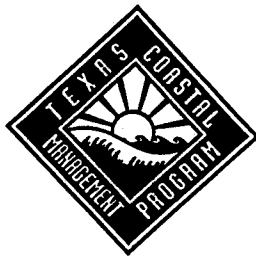


**The Evaluation of Six Potential Sand Sources
For Beach Nourishment On the Upper Texas Coast
A Final Report to the General Land Office**

**Task 5
Of A Grant Funded By
The Texas Coastal Management Program**

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September 1, 1998

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INTRODUCTION

This project was proposed to conduct surveys in 6 areas of potentially high sediment accretion to aid in identifying effective sources for beach nourishment materials. The sites were evaluated based on: 1) projected locations of future nourishment activities, 2) logistic feasibility of mechanical transport of sediments to nourishment sites and 3) sites having the geologic and hydrodynamic characteristics that maximize the potential for adequate volume and grain size for use in beach nourishment. The goal of the project was to identify accretionary areas on the Texas coast that can be cost-effectively used for beach nourishment activities. In addition to the above criteria, accretionary sites in close proximity to coastal waterways will be considered more favorably for the potential beneficial use of dredge spoil. Attachments to this document include the sand analysis data, the volumetric calculation data used for calculating sand volumes, and graphics of the substrate sand lenses of each site.

Site Selection Criteria

In consultation with General Land Office staff, areas of greatest need include locations on the upper Texas coast, primarily in beach areas of Galveston and Brazoria Counties. Additional criteria used for selecting sites included:

Site Stability - areas where sand was accumulating consistently due to an historic reduction in energy enabling the ability to identify and utilize these sources in the future. This energy reduction may be from washovers into the backbay caused by major storms, depositional areas from current or relic river deltas, the deposition from current dredge spoil sites, or the energy change at the Bay/Gulf interface.

Area of Need - the sand is in a location where current or future renourishment activities can take advantage of the material. These sites include, but were not limited to: Caplen Beach, Surfside, and the area of current erosion adjacent to and including Jamaica Beach. Proximity to areas of need reduces transport costs, and ideally would be associated with maintenance dredge operations.

Grain Size - the sand grain size is consistent with that of the corresponding beach. Grain sizes less than that of the current and natural energy regime of the selected beachface would prematurely migrate through longshore movement.

Potential Dredge Areas - in areas of high density development or currently planned or operating dredge activities on the bay aspect of Galveston Island, Surfside and the Bolivar peninsula and the need for access to the bay will cause pressure on public and private services to deepen waterways to allow for recreational and commercial access. By identifying sand sources prior to dredging it is possible to stipulate the appropriate manner of dredge material use.

Sensitive Habitat - this study attempted to identify and avoid areas that are sensitive habitats for consideration for future sand excavation. Selection of such sites were made as a result of current and/or planned development that could threaten such habitats

Identification of Sites

Currently there exists several areas on the upper Texas Coast that have been identified as areas of sand accretion. Among these are: Big Sandy - associated with the western jetty into Galveston Bay, Bolivar Flats - associated with the eastern jetty of Galveston Bay, and the San Luis Pass area on the western extremity of Galveston Island. Although these sites are known areas of sand accretion, by their nature, each are situated in locations some distance from areas needing renourishment. To provide the public with cost effective services, sites must be identified that will serve multiple uses and reduce the costs generally associated with beach nourishment operations.

As a barrier island and peninsula system associated with the Intracoastal Waterway, the two primary areas explored for sand accretion include:

Current Dredge Spoil Sites

Exploration of current dredge spoil sites for beneficial use has not been undertaken in the state of Texas prior to this project. Sand, however is routinely removed from the waterway in a wide range of percentages in the course of maintenance dredging. As an extension of the current efforts to beneficially use dredge material In Galveston Bay (e.g. the Beneficial Use Group of the Port of Houston), this project will explore two dredge spoil sites to determine both the volume and quality of sand available and determine the feasibility of excavation should acceptable material be discovered. The two sites to be prospected are located 1) ^{at} Bryan Beach west of Surfside in Brazoria County, and ⁽²⁾ the site on the bay side and adjacent to the Intracoastal Waterway in the proximity of Rollover Pass, Galveston County.

Washover Areas

Sand washovers are a frequent occurrence in the life and migration of barrier islands. As storm surges and winds advance through the natural protection of the dune system, large volumes of material are transported to the backbay, forming characteristic cusps or deltaic formations. Over time these cusps submerge through subsidence or are obscured by the continual overlayment of finer, low energy sediments over tens to hundreds of years. Four potential sites of sand for renourishment operations were identified through Joint discussions with the General Land Office. From the criteria developed above, these sites include: Swan Lake, Brazoria County, adjacent to Surfside Beach; ^{SEP 7} Echart's Bayou ⁽³⁾ and Starvation Cove, Galveston County, adjacent to and including Jamaica Beach; and the ⁽⁴⁾ western extreme of Rollover Bay, Galveston County, adjacent to Caplen Beach.

TECHNIQUE AND METHODS

Site Identification and Selection

Through a coordinated effort with the General Land Office 10 potential sites were initially offered for evaluation based on the above criteria. Through evaluation of quad maps, experience in the geologic coastal regime of the Galveston Bay system, and through qualitative information from various sources, these 10 sites were narrowed to six candidates for sand prospecting. With an interest in the beneficial use of dredge spoil sites, two of these sites were selected away from the submerged lands, focusing on materials currently stockpiled in leveed containment areas.

Sampling Method

Submerged Sites - To obtain nondestructive core samples from the submerged and saturated soils a 3 inch Vibracore tube was inserted into the sediment base to a depth of six feet through liquefaction. Cores were taken in a uniform grid pattern, positioned through differential GPS. Because of the topographic and energy regime variability of the sites, this grid pattern was comprised of between 9 and 12 core samples each. Each core sample was marked for position and orientation. Samples were then capped in the Vibracore tube on site and transported to the laboratory to be split for analysis.

Dredge Spoil Sites - Dredge spoil sites are particularly unstable due to the nature of the material and the method of fill. Often thin crusts of dry material overlay lenses of unconsolidated silts and muds.

To ensure the safety of the crew, only sites that proved to be stable were used in this study. Because the Vibracore is only viable in saturated soils, alternative methods had to be used to obtain samples capable of providing stratigraphic information.

A specific and signature cone formed immediately beneath the dredge exit pipe was hypothesized to have the greatest potential for sand sized sediments. It was hypothesized that lighter sediments remain in suspension for a greater period of time and would be carried further from the dredge pipe before being more settling. Heavier sediments (sand) would settle almost immediately after leaving the dredge pipe, creating a differentiated cone of sand immediately beneath the pipe.

A 1 inch soil probe capable of drilling 6 feet into the spoil material was used for this aspect of the project. At each foot the probe was removed and the contents was placed in a sample bag. Although none of the core holes collapsed, when re-entering the hole, the depth was noted and compared with the previous exit depth. Sample bags were marked relative to position of the core and depth within the core. Cores were taken in a uniform grid pattern, positioned through differential GPS. Because of the cone configuration, this grid pattern was comprised of 9 or 10 core holes, each comprised of 6 samples.

Sample Analysis

The methodology for analysis is as follows:

- 1) In the laboratory each core was split exposing the sediment layers. A qualitative description of the entire core, with preliminary sediment percentages differentiating the layers by depth. A 1 in. X 1 in. sample running the length of each core was collected and placed into a corresponding sample bag.
- 2) For the soil probe samples of the dredge spoil sites, each collected sample was described, by depth relative to the particle size percentages of each sample.
- 3) Each of the samples was dried and weighed.
- 4) The sample was then wet sieved to remove the silt and clay fraction and dried.
- 5) The samples were then weighed and the sand fraction of the entire core was calculated.
- 6) The samples were then Ro-tapped, with each fraction separately weighed to determine:
 - mean** - the mean grain size of the sand size fraction of the sample - the average Galveston Beach sand size is approximately 3.00 phi or greater.
 - sorting** - as displayed in the analysis is an expression of one standard deviation from the mean phi size of the sample.
 - skewness** - weighting of the sample toward coarser or finer sand sizes from the mean. A positive skew shows that the sample tends toward the less coarse phi sizes. A negative skew shows that the sample tends toward the more coarse phi sizes.
 - kurtosis** - The kurtosis of the sample is an expression of the flatness or peakedness of the frequency distribution of the phi sizes.

Sand Volume

Samples were analyzed using the graphic and mathematical program, SURFER, to determine the volume of sand that is of similar size to that of the Galveston/Surfside regime. This is accomplished by inputting the latitude and longitude of each core within the site and correlating that position with the description of the layers at relative depth. Layers and lenses of material consisting of 60% or more of sand were used for this volumetric study of potential sites for beach nourishment projects.

RESULTS

Of the candidate sites for sand borrow for beach nourishment, 3 sites: Starvation Cove, Rollover Bay and the Bryan Beach Dredge Spoil Site have proven to contain effective volumes of sand. One site Echart's Bayou is marginal in it's value as a sand source, and 2 sites, Swan Lake and the Rollover Dredge Spoil Site proved to be completely lacking in materials appropriate for sand replacement. A more detailed analysis of each site can be reviewed in the attachment. Because of the lack of sand sized sediments in the Rollover Pass Dredge Spoil Site, and that of Swan Lake, analysis of samples concluded in the description phase. As a result, no statistical data is available.

With regard to the use of leveed dredge spoil as a source for beach material, the project provided no conclusive evidence to either support or deny the possibility. This project was designed as a benthic study in saturated soils using state of the art equipment. As a secondary consideration - only raised after the award of the grant, only rudimentary equipment (a hand operated soil probe) was available for collecting samples in dry sites. Because of the inefficiency of the equipment in the dredge material only two sites were sampled. From these results, however, promise can be seen in the Bryan Beach Dredge Spoil material, while the Rollover Pass Dredge Site proved to lack the desired sand grain sized material.

Another aspect of dredge spoil sampling that must be considered before relying too heavily on the results of this study relates to the number of times the dredge pipe was moved while filling the leveed area. Given the sheer volume of dredge spoil sites, it is statistically possible to have missed a sand lens while sampling given the varying locations and possible depths of the materials at various stages of filling the site.

Individual Site Analysis

Echart's Bayou

- **percent sand** - range: 84 - 95 (4 of 12 cores)
- **mean** - range: 2.4 to 2.7 making the site an acceptable candidate for beach nourishment, being of similar size than that found in the beach regime of Caplen Beach.
- **sorting** - range: 0.30 to 0.97 - the sand fraction lies relatively close to the mean, however, an SD of .97 indicates an area where sand grains vary toward finer material
- **skewness** - range: -0.56 to +0.08 - the sand remains close to the mean, slightly skewed toward the coarser particles.
- **kurtosis** - range: 1.14 to 2.29 - the statistical distribution of sand sizes is in a rather wide distribution.
- **volume of sand**- 432,000 - 720,000 ft³ in a 120,000 ft² area

Echart's Bayou was chosen as a candidate for nourishment materials because of its association with a sand wash-over cusp and that it is directly adjacent to residential development that will potentially request future dredge permitting to give deeper draft vessels access to the development. Lenses of beach quality sand were fewer than anticipated, however the quality of the material found could aid in beach nourishment activities. Around the perimeter of the bayou is emergent *Spartina* sp. marshes making it relatively sensitive to dredging operations, however, the location of the lenses is approximately mid-channel, reducing the environmental impact.

Starvation Cove

- **percent sand** - range: 70 - 88 (12 of 12 cores)
- **mean** - range: 3.0 to 2.8 making the site a good candidate for beach nourishment, being of equal or greater size than that found in the beach regime of Jamaica Beach.
- **sorting** - range: .28 to .44 - the sand fraction lies close to the mean
- **skewness** - range: -0.14 to + 0.28 - the sand remains close to the mean.
- **kurtosis** - range: 0.9 to 1.88 - the sand remains in a relatively tight distribution.
- **volume of sand** - 1,789,134 - 2,981,890 ft³ in a 600,000 ft² area

Of the submerged sites identified, Starvation Cove provided the greatest volume of beach quality sand. Adjacent to the Echart's Bayou site, Starvation Cove is situated in the middle of a well defined wash-over field. Dredging potential for this site is limited to the outer extremity due to two factors: 1) Maintenance dredging by the Corps of Engineers for the Intracoastal Waterway would require only the bay aspect of the site to be excavated. 2) Spartina sp. marshes throughout the area and the sand bottom of the cove provide excellent habitat for wading birds and game fish.

Rollover Bay

- percent sand** - range: 44 - 73 (12 of 12 cores)
- mean** - range: 3.1 to 3.3 making the site a good candidate for beach nourishment, being of equal or greater size than that found in the beach regime of Caplen Beach.
- sorting** - range: .24 to .61 - the sand fraction lies close to the mean
- skewness** - range: -0.41 to 0.00 - the sand remains close to the mean, skewed little toward the coarser particles.
- kurtosis** - range: 0.95 to 3.7 - the sand remains in a tight distribution, however, a spike of fine sediments resulted in an anomalous 3.7 due to inadequate wet sieving of one sample.
- volume of sand** - 891,504 - 1,485,840 ft³ in a 300,000 ft² area

Rollover Bay was selected as a site in conjunction with the previous study conducted by the General Land Office in 1996. The rationale for this extension was to determine the sand sediment loadings relative to the differing energy regime of the western extremity of the bay, studied on that previous occasion.

Although adequate grain sizes of sand were identified the percentage, relative to fines, was lower than that of the previous study. This indicates that, on average, the western aspect of Rollover Bay is of a lower energy regime than its eastern counterpart. Through this study evidence indicates that the larger grain sizes are likely to be accumulated within the Intracoastal Waterway at the outflow of the channel through Rollover Pass.

Bryan Beach Dredge Spoil Site

percent sand - range: 0 - 100 Differentiation between layers was distinct with no mixing between layers

mean - range: 3.2 to 2.5 making the site a good candidate for beach nourishment, being of equal or greater size than that found in the beach regime of Surfside.

sorting - range: .71 to .42 - the sand fraction lies close to the mean

skewness - range: -0.29 to +0.13 - the sand remains close to the mean, skewed little toward the coarser particles.

kurtosis - range: 0.97 to 1.985 - the sand remains in a tight distribution.

volume of sand - 294,415 - 450,693 ft³ in a 120,000 ft² area

Of all of the sites studied, the most intriguing for policy consideration is the Bryan Beach Dredge Spoil site. As a site used to store dredge spoil, consultation with the General Land Office determined that the most promising prospect for nourishment quality material would be directly beneath and radially out from the dredge pipe outflow, forming a cone of heavier sediments. As the material enters the low energy environment from the dredge it naturally differentiates with larger grain sizes settling at a faster rate and fines washing out into the basin.

The characteristic cone outfall was identified and was the focus of the study on this site. As was predicted, the area adjacent to this cone contained high quantities of beach quality sand which winnowed out, terminating approximately 150 feet from the point of entry. As the depth of analysis was restricted to 6 feet, it is not possible to determine the volume of the site, however sand quality near the dredge pipe outflow remained high (90 - 100%) throughout the entirety of the core sample.

POLICY RECOMMENDATIONS

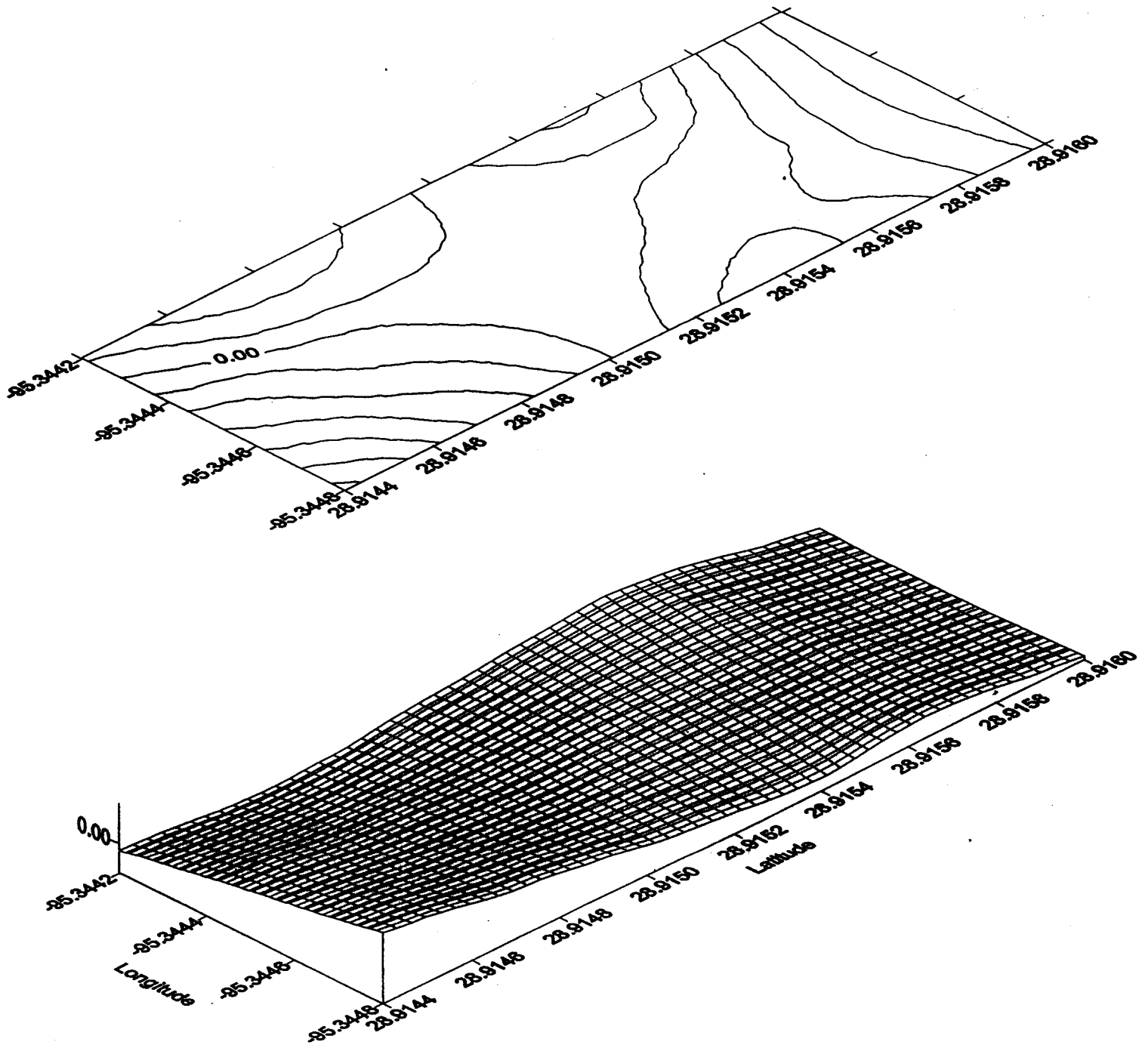
An easily transported and available sand source for beach nourishment is essential in maintaining the beaches of Galveston and Brazoria Counties. The intent of this study was to identify sites that could supplement current or planned erosion mitigation and recovery activities by identifying such sand sources.

A dominant criteria used in the selection of sites was their association with the Intracoastal Waterway, allowing materials previously considered waste to be used for beneficial purposes. In both the submerged and dredge spoil areas, adequate sand exists to realize this goal. To maximize the potential of these and other sites, several policy positions are being recommended.

- 1) Prior to excavation for maintenance or new dredge activities, identify potential sources of sand and conduct characterization and volumetric studies of those areas. Where sites are identified, coordinate dredging activities with the Corps of Engineers to ensure the desired materials are separated from the finer material for use in future nourishment activities.

- 2) Conduct an extensive study of current dredge spoil sites capable of taking transects at depth of each of the candidate dredge spoil sites. By identifying these sites and using this material, additional space will be made available within current dredge spoil areas - reducing the need to create new ones.
- 3) Establish a mechanism by which all new, proposed dredge sites must conduct characterization and volumetric studies prior to obtaining a dredge permit. This will transfer the responsibility of identifying desirable material on the entity creating the waste rather than on the state, and will provide the state with additional information regarding the manner in which materials are taken and stored.

Attachment A



Bryan Beach Spoil Area Contor Map of Sand Fraction Volume

Bryan Beach Spoil Area Surfer Data

VOLUME COMPUTATIONS

UPPER SURFACE

Grid File: A:/BRBSPTOP1.GRD
Grid size as read: 50 cols by 45 rows
Delta X: 4.08163
Delta Y: 13.6364
X-Range: -3.01801E+007 to -3.01799E+007
Y-Range: 1.05158E+007 to 1.05164E+007
Z-Range: -1.71007 to 0.106382

LOWER SURFACE

Grid File: A:/BRBSPBTTM1.GRD
Grid size as read: 50 cols by 45 rows
Delta X: 4.08163
Delta Y: 13.6364
X-Range: -3.01801E+007 to -3.01799E+007
Y-Range: 1.05158E+007 to 1.05164E+007
Z-Range: -6.07351 to -1.00443

VOLUMES

Approximated Volume by
Trapezoidal Rule: 450681
Simpson's Rule: 450646
Simpson's 3/8 Rule: 450637

CUT & FILL VOLUMES

Positive Volume [Cut]: 450693
Negative Volume [Fill]: 0
Cut minus Fill: 450693

AREAS

Positive Planar Area
(Upper above Lower): 120000
Negative Planar Area
(Lower above Upper): 0
Blanked Planar Area: 0
Total Planar Area: 120000

Positive Surface Area
(Upper above Lower): 120037
Negative Surface Area
(Lower above Upper): 0

Sample Analysis - Bryan Dredge Spoil

Sample #	Net Wt	Sample #	Net Wt
Bryan Dredge Spoil			
BDS 1.1	117.75	BDS 6.1	64.2
BDS 1.2	162.5	BDS 6.2	122.26
BDS 1.3	102.66	BDS 6.3	149.391
BDS 1.4	115.68	BDS 6.4	147.31
BDS 1.5	118.55	BDS 6.5	143.46
BDS 1.6	139.98	BDS 6.6	146.03
BDS 2.1	85.89	BDS 7.1	75.95
BDS 2.2	109.07	BDS 7.2	70.76
BDS 2.3	66.28	BDS 7.3	155.29
BDS 2.4	136.15	BDS 7.4	111.77
BDS 2.5	57.74	BDS 7.5	117.82
BDS 2.6	112.36	BDS 7.6	113.68
BDS 3.1	72.27	BDS 8.1	100.29
BDS 3.2	113.14	BDS 8.2	150.05
BDS 3.3	113.11	BDS 8.3	69.73
BDS 3.4	132.08	BDS 8.4	86.95
BDS 3.5	149.71	BDS 8.5	48.43
BDS 3.6	103.6	BDS 8.6	122.8
BDS 4.1	62.19	BDS 9.1	66.76
BDS 4.2	81.92	BDS 9.2	100.56
BDS 4.3	113.1	BDS 9.3	49.59
BDS 4.4	67.01	BDS 9.4	158.94
BDS 4.5	90.07	BDS 9.5	44.42
BDS 4.6	50.19	BDS 9.6	93.48
BDS 5.1	58.1	BDS 10.1	104.72
BDS 5.2	104.45	BDS 10.2	98.87
BDS 5.3	115.61	BDS 10.3	100.1
BDS 5.4	118.29	BDS 10.4	87.46
BDS 5.5	129.95	BDS 10.5	146
BDS 5.6	130.5	BDS 10.6	127.69

SAMPLE: BDS-1

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 145.47
 COURSE FRACTION WEIGHT: 145.47
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

+	O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
	/	/	/	/	/	/	/
	999.990	999.990	999.990	999.990	999.990	999.990	999.990

MEAN
 999.9900

SORTING
 999.9900

SKEWNESS
 999.9900

KURTOSIS
 999.9900

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	9.22	6.34
-0.50	3.32	8.62
0.00	2.66	10.45
0.50	2.75	12.34
1.00	2.51	14.06
1.50	4.09	16.88
2.00	13.36	26.06
2.50	22.28	41.38
3.00	43.83	71.51
3.50	32.75	94.02
4.00	8.70	100.00

SAMPLE: BDS-2

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 110.41
 COURSE FRACTION WEIGHT: 110.41
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

+	O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
	/	/	/	/	/	/	/
	1.008	2.771	2.999	3.336	3.644	3.768	3.926

MEAN
3.2917

SORTING
0.6912

SKEWNESS
-0.3644

KURTOSIS
1.8543

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.50	0.45
-0.50	1.01	1.37
0.00	1.30	2.55
0.50	1.28	3.70
1.00	1.40	4.97
1.50	1.62	6.44
2.00	2.01	8.26
2.50	3.55	11.48
3.00	15.02	25.08
3.50	42.75	63.80
4.00	39.97	100.00

SAMPLE: BDS-3

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 115.11
 COURSE FRACTION WEIGHT: 115.11
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
1.867	2.555	2.659	2.913	3.481	3.705	3.912

MEAN
 3.0575

SORTING
 0.5974

SKEWNESS
 0.1773

KURTOSIS
 1.0195

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	1.29	1.12
-0.50	0.73	1.75
0.00	0.47	2.16
0.50	0.34	2.46
1.00	0.38	2.79
1.50	0.42	3.15
2.00	2.16	5.03
2.50	8.32	12.26
3.00	51.63	57.11
3.50	21.28	75.60
4.00	28.09	100.00

SAMPLE: BDS-4

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 107.38
 COURSE FRACTION WEIGHT: 107.38
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

0(5)	0(16)	0(25)	0(50)	0(75)	0(84)	0(95)
/	/	/	/	/	/	/
2.084	2.557	2.735	3.055	3.309	3.412	3.599

MEAN
3.0083

SORTING
0.4434

SKEWNESS
-0.2238

KURTOSIS
1.0832

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.03	0.03
-0.50	0.05	0.07
0.00	0.07	0.14
0.50	0.04	0.18
1.00	0.14	0.31
1.50	0.32	0.61
2.00	3.78	4.13
2.50	10.37	13.78
3.00	33.32	44.81
3.50	48.68	90.15
4.00	10.58	100.00

SAMPLE: BDS-5

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 91.46
 COURSE FRACTION WEIGHT: 91.46
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

0(5)	0(16)	0(25)	0(50)	0(75)	0(84)	0(95)
/	/	/	/	/	/	/
2.527	2.937	3.085	3.384	3.675	3.789	3.934

MEAN
3.3698

SORTING
0.4262

SKEWNESS
-0.1337

KURTOSIS
0.9779

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.11	0.12
-0.50	0.02	0.14
0.00	0.02	0.16
0.50	0.05	0.22
1.00	0.08	0.31
1.50	0.11	0.43
2.00	0.63	1.12
2.50	3.25	4.67
3.00	13.49	19.42
3.50	37.47	60.39
4.00	36.23	100.00

SAMPLE: BDS-6

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 109.50
 COURSE FRACTION WEIGHT: 109.50
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

+	O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
	/	/	/	/	/	/	/
	1.877	2.468	2.630	2.942	3.225	3.343	3.545

MEAN
 2.9174

SORTING
 0.4716

SKEWNESS
 -0.1801

KURTOSIS
 1.1480

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.13	0.12
-0.50	0.27	0.37
0.00	0.22	0.57
0.50	0.30	0.84
1.00	0.29	1.11
1.50	0.73	1.77
2.00	4.93	6.27
2.50	12.28	17.49
3.00	41.32	55.22
3.50	41.53	93.15
4.00	7.50	100.00

SAMPLE: BDS-7 .

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 142.51
 COURSE FRACTION WEIGHT: 142.51
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
1.831	2.108	2.243	2.541	2.837	2.986	3.747

MEAN
 2.5449

SORTING
 0.5098

SKEWNESS
 0.1361

KURTOSIS
 1.3214

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.05	0.04
-0.50	0.05	0.07
0.00	0.10	0.14
0.50	0.09	0.20
1.00	0.24	0.37
1.50	1.80	1.63
2.00	12.54	10.43
2.50	51.15	46.33
3.00	54.62	84.65
3.50	10.31	91.89
4.00	11.56	100.00

SAMPLE: BDS-8

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 159.14
 COURSE FRACTION WEIGHT: 159.14
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
1.787	2.270	2.438	2.689	2.908	3.013	3.623

MEAN
 2.6571

SORTING
 0.4641

SKEWNESS
 -0.0548

KURTOSIS
 1.6023

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.05	0.03
-0.50	0.01	0.04
0.00	0.04	0.06
0.50	0.08	0.11
1.00	0.16	0.21
1.50	0.89	0.77
2.00	13.38	9.18
2.50	32.92	29.87
3.00	84.65	83.06
3.50	17.85	94.28
4.00	9.11	100.00

SAMPLE: BDS-9

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 117.98
 COURSE FRACTION WEIGHT: 117.98
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

0(5)	0(16)	0(25)	0(50)	0(75)	0(84)	0(95)
/	/	/	/	/	/	/
1.410	2.029	2.257	2.633	2.970	3.387	3.864

MEAN
2.6829

SORTING
0.7113

SKEWNESS
0.0564

KURTOSIS
1.4108

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	1.52	1.29
-0.50	0.71	1.89
0.00	0.81	2.58
0.50	0.74	3.20
1.00	0.81	3.89
1.50	2.12	5.69
2.00	11.11	15.10
2.50	28.80	39.52
3.00	43.63	76.50
3.50	10.24	85.18
4.00	17.49	100.00

SAMPLE: BDS-10

DATE: 7-14-98

LOCATION: Bryan Dredge SpoilANALYST: GFH

TEST WEIGHT: 129.88
 COURSE FRACTION WEIGHT: 129.88
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
1.293	1.997	2.309	2.688	2.974	3.107	3.362

MEAN
2.5972

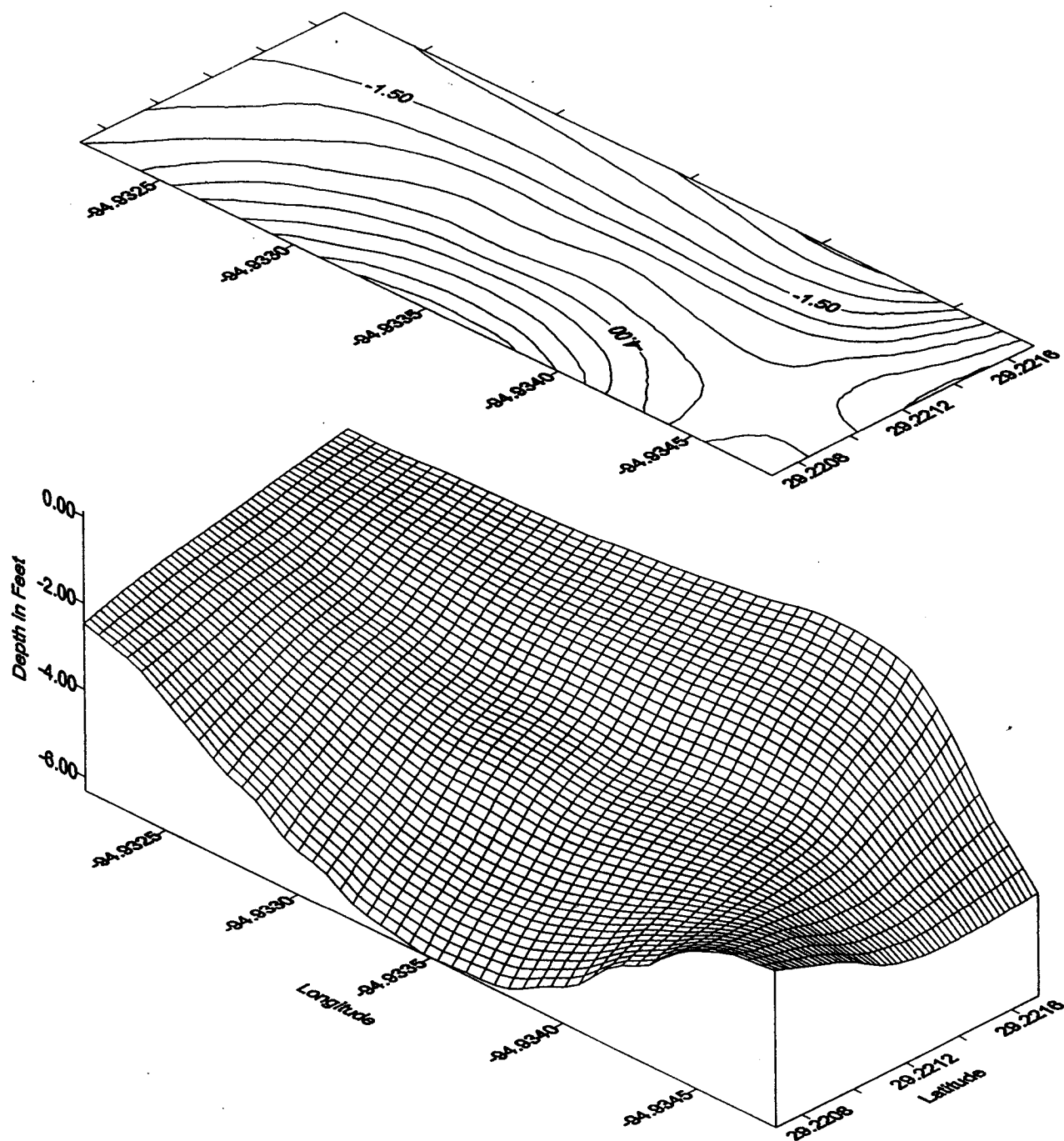
SORTING
0.5910

SKEWNESS
-0.2963

KURTOSIS
1.2743

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	1.98	1.52
-0.50	1.27	2.50
0.00	0.98	3.26
0.50	0.77	3.85
1.00	0.93	4.57
1.50	2.47	6.47
2.00	12.47	16.07
2.50	24.65	35.05
3.00	54.42	76.95
3.50	27.52	98.14
4.00	2.42	100.00

Attachment B



Echart's Bayou Area Contour Map of Sand Fraction Volume

Echart's Bayou Surfer Data

VOLUME COMPUTATIONS

UPPER SURFACE

Grid File: A:/EKRTTOP1.GRD
Grid size as read: 50 cols by 45 rows
Delta X: 8.16327
Delta Y: 6.81818
X-Range: -3.00503E+007 to -3.00499E+007
Y-Range: 1.06272E+007 to 1.06275E+007
Z-Range: 0 to 0

LOWER SURFACE

Grid File: A:/EKRTBTTM1.GRD
Grid size as read: 50 cols by 45 rows
Delta X: 8.16327
Delta Y: 6.81818
X-Range: -3.00503E+007 to -3.00499E+007
Y-Range: 1.06272E+007 to 1.06275E+007
Z-Range: -6 to -6

VOLUMES

Approximated Volume by
Trapezoidal Rule: 720000
Simpson's Rule: 720000
Simpson's 3/8 Rule: 720000

CUT & FILL VOLUMES

Positive Volume [Cut]: 720000
Negative Volume [Fill]: 0
Cut minus Fill: 720000

AREAS

Positive Planar Area
(Upper above Lower): 120000
Negative Planar Area
(Lower above Upper): 0
Blanked Planar Area: 0
Total Planar Area: 120000

Positive Surface Area
(Upper above Lower): 120000
Negative Surface Area
(Lower above Upper): 0

Sample Analysis - Eckert's Bayou

Sample #	Net Wt	Wt Before	Wt After Sieve	Sand Wt	Clay Wt	% Sand
Eckert's Bayou						
EB-2	101.75	85.49	83.55	85.49	16.26	84.01966
EB-6	257.04	246.5	245.42	246.5	10.54	95.89947
EB-7	267.38	255.31	255.31	255.31	12.07	95.48583
EB-10	343.67	300.82	300.3	300.82	42.85	87.53164

SAMPLE: EB-02

DATE: 7-14-98

LOCATION: Eckert's BayouANALYST: GFH

TEST WEIGHT: 83.55
 COURSE FRACTION WEIGHT: 83.55
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
-0.473	1.525	2.193	2.680	2.959	3.088	3.357

MEAN
 2.4312

SORTING
 0.9710

SKEWNESS
 -0.5620

KURTOSIS
 2.0509

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	2.51	3.00
-0.50	1.58	4.90
0.00	1.64	6.86
0.50	2.11	9.38
1.00	2.29	12.12
1.50	3.00	15.72
2.00	5.63	22.45
2.50	11.32	36.00
3.00	35.23	78.17
3.50	16.41	97.81
4.00	1.83	100.00

SAMPLE: EB-06

DATE: 7-14-98

LOCATION: Eckert's BayouANALYST: GFH

TEST WEIGHT: 245.42
 COURSE FRACTION WEIGHT: 245.42
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
0.195	2.139	2.279	2.555	2.793	2.893	3.069

MEAN
2.5288

SORTING
0.6239

SKEWNESS
-0.3737

KURTOSIS
2.2894

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	7.14	2.91
-0.50	1.94	3.70
0.00	2.23	4.61
0.50	2.37	5.57
1.00	2.42	6.56
1.50	2.15	7.44
2.00	6.47	10.07
2.50	84.12	44.35
3.00	116.04	91.63
3.50	18.28	99.08
4.00	2.26	100.00

SAMPLE: EB-007

DATE: 7-14-98

LOCATION: Eckert's BayouANALYST: GFH

TEST WEIGHT: 260.31
 COURSE FRACTION WEIGHT: 260.31
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
0.625	2.081	2.186	2.426	2.701	2.839	3.153

MEAN
 2.4490

SORTING
 0.5726

SKEWNESS
 -0.1675

KURTOSIS
 2.0125

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	4.02	1.54
-0.50	2.70	2.58
0.00	3.20	3.81
0.50	2.72	4.86
1.00	2.31	5.74
1.50	1.98	6.50
2.00	10.98	10.72
2.50	121.91	57.55
3.00	87.74	91.26
3.50	15.36	97.16
4.00	7.39	100.00

SAMPLE: EB-010

DATE: 7-14-98

LOCATION: Eckert's BayouANALYST: GFH

TEST WEIGHT: 300.28
 COURSE FRACTION WEIGHT: 300.28
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.318	2.509	2.594	2.779	2.972	3.073	3.377

MEAN
 2.7868

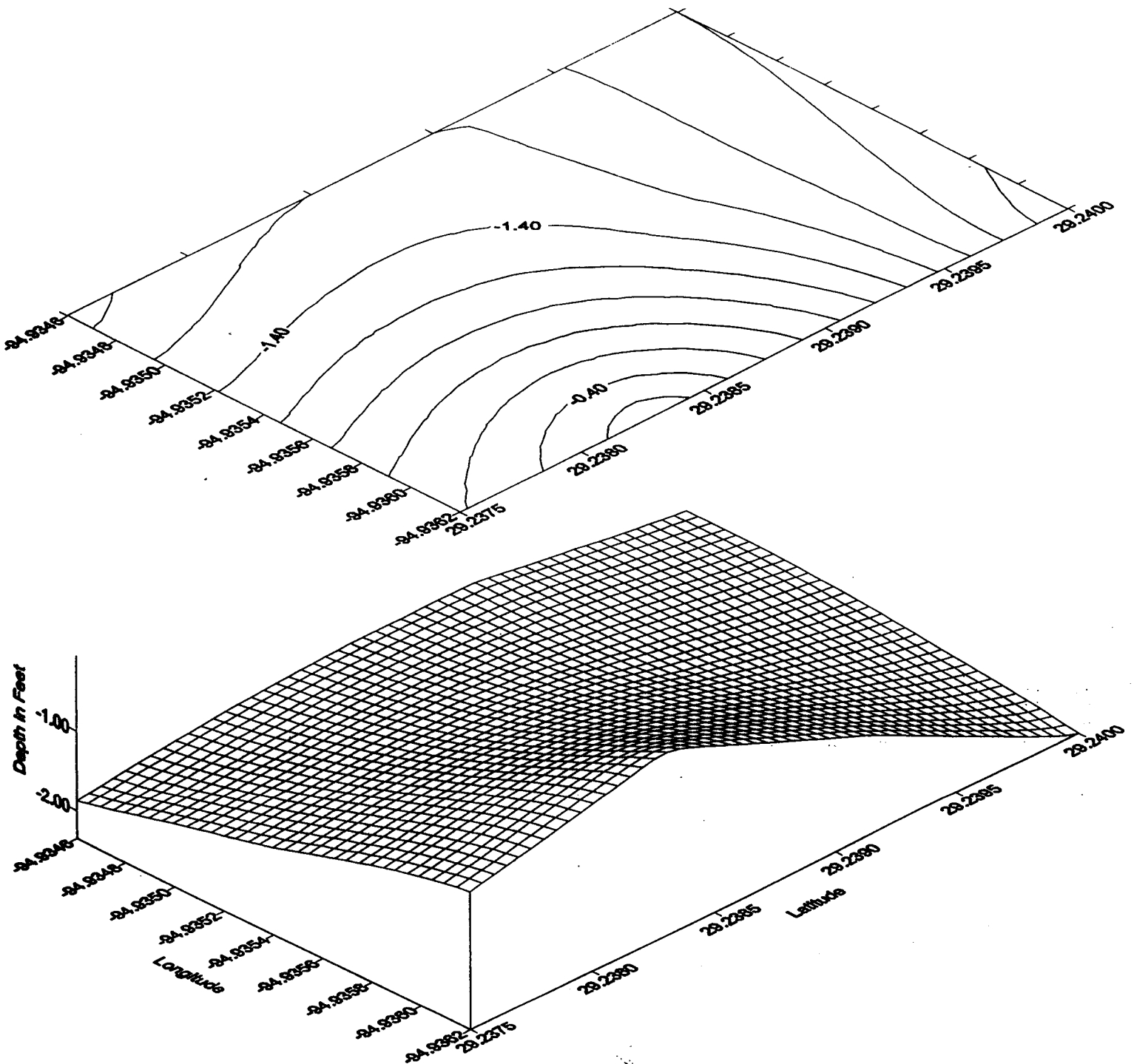
SORTING
 0.3013

SKEWNESS
 0.0868

KURTOSIS
 1.1454

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	2.40	0.80
-0.50	1.19	1.20
0.00	1.68	1.76
0.50	1.07	2.11
1.00	0.79	2.37
1.50	0.56	2.56
2.00	2.50	3.39
2.50	35.40	15.18
3.00	188.15	77.84
3.50	54.56	96.01
4.00	11.98	100.00

Attachment C



Starvation Cove Contour Map of Sand Fraction Volume

StarvationCoveSurferData

VOLUME COMPUTATIONS

UPPER SURFACE

GridFile: A:/STRVCVETOP1.GRD
Gridsizeasread: 44colsby50rows
DeltaX: 11.6279
DeltaY: 24.4898
X-Range: -3.00507E+007to-3.00502E+007
Y-Range: 1.0633E+007to1.06342E+007
Z-Range: -2.59309to0.123372

LOWER SURFACE

GridFile: A:/STRVCVEBTM1.GRD
Gridsizeasread: 44colsby50rows
DeltaX: 11.6279
DeltaY: 24.4898
X-Range: -3.00507E+007to-3.00502E+007
Y-Range: 1.0633E+007to1.06342E+007
Z-Range: -6.17335to-0.823007

VOLUMES

ApproximatedVolumeby
TrapezoidalRule: 2.98194E+006
Simpson'sRule: 2.98234E+006
Simpson's3/8Rule: 2.98233E+006

CUT&FILL VOLUMES

PositiveVolume[Cut]: 2.98189E+006
NegativeVolume[Fill]: 0
CutminusFill: 2.98189E+006

AREAS

PositivePlanarArea
(UpperaboveLower): 600000
NegativePlanarArea
(LoweraboveUpper): 0
BlankedPlanarArea: 0
TotalPlanarArea: 600000

PositiveSurfaceArea
(UpperaboveLower): 600036
NegativeSurfaceArea
(LoweraboveUpper): 0

Sample Analysis - Starvation Cove

Sample #	Net Wt	Wt Before	Wt After Sieve	Sand Wt	Clay Wt	% Sand
Starvation Cove						
SC-012	296.2	229.54	230.06	229.54	66.66	77.49494
SC-013	unknown	239.11	320.02	239.11		
SC-014	338.94	259.31	258.96	259.31	79.63	76.50617
SC-015	316.88	247.83	245.74	247.83	69.05	78.20942
SC-016	395.78	303.03	302.82	303.03	92.75	76.56526
SC-017	240.32	212.21	212.23	212.21	28.11	88.3031
SC-018	262.34	193.58	193.74	193.58	68.76	73.78974
SC-019	303.73	238.98	237.16	238.98	64.75	78.68172
SC-020	294.49	242.74	242.35	242.74	51.75	82.42725
SC-021	260.42	210.19	207.2	210.19	50.23	80.71193
SC-022	220.47	156.4	157.1	156.4	64.07	70.93936
SC-023	334.04	245.05	246.4	245.05	88.99	73.35948

SAMPLE: SC-12

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 230.06
 COURSE FRACTION WEIGHT: 230.06
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.434	2.585	2.673	2.887	3.178	3.386	3.792

MEAN
 2.9529

SORTING
 0.4060

SKEWNESS
 0.2897

KURTOSIS
 1.1011

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.15	0.07
-0.50	0.07	0.10
0.00	0.08	0.13
0.50	0.10	0.17
1.00	0.08	0.21
1.50	0.16	0.28
2.00	0.77	0.61
2.50	19.10	8.92
3.00	121.74	61.83
3.50	58.83	87.40
4.00	28.98	100.00

SAMPLE: SC-013

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 236.66
 COURSE FRACTION WEIGHT: 236.66
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.466	2.594	2.671	2.856	3.069	3.185	3.441

MEAN
2.8785

SORTING
0.2955

SKEWNESS
0.1576

KURTOSIS
1.0024

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	1.07	0.45
-0.50	0.16	0.52
0.00	0.32	0.65
0.50	0.38	0.82
1.00	0.33	0.95
1.50	0.33	1.09
2.00	1.25	1.62
2.50	13.40	7.28
3.00	143.77	68.03
3.50	66.97	96.33
4.00	8.68	100.00

SAMPLE: SC-014

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 258.97
 COURSE FRACTION WEIGHT: 258.97
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.559	2.694	2.781	3.000	3.236	3.340	3.517

MEAN
 3.0110

SORTING
 0.3067

SKEWNESS
 0.0669

KURTOSIS
 0.8642

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.73	0.28
-0.50	0.14	0.34
0.00	0.14	0.39
0.50	0.13	0.44
1.00	0.13	0.49
1.50	0.13	0.54
2.00	0.33	0.67
2.50	2.48	1.63
3.00	125.41	50.05
3.50	114.39	94.22
4.00	14.96	100.00

SAMPLE: SC-15

DATE: 7-14-98

LOCATION: Starvation Cove

ANALYST: GFH

TEST WEIGHT: 245.74
 COURSE FRACTION WEIGHT: 245.74
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.502	2.612	2.682	2.857	3.061	3.175	3.444

MEAN
2.8812

SORTING
0.2836

SKEWNESS
0.1873

KURTOSIS
1.0189

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.04	0.02
-0.50	0.08	0.05
0.00	0.09	0.09
0.50	0.12	0.13
1.00	0.10	0.17
1.50	0.21	0.26
2.00	0.60	0.50
2.50	10.70	4.86
3.00	156.74	68.64
3.50	67.51	96.11
4.00	9.55	100.00

SAMPLE: SC-16

DATE: 7-14-98

LOCATION: Starvation Cove

ANALYST: GFH

TEST WEIGHT: 303.17
COURSE FRACTION WEIGHT: 303.17
FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
4 PHI PIPETTE SAMPLE: 0.00
DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
PERCENT SILT BY WEIGHT: 0.00%
PERCENT CLAY BY WEIGHT: 0.00%

+ O(5) O(16) O(25) O(50) O(75) O(84) O(95)
 / / / / / / /
 2.506 2.623 2.698 2.884 3.106 3.225 3.472

 MEAN SORTING SKEWNESS KURTOSIS
 2.9108 0.2968 0.1741 0.9710

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.23	0.08
-0.50	0.13	0.12
0.00	0.50	0.28
0.50	0.22	0.36
1.00	0.31	0.46
1.50	0.62	0.66
2.00	0.92	0.97
2.50	10.95	4.58
3.00	181.35	64.40
3.50	95.02	95.74
4.00	12.92	100.00

SAMPLE: SC-017

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 212.23
 COURSE FRACTION WEIGHT: 212.23
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.471	2.596	2.672	2.859	3.089	3.236	3.667

MEAN
2.8971

SORTING
0.3413

SKEWNESS
0.2649

KURTOSIS
1.1740

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.30	0.14
-0.50	0.14	0.21
0.00	0.13	0.27
0.50	0.06	0.30
1.00	0.13	0.36
1.50	0.09	0.40
2.00	0.52	0.65
2.50	13.51	7.01
3.00	127.19	66.94
3.50	53.03	91.93
4.00	17.13	100.00

SAMPLE: SC-18

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 193.74
 COURSE FRACTION WEIGHT: 193.74
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.452	2.611	2.703	2.933	3.245	3.434	3.787

MEAN
2.9924

SORTING
0.4080

SKEWNESS
0.2488

KURTOSIS
1.0094

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.13	0.07
-0.50	0.17	0.15
0.00	0.19	0.25
0.50	0.23	0.37
1.00	0.37	0.56
1.50	0.65	0.90
2.00	1.48	1.66
2.50	11.44	7.57
3.00	95.25	56.73
3.50	57.66	86.49
4.00	26.17	100.00

SAMPLE: SC-019

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 236.66
 COURSE FRACTION WEIGHT: 236.66
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.466	2.594	2.671	2.856	3.069	3.185	3.441
+						
MEAN	SORTING		SKEWNESS		KURTOSIS	
2.8785	0.2955		0.1576		1.0024	

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	1.07	0.45
-0.50	0.16	0.52
0.00	0.32	0.65
0.50	0.38	0.82
1.00	0.33	0.95
1.50	0.33	1.09
2.00	1.25	1.62
2.50	13.40	7.28
3.00	143.77	68.03
3.50	66.97	96.33
4.00	8.68	100.00

Note: Miscalculation in ϕ data from ROTAP

SAMPLE: SC-020

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 242.35
 COURSE FRACTION WEIGHT: 242.35
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

0(5)	0(16)	0(25)	0(50)	0(75)	0(84)	0(95)
/	/	/	/	/	/	/
2.402	2.553	2.635	2.827	3.040	3.154	3.419

MEAN
2.8448

SORTING
0.3044

SKEWNESS
0.1275

KURTOSIS
1.0315

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.21	0.09
-0.50	0.12	0.14
0.00	0.07	0.17
0.50	0.12	0.21
1.00	0.25	0.32
1.50	0.19	0.40
2.00	1.39	0.97
2.50	24.78	11.19
3.00	145.24	71.12
3.50	61.74	96.60
4.00	8.24	100.00

SAMPLE: SC-021

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 207.20
 COURSE FRACTION WEIGHT: 207.20
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.541	2.728	2.838	3.084	3.316	3.415	3.593

MEAN
3.0756

SORTING
0.3311

SKEWNESS
-0.0353

KURTOSIS
0.9022

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.79	0.38
-0.50	0.19	0.47
0.00	0.13	0.54
0.50	0.12	0.59
1.00	0.12	0.65
1.50	0.10	0.70
2.00	0.82	1.10
2.50	4.84	3.43
3.00	77.53	40.85
3.50	102.29	90.22
4.00	20.27	100.00

SAMPLE: SC-22

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 157.10
 COURSE FRACTION WEIGHT: 157.10
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

0(5)	0(16)	0(25)	0(50)	0(75)	0(84)	0(95)
/	/	/	/	/	/	/
2.381	2.669	2.798	3.060	3.284	3.375	3.523

MEAN
 3.0347

SORTING
 0.3496

SKEWNESS
 -0.1478

KURTOSIS
 0.9629

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.58	0.37
-0.50	0.53	0.71
0.00	0.38	0.95
0.50	0.61	1.34
1.00	0.72	1.80
1.50	1.13	2.51
2.00	1.75	3.63
2.50	6.86	7.99
3.00	55.88	43.56
3.50	78.70	93.66
4.00	9.96	100.00

SAMPLE: SC-23

DATE: 7-14-98

LOCATION: Starvation CoveANALYST: GFH

TEST WEIGHT: 246.40
 COURSE FRACTION WEIGHT: 246.40
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.195	2.478	2.591	2.835	3.135	3.339	3.771

MEAN
2.8843

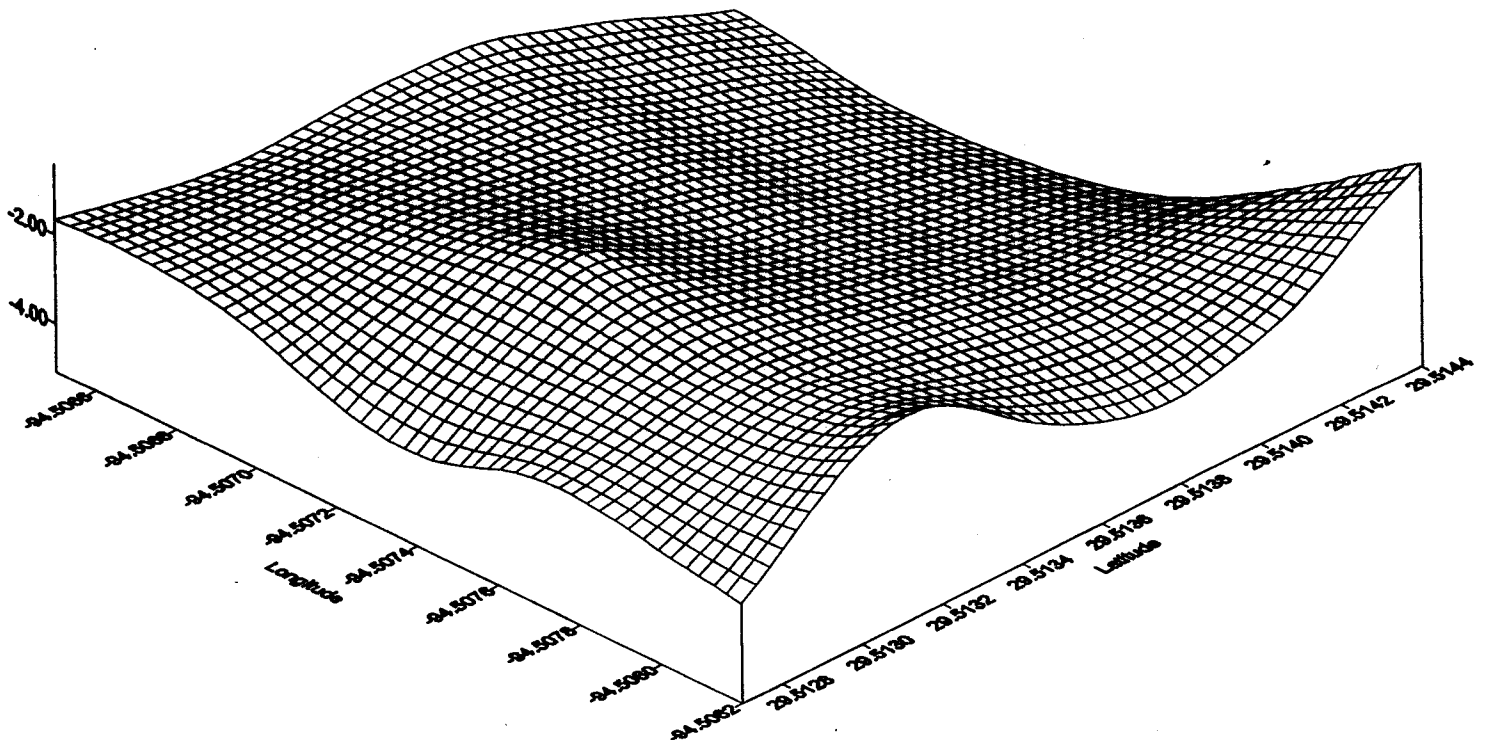
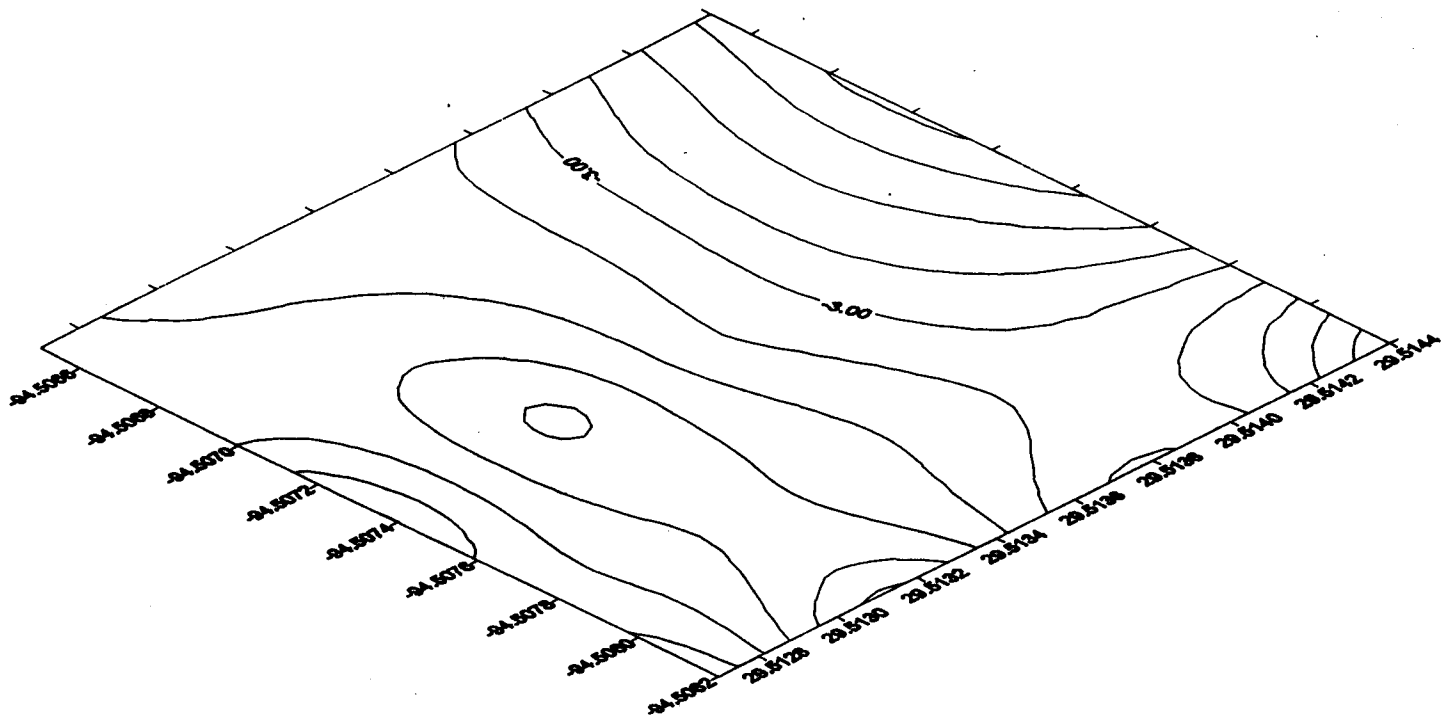
SORTING
0.4540

SKEWNESS
0.1786

KURTOSIS
1.1879

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.30	0.12
-0.50	0.31	0.25
0.00	0.43	0.42
0.50	0.42	0.59
1.00	0.75	0.90
1.50	1.58	1.54
2.00	3.70	3.04
2.50	35.68	17.52
3.00	118.68	65.69
3.50	56.43	88.59
4.00	28.12	100.00

Attachment D



Rollover Pass Area Contour Map of Sand Fraction Volume

Rollover Pass Surfer Data

VOLUME COMPUTATIONS

UPPER SURFACE

Grid File: C:/SURFER6/VCRFINAL/RLOVRTP1.GRD
Grid size as read: 44 cols by 50 rows
Delta X: 11.6279
Delta Y: 12.2449
X-Range: -2.99152E+007 to -2.99147E+007
Y-Range: 1.07334E+007 to 1.0734E+007
Z-Range: -2.73326 to -0.0145623

LOWER SURFACE

Grid File: C:/SURFER6/VCRFINAL/RLOVRBTTM1.GRD
Grid size as read: 44 cols by 50 rows
Delta X: 11.6279
Delta Y: 12.2449
X-Range: -2.99152E+007 to -2.99147E+007
Y-Range: 1.07334E+007 to 1.0734E+007
Z-Range: -6 to -6

VOLUMES

Approximated Volume by
Trapezoidal Rule: 1.48587E+006
Simpson's Rule: 1.48595E+006
Simpson's 3/8 Rule: 1.48595E+006

CUT & FILL VOLUMES

Positive Volume [Cut]: 1.48584E+006
Negative Volume [Fill]: 0
Cut minus Fill: 1.48584E+006

AREAS

Positive Planar Area
(Upper above Lower): 300000
Negative Planar Area
(Lower above Upper): 0
Blanked Planar Area: 0
Total Planar Area: 300000

Positive Surface Area
(Upper above Lower): 300009
Negative Surface Area
(Lower above Upper): 0

Sample Analysis - Rollover Pass

Sample #	Net Wt	Wt Before	Wt After Sieve	Sand Wt	Clay Wt	% Sand
Rollover Pass						
RP-1	306.14	215.58	215.53	215.58	90.56	70.41876
RP-2	285.51	184.74	184.74	184.74	100.77	64.70526
RP-3	303.79	181.16	178.69	181.16	122.63	59.6333
RP-4	252.41	127.18	127.17	127.18	125.23	50.38628
RP-5	234.42	143.68	144.34	143.68	90.74	61.2917
RP-6	377.94	254.73	254.82	254.73	123.21	67.39959
RP-7	164.54	121.23	117.35	121.23	43.31	73.67813
RP-8	294.54	190.91	190.17	190.91	103.63	64.81632
RP-9	493.01	306.27	306.71	306.27	186.74	62.12247
RP-10	322.66	145.08	143.89	145.08	177.58	44.96374
RP-11	176.9	106.32	105.84	106.32	70.58	60.10175
RP-12	366.02	178.22	177.29	178.22	187.8	48.69133

SAMPLE: RP-01

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 215.13
 COURSE FRACTION WEIGHT: 215.13
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.487	2.749	2.883	3.165	3.436	3.565	3.818

MEAN
 3.1595

SORTING
 0.4057

SKEWNESS
 -0.0197

KURTOSIS
 0.9874

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	4.21	1.96
-0.50	0.23	2.06
0.00	0.16	2.14
0.50	0.13	2.20
1.00	0.11	2.25
1.50	0.15	2.32
2.00	0.80	2.69
2.50	5.67	5.33
3.00	62.74	34.49
3.50	97.53	79.83
4.00	43.40	100.00

SAMPLE: RP-02

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 184.74
 COURSE FRACTION WEIGHT: 184.74
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.550	2.824	2.964	3.250	3.537	3.675	3.889

MEAN
3.2496

SORTING
0.4154

SKEWNESS
-0.0230

KURTOSIS
0.9574

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	2.50	1.35
-0.50	0.16	1.44
0.00	0.14	1.52
0.50	0.16	1.60
1.00	0.09	1.65
1.50	0.12	1.72
2.00	0.54	2.01
2.50	3.47	3.89
3.00	44.11	27.76
3.50	82.15	72.23
4.00	51.30	100.00

SAMPLE: RP-03

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 178.73
 COURSE FRACTION WEIGHT: 178.73
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.578	2.854	2.969	3.181	3.372	3.453	3.600

MEAN
 3.1628

SORTING
 0.3046

SKEWNESS
 -0.1339

KURTOSIS
 1.0391

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.10	0.06
-0.50	0.04	0.08
0.00	0.16	0.17
0.50	0.14	0.25
1.00	0.25	0.39
1.50	0.39	0.60
2.00	1.92	1.68
2.50	3.61	3.70
3.00	43.56	28.07
3.50	107.63	88.29
4.00	20.93	100.00

SAMPLE: RP-04

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 127.17
 COURSE FRACTION WEIGHT: 127.17
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

0(5)	0(16)	0(25)	0(50)	0(75)	0(84)	0(95)
/	/	/	/	/	/	/
2.665	2.948	3.064	3.304	3.556	3.682	3.889

MEAN
 3.3111

SORTING
 0.3691

SKEWNESS
 -0.0068

KURTOSIS
 1.0189

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.13	0.10
-0.50	0.06	0.15
0.00	0.05	0.19
0.50	0.14	0.30
1.00	0.17	0.43
1.50	0.23	0.61
2.00	0.62	1.10
2.50	2.24	2.86
3.00	21.40	19.69
3.50	64.27	70.23
4.00	37.86	100.00

SAMPLE: RP-05

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 144.34
 COURSE FRACTION WEIGHT: 144.34
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.614	2.903	3.031	3.291	3.559	3.689	3.894

MEAN
 3.2943

SORTING
 0.3906

SKEWNESS
 -0.0220

KURTOSIS
 0.9940

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.66	0.46
-0.50	0.07	0.51
0.00	0.06	0.55
0.50	0.06	0.59
1.00	0.21	0.73
1.50	0.16	0.85
2.00	0.56	1.23
2.50	2.64	3.06
3.00	28.12	22.54
3.50	68.85	70.24
4.00	42.95	100.00

SAMPLE: RP-06

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 254.82
 COURSE FRACTION WEIGHT: 254.82
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
999.990	999.990	999.990	999.990	999.990	999.990	999.990

MEAN
 999.9900

SORTING
 999.9900

SKEWNESS
 999.9900

KURTOSIS
 999.9900

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	20.16	7.91
-0.50	0.35	8.05
0.00	0.39	8.20
0.50	0.23	8.29
1.00	0.20	8.37
1.50	0.20	8.45
2.00	0.65	8.70
2.50	5.28	10.78
3.00	53.77	31.88
3.50	109.34	74.79
4.00	64.25	100.00

SAMPLE: RP-07

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 117.35
 COURSE FRACTION WEIGHT: 117.35
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
0.375	2.954	3.045	3.224	3.392	3.464	3.591

MEAN
 3.2141

SORTING
 0.6148

SKEWNESS
 -0.4141

KURTOSIS
 3.7982

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	5.39	4.59
-0.50	0.21	4.77
0.00	0.18	4.93
0.50	0.12	5.03
1.00	0.12	5.13
1.50	0.07	5.19
2.00	0.27	5.42
2.50	0.28	5.66
3.00	16.95	20.10
3.50	79.42	87.78
4.00	14.34	100.00

SAMPLE: RP-09

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 306.71
 COURSE FRACTION WEIGHT: 306.71
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.564	2.901	3.031	3.286	3.548	3.677	3.887

MEAN
 3.2881

SORTING
 0.3945

SKEWNESS
 -0.0417

KURTOSIS
 1.0481

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	8.16	2.66
-0.50	0.32	2.76
0.00	0.22	2.84
0.50	0.11	2.87
1.00	0.13	2.91
1.50	0.16	2.97
2.00	0.67	3.19
2.50	3.18	4.22
3.00	56.28	22.57
3.50	148.75	71.07
4.00	88.73	100.00

SAMPLE: RP-010

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 143.89
 COURSE FRACTION WEIGHT: 143.89
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.861	3.014	3.091	3.262	3.436	3.516	3.675

MEAN
 3.2640

SORTING
 0.2489

SKEWNESS
 0.0114

KURTOSIS
 0.9673

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.11	0.08
-0.50	0.06	0.12
0.00	0.04	0.15
0.50	0.08	0.20
1.00	0.12	0.28
1.50	0.11	0.36
2.00	0.60	0.78
2.50	0.79	1.33
3.00	19.15	14.64
3.50	97.53	82.42
4.00	25.30	100.00

Note: Notable amounts of organic material or wood remnants found (ϕ 1.0- ϕ 3.0)

SAMPLE: RP-11

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 105.84
 COURSE FRACTION WEIGHT: 105.84
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

	O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
+	/	/	/	/	/	/	/
	999.990	999.990	999.990	999.990	999.990	999.990	999.990

MEAN
 999.9900

SORTING
 999.9900

SKEWNESS
 999.9900

KURTOSIS
 999.9900

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	6.16	5.82
-0.50	0.10	5.91
0.00	0.02	5.93
0.50	0.08	6.01
1.00	0.09	6.09
1.50	0.12	6.21
2.00	0.32	6.51
2.50	1.65	8.07
3.00	14.87	22.12
3.50	49.68	69.06
4.00	32.75	100.00

SAMPLE: RP-12

DATE: 7-14-98

LOCATION: Rollover PassANALYST: GFH

TEST WEIGHT: 177.29
 COURSE FRACTION WEIGHT: 177.29
 FINE FRACTION WEIGHT: 0.00

WEIGHT RETAINED IN THE
 4 PHI PIPETTE SAMPLE: 0.00
 DISPERSANT WT IN 20 ML: 0.000

PERCENT SAND BY WEIGHT: 100.00%
 PERCENT SILT BY WEIGHT: 0.00%
 PERCENT CLAY BY WEIGHT: 0.00%

O(5)	O(16)	O(25)	O(50)	O(75)	O(84)	O(95)
/	/	/	/	/	/	/
2.549	2.778	2.896	3.130	3.336	3.423	3.572

MEAN
 3.1103

SORTING
 0.3160

SKEWNESS
 -0.1133

KURTOSIS
 0.9522

PHI SIZE	WEIGHT RETAINED	CUMULATIVE PERCENT
-1.00	0.19	0.11
-0.50	0.08	0.15
0.00	0.10	0.21
0.50	0.16	0.30
1.00	0.47	0.56
1.50	0.38	0.78
2.00	1.33	1.53
2.50	3.75	3.64
3.00	55.56	34.98
3.50	98.50	90.54
4.00	16.77	100.00