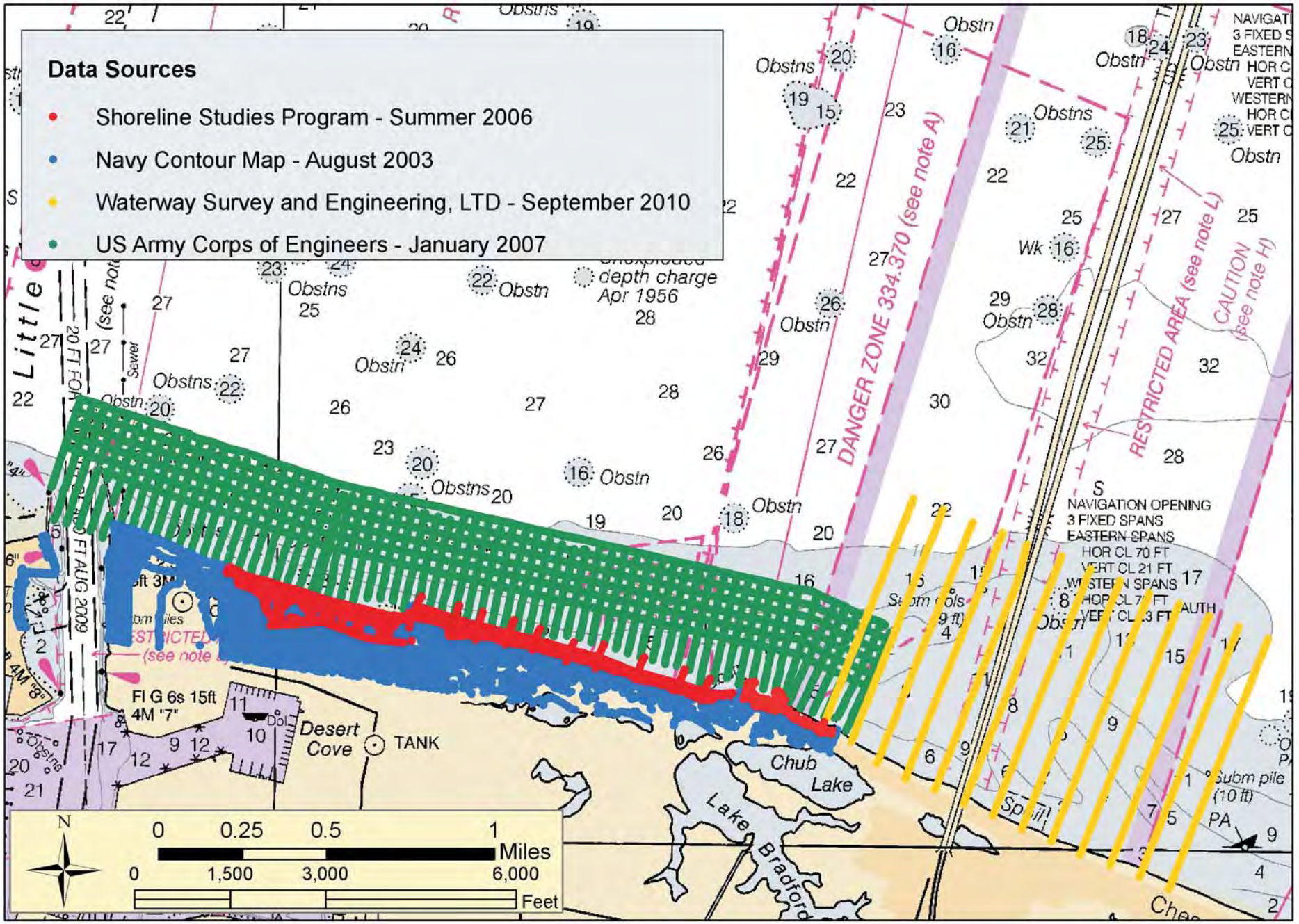


Figure 1-2. Location of cores taken for this project, and the location of the core taken by Hobbs *et al.* (1981).



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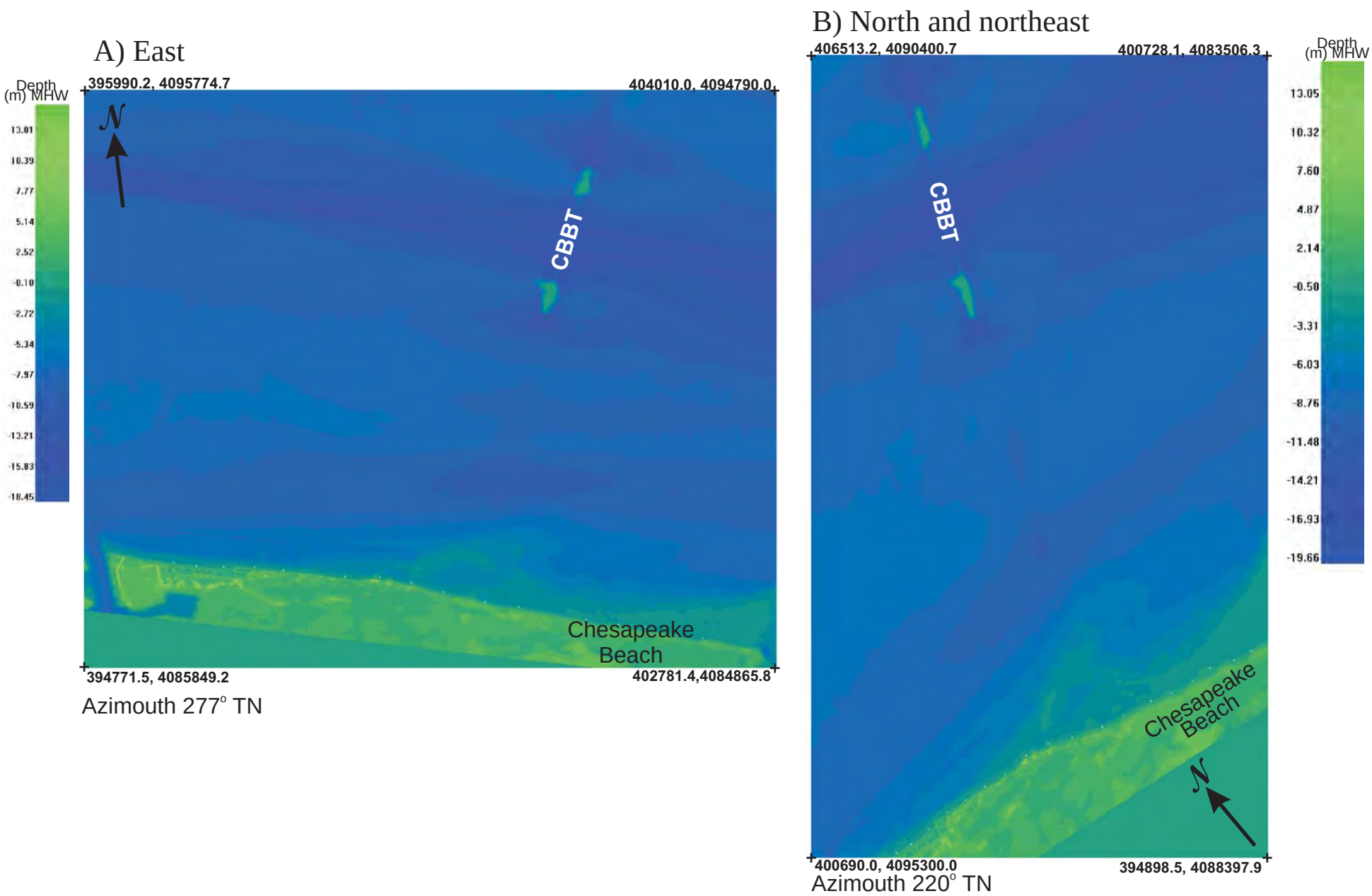

Figure 2-2. Nearshore bathymetry used in the wave refraction model. A) is the area modeled for waves approaching from the east. B) is the area modeled for waves approaching from the north and northeast.

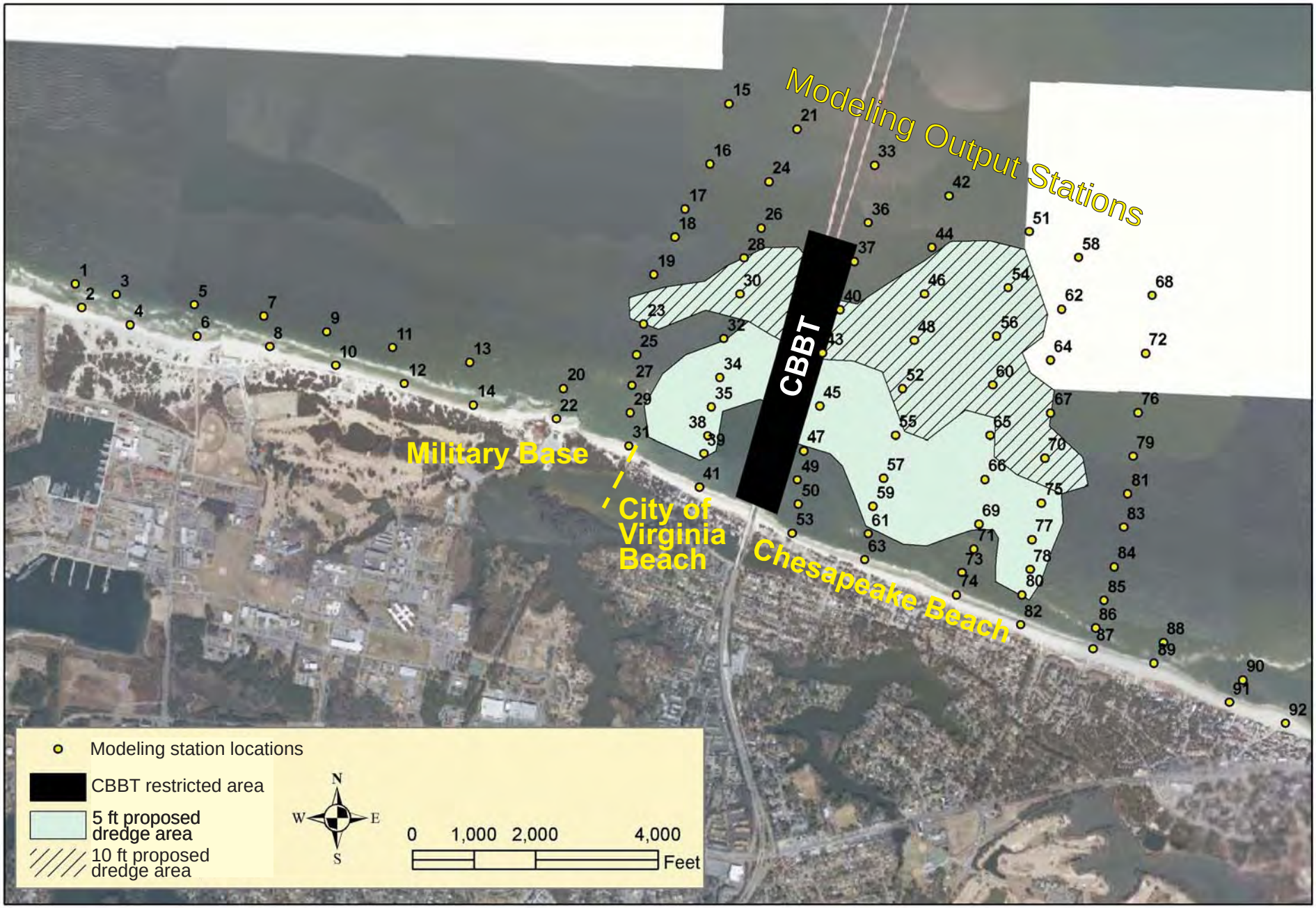

Figure 2-3. Proposed 5 ft and 10 ft dredging scenarios for modeling purposes, and output station locations for the nearshore wave modeling.

Figure 3-1. Mean-weighed average of the percent of sand and gravel in the first 5 ft of each core. Also shown is the mean-weighted D50 in mm and the percent of sand and gravel. 2009 VGIN image.

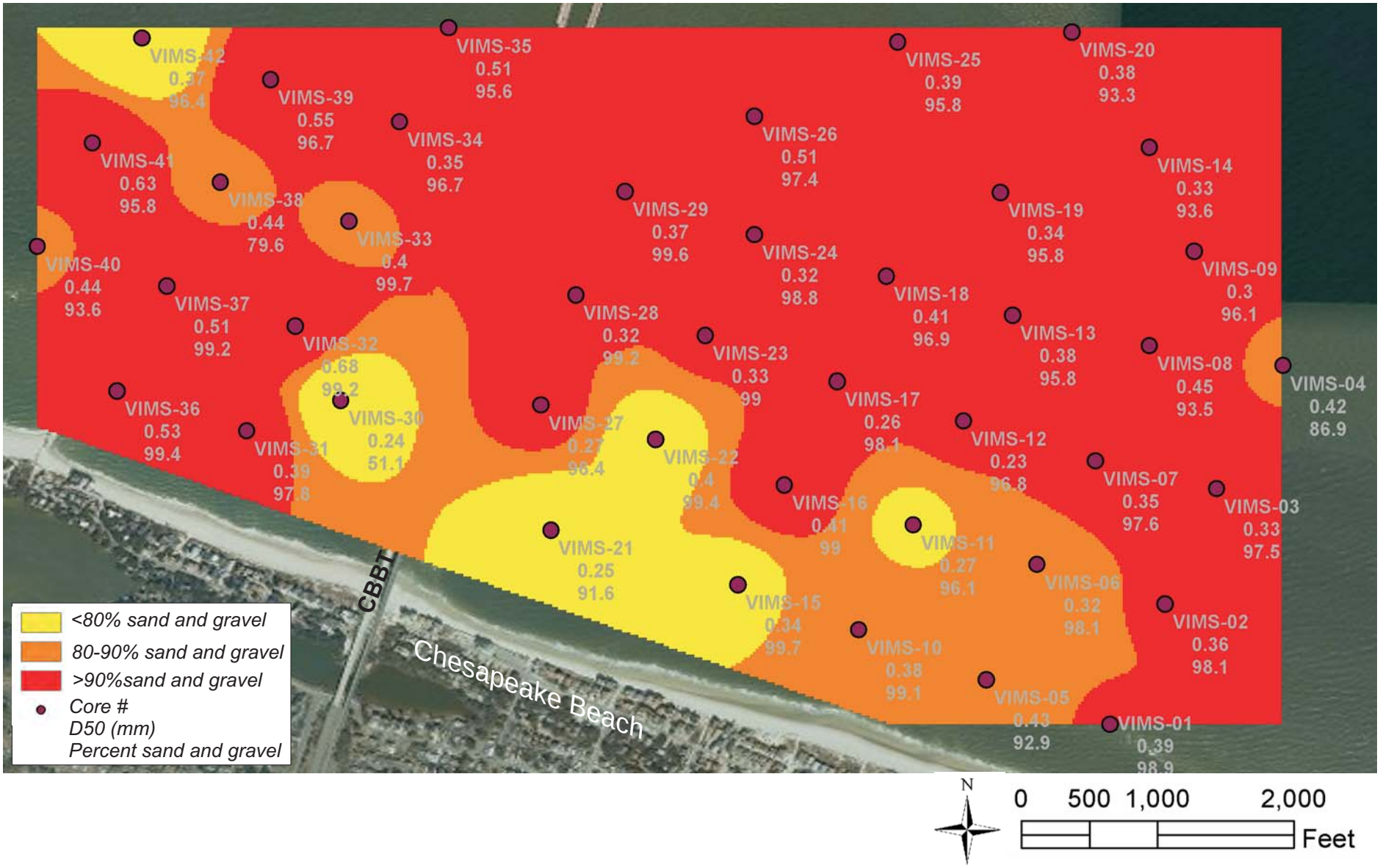

Figure 3-2. Mean-weighed average of the percent of sand and gravel in the first 10 ft of each core. Also shown is the mean-weighted D50 in mm and the percent of sand and gravel. 2009 VGIN image.

Figure 3-3. Proposed dredge scenarios for the areas on the east and west side of the Chesapeake Bay Bridge Tunnel. 2009 VGIN image.

Appendix A

Final Report submitted to VIMS
by

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Field Sampling Methodologies Used for the Collection of Vibracore Samples Offshore of Virginia Beach, Virginia in the Vicinity of the Chesapeake Bay Bridge Tunnel.

Athena Technologies, Inc. used the following methods in support of a geotechnical study at Virginia Beach, Virginia. Athena was contracted by the Virginia Institute of Marine Science (VIMS) through the College of William & Mary to perform the vibracore sampling, which took place in August, 2011.

Athena deployed our thirty-five foot research vessel, Artemis, to act as the primary sampling platform for this project. It utilized a Trimble DGPS (sub-meter accurate) interfaced through HYPACK and a Sitex CVS-106 fathometer (accurate to 0.1') for basic horizontal and vertical positioning. Final elevations were derived using tidal data provided by the National Oceanic and Atmospheric Association (NOAA) for station 8638863, Chesapeake Bay Bridge Tunnel. (http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8638863%20Chesapeake%20Bay%20Bridge%20Tunnel,%20VA&cype=Tide%20Data)

The vessel was maneuvered to the desired sample site using coordinates provided to Athena by VIMS (See Figure 1). Once on station, the vessel was immobilized using a triple point anchor system. Athena's custom designed and built vibracore system was then deployed from the vessel. This system consists of a generator with a mechanical vibrator attached via cable directly to the sampler apparatus. The sample barrel was a three inch, 16 gauge steel tube. The sample barrel was lowered to the sea-floor through a moon pool in the deck of the vessel by attaching lengths of drill stem. The vibracore machine was then turned on and the sample barrel was allowed to penetrate until it reached target depth or refusal. The sample barrel was then retrieved using an electric winch. Once the sample was on deck, the sample barrel was cut, capped, labeled and measured.

Jetting was required at station VIMS-37. This involved the attaching of a jet pump to the sample barrel and lowering it to the sea floor. The pump was then turned on and the sample barrel was advanced to one foot above the previous penetrated depth. The vibracore machine was then turned on and the system was allowed to penetrate materials until refusal or target depth was achieved. The retrieval process does not differ from what was outlined in the previous paragraph.

Penetration was recorded using a video camera that recorded our vibracore system as it advanced. The equipment is marked in half-foot increments and advancement is graphed in the office by recording the time passed as each one-foot interval is passed.

The completed cores were opened, transferred to PVC pipe, wrapped in plastic wrap and then placed into heavy-duty plastic tubing. They were then transferred to VIMS for processing.

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Table 1: Vibracore Summary
VIMS - Virginia Beach, VA
August, 2011

Station ID	Date	Latitude (North)	Longitude (West)	East (x)	North (y)	Vibracore Start Time	Run Time (s)	Approximate Weight on Sample Barrel (lbs.)	Water Depth (feet)	Verified Water Elevation* (feet relative to MLLW)	Top of Core Elevation (feet relative to MLLW)	Penetration (feet)	Recovery (feet)	Recovery (%)	Location Notes
VIMS-01	08/02/11	36°54'58.62	76°06'54.25	12180059.41	3501892.20	8:47:13	492	110	5.8	0.2	-5.6	20.0	17.6	87.9	No penetrometer video.
VIMS-02	08/02/11	36°55'07.34	76°06'50.26	12180355.18	3502769.34	8:18:25	102	110	13.6	0.1	-13.5	22.0	21.2	96.2	
VIMS-03	08/02/11	36°55'15.69	76°06'46.53	12180657.53	3503619.37	7:51:27	55	105	19.3	0.1	-19.2	10.0	9.9	99.2	
VIMS-04	08/02/11	36°55'24.59	76°06'41.72	12181011.09	3504535.73	7:13:08	38	65	21.7	0.6	-21.1	12.0	12.0	100.0	
VIMS-05	08/02/11	36°55'01.86	76°07'03.23	12179320.51	3502198.65	9:25:16	55	65	9.3	0.3	-9.0	10.0	10.0	100.0	
VIMS-06	08/02/11	36°55'10.19	76°06'59.55	12179619.52	3503048.61	9:48:35	53	65	16.0	0.4	-15.6	10.0	9.8	97.5	
VIMS-07	08/02/11	36°55'17.71	76°06'55.32	12179923.41	3503820.25	10:13:53	38	65	21.7	0.7	-21.0	10.0	10.0	100.0	
VIMS-08	08/02/11	36°55'26.03	76°06'51.39	12180219.57	3504665.10	10:36:52	20	105	23.1	0.9	-22.1	10.0	9.2	91.7	
VIMS-09	08/02/11	36°55'32.89	76°06'48.15	12180464.96	3505365.82	11:17:47	19	65	21.8	1.4	-20.4	10.0	9.5	95.0	
VIMS-10	08/02/11	36°55'05.48	76°07'12.47	12178580.26	3502548.79	13:47:22	63	65	9.3	3.3	-6.0	10.5	10.2	96.9	
VIMS-11	08/02/11	36°55'13.07	76°07'08.51	12178880.10	3503318.99	13:06:13	114	65	13.4	2.9	-10.5	12.0	11.2	93.1	
VIMS-12	08/02/11	36°55'20.62	76°07'04.87	12179156.83	3504091.87	12:39:27	129	65	19.2	2.7	-16.5	10.5	10.3	97.6	
VIMS-13	08/02/11	36°55'28.24	76°07'01.30	12179426.73	3504862.72	12:10:07	31	105	20.4	2.2	-18.3	10.0	9.1	90.8	
VIMS-14	08/02/11	36°55'40.40	76°06'51.38	12180181.26	3506117.41	14:46:24	17	65	20.3	3.5	-16.9	10.0	9.7	96.6	
VIMS-15	08/03/11	36°55'08.75	76°07'21.23	12177840.92	3502854.39	7:31:06	820	110	7.8	0.8	-7.1	20.0	18.0	90.0	
VIMS-16	08/03/11	36°55'15.98	76°07'17.86	12178115.84	3503590.06	8:46:00	288	110	9.2	0.2	-9.0	21.5	20.5	95.3	
VIMS-17	08/02/11	36°55'23.46	76°07'14.04	12178388.22	3504363.32	16:14:58	40	65	13.7	3.1	-10.6	12.0	11.0	91.7	
VIMS-18	08/02/11	36°55'31.08	76°07'10.47	12178656.44	3505134.38	15:47:12	37	65	15.3	3.3	-12.0	10.5	9.9	94.5	
VIMS-19	08/02/11	36°55'37.15	76°07'02.21	12179311.04	3505768.41	15:10:41	42	65	17.3	3.5	-13.9	10.0	10.0	100.0	
VIMS-20	08/03/11	36°55'48.77	76°06'57.02	12179721.89	3506947.90	10:04:19	35	105	23.7	0.3	-23.3	11.0	10.7	96.9	
VIMS-21	08/03/11	36°55'12.69	76°07'34.78	12176750.95	3503228.83	14:18:50	72	65	10.7	3.3	-7.4	10.0	9.5	95.0	
VIMS-22	08/03/11	36°55'19.28	76°07'27.20	12177348.78	3503900.70	14:02:22	56	65	12.7	3.1	-9.6	11.5	10.8	93.5	
VIMS-23	08/03/11	36°55'26.78	76°07'23.59	12177619.89	3504671.24	13:09:13	49	65	14.9	2.4	-12.5	11.0	10.7	96.9	
VIMS-24	08/03/11	36°55'34.08	76°07'20.02	12177892.84	3505408.39	11:59:55	46	65	14.8	1.4	-13.3	10.5	10.0	95.2	
VIMS-25	08/03/11	36°55'48.04	76°07'09.64	12178701.31	3506844.47	10:35:44	14	105	22.1	0.5	-21.6	11.0	10.2	92.5	
VIMS-26	08/03/11	36°55'42.68	76°07'20.03	12177870.52	3506280.57	11:01:18	69	65	18.3	0.8	-17.5	12.0	11.4	95.2	
VIMS-27	08/03/11	36°55'21.75	76°07'35.51	12176667.78	3504137.10	13:29:56	32	65	14.8	2.7	-12.1	10.0	9.2	91.7	
VIMS-28	08/03/11	36°55'29.71	76°07'32.97	12176853.54	3504942.64	12:45:56	101	65	11.2	2.1	-9.1	10.0	9.8	97.5	
VIMS-29	08/03/11	36°55'37.21	76°07'29.41	12177123.68	3505709.20	11:27:54	77	65	14.3	1.1	-13.2	10.0	9.7	96.6	
VIMS-30	08/03/11	36°55'22.10	76°07'50.01	12175470.68	3504145.01	18:17:19	86	65	12.6	2.5	-10.1	11.0	10.5	95.5	
VIMS-31	08/03/11	36°55'19.90	76°07'56.84	12174921.95	3503911.50	17:57:19	44	110	12.7	2.8	-9.9	10.0	9.5	95.0	
VIMS-32	08/03/11	36°55'27.46	76°07'53.33	12175187.60	3504681.30	18:34:11	85	110	9.3	2.3	-7.1	10.0	8.8	87.5	
VIMS-33	08/03/11	36°55'35.06	76°07'49.41	12175495.24	3505456.08	19:05:15	58	65	8.4	1.8	-6.7	13.0	12.1	92.9	No penetrometer video.
VIMS-34	08/03/11	36°55'42.25	76°07'45.73	12175765.90	3506190.98	19:23:30	64	65	15.8	1.6	-14.2	12.0	11.5	95.8	
VIMS-35	08/02/11	36°55'49.06	76°07'42.19	12176041.61	3506893.38	19:25:47	37	105	21.7	0.8	-20.9	11.5	10.8	93.5	
VIMS-36	08/03/11	36°55'22.79	76°08'06.24	12174152.40	3504186.25	15:38:08	192	65	7.7	3.6	-4.0	22.0	20.9	95.1	
VIMS-37	08/03/11	36°55'30.35	76°08'02.61	12174434.16	3504955.15	17:28:28	60	110	5.1	3.1	-2.0	11.0	9.5	86.4	Made 3 jetting attempts. Refusal at ~11' below sed surface.
VIMS-38	08/02/11	36°55'37.90	76°07'58.74	12174721.70	3505728.72	18:33:00	105	65	14.2	1.4	-12.8	11.0	10.0	90.9	
VIMS-39	08/02/11	36°55'45.34	76°07'55.10	12174999.38	3506493.70	19:04:05	92	65	19.4	1.0	-18.4	12.0	11.5	95.8	
VIMS-40	08/02/11	36°55'33.23	76°08'11.99	12173657.28	3505226.26	18:09:50	81	65	11.3	1.7	-9.6	10.0	9.3	93.3	
VIMS-41	08/02/11	36°55'40.74	76°08'08.01	12173961.17	3505999.10	17:48:42	97	105	16.3	2.0	-14.3	10.0	8.8	88.3	
VIMS-42	08/02/11	36°55'48.34	76°08'04.42	12174233.74	3506773.70	17:26:08	58	65	19.8	2.3	-17.5	11.5	11.0	95.7	
Project Notes	The vibracores were collected using Athena's cutom designed and built vibracore system. The system consists of a generator with a mechanical vibrator attached via cable. The vibrator is then attached directly to a three-inch diamter, galvanized sample barrel. (Vibracore Make/Model = Not Applicable)														
	MLLW - Mean Lower Low Water														
	State Plan coordinates (East/North) were measured using NAD83, Virginia South (Zone 4502) and were collected using a Trimble DGPS (sub-meter accuracy) interfaced with Hypack. Latitude and longitude coordinates, were collected using a Trimble 4800 RTK GPS.														
	Verified Water Elevation* - The tidal benchmark utilized to verify tidal elevations was located at the entrance to the Chesapeake Bay Bridge Tunnel, which is approximately 3 miles from the project site. Verified tide data was retrieved from the following website: http://tidesandcurrents.noaa.gov/station_info.shtml?stn=8638863 Chesapeake Bay Bridge Tunnel, VA .														

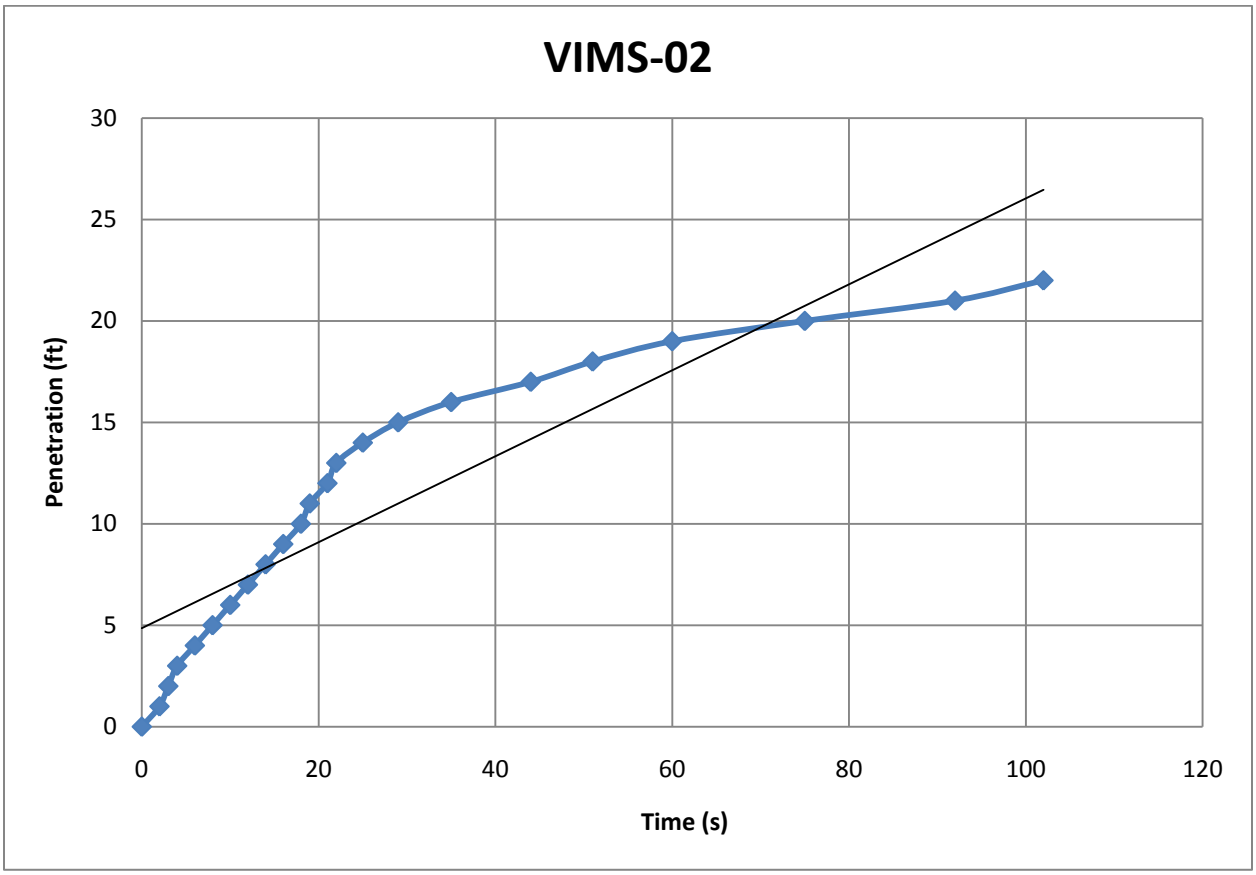
ATHENA TECHNOLOGIES, INC.

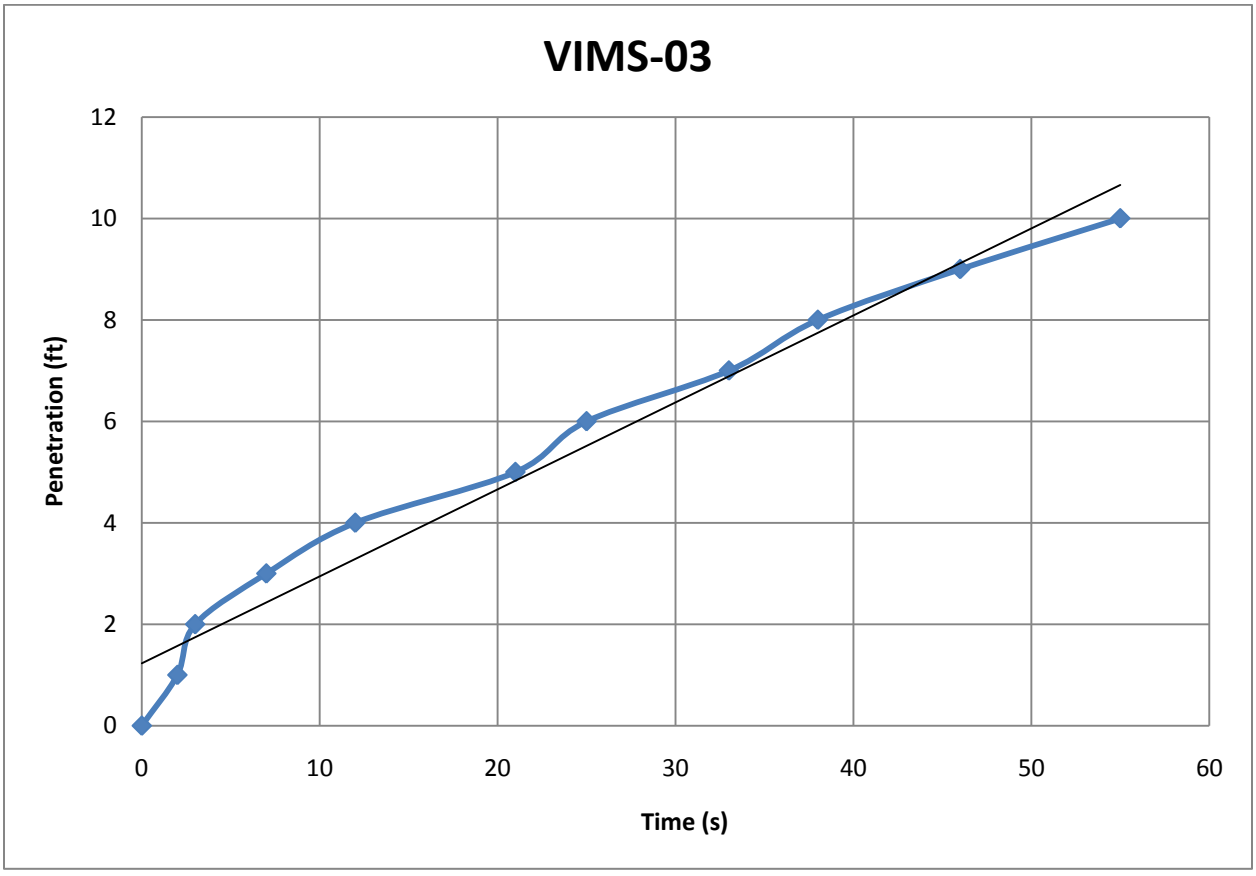
1293 Graham Farm Road
P.O. Box 68
McClellanville, SC 29458
(843) 887-3800
www.athenatechnologies.com

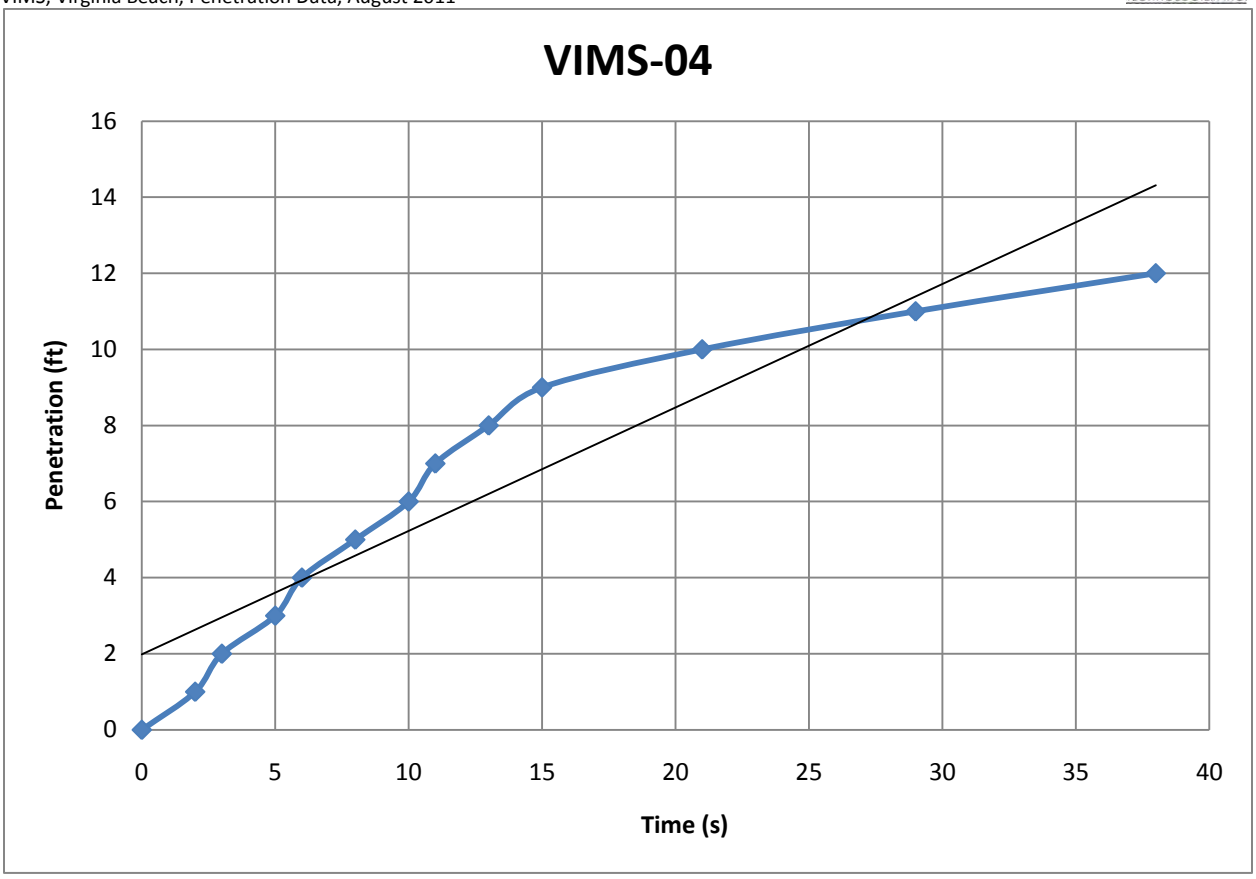
Figure 1: Vibracore Station Plot, Virginia Beach, Virginia
Contract Number WM-C950

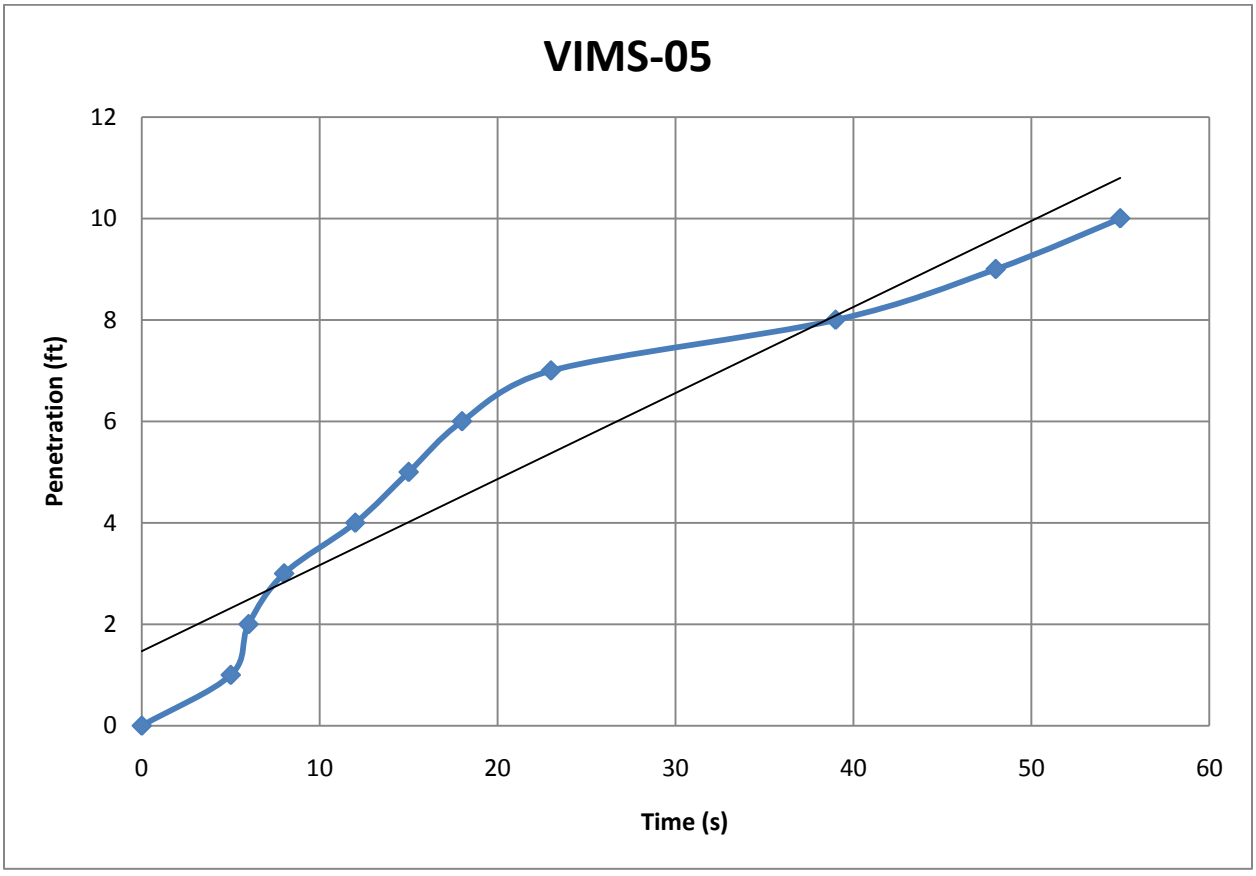
Athena Technologies, Inc.
PO Box 68
McClellanville, South Carolina 29458
www.athenatechnologies.com

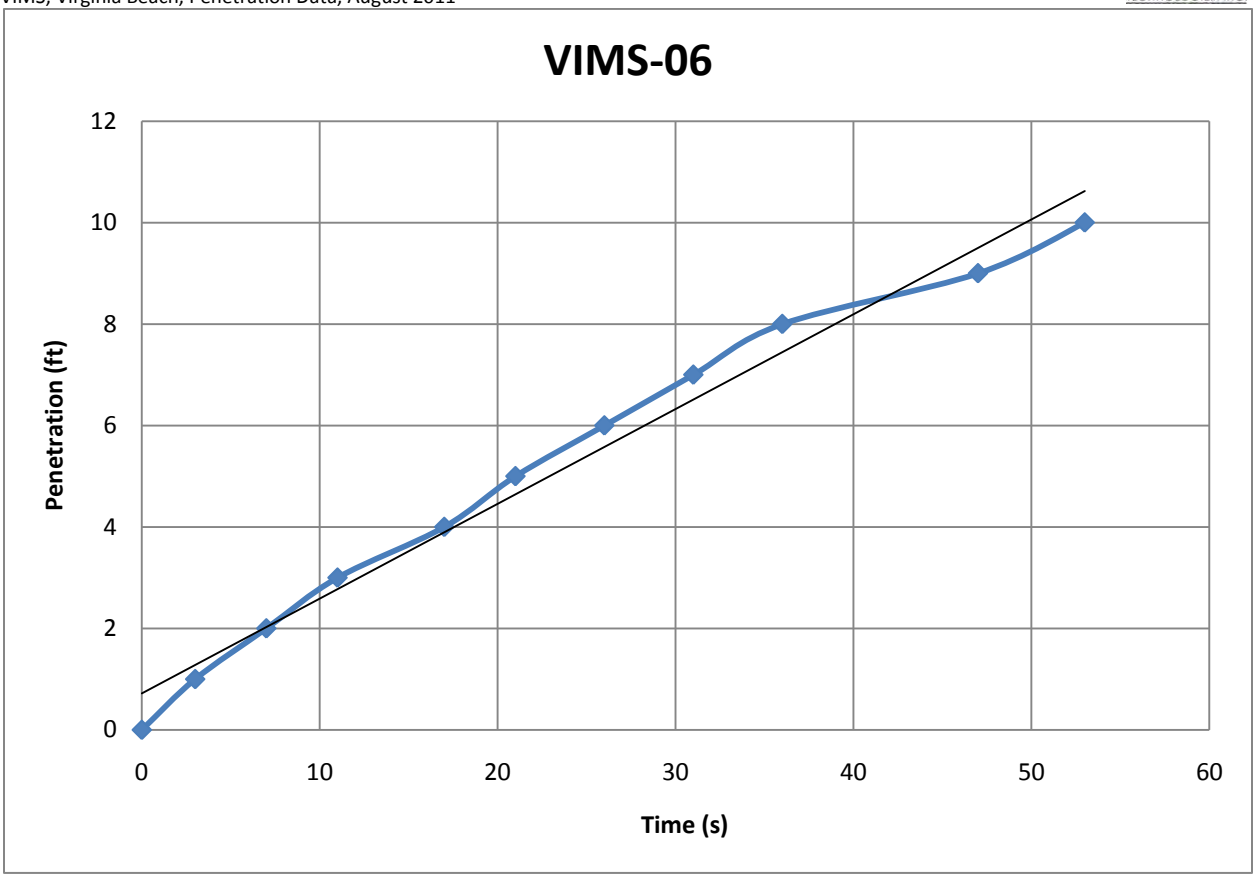
ATHENA TECHNOLOGIES, INC.

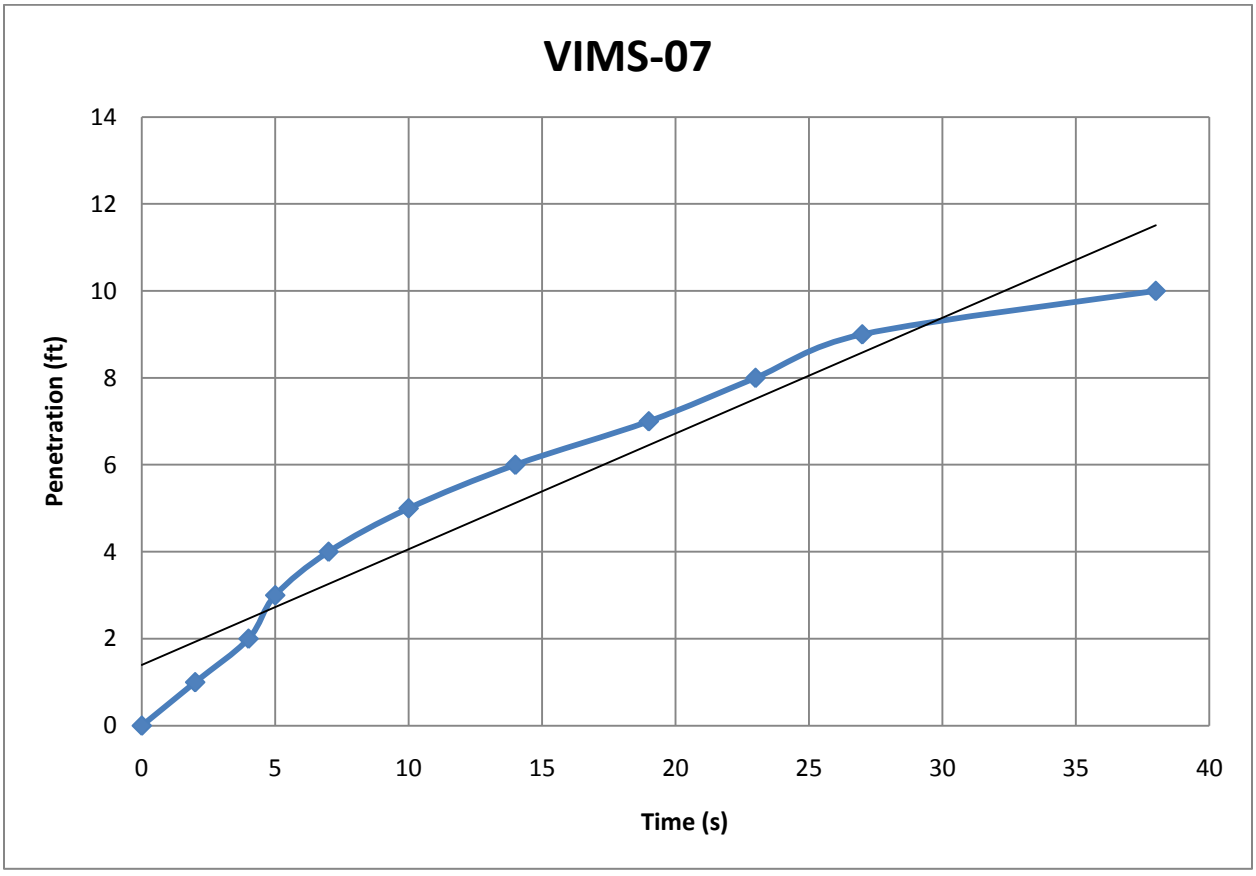

VIMS-02
Penetration (ft)
0
5
10
15
20
25
30
0
20
40
60
80
100
120
Time (s)

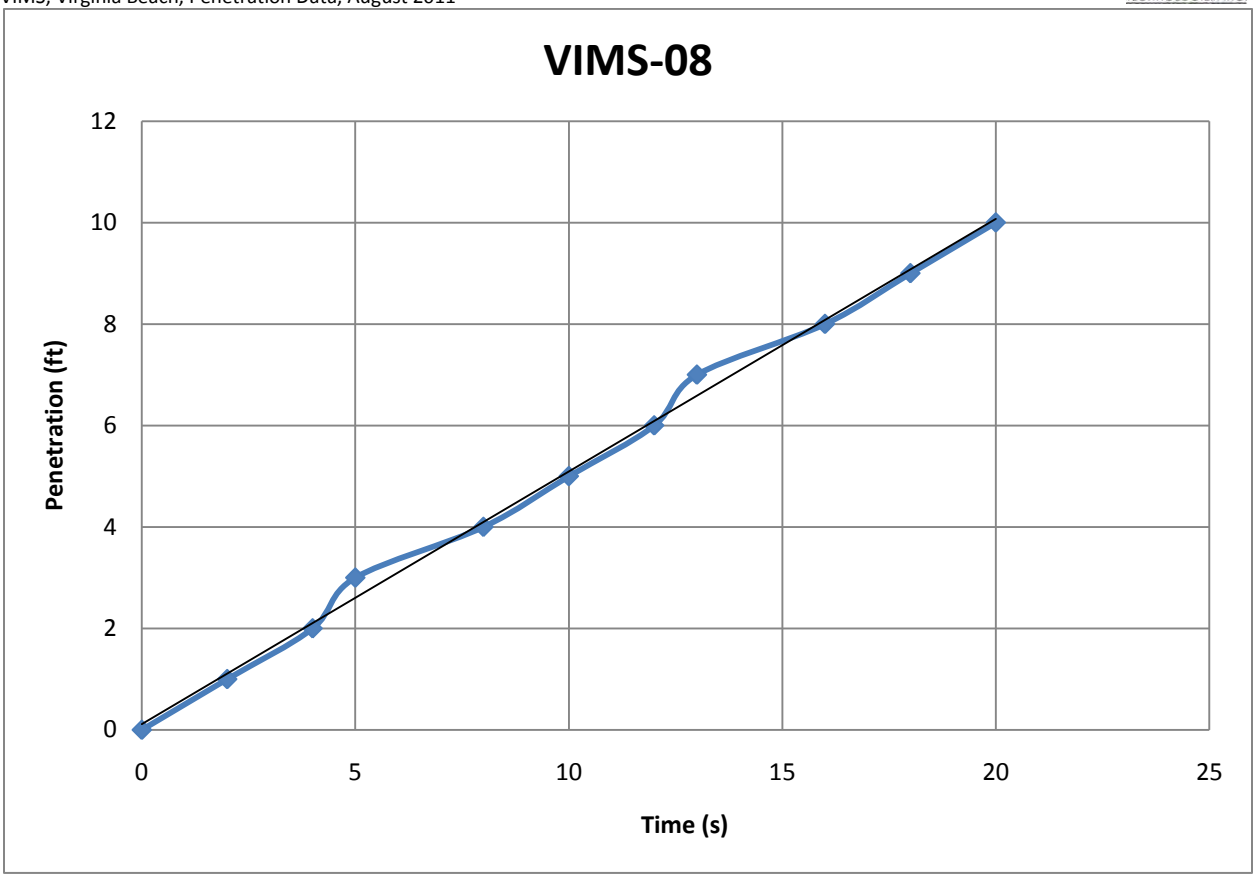

VIMS-03
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
Time (s)

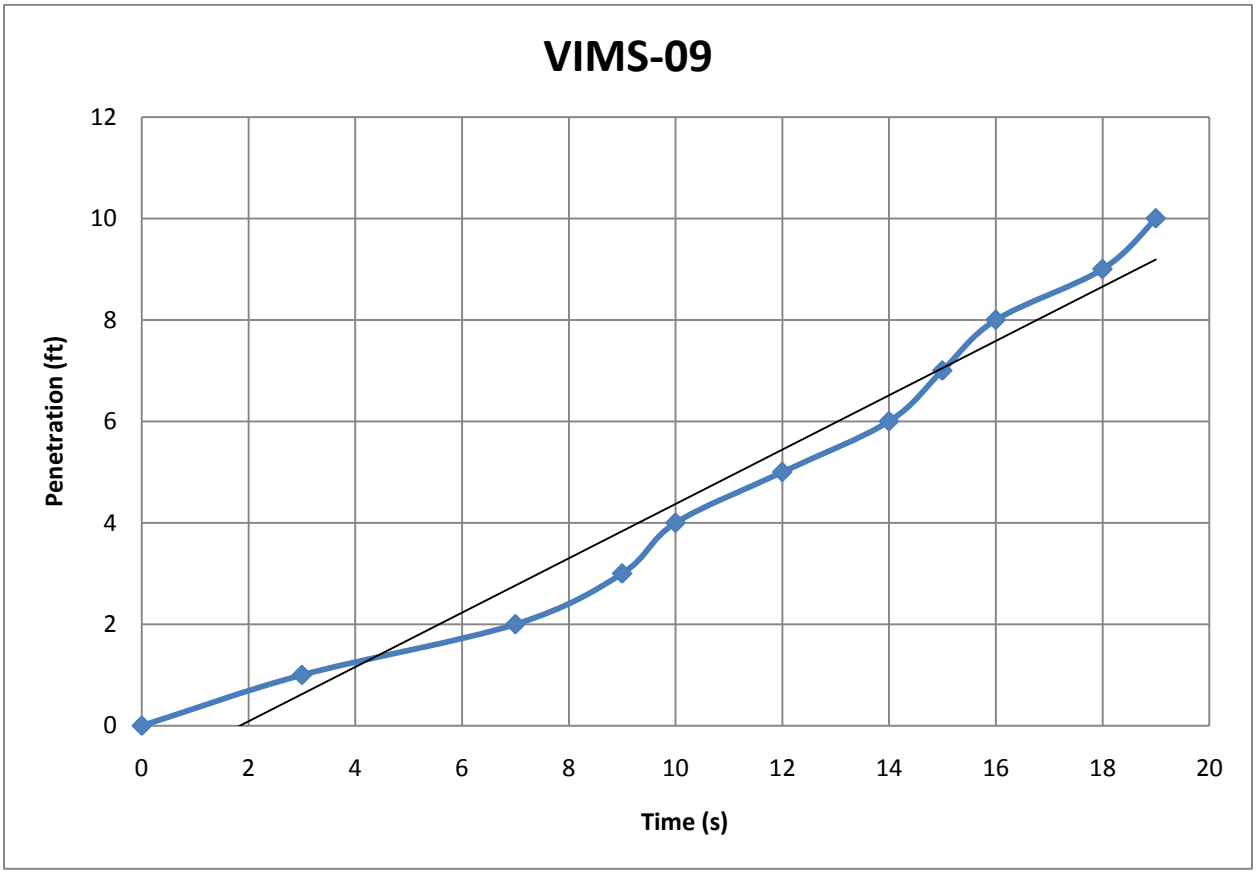

VIMS-04
Penetration (ft)
Time (s)
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25
30
35
40

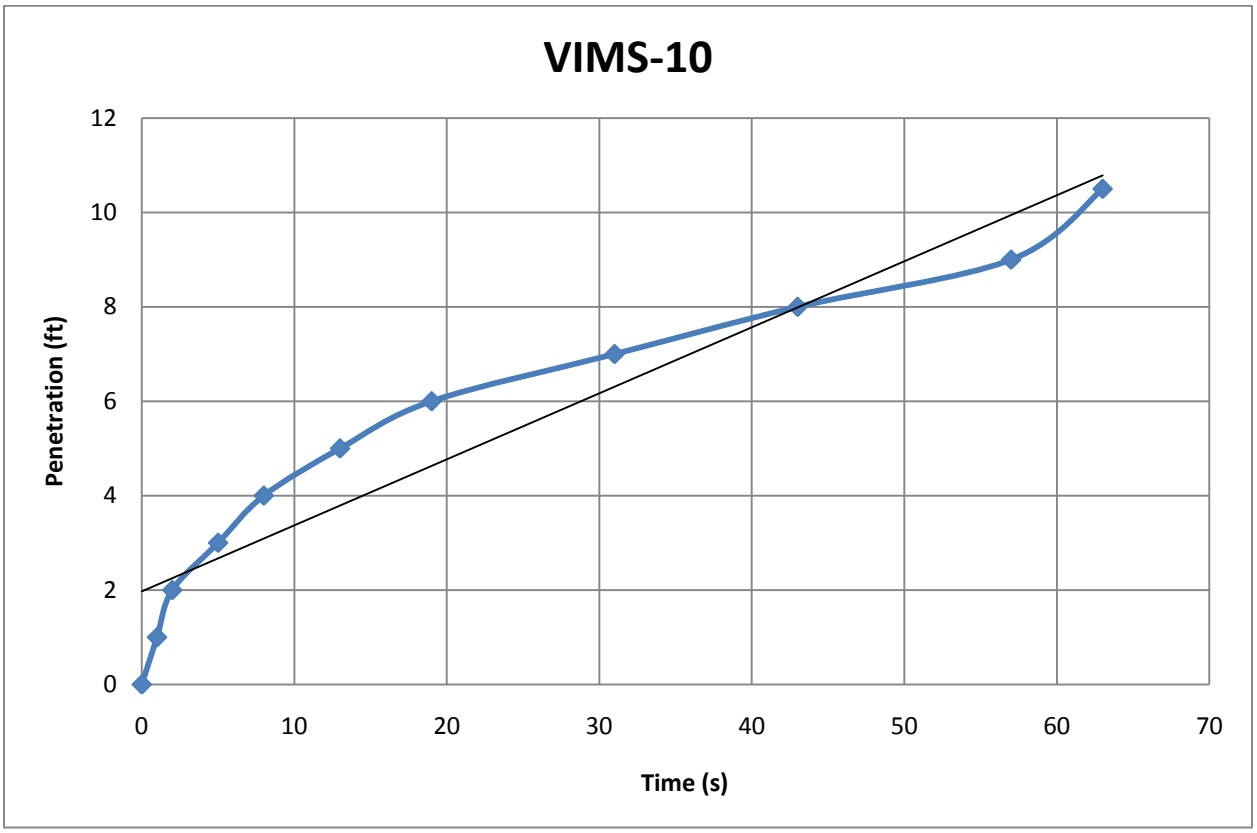

VIMS-05
Penetration (ft)
Time (s)
0
2
4
6
8
10
12
0
10
20
30
40
50
60

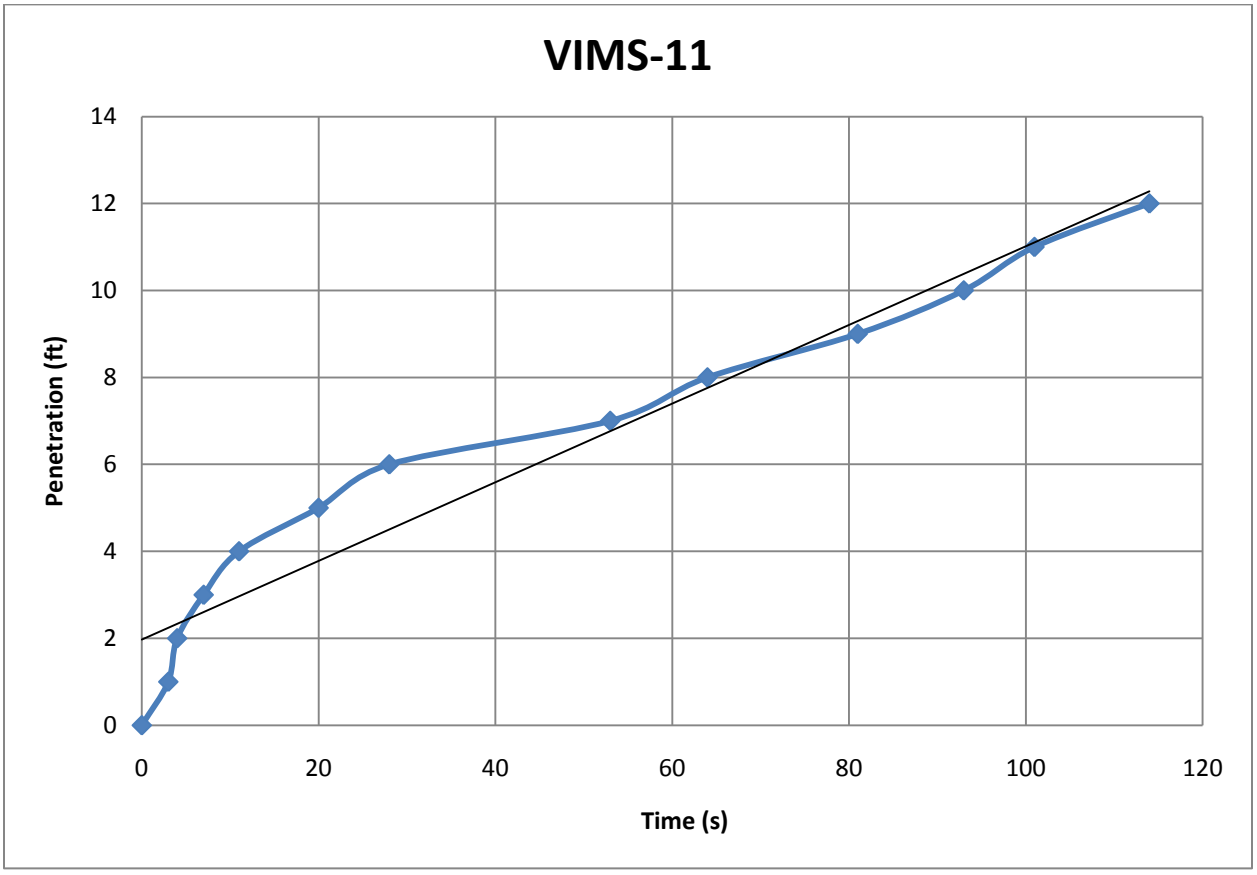

VIMS-06
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
Time (s)

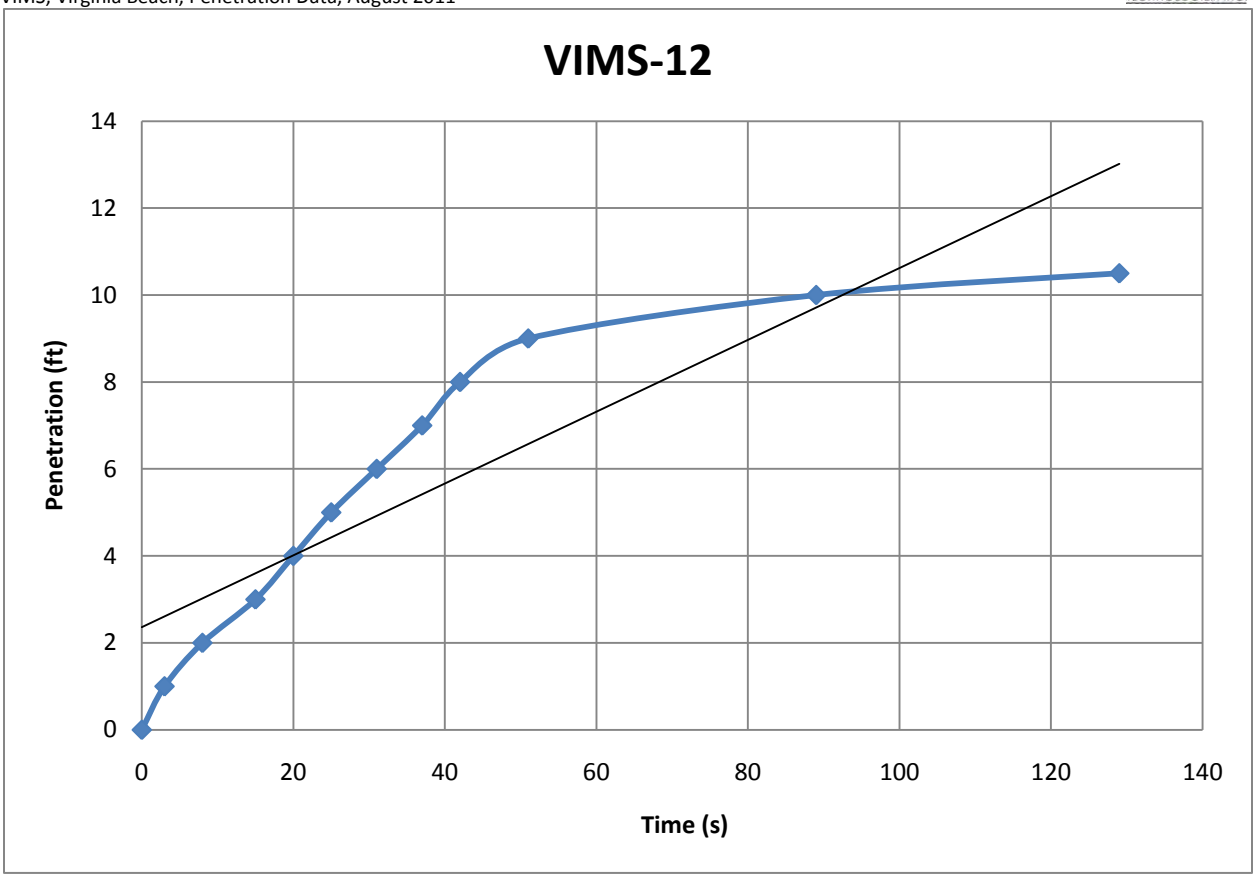

VIMS-07
Penetration (ft)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
Time (s)

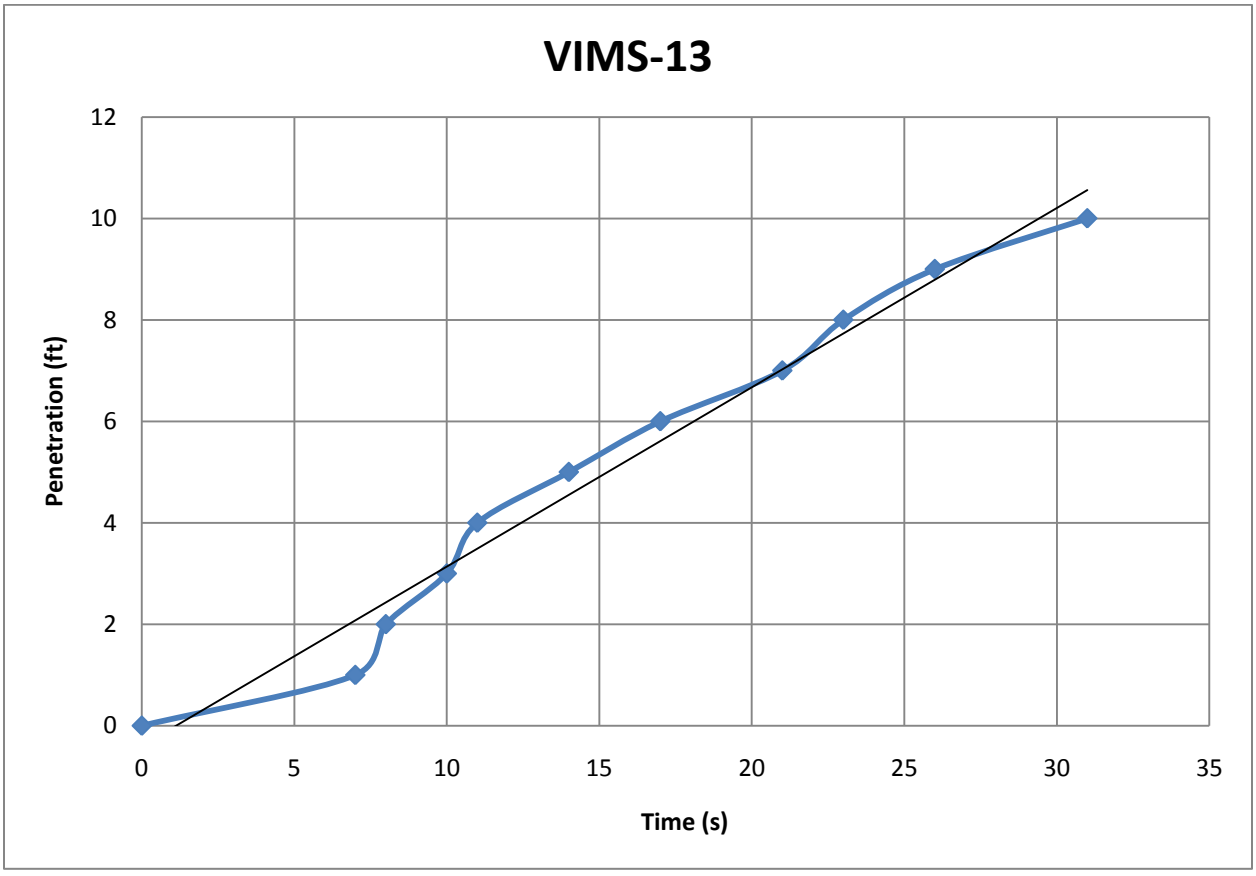

VIMS-08
Penetration (ft)
Time (s)
0
2
4
6
8
10
12
0
5
10
15
20
25

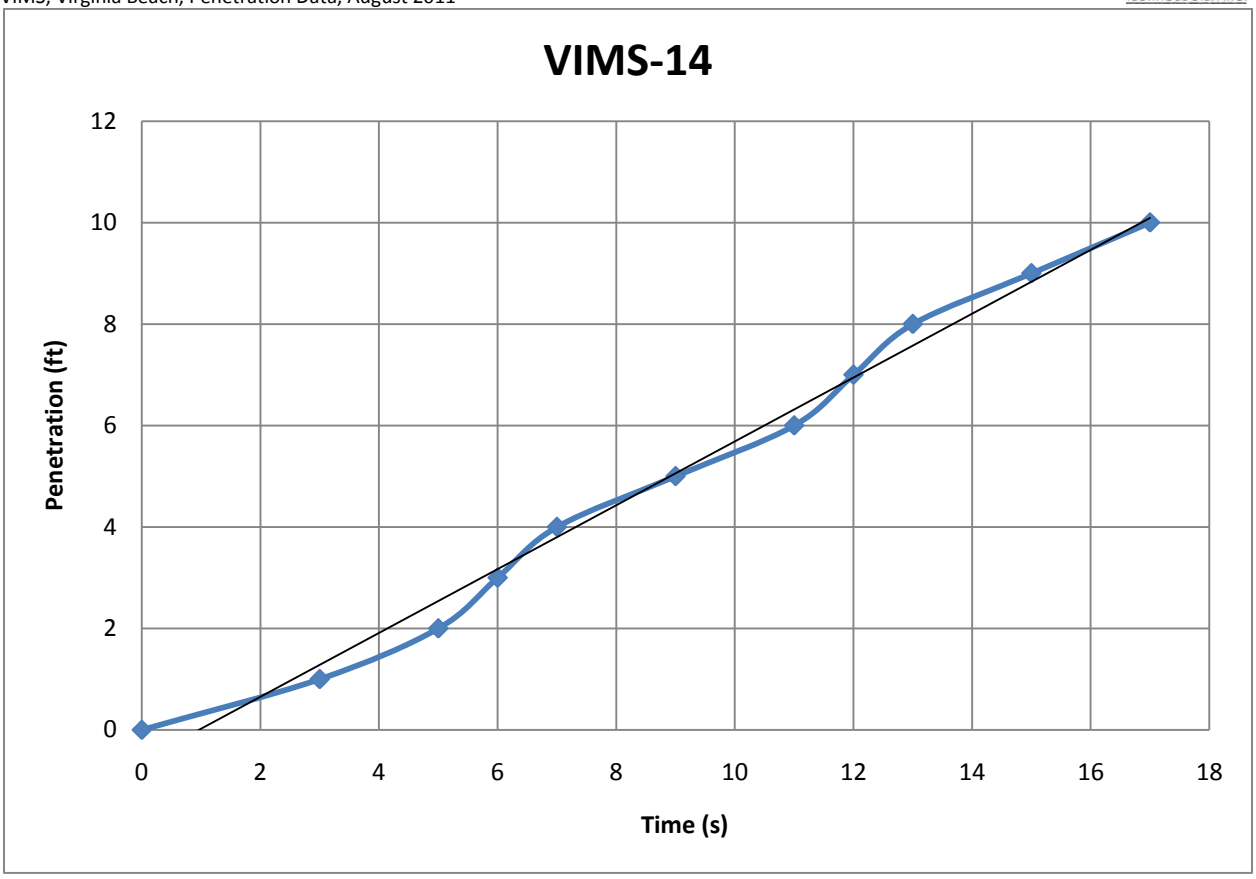

VIMS-09
Penetration (ft)
Time (s)
0
2
4
6
8
10
12
0
2
4
6
8
10
12
14
16
18
20

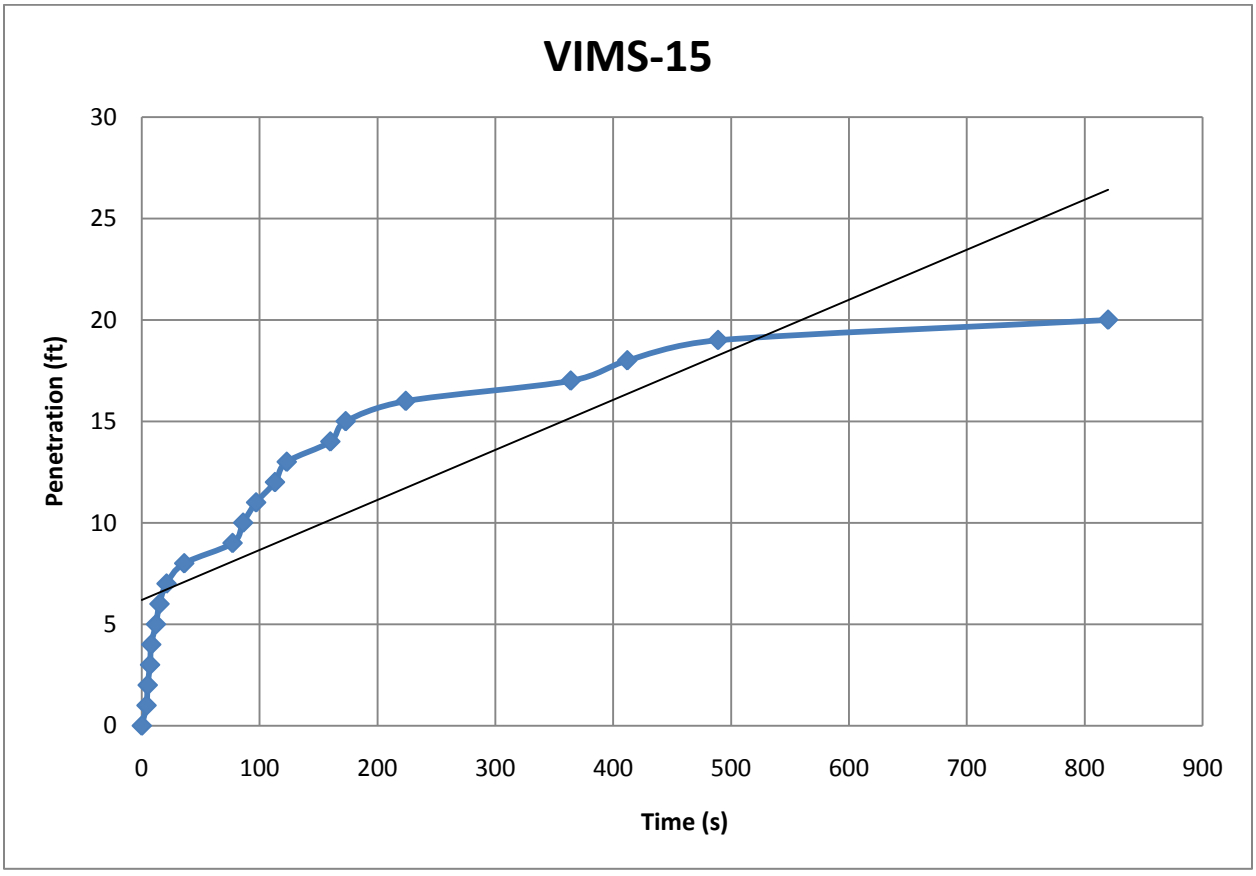

VIMS-10
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
Time (s)

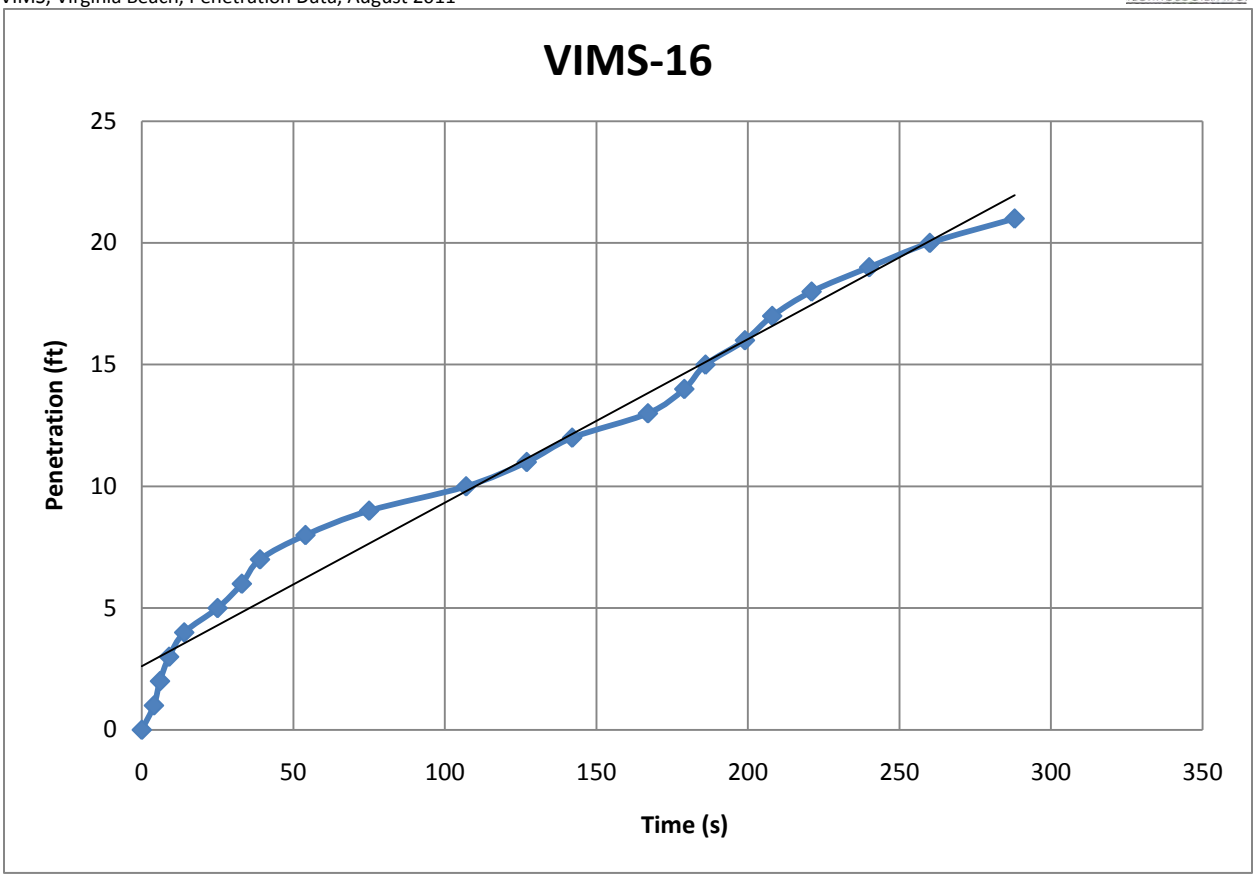

VIMS-11
Penetration (ft)
0
2
4
6
8
10
12
14
0
20
40
60
80
100
120
Time (s)

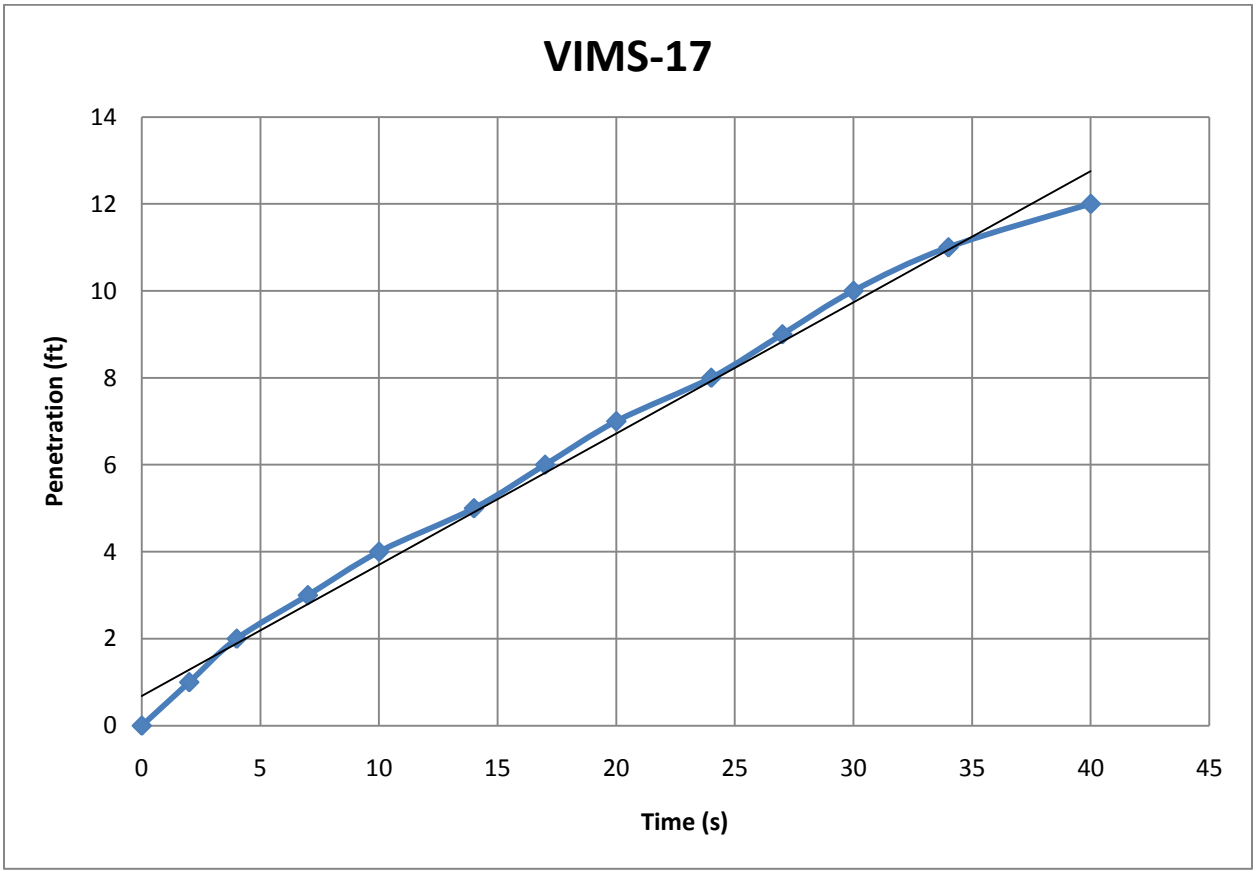

VIMS-12
Penetration (ft)
0
2
4
6
8
10
12
14
0
20
40
60
80
100
120
140
Time (s)

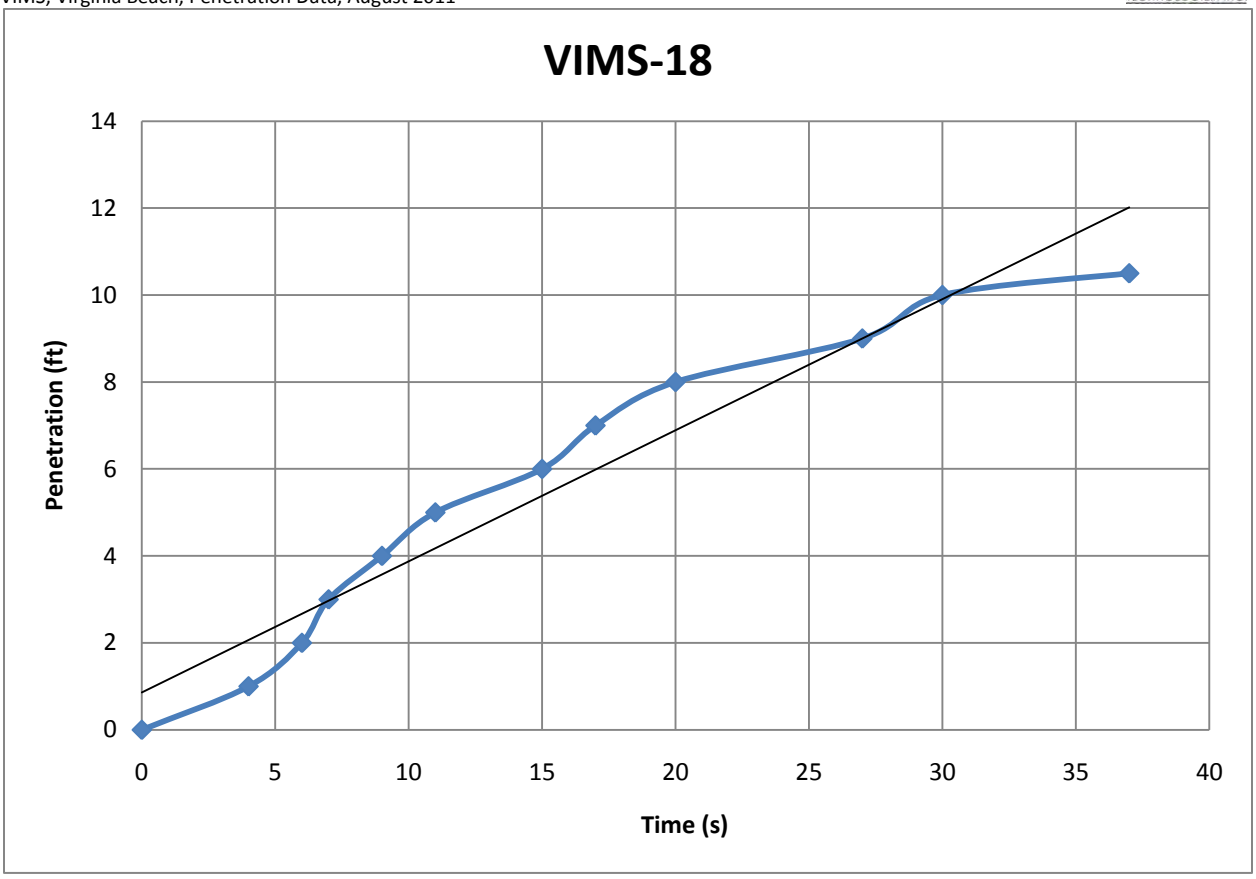

VIMS-13
Penetration (ft)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
Time (s)

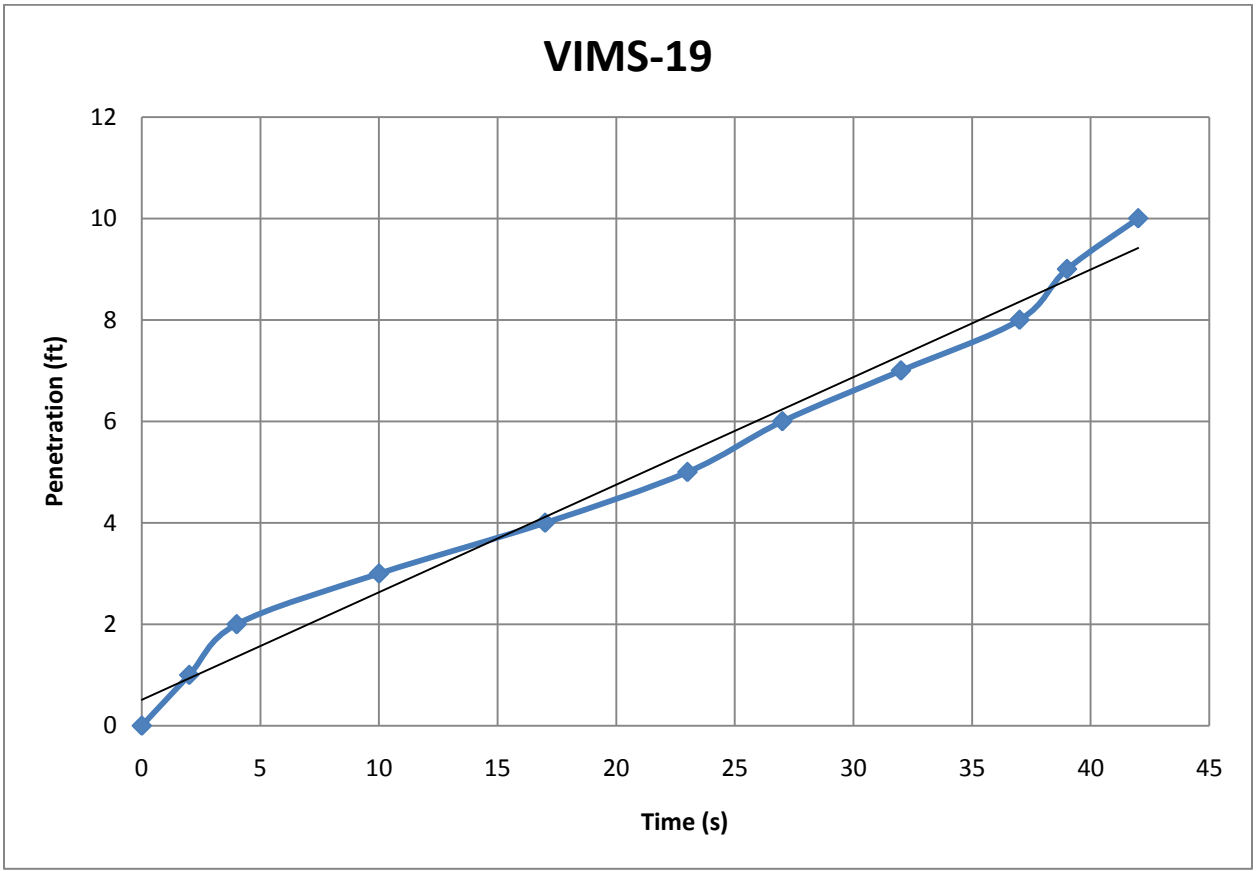

VIMS-14
Penetration (ft)
0
2
4
6
8
10
12
0
2
4
6
8
10
12
14
16
18
Time (s)

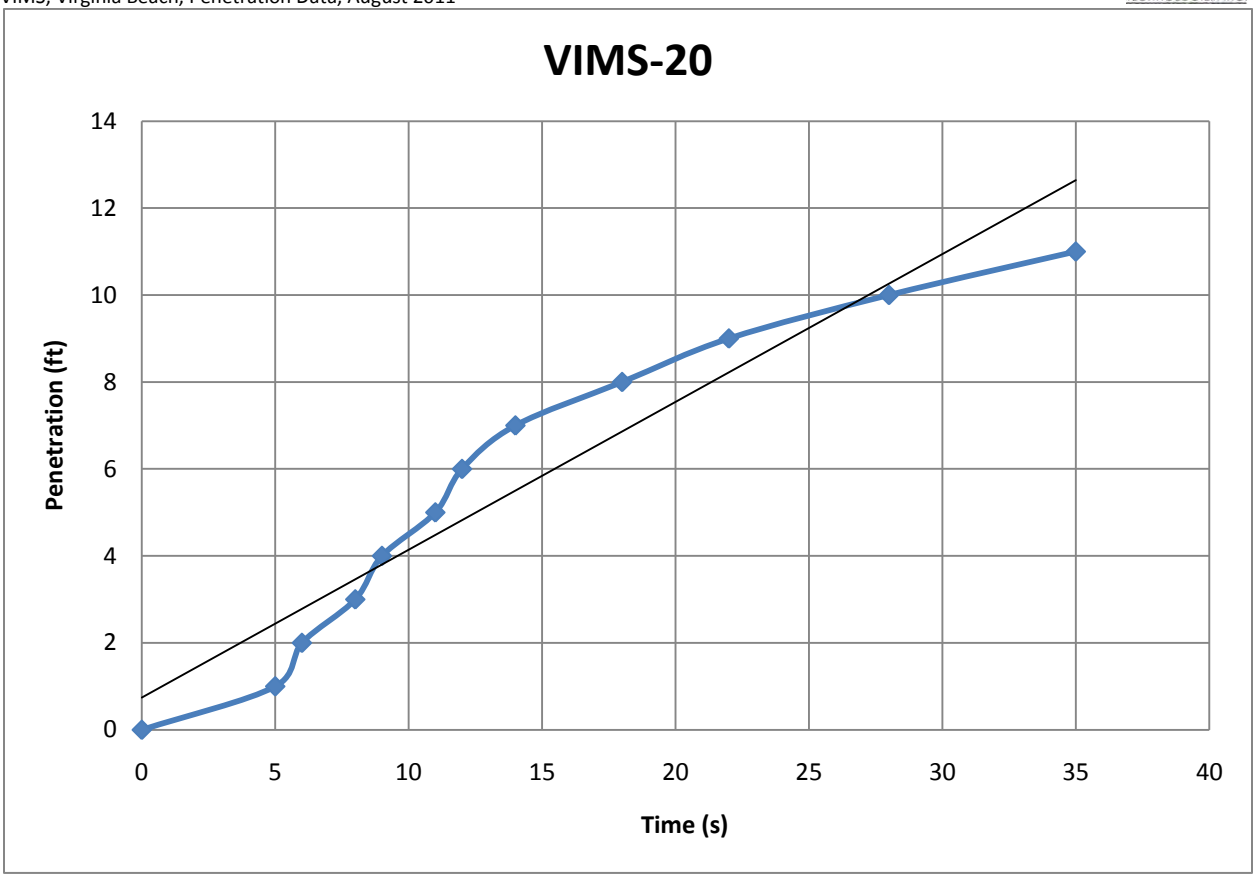

VIMS-15
Penetration (ft)
0
5
10
15
20
25
30
0
100
200
300
400
500
600
700
800
900
Time (s)

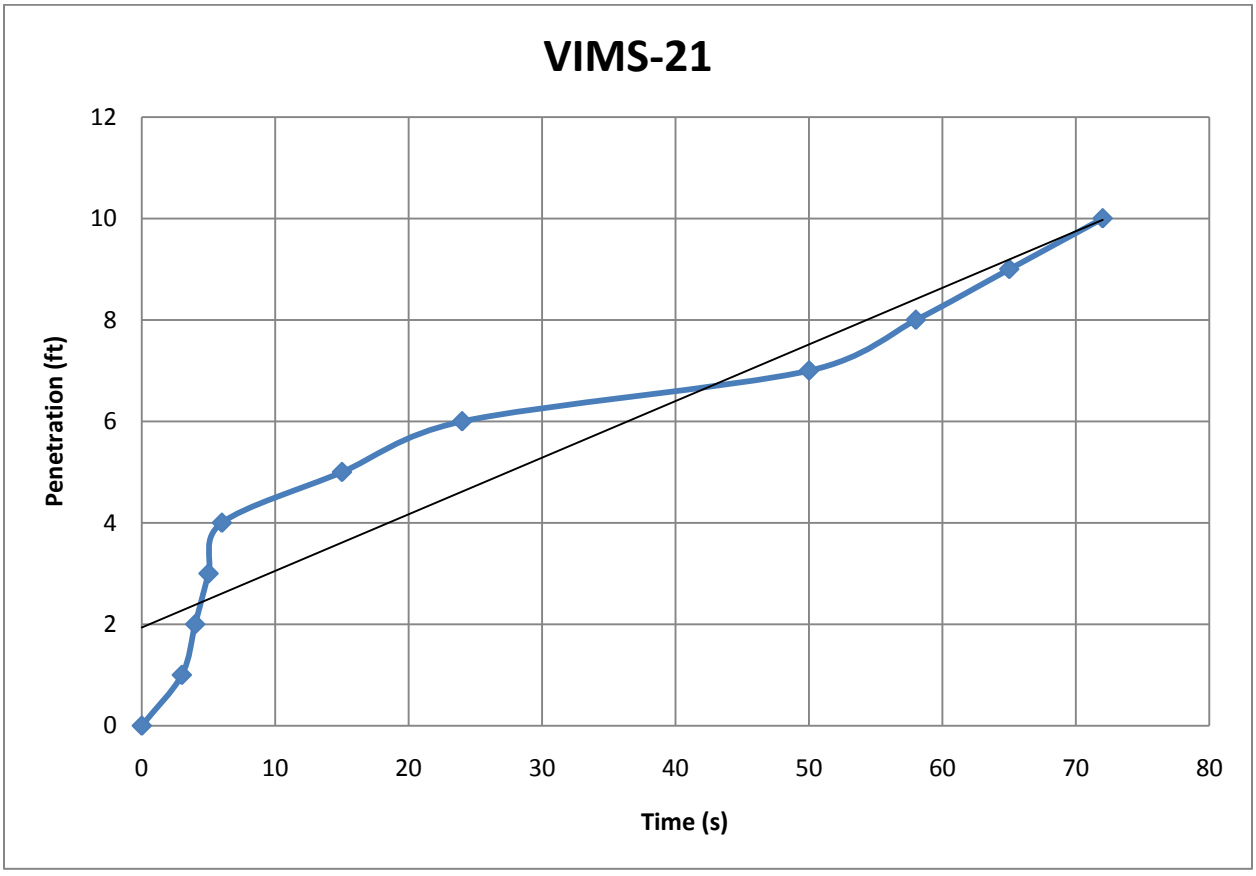

VIMS-16
Penetration (ft)
0
5
10
15
20
25
0
50
100
150
200
250
300
350
Time (s)

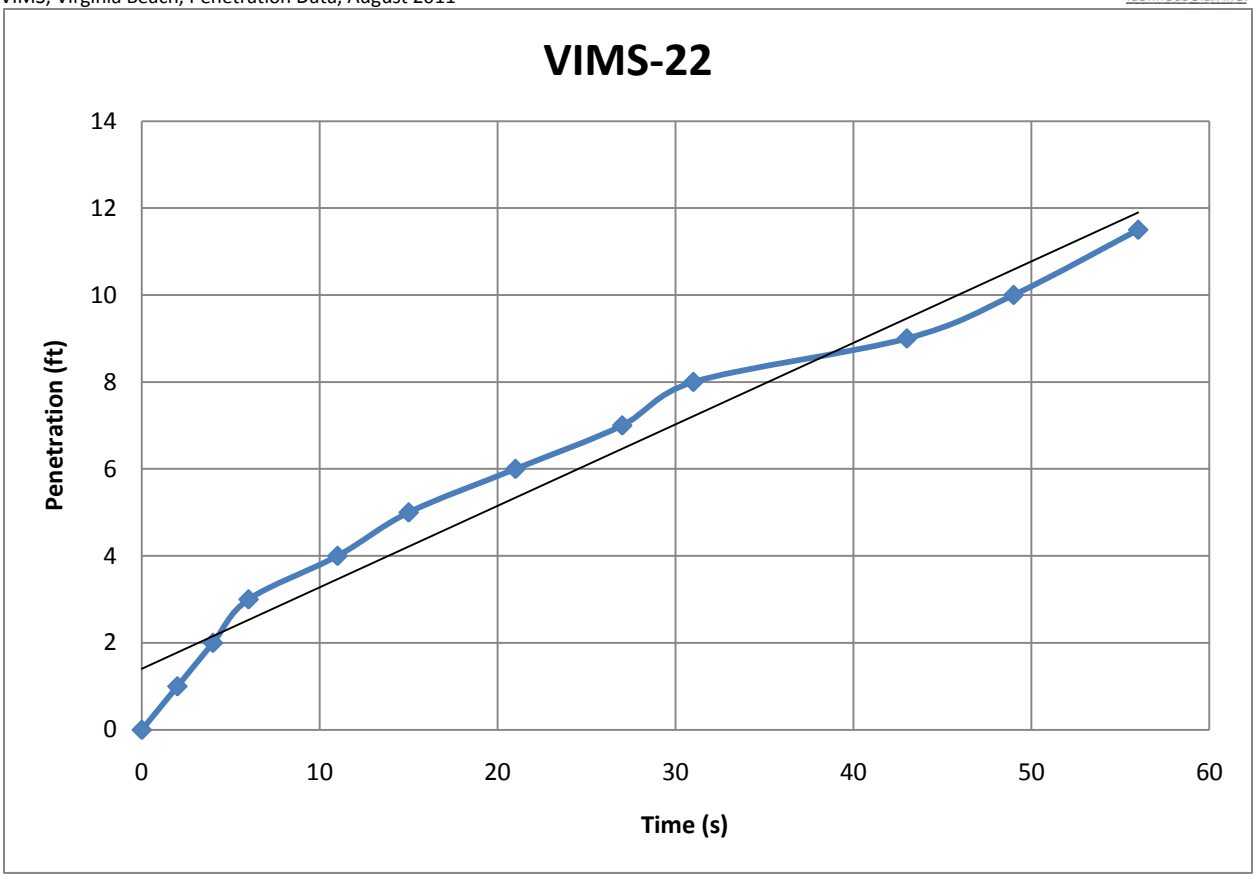

VIMS-17
Penetration (ft)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
Time (s)

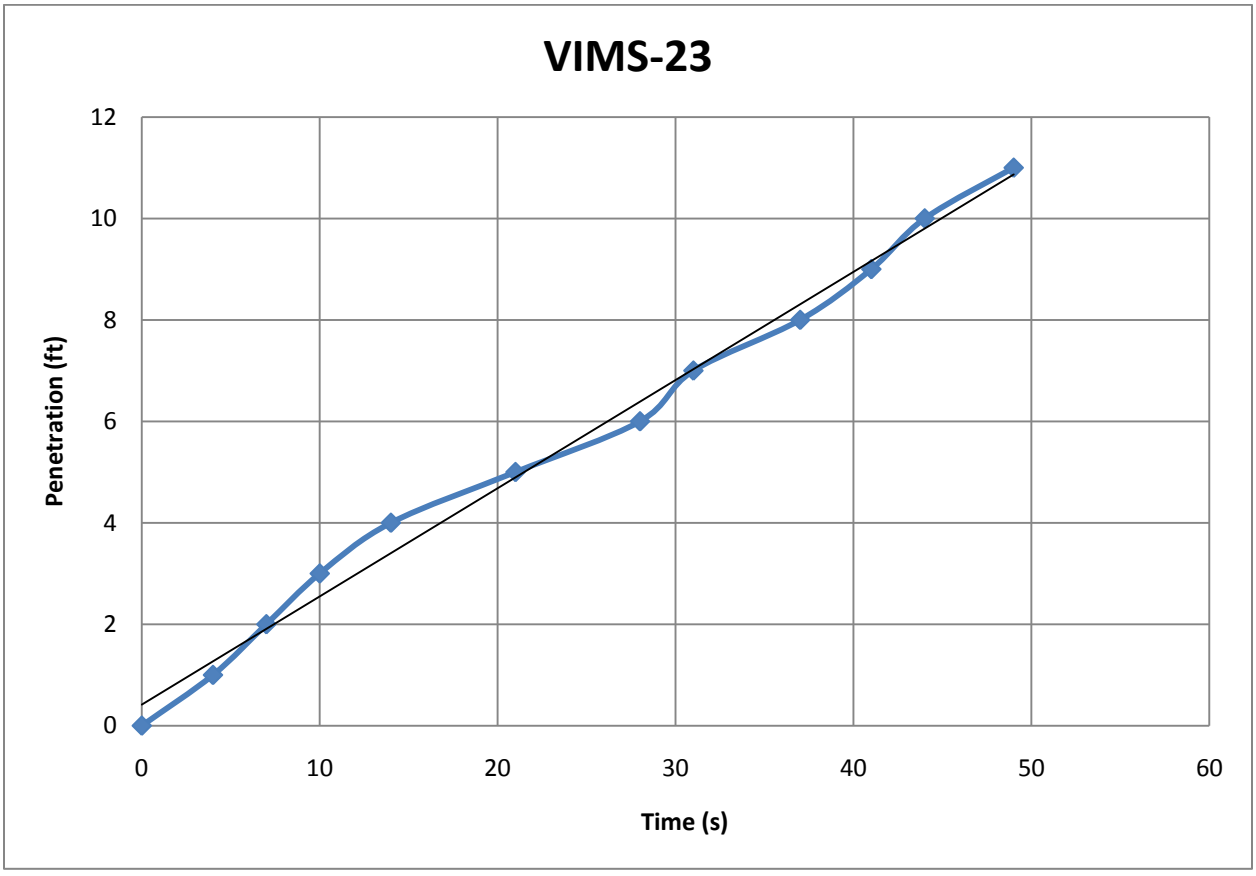

VIMS-18
Penetration (ft)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
Time (s)

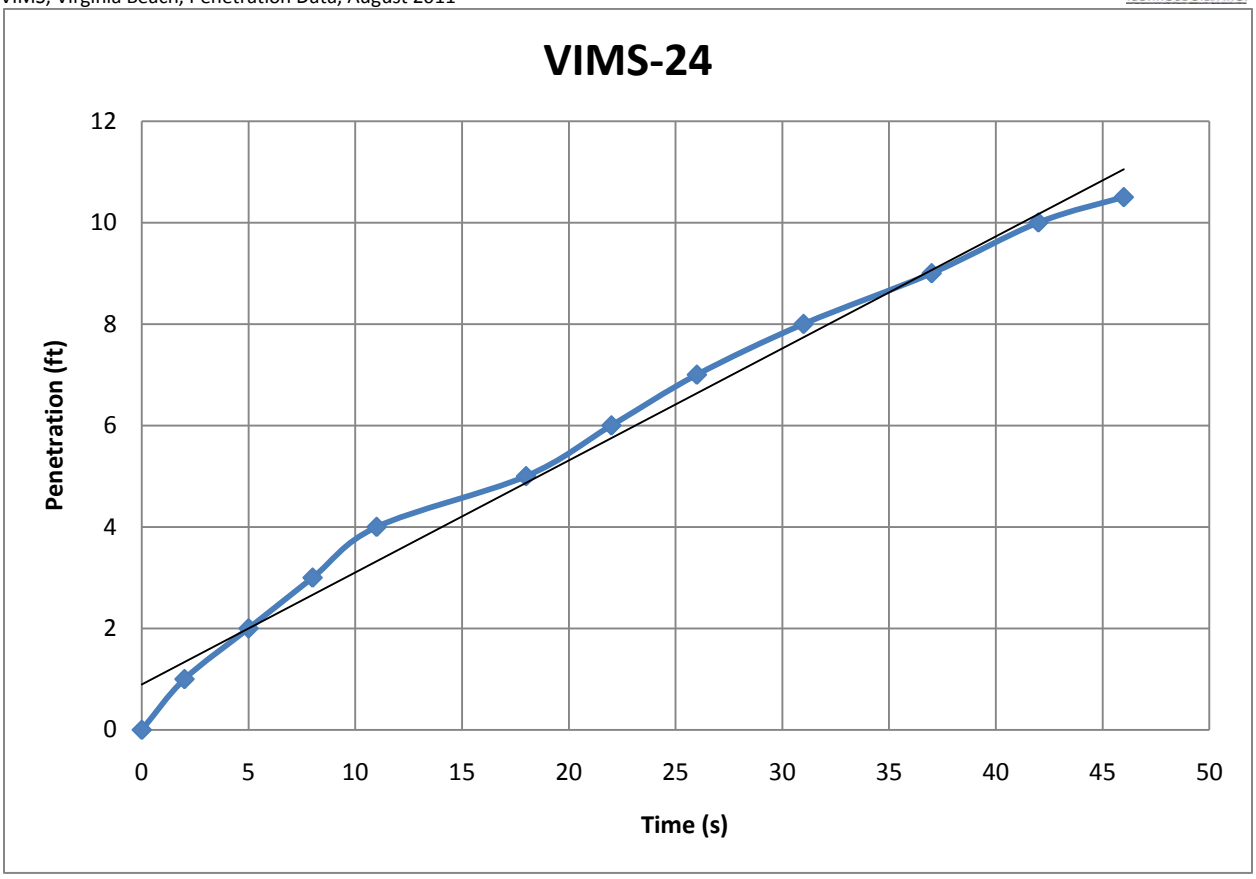

VIMS-19
Penetration (ft)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
40
45
Time (s)

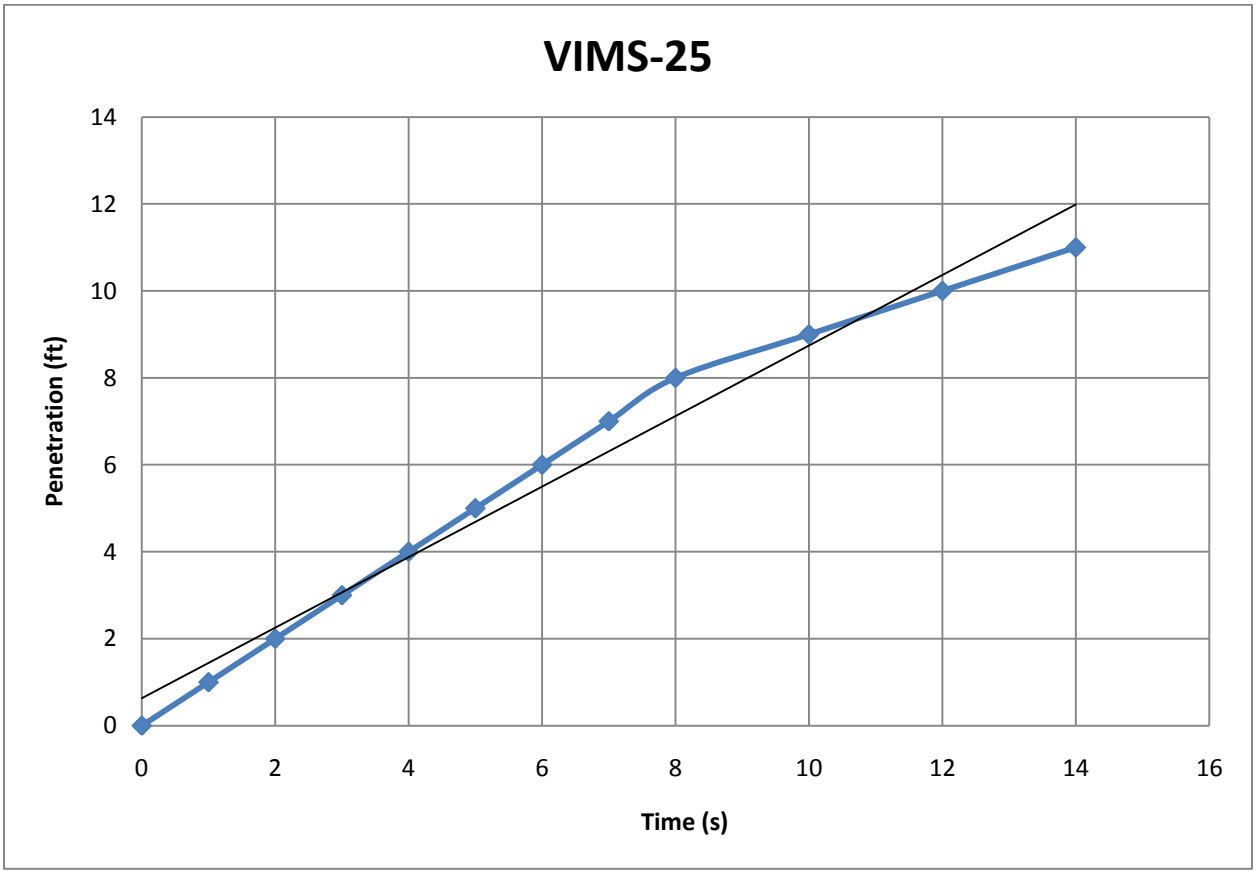

VIMS-20
Penetration (ft)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
Time (s)

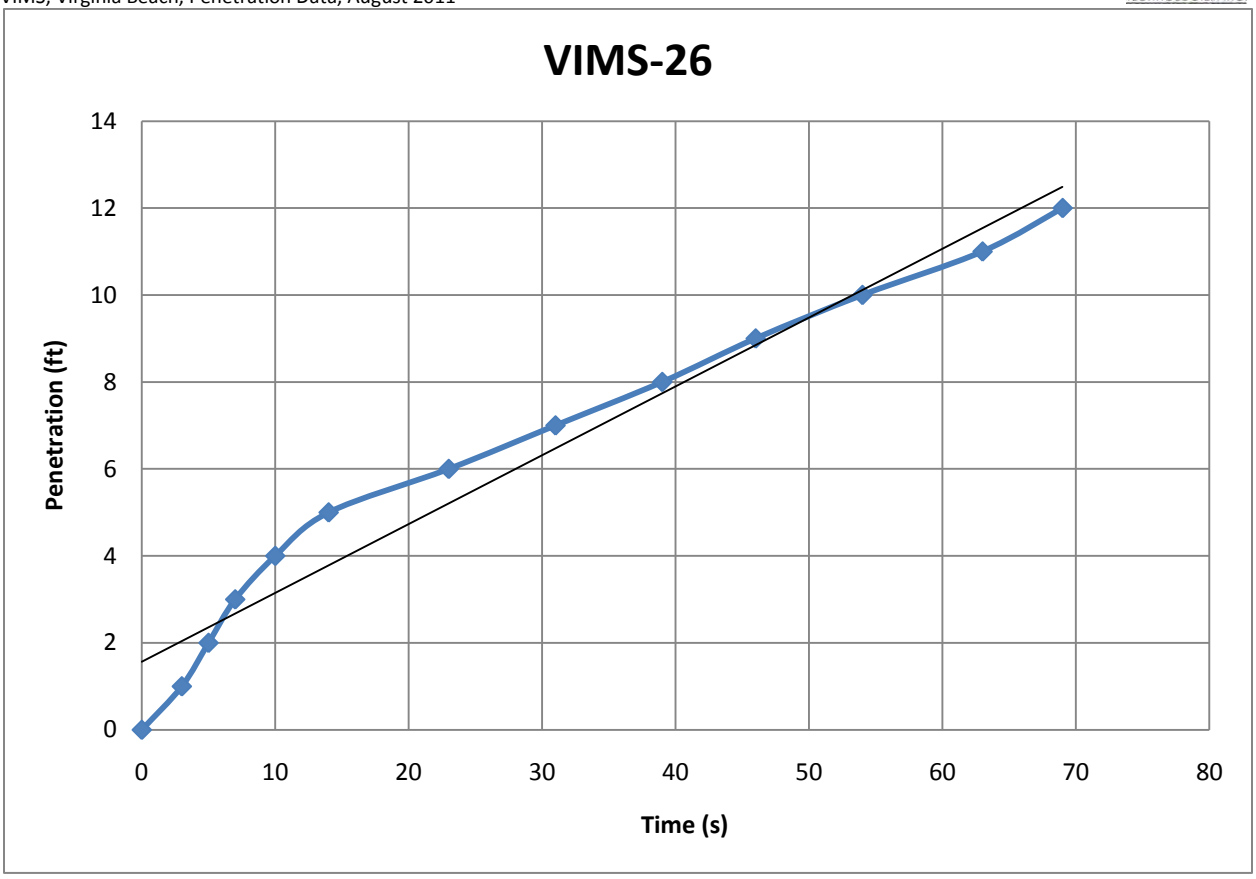

VIMS-21
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
Time (s)

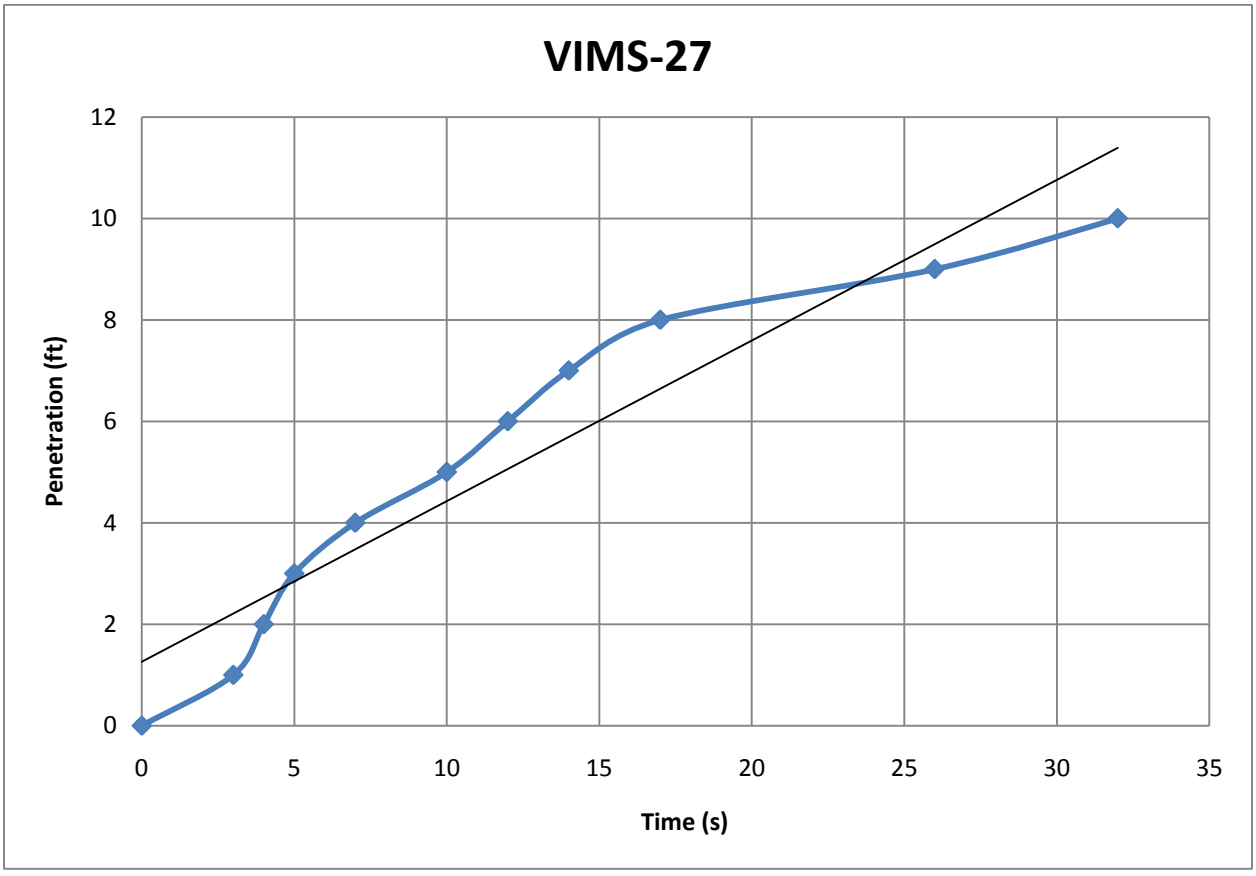

VIMS-22
Penetration (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
Time (s)

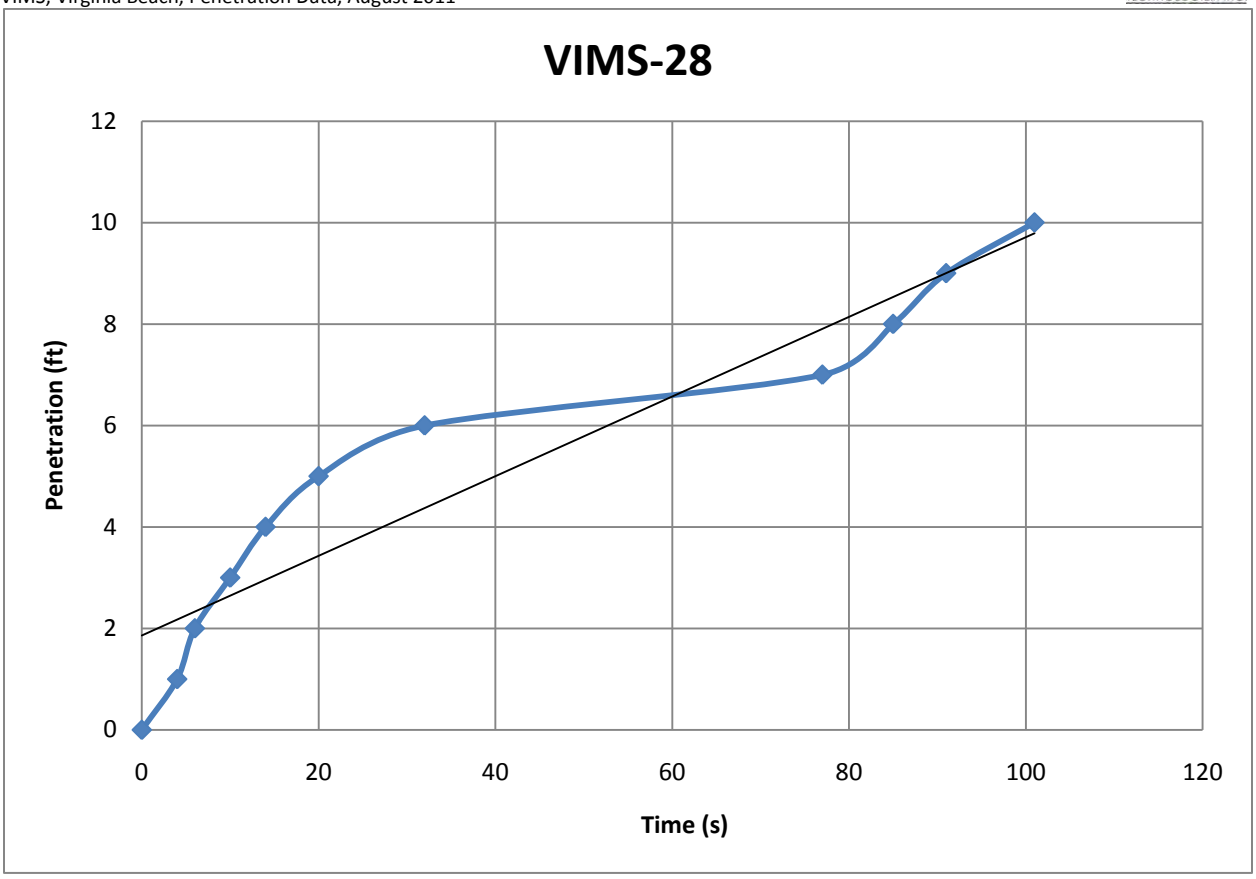

VIMS-23
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
Time (s)

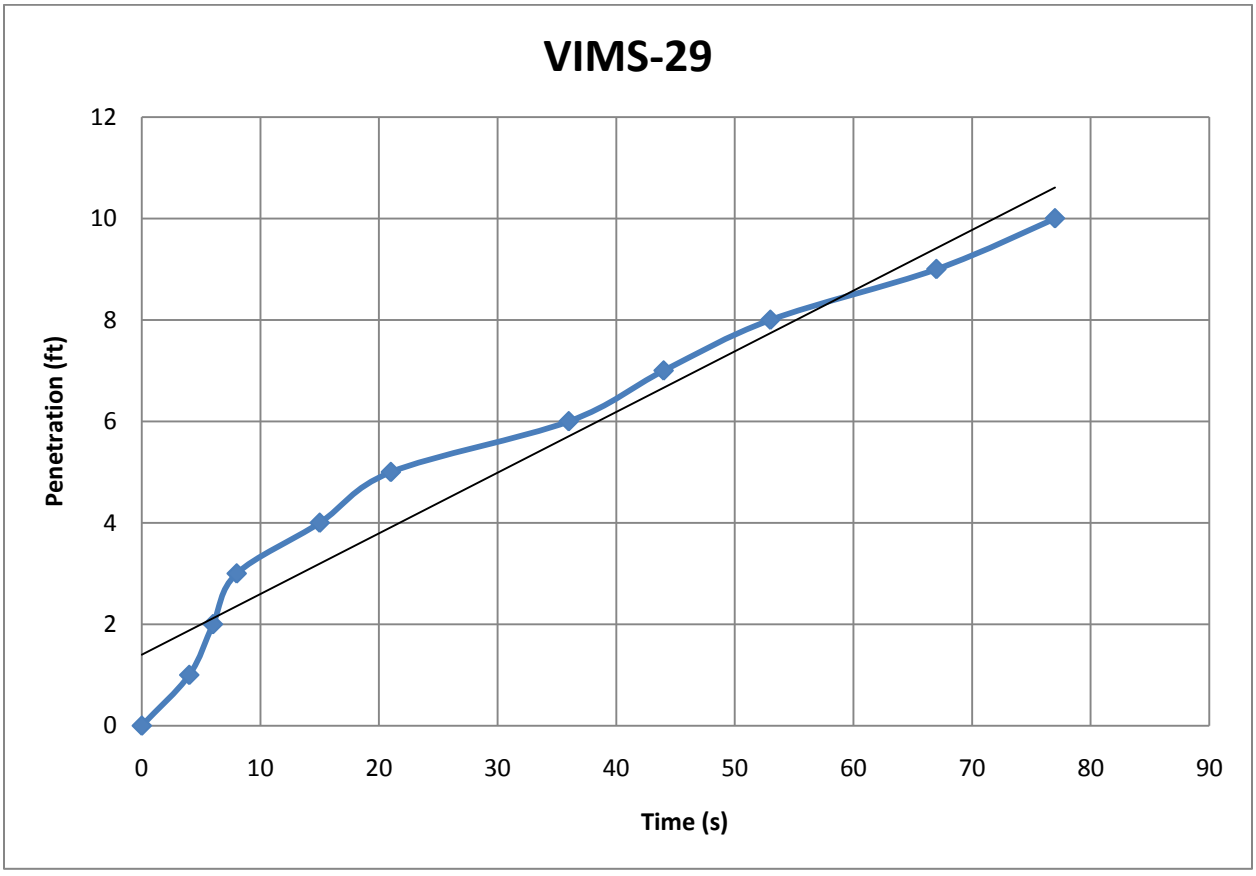

VIMS-24
Penetration (ft)
Time (s)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
40
45
50

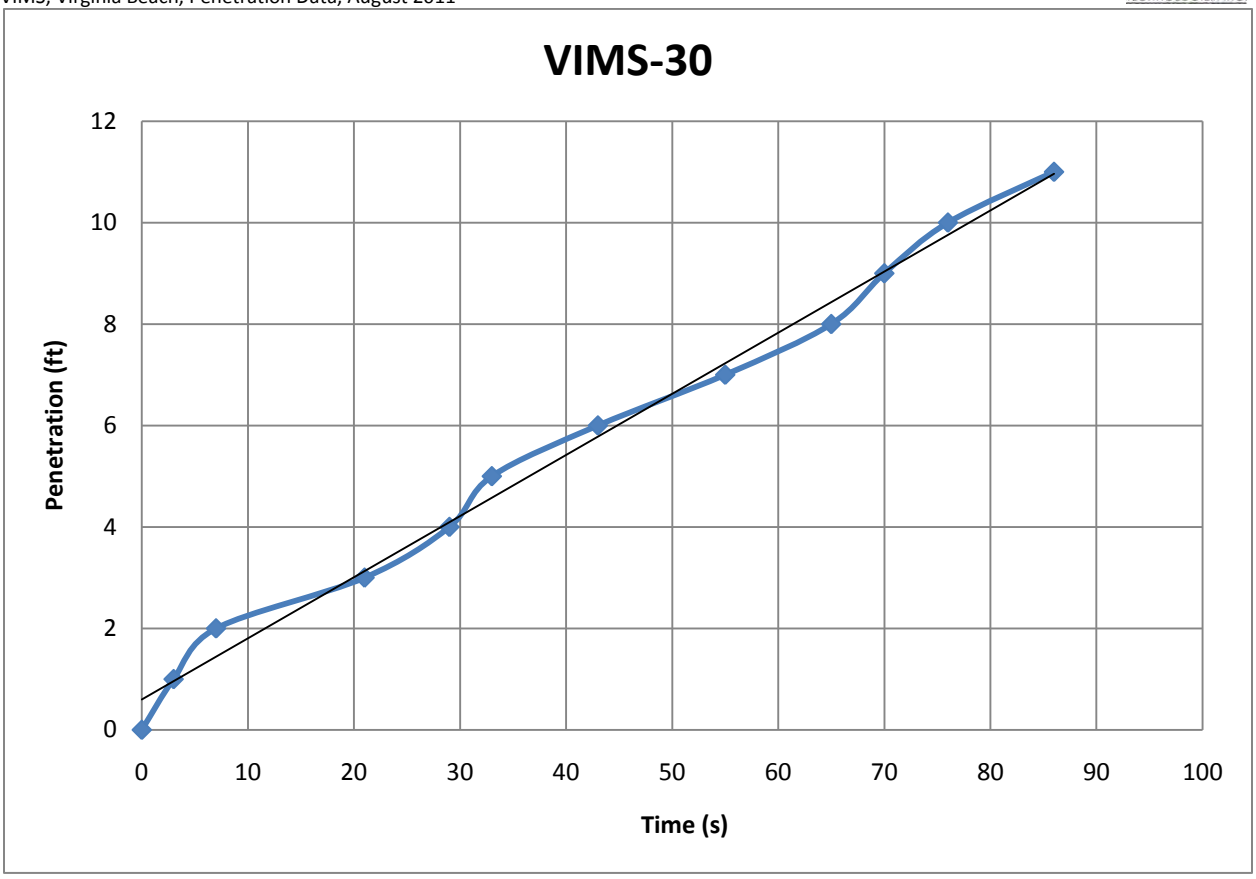

VIMS-25
Penetration (ft)
Time (s)
0
2
4
6
8
10
12
14
0
2
4
6
8
10
12
14
16

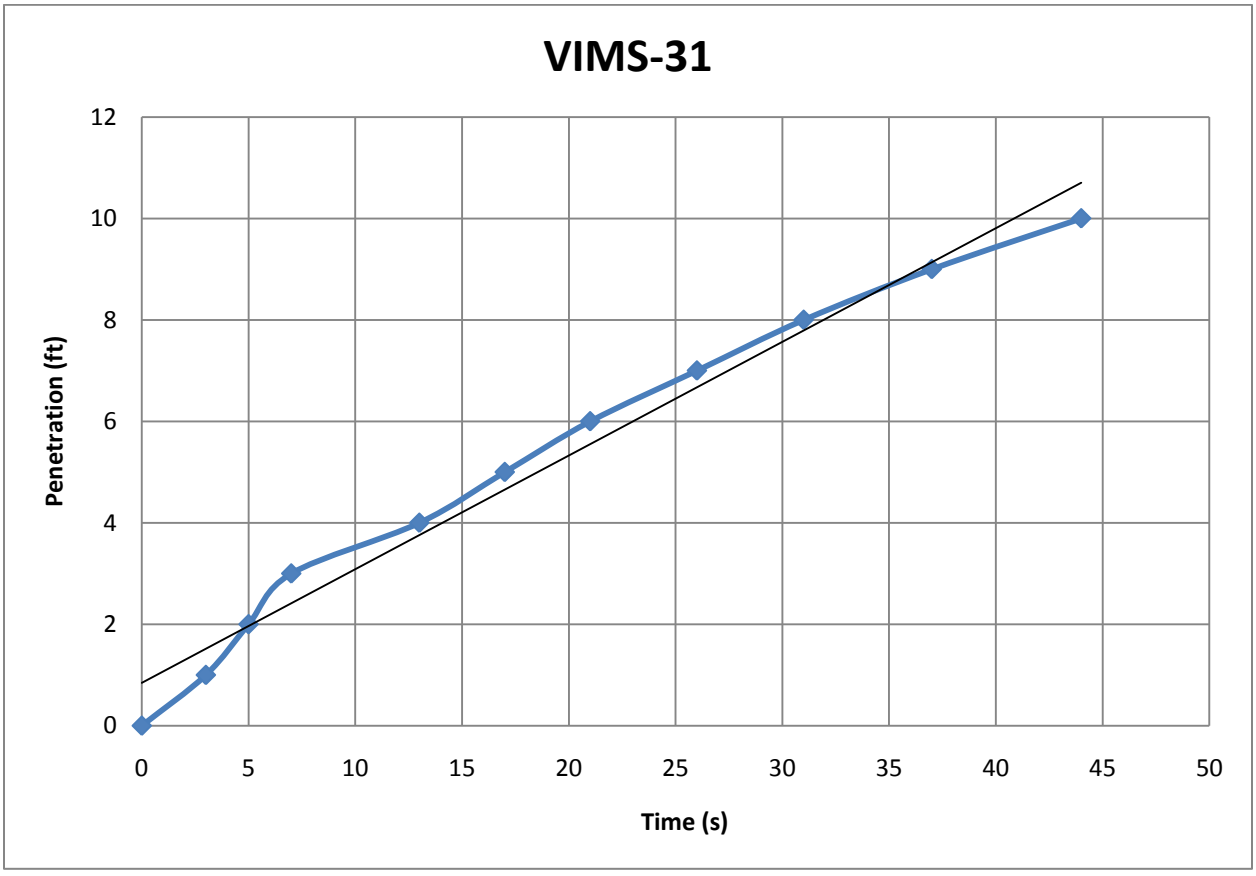

VIMS-26
Penetration (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
Time (s)

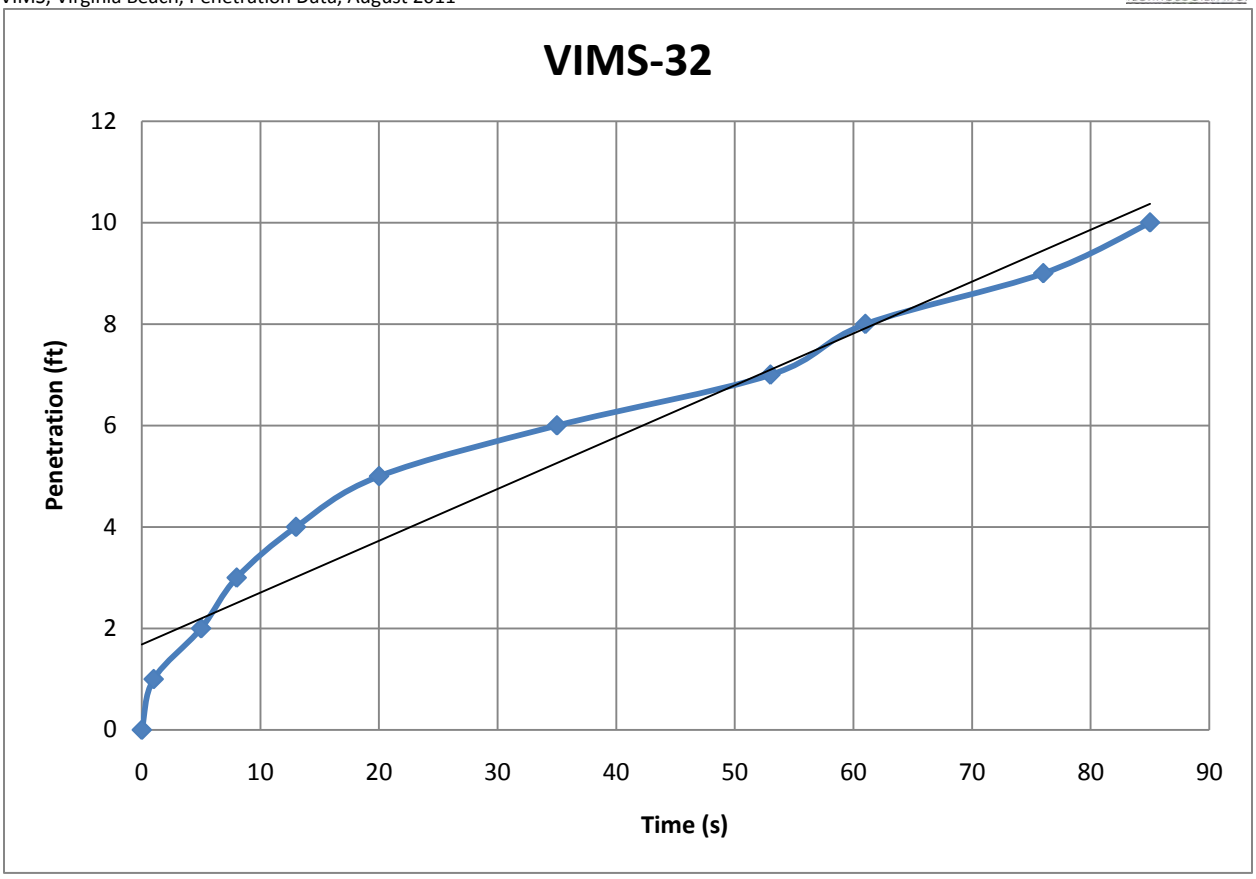

VIMS-27
Penetration (ft)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
Time (s)

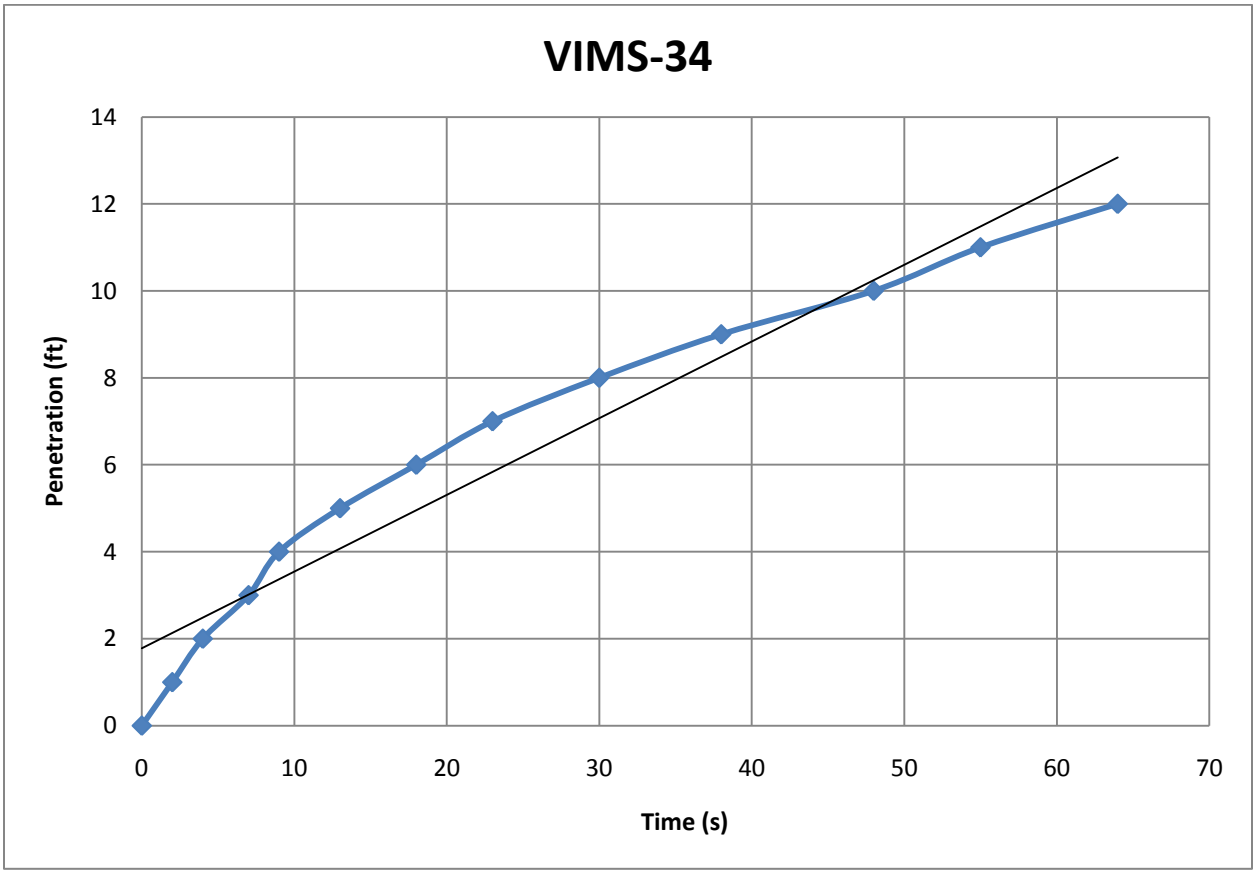

VIMS-28
Penetration (ft)
0
2
4
6
8
10
12
0
20
40
60
80
100
120
Time (s)

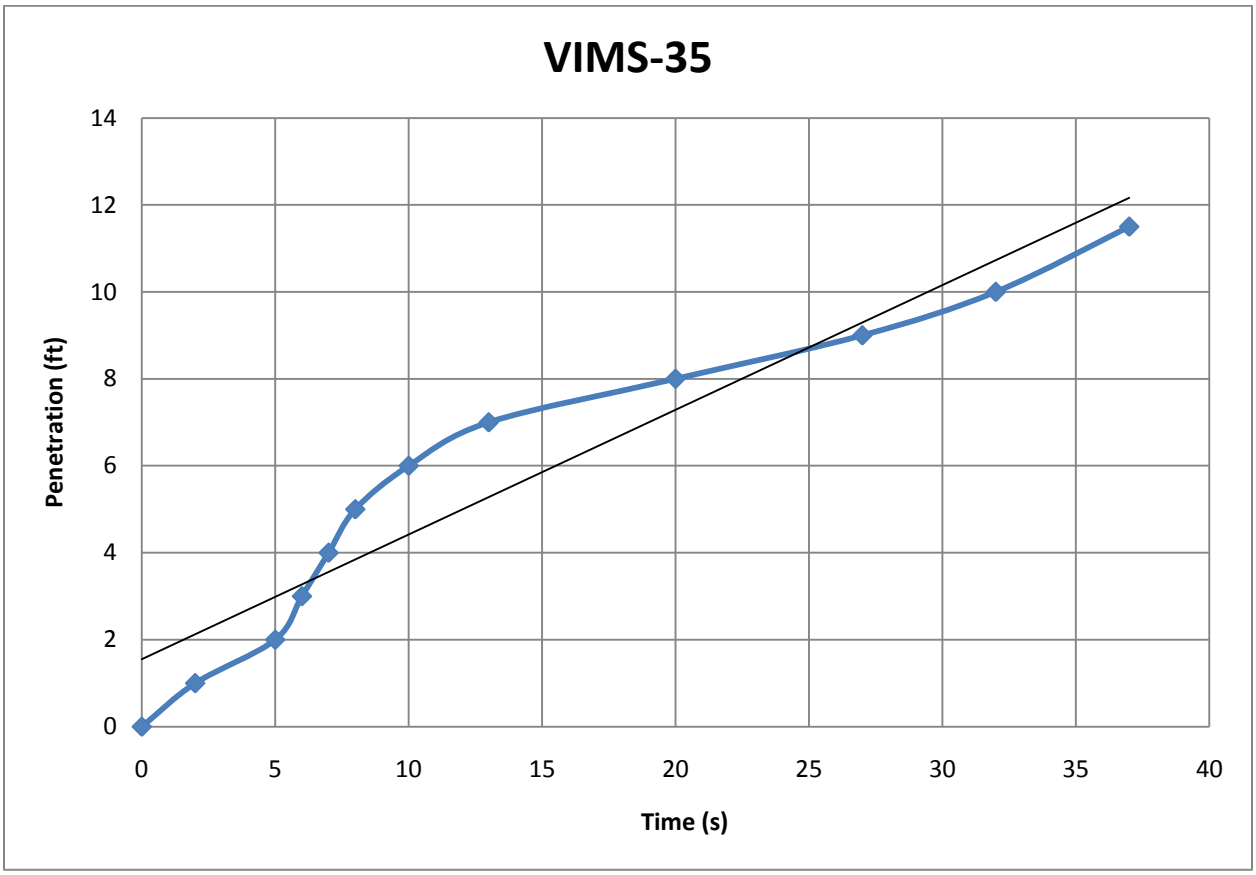

VIMS-29
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Time (s)

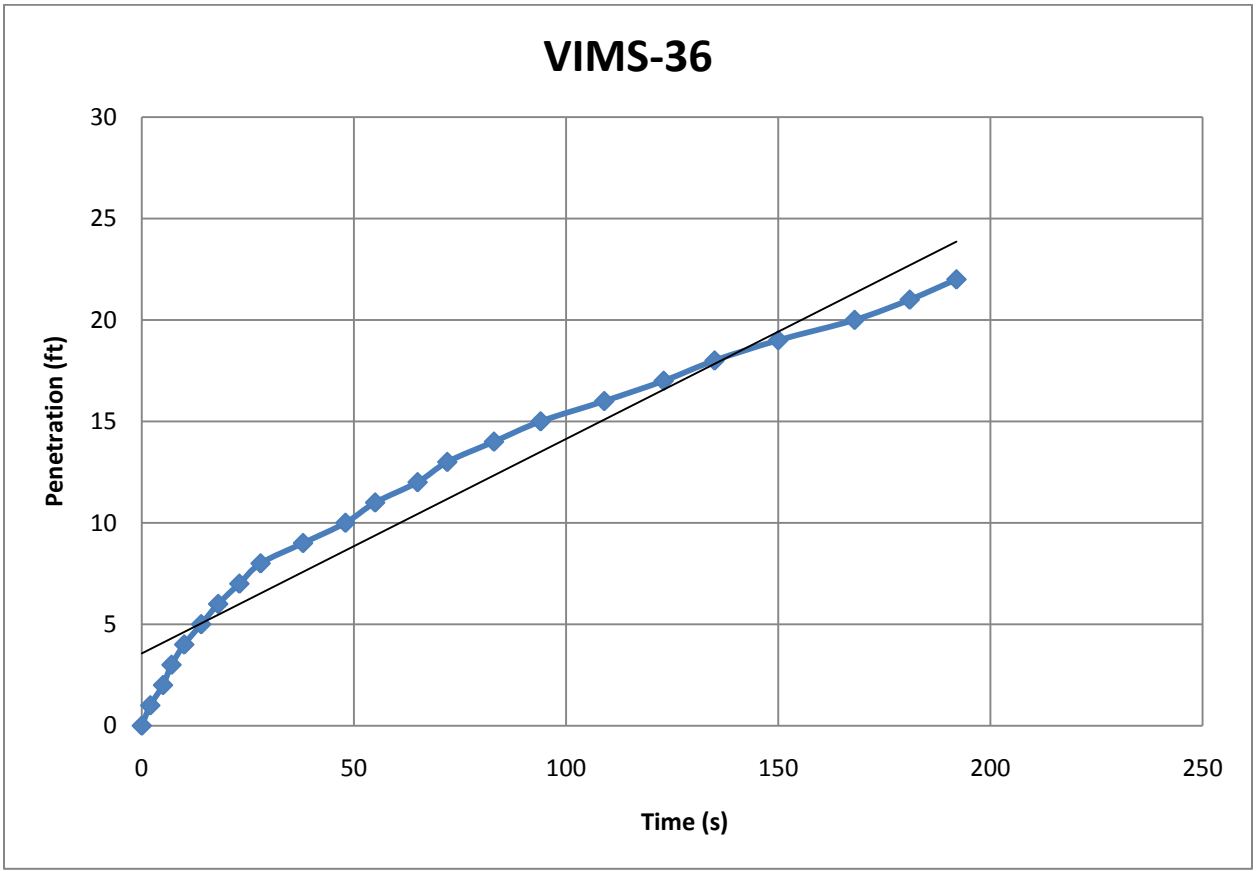

VIMS-30
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
100
Time (s)

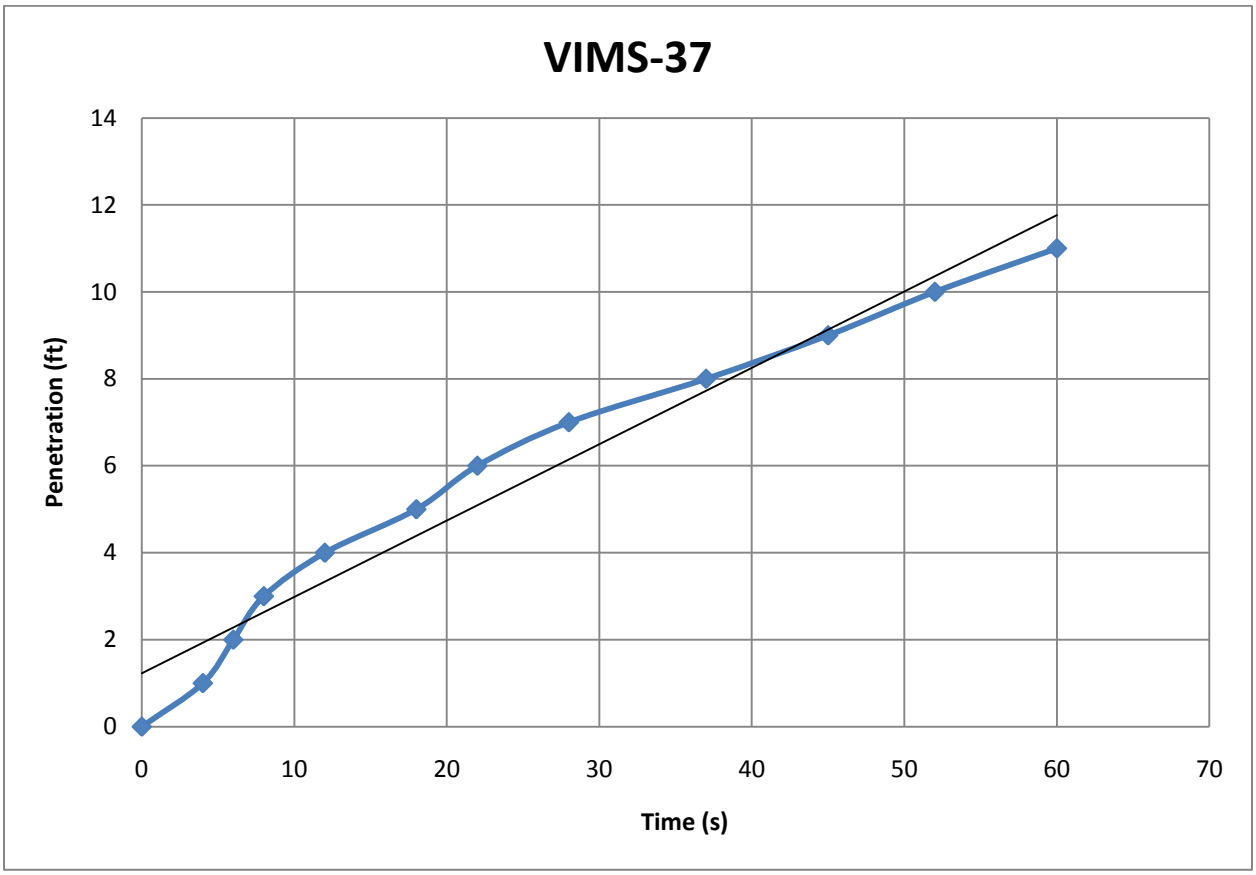

VIMS-31
Penetration (ft)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
40
45
50
Time (s)

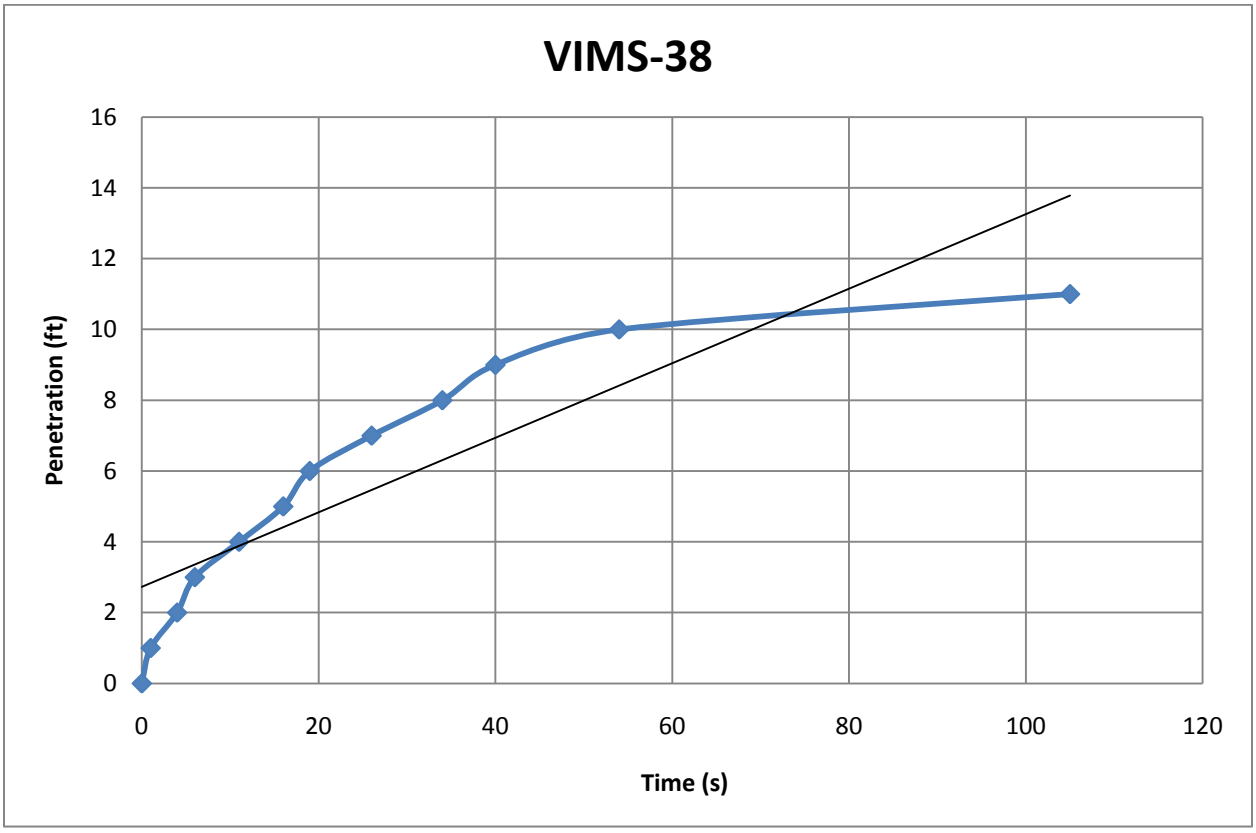

VIMS-32
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Time (s)

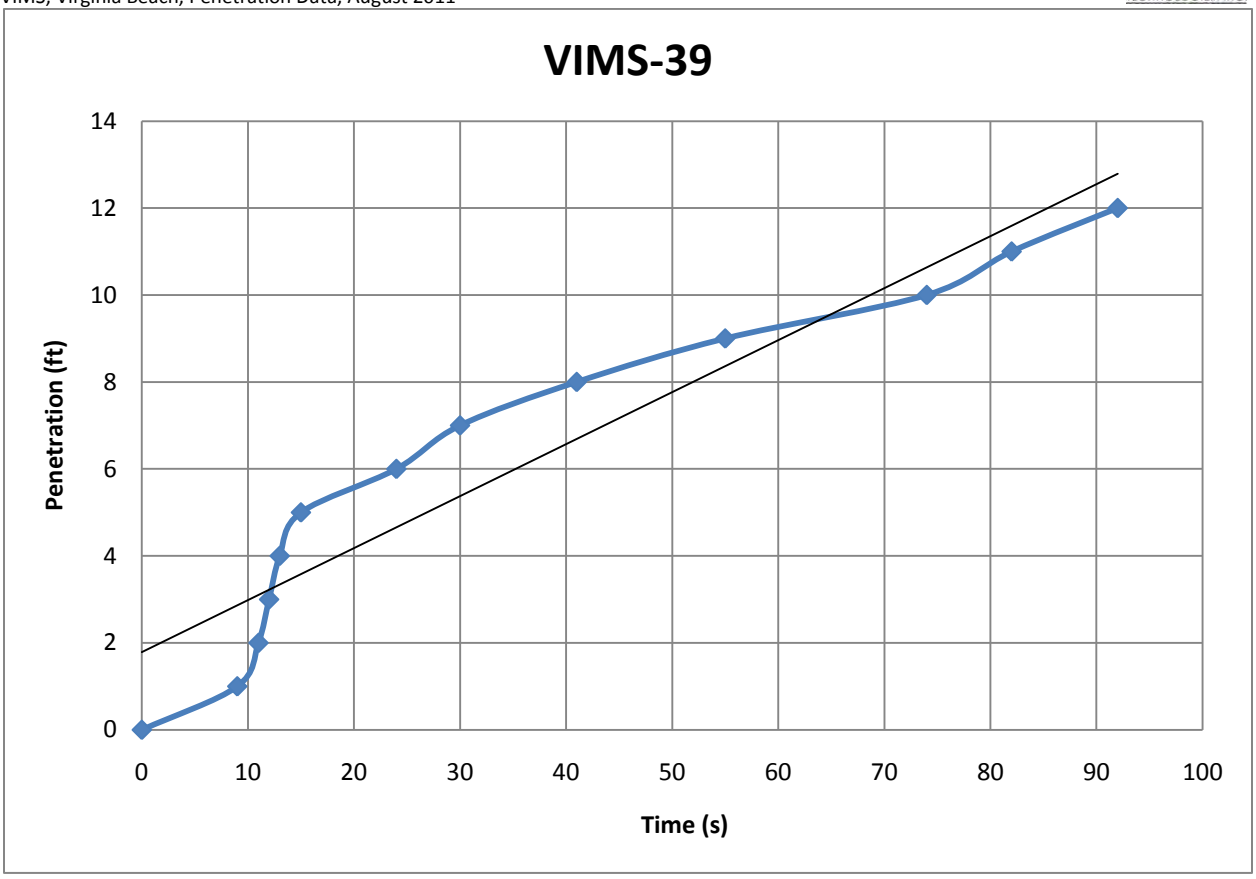

VIMS-34
Penetration (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
Time (s)

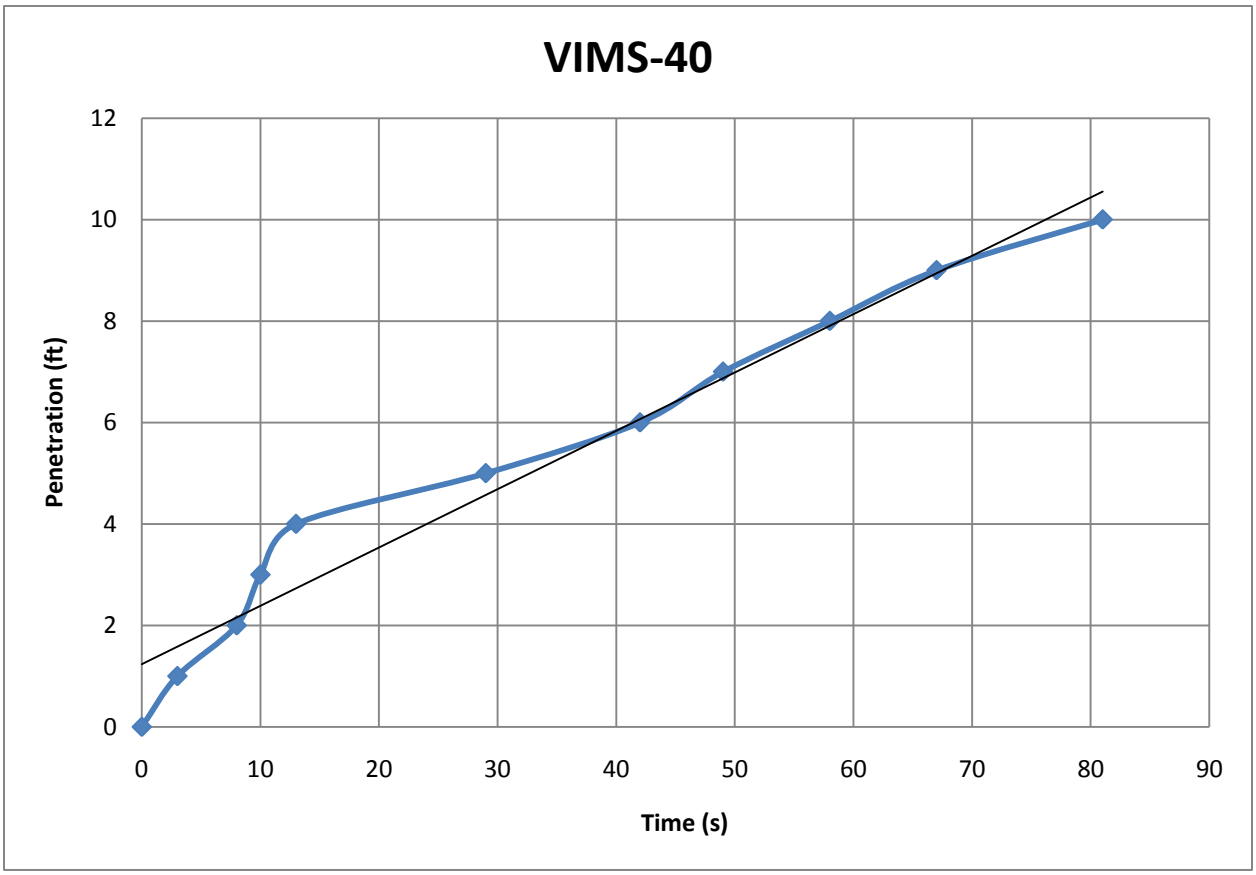

VIMS-35
Penetration (ft)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
Time (s)

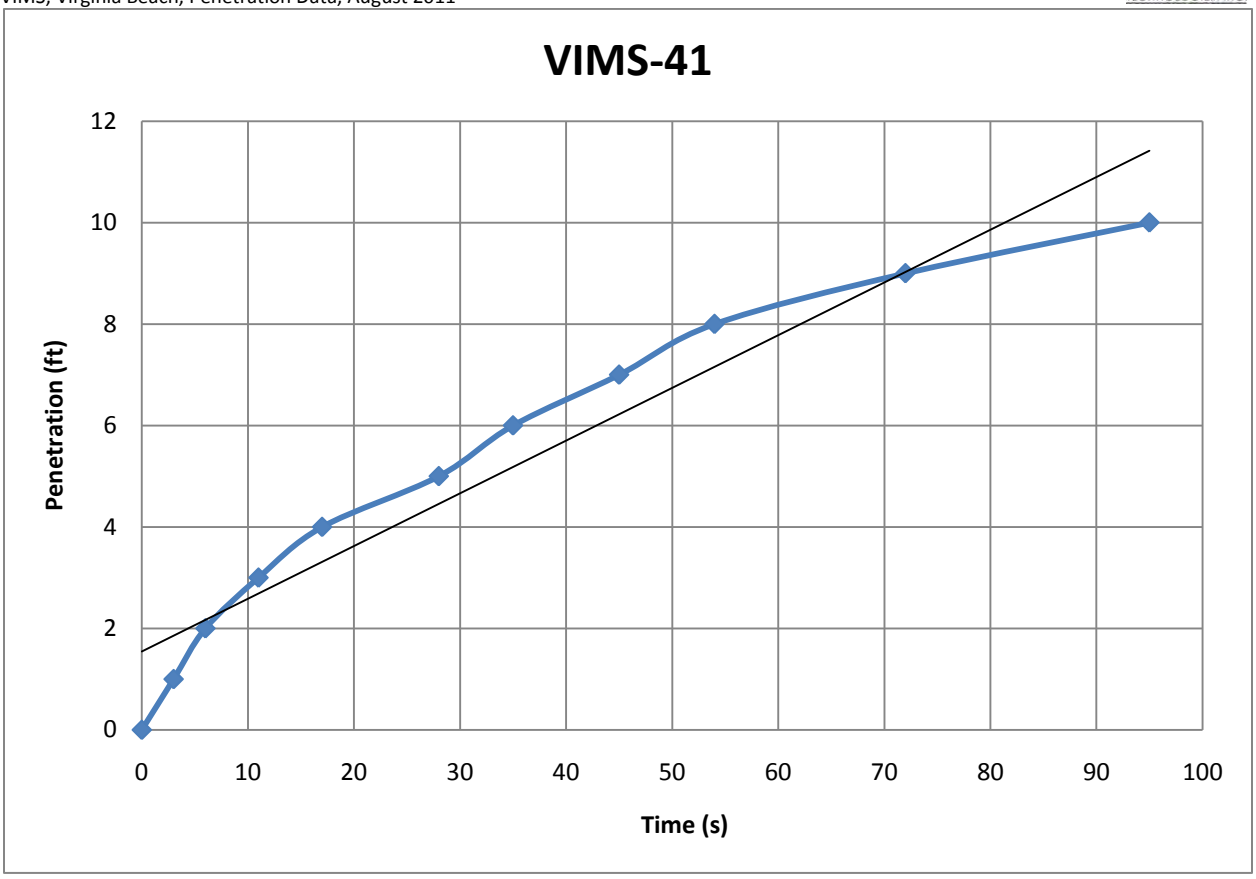

VIMS-36
Penetration (ft)
0
5
10
15
20
25
30
0
50
100
150
200
250
Time (s)

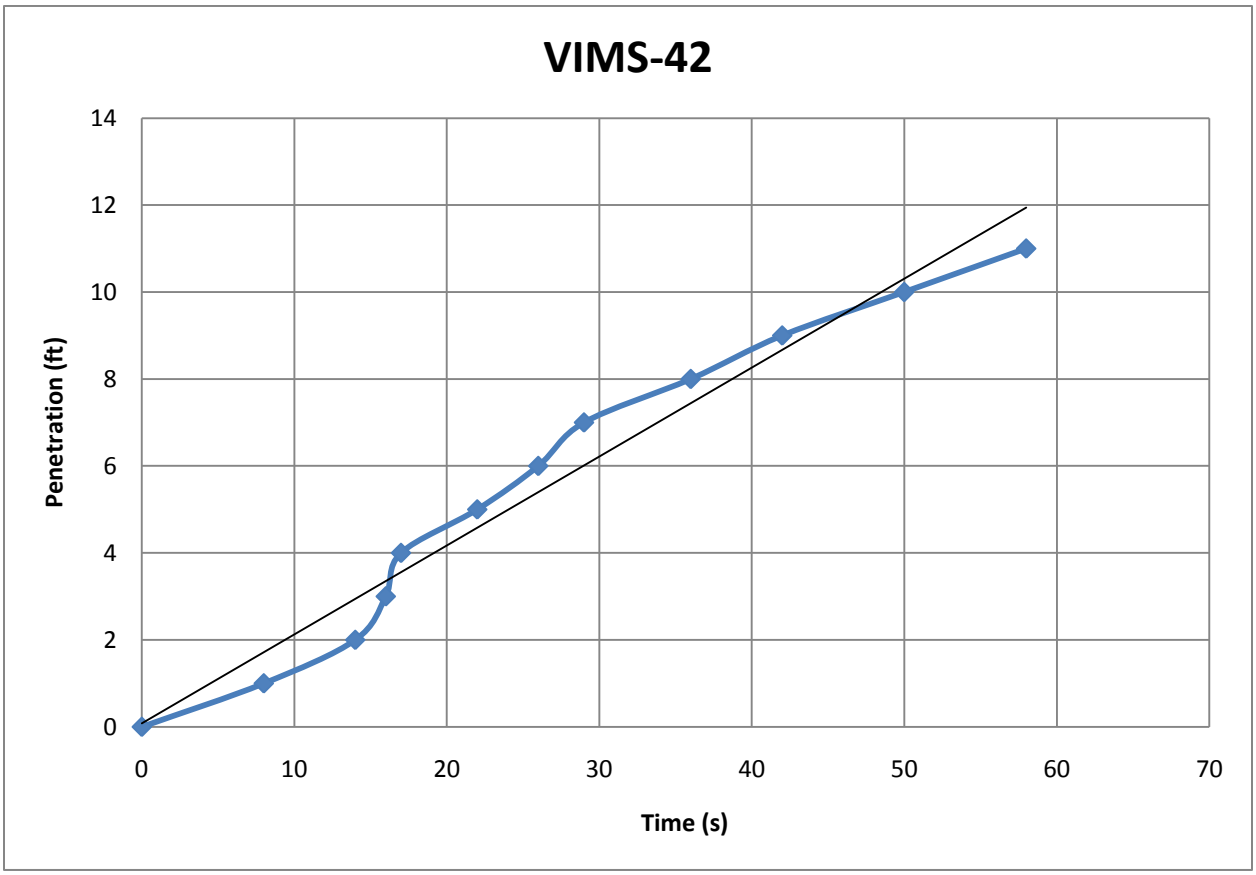

VIMS-37
Penetration (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
Time (s)


VIMS-38
Penetration (ft)
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
Time (s)


VIMS-39
Penetration (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100
Time (s)


VIMS-40
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Time (s)

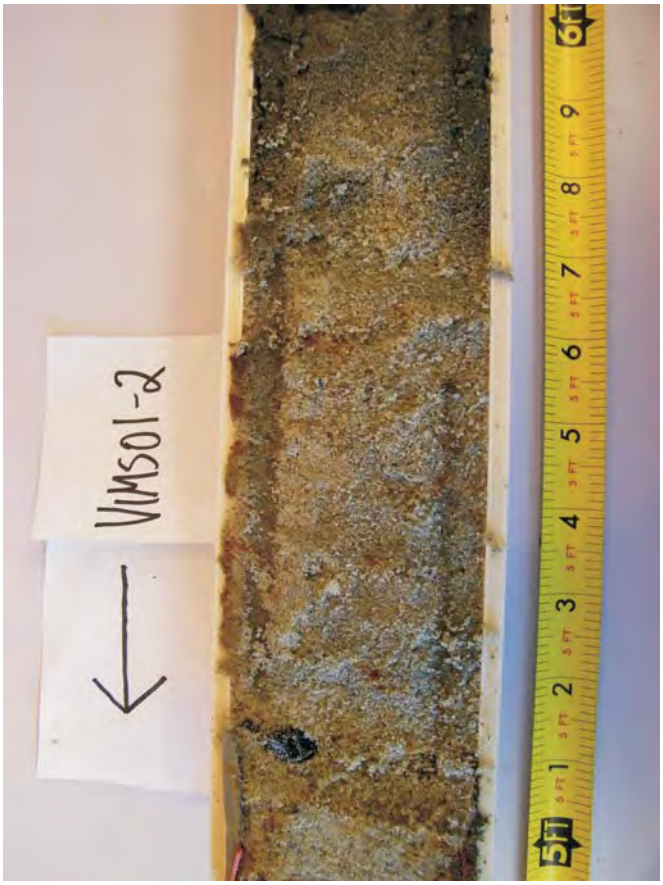

VIMS-41
Penetration (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
100
Time (s)

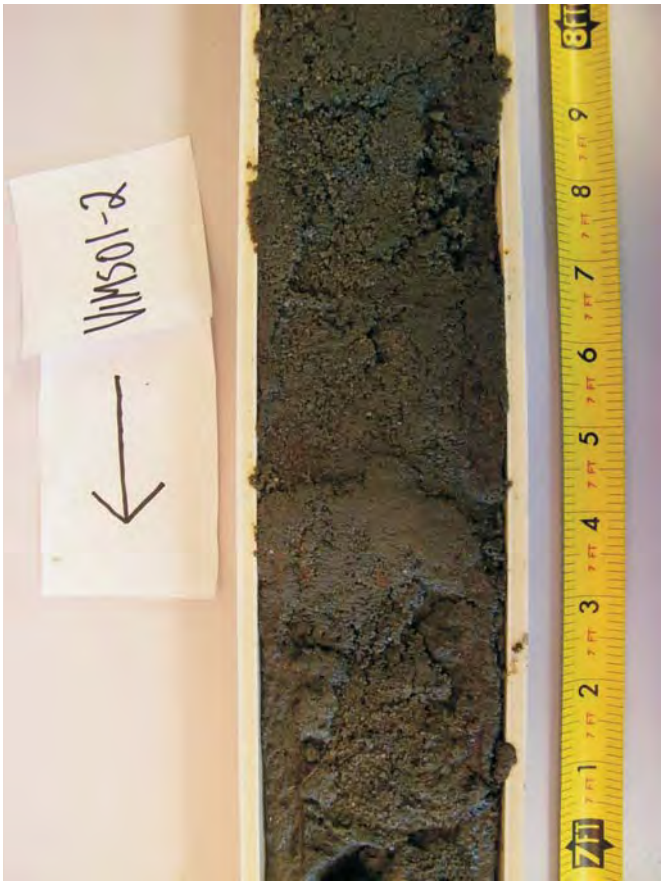

VIMS-42
Penetration (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
Time (s)

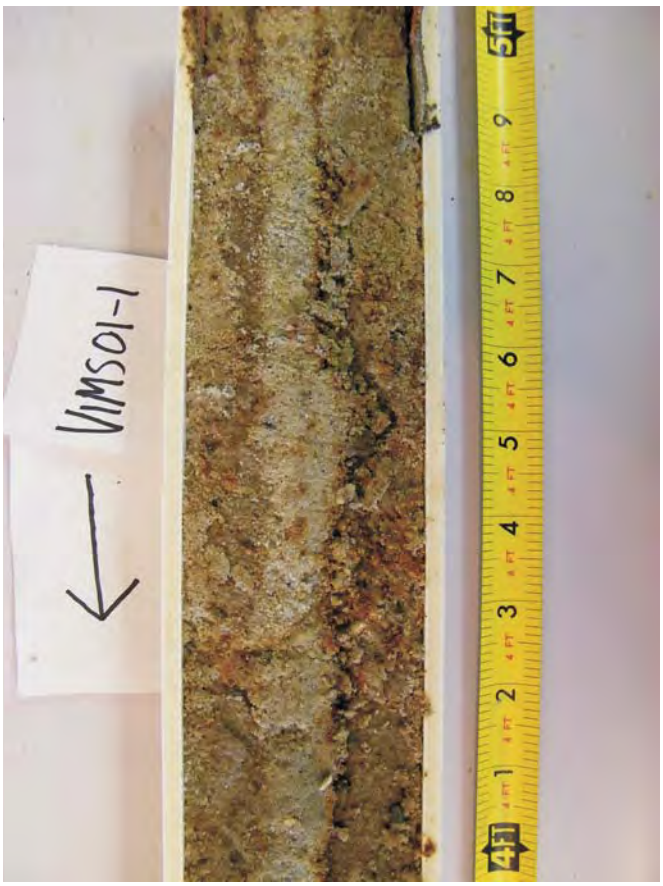
Appendix B

Core Photos

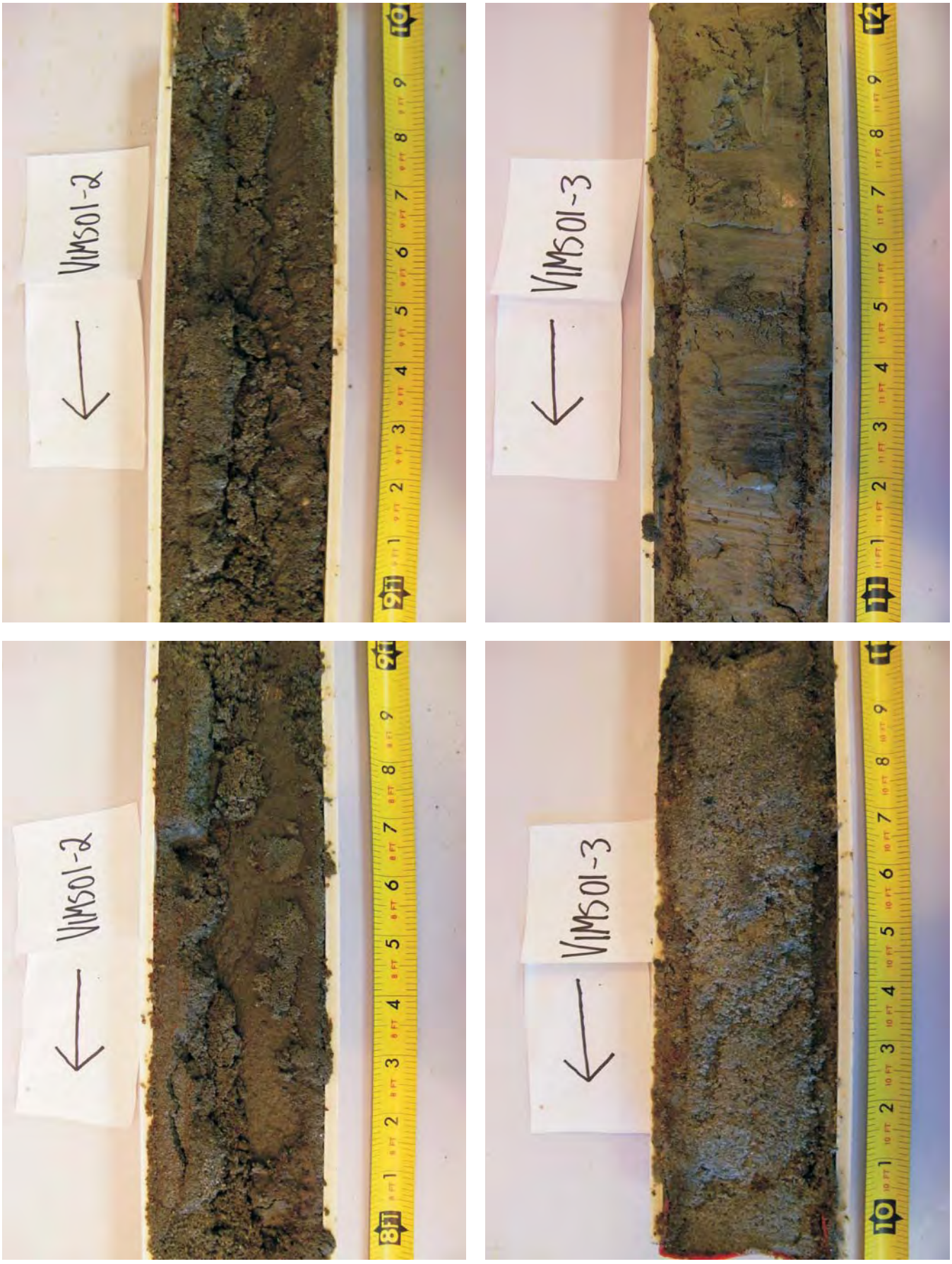
VIMS Core 1



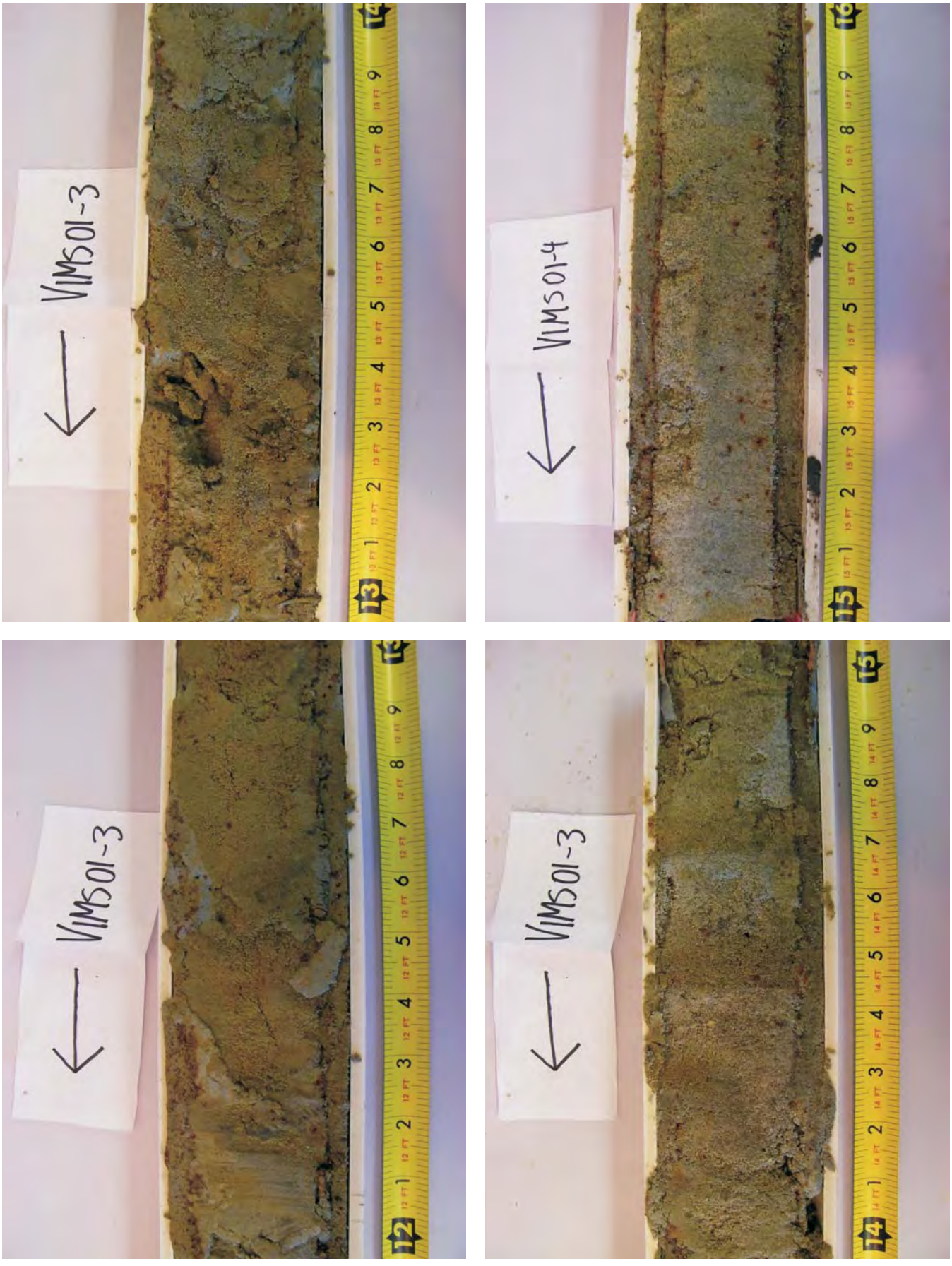




VIMS Core 1

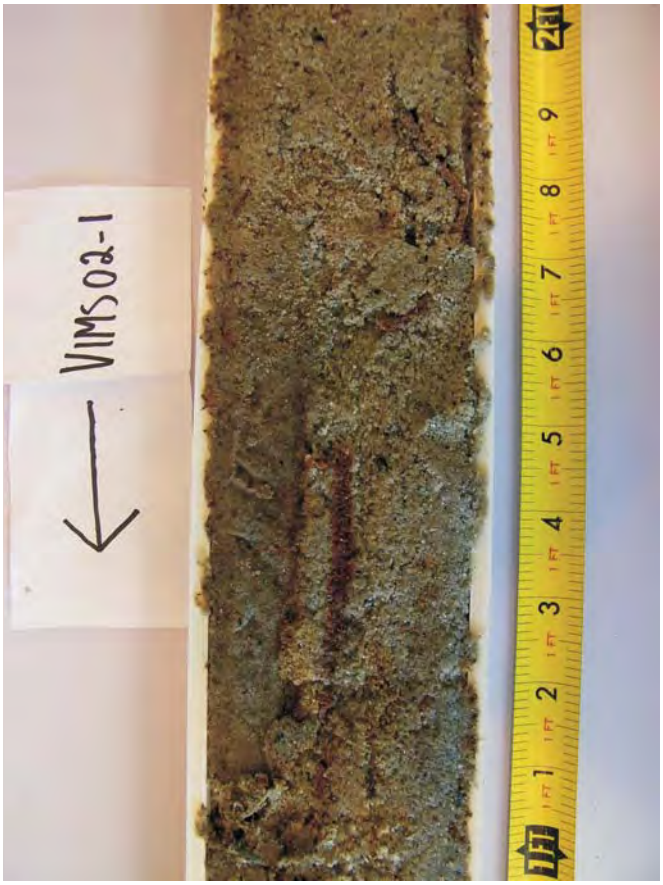


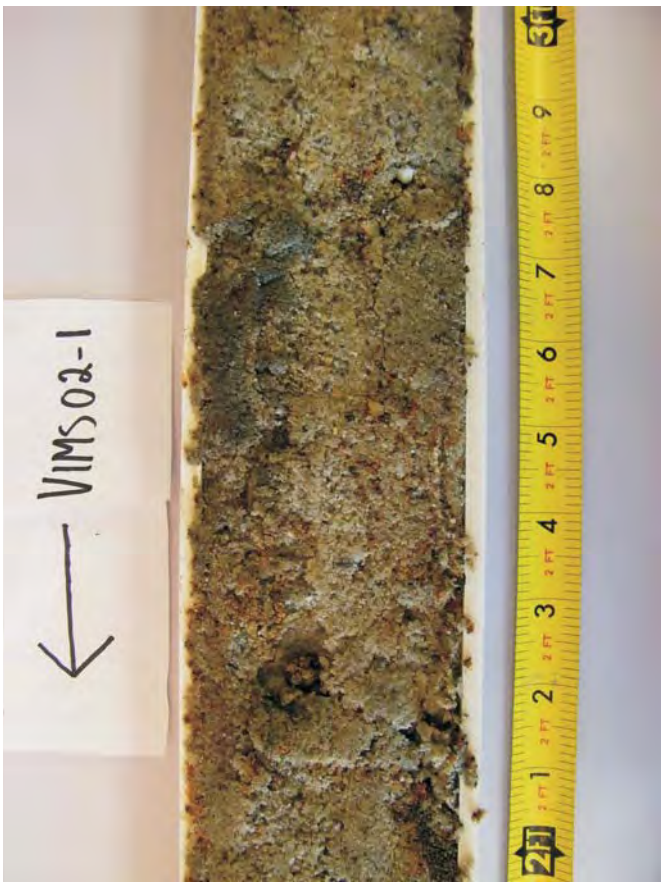
VIMS Core 1



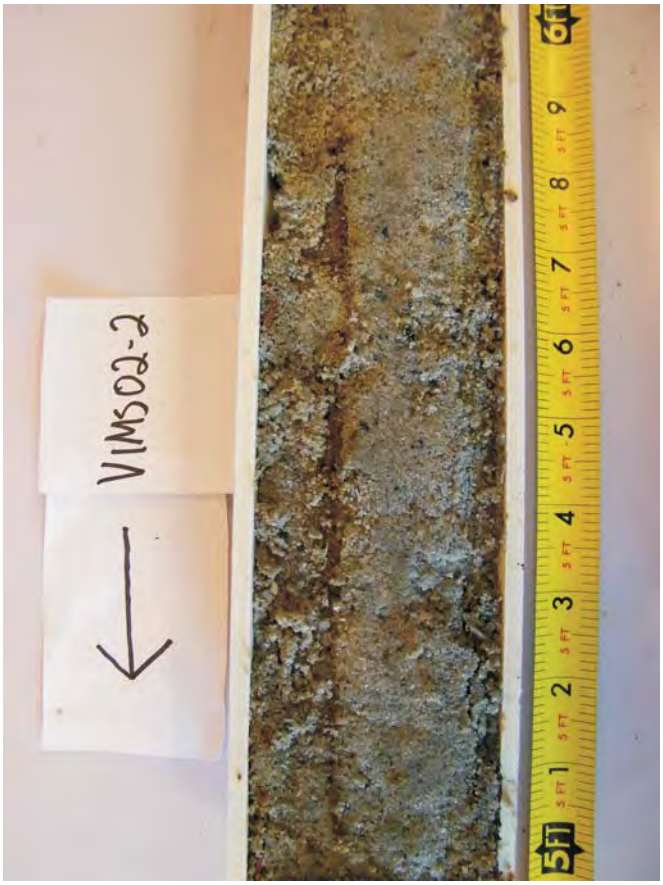
VIMS Core 1

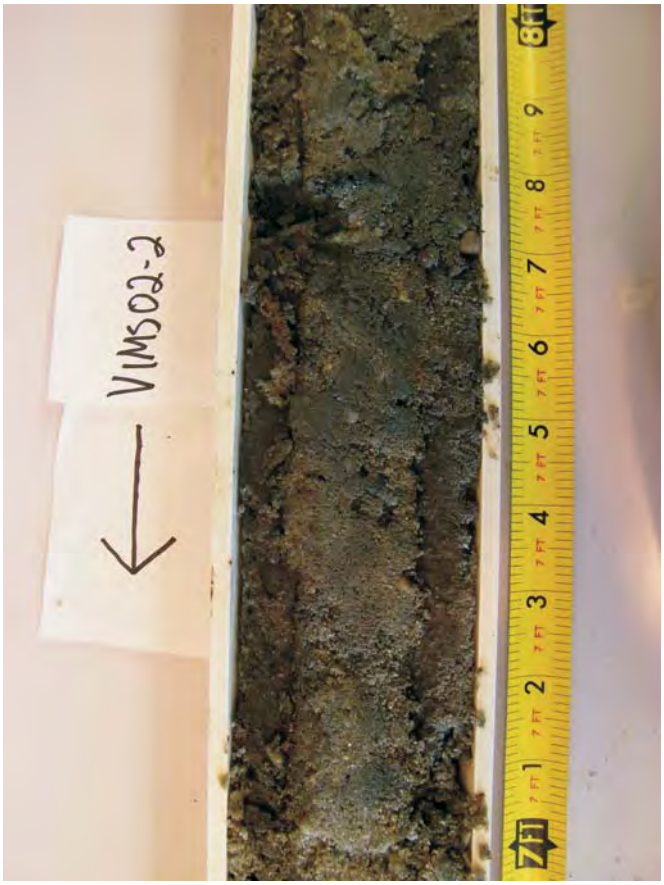
VIMS Core 1

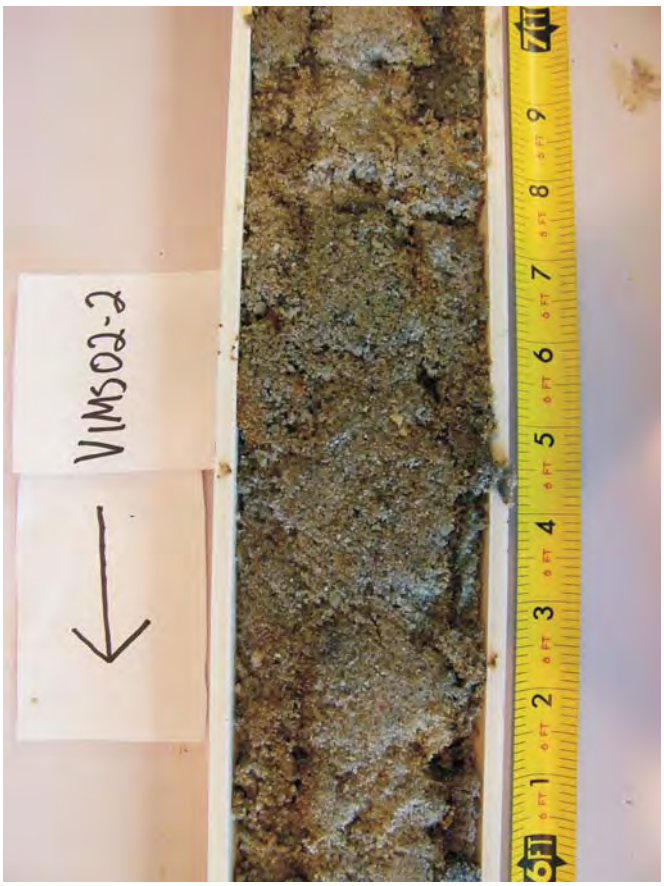




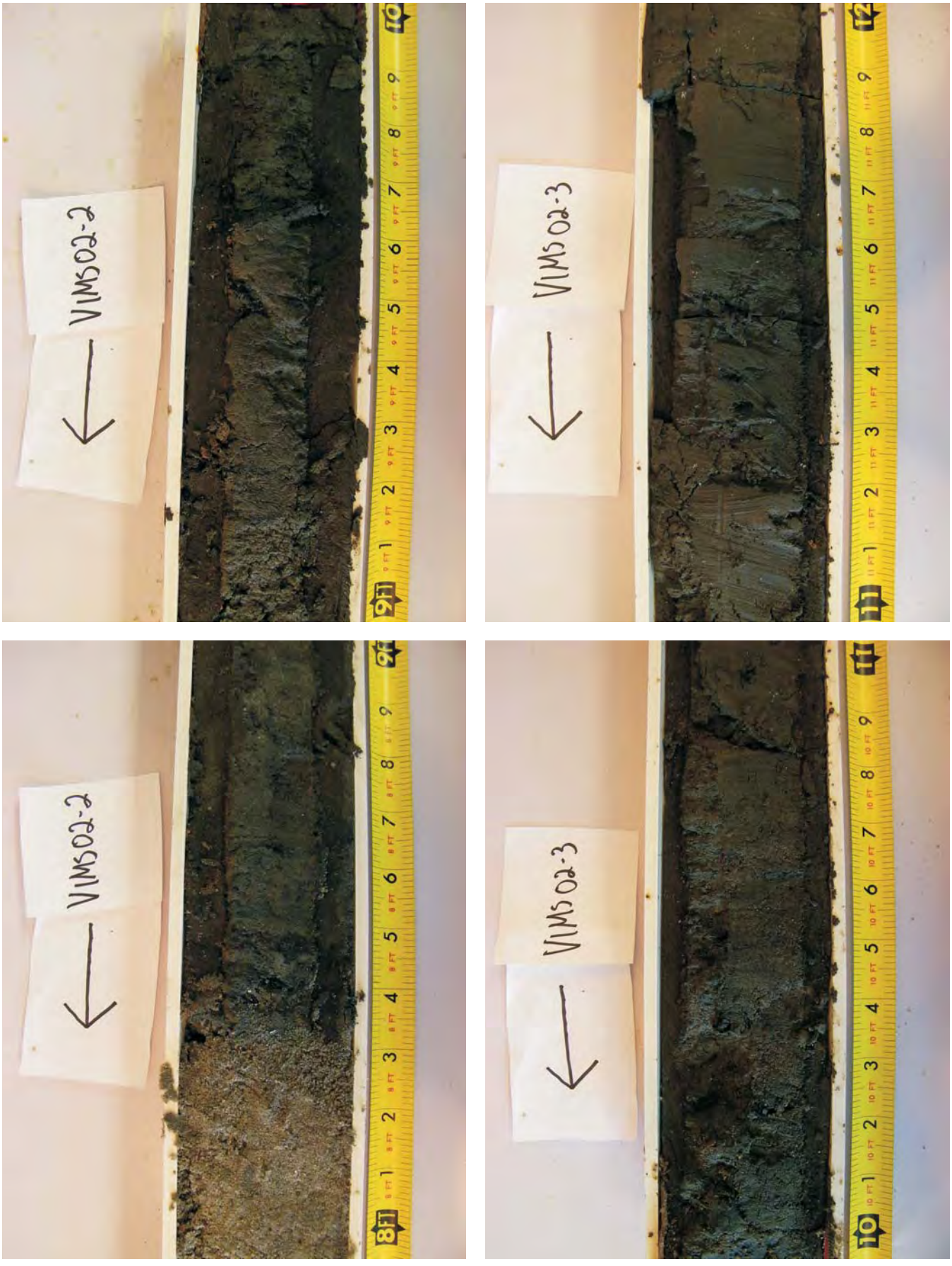
VIMS Core 2



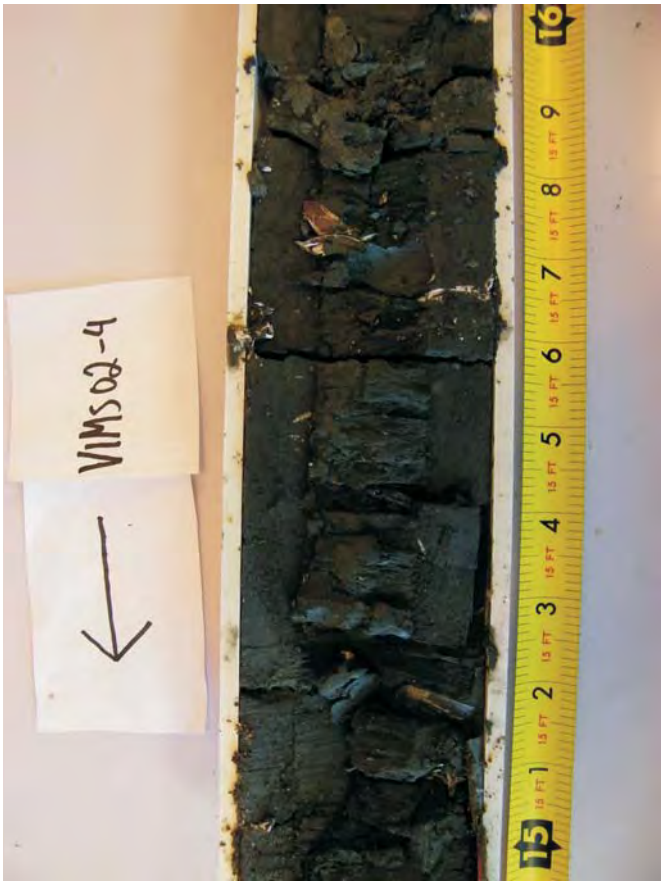


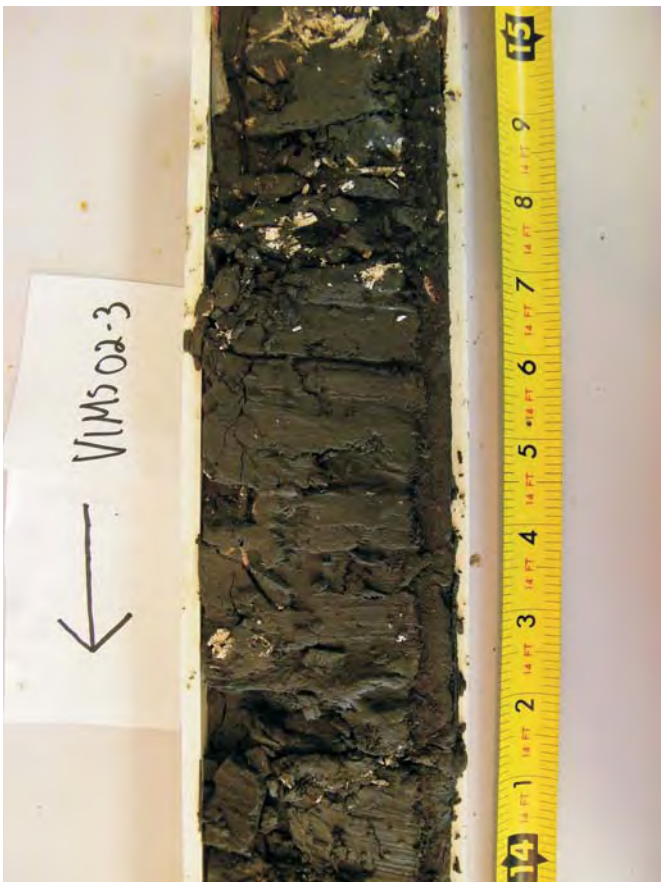


VIMS Core 2

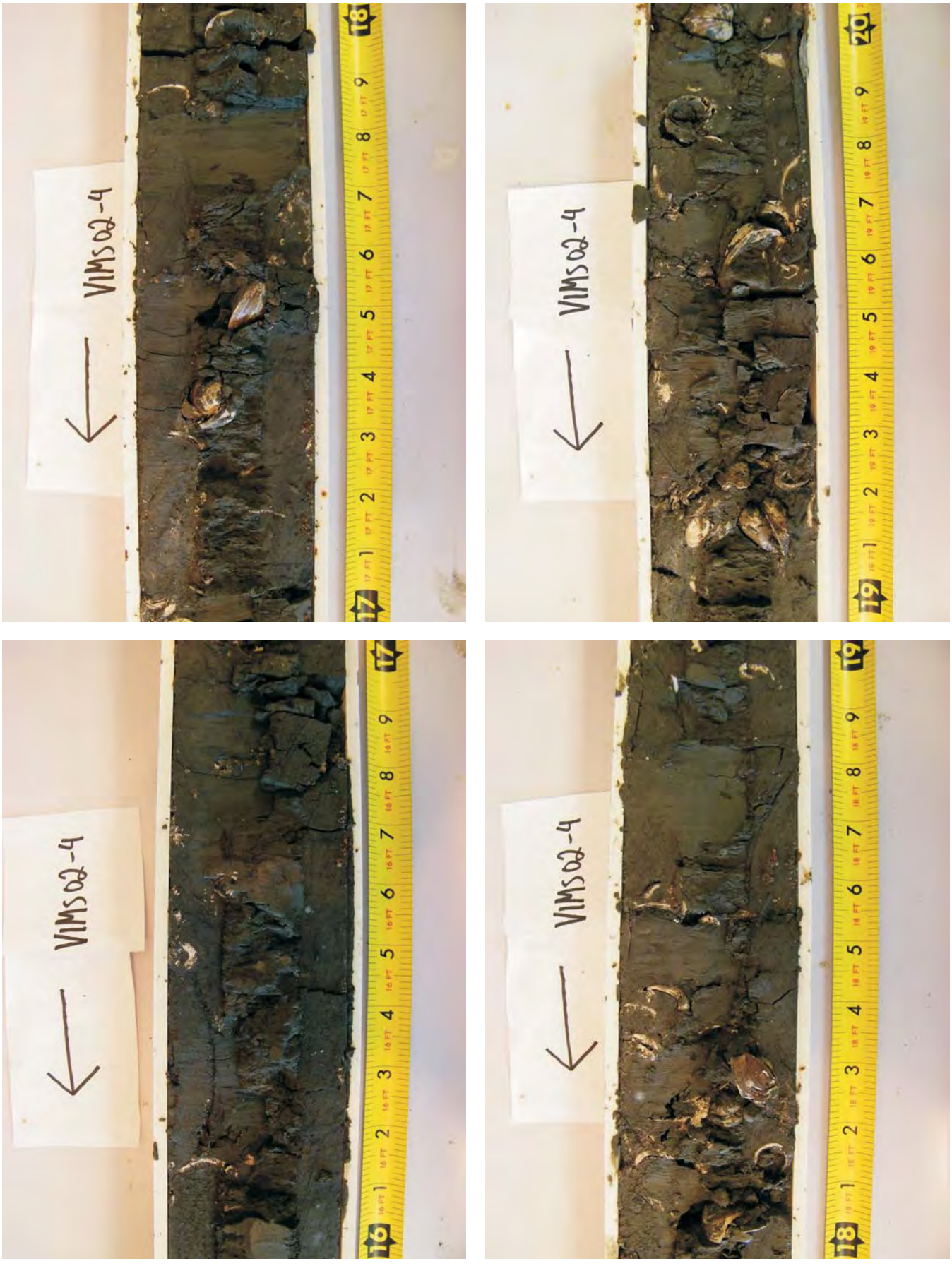


VIMS Core 2



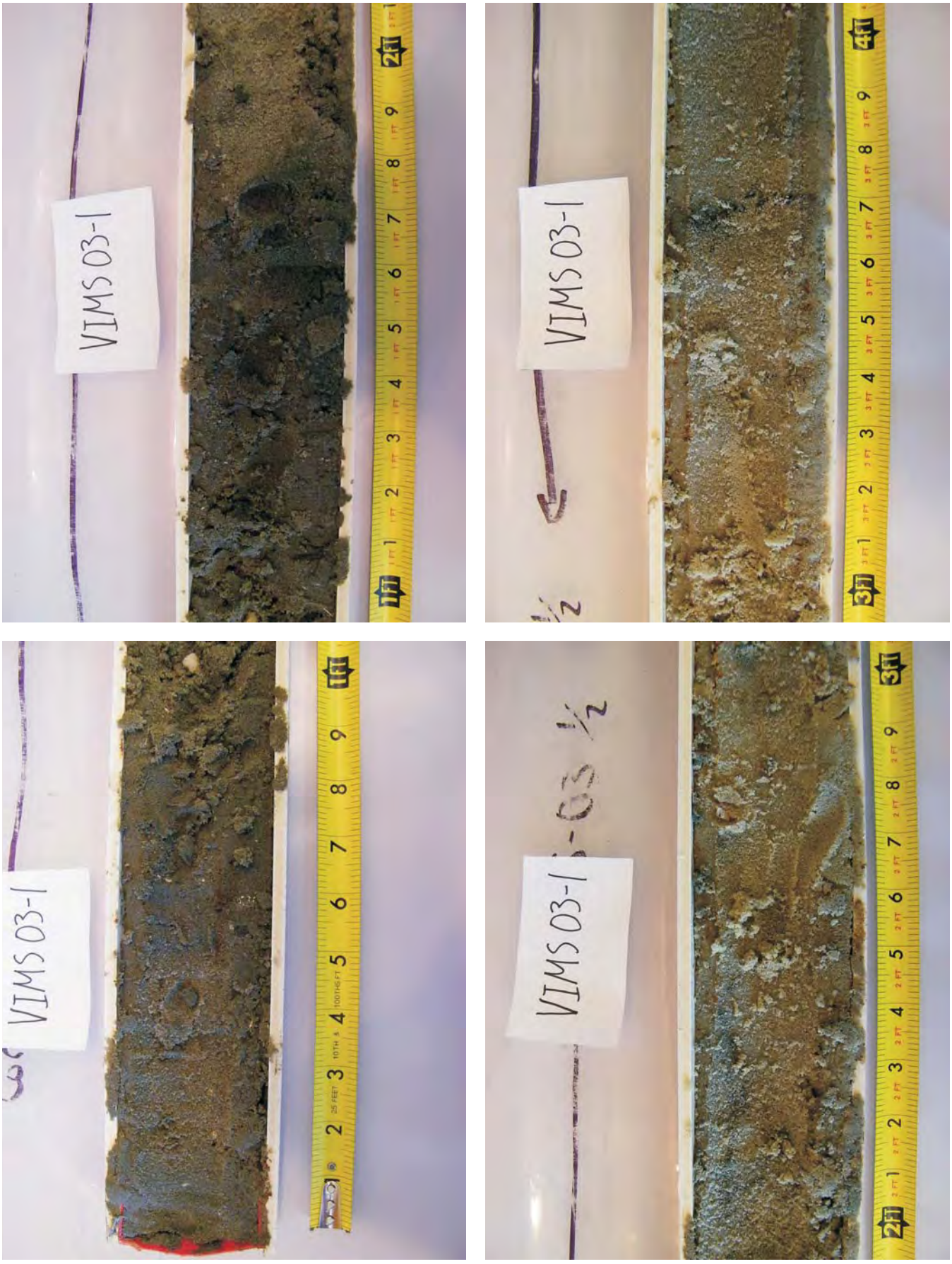


VIMS Core 2



VIMS Core 2

VIMS Core 2



VIMS Core 3

VIMS Core 3

VIMS 03-1
5'
4FT
5FT

VIMS 03-2
5FT
6FT

VIMS 03-2
6FT
7FT

VIMS 03-2
7FT
8FT

VIMS Core 3

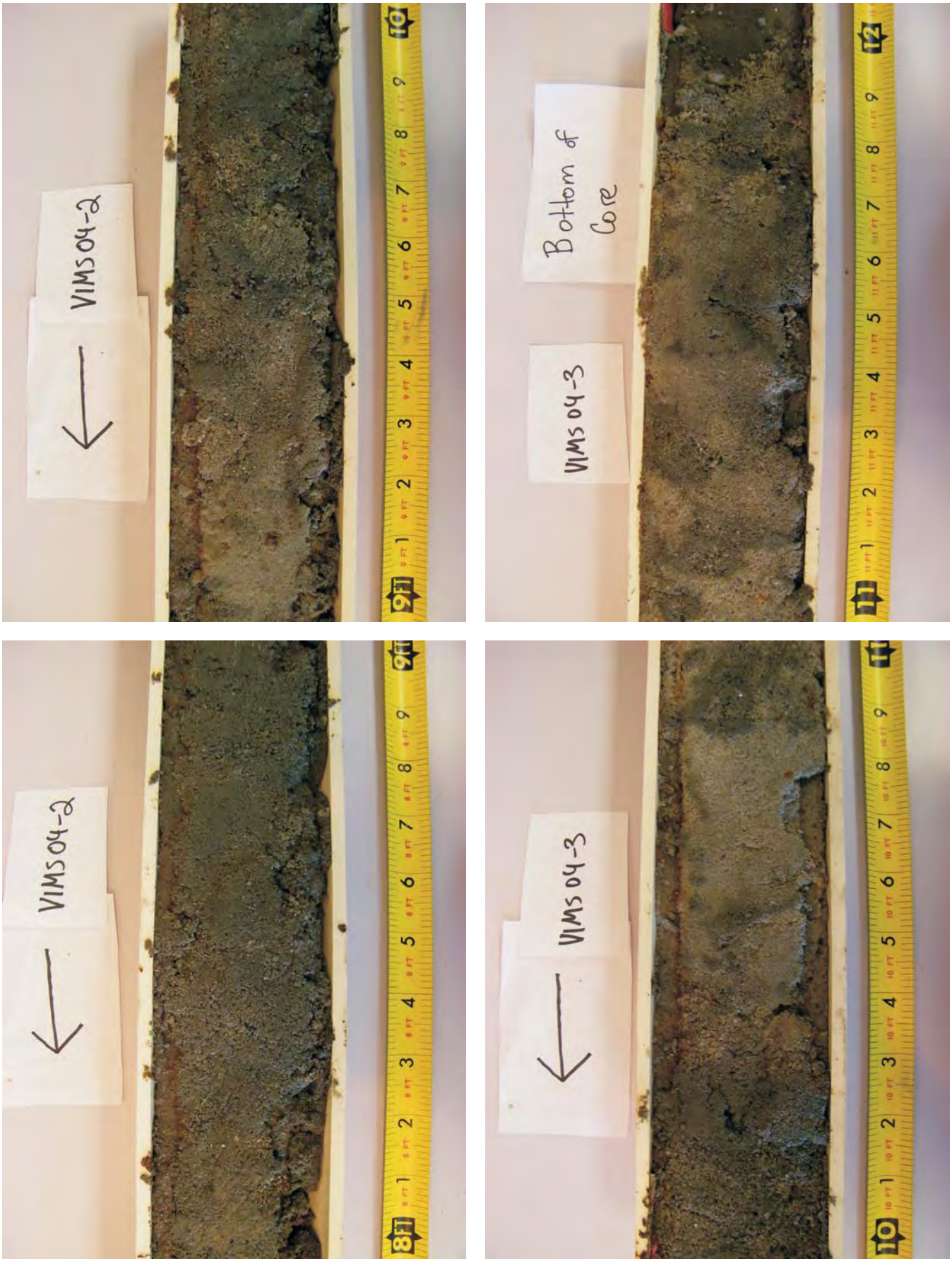
VIMS Core 4

VIMS04-1

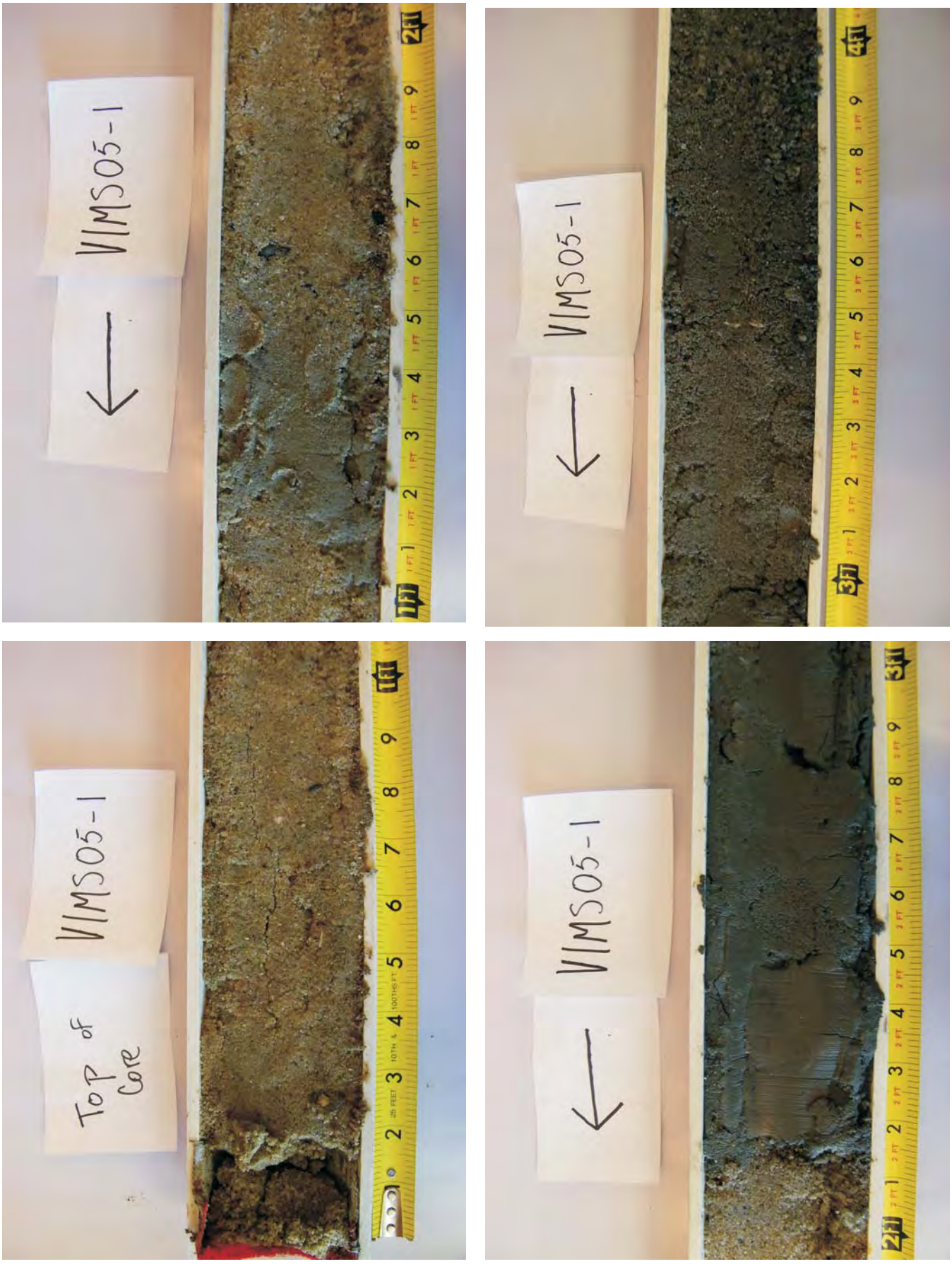
VIMS04-2

VIMS04-2

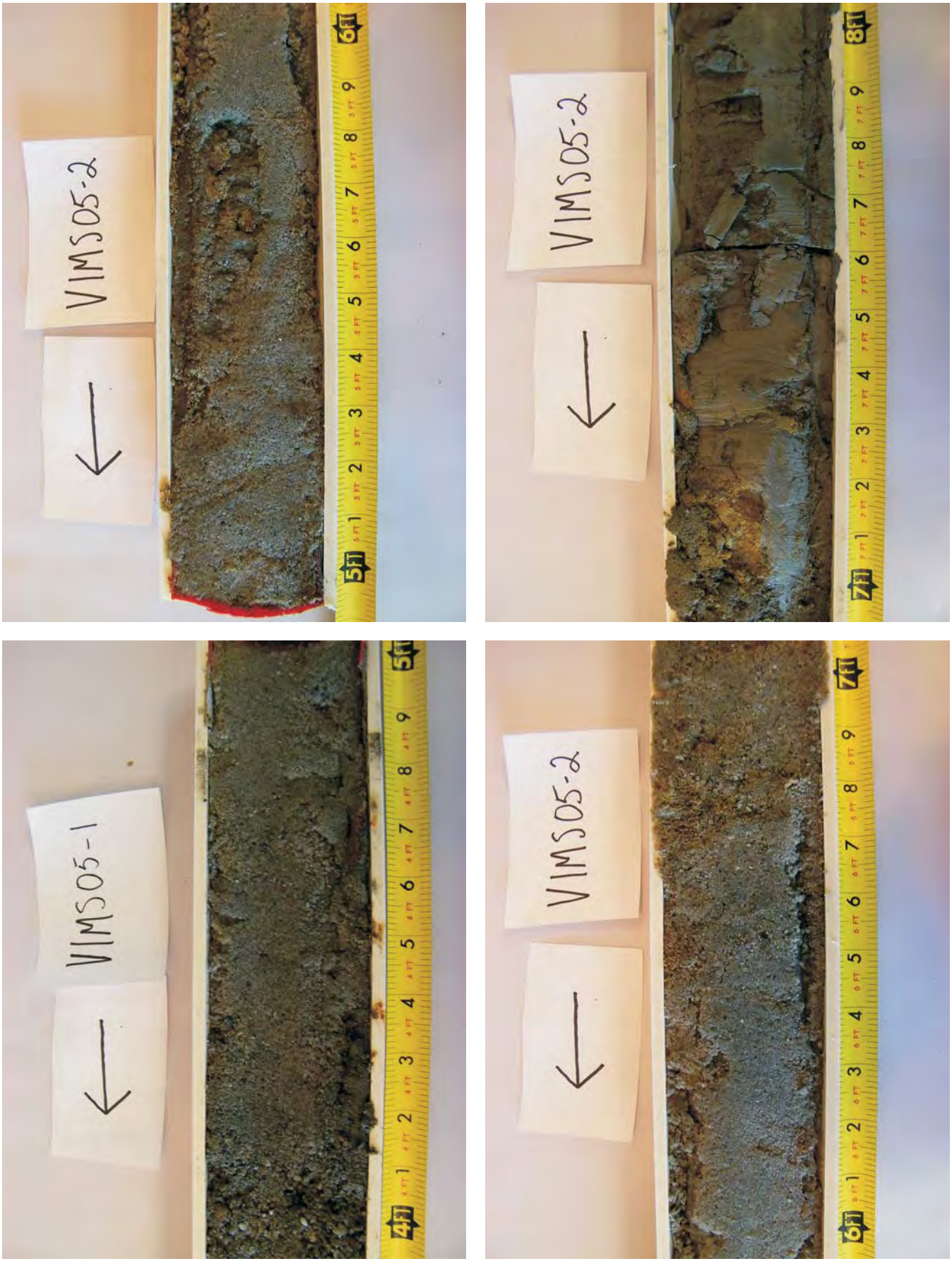
VIMS04-2



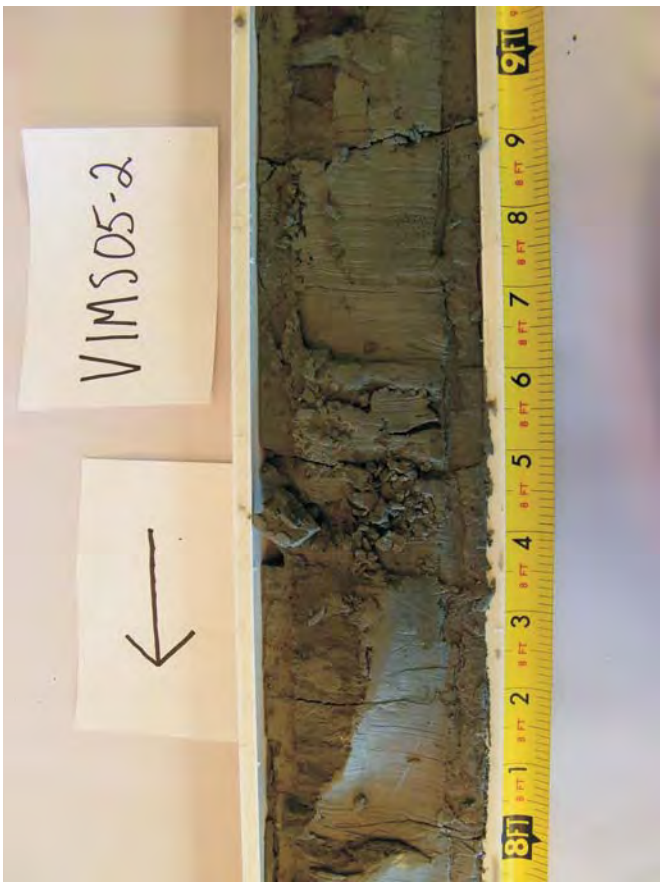
VIMS Core 4



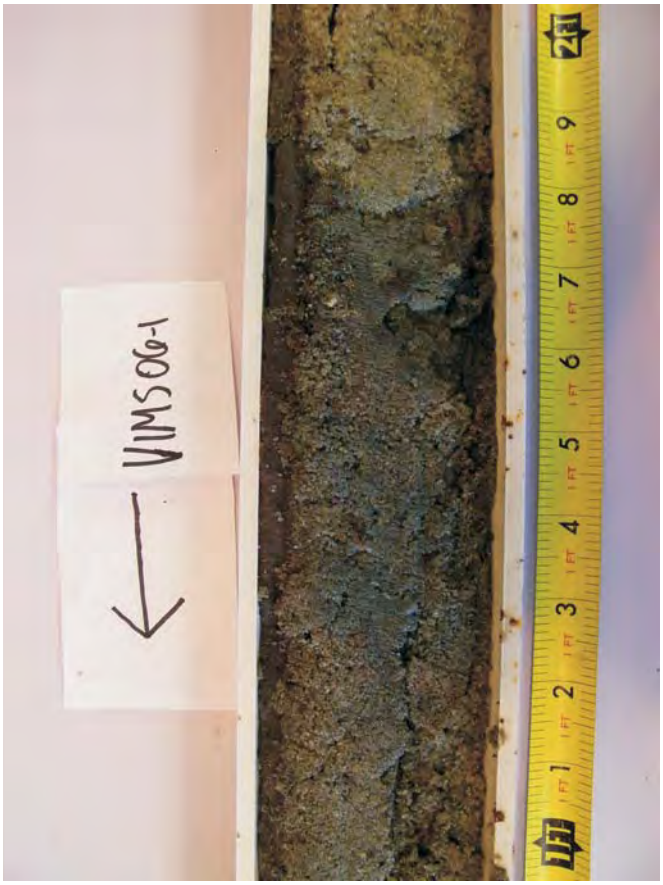
VIMS Core 5

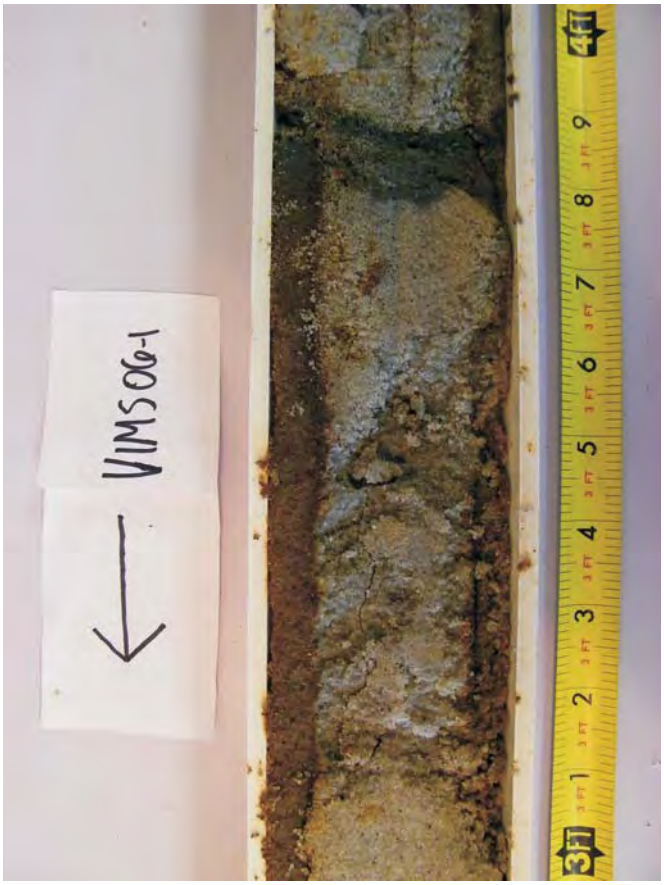


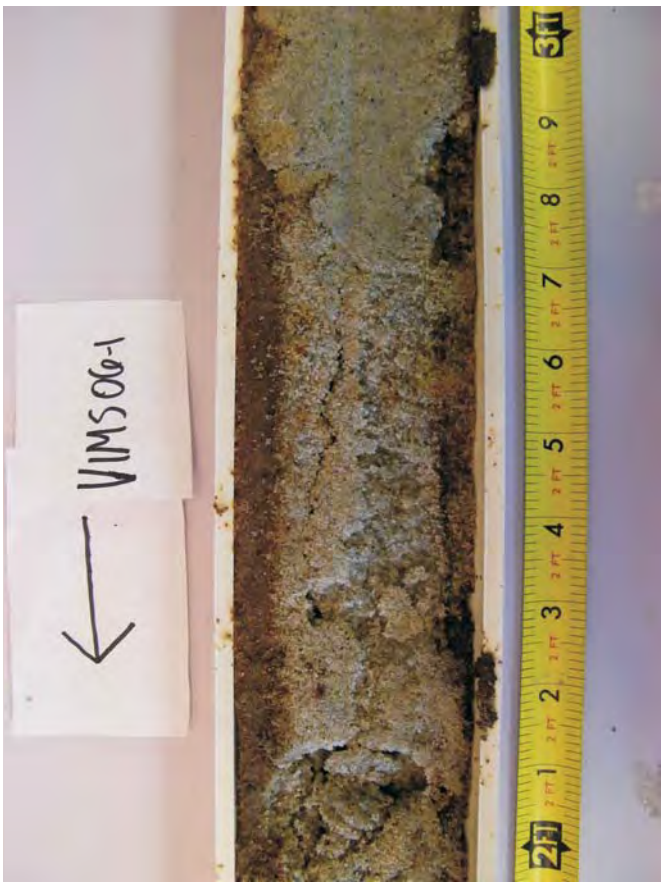
VIMS Core 5



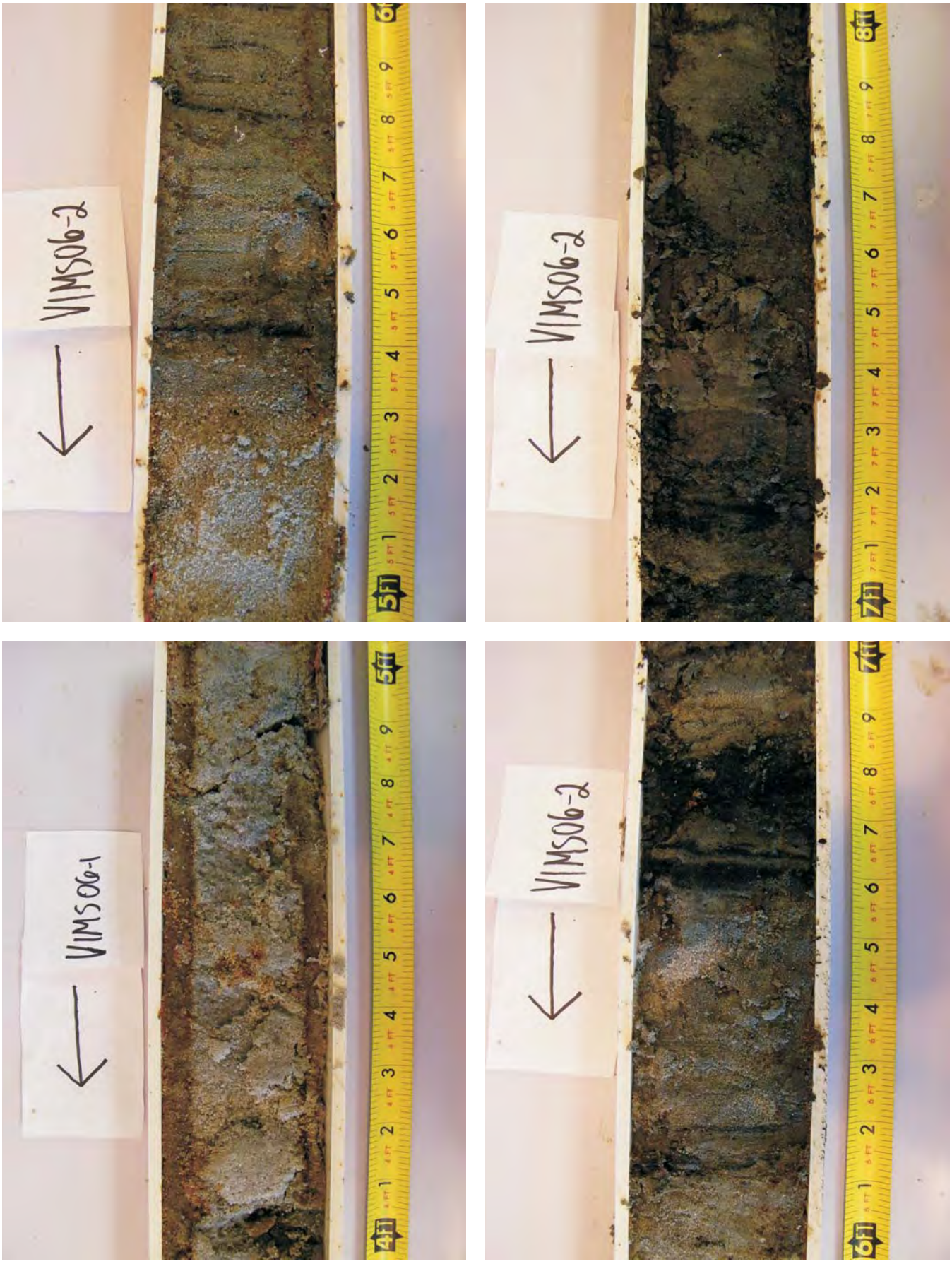
VIMS Core 5







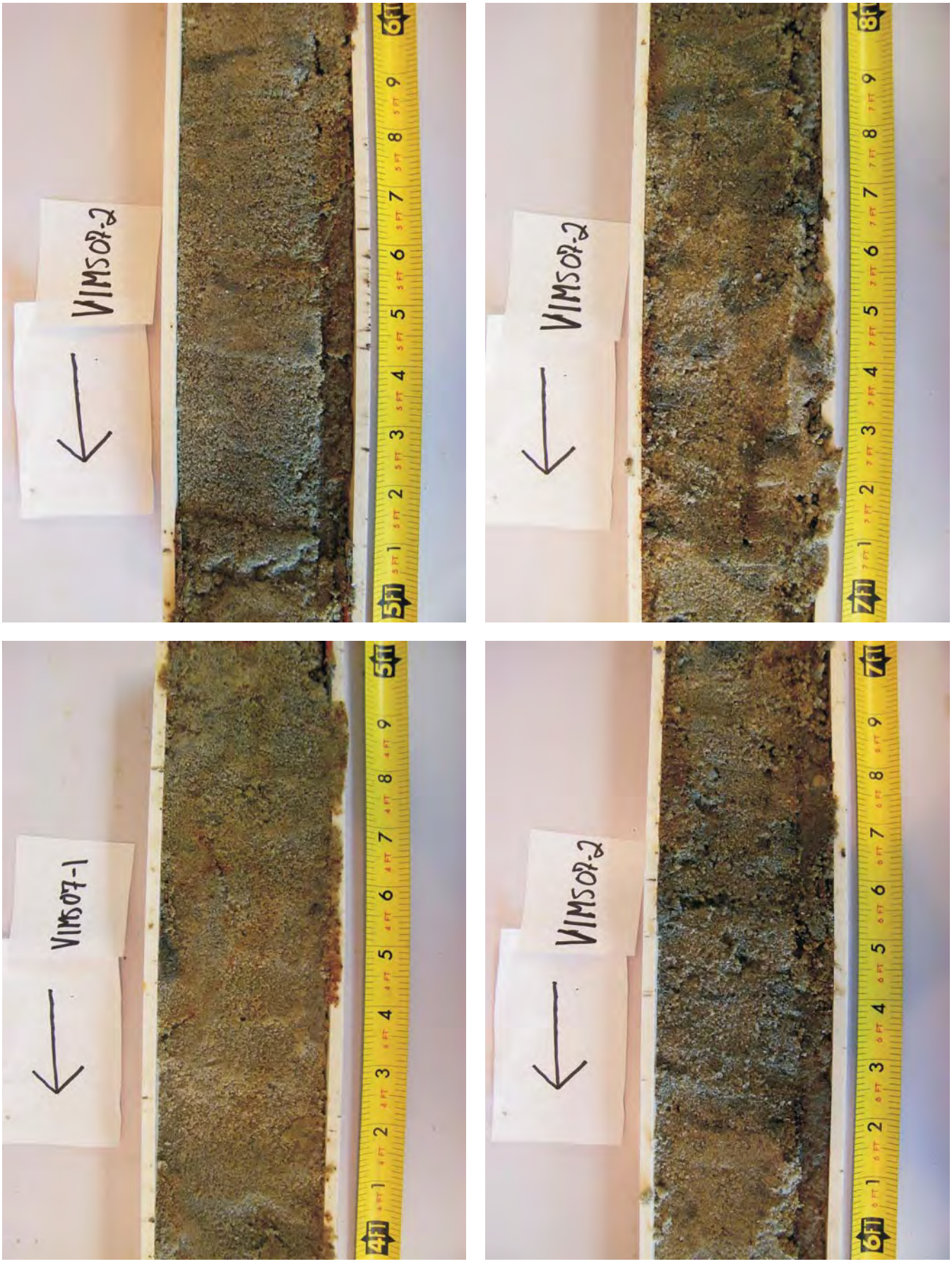
VIMS Core 6



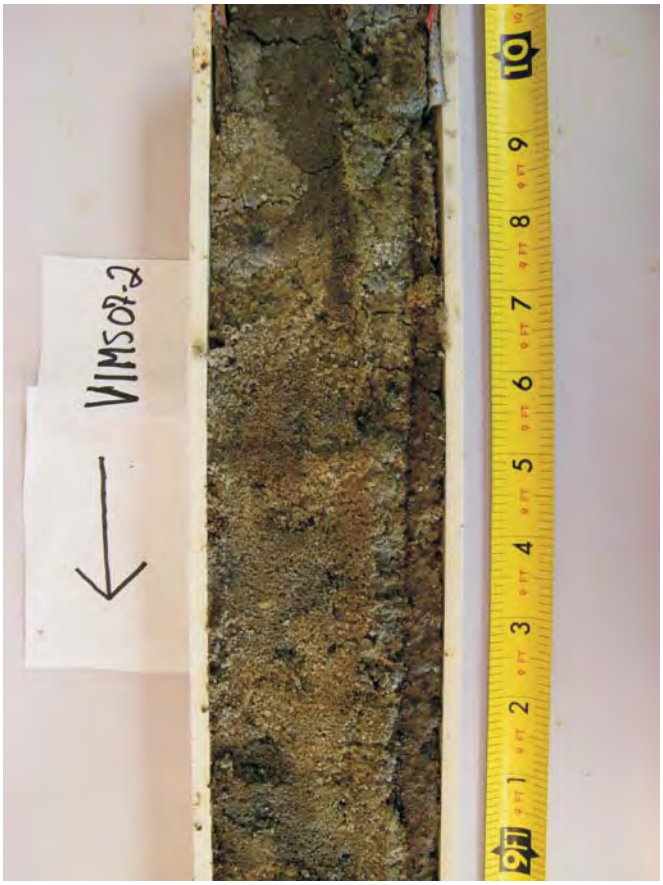
VIMS Core 6

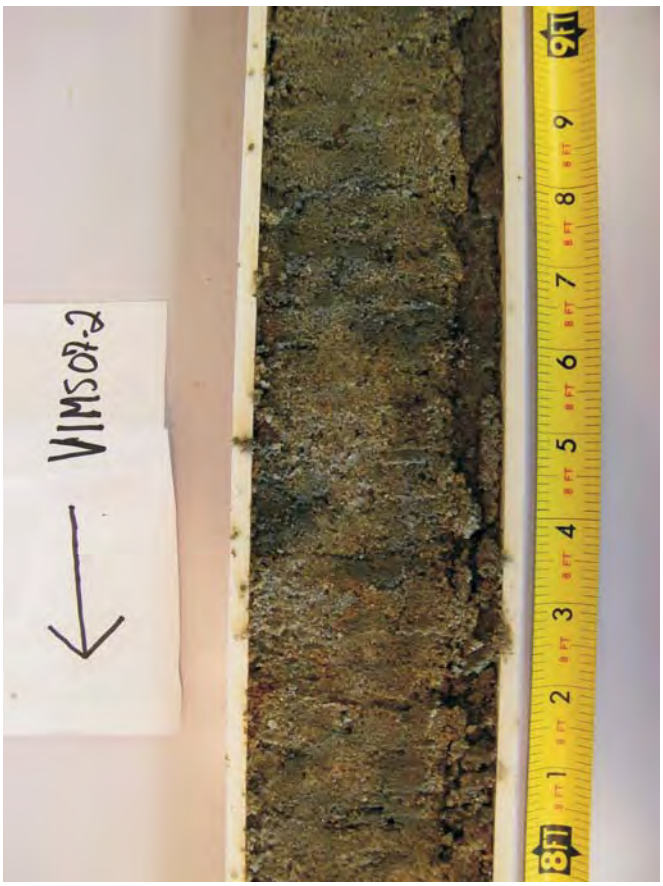
VIMS Core 6

VIMS Core 7



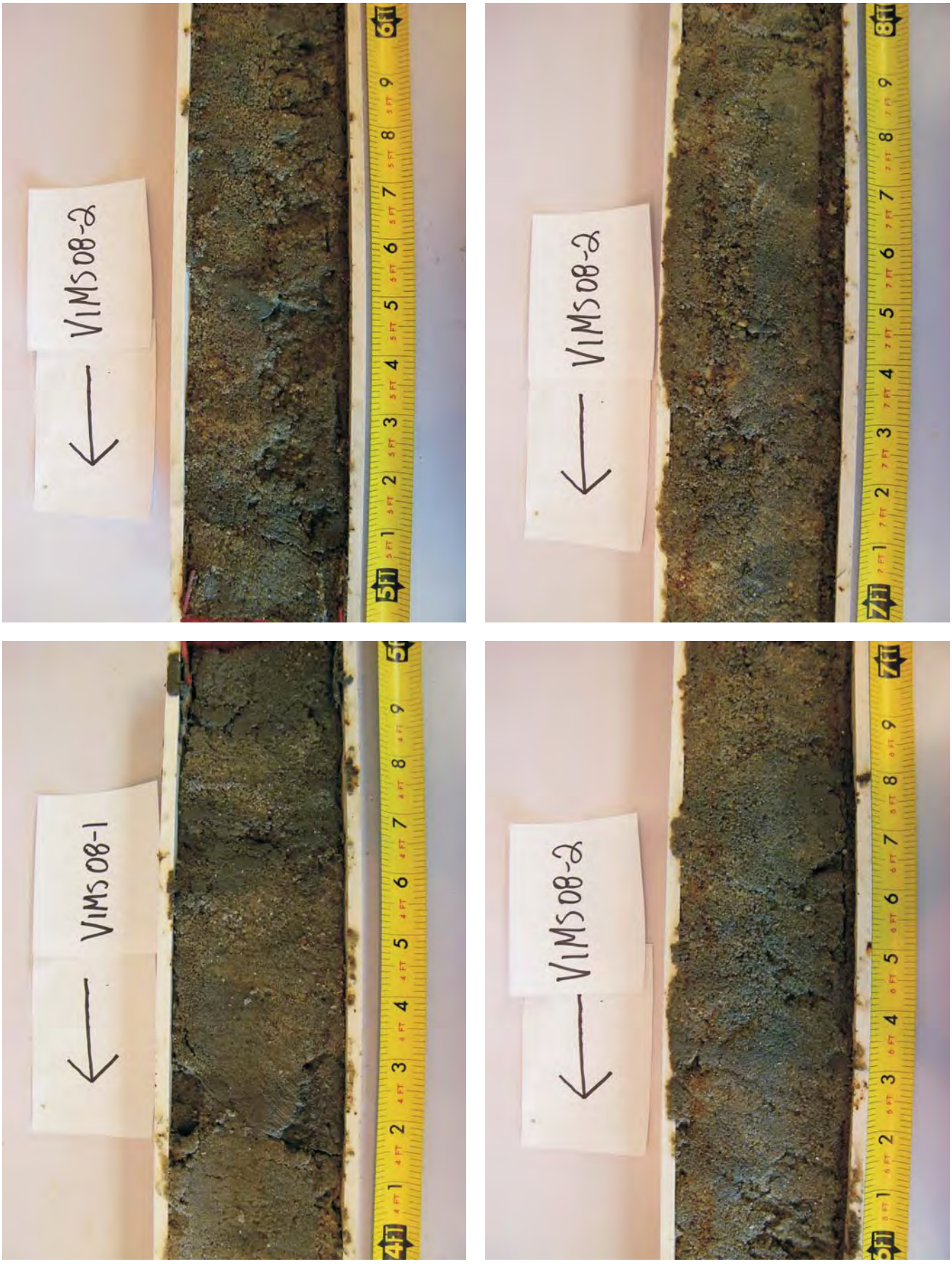
VIMS Core 7





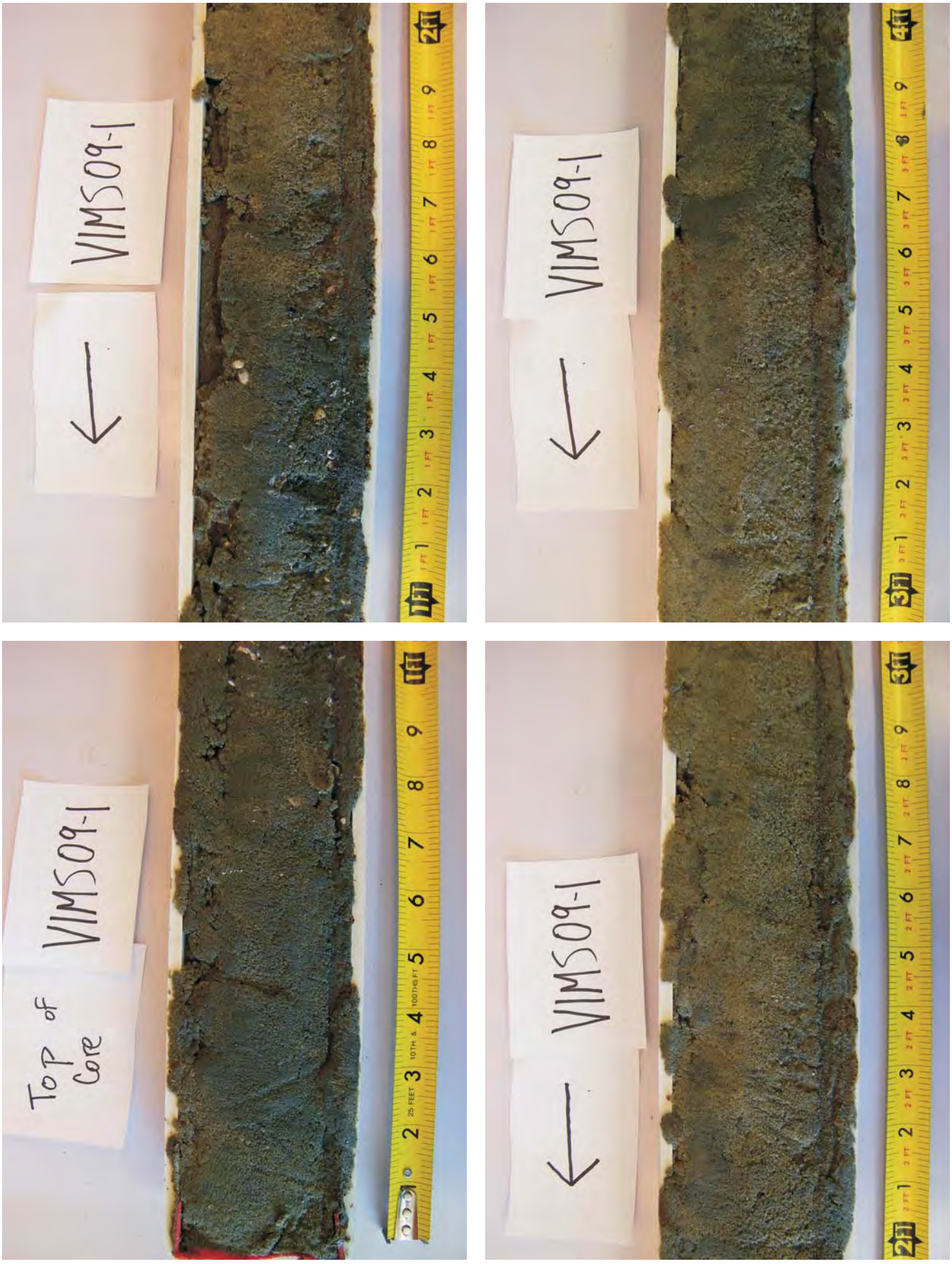
VIMS Core 7

VIMS Core 8

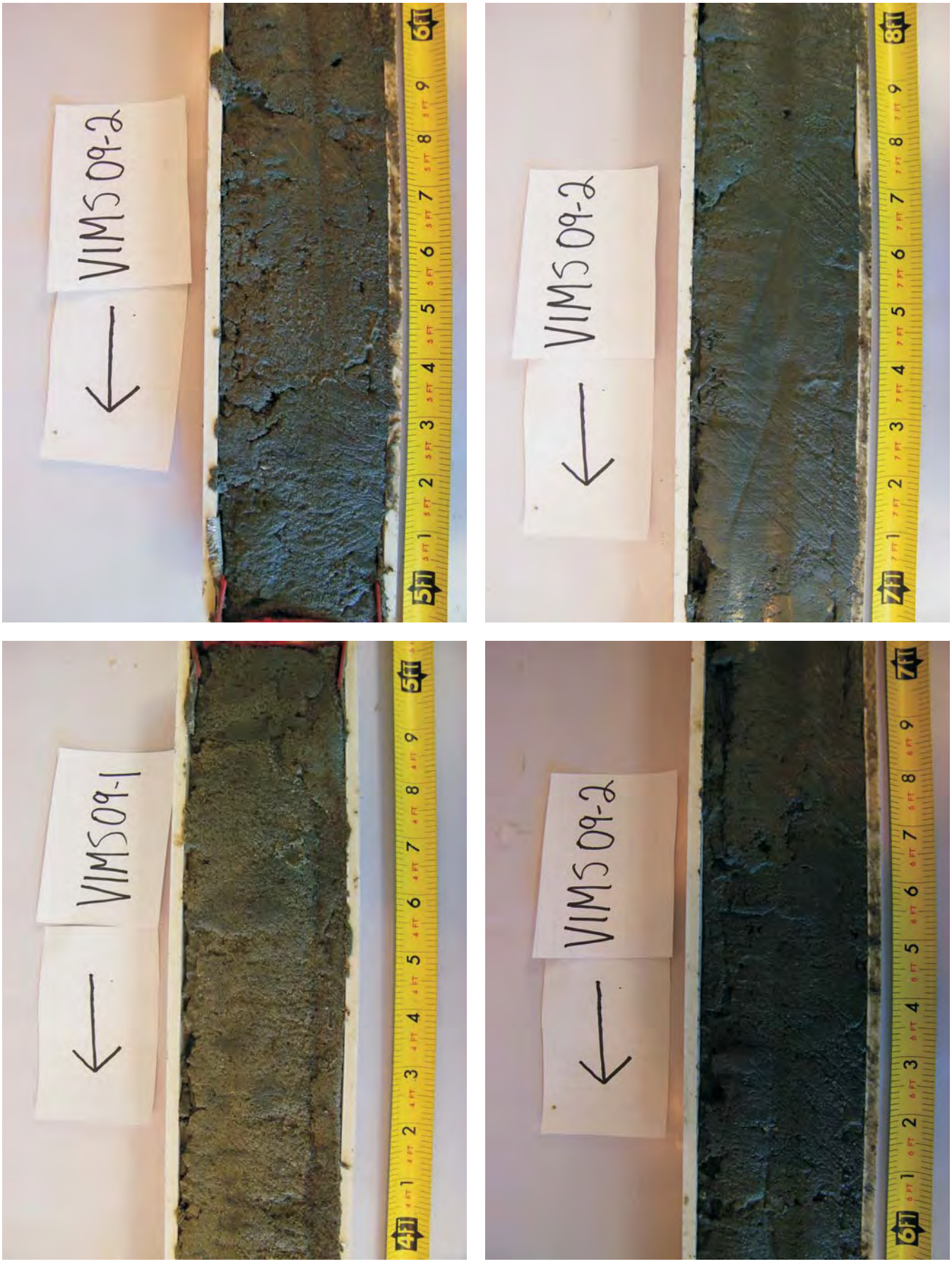


VIMS Core 8

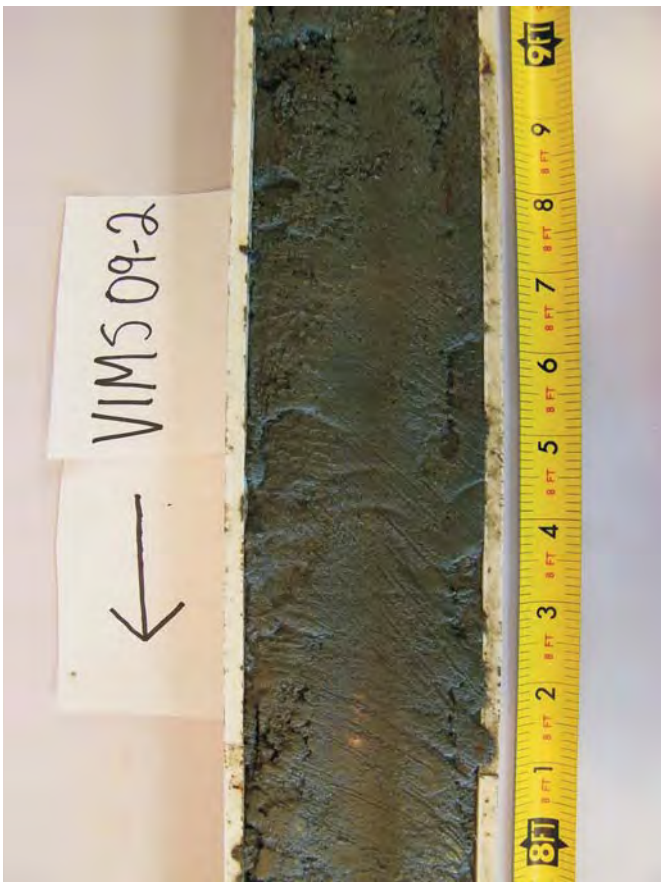
VIMS Core 8



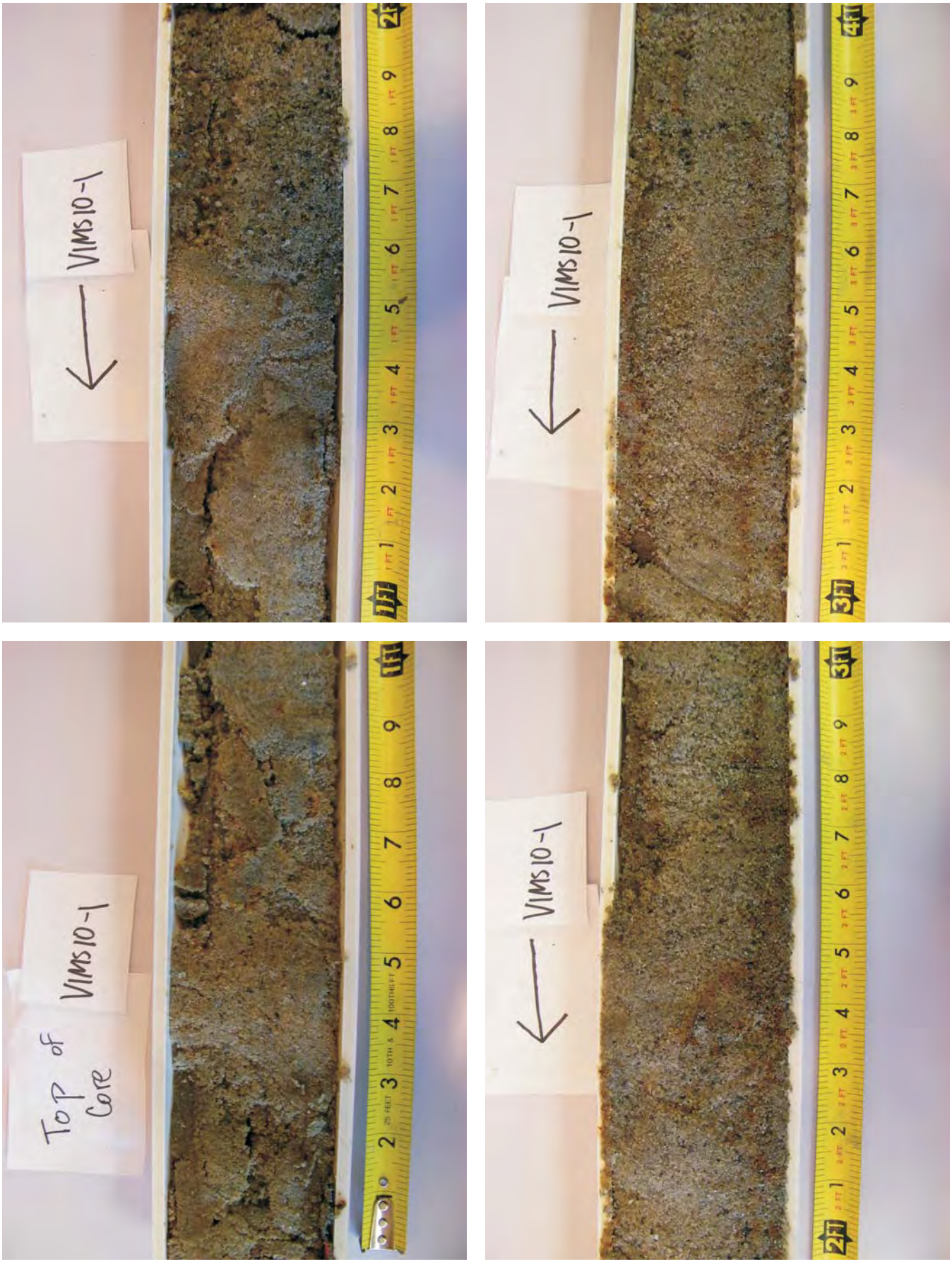
VIMS Core 9



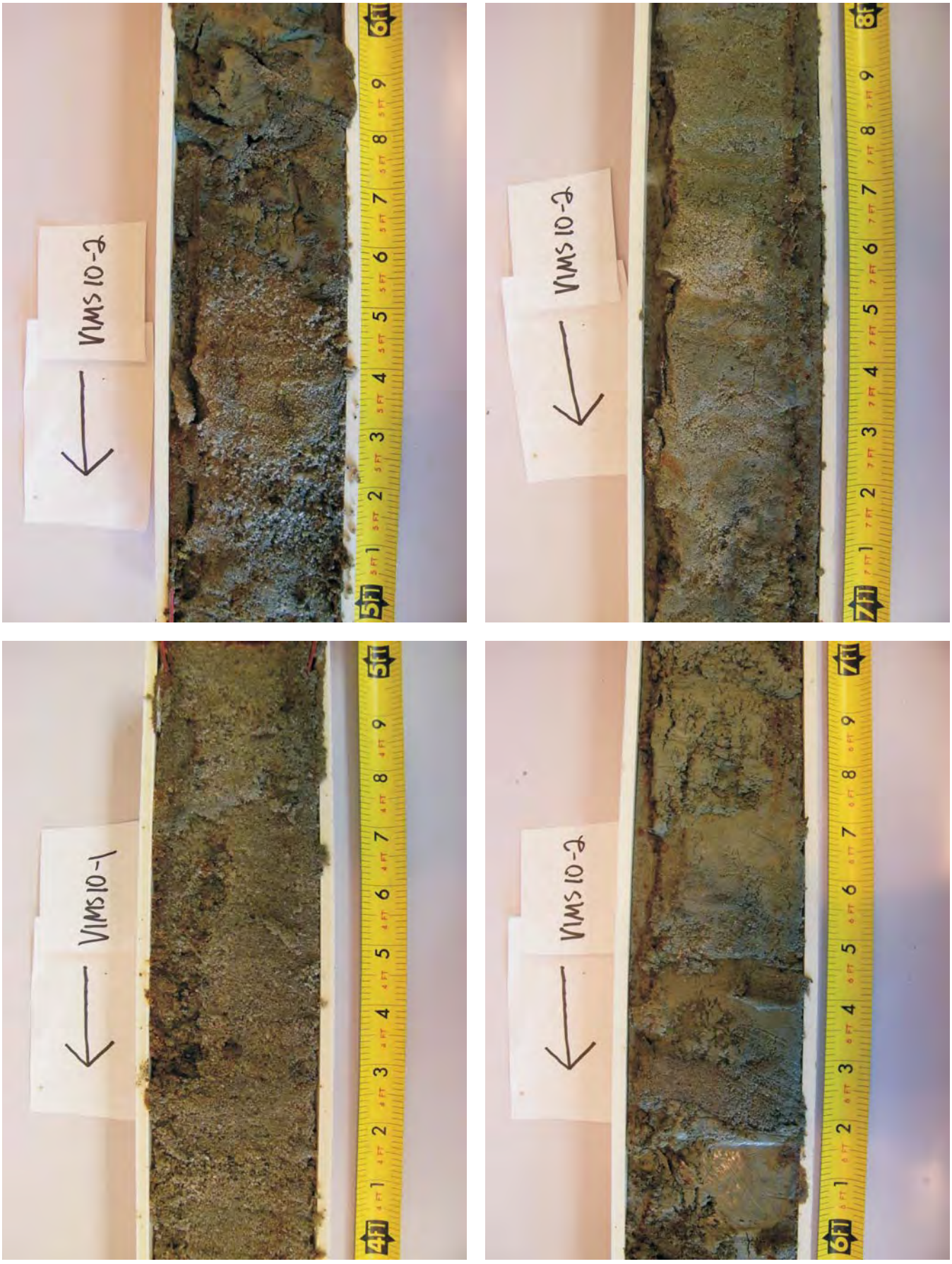
VIMS Core 9



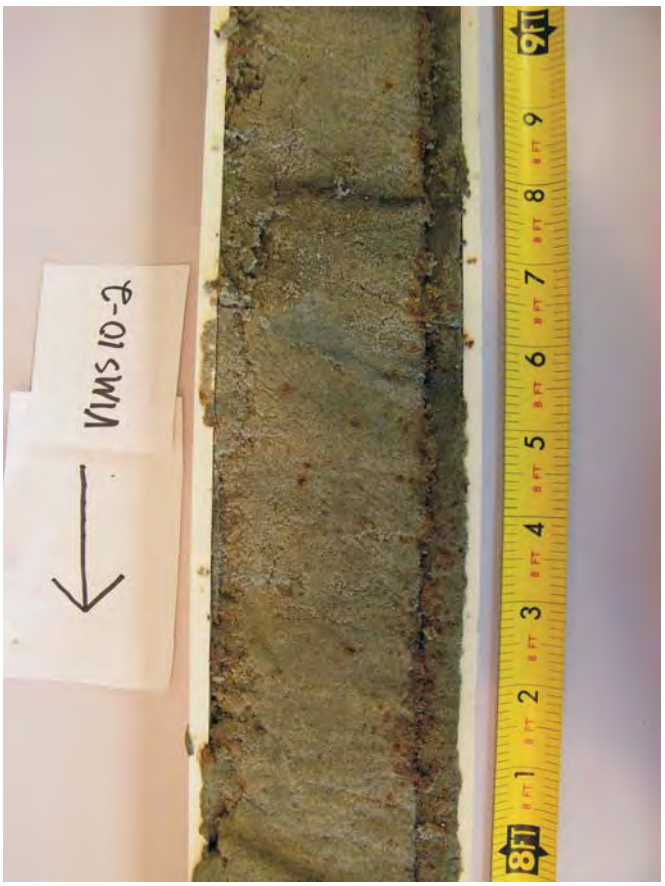
VIMS Core 9



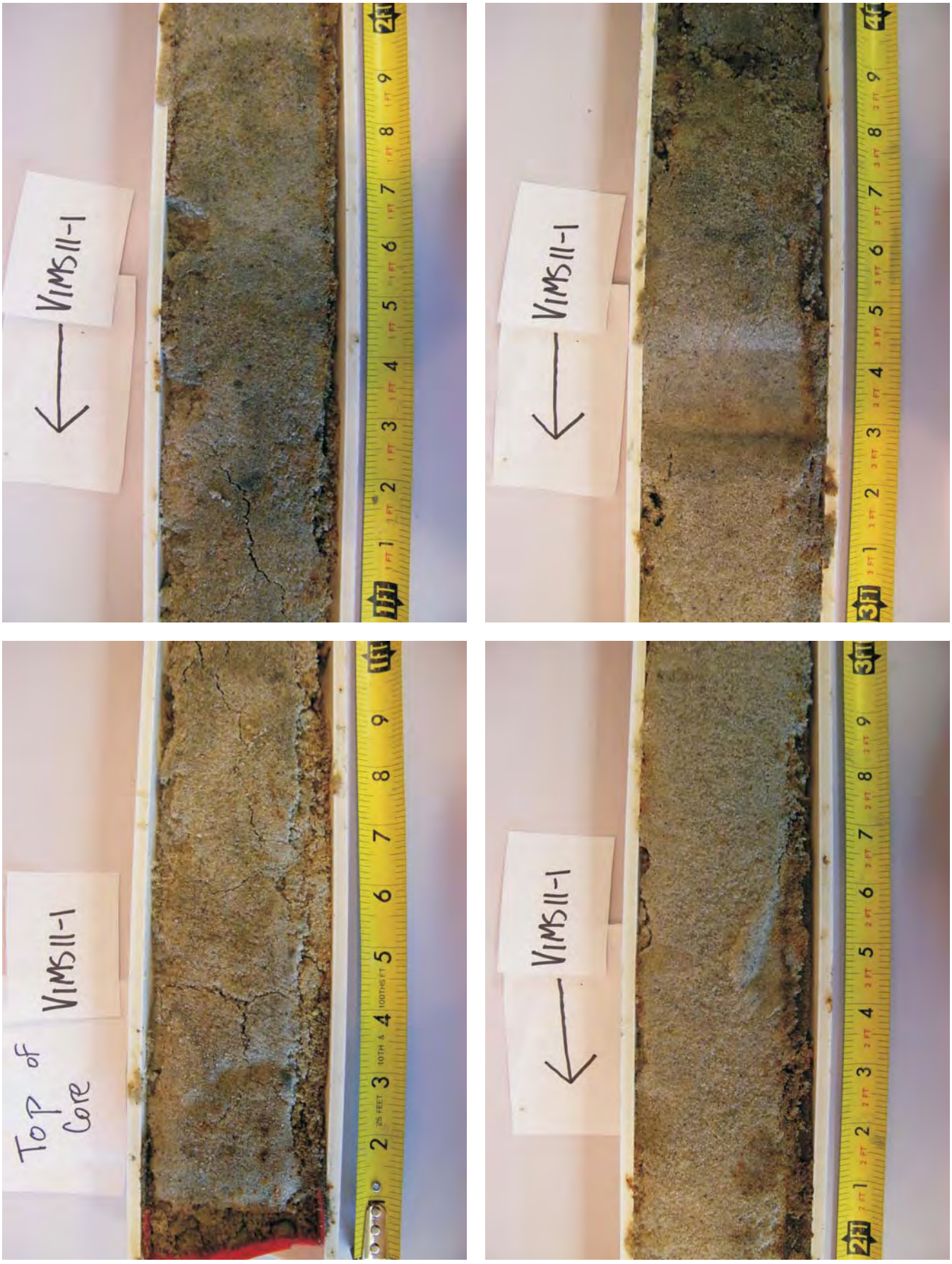
VIMS Core 10



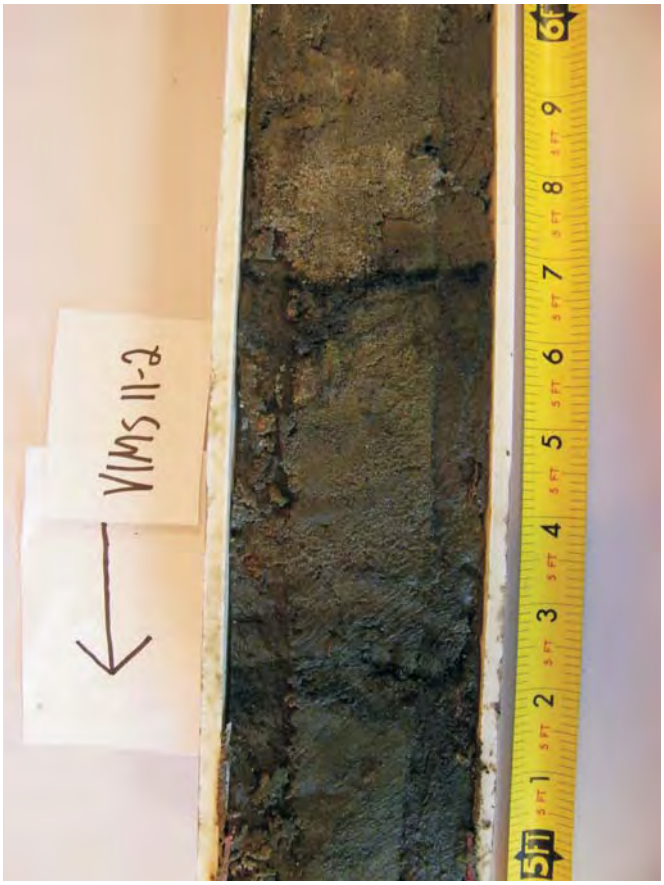
VIMS Core 10

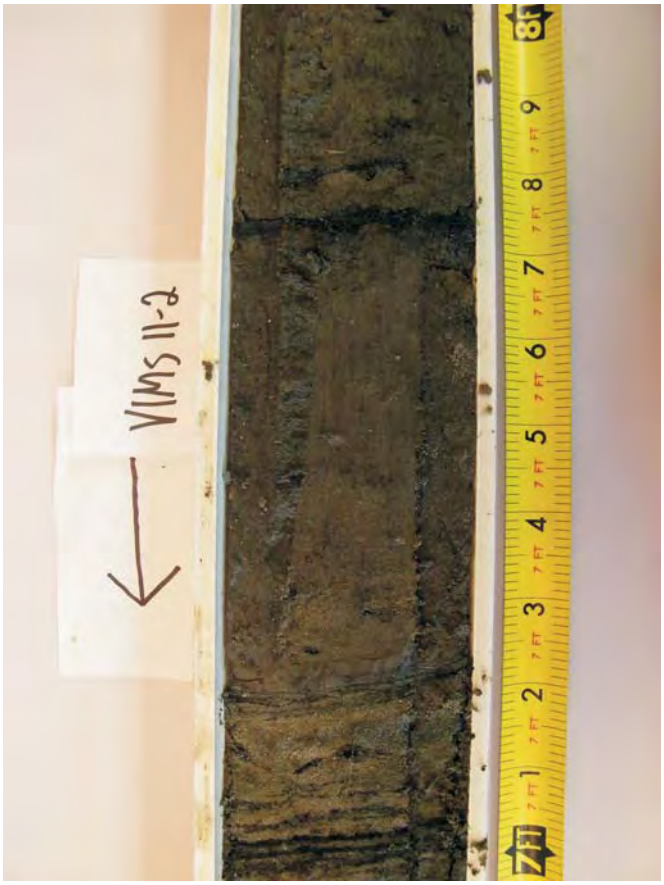


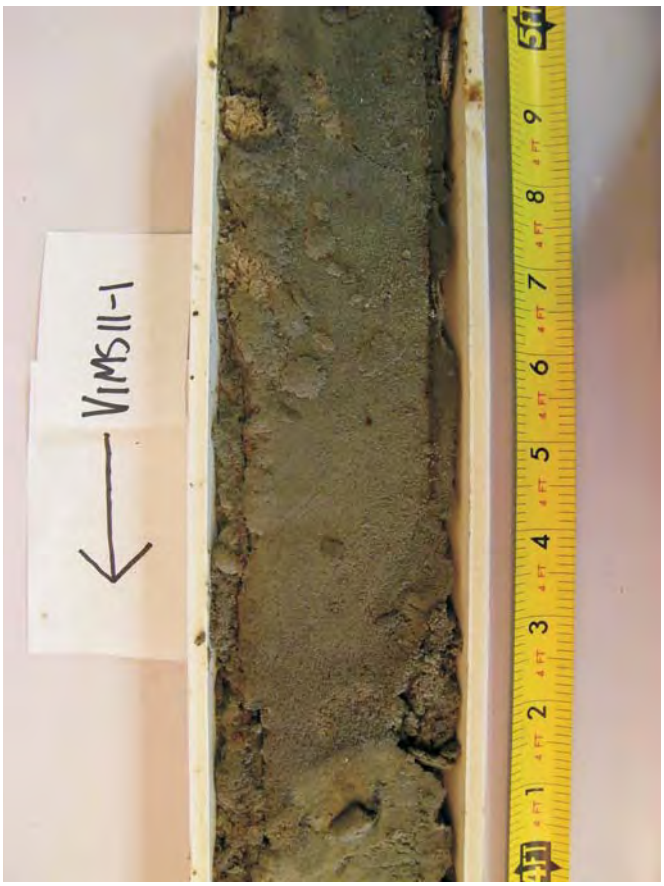
VIMS Core 10



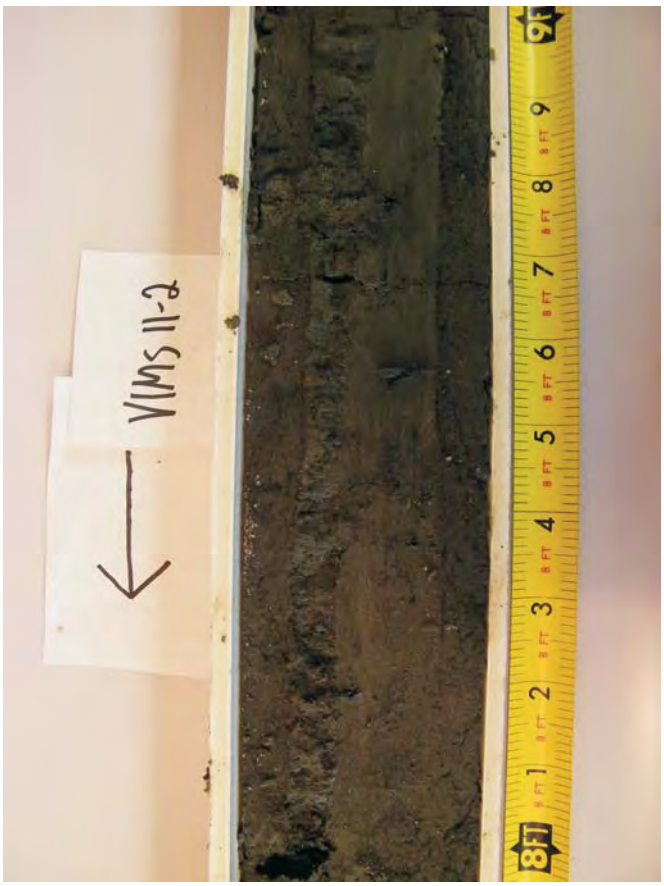
VIMS Core 11







VIMS Core 11



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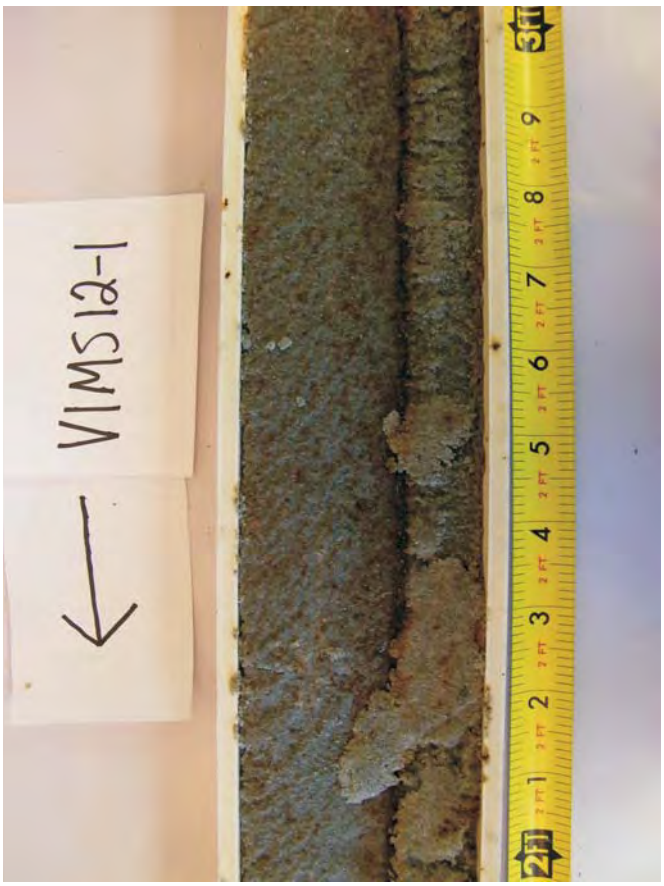

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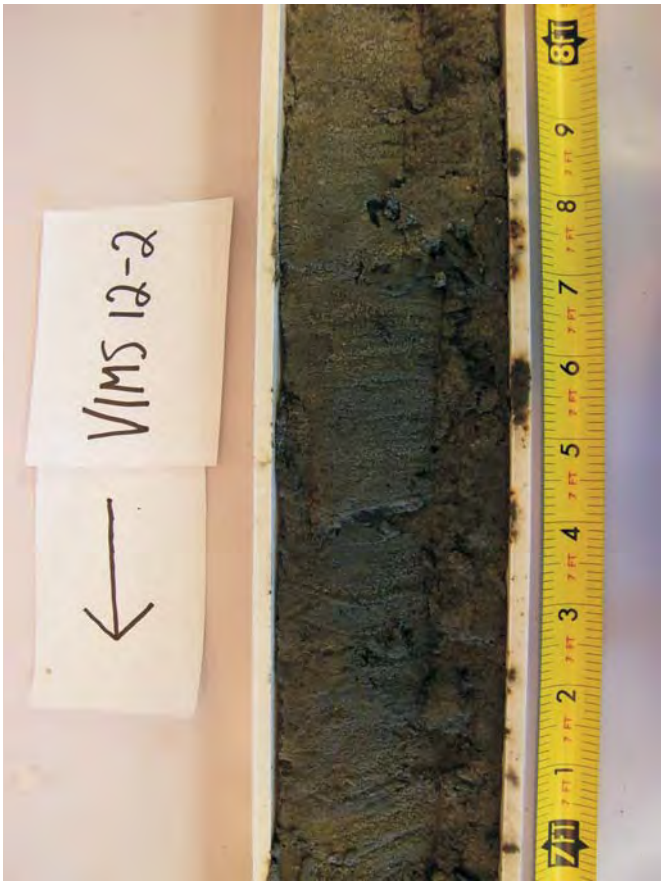

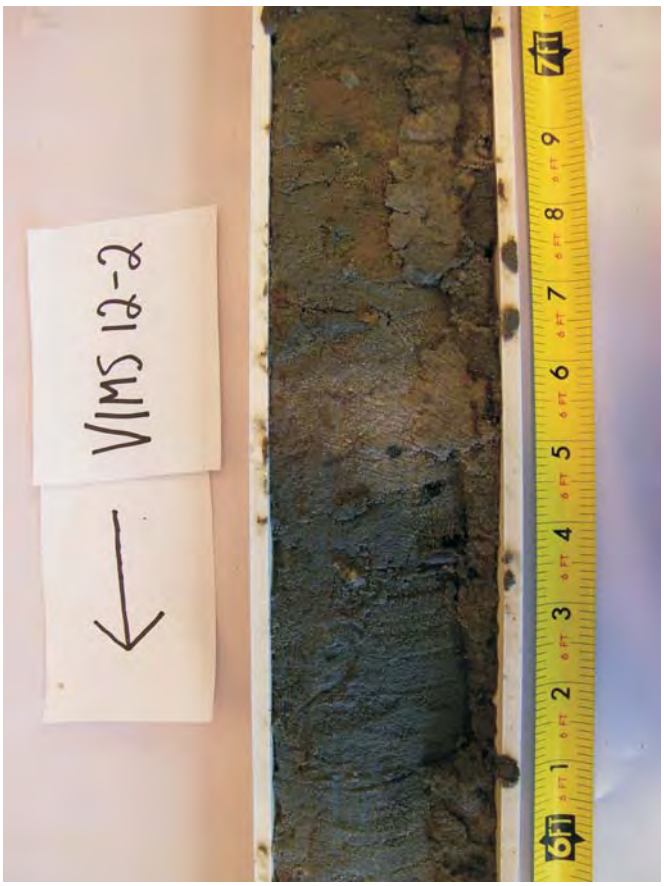

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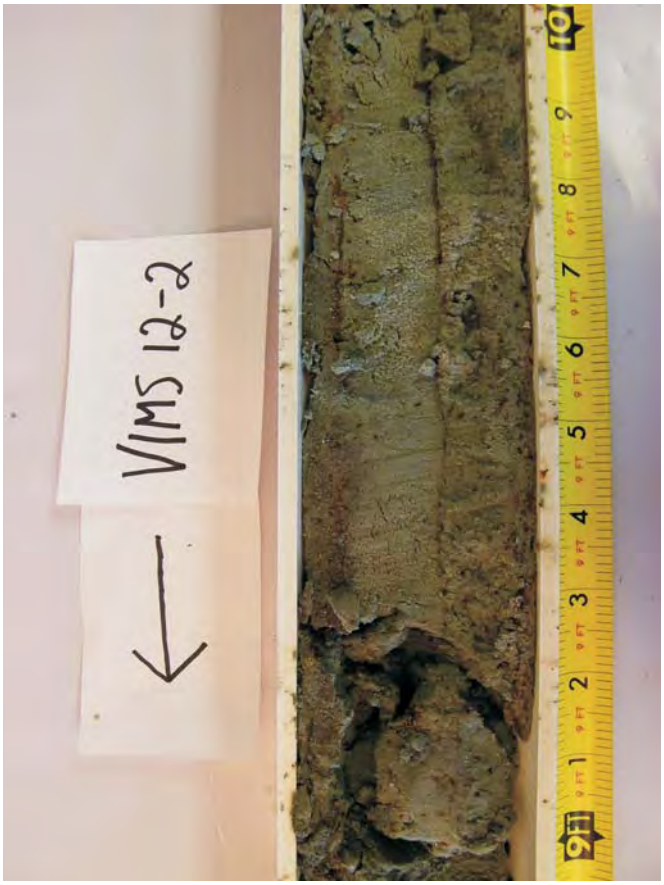

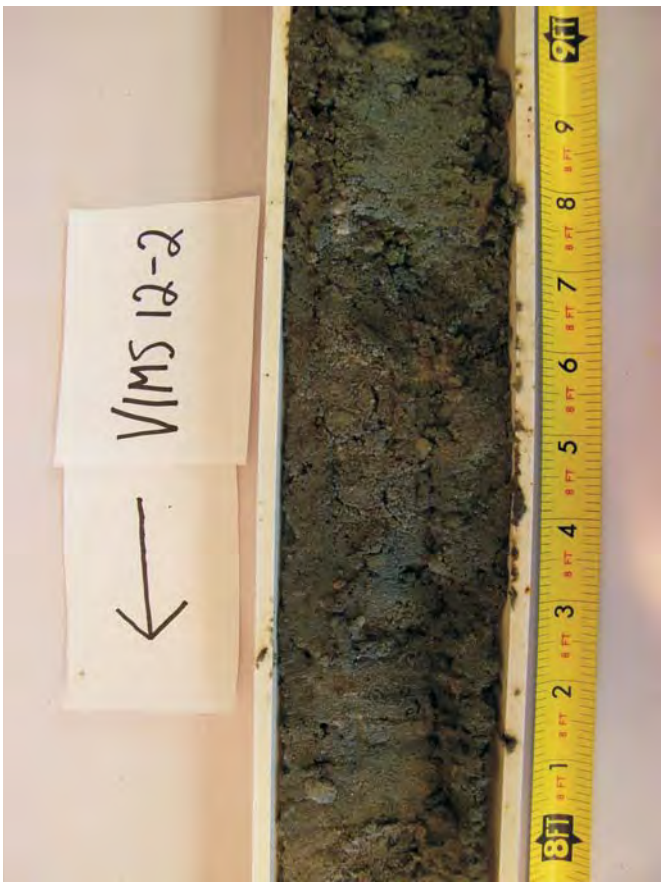

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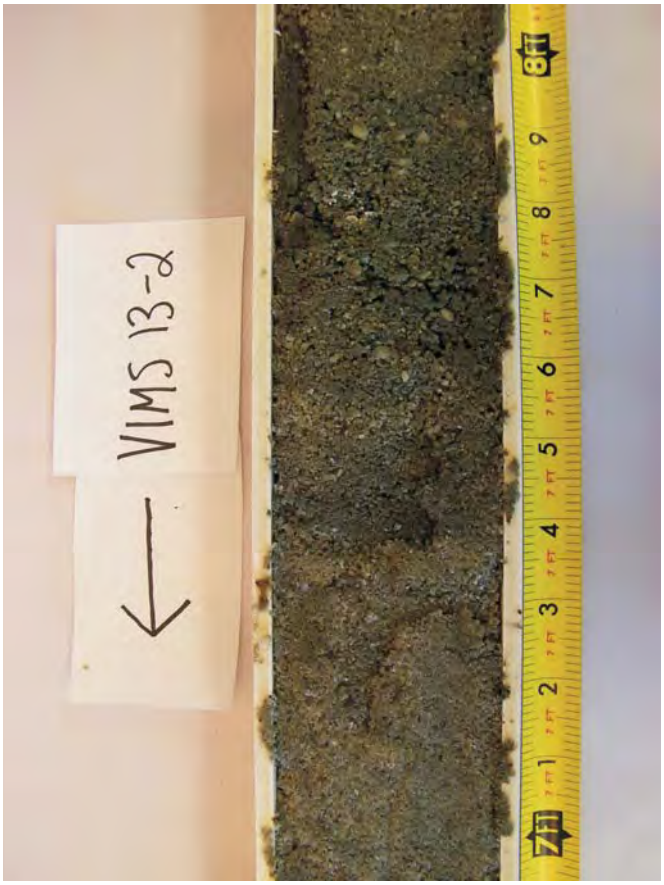

VIMS Core 13

VIMS Core 13

VIMS Core 14

Top of Core
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VIMS14-1
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2FT

VIMS14-1
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3FT

VIMS14-1
3FT
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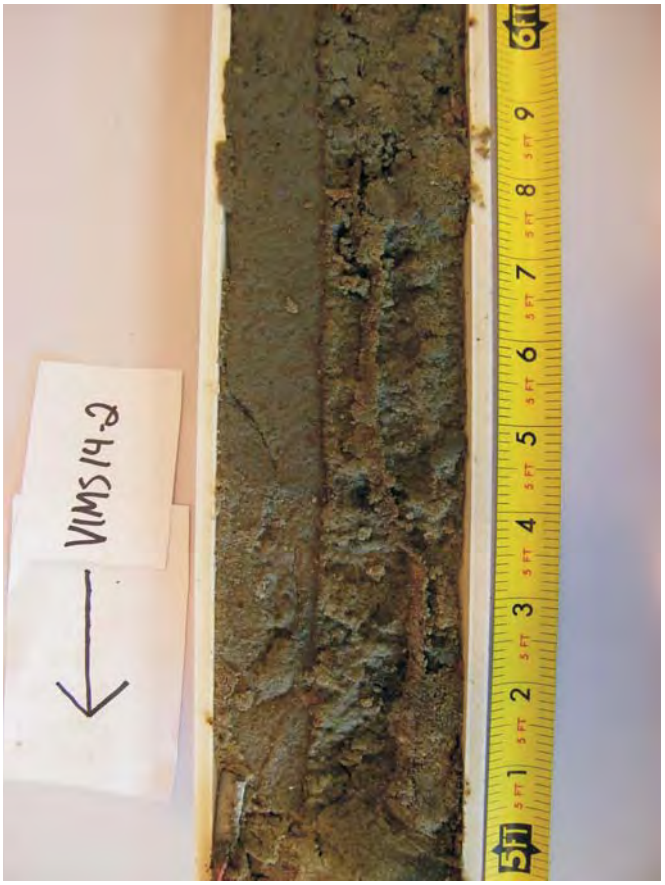

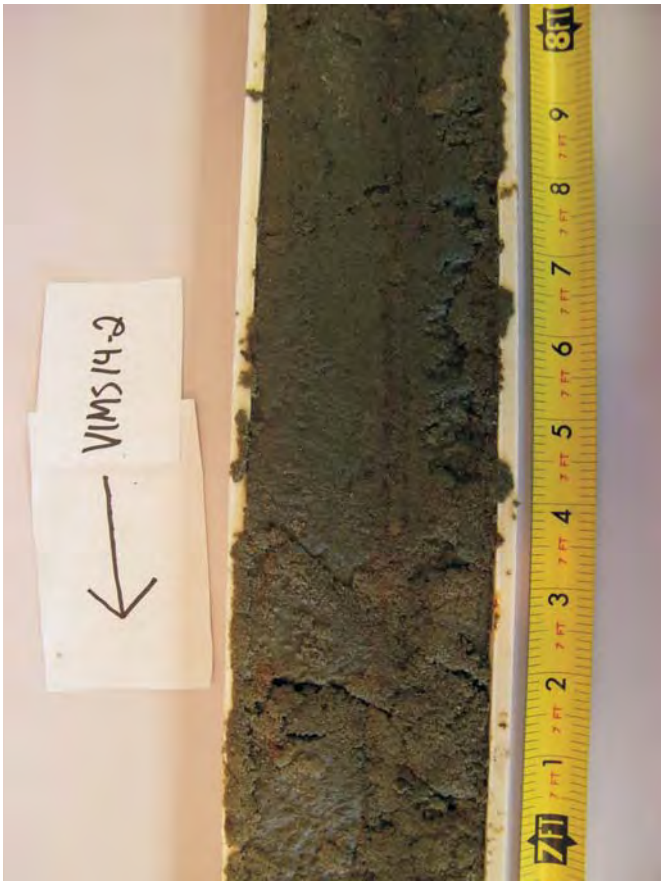

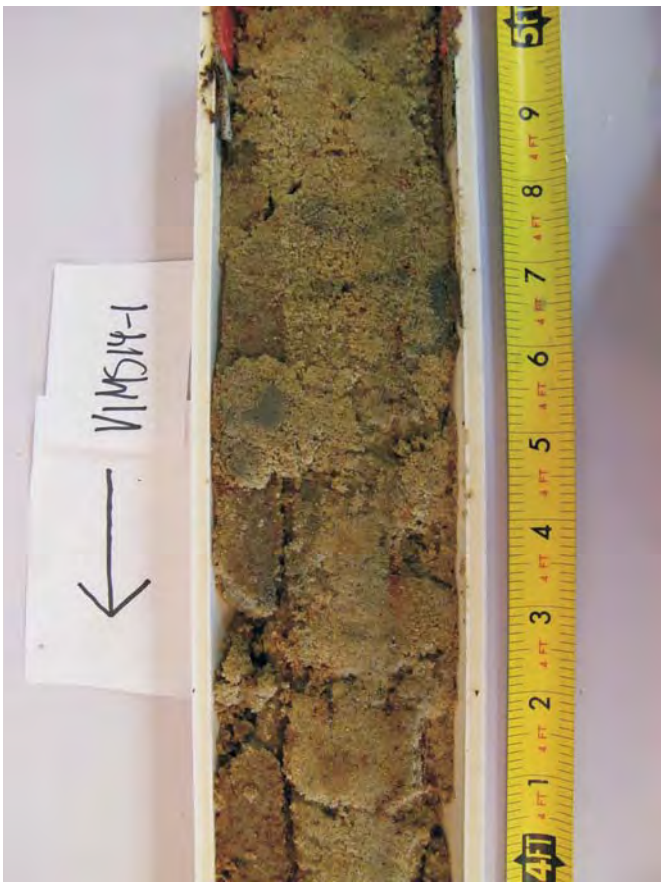

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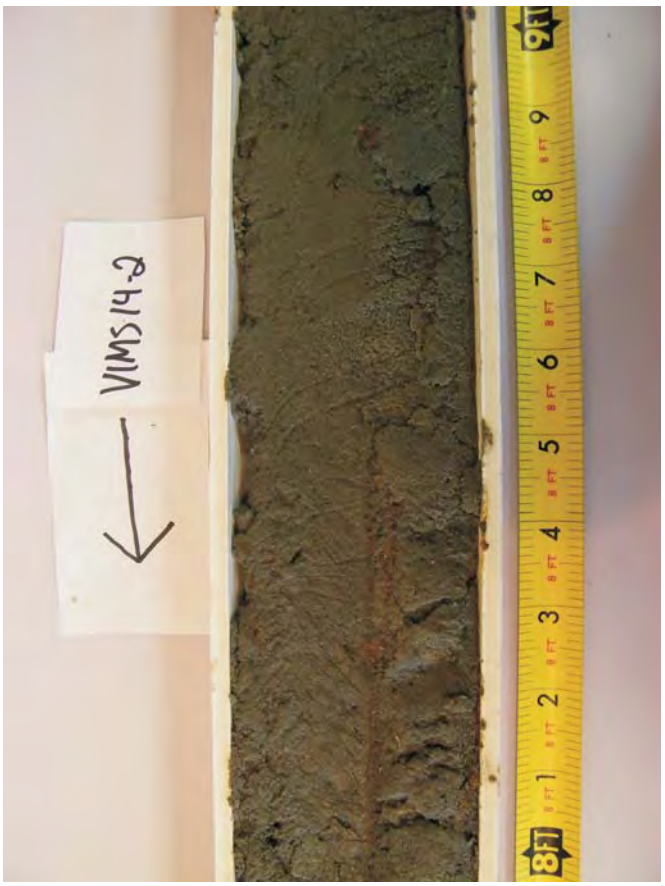

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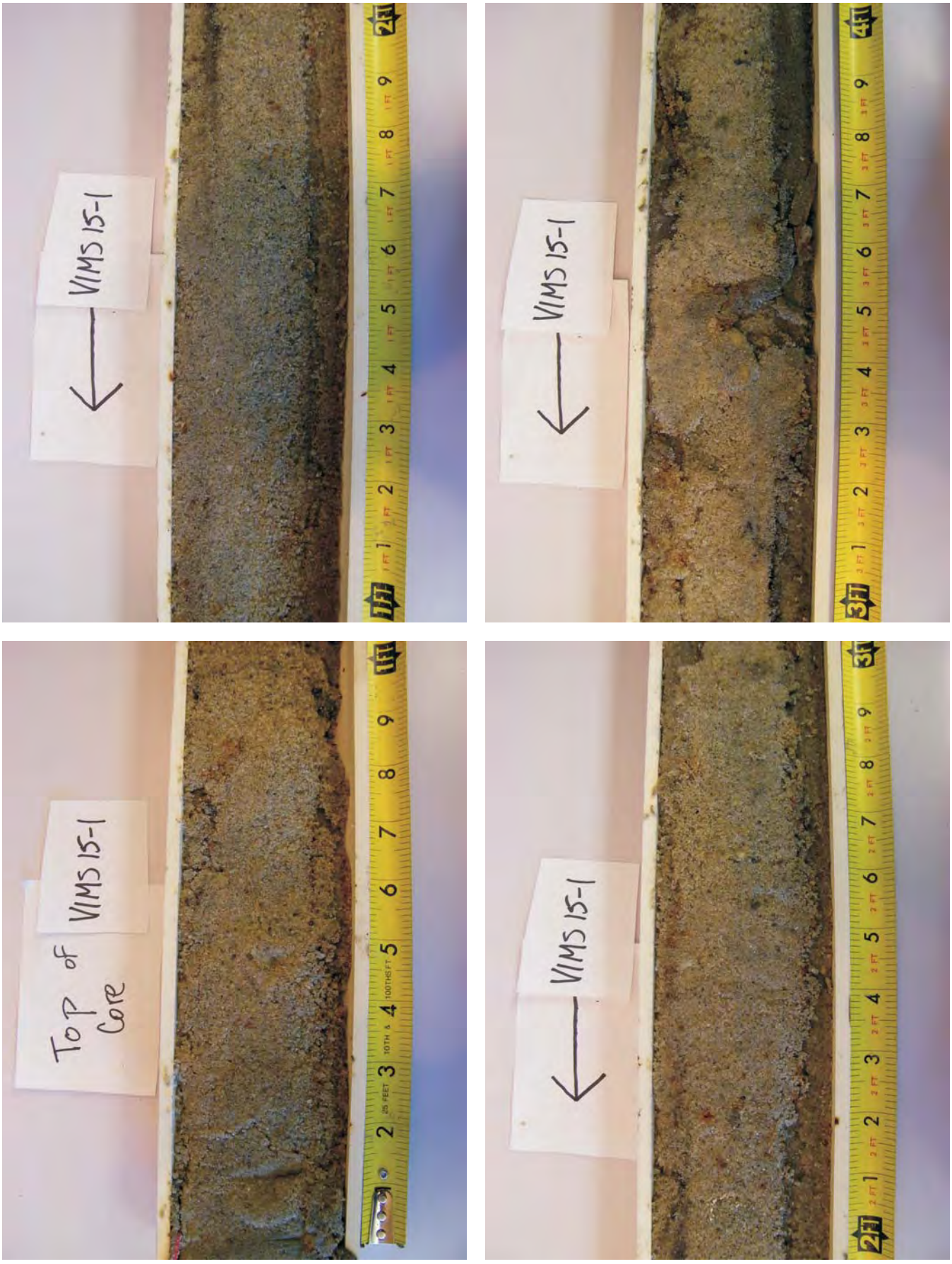

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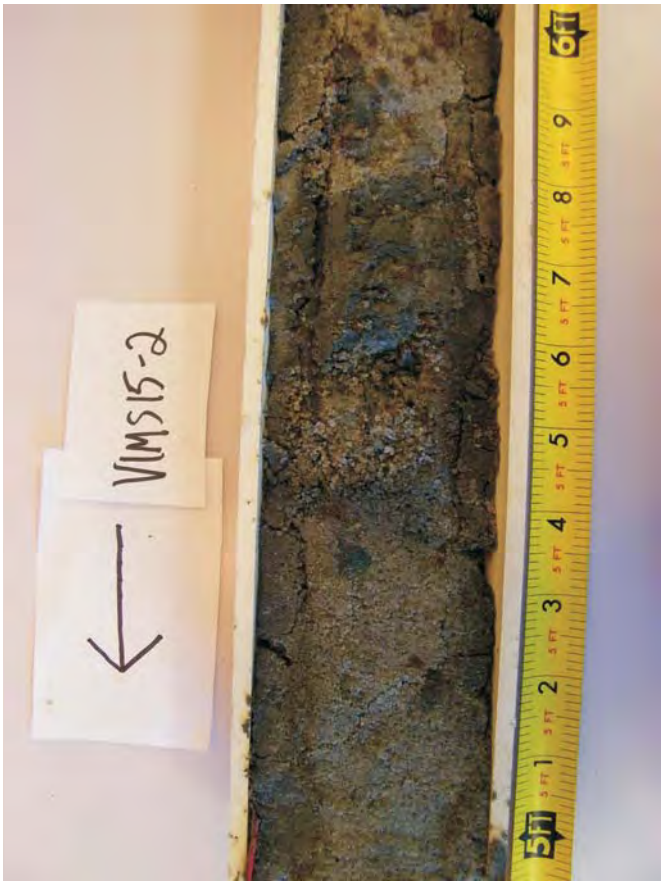

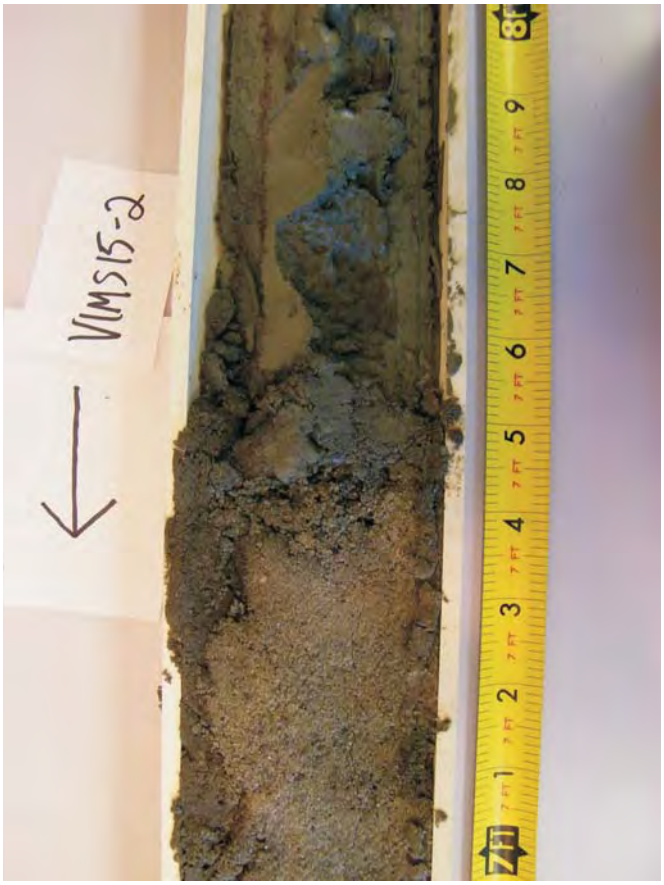

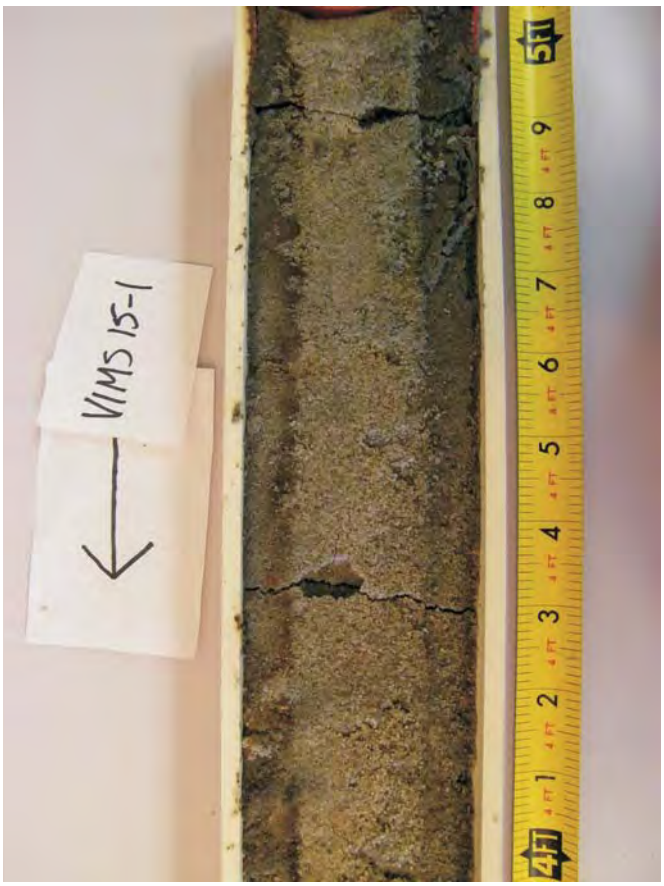

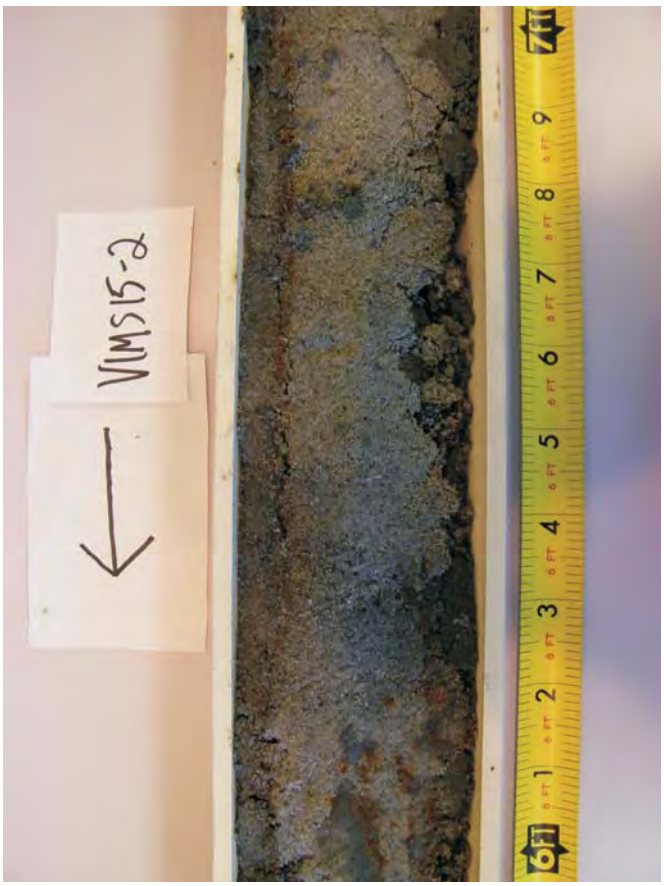

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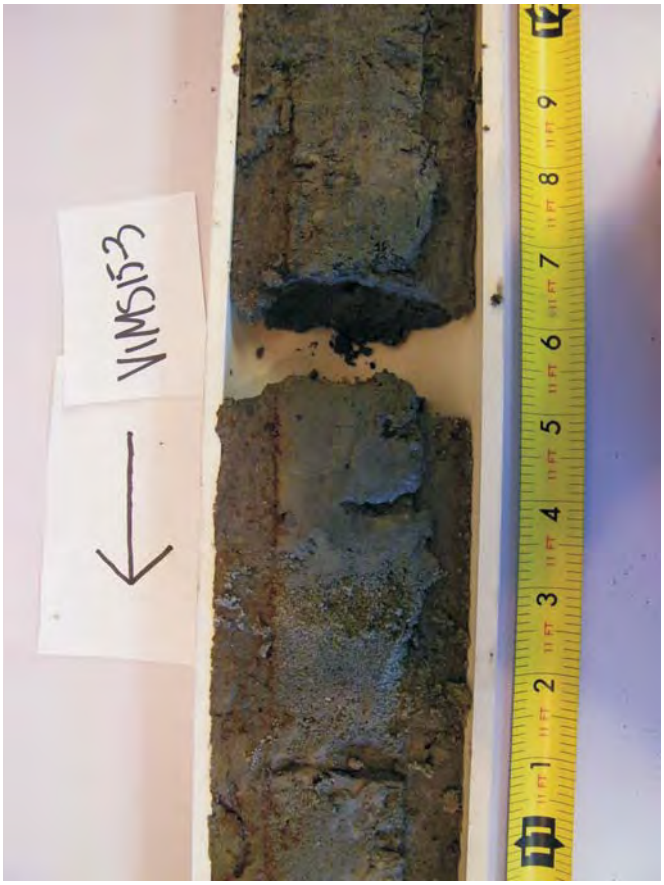

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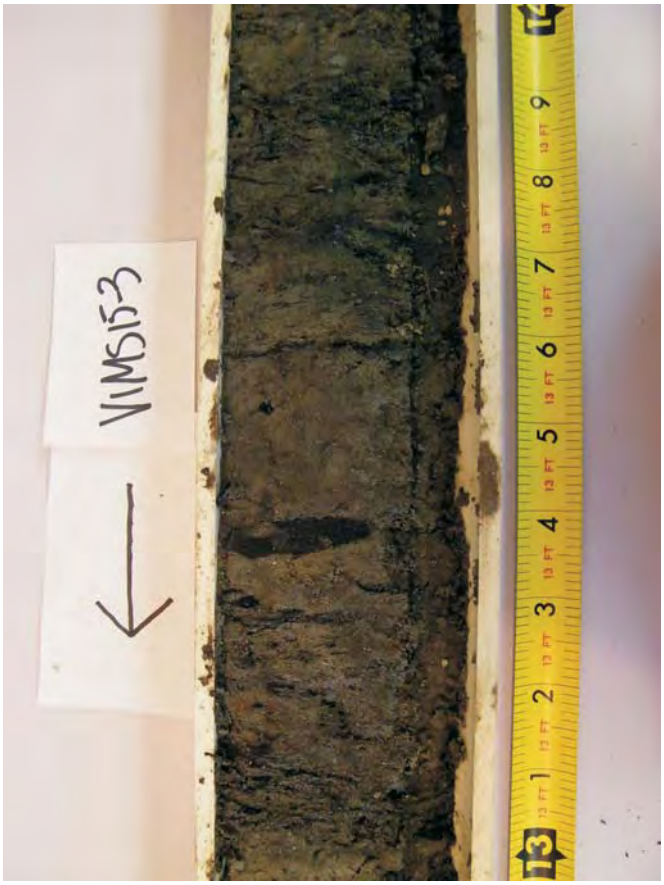

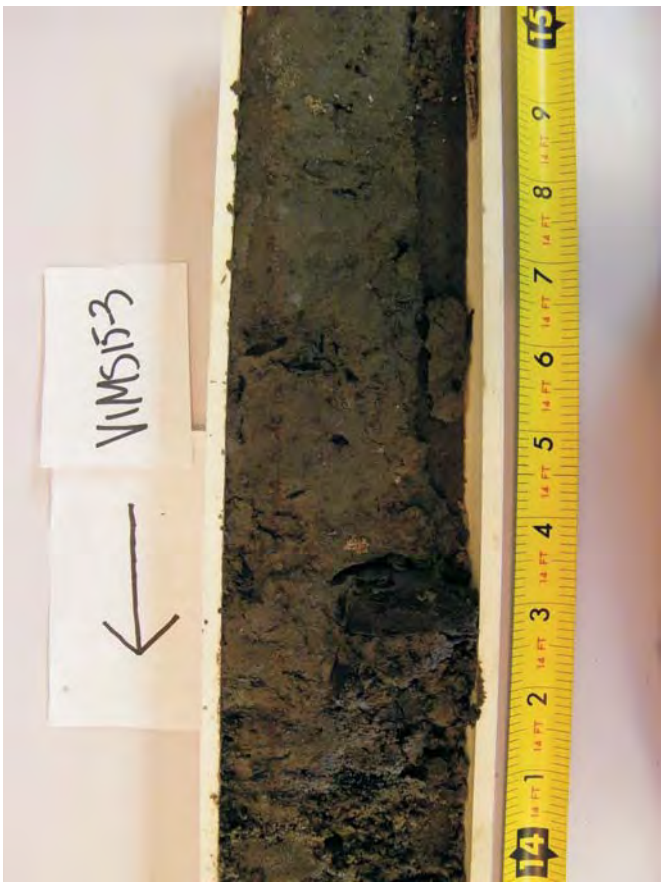

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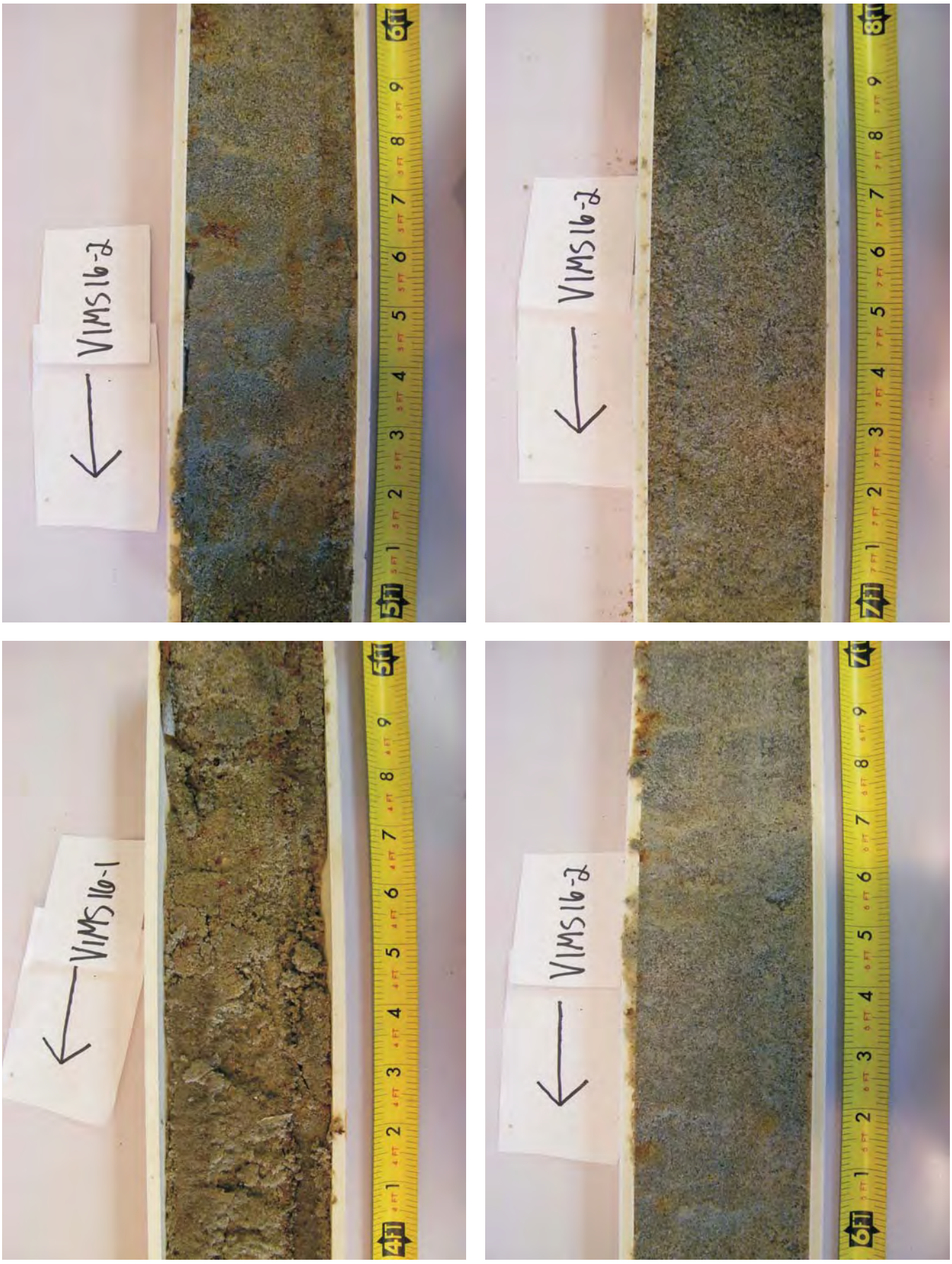
VIMS Core 15

VIMS Core 16



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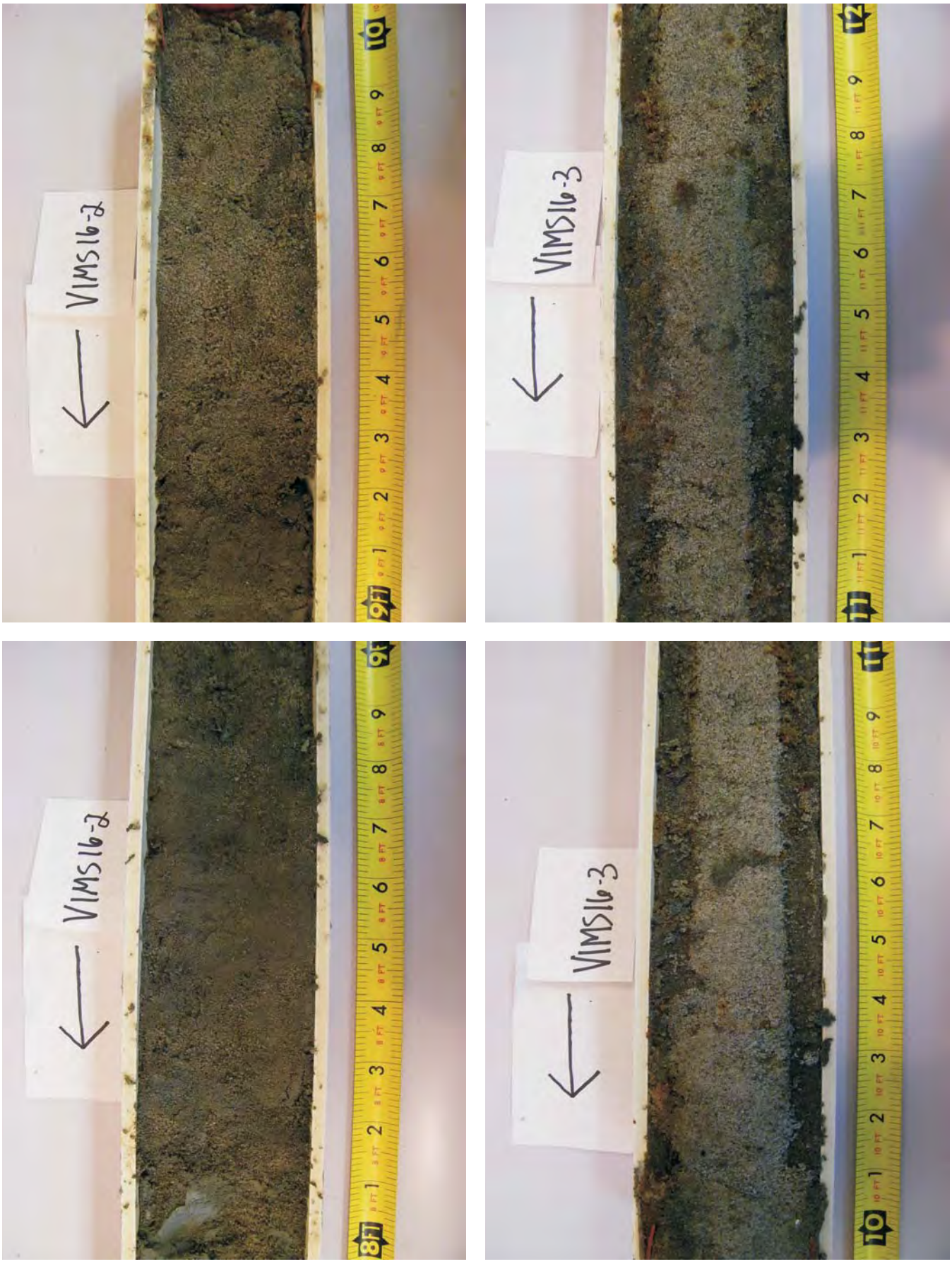

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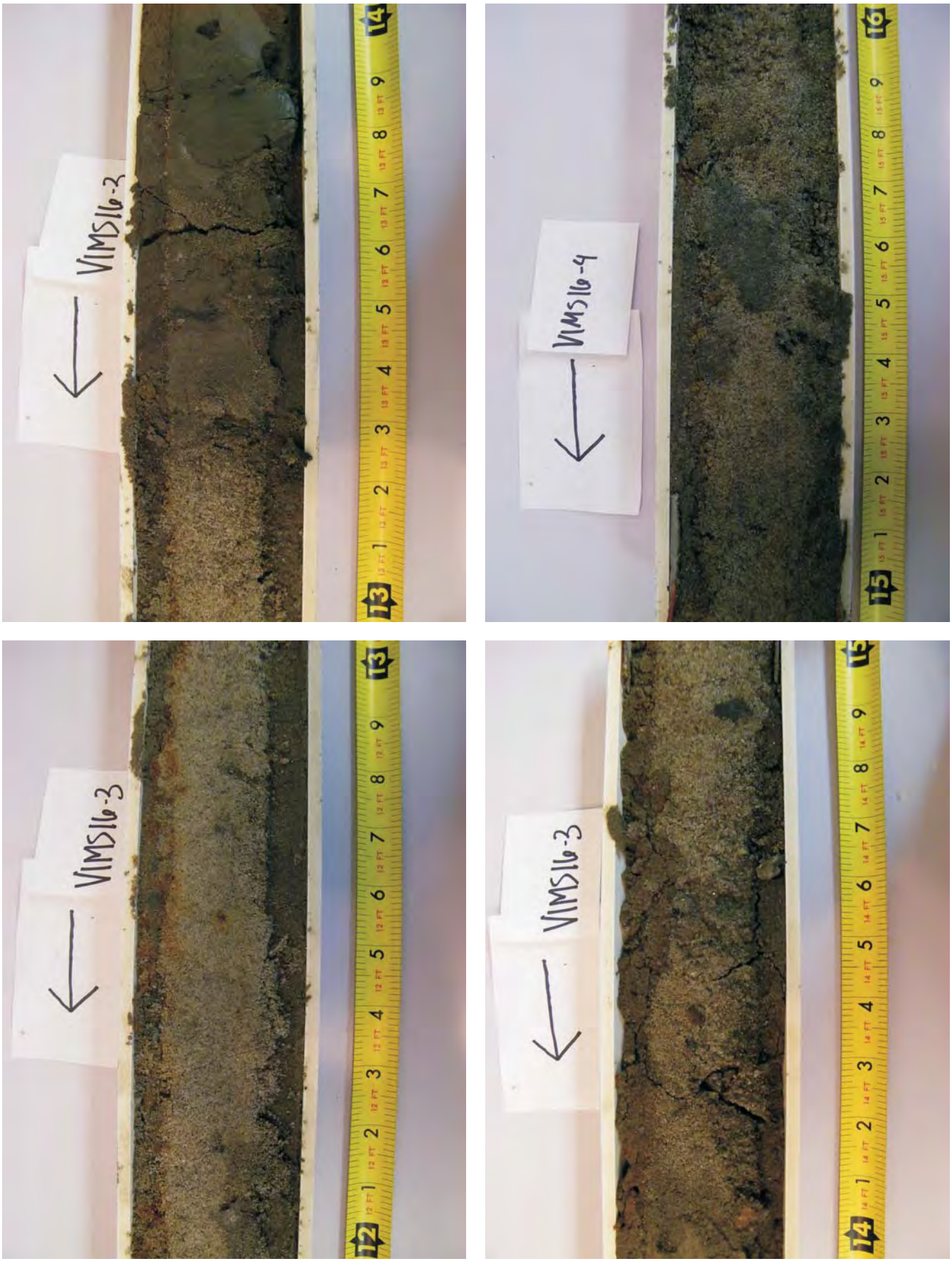

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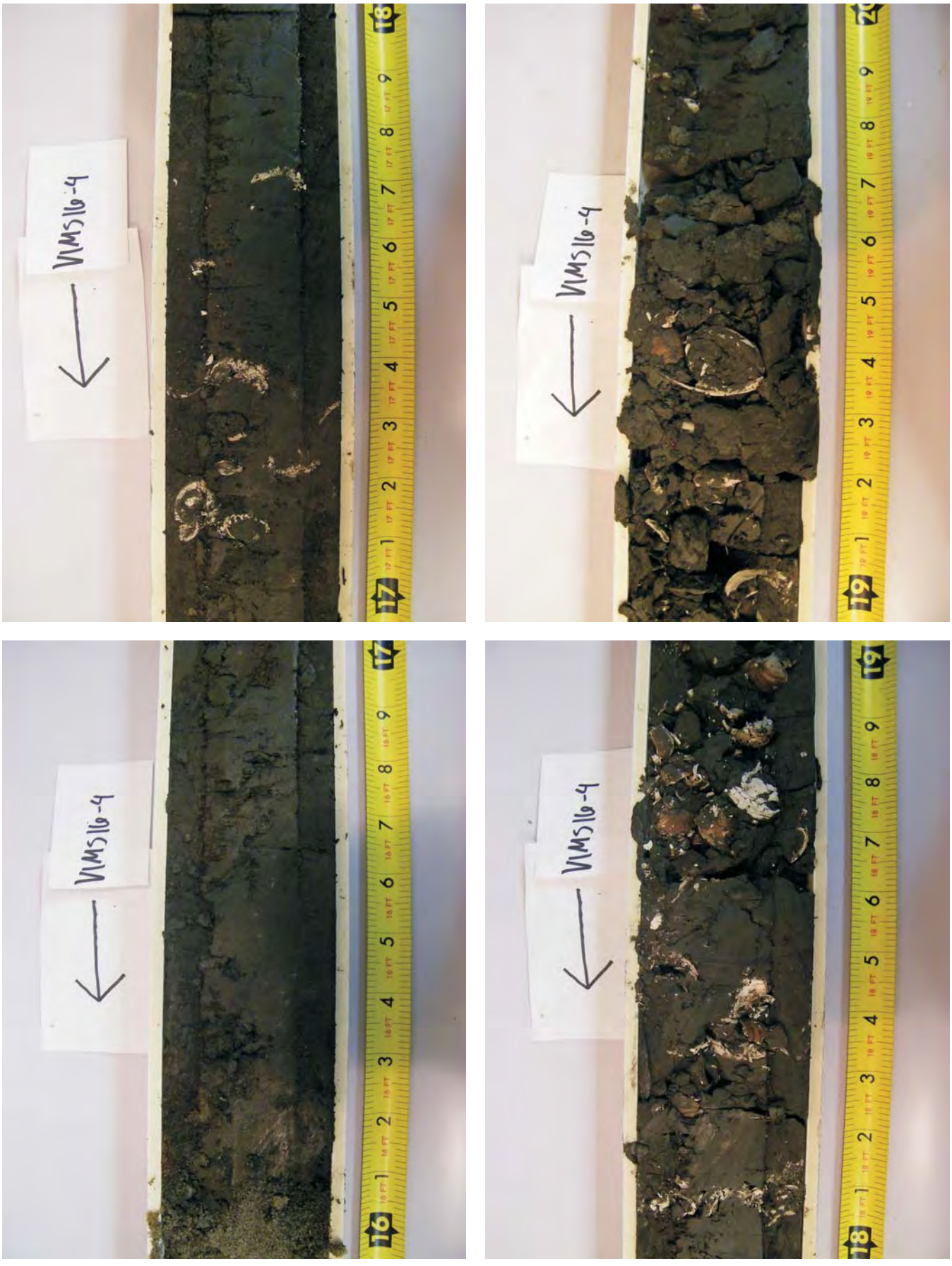

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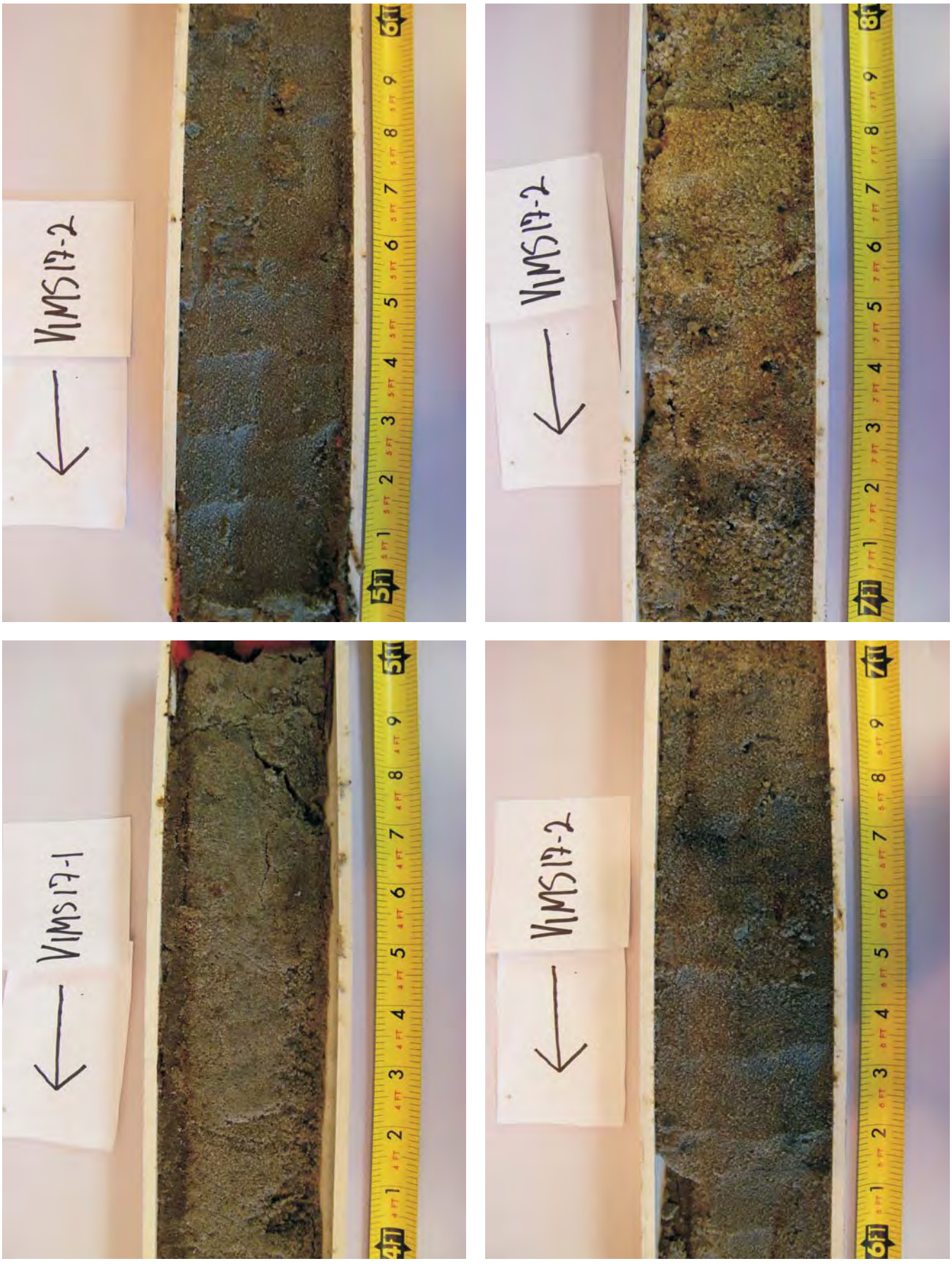
VIMS Core 16

VIMS Core 17



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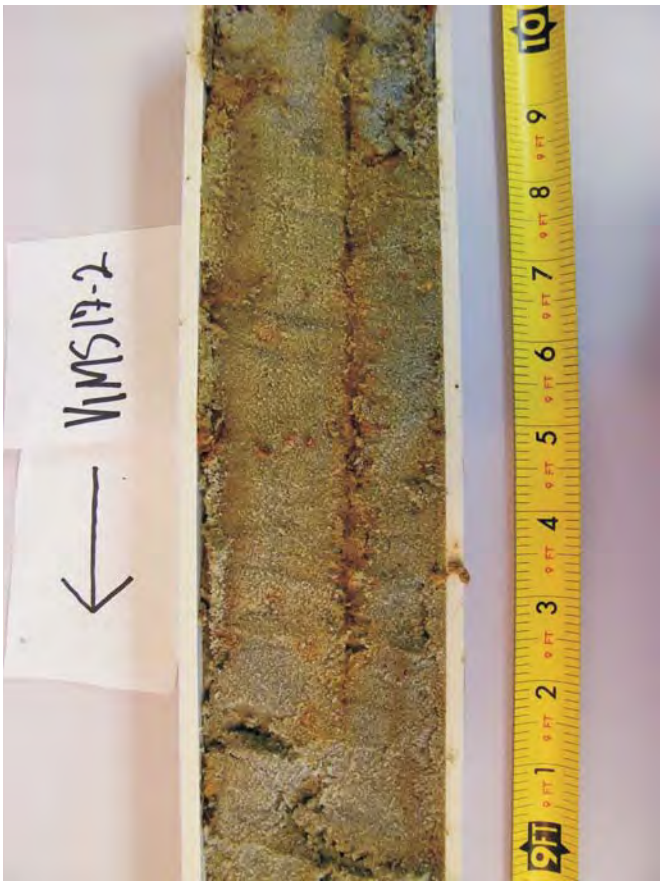

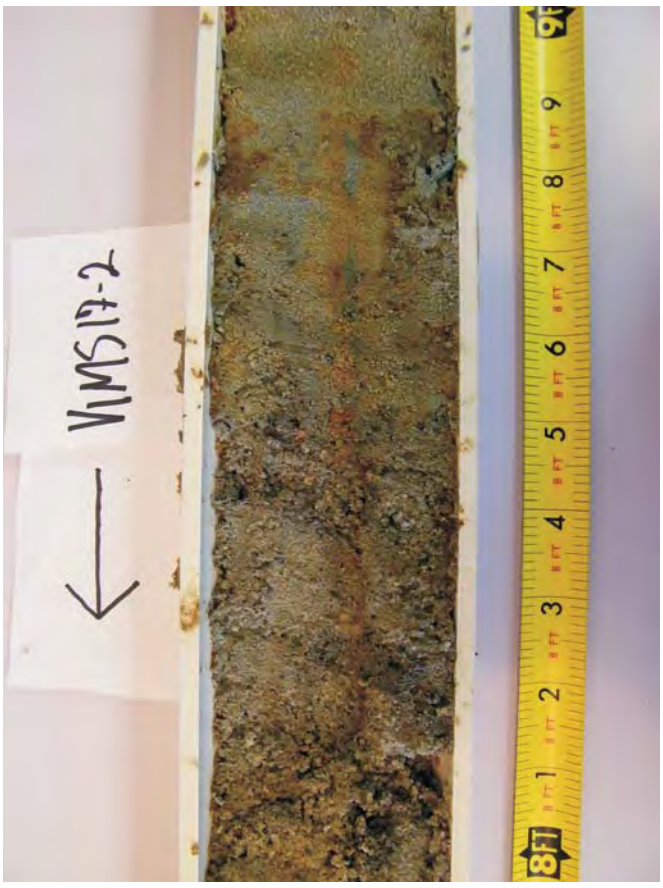

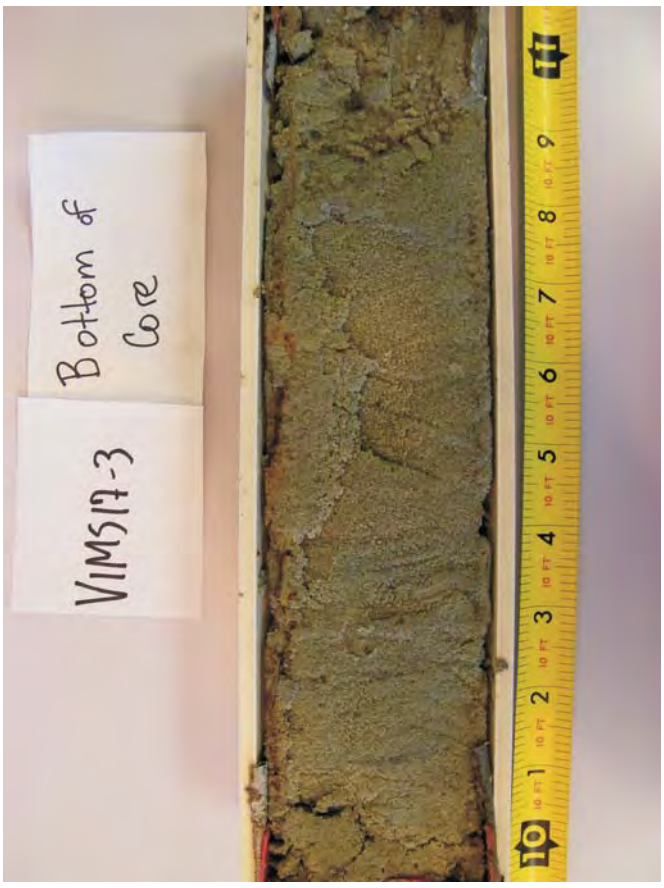

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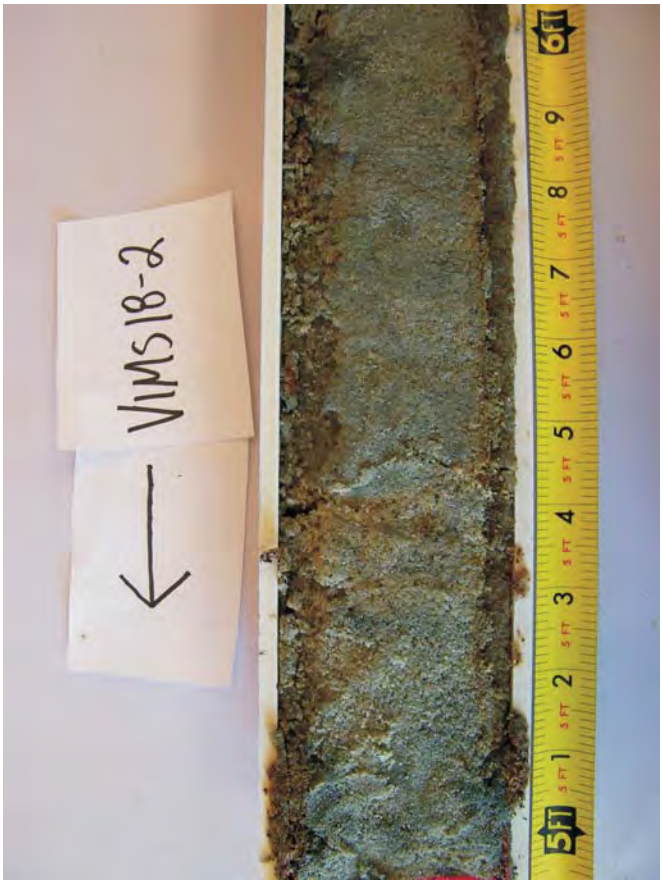

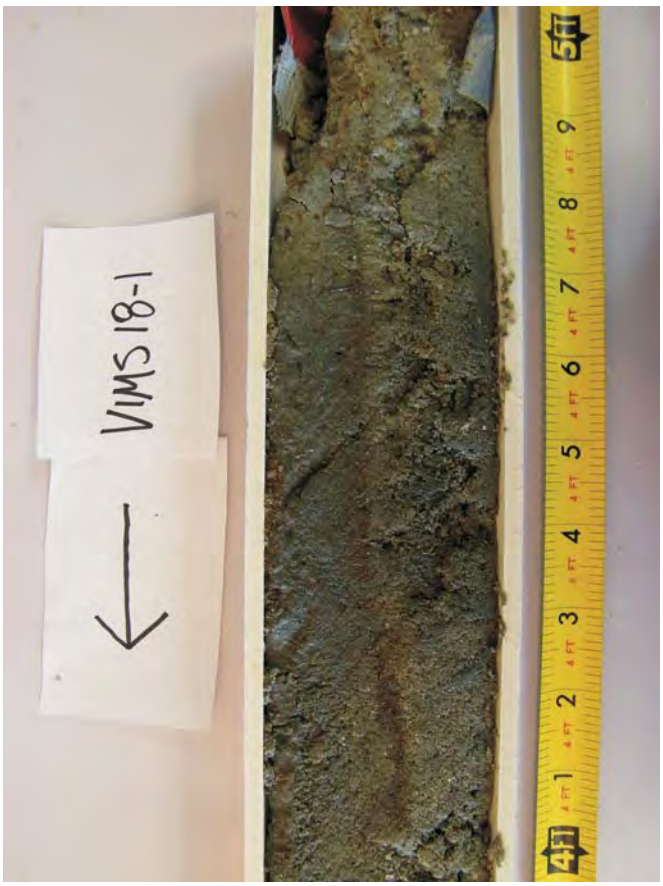

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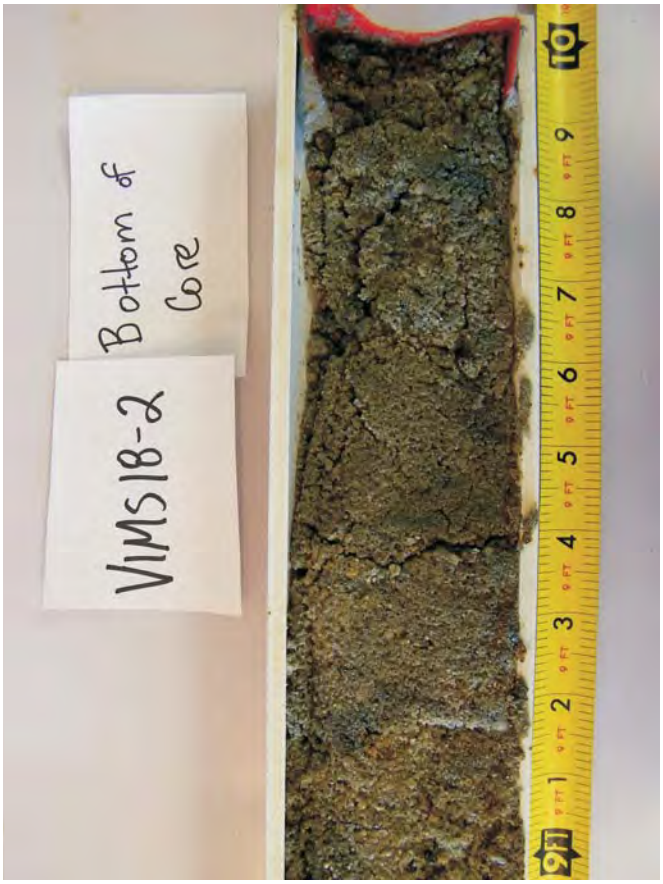

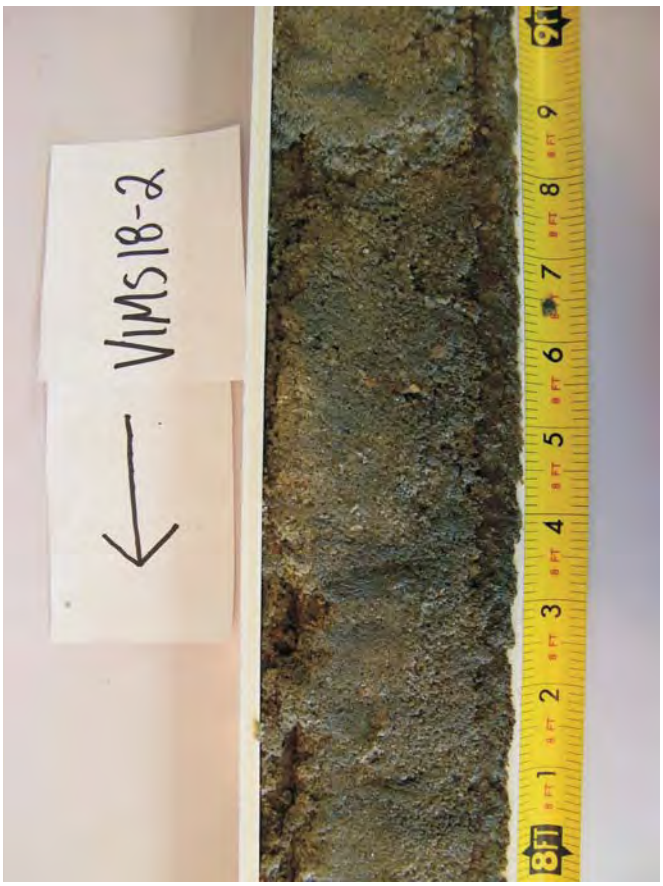

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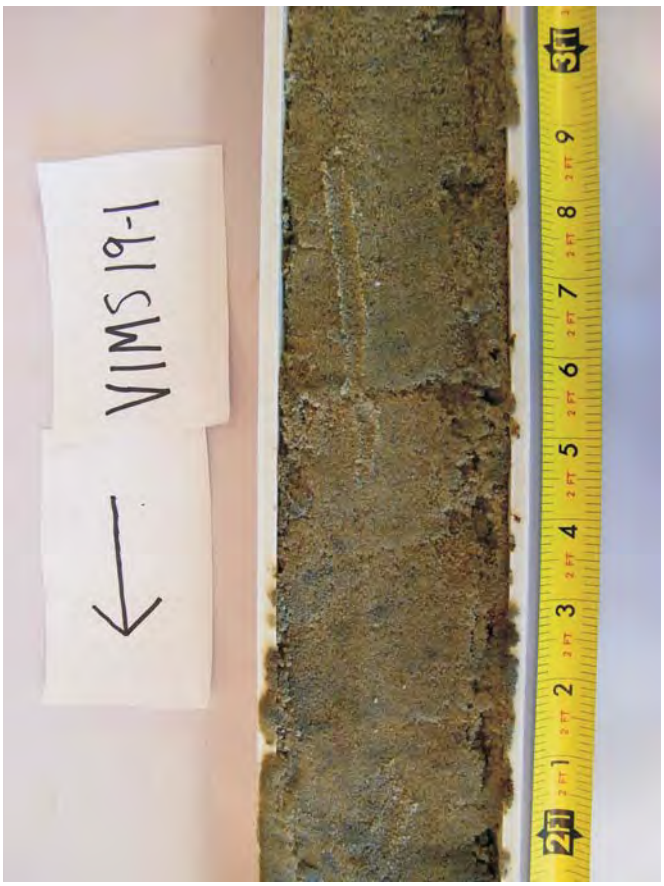

VIMS Core 19

VIMS Core 19

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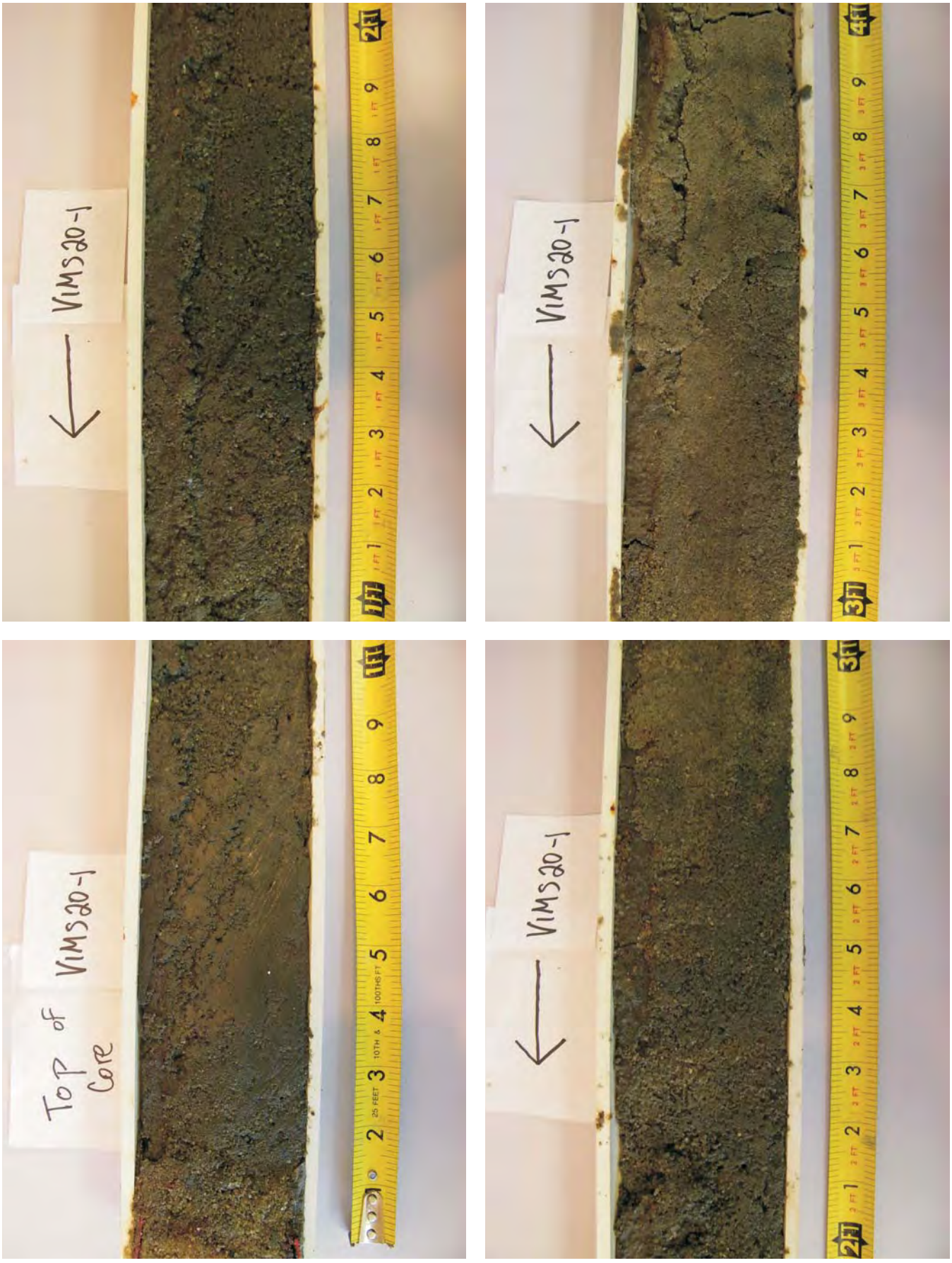

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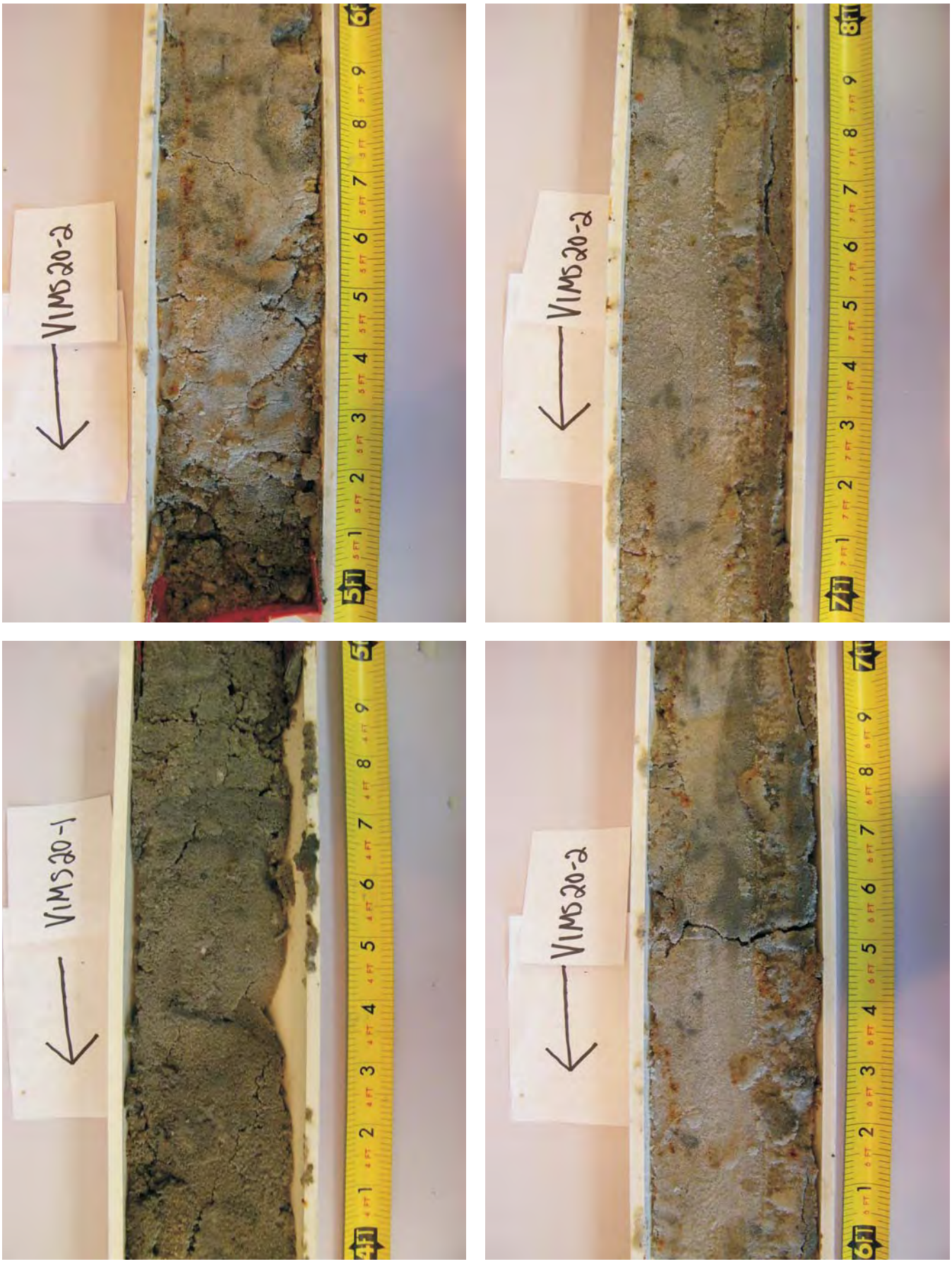

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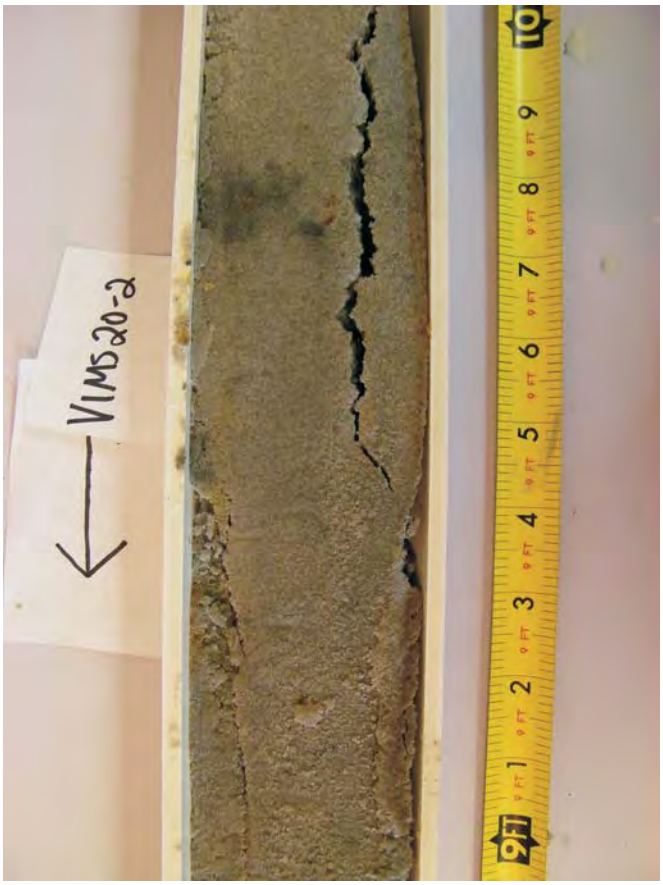

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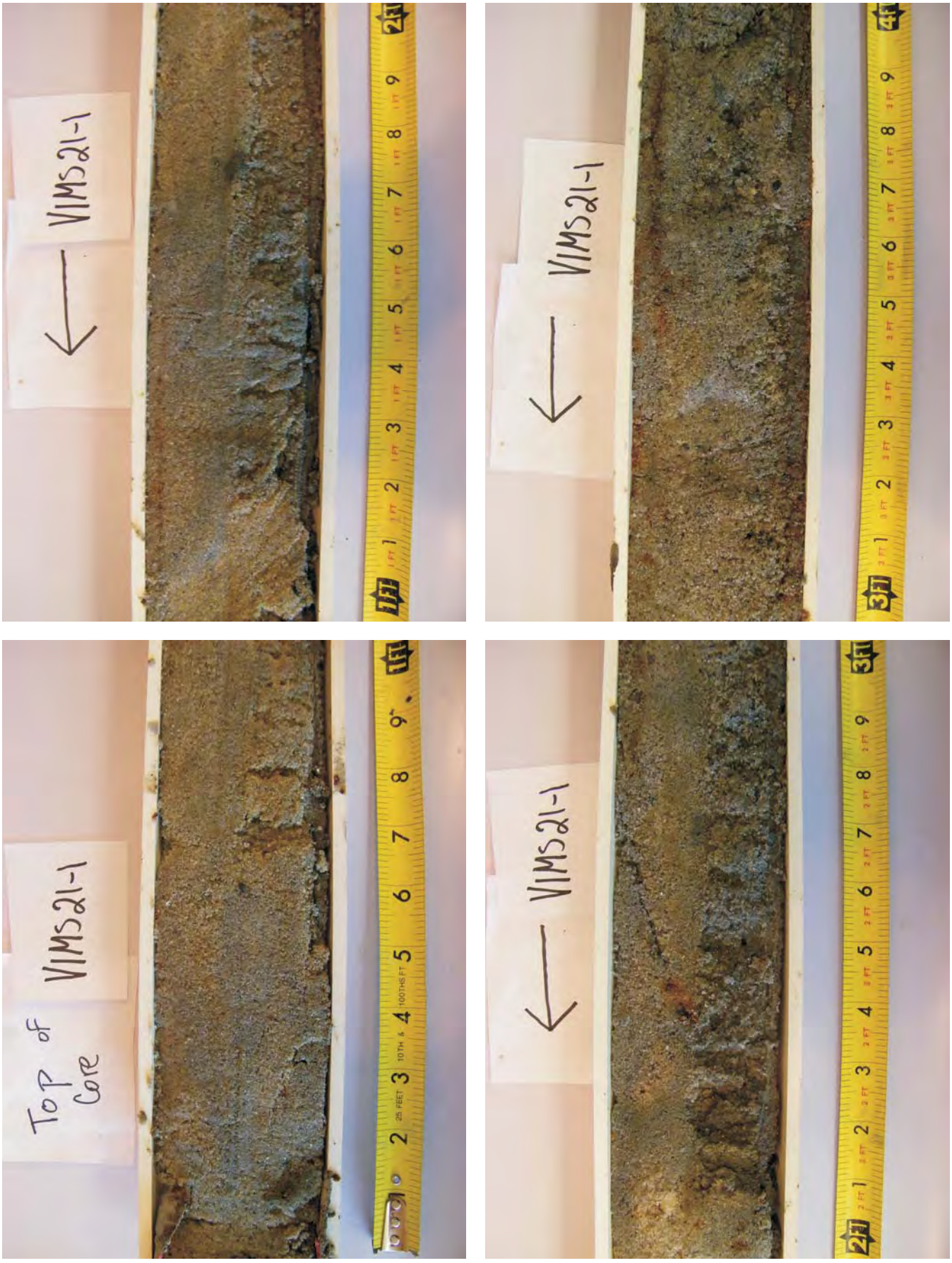

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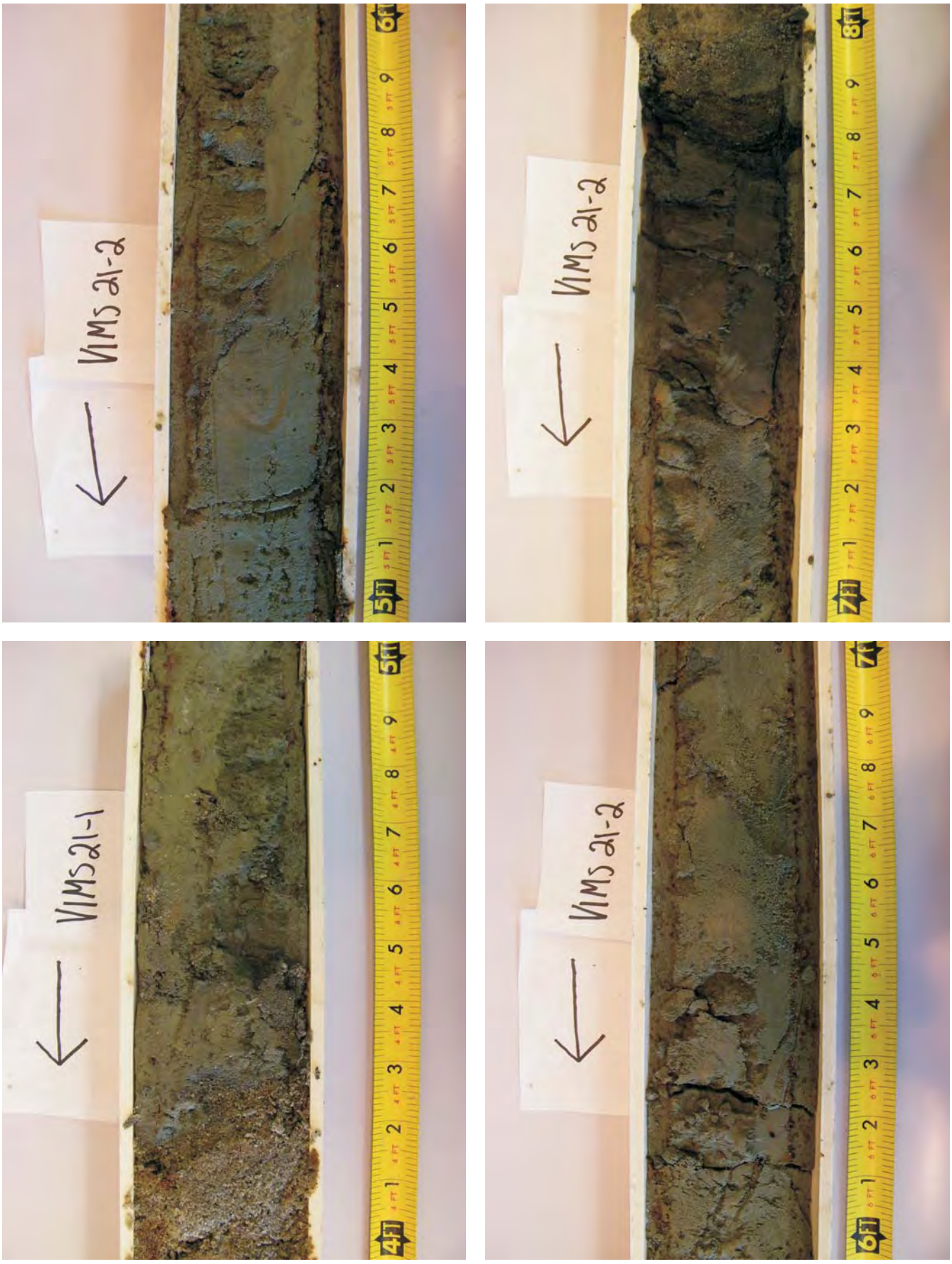

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VIMS Core 21

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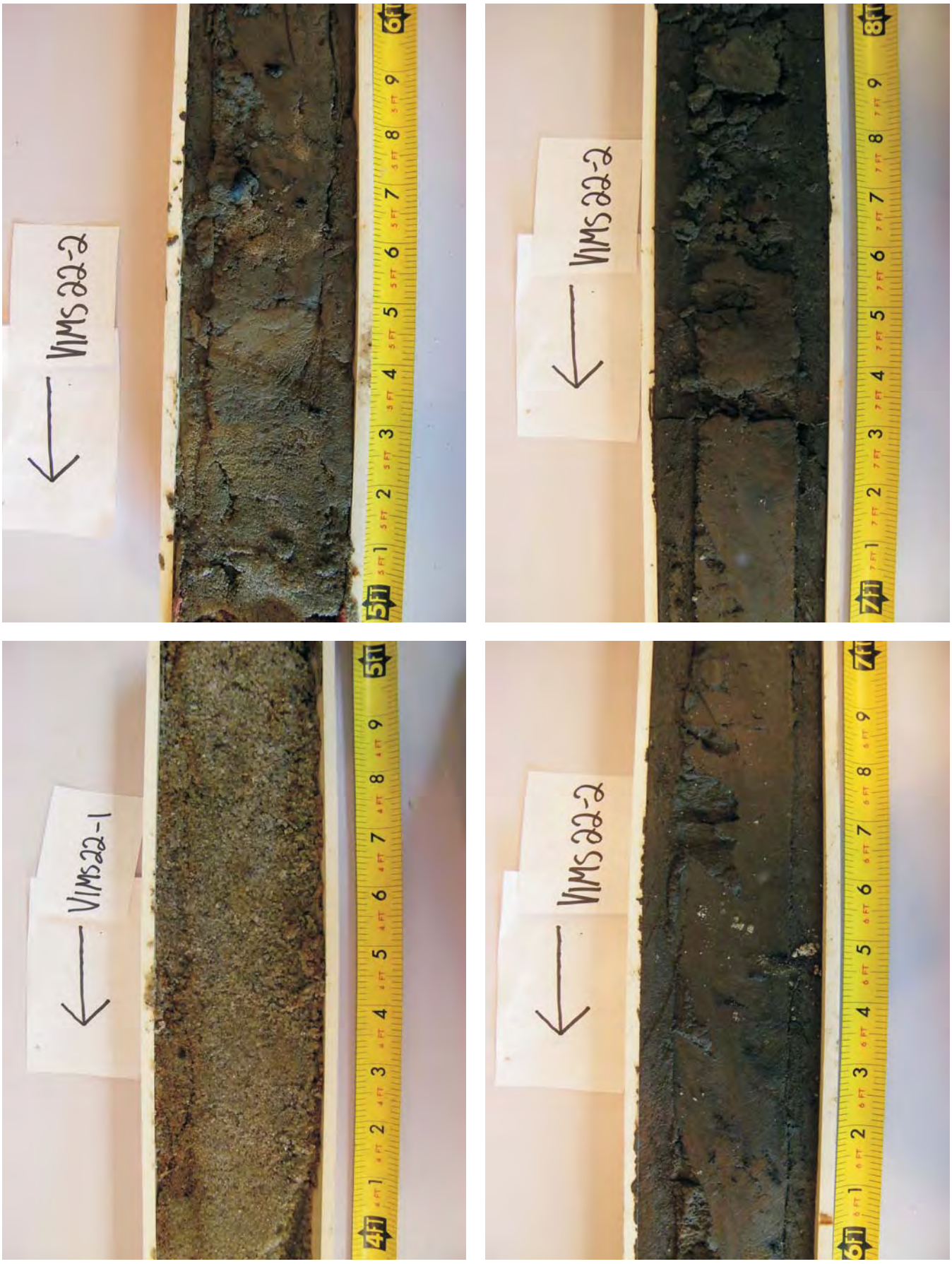

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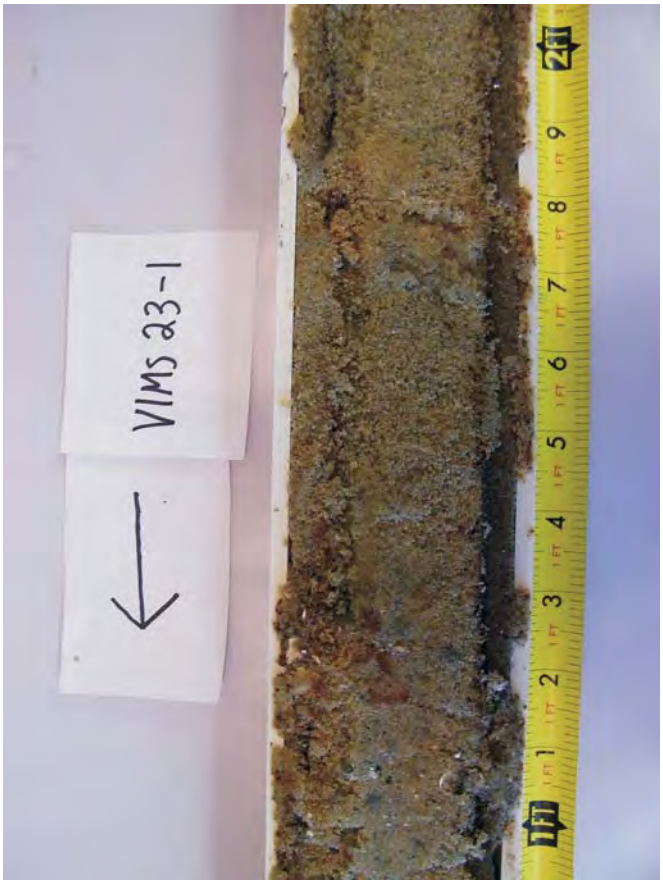

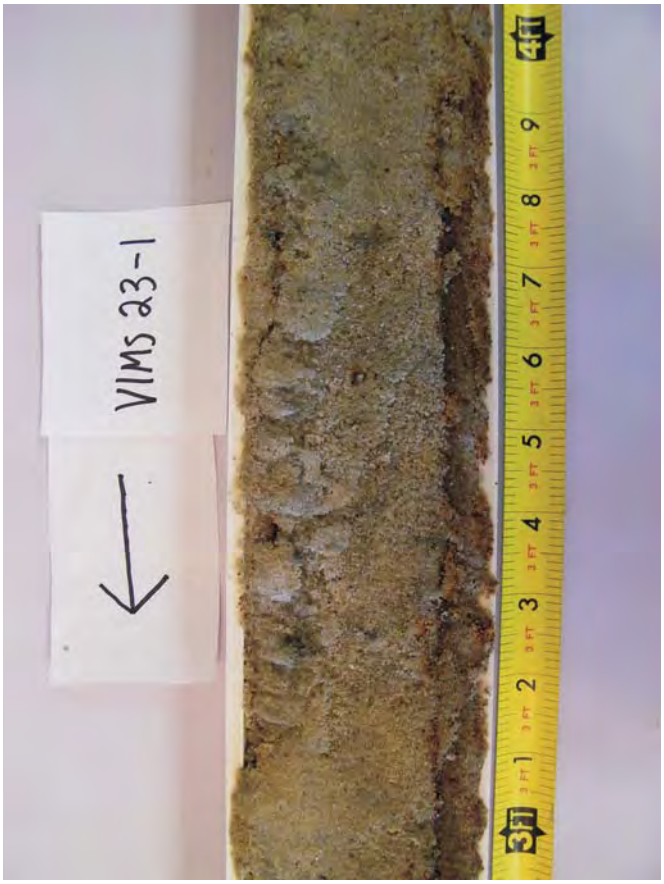

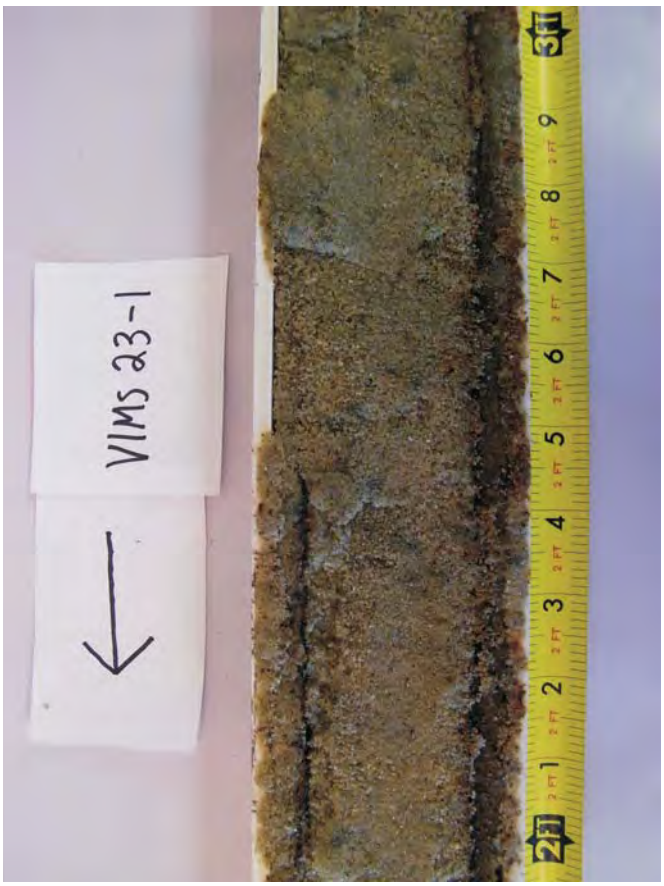

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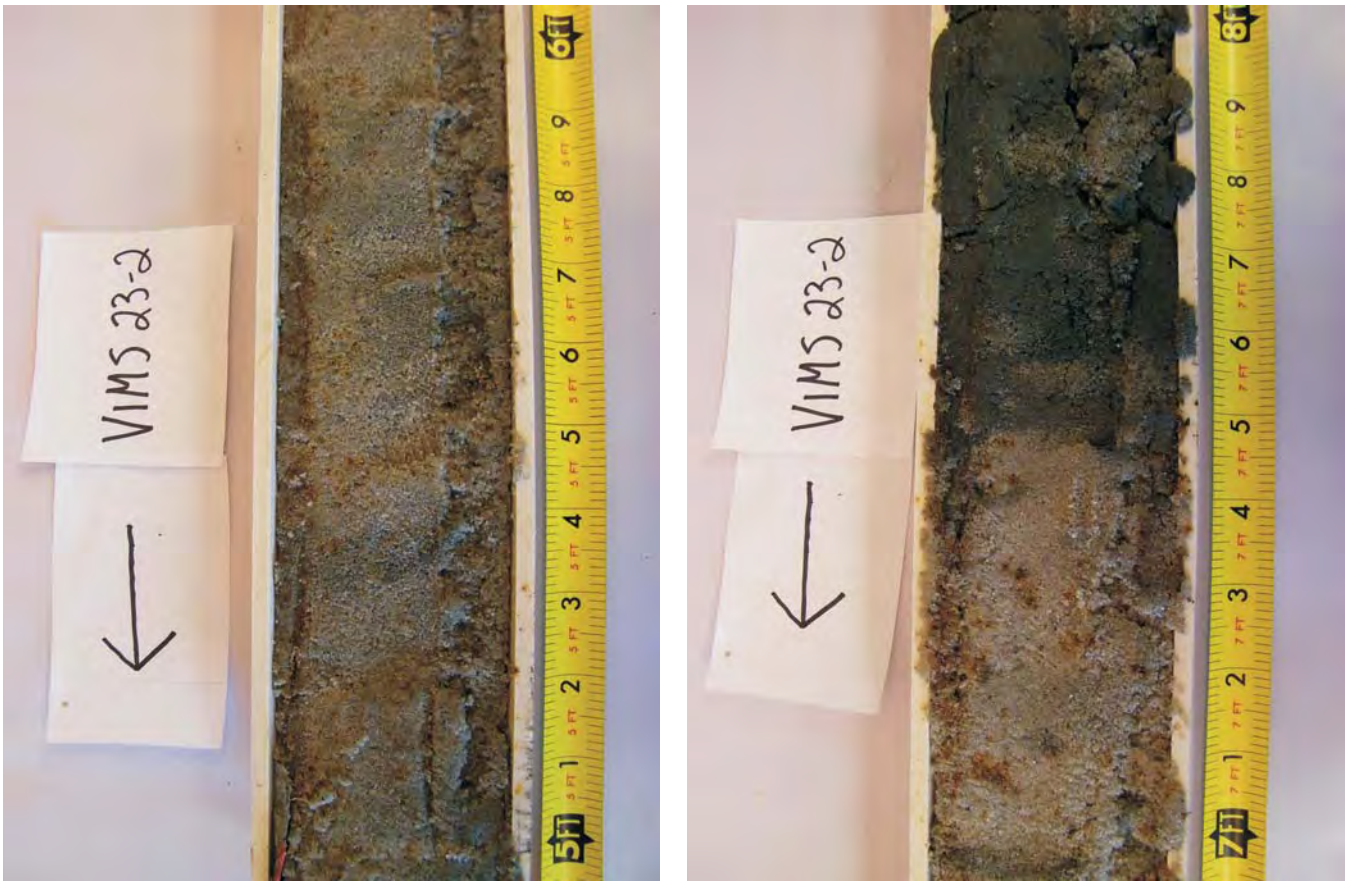

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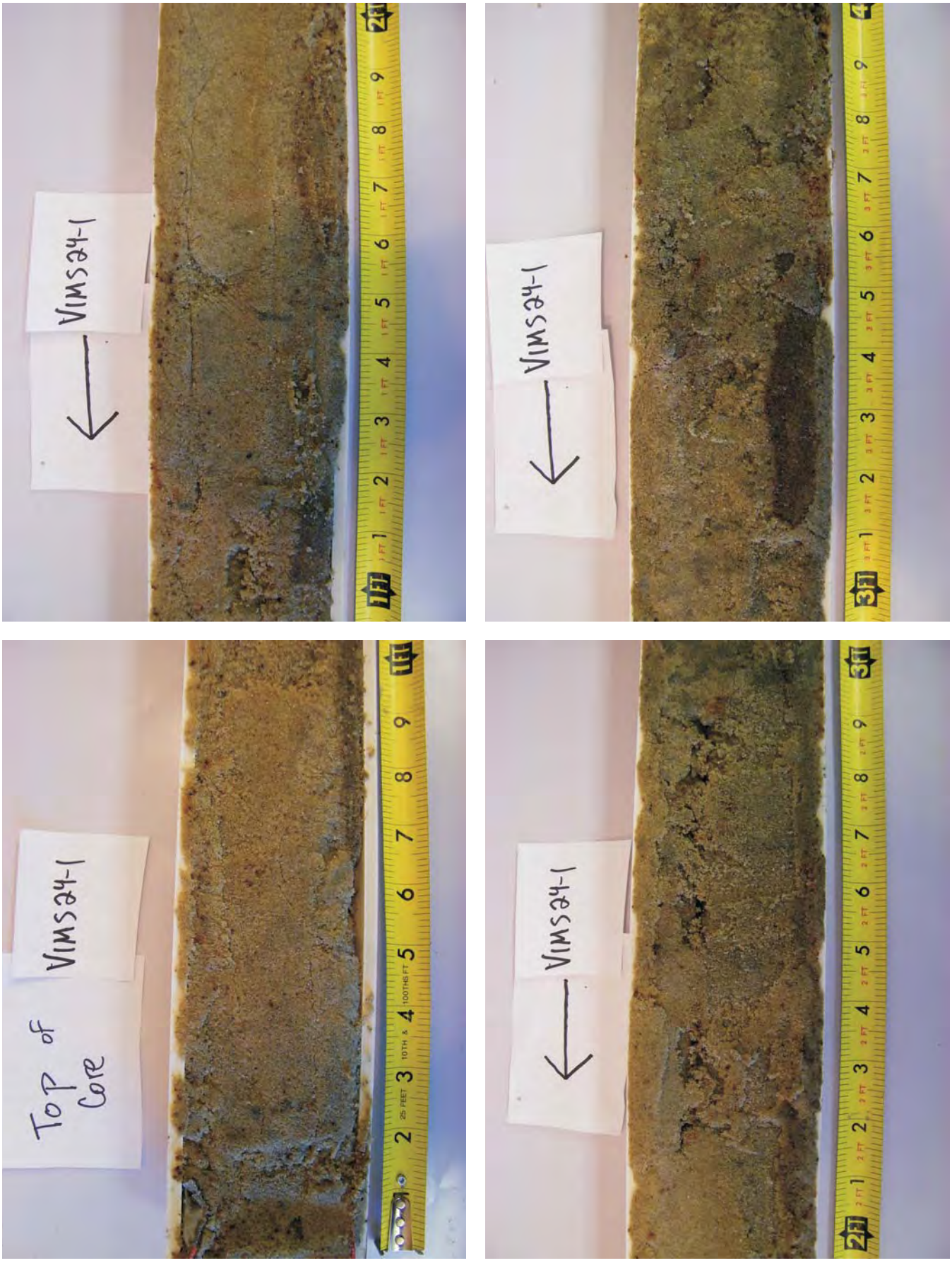

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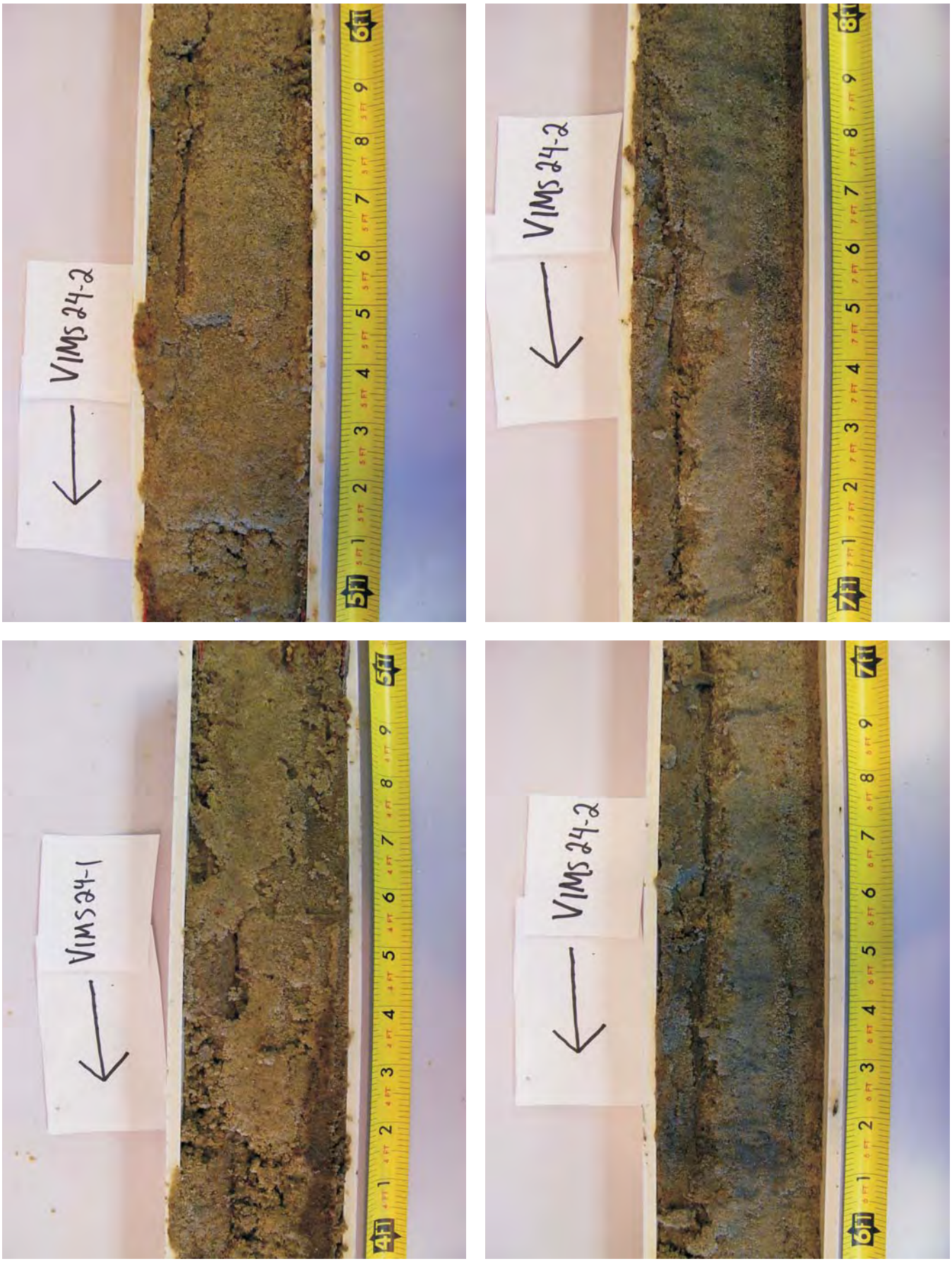

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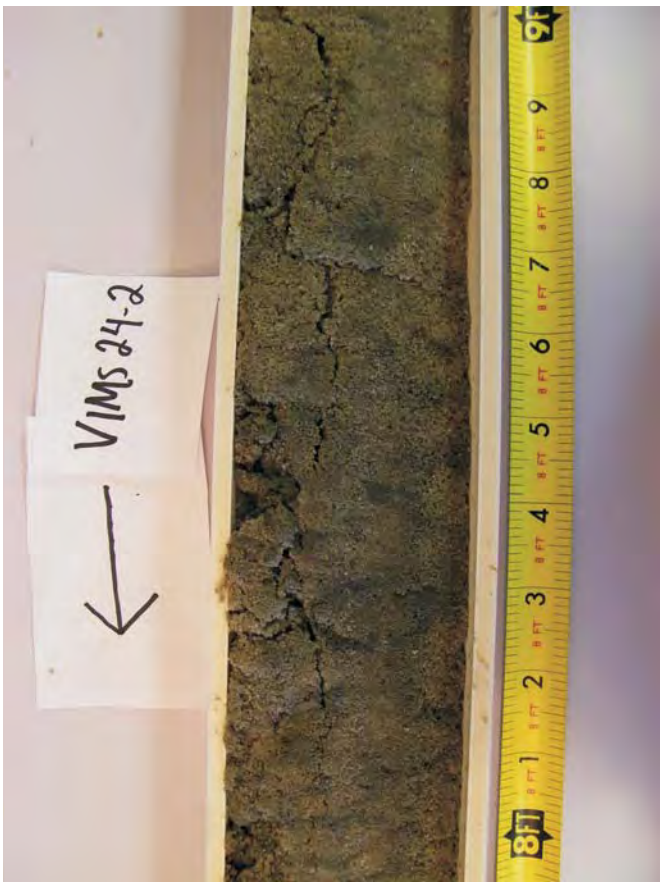

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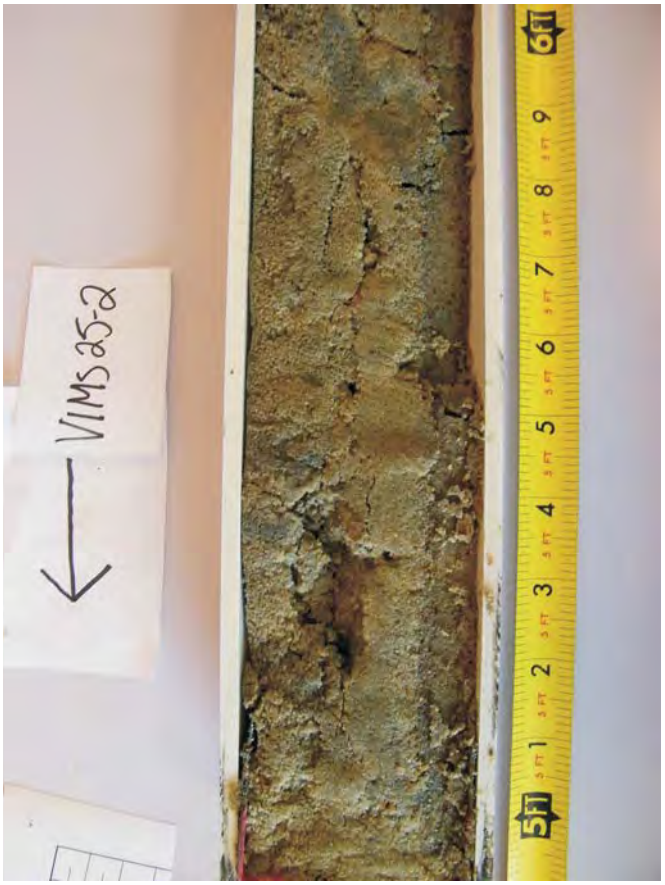

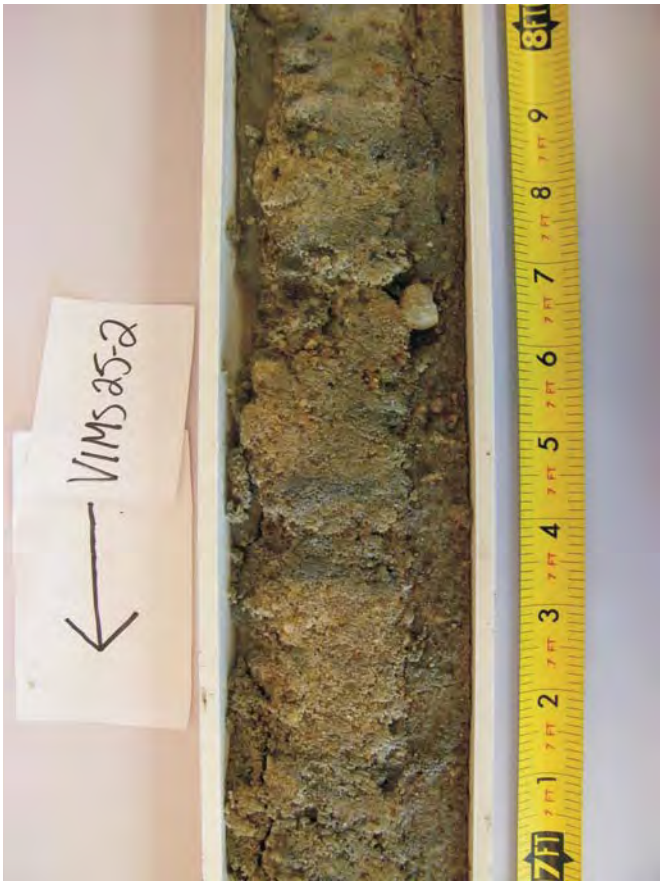

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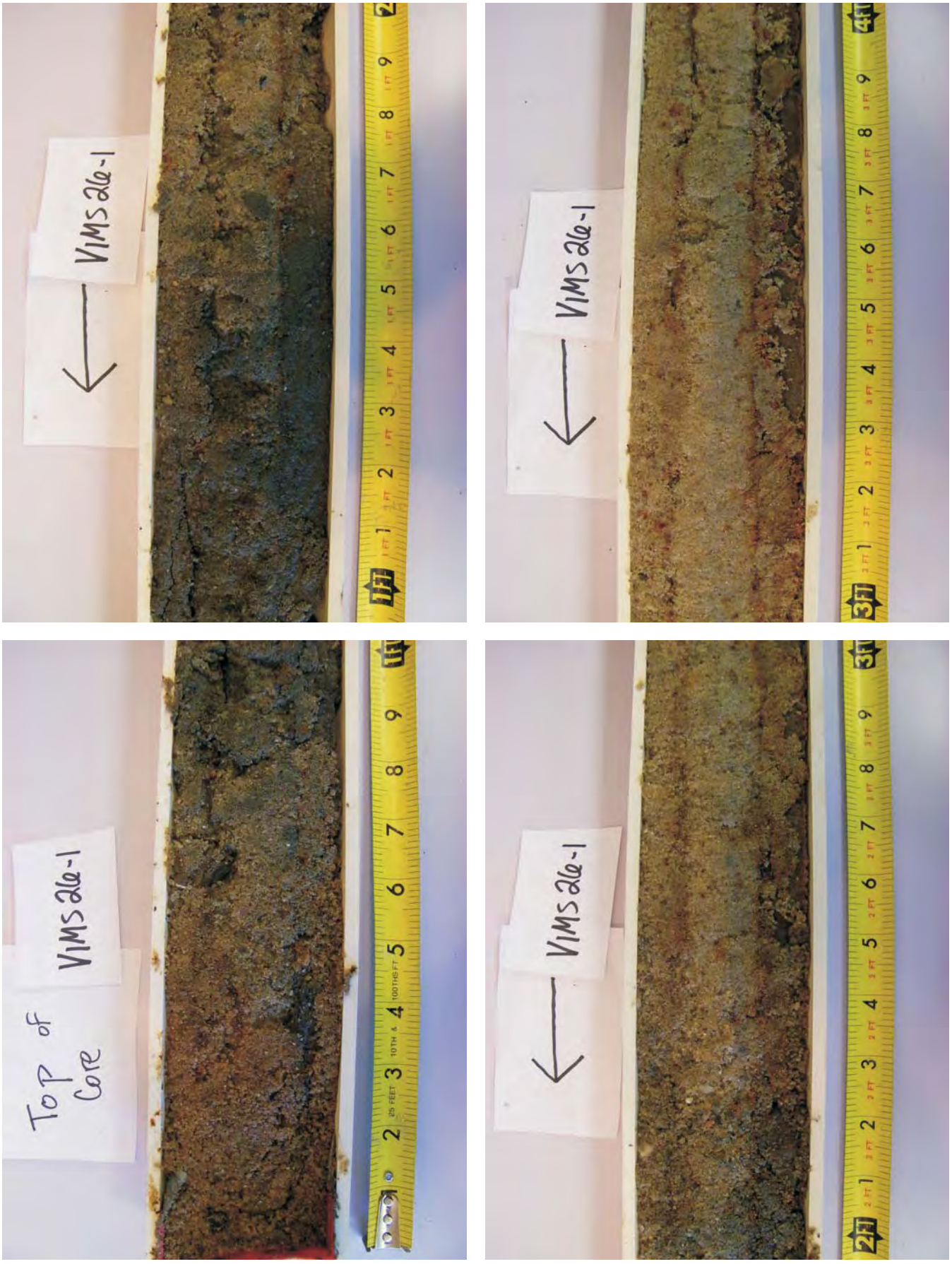

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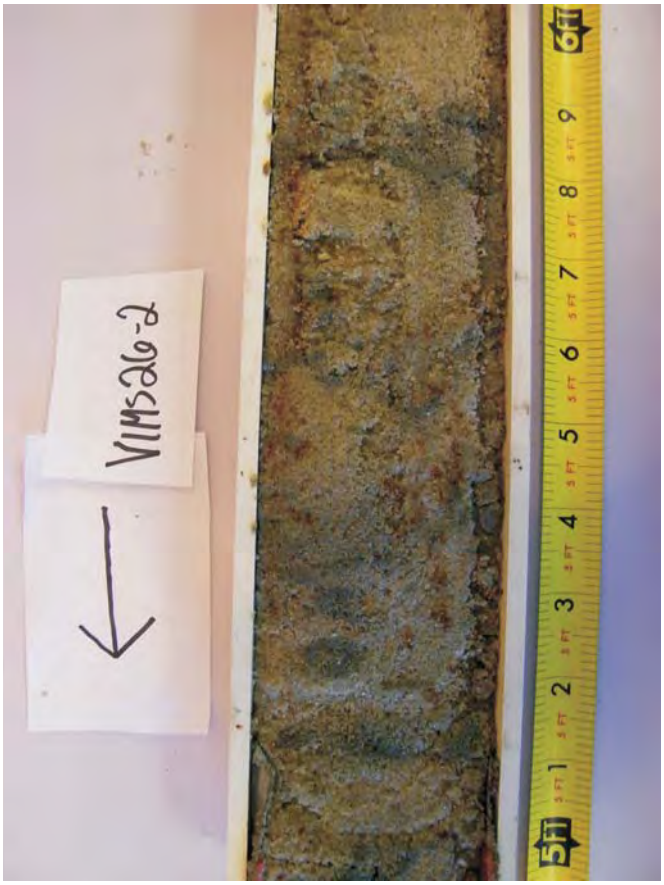

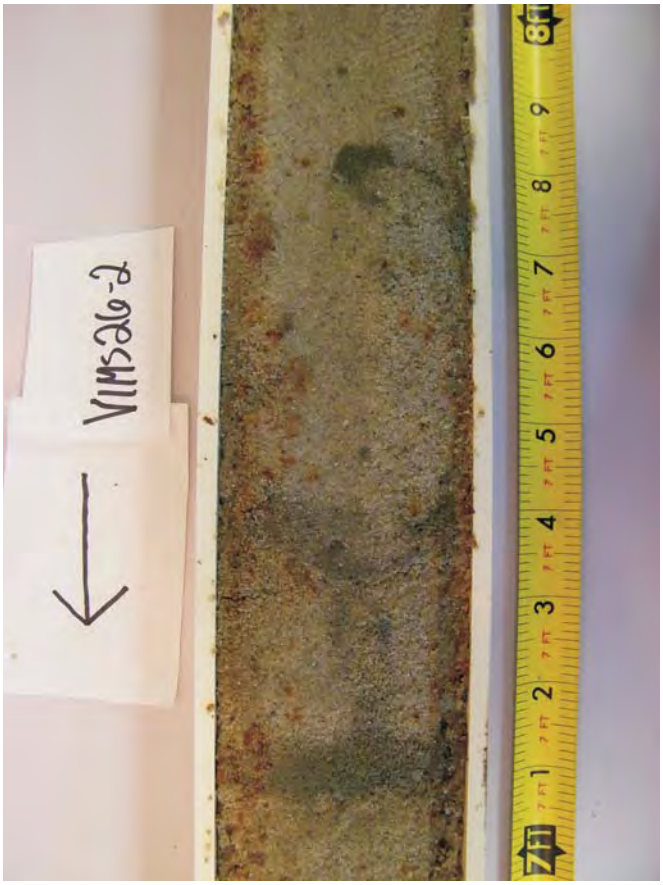

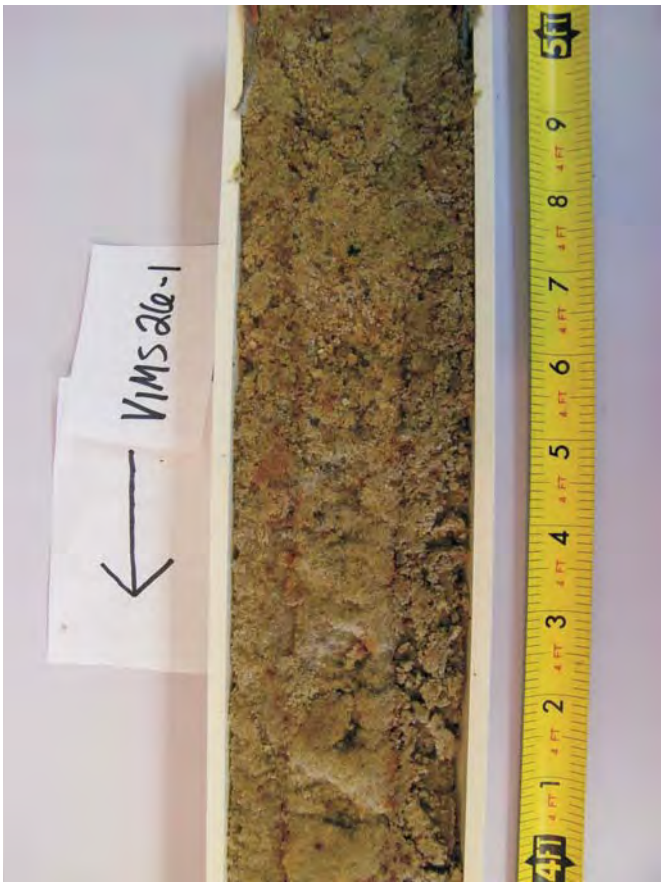

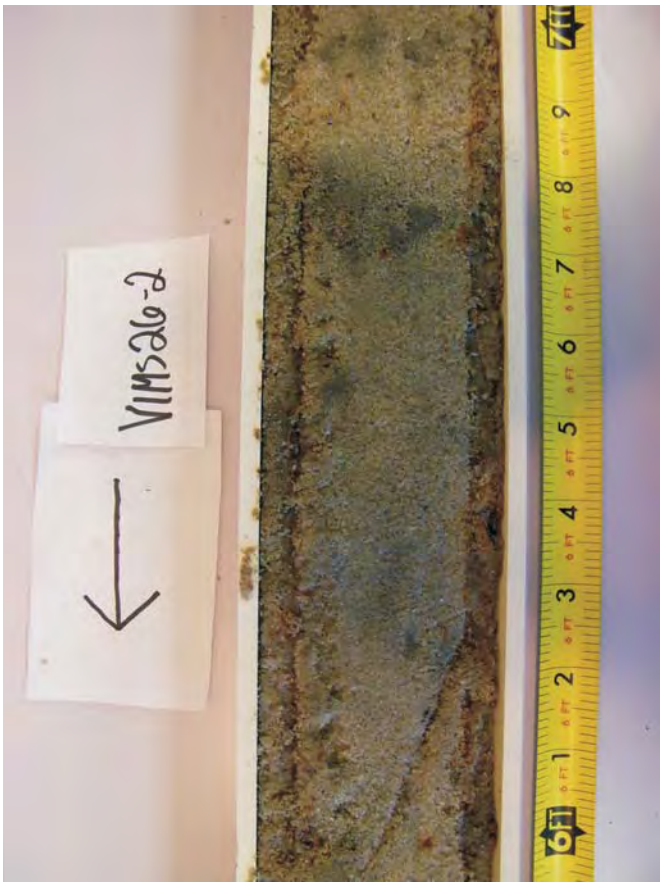

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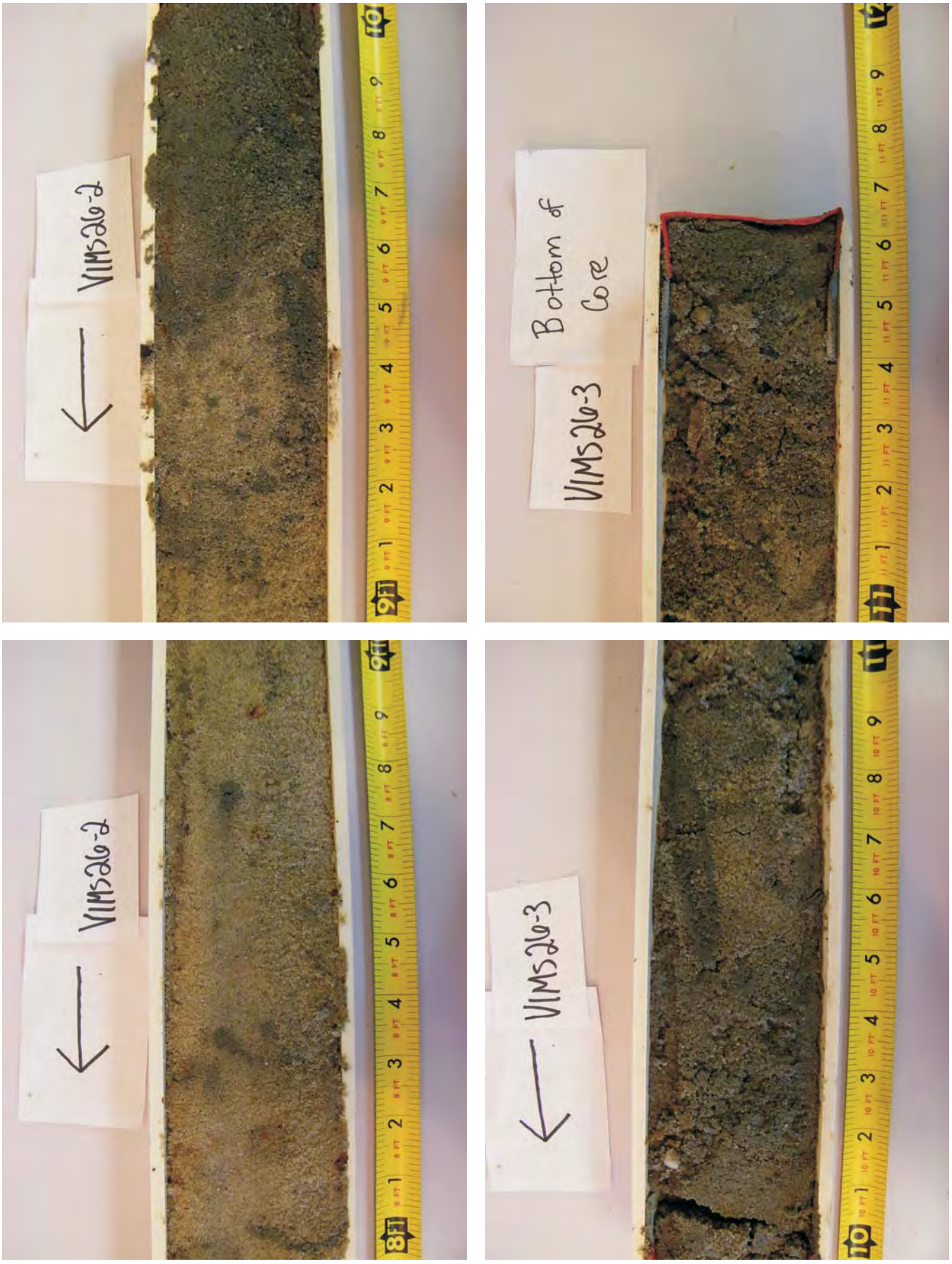

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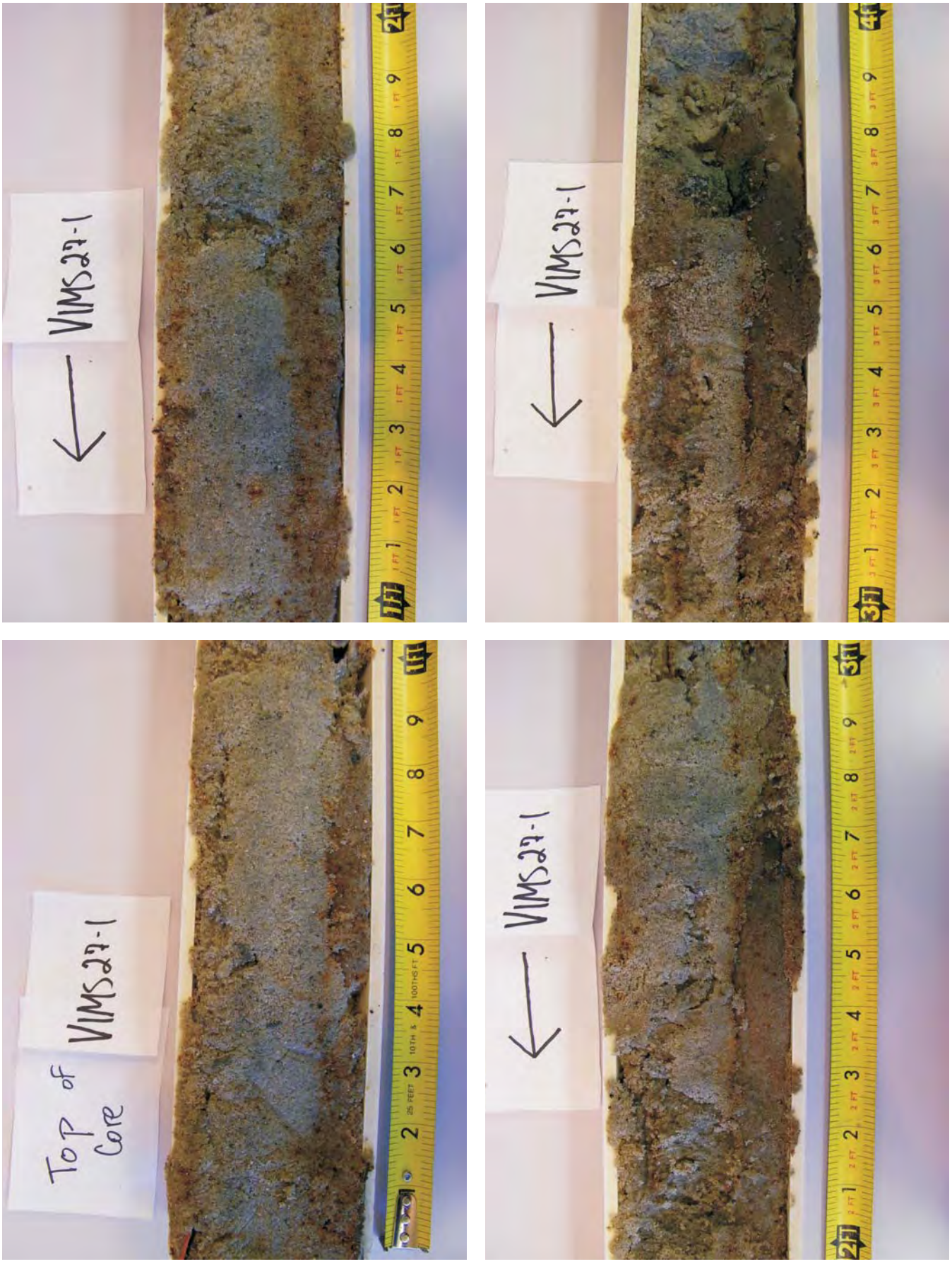

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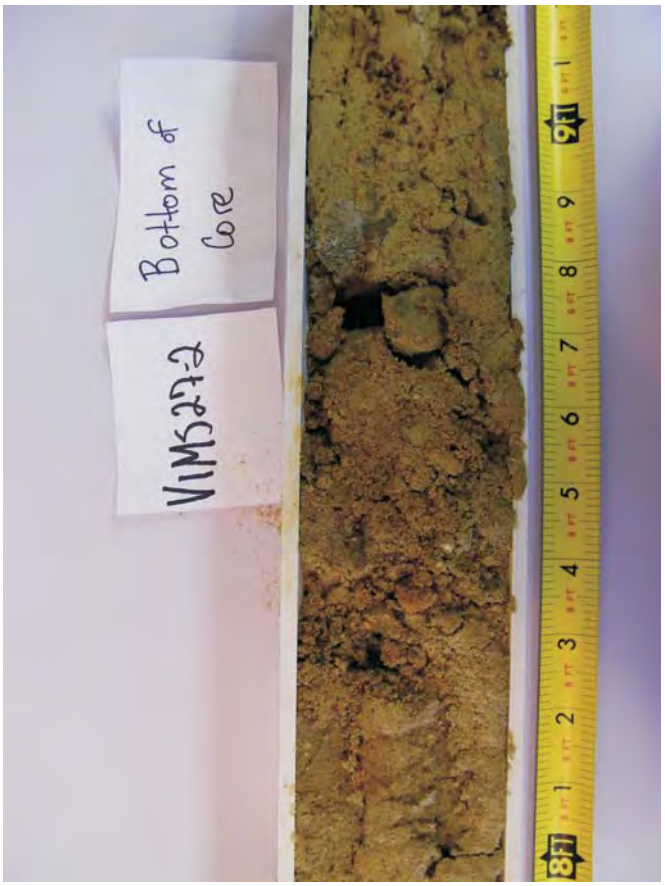

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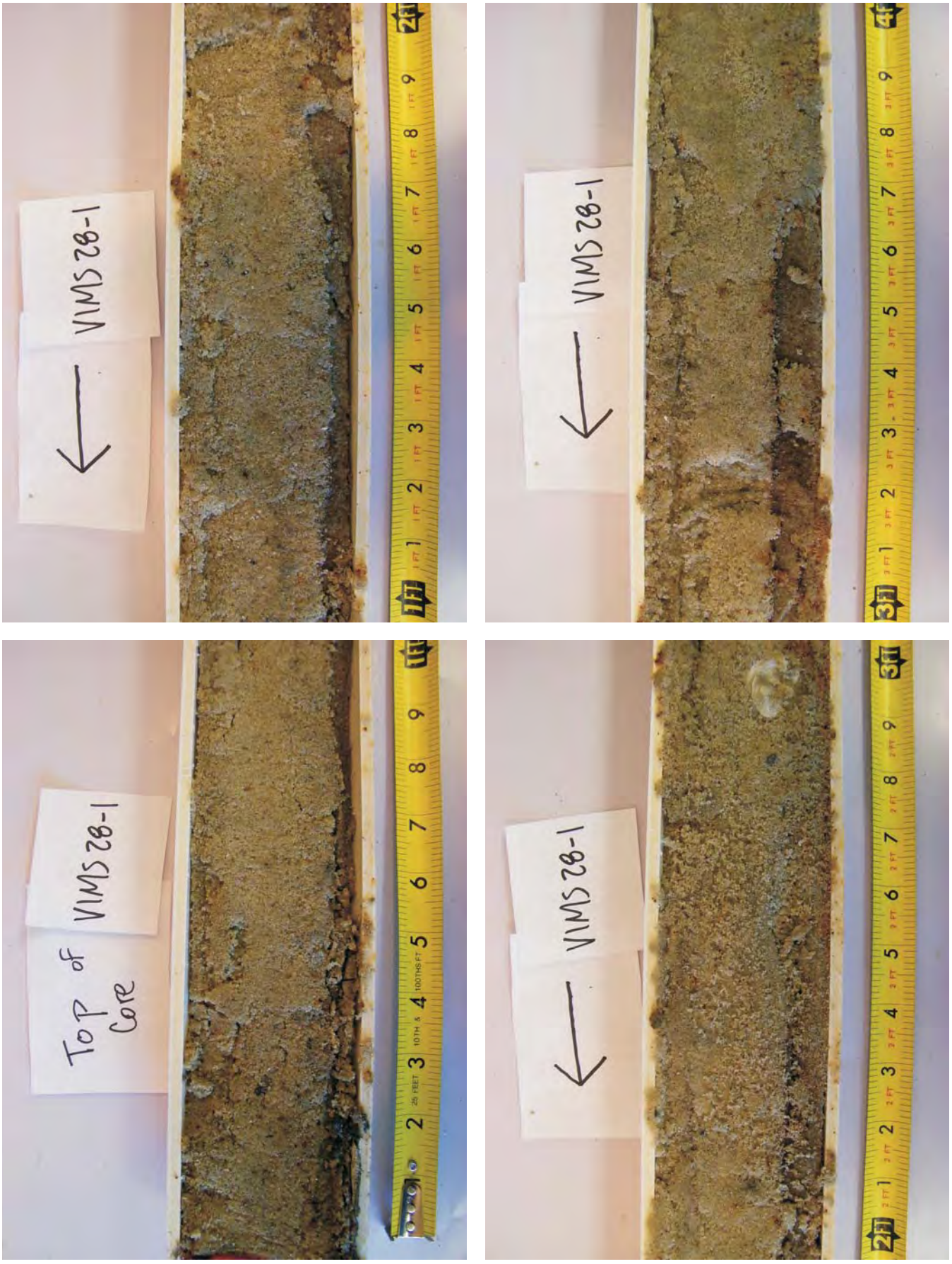

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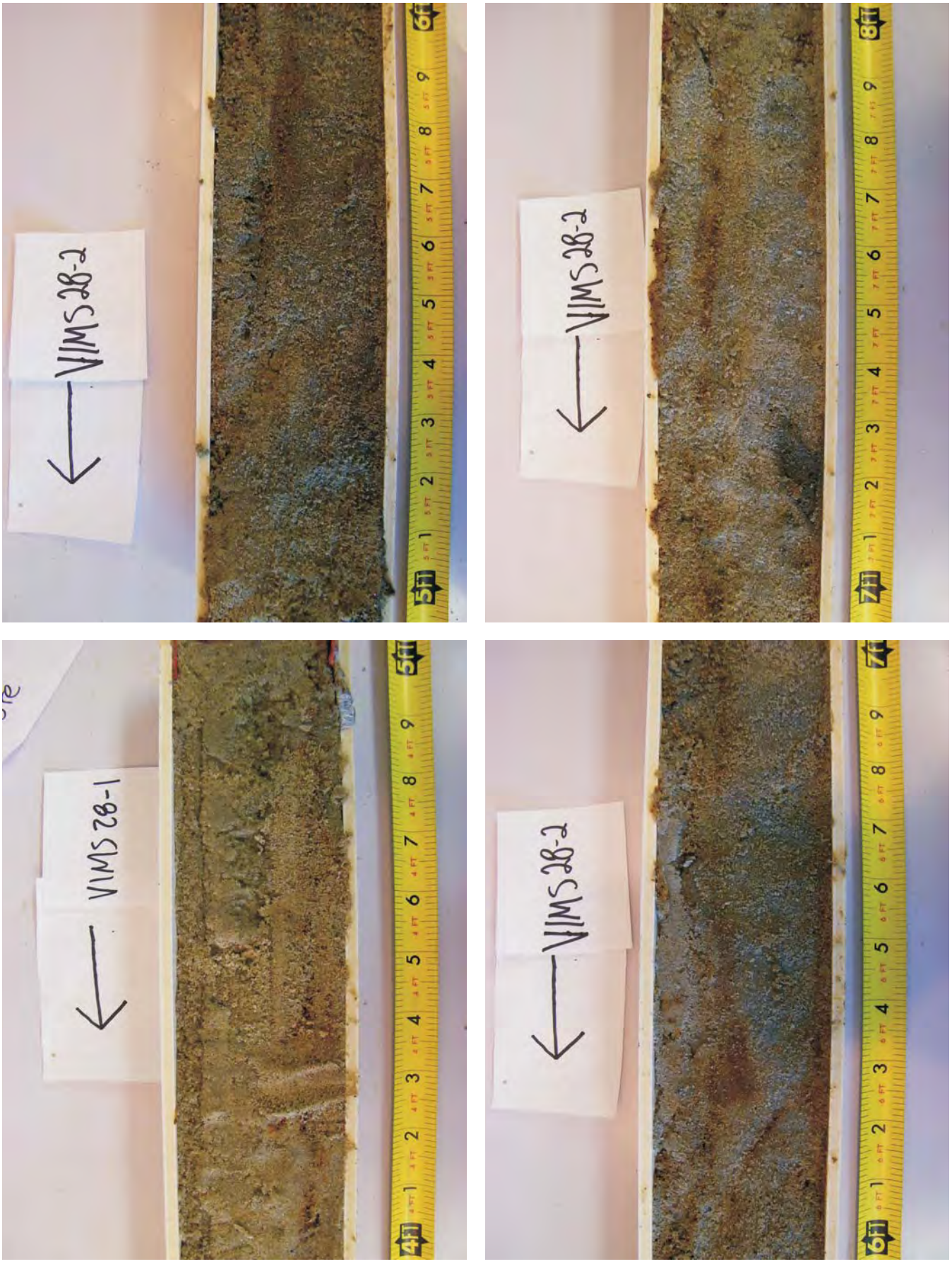

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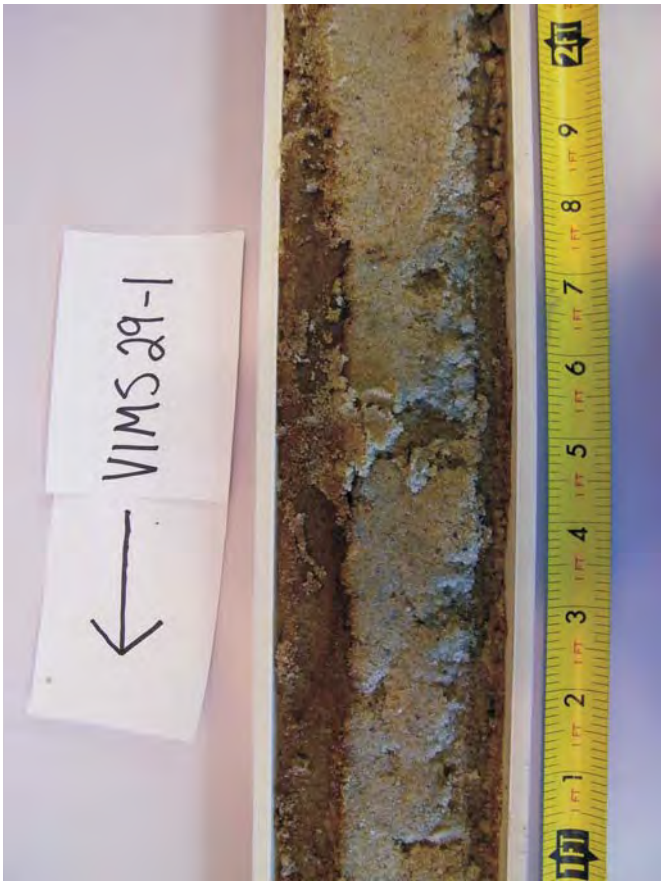

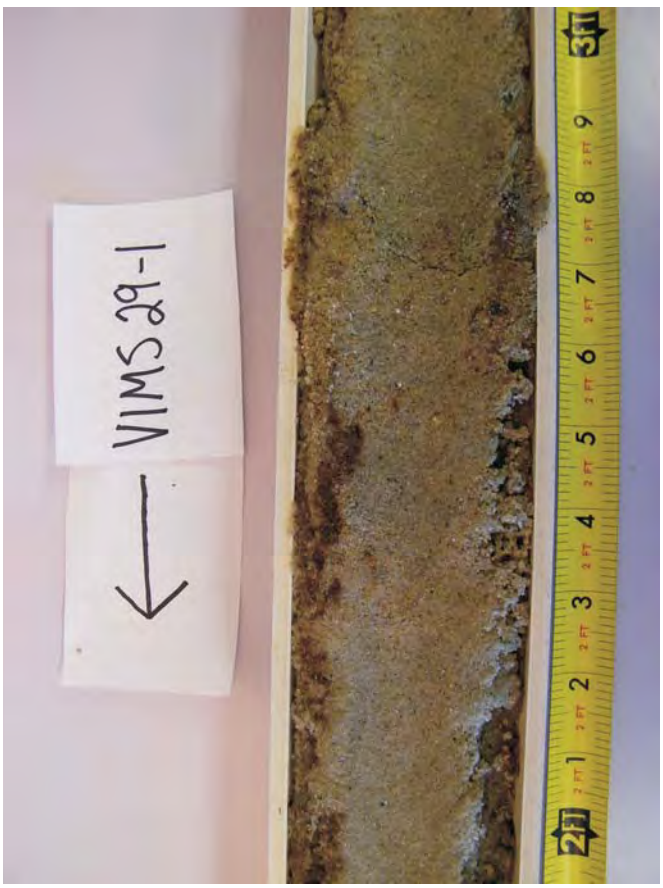

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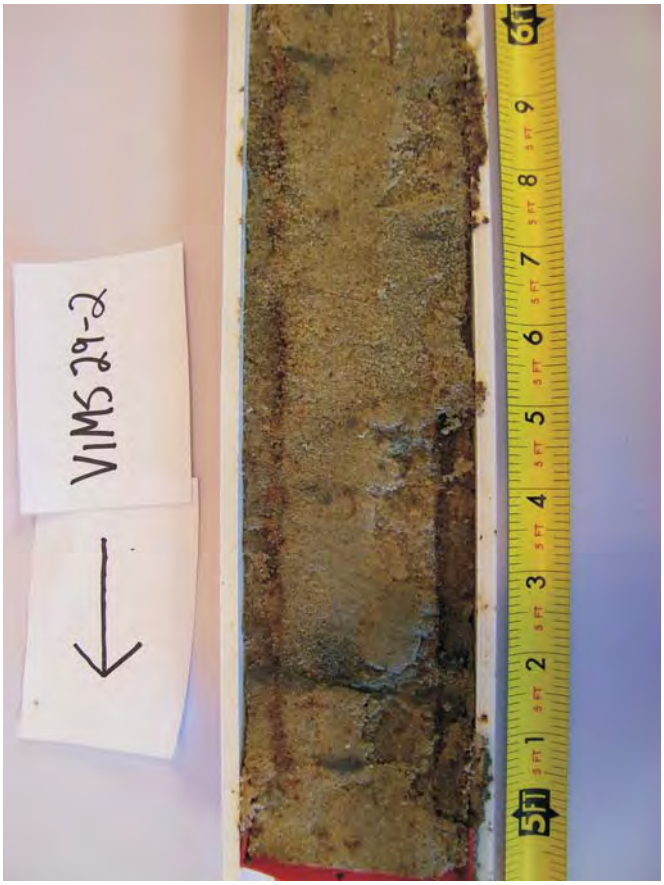

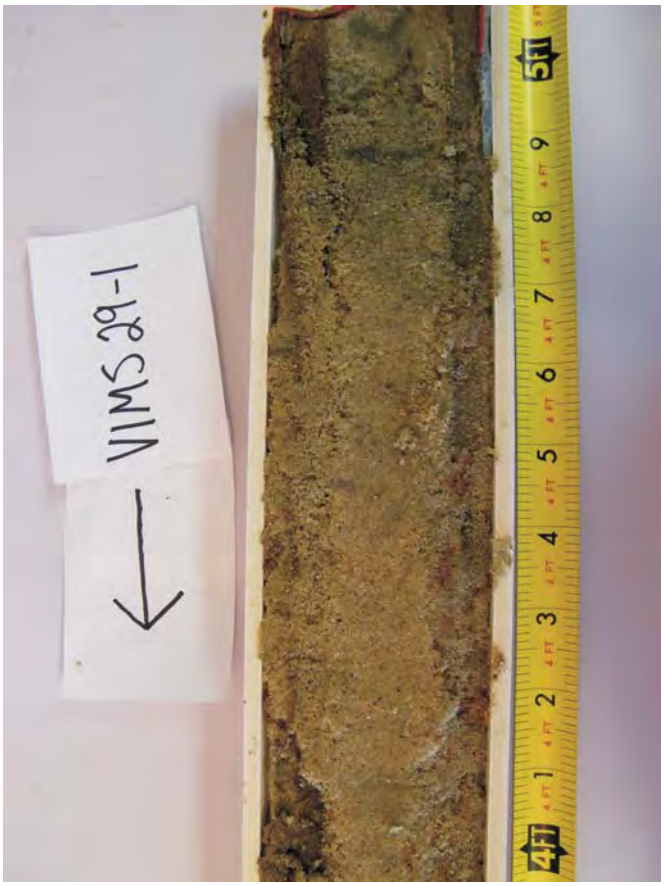

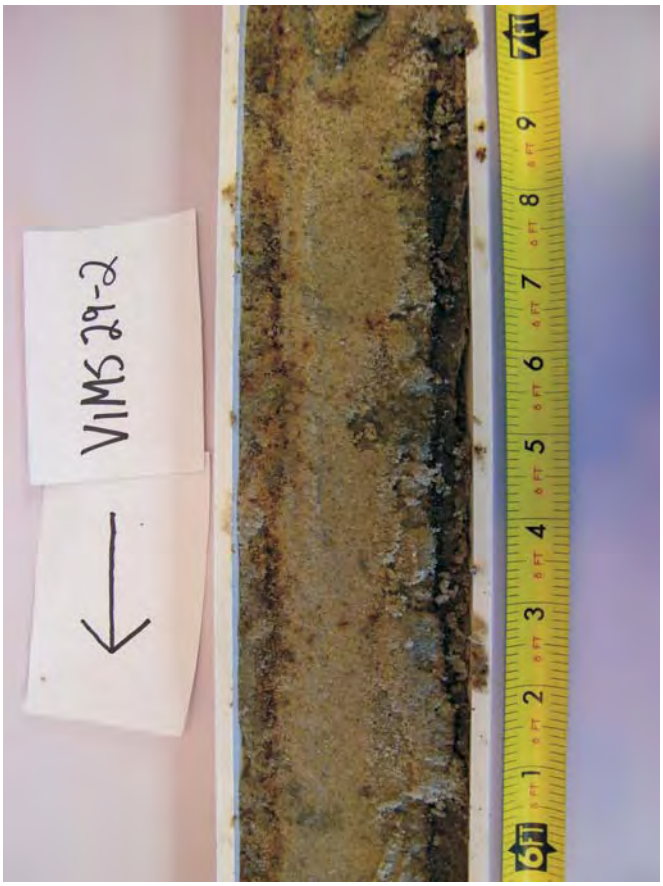

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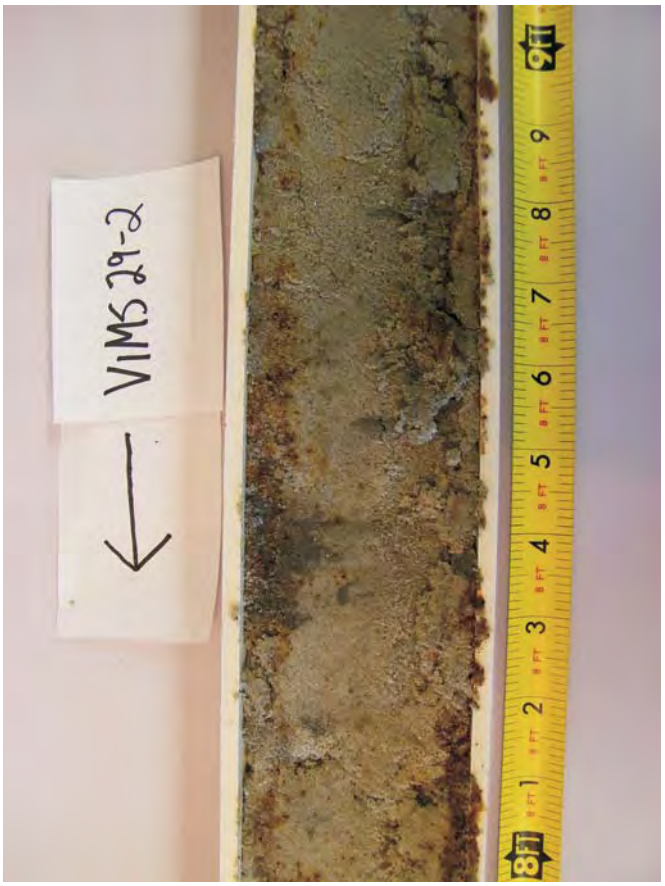

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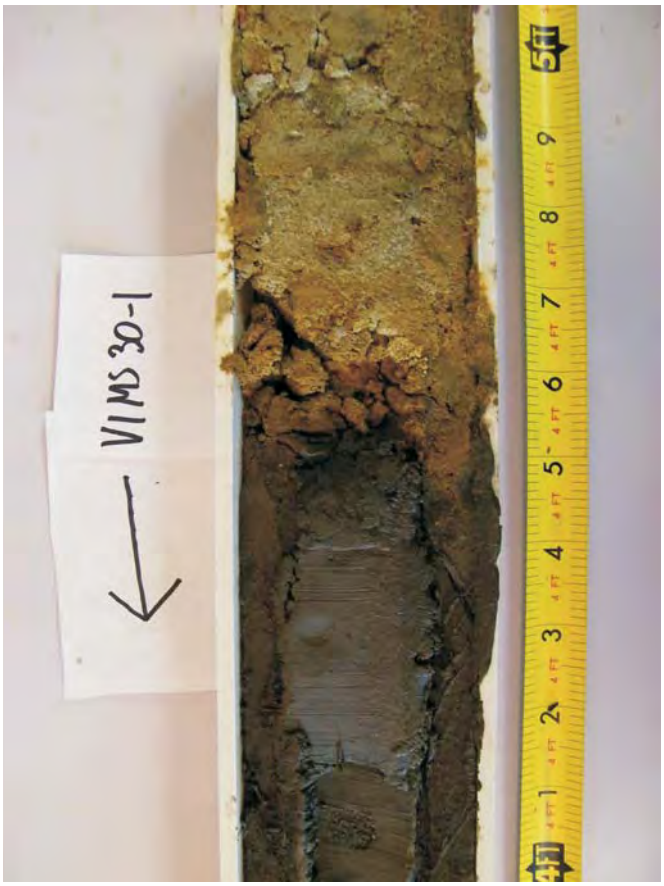

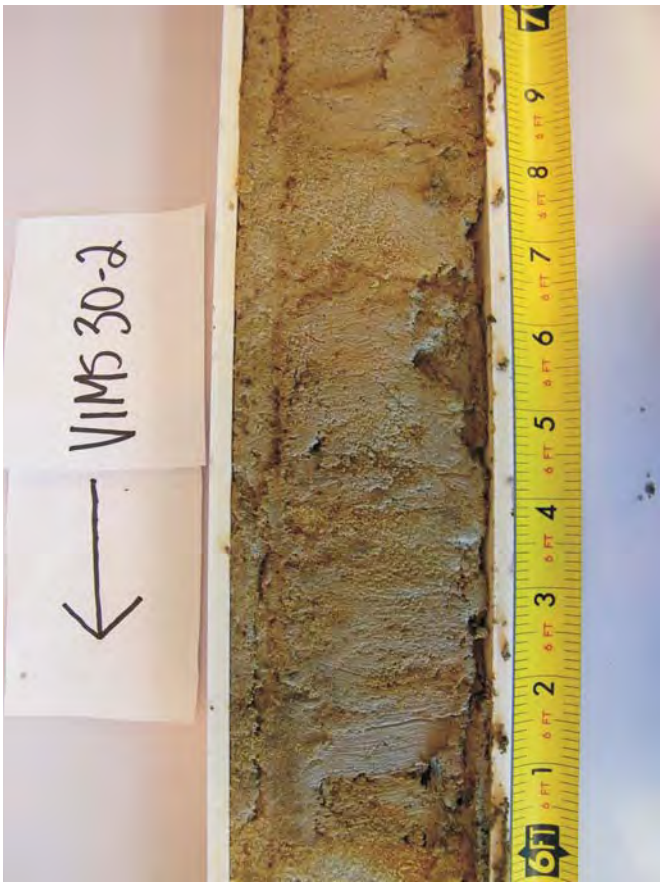

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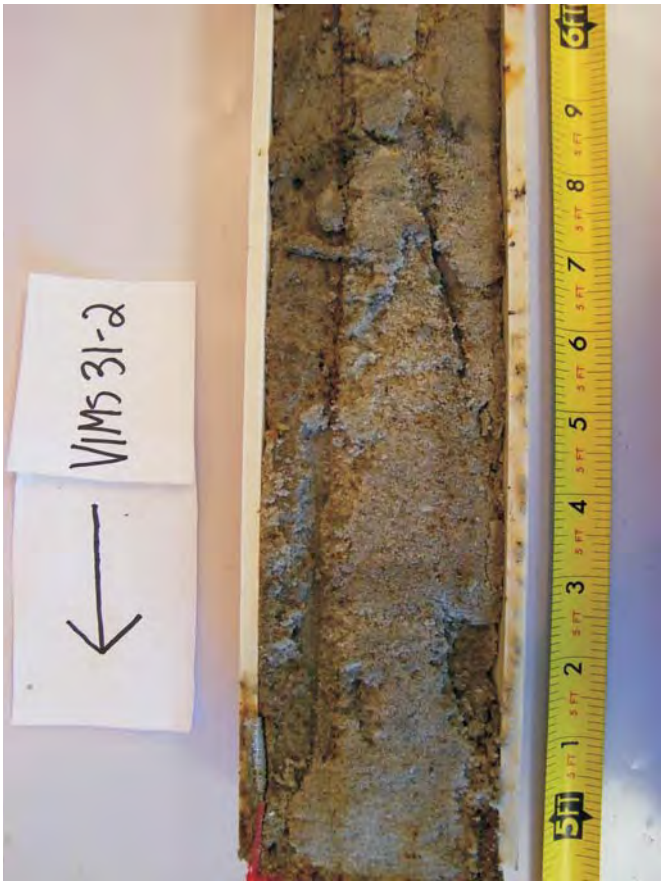
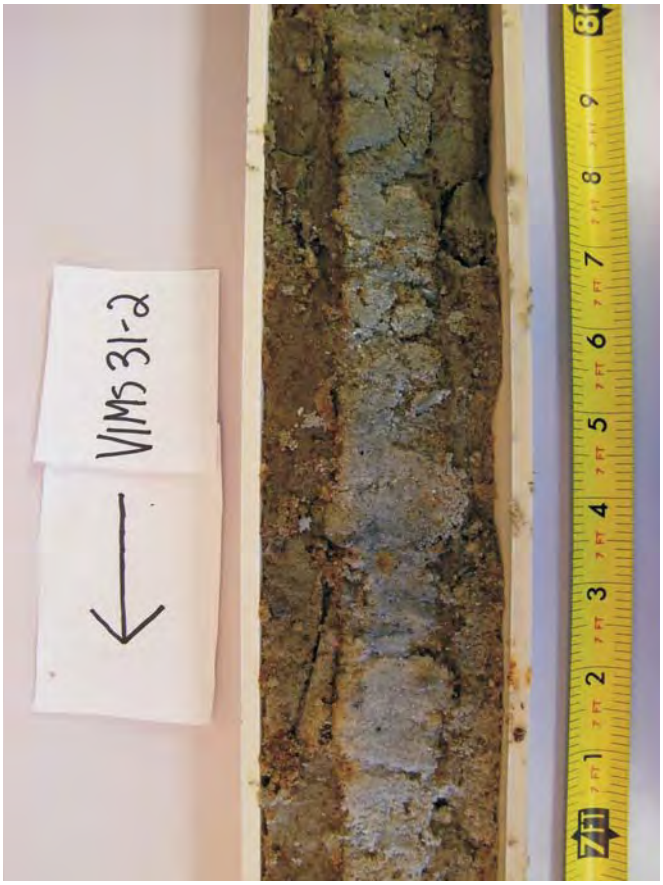
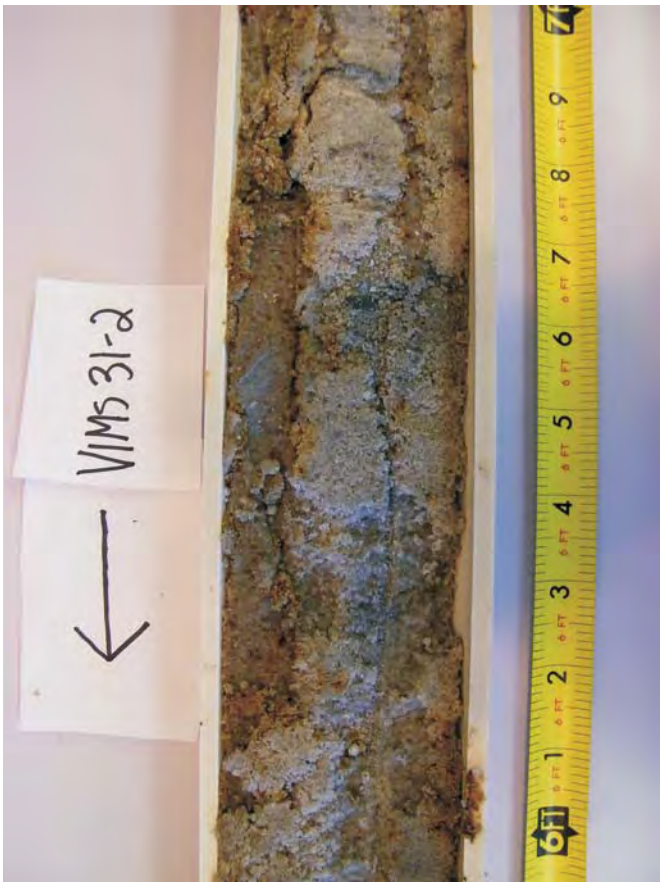
VIMS Core 30

VIMS Core 31







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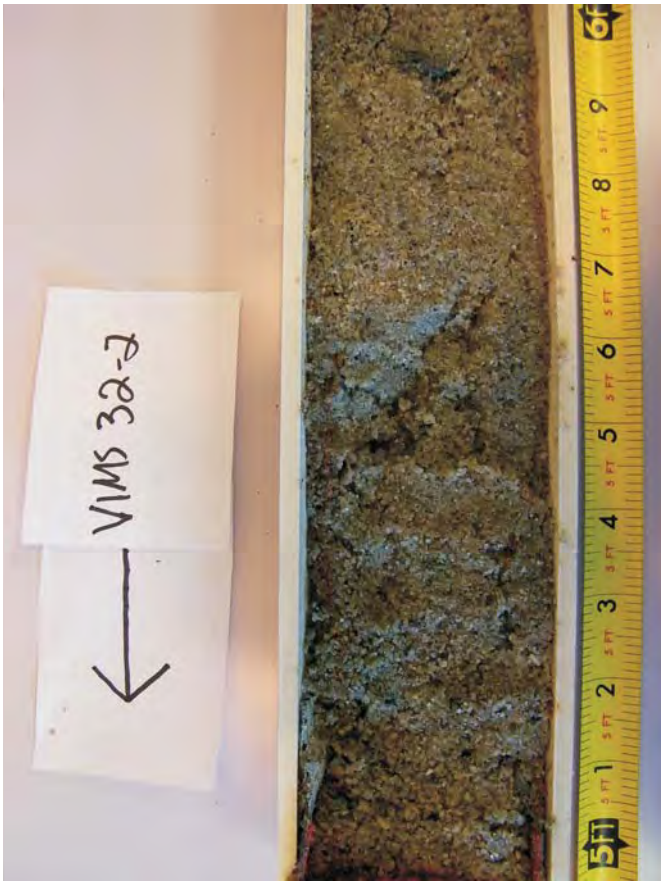
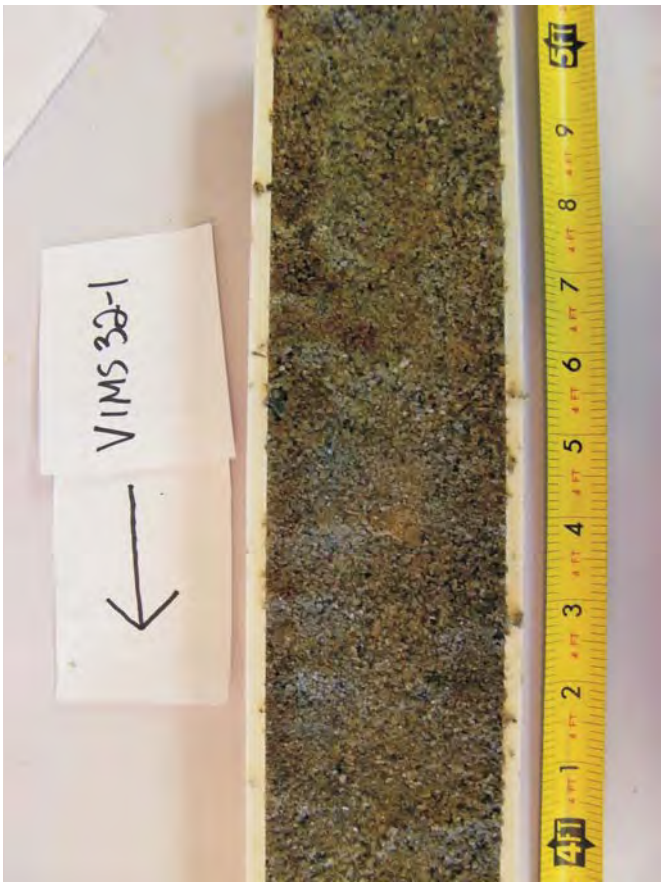
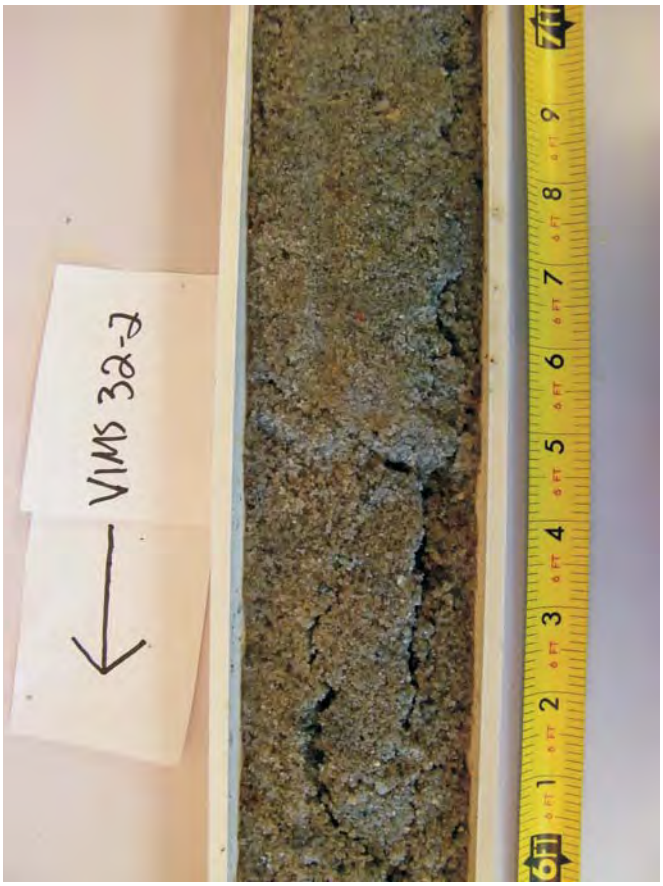
VIMS Core 31

VIMS Core 32







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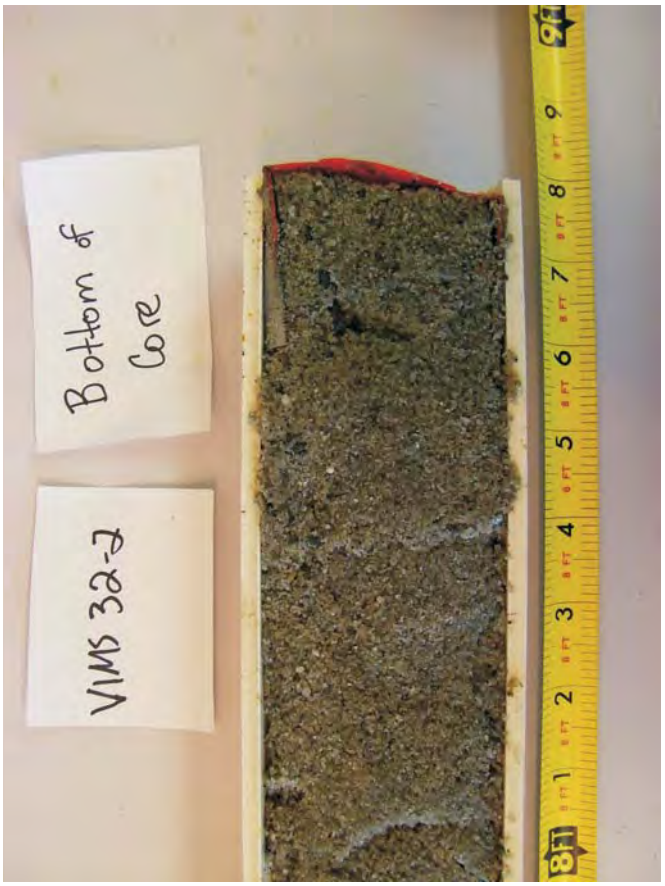

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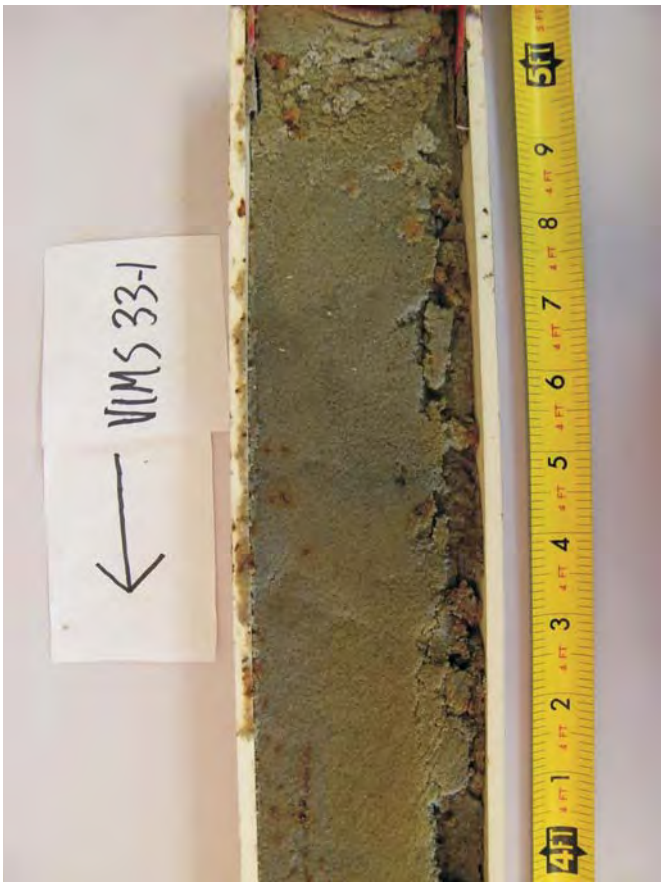
VIMS Core 33



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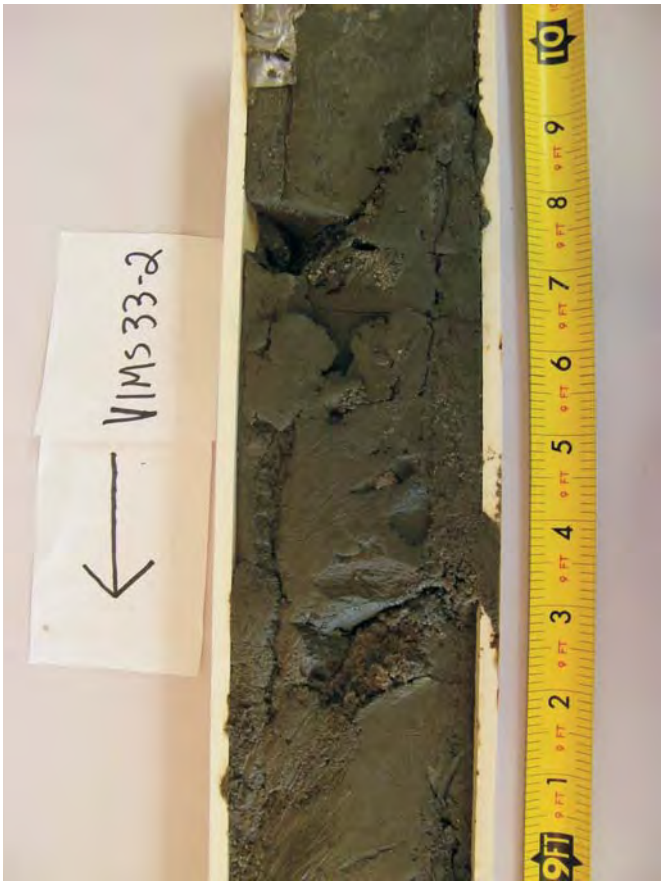

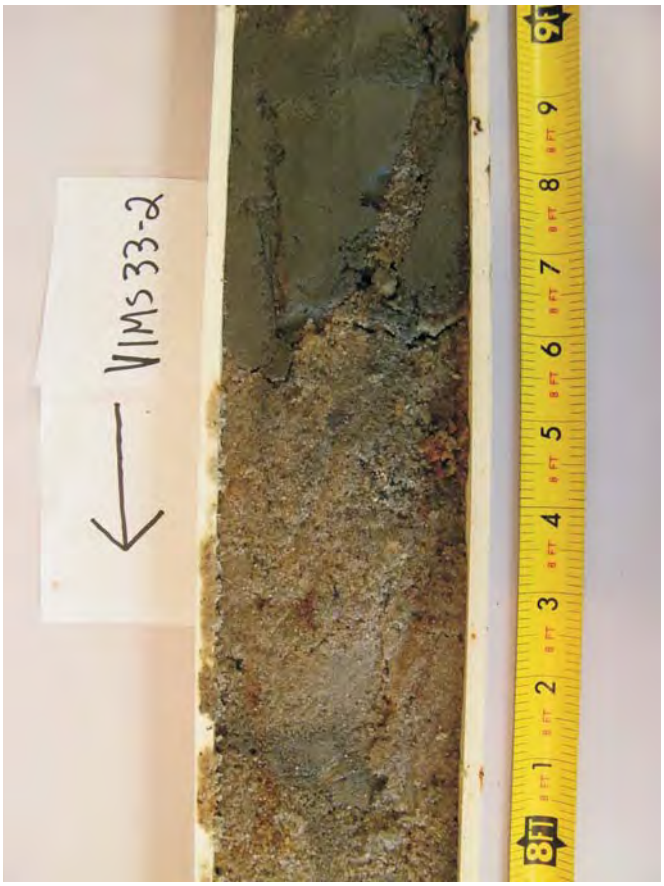

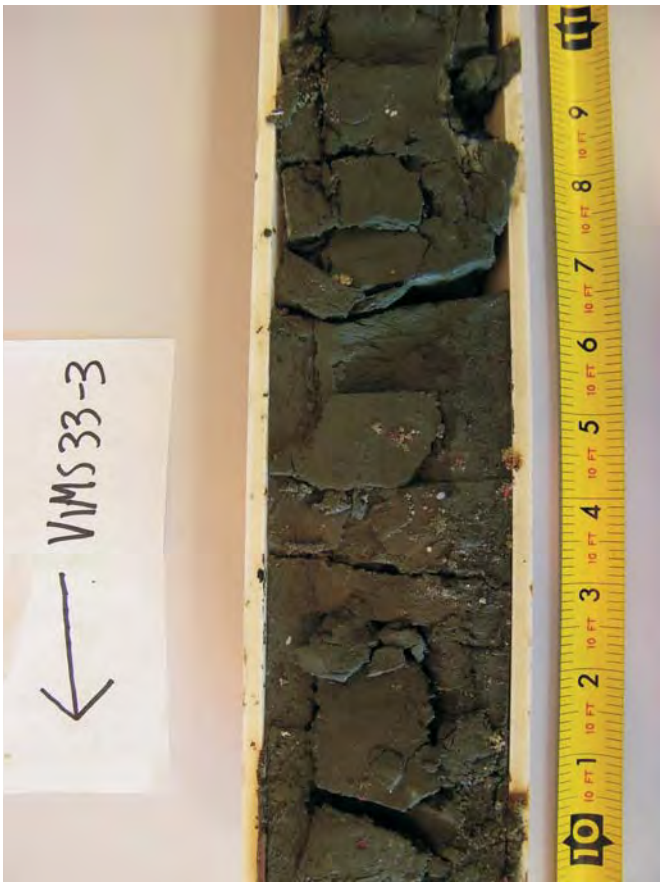

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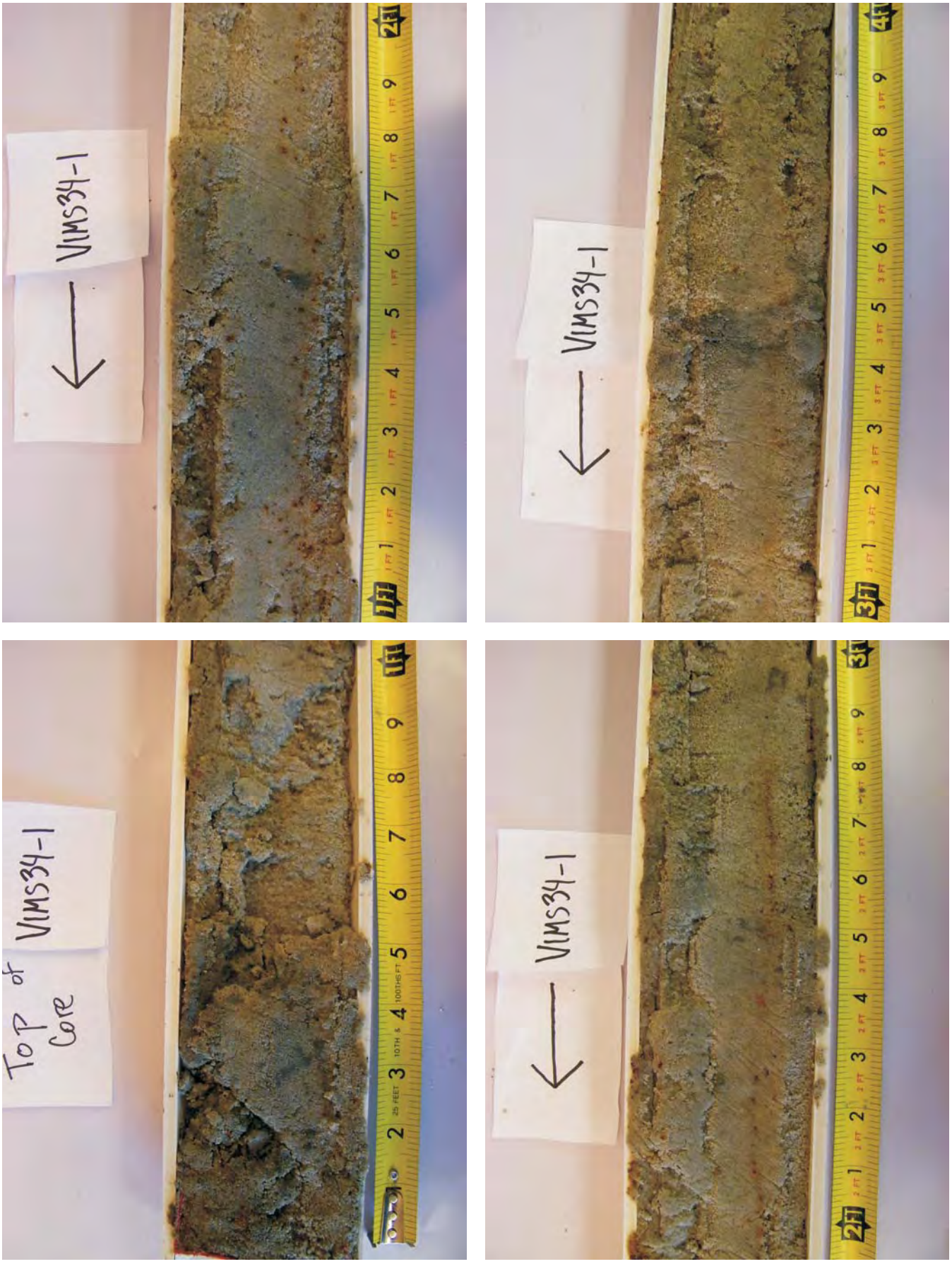

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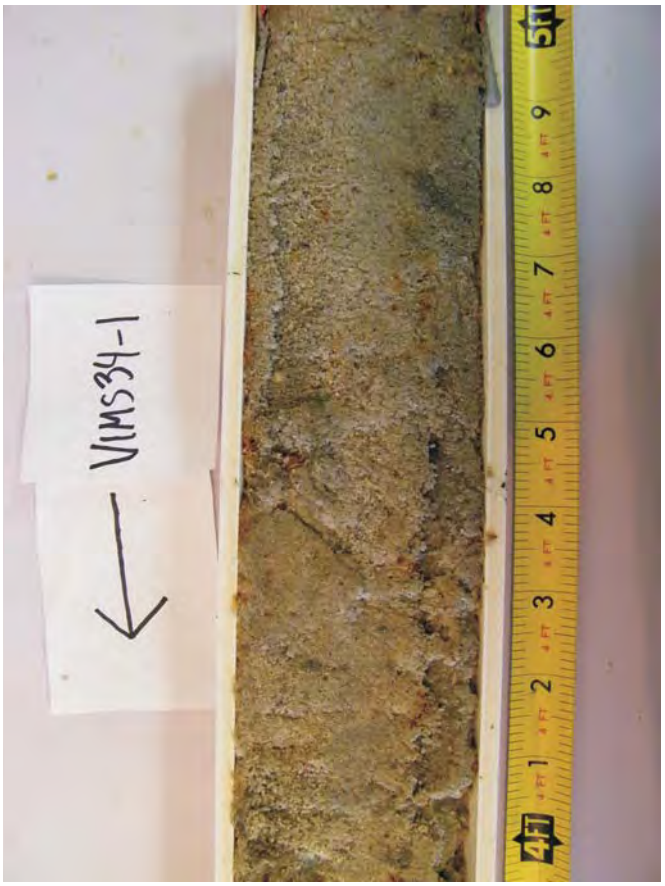

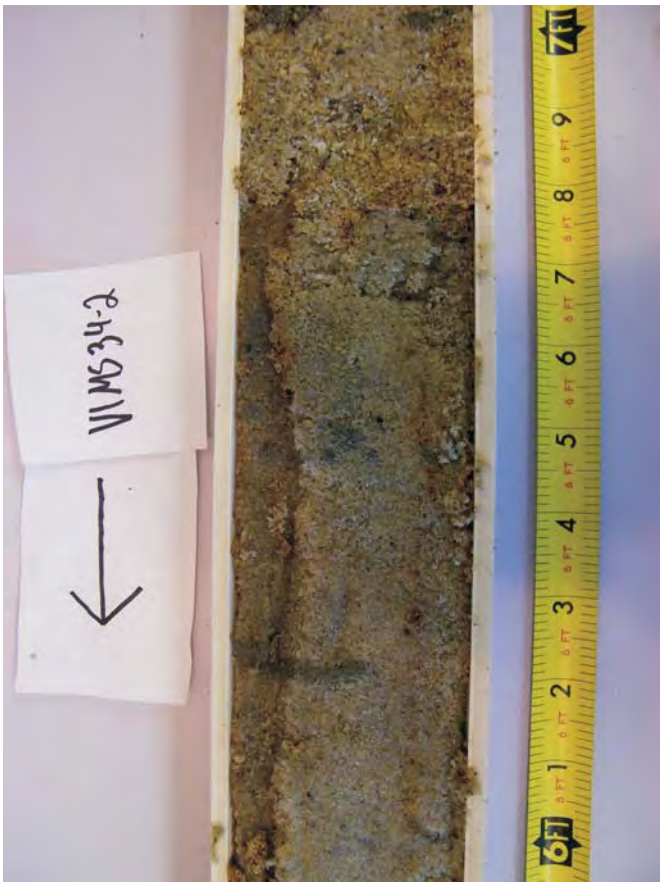

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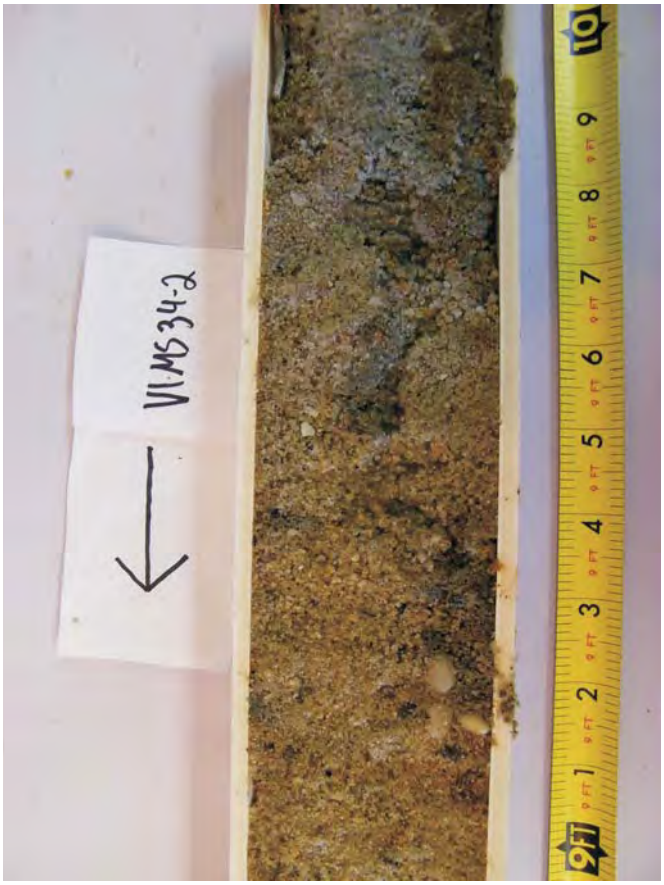
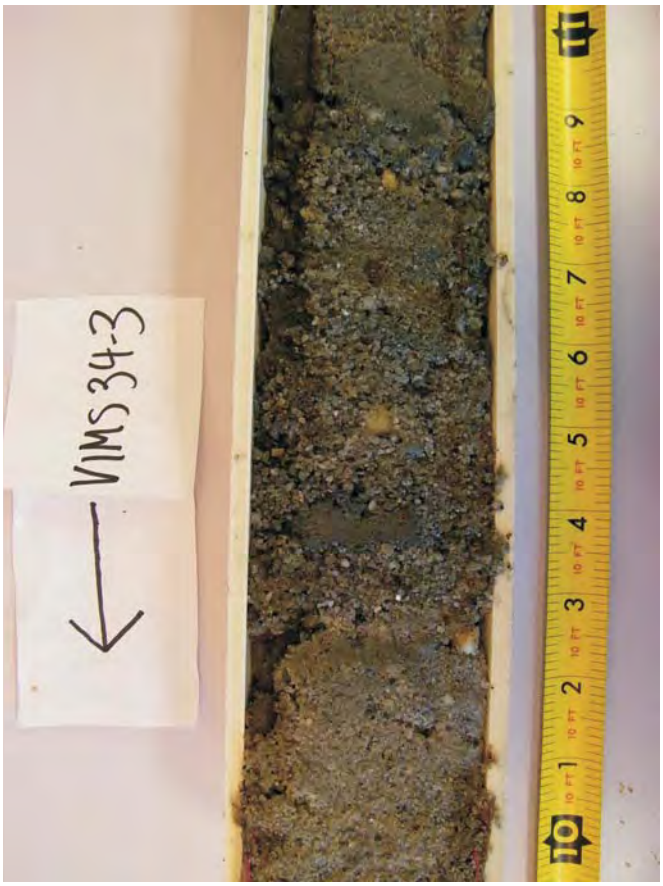
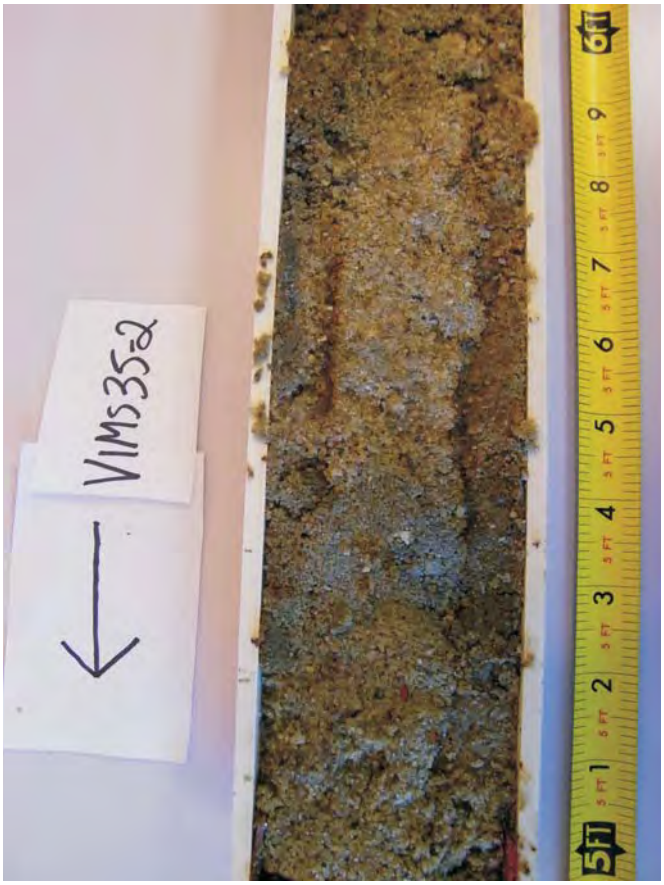
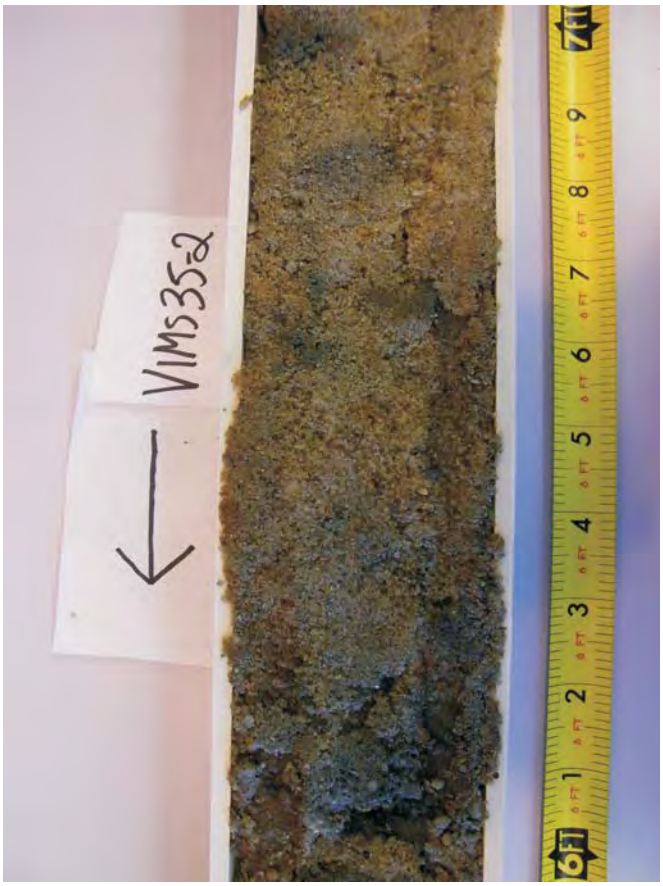




VIMS Core 34

VIMS Core 35



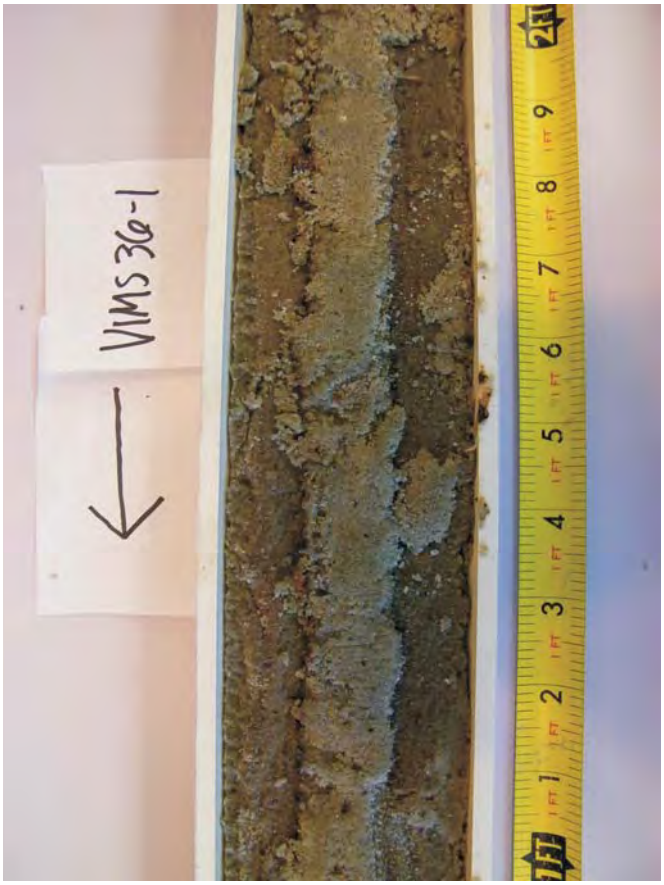


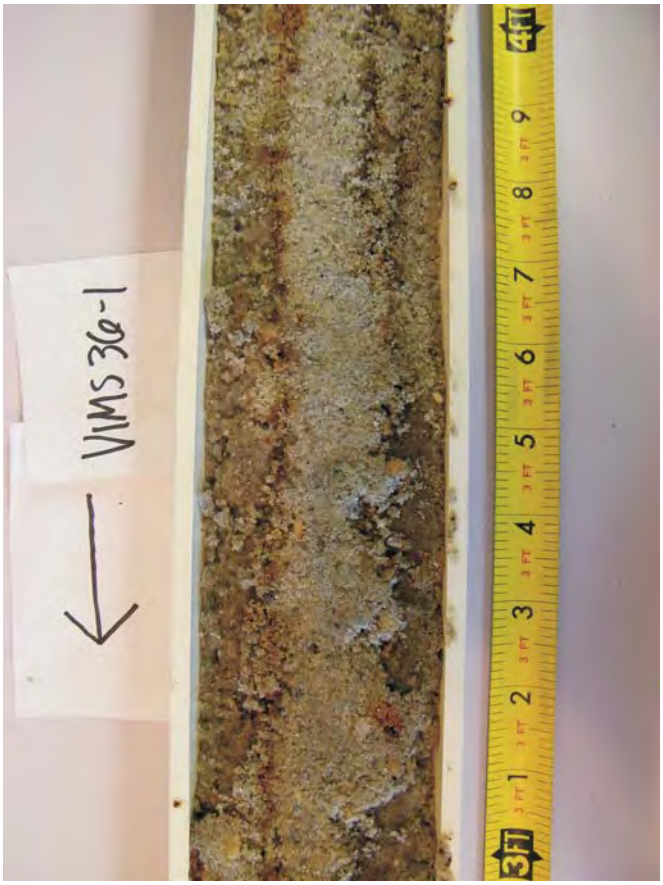
VIMS Core 35

VIMS35-2
8FT
9FT

VIMS35-2
9FT
10

VIMS35-2
Bottom of Core
10
11





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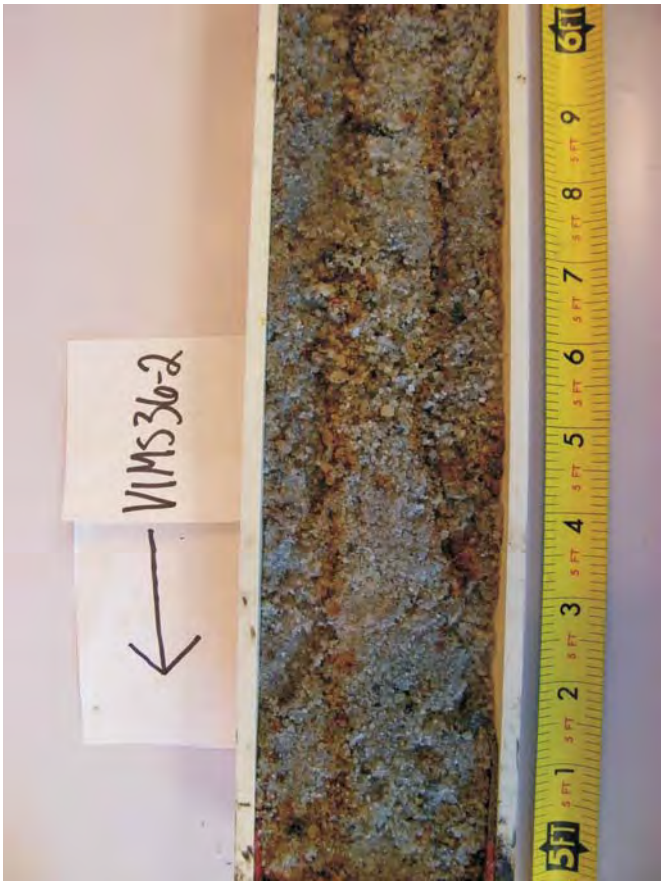

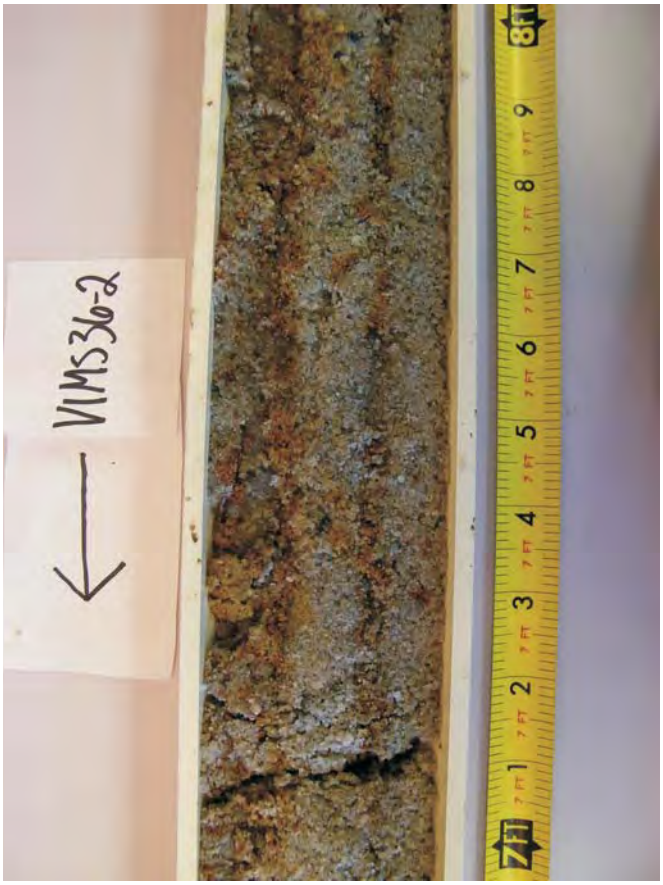

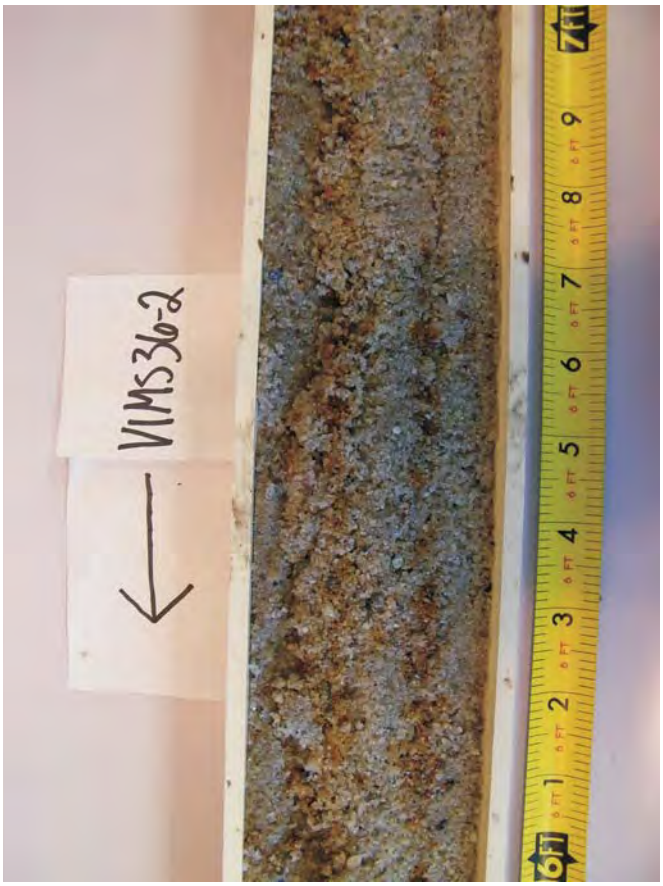

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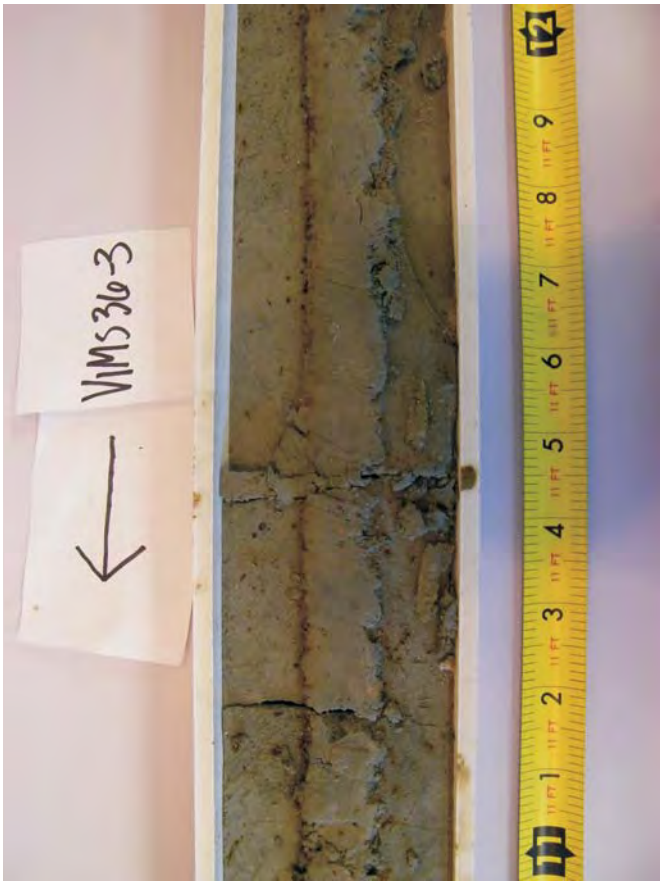

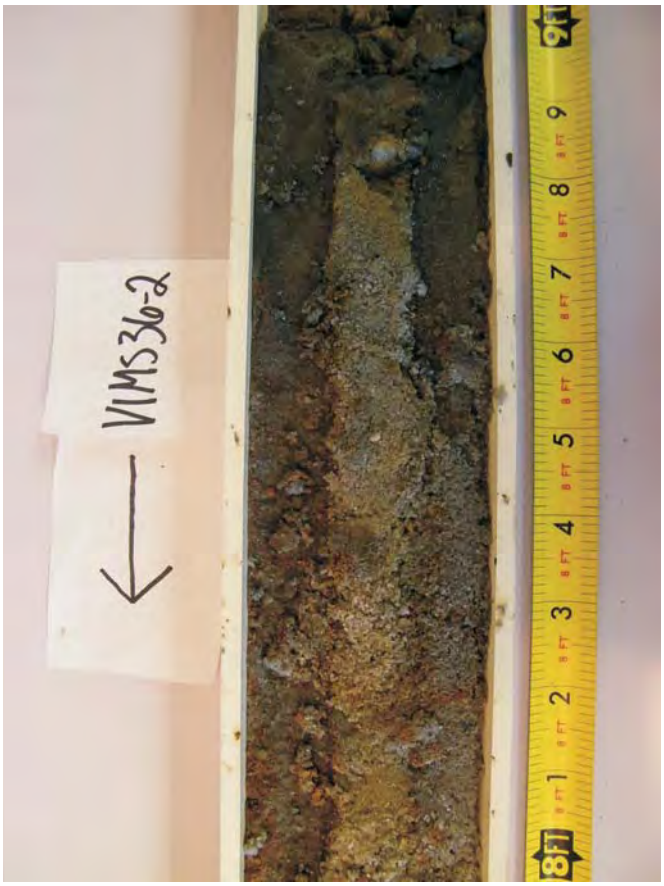

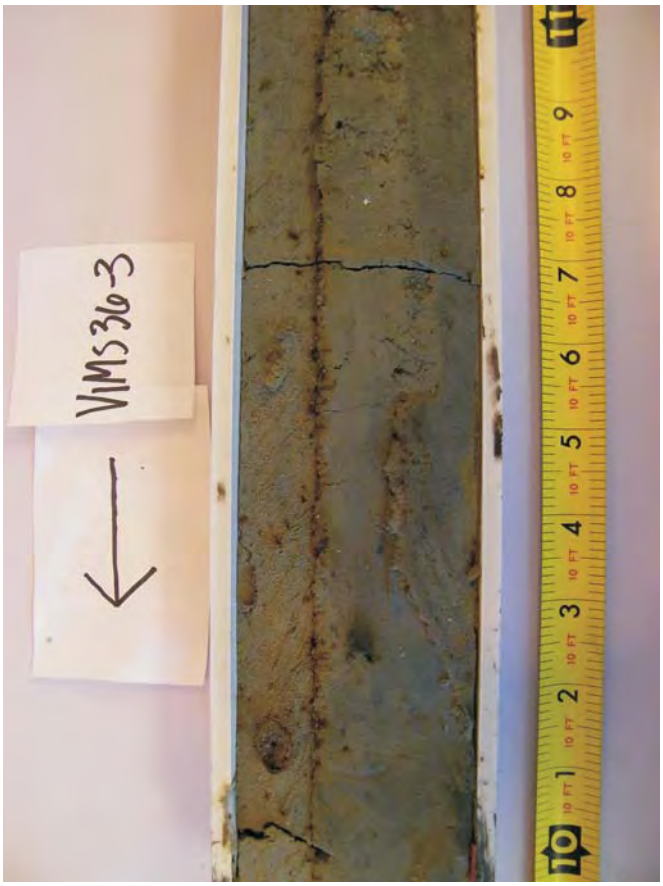

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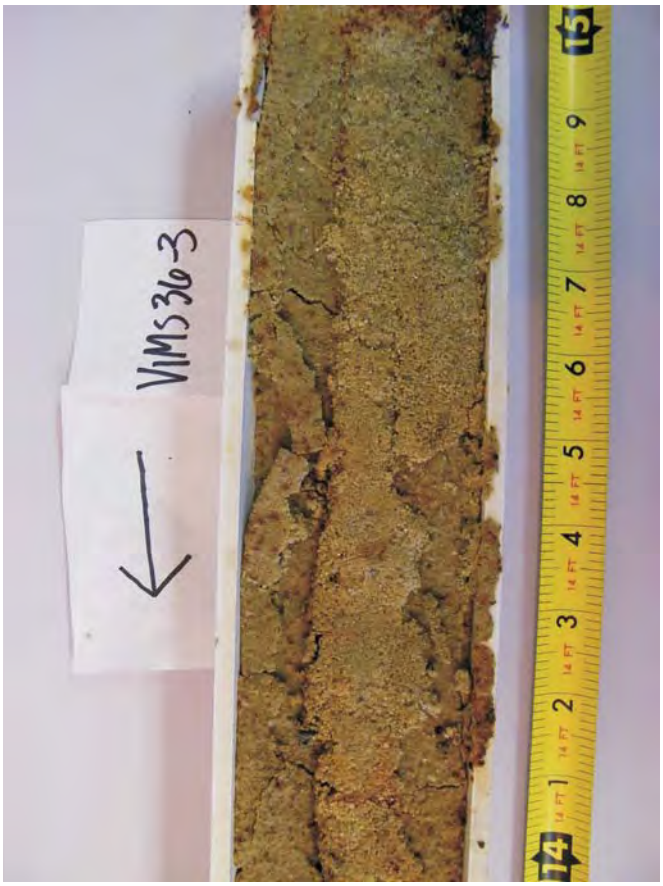

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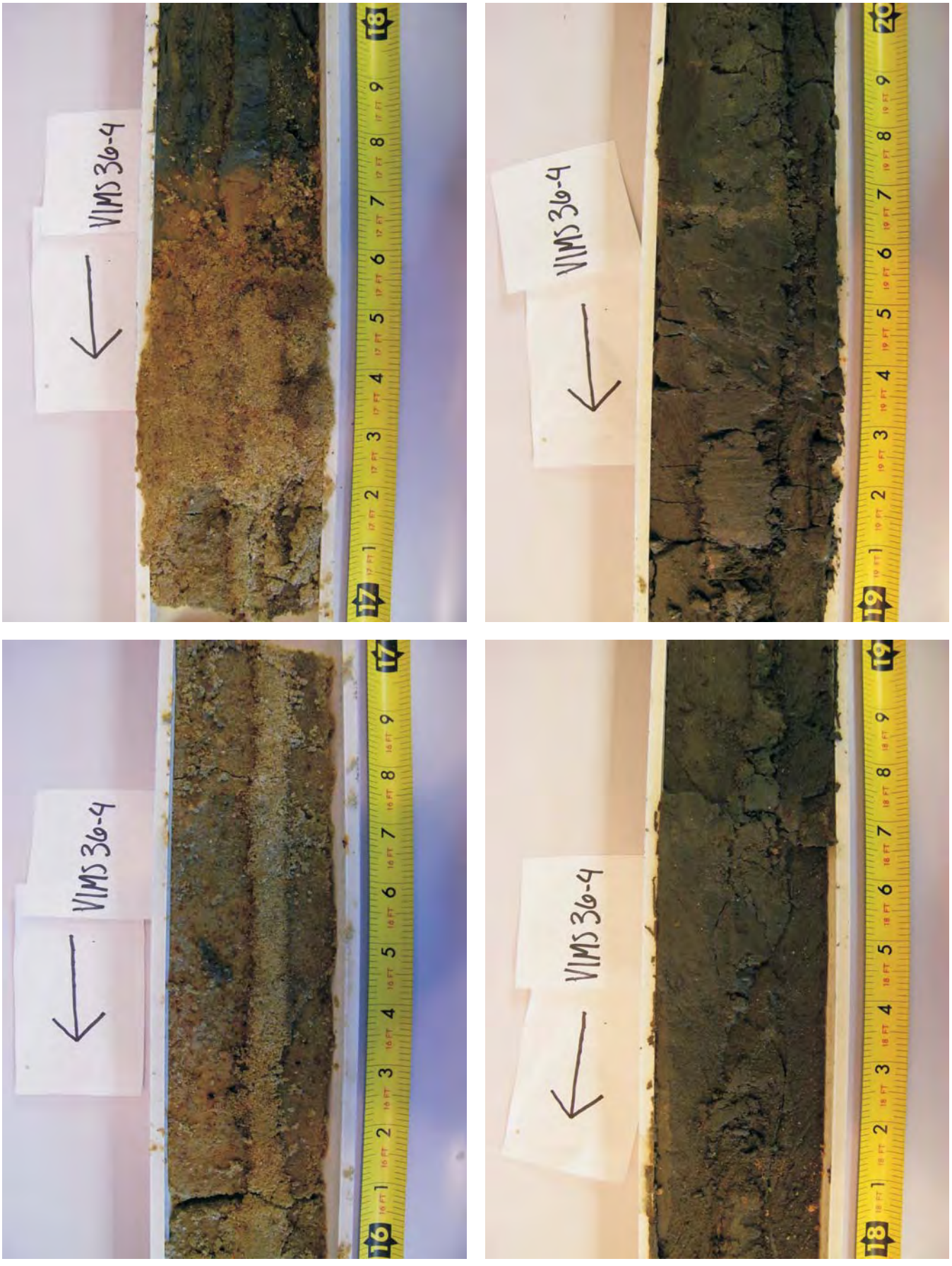

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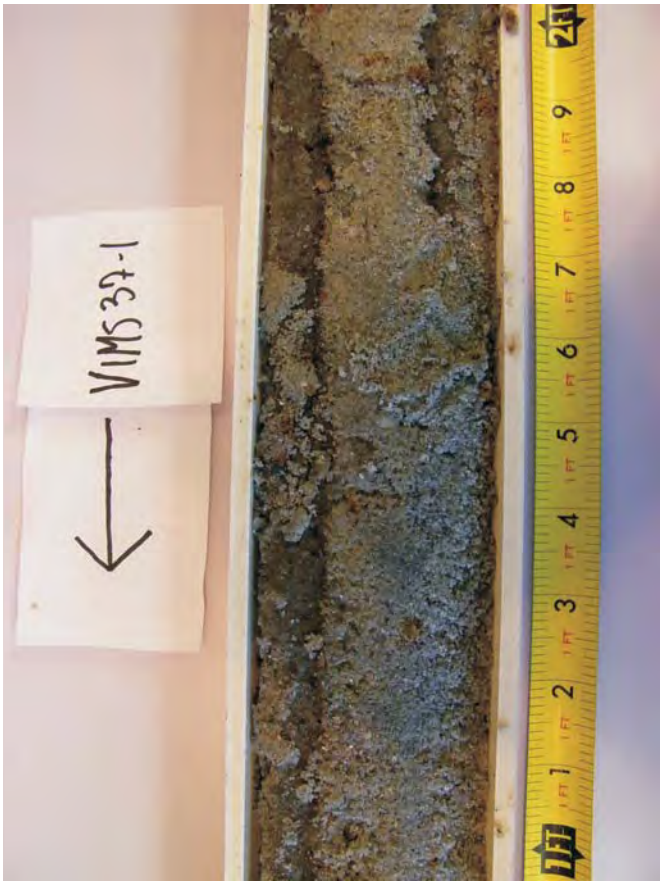
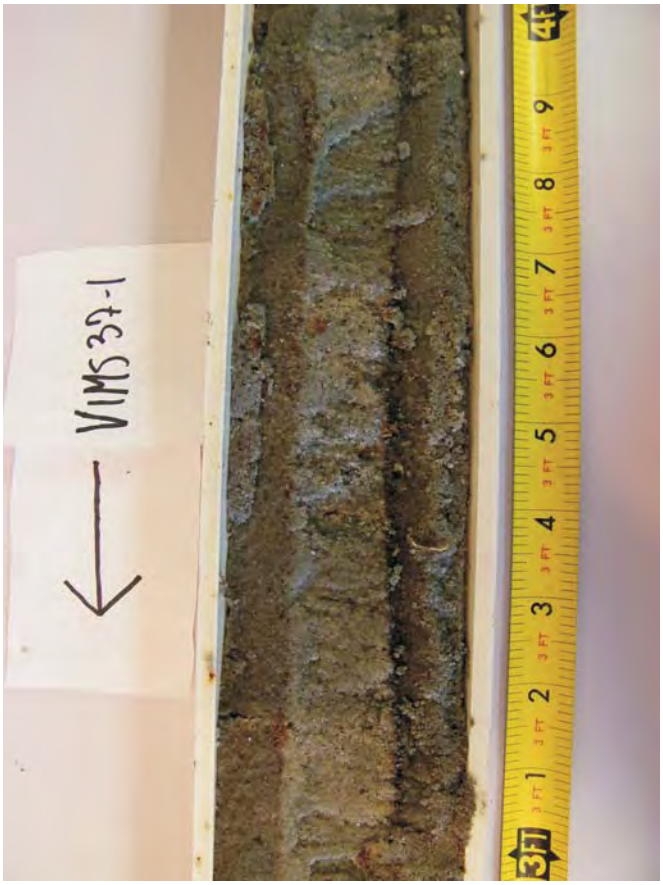
VIMS Core 36





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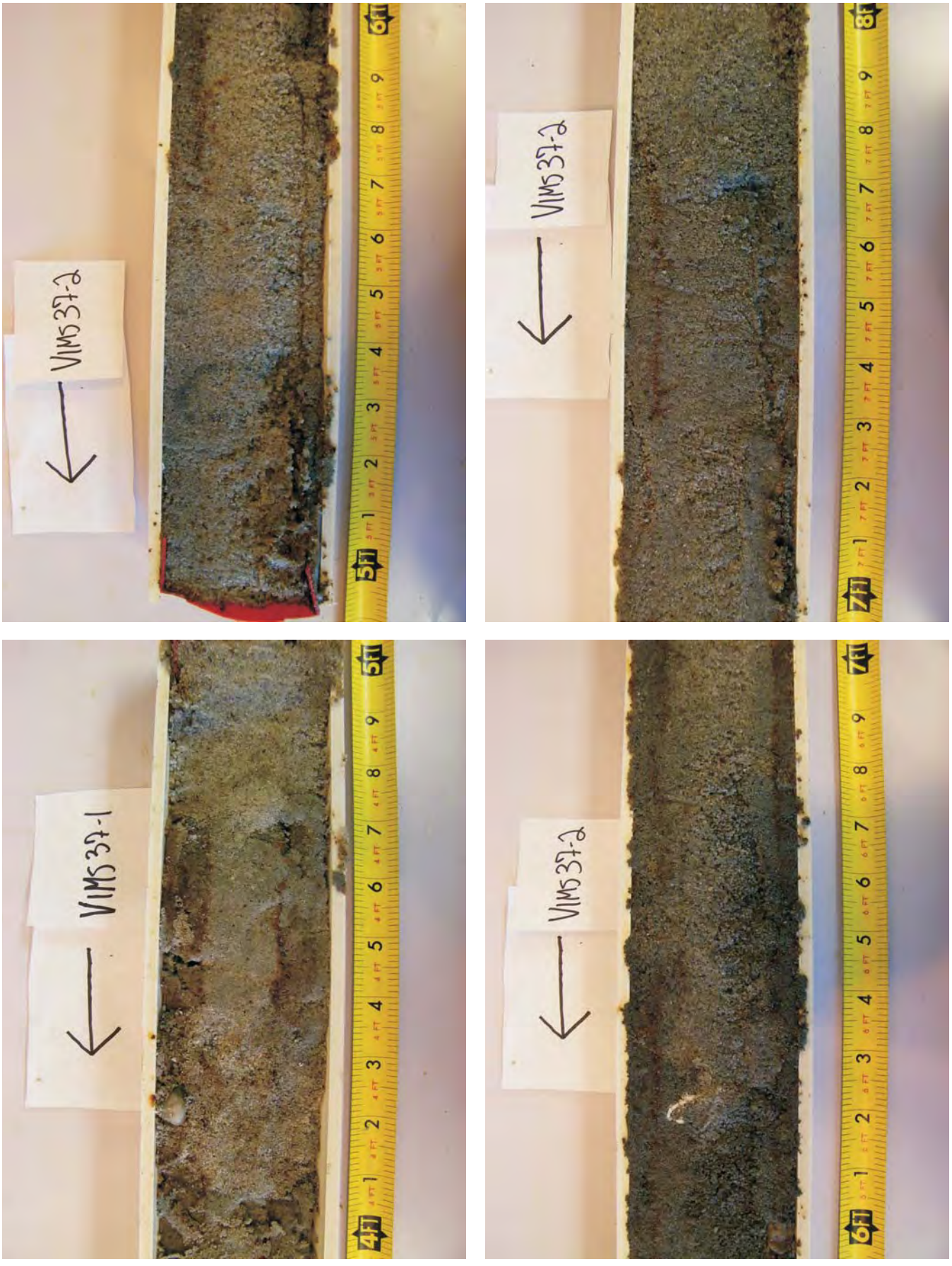
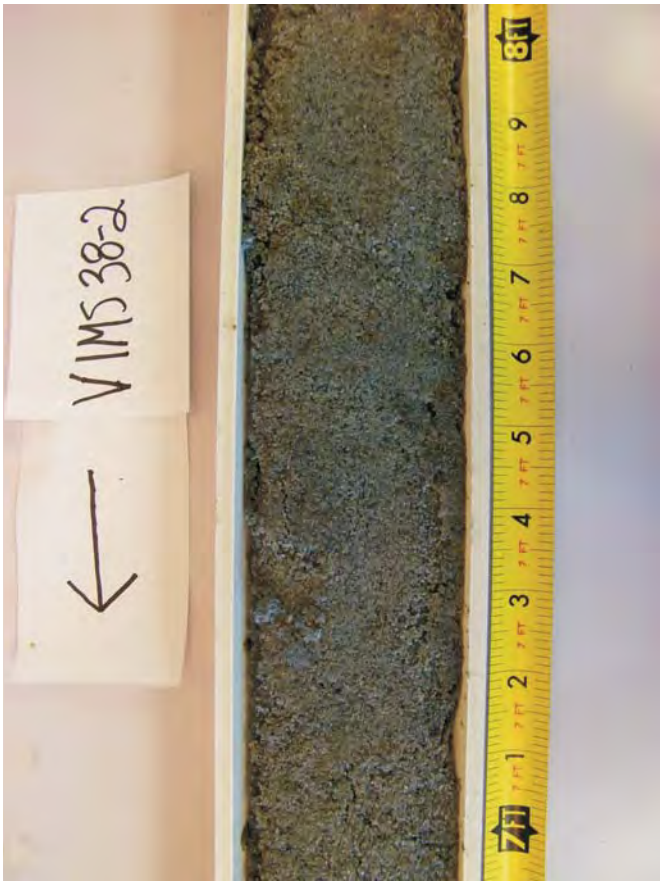
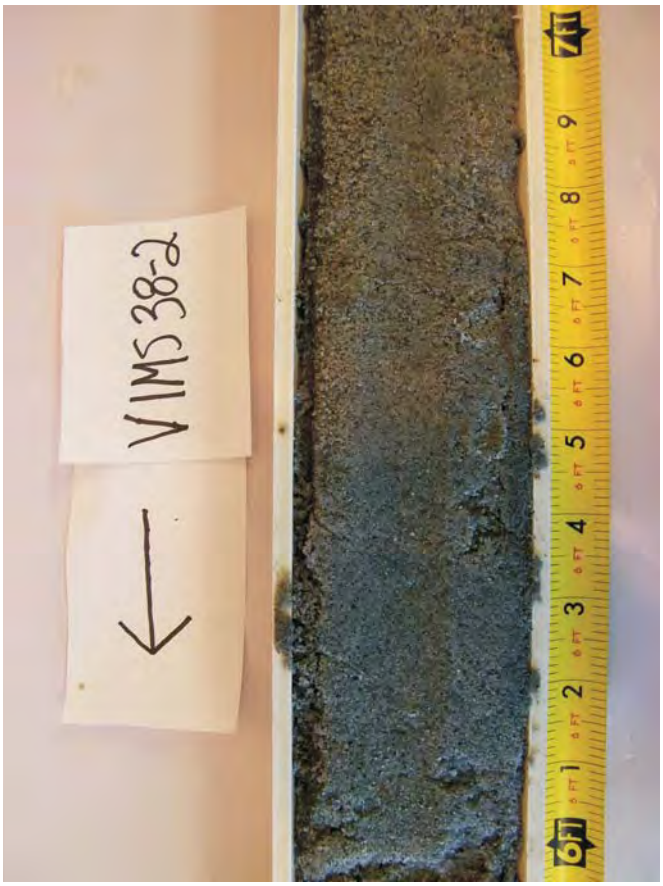


VIMS Core 37

VIMS Core 37

VIMS Core 38





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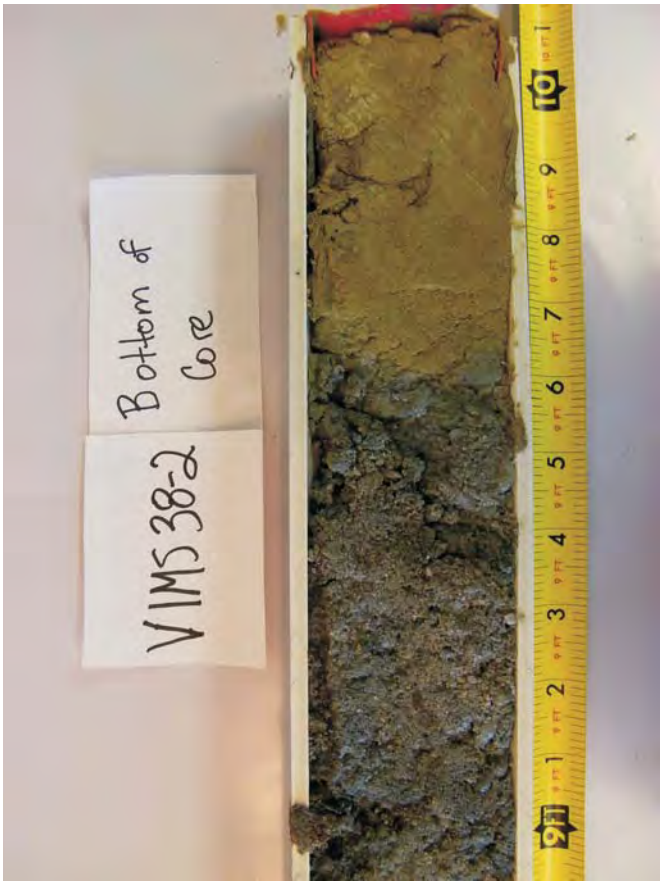

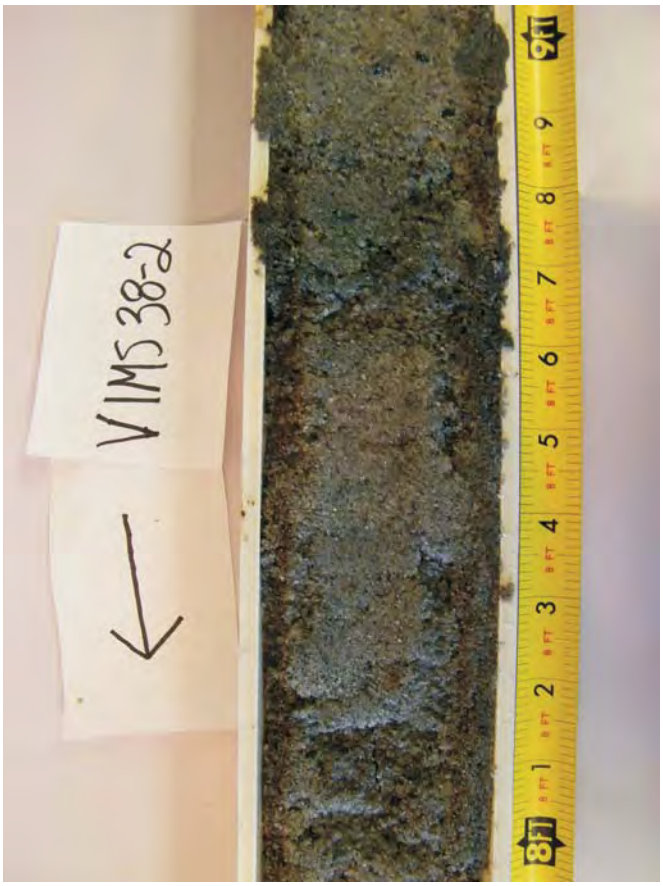

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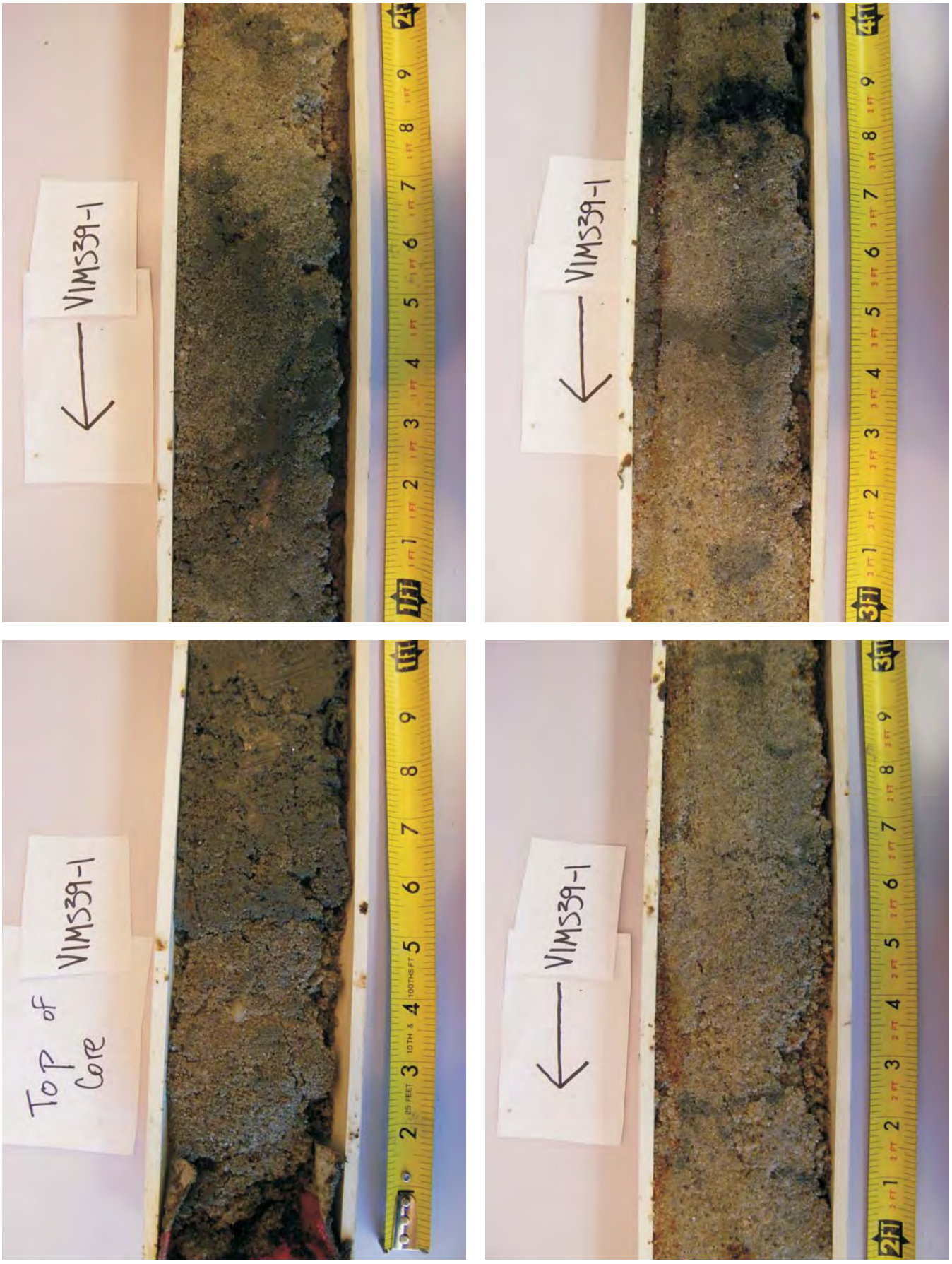

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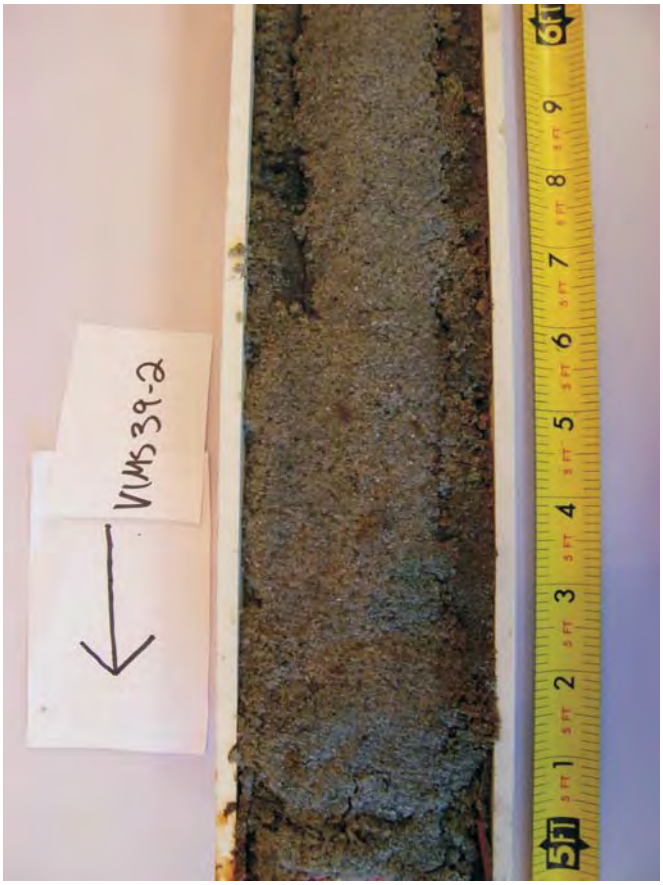

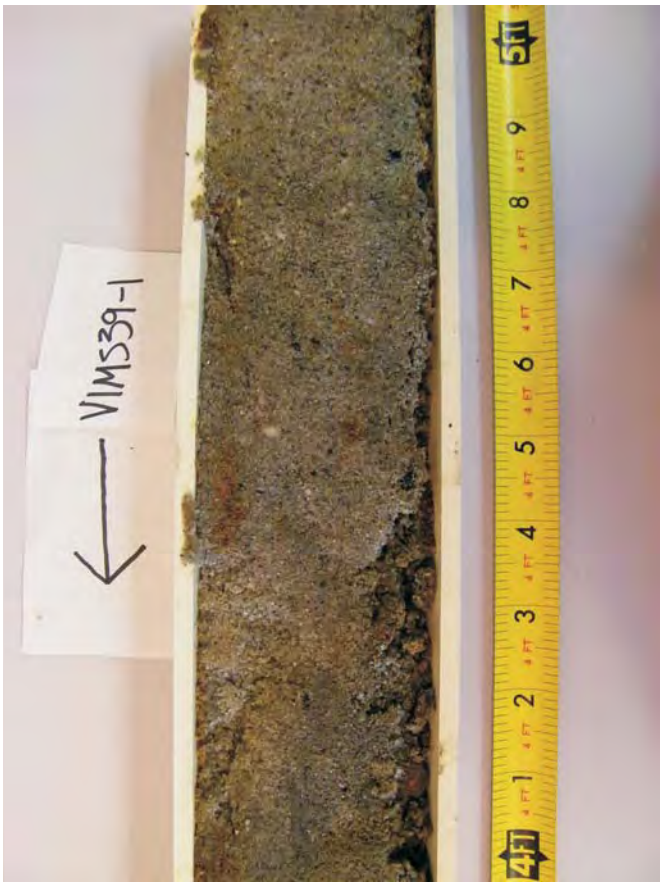

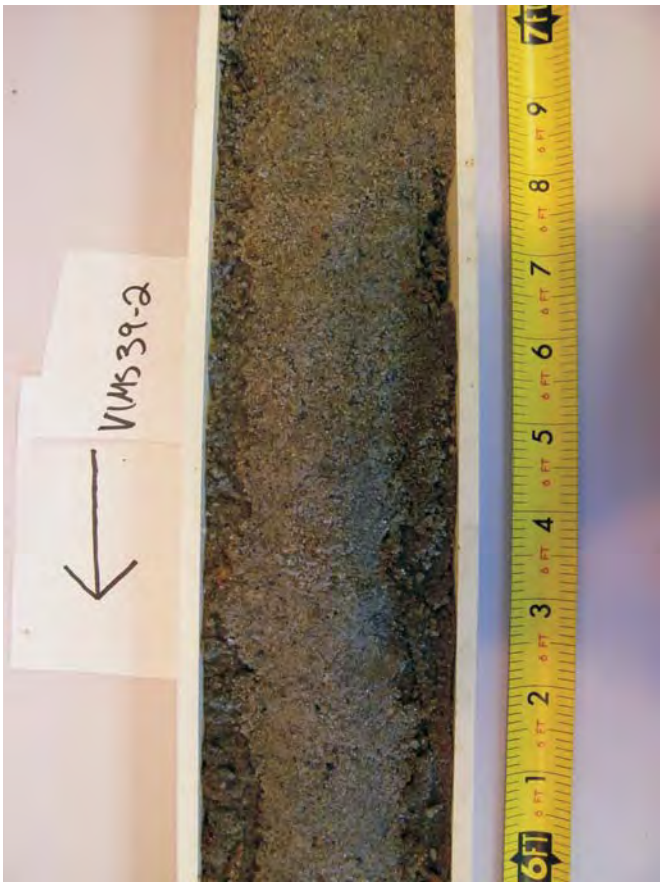

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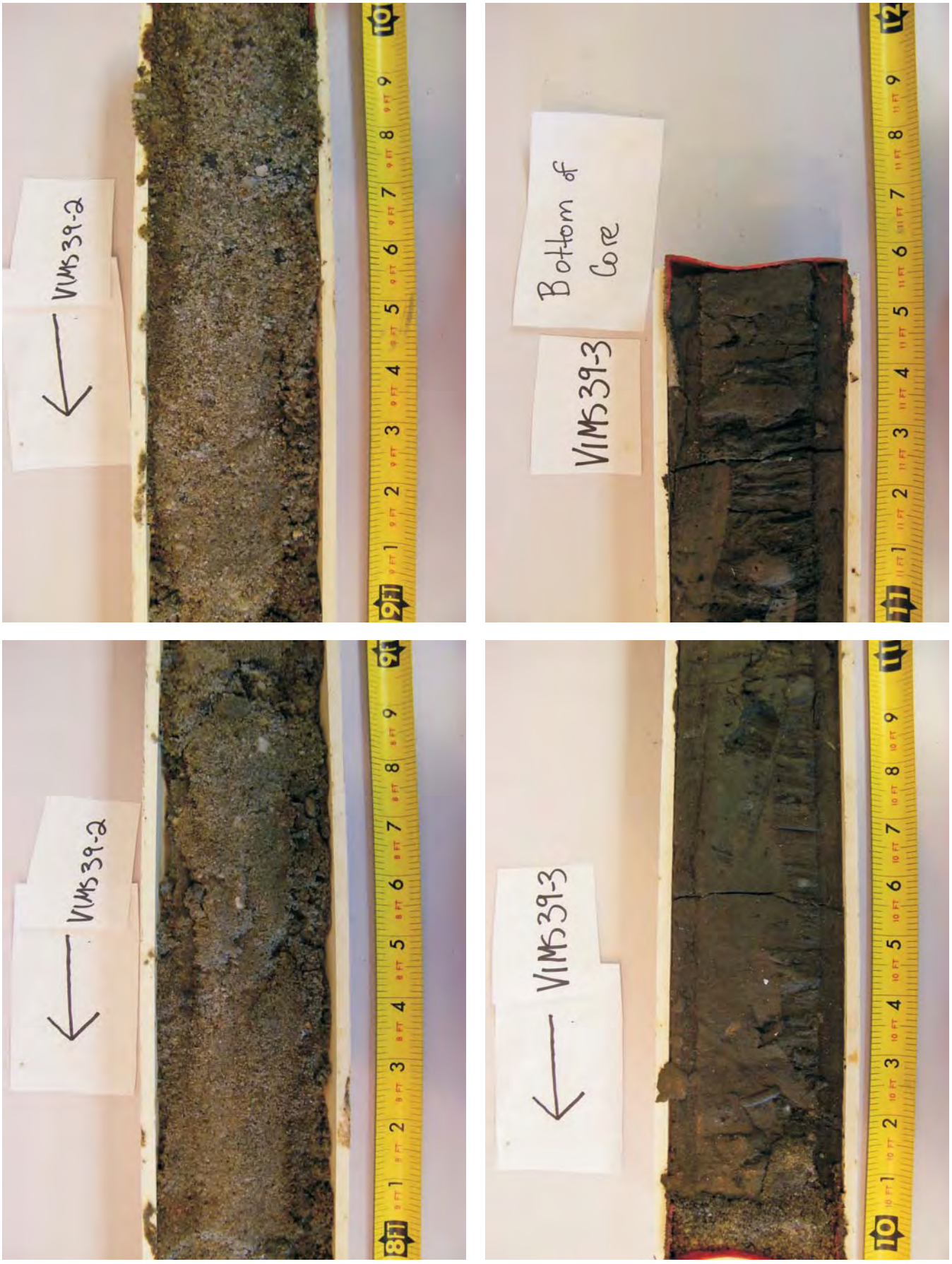
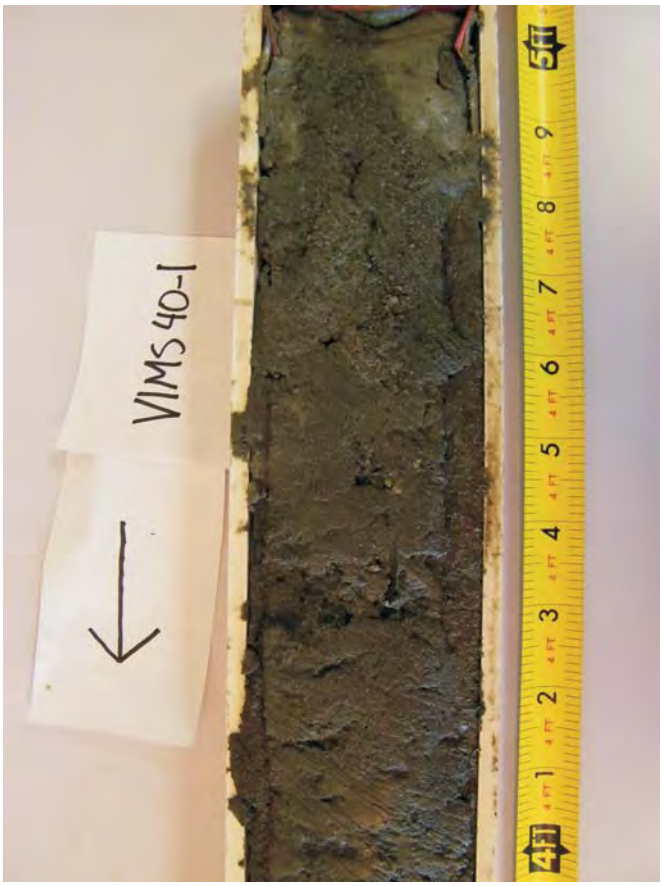


VIMS Core 39

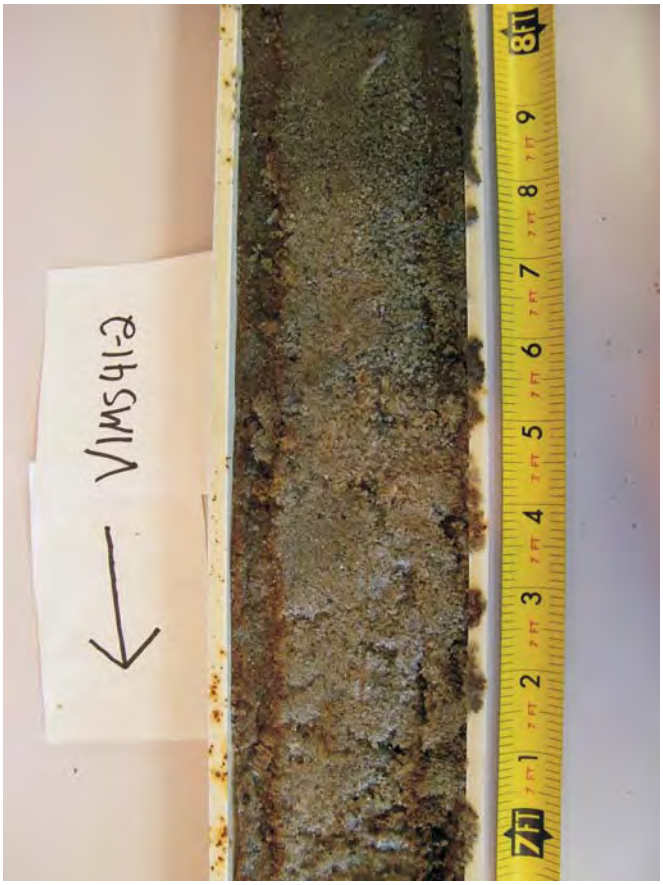
VIMS Core 40

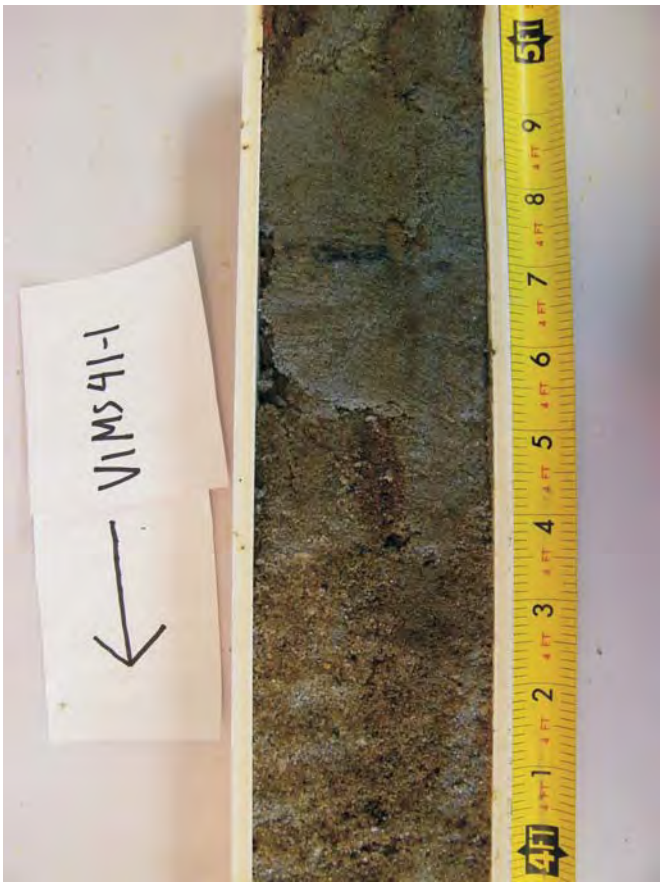


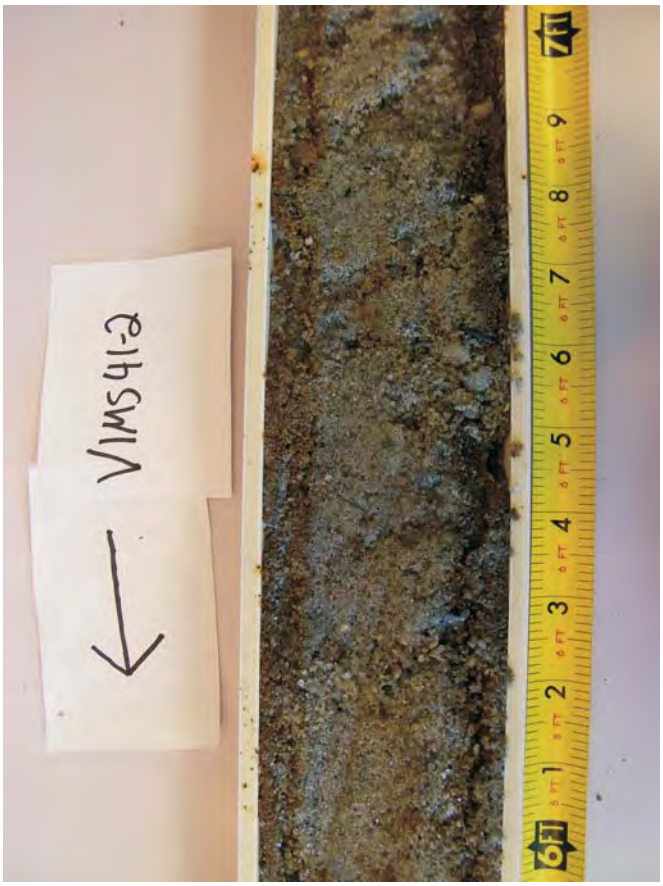
VIMS Core 40

VIMS Core 40

VIMS Core 41





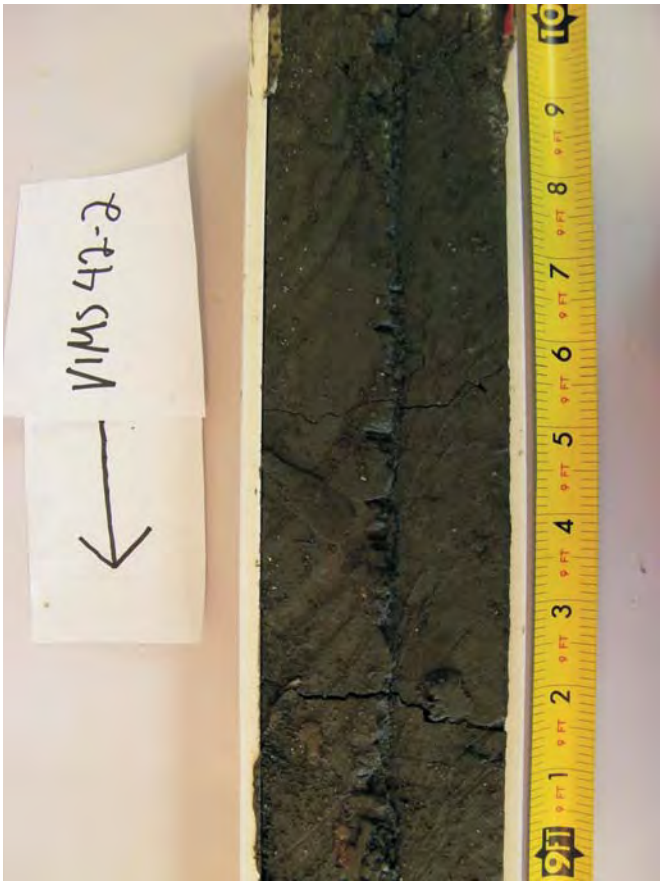


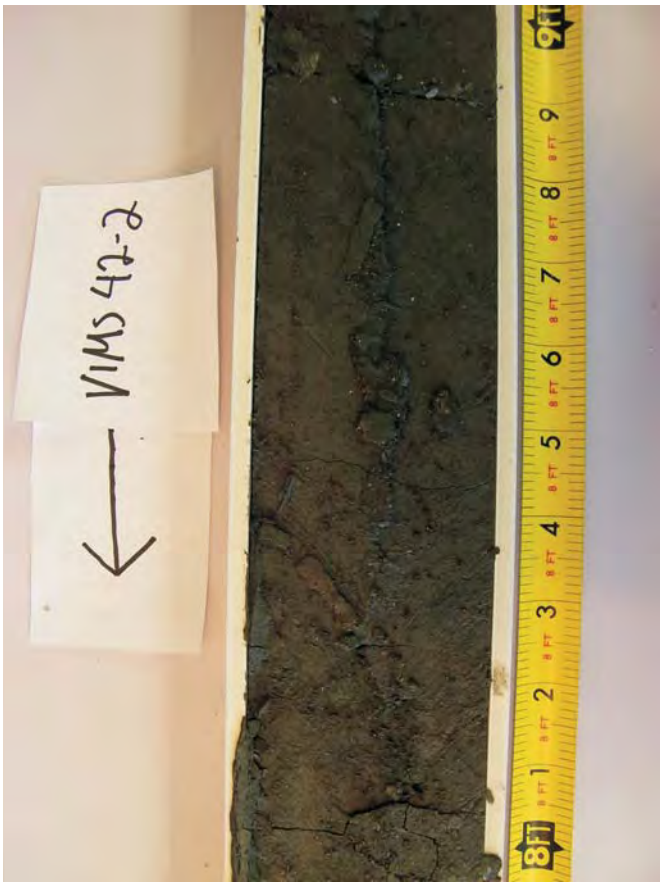
VIMS Core 41

VIMS Core 41

VIMS Core 42

VIMS Core 42



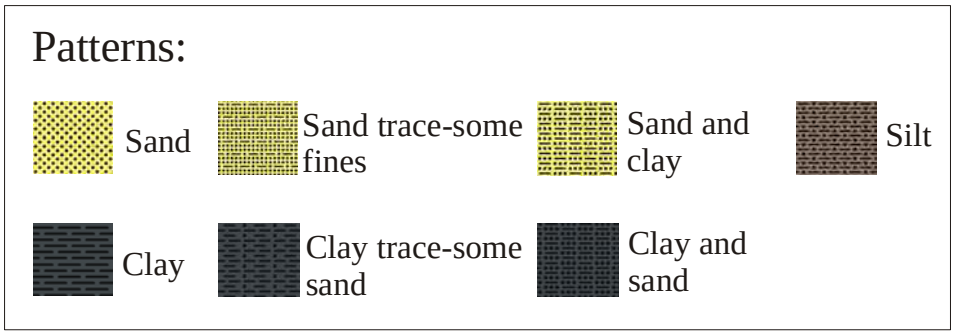


VIMS Core 42

Appendix C

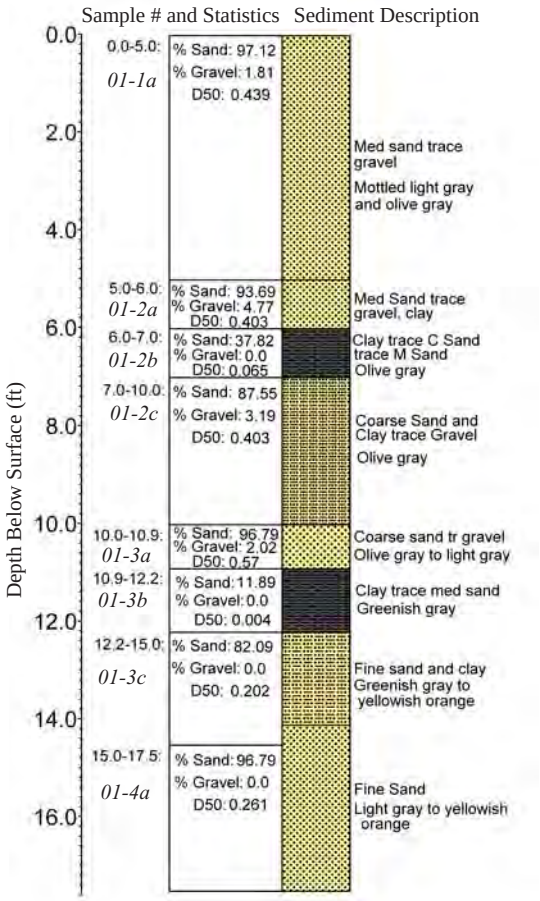
Core Logs

Depth below the bottom surface in feet of:
Channel sediment sample depth range in feet
Sediment Analysis Characteristics
Description

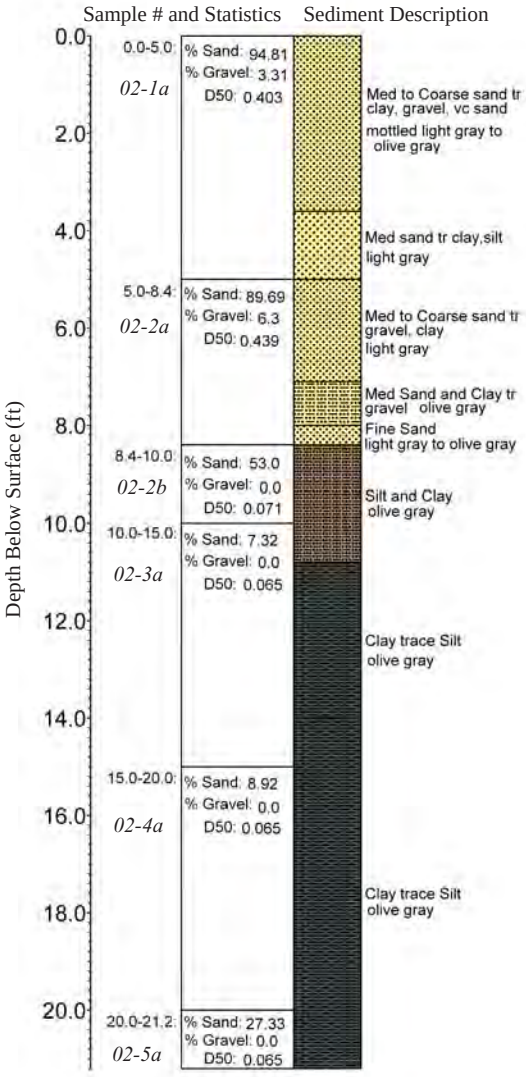


Core Logs

VIMS01

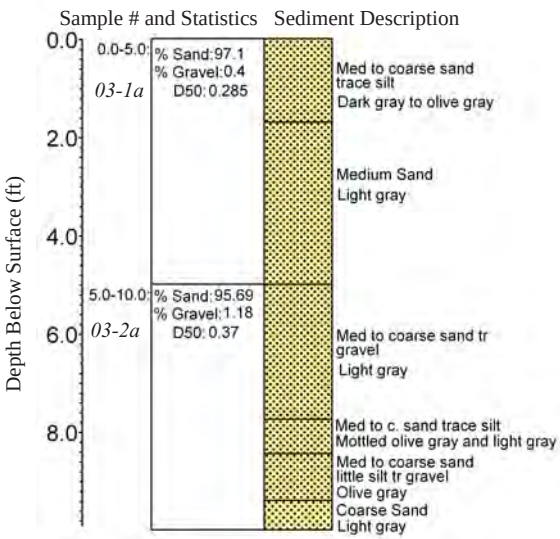


VIMS02



Core Logs

VIMS03



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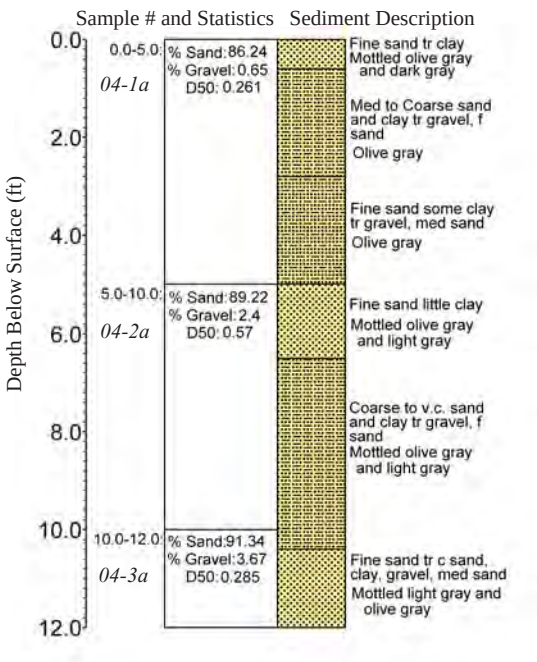

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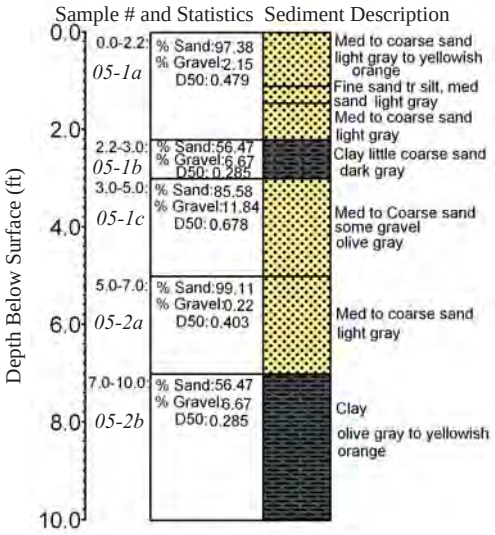
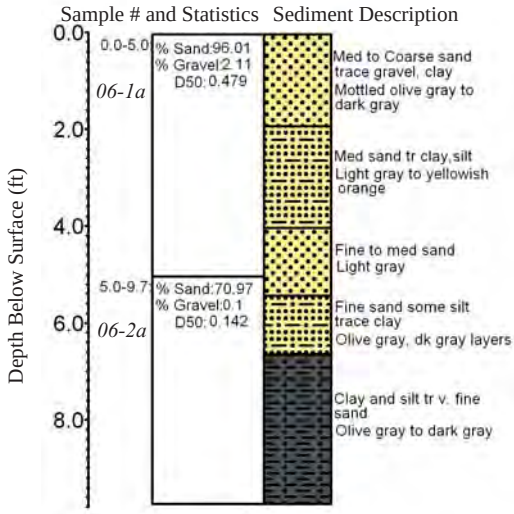
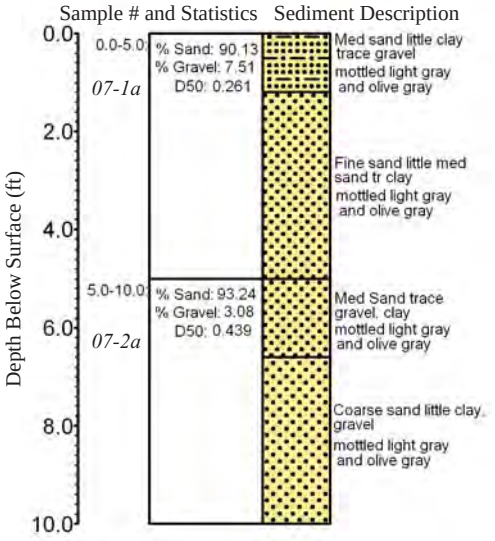


VIMS06

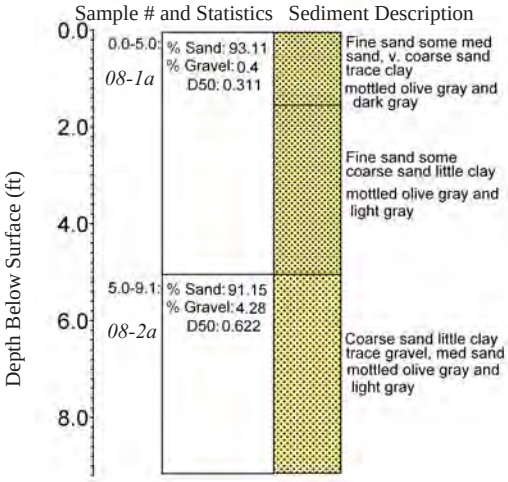


Core Logs

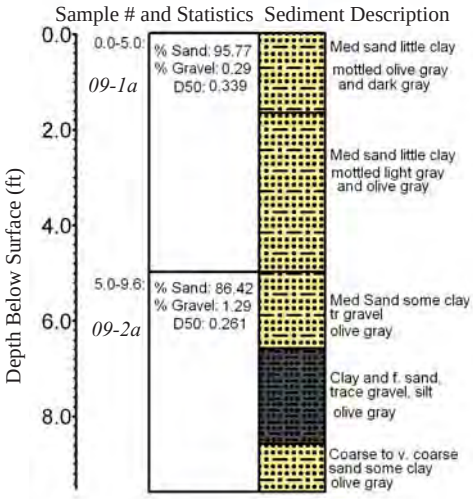
VIMS07



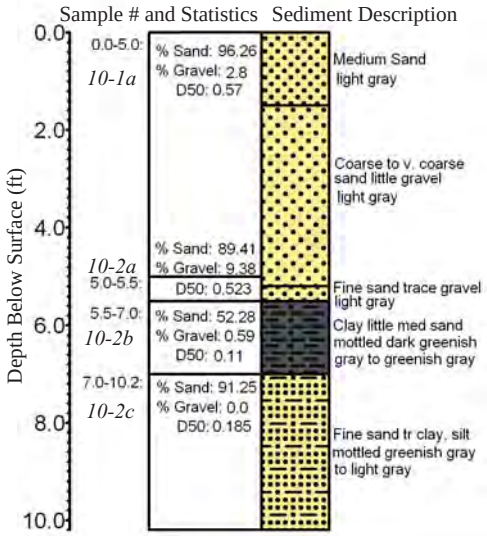
VIMS08



VIMS09

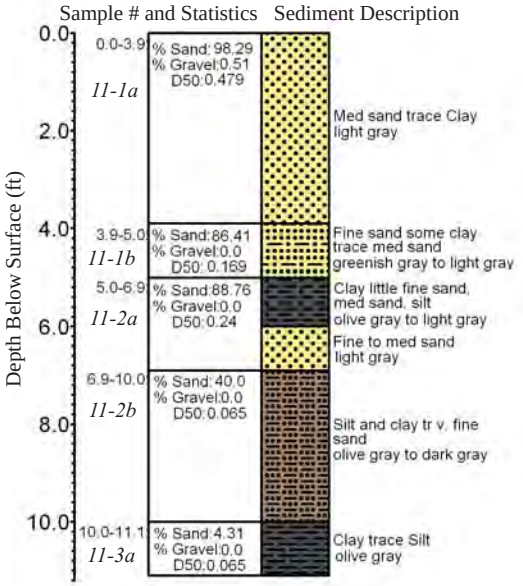


VIMS10

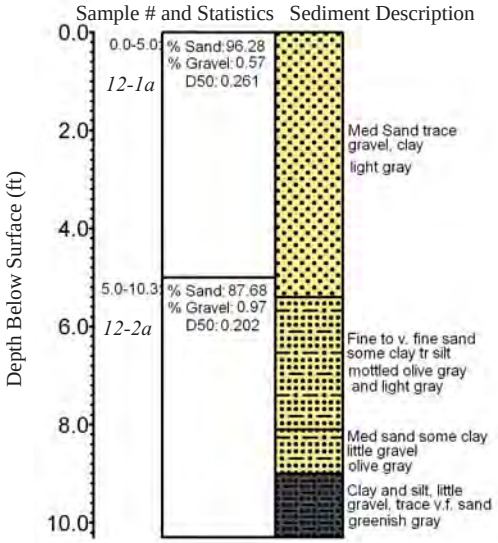


Core Logs

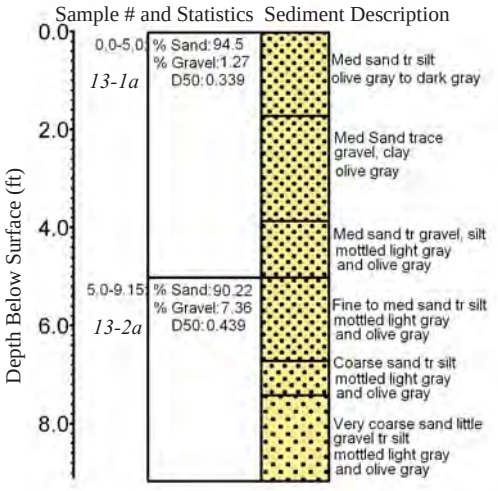
VIMS11



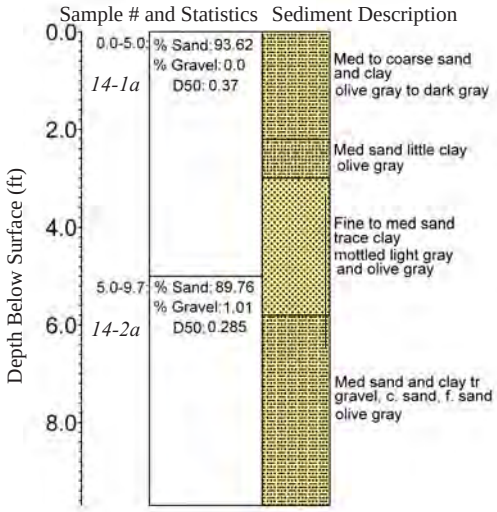
VIMS12



VIMS13

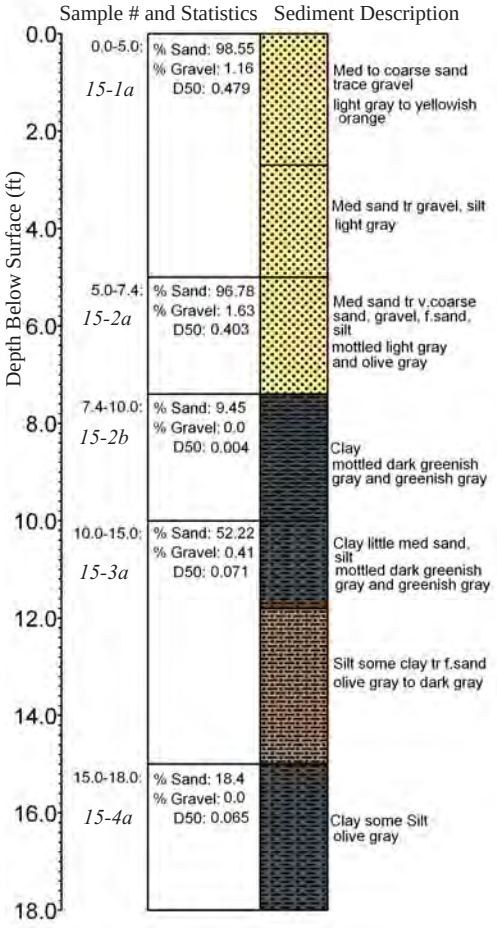


VIMS14



Core Logs

VIMS15



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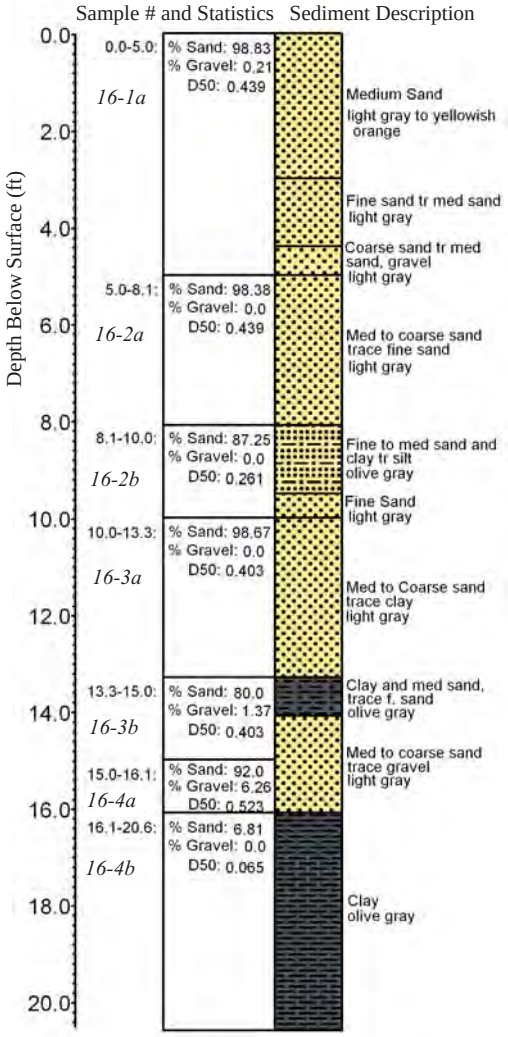
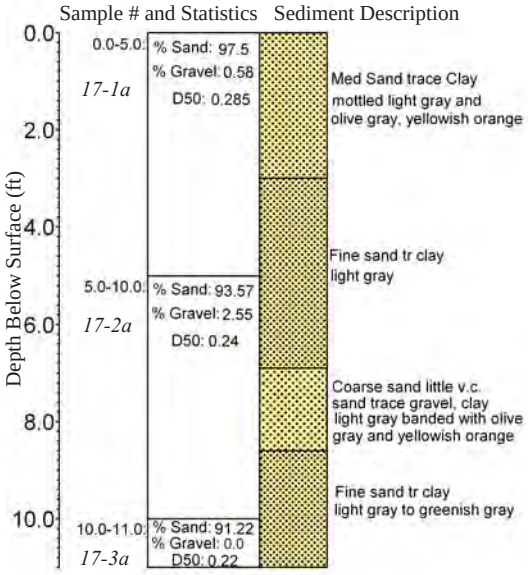
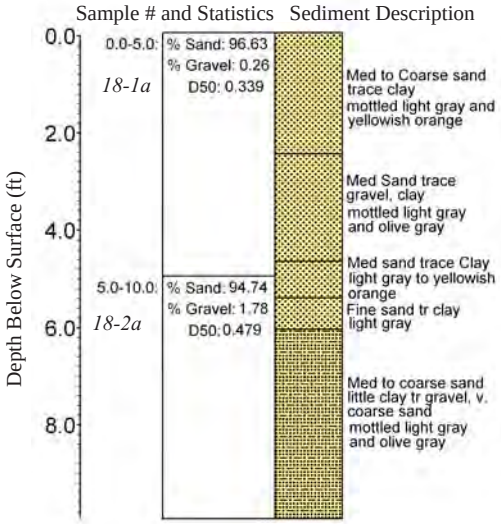


Core Logs

VIMS17



VIMS18



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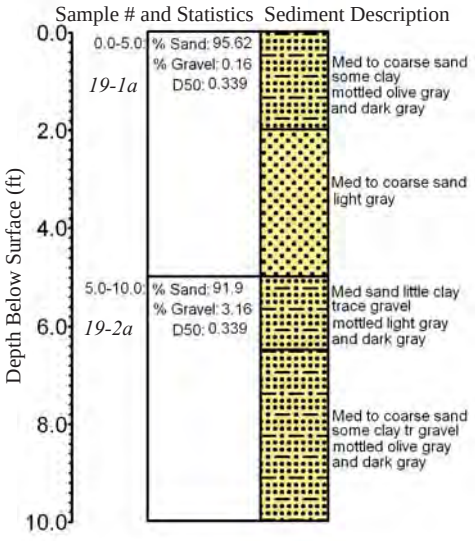

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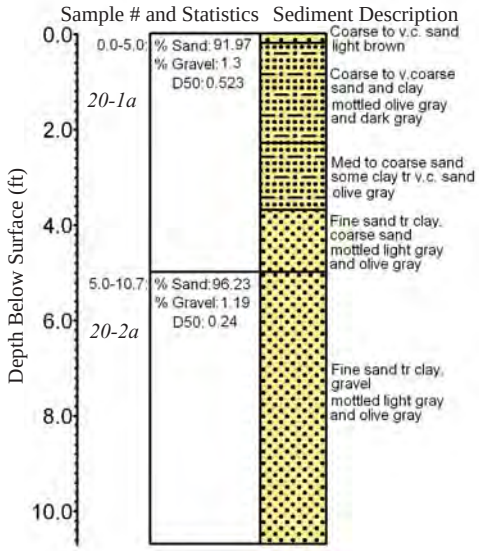
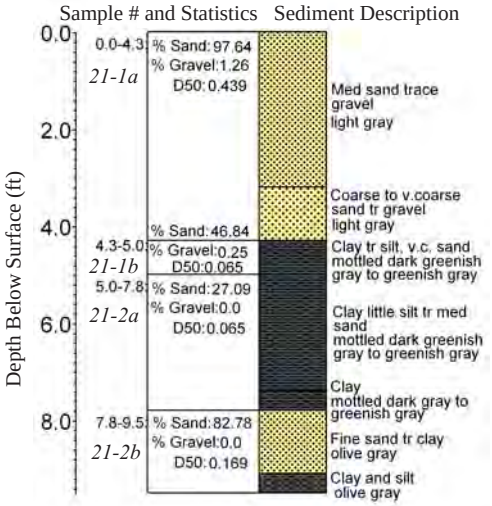
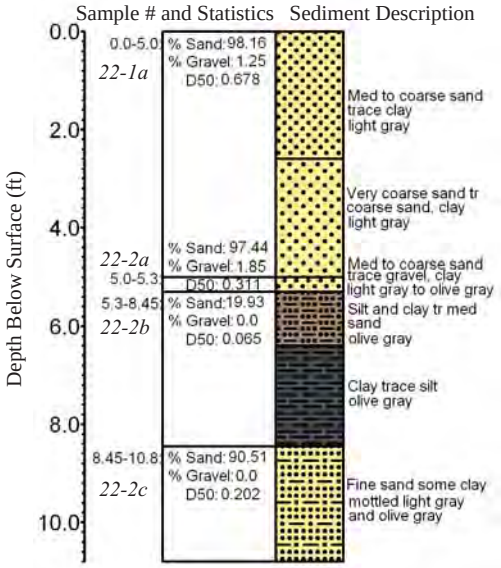


Core Logs

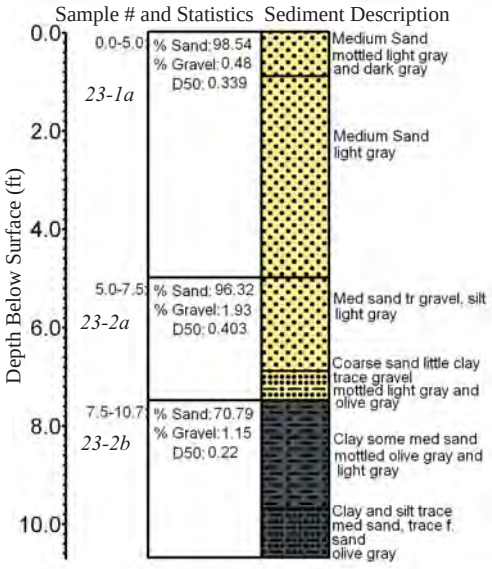
VIMS21



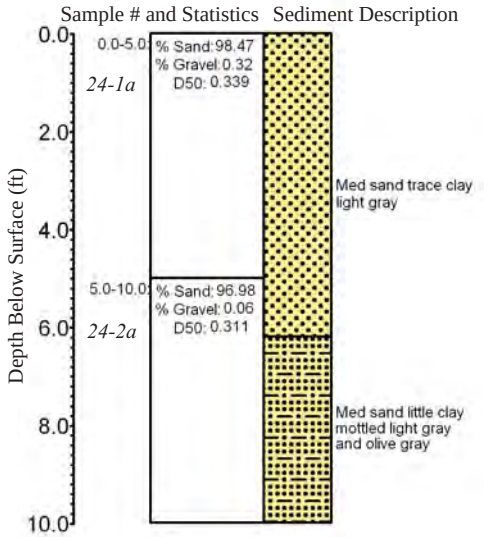
VIMS22



VIMS23

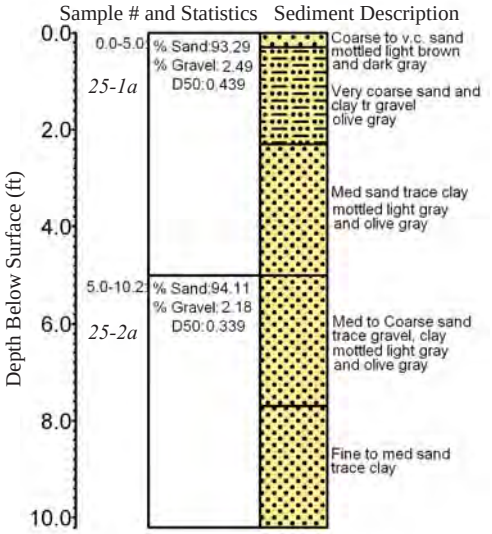


VIMS24

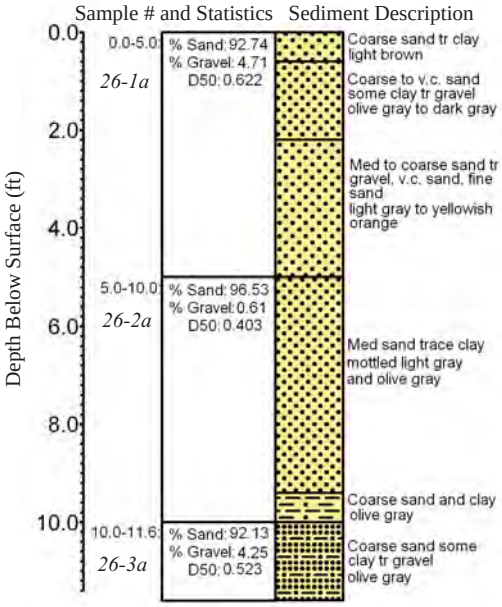


Core Logs

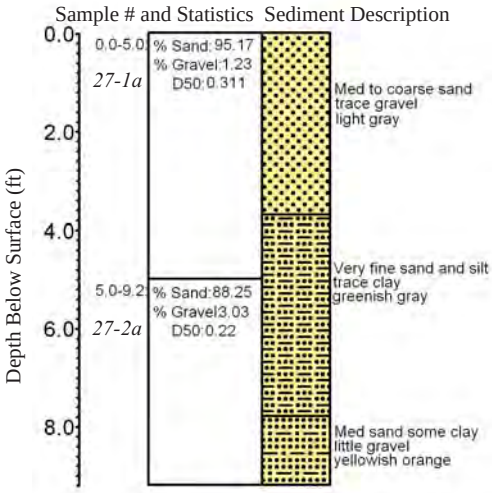
VIMS25



VIMS26



VIMS27



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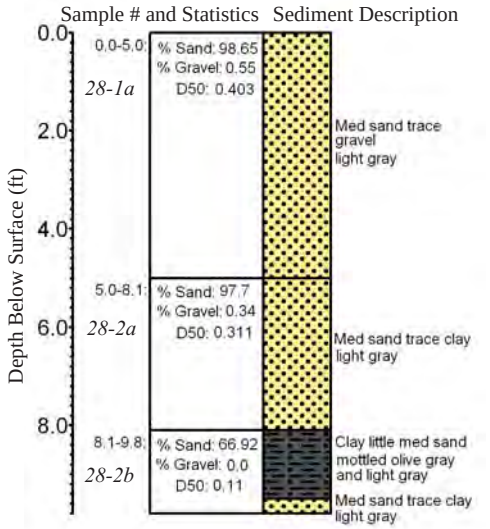
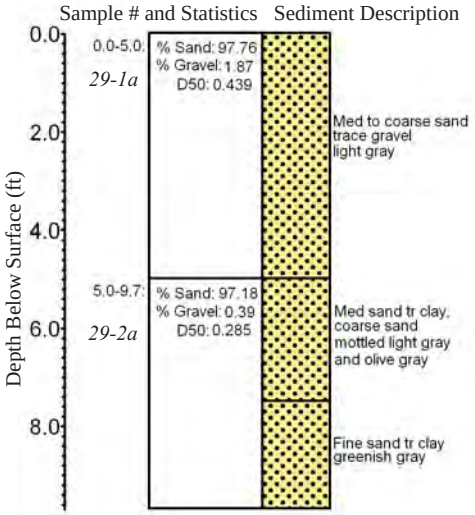


Core Logs

VIMS29



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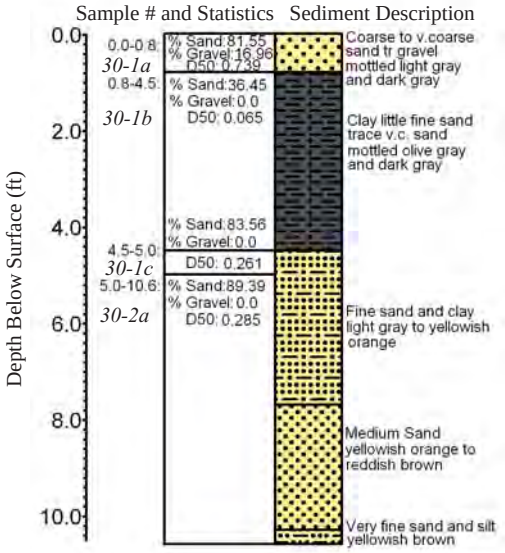

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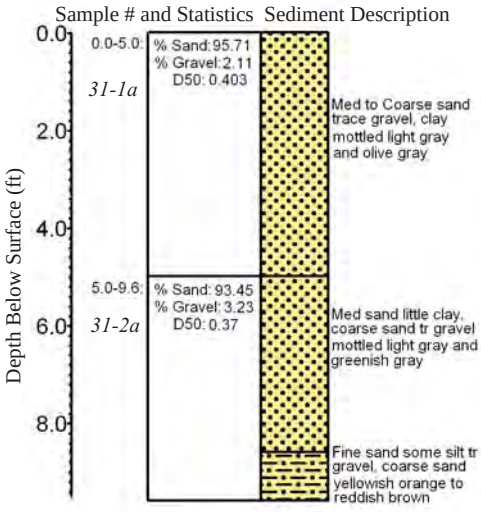

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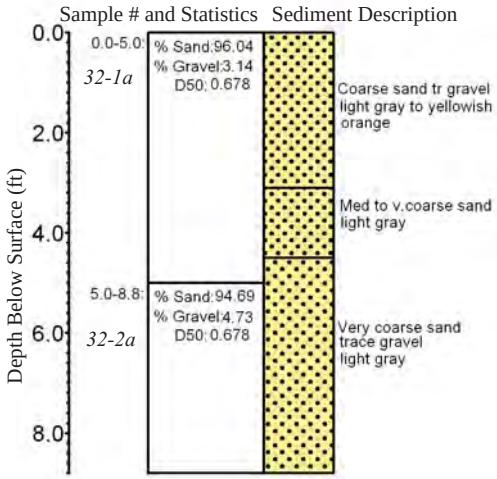
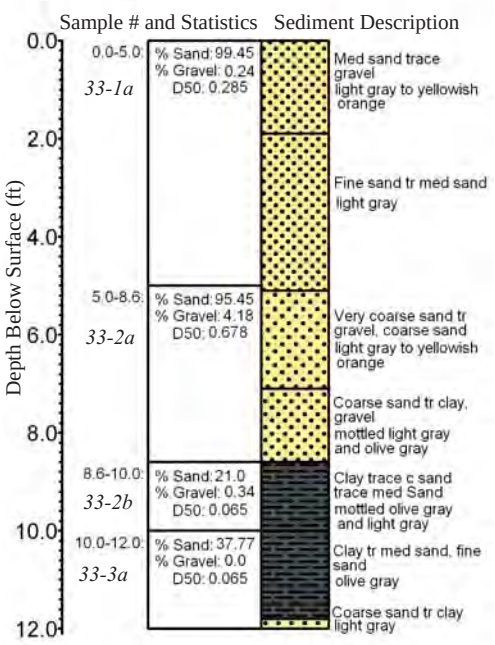


Core Logs

VIMS33



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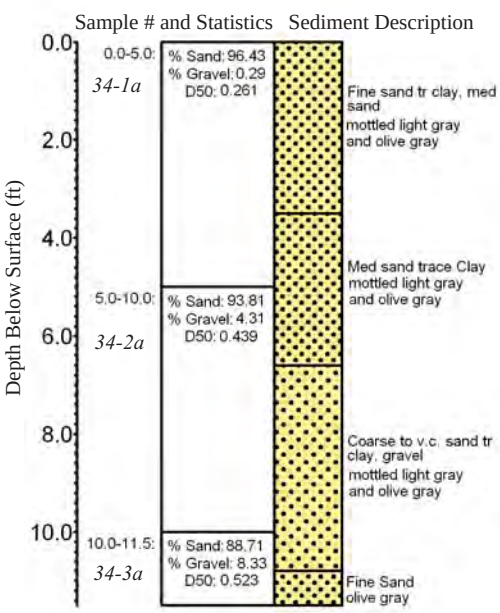

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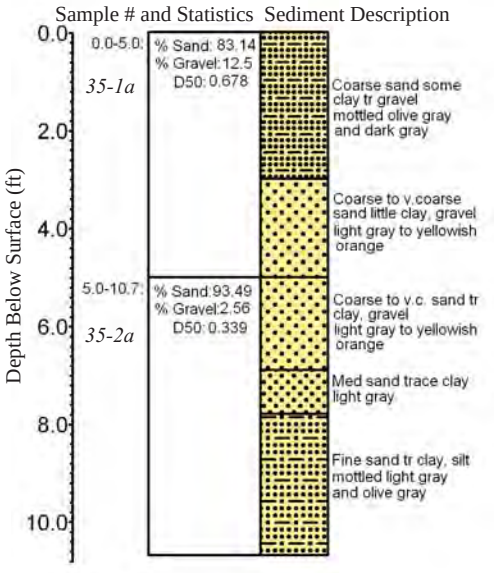
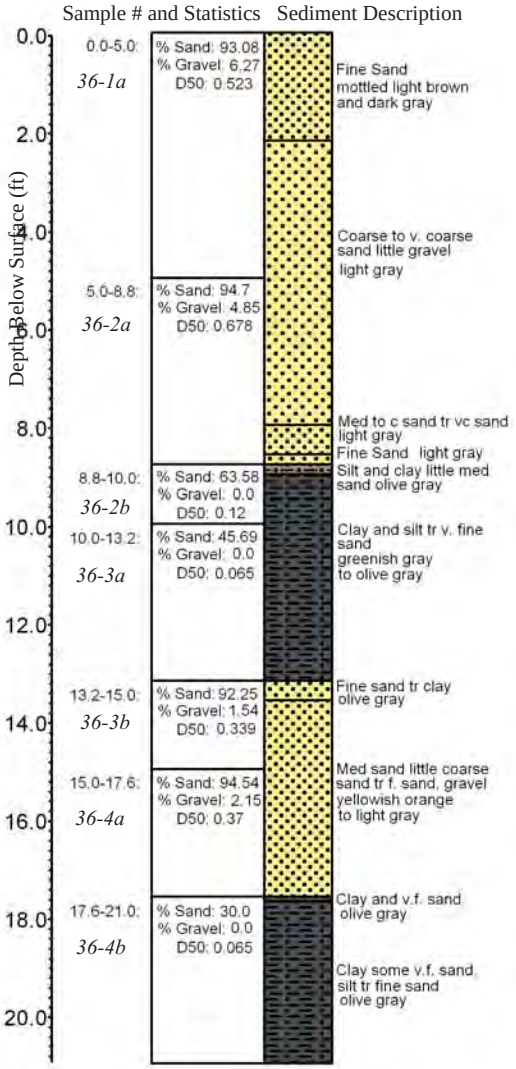


Core Logs

VIMS36



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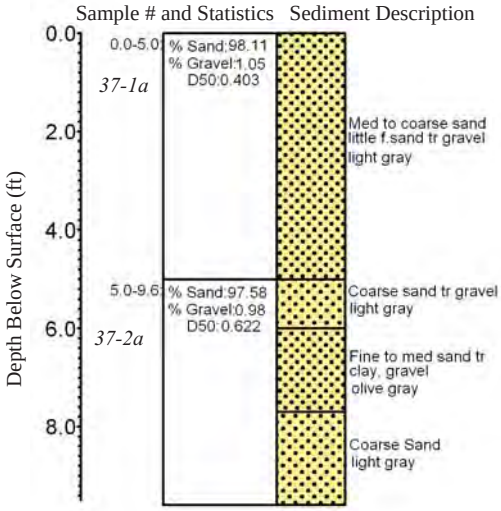

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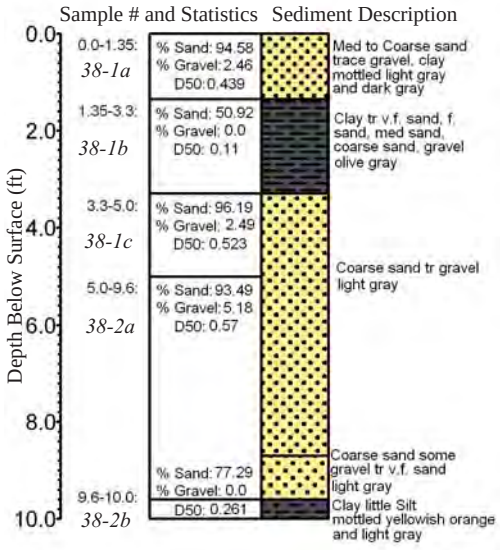
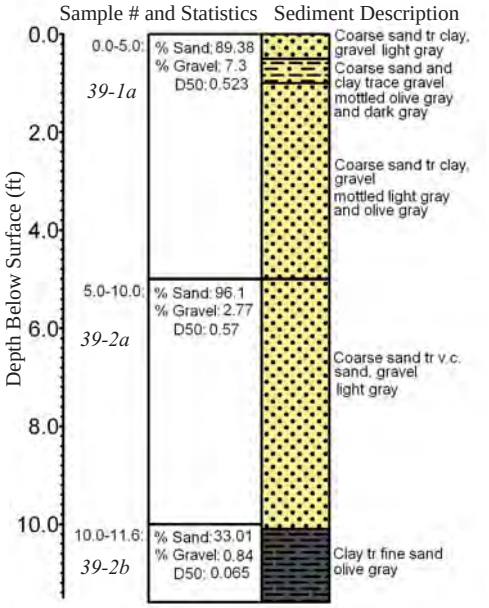
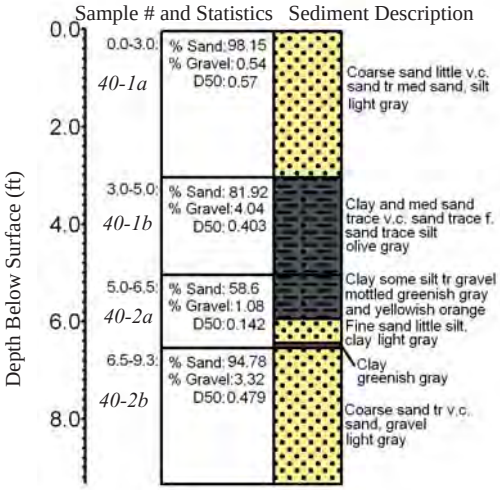


Core Logs

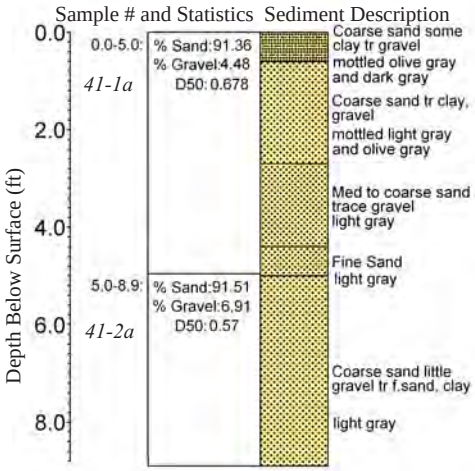
VIMS39



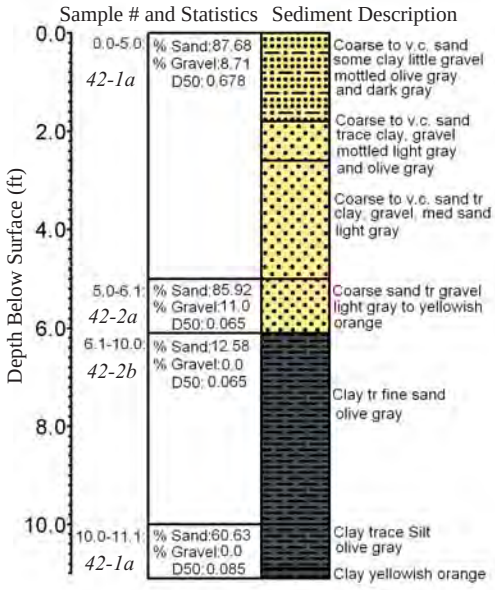
VIMS40



VIMS41



VIMS42



Appendix D

Sediment Sample Grain Size Characteristic Graphs

Sample Name
location-core#-section,sample
(ChesBay-01-1a)

Section length that was channel-sampled, in feet
(0'-5')

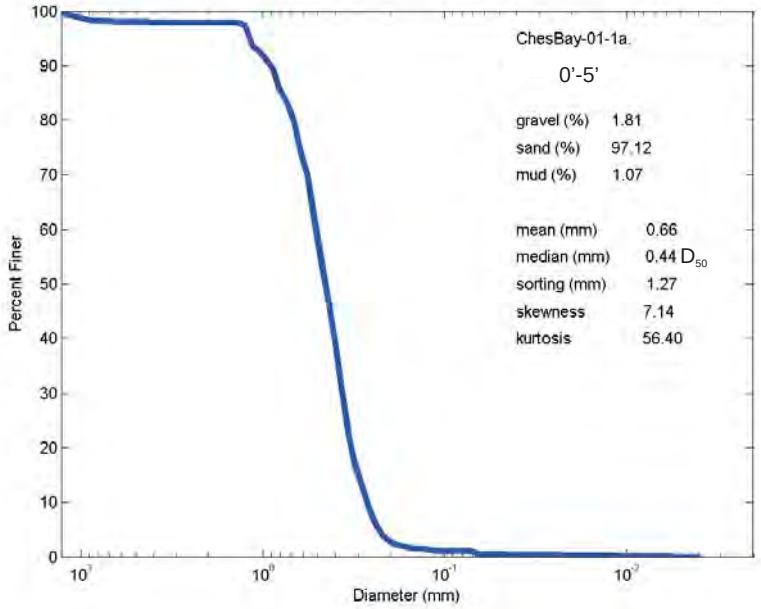
Percent of material in each category
The gravel portion of the samples were analyzed by sieve, the sand portion of the sample was analyzed with VIMS' Rapid Sediment Analyzer, and the silt and clay portion by pipette analysis.
gravel (>2 mm)
sand (2mm>sand<0.0625 mm)
mud (<0.0625mm)

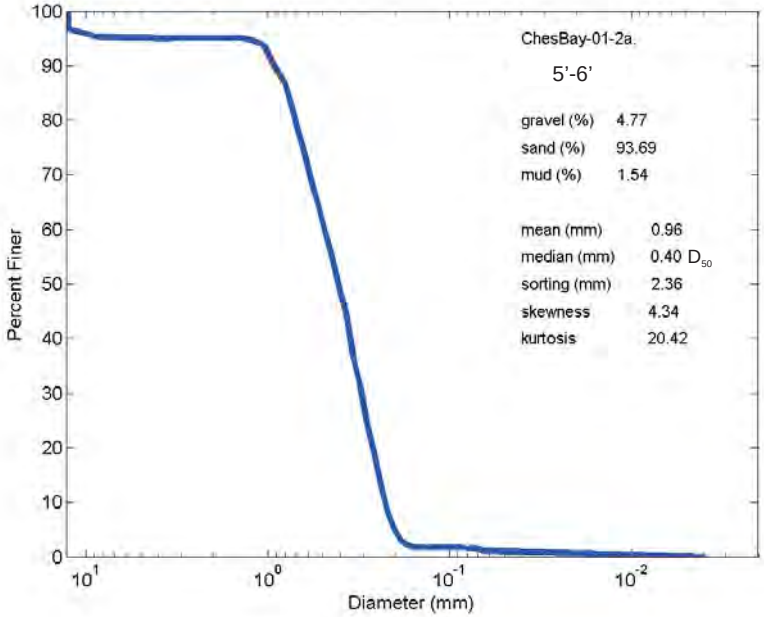
Sample statistics
The overall sample statistics shown on the graph were calculated in MATLAB using procedures outlined by Blott and Pye (2001) in Earth Surf. Process. Landforms 26, 1237–1248 as shown below.

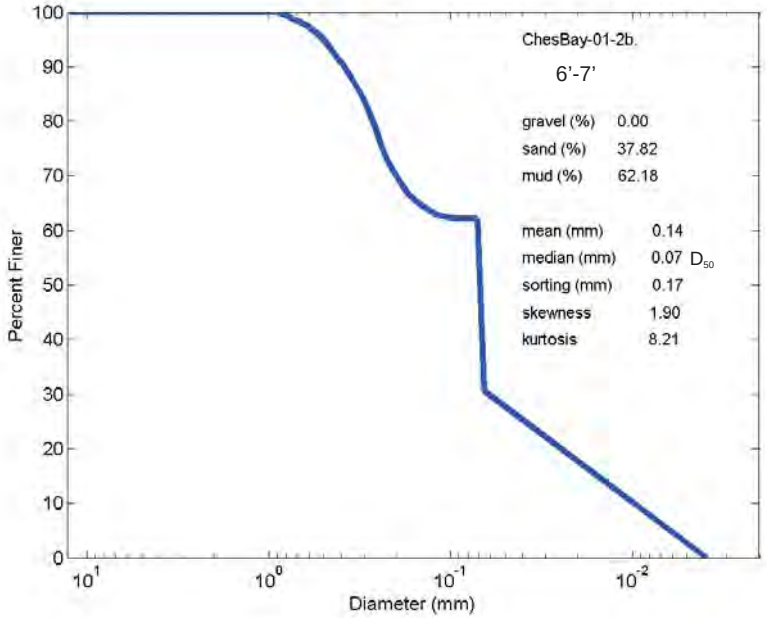
(a) Arithmetic method of moments

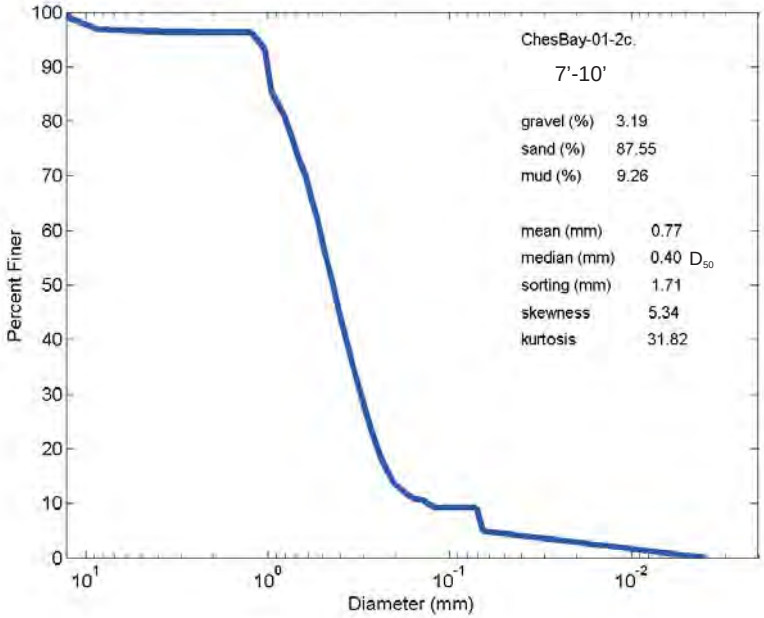
Mean	Standard deviation	Skewness	Kurtosis
$\bar{x}_a = \frac{\Sigma f m_m}{100}$	$\sigma_a = \sqrt{\frac{\Sigma f (m_m - \bar{x}_a)^2}{100}}$	$Sk_a = \frac{\Sigma f (m_m - \bar{x}_a)^3}{100\sigma_a{}^3}$	$K_a = \frac{\Sigma f (m_m - \bar{x}_a)^4}{100\sigma_a{}^4}$

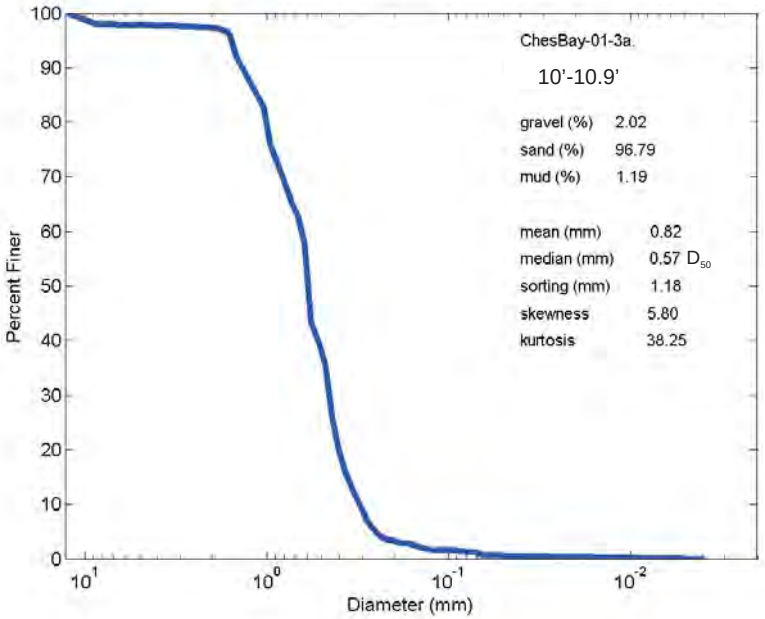
Sorting (σ_g)		Skewness (Sk_g)		Kurtosis (K_g)	
Very well sorted	<1·27	Very fine skewed	<$^{-}$1·30	Very platykurtic	<1·70
Well sorted	1·27–1·41	Fine skewed	$^{-}$1·30 to $^{-}$0·43	Platykurtic	1·70–2·55
Moderately well sorted	1·41–1·62	Symmetrical	$^{-}$0·43 to $^{+}$0·43	Mesokurtic	2·55–3·70
Moderately sorted	1·62–2·00	Coarse skewed	$^{+}$0·43 to $^{+}$1·30	Leptokurtic	3·70–7·40
Poorly sorted	2·00–4·00	Very coarse skewed	>$^{+}$1·30	Very leptokurtic	>7·40
Very poorly sorted	4·00–16·00				
Extremely poorly sorted	>16·00				

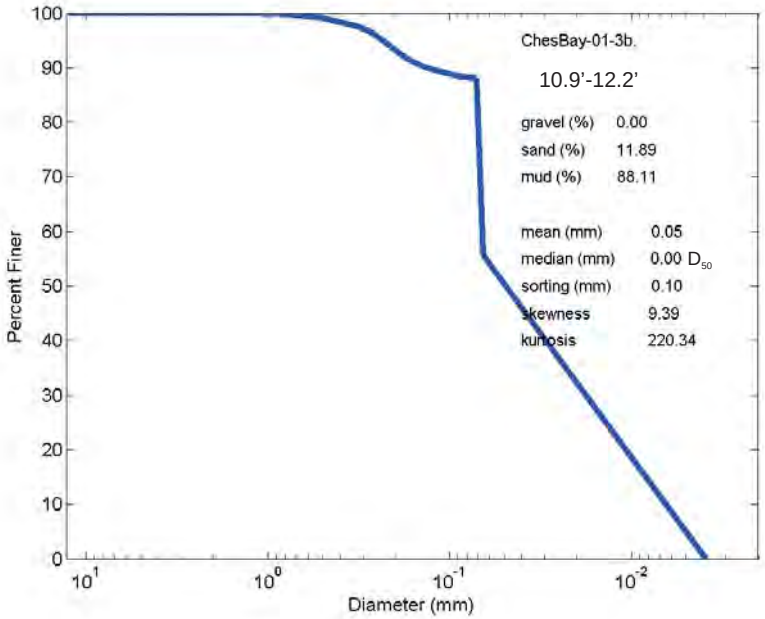

ChesBay-01-1a.
0'-5'
gravel (%) 1.81
sand (%) 97.12
mud (%) 1.07
mean (mm) 0.66
median (mm) 0.44 D50
sorting (mm) 1.27
skewness 7.14
kurtosis 56.40
Percent Finer
Diameter (mm)

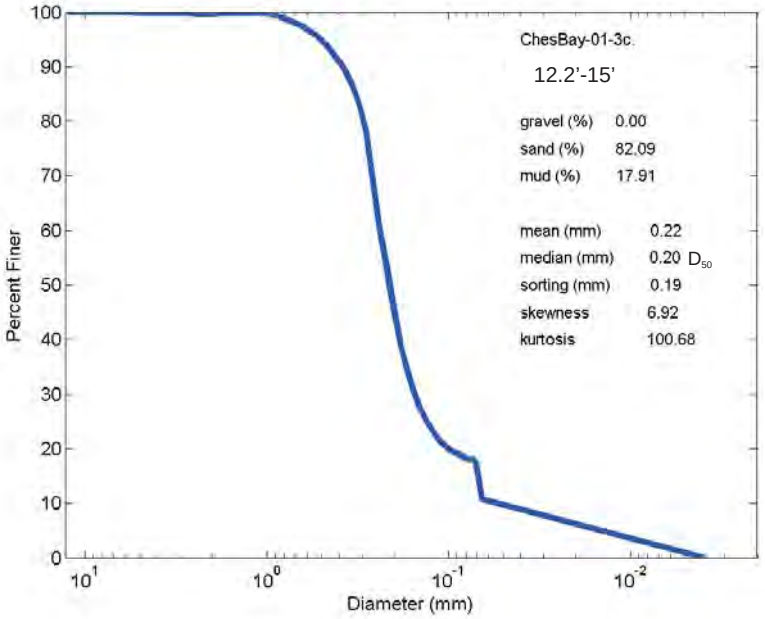

ChesBay-01-2a.
5'-6'
gravel (%) 4.77
sand (%) 93.69
mud (%) 1.54
mean (mm) 0.96
median (mm) 0.40 D50
sorting (mm) 2.36
skewness 4.34
kurtosis 20.42
Percent Finer
Diameter (mm)

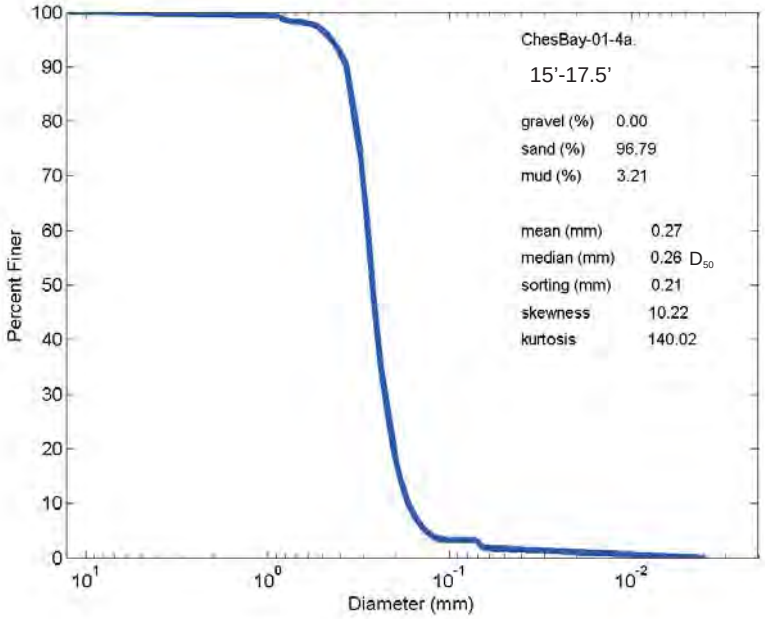

ChesBay-01-2b.
6'-7'
gravel (%) 0.00
sand (%) 37.82
mud (%) 62.18
mean (mm) 0.14
median (mm) 0.07 D50
sorting (mm) 0.17
skewness 1.90
kurtosis 8.21
Percent Finer
Diameter (mm)

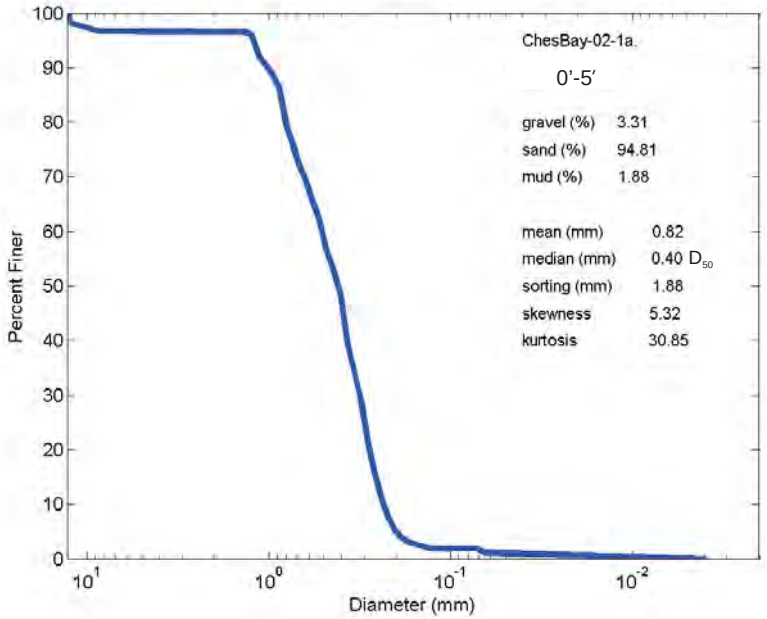

ChesBay-01-2c.
7'-10'
gravel (%) 3.19
sand (%) 87.55
mud (%) 9.26
mean (mm) 0.77
median (mm) 0.40 D50
sorting (mm) 1.71
skewness 5.34
kurtosis 31.82
Percent Finer
Diameter (mm)

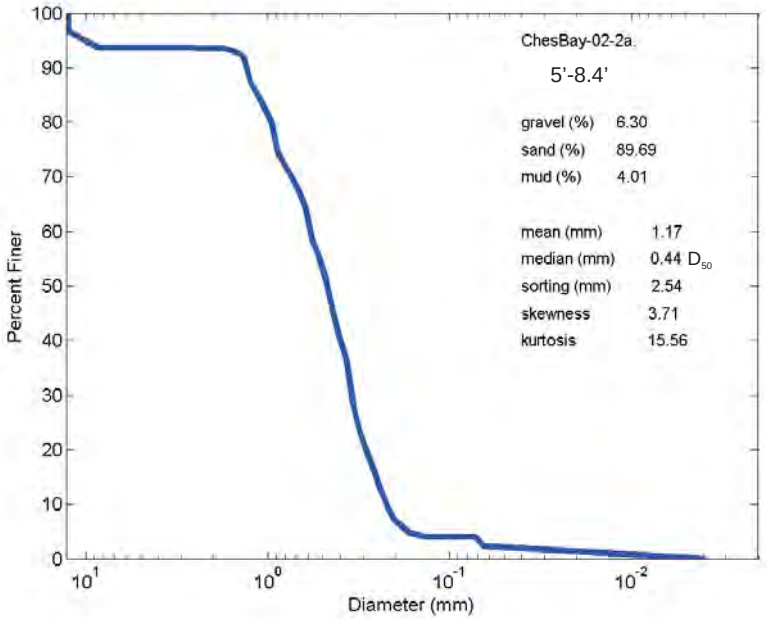

ChesBay-01-3a.
10'-10.9'
gravel (%) 2.02
sand (%) 96.79
mud (%) 1.19
mean (mm) 0.82
median (mm) 0.57 D50
sorting (mm) 1.18
skewness 5.80
kurtosis 38.25
Percent Finer
Diameter (mm)

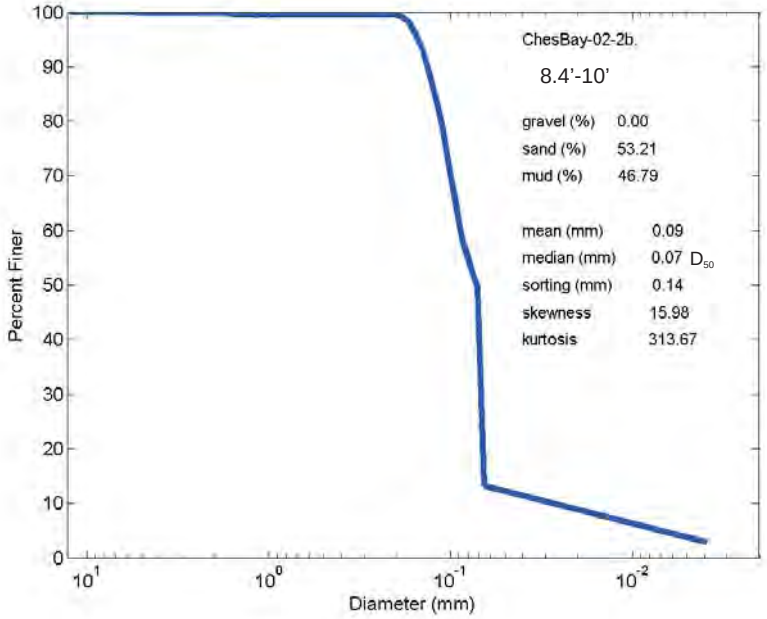

ChesBay-01-3b.
10.9'-12.2'
gravel (%) 0.00
sand (%) 11.89
mud (%) 88.11
mean (mm) 0.05
median (mm) 0.00 D50
sorting (mm) 0.10
skewness 9.39
kurtosis 220.34
Percent Finer
Diameter (mm)

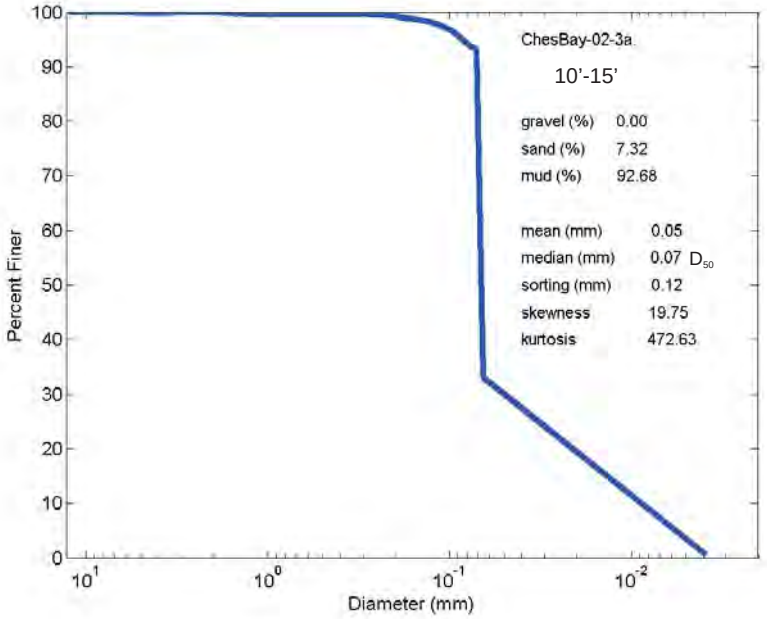

ChesBay-01-3c.
12.2'-15'
gravel (%) 0.00
sand (%) 82.09
mud (%) 17.91
mean (mm) 0.22
median (mm) 0.20 D50
sorting (mm) 0.19
skewness 6.92
kurtosis 100.68
Percent Finer
Diameter (mm)

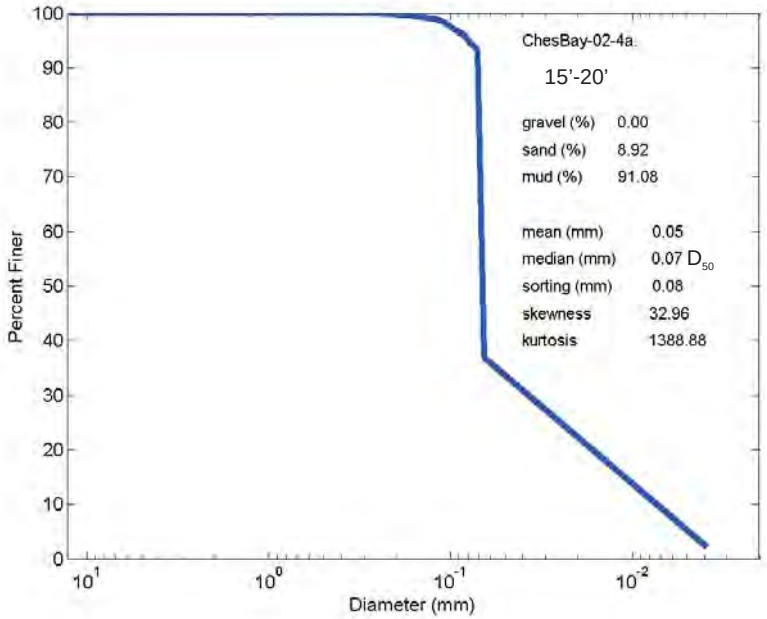

ChesBay-01-4a.
15'-17.5'
gravel (%) 0.00
sand (%) 96.79
mud (%) 3.21
mean (mm) 0.27
median (mm) 0.26 D50
sorting (mm) 0.21
skewness 10.22
kurtosis 140.02
Percent Finer
Diameter (mm)

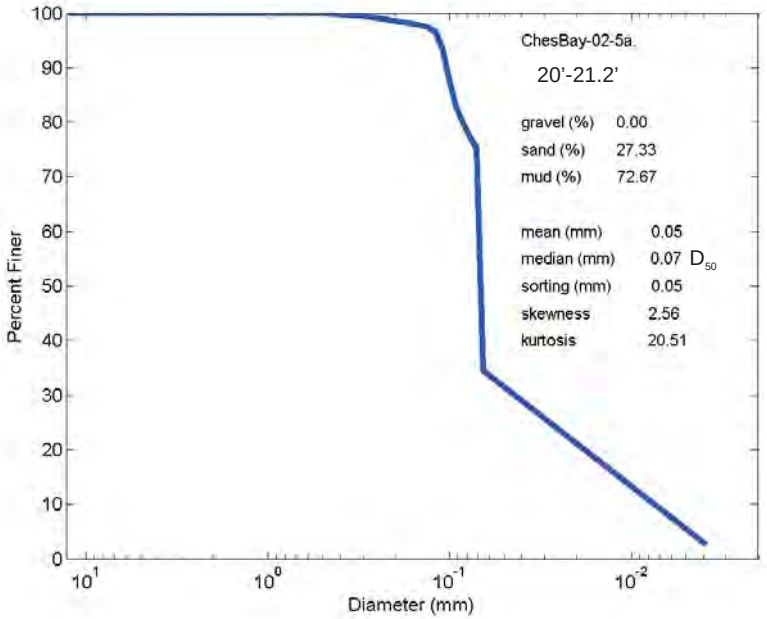

ChesBay-02-1a.
0'-5'
gravel (%) 3.31
sand (%) 94.81
mud (%) 1.88
mean (mm) 0.82
median (mm) 0.40 D_{50}
sorting (mm) 1.88
skewness 5.32
kurtosis 30.85
Percent Finer
Diameter (mm)

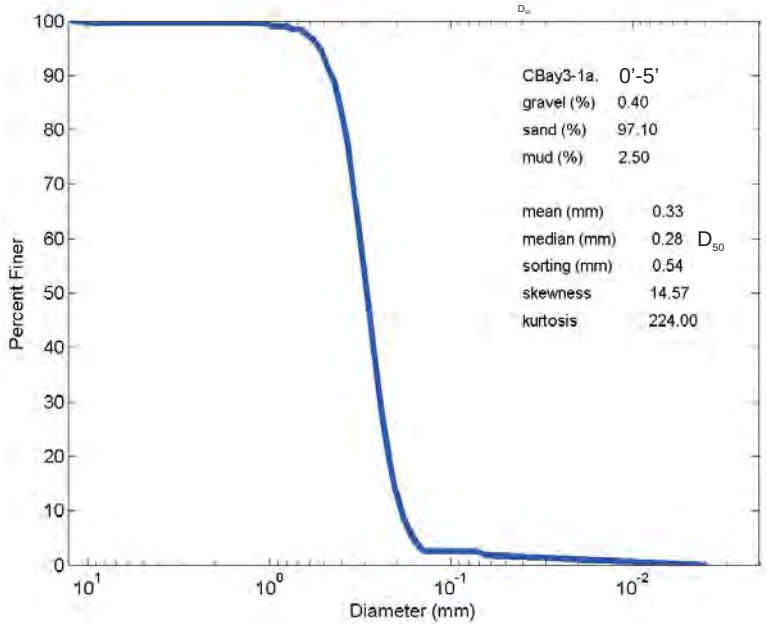

ChesBay-02-2a.
5'-8.4'
gravel (%) 6.30
sand (%) 89.69
mud (%) 4.01
mean (mm) 1.17
median (mm) 0.44 D_{50}
sorting (mm) 2.54
skewness 3.71
kurtosis 15.56
Percent Finer
Diameter (mm)

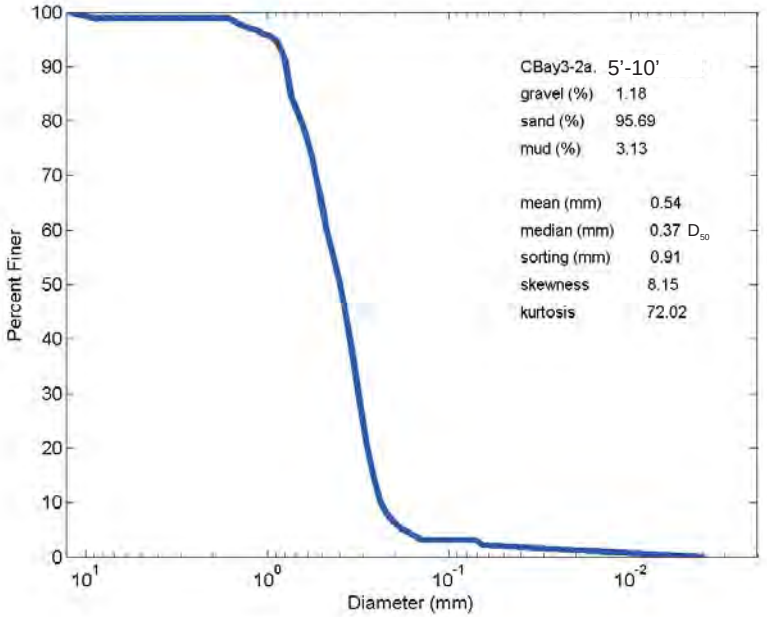

ChesBay-02-2b.
8.4'-10'
gravel (%) 0.00
sand (%) 53.21
mud (%) 46.79
mean (mm) 0.09
median (mm) 0.07 D_{50}
sorting (mm) 0.14
skewness 15.98
kurtosis 313.67
Percent Finer
Diameter (mm)

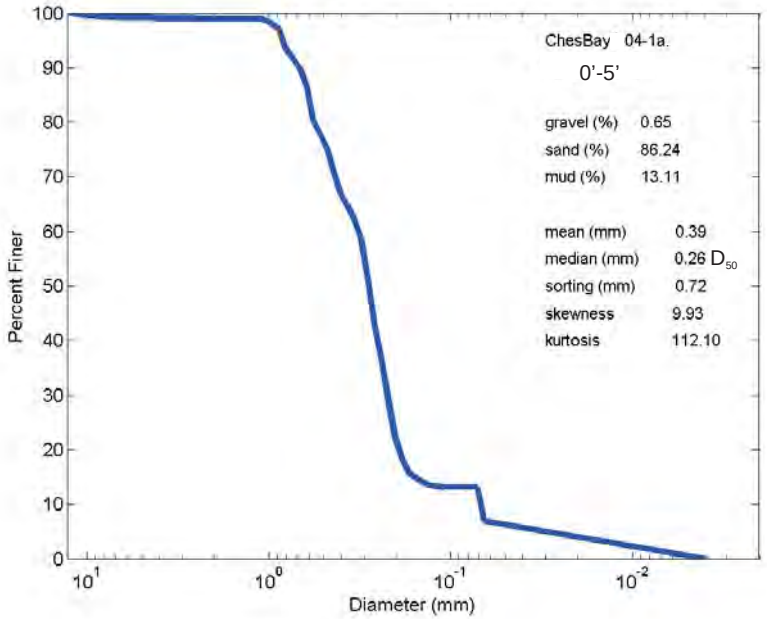

ChesBay-02-3a.
10'-15'
gravel (%) 0.00
sand (%) 7.32
mud (%) 92.68
mean (mm) 0.05
median (mm) 0.07 D_{50}
sorting (mm) 0.12
skewness 19.75
kurtosis 472.63
Percent Finer
Diameter (mm)

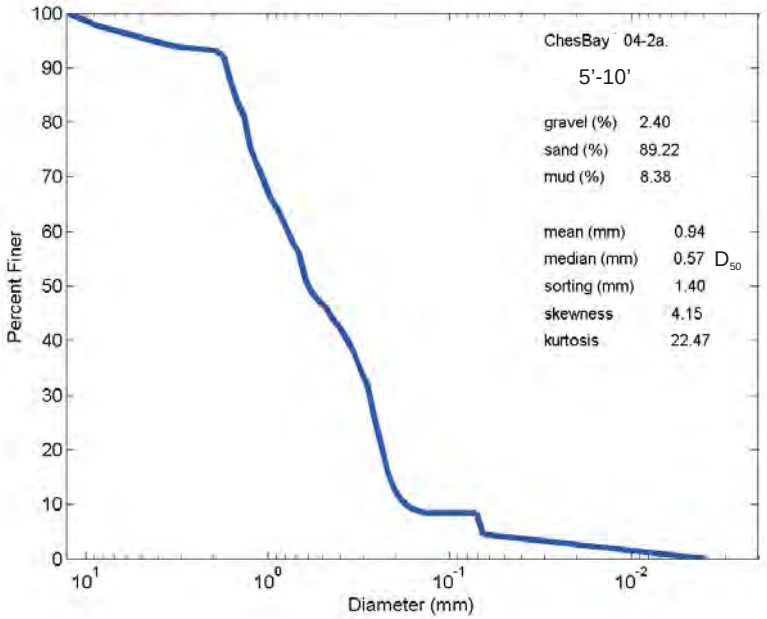

ChesBay-02-4a.
15'-20'
gravel (%) 0.00
sand (%) 8.92
mud (%) 91.08
mean (mm) 0.05
median (mm) 0.07 D50
sorting (mm) 0.08
skewness 32.96
kurtosis 1388.88
Percent Finer
Diameter (mm)

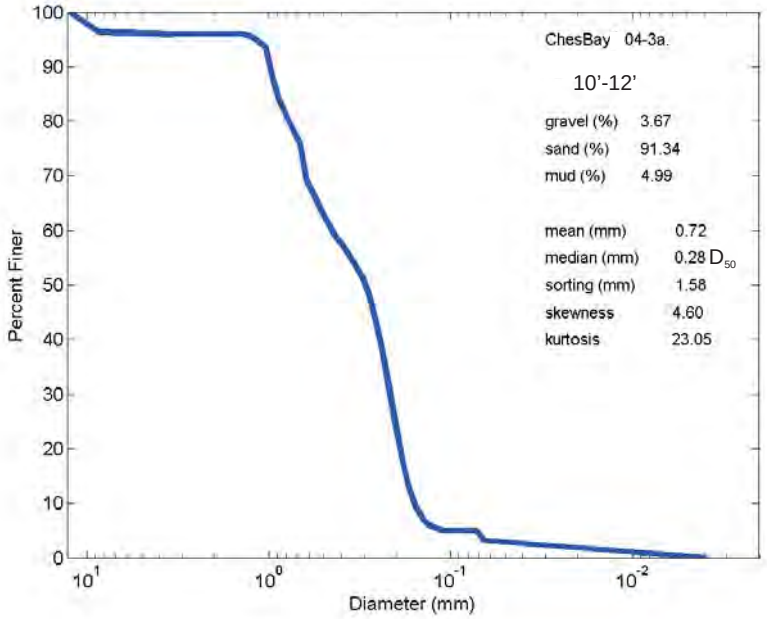

ChesBay-02-5a.
20'-21.2'
gravel (%) 0.00
sand (%) 27.33
mud (%) 72.67
mean (mm) 0.05
median (mm) 0.07 D50
sorting (mm) 0.05
skewness 2.56
kurtosis 20.51
Percent Finer
Diameter (mm)

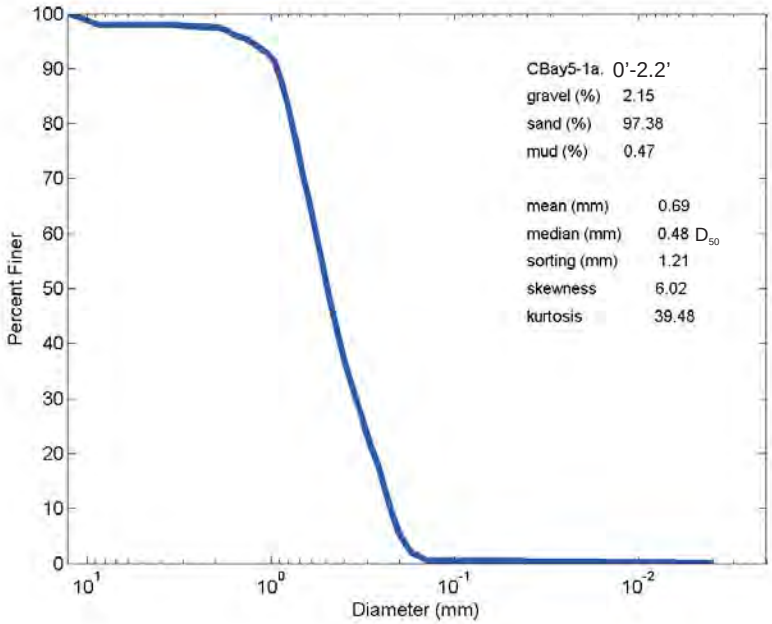

CBay3-1a. 0'-5'
gravel (%) 0.40
sand (%) 97.10
mud (%) 2.50
mean (mm) 0.33
median (mm) 0.28 D50
sorting (mm) 0.54
skewness 14.57
kurtosis 224.00
Percent Finer
Diameter (mm)

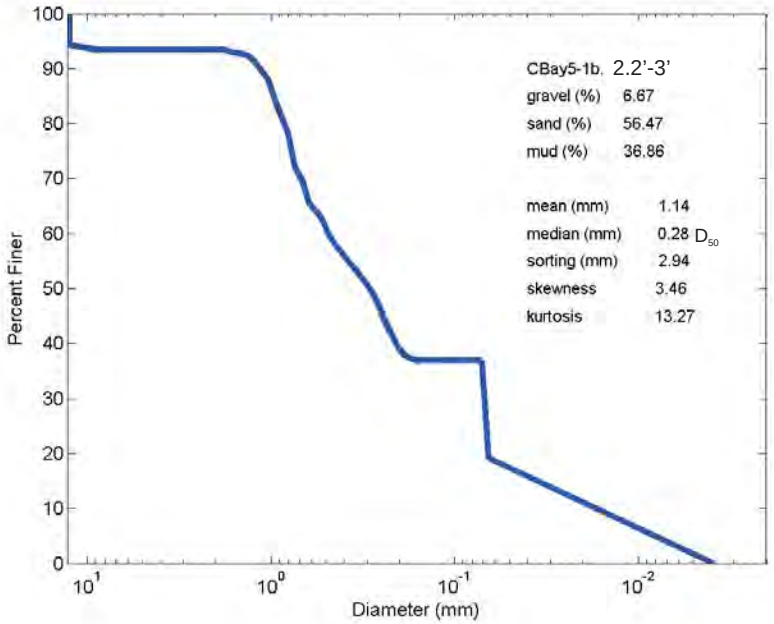

CBay3-2a. 5'-10'
gravel (%) 1.18
sand (%) 95.69
mud (%) 3.13
mean (mm) 0.54
median (mm) 0.37 D50
sorting (mm) 0.91
skewness 8.15
kurtosis 72.02
Percent Finer
Diameter (mm)

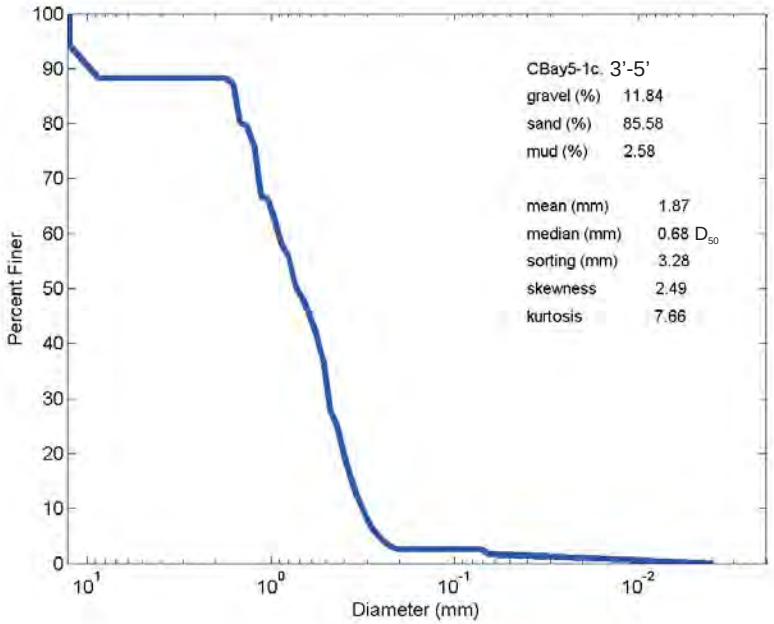

ChesBay 04-1a.
0'-5'
gravel (%) 0.65
sand (%) 86.24
mud (%) 13.11
mean (mm) 0.39
median (mm) 0.26 D50
sorting (mm) 0.72
skewness 9.93
kurtosis 112.10
Percent Finer
Diameter (mm)

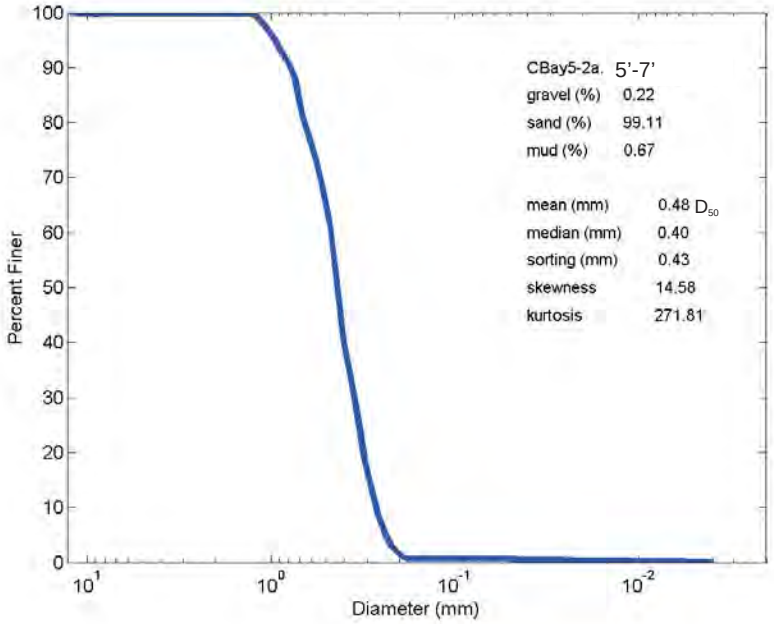

ChesBay 04-2a.
5'-10'
gravel (%) 2.40
sand (%) 89.22
mud (%) 8.38
mean (mm) 0.94
median (mm) 0.57 D50
sorting (mm) 1.40
skewness 4.15
kurtosis 22.47
Percent Finer
Diameter (mm)

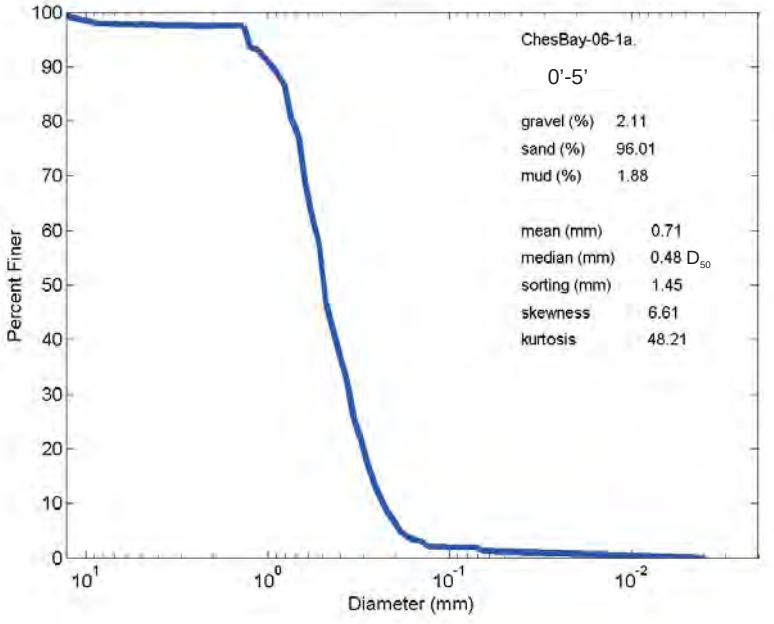

ChesBay 04-3a.
10'-12'
gravel (%) 3.67
sand (%) 91.34
mud (%) 4.99
mean (mm) 0.72
median (mm) 0.28 D50
sorting (mm) 1.58
skewness 4.60
kurtosis 23.05
Percent Finer
Diameter (mm)

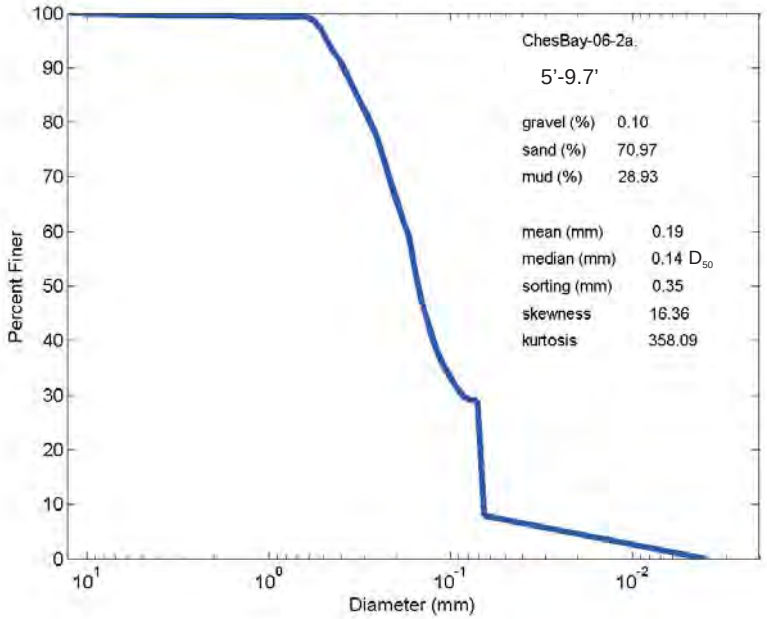

CBay5-1a. 0'-2.2'
gravel (%) 2.15
sand (%) 97.38
mud (%) 0.47
mean (mm) 0.69
median (mm) 0.48 D50
sorting (mm) 1.21
skewness 6.02
kurtosis 39.48
Percent Finer
Diameter (mm)

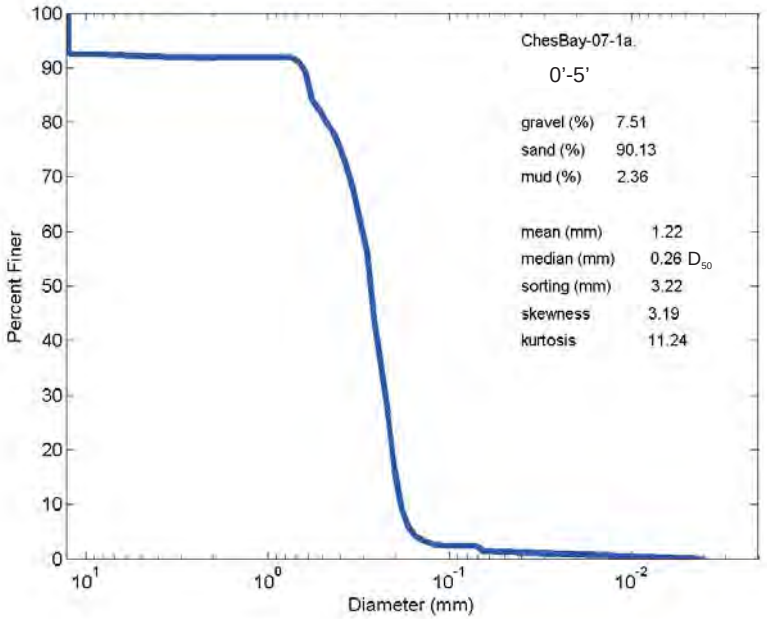

CBay5-1b. 2.2'-3'
gravel (%) 6.67
sand (%) 56.47
mud (%) 36.86
mean (mm) 1.14
median (mm) 0.28 D_{50}
sorting (mm) 2.94
skewness 3.46
kurtosis 13.27
Percent Finer
Diameter (mm)

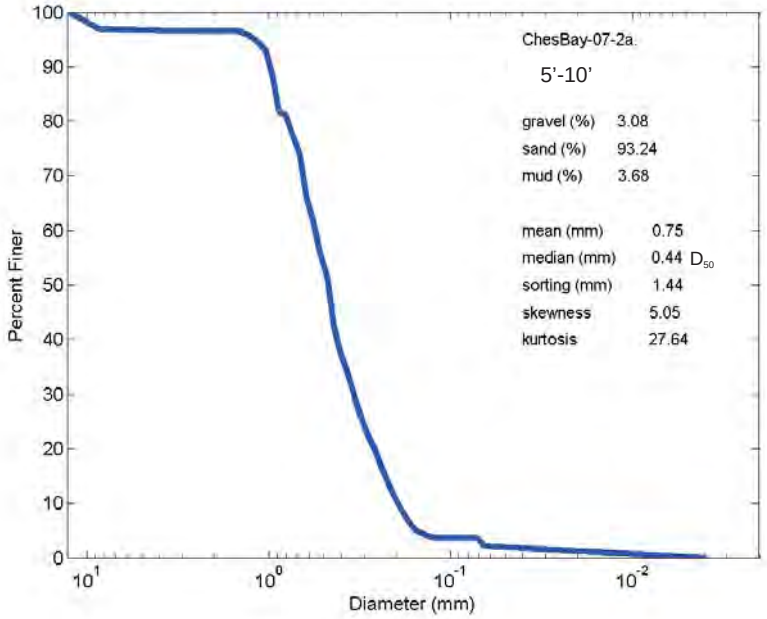

CBay5-1c. 3'-5'
gravel (%) 11.84
sand (%) 85.58
mud (%) 2.58
mean (mm) 1.87
median (mm) 0.68 D_{50}
sorting (mm) 3.28
skewness 2.49
kurtosis 7.66
Percent Finer
Diameter (mm)

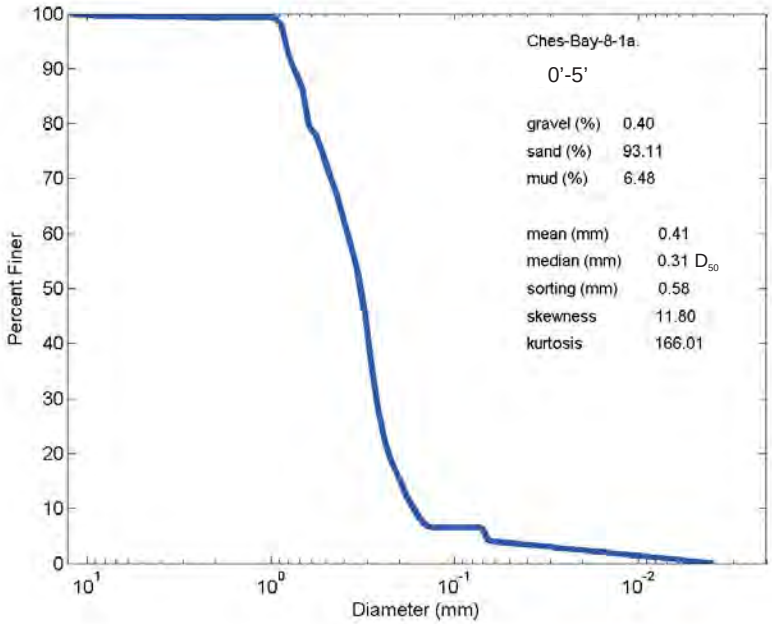

CBay5-2a. 5'-7'
gravel (%) 0.22
sand (%) 99.11
mud (%) 0.67
mean (mm) 0.48 D_{50}
median (mm) 0.40
sorting (mm) 0.43
skewness 14.58
kurtosis 271.81
Percent Finer
Diameter (mm)

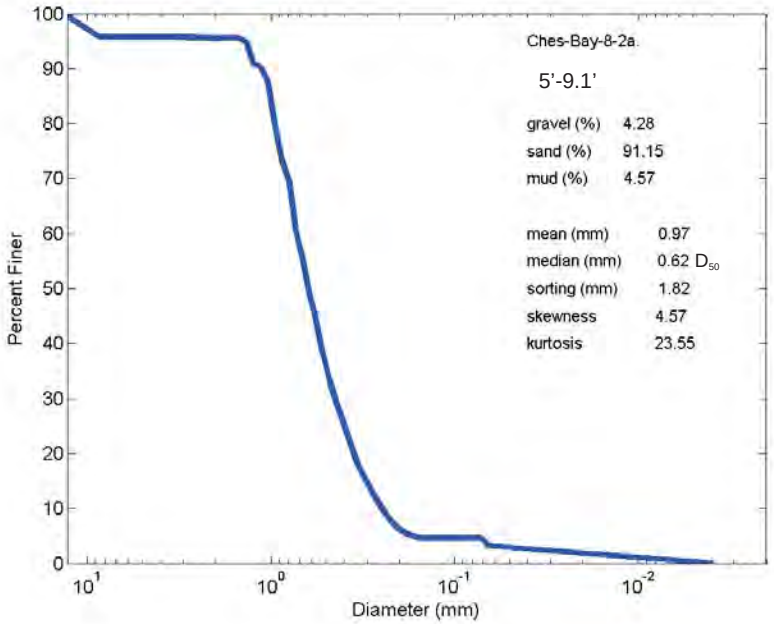

ChesBay-06-1a.
0'-5'
gravel (%) 2.11
sand (%) 96.01
mud (%) 1.88
mean (mm) 0.71
median (mm) 0.48 D_{50}
sorting (mm) 1.45
skewness 6.61
kurtosis 48.21
Percent Finer
Diameter (mm)

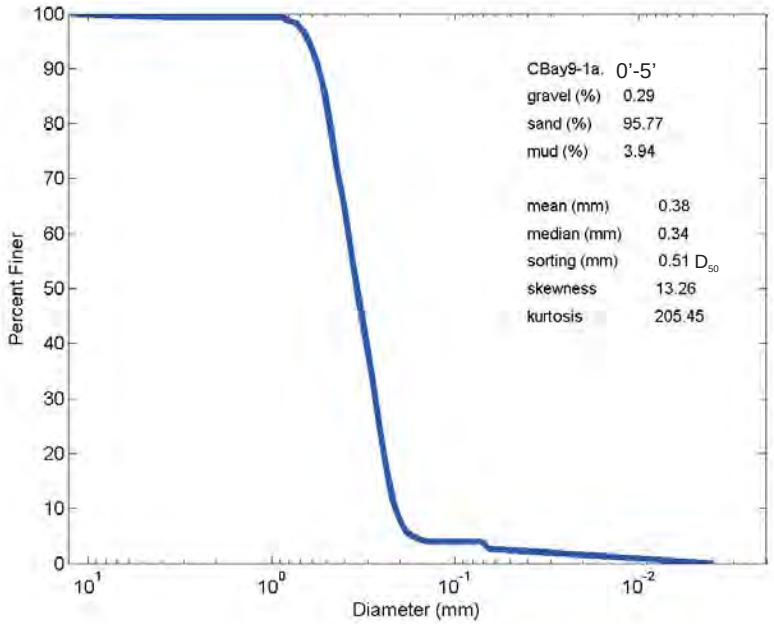

ChesBay-06-2a.
5'-9.7'
gravel (%) 0.10
sand (%) 70.97
mud (%) 28.93
mean (mm) 0.19
median (mm) 0.14 D50
sorting (mm) 0.35
skewness 16.36
kurtosis 358.09
Percent Finer
Diameter (mm)

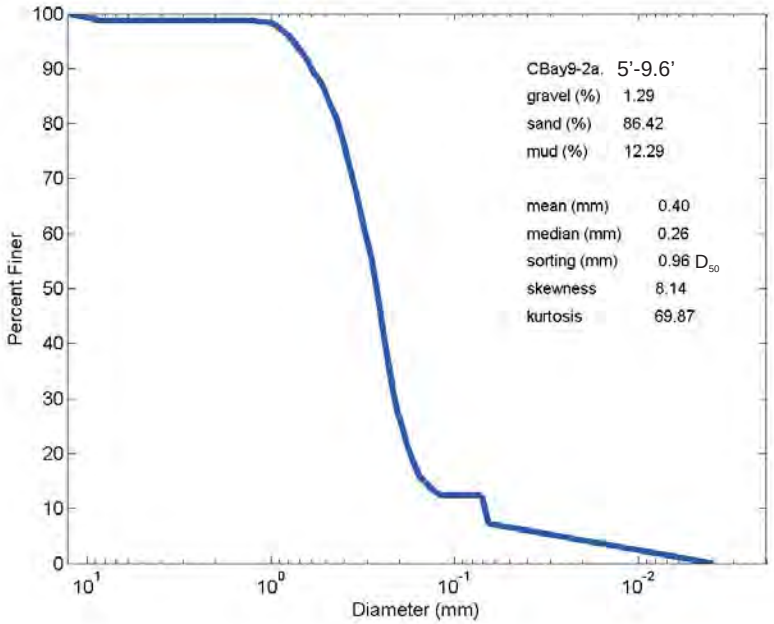

ChesBay-07-1a.
0'-5'
gravel (%) 7.51
sand (%) 90.13
mud (%) 2.36
mean (mm) 1.22
median (mm) 0.26 D50
sorting (mm) 3.22
skewness 3.19
kurtosis 11.24
Percent Finer
Diameter (mm)

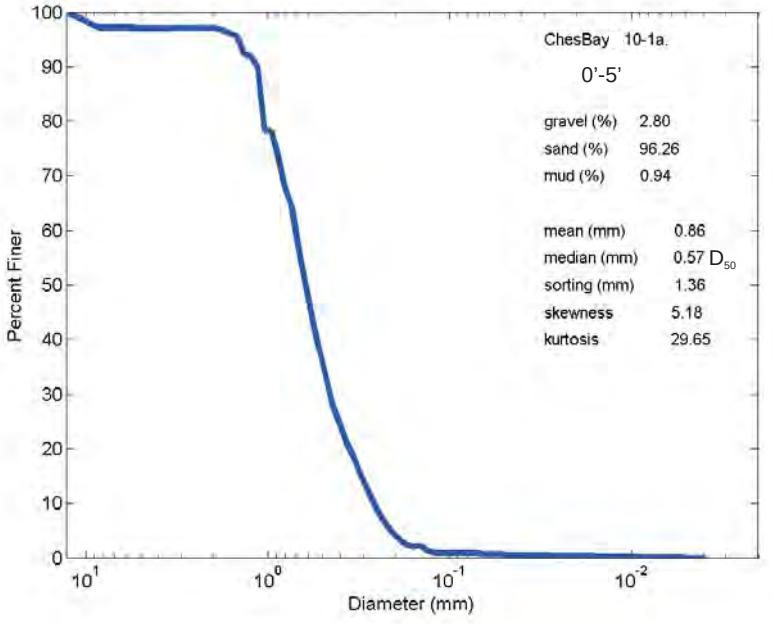

ChesBay-07-2a.
5'-10'
gravel (%) 3.08
sand (%) 93.24
mud (%) 3.68
mean (mm) 0.75
median (mm) 0.44 D50
sorting (mm) 1.44
skewness 5.05
kurtosis 27.64
Percent Finer
Diameter (mm)

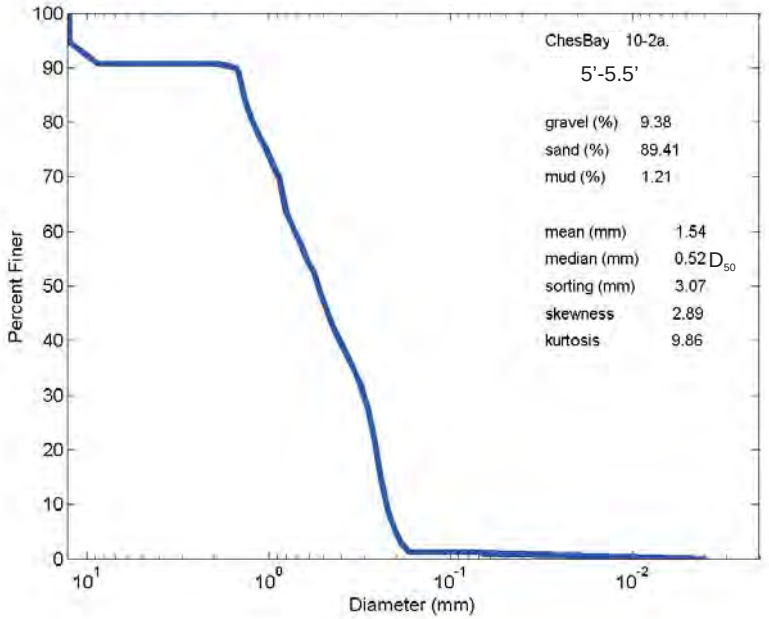

Ches-Bay-8-1a.
0'-5'
gravel (%) 0.40
sand (%) 93.11
mud (%) 6.48
mean (mm) 0.41
median (mm) 0.31 D50
sorting (mm) 0.58
skewness 11.80
kurtosis 166.01
Percent Finer
Diameter (mm)

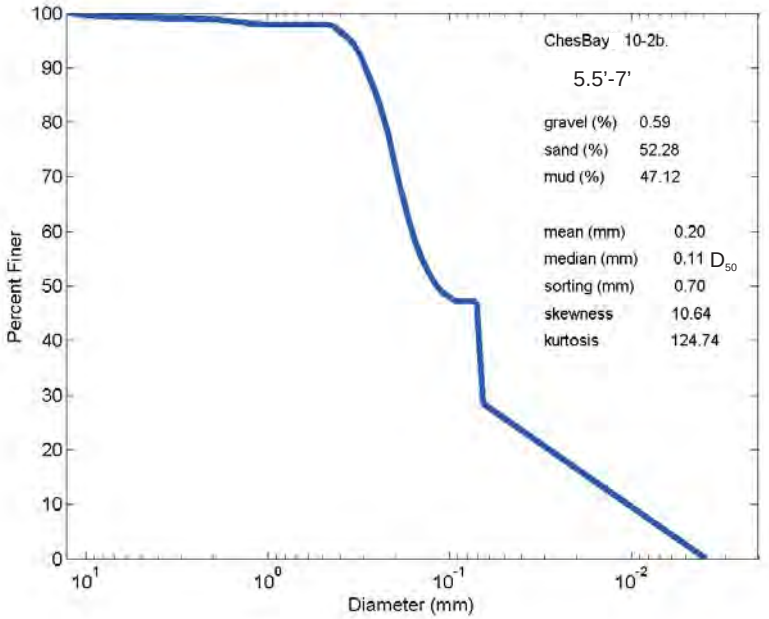

Ches-Bay-8-2a.
5'-9.1'
gravel (%) 4.28
sand (%) 91.15
mud (%) 4.57
mean (mm) 0.97
median (mm) 0.62 D_{50}
sorting (mm) 1.82
skewness 4.57
kurtosis 23.55
Percent Finer
Diameter (mm)

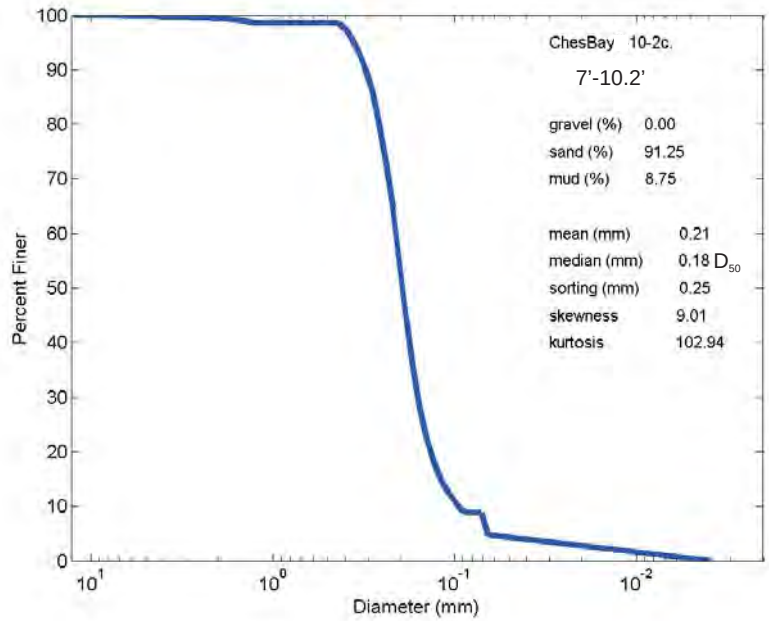

CBay9-1a. 0'-5'
gravel (%) 0.29
sand (%) 95.77
mud (%) 3.94
mean (mm) 0.38
median (mm) 0.34
sorting (mm) 0.51 D_{50}
skewness 13.26
kurtosis 205.45
Percent Finer
Diameter (mm)

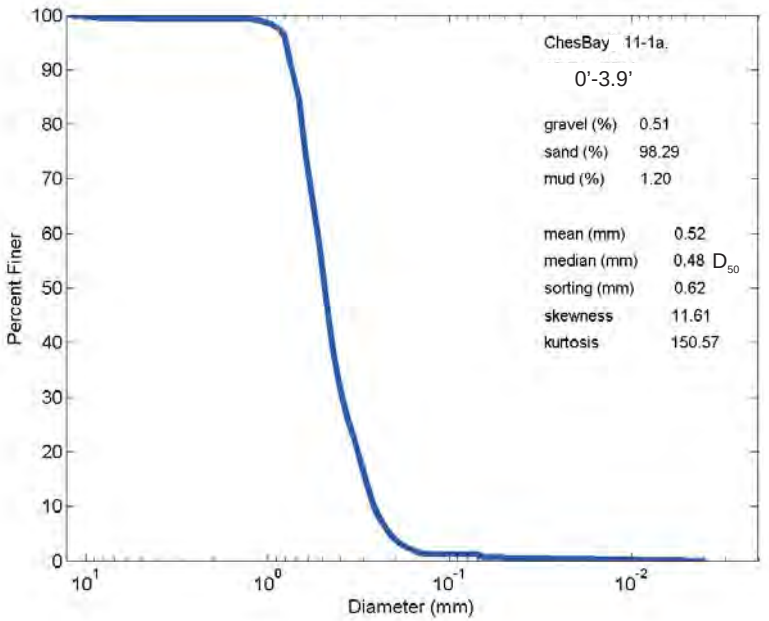

CBay9-2a. 5'-9.6'
gravel (%) 1.29
sand (%) 86.42
mud (%) 12.29
mean (mm) 0.40
median (mm) 0.26
sorting (mm) 0.96 D_{50}
skewness 8.14
kurtosis 69.87
Percent Finer
Diameter (mm)

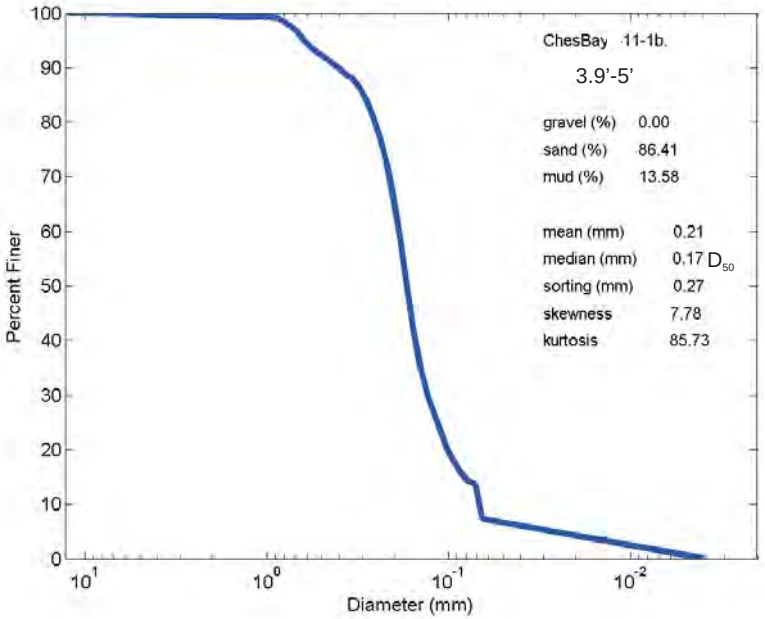

ChesBay 10-1a.
0'-5'
gravel (%) 2.80
sand (%) 96.26
mud (%) 0.94
mean (mm) 0.86
median (mm) 0.57 D_{50}
sorting (mm) 1.36
skewness 5.18
kurtosis 29.65
Percent Finer
Diameter (mm)

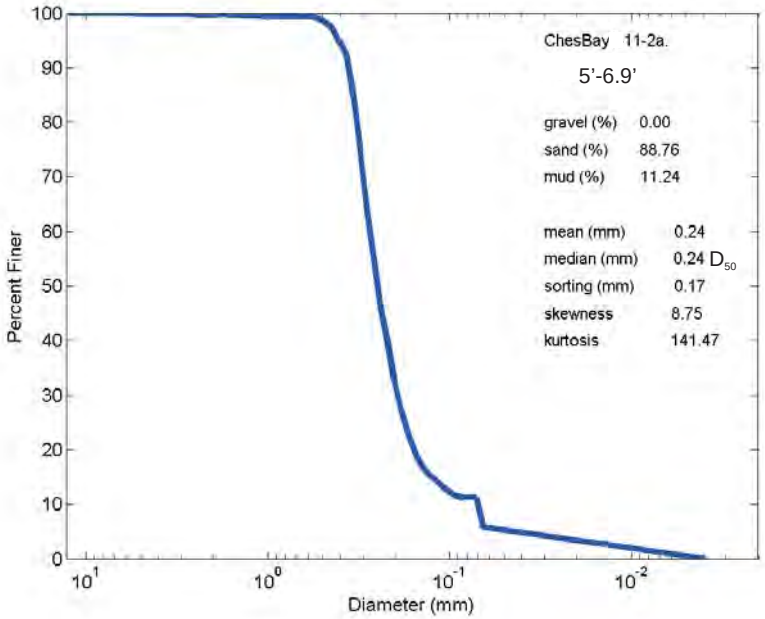

ChesBay 10-2a.
5'-5.5'
gravel (%) 9.38
sand (%) 89.41
mud (%) 1.21
mean (mm) 1.54
median (mm) 0.52 D_{50}
sorting (mm) 3.07
skewness 2.89
kurtosis 9.86
Percent Finer
Diameter (mm)

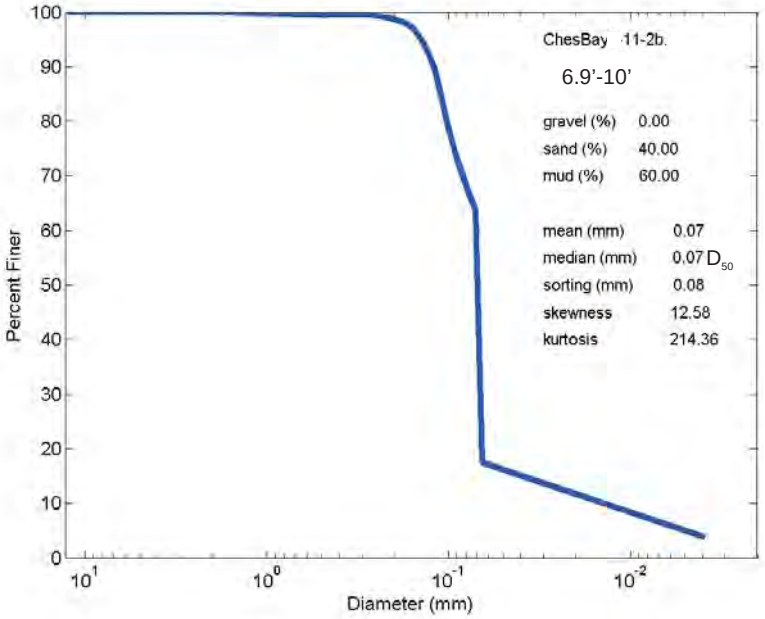

ChesBay 10-2b.
5.5'-7'
gravel (%) 0.59
sand (%) 52.28
mud (%) 47.12
mean (mm) 0.20
median (mm) 0.11 D_{50}
sorting (mm) 0.70
skewness 10.64
kurtosis 124.74
Percent Finer
Diameter (mm)

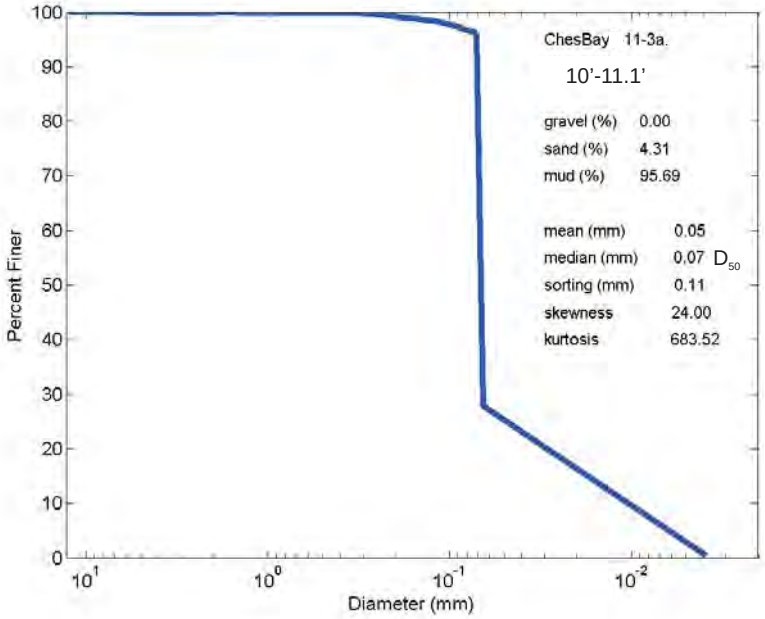

ChesBay 10-2c.
7'-10.2'
gravel (%) 0.00
sand (%) 91.25
mud (%) 8.75
mean (mm) 0.21
median (mm) 0.18 D_{50}
sorting (mm) 0.25
skewness 9.01
kurtosis 102.94
Percent Finer
Diameter (mm)

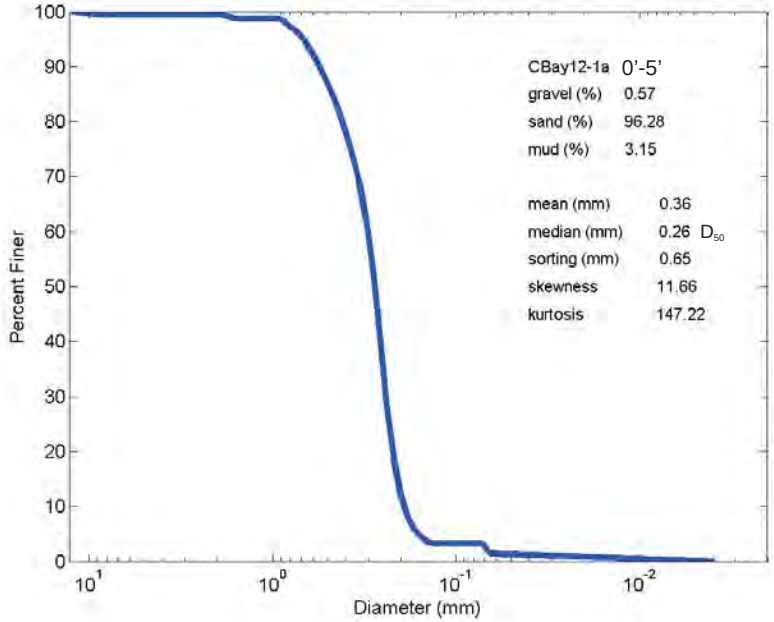

ChesBay 11-1a.
0'-3.9'
gravel (%) 0.51
sand (%) 98.29
mud (%) 1.20
mean (mm) 0.52
median (mm) 0.48 D_{50}
sorting (mm) 0.62
skewness 11.61
kurtosis 150.57
Percent Finer
Diameter (mm)

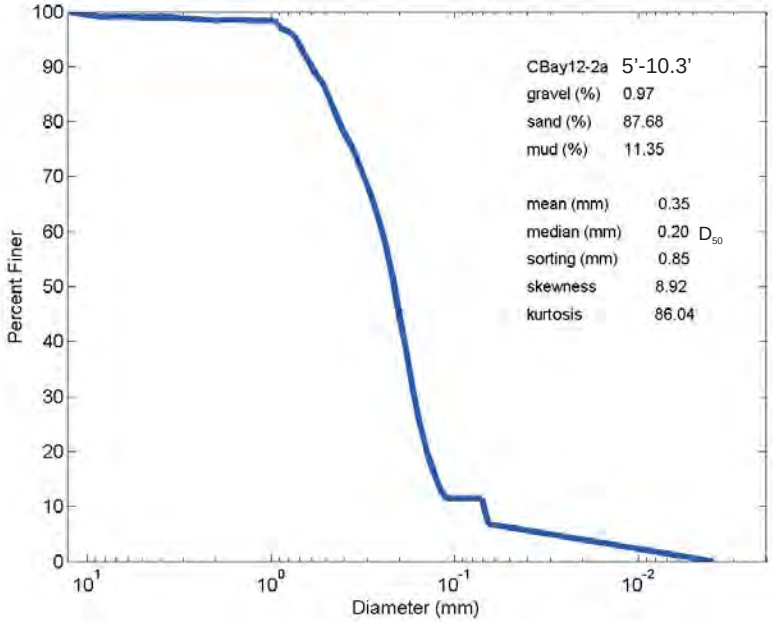

ChesBay 11-1b.
3.9'-5'
gravel (%) 0.00
sand (%) 86.41
mud (%) 13.58
mean (mm) 0.21
median (mm) 0.17 D50
sorting (mm) 0.27
skewness 7.78
kurtosis 85.73
Percent Finer
Diameter (mm)

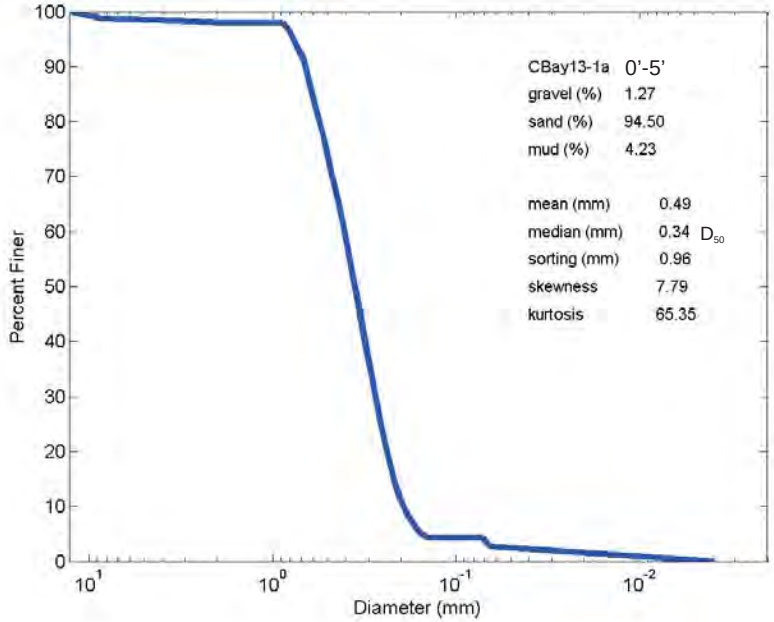

ChesBay 11-2a.
5'-6.9'
gravel (%) 0.00
sand (%) 88.76
mud (%) 11.24
mean (mm) 0.24
median (mm) 0.24 D50
sorting (mm) 0.17
skewness 8.75
kurtosis 141.47
Percent Finer
Diameter (mm)

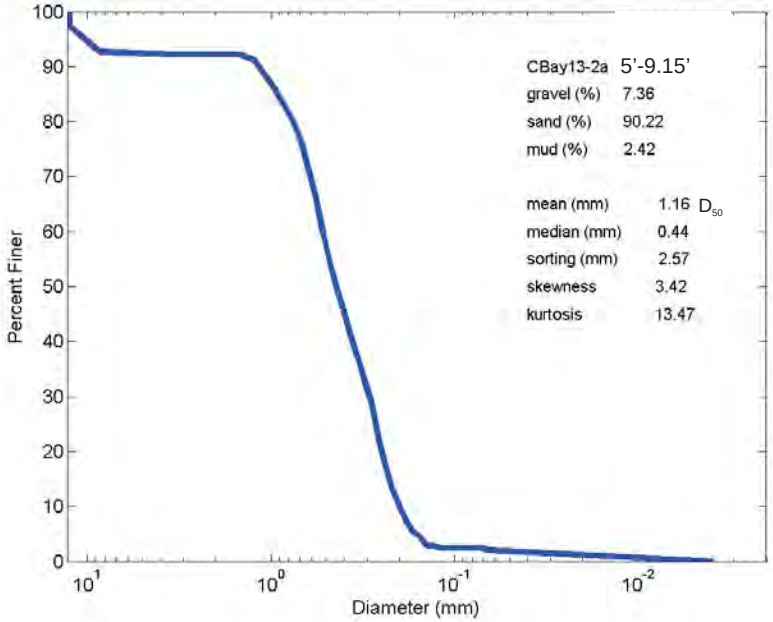

ChesBay 11-2b.
6.9'-10'
gravel (%) 0.00
sand (%) 40.00
mud (%) 60.00
mean (mm) 0.07
median (mm) 0.07 D50
sorting (mm) 0.08
skewness 12.58
kurtosis 214.36
Percent Finer
Diameter (mm)

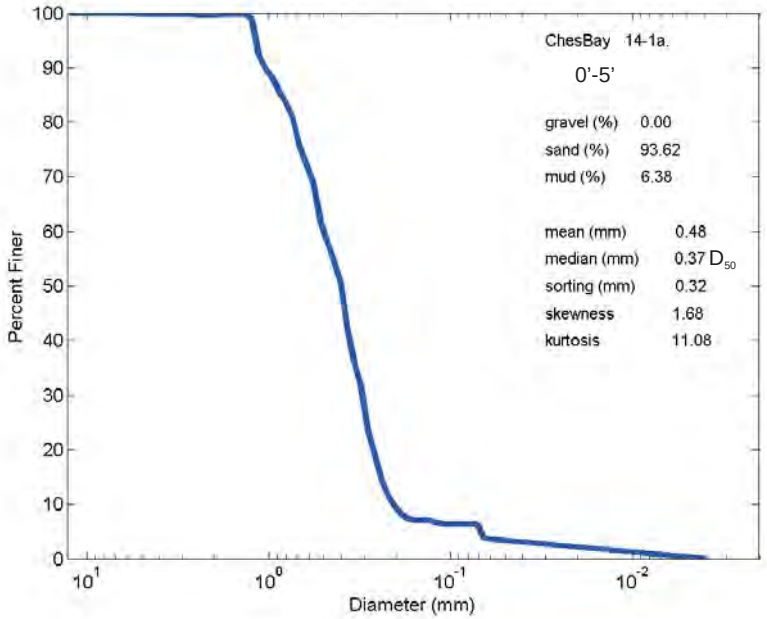

ChesBay 11-3a.
10'-11.1'
gravel (%) 0.00
sand (%) 4.31
mud (%) 95.69
mean (mm) 0.05
median (mm) 0.07 D50
sorting (mm) 0.11
skewness 24.00
kurtosis 683.52
Percent Finer
Diameter (mm)

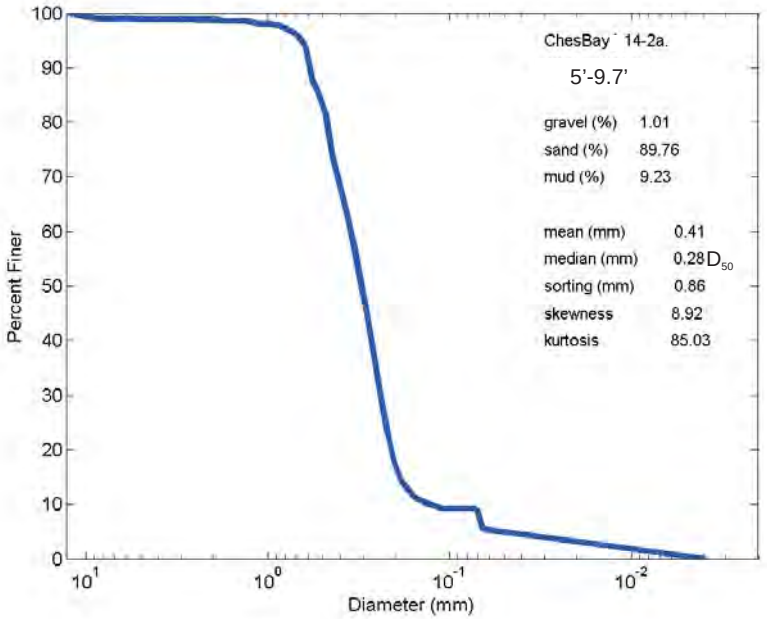

CBay12-1a 0'-5'
gravel (%) 0.57
sand (%) 96.28
mud (%) 3.15
mean (mm) 0.36
median (mm) 0.26 D50
sorting (mm) 0.65
skewness 11.66
kurtosis 147.22
Percent Finer
Diameter (mm)

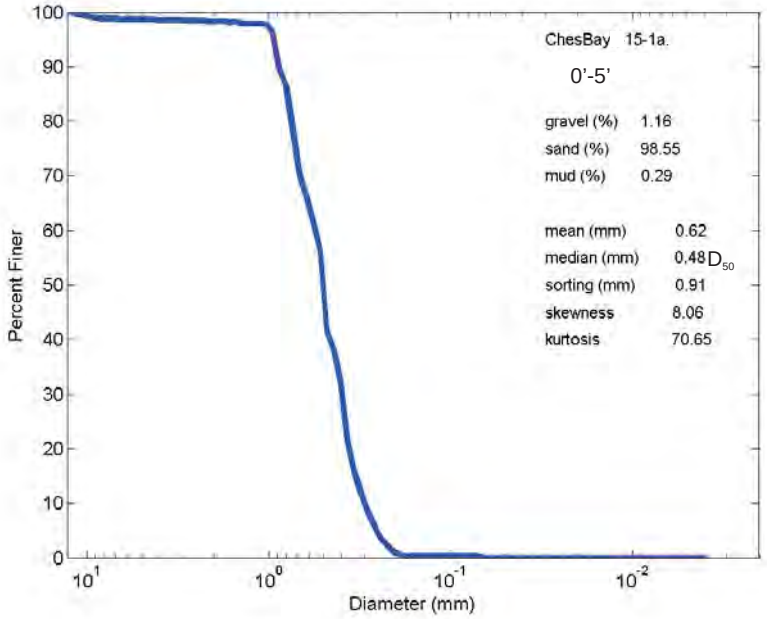

CBay12-2a 5'-10.3'
gravel (%) 0.97
sand (%) 87.68
mud (%) 11.35
mean (mm) 0.35
median (mm) 0.20 D50
sorting (mm) 0.85
skewness 8.92
kurtosis 86.04
Percent Finer
Diameter (mm)

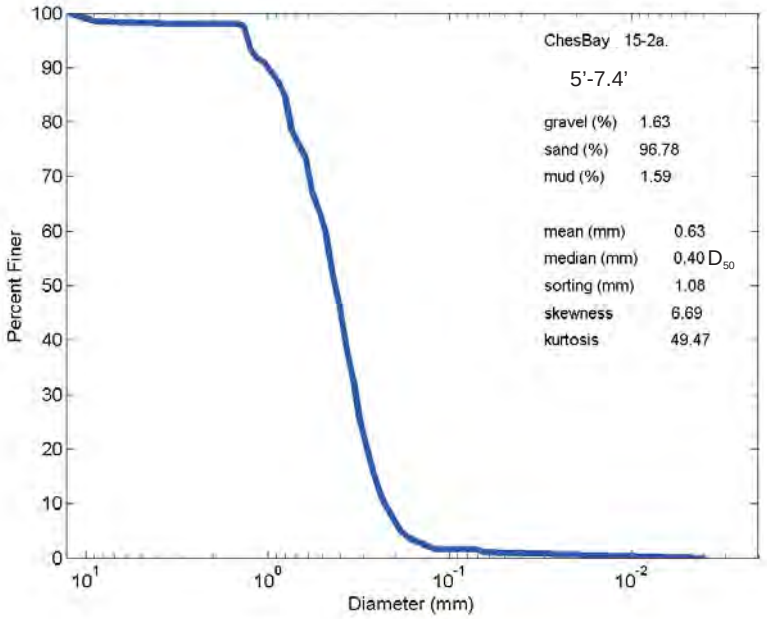

CBay13-1a 0'-5'
gravel (%) 1.27
sand (%) 94.50
mud (%) 4.23
mean (mm) 0.49
median (mm) 0.34 D50
sorting (mm) 0.96
skewness 7.79
kurtosis 65.35
Percent Finer
Diameter (mm)

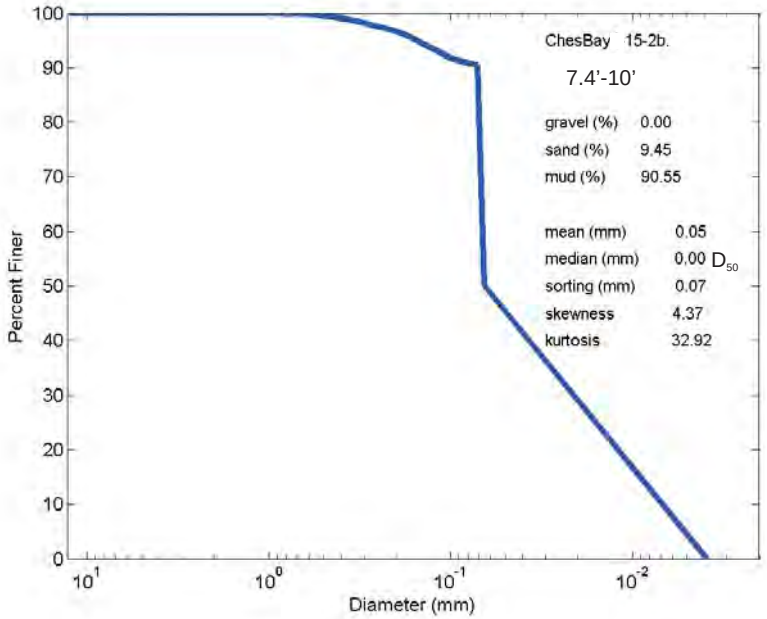

CBay13-2a 5'-9.15'
gravel (%) 7.36
sand (%) 90.22
mud (%) 2.42
mean (mm) 1.16 D50
median (mm) 0.44
sorting (mm) 2.57
skewness 3.42
kurtosis 13.47
Percent Finer
Diameter (mm)

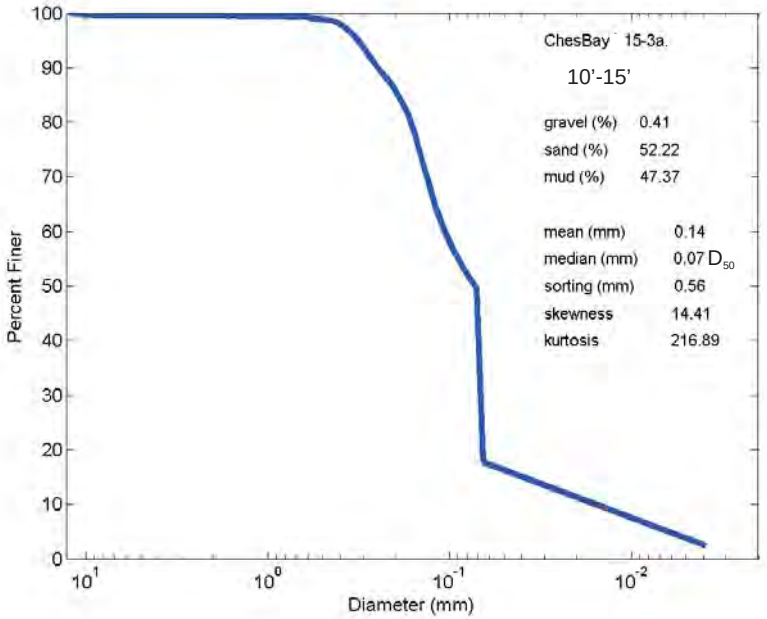

ChesBay 14-1a.
0'-5'
gravel (%) 0.00
sand (%) 93.62
mud (%) 6.38
mean (mm) 0.48
median (mm) 0.37 D50
sorting (mm) 0.32
skewness 1.68
kurtosis 11.08
Percent Finer
Diameter (mm)

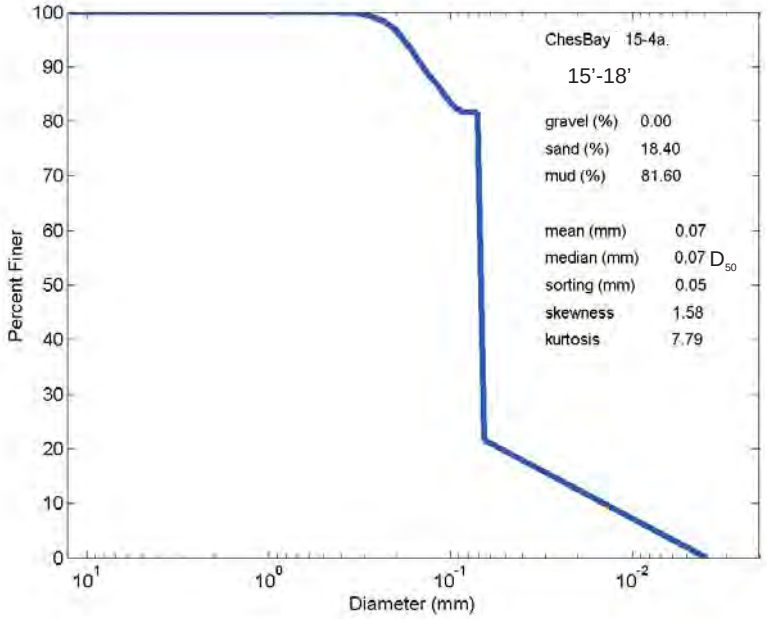

ChesBay 14-2a.
5'-9.7'
gravel (%) 1.01
sand (%) 89.76
mud (%) 9.23
mean (mm) 0.41
median (mm) 0.28 D50
sorting (mm) 0.86
skewness 8.92
kurtosis 85.03
Percent Finer
Diameter (mm)

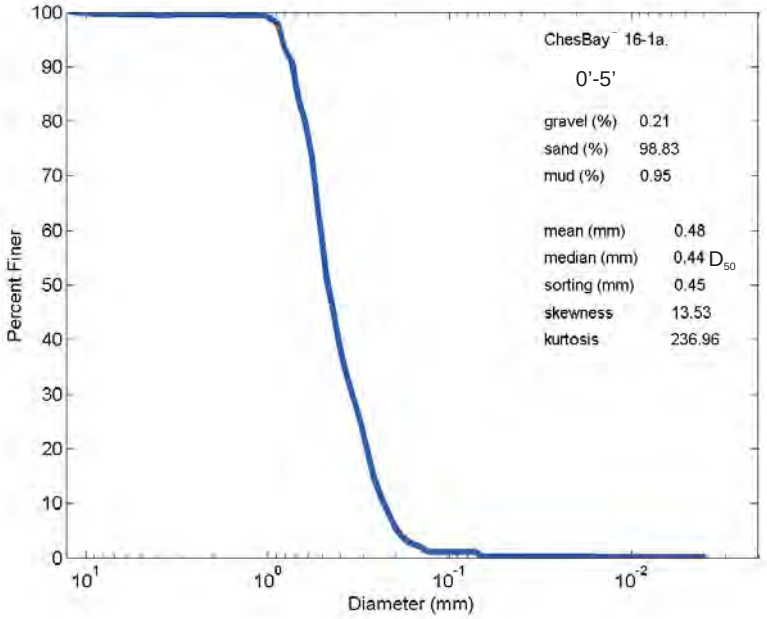

ChesBay 15-1a.
0'-5'
gravel (%) 1.16
sand (%) 98.55
mud (%) 0.29
mean (mm) 0.62
median (mm) 0.48 D50
sorting (mm) 0.91
skewness 8.06
kurtosis 70.65
Percent Finer
Diameter (mm)

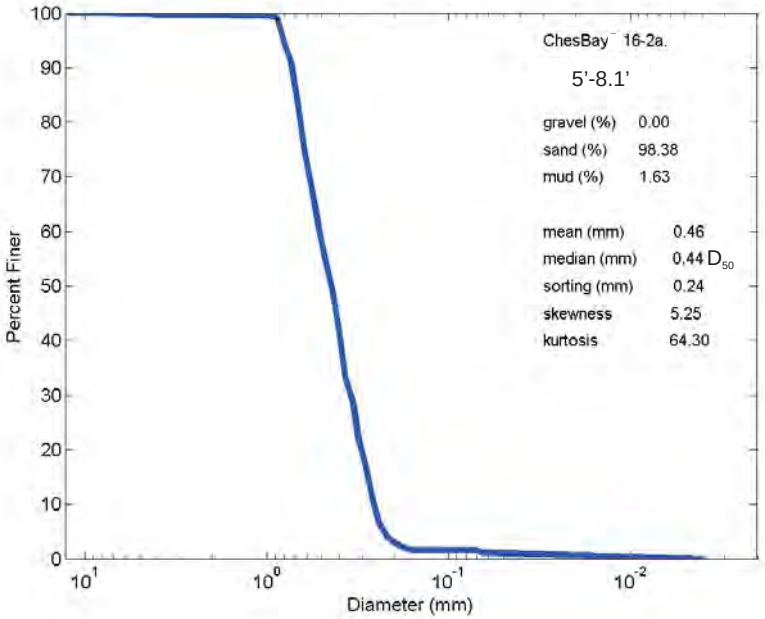

ChesBay 15-2a.
5'-7.4'
gravel (%) 1.63
sand (%) 96.78
mud (%) 1.59
mean (mm) 0.63
median (mm) 0.40 D50
sorting (mm) 1.08
skewness 6.69
kurtosis 49.47
Percent Finer
Diameter (mm)

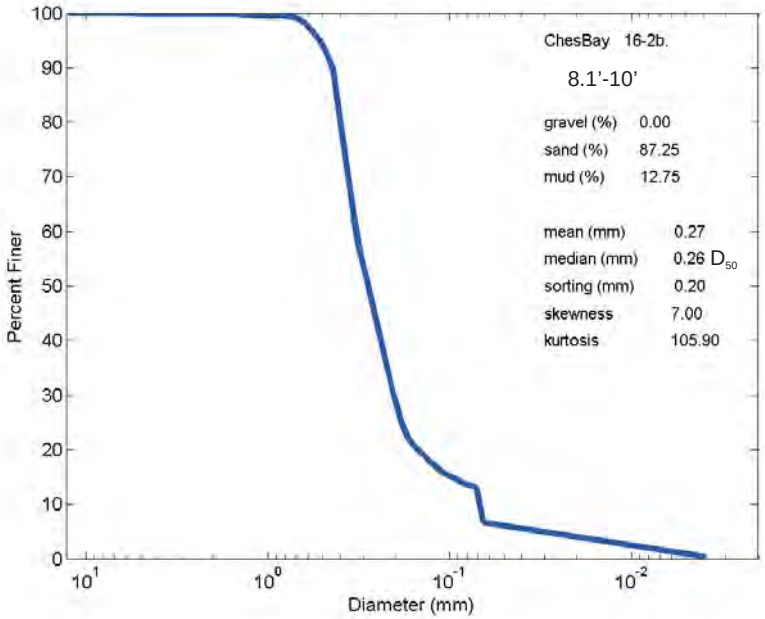

ChesBay 15-2b.
7.4'-10'
gravel (%) 0.00
sand (%) 9.45
mud (%) 90.55
mean (mm) 0.05
median (mm) 0.00 D50
sorting (mm) 0.07
skewness 4.37
kurtosis 32.92
Percent Finer
Diameter (mm)

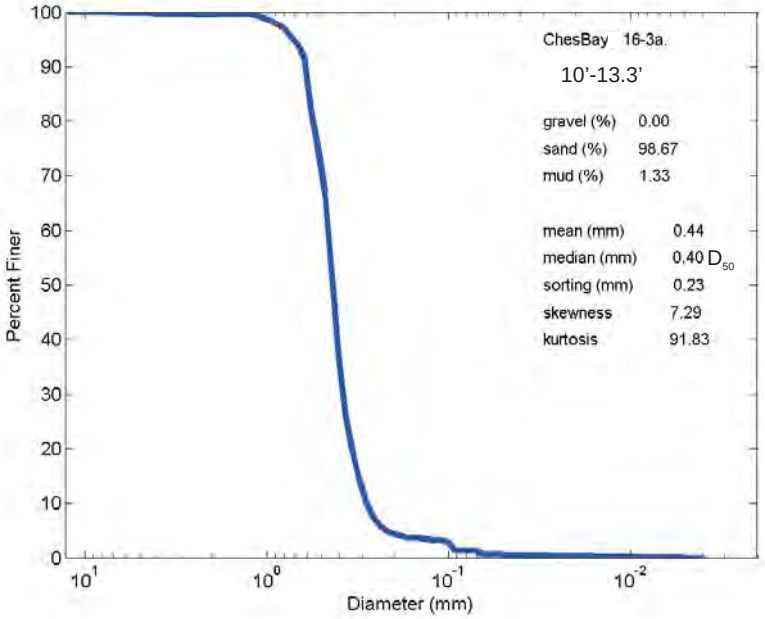

ChesBay 15-3a.
10'-15'
gravel (%) 0.41
sand (%) 52.22
mud (%) 47.37
mean (mm) 0.14
median (mm) 0.07 D50
sorting (mm) 0.56
skewness 14.41
kurtosis 216.89
Percent Finer
Diameter (mm)

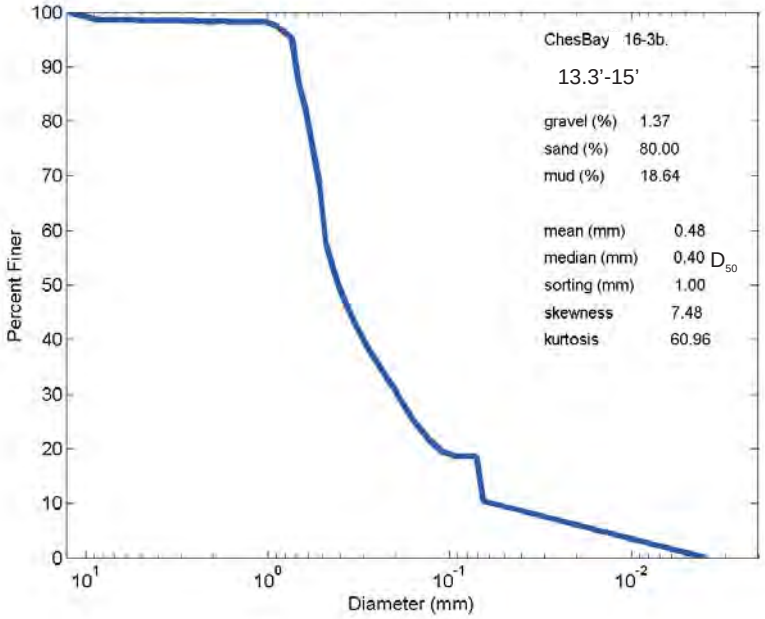

ChesBay 15-4a.
15'-18'
gravel (%) 0.00
sand (%) 18.40
mud (%) 81.60
mean (mm) 0.07
median (mm) 0.07 D50
sorting (mm) 0.05
skewness 1.58
kurtosis 7.79
Percent Finer
Diameter (mm)

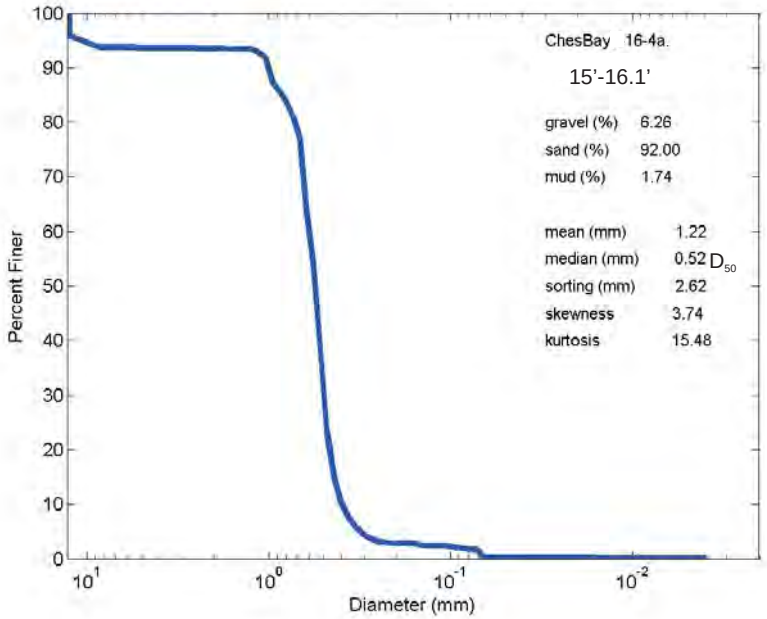

ChesBay 16-1a.
0'-5'
gravel (%) 0.21
sand (%) 98.83
mud (%) 0.95
mean (mm) 0.48
median (mm) 0.44 D50
sorting (mm) 0.45
skewness 13.53
kurtosis 236.96
Percent Finer
Diameter (mm)

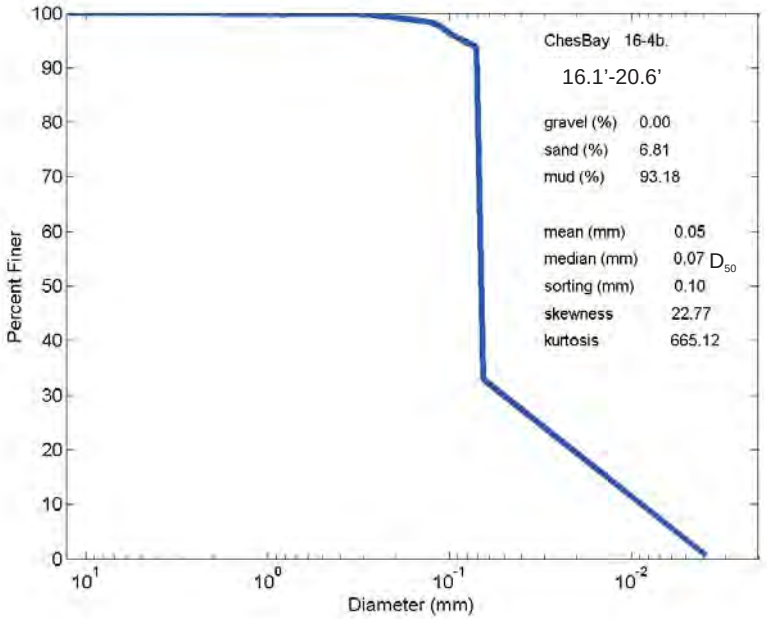

ChesBay 16-2a.
5'-8.1'
gravel (%) 0.00
sand (%) 98.38
mud (%) 1.63
mean (mm) 0.46
median (mm) 0.44 D_{50}
sorting (mm) 0.24
skewness 5.25
kurtosis 64.30
Percent Finer
Diameter (mm)

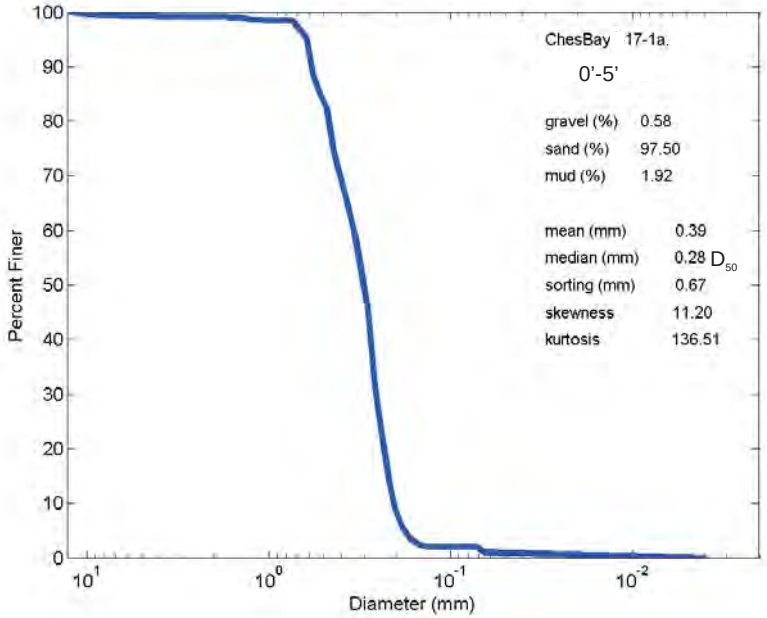

ChesBay 16-2b.
8.1'-10'
gravel (%) 0.00
sand (%) 87.25
mud (%) 12.75
mean (mm) 0.27
median (mm) 0.26 D_{50}
sorting (mm) 0.20
skewness 7.00
kurtosis 105.90
Percent Finer
Diameter (mm)

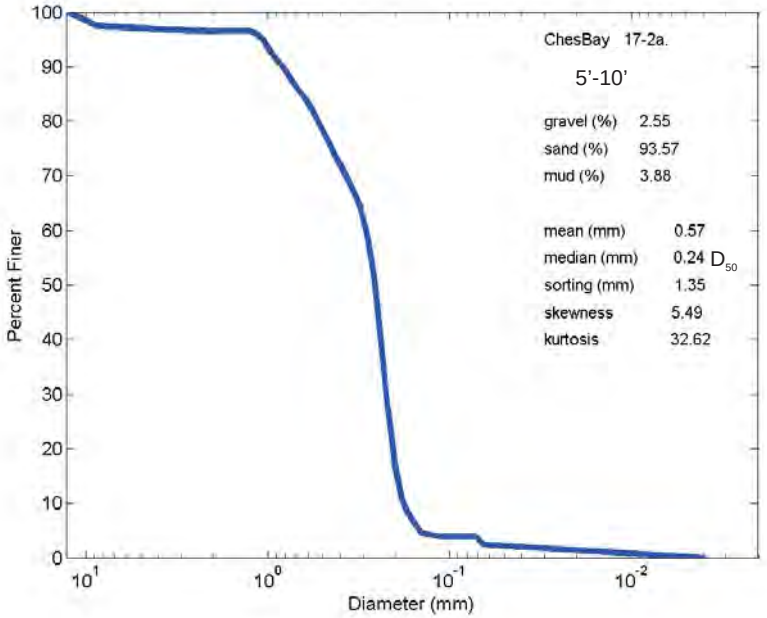

ChesBay 16-3a.
10'-13.3'
gravel (%) 0.00
sand (%) 98.67
mud (%) 1.33
mean (mm) 0.44
median (mm) 0.40 D_{50}
sorting (mm) 0.23
skewness 7.29
kurtosis 91.83
Percent Finer
Diameter (mm)

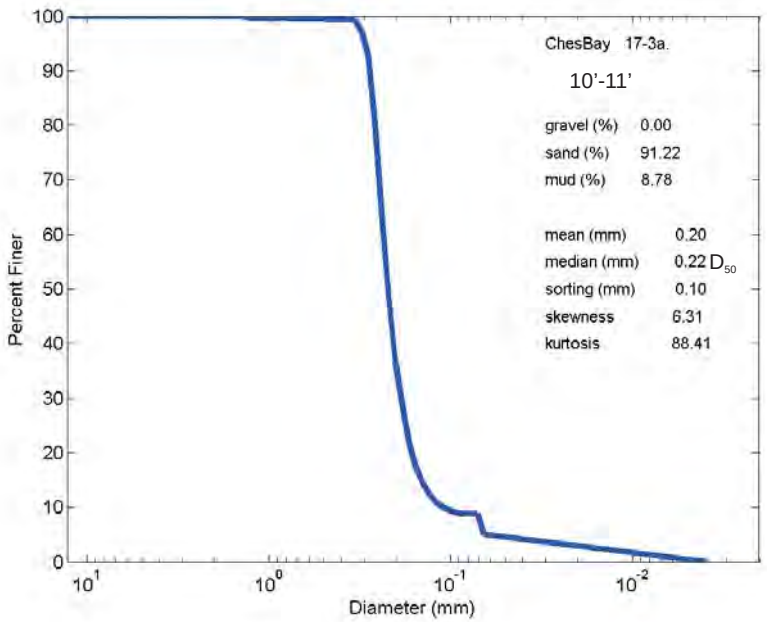

ChesBay 16-3b.
13.3'-15'
gravel (%) 1.37
sand (%) 80.00
mud (%) 18.64
mean (mm) 0.48
median (mm) 0.40 D_{50}
sorting (mm) 1.00
skewness 7.48
kurtosis 60.96
Percent Finer
Diameter (mm)

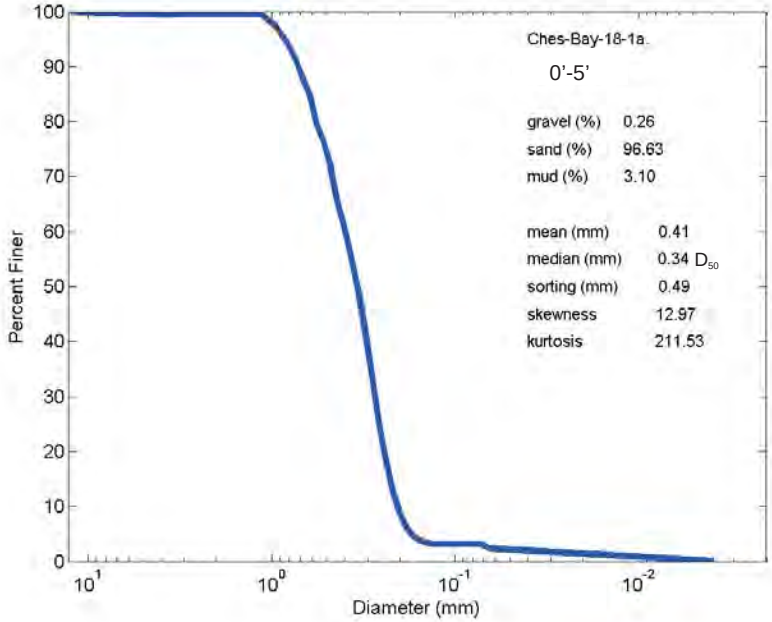

ChesBay 16-4a.
15'-16.1'
gravel (%) 6.26
sand (%) 92.00
mud (%) 1.74
mean (mm) 1.22
median (mm) 0.52 D50
sorting (mm) 2.62
skewness 3.74
kurtosis 15.48
Percent Finer
Diameter (mm)

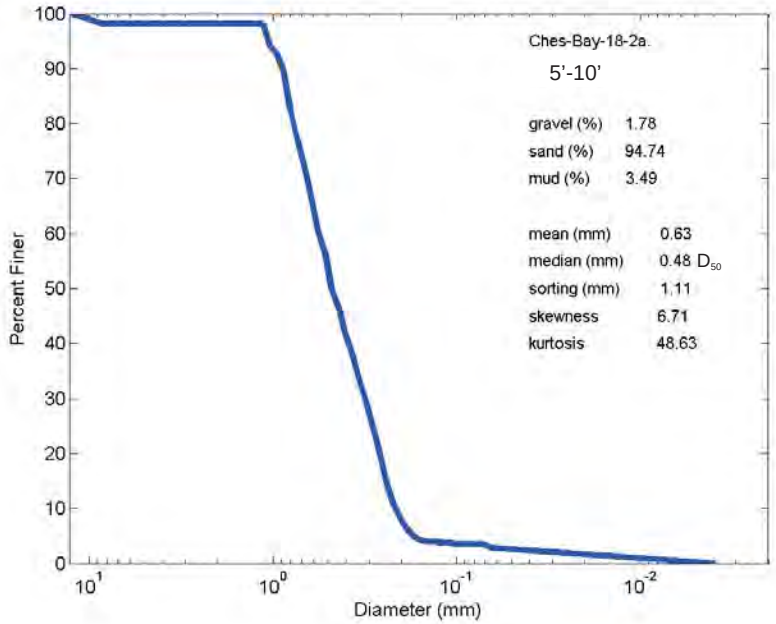

ChesBay 16-4b.
16.1'-20.6'
gravel (%) 0.00
sand (%) 6.81
mud (%) 93.18
mean (mm) 0.05
median (mm) 0.07 D50
sorting (mm) 0.10
skewness 22.77
kurtosis 665.12
Percent Finer
Diameter (mm)

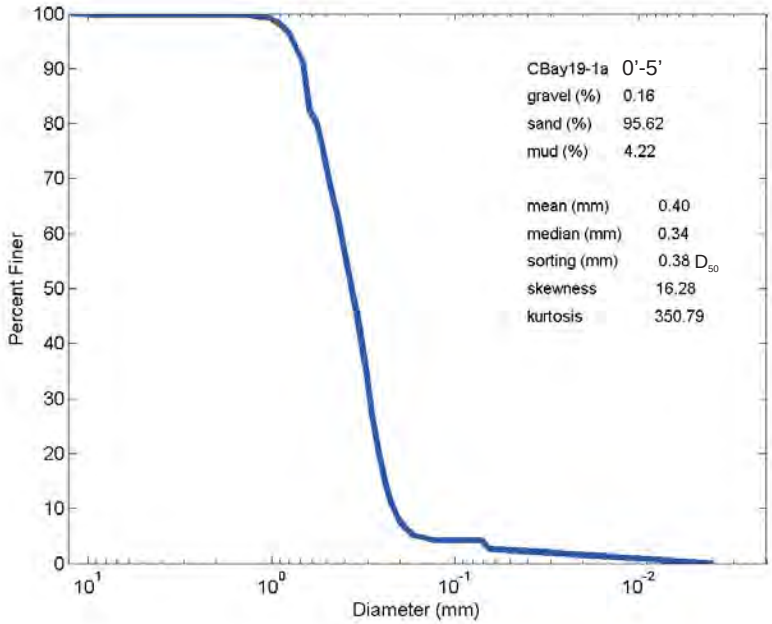

ChesBay 17-1a.
0'-5'
gravel (%) 0.58
sand (%) 97.50
mud (%) 1.92
mean (mm) 0.39
median (mm) 0.28 D50
sorting (mm) 0.67
skewness 11.20
kurtosis 136.51
Percent Finer
Diameter (mm)

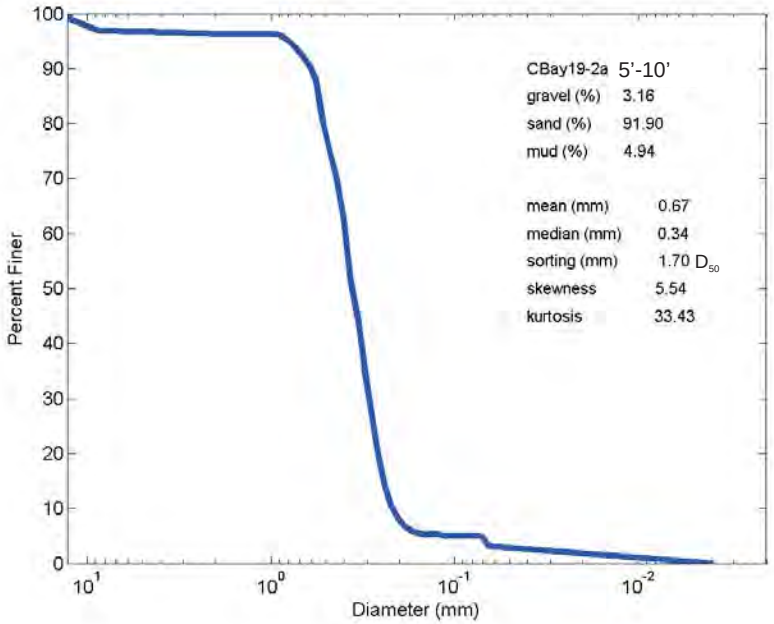

ChesBay 17-2a.
5'-10'
gravel (%) 2.55
sand (%) 93.57
mud (%) 3.88
mean (mm) 0.57
median (mm) 0.24 D50
sorting (mm) 1.35
skewness 5.49
kurtosis 32.62
Percent Finer
Diameter (mm)

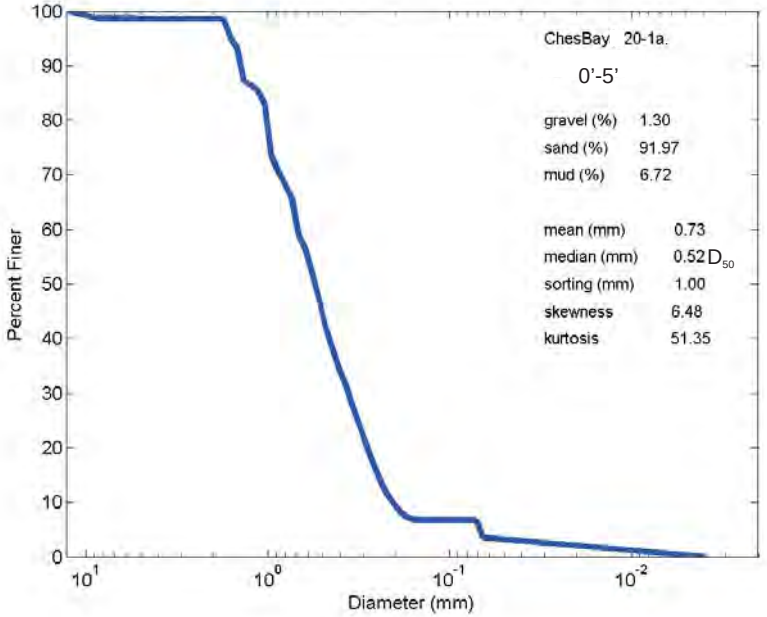

ChesBay 17-3a.
10'-11'
gravel (%) 0.00
sand (%) 91.22
mud (%) 8.78
mean (mm) 0.20
median (mm) 0.22 D_{50}
sorting (mm) 0.10
skewness 6.31
kurtosis 88.41
Percent Finer
Diameter (mm)

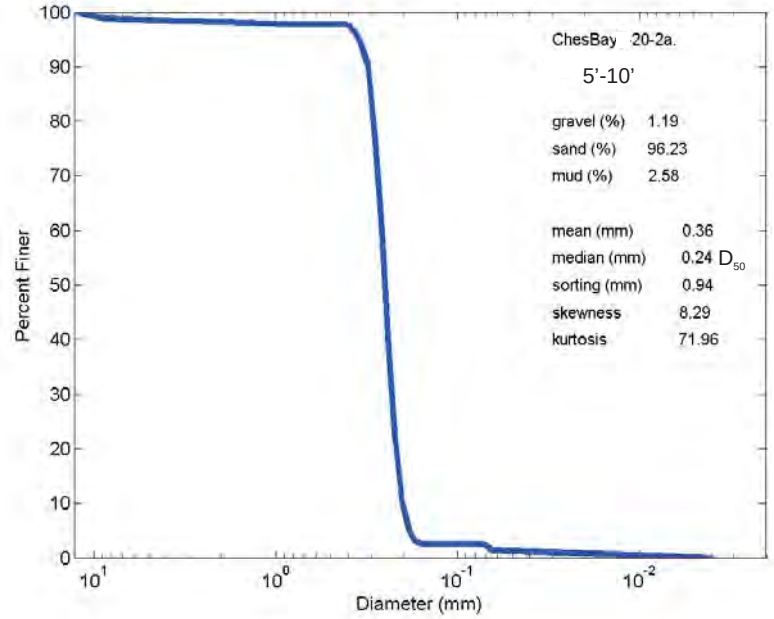

Ches-Bay-18-1a.
0'-5'
gravel (%) 0.26
sand (%) 96.63
mud (%) 3.10
mean (mm) 0.41
median (mm) 0.34 D_{50}
sorting (mm) 0.49
skewness 12.97
kurtosis 211.53
Percent Finer
Diameter (mm)

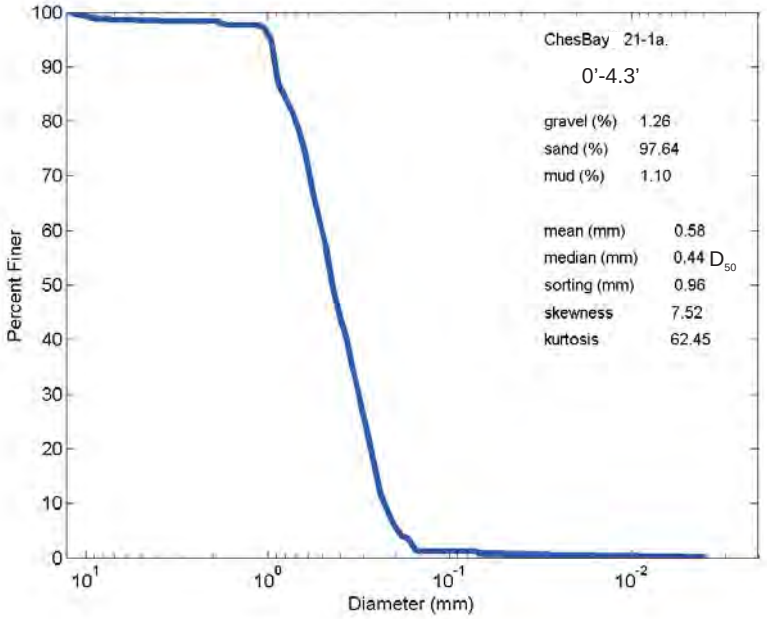

Ches-Bay-18-2a.
5'-10'
gravel (%) 1.78
sand (%) 94.74
mud (%) 3.49
mean (mm) 0.63
median (mm) 0.48 D_{50}
sorting (mm) 1.11
skewness 6.71
kurtosis 48.63
Percent Finer
Diameter (mm)

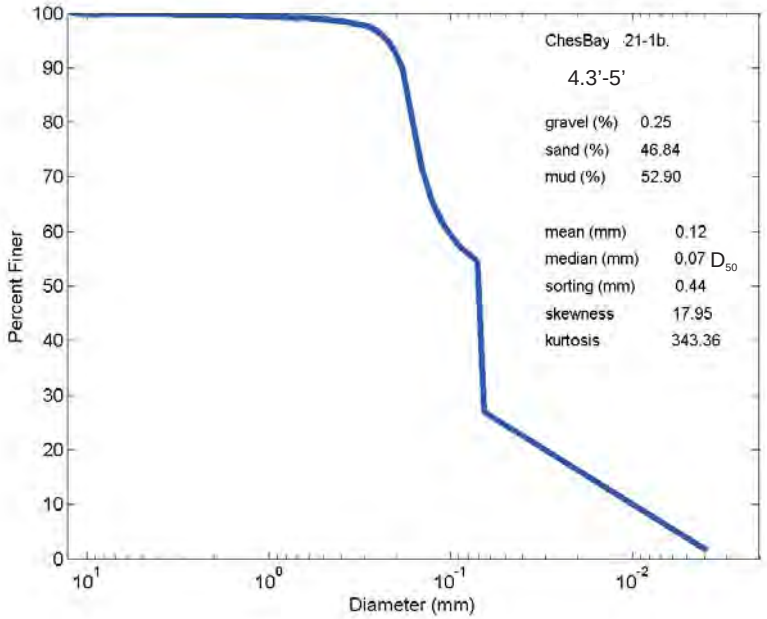

CBay19-1a 0'-5'
gravel (%) 0.16
sand (%) 95.62
mud (%) 4.22
mean (mm) 0.40
median (mm) 0.34
sorting (mm) 0.38 D_{50}
skewness 16.28
kurtosis 350.79
Percent Finer
Diameter (mm)

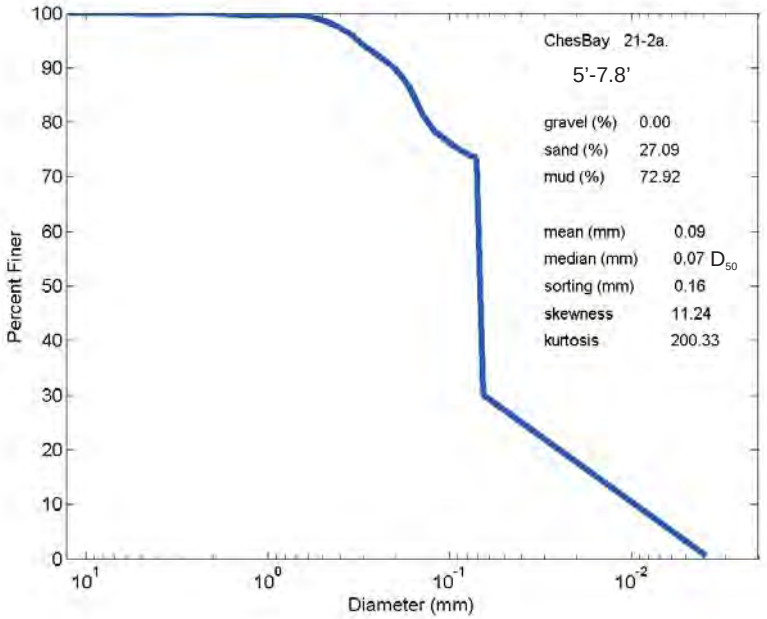

CBay19-2a 5'-10'
gravel (%) 3.16
sand (%) 91.90
mud (%) 4.94
mean (mm) 0.67
median (mm) 0.34
sorting (mm) 1.70
skewness 5.54
kurtosis 33.43
D_{50}
Percent Finer
Diameter (mm)

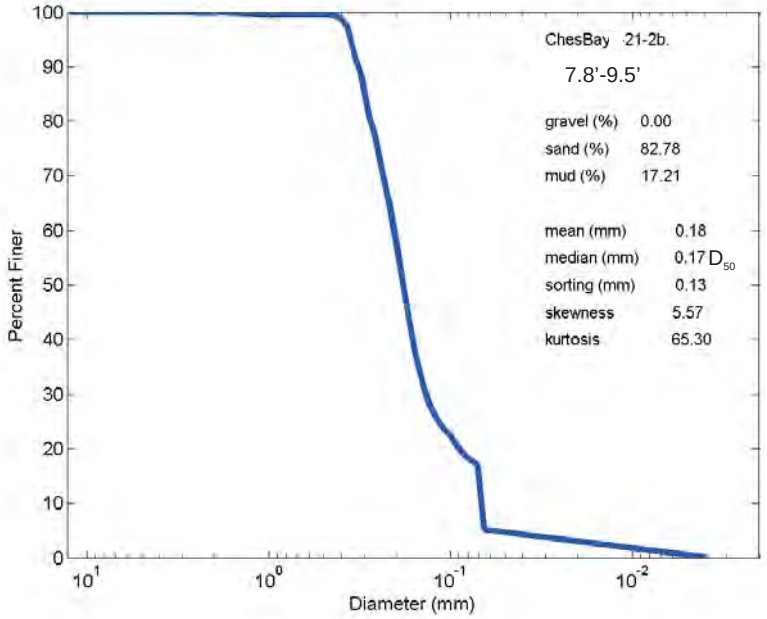

ChesBay 20-1a.
0'-5'
gravel (%) 1.30
sand (%) 91.97
mud (%) 6.72
mean (mm) 0.73
median (mm) 0.52
sorting (mm) 1.00
skewness 6.48
kurtosis 51.35
D_{50}
Percent Finer
Diameter (mm)

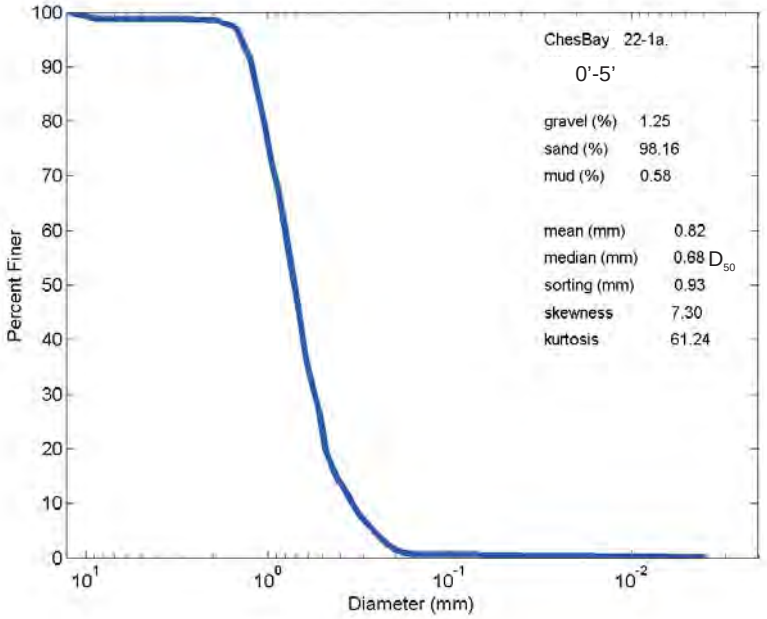

ChesBay 20-2a.
5'-10'
gravel (%) 1.19
sand (%) 96.23
mud (%) 2.58
mean (mm) 0.36
median (mm) 0.24
sorting (mm) 0.94
skewness 8.29
kurtosis 71.96
D_{50}
Percent Finer
Diameter (mm)

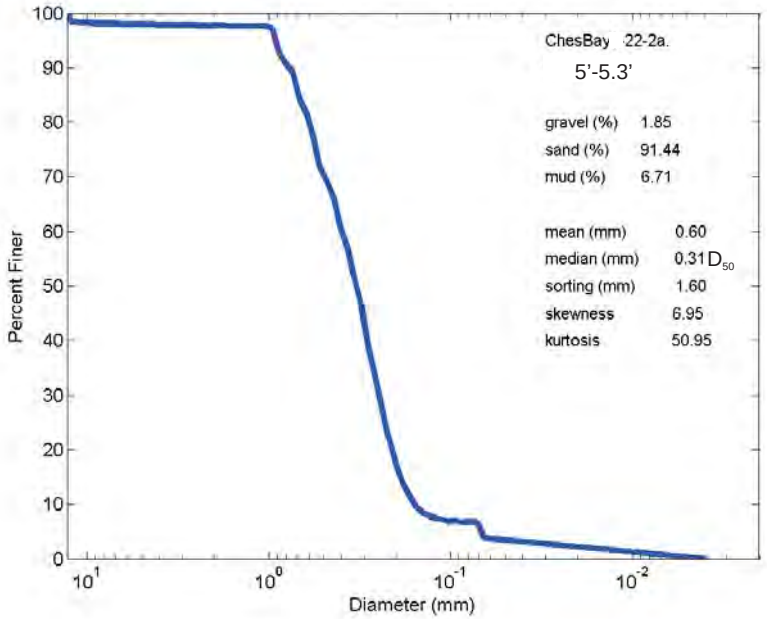

ChesBay 21-1a.
0'-4.3'
gravel (%) 1.26
sand (%) 97.64
mud (%) 1.10
mean (mm) 0.58
median (mm) 0.44
sorting (mm) 0.96
skewness 7.52
kurtosis 62.45
D_{50}
Percent Finer
Diameter (mm)

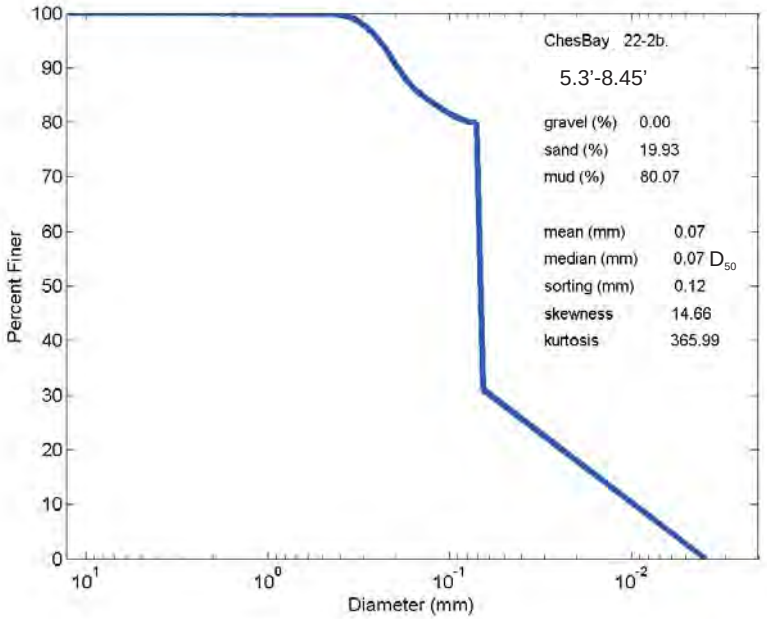

ChesBay 21-1b.
4.3'-5'
gravel (%) 0.25
sand (%) 46.84
mud (%) 52.90
mean (mm) 0.12
median (mm) 0.07 D_{50}
sorting (mm) 0.44
skewness 17.95
kurtosis 343.36
Percent Finer
Diameter (mm)

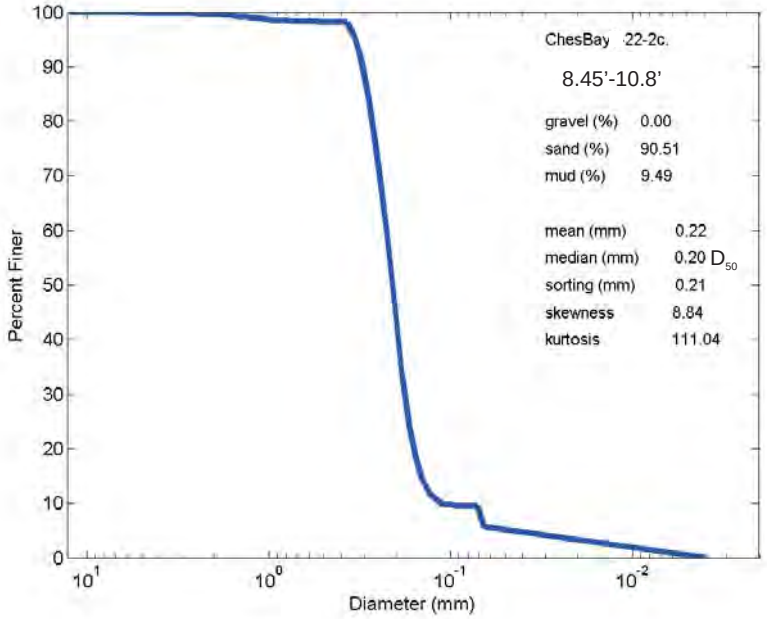

ChesBay 21-2a.
5'-7.8'
gravel (%) 0.00
sand (%) 27.09
mud (%) 72.92
mean (mm) 0.09
median (mm) 0.07 D_{50}
sorting (mm) 0.16
skewness 11.24
kurtosis 200.33
Percent Finer
Diameter (mm)

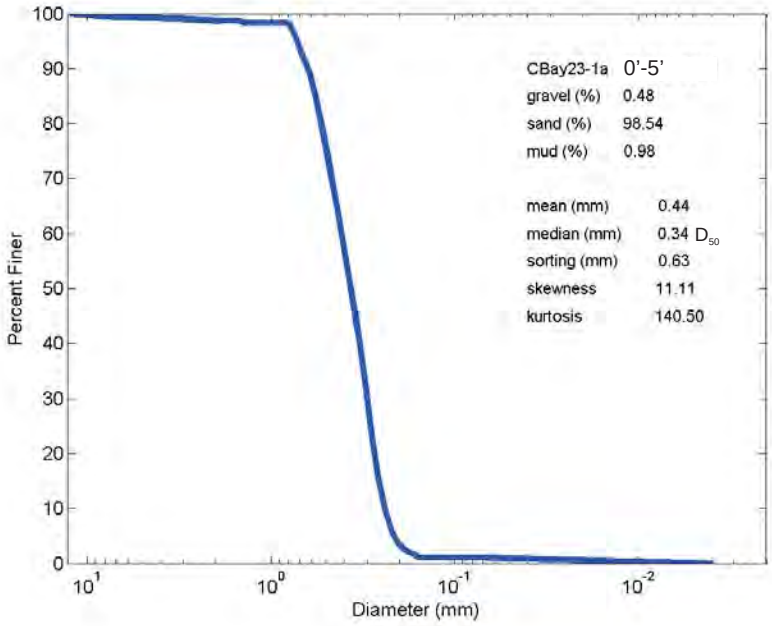

ChesBay 21-2b.
7.8'-9.5'
gravel (%) 0.00
sand (%) 82.78
mud (%) 17.21
mean (mm) 0.18
median (mm) 0.17 D_{50}
sorting (mm) 0.13
skewness 5.57
kurtosis 65.30
Percent Finer
Diameter (mm)

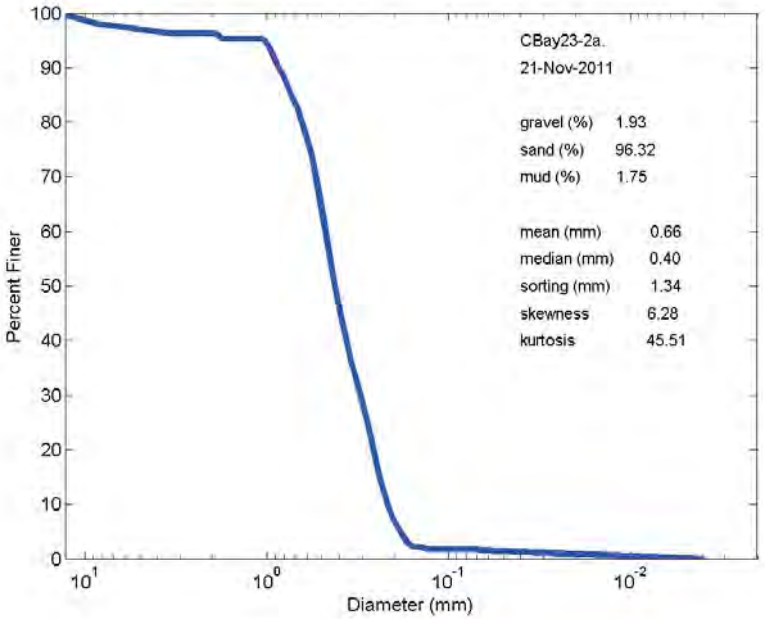

ChesBay 22-1a.
0'-5'
gravel (%) 1.25
sand (%) 98.16
mud (%) 0.58
mean (mm) 0.82
median (mm) 0.68 D_{50}
sorting (mm) 0.93
skewness 7.30
kurtosis 61.24
Percent Finer
Diameter (mm)

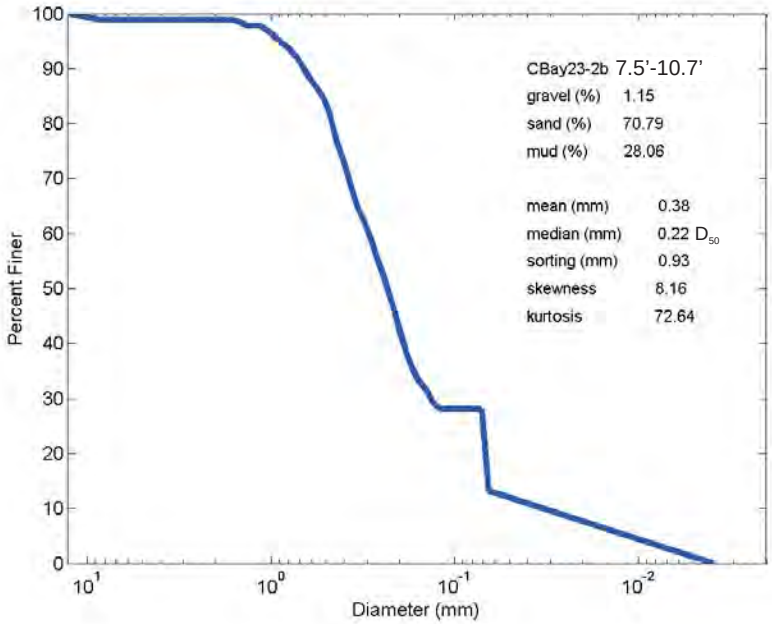

ChesBay 22-2a.
5'-5.3'
gravel (%) 1.85
sand (%) 91.44
mud (%) 6.71
mean (mm) 0.60
median (mm) 0.31 D50
sorting (mm) 1.60
skewness 6.95
kurtosis 50.95
Percent Finer
Diameter (mm)

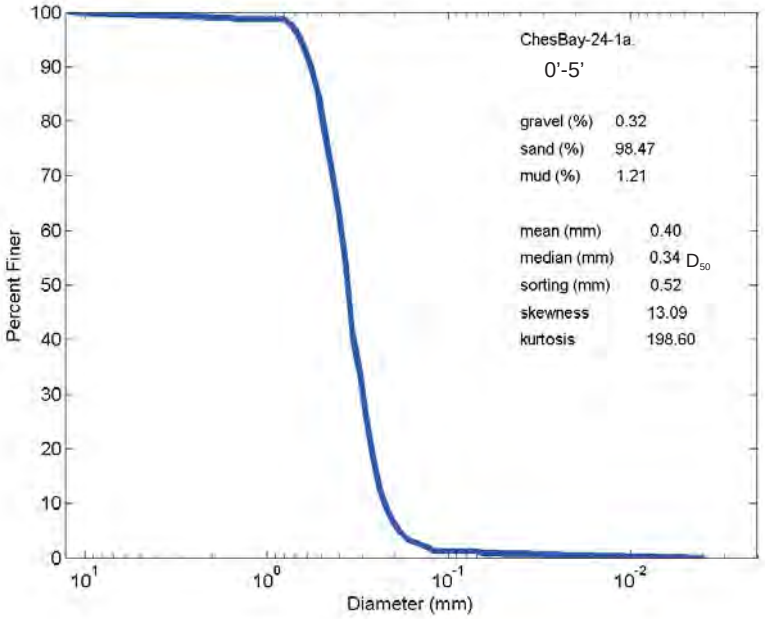

ChesBay 22-2b.
5.3'-8.45'
gravel (%) 0.00
sand (%) 19.93
mud (%) 80.07
mean (mm) 0.07
median (mm) 0.07 D50
sorting (mm) 0.12
skewness 14.66
kurtosis 365.99
Percent Finer
Diameter (mm)

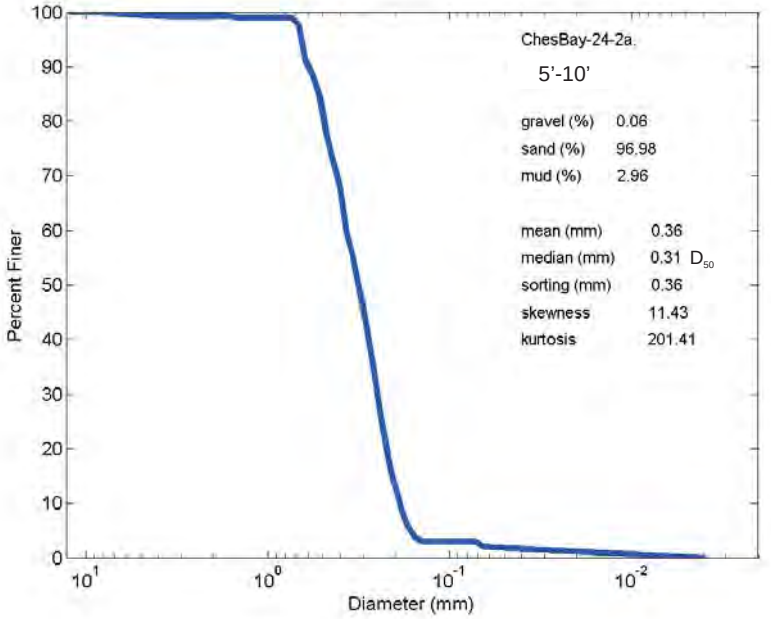

ChesBay 22-2c.
8.45'-10.8'
gravel (%) 0.00
sand (%) 90.51
mud (%) 9.49
mean (mm) 0.22
median (mm) 0.20 D50
sorting (mm) 0.21
skewness 8.84
kurtosis 111.04
Percent Finer
Diameter (mm)

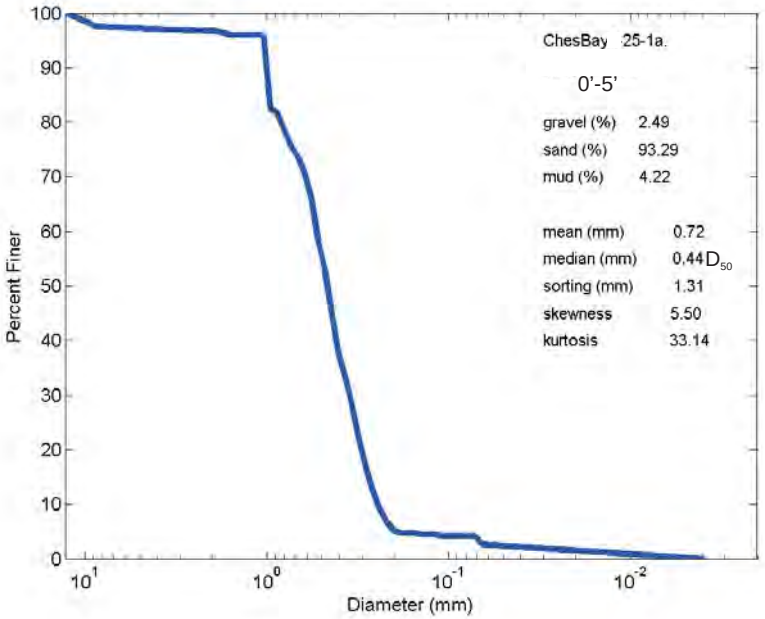

CBay23-1a 0'-5'
gravel (%) 0.48
sand (%) 98.54
mud (%) 0.98
mean (mm) 0.44
median (mm) 0.34 D50
sorting (mm) 0.63
skewness 11.11
kurtosis 140.50
Percent Finer
Diameter (mm)

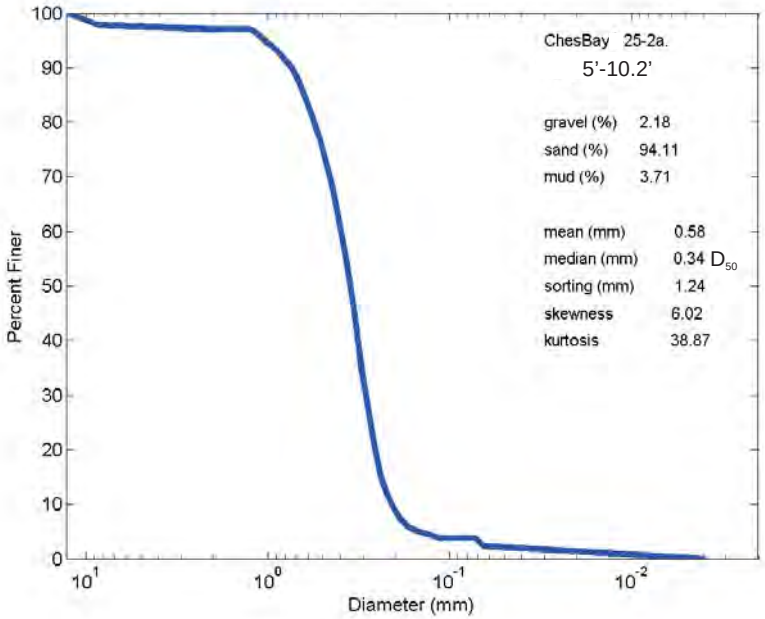

CBay23-2a.
21-Nov-2011
gravel (%) 1.93
sand (%) 96.32
mud (%) 1.75
mean (mm) 0.66
median (mm) 0.40
sorting (mm) 1.34
skewness 6.28
kurtosis 45.51
Percent Finer
Diameter (mm)

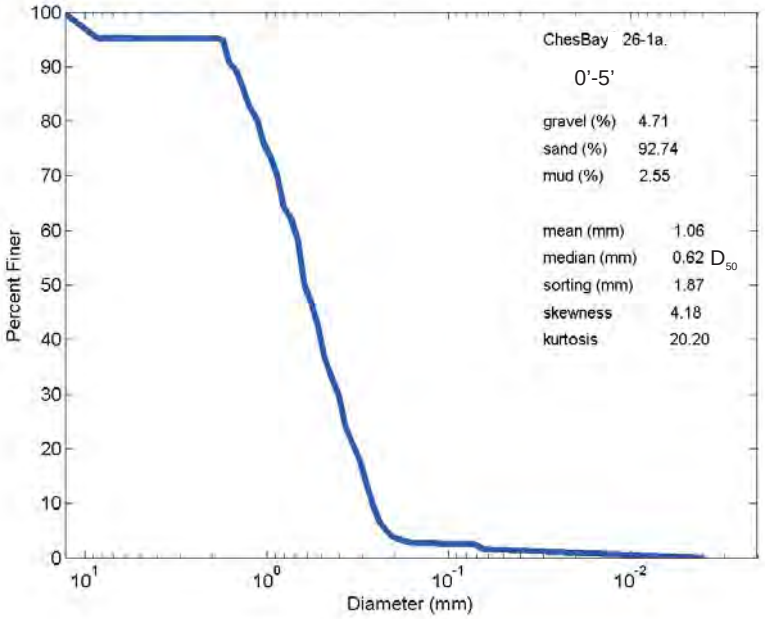

CBay23-2b 7.5'-10.7'
gravel (%) 1.15
sand (%) 70.79
mud (%) 28.06
mean (mm) 0.38
median (mm) 0.22 D50
sorting (mm) 0.93
skewness 8.16
kurtosis 72.64
Percent Finer
Diameter (mm)

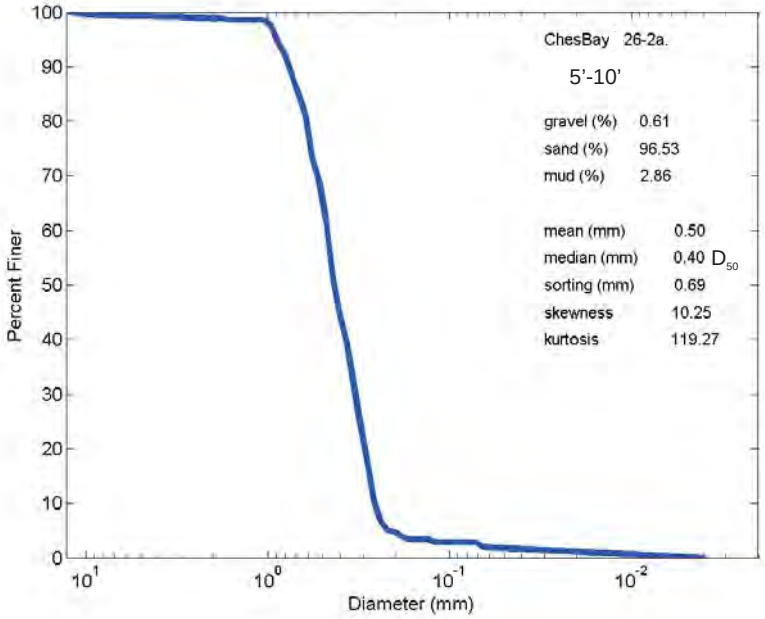

ChesBay-24-1a.
0'-5'
gravel (%) 0.32
sand (%) 98.47
mud (%) 1.21
mean (mm) 0.40
median (mm) 0.34 D50
sorting (mm) 0.52
skewness 13.09
kurtosis 198.60
Percent Finer
Diameter (mm)

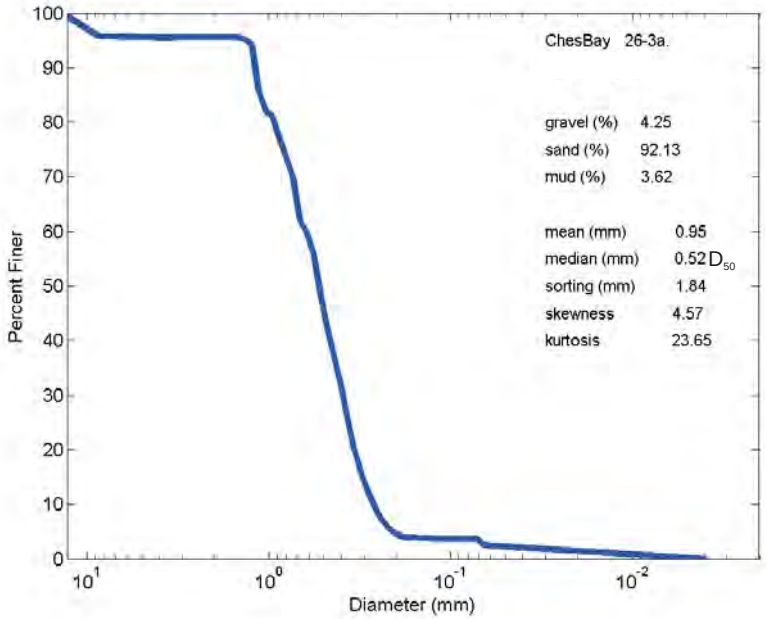

ChesBay-24-2a.
5'-10'
gravel (%) 0.08
sand (%) 96.98
mud (%) 2.96
mean (mm) 0.36
median (mm) 0.31 D50
sorting (mm) 0.36
skewness 11.43
kurtosis 201.41
Percent Finer
Diameter (mm)

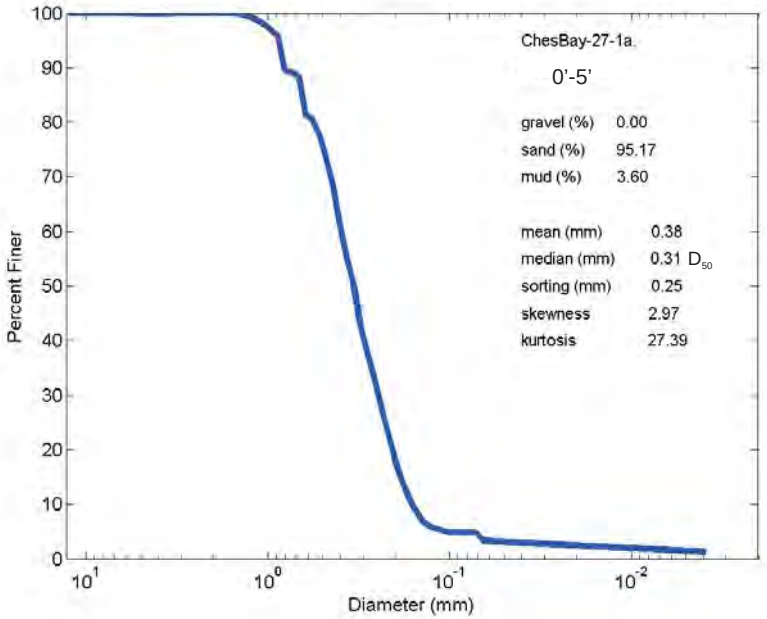

ChesBay 25-1a.
0'-5'
gravel (%) 2.49
sand (%) 93.29
mud (%) 4.22
mean (mm) 0.72
median (mm) 0.44 D50
sorting (mm) 1.31
skewness 5.50
kurtosis 33.14
Percent Finer
Diameter (mm)

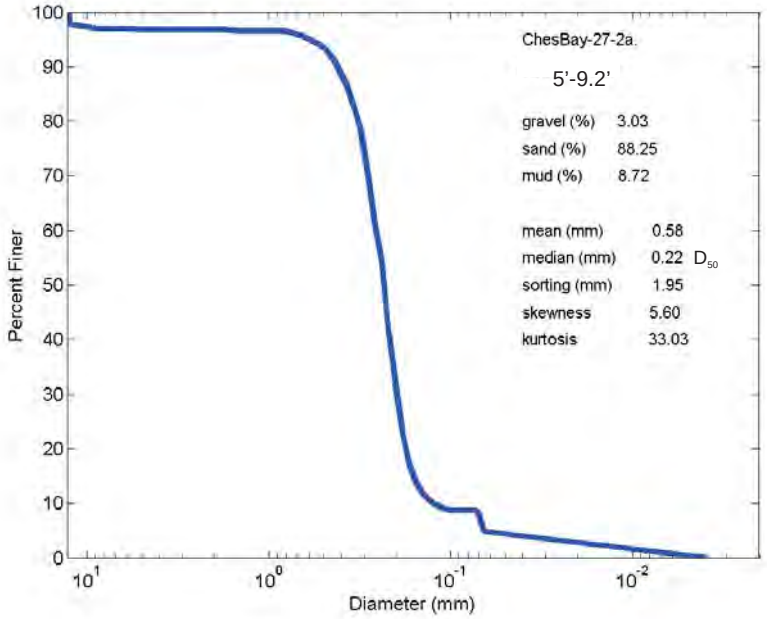

ChesBay 25-2a.
5'-10.2'
gravel (%) 2.18
sand (%) 94.11
mud (%) 3.71
mean (mm) 0.58
median (mm) 0.34 D50
sorting (mm) 1.24
skewness 6.02
kurtosis 38.87
Percent Finer
Diameter (mm)

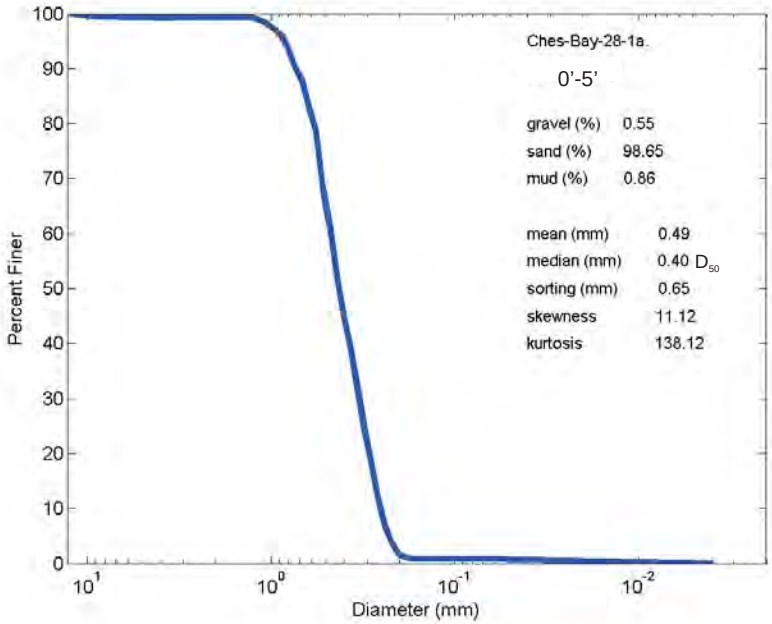

ChesBay 26-1a.
0'-5'
gravel (%) 4.71
sand (%) 92.74
mud (%) 2.55
mean (mm) 1.06
median (mm) 0.62 D50
sorting (mm) 1.87
skewness 4.18
kurtosis 20.20
Percent Finer
Diameter (mm)

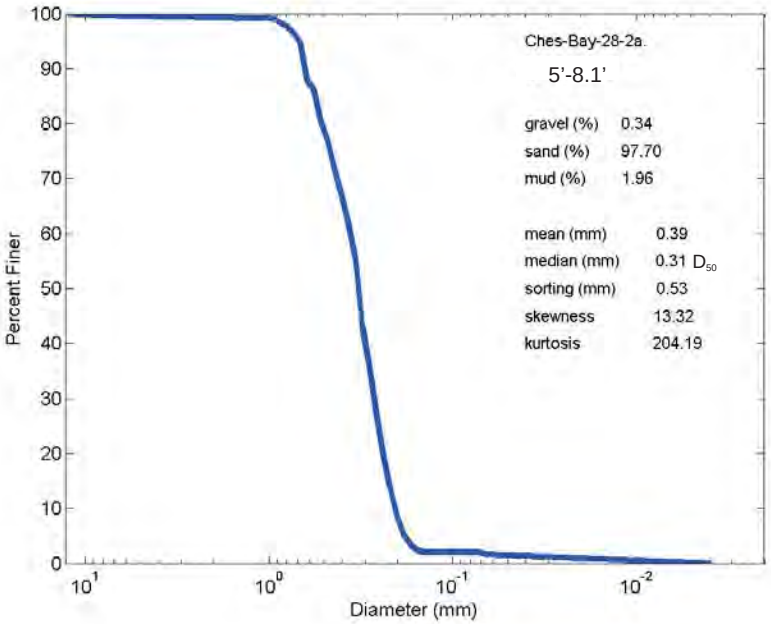

ChesBay 26-2a.
5'-10'
gravel (%) 0.61
sand (%) 96.53
mud (%) 2.86
mean (mm) 0.50
median (mm) 0.40 D50
sorting (mm) 0.69
skewness 10.25
kurtosis 119.27
Percent Finer
Diameter (mm)

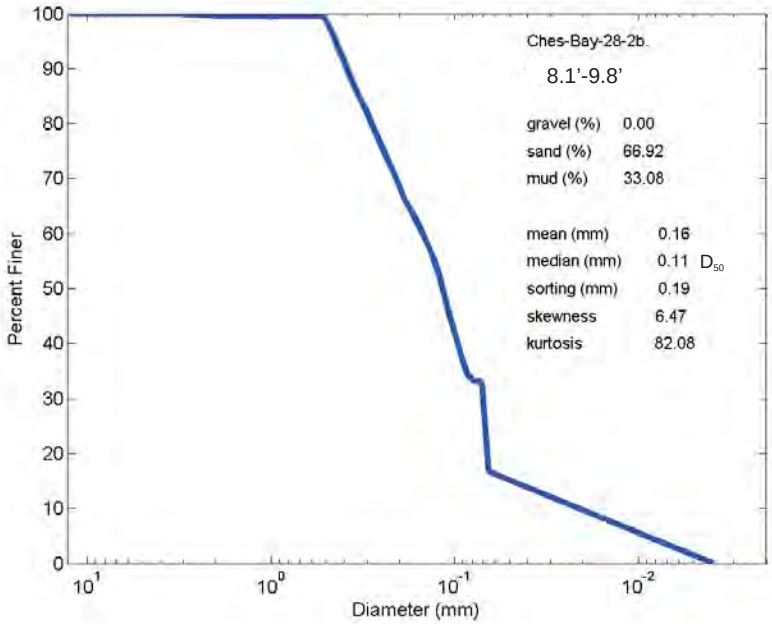

ChesBay 26-3a.
gravel (%) 4.25
sand (%) 92.13
mud (%) 3.62
mean (mm) 0.95
median (mm) 0.52 D50
sorting (mm) 1.84
skewness 4.57
kurtosis 23.65
Percent Finer
Diameter (mm)

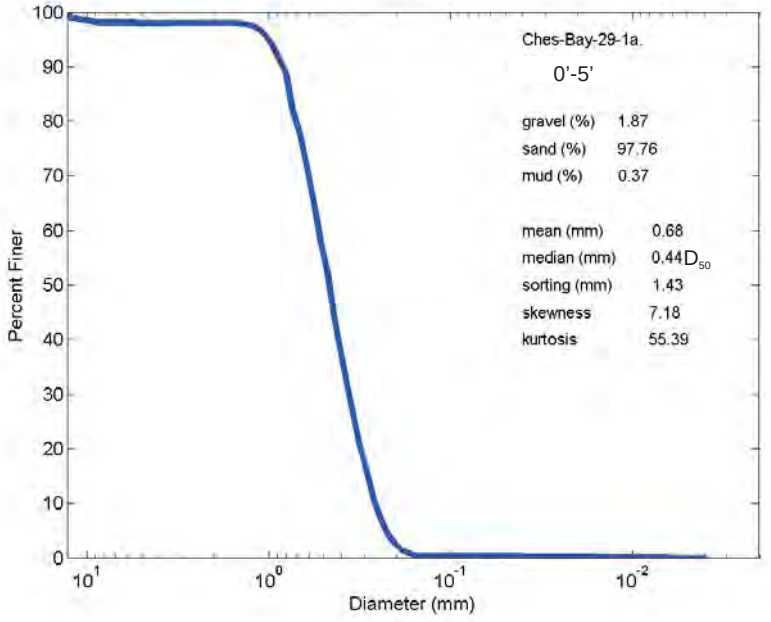

ChesBay-27-1a.
0'-5'
gravel (%) 0.00
sand (%) 95.17
mud (%) 3.60
mean (mm) 0.38
median (mm) 0.31 D50
sorting (mm) 0.25
skewness 2.97
kurtosis 27.39
Percent Finer
Diameter (mm)

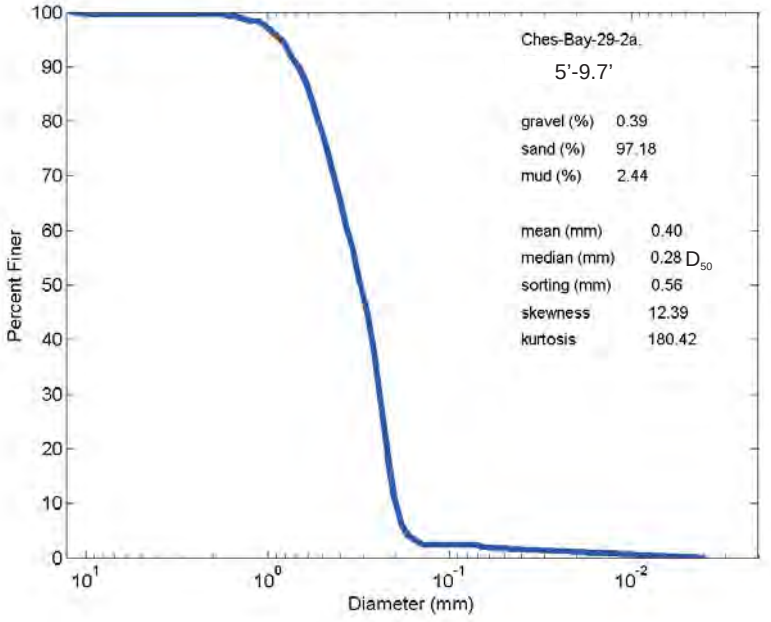

ChesBay-27-2a.
5'-9.2'
gravel (%) 3.03
sand (%) 88.25
mud (%) 8.72
mean (mm) 0.58
median (mm) 0.22 D50
sorting (mm) 1.95
skewness 5.60
kurtosis 33.03
Percent Finer
Diameter (mm)

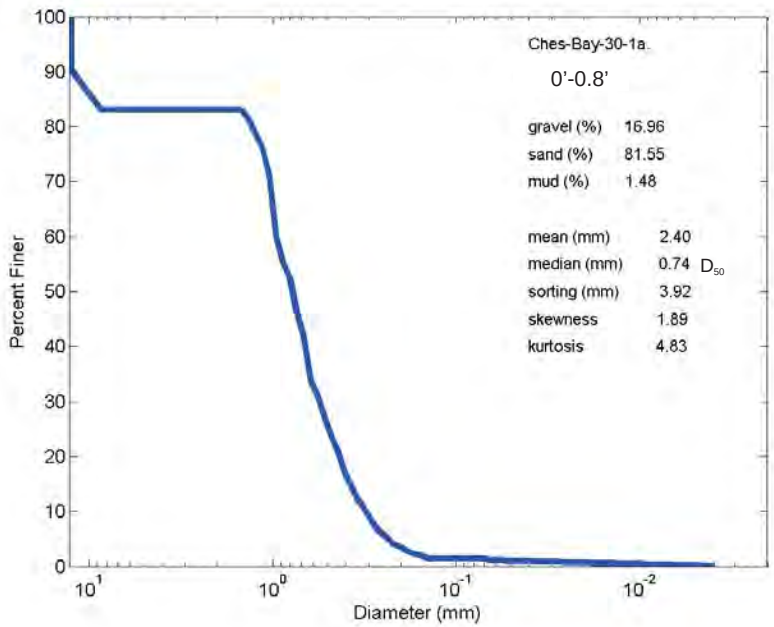

Ches-Bay-28-1a.
0'-5'
gravel (%) 0.55
sand (%) 98.65
mud (%) 0.86
mean (mm) 0.49
median (mm) 0.40 D50
sorting (mm) 0.65
skewness 11.12
kurtosis 138.12
Percent Finer
Diameter (mm)

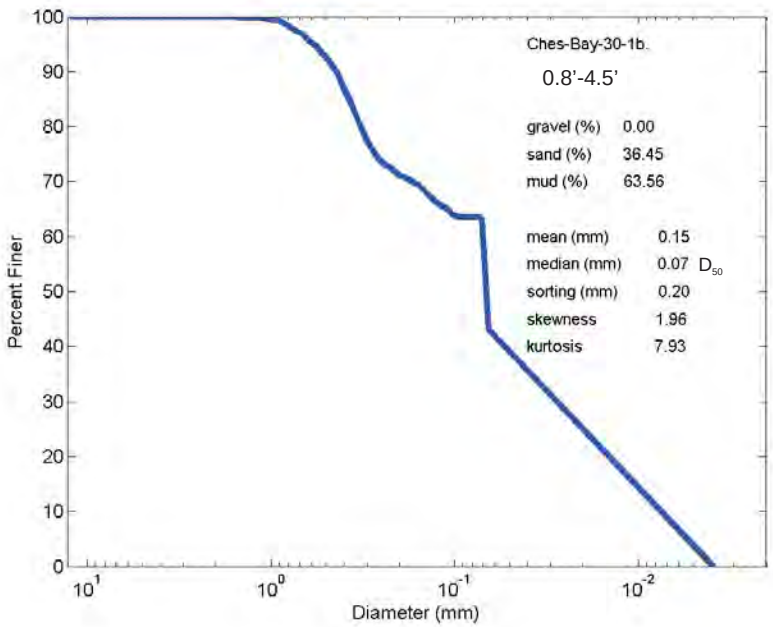

Ches-Bay-28-2a
5'-8.1'
gravel (%) 0.34
sand (%) 97.70
mud (%) 1.96
mean (mm) 0.39
median (mm) 0.31 D50
sorting (mm) 0.53
skewness 13.32
kurtosis 204.19
Percent Finer
Diameter (mm)

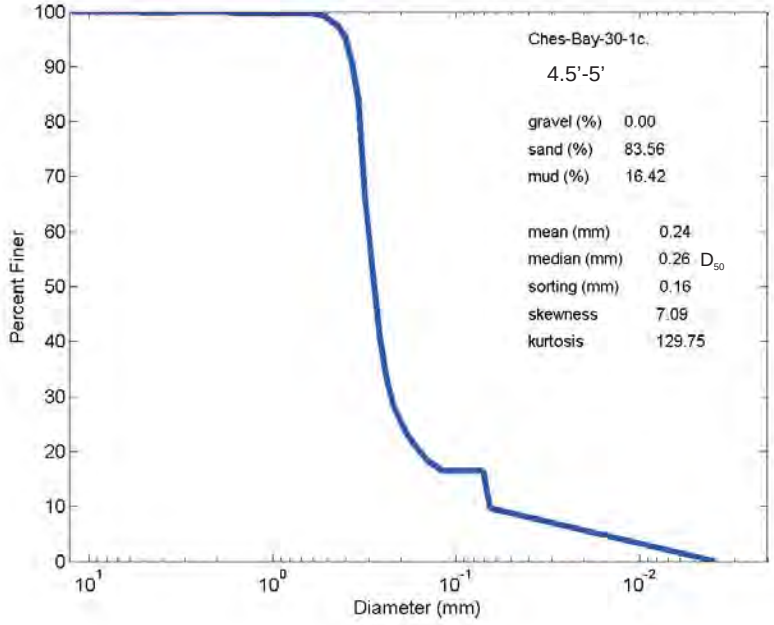

Ches-Bay-28-2b
8.1'-9.8'
gravel (%) 0.00
sand (%) 66.92
mud (%) 33.08
mean (mm) 0.16
median (mm) 0.11 D50
sorting (mm) 0.19
skewness 6.47
kurtosis 82.08
Percent Finer
Diameter (mm)

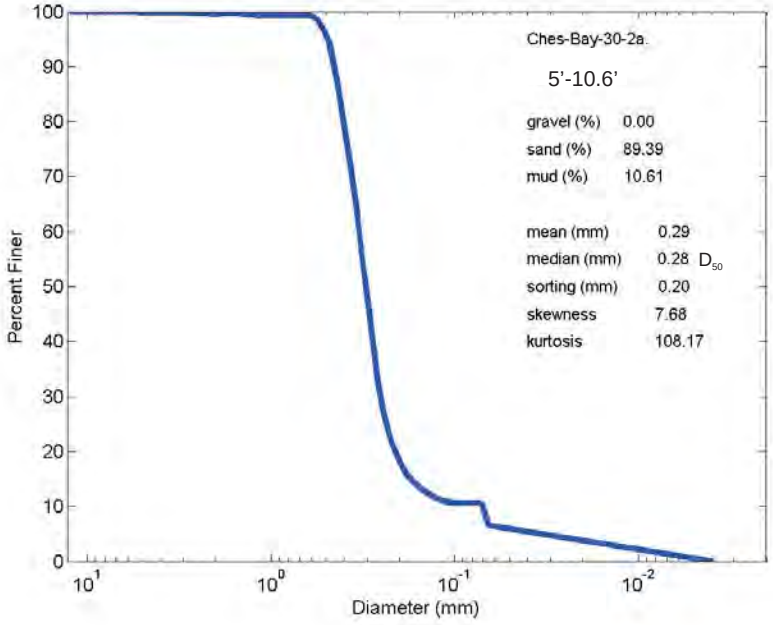

Ches-Bay-29-1a
0'-5'
gravel (%) 1.87
sand (%) 97.76
mud (%) 0.37
mean (mm) 0.68
median (mm) 0.44D50
sorting (mm) 1.43
skewness 7.18
kurtosis 55.39
Percent Finer
Diameter (mm)

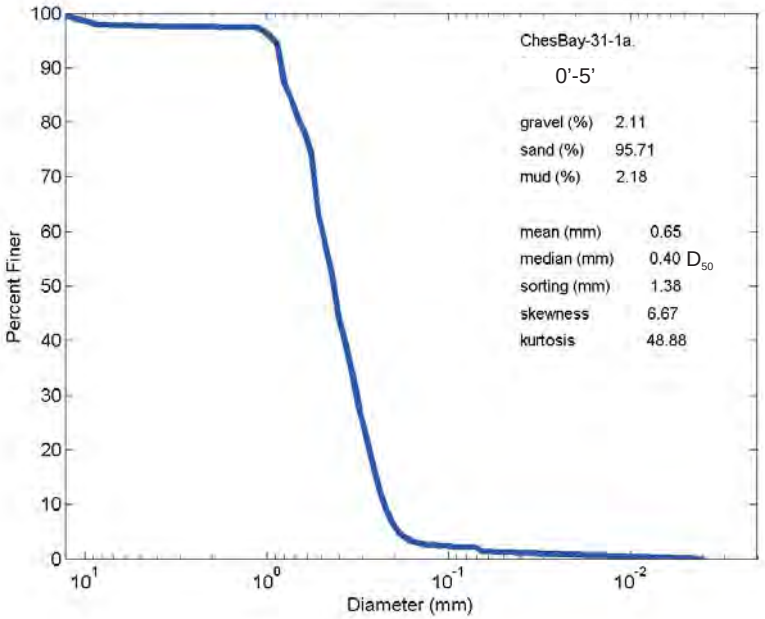

Ches-Bay-29-2a
5'-9.7'
gravel (%) 0.39
sand (%) 97.18
mud (%) 2.44
mean (mm) 0.40
median (mm) 0.28 D50
sorting (mm) 0.56
skewness 12.39
kurtosis 180.42
Percent Finer
Diameter (mm)

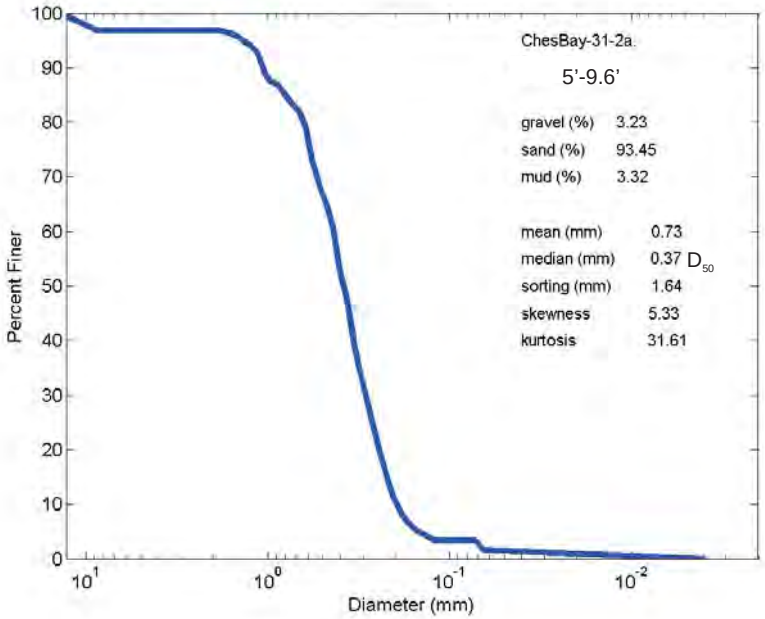

Ches-Bay-30-1a.
0'-0.8'
gravel (%) 16.96
sand (%) 81.55
mud (%) 1.48
mean (mm) 2.40
median (mm) 0.74 D50
sorting (mm) 3.92
skewness 1.89
kurtosis 4.83
Percent Finer
Diameter (mm)

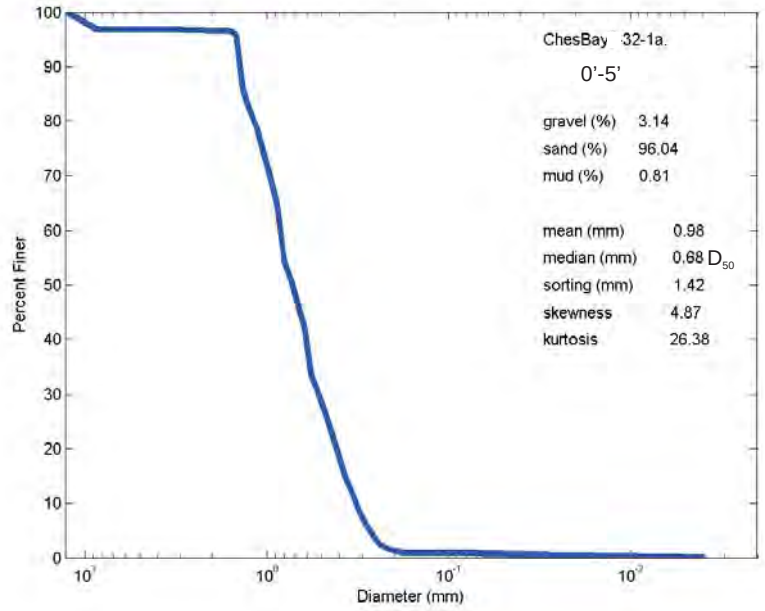

Ches-Bay-30-1b.
0.8'-4.5'
gravel (%) 0.00
sand (%) 36.45
mud (%) 63.56
mean (mm) 0.15
median (mm) 0.07 D50
sorting (mm) 0.20
skewness 1.96
kurtosis 7.93
Percent Finer
Diameter (mm)

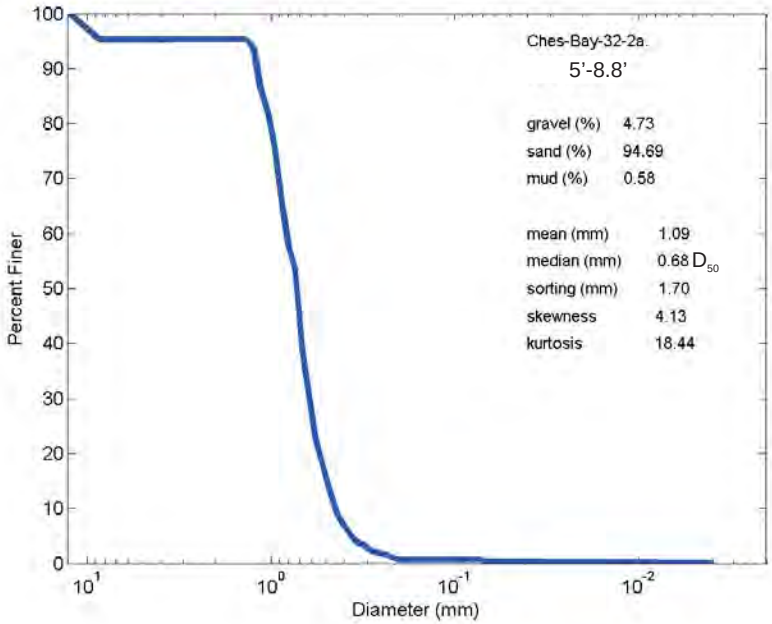

Ches-Bay-30-1c.
4.5'-5'
gravel (%) 0.00
sand (%) 83.56
mud (%) 16.42
mean (mm) 0.24
median (mm) 0.26 D50
sorting (mm) 0.16
skewness 7.09
kurtosis 129.75
Percent Finer
Diameter (mm)

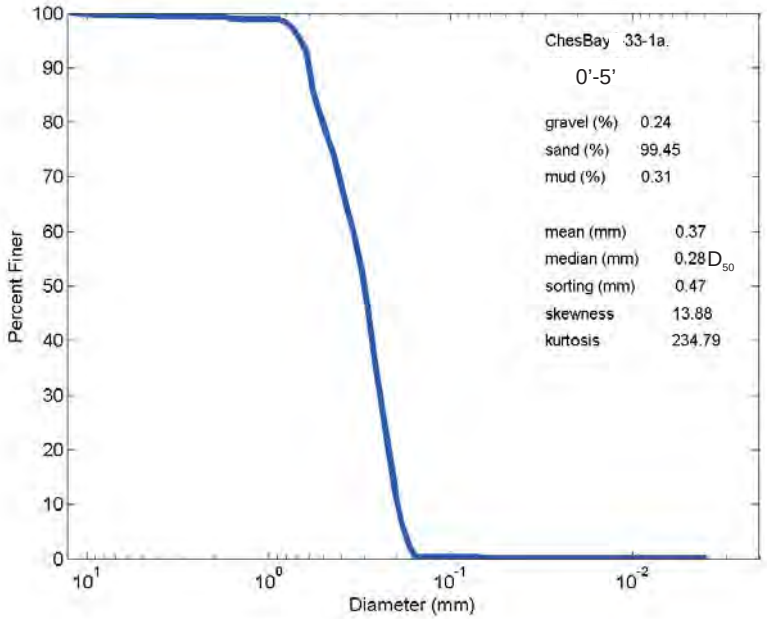

Ches-Bay-30-2a.
5'-10.6'
gravel (%) 0.00
sand (%) 89.39
mud (%) 10.61
mean (mm) 0.29
median (mm) 0.28 D50
sorting (mm) 0.20
skewness 7.68
kurtosis 108.17
Percent Finer
Diameter (mm)

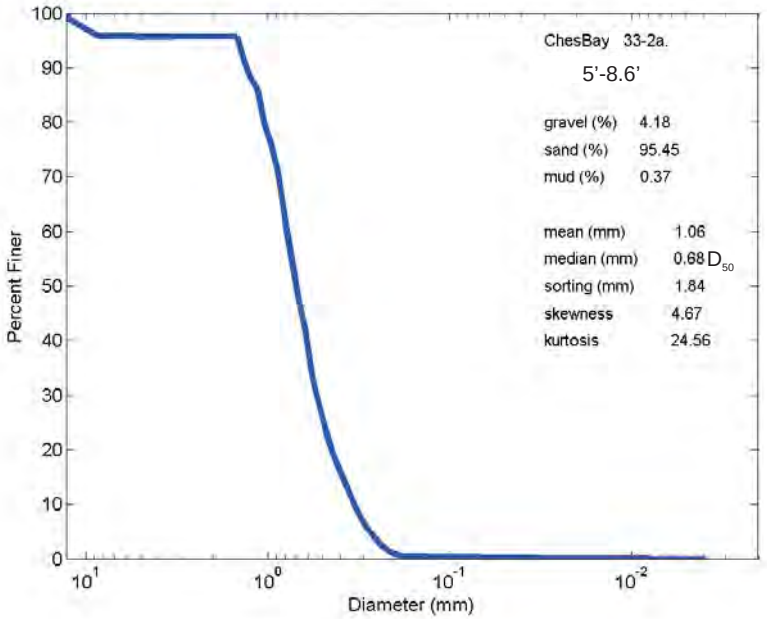

ChesBay-31-1a.
0'-5'
gravel (%) 2.11
sand (%) 95.71
mud (%) 2.18
mean (mm) 0.65
median (mm) 0.40 D_{50}
sorting (mm) 1.38
skewness 6.67
kurtosis 48.88
Percent Finer
Diameter (mm)

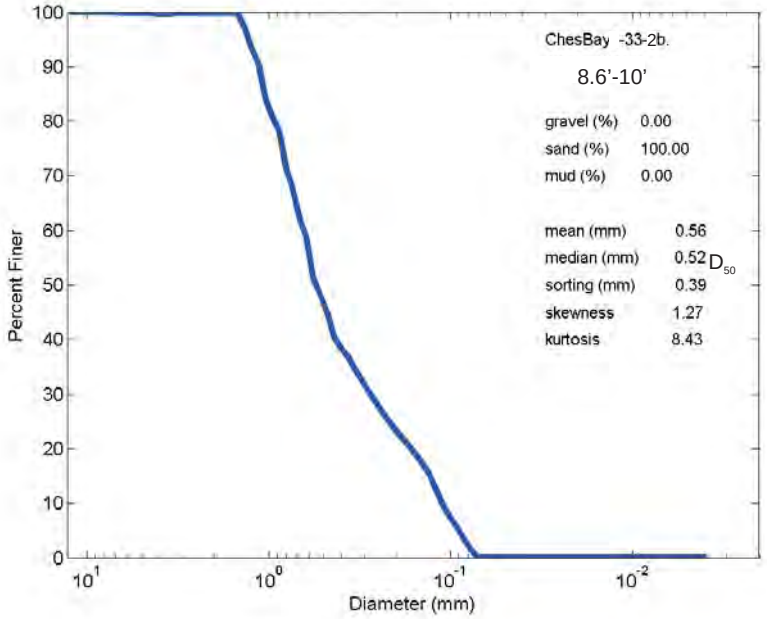

ChesBay-31-2a.
5'-9.6'
gravel (%) 3.23
sand (%) 93.45
mud (%) 3.32
mean (mm) 0.73
median (mm) 0.37 D_{50}
sorting (mm) 1.64
skewness 5.33
kurtosis 31.61
Percent Finer
Diameter (mm)

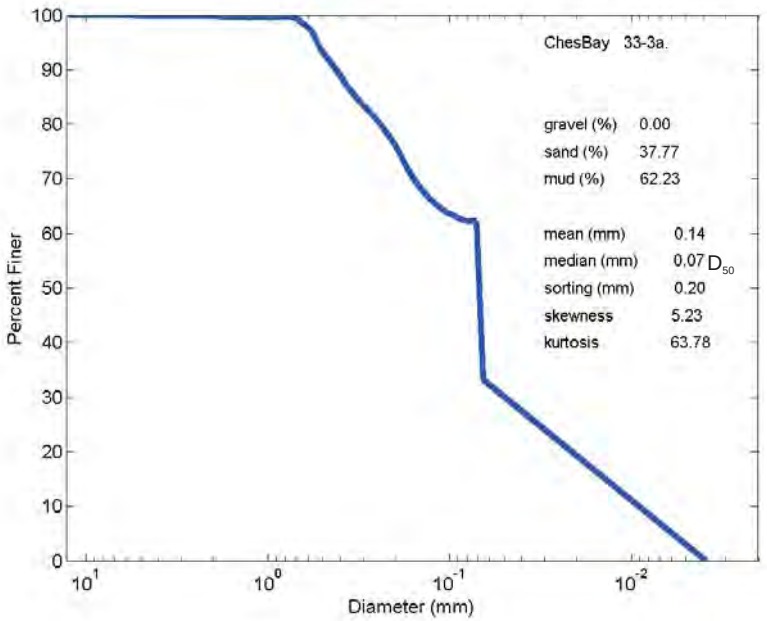

ChesBay 32-1a.
0'-5'
gravel (%) 3.14
sand (%) 96.04
mud (%) 0.81
mean (mm) 0.98
median (mm) 0.68 D_{50}
sorting (mm) 1.42
skewness 4.87
kurtosis 26.38
Percent Finer
Diameter (mm)

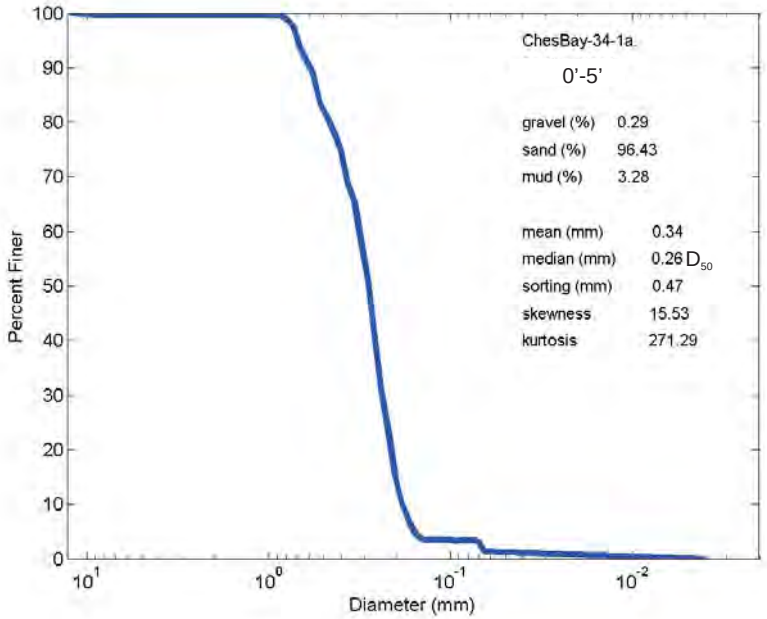

Ches-Bay-32-2a.
5'-8.8'
gravel (%) 4.73
sand (%) 94.69
mud (%) 0.58
mean (mm) 1.09
median (mm) 0.68 D_{50}
sorting (mm) 1.70
skewness 4.13
kurtosis 18.44
Percent Finer
Diameter (mm)

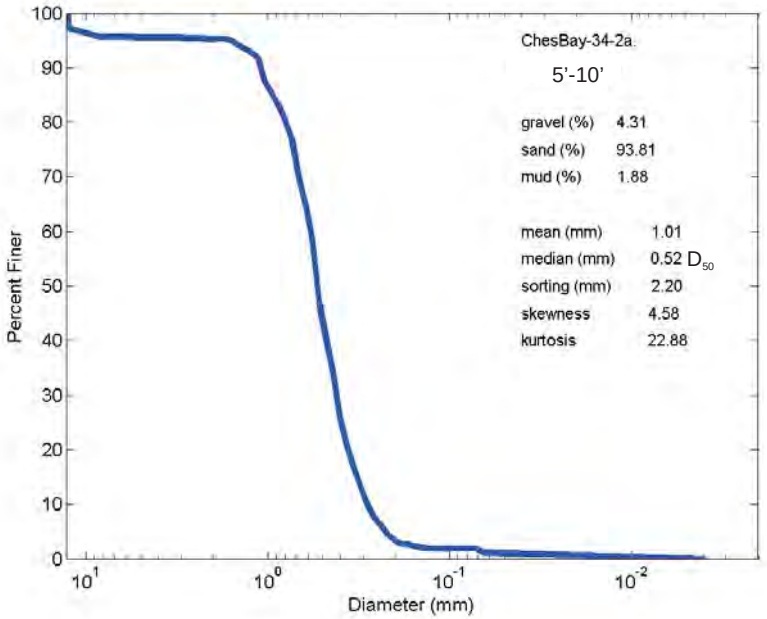

ChesBay 33-1a.
0'-5'
gravel (%) 0.24
sand (%) 99.45
mud (%) 0.31
mean (mm) 0.37
median (mm) 0.28 D_{50}
sorting (mm) 0.47
skewness 13.88
kurtosis 234.79
Percent Finer
Diameter (mm)

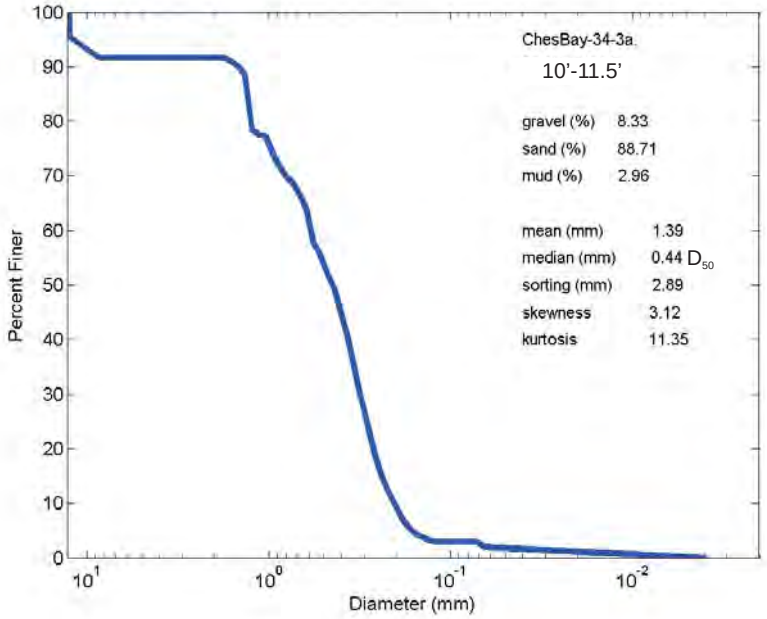

ChesBay 33-2a.
5'-8.6'
gravel (%) 4.18
sand (%) 95.45
mud (%) 0.37
mean (mm) 1.06
median (mm) 0.68 D_{50}
sorting (mm) 1.84
skewness 4.67
kurtosis 24.56
Percent Finer
Diameter (mm)

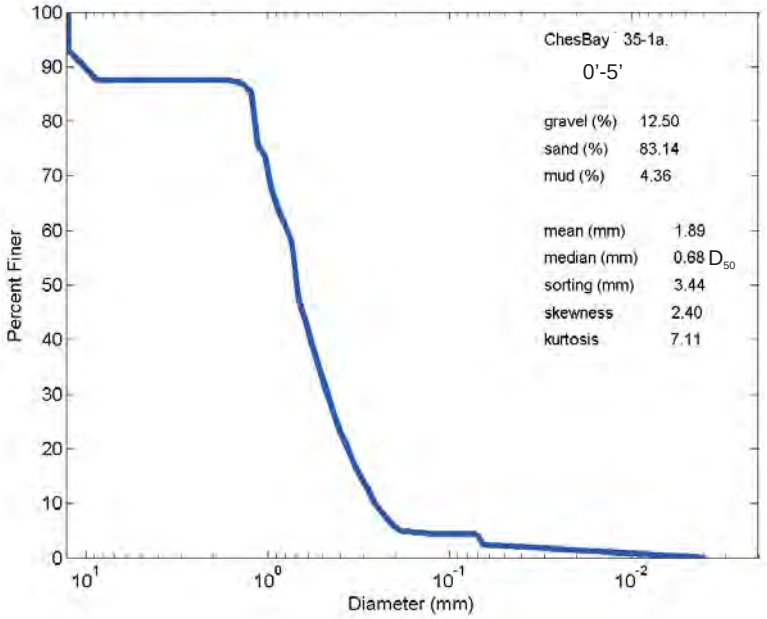

ChesBay -33-2b.
8.6'-10'
gravel (%) 0.00
sand (%) 100.00
mud (%) 0.00
mean (mm) 0.56
median (mm) 0.52 D_{50}
sorting (mm) 0.39
skewness 1.27
kurtosis 8.43
Percent Finer
Diameter (mm)

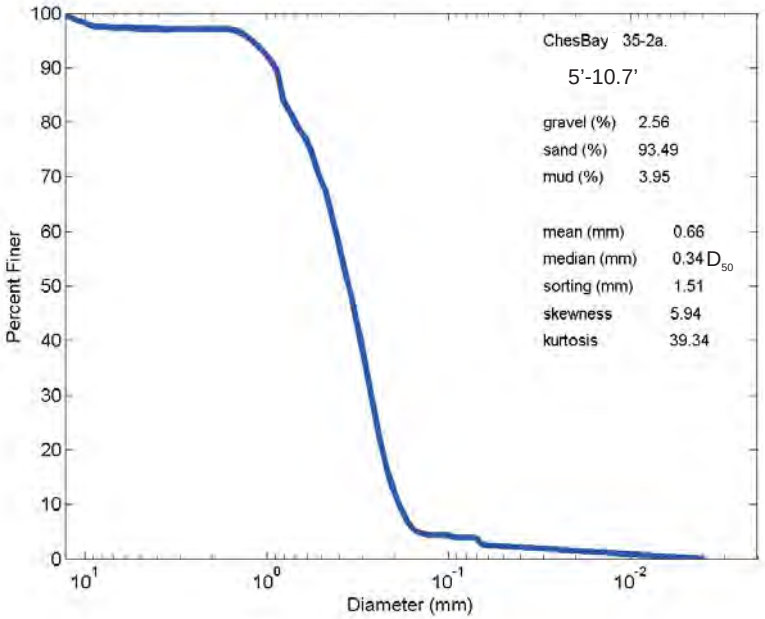

ChesBay 33-3a.
gravel (%) 0.00
sand (%) 37.77
mud (%) 62.23
mean (mm) 0.14
median (mm) 0.07 D_{50}
sorting (mm) 0.20
skewness 5.23
kurtosis 63.78
Percent Finer
Diameter (mm)

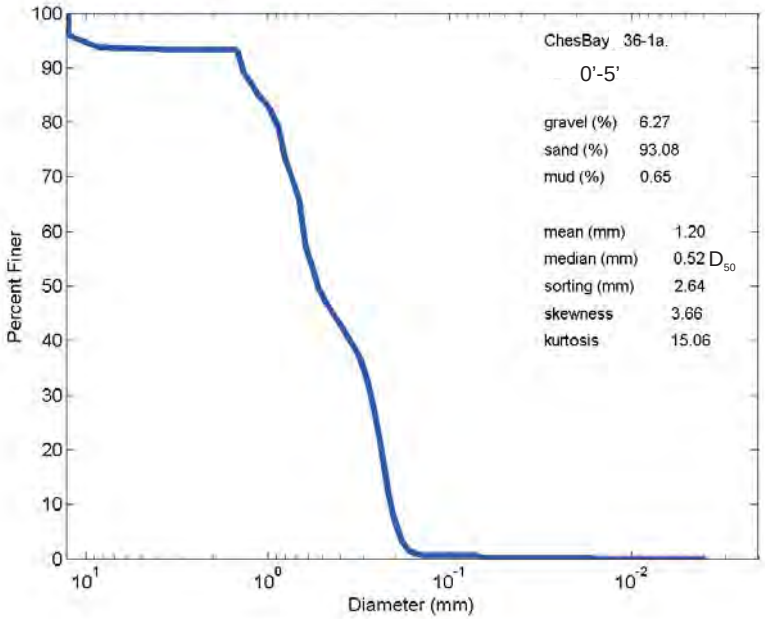

ChesBay-34-1a
0'-5'
gravel (%) 0.29
sand (%) 96.43
mud (%) 3.28
mean (mm) 0.34
median (mm) 0.26 D_{50}
sorting (mm) 0.47
skewness 15.53
kurtosis 271.29
Percent Finer
Diameter (mm)

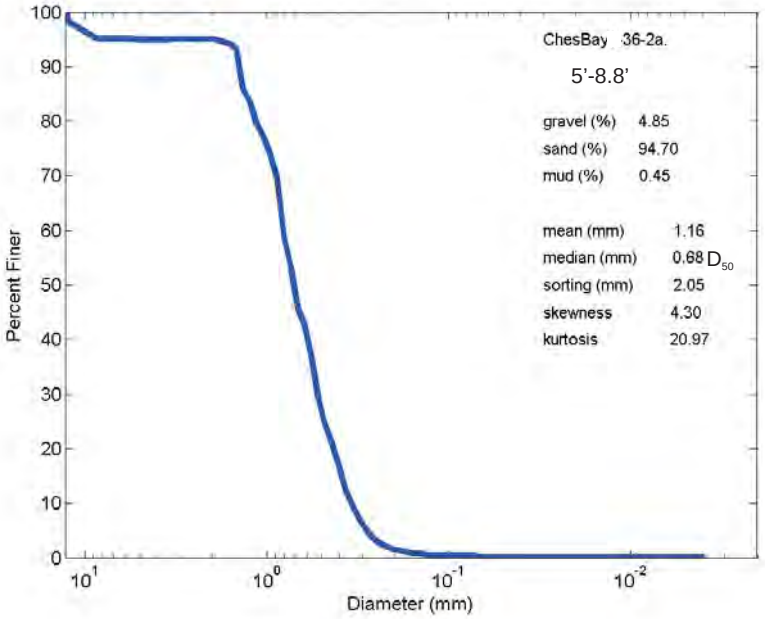

ChesBay-34-2a
5'-10'
gravel (%) 4.31
sand (%) 93.81
mud (%) 1.88
mean (mm) 1.01
median (mm) 0.52 D_{50}
sorting (mm) 2.20
skewness 4.58
kurtosis 22.88
Percent Finer
Diameter (mm)

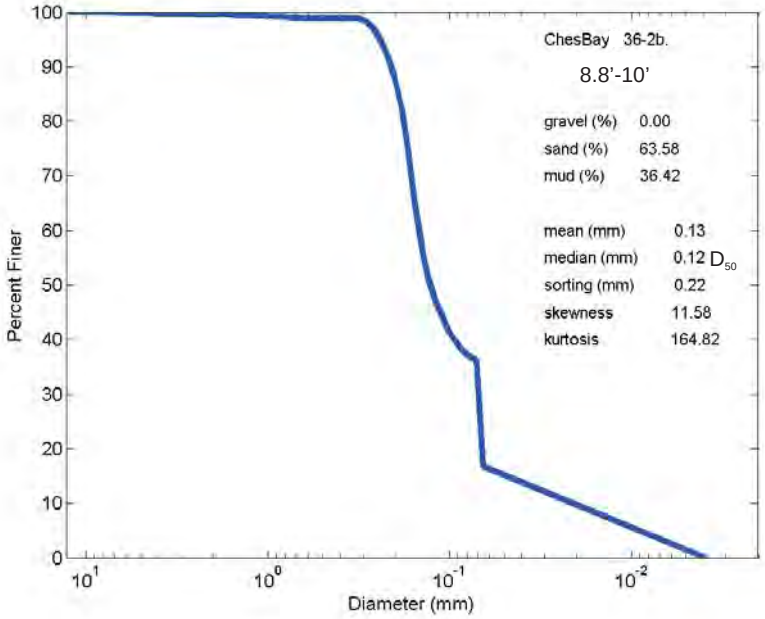

ChesBay-34-3a
10'-11.5'
gravel (%) 8.33
sand (%) 88.71
mud (%) 2.96
mean (mm) 1.39
median (mm) 0.44 D_{50}
sorting (mm) 2.89
skewness 3.12
kurtosis 11.35
Percent Finer
Diameter (mm)

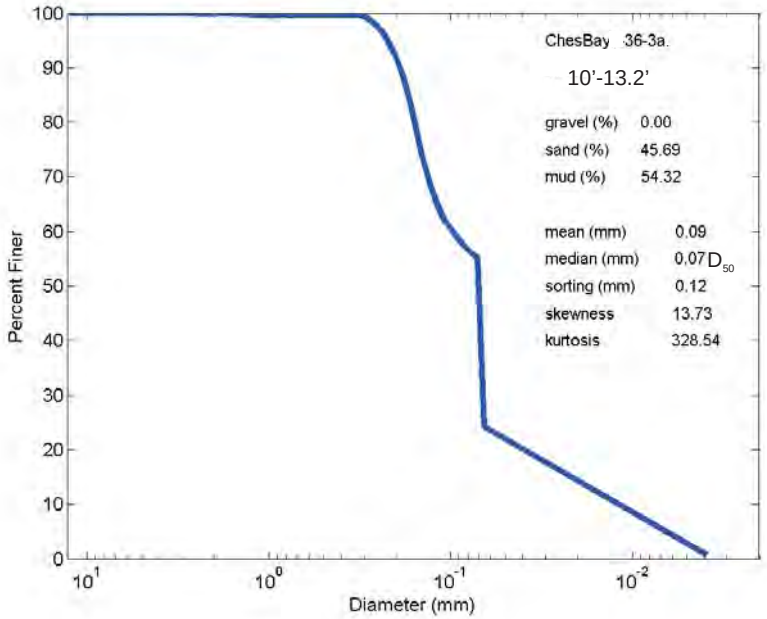

ChesBay 35-1a
0'-5'
gravel (%) 12.50
sand (%) 83.14
mud (%) 4.36
mean (mm) 1.89
median (mm) 0.68 D_{50}
sorting (mm) 3.44
skewness 2.40
kurtosis 7.11
Percent Finer
Diameter (mm)

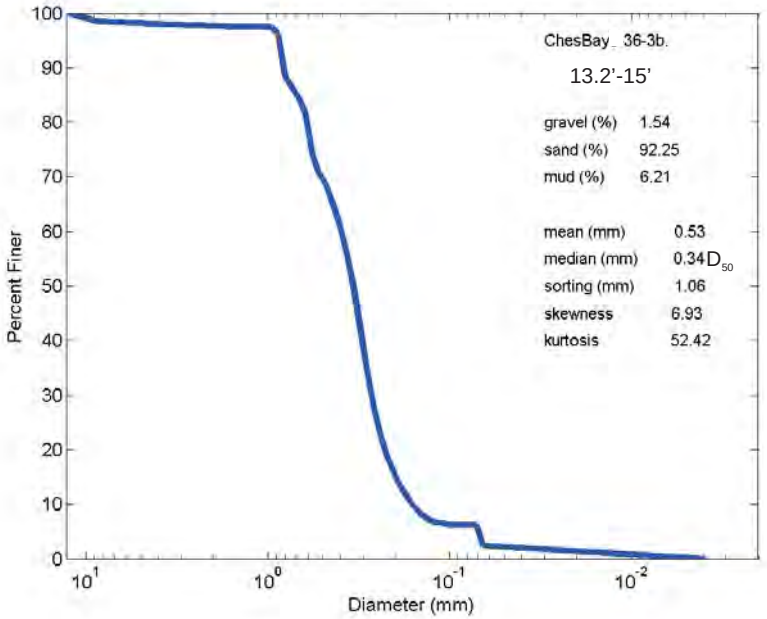

ChesBay 35-2a.
5'-10.7'
gravel (%) 2.56
sand (%) 93.49
mud (%) 3.95
mean (mm) 0.66
median (mm) 0.34 D50
sorting (mm) 1.51
skewness 5.94
kurtosis 39.34
Percent Finer
Diameter (mm)

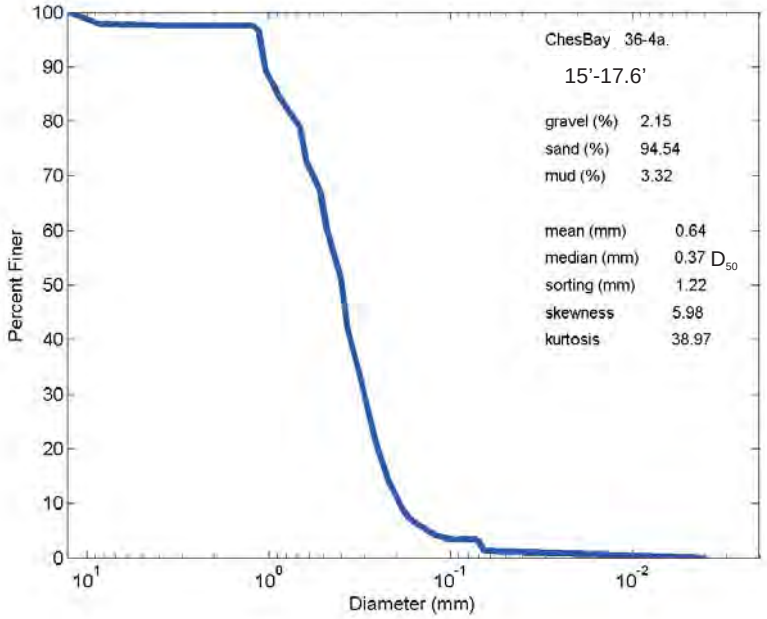

ChesBay 36-1a.
0'-5'
gravel (%) 6.27
sand (%) 93.08
mud (%) 0.65
mean (mm) 1.20
median (mm) 0.52 D50
sorting (mm) 2.64
skewness 3.66
kurtosis 15.06
Percent Finer
Diameter (mm)

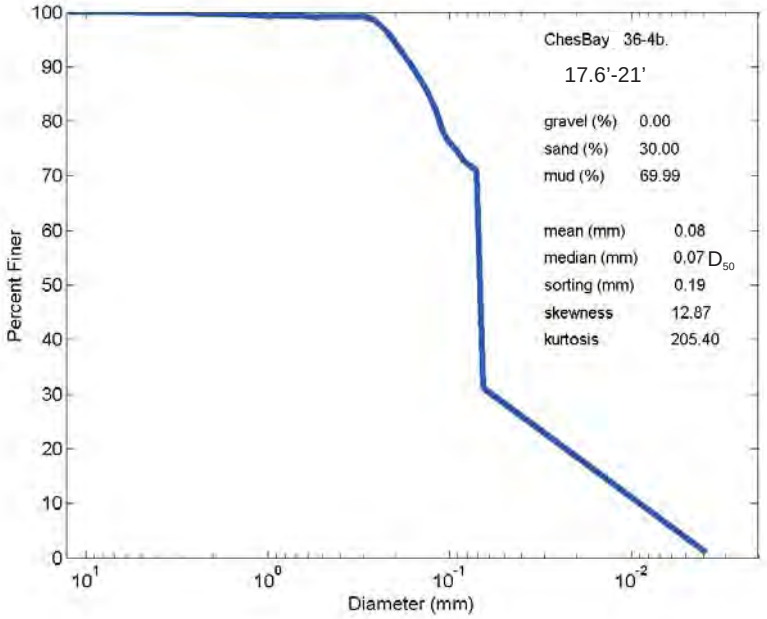

ChesBay 36-2a.
5'-8.8'
gravel (%) 4.85
sand (%) 94.70
mud (%) 0.45
mean (mm) 1.16
median (mm) 0.68 D50
sorting (mm) 2.05
skewness 4.30
kurtosis 20.97
Percent Finer
Diameter (mm)

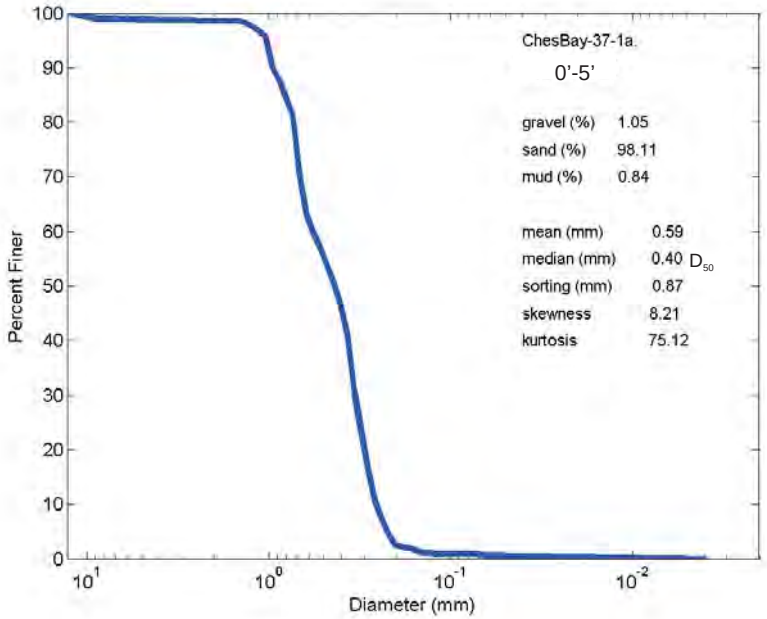

ChesBay 36-2b.
8.8'-10'
gravel (%) 0.00
sand (%) 63.58
mud (%) 36.42
mean (mm) 0.13
median (mm) 0.12 D50
sorting (mm) 0.22
skewness 11.58
kurtosis 164.82
Percent Finer
Diameter (mm)

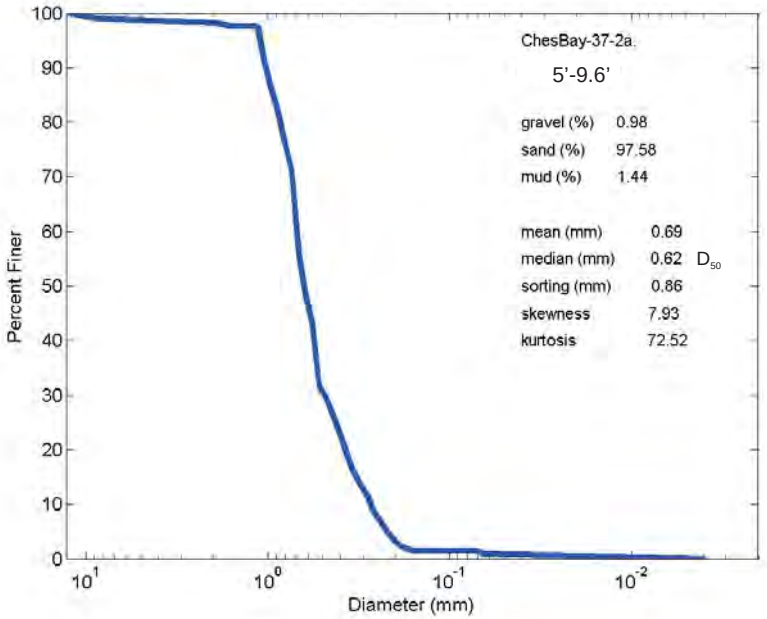

ChesBay 36-3a.
10'-13.2'
gravel (%) 0.00
sand (%) 45.69
mud (%) 54.32
mean (mm) 0.09
median (mm) 0.07 D_{50}
sorting (mm) 0.12
skewness 13.73
kurtosis 328.54
Percent Finer
Diameter (mm)

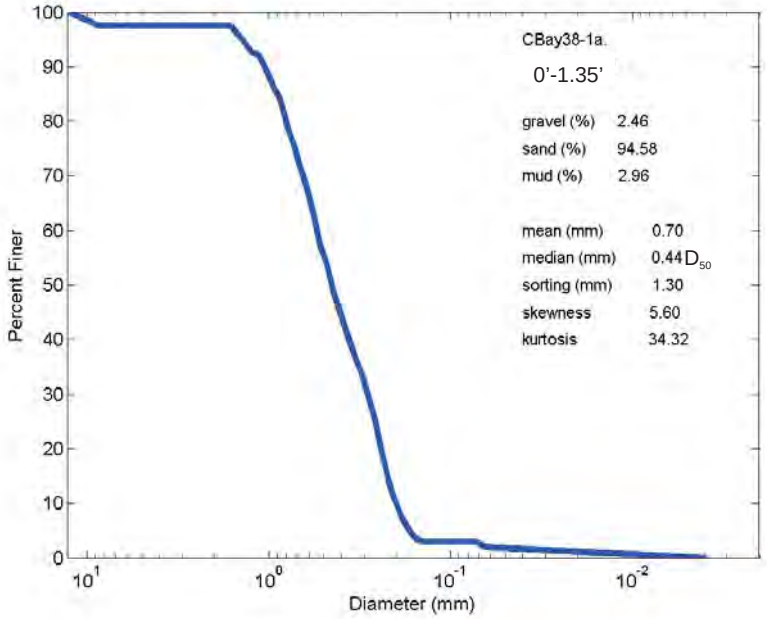

ChesBay_ 36-3b.
13.2'-15'
gravel (%) 1.54
sand (%) 92.25
mud (%) 6.21
mean (mm) 0.53
median (mm) 0.34 D_{50}
sorting (mm) 1.06
skewness 6.93
kurtosis 52.42
Percent Finer
Diameter (mm)

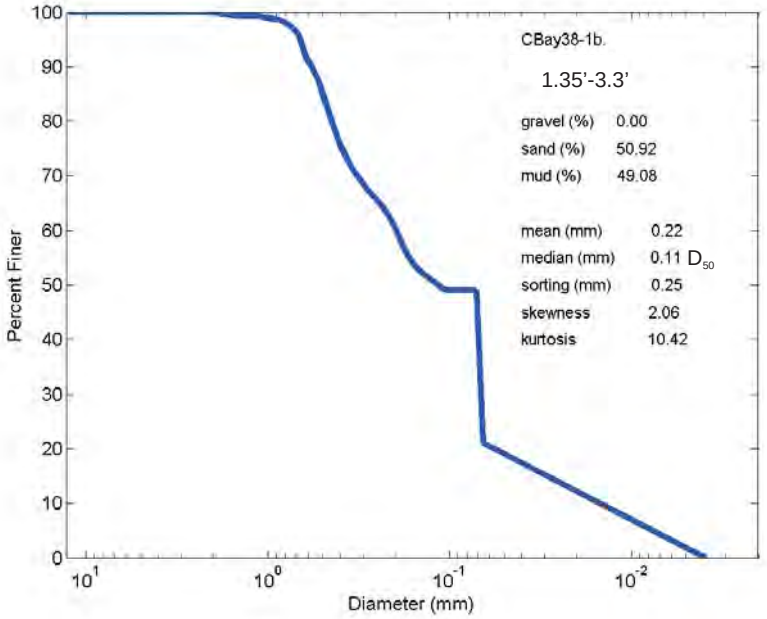

ChesBay 36-4a.
15'-17.6'
gravel (%) 2.15
sand (%) 94.54
mud (%) 3.32
mean (mm) 0.64
median (mm) 0.37 D_{50}
sorting (mm) 1.22
skewness 5.98
kurtosis 38.97
Percent Finer
Diameter (mm)

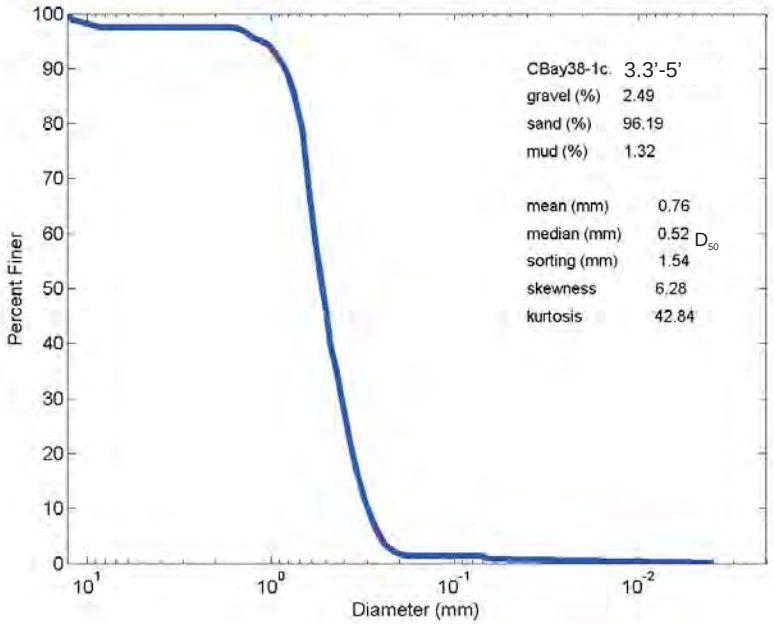

ChesBay 36-4b.
17.6'-21'
gravel (%) 0.00
sand (%) 30.00
mud (%) 69.99
mean (mm) 0.08
median (mm) 0.07 D_{50}
sorting (mm) 0.19
skewness 12.87
kurtosis 205.40
Percent Finer
Diameter (mm)

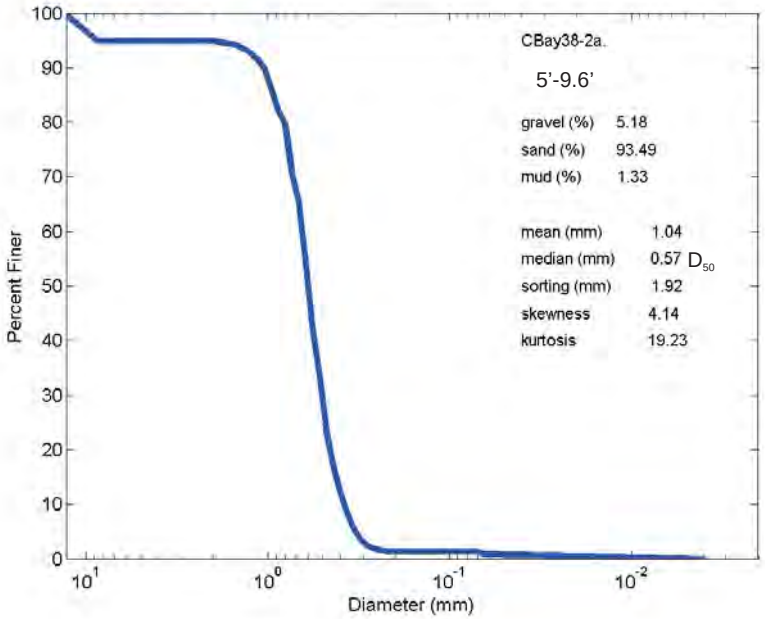

ChesBay-37-1a.
0'-5'
gravel (%) 1.05
sand (%) 98.11
mud (%) 0.84
mean (mm) 0.59
median (mm) 0.40 D50
sorting (mm) 0.87
skewness 8.21
kurtosis 75.12
Percent Finer
Diameter (mm)

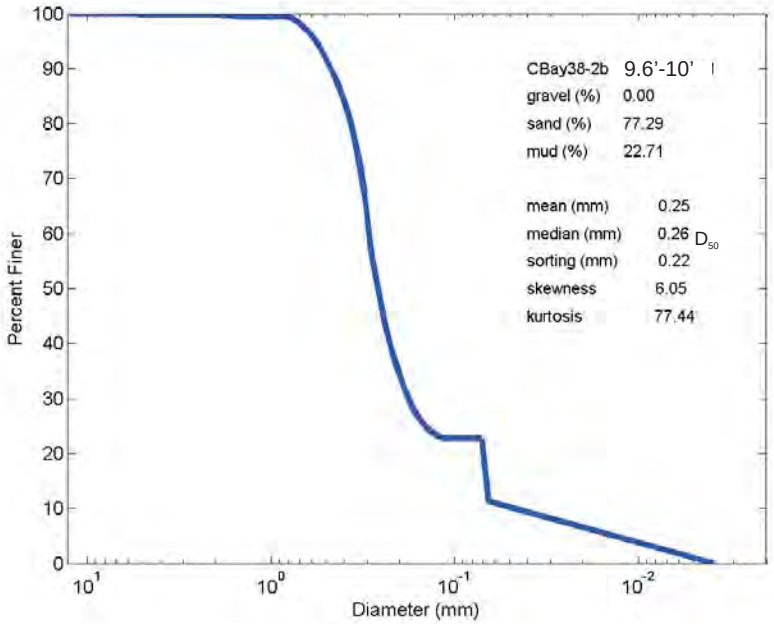

ChesBay-37-2a.
5'-9.6'
gravel (%) 0.98
sand (%) 97.58
mud (%) 1.44
mean (mm) 0.69
median (mm) 0.62 D50
sorting (mm) 0.86
skewness 7.93
kurtosis 72.52
Percent Finer
Diameter (mm)

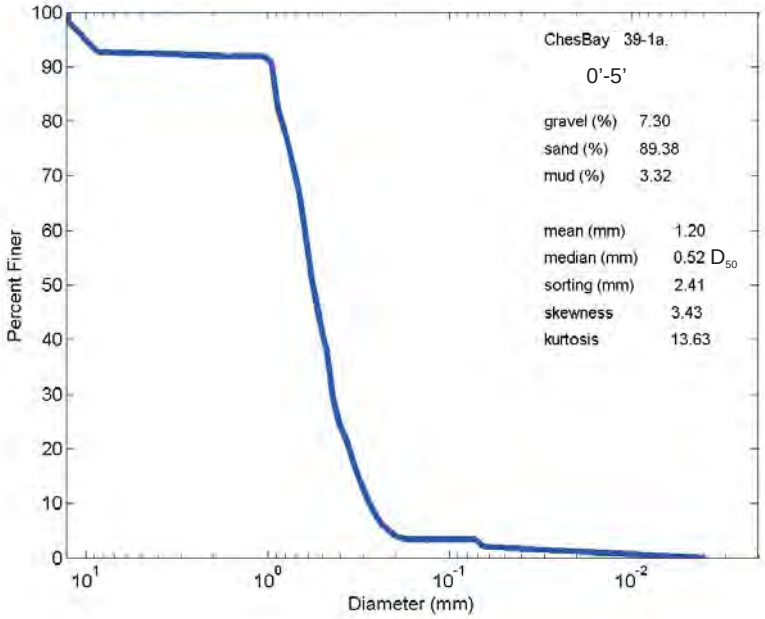

CBay38-1a.
0'-1.35'
gravel (%) 2.46
sand (%) 94.58
mud (%) 2.96
mean (mm) 0.70
median (mm) 0.44 D50
sorting (mm) 1.30
skewness 5.60
kurtosis 34.32
Percent Finer
Diameter (mm)

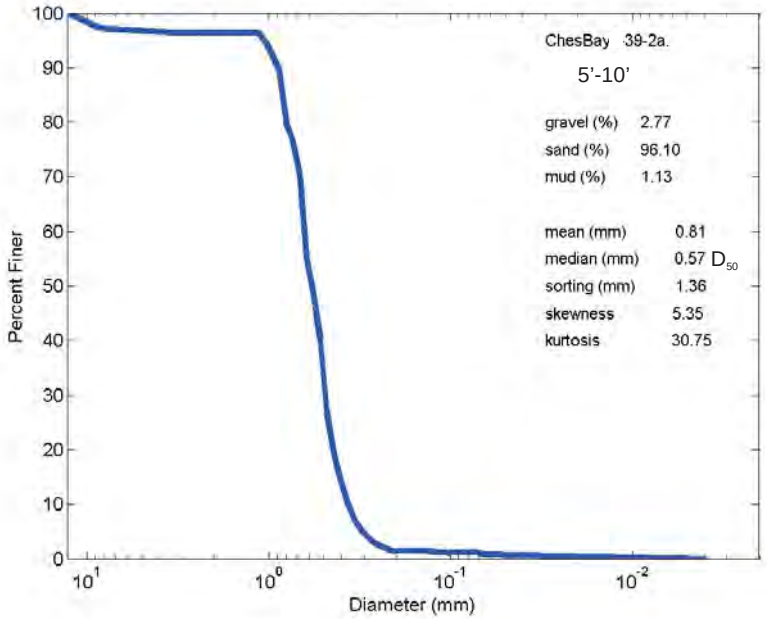

CBay38-1b.
1.35'-3.3'
gravel (%) 0.00
sand (%) 50.92
mud (%) 49.08
mean (mm) 0.22
median (mm) 0.11 D50
sorting (mm) 0.25
skewness 2.06
kurtosis 10.42
Percent Finer
Diameter (mm)

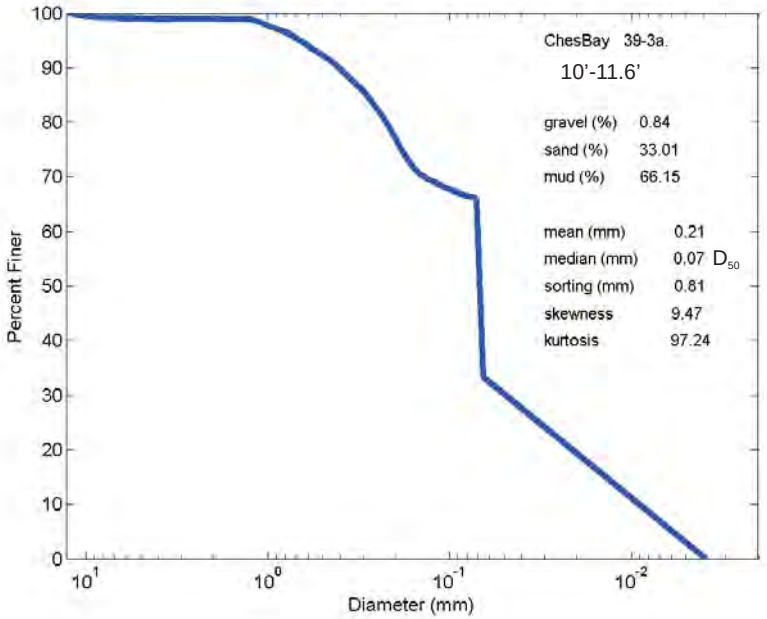

CBay38-1c. 3.3'-5'
gravel (%) 2.49
sand (%) 96.19
mud (%) 1.32
mean (mm) 0.76
median (mm) 0.52 D50
sorting (mm) 1.54
skewness 6.28
kurtosis 42.84
Percent Finer
Diameter (mm)

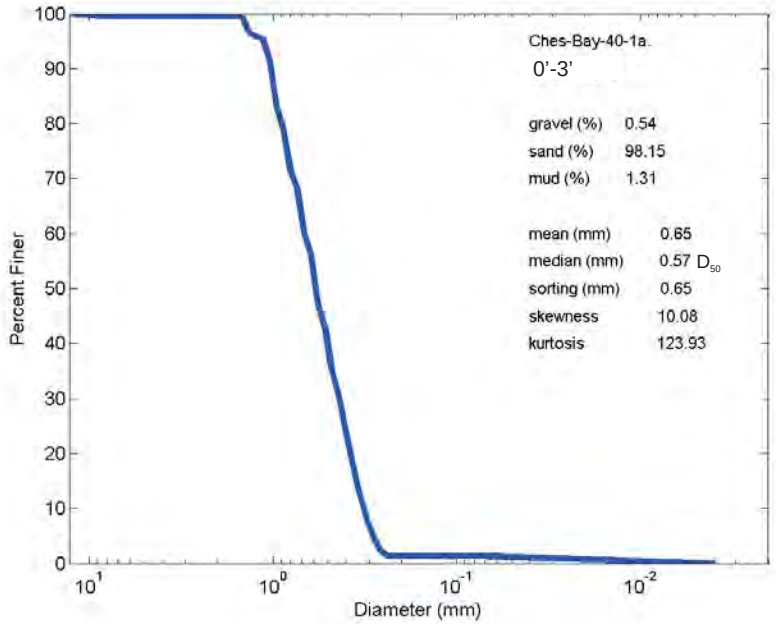

CBay38-2a.
5'-9.6'
gravel (%) 5.18
sand (%) 93.49
mud (%) 1.33
mean (mm) 1.04
median (mm) 0.57 D50
sorting (mm) 1.92
skewness 4.14
kurtosis 19.23
Percent Finer
Diameter (mm)

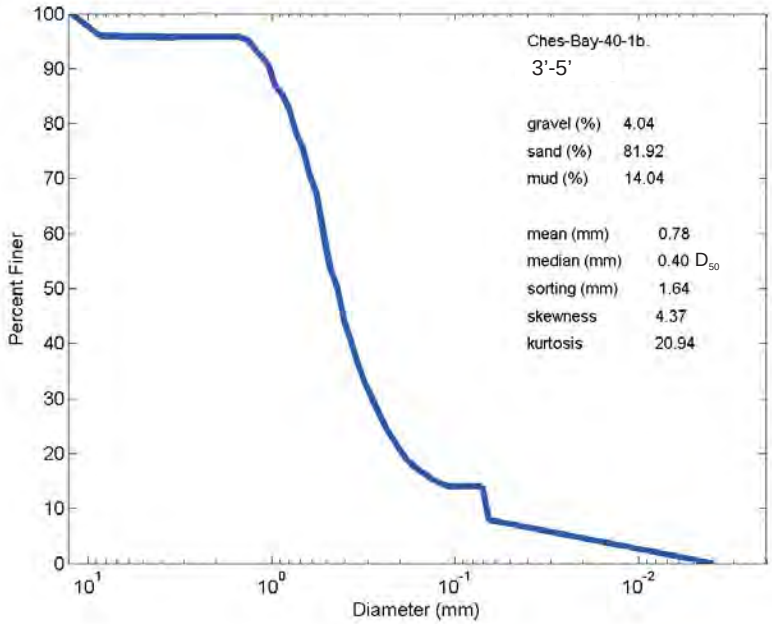

CBay38-2b 9.6'-10'
gravel (%) 0.00
sand (%) 77.29
mud (%) 22.71
mean (mm) 0.25
median (mm) 0.26 D50
sorting (mm) 0.22
skewness 6.05
kurtosis 77.44
Percent Finer
Diameter (mm)

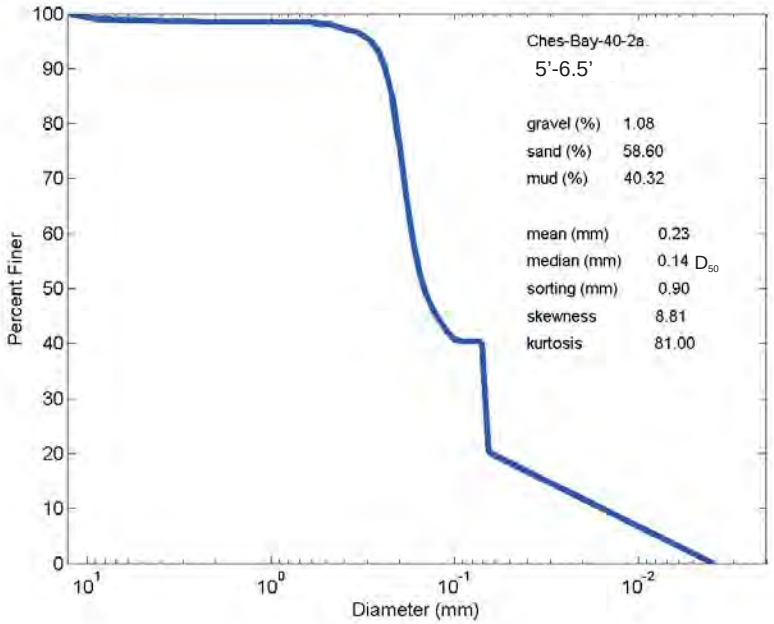

ChesBay 39-1a.
0'-5'
gravel (%) 7.30
sand (%) 89.38
mud (%) 3.32
mean (mm) 1.20
median (mm) 0.52 D50
sorting (mm) 2.41
skewness 3.43
kurtosis 13.63
Percent Finer
Diameter (mm)

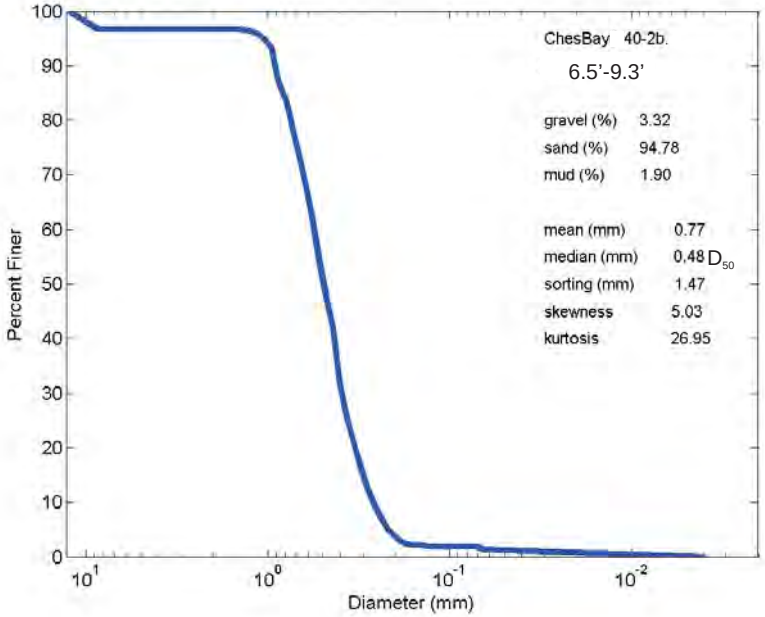

ChesBay 39-2a.
5'-10'
gravel (%) 2.77
sand (%) 96.10
mud (%) 1.13
mean (mm) 0.81
median (mm) 0.57 D50
sorting (mm) 1.36
skewness 5.35
kurtosis 30.75
Percent Finer
Diameter (mm)

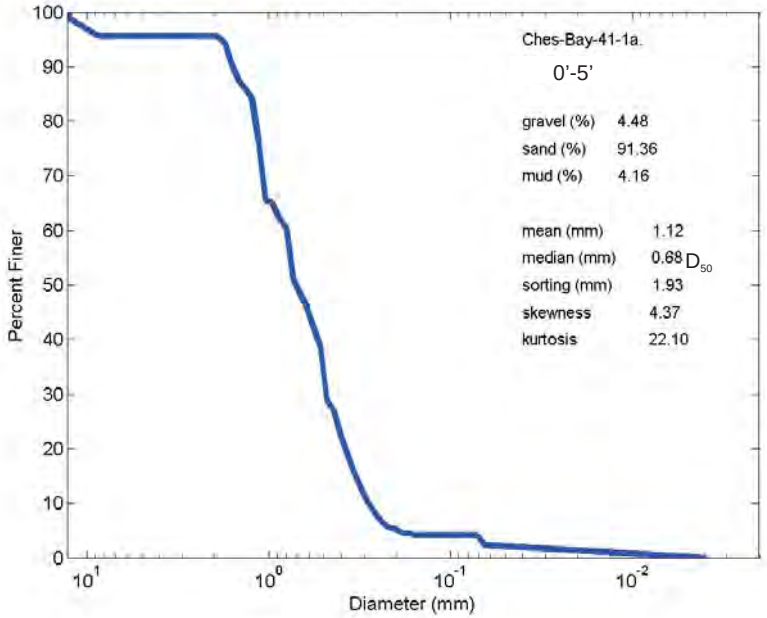

ChesBay 39-3a.
10'-11.6'
gravel (%) 0.84
sand (%) 33.01
mud (%) 66.15
mean (mm) 0.21
median (mm) 0.07 D50
sorting (mm) 0.81
skewness 9.47
kurtosis 97.24
Percent Finer
Diameter (mm)

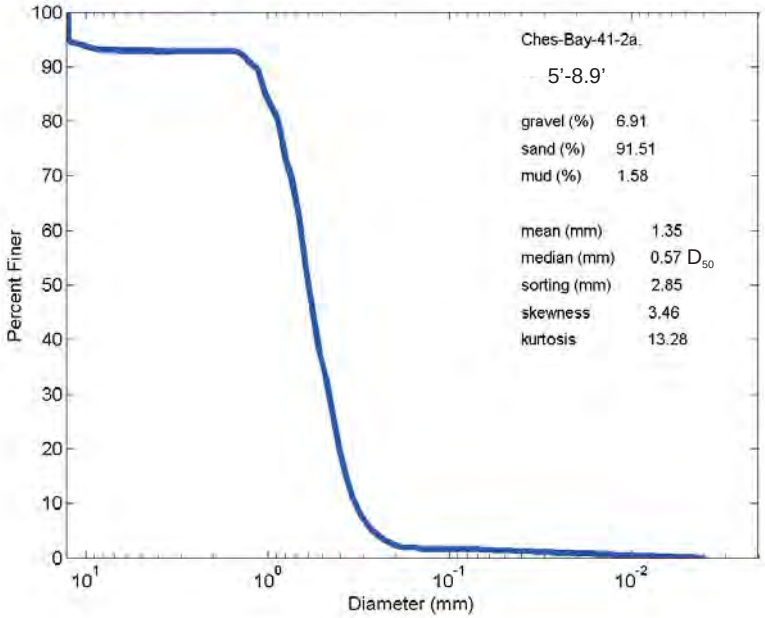

Ches-Bay-40-1a.
0'-3'
gravel (%) 0.54
sand (%) 98.15
mud (%) 1.31
mean (mm) 0.65
median (mm) 0.57 D50
sorting (mm) 0.65
skewness 10.08
kurtosis 123.93
Percent Finer
Diameter (mm)

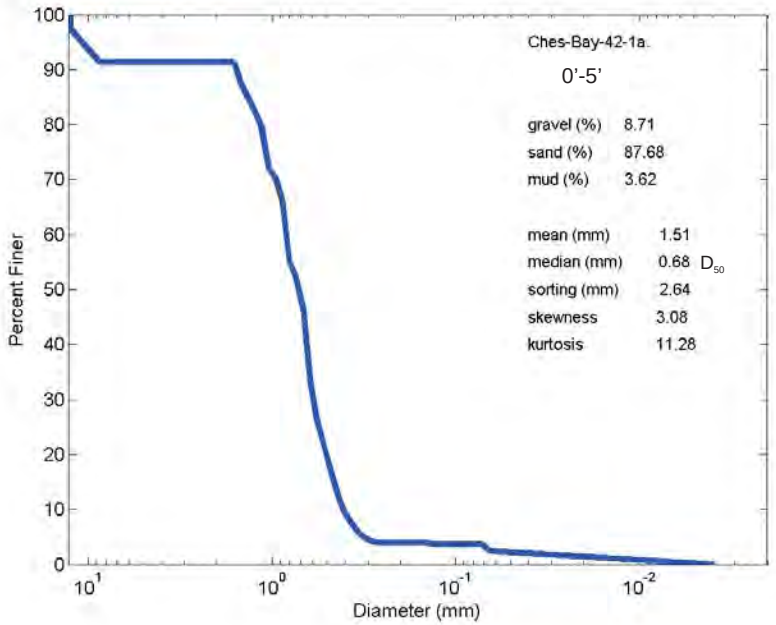

Ches-Bay-40-1b.
3'-5'
gravel (%) 4.04
sand (%) 81.92
mud (%) 14.04
mean (mm) 0.78
median (mm) 0.40 D50
sorting (mm) 1.64
skewness 4.37
kurtosis 20.94
Percent Finer
Diameter (mm)

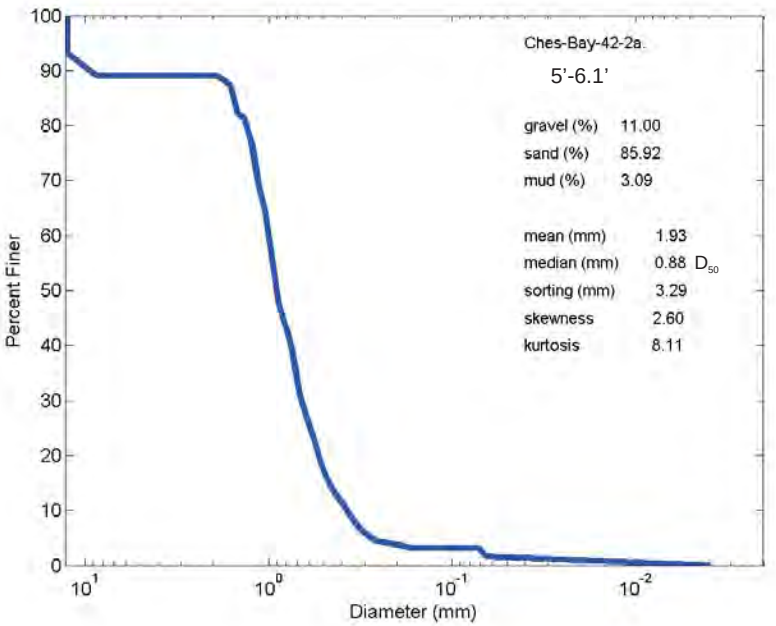

Ches-Bay-40-2a.
5'-6.5'
gravel (%) 1.08
sand (%) 58.60
mud (%) 40.32
mean (mm) 0.23
median (mm) 0.14 D50
sorting (mm) 0.90
skewness 8.81
kurtosis 81.00
Percent Finer
Diameter (mm)

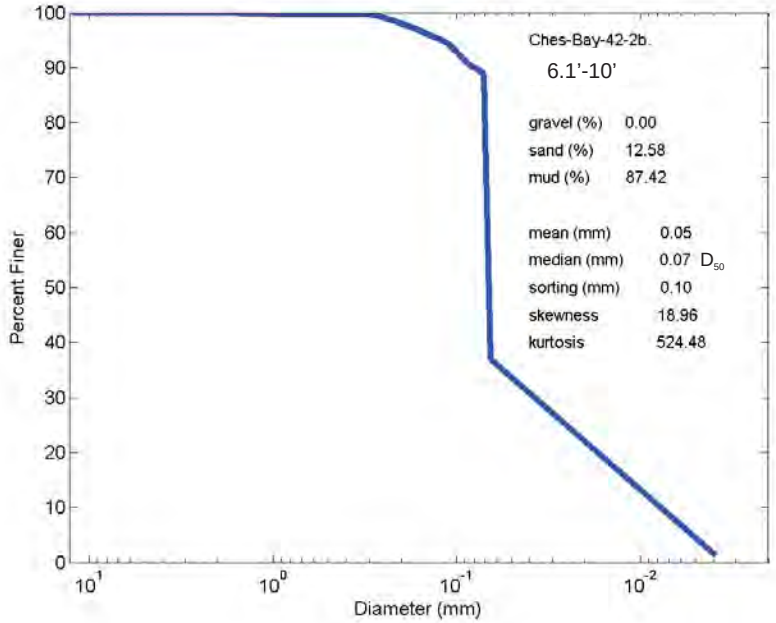

ChesBay 40-2b.
6.5'-9.3'
gravel (%) 3.32
sand (%) 94.78
mud (%) 1.90
mean (mm) 0.77
median (mm) 0.48 D50
sorting (mm) 1.47
skewness 5.03
kurtosis 26.95
Percent Finer
Diameter (mm)

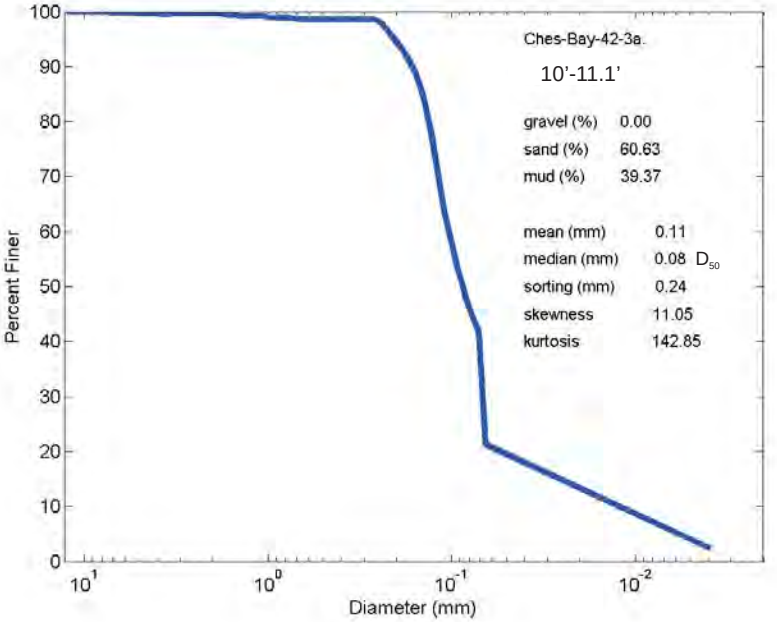

Ches-Bay-41-1a.
0'-5'
gravel (%) 4.48
sand (%) 91.36
mud (%) 4.16
mean (mm) 1.12
median (mm) 0.68 D50
sorting (mm) 1.93
skewness 4.37
kurtosis 22.10
Percent Finer
Diameter (mm)


Ches-Bay-41-2a.
5'-8.9'
gravel (%) 6.91
sand (%) 91.51
mud (%) 1.58
mean (mm) 1.35
median (mm) 0.57 D50
sorting (mm) 2.85
skewness 3.46
kurtosis 13.28
Percent Finer
Diameter (mm)


Ches-Bay-42-1a.
0'-5'
gravel (%) 8.71
sand (%) 87.68
mud (%) 3.62
mean (mm) 1.51
median (mm) 0.68 D50
sorting (mm) 2.64
skewness 3.08
kurtosis 11.28
Percent Finer
Diameter (mm)


Ches-Bay-42-2a.
5'-6.1'
gravel (%) 11.00
sand (%) 85.92
mud (%) 3.09
mean (mm) 1.93
median (mm) 0.88 D50
sorting (mm) 3.29
skewness 2.60
kurtosis 8.11
Percent Finer
Diameter (mm)

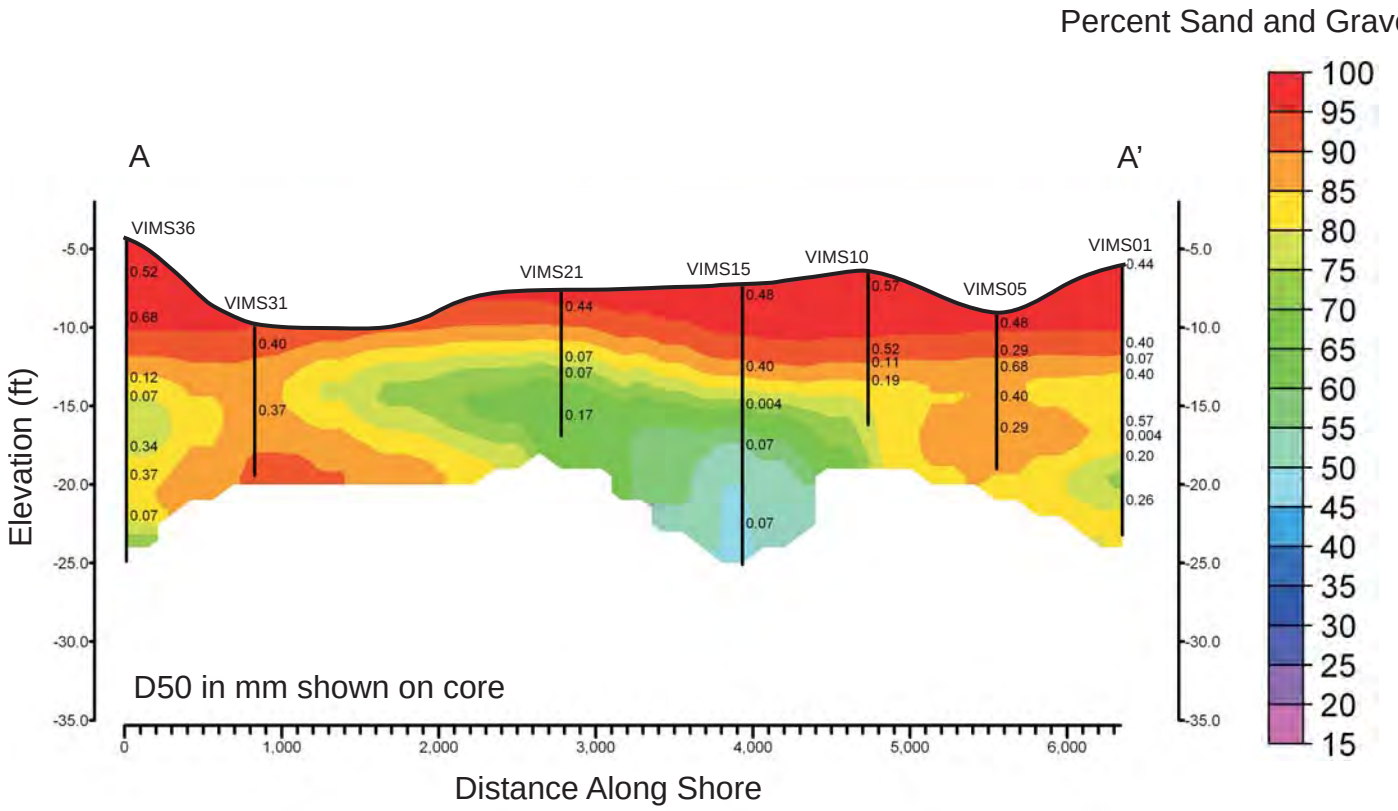

Ches-Bay-42-2b.
6.1'-10'
gravel (%) 0.00
sand (%) 12.58
mud (%) 87.42
mean (mm) 0.05
median (mm) 0.07 D50
sorting (mm) 0.10
skewness 18.96
kurtosis 524.48
Percent Finer
Diameter (mm)


Ches-Bay-42-3a.
10'-11.1'
gravel (%) 0.00
sand (%) 60.63
mud (%) 39.37
mean (mm) 0.11
median (mm) 0.08 D50
sorting (mm) 0.24
skewness 11.05
kurtosis 142.85
Percent Finer
Diameter (mm)

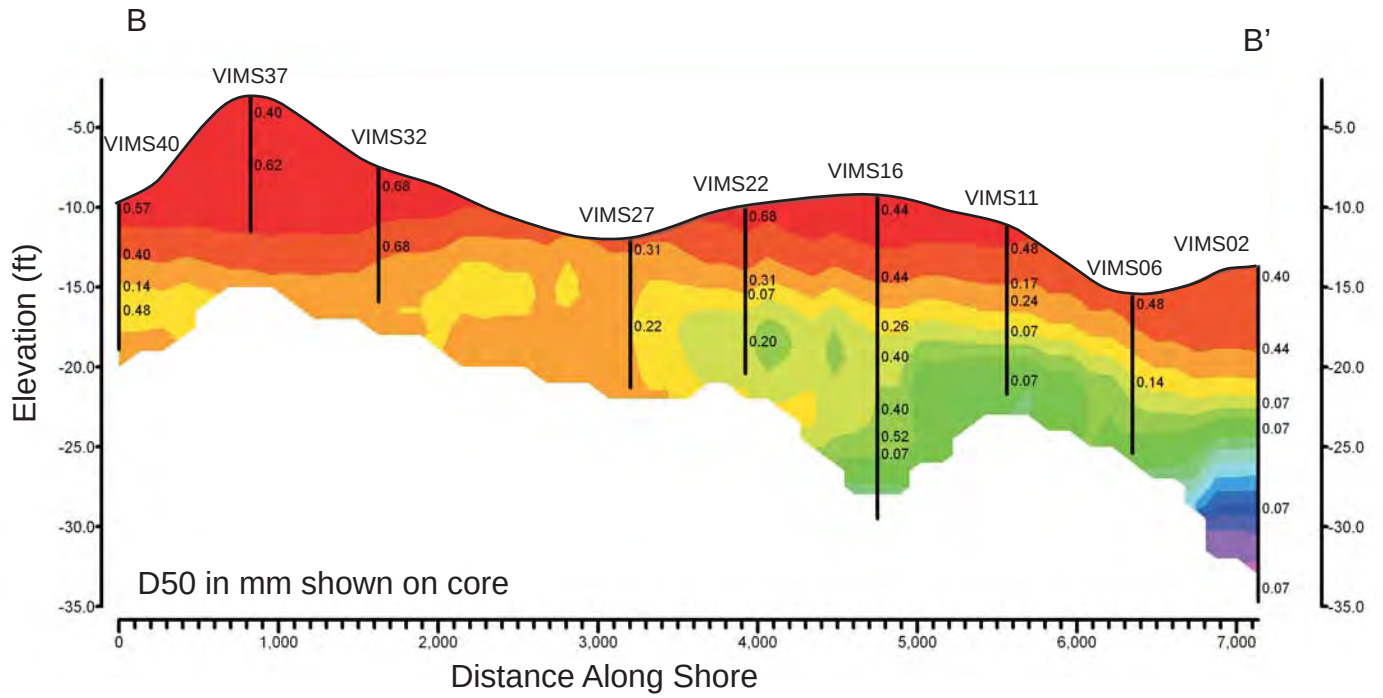
Appendix E

Sub-Bottom Cross-Sections derived from Core Data

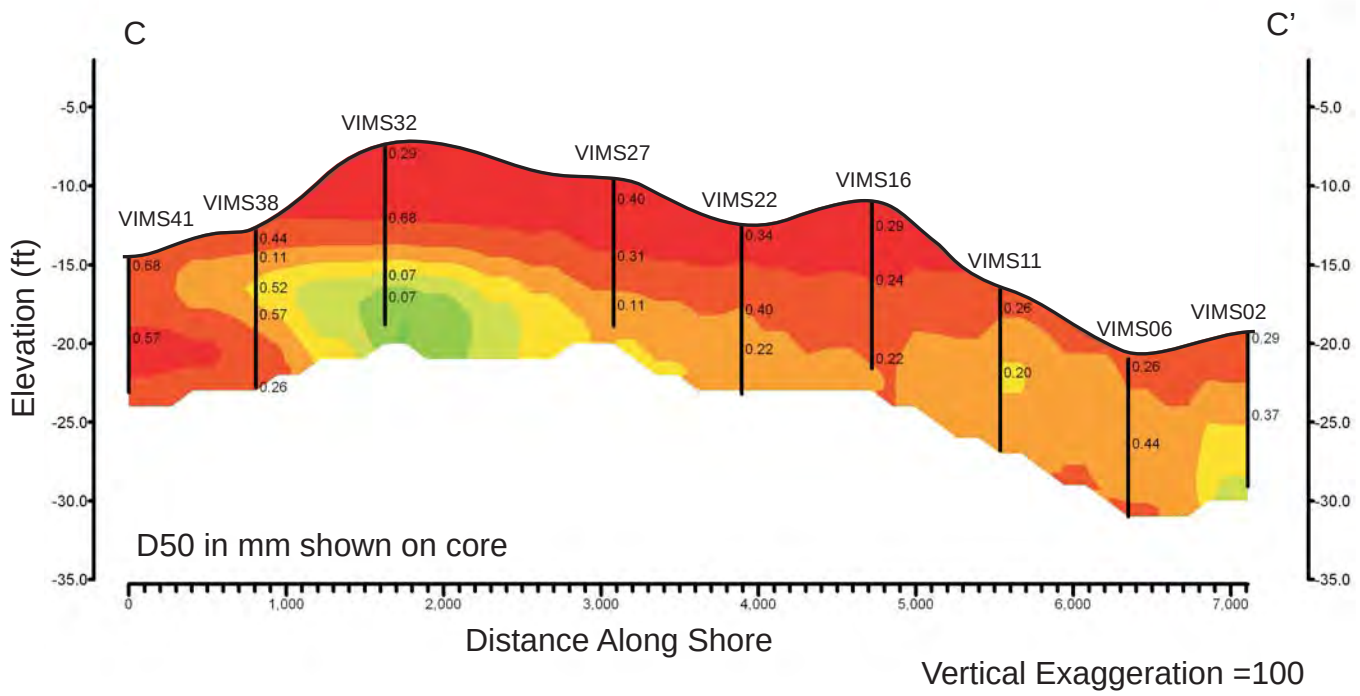
Cross Section Locations
BoreholeLocations
10' Cores
20' Cores
N
VIMS-42
VIMS-35
VIMS-25
VIMS-20
VIMS-39
VIMS-34
VIMS-26
VIMS-14
VIMS-41
VIMS-38
VIMS-29
VIMS-19
VIMS-33
VIMS-24
VIMS-09
VIMS-40
VIMS-37
VIMS-18
VIMS-28
VIMS-13
VIMS-32
VIMS-23
VIMS-08
VIMS-04
VIMS-36
VIMS-30
VIMS-27
VIMS-17
VIMS-31
VIMS-22
VIMS-12
VIMS-07
VIMS-16
VIMS-03
VIMS-21
VIMS-11
VIMS-06
VIMS-15
VIMS-02
VIMS-10
VIMS-05
VIMS-01
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
A'
B'
C'
D'
E'
F'
G'
H'
I'
J'
K'
L'
M'
N'
O'

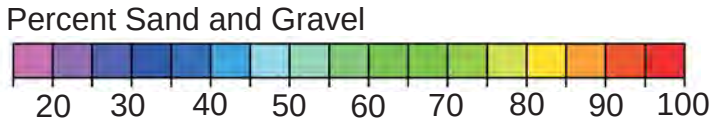


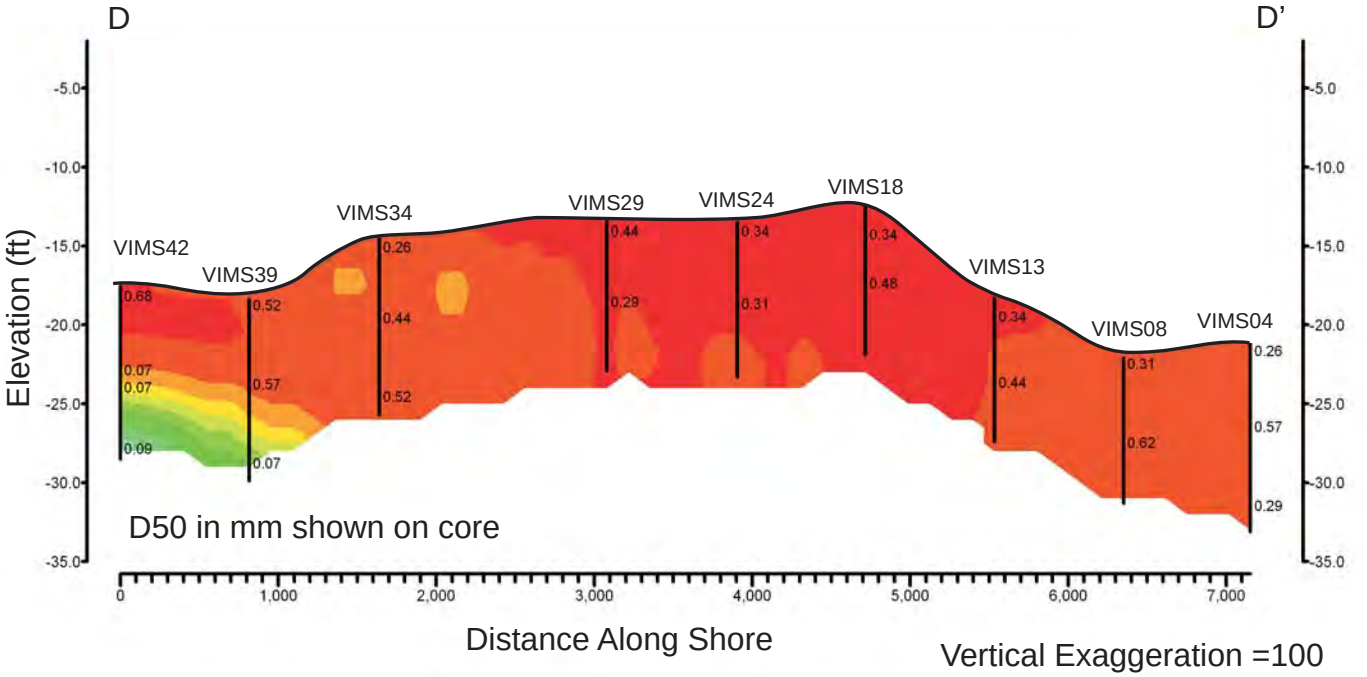
Vertical Exaggeration =100

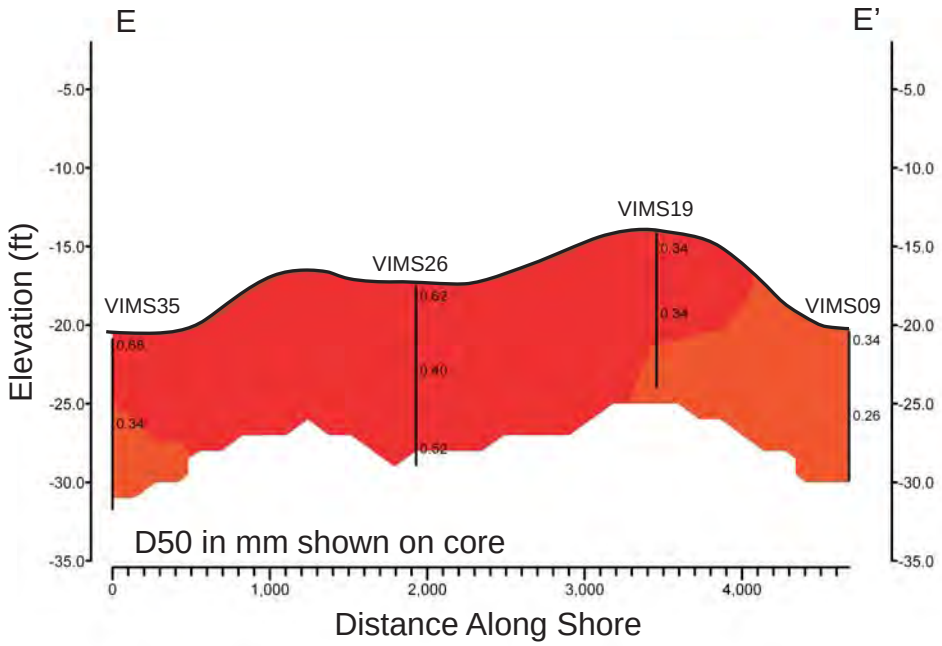


Vertical Exaggeration =100

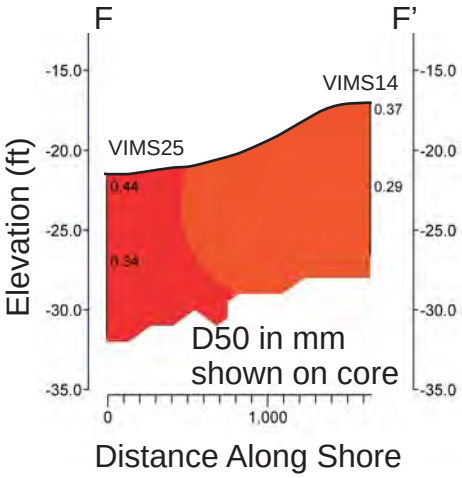

C
C'
VIMS41
VIMS38
VIMS32
VIMS27
VIMS22
VIMS16
VIMS11
VIMS06
VIMS02
Elevation (ft)
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
0.68
0.57
0.44
0.11
0.52
0.57
0.26
0.29
0.68
0.07
0.07
0.40
0.31
0.11
0.34
0.40
0.22
0.29
0.24
0.22
0.26
0.20
0.26
0.44
0.29
0.37
D50 in mm shown on core
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Distance Along Shore
Vertical Exaggeration =100


Percent Sand and Gravel
20
30
40
50
60
70
80
90
100

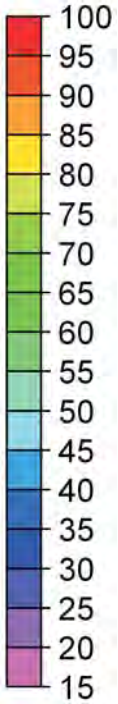

D
D'
VIMS42
VIMS39
VIMS34
VIMS29
VIMS24
VIMS18
VIMS13
VIMS08
VIMS04
Elevation (ft)
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
0.68
0.07
0.07
0.09
0.52
0.57
0.07
0.26
0.44
0.52
0.44
0.29
0.34
0.31
0.34
0.48
0.34
0.44
0.31
0.62
0.26
0.57
0.29
D50 in mm shown on core
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Distance Along Shore
Vertical Exaggeration =100

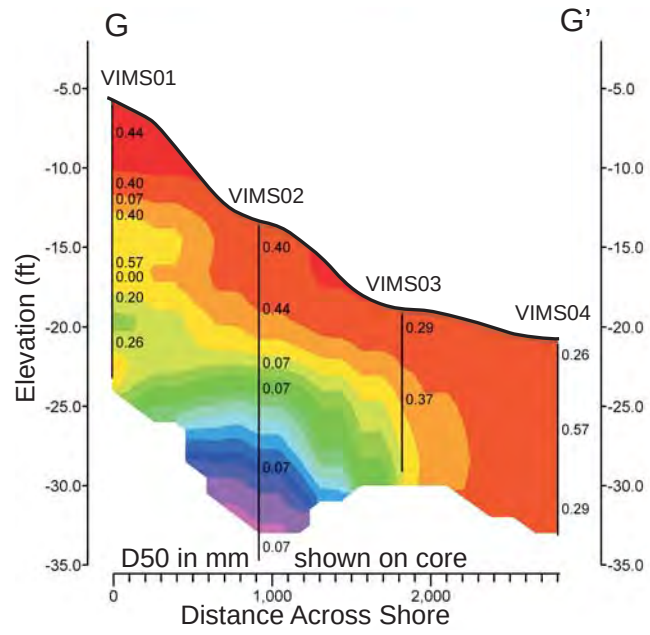


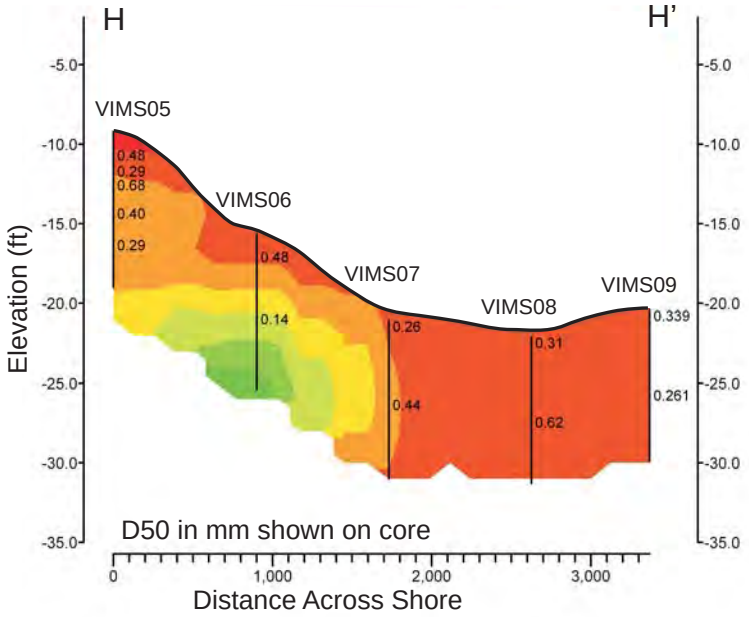
Vertical Exaggeration =100

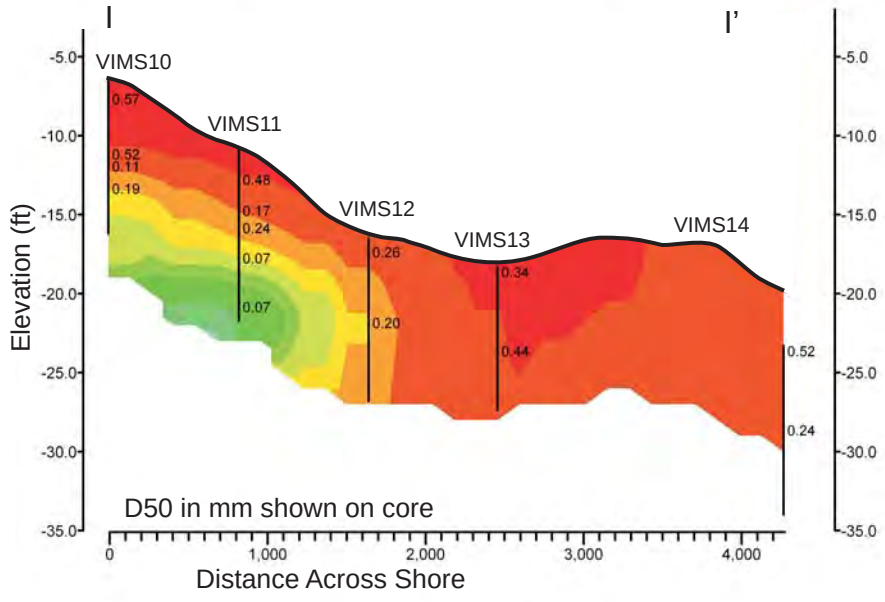


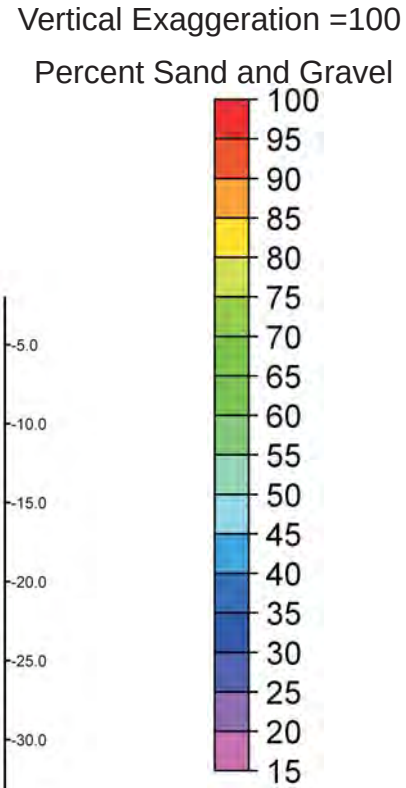
Percent Sand and Gravel

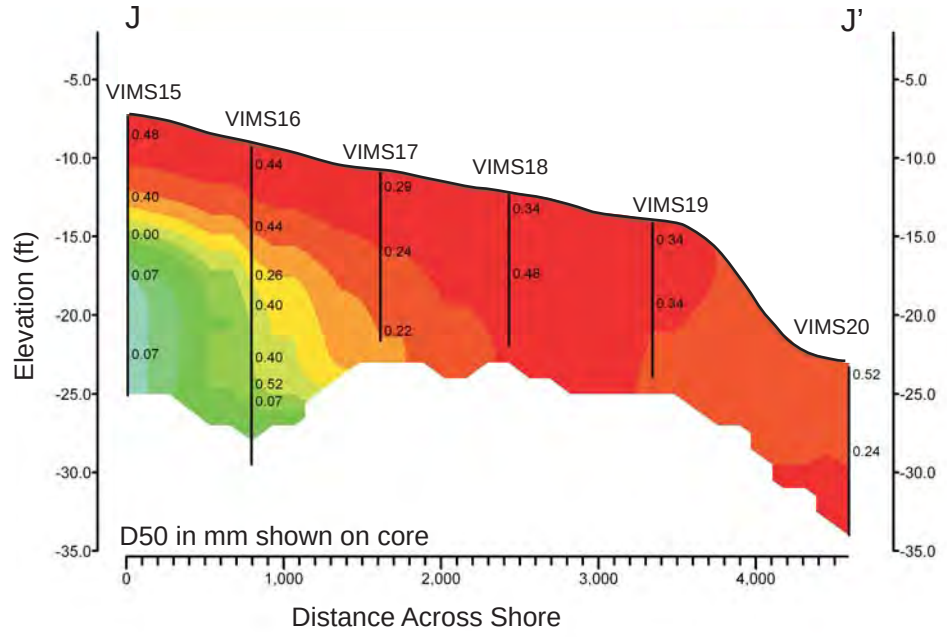


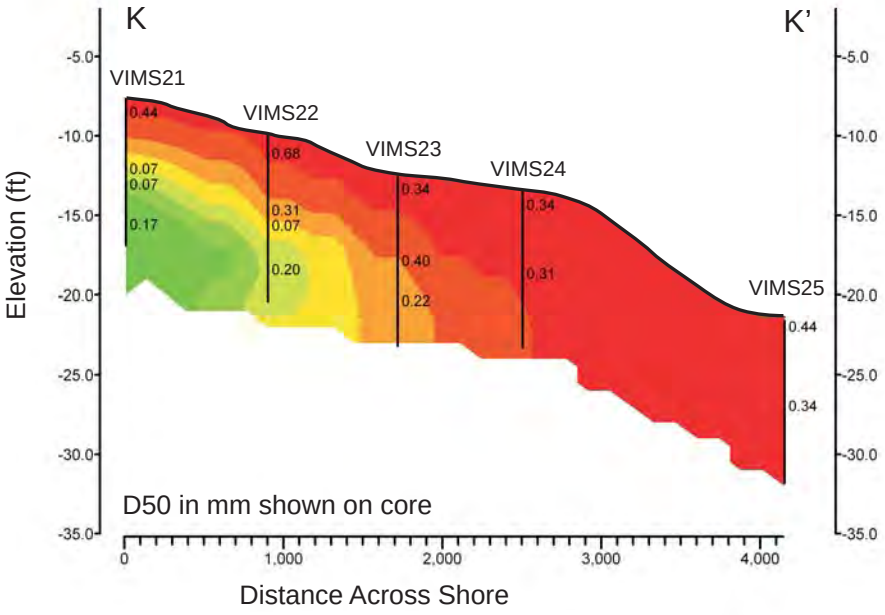

G
G'
VIMS01
VIMS02
VIMS03
VIMS04
Elevation (ft)
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
0.44
0.40
0.07
0.40
0.57
0.00
0.20
0.26
0.40
0.44
0.07
0.07
0.07
0.07
0.29
0.37
0.26
0.57
0.29
D50 in mm shown on core
0
1,000
2,000
Distance Across Shore

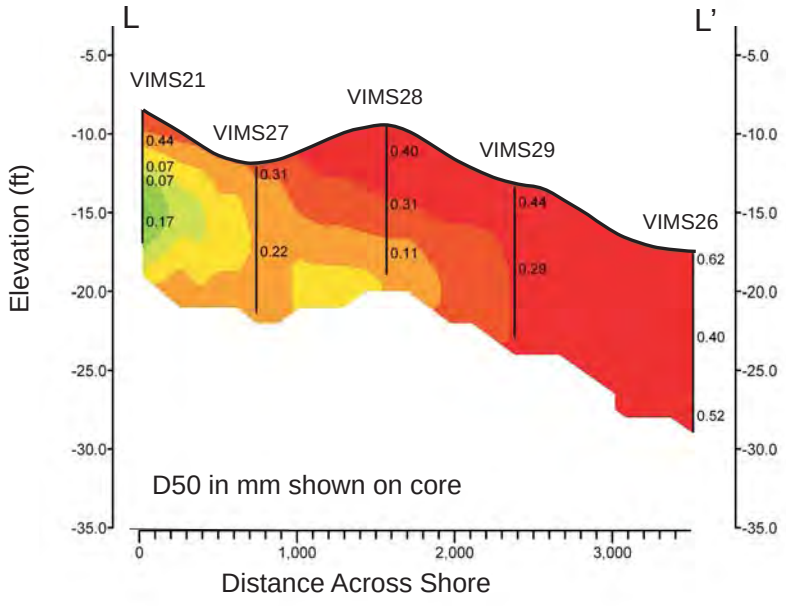

H
H'
VIMS05
VIMS06
VIMS07
VIMS08
VIMS09
Elevation (ft)
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
0.48
0.29
0.68
0.40
0.29
0.48
0.14
0.26
0.44
0.31
0.62
0.339
0.261
D50 in mm shown on core
0
1,000
2,000
3,000
Distance Across Shore


I
I'
VIMS10
VIMS11
VIMS12
VIMS13
VIMS14
Elevation (ft)
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
0.57
0.52
0.11
0.19
0.48
0.17
0.24
0.07
0.07
0.26
0.20
0.34
0.44
0.52
0.24
D50 in mm shown on core
0
1,000
2,000
3,000
4,000
Distance Across Shore


Vertical Exaggeration =100
Percent Sand and Gravel
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15

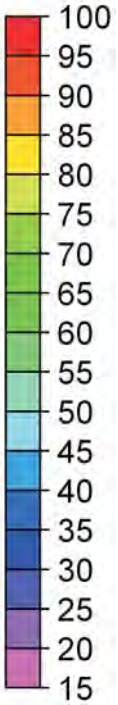


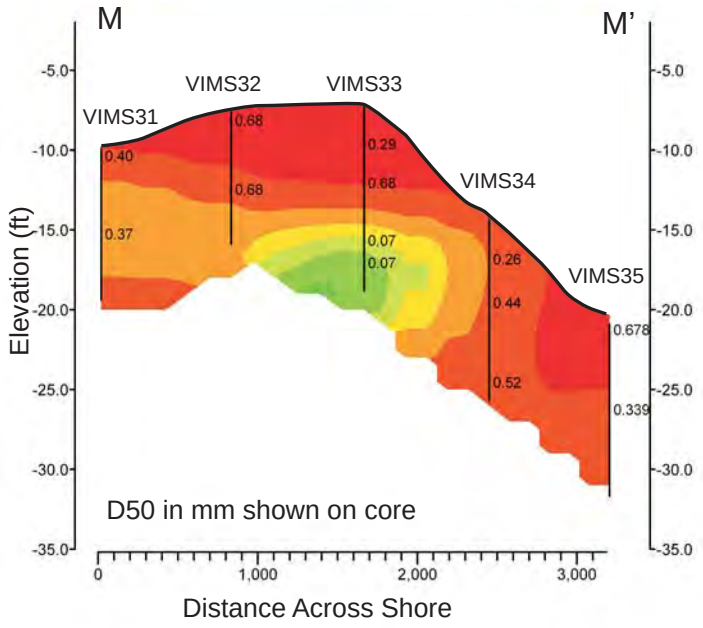


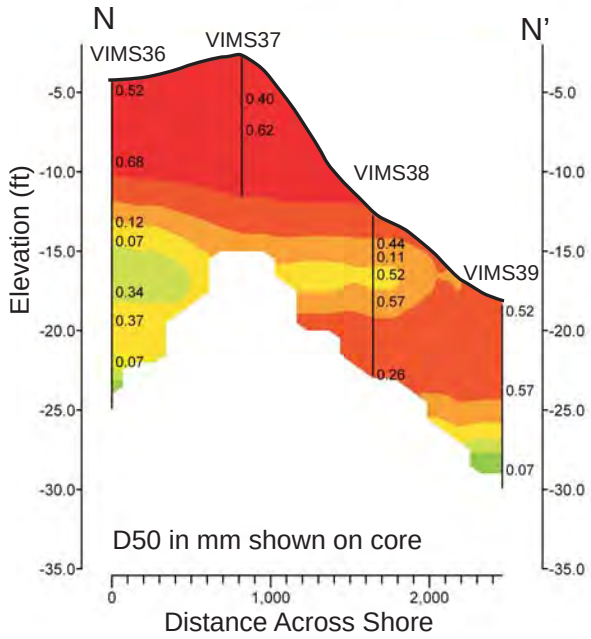


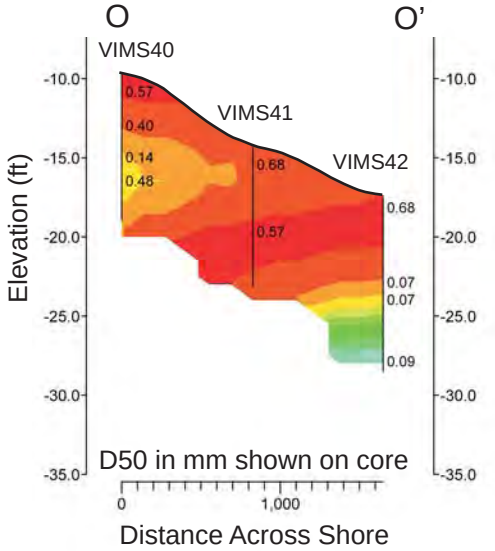
Vertical Exaggeration =100

Percent Sand and Gravel



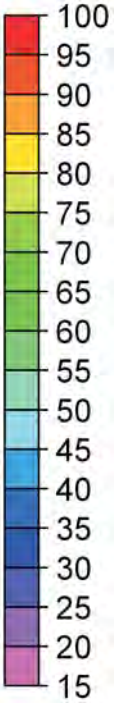






Vertical Exaggeration =100

Percent Sand and Gravel



Appendix F

Wave Modeling Result Summary

For wave height, positive differences indicate that the wave height is larger, while negative differences indicate a reduction in wave height. For wave angle, positive values indicate that the wave will have a more westerly heading while negative values indicate the waves become more easterly.

North

Station	UTM, NAD83 meters, zone 18N		Water Depth	Change in Height (m)		Change in Direction (deg)	
Number	X	Y	(m)	5ft-exist	10ft-exist	5ft-exist	10ft-exist
1	396009	4087636	-3.4	0.00	0.01	0.00	0.00
2	396040	4087518	-1.0	0.00	0.00	0.00	0.00
3	396212	4087583	-3.3	0.00	0.00	0.00	0.00
4	396282	4087433	-1.1	0.00	0.00	0.00	0.00
5	396600	4087532	-5.0	0.00	0.00	0.00	1.00
6	396613	4087377	-1.1	0.00	0.00	0.00	0.00
7	396945	4087477	-5.7	0.00	0.00	0.00	0.00
8	396973	4087323	-1.2	0.00	0.00	0.00	0.00
9	397257	4087398	-5.6	0.01	0.01	0.00	0.00
10	397300	4087231	-1.2	0.00	0.00	0.00	0.00
11	397584	4087320	-4.9	0.00	0.01	0.00	0.00
12	397642	4087140	-1.1	0.01	0.01	1.00	1.00
13	397966	4087247	-3.7	0.02	0.02	0.00	0.00
14	397985	4087035	-1.1	0.00	0.00	0.00	1.00
15	399252	4088530	-10.0	0.00	0.00	0.00	0.00
16	399158	4088231	-9.6	0.00	0.00	0.00	0.00
17	399035	4088007	-8.2	0.00	0.00	0.00	0.00
18	398984	4087868	-7.6	0.00	0.00	0.00	0.00
19	398879	4087682	-6.5	0.00	0.01	0.00	1.00
20	398432	4087117	-3.6	0.02	0.03	1.00	2.00
21	399590	4088404	-10.1	0.00	0.00	0.00	0.00
22	398395	4086965	-1.1	0.00	0.00	0.00	1.00
23	398830	4087436	-5.1	0.01	0.02	2.00	3.00
24	399449	4088143	-9.5	0.00	0.00	0.00	0.00
25	398793	4087284	-5.3	-0.04	-0.08	2.00	3.00
26	399413	4087913	-8.0	0.00	0.00	0.00	0.00
27	398771	4087133	-3.3	0.00	-0.03	2.00	2.00
28	399326	4087763	-7.0	0.02	0.03	1.00	2.00
29	398762	4086997	-2.6	0.15	0.01	9.00	3.00
30	399307	4087584	-6.0	0.03	0.06	0.00	1.00
31	398755	4086833	-1.0	0.00	0.00	5.00	1.00
32	399226	4087364	-4.0	0.01	-0.01	2.00	2.00
33	399975	4088225	-10.4	0.00	0.00	0.00	0.00
34	399208	4087171	-2.5	0.00	0.06	2.00	2.00
35	399164	4087025	-3.4	0.05	0.04	-2.00	2.00
36	399943	4087938	-8.5	0.00	0.00	0.00	0.00
37	399874	4087747	-6.8	0.00	0.01	0.00	0.00
38	399148	4086882	-4.3	0.01	0.00	-1.00	3.00
39	399127	4086795	-3.9	-0.01	-0.01	-2.00	2.00
40	399803	4087507	-4.9	0.08	0.15	3.00	5.00
41	399104	4086630	-1.1	0.00	0.00	1.00	1.00
42	400343	4088072	-9.4	0.00	0.00	0.00	0.00
43	399715	4087293	-3.6	0.15	0.21	4.00	4.00
44	400259	4087816	-7.1	0.01	0.03	1.00	2.00
45	399703	4087030	-3.2	0.04	0.06	4.00	0.00
46	400222	4087586	-5.9	-0.01	-0.01	2.00	3.00

North

47	399623	4086810	-3.8	0.05	-0.03	1.00	3.00
48	400171	4087354	-5.3	0.00	0.00	0.00	1.00
49	399593	4086665	-3.4	0.06	-0.02	0.00	2.00
50	399596	4086545	-3.1	0.04	-0.04	0.00	1.00
51	400742	4087894	-8.7	0.00	0.00	0.00	0.00
52	400114	4087115	-5.1	0.00	-0.02	-2.00	-1.00
53	399566	4086400	-1.0	0.00	0.00	1.00	0.00
54	400638	4087615	-6.6	-0.01	0.00	-1.00	-2.00
55	400078	4086885	-3.9	-0.01	-0.14	-2.00	3.00
56	400581	4087376	-5.9	-0.02	-0.03	-1.00	-2.00
57	400018	4086674	-2.9	-0.01	-0.12	0.00	1.00
58	400987	4087767	-8.4	0.00	0.00	0.00	0.00
59	399966	4086534	-3.2	0.01	-0.04	2.00	-2.00
60	400560	4087133	-6.1	-0.04	-0.05	-2.00	-4.00
61	399943	4086398	-2.5	0.01	-0.02	5.00	-1.00
62	400903	4087511	-7.1	0.02	0.04	-1.00	-3.00
63	399926	4086268	-1.1	0.00	0.00	3.00	0.00
64	400847	4087257	-6.2	0.05	0.08	-2.00	-3.00
65	400546	4086883	-6.3	-0.02	-0.05	-2.00	0.00
66	400522	4086668	-5.6	-0.01	-0.02	-1.00	0.00
67	400849	4086995	-6.6	0.04	0.06	-4.00	-7.00
68	401351	4087578	-8.1	0.00	0.00	0.00	0.00
69	400492	4086446	-4.2	0.01	0.00	-1.00	-2.00
70	400819	4086772	-6.2	0.02	0.03	-1.00	-2.00
71	400467	4086323	-2.2	0.08	0.00	-3.00	-1.00
72	401320	4087292	-7.1	0.01	0.01	0.00	0.00
73	400407	4086204	-3.0	0.10	-0.01	0.00	-1.00
74	400381	4086095	-1.0	0.00	0.00	0.00	-1.00
75	400802	4086551	-4.8	0.00	-0.03	-2.00	-1.00
76	401282	4086997	-7.0	0.00	0.01	0.00	-1.00
77	400754	4086369	-3.6	-0.03	-0.07	-3.00	-1.00
78	400746	4086219	-2.7	-0.09	-0.05	-6.00	0.00
79	401258	4086782	-6.9	0.03	0.04	-2.00	-2.00
80	400707	4086095	-2.2	-0.11	-0.02	-5.00	0.00
81	401232	4086595	-5.9	0.04	0.06	-2.00	-3.00
82	400699	4085946	-0.9	1.01	1.01	-3.00	0.00
83	401210	4086430	-5.0	0.06	0.10	-4.00	-6.00
84	401164	4086235	-3.7	0.03	0.03	-2.00	-3.00
85	401114	4086067	-2.7	0.02	0.00	-2.00	-1.00
86	401071	4085930	-1.7	0.01	0.00	-3.00	0.00
87	401057	4085828	-1.1	0.00	0.00	-2.00	0.00
88	401408	4085859	-1.4	0.01	0.01	-3.00	-4.00
89	401362	4085755	-1.1	0.01	0.01	-2.00	-2.00
90	401802	4085673	-1.6	0.01	0.02	0.00	-1.00
91	401734	4085560	-1.1	0.00	0.00	0.00	-1.00
92	402013	4085457	-1.0	0.00	0.00	0.00	0.00
			max	1.01	1.01	9.00	5.00
			min	-0.11	-0.14	-6.00	-7.00
			avg	0.02	0.02	-0.16	0.01

Northeast

Station	UTM, NAD83		Water Dpth	Change in Height (m)		Change in Direction (deg)	
Number	X	Y	(m)	5ft-exist	10ft-exist	5ft-exist	10ft-exist
1	396009	4087636	-3.4	0.00	0.01	0.00	8.84
2	396040	4087518	-1.0	0.00	0.00	0.00	15.74
3	396212	4087583	-3.3	0.00	0.01	0.00	8.84
4	396282	4087433	-1.1	0.00	0.00	0.00	21.62
5	396600	4087532	-5.0	0.00	0.01	0.00	6.88
6	396613	4087377	-1.1	0.00	0.00	0.00	18.67
7	396945	4087477	-5.7	0.01	0.02	0.00	5.91
8	396973	4087323	-1.2	0.00	0.00	1.00	9.84
9	397257	4087398	-5.6	0.01	0.03	1.00	6.91
10	397300	4087231	-1.2	0.00	0.00	0.00	22.62
11	397584	4087320	-4.9	0.02	0.03	0.00	8.86
12	397642	4087140	-1.1	0.00	0.00	0.00	25.56
13	397966	4087247	-3.7	0.02	0.03	1.00	7.90
14	397985	4087035	-1.1	0.00	0.00	1.00	18.69
15	399252	4088530	-10.0	0.00	0.00	0.00	-3.93
16	399158	4088231	-9.6	0.00	0.00	0.00	-1.95
17	399035	4088007	-8.2	0.01	0.01	0.00	0.00
18	398984	4087868	-7.6	0.01	0.02	0.00	1.00
19	398879	4087682	-6.5	0.05	0.10	2.00	3.03
20	398432	4087117	-3.6	-0.01	-0.04	0.00	6.88
21	399590	4088404	-10.1	0.00	0.00	0.00	-3.93
22	398395	4086965	-1.1	0.00	0.00	1.00	7.86
23	398830	4087436	-5.1	-0.02	-0.05	1.00	6.90
24	399449	4088143	-9.5	0.00	0.00	0.00	-2.95
25	398793	4087284	-5.3	-0.03	-0.10	2.00	9.83
26	399413	4087913	-8.0	0.01	0.01	0.00	0.00
27	398771	4087133	-3.3	0.09	-0.05	4.00	12.81
28	399326	4087763	-7.0	0.05	0.07	3.00	2.05
29	398762	4086997	-2.6	0.25	0.01	7.00	4.98
30	399307	4087584	-6.0	0.01	0.03	2.00	4.98
31	398755	4086833	-1.0	0.00	0.00	3.00	10.83
32	399226	4087364	-4.0	0.04	-0.03	5.00	10.84
33	399975	4088225	-10.4	0.00	0.00	0.00	-2.95
34	399208	4087171	-2.5	-0.03	0.02	2.00	2.02
35	399164	4087025	-3.4	-0.04	-0.02	-4.00	-2.93
36	399943	4087938	-8.5	0.01	0.02	1.00	1.00
37	399874	4087747	-6.8	0.03	0.06	2.00	3.00
38	399148	4086882	-4.3	0.05	-0.03	-2.00	0.02
39	399127	4086795	-3.9	0.05	-0.03	-3.00	2.95
40	399803	4087507	-4.9	0.09	0.12	5.00	5.03
41	399104	4086630	-1.1	0.00	0.00	-1.00	7.88
42	400343	4088072	-9.4	0.00	0.00	0.00	-1.97
43	399715	4087293	-3.6	0.08	0.04	5.00	4.00
44	400259	4087816	-7.1	0.05	0.08	3.00	1.07
45	399703	4087030	-3.2	-0.05	0.00	5.00	-3.93
46	400222	4087586	-5.9	0.00	0.00	2.00	2.02
47	399623	4086810	-3.8	0.00	0.00	1.00	1.95

Northeast

48	400171	4087354	-5.3	0.01	0.00	1.00	0.02
49	399593	4086665	-3.4	0.05	-0.03	0.00	4.88
50	399596	4086545	-3.1	0.09	-0.03	2.00	3.91
51	400742	4087894	-8.7	0.00	0.00	0.00	-1.97
52	400114	4087115	-5.1	0.02	0.00	-1.00	-4.93
53	399566	4086400	-1.0	0.00	0.00	1.00	7.86
54	400638	4087615	-6.6	0.00	0.01	0.00	-0.98
55	400078	4086885	-3.9	0.04	-0.07	-1.00	-2.98
56	400581	4087376	-5.9	0.00	-0.01	-1.00	-1.02
57	400018	4086674	-2.9	0.07	-0.03	1.00	1.00
58	400987	4087767	-8.4	0.00	0.00	0.00	-1.97
59	399966	4086534	-3.2	0.07	-0.02	1.00	1.97
60	400560	4087133	-6.1	0.02	0.02	-1.00	-2.98
61	399943	4086398	-2.5	0.06	-0.01	2.00	1.95
62	400903	4087511	-7.1	0.01	0.01	0.00	-1.00
63	399926	4086268	-1.1	0.00	0.00	0.00	8.83
64	400847	4087257	-6.2	0.04	0.07	-3.00	-2.05
65	400546	4086883	-6.3	0.04	0.06	-1.00	-1.97
66	400522	4086668	-5.6	0.05	-0.01	-1.00	-1.00
67	400849	4086995	-6.6	0.07	0.11	-4.00	-2.09
68	401351	4087578	-8.1	0.00	0.00	0.00	-0.98
69	400492	4086446	-4.2	0.04	-0.03	-1.00	1.91
70	400819	4086772	-6.2	0.07	0.11	-2.00	-1.03
71	400467	4086323	-2.2	0.13	-0.01	-2.00	5.86
72	401320	4087292	-7.1	0.00	0.00	0.00	-0.98
73	400407	4086204	-3.0	0.14	0.00	-1.00	5.86
74	400381	4086095	-1.0	0.00	0.00	-1.00	9.81
75	400802	4086551	-4.8	-0.01	-0.01	-4.00	0.88
76	401282	4086997	-7.0	0.00	0.00	0.00	-1.97
77	400754	4086369	-3.6	-0.01	0.02	-3.00	2.91
78	400746	4086219	-2.7	-0.07	0.02	-6.00	3.90
79	401258	4086782	-6.9	0.00	0.01	0.00	-1.97
80	400707	4086095	-2.2	-0.11	0.02	-8.00	8.81
81	401232	4086595	-5.9	0.00	0.01	0.00	-0.02
82	400699	4085946	-0.9	0.01	0.01	-5.00	8.83
83	401210	4086430	-5.0	0.01	0.03	-1.00	1.93
84	401164	4086235	-3.7	0.02	0.02	-1.00	5.86
85	401114	4086067	-2.7	0.01	0.01	-1.00	6.86
86	401071	4085930	-1.7	0.00	0.00	-1.00	13.74
87	401057	4085828	-1.1	0.00	0.00	-1.00	18.65
88	401408	4085859	-1.4	0.01	0.01	-1.00	16.67
89	401362	4085755	-1.1	0.01	0.01	-1.00	11.76
90	401802	4085673	-1.6	0.00	0.00	0.00	15.72
91	401734	4085560	-1.1	0.00	0.00	-1.00	12.76
92	402013	4085457	-1.0	0.00	0.00	0.00	21.62
			max	0.25	0.12	7.00	25.56
			min	-0.11	-0.10	-8.00	-4.93
			average	0.02	0.01	0.04	4.87

	UTM, NAD83			Change in		Change in	
Station	meters		Water Dpth	Height (m)		Direction (deg)	
Number	X	Y	(m)	5ft-exist	10ft-exist	5ft-exist	10ft-exist
2	396040.15	4087518.29	-1.1	0.03	0.04	0.00	0.00
4	396281.86	4087432.96	-1.1	0.00	0.00	0.00	0.00
6	396613.28	4087376.78	-1.1	0.03	0.04	0.00	0.00
8	396972.89	4087323.07	-1.2	0.02	0.02	1.03	1.03
10	397300.35	4087231.05	-1.2	-0.05	0.02	0.00	0.00
12	397641.9	4087140.26	-1.1	0.00	0.00	0.00	-0.97
14	397984.69	4087035.39	-1.1	0.00	0.00	0.97	0.97
22	398395.45	4086964.86	-1.1	0.05	-0.09	2.01	2.01
31	398754.79	4086833.04	-1.0	-0.02	0.00	6.02	0.00
41	399106.2	4086629.55	-1.1	0.00	0.00	-2.01	-0.97
42	400342.82	4088072.17	-8.5	0.03	0.06	1.00	2.00
44	400258.73	4087816.38	-7.0	0.01	0.00	3.00	5.00
46	400222.09	4087586.04	-5.7	0.00	0.00	2.00	3.00
48	400171.37	4087354.47	-5.4	0.02	0.02	2.00	3.00
51	400741.69	4087894.13	-8.3	0.00	0.00	0.00	0.00
52	400114.22	4087115.23	-5.3	0.03	0.00	0.00	-1.00
53	399566.36	4086400.08	-0.9	0.00	0.00	0.00	-2.01
54	400638.32	4087615.36	-7.4	0.02	0.04	1.00	2.00
55	400077.59	4086884.89	-3.2	0.01	0.02	1.00	-3.00
56	400581.17	4087376.12	-6.5	0.02	0.05	0.00	-1.00
57	400017.98	4086673.83	-2.6	-0.01	0.03	2.00	-4.00
59	399966.29	4086534.44	-2.7	0.02	0.04	2.00	-5.00
60	400559.86	4087132.92	-6.4	0.04	0.09	0.00	0.00
61	399942.78	4086397.52	-2.8	-0.10	0.02	-6.00	-4.00
63	399925.7	4086268.26	-1.0	-0.03	0.00	-4.01	-2.01
65	400546.20	4086883.30	-6.7	0.04	0.08	1.00	1.00
66	400522.43	4086668.27	-5.6	0.00	-0.10	0.00	-4.00
69	400492.22	4086445.59	-4.3	-0.03	-0.01	2.00	-1.00
71	400467.48	4086322.76	-2.1	0.07	0.03	2.00	-1.00
73	400406.90	4086203.89	-3.0	-0.03	0.01	2.00	0.00
74	400380.92	4086095.14	-1.0	0.00	0.00	1.95	0.00
82	400699.23	4085945.54	-0.9	0.01	0.01	-5.96	0.00
87	401057.33	4085827.81	-1.1	0.00	0.00	0.00	0.00
89	401361.82	4085755.08	-1.1	0.00	0.00	0.00	0.00
91	401733.75	4085560.48	-1.1	0.00	0.00	0.00	0.00
92	402012.52	4085457.1	-1.0	0.00	0.00	0.00	0.00
			max	0.07	0.09	6.02	5.00
			min	-0.10	-0.10	-6.00	-5.00
			average	0.01	0.01	0.42	-0.28