Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Finer Than Indicated Size

Sample No.	Gravel			Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt				Clay	
Phi Size	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Sieve Size (microns)	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (62)	31.00	15.60	7.80	3.90	2.00	1.00
GWS-EC14-0112	100.0	100.0	100.0	99.7	86.4	75.6	65.3	54.8	54.1	43.6	33.6	24.5	11.5	6.6
GWS-EC14-0112	100.0	100.0	99.6	93.9	85.6	74.1	63.4	52.9	50.0	40.7	31.0	22.3	11.0	5.8
GWS-EC14-0112	100.0	100.0	99.9	97.7	86.1	76.2	66.1	55.2	53.8	43.2	33.6	24.9	11.7	6.2
GWS-EC14-0008	100.0	100.0	100.0	99.9	95.8	91.9	85.8	71.5	62.4	48.6	36.2	25.5	16.0	9.5
GWS-EC14-0042	100.0	100.0	100.0	99.9	89.3	80.7	74.2	67.7	65.2	58.6	50.7	38.0	20.1	11.9
GWS-EC14-0068	100.0	100.0	100.0	99.5	89.2	79.3	72.6	66.3	65.7	57.6	46.8	33.5	16.1	9.0
GWS-EC22-0015	100.0	100.0	100.0	99.7	89.5	80.8	73.6	65.8	63.8	55.4	46.5	34.0	16.7	9.2
GWS-EC22-0055	100.0	100.0	99.9	98.9	89.4	81.4	73.5	63.2	62.9	57.0	47.2	32.5	14.6	8.7
GWS-EC22-0078	100.0	100.0	100.0	100.0	93.0	87.0	82.1	76.2	75.6	68.1	59.3	44.1	19.1	10.0
GWS-EC22-0105	100.0	100.0	100.0	99.9	95.7	92.5	90.0	87.3	85.9	78.3	68.2	49.7	19.3	11.3
GWS-EC22-0135	100.0	100.0	100.0	99.7	94.7	90.7	87.7	84.3	82.8	73.4	66.4	47.0	18.1	10.8
GWS-EC22-0162	100.0	100.0	100.0	99.9	94.2	89.7	86.1	81.9	80.6	71.3	66.1	49.8	19.7	12.5

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Retained in Each Size Fraction

Sample No.	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Coarse Silt	Medium Silt	Fine Silt	Very Fine Silt	Clay		
Phi Size	> -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	< 10
Sieve Size (microns)	> #10 (2000)	10 to 18 (2000-1000)	18-35 (1000-500)	35-60 (500-250)	60-120 (250-125)	120-230 (125-62)	62.5-31.0	31.0-15.6	15.6-7.8	7.8-3.9	3.9-2.0	2.0-1.0	<1.0
GWS-EC14-0112	0.0	0.3	13.4	10.7	10.3	10.5	0.8	10.5	10.0	9.1	13.0	5.0	6.6
GWS-EC14-0112	0.4	5.7	8.3	11.5	10.8	10.5	2.9	9.3	9.7	8.7	11.3	5.2	5.8
GWS-EC14-0112	0.1	2.2	11.6	9.9	10.2	10.9	1.4	10.6	9.6	8.7	13.3	5.5	6.2
GWS-EC14-0008	0.0	0.1	4.0	3.9	6.1	14.3	9.2	13.8	12.4	10.7	9.5	6.4	9.5
GWS-EC14-0042	0.0	0.1	10.5	8.6	6.5	6.5	2.5	6.5	8.0	12.7	17.9	8.1	11.9
GWS-EC14-0068	0.0	0.5	10.3	9.9	6.7	6.3	0.6	8.2	10.8	13.2	17.4	7.1	9.0
GWS-EC22-0015	0.0	0.3	10.2	8.7	7.2	7.9	2.0	8.4	8.9	12.4	17.3	7.5	9.2
GWS-EC22-0055	0.1	1.0	9.5	8.0	7.9	10.3	0.3	5.8	9.9	14.6	17.9	6.0	8.7
GWS-EC22-0078	0.0	0.0	6.9	6.0	4.9	5.9	0.5	7.5	8.8	15.2	25.0	9.1	10.0
GWS-EC22-0105	0.0	0.1	4.3	3.1	2.5	2.7	1.4	7.5	10.1	18.5	30.4	8.0	11.3
GWS-EC22-0135	0.0	0.3	5.0	4.0	3.0	3.3	1.6	9.4	7.0	19.4	28.9	7.3	10.8
GWS-EC22-0162	0.0	0.1	5.7	4.5	3.7	4.2	1.3	9.3	5.2	16.3	30.1	7.2	12.5

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IB67

000423

ANALYTICAL RESOURCES INCORPORATED

Floyd/Snideryÿ3X

Gas Works Sed WSA RI/FS

Percent Finer Than Indicated Size

Sieve Size (microns)	2"	1"	3/4"	1/2"	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (63)
GWS-EC23-0019	100.0	100.0	100.0	100.0	98.1	95.8	90.0	85.0	75.8	45.4	10.4	3.0
GWS-EC23-0048	100.0	100.0	100.0	100.0	100.0	99.9	99.1	97.8	86.3	38.6	6.1	0.9
GWS-EC23-0067	100.0	64.7	64.7	60.4	59.1	57.8	57.0	54.7	43.0	22.5	11.2	6.1

IB67

000424

Floyd/Snider
Gas Works Sed WSA RI/FS

Percent Retained in Each Size Fraction

Sieve Size (microns)	>4750	4750-2000	2000-1000	1000-500	500-250	250-125	125-63	<63
GWS-EC23-0019	4.2	5.8	4.9	9.3	30.4	35.0	7.4	3.0
GWS-EC23-0048	0.1	0.8	1.3	11.5	47.7	32.4	5.2	0.9
GWS-EC23-0067	42.2	0.9	2.2	11.7	20.5	11.4	5.0	6.1

IB67

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

PSEP Total Solids Analysis
Percent of Wet Weight

Sample No.	Total Solids (%)
GWS-EC14-0112	18.1
GWS-EC14-0112	18.7
GWS-EC14-0112	18.3
GWS-EC14-0008	32.3
GWS-EC14-0042	13.9
GWS-EC14-0068	15.6
GWS-EC22-0015	12.0
GWS-EC22-0055	13.2
GWS-EC22-0078	14.1
GWS-EC22-0105	15.8
GWS-EC22-0135	16.3
GWS-EC22-0162	17.0

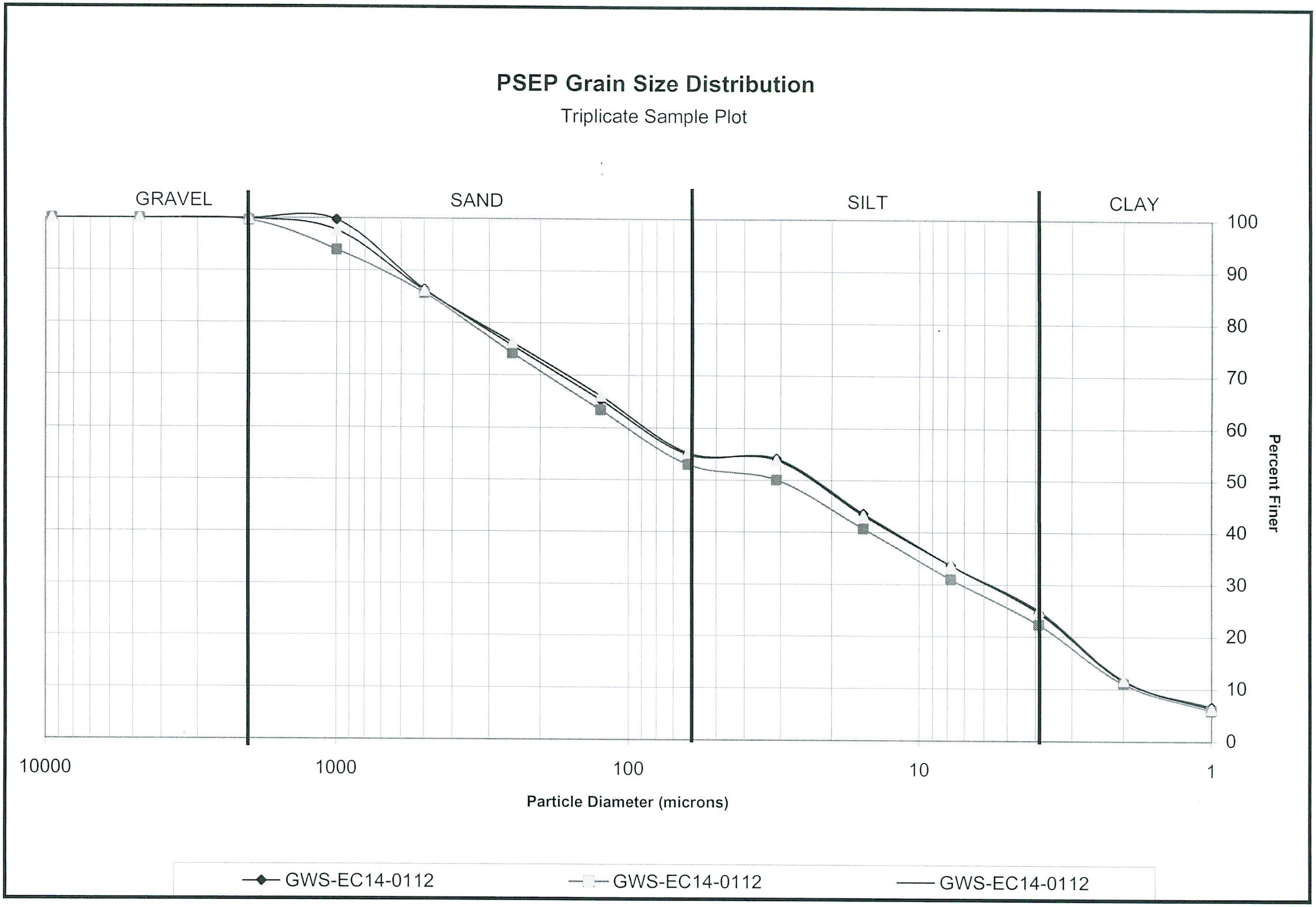
Triplicate Average	18.4
Standard Deviation	0.29
%RSD	1.58

(Total Solids at 90 C)

IB67

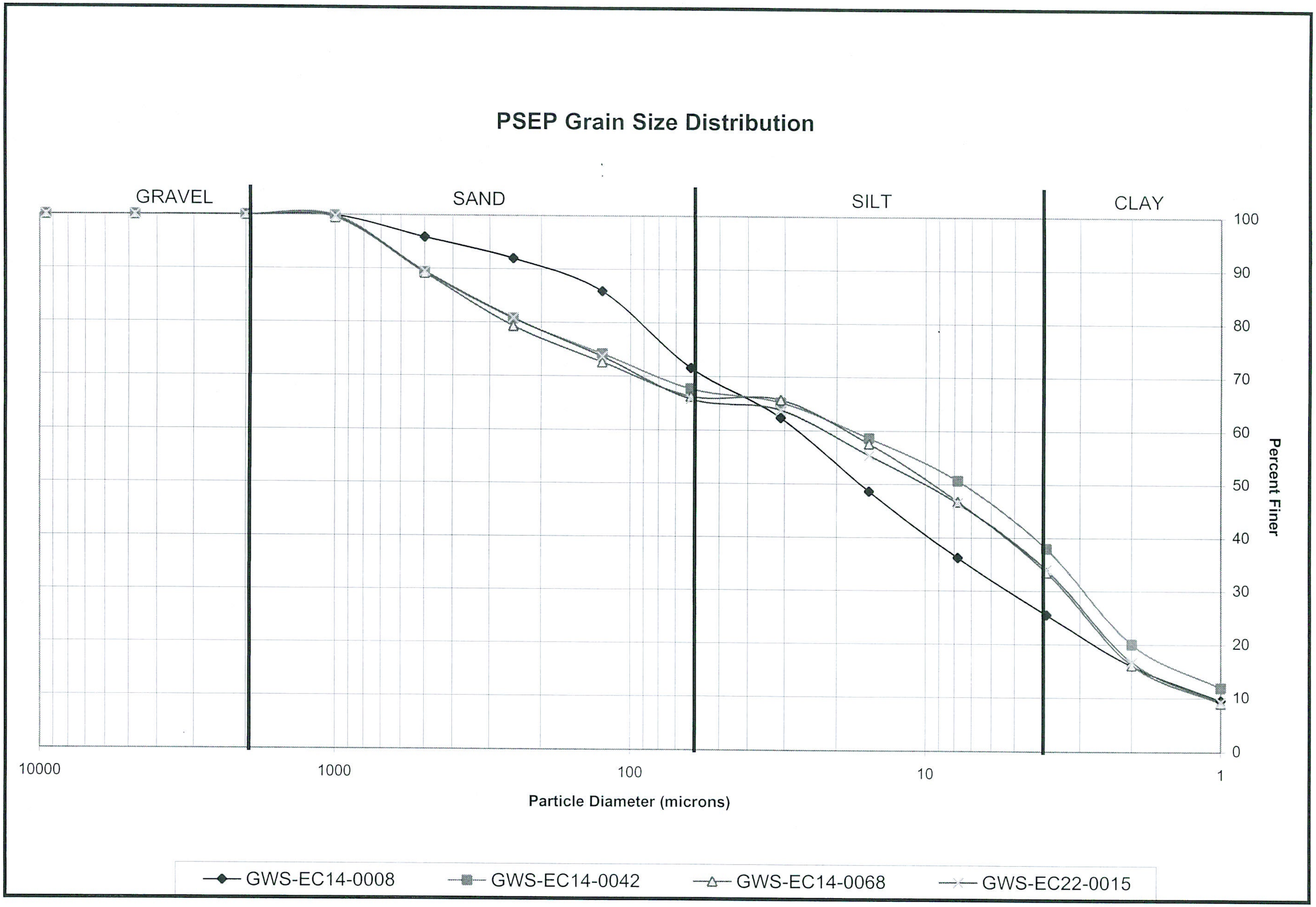
ANALYTICAL RESOURCES INCORPORATED

000427



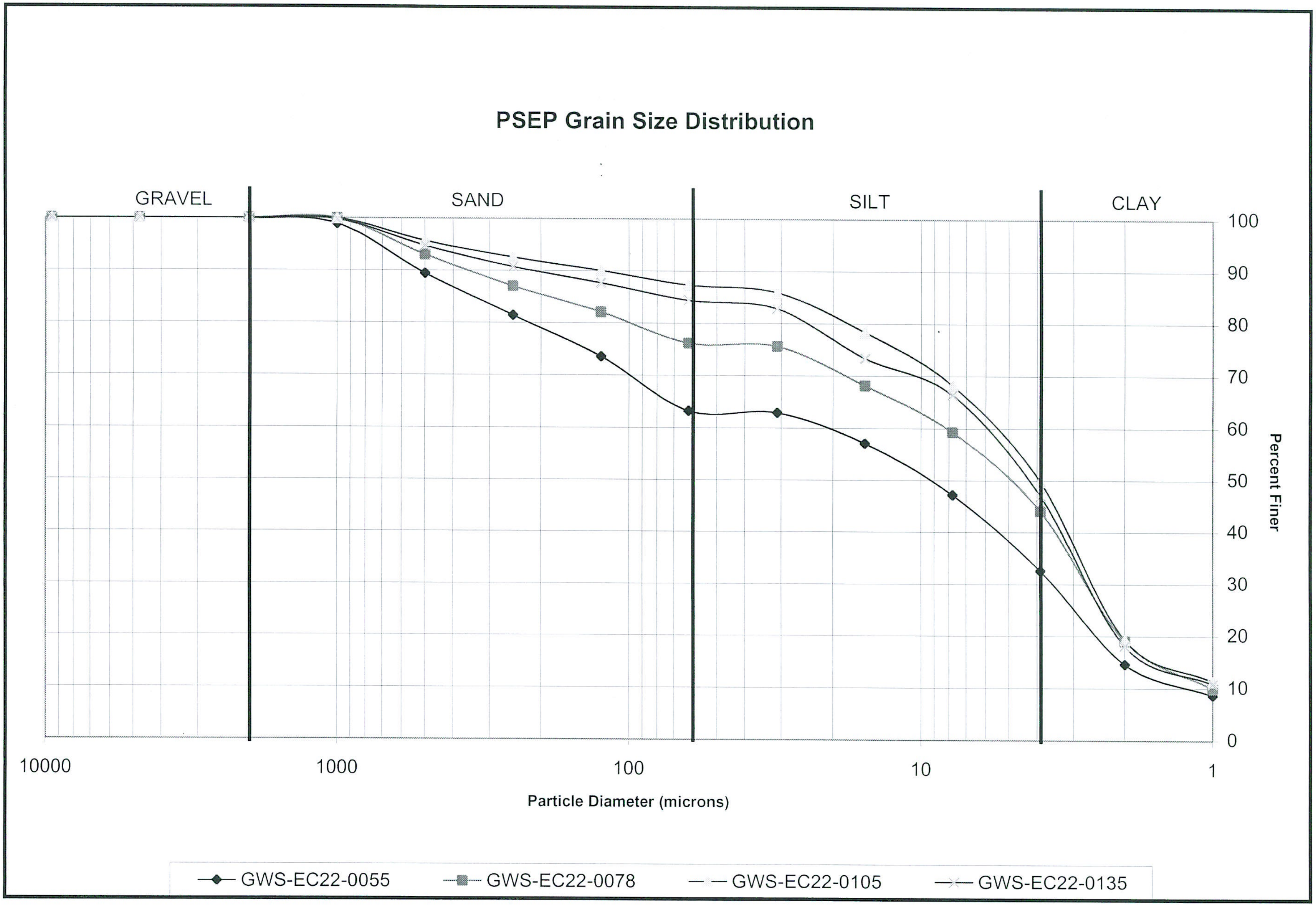
ANALYTICAL RESOURCES INCORPORATED

000428



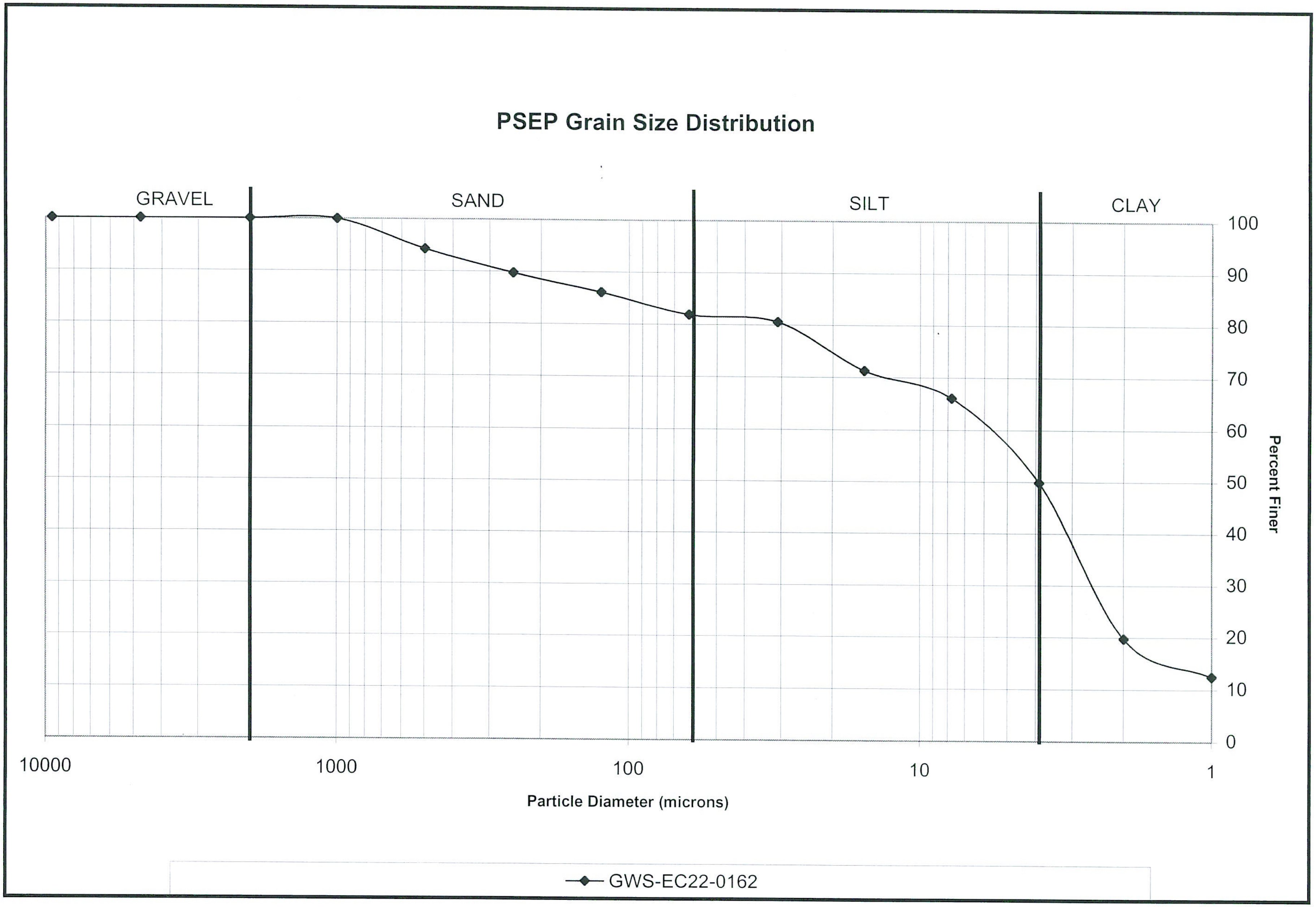
ANALYTICAL RESOURCES INCORPORATED

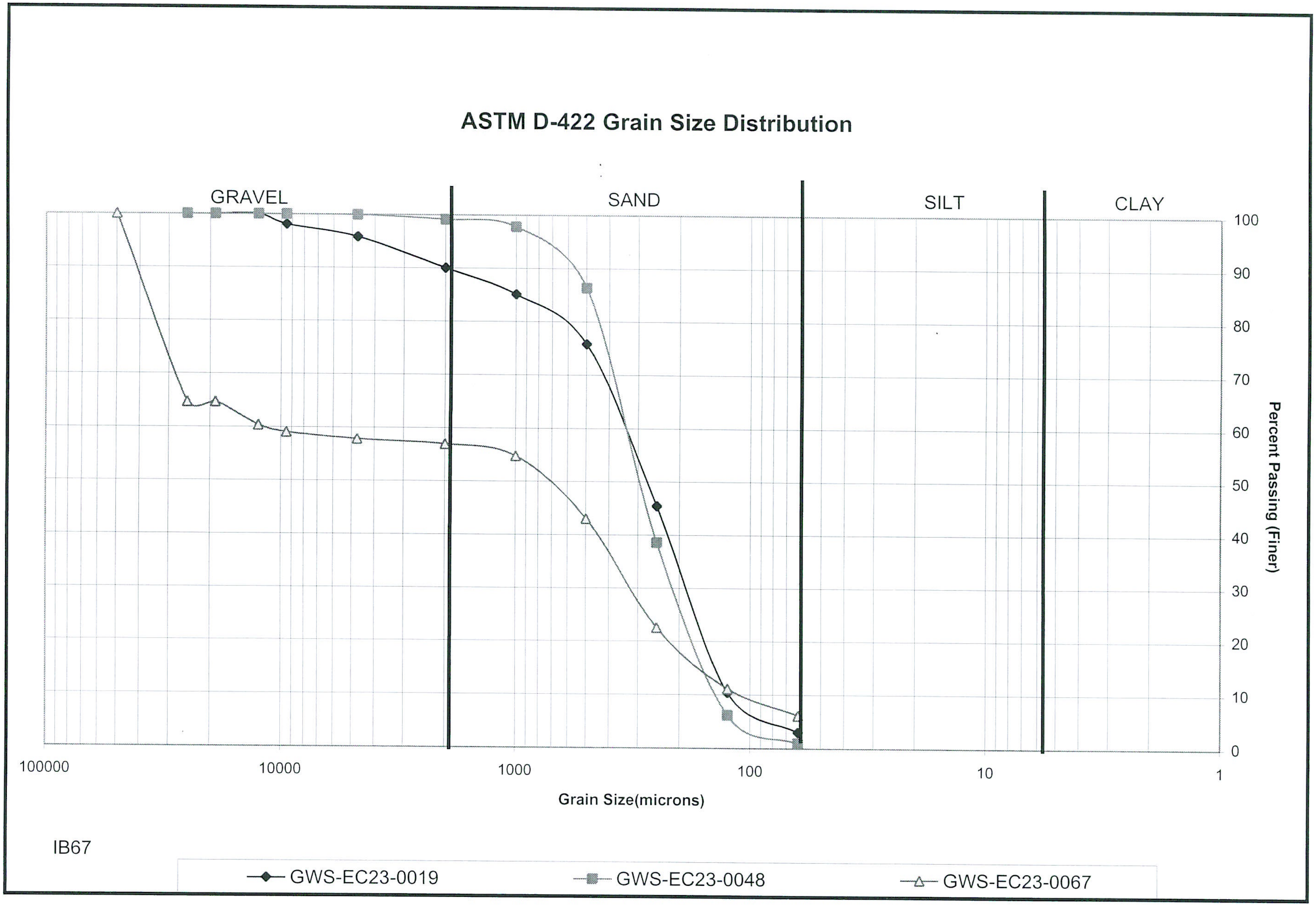
000429



ANALYTICAL RESOURCES INCORPORATED

000430




ASTM D-422 Grain Size Distribution
GRAVEL
SAND
SILT
CLAY
100
90
80
70
60
50
40
30
20
10
0
Percent Passing (Finer)
100000
10000
1000
100
10
1
Grain Size(microns)
IB67
GWS-EC23-0019
GWS-EC23-0048
GWS-EC23-0067

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Finer Than Indicated Size

Sample No.	Gravel			Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt				Clay	
Phi Size	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Sieve Size (microns)	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (62)	31.00	15.60	7.80	3.90	2.00	1.00
GWS-EC14-0112	100.0	100.0	100.0	99.7	86.4	75.6	65.3	54.8	54.1	43.6	33.6	24.5	11.5	6.6
GWS-EC14-0112	100.0	100.0	99.6	93.9	85.6	74.1	63.4	52.9	50.0	40.7	31.0	22.3	11.0	5.8
GWS-EC14-0112	100.0	100.0	99.9	97.7	86.1	76.2	66.1	55.2	53.8	43.2	33.6	24.9	11.7	6.2
GWS-EC19-0010	100.0	100.0	100.0	99.8	91.5	82.6	75.1	68.6	68.3	59.8	51.3	37.0	18.8	12.4
GWS-EC19-0160	100.0	100.0	100.0	99.9	94.5	88.8	84.0	78.5	78.3	73.0	64.7	48.8	22.5	12.9
GWS-EC16-0066	100.0	100.0	100.0	99.8	92.6	87.7	83.9	79.8	78.5	70.0	60.3	44.6	22.6	15.2
GWS-EC21-0006	100.0	100.0	100.0	99.7	89.3	80.2	72.2	62.8	60.7	55.6	45.1	33.8	18.0	9.9
GWS-EC21-0177	100.0	100.0	100.0	99.9	93.7	89.2	86.0	82.4	81.1	72.5	64.8	49.7	19.9	10.8

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IB68

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Retained in Each Size Fraction

Sample No.	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Coarse Silt	Medium Silt	Fine Silt	Very Fine Silt	Clay		
Phi Size	> -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	< 10
Sieve Size (microns)	> #10 (2000)	10 to 18 (2000-1000)	18-35 (1000-500)	35-60 (500-250)	60-120 (250-125)	120-230 (125-62)	62.5-31.0	31.0-15.6	15.6-7.8	7.8-3.9	3.9-2.0	2.0-1.0	<1.0
GWS-EC14-0112	0.0	0.3	13.4	10.7	10.3	10.5	0.8	10.5	10.0	9.1	13.0	5.0	6.6
GWS-EC14-0112	0.4	5.7	8.3	11.5	10.8	10.5	2.9	9.3	9.7	8.7	11.3	5.2	5.8
GWS-EC14-0112	0.1	2.2	11.6	9.9	10.2	10.9	1.4	10.6	9.6	8.7	13.3	5.5	6.2
GWS-EC19-0010	0.0	0.2	8.3	8.9	7.5	6.5	0.4	8.5	8.5	14.3	18.2	6.4	12.4
GWS-EC19-0160	0.0	0.1	5.4	5.7	4.8	5.5	0.2	5.3	8.3	15.9	26.3	9.6	12.9
GWS-EC16-0066	0.0	0.2	7.2	4.9	3.8	4.1	1.2	8.5	9.7	15.7	22.0	7.4	15.2
GWS-EC21-0006	0.0	0.3	10.5	9.0	8.0	9.4	2.2	5.1	10.4	11.3	15.8	8.2	9.9
GWS-EC21-0177	0.0	0.1	6.2	4.5	3.3	3.6	1.3	8.6	7.7	15.1	29.8	9.1	10.8

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IB68

000397

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

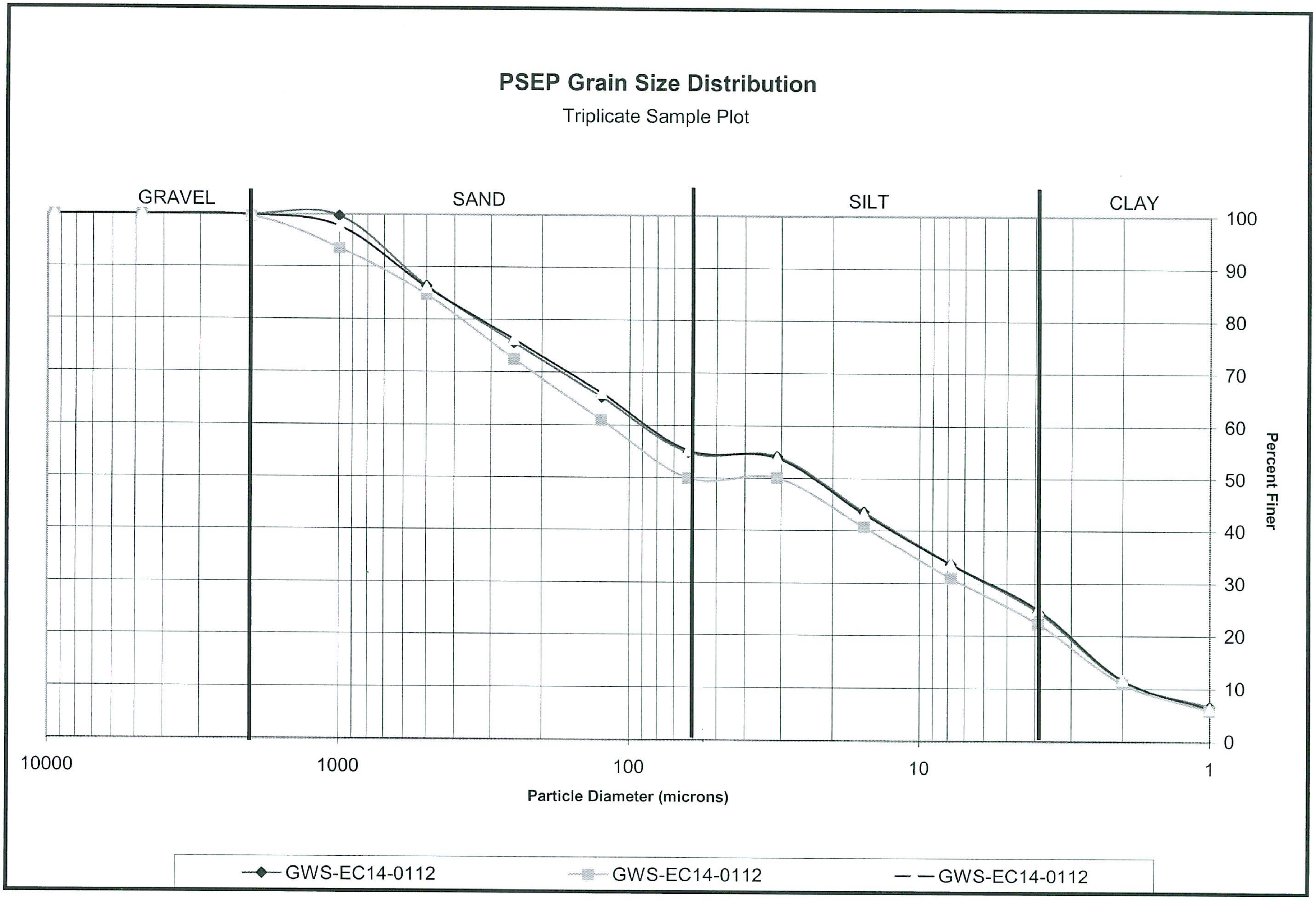
PSEP Total Solids Analysis
Percent of Wet Weight

Sample No.	Total Solids (%)
GWS-EC14-0112	18.1
GWS-EC14-0112	18.7
GWS-EC14-0112	18.3
GWS-EC19-0010	11.4
GWS-EC19-0160	15.3
GWS-EC16-0066	12.7
GWS-EC21-0006	12.1
GWS-EC21-0177	16.3

Triplicate Average	18.4
Standard Deviation	0.29
%RSD	1.58

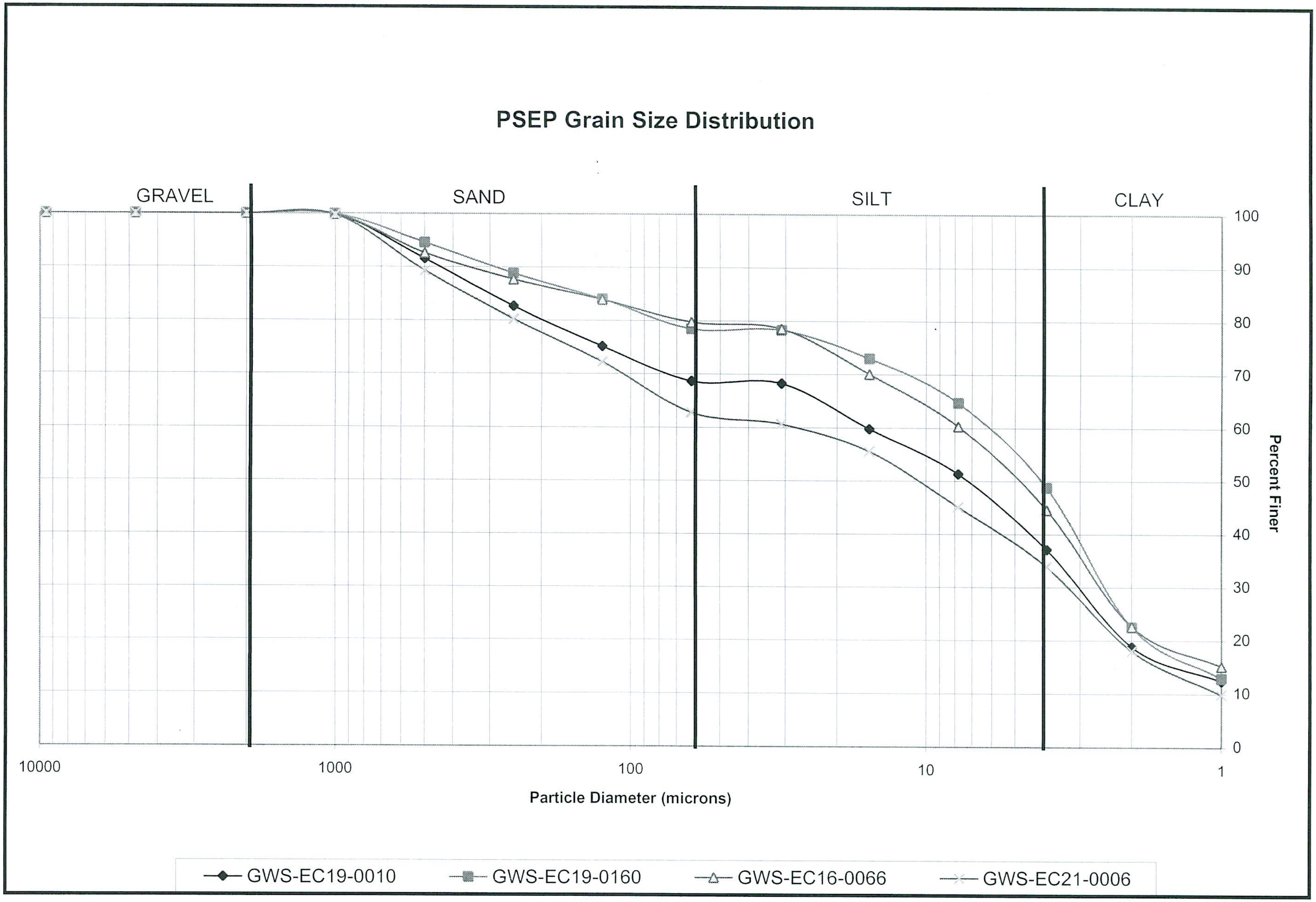
(Total Solids at 90 C)

IB68



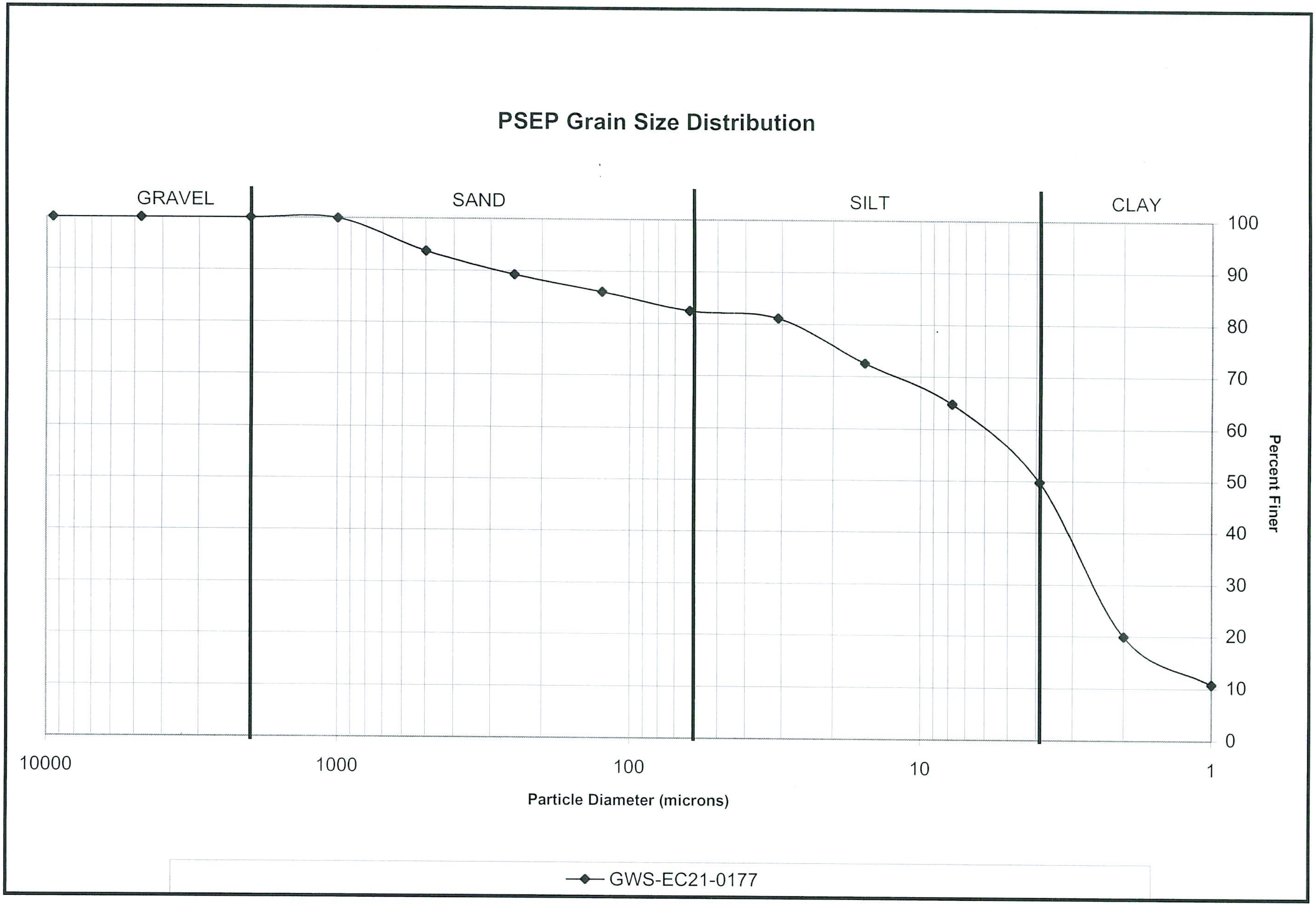
PSEP Grain Size Distribution
Triplicate Sample Plot
GRAVEL
SAND
SILT
CLAY
100
90
80
70
60
50
40
30
20
10
0
Percent Finer
10000
1000
100
10
1
Particle Diameter (microns)
GWS-EC14-0112
GWS-EC14-0112
GWS-EC14-0112

ANALYTICAL RESOURCES INCORPORATED



000400

ANALYTICAL RESOURCES INCORPORATED



000401

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Finer Than Indicated Size

Sample No.	Gravel			Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt				Clay	
Phi Size	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Sieve Size (microns)	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (62)	31.00	15.60	7.80	3.90	2.00	1.00
GWS-EC02-0175	100.0	100.0	100.0	98.9	89.5	81.6	74.9	66.1	64.1	52.4	41.9	32.0	17.4	9.1
GWS-EC02-0175	100.0	100.0	99.6	99.5	89.7	80.9	73.6	64.6	62.8	52.3	41.7	31.7	16.9	8.9
GWS-EC02-0175	100.0	100.0	99.6	98.8	86.0	76.6	68.9	60.1	58.3	48.5	38.4	30.0	15.7	8.3
GWS-EC01-0090	100.0	100.0	100.0	99.5	91.9	86.2	81.8	76.9	76.3	67.8	59.4	39.8	19.6	10.6
GWS-EC10-0025	100.0	100.0	100.0	99.9	89.9	83.3	77.8	72.0	69.0	60.3	49.6	38.1	20.8	11.8
GWS-EC10-0180	100.0	100.0	100.0	99.9	95.3	90.3	86.0	81.5	80.5	73.1	63.3	48.8	19.7	10.6

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IB87

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Retained in Each Size Fraction

Sample No.	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Coarse Silt	Medium Silt	Fine Silt	Very Fine Silt	Clay		
Phi Size	> -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	< 10
Sieve Size (microns)	> #10 (2000)	10 to 18 (2000-1000)	18-35 (1000-500)	35-60 (500-250)	60-120 (250-125)	120-230 (125-62)	62.5-31.0	31.0-15.6	15.6-7.8	7.8-3.9	3.9-2.0	2.0-1.0	<1.0
GWS-EC02-0175	0.0	1.1	9.4	7.9	6.7	8.8	1.9	11.7	10.5	9.9	14.7	8.2	9.1
GWS-EC02-0175	0.4	0.1	9.8	8.7	7.3	9.0	1.8	10.5	10.6	9.9	14.8	8.0	8.9
GWS-EC02-0175	0.4	0.8	12.8	9.3	7.7	8.9	1.8	9.8	10.1	8.4	14.3	7.3	8.3
GWS-EC01-0090	0.0	0.5	7.6	5.6	4.5	4.9	0.6	8.5	8.4	19.6	20.2	9.0	10.6
GWS-EC10-0025	0.0	0.1	10.0	6.5	5.6	5.8	3.0	8.7	10.7	11.5	17.3	9.0	11.8
GWS-EC10-0180	0.0	0.1	4.7	5.0	4.2	4.5	1.0	7.4	9.7	14.6	29.0	9.1	10.6

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IB87

000417

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

PSEP Total Solids Analysis
Percent of Wet Weight

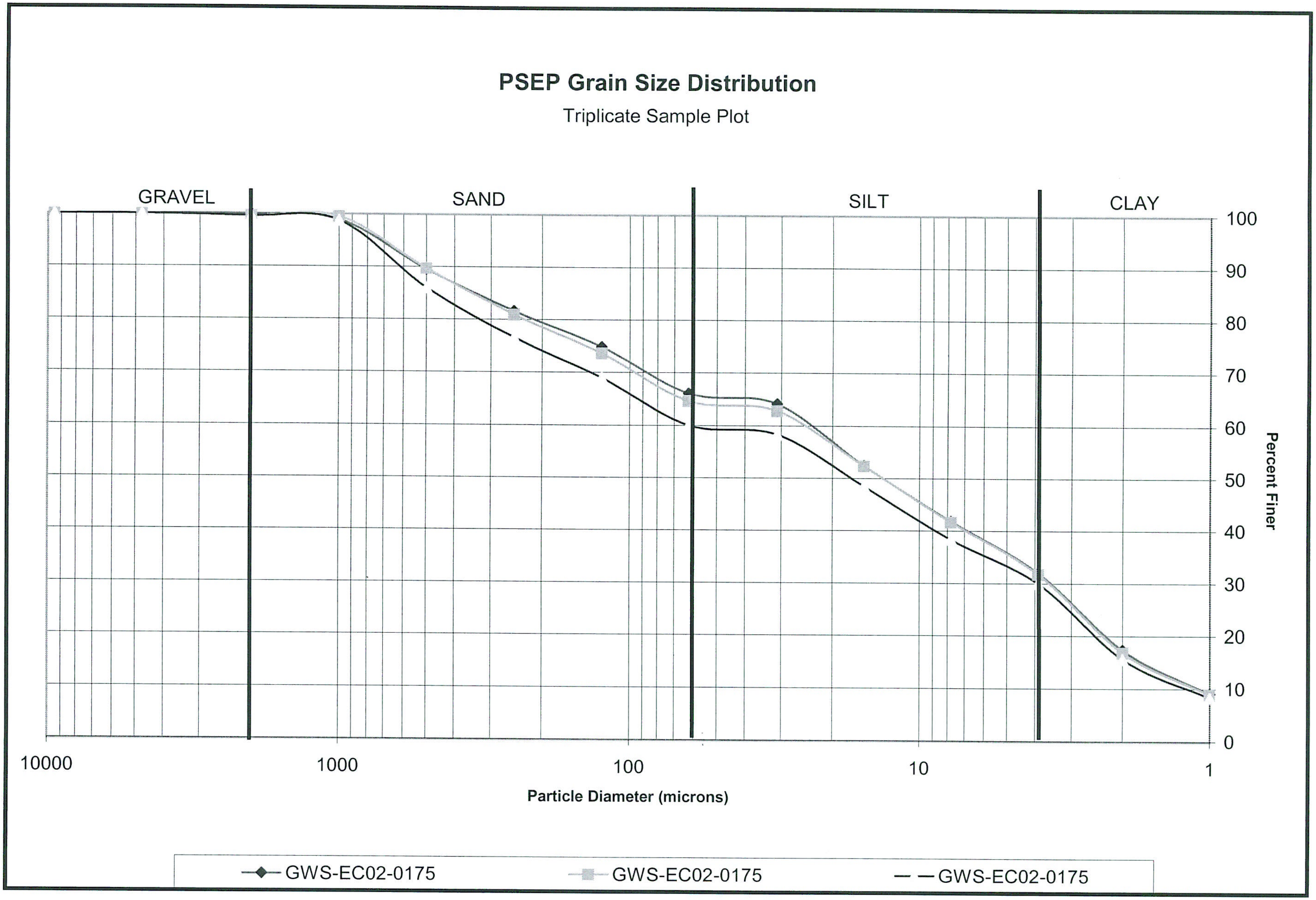
Sample No.	Total Solids (%)
GWS-EC02-0175	16.4
GWS-EC02-0175	16.5
GWS-EC02-0175	16.5
GWS-EC01-0090	14.3
GWS-EC10-0025	10.8
GWS-EC10-0180	15.7

Triplicate Average	16.5
Standard Deviation	0.08
%RSD	0.51

(Total Solids at 90 C)

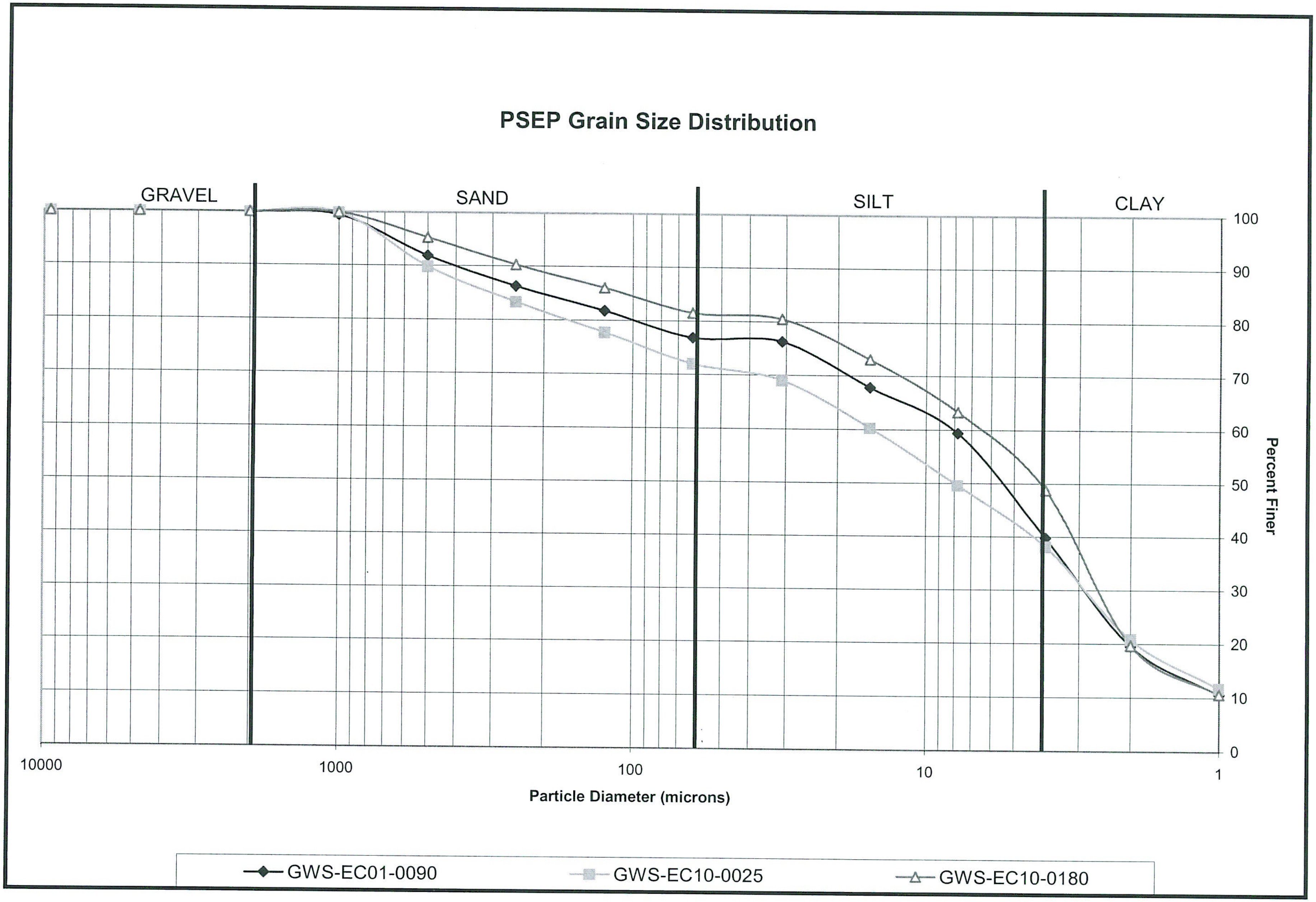
IB87

ANALYTICAL RESOURCES INCORPORATED



000423

ANALYTICAL RESOURCES INCORPORATED



000427

ANALYTICAL RESOURCES INCORPORATED

000449

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Finer Than Indicated Size

Sample No.	Gravel			Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt				Clay	
Phi Size	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Sieve Size (microns)	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (62)	31.00	15.60	7.80	3.90	2.00	1.00
GWS-EC02-0175	100.0	100.0	100.0	98.9	89.5	81.6	74.9	66.1	64.1	52.4	41.9	32.0	17.4	9.1
GWS-EC02-0175	100.0	100.0	99.6	99.5	89.7	80.9	73.6	64.6	62.8	52.3	41.7	31.7	16.9	8.9
GWS-EC02-0175	100.0	100.0	99.6	98.8	86.0	76.6	68.9	60.1	58.3	48.5	38.4	30.0	15.7	8.3
GWS-EC02-0025	100.0	100.0	100.0	99.5	89.5	82.9	77.5	71.8	67.8	64.4	49.6	38.8	22.0	11.3
GWS-EC20-0058	100.0	100.0	100.0	98.4	88.4	81.5	76.6	72.2	71.4	63.3	53.9	40.5	20.1	11.2
GWS-EC09-0008	100.0	100.0	100.0	98.7	90.3	84.9	80.5	76.2	74.8	66.5	55.3	43.0	23.0	13.3
GWS-EC03-0110	100.0	100.0	99.9	98.6	89.6	82.3	76.6	70.0	67.5	56.3	45.6	33.7	16.3	9.5

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

ANALYTICAL RESOURCES INCORPORATED

000450

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Retained in Each Size Fraction

Sample No.	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Coarse Silt	Medium Silt	Fine Silt	Very Fine Silt	Clay		
Phi Size	> -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	< 10
Sieve Size (microns)	> #10 (2000)	10 to 18 (2000-1000)	18-35 (1000-500)	35-60 (500-250)	60-120 (250-125)	120-230 (125-62)	62.5-31.0	31.0-15.6	15.6-7.8	7.8-3.9	3.9-2.0	2.0-1.0	<1.0
GWS-EC02-0175	0.0	1.1	9.4	7.9	6.7	8.8	1.9	11.7	10.5	9.9	14.7	8.2	9.1
GWS-EC02-0175	0.4	0.1	9.8	8.7	7.3	9.0	1.8	10.5	10.6	9.9	14.8	8.0	8.9
GWS-EC02-0175	0.4	0.8	12.8	9.3	7.7	8.9	1.8	9.8	10.1	8.4	14.3	7.3	8.3
GWS-EC02-0025	0.0	0.5	10.0	6.6	5.4	5.7	4.0	3.4	14.8	10.8	16.7	10.7	11.3
GWS-EC20-0058	0.0	1.6	10.0	6.9	4.9	4.4	0.8	8.1	9.4	13.3	20.4	8.9	11.2
GWS-EC09-0008	0.0	1.3	8.4	5.4	4.3	4.4	1.4	8.3	11.2	12.4	20.0	9.7	13.3
GWS-EC03-0110	0.1	1.2	9.1	7.2	5.7	6.6	2.6	11.1	10.8	11.8	17.4	6.8	9.5

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IB91

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

PSEP Total Solids Analysis
Percent of Wet Weight

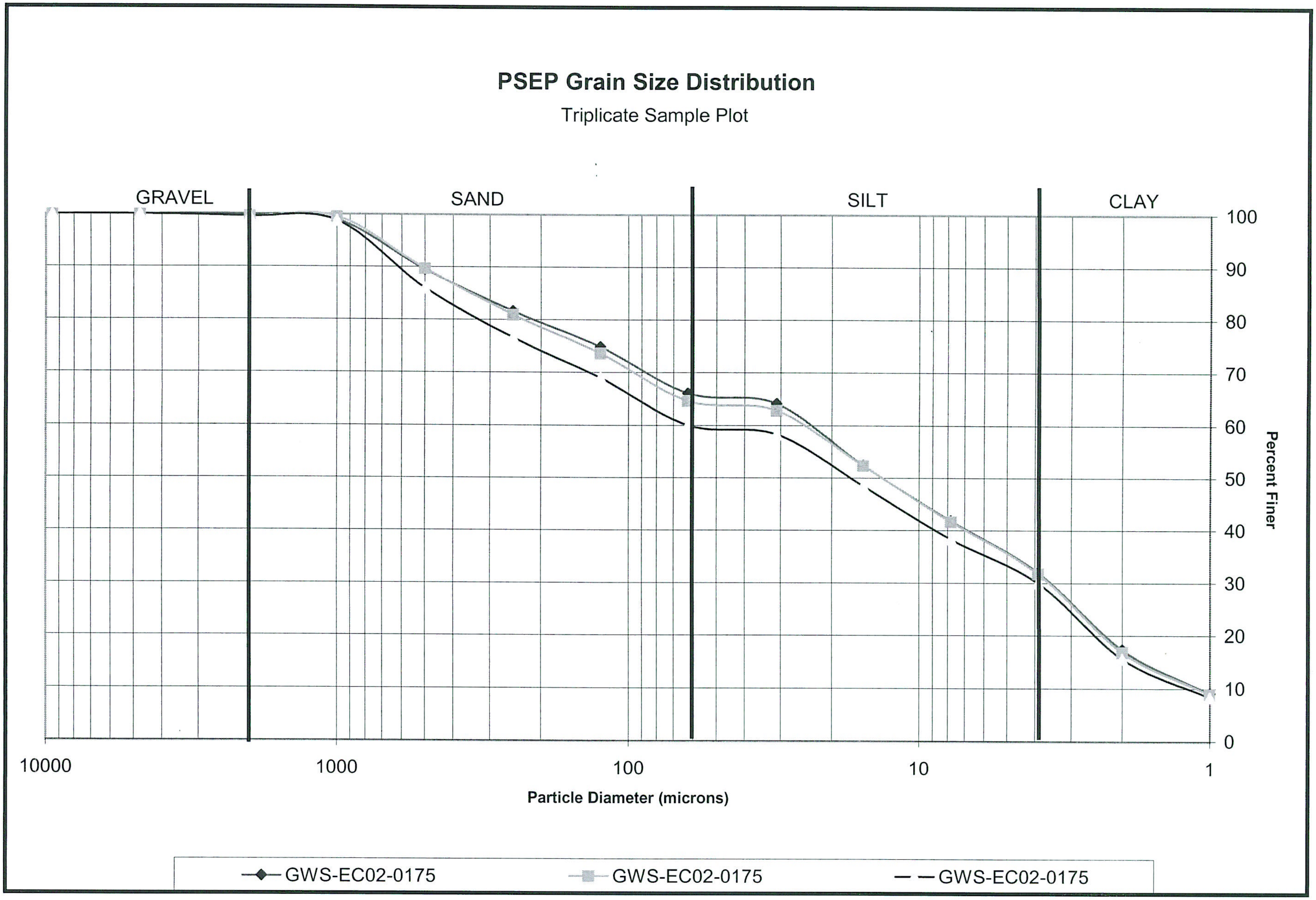
Sample No.	Total Solids (%)
GWS-EC02-0175	16.4
GWS-EC02-0175	16.5
GWS-EC02-0175	16.5
GWS-EC02-0025	11.7
GWS-EC20-0058	12.4
GWS-EC09-0008	11.3
GWS-EC03-0110	14.8

Triplicate Average	16.5
Standard Deviation	0.08
%RSD	0.51

(Total Solids at 90 C)

IB91

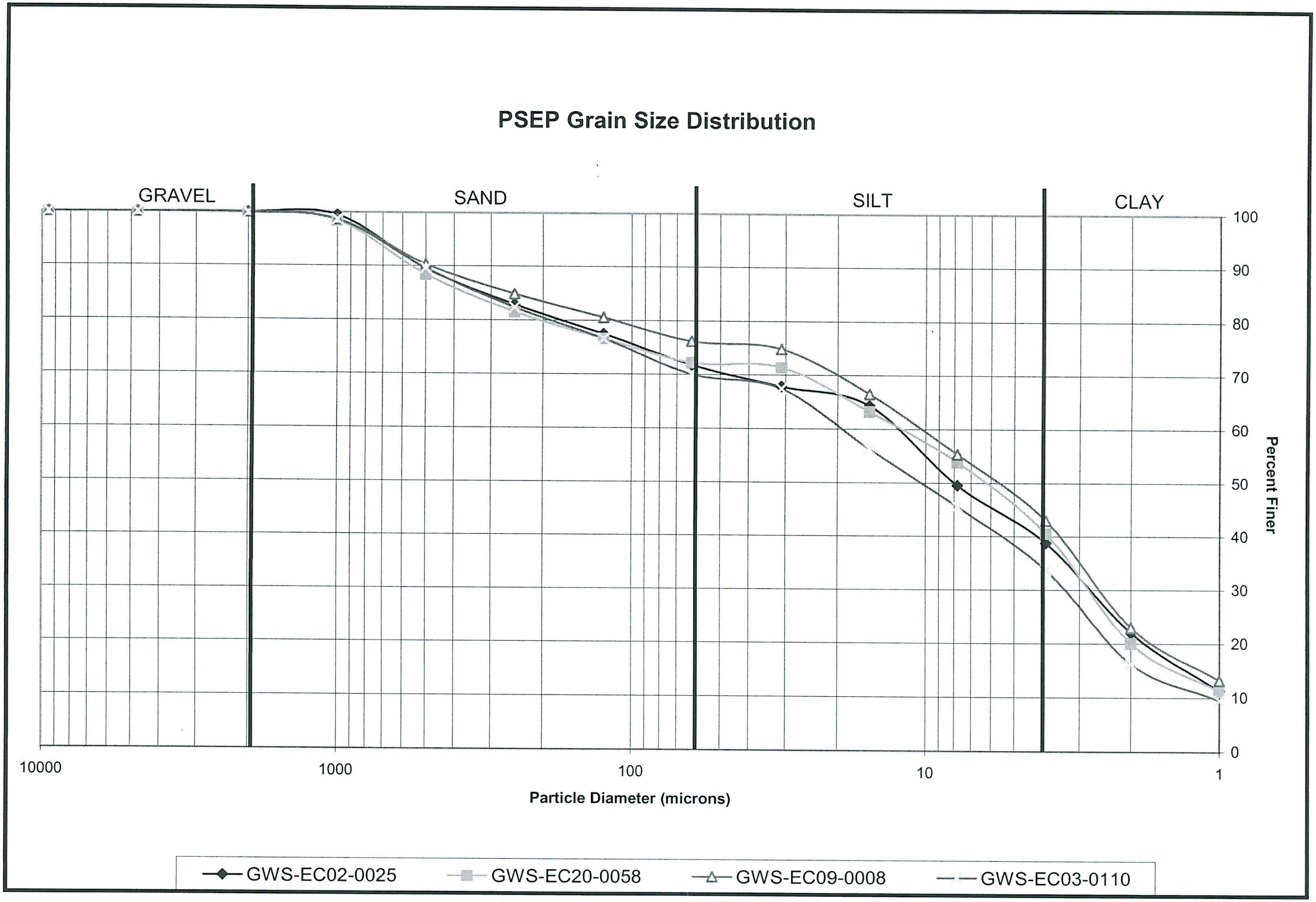
000456



PSEP Grain Size Distribution
Triplicate Sample Plot
GRAVEL
SAND
SILT
CLAY
100
90
80
70
60
50
40
30
20
10
0
Percent Finer
10000
1000
100
10
1
Particle Diameter (microns)
GWS-EC02-0175
GWS-EC02-0175
GWS-EC02-0175

ANALYTICAL
RESOURCES
INCORPORATED

000461



ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Finer Than Indicated Size

Sample No.	Gravel			Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt				Clay	
Phi Size	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Sieve Size (microns)	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (62)	31.00	15.60	7.80	3.90	2.00	1.00
GWS-EC02-0175	100.0	100.0	100.0	98.9	89.5	81.6	74.9	66.1	64.1	52.4	41.9	32.0	17.4	9.1
GWS-EC02-0175	100.0	100.0	99.6	99.5	89.7	80.9	73.6	64.6	62.8	52.3	41.7	31.7	16.9	8.9
GWS-EC02-0175	100.0	100.0	99.6	98.8	86.0	76.6	68.9	60.1	58.3	48.5	38.4	30.0	15.7	8.3
GWS-EC17-0055	100.0	100.0	100.0	98.9	90.9	84.0	78.1	71.6	68.3	60.8	51.6	37.5	19.0	10.5
GWS-EC15-0050	100.0	100.0	99.9	99.6	91.5	84.8	79.5	73.2	69.1	60.4	51.0	36.9	19.4	10.9
GWS-EC15-0106	100.0	100.0	100.0	99.7	92.8	85.8	78.8	68.7	65.6	55.2	45.7	30.2	13.4	7.8
GWS-EC24-0008	100.0	100.0	100.0	99.6	90.5	83.1	76.9	69.7	66.0	54.6	47.0	33.5	17.4	10.0
GWS-EC18-0068	100.0	100.0	100.0	99.7	91.9	85.5	80.0	73.3	71.4	62.0	53.3	38.7	19.2	10.9

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IC04

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Retained in Each Size Fraction

Sample No.	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Coarse Silt	Medium Silt	Fine Silt	Very Fine Silt	Clay		
Phi Size	> -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	< 10
Sieve Size (microns)	> #10 (2000)	10 to 18 (2000-1000)	18-35 (1000-500)	35-60 (500-250)	60-120 (250-125)	120-230 (125-62)	62.5-31.0	31.0-15.6	15.6-7.8	7.8-3.9	3.9-2.0	2.0-1.0	<1.0
GWS-EC02-0175	0.0	1.1	9.4	7.9	6.7	8.8	1.9	11.7	10.5	9.9	14.7	8.2	9.1
GWS-EC02-0175	0.4	0.1	9.8	8.7	7.3	9.0	1.8	10.5	10.6	9.9	14.8	8.0	8.9
GWS-EC02-0175	0.4	0.8	12.8	9.3	7.7	8.9	1.8	9.8	10.1	8.4	14.3	7.3	8.3
GWS-EC17-0055	0.0	1.1	8.0	7.0	5.8	6.6	3.3	7.4	9.2	14.2	18.4	8.5	10.5
GWS-EC15-0050	0.1	0.3	8.1	6.6	5.4	6.2	4.1	8.7	9.4	14.1	17.5	8.5	10.9
GWS-EC15-0106	0.0	0.3	6.9	7.0	7.0	10.1	3.1	10.4	9.5	15.5	16.8	5.6	7.8
GWS-EC24-0008	0.0	0.4	9.0	7.4	6.2	7.3	3.6	11.4	7.6	13.6	16.1	7.4	10.0
GWS-EC18-0068	0.0	0.3	7.8	6.5	5.5	6.6	1.9	9.4	8.7	14.6	19.4	8.3	10.9

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IC04

000379

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

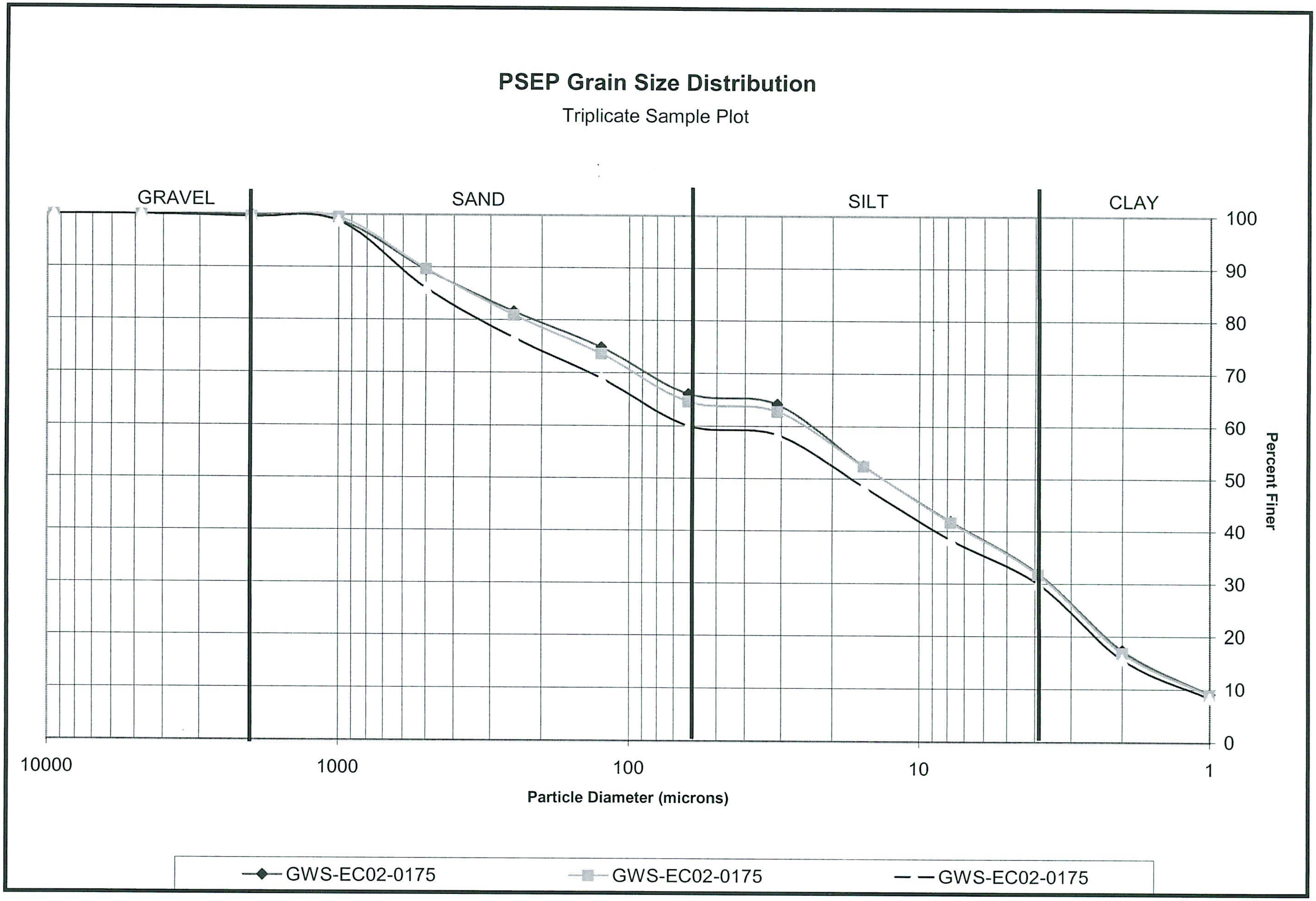
PSEP Total Solids Analysis
Percent of Wet Weight

Sample No.	Total Solids (%)
GWS-EC02-0175	16.4
GWS-EC02-0175	16.5
GWS-EC02-0175	16.5
GWS-EC17-0055	13.0
GWS-EC15-0050	13.1
GWS-EC15-0106	14.0
GWS-EC24-0008	11.4
GWS-EC18-0068	12.3

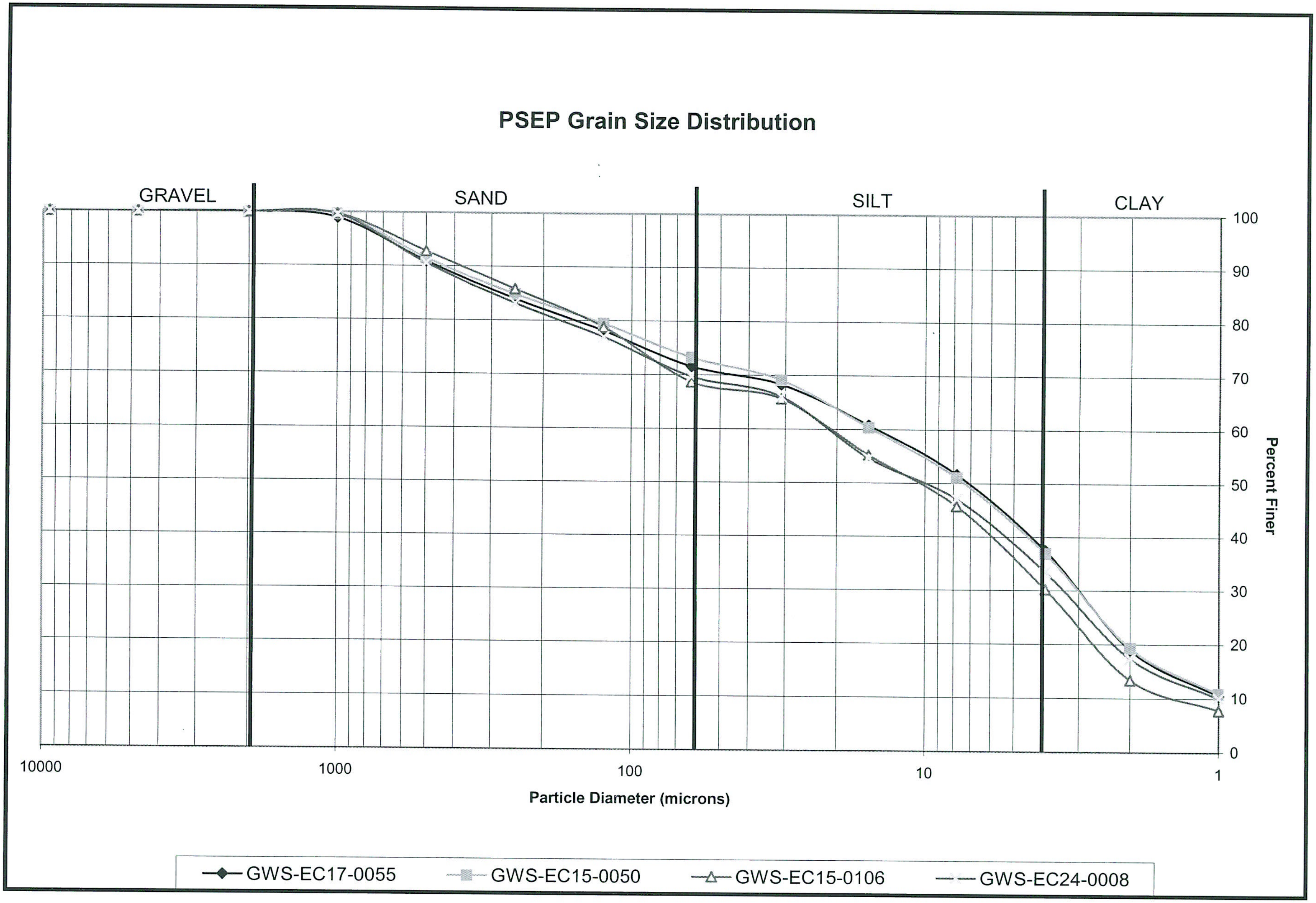
Triplicate Average	16.5
Standard Deviation	0.08
%RSD	0.51

(Total Solids at 90 C)

IC04


PSEP Grain Size Distribution
Triplicate Sample Plot
GRAVEL
SAND
SILT
CLAY
100
90
80
70
60
50
40
30
20
10
0
Percent Finer
10000
1000
100
10
1
Particle Diameter (microns)
GWS-EC02-0175
GWS-EC02-0175
GWS-EC02-0175

ANALYTICAL RESOURCES INCORPORATED



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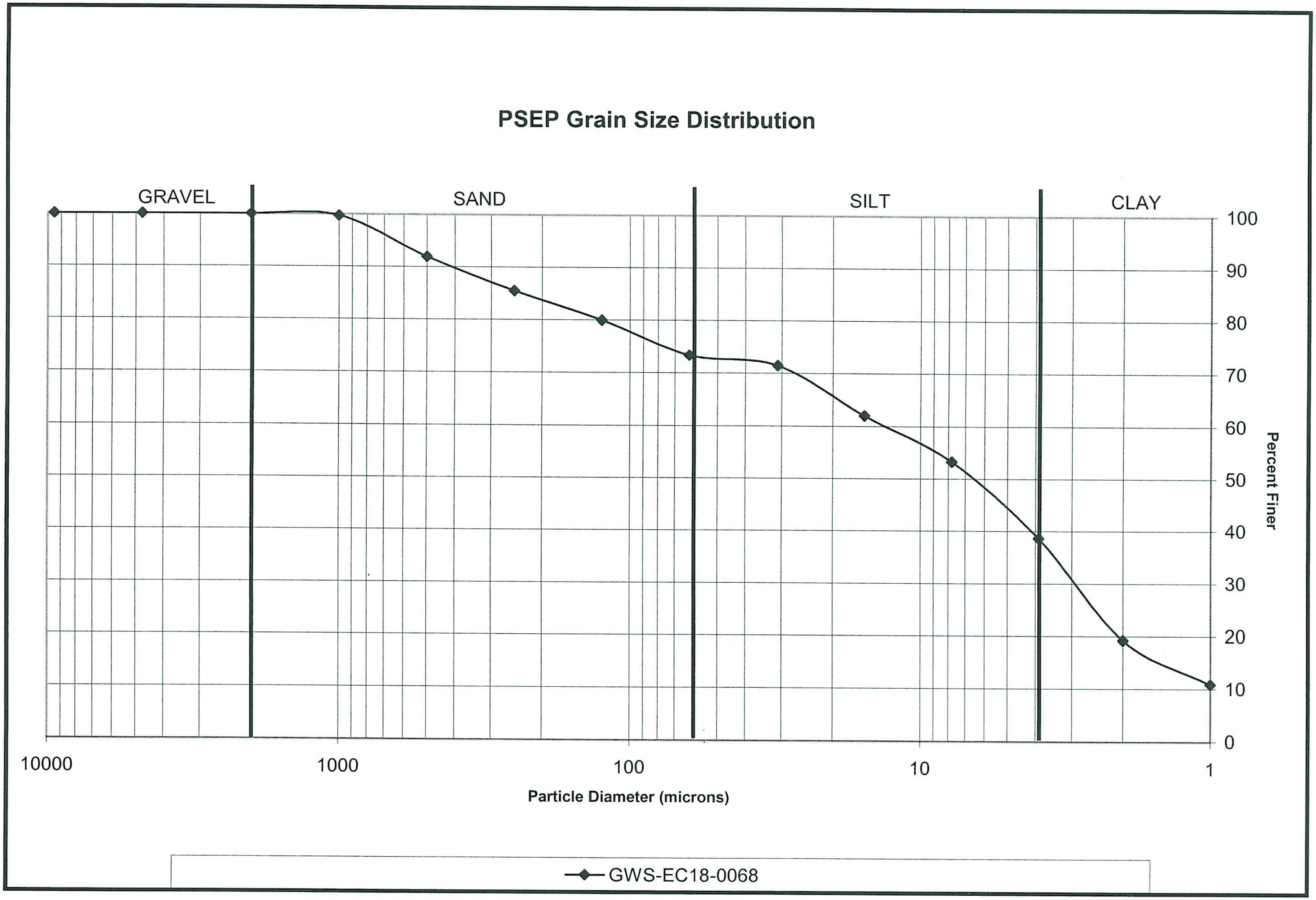


000392

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Finer Than Indicated Size

Sample No.	Gravel			Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt				Clay	
Phi Size	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Sieve Size (microns)	3/8"	#4	#10 (2000)	#18 (1000)	#35 (500)	#60 (250)	#120 (125)	#230 (62)	31.00	15.60	7.80	3.90	2.00	1.00
GWS-SG10	100.0	100.0	98.7	97.3	85.9	78.0	69.8	61.8	58.9	48.3	35.2	22.4	14.7	8.9
GWS-SG10	100.0	100.0	100.0	99.6	94.4	88.4	80.6	73.1	69.0	56.3	41.9	27.0	17.8	10.7
GWS-SG10	100.0	100.0	99.6	99.3	95.4	90.3	83.0	75.3	71.8	58.5	43.6	27.7	18.4	11.2
GWS-SG09	100.0	100.0	98.9	98.1	91.0	84.8	76.7	68.7	65.9	52.4	38.3	24.5	16.1	9.5
GWS-SG12	100.0	100.0	99.6	98.5	94.4	87.0	77.4	70.8	68.4	57.3	46.5	33.3	23.6	15.2
GWS-SG08	100.0	100.0	99.9	99.5	92.3	82.2	73.7	66.2	62.4	48.6	35.2	20.7	13.0	7.4
GWS-SG14	100.0	100.0	99.8	99.5	97.0	93.5	89.2	84.9	81.4	68.4	53.6	34.6	21.6	13.1
GWS-SG15	100.0	100.0	100.0	99.8	92.8	86.4	78.7	69.6	66.6	53.0	39.9	24.7	14.5	8.6
GWS-SG06	100.0	100.0	100.0	99.6	92.5	86.0	78.7	70.6	67.0	52.3	38.0	23.3	13.8	8.3
GWS-SG11	100.0	100.0	100.0	99.8	94.7	89.1	80.2	71.5	68.4	53.8	39.9	26.1	16.2	10.0
GWS-SG02	100.0	100.0	100.0	99.9	93.7	86.3	75.8	65.5	59.2	44.6	32.0	19.3	11.7	7.1
GWS-SG04	100.0	100.0	100.0	99.9	94.2	87.7	79.5	69.8	66.6	53.0	39.4	26.3	17.1	12.8
GWS-SG07	100.0	98.9	97.6	94.8	84.6	54.0	31.0	21.2	19.9	14.8	10.7	7.1	4.9	3.4
GWS-SG17	100.0	96.6	95.6	92.4	80.7	45.5	22.9	14.6	12.5	9.6	7.0	4.8	3.3	2.5
GWS-SG03	100.0	100.0	100.0	99.9	92.9	86.2	78.9	70.9	67.8	52.5	39.5	25.9	17.5	12.4
GWS-SG01	100.0	100.0	99.5	98.4	93.6	87.8	79.6	70.1	63.9	44.7	28.5	17.8	13.5	9.7
GWS-SG05	100.0	99.9	96.0	90.2	81.3	65.7	52.7	45.9	45.4	38.7	31.4	23.5	17.2	12.6
GWS-SG16	100.0	100.0	100.0	99.9	98.4	95.2	89.0	81.8	79.1	66.5	52.3	36.9	25.4	18.0
GWS-SG13	100.0	97.6	91.8	87.2	74.9	45.8	24.5	13.0	2.9	1.7	1.2	1.0	0.7	0.6

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

Apparent Grain Size Distribution Summary
Percent Retained in Each Size Fraction

Sample No.	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Coarse Silt	Medium Silt	Fine Silt	Very Fine Silt	Clay		
Phi Size	> -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	< 10
Sieve Size (microns)	> #10 (2000)	10 to 18 (2000-1000)	18-35 (1000-500)	35-60 (500-250)	60-120 (250-125)	120-230 (125-62)	62.5-31.0	31.0-15.6	15.6-7.8	7.8-3.9	3.9-2.0	2.0-1.0	<1.0
GWS-SG10	1.3	1.4	11.4	7.9	8.2	8.0	2.9	10.6	13.1	12.9	7.6	5.8	8.9
GWS-SG10	0.0	0.4	5.1	6.1	7.8	7.5	4.1	12.6	14.4	14.9	9.2	7.0	10.7
GWS-SG10	0.4	0.3	3.9	5.1	7.2	7.7	3.5	13.3	14.9	15.9	9.3	7.2	11.2
GWS-SG09	1.1	0.9	7.1	6.2	8.1	8.0	2.9	13.5	14.1	13.9	8.4	6.5	9.5
GWS-SG12	0.4	1.1	4.2	7.3	9.6	6.6	2.4	11.2	10.8	13.2	9.7	8.4	15.2
GWS-SG08	0.1	0.5	7.2	10.1	8.5	7.5	3.8	13.8	13.3	14.5	7.7	5.6	7.4
GWS-SG14	0.2	0.3	2.6	3.5	4.2	4.3	3.5	13.0	14.8	19.0	13.0	8.5	13.1
GWS-SG15	0.0	0.2	7.0	6.4	7.8	9.0	3.1	13.6	13.1	15.2	10.1	5.9	8.6
GWS-SG06	0.0	0.4	7.1	6.4	7.3	8.2	3.6	14.6	14.3	14.7	9.5	5.5	8.3
GWS-SG11	0.0	0.2	5.1	5.6	8.9	8.7	3.1	14.6	13.9	13.9	9.9	6.1	10.0
GWS-SG02	0.0	0.1	6.2	7.3	10.5	10.4	6.3	14.7	12.5	12.7	7.7	4.6	7.1
GWS-SG04	0.0	0.1	5.7	6.5	8.1	9.7	3.2	13.6	13.7	13.1	9.1	4.3	12.8
GWS-SG07	2.4	2.8	10.2	30.6	23.0	9.9	1.2	5.2	4.0	3.6	2.2	1.5	3.4
GWS-SG17	4.4	3.2	11.7	35.2	22.6	8.3	2.2	2.9	2.6	2.3	1.4	0.9	2.5
GWS-SG03	0.0	0.1	7.0	6.7	7.3	8.1	3.1	15.2	13.0	13.6	8.4	5.1	12.4
GWS-SG01	0.5	1.1	4.8	5.8	8.2	9.5	6.2	19.3	16.1	10.7	4.3	3.8	9.7
GWS-SG05	4.0	5.8	8.9	15.5	13.0	6.8	0.5	6.7	7.3	7.9	6.3	4.5	12.6
GWS-SG16	0.0	0.1	1.5	3.1	6.2	7.2	2.8	12.6	14.2	15.4	11.6	7.4	18.0
GWS-SG13	8.2	4.6	12.3	29.1	21.3	11.5	10.1	1.2	0.5	0.3	0.3	0.1	0.6

Notes to the Testing:

1. Organic matter was not removed prior to testing, thus the reported values are the "apparent" grain size distribution. See narrative for discussion of the testing.

IC14

ANALYTICAL RESOURCES INCORPORATED

Floyd, Snider
340542.002

PSEP Total Solids Analysis
Percent of Wet Weight

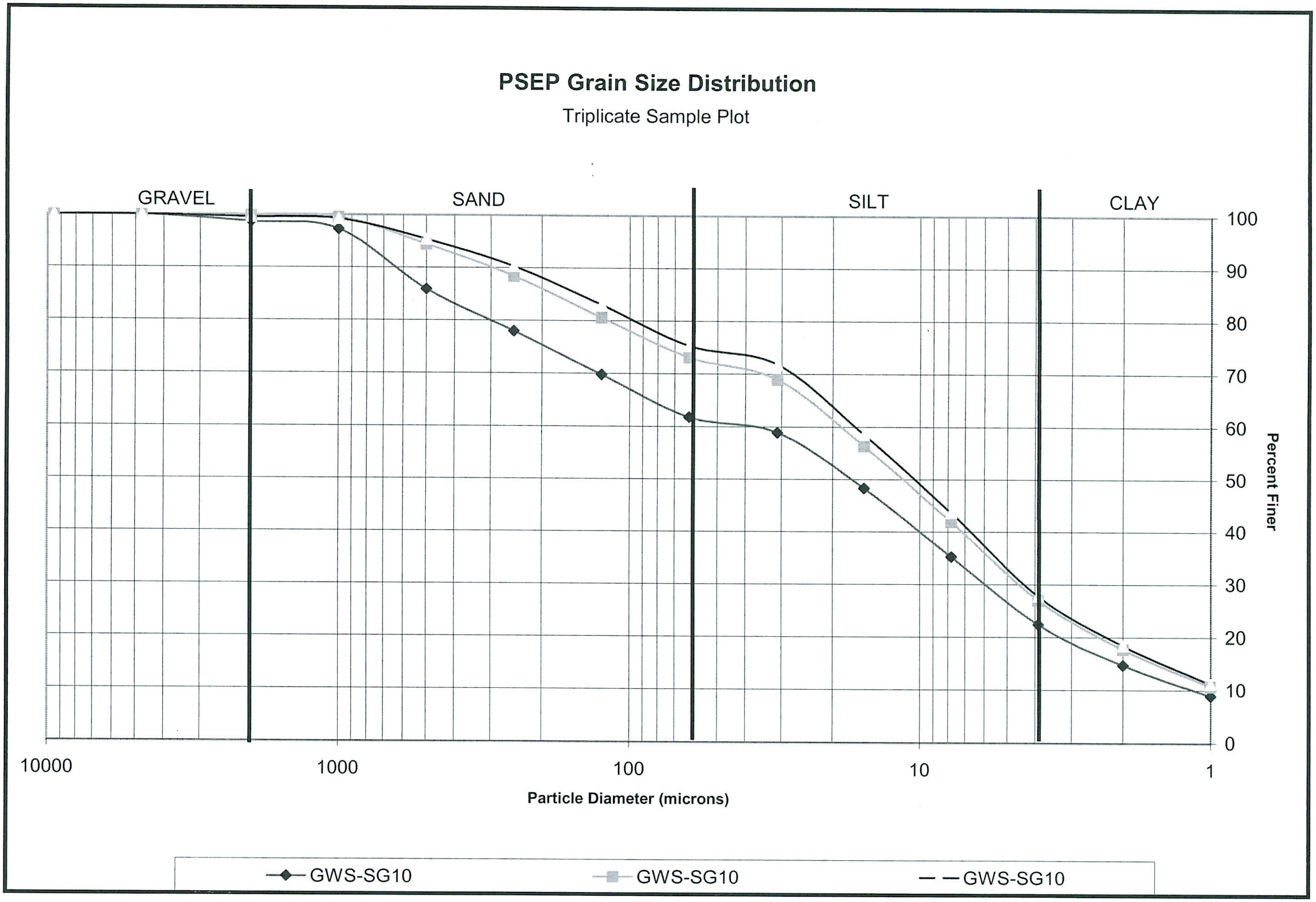
Sample No.	Total Solids (%)
GWS-SG10	14.9
GWS-SG10	14.6
GWS-SG10	14.4
GWS-SG09	14.4
GWS-SG12	18.9
GWS-SG08	12.7
GWS-SG14	19.2
GWS-SG15	11.8
GWS-SG06	11.9
GWS-SG11	13.4
GWS-SG02	13.1
GWS-SG04	10.9
GWS-SG07	34.6
GWS-SG17	43.3
GWS-SG03	10.9
GWS-SG01	13.2
GWS-SG05	29.2
GWS-SG16	16.3
GWS-SG13	75.6

Triplicate Average	14.6
Standard Deviation	0.27
%RSD	1.83

(Total Solids at 90 C)

IC14

ANALYTICAL RESOURCES INCORPORATED



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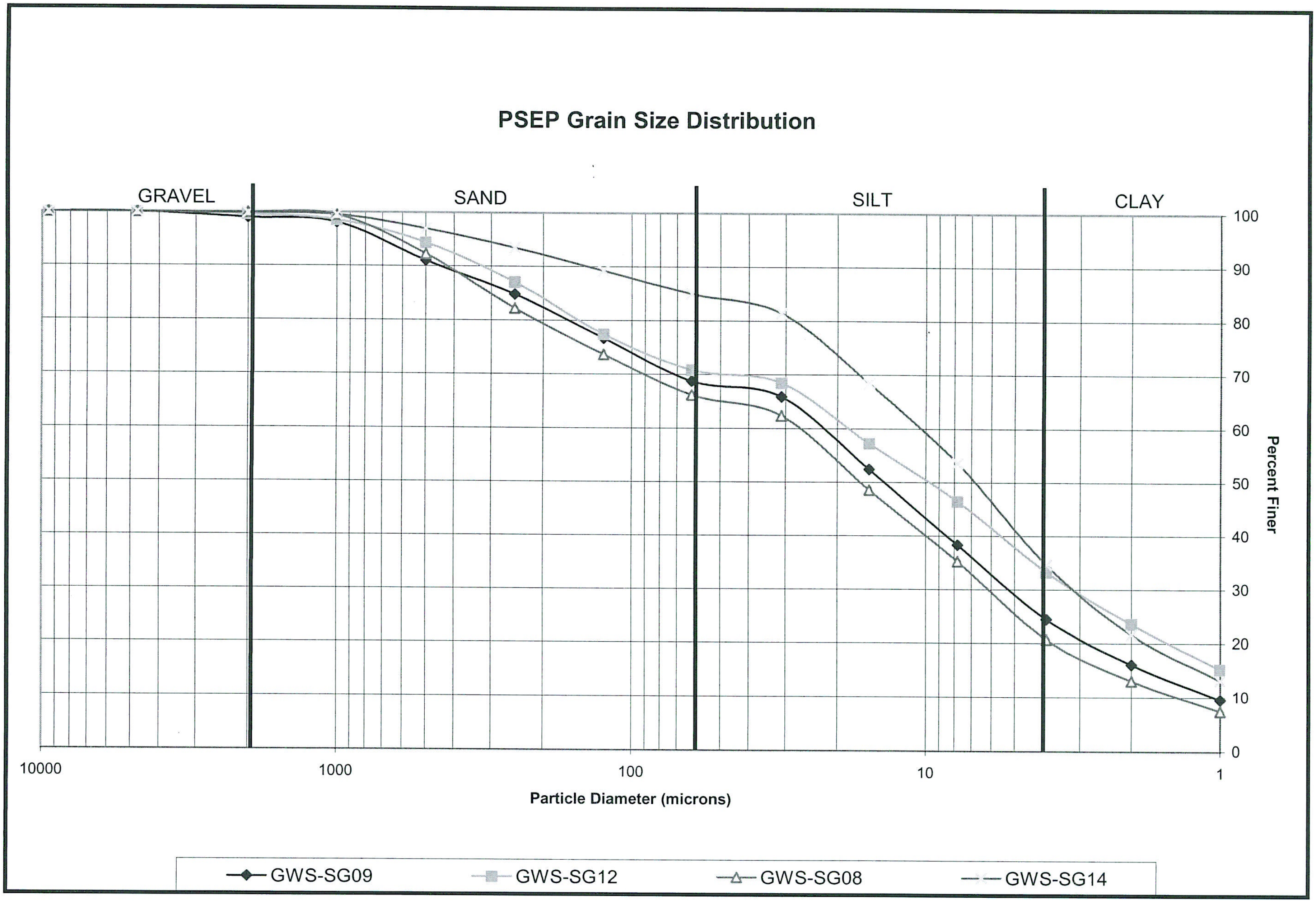
ANALYTICAL RESOURCES INCORPORATED



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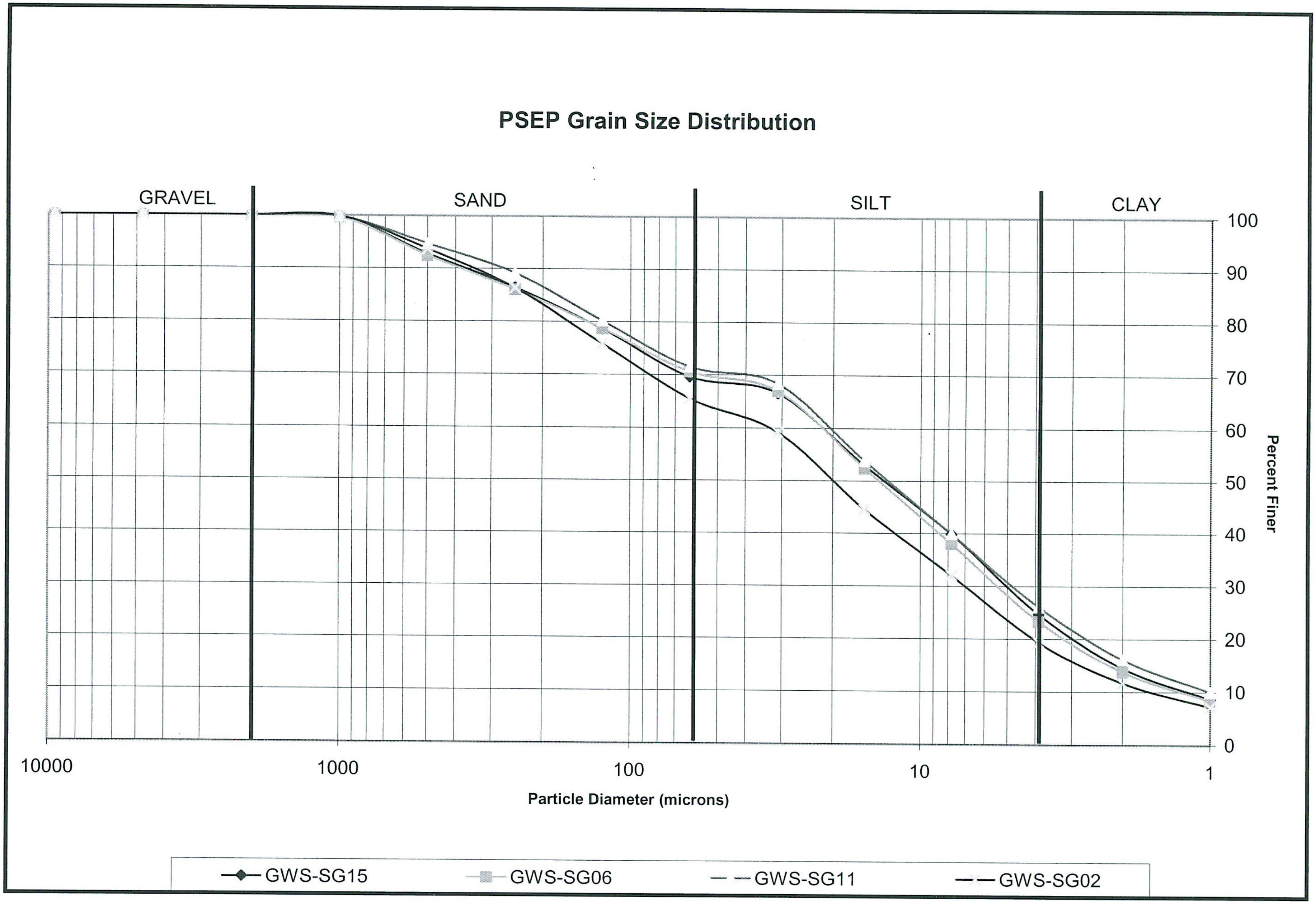

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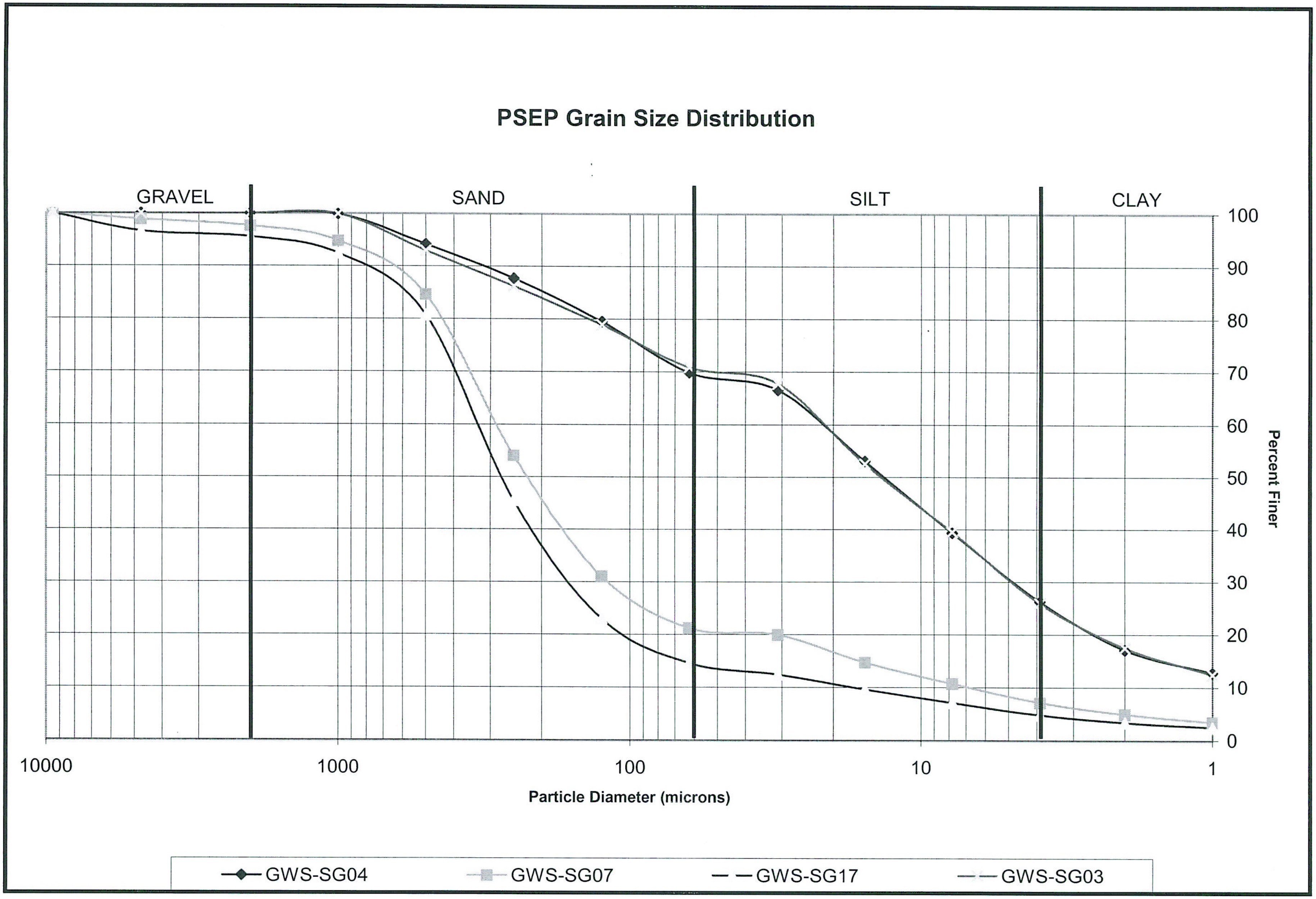

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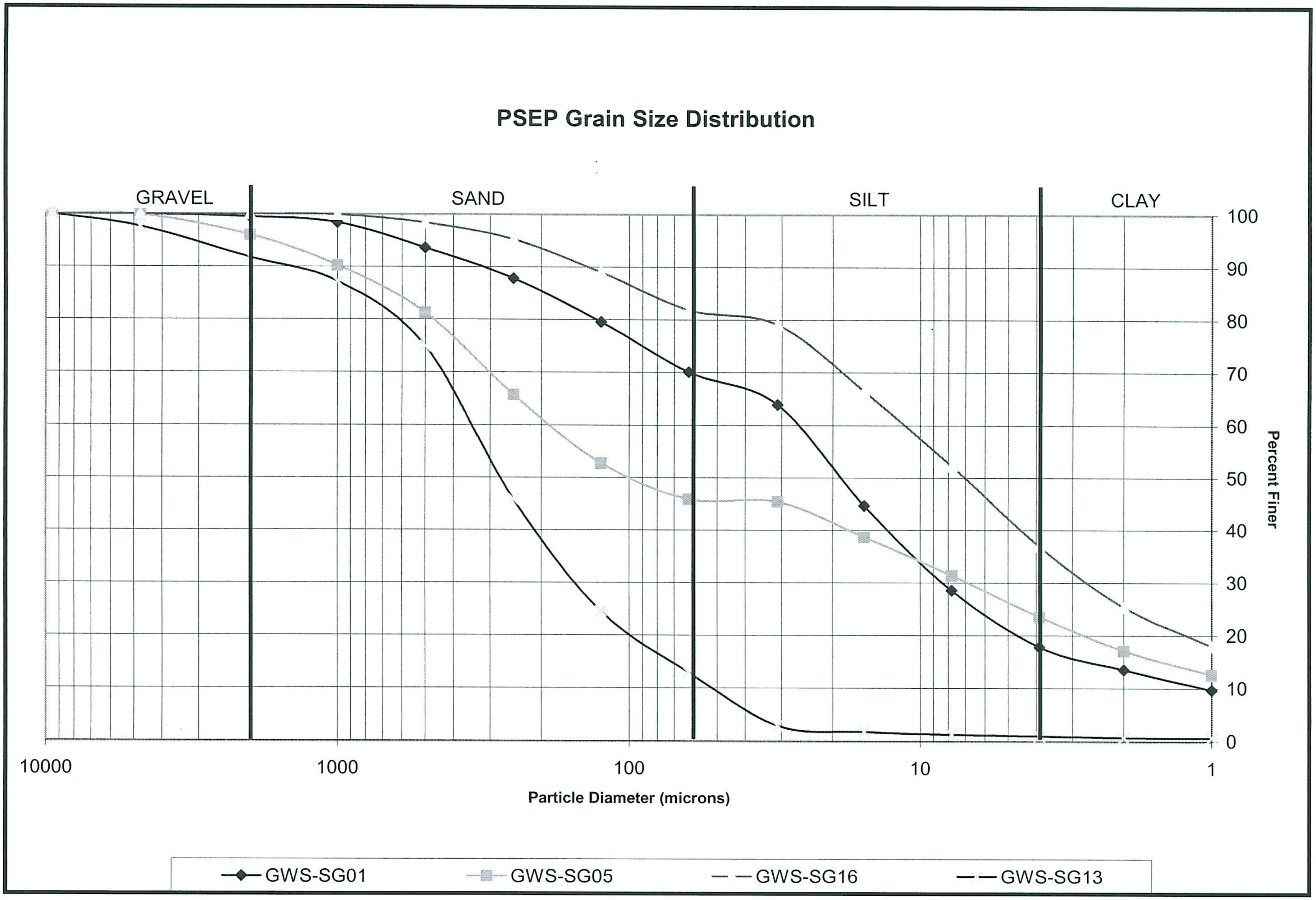
ANALYTICAL RESOURCES INCORPORATED



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SUB-ATTACHMENT 3D-2.6.3
Floyd|Snider 2005 Geotechnical Field Sampling Methods and Laboratory Testing Program

Gas Works Sediment
Western Study Area

Data Report

Appendix C
Geotechnical Field Sampling Methods

December 7, 2005

List of Tables

List of Figures

List of Attachments

Geotechnical Field Sampling Methods

This appendix documents the processes used in determining the nature and classification of sediments in the GWS-WSA. This appendix includes information on the following subjects:

- Explorations and their locations
- The use of auger borings
- Standard Penetration Test (SPT) procedures
- The use of Shelby Tubes
- The use of Cone Penetrometer Probes
- The use of Vane Shear (VS) Probes

EXPLORATIONS AND THEIR LOCATIONS

Subsurface explorations for this program consisted of 6 sediment borings, 5 VS tests, and 5 Cone penetrometer tests (CPTs). In the field, samples were classified according to the methods presented on Figure C.1. Boring logs (Figures C.2 through C.7) show the interpretation of the drilling, sampling, and testing data. They indicate the depths where soil conditions changed. Figure C.1 provides a legend explaining the symbols and abbreviations used in the boring logs.

Discussions of the VS and CPTs are presented below.

Figure 2.1 in the Data Report shows the location of explorations, located using a Global positioning system (GPS) receiver in the field. Mudline elevations at these locations were established using a weighted tape measure to determine the depth of the water column at each exploration location.

THE USE OF AUGER BORINGS

Six hollow stem auger borings, designated GWS-GC01 through GWS-GC06, were drilled to depths ranging from 14 to 76 feet below the existing mudline surface, in the period between April 25 and 28, 2005. The borings use a 3-3/8-inch inside diameter hollow stem auger and were advanced with a truck-mounted drill rig. A Washington State licensed geologist continuously observed the drilling. Detailed field logs were prepared for each boring. The SPT was used to generally obtain sediment samples at 2.5 to 5-foot depth intervals.

The boring logs are presented on Figures C.2 through C.7.

STANDARD PENETRATION TEST PROCEDURES

This test is an approximate measure of soil density and consistency. To be useful, results must be used with engineering judgment in conjunction with other tests. The SPT, as described in ASTM D1587, was used to obtain disturbed samples. The test employs a standard 2-inch outside diameter split-spoon sampler. Using a 140-pound hammer free-falling 30 inches, the sampler is driven into the soil for 18 inches. The number of blows required to drive the sampler the last 12 inches is the Standard Penetration Resistance. This resistance (or blow count) measures the relative density of granular soils and the consistency of cohesive soils. The blow counts are plotted on the boring logs at their respective sample depths.

Soil samples were recovered from the split-spoon sampler, and were field classified and placed into watertight jars. Select samples were sent to ARI for further testing.

Occasionally, very dense or hard materials preclude driving the total 18-inch sample. When this happens, the penetration resistance is entered on the logs as follows:

> **Penetration Less Than Six Inches.** The log indicates the total number of blows over the number of inches of penetration.
>
> **Penetration Greater Than Six Inches.** The blow count noted on the log is the sum of the total number of blows completed after the first 6 inches of penetration. The sum is expressed over the number of inches driven that exceed the first 6 inches. The number of blows needed to drive the first 6 inches are not reported. For example, a blow count series of 12 blows for 6 inches, 30 blows for 6 inches, and 50 (the maximum number of blows counted within a 6-inch increment for SPT) for 3 inches would be recorded as 80/9.

THE USE OF SHELBY TUBES

To obtain a relatively undisturbed sample for classification and testing in fine-grained sediments, a 3-inch diameter thin-walled steel Shelby tube sampler was pushed hydraulically below the auger in accordance with ASTM D1587. The tubes were sealed in the field and taken to the laboratory for extrusion and classification.

THE USE OF CONE PENETROMETER PROBES

A cone penetrometer was used to probe the subgrade sediments at five locations in the GWS-WSA. The probes, designated GWS-CPT01 through GWS-CPT05, were advanced to depths ranging from 6 to 47 feet below the mudline surface. The probes were advanced from an anchored barge through stiffness casing fixed to a splayed footing at the mudline. The stiffness casing and splayed anchor footing provide reaction to advance the probes while allowing vertical barge movement, resulting from wave and tidal action, without affecting the probe advance rate. A hydraulic ram is fixed to the top of the stiffness casing.

The cone and its sleeve provide information regarding the density and consistency of the sediment. A direct correlation exists between the point resistance of the cone and the bearing capacity of the sediment. Another direct correlation exists between the friction registered on the sleeve and the friction characteristics of the sediment.

Generally, a friction ratio (e.g., point resistance to sleeve resistance) less than 2 indicates sand; a friction ratio between 2 and 4 indicates silt-sand mixture, clayey sand, or silt; and ratios greater than 4 indicate a clayey silt or clay.

Logs of cone penetrometer probes are presented in Attachment C.1.

THE USE OF VANE SHEAR PROBES

VS probes are used to determine the *in-situ* shear strength of a low strength, homogeneous cohesive sediment. VS probes consist of a four-bladed vane mounted on a vertical shaft. The blades are pushed into the sediment and a torque is applied to the shaft until the apparatus rotates. When the sediment is stressed to its shear strength, the vanes will rotate in the sediment. Because the soil fails along the cylindrical surface of the vanes, the shearing resistance can be calculated from the vane dimensions and the applied torque.

VS tests were performed at five locations in the GWS-WSA. The probes, designated GWS-VS01 through GWS-VS05, were advanced to depths ranging from 1 to 13 feet below the mudline surface.

Results of the VS tests are presented in Table C.1 and the peak shear strength plot is shown in Figure C.8.

Gas Works Sediment
Western Study Area

Data Report

Appendix C
Geotechnical Field Sampling Methods

Tables

December 7, 2005

Table C.1
Vane Shear Test Results[1]

	Test Location[2]							
Vane Shear Test Designation	**Northing**	**Easting**	**Test Date**	**Depth (feet)[3]**	**Peak Shear Strength (psf)**	**Residual Shear Strength (psf)**	**Sensitivity Ratio[4]**	**Comments**
CPT-01	239179	1269480	5/4/2005	3	47	0	-	Potential stick or rock obstructions.
CPT-02	239046	1269571	5/4/2005	2	259	29	8.9	Potential sand lense or stick.
CPT-02	239046	1269571	5/4/2005	4	37	9	4.1	
CPT-03	238764	1269717	5/3/2005	1.5	37	9	4.1	
CPT-03	238764	1269717	5/3/2005	3.5	75	22	3.4	
CPT-03	238764	1269717	5/3/2005	5.5	47	18	2.6	
CPT-04	238600	1269632	5/5/2005	1	62	26	2.4	Erratic results.
CPT-04	238600	1269632	5/5/2005	3	50	21	2.4	
CPT-04	238600	1269632	5/5/2005	5	74	21	3.5	
CPT-04	238600	1269632	5/5/2005	7	101	38	2.7	
CPT-04	238600	1269632	5/5/2005	9	108	37	2.9	
CPT-04	238600	1269632	5/5/2005	11	142	19	7.5	
CPT-04	238600	1269632	5/5/2005	13	178	36	4.9	
CPT-05	238655	1269207	5/5/2005	1	14	3	4.7	

	Test Location[2]							
Vane Shear Test Designation	**Northing**	**Easting**	**Test Date**	**Depth (feet)[3]**	**Peak Shear Strength (psf)**	**Residual Shear Strength (psf)**	**Sensitivity Ratio[4]**	**Comments**
CPT-05	238655	1269207	5/5/2005	3	30	18	1.7	
CPT-05	238655	1269207	5/5/2005	5	62	11	5.6	
CPT-05	238655	1269207	5/5/2005	7	74	20	3.7	
CPT-05	238655	1269207	5/5/2005	9	104	26	4.0	
CPT-05	238655	1269207	5/5/2005	11	129	37	3.5	
CPT-05	238655	1269207	5/5/2005	13	142	31	4.6	

Notes:

1 All data results from Northwest Cone Exploration, Inc.
2 Location coordinates are given in Washington State Plane (North). Sample locations are also shown on Figure 2.1.
3 Depths are provided as depth below mudline.
4 Sensitivity Ratio is defined as the ratio of the peak shear strength to the residual shear strength.

Gas Works Sediment
Western Study Area

Data Report

Appendix C
Geotechnical Field Sampling Methods

Figures

December 7, 2005

SAMPLE DESCRIPTION

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

DENSITY/CONSISTENCY

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance(N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

MOISTURE

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

MINOR CONSTITUENTS

MINOR CONSTITUENTS	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

LEGENDS

SAMPLING TEST SYMBOLS

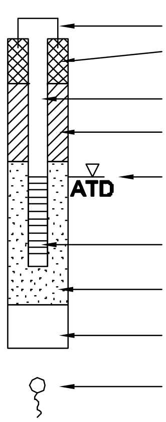
Boring Samples

- Split Spoon
- Shelby Tube
- Cuttings
- Core Run
- * No Sample Recovery
- P Tube Pushed, Not Driven

Test Pit Samples

- Grab (Jar)
- Bag
- Shelby Tube

GROUNDWATER OBSERVATION WELLS



Groundwater Seepage (Test Pits)

TEST SYMBOLS

GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits
	Water Content in Percent; Liquid Limit; Natural; Plastic Limit
PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	*In Situ* Density Test

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Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.1
Key to
Exploration Logs

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-DataReport\Data Report-Internal Draft\Figures\Figure C.1.dwg

Soil Descriptions

Approximate Mudline Elevation = -8.2 Feet (USACE)

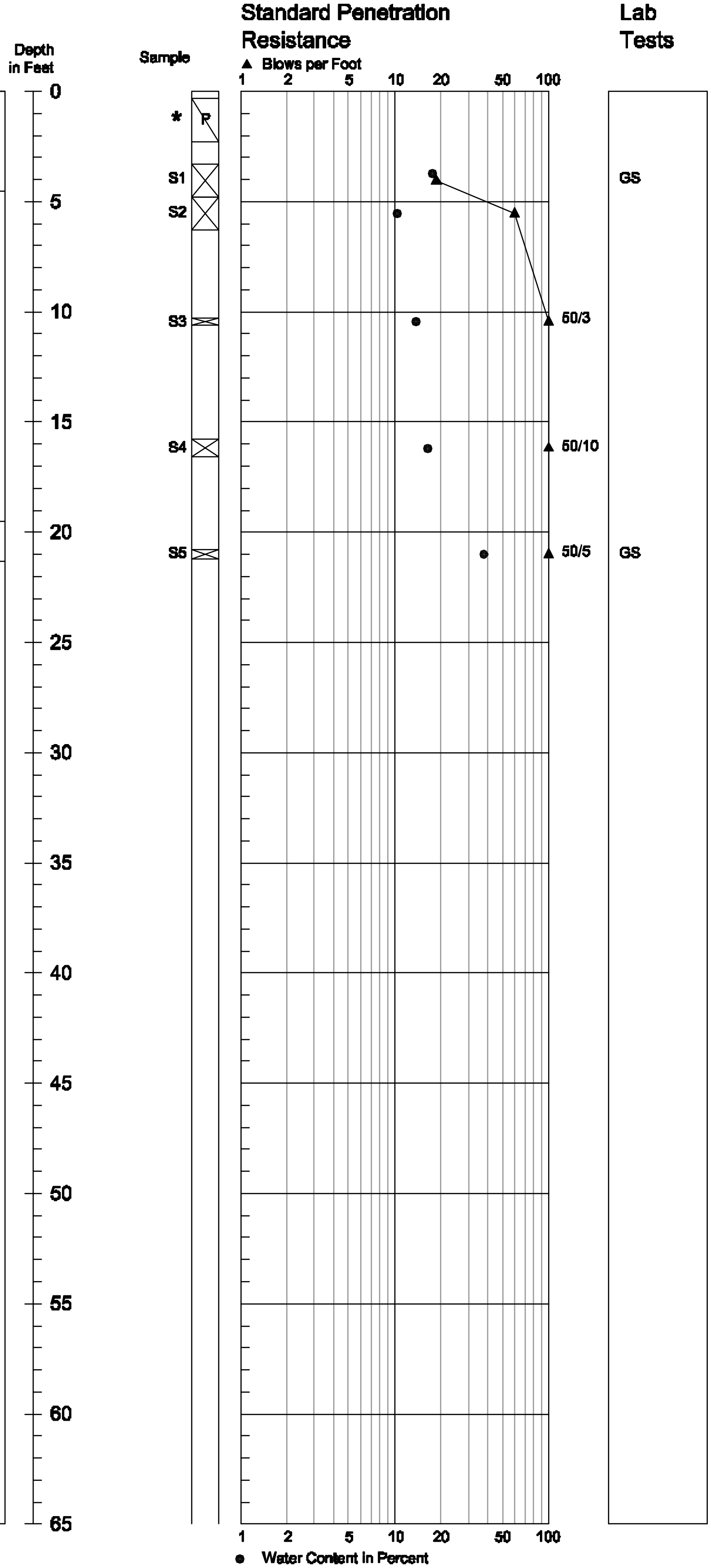
Depth in Feet

(Very soft), wet, black, slightly silty, gravelly SAND with organic material (FILL)

Very dense, wet, dark gray, slightly silty, gravelly SAND with asphalt odor

Very dense, wet, dark gray, slightly silty, SAND.

Bottom of Boring at Depth 21.3 feet.
Completed 4/27/2005.



Boring Location — N 239,185 ft
Washington State Plane (North) — E 1,269,476 ft

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.2.dwg

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Data Report
Gas Works Sediment Western Study Area
City of Seattle

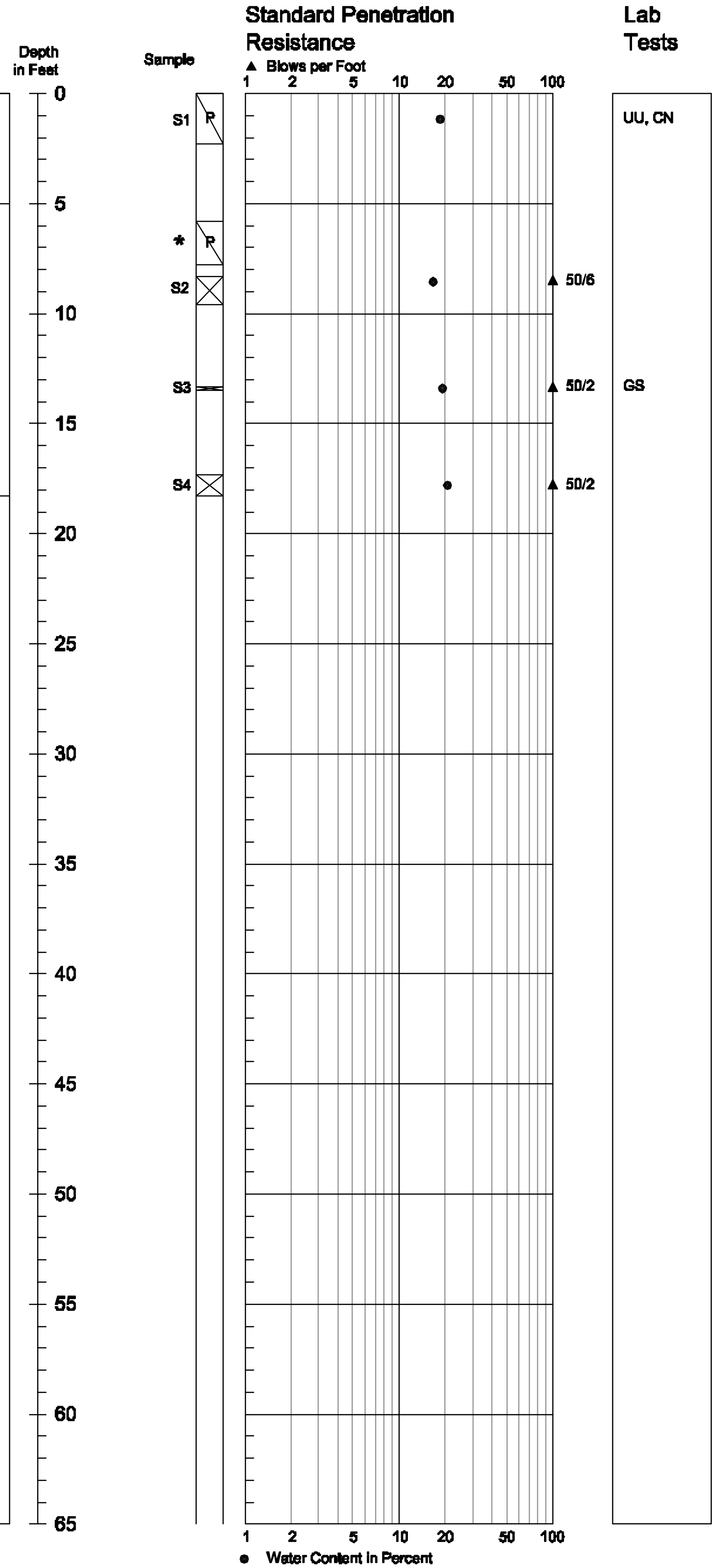
Figure C.2
Boring Log
GWS-GC01

December 7, 2005

Soil Descriptions

Approximate Mudline Elevation = -3.8 Feet (USACE)

Depth in Feet	Soil Descriptions
0–5	(Very loose), wet, gray, slightly silty, gravelly SAND with organic material and oily odor (FILL)
5–18.3	Very dense, wet, dark gray, slightly gravelly, slightly silty SAND with slight asphalt odor
18.3	Bottom of Boring at Depth 18.3 feet. Completed 4/27/2005.



Boring Location N 239,075 ft
Washington State Plane (North) E 1,269,612 ft

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.3.dwg

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Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.3
Boring Log
GWS-GC02

Soil Descriptions

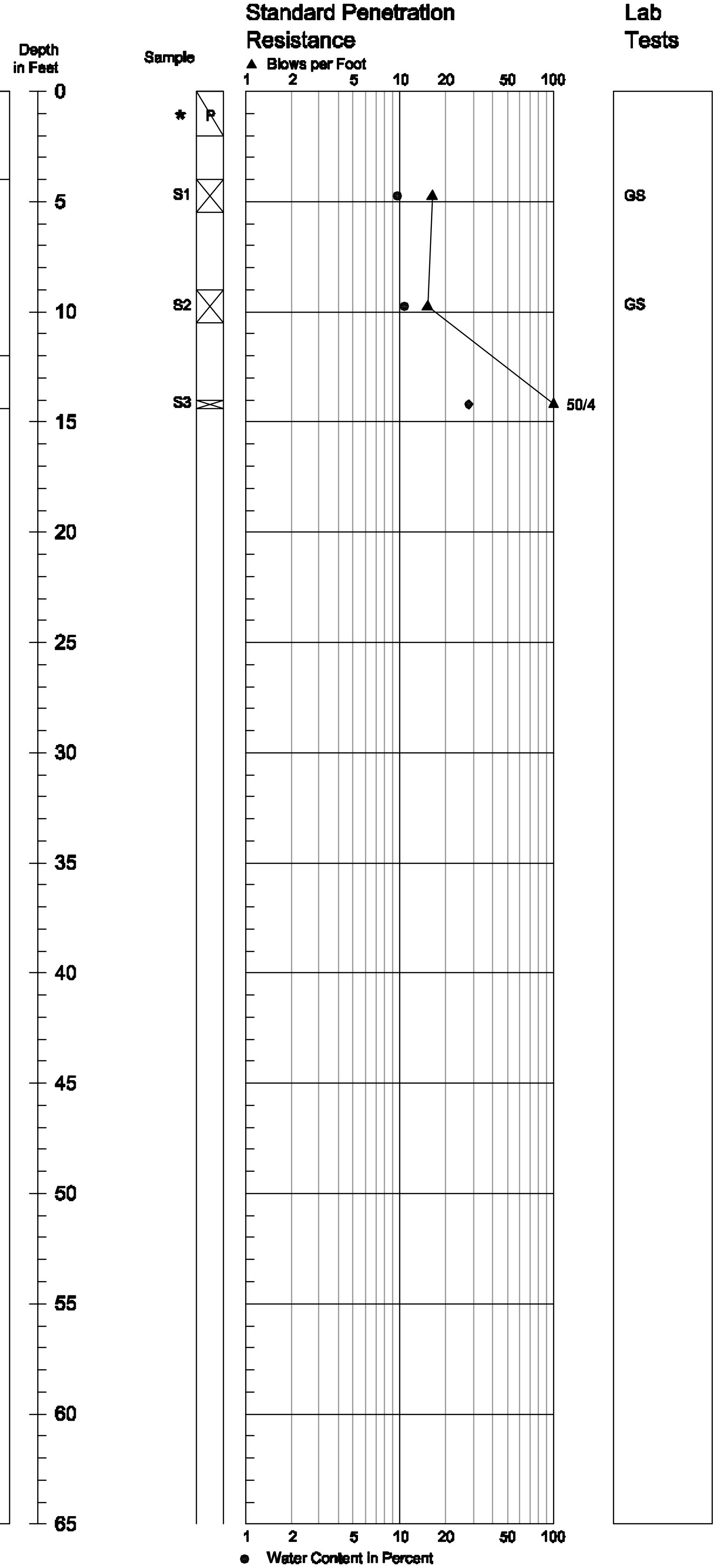
Approximate Mudline Elevation = -10.5 Feet (USACE)

(Very soft), wet, black, silty CLAY with mixture of sand and organic material (oil observed in sample).

Medium dense, wet, gray, sandy GRAVEL and gravelly SAND

Very dense, wet, gray, very gravelly SAND.

Bottom of Boring at Depth 14.4 feet.
Completed 4/26/2005.



Boring Location Washington State Plane (North) N 238,814 ft E 1,269,771 ft

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.4.dwg

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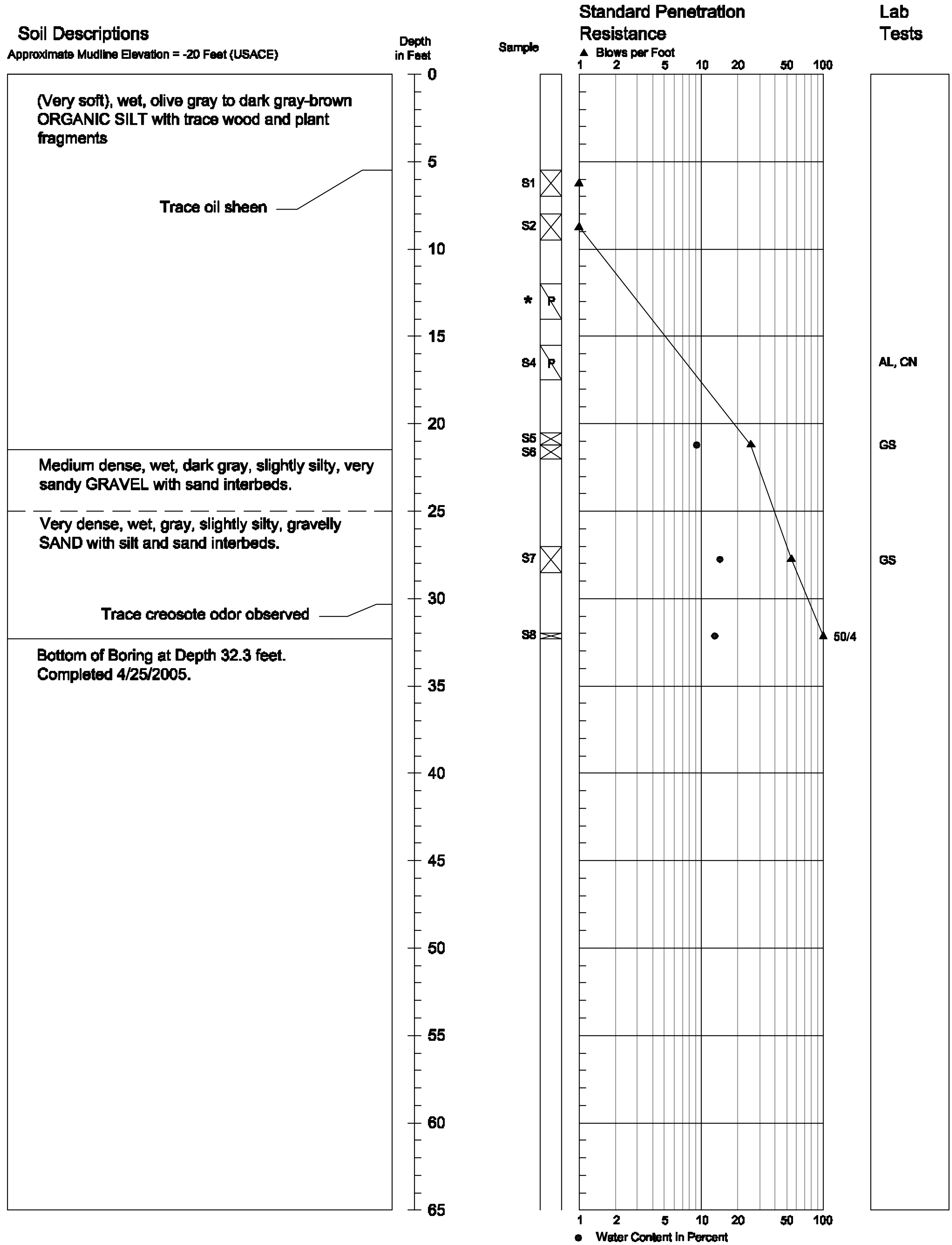
Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.4
Boring Log
GWS-GC03



Boring Location N 238,611 ft
Washington State Plane (North) E 1,269,635 ft

DATE: 10/15/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.5.dwg

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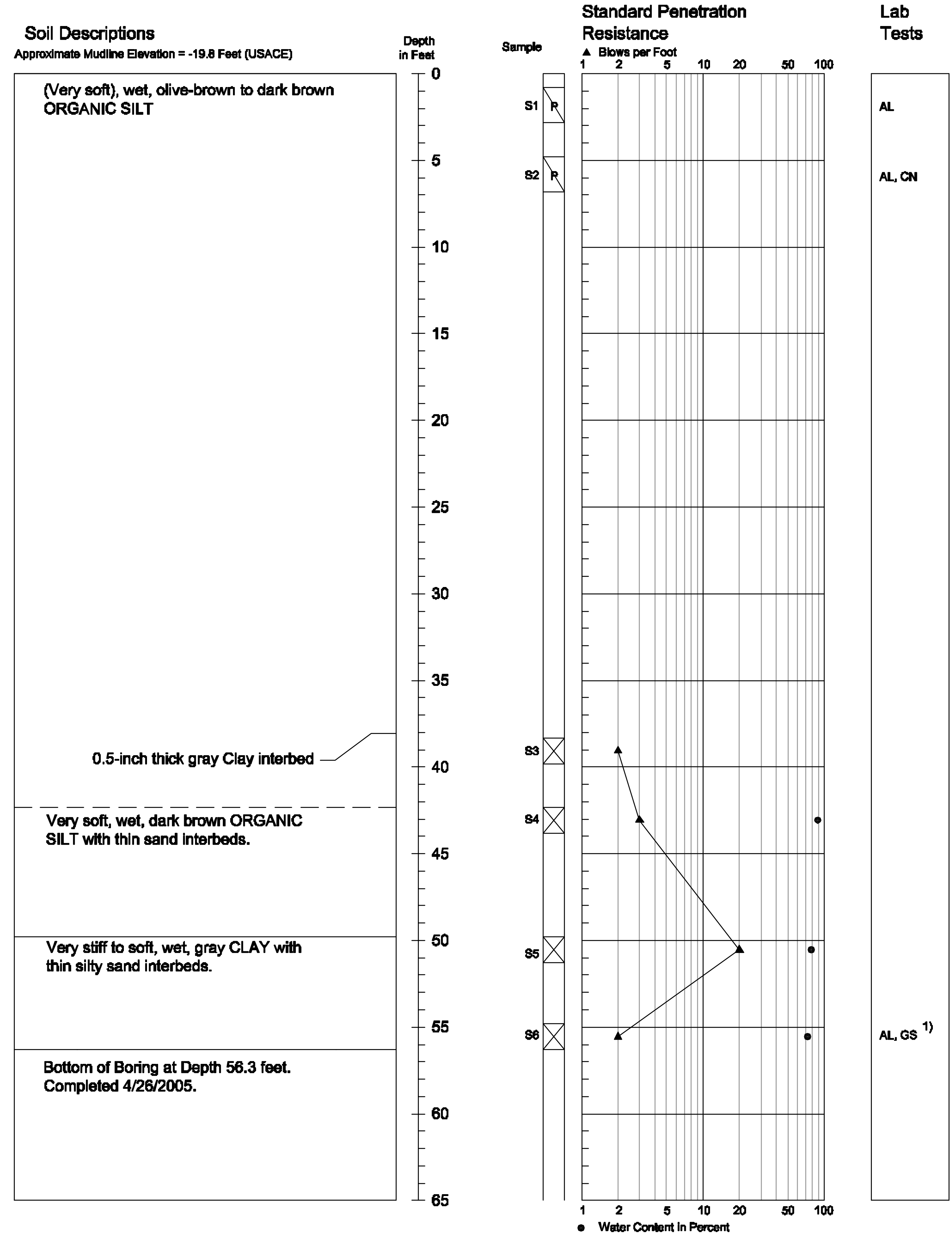
Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.5
Boring Log
GWS-GC04



Boring Location N 238,654 ft
Washington State Plane (North) E 1,269,201 ft

Note: 1) Grain size analysis performed on silty sand portion of recovered sample.

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.6.dwg

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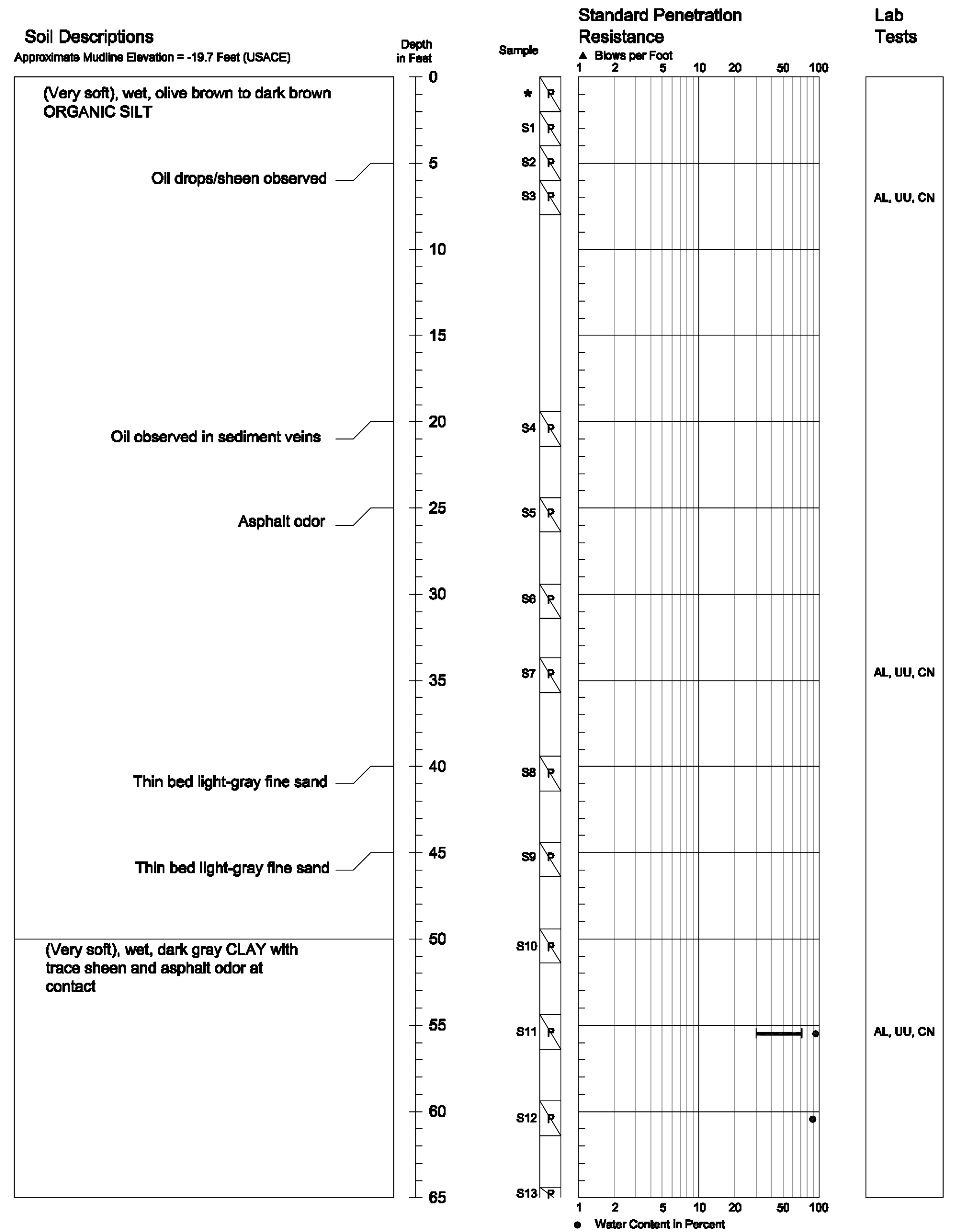
Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.6
Boring Log
GWS-GC05



Boring Location N 238,907 ft
Washington State Plane (North) E 1,269,190 ft

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.7.dwg

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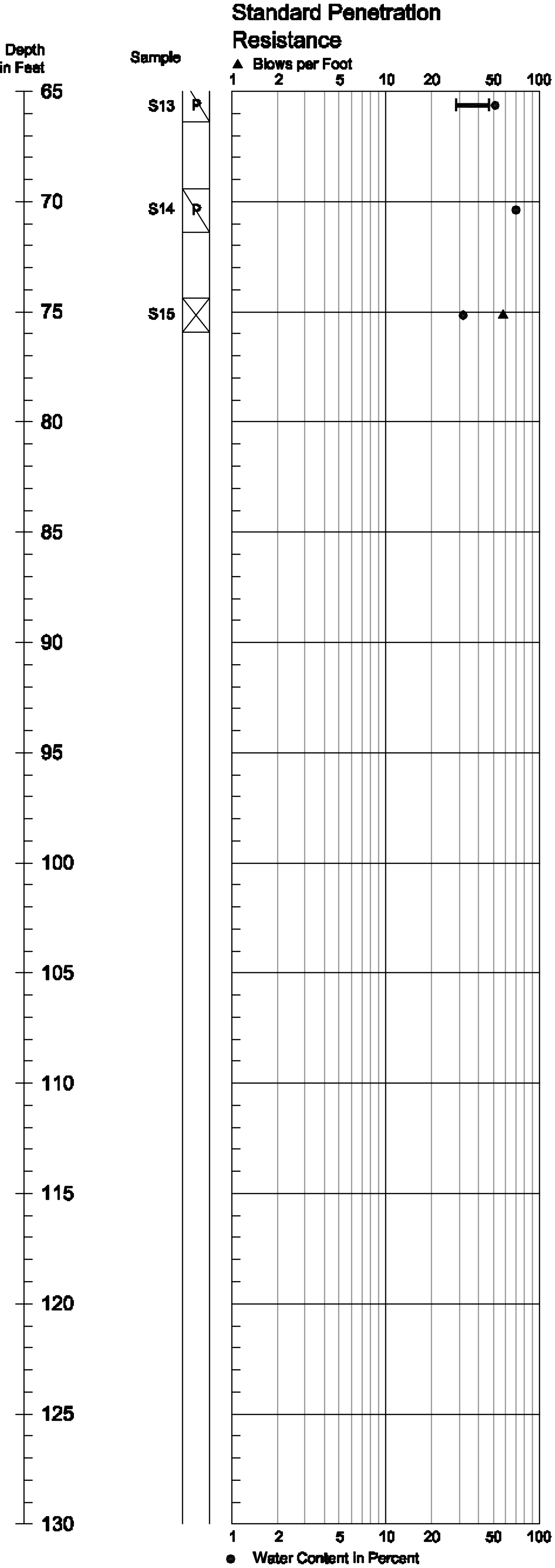
Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.7 (1 of 2)
Boring Log
GWS-GC06

Soil Descriptions

Approximate Mudline Elevation = -19.7 Feet (USACE)

Soil Descriptions	Depth in Feet	Sample	Lab Tests
(Very Soft), wet, dark gray, CLAY	65	S13 (P)	AL, UU, CN
(Loose), wet, dark gray, silty SAND.	70	S14 (P)	
Very stiff, wet, dark gray, slightly sandy, clayey SILT.	75	S15	GS
Bottom of Boring at Depth 76 feet. Completed 4/28/2005.			



Boring Location N 238,907 ft
Washington State Plane (North) E 1,269,190 ft

DATE: 10/14/2005
DWG NAME: F:\Projects\COS-SPUDR\Task5 Data Analysis-Data Report\Data Report-Internal Draft\Figures\FigureC.7.dwg

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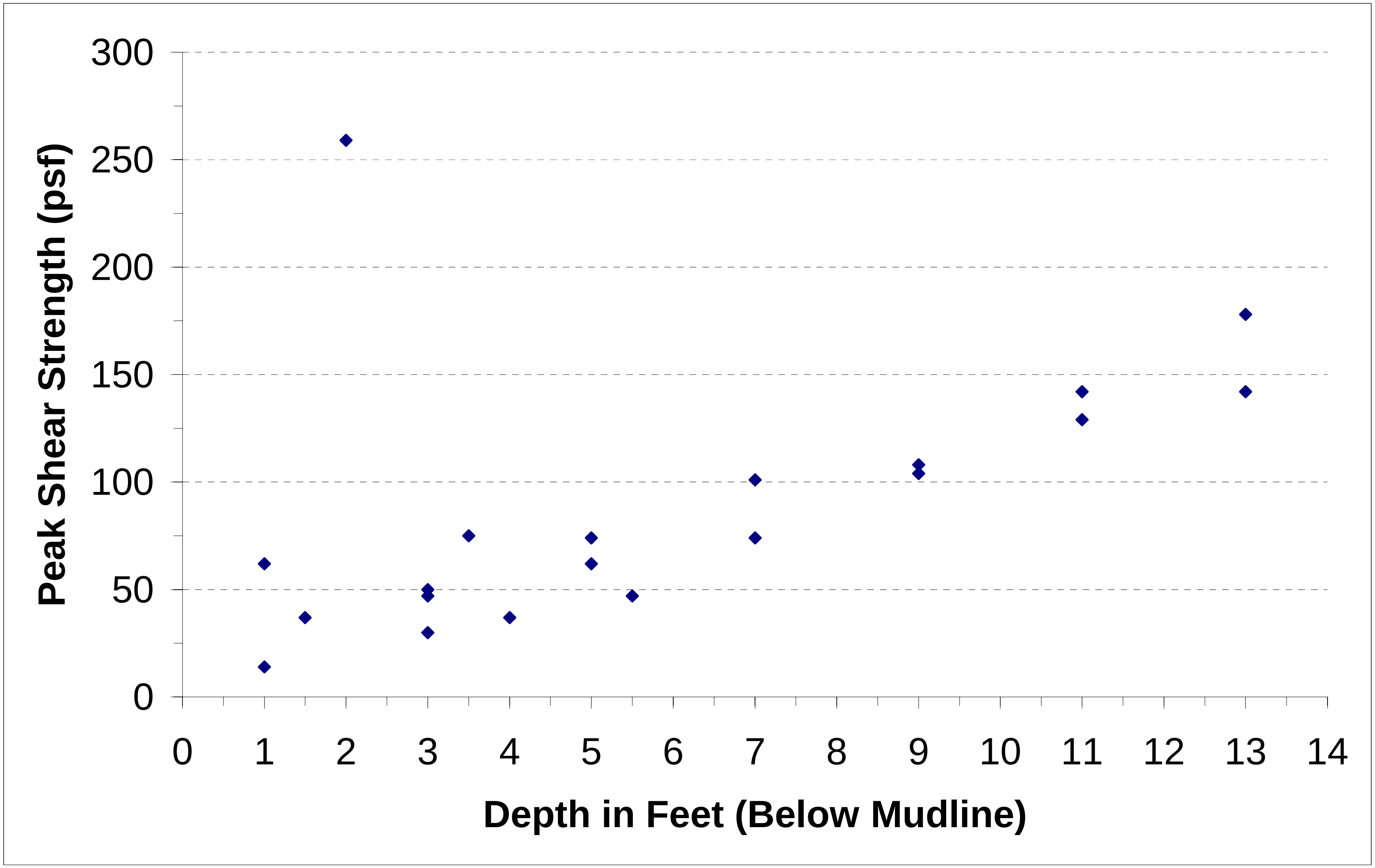
Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure C.7 (2 of 2)
Boring Log
GWS-GC06



Note: All data from Northwest Cone Exploration, Inc.

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Gas Works Sediment
Western Study Area

Data Report

Appendix C
Geotechnical Field Sampling Methods

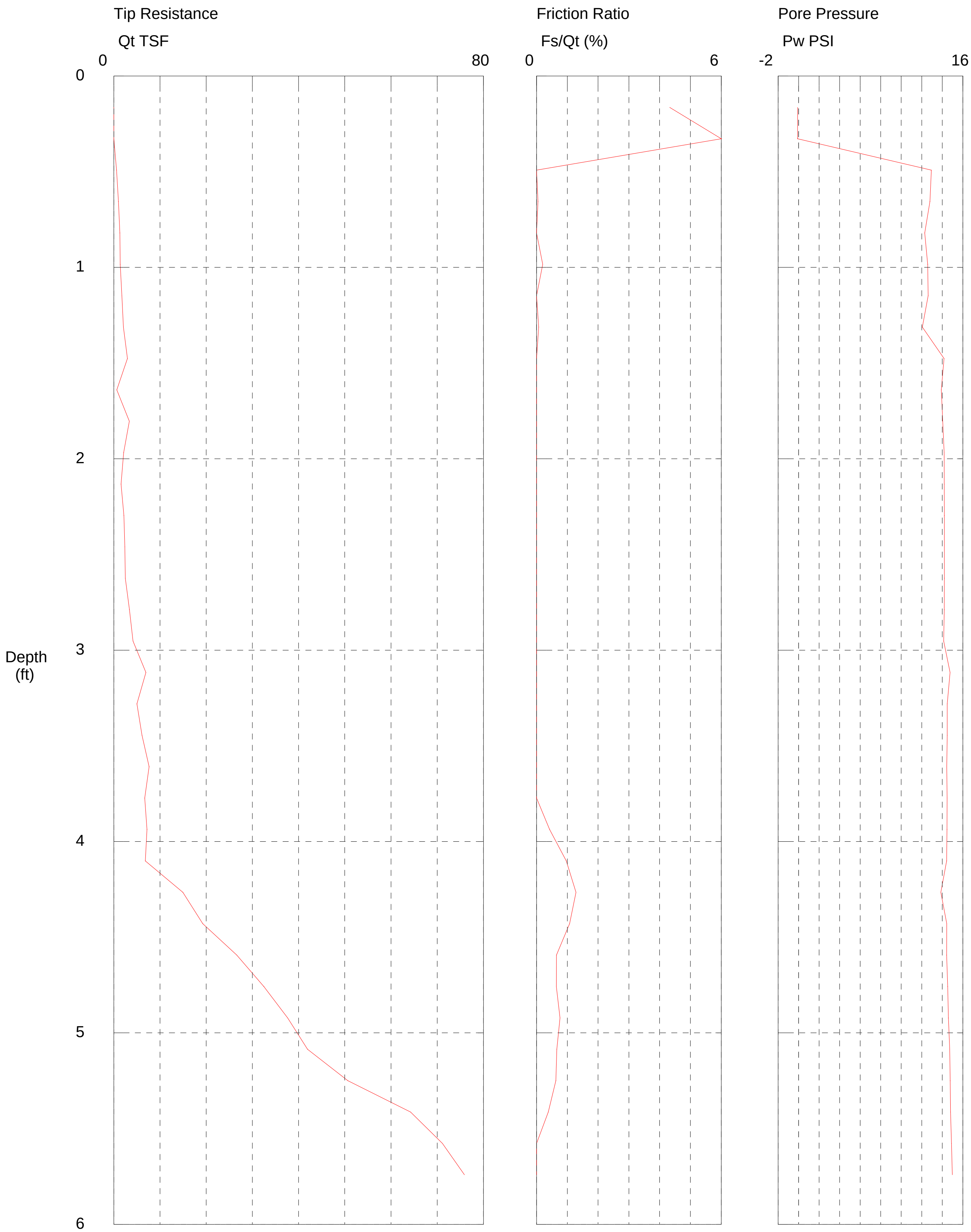
Attachments

December 7, 2005

Floyd Snider

Operator: Brown
Sounding: GWS-CPT-01
Cone Used: DSG0708

CPT Date/Time: 5/4/2005 11:14:30 AM
Location: Lake Union - Gas Works Park
Job Number: GWS-GSA



Maximum Depth = 5.74 feet

Depth Increment = 0.164 feet

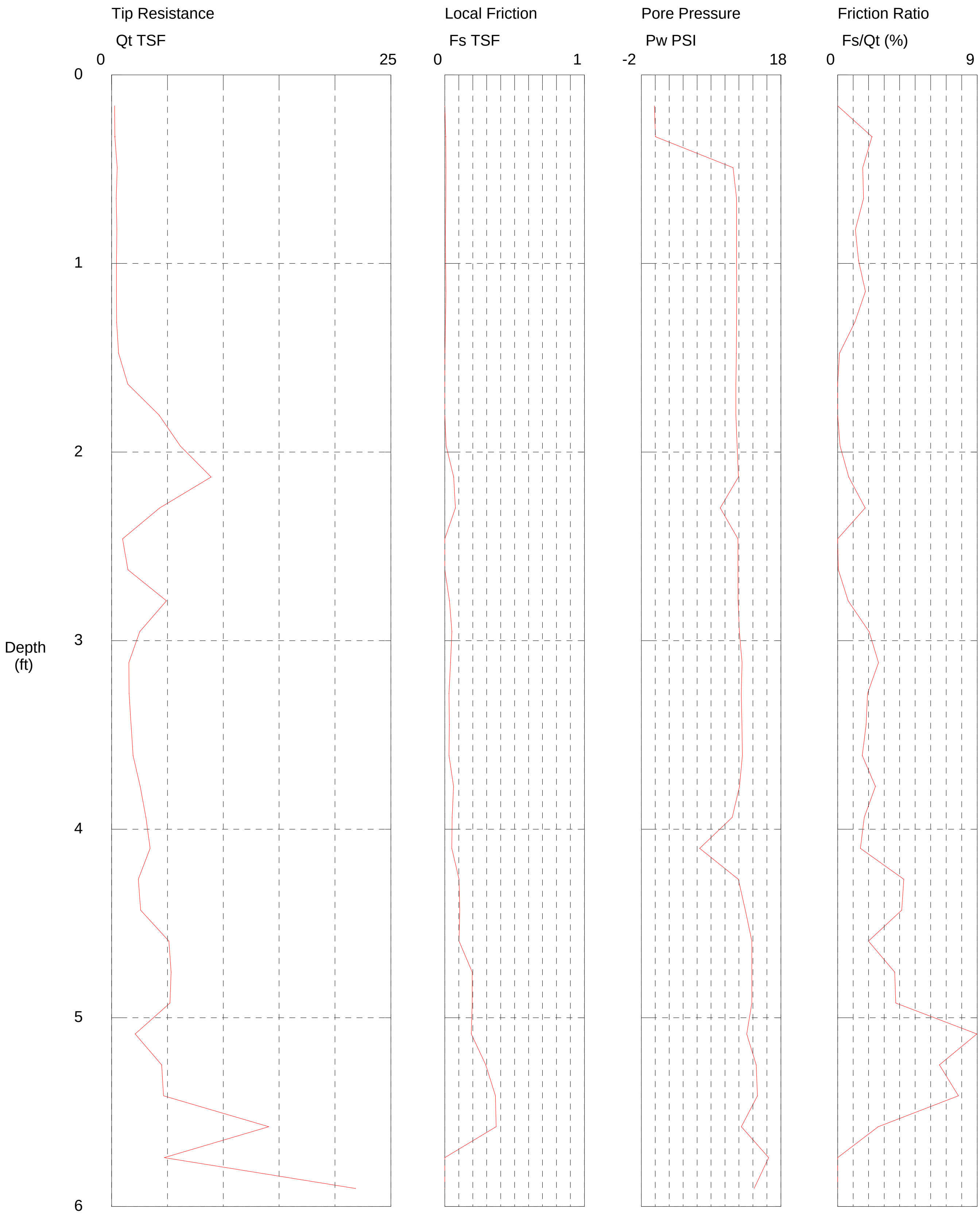
Mudline Elevation = -7.0 ft
Depth of water is 29 feet.

239186.7N 1269483.8E
Northwest Cone Exploration

Floyd Snider

Operator: Brown
Sounding: GWS-CPT-02
Cone Used: DSG0708

CPT Date/Time: 5/4/2005 2:04:51 PM
Location: Lake Union - Gas Works Park
Job Number: GWS-GSA



Maximum Depth = 5.91 feet

Depth Increment = 0.164 feet

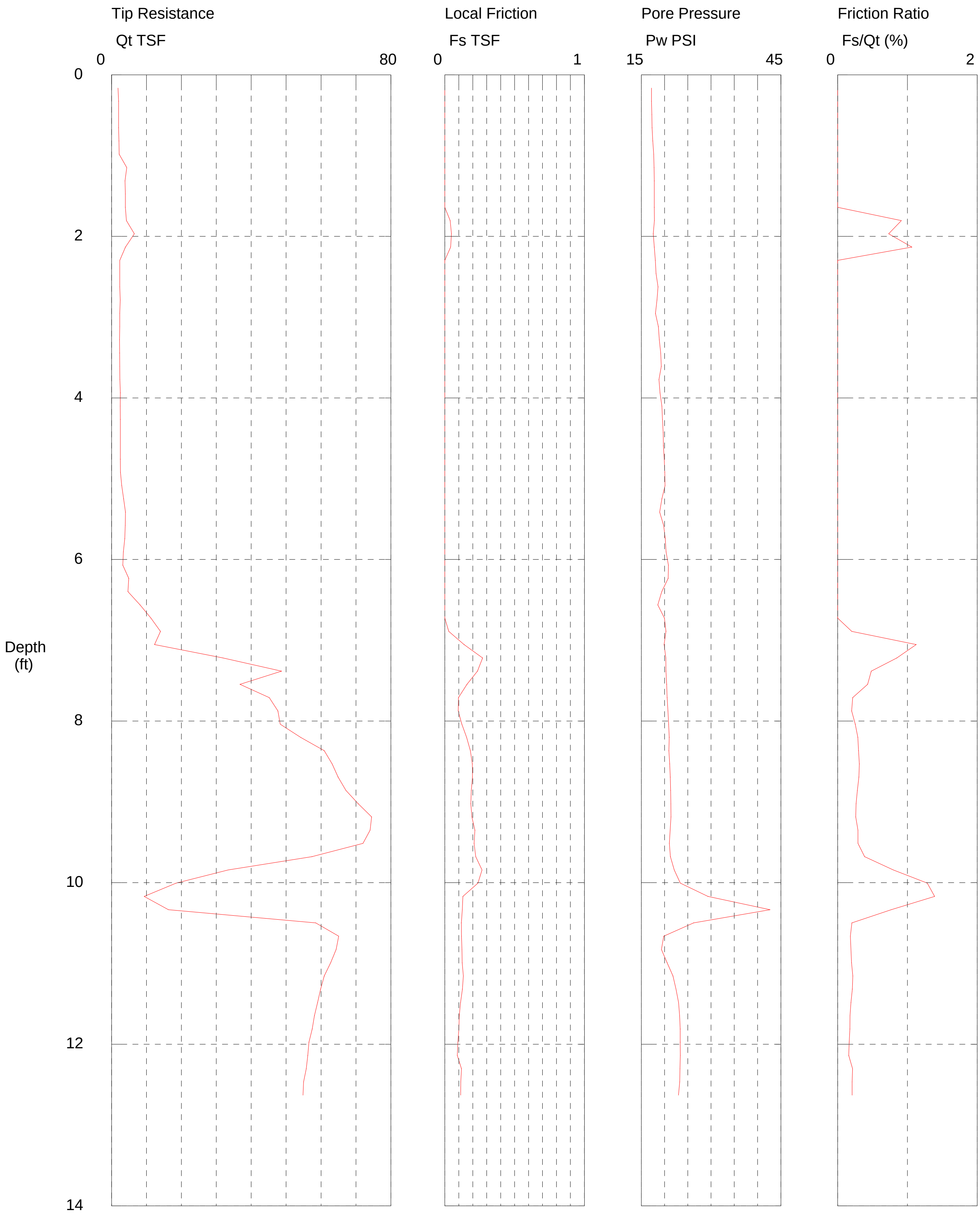
Mudline Elevation = -4.5 ft
Depth of water is 26.5 feet.

239079.3N 1269608.0E
Northwest Cone Exploration

Floyd Snider

Operator: Brown
Sounding: GWS-CPT-03
Cone Used: DSG0851

CPT Date/Time: 5/2/2005 12:42:15 PM
Location: Lake Union - Gas Works Park
Job Number: GWS-GSA



Maximum Depth = 12.63 feet

Depth Increment = 0.164 feet

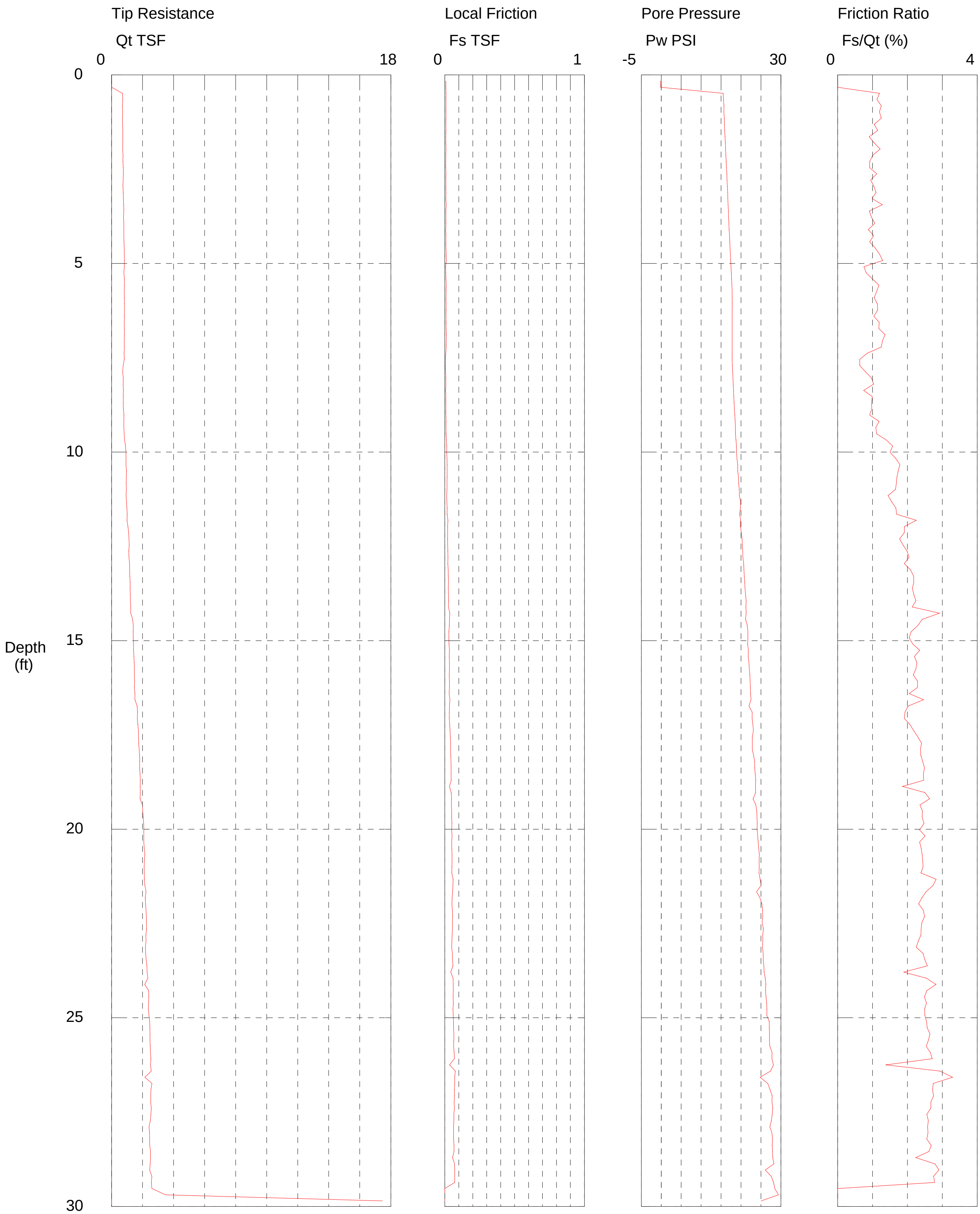
Mudline Elevation = -17.8 ft
Depth of water is 39.8 feet.

238760N 1269725E
Northwest Cone Exploration

Floyd Snider

Operator: Brown
Sounding: GWS-CPT-04
Cone Used: DSG0708

CPT Date/Time: 5/5/2005 11:58:54 AM
Location: Lake Union - Gas Works Park
Job Number: GWS-GSA



Maximum Depth = 29.86 feet

Depth Increment = 0.164 feet

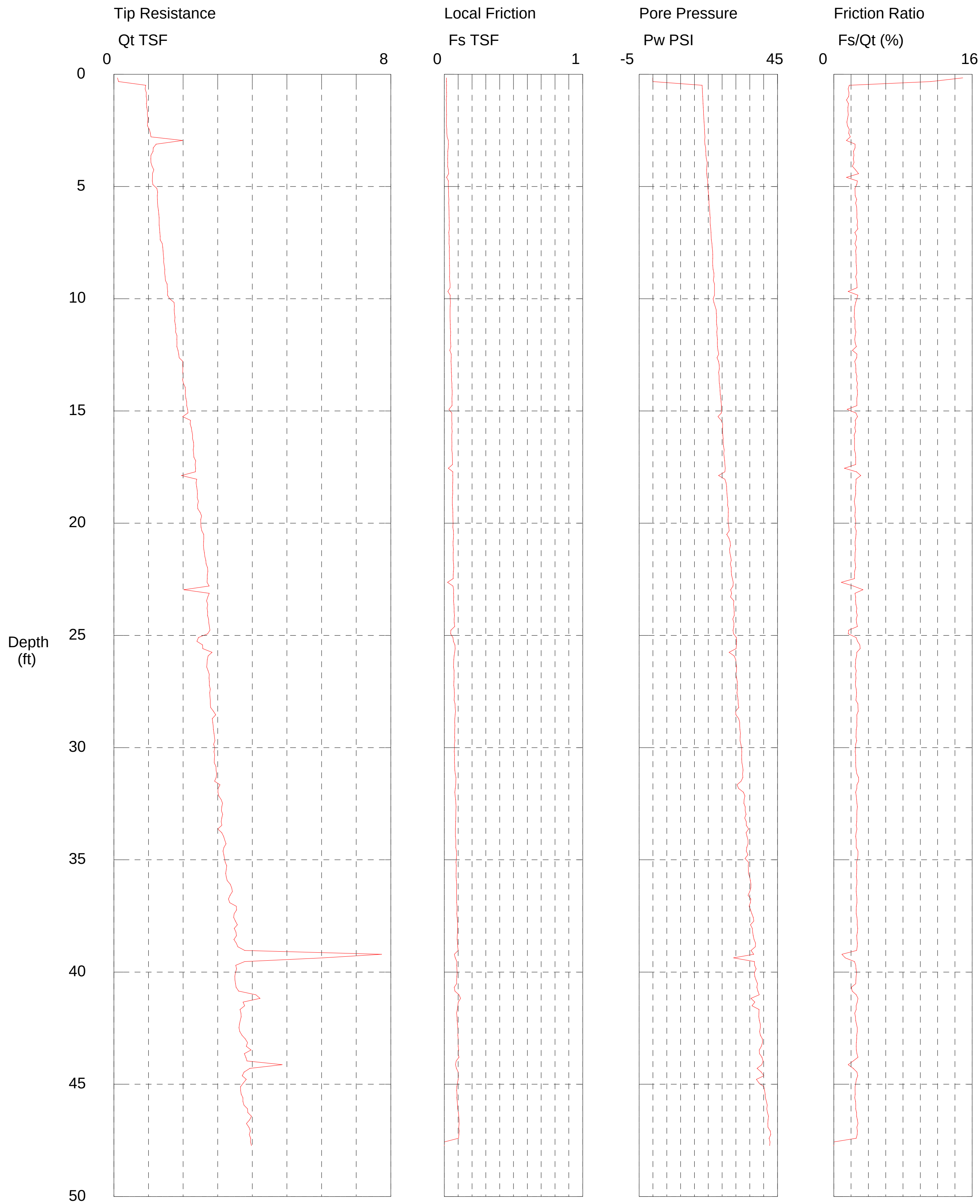
Mudline Elevation = -19.75 ft
Depth of water is 41.75 feet.

238612.4N 1269635.7E
Northwest Cone Exploration

Floyd Snider

Operator: Brown
Sounding: GWS-CPT-05
Cone Used: DSG0708

CPT Date/Time: 5/3/2005 12:11:38 PM
Location: Lake Union - Gas Works Park
Job Number: GWS-GSA



Maximum Depth = 47.74 feet

Depth Increment = 0.164 feet

Mudline Elevation = -19.0 ft
Depth of water is 41.0 feet.

238655N 1269207E
Northwest Cone Exploration

Gas Works Sediment
Western Study Area

Data Report

Appendix D
Geotechnical Physical Laboratory Testing Program

December 7, 2005

List of Figures

List of Attachments

Geotechnical Physical Laboratory Testing Program

A laboratory testing program was performed to evaluate the basic index and geotechnical engineering properties of the site sediments within the GWS-WSA. Both disturbed and undisturbed samples were tested. The tests performed and procedures followed are outlined below.

SOIL CLASSIFICATION

Soil samples from the explorations were visually classified in the field and then taken to the laboratory where the classifications were verified in a relatively controlled laboratory environment. Field and laboratory observations include density/consistency, moisture condition, and estimates of grain-size and plasticity.

The classifications of selected samples were checked by laboratory tests such as Atterberg limits determinations and grain-size analyses. Classifications were made in accordance with the USCS, ASTM D2487, as presented on Figure D.1.

MOISTURE CONTENT DETERMINATIONS

As soon as possible following sample arrival to the laboratory, moisture contents were determined in accordance with ASTM D2216. The results of these tests are plotted at the corresponding sample depths on the boring logs (Appendix C) and also presented in Attachment D.1.

ATTERBERG LIMITS

Atterberg limits were determined for selected fine-grained sediment samples. The liquid and plastic limits were determined in accordance with ASTM D4318-84. The results of the Atterberg Limits analyses and the plasticity characteristics are summarized in Attachment D.2. The results of the Atterberg Limits tests are also shown graphically on the boring logs (Appendix C).

GRAIN-SIZE ANALYSIS

Grain-size distribution was analyzed on representative samples in accordance with ASTM D422. Wet sieve analysis was used to determine the size distribution greater than the U.S. No. 200 mesh sieve. A hydrometer was used on sample GWS-GC06-S15 due to high fines content (greater than 90 percent). The results of the tests are presented as curves in Attachment D.3, plotting percent finer by weight versus grain-size.

SPECIFIC GRAVITY

Specific gravity is defined as the ratio of the average density of solid constituents in a sediment sample to the density of water. Specific gravity was determined from selected sediment samples according to ASTM D854. Results of specific gravity tests are presented in Attachment D.4.

TRIAXIAL UNCONSOLIDATED UNDRAINED TEST

The triaxial unconsolidated undrained (UU) compression test estimates the undrained shear strength of the soil. This test was performed in accordance with ASTM D2850. A relatively undisturbed fine-grained sample is trimmed to a length of about 6 inches, encased in a rubber membrane, and placed in a triaxial cell. An all-around confining pressure is applied hydraulically, but the sample is not allowed to consolidate, and no back pressure is applied. An axial load is then applied to the sample at a constant strain rate without allowing drainage from the specimen. The stress strain behavior is recorded until failure occurs.

The failure stress is generally taken as the maximum load on the sample or the load recorded at 20 percent strain, whichever is greater. The test results, plotted in terms of axial strain versus deviator stress, are presented in Attachment D.5. The shear strength is considered to be one-half the maximum stress difference.

ONE DIMENSIONAL CONSOLIDATION TEST

Consolidation tests were performed according to ASTM D2435 by placing a disk of cohesive sediment within a metal loading ring. The faces of the sediment are covered with porous plates. The disc apparatus is then loaded and submerged in water. Static loads are applied in increments, and the vertical displacement is measured with time for each load increment. When the displacement rate levels off, the final void ratio is determined for that increment. The load versus the void ratio is then plotted together as an e-log p curve.

Results of the consolidation tests performed for this program are presented in Attachment D.6.

Gas Works Sediment
Western Study Area

Data Report

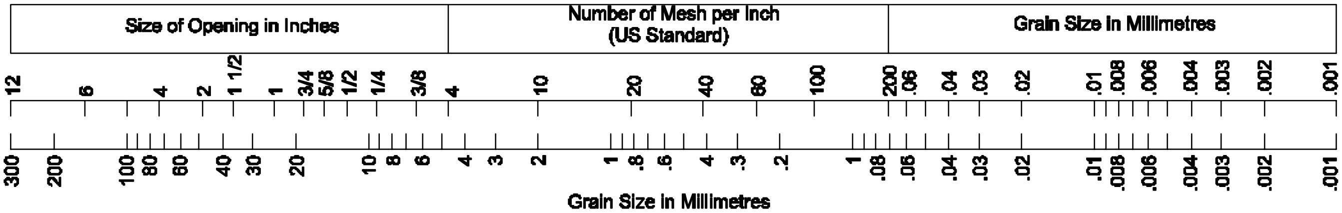
Appendix D
Geotechnical Physical Laboratory Testing Program

Figures

December 7, 2005

Unified Soil Classification (USC) System

Soil Grain Size



COBBLES	GRAVEL	SAND	SILT and CLAY
Coarst Grained Soils			Fine Grained Soils

Coarse-Grained Soils

G W	G P	G M	G C	S W	S P	S M	S C
Clean GRAVEL <5% fines		* GRAVEL with >12% fines		Clean GRAVEL <5% fines		* GRAVEL with >12% fines	
GRAVEL >50% coarse fraction larger than No. 4				SAND >50% coarse fraction smaller than No. 4			
Coarse-Grained Soils >50% larger than No. 200 sieve							

G W and S W $\left(\frac{D_{60}}{D_{10}}\right)$ >4 for G W, >6 for S W & $1 \leq \left(\frac{(D_{30})^2}{D_{10} \times D_{60}}\right) \leq 3$

G P and S P Clean GRAVEL or SNAD not meeting requirements for G W and S W

G M AND S M Atterberg limits below A line with PI <4

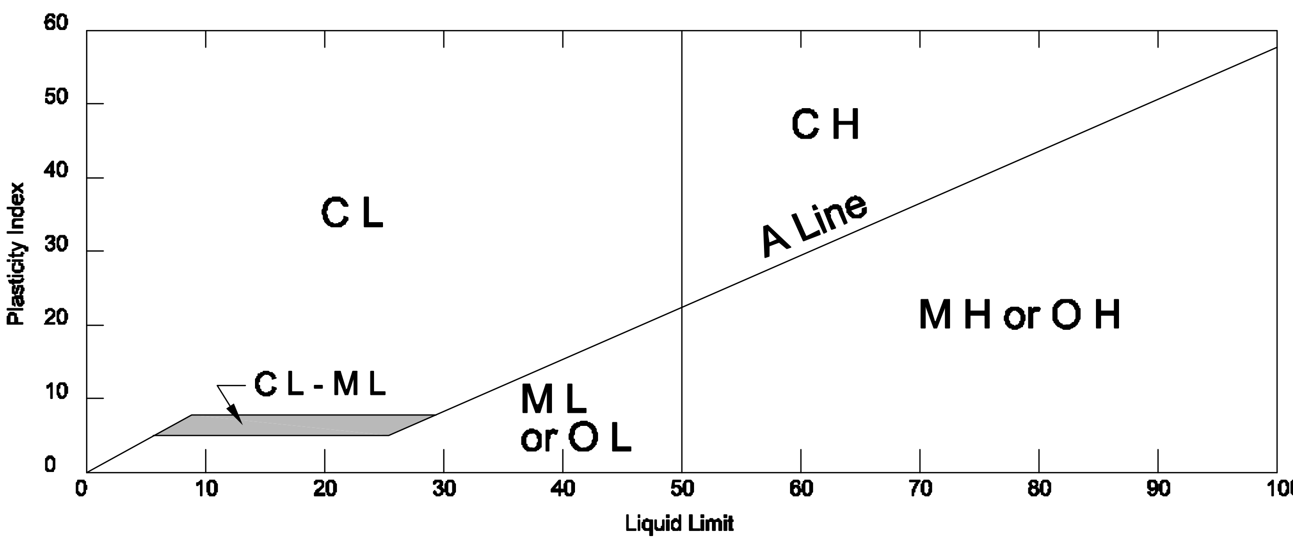
G C and S C Atterberg limits above A line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases required use of dual symbols.

D_{10}, D_{30}, and D_{60} are the particles diameter of which 10, 30, and 60 percent, respectively, of the soil weight are finer.

Fine-Grained Soils

M L	C L	O L	M H	C H	O H	Pt
SILT	CLAY	Organic	SILT	CLAY	Organic	Highly Organic Soils
Soils with Liquid Limit <50%			Soils with Liquid Limit >50%			
Fine-Grained Soils >50% smaller than No. 200 sieve						



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Data Report
Gas Works Sediment Western Study Area
City of Seattle

Figure D.1
Unified Soil Classification System

December 7, 2005

Gas Works Sediment
Western Study Area

Data Report

Appendix D
Geotechnical Physical Laboratory Testing Program

Attachments

December 7, 2005

Attachment D.1

Moisture Content

ASTM D2216

ANALYTICAL RESOURCES INCORPORATED

FLOYD/SNIDER
Gasworks Park RI/FS

Moisture Content

Client Sample Number	ARI Sample Number	Moisture Content (%)
GWS-GC02-S1	IA09A	18.9*
GWS-GC02-S2	IA09B	17.3
GWS-GC02-S3	IA09C	19.4
GWS-GC02-S4	IA09D	20.4
GWS-GC01-S1	IA09E	18.2
GWS-GC01-S2	IA09F	10.6
GWS-GC01-S3	IA09G	14.5*
GWS-GC01-S4	IA09H	17.2
GWS-GC01-S5	IA09I	38.0
GWS-GC06-S1	IA09J	523.0
GWS-GC06-S2	IA09K	731.3
GWS-GC06-S3	IA09L	732.0
GWS-GC06-S4	IA09M	520.3
GWS-GC06-S5	IA09N	637.1
GWS-GC06-S6	IA09O	548.7
GWS-GC06-S7	IA09P	546*
GWS-GC06-S8	IA09Q	358.9
GWS-GC06-S9	IA09R	390.7
GWS-GC06-S10	IA09S	129.4
GWS-GC06-S11	IA09T	93.7*
GWS-GC06-S12	IA09U	88.0
GWS-GC06-S13	IA09V	51.7*
GWS-GC06-S14	IA09W	70.6
GWS-GC06-S15	IA09X	32.0

Moisture content by ASTM D2216.

* this value taken from the consolidation test.

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Initial Moisture Content

Client Sample Number	ARI Sample Number	Moisture Content (%)
GWS-GC04-S1	IA11A	703.2
GWS-GC04-S2	IA11B	408.9
GWS-GC04-S5	IA11C	436.7
GWS-GC04-S6	IA11D	9.2
GWS-GC04-S7	IA11E	15.1
GWS-GC04-S8	IA11F	13.7
GWS-GC03-S1	IA11G	9.7
GWS-GC03-S2	IA11H	11.0
GWS-GC03-S3	IA11I	28.3
GWS-GC05-S1	IA11J	289.2
GWS-GC05-S2	IA11K	740.6
GWS-GC05-S3	IA11L	304.2
GWS-GC05-S4	IA11M	87.9
GWS-GC05-S5	IA11N	78.5
GWS-GC05-S6	IA11Q	73.3

Moisture content by ASTM D2216.

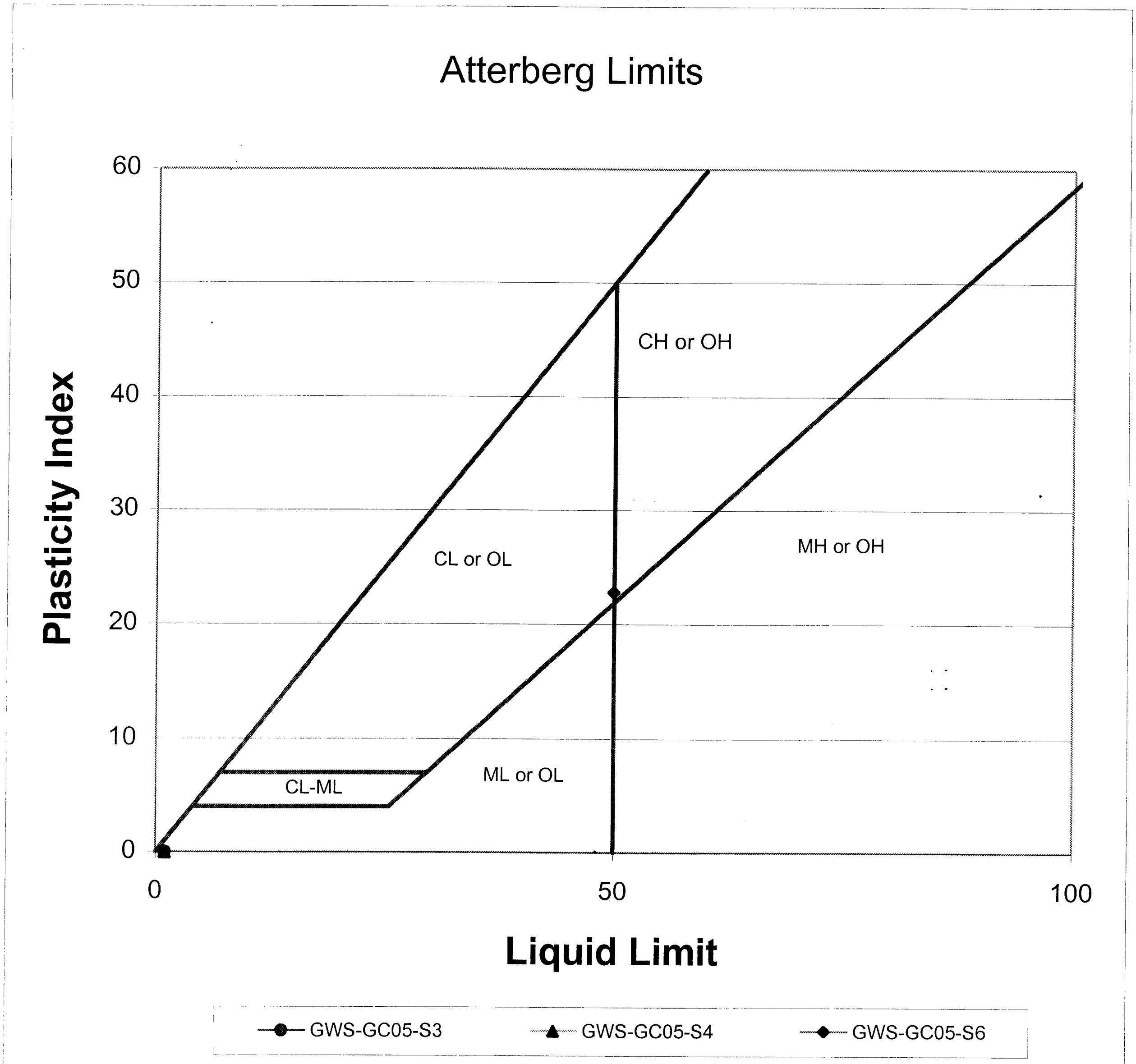
Attachment D.2

Atterberg Limits

ASTM D4318

Floyd / Snider
Gas Works Park

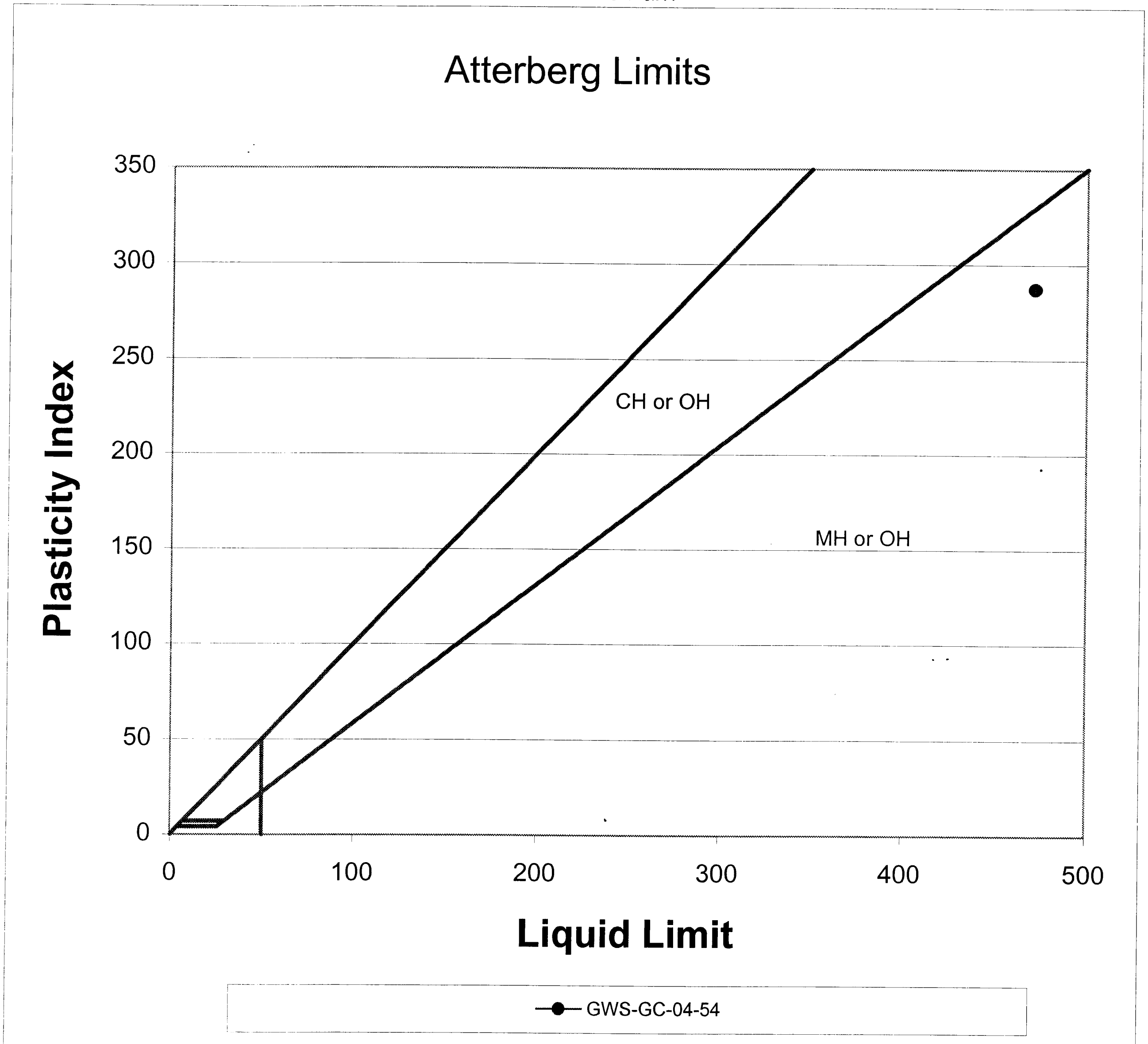
ANALYTICAL RESOURCES INCORPORATED



Sample Number	Depth	Plasticity Index	Liquid Limit	Plastic Limit	Classification
GWS-GC05-S3	NA	NA	NA	NA	Non-Plastic
GWS-GC05-S4	NA	NA	NA	NA	Non-Plastic
GWS-GC05-S6	NA	22.8	50.0	27.2	CL-CH

ANALYTICAL RESOURCES INCORPORATED

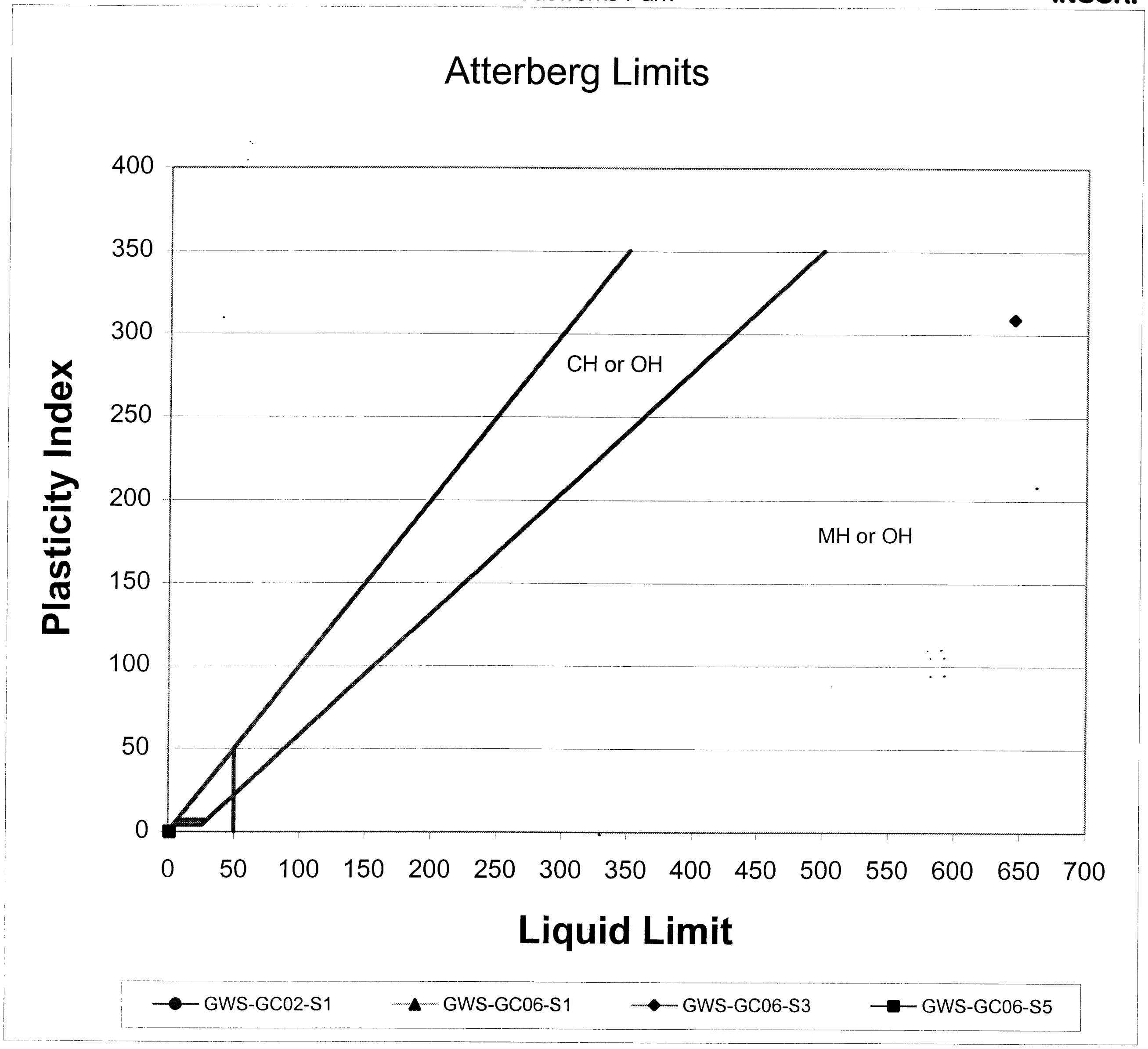
Floyd-Snider
Gasworks Park



Sample Number	Depth	Plasticity Index	Liquid Limit	Plastic Limit	Classification
GWS-GC-04-54	17	287	472	185	OH

Floyd Snider, Inc.
Gasworks Park

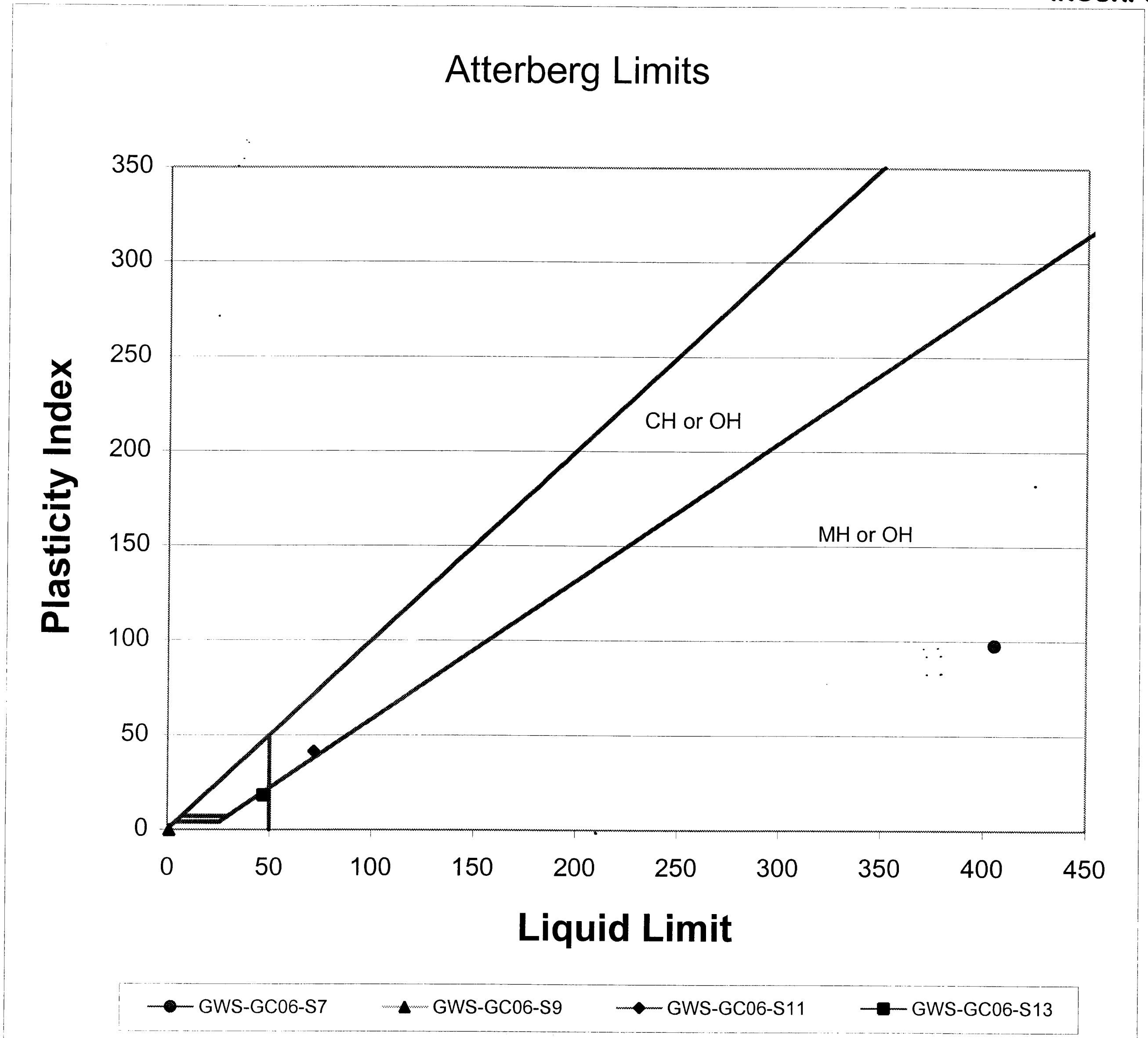
ANALYTICAL RESOURCES INCORPORATED



Sample Number	Depth	Plasticity Index	Liquid Limit	Plastic Limit	Classification
GWS-GC02-S1	1	NA	NA	NA	Non-Plastic
GWS-GC06-S1	2	NA	NA	NA	Non-Plastic
GWS-GC06-S3	7	309.0	645.2	336.1	OH
GWS-GC06-S5	25	NA	NA	NA	Non-Plastic

Floyd Snider, Inc.
Gasworks Park

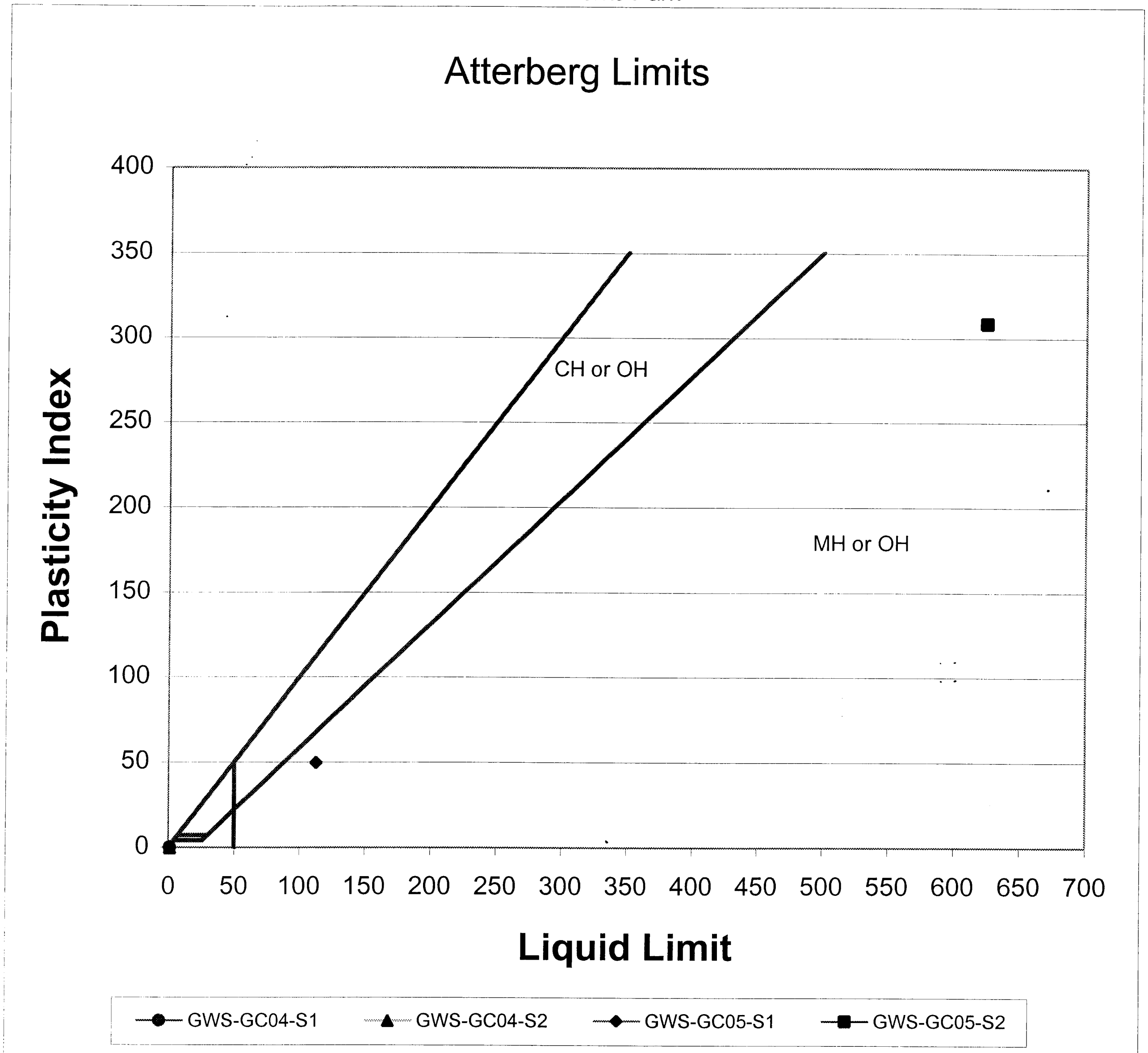
ANALYTICAL RESOURCES INCORPORATED



Sample Number	Depth	Plasticity Index	Liquid Limit	Plastic Limit	Classification
GWS-GC06-S7	35	97.7	405.5	307.8	OH
GWS-GC06-S9	45	NA	NA	NA	Non-Plastic
GWS-GC06-S11	55	41.4	71.8	30.4	CH
GWS-GC06-S13	65	18.1	47.0	28.8	OL

Floyd / Snider
Gas Works Park

ANALYTICAL RESOURCES INCORPORATED



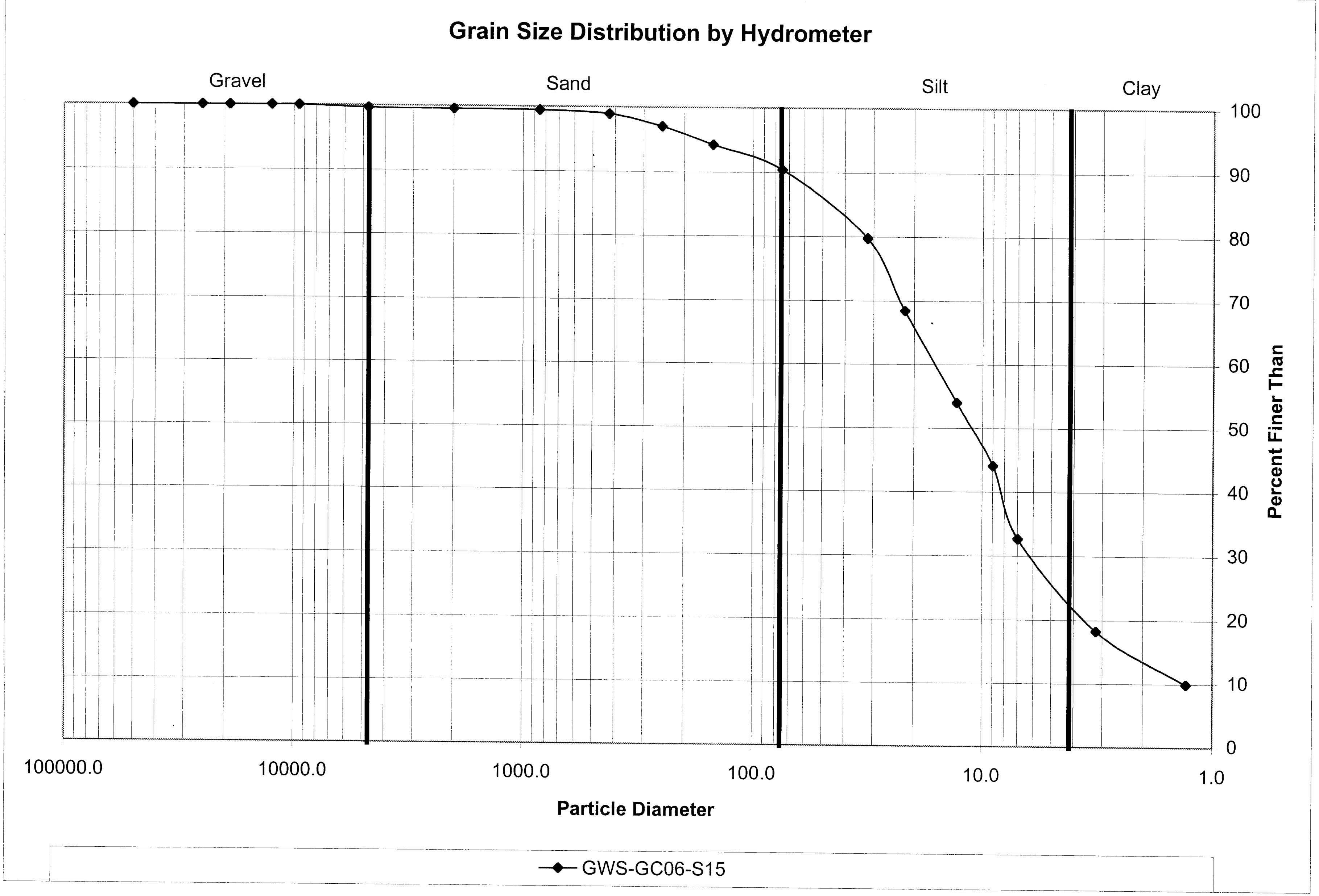
Sample Number	Depth	Plasticity Index	Liquid Limit	Plastic Limit	Classification
GWS-GC04-S1	NA	NA	NA	NA	Non-Plastic
GWS-GC04-S2	NA	NA	NA	NA	Non-Plastic
GWS-GC05-S1	NA	49.7	112.7	63.0	OH
GWS-GC05-S2	NA	308.4	624.3	315.8	OH

Attachment D.3

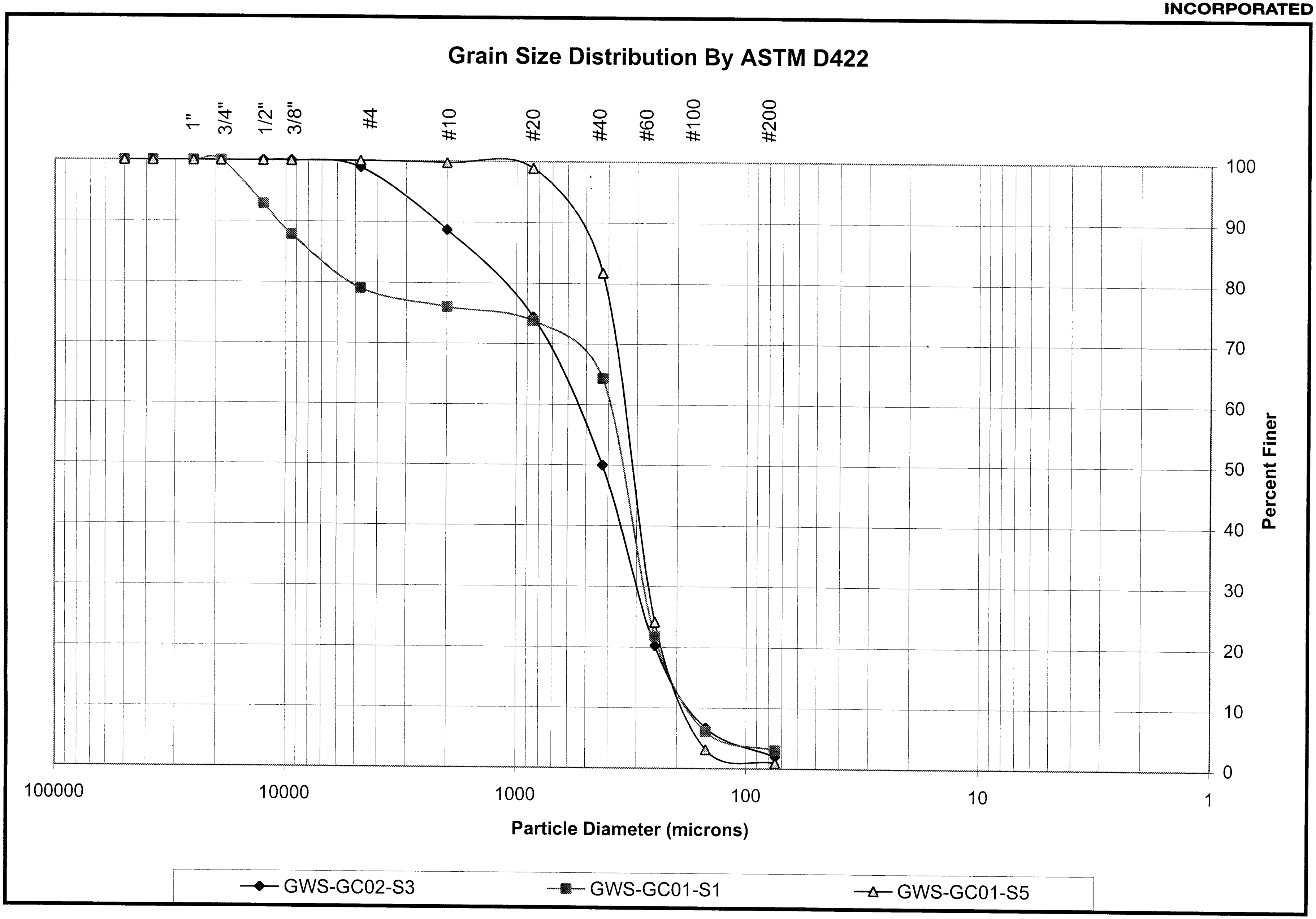
Grain Size

ASTM D422

ANALYTICAL RESOURCES INCORPORATED



ANALYTICAL RESOURCES INCORPORATED



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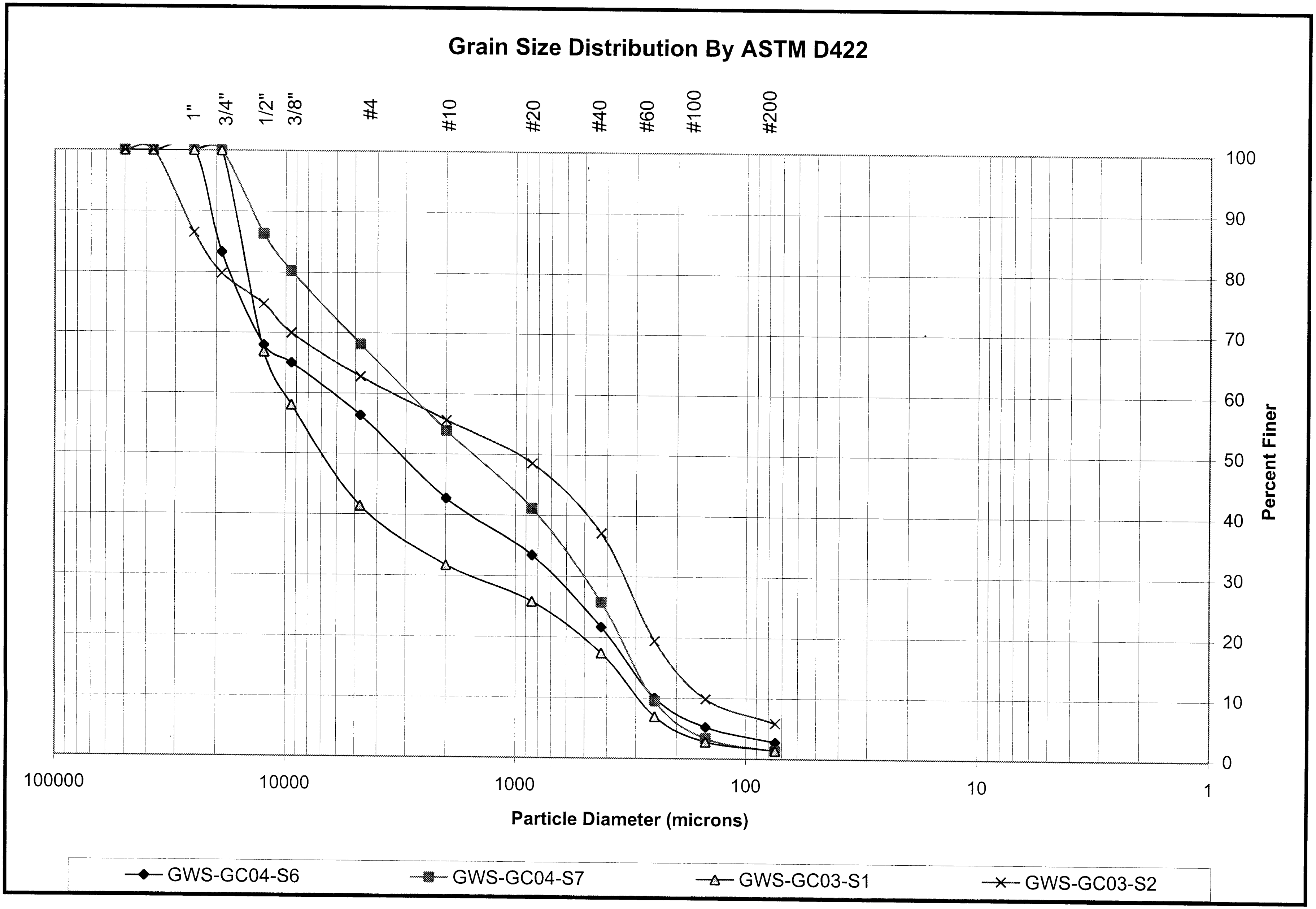
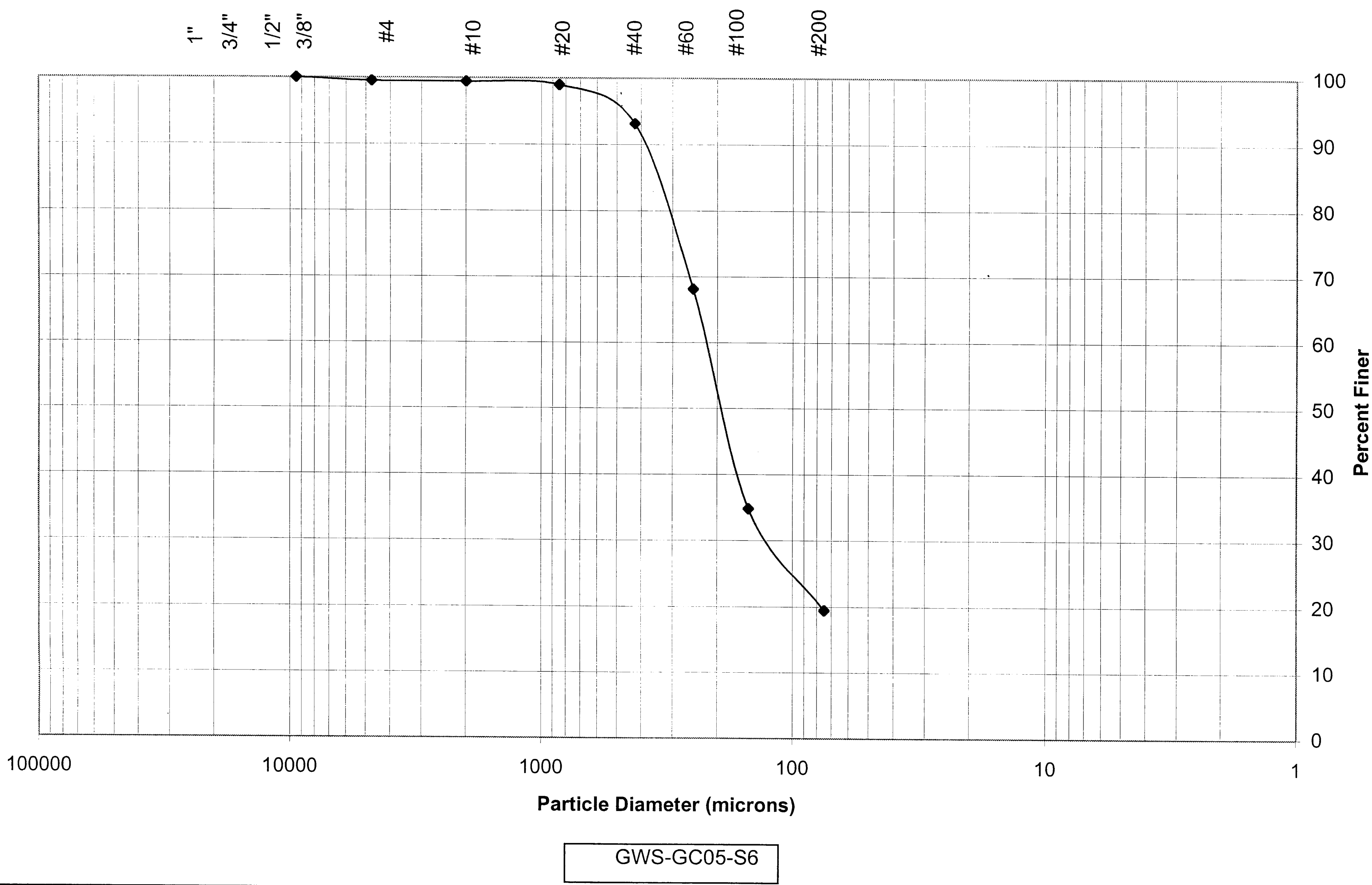


ANALYTICAL RESOURCES INCORPORATED

Grain Size Distribution By ASTM D422



Attachment D.4

Specific Gravity

ASTM D854

ANALYTICAL RESOURCES INCORPORATED

Floyd Snider, Inc.

Gasworks RI/FS

Specific Gravity

Sample ID	Descritption	Specific Gravity
GWS-GC02-S1	Gravely Sand	2.71
GWS-GC06-S1	Organic Silt	2.43
GWS-GC06-S3	Organic Silt	1.83
GWS-GC06-S5	Organic Silt	2.04
GWS-GC06-S7	Organic Silt	2.08
GWS-GC06-S9	Organic Silt	2.19
GWS-GC06-S11	Clay	2.76
GWS-GC06-S13	Clay	2.75

IA09

ANALYTICAL RESOURCES INCORPORATED

FLOYD/SNIDER
COS-SPUDR.0040

Specific Gravity

Client Sample Number	ARI Sample Number	Specific Gravity
GWS-GC04-S1	IA11A	1.98
GWS-GC04-S2	IA11B	2.20
GWS-GC03-S1	IA11G	2.77
GWS-GC05-S1	IA11J	2.44
GWS-GC05-S2	IA11K	2.00
GWS-GC05-S3	IA11L	2.30
GWS-GC05-S4	IA11M	2.73
GWS-GC05-S6	IA11Q	2.80

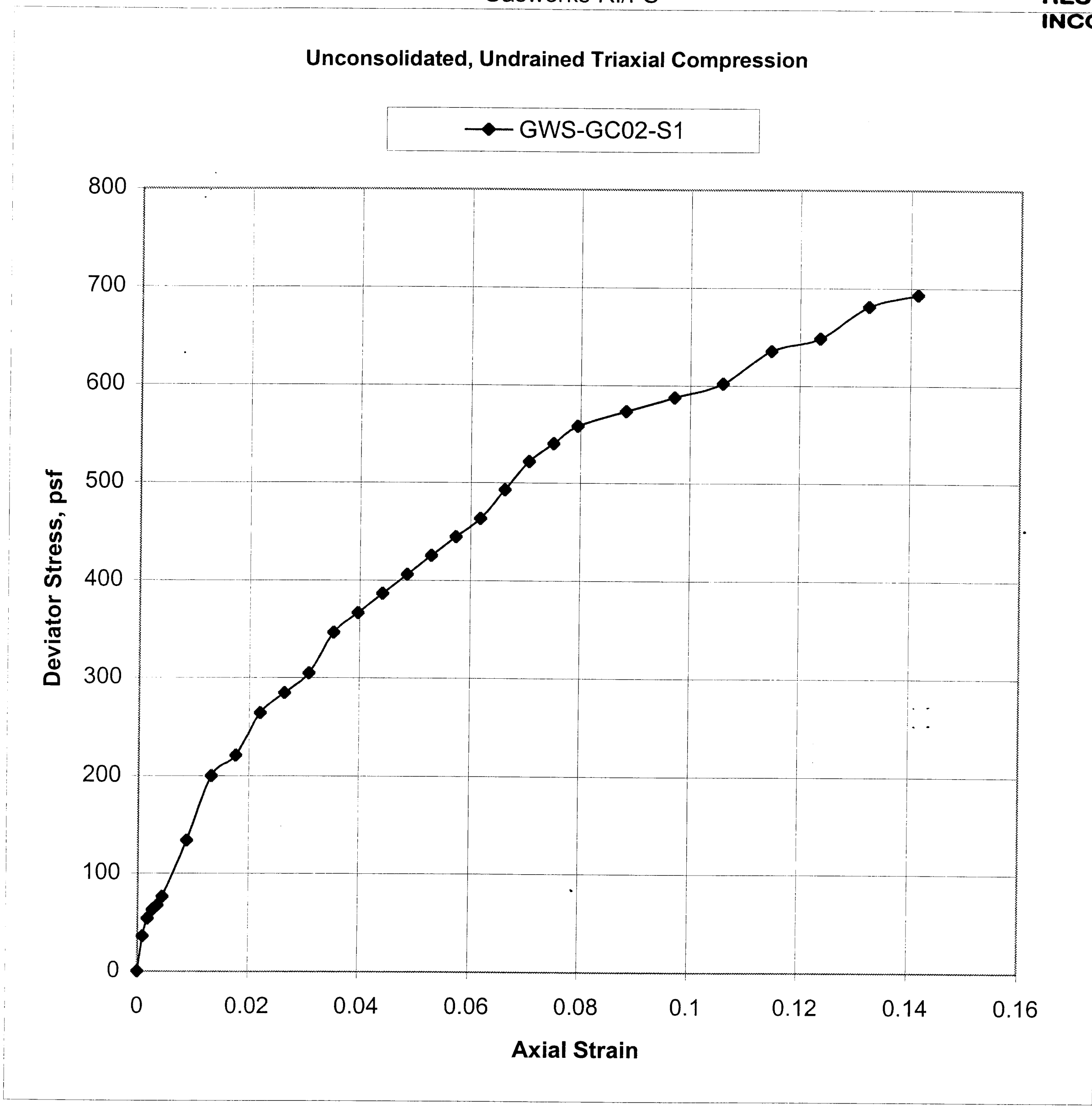
Specific Gravity by ASTM D854

Attachment D.5

Unconsolidated, Undrained Triaxial Strength

ASTM D2850

ANALYTICAL RESOURCES INCORPORATED

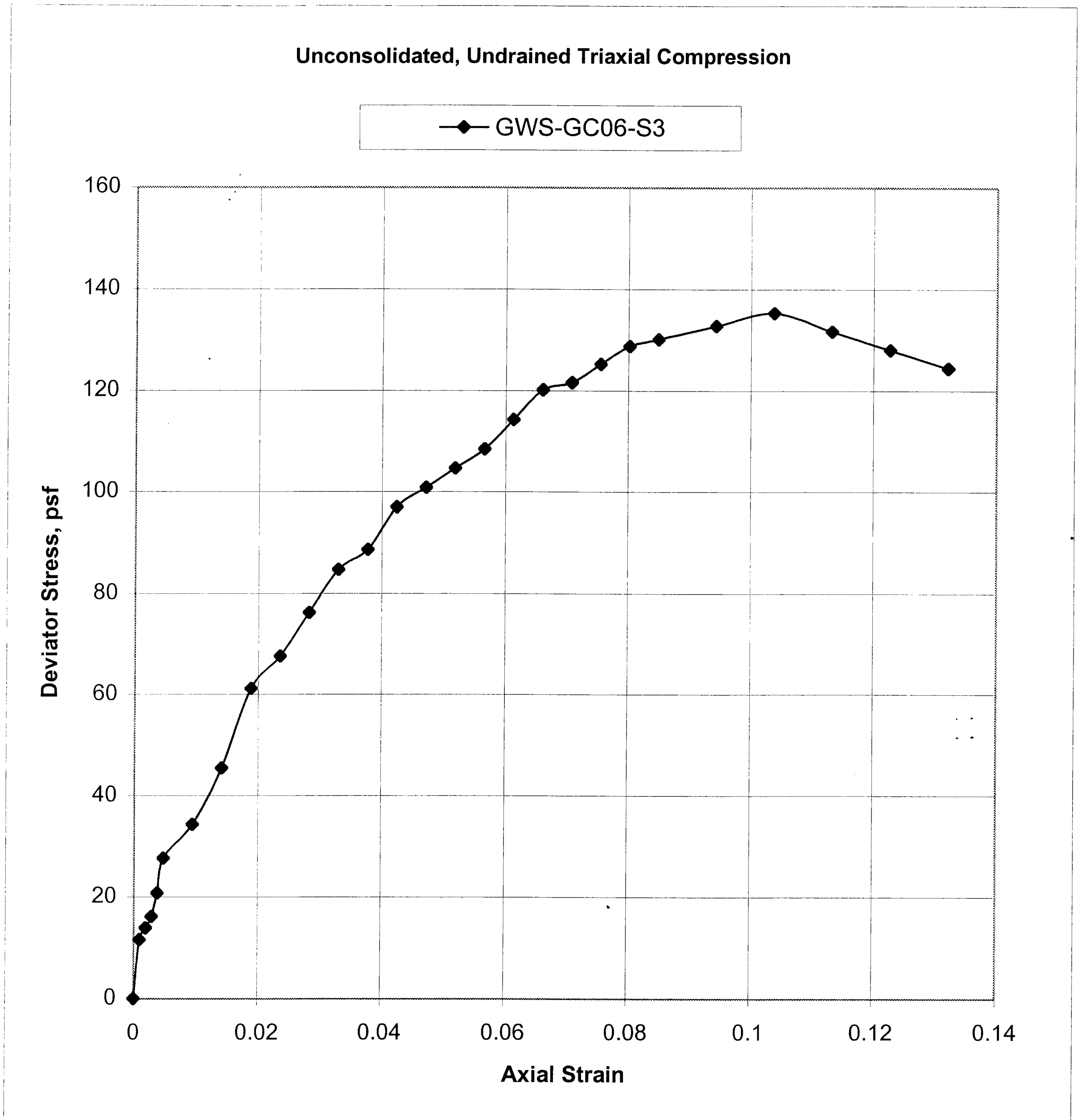


Sample ID	Depth (ft)	Confining Pressure (psi)	Wet Density (pcf)	Moisture Content (%)	Dry Density (pcf)
GWS-GC02-S1	1	5.0	125.1	18.5	105.6

Notes to the testing:
1. The testing was performed according to ASTM D-2850.
2. The sample had a bulging failure.

Floyd / Snider
Gasworks RI/FS

ANALYTICAL RESOURCES INCORPORATED

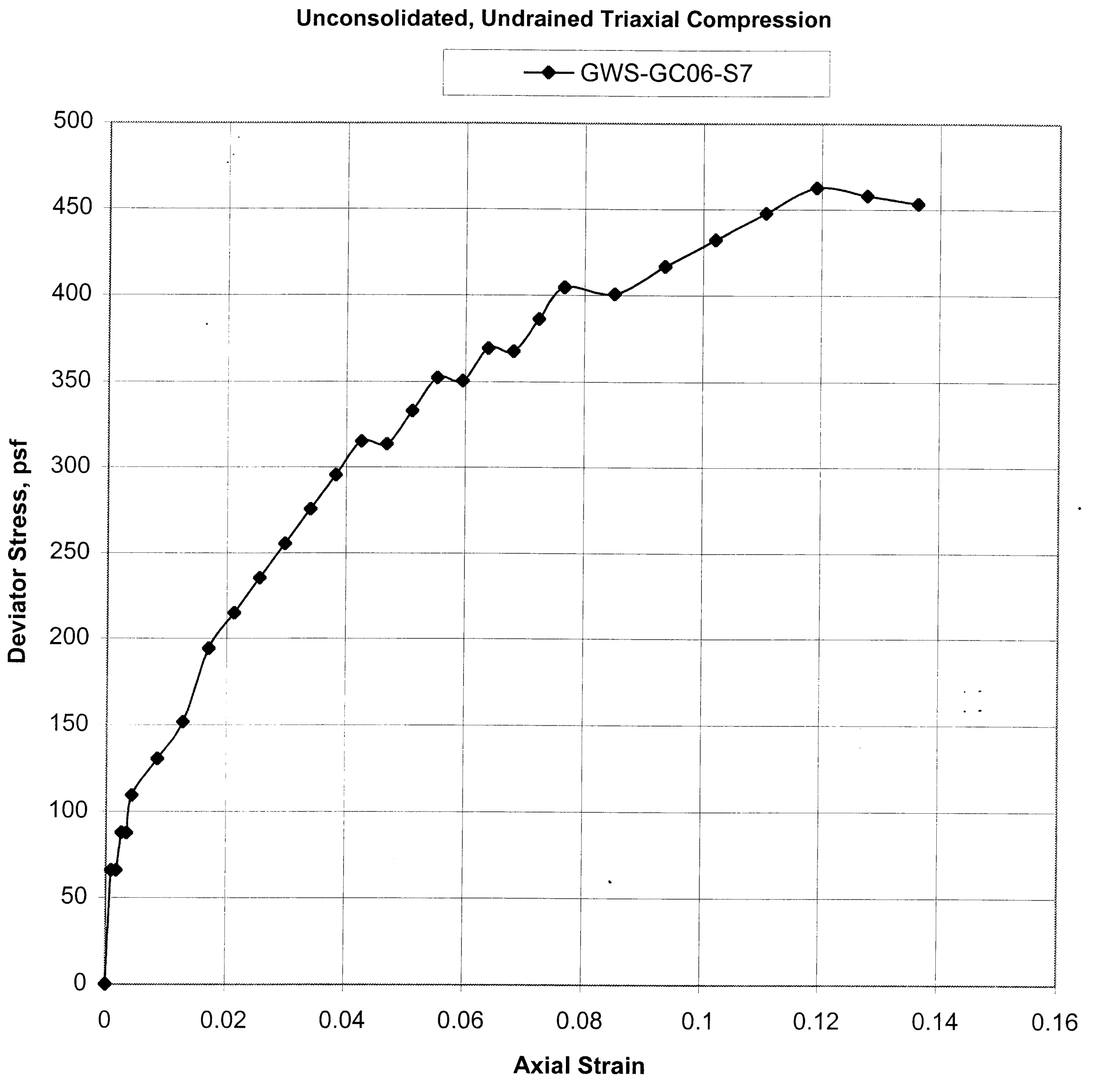


Sample ID	Depth (ft)	Confining Pressure (psi)	Wet Density (pcf)	Moisture Content (%)	Dry Density (pcf)
GWS-GC06-S3	7	5.0	65.9	676.7	8.5

Notes to the testing:
1. The testing was performed according to ASTM D-2850.
2. The sample had a bulging failure.

Floyd / Snider
Gasworks RI/FS

ANALYTICAL RESOURCES INCORPORATED

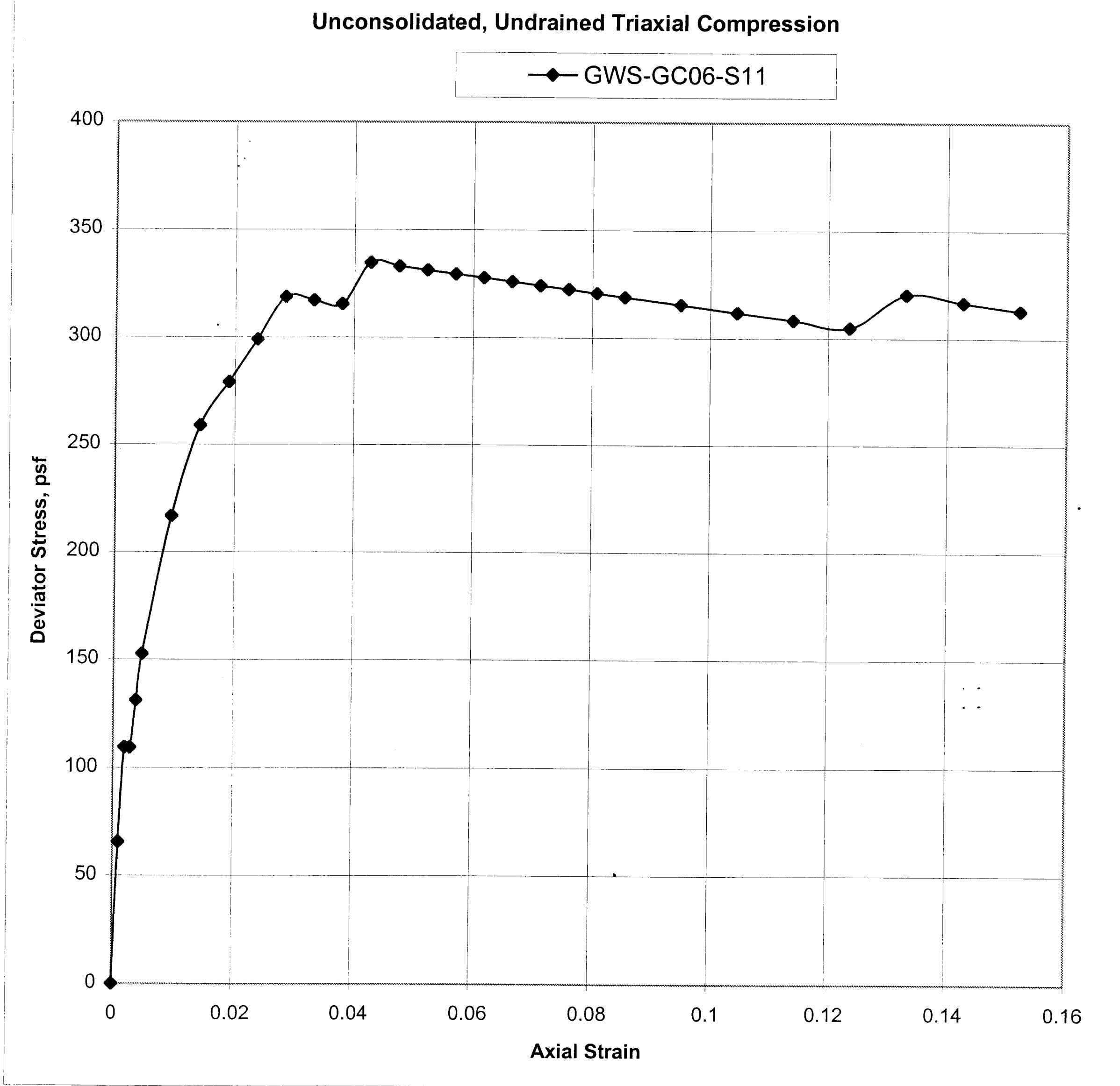


Sample ID	Depth (ft)	Confining Pressure (psi)	Wet Density (pcf)	Moisture Content (%)	Dry Density (pcf)
GWS-GC06-S7	35	5.0	66.2	528.9	10.5

Notes to the testing:
1. The testing was performed according to ASTM D-2850.
2. The sample had a bulging failure.

Floyd / Snider
Gasworks RI/FS

ANALYTICAL RESOURCES INCORPORATED



Sample ID	Depth (ft)	Confining Pressure (psi)	Wet Density (pcf)	Moisture Content (%)	Dry Density (pcf)
GWS-GC06-S11	55	5.0	93.6	92.1	48.7

Notes to the testing:
1. The testing was performed according to ASTM D-2850.
2. The sample had a bulging failure.

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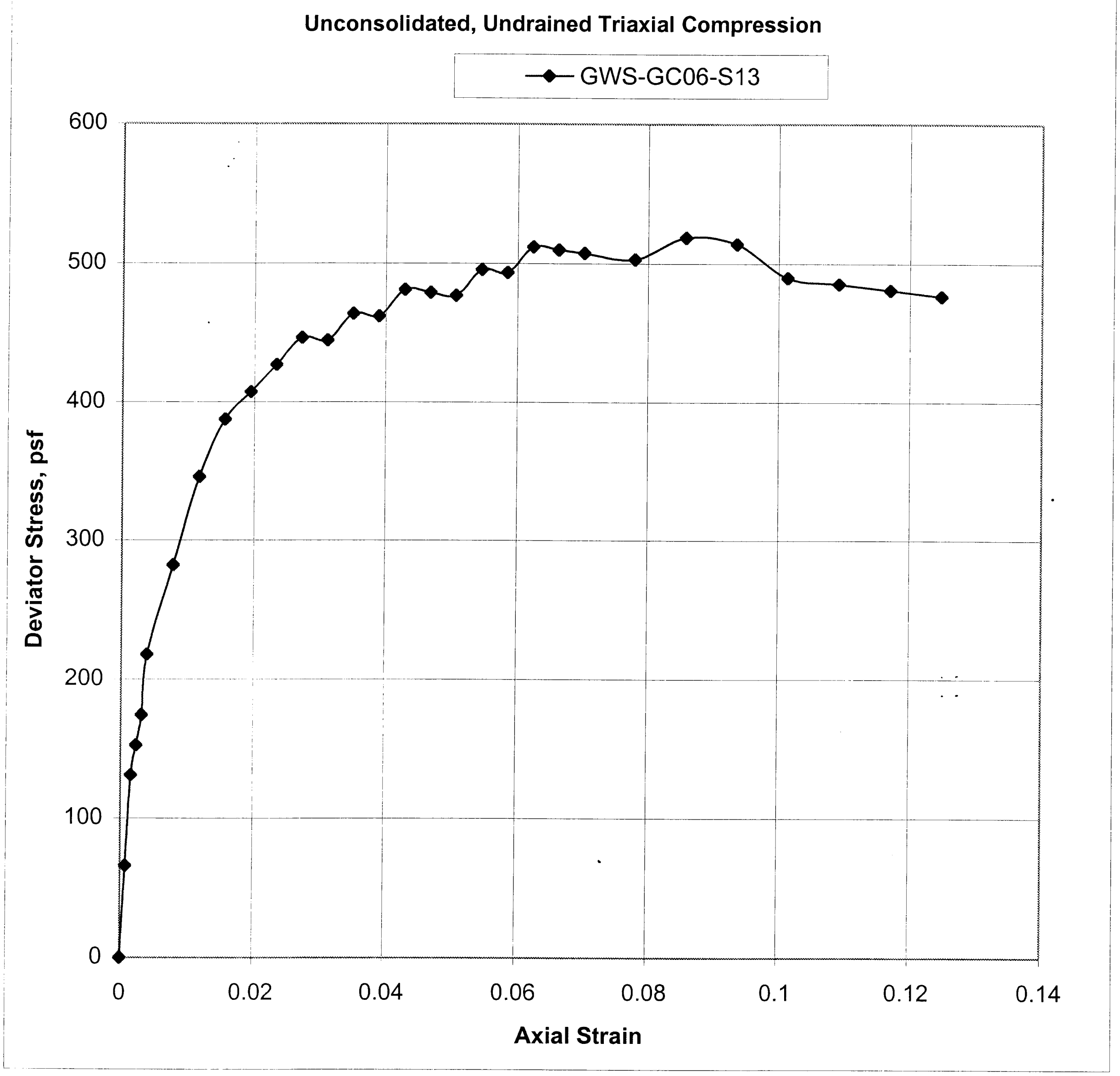

Sample ID	Depth (ft)	Confining Pressure (psi)	Wet Density (pcf)	Moisture Content (%)	Dry Density (pcf)
GWS-GC06-S13	65	5.0	98.5	65.2	59.6

Notes to the testing:
1. The testing was performed according to ASTM D-2850.
2. The sample had a bulging failure.

Attachment D.6

One Dimensional Consolidation

ASTM D2435

ANALYTICAL RESOURCES INCORPORATED

Project Number:	IA09	Job Name:	Gasworks RI/FS
Boring / Sample	QWS-GC02-S1	Job Number	COS-SPUDR-.0400
Sample Initial Height	1.0955	Job Location	Seattle
Initial Dial Indicator	0.4990	DI after Seating load	0.4945

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	Sample Height	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.4932	0.4903	0.4900	0.4894	1.00	1.0904	0.5452	0.252	0.0625	0.0088
0.4889	0.4860	0.4857	0.4855	1.00	1.0865	0.5433	0.250	0.125	0.0123
0.4840	0.4811	0.4808	0.4800	0.60	1.0810	0.5405	0.413	0.25	0.0173
0.4780	0.4745	0.4741	0.4737	0.60	1.0747	0.5374	0.408	0.5	0.0231
0.4698	0.4663	0.4659	0.4652	0.50	1.0662	0.5331	0.482	1	0.0309
0.4570	0.4527	0.4522	0.4515	0.50	1.0525	0.5263	0.470	2	0.0434
0.4458	0.4403	0.4397	0.4385	0.40	1.0395	0.5198	0.573	4	0.0552
0.4304	0.4244	0.4237	0.4225	0.40	1.0235	0.5118	0.555	8	0.0698
0.4244	0.4253	0.4254	0.4254	0.50	1.0264	0.5132	0.447	2	0.0672
0.4286	0.4294	0.4295	0.4297	0.60	1.0307	0.5154	0.375	0.5	0.0633
0.4312	0.4327	0.4329	0.4335	0.50	1.0345	0.5173	0.454	0.125	0.0598

Sample Parameters

Initial Moisture Content, %	19	Final Moisture Content, %	16
Initial Dry Unit Weight, lb/ft^3	102	Final Dry Unit Weight, lb/ft^3	108
Initial Void Ratio	0.66	Final Void Ratio	0.57
Initial Saturation	0.77	Final Saturation	0.78

The following equations were used to calculate the values shown in the table above:

$$Cv = T\ H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2

$(S_0 + S_{100})/2$ (for double drainage paths)

t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

Notes to the Testing:

1. The sample was extruded from the sample tube and trimmed into a consolidation ring. The sample was inundated at the time of the seating load was applied. The test was run according to ASTM D-2435, Method B.
2. The sample was gravely sand with silt.

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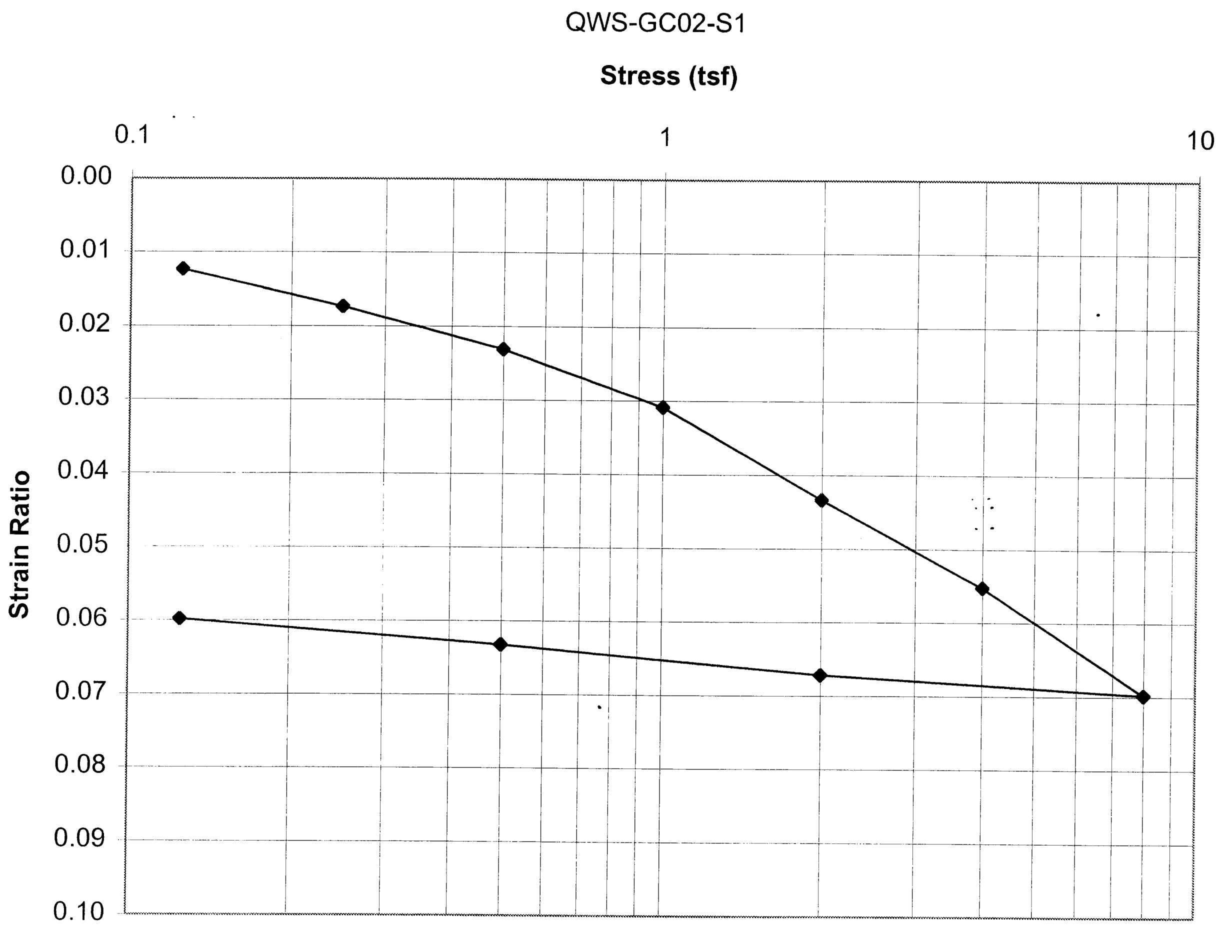
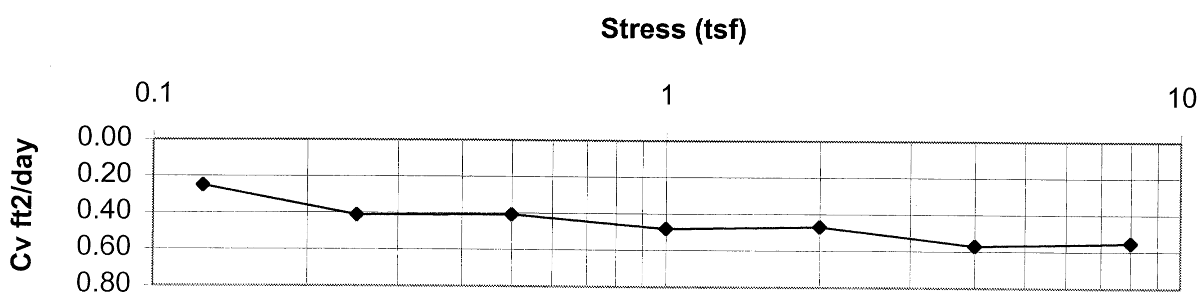
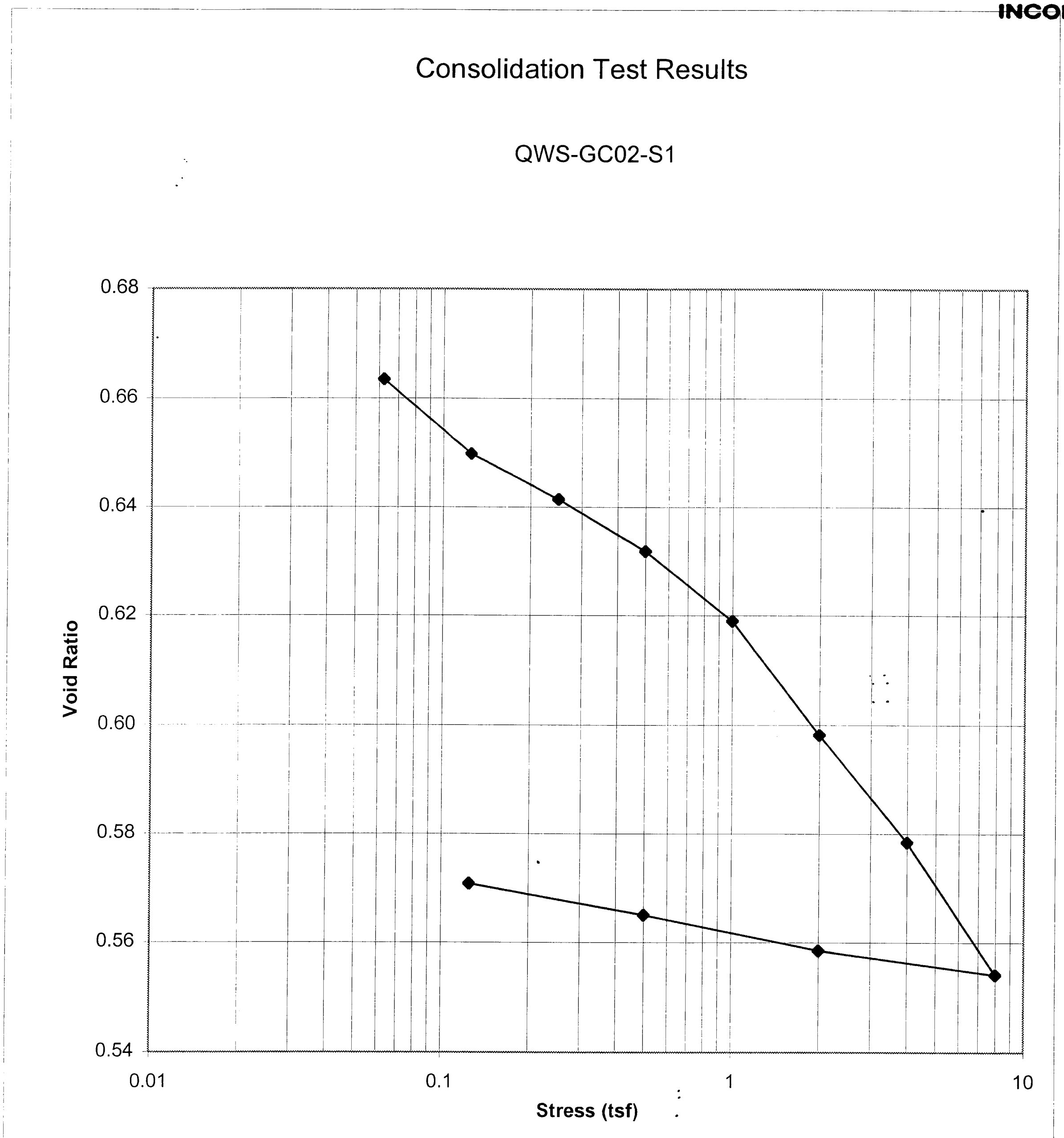
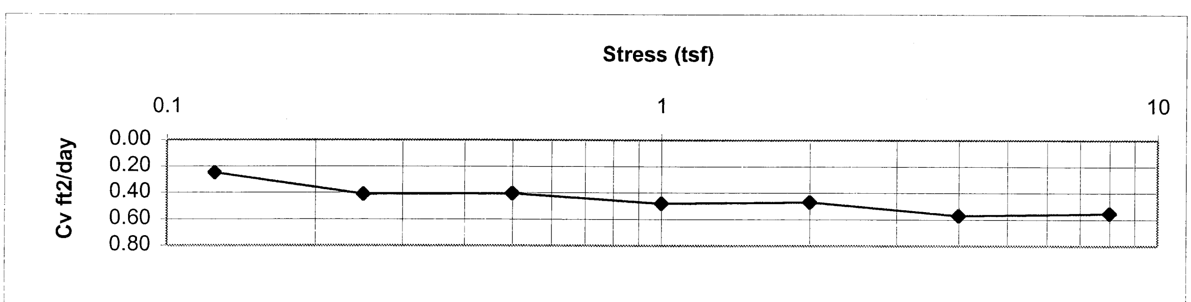
Consolidation Test Results





ANALYTICAL RESOURCES INCORPORATED





ANALYTICAL RESOURCES INCORPORATED

Project Number:	HZ66	Client:		Floyd-Snider
Boring / Sample	GWS-GC-04-S4	Job Number		COS-
Sample Initial Height	1.0017	Job Location		Gasworks Park
Initial Dial Reading	0.5243	DI After Seating Load		0.526

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	H	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.5257	0.5248	0.5247	0.5245	0.5	0.5245	0.2623	1.166	0.005	-0.0002
0.5239	0.5226	0.5225	0.5215	1.5	0.5215	0.2608	0.384	0.01	0.0028
0.5207	0.5102	0.5090	0.5090	11	0.5090	0.2545	0.050	0.02	0.0153
0.5080	0.4675	0.4630	0.4630	35	0.4630	0.2315	0.013	0.04	0.0612
0.4620	0.3965	0.3892	0.3890	25	0.3890	0.1945	0.013	0.09	0.1351
0.3895	0.3402	0.3347	0.3330	13	0.3330	0.1665	0.018	0.14	0.1910
0.3330	0.2520	0.2430	0.2400	28	0.2400	0.1200	0.004	0.24	0.2838
0.2420	0.2539	0.2552	0.2554	7	0.2554	0.1277	0.020	0.09	0.2684
0.2560	0.2875	0.2910	0.2910	28	0.2910	0.1455	0.006	0.02	0.2329
0.2912	0.3500	0.3565	0.3565	90	0.3565	0.1783	0.003	0.005	0.1675

Sample Parameters

Initial Moisture Content, %	500	Final Moisture Content, %	410
Initial Dry Unit Weight, lb/ft^3	11	Final Dry Unit Weight, lb/ft^3	13
Initial Void Ratio	13.31	Final Void Ratio	10.89
Initial Saturation	0.92	Final Saturation	0.95

The following equations were used to calculate the values shown in the table above:

$$Cv = T\ H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2
$(S_0 + S_{100})/2$ (for double drainage paths)

t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

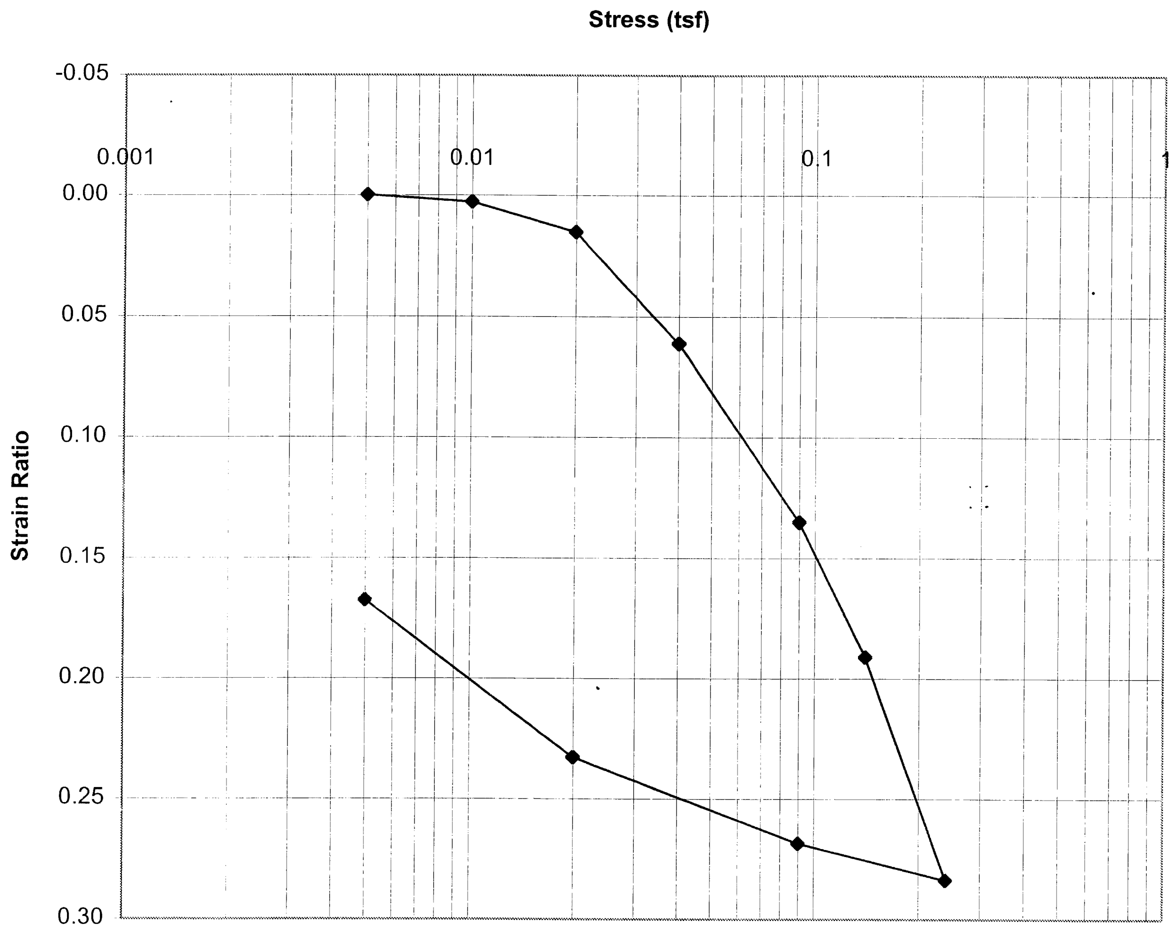
Notes to the Testing:

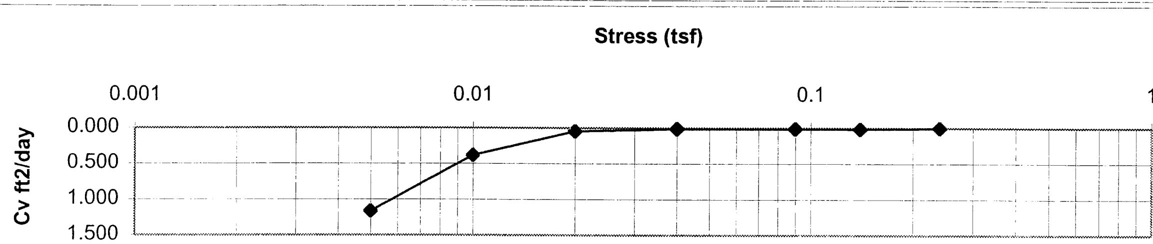
1. The sample was extruded from the sample tube and trimmed into a consolidation ring.
2. The sample was organic silt, which swelled when inundated with water.

ANALYTICAL RESOURCES INCORPORATED

Consolidation Test Results

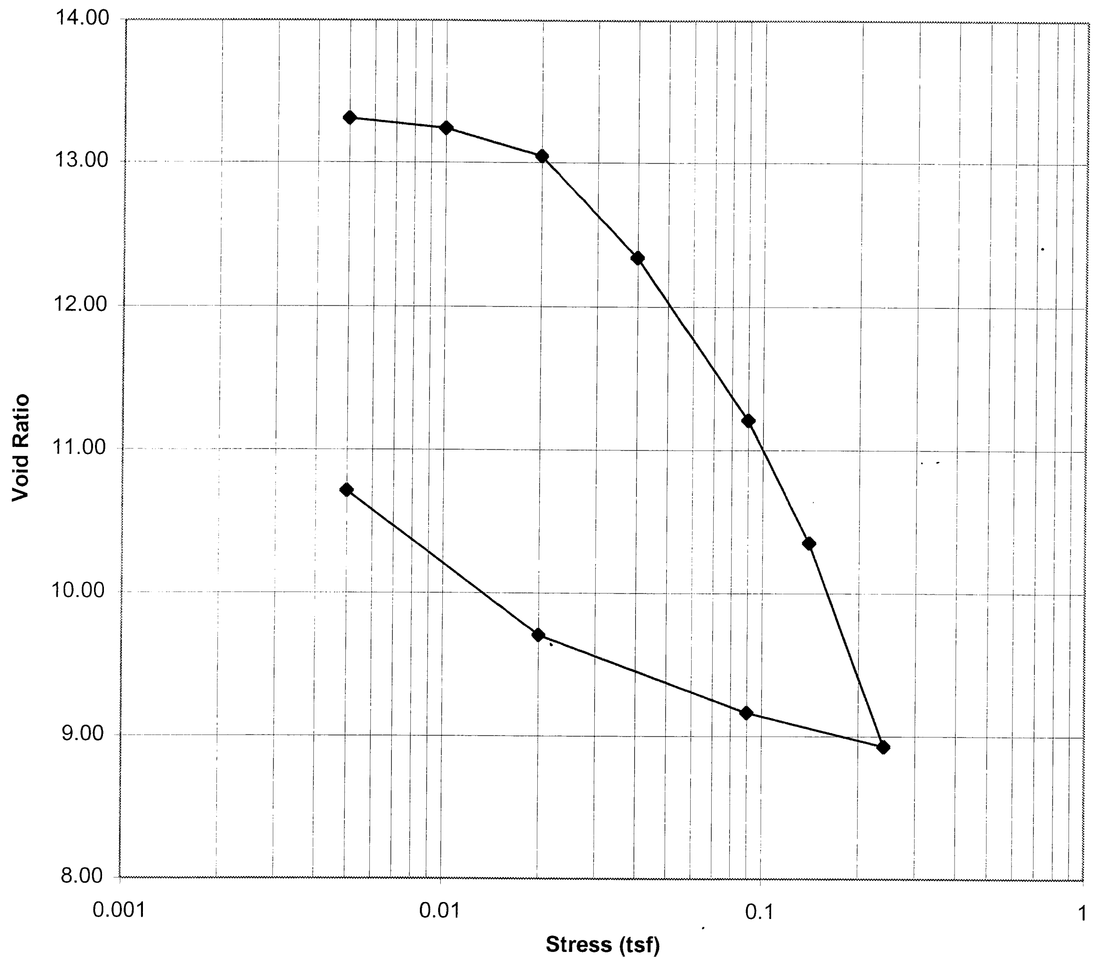
GWS-GC-04-S4

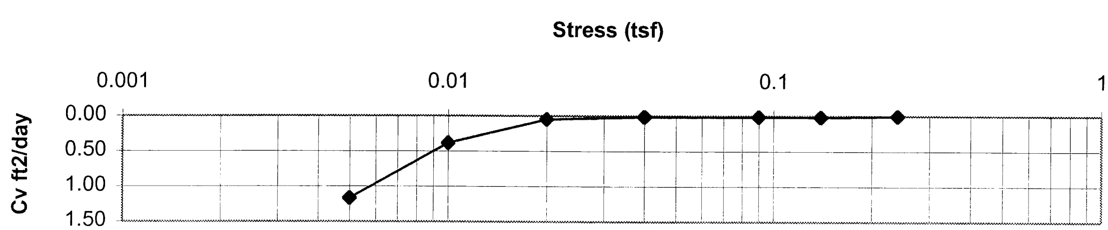




Consolidation Test Results

GWS-GC-04-S4





ANALYTICAL RESOURCES INCORPORATED

Project Number:	IA09	Job Name:		Gasworks RI/FS
Boring / Sample	GWS-GC06-S3	Job Number		COS-SPUDR-.0400
Sample Initial Height	1.0014	Job Location		Seattle
Initial Dial Reading	0.5268	DI After Seating Load		0.5282

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	H	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.5278	0.5270	0.5269	0.5267	0.5	0.5267	0.2634	1.176	0.005	0.0001
0.5262	0.5247	0.5245	0.5247	1.8	0.5247	0.2624	0.324	0.01	0.0021
0.5235	0.5165	0.5157	0.5153	5	0.5153	0.2577	0.113	0.02	0.0115
0.5123	0.4915	0.4892	0.4892	10.5	0.4892	0.2446	0.048	0.04	0.0375
0.4855	0.4280	0.4216	0.4180	18.5	0.4180	0.2090	0.020	0.09	0.1086
0.4190	0.3552	0.3481	0.3461	34	0.3461	0.1731	0.007	0.14	0.1804
0.3586	0.3661	0.3669	0.3682	5.8	0.3682	0.1841	0.050	0.04	0.1584
0.3675	0.4190	0.4247	0.4336	35	0.4336	0.2168	0.011	0.01	0.0931

Sample Parameters

Initial Moisture Content, %	732	Final Moisture Content, %	678
Initial Dry Unit Weight, lb/ft^3	8	Final Dry Unit Weight, lb/ft^3	9
Initial Void Ratio	13.84	Final Void Ratio	12.44
Initial Saturation	0.92	Final Saturation	1.00

The following equations were used to calculate the values shown in the table above:

$$Cv = T\ H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2

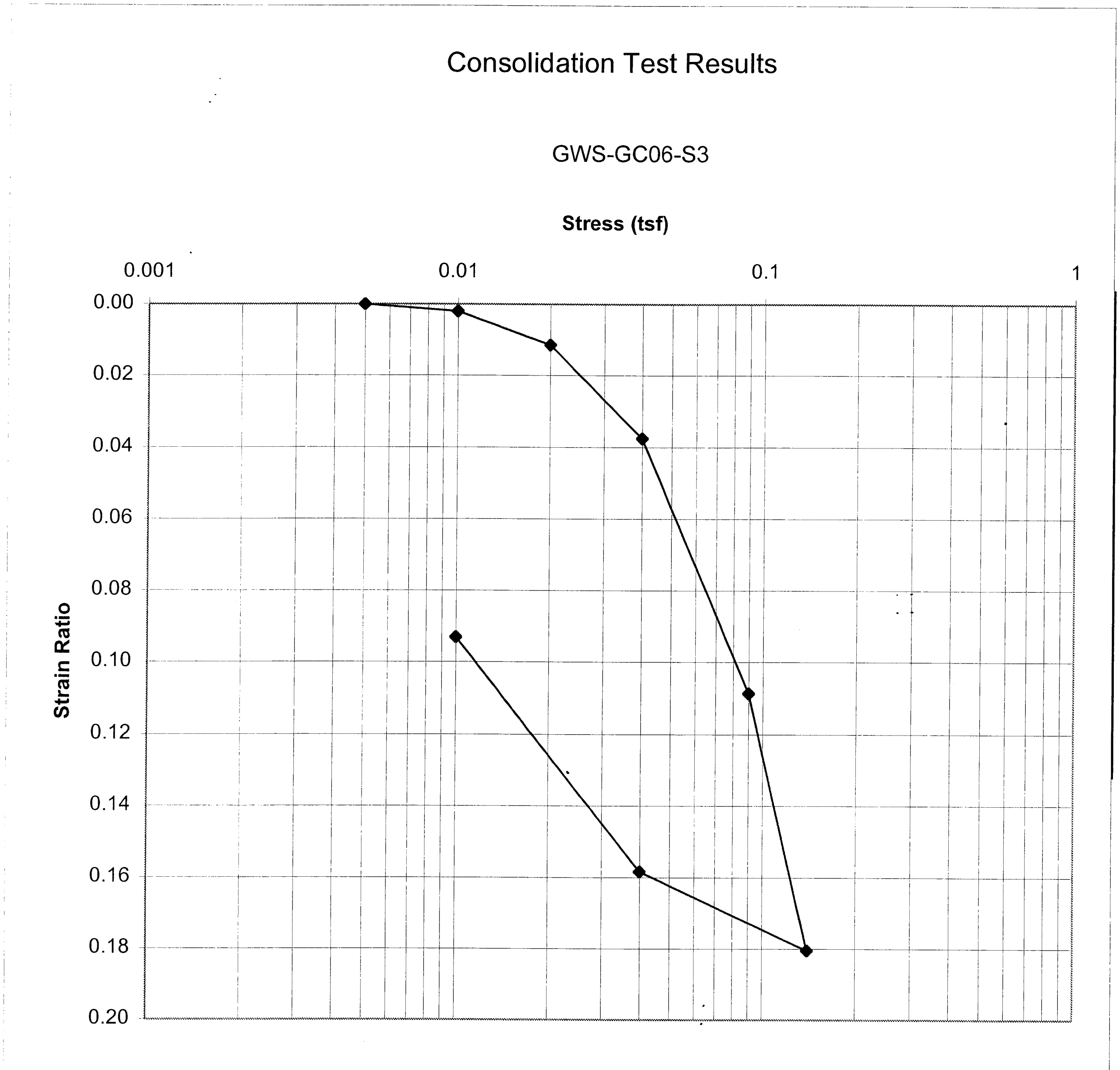
$(S_0 + S_{100})/2$ (for double drainage paths)

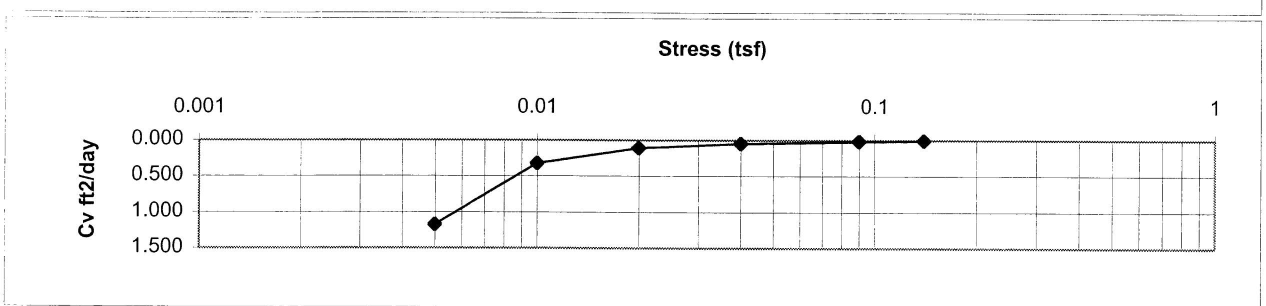
t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

Notes to the Testing:

1. The sample was extruded from the sample tube and trimmed into a consolidation ring.
2. The sample was peat, which began to swell when inundated with water.

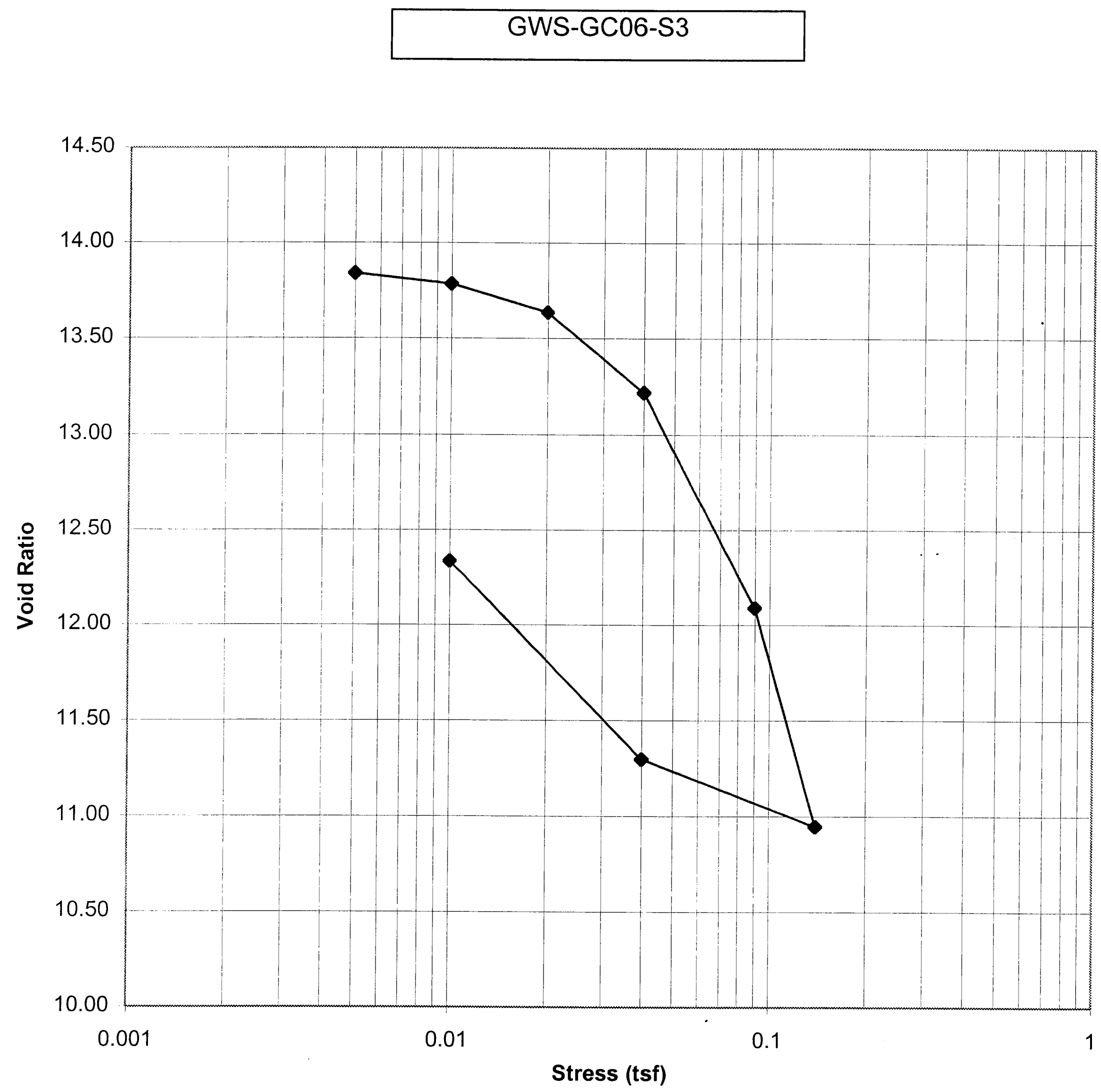
ANALYTICAL RESOURCES INCORPORATED

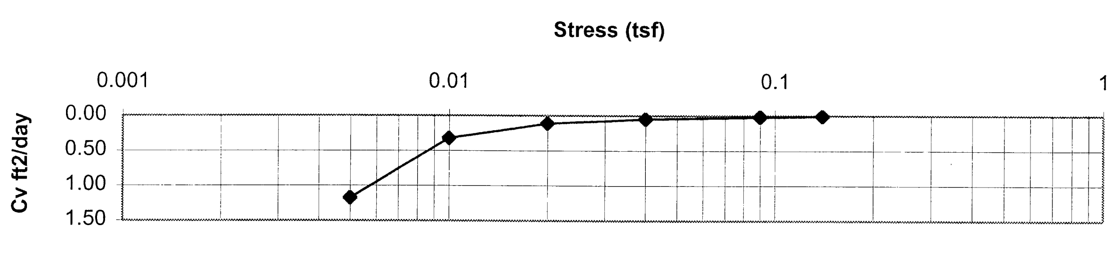




ANALYTICAL RESOURCES INCORPORATED

Consolidation Test Results





ANALYTICAL RESOURCES INCORPORATED

Project Number:	IA09	Job Name:		Gasworks RI/FS
Boring / Sample	GWS-GC06-S7	Job Number		COS-SPUDR-.0400
Sample Initial Height	1.0000	Job Location		Seattle
Initial Dial Reading	0.5268	DI After Seating Load		0.49

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	H	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.4898	0.4895	0.4895	0.4895	0.4	0.4895	0.2448	1.270	0.005	0.0005
0.4891	0.4882	0.4881	0.4881	3.5	0.4881	0.2441	0.144	0.01	0.0019
0.4875	0.4850	0.4847	0.4845	1.5	0.4845	0.2423	0.332	0.02	0.0055
0.4830	0.4778	0.4772	0.4770	1.5	0.4770	0.2385	0.322	0.04	0.0130
0.4735	0.4650	0.4641	0.4580	0.5	0.4580	0.2290	0.889	0.09	0.0320
0.4563	0.4438	0.4424	0.4423	2.5	0.4423	0.2212	0.166	0.14	0.0477
0.4400	0.4113	0.4081	0.4080	4	0.4080	0.2040	0.088	0.24	0.0820
0.4060	0.3342	0.3262	0.3262	7	0.3262	0.1631	0.032	0.44	0.1638
0.3250	0.2235	0.2122	0.2122	6.25	0.2122	0.1061	0.015	0.84	0.2778
0.2153	0.2265	0.2277	0.2290	0.75	0.2290	0.1145	0.148	0.24	0.2610
0.2292	0.2500	0.2523	0.2530	2.5	0.2530	0.1265	0.054	0.09	0.2370
0.2538	0.3020	0.3074	0.3074	16	0.3074	0.1537	0.013	0.02	0.1826
0.3083	0.3422	0.3460	0.3494	38.5	0.3494	0.1747	0.007	0.005	0.1406

Sample Parameters

Initial Moisture Content, %	546	Final Moisture Content, %	481
Initial Dry Unit Weight, lb/ft^3	10	Final Dry Unit Weight, lb/ft^3	12
Initial Void Ratio	11.73	Final Void Ratio	9.94
Initial Saturation	0.92	Final Saturation	1.01

The following equations were used to calculate the values shown in the table above:

$$Cv = T\, H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2

$(S_0 + S_{100})/2$ (for double drainage paths)

t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

Notes to the Testing:

1. The sample was extruded from the sample tube and trimmed into a consolidation ring.
2. The sample was peat, which began to swell when inundated with water.

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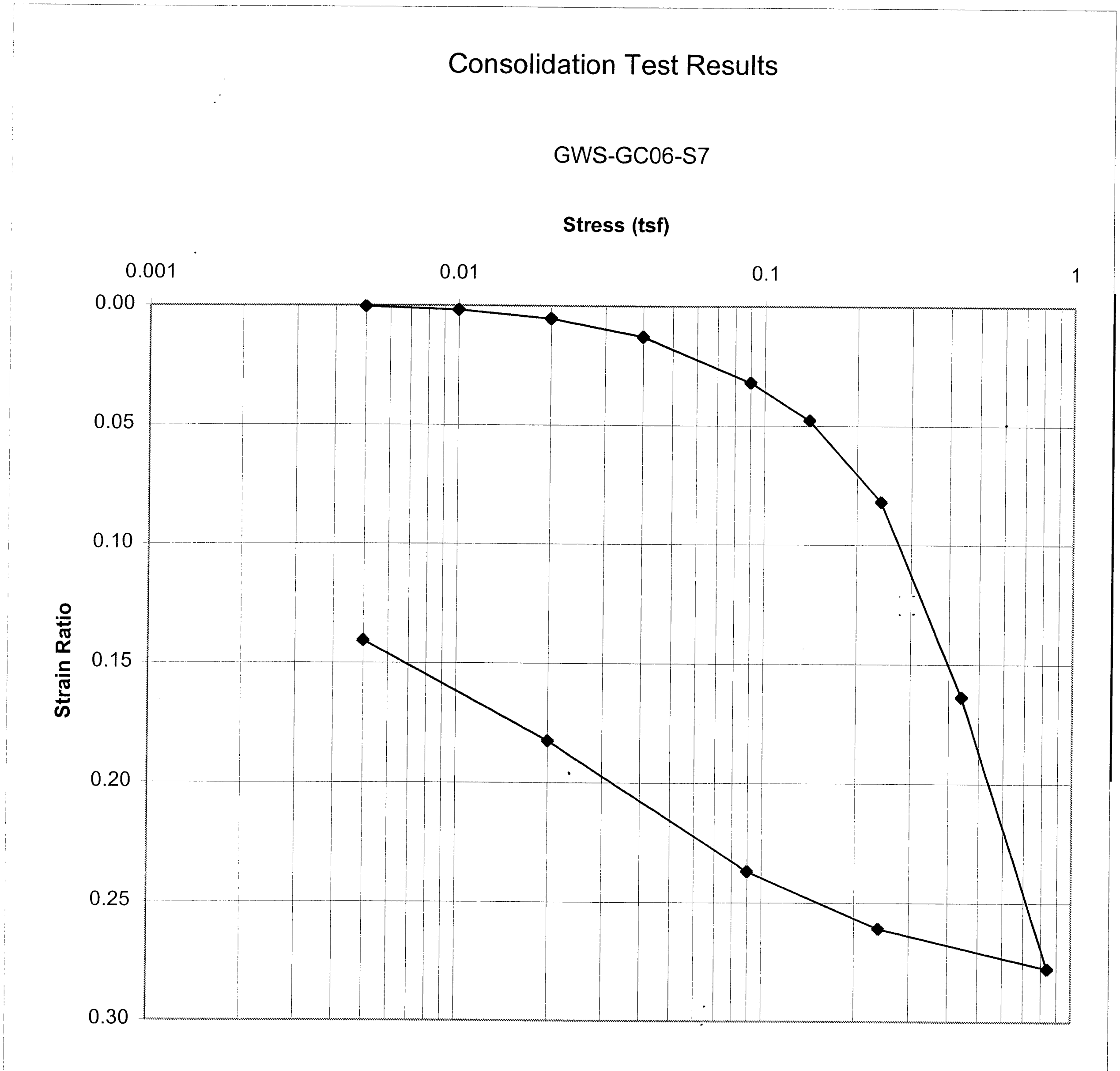

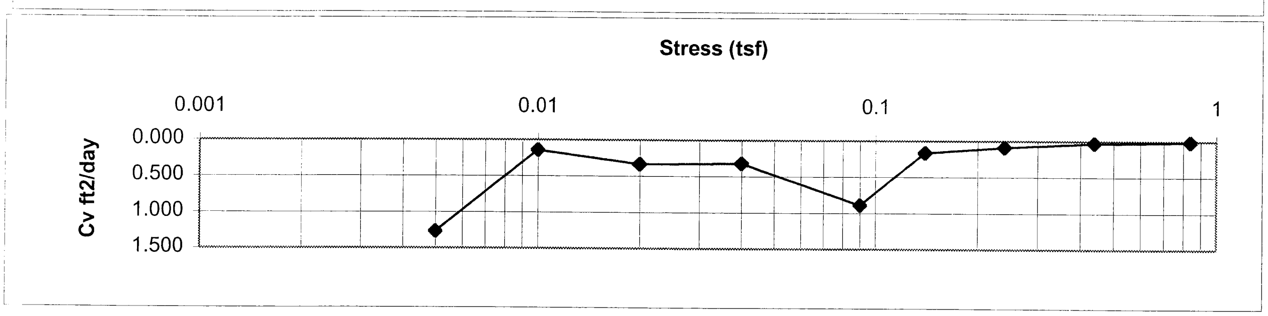

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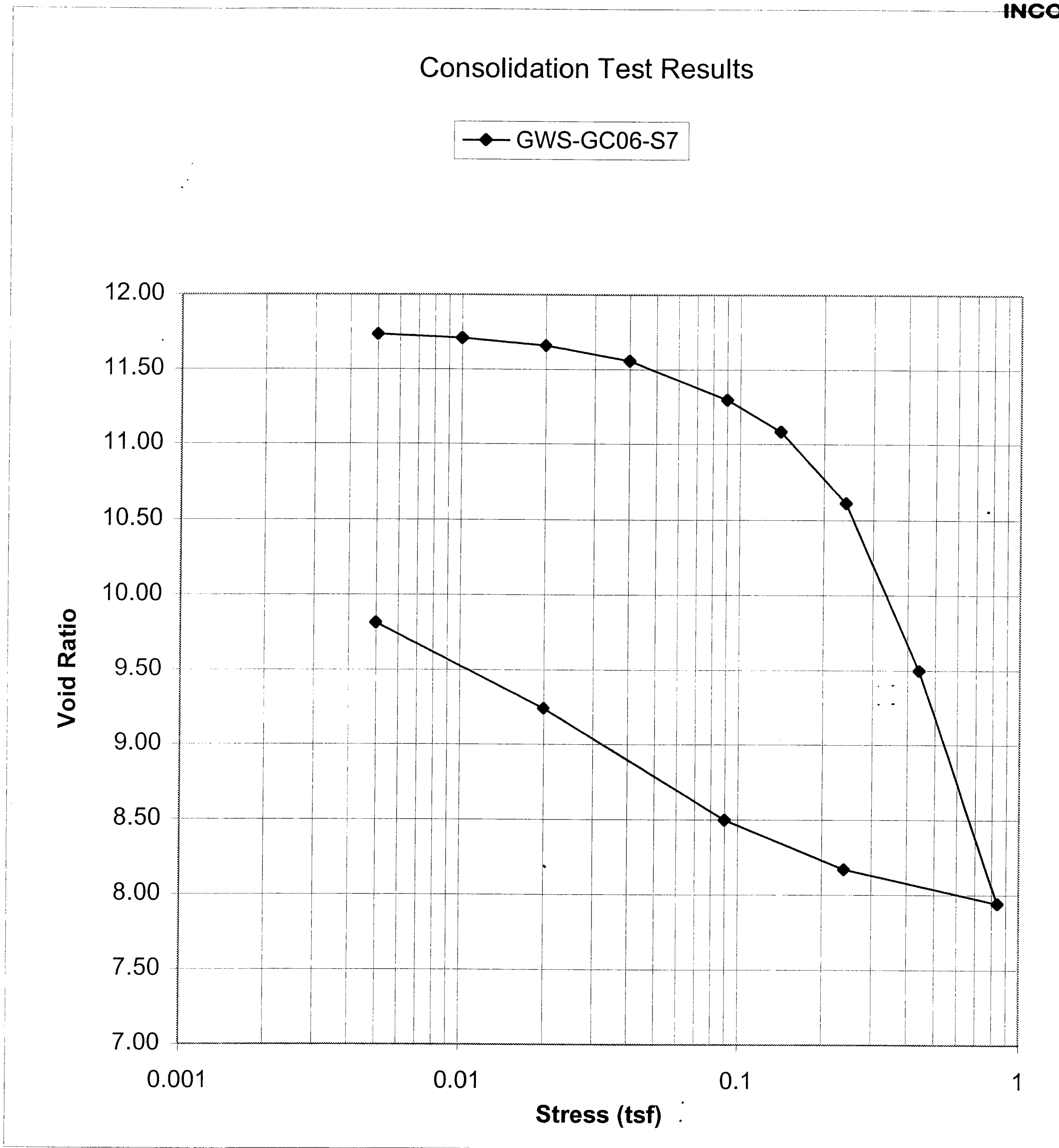

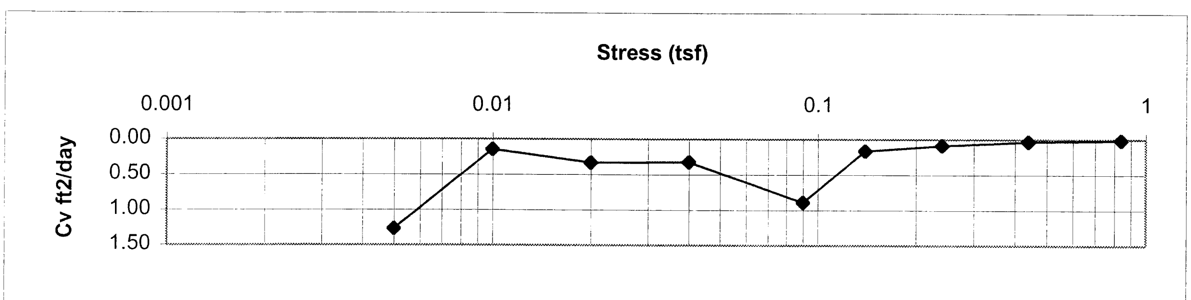

ANALYTICAL RESOURCES INCORPORATED

Project Number:	IA09	Job Name:	Gasworks RI/FS
Boring / Sample	QWS-GC06-S11	Job Number	COS-SPUDR-.0400
Sample Initial Height	1.1007	Job Location	Seattle
Initial Dial Indicator	0.4993	DI after Seating load	0.5

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	Sample Height	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.4999	0.4981	0.4979	0.4974	0.50	1.0981	0.5491	0.511	0.03125	0.0017
0.4968	0.4929	0.4925	0.4925	7.00	1.0932	0.5466	0.036	0.0625	0.0062
0.4916	0.4890	0.4887	0.4875	0.60	1.0882	0.5441	0.418	0.125	0.0107
0.4843	0.4772	0.4764	0.4765	2.50	1.0772	0.5386	0.098	0.25	0.0207
0.4732	0.4600	0.4585	0.4573	2.50	1.0580	0.5290	0.095	0.5	0.0382
0.4500	0.4250	0.4222	0.4170	1.50	1.0177	0.5089	0.146	1	0.0748
0.4080	0.3330	0.3247	0.3280	3.00	0.9287	0.4644	0.061	2	0.1556
0.3320	0.2570	0.2487	0.2350	2.00	0.8357	0.4179	0.074	4	0.2401
0.2414	0.2429	0.2431	0.2430	0.40	0.8437	0.4219	0.377	1	0.2329
0.2540	0.2604	0.2611	0.2620	1.50	0.8627	0.4314	0.105	0.25	0.2156
0.2662	0.2735	0.2743	0.2750	2.00	0.8757	0.4379	0.081	0.0625	0.2038

Sample Parameters

Initial Moisture Content, %	94	Final Moisture Content, %	66
Initial Dry Unit Weight, lb/ft^3	44	Final Dry Unit Weight, lb/ft^3	56
Initial Void Ratio	2.95	Final Void Ratio	2.14
Initial Saturation	0.84	Final Saturation	0.84

The following equations were used to calculate the values shown in the table above:

$$Cv = T\,H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2

$(S_0 + S_{100})/2$ (for double drainage paths)

t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

Notes to the Testing:

1. The sample was extruded from the sample tube and trimmed into a consolidation ring. The sample was inundated at the time of the seating load was applied. The test was run according to ASTM D-2435, Method B.
2. The sample was soft gray clay.

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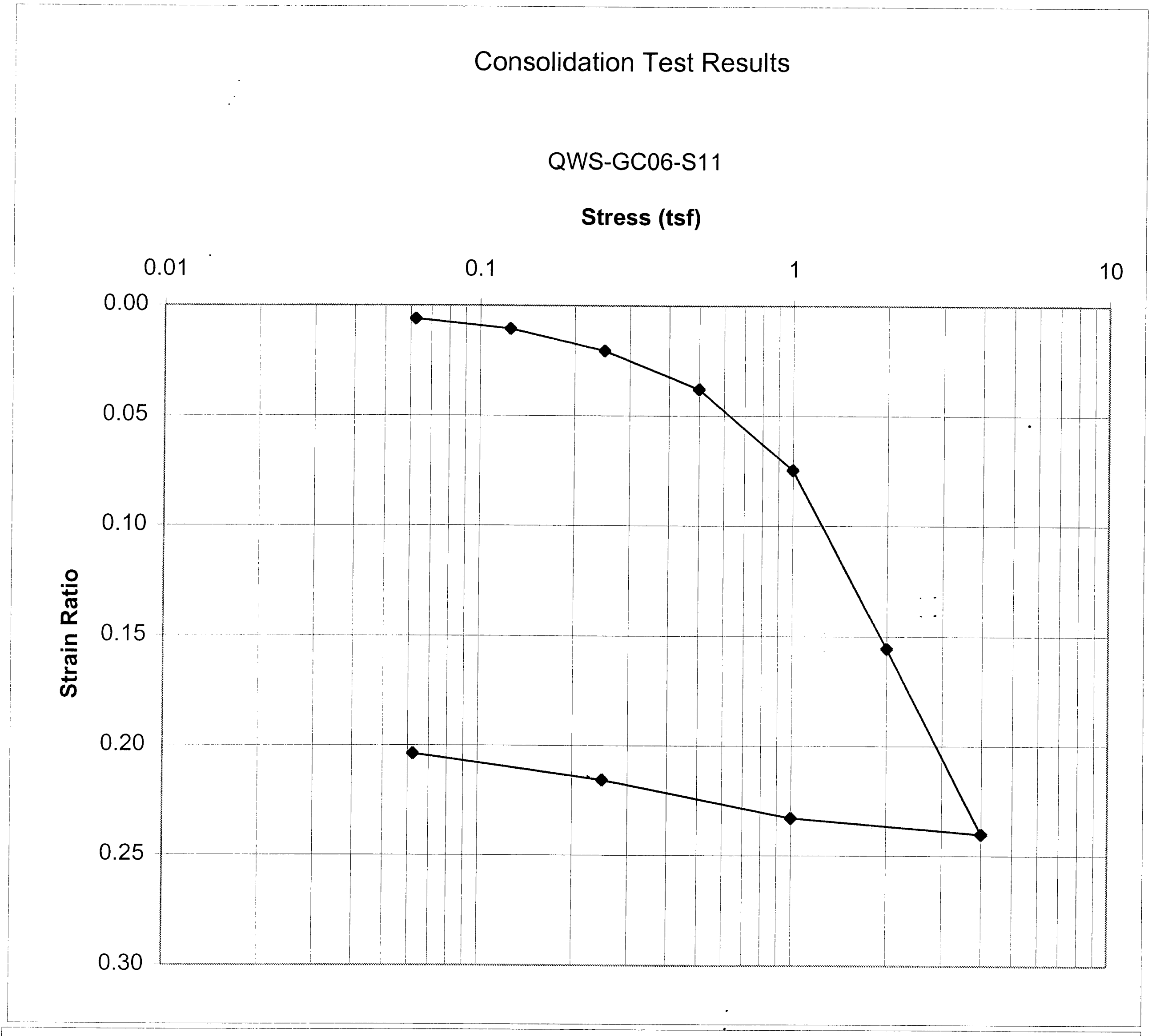

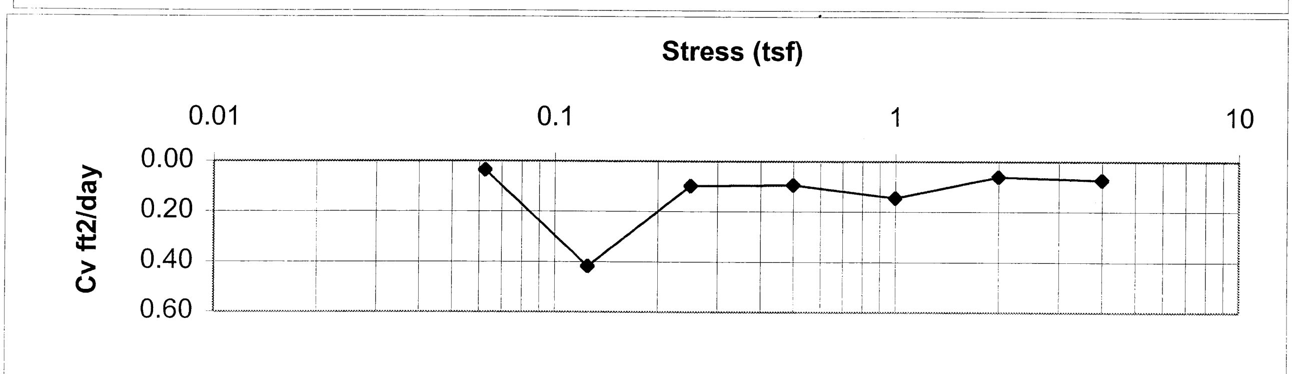

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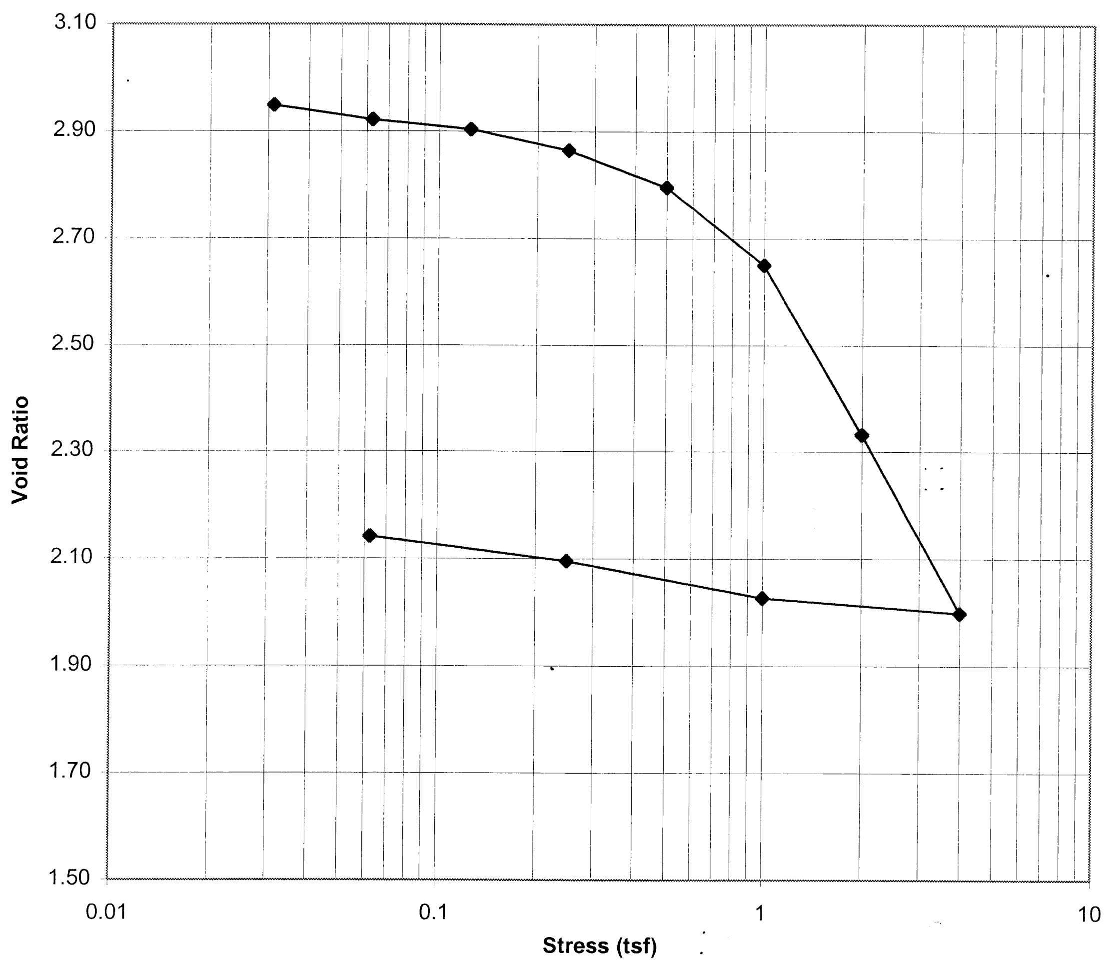
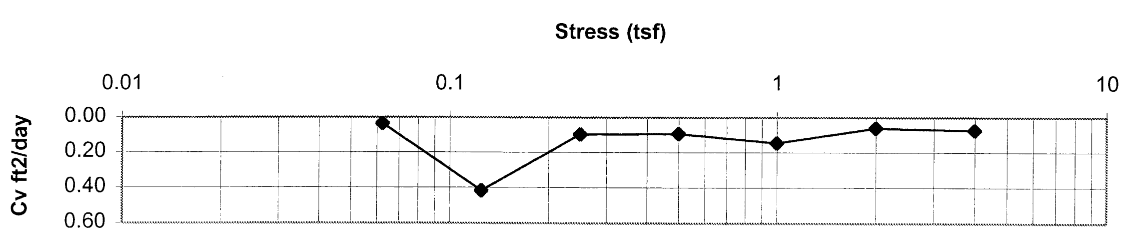
Consolidation Test Results

QWS-GC06-S11





ANALYTICAL RESOURCES INCORPORATED

Project Number:	IA09	Job Name:	Gasworks RI/FS
Boring / Sample	QWS-GC06-S13	Job Number	COS-SPUDR-.0400
Sample Initial Height	1.0955	Job Location	Seattle
Initial Dial Indicator	0.5085	DI after Seating load	0.504

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	Sample Height	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.5038	0.5018	0.5016	0.5013	1.00	1.0928	0.5464	0.253	0.03125	0.0066
0.5007	0.4954	0.4948	0.4950	4.50	1.0865	0.5433	0.056	0.0625	0.0123
0.4932	0.4812	0.4799	0.4800	8.00	1.0715	0.5358	0.030	0.125	0.0260
0.4765	0.4558	0.4535	0.4550	12.00	1.0465	0.5233	0.019	0.25	0.0488
0.4510	0.4064	0.4014	0.4014	23.00	0.9929	0.4965	0.009	0.5	0.0978
0.3955	0.3528	0.3481	0.3481	16.00	0.9396	0.4698	0.012	1	0.1464
0.3579	0.3590	0.3591	0.3495	0.50	0.9410	0.4705	0.375	0.25	0.1451
0.3507	0.3587	0.3596	0.3596	9.00	0.9511	0.4756	0.021	0.0625	0.1359

Sample Parameters

Initial Moisture Content, %	65	Final Moisture Content, %	52
Initial Dry Unit Weight, lb/ft^3	55	Final Dry Unit Weight, lb/ft^3	64
Initial Void Ratio	2.09	Final Void Ratio	1.69
Initial Saturation	0.84	Final Saturation	0.84

The following equations were used to calculate the values shown in the table above:

$$Cv = T\,H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2

$(S_0 + S_{100})/2$ (for double drainage paths)

t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

Notes to the Testing:

1. The sample was extruded from the sample tube and trimmed into a consolidation ring. The sample was inundated at the time of the seating load was applied. The test was run according to ASTM D-2435, Method B.
2. The sample was soft gray clay.

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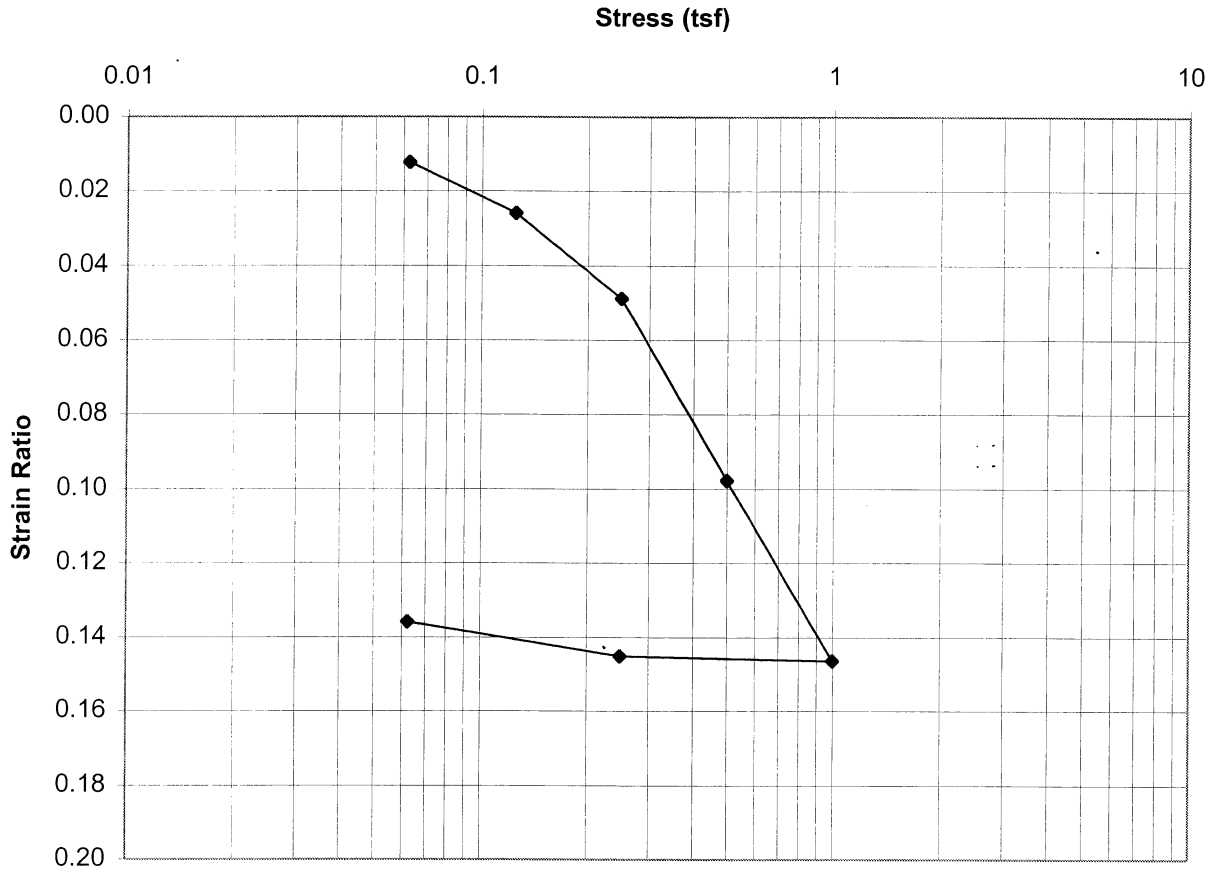
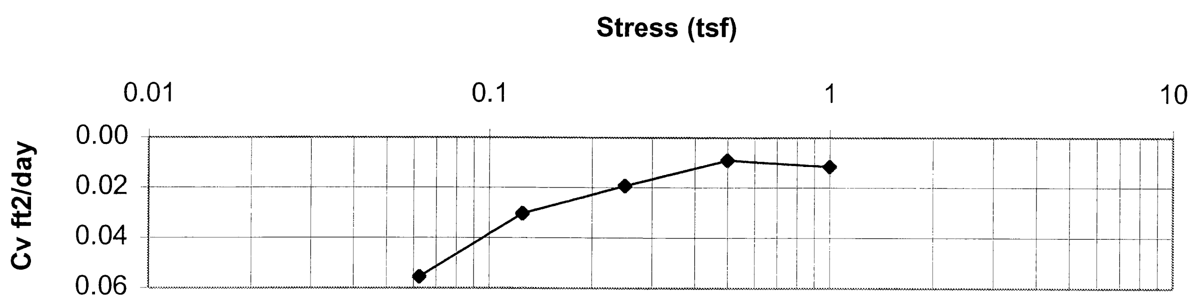
Consolidation Test Results

QWS-GC06-S13





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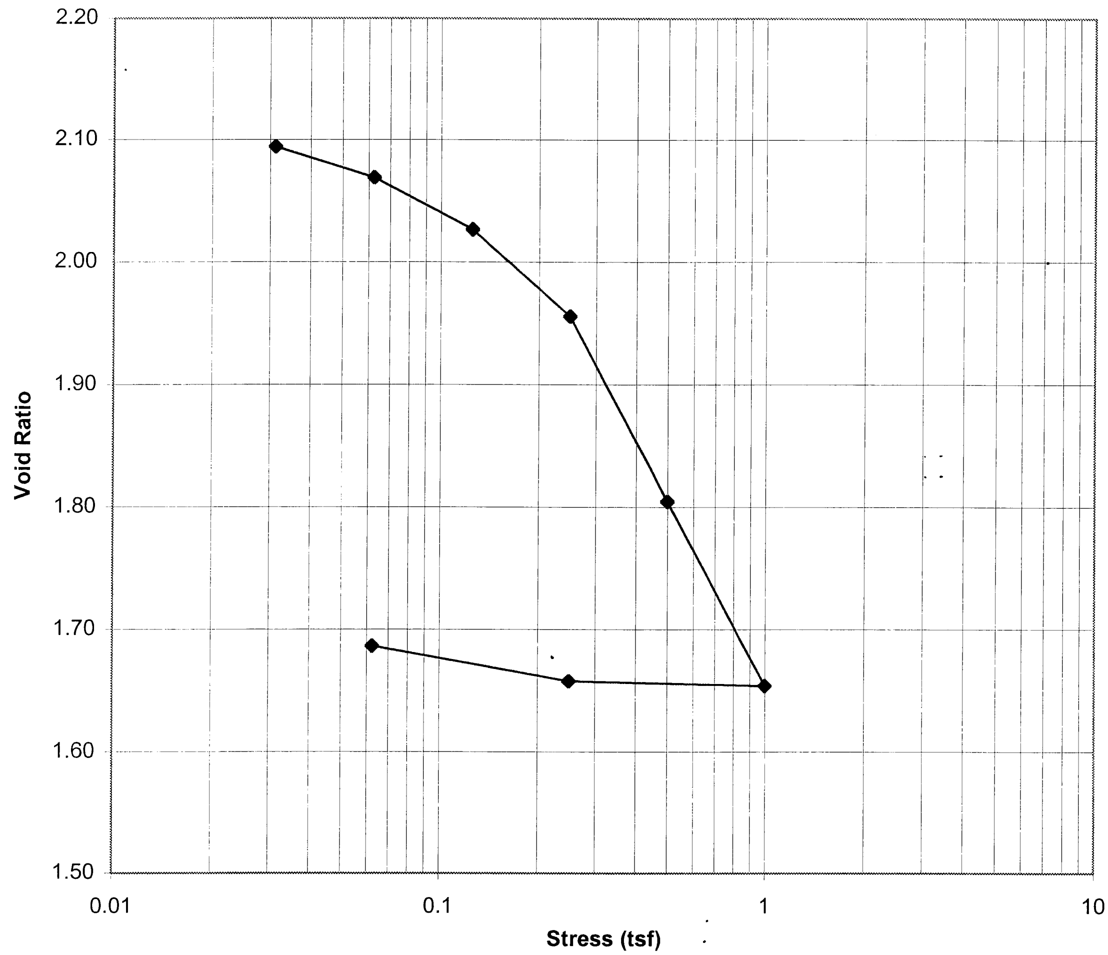
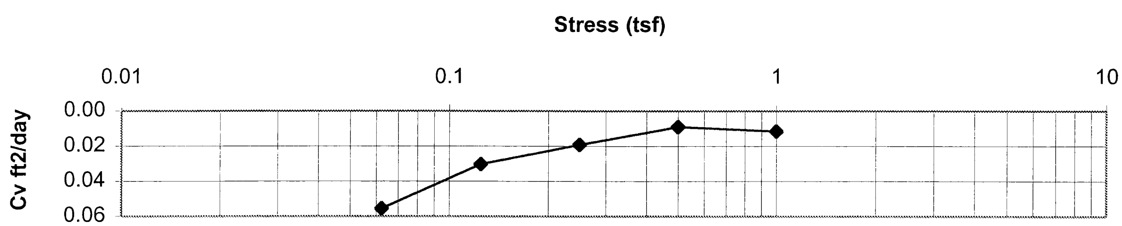
Consolidation Test Results

QWS-GC06-S13





ANALYTICAL RESOURCES INCORPORATED

Project Number:	IA11	Job Name:		Floyd / Snider
Boring / Sample	GWS-GC05-S2	Job Number		COS-SPUDR.0040
Sample Initial Height	0.9984	Job Location		Gas Works
Initial Dial Reading	0.5295	DI After Seating Load		0.4574

Consolidation Test Summary

S_0	S_{90}	S_{100}	S_f	t_{90} (min)	H	Drainage Path	Cv (ft^2/day)	Load (tsf)	Strain Ratio
0.4570	0.5175	0.5242	0.4551	1	0.4551	0.2276	0.439	0.005	0.0039
0.4547	0.4995	0.5045	0.4501	4	0.4501	0.2251	0.107	0.01	0.0089
0.4493	0.4753	0.4782	0.4380	8	0.4380	0.2190	0.051	0.02	0.0210
0.4377	0.3947	0.3899	0.3880	30	0.3880	0.1940	0.011	0.04	0.0711
0.3885	0.3100	0.3013	0.3013	34	0.3013	0.1507	0.006	0.09	0.1580
0.3005	0.2350	0.2277	0.2277	55	0.2277	0.1139	0.002	0.14	0.2317
0.2283	0.2368	0.2377	0.2410	1.5	0.2410	0.1205	0.082	0.04	0.2183
0.2410	0.2841	0.2889	0.2889	36	0.2889	0.1445	0.005	0.01	0.1704

Sample Parameters

Initial Moisture Content, %	426	Final Moisture Content, %	345
Initial Dry Unit Weight, lb/ft^3	12	Final Dry Unit Weight, lb/ft^3	16
Initial Void Ratio	9.14	Final Void Ratio	6.78
Initial Saturation	0.92	Final Saturation	1.02

The following equations were used to calculate the values shown in the table above:

$$Cv = T\, H^2/t_{90}$$

Where:

T = the time factor for 90% consolidation

H = average of initial and final heights of the sample at each load, divided by 2

$(S_0 + S_{100})/2$ (for double drainage paths)

t_{90} = the time at which 90% consolidation has occurred, as derived from square root of time plots for each load.

Notes to the Testing:

1. The sample was extruded from the sample tube and trimmed into a consolidation ring.
2. The sample was Peat.

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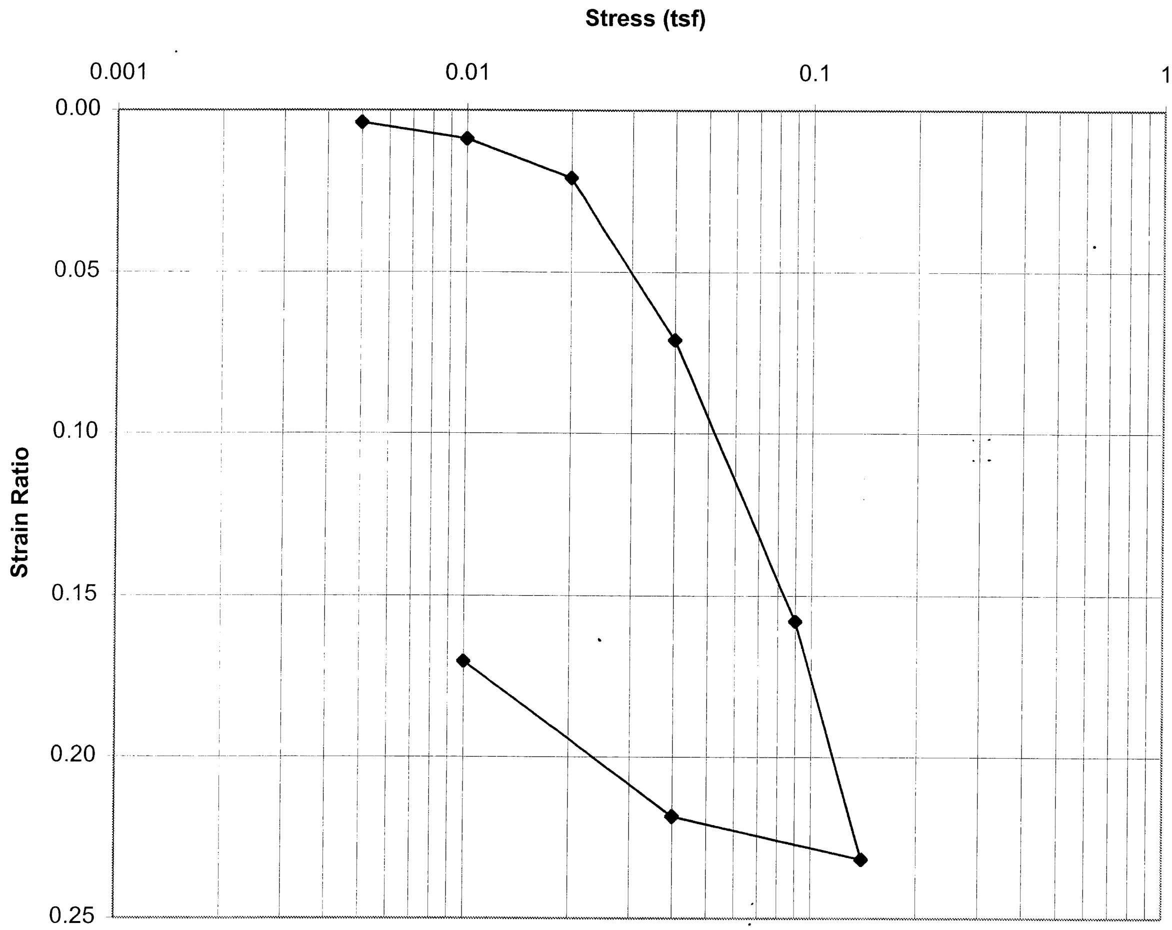
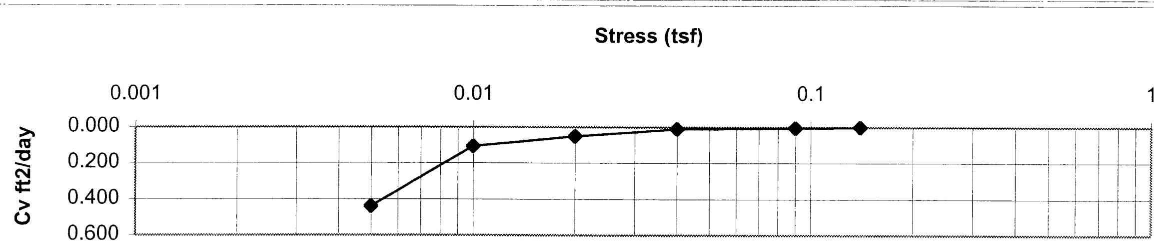
Consolidation Test Results

GWS-GC05-S2





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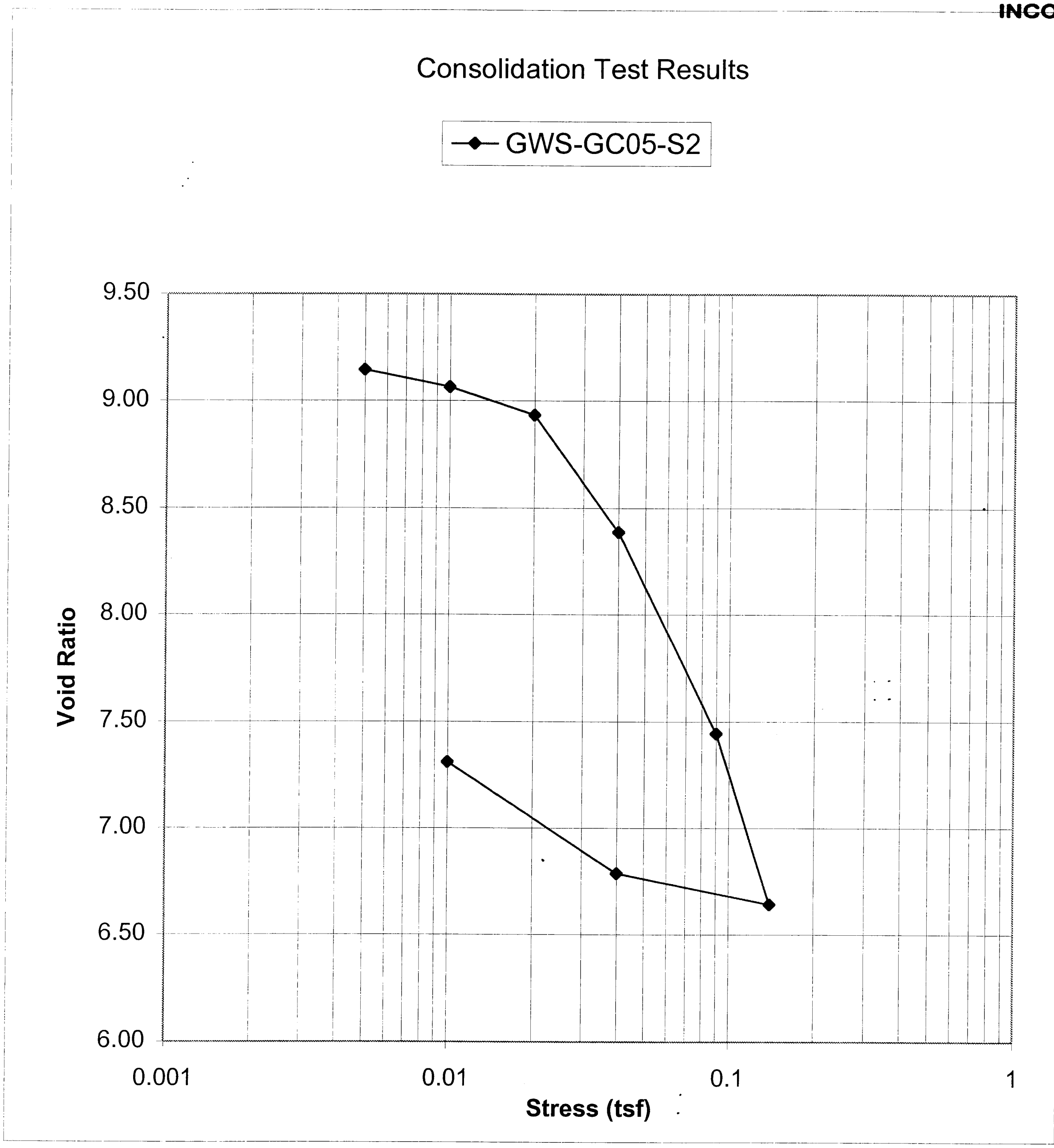

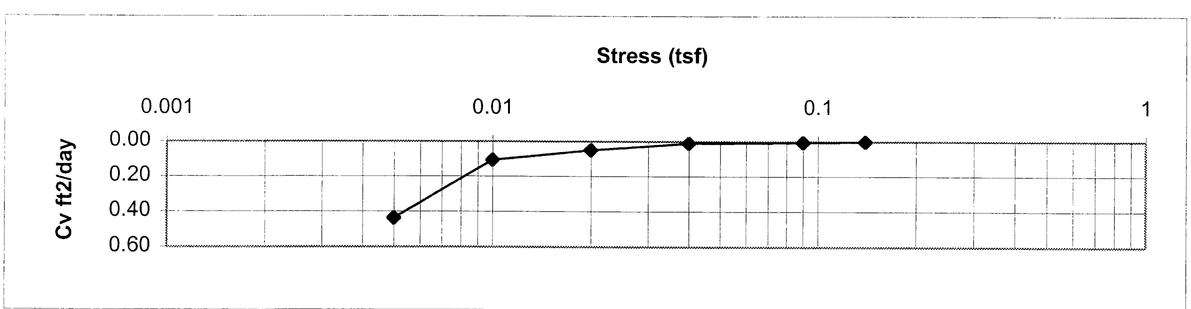

SUB-ATTACHMENT 3D-2.7
Herrera 2009 NLSY Investigation Geotechnical Data

Herrera Environmental Consultants, Inc.

Memorandum

To	Mark Longtine, L.G., Ecology & Environment, Inc.
cc	Alexander Whitman, P.E., Ecology and Environment, Inc.
From	Chris Brummer, Ph.D., P.E., L.E.G. and Rob Zisette, Herrera Environmental Consultants
Date	July 2, 2009
Subject	Northlake Shipyard Geotechnical Sampling and Analysis

Introduction and Purpose

This memorandum presents the results of the geotechnical laboratory testing of lake sediments collected from Lake Union, Seattle, Washington, within the vicinity of the Northlake Shipyard. Collection and analysis of the geotechnical cores were conducted in accordance with the revised final Northlake Shipyard Sandblast Grit Study Sampling and Analysis Plan (SAP; Ecology and Environment, Inc. 2009). The geotechnical samples were collected in coordination with sandblast grit identification and characterization activities. The geotechnical cores were collected on April 20, 2009, from locations that appeared to be representative of conditions across an area potentially subject to grit removal pending determination by Ecology. Laboratory analyses occurred through May 29, 2009. The purpose of the geotechnical sampling and analysis was to provide information required to develop a dredge plan for the sandblast grit area associated with the Northlake Shipyard.

Sample Locations

A total of four sediment cores were collected from the project area and submitted to Analytical Resources, Inc. (ARI) for geotechnical analyses. A fifth geotechnical core was attempted at station NS01-G, but the core was rejected due to insufficient recovery. Three of the cores were split into 24-inch intervals, for a total of seven analytical samples. Core collection information is summarized in the Northlake Shipyard Sandblast Grit Study Report. Geotechnical samples are summarized as follows:

- Sample NS06-G was collected from the sloping shoreline at an approximate depth of 30 feet below the water surface.
- Sample NS05-G was collected at a depth of approximate depth of 39 feet within the transition zone between the toe of the sloping shoreline and the flat lake bottom. The core was split into two samples (intervals 0 – 24 inches and 24 – 48 inches).
- Samples NS12-G and NS18-G were collected at depths of 40 feet and 39 feet, respectively, within the flat lake bottom at the distal limits of the project area. Both cores were split into two samples each (intervals 0 – 24 inches and 24 – 48 inches).

Sample locations are shown in Figures 3-1 and 3-2 of the Northlake Shipyard Sandblast Grit Study Report.

Sampling Methods

Geotechnical sediment cores were collected using the same methods and equipment as the sandblast grit characterization sediment cores, as described in the Northlake Shipyard Sandblast Grit Study Report. Geotechnical sediment core locations were selected based on field screening results and methods described in the SAP (Ecology and Environment, Inc. 2009).

In most instances, the divers were able to advance the cores beyond 30 inches below the sediment surface, with percent recovery ranging from 38.5 to 94.1 percent. Poor penetration and recovery depths occurred at Station NS01-G, due to large amounts of debris and sandblast grit at the sediment surface. Because of these limitations and poor sediment recovery, the core from Station NS01-G was rejected and station NS06-G was selected as a replacement.

Laboratory Testing

The core samples were submitted to ARI on April 21, 2009 for the following analyses:

- Grain size, sieve, and hydrometer (ASTM D 422)
- Moisture content (ASTM D 2216)
- Porosity calculated from specific gravity (ASTM D 854) and bulk unit weight (ASTM D 2937)
- Atterberg limits (ASTM D 4318)
- Consolidation (ASTM D 2435)
- Vane shear (ASTM D 4648)
- Unconsolidated, undrained triaxial strength tests (ASTM D 2850)

All testing was performed in accordance with the SAP, except the samples were not analyzed for unconsolidated, undrained triaxial strength tests (ASTM D 2850) because the extruded sediments were not able to stand undeformed under their own weight at a height-to-diameter ratio of 2:1. As a result, it was decided, in consultation with the E & E project manager and the Ecology project manager, to substitute the the unconsolidated, undrained triaxial strength test with a tilting table test. The tilting table test was performed in accordance with *Parsons, J. D., Whipple, K. X., and Simoni, A., 2001, Experimental study of the grain-flow, fluid-mud transition in debris flows, Journal of Geology 109(4), pages 427-447*. In general, the tilting table test consisted of extruding a 7-mm to 9-mm core on a roughened piece of plywood, slowly tilting the board, and noting the angle at which the sample failed. The yield strength of the sample was calculated from the product of the sample unit weight, sample height, and sine of the titling board angle at failure.

Quality Assurance/ Quality Control

Laboratory testing was conducted in accordance with ARI's laboratory QA/QC Plan. Herrera provided quality assurance review of the laboratory results and procedures that generally consisted of cross-checking laboratory results with field descriptions of sample cores, checking laboratory results for internal consistency, and maintaining regular communications with ARI during testing and reporting of results. The laboratory results are considered to be acceptable and generally meet the measurement objectives specified in the SAP (Ecology and Environment 2009).

Analytical Results

The following sections describe the analytical laboratory results of the geotechnical testing. A summary of geotechnical results is presented in Table 1; the complete laboratory report is included in the Northlake Shipyard Sandblast Grit Study Report.

Subsurface conditions

Detailed lithologic information on the materials encountered in the geotechnical cores is inferred based on the descriptions for the grit identification and characterization cores presented in Section 7 of the Northlake Shipyard Sandblast Grit Study Report.

Grain size analysis, sieve, and hydrometer (ASTM D 422)

Most of the samples contained less than 10 percent sand and gravel. Exceptions include sample NS06-G (0-18), which contained approximately 88 percent sand and gravel, and sample NS18-G (24-48), which contained approximately 20 percent sand and gravel.

Atterberg limits (ASTM D 4318)

All samples except NS05-G (0-24) and NS06-G (0-18) were classified as high-plasticity, organic clays (OH) with liquid limits greater than 50. Sample NS05-G (0-24) was classified as a high-plasticity silt (MH) due the high silt content. Sample NS06-G (0-18) was determined to be non-plastic due to high sand and gravel content.

Bulk unit weight (ASTM D 2937)

The bulk unit weight is reported as both wet and dry density. Wet density is calculated from the known volume and weight of an undisturbed sample; dry density is calculated from the same volume as wet density without water. Wet densities ranged from 59.1 to 96.7 lbs/ft^3; dry densities ranged from 6.3 to 69.3 lbs/ft^3, with the highest value measured in the sandy gravelly sample (NS06-G).

Moisture content (ASTM D 2216)

The moisture content was measured from the center of each of the four cores upon receipt of the samples and again from tilting table samples. The moisture content of samples ranged from 38.1 to 881 percent. The lowest values were measured in cores NS05-G and NS06-G, collected from the sloping shoreline and transition zone. The highest values were found in cores NS12-G and NS18-G collected from the distal lake bottom. The anomalously low value measured from the center of NS05-G may be attributed to the presence of suspected coke briquettes found in this sample. The higher moisture content measured for this sample during the tilting table analysis may have been due to an absence of suspected coke briquettes in the analyzed portion of the sample, and may be more representative of the sediment moisture content in the sample.

Porosity calculated from specific gravity (ASTM D 854) and bulk unit weight (ASTM D 2937)

The porosity of samples ranged from 0.59 to 0.95. The lowest values were measured in samples NS05-G and NS06-G collected from the sloping shoreline and transition zone, whereas the highest values were found in samples NS12-G and NS18-G collected from the distal lake bottom.

Consolidation (ASTM D 2435)

The rate of consolidation of saturated clay deposits is a function of several factors that include permeability, void ratio, sample thickness, and the ratio of new loading relative to the loading history. A higher consolidation coefficient (c_v) indicates a longer time required for a given percentage of consolidation to occur during loading. Maximum consolidation measured for each sample ranged from 0.05 to 0.7 ft^2/day, with the highest consolidation coefficient identified for sample NS06-G.

Vane shear (ASTM D 4648)

Measurements of the unconfined shear strength of samples were conducted in the laboratory on undisturbed cores using a hand-held vane shear apparatus fitted with large vanes (vane ratio of 0.2). Results of the vane shear testing were highly variable and ranged from <20 lbs/ft^2 (the minimum reading possible) to 400 lbs/ft^2. The anomalously high value was found in sample NS05-G and may be due to the presence of the suspected coke briquettes or other debris found in this sample.

Tilting table (Parsons et al. 2001)

The yield strength calculated from the tilting table ranged from 5.3 to 14 lbs/ft^2. Results indicate that all of the core samples are composed of extremely weak sediments.

Dredging Considerations

The lake bottom sediments are very weak, compressible, and exhibit extremely high water contents. The properties of the soft sediments may pose some difficulties with the application of dredging technologies whether mechanical or hydraulic. The geotechnical properties of the soft sediments (low strength and high water content) are not sufficient to maintain a stable cut surface or sidewall during dredging. The soft sediments will be prone to re-suspension and sloughing at the dredge margin. Total source removal by dredging (without an excessive amount of over-excavation) may not be possible due to these limitations. The risks to in-water infrastructure (e.g., shoreline and piers) as a result of dredging is not a significant concern due to the depth of embedment of existing piles below the weak surface sediments and the shallow depth (less than 4 feet) of anticipated dredging.

Table 1. Summary of geotechnical laboratory results for sediment cores collected from Lake Union adjacent to the Northlake Shipyard.

Station		NS05-G	NS05-G	NS06-G	NS12-G	NS12-G	NS18-G	NS18-G
Depth Interval (Inches)		0 - 24	24 - 48	0 - 18	0 - 24	24 - 48	0 - 24	24 - 48
Date Sampled		4/20/2009	4/20/2009	4/20/2009	4/20/2009	4/20/2009	4/20/2009	4/20/2009
Time Sampled		13:05	13:05	17:30	15:05	15:05	16:20	16:20
Particle/ Grain Size	Gravel (percent)	0.2	0.3	10.8	0.1	0.1	0.1	9.9
	Sand (percent)	3.0	5.8	76.6	2.9	0.7	9.4	10.2
	Silt (percent)	52.4	50.9	7.4	48.9	47.0	43.7	33.4
	Clay (percent)	44.5	42.9	5.2	48.0	52.5	46.9	46.5
Wet Density (lb/ft^3)		96.7	64.5	95.7	72.9	62.9	84.9	59.1
Moisture Content (percent)	Center of core	126	126	38.1	881	881	843	843
	Tilting Table sample	120	684	42.6	252	870	163	NA[1]
Dry Density (lb/ft^3)		42.8	28.5	69.3	7.4	6.4	9.0	6.3
Porosity (standard units)		0.73	0.75	0.59	0.95	0.95	0.94	0.95
Atterberg Limits	Plasticity Index (percent)	28.1	493	NA[2]	345	453	390	519
	Liquid Limit (percent)	87.4	655	NA[2]	486	625	510	718
	Plastic Limit (percent)	59.3	162	NA[2]	141	172	120	199
	USCS Classification	MH	OH	SM	OH	OH	OH	OH
Max. Consolidation, c_v (ft^2/day)		0.21	0.2	0.7	0.08	0.05	0.11	0.18
Shear Strength, Vane Shear (lb/ft^2)		<20	400	<20	<20	<20	<20	<20
Shear Strength, Tilting Table (lb/ft^2)		10	8.8	14	5.3	5.3	12	NA[1]

[1] A tilting table test was not performed for sample NS18-6 (24-48) because the sample was disturbed during an attempt to setup for a triaxial test.

[2] Atterberg limits are not available for sample NS06-G (0-18) due to lack of fines.

Table 7-2. Grain Size Field Screening and Laboratory Analytical Results

Core Location ID	Sample ID	Depth Interval (feet below top of core)	Field Screening Weight % >125 um DW	PSEP Grain Size (weight % DW)													
				Sum Phi <-1 to 3 (> 125 um) Fine Sand and Coarser	Phi < -1 (>2000 um) Gravel	Phi -1 to 0 (2000 - 1000 um) Very Coarse Sand	Phi 0 to 1 (1000 - 500 um) Coarse Sand	Phi 1 to 2 (500 - 250 um) Medium Sand	Phi 2 to 3 (250 - 125 um) Fine Sand	Phi 3 to 4 (125 - 62.5 um) Very Fine Sand	Phi 4 to 5 (62.5 - 31 um) Coarse Silt	Phi 5 to 6 (31 - 15.6 um) Medium Silt	Phi 6 to 7 (15.6 - 7.8 um) Fine Silt	Phi 7 to 8 (7.8 - 3.9 um) Very Fine Silt	Phi 8 to 9 (3.9 - 2.0 um) Clay	Phi 9 to 10 (2.0 - 1.0 um) Clay	Phi >10 (<1.0 um) Clay
NS01	NS01-GC-10	0 - 1	76.37	74.8	6.3	18.4	24	18	8.2	4.1	5.1	5	3.7	3.4	1.7	0.9	1.4
	NS01-GC-15	1 - 1.5	12.48														
NS02	NS02-GC-10	0 - 1	20.05	12.6	0.3	2.2	3.5	3.5	3.2	4.1	8	19.8	15.7	13.6	8.1	6.8	11.3
	NS02-GC-20	1 - 2	80.75	80.1	4.7	6.4	12	28.9	28.1	10.8	1.5	1.5	0.9	1.2	1.1	0.9	1.8
	NS02-GC-30	2 - 3	43.88														
	NS02-GC-40	3 - 4	60.72														
NS03	NS03-GC-10	0 - 1	25.17	20.7	0.5	3.2	5.4	5.5	6.1	5	4	14.4	17.1	14	9.3	6.4	9.2
	NS03-GC-20	1 - 2	2.45														
	NS03-GC-30	2 - 3	1.55														
	NS03-GC-40	3 - 4	2.45														
	NS03-GC-45	4 - 4.5	7.85														
NS04	NS04-GC-10	0 - 1	83.81	69	6.8	12.3	20.3	20.1	9.5	4.5	2.9	5.4	3.9	4.2	3.1	2.7	4.3
	NS04-GC-20	1 - 2	3.56	4.4	0.4	0.8	1.2	1.1	0.9	1.5	4.6	16.7	19.7	17.1	11.8	9.4	14.8
NS05	NS05-GC-10	0 - 1	29.48														
	NS05-GC-20	1 - 2	30.32														
	NS05-GC-30	2 - 3	13.03														
	NS05-GC-40	3 - 4	14.55														
	NS05-GC-50	4 - 5	NA														
NS06	NS06-GC-10	0 - 1	58.67	65.2	3.5	7.2	11.1	21.1	22.3	8.8	5.4	2.1	6.9	4.9	2.7	1.8	2.1
	NS06-GC-20	1 - 2	61.74														
NS07	NS07-GC-10	0 - 1	2.38	8.2	0.8	1.9	1.2	1.3	2.9	6.3	11.8	13.8	10.6	16.2	9.7	8.2	15.2
	NS07-GC-20	1 - 2	2.20														
	NS07-GC-30	2 - 3	0.36	4.2	0.3	2.8	0.5	0.3	0.3	1	0.5	7.3	16.8	17.2	25.1	12.5	15.3
	NS07-GC-40	3 - 4	1.61														
NS08	NS08-GC-10	0 - 1	2.57	3.1	0.1	1.1	1.2	0.5	0.3	1.5	4.8	13.2	16.8	18.6	13.2	11.2	17.6
	NS08-GC-20	1 - 2	5.58														
	NS08-GC-30	2 - 3	2.91														
	NS08-GC-40	3 - 4	1.05														
	NS08-GC-50	4 - 5	0.00														
NS09	NS09-GC-02	0 - 0.2	NA														
	NS09-GC-10	0 - 1	3.41	2.1	0.1	0.6	0.6	0.4	0.5	0.7	3.5	8.7	19.4	21	14.5	11.9	18.3
	NS09-GC-20	1 - 2	0.66														
	NS09-GC-30	2 - 3	2.68														
NS10	NS10-GC-10	0 - 1	1.82	1.4	0.2	0.2	0.4	0.5	0.2	0.2	3	11.2	17	21.6	13.9	12.7	19.1
	NS10-GC-20	1 - 2	2.19														
	NS10-GC-30	2 - 3	0.35														
	NS10-GC-40	3 - 4	1.36														
	NS10-GC-50	4 - 5	0.09														
NS11	NS11-GC-10	0 - 1	4.32	6	0.1	2.4	2	1	0.7	0.8	3.3	10.1	18.9	14.5	15.7	11.8	18.8
	NS11-GC-20	1 - 2	0.23														
	NS11-GC-30	2 - 3	0.58														
NS12	NS12-GC-10	0 - 1	4.20														
	NS12-GC-20	1 - 2	1.01														
	NS12-GC-30	2 - 3	1.81														
	NS12-GC-40	3 - 4	1.66														
	NS12-GC-50	4 - 5	7.65														
NS13	NS13-GC-10	0 - 1	5.37	4.6	0.1	0.2	0.3	0.5	3.7	9.6	6.4	14	24.7	17.3	7	6.5	10
	NS13-GC-20	1 - 2	7.73	5.8	0.1	1.3	1.3	1.3	1.9	8.8	13.7	19.8	13.7	13.1	9.3	6.6	9.3
	NS13-GC-30	2 - 3	2.29														
	NS13-GC-40	3 - 4	6.71														
NS14	NS14-GC-10	0 - 1	2.82	6.5	0.1	2.8	1.6	0.8	1.2	1.7	3.5	11	16.2	19.5	14.8	10.1	16.6
	NS14-GC-20	1 - 2	1.87														
	NS14-GC-30	2 - 3	2.95														
	NS14-GC-40	3 - 4	2.20														
NS15	NS15-GC-10	0 - 1	0.43														
	NS15-GC-20	1 - 2	2.33														
	NS15-GC-30	2 - 3	2.91														
	NS15-GC-40	3 - 4	0.58														

Table 7-2. Grain Size Field Screening and Laboratory Analytical Results

Core Location ID	Sample ID	Depth Interval (feet below top of core)	Field Screening Weight % >125 um DW	PSEP Grain Size (weight % DW)													
				Sum Phi <-1 to 3 (> 125 um) Fine Sand and Coarser	Phi < -1 (>2000 um) Gravel	Phi -1 to 0 (2000 - 1000 um) Very Coarse Sand	Phi 0 to 1 (1000 - 500 um) Coarse Sand	Phi 1 to 2 (500 - 250 um) Medium Sand	Phi 2 to 3 (250 - 125 um) Fine Sand	Phi 3 to 4 (125 - 62.5 um) Very Fine Sand	Phi 4 to 5 (62.5 - 31 um) Coarse Silt	Phi 5 to 6 (31 - 15.6 um) Medium Silt	Phi 6 to 7 (15.6 - 7.8 um) Fine Silt	Phi 7 to 8 (7.8 - 3.9 um) Very Fine Silt	Phi 8 to 9 (3.9 - 2.0 um) Clay	Phi 9 to 10 (2.0 - 1.0 um) Clay	Phi >10 (<1.0 um) Clay
NS16	NS16-GC-10	0 - 1	1.84	3.7	0.1	0.7	0.3	0.7	2	2.5	3.6	10.7	16.1	21.3	13.8	10	18.4
	NS16-GC-20	1 - 2	1.54														
	NS16-GC-30	2 - 3	0.67														
	NS16-GC-40	3 - 4	2.95														
	NS16-GC-50	4 - 5	2.00														
NS17	NS17-GC-10	0 - 1	2.49	2.1	0.1	0.1	0.1	0.6	1.2	2	24	8.9	11.7	13.7	10.8	8	18.9
	NS17-GC-20	1 - 2	1.26														
	NS17-GC-30	2 - 3	3.27														
	NS17-GC-40	3 - 4	2.04														
NS18	NS18-GC-10	0 - 1	4.10														
	NS18-GC-20	1 - 2	0.43														
	NS18-GC-30	2 - 3	2.91														
	NS18-GC-40	3 - 4	5.66														
NS19	NS19-GC-10	0 - 1	NA	3.4	0.1	0.1	0.2	0.7	2.4	5.1	7	12.2	16.1	18.7	11.7	9	16.6
	NS19-GC-20	1 - 2	NA	4.8	0.5	2	1.3	0.4	0.5	2.7	8.6	10.2	15.5	16	12.9	10.4	19
	NS19-GC-30	2 - 3	NA														
NS20	NS20-GC-10	0 - 1	20.81	20.8	0.3	0.5	1.1	5.4	13.6	10.1	6.6	9.6	13.2	13.9	9.5	5	11.1
	NS20-GC-20	1 - 2	36.77														
	NS20-GC-30	2 - 3	NA														
NS21	NS21-GC-10	0 - 1	30.44														
NS23	NS23-GC-10	0 - 1	0.42														
	NS23-GC-20	1 - 2	2.88														
	NS23-GC-30	2 - 3	1.55														
NS24	NS24-GC-10	0 - 1	2.42														
	NS24-GC-20	1 - 2	5.76														
	NS24-GC-30	2 - 3	10.78														
NS26	NS26-GC-10	0 - 1	3.73														
	NS26-GC-20	1 - 2	0.00														
	NS26-GC-30	2 - 3	6.66														
NS27	NS27-GC-10	0 - 1	9.56														
	NS27-GC-20	1 - 2	NA														
	NS27-GC-30	2 - 3	32.08														
NS28	NS28-GC-02	0 - 0.2	NA														
	NS28-GC-10	0 - 1	6.85														
	NS28-GC-20	1 - 2	4.72														
	NS28-GC-30	2 - 3	0.65														
NS29	NS29-GC-10	0 - 1	2.93														
	NS29-GC-20	1 - 2	1.30														
	NS29-GC-30	2 - 3	5.40														
NS33	NS33-GC-10	0 - 1	3.50														
	NS33-GC-20	1 - 2	0.60														
	NS33-GC-30	2 - 3	0.90														
NS34	NS34-GC-02	0 - 0.2	NA														
	NS34-GC-10	0 - 1	2.38														
	NS34-GC-20	1 - 2	0.54														
	NS34-GC-30	2 - 3	3.80														
NS35	NS35-GC-10	0 - 1	96.75														

Key:
DW = Dry weight
ft = Feet
ID = Identification
NA = Not analyzed
PSEP = Puget Sound Estuary Program
um = Micrometer