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Offshore Sand Resources in Northern Maryland Shoal Fields

by
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Roger Amato
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Executive Summary

Extensive beach restoration projects on the Maryland coast are placing increased pressure on known offshore sand resources within state waters. Assessment of potential sand resources in Federal waters will encourage both the development of new resources, and further restoration projects. Previous studies suggest that most usable sand deposits will occur within linear shoals on the inner continental shelf. A shoal field in waters off Fenwick Island, MD was sampled for potential sand resources in 1992 and again in 1997. This field, designated Shoal Field I, is located approximately 6.4 kilometers off Fenwick Island at the Maryland - Delaware state line. The eastern edge of the shoal field extends to 14.5 kilometers offshore.

Vibracore samples were used to estimate the quality and quantity of sediments contained in the three shoals of Shoal Field I. The following figures represent the minimum amount of sand contained in the shoals, suitable for beach nourishment projects:

Fenwick Shoal -95.8 million cubic meters
Weaver Shoal - 57.6 million cubic meters
Isle of Wight - 72.6 million cubic meters

These sand resources are similar in character to native beach sands found on Assateague and Ocean City, Maryland, beaches.

INTRODUCTION

Atlantic coast beaches are primary economic and recreational resources in Maryland. Two barrier islands separated by Ocean City Inlet comprise Maryland's coastline. Fenwick Island, to the north of the inlet, is highly developed and is the site of the state's only coastal resort, Ocean City. The 12.9 kilometers of Fenwick Island within Maryland consist of public beaches fronting commercial and private real estate. South of the inlet, the 51.3 kilometers of Assateague Island in Maryland are undeveloped state and federal parklands. Maryland's barrier islands and coastal bays are readily accessible to nearly thirty-million people.

Although coastal lands are immensely valuable resources, they are also potentially an expensive liability. While barrier islands are ephemeral land forms, they are often commercially developed as though they were permanent features. Urbanization of these fragile islands may actually enhance their inherent instability. The natural migration of barrier island/inlet systems, exaggerated by development, poses a threat to regional economic and cultural commitments. In Maryland, rapid shoreward erosion of these islands jeopardizes both property and economy. A variety of shoreline stabilization and remediation schemes are available to protect established communities and investments. Beach nourishment is currently one of the most attractive options for barrier island protection.

Studies conducted by the U.S. Army Corps of Engineers in the 1980's indicated an immediate need for beach replenishment along the Ocean City shoreline (U.S. Army Corps of Engineers, 1980). A later Army Corps study projected a need for beach replenishment on Assateague Island (U.S. Army Corps of Engineers, 1994). The Army Corps has examined potential sand sources for these rapid eroding areas.

Beach nourishment projects demand that sand resources meet certain physical, economic, and environmental criteria. Sand used for replenishment must be of an optimum grain size, which is determined by kinetic factors specific for each region. The volume of sand required for restoration is also dependent on these factors. Proximity of sand sources to the target beach is an important economic factor. The Army Corps studies concluded that offshore sands are the most desirable materials for beach nourishment projects in Maryland.

Currently utilized resources are located in waters northeast of Ocean City Inlet, within the three-mile limit of state jurisdiction. These sands are committed to the reconstruction and periodic nourishment of Ocean City beaches. An increase in the frequency of strong storms has accelerated erosion of the restored beaches, placing increased demands on sand resources within state waters. It is conceivable that these resources could be depleted within a decade. New sand sources must be found to meet the growing demand for suitable beach nourishment material. Access to aggregate resources in Federal waters would encourage the continuation of shoreline restoration projects. While the general distribution of offshore sand is understood, detailed information on potential resources is sparse. Site-specific data will encourage development of these resources.

The Offshore Sand Resources Cooperative Agreement between Maryland Geological Survey, Delaware Geological Survey, and the U.S. Minerals Management Service was created to encourage and expedite an inventory of potential offshore sand resources for beach nourishment in the Delmarva region. Specifically, the cooperative agreement seeks to exchange field, laboratory, financial, and data resources for efficient production of this information.

In Maryland, the cooperative's sixth year objective was to examine in detail sand resources within Shoal Field I. The shoals are currently being considered as a sand source for beach restoration projects on Fenwick Island, in both Maryland and Delaware. We designed the study to further refine our previous resource potential estimates made during the 1992 Offshore Sand Resources Study (Conkwright and Gast, 1994a).

Acknowledgments

The cooperative was funded by a grant from U.S. Minerals Management Service, and contributions from Maryland Department of Natural Resources, and Delaware Geological Survey. Thanks go to Roger Amato of the U.S. Minerals Management Service who has been our chief instigator for nearly a decade. Kelvin Ramsey and Kimberly McKenna of Delaware Geological Survey were of invaluable assistance, as was their data. We are grateful to Darlene Wells for her constant assistance in the preparation of this study.

Randy Kerhin was the guiding light of these projects. He began our relationship with MMS in the mid-1980's during his pioneering work on Maryland's inner continental shelf Quaternary geology. Because of his interest and energy, his work continued to provide invaluable scientific and economic information through the following decade. We miss him but his inspiration continues to guide us.

SIXTH YEAR GEOLOGICAL INVESTIGATIONS

Objective

Because of the proximity of Shoal Field I to both Maryland and Delaware beaches, it is an important sand resource. In 1992 during the cooperative's first year the shoal field's resource potential was investigated. That study used seismic profile interpretations, vibracore and archival data to examine the resources. Because relatively few cores and little archival sedimentologic data were available to characterize sand quality and quantity accurately, only rough estimates of these parameters were calculated.

The objective of this study is to more accurately define the resource potential of the three shoals within Shoal Field I. This was achieved by collecting and analyzing vibracore sampling to determine sediment quality in each shoal. Shoal sands were then classified as having high, moderate or low resource potential based on grain size, sorting and deposit depth. The sand volume for each resource classification was calculated.

Previous Studies

Numerous scientists have investigated the Atlantic inner continental shelf. Comprehensive reviews of these works have been published by Duane and others (1972), Field (1976, 1980), Toscano *et al.* (1989), McBride and Moslow (1991), and Wells (1994). Of primary interest to this study are the origins and morphology of linear shoals on the Atlantic inner shelf. Linear shoals have long been recognized as important sand reservoirs on the Atlantic shelf. As a group, linear shoals share several common features. Duane and others (1972) characterized these features:

1) Linear shoal fields occur in clusters, or fields, from Long Island, New York to Florida.
2) Shoals typically exhibit relief up to nine meters, side slopes of a few degrees, and extend for tens of kilometers.
3) The long axes of linear shoals trend to the northeast and form an angle of less than 35° with the shoreline.
4) Shoals may be shoreface-attached, or detached. Shoreface-attached shoals may be associated with barrier island inlets.
5) Shoal sediments are markedly different from underlying sediments. Shoals are composed of sands and generally overlay fine, occasionally peaty, sediments.

With so many common characteristics, early researchers assigned a common origin for these features. Generally, it was assumed that linear ridges represented relict barriers or subaerial beaches, developed at a lower sea level stand, and preserved by the transgressive oceans (Veatch and Smith, 1939; Shepard, 1963; Emery, 1966; Kraft, 1971; and many others). Improvements in seismic data collection and reexamination of earlier data led to a new hypothesis of shoal evolution: linear shoals are post-transgressive expressions of modern shelf processes. In particular, Field's (1976, 1980) work on the Delmarva shelf could find no support for the theory of relict, submerged shorelines. Many investigators (including Field 1980; Swift and Field, 1981) concluded that ridge and swale topography developed from the interaction of storm-induced currents with sediments at the base of the shoreface. As the shoreface retreated during transgression, shoreface-attached shoals became detached and isolated from their sand source. Once detached, the shoals continued to evolve within the modern hydraulic regime.

McBride and Moslow (1991) employed a statistical approach to analyze existing geomorphologic and sedimentologic data on linear shoals. They found a correlation between the distribution of shore-attached and detached shoals and the locations of historical and active inlets along the Atlantic coast. They developed a model for shoal field genesis and evolution, based on the formation and migration of ebb-tidal deltas. This model describes a source of sediment for shoal formation, and explains the orientation, shape, distribution and evolution of linear shoals. While the authors recognized that diverse mechanisms account for shoal formation, the ebb-tidal shoal model provided the first field-tested explanation for the formation of linear shoals.

A model of late Tertiary and Quaternary stratigraphy on the Maryland shelf has been published by Toscano and others (1989) and Toscano and Kerhin (1989). The model uses Field's (1976, 1980) framework and clarifies spatial, temporal, and climatic relationships through extensive seismic, sedimentologic, and paleontologic investigations. Application of the model to field investigations led Kerhin (1989) and Wells (1994) to conclude that sand resources off the Maryland coast are confined mainly to the linear shoal fields. It was Kerhin's (1989) preliminary assessment that any non-shoal sand resources within the explored Maryland shelf were limited to 39 kilometers east of the Maryland-Virginia boundary. Wells (1994) found that significant sand sources within her study area east of Ocean City were confined to shoals. Furthermore, she found that the shore-attached shoals in Maryland typically contained fine sands and muds, unsuitable as beach fill. Coarser sands were generally found in shore-detached shoals. The Offshore Sand Resources Study employs the Toscano-Kerhin model of Maryland Quaternary shelf deposits to define shoal field structures.

Shoal Field I was the subject of the first MGS/DGS/MMS cooperative study in 1992. Five vibracores from Weaver Shoal and four from Isle of Wight were obtained. More than 137 kilometers of seismic profiles were also taken during the project. The results of that study were published in 1994 (Conkwright and Gast, 1994a).

The U.S. Minerals Management Service has investigated the possible environmental impact of sand mining on Fenwick and Weaver Shoals, in anticipation of developing these shoals as sand resources in the future (U.S. Minerals Management Service, 1999). This study found that with proper mining and restoration practices environmental damage to the region would be minor and temporary.

Study Area

Shoal Field I is located approximately 6.4 kilometers east of the Maryland-Delware state line. The eastern edge of the shoal field extends to 14.5 kilometers offshore. The study region includes Fenwick and Isle of Wight Shoals, and an unnamed shoal, designated Weaver Shoal, for these studies. Shoal Field I encloses 128 square kilometers of ocean floor, from depths of -3.8 meters to -23.1 meters below National Global Vertical Datum (NGVD). The size and shape of Shoal Filed I originally outlined in 1992 have been changed to include a larger portion of Fenwick Shoal. In the 1992 project relatively sparse data on the Isle of Wight and Weaver shoals permitted only rough estimates of grain size parameters and volumes of shoal sands. Estimates for Fenwick Shoal were not made because sedimentologic data on the shoal were unavailable.

The Maryland Department of Natural Resources proposed some practical limits for offshore sand resource locations in 1992 (J. Loran, pers. comm., 1992). These guidelines suggested that resources be located within a 24 kilometers radius from the point they are needed, and in waters less than 15 meters deep. The limits were based on economic and mechanical constraints know to exist in 1992. Dredging to depth of greater than 15 meters is more common now. Therefore this limitation is not critical, but still serves as a useful guide. Figure 1 details the location of Shoal Field I.

Index of Shoal Fields

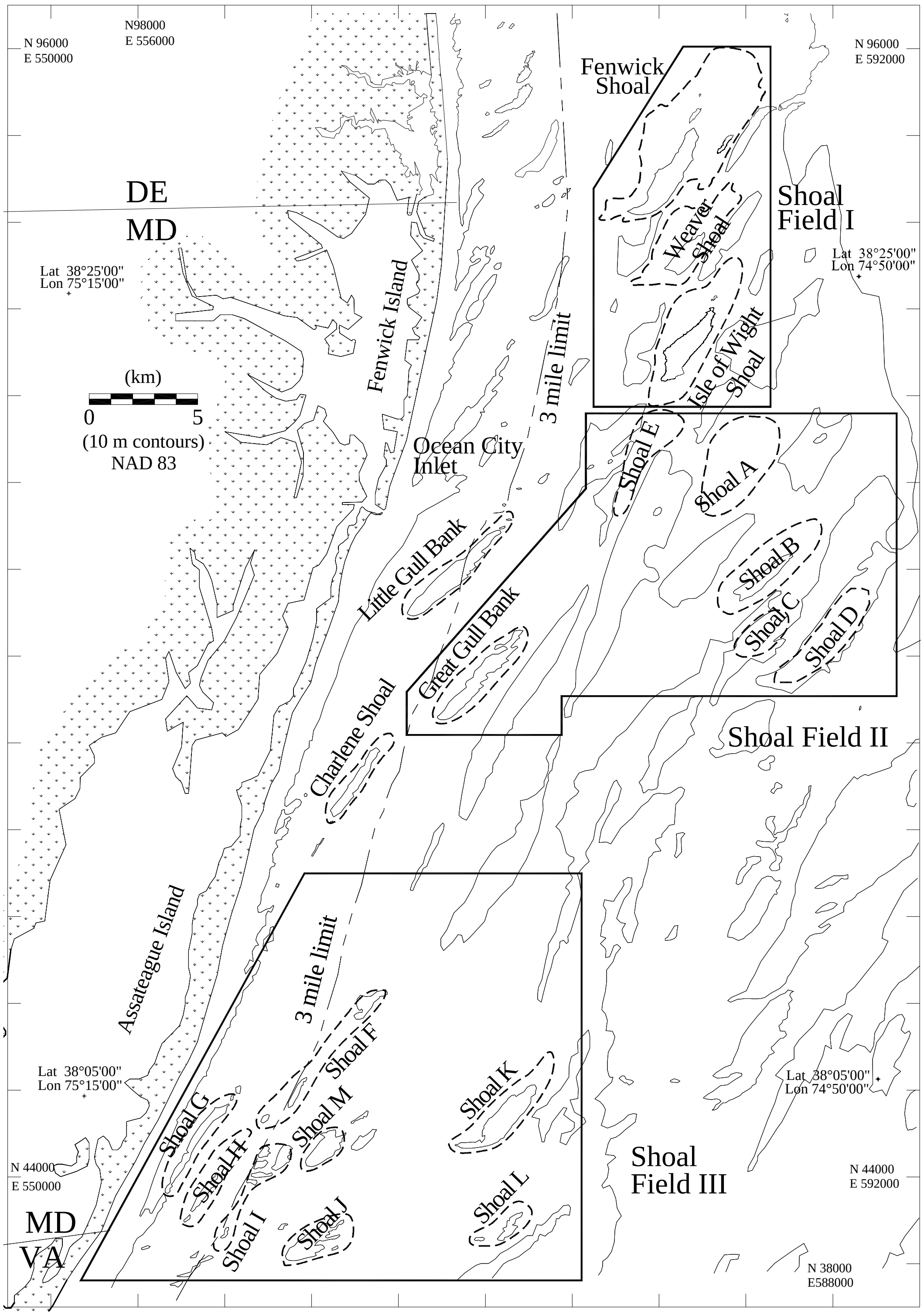

Figure 1
(Grid: MD State Plane Coordinates, NAD 1983, meters)

Study Methodology

Our goal in the sixth year of the cooperative was to more accurately define the potential sand resources within Shoal Field I and to include data for Fenwick Shoal. To achieve these goals twenty-five, six-meter vibracores were taken in and around the shoals. Seismic data obtained during the 1992 and 1993 studies (Conkwright and Gast, 1994a and 1994b) provided a basis for stratigraphic and volumetric analysis of the shoals. Textural parameter measurements of shoal sediments are based on vibracore sample. Data from vibracores obtained by Field (1976), and Toscano and Kerhin (1989) are also available for this region. Using this information, the shoals were classified according to their resource potential. The data also contributed to the model of regional shoal classification.

Previous studies by McBride and Moslow (1991), Toscano and Kerhin (1989), Kerhin (1989), and Wells (1994) show that significant sand deposits will most likely be found in linear shoals. We therefore concentrated our data collection to the shoals and their flanks. Seismic lines were arrayed to provide cross-sections and axial profiles of the linear shoals, and the perimeter of the shoal field. Sediment samples provided ground truthing for seismic interpretations.

Bathymetry and Subbottom Profiling

Bathymetry and subbottom structures were determined by high-resolution seismic profiling. We carried out the seismic survey on board Maryland Department of Natural Resources' *R/V Kerhin*. The *R/V Kerhin* was formerly known as the *R/V Discovery* until its rededication in 1999. The vessel was christened in honor Randall T. Kerhin, deputy director of the Maryland Geological Survey. The seismic survey took place in August 1992 and again in August of 1993. More than 320 kilometers of seismic lines were recorded off the Maryland coast. We used a Datasonics acoustic profiling system for data collection. The best subbottom acoustic records were obtained at 3.5 kHz. While the Datasonics system can provide penetrations greater than 91 meters, shallow water depths and a generally hard, sandy sea floor limited penetration to less than 27 meters in shoal areas. However, this limitation was not significant for the study because our interests were in shallow and surficial sediments. Better seismic penetration was obtained in inter-shoal regions, due to the presence of more acoustically transparent, fine sediments. Bathymetry was recorded at 200 kHz. A bathymetric map of Shoal Field I is shown on Figure 2. Track line positioning was determined by an onboard geographical positioning system, which provided fix marks at five minute intervals. Horizontal data is reported in Maryland state plane coordinates (NAD 83, meters). Water depths from electronic soundings were corrected to NGVD, and based on NOAA predicted tides for the time of sampling. Conversion between Maryland state plane coordinates and geographic coordinates was performed by *CORPSCON* software.

Shoal Field I Bathymetry

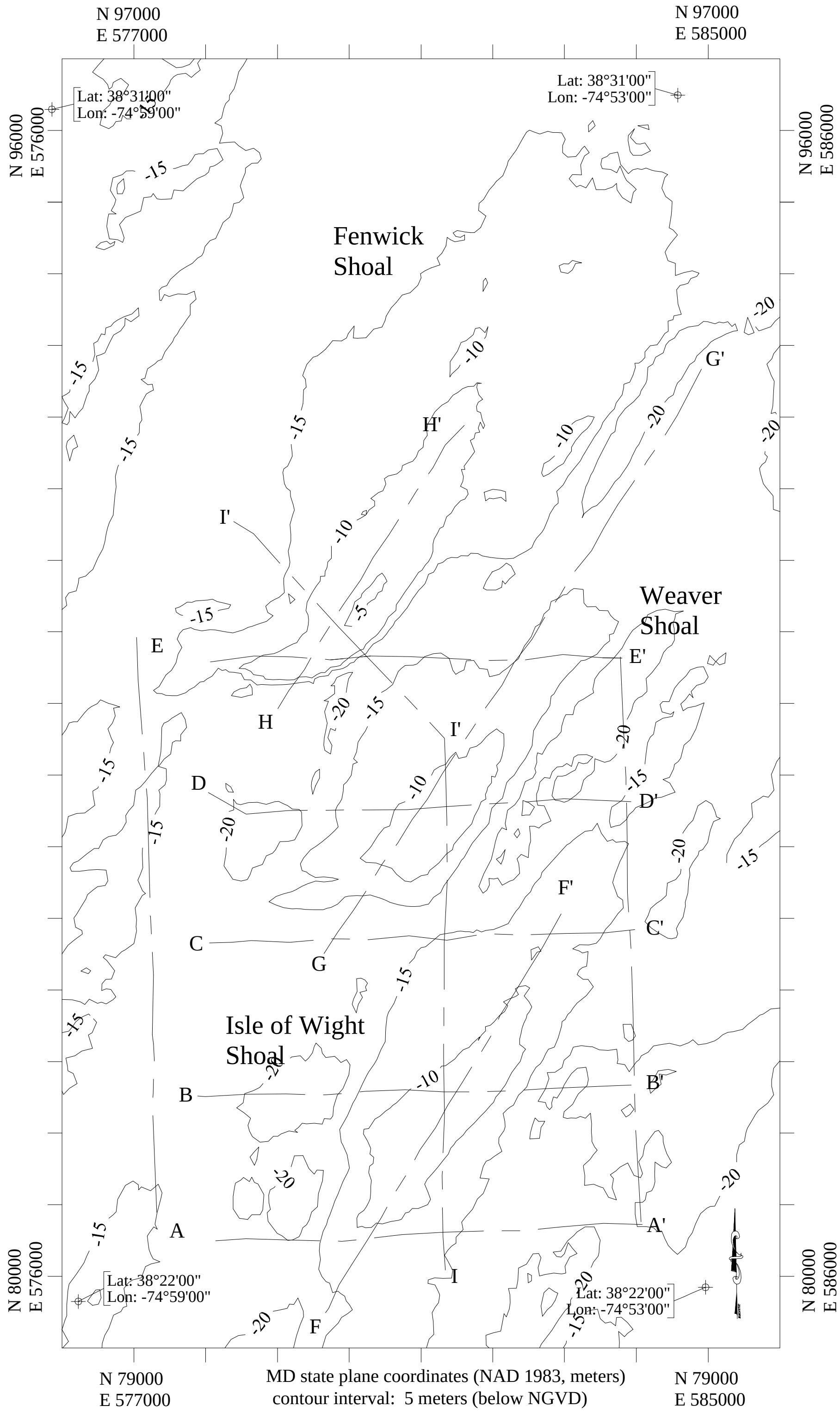

Figure 2

Sediment sampling

Twenty-five vibracores were obtained during the fall and winter of 1997. Vibracore sampling stations were selected based on the findings of the 1992 Offshore Sand Resources Study (Conkwright and Gast, 1994a). That study suggested that Weaver and Isle of Wight Shoals have the highest resource potential, based on data from nine vibracore. Fenwick Shoal was estimated to have only a moderate to low potential based only on seismic evidence. We decided to confirm our estimate of Fenwick Shoal resources by taking eleven vibracores on and around the shoal. Seven cores were obtained from Weaver Shoal and seven from Isle of Wight Shoal. Coring locations on these shoals were selected to give a more complete data set than that provided from the 1992 project. Generally coring locations were positioned to fall on or near existing seismic lines (Figure 5).

Vibracore Sites and Seismic Survey Track Lines

Table 1 summarizes 1997 Maryland vibracore station details. Several cores were taken on the northeast-trending, long axis of each shoal. Cores on the southwest crest, the center, and the northeast tail provide axial trend information. Cores from the west and east flanks provide cross-sectional data. We hoped to penetrate the lower boundary of the shoals on at least one flank. Stations location details for 1997 Delaware cores and 1992 Maryland cores are summarized in Appendix C.

TABLE 1 **Locations of Vibracores Processed by Maryland Geological Survey in 1998**					
Core ID	Latitude[1]	Longitude[1]	Northing[2]	Easting[2]	Depth[3]
FS1	38.446766	-74.959340	88585.19	578124.55	-12.35
FS2	38.445992	-74.952601	88512.47	578714.61	-9.29
FS3	38.444133	-74.949435	88312.37	578995.56	-9.52
FS4R1	38.446510	-74.945500	88583.88	579333.05	-9.09
FS4R2	38.446481	-74.945486	88580.69	579334.34	-9.05
FS5	38.450098	-74.945628	88981.80	579312.92	-10.17
FS6	38.450490	-74.937858	89040.59	579990.01	-4.94
FS7	38.448003	-74.936278	88767.72	580134.14	-8.60
FS8.1	38.442961	-74.939325	88202.18	579880.85	-20.58
FS8.2	38.443008	-74.939258	88207.53	579886.58	-20.18
FS9	38.456505	-74.929613	89724.39	580694.40	-6.85
FS10	38.456450	-74.936040	89705.59	580133.71	-7.56
FS11	38.456330	-74.940126	89684.22	579777.46	-8.59
WS6	38.416620	-74.945483	85266.89	579409.20	-12.63
WS7	38.423383	-74.930955	86046.06	580660.62	-9.21
WS8	38.421820	-74.922931	85888.52	581365.07	-9.26
WS9	38.431566	-74.922836	86970.25	581348.75	-9.73
WS10	38.428325	-74.909098	86637.97	582556.18	-20.08
WS11	38.440171	-74.916425	87937.94	581886.57	-13.65
WS12.1	38.427685	-74.926901	86531.50	581003.69	-8.83
WS12.2	38.427695	-74.926938	86532.53	581000.43	-9.15
IW6	38.365083	-74.943446	79551.62	579715.91	-15.47
IW7	38.376766	-74.924968	80884.67	581300.90	-12.34
IW8	38.382700	-74.929801	81533.60	580863.76	-8.08
IW9	38.394663	-74.924211	82872.26	581321.86	-9.46
IW10	38.391998	-74.922371	82580.18	581489.29	-6.03
IW11	38.392296	-74.902040	82653.86	583264.21	-19.19
IW12	38.388155	-74.931741	82135.12	580680.58	-8.41

[1] NAD 1983
[2] Maryland State Plane Coordinate System, NAD 1983, meters
[3] Below NGVD, meters

Core Processing

Vibracoring was contracted to Alpine Seismic Surveys, Inc. of Norwood, NJ. Alpine provide the 27-meter *R/V Atlantic Twin* for the work. An Alpine 271 B Pneumatic vibracore drill rig was outfitted to take 6 meter by 9.2 centimeter diameter, cellulose butyrate-lined vibracores. The rig was fitted with a penetrometer and a high pressure water pump for jet retries. When the penetrometer indicated penetration refusal in less than 4.6 meters, a retry in the same location was made. During repenetration, the incomplete core was withdrawn and saved, and the corer was replaced on-station. The core barrel was jetted down to the depth of refusal, and vibracoring was continued for another 6 meters, or until another refusal was encountered. Upon retrieval, the 6 meter lengths were cut into 1.5 m sections and labeled for transportation to the laboratory.

Vibracores taken off Maryland's coast were opened by cutting the plastic liners along their length. An electro-osmotic knife (Strum and Matter, 1972) was used to split muddy cores lengthwise. This tool slices the sediment without smearing internal structures, thus providing a clear cross-section for imaging. Sandy cores did not require electro-osmotic cutting. The cores were imaged for a visual record using a Umax Astra 610P, 30-bit color scanner. This method replaced our previous practice of photographing each core section. The cores were logged for sedimentary and biogenic structures, texture, color, approximate grain size and other features. Sediment, biologic, and age dating samples were removed for further analysis, and the remaining materials were sealed and archived for future work.

Processing of vibracores taken in waters off Delaware was similar to Maryland procedures and is described by Ramsey and McKenna (1999).

Textural Analysis

Textural parameters were analyzed by Maryland Geological Survey. Textural analysis procedure is detailed in Kerhin and others (1988). Sediment samples were first treated with 10% solution of hydrochloric acid to remove carbonate material such as shells and then treated with a 6% or 15% solution of hydrogen peroxide to remove organic material. The samples were then passed through a 63-micron mesh sieve, followed by a 2-mm sieve, separating sands from mud and gravel fractions. Mud fractions were analyzed using a pipette technique to determine silt and clay contents. Weights of the sand, silt and clay fractions were converted to weight percentages. Sediments were categorized according to Shepard's (1954) classification based on percent sand, silt and clay components.

Sand fractions were analyzed using a rapid sediment analyzer (RSA) (Halka and others, 1980). The RSA technique measured cumulative weight in ¼k (phi) intervals. Data were normalized to a 100% sand distribution, and the method of Folk and Ward (1957) was used to report graphic mean and sorting. When mud contents were less than 5%, grain size analyses were conducted only on the sand fraction. Pipette analyses were used to determine silt and clay content in samples with greater than 5% mud.

Digital analysis of Bathymetric and Subbottom Data

Seismic data were collected on an analog strip chart recorder but were required in digital form. We developed a method of transferring the two-dimensional, graphic information into a three-dimensional, digital model. We used a Calcomp 9800, large format digitizer to enter the seismic data into Autodesk's *Map2000*. A program was developed for *AutoCAD* that calculates the three coordinates (northing, easting and depth) for each digitized point. Bathymetric and subbottom reflectors were digitized along each track line to produce three-dimensional profiles of the bottom and subbottom.

We used Autodesk's *Land Development Desktop (LDD) Release 2* to generate surface models of the ocean floor and seismic reflectors, based on the digitized data. *LDD* uses triangular irregular networks, or TINs, to construct surface models. This is the most commonly employed method for constructing elevation models. TINs are generated by connecting elevation points with lines to form triangles. The network of interconnected triangles forms an interpolated surface model. These models can be represented in several forms, including contour maps, cross-sections, and a variety of gridded and rendered surfaces. Separate TINs are generated for bathymetric data and each digitized subsurface horizon. The TIN surfaces derived from these data are then used to calculate area, volume, slope, intersecting surfaces and elevations.

Our bathymetric model was constructed from a digital bathymetric database of the Delmarva Atlantic shelf, compiled by the National Ocean Service. The bathymetric model generated from this database is accurate and highly detailed. The surface models of subbottom reflectors are less detailed due to the limited amount of data points available from the digitized data. Because the shoals are usually acoustically opaque several meters below their surfaces, few subsurface data points under the shoals were obtained. The contours depicted under the shoals are extrapolated by the contouring program from data surrounding and under the thinner, more acoustically transparent margins of the shoals. Seismic reflectors are subject to the phenomenon of 'pull-up'. This effect is seen as a change in depth of the reflector as it passes under a shoal. The density and thickness of shoal sediments change the two-way travel time of the acoustic signal and artificially warp the underlying seismic signatures. This causes anomalous contour highs on reflector surfaces under ridges. Predicting the net effect of this phenomenon on seismic reflectors is difficult. Although the pull-up effect causes inaccuracies in portions of the surface models, it is limited to a tolerance of approximately a meter and has minimum influence on volumetric calculations. We assume that, while the contours under the shoals may not accurately reflect the detailed surface geometry, they are a reasonable representation of the mean depth of these reflectors.

Seismic Track Lines

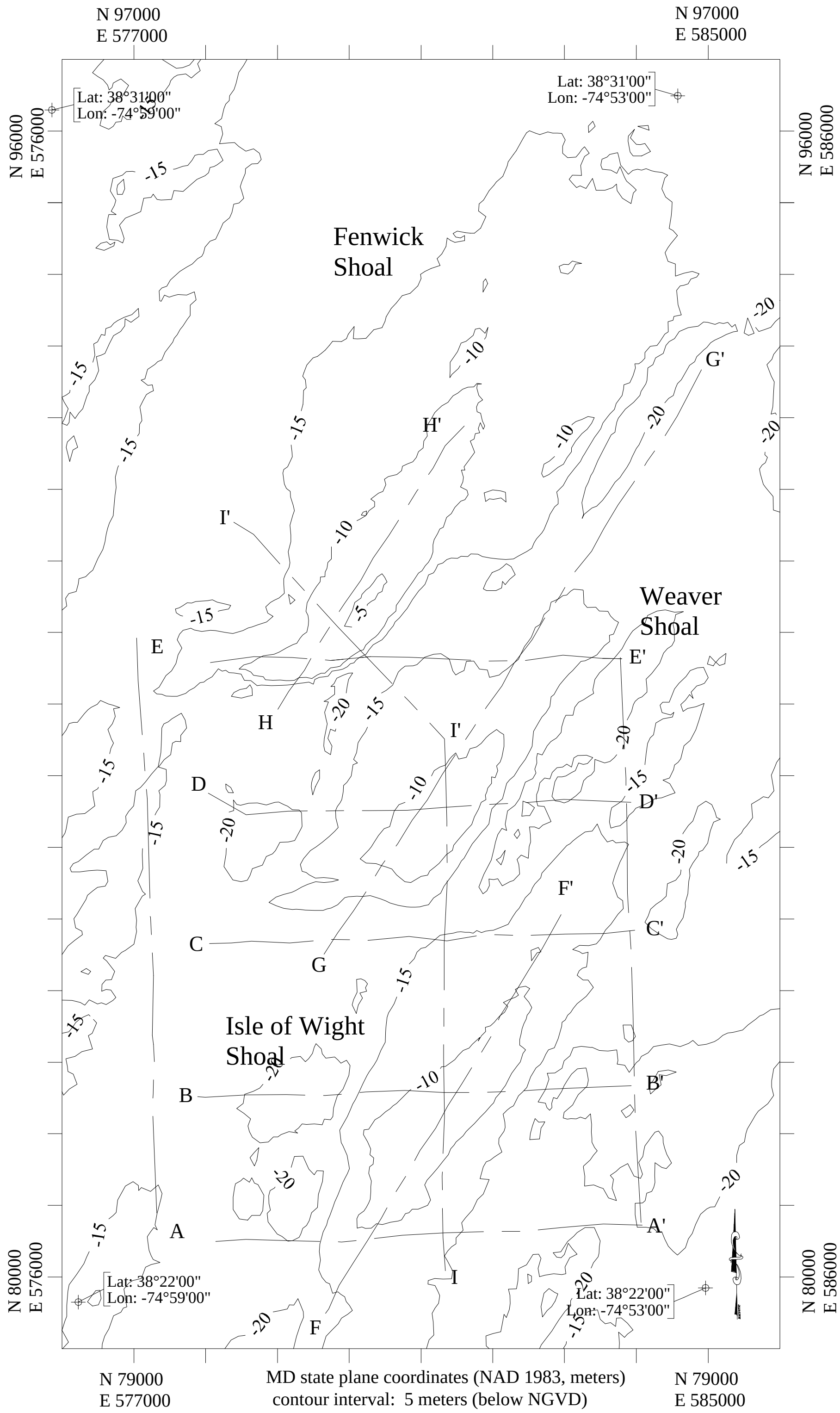

Figure 3

Volumetric Calculations

Volumetric determinations were carried out by *LDD*. This program offers several methods for volume determinations. The ‘composite’ method is most appropriate for the type of data available. To determine shoal volumes, the upper and lower surfaces of the shoals and their flanking boundaries must be defined. The upper surface is defined as the bathymetric surface, derived from the bathymetric model. The lower bounding surface is determined from core and seismic data. Shoal edges are defined by either pinch-out of shoal sediments, or a significant fining in flank sediment texture. Pinch-out was considered to occur where shoal sediments thin to one meter or less, which is the practical limit for dredging. These conditions were determined from seismic and core data. The volumetric program creates a TIN of the upper and lower surfaces, within the shoal boundaries. The volume between the surfaces is then calculated.

RESULTS

Shoal Field Structure

Shoal Field I includes Fenwick Shoal, Weaver Shoal and Isle of Wight Shoal. A bathymetric map of Shoal Field I shows features typical of a linear shoal field (Figures 2). Bathymetric elevations range from a minimum of -3.78 meters on the crest of Fenwick Shoal to a maximum of -23.1 meters in a trough in the northeast corner of the field. The minimum elevations for Fenwick, Weaver and Isle of Wight Shoals are -3.78, -7.34, and -5.61 meters respectively. The mean elevation of the shoal field is -15.6 meters. Weaver Shoal has a maximum thickness of 19.3 meters. Isle of Wight Shoal has a maximum thickness of 16.7 meters. Fenwick Shoal has a maximum thickness of 19.3 meters. While each shoal possesses a unique shape, they all display the general morphologic characteristics associated with linear sand ridges:

- elongated bodies with northeast axial trends;
- an elevational high, or crest, proximal to the shore to the southwest;
- elevation decreases to the northeast toward the shore distal end;
- relief above surrounding terrain of tens of feet;
- flank slopes between 0.2E and 7.0E;
- seaward flanks steeper than landward flanks.

The contour map shows the variations in form of these three shoals. The proximal crest of Weaver Shoal is blunt and the distal portions display irregular topography. Isle of Wight Shoal has a more symmetrical appearance and a more elongated crest than Weaver Shoal. Fenwick Shoal has an arcuate crest that abruptly bends to the west at the proximal end. The seaward flank of Fenwick Shoal is the steepest slope in the shoal field, with a grade of 33.13%. A summary of shoal geometry is presented in Table 2.

Table 2
Physical Parameters of Shoal Bodies

Parameter	Fenwick Shoal	Weaver Shoal	Isle of Wight Shoal
area (million meters^2)	27.1	9.7	14.2
axis (E from north)	38	35	31
base length (km)	10.2	6.6	7.9
maximum width (km)	4.0	2.3	2.5
minimum depth (m, NGVD)	-3.78	-7.34	-5.61
mean depth (m, NGVD)	-12.4	-12.47	-12.14
maximum grade (%)	33.13	30.97	9.12
mean grade (%)	0.93	0.95	0.88
base depth (m)	-18.3	-18.3	-18.3

Seismic records reveal some of the shallow structure of Shoal Field I. The shoal bodies exhibit little internal structure. While this is in part due to the acoustic opacity of these sand bodies, it is also an indication of the massive, homogeneous structure characteristic of linear sand shoals. Occasionally, cross-bedding is observed on the seaward flanks near shoal crest. Minor internal reflectors that are not clearly related to core data also occur. These internal reflectors are indicative of changes in sediment density.

The shoal field is underlain by a continuous, mappable reflector. This reflector has relatively flat relief, with maximum elevation of -19.9 meters, a minimum of -25.3 meters and an average elevation of -22.8 meters. A contour map of this surface (Figure 4) shows irregular, low relief. The contours are based on a surface model derived from digitized seismic data. Because the shoals are acoustically opaque below -18.3 meters, no data points for this surface were obtained under the main body of the shoals. The contour highs and lows depicted under the shoals are extrapolated by the contouring program from data surrounding the shoals. Two of Field's (1976) vibracores, 19 and 20, penetrated this reflector between -18.3 and -20.1 meters. We assume that, while the contours under the shoals may not accurately reflect the surface geometry, they are a reasonable representation of the average depth of this reflector.

Elevation of Ravinement Surface

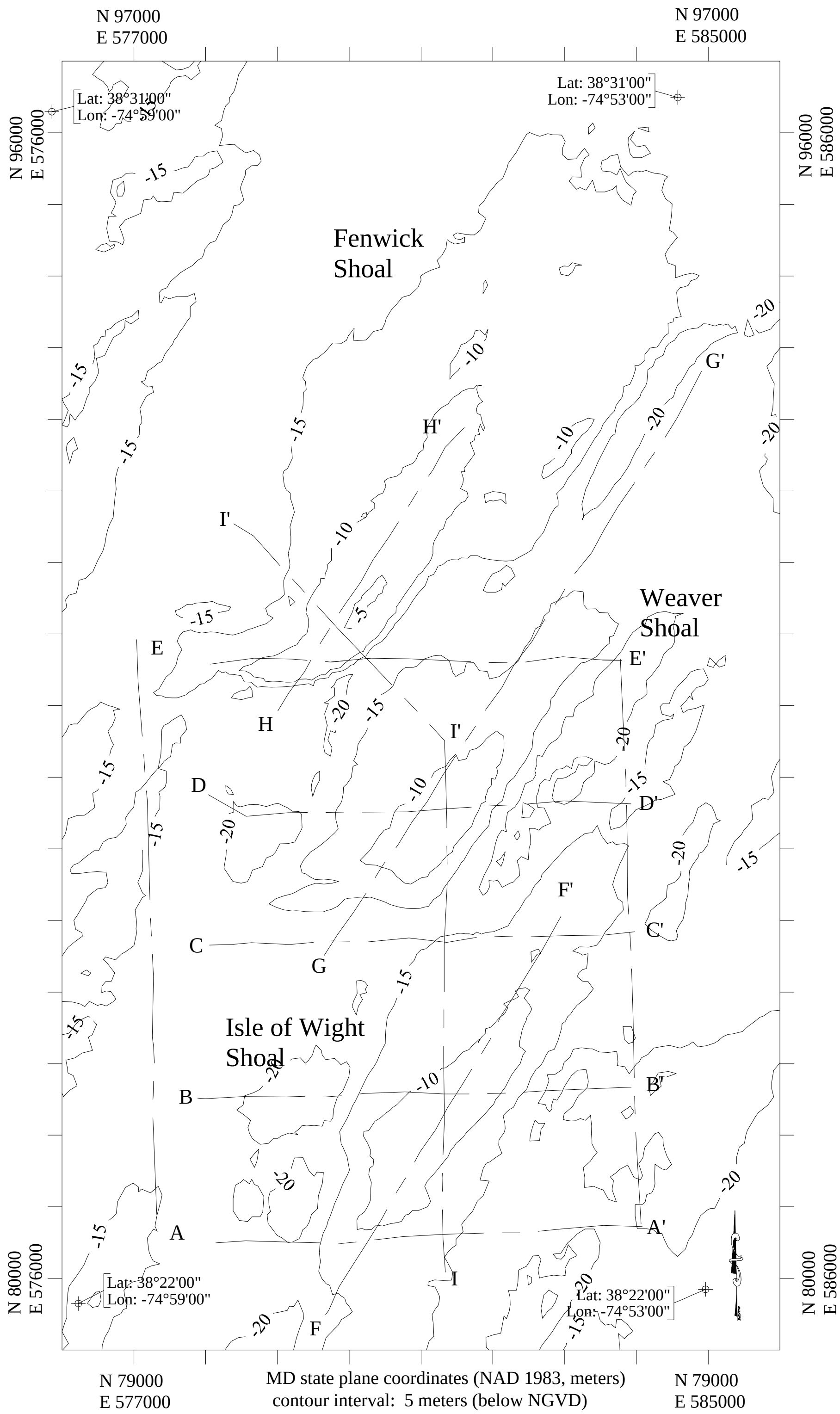

Figure 4

Toscano *et al.* (1980) described this discontinuity as evidence of a time-transgressive ravinement surface. The surface developed as a result of ravinement processes operating on the shore face during the last Holocene transgression. Modern shelf sands that make up the sea floor, including the linear shoals, are designated Q5 and are bounded by bathymetry on the upper surface, and the ravinement surface underlying these sands. The ravinement surface is not always apparent on seismic records, probably due to the mixing of the bounding lithologies that is likely to occur during its formation.

Shoal edges were usually observed in seismic records as a feathering out of shoal sediments over underlying units. However, shoal edges were not always this distinct, particularly where shoal sands migrated over or overlapped older units. We have defined shoal edge boundaries for this study by the thickness of sediments, or abrupt changes in lithology. Because it is impractical to dredge sand from deposits less than 1 meter thick, we delimit the shoal to thicknesses greater than 1 meter. Additionally, we define the shoal edge where seismic records suggest sediment types become abruptly fine or mixed. These lithologies are not considered as potential beach fill material. A somewhat subjective compromise of these various terms leads to the shoal boundaries outlined in Figure 5.

Vibracore Locations and Shoal Boundaries

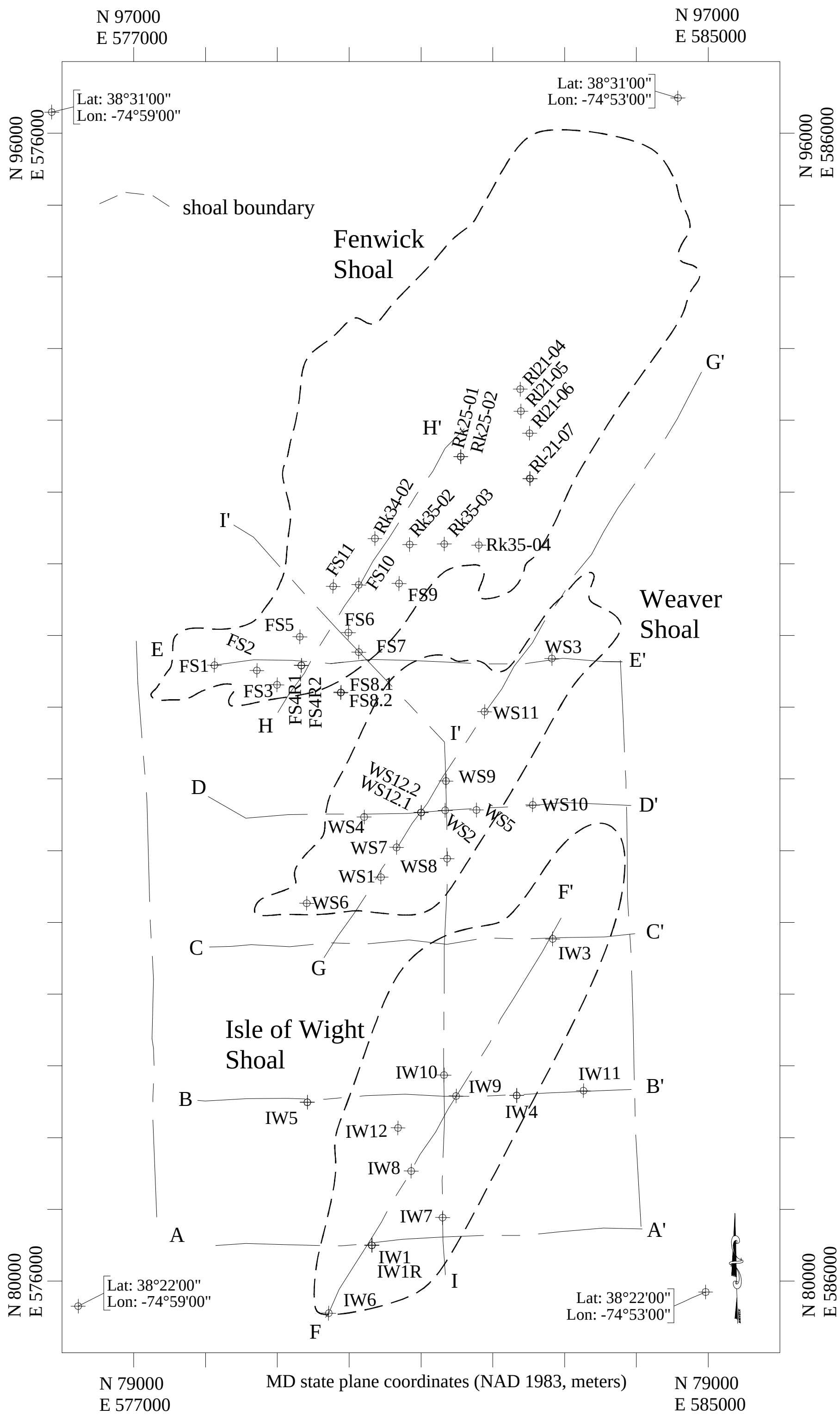

Figure 5

SAND RESOURCE POTENTIAL OF SHOAL FIELD I

Criteria for estimating resource potential

Several factors must be considered in determining the utility of a particular deposit for use as beach fill. The U.S. Army Corps of Engineers and Maryland Department of Natural Resources have previously concluded that offshore deposits are the most desirable from economic and engineering standpoints. Additionally, sand deposits within a 24 kilometers radius from the point of use are most desirable. Water depths of less than 15 meters are also advantageous for dredging technologies.

Potential beach fill material should exhibit textural parameters similar to the native sands they are intended to replenish. The Shore Protection Manual (U.S. Army Corps, 1984) describes methodologies to determine acceptable beach fill textural parameters for any particular site. An important consideration is the overfill factor. The overfill factor is derived from the comparison of textural properties such as composite graphic mean (Folk and Ward, 1957) and sorting of the potential borrow sediments to those of the native beach sand, using an overfill criteria developed by James (1975). The overfill factor takes into account that portion of borrowed material expected to remain on the beach after equilibrium is achieved. High overfill factors indicate the borrowed material will be unstable on the native beach because finer fractions will be removed more rapidly than coarse fractions. Thus, a larger volume of borrowed material with a high overfill factor must be placed on the beach to maintain stability. This in turn increases the cost of placement and maintenance.

Native Ocean City beach sands have a composite graphic mean diameter of 1.84 k and a sorting of 1.22k (Anders and others, 1987; Anders and Hansen, 1990). Sediments that are finer or more poorly sorted than native sands will have increasingly higher overfill factors. Therefore, sand suitable for beach fill should have a mean grain size coarser than 1.84 k (medium sand) and have a sorting value less than 1.22 k (moderately sorted). To be classified as a high potential sand resource, deposits must exceed these grain size parameters. Sands that fall between 1.88k and 2.0k mean diameter and/or with a sorting of greater than 1.22k are classified as having a moderate potential. Deposits below -15 meters are also considered to have a moderate potential. Sediments with mean diameters less than 2k are considered low potential.

None of the vibracores taken at the shoal crests penetrated the entire shoal bodies. Therefore, the quality of shoal sands below the depth of vibracore penetration can only be inferred from the interpretation of seismic records and shoal etiology. A sampling project that used a 12-meter vibracore would penetrate these shoals and provide a more accurate estimate of sand resources in Shoal Field I.

Sediment quality

The figures in Appendix A compare vibracore samples' mean diameter to depth. The data are summarized in Appendix B. Interpretation of sediment quality in Shoal Field I is based on these cores and the seismic record. Seismic reflections vary according to sediment type, an effect that produces characteristic seismic signatures. Coarse sediments tend to be excellent reflectors, and limit the amount of signal penetration into underlying sediments. Fine sediments are more acoustically transparent than coarse material. Coarse sediments produce dark, surface reflectors with little detail below the surface. Thus the seismic record coupled with sediment samples can assist in determining sediment types.

Sediments of Shoal Field I

Fenwick Shoal

Vibracore and seismic data characterize Fenwick Shoal as an excellent source of beach sand. Cores FS1, FS2, FS3 and FS5 from the southwestern portion of the shoal contain at least 94% sand with varying amounts of gravel and less than 1.5% mud. Textural parameters in this region meet or exceed the mean and sorting standards for beach nourishment sands. One core (FS4.1 and its retry 4.2) contained an abundance of gravel, about 15%, through the lower three-quarters of its length. The material from this portion of the shoal may be coarser than is desirable for beach fill. However, the gravelly sediment is confined to a relatively narrow layer and does not extend over a large area, and therefore does not detract from the overall value of deposits in this region.

Cores FS6, FS7 and FS9 from the eastern flank of the shoal middle all contain greater than 99% sand, less than 1% mud and no gravel. The mean grain size from this region is larger than 1.8k and the sorting is better than 0.7k. Cores FS10 and FS11, from the crest in the shoa1's center, are similar to the previous three cores, except they are slightly coarser.

Core FS8.1 and its retry 8.2 were collected off Fenwick Shoal, in a trough between Fenwick and Weaver Shoal to the south. FS8 characterizes the inter-shoal region as layers of medium to fine sand and muddy sand alternating with mud and clay layers. This type of muddy sediment underlies Fenwick Shoal, below the ravinement surface. The sediments in the inter-shoal regions are not suitable for beach nourishment.

The following nine cores were taken off the Delaware coast and were processed and analyzed by Delaware Geological Survey. Detailed descriptions of the cores and methods used to analyze them have been published (Ramsey and McKenna, 1999). Cores Rk34-02 and Rk35-02 show this north-central section of Fenwick Shoal to contain at least 85% sand and less than 15% gravel, and less than 1% mud. The mean diameter is greater than 1.8k and sorting is better than 0.81k. To the east of these cores, on the eastern flank, cores Rk35-03 and Rk35-04 show a distinct trend to finer sands and slightly more mud. Mean diameters on the eastern flank are as fine as 2.6k. Sediments from Rk35-04 are somewhat coarser than Rk35-03, due mainly to a slightly greater gravel content, and somewhat more poorly sorted. The finer sand in this region defines a broad area with a moderate potential, grading to poor potential eastward.

Cores from the northeastern end of Fenwick Shoal indicate sand in this region is finer than that found in the more southerly sections. While sand from these cores is still coarse enough for beach fill, a trend of finer sand northward is evident. This fining trend suggests that the northernmost regions can only have a moderate sand resource potential.

Weaver Shoal

Weaver Shoal sediments were previously described from vibracores WS1 through WS5, taken in 1992 (Conkwright and Gast, 1994). Cores WS6 through WS12 were taken in 1997and are described here for the first time. Core WS6 was taken at the extreme south western end of Weaver Shoal. This core shows sediments consisting of at least 97% sand and less than 3% mud. Mean grain diameters vary between 2.7k and 1.1k, with sortings better than 0.86k. This variability and relatively fine diameter place the southwestern extreme of Weaver Shoal in the low to medium resource potential range. Vibracores WS1 through WS5 were taken in 1992 and defined the region of high resource potential within Weaver Shoal.

Cores WS7 and WS1 were taken near the crest of Weaver Shoal. This region contains at least 80% sand with as much as 20% gravel. No more than 0.6% mud was found. The mean grain size is larger than 1.7k and has a sorting of better than 1.8k. Several thin layers within these two cores have anomalous sorting numbers due to very coarse gravel and pebbles. Two sections of WS7, around -10.90 and -12.02 meters below NGVD, contained very coarse gravel and pebbles. WS1 also contains thin layers of very coarse material.

Core WS8 was taken on the east-central flank of Weaver Shoal. Sediments here are at least 99.5% sand and less than 0.5% mud. Mean diameter and sorting are better than 1.2k and 0.5k respectively. This core and WS5 from 1992 are both close to the eastern edge of Weaver Shoal, and suggest that sediments with a high resource potential exist almost to the eastern edge of this shoal.

Two cores from the central portion of Weaver Shoal, WS9 and WS12 are similar, showing mean diameters between 1.0k and 1.8k and sortings from 0.3k to 0.5k. Sediments in WS12 are slightly coarser than WS 9 to the northeast, and Core WS3 taken in 1992 is slightly finer than WS 9 and 12. Similar to the trend observed in Fenwick Shoal, these cores suggest a fining of sediments toward the northeast.

Cores WS10 and WS11 were taken near the edge of the shoal. Both cores contain fine sand and mud layers, showing the off-shoal areas to have a low resource potential.

Isle of Wight Shoal

Isles of Wight Shoal sediments were initially described from vibracores IW1 through IW5 in 1992 (Conkwright and Gast, 1994). Cores IW6 through IW12 were taken in 1997 and are described here for the first time.

Vibracore IW6 was taken on the extreme southwestern tip of the shoal. This core contains medium to fine sand with some mud layers. Mud makes up as much as 37% of some core sections. Mean diameters range from 1.5k to 4.1k and sortings from 0.4k to 2.8k. Based on this core, the southwestern extreme of this shoal has a low resource potential.

Isle of Wight Shoal's eastern flank was sampled in two locations. Core IW7 was taken in 1997 on the southeast edge, and IW3 was obtained in 1992 on the northeastern edge. Sediments from IW7 are at least 97.7% sand and no more than 2.3% mud. The average diameter of these sediments is 2.3k, and the sorting is better than 0.6k. Core IW4 contains at least 97.5% sand between -15.4 and -19.7 meters, with small amounts of mud and gravel. From -19.7 to -30 meters the sediments become muddier, with as much as 50% mud. The average grain size of IW4 sediments is 2.11k. Both of these cores suggest that the eastern flank of Isle of Wight Shoal has at best a moderate to low resource potential.

Cores from the center of this shoal all show similar textural parameters. Cores IW1, IW8, IW9, IW10 and IW 12 have at least 99% sand and less than 1% mud. Mean grain diameters range from 1.0k to 1.7k. Only IW12 has significant gravel, and this is confined to the upper 10 centimeters of the core. The sediments are moderately to well sorted. The center section of Isle of Wight Shoal has a high resource potential.

Cores IW5, from 1992, and IW11 were taken off the shoal, to the northwest and northeast respectively. These cores contain the layered fine sand and mud that are typical of the inter-shoal regions. These areas have low resource potential.

Sediment volumes

A summary of sediment volumes contained within the shoals studied is presented in Table 3. Total shoal volumes, and volumes of regions with moderate and high potentials are calculated. Volumes are based on an entire shoal body, from its surface to its base, as defined by the underlying ravinement surface.

Table 3

Sediment Volumes (million cubic meters)

REGION	**POTENTIAL CLASS**	**VOLUME (million m^3)**
Fenwick	high potential	95.8
	moderate potential	65.4
	total	**161.2**
Weaver	high potential	57.6
	moderate potential	16.4
	total	**74**
Isle of Wight	high potential	72.6
	moderate potential	26.1
	total	**98.7**
Shoal Field I	Total, high potential	**226**
	Total, moderate potential	**107.9**
	TOTAL	**333.9**

RESOURCE POTENTIAL

A summary of sediment grain size parameters and volumes is presented as a map in Figure 6. The map outlines those regions that contain usable sand resources within Shoal Field II. Areas of high potential contain sands

1) have mean grain size greater than 1.84k and sorting less than 1.22k
2) are in depths less than -15 meters ;

Areas of moderate potential contain sands

1) have mean grain size between 1.84k and 2.0k and sorting greater than 1.22k
   or
2) are in depths -15 meters or more

Areas of low potential are regions with sediments finer than 2k.

Sand Resources Potentials

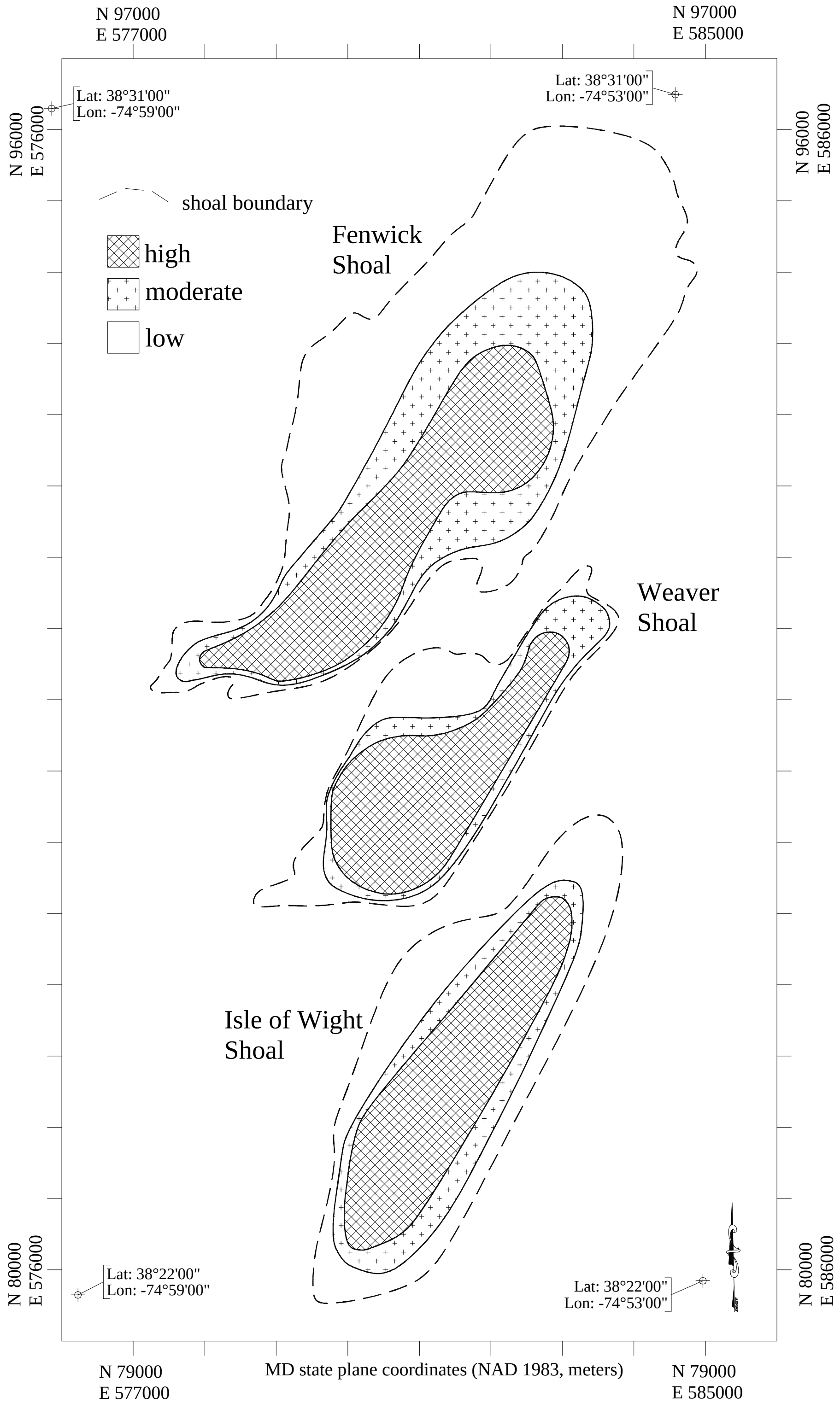

Figure 6

CONCLUSION

Shoal Field I encompasses three shoals, all possessing a high potential for sand resources. Fenwick Shoal contains the largest volume of high-quality sands, followed by Isle of Wight and Weaver Shoals. Overall, Fenwick Shoal has the coarsest sediments and Isle of Wight Shoal the finest sediments. The area around core FS4 Fenwick Shoal may be slightly too coarse for beach fill. Weaver Shoal sediment textures are somewhat more homogeneous and coarser than Isle of Wight Shoal sediments. While Isle of Wight Shoal has a more mixed textural environment than the other shoals it still contains a large volume of usable sand. All three shoals are located within economical distances and depths for beach restoration projects. Fenwick Shoal is particularly well suited for projects on Fenwick Island in both Maryland and Delaware.

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Appendix A

Textural Parameters versus Depth

The following graphs present textural data from vibracores taken in 1992 and 1997. Two series of graphs are presented for each core. The first graph series depicts mean grain diameter and sorting versus depth. Mean diameters and sorting are reported in k (phi) units. The second graph series shows percent gravel / sand / mud versus depth. Core depths and sampling intervals are reported in meters below NGVD. Please note that on these graphs depth increases upward along the Y axis.

Cores FS1 through FS11, WS6 through WS12 and IW6 through IW12 are represented by graphs for both individual samples and bulk samples taken from each core. The graphs labeled with only the core names display data for individual samples from each core. Generally, these samples were taken from 3-centimeter cuts near the top, middle and bottom of each core section, and also where significant textural changes were observed. The graphs labeled with the core name and “Bulk” display data from bulk samples taken from each core section. The bulk samples were taken from a continuous cut, from top to bottom of each section. Bulk sample data give an indication of the overall sediment quality for each core, while individual sample data show detailed variations within the sediment.

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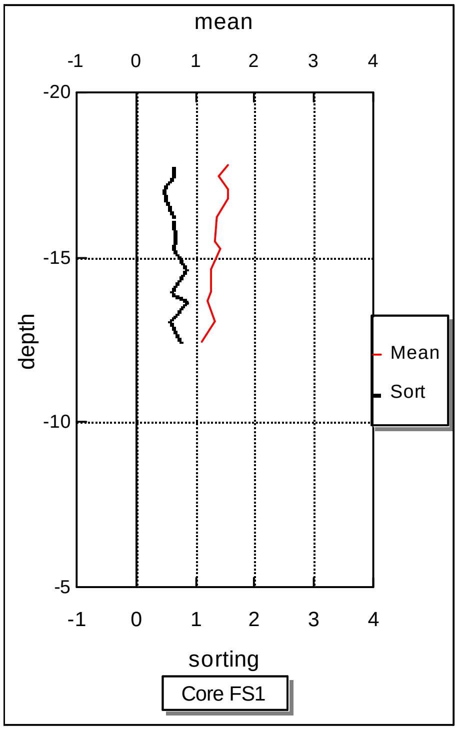
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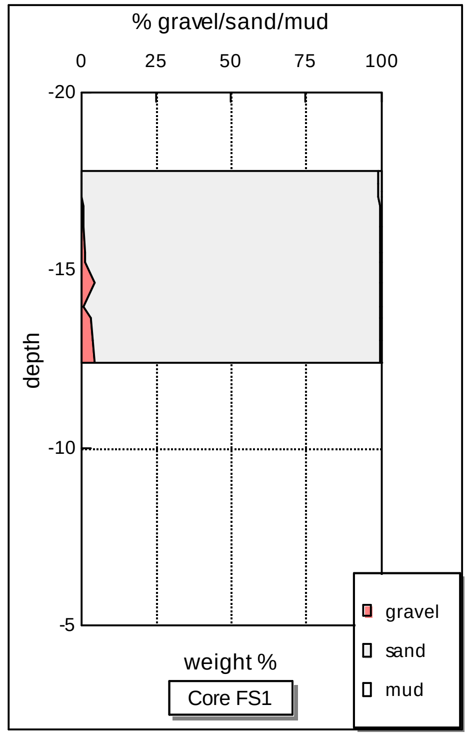
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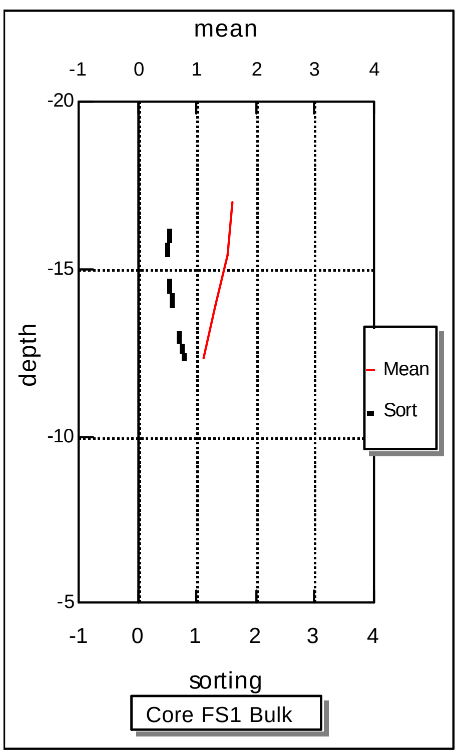
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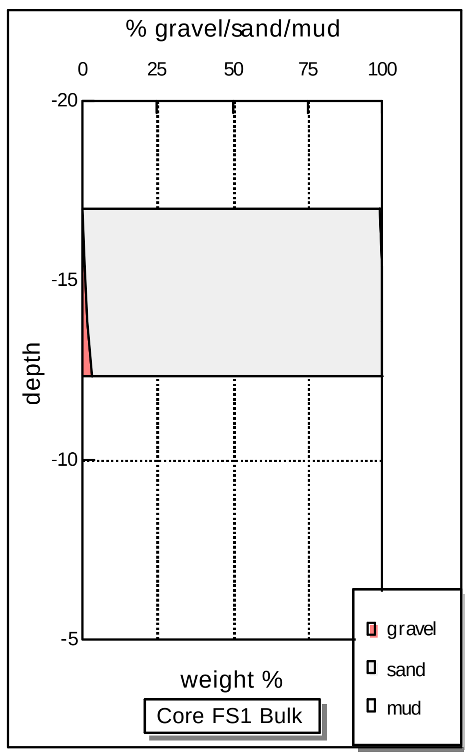
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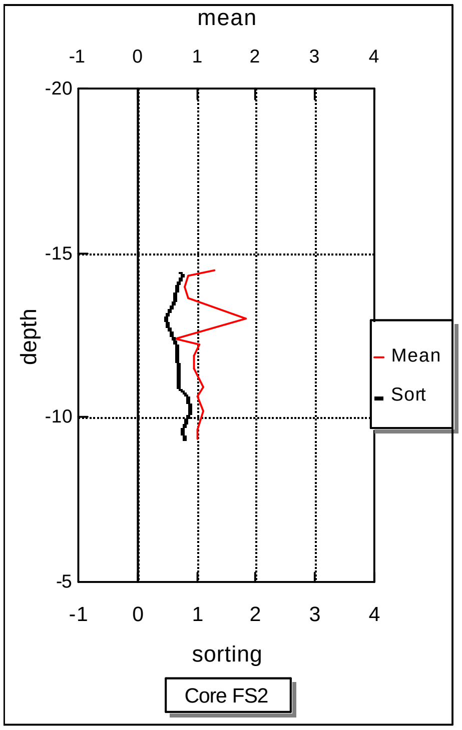
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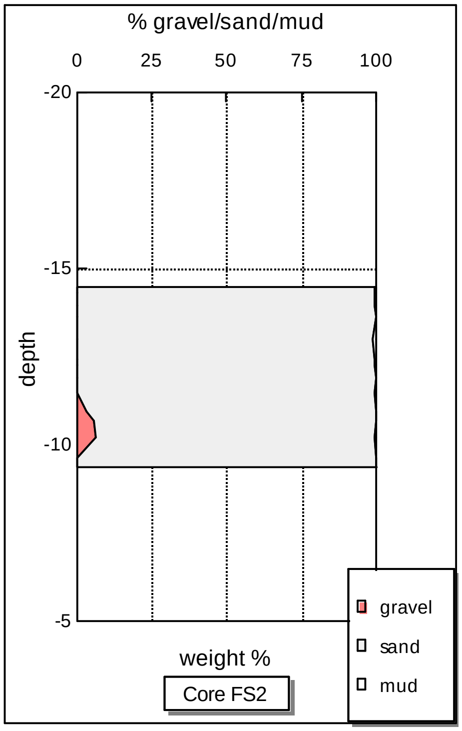
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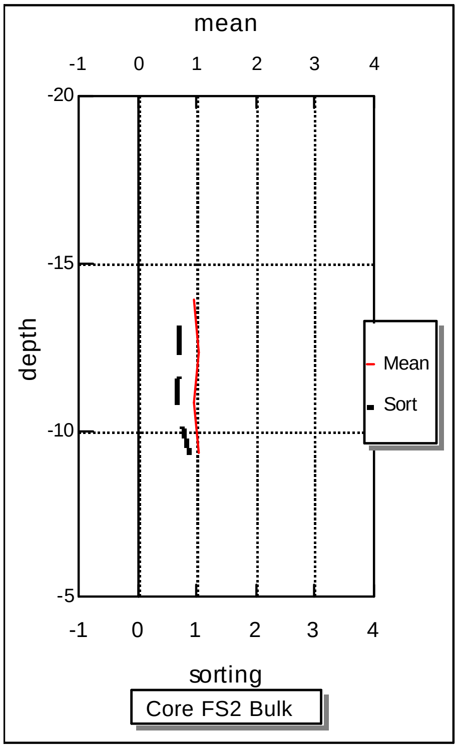
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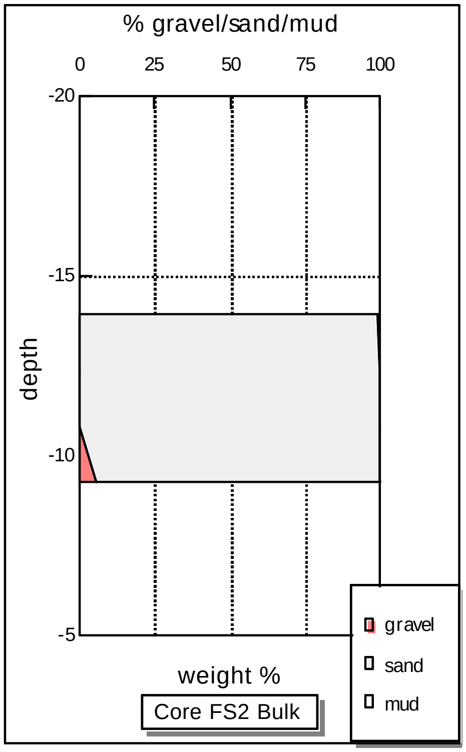
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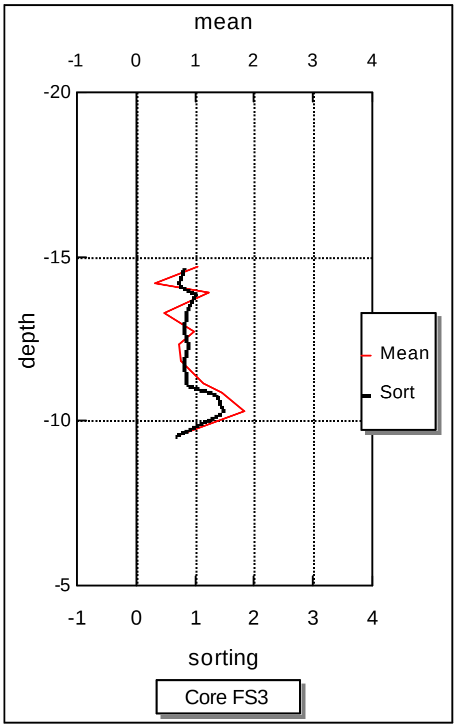
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Mean
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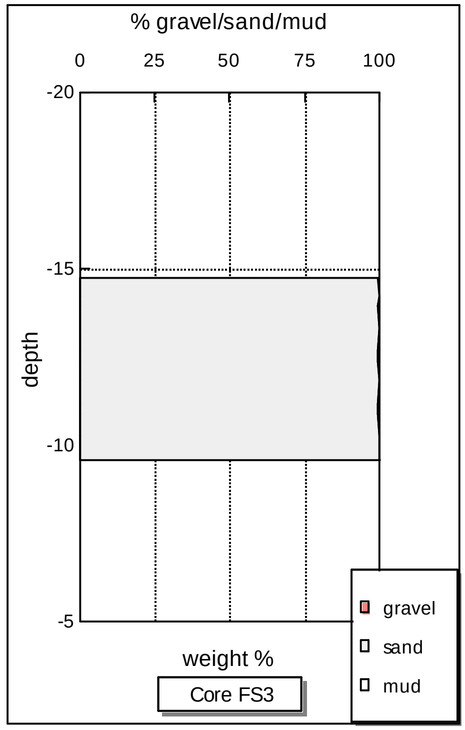
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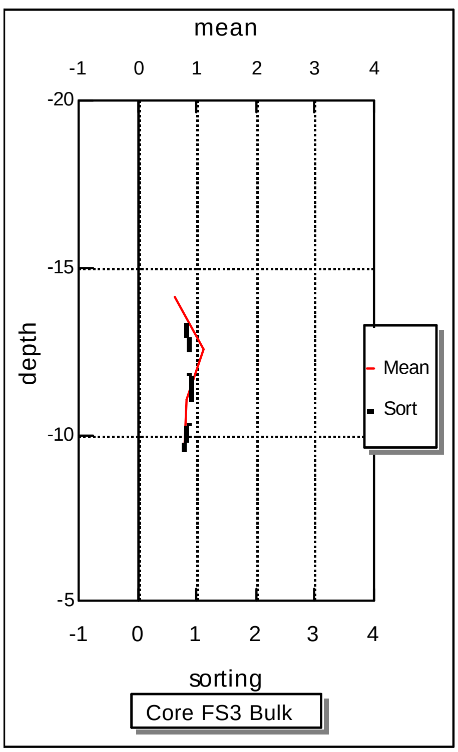
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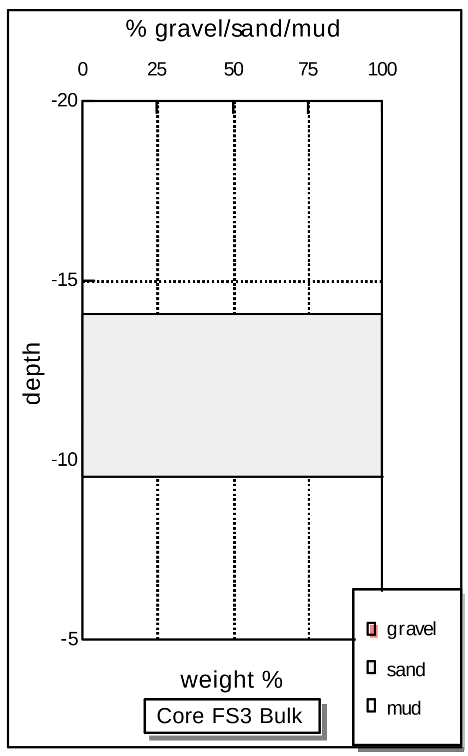
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Core FS3 Bulk
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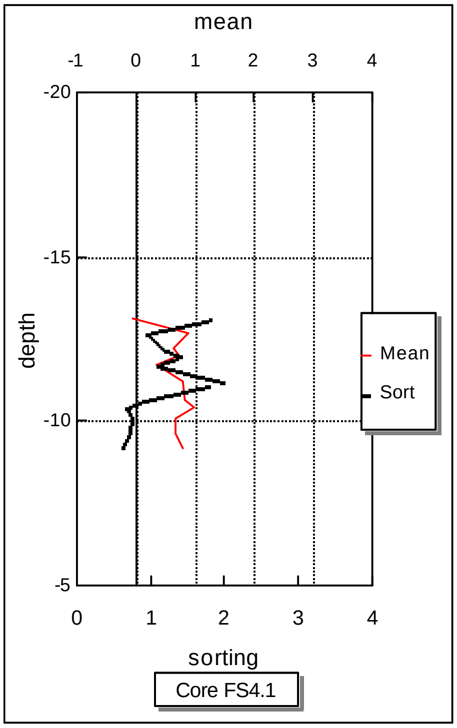
sand
mud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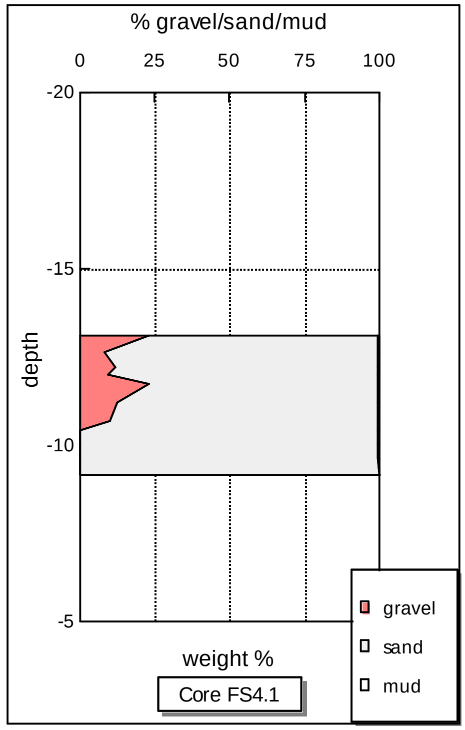
sorting
Core FS4.1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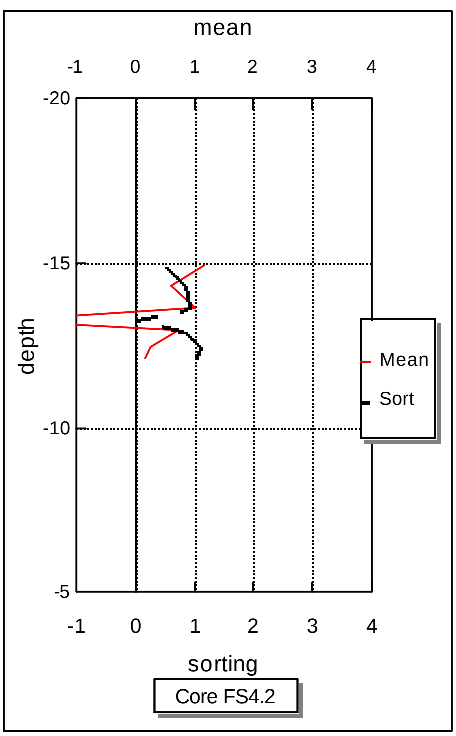
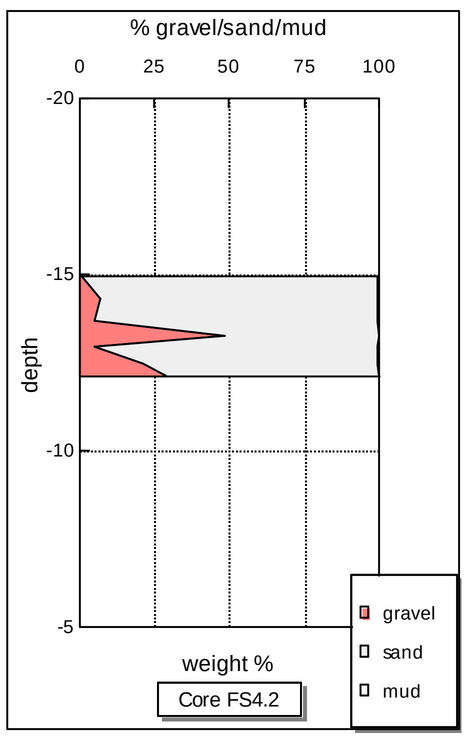
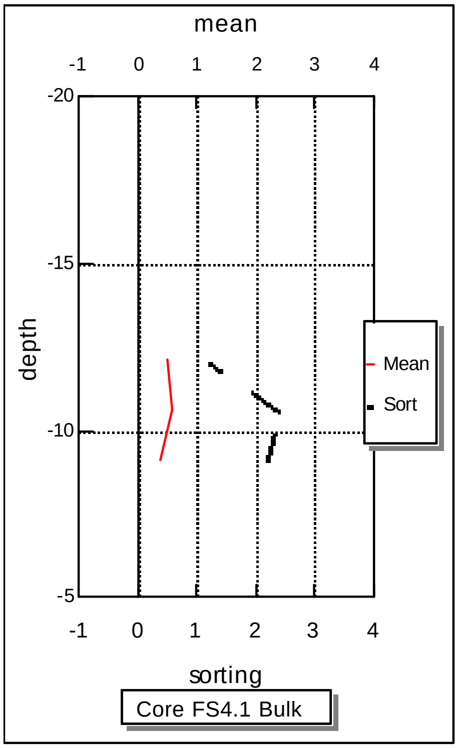
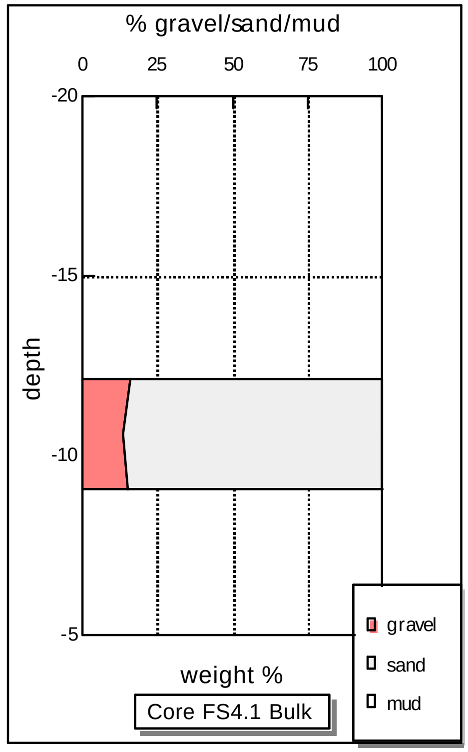
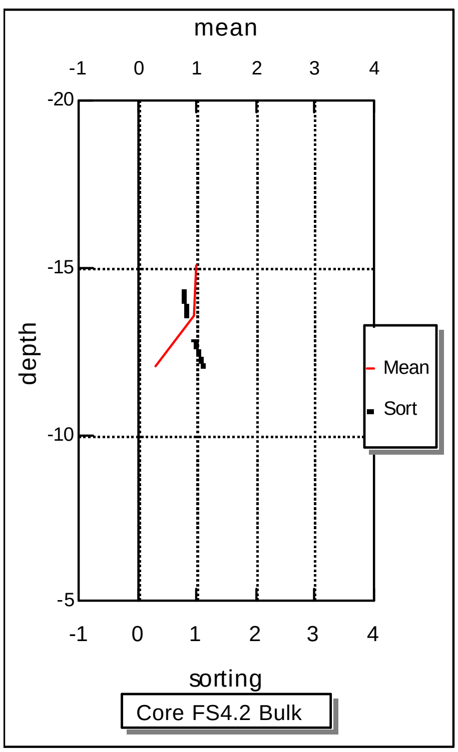
depth
weight %
Core FS4.1
gravel
sand
mud

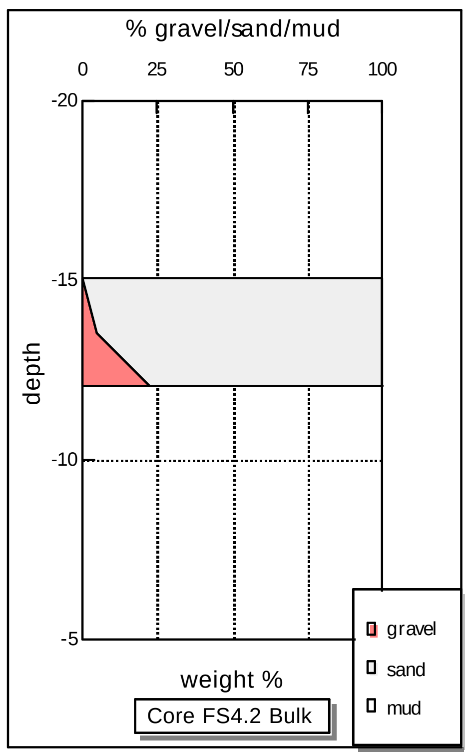

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
-1
0
1
2
3
4
sorting
Core FS4.2

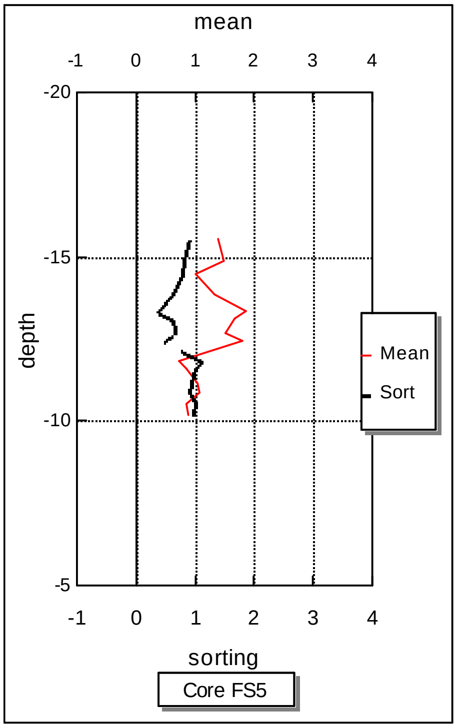

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core FS4.2
gravel
sand
mud

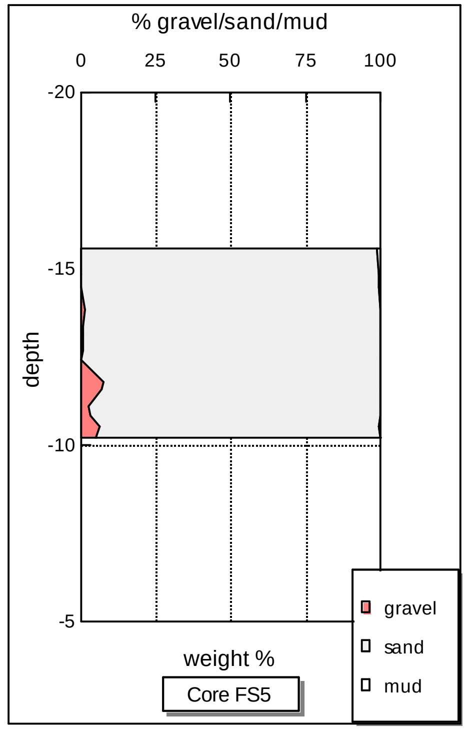

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core FS4.1 Bulk

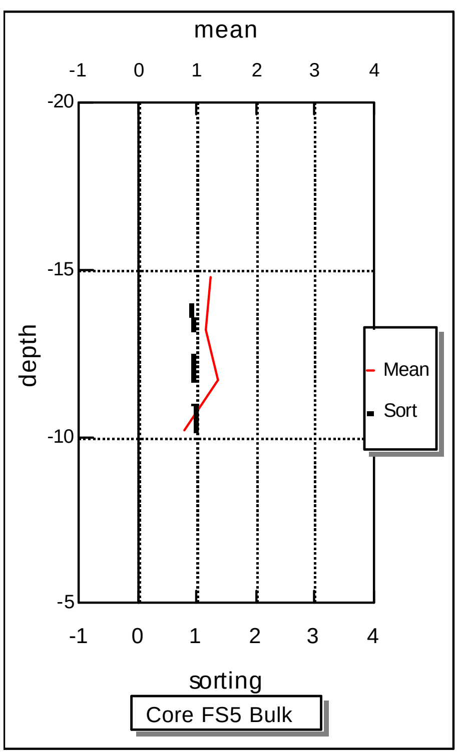

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core FS4.1 Bulk
gravel
sand
mud

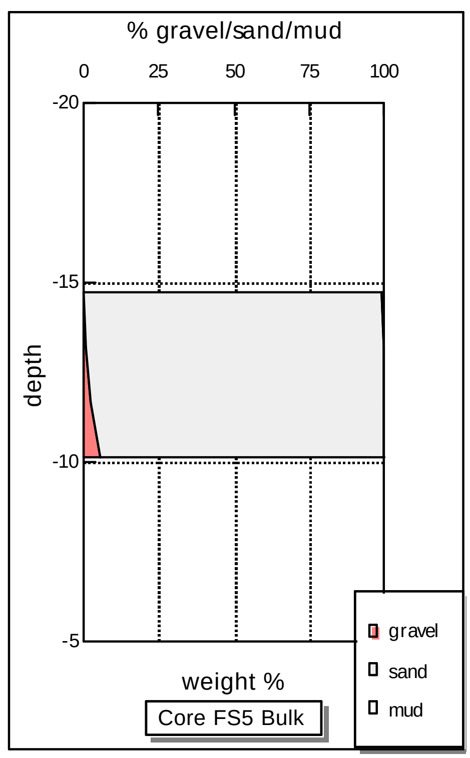

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core FS4.2 Bulk

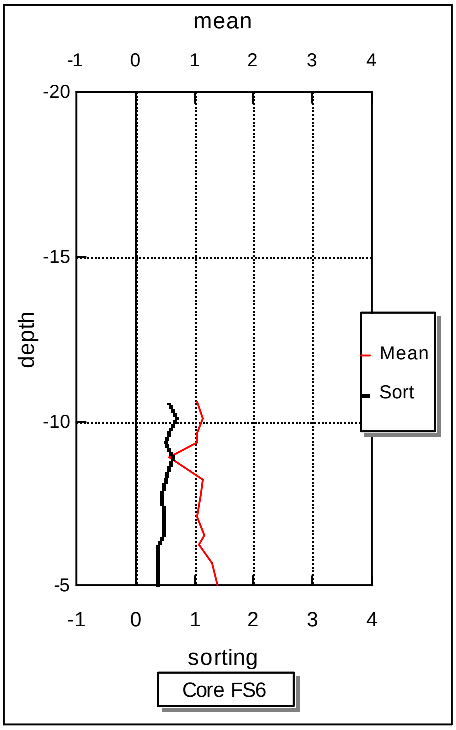

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core FS4.2 Bulk
gravel
sand
mud

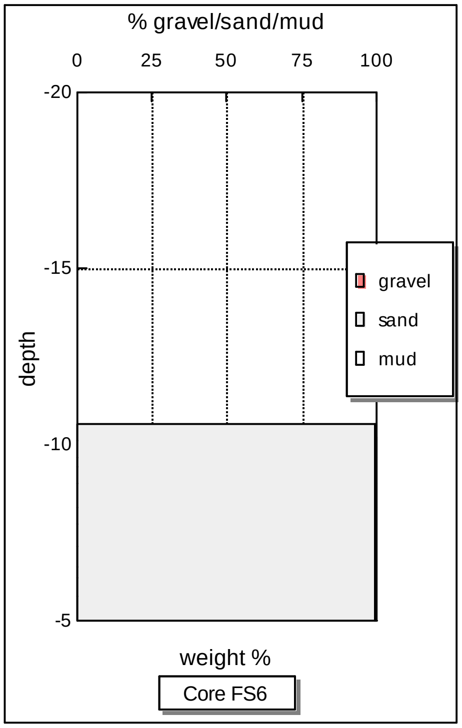

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core FS5

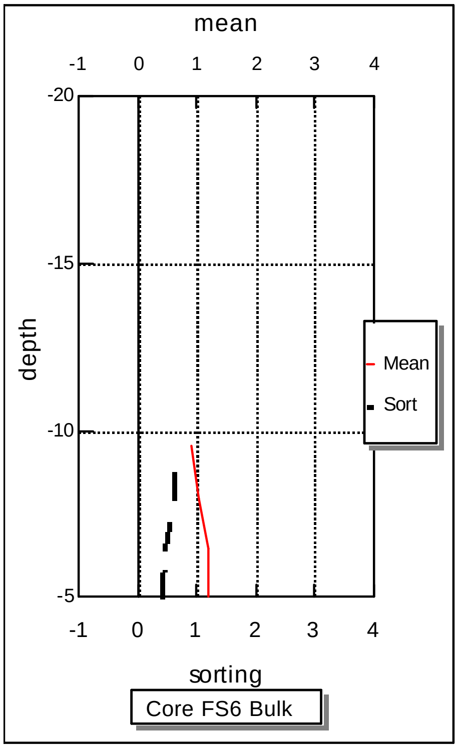

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core FS5
gravel
sand
mud

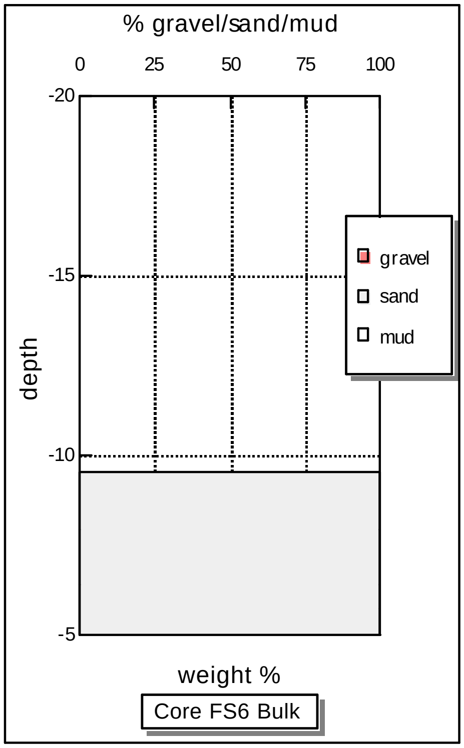

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core FS5 Bulk

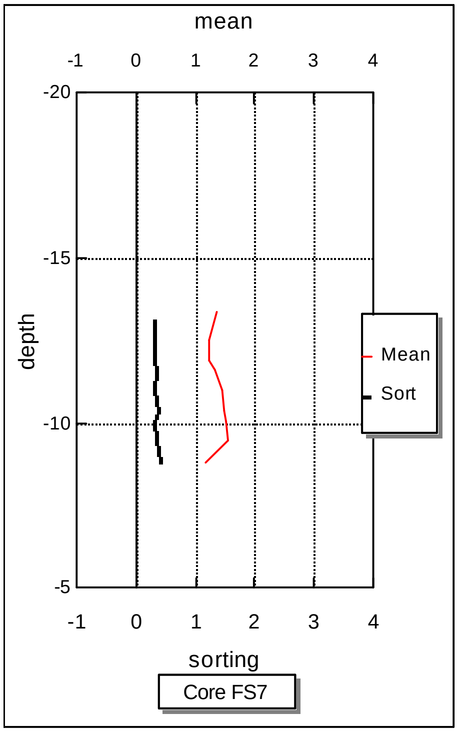

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core FS5 Bulk
gravel
sand
mud

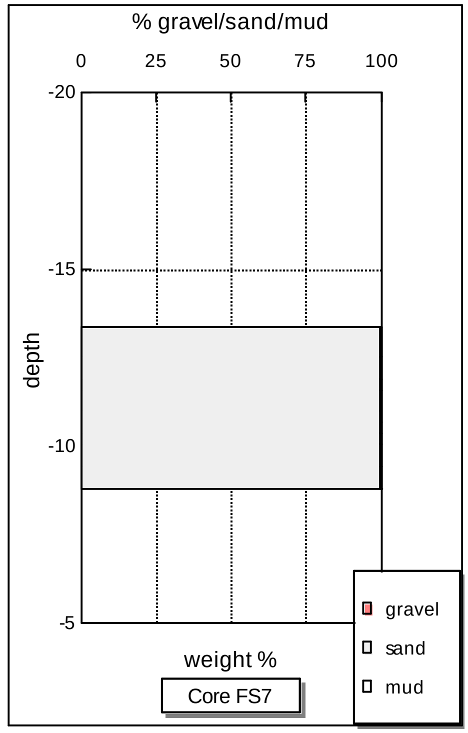

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS6

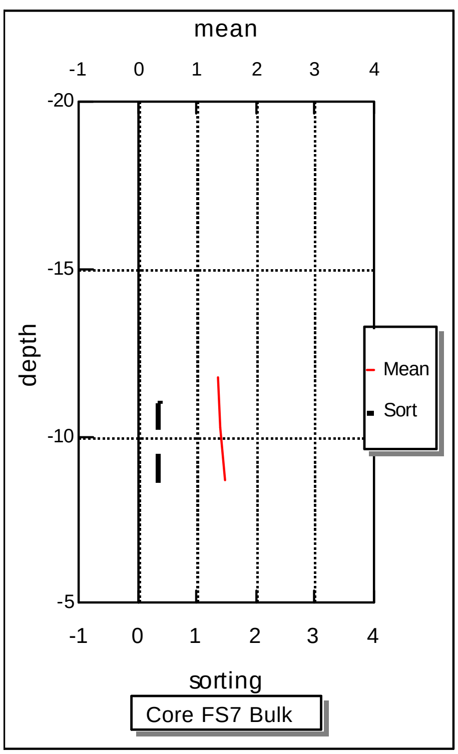

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core FS6

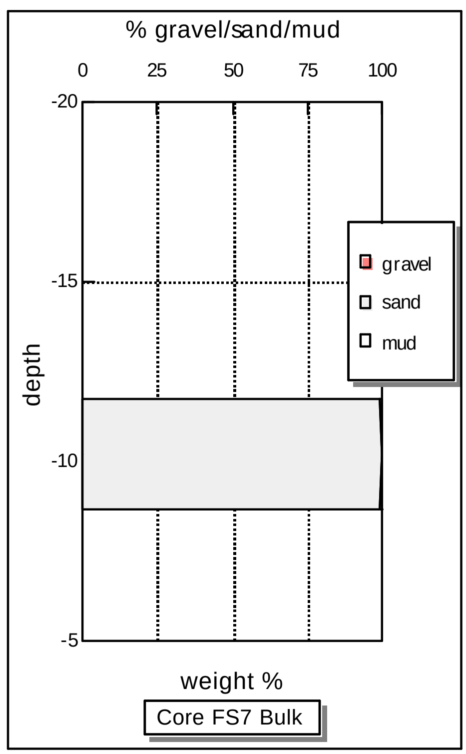

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS6 Bulk

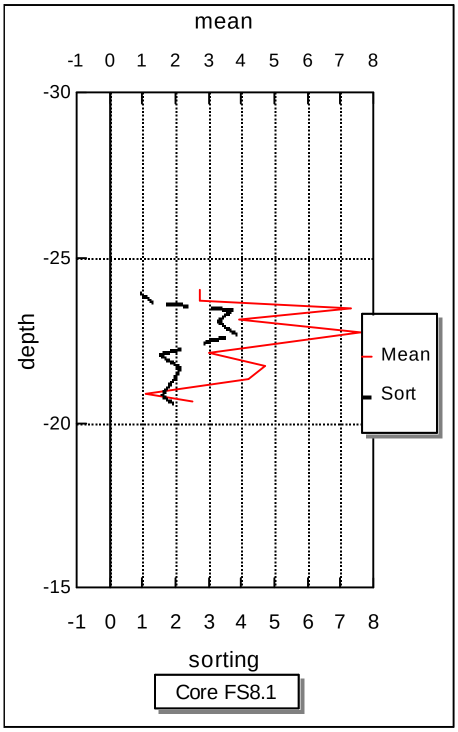

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core FS6 Bulk

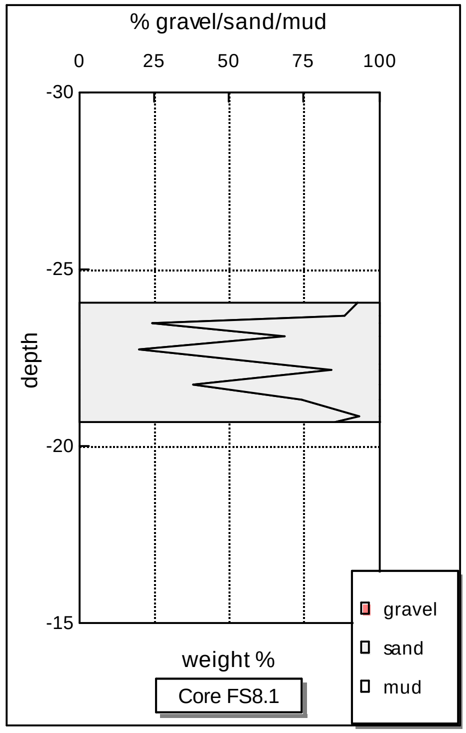

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core FS7

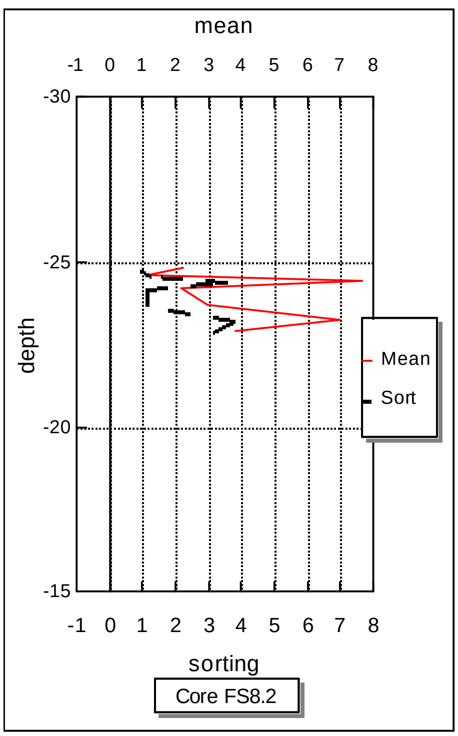

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core FS7
gravel
sand
mud

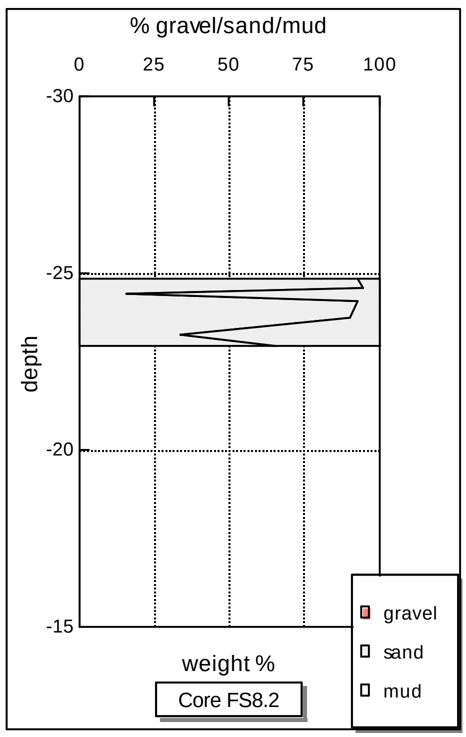

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core FS7 Bulk

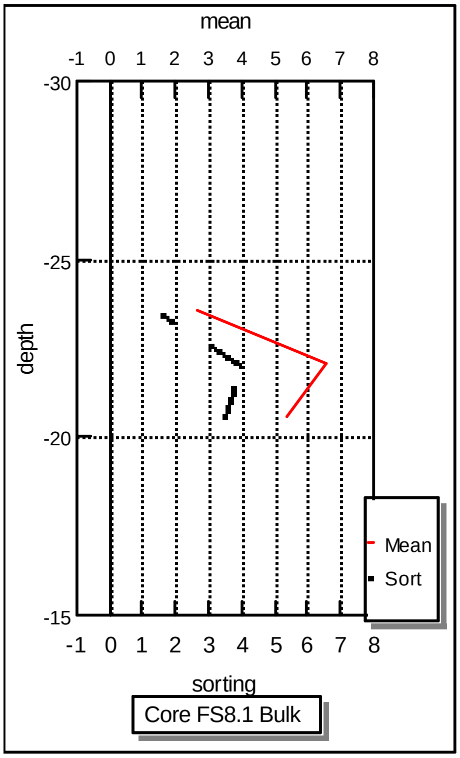

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core FS7 Bulk

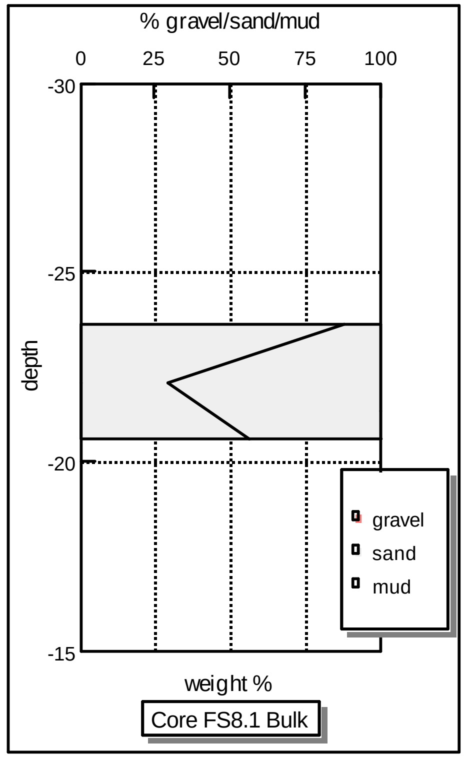

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core FS8.1

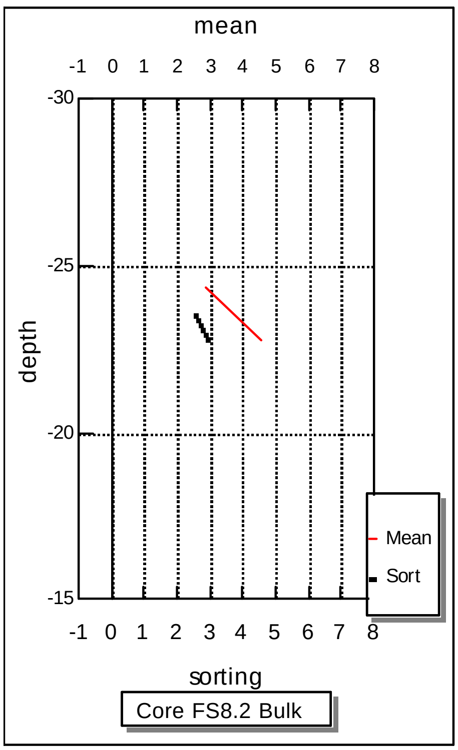

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
weight %
Core FS8.1
gravel
sand
mud

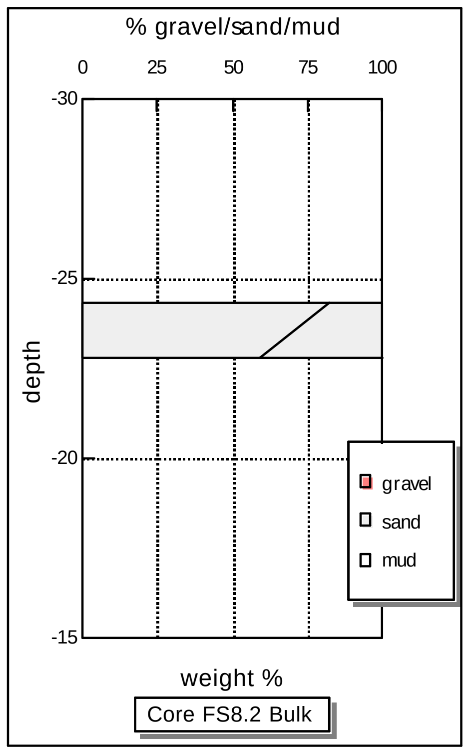

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core FS8.2

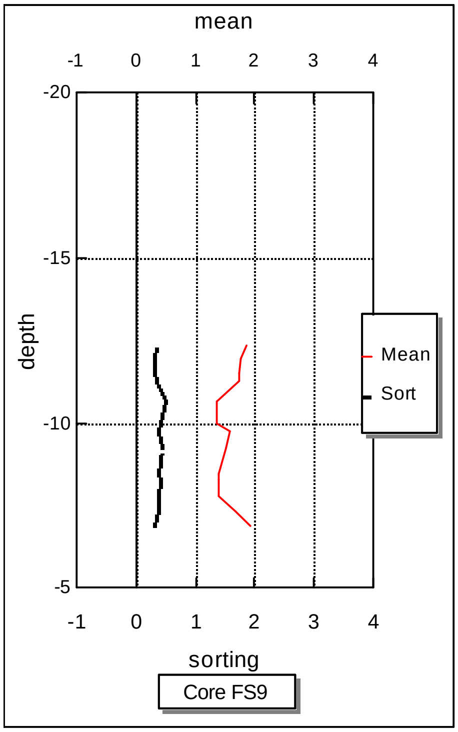

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
weight %
Core FS8.2
gravel
sand
mud

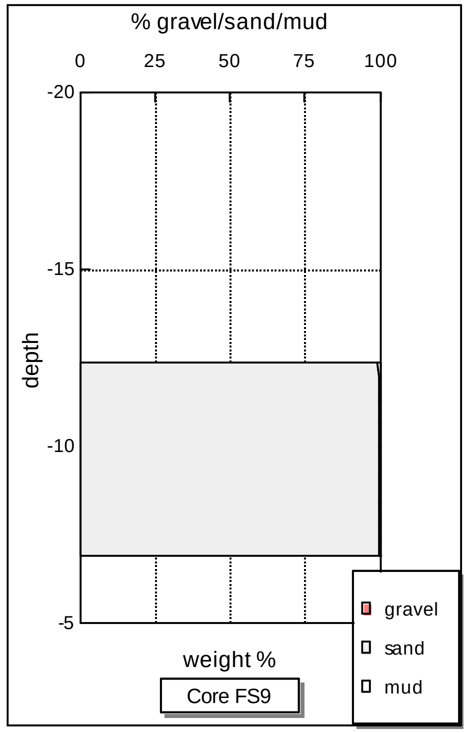

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core FS8.1 Bulk

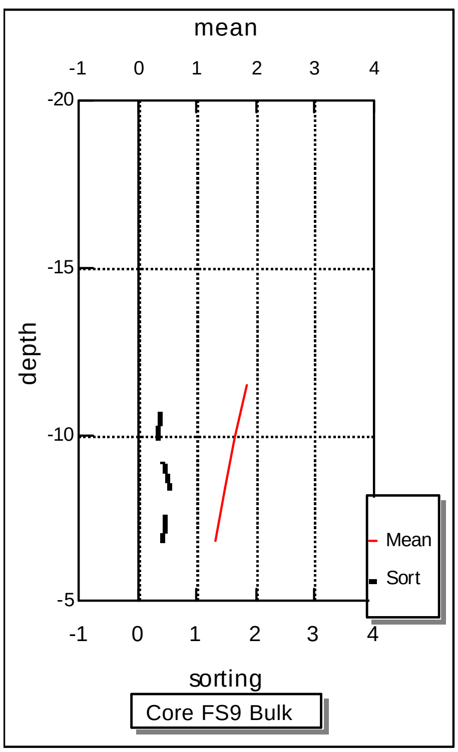

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core FS8.1 Bulk

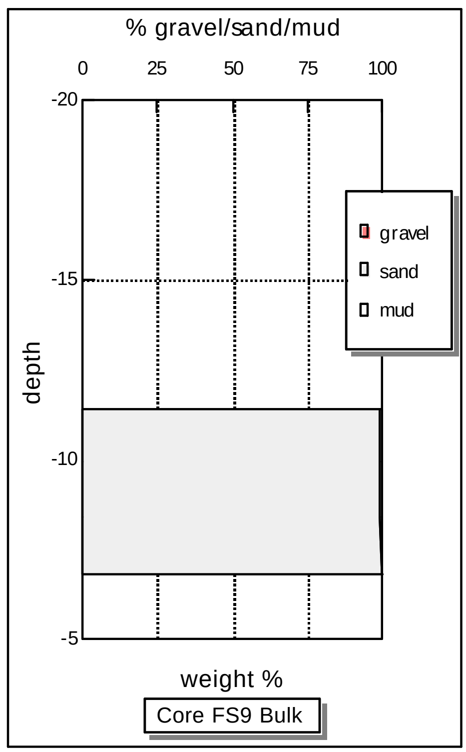

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core FS8.2 Bulk

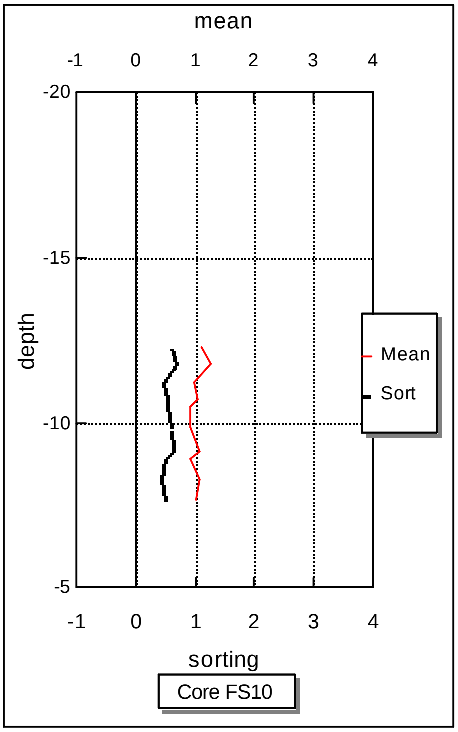

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core FS8.2 Bulk


mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS9

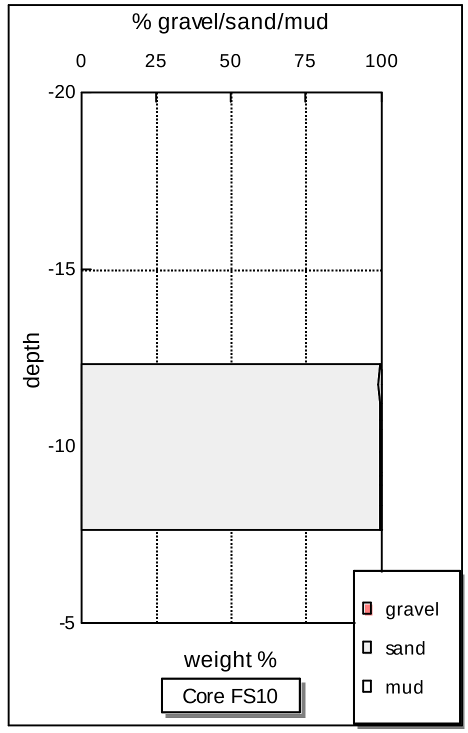

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
gravel
sand
mud
Core FS9


mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS9 Bulk

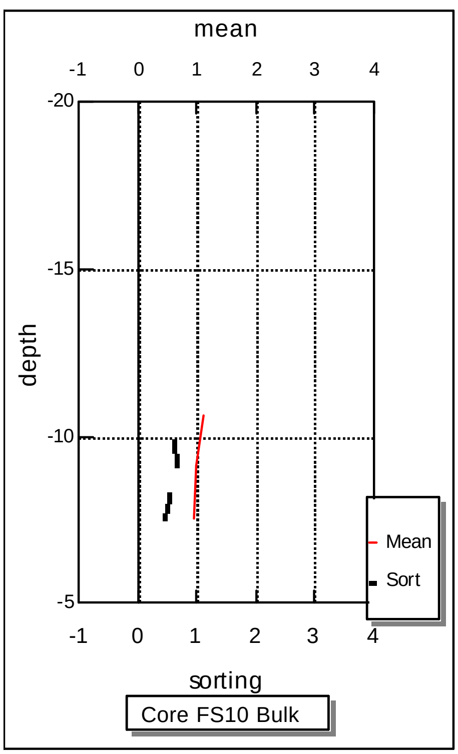

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core FS9 Bulk



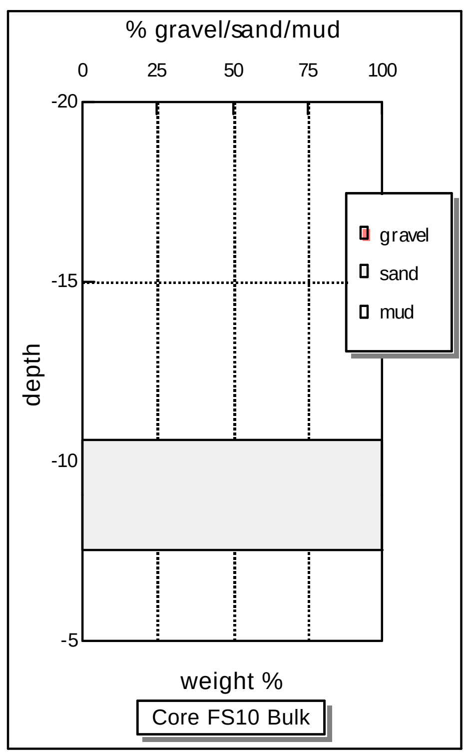
mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS10



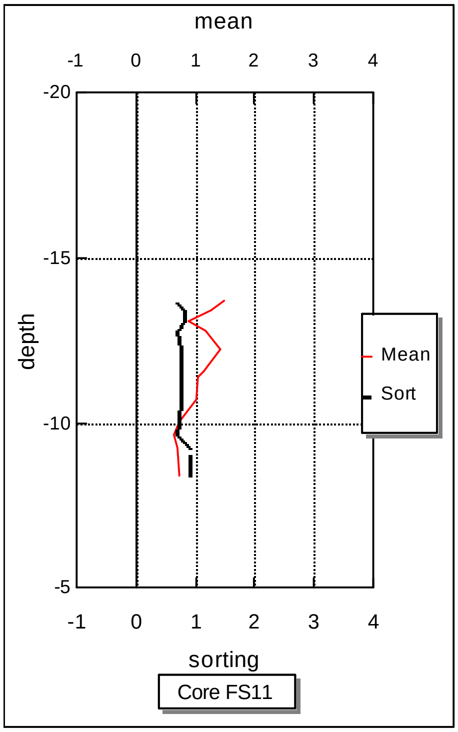
% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core FS10
gravel
sand
mud

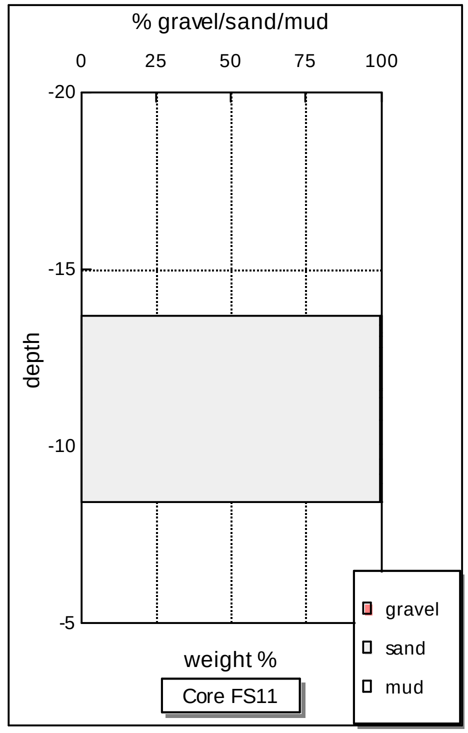


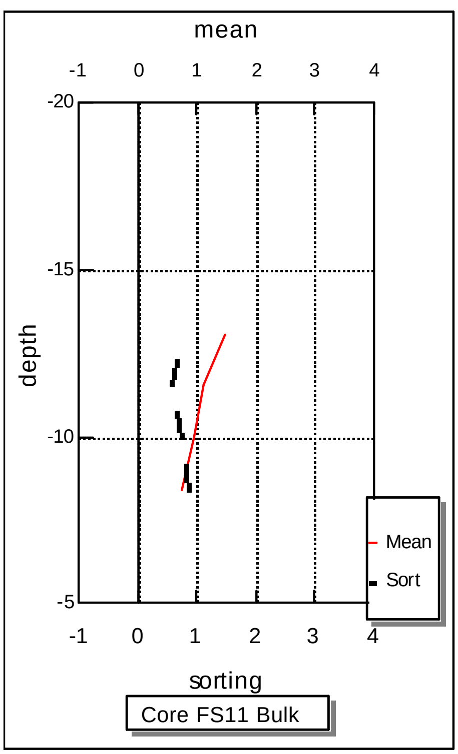
mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS10 Bulk

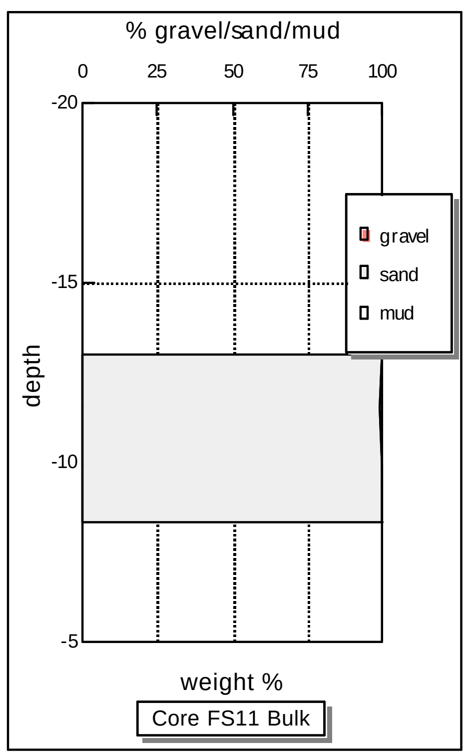


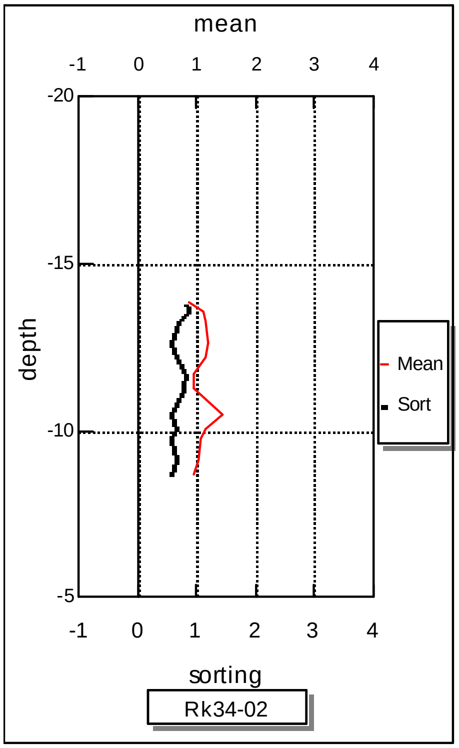
% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core FS10 Bulk

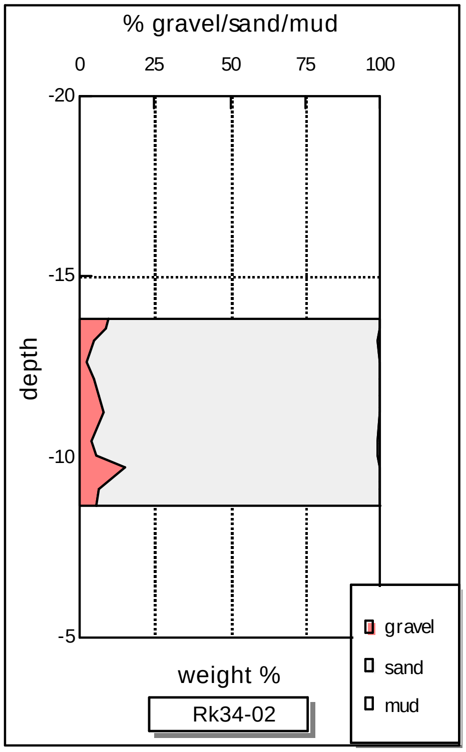

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS11

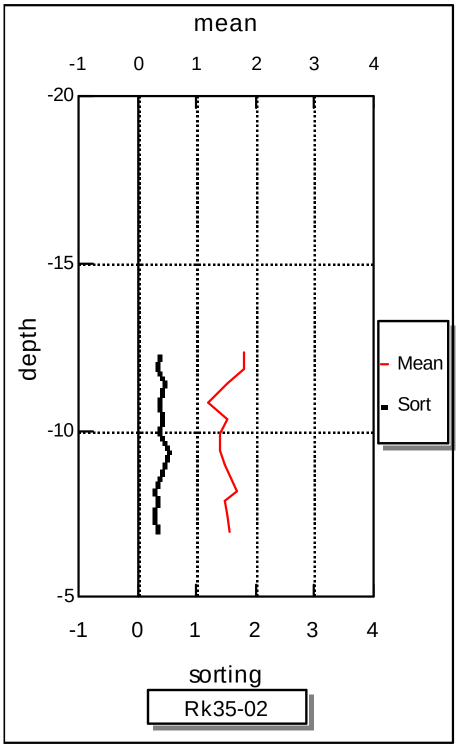

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core FS11
gravel
sand
mud

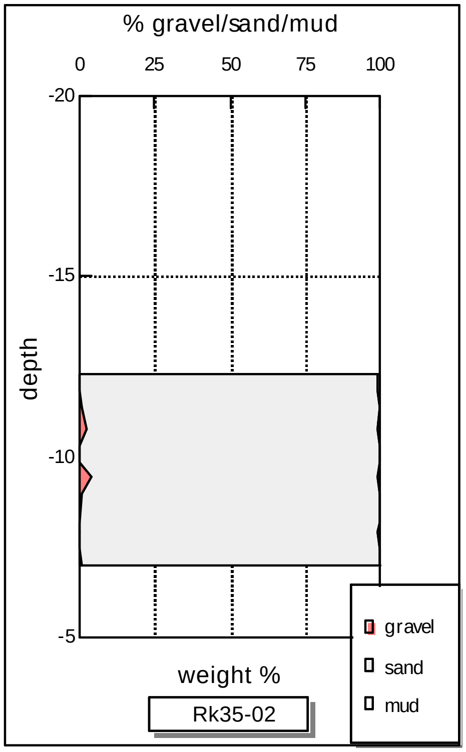

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core FS11 Bulk

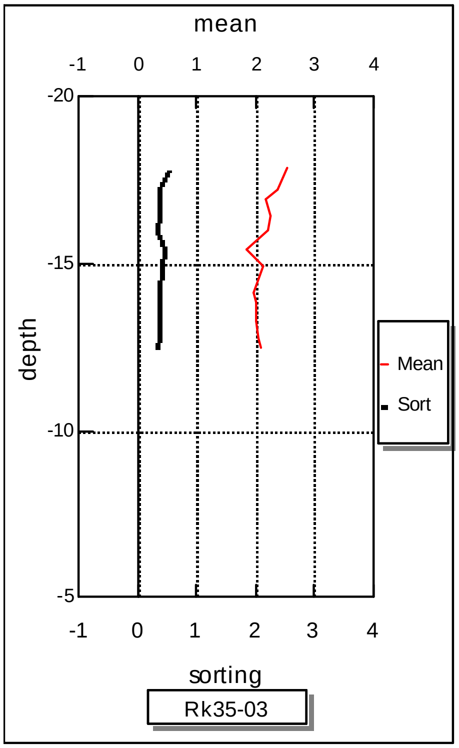

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core FS11 Bulk

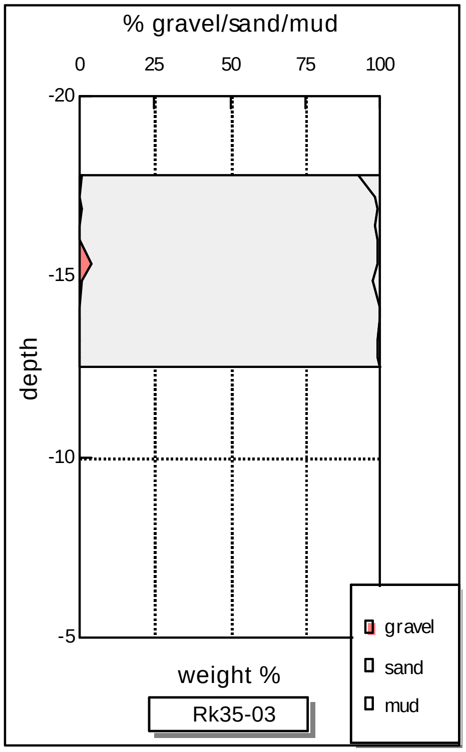

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Rk34-02

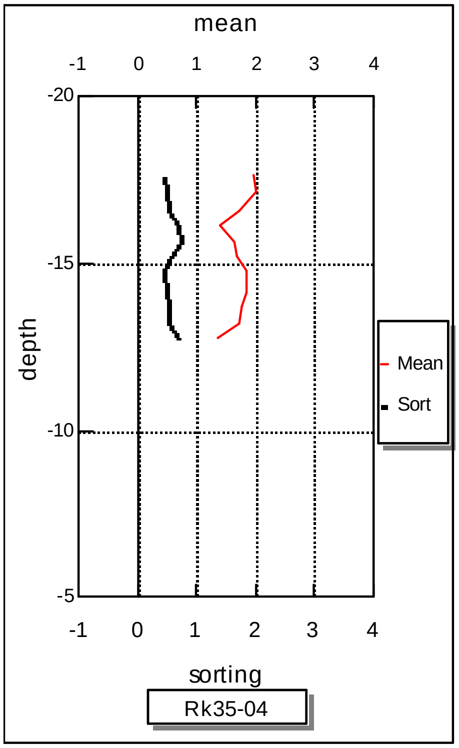

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Rk34-02
gravel
sand
mud

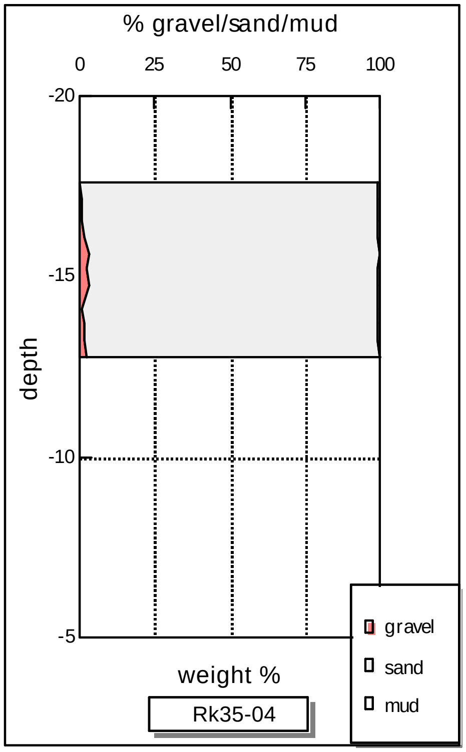

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Rk35-02

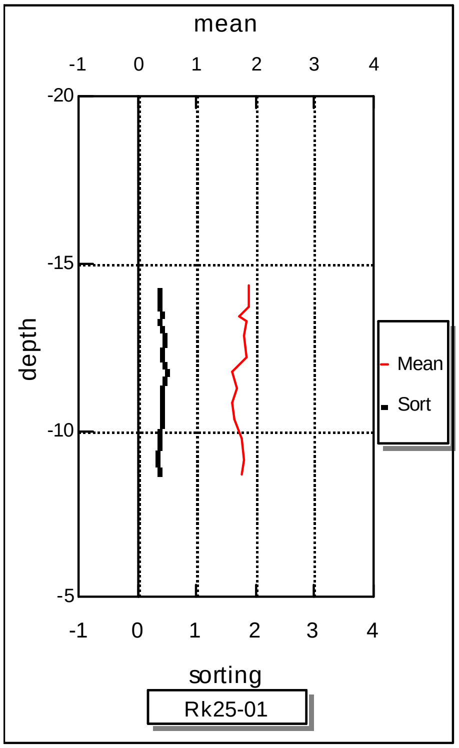

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Rk35-02
gravel
sand
mud

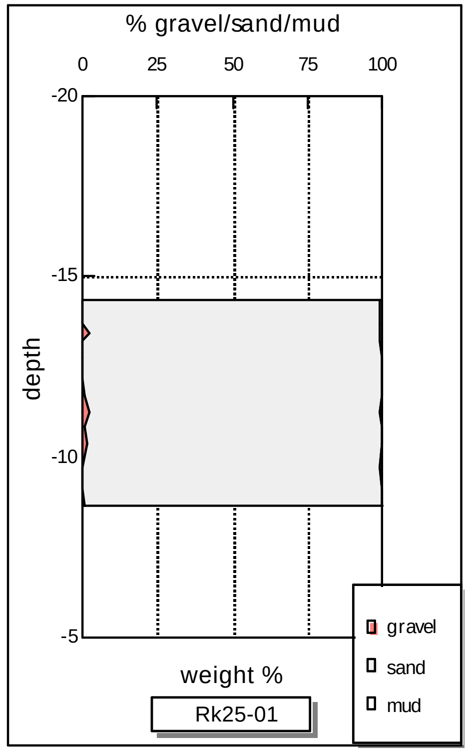

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Rk35-03

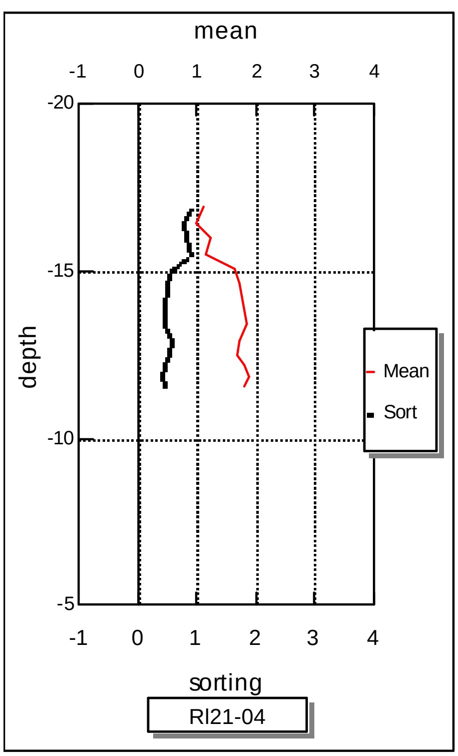

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Rk35-03
gravel
sand
mud

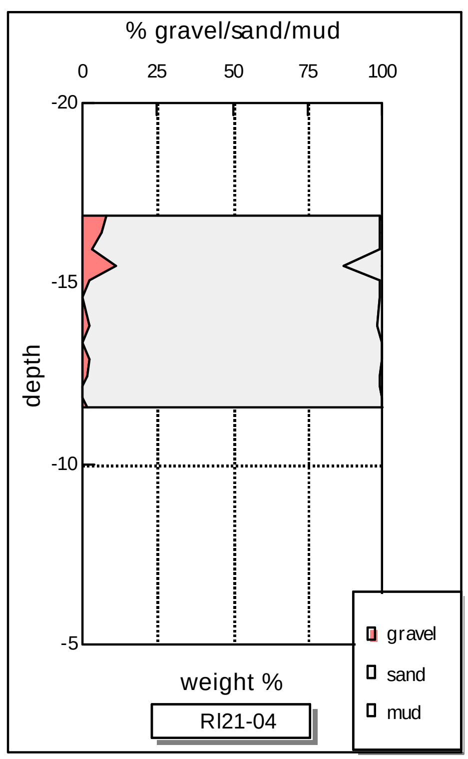

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Rk35-04

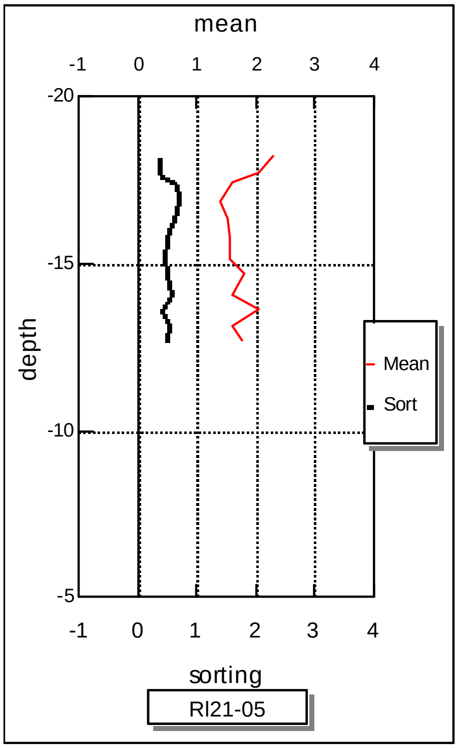

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Rk35-04
gravel
sand
mud

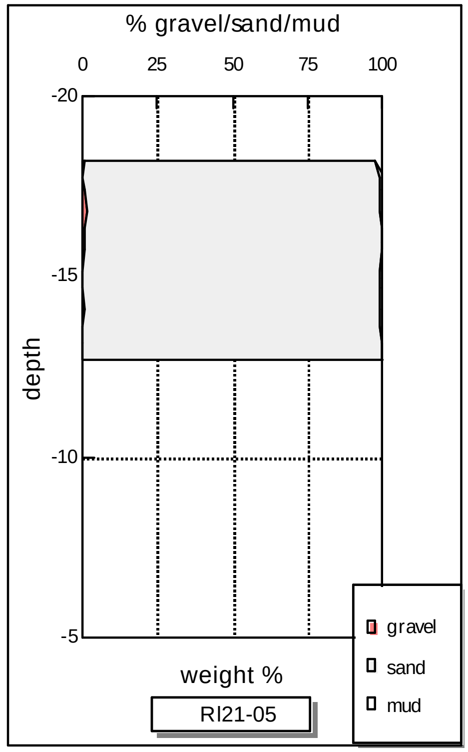

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Rk25-01

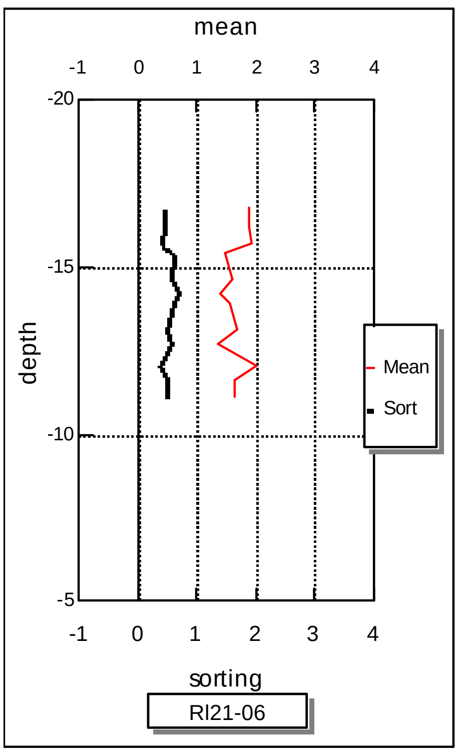

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Rk25-01
gravel
sand
mud

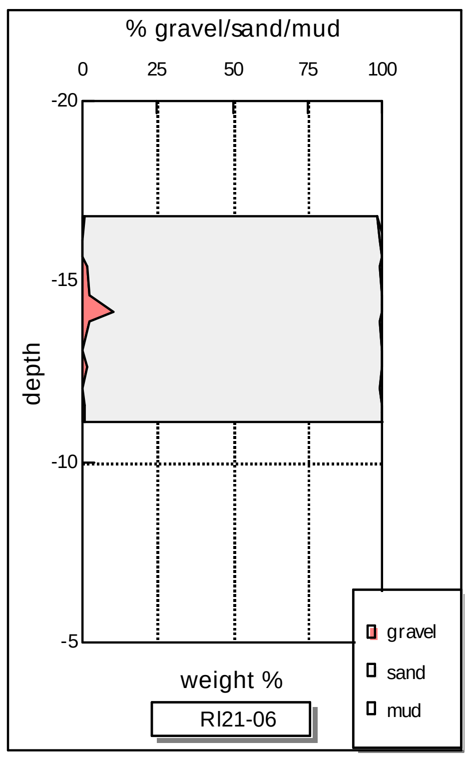

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Rl21-04

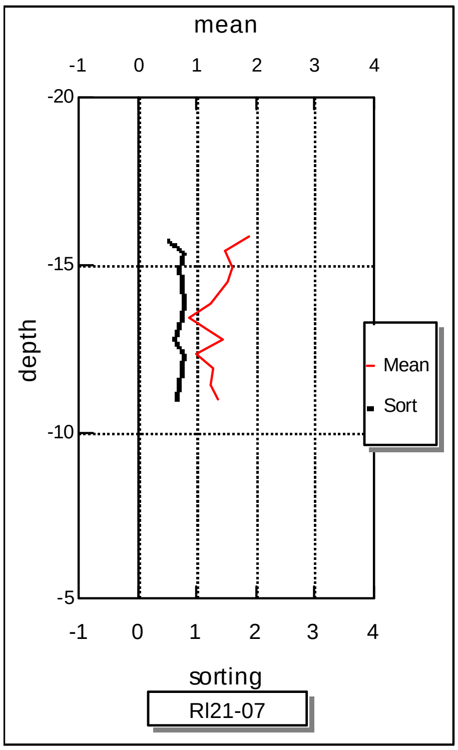

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Rl21-04
gravel
sand
mud

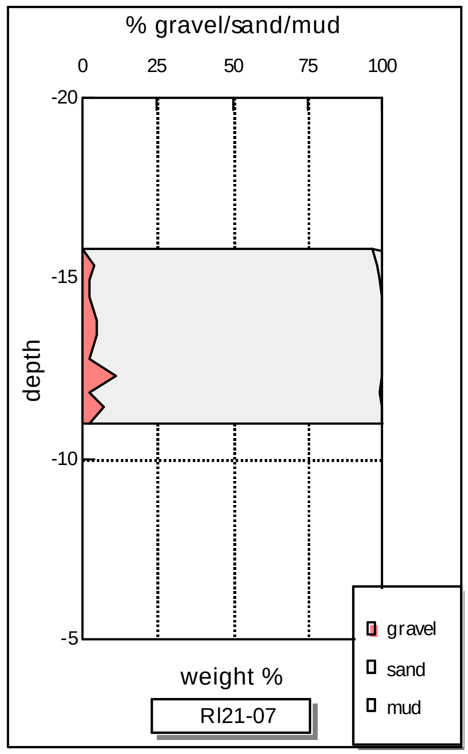

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
RI21-05

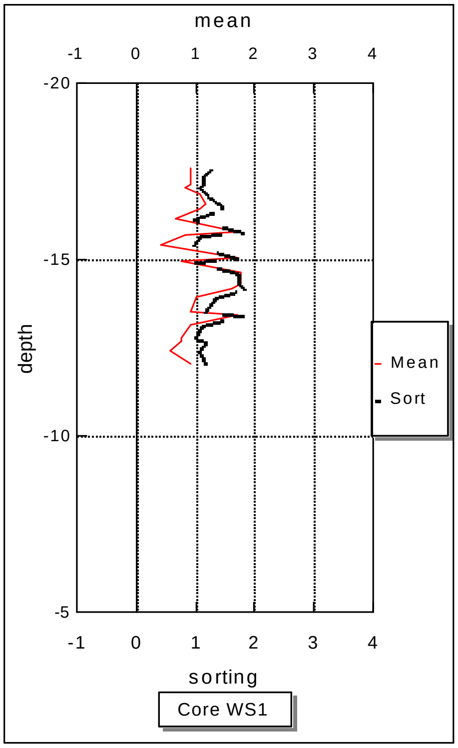

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
RI21-05
gravel
sand
mud

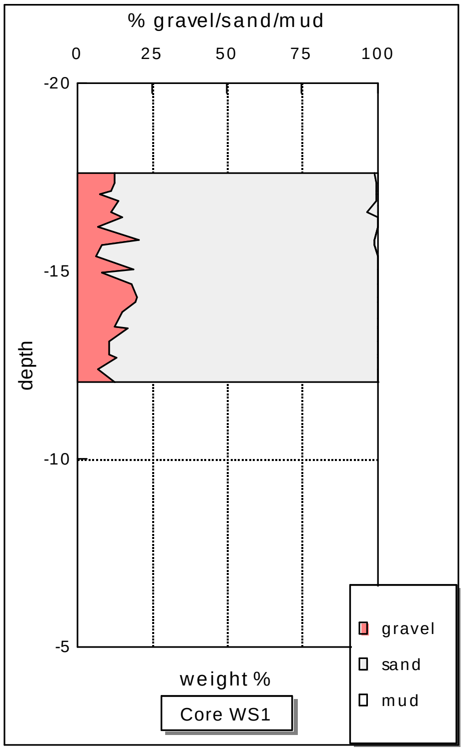

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
RI21-06

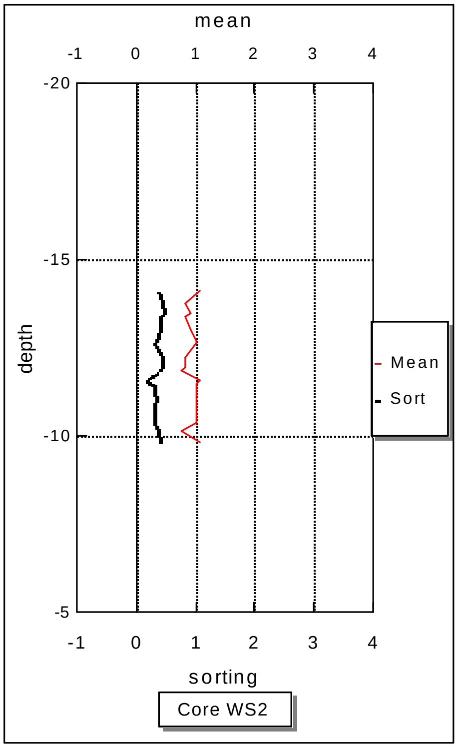

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
RI21-06
gravel
sand
mud

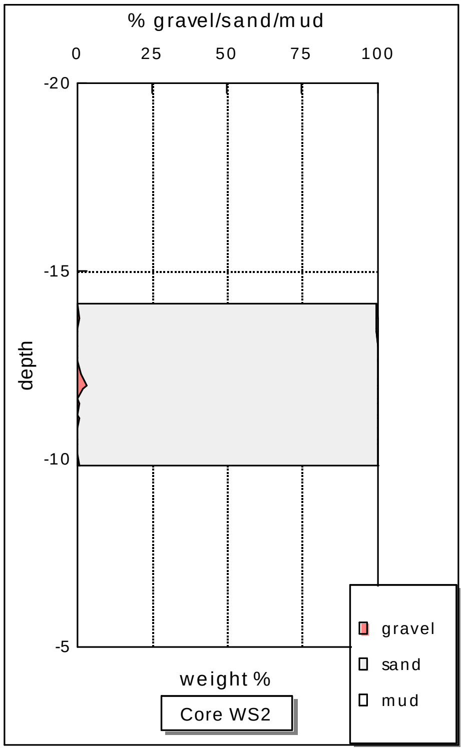

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
RI21-07

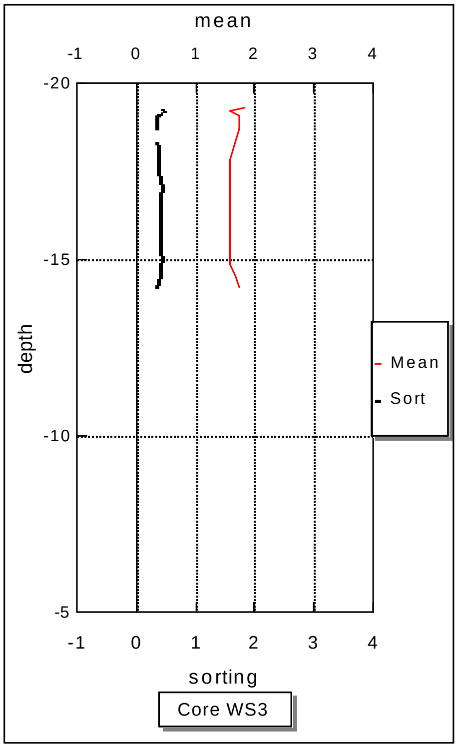

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
RI21-07
gravel
sand
mud

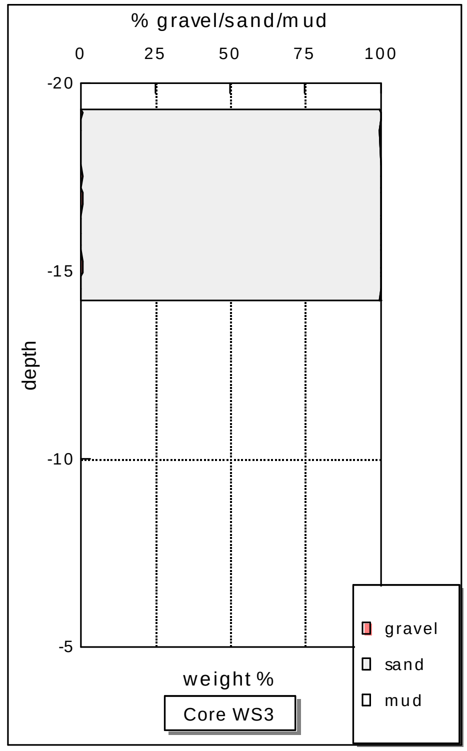

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS1

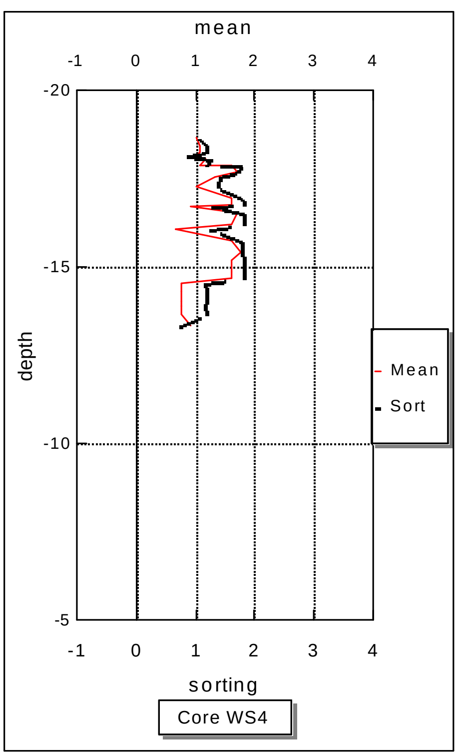

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS1
gravel
sand
mud

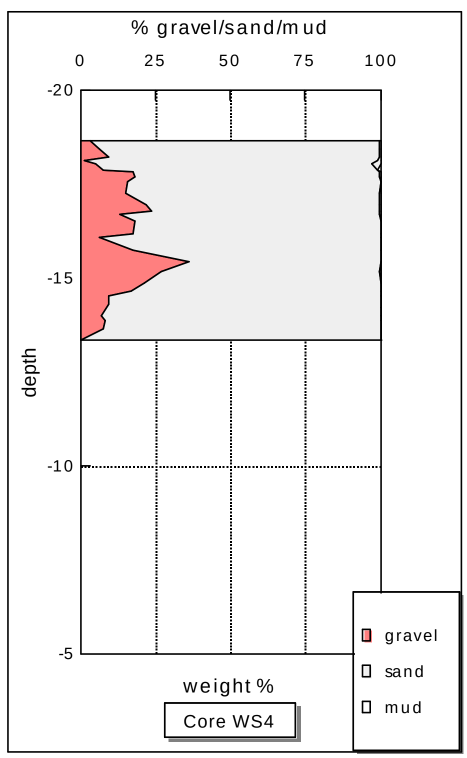

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS2

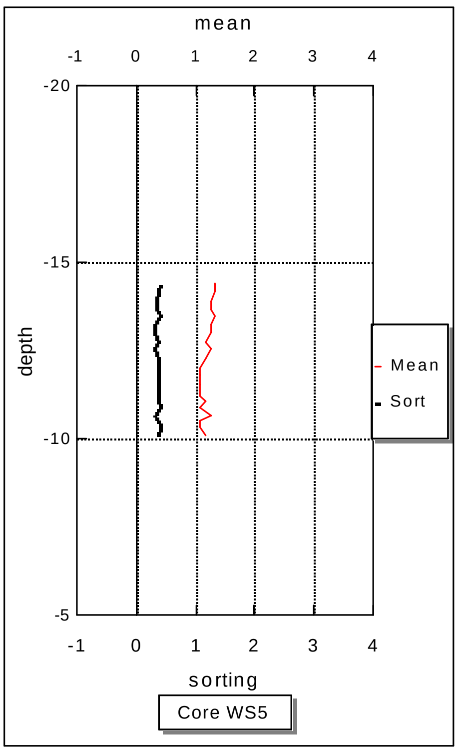

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS2
gravel
sand
mud

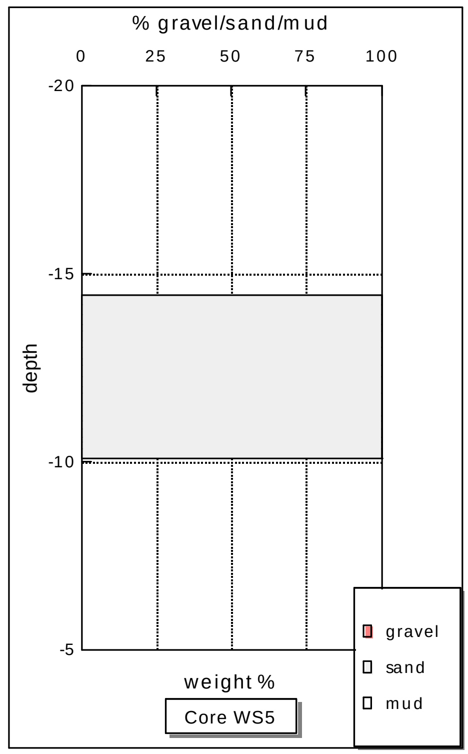

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core WS3

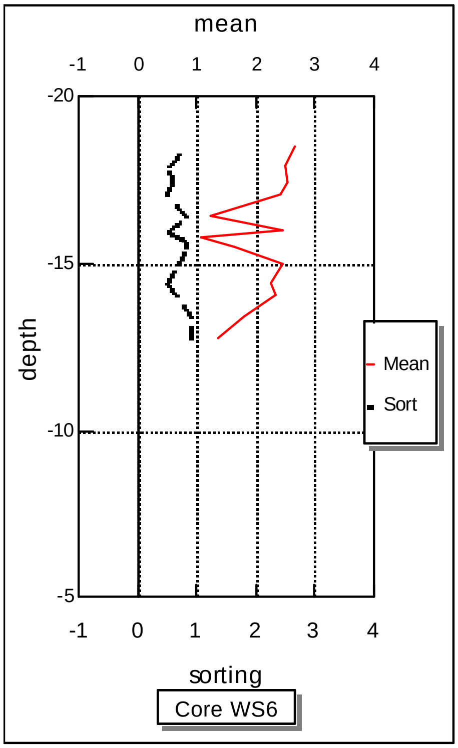

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core WS3

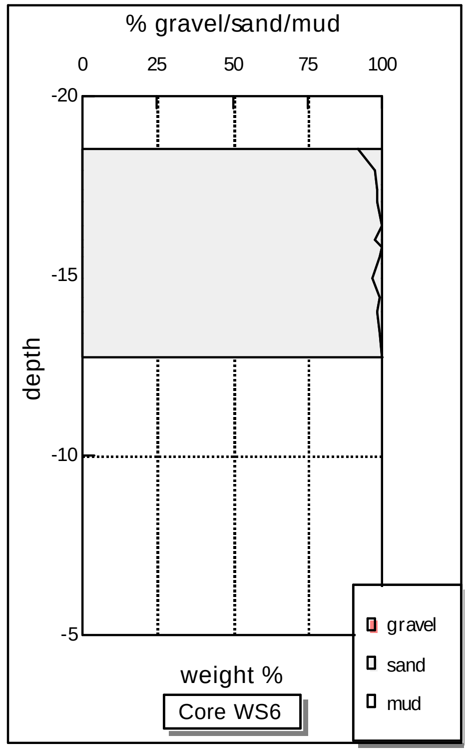

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core WS4

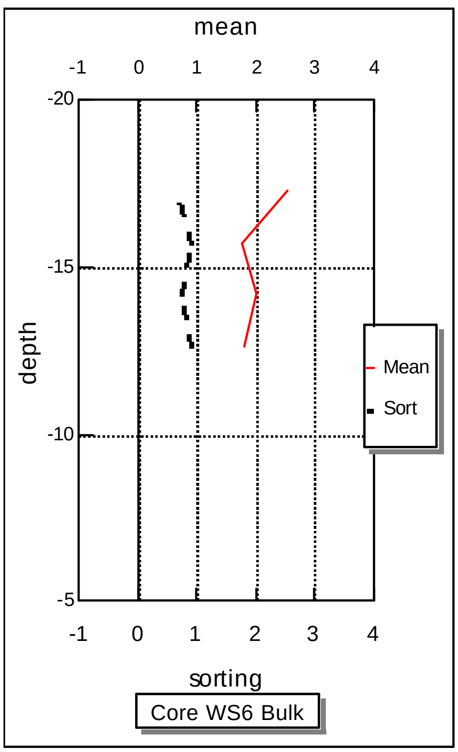

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core WS4

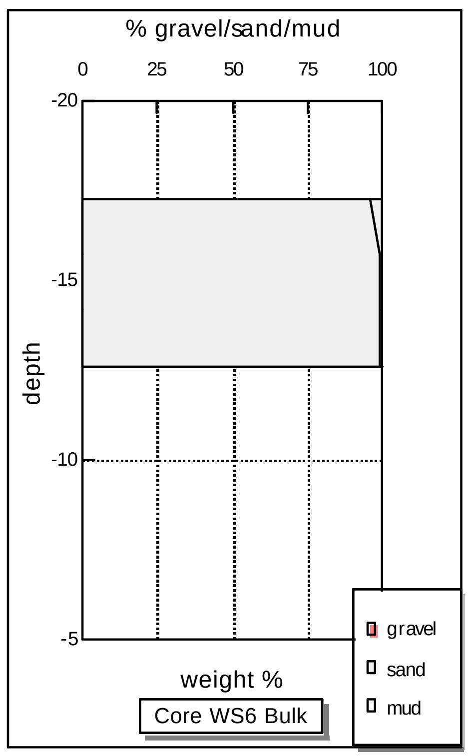

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS5

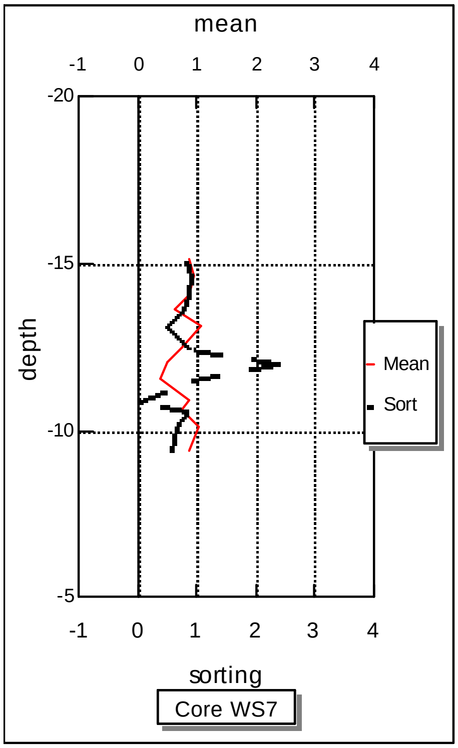

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core WS5
gravel
sand
mud

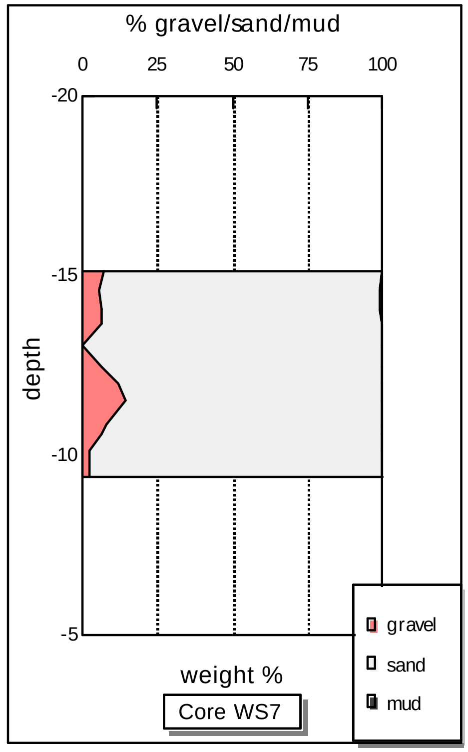

mean
depth
Mean
Sort
sorting
Core WS6

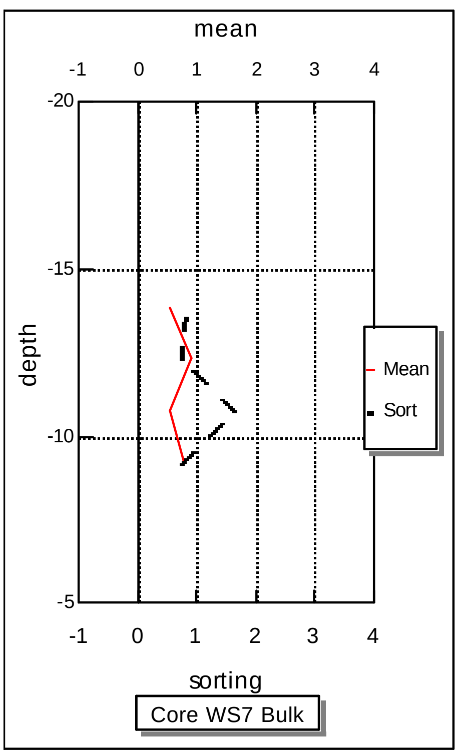

% gravel/sand/mud
depth
weight %
Core WS6
gravel
sand
mud

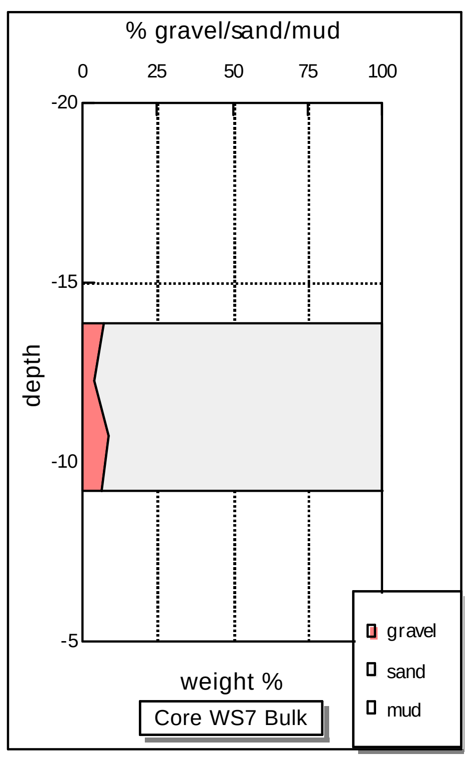

mean
depth
Mean
Sort
sorting
Core WS6 Bulk

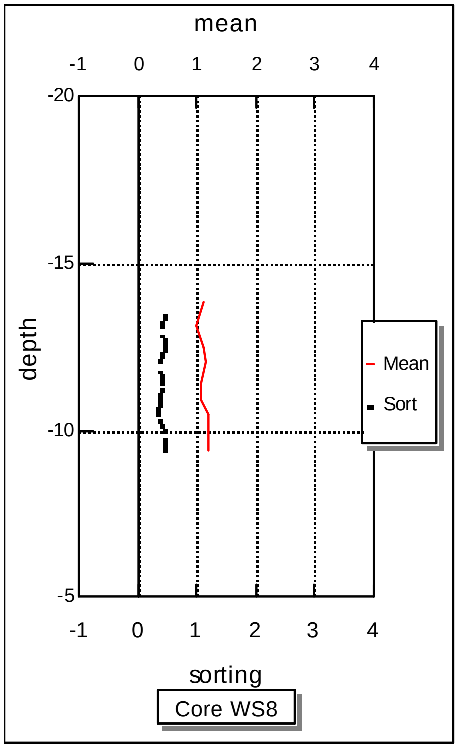

% gravel/sand/mud
depth
weight %
Core WS6 Bulk
gravel
sand
mud

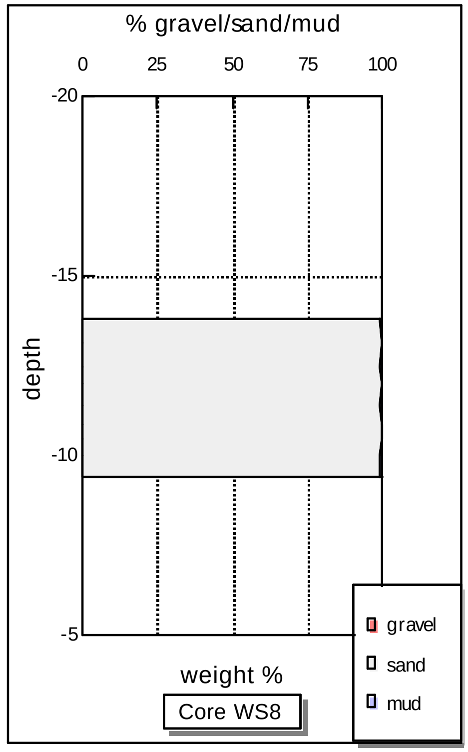

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core WS7

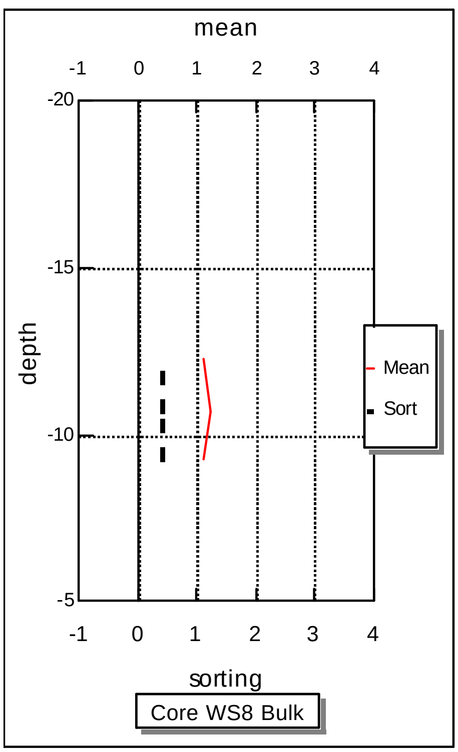

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS7
gravel
sand
mud

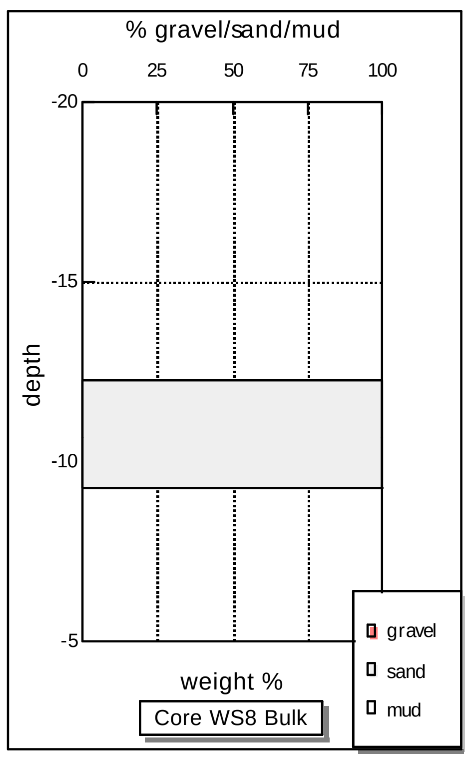

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
-1 0 1 2 3 4
sorting
Core WS7 Bulk

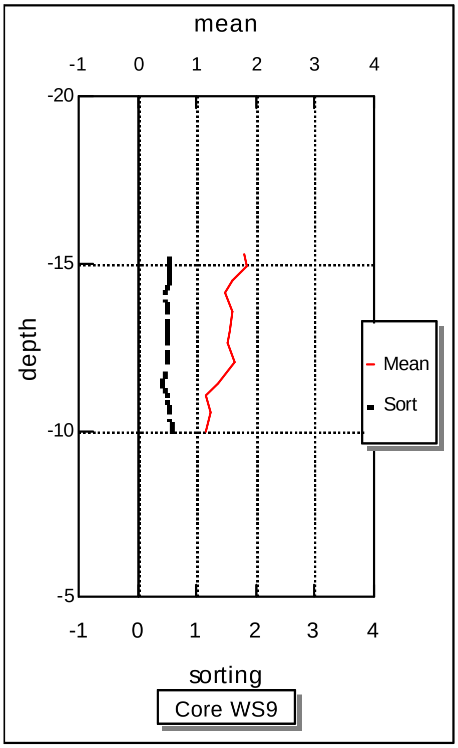

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS7 Bulk
gravel
sand
mud

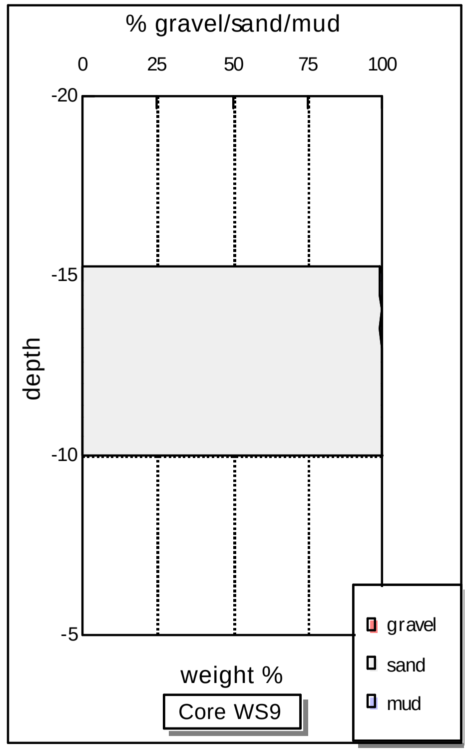

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS8

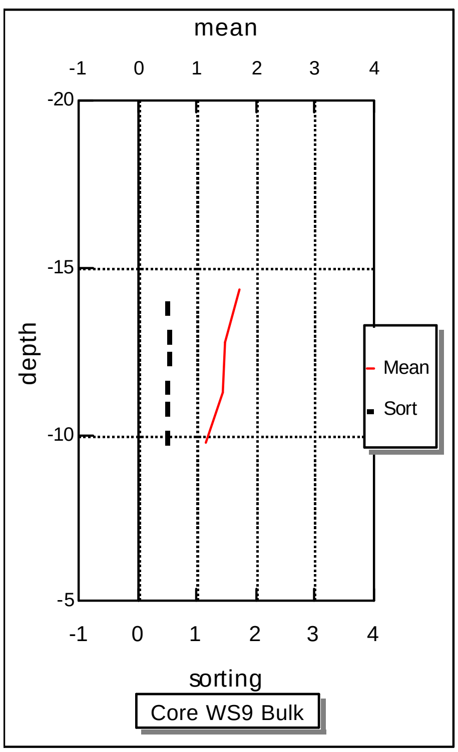

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS8
gravel
sand
mud

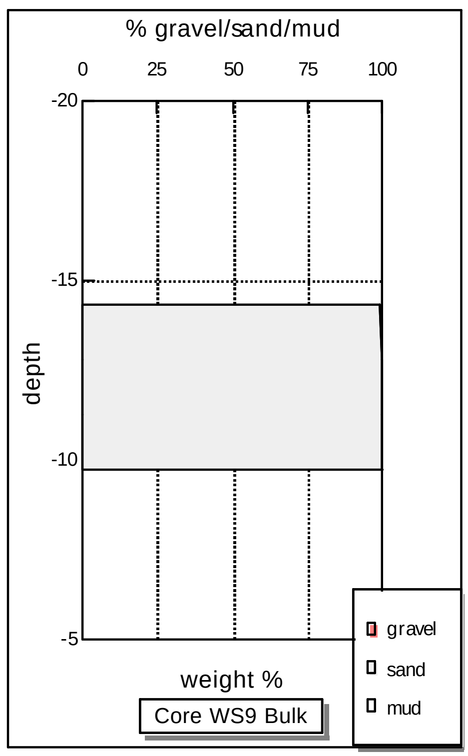

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS8 Bulk

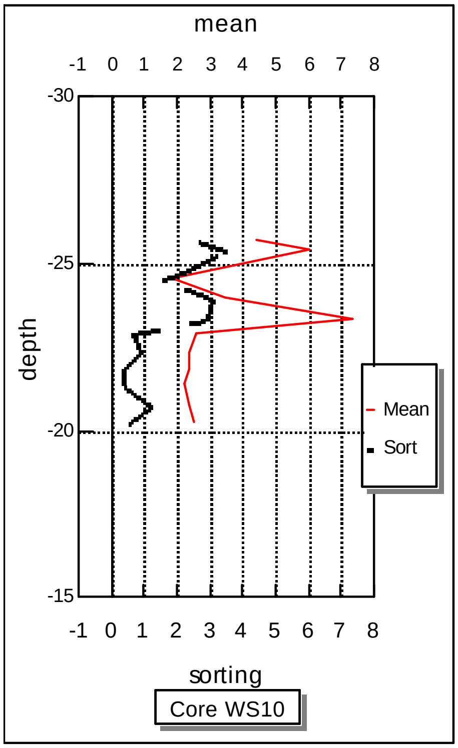

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS8 Bulk
gravel
sand
mud

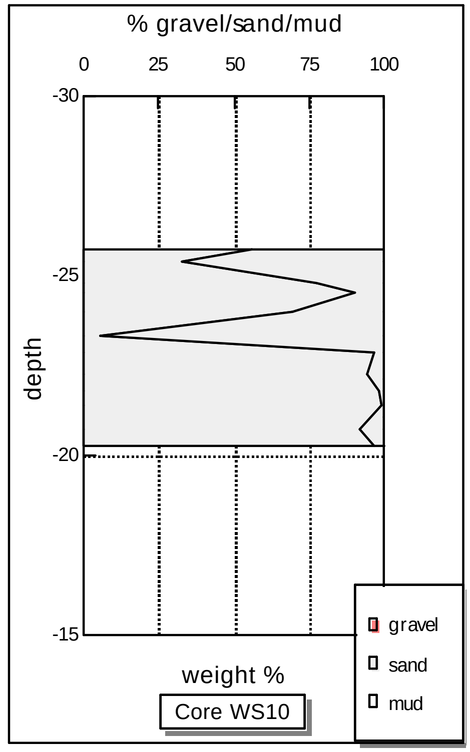

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS9

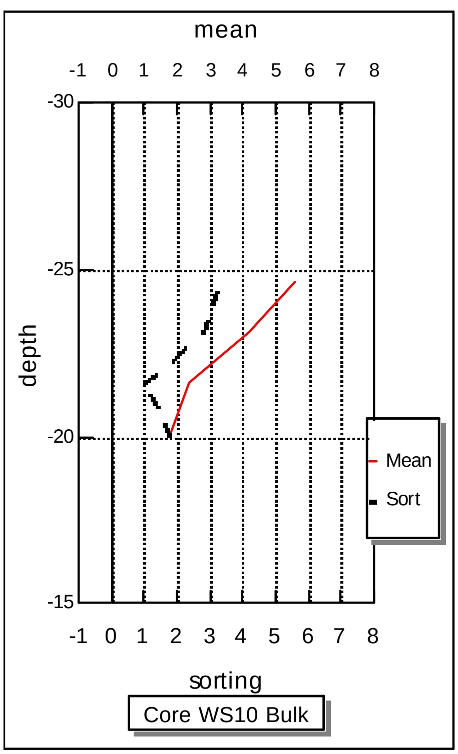

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core WS9
gravel
sand
mud

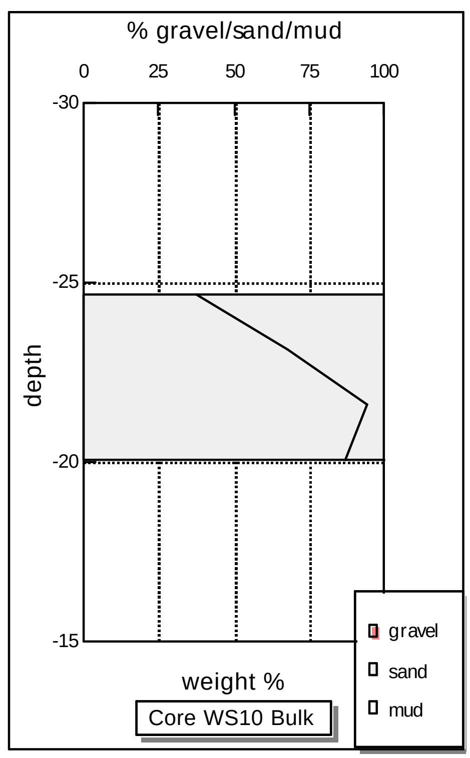

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS9 Bulk

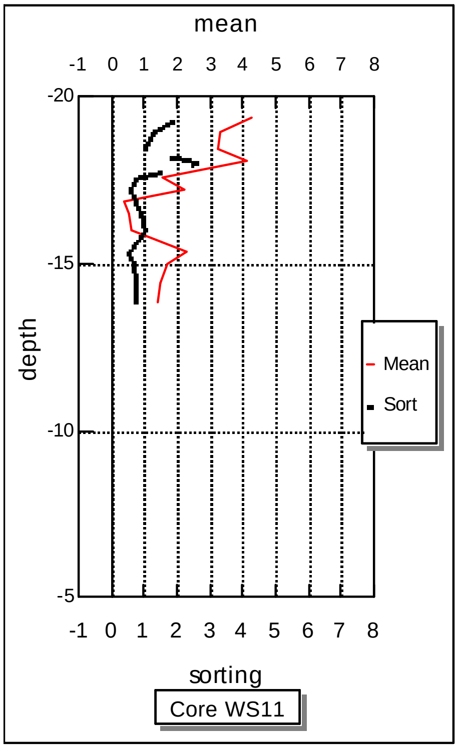

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core WS9 Bulk
gravel
sand
mud

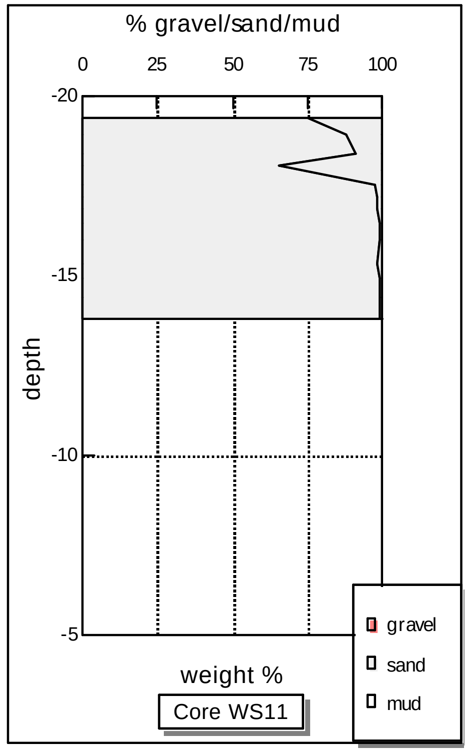

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
-1 0 1 2 3 4 5 6 7 8
sorting
Core WS10

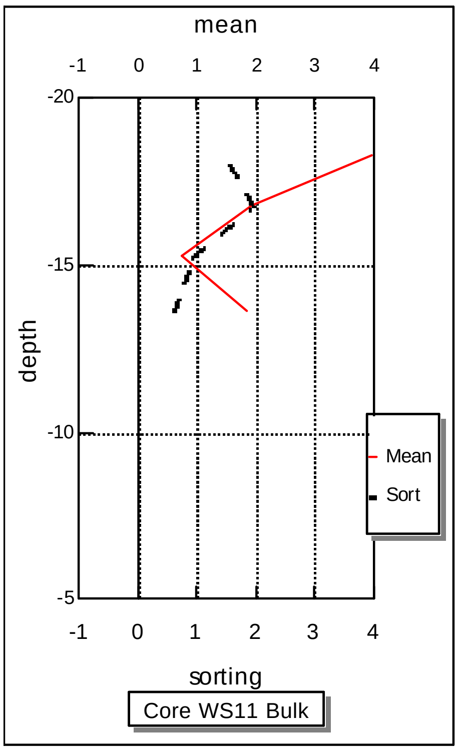

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
weight %
Core WS10
gravel
sand
mud

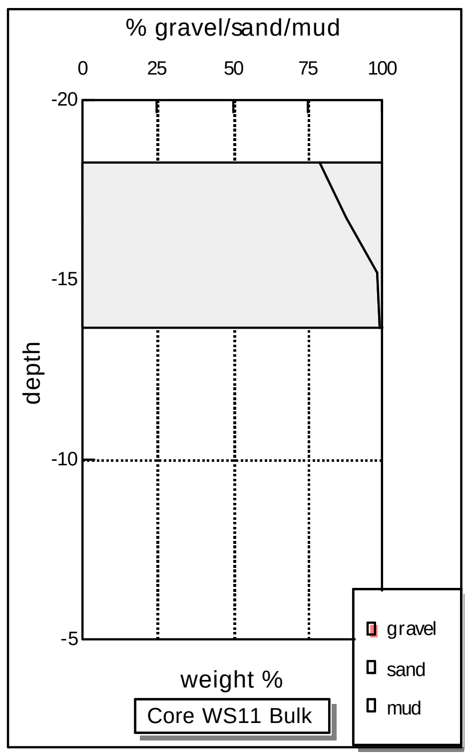

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
-1 0 1 2 3 4 5 6 7 8
sorting
Core WS10 Bulk

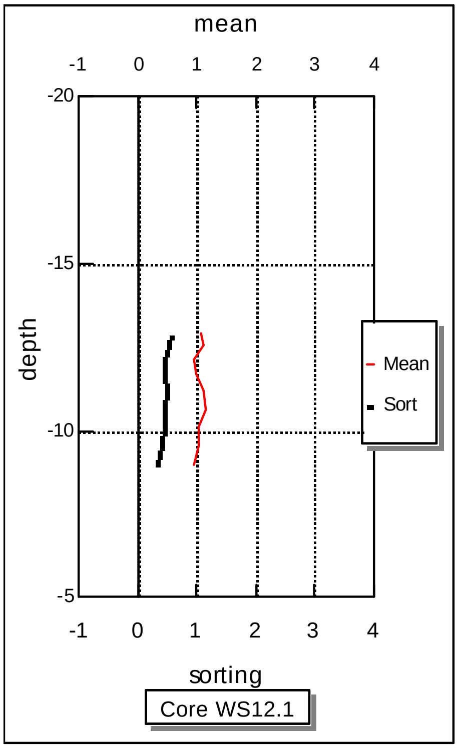

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
weight %
Core WS10 Bulk
gravel
sand
mud

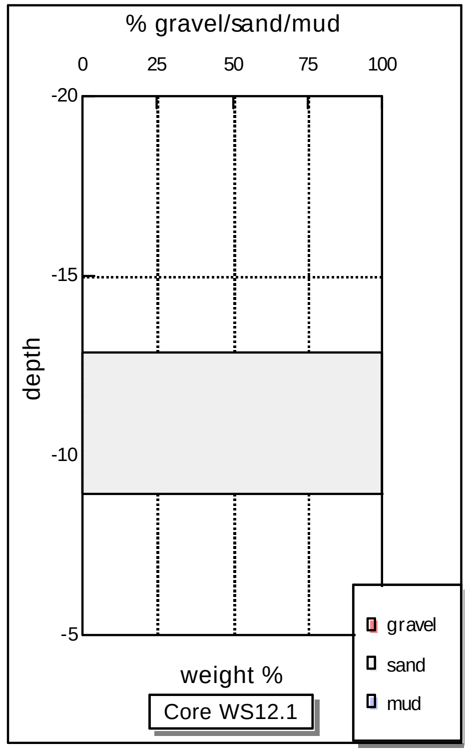

mean
-1 0 1 2 3 4 5 6 7 8
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS11

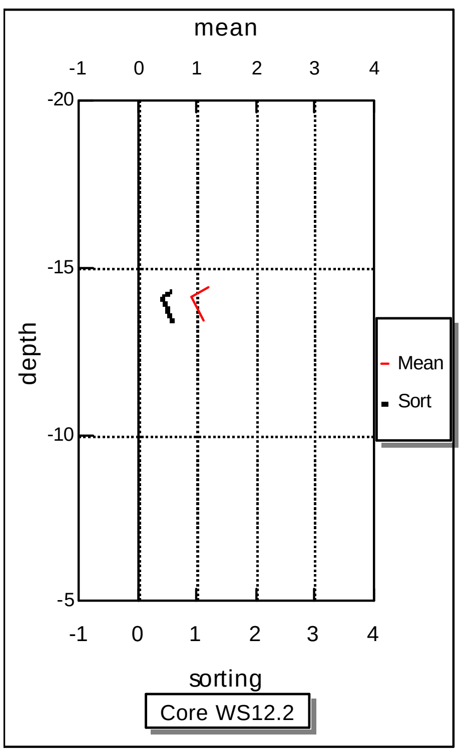

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS11
gravel
sand
mud

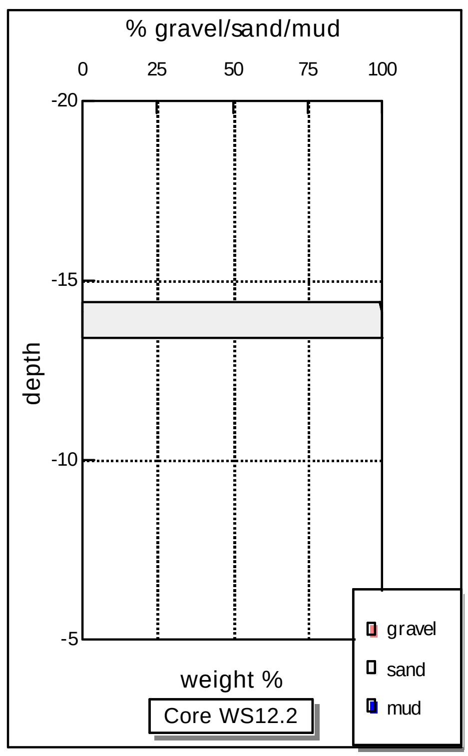

mean
-1 0 1 2 3 4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS11 Bulk

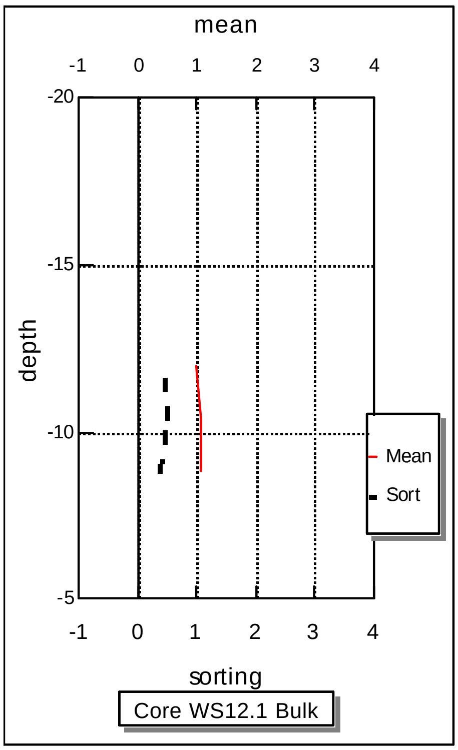

% gravel/sand/mud
0 25 50 75 100
-20
-15
-10
-5
depth
weight %
Core WS11 Bulk
gravel
sand
mud

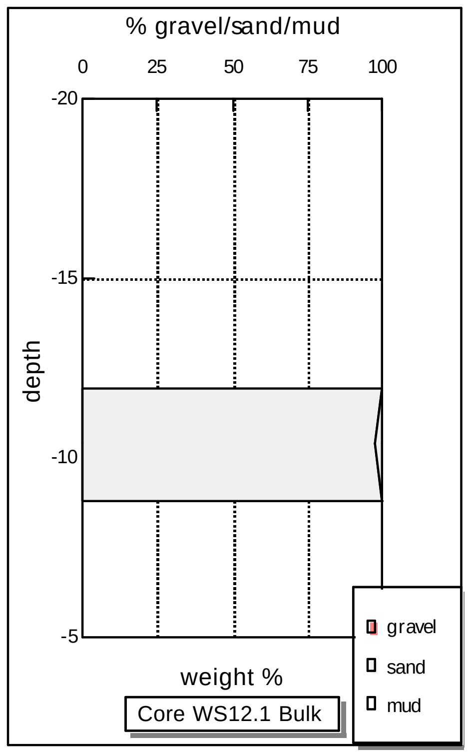

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS12.1

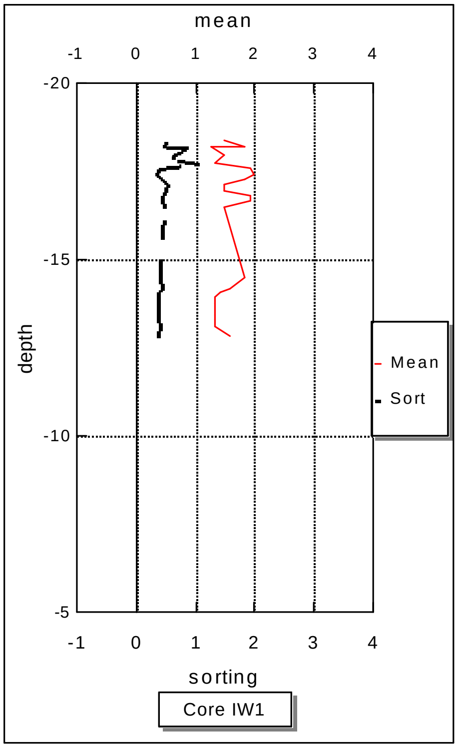

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core WS12.1
gravel
sand
mud

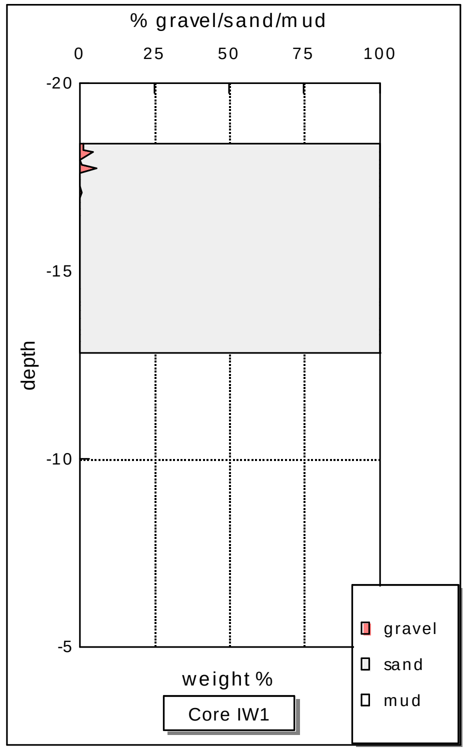

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core WS12.2

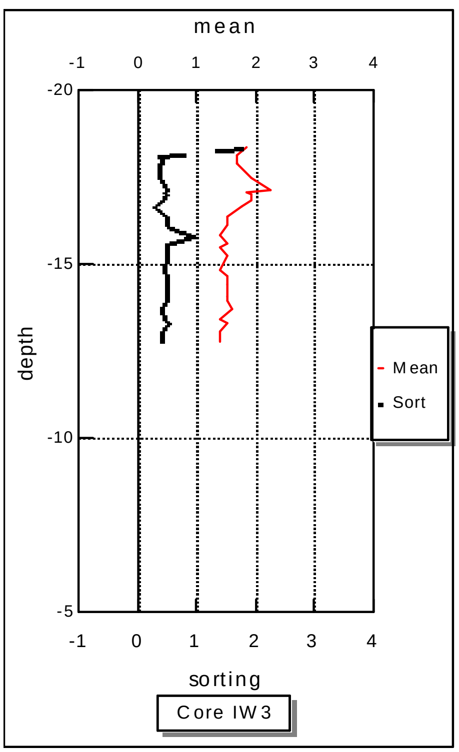

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core WS12.2
gravel
sand
mud

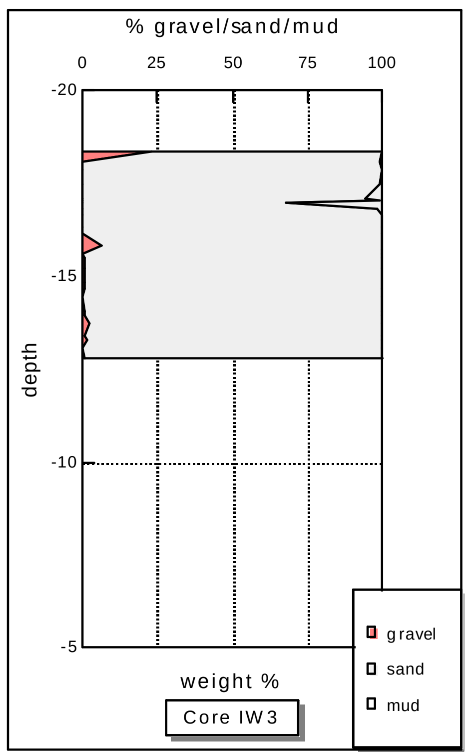

mean
-1
0
1
2
3
4
-20
-15
depth
-10
-5
Mean
Sort
sorting
Core WS12.1 Bulk

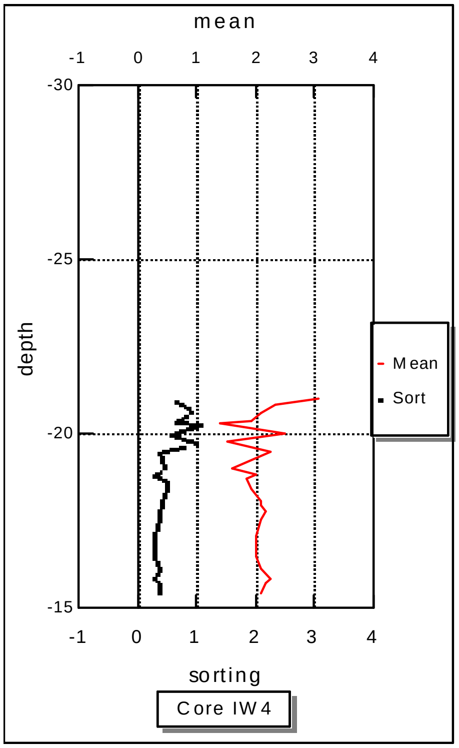

% gravel/sand/mud
0
25
50
75
100
-20
-15
depth
-10
-5
weight %
Core WS12.1 Bulk
gravel
sand
mud

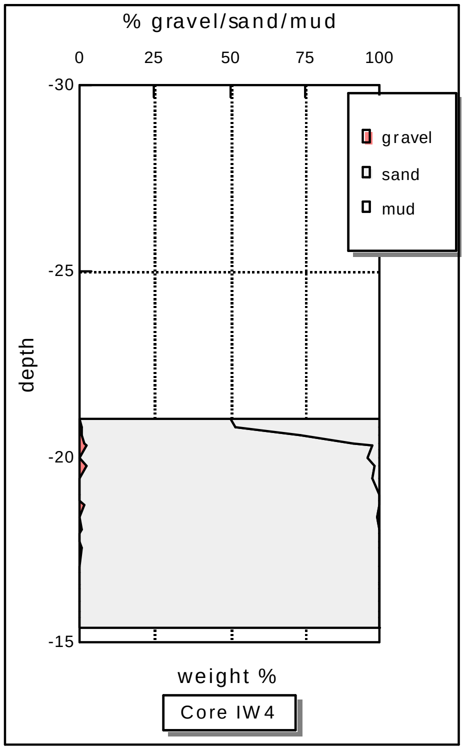

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW1

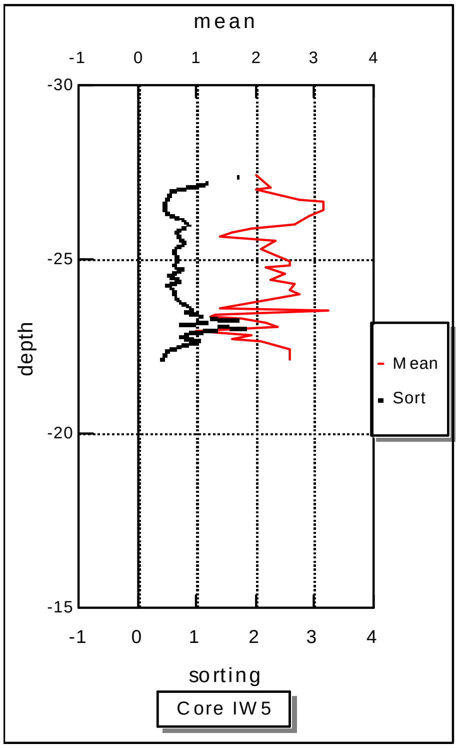

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW1

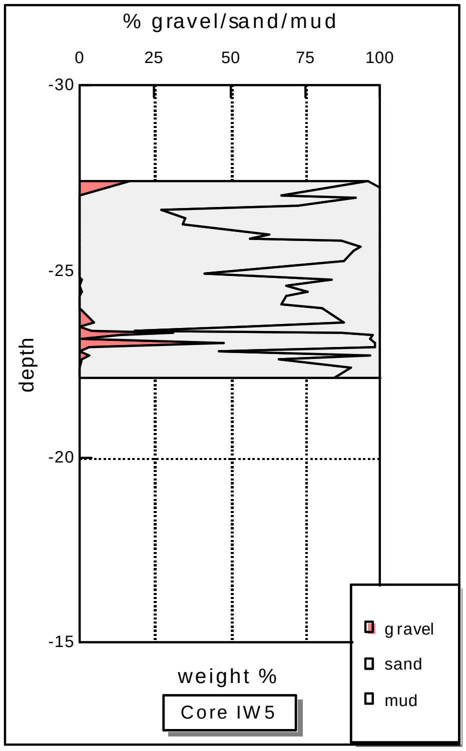

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW3

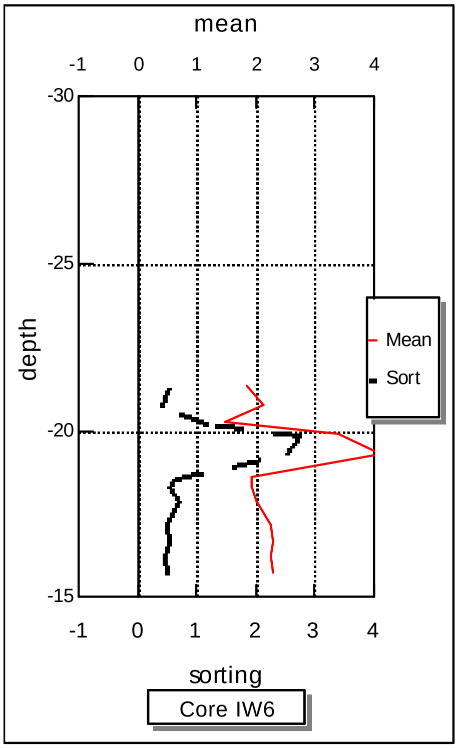

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW3

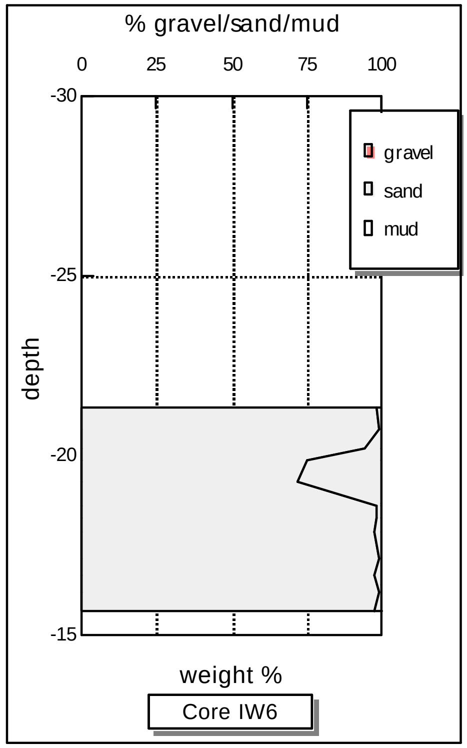

mean
-1
0
1
2
3
4
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core IW4

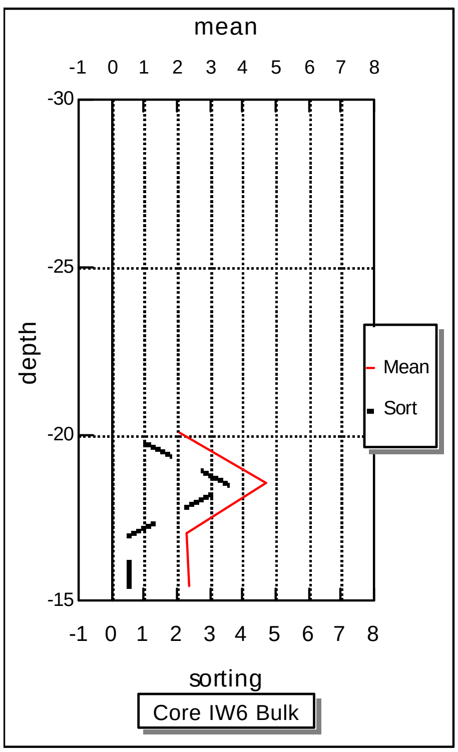

% gravel/sand/mud
0
25
50
75
100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core IW4

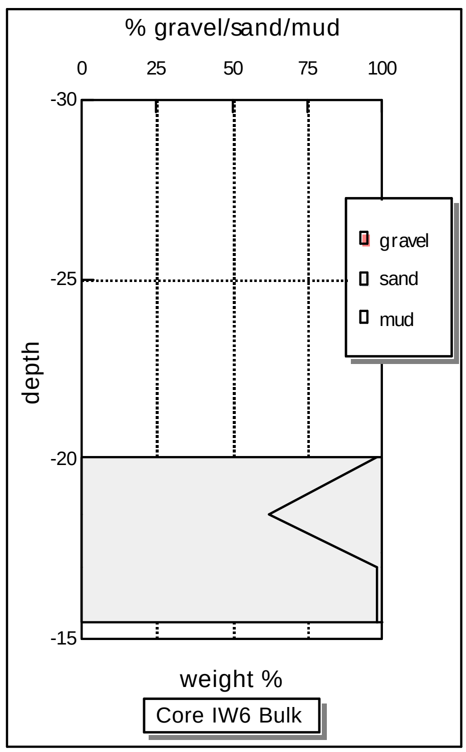

mean
-1
0
1
2
3
4
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core IW5

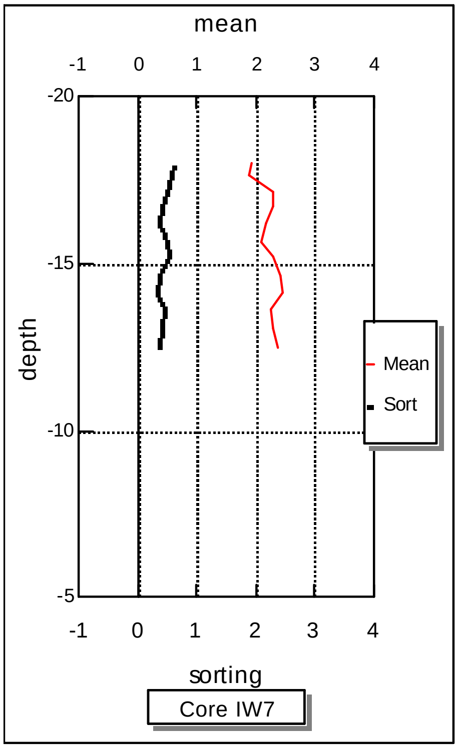

% gravel/sand/mud
0
25
50
75
100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core IW5

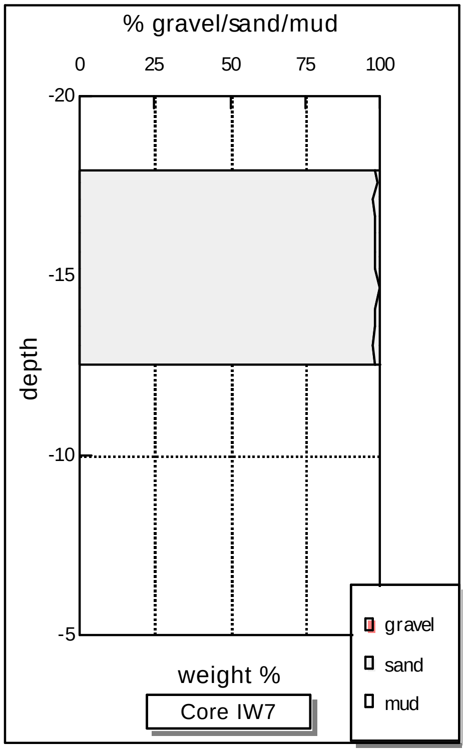

mean
-1 0 1 2 3 4
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core IW6

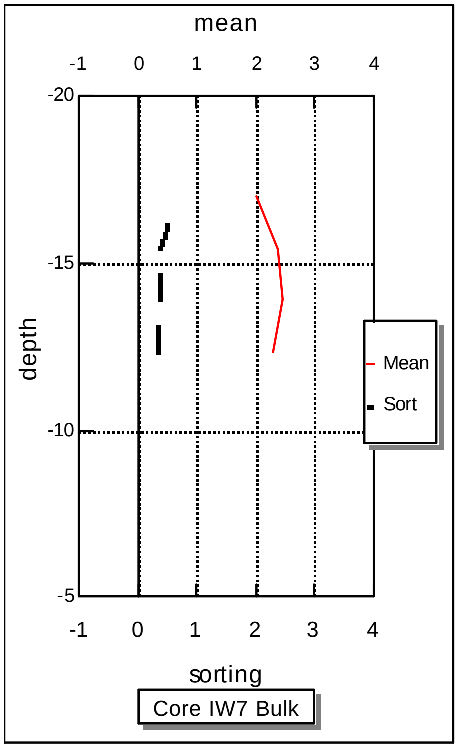

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core IW6

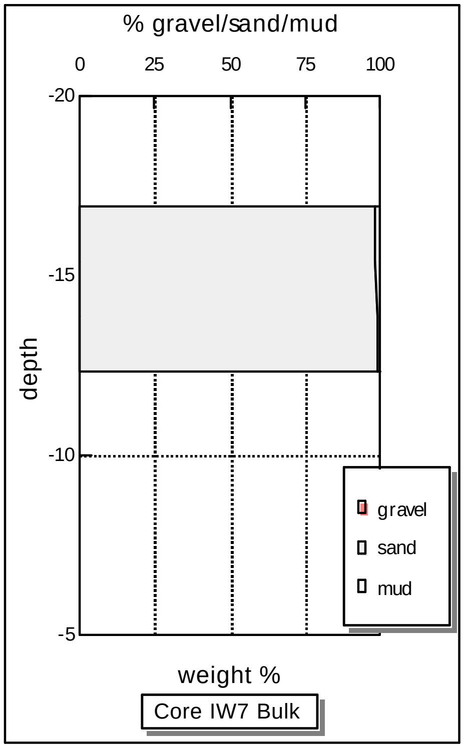

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
sorting
Core IW6 Bulk

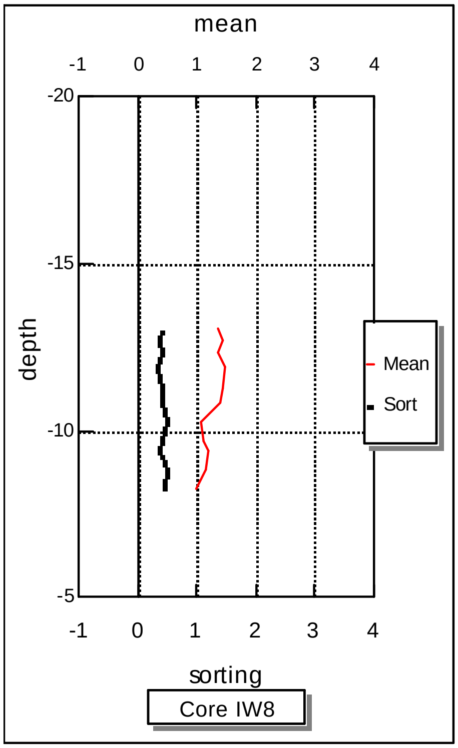

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core IW6 Bulk

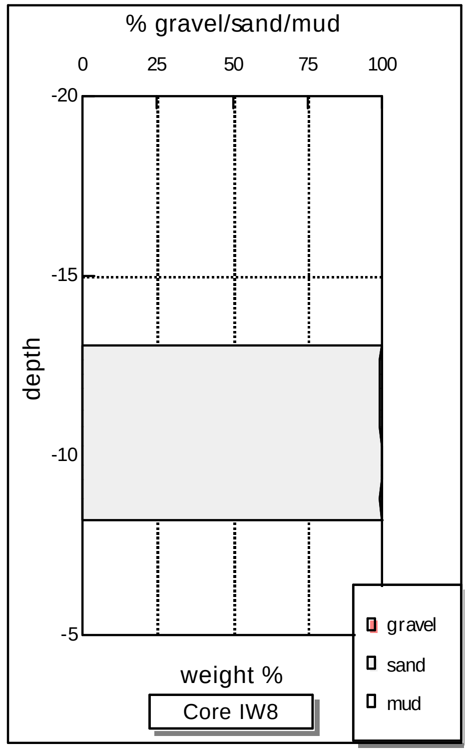

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW7

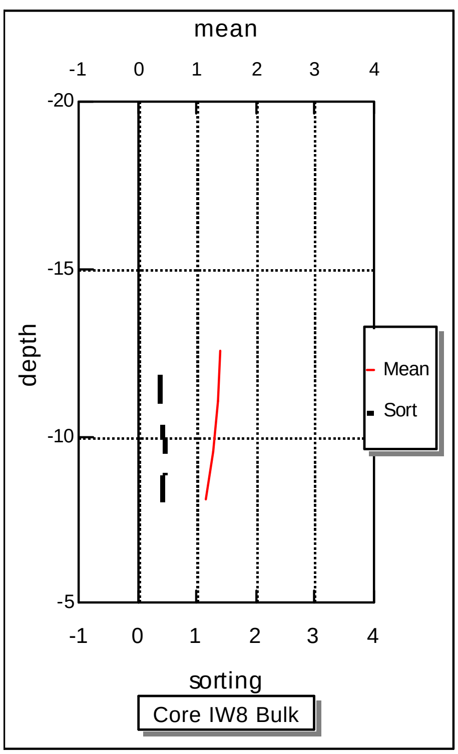

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core IW7
gravel
sand
mud

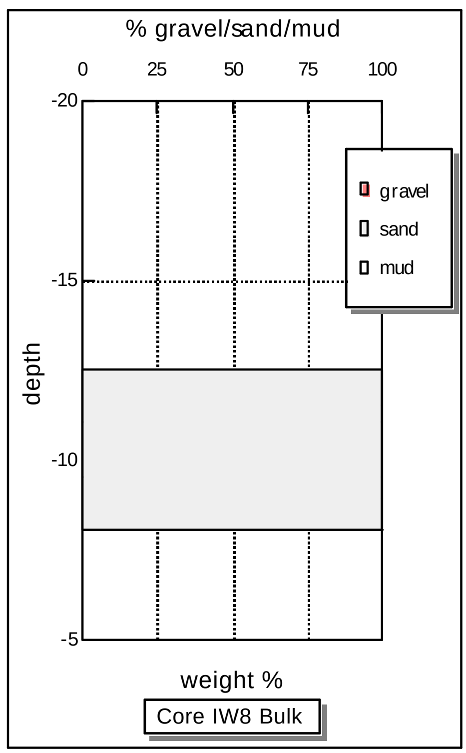

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW7 Bulk

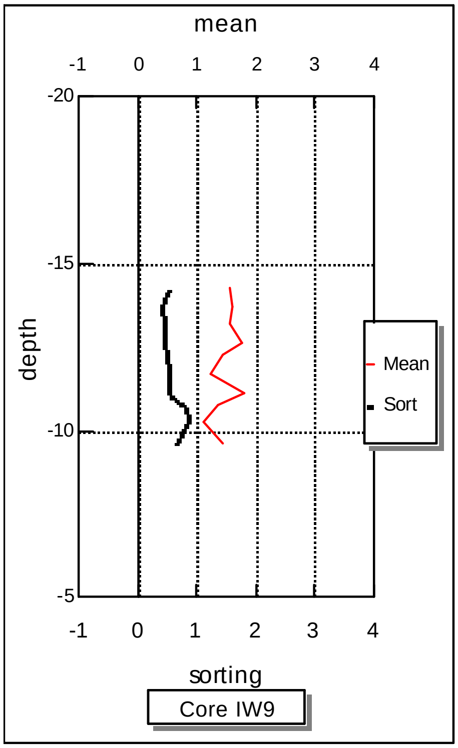

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
Core IW7 Bulk
gravel
sand
mud

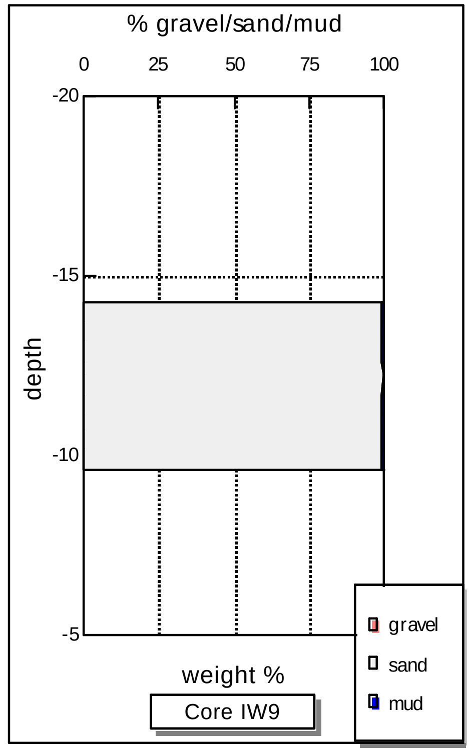

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW8

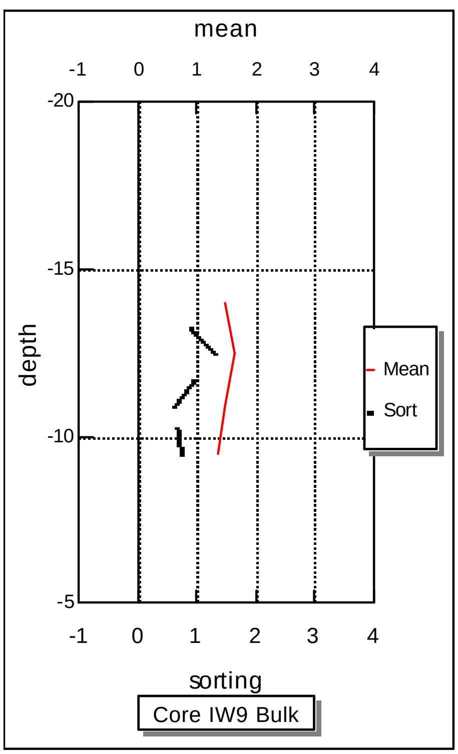

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
weight %
gravel
sand
mud
Core IW8

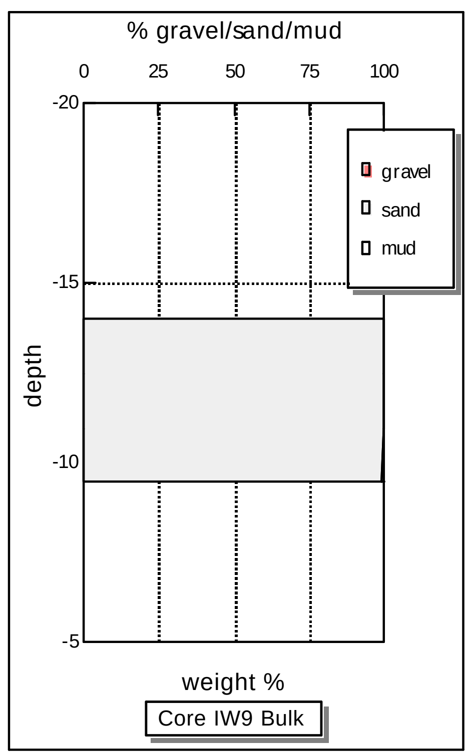

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW8 Bulk

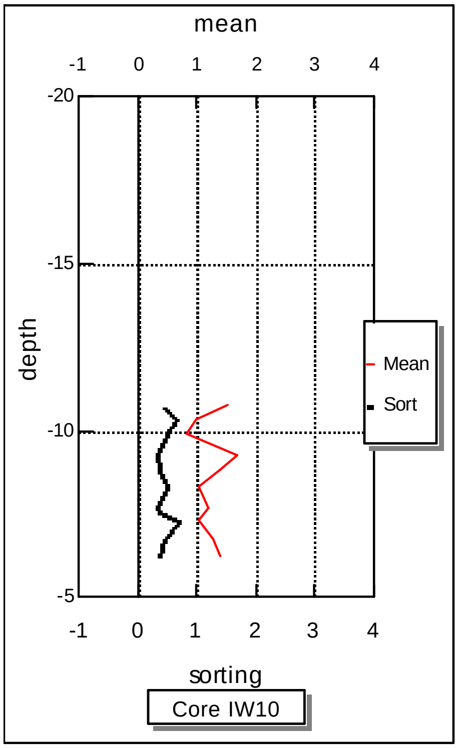

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW8 Bulk

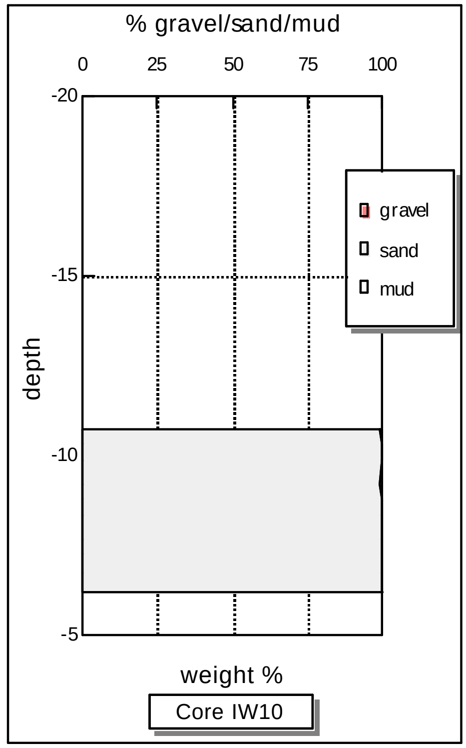

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW9

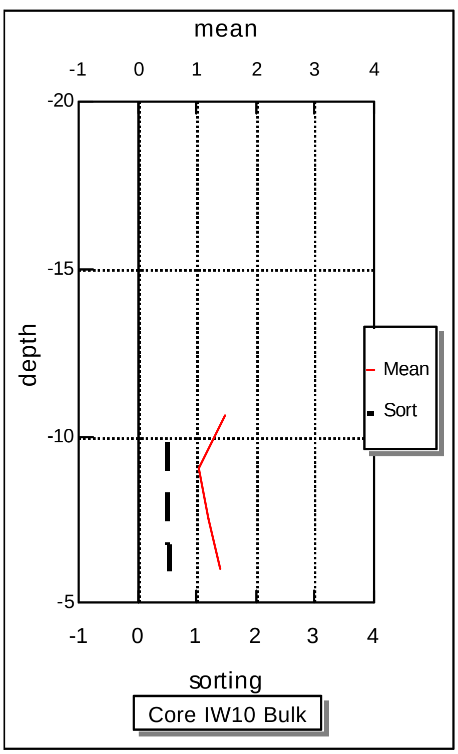

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW9

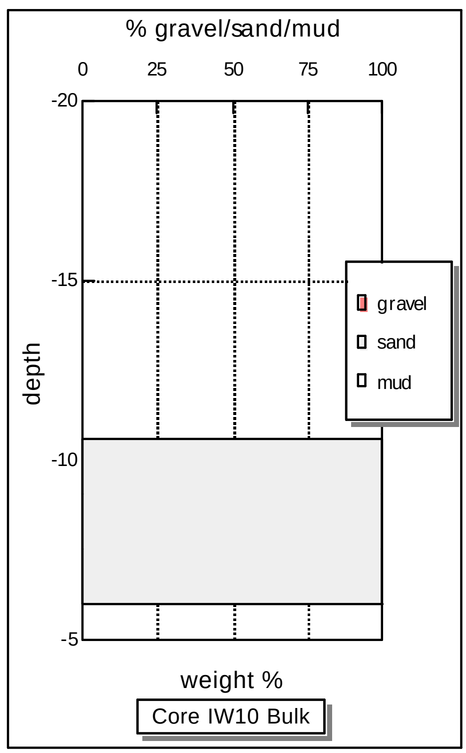

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW9 Bulk

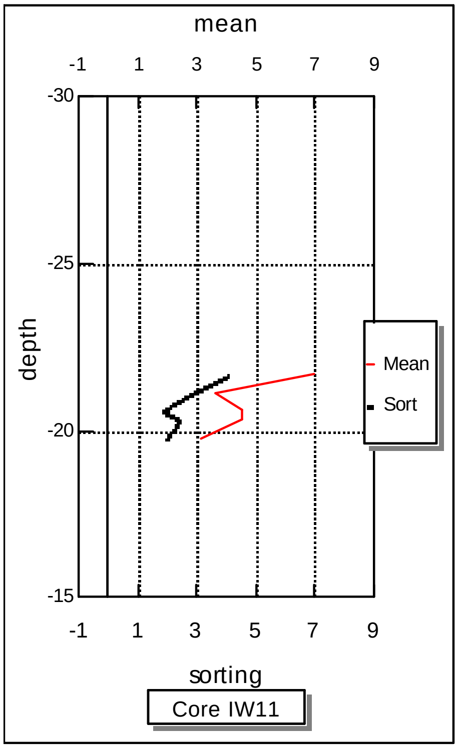

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW9 Bulk

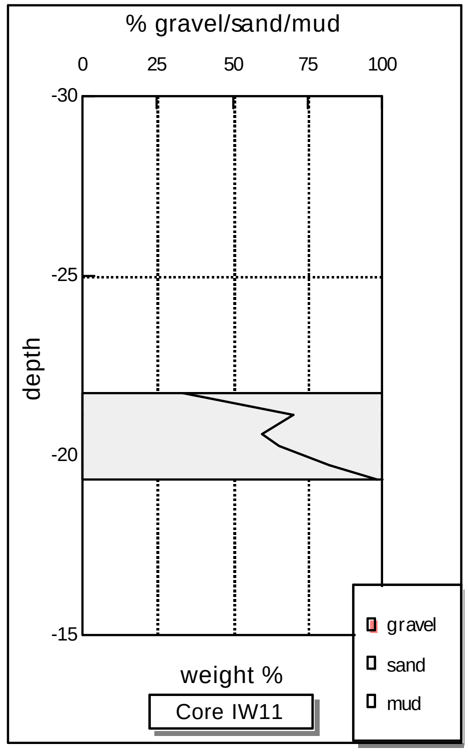

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW10

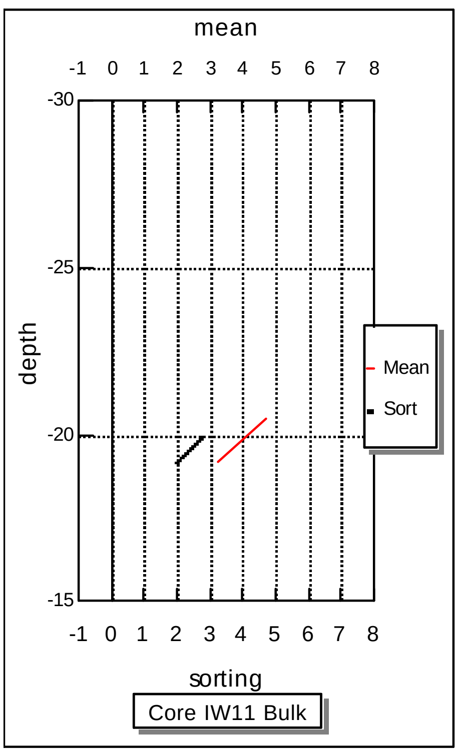

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW10

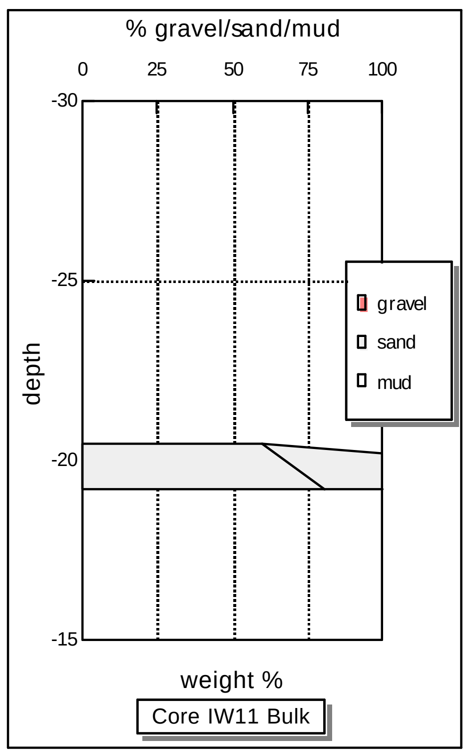

mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW10 Bulk

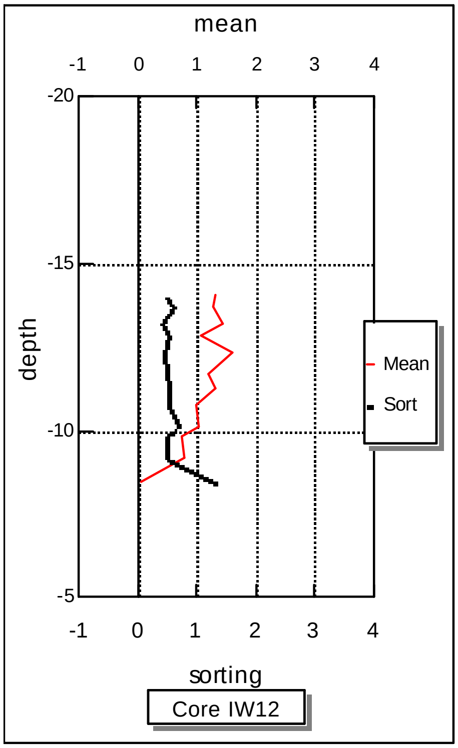

% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW10 Bulk

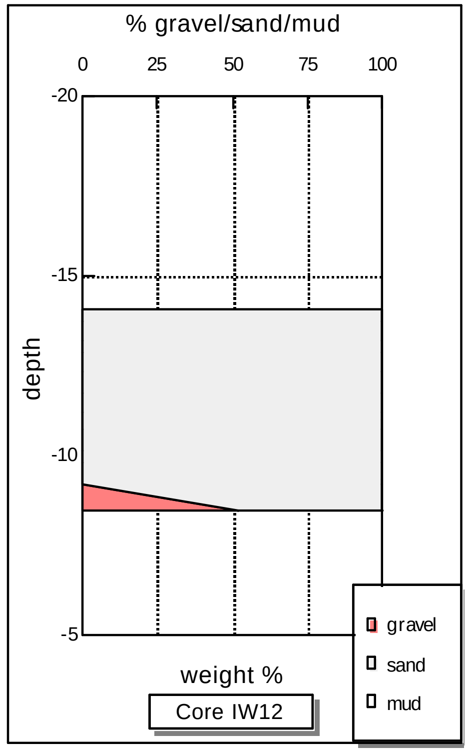

mean
-1 1 3 5 7 9
-30
-25
-20
-15
depth
Mean
Sort
-1 1 3 5 7 9
sorting
Core IW11

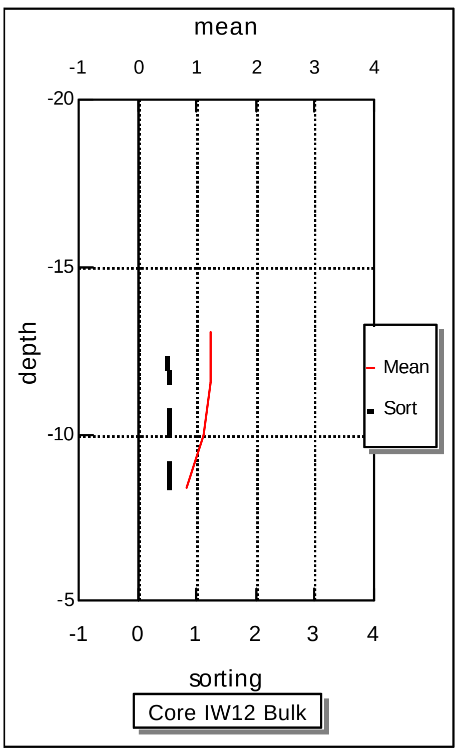

% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core IW11

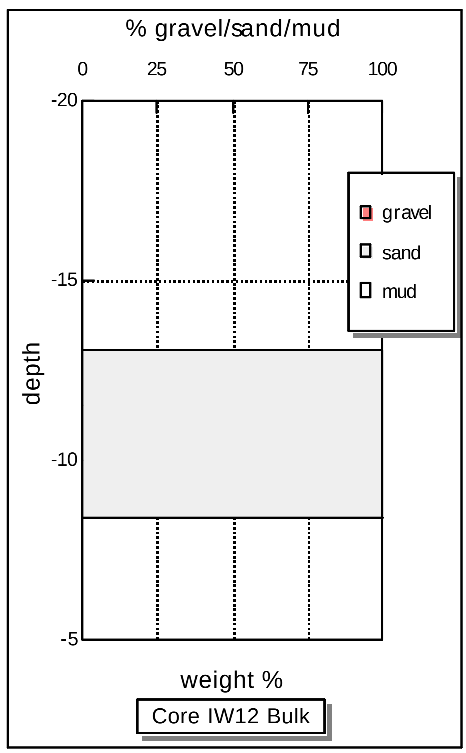

mean
-1 0 1 2 3 4 5 6 7 8
-30
-25
-20
-15
depth
Mean
Sort
-1 0 1 2 3 4 5 6 7 8
sorting
Core IW11 Bulk


% gravel/sand/mud
0 25 50 75 100
-30
-25
-20
-15
depth
gravel
sand
mud
weight %
Core IW11 Bulk


mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW12


% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW12


mean
-1
0
1
2
3
4
-20
-15
-10
-5
depth
Mean
Sort
sorting
Core IW12 Bulk


% gravel/sand/mud
0
25
50
75
100
-20
-15
-10
-5
depth
gravel
sand
mud
weight %
Core IW12 Bulk

Appendix B

Textural Data

The following table presents textural data for all vibracores used in this study. These cores include those taken in 1992 and 1997 by Maryland Geological Survey and by Delaware Geological Survey in 1997.

The sample intervals, (top and bottom) are measured in centimeters from the top of the core. The sample depths represent the depth below NGVD to the top of each interval. Mean grain diameter and sorting are reported in k (phi) units. Skewness and kurtosis are dimensionless. Percent gravel / sand / mud are weight percent of total sample. Percent silt and clay, where reported, are summed to produce percent mud. Shepard's classification, where reported, are based on the parameters set forth by Shepard (1954). The average diameters for Maryland cores are based on the bulk samples, not the individual samples.

The symbol ** indicated undetermined values.

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
MARYLAND CORES													
FS1A-1	6	9	-12.41	1.12	0.72	-0.2595	1.2812	4.56	95.29	0.15	0.00	0.15	Sand
FS1A-2	70	73	-13.05	1.34	0.53	-0.1650	1.1239	3.98	95.79	0.22	0.00	0.22	Sand
FS1A-3	131	134	-13.66	1.21	0.86	-0.4106	1.2848	3.39	96.42	0.19	0.00	0.19	Sand
FS1B-1	161	164	-13.96	1.27	0.58	-0.0541	0.8747	0.69	99.14	0.16	0.00	0.16	Sand
FS1B-2	229	232	-14.64	1.26	0.83	-0.3305	1.3208	4.35	95.44	0.20	0.00	0.20	Sand
FS1B-3	289	292	-15.24	1.44	0.61	-0.2689	1.3614	1.23	98.48	0.28	0.00	0.28	Sand
FS1C-1	314	317	-15.49	1.33	0.63	-0.1015	1.1487	1.28	98.27	0.45	0.00	0.45	Sand
FS1C-2	389	392	-16.24	1.35	0.60	-0.1299	1.0974	0.71	98.67	0.62	0.00	0.62	Sand
FS1C-3	442	445	-16.77	1.55	0.47	-0.0985	1.0192	0.54	98.99	0.46	0.00	0.46	Sand
FS1D-1	469	472	-17.04	1.54	0.45	-0.0258	0.8973	0.00	98.81	1.19	0.00	1.19	Sand
FS1D-2	509	512	-17.44	1.40	0.62	-0.1863	0.9097	0.00	99.08	0.92	0.00	0.92	Sand
FS1D-3	544	547	-17.79	1.55	0.60	0.0512	1.0744	0.00	98.84	1.16	0.00	1.16	Sand
FS1A-4(bulk)	0	148.5	-12.35	1.09	0.75	-0.2564	0.9731	3.57	96.26	0.17	0.00	0.17	Sand
FS1B-4(bulk)	154	307	-13.89	1.32	0.55	-0.0455	0.9919	1.60	98.20	0.20	0.00	0.20	Sand
FS1C-4(bulk)	307	461	-15.42	1.53	0.48	-0.1215	0.9758	1.06	98.62	0.32	0.00	0.32	Sand
FS1D-4(bulk)	461	558	-16.96	1.60	0.53	-0.0698	0.9900	0.00	99.01	0.99	0.00	0.99	Sand
average				1.39									
FS2A-1	6	9	-9.35	1.01	0.75	-0.0665	0.9145	0.00	99.81	0.19	0.00	0.19	Sand
FS2A-2	35	38	-9.64	1.00	0.71	-0.0100	0.8188	0.00	99.86	0.14	0.00	0.14	Sand
FS2A-3	90	93	-10.19	1.09	0.87	-0.1816	1.1004	6.42	93.32	0.26	0.00	0.26	Sand
FS2A-4	138	141	-10.67	1.01	0.83	-0.1005	1.3193	5.43	94.36	0.20	0.00	0.20	Sand
FS2B-1	165	168	-10.94	1.11	0.66	-0.1666	0.7929	3.21	96.58	0.21	0.00	0.21	Sand
FS2B-2	220	223	-11.49	0.94	0.68	0.1782	0.9373	0.00	99.69	0.31	0.00	0.31	Sand
FS2B-3	262	265	-11.91	0.93	0.62	0.0739	0.9225	0.00	99.81	0.19	0.00	0.19	Sand
FS2B-4	296	299	-12.25	1.04	0.64	-0.0851	1.0415	0.00	99.37	0.63	0.00	0.63	Sand
FS2C-1	313	316	-12.42	0.63	0.56	0.2793	1.0122	0.00	99.71	0.29	0.00	0.29	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS2C-2	371	374	-13.00	1.82	0.45	-0.0512	1.2456	0.00	99.13	0.87	0.00	0.87	Sand
FS2C-3	432	435	-13.61	0.84	0.59	0.0436	0.9569	0.00	99.76	0.24	0.00	0.24	Sand
FS2D-1	466	469	-13.95	0.79	0.62	0.2233	1.0757	0.00	99.49	0.51	0.00	0.51	Sand
FS2D-2	500	503	-14.29	0.85	0.73	0.0171	0.9056	0.00	99.44	0.56	0.00	0.56	Sand
FS2D-3	520	523	-14.49	1.31	0.70	-0.0343	0.8219	0.00	99.35	0.65	0.00	0.65	Sand
FS2A-5(bulk)	0	155	-9.29	1.03	0.83	-0.2297	1.1635	5.51	94.39	0.10	0.00	0.10	Sand
FS2B-5(bulk)	155	307	-10.84	0.95	0.61	0.0632	0.9111	0.00	99.68	0.32	0.00	0.32	Sand
FS2C-4(bulk)	307	461	-12.36	1.05	0.65	-0.0122	0.8587	0.00	99.66	0.34	0.00	0.34	Sand
FS2D-4(bulk)	461	536	-13.90	0.96	0.65	0.1904	0.8186	0.00	99.37	0.63	0.00	0.63	Sand
average				1.00									
FS3A-1	6	9	-9.58	0.72	0.68	0.2404	1.0297	0.00	99.86	0.14	0.00	0.14	Sand
FS3A-2	76	79	-10.28	1.82	1.45	0.1404	0.5336	0.00	99.81	0.19	0.00	0.19	Sand
FS3A-3	136	139	-10.88	1.47	1.34	0.0723	0.8652	0.00	99.65	0.35	0.00	0.35	Sand
FS3B-1	165	168	-11.17	1.12	0.82	-0.0698	0.8510	0.00	99.75	0.25	0.00	0.25	Sand
FS3B-2	230	233	-11.82	0.77	0.79	0.1520	0.9819	0.00	99.77	0.23	0.00	0.23	Sand
FS3B-3	284	287	-12.36	0.74	0.87	0.3096	0.8531	0.00	99.63	0.37	0.00	0.37	Sand
FS3C-1	319	322	-12.71	0.99	0.81	0.0205	0.7801	0.00	99.68	0.32	0.00	0.32	Sand
FS3C-2	377	380	-13.29	0.47	0.83	0.3131	0.9561	0.00	99.80	0.20	0.00	0.20	Sand
FS3C-3	440	443	-13.92	1.24	0.99	-0.2478	0.7579	0.00	99.41	0.59	0.00	0.59	Sand
FS3D-1	469	472	-14.21	0.31	0.71	0.2065	1.1605	0.00	99.76	0.24	0.00	0.24	Sand
FS3D-2	520	523	-14.72	1.03	0.81	0.0090	0.7935	0.00	99.61	0.39	0.00	0.39	Sand
FS3A-4(bulk)	0	153	-9.52	0.80	0.75	0.2236	0.9095	0.00	99.75	0.25	0.00	0.25	Sand
FS3B-4(bulk)	153	304	-11.05	0.81	0.88	0.1183	0.7923	0.00	99.81	0.19	0.00	0.19	Sand
FS3C-4(bulk)	304	457	-12.56	1.12	0.84	-0.0588	0.7839	0.00	99.73	0.27	0.00	0.27	Sand
FS3D-3(bulk)	457	530	-14.09	0.62	0.75	0.3162	0.8937	0.00	99.75	0.25	0.00	0.25	Sand
average				0.84									
FS4.1A-1	6	9	-9.15	0.80	0.62	0.1891	1.1335	0.00	99.78	0.22	0.00	0.22	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS4.1A-2	53	56	-9.62	0.66	0.69	0.1646	1.1218	0.00	99.68	0.32	0.00	0.32	Sand
FS4.1A-3	97	100	-10.06	0.68	0.73	0.1883	1.2338	0.00	99.49	0.51	0.00	0.51	Sand
FS4.1A-4	134	137	-10.43	0.97	0.66	0.0416	0.8616	0.00	99.70	0.30	0.00	0.30	Sand
FS4.1B-1	157	160	-10.66	0.81	0.90	-0.1391	1.0729	9.97	89.70	0.33	0.00	0.33	Sand
FS4.1B-2	211	214	-11.20	0.79	1.98	-0.5438	3.9912	12.27	87.48	0.24	0.00	0.24	Sand
FS4.1B-3	262	265	-11.71	0.35	1.09	-0.1005	0.8035	23.24	76.37	0.40	0.00	0.40	Sand
FS4.1B-4	290	293	-11.99	0.74	1.41	-0.3487	3.1977	9.20	90.42	0.38	0.00	0.38	Sand
FS4.1C-1	311	315	-12.20	0.65	1.14	-0.1637	1.6254	11.62	87.75	0.63	0.00	0.63	Sand
FS4.1C-2	356	359	-12.65	0.88	0.93	-0.0591	1.0822	7.92	91.39	0.70	0.00	0.70	Sand
FS4.1C-3	401	404	-13.10	-0.06	1.83	-0.3453	1.3339	23.20	76.22	0.58	0.00	0.58	Sand
FS4.1A-5(bulk)	0	149	-9.09	0.39	2.17	-0.4905	4.0216	15.07	84.54	0.39	0.00	0.39	Sand
FS4.1B-5(bulk)	149	302	-10.58	0.58	2.36	-0.5205	5.1395	13.24	86.47	0.29	0.00	0.29	Sand
FS4.1C-4(bulk)	302	419	-12.11	0.49	1.16	-0.1125	0.8923	15.69	83.91	0.41	0.00	0.41	Sand
average				0.49									
FS4.2A-1	306	309	-12.12	0.17	1.01	0.0208	0.6142	28.94	70.97	0.10	0.00	0.10	Sand
FS4.2A-2	342	345	-12.48	0.25	1.09	0.0606	0.9966	21.34	78.22	0.45	0.00	0.45	Sand
FS4.2A-3	389	392	-12.95	0.74	0.81	0.0132	1.3218	4.90	94.83	0.27	0.00	0.27	Sand
FS4.2A-4	423	426	-13.29	-2.00	**	**	**	48.59	51.20	0.21	0.00	0.21	Sand
FS4.2B-1	460	463	-13.66	1.01	0.89	0.0613	0.9891	4.76	94.73	0.51	0.00	0.51	Sand
FS4.2B-2	528	531	-14.34	0.61	0.83	-0.0557	1.1074	6.98	92.64	0.38	0.00	0.38	Sand
FS4.2B-3	589	592	-14.95	1.17	0.49	0.0462	1.0383	0.52	99.15	0.33	0.00	0.33	Sand
FS4.2A-5(bulk)	300	448	-12.06	0.32	1.07	-0.0870	0.8469	22.21	77.57	0.22	0.00	0.22	Sand
FS4.2B-4(bulk)	448	602	-13.54	0.95	0.78	-0.1829	1.4324	4.79	94.81	0.40	0.00	0.40	Sand
FS4.2C-1(bulk)	602	650	-15.08	0.97	0.69	0.0113	0.8251	0.00	99.66	0.34	0.00	0.34	Sand
average				0.75									
FS5A-1	3	6	-10.20	0.90	0.95	-0.0574	0.9166	5.02	94.84	0.14	0.00	0.14	Sand
FS5A-2	35	37	-10.52	0.85	0.98	-0.0183	0.9216	6.14	93.56	0.30	0.00	0.30	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS5A-3	69	72	-10.86	1.06	0.88	-0.1249	0.7569	2.94	96.91	0.14	0.00	0.14	Sand
FS5A-4	95	98	-11.12	1.04	0.91	-0.0427	0.7116	2.77	97.08	0.15	0.00	0.15	Sand
FS5A-5	140	143	-11.57	0.85	0.98	0.0918	0.8621	7.08	92.85	0.08	0.00	0.08	Sand
FS5B-1	162	165	-11.79	0.73	1.12	0.1017	0.7899	7.66	92.14	0.20	0.00	0.20	Sand
FS5B-2	227	230	-12.44	1.79	0.47	-0.2790	1.1469	0.04	99.74	0.22	0.00	0.22	Sand
FS5B-3	250	253	-12.67	1.51	0.64	-0.1528	0.7941	0.58	99.30	0.13	0.00	0.13	Sand
FS5B-4	293	296	-13.10	1.68	0.61	-0.3797	1.0248	0.33	99.49	0.18	0.00	0.18	Sand
FS5C-1	318	321	-13.35	1.86	0.37	-0.1237	1.1005	0.45	99.41	0.14	0.00	0.14	Sand
FS5C-2	367	370	-13.84	1.34	0.61	-0.0965	0.8344	1.18	98.70	0.12	0.00	0.12	Sand
FS5C-3	430	433	-14.47	1.03	0.77	0.2007	0.6774	0.24	99.29	0.47	0.00	0.47	Sand
FS5D-1	468	471	-14.85	1.48	0.79	-0.2938	0.8052	0.00	99.40	0.60	0.00	0.60	Sand
FS5D-2	538	541	-15.55	1.38	0.87	-0.3131	0.8163	0.00	98.94	1.06	0.00	1.06	Sand
FS5A-6(bulk)	0	152	-10.17	0.77	0.97	-0.0323	0.8881	5.41	94.53	0.06	0.00	0.06	Sand
FS5B-5(bulk)	152	305	-11.69	1.36	0.91	-0.4603	0.9994	2.20	97.68	0.12	0.00	0.12	Sand
FS5C-4(bulk)	305	458	-13.22	1.15	0.90	-0.1405	0.8659	1.16	98.48	0.35	0.00	0.35	Sand
FS5D-3(bulk)	458	565	-14.75	1.25	0.83	-0.1013	0.7904	0.00	99.19	0.81	0.00	0.81	Sand
average				1.14									
FS6A-1	6	9	-5.01	1.38	0.34	-0.0333	1.0292	0.00	99.60	0.40	0.00	0.40	Sand
FS6A-2	75	78	-5.70	1.30	0.36	-0.0806	0.9278	0.00	99.70	0.30	0.00	0.30	Sand
FS6A-3	129	132	-6.24	1.09	0.34	0.1422	1.0573	0.00	99.74	0.26	0.00	0.26	Sand
FS6B-1	158	161	-6.53	1.17	0.45	0.3973	1.1773	0.00	99.69	0.31	0.00	0.31	Sand
FS6B-2	216	219	-7.11	1.03	0.45	0.2138	1.2607	0.00	99.67	0.33	0.00	0.33	Sand
FS6B-3	282	285	-7.77	1.11	0.40	0.2061	1.0850	0.00	99.66	0.34	0.00	0.34	Sand
FS6C-1	326	329	-8.21	1.14	0.49	-0.0385	1.0080	0.00	99.66	0.34	0.00	0.34	Sand
FS6C-2	395	398	-8.90	0.58	0.60	0.2124	0.9919	0.00	99.74	0.26	0.00	0.26	Sand
FS6C-3	440	443	-9.35	1.05	0.48	-0.0171	1.0180	0.00	99.59	0.41	0.00	0.41	Sand
FS6D-1	470	473	-9.65	1.03	0.53	0.0138	1.0485	0.00	99.55	0.45	0.00	0.45	Sand
FS6D-2	515	518	-10.10	1.15	0.67	-0.2063	1.4995	0.00	99.51	0.49	0.00	0.49	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS6D-3	564	567	-10.59	1.06	0.54	0.0277	1.0531	0.00	99.68	0.32	0.00	0.32	Sand
FS6A-4(bulk)	0	152	-4.95	1.18	0.37	-0.0911	1.0536	0.00	99.78	0.22	0.00	0.22	Sand
FS6B-4(bulk)	150	303	-6.45	1.18	0.42	0.1105	1.0088	0.00	99.83	0.17	0.00	0.17	Sand
FS6C-4(bulk)	303	458	-7.98	1.03	0.57	-0.0239	0.9937	0.00	99.70	0.30	0.00	0.30	Sand
FS6D-4(bulk)	458	580	-9.53	0.90	0.57	-0.0431	1.4032	0.00	99.64	0.36	0.00	0.36	Sand
average				1.07									
FS7A-1	6	9	-8.77	1.18	0.39	0.0532	1.1536	0.00	99.67	0.33	0.00	0.33	Sand
FS7A-2	73	76	-9.44	1.55	0.32	0.3871	1.1673	0.00	99.50	0.50	0.00	0.50	Sand
FS7A-3	134	137	-10.05	1.51	0.30	0.2154	1.1560	0.00	99.57	0.43	0.00	0.43	Sand
FS7B-1	165	168	-10.36	1.49	0.34	0.3204	1.2438	0.00	99.54	0.46	0.00	0.46	Sand
FS7B-2	230	233	-11.01	1.46	0.31	0.2177	1.2790	0.00	99.43	0.57	0.00	0.57	Sand
FS7B-3	288	291	-11.59	1.32	0.31	0.0216	1.3432	0.00	99.54	0.46	0.00	0.46	Sand
FS7C-1	316	319	-11.87	1.25	0.30	0.0389	1.0674	0.00	99.57	0.43	0.00	0.43	Sand
FS7C-2	381	384	-12.52	1.23	0.29	0.3046	1.2814	0.00	99.63	0.37	0.00	0.37	Sand
FS7C-3	463	466	-13.34	1.37	0.29	0.2035	1.2494	0.00	99.48	0.52	0.00	0.52	Sand
FS7A-4(bulk)	0	152	-8.71	1.46	0.30	0.1625	1.1557	0.00	99.57	0.43	0.00	0.43	Sand
FS7B-4(bulk)	152	305	-10.23	1.39	0.30	0.2027	1.0695	0.00	99.61	0.39	0.00	0.39	Sand
FS7C-4(bulk)	305	480	-11.76	1.34	0.35	0.1609	1.2335	0.00	99.53	0.47	0.00	0.47	Sand
average				1.40									
FS8.1A-1	9	12	-20.67	2.50	1.91	0.0903	2.9806	0.00	85.17	9.64	5.19	14.83	Sand
FS8.1A-2	28	31	-20.86	1.08	1.55	0.6909	2.3071	0.00	93.33	4.41	2.26	6.67	Sand
FS8.1A-3	75	78	-21.33	4.20	1.90	0.6454	3.3996	0.00	74.24	18.90	6.85	25.76	Silty Sand
FS8.1A-4	115	118	-21.73	4.71	2.11	-0.0492	0.8261	0.00	38.17	60.99	0.85	61.83	Sandy Silt
FS8.1B-1	156	159	-22.14	3.04	1.49	-0.0585	1.7499	0.00	84.07	13.79	2.14	15.93	Sand
FS8.1B-2	218	221	-22.76	7.61	3.82	0.0441	0.7518	0.00	20.29	34.21	45.50	79.71	Sand-Silt-Clay
FS8.1B-3	253	256	-23.11	3.90	3.24	0.7176	1.2109	0.00	68.70	16.32	14.99	31.30	Silty Sand
FS8.1B-4	287	290	-23.45	7.32	3.70	0.1598	0.7227	0.00	24.53	35.25	40.22	75.47	Sand-Silt-Clay

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS8.1C-1	312	315	-23.70	2.75	1.26	0.4246	1.5745	0.00	88.23	9.56	2.21	11.77	Sand
FS8.1C-2	346	349	-24.04	2.76	0.89	0.3267	1.2689	0.00	93.02	6.98	0.00	6.98	Sand
FS8.1A-5(bulk)	0	148	-20.58	5.41	3.38	0.6997	1.0212	0.00	55.96	21.65	22.39	44.04	Sand-Silt-Clay
FS8.1B-5(bulk)	148	301	-22.06	6.53	3.94	0.1591	0.7776	0.00	29.78	37.27	32.95	70.22	Sand-Silt-Clay
FS8.1C-3(bulk)	301	371	-23.59	2.70	1.43	0.3353	2.3122	0.00	87.93	8.18	3.89	12.07	Sand
average				4.88									
FS8.2A-1	274	277	-22.93	3.79	3.12	0.7310	1.1077	0.00	65.58	21.23	13.19	34.42	Silty Sand
FS8.2A-2	308	311	-23.27	6.96	3.75	0.2486	0.6915	0.00	33.56	28.84	37.60	66.44	Sand-Silt-Clay
FS8.2A-3	353	356	-23.72	2.98	1.10	0.1466	1.6660	0.00	90.24	7.97	1.79	9.76	Sand
FS8.2A-4	400	403	-24.19	2.18	1.12	0.4066	1.6659	0.00	92.86	7.14	0.00	7.14	Sand
FS8.2B-1	423	426	-24.42	7.64	3.55	0.1487	0.7988	0.00	15.77	42.71	41.52	84.23	Clayey Silt
FS8.2B-2	441	444	-24.60	1.17	1.22	0.5405	1.3549	0.00	94.50	3.96	1.54	5.50	Sand
FS8.2B-3	466	469	-24.85	2.26	0.89	0.5179	3.6746	0.00	92.84	3.95	3.21	7.16	Sand
FS8.2A-5(bulk)	259	413	-22.78	4.54	2.89	0.5190	1.1951	0.00	59.17	27.45	13.38	40.83	Silty Sand
FS8.2B-4(bulk)	413	482	-24.32	2.87	2.17	0.5997	4.1147	0.00	82.18	10.57	7.25	17.82	Sand
average				3.71									
FS9A-1	6	9	-6.91	1.91	0.29	0.1366	0.9978	0.00	99.35	0.65	0.00	0.65	Sand
FS9A-2	48	51	-7.33	1.66	0.36	0.0451	1.0147	0.00	99.36	0.64	0.00	0.64	Sand
FS9A-3	94	97	-7.79	1.40	0.35	0.0239	1.0338	0.00	99.72	0.28	0.00	0.28	Sand
FS9A-4	141	144	-8.26	1.39	0.38	0.1068	1.1705	0.00	99.58	0.42	0.00	0.42	Sand
FS9B-1	160	163	-8.45	1.40	0.36	0.0052	1.1607	0.00	99.66	0.34	0.00	0.34	Sand
FS9B-2	238	241	-9.23	1.52	0.41	-0.0877	1.0432	0.00	99.52	0.48	0.00	0.48	Sand
FS9B-3	291	294	-9.76	1.57	0.36	0.2055	1.2201	0.00	99.63	0.37	0.00	0.37	Sand
FS9C-1	313	316	-9.98	1.37	0.38	0.2038	0.9894	0.00	99.65	0.35	0.00	0.35	Sand
FS9C-2	383	386	-10.68	1.35	0.46	0.1206	1.1466	0.00	99.68	0.32	0.00	0.32	Sand
FS9C-3	440	443	-11.25	1.75	0.31	0.1879	1.0694	0.00	99.45	0.55	0.00	0.55	Sand
FS9D-1	465	468	-11.50	1.73	0.28	0.1937	1.0144	0.00	99.38	0.62	0.00	0.62	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS9D-2	510	513	-11.95	1.78	0.29	0.1845	1.0589	0.00	99.51	0.49	0.00	0.49	Sand
FS9D-3	551	554	-12.36	1.85	0.31	0.1771	0.9784	0.00	99.19	0.81	0.00	0.81	Sand
FS9A-5(bulk)	0	154	-6.85	1.32	0.38	0.1003	1.0924	0.00	99.68	0.32	0.00	0.32	Sand
FS9B-4(bulk)	154	307	-8.39	1.47	0.50	-0.0689	1.7242	0.00	99.56	0.44	0.00	0.44	Sand
FS9C-4(bulk)	307	459	-9.92	1.64	0.30	0.1109	1.1276	0.00	99.47	0.53	0.00	0.53	Sand
FS9D-4(bulk)	459	565	-11.44	1.85	0.39	-0.1040	1.8772	0.00	99.34	0.66	0.00	0.66	Sand
average				1.57									
FS10A-1	8	11	-7.64	1.01	0.47	0.1401	1.0046	0.00	99.74	0.26	0.00	0.26	Sand
FS10A-2	75	78	-8.31	1.09	0.42	0.0090	1.1516	0.00	99.65	0.35	0.00	0.35	Sand
FS10A-3	135	138	-8.91	0.93	0.47	0.1489	0.8857	0.00	99.78	0.22	0.00	0.22	Sand
FS10B-1	159	162	-9.15	1.07	0.59	-0.1439	1.4214	0.00	99.70	0.30	0.00	0.30	Sand
FS10B-2	228	231	-9.84	0.92	0.56	0.0684	1.0796	0.00	99.72	0.28	0.00	0.28	Sand
FS10B-3	290	293	-10.46	0.93	0.52	0.1383	1.1069	0.00	99.63	0.37	0.00	0.37	Sand
FS10C-1	315	318	-10.71	1.05	0.52	0.0640	1.0308	0.00	99.52	0.48	0.00	0.48	Sand
FS10C-2	365	368	-11.21	0.99	0.43	0.1030	1.0817	0.00	99.75	0.25	0.00	0.25	Sand
FS10C-3	420	423	-11.76	1.28	0.67	0.1530	0.9503	0.00	99.13	0.87	0.00	0.87	Sand
FS10C-4	475	478	-12.31	1.09	0.56	0.1011	0.9171	0.00	99.59	0.41	0.00	0.41	Sand
FS10A-4(bulk)	0	153	-7.56	0.96	0.44	0.1616	0.9749	0.00	99.85	0.15	0.00	0.15	Sand
FS10B-4(bulk)	153	305	-9.09	1.00	0.61	0.2001	0.9514	0.00	99.65	0.35	0.00	0.35	Sand
FS10C-5(bulk)	305	492	-10.61	1.11	0.55	0.1352	0.8854	0.00	99.66	0.34	0.00	0.34	Sand
average				1.03									
FS11A-1	5	8	-8.43	0.73	0.88	0.0972	0.7785	0.00	99.72	0.28	0.00	0.28	Sand
FS11A-2	85	88	-9.23	0.70	0.88	0.4460	0.8492	0.00	99.70	0.30	0.00	0.30	Sand
FS11A-3	127	130	-9.65	0.65	0.67	0.3285	0.9557	0.00	99.75	0.25	0.00	0.25	Sand
FS11B-1	167	170	-10.05	0.73	0.71	-0.0940	0.8580	0.00	99.70	0.30	0.00	0.30	Sand
FS11B-2	235	238	-10.73	1.01	0.73	-0.0027	0.9551	0.00	99.61	0.39	0.00	0.39	Sand
FS11B-3	299	302	-11.37	1.04	0.73	-0.0905	0.8271	0.00	99.60	0.40	0.00	0.40	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
FS11C-1	320	323	-11.58	1.13	0.74	-0.0796	0.8269	0.00	99.46	0.54	0.00	0.54	Sand
FS11C-2	386	389	-12.24	1.41	0.74	-0.2904	0.8715	0.00	99.42	0.58	0.00	0.58	Sand
FS11C-3	440	443	-12.78	1.17	0.66	0.0697	0.8410	0.00	99.43	0.57	0.00	0.57	Sand
FS11D-1	471	474	-13.09	0.90	0.81	0.1008	0.9083	0.00	99.66	0.34	0.00	0.34	Sand
FS11D-2	503	506	-13.41	1.25	0.81	-0.2355	0.7949	0.00	99.52	0.48	0.00	0.48	Sand
FS11D-3	533	536	-13.71	1.48	0.64	-0.2044	0.9818	0.00	99.33	0.67	0.00	0.67	Sand
FS11A-4(bulk)	0	159	-8.38	0.73	0.82	0.0866	0.8122	0.00	99.81	0.19	0.00	0.19	Sand
FS11B-4(bulk)	159	313	-9.97	0.97	0.71	-0.0621	0.8770	0.00	99.70	0.30	0.00	0.30	Sand
FS11C-4(bulk)	313	465	-11.51	1.11	0.55	0.1365	0.8889	0.00	99.51	0.49	0.00	0.49	Sand
FS11D-4(bulk)	465	544	-13.03	1.46	0.71	-0.2830	0.8442	0.00	99.58	0.42	0.00	0.42	Sand
average				1.07									
WS6A-1	12	15	-12.75	1.37	0.86	0.1179	0.7593	0.00	99.58	0.42	0.00	0.42	Sand
WS6A-2	77	80	-13.40	1.79	0.86	-0.3856	0.8370	0.00	99.25	0.75	0.00	0.75	Sand
WS6A-3	140	143	-14.03	2.32	0.62	-0.1267	1.3136	0.00	98.05	1.95	0.00	1.95	Sand
WS6B-1	177	180	-14.40	2.24	0.48	-0.1795	1.1630	0.00	98.80	1.20	0.00	1.20	Sand
WS6B-2	233	236	-14.96	2.46	0.68	-0.0089	1.1324	0.00	97.10	2.90	0.00	2.90	Sand
WS6B-3	288	291	-15.51	1.65	0.78	-0.2242	0.7329	0.00	99.00	1.00	0.00	1.00	Sand
WS6C-1	315	318	-15.78	1.08	0.74	0.2922	0.8243	0.00	99.79	0.21	0.00	0.21	Sand
WS6C-2	337	340	-16.00	2.46	0.51	0.0992	1.4611	0.00	97.38	2.62	0.00	2.62	Sand
WS6C-3	376	379	-16.39	1.25	0.78	0.2099	0.7063	0.00	99.62	0.38	0.00	0.38	Sand
WS6C-4	442	445	-17.05	2.44	0.44	-0.1441	1.6663	0.00	98.54	1.46	0.00	1.46	Sand
WS6D-1	474	477	-17.37	2.55	0.53	-0.1949	2.0822	0.00	98.09	1.91	0.00	1.91	Sand
WS6D-2	531	534	-17.94	2.49	0.48	-0.1455	2.0973	0.00	97.67	2.33	0.00	2.33	Sand
WS6D-3	586	589	-18.49	2.68	0.79	0.5610	3.1835	0.00	92.14	6.68	1.19	7.86	Sand
WS6A-4(bulk)	0	156	-12.63	1.79	0.85	-0.3541	1.0440	0.00	99.35	0.65	0.00	0.65	Sand
WS6B-4(bulk)	156	308	-14.19	2.01	0.69	-0.3103	1.2503	0.00	99.14	0.86	0.00	0.86	Sand
WS6C-5(bulk)	308	461	-15.71	1.76	0.86	-0.3793	0.8041	0.00	99.26	0.74	0.00	0.74	Sand
WS6D-4(bulk)	461	613	-17.24	2.53	0.61	-0.0131	2.1740	0.05	95.80	3.08	1.07	4.15	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
average				2.02									
WS7A-1	20	23	-9.41	0.89	0.54	-0.1131	2.0824	2.32	97.58	0.11	0.00	0.11	Sand
WS7A-2	91	94	-10.12	1.03	0.61	0.3679	1.1974	2.14	97.73	0.13	0.00	0.13	Sand
WS7A-3	137	140	-10.58	0.76	0.84	-0.0122	1.6125	6.53	93.29	0.18	0.00	0.18	Sand
WS7B-1	169	172	-10.90	0.86	**	**	**	8.11	91.72	0.17	0.00	0.17	Sand
WS7B-2	233	236	-11.54	0.38	0.92	-0.2535	1.3183	14.50	85.33	0.17	0.00	0.17	Sand
WS7B-3	281	284	-12.02	0.49	2.38	-0.5095	6.2315	12.05	87.78	0.16	0.00	0.16	Sand
WS7C-1	325	328	-12.46	0.75	0.84	-0.0296	1.6033	6.57	93.17	0.26	0.00	0.26	Sand
WS7C-2	387	390	-13.08	1.06	0.46	0.3932	1.8109	0.18	99.49	0.32	0.00	0.32	Sand
WS7C-3	444	447	-13.65	0.62	0.73	-0.1817	1.4947	6.64	92.99	0.37	0.00	0.37	Sand
WS7D-1	482	485	-14.03	0.86	0.84	0.0091	1.5803	6.30	93.23	0.47	0.00	0.47	Sand
WS7D-2	538	541	-14.59	0.94	0.85	0.0374	1.5879	5.32	94.12	0.56	0.00	0.56	Sand
WS7D-3	589	592	-15.10	0.88	0.78	0.0255	1.8108	6.85	92.74	0.42	0.00	0.42	Sand
WS7A-4(bulk)	0	155	-9.21	0.79	0.69	-0.0993	1.8257	6.66	93.23	0.11	0.00	0.11	Sand
WS7B-4(bulk)	155	309	-10.76	0.52	1.61	-0.4768	3.8212	8.48	91.39	0.13	0.00	0.13	Sand
WS7C-4(bulk)	309	462	-12.30	0.91	0.71	-0.0467	2.1469	4.16	95.63	0.21	0.00	0.21	Sand
WS7D-4(bulk)	462	600	-13.83	0.53	0.77	-0.0706	1.4285	7.25	92.46	0.29	0.00	0.29	Sand
average				0.69									
WS8A-1	16	19	-9.42	1.19	0.42	0.2532	1.3130	0.00	99.51	0.49	0.00	0.49	Sand
WS8A-2	73	76	-9.99	1.21	0.42	0.3015	1.4192	0.00	99.54	0.46	0.00	0.46	Sand
WS8A-3	122	125	-10.48	1.18	0.32	0.2740	1.4455	0.00	99.64	0.36	0.00	0.36	Sand
WS8B-1	164	167	-10.90	1.08	0.32	0.1859	1.3433	0.00	99.65	0.35	0.00	0.35	Sand
WS8B-2	217	220	-11.43	1.07	0.36	0.2500	1.4001	0.00	99.47	0.53	0.00	0.53	Sand
WS8B-3	275	278	-12.01	1.17	0.34	0.2566	1.2303	0.00	99.61	0.39	0.00	0.39	Sand
WS8C-1	322	325	-12.48	1.09	0.41	0.3321	1.4103	0.00	99.41	0.59	0.00	0.59	Sand
WS8C-2	389	392	-13.15	1.00	0.37	0.2176	1.3748	0.00	99.70	0.30	0.00	0.30	Sand
WS8C-3	457	460	-13.83	1.10	0.45	0.1714	1.3259	0.00	99.55	0.45	0.00	0.45	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
WS8A-4(bulk)	0	144	-9.26	1.09	0.37	0.2160	1.3456	0.00	99.69	0.31	0.00	0.31	Sand
WS8B-4(bulk)	144	298	-10.70	1.23	0.37	0.3179	1.3018	0.00	99.72	0.28	0.00	0.28	Sand
WS8C-4(bulk)	298	482	-12.24	1.12	0.39	0.3130	1.3623	0.00	99.74	0.26	0.00	0.26	Sand
average				1.15									
WS9A-1	26	30	-9.99	1.15	0.53	0.2115	1.7736	0.00	99.87	0.13	0.00	0.13	Sand
WS9A-2	79	82	-10.52	1.22	0.50	0.2894	1.0885	0.08	99.78	0.14	0.00	0.14	Sand
WS9A-3	132	135	-11.05	1.17	0.46	0.3409	1.1045	0.00	99.80	0.20	0.00	0.20	Sand
WS9B-1	170	173	-11.43	1.35	0.40	0.2860	1.1683	0.00	99.82	0.18	0.00	0.18	Sand
WS9B-2	229	232	-12.02	1.63	0.46	0.2245	0.8871	0.02	99.76	0.21	0.00	0.21	Sand
WS9B-3	288	291	-12.61	1.53	0.47	0.0511	0.8926	0.00	99.74	0.26	0.00	0.26	Sand
WS9C-1	325	328	-12.98	1.54	0.45	0.0196	0.9277	0.00	99.82	0.18	0.00	0.18	Sand
WS9C-2	378	381	-13.51	1.58	0.47	0.0368	0.8932	0.00	99.51	0.49	0.00	0.49	Sand
WS9C-3	436	439	-14.09	1.47	0.43	0.1834	0.9015	0.00	99.77	0.23	0.00	0.23	Sand
WS9D-1	473	476	-14.46	1.60	0.50	0.1175	0.9131	0.00	99.50	0.50	0.00	0.50	Sand
WS9D-2	514	517	-14.87	1.84	0.49	0.0349	0.8451	0.00	99.50	0.50	0.00	0.50	Sand
WS9D-3	556	559	-15.29	1.82	0.49	0.0288	0.8796	0.00	99.32	0.68	0.00	0.68	Sand
WS9A-4(bulk)	0	152	-9.73	1.14	0.47	0.3102	1.1594	0.00	99.94	0.06	0.00	0.06	Sand
WS9B-4(bulk)	152	305	-11.25	1.42	0.47	0.1688	0.9822	0.08	99.79	0.14	0.00	0.14	Sand
WS9C-4(bulk)	305	458	-12.78	1.48	0.49	0.1912	0.8415	0.13	99.62	0.26	0.00	0.26	Sand
WS9D-4(bulk)	458	573	-14.31	1.72	0.47	0.0811	0.8185	0.00	99.49	0.51	0.00	0.51	Sand
average				1.44									
WS10A-1	17	20	-20.25	2.51	0.51	-0.0562	1.8591	0.00	96.60	2.05	1.35	3.40	Sand
WS10A-2	68	71	-20.76	2.39	1.16	0.1971	4.7922	0.00	91.80	4.21	3.99	8.20	Sand
WS10A-3	130	133	-21.38	2.24	0.32	0.0538	1.2567	0.00	99.46	0.54	0.00	0.54	Sand
WS10B-1	174	177	-21.82	2.33	0.30	0.2165	1.1466	0.00	98.24	1.76	0.00	1.76	Sand
WS10B-2	222	225	-22.30	2.33	0.82	0.1970	2.9939	0.00	94.05	2.80	3.16	5.95	Sand
WS10B-3	279	282	-22.87	2.59	0.58	-0.3645	2.1878	0.00	96.43	2.26	1.31	3.57	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
WS10C-1	325	328	-23.33	7.36	2.88	0.3484	1.0129	0.00	5.46	65.41	29.13	94.54	Clayey Silt
WS10C-2	390	393	-23.98	3.49	3.02	0.6270	1.1920	0.00	69.41	20.11	10.48	30.59	Silty Sand
WS10C-3	447	450	-24.55	1.87	1.58	0.2152	1.8740	0.00	90.50	6.26	3.23	9.50	Sand
WS10D-1	474	477	-24.82	3.26	2.37	0.7374	2.5735	0.00	77.54	14.56	7.89	22.46	Sand
WS10D-2	533	536	-25.41	6.04	3.48	0.2601	0.9042	0.00	32.48	43.47	24.05	67.52	Sand-Silt-Clay
WS10D-3	563	566	-25.71	4.40	2.56	0.5119	0.9786	0.00	56.22	34.51	9.26	43.78	Silty Sand
WS10A-4(bulk)	0	152	-20.08	1.75	1.72	0.4284	3.2092	0.00	87.50	6.74	5.76	12.50	Sand
WS10B-4(bulk)	152	304	-21.60	2.38	0.98	-0.1395	1.9257	0.00	94.14	3.08	2.78	5.86	Sand
WS10C-4(bulk)	304	457	-23.12	4.21	2.70	0.7368	1.5010	0.00	67.84	20.40	11.76	32.16	Silty Sand
WS10D-4(bulk)	457	585	-24.65	5.58	3.26	0.2886	0.9865	0.00	37.83	42.58	19.59	62.17	Sandy Silt
average				3.48								0.00	
WS11A-1	16	19	-13.81	1.42	0.69	0.0081	1.0269	0.00	99.23	0.77	0.00	0.77	Sand
WS11A-2	74	77	-14.39	1.48	0.69	0.0346	0.7667	0.00	99.20	0.80	0.00	0.80	Sand
WS11A-3	131	134	-14.96	1.67	0.58	0.0301	0.8104	0.00	99.21	0.79	0.00	0.79	Sand
WS11B-1	171	174	-15.36	2.29	0.45	-0.0417	1.3587	0.00	98.17	1.83	0.00	1.83	Sand
WS11B-2	232	235	-15.97	0.62	0.95	0.5111	0.9423	0.00	99.07	0.93	0.00	0.93	Sand
WS11B-3	283	286	-16.48	0.55	0.85	0.5475	1.2614	0.00	99.09	0.91	0.00	0.91	Sand
WS11C-1	322	325	-16.87	0.39	0.66	0.4661	2.0407	0.00	98.64	1.36	0.00	1.36	Sand
WS11C-2	353	356	-17.18	2.21	0.56	-0.3310	1.0697	0.00	98.60	1.40	0.00	1.40	Sand
WS11C-3	388	391	-17.53	1.53	0.67	0.1634	1.2305	0.00	97.73	2.27	0.00	2.27	Sand
WS11C-4	442	445	-18.07	4.16	2.56	0.7191	1.3566	0.00	65.45	24.97	9.58	34.55	Silty Sand
WS11D-1	474	477	-18.39	3.21	0.97	0.1715	5.4433	0.00	91.04	5.75	3.21	8.96	Sand
WS11D-2	524	527	-18.89	3.30	1.16	0.2269	5.2635	0.00	88.39	6.63	4.98	11.61	Sand
WS11D-3	571	574	-19.36	4.27	1.91	0.8300	4.2516	0.00	75.15	16.15	8.69	24.85	Sand
WS11A-4(bulk)	0	158	-13.65	1.86	0.57	-0.0676	0.7911	0.00	99.20	0.80	0.00	0.80	Sand
WS11B-4(bulk)	158	311	-15.23	0.75	0.93	0.5608	0.8334	0.00	98.24	1.76	0.00	1.76	Sand
WS11C-5(bulk)	311	463	-16.76	1.94	1.95	0.2025	1.3796	0.00	87.67	8.00	4.33	12.33	Sand
WS11D-4(bulk)	463	601	-18.28	3.96	1.45	0.7547	4.3751	0.00	79.28	14.78	5.93	20.72	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
average				2.13									
WS12.1A-1	12	15	-8.95	0.94	0.32	0.1383	1.3167	0.00	99.94	0.06	0.00	0.06	Sand
WS12.1A-2	74	77	-9.57	1.04	0.36	0.2354	0.9619	0.00	99.91	0.09	0.00	0.09	Sand
WS12.1A-3	129	132	-10.12	1.02	0.40	-0.2728	2.3185	0.00	99.85	0.15	0.00	0.15	Sand
WS12.1B-1	175	178	-10.58	1.14	0.42	0.2762	1.0490	0.00	99.81	0.19	0.00	0.19	Sand
WS12.1B-2	235	238	-11.18	1.11	0.47	0.3812	1.2638	0.00	99.70	0.30	0.00	0.30	Sand
WS12.1B-3	282	285	-11.65	0.99	0.43	0.2293	1.3888	0.00	99.78	0.22	0.00	0.22	Sand
WS12.1C-1	328	331	-12.11	0.96	0.42	0.2872	1.5468	0.00	99.71	0.29	0.00	0.29	Sand
WS12.1C-2	370	373	-12.53	1.13	0.49	0.4074	1.2753	0.00	99.68	0.32	0.00	0.32	Sand
WS12.1C-3	407	410	-12.90	1.05	0.52	0.3405	1.4605	0.00	99.63	0.37	0.00	0.37	Sand
WS12.1A-4(bulk)	0	159	-8.83	1.09	0.35	0.1724	1.0501	0.00	99.81	0.19	0.00	0.19	Sand
WS12.1B-4(bulk)	159	312	-10.42	1.06	0.45	0.4144	1.6942	0.00	97.78	2.22	0.00	2.22	Sand
WS12.1C-4(bulk)	312	432	-11.95	1.01	0.44	0.3385	1.5607	0.00	99.81	0.19	0.00	0.19	Sand
average				1.05									
WS12.2A-1	16	19	-13.43	1.13	0.54	0.4168	1.4211	0.00	99.87	0.13	0.00	0.13	Sand
WS12.2A-2	85	88	-14.12	0.91	0.39	0.2225	1.5216	0.00	99.81	0.19	0.00	0.19	Sand
WS12.2A-3	113	116	-14.40	1.21	0.59	0.4135	1.0204	0.00	99.12	0.88	0.00	0.88	Sand
WS12.2A-4(bulk)	0	124	-13.27	1.00	0.46	0.3104	1.6216	0.00	99.79	0.21	0.00	0.21	Sand
average				1.00									
IW6A-1	24	27	-15.72	2.29	0.44	0.0453	1.2827	0.00	97.78	2.22	0.00	2.22	Sand
IW6A-2	76	79	-16.24	2.25	0.43	-0.0642	1.0802	0.00	99.38	0.62	0.00	0.62	Sand
IW6A-3	123	126	-16.71	2.28	0.51	-0.0623	1.2846	0.00	97.72	2.28	0.00	2.28	Sand
IW6B-1	169	172	-17.17	2.26	0.44	-0.0969	1.1503	0.00	98.83	1.17	0.00	1.17	Sand
IW6B-2	242	245	-17.90	2.00	0.67	-0.2245	0.9806	0.00	97.96	2.04	0.00	2.04	Sand
IW6B-3	281	284	-18.29	1.93	0.51	-0.0603	1.0177	0.00	98.55	1.45	0.00	1.45	Sand
IW6C-1	317	320	-18.65	1.94	0.61	-0.2081	0.9694	0.00	98.56	1.44	0.00	1.44	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
IW6C-2	383	386	-19.31	4.10	2.50	0.5158	2.2516	0.00	72.38	17.95	9.67	27.62	Silty Sand
IW6C-3	439	442	-19.87	3.38	2.76	0.5588	1.9464	0.00	75.55	15.17	9.27	24.45	Sand
IW6D-1	476	479	-20.24	1.46	1.14	0.1847	1.1465	0.00	94.63	2.69	2.69	5.37	Sand
IW6D-2	527	530	-20.75	2.15	0.36	-0.1176	1.0469	0.00	99.15	0.85	0.00	0.85	Sand
IW6D-3	587	590	-21.35	1.85	0.49	-0.0653	0.9921	0.00	98.29	1.71	0.00	1.71	Sand
IW6A-4(bulk)	0	153	-15.48	2.34	0.44	-0.0423	1.1244	0.00	98.21	1.79	0.00	1.79	Sand
IW6B-4(bulk)	153	304	-17.01	2.25	0.46	-0.0480	1.0626	0.00	98.12	1.88	0.00	1.88	Sand
IW6C-4(bulk)	304	457	-18.52	4.71	3.55	0.6538	0.9772	0.00	62.67	17.39	19.93	37.33	Clayey Sand
IW6D-4(bulk)	457	611	-20.05	2.09	0.49	-0.2746	1.3476	0.00	98.63	1.37	0.00	1.37	Sand
average				2.85									
IW7A-1	16	19	-12.51	2.37	0.33	0.0358	1.1947	0.00	98.30	1.70	0.00	1.70	Sand
IW7A-2	73	76	-13.08	2.31	0.37	-0.0262	1.1971	0.00	97.75	2.25	0.00	2.25	Sand
IW7A-3	126	129	-13.61	2.26	0.40	-0.1098	1.2451	0.00	98.30	1.70	0.00	1.70	Sand
IW7B-1	175	178	-14.10	2.47	0.31	-0.0493	1.2666	0.00	98.03	1.97	0.00	1.97	Sand
IW7B-2	230	233	-14.65	2.42	0.33	-0.1402	1.1785	0.00	99.91	0.09	0.00	0.09	Sand
IW7B-3	287	290	-15.22	2.29	0.48	-0.2179	1.3963	0.00	98.26	1.74	0.00	1.74	Sand
IW7C-1	330	333	-15.65	2.10	0.45	-0.1020	1.2169	0.00	98.76	1.24	0.00	1.24	Sand
IW7C-2	387	390	-16.22	2.19	0.34	-0.1261	1.1221	0.00	98.72	1.28	0.00	1.28	Sand
IW7C-3	434	437	-16.69	2.31	0.39	-0.0393	1.1852	0.00	98.23	1.77	0.00	1.77	Sand
IW7D-1	475	478	-17.10	2.30	0.48	-0.1860	1.2887	0.00	97.95	2.05	0.00	2.05	Sand
IW7D-2	524	527	-17.59	1.90	0.55	-0.1863	1.0640	0.00	99.12	0.88	0.00	0.88	Sand
IW7D-3	560	563	-17.95	1.92	0.58	-0.1022	1.0222	0.00	98.49	1.51	0.00	1.51	Sand
IW7A-4(bulk)	0	155	-12.35	2.29	0.28	-0.0420	1.0661	0.00	99.06	0.94	0.00	0.94	Sand
IW7B-4(bulk)	155	307	-13.90	2.45	0.35	-0.1105	1.2733	0.00	99.53	0.47	0.00	0.47	Sand
IW7C-4(bulk)	307	460	-15.42	2.38	0.35	0.0347	1.1292	0.00	98.41	1.59	0.00	1.59	Sand
IW7D-4(bulk)	460	578	-16.95	2.01	0.61	-0.1968	1.0450	0.00	98.52	1.48	0.00	1.48	Sand
average				2.28									

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
IW8A-1	14	17	-8.23	0.97	0.40	-0.0109	0.9980	0.00	99.72	0.28	0.00	0.28	Sand
IW8A-2	76	79	-8.85	1.13	0.47	-0.1577	0.9648	0.00	99.48	0.52	0.00	0.52	Sand
IW8A-3	128	131	-9.37	1.18	0.34	-0.1641	1.0419	0.00	99.58	0.42	0.00	0.42	Sand
IW8B-1	163	166	-9.72	1.11	0.38	0.0731	1.1205	0.00	99.66	0.34	0.00	0.34	Sand
IW8B-2	220	223	-10.29	1.07	0.46	-0.1674	1.0235	0.00	99.63	0.37	0.00	0.37	Sand
IW8B-3	274	277	-10.83	1.38	0.37	0.0786	1.1410	0.00	99.47	0.53	0.00	0.53	Sand
IW8C-1	318	321	-11.27	1.45	0.38	0.0500	1.1299	0.00	99.55	0.45	0.00	0.45	Sand
IW8C-2	380	383	-11.89	1.47	0.31	0.0583	1.1746	0.00	99.48	0.52	0.00	0.52	Sand
IW8C-3	421	424	-12.30	1.37	0.38	-0.0123	1.1630	0.00	99.56	0.44	0.00	0.44	Sand
IW8D-1	458	461	-12.67	1.46	0.32	0.2096	1.1528	0.00	99.54	0.46	0.00	0.46	Sand
IW8D-2	498	501	-13.07	1.37	0.37	0.0604	1.0558	0.00	99.58	0.42	0.00	0.42	Sand
IW8A-4(bulk)	0	146	-8.09	1.14	0.37	-0.0770	1.0573	0.00	99.73	0.27	0.00	0.27	Sand
IW8B-4(bulk)	146	298	-9.55	1.28	0.40	-0.0183	1.1648	0.00	99.76	0.24	0.00	0.24	Sand
IW8C-4(bulk)	298	448	-11.07	1.34	0.32	0.1267	1.2511	0.00	99.72	0.28	0.00	0.28	Sand
IW8D-3(bulk)	448	531	-12.57	1.40	0.35	0.0529	1.1665	0.00	99.64	0.36	0.00	0.36	Sand
average				1.29									
IW9A-1	12	15	-9.58	1.44	0.62	-0.1759	1.1335	0.00	99.49	0.51	0.00	0.51	Sand
IW9A-2	77	80	-10.23	1.12	0.82	0.0198	0.7615	0.00	99.49	0.51	0.00	0.51	Sand
IW9A-3	126	129	-10.72	1.36	0.77	-0.2051	0.7152	0.00	99.38	0.62	0.00	0.62	Sand
IW9B-1	165	168	-11.11	1.82	0.49	-0.1352	1.0945	0.00	99.06	0.94	0.00	0.94	Sand
IW9B-2	222	225	-11.68	1.24	0.49	0.0534	1.1584	0.00	99.55	0.45	0.00	0.45	Sand
IW9B-3	279	282	-12.25	1.44	0.47	0.0773	0.9633	0.00	99.58	0.42	0.00	0.42	Sand
IW9C-1	314	317	-12.60	1.76	0.40	-0.0364	1.1078	0.00	99.47	0.53	0.00	0.53	Sand
IW9C-2	373	376	-13.19	1.58	0.44	-0.0435	1.0612	0.00	99.46	0.54	0.00	0.54	Sand
IW9C-3	424	427	-13.70	1.61	0.40	0.1054	0.9502	0.00	99.42	0.58	0.00	0.58	Sand
IW9D-1	478	481	-14.24	1.54	0.49	0.0149	0.9864	0.00	99.51	0.49	0.00	0.49	Sand
IW9A-4(bulk)	0	147	-9.46	1.34	0.72	-0.1148	0.7546	0.00	99.49	0.51	0.00	0.51	Sand
IW9B-4(bulk)	147	299	-10.93	1.50	0.59	-0.0127	0.9227	0.00	99.65	0.35	0.00	0.35	Sand

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
IW9C-4(bulk)	299	452	-12.45	1.64	1.28	0.0213	0.6667	0.00	99.75	0.25	0.00	0.25	Sand
IW9D-2(bulk)	452	511	-13.98	1.50	0.47	-0.0063	1.0925	0.00	99.67	0.33	0.00	0.33	Sand
average				1.49									
IW10A-1	22	25	-6.26	1.41	0.35	-0.0862	1.1738	0.00	99.77	0.23	0.00	0.23	Sand
IW10A-2	73	76	-6.77	1.28	0.42	-0.2176	1.0857	0.00	99.61	0.39	0.00	0.39	Sand
IW10A-3	127	130	-7.31	1.03	0.69	0.1058	0.8532	0.00	99.64	0.36	0.00	0.36	Sand
IW10B-1	168	171	-7.72	1.18	0.28	0.0349	1.2297	0.00	99.66	0.34	0.00	0.34	Sand
IW10B-2	232	235	-8.36	1.02	0.45	-0.0596	0.9578	0.00	99.79	0.21	0.00	0.21	Sand
IW10B-3	278	281	-8.82	1.40	0.34	-0.0548	1.0616	0.00	99.72	0.28	0.00	0.28	Sand
IW10C-1	320	323	-9.24	1.67	0.31	0.0195	1.1003	0.00	99.53	0.47	0.00	0.47	Sand
IW10C-2	386	389	-9.90	0.83	0.47	0.1023	1.0673	0.00	99.72	0.28	0.00	0.28	Sand
IW10C-3	432	435	-10.36	0.97	0.64	0.1768	0.7475	0.00	99.75	0.25	0.00	0.25	Sand
IW10D-1	473	476	-10.77	1.53	0.38	0.0631	1.0076	0.00	99.56	0.44	0.00	0.44	Sand
IW10A-4(bulk)	0	153	-6.04	1.39	0.51	-0.0379	0.9588	0.00	99.69	0.31	0.00	0.31	Sand
IW10B-4(bulk)	152	304	-7.56	1.20	0.44	-0.0195	1.0854	0.00	99.86	0.14	0.00	0.14	Sand
IW10C-4(bulk)	304	456	-9.08	1.02	0.46	0.0564	0.9132	0.00	99.78	0.22	0.00	0.22	Sand
IW10D-2(bulk)	456	494	-10.60	1.47	0.40	-0.0292	1.1987	0.00	99.65	0.35	0.00	0.35	Sand
average				1.27									
IW11A-1	15	18	-19.35					0.00	98.65	1.35	0.00	1.35	Sand
IW11A-2	57	59	-19.77	3.11	1.89	0.6955	3.3751	0.00	82.68	9.40	7.92	17.32	Sand
IW11A-3	111	114	-20.31	4.55	2.40	0.7306	1.5770	0.00	65.90	23.38	10.72	34.10	Silty Sand
IW11B-1	142	145	-20.62	4.53	1.83	0.7041	1.0126	0.00	60.20	34.05	5.75	39.80	Silty Sand
IW11B-2	195	198	-21.15	3.63	2.70	0.6366	1.2923	0.10	70.49	20.33	9.07	29.41	Silty Sand
IW11B-3	252	255	-21.72	6.98	4.11	0.0789	0.5851	0.00	33.50	22.89	43.61	66.50	Sand-Silt-Clay
IW11A-4(bulk)	0	128	-19.20	3.21	1.90	0.6761	2.4643	0.05	80.59	13.20	6.16	19.36	Sand
IW11B-4(bulk)	128	281	-20.48	4.71	3.21	0.6466	1.0301	0.00	60.20	21.91	17.89	39.80	Silty Sand
average				3.96									

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
IW12A-1	8	11	-8.49	0.04	1.31	1.0000	0.5298	51.68	48.17	0.15	0.00	0.15	Sand
IW12A-2	77	80	-9.18	0.77	0.46	0.3034	1.4389	0.00	99.88	0.12	0.00	0.12	Sand
IW12A-3	141	144	-9.82	0.74	0.46	0.0804	1.3731	0.00	99.90	0.10	0.00	0.10	Sand
IW12B-1	172	175	-10.13	1.01	0.65	0.3209	0.8314	0.00	99.85	0.15	0.00	0.15	Sand
IW12B-2	231	234	-10.72	0.99	0.50	0.2463	1.1660	0.00	99.81	0.19	0.00	0.19	Sand
IW12B-3	282	285	-11.23	1.31	0.49	0.0758	1.6200	0.00	99.74	0.26	0.00	0.26	Sand
IW12C-1	331	334	-11.72	1.20	0.45	0.1644	1.1902	0.00	99.76	0.24	0.00	0.24	Sand
IW12C-2	391	394	-12.32	1.60	0.41	0.1046	0.9222	0.00	99.66	0.34	0.00	0.34	Sand
IW12C-3	444	447	-12.85	1.07	0.50	-0.0954	1.0226	0.00	99.90	0.10	0.00	0.10	Sand
IW12D-1	477	480	-13.18	1.44	0.40	0.1509	1.0734	0.00	99.63	0.37	0.00	0.37	Sand
IW12D-2	530	533	-13.71	1.26	0.58	0.0564	1.2492	0.00	99.84	0.16	0.00	0.16	Sand
IW12D-3	566	569	-14.07	1.32	0.41	0.0545	1.1282	0.00	99.71	0.29	0.00	0.29	Sand
IW12A-4(bulk)	0	157	-8.41	0.84	0.52	0.1646	1.1092	0.00	99.87	0.13	0.00	0.13	Sand
IW12B-4(bulk)	157	311	-9.98	1.12	0.49	0.0823	1.1971	0.00	99.82	0.18	0.00	0.18	Sand
IW12C-4(bulk)	311	463	-11.52	1.23	0.52	-0.0123	1.0030	0.00	99.83	0.17	0.00	0.17	Sand
IW12D-4(bulk)	463	588	-13.04	1.24	0.44	0.0423	1.2493	0.00	99.82	0.18	0.00	0.18	Sand
average				1.11									
DELAWARE CORES													
Rk25-01, - 02													
61299_1	0.5	1	-8.68	1.78	0.33	-0.0182	1.1419	0.80	99.08			0.11	
61299_2	2	2.5	-9.14	1.82	0.31	0.0440	1.1184	0.20	99.48			0.32	
61299_3	4	4.5	-9.75	1.78	0.32	0.1161	1.0169	0.15	99.26			0.59	
61300_1	6	6.5	-10.36	1.64	0.38	-0.1419	1.0870	1.47	98.30			0.23	
61300_2	7.5	8	-10.82	1.60	0.39	-0.1002	1.0939	0.96	98.97			0.06	

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
61300_3	9	9.5	-11.27	1.67	0.36	-0.2255	1.2943	2.46	96.69			0.85	
61301_1	10.5	11	-11.73	1.60	0.48	-0.2511	1.1825	0.83	98.95			0.22	
61301_2	12	12.5	-12.19	1.84	0.36	0.0099	1.0129	0.08	99.71			0.21	
61302_1	14	14.5	-12.80	1.82	0.41	-0.0035	1.0351	0.36	99.56			0.08	
61302_2	15.5	16	-13.26	1.85	0.32	0.0533	1.2399	0.29	98.83			0.88	
61304_1	16	16.5	-13.41	1.72	0.37	-0.0806	1.0469	2.11	97.18			0.71	
61302_3	17	17.5	-13.71	1.88	0.34	-0.0759	1.1001	0.11	99.06			0.82	
61303_1	19	19.5	-14.32	1.91	0.33	0.0011	0.9285	0.05	99.32			0.63	
average				1.76	0.36	-0.0517	1.0999	0.76	98.80			0.44	
Rk34-02													
61287_1	0.5	1	-8.66	0.95	0.56	-0.0383	1.0536	5.37	94.63			0.00	
61287_2	2	2.5	-9.11	1.02	0.64	-0.0287	0.9532	6.28	93.61			0.11	
61287_3	4	4.5	-9.72	1.06	0.55	0.0414	0.7959	14.91	84.88			0.21	
61288_1	5	5.5	-10.03	1.16	0.64	-0.2200	0.9001	5.52	94.00			0.48	
61288_2	6.5	7	-10.49	1.43	0.54	-0.1802	1.1749	4.21	95.02			0.77	
61288_3	9	9.5	-11.25	0.96	0.76	-0.1481	0.8138	7.94	91.74			0.33	
61289_1	10.5	11	-11.70	0.94	0.77	-0.1238	0.8496	6.12	93.69			0.18	
61289_2	12	12.5	-12.16	1.16	0.62	-0.0367	1.0265	4.84	95.13			0.04	
61289_3	13.5	14	-12.62	1.20	0.56	-0.0998	1.0386	2.69	97.26			0.04	
61290_1	15.5	16	-13.23	1.16	0.65	-0.1622	0.9772	4.66	94.52			0.82	
61290_2	16.5	17	-13.53	1.10	0.82	-0.2328	0.9298	9.09	90.57			0.34	
61290-3	17.5	18	-13.84	0.87	0.77	-0.1503	0.8139	9.91	90.05			0.04	
average				1.10	0.65	-0.1118	0.9557	6.79	92.93			0.28	
Rk35-02													
61241_1	1	1.5	-6.99	1.58	0.30	0.0086	1.3192	0.81	98.97			0.23	
61241_2	2.5	3	-7.45	1.51	0.25	0.0361	1.0374	0.28	99.54			0.18	
61241_3	4	4.5	-7.90	1.49	0.28	-0.0800	1.0785	0.42	98.96			0.62	

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
61242_1	5	5.5	-8.21	1.70	0.26	0.1866	1.1112	0.04	99.86			0.11	
61242_2	7.5	8	-8.97	1.46	0.43	0.0176	0.9951	0.54	99.19			0.27	
61242_3	9	9.5	-9.43	1.41	0.50	-0.2067	0.8663	3.79	95.69			0.53	
61243_1	10.5	11	-9.88	1.38	0.34	0.1042	1.0305	0.21	99.64			0.15	
61243_2	12	12.5	-10.34	1.52	0.38	0.1943	0.9471	0.28	99.38			0.34	
61243_3	13.5	14	-10.80	1.21	0.33	0.2036	0.9674	2.53	96.99			0.48	
61244_1	15.5	16	-11.41	1.53	0.41	0.1041	0.8840	1.09	98.80			0.11	
61244_2	17	17.5	-11.87	1.82	0.30	-0.0381	1.1722	0.22	99.20			0.58	
61244_3	18.5	19	-12.32	1.81	0.33	-0.0332	1.0556	0.17	98.66			1.17	
average				1.53	0.34	0.0414	1.0387	0.86	98.74			0.40	
Rk35-03													
61257_1	1	1.5	-12.48	2.08	0.29	-0.1265	0.9923	0.00	99.62			0.38	
61257_2	2	2.5	-12.78	2.05	0.33	-0.0719	1.0406	0.00	99.25			0.75	
61257_3	3.5	4	-13.24	2.01	0.33	-0.0910	1.0545	0.07	99.24			0.69	
61258_1	5.5	6	-13.85	2.02	0.34	-0.1257	1.0734	0.09	99.62			0.29	
61258_2	6.5	7	-14.15	1.98	0.32	0.0651	0.8968	0.04	99.70			0.26	
61258_3	9	9.5	-14.91	2.14	0.37	-0.1167	1.0415	0.51	97.06			2.44	
61259_1	10.5	11	-15.37	1.83	0.43	-0.1343	1.1303	4.36	95.09			0.55	
61259_2	12.5	13	-15.98	2.20	0.30	-0.1193	1.0691	0.21	99.08			0.71	
61259_3	14	14.5	-16.44	2.24	0.34	-0.0405	1.2047	0.38	98.16			1.46	
61260_1	15.5	16	-16.90	2.16	0.34	-0.0989	1.1364	0.74	98.64			0.61	
61260_2	16.5	17	-17.20	2.39	0.34	0.0254	1.1953	0.40	98.34			1.26	
61260_3	18.5	19	-17.81	2.55	0.49	-0.0401	1.7551	0.47	92.30			7.23	
average				2.14	0.35	-0.0729	1.1325	0.61	98.01			1.39	
Rk35-04													
61245_1	1	1.5	-12.75	1.34	0.68	-0.1234	0.8019	2.66	96.97			0.36	
61245_2	2.5	3	-13.21	1.72	0.49	-0.1004	0.9966	1.60	97.52			0.87	

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
61245_3	4	4.5	-13.66	1.75	0.48	-0.1765	1.0635	1.95	97.20			0.85	
61246_1	5.5	6	-14.12	1.85	0.47	-0.2936	1.1447	1.09	98.34			0.57	
61246_2	7.5	8	-14.73	1.86	0.43	-0.1271	1.0674	3.19	96.07			0.74	
61246_3	9	9.5	-15.19	1.68	0.53	-0.2199	1.0749	2.24	96.65			1.11	
61247_1	10.5	11	-15.65	1.64	0.70	-0.3952	1.4802	3.24	96.41			0.35	
61247_2	12	12.5	-16.10	1.39	0.67	-0.2221	0.7817	1.25	98.16			0.60	
61247_3	13.5	14	-16.56	1.71	0.51	-0.1203	1.0318	0.74	98.33			0.93	
61248_1	15.3	15.8	-17.11	1.99	0.46	-0.1865	1.2321	0.55	98.86			0.59	
61248_2	17	17.5	-17.63	1.97	0.43	-0.1089	1.1104	0.45	98.78			0.78	
average				1.72	0.53	-0.1885	1.0714	1.72	97.57			0.70	
Rl21-04													
61228-1	1	1.5	-11.55	1.82	0.42	-0.0920	1.1133	1.64	98.12			0.24	
61228-2	2	2.5	-11.85	1.88	0.36	-0.0327	1.0444	0.02	99.79			0.19	
61228-3	3	3.5	-12.16	1.82	0.42	-0.0858	1.0508	0.05	99.42			0.52	
61228_4	4	4.5	-12.46	1.68	0.50	-0.2357	1.1482	1.28	98.09			0.62	
61229_1	5.5	6	-12.92	1.71	0.54	-0.1766	1.2026	2.27	97.48			0.25	
61229_2	7	7.5	-13.37	1.85	0.41	-0.0616	1.0247	0.19	99.45			0.36	
61229_3	8.5	9	-13.83	1.79	0.42	-0.1040	1.1368	2.62	95.97			1.41	
61230_1	11	11.5	-14.59	1.74	0.47	-0.0821	1.1021	0.21	99.29			0.50	
61230_2	12.5	13	-15.05	1.66	0.52	-0.2126	1.0429	2.43	96.38			1.19	
61230_3	14	14.5	-15.51	1.16	0.87	-0.0950	0.8602	11.46	76.07			12.47	
61231_1	15.5	16	-15.97	1.25	0.80	-0.1908	0.7003	3.40	96.13			0.47	
61231_2	17	17.5	-16.42	0.97	0.75	-0.0907	0.7931	6.07	93.48			0.45	
61231_3	18.5	19	-16.88	1.10	0.88	0.0615	0.7052	8.17	90.66			1.17	
average				1.49	0.62	-0.1188	0.9716	3.06	95.41			1.53	
Rl21-05													
61232-1	1	1.5	-12.69	1.77	0.47	-0.1967	1.1262	0.13	99.63			0.24	

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
61232-2	2.5	3	-13.15	1.61	0.48	-0.0252	0.9599	0.20	99.57			0.22	
61232-3	4	4.5	-13.61	2.03	0.37	0.0121	1.1941	0.08	98.98			0.95	
61233-1	5.5	6	-14.06	1.61	0.55	-0.1932	1.0925	0.66	98.89			0.46	
61233_2	7.5	8	-14.67	1.80	0.45	-0.1341	1.0743	0.21	99.33			0.45	
61233_3	9	9.5	-15.13	1.57	0.42	0.0210	1.0591	0.28	98.75			0.96	
61234_1	11	11.5	-15.74	1.58	0.45	-0.0771	1.1360	0.93	98.85			0.22	
61234_2	13	13.5	-16.35	1.53	0.58	-0.2816	0.8763	0.91	98.71			0.38	
61234_3	14.5	15	-16.81	1.40	0.66	-0.1661	0.8634	1.98	97.30			0.72	
61235_1	16.5	17	-17.42	1.60	0.62	-0.3454	1.0729	0.98	98.47			0.55	
61235_2	17.5	18	-17.72	2.04	0.35	-0.0957	1.1750	0.02	99.12			0.86	
61235_3	19	19.5	-18.18	2.31	0.33	-0.1227	1.3316	0.58	96.76			2.66	
average				1.73	0.48	-0.1502	1.0736	0.58	98.70			0.72	
Rl21-06													
61249_1	0.5	1	-11.13	1.65	0.48	-0.2208	1.0506	0.77	99.11			0.12	
61249_2	2	2.5	-11.59	1.63	0.46	-0.1064	1.0512	0.49	99.33			0.18	
61249_3	3.5	4	-12.05	2.00	0.35	-0.2065	1.1424	0.02	99.44			0.54	
61250_1	5.5	6	-12.66	1.38	0.54	-0.0803	0.9712	1.78	98.08			0.14	
61250_2	7	7.5	-13.12	1.67	0.48	-0.1955	0.9587	0.33	99.50			0.17	
61250_3	9.5	10	-13.88	1.56	0.57	-0.2933	1.0380	2.40	97.07			0.53	
61251_1	10.5	11	-14.18	1.40	0.66	-0.3198	1.0362	10.10	89.70			0.20	
61251_2	12	12.5	-14.64	1.61	0.54	-0.3197	1.0073	2.23	97.60			0.16	
61251_3	14.5	15	-15.40	1.50	0.59	-0.2850	1.0985	1.56	97.34			1.10	
61252-1	15.5	16	-15.71	1.92	0.36	-0.1322	1.2804	0.08	99.57			0.35	
61252_2	17	17.5	-16.16	1.88	0.40	-0.1334	1.3291	0.19	99.04			0.77	
61252_3	19	19.5	-16.77	1.90	0.42	-0.2179	1.1700	0.55	97.64			1.81	
average				1.65	0.50	-0.2162	1.0776	1.71	97.78			0.51	
Rl21-07													

Sample	Interval Top	Interval Bottom	Sample Depth	Mean	Sorting	Skewness	Kurtosis	% Gravel	% Sand	% Silt	% Clay	% Mud	SHEPARD'S CLASS
61237_1	1	1.5	-10.96	1.35	0.61	-0.2282	0.7415	2.53	97.26			0.22	
61237_2	2.5	3	-11.42	1.22	0.67	-0.1633	0.8632	7.65	92.27			0.08	
61237_3	4	4.5	-11.88	1.26	0.71	-0.1910	0.8593	2.17	97.14			0.69	
61238_1	5.5	6	-12.33	0.98	0.76	-0.1210	1.0111	11.01	88.93			0.06	
61238_2	7	7.5	-12.79	1.43	0.59	-0.2951	0.7860	2.28	97.57			0.15	
61238_3	9	9.5	-13.40	0.87	0.69	0.0242	0.9397	4.51	95.21			0.28	
61239_1	10.5	11	-13.86	1.24	0.74	-0.2604	0.7958	4.77	95.11			0.11	
61239_2	12.5	13	-14.47	1.51	0.72	-0.3733	1.2174	2.44	97.22			0.34	
61239_3	14	14.5	-14.92	1.60	0.66	-0.3805	0.9367	2.12	97.05			0.84	
61240_1	15.5	16	-15.38	1.49	0.75	-0.3671	1.0612	3.66	94.45			1.89	
61240_2	17	17.5	-15.84	1.87	0.44	-0.2599	1.2425	0.33	96.47			3.20	
average				1.35	0.67	-0.2400	0.9500	3.95	95.33			0.71	

Appendix C

Vibracore Station Locations for 1992 Maryland Geological Survey and 1997 Delaware Geological Survey Cores

The following table presents the coordinates for cores taken in 1992 by Maryland Geological Survey and 1997 by Delaware Geological Survey. These locations have been previously published and are included here for reference. Core location for Maryland were originally published by Conkwright and Gast (1994). Core locations for Delaware were published by Ramsey and McKenna (1999)

Coordinates in these tables are reported in both geographic (decimal degrees, NAD 1983) and Maryland State Plane units (NAD 1983, meters). Depths to the top of each core are in meters below NGVD.

Core	Date	Latitude	Longitude	Easting	Northing	Depth
Maryland Cores						
WS1	10/2/92	38.419485	-74.933553	580443	85630	-12.01
WS2	10/2/92	38.427900	-74.923071	581337	86562	-9.78
WS3	10/2/92	38.446656	-74.905510	582822	88679	-14.17
WS4	10/2/92	38.427285	-74.936005	580209	86469	-13.32
WS5	10/2/92	38.427856	-74.918073	581773	86567	-10.03
IW1	11/17/92	38.373500	-74.936333	580316	80499	-12.77
IW3	10/2/92	38.411443	-74.906398	582834	84770	-12.74
IW4	11/17/92	38.391895	-74.912711	580209	86469	-15.06
IW5	11/6/92	38.391636	-74.946085	581773	86567	-22.07
Delaware Cores						
Rk25-01,02	12/4/97	38.472246	-74.919298	581553.74	91493.90	-12.54
Rk34-02	12/3/97	38.462223	-74.933288	580359.34	90351.67	-13.61
Rk35-02	12/3/97	38.461370	-74.927771	580842.87	90267.93	-11.53
Rk35-03	12/3/97	38.461335	-74.922246	581325.04	90275.00	-18.06
Rk35-04	12/3/97	38.461103	-74.916760	581804.31	90260.17	-18.39
Rl21-04	12/4/97	38.480558	-74.909558	582383.27	92433.53	-16.53
Rl21-05	12/4/97	38.477790	-74.909546	582391.35	92126.37	-17.67
Rl21-06	12/4/97	38.474993	-74.908248	582511.70	91818.58	-16.76
Rl21-07	12/3/97	38.469320	-74.908386	582514.08	91188.75	-14.43