

**Phase I Groundwater Resource Investigation
at the Padre Island National Seashore -
Final Report**

Report on Contract (Order # 1443PX749093149)

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Executive Summary

The Padre Island National Seashore is located on a barrier island in South Texas and lies between the Laguna Madre to the west and the Gulf of Mexico to the east. The water table aquifer on this section of the barrier island was investigated using nine monitoring wells installed in three transects (foredunes to lagoon) across the island, and three monitoring wells installed near gas production facilities.

The aquifer is composed of Holocene eolian/marine sands deposited over the Pleistocene age Beaumont Formation and appears to run the length of the area of investigation. Water chemistry data suggest that the water table aquifer contains three distinct zones of water quality: the hypersaline zone, the freshwater zone, and the seawater zone. The freshwater zone rests above the seawater zone to the east, where it abuts the Gulf of Mexico and then thickens rapidly toward the center of the island and finally tapers to a thin layer resting on the hypersaline zone to the west.

The freshwater zone in the aquifer is recharged from precipitation over the island and is not directly connected to the mainland aquifer system. The groundwater is discharged through evapotranspiration, biologic activities, and through springs and seeps into the Gulf of Mexico and the Laguna Madre.

Introduction

This contract was to report on the occurrence and quality of groundwater within the Padre Island National Seashore through the installation and monitoring of twelve groundwater monitoring wells in four island transects of three wells each (Novillo line camp, Yarborough Pass, Dunn Ranch corrals, and washover pass). All wells were to be installed in the upper (water table) aquifer. During installation, sediment samples were to be obtained at various depth intervals and analyzed for size distribution and sediment type. Upon installation, these wells were to be monitored monthly for basic water quality parameters and a single sampling event was to occur for the testing of "organics". A final report discussing the occurrence of groundwater and its quality was to be submitted to the National Seashore. The final report was to include the results of the monthly monitoring of groundwater chemistry and elevations, results of tests to determine aquifer parameters, and a set of U.S. Geological Survey 7½' Quadrangle maps indicating the location of the monitoring wells.

During contract execution, the initial scope of work was modified with respect to the location of the monitoring wells. Installation of monitoring wells at the washover pass near the 45 mile marker was shifted to the Phase II Investigation. Instead, three monitoring wells were installed at alternate sites near natural gas production facilities.

Monitoring Wells

Groundwater monitoring wells were required to provide access for the collection of groundwater samples for chemical analysis, and measurement of water table elevations. The monitoring wells were to be designed in a manner that would allow both composite sampling for testing general water quality parameters and discrete sampling to record observations relating to changes in temperature and specific conductance with depth. Also, the borings would provide geological data such as formation/soil type, and grain/particle size which could be used to determine a range of hydraulic conductivities at each location.

Monitoring well location. Nine of the wells were located (**Figure 2**) with three per transect to most effectively determining the thickness and shape of the predicted freshwater lens lying beneath the island. Three other wells were located near gas production facilities primarily to provide groundwater quality data. After installation of the wells, National Park Service personnel furnished UTM X and Y coordinates using a Global Positioning Satellite system (**Table 1**).

Monitor well design. The wells were designed as small diameter, single riser, flow-through wells which are virtually transparent to the groundwater flow field. This type of well can supply representative groundwater samples that are composites of the water intercepted by the well if at least three casing volumes of water are bailed from the well before a water sample is acquired. If the wells are not bailed, swabbed or surged, and the flow-through equilibrium is not disturbed, a bailer or pump can be carefully lowered into the well to a certain depth and a virtually undisturbed discrete sample may be obtained from the well.

Drilling methods. Initially hand augering was selected for well installation because the method did not require an extensive equipment inventory which, in turn, minimized the impact of well installation on an environmentally sensitive area. The first well was drilled on April 3, 1993 by hand auguring to a depth of approximately 16 feet and required 13 hours to complete. This slow progress was due to up-welling, or "heaving" sand in the casing caused by a combination of unbalanced hydraulic pressure and the fluidity of the unconsolidated sand below the water table. This condition prevented penetration below a depth of 16' using the hand auger method.

A modification of the jet-percussion drilling method (Aller, et al. 1989) in combination with hand augering was used for the remainder of the well installations. The jet-percussion method is particularly suited for shallow wells in unconsolidated sands using a 4" drive casing and completing the well with 2" screen and casing. In this case no percussion was necessary to loosen the sediment at the bottom of the borehole.

The hand augering method was employed until the water table was reached and then 4" casing was inserted into the borehole. 2" PVC tubing was then assembled and attached to a flexible PVC hose that connected to a 140 gpm gasoline powered water pump. The pump was arranged so that the intake sucked water from a large stock tank and discharged the water at a rate of 140 gpm through the 2" PVC tubing (referred to here as the jetting assembly). The jetting assembly was then inserted into the 4" casing and the pump was started. Water circulated down the jetting assembly

agitating and removing sand from the bottom of the well bore and forced it up the annulus to the surface. At the surface the water was discharged from the well into a stock tank where the sand dropped from suspension and the water was recirculated. As penetration proceeded the casing was advanced, by force, into the newly opened hole. Using this procedure the well bore was advanced

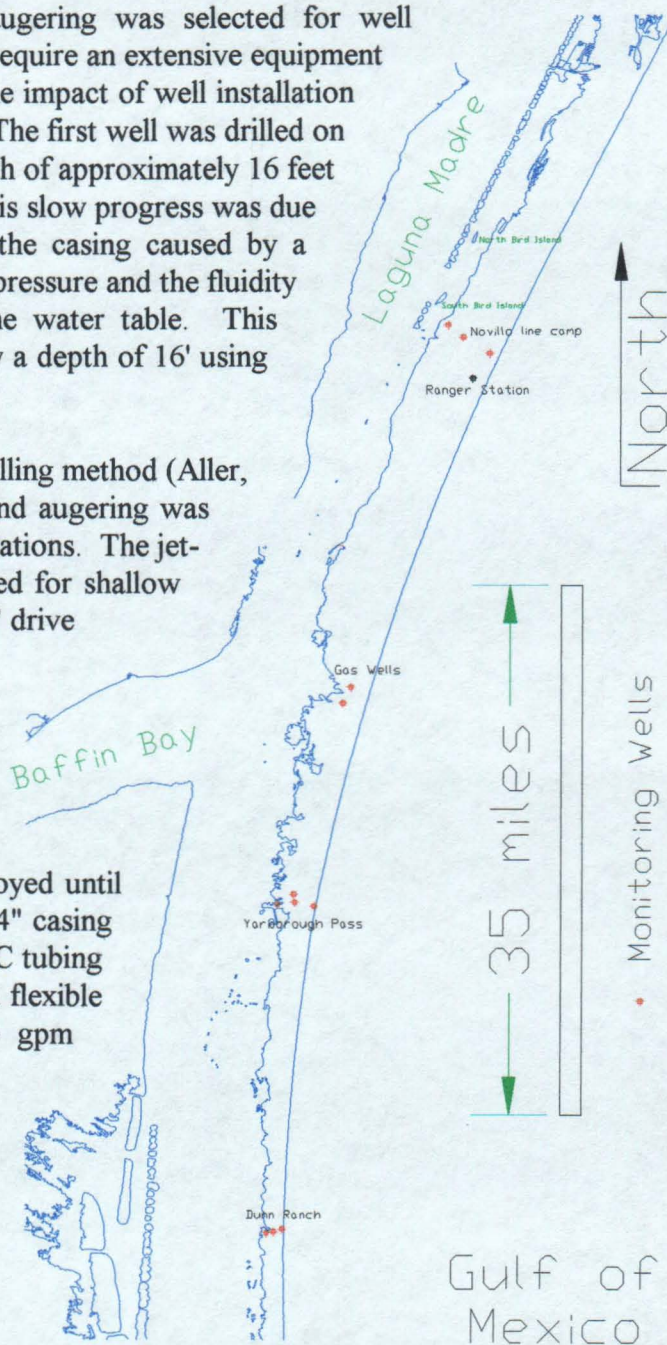


Figure 2. Location of monitoring wells.

Padre Island National Seashore

<u>Well Name</u>	<u>UTM X</u>	<u>UTM Y</u>	<u>Well Location</u>
MW-0-GM	669,871	3,038,541	Novillo line camp, Gulf of Mexico
MW-0-LG	668,049	3,039,156	Novillo line camp, between lagoon and gulf
MW-0-LM	666,665	3,039,135	Novillo line camp, Laguna Madre
MW-15-GM	661,982	3,009,983	Yarborough Pass, Gulf of Mexico
MW-15-LG	660,594	3,010,615	Yarborough Pass, between lagoon and gulf
MW-15-LM	659,495	3,010,081	Yarborough Pass, Laguna Madre
MW-25-GM	660,740	2,992,689	Dunn Ranch, Gulf of Mexico
MW-25-LG	660,171	2,992,556	Dunn Ranch, between lagoon and gulf
MW-25-LM	659,699	2,992,494	Dunn Ranch, Laguna Madre
MW-GW-A6	662,626	3,020,496	American Exploration well A-6
MW-GW-A8/A3	663,170	3,021,333	American Exploration wells A-8 & A-3
MW-15-GF	660,667	3,010,195	Yarborough Pass gas facility

Table 1 Location of Monitoring Wells.

until the casing could not be forced deeper, usually 20-25' below grade (b.g.). At this point, jetting ceased and a 2" monitoring well was installed.

Monitor well installation. Twelve monitoring wells were installed at Padre Island National Seashore between June 12, 1993 and December 16, 1993. Nine of the wells were placed in three transects across the island. On each transect, a well was installed in front of the fore dunes, a second well approximately midway between the Gulf of Mexico and the Laguna Madre, and a third well adjacent to the Laguna Madre shoreline. Three additional wells were installed near active gas production wells to provide access for groundwater quality monitoring in the vicinity. Formation samples were collected at depth intervals of two feet during the installation process and reserved for grain size analysis and identification.

Monitor well completion. The monitoring wells were completed with 2" (0.01" slot) PVC screen from 1-4" above the water table to the total depth of the hole. A riser was installed from the top of the screen to surface plus 1-2' of "stick-up". The screened interval was packed with standard washed and 20/40 screen graded filter sand. Bentonite pellets (3/8") were used to seal the annulus from the top of the screen to the surface. At the surface a cement pad (18"x 18"x 4") was built using Class H cement. The well heads were secured with a 2" locking cap.

Development of each well was made by swabbing and surging the well using a hand bailer or gasoline powered pump. Development continued until well water removed was clear or at least three well volumes had been removed.

Data Collection and Analysis

Water quality data was collected on a monthly basis after completion of the wells. Groundwater from each monitoring well was analyzed for temperature, specific conductance, total hardness, salinity, pH,

and sulfides. Ambient air temperature and water table elevation were also measured at each well site at the time of sampling. Since there is no reliable vertical datum in the Park at this time, all references to groundwater elevation are relative to ground surface at each well and are presented in this report as depth below grade (b.g.).

Methods

Temperature and Specific conductance were measured before bailing the well in order to profile the aquifer by making discrete specific conductance and temperature measurements at one foot depth intervals in the well bore. The Yellow Springs Inc. (YSI) Model 3000 T-L-C Meter, which gives instantaneous readings of the water's specific conductance (either direct or temperature compensated) in the range of 0 to 20 mMHos, or the YSI Model 33 S-C-T Meter, which gives instantaneous readings of specific conductance in the range of 0 to 50 mMHos, were used to make the conductivity measurements.

Both instruments are capable of measuring temperature and were used to acquire air temperature (prior to well entry), and groundwater temperatures at discrete intervals corresponding to specific conductance measurements of the groundwater.

Elevation of the water table was measured to the nearest 0.01 foot using either the YSI 3000 T-L-C or the YSI 33 S-C-T Meter by recording the depth from the top of casing to the measurement point of the conductivity probe when it first registers a value greater than zero (while set on the conductivity range), indicating that it has come in contact with the groundwater.

After completing the temperature/conductivity profile, the monitor wells were purged of at least three well volumes of water before groundwater samples were collected. These samples were used for the measurement of total hardness, pH, and sulfides. Total hardness was determined using the direct reading titration method. Sulfides and pH each used octet comparator methods.

Total hardness was determined using the Hach AL-36DT Kit (Cat. No. 20638), direct reading titration method using a digital titrator. The following procedure (supplied with the kit by the manufacturer) was performed:

1. Attach a clean 180°-delivery tube to a 0.800M EDTA Titration Cartridge. Twist cartridge onto the titrator body.
2. Flush out the delivery tube by turning knob until a few drops of titrant are ejected from the tube. Wipe tip and reset counter to zero.
3. Take a water sample by filling a clean 100-ml graduated cylinder to the 100-mL mark. Pour the sample into a clean 250-mL Erlenmeyer flask.
4. Using the 1-mL calibrated dropper, add 1 mL of Buffer Solution, Hardness 1, and swirl to mix.
5. Add the contents of one ManVer®2 Hardness Indicator Powder Pillow and swirl to mix.

6. Titrate sample with the EDTA standard solution while swirling the flask until the color changes from red to pure blue.
7. Read and record the concentration of total hardness (as mg/L CaCO_3).

Sulfides were tested using the LaMotte Model P-70 test kit. This field kit uses the Pomeroy reagent system with an octet comparator and is capable of measuring aqueous sulfide concentrations in the range of 0.2 to 20.0 ppm S^{2-} . The following procedure (supplied with the kit by the manufacturer) was performed:

1. Fill test tube (0230) to mark with sample water.
2. Add 15 drops of Sulfide Reagent A (4458). Cap and gently invert to mix.
3. Add 3 drops of Sulfide Reagent B (4459). Cap and mix. Wait 1 minute.
4. Use the pipette (0354) to add 1 mL of Sulfide Reagent C (4460). Cap and mix.
5. Insert test tube into Octet Comparator (4457). Record as ppm sulfide (S^{2-}).

pH was determined using the Hach AL-36DT Kit (Cat. No. 20638) colorimetric method. This method is capable of determining pH, within the range of 4.0 to 10.0 standard units, of a water sample to the nearest 0.5 SU increment. The following procedure (supplied with the kit by the manufacturer) was followed:

1. Fill the two glass sample tubes to the 5-mL mark. It is imperative that the tube be rinsed completely free of any solutions that may have been used previously.
2. Add six drops of Wide Range 4 pH Indicator Solution to one of the tubes and swirl to mix.
3. Insert the prepared sample in the right opening of the color comparator.
4. Insert the tube of untreated water sample in the left opening of the color comparator.
5. Hold the color comparator up to a light such as the sky, a window, or a lamp and view through the two openings in the front. Rotate the color disc until a color match is obtained. Read the pH through the scale window.

Salinity was determined using a Spartan Model A366ATC Salinity Hand Refractometer with automatic temperature correction. This instrument is capable of measuring salinity to the nearest part per thousand (ppt) using the following procedures (supplied by the manufacturer):

1. Hold refractometer horizontally and point it towards a light source. Look into the eyepiece and rotate it until the image of the scale is clear.
2. Place two drops of sample to be tested on the prism, and close the daylight plate.
3. With the daylight plate and prism facing a light source, look into the eyepiece and note the point at which the blue field crossed the scale. The correct

measurement, in parts per thousand, of the concentration of the salt is read at this point.

4. When finished, carefully clean the sample from the prism with a wet tissue paper.

Groundwater Quality

Groundwater quality varied significantly over the study area with dissolved solids parameters exerting the most influence over water chemistry. In the following comparisons, MW-15-GF, the monitor well located near a gas production facility at Yarborough Pass, has been substituted for MW-15-LM which was vandalized early in the study. Although MW-15-GF is not as far west as MW-15-LM, it displays groundwater chemistry similar to the other wells near the Laguna Madre.

Specific conductance profiles defined distinct zones of water quality within many of the wells. A transition from water of low specific conductance (fresh) to water of high specific conductance could be observed in every well except MW-25-GM and MW-0-LG, at some time during the study period indicating a low salinity (fresh water) layer exists above more saline water at depth. MW-25-GM and MW-0-LG had relatively low specific conductance values throughout the screened interval for the entire study period, suggesting that fresh, or low salinity water, layer is thicker at these sites.

Salinity measurements (**Figure 3**) ranged from a maximum of 95‰ on 2/22/94 in MW-0-LM to less than 1‰ in many of the other monitoring wells on the Island. Salinity in the wells along the Gulf of Mexico beach (MW-0-GM, MW-15-GM, and MW-25-GM) were consistently below 3‰ and rarely exceeded 5‰ in the wells installed near the center of the Island (MW-0-LG, MW-15-LG, and

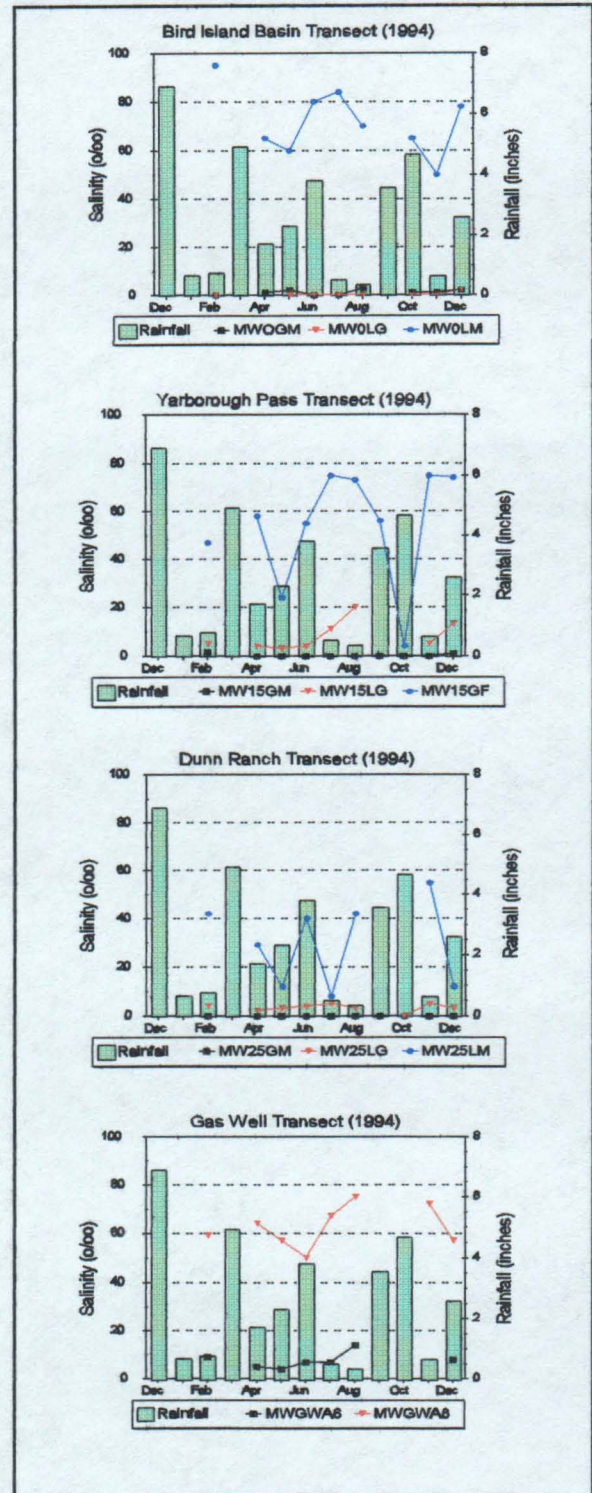


Figure 3 Monthly groundwater salinity values in monitoring wells for 1994. Monthly rainfall data collected at the ranger station.

MW-25-LG). High salinity was noted only in the wells located along or near the Laguna Madre (MW-0-LM, MW-15-GF, MW-25-LM, MW-GW-A6, MW-GW-A8, MW-15-LG). On several occasions salinity was determined for the adjacent Laguna Madre waters while sampling the monitoring wells. These measurements were generally near 40‰.

Sulfide concentration values (Figure 4) ranged from 20 mg/L (upper limit of test kit) to less than the minimum detection limit of 0.2 mg/L-S⁼. Average value for the monitoring wells over the study period was 5.75 mg/L. Sulfide concentrations for individual wells showed little variation over the study period with the exception of MW-15-LG and MW-GW-A6. These wells had markedly higher sulfide concentrations during the dry months of July and August. Average sulfide concentrations for wells along the Gulf of Mexico shore line (MW-0-GM, MW-15-GM, and MW-25-GM) were consistently below detection limits. Sulfide concentrations for the wells along the Laguna Madre shore (MW-0-LM, MW-15-LM, and MW-25-LM) and MW-15-GF (near Yarbrough Pass gas facility) averaged 13.74 mg/L with MW-0-LM consistently reaching the maximum quantifiable limit of the test kit.

Total hardness values (Figure 5) varied from a low of 100 mg/L -CaCO₃eq. in MW-0-LG on 11/25/94 to a high of 19670 mg/L -CaCO₃eq. in MW-25-LM on 11/25/94. Although the average total hardness was 4260 mg/L, the wells located along the Gulf of Mexico shore averaged on 381 mg/L and the wells located in the center of the island averaged 1552 mg/L for the study period. The high concentration of dissolved solids as reflected by salinity measurements (Figure 3) in monitoring wells along the Laguna Madre is consistent with the high concentration of Mg⁺⁺ and Ca⁺⁺ ions which comprise the total hardness measurement.

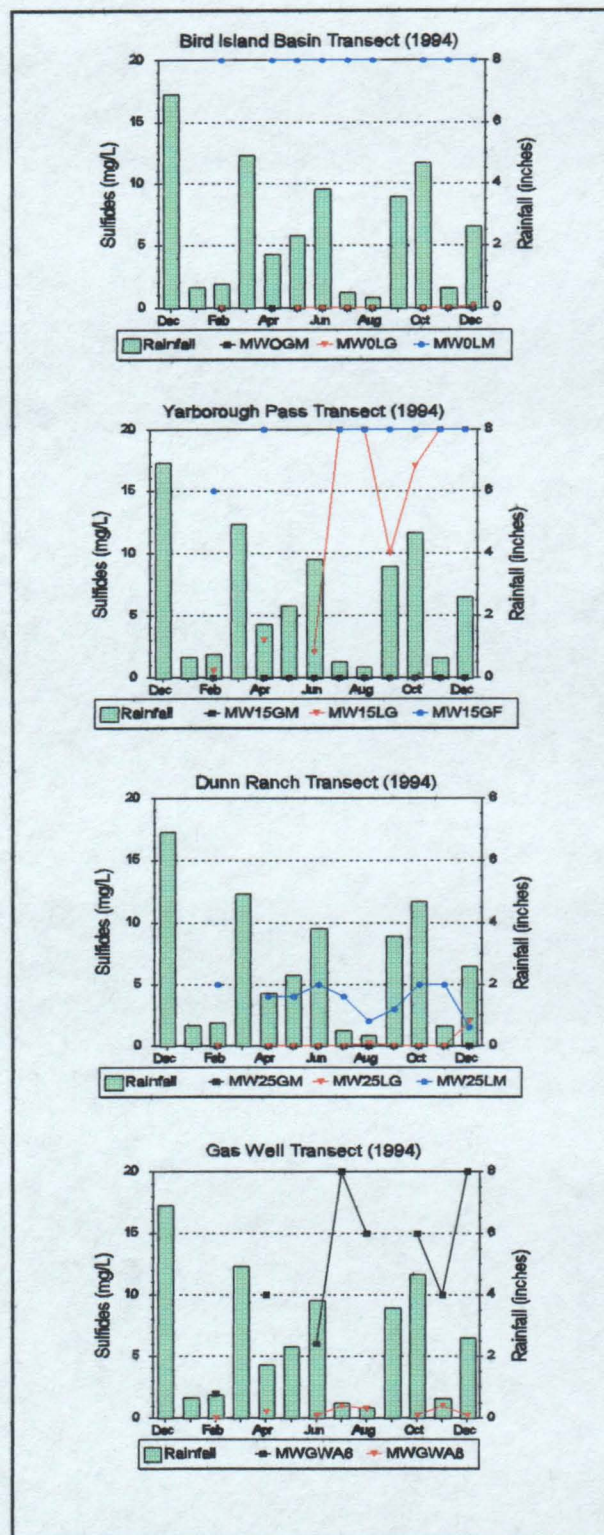


Figure 4 Monthly groundwater sulfide values in monitoring wells for 1994. Monthly rainfall data was collected at the ranger station.

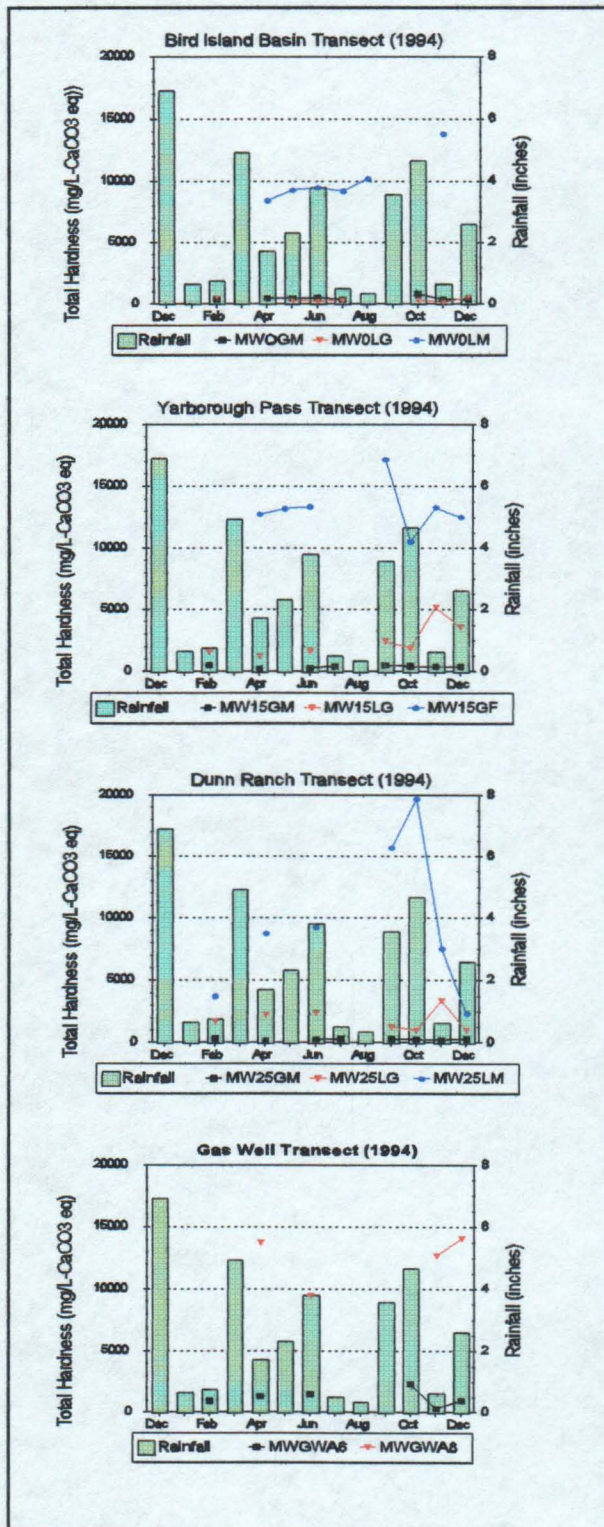


Figure 5 Monthly groundwater total hardness values in monitoring wells for 1994. Monthly rainfall data was collected at the ranger station.

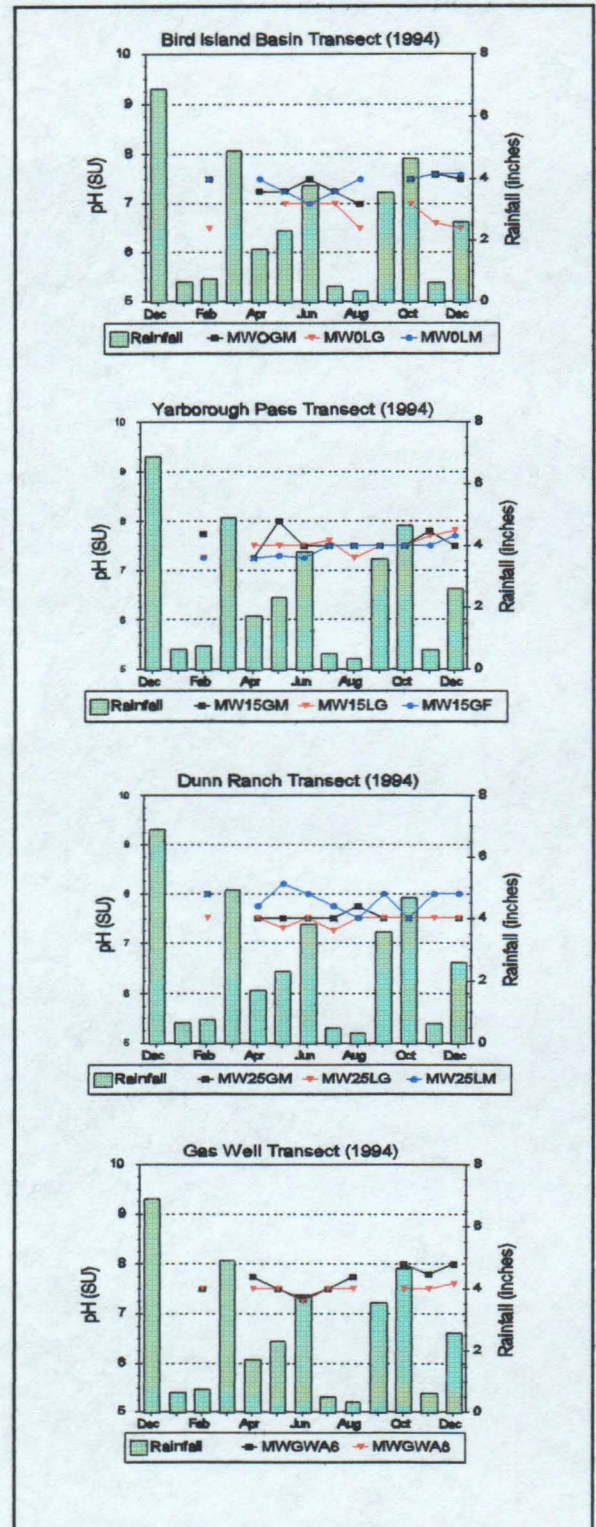


Figure 6 Monthly groundwater pH values in monitoring wells for 1994. Monthly rainfall data was collected at the ranger station.

Hydrogen ion concentration or pH (Figure 6), measured in standard units (SU), averaged 7.48 SU for all monitoring wells over the study period. The lowest pH recorded, 6.50 SU, was observed in monitoring well MW-0-LG on 2/24/94. This low value is characteristic of rain water and is likely due to the influence of a freshwater pond lying approximately 150' to the east. Other than MW-0-LG the pH values remained near 7.50 SU with only minor variation.

Groundwater elevation (Figure 7) fluctuated in the monitoring wells from as little as 1.10' in MW-15-GM and MW-0-LM to as much as 3.04' in MW-15-LG over the study period. Depth to the water table varied from 10.85' below grade in MW-25-GM to 0.33' above grade in MW-25-LG which stood in several inches of surface water at the time.

Results

The data currently available indicates three zones of water quality on the island, a hypersaline zone, a fresh water zone, and an oceanic or sea water zone. The hypersaline and freshwater zones are suggested by salinity measurements that, when averaged by well transect position (Figure 8), clearly demonstrate two zones of water quality within the water table aquifer.

The high salinities observed in monitoring wells MW-0-LM and MW-15-LM appear representative of hypersaline episodes in the Laguna Madre. These well salinities, as high as 95‰, are comparable to the salinity of groundwater at the wind tidal flats south of Baffin Bay as measured by Long and Gudramovics (1983).

The sea water zone is evident from specific conductance measurements taken near the bottom of the monitoring wells located along the

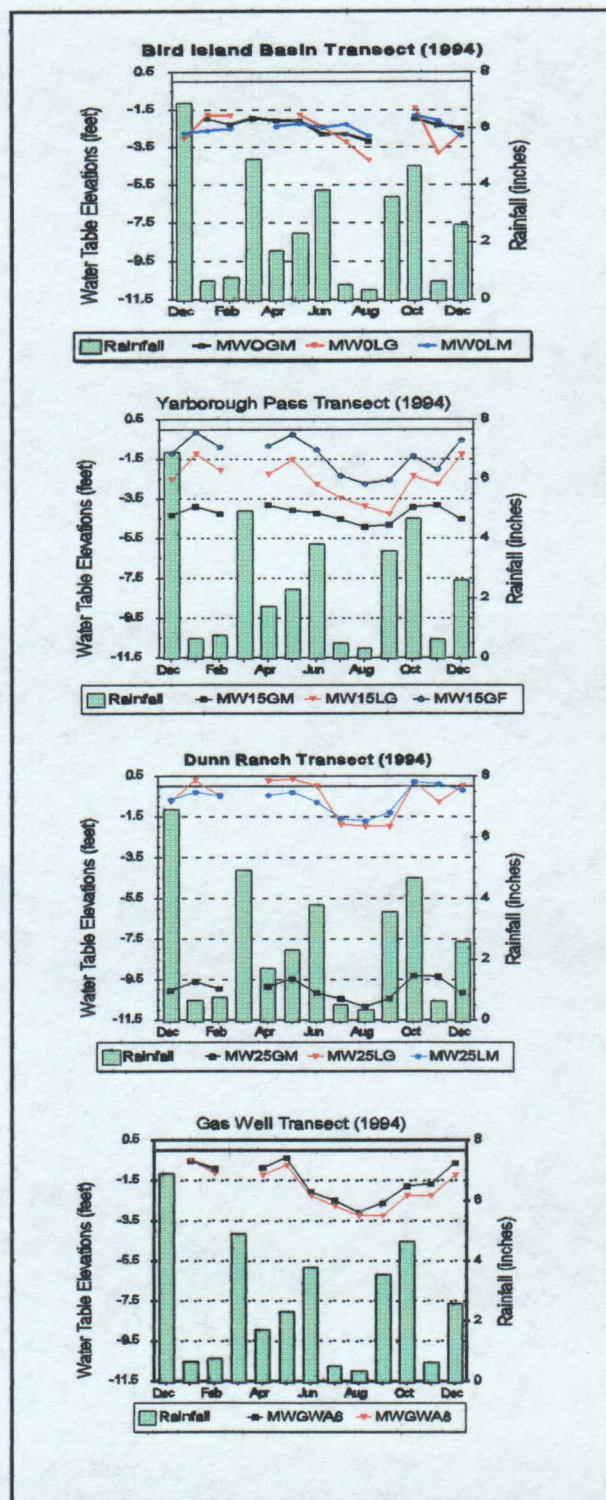


Figure 7 Monthly groundwater levels in monitoring wells for 1994. Water levels are reference to the well pad. Rainfall data was collected at the ranger station.

Gulf of Mexico beach. The data are insufficient to further characterize this zone.

The fresh water zone generally contains water of less than 2‰ salinity, hardness less than 500 mg/L and specific conductivities less than 1.00 mS/cm (mSiemens/cm) or roughly 700 mg/L total dissolved solids (TDS). Hydrogen ion concentration in the fresh water zone is in the pH range of 6.5 to 7.5 SU. Using TDS values (calculated from specific conductivity) as a reference, guidelines presented by Davis and DeWiest (1966) classify water of less than 1000 mg/L TDS as fresh water and suggest that water of this quality is suitable for most domestic and industrial uses, although individual ion concentrations should be used to ultimately determine a water's suitability to any particular application. Water below 3000 mg/L TDS can be used for most agricultural applications including livestock (Alexander et al. 1964).

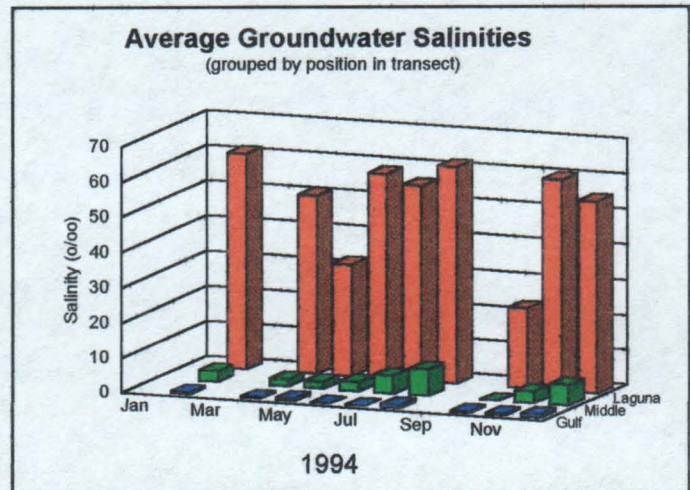


Figure 8 Monthly groundwater salinity values averaged for wells having similar position on each transect. All wells located along the Laguna Madre, for example, are averaged and represented above in the row labeled Laguna.

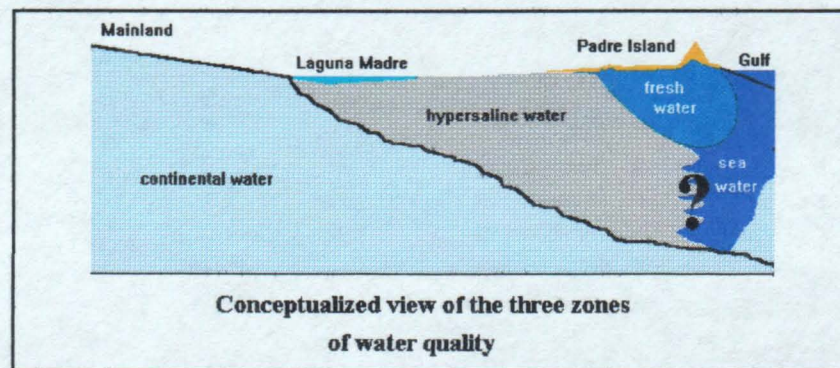


Figure 9 The geological interpretation is based loosely on Shideler (1986). Note the uncertainty in the area below the freshwater zone and that the vertical scale has been greatly exaggerated.

Particle Size Analysis

While installing each monitor well, representative samples of the penetrated formation were collected at two foot intervals from surface to the total depth of the well. These samples were subsequently analyzed for particle size distribution using standard procedures as outlined by Folk (1974) using a

Tyler Industrial Products Ro-Tap Testing Sieve Shaker and a set of nested U.S.A. Standard Series sieves arranged at a $1/4 \phi$ interval.

Particle size distribution for each sample was evaluated using the statistical indicators: mean, median, and mode (Folk 1974), and the graphical indicators: kurtosis and skewness. Effective particle size (Hazen 1911) was also described. Analysis for individual samples and their cumulative curves may be found in Appendix II through Appendix XII. The most descriptive indicators, kurtosis, skewness, and mode are presented graphically in **Figure 10**, **Figure 11**, **Figure 12**, and **Figure 13**.

Well Name	Sample Depth (ft)
MW-15-LM	10
MW-15-LM	12
MW-15-LM	14
MW-15-LM	16
MW-15-LM	18
MW-15-LM	20
MW-15-LG	10
MW-15-LG	12
MW-15-LG	14
MW-15-LG	16
MW-15-LG	18
MW-15-LG	20

Table 2 Sample intervals with high clay content.

In order to allow comparisons of particle size distribution between various depths in a well, and between wells, skewness and kurtosis were evaluated using a particle size range of -1.75ϕ to 4.50ϕ . This range was selected because it encompassed the entire range of particle sizes greater than 4.50ϕ found in the monitoring wells.

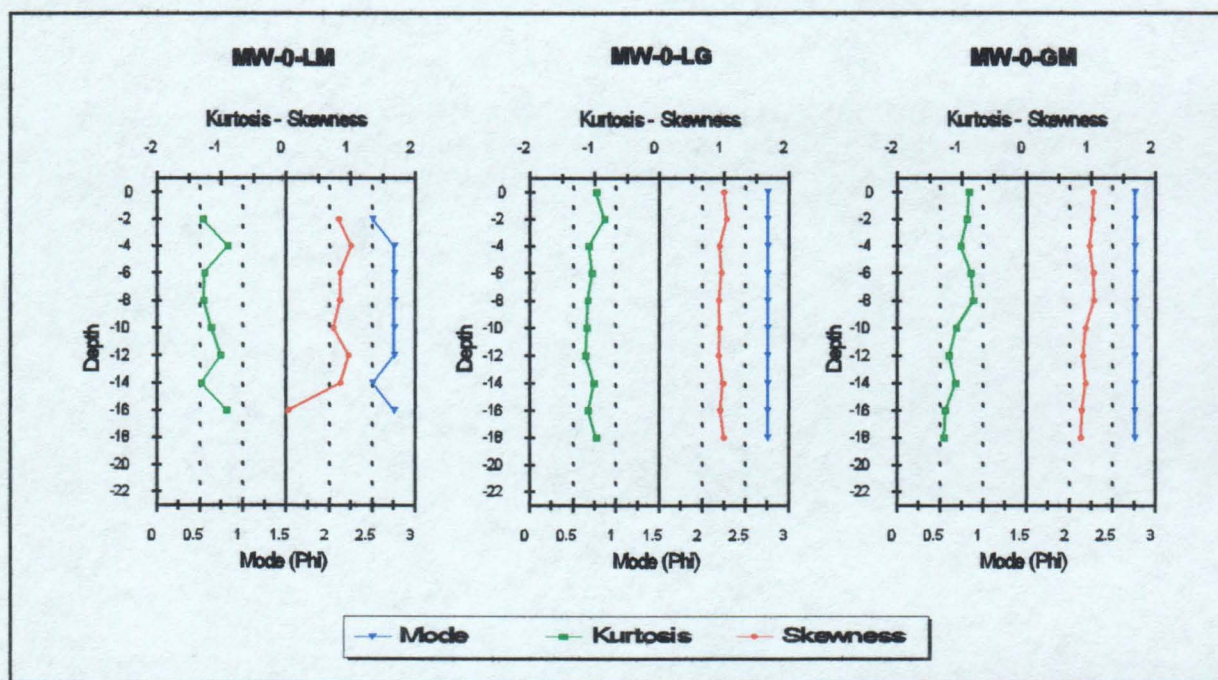


Figure 10 Major statistical indicators from particle size analysis of samples retrieved from well borings on the Novillo line camp transect, near Bird Island Basin.

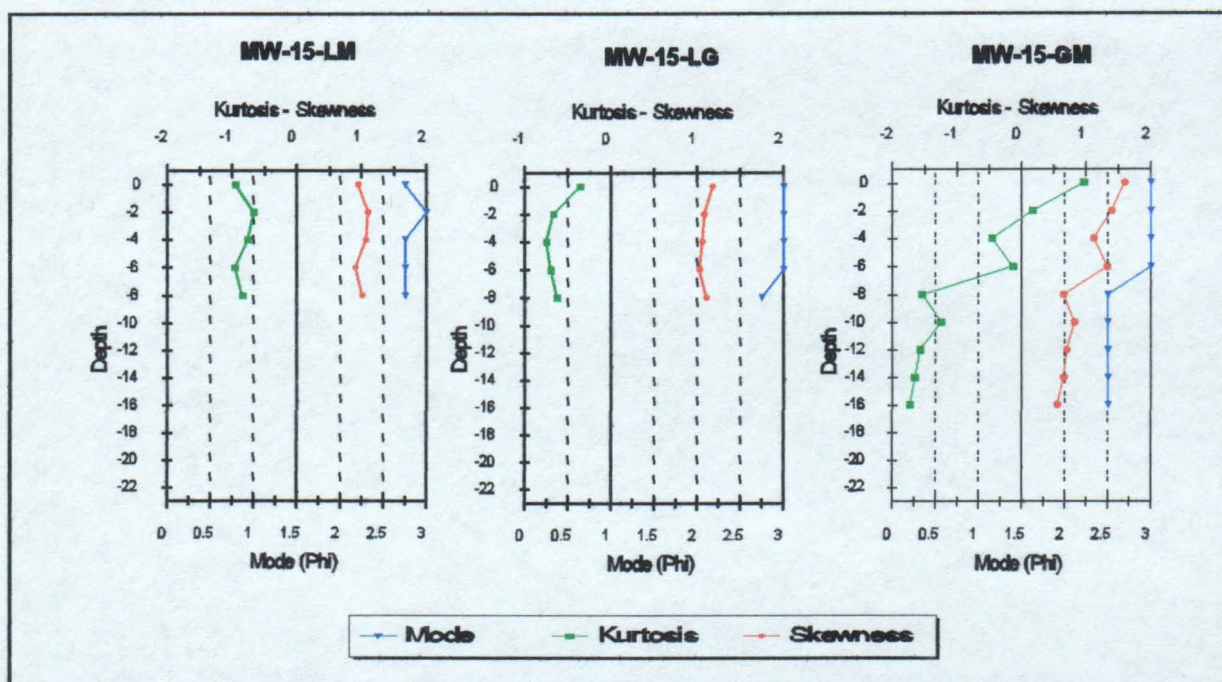


Figure 11 Major statistical indicators from particle size analysis of samples retrieved from well borings on the Yarbrough Pass transect, near mile marker 15.

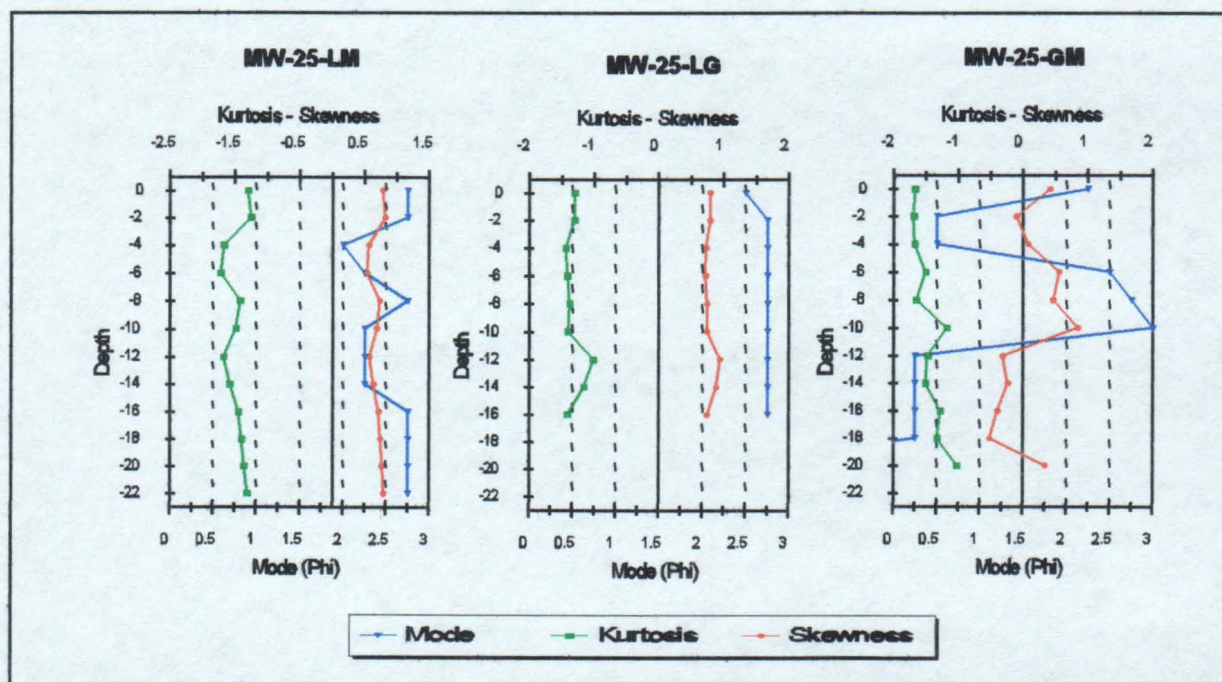


Figure 12 Major statistical indicators from particle size analysis of samples retrieved from well borings on the Dunn Ranch transect, near the 25 mile marker.

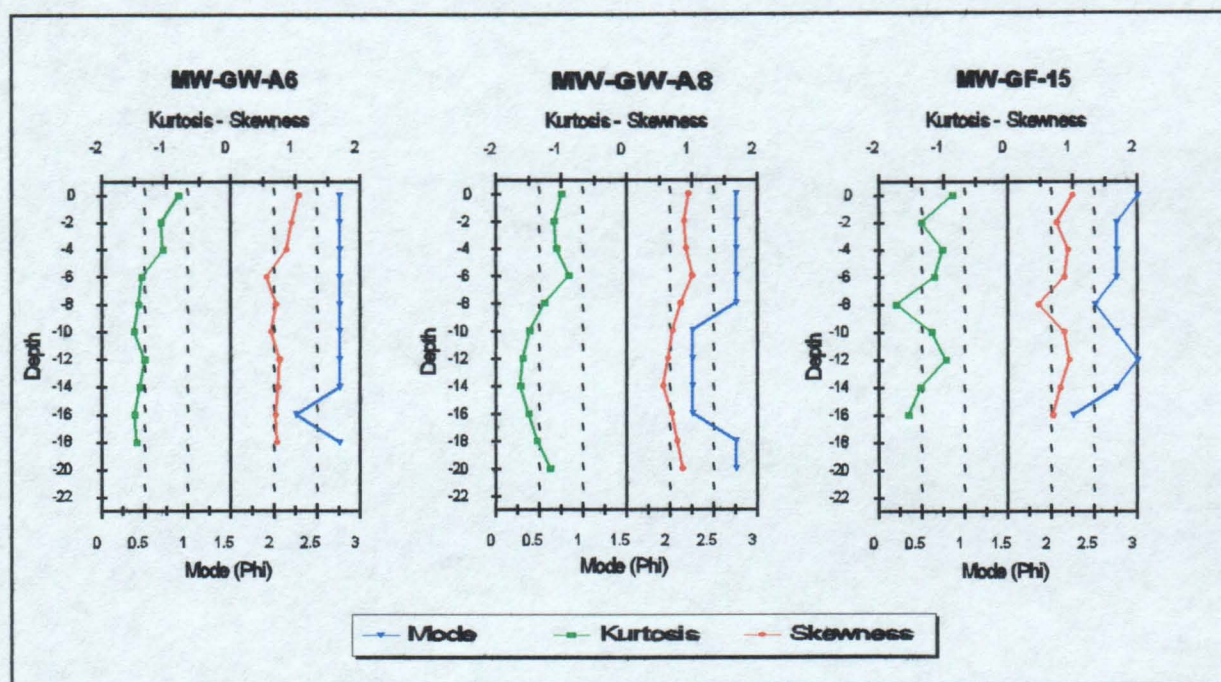


Figure 13 Major statistical indicators from particle size analysis of samples retrieved from a well boring near a gas production facility on the Yarbrough Pass transect and from two well borings near actively producing gas wells.

Mean and median were evaluated for the interval of sieves in which sediments were retained for any individual analysis. Mode is defined as the most frequently occurring particle size (Folk 1974). None of the samples were analyzed for particle size distribution smaller than 4.50ϕ other than to attribute the particles passing through the 4.50ϕ sieve to the clay fraction of the sample. Since no size analysis was made of the clay fraction, statistical analyses of samples with significant amounts of clay will not be representative. Therefore samples with high clay content were not analyzed for particle size distribution (**Table 2**).

The most influential factor affecting the mode was the quantity of shell fragments present in the sample. This is particularly evident in MW-25-GM (**Figure 12**) where extreme fluctuations in mode with depth may be interpreted as layers of shell when the mode is coarse and as layers of sand where mode is fine. These shell layers may coincide with now buried washover fans or buried shell beaches (MW-25-LM and MW-25-GM in **Figure 12**).

Monitor wells MW-15-LM and MW-15-LG displayed high clay content in samples collected below 8' in depth. This would seem to correspond to a transitional period when this part of Padre Island began to prograde rapidly toward the Laguna Madre beginning in the late 1800's (Prouty and Prouty 1989) however, other wells installed along the Laguna Madre in this study and in other studies (Amdurer and Land 1982) have penetrated sediments that are primarily sand, although some thin clay

layers were observed. Sufficient data are not currently available to evaluate the significance of this phenomenon and at this time we only wish to draw attention to its anomalous existence.

Aquifer Features and Properties

The aquifer appears to extend the length of the study area (from the Bird Island Basin transect to the Dunn Ranch transect) and is thin near the Laguna Madre shore and gradually thickens toward the center of the island. On the Gulf of Mexico shoreline the aquifer thickens rapidly toward the center of the island and is probably the thickest below the western edge of the main dune complex.

Aquifer type. The aquifer penetrated by the monitoring wells in this investigation is an unconfined or water table aquifer made up of marine/eolian sand deposits of Holocene age deposited on the Pleistocene age Beaumont formation in a depositional environment similar to Mustang Island lying immediately to the north and described by Shideler (1986). The aquifer material is a brown, very fine grain, silty, unconsolidated sand with occasional layers of shells and grayish clay. Clay layers were generally only a few inches in thickness. Two wells along the Laguna Madre (MW-15-LM and MW-15-LG, **Figure 20**) were predominantly clay from a depth of 10' to total depth of 19'. Within this section of clay were several thin horizons (0.25" thick) of calcareously cemented sand and shells.

Aquifer recharge. The source of water for this aquifer is precipitation. Annual precipitation at Padre Island National Seashore from the year 1987 through 1994 ranges from 16.66 inches in 1988 to 44.53 inches in 1992. Average annual precipitation is 30.95 inches. Aquifer response to a precipitation event occurring near the end of December 1993 can be seen in **Figure 14**. The increase in groundwater elevation at MW-15-GF in January 1994 is in response to the rainfall event and the subsequent drop in groundwater elevation is in response to the following two months of light precipitation. Aquifer response to the low rainfall of July and August is evident in **Figure 7**.

Hydraulic conductivity. Hydraulic conductivity ranges (K_{max} , K_{min}) were calculated from particle size analysis data using the Hazen Method (Hazen 1911) for each sediment sample collected during well installation (**Figure 15**, **Figure 16**, **Figure 17**, and **Figure 18**). In sections of high clay content, hydraulic conductivity was not calculated due to limitations of the Hazen Method. Values for hydraulic conductivity ranged from 2.2 ft/day to 50.01 ft/day.

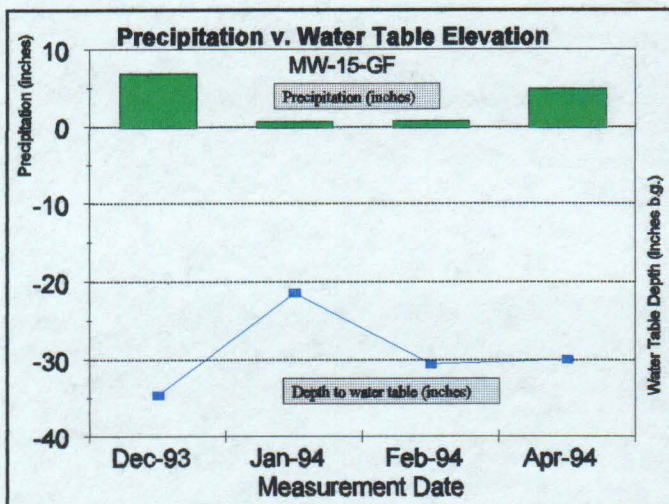


Figure 14 Response of water table to a precipitation event occurring near the end of December 1993.

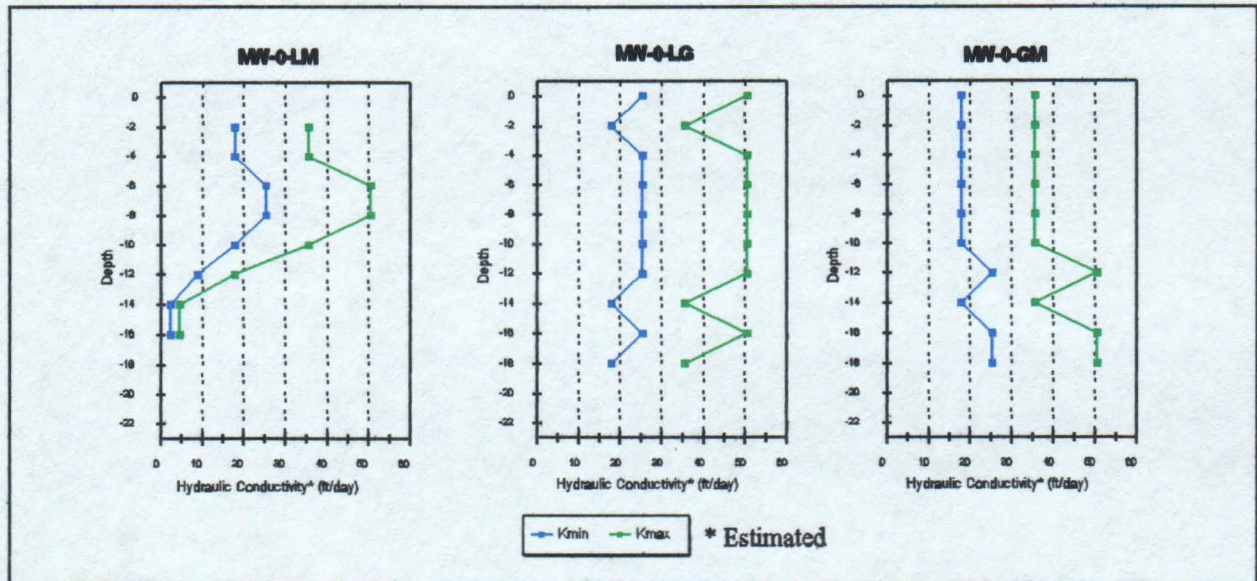


Figure 15. Estimated hydraulic conductivity (K) calculated using the Hazen Method (Hazen 1911) for monitoring wells along the Novillo line camp transect. $K_{\max}$ was calculated using $C=80$ and $K_{\min}$ was calculated using $C=40$.

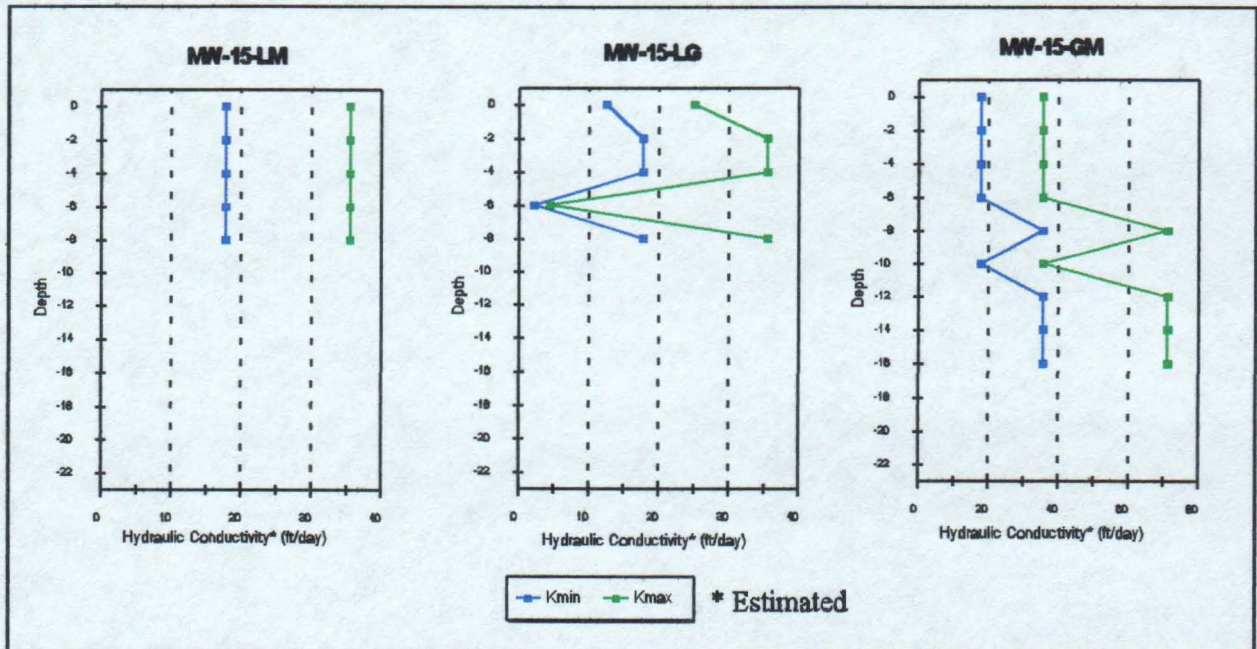


Figure 16. Estimated hydraulic conductivity (K) calculated using the Hazen Method (Hazen 1911) for monitoring wells along the Yarborough Pass transect. $K_{\max}$ was calculated using $C=80$ and $K_{\min}$ was calculated using $C=40$.

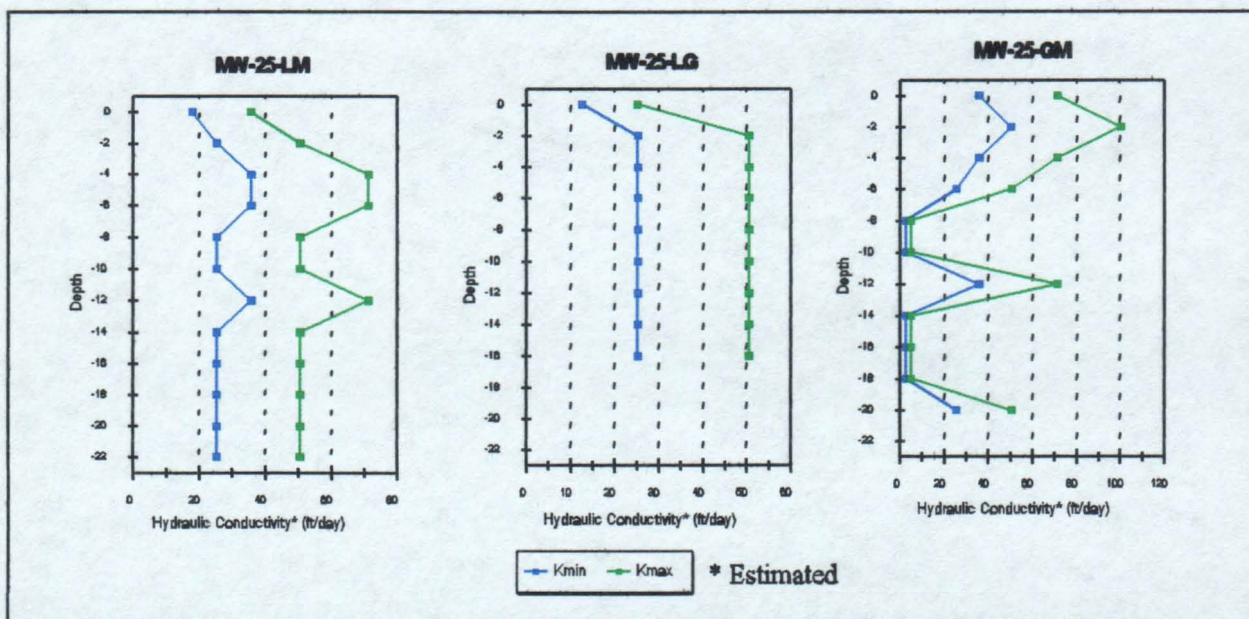


Figure 17. Estimated hydraulic conductivity (K) calculated using the Hazen Method (Hazen 1911) for monitoring wells along the Dunn Ranch transect. $K_{\max}$ was calculated using $C=80$ and $K_{\min}$ was calculated using $C=40$.

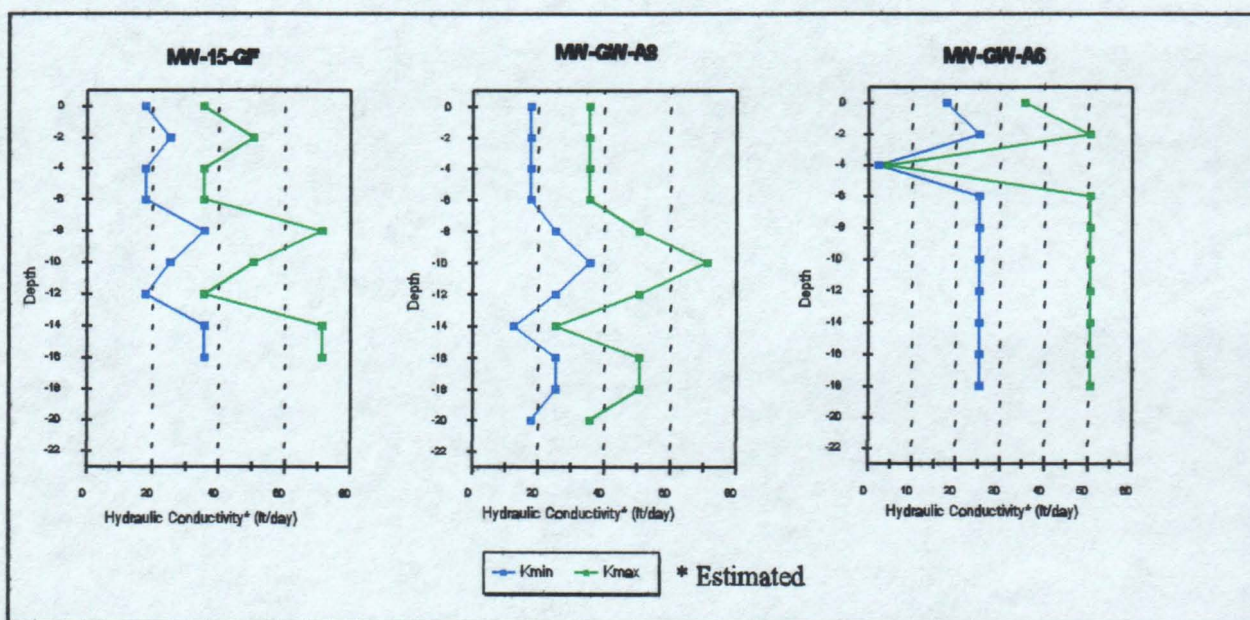


Figure 18. Estimated hydraulic conductivity (K) calculated using the Hazen Method (Hazen 1911) for monitoring wells installed near gas production facilities. $K_{\max}$ was calculated using $C=80$ and $K_{\min}$ was calculated using $C=40$.

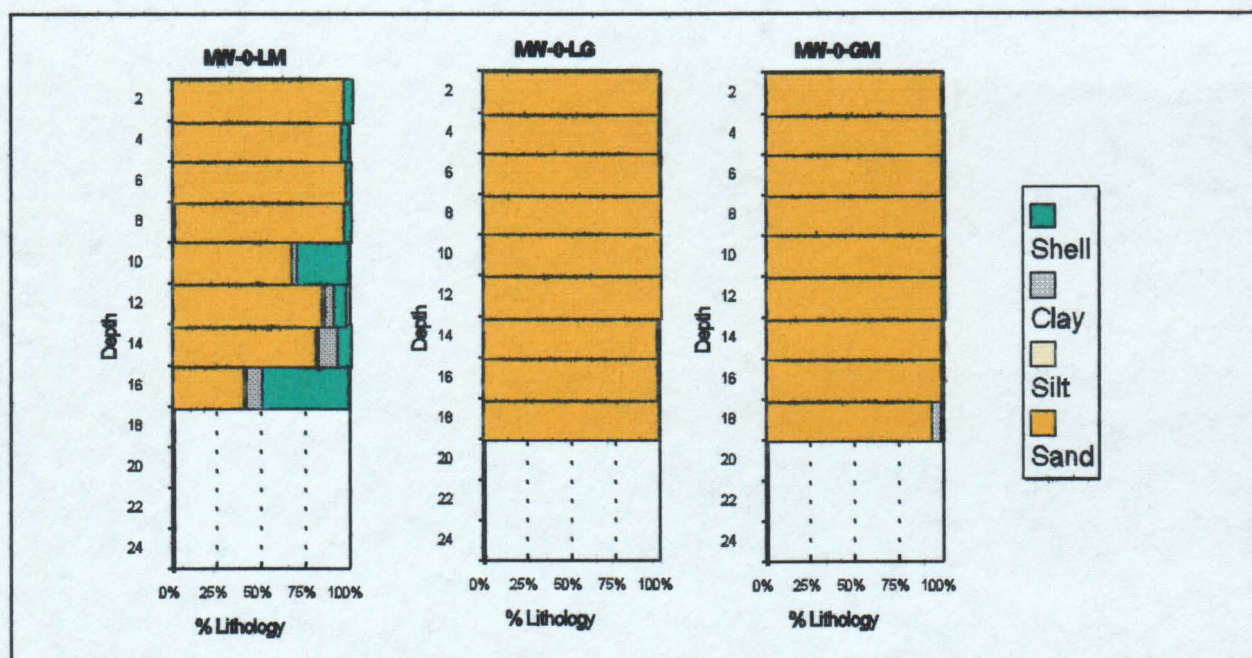


Figure 19. Lithologic log of sediments penetrated while installing the monitoring wells along the Novillo line camp transect.

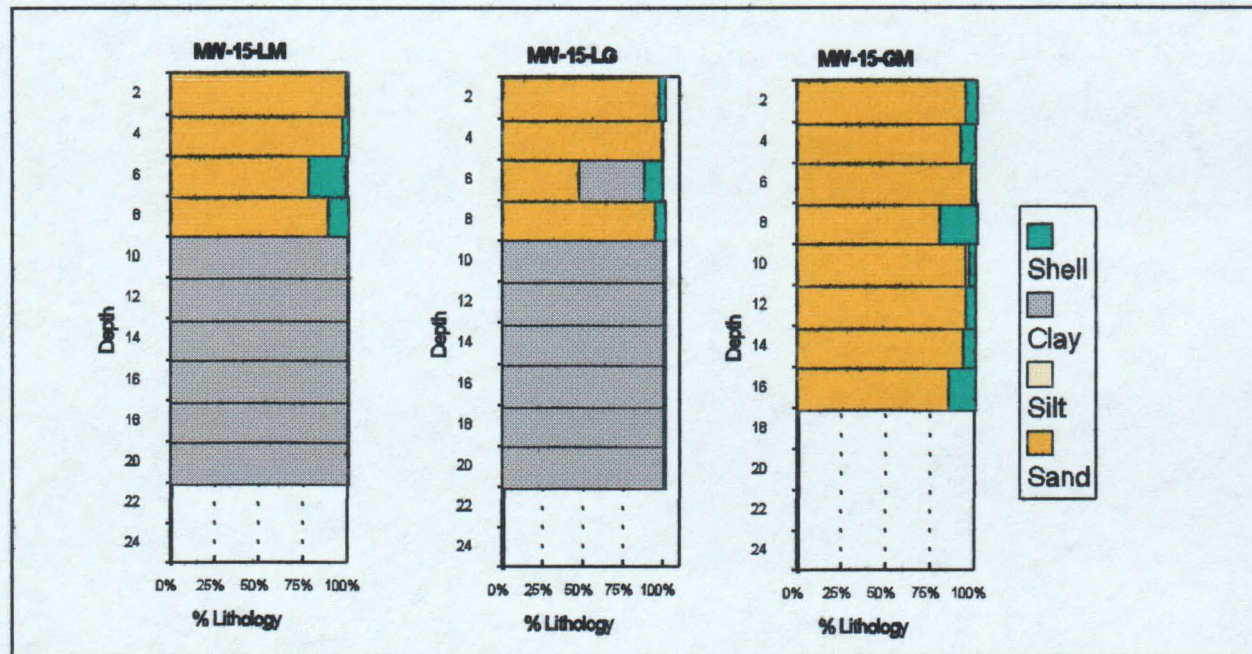


Figure 20. Lithologic log of sediments penetrated while installing the monitoring wells along the Yarborough Pass transect.

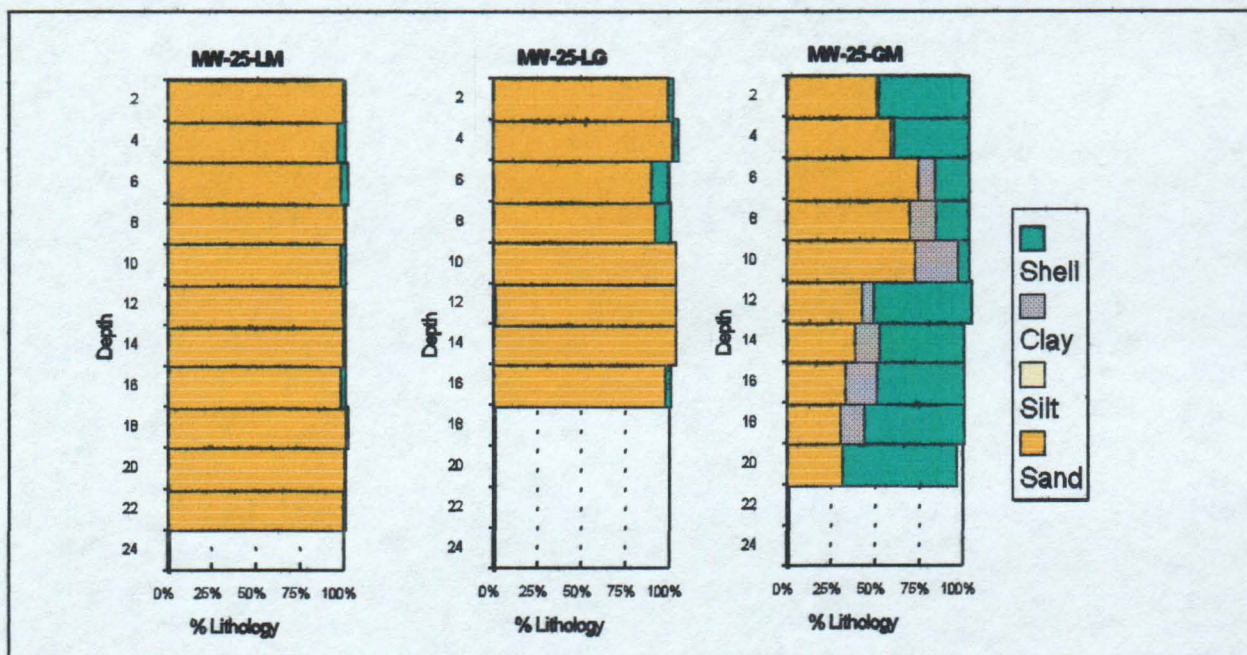


Figure 21. Lithologic log of sediments penetrated while installing the monitoring wells along the Dunn Ranch transect.

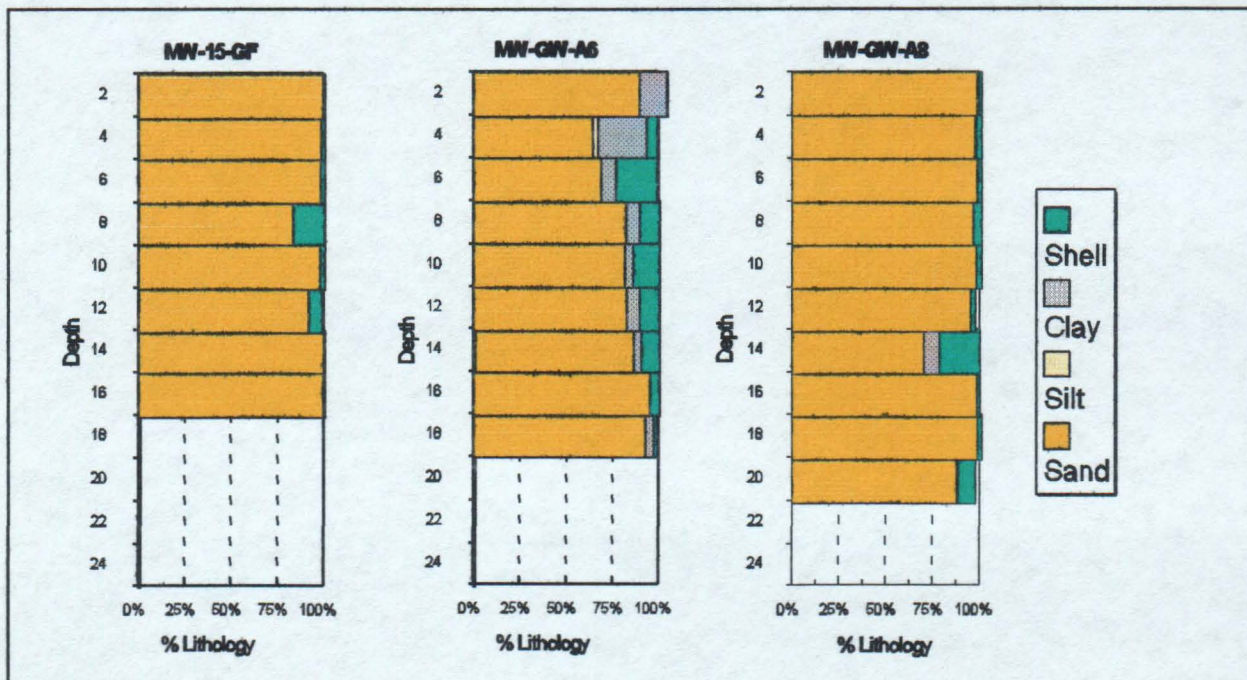


Figure 22. Lithologic log of sediments penetrated while installing the monitoring wells near several gas production facilities.

Strata with some clay content (**Figure 21**, MW-25-GM) show very low hydraulic conductivities even through intervals with high shell content (**Figure 17**, MW-25-GM at 8', 10', 14', 16', and 18' depths). This reflects the effect of fine particles on the Hazen Method calculations, and their overriding influence on reducing effective permeability.

Conclusions and Recommendations

Installation and sampling of the shallow monitoring wells at the Padre Island National Seashore has indicated that a freshwater aquifer exists on the island and appears to be independent of the mainland aquifers and separated from them by the hypersaline waters of the Laguna Madre. The primary source of recharge for the aquifer is from precipitation. The duration, frequency and intensity of precipitation events have an almost immediate effect on the water table elevation. Monitoring of precipitation occurs at the Park Headquarters, however additional locations in the Park would be useful in defining the spatial variation of groundwater fluctuations on the island.

The thickness of the freshwater layer in the water table aquifer was observed in the wells along the Gulf of Mexico and the Laguna Madre. Specific conductance profiles of the undisturbed well water suggest that the freshwater layer is thin along the Laguna Madre side and gradually thickens toward the center of the island. The freshwater layer thickens rapidly from the Gulf of Mexico beach toward the center of the island. The exact thickness of the freshwater is difficult to determine from current data. Modeling can be used to develop a more rigorous determination of freshwater thickness and flow patterns. However, orthographic elevations, a critical element in the models, have not yet been determined for the monitoring wells. Until this is resolved, a more comprehensive interpretation of the vertical depth and shape of the aquifer is not possible.

Further investigation is recommended in several areas:

Soil samples should be collected and analyzed for Total Petroleum Hydrocarbons (TPH) in the vicinity of MW-GW-A6, where a hydrocarbon odor was noted during well installation, to determine whether hydrocarbon contamination exists at this site and identify its source.

Waters of high density would buoy the freshwater lens higher than seawater of normal salinity. Thus, determination of the migration and fate of the hypersaline (high density) waters of the Laguna Madre below the island would assist in developing flow patterns and freshwater thicknesses. This would require data from several deep piezometers near the center of the island.

The acquisition of data from slug or pumping tests will enhance groundwater modeling results.

Additional monitoring wells or borings should be installed in the shallow (water table) aquifer in the area of the MW-15-LM and MW-15-LG to investigate the unusual mud layers found in this area.

Monitoring wells should be installed on at least one more transect further south (40 mile marker) to extend the investigation into an area that has previously been the subject of geochemical studies (Land and Gudmorovics 1983).

Acknowledgements

We would like to acknowledge Christopher McKinley and Steven Gibson of Texas A&M - Corpus Christi for installing the monitoring wells and for sampling monthly to collect the chemical and hydrologic data from the wells. Padre Island National Seashore personnel, John Miller, Sean Baker, Darrell Echols, and Paul Eubanks gave us invaluable assistance and logistical support with well installation and monitoring, and with locating the wells using the Seashore's GPS system. Additionally we would like to thank Jennifer Prouty of the Center for Water Supply Studies for her assistance in report preparation and geological interpretation, and Adolfo Romero of Texas A&M - Corpus Christi for performing extensive particle size analysis and lithologic identification of the drilled samples.

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Appendices

Appendix I.
Well completion reports

Well Name: MW-0-GM

Date Drilled: 08/07/93

Well installed by: Chris McKinley, Pam Wood

Location: 1.2 miles south of the northern Malaquite beach barrier.

UTM Y 3,038,541.42

UTM X 669,871.31

Drill method: Hydraulic jetting

Total Depth (ft. below grade): 22.44

Top of casing (ft. above grade): 2.92

Top of Screen (ft. below grade): 1.80

Total screen length (ft): 20.00

Top of sand pack (ft. below grade): 1.50

Total water used to drill: 150 gals.

Type of water used to install well: Salt (gulf)

Total volume of sand used: 45 cans (11.25 gal)

Total volume of bentonite used: 4 cans (1 gal)

Depth to water table (ft. below grade): 2.75

Geologic description of well cuttings:

Surface: Sand: fine to medium grain, clean, well sorted.

0-2' Silt: light brown, very well sorted, subangular. Capillary fringe.

2-4' Silt: 95% light brown, very well sorted, subangular. Shell fragments: 5%.

4-6' Sand: light brown, silty to very fine grain, well sorted, subrounded.

6-8' Sand: light brown, silty sand to very fine grain, very well sorted, subrounded.

8-10' Sand: light brown, very fine grain to silty, well sorted, subrounded. Trace of shell fragments.

10-12' Sand: 95% light brownish grey, very fine grain to silty, well sorted, subrounded to subangular. Shell fragments: 5%.

12-14' Sand: light brownish grey, very fine grain to silty, well sorted, subrounded. Very little returns.

14-16' Sand: light brown, very fine to silty, well sorted, subrounded to subangular.

16-18' Sand: light brown, very fine to silty, well sorted, subrounded to subangular.

18-20' Sand: light brown, very fine to silty, well sorted, subrounded.

20-22' Silt: light brown, well sorted, subangular. Hit hard spot, unable to jet further.

TD: 22.44'

Comments on well installation: No problems encountered. Very easy to drill with excellent results.

Well development date: 12/02/93

Volume of water removed: 45 gals

Well Name: MW-0-LG

Date Drilled: 09/25/93

Well installed by: Chris McKinley, Pam Wood

Location: 100' south of Bird Island Basin road, 100' west of Pond

UTM Y 3,039,156.88

UTM X 668,049.76

Drill method: Hydraulic jetting

Total Depth (ft. below grade): 21.13

Top of casing (ft. above grade): 1.08

Top of Screen (ft. below grade): 1.33

Total screen length (ft): 19.46

Top of sand pack (ft. below grade): 1.25

Total water used to drill: 180 gals

Type of water used to install well: fresh (from pond)

Total volume of sand used: 95 cans (23.75 gal)

Total volume of bentonite used: 6 cans (1.5 gal)

Depth to water table (ft. below grade): 2.25

Geologic description of well cuttings:

Surface: Sand, light brown, well sorted. Clean with occasional roots

0-2' Sand: light brown, very fine grain, well sorted, subrounded.

2-4' Sand: light brown, very fine grain, slightly silty, well sorted, subrounded.

4-6' Sand: light brown, very fine grain, well sorted, subrounded.

6-8' Sand: light brown, very fine grain, well sorted, subrounded.

8-10' Sand: light brown, very fine grain to silty, well sorted, well sorted, subrounded.

10-12' Sand: light brown, very fine grain to silty, well sorted, subrounded.

12-14' Sand: light brown, very fine grain to silty, well sorted, subrounded.

14-16' Sand: light brown, very fine grain to silty, well sorted, subrounded.

16-18' Sand: light brown, very fine grain to silty, well sorted, subrounded.

18-20' Sand: light brown, very fine grain to silty, well sorted, subrounded.

TD: 21.13'

Comments on well installation: Had washout at 18+ ft. Drove to Alice for 20/40 sand.

Complete well on 09-26-93.

Well development date: 11/24/93

Volume of water removed: 12 gals.

Well Name: MW-0-LM
Date Drilled: 09/12/93
Well installed by: Chris McKinley, Pam Wood
Location: At end of BIB road on waters edge 100' north of turn (behind dune).
UTM Y 3,039,135
UTM X 666,665
Drill method: Hydraulic jetting
Total Depth (ft. below grade): 15.20
Top of casing (ft. above grade): Not available at this time.
Top of Screen (ft. below grade): 1.00
Total screen length (ft): 13.10
Top of sand pack (ft. below grade): 0.83
Total water used to drill: 135.00 gals.
Type of water used to install well: salt (from laguna)
Total volume of sand used: 35 cans (8.75 gal)
Total volume of bentonite used: 4.00 cans (1 gal)
Depth to water table (ft. below grade): 1.00

Geologic description of well cuttings:

Surface: Pebble to cobble size rock from adjacent road. Have asphalt coating.
0-2' Sand: grey, fine grain, clean, well sorted, sulfur smell.
2-4' Sand: light brown, very fine to silty, well sorted, subrounded. Trace of shell fragments.
4-6' Sand: 95% dark brown, very fine to slightly silty, well sorted, subrounded. Shell fragments: 5%. Occasional clay stringers.
6-8' Sand: light brown, very fine to slightly silty, well sorted, subrounded. Trace of shell fragments.
8-10' Sand: light brown, very fine to slightly silty, well sorted, subrounded. Trace of shell fragments.
10-12' Sand: 80% light brown, fine to very fine, well sorted, subrounded. Gastropods and separated valves of shells: 20%.
12-14' Sand: 90% dark brown, very fine to slightly silty, well sorted, subrounded. Shell fragments: 10%.
14-15' Sand: 60% light brown, fine, muddy, well sorted, subrounded. Shell fragments, gastropods and cockle: 40%.
TD: 15.20'

Comments on well installation: None

Well development date: 11/24/93
Volume of water removed: 15 gals.

Well Name: MW-GW-A6

Date Drilled: 12/02/93

Well installed by: Chris McKinley, Steve Gibson

Location: 8 mi. south of Malaquite, south of American Exploration. well A6

UTM Y 3,020,496

UTM X 662,626

Drill method: Hydraulic jetting

Total Depth (ft. below grade): 19.28

Top of casing (ft. above grade): 1.13

Top of Screen (ft. below grade): 1.63

Total screen length (ft.): 17.32

Top of sand pack (ft. below grade): 0.00

Total water used to drill: 150.00 gals.

Type of water used to install well: fresh from ranger station faucet

Total volume of sand used: 43 cans (10.75 gal)

Total volume of bentonite used: 5 cans (1.25 gal)

Depth to water table (ft. below grade): 1.58

Geologic description of well cuttings:

Surface: Silt: light brown, slightly weathered sand, well sorted, subrounded. Trace of shell fragments. Discoloration (brown-yellow). Marsh grass.

0-2' Sand: light brownish grey, silty sand to very fine grain, moderately well sorted, subangular to subrounded. Some cemented sand grains.

2-4' Sand: 90% light grey, very fine grain, well sorted, subrounded. Shell fragments: 10%.

4-6' Sand: 80% light greyish brown, very fine grain, moderately sorted. Abraded shell fragments: 20%. Slight H₂S smell. Some cemented sand grains.

6-8' Sand: 90% light grey, very fine grain, well sorted, subrounded. Shell fragments: 10%. Some cemented sand grains.

8-10' Sand: 85% light grey, very fine grain, well sorted, subrounded. Shell fragments: 10%. Cemented sand grains: 5%.

10-12' Sand: 95% light grey, very fine grain, well sorted, subrounded. Shell fragments: 5%.

12-14' Sand: 90% light grey, very fine grain to silty, well sorted, subrounded to subangular. Abraded shell fragments: 10%.

14-16' Sand: 95% light grey, very fine grain to silty, well sorted, subrounded to subangular. Abraded shell fragments: 5%.

16-19' Sand: 95% light grey, very fine grain to silty, well sorted, subrounded to subangular. Abraded shell fragments: 5%.

TD: 19.28'

Comments on well installation: Had surface blowout due to lack of material in annulus.

Had a Distinct hydrocarbon odor just before reaching clay layer.

Well development date: 12/03/93

Volume of water removed: 25 gals. (until clear)

Well Name: MW-GW-A 8/3
Date Drilled: 12/16/93
Well installed by: Chris McKinley, Steve Gibson
Location: 9 mi. south of Malaquite, east of gas wells A-8 & A-6
UTM Y 3,021,333
UTM X 663,170

Drill method: Hydraulic jetting
Total Depth (ft. below grade): 20.45
Top of casing (ft. above grade): 2.50
Top of Screen (ft. below grade): 2.54
Total screen length (ft): 17.90
Top of sand pack (ft. below grade): 1.50
Total water used to drill: 150 gals.
Type of water used to install well: saltwater from gulf
Total volume of sand used: 41 cans (10.25 gal)
Total volume of bentonite used: 6 cans (1.5 gal)
Depth to water table (ft. below grade): 1.75

Geologic description of well cuttings:

Surface: Sand: dark brown, very fine grain, well sorted, subrounded. Trace of shell fragments.
0-2' Sand: dark brown, very fine grain, well sorted, subrounded. Trace of shell fragments.
2-4' Sand: 95% light brown, very fine grain, well sorted, subrounded. Shell fragments: 5%.
4-6' Sand: 95% light brown, very fine grain, well sorted, subrounded. Shell fragments: 5%.
6-8' Sand: 95% greyish brown, very fine grain, well sorted, subrounded. Shell fragments: 5%.
8-10' Sand: 90% light grey, fine grain, well sorted, subrounded. Shell fragments: 5%.
10-12' Sand: light grey, fine grain, well sorted subrounded. Trace of shell fragments.
12-14' Sand: 80% light grey, very fine grain and slightly muddy, well sorted, subrounded. Separated cockle valves and shell fragments: 20%.
14-16' Sand: 95% light grey, very fine grain, well sorted subrounded. Separated cockle valves and shell fragments: 5%.
16-18' Sand: light grey, very fine grain, well sorted, subrounded. Trace of shell fragments.
18-20' Sand: 90% light grey, very fine, well sorted, subrounded. Separated cockle valves and broken gastropods shell: 10%.
TD: 20.45'

Comments on well installation: 04-07-94 well base broken. (Cement pad)

Well development date: 01/19/94

Volume of water removed: 30 gals.

Well Name: MW-15-GF

Date Drilled: 11/18/93

Well installed by: Chris McKinley, Steve Gibson

Location: 100 yds. WNW from gas facility

UTM Y 3,010,195

UTM X 660,667

Drill method: Hydraulic jetting

Total Depth from surface: 18.77

Top of casing (ft. above grade): 1.67

Top of Screen (ft. below grade): 0.91

Total screen length (ft): 17.88

Top of sand pack (ft. below grade): 0.67

Total water used to drill: 160.00 gal.

Type of water used to install well: saltwater from pond next to well

Total volume of sand used: 40 cans (10 gal)

Total volume of bentonite used: 4 cans (1 gal)

Depth to water table (ft. below grade): 0.83

Geologic description of well cuttings:

Surface: sparse marsh plant coverage

0-2' Sand: dark brown, fine grain, very well sorted, subrounded. Occasional plant material.

2-4' Sand: light brown, fine grain, very well sorted, subrounded. Trace of shell fragments, small black organic specks, H₂S odor.

4-6' Sand: light brown, fine grain, very well sorted, subrounded. Trace of abraded fragments of shell. Occasional plant material.

6-8' Sand: light brown, fine grain, well sorted, subrounded. Trace of abraded shell fragments.

8-10' Sand: 90% light brown, fine grain, moderately sorted, subrounded. Abraded shell fragments: 10% .

10-12' Sand: dark grey, fine grain, well sorted, subrounded. Trace of abraded shell fragments.

12-14' Sand: 85% dark grey, fine grain, well sorted, subrounded. Abraded fragments of cockle shell: 15%.

14-16' Sand: 95% dark, fine grain, well sorted, subrounded. Shell fragments: 5% .

16-18' Sand: light grey, very fine grain, very well sorted, subrounded. Trace of shell fragments.

TD: 18.77'

Comments on well installation: None

Well development date: 11/18/93

Volume of water removed: 20.00 gal.

Well Name: MW-15-GM

Date Drilled: 6/12/93

Well installed by: Chris McKinley, Rick Hay

Location: Between foredunes and dunes 100 yds. south of Yarborough Pass

UTM Y 3,009,983

UTM X 661,982

Drill method: Hand augering

Total Depth from surface: 16.37

Top of casing (ft. above grade): 1.67

Top of Screen (ft. below grade): 3.28

Total screen length (ft): 12.67

Top of sand pack (ft. below grade): 3.00

Total water used to drill: n/a

Type of water used to install well: n/a

Total volume of sand used: 0.88 cu ft.

Total volume of bentonite used: 1.47 gal.

Depth to water table (ft. below grade): 3.60

Geologic description of well cuttings:

Surface: Sand: light brown, very fine, well sorted, subrounded. Trace of abraded shell fragments.

0-2' Sand: 95% light brown, very fine grain, well sorted, subrounded. Abraded shell fragments: 5%. Soil damp @ 3.40'. Water table @ 3.60'.

2-4' Sand: 90% light brown, fine grain, moderately sorted, subrounded. Abraded shell fragments: 10%.

4-6' Sand: light brown, very fine grain, very well sorted, subrounded. Trace of abraded shell fragments.

6-8' Sand: 70% light brown, fine grain, well sorted, subrounded. Separated valves of cockle, and abraded shell fragments: 30%.

8-10' Sand: 90% dark brown, fine grain, moderately sorted, subrounded. Abraded shell fragments, and separated valves of common cockle: 10%.

10-12' Sand: 85% light brown, medium grain, well sorted, subrounded. Shell fragments: 15%

12-14' Sand: 80% light brown, medium grain, well sorted, subrounded. Abraded shell fragments: 20%.

14-16' Sand: 80% light brown, medium grain, moderately sorted, subrounded. Abraded shell fragments: 20%.

TD: 16.37'

Comments on well installation: Very difficult installation due to heaving sand. Unable to clear sand from casing with 17.93' of casing in hole. Casing shoe left at bottom of hole.

Well development date: 6/12/93

Volume of water removed: bailed until clear.

Well Name: MW-15-LG

Date Drilled: 07/17/93

Well installed by: Chris McKinley

Location: Approx. 1/2 mi. north of gas facility at Yarborough Pass

UTM Y 3,010,615

UTM X 660,594

Drill method: Hydraulic jetting

Total Depth from surface: 19.25

Top of casing (ft. above grade): 3.21

Top of Screen (ft. below grade): 1.30

Total screen length (ft): 15.78

Top of sand pack (ft. below grade): 1.10

Total water used to drill: 220.00 gal.

Type of water used to install well: saltwater from pond next to MW-15-GF

Total volume of sand used: 38 cans (9.5 gal)

Total volume of bentonite used: 4 cans (1 gal)

Depth to water table (ft. below grade): 3.50

Geologic description of well cuttings:

Surface: Sand: light grey, very fine grain, well sorted, subrounded. Trace of shell fragments.

0-2' Sand: light grey, very fine grain, very well sorted, subrounded. Trace of shell fragments.

2-4' Sand: light grey, very fine grain, well sorted, subrounded. Trace of shell fragments.

4-6' Sand: 90% light grey, very fine grain to silty, well sorted, subrounded. Shell fragments: 10%.

6-8' Sand: 90% light brown, very fine grain, well sorted, subrounded. Abraded shell fragments: 10%.

8-10' Mud: dark brown, slightly muddy, sandy. Trace of abraded shell fragments.

10-12' Mud: greyish brown, slightly silty, sandy. Trace of shell fragments.

12-14' Mud: grey, slightly silty, sandy. Trace of shell fragments.

14-16' Mud: dark grey, silty, sandy. Trace of shell fragments.

16-18' Mud: dark greyish brown, silty, sandy. Trace of shell fragments.

TD: 19.25'

Comments on well installation: None.

Well development date: 07/29/93

Volume of water removed: 10.00 gal

Well Name: MW-15-LM
Date Drilled: 07/10/93
Well installed by: Chris McKinley, Steve Gibson
Location: 1/4 mi. N. of Yarborough Pass boat dock on waters edge
UTM Y 3,010,081
UTM X 659,495
Drill method: Hydraulic jetting
Total Depth from surface: 19.44
Top of casing (ft. above grade): 3.21
Top of Screen (ft. below grade): 1.48
Total screen length (ft): 17.96
Top of sand pack (ft. below grade): 1.30
Total water used to drill: 250.00 gal
Type of water used to install well: saltwater from Laguna Madre at site
Total volume of sand used: 41 cans (10.25 gal)
Total volume of bentonite used: 5 cans (1.25 gal)
Depth to water table (ft. below grade): 0.50

Geologic description of well cuttings:

Surface: Sand: light brown, very fine grain, well sorted, subrounded. Trace of shell fragments. Mud flats
0-2' Sand: light brown, fine grain, well sorted, subrounded. Trace of shell fragments.
2-4' Sand: 90% light brown, fine grain, well sorted, subrounded. Shell fragments: 10%.
4-6' Sand: 85% light brown, very fine grain, well sorted, subrounded. Shell fragments: 15%.
6-8' Silt: 95% light brownish grey, sandy silt, well sorted, subrounded. Shell fragments: 5%.
8-10' Mud: dark grey, slightly sandy. Trace of shell fragments.
10-12' Mud: dark grey, argillaceous. Trace of shell fragments.
12-14' Mud: light grey, argillaceous. Trace of shell fragments.
14-16' Mud: light grey, argillaceous, slightly sandy. Trace of shell fragments.
16-18' Mud: light grey, argillaceous, slightly sandy. Trace of shell fragments.
18-20' Mud: light greyish brown, argillaceous slightly sandy. Trace of shell fragments.

TD: 19.44'

Comments on well installation: First well installed by the jetting method. Fairly smooth operation overall. Drilling stopped by hitting hard wooden object of which pieces reached surface along with? fish bones.

Well development date: 12/15/93

Volume of water removed: 15 gals.

Well Name: MW-25-GM
Date Drilled: 10-06-93
Well installed by: Chris McKinley, Steve Gibson
Location: 150 ft. S. of Dunn Ranch Corrals rd. 5' W. of high road on dune
UTM Y 2,992,689
UTM X 660,740
Drill method: Hydraulic jetting
Total Depth (ft. below grade): 19.33
Top of casing (ft. above grade): 1.05
Top of Screen (ft. below grade): 4.00
Total screen length (ft): 15.33
Total water used to drill: 250 gal.
Type of water used to install well: Seawater
Total volume of sand used: 37 cans
Total volume of bentonite used: 10 cans
Depth to water table (ft. below grade): 10.5

Geologic description of well cuttings:

Surface: Sand: 65% light brown, very fine to fine grain, moderately sorted, subrounded.
Shell fragments: 35%.
0-2' Sand: 65% light brown, very fine, well sorted, subrounded. Abraded shell fragments:
35%.
2-4' Sand: 50% light brown, very fine, well sorted, subrounded. Abraded shell fragments:
50%.
4-6' Sand: 70% dark brown, very fine, well sorted, subrounded. Abraded shell fragments:
30%.
6-8' Sand: 75% dark brown, very fine, well sorted, subrounded. Shell fragments: 25% .
8-10' Sand: 80% dark brown, very fine, well sorted, subrounded. Shell fragments: 20% .
10-12' Sand: 65% light brown, very fine, well sorted, subrounded. Shell fragments: 35% .
12-14' Sand: 50% light brown, very fine, well sorted, subrounded. Shell fragments: 50% .
14-16' Sand: 75% light brown, very fine, well sorted, subrounded. Shell fragments: 25% .
16-18' Sand: 65% light brown, very fine, well sorted, subrounded. Shell fragments: 35% .
18-20' Sand: 25% light brown, very fine, well sorted, subrounded. Shell fragments: 65% .
TD:

Comments on well installation: Drilling impeded by thick layer of large diameter shells.

Well development date: 10/06/93

Volume of water removed: 20 gal.

Well Name: MW-25-LG
Date Drilled: 9/23/93
Well installed by: Chris McKinley, Steve Gibson
Location: 50 ft. S. of Dunn Ranch Corrals rd. near corrals in center of Island
UTM Y 2,992,556
UTM X 660,171
Drill method: Hand auger.
Total Depth (ft. below grade): 16
Top of casing (ft. above grade): 2
Top of Screen (ft. below grade): 2.5
Total screen length (ft): 15.5
Total water used to drill: N/A.
Type of water used to install well: N/A.
Total volume of sand used: 34 cans
Total volume of bentonite used: 3 cans
Depth to water table (ft. below grade): 2

Geologic description of well cuttings:

Surface:

0-2' Sand: dark brown, very fine grain and silty sand, very well sorted, subrounded to rounded. Trace of shell fragments.
2-4' Sand: 95% light brown, very fine grain, very well sorted, subrounded to rounded. Shell fragments: 5%.
4-6' Sand: light brown, very fine grain, well sorted, subrounded. Trace of shell fragments.
6-8' Sand: 90% light brown, very fine grain, well sorted, subrounded. Shell fragments: 10%.
8-10' Sand: light brown, very fine grain, well sorted, subrounded.
10-12' Sand: light brown, very fine grain, very well sorted, subrounded. Trace of shell fragments.
12-14' No sample.
14-16' Sand: light grey, very fine grain, well sorted, subrounded. Trace of shell fragments.
16-18' Sand: light grey, very fine grain, well sorted, subrounded.
TD:

Comments on well installation: None.

Well development date: 12/15/93

Volume of water removed: 22 gal.

Well Name: MW-25-LM

Date Drilled: 9/16/93

Well installed by: Chris McKinley, Steve Gibson

Location: 200 ft. S. of Dunn Ranch Corrals rd. along dune ridge on Laguna side of Island.

UTM Y 2,992,494

UTM X 659,699

Drill method: Hydraulic jetting

Total Depth (ft. below grade): 25.7

Top of casing (ft. above grade): 2.2

Top of Screen (ft. below grade): 1.1

Total screen length (ft): 24.5

Total water used to drill: 200gal.

Type of water used to install well: Seawater

Total volume of sand used: 55 cans

Total volume of bentonite used: 2 cans

Depth to water table (ft. below grade): 2

Geologic description of well cuttings:

Surface:

0-2' Silt: dark brown , well sorted, subangular. Trace of shell fragments.

2-4' Sand: 95% dark grey, very fine grain , well sorted, subrounded. Shell fragments: 5%.

4-6' Sand: 95% dark grey ,very fine grain, well sorted, subrounded. Shell fragments: 5%.

6-8' Sand: dark grey, very fine grain, well sorted, subrounded. Trace of shell fragments.

8-10' Sand: dark grey, very fine grain, well sorted, subrounded. Trace of shell fragments.

10-12' Sand: dark grey, fine grain, well sorted, subrounded. Trace of shell fragments.

12-14' Sand: dark grey, fine grain , well sorted, subrounded.

14-16' Sand: dark grey, very fine grain, well sorted, subrounded. Trace of shell fragments.

16-18' Sand: dark grey, very fine grain, well sorted, subrounded.

18-20' Sand: dark grey, very fine grain, well sorted, subrounded.

20-22' Sand: dark grey, very fine grain, well sorted, subrounded. Trace of shell fragments.

TD:

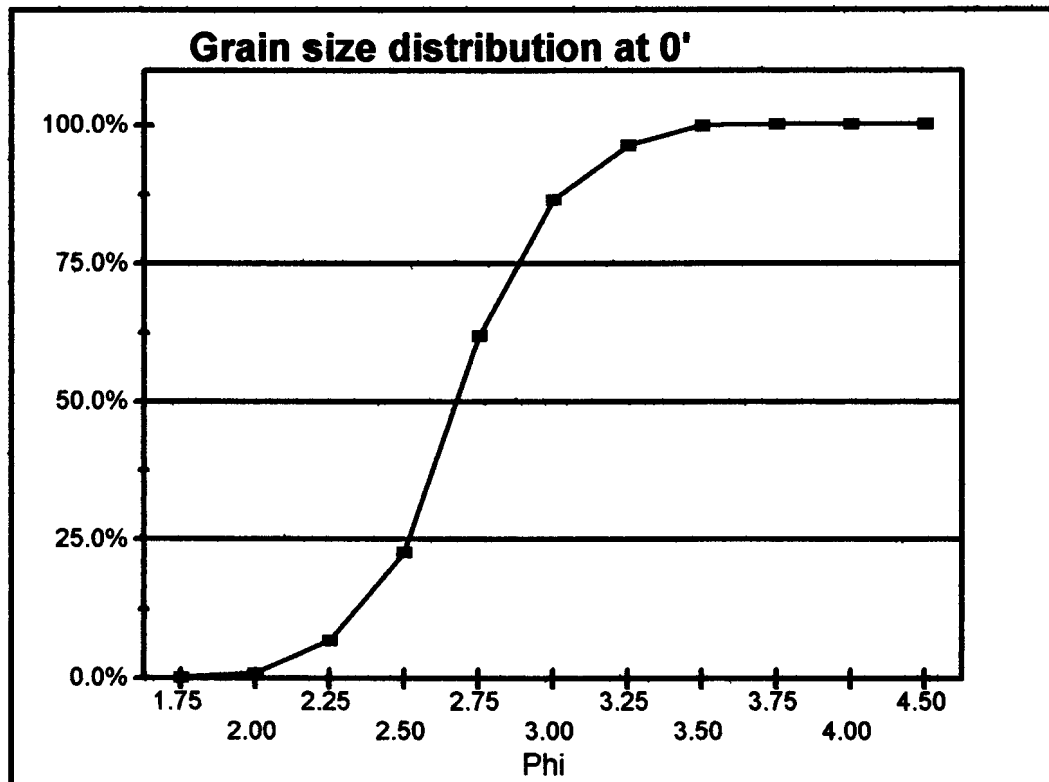
Comments on well installation: None.

Well development date: 12/15/93

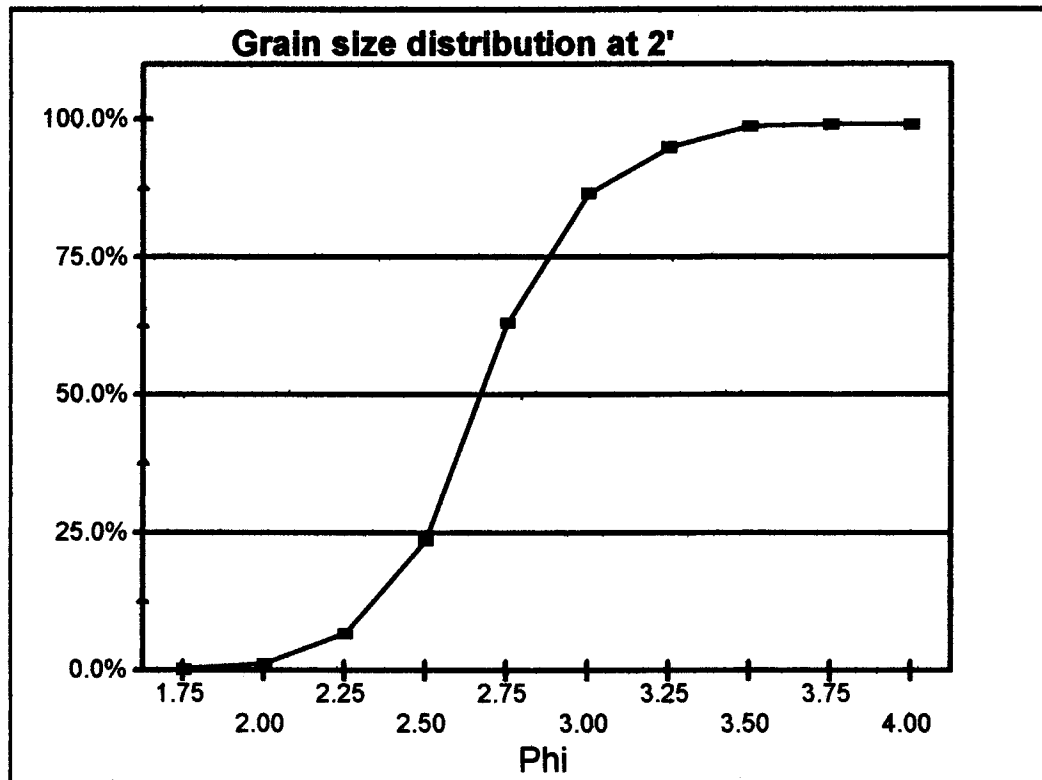
Volume of water removed: 50 gal.

Appendix II.
Particle size analysis for MW-0-GM

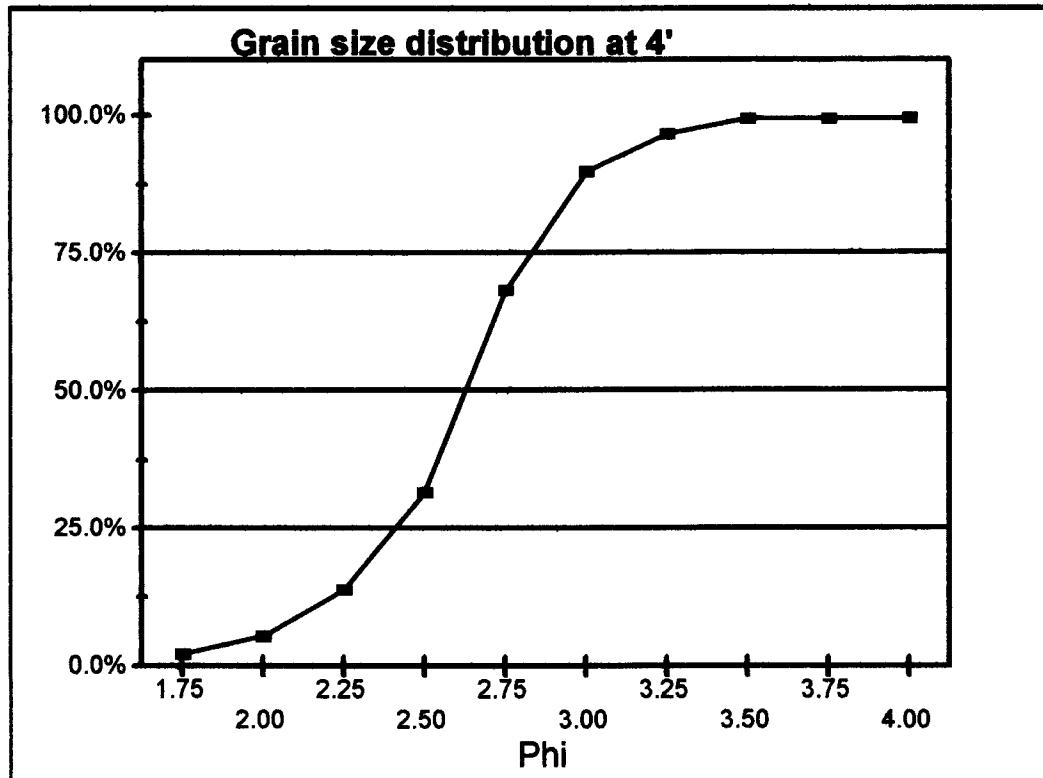
Statistical analysis of MW-0-GM @ depth 0				
	%	Phi		
Mean	61.40%	2.50	Kurtosis	-0.8995
Median	86.39%	3.00	Skewness	1.0267
Mode	39.27%	2.75	Range	1.0021
Standard Dev.	41.94%		Minimum	0.0004
Count	11.0000		Maximum	1.0025
Effective diameter 0.125 mm (Hazen 1911)				



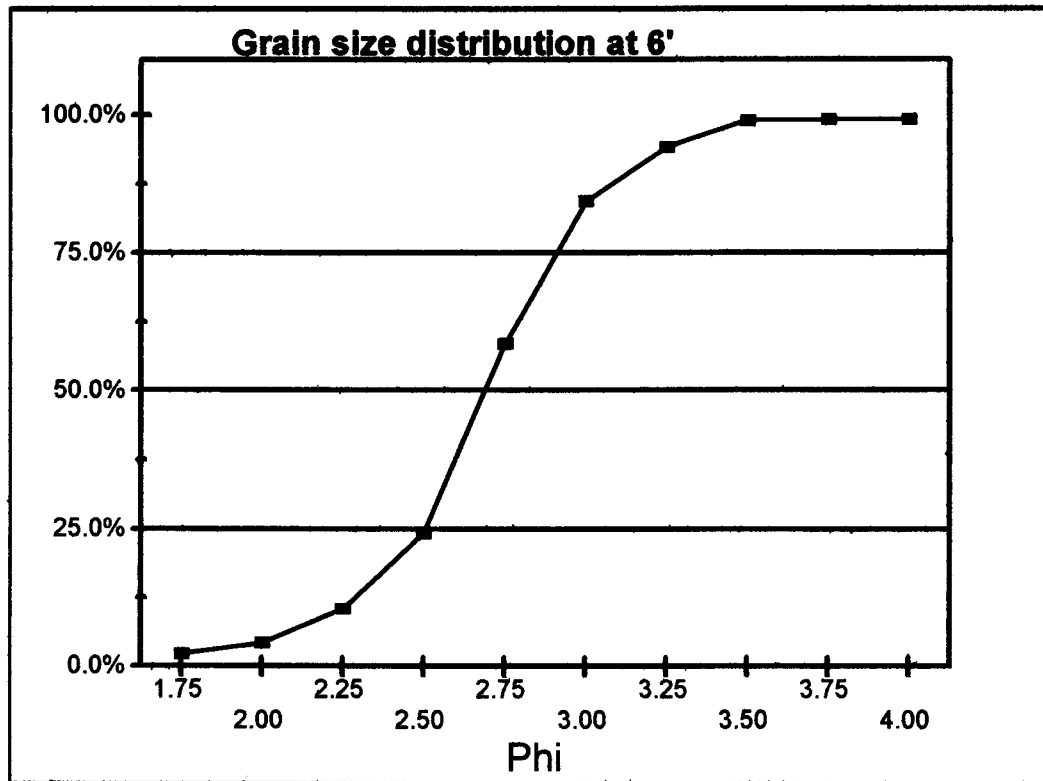
Statistical analysis of MW-0-GM @ depth 2				
	%	Phi		
Mean	61.04%	2.50	Kurtosis	-0.9300
Median	86.56%	3.00	Skewness	1.0149
Mode	39.39%	2.75	Range	0.9881
Standard Dev.	41.77%		Minimum	0.0016
Count	11.0000		Maximum	0.9897
Effective diameter 0.125 mm (Hazen 1911)				



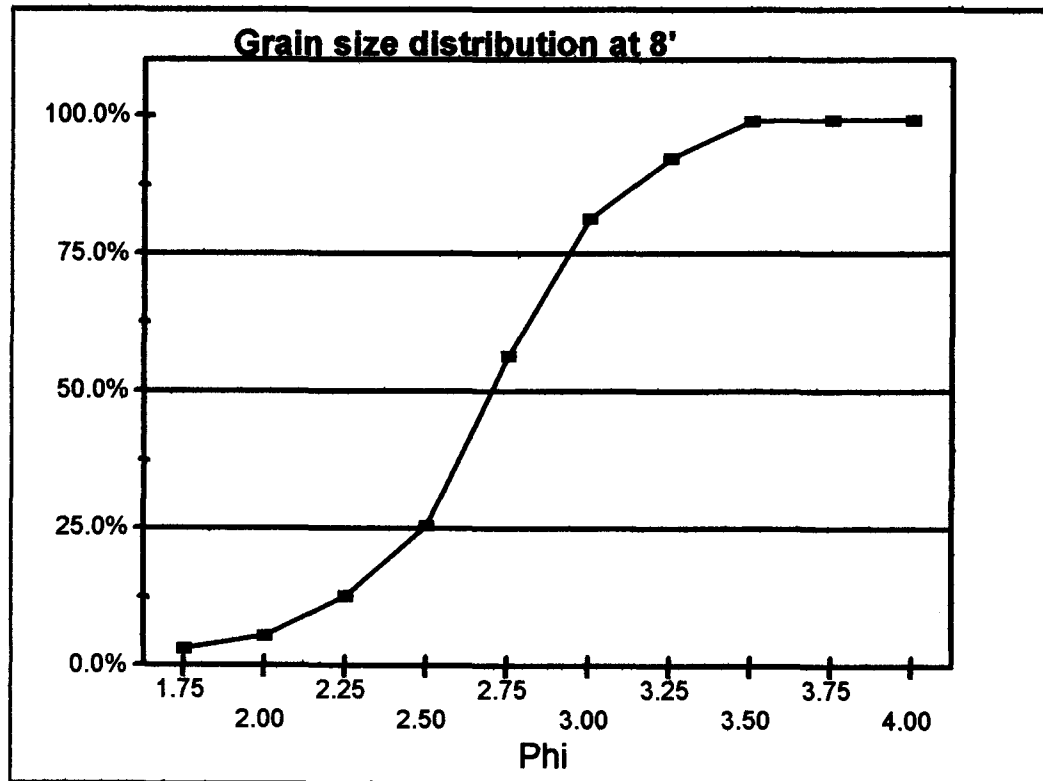
Statistical analysis of MW-0-GM @ depth 4				
	%	Phi		
Mean	63.99%	2.50	Kurtosis	-1.0230
Median	89.66%	3.00	Skewness	0.9643
Mode	36.60%	2.75	Range	0.9728
Standard Dev.	40.00%		Minimum	0.0211
Count	11.0000		Maximum	0.9939
Effective diameter 0.125 mm (Hazen 1911)				



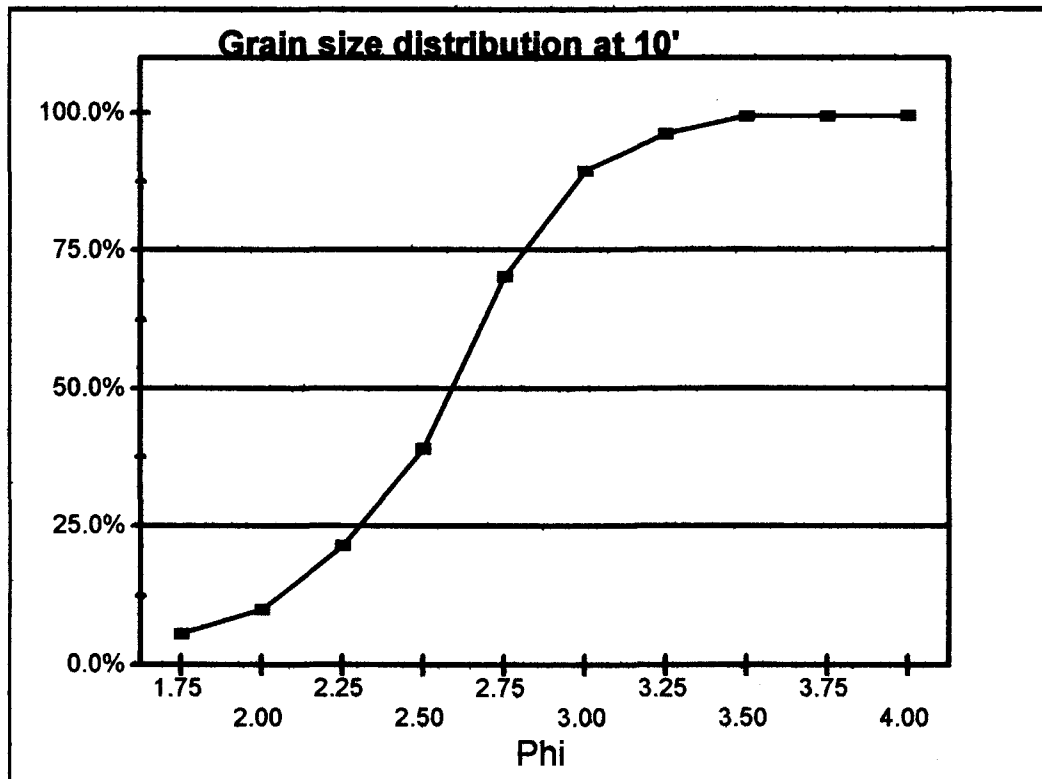
Statistical analysis of MW-0-GM @ depth 6				
	%	Phi		
Mean	61.27%	2.75	Kurtosis	-0.8708
Median	84.32%	3.00	Skewness	1.0290
Mode	34.32%	2.75	Range	0.9679
Standard Dev.	40.45%		Minimum	0.0227
Count	11.0000		Maximum	0.9906
Effective diameter 0.125 mm (Hazen 1911)				



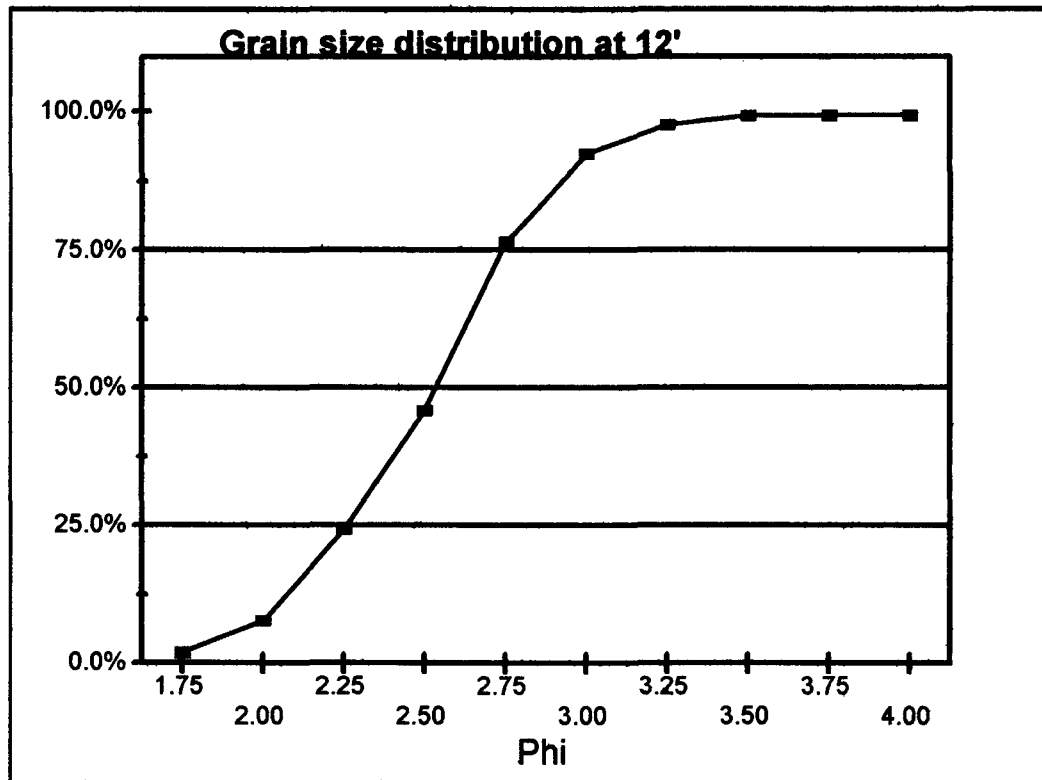
Statistical analysis of MW-0-GM @ depth 8				
	%	Phi		
Mean	61.22%	2.75	Kurtosis	-0.8311
Median	81.44%	3.00	Skewness	1.0350
Mode	30.84%	2.75	Range	0.9616
Standard Dev.	39.64%		Minimum	0.0313
Count	11.0000		Maximum	0.9929
Effective diameter 0.125 mm (Hazen 1911)				



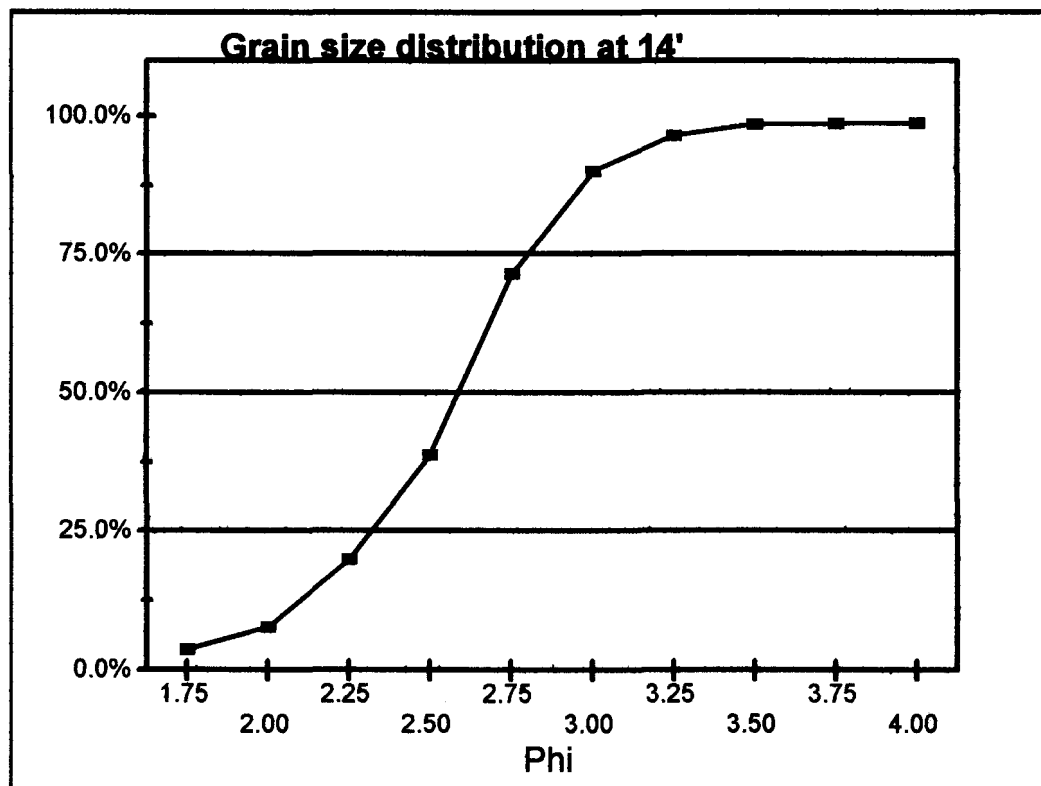
Statistical analysis of MW-0-GM @ depth 10				
	%	Phi		
Mean	66.27%	2.50	Kurtosis	-1.0952
Median	89.32%	3.00	Skewness	0.9115
Mode	31.24%	2.75	Range	0.9403
Standard Dev.	37.50%		Minimum	0.0552
Count	11.0000		Maximum	0.9955
Effective diameter 0.125 mm (Hazen 1911)				



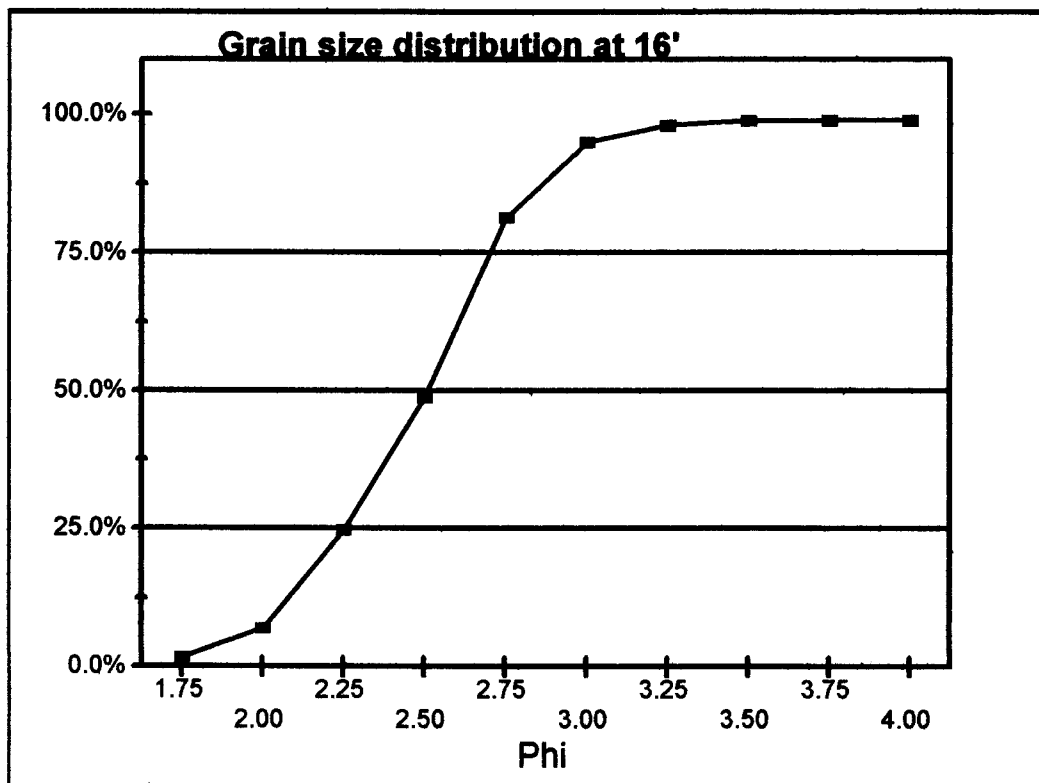
Statistical analysis of MW-0-GM @ depth 12				
	%	Phi		
Mean	67.45%	2.50	Kurtosis	-1.2076
Median	92.26%	3.00	Skewness	0.8643
Mode	30.75%	2.75	Range	0.9742
Standard Dev.	37.96%		Minimum	0.0174
Count	11.0000		Maximum	0.9916
Effective diameter 0.149 mm (Hazen 1911)				



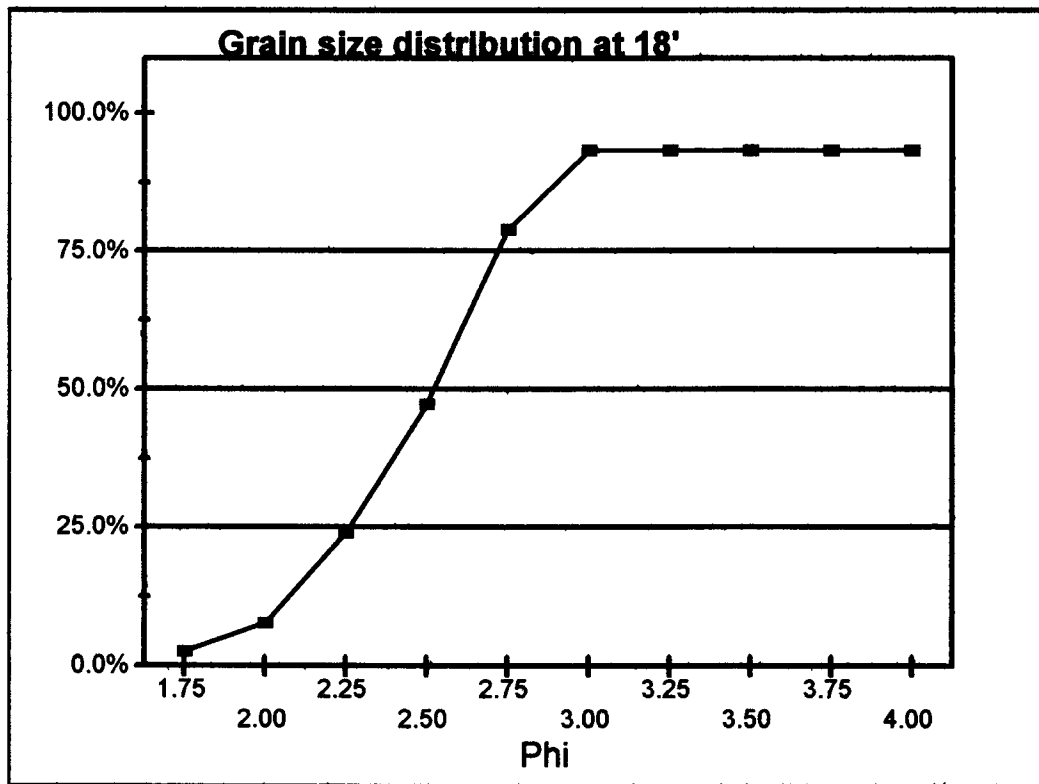
Statistical analysis of MW-0-GM @ depth 14				
	%	Phi		
Mean	65.64%	2.50	Kurtosis	-1.1115
Median	89.94%	3.00	Skewness	0.9120
Mode	32.57%	2.75	Range	0.9508
Standard Dev.	38.10%		Minimum	0.0363
Count	11.0000		Maximum	0.9871
Effective diameter 0.125 mm (Hazen 1911)				



Statistical analysis of MW-0-GM @ depth 16				
	%	Phi		
Mean	68.27%	2.50	Kurtosis	-1.2667
Median	94.82%	3.00	Skewness	0.8421
Mode	32.57%	2.75	Range	0.9723
Standard Dev.	38.11%		Minimum	0.0155
Count	11.0000		Maximum	0.9879
Effective diameter 0.149 mm (Hazen 1911)				

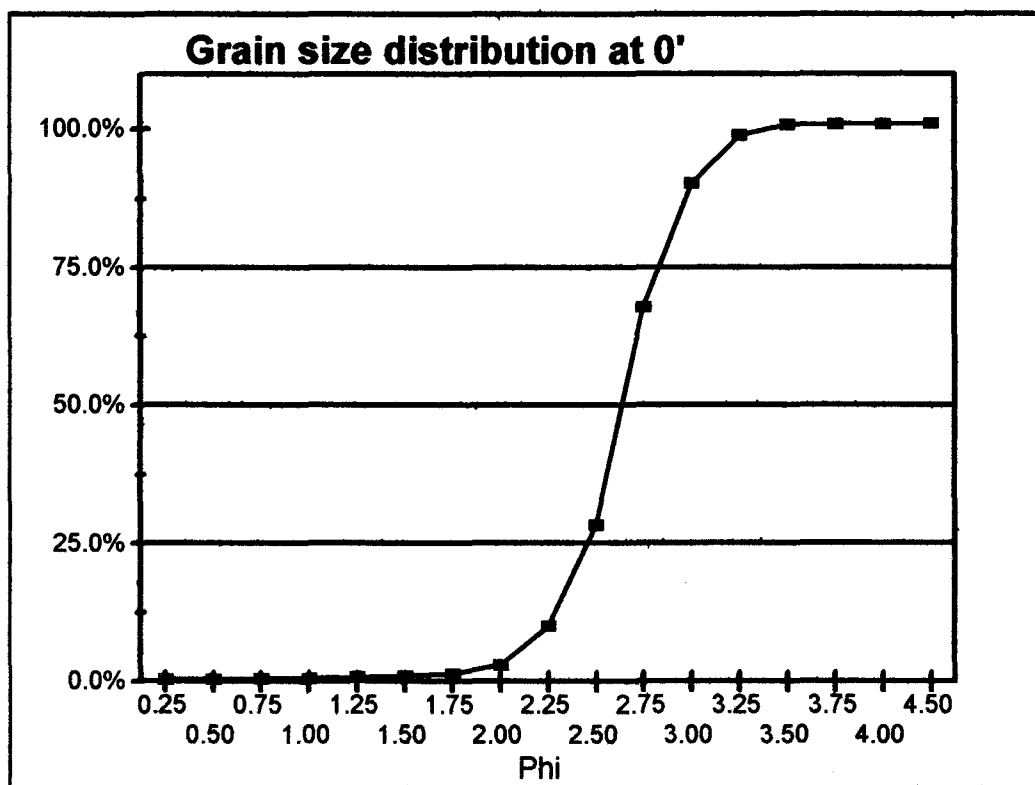


Statistical analysis of MW-0-GM @ depth 18				
	%	Phi		
Mean	65.42%	2.50	Kurtosis	-1.2876
Median	93.22%	3.00	Skewness	0.8327
Mode	31.77%	2.75	Range	0.9070
Standard Dev.	35.89%		Minimum	0.0252
Count	11.0000		Maximum	0.9322
Effective diameter 0.149 mm (Hazen 1911)				

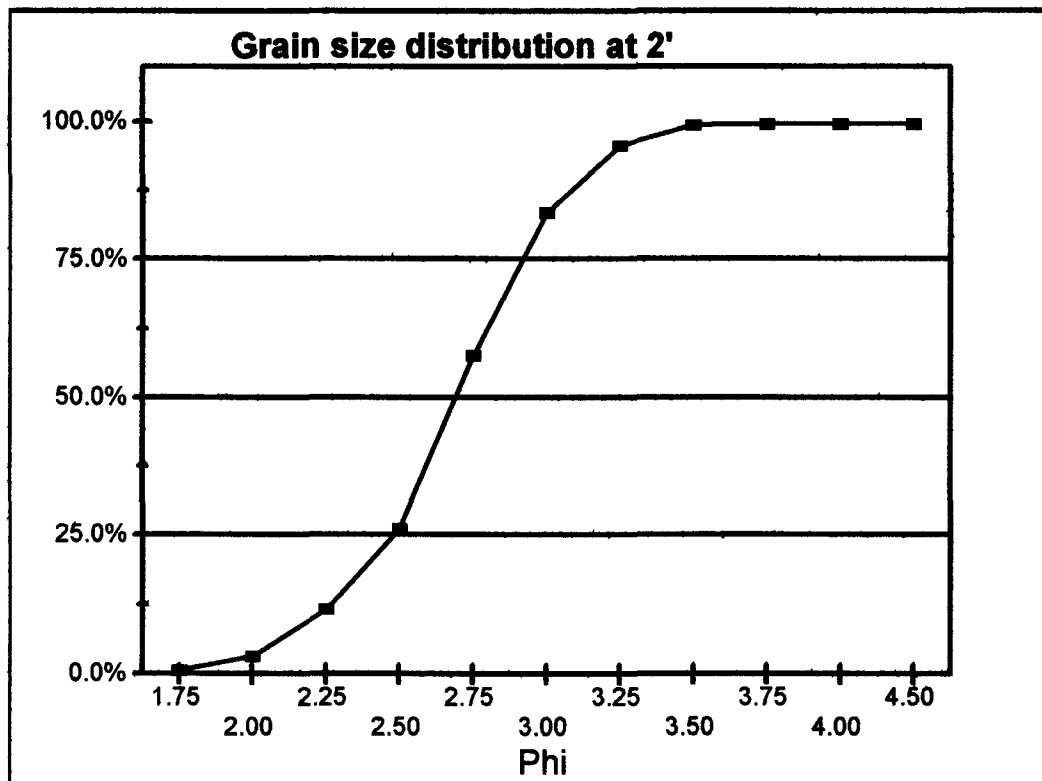


Appendix III.
Particle size analysis for MW-0-LG

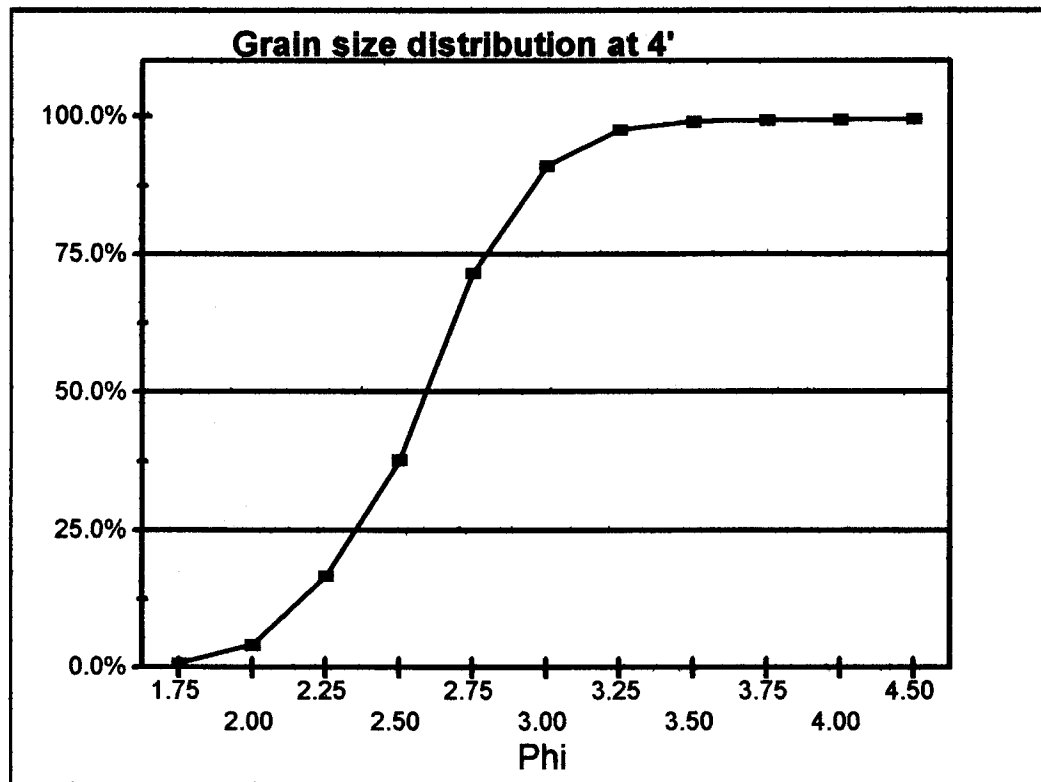
Statistical analysis of MW-0-LG @ depth 0				
	%	Phi		
Mean	41.50%	2.50	Kurtosis	-0.9863
Median	9.93%	2.25	Skewness	0.9881
Mode	39.42%	2.75	Range	1.0060
Standard Dev.	45.24%		Minimum	0.0029
Count	17.0000		Maximum	1.0089
Effective diameter 0.149 mm (Hazen 1911)				



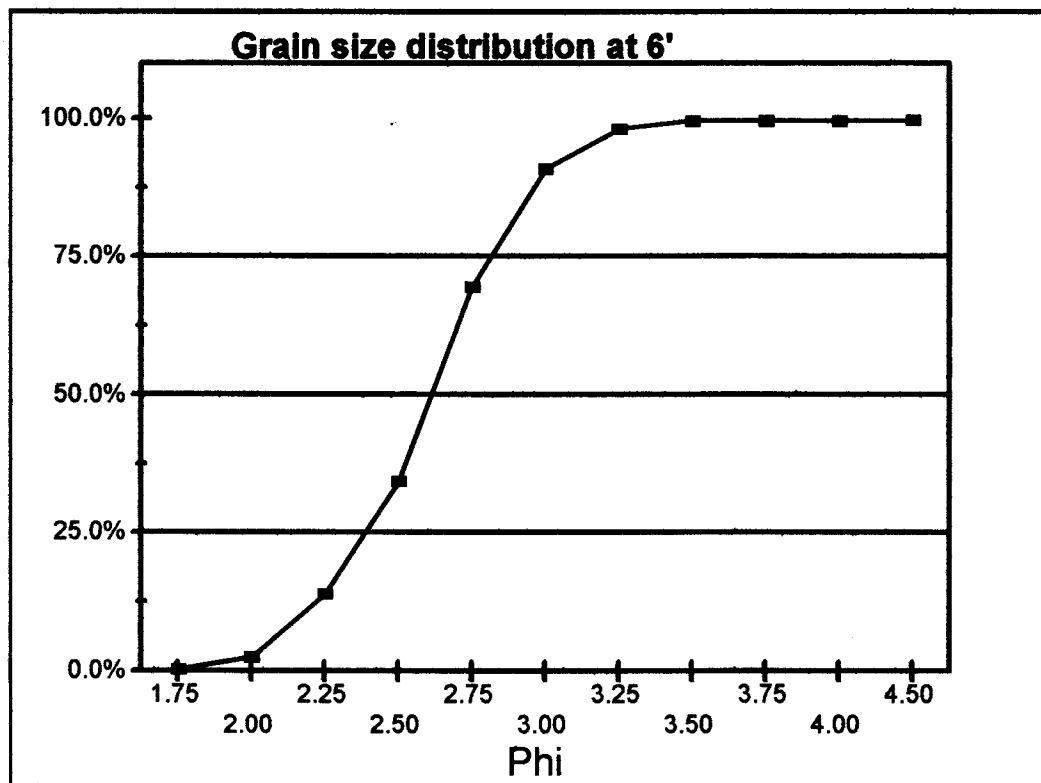
Statistical analysis of MW-0-LG @ depth 2				
	%	Phi		
Mean	61.39%	2.75	Kurtosis	-0.8587
Median	83.32%	3.00	Skewness	1.0294
Mode	31.52%	2.75	Range	0.9900
Standard Dev.	40.79%		Minimum	0.0049
Count	11.0000		Maximum	0.9950
Effective diameter 0.125 mm (Hazen 1911)				



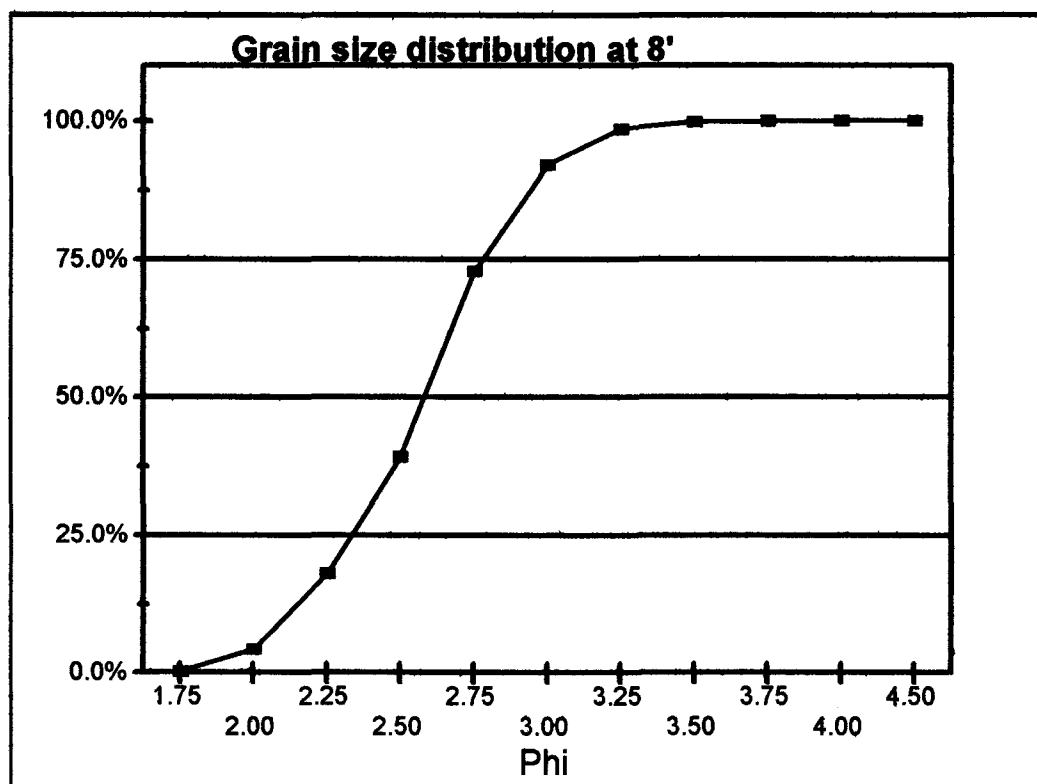
Statistical analysis of MW-0-LG @ depth 4				
	%	Phi		
Mean	65.05%	2.50	Kurtosis	-1.0988
Median	90.95%	3.00	Skewness	0.9262
Mode	33.92%	2.75	Range	0.9865
Standard Dev.	39.75%		Minimum	0.0069
Count	11.0000		Maximum	0.9934
Effective diameter 0.149 mm (Hazen 1911)				



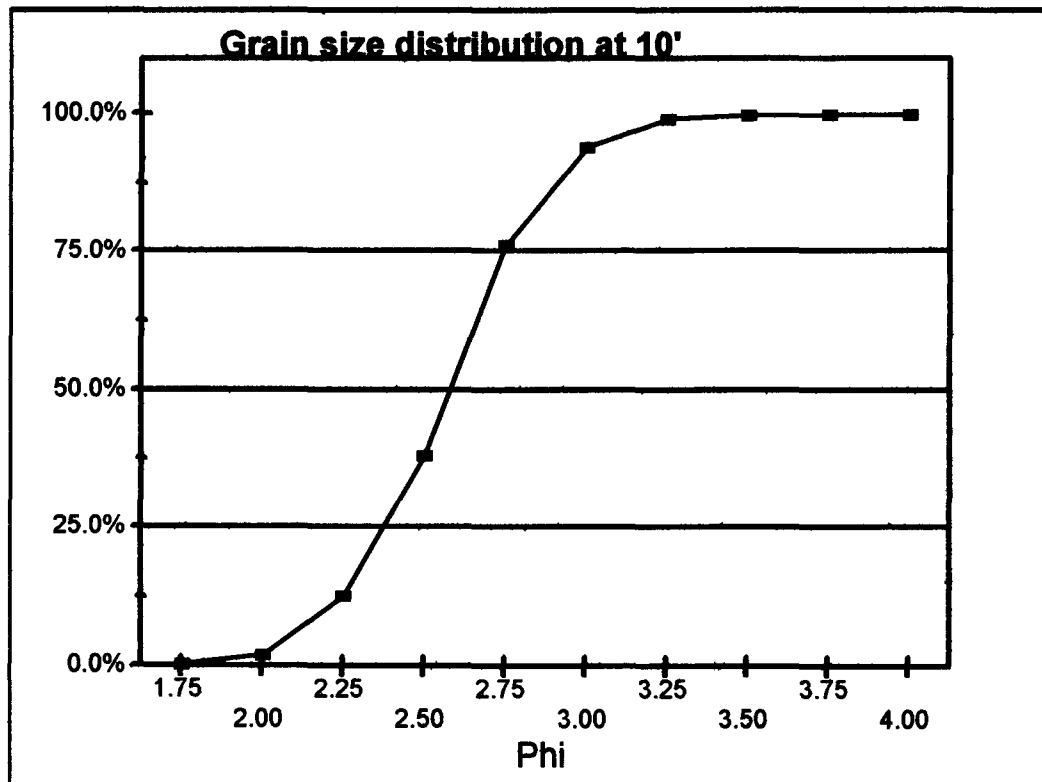
Statistical analysis of MW-0-LG @ depth 6				
	%	Phi		
Mean	64.24%	2.50	Kurtosis	-1.0526
Median	90.76%	3.00	Skewness	0.9515
Mode	35.20%	2.75	Range	0.9938
Standard Dev.	40.67%		Minimum	0.0022
Count	11.0000		Maximum	0.9960
Effective diameter 0.149 mm (Hazen 1911)				



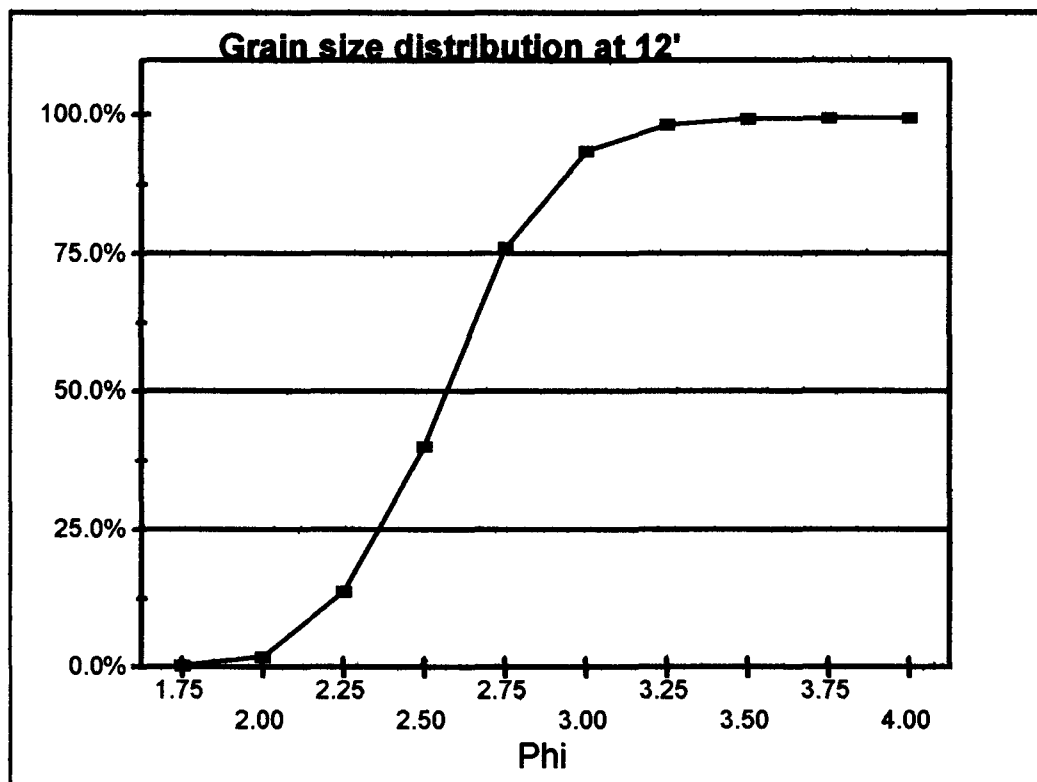
Statistical analysis of MW-0-LG @ depth 8				
	%	Phi		
Mean	65.88%	2.50	Kurtosis	-1.1153
Median	92.04%	3.00	Skewness	0.9169
Mode	33.63%	2.75	Range	0.9973
Standard Dev.	39.93%		Minimum	0.0024
Count	11.0000		Maximum	0.9997
Effective diameter 0.149 mm (Hazen 1911)				



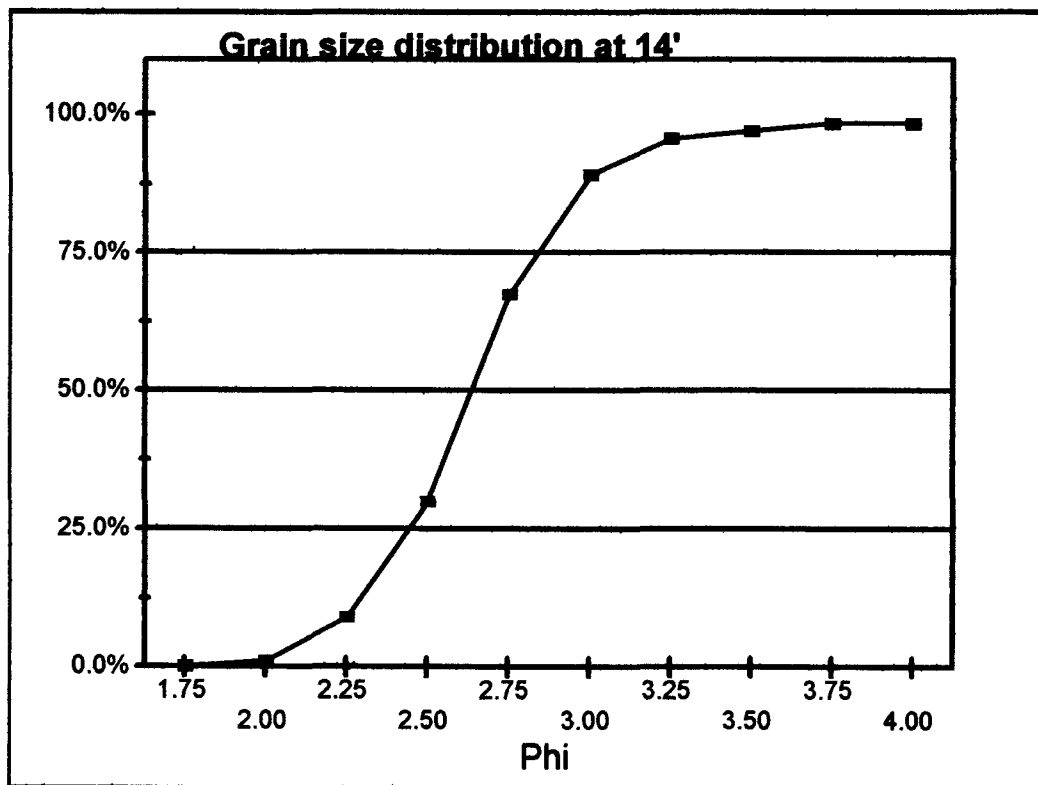
Statistical analysis of MW-0-LG @ depth 10				
	%	Phi		
Mean	65.39%	2.50	Kurtosis	-1.1317
Median	93.79%	3.00	Skewness	0.9231
Mode	38.08%	2.75	Range	0.9949
Standard Dev.	41.11%		Minimum	0.0013
Count	11.0000		Maximum	0.9962
Effective diameter 0.149 mm (Hazen 1911)				



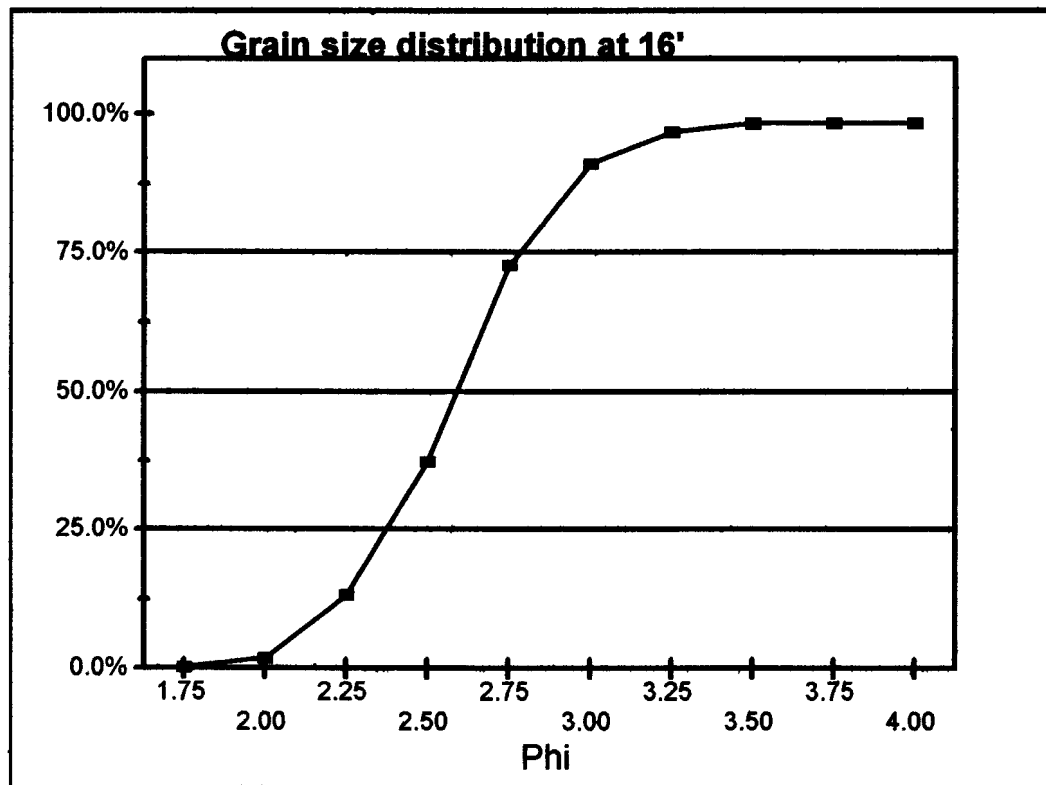
Statistical analysis of MW-0-LG @ depth 12				
	%	Phi		
Mean	65.46%	2.50	Kurtosis	-1.1505
Median	93.34%	3.00	Skewness	0.9117
Mode	36.17%	2.75	Range	0.9916
Standard Dev.	40.67%		Minimum	0.0014
Count	11.0000		Maximum	0.9930
Effective diameter 0.149 mm (Hazen 1911)				



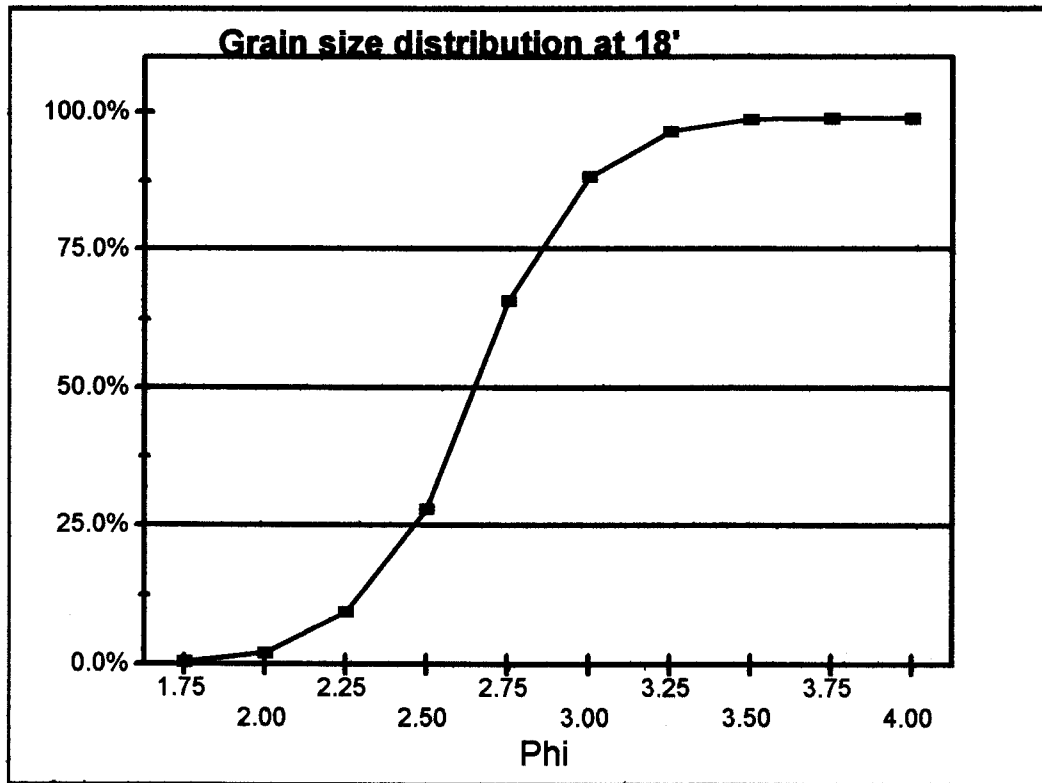
Statistical analysis of MW-0-LG @ depth 14				
	%	Phi		
Mean	62.13%	2.50	Kurtosis	-1.0213
Median	89.02%	3.00	Skewness	0.9733
Mode	37.53%	2.75	Range	0.9826
Standard Dev.	40.96%		Minimum	0.0001
Count	11.0000		Maximum	0.9828
Effective diameter 0.125 mm (Hazen 1911)				



Statistical analysis of MW-0-LG @ depth 16				
	%	Phi		
Mean	64.16%	2.50	Kurtosis	-1.1112
Median	90.95%	3.00	Skewness	0.9279
Mode	35.38%	2.75	Range	0.9834
Standard Dev.	40.29%		Minimum	0.0004
Count	11.0000		Maximum	0.9838
Effective diameter 0.149 mm (Hazen 1911)				

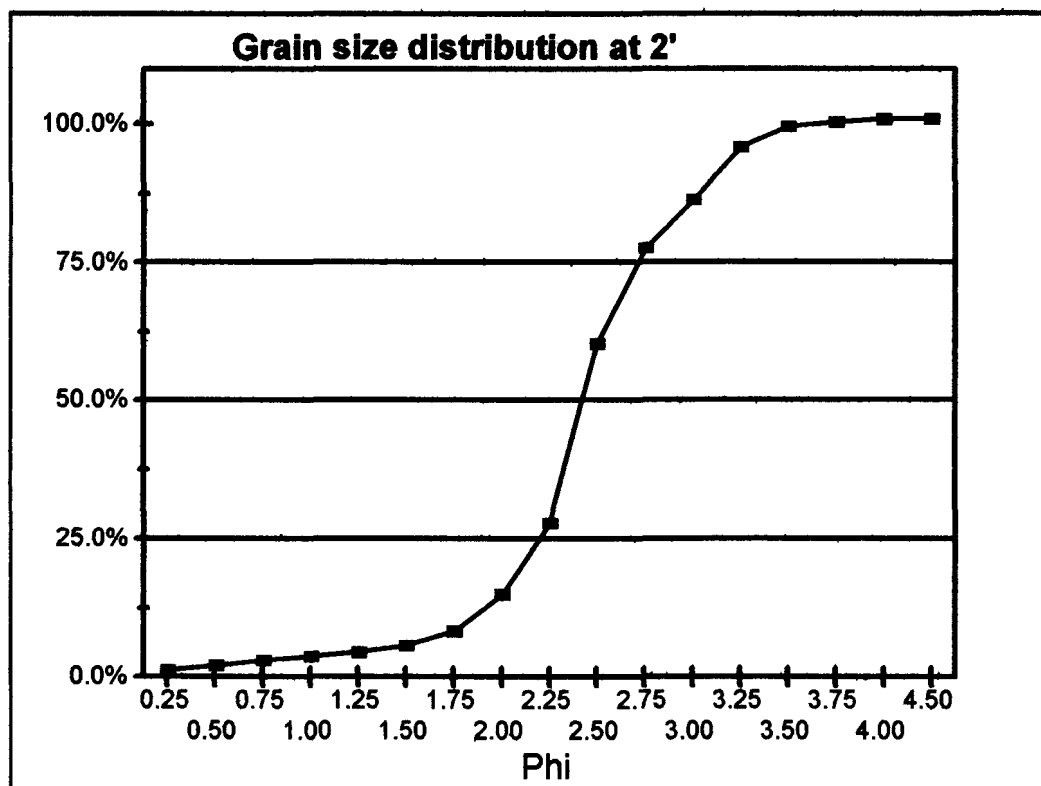


Statistical analysis of MW-0-LG @ depth 18				
	%	Phi		
Mean	62.29%	2.50	Kurtosis	-0.9828
Median	88.20%	3.00	Skewness	0.9888
Mode	37.76%	2.75	Range	0.9860
Standard Dev.	41.17%		Minimum	0.0038
Count	11.0000		Maximum	0.9899
Effective diameter 0.125 mm (Hazen 1911)				

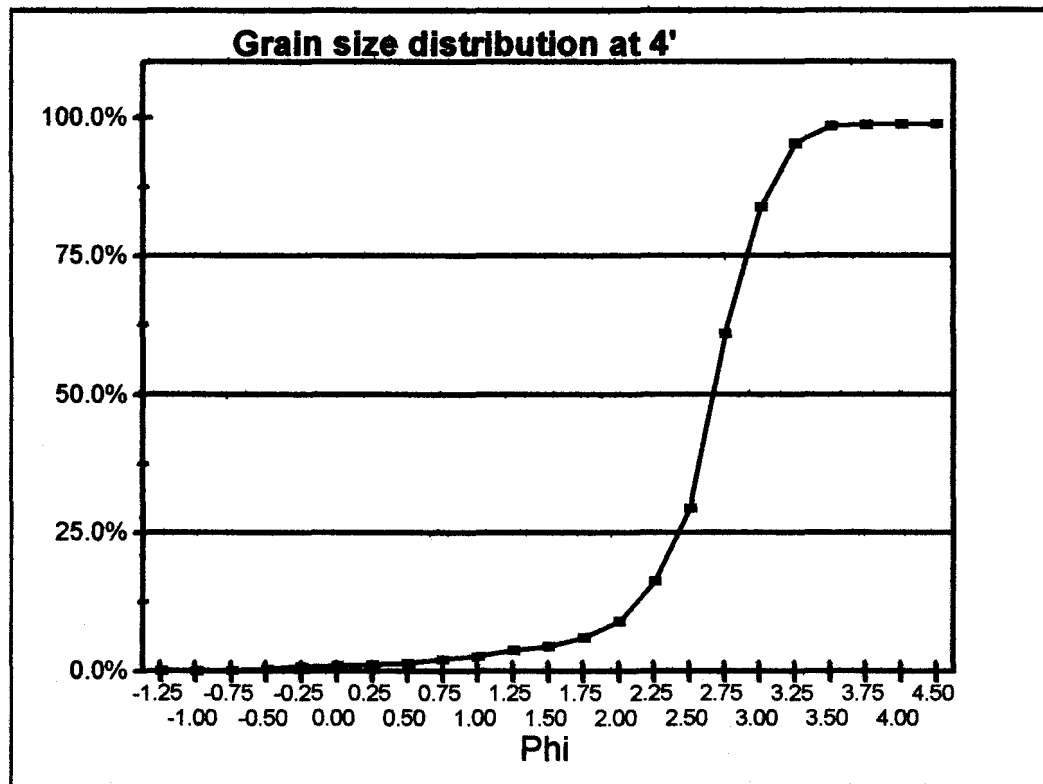


Appendix IV.
Particle size analysis for MW-0-LM

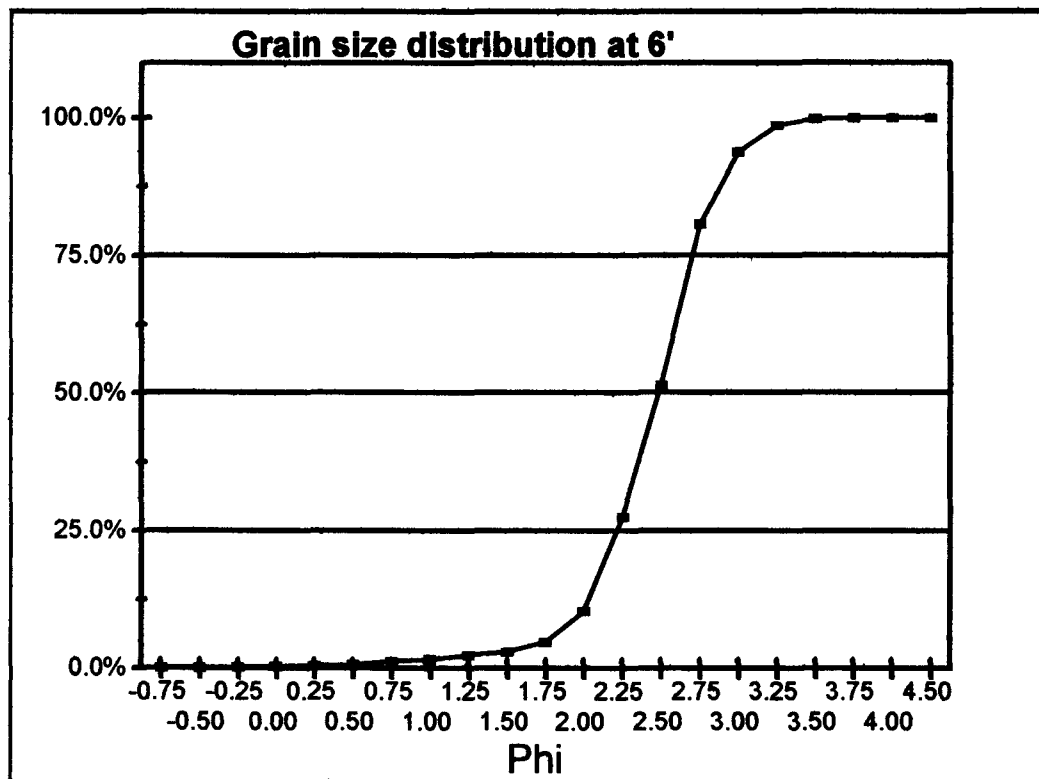
Statistical analysis of MW-0-LM @ depth 2				
	%	Phi		
Mean	43.97%	2.25	Kurtosis	-1.2908
Median	21.30%	2.00	Skewness	0.8025
Mode	32.41%	2.50	Range	1.0041
Standard Dev.	42.72%		Minimum	0.0044
Count	18.0000		Maximum	1.0085
Effective diameter 0.125 mm (Hazen 1911)				



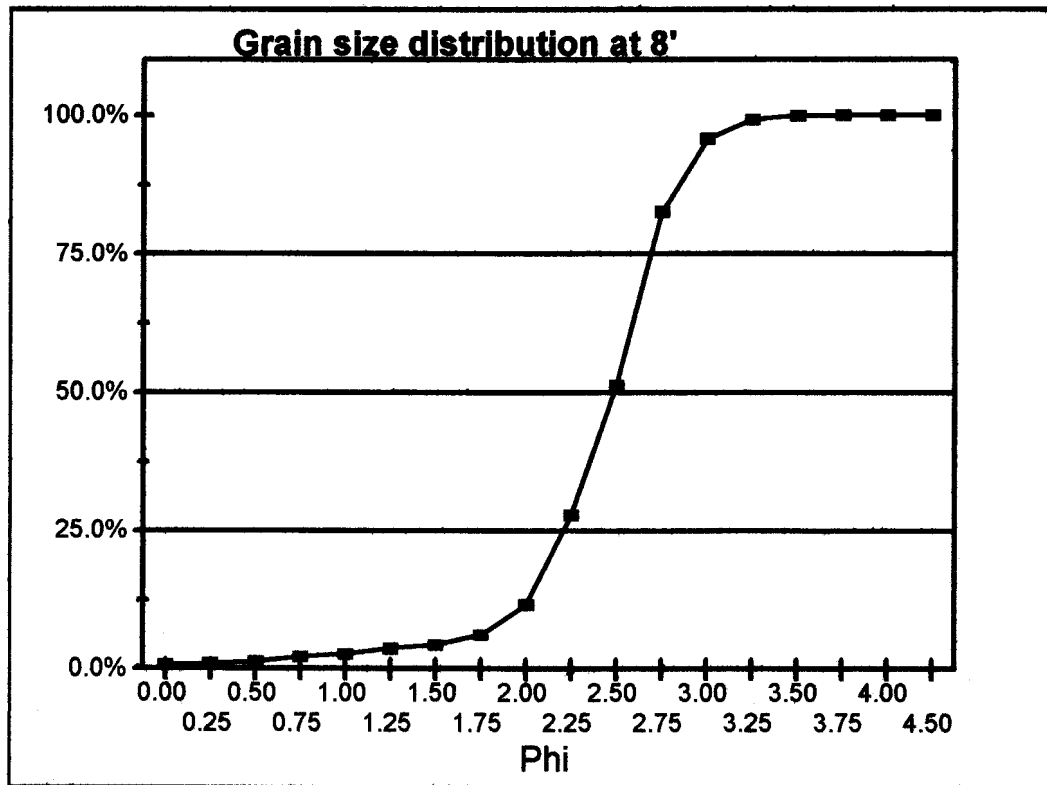
Statistical analysis of MW-0-LM @ depth 4				
	%	Phi		
Mean	31.00%	2.50	Kurtosis	-0.9146
Median	4.42%	1.50	Skewness	0.9965
Mode	31.62%	2.75	Range	0.9878
Standard Dev.	40.62%		Minimum	0.0006
Count	23.0000		Maximum	0.9883
Effective diameter 0.125 mm (Hazen 1911)				



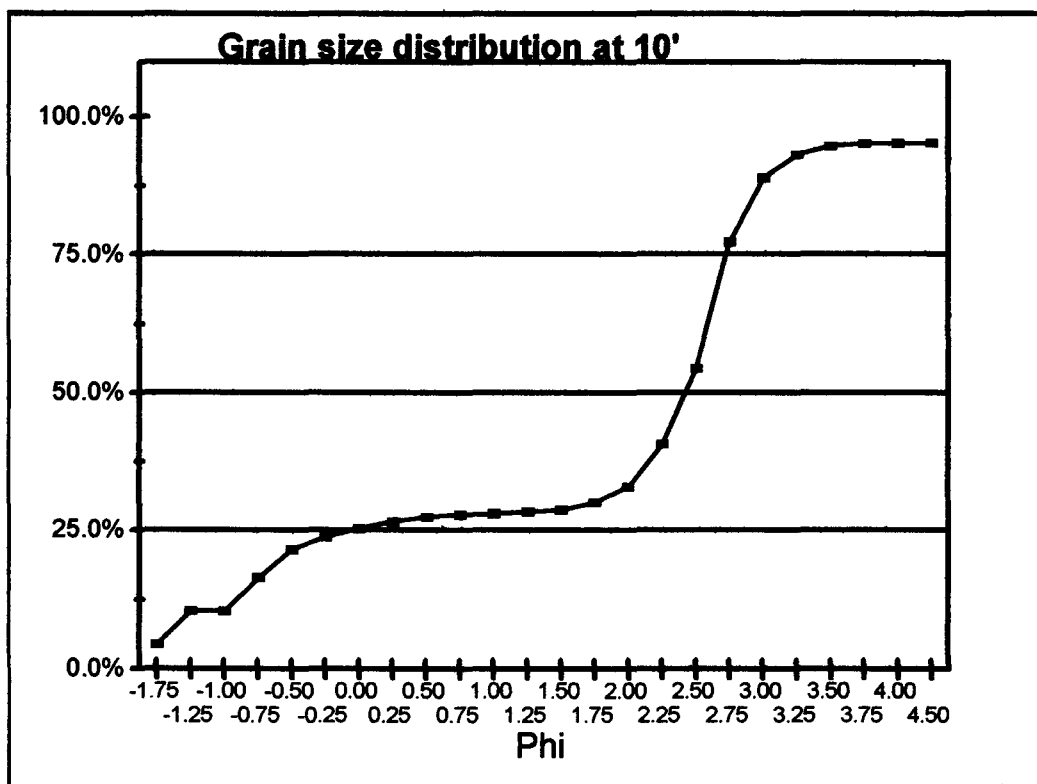
Statistical analysis of MW-0-LM @ depth 6				
	%	Phi		
Mean	36.91%	2.25	Kurtosis	-1.2722
Median	4.72%	1.75	Skewness	0.8298
Mode	29.38%	2.75	Range	0.9983
Standard Dev.	43.49%		Minimum	0.0005
Count	21.0000		Maximum	0.9988
Effective diameter 0.149 mm (Hazen 1911)				



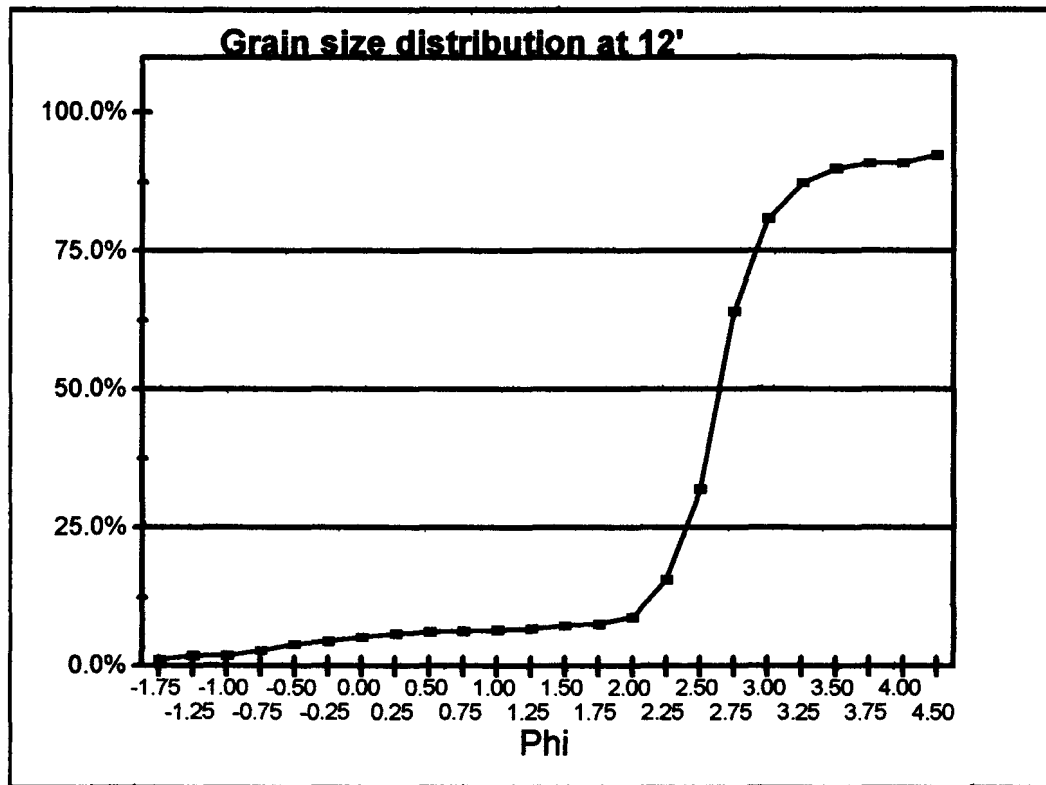
Statistical analysis of MW-0-LM @ depth 8				
	%	Phi		
Mean	43.86%	2.25	Kurtosis	-1.2816
Median	19.68%	2.00	Skewness	0.8255
Mode	31.34%	2.75	Range	0.9929
Standard Dev.	43.96%		Minimum	0.0068
Count	18.0000		Maximum	0.9998
Effective diameter 0.149 mm (Hazen 1911)				



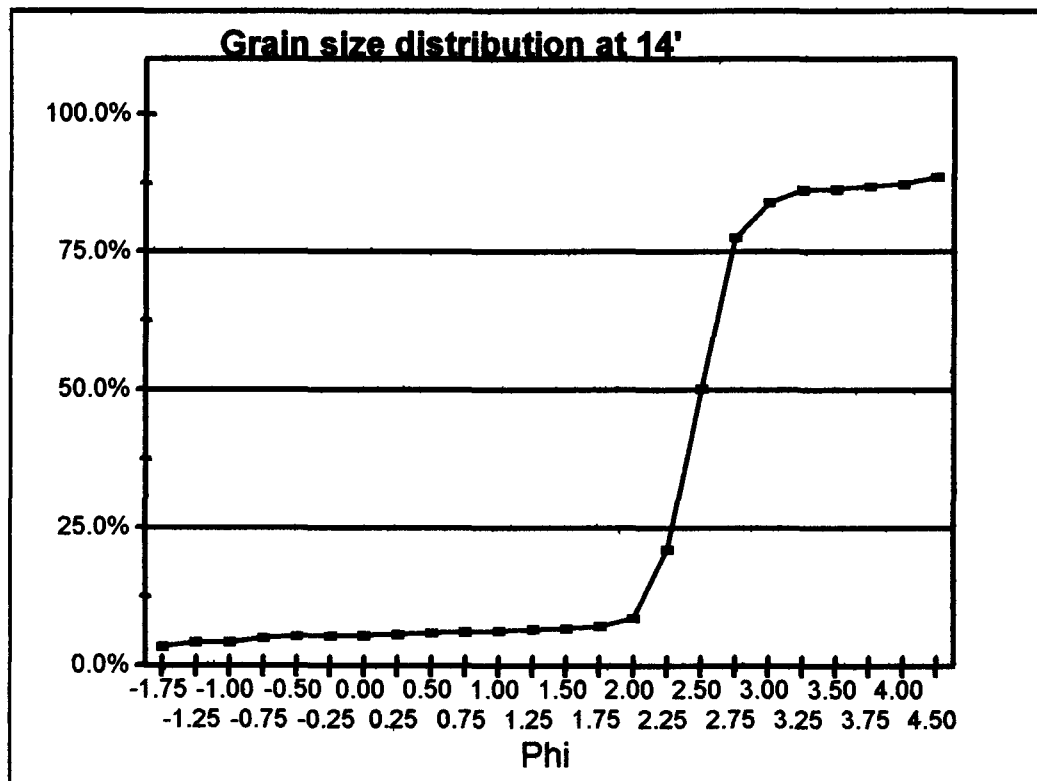
Statistical analysis of MW-0-LM @ depth 10				
	%	Phi		
Mean	44.83%	2.25	Kurtosis	-1.1646
Median	28.50%	1.25	Skewness	0.7174
Mode	22.81%	2.75	Range	0.9091
Standard Dev.	31.53%		Minimum	0.0439
Count	24.0000		Maximum	0.9530
Effective diameter 0.125 mm (Hazen 1911)				



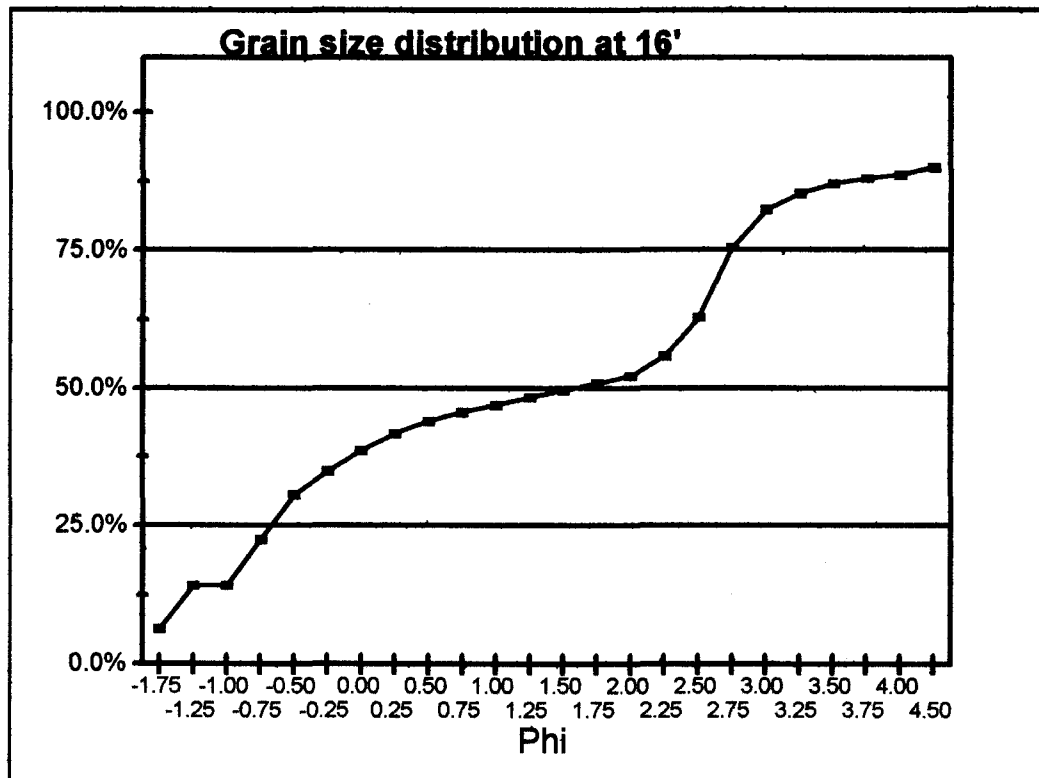
Statistical analysis of MW-0-LM @ depth 12				
	%	Phi		
Mean	29.96%	2.25	Kurtosis	-1.0201
Median	6.96%	1.25	Skewness	0.9593
Mode	32.11%	2.75	Range	0.9111
Standard Dev.	36.21%		Minimum	0.0107
Count	24.0000		Maximum	0.9218
Effective diameter 0.088 mm (Hazen 1911)				



Statistical analysis of MW-0-LM @ depth 14				
	%	Phi		
Mean	31.36%	2.25	Kurtosis	-1.3222
Median	6.56%	1.25	Skewness	0.8291
Mode	29.10%	2.50	Range	0.8521
Standard Dev.	35.83%		Minimum	0.0338
Count	24.0000		Maximum	0.8859
Effective diameter 0.044 mm (Hazen 1911)				

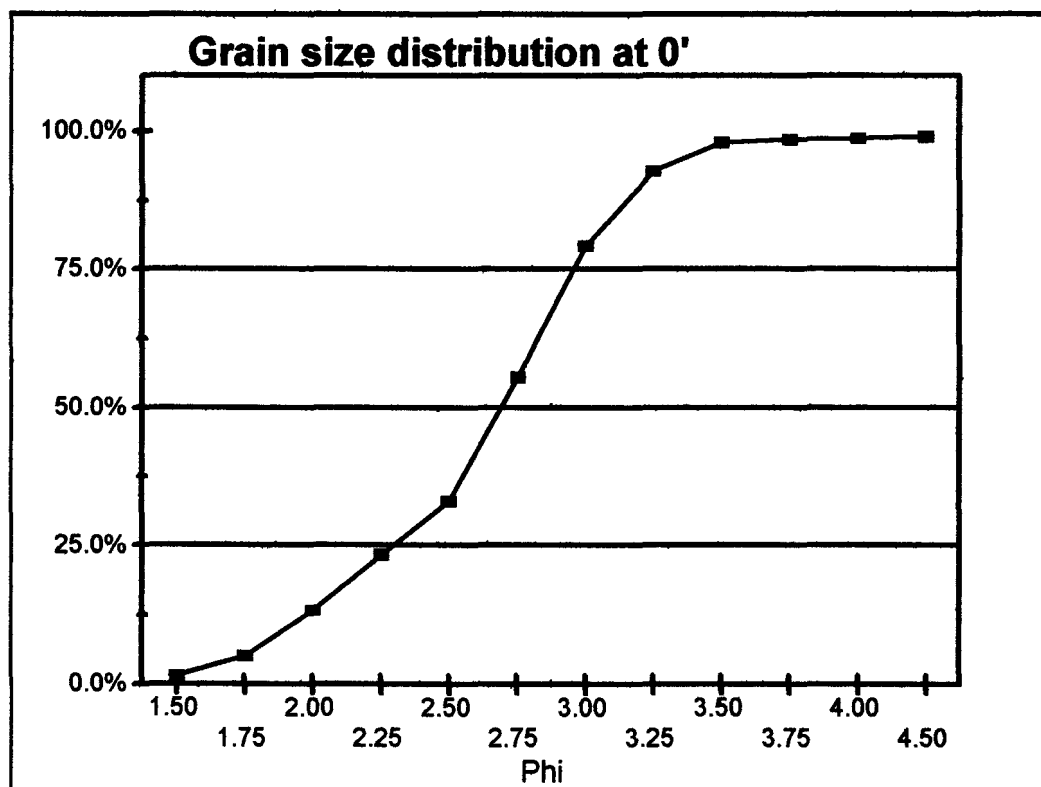


Statistical analysis of MW-0-LM @ depth 16				
	%	Phi		
Mean	52.27%	2.00	Kurtosis	-0.9225
Median	48.91%	1.25	Skewness	0.0254
Mode	12.63%	2.75	Range	0.8368
Standard Dev.	25.01%		Minimum	0.0624
Count	24.0000		Maximum	0.8991
Effective diameter 0.044 mm (Hazen 1911)				

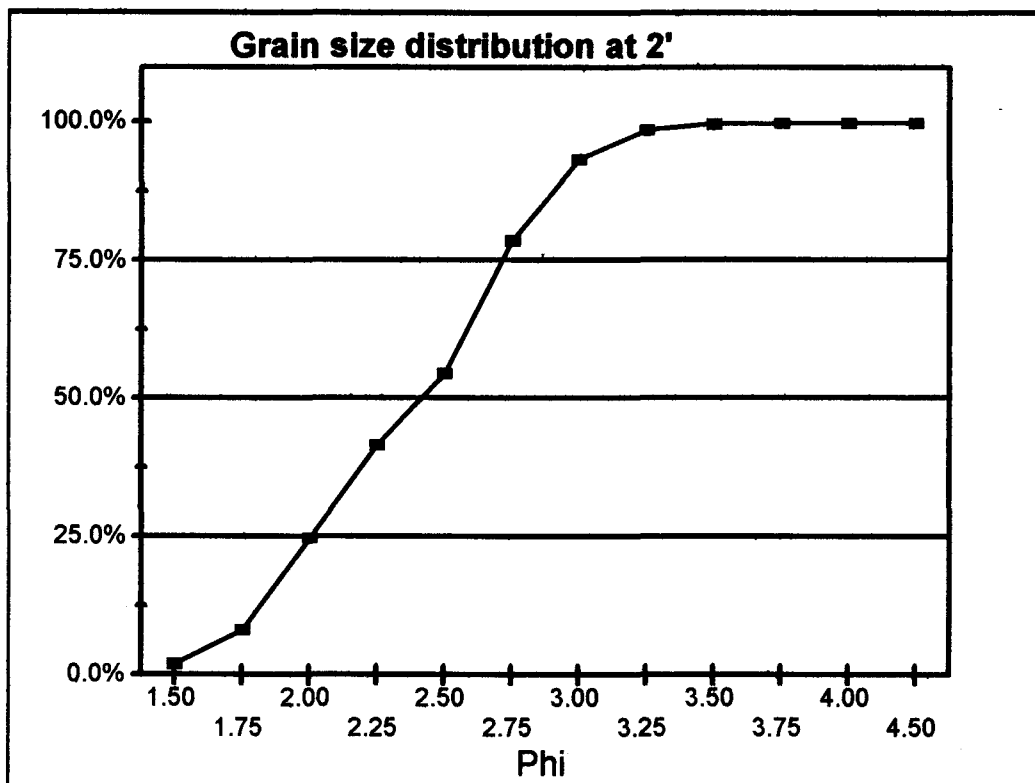


Appendix V.
Particle size analysis for MW-15-GF

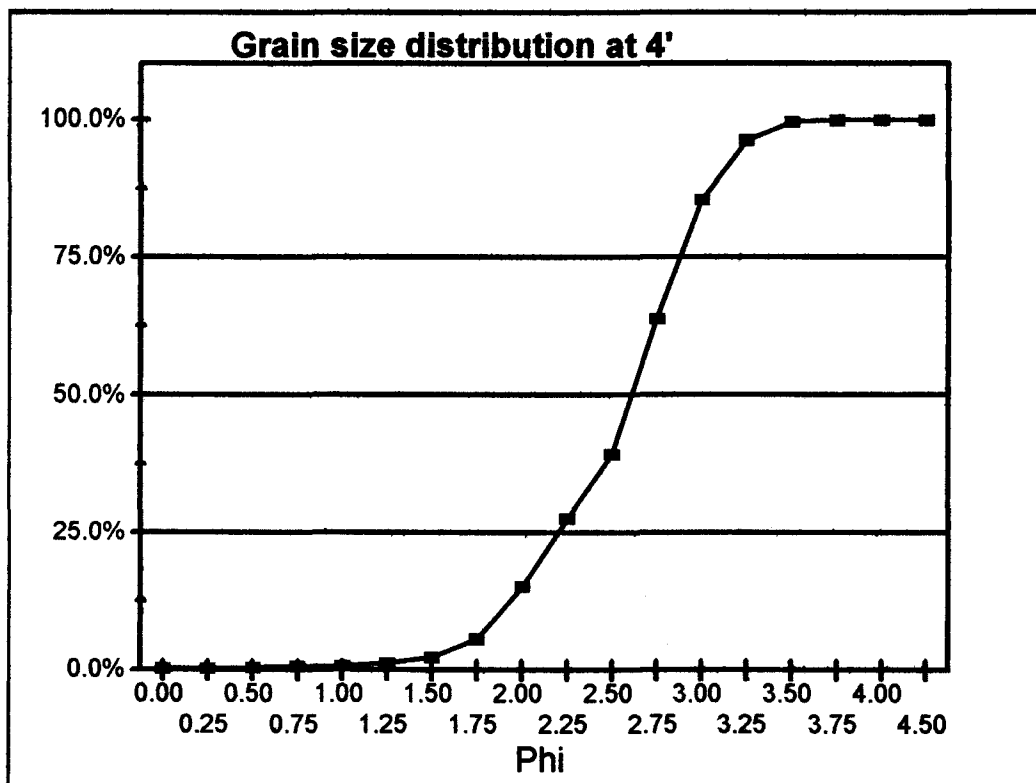
Statistical analysis of MW-15-GF @ depth 0				
	%	Phi		
Mean	58.10%	2.75	Kurtosis	-0.8755
Median	67.28%	2.75	Skewness	0.9828
Mode	23.62%	3.00	Range	0.9750
Standard Dev.	39.95%		Minimum	0.0147
Count	12.0000		Maximum	0.9897
Effective diameter 0.125 mm (Hazen 1911)				



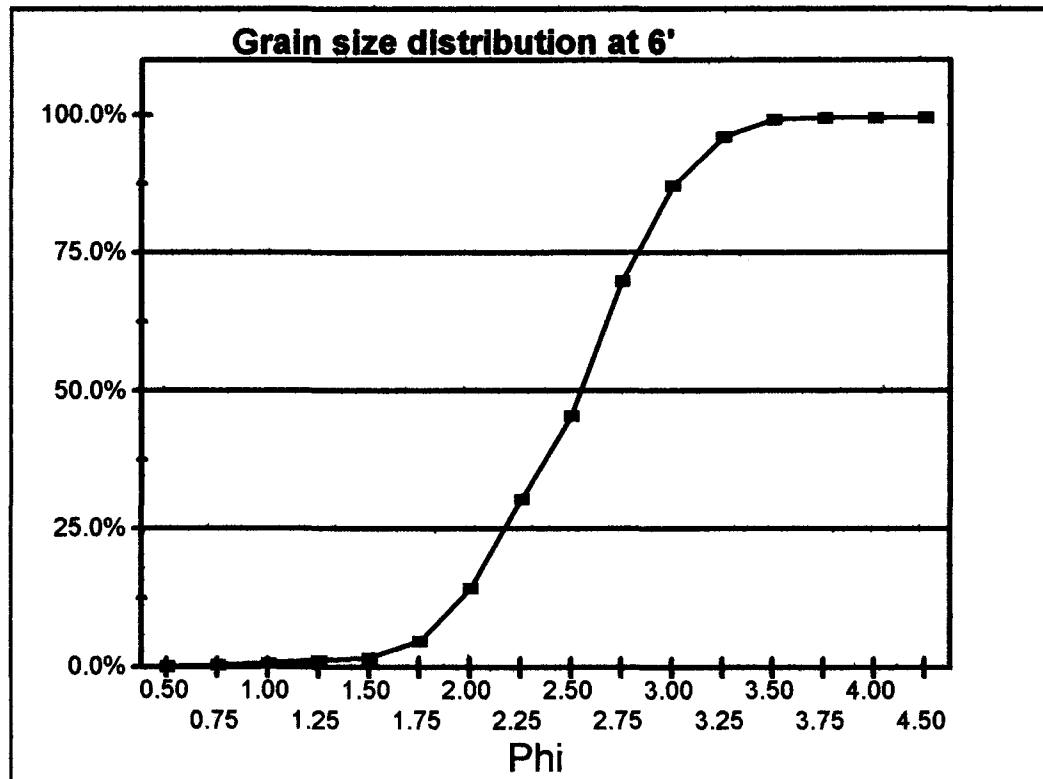
Statistical analysis of MW-15-GF @ depth 2				
	%	Phi		
Mean	66.56%	2.50	Kurtosis	-1.3525
Median	85.79%	2.75	Skewness	0.7458
Mode	24.09%	2.75	Range	0.9778
Standard Dev.	36.94%		Minimum	0.0188
Count	12.0000		Maximum	0.9966
Effective diameter 0.149 mm (Hazen 1911)				



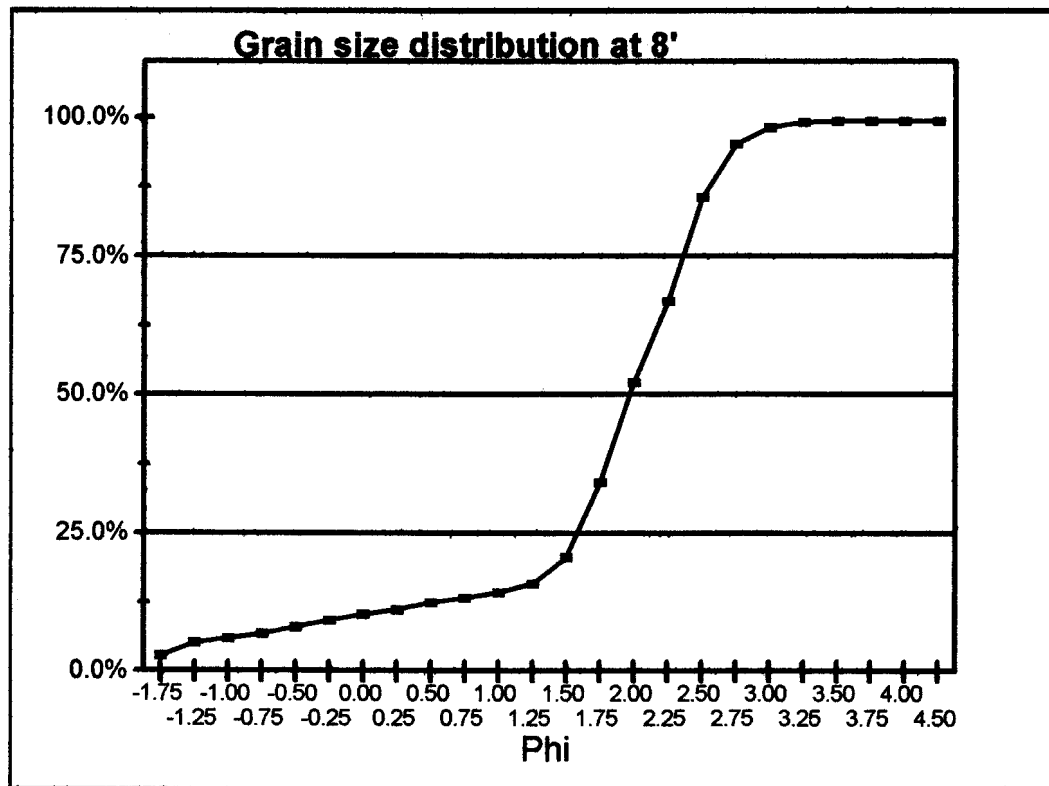
Statistical analysis of MW-15-GF @ depth 4				
	%	Phi		
Mean	40.94%	2.50	Kurtosis	-1.0317
Median	21.30%	2.00	Skewness	0.9147
Mode	24.51%	2.75	Range	0.9968
Standard Dev.	42.68%		Minimum	0.0020
Count	18.0000		Maximum	0.9968
Effective diameter 0.125 mm (Hazen 1911)				



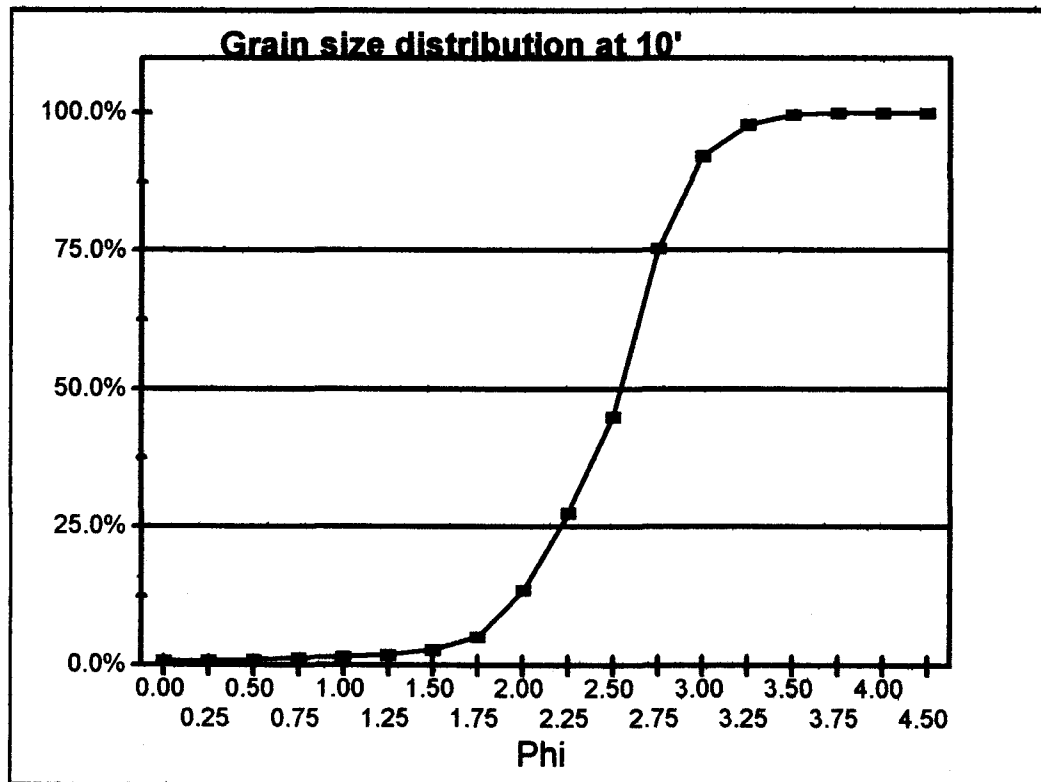
Statistical analysis of MW-15-GF @ depth 6				
	%	Phi		
Mean	46.78%	2.50	Kurtosis	-1.1545
Median	37.87%	2.25	Skewness	0.8603
Mode	24.35%	2.75	Range	0.9940
Standard Dev.	42.78%		Minimum	0.0004
Count	16.0000		Maximum	0.9943
Effective diameter 0.125 mm (Hazen 1911)				



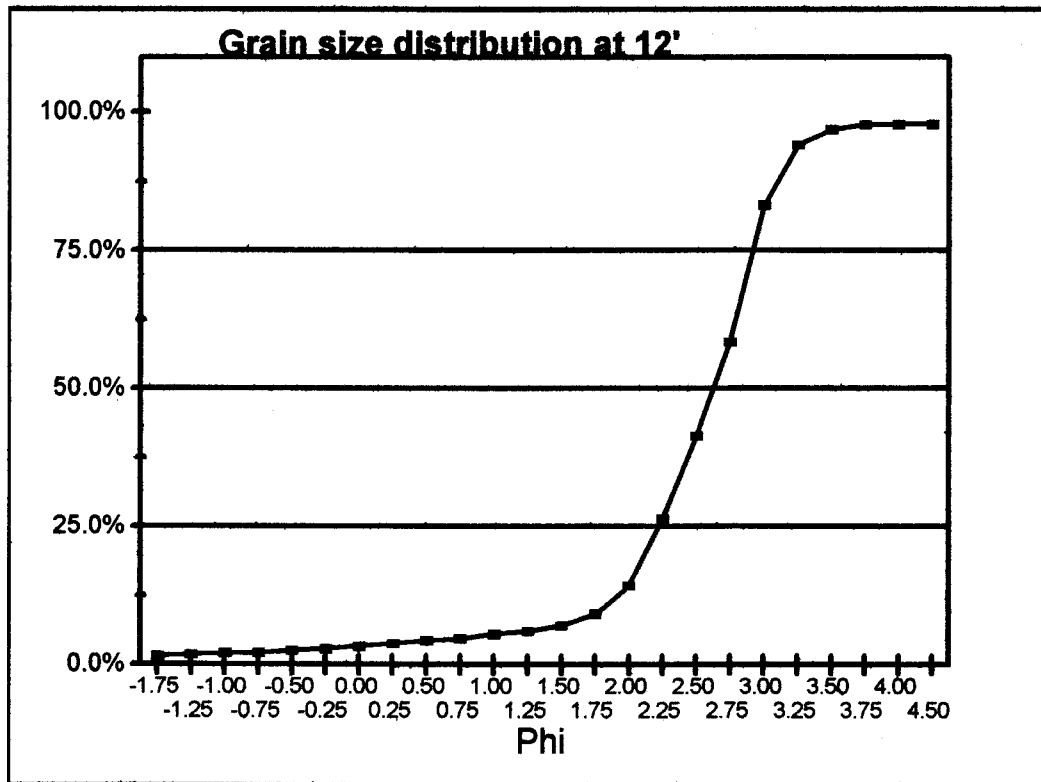
Statistical analysis of MW-15-GF @ depth 8				
	%	Phi		
Mean	44.26%	1.75	Kurtosis	-1.7366
Median	18.17%	1.25	Skewness	0.4642
Mode	18.71%	2.50	Range	0.9650
Standard Dev.	39.90%		Minimum	0.0277
Count	24.0000		Maximum	0.9927
Effective diameter 0.177 mm (Hazen 1911)				



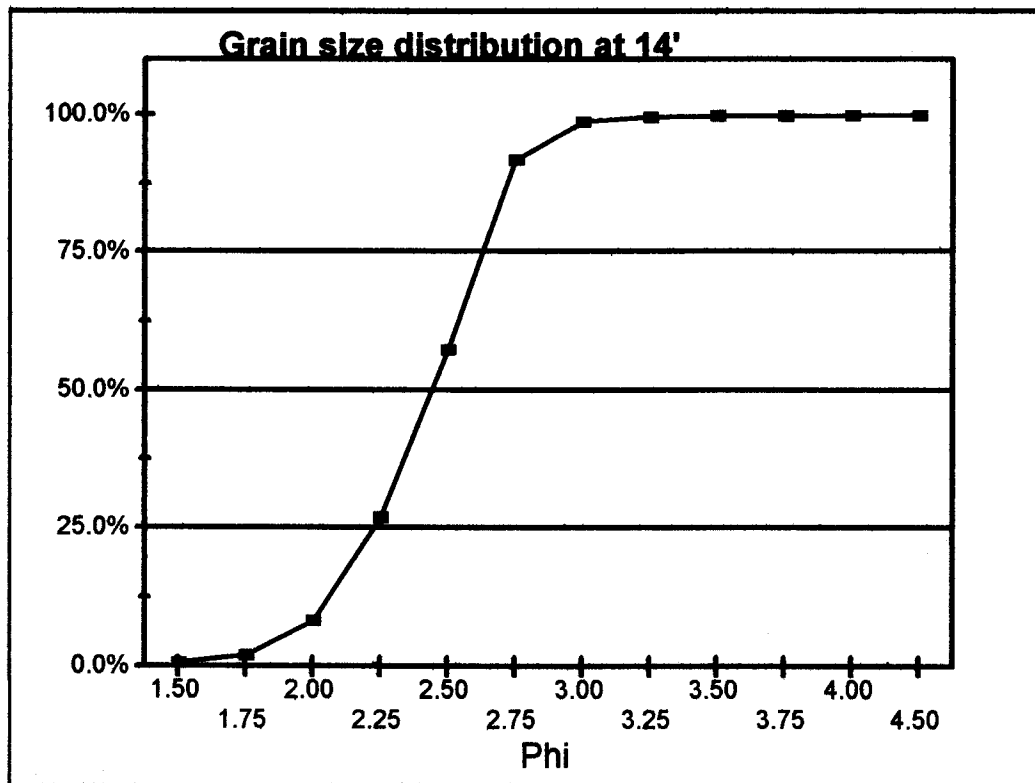
Statistical analysis of MW-15-GF @ depth 10				
	%	Phi		
Mean	42.46%	2.25	Kurtosis	-1.1888
Median	20.42%	2.00	Skewness	0.8609
Mode	30.43%	2.75	Range	0.9927
Standard Dev.	43.50%		Minimum	0.0062
Count	18.0000		Maximum	0.9989
Effective diameter 0.149 mm (Hazen 1911)				



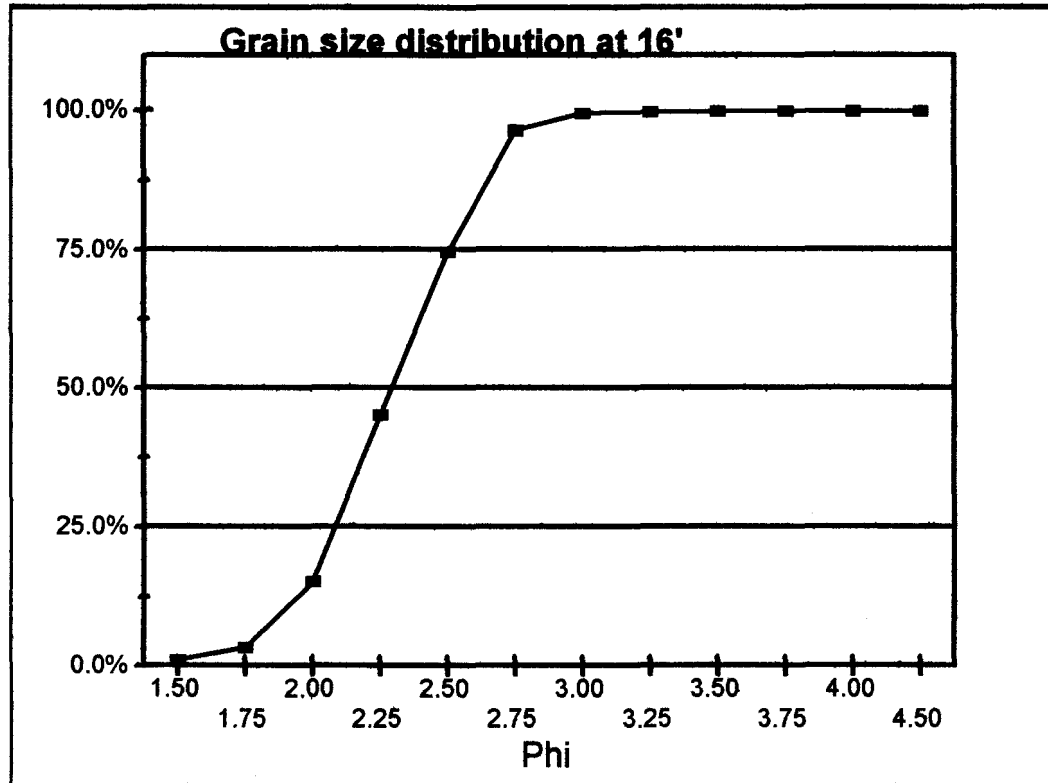
Statistical analysis of MW-15-GF @ depth 12				
	%	Phi		
Mean	31.74%	2.25	Kurtosis	-0.9736
Median	6.39%	1.25	Skewness	0.9396
Mode	24.86%	3.00	Range	0.9629
Standard Dev.	38.63%		Minimum	0.0138
Count	24.0000		Maximum	0.9767
Effective diameter 0.125 mm (Hazen 1911)				



Statistical analysis of MW-15-GF @ depth 14				
	%	Phi		
Mean	65.28%	2.50	Kurtosis	-1.3685
Median	95.15%	2.75	Skewness	0.7979
Mode	34.44%	2.75	Range	0.9917
Standard Dev.	41.57%		Minimum	0.0060
Count	12.0000		Maximum	0.9977
Effective diameter 0.177 mm (Hazen 1911)				

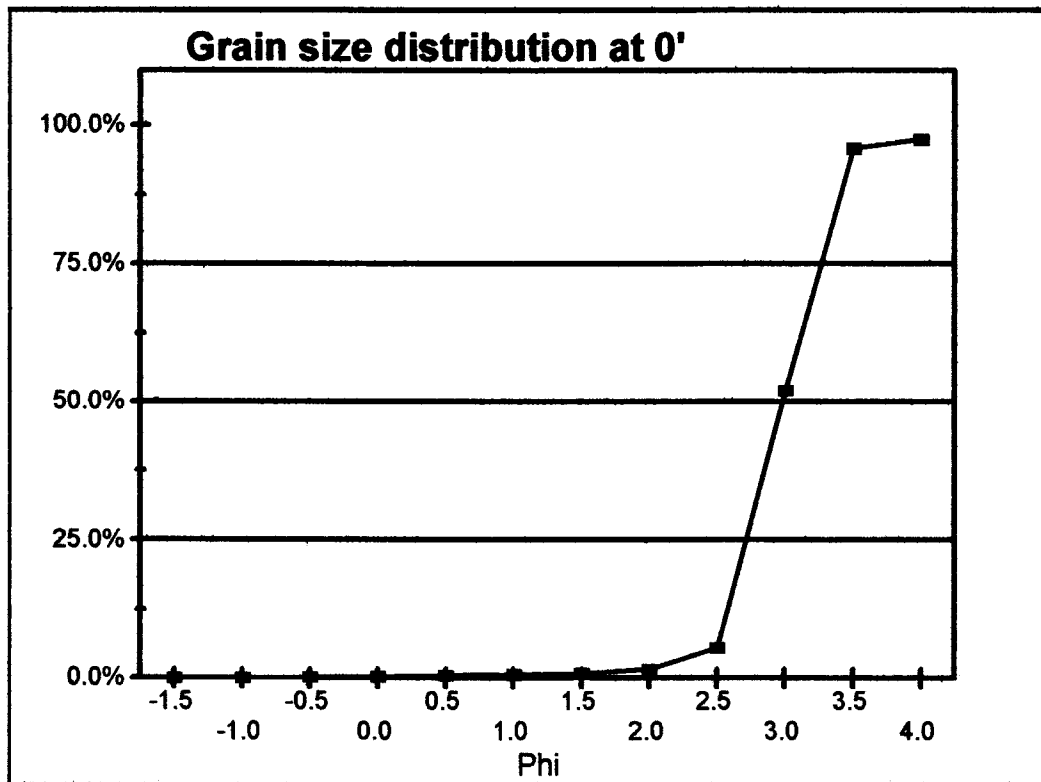


Statistical analysis of MW-15-GF @ depth 16				
	%	Phi		
Mean	69.38%	2.25	Kurtosis	-1.5568
Median	97.80%	2.75	Skewness	0.6825
Mode	29.93%	2.25	Range	0.9879
Standard Dev.	39.62%		Minimum	0.0089
Count	12.0000		Maximum	0.9968
Effective diameter 0.177 mm (Hazen 1911)				

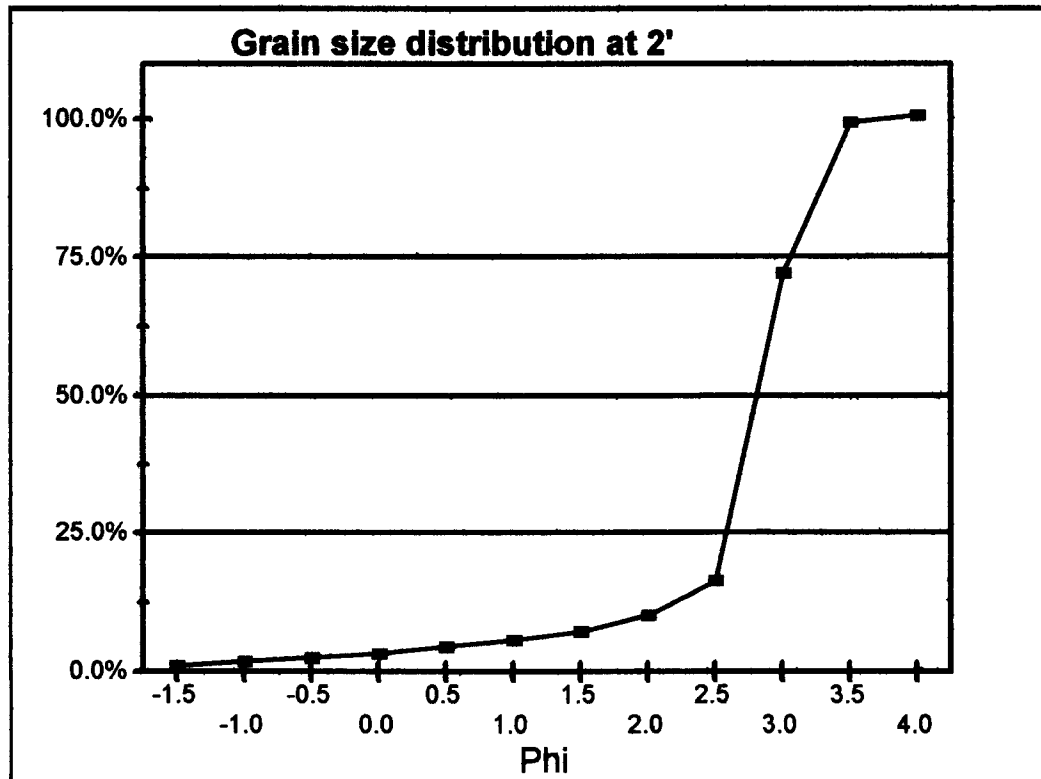


Appendix VI.
Particle size analysis for MW-15-GM

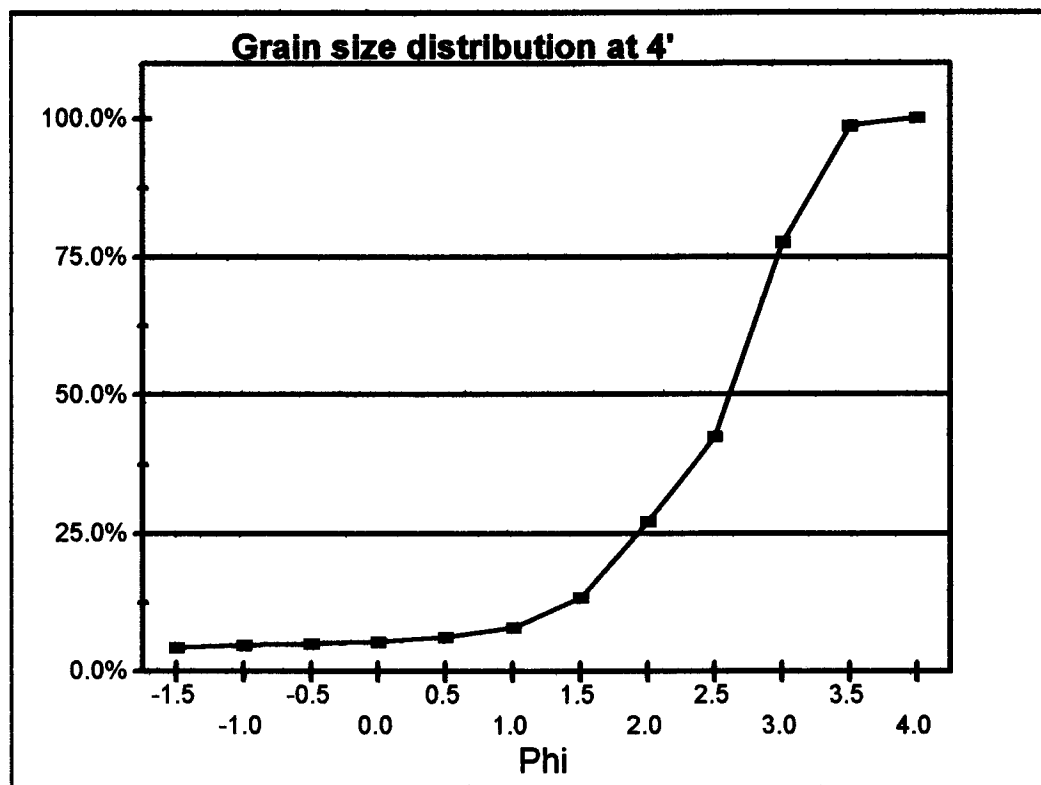
Statistical analysis of MW-15-GM @ depth 0				
	%	Phi		
Mean	21.14%	2.50	Kurtosis	0.9588
Median	0.60%	1.00	Skewness	1.5940
Mode	46.57%	3.00	Range	0.9734
Standard Dev.	36.53%		Minimum	0.0000
Count	12.0000		Maximum	0.9734
Effective diameter 0.125 mm (Hazen 1911)				



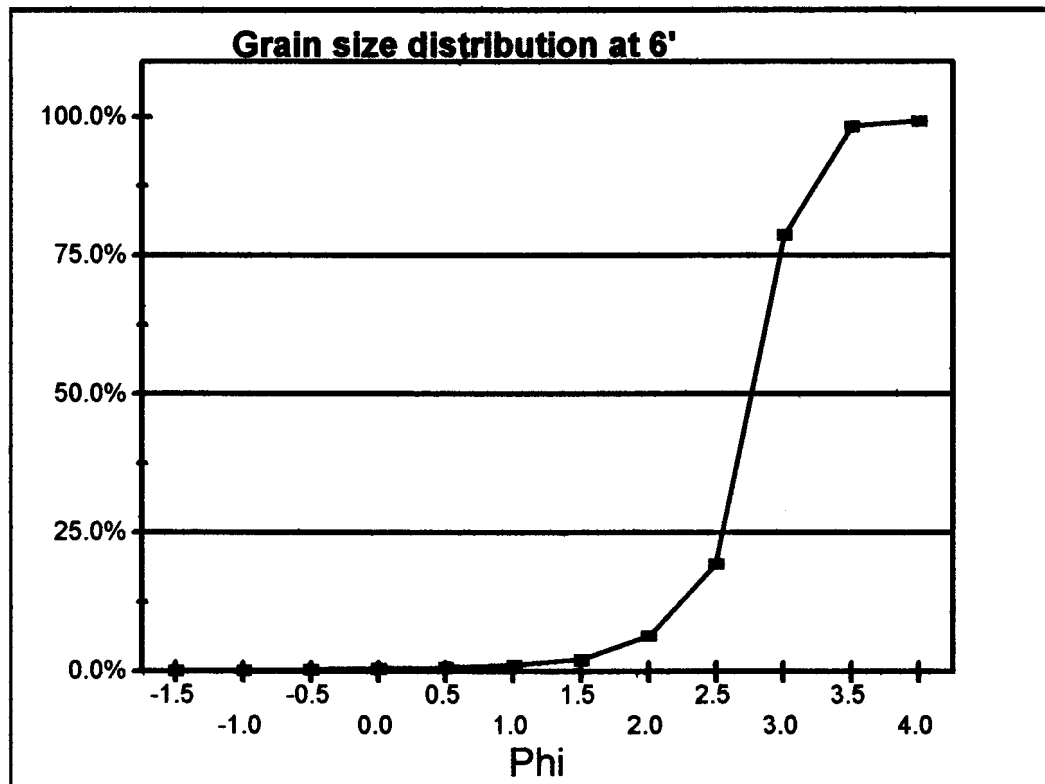
Statistical analysis of MW-15-GM @ depth 2				
	%	Phi		
Mean	26.91%	2.50	Kurtosis	0.1706
Median	6.27%	1.00	Skewness	1.3953
Mode	55.69%	3.00	Range	0.9973
Standard Dev.	37.58%		Minimum	0.0086
Count	12.0000		Maximum	1.0059
Effective diameter 0.125 mm (Hazen 1911)				



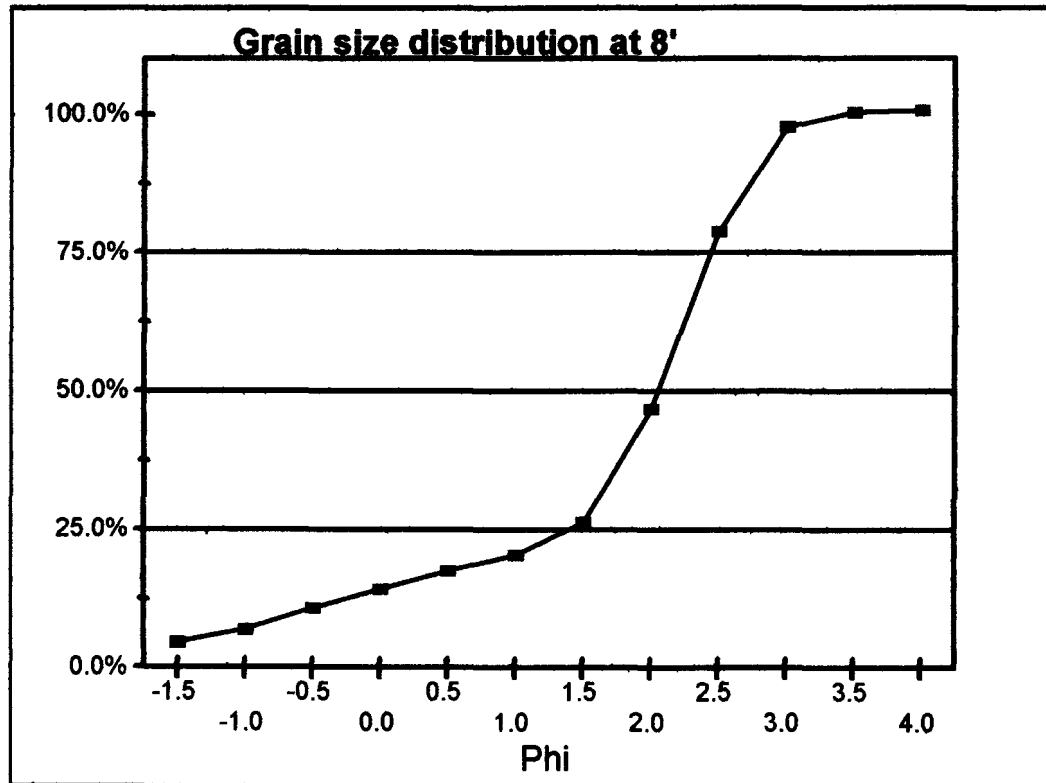
Statistical analysis of MW-15-GM @ depth 4				
	%	Phi		
Mean	32.67%	2.00	Kurtosis	-0.4611
Median	10.59%	1.00	Skewness	1.1096
Mode	35.29%	3.00	Range	0.9559
Standard Dev.	36.28%		Minimum	0.0433
Count	12.0000		Maximum	0.9992
Effective diameter 0.125 mm (Hazen 1911)				



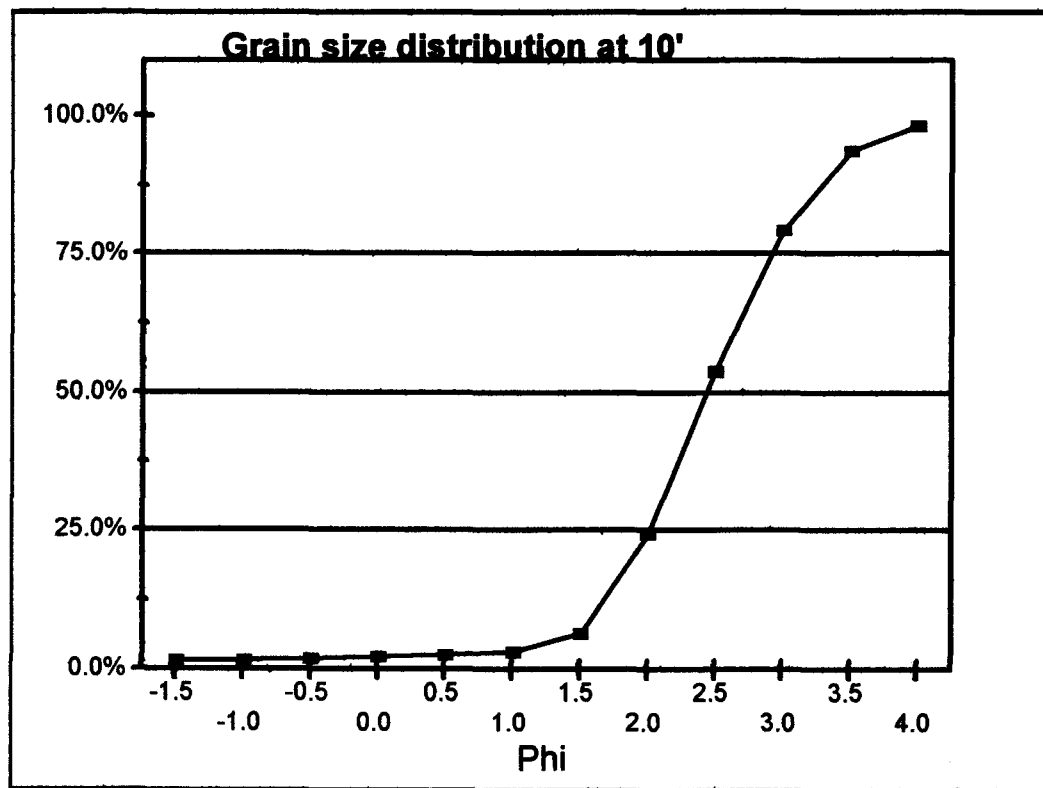
Statistical analysis of MW-15-GM @ depth 6				
	%	Phi		
Mean	25.52%	2.50	Kurtosis	-0.1385
Median	1.55%	1.00	Skewness	1.3197
Mode	59.29%	3.00	Range	0.9910
Standard Dev.	39.00%		Minimum	0.0008
Count	12.0000		Maximum	0.9917
Effective diameter 0.125 mm (Hazen 1911)				



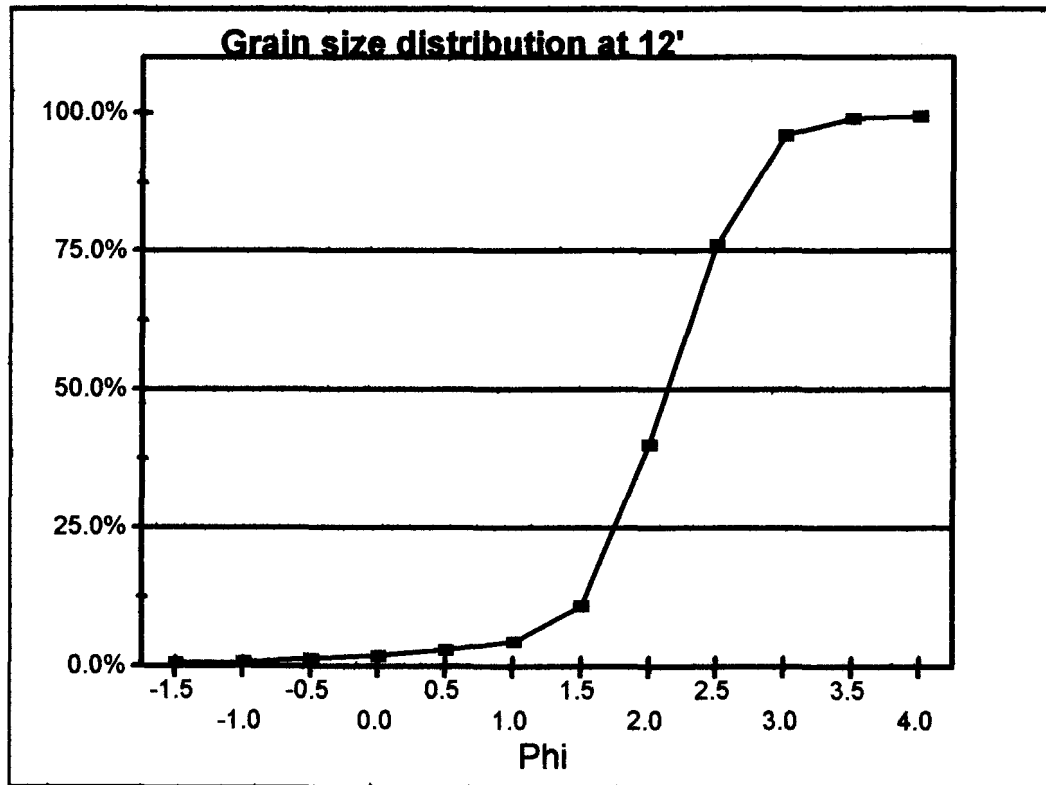
Statistical analysis of MW-15-GM @ depth 8				
	%	Phi		
Mean	43.73%	1.50	Kurtosis	-1.5389
Median	23.35%	1.00	Skewness	0.6428
Mode	32.07%	2.50	Range	0.9621
Standard Dev.	37.66%		Minimum	0.0448
Count	12.0000		Maximum	1.0069
Effective diameter 0.177 mm (Hazen 1911)				



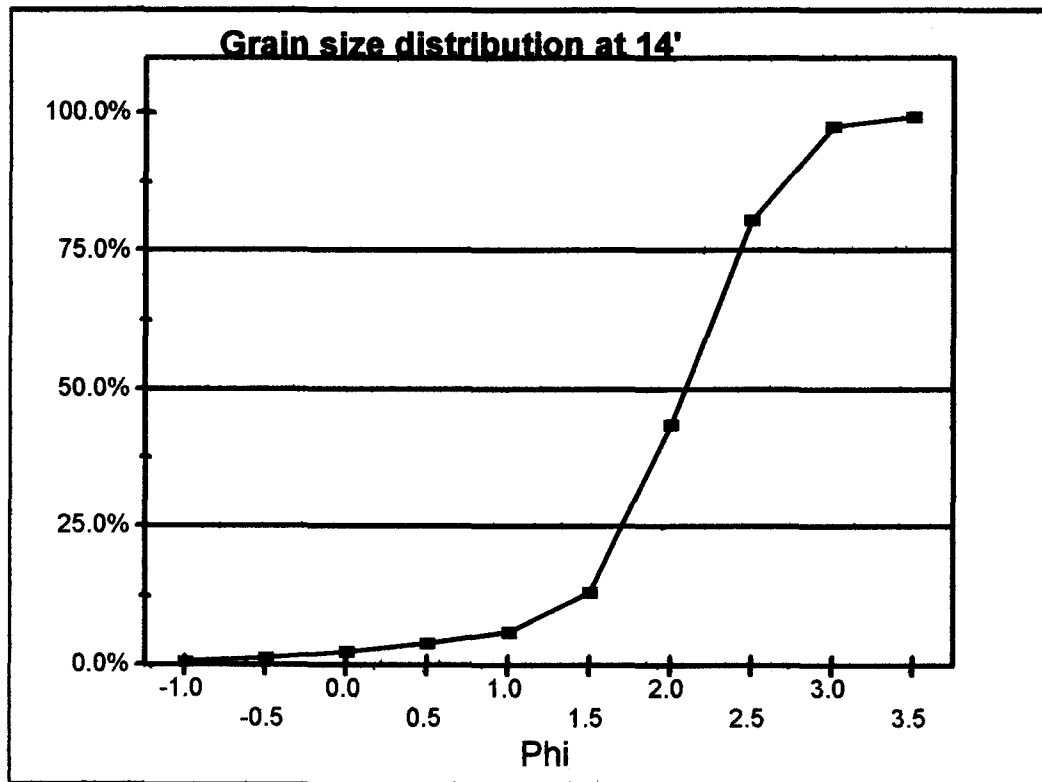
Statistical analysis of MW-15-GM @ depth 10				
	%	Phi		
Mean	33.32%	2.00	Kurtosis	-1.2516
Median	6.34%	1.50	Skewness	0.8144
Mode	29.47%	2.50	Range	0.9664
Standard Dev.	38.16%		Minimum	0.0156
Count	11.0000		Maximum	0.9820
Effective diameter 0.125 mm (Hazen 1911)				



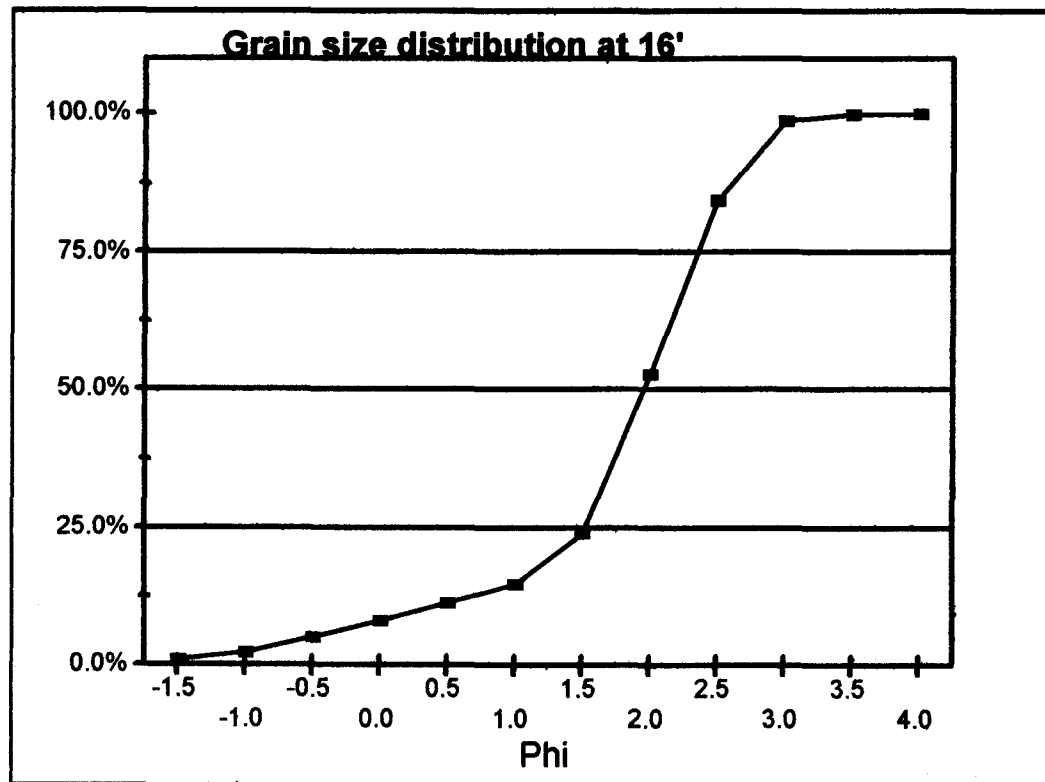
Statistical analysis of MW-15-GM @ depth 12				
	%	Phi		
Mean	36.07%	1.50	Kurtosis	-1.5782
Median	7.59%	1.00	Skewness	0.6968
Mode	36.12%	2.50	Range	0.9881
Standard Dev.	41.66%		Minimum	0.0059
Count	12.0000		Maximum	0.9939
Effective diameter 0.177 mm (Hazen 1911)				



Statistical analysis of MW-15-GM @ depth 14				
	%	Phi		
Mean	37.27%	1.50	Kurtosis	-1.6594
Median	9.52%	1.00	Skewness	0.6530
Mode	37.01%	2.50	Range	0.9925
Standard Dev.	42.00%		Minimum	0.0022
Count	12.0000		Maximum	0.9947
Effective diameter 0.177 mm (Hazen 1911)				

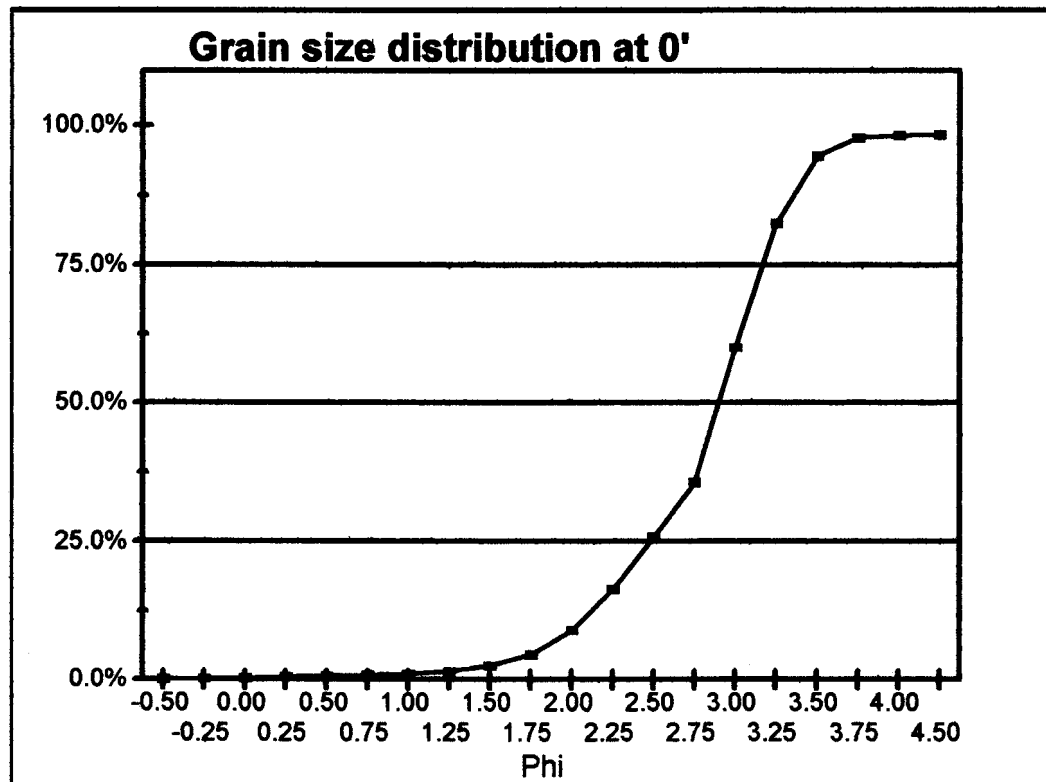


Statistical analysis of MW-15-GM @ depth 16				
	%	Phi		
Mean	41.73%	1.50	Kurtosis	-1.7362
Median	19.32%	1.00	Skewness	0.5518
Mode	31.76%	2.50	Range	0.9910
Standard Dev.	40.47%		Minimum	0.0083
Count	12.0000		Maximum	0.9993
Effective diameter 0.177 mm (Hazen 1911)				

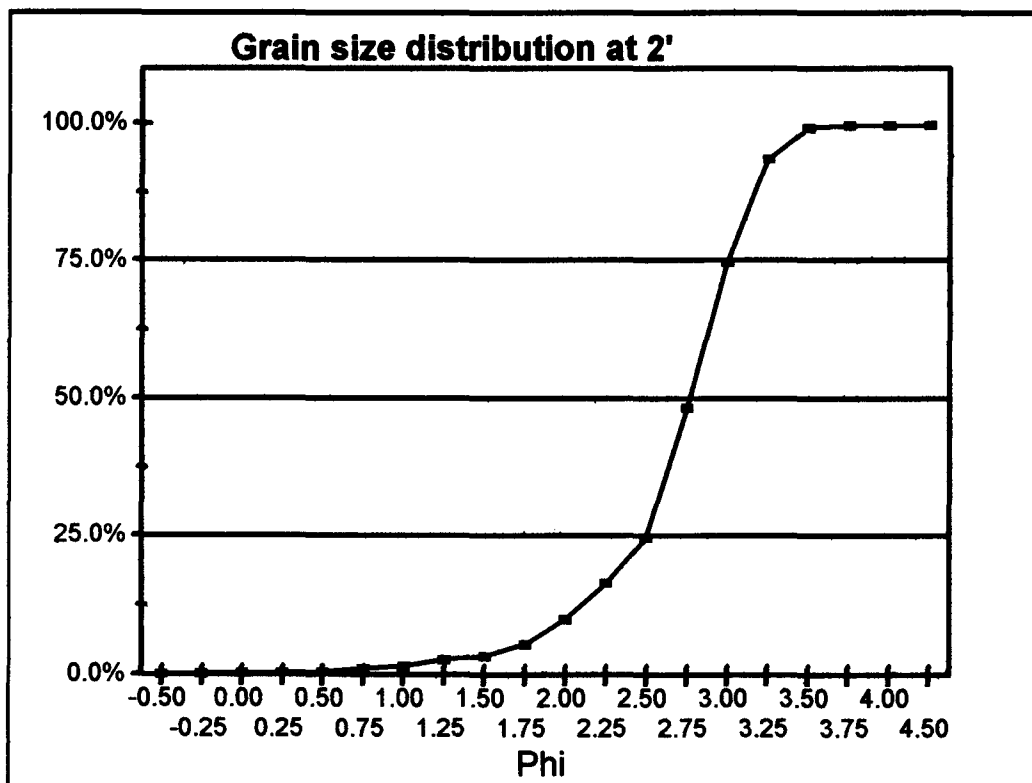


Appendix VII.
Particle size analysis for MW-15-LG

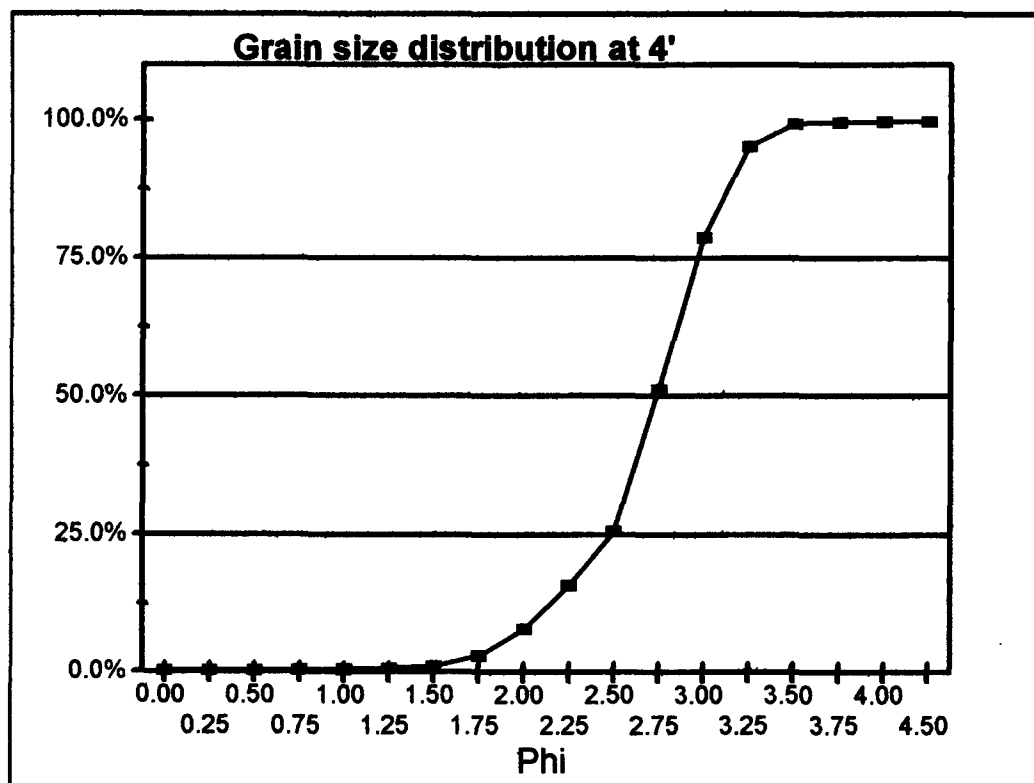
Statistical analysis of MW-15-LG @ depth 0				
	%	Phi		
Mean	31.42%	2.50	Kurtosis	-0.3599
Median	6.69%	1.75	Skewness	1.1774
Mode	24.31%	3.00	Range	0.9821
Standard Dev.	37.63%		Minimum	0.0001
Count	20.0000		Maximum	0.9822
Effective diameter 0.105 mm (Hazen 1911)				



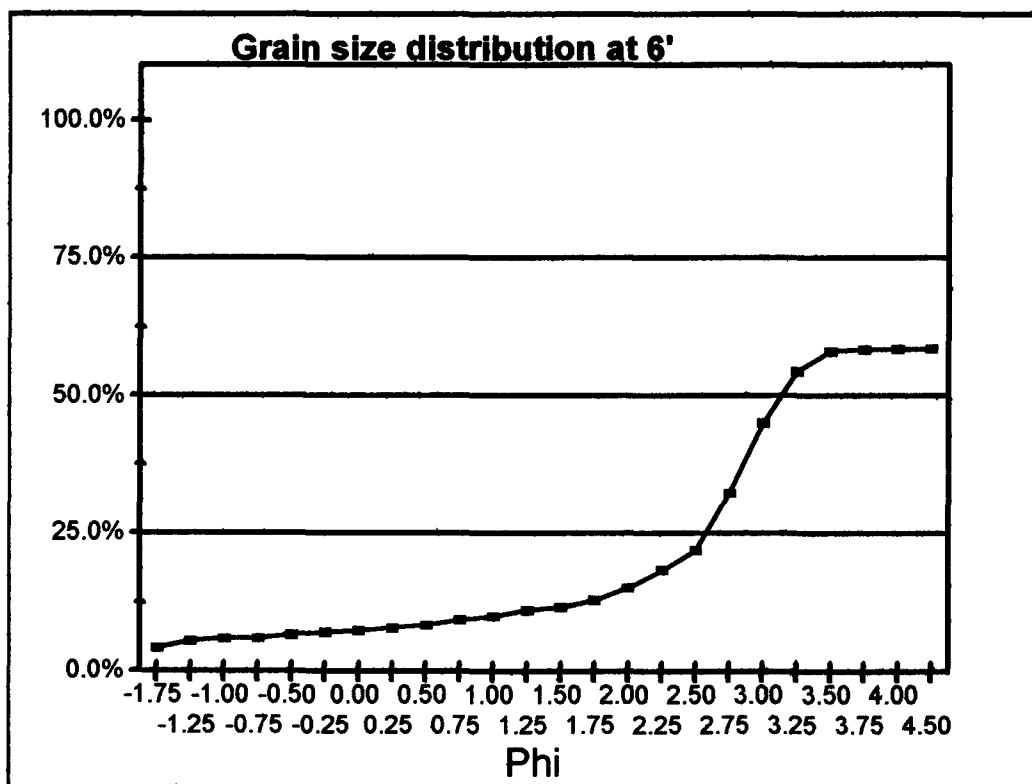
Statistical analysis of MW-15-LG @ depth 2				
	%	Phi		
Mean	33.99%	2.50	Kurtosis	-0.6746
Median	7.59%	1.75	Skewness	1.0813
Mode	26.38%	3.00	Range	0.9962
Standard Dev.	41.32%		Minimum	0.0005
Count	20.0000		Maximum	0.9967
Effective diameter 0.125 mm (Hazen 1911)				



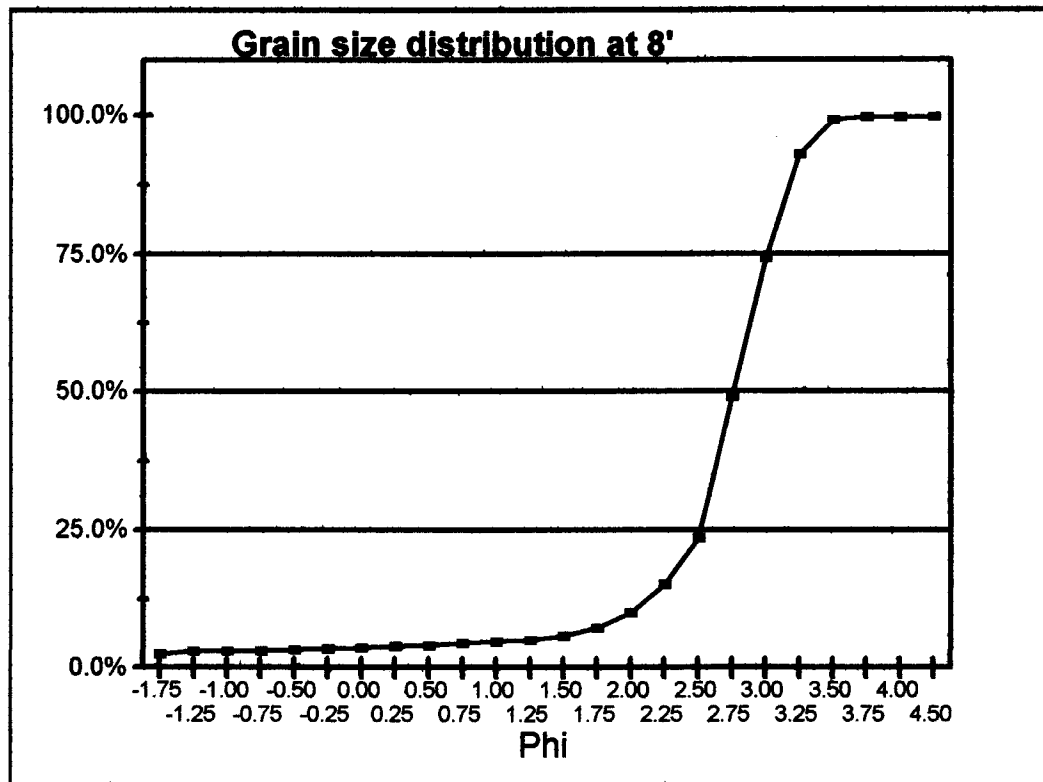
Statistical analysis of MW-15-LG @ depth 4				
	%	Phi		
Mean	37.68%	2.50	Kurtosis	-0.7552
Median	11.88%	2.00	Skewness	1.0569
Mode	27.55%	3.00	Range	0.9940
Standard Dev.	42.74%		Minimum	0.0018
Count	18.0000		Maximum	0.9957
Effective diameter 0.125 mm (Hazen 1911)				



Statistical analysis of MW-15-LG @ depth 6				
	%	Phi		
Mean	22.24%	2.50	Kurtosis	-0.7013
Median	11.33%	1.25	Skewness	1.0280
Mode	12.88%	3.00	Range	0.5446
Standard Dev.	20.26%		Minimum	0.0416
Count	24.0000		Maximum	0.5863
Effective diameter 0.044 mm (Hazen 1911)				

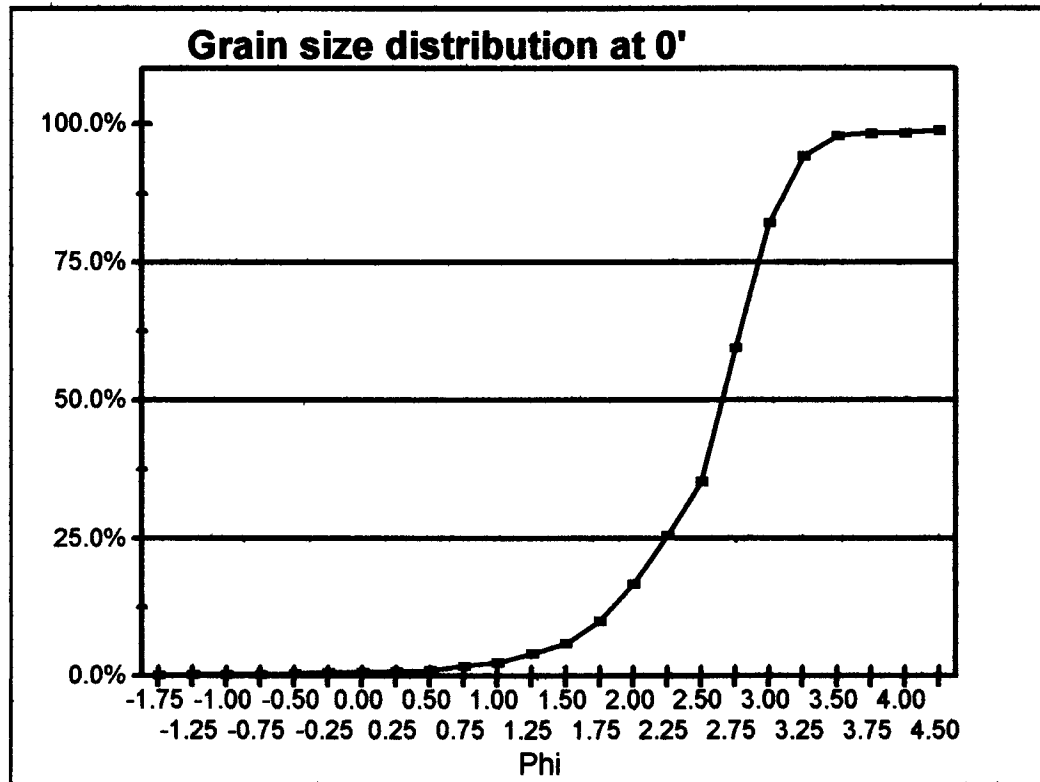


Statistical analysis of MW-15-LG @ depth 8				
	%	Phi		
Mean	29.94%	2.50	Kurtosis	-0.6333
Median	5.27%	1.25	Skewness	1.1075
Mode	25.41%	2.75	Range	0.9728
Standard Dev.	38.60%		Minimum	0.0239
Count	24.0000		Maximum	0.9966
Effective diameter 0.125 mm (Hazen 1911)				

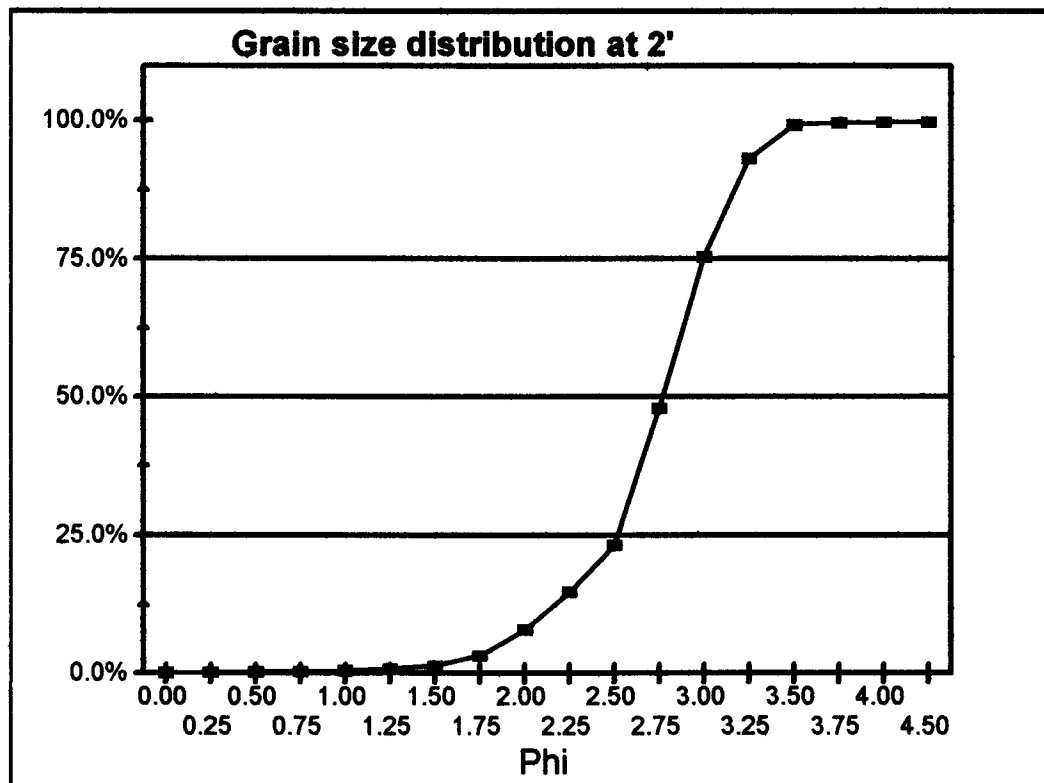


Appendix VIII.
Particle size analysis for MW-15-LM

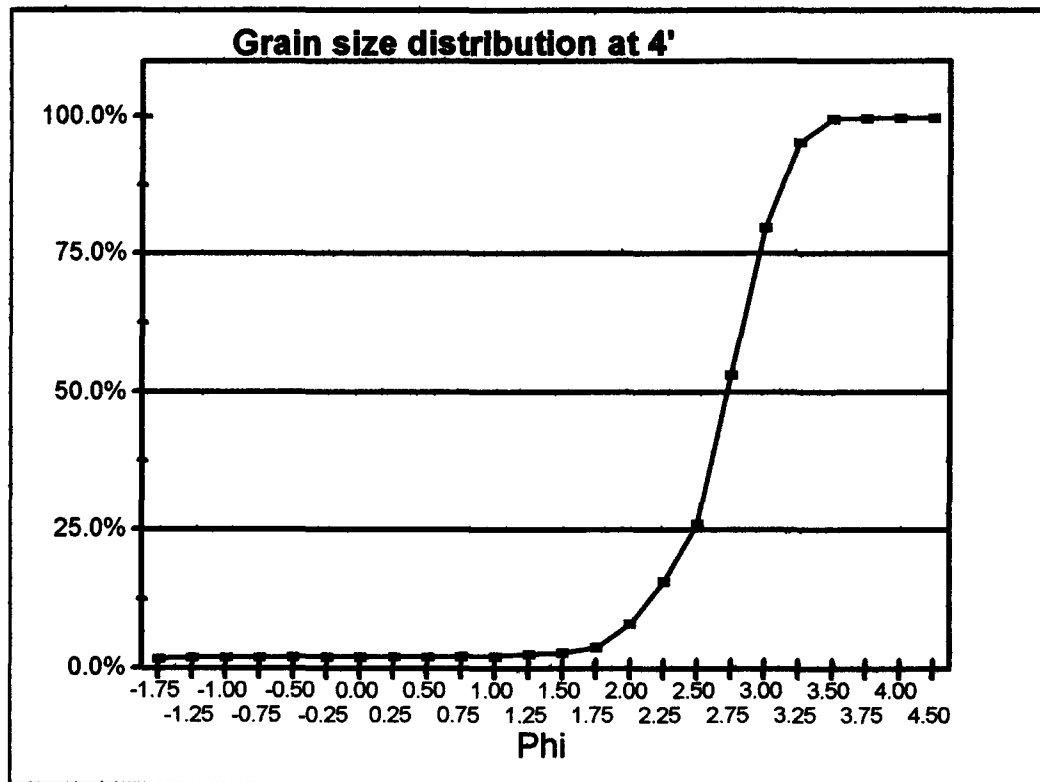
Statistical analysis of MW-15-LM @ depth 0				
	%	Phi		
Mean	30.58%	2.25	Kurtosis	-0.9495
Median	4.86%	1.25	Skewness	0.9455
Mode	24.08%	2.75	Range	0.9871
Standard Dev.	39.63%		Minimum	0.0008
Count	24.0000		Maximum	0.9879
Effective diameter 0.125 mm (Hazen 1911)				



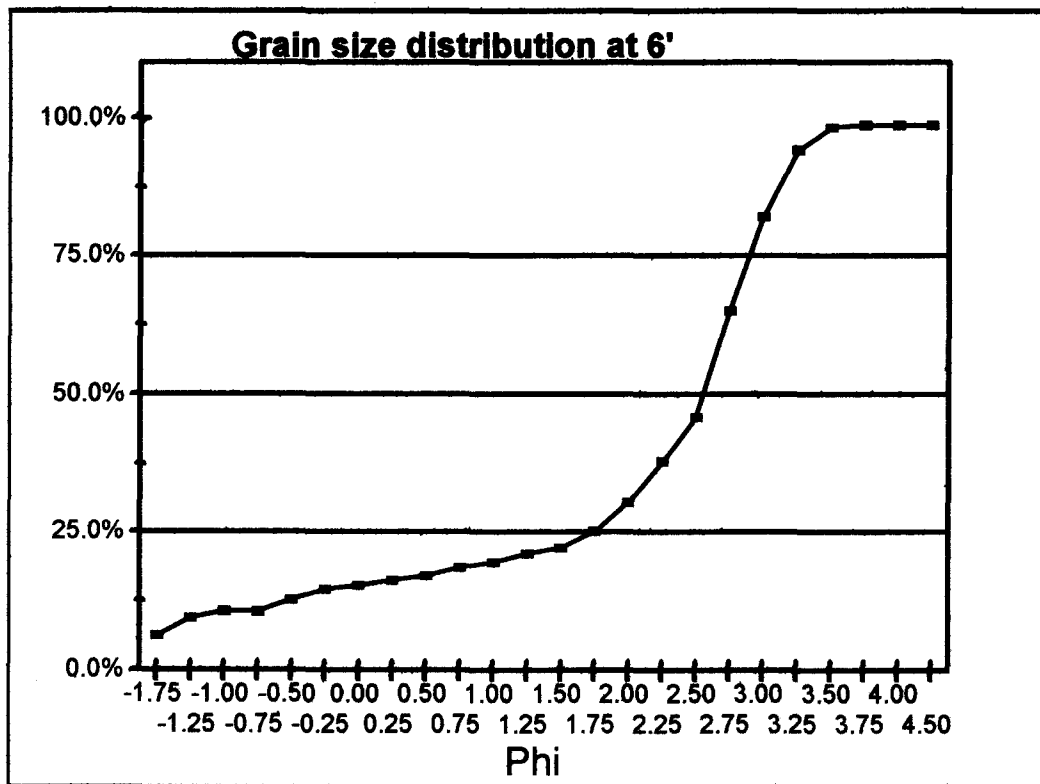
Statistical analysis of MW-15-LM @ depth 2				
	%	Phi		
Mean	36.98%	2.50	Kurtosis	-0.6735
Median	11.26%	2.00	Skewness	1.0883
Mode	27.55%	3.00	Range	0.9964
Standard Dev.	42.46%		Minimum	0.0003
Count	18.0000		Maximum	0.9968
Effective diameter 0.125 mm (Hazen 1911)				



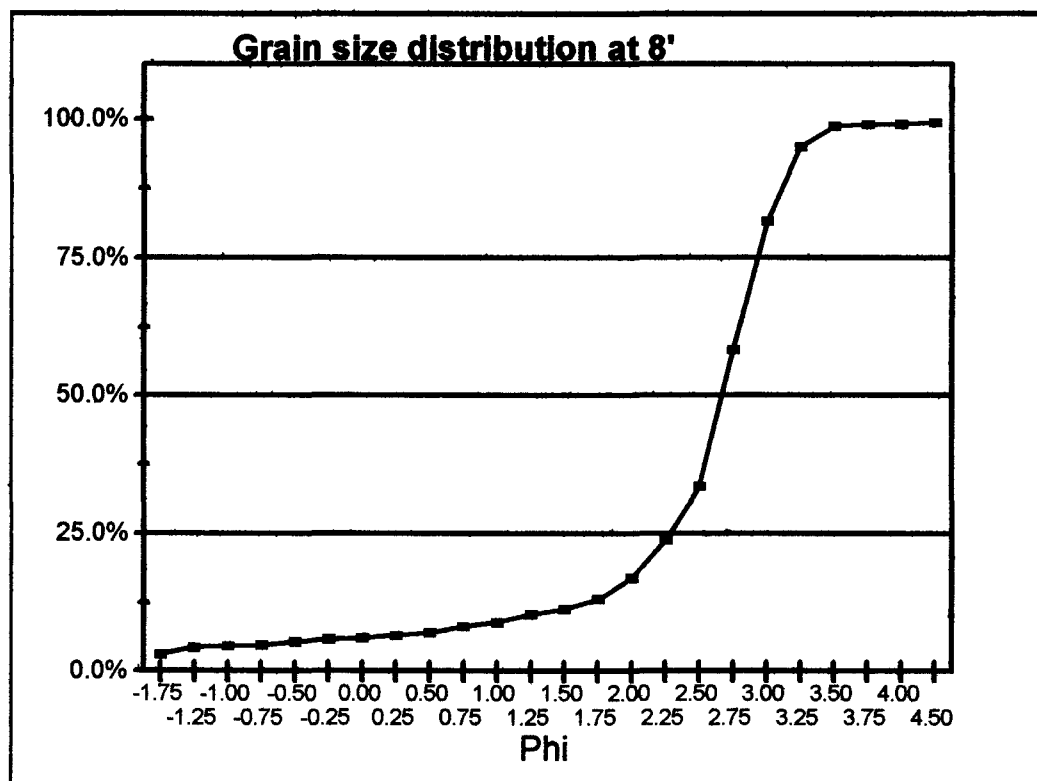
Statistical analysis of MW-15-LM @ depth 4				
	%	Phi		
Mean	29.48%	2.50	Kurtosis	-0.7632
Median	2.66%	1.25	Skewness	1.0592
Mode	27.16%	2.75	Range	0.9788
Standard Dev.	39.84%		Minimum	0.0177
Count	24.0000		Maximum	0.9964
Effective diameter 0.125 mm (Hazen 1911)				



Statistical analysis of MW-15-LM @ depth 6				
	%	Phi		
Mean	40.27%	4.50	Kurtosis	-0.9593
Median	21.45%	4.50	Skewness	0.8921
Mode	19.14%	2.75	Range	0.9241
Standard Dev.	34.09%		Minimum	0.0624
Count	24.0000		Maximum	0.9865
Effective diameter 0.125 mm (Hazen 1911)				

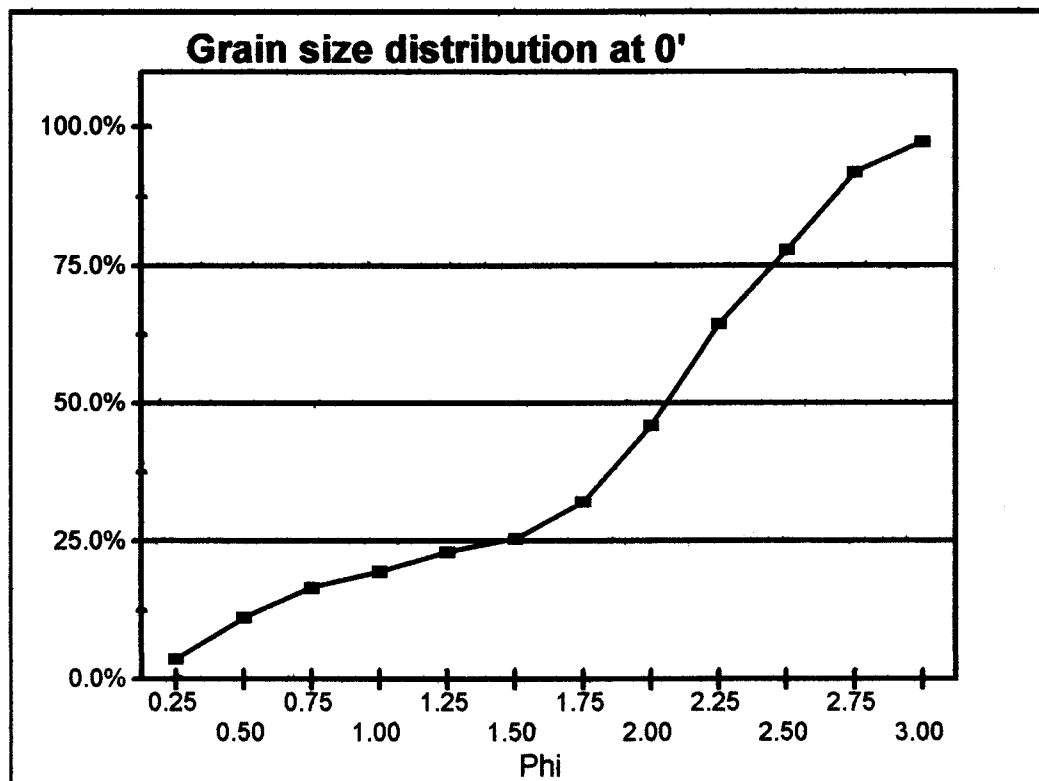


Statistical analysis of MW-15-LM @ depth 8				
	%	Phi		
Mean	33.46%	2.50	Kurtosis	-0.8455
Median	10.74%	1.25	Skewness	1.0040
Mode	24.89%	2.75	Range	0.9623
Standard Dev.	37.71%		Minimum	0.0304
Count	24.0000		Maximum	0.9927
Effective diameter 0.125 mm (Hazen 1911)				

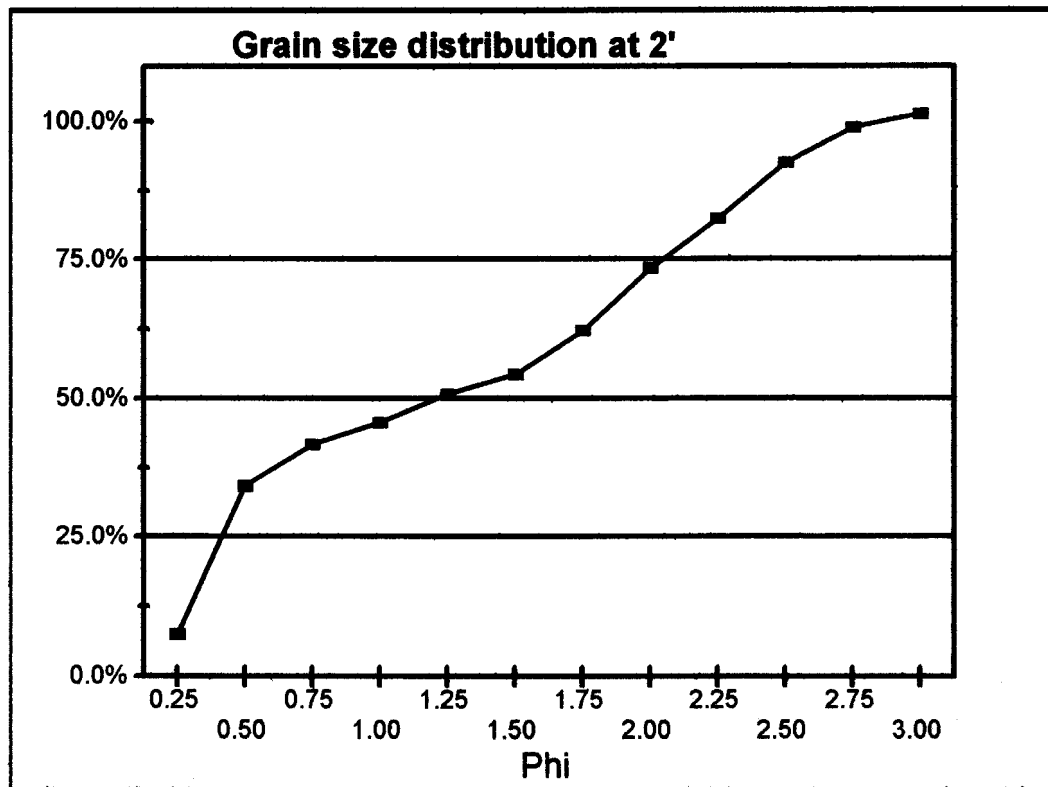


Appendix IX.
Particle size analysis for MW-25-GM

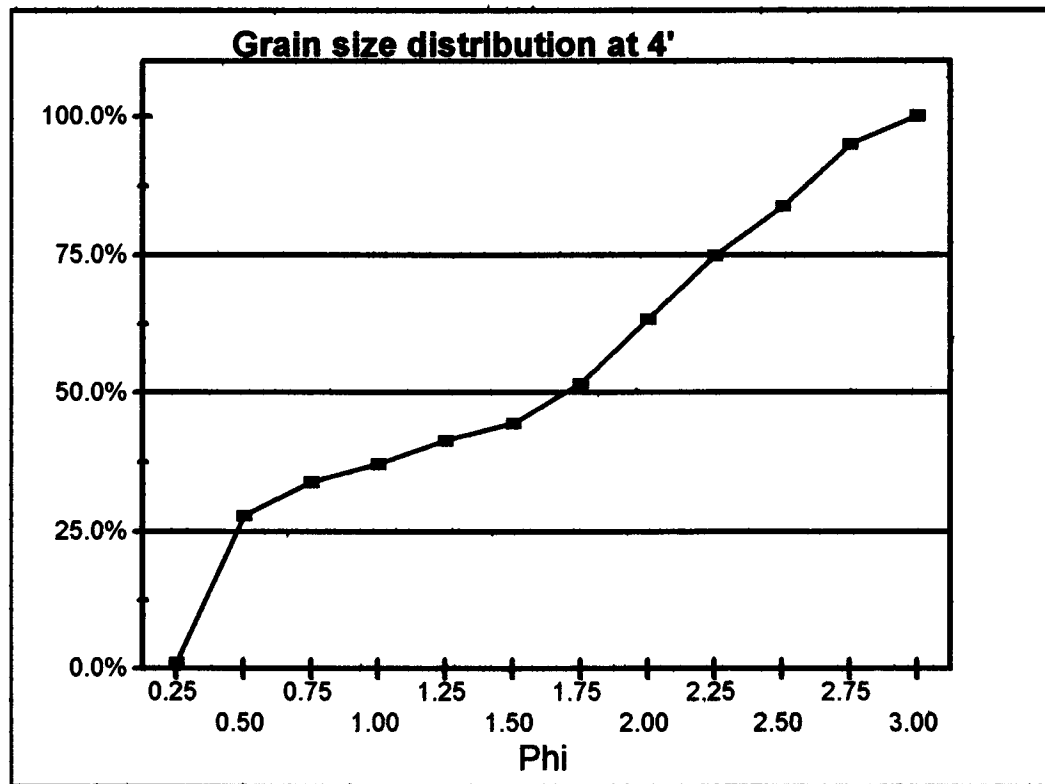
Statistical analysis of MW-25-GM @ depth 0				
	%	Phi		
Mean	42.35%	1.75	Kurtosis	-1.6717
Median	28.78%	1.50	Skewness	0.4118
Mode	18.57%	2.25	Range	0.9343
Standard Dev.	32.07%		Minimum	0.0368
Count	12.0000		Maximum	0.9711
Effective diameter 0.177 mm (Hazen 1911)				



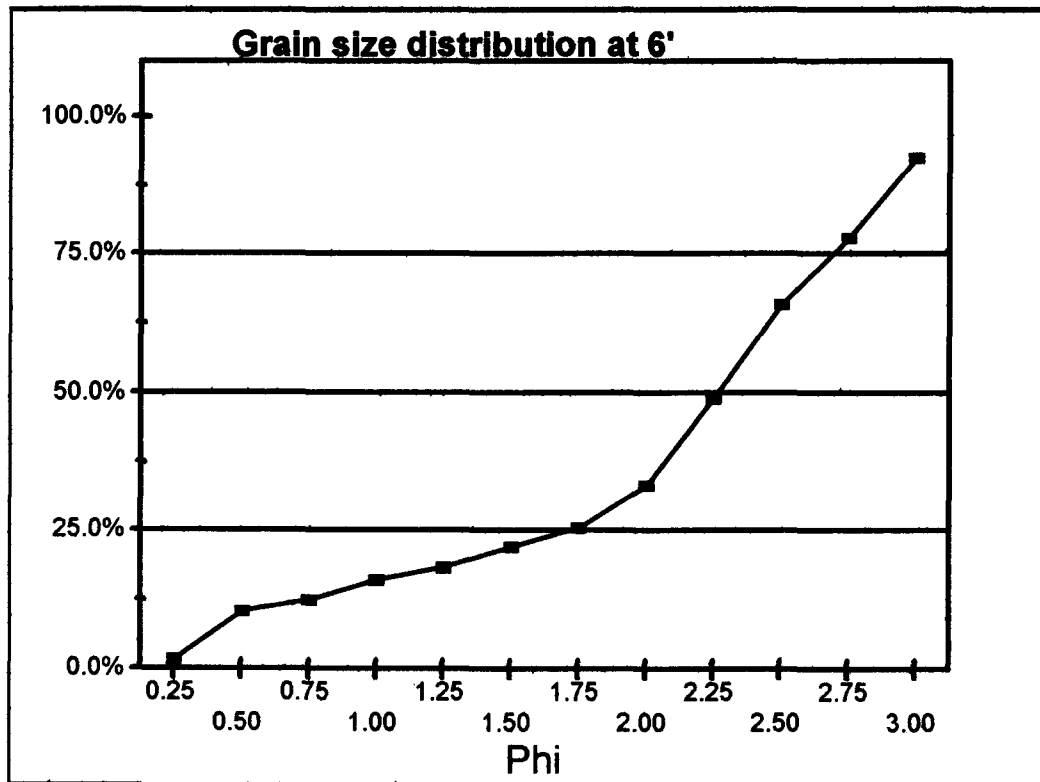
Statistical analysis of MW-25-GM @ depth 2				
	%	Phi		
Mean	62.01%	1.50	Kurtosis	-1.6939
Median	58.17%	1.50	Skewness	-0.1044
Mode	26.81%	0.50	Range	0.9387
Standard Dev.	27.38%		Minimum	0.0741
Count	12.0000		Maximum	1.0128
Effective diameter 0.210 mm (Hazen 1911)				



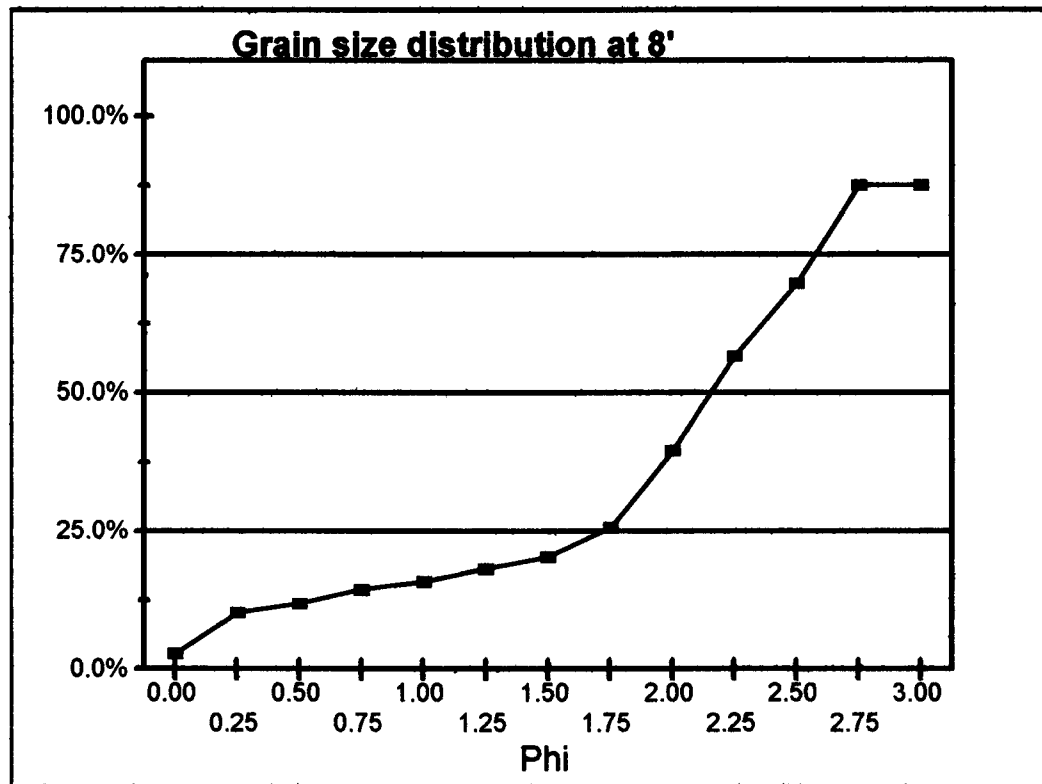
Statistical analysis of MW-25-GM @ depth 4				
	%	Phi		
Mean	54.49%	1.75	Kurtosis	-1.6783
Median	48.04%	1.50	Skewness	0.0762
Mode	26.91%	0.50	Range	0.9902
Standard Dev.	28.35%		Minimum	0.0100
Count	12.0000		Maximum	1.0002
Effective diameter 0.177 mm (Hazen 1911)				



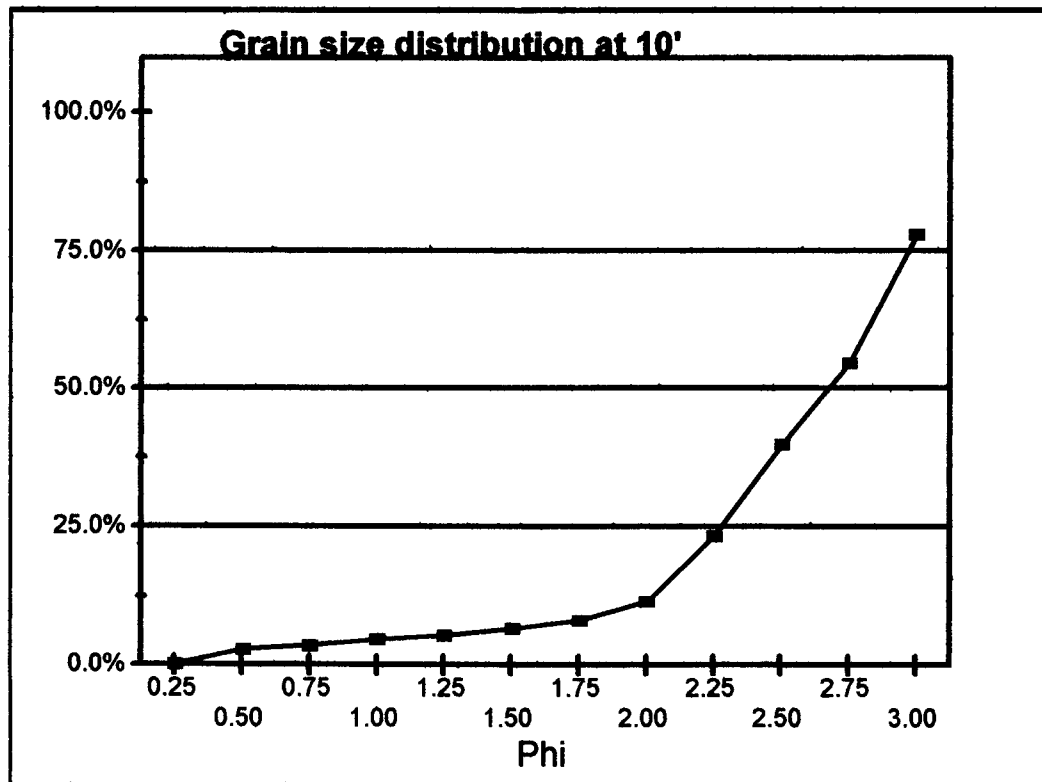
Statistical analysis of MW-25-GM @ depth 6				
	%	Phi		
Mean	35.27%	2.00	Kurtosis	-1.5086
Median	23.59%	1.50	Skewness	0.5509
Mode	16.90%	2.50	Range	0.9073
Standard Dev.	28.03%		Minimum	0.0171
Count	12.0000		Maximum	0.9244
Effective diameter 0.149 mm (Hazen 1911)				



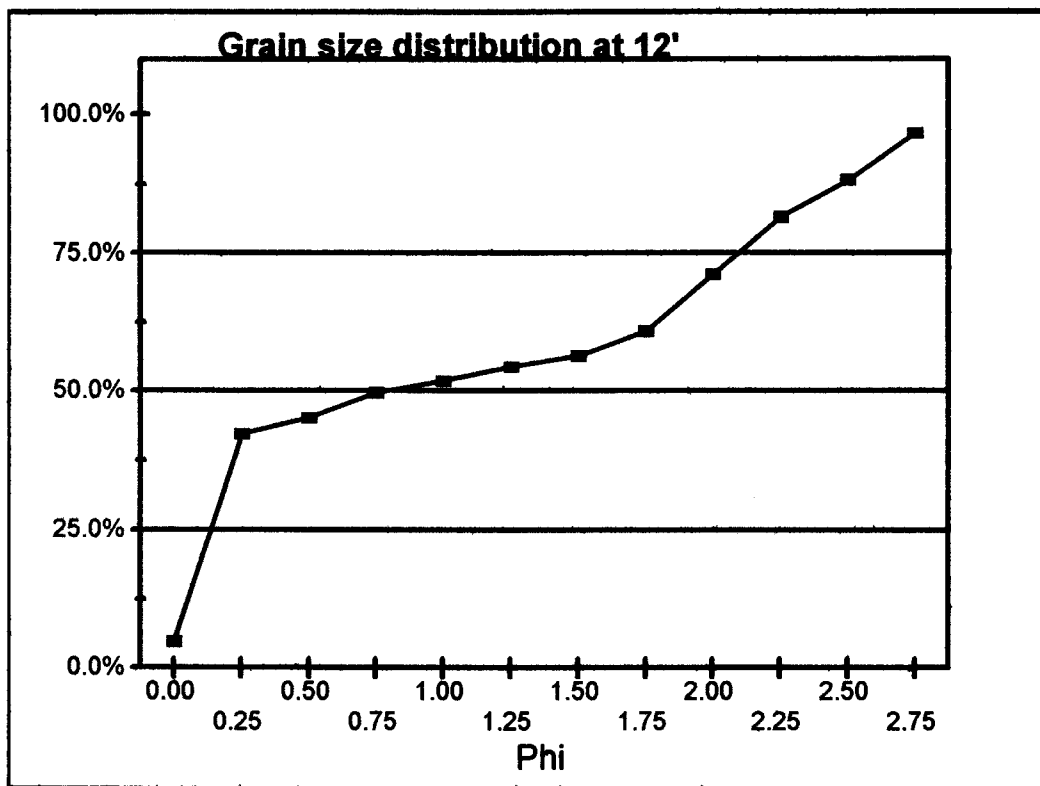
Statistical analysis of MW-25-GM @ depth 8				
	%	Phi		
Mean	30.98%	1.75	Kurtosis	-1.6519
Median	19.13%	1.25	Skewness	0.4575
Mode	17.84%	2.75	Range	0.8480
Standard Dev.	25.57%		Minimum	0.0275
Count	12.0000		Maximum	0.8754
Effective diameter 0.044 mm (Hazen 1911)				



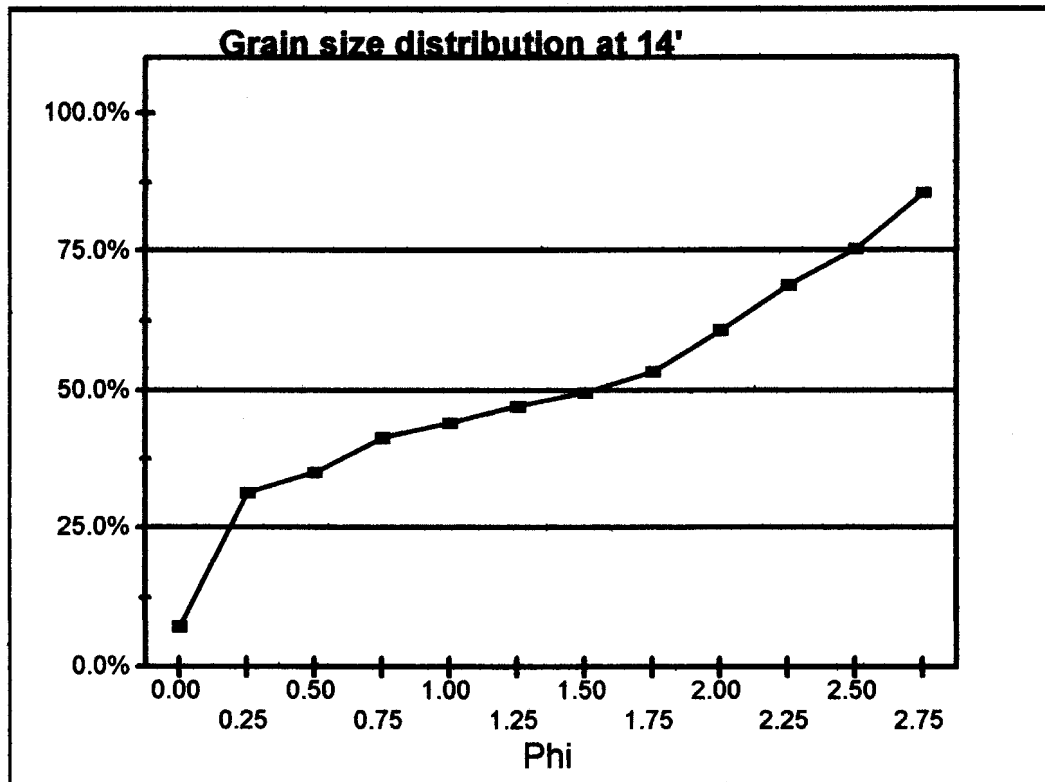
Statistical analysis of MW-25-GM @ depth 10				
	%	Phi		
Mean	19.76%	2.00	Kurtosis	-1.1802
Median	7.19%	1.50	Skewness	0.8464
Mode	23.47%	3.00	Range	0.7795
Standard Dev.	23.78%		Minimum	0.0002
Count	12.0000		Maximum	0.7797
Effective diameter 0.044 mm (Hazen 1911)				



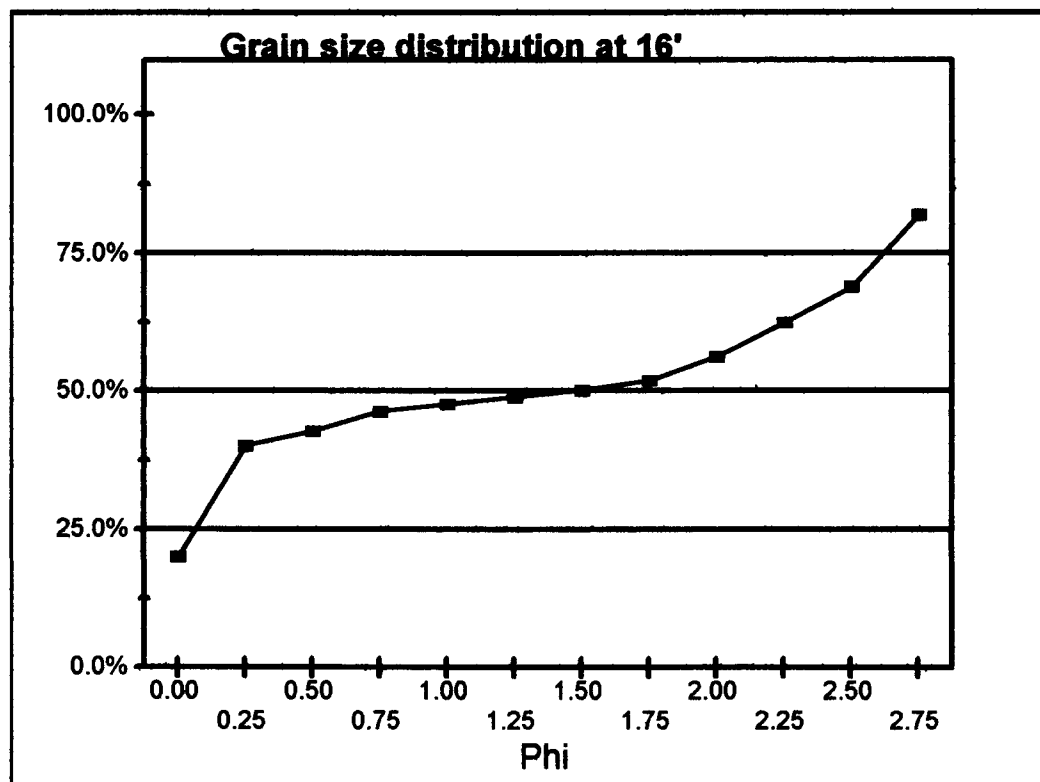
Statistical analysis of MW-25-GM @ depth 12				
	%	Phi		
Mean	58.47%	1.50	Kurtosis	-1.4758
Median	55.23%	1.25	Skewness	-0.3149
Mode	37.47%	0.25	Range	0.9192
Standard Dev.	23.32%		Minimum	0.0463
Count	12.0000		Maximum	0.9655
Effective diameter 0.177 mm (Hazen 1911)				



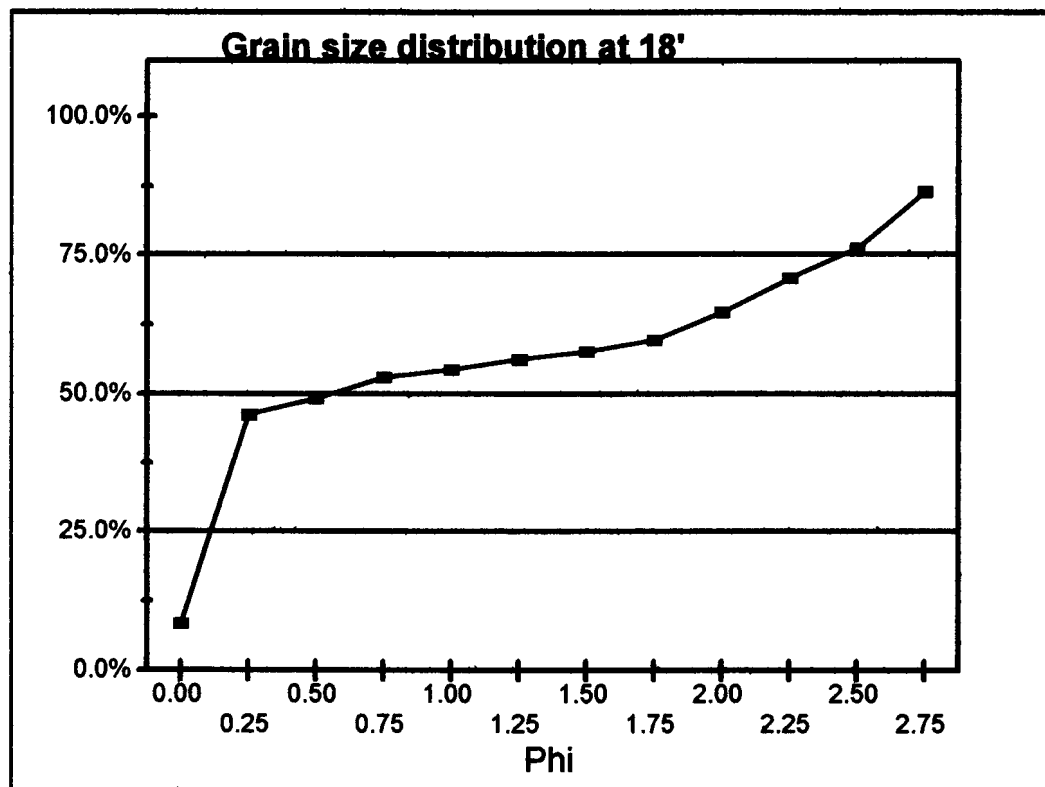
Statistical analysis of MW-25-GM @ depth 14				
	%	Phi		
Mean	49.90%	1.50	Kurtosis	-1.5083
Median	48.29%	1.25	Skewness	-0.2363
Mode	24.11%	0.25	Range	0.7834
Standard Dev.	20.23%		Minimum	0.0716
Count	12.0000		Maximum	0.8550
Effective diameter 0.044 mm (Hazen 1911)				



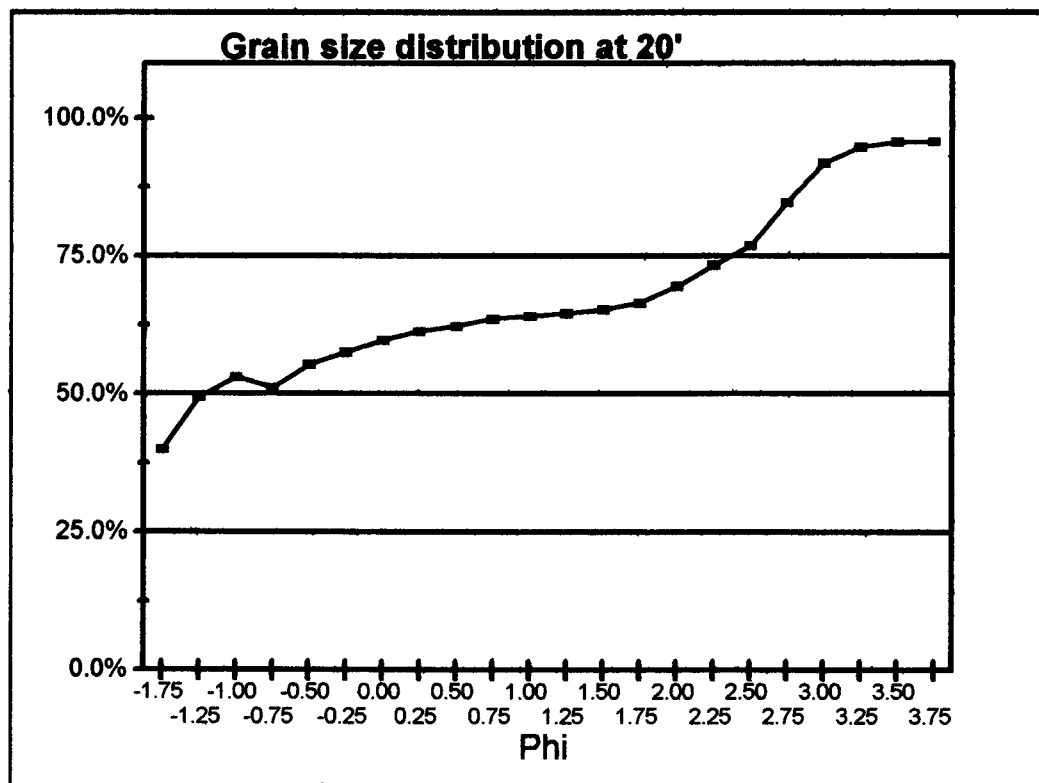
Statistical analysis of MW-25-GM @ depth 16				
	%	Phi		
Mean	51.30%	1.50	Kurtosis	-1.2810
Median	49.34%	1.25	Skewness	-0.3959
Mode	20.03%	0.25	Range	0.6185
Standard Dev.	14.77%		Minimum	0.1997
Count	12.0000		Maximum	0.8182
Effective diameter 0.044 mm (Hazen 1911)				



Statistical analysis of MW-25-GM @ depth 18				
	%	Phi		
Mean	56.78%	1.25	Kurtosis	-1.3303
Median	56.76%	1.25	Skewness	-0.5190
Mode	37.82%	0.25	Range	0.7807
Standard Dev.	18.37%		Minimum	0.0830
Count	12.0000		Maximum	0.8637
Effective diameter 0.044 mm (Hazen 1911)				

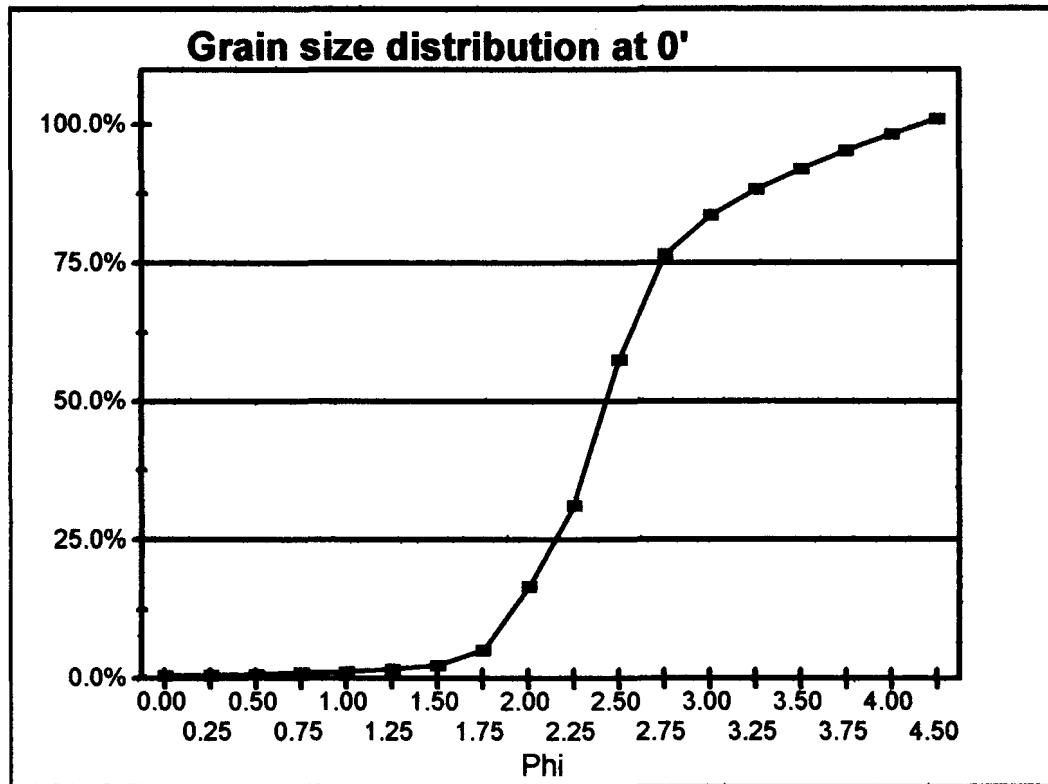


Statistical analysis of MW-25-GM @ depth 20				
	%	Phi		
Mean	67.92%	1.75	Kurtosis	-1.0231
Median	64.28%	1.00	Skewness	0.3297
Mode	39.85%	-1.75	Range	0.5574
Standard Dev.	15.51%		Minimum	0.3985
Count	22.0000		Maximum	0.9559
Effective diameter 0.149 mm (Hazen 1911)				

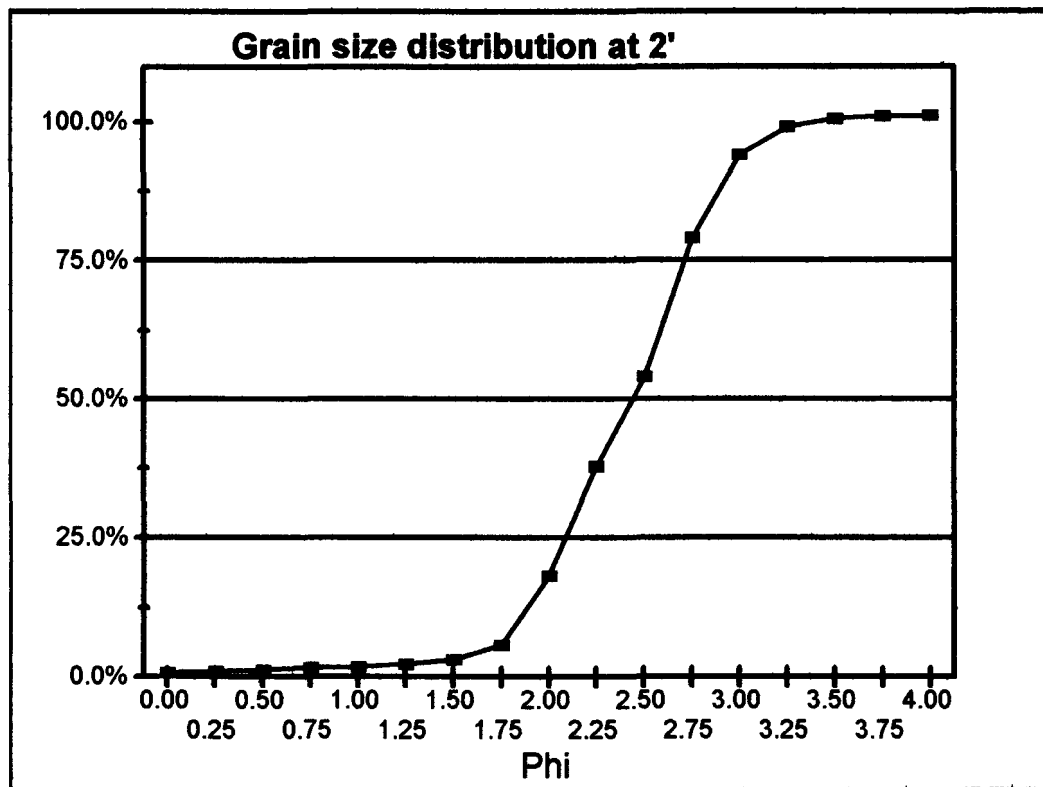


Appendix X.
Particle size analysis for MW-25-LG

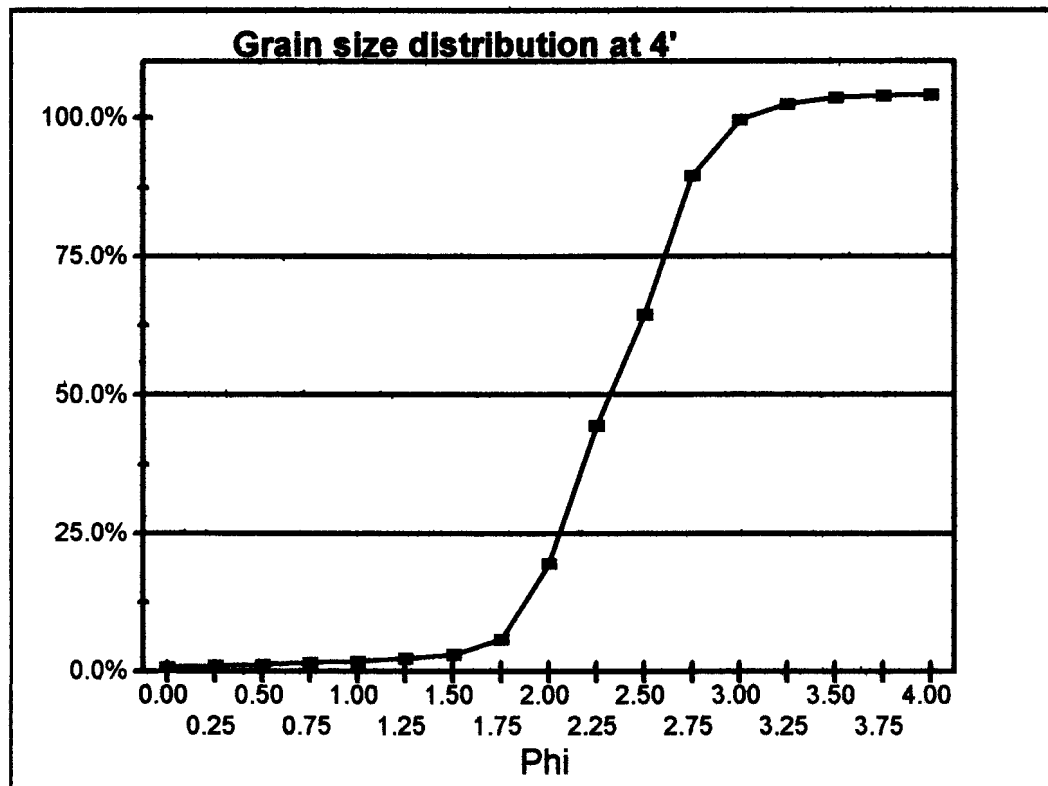
Statistical analysis of MW-25-LG @ depth 0				
	%	Phi		
Mean	41.77%	2.25	Kurtosis	-1.3049
Median	23.82%	2.00	Skewness	0.7851
Mode	26.48%	2.50	Range	1.0057
Standard Dev.	40.27%		Minimum	0.0039
Count	18.0000		Maximum	1.0095
Effective diameter 0.105 mm (Hazen 1911)				



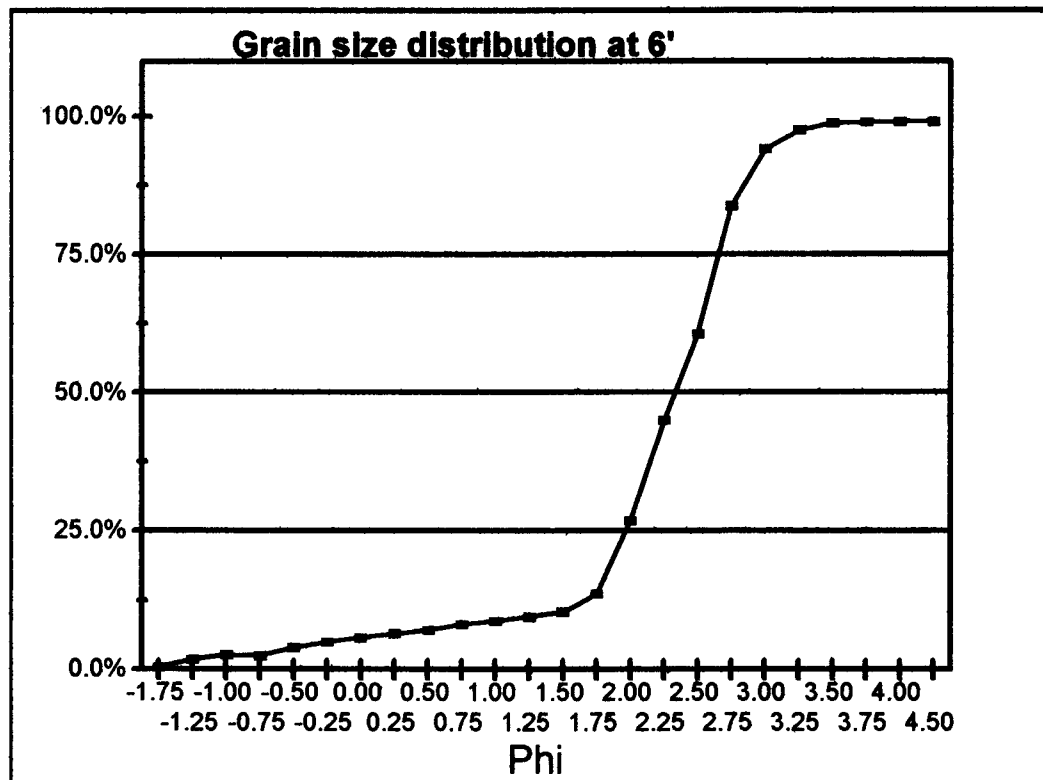
Statistical analysis of MW-25-LG @ depth 2				
	%	Phi		
Mean	44.56%	2.25	Kurtosis	-1.3089
Median	27.88%	2.00	Skewness	0.7849
Mode	24.98%	2.75	Range	1.0060
Standard Dev.	43.83%		Minimum	0.0061
Count	18.0000		Maximum	1.0121
Effective diameter 0.149 mm (Hazen 1911)				



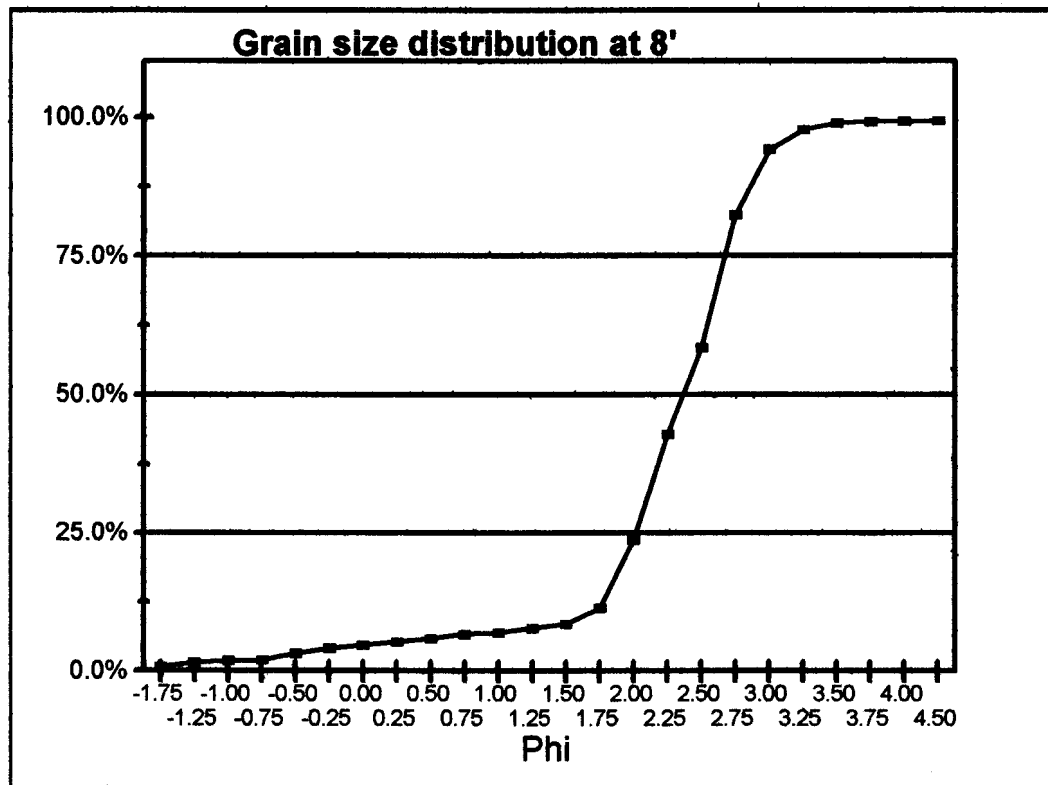
Statistical analysis of MW-25-LG @ depth 4				
	%	Phi		
Mean	47.31%	2.25	Kurtosis	-1.4388
Median	31.91%	2.00	Skewness	0.7247
Mode	25.26%	2.75	Range	1.0335
Standard Dev.	45.78%		Minimum	0.0068
Count	18.0000		Maximum	1.0403
Effective diameter 0.149 mm (Hazen 1911)				



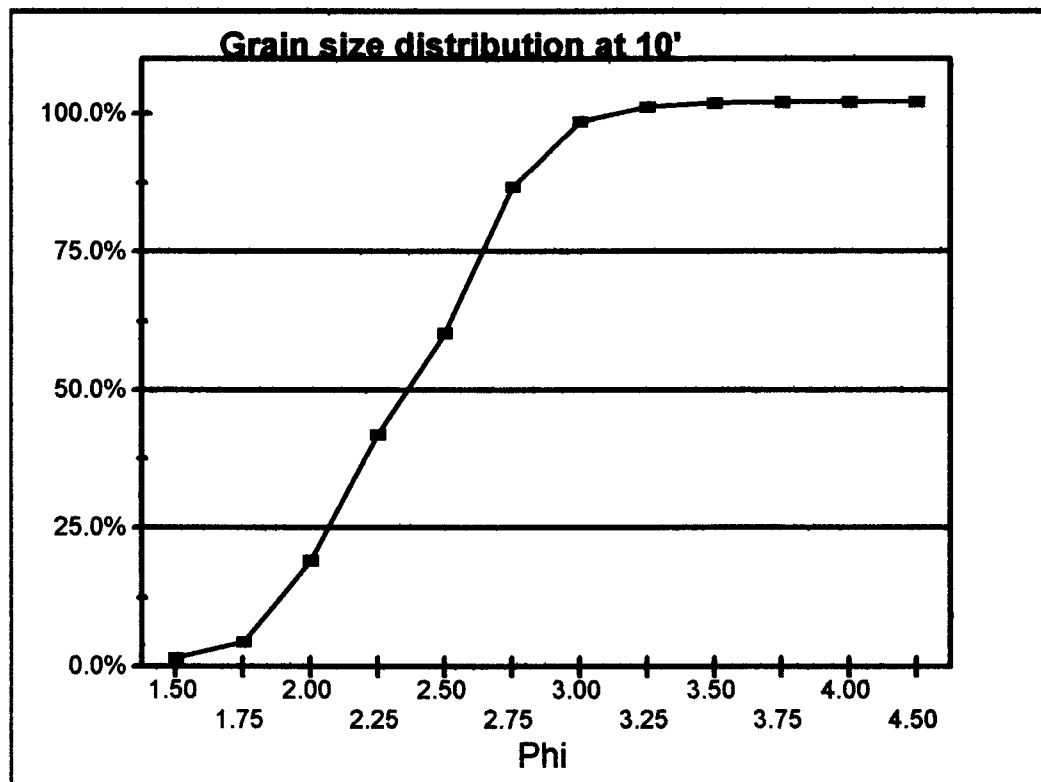
Statistical analysis of MW-25-LG @ depth 6				
	%	Phi		
Mean	36.97%	2.00	Kurtosis	-1.4107
Median	9.89%	1.25	Skewness	0.7132
Mode	23.01%	2.75	Range	0.9853
Standard Dev.	40.11%		Minimum	0.0037
Count	24.0000		Maximum	0.9890
Effective diameter 0.149 mm (Hazen 1911)				



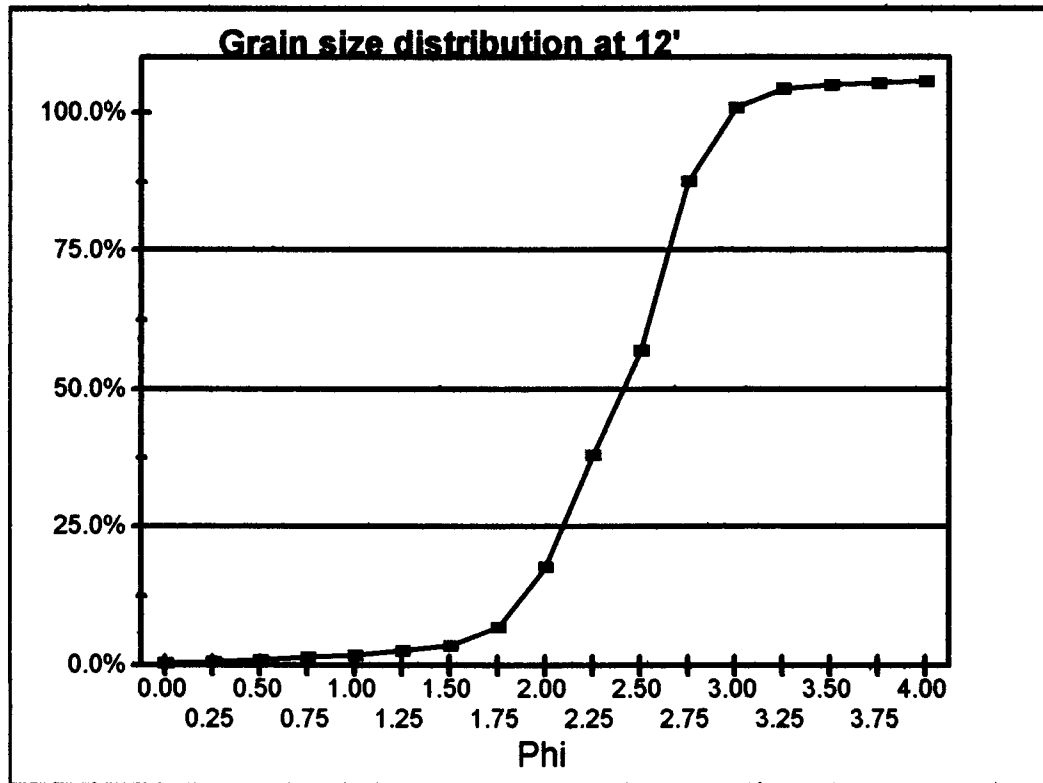
Statistical analysis of MW-25-LG @ depth 8				
	%	Phi		
Mean	36.02%	2.00	Kurtosis	-1.3803
Median	7.88%	1.25	Skewness	0.7389
Mode	24.04%	2.75	Range	0.9858
Standard Dev.	40.64%		Minimum	0.0070
Count	24.0000		Maximum	0.9928
Effective diameter 0.149 mm (Hazen 1911)				



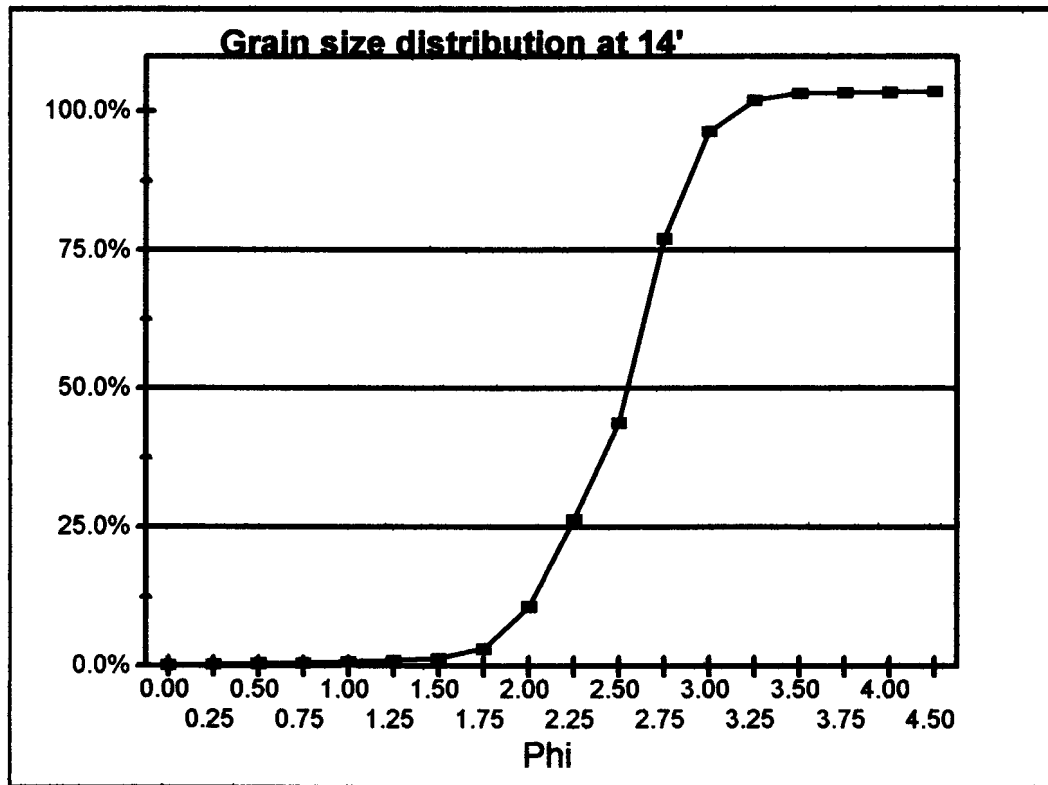
Statistical analysis of MW-25-LG @ depth 10				
	%	Phi		
Mean	68.43%	2.50	Kurtosis	-1.4087
Median	92.60%	2.75	Skewness	0.7397
Mode	26.37%	2.75	Range	1.0072
Standard Dev.	39.41%		Minimum	0.0138
Count	12.0000		Maximum	1.0210
Effective diameter 0.149 mm (Hazen 1911)				



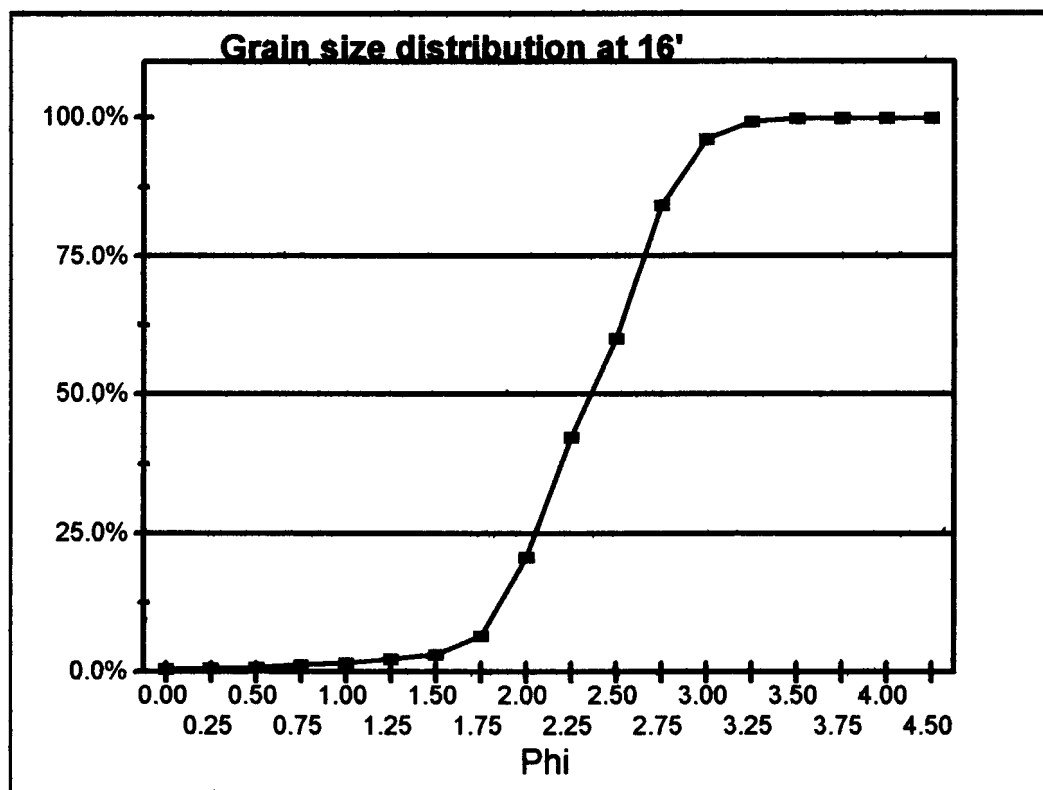
Statistical analysis of MW-25-LG @ depth 12				
	%	Phi		
Mean	43.42%	2.25	Kurtosis	-1.0181
Median	17.60%	2.00	Skewness	0.9362
Mode	30.57%	2.75	Range	1.0530
Standard Dev.	45.31%		Minimum	0.0027
Count	17.0000		Maximum	1.0556
Effective diameter 0.149 mm (Hazen 1911)				



Statistical analysis of MW-25-LG @ depth 14				
	%	Phi		
Mean	43.08%	2.25	Kurtosis	-1.1631
Median	18.45%	2.00	Skewness	0.8808
Mode	33.36%	2.75	Range	1.0346
Standard Dev.	45.66%		Minimum	0.0009
Count	18.0000		Maximum	1.0355
Effective diameter 0.149 mm (Hazen 1911)				

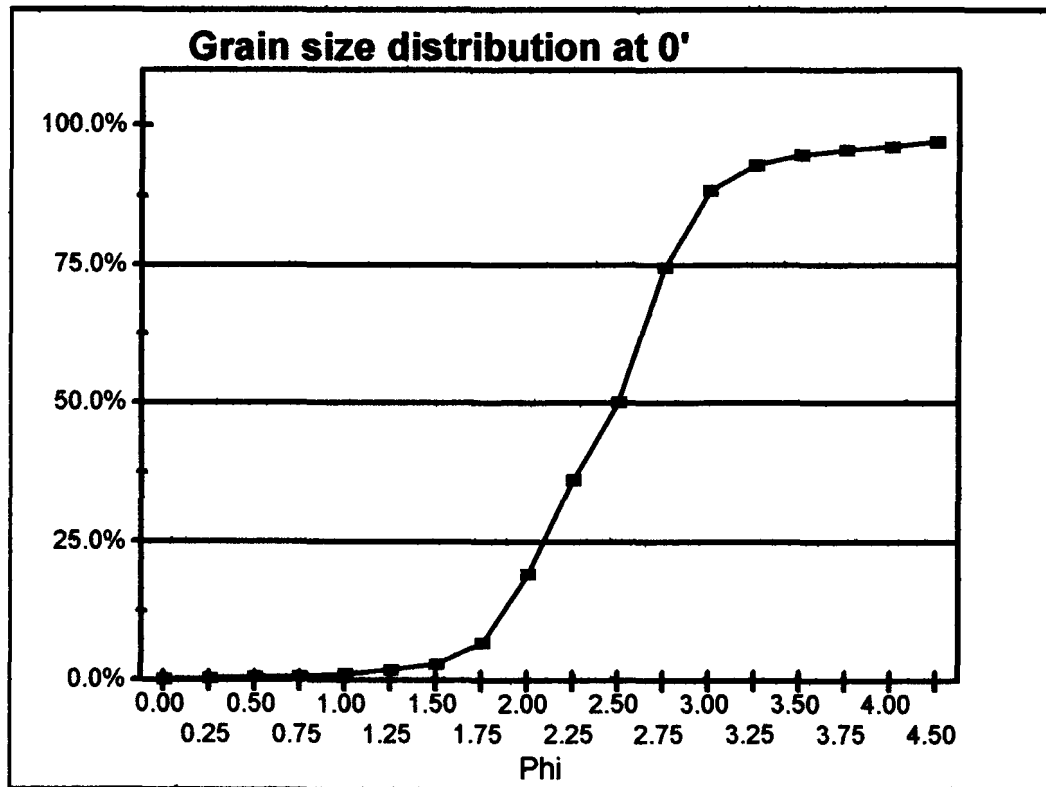


Statistical analysis of MW-25-LG @ depth 16				
	%	Phi		
Mean	45.33%	2.25	Kurtosis	-1.4153
Median	31.37%	2.00	Skewness	0.7312
Mode	24.14%	2.75	Range	0.9933
Standard Dev.	43.90%		Minimum	0.0036
Count	18.0000		Maximum	0.9969
Effective diameter 0.149 mm (Hazen 1911)				

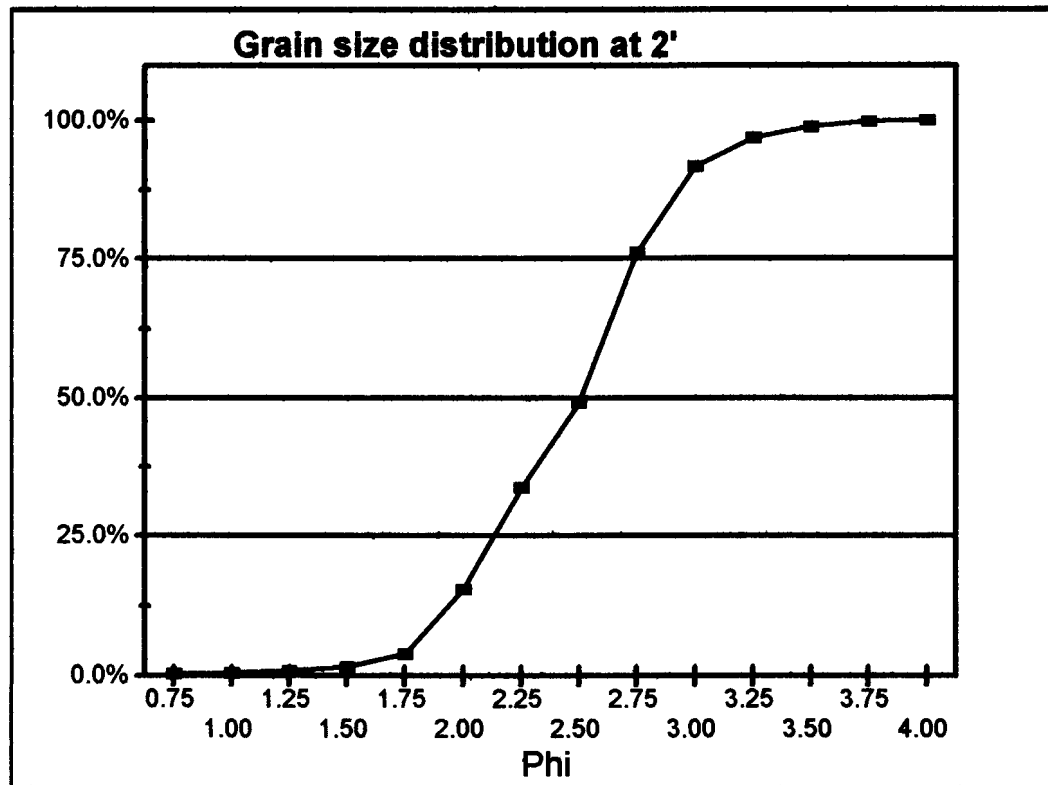


Appendix XI.
Particle size analysis for MW-25-LM

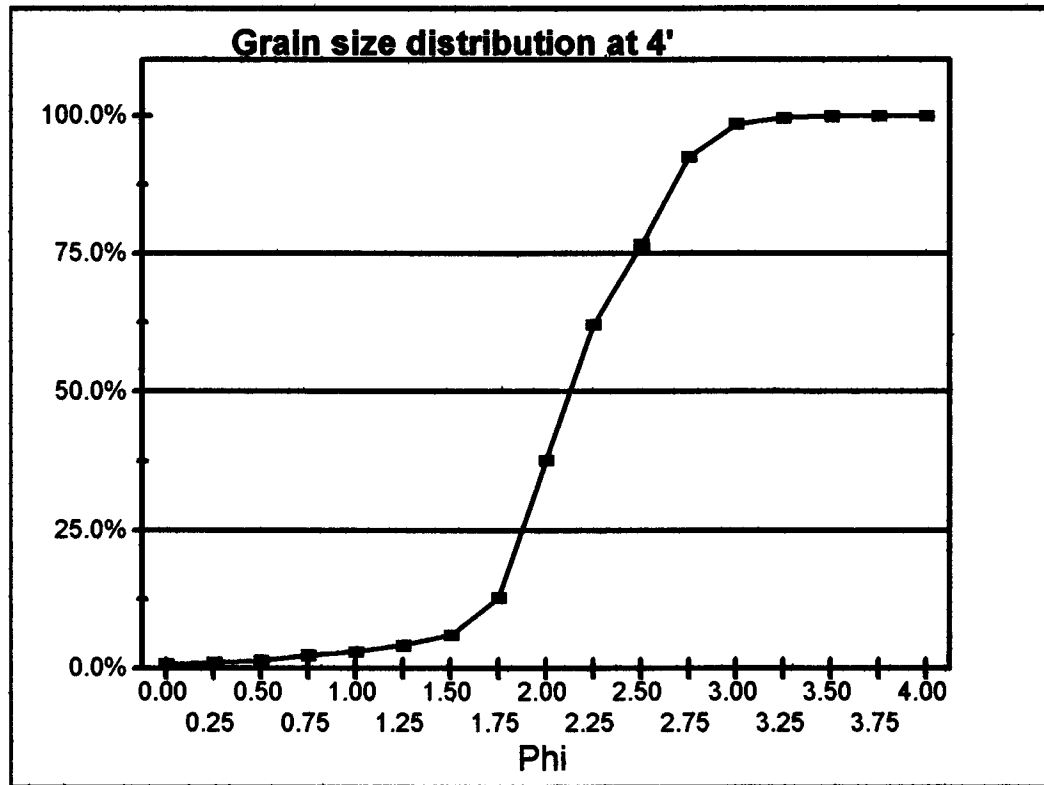
Statistical analysis of MW-25-LM @ depth 0				
	%	Phi		
Mean	42.14%	2.25	Kurtosis	-1.3014
Median	27.68%	2.00	Skewness	0.7821
Mode	24.38%	2.75	Range	0.9688
Standard Dev.	40.30%		Minimum	0.0013
Count	18.0000		Maximum	0.9701
Effective diameter 0.125 mm (Hazen 1911)				



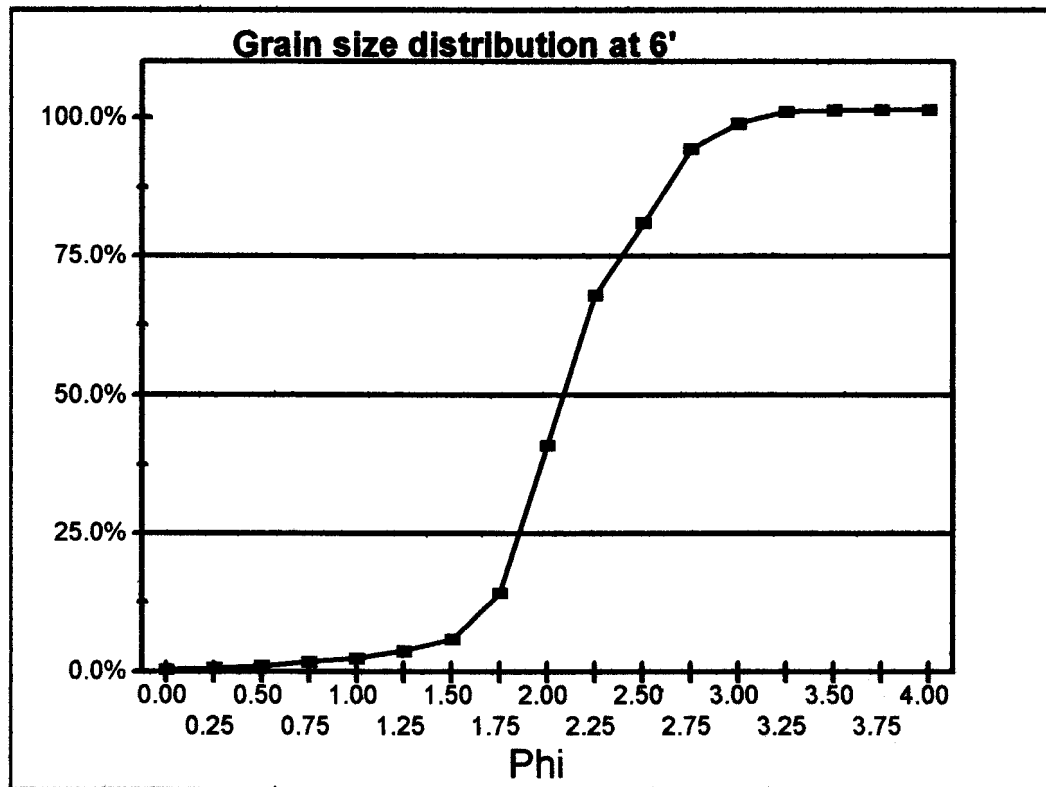
Statistical analysis of MW-25-LM @ depth 2				
	%	Phi		
Mean	51.18%	2.50	Kurtosis	-1.2530
Median	49.09%	2.50	Skewness	0.8180
Mode	26.97%	2.75	Range	0.9980
Standard Dev.	43.04%		Minimum	0.0025
Count	15.0000		Maximum	1.0005
Effective diameter 0.149 mm (Hazen 1911)				



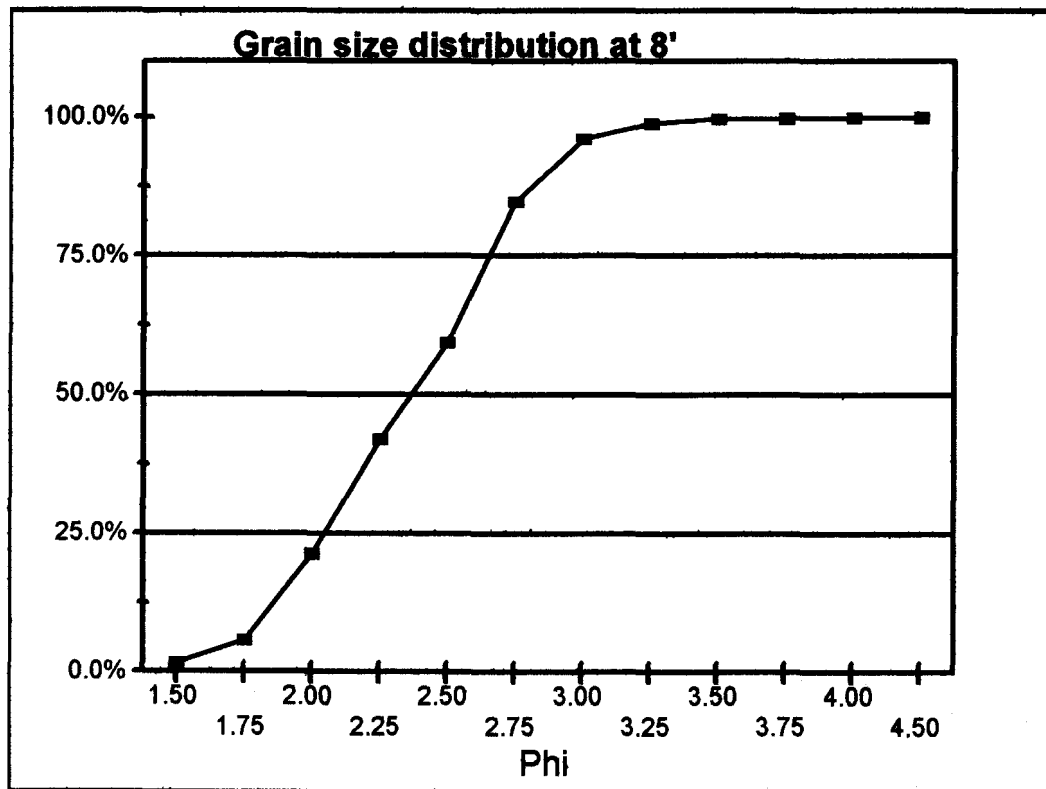
Statistical analysis of MW-25-LM @ depth 4				
	%	Phi		
Mean	49.80%	2.00	Kurtosis	-1.6710
Median	49.77%	2.00	Skewness	0.5655
Mode	24.79%	2.00	Range	0.9929
Standard Dev.	43.91%		Minimum	0.0061
Count	18.0000		Maximum	0.9989
Effective diameter 0.177 mm (Hazen 1911)				



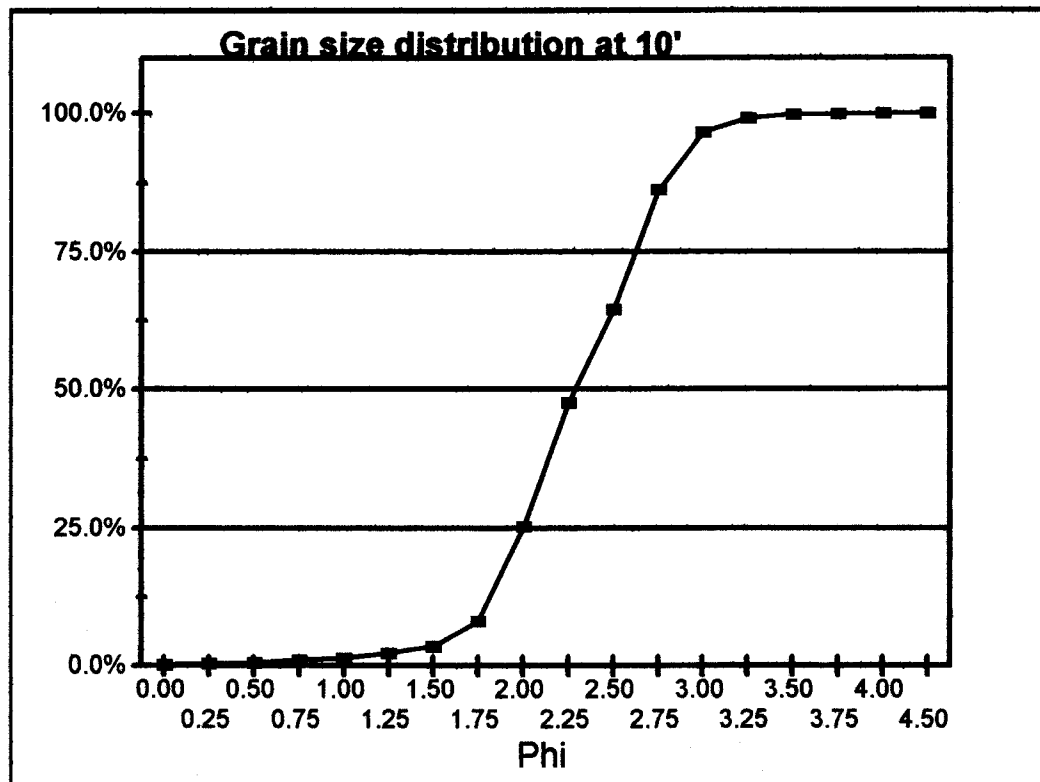
Statistical analysis of MW-25-LM @ depth 6				
	%	Phi		
Mean	51.05%	2.00	Kurtosis	-1.7225
Median	54.36%	2.00	Skewness	0.5343
Mode	26.95%	2.25	Range	1.0100
Standard Dev.	44.80%		Minimum	0.0036
Count	18.0000		Maximum	1.0137
Effective diameter 0.177 mm (Hazen 1911)				



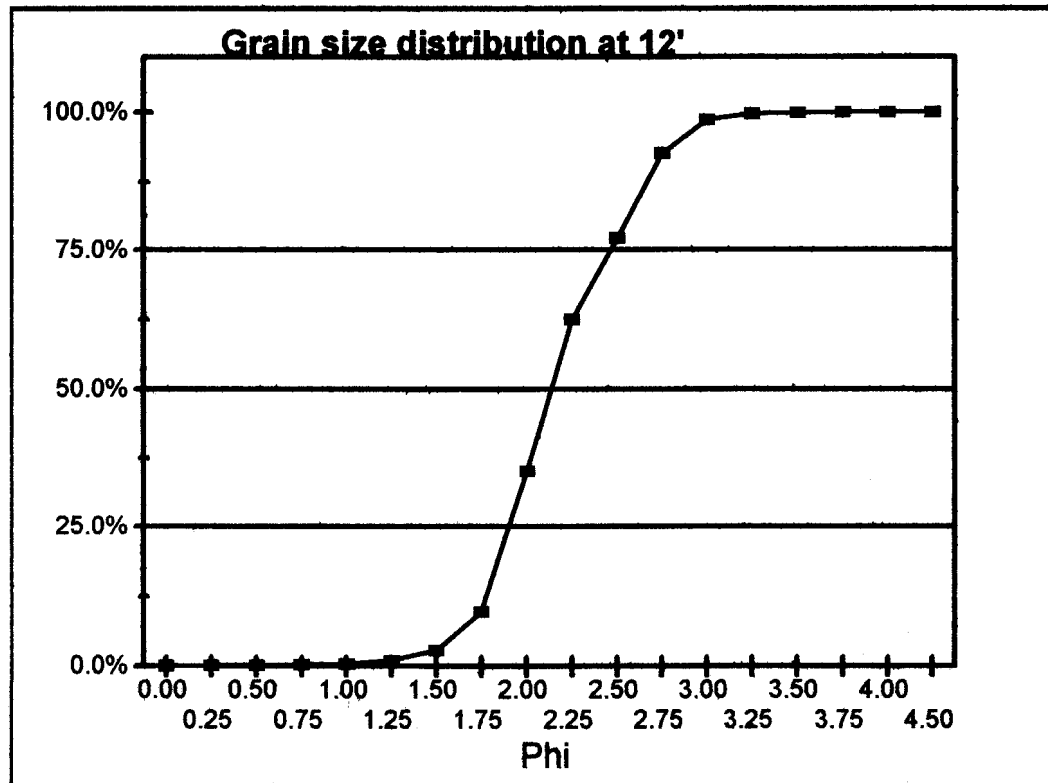
Statistical analysis of MW-25-LM @ depth 8				
	%	Phi		
Mean	67.35%	2.50	Kurtosis	-1.4172
Median	90.39%	2.75	Skewness	0.7294
Mode	25.47%	2.75	Range	0.9838
Standard Dev.	37.99%		Minimum	0.0154
Count	12.0000		Maximum	0.9993
Effective diameter 0.149 mm (Hazen 1911)				



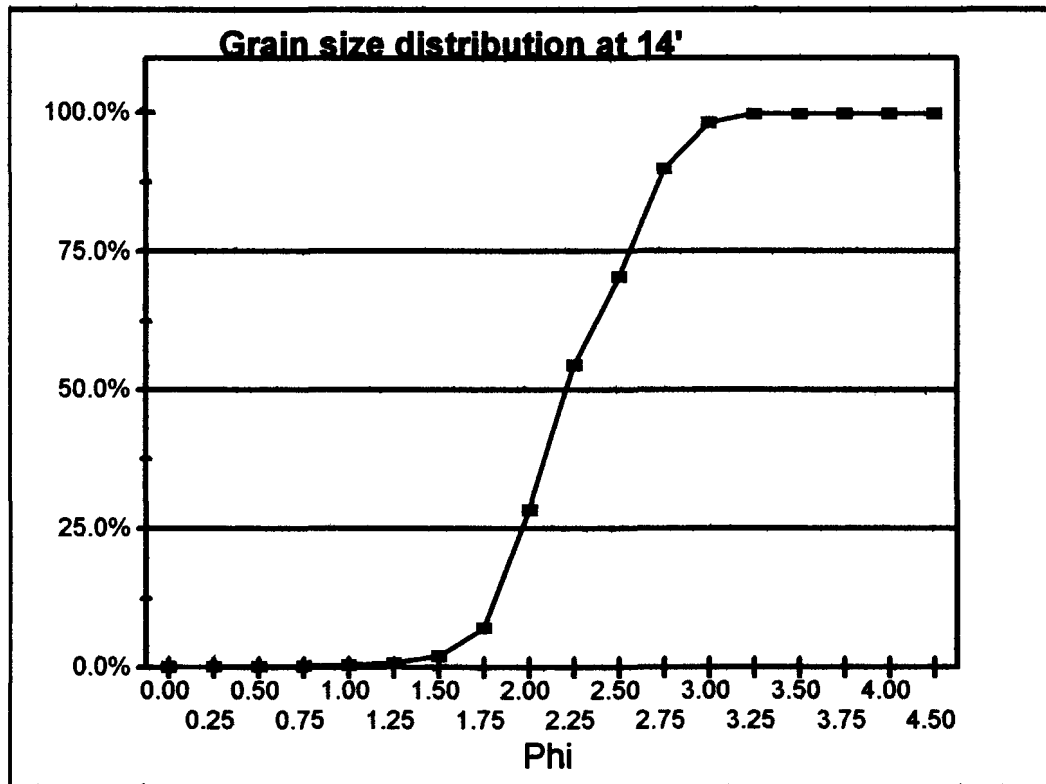
Statistical analysis of MW-25-LM @ depth 10				
	%	Phi		
Mean	46.34%	2.00	Kurtosis	-1.4866
Median	36.37%	2.00	Skewness	0.6839
Mode	22.12%	2.25	Range	0.9982
Standard Dev.	43.97%		Minimum	0.0006
Count	18.0000		Maximum	0.9988
Effective diameter 0.149 mm (Hazen 1911)				



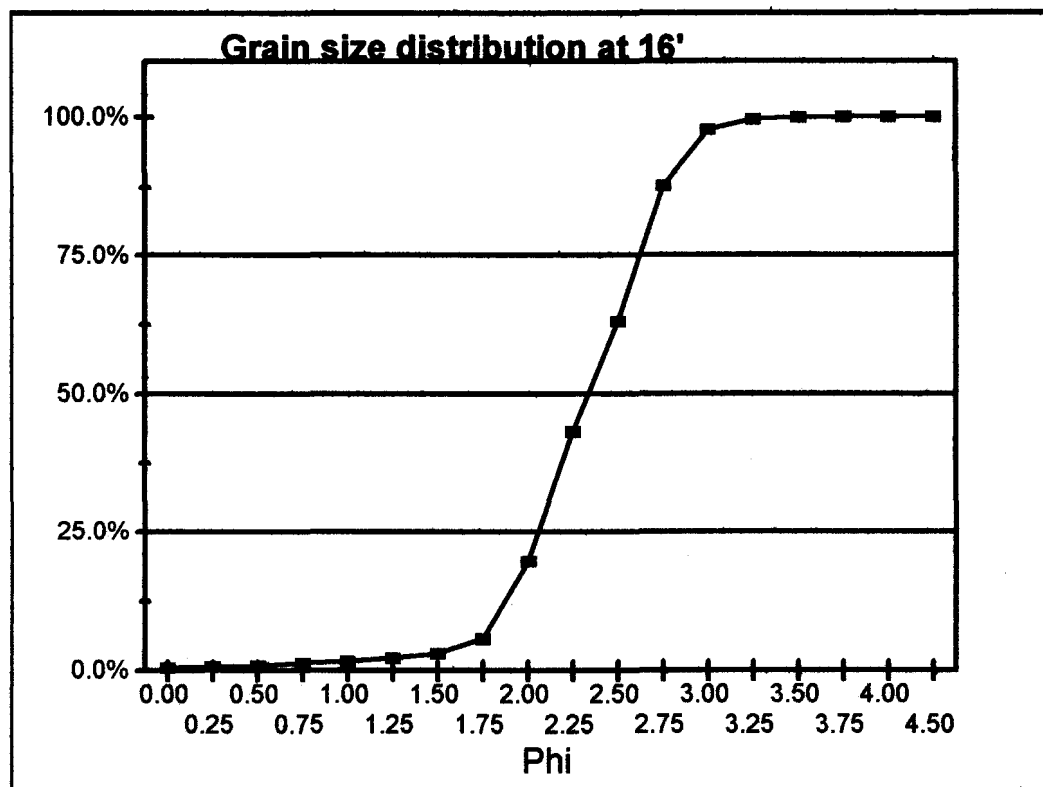
Statistical analysis of MW-25-LM @ depth 12				
	%	Phi		
Mean	48.87%	2.00	Kurtosis	-1.6769
Median	48.79%	2.00	Skewness	0.5720
Mode	27.40%	2.25	Range	1.0000
Standard Dev.	45.00%		Minimum	0.0003
Count	18.0000		Maximum	1.0003
Effective diameter 0.177 mm (Hazen 1911)				



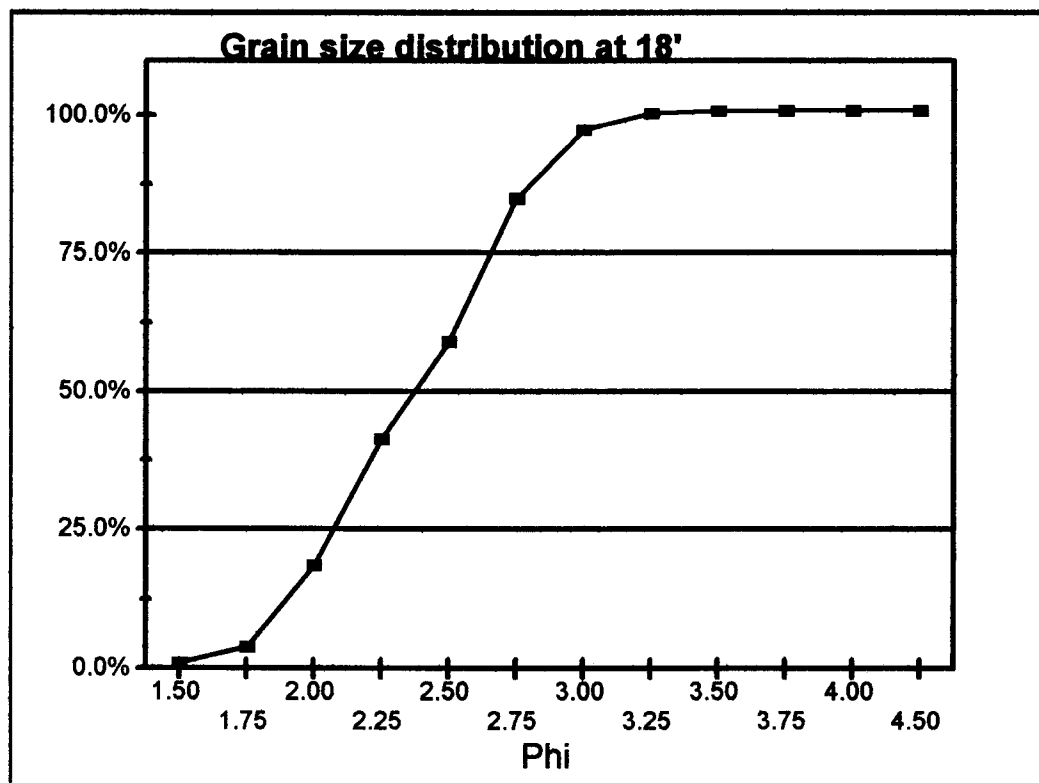
Statistical analysis of MW-25-LM @ depth 14				
	%	Phi		
Mean	47.19%	2.00	Kurtosis	-1.5805
Median	41.37%	2.00	Skewness	0.6333
Mode	26.07%	2.25	Range	0.9966
Standard Dev.	44.74%		Minimum	0.0003
Count	18.0000		Maximum	0.9970
Effective diameter 0.149 mm (Hazen 1911)				



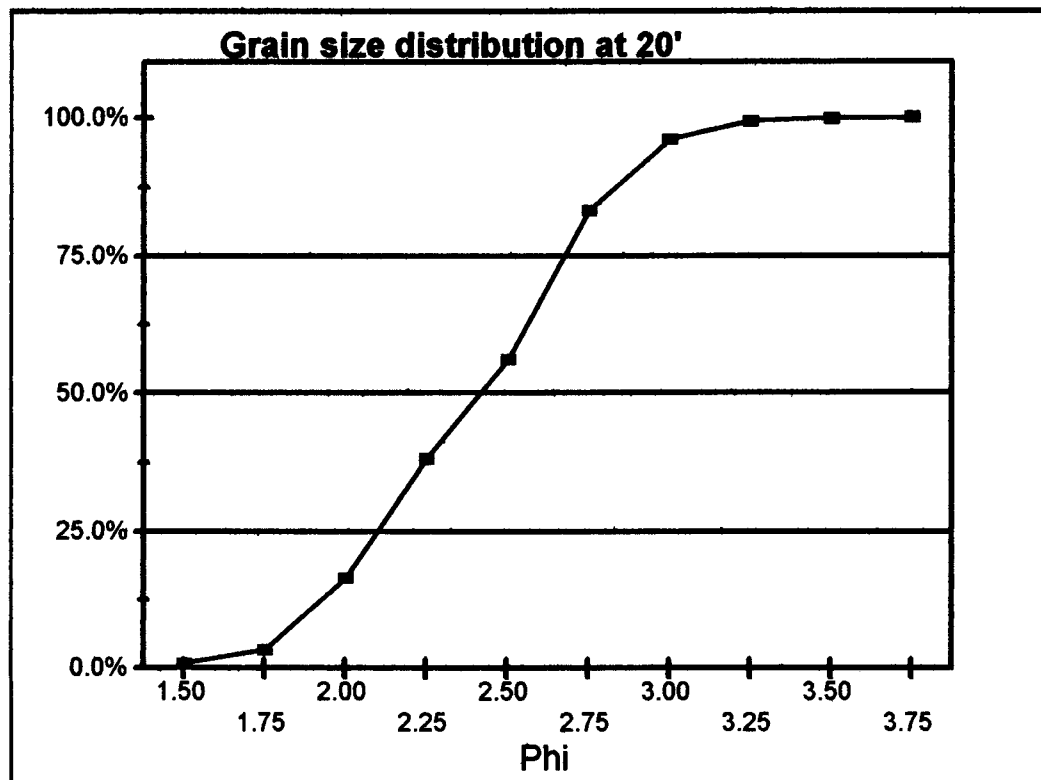
Statistical analysis of MW-25-LM @ depth 16				
	%	Phi		
Mean	45.87%	2.25	Kurtosis	-1.4521
Median	31.37%	2.00	Skewness	0.7180
Mode	24.76%	2.75	Range	0.9955
Standard Dev.	44.39%		Minimum	0.0046
Count	18.0000		Maximum	1.0000
Effective diameter 0.149 mm (Hazen 1911)				



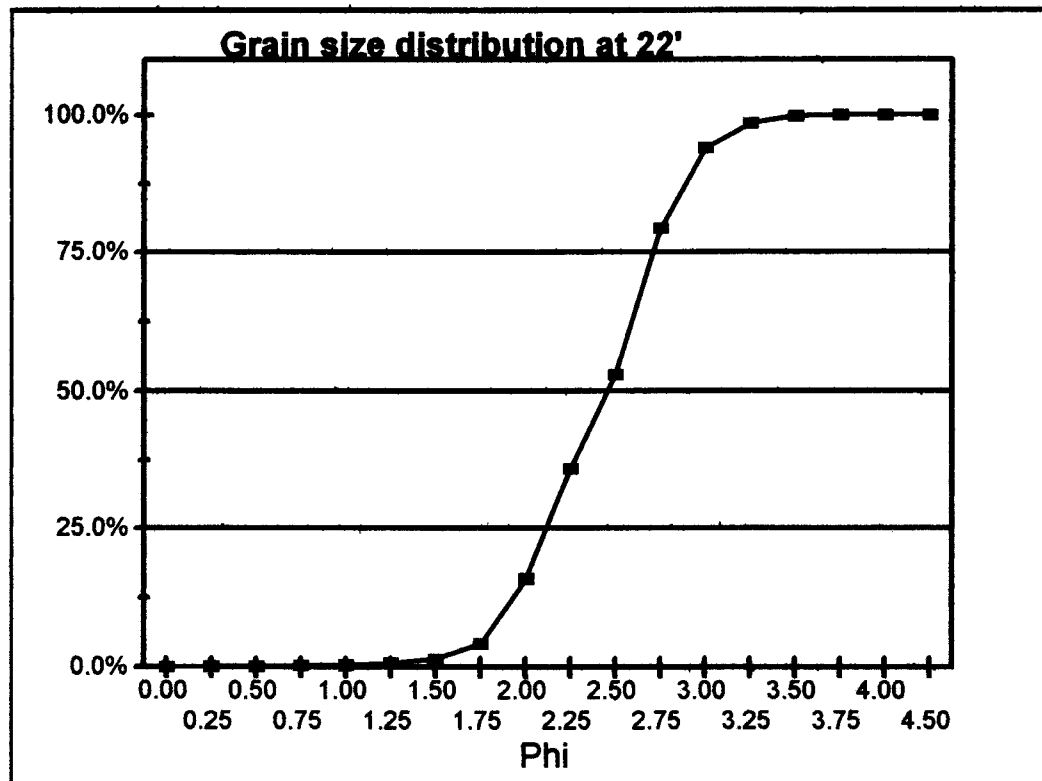
Statistical analysis of MW-25-LM @ depth 18				
	%	Phi		
Mean	67.37%	2.50	Kurtosis	-1.4006
Median	90.97%	2.75	Skewness	0.7435
Mode	25.72%	2.75	Range	0.9985
Standard Dev.	39.10%		Minimum	0.0092
Count	12.0000		Maximum	1.0076
Effective diameter 0.149 mm (Hazen 1911)				



Statistical analysis of MW-25-LM @ depth 20				
	%	Phi		
Mean	59.29%	2.50	Kurtosis	-1.3658
Median	69.61%	2.50	Skewness	0.7656
Mode	27.14%	2.75	Range	0.9923
Standard Dev.	39.60%		Minimum	0.0077
Count	10.0000		Maximum	1.0000
Effective diameter 0.149 mm (Hazen 1911)				

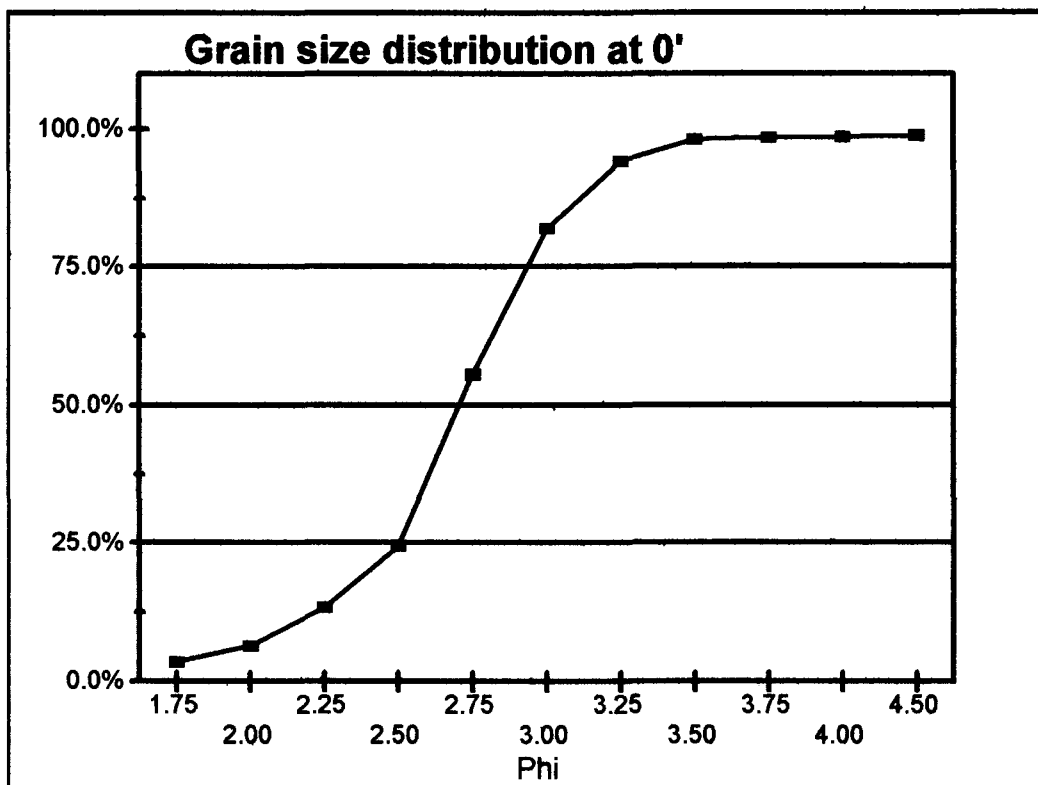


Statistical analysis of MW-25-LM @ depth 22				
	%	Phi		
Mean	43.47%	2.25	Kurtosis	-1.3103
Median	25.82%	2.00	Skewness	0.7911
Mode	26.42%	2.75	Range	0.9995
Standard Dev.	44.13%		Minimum	0.0001
Count	18.0000		Maximum	0.9996
Effective diameter 0.149 mm (Hazen 1911)				

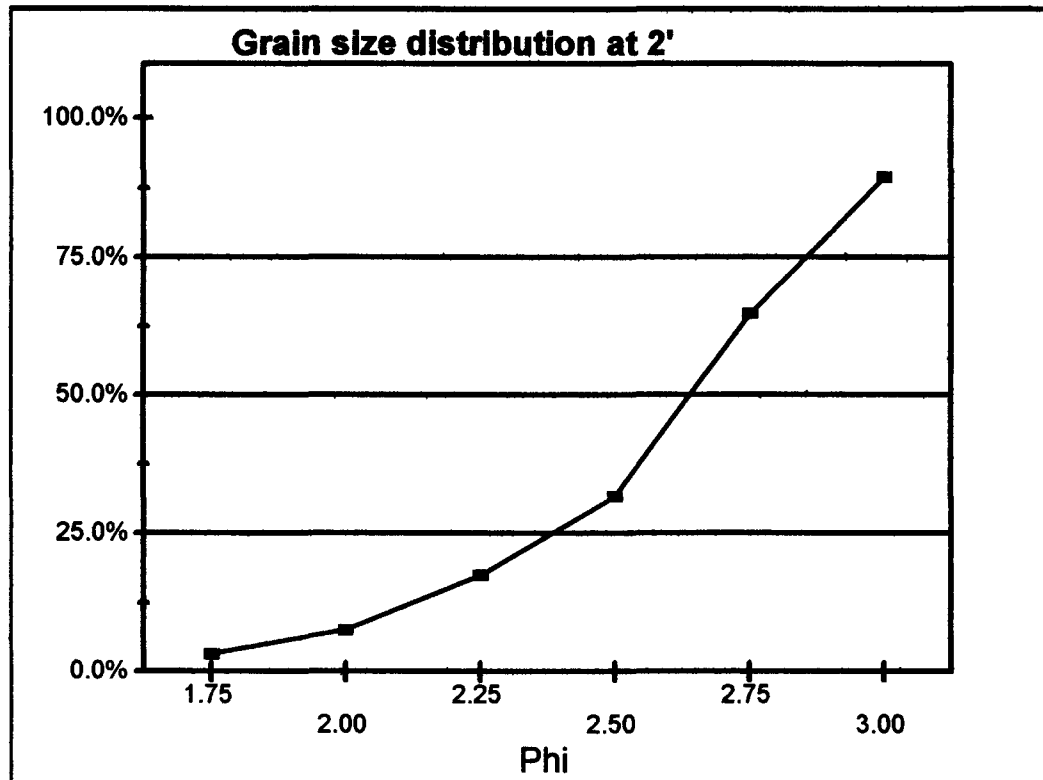


Appendix XII.
Particle size analysis for MW-GW-A6

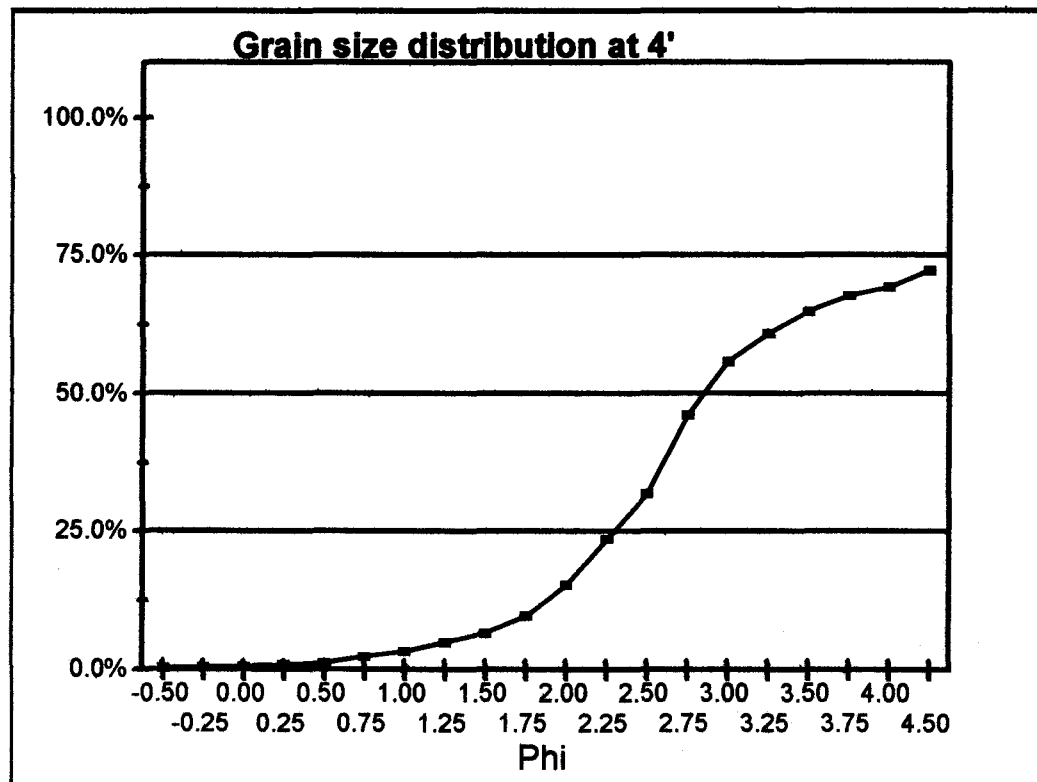
Statistical analysis of MW-GW-A6 @ depth 0				
	%	Phi		
Mean	30.78%	2.50	Kurtosis	-0.8245
Median	18.80%	2.25	Skewness	1.0414
Mode	31.12%	2.75	Range	0.7844
Standard Dev.	21.26%		Minimum	0.0344
Count	6.0000		Maximum	0.8188
Effective diameter 0.125 mm (Hazen 1911)				



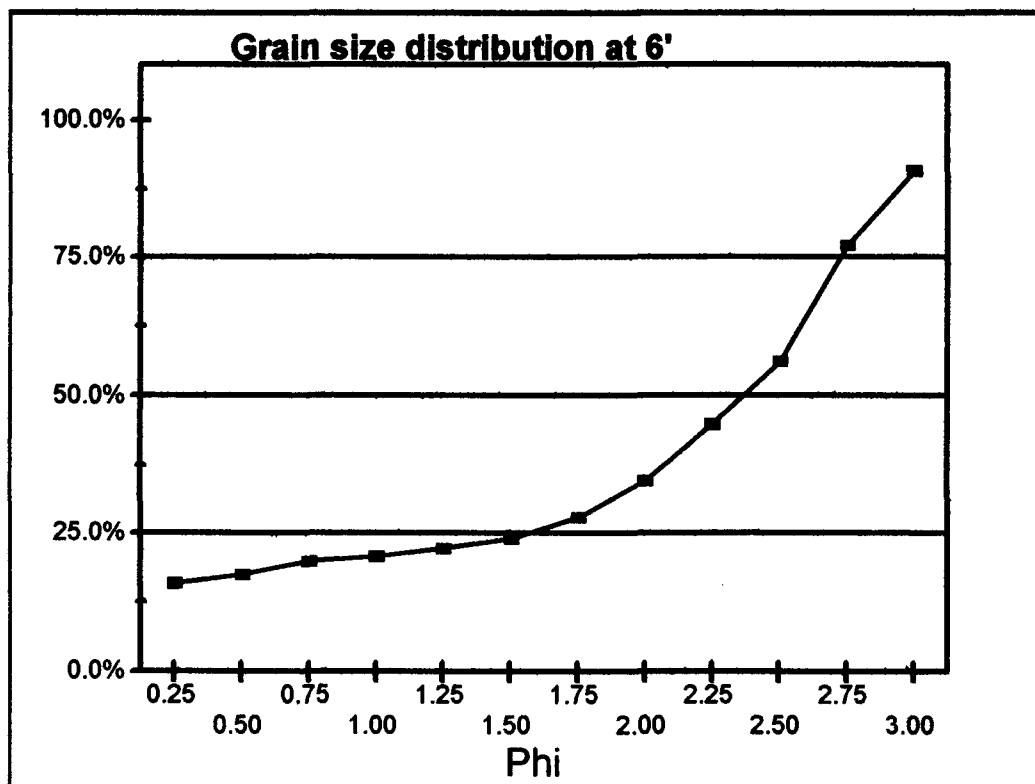
Statistical analysis of MW-GW-A6 @ depth 2				
	%	Phi		
Mean	35.62%	2.50	Kurtosis	-1.0941
Median	24.50%	2.25	Skewness	0.9277
Mode	33.16%	2.75	Range	0.8629
Standard Dev.	31.46%		Minimum	0.0307
Count	6.0000		Maximum	0.8936
Effective diameter 0.044 mm (Hazen 1911)				



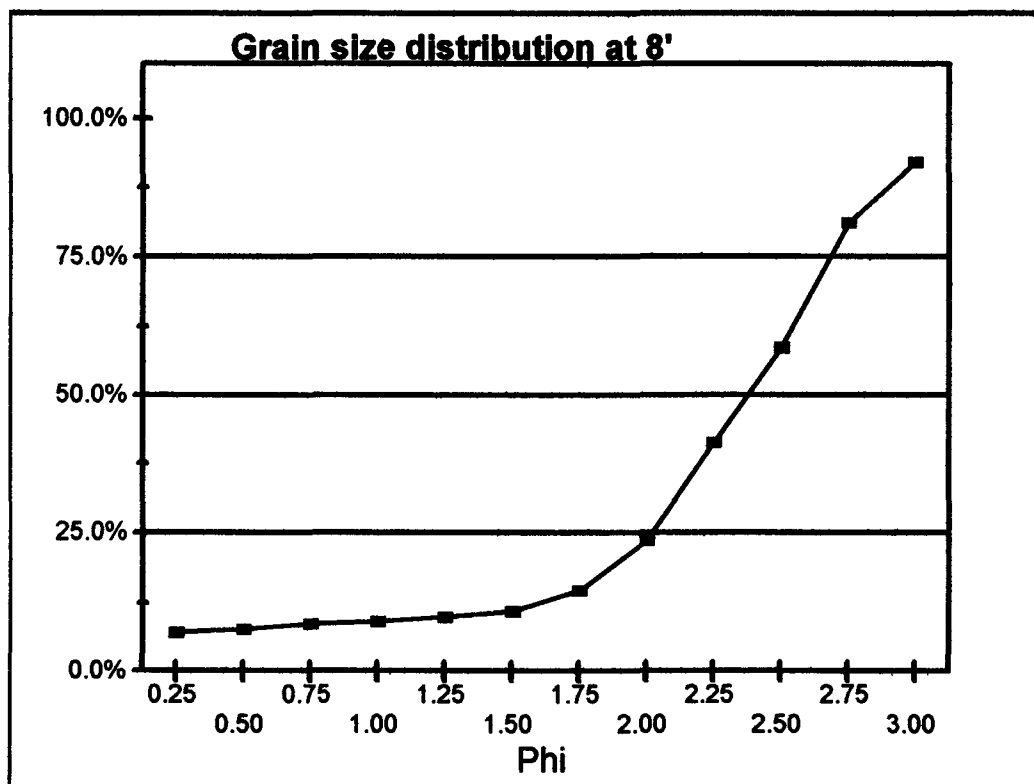
Statistical analysis of MW-GW-A6 @ depth 4				
	%	Phi		
Mean	26.83%	2.25	Kurtosis	-1.0671
Median	12.39%	1.75	Skewness	0.8485
Mode	14.38%	2.75	Range	0.7189
Standard Dev.	27.62%		Minimum	0.0029
Count	20.0000		Maximum	0.7218
Effective diameter 0.044 mm (Hazen 1911)				



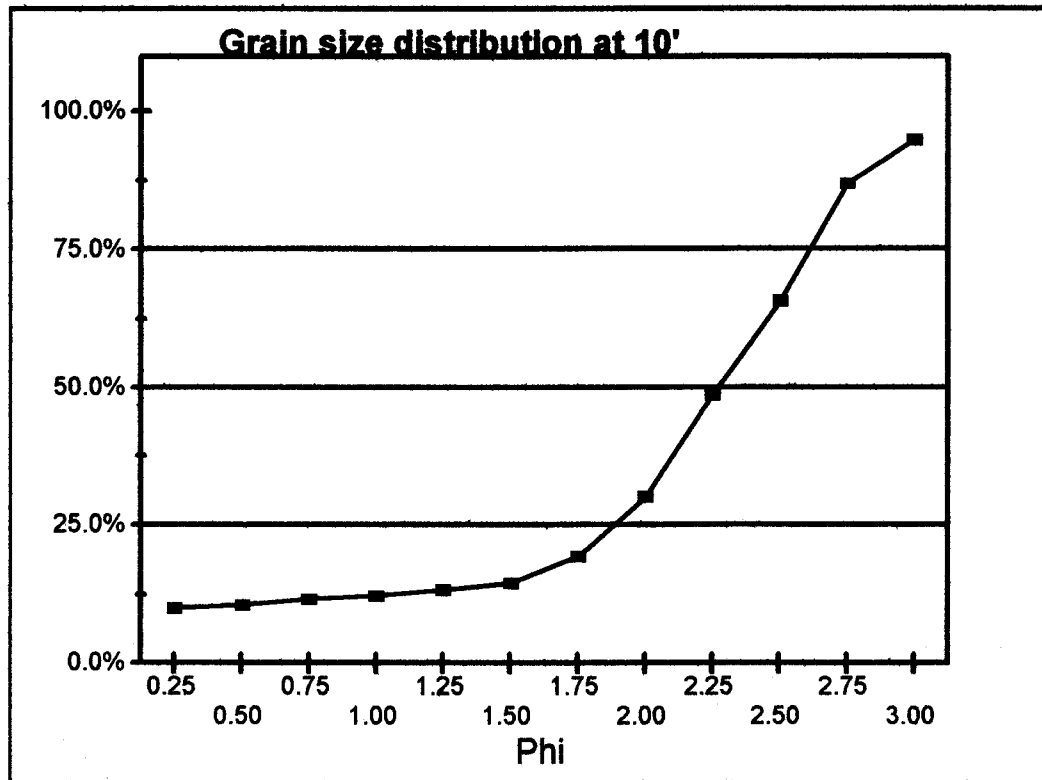
Statistical analysis of MW-GW-A6 @ depth 6				
	%	Phi		
Mean	37.53%	2.00	Kurtosis	-1.3933
Median	25.77%	1.50	Skewness	0.5357
Mode	21.10%	2.75	Range	0.7498
Standard Dev.	23.82%		Minimum	0.1579
Count	12.0000		Maximum	0.9078
Effective diameter 0.149 mm (Hazen 1911)				



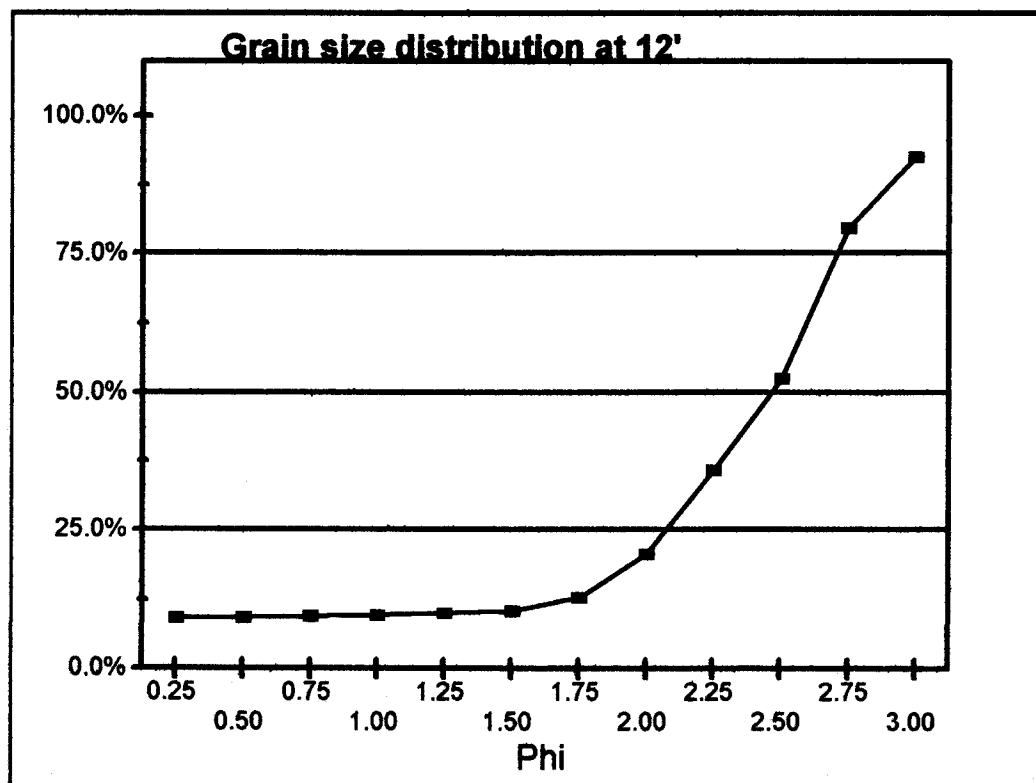
Statistical analysis of MW-GW-A6 @ depth 8				
	%	Phi		
Mean	30.29%	2.00	Kurtosis	-1.4402
Median	12.69%	1.50	Skewness	0.6857
Mode	22.45%	2.75	Range	0.8500
Standard Dev.	29.43%		Minimum	0.0697
Count	12.0000		Maximum	0.9197
Effective diameter 0.149 mm (Hazen 1911)				



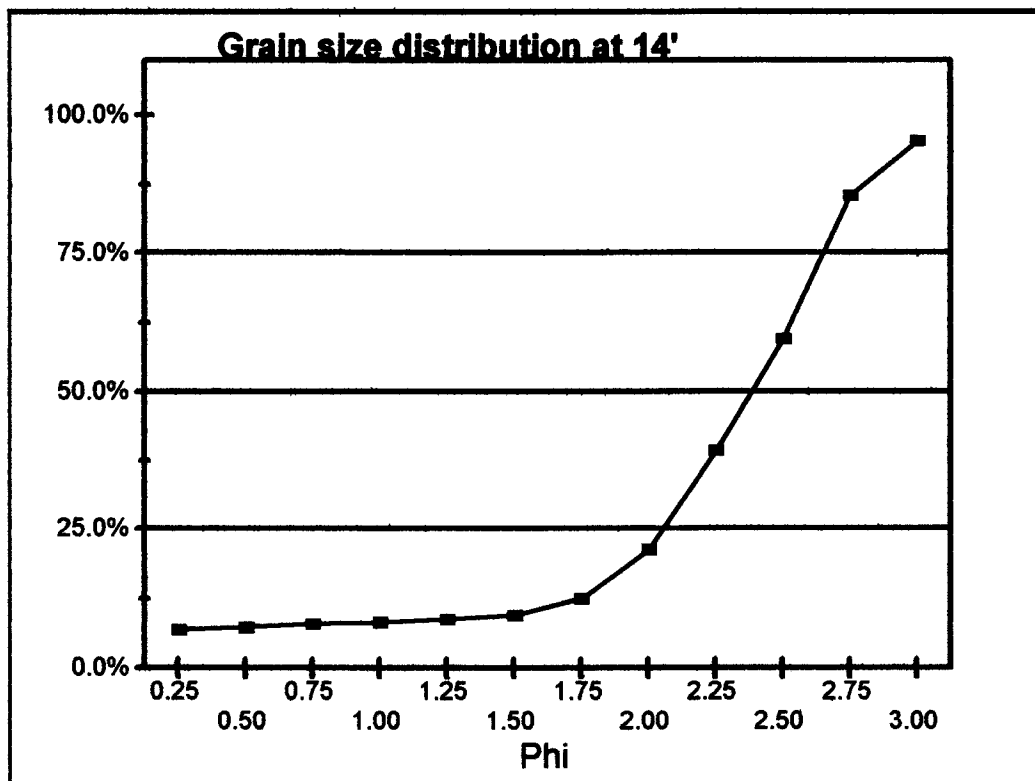
Statistical analysis of MW-GW-A6 @ depth 10				
	%	Phi		
Mean	34.70%	2.00	Kurtosis	-1.5139
Median	16.86%	1.50	Skewness	0.6111
Mode	21.13%	2.75	Range	0.8479
Standard Dev.	30.06%		Minimum	0.0989
Count	12.0000		Maximum	0.9468
Effective diameter 0.149 mm (Hazen 1911)				



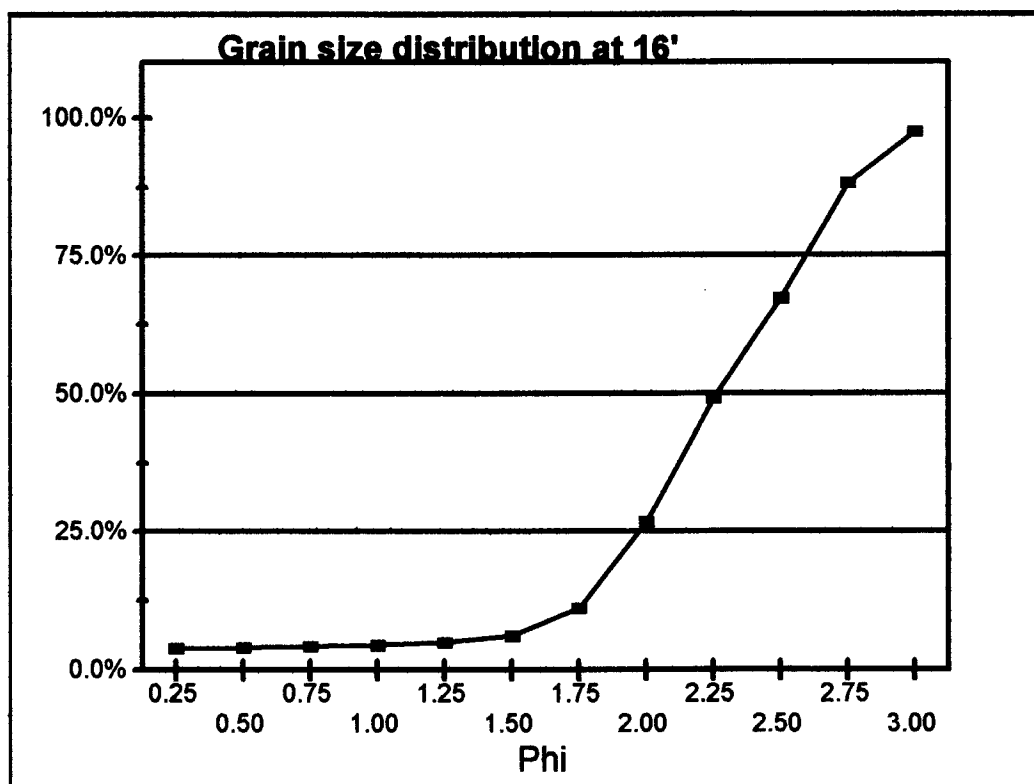
Statistical analysis of MW-GW-A6 @ depth 12				
	%	Phi		
Mean	29.23%	2.00	Kurtosis	-1.3475
Median	11.53%	1.50	Skewness	0.7425
Mode	27.07%	2.75	Range	0.8349
Standard Dev.	28.56%		Minimum	0.0906
Count	12.0000		Maximum	0.9255
Effective diameter 0.149 mm (Hazen 1911)				



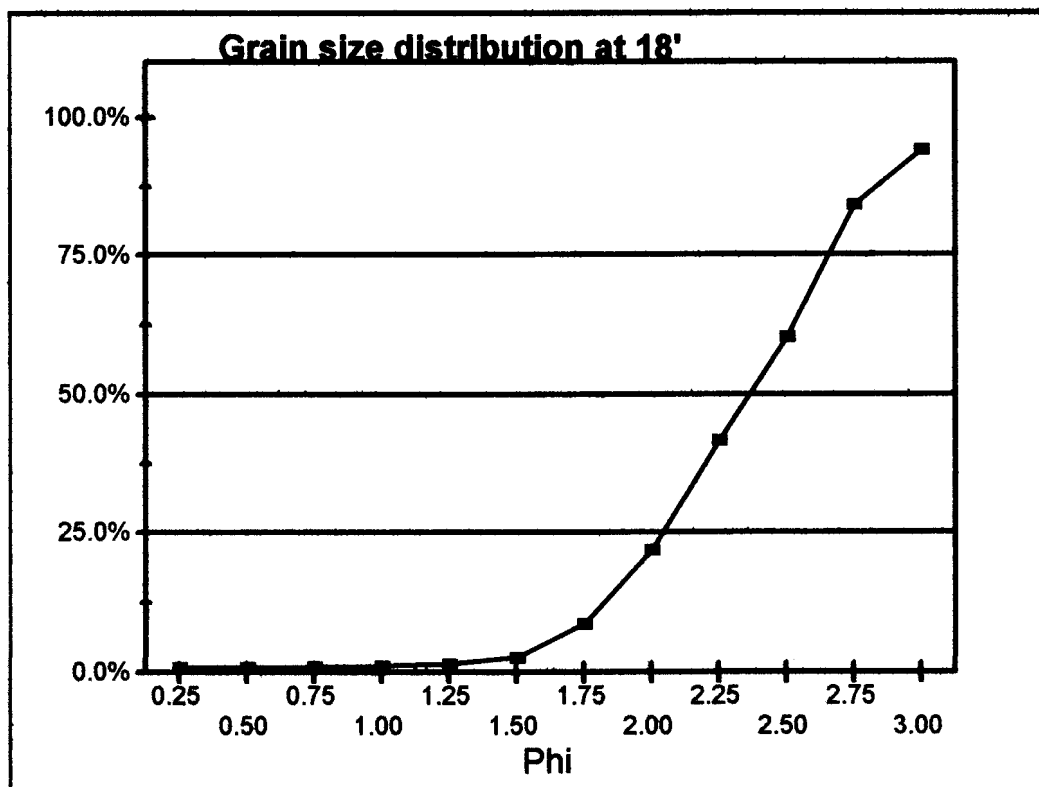
Statistical analysis of MW-GW-A6 @ depth 14				
	%	Phi		
Mean	30.05%	2.00	Kurtosis	-1.4216
Median	10.80%	1.50	Skewness	0.7153
Mode	25.96%	2.75	Range	0.8848
Standard Dev.	31.07%		Minimum	0.0679
Count	12.0000		Maximum	0.9527
Effective diameter 0.149 mm (Hazen 1911)				



Statistical analysis of MW-GW-A6 @ depth 16				
	%	Phi		
Mean	30.49%	2.00	Kurtosis	-1.5029
Median	8.44%	1.50	Skewness	0.6787
Mode	22.52%	2.25	Range	0.9363
Standard Dev.	34.08%		Minimum	0.0371
Count	12.0000		Maximum	0.9734
Effective diameter 0.149 mm (Hazen 1911)				

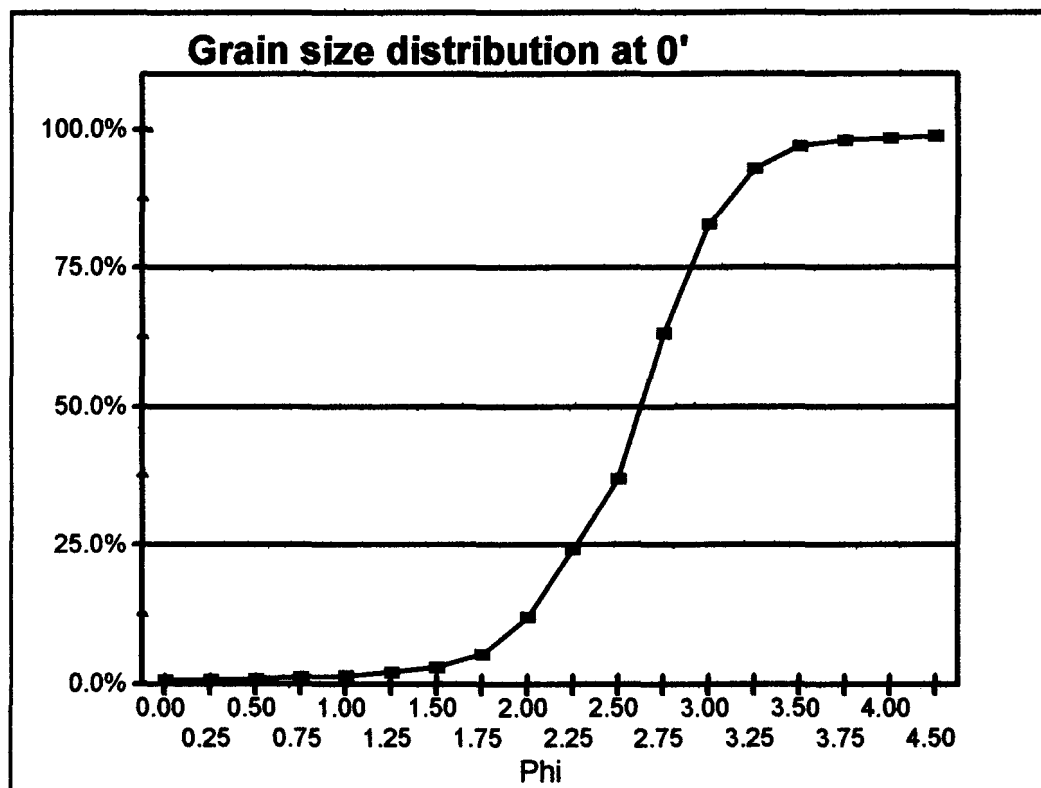


Statistical analysis of MW-GW-A6 @ depth 18				
	%	Phi		
Mean	26.47%	2.00	Kurtosis	-1.4717
Median	5.51%	1.50	Skewness	0.7005
Mode	23.81%	2.75	Range	0.9328
Standard Dev.	33.47%		Minimum	0.0079
Count	12.0000		Maximum	0.9407
Effective diameter 0.149 mm (Hazen 1911)				

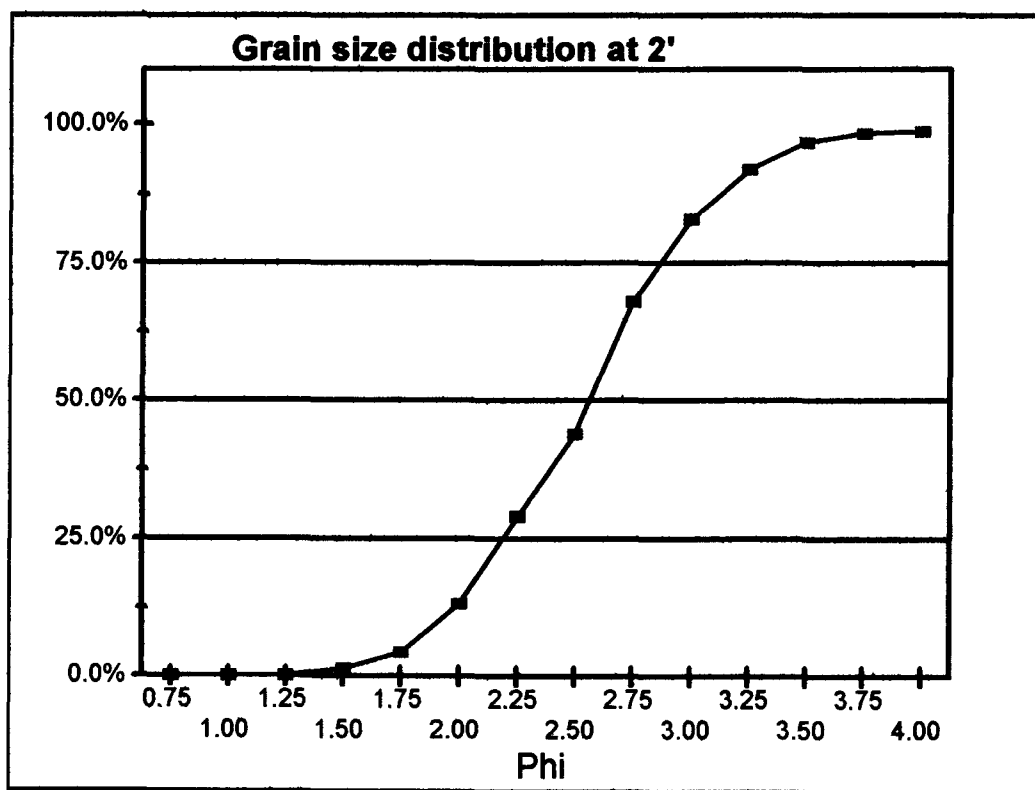


Appendix XIII.
Particle size analysis for MW-GW-A8

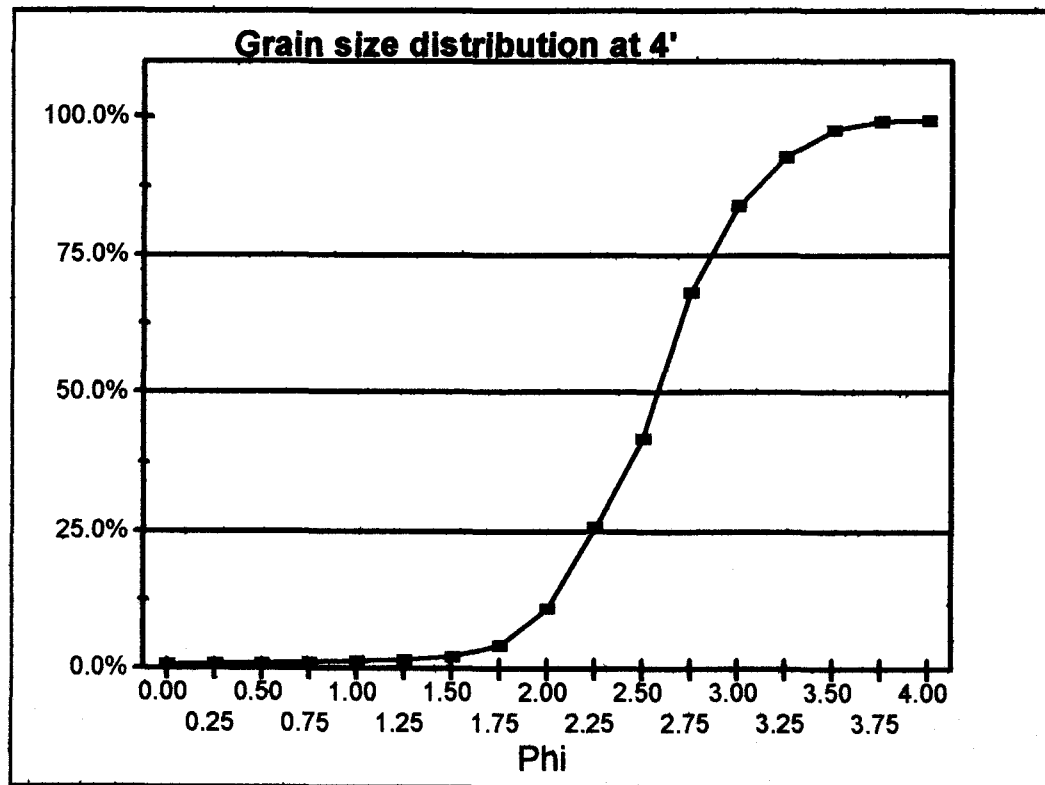
Statistical analysis of MW-GW-A8 @ depth 0				
	%	Phi		
Mean	39.97%	2.50	Kurtosis	-1.0042
Median	18.05%	2.00	Skewness	0.9350
Mode	26.15%	2.75	Range	0.9815
Standard Dev.	40.06%		Minimum	0.0064
Count	18.0000		Maximum	0.9878
Effective diameter 0.125 mm (Hazen 1911)				



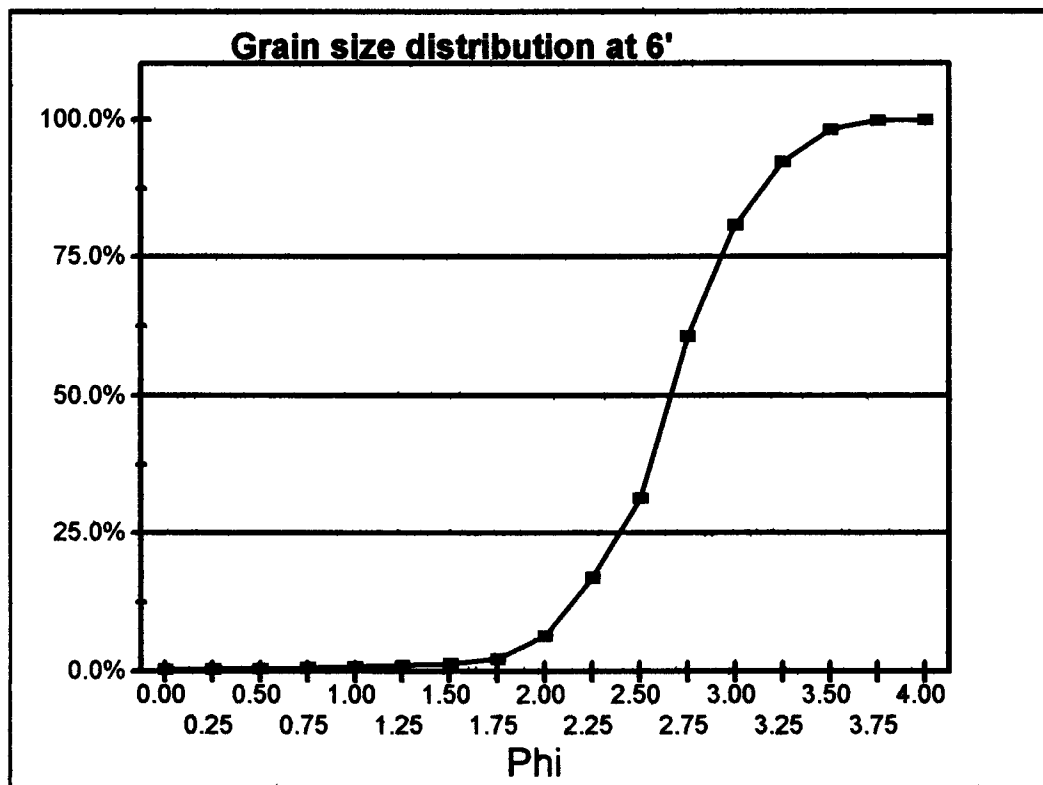
Statistical analysis of MW-GW-A8 @ depth 2				
	%	Phi		
Mean	60.59%	2.50	Kurtosis	-1.1192
Median	75.46%	2.75	Skewness	0.8734
Mode	24.07%	2.75	Range	0.9795
Standard Dev.	38.10%		Minimum	0.0129
Count	12.0000		Maximum	0.9925
Effective diameter 0.125 mm (Hazen 1911)				



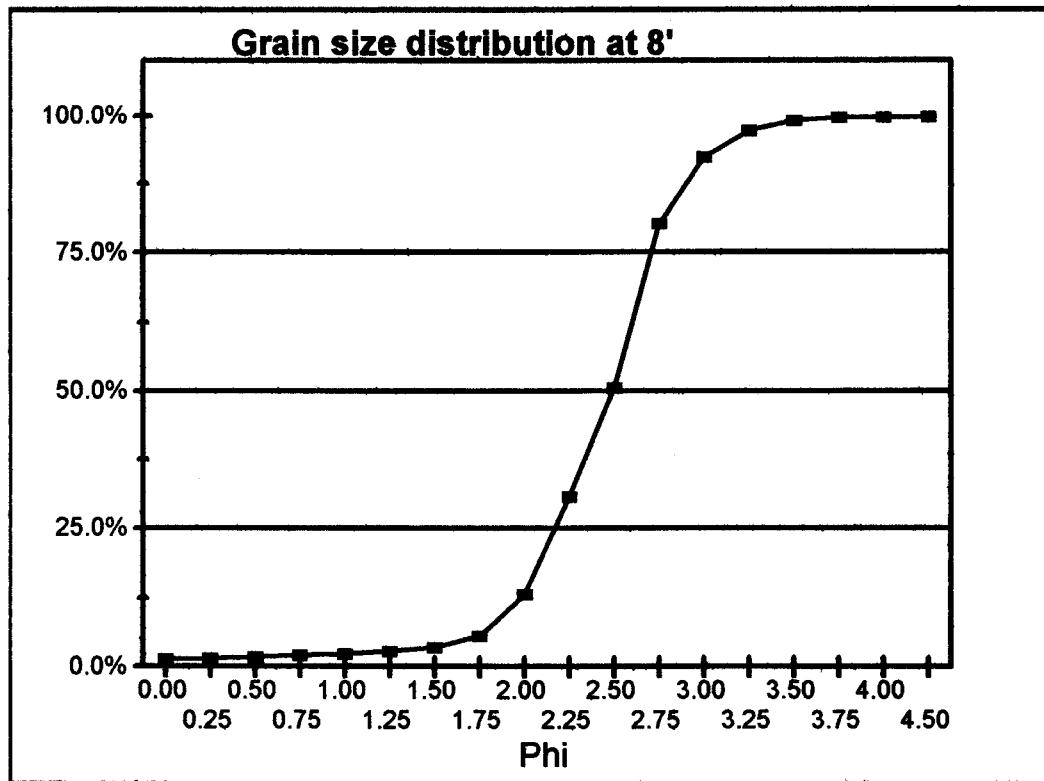
Statistical analysis of MW-GW-A8 @ depth 4				
	%	Phi		
Mean	40.61%	2.25	Kurtosis	-1.0844
Median	18.29%	2.00	Skewness	0.9000
Mode	26.42%	2.75	Range	0.9892
Standard Dev.	42.33%		Minimum	0.0065
Count	18.0000		Maximum	0.9957
Effective diameter 0.125 mm (Hazen 1911)				



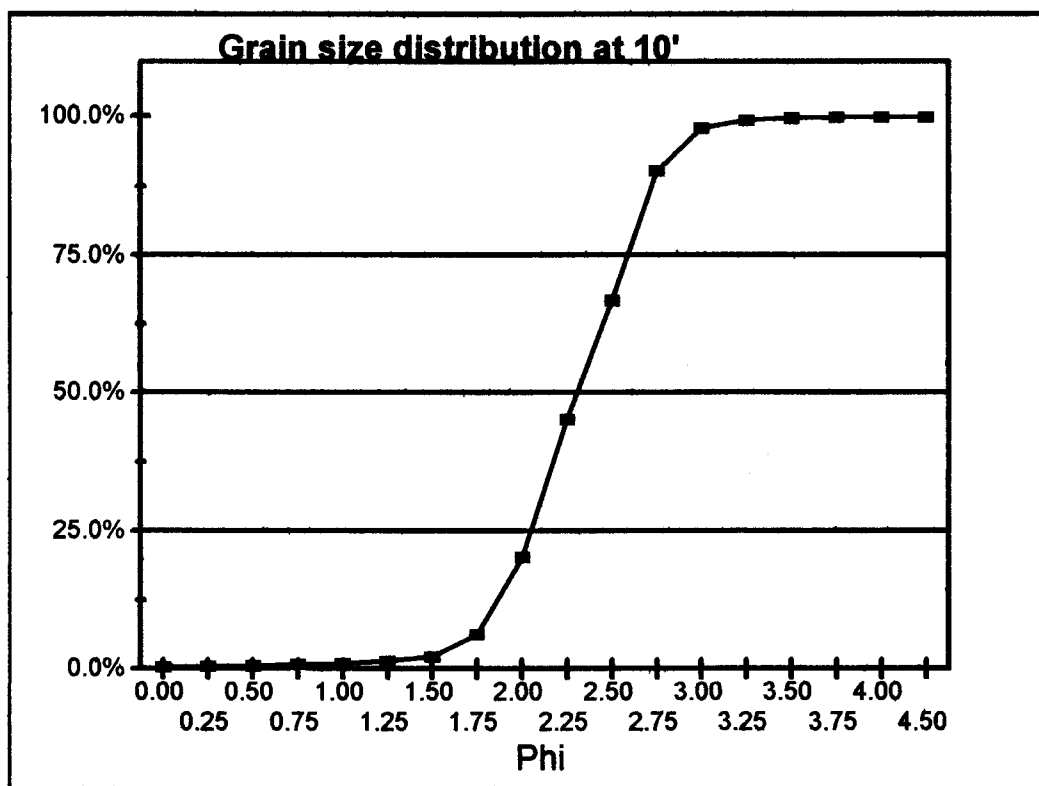
Statistical analysis of MW-GW-A8 @ depth 6				
	%	Phi		
Mean	38.51%	2.50	Kurtosis	-0.8978
Median	11.57%	2.00	Skewness	0.9963
Mode	29.27%	2.75	Range	0.9950
Standard Dev.	42.72%		Minimum	0.0038
Count	18.0000		Maximum	0.9989
Effective diameter 0.125 mm (Hazen 1911)				



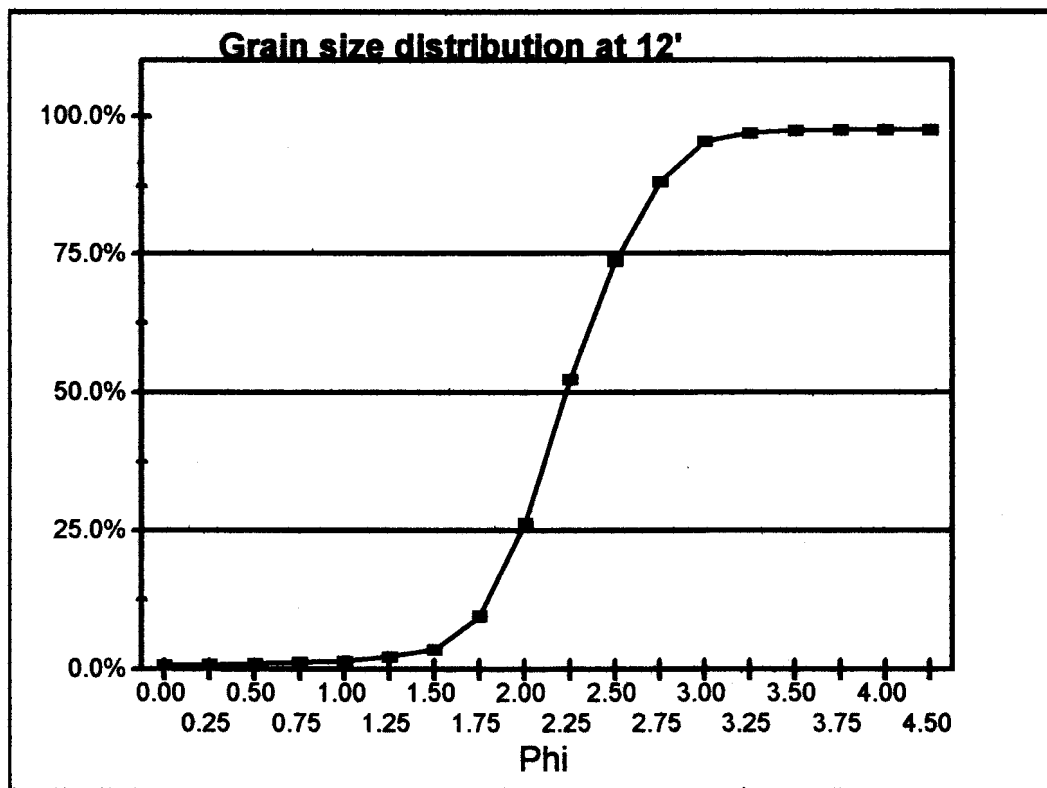
Statistical analysis of MW-GW-A8 @ depth 8				
	%	Phi		
Mean	43.46%	2.25	Kurtosis	-1.2724
Median	21.73%	2.00	Skewness	0.8213
Mode	29.68%	2.75	Range	0.9841
Standard Dev.	43.30%		Minimum	0.0133
Count	18.0000		Maximum	0.9973
Effective diameter 0.149 mm (Hazen 1911)				



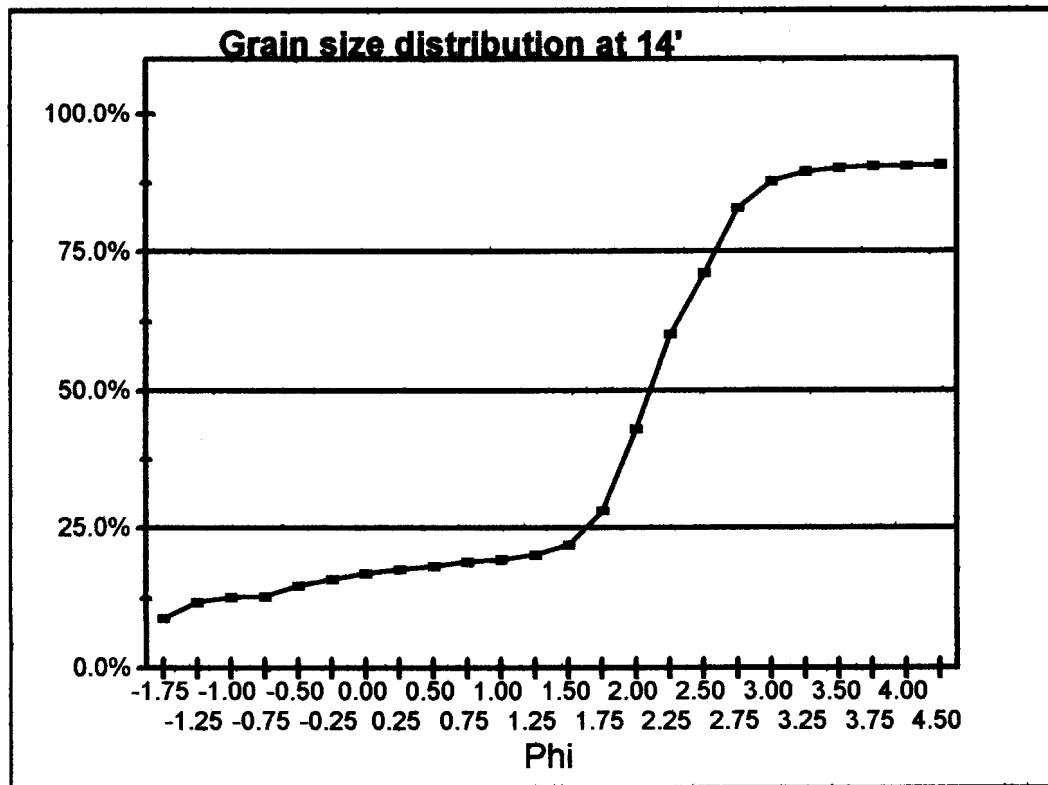
Statistical analysis of MW-GW-A8 @ depth 10				
	%	Phi		
Mean	46.04%	2.25	Kurtosis	-1.4997
Median	32.61%	2.00	Skewness	0.6945
Mode	24.74%	2.25	Range	0.9947
Standard Dev.	44.68%		Minimum	0.0021
Count	18.0000		Maximum	0.9968
Effective diameter 0.177 mm (Hazen 1911)				



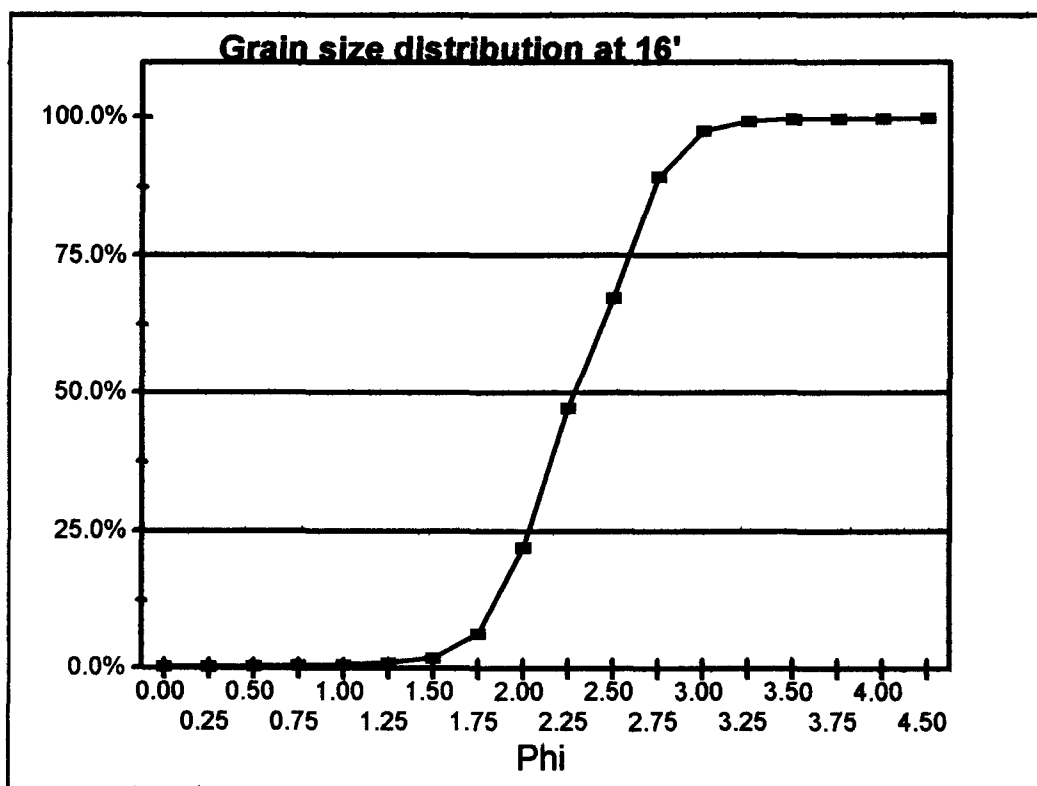
Statistical analysis of MW-GW-A8 @ depth 12				
	%	Phi		
Mean	46.77%	2.00	Kurtosis	-1.6002
Median	39.31%	2.00	Skewness	0.6274
Mode	26.06%	2.25	Range	0.9685
Standard Dev.	43.34%		Minimum	0.0062
Count	18.0000		Maximum	0.9748
Effective diameter 0.149 mm (Hazen 1911)				



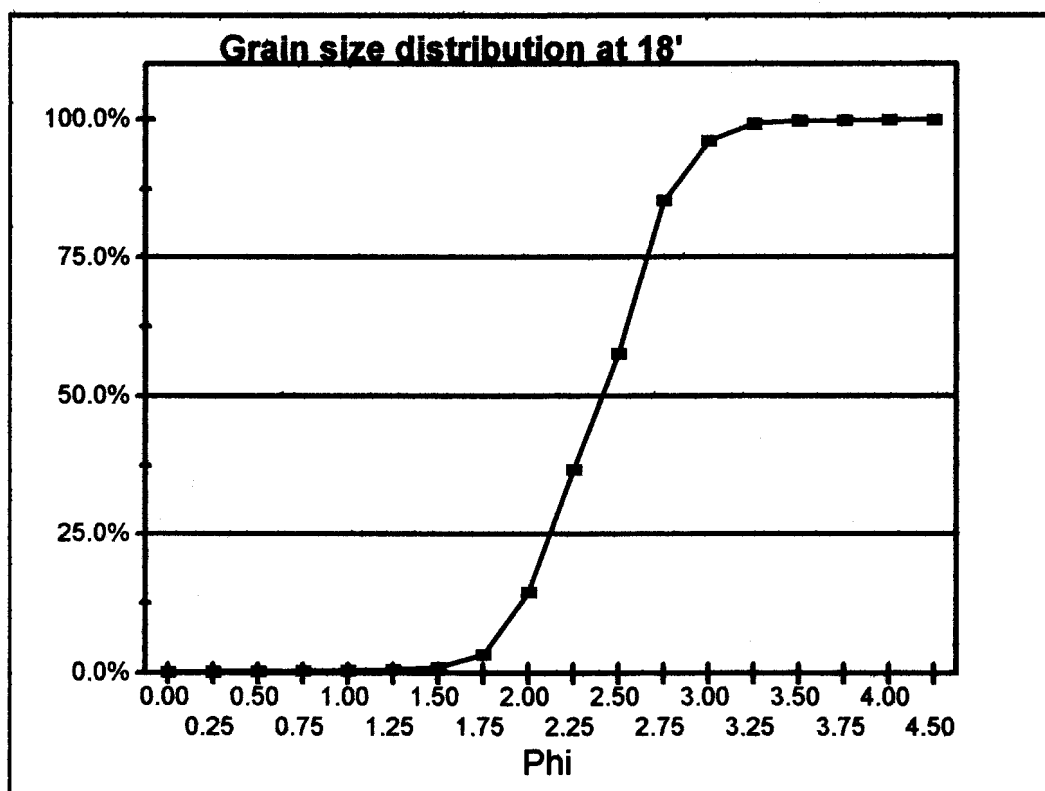
Statistical analysis of MW-GW-A8 @ depth 14				
	%	Phi		
Mean	43.02%	2.00	Kurtosis	-1.6327
Median	21.04%	1.25	Skewness	0.5505
Mode	17.18%	2.25	Range	0.8171
Standard Dev.	32.65%		Minimum	0.0889
Count	24.0000		Maximum	0.9059
Effective diameter 0.105 mm (Hazen 1911)				



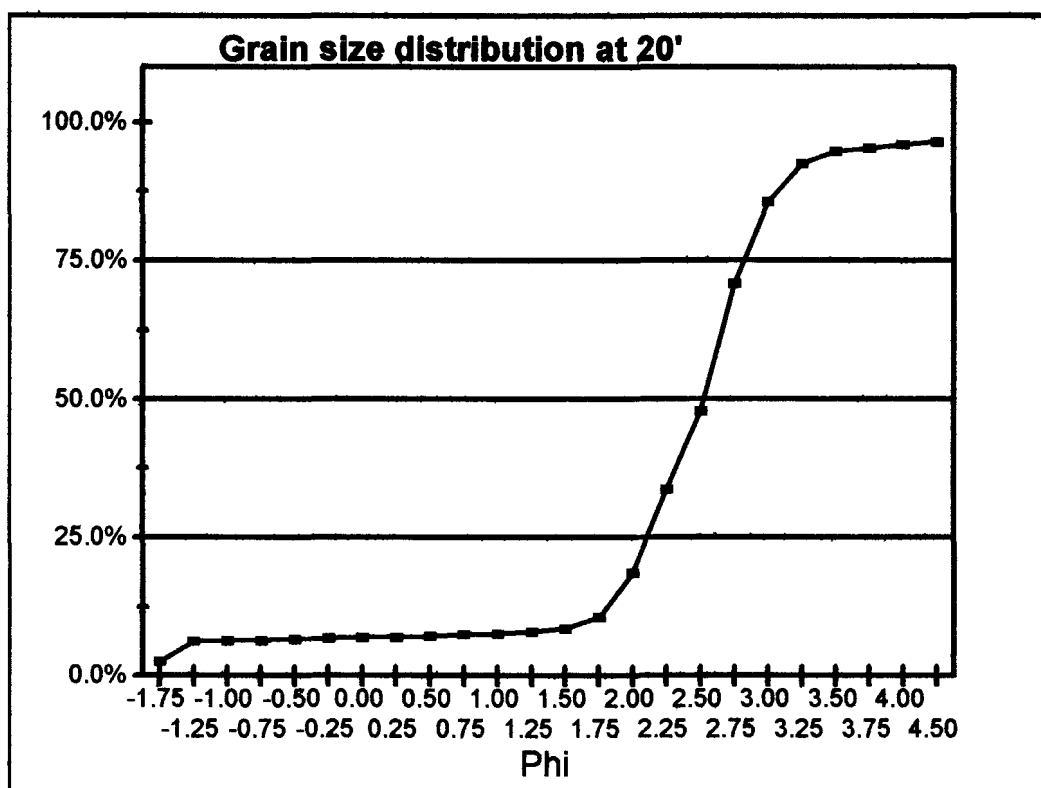
Statistical analysis of MW-GW-A8 @ depth 16				
	%	Phi		
Mean	46.16%	2.00	Kurtosis	-1.5141
Median	34.56%	2.00	Skewness	0.6816
Mode	25.09%	2.25	Range	0.9944
Standard Dev.	44.61%		Minimum	0.0020
Count	18.0000		Maximum	0.9964
Effective diameter 0.149 mm (Hazen 1911)				



Statistical analysis of MW-GW-A8 @ depth 18				
	%	Phi		
Mean	44.12%	2.25	Kurtosis	-1.3803
Median	25.50%	2.00	Skewness	0.7658
Mode	27.77%	2.75	Range	0.9976
Standard Dev.	44.74%		Minimum	0.0009
Count	18.0000		Maximum	0.9985
Effective diameter 0.149 mm (Hazen 1911)				



Statistical analysis of MW-GW-A8 @ depth 20				
	%	Phi		
Mean	34.50%	2.25	Kurtosis	-1.1788
Median	8.20%	1.25	Skewness	0.8505
Mode	23.00%	2.75	Range	0.9376
Standard Dev.	37.19%		Minimum	0.0254
Count	24.0000		Maximum	0.9630
Effective diameter 0.125 mm (Hazen 1911)				



Appendix XIV.

Water Quality Data

Summary of Water Quality Data for MW-0-GM

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Jan	01/20/94	N/A	-1.97	N/A	19.10	N/A	N/A	11.93	1.17	3.33	24.20	20.30	22.33	None
Feb	02/22/94	7.50	-2.28	0	16.30	0.00	380	18.87	1.26	4.84	23.70	18.50	21.36	None
Mar	03/30/94	N/A	-1.96	N/A	23.20	N/A	N/A	10.30	0.53	2.13	22.80	20.90	21.60	None
Apr	04/07/94	7.25	-2.08	1	N/A	0.00	450	ERR	ERR	ERR	ERR	ERR	ERR	conductivity meter failed
May	05/22/94	7.25	-2.08	2	30.00	0.00	450	17.10	0.68	4.77	25.00	21.90	22.54	None
Jun	07/03/94	7.50	-2.78	0	35.00	0.00	500	18.00	1.10	3.67	28.00	21.90	23.49	None
Jul	07/23/94	7.25	-2.78	0	32.90	0.00	350	28.80	1.12	9.95	28.80	23.00	24.29	None
Aug	08/27/94	7.00	-3.18	3	34.20	0.00	N/A	16.00	0.99	3.57	32.00	26.00	27.59	None
Sep	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Oct	10/30/94	7.50	-1.98	1	31.50	0.00	817	26.20	4.43	9.49	28.00	26.90	27.56	None
Nov	11/25/94	7.60	-2.33	1	26.70	0.00	345	23.50	2.10	10.90	28.20	27.30	27.82	None
Dec	01/14/95	7.50	-2.48	2	24.90	0.00	347	23.20	0.91	6.42	31.00	26.20	29.38	None

Summary of Water Quality Data for MW-0-LG

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-3.07	N/A	17.50	N/A	N/A	0.47	0.45	0.46	23.60	21.60	22.58	None
Jan	01/20/94	N/A	-1.77	N/A	20.10	N/A	N/A	0.55	0.49	0.50	22.90	18.40	20.64	None
Feb	02/24/94	6.50	-1.83	0	18.30	0.00	480	1.07	0.42	0.49	22.40	18.60	20.39	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
May	05/22/94	7.00	-1.77	0	29.90	0.00	320	0.85	0.49	0.60	29.00	21.50	23.37	None
Jun	07/07/94	7.00	-2.42	0	N/A	0.00	213	0.59	0.49	0.51	28.00	22.50	24.91	None
Jul	07/23/94	7.00	-3.22	0	33.50	0.00	280	0.88	0.50	0.63	28.50	22.80	25.76	None
Aug	08/27/94	6.50	-4.22	0	N/A	0.00	N/A	0.56	0.49	0.50	28.10	26.00	26.77	None
Sep	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Oct	10/30/94	7.00	-1.42	0	28.00	0.00	320	0.55	0.55	0.55	25.80	25.80	25.80	None
Nov	11/25/94	6.60	-3.82	0	32.00	0.00	100	0.51	0.47	0.49	27.50	26.50	26.98	None
Dec	01/14/95	6.50	-2.82	2	30.50	0.20	500	0.50	0.42	0.43	29.20	27.00	28.12	None

Summary of Water Quality Data for MW-0-LM

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-2.76	N/A	21.20	N/A	N/A	20.00	8.00	19.29	24.30	18.40	22.06	None
Jan	01/20/94	N/A	-2.61	N/A	21.10	N/A	N/A	14.90	0.89	14.01	22.10	18.60	20.42	None
Feb	02/22/94	7.50	-2.53	95	19.50	20.00	N/A	50.00	50.00	50.00	21.20	18.70	19.72	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.50	-2.40	65	27.50	20.00	8430	50.00	50.00	50.00	20.10	20.10	20.10	None
May	05/22/94	7.25	-2.25	60	24.90	20.00	9300	50.00	28.90	39.45	29.00	29.00	29.00	None
Jun	06/30/94	7.00	-2.45	80	32.20	20.00	9500	50.00	50.00	50.00	29.30	29.30	29.30	None
Jul	07/23/94	7.25	-2.30	84	29.50	20.00	9200	50.00	50.00	50.00	28.50	28.50	28.50	None
Aug	08/27/94	7.50	-2.90	70	32.00	20.00	10200	50.00	50.00	50.00	34.00	28.20	30.46	None
Sep	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Oct	10/30/94	7.50	-1.80	65	N/A	20.00	N/A	50.00	50.00	50.00	28.50	25.80	27.78	None
Nov	11/25/94	7.60	-2.10	50	25.00	20.00	13810	50.00	50.00	50.00	24.10	24.10	24.10	None
Dec	01/14/95	7.60	-2.90	78	28.80	20.00	N/A	50.00	25.10	44.42	28.50	22.90	24.52	None

Summary of Water Quality Data for MW-15-GM

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-4.33	N/A	19.7	N/A	N/A	0.18	0.16	0.17	24.4	22.3	23.53	None
Jan	01/19/94	N/A	-3.89	N/A	20.5	N/A	N/A	1.56	0.76	1.4	23.1	19.8	21.56	None
Feb	02/24/94	7.75	-4.27	1.5	18.8	0	526	1.62	1.28	1.55	22.1	19.9	21.16	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.25	-3.83	0	21.5	0	246	1.45	0.75	1.19	24.3	21.7	22.25	None
May	05/21/94	8	-4.08	0	29	0	N/A	1.7	0.91	1.25	23	21.7	22.11	None
Jun	06/30/94	7.5	-4.23	0	N/A	0	273	1.35	0.89	1.15	24.1	23	23.57	None
Jul	07/23/94	7.5	-4.53	0	31.3	0	430	1.82	1.32	1.6	28.1	24.8	26.99	None
Aug	08/27/94	7.5	-4.93	0	N/A	0	N/A	1.76	1.65	1.7	32.1	27.9	29.74	None
Sep	09/29/94	7.5	-4.83	0	N/A	0	503	ERR	ERR	ERR	ERR	ERR	ERR	conductivity meter nonfunctional
Oct	10/29/94	7.5	-3.93	0	31.8	0	446	1.65	1.52	1.57	30.5	29.2	29.88	None
Nov	11/25/94	7.8	-3.83	0	31.5	0	400	1.92	1.58	1.72	27.8	27	27.33	None
Dec	01/14/95	7.5	-4.53	1	30.5	0	440	1.3	1.2	1.25	28.2	26.5	27.4	None

Summary of Water Quality Data for MW-15-LG

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/13/93	N/A	-2.57	N/A	20.10	N/A	N/A	20.00	4.67	16.75	24.20	21.10	23.13	None
Jan	01/19/94	N/A	-1.25	N/A	15.60	N/A	N/A	20.00	2.15	12.55	20.40	17.20	18.91	none
Feb	02/24/94	7.25	-2.09	5	18.00	0.50	1560	20.00	1.28	11.35	20.70	18.50	19.53	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.50	-2.29	4	28.70	3.00	1210	14.88	2.33	11.36	24.10	20.30	21.16	Conductivity meter failed @ 18'
May	05/21/94	7.50	-1.54	3	31.00	N/A	N/A	50.00	1.10	17.43	26.50	21.20	22.95	None
Jun	06/30/94	7.50	-2.79	4	N/A	2.00	1640	48.00	2.00	16.86	25.20	25.20	25.20	One temperature at -6"TOC
Jul	07/23/94	7.60	-3.49	11	36.00	20.00	N/A	49.90	10.20	27.51	29.80	24.10	26.32	None
Aug	08/27/94	7.25	-3.89	20	N/A	20.00	N/A	50.00	12.80	26.07	33.00	28.20	30.00	None
Sep	09/29/94	7.50	-4.29	N/A	N/A	10.00	2410	ERR	ERR	ERR	ERR	ERR	ERR	conductivity meter not operable
Oct	10/29/94	7.50	-2.39	N/A	32.30	17.00	1850	50.10	5.00	25.23	28.50	26.80	28.01	None
Nov	11/25/94	7.70	-2.79	5	32.00	20.00	5175	50.00	5.00	29.76	27.00	26.00	26.68	None
Dec	01/14/95	7.80	-1.29	13	N/A	20.00	3550	50.00	1.82	20.61	27.00	22.50	25.00	None

Summary of Water Quality Data for MW-15-LM

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Jan	01/19/94	N/A	-0.13	N/A	16	N/A	N/A	0	0	0	21.5	15.9	18.32	Conductivity meter not working
Feb	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Apr	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
May	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Jun	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Jul	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Aug	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Sep	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Oct	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Nov	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed
Dec	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	Well destroyed

Summary of Water Quality Data for MW-25-GM

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-10.05	N/A	24.80	N/A	N/A	1.27	1.10	1.14	25.60	25.00	25.44	None
Jan	01/19/94	N/A	-9.60	N/A	21.00	N/A	N/A	1.11	1.10	1.10	25.20	24.30	24.83	None
Feb	02/23/94	8.00	-9.95	0	17.30	0.00	354	1.09	1.07	1.09	24.80	23.80	24.40	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.50	-9.85	0	20.20	0.00	199	1.18	1.01	1.08	24.50	24.10	24.19	None
May	05/21/94	7.50	-9.45	0	28.10	0.00	N/A	1.03	1.00	1.01	25.90	25.70	25.80	None
Jun	06/30/94	7.50	-10.15	0	N/A	0.00	254	1.09	1.05	1.07	24.00	23.90	23.97	None
Jul	07/23/94	7.50	-10.45	0	33.00	0.00	317	1.10	1.05	1.08	26.50	23.80	24.86	None
Aug	08/27/94	7.75	-10.85	0	N/A	0.00	N/A	1.05	1.02	1.03	28.80	26.10	27.05	None
Sep	09/29/94	7.50	-10.45	0	N/A	0.00	320	0.99	0.98	0.99	27.50	27.00	27.20	None
Oct	10/29/94	7.50	-9.30	0	35.00	0.00	265	1.10	0.93	0.99	28.30	26.00	27.15	None
Nov	11/25/94	N/A	-9.35	0	24.00	0.00	223	0.98	0.92	0.94	26.60	25.00	25.94	None
Dec	01/14/95	7.50	-10.15	0	31.00	0.00	325	0.83	0.83	0.83	29.20	29.00	29.07	None

Summary of Water Quality Data for MW-25-LG

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-0.79	N/A	23.90	N/A	N/A	18.45	3.99	10.66	24.60	18.40	21.78	None
Jan	01/19/94	N/A	0.27	N/A	19.50	N/A	N/A	19.03	4.75	11.68	23.50	15.10	19.92	None
Feb	02/23/94	7.50	-0.47	4	14.20	0.00	1730	17.99	7.68	13.42	22.60	19.00	20.45	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.50	0.25	2	24.00	0.00	2250	14.74	5.38	9.56	21.70	20.80	21.09	None
May	05/21/94	7.30	0.33	3	26.50	0.00	N/A	20.30	4.68	11.25	28.80	22.00	23.96	None
Jun	06/30/94	7.50	0.00	4	N/A	0.00	2375	17.50	4.48	10.42	27.50	21.90	23.62	None
Jul	07/23/94	7.25	-1.90	5	33.50	0.01	N/A	20.50	8.90	14.88	29.70	23.30	26.39	None
Aug	08/27/94	7.50	-2.00	3	N/A	0.20	N/A	19.60	4.15	12.31	32.00	25.10	28.43	None
Sep	09/29/94	7.50	-2.00	N/A	N/A	0.00	1269	ERR	ERR	ERR	ERR	ERR	ERR	Conductivity meter not working
Oct	10/29/94	7.50	0.20	0	34.00	0.00	1010	19.00	3.75	10.89	27.80	26.00	26.83	None
Nov	11/25/94	7.50	-0.80	5	28.00	0.00	3375	18.20	4.00	10.38	28.00	25.00	27.17	None
Dec	01/14/95	7.50	0.00	3	21.30	2.00	1000	17.50	1.82	8.58	27.00	19.50	23.53	None

Summary of Water Quality Data for MW-25-LM

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-0.67	N/A	23.70	N/A	N/A	20.00	15.46	19.76	24.70	19.10	22.63	None
Jan	01/19/94	N/A	-0.30	N/A	N/A	N/A	N/A	ERR	ERR	ERR	22.50	17.50	19.71	Conductivity meter not functioning
Feb	02/23/94	8.00	-0.48	42	30.00	5.00	3730	ERR	ERR	ERR	23.60	18.20	20.34	Conductivity meter not functioning
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.75	-0.45	29	22.60	4.00	8750	ERR	ERR	ERR	21.80	19.50	19.99	Conductivity meter not functioning
May	05/21/94	8.20	-0.30	12	27.30	4.00	N/A	50.00	18.30	33.30	25.70	23.20	24.15	None
Jun	06/30/94	8.00	-0.80	40	N/A	5.00	9235	50.00	17.80	35.62	25.50	23.50	24.40	None
Jul	07/23/94	7.75	-1.60	8	31.80	4.00	N/A	50.00	8.20	27.51	29.10	27.10	27.89	None
Aug	08/27/94	7.50	-1.70	42	N/A	2.00	N/A	47.90	9.20	23.53	29.90	27.70	28.47	None
Sep	09/29/94	8.00	-1.30	N/A	N/A	3.00	15700	ERR	ERR	ERR	ERR	ERR	ERR	Conductivity meter not functioning
Oct	10/29/94	7.50	0.20	N/A	N/A	5.00	19670	50.00	24.00	36.73	26.00	25.00	25.42	None
Nov	11/25/94	8.00	0.10	55	24.00	5.00	7520	50.00	17.10	40.78	25.80	22.20	24.58	None
Dec	01/14/95	8.00	-0.20	12	14.10	1.50	2350	50.00	13.20	38.97	26.00	17.00	21.41	None

Summary of Water Quality Data for MW-15-GF

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	12/15/93	N/A	-1.22	N/A	24.20	N/A	N/A	20.00	17.84	19.88	24.80	18.90	21.95	None
Jan	01/19/94	N/A	-0.12	N/A	16.80	N/A	N/A	50.00	50.00	50.00	22.90	15.80	18.91	water in pond temp. 16.1
Feb	02/24/94	7.25	-0.88	47	16.50	15.00	N/A	50.00	50.00	50.00	22.50	19.00	20.27	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.25	-0.83	58	24.00	20.00	12770	ERR	ERR	ERR	22.40	20.80	21.31	No conductivity data
May	05/21/94	7.30	-0.25	24	32.00	N/A	13200	50.00	11.00	34.79	28.00	26.00	26.61	None
Jun	06/30/94	7.25	-1.03	55	N/A	25.00	13340	50.00	12.50	33.18	27.20	25.70	26.18	None
Jul	07/23/94	7.50	-2.33	75	32.00	20.00	N/A	20.00	20.00	20.00	ERR	ERR	ERR	No temerature data
Aug	08/27/94	7.50	-2.75	73	38.00	20.00	N/A	50.00	50.00	50.00	35.90	35.90	35.90	None
Sep	09/29/94	7.50	-2.58	56	N/A	20.00	17180	50.00	50.00	50.00	ERR	ERR	ERR	No temperature data
Oct	10/29/94	7.50	-1.33	4	32.50	20.00	10525	50.20	5.10	37.59	27.80	26.30	26.99	None
Nov	11/25/94	7.50	-2.03	75	33.00	20.00	13280	50.00	50.00	50.00	25.40	25.40	25.40	None
Dec	01/14/95	7.70	-0.53	74	31.00	20.00	12500	49.00	8.00	29.04	26.80	21.20	22.64	None

Summary of Water Quality Data for MW-GW-A6

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Jan	01/20/94	N/A	-0.52	N/A	22.00	N/A	N/A	20.00	3.23	13.93	21.70	16.80	19.76	None
Feb	02/24/94	7.50	-0.89	9	17.50	2.00	970	20.00	7.18	12.65	21.30	17.50	19.70	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.75	-0.87	5	24.10	10.00	1340	13.50	7.97	12.07	22.10	20.20	20.71	None
May	05/22/94	7.50	-0.37	4	N/A	N/A	N/A	50.00	5.50	19.91	26.00	22.00	22.81	None
Jun	07/03/94	7.30	-2.07	7	N/A	6.00	1500	50.00	13.80	23.81	31.50	21.80	24.24	None
Jul	07/23/94	7.50	-2.47	7	31.50	20.00	N/A	50.00	8.00	23.56	29.80	24.00	26.06	None
Aug	08/27/94	7.75	-3.07	14	N/A	15.00	N/A	50.00	13.10	22.87	32.30	27.00	28.77	None
Sep	09/25/94	N/A	-2.62	N/A	28.20	N/A	N/A	50.00	9.40	19.32	28.00	25.10	26.44	None
Oct	10/30/94	8.00	-1.77	N/A	N/A	15.00	2390	50.00	9.60	21.41	27.10	26.00	26.54	None
Nov	11/25/94	7.80	-1.67	N/A	29.60	10.00	330	50.00	9.80	23.50	25.40	24.50	25.23	None
Dec	01/14/95	8.00	-0.62	8	30.90	20.00	1000	50.00	3.49	18.83	27.10	23.40	25.94	None

Summary of Water Quality Data for MW-GW-A8

Event	Date	pH	Elevation	Salinity	Air Temp	Sulfides	Hardness	Conductivity (mMhos/cm)			Temperature (deg. C)			Remarks
		(S.U.)	(feet b.g.)	(ppt)	(deg C)	(mg/L)	(mg/L)	Maximum	Minimum	Average	Maximum	Minimum	Average	
Dec	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Jan	01/20/94	N/A	-0.50	N/A	22.50	N/A	N/A	50.00	50.00	50.00	24.20	16.70	20.16	None
Feb	02/24/94	7.50	-1.16	59	19.00	0.00	N/A	50.00	50.00	50.00	23.60	19.40	21.11	None
Mar	no event	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	None
Apr	04/07/94	7.50	-1.25	64	25.70	0.50	13750	50.00	50.00	50.00	24.20	21.10	21.89	None
May	05/22/94	7.50	-0.75	57	N/A	N/A	N/A	50.00	50.00	50.00	26.00	22.70	23.61	None
Jun	07/03/94	7.25	-2.25	50	N/A	0.20	9500	50.00	50.00	50.00	28.50	28.50	28.50	None
Jul	07/23/94	7.50	-2.75	67	30.50	1.00	N/A	50.00	50.00	50.00	ERR	ERR	ERR	None
Aug	08/27/94	7.50	-3.25	75	N/A	0.75	N/A	50.00	50.00	50.00	32.50	32.50	32.50	None
Sep	09/25/94	N/A	-3.25	N/A	27.80	N/A	N/A	50.00	50.00	50.00	30.00	30.00	30.00	None
Oct	10/30/94	7.50	-2.25	N/A	27.90	0.20	N/A	50.00	50.00	50.00	26.50	26.50	26.50	None
Nov	11/25/94	7.50	-2.25	72	29.50	1.00	12680	50.00	50.00	50.00	25.00	25.00	25.00	None
Dec	01/14/95	7.60	-1.25	57	29.00	0.20	14080	50.00	19.70	38.13	22.50	22.10	22.30	None

Appendix XV.

Precipitation Data

Padre Island National Seashore
Average Monthly and Yearly Rainfall
(Inches)

	1987	1988	1989	1990	1991	1992	1993	1994	Average
January	1.6	1.51	2.56	0.49	2.47	4.56	1.71	0.65	1.94
February	4.61	2.67	0.16	2.35	2.81	6.05	3.12	0.75	2.82
March	0.66	1.37	0.67	6.44	1.2	3.04	4.44	4.92	2.84
April	0.55	0.66	2.36	2.08	3.58	5.08	5.25	1.71	2.66
May	1.32	1.09	0.02	1.33	4.35	5.11	6.99	2.31	2.82
June	9.92	1.4	1.22	0.66	8.88	6.31	5.1	3.8	4.66
July	2.71	1.49	1.64	1.26	0.39	0.43	0	0.5	1.05
August	1.48	2.35	5.47	0.22	0.92	3.8	1.13	0.33	1.96
September	4.99	2.11	1.48	1.31	13.18	3.65	3.25	3.56	4.19
October	2.06	0.92	0.13	3.46	3	2.2	4.4	4.66	2.6
November	1.08	0.54	2.85	0.8	0.45	3.26	2.02	0.63	1.45
December	0.4	0.55	1.83	0.37	1.95	1.04	6.9	2.59	1.95
Annual	31.38	16.66	20.39	20.77	43.18	44.53	44.31	26.41	30.95