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Pacific Northwest National Laboratory
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Core Sampling in Support of the Vadose Zone Transport Field Study

G. V. Last
T. G. Caldwell

March 2001

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

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Introduction

Soil samples were collected from three boreholes in support of the Vadose Zone Transport Field Study (VZTFS). These samples were collected to determine geotechnical and geochemical characteristics of the field test site before and after a number of water and tracer injection tests. The scope of the VZTFS experiments and the *Sampling and Analysis Plan* for collection of soil cores is presented in the *Detailed Test Plan* (Ward and Gee, 2000). The discussion below presents a detailed account of the core sampling and a description of the geologic materials penetrated by these boreholes.

Sampling Locations

Three of four planned boreholes (Figure 1) were sampled using a hollow-stem auger and splitspoon sampler as described in the sampling and analysis plan (Ward and Gee, 2000). Note however, that the location of borehole S-3 was shifted from the original location to provide temporal data at the same radial distance from the injection well, as borehole S-2. The fourth borehole (S-4) was never completed. However, 3 additional boreholes were sampled at later dates using a cone penetrometer and wireline-sampling tool. The first of these wireline-sampling holes (CP1) is discussed in a report by Bratton and Dickerson[1]. Only the boreholes S-1, S-2, and S-3 are discussed here.

The *Sampling and Analysis Plan* (Ward and Gee, 2000) generally called for continuous splitspoon sampling to a depth of 18 m (59 ft). Subsamples (e.g. individual liners within the sampler) would then be selected from stratigraphic units of interest and submitted for laboratory analyses. Splitspoon samples were actually collected (nearly continuously) from between 4 and 6 m (13-19 ft) in depth, to about 12 m (40 ft) in depth, and at approximately every meter (4 ft) thereafter to a total depth of 17 m (56.5 ft). Table 1 summarizes the pertinent sampling information for each borehole.

Drilling and Sampling Methodology

Each borehole was drilled using a Mobile Drill 61 drill rig and 25 cm (10 in.) OD hollow-stem auger flights. The upper 4 m (13 ft) of each borehole was drilled with a pilot bit inside the hollow-stem auger to keep drill cuttings out. Once the borehole was advanced to the desired sampling interval, the pilot bit was removed, and a 7.6 cm (3 in) ID by 0.6 m (2 ft) long splitspoon sampler was lowered to the bottom of the borehole.

---

[1] Bratton, W. L. and W. C. Dickerson. August 2000. Informal Report “Vadose Zone Transport Field Study, Cone Penetrometer Tests, ERT, Advanced Tensiometer, and Well Installation at the Sisson and Lu Site.” ARA Report No. 0099. Applied Research Associates, Inc., Richland, Washington.

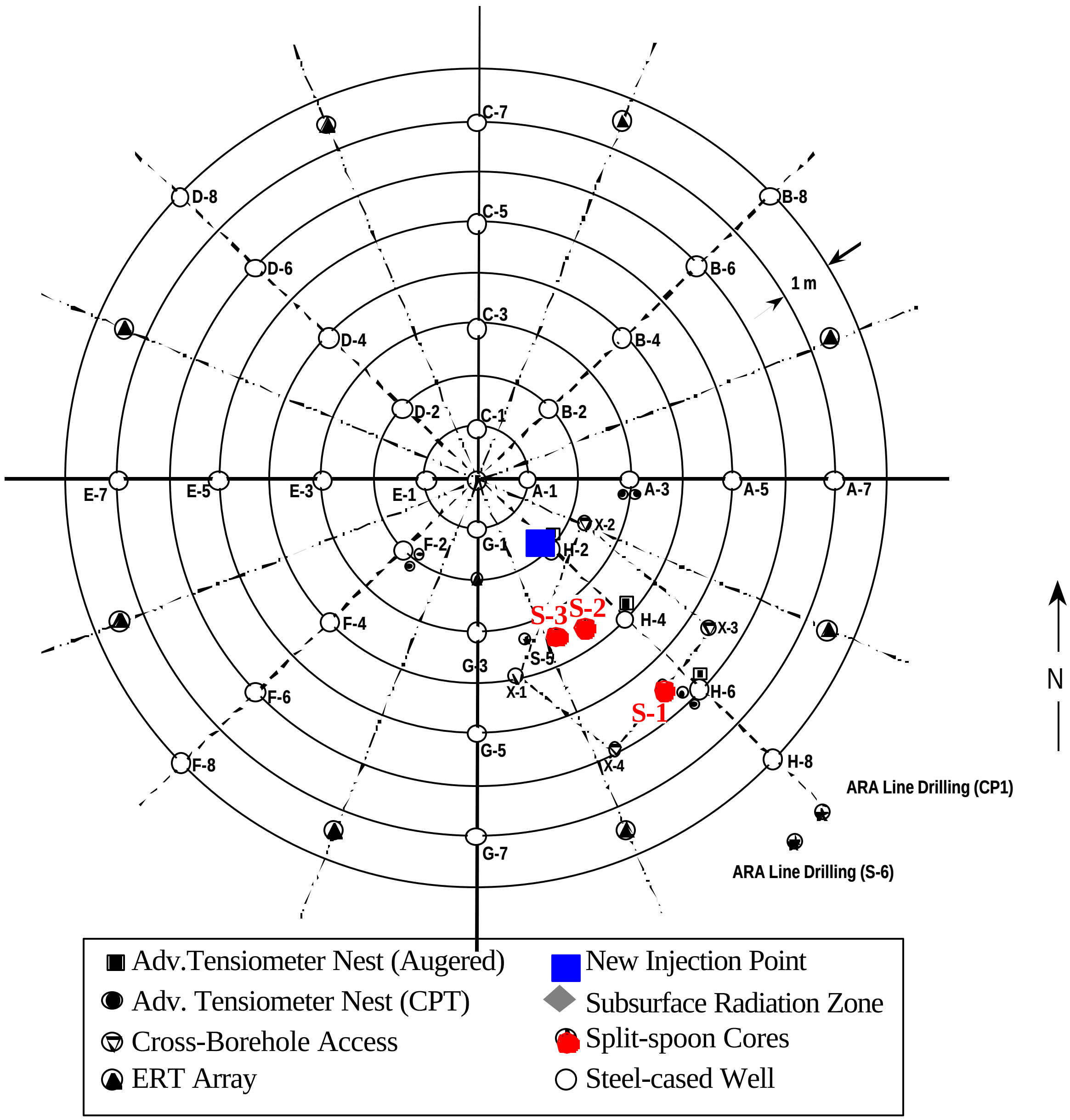

Figure 1. Location of boreholes S-1, -2, and -3 at the Vadose Zone Transport Field Study

Table 1. Soil Sampling, Injection Dates, and Other Pertinent Sampling Information

Borehole/Injection	Date	Sampled Interval	Number of Sample Collected
S-1	5/30-31/00	5.5 – 12.2 m (18 – 40 ft)	31
First Injection (Water Only)	6/1/00		
Second Injection (Water Only)	6/8/00		
Third Injection (With Tracers)	6/15/00		
Fourth Injection (Water Only))	6/22/00		
Fifth Injection (Water Only)	6/28/00		
S-2	7/6/00	3.9 – 16.3 m (13 – 53.5 ft)	60
S-3	7/10-11/00	4.4 – 17.2 m (14.5 – 56.5 ft)	40

The sampler was then driven into relatively undisturbed materials in front of (i.e., below) the auger flights using a drive hammer weighting up to 227 kg (500 lbs.) (Figure 2). Once the sampler had been driven the length of the sampler, or to refusal, the sampler was withdrawn and taken to the breakdown table for disassembly and subsampling (refer to the following section). However, at times, during difficult retrievals, the sampled materials were not retained by the sampler, and thus not recovered from that particular sampling interval. Once the sampler was retrieved from the borehole, the pilot bit was again lowered into the auger flights and the borehole advanced to the next sampling interval.

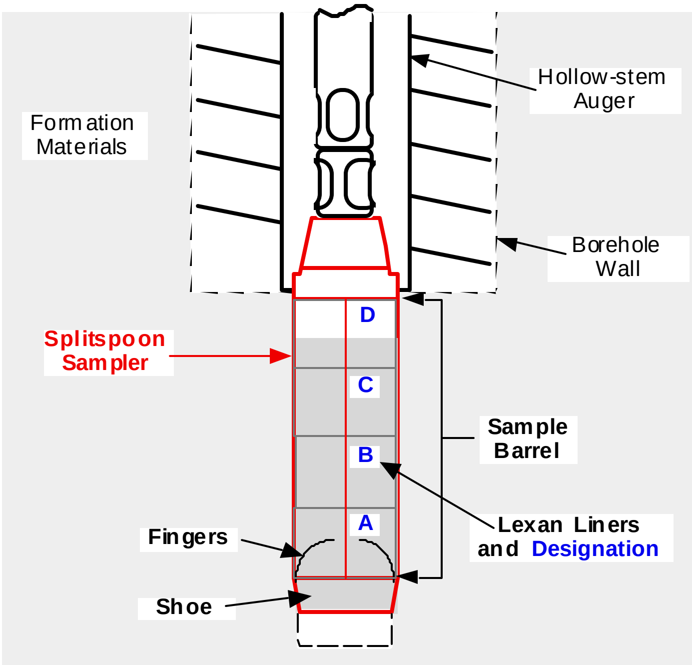

Figure 2. Schematic of Splitspoon Sampling Procedure and Typical Liner Designation

Subsampling Methodology

Once the splitspoon sampler was taken to the breakdown table and disassembled, one half of the sample barrel was removed to expose the four 15 cm (6 in.) long Lexan® core liners and, a cursory inspection was made to evaluate the representativeness and the vertical heterogeneity of the various geologic strata. The most intact and representative core liners were selected for analysis and/or archiving, marked with an up arrow, and labeled in accordance with the Pacific Northwest National Laboratory's (PNNL) procedure PNL-MA-567, DO-2. The selected core liners were carefully removed from the sample barrel in a way that would minimize the loss of material out of the liner. The liners were then capped and transferred to the field laboratory for archiving and further subsampling. Remaining sample was then recapped, sealed and refrigerated.

Each splitspoon sampling run was identified by a unique number, and each sample liner was labeled relative to its position within the splitspoon sampler. For boreholes S-2 and S-3, the bottom most (deepest) liner was designated as "A" and the top most (shallowest) liner designated as "D" (Figure 2), in accordance with procedure PNL-MA-567, DO-2. Note, however, that the liners for borehole S-1 were labeled just opposite to this with "D" being the deepest sample liner and "A" being the shallowest. Each sample was labeled not only with the unique sample and liner number, but also with the borehole number, the depth interval, and the date of sample collection.

Geologic Field Descriptions

Residual sample materials in the sample barrel, and/or shoe were examined and a small aliquot was collected for detailed geologic description in accordance with PNNL procedure PNL-MA-567, DO-1 and ASTM D 2488. These materials generally were disaggregated and lacked any sedimentary structure. However, the sample materials were visually inspected for their grain size, color, moisture, gross mineralogy/lithology, and reaction to hydrochloric acid. Each sample was subjectively assigned to one of nineteen sediment types based on the modified Folk (1974)/Wentworth (1922) classification scheme historically used at the Hanford Site (Figure 3), and described by Fecht, Last, and Marratt (1978). A small aliquot of each material was then placed in a chip tray for future referral. Detailed borehole logs are presented in Appendix A, and a tabulation of the samples collected is provided in Appendix B.

Note that no record was made of the geologic materials penetrated above a depth of 4 m (13 ft). However, the materials penetrated below this depth generally consisted of stratified sand deposits, with variable silt content, and rare pebbles. This is consistent with the third layer (Layer 3) of a sandy sequence described by Reidel and Horton (1999) within the uppermost Hanford formation beneath the southeast portion of 200 East Area.

PARTICLE DESIGNATION			PARTICLE DIAM. (MM)
GRAVEL	BOULDER		>256
GRAVEL	COBBLE	Large	256 - 128
		Small	128 - 64
GRAVEL	PEBBLE	Very Coarse	64 - 32
		Coarse	32 - 16
		Medium	16 - 8
		Fine	8 - 4
		Very Fine	4 - 2
SAND		Very Coarse	2 - 1
		Coarse	1 - 1/2
		Medium	1/2 - 1/4
		Fine	1/4 - 1/8
		Very Fine	1/8 - 1/16
MUD		Silt & Clay	< 1/16

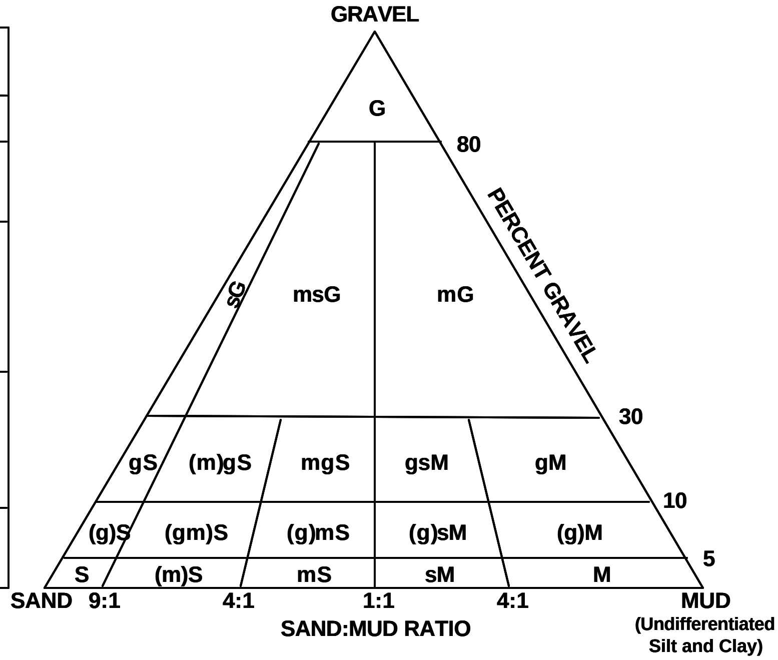

Figure 3. Grain size nomenclature (after Wentworth, 1922) and sediment classification scheme (modified after Folk, 1968) used at the Hanford Site

Limited observation of the sedimentary structures within the splitspoon samples (due to the method of sampling and subsample preservation) suggest that individual beds within this stratified sand sequence may be on the order of 60 cm (2 ft) or less and that in some cases these beds are horizontally laminated and/or fine upward. Correlation of individual beds between the three boreholes is not obvious. Note the high degree of heterogeneity in the fine fraction displayed in Figure 4. However, the materials penetrated by these boreholes can be grouped into several general units briefly described in Table 2.

Borehole Decommissioning

Following the collection of the final sample from each borehole, the boreholes were decommissioned by reversing the augers and backfilling the hole with native sand (from the drill cuttings) and bentonite pellets. The bentonite pellets were strategically placed in two horizons juxtaposed to two siltier horizons encountered at depths of about 6 and 12 m (20 and 38 ft). Appendix A illustrates the borehole construction and decommissioning details for each borehole.

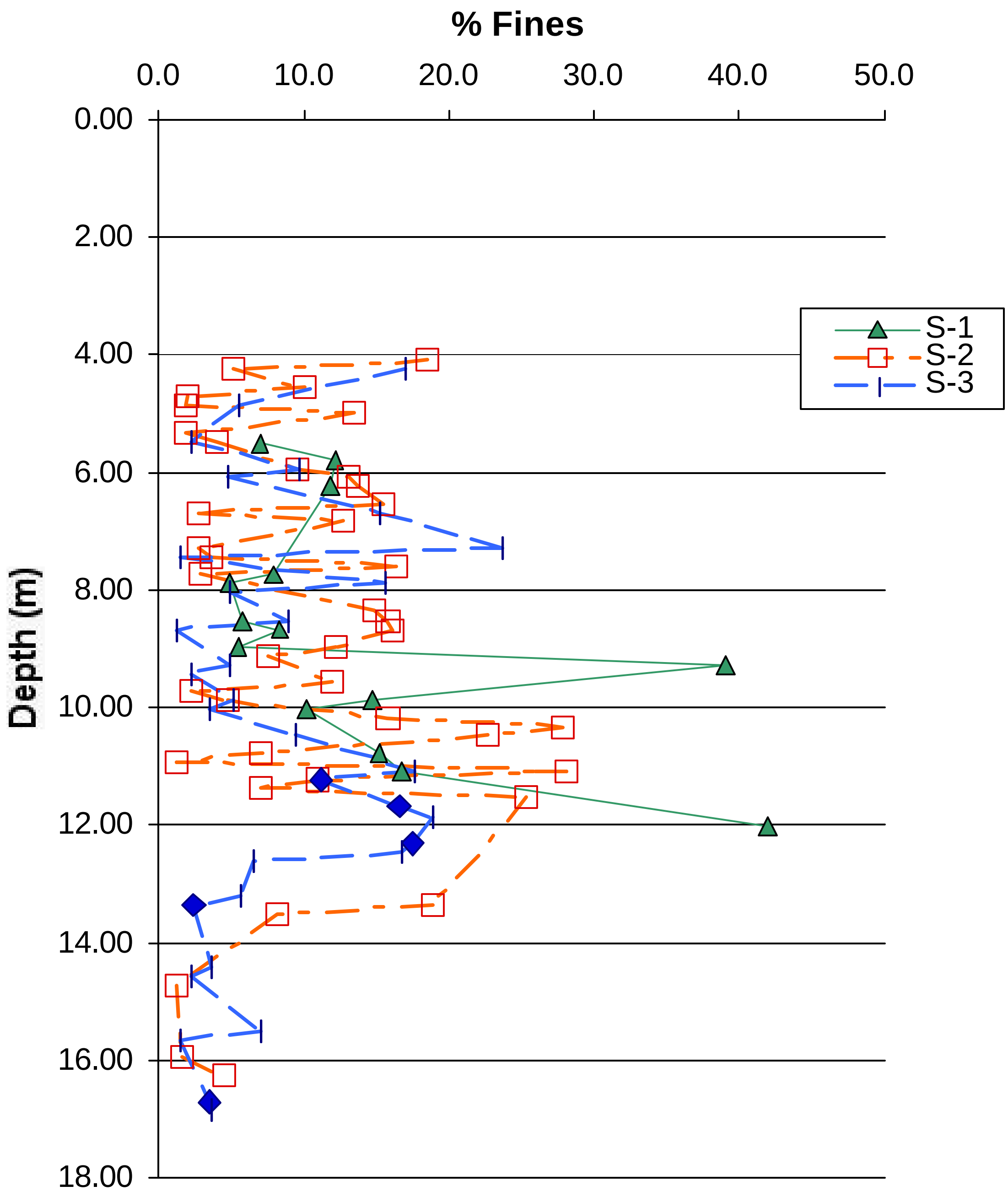

Figure 4. Percent Fine Fraction for Boreholes S-1, S-2, and S-3

Table 2. General Description of Materials Penetrated by Boreholes S-1, -2, and –3

Approximate Depth Range (m/ft)	General Description	Reaction to HCl (per ASTM D 2488)	% Fines Determined in Laboratory
0-4 (0-13 ft)	**GRAVELLY SAND**? Not sampled.	NA	NA
4-6 (13-20 ft)	**SAND**. This is a laminated, mostly medium sand with some coarse sand stringers and some upward fining sequences, and generally described as grayish brown in color. The coarse sand stringers exhibit a "salt and pepper" texture due to their abundance of both mafic and felsic grains. Some micas were also noted. The sand is described as clean, ranging from virtually no silt to a trace of silt.	None to Weak	2-19
6-7 (20-22 ft)	**SAND to SLIGHTLY SILTY SAND**. This is mostly coarse sand with a dark grayish brown color, and exhibiting the same "salt and pepper" texture described above. However, this material contains more silt than above. Some compacted and/or weakly cemented clods that react strongly to HCl were noted in boreholes S-2 and S-3.	None to Strong	3-15
7-8 (22-27 ft)	**SAND**. This is a laminated, mostly coarse to medium sand with variable silt content. These sands continue to exhibiting "salt and pepper" texture, with some coarse sand laminae, and an overall color of grayish brown to dark grayish brown. Materials near the bottom of this unit exhibit a lighter color with less mafics, and some mica.	None to Weak	1-24
8-9 (27-29 ft)	**SAND to SLIGHTLY SILTY SAND**. This is mostly medium sand with occasional pebbles (in boreholes S-1 and S-2) and some silt. The overall color is described as dark grayish brown to olive brown. Some weakly cemented clods that react strongly to HCl were identified in borehole S-2.	None to Strong	6-16
9-10 (29-32 ft)	**SAND**. This is mostly medium to fine sand, with no obvious sedimentary structure or laminations. The overall color is light brownish gray to grayish brown.	None to Weak	1-12
10-12 (32-39 ft)	**SAND to SILTY SAND**. This material consists of layered sand units ranging from mostly coarse sand with virtually no silt, to slightly silty fine to very fine sand, to silty sand with up to ~40% silt and very fine sand. The material contains some silty laminations as well as an occasional very coarse sand stringer. A micaceous silt lens approximately 5 cm (2 in.) thick was encountered at a depth of 11 m (36 ft), in borehole S-2. Weakly cemented clods that react strongly to HCl were also noted in borehole S-2 near the top of this material. Occasional pebbles were encountered in borehole S-3 at a depth of 11 m (33 ft). The overall color of this material varies from olive brown to light brownish gray to dark grayish brown. Some descriptions suggest the presence of alternating coarse and finer layers with a higher mafic content that the above material.	None to Strong	1-39
12-17 (39-56 ft)	**SAND**. This material is mostly coarse to medium or coarse to fine sand with very little silt, and a grayish brown coloration. Some laminations are present along with an occasional very coarse sand or siltier sand stringer. A few very fine pebbles were observed near the bottom of borehole S-2.	None to weak	1-19

Laboratory Analyses

Laboratory analyses consisted of water content, percent fine material, and tracer concentration. Samples for analysis were chosen primarily on splitspoon location, with preference being given to inner sleeve samples (B and C cores). Lexan® cores were subsampled in the laboratory and oven dried at 105°C for 24 hrs to determine the gravimetric water content (g_{water}/g_{soil}). Percent fines (silt and clay fraction) were determined by wet sieving through a #270 sieve.

Pre-tracer samples (S-1) were analyzed in a 1:1 soil-to-solution ratio for chloride via ion specific electrode. Minimum detection limits for Cl^- were <1.0 mg kg_{soil}^{-1}. Post-tracer samples (S-2 and S-3) were also analyzed in a 1:1 soil-to-solution ratio, but for bromide via ion specific electrode. Minimum detection limits for Br^- were <0.4 mg kg_{soil}^{-1}. Soil extractions consisted of 20 g of oven dried soil in 20 mL of deionized water. To reduce interference and activity effects, 0.5 mL of ionic strength adjuster (3 M $NaNO_3$) was added. Samples were shaken for 30 minutes and analyzed immediately. Analytical results for all samples are present in Appendix C.

Samples were also provided to the U.S. Salinity Laboratory, Riverside, California and Lawrence Berkley National Laboratory for additional tracer and hydraulic property analyses, those data will be reported separately.

Discussion

Figure 5 illustrates the water content profiles before and after the injections. These results show that moisture contents increased throughout the 6 to 12 meter depth range, with two primary peaks increasing with time at the 7 and 11-12 m depths. These two primary peaks in moisture content correlate well with interfaces between overlying siltier sand horizons and underlying less silty sand horizons.

Figure 6 shows that the peak of the bromide tracer reached a depth of approximately 11 m (i.e. 6 m below the injection point) 8 days after the final water injection. Bromide concentrations appear to have increased in this silty sand horizon 4 days later, and the major bromide concentration front has migrated another 2 m to the 13-m depth.

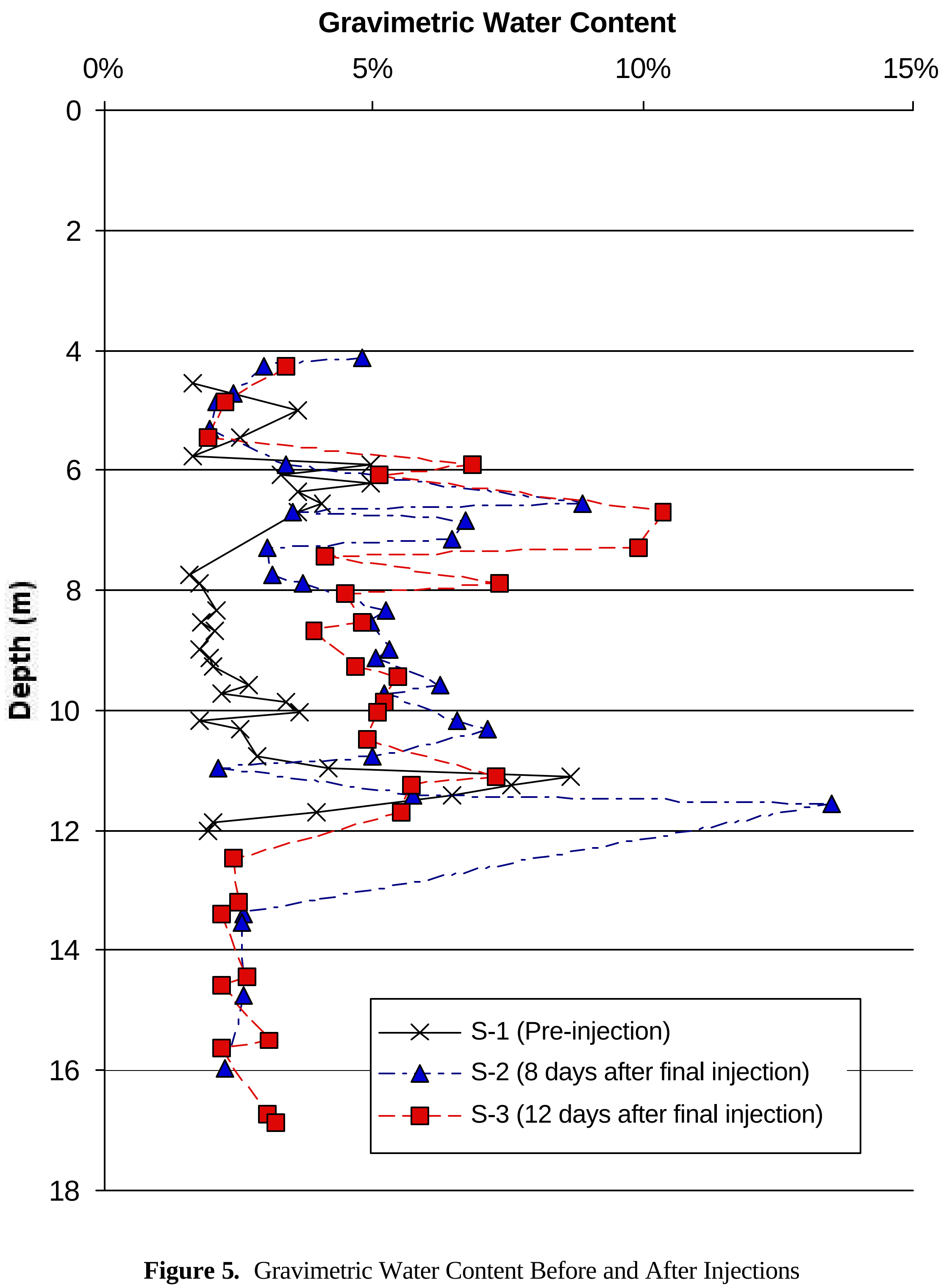

Figure 5. Gravimetric Water Content Before and After Injections

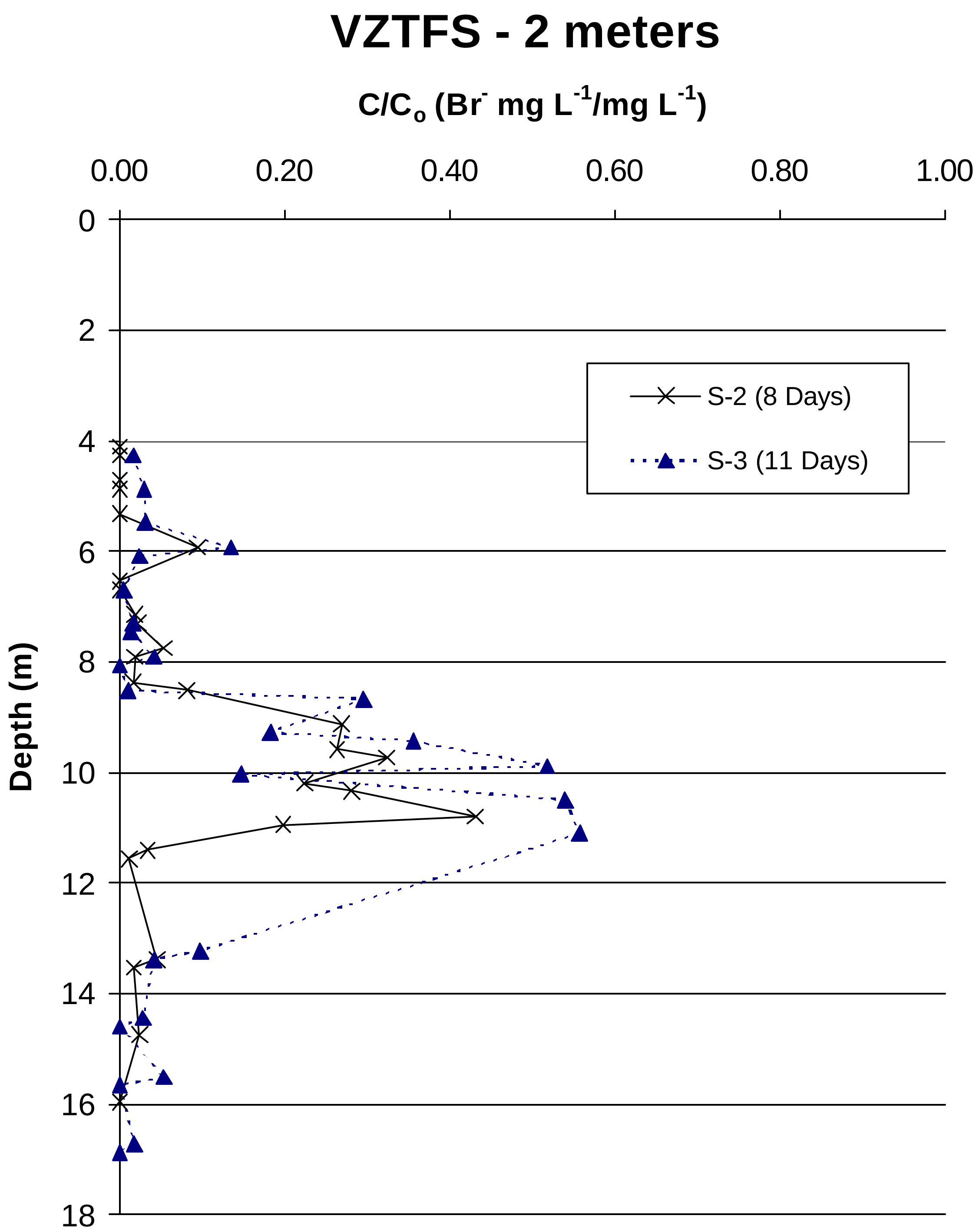

Figure 6. Bromide (tracer) concentration profile for boreholes S-2 and S-3

Summary

Over 130 soil samples were collected from three soil borings in support of the VZFTS. The first boring was sampled just prior to the first injection test. The other two borings were sampled after completion of the injection tests. These soil samples were collected using a 7.6 cm (3 in) ID splitspoon sampler, with internal 15 cm (6 in.) long Lexan® liners. The samples ranged in depth from 4 to 17 m (13.5 to 56.5 ft). Core samples were used to obtain basic characteristics, such as water content, density, and porewater chemistry. Selected samples were submitted to the U.S. Salinity Laboratory, Riverside, California for hydrologic property characterization and to Lawrence Berkeley National Laboratory for geochemical analysis.

References

Fecht, K. R., G. V. Last, and M. C. Marratt. 1978. *Granulometric Data, 216-A Crib Facilities Monitoring Well Sediments*. RHO-LD-44. Rockwell Hanford Operations, Richland, Washington.

Folk, R. L. 1968. *Petrology of Sedimentary Rocks*. University of Texas, Austin, Texas.

Reidel, S. P. and D. G. Horton. 1999. *Geologic Data Package for 2001 Immobilized Low-Activity Waste Performance Assessment*. PNNL-12257, Rev. 1. Pacific Northwest National Laboratory, Richland, Washington.

Ward, A. L. and G. W. Gee. 2000. *Vadose Zone Transport Field Study: Detailed Test Plan for Simulated Leak Tests*. PNNL-13263. Pacific Northwest National Laboratory, Richland, Washington.

Wentworth, C. K. 1922. "A Grade Scale and Class Terms for Clastic Sediments" in *Journal of Geology*, Vol. 30, p 377-392.

Appendix A

Borehole Logs

Pacific Northwest National Laboratory	BOREHOLE LOG	Boring/Well No. S-1	Depth 0-40'	Date /30-31/0	Sheet 1 of 1
		Location Sisson & Lu Site, 200 East Area	Project VZTF Study		

DEPTH	TIME	SAMPLES TYPE	SAMPLES ID NUMBER	MOISTURE	GRAPHIC C Z S G	LITHOLOGIC DESCRIPTION (particle size distribution, sorting, mineralogy,	COLOR MUNSELL CODE	COLOR NAME	HCl REACTION	CASING LOG	DRILLING AND COMPLETION COMMENTS (drilling rate, down time, blow
0.0											Ground Surface
0.5											
1.0											
1.5											
2.0											
2.5											
3.0											
3.5											
4.0											
4.5											
5.0											
5.5											
6.0											
6.5											
7.0											
7.5											
8.0						Not Sampled.					
8.5											
9.0											
9.5											10" ID Borehole.
10.0											
10.5											
11.0											Native sand backfill
11.5											
12.0											
12.5											
13.0											
13.5											
14.0											
14.5											
15.0											
15.5											
16.0											
16.5						No recovery.					
17.0											Mix of sand and bentonite pellets.
17.5											
18.0		SS	24		?	Not described.					
18.5		SS			?	Not described.					
19.0			25								
19.5	###					Sluff					
20.0		SS	26B	M		SAND. 25% coarse (C), 50% medium	2.5Y5/3	ight olive brow	none		Over 100 blows/6"
20.5		SS	26C			fine (F), 5% very fine (VF) sand to si					
21.0		SS	26D			structure.					
21.5	###	SS	27B	M		SAND. 5% VC, 55% C (& M), 30% F,	2.5Y5/2	grayish brown	none to		~30 blows/6"
22.0		SS	27C			sands; 50% quartz rich, 50% mafic (s			weak		
22.5		SS	27D			texture). Finer and less silt than above					
23.0						Not sampled.					Native sand backfill
23.5											
24.0						No recovery					Lower blow counts (5-10/6"). Sa
24.5											nearly empty. Took grab samp
25.0	###	Grab	29	M		SAND. 20% VC, 60% C (& M), 10% F	2.5Y5/2	grayish brown	weak		near middle of sampler. Mayb
25.5						to silt. More fines. Slough?					
26.0	###	SS	32B	M		SAND. 20% C, 60% M, 20% F. Finer t	2.5Y5/2	grayish brown	none		Harder than above. 14/16/30 blo
26.5		SS	32C			but cleaner (less fines). 60% quartz ri					
27.0						35% mafics. Some mica.					
27.5						No recovery					
28.0	###	SS	34B	M		SAND. 10% VC sand to VF pebble, 80	2.5Y4/2	rk grayish brov	none		18 blows/6".
28.5		SS	34C			10% F-VF sand, trace of silt. Poorly					
29.0		SS	34D								
29.5						No recovery					
30.0	###	SS	36B	M-D		SAND. Finer. 10% C, 40% M, 35% F, 1	2.5Y6/2	ght brownish gr	weak		Drove about the same as above.
30.5		SS	36C			perhaps a little drier.					
31.0		SS	36D								
31.5						No recovery.					
32.0	###	SS	38B	M-D		SLIGHTLY SILTY SAND. Finer yet. M	2.5Y6/2	ght brownish gr	weak to		20/19 blows/6"
32.5		SS	38C			65% F-VF, 10% silt.			strong		
33.0		SS	38D								
33.5	###	SS	40B	M		SAND. 80% C. Well sorted. Vertually n	2.5Y5/2	grayish brown	none		blow count about the same as abo
34.0		SS	40C			F-VF Sand. One finer siltier layer. Ma					
34.5		SS	40D			nating coarse/fine units. More mafics					
35.0						Not sampled					Bentonite pellets.
35.5						No recovery.					
36.0	###	SS	42B	M-D		SAND. Primarily coarse sand (70%), 25	2.5Y5/2	grayish brown	none to		blow counts about the same or pe
36.5		SS	42C			silt. Changes to fine to very fine sand			weak		than above.
37.0		SS	42D								
37.5	###	SS	43C	M		SILTY SAND. 30% C, 30% M-F, 40%	2.5Y4/2	rk grayish brov	weak		
38.0		SS	43D			Looks wetter. Changes to clean medi					Note: Lithologic description based
38.5						No recovery.					examination of chip samples
39.0	###	SS	45B			SILTY SAND. More fines than above.	2.5Y4/2	rk grayish brov	weak		mostly from the drive shoe and
39.5		SS	45C			20% F, 20% VF to silt. Poorly sorted.					of sample liners ends. Some de
40.0		SS	45D			clean medium sand then to clean coar					were modified after re-examina
											samples in the laboratory.

W = Wet, M = Moist, D = Dry

2000/GVL/GW-VZ S&T/001

Pacific Northwest National Laboratory	BOREHOLE LOG	Boring/Well N S-2	Depth 0-53.5'	Date ######	Sheet 1 of 1
		Location Sisson & Lu Site, 200 East Area	Project VZTF Study		

DEPTH	TIME	SAMPLES TYPE	SAMPLES ID NUMBER	MOISTURE	LITHOLOGIC DESCRIPTION (particle size distribution, sorting, mineralogy,	COLOR MUNSELL CODE	COLOR NAME	HCl REACTION	DRILLING AND COMPLETION COMMENTS (drilling rate, down time, blow
0.0									Ground Surface
0.5									
1.0									
1.5									
2.0									
2.5									
3.0									
3.5									
4.0									
4.5									
5.0									
5.5									
6.0									
6.5					Not Sampled.				
7.0									
7.5									
8.0									
8.5									
9.0									
9.5									10" ID Borehole.
10.0									
10.5									Native sand backfill
11.0									
11.5									
12.0									
12.5									
13.0					No recovery.				
13.5	7:30	SS	1C	D	SAND. Mostly medium (M) to fine (F)	2.5Y5/2	grayish brown	weak	
14.0		SS	1B		Looks horizontally laminated. Trace c				
14.5		SS	1A						
15.0	8:00	SS	3D	M-D	SAND. Mostly M. Some coarse (C) & F	2.5Y5/2	grayish brown	weak	
15.5		SS	3C		laminations. Also seems to fine upwa				
16.0		SS	3B		mica. Clean - no silt.				
16.5		SS	3A						
17.0	8:19	SS	5D	M-D	SAND. Mostly M-F, some VF. A coarse	2.5Y5/2	grayish brown	weak	Bentonite pellets
17.5		SS	5C		17.5'. Some mica.				
18.0		SS	5B						
18.5		SS	5A						
19.0	8:49	SS	7D	M	SAND. Mostly C. Appears to fine upwa	2.5Y3/2	very dark	none	
19.5		SS	7C		wetter. Salt and pepper texture, with s		grayish brown		
20.0		SS	7B		Clean, no silt.				
20.5		SS	7A						
21.0	9:15	SS	9D	M	SAND. Mostly coarse. No obvious chan	2.5Y4/2	rk grayish brov	none to	
21.5		SS	9C		above. Salt and pepper texture. Some			strong	
22.0		SS	9B		cemented clods, with strong reaction t				
22.5		SS	9A						
23.0	9:40	SS	11D	M	SAND. Mostly Coarse. Finer (F-VF) at	2.5Y4/2	rk grayish brov	none	
23.5		SS	11D		and pepper texture. Clean - no silt.				
24.0		SS	11B						
24.5		SS	11A						
25.0	###	SS	13D	M	SAND. Mostly medium at the bottom.	2.5Y4/2	rk grayish brov	none	
25.5		SS	13C		26.2'. At least one coarse lamination				
26.0		SS	13B						
26.5		SS	13A						
27.0	###	SS	15D	M	SAND. Mostly medium at the bottom.	2.5Y5/2	grayish brown	weak to	Hard drilling (i.e., lots of blow co
27.5		SS	15C		(F-VF) at 28.2-26.5'. Some pebbles a			strong	
28.0		SS	15B		silt at 27' (old paleosol?). Some weak				Native sand backfill
28.5		SS	15A		clods.				
29.0	###	SS	17D	M	SLIGHTLY SILTY SAND. Mostly C-M	2.5Y4/3	olive brown	weak-	
29.5		SS	17C		Laminated. Some pebbles.			strong	
30.0		SS	17B						
30.5					No recovery				
31.0	###	SS	19D	M	SAND. Mostly M. Clean, very little silt	2.5Y5/2	grayish brown	none	
31.5		SS	19C		obvious structure. Maybe some sloug				
32.0		SS	19B						
32.5		SS	19A						
33.0	###	SS	21D	M	SILTY SAND. Mostly C-M. ~15% silt	2.5Y4/3	olive brown	weak to	
33.5		SS	21C		Some weakly cemented clods.			strong	
34.0		SS	21B						
34.5		SS	21A						
35.0	###	SS	23D	M	SAND. Mostly C, and clean (little silt).	2.5Y6/2	light brownish	none	
35.5		SS	23C		silt to very fine sand near bottom. So		gray		
36.0		SS	23B		below it.				
36.5		SS	23A		SILT is micaceous.	2.5Y4/2	rk grayish brov	weak	
37.0	###	SS	25D	M-W	SLIGHTLY SILTY SAND. 60% VC-C	2.5Y4/2	rk grayish brov	weak	Bentonite pellets.
37.5		SS	25C		5-10% silt. Seems pretty wet. Some la				
38.0		SS	25B		VC sand.				
38.5		SS	25A						
39.0	###								Lost sample - no fingers.
39.5					Not sampled.				
40.0									
40.5									
41.0	###	SS	27A	M	SAND. 50% C, 40% M, 10% V-VF, tra	2.5Y4/2	rk grayish brov	weak	
41.5									
42.0					No recovery.				Sample probably from top of sam

42.5									of sample fell out during recove
43.0					Not sampled.				
43.5	###	SS	28D	M-D	SAND. Mostly M. Some VC-C, and F-	2.5Y5/2	grayish brown	weak -	All sleeves only partially full. Los
44.0		SS	28C		of silt. Laminated.			strong	sample during recovery, so dep
44.5		SS	28B						(6" too deep).
45.0					No recovery.				Native sand backfill
45.5									
46.0					Not sampled.				
46.5									
47.0									
47.5	###								Lost some sample during recovery
48.0		SS	29C		SAND. C-F. Same as above.	2.5Y5/2	grayish brown	none	are probably off (6" too deep).
48.5		SS	29B	M-D					
49.0		SS	29A						
49.5									
50.0									
50.5									
51.0									
51.5									Note: Lithologic description based
52.0	###				SAND. Mostly M, some C-F. Some VI	2.5Y5/2	grayish brown	none	examination of chip samples
52.5		SS	30C	M-D	Seems more quartz rich.				mostly from the drive shoe and
53.0		SS	30B						of sample liners ends. Some de
53.5		SS	30A						were modified after re-examina
									samples in the laboratory.

W = Wet, M = Moist, D = Dry

2000/GVL/GW-VZ S&T/001

Pacific Northwest National Laboratory	BOREHOLE LOG	Boring/Well No S-3	Depth 0-56.5'	Date /10-11/0	Sheet 1 of 1
		Location Sisson & Lu Site, 200 East Area		Project VZTF Study	

Logged by ______ Print ______ Sign ______

Reviewed by ______ Print ______ Sign ______ Date ______

Lithologic Class. Scheme ______ Procedure ______ Rev ______

Steel Tape/E-Tape ______ / ______ Field Indicator Equip. 1) ______ 2) ______

Drilling Contractor ______

Driller ______

Rig/Method ______

Depth Control Point ______

DEPTH	TIME	SAMPLES TYPE	SAMPLES ID NUMBER	MOISTURE	LITHOLOGIC DESCRIPTION (particle size distribution, sorting, mineralogy,	COLOR MUNSELL CODE	COLOR NAME	HCl REACTION	DRILLING AND COMPLETION COMMENTS (drilling rate, down time, blow
0.0									Ground Surface
0.5									
1.0									
1.5									
2.0									
2.5									
3.0									
3.5									
4.0									
4.5									
5.0									
5.5									
6.0									
6.5									
7.0					Not Sampled.				
7.5									
8.0									
8.5									
9.0									
9.5									10" ID Borehole.
10.0									
10.5									Native sand backfill
11.0									
11.5									
12.0									
12.5									
13.0									
13.5	###				Slough, very silty.				
14.0									
14.5		SS	1		SAND. Coarse.				
15.0					Not Sampled.				
15.5		SS	2B	D	SAND. Still very dry.				
16.0		SS	2C						
16.5					Not sampled				
17.0									
17.5									
18.0		SS	3B		SAND. Coarse to medium. Wetting up.				
18.5		SS	3C						
19.0					Not sampled				Bentonite pellets
19.5	###			D	SAND. Fine (F) near top, then coarsens				Blow counts/6" = 16, 17, 15, 15
20.0		SS	8C	----	Silty at bottom. Moisture change at 1				
20.5		SS	8B	M-W					
21.0					SLIGHTLY SILTY SAND. Mostly C. V	2.5Y4/2	rk grayish brow	weak - str	
21.5	###				SAND. Coarse (C). Pretty clean (no silt)				Blow counts/6" ~20-25.
22.0		SS	10C		some silt at top (slough?).				
22.5		SS	10B						
23.0				M-W		2.5Y5/2	grayish brown	none	
23.5					Not sampled				
24.0	###				SAND. C-F. Siltier at top (slough?). Lo	2.5Y5/2	grayish brown	none	Sampler drove easily.
24.5		SS	12C		middle. Salt and pepper texture. No s				
25.0		SS	12B						
25.5		SS	12A	M-W					
26.0	###				SAND. C-F. Clean (no silt). Salt and pe	2.5Y5/2	grayish brown	none to	Sampler drove a little harder, still
26.5		SS	14C		Coarsens upward. Silty at bottom. Lig			weak	
27.0		SS	14B		than above, less mafics.				
27.5				M-W					
28.0	###				SAND. Mostly M., some C. No obvious	2.5Y5/2	grayish brown	none to	Native sand backfill
28.5		SS	16C		Some mica. No silt.			weak	
29.0		SS	16B						
29.5				M-W					
30.0					Not sampled.				
30.5	###				SAND. M-F, coarsens upward to C. Bo	2.5Y4/2	rk grayish brov	weak to	
31.0		SS	18C		F-VF sand.			strong	
31.5		SS	18B					at bottom	
32.0				M-W					
32.5	###				SAND. M. coarsens downward to slight				
33.0		SS	20C		VC. sand. Some silty laminations. Po				
33.5		SS	20B					none to	
34.0				W		2.5Y4/3	olive brown	weak	
34.5	###				SLIGHTLY SILTY SAND. F-VF.	2.5Y4/3	olive brown	weak	
35.0		SS	22C						
35.5		SS	22B		SAND. Mostly C, with trace of silt.	2.5Y5/2	grayish brown	weak	
36.0				M-W					
36.5	###								
37.0		SS	C		SAND. C-M				Bentonite pellets.
37.5		SS	B						
38.0				M-W	SLIGHTLY SILTY SAND. F-VF. Som	2.5Y4/2	rk grayish brov	weak	
38.5	###				SILTY SAND. Poorly sorted, ranging u	2.5Y4/2 - 5/2	rk grayish brov	weak to	
39.0		SS	C		Clumps of silty VF sand. Coarsens do		o grayish brow	strong	
39.5		SS	B		SAND. F. Slightly less wet.				

Depth	Time	Type		Liner	Moist.	Description	Munsell	Color	Reaction	Notes
40.0					M					
40.5	###									
41.0		SS		C	M-W	SAND. C-M. Clean, no silt. Silty at 41'.	2.5Y5/1	gray	none	
41.5		SS		B						
42.0					D	SAND. VC. Dry.				
42.5						Not sampled.				
43.0										
43.5	8:00					SAND. Mostly clean C-M. Finer at bott				
44.0		SS		C						
44.5		SS		B						
45.0					M-D	SAND. Poorly sorted VF-VC (mostly C	2.5Y6/2	ght brownish gr	weak	Native sand backfill
45.5										
46.0						Not sampled				
46.5										
47.0										
47.5	8:20					SAND. Mostly C-M. Some VC. No obv	2.5Y5/2	grayish brown	none	
48.0		SS		C		throughout. Clean, no silt. Some mic				
48.5		SS		B						
49.0		SS		A	M					
49.5										
50.0						Not sampled				
50.5										
51.0	8:45									Some sample may have fallen out
51.5		SS		C		Slough.				recovery. Depths could be 6" t
52.0		SS		B		SAND. C.				
52.5		SS		A	M	SAND. Mostly M. Fairly well sorted.	2.5Y5/2	grayish brown	none	
53.0										
53.5						Not sampled.				Note: Samples from 36.5'-42' wer
54.0										described the next day.
54.5										Note: Lithologic description based
55.0	9:10									examination of chip samples
55.5		SS		C		SAND. Poorly sorted C-M. with fines.				mostly from the drive shoe and
56.0		SS		B		SAND. C.				of sample liners ends. Some de
56.5		SS		A	M	SAND. M-F. Well sorted. Few fines.	2.5Y5/2	grayish brown	none	were modified after re-examina
										samples in the laboratory.

W = Wet, M = Moist, D = Dry

2000/GVL/GW-VZ S&T/001

Appendix B

Sample Lists

Borehole S-1 Samples

Sample Number	Liner Number*	Depth (ft) Top	Depth (ft) Bottom	Recovery (%)	Date Collected	Collector's Initials	Comments	Requested Analysis (PNNL) Moisture	%Fines	Chloride
24	B	17.5	18		05/29/2000	TGC	First sample, very poor recovery	X		X
25	C	18	19.5		05/29/2000	TGC		X	X	X
26	B	19.5	20		05/30/2000	GVL	Heavier hammer added for split spoon	X	X	X
	C	20	20.5		05/30/2000	GVL		X		X
	D	20.5	21	<100%	05/30/2000	GVL	Not full.	X		X
27	B	21	21.5		05/30/2000	GVL		X	X	X
	C	21.5	22		05/30/2000	GVL		X		X
	D	22	22.5		05/30/2000	GVL		X		X
29	NA	23	25		05/30/2000	GVL	Sample taken from B liner. Actual depth uncertain, could be from anywhere within the 23-25' sample interval, but most likely from near the top of the interval, and likely includes slough.			
32	B	25.5	26		05/30/2000	GVL		X		X
	C	26	26.5		05/30/2000	GVL		X	X	X
34	B	27.5	28		05/30/2000	GVL		X	X	X
	C	28	28.5		05/30/2000	GVL		X		X
	D	28.5	29		05/30/2000	GVL		X	X	X
36	B	29.5	30		05/30/2000	GVL		X	X	X
	C	30	30.5		05/30/2000	GVL		X	X	X
	D	30.5	31		05/30/2000	GVL		X		X
38	B	31.5	32		05/30/2000	GVL		X	X	X
	C	32	32.5		05/30/2000	GVL		X		X
	D	32.5	33		05/30/2000	GVL		X		X
40	B	33	33.5		05/30/2000	GVL		X	X	X
	C	33.5	34		05/30/2000	GVL		X	X	X
	D	34	34.5		05/30/2000	GVL		X		X
42	B	35.5	36		05/30/2000	GVL		X		X
	C	36	36.5		05/30/2000	GVL		X	X	X
	D	36.5	37		05/30/2000	GVL		X		X
43	C	37	37.5		05/30/2000	GVL		X	X	X
	D	37.5	38		05/30/2000	GVL		X		X
45	B	38.5	39		05/30/2000	GVL		X		X
	C	39	39.5		05/30/2000	GVL		X		X
	D	39.5	40		05/30/2000	GVL		X		X

Note: In general, the C liners provided the best samples. The D liners were generally not full, and the B liners, may contain some slough, and were generally more friable. The A liners were generally considered slough and not collected.

Borehole S-2 Samples

Sample Number	Liner Number*	Depth (ft)		Sample Length (ft)	Recovery (%)	Date Collected	Collector's Initials	Comments	Requested Analysis (PNNL)			Laboratory
		Top	Bottom						Moisture	%Fines	Bromide	
1	C	13	13.5	0.5		07/06/2000	GVL		X	X	X	
	B	13.5	14	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	14	14.5	0.5		07/06/2000	GVL			X		
3	D	14.5	15	0.5	90%	07/06/2000	GVL	May contain some slough.		X		
	C	15	15.5	0.5		07/06/2000	GVL		X	X	X	
	B	15.5	16	0.5		07/06/2000	GVL		X	X	X	
	A	16	16.5	0.5	70%	07/06/2000	GVL					
5	D	16.5	17	0.5	90%	07/06/2000	GVL	May contain some slough.		X		
	C	17	17.5	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	B	17.5	18	0.5		07/06/2000	GVL			X		
	A	18	18.5	0.5		07/06/2000	GVL					
7	D	18.5	19	0.5		07/06/2000	GVL					
	C	19	19.5	0.5		07/06/2000	GVL		X	X	X	
	B	19.5	20	0.5		07/06/2000	GVL			X		
	A	20	20.5	0.5	90%	07/06/2000	GVL			X		
9	D	20.5	21	0.5		07/06/2000	GVL					
	C	21	21.5	0.5		07/06/2000	GVL	Core has finer grained rind along liner walls.	X	X	X	
	B	21.5	22	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	22	22.5	0.5	70%	07/06/2000	GVL			X		
11	D	22.5	23	0.5		07/06/2000	GVL					
	C	23	23.5	0.5		07/06/2000	GVL		X	X		
	B	23.5	24	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	24	24.5	0.5	60%	07/06/2000	GVL			X		
13	D	24.5	25	0.5	60%	07/06/2000	GVL			X		
	C	25	25.5	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	B	25.5	26	0.5		07/06/2000	GVL		X		X	
	A	26	26.5	0.5	70%	07/06/2000	GVL					
15	D	26.5	27	0.5	80%	07/06/2000	GVL					
	C	27	27.5	0.5		07/06/2000	GVL		X	X	X	
	B	27.5	28	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	28	28.5	0.5	70%	07/06/2000	GVL			X		
17	D	28.5	29	0.5	50%	07/06/2000	GVL					
	C	29	29.5	0.5		07/06/2000	GVL		X			
	B	29.5	30	0.5	80%	07/06/2000	GVL		X	X	X	
19	D	30.5	31	0.5		07/06/2000	GVL	May contain some slough.				
	C	31	31.5	0.5		07/06/2000	GVL		X	X	X	
	B	31.5	32	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	32	32.5	0.5	70%	07/06/2000	GVL			X		
21	D	32.5	33	0.5		07/06/2000	GVL					
	C	33	33.5	0.5		07/06/2000	GVL		X	X	X	
	B	33.5	34	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	34	34.5	0.5	70%	07/06/2000	GVL			X		
23	D	34.5	35	0.5		07/06/2000	GVL					
	C	35	35.5	0.5		07/06/2000	GVL		X	X	X	
	B	35.5	36	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	36	36.5	0.5	70%	07/06/2000	GVL			X		
25	D	36.5	37	0.5	50%	07/06/2000	GVL			X		
	C	37	37.5	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	B	37.5	38	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	A	38	38.5	0.5	70%	07/06/2000	GVL					

Sample Number	Liner Number*	Depth (ft)		Sample Length (ft)	Recovery (%)	Date Collected	Collector's Initials	Comments	Requested Analysis (PNNL)			Laboratory
		Top	Bottom						Moisture	%Fines	Bromide	
27	A	40.5	41	0.5	70%	07/06/2000	GVL	Probably from top of sampling interval. Rest of sample fell out during recovery.				
28	D	43	43.5	0.5		07/06/2000	GVL					
	C	43.5	44	0.5		07/06/2000	GVL	All cores only partially full. Lost some sample during retrieval, so depths are probably off 6" (too deep).	X	X	X	
	B	44	44.5	0.5		07/06/2000	GVL		X	X	X	
29	C	47.5	48	0.5	50%	07/06/2000	GVL					
	B	48	48.5	0.5		07/06/2000	GVL	Lost some smple during retrieval, so depths are probably off 6" (too deep).	X	X	X	
	A	48.5	49	0.5	70%	07/06/2000	GVL					
30	C	52	52.5	0.5		07/06/2000	GVL		X	X	X	Salinity Lab
	B	52.5	53	0.5		07/06/2000	GVL					
	A	53	53.5	0.5	70%	07/06/2000	GVL			X		

Note: In general, the B & C liners provided the best samples. The A and D liners were generally not full. Also, the D liners may contain some slough.

Borehole S-3 Samples

Sample Number	Liner Number*	Depth (ft)		Sample Length (ft)	Recovery (%)	Date Collected	Collector's Initials	Comments	Requested Analysis (PNNL)		
		Top	Bottom						Moisture	%Fines	Bromide
1'	C	14	14.5	0.5	100%	07/10/2000	TGC	Only good section of core #1	X	X	X
2	B	15	15.5	0.5	100%	07/10/2000	TGC				
	C	15.5	16	0.5		07/10/2000	TGC		X	X	X
3'	B	17.5	18	0.5		07/10/2000	TGC				
	C	18	18.5	0.5		07/10/2000	TGC		X	X	X
8	C	19.5	20	0.5	95%	07/10/2000	GVL	Note change is liner designation, with A being deepest and "D" being shallowest.	X	X	X
	B	20.5	21	0.5	95%	07/10/2000	GVL		X	X	X
10	C	21.5	22	0.5	100%	07/10/2000	GVL				
	B	22	22.5	0.5	100%	07/10/2000	GVL		X	X	X
12	C	24	24.5	0.5	100%	07/10/2000	GVL		X	X	X
	B	24.5	25	0.5	100%	07/10/2000	GVL		X	X	X
	A	25	25.5	0.5	65%	07/10/2000	GVL				
14	C	26	26.5	0.5	100%	07/10/2000	GVL		X	X	X
	B	26.5	27	0.5	100%	07/10/2000	GVL		X	X	X
16	C	28	28.5	0.5	100%	07/10/2000	GVL		X	X	X
	B	28.5	29	0.5	100%	07/10/2000	GVL		X	X	X
	A	29	29.5	0.5	70%	07/10/2000	GVL				
18	C	30.5	31	0.5	100%	07/10/2000	GVL		X	X	X
	B	31	31.5	0.5	100%	07/10/2000	GVL		X	X	X
20	C	32.5	33	0.5	100%	07/10/2000	GVL		X	X	X
	B	33	33.5	0.5	100%	07/10/2000	GVL		X	X	X
22	C	34.5	35	0.5	100%	07/10/2000	GVL		X	X	X
	B	35	35.5	0.5	100%	07/10/2000	GVL		X	X	X
NA	C	36.5	37	0.5	100%	07/10/2000	TGC		X	X	X
	B	37	37.5	0.5	100%	07/10/2000	TGC		X	X	
NA	C	38.5	39	0.5	100%	07/10/2000	TGC		X	X	
	B	39	39.5	0.5	100%	07/10/2000	TGC			X	
NA	C	40.5	41	0.5	100%	07/10/2000	TGC			X	
	B	41	41.5	0.5	100%	07/10/2000	TGC			X	
NA	C	43.5	44	0.5	100%	07/11/2000	GVL		X	X	X
	B	44	44.5	0.5	100%	07/11/2000	GVL		X	X	X
NA	C	47.5	48	0.5	100%	07/11/2000	GVL		X	X	X
	B	48	48.5	0.5	100%	07/11/2000	GVL		X	X	X
	A	48.5	49	0.5	70%	07/11/2000	GVL				
NA	C	51	51.5	0.5	80%	07/11/2000	GVL		X	X	X
	B	51.5	52	0.5	100%	07/11/2000	GVL	Some sample may have fallen out, depths may be 6" too deep.	X	X	X
	A	52	52.5	0.5	70%	07/11/2000	GVL				
NA	C	55	55.5	0.5	100%	07/11/2000	GVL		X	X	X
	B	55.5	56	0.5	100%	07/11/2000	GVL		X	X	X
	A	56	56.5	0.5	80%	07/11/2000	GVL				

Note: In general, the B & C liners provided the best samples. The A and D liners were generally not full. Also, the D liners may contain some slough.

Appendix C

Analytical Data

Borehole S-1 Analytical Results

Sample ID	Borehole	Depth (m)	Grav. Water Cont. ($g\ g^{-1}$)	Chloride ($mg\ kg^{-1}$)	Chloride ($mg\ L^{-1}$)	%Fine
S-1/24 (18.5-19)	S-1	5.472	0.0253	1.700	67.19	
S-1/25 (19)	S-1	5.776	0.0165	2.047	124.00	6.89
S-1/26B	S-1	5.928	0.0493	2.113	42.85	12.18
S-1/26C	S-1	6.08	0.0325	2.128	65.48	
S-1/26D	S-1	6.232	0.0493	1.635	33.16	
S-1/27B	S-1	6.384	0.0357	12.161	340.39	11.84
S-1/27C	S-1	6.536	0.0406	2.841	70.03	
S-1/27D	S-1	6.688	0.0358	9.334	260.91	
S-1/32B	S-1	7.752	0.0157	2.141	136.63	
S-1/32C	S-1	7.904	0.0176	5.018	285.20	7.94
S-1/34B	S-1	8.36	0.0208	2.224	107.17	4.90
S-1/34C	S-1	8.512	0.0181	3.815	211.17	
S-1/34D	S-1	8.664	0.0203	1.576	77.52	5.75
S-1/36B	S-1	8.968	0.0178	2.764	155.19	8.39
S-1/36C	S-1	9.12	0.0196	1.993	101.76	5.45
S-1/36D	S-1	9.272	0.0200	1.972	98.61	
S-1/38B	S-1	9.576	0.0266	2.244	84.50	39.00
S-1/38C	S-1	9.728	0.0214	2.336	109.03	
S-1/38D	S-1	9.88	0.0337	4.518	134.03	
S-1/40B	S-1	10.032	0.0360	2.516	69.82	14.79
S-1/40C	S-1	10.184	0.0175	11.291	645.15	10.24
S-1/40D	S-1	10.336	0.0252	4.218	167.13	
S-1/42B	S-1	10.792	0.0281	2.701	96.20	
S-1/42C	S-1	10.944	0.0415	2.780	66.93	15.13
S-1/42D	S-1	11.096	0.0865	1.681	19.42	
S-1/43C	S-1	11.248	0.0756	6.364	84.22	16.74
S-1/43D	S-1	11.4	0.0643	3.483	54.21	
S-1/45B	S-1	11.704	0.0394	2.169	55.01	
S-1/45C	S-1	11.856	0.0201	2.583	128.72	
S-1/45D	S-1	12.008	0.0193	3.810	197.77	

Borehole S-2 Analytical Results

Sample ID	Borehole	Depth (m)	Grav. Water Cont. ($g\ g^{-1}$)	Bromide ($mg\ kg^{-1}$)	Bromide ($mg\ L^{-1}$)	%Fine
S-2/1C 13'	S-2	4.104	0.0479	0.000	0.000	18.50
S-2/1B 13.5-14	S-2	4.256	0.0294	0.000	0.000	5.15
S-2/1A 14.5-15	S-2	4.56				10.03
S-2/3C 15'	S-2	4.712	0.0238	0.000	0.000	1.94
S-2/3B 15.5'	S-2	4.864	0.0207	0.000	0.000	1.80
S-2/5D 16.5-17	S-2	5.016				13.50
S-2/5C 17-17.5	S-2	5.32	0.0198	0.000	0.000	1.80
S-2/5B	S-2	5.472				3.89
S-2/7C	S-2	5.928	0.0336	3.155	93.950	9.54
S-2/7B	S-2	6.08				13.08
S-2/7A 20-20.5	S-2	6.232				13.71
S-2/9C 20	S-2	6.536	0.0888	0.000	0.000	15.43
S-2/9B 21.5-22	S-2	6.688	0.0351	0.000	0.000	2.70
S-2/9A	S-2	6.84	0.0670			12.76
S-2/11C 23'	S-2	7.144	0.0645	1.196	18.544	
S-2/11B 23.5-24	S-2	7.296	0.0302	0.664	21.934	2.75
S-2/11A 24-24.5	S-2	7.448				3.63
S-2/13D 24.5-25	S-2	7.6				16.48
S-2/13C 25-25.5	S-2	7.752	0.0312	1.688	53.459	2.84
S-2/13B 25.5'	S-2	7.904	0.0371	0.678	18.287	
S-2/15C 27'	S-2	8.36	0.0522	0.862	16.529	14.93
S-2/15B 27.5-28	S-2	8.512	0.0494	4.024	81.423	15.78
S-2/15A 28-28.5	S-2	8.664				16.14
S-2/17C	S-2	8.968	0.0530			12.09
S-2/17B 29.5'	S-2	9.12	0.0502	13.458	268.086	7.59
S-2/19C 31'	S-2	9.576	0.0624	16.383	262.362	12.08
S-2/19B 31.5-32	S-2	9.728	0.0517	16.873	322.113	2.34
S-2/19A 32-32.5	S-2	9.88				4.65
S-2/21C 33'	S-2	10.184	0.0658	14.677	223.160	15.82
S-2/21B 33.5-34	S-2	10.336	0.0711	20.064	279.491	27.74
S-2/21A 34-34.5	S-2	10.488				22.60
S-2/23C 35'	S-2	10.792	0.0500	21.476	429.713	6.98
S-2/23B 35.5-36	S-2	10.944	0.0211	4.169	197.328	1.25
S-2/23A 36-36.5	S-2	11.096				28.17
S-2/25D 36.5-37	S-2	11.248				10.92
S-2/25C 37-37.5	S-2	11.4	0.0574	1.962	33.563	7.00
S-2/25B 37.5-38	S-2	11.552	0.1352	1.507	11.319	25.36
S-2/28C 43.5'	S-2	13.376	0.0259	1.156	44.568	18.80
S-2/28B 44'	S-2	13.528	0.0255	0.439	17.211	8.15
S-2/29B 48'	S-2	14.744	0.0258	0.618	23.986	1.15
S-2/30C 52-52.5	S-2	15.96	0.0224	0.000	0.000	1.70
S-2/30A 53-53.5	S-2	16.264				4.59

Borehole S-3 Analytical Results

Sample ID	Borehole	Depth (m)	Grav. Water Cont. ($g\ g^{-1}$)	Bromide ($mg\ kg^{-1}$)	Bromide ($mg\ L^{-1}$)	%Fine
S-3/14'	S-3	4.256	0.0338	0.56	16.44	16.98
S-3/15.5-16	S-3	4.864	0.0225	0.68	29.66	5.40
S-3/18-18.5	S-3	5.472	0.0191	0.59	30.96	2.34
S-3/19.5-20	S-3	5.928	0.0682	9.13	134.59	9.78
S-3/20-20.5	S-3	6.08	0.0509	1.23	24.31	4.70
S-3/22-22.5	S-3	6.688	0.1038	0.52	5.02	15.22
S-3/24-24.5	S-3	7.296	0.0988	1.60	15.98	23.70
S-3/24.5'	S-3	7.448	0.0410	0.56	13.60	1.50
S-3/26-26.5	S-3	7.904	0.0735	3.03	41.91	15.60
S-3/26.5'	S-3	8.056	0.0447	0.00	0.00	4.84
S-3/28'	S-3	8.512	0.0480	0.47	9.72	9.01
S-3/28.5-29	S-3	8.664	0.0387	11.48	294.40	1.25
S-3/30.5'	S-3	9.272	0.0465	8.48	182.20	4.84
S-3/31'	S-3	9.424	0.0547	19.36	354.18	2.29
S-3/32.5-33	S-3	9.88	0.0519	26.90	515.90	5.19
S-3/33-33.5	S-3	10.032	0.0508	7.40	146.22	3.49
S-3/34.5-35	S-3	10.488	0.0488	26.52	537.79	9.48
S-3/36.5-37	S-3	11.096	0.0727	40.17	554.92	17.61
S-3/37-37.5	S-3	11.248	0.0570			11.26
S-3/38.5-39	S-3	11.704	0.0550			16.64
S-3/39-39.5	S-3	11.856				18.84
S-3/40.5-41	S-3	12.312				17.44
S-3/41-41.5	S-3	12.464	0.0240			16.66
S-3/41.5-42	S-3	12.616				6.57
S-3/43.5'	S-3	13.224	0.0249	2.42	97.31	5.59
S-3/44-44.5	S-3	13.376	0.0215	0.89	41.05	2.40
S-3/47.5-48	S-3	14.44	0.0263	0.75	28.28	3.59
S-3/48'	S-3	14.592	0.0217	0.00	0.00	2.25
S-3/51'	S-3	15.504	0.0305	1.63	53.29	7.00
S-3/51.5'	S-3	15.656	0.0218	0.00	0.00	1.55
S-3/55-55.5	S-3	16.72	0.0302	0.55	17.84	3.54
S-3/55.5'	S-3	16.872	0.0317	0.00	0.00	3.59

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