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VOLUME II

FINAL (100%) DESIGN REPORT SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

Prepared for

United States Environmental Protection Agency, Remedial Project Manager

Prepared by

TRC

Irvine, California

Representing

The Waste Disposal, Inc. Group (WDIG)

Project No. 30747

March 2003

TRC
21 Technology Drive
Irvine, California 92618
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WASTE DISPOSAL, INC. SUPERFUND SITE
FINAL (100%) DESIGN REPORT
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

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APPENDIX D

GEOTECHNICAL LABORATORY TESTING

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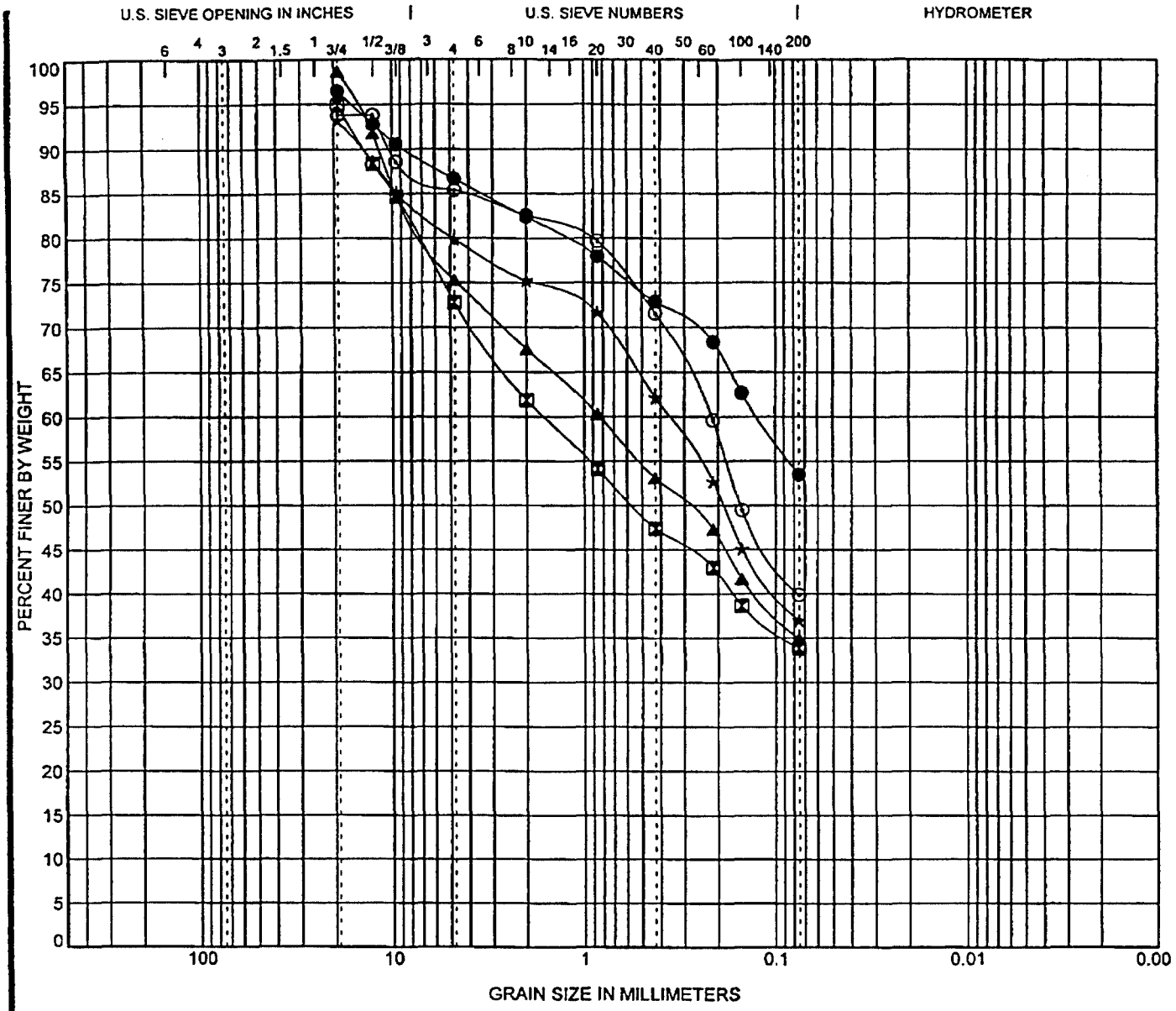
APPENDIX D.1

INDEX TESTING SUMMARY



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	G-01	0.0	FILL: SANDY CLAY (CL)	31	14	17		
⊠	G-02	0.0	FILL: CLAYEY SAND (SC)					
▲	G-03	0.0	FILL: CLAYEY SAND (SC), brown	31	15	16		
★	G-04	0.0	FILL: CLAYEY SAND (SC), brown	26	15	11		
⊙	G-05	0.0	FILL: CLAYEY SAND (SC), brown	23	12	11		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	G-01	0.0	19	0.122			9.8	33.2	53.5	
⊠	G-02	0.0	19	1.624			22.1	38.9	33.9	
▲	G-03	0.0	19	0.826			23.4	40.4	34.9	
★	G-04	0.0	19	0.362			13.3	42.9	37.0	
⊙	G-05	0.0	19	0.217			8.4	45.5	39.9	

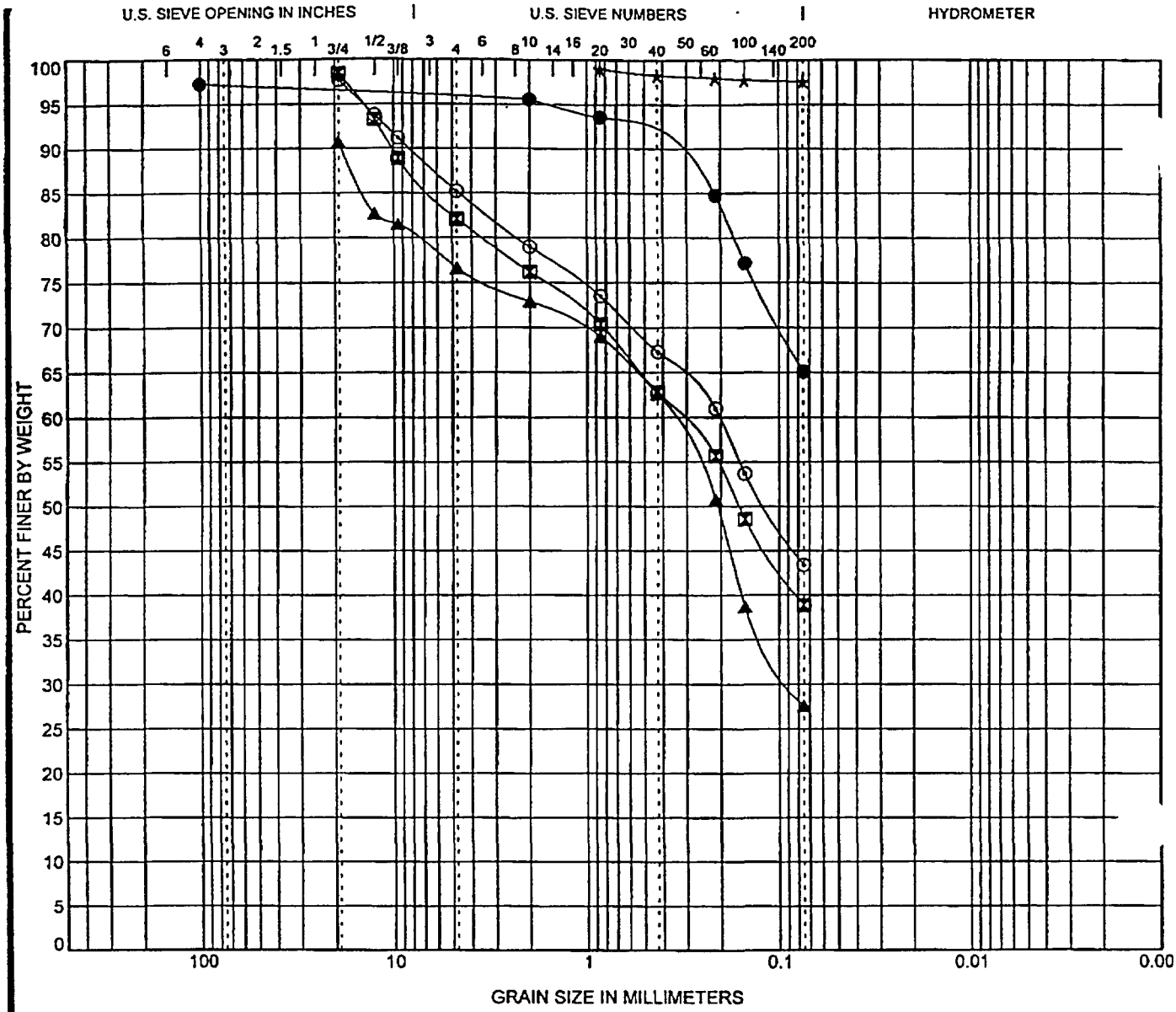
3/02 Fullerton*

LA CORP.G

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

GRAIN SIZE DISTRIBUTION

Project: WASTE DISPOSAL SUPERFUND SITE
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	G-05	11.0	NATIVE: SILT (ML)					
⊠	G-06	0.0	FILL: CLAYEY SAND (SC), brown	28	14	14		
▲	G-07	0.0	FILL: CLAYEY SAND (SC)					
★	G-07	26.0	SILT (ML)					
⊙	G-08	0.0	FILL: CLAYEY SAND (SC)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	G-05	11.0	100				1.2	30.9	65.1	
⊠	G-06	0.0	19	0.323			16.3	43.2	38.9	
▲	G-07	0.0	19	0.365	0.087		14.1	49.0	27.6	
★	G-07	26.0	0.85				0.0	1.4	97.6	
⊙	G-08	0.0	19	0.202			12.5	41.8	43.4	

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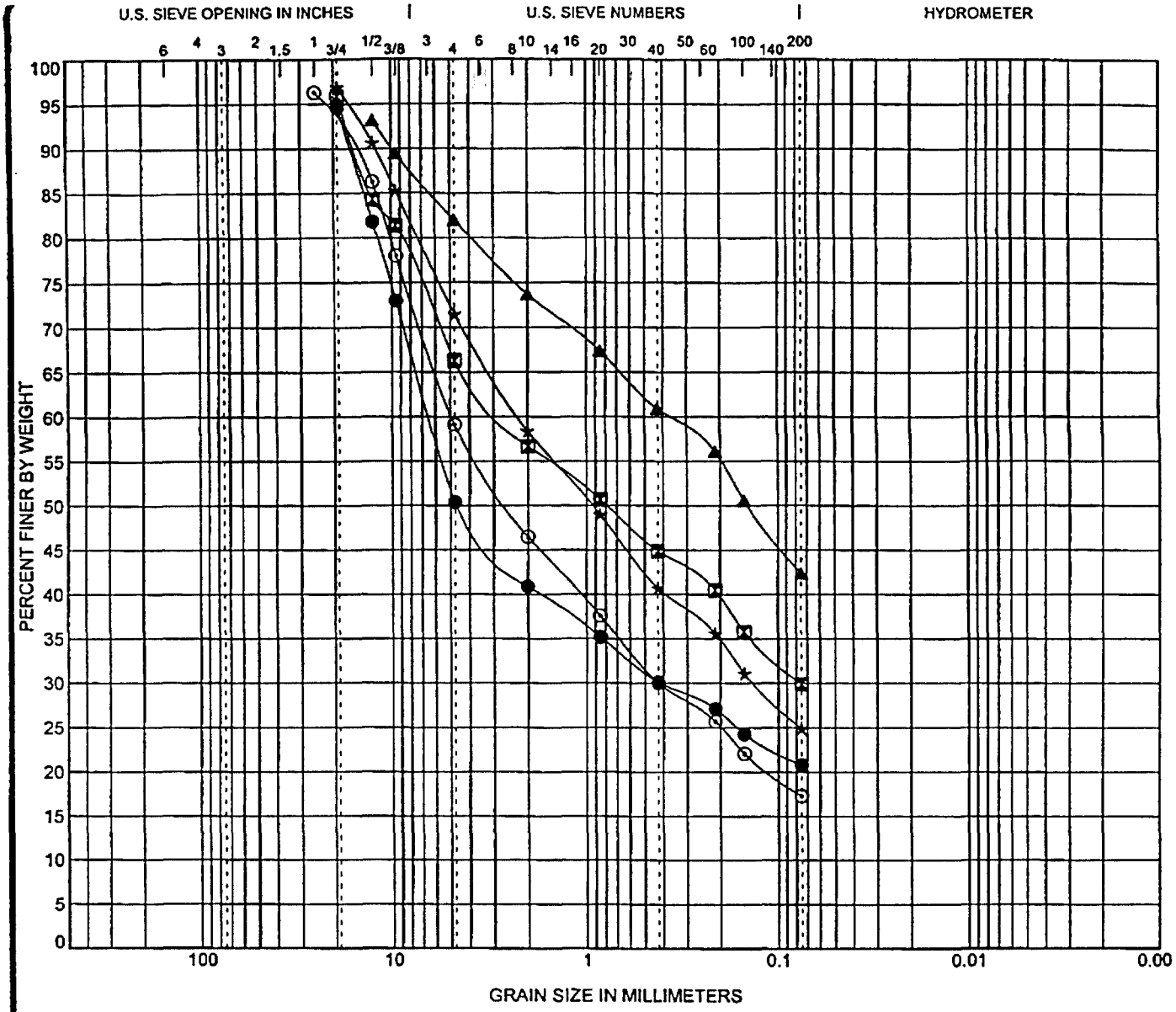
GRAIN SIZE DISTRIBUTION

Project: WASTE DISPOSAL SUPERFUND SITE
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8A

LA CORP.GDT 12/23/02 Fullerton*



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	G-09	0.0	FILL: CLAYEY SAND (SC), brown	33	17	16		
⊠	G-10	0.0	FILL: CLAYEY SAND (SC)					
▲	G-11	0.0	FILL: CLAYEY SAND (SC)					
★	G-12	0.0	FILL: CLAYEY SAND (SC), brown					
⊙	G-13	0.0	FILL: CLAYEY SAND (SC), brown	31	18	13		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	G-09	0.0	19	6.376	0.415		44.2	29.6	20.8	
⊠	G-10	0.0	19	2.693	0.076		29.6	36.4	29.9	
▲	G-11	0.0	12.5	0.373			11.2	39.6	42.4	
★	G-12	0.0	19	2.223	0.133		25.4	46.6	24.9	
⊙	G-13	0.0	25	4.909	0.425		37.2	41.8	17.3	

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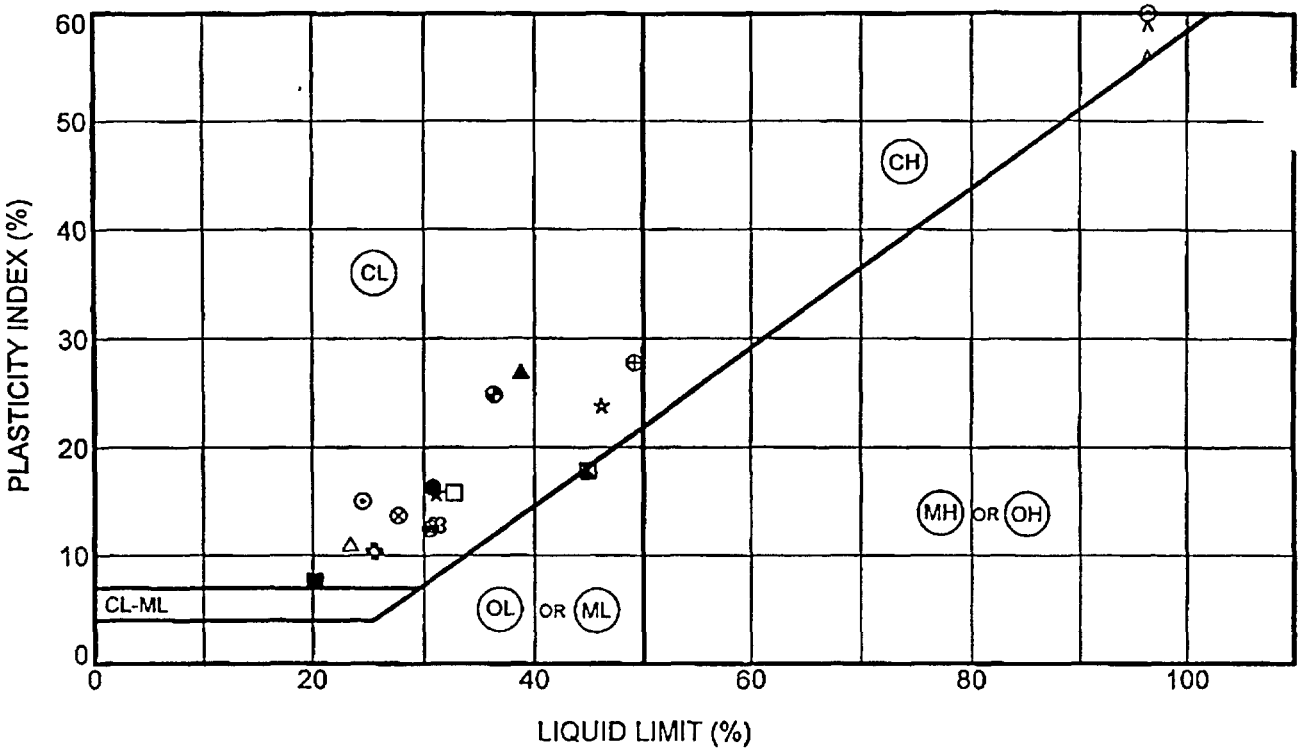
GRAIN SIZE DISTRIBUTION

Project: WASTE DISPOSAL SUPERFUND SITE

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8A

LA CORP.GD J/02 Fullerton



Symbol	Boring No.	Depth (ft.)	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing No. 200 Sieve	Unified Soil Classification Description
●	G-01	0.0	-NA-	31	14	17	54	FILL: SANDY CLAY (CL)
⊠	G-01	20.0		45	27	18		FILL: BENTONITE CLAY (CL)
▲	G-02	15.0		39	12	27		CLAY (CL), olive brown
★	G-03	0.0		31	15	16	35	FILL: CLAYEY SAND (SC), brown
⊙	G-03	15.0		25	9	16		FILL: CLAY (CL)
✿	G-04	0.0		26	15	11	37	FILL: CLAYEY SAND (SC), brown
○	G-04	10.0		96	19	77		FILL: BENTONITE CLAY (CH)
△	G-05	0.0		23	12	11	40	FILL: CLAYEY SAND (SC), brown
⊗	G-06	0.0		28	14	14	39	FILL: CLAYEY SAND (SC), brown
⊕	G-06	15.0		49	21	28		FILL: BENTONITE CLAY (CL)
□	G-09	0.0		33	17	16	21	FILL: CLAYEY GRAVEL (GC)
⊖	G-09	11.0		31	18	13		FILL: CLAY (CL)
⊛	G-09	20.0		36	11	25		FILL: BENTONITE CLAY (CL)
☆	G-10	11.0		46	22	24		FILL: BENTONITE CLAY (CL)
⊠	G-13	0.0		31	18	13	17	FILL: CLAYEY SAND (SC), brown
■	G-13	15.0		20	13	7		FILL: CLAY (CL)

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Environmental/Geotechnical/Engineering Services

PLASTICITY CHART AND DAT.

Project: WASTE DISPOSAL SUPERFUND SITE

Location: SANTA FE SPRINGS, CALIFORNIA

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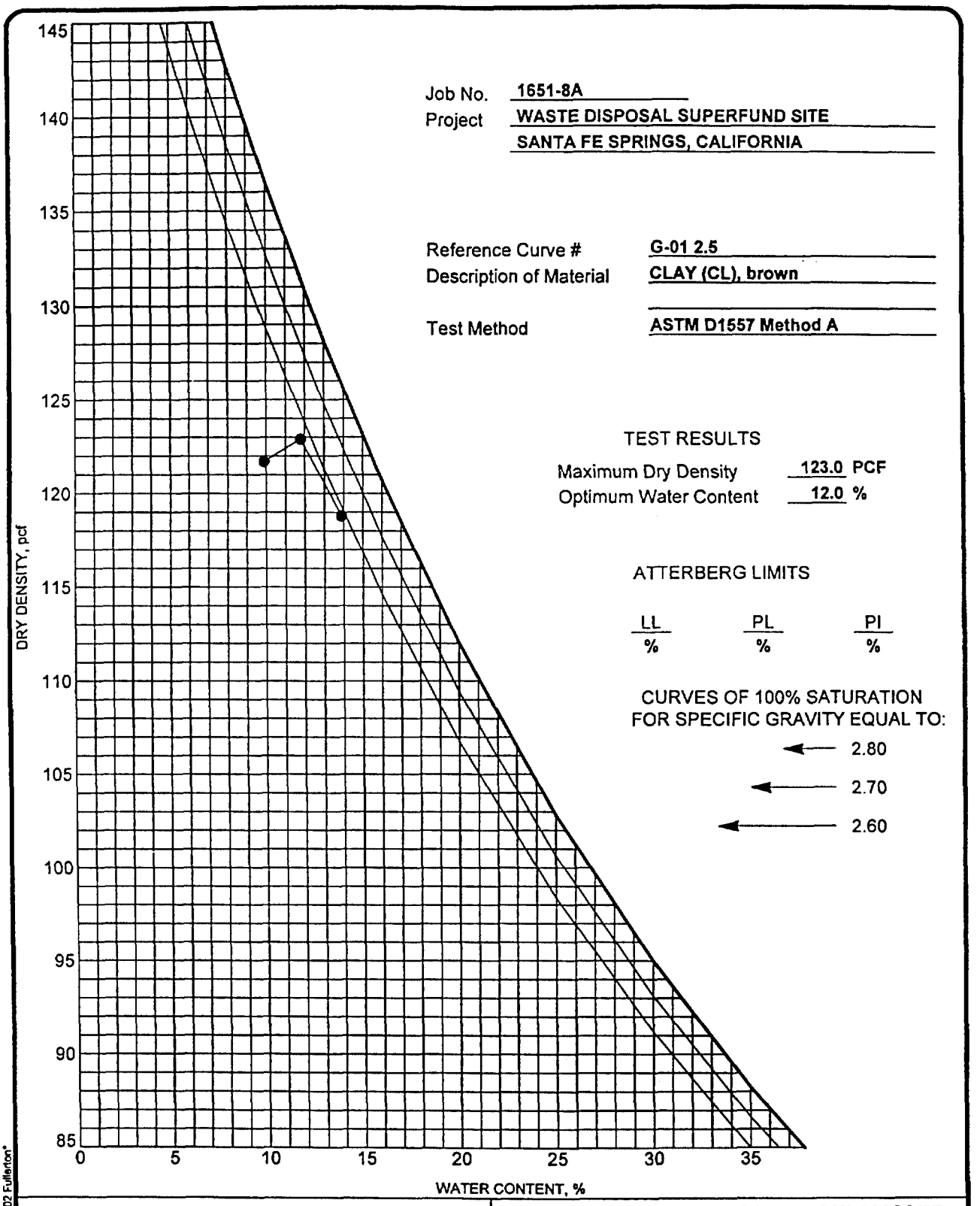

Job No. 1651-8A
Project WASTE DISPOSAL SUPERFUND SITE
SANTA FE SPRINGS, CALIFORNIA

Reference Curve # G-01 2.5
Description of Material CLAY (CL), brown

Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 123.0 PCF
Optimum Water Content 12.0 %

ATTERBERG LIMITS

LL	PL	PI
%	%	%

CURVES OF 100% SATURATION
FOR SPECIFIC GRAVITY EQUAL TO:

← 2.80
← 2.70
← 2.60

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MOISTURE-DENSITY RELATIONSHIP

Project: WASTE DISPOSAL SUPERFUND SITE
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8A

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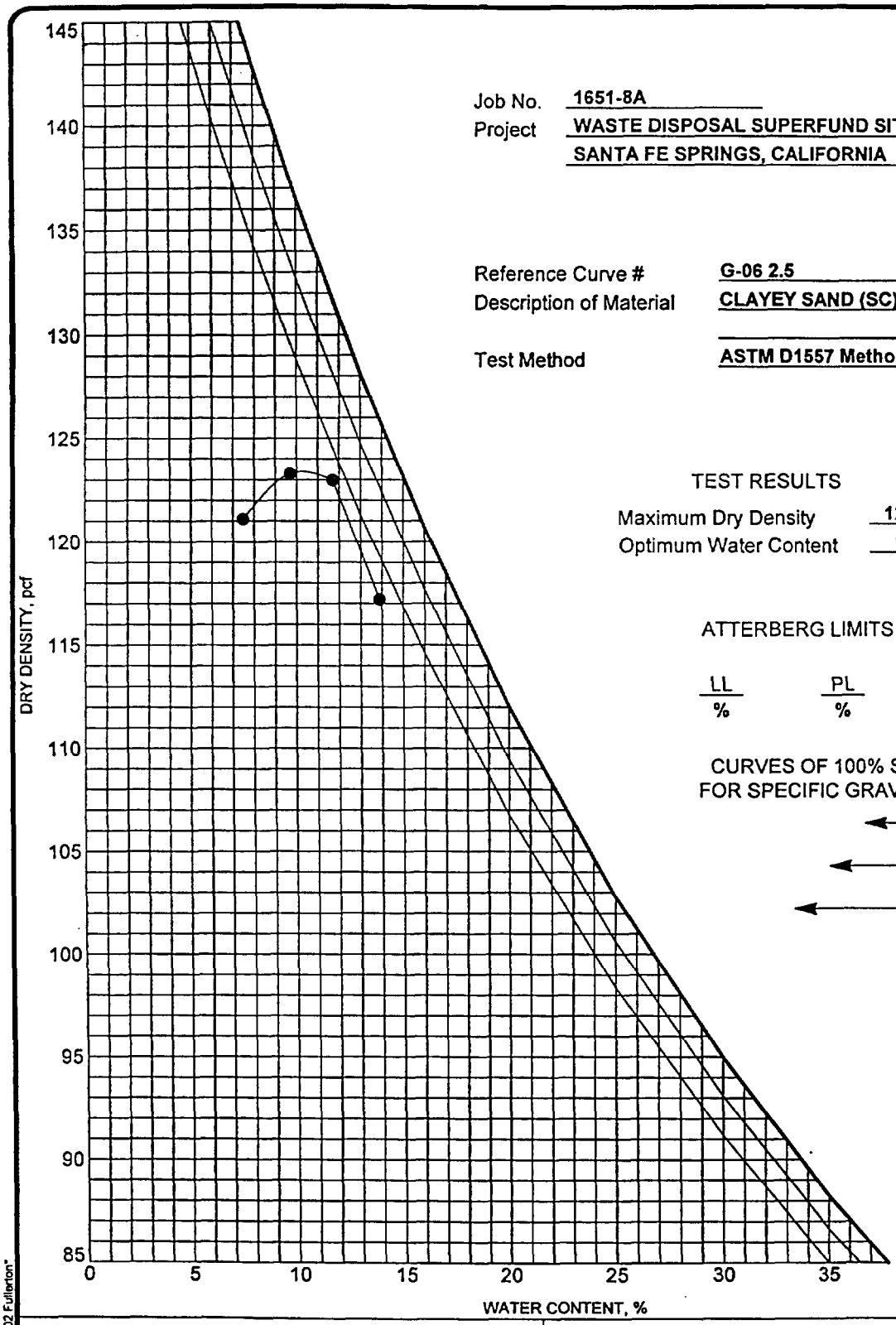

Job No. 1651-8A
Project WASTE DISPOSAL SUPERFUND SITE
SANTA FE SPRINGS, CALIFORNIA

Reference Curve # G-06 2.5
Description of Material CLAYEY SAND (SC), brown

Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 124.0 PCF
Optimum Water Content 11.0 %

ATTERBERG LIMITS

LL	PL	PI
%	%	%

CURVES OF 100% SATURATION
FOR SPECIFIC GRAVITY EQUAL TO:

← 2.80
← 2.70
← 2.60

LOWNEY ASSOCIATES
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MOISTURE-DENSITY RELATIONSHIP

Project: WASTE DISPOSAL SUPERFUND SITE
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8A

LA CORP.GDT 10/23/02 Fullerton

APPENDIX D.2

KEANTAN LABORATORY TEST DATA - TM NO. 15 INVESTIGATIONS

KEANTAN LABORATORIES

www.keantanlabs.com
email: keantanlab@aol.com

October 4, 2002

TRC Environmental Solutions, Inc.
21 Technology Drive
Irvine, CA 92718

Attention: Mr. Allen Blodgett

Subject: Report/Laboratory Test Results
Project Name: WDI Santa Fe Springs
Project No.: 1651-8A
KTL Project No.: 02-056-002

Dear Mr. Blodgett:

Enclosed are results of the laboratory testing program conducted on samples from the above referenced project. The testing performed for this program was conducted in general accordance with testing procedures as follows:

TYPE OF TEST	TEST PROCEDURE
Moisture/Density	ASTM D 2216/2937
Grain Size Analysis	ASTM D 422
Modified Proctor	ASTM D 1557
Atterberg Limits	ASTM D 4318
UU Triaxial	ASTM D 2850
Direct Shear	ASTM D 3080
Hydraulic Conductivity	ASTM D 5084
Consolidation	ASTM D 2435

Attached herewith are Summary of Laboratory Test Results(3), Summary of Triaxial Permeability Test Results(1), Consolidation Test Results with summary tables (6), Modified Compaction Test Results(8), UU Triaxial Results(9), Grain Size Distribution Curves(17), and Direct Shear Test Results(7)

We appreciate the opportunity to provide testing services to TRC Environmental Solutions, Inc. If you have any questions regarding the test results, please contact us.

Very truly yours,
Keantan Laboratories

Kean Tan, PE
Principal

Encls.

720 North Valley Street, Suite B, Anaheim, CA 92801 • Tel.: (714) 535-7616 • Fax: (714) 535-7568

KEANTAN LABORATORIES

www.keantanlabs.com
email: keantanlab@aol.com

[illegible]MARY OF LABORATORY TEST RESULTS (page 1of 3)

PROJECT NA[illegible] [illegible]ANTA FE SPRINGS — KTL NO.: 02-056-002

PROJECT [illegible] — CLIENT: TRC ENV. SOLUTIONS

DATE: [illegible] — SUMMARIZED BY: K. Tan

BORING NO.	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	USCS CLASS.	GRAIN SIZE DIST. GR:SA:FI	ATTERBERG LIMITS LL:PL:PI
G-01	0-5			CL	13:33:54	30:14:16
	5.5	11.4	113.4			
	10.5	81.1	50.7			
	15.5	47.6	67.7			
	20	54.7	59.4			44:27:17
	23					
G-02	0-5				27:39:34	
	1.5	12.7	99.3			
	5.5	11.1	122.4			
	10.0	17.3	112.2			
	15	17.0	97.5			38:12:26
	20.5					
	25.5					
G-03	0-5			SC	25:40:35	29:15:14
	1.5	13.1	104.2			
	5.5	19.9	103.2			
	10.5	15.8	118.0			
	15.0	13.3	121.3			24:9:14
	20.5					
	25.5					
	30.5					
	35.5					
	40.5					
	45.5					
G-04	0-5			SC	20:43:37	24:15:9
	1.5	15.8	97.0			
	5.5	19.8	93.7			
	10.0	103.9	41.3			96:19:77
	15.0	17.1				

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KEANTAN LABORATORIES

www.keantanlabs.com
email: keantanlab@aol.com

SUMMARY OF LABORATORY TEST RESULTS (page 2 of 3)

PROJECT NAME: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

PROJECT NO.: 1651-8A CLIENT: TRC ENV. SOLUTIONS

DATE: 10-4-02 SUMMARIZED BY: K. Tan

BORING NO.	SAMPLE NO.	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	USCS CLASS.	GRAIN SIZE DIST. GR:SA:FI	ATTERBERG LIMITS LL:PL:PI
G-04	5	20.0	18.0	82.4			
G-05	Bulk	0-5			SC	15:45:40	23:12:11
	1	1.5	10.7	95.2			
	2	5.5	9.5	113.9			
	3	10.5	12.7	98.9		3:32:65	
	4	15.5					
	5	20.5					
G-06	Bulk	0-5			SC	18:43:39	26:14:12
	1	1.5	4.9	103.7			
	2	5.5	15.4	87.2			
	3	10.5	125.8	46.1			
	4	12.0	58.2				
	5	15.0	44.0	74.6			47:21:26
	6	20	44.6	69.5			
	7	25	5.1				
	8	30.5					
	9	35.5					
G-07	Bulk	0-5				23:49:28	
	1	1.5	2.9	96.7			
	2	5.5	10.3	111.4			
	3	10.0	52.8	63.5			
	4	15.0	13.5	101.5			
	5	20.5	12.6	104.3			
	6	25.5	34.8	92.5		0:2:98	
	7	30.5					
	8	35.5					
G-08	Bulk	0-5				15:42:43	
	1	1.5	8.1	94.3			
	2	5.5	56.5	70.0			
	3	10.0	24.4				
	4	15.0	12.8	107.2			

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KEANTAN LABORATORIES

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email: keantanlab@aol.com

SUMMARY OF LABORATORY TEST RESULTS (page 3 of 3)

PROJECT NAME: [illegible]SANTA FE SPRINGS — KTL NO.: 02-056-002

PROJECT NO.: [illegible]-A — CLIENT: TRC ENV. SOLUTIONS

DATE: [illegible] — SUMMARIZED BY: K. Tan

BORING NO.	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	USCS CLASS.	GRAIN SIZE DIST. GR:SA:FI	ATTERBERG LIMITS LL:PL:PI
G-08	20.0	31.7	86.5			
G-09	0-5			SC	50:29:21	29:17:12
	5.5	13.9	105.6			
	10.5	15.7	114.7	CL	0:35:65	28:18:10
	16.5	14.8	115.6			
	20.0	13.4	114.6			32:12:21
	23.5	11.5	120.2			
G-10	0-5				34:36:30	
	1.5	10.6	106.7			
	5.5	76.8	61.3			
	10.5	27.5	92.9			43:22:21
	15.5	22.8	*			
G-11	0-5				18:40:42	
	5.0	11.8	103.2			
	12.5	7.6	117.5		**	
	15.5	12.2	123.2			
	20.5	28.6	*			
G-12	[illegible]				28:47:25	
	[illegible]	3.3	*			
	5.5	11.1	96.7			
	10.0	41.3	69.3			
	15.0	12.5	117.0			
	20.0	14.9				
	25.5	14.7	101.8			
G-13	0-5			SC	41:42:17	28:18:10
	1.5	5.61				
	5.5	11.1	*			
	10.5	58.0	61.3			
	15.0	17.3	112.2			18:13:5
	20.5	14.0	121.5		0:47:53	
	25.5	11.1	94.7			

c:\ My Documen[illegible] Solutions \wdi

* disturbed sam[illegible] **too much liquid oil for sieve to be performed.

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TABLE

SUMMARY OF CONSOLIDATION TEST RESULTS

(ASTM D2435)

PROJECT NAME:	SANTA FE SPRINGS	KTL #:	02-056-002
CLIENT PROJECT NO.	61-8A	CLIENT:	TRC
REPORT DATE:	UST 2002	SUMMARIZED B	Kean Tan

Boring No.:	61/#4	Depth (ft.) :	20
Dry Density (pcf):	59.4	Specific Gravity:	2.70 (Assumed)
Initial Moisture (%):	54.70	Final Moisture (%	68.50
Initial Length (in.):	1.000	Initial Void Ratio :	1.838
Initial Dial Reading:	0.5142		

PRESSURE (p) (ksf)	Fi READ	CKNESS	VOID RATIO	STRAIN % OF SAMPLE THICKNESS	LOAD COMPLIANCE (%)	CORRECTED STRAIN (%)
0.10		.0000	1.838	0	0	0.00
0.50		.777	1.774	2.23	0.00	2.23
1.00		.763	1.770	2.37	0.00	2.37
2.00		.238	1.338	17.62	0.00	17.62
0.30		.283	1.350	17.17	0.00	17.17
0.50		.8230	1.335	17.70	0.00	17.70
H2O		.8315	1.360	16.85	0.00	16.85
1		.8276	1.349	17.24	0.00	17.24
2		.8121	1.305	18.79	0.00	18.79
1		.8154	1.314	18.46	0.00	18.46
0.3		0.8164	1.317	18.36	0.00	18.36

TABLE

SUMMARY OF CONSOLIDATION TEST RESULTS

(ASTM D2435)

PROJECT NAME:	WDI/SANTA FE SPRINGS	KTL #:	02-056-002
CLIENT PROJECT NO.:	1651-8A	CLIENT:	TRC
REPORT DATE:	AUGUST 2002	SUMMARIZED B	Kean Tan

Boring No.:	G-04/#3	Depth (ft.) :	10
Dry Density (pcf):	41.3	Specific Gravity:	2.70 (Assumed)
Initial Moisture (%):	103.90	Final Moisture (%	114.30
Initial Length (in.):	1.000	Initial Void Ratio :	3.081
Initial Dial Reading:	0.2476		

PRESSURE (p) (ksf)	FINAL READING (in)	THICKNESS (in)	VOID RATIO	STRAIN % OF SAMPLE THICKNESS	LOAD COMPLIANCE (%)	CORRECTED STRAIN (%)
0.10	0.2476	1.0000	3.081	0	0	0.00
0.20	0.2576	0.9900	3.041	1	0.00	1.00
0.50	0.2670	0.9806	3.002	1.94	0.00	1.94
1.00	0.3312	0.9164	2.740	8.36	0.00	8.36
0.30	0.3302	0.9174	2.744	8.26	0.00	8.26
0.50	0.3444	0.9032	2.686	9.68	0.00	9.68
H2O	0.3288	0.9188	2.750	8.12	0.00	8.12
1	0.3358	0.9118	2.721	8.82	0.00	8.82
2	0.3698	0.8778	2.583	12.22	0.00	12.22
1	0.3651	0.8825	2.602	11.75	0.00	11.75
0.3	0.3483	0.8993	2.670	10.07	0.00	10.07

TABLE

SUMMARY OF CONSOLIDATION TEST RESULTS

(ASTM D2435)

PROJECT NAME:	SANTA FE SPRINGS	KTL #:	02-056-002
CLIENT PROJECT NO	51-8A	CLIENT:	TRC
REPORT DATE:	GUST 2002	SUMMARIZED B	Kean Tan

Boring No.:	-06/#5	Depth (ft.) :	15
Dry Density (pcf)	74.6	Specific Gravity:	2.70 (Assumed)
Initial Moisture (%)	44.00	Final Moisture (%	35.20
Initial Length (in.)	1.000	Initial Void Ratio :	1.260
Initial Dial Reading	0.2449		

PRESSURE (p) (ksf)		HICKNESS (in)	VOID RATIO	STRAIN % OF SAMPLE THICKNESS	LOAD COMPLIANCE (%)	CORRECTED STRAIN (%)
0.10		1.0000	1.260	0	0	0.00
0.50		.9804	1.215	1.96	0.00	1.96
1.00		.9063	1.048	9.37	0.00	9.37
1.50		.8959	1.024	10.41	0.00	10.41
0.30		.8976	1.028	10.24	0.00	10.24
0.50		0.8948	1.022	10.52	0.00	10.52
H2O		0.9039	1.042	9.61	0.00	9.61
1		0.9005	1.035	9.95	0.00	9.95
2		0.8908	1.013	10.92	0.00	10.92
1		0.8934	1.019	10.66	0.00	10.66
0.3		0.9012	1.036	9.88	0.00	9.88

TABLE

SUMMARY OF CONSOLIDATION TEST RESULTS

(ASTM D2435)

PROJECT NAME:	WDI/SANTA FE SPRINGS	KTL #:	02-056-002
CLIENT PROJECT NO.:	1651-8A	CLIENT:	TRC
REPORT DATE:	AUGUST 2002	SUMMARIZED B	Kean Tan

Boring No.:	G-09/#4	Depth (ft.) :	20
Dry Density (pcf):	114.6	Specific Gravity:	2.70 (Assumed)
Initial Moisture (%):	13.40	Final Moisture (%	15.24
Initial Length (in.):	1.000	Initial Void Ratio :	0.471
Initial Dial Reading:	0.5851		

PRESSURE (p) (ksf)	FINAL READING (in)	THICKNESS (in)	VOID RATIO	STRAIN % OF SAMPLE THICKNESS	LOAD COMPLIANCE (%)	CORRECTED STRAIN (%)
0.10	0.5851	1.0000	0.471	0	0	0.00
0.50	0.5787	0.9936	0.461	0.64	0.00	0.64
1.00	0.5737	0.9886	0.454	1.14	0.00	1.14
2.00	0.5638	0.9787	0.440	2.13	0.00	2.13
0.30	0.5653	0.9802	0.442	1.98	0.00	1.98
0.50	0.5652	0.9801	0.442	1.99	0.00	1.99
H2O	0.5801	0.9950	0.464	0.50	0.00	0.50
1	0.5784	0.9933	0.461	0.67	0.00	0.67
2	0.5722	0.9871	0.452	1.29	0.00	1.29
1	0.5736	0.9885	0.454	1.15	0.00	1.15
0.3	0.5772	0.9921	0.459	0.79	0.00	0.79

TABLE

SUMMARY OF CONSOLIDATION TEST RESULTS

(ASTM D2435)

PROJECT NAME:	/CI/SANTA FE SPRINGS	KTL #:	02-056-002
CLIENT PROJECT NO:	1651-8A	CLIENT:	TRC
REPORT DATE:	GUST 2002	SUMMARIZED B	Kean Tan

Boring No.:	1-10/#3	Depth (ft.) :	10.5
Dry Density (pcf)	92.9	Specific Gravity:	2.70 (Assumed)
Initial Moisture (%)	27.52	Final Moisture (%	27.68
Initial Length (in.)	1.000	Initial Void Ratio :	0.814
Initial Dial Reading	0.1940		

PRESSURE (p) (ksf)	READ	THICKNESS (in)	VOID RATIO	STRAIN % OF SAMPLE THICKNESS	LOAD COMPLIANCE (%)	CORRECTED STRAIN (%)
0.10		1.0000	0.814	0	0	0.00
0.2		1.9907	0.798	0.93	0	0.93
0.50		1.9817	0.781	1.83	0	1.83
1.00		1.9623	0.746	3.77	0	3.77
0.30		1.9630	0.747	3.7	0	3.70
0.50		0.9626	0.747	3.74	0	3.74
H20		0.9645	0.750	3.55	0.00	3.55
1		0.9629	0.747	3.71	0.00	3.71
2		0.9493	0.722	5.07	0.00	5.07
1		0.9508	0.725	4.92	0.00	4.92
0.3		0.9531	0.729	4.69	0.00	4.69

TABLE

SUMMARY OF CONSOLIDATION TEST RESULTS

(ASTM D2435)

PROJECT NAME:	WDI/SANTA FE SPRINGS	KTL #:	02-056-002
CLIENT PROJECT NO.:	1651-8A	CLIENT:	TRC
REPORT DATE:	AUGUST 2002	SUMMARIZED B	Kean Tan

Boring No.:	G-12/#4	Depth (ft.) :	15
Dry Density (pcf):	117.0	Specific Gravity:	2.70 (Assumed)
Initial Moisture (%):	12.50	Final Moisture (%	11.88
Initial Length (in.):	1.000	Initial Void Ratio :	0.441
Initial Dial Reading:	0.1954		

PRESSURE (p) (ksf)	FINAL READING (in)	THICKNESS (in)	VOID RATIO	STRAIN % OF SAMPLE THICKNESS	LOAD COMPLIANCE (%)	CORRECTED STRAIN (%)
0.10	0.1954	1.0000	0.441	0	0	0.00
0.5	0.201	0.9944	0.433	0.56	0	0.56
1.00	0.2061	0.9893	0.425	1.07	0	1.07
1.50	0.2110	0.9844	0.418	1.56	0	1.56
0.30	0.2093	0.9861	0.421	1.39	0	1.39
0.50	0.2096	0.9858	0.420	1.42	0	1.42
H20	0.2077	0.9877	0.423	1.23	0.00	1.23
1	0.209	0.9864	0.421	1.36	0.00	1.36
2	0.2119	0.9835	0.417	1.65	0.00	1.65
1	0.2108	0.9846	0.419	1.54	0.00	1.54
0.3	0.2089	0.9865	0.421	1.35	0.00	1.35

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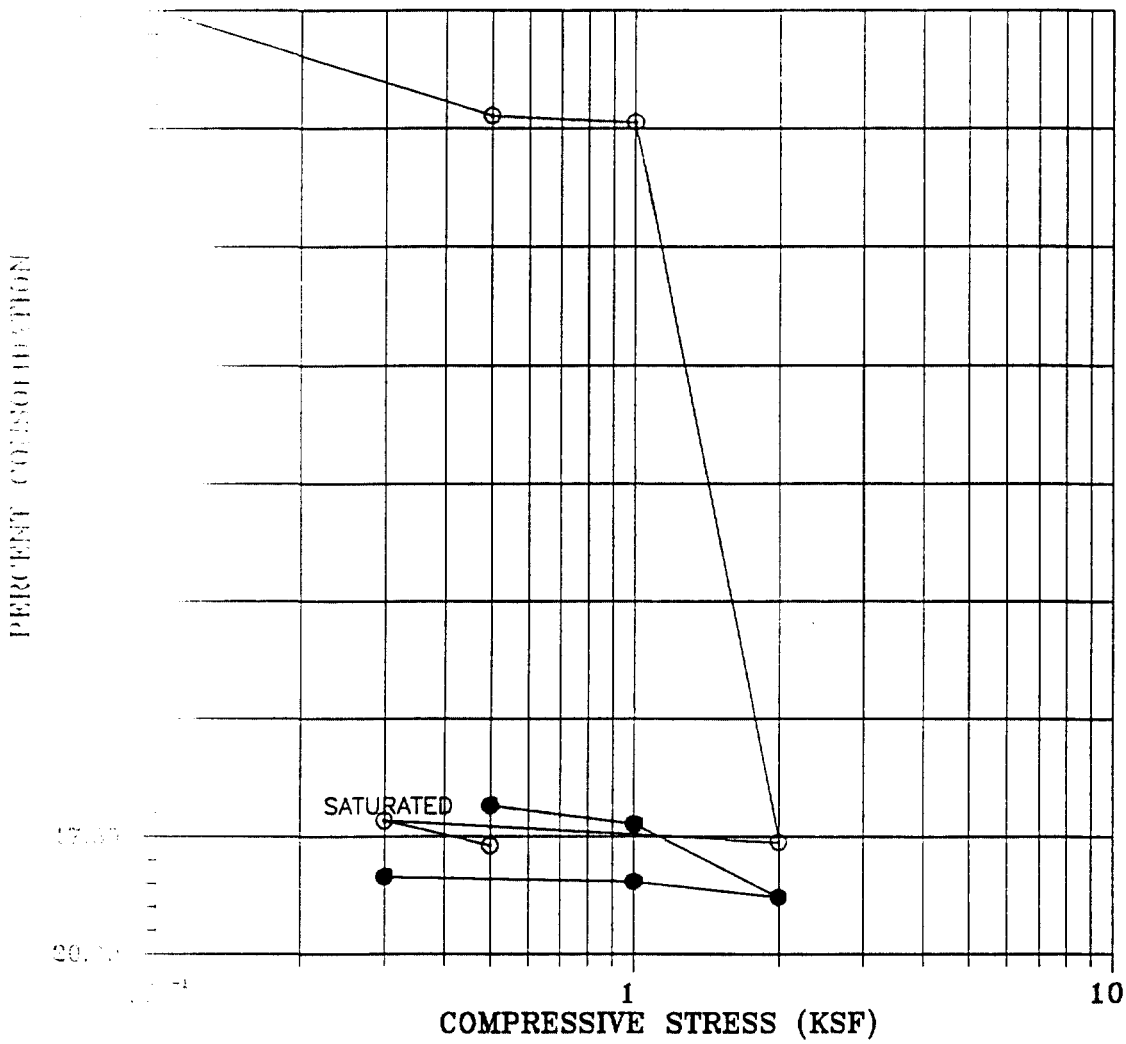
CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT	WDI/SANTA FE SPRINGS	KTL NO.:	02-056-002
CLIENT PROJECT NO.:	1651-8A	CLIENT :	TRC
REPORT DATE :	AUG 2002	SUMMARIZED BY :	K. TAN

BORING	G-01/ 4	DEPTH :	20 ft.
INITIAL DENSITY :	59.4 pcf.	INITIAL MOISTURE CONTENT :	54.7 pct.
INITIAL RATIO :	1.838		
SPECIFIC GRAVITY :	2.70(ASSUMED)		



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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

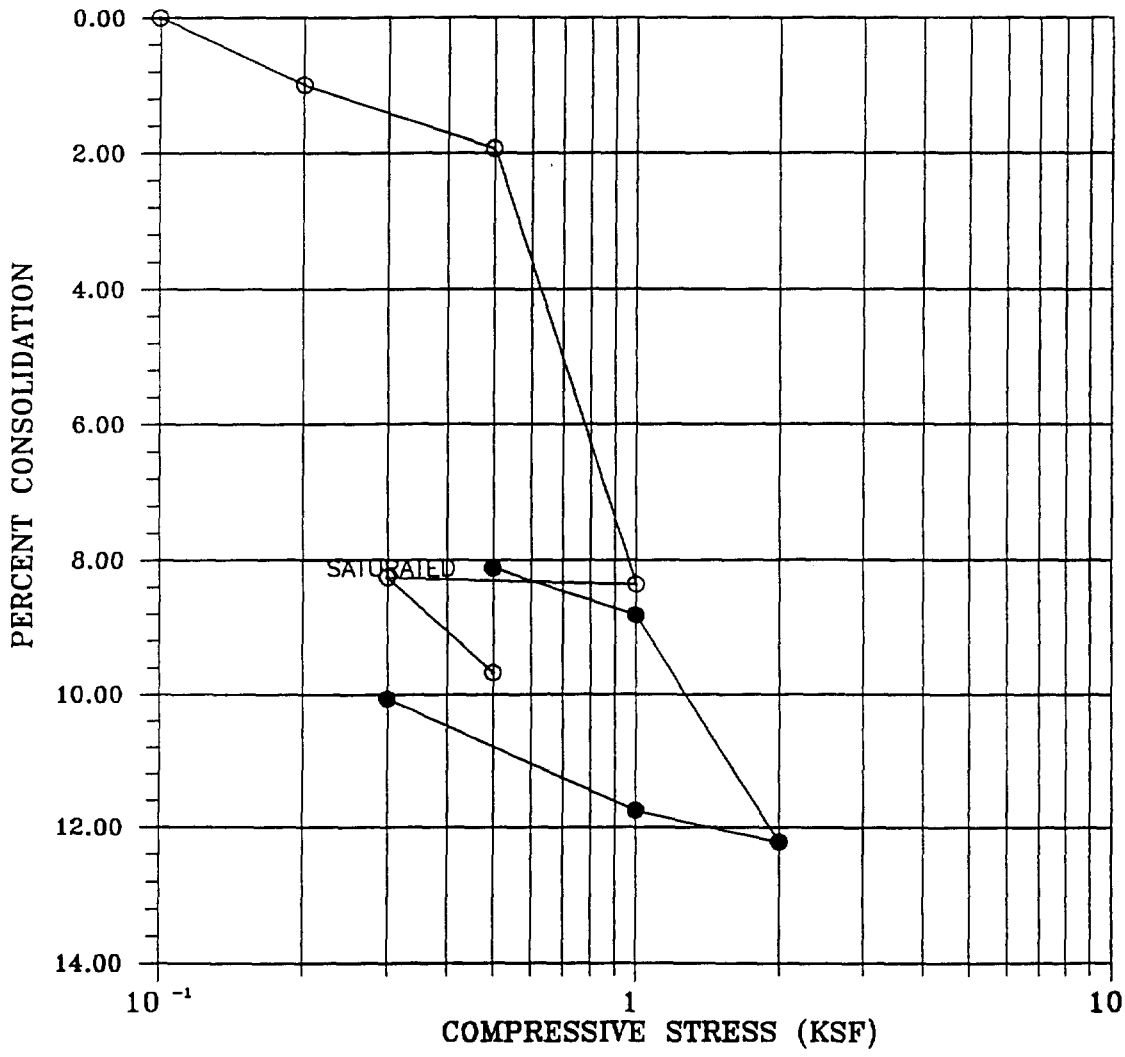
REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-04/ 3 DEPTH : 10 ft.

INITIAL DRY DENSITY : 41.3 pcf. INITIAL MOISTURE CONTENT : 103.9 pct.

INITIAL VOID RATIO : 3.081

SPECIFIC GRAVITY : 2.70(ASSUMED)



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CONSOLIDATION TEST RESULTS
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PROJECT: WDI/SANTA FE SPRINGS — KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A — CLIENT : TRC

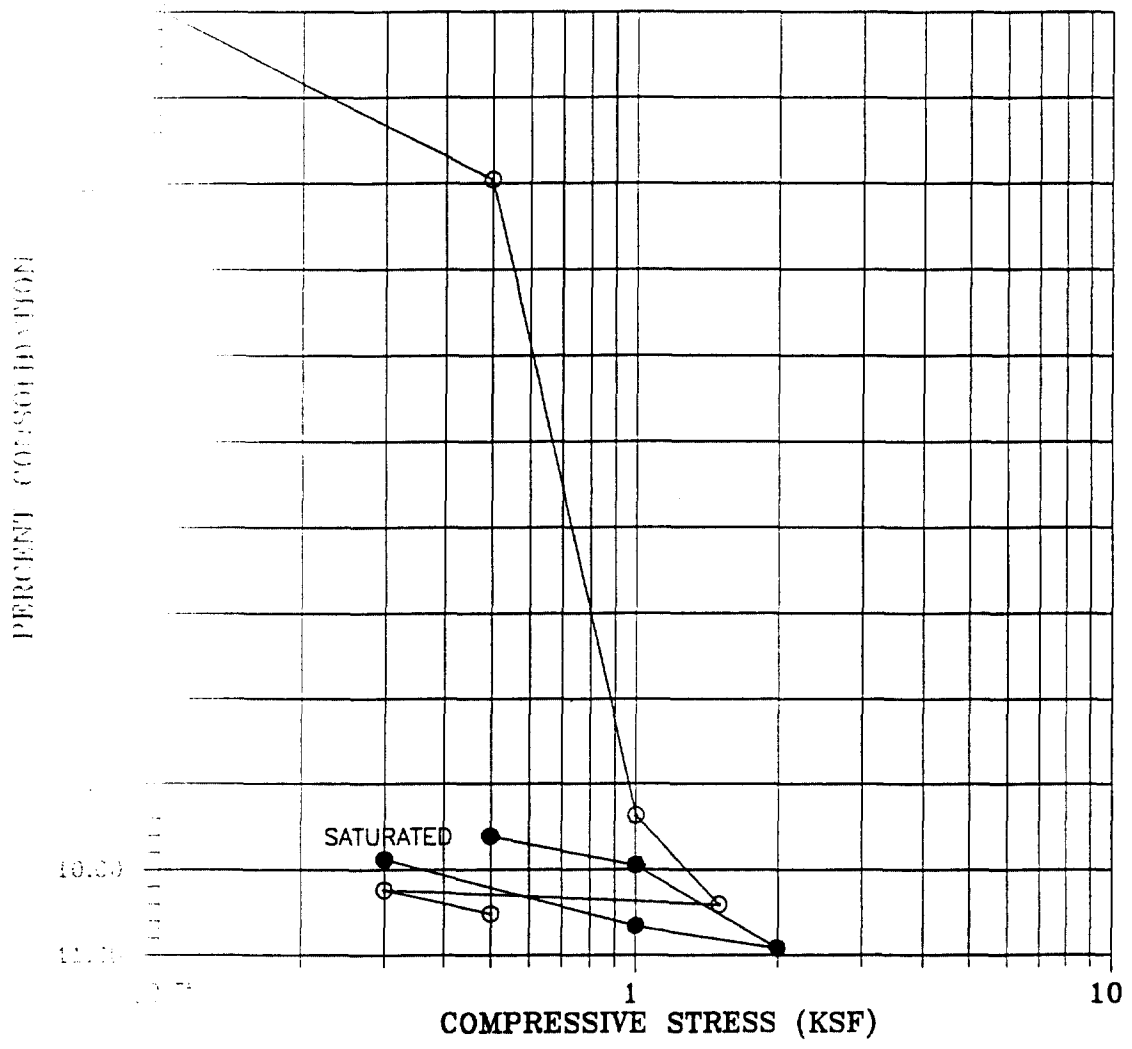
REPORT DATE : AUG 2002 — SUMMARIZED BY : K. TAN

BORING: G-06/ 5 — DEPTH : 15 ft.

INITIAL DENSITY : 74.6 pcf. — INITIAL MOISTURE CONTENT : 44.0 pct.

INITIAL RATIO : 1.260

SPECIFIC GRAVITY : 2.70(ASSUMED)



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CONSOLIDATION TEST RESULTS
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PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

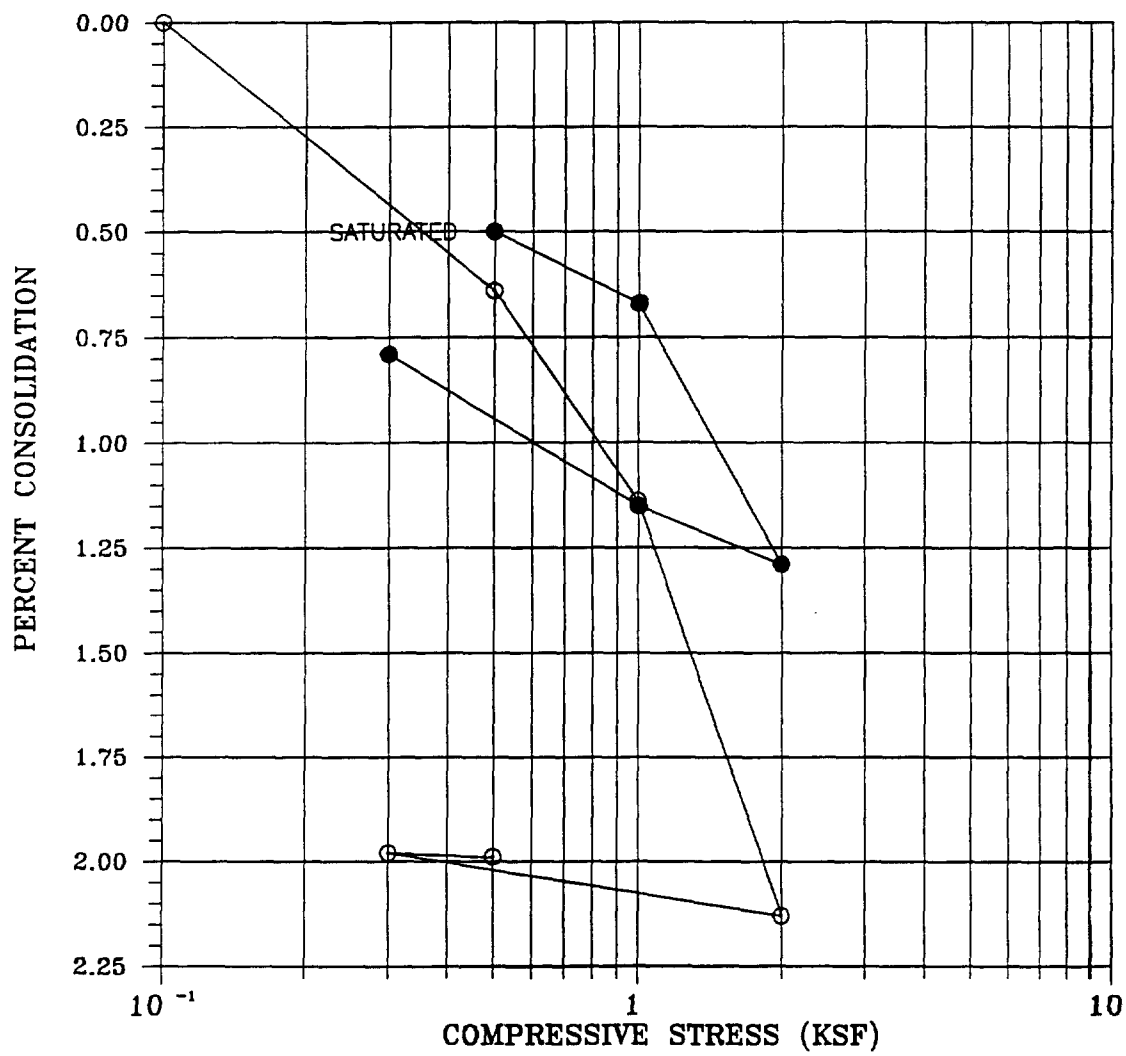
REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-09/ 4 DEPTH : 20 ft.

INITIAL DRY DENSITY : 114.6 pcf. INITIAL MOISTURE CONTENT : 13.4 pct.

INITIAL VOID RATIO : 0.471

SPECIFIC GRAVITY : 2.70(ASSUMED)



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CONSOLIDATION TEST RESULTS
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PROJECT : WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

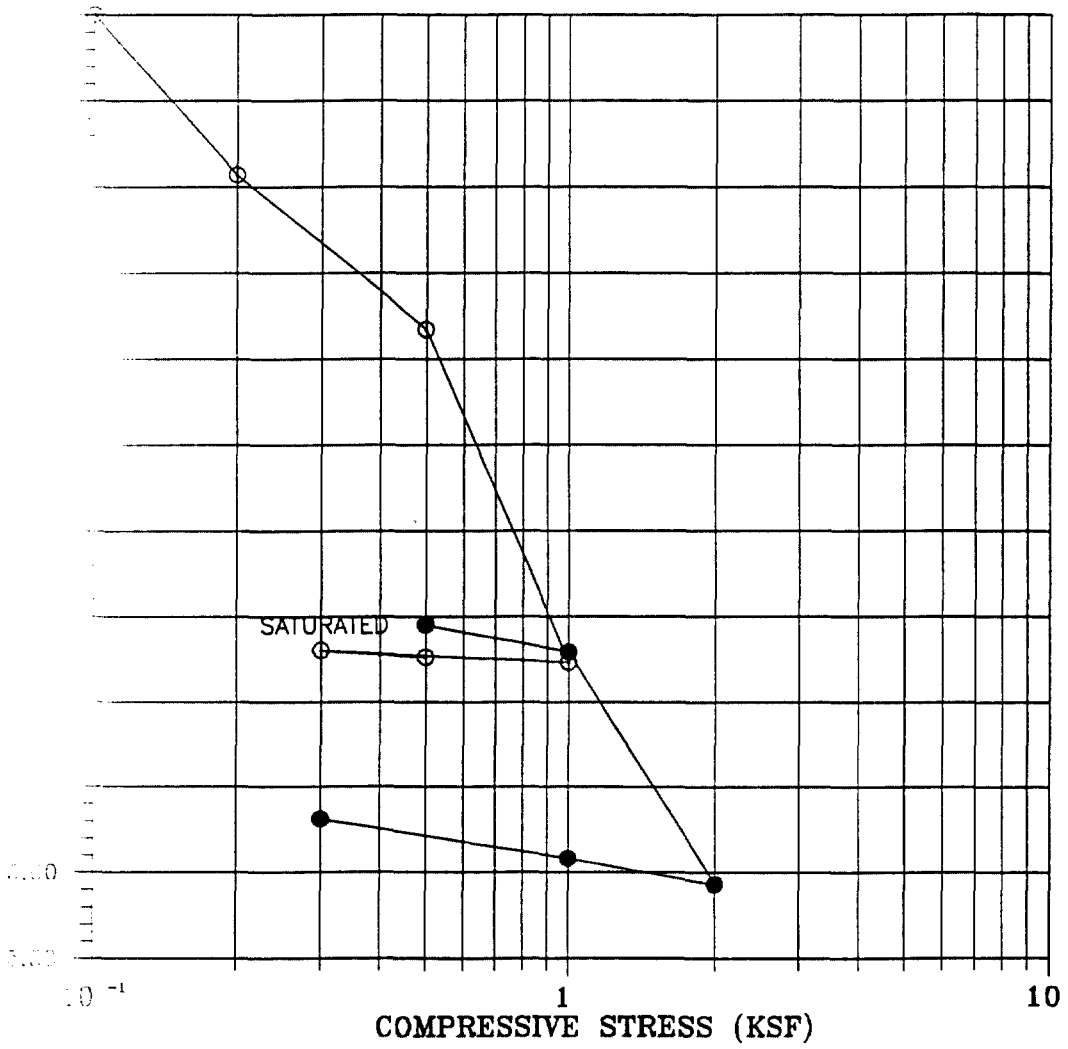
REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING G-10/ 3 DEPTH : 10.5 ft.

DRY DENSITY : 92.9 pcf. INITIAL MOISTURE CONTENT : 27.5 pct.

INITIAL VOID RATIO : 0.814

SPECIFIC GRAVITY : 2.70(ASSUMED)



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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

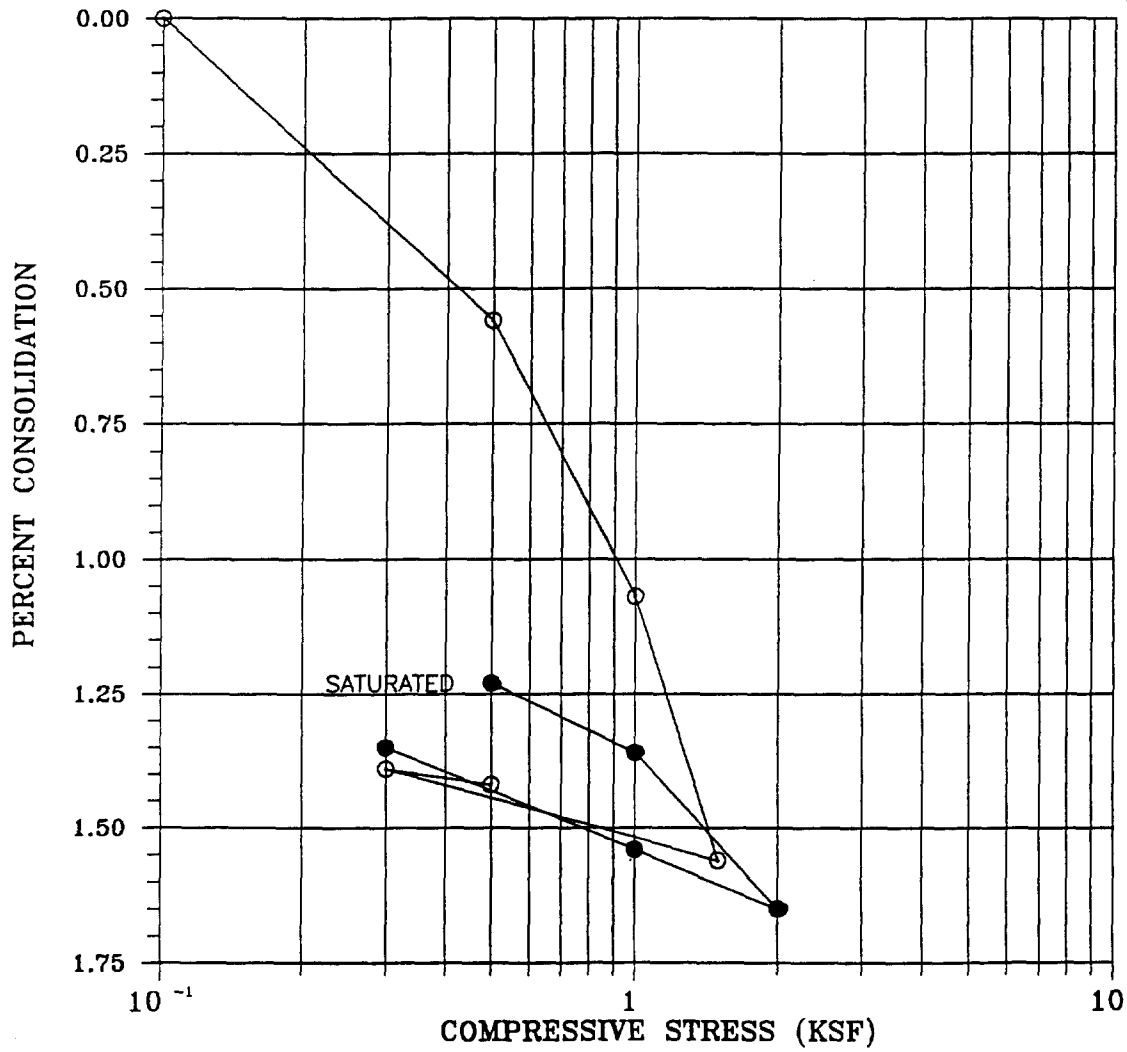
REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-12/ 4 DEPTH : 15 ft.

INITIAL DRY DENSITY : 117.0 pcf. INITIAL MOISTURE CONTENT : 12.5 pct.

INITIAL VOID RATIO : 0.441

SPECIFIC GRAVITY : 2.70(ASSUMED)



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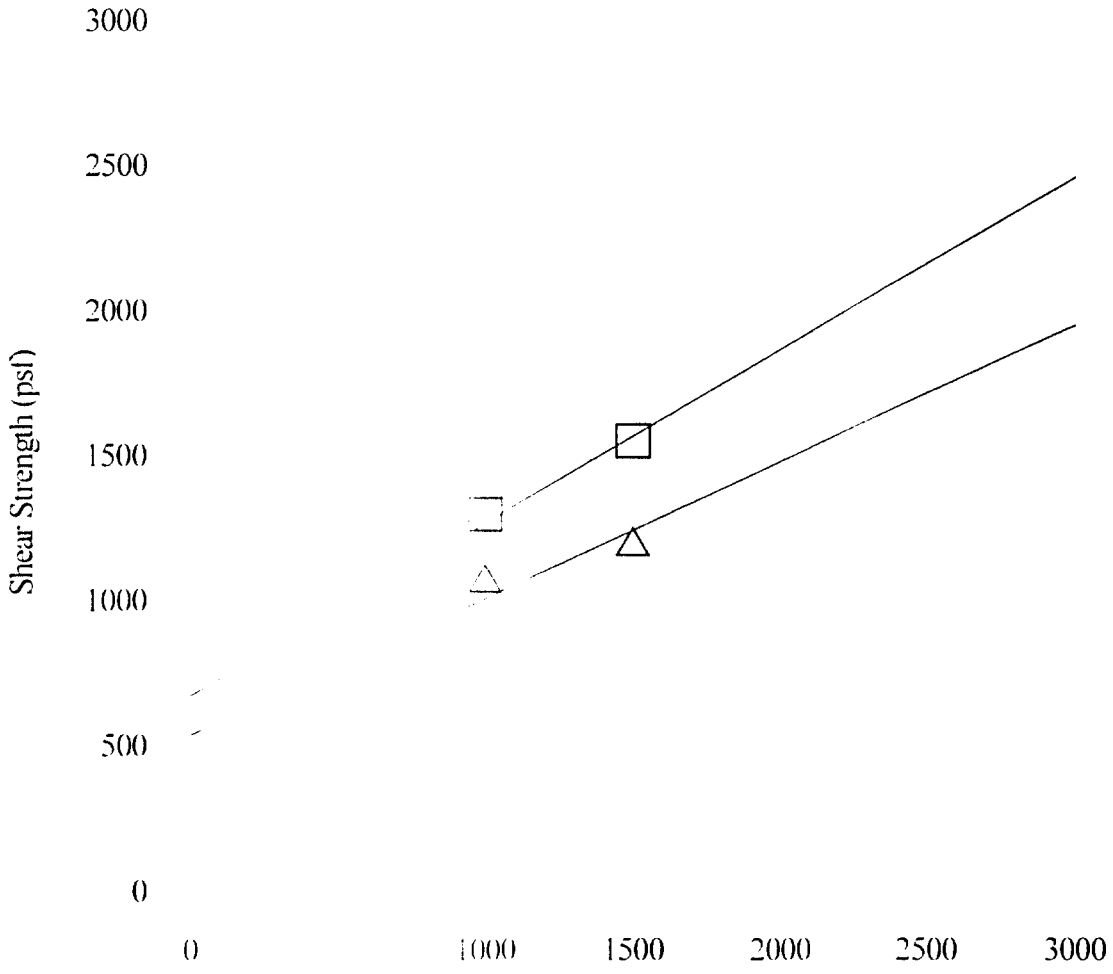
Direct Shear (CD) Test Results
ASTM D 3080

PROJ	SANTA FE SPRINGS	KTL NO.: 02-056-002
PROJ		CLIENT: TRC
DATE	2002	DEPTH (ft): 0-5
BORE		USCS CLASS.: SC
SAMP		
SAMP	OLD	
RING	2 IN.	
RING		SATURATED: YES
MOIST	12.0 percent	DRY DENSITY: 110.7 pcf



	Angle (degrees)	Cohesion (psf)
Peak		688
Ultimate		552

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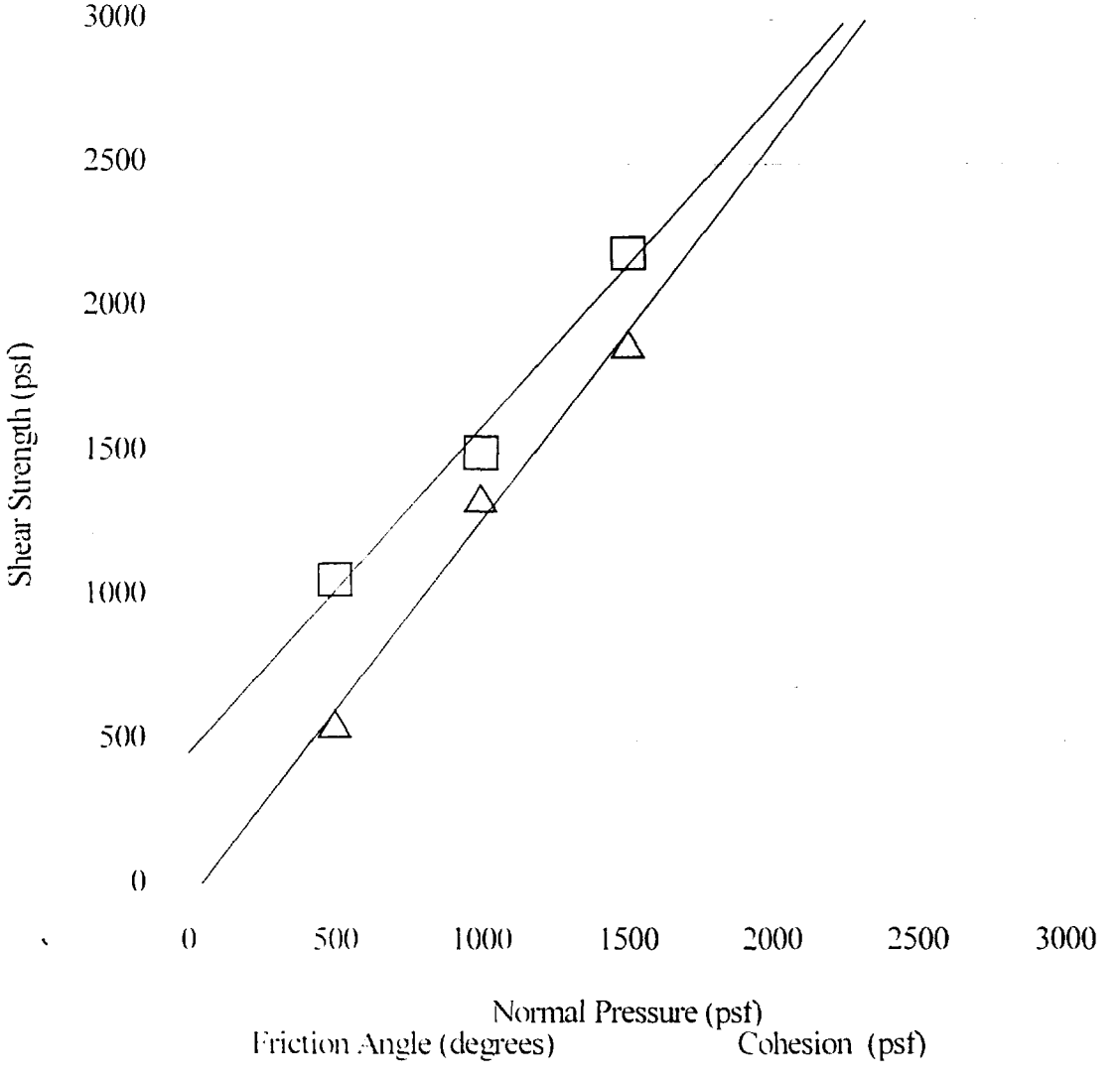
Direct Shear (CD) Test Results
ASTM D 3080

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: AUGUST 2002
BORING NO.: G-01
SAMPLE NO.: #1
SAMPLE TYPE: RING
RING DIAMETER: 2.42 IN.
RING HEIGHT: 1.0 IN.
MOISTURE CONTENT: 11.4 percent

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 5.5
USCS CLASS.: SC with rocks

SATURATED: YES
DRY DENSITY: 113.4 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	48	459
Ultimate	53	0

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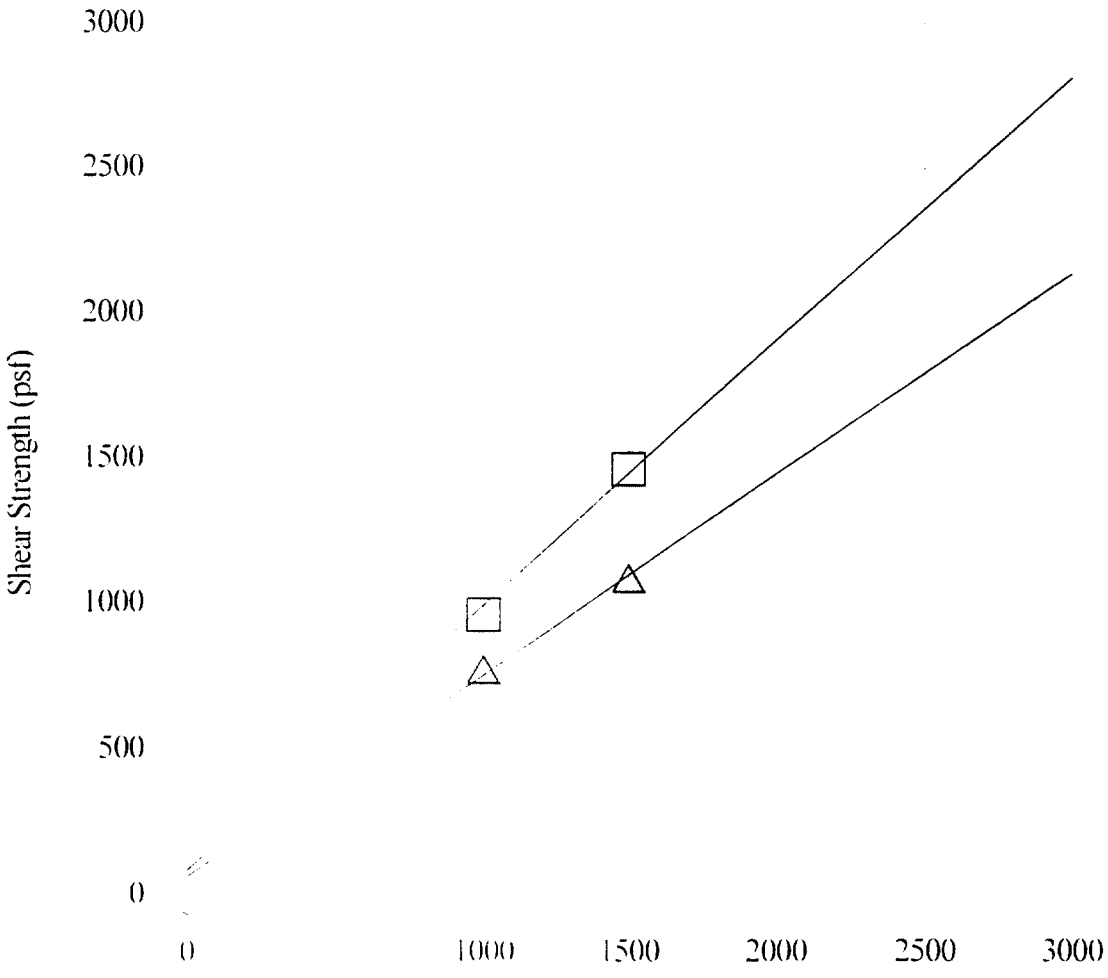
Direct Shear (CD) Test Results
ASTM D 3080

PROJECT	EDI SANTA FE SPRINGS	KTL NO.: 02-056-002
PROJECT	[illegible]-8A	CLIENT: TRC
DATE	[illegible]ST 2002	DEPTH (ft): 0-5
BORING		USCS CLASS.: SC
SAMPLE		
SAMPLE	[illegible]OLD	
RING	[illegible]2.12 IN.	
RING	[illegible]	SATURATED: YES
MOISTURE CONTENT: 10.5 percent		DRY DENSITY: 111.2 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	[illegible]2	94
Ultimate	[illegible]5	72

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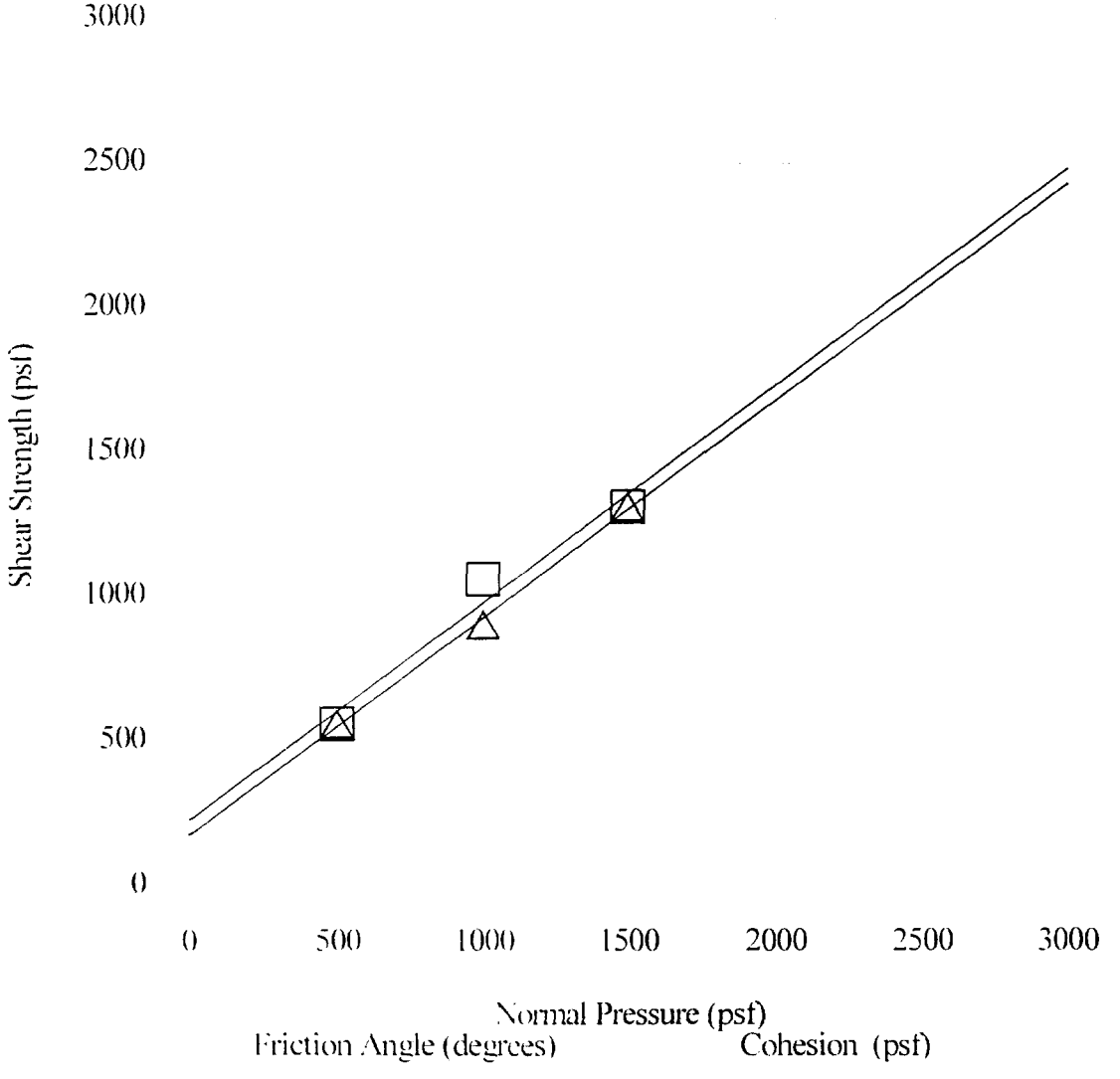
Direct Shear (CD) Test Results
ASTM D 3080

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: AUGUST 2002
BORING NO.: G-06
SAMPLE NO.: #1
SAMPLE TYPE: RING
RING DIAMETER: 2.42 IN.
RING HEIGHT: 1.0 IN.
MOISTURE CONTENT: 4.9 percent

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 1.5
USCS CLASS.: SC

SATURATED: YES
DRY DENSITY: 103.7 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	37	230
Ultimate	37	177

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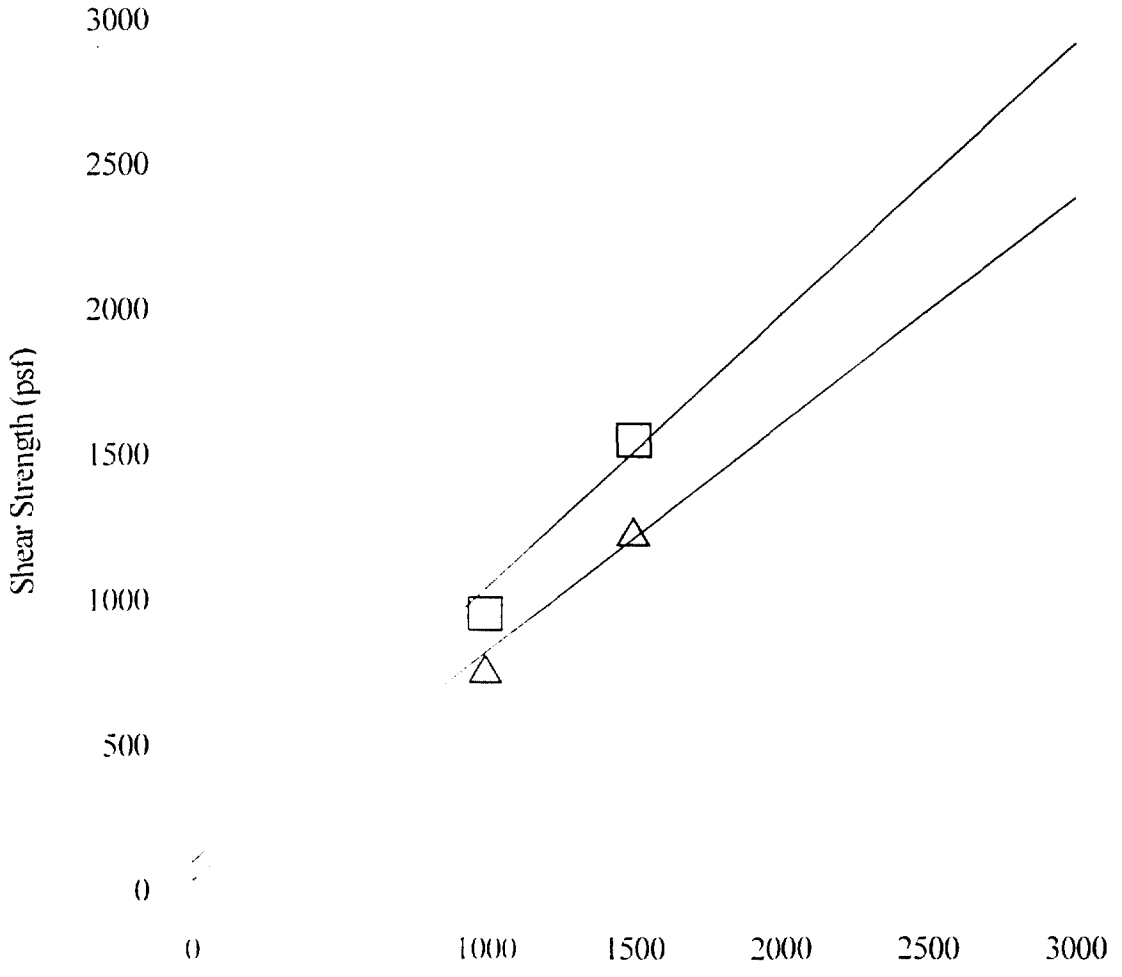
Direct Shear (CD) Test Results
ASTM D 3080

PRO[illegible]	[illegible]DESANTA FE SPRINGS	KTL NO.: 02-056-002
PRO[illegible]	[illegible]-8A	CLIENT: TRC
DA[illegible]	[illegible]ST 2002	DEPTH (ft): 0-5
BOR[illegible]	[illegible]	USCS CLASS.: SC
SAM[illegible]		
S[illegible]	[illegible]OLD	
RI[illegible]	[illegible].42 IN.	
RI[illegible]	[illegible]N.	SATURATED: YES
MO[illegible]	[illegible]NT: 9.5 percent	DRY DENSITY: 112.5 pcf



	[illegible] Angle (degrees)	Cohesion (psf)
Peak	[illegible]	114
Ultimate	[illegible]	52

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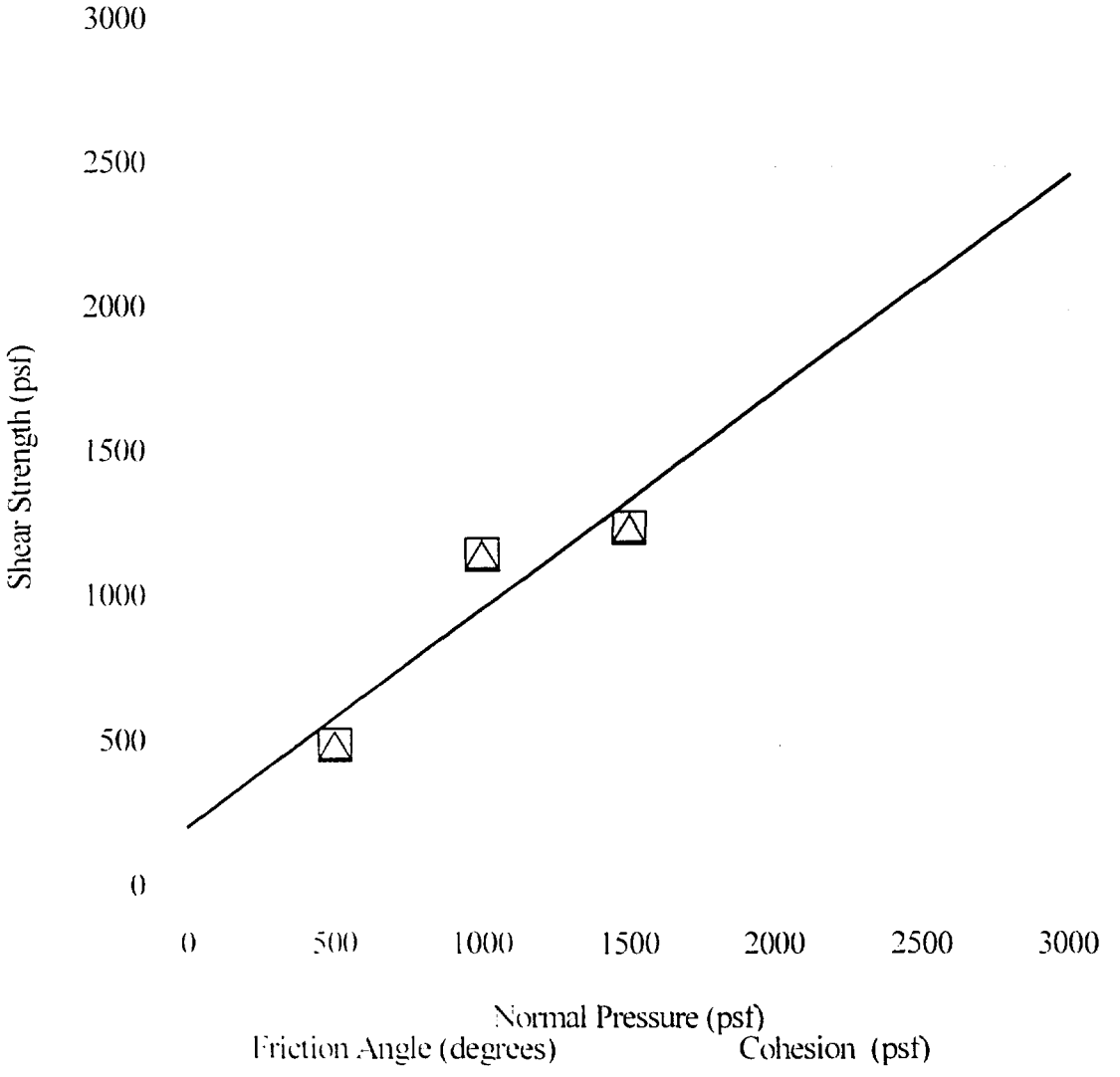
Direct Shear (CD) Test Results
ASTM D 3080

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: AUGUST 2002
BORING NO.: G-12
SAMPLE NO.: #2
SAMPLE TYPE: RING
RING DIAMETER: 2.42 IN.
RING HEIGHT: 1.0 IN.
MOISTURE CONTENT: 11.1 percent

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 5.5
USCS CLASS.: SC

SATURATED: YES
DRY DENSITY: 96.7 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	37	219
Ultimate	37	219

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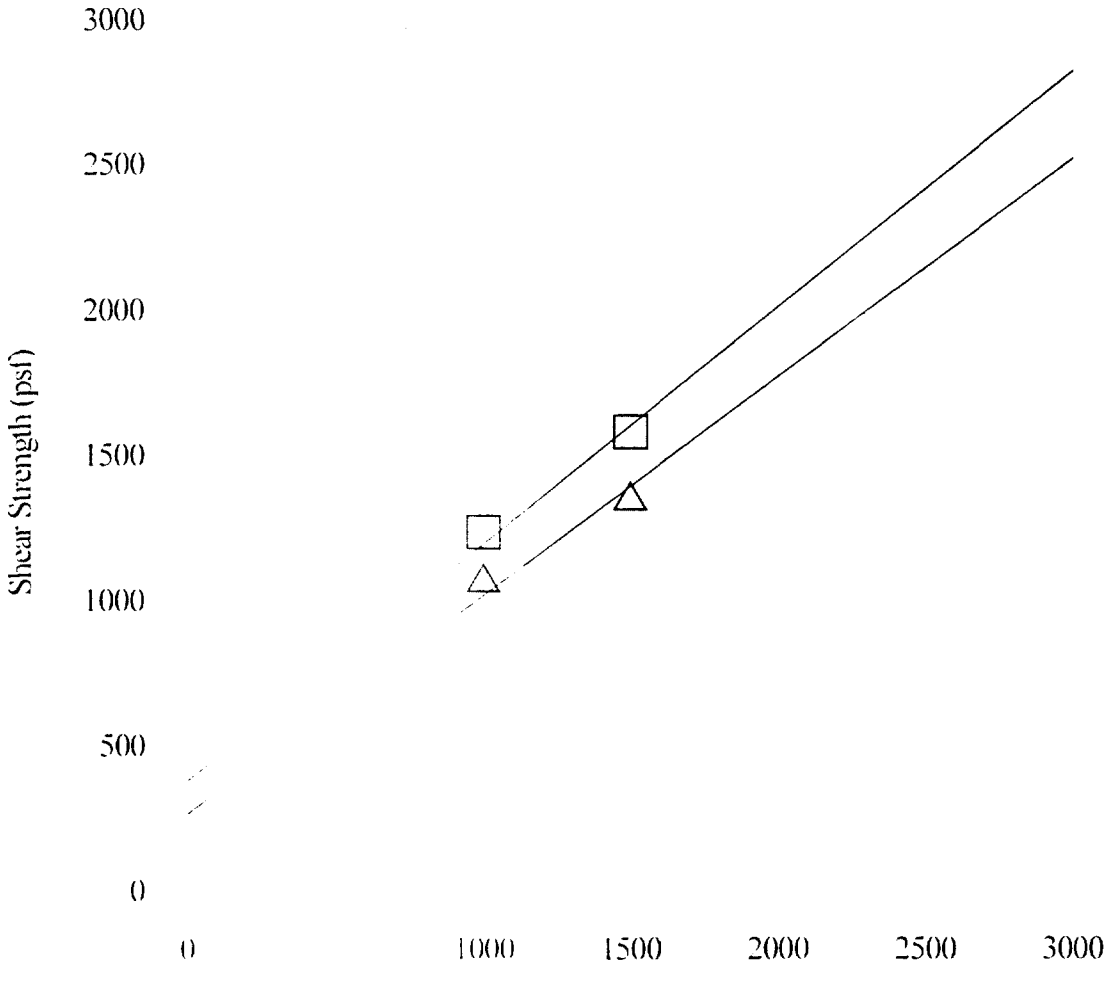
Direct Shear (CD) Test Results
ASTM D 3080

PROJ	ADI/SANTA FE SPRINGS	KTL NO.: 02-056-002
PRO	-8A	CLIENT: TRC
DAT	ST 2002	DEPTH (ft): 0-5
BOR		USCS CLASS.: SC
SAM		
SAM	MOLD	
RIN	2.42 IN.	
RIN	IN.	SATURATED: YES
MO	NT: 9.0 percent	DRY DENSITY: 113.9 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	[illegible]	395
Ultimate	[illegible]	281

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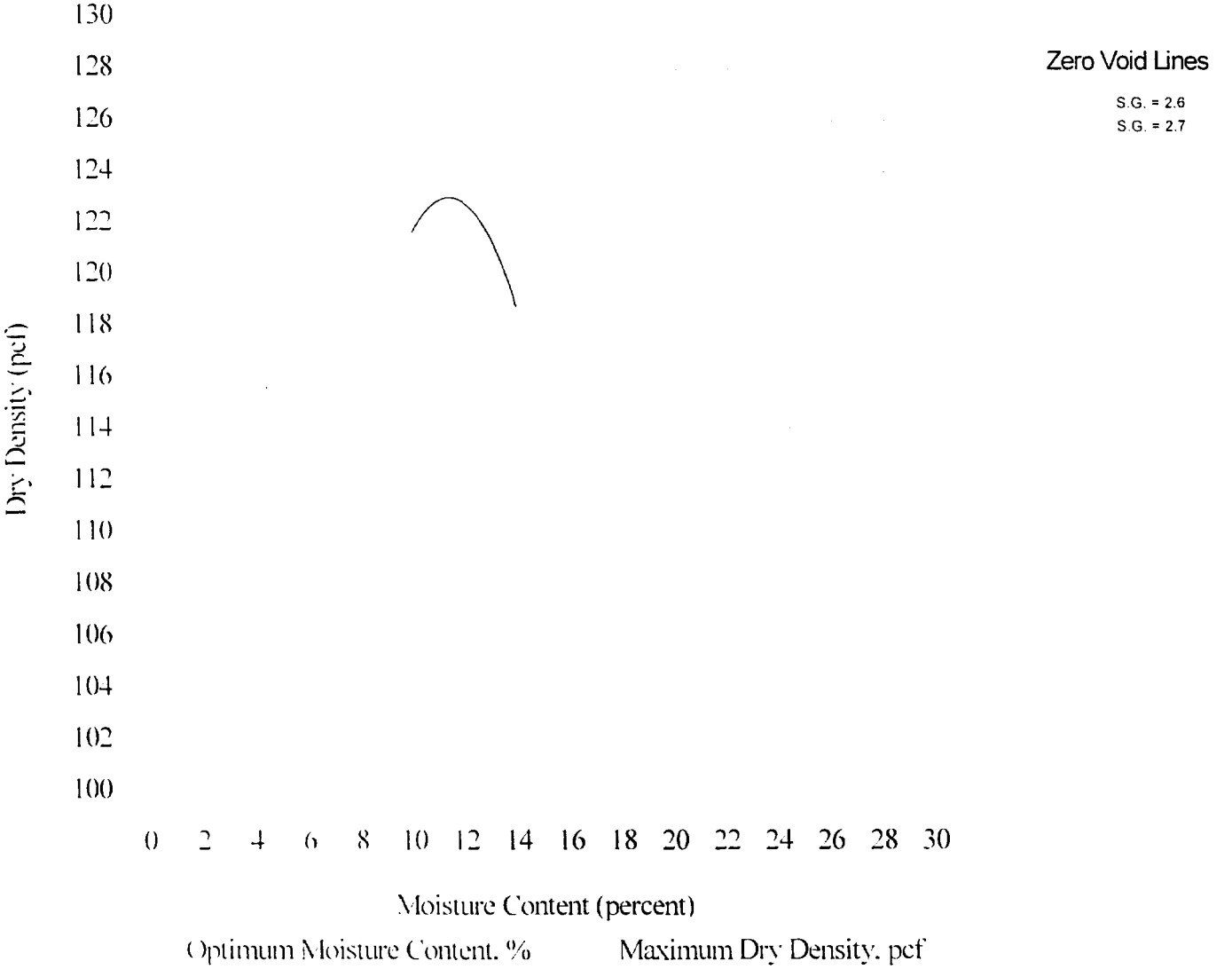
Modified Compaction Test Results
ASTM D 1557

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: September 2002
BORING NO.: G-01
SAMPLE NO.: Bulk

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 0-5
USCS CLASS.: SC

METHOD: A
DROP: 18 INCHES
NUMBER OF LAYERS: 5

RAM WEIGHT: 10 LBS
RAM TYPE: MANUAL
BLOWS/LAYER: 25



Optimum Moisture Content, %	Maximum Dry Density, pcf
12	123

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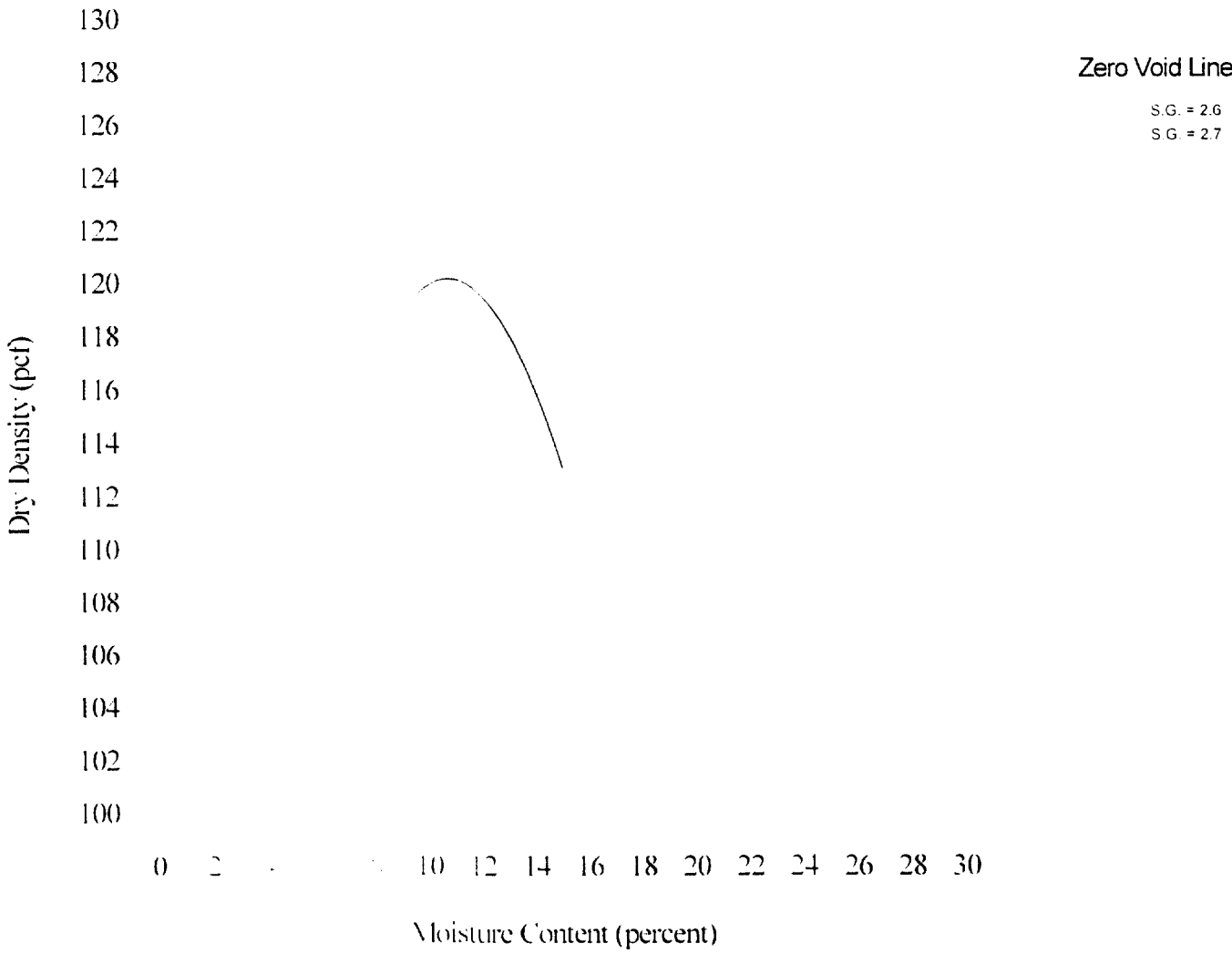
Modified Compaction Test Results
ASTM D 1557

PROJ	DI SANTA FE SPRINGS	KTL NO.: 02-056-002
PROJ	-3A	CLIENT: TRC
DATE	Apr 2002	DEPTH (ft): 0-5
BORE		USCS CLASS.: SC
SAMP		
MET		RAM WEIGHT: 10 LBS
DRO		RAM TYPE: MANUAL
NUMB	RS: 5	BLOWS/LAYER: 25



Optimum Moisture Content, %	Maximum Dry Density, pcf
.5	120.5

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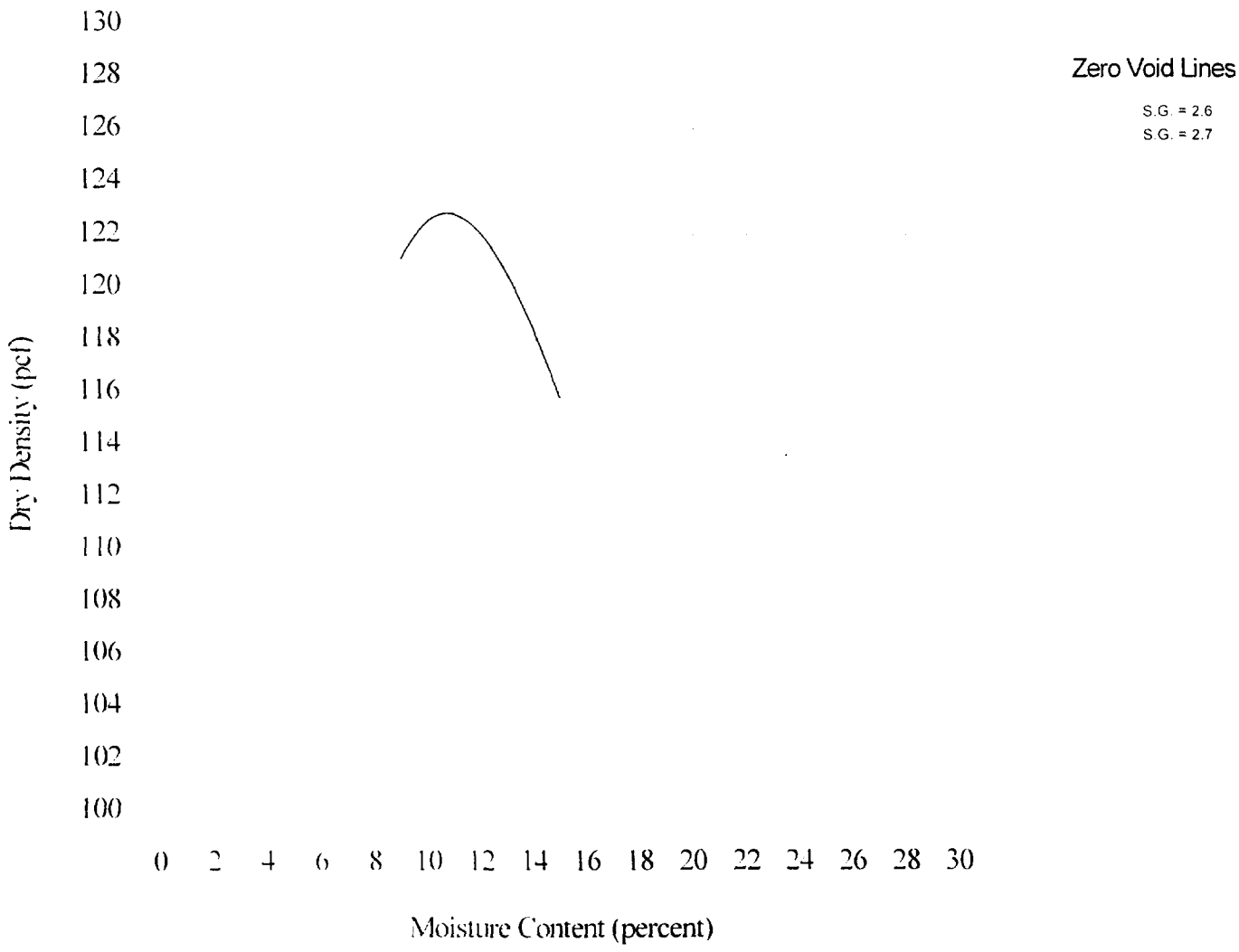
Modified Compaction Test Results
ASTM D 1557

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: September 2002
BORING NO.: G-04
SAMPLE NO.: Bulk

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 0-5
USCS CLASS.: SC

METHOD: A
DROP: 18 INCHES
NUMBER OF LAYERS: 5

RAM WEIGHT: 10 LBS
RAM TYPE: MANUAL
BLOWS/LAYER: 25



Optimum Moisture Content, %	Maximum Dry Density, pcf
11.5	123

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Modified Compaction Test Results
ASTM D 1557

PROJ	DI SANTA FE SPRINGS	KTL NO.: 02-056-002
PRO	A	CLIENT: TRC
DA	r 2002	DEPTH (ft): 0-5
BORI		USCS CLASS.: SC
SAMP		
ME		RAM WEIGHT: 10 LBS
DRO		RAM TYPE: MANUAL
NU	RS: 5	BLOWS/LAYER: 25

Optimum Moisture Content, % Maximum Dry Density, pcf

125

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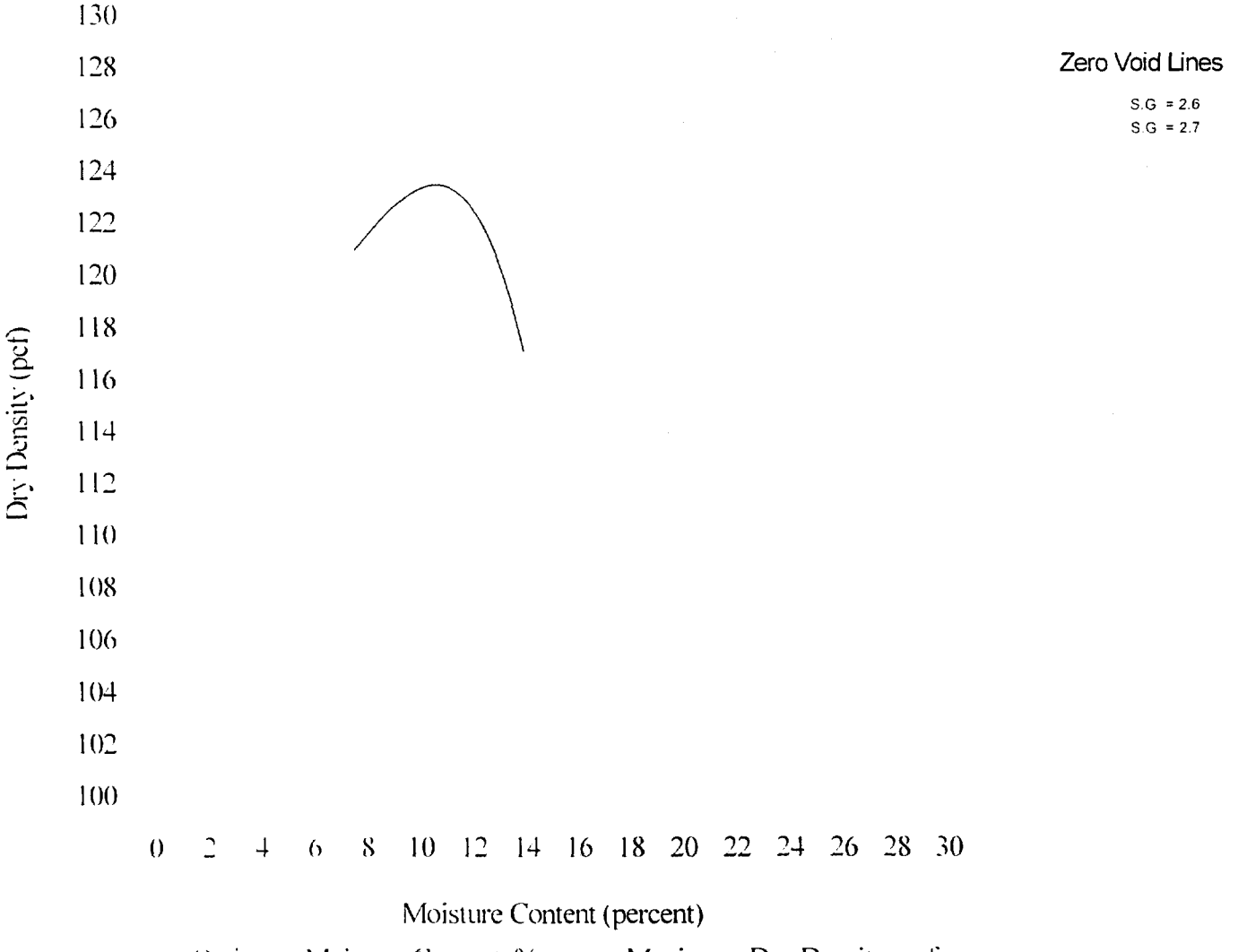
Modified Compaction Test Results
ASTM D 1557

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: September 2002
BORING NO.: G-06
SAMPLE NO.: Bulk

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 0-5
USCS CLASS.: SC

METHOD: A
DROP: 18 INCHES
NUMBER OF LAYERS: 5

RAM WEIGHT: 10 LBS
RAM TYPE: MANUAL
BLOWS/LAYER: 25



Optimum Moisture Content, %	Maximum Dry Density, pcf
10.5	123.5

FIGURE NO.

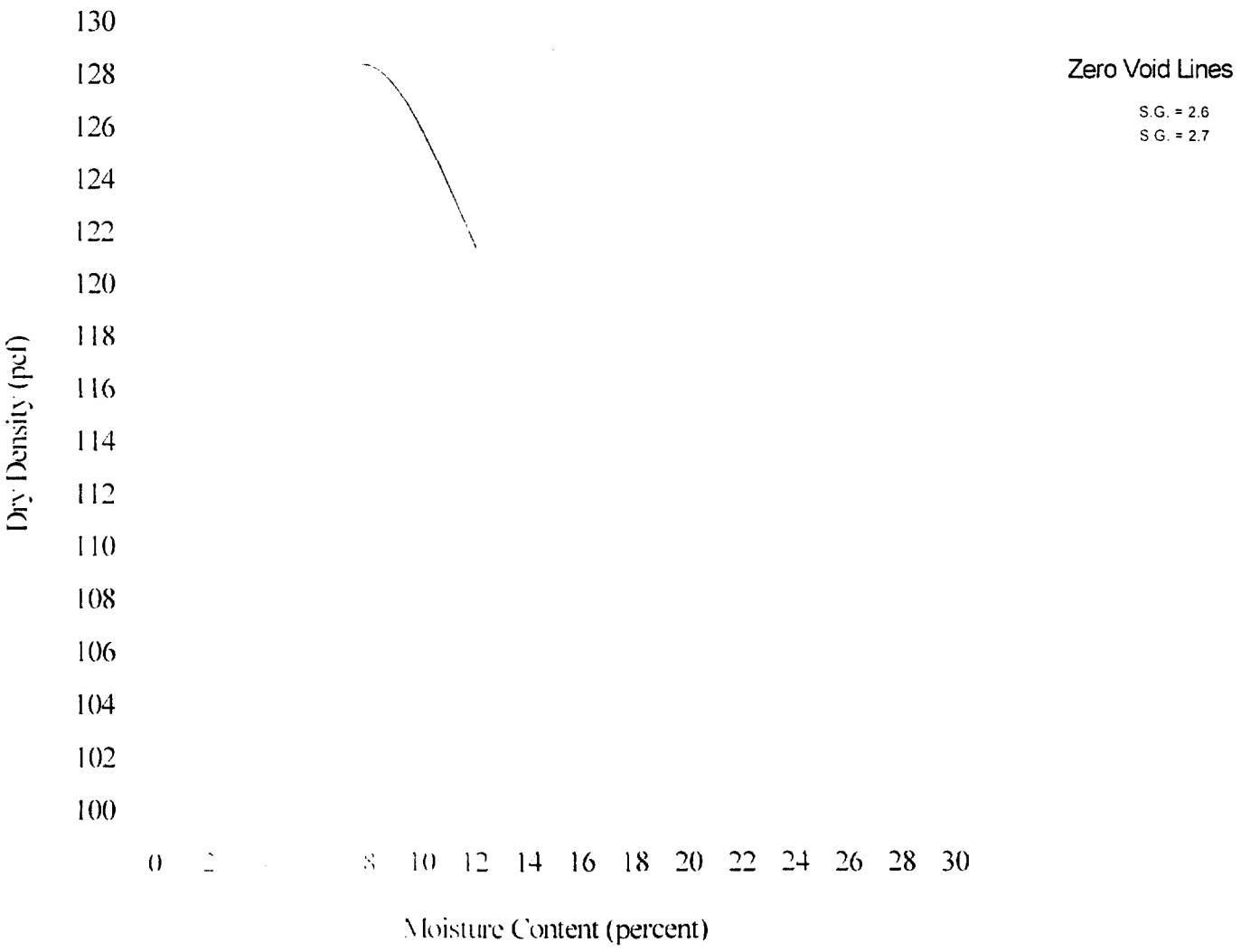
720 North Valley Street, Suite B, Anaheim, CA 92801 • Tel.: (714) 535-7616 • Fax: (714) 535-7568

KEANTAN LABORATORIES

www.keantanlabs.com
email: keantanlab@aol.com

Modified Compaction Test Results
ASTM D 1557

PR[illegible]	[illegible]WDI SANTA FE SPRINGS	KTL NO.: 02-056-002
PR[illegible]	[illegible]51-8A	CLIENT: TRC
DA[illegible]	[illegible]mber 2002	DEPTH (ft): 0-5
BO[illegible]	[illegible]	USCS CLASS.: SC
S[illegible]	[illegible]k	
M[illegible]		RAM WEIGHT: 10 LBS
D[illegible]	[illegible]	RAM TYPE: MANUAL
N[illegible]	[illegible]ERS: 5	BLOWS/LAYER: 25



Optimum Moisture Content, % Maximum Dry Density, pcf

128.5

FIGURE NO.

720 North Valley [illegible] B. Anaheim, CA 92801 • Tel.: (714) 535-7616 • Fax: (714) 535-7568

KEANTAN LABORATORIES

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email: keantanlab@aol.com

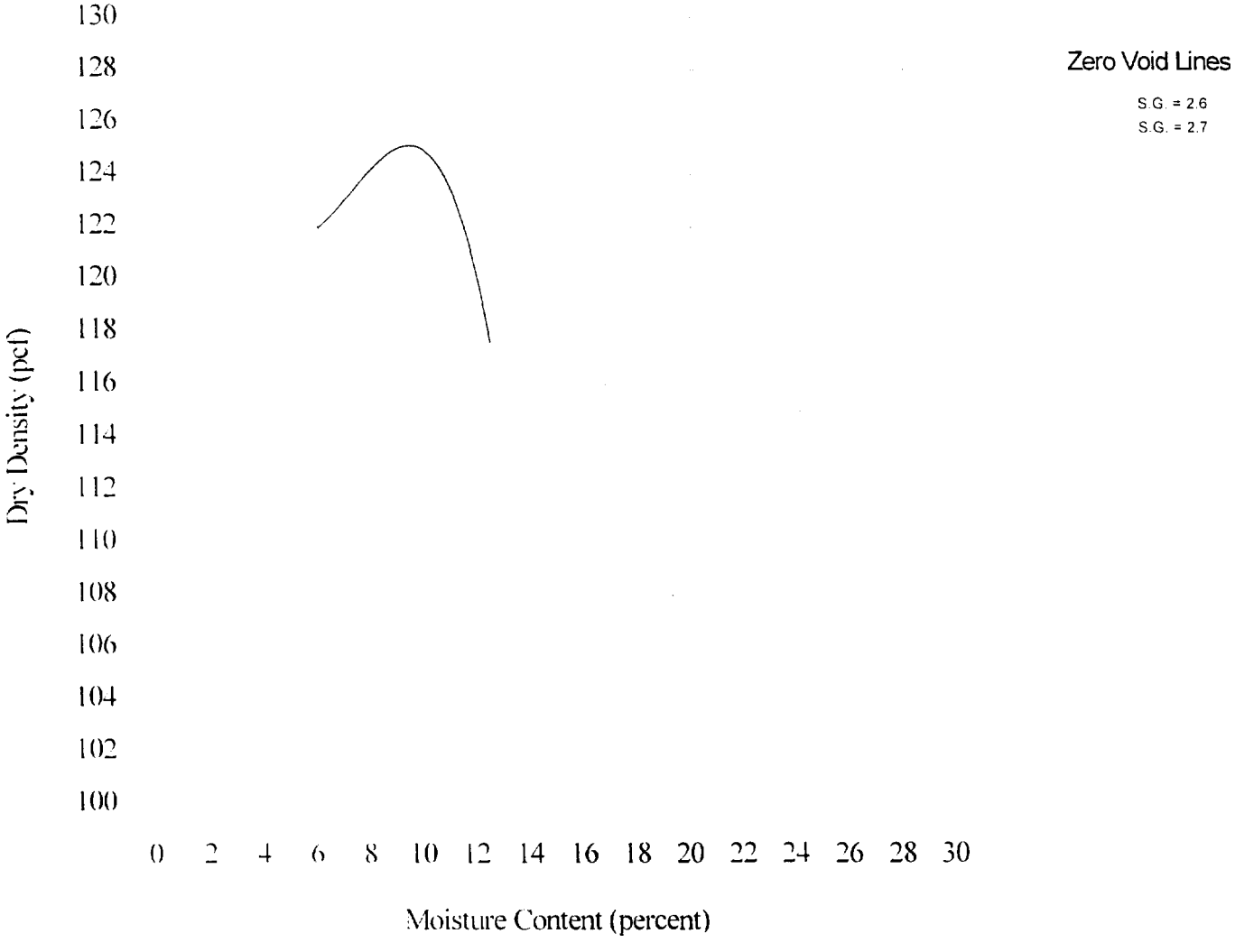
Modified Compaction Test Results
ASTM D 1557

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A
DATE: September 2002
BORING NO.: G-12
SAMPLE NO.: Bulk

KTL NO.: 02-056-002
CLIENT: TRC
DEPTH (ft): 0-5
USCS CLASS.: SC

METHOD: A
DROP: 18 INCHES
NUMBER OF LAYERS: 5

RAM WEIGHT: 10 LBS
RAM TYPE: MANUAL
BLOWS/LAYER: 25



Optimum Moisture Content, %	Maximum Dry Density, pcf
9.5	125

FIGURE NO.

720 North Valley Street, Suite B, Anaheim, CA 92801 • Tel.: (714) 535-7616 • Fax: (714) 535-7568

KEANTAN LABORATORIES

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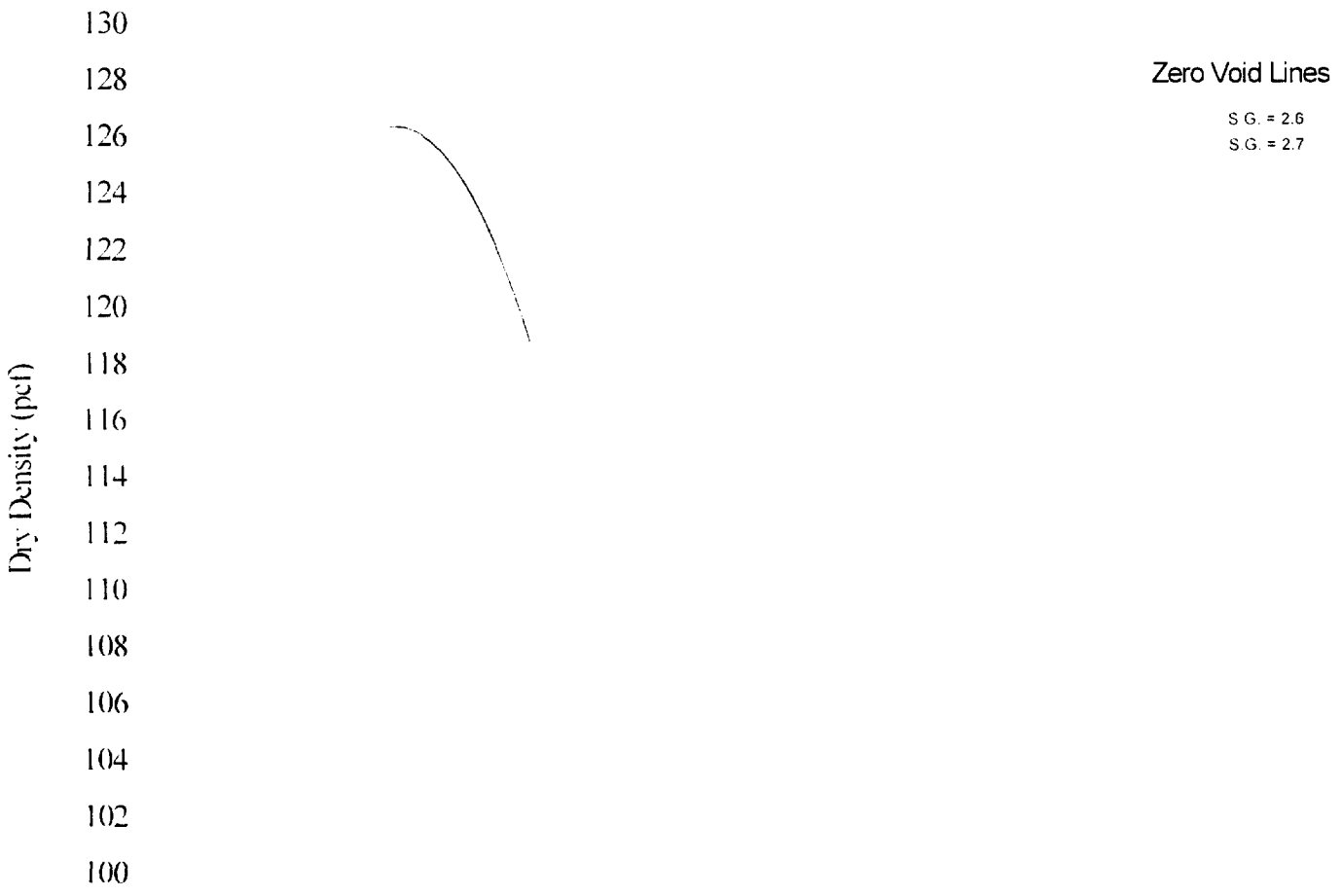
email: keantanlab@aol.com

Modified Compaction Test Results
ASTM D 1557

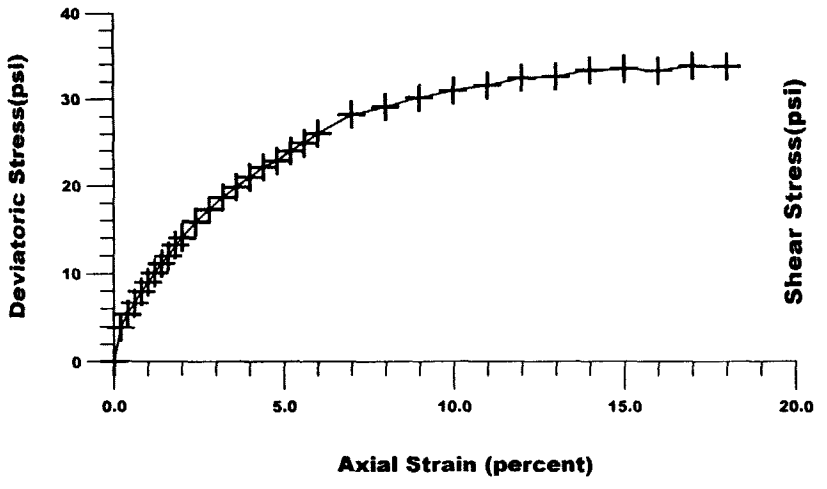
PRO[illegible]	[illegible]VDI SANTA FE SPRINGS	KTL NO.: 02-056-002	
PRO[illegible]	[illegible]1-8A	CLIENT: TRC	
D[illegible]	[illegible]mber 2002	DEPTH (ft): 0-5	
BO[illegible]	[illegible]	USCS CLASS.: SC	
S[illegible]	[illegible]nk		
M[illegible]		RAM WEIGHT: 10 LBS	
DR[illegible]		RAM TYPE: MANUAL	
N[illegible]	[illegible]ERS: 5	BLOWS/LAYER: 25	

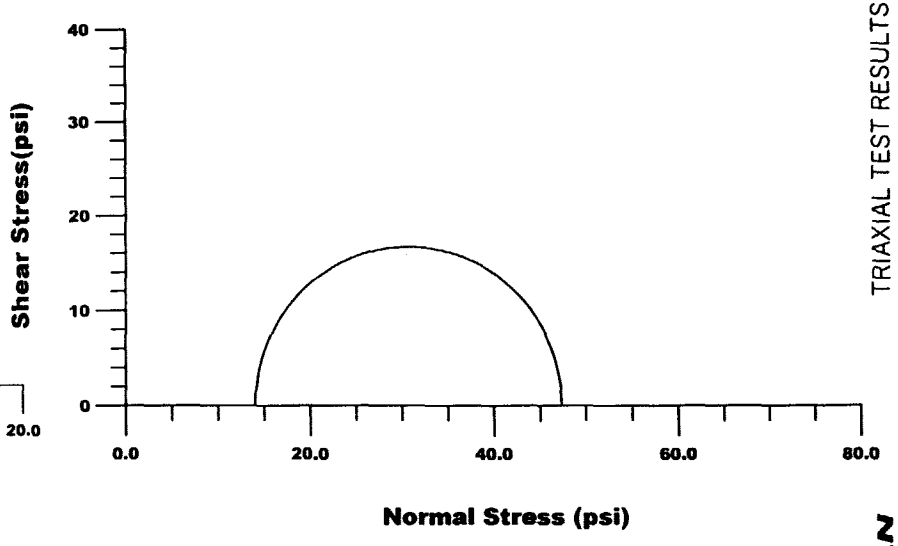


Optimum Moisture Content, %	Maximum Dry Density, pcf
[illegible]	126.5

FIGURE NO.

720 North Valley St[illegible] B, Anaheim, CA 92801 • Tel.: (714) 535-7616 • Fax: (714) 535-7568



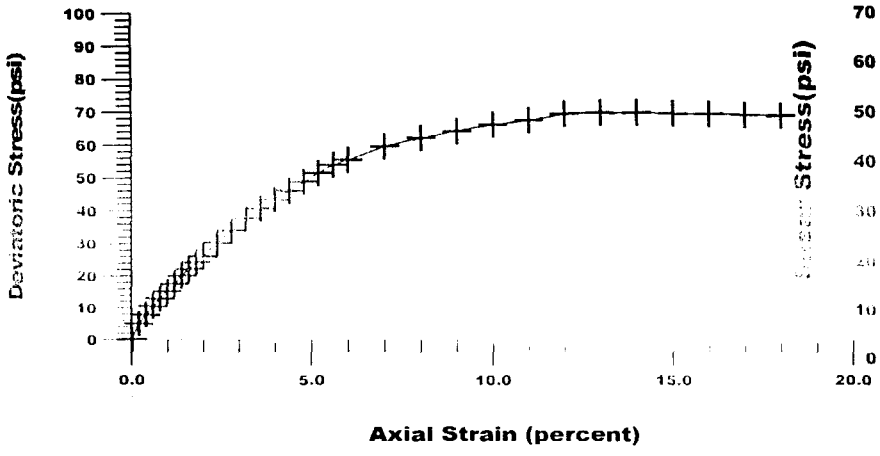


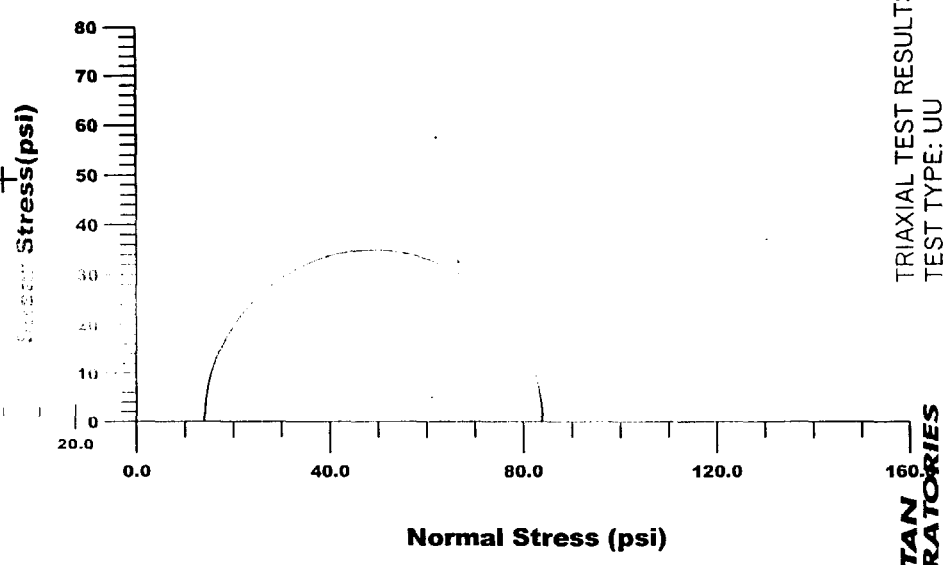
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
—+—	G-02	#3	10	17.3	112.2	14.0	0.0	14.0	33.7



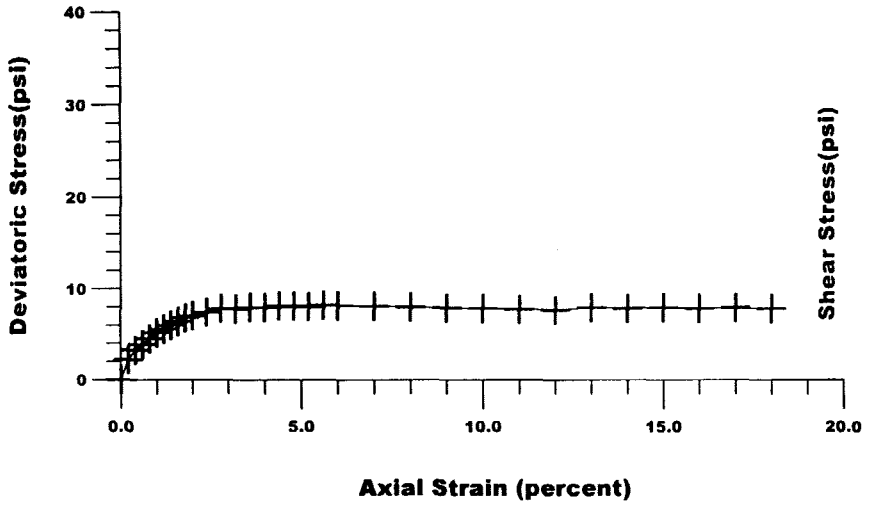


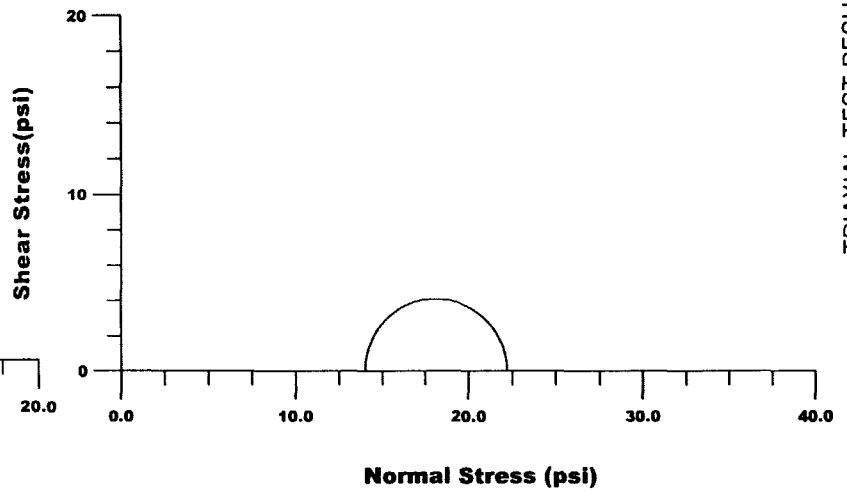
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
⊢	G-03	#4	15	13.3	121.3	14.0	0.0	14.0	69.9



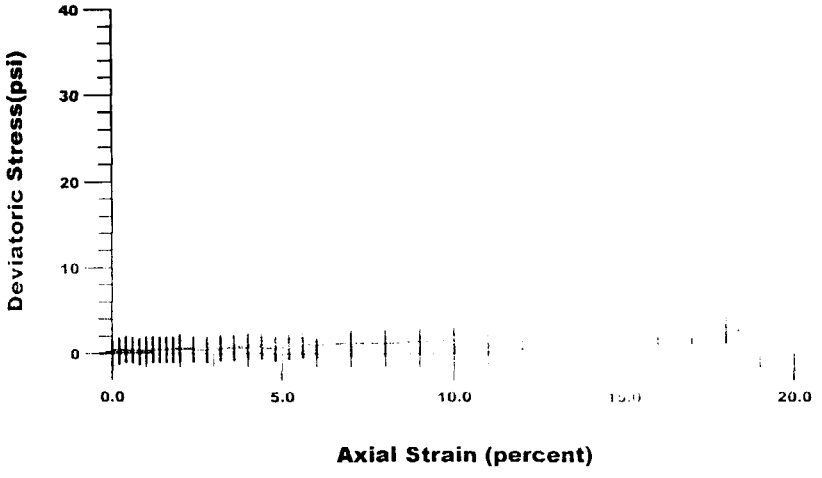


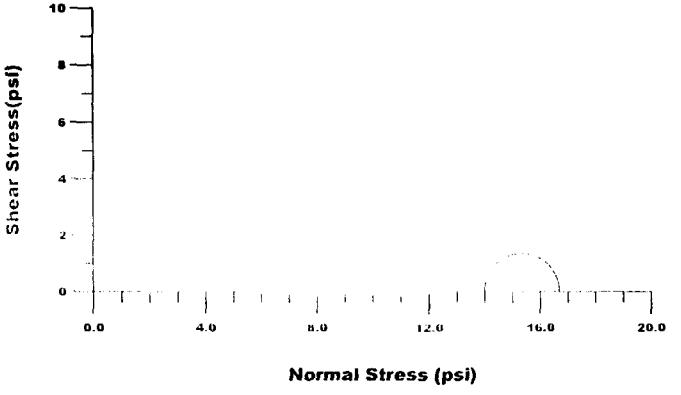
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
	G-04	#3	10	103.9	47.3	14.0	0.0	14.0	8.2



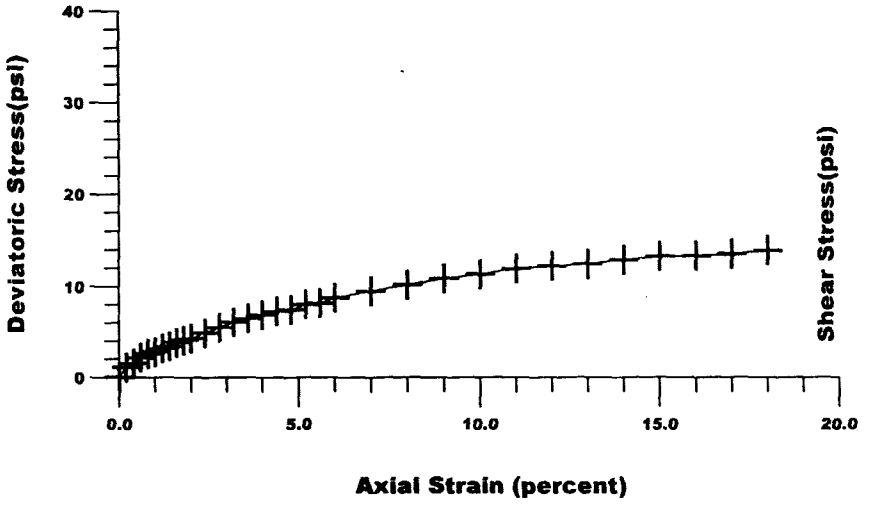


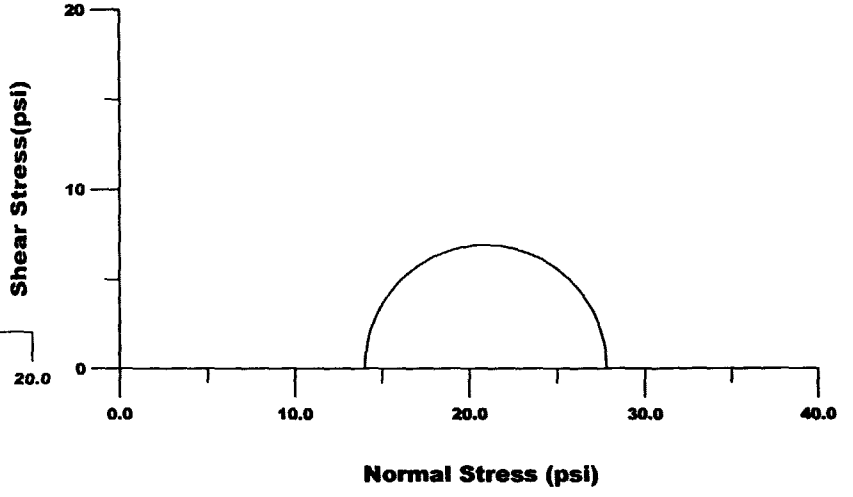
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
	G-08	#4	15	12.8	107.2	14.0	0.0	14.0	2.7



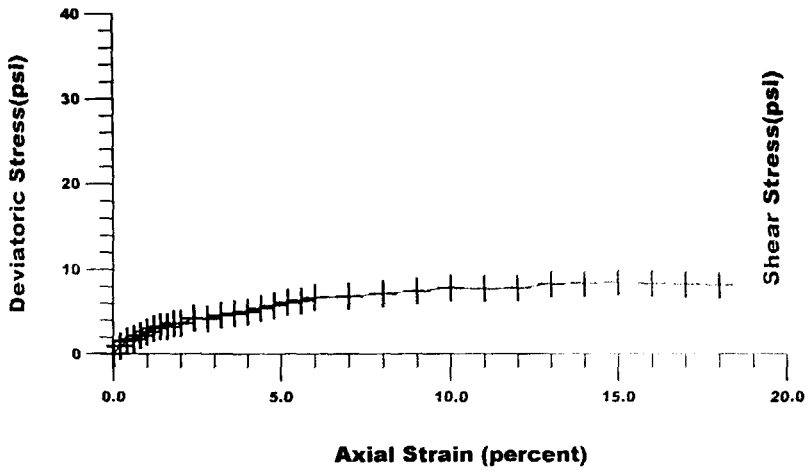


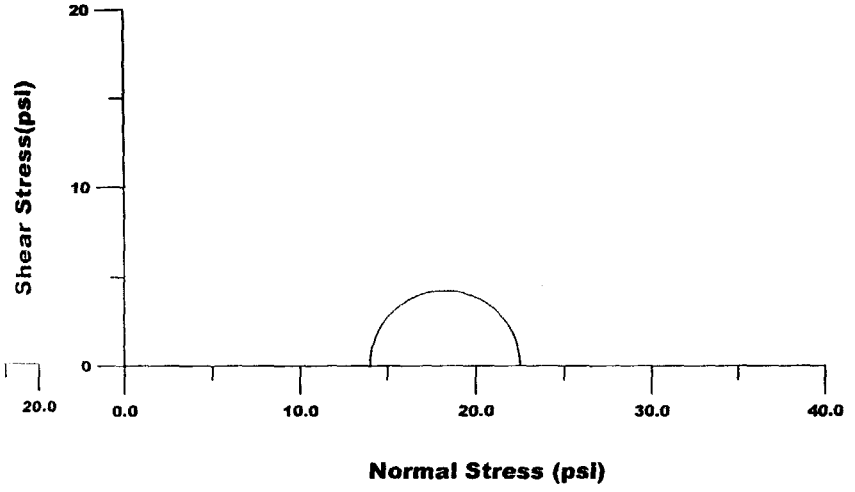
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
+	G-13	#4	15	17.3	112.2	14.0	0.0	14.0	13.8



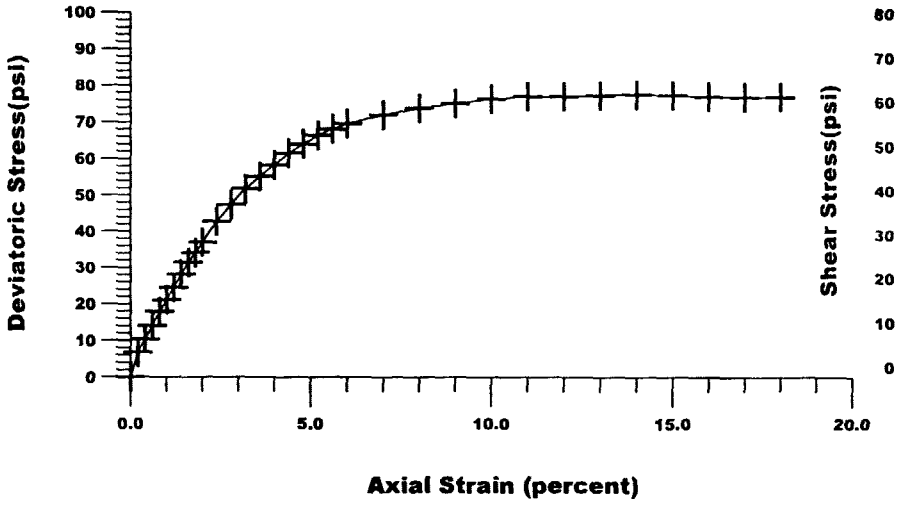


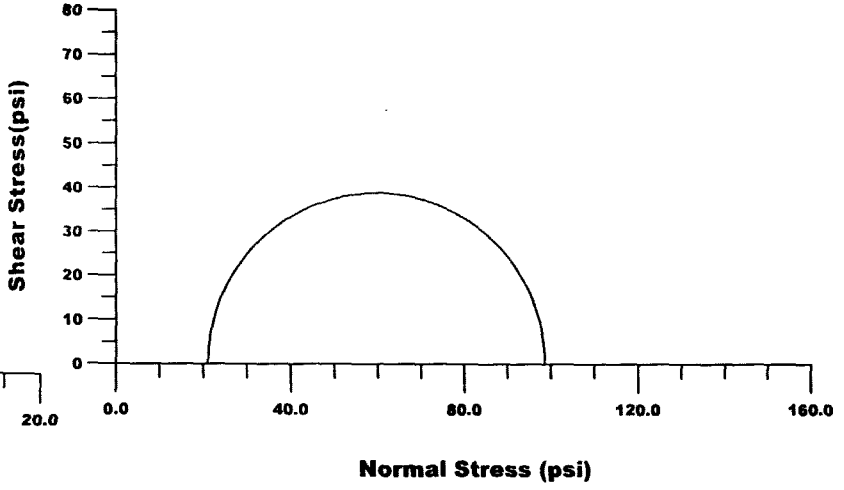
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
+	G-12	#3	10	41.3	69.3	14.0	0.0	14.0	8.5



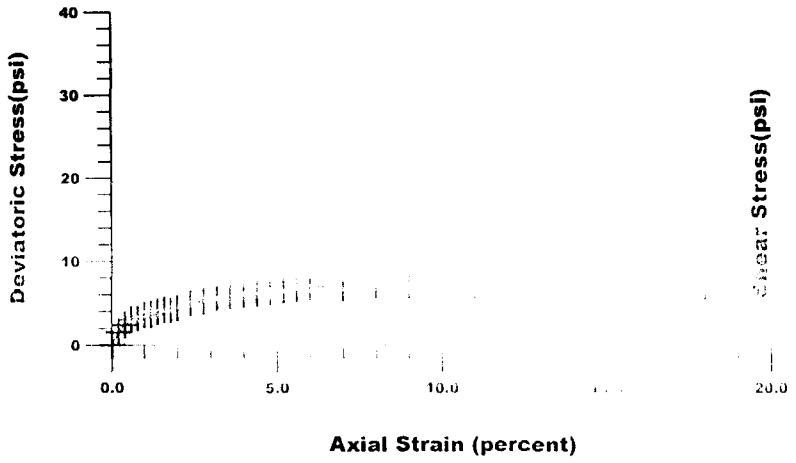


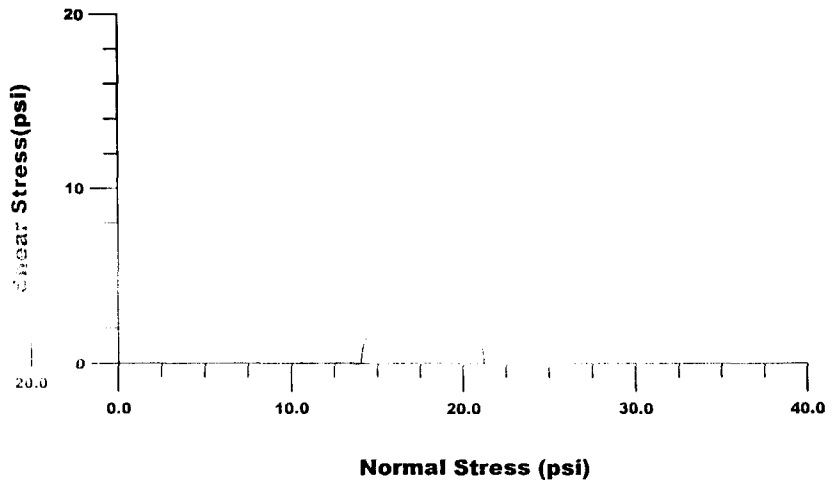
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
+	G-09	#4	20	13.4	116.7	21.0	0.0	21.0	77.5



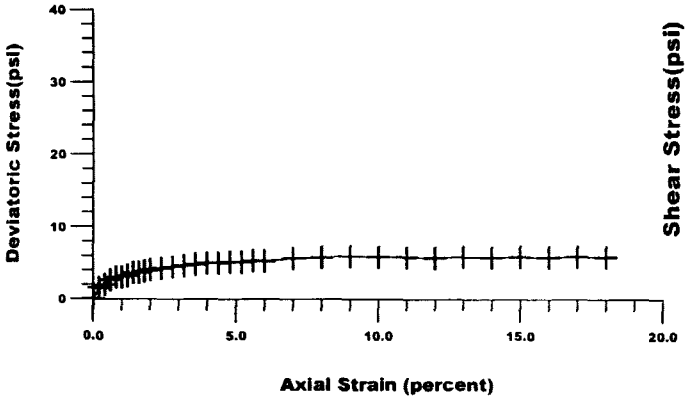


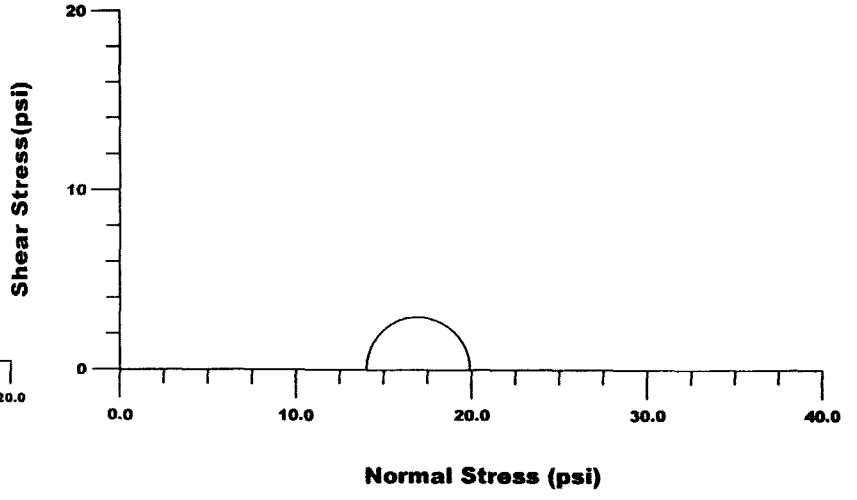
TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
+	G-06	#5	15	44.0	74.4	14.0	0.0	14.0	7.2



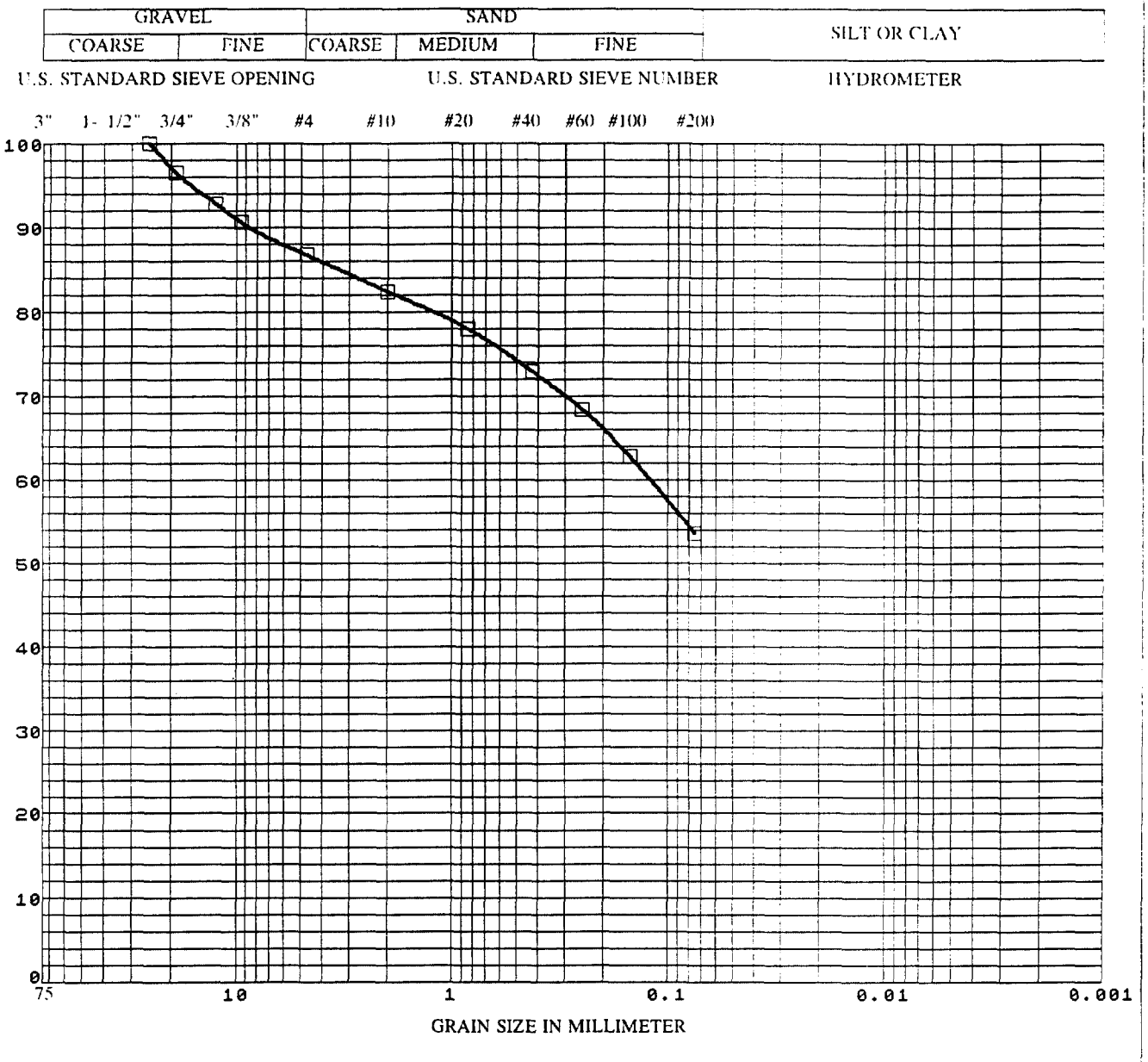


TRIAXIAL TEST RESULTS
TEST TYPE: UU

KEANTAN LABORATORIES

PROJECT NAME: WDI/SANTA FE SPRINGS
PROJECT NO.: 1651-8A

Symbol	BORING NO.	SAMPLE NO.	DEPTH (FT)	MOISTURE CONTENT(%)	DRY DENSITY(PCF)	CELL PRESSURE(PSI)	BACK PRESSURE(PSI)	EFFECTIVE STRESS(PSI)	MAX DEVIATOR STRESS(PSI)
+	G-07	#3	10	52.8	63.5	14.0	0.0	14.0	5.9



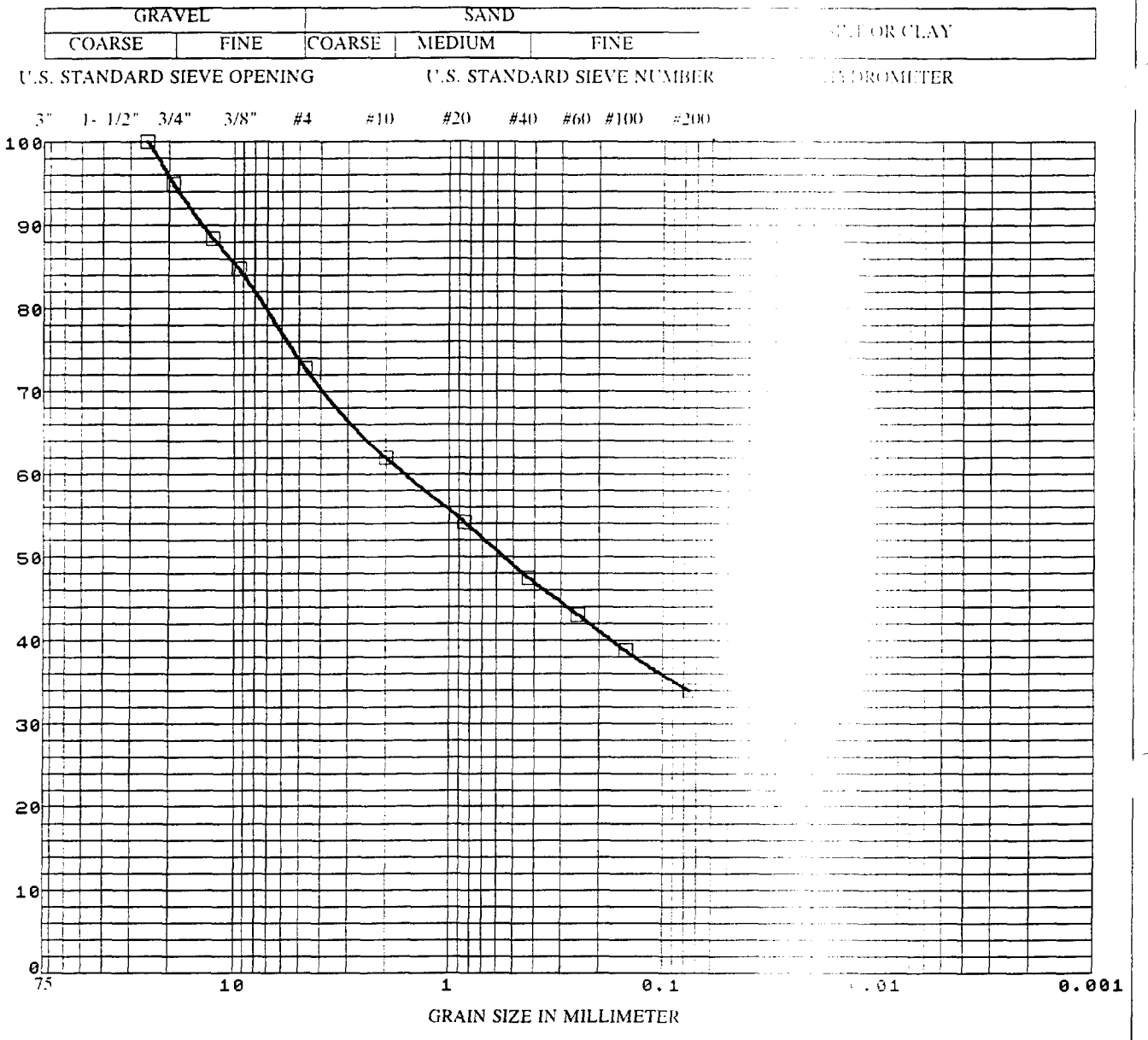
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-01	Bulk	0-5	bag	CL	31	16

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-02	Bulk	0-5	B			

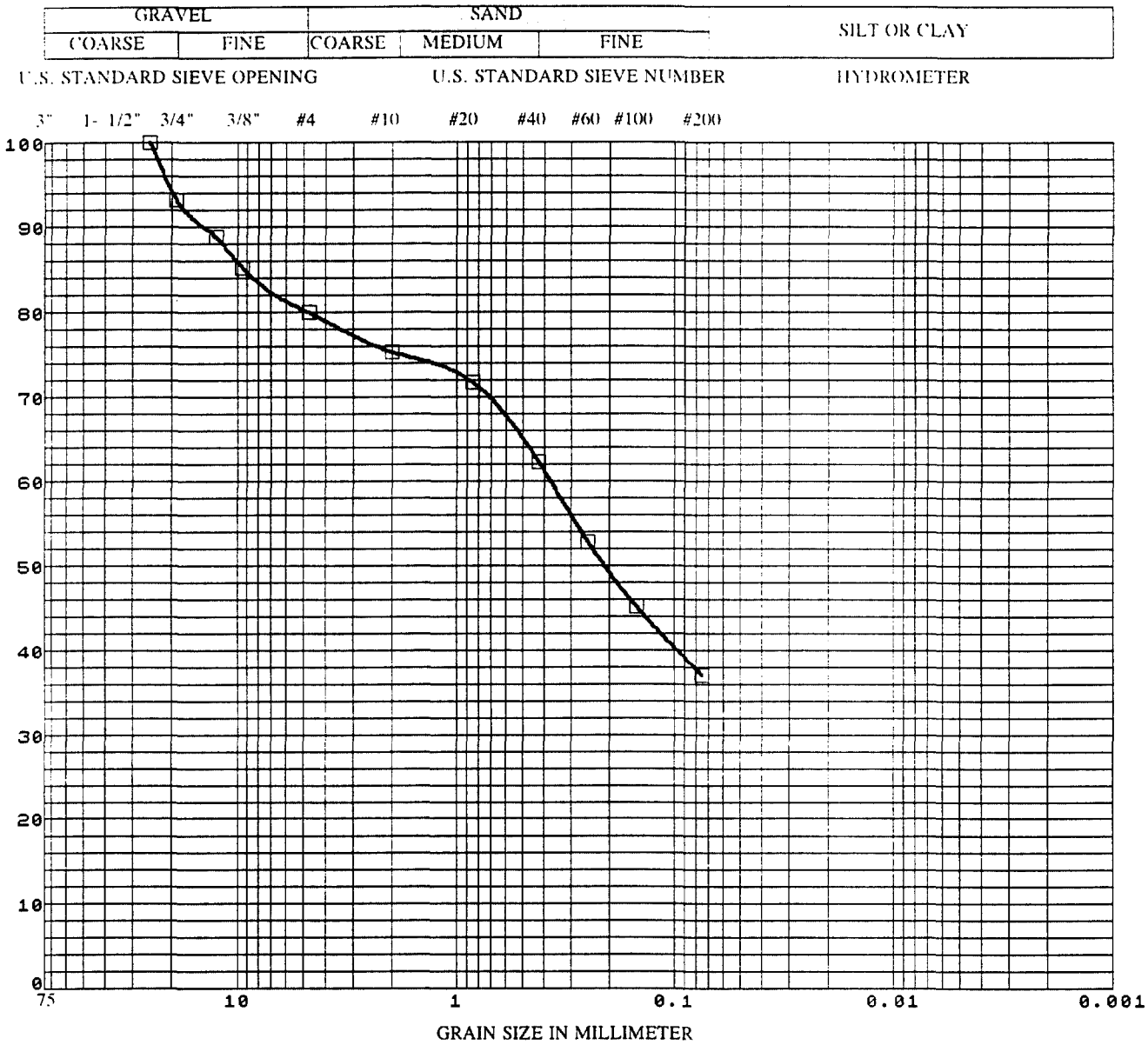
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



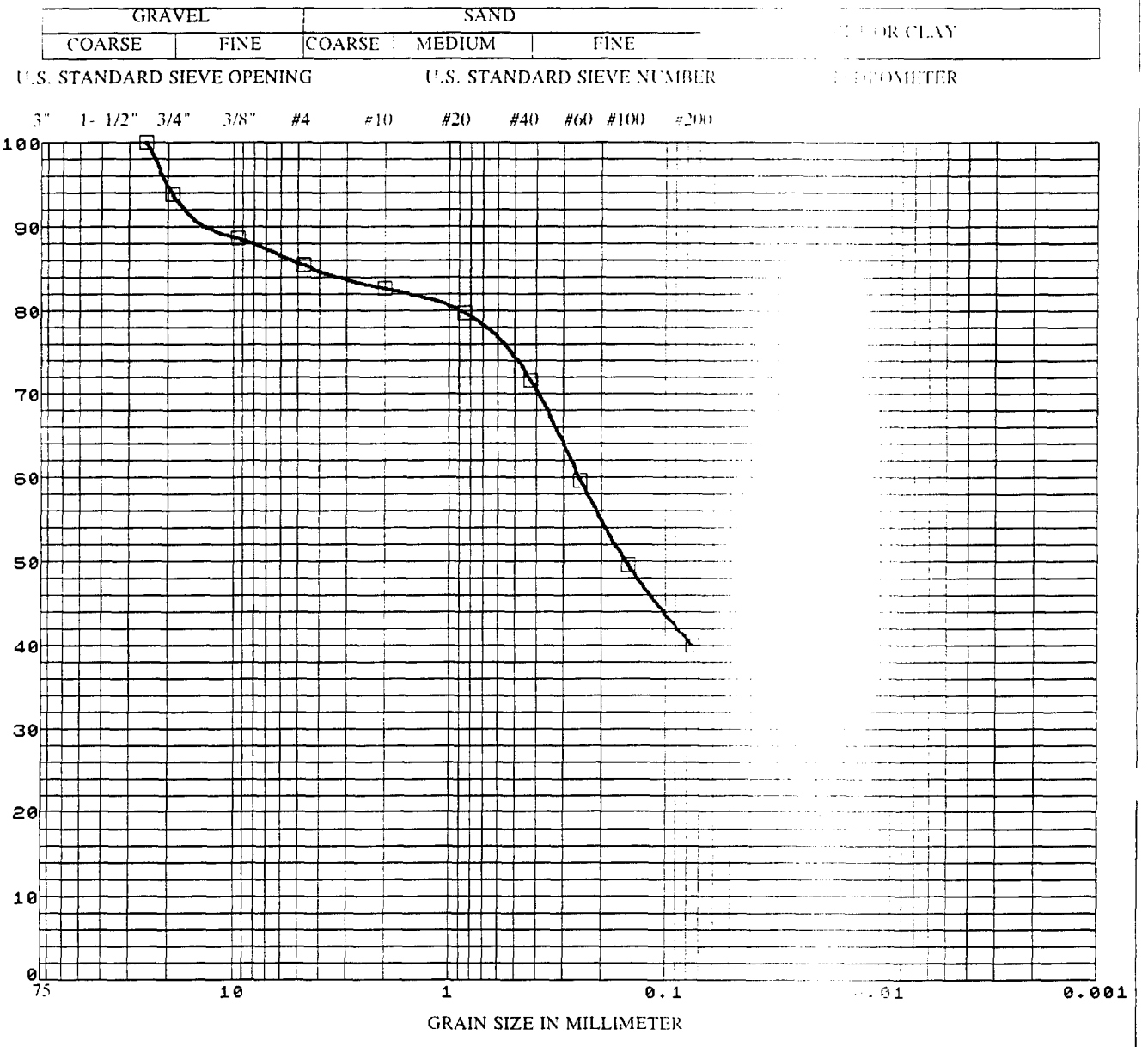
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-04	Bulk	0-5	B	SC	26	10

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-05	Bulk	0-5	SC		23	11

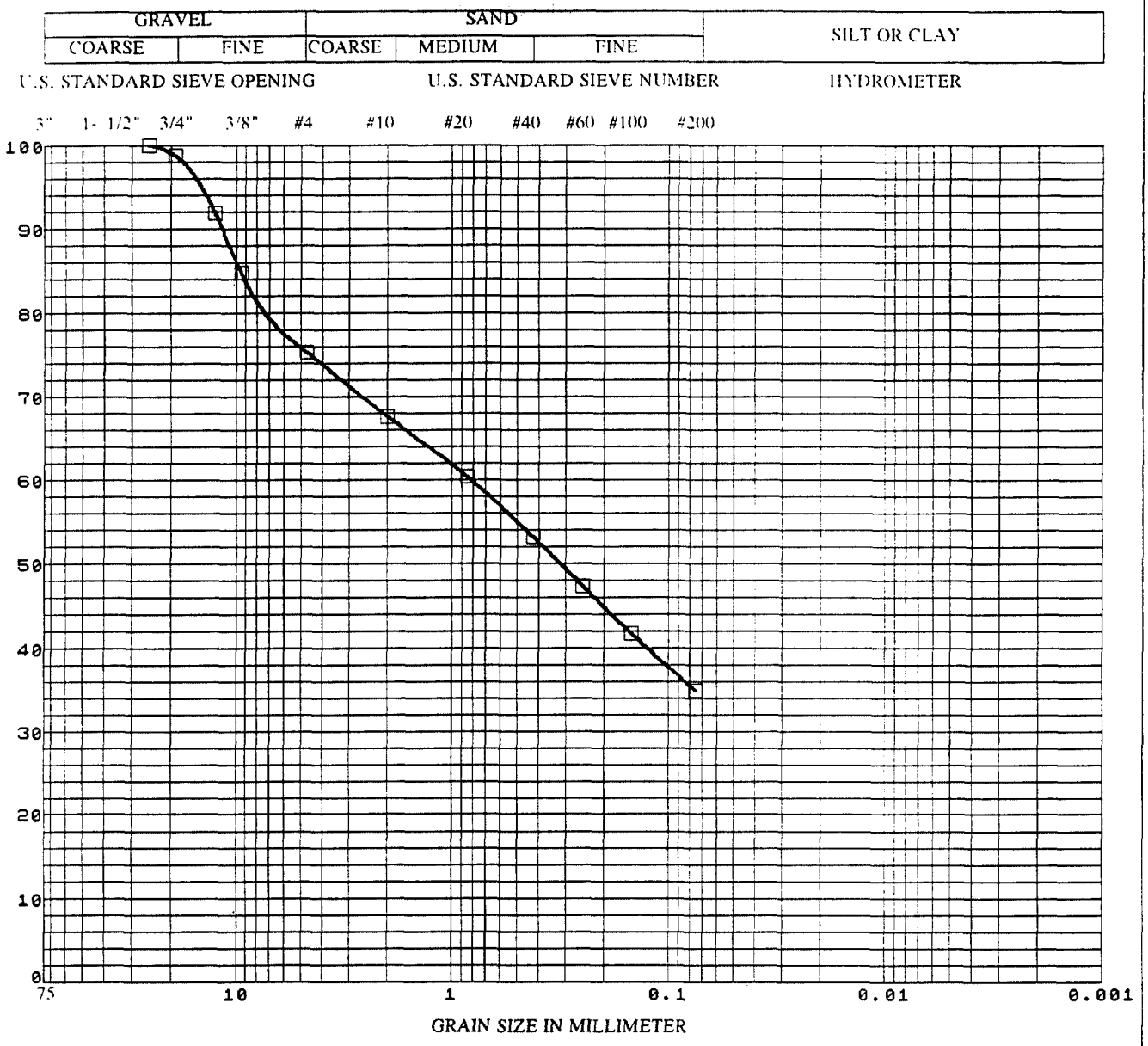
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



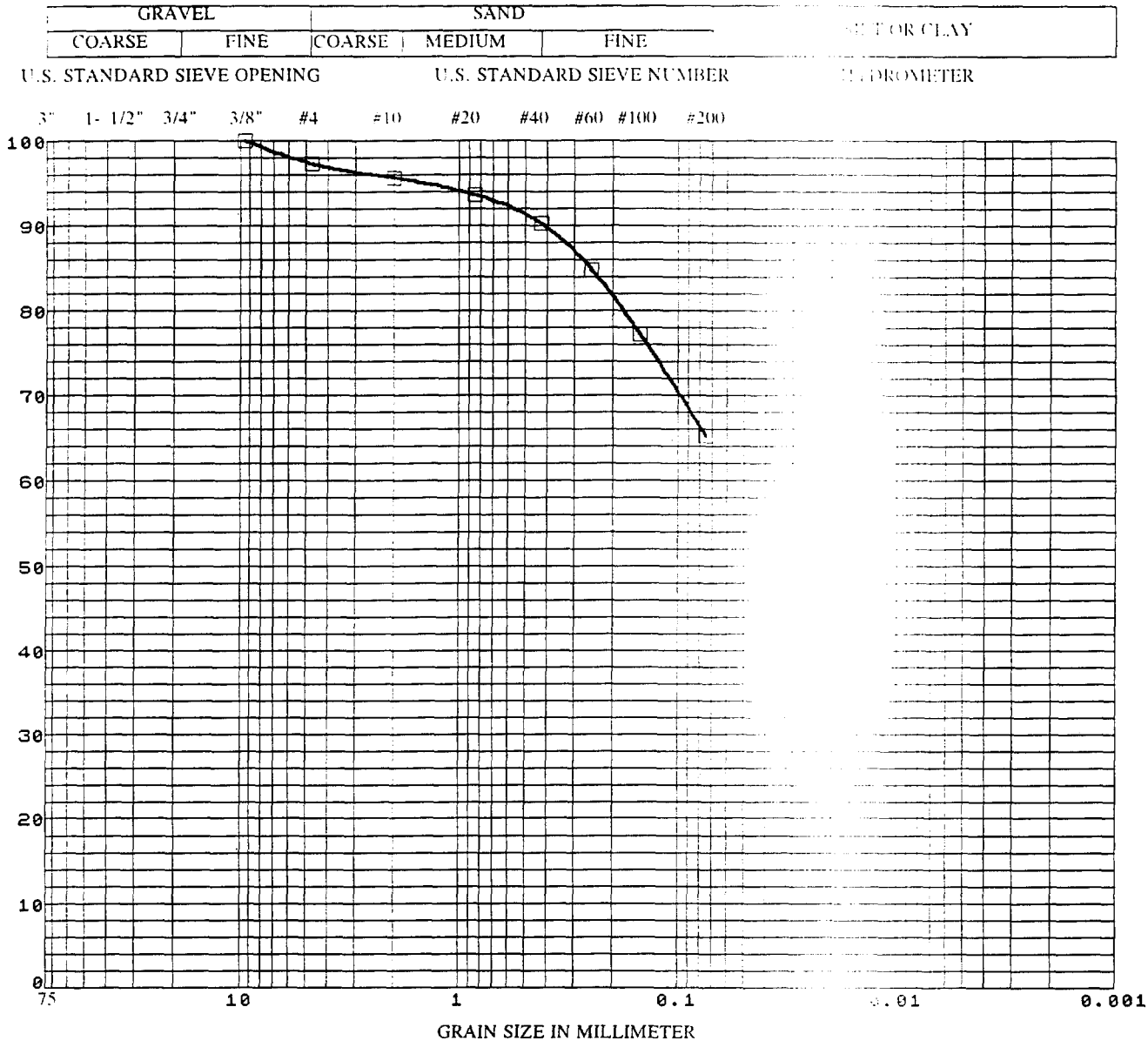
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-03	Bulk	0-5	B	SC	31	16

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-05	3	10.5	R			

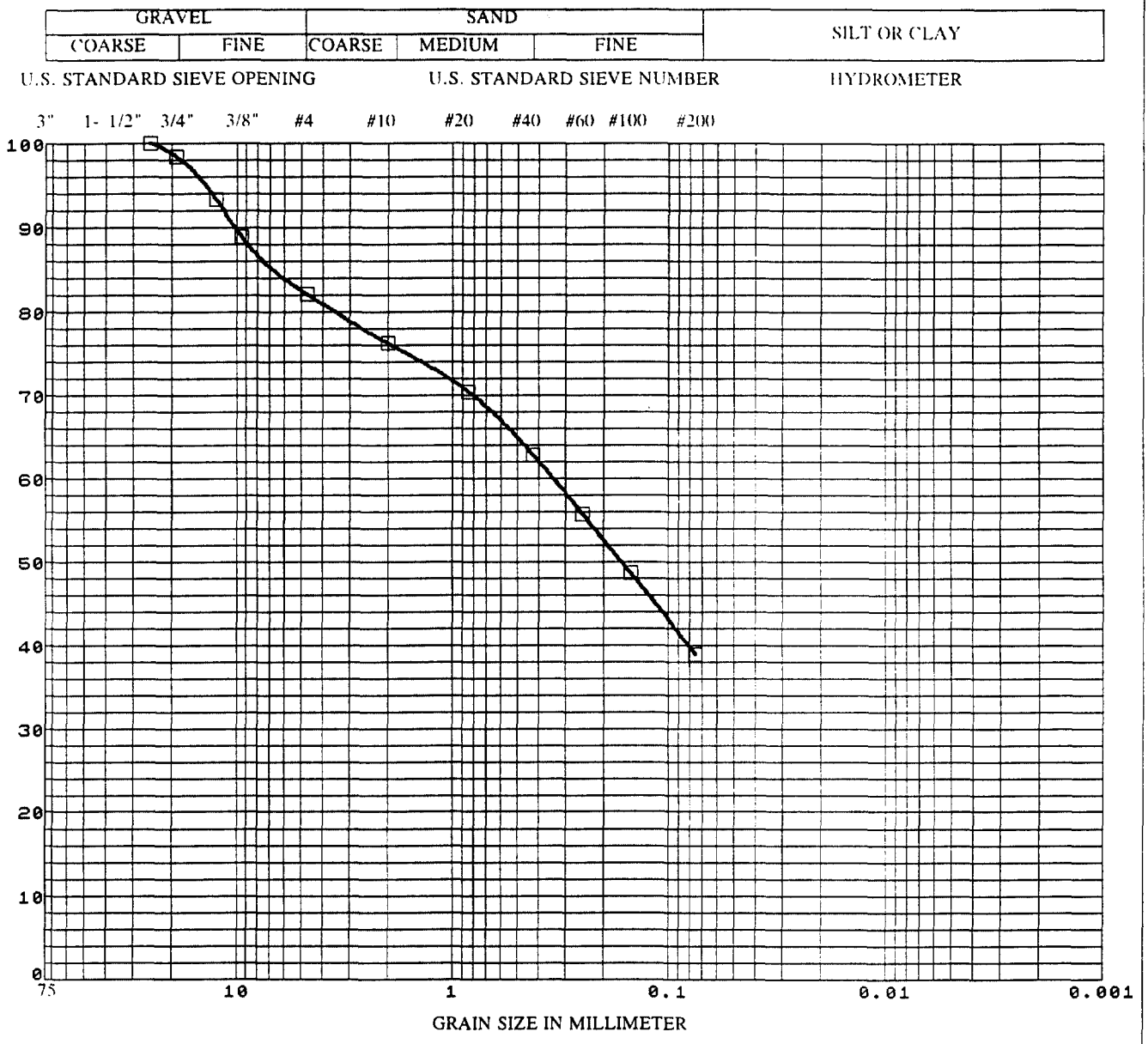
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



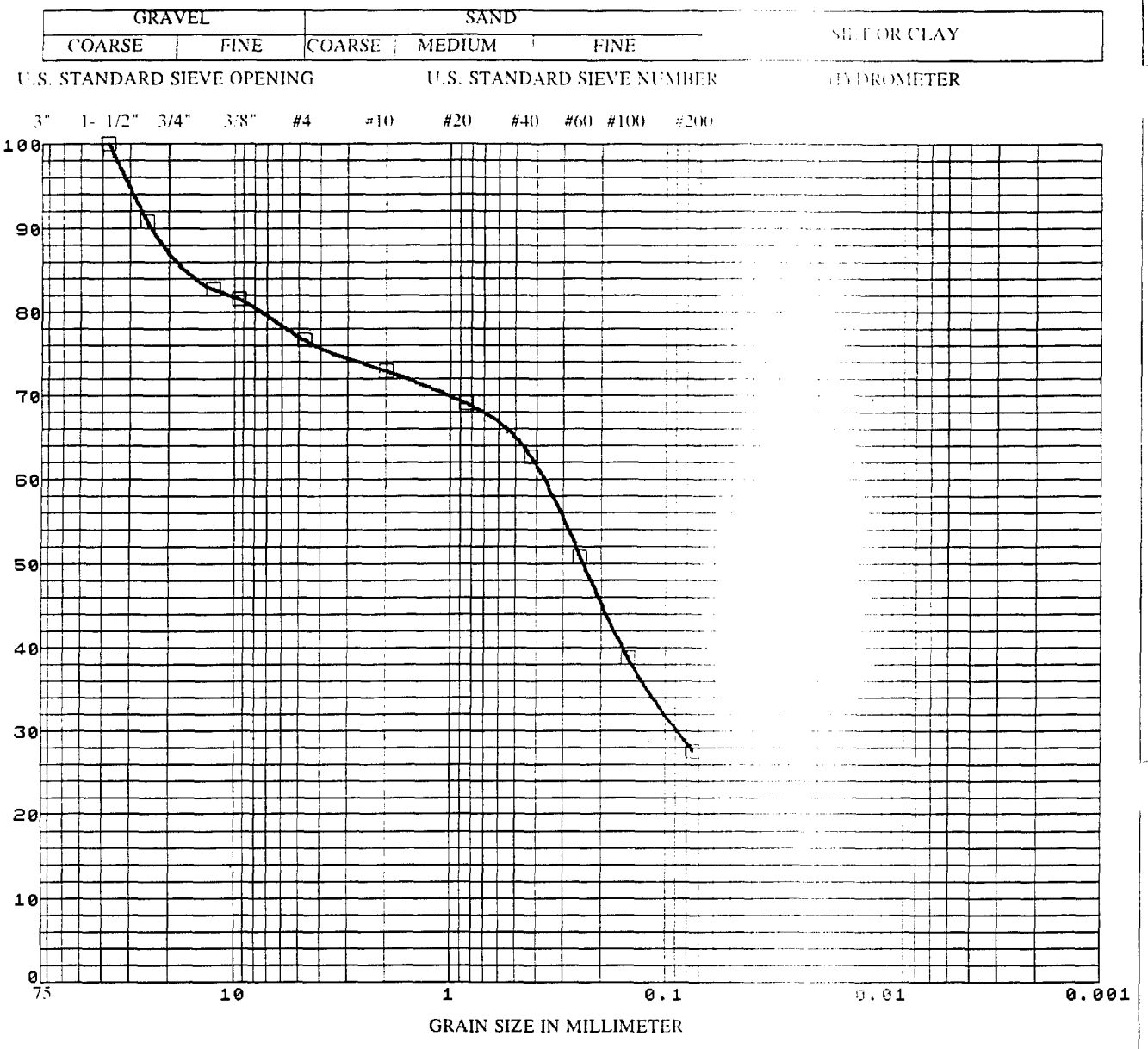
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-06	Bulk	0-5	SC		26	12

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-07	Bulk	0-5	B			

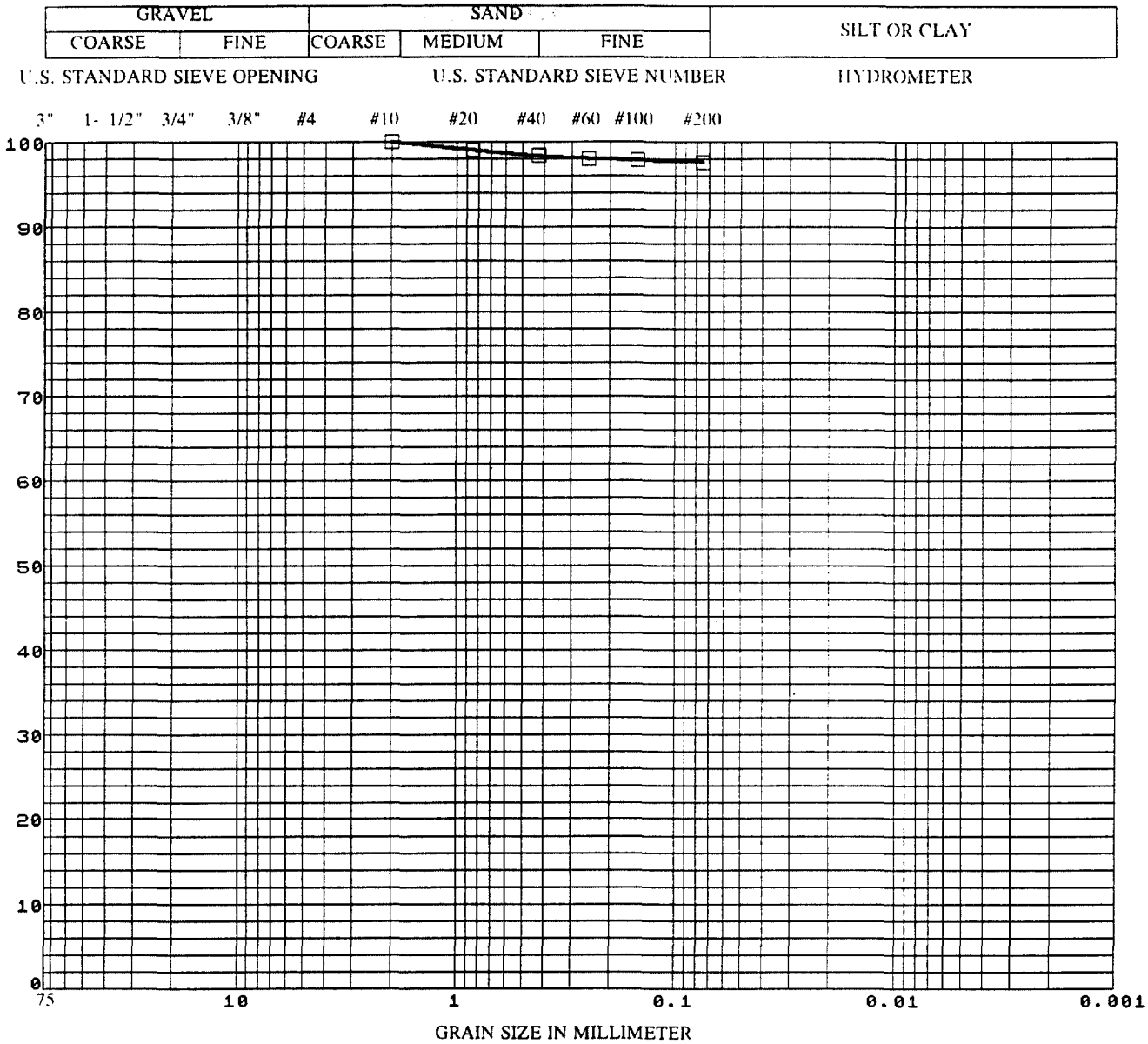
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



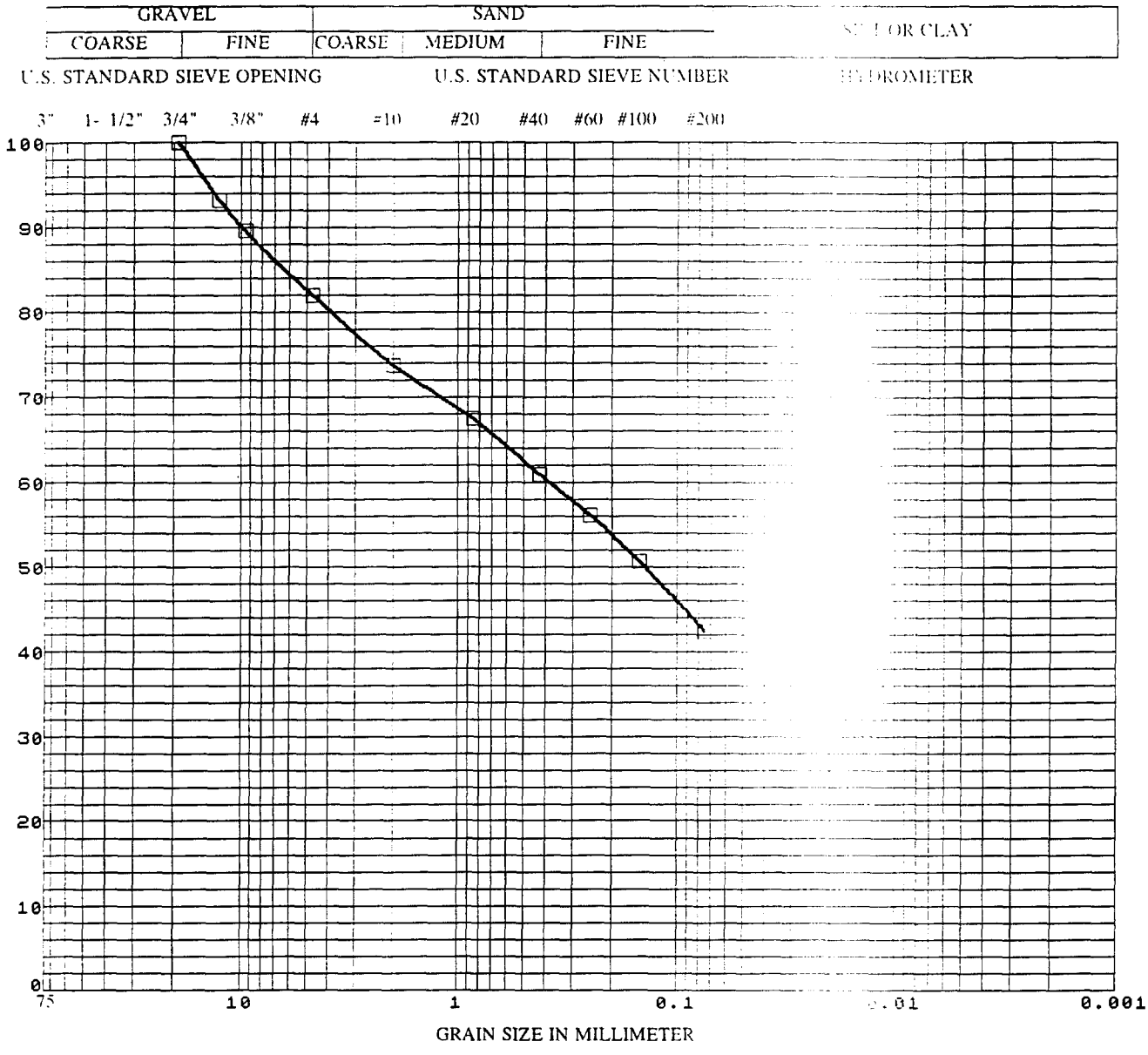
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-07	6	25.5	R			

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-11	Bulk	0-5	B			

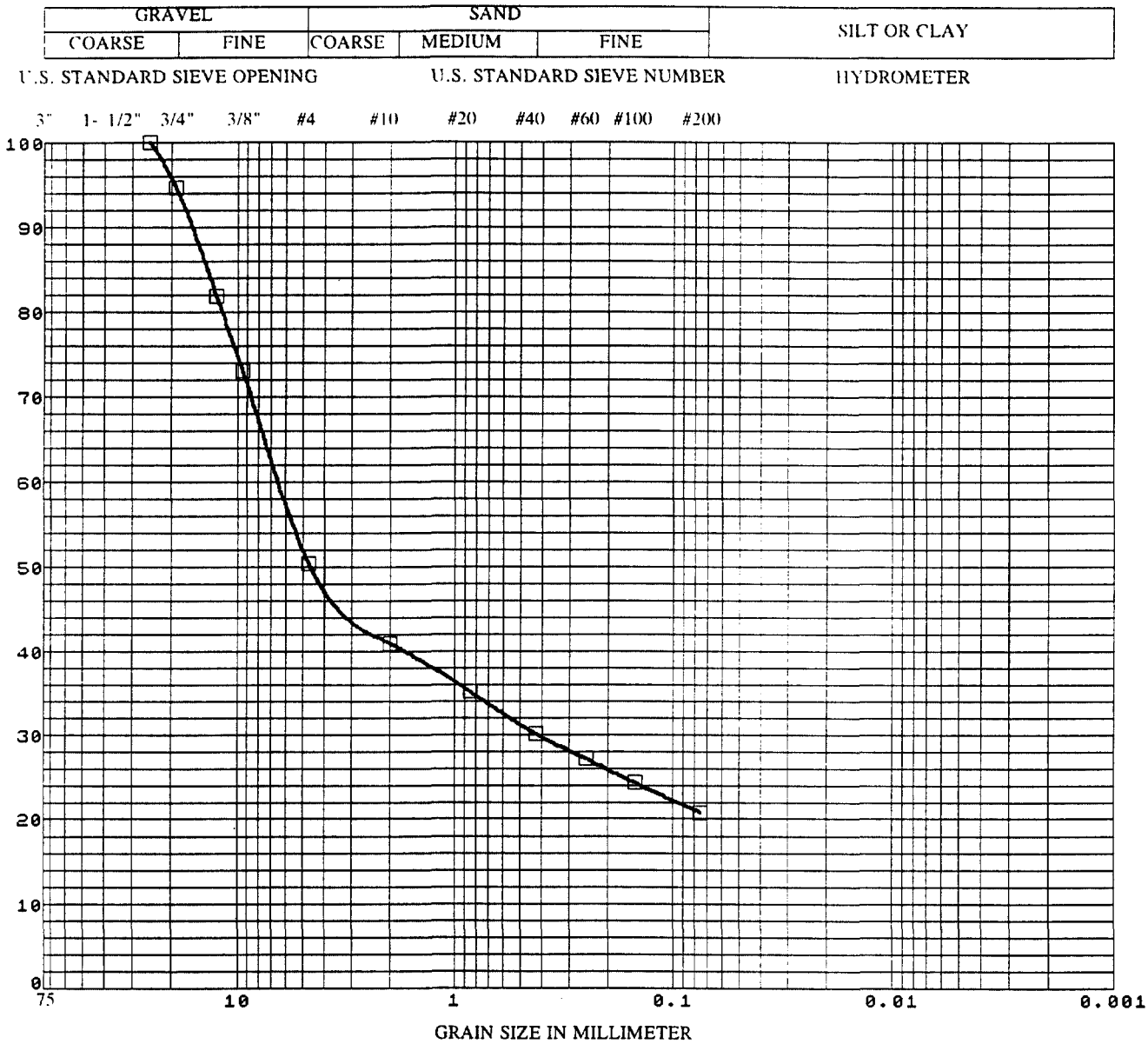
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



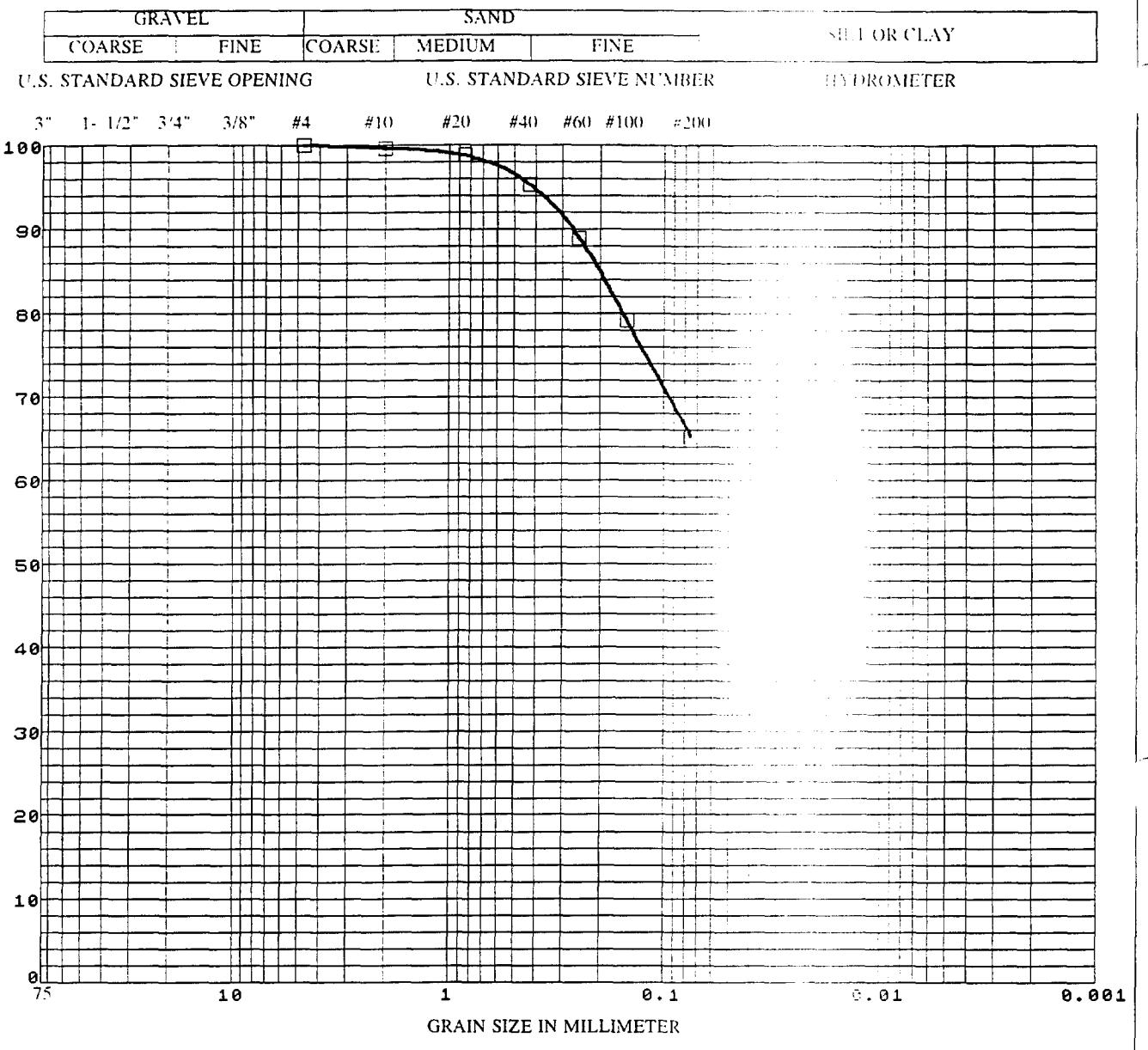
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-09	Bulk	0-5	B	SC	30	14

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-09	2	10.5	R	CL	29	11

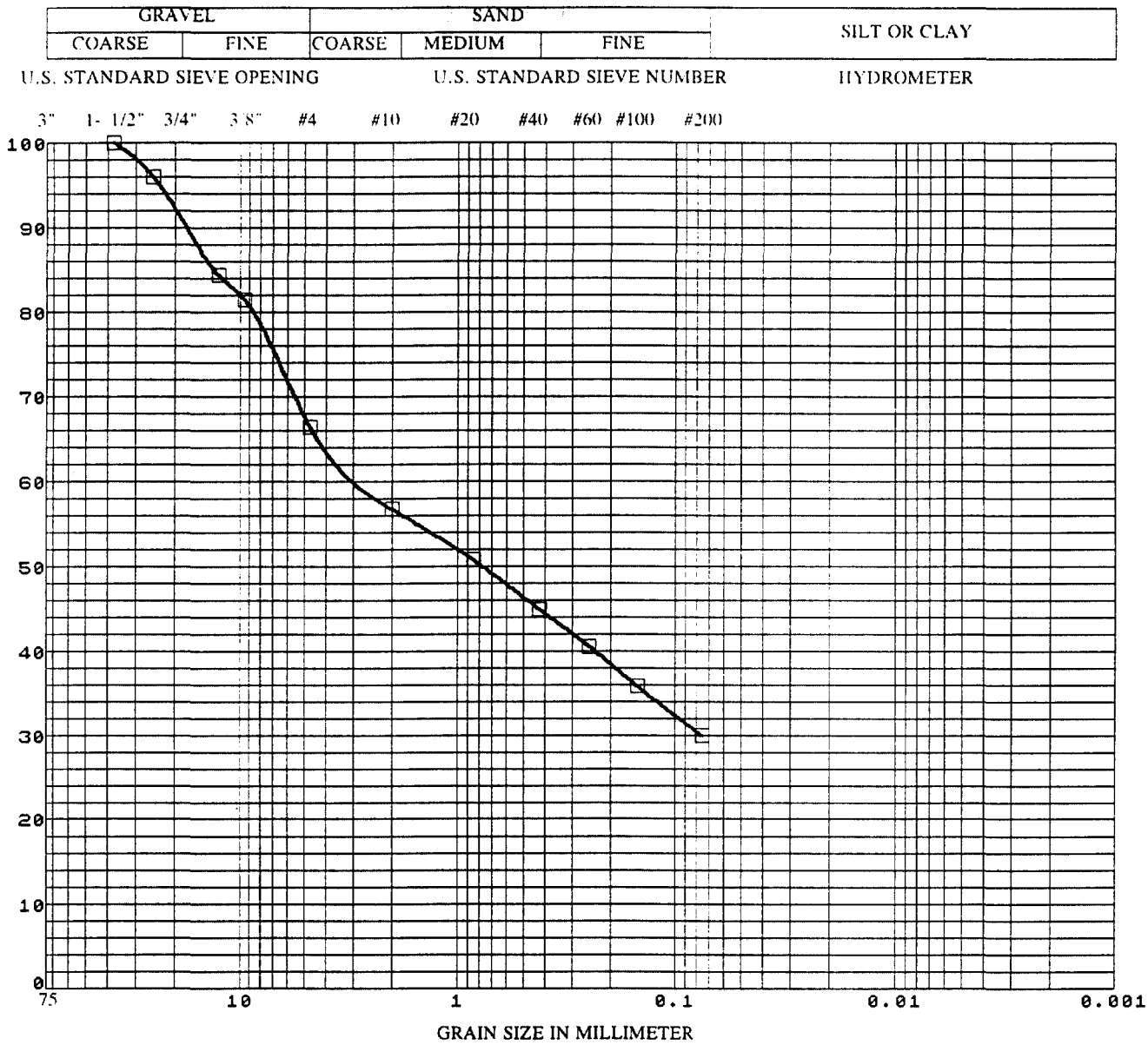
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



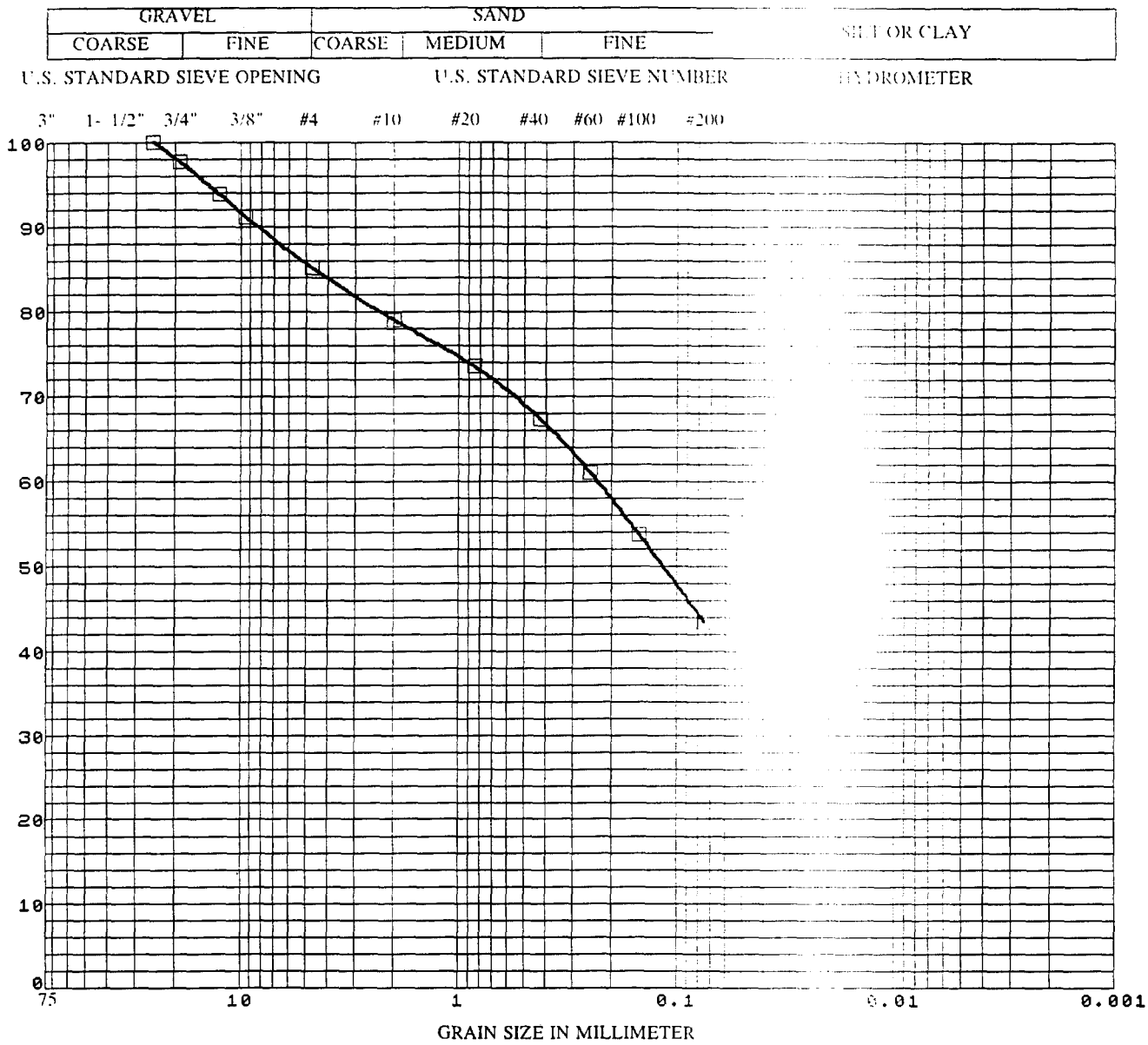
SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-10	Bulk	0-5	B			

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-08	Bulk	0-5	B			

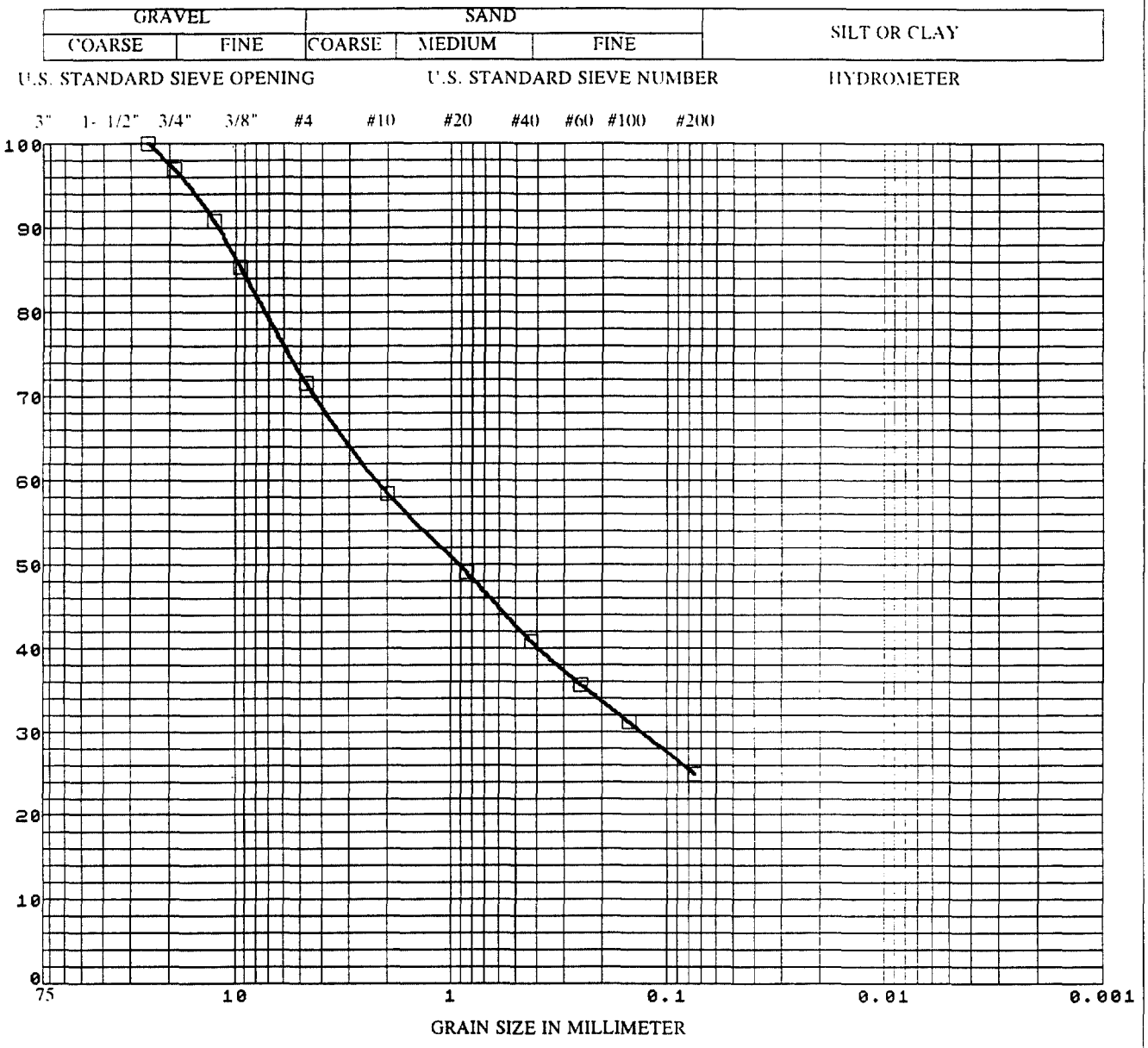
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



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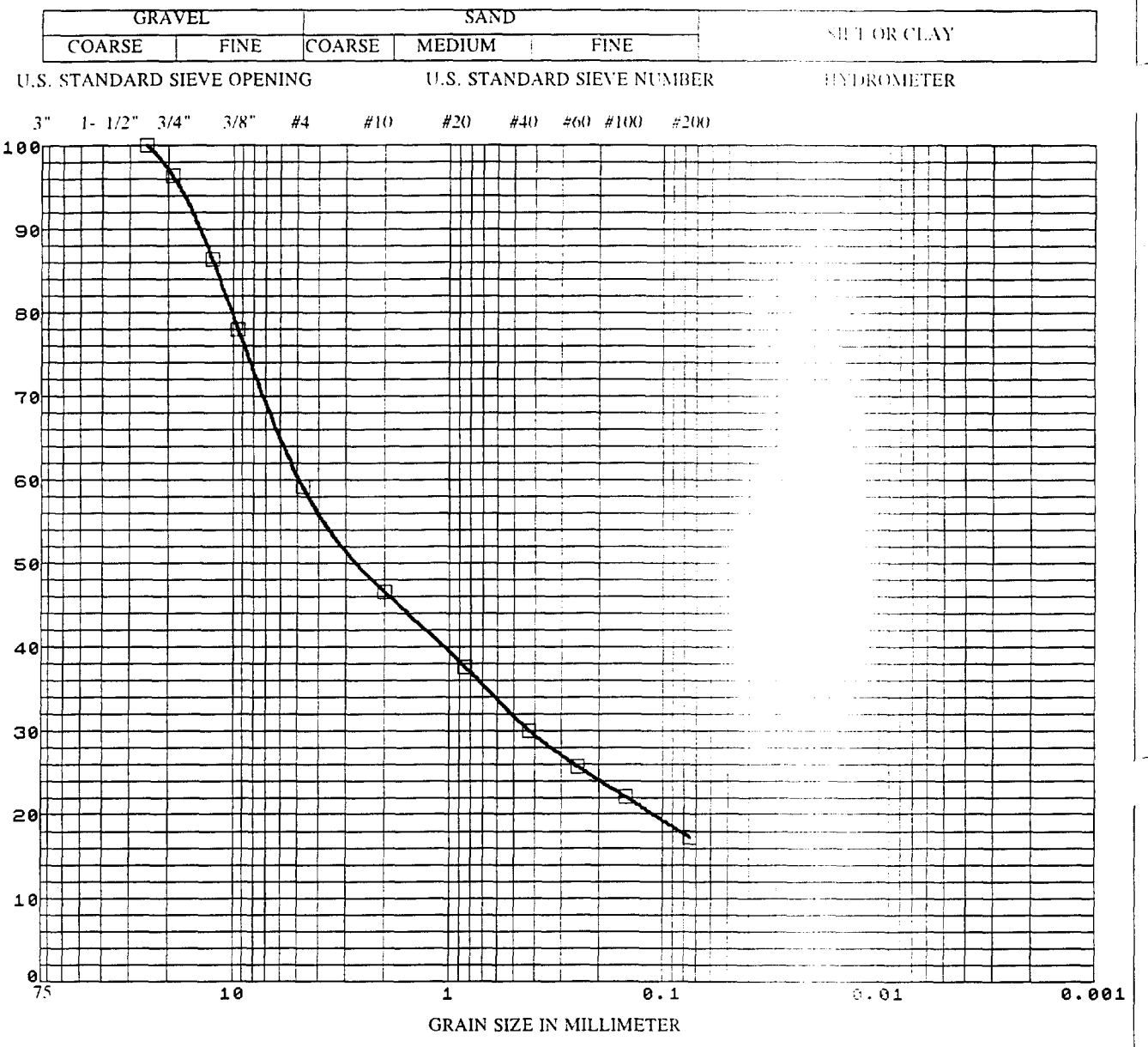
□	G-12	Bulk	0-5	B			

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-13	Bulk	0-5	B	SC	29	11

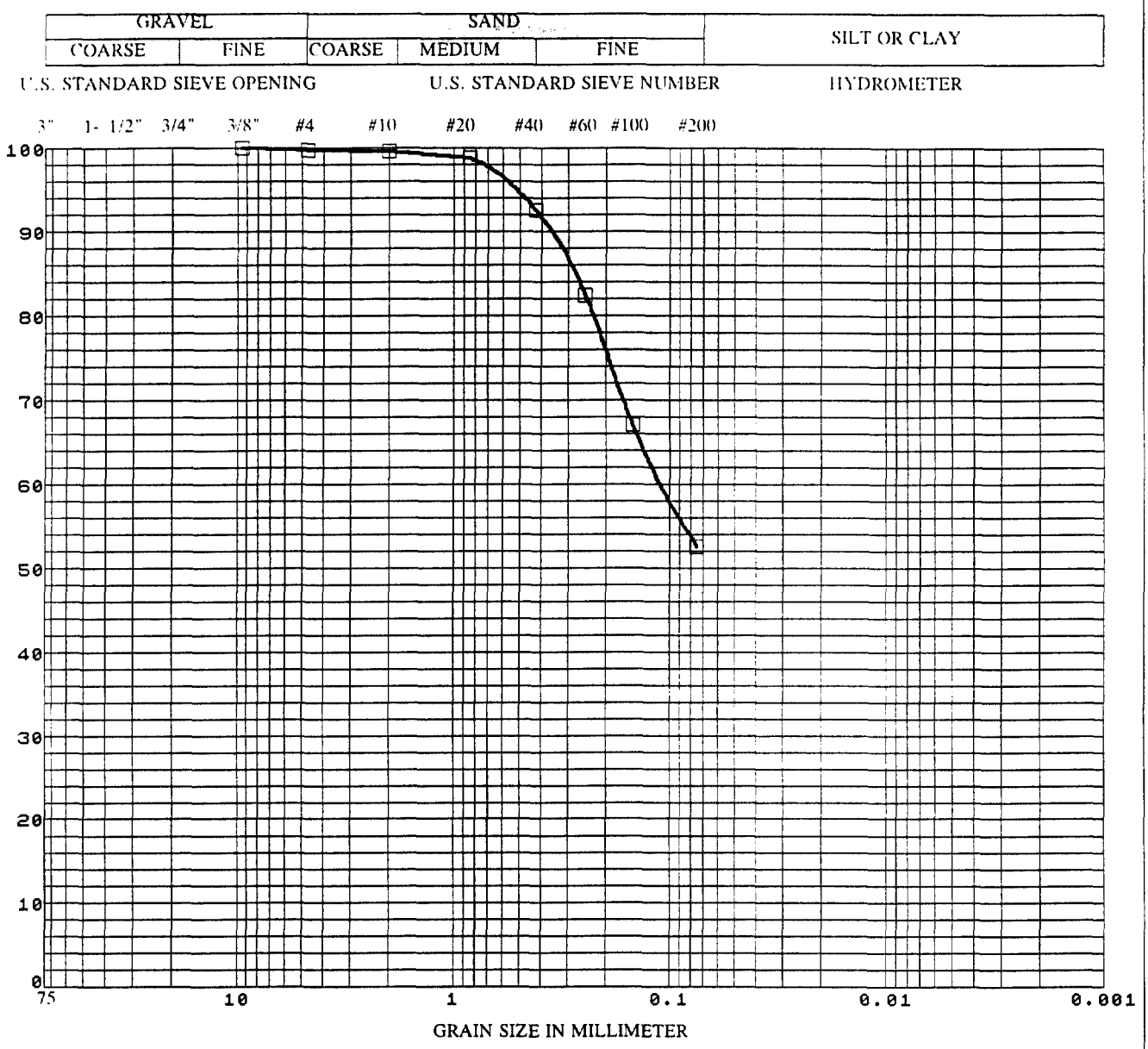
KEANTAN LABORATORIES

PROJECT NAME:
WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	G-13	5	20.5	R			

KEANTAN LABORATORIES	PROJECT NAME: WDI/SANTA FE SPRINGS

GRAIN SIZE DISTRIBUTION CURVE

9/02

FIGURE

ATTERBERG LIMITS

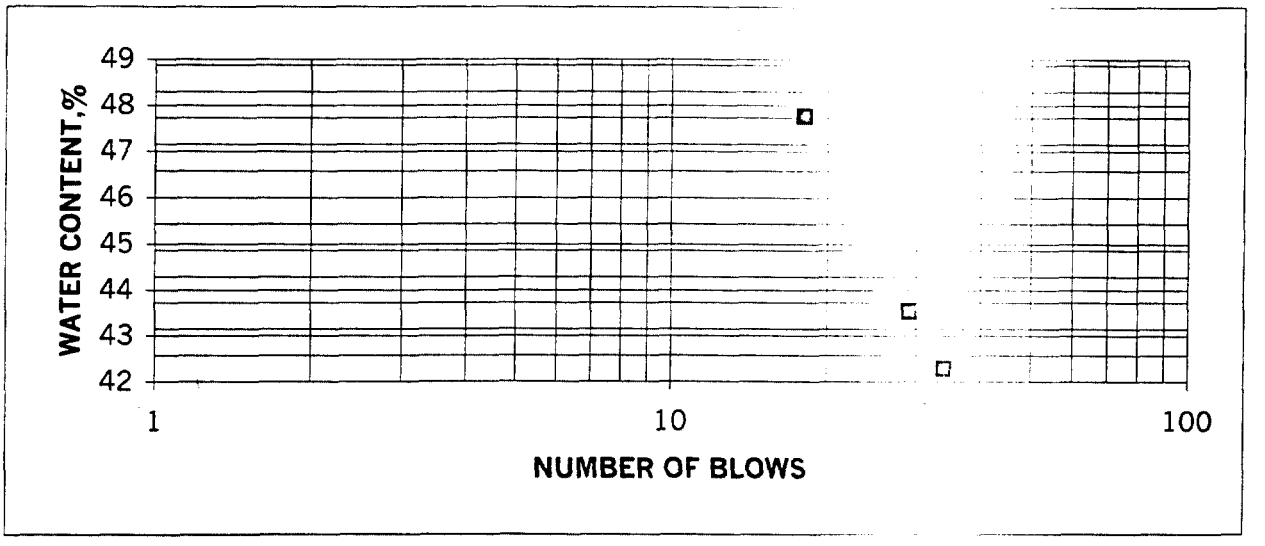
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-01/#4	**DEPTH:**	20	**Date:**	9/25/02
Description:	OLIVE (ML)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-47	HA-21	[illegible]	B-20	B-55	
Weight of Can + Wet Soil, gms.	9.18	10.14	[illegible]	5.93	6.05	
Weight of Can + Dry Soil, gms.	6.79	7.41	[illegible]	4.91	5.00	
Weight of Can, gms.	1.14	1.14	[illegible]	1.12	1.14	
Weight of Dry Soil, gms.	5.65	6.27	[illegible]	3.79	3.86	
Weight of Water, gms.	2.39	2.73	[illegible]	1.02	1.05	
Water Content, %	42.3	43.5	[illegible]	26.9	27.2	
Number of Blows	34	29	[illegible]			

Unified Soil Classification ML



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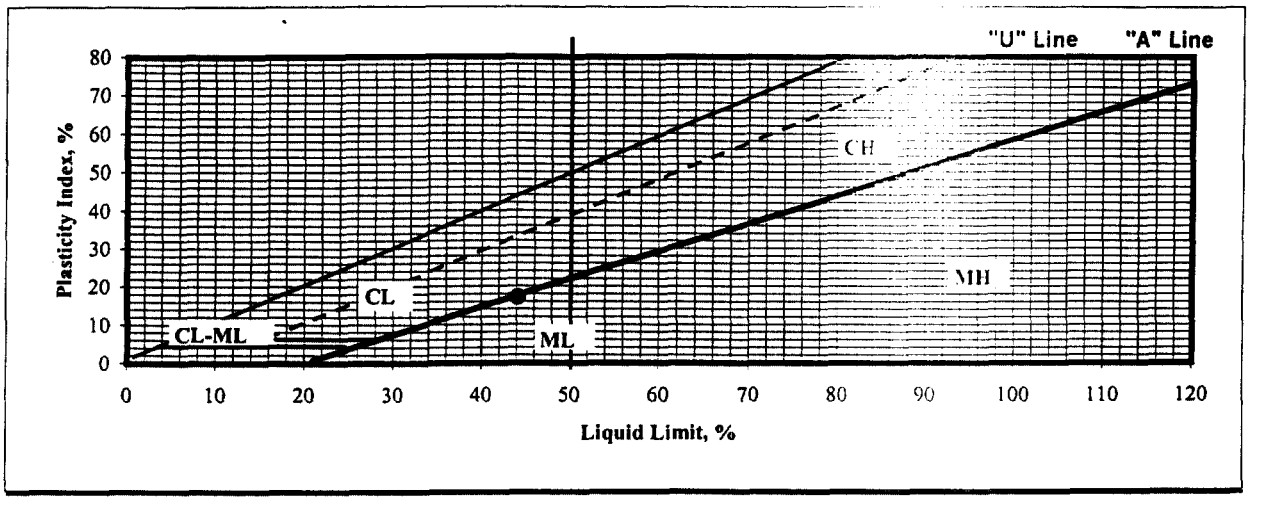

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KEANTAN LABORATORIES

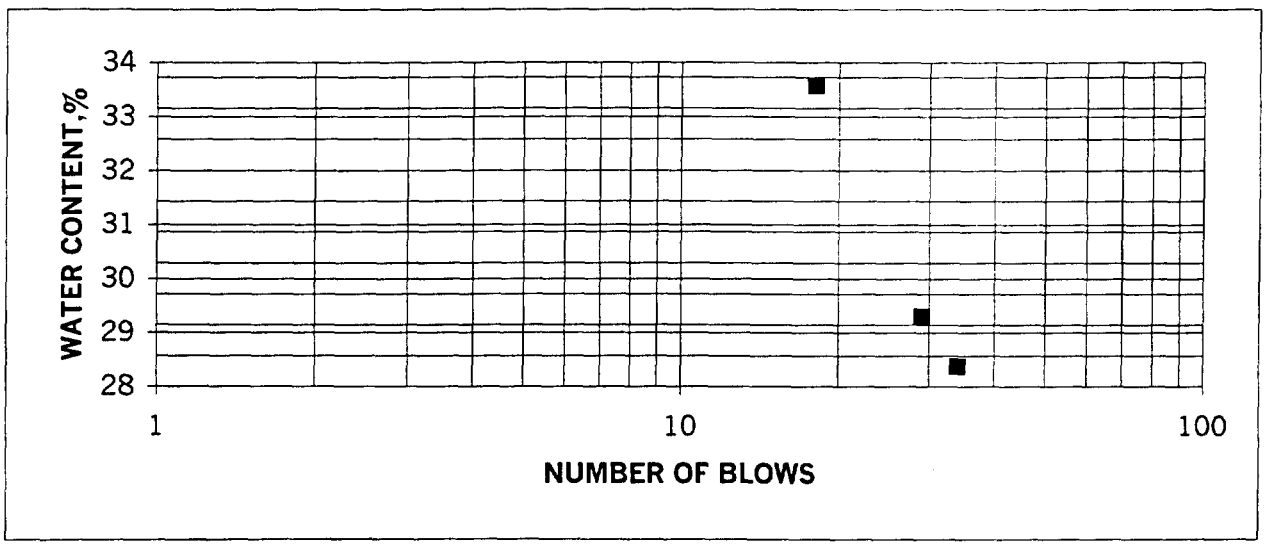
ATTERBERG LIMITS

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-01/#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-23	HA-60	HA-2	B-26	B-51A	
Weight of Can + Wet Soil, gms.	9.77	10.67	11.80	6.45	6.26	
Weight of Can + Dry Soil, gms.	7.86	8.51	9.12	5.78	5.61	
Weight of Can, gms.	1.13	1.14	1.14	1.14	1.13	
Weight of Dry Soil, gms.	6.73	7.37	7.98	4.64	4.48	
Weight of Water, gms.	1.91	2.16	2.68	0.67	0.65	
Water Content, %	28.4	29.3	33.6	14.4	14.5	
Number of Blows	34	29	18			

Unified Soil Classification CL



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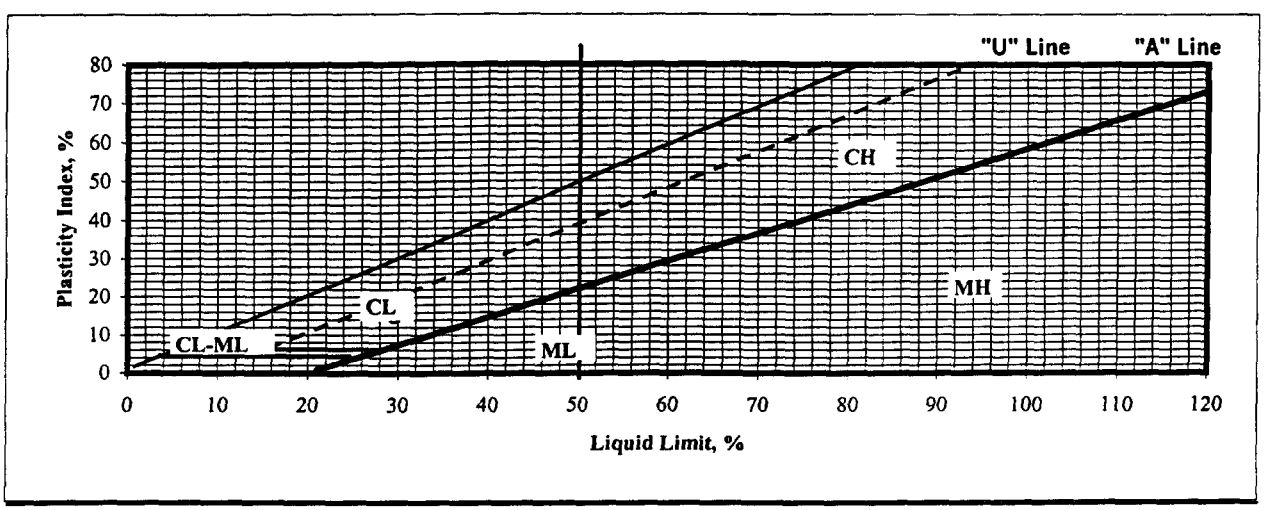

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ATTERBERG LIMITS

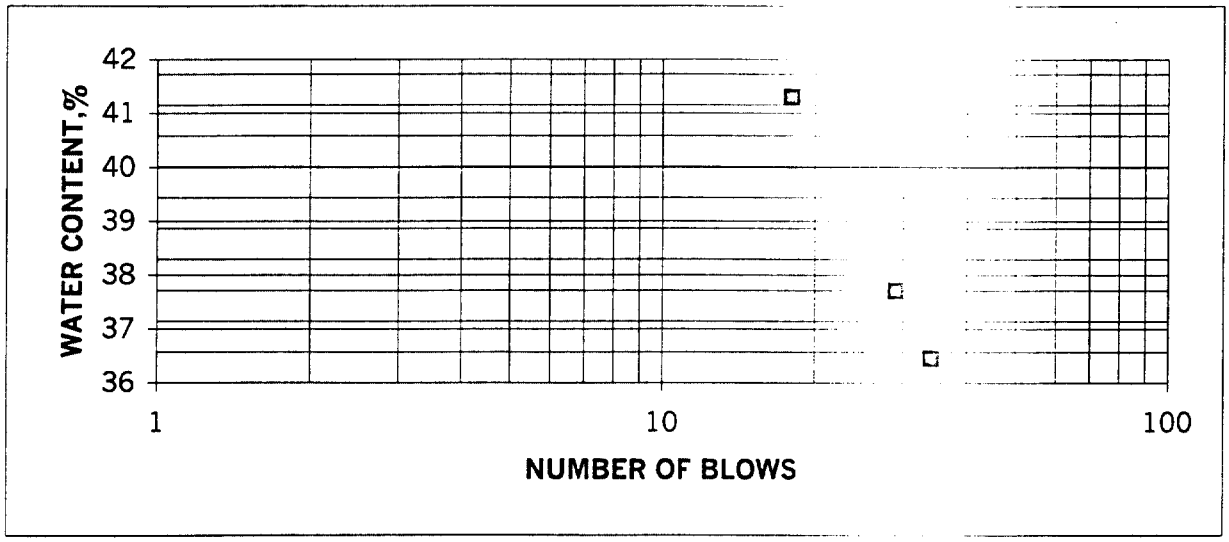
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-02/#4	**Depth, ft.:**	15	**Date:**	9/25/02
Description:	OLIVE BROWN (CL)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-63	HA-55	HA-65	B-51A	B-26	
Weight of Can + Wet Soil, gms.	9.85	10.68	11.5[illegible]	5.66	5.66	
Weight of Can + Dry Soil, gms.	7.52	8.07	8.5[illegible]	5.19	5.17	
Weight of Can, gms.	1.13	1.15	1.1[illegible]	1.13	1.13	
Weight of Dry Soil, gms.	6.39	6.92	7.3[illegible]	4.06	4.04	
Weight of Water, gms.	2.33	2.61	3.0[illegible]	0.47	0.49	
Water Content, %	36.5	37.7	4[illegible]	11.6	12.1	
Number of Blows	34	29				

Unified Soil Classification CL



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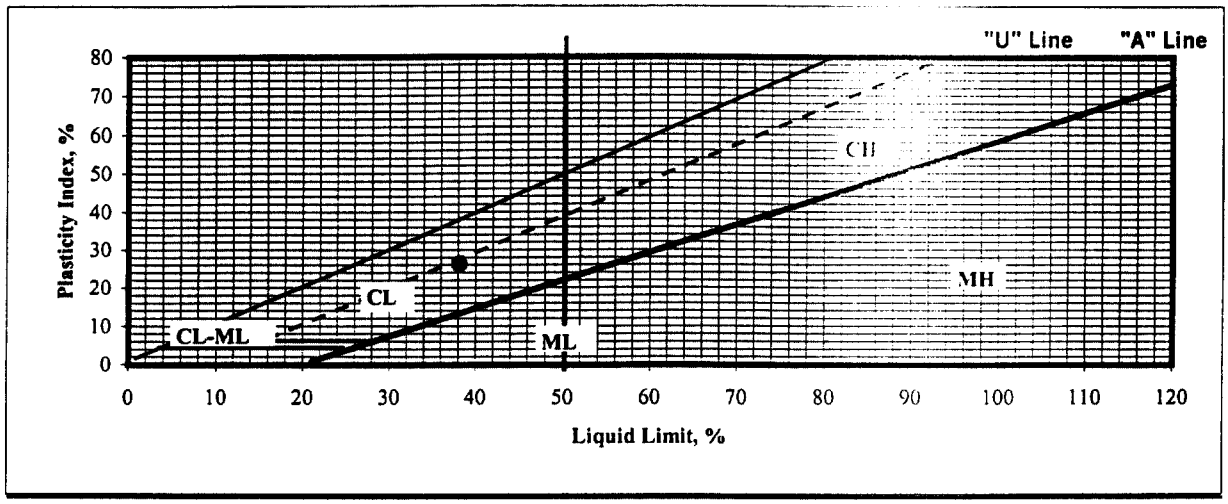

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KEANTAN LABORATORIES

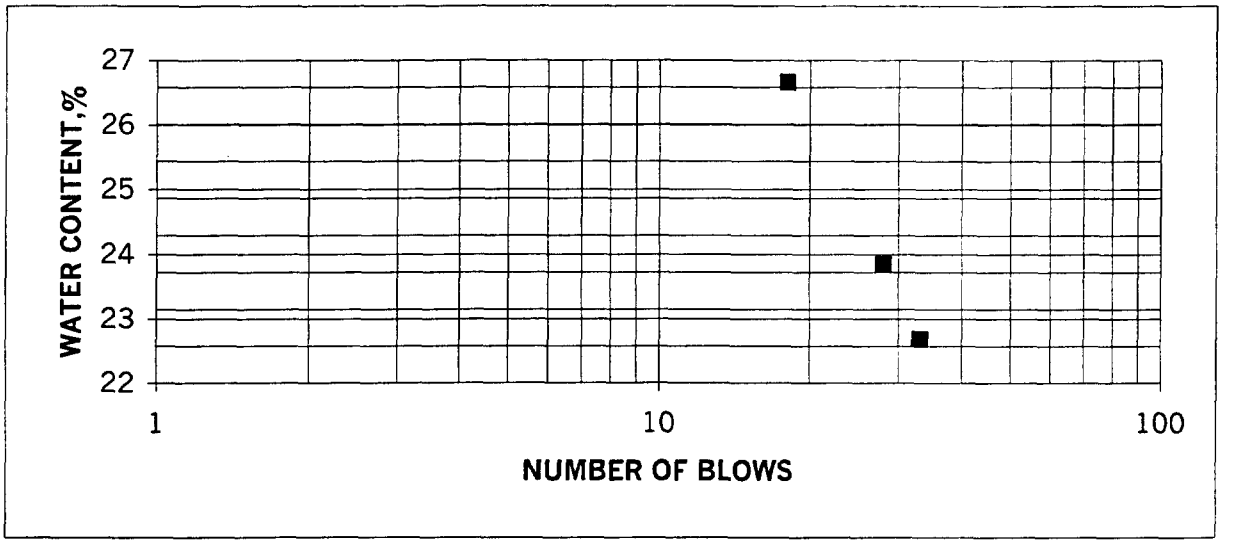
ATTERBERG LIMITS

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-03/#4	**Depth, ft.:**	15	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-46	HA-52	HA-50	B-24	B-13	
Weight of Can + Wet Soil, gms.	8.71	9.24	11.77	5.92	5.69	
Weight of Can + Dry Soil, gms.	7.31	7.68	9.53	5.51	5.29	
Weight of Can, gms.	1.14	1.14	1.13	1.15	1.12	
Weight of Dry Soil, gms.	6.17	6.54	8.40	4.36	4.17	
Weight of Water, gms.	1.40	1.56	2.24	0.41	0.40	
Water Content, %	22.7	23.9	26.7	9.4	9.6	
Number of Blows	33	28	18			

Unified Soil Classification CL



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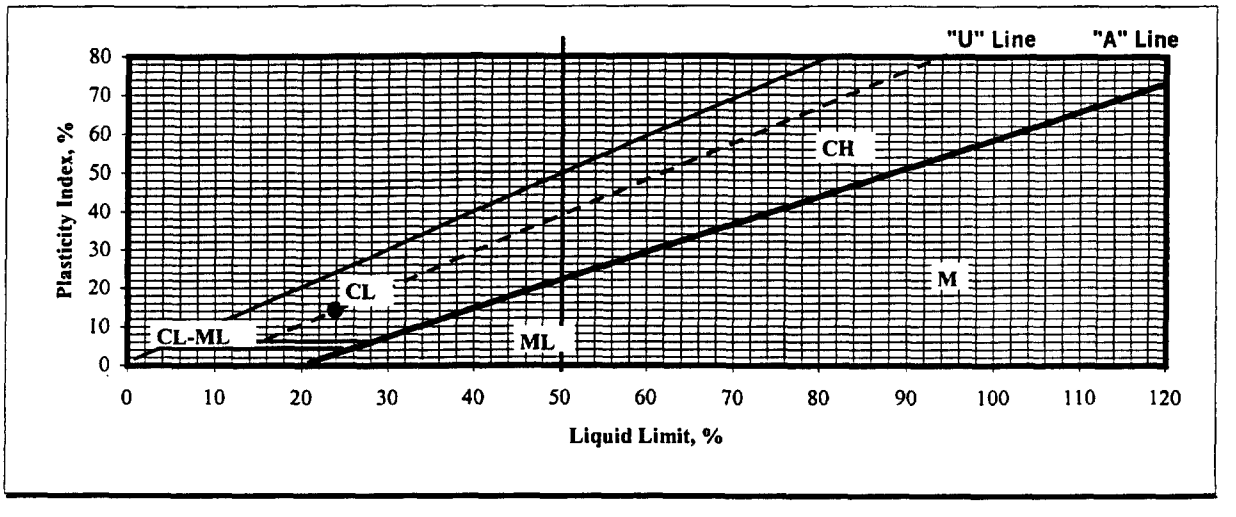

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ATTERBERG LIMITS

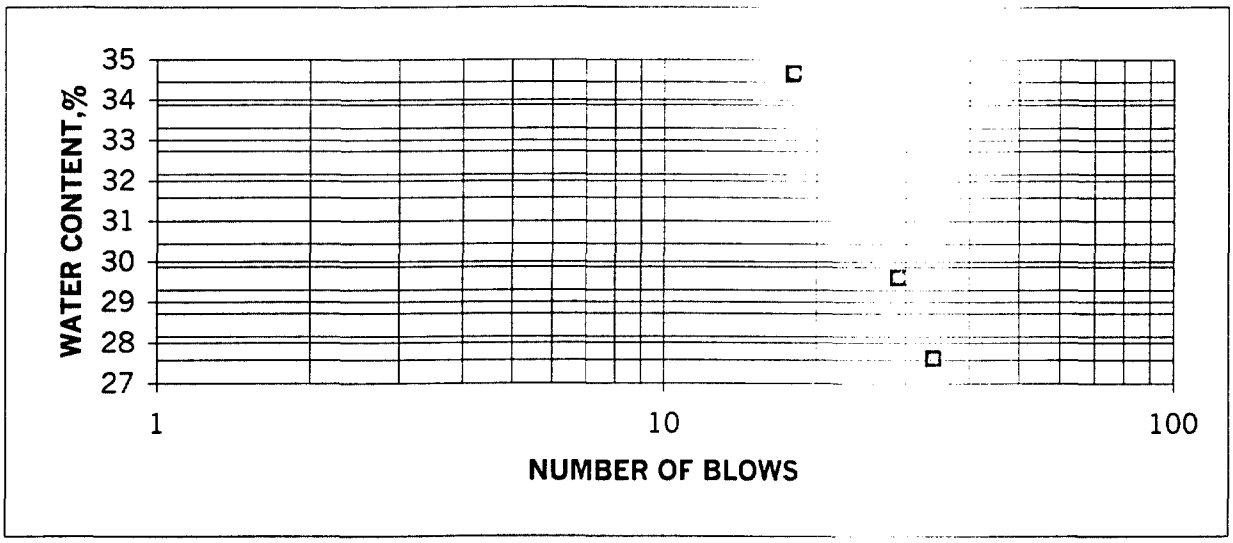
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-03/#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-38	HA-39	HA-24	B-53	B-50A	
Weight of Can + Wet Soil, gms.	9.65	9.96	[illegible]	6.04	6.46	
Weight of Can + Dry Soil, gms.	7.81	7.94	[illegible]	5.38	5.76	
Weight of Can, gms.	1.15	1.12	[illegible]	1.13	1.16	
Weight of Dry Soil, gms.	6.66	6.82	[illegible]	4.25	4.60	
Weight of Water, gms.	1.84	2.02	[illegible]	0.66	0.70	
Water Content, %	27.6	29.6	[illegible]	15.5	15.2	
Number of Blows	34	29				

Unified Soil Classification **CL**



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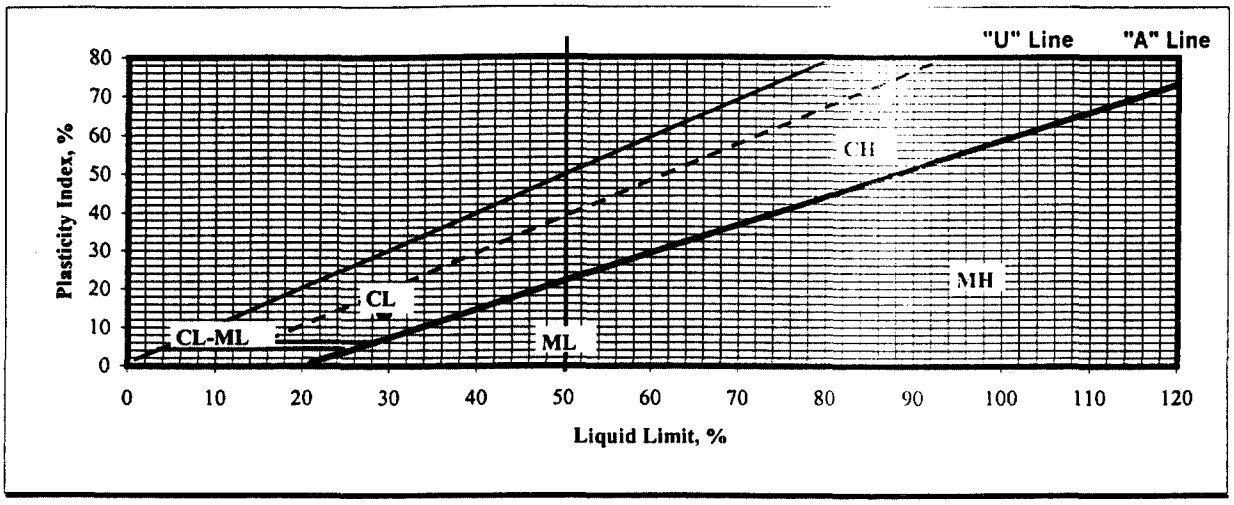

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ATTERBERG LIMITS

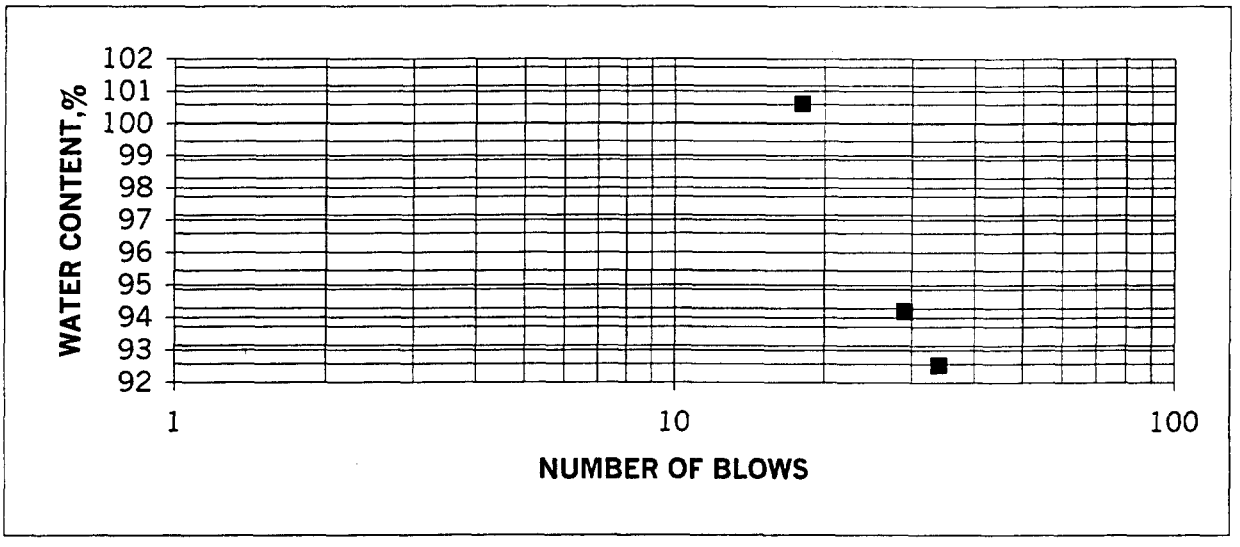
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-04/#3	**DEPTH:**	10	**Date:**	9/25/02
Description:	OLIVE (ML-CL)-(CH)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-35	HA-8	HA-27	B-12	B-25	
Weight of Can + Wet Soil, gms.	7.87	8.51	10.74	5.42	5.48	
Weight of Can + Dry Soil, gms.	4.64	4.93	5.92	4.73	4.77	
Weight of Can, gms.	1.15	1.13	1.13	1.13	1.14	
Weight of Dry Soil, gms.	3.49	3.80	4.79	3.60	3.63	
Weight of Water, gms.	3.23	3.58	4.82	0.69	0.71	
Water Content, %	92.6	94.2	100.6	19.2	19.6	
Number of Blows	34	29	18			

Unified Soil Classification **CH**



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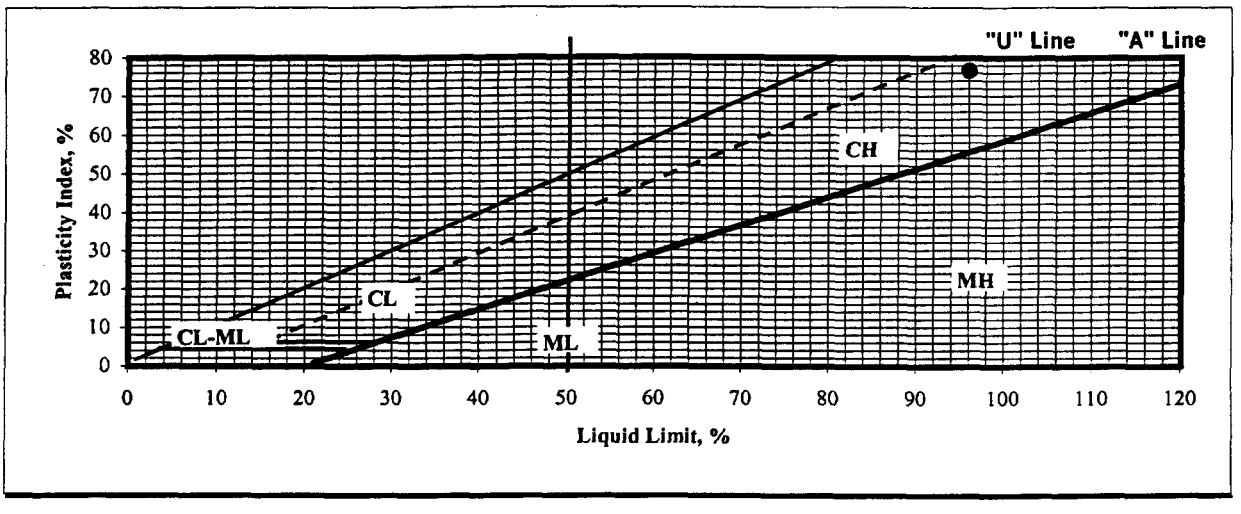

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KEANTAN LABORATORIES

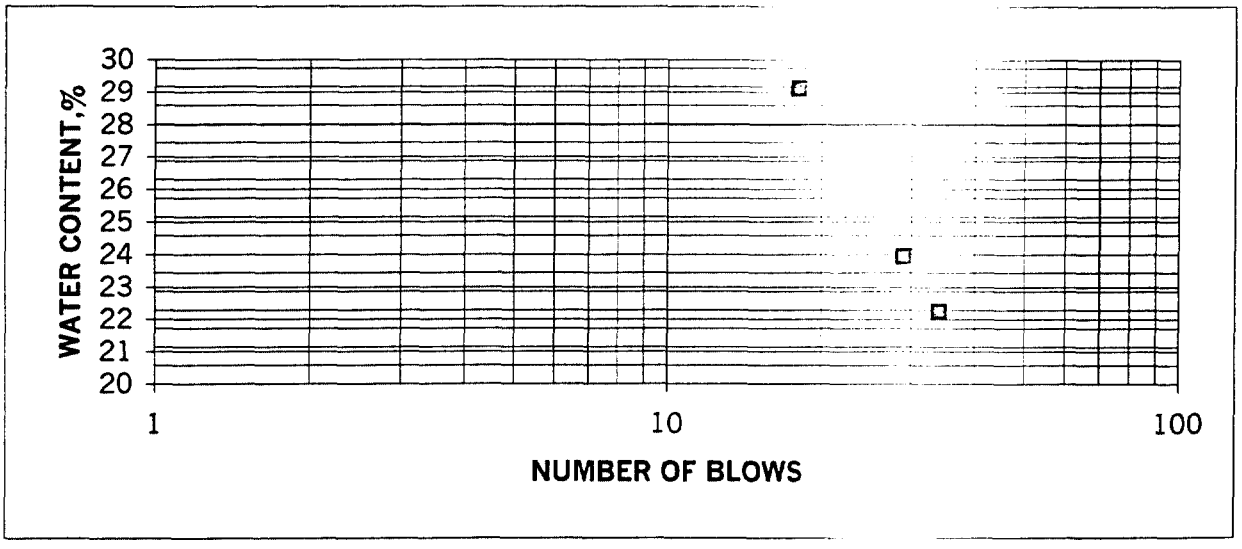
ATTERBERG LIMITS

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-04#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-58	HA-53	HA-14	B-20	B-18	
Weight of Can + Wet Soil, gms.	9.50	10.39	10.97	5.95	5.61	
Weight of Can + Dry Soil, gms.	7.98	8.60	8.75	5.31	5.02	
Weight of Can, gms.	1.15	1.13	1.13	1.12	1.13	
Weight of Dry Soil, gms.	6.83	7.47	7.62	4.19	3.89	
Weight of Water, gms.	1.52	1.79	2.22	0.64	0.59	
Water Content, %	22.3	24.0	29.1	15.3	15.2	
Number of Blows	34	29	19			

Unified Soil Classification CL



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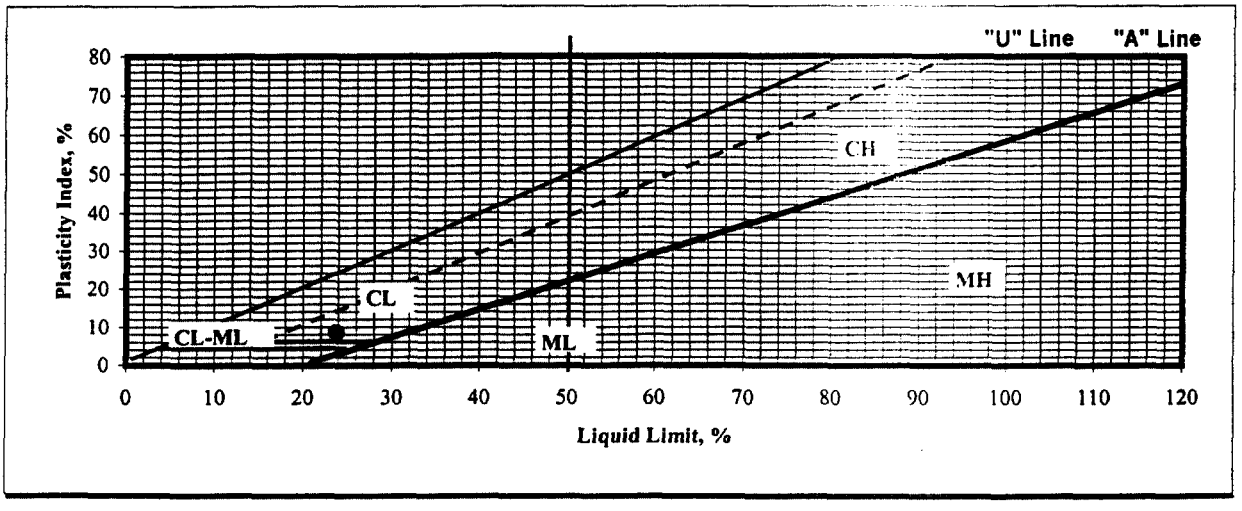

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KEANTAN LABORATORIES

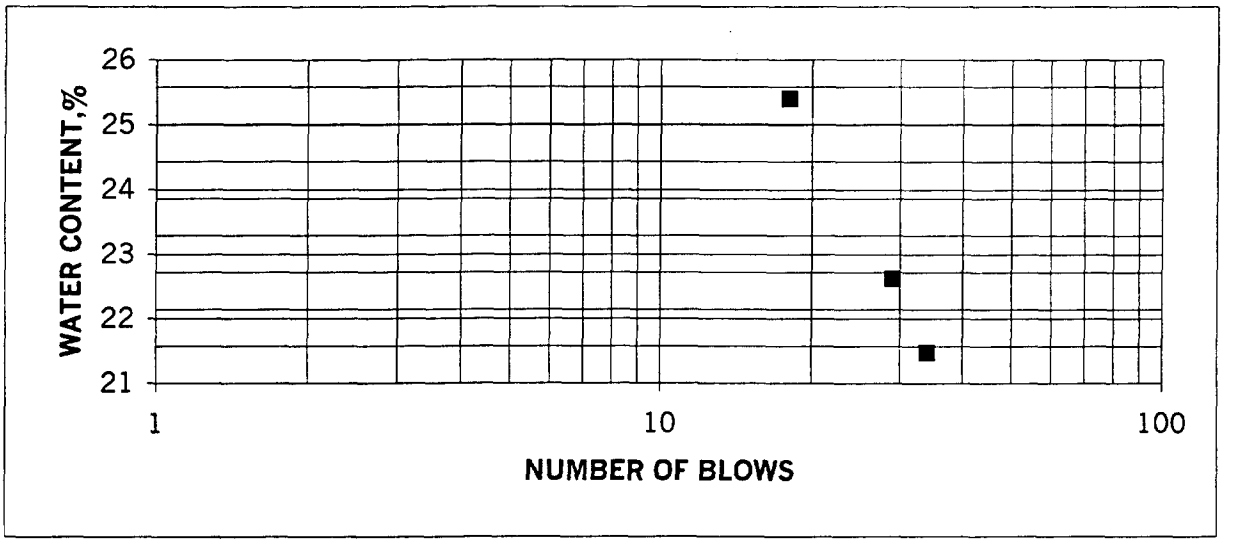
ATTERBERG LIMITS

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-05#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-49	HA-4	HA-1	B-29	B-53A	
Weight of Can + Wet Soil, gms.	10.98	12.12	12.75	6.80	6.75	
Weight of Can + Dry Soil, gms.	9.24	10.09	10.40	6.18	6.13	
Weight of Can, gms.	1.14	1.12	1.15	1.15	1.13	
Weight of Dry Soil, gms.	8.10	8.97	9.25	5.03	5.00	
Weight of Water, gms.	1.74	2.03	2.35	0.62	0.62	
Water Content, %	21.5	22.6	25.4	12.3	12.4	
Number of Blows	34	29	18			

Unified Soil Classification CL



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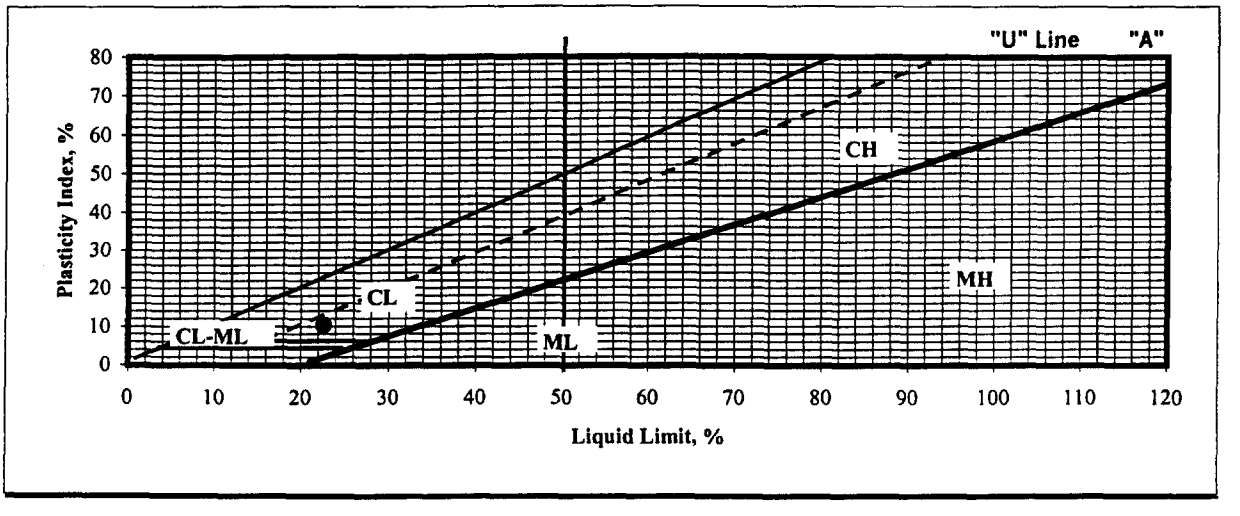

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ATTERBERG LIMITS

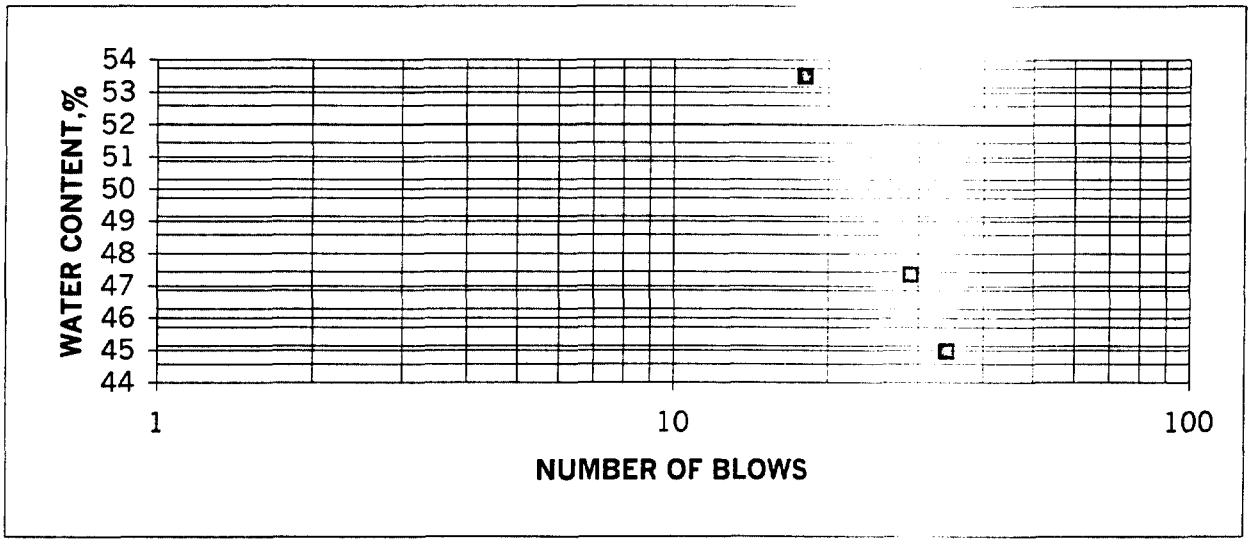
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-06/#5	**DEPTH:**	15	**Date:**	9/25/02
Description:	OLIVE (ML-CL)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	B-26	B-53	B-53A	HA-63	HA-28	
Weight of Can + Wet Soil, gms.	8.52	9.54	10.51	5.43	5.70	
Weight of Can + Dry Soil, gms.	6.23	6.84	7.24	4.67	4.90	
Weight of Can, gms.	1.14	1.14	1.13	1.14	1.14	
Weight of Dry Soil, gms.	5.09	5.70	6.11	3.53	3.76	
Weight of Water, gms.	2.29	2.70	3.27	0.76	0.80	
Water Content, %	45.0	47.4	53.5	21.5	21.3	
Number of Blows	34	29	18			

Unified Soil Classification **CL**



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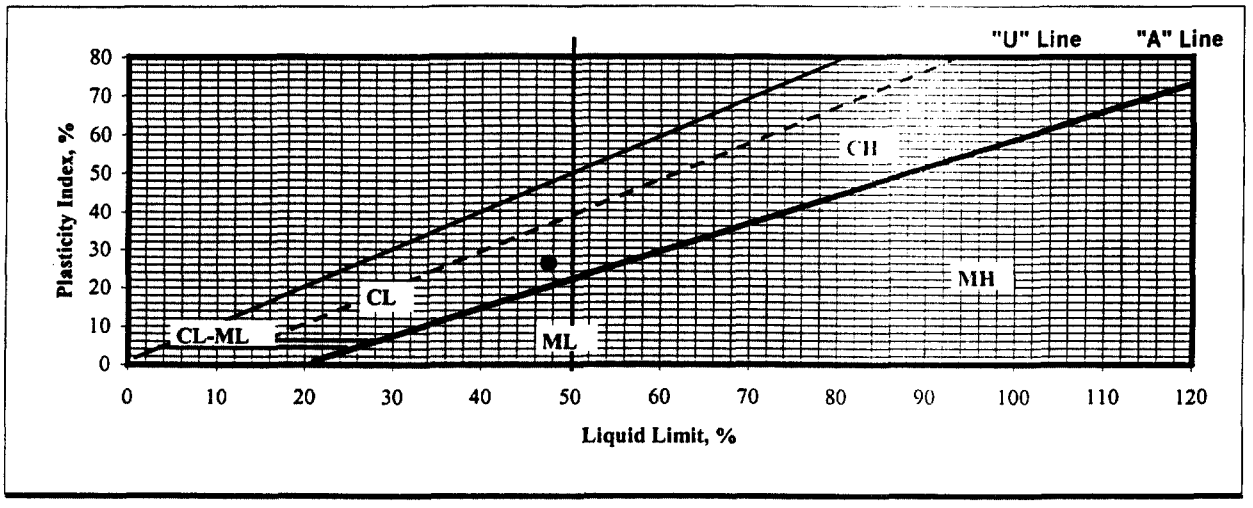

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KEANTAN LABORATORIES

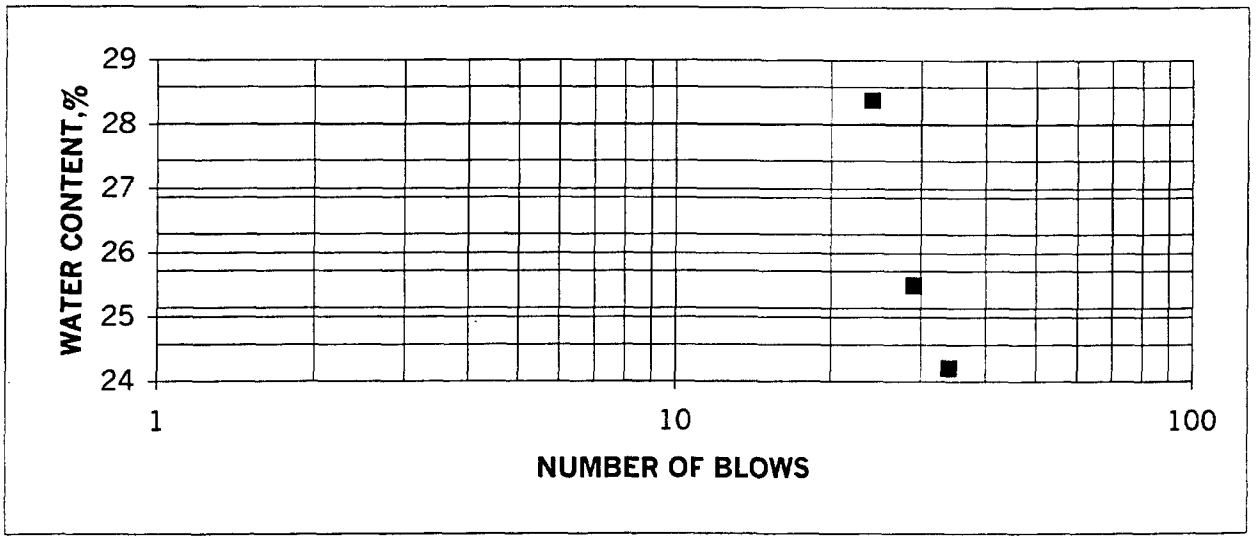
ATTERBERG LIMITS

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-06#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-11	HA-16	HA-8	B-51	B-14	
Weight of Can + Wet Soil, gms.	9.80	10.54	11.76	6.04	5.98	
Weight of Can + Dry Soil, gms.	8.11	8.63	9.41	5.44	5.38	
Weight of Can, gms.	1.13	1.14	1.13	1.13	1.14	
Weight of Dry Soil, gms.	6.98	7.49	8.28	4.31	4.24	
Weight of Water, gms.	1.69	1.91	2.35	0.60	0.60	
Water Content, %	24.2	25.5	28.4	13.9	14.2	
Number of Blows	34	29	24			

Unified Soil Classification **CL**



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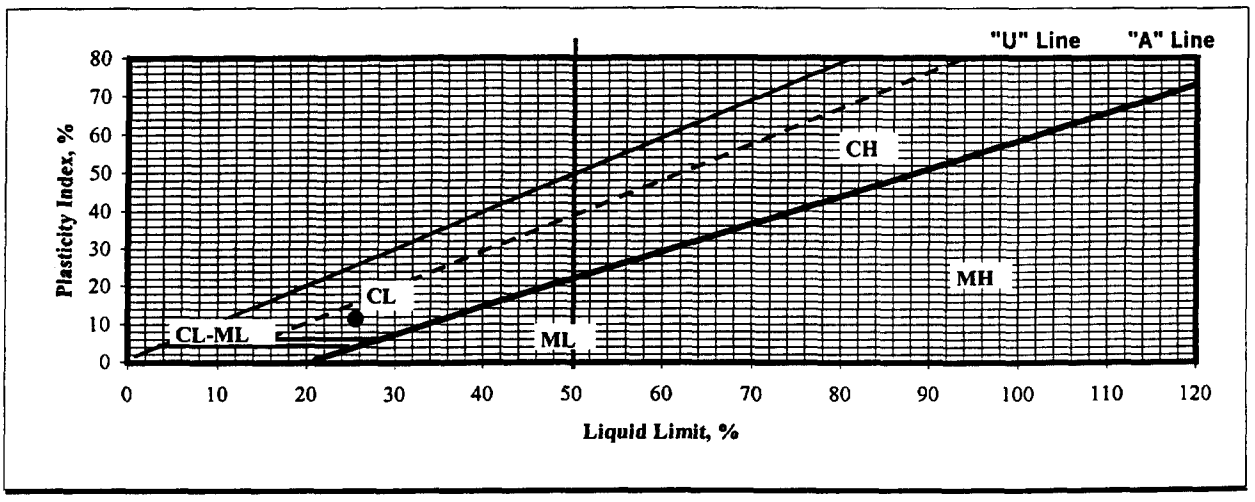

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ATTERBERG LIMITS

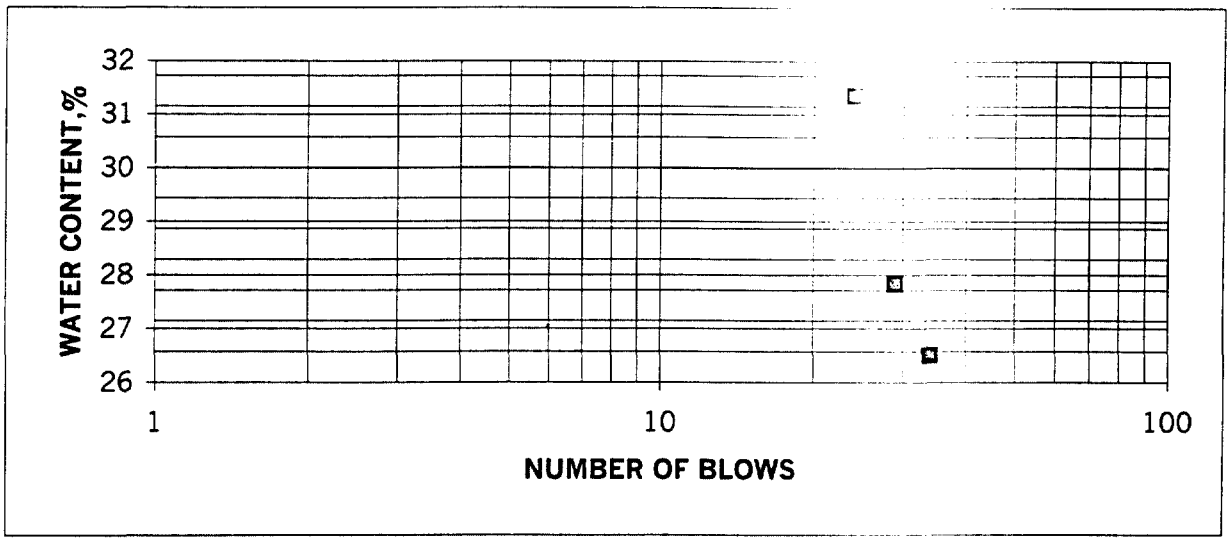
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-09/#2	**Depth, ft.:**	10.5	**Date:**	9/25/02
Description:	OLIVE (ML)-(SM)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-25	HA-21	HA-321	B-14	B-55	
Weight of Can + Wet Soil, gms.	9.30	9.90	10.69	5.53	5.42	
Weight of Can + Dry Soil, gms.	7.59	7.99	8.41	4.87	4.75	
Weight of Can, gms.	1.14	1.13	1.14	1.13	1.14	
Weight of Dry Soil, gms.	6.45	6.86	7.27	3.74	3.61	
Weight of Water, gms.	1.71	1.91	2.28	0.66	0.67	
Water Content, %	26.5	27.8	31.4	17.6	18.6	
Number of Blows	34	29	24			

Unified Soil Classification **CL**



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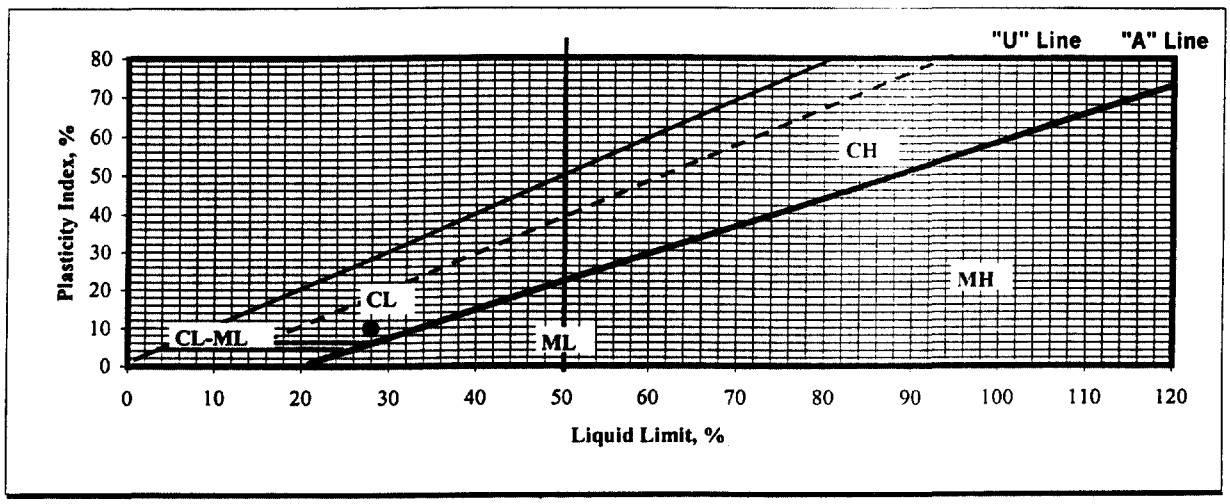

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KEANTAN LABORATORIES

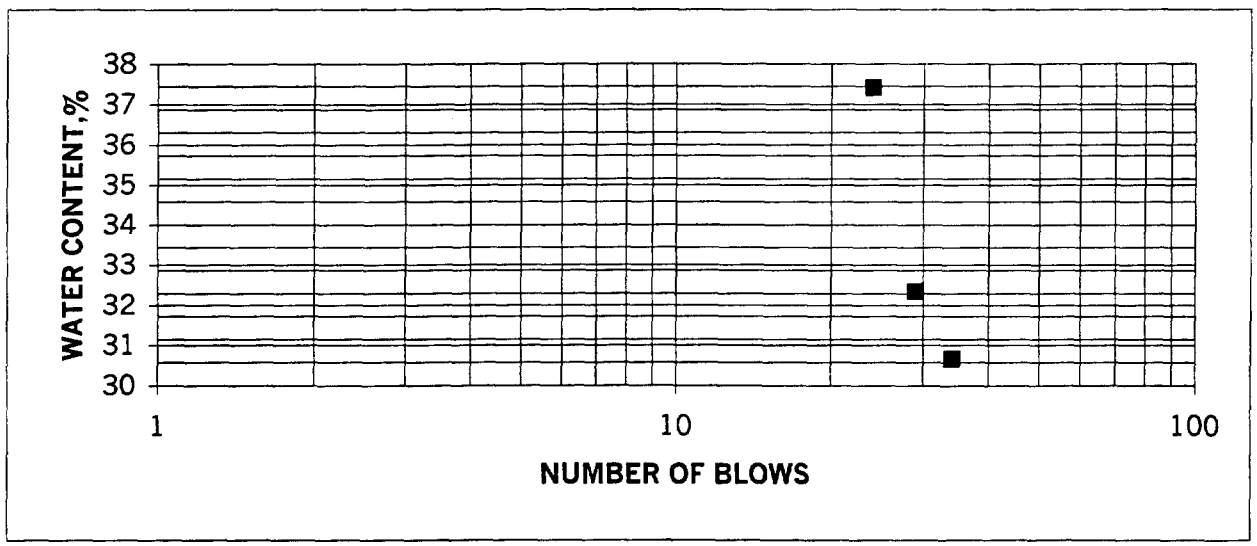
ATTERBERG LIMITS

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-09/#4	**DEPTH:**	20	**Date:**	9/25/02
Description:	BROWN (SC)-(CL)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	B-23	B-14	B-29	J.C.	HA-50	
Weight of Can + Wet Soil, gms.	8.34	9.15	10.10	5.28	5.23	
Weight of Can + Dry Soil, gms.	6.65	7.19	7.66	4.85	4.81	
Weight of Can, gms.	1.14	1.13	1.14	1.11	1.13	
Weight of Dry Soil, gms.	5.51	6.06	6.52	3.74	3.68	
Weight of Water, gms.	1.69	1.96	2.44	0.43	0.42	
Water Content, %	30.7	32.3	37.4	11.5	11.4	
Number of Blows	34	29	24			

Unified Soil Classification CL



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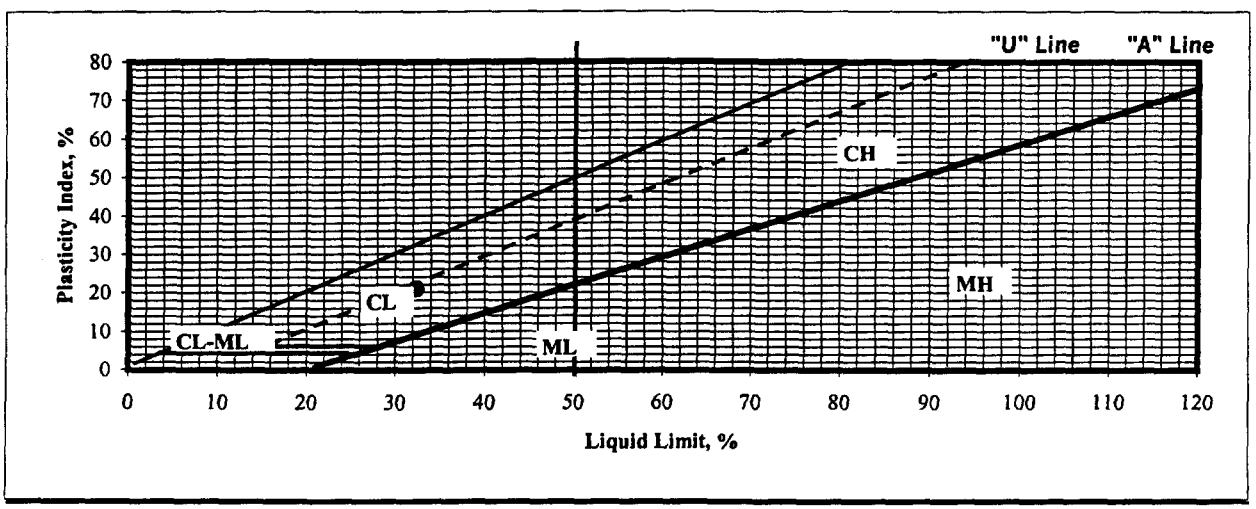

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ATTERBERG LIMITS

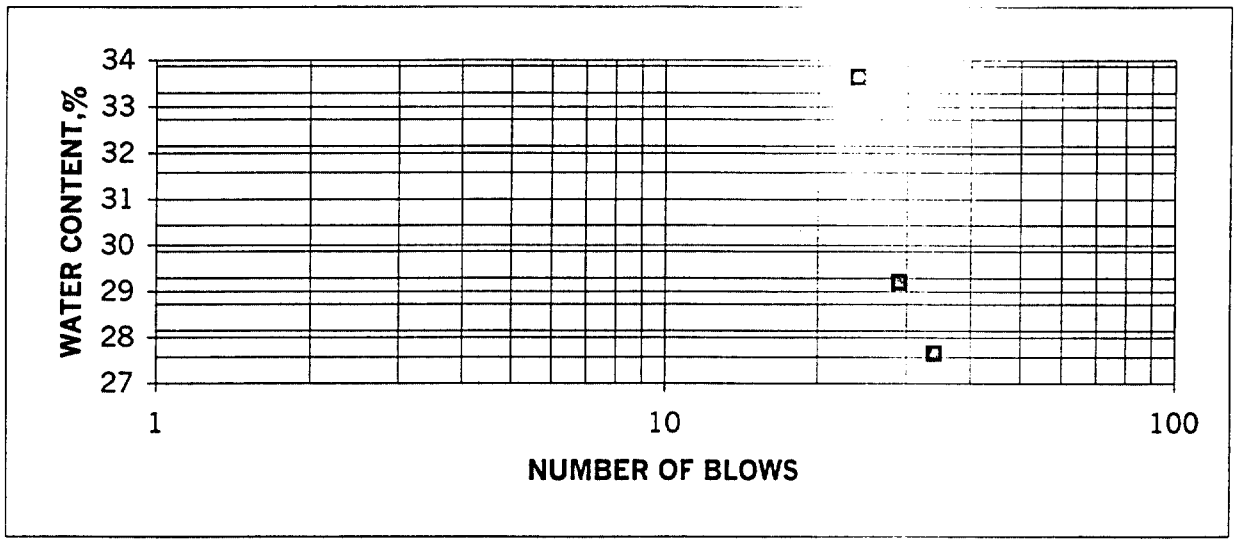
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-09#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-54	HA-35	HA-6	B-21	B-55	
Weight of Can + Wet Soil, gms.	8.56	9.50	11.09	5.65	5.63	
Weight of Can + Dry Soil, gms.	6.95	7.61	8.58	5.00	4.98	
Weight of Can, gms.	1.13	1.14	1.12	1.14	1.14	
Weight of Dry Soil, gms.	5.82	6.47	7.46	3.86	3.84	
Weight of Water, gms.	1.61	1.89	2.51	0.65	0.65	
Water Content, %	27.7	29.2	33.6	16.8	16.9	
Number of Blows	34	29	24			

Unified Soil Classification CL



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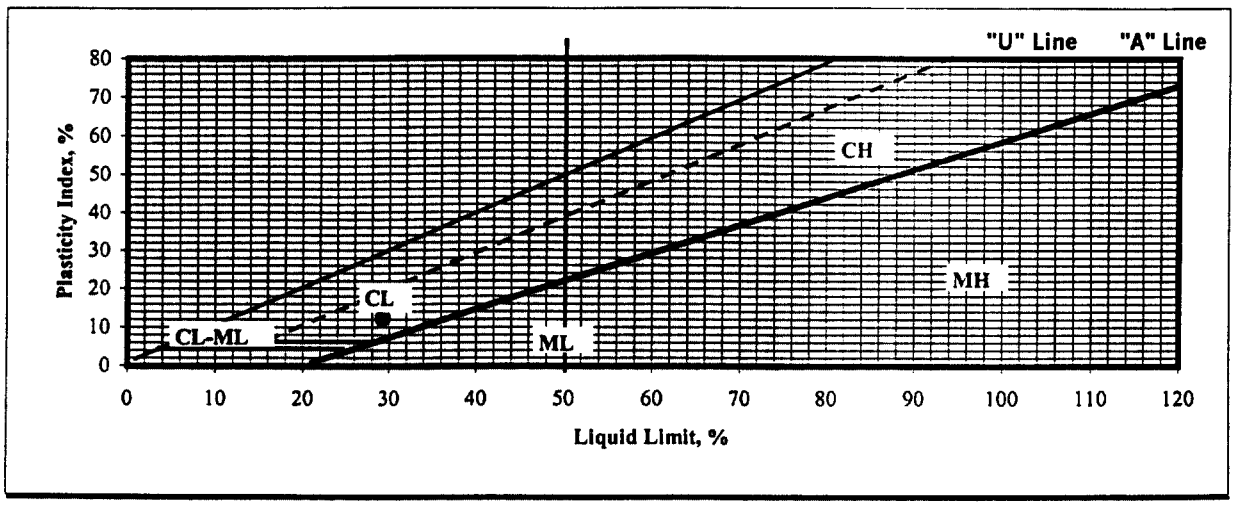

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ATTERBERG LIMITS

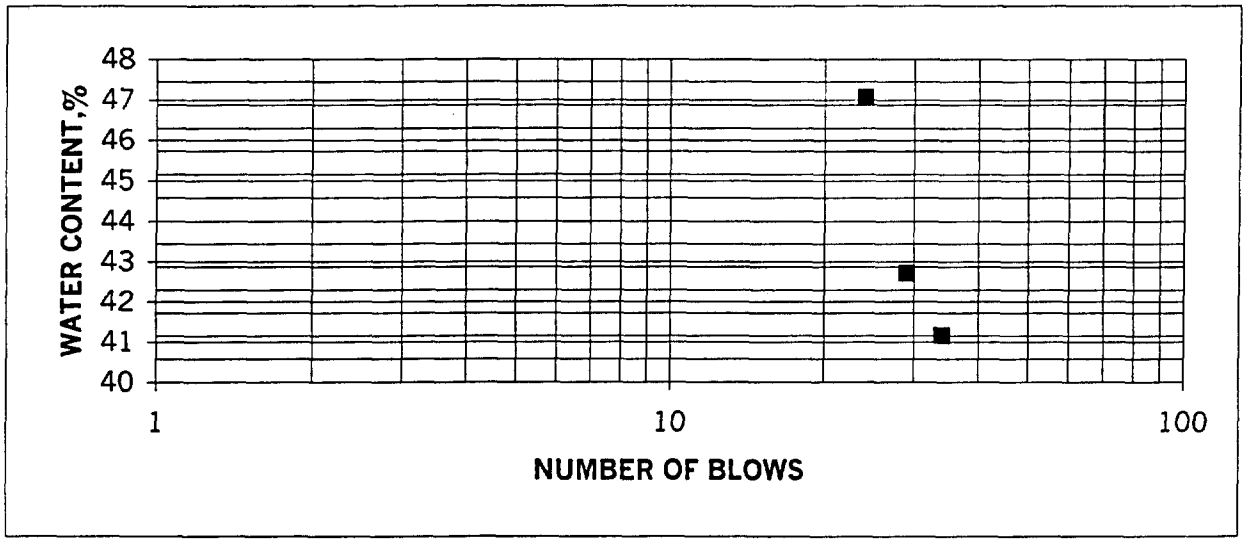
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-10/#3	**Depth, ft.:**	10.5	**Date:**	9/25/02
Description:	OLIVE (ML)-(ML-CL) W/ ASPHALT			**Tested By:**	JC
				Checked By:	

*/	Liquid Limit			Plastic Limit		
Can Number	HA-28	HA-41	HA-53	B-15	B-54A	
Weight of Can + Wet Soil, gms.	9.61	10.27	11.66	6.22	6.02	
Weight of Can + Dry Soil, gms.	7.14	7.54	8.29	5.30	5.12	
Weight of Can, gms.	1.14	1.15	1.13	1.13	1.13	
Weight of Dry Soil, gms.	6.00	6.39	7.16	4.17	3.99	
Weight of Water, gms.	2.47	2.73	3.37	0.92	0.90	
Water Content, %	41.2	42.7	47.1	22.1	22.6	
Number of Blows	34	29	24			

Unified Soil Classification CL



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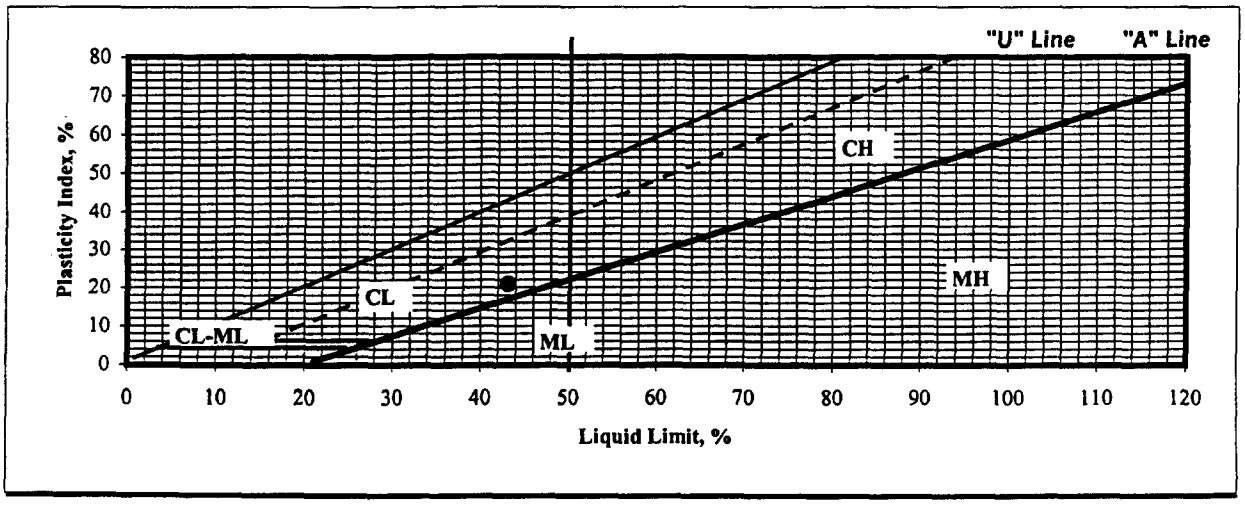

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ATTERBERG LIMITS

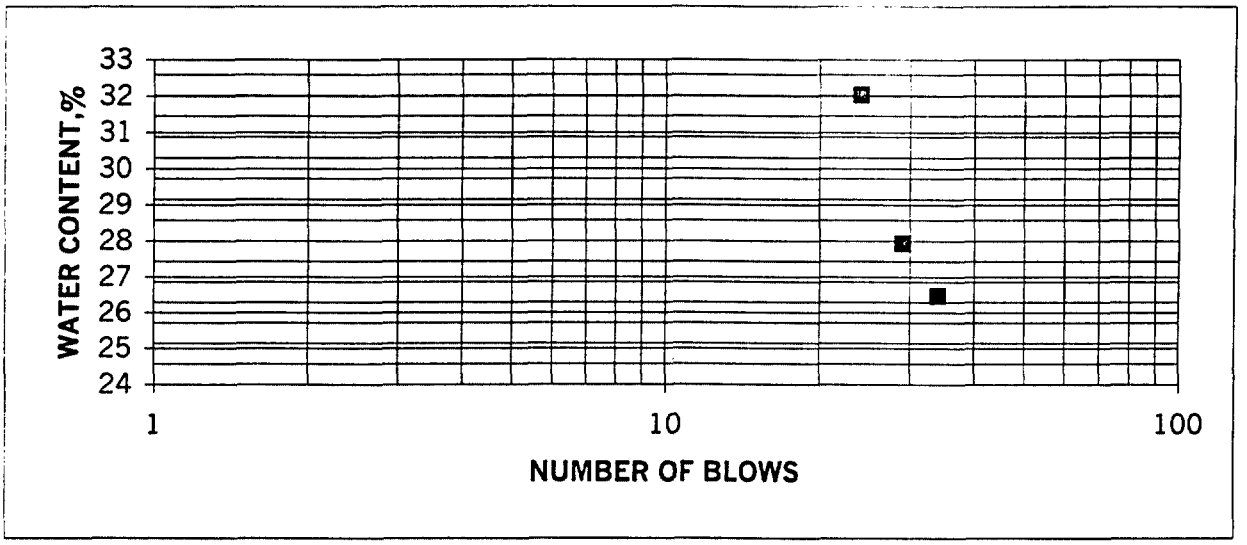
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-13/#BULK	**DEPTH:**	0-5	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-17	HA-62	HA-19	B-27	B-50	
Weight of Can + Wet Soil, gms.	10.25	10.69	12.42	5.55	5.34	
Weight of Can + Dry Soil, gms.	8.34	8.60	9.68	4.86	4.69	
Weight of Can, gms.	1.13	1.12	1.13	1.13	1.13	
Weight of Dry Soil, gms.	7.21	7.48	8.55	3.73	3.56	
Weight of Water, gms.	1.91	2.09	2.74	0.69	0.65	
Water Content, %	26.5	27.9	32.0	18.5	18.3	
Number of Blows	34	29	24			

Unified Soil Classification CL



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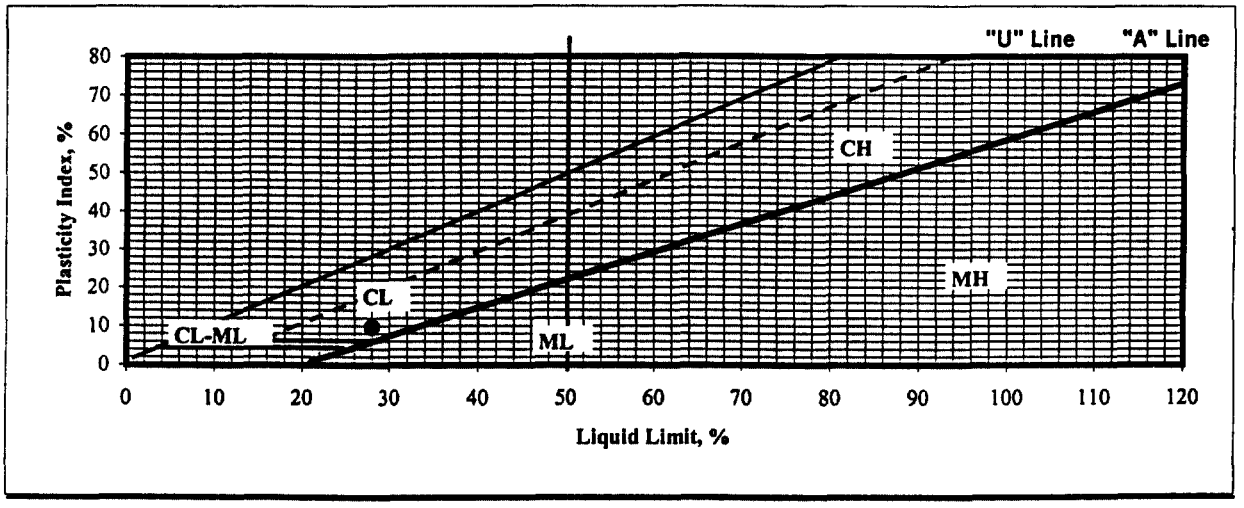

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ATTERBERG LIMITS

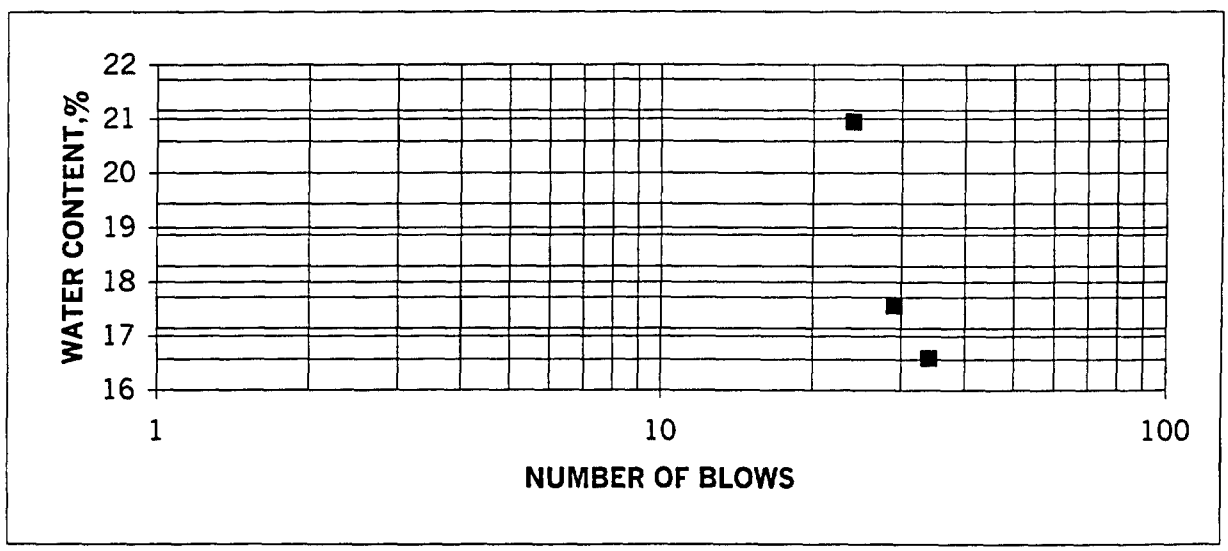
KEANTAN LABORATORIES

ASTM D4318

Project Name:	WDI/SANTA FE SPRINGS	**KTL No.:**	02-056-002	**Proj. No.:**	1651-8A
Sample No.:	G-13/#4	**DEPTH:**	15	**Date:**	9/25/02
Description:	BROWN (SC)			**Tested By:**	JC
				Checked By:	

	Liquid Limit			Plastic Limit		
Can Number	HA-58	HA-61	HA-16	B-12	B-21	
Weight of Can + Wet Soil, gms.	10.07	10.84	12.86	5.75	5.25	
Weight of Can + Dry Soil, gms.	8.80	9.39	10.83	5.22	4.80	
Weight of Can, gms.	1.15	1.14	1.14	1.14	1.13	
Weight of Dry Soil, gms.	7.65	8.25	9.69	4.08	3.67	
Weight of Water, gms.	1.27	1.45	2.03	0.53	0.45	
Water Content, %	16.6	17.6	20.9	13.0	12.3	
Number of Blows	34	29	24			

Unified Soil Classification **CL**



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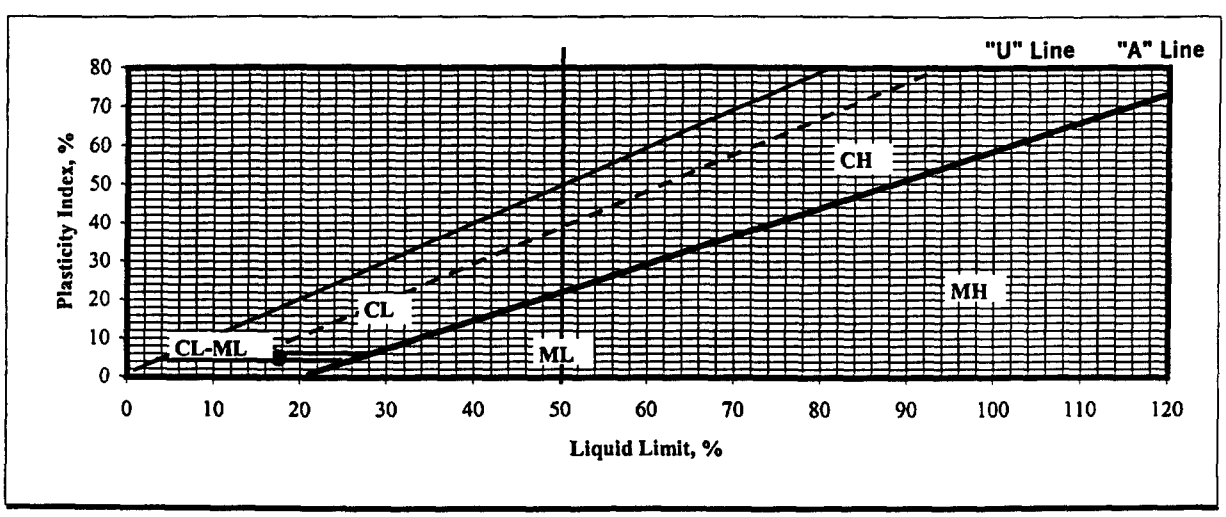

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APPENDIX D.3

UNSATURATED HYDRAULIC CONDUCTIVITY TESTING
BY DANIEL B. STEVENS & ASSOCIATES, INC.

October 31, 2002

Mr. Suji Somasundaram
Advanced Earth Sciences
20 Fairbanks, Suite 178
Irvine, CA 92618

Dear Mr. Somasundaram:

Enclosed is the final report for the AES (TRC WDI Site job). Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

We are pleased to provide this service to Advanced Earth Sciences Corporation and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Daniel O'Dowd
Enclosure

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 505-822-9400
Albuquerque, NM 87109 FAX 505-822-8877

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Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1] (θ, ρ_d, ϕ)	Saturated Hydraulic Conductivity[2]		Moisture Characteristics[3]					Unsaturated Hydraulic Conductivity	Particle Size[4]			Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH		DS	WS	H						
G-03	X	X		X	X		X	X	X									
G-04	X	X		X	X		X	X	X									
G-06	X	X		X	X		X	X	X									
G-08	X	X		X	X		X	X	X									
G-12	X	X		X	X		X	X	X									

[1] θ = Initial moisture content, ρ_d = Dry bulk density, ϕ = Calculated porosity
[2] CH = Constant head, FH = falling head
[3] HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box
[4] DS = Dry sieve, WS = Wet sieve, H = Hydrometer

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
G-03	11.8	19.4	1.63	1.83	38.3
G-04	11.9	20.0	1.68	1.88	36.7
G-06	11.3	19.0	1.69	1.88	36.4
G-08	13.8	23.4	1.70	1.93	36.0
G-12	9.2	15.7	1.70	1.86	35.8

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
G-03	1.6E-04	X	
G-04	6.5E-04	X	
G-06	2.0E-04	X	
G-08	1.6E-04	X	
G-12	2.9E-04	X	

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
G-03	0	39.9
	19	34.9
	51	30.1
	143	25.2
	510	21.8
	13053	7.9
	851293	2.4
G-04	0	41.0
	19	39.0
	51	33.9
	143	26.4
	510	22.5
	9688	9.2
	851293	2.6
G-06	0	39.6
	24	37.4
	52	35.9
	146	27.6
	510	24.3
	6935	12.9
	851293	3.5
G-08	0	38.3
	18	36.6
	46	36.1
	148	33.0
	510	29.1
	8260	14.9
	851293	3.6

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
G-12	0	39.5
	18	36.6
	46	34.7
	148	28.3
	510	23.3
	19478	9.7
	851293	3.0

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
G-03	0.0425	1.2320	0.0000	0.3944
G-04	0.0282	1.2578	0.0000	0.4133
G-06	0.0203	1.2307	0.0000	0.3985
G-08	0.0041	1.2672	0.0000	0.3723
G-12	0.0199	1.2361	0.0000	0.3904

Raw Laboratory Data and Graphical Plots

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
G-03	11.8	19.4	1.63	1.83	38.3
G-04	11.9	20.0	1.68	1.88	36.7
G-06	11.3	19.0	1.69	1.88	36.4
G-08	13.8	23.4	1.70	1.93	36.0
G-12	9.2	15.7	1.70	1.86	35.8

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-03
Ring Number: NA
Depth: NA

Test Date: 20-Sep-02

Field weight of sample* (g): 2609.92
Tare weight, ring (g): 170.92
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 2180.75
Sample volume (cm^3): 1333.86
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 19.4

Initial Gravimetric Moisture Content (% g/g): 11.8

Dry bulk density (g/cm^3): 1.63

Wet bulk density (g/cm^3): 1.83

Calculated Porosity (% vol): 38.3

Percent Saturation: 50.5

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-04
Ring Number: NA
Depth: NA
Test Date: 20-Sep-02

Field weight of sample* (g): 2664.98
Tare weight, ring (g): 171.98
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 2227.13
Sample volume (cm^3): 1327.64
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 20.0
Initial Gravimetric Moisture Content (% g/g): 11.9
Dry bulk density (g/cm^3): 1.68
Wet bulk density (g/cm^3): 1.88
Calculated Porosity (% vol): 36.7
Percent Saturation: 54.6

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-06
Ring Number: NA
Depth: NA
Test Date: 20-Sep-02

Field weight of sample* (g): 2695.42
Tare weight, ring (g): 172.42
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 2267.29
Sample volume (cm^3): 1345.55
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 19.0
Initial Gravimetric Moisture Content (% g/g): 11.3
Dry bulk density (g/cm^3): 1.69
Wet bulk density (g/cm^3): 1.88
Calculated Porosity (% vol): 36.4
Percent Saturation: 52.2

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-08
Ring Number: NA
Depth: NA

Test Date: 20-Sep-02

Field weight of sample* (g): 2768.28
Tare weight, ring (g): 173.16
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 2280.72
Sample volume (cm^3): 1344.19
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 23.4

Initial Gravimetric Moisture Content (% g/g): 13.8

Dry bulk density (g/cm^3): 1.70

Wet bulk density (g/cm^3): 1.93

Calculated Porosity (% vol): 36.0

Percent Saturation: 65.0

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-12
Ring Number: NA
Depth: NA

Test Date: 20-Sep-02

Field weight of sample* (g): 2666.00
Tare weight, ring (g): 173.00
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 2282.97
Sample volume (cm^3): 1341.85
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 15.7

Initial Gravimetric Moisture Content (% g/g): 9.2

Dry bulk density (g/cm^3): 1.70

Wet bulk density (g/cm^3): 1.86

Calculated Porosity (% vol): 35.8

Percent Saturation: 43.7

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
G-03	1.6E-04	X	
G-04	6.5E-04	X	
G-06	2.0E-04	X	
G-08	1.6E-04	X	
G-12	2.9E-04	X	

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name:	TRC/ AES	*Type of water used:*	TAP
Job number:	L142.0000.00	*Collection vessel tare* (g):	10.85
Sample number:	G-03	*Sample length* (cm):	7.62
Ring number:	NA	*Sample diameter* (cm):	14.93
Depth:	NA	*Sample x-sectional area* (cm^2):	175.09

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
01-Oct-02	15:44:44	21.0	9.3	19.8	8.9	232	1.8E-04	1.8E-04
01-Oct-02	15:48:36							
Test # 2:								
02-Oct-02	08:27:01	21.0	9.3	18.8	7.9	226	1.6E-04	1.6E-04
02-Oct-02	08:30:47							
Test # 3:								
02-Oct-02	10:40:13	21.0	9.3	18.5	7.6	218	1.6E-04	1.6E-04
02-Oct-02	10:43:51							

***Average Ksat* (cm/sec):** **1.6E-04**

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name:	TRC/ AES	*Type of water used:*	TAP
Job number:	L142.0000.00	*Collection vessel tare* (g):	6.64
Sample number:	G-04	*Sample length* (cm):	7.61
Ring number:	NA	*Sample diameter* (cm):	14.91
Depth:	NA	*Sample x-sectional area* (cm^2):	174.48

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
01-Oct-02	15:44:56	21.0	2.9	15.5	8.9	201	6.7E-04	6.5E-04
01-Oct-02	15:48:17							
Test # 2:								
02-Oct-02	08:27:13	21.0	2.9	13.4	6.8	153	6.6E-04	6.5E-04
02-Oct-02	08:29:46							
Test # 3:								
02-Oct-02	10:40:46	21.0	2.9	14.0	7.3	167	6.6E-04	6.4E-04
02-Oct-02	10:43:33							

***Average Ksat* (cm/sec):** **6.5E-04**

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name: TRC/ AES
Job number: L142.0000.00
Sample number: G-06
Ring number: NA
Depth: NA

Type of water used: TAP
Collection vessel tare (g): 11.26
Sample length (cm): 7.65
Sample diameter (cm): 14.96
Sample x-sectional area (cm^2): 175.82

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
30-Sep-02	15:04:55	21.0	2.7	15.5	4.3	346	2.0E-04	1.9E-04
30-Sep-02	15:10:41							
Test # 2:								
01-Oct-02	15:46:24	21.0	2.7	18.8	7.5	583	2.1E-04	2.0E-04
01-Oct-02	15:56:07							
Test # 3:								
02-Oct-02	08:27:50	21.0	2.7	13.7	2.5	202	2.0E-04	1.9E-04
02-Oct-02	08:31:12							

***Average Ksat* (cm/sec):** **2.0E-04**

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name:	TRC/ AES	*Type of water used:*	TAP
Job number:	L142.0000.00	*Collection vessel tare* (g):	11.30
Sample number:	G-08	*Sample length* (cm):	7.68
Ring number:	NA	*Sample diameter* (cm):	14.93
Depth:	NA	*Sample x-sectional area* (cm^2):	175.09

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
01-Oct-02	15:47:05	21.0	3.7	18.4	7.1	504	1.7E-04	1.6E-04
01-Oct-02	15:55:29							
Test # 2:								
02-Oct-02	08:28:44	21.0	3.7	13.9	2.6	198	1.6E-04	1.5E-04
02-Oct-02	08:32:02							
Test # 3:								
02-Oct-02	10:42:35	21.0	3.7	12.9	1.6	121	1.5E-04	1.5E-04
02-Oct-02	10:44:36							

***Average Ksat* (cm/sec):** **1.6E-04**

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name: TRC/ AES
Job number: L142.0000.00
Sample number: G-12
Ring number: NA
Depth: NA

Type of water used: TAP
Collection vessel tare (g): 10.70
Sample length (cm): 7.64
Sample diameter (cm): 14.96
Sample x-sectional area (cm^2): 175.73

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
01-Oct-02	15:47:27	21.0	3.9	22.9	12.2	465	2.9E-04	2.9E-04
01-Oct-02	15:55:12							
Test # 2:								
02-Oct-02	08:28:58	21.0	3.9	15.1	4.4	166	3.0E-04	2.9E-04
02-Oct-02	08:31:44							
Test # 3:								
02-Oct-02	10:42:45	21.0	3.9	14.0	3.3	126	3.0E-04	2.9E-04
02-Oct-02	10:44:51							

***Average Ksat* (cm/sec):** **2.9E-04**

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
G-03	0	39.9
	19	34.9
	51	30.1
	143	25.2
	510	21.8
	13053	7.9
	851293	2.4
G-04	0	41.0
	19	39.0
	51	33.9
	143	26.4
	510	22.5
	9688	9.2
	851293	2.6
G-06	0	39.6
	24	37.4
	52	35.9
	146	27.6
	510	24.3
	6935	12.9
	851293	3.5
G-08	0	38.3
	18	36.6
	46	36.1
	148	33.0
	510	29.1
	8260	14.9
	851293	3.6

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
G-12	0	39.5
	18	36.6
	46	34.7
	148	28.3
	510	23.3
	19478	9.7
	851293	3.0

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
G-03	0.0425	1.2320	0.0000	0.3944
G-04	0.0282	1.2578	0.0000	0.4133
G-06	0.0203	1.2307	0.0000	0.3985
G-08	0.0041	1.2672	0.0000	0.3723
G-12	0.0199	1.2361	0.0000	0.3904

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
G-03	0.0425	1.2320	0.0000	0.3944

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-03
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 2180.75
Tare wt., screen & clamp (g): 55.80
Tare wt., ring (g): 170.92
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 1333.86

Saturated weight at 0 cm tension* (g): 2939.70
Volume of water† in saturated sample (cm^3): 532.23
Saturated moisture content (% vol): 39.90
Sample bulk density (g/cm^3): 1.63

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	10-Oct-02 / 09:45	2939.70	0.00	39.90
	12-Oct-02 / 16:00	2872.60	19.00	34.87
	15-Oct-02 / 13:45	2809.40	51.00	30.13
	18-Oct-02 / 12:00	2743.90	143.00	25.22
Pressure plate:	21-Oct-02 / 09:10	2698.50	509.90	21.82

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-03
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 152.59
Tare weight, jar (g): 114.93
Sample bulk density (g/cm^3): 1.63

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	22-Oct-02 / 09:00	154.40	13053.4	7.86

Dry weight of relative humidity box sample* (g): 91.61
Tare weight (g): 46.35
Sample bulk density (g/cm^3): 1.63

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	29-Oct-02 / 08:30	92.28	851293	2.42

Comments:

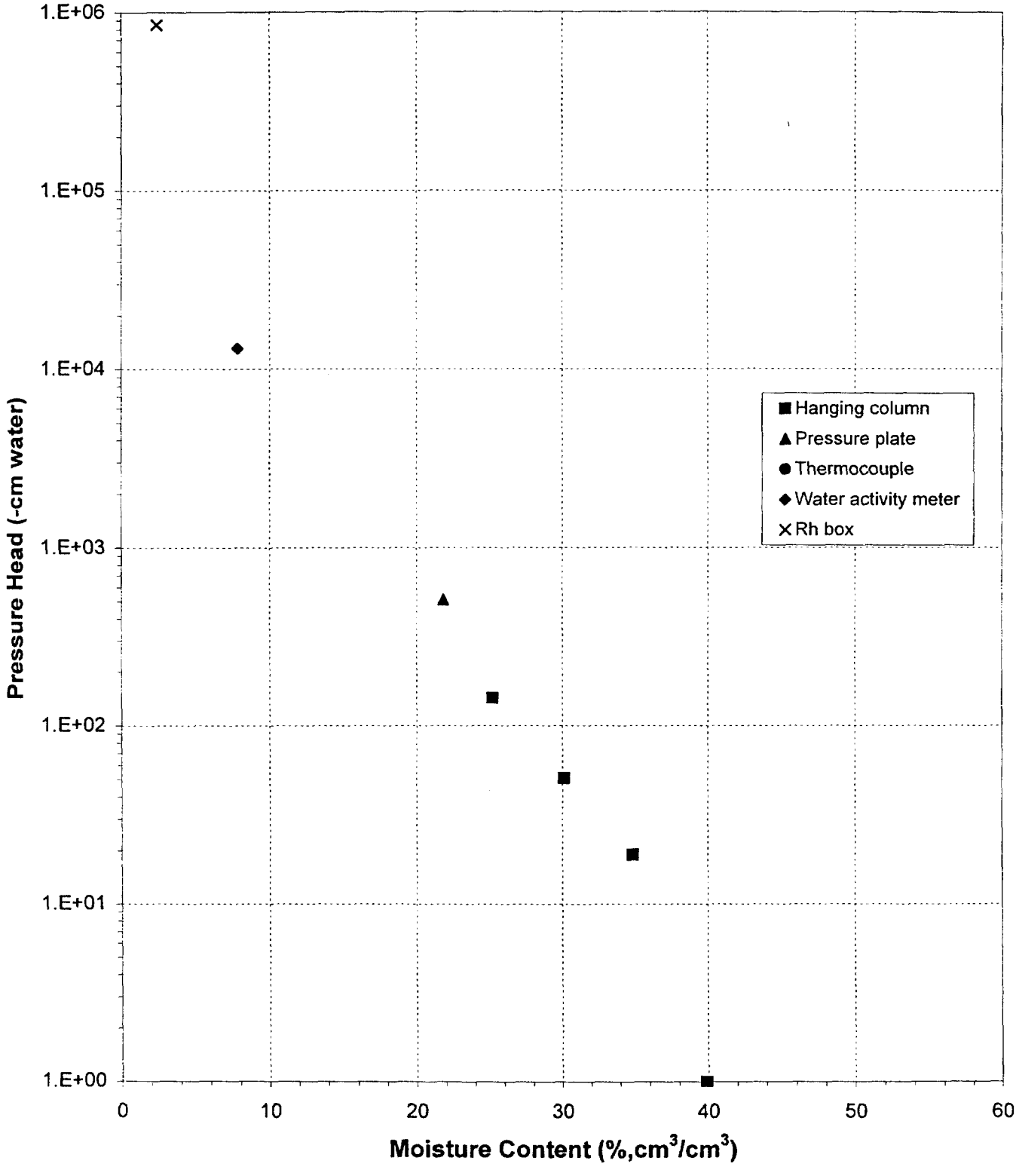
* Weight including tares

† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

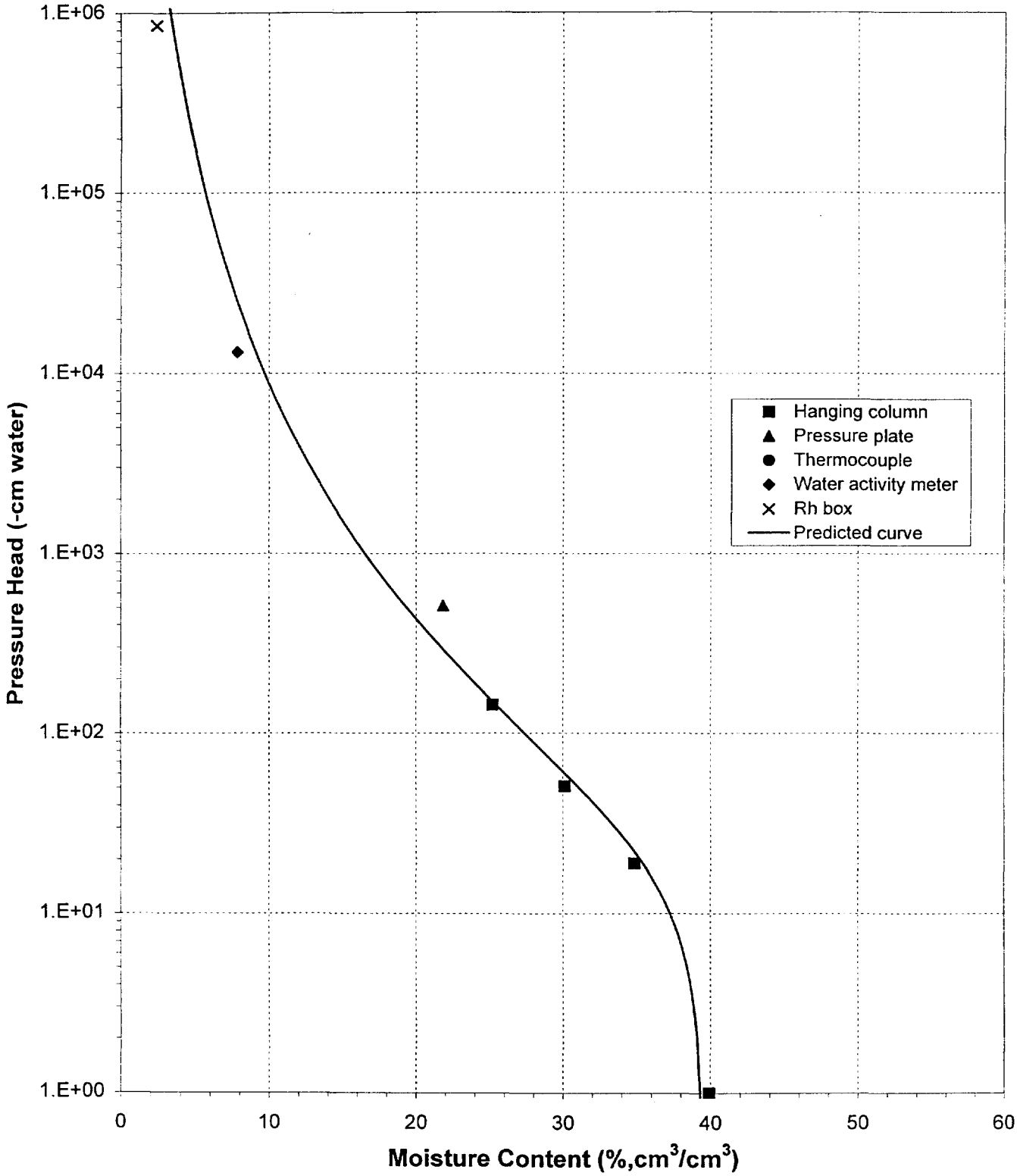
Water Retention Data Points

Sample Number: G-03



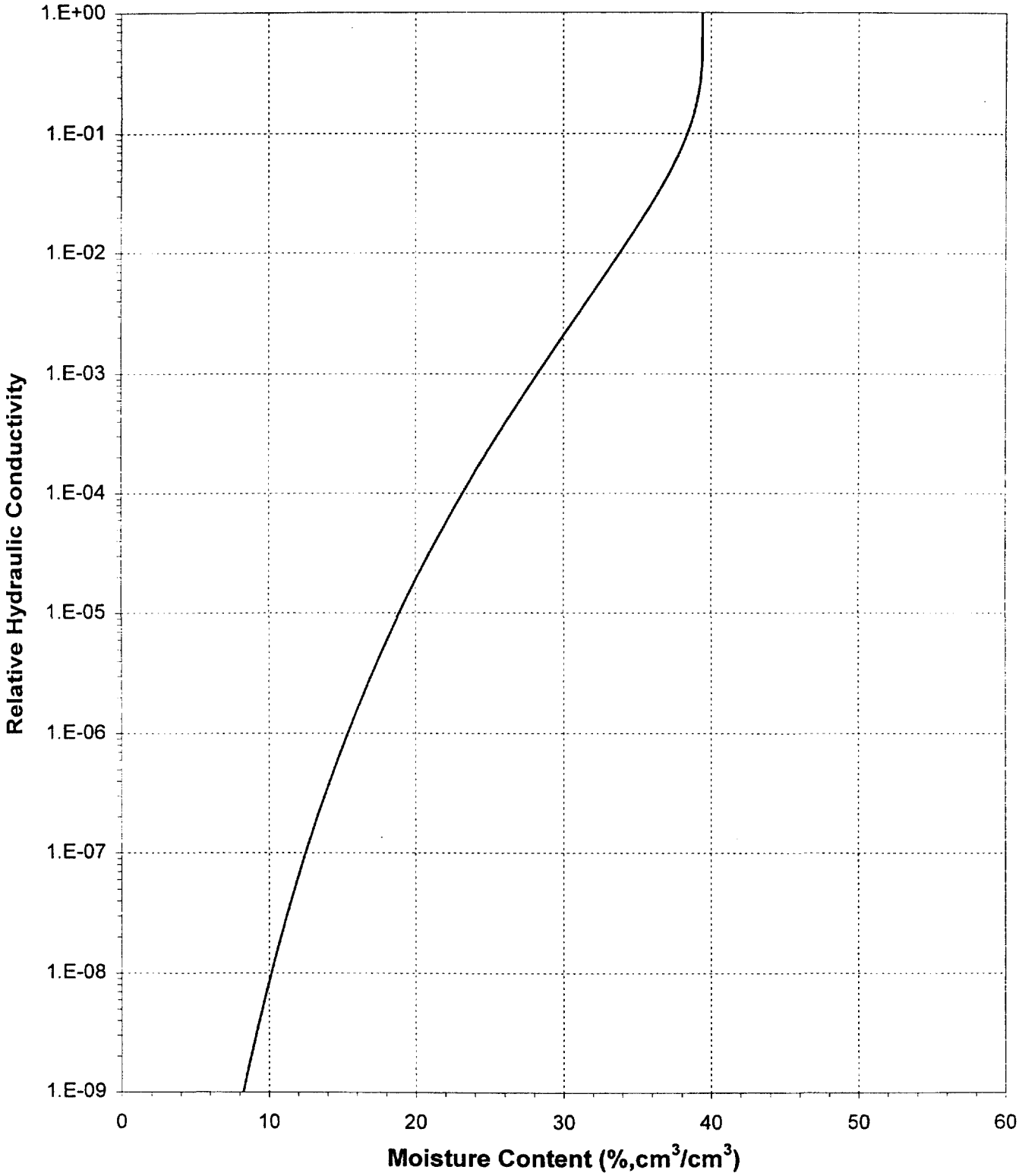
Predicted Water Retention Curve and Data Points

Sample Number: G-03



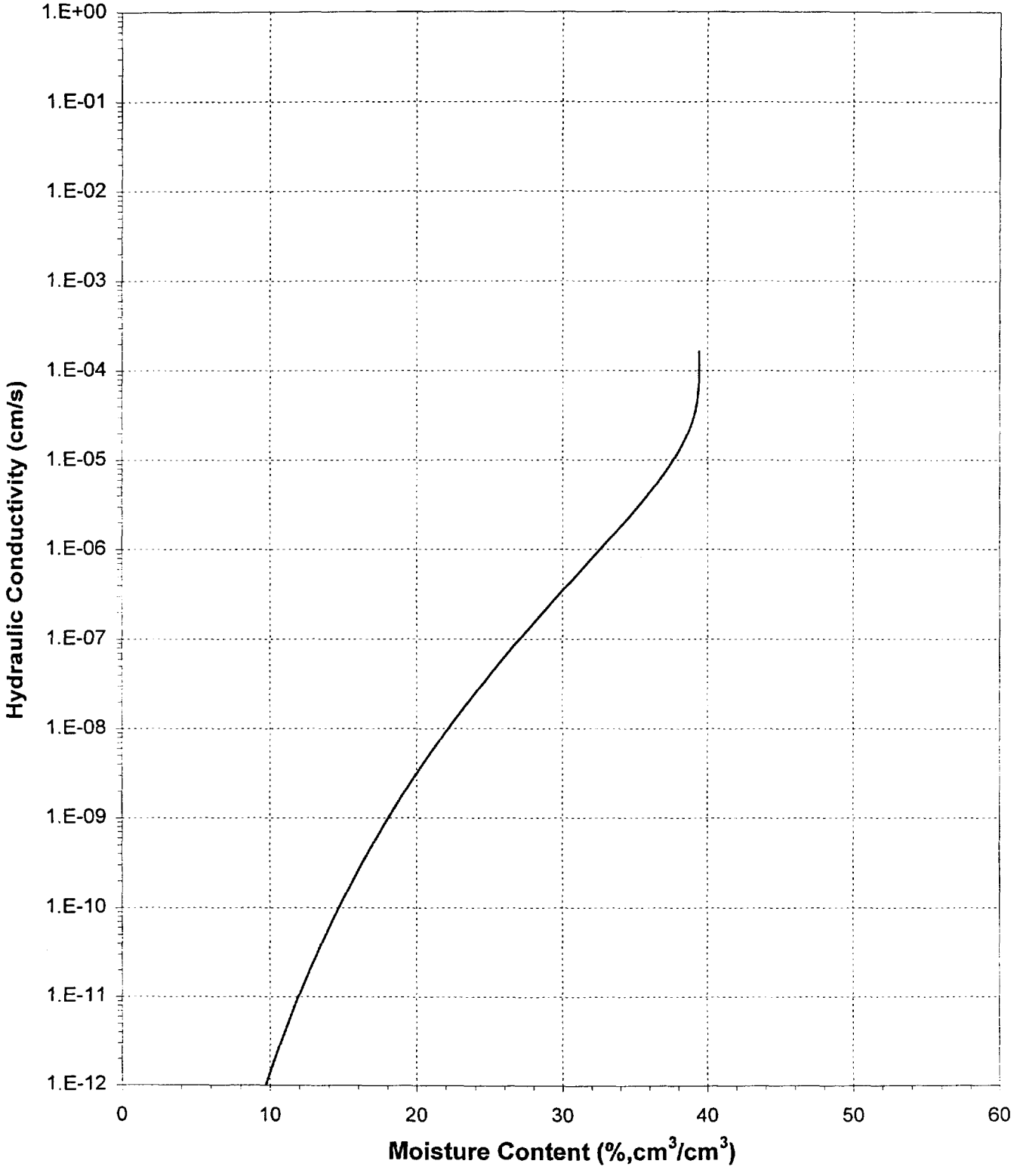
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: G-03



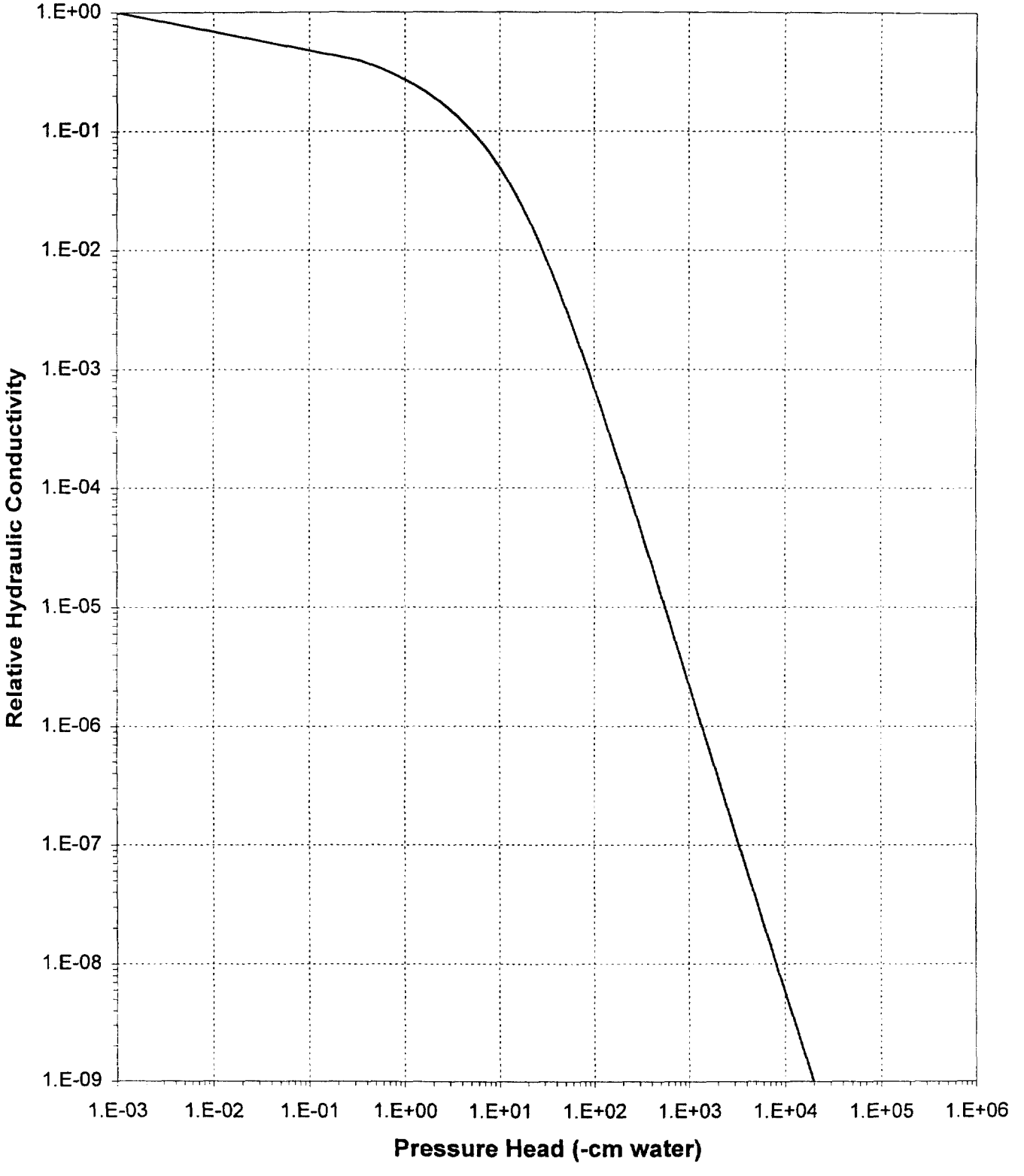
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: G-03



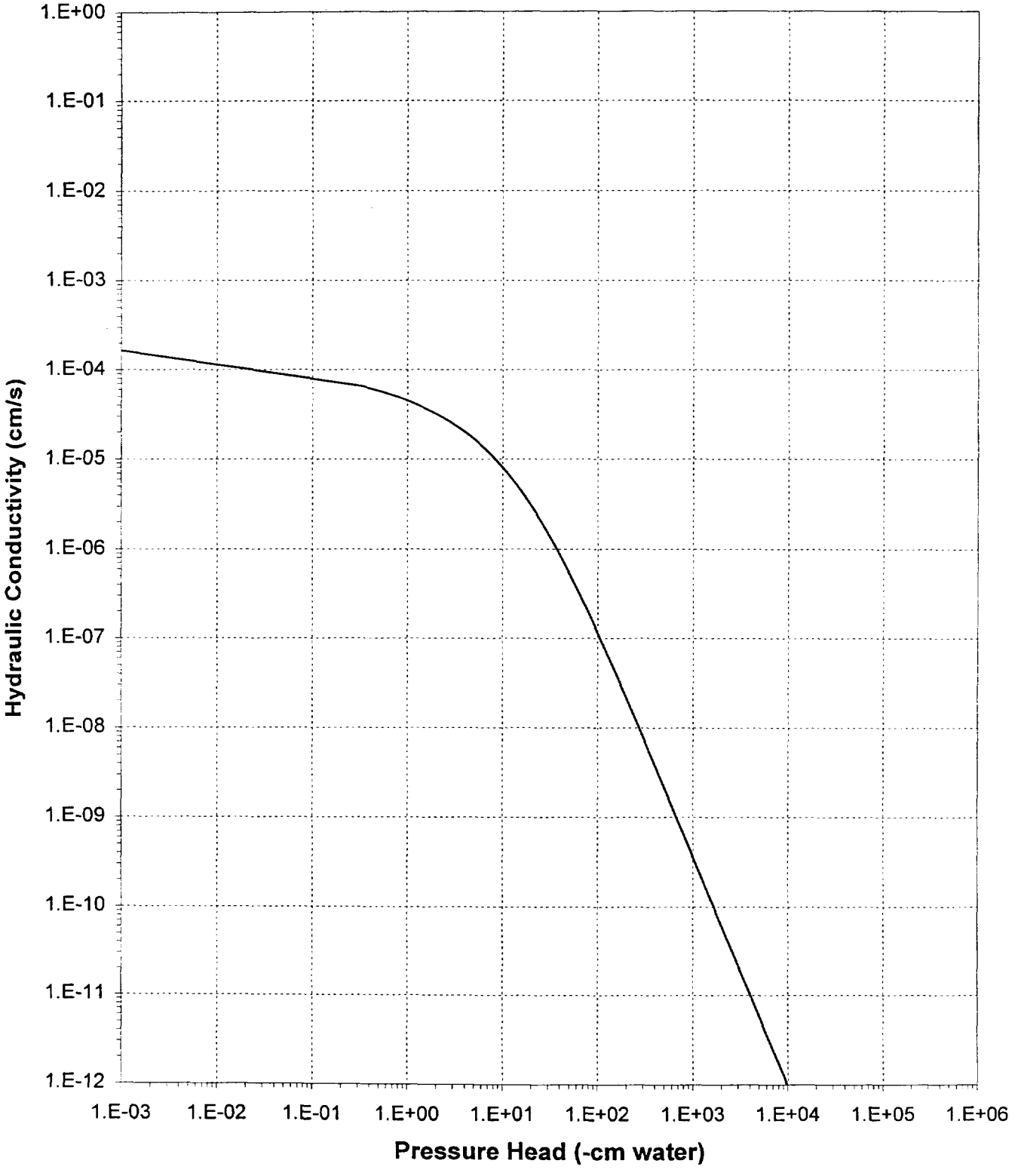
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: G-03



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: G-03



Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-04
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 2227.13
Tare wt., screen & clamp (g): 55.78
Tare wt., ring (g): 171.98
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 1327.64

Saturated weight at 0 cm tension* (g): 2999.40
Volume of water† in saturated sample (cm^3): 544.51
Saturated moisture content (% vol): 41.01
Sample bulk density (g/cm^3): 1.68

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	10-Oct-02 / 09:45	2999.40	0.00	41.01
	12-Oct-02 / 16:00	2973.20	19.00	39.04
	15-Oct-02 / 13:45	2904.60	51.00	33.87
	18-Oct-02 / 12:00	2805.30	143.00	26.39
Pressure plate:	21-Oct-02 / 09:10	2753.40	509.90	22.48

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-04
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 146.47
Tare weight, jar (g): 114.41
Sample bulk density (g/cm^3): 1.68

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	23-Oct-02 / 15:00	148.23	9688.1	9.21

Dry weight of relative humidity box sample* (g): 82.62
Tare weight (g): 38.81
Sample bulk density (g/cm^3): 1.68

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	29-Oct-02 / 08:30	83.30	851293	2.62

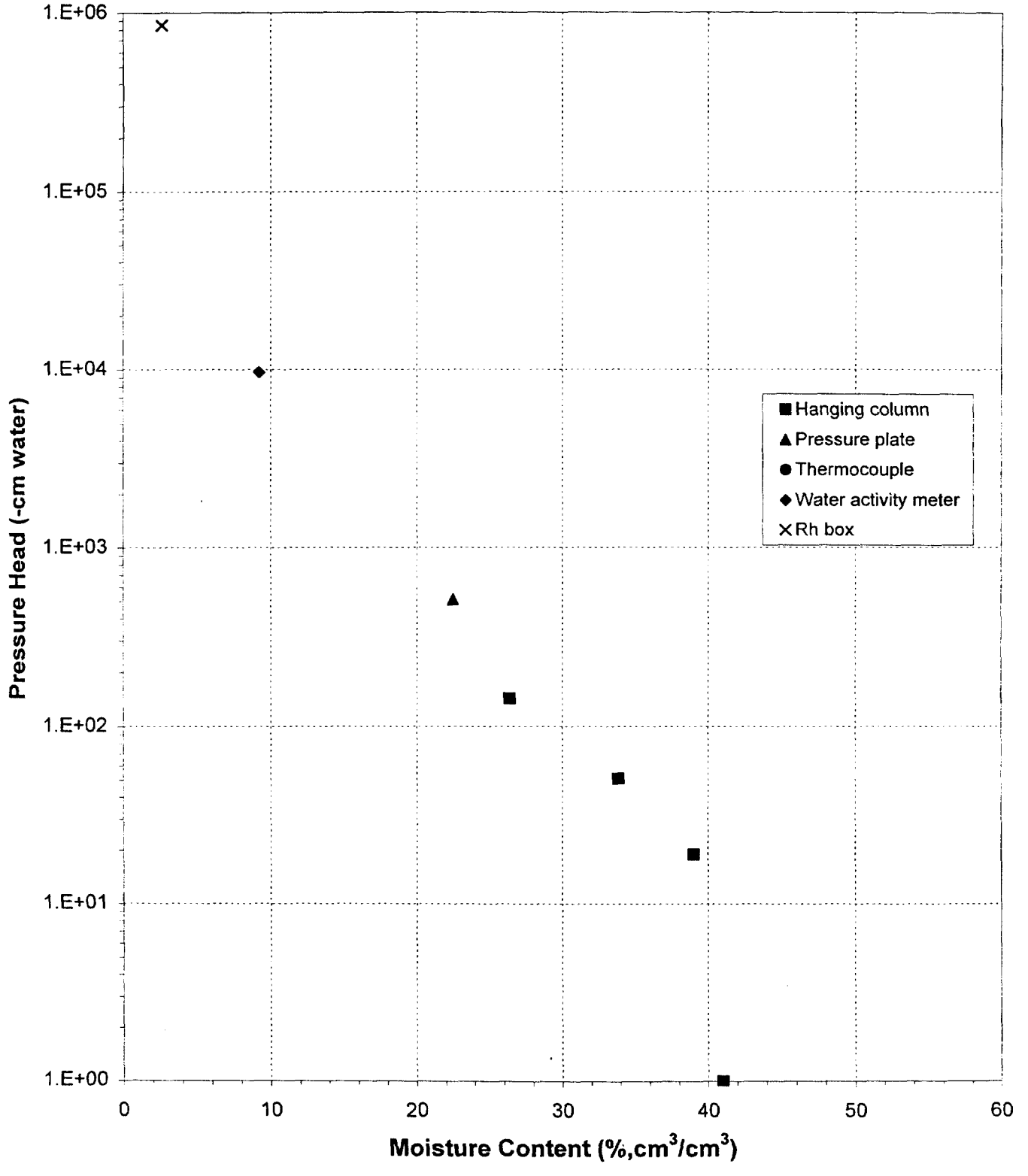
Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

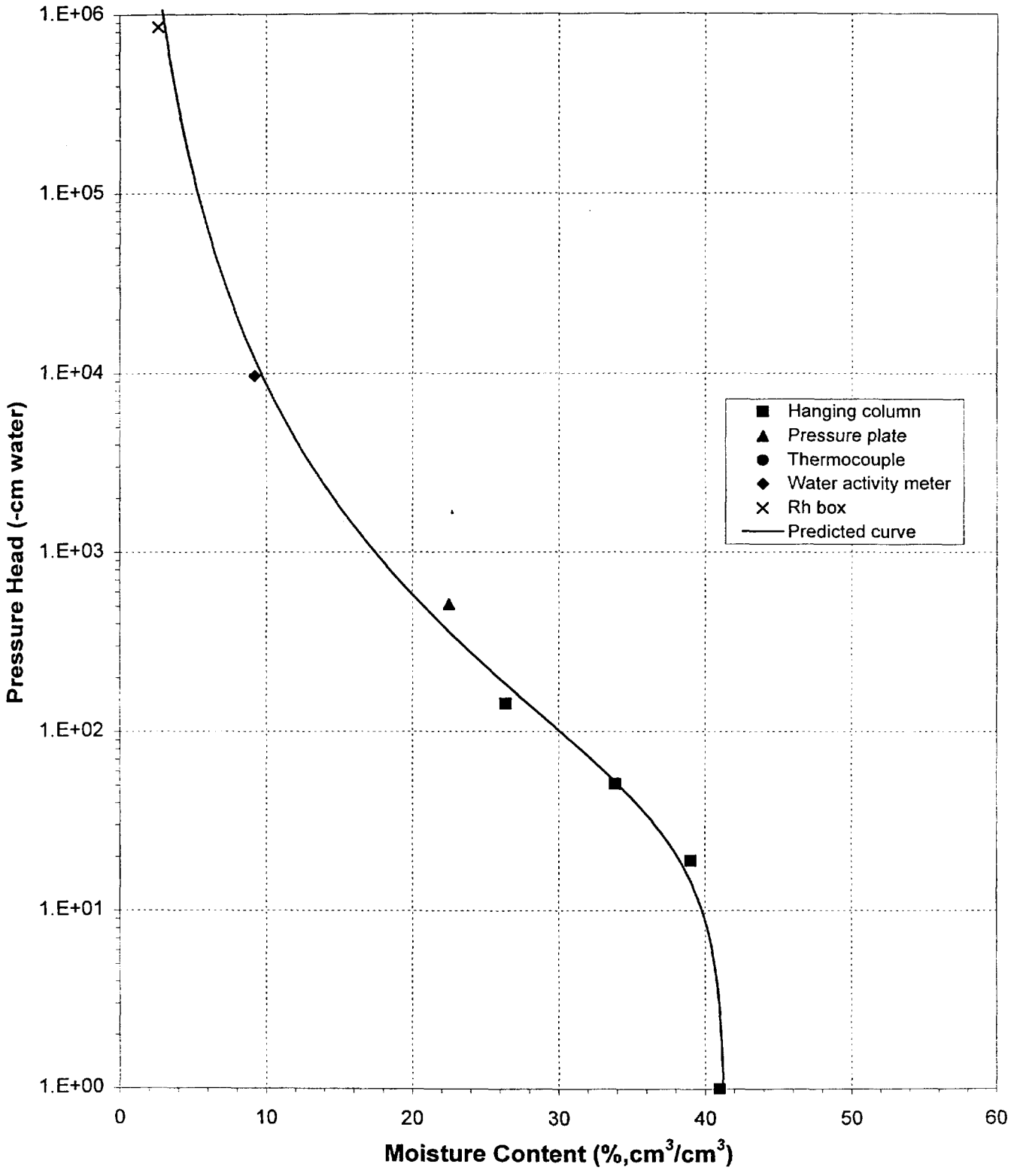
Water Retention Data Points

Sample Number: G-04



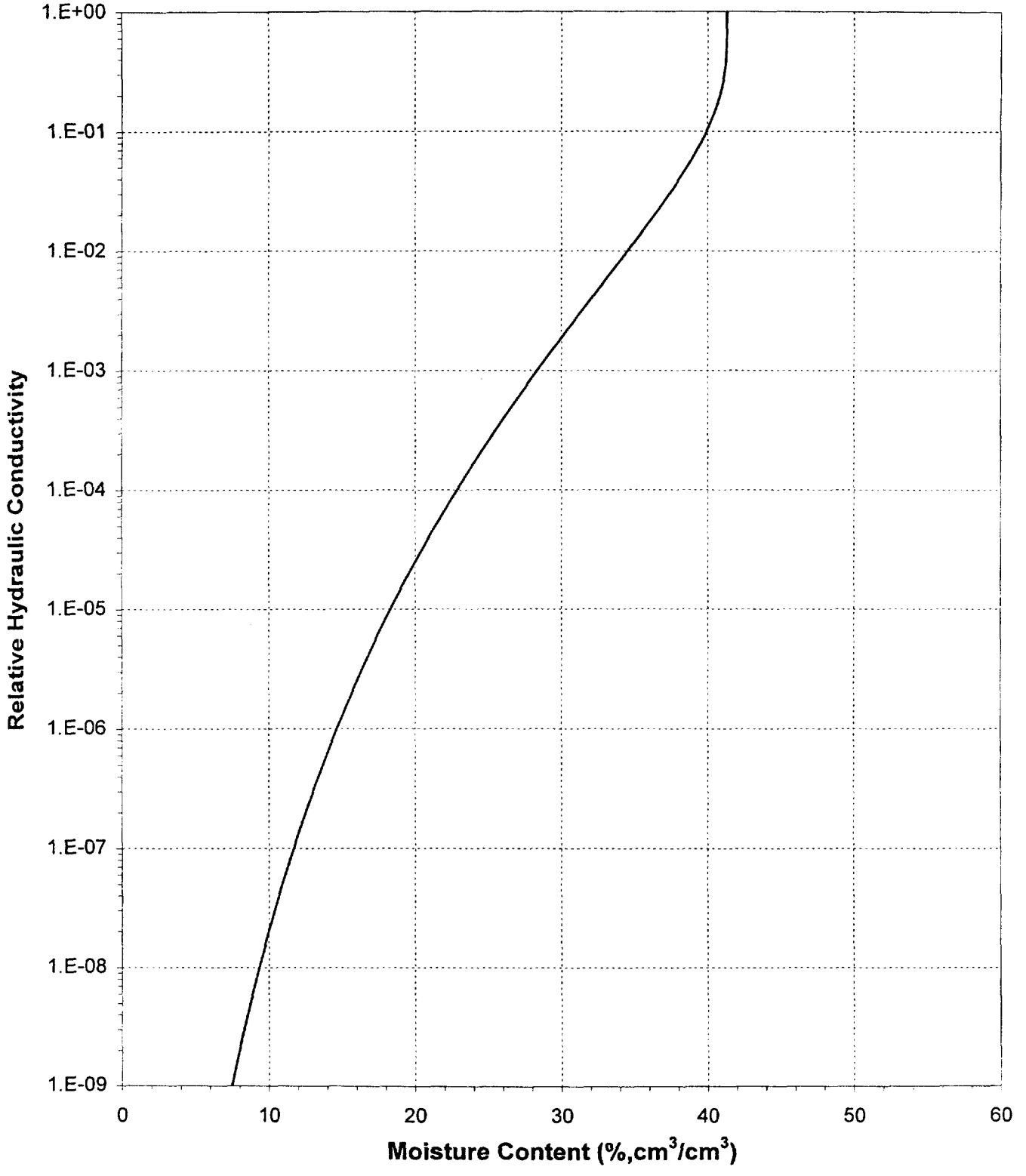
Predicted Water Retention Curve and Data Points

Sample Number: G-04



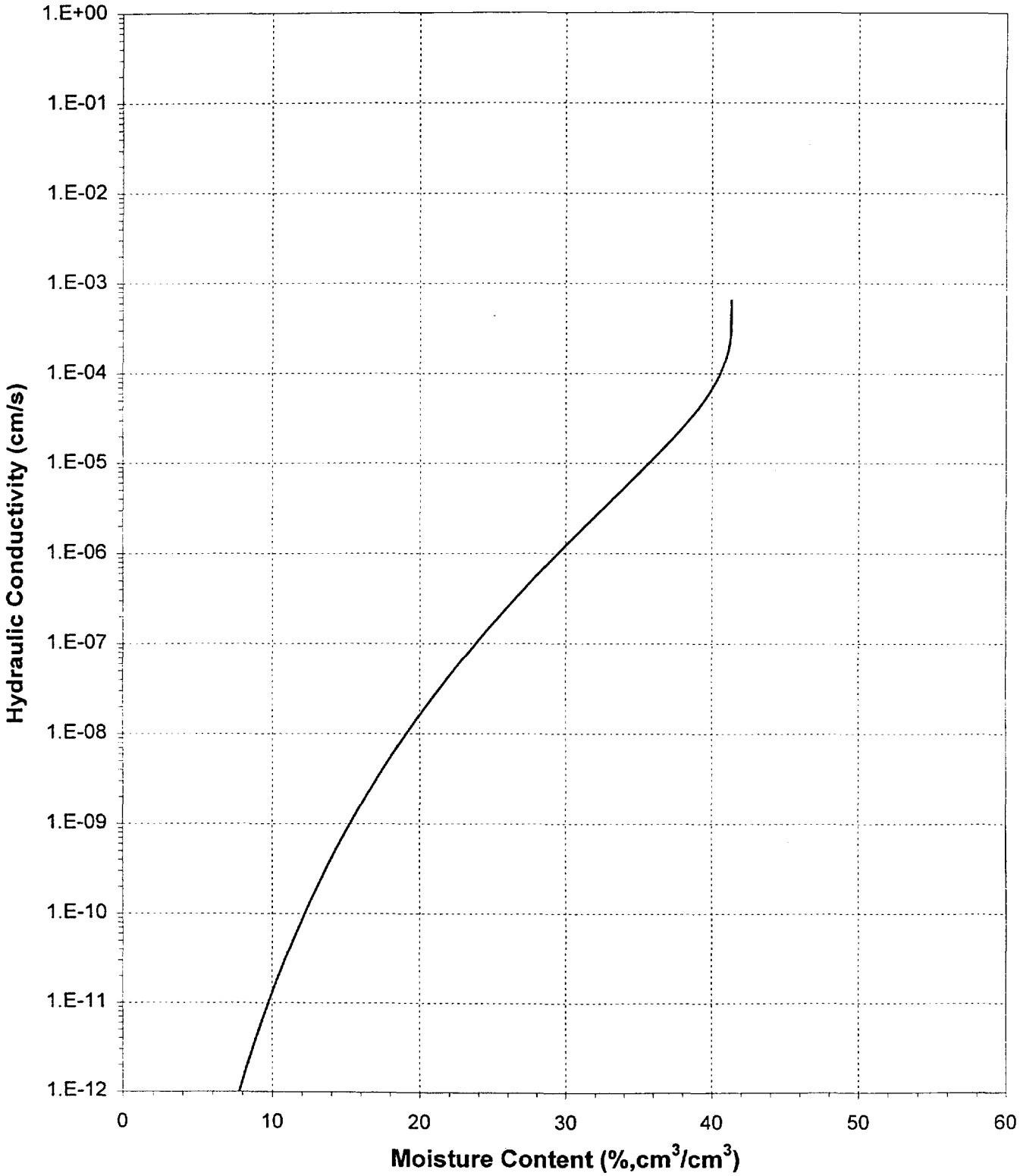
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: G-04



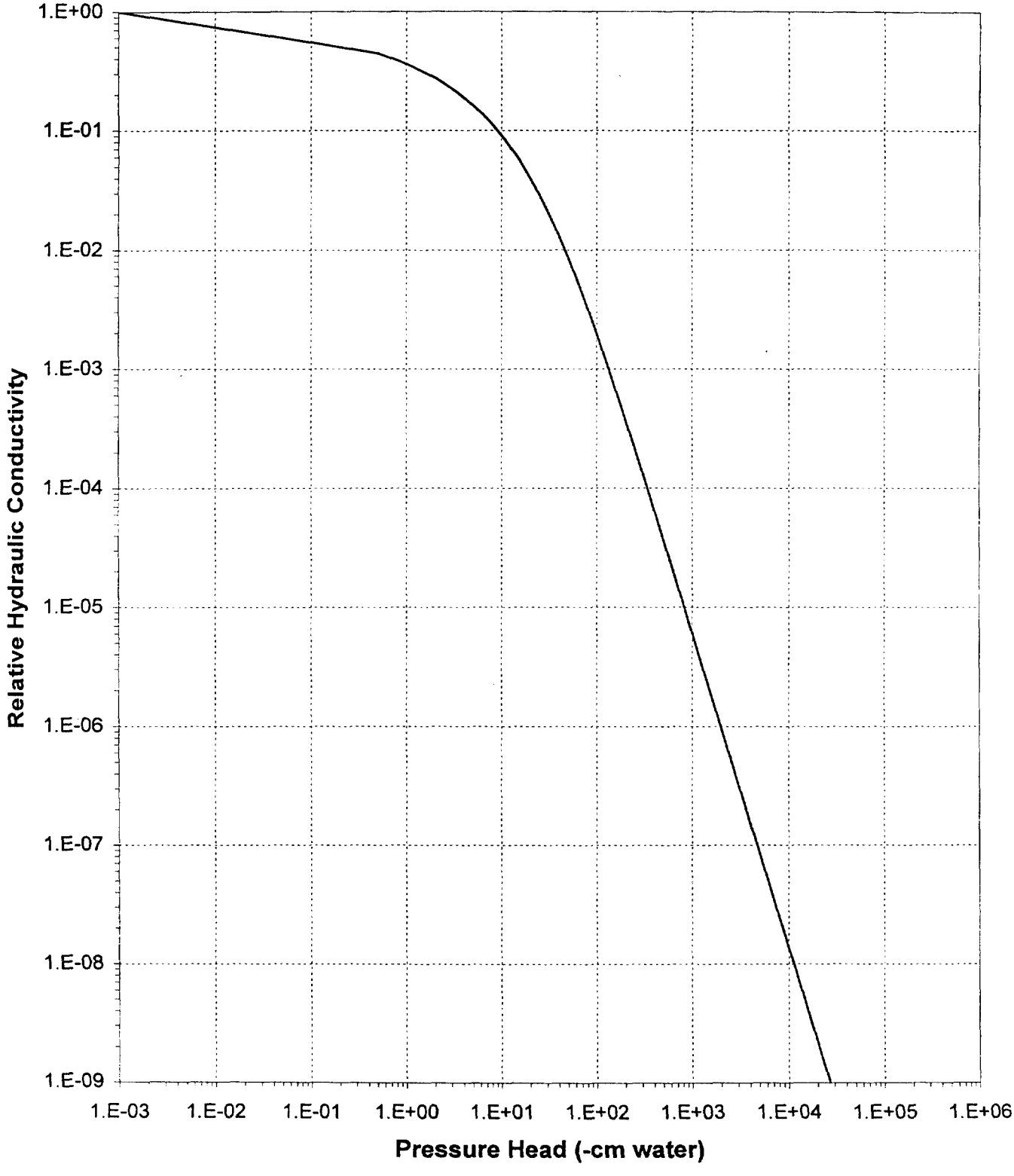
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: G-04



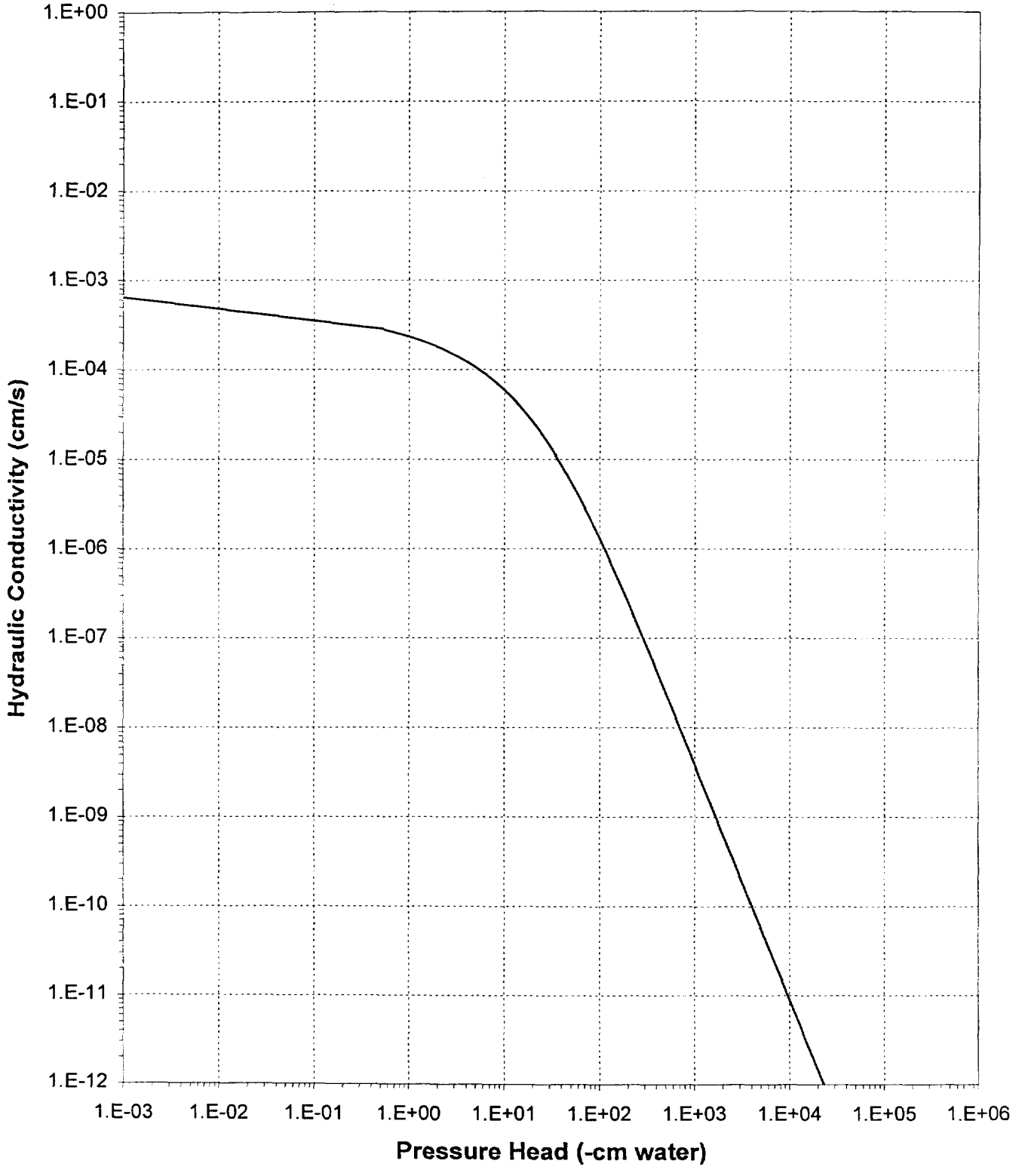
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: G-04



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: G-04



Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-06
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 2267.29
Tare wt., screen & clamp (g): 61.93
Tare wt., ring (g): 172.42
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 1345.55

Saturated weight at 0 cm tension* (g): 303.47
Volume of water† in saturated sample (cm^3): -2198.17
Saturated moisture content (% vol): 39.62
Sample bulk density (g/cm^3): 1.69

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	10-Oct-02 / 13:25	3034.70	0.00	39.62
	12-Oct-02 / 16:00	3004.70	24.00	37.39
	15-Oct-02 / 13:45	2985.20	52.00	35.94
	21-Oct-02 / 09:10	2872.60	146.00	27.57
Pressure plate:	23-Oct-02 / 14:20	2828.90	509.90	24.32

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-06
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 155.13
Tare weight, jar (g): 112.96
Sample bulk density (g/cm^3): 1.69

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	18-Oct-02 / 12:13	158.36	6934.6	12.91

Dry weight of relative humidity box sample* (g): 83.36
Tare weight (g): 41.63
Sample bulk density (g/cm^3): 1.69

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	29-Oct-02 / 08:30	84.23	851293	3.50

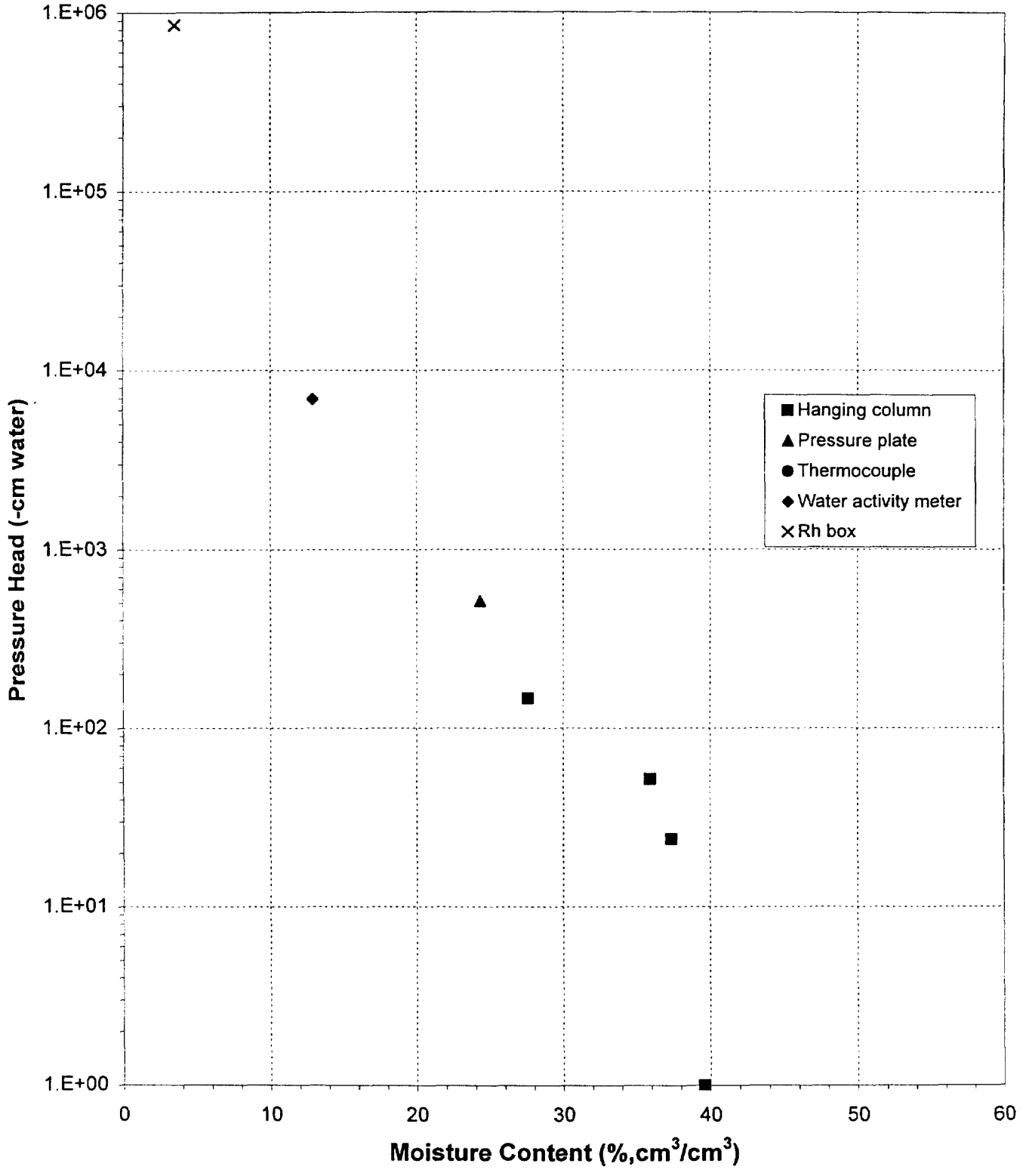
Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: B. Baum/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

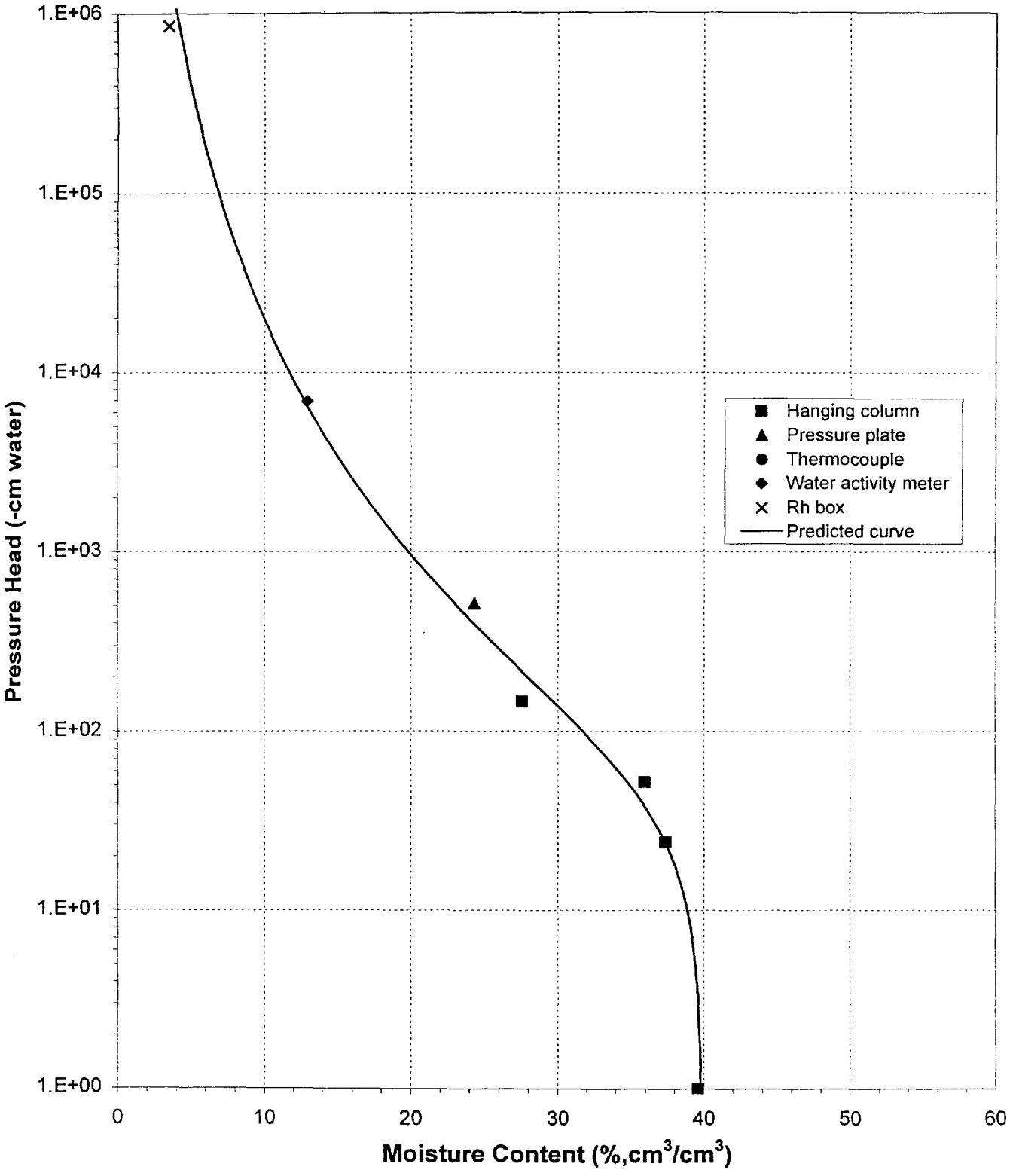
Water Retention Data Points

Sample Number: G-06



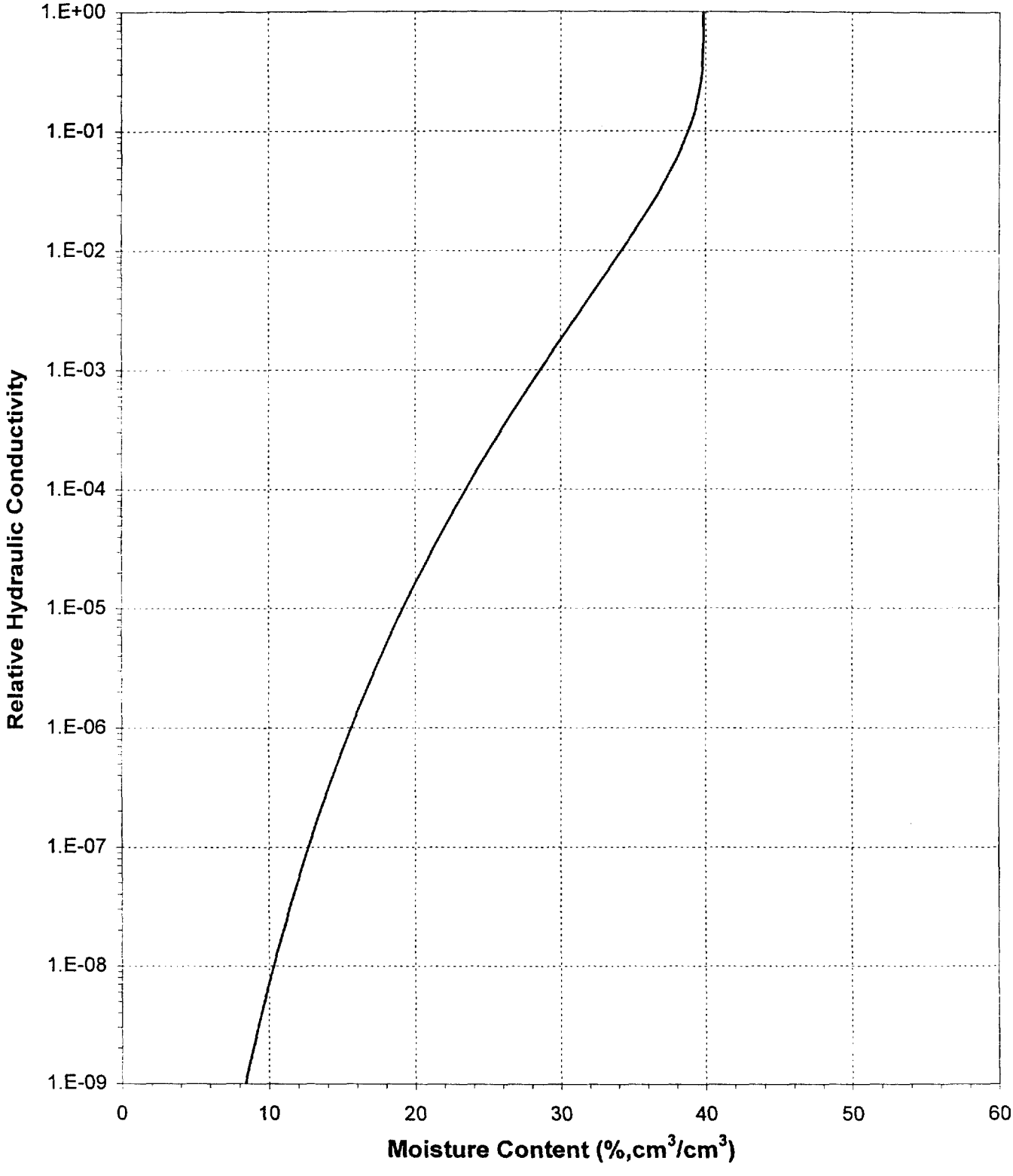
Predicted Water Retention Curve and Data Points

Sample Number: G-06



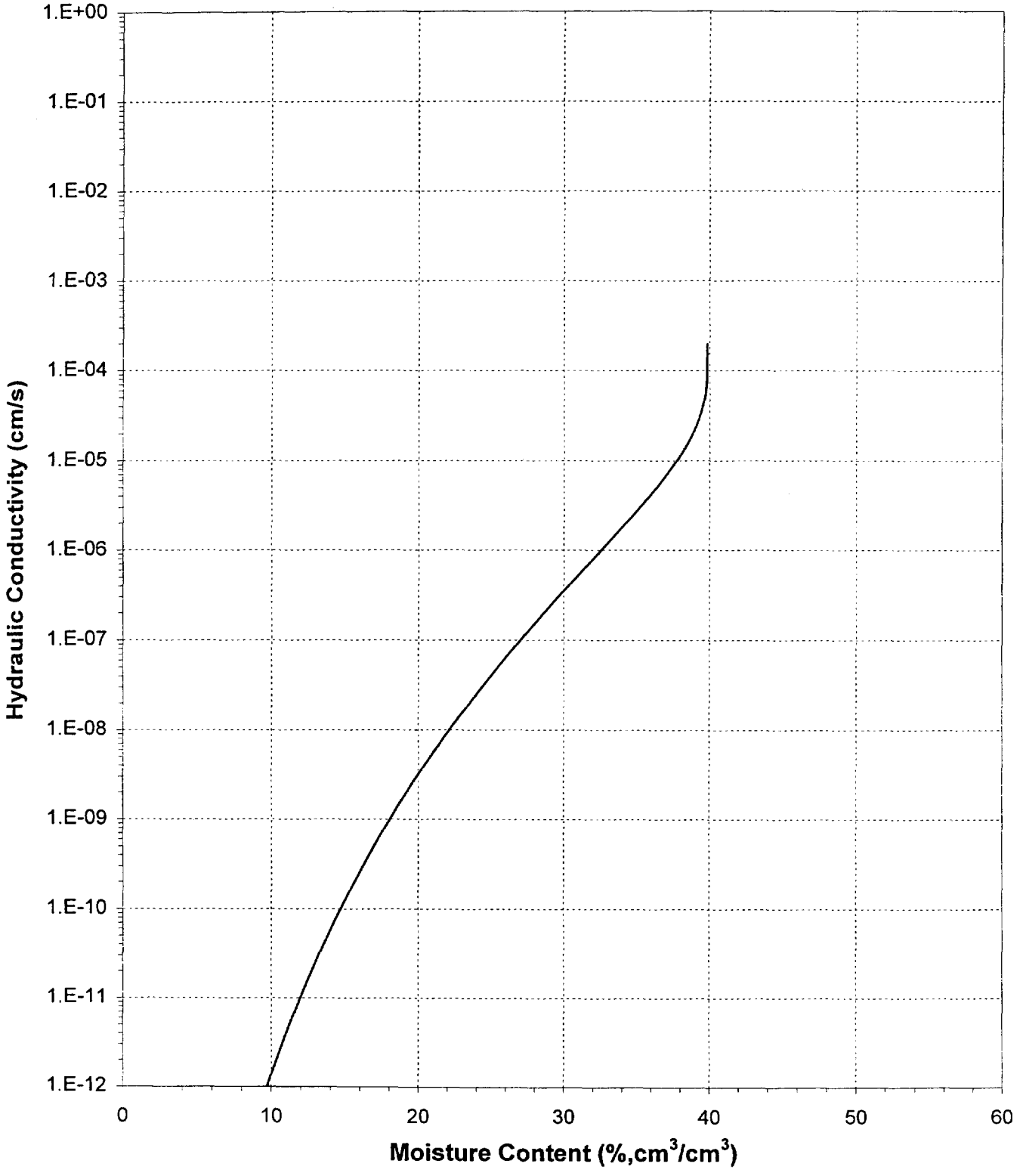
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: G-06



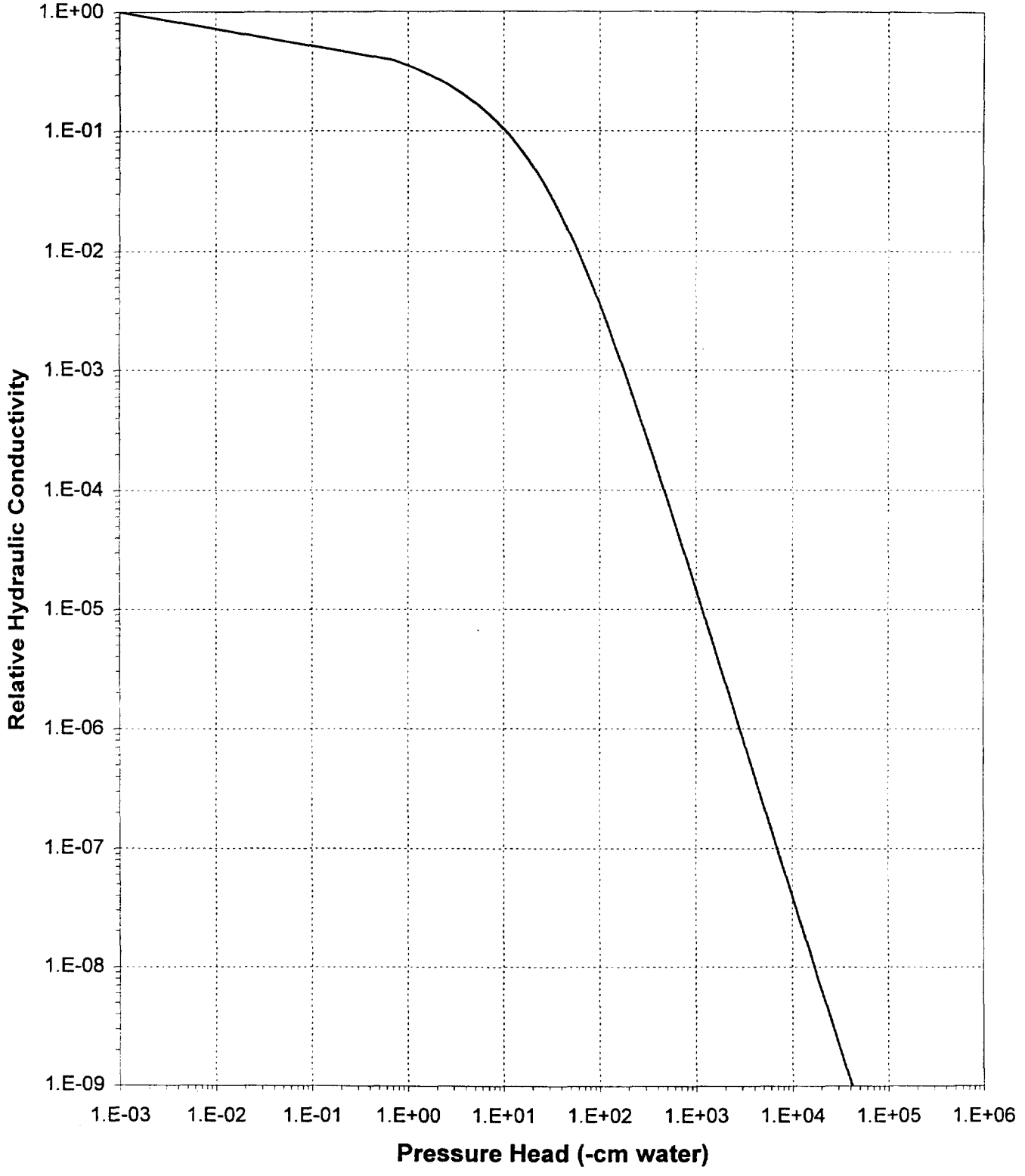
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: G-06



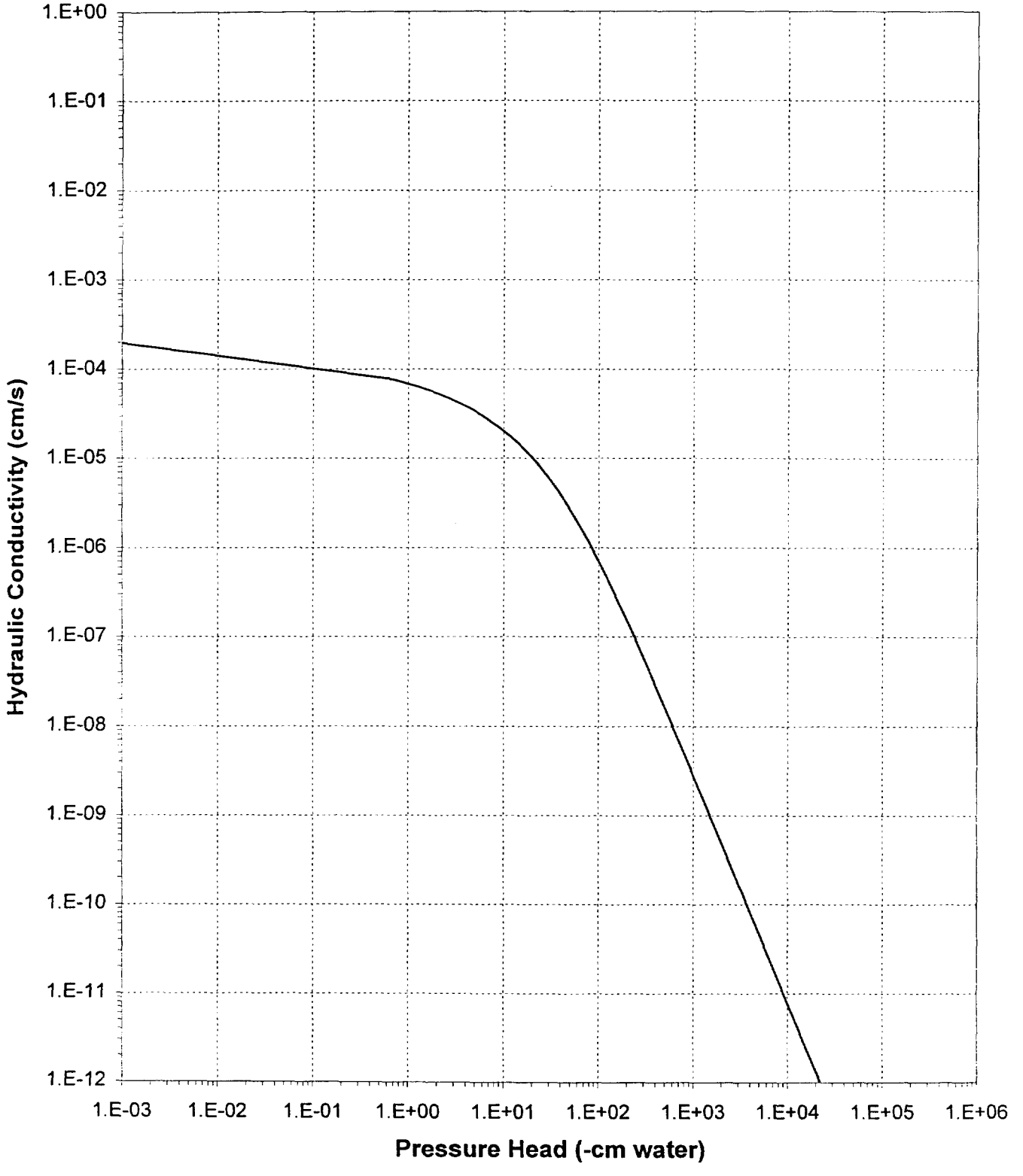
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: G-06



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: G-06



Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-08
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 2280.72
Tare wt., screen & clamp (g): 58.30
Tare wt., ring (g): 173.16
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 1344.19

Saturated weight at 0 cm tension* (g): 3026.70
Volume of water† in saturated sample (cm^3): 514.52
Saturated moisture content (% vol): 38.28
Sample bulk density (g/cm^3): 1.70

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	15-Oct-02 / 11:15	3026.70	0.00	38.28
	18-Oct-02 / 12:00	3003.90	18.00	36.58
	21-Oct-02 / 09:30	2997.90	46.00	36.13
	23-Oct-02 / 14:30	2956.20	148.00	33.03
Pressure plate:	25-Oct-02 / 14:10	2903.90	509.90	29.14

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-08
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 152.61
Tare weight, jar (g): 115.02
Sample bulk density (g/cm^3): 1.70

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	23-Oct-02 / 13:25	155.90	8260.4	14.85

Dry weight of relative humidity box sample* (g): 90.92
Tare weight (g): 40.04
Sample bulk density (g/cm^3): 1.70

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	29-Oct-02 / 08:30	91.99	851293	3.56

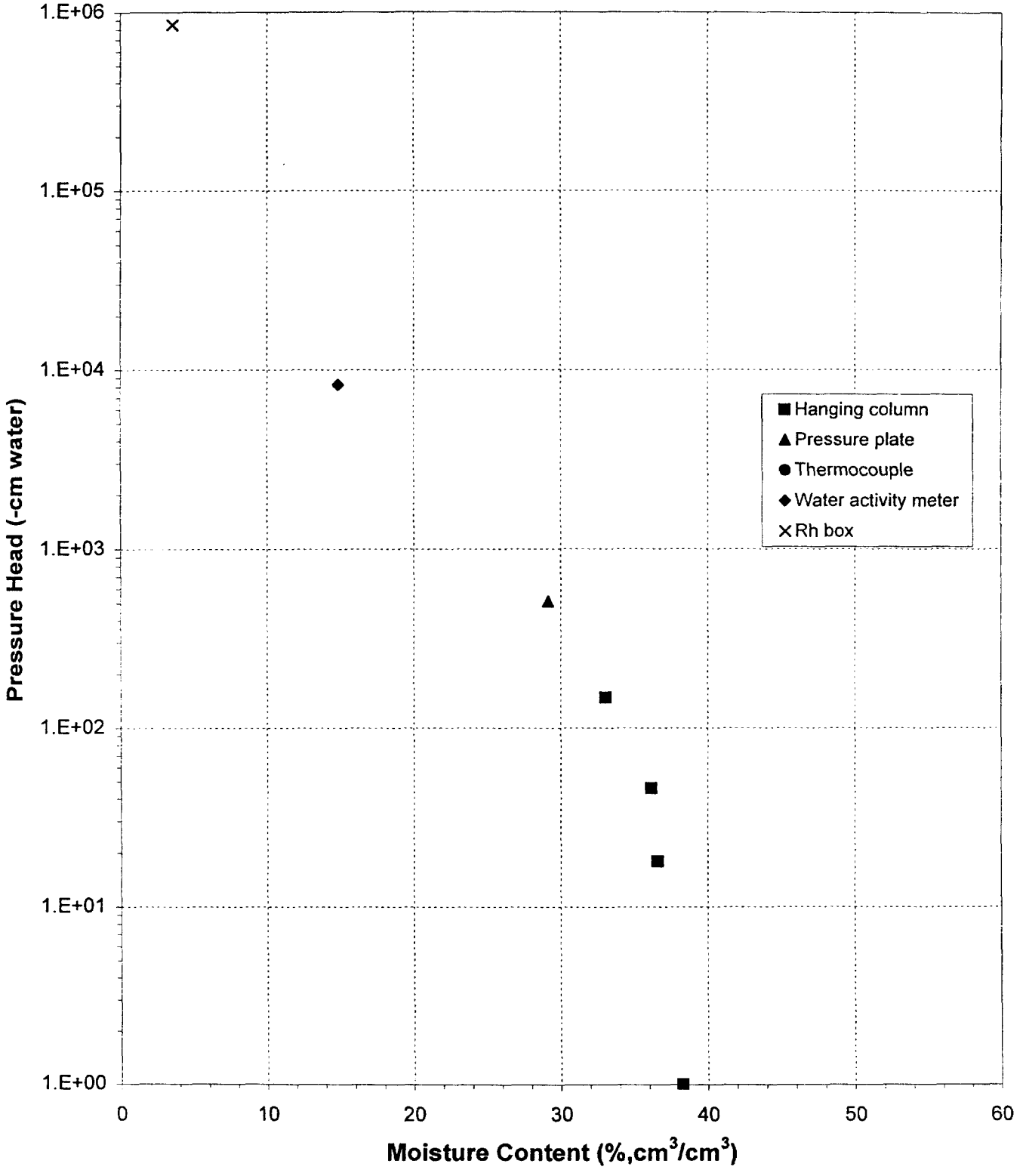
Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

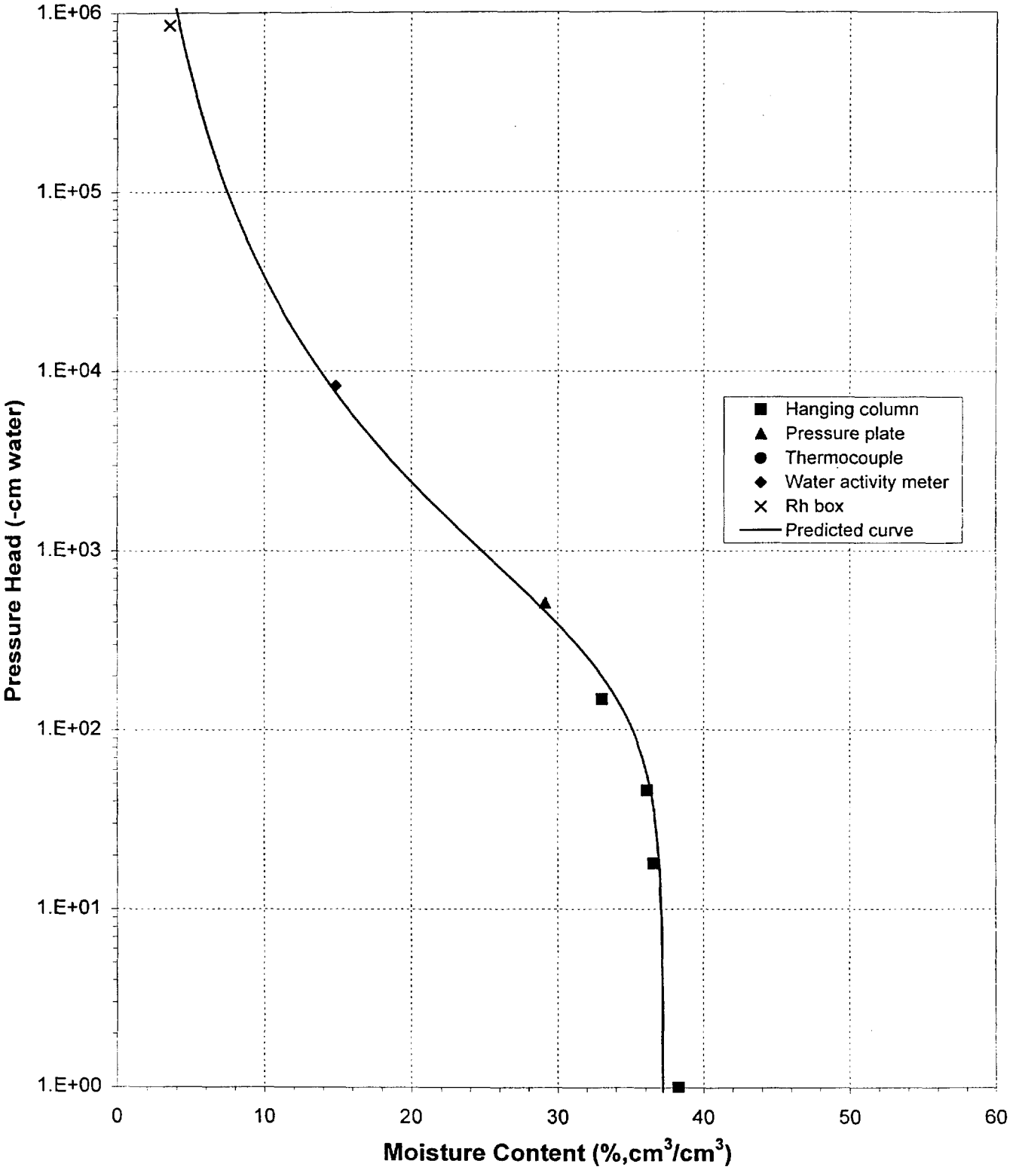
Water Retention Data Points

Sample Number: G-08



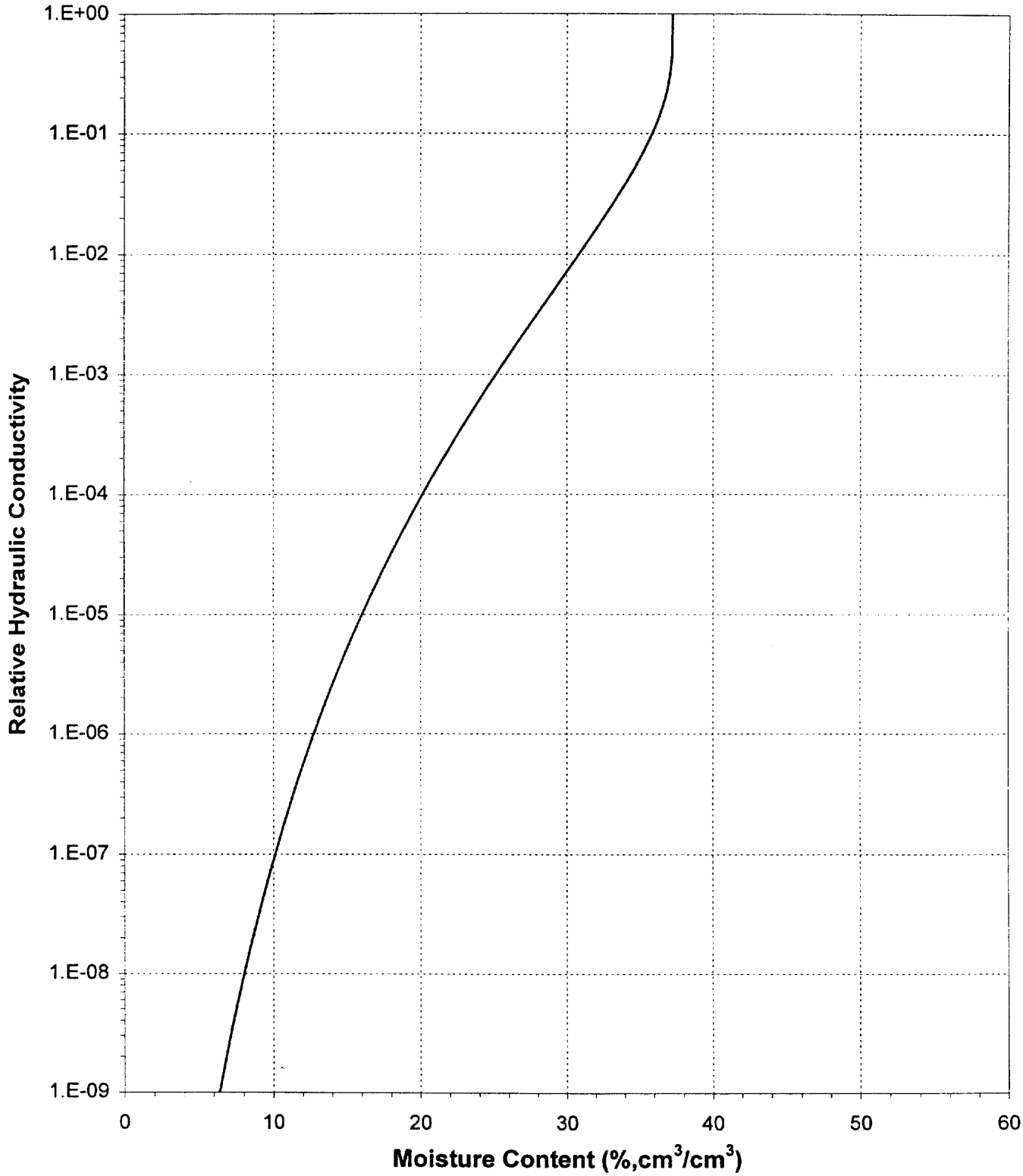
Predicted Water Retention Curve and Data Points

Sample Number: G-08



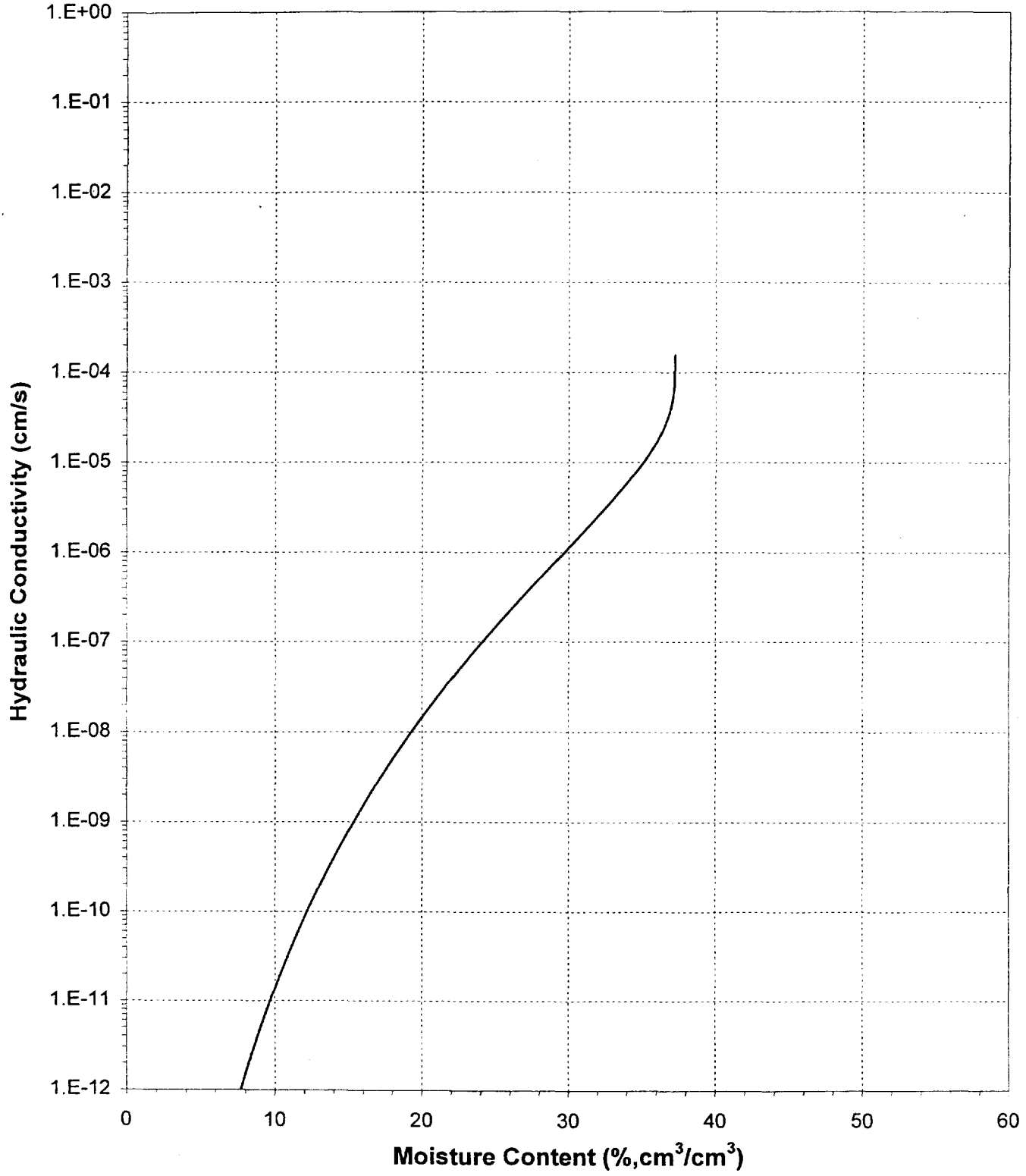
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: G-08



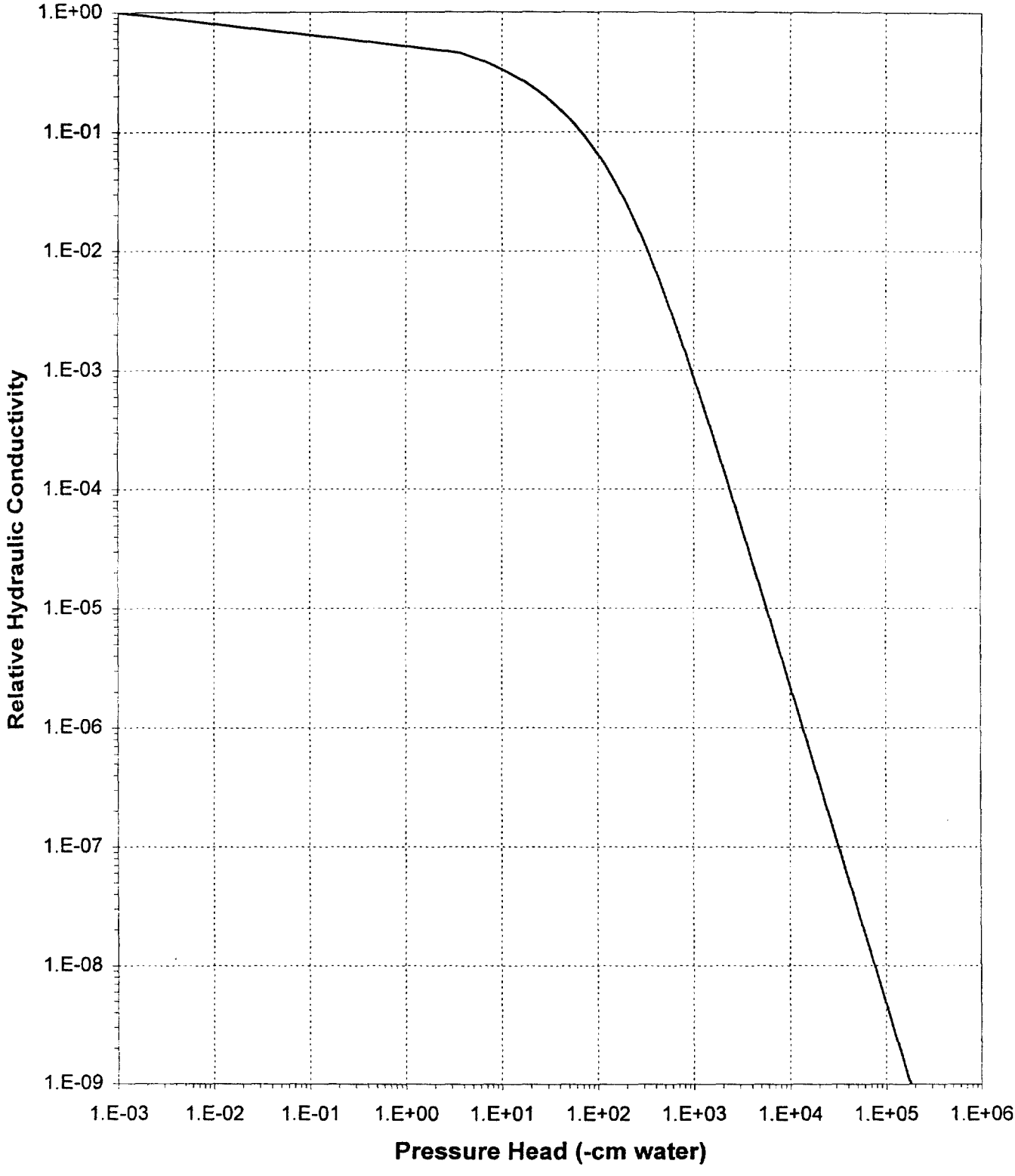
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: G-08



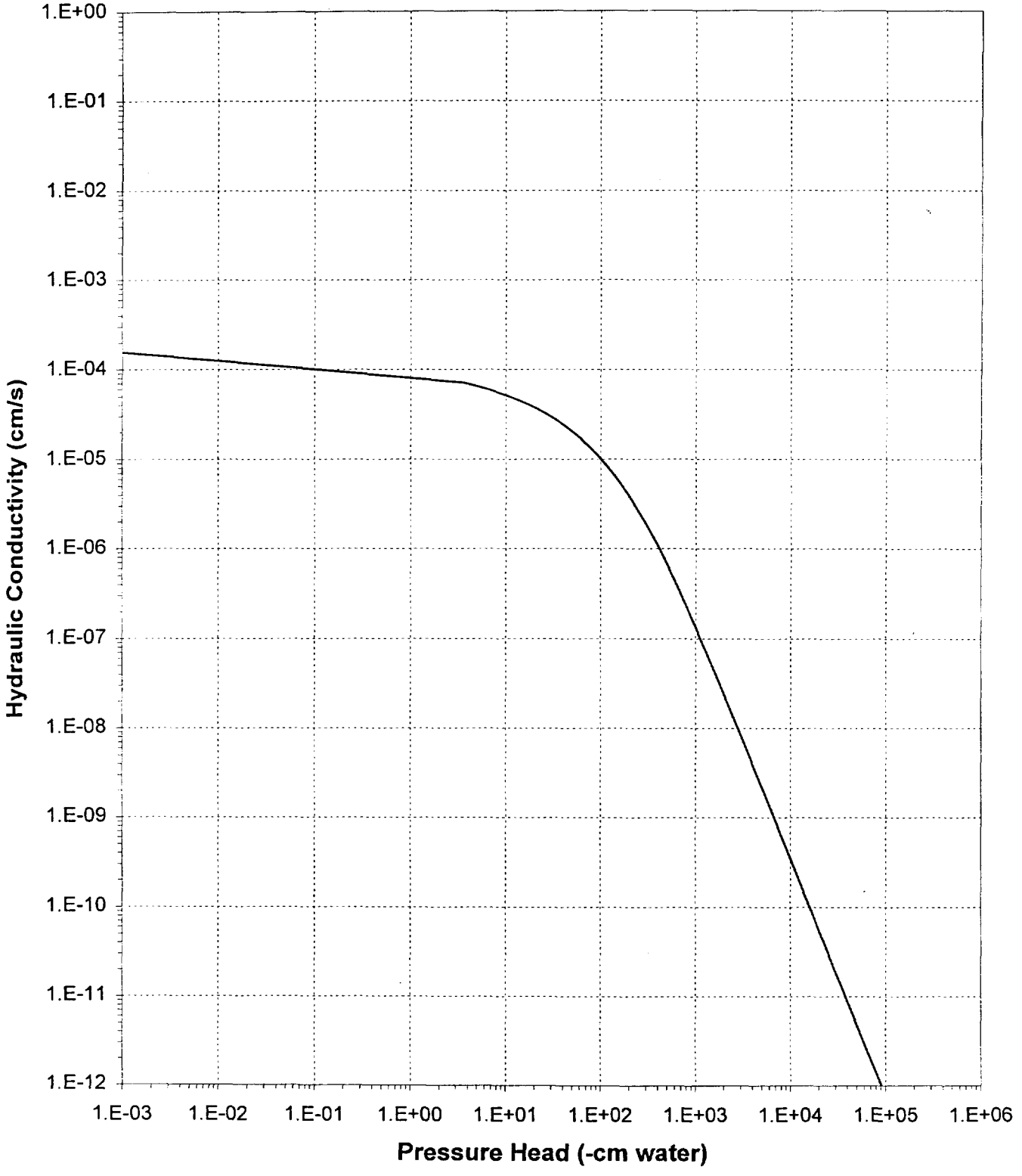
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: G-08



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: G-08



Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-12
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 158.39
Tare weight, jar (g): 114.45
Sample bulk density (g/cm^3): 1.70

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	02-Oct-02 / 11:20	160.89	19478.2	9.68

Dry weight of relative humidity box sample* (g): 102.50
Tare weight (g): 41.87
Sample bulk density (g/cm^3): 1.70

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	29-Oct-02 / 08:30	103.59	851293	3.03

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: B. Baum/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: TRC/ AES
Job Number: L142.0000.00
Sample Number: G-12
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 2282.97
Tare wt., screen & clamp (g): 58.07
Tare wt., ring (g): 173.00
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 1341.85

Saturated weight at 0 cm tension* (g): 30445.00
Volume of water† in saturated sample (cm^3): 27930.96
Saturated moisture content (% vol): 39.53
Sample bulk density (g/cm^3): 1.70

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	15-Oct-02 / 11:15	3044.50	0.00	39.53
	18-Oct-02 / 12:00	3004.50	18.00	36.55
	21-Oct-02 / 09:30	2979.80	46.00	34.71
	23-Oct-02 / 14:30	2893.20	148.00	28.26
Pressure plate:	25-Oct-02 / 14:10	2826.40	509.90	23.28

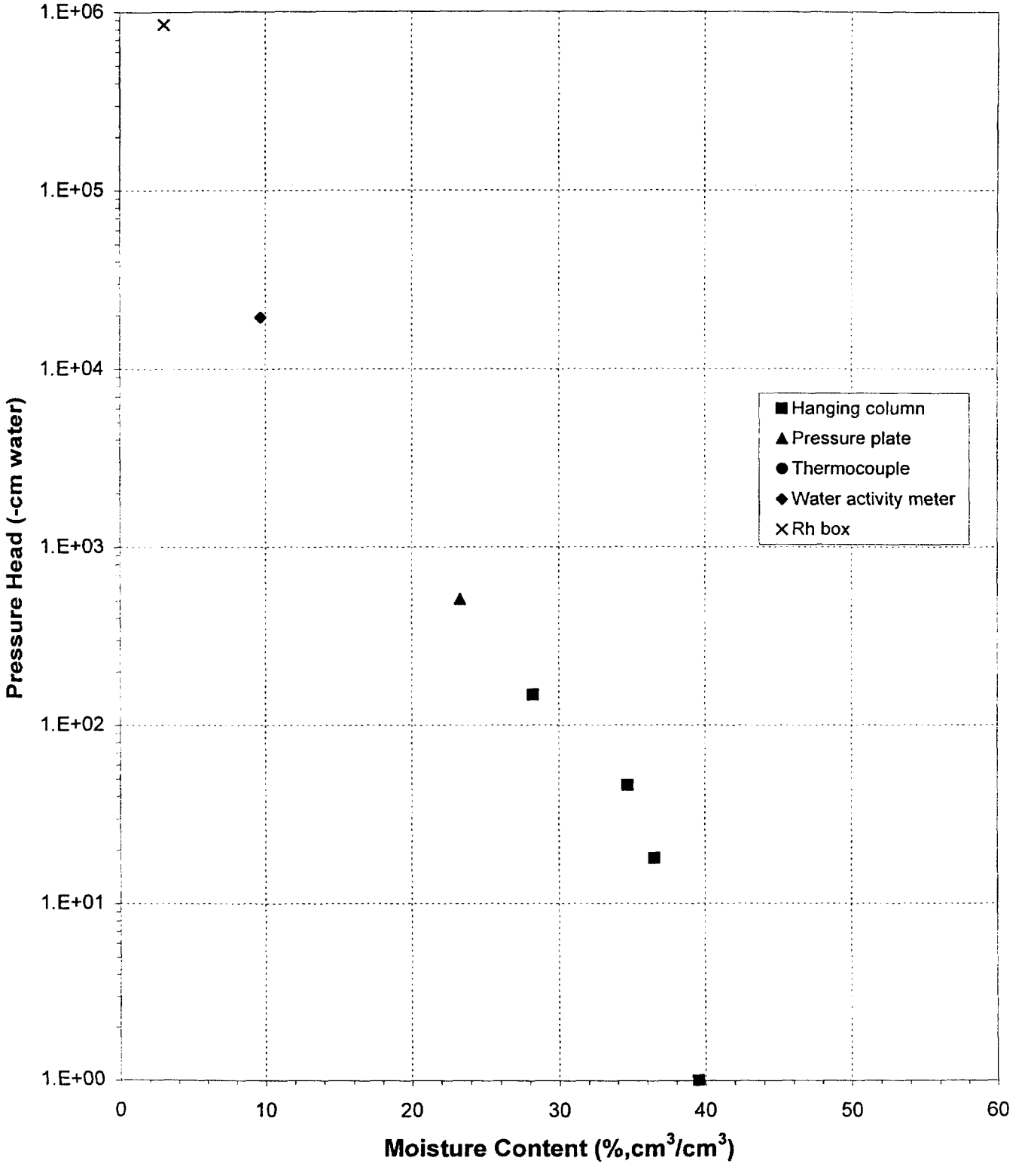
Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

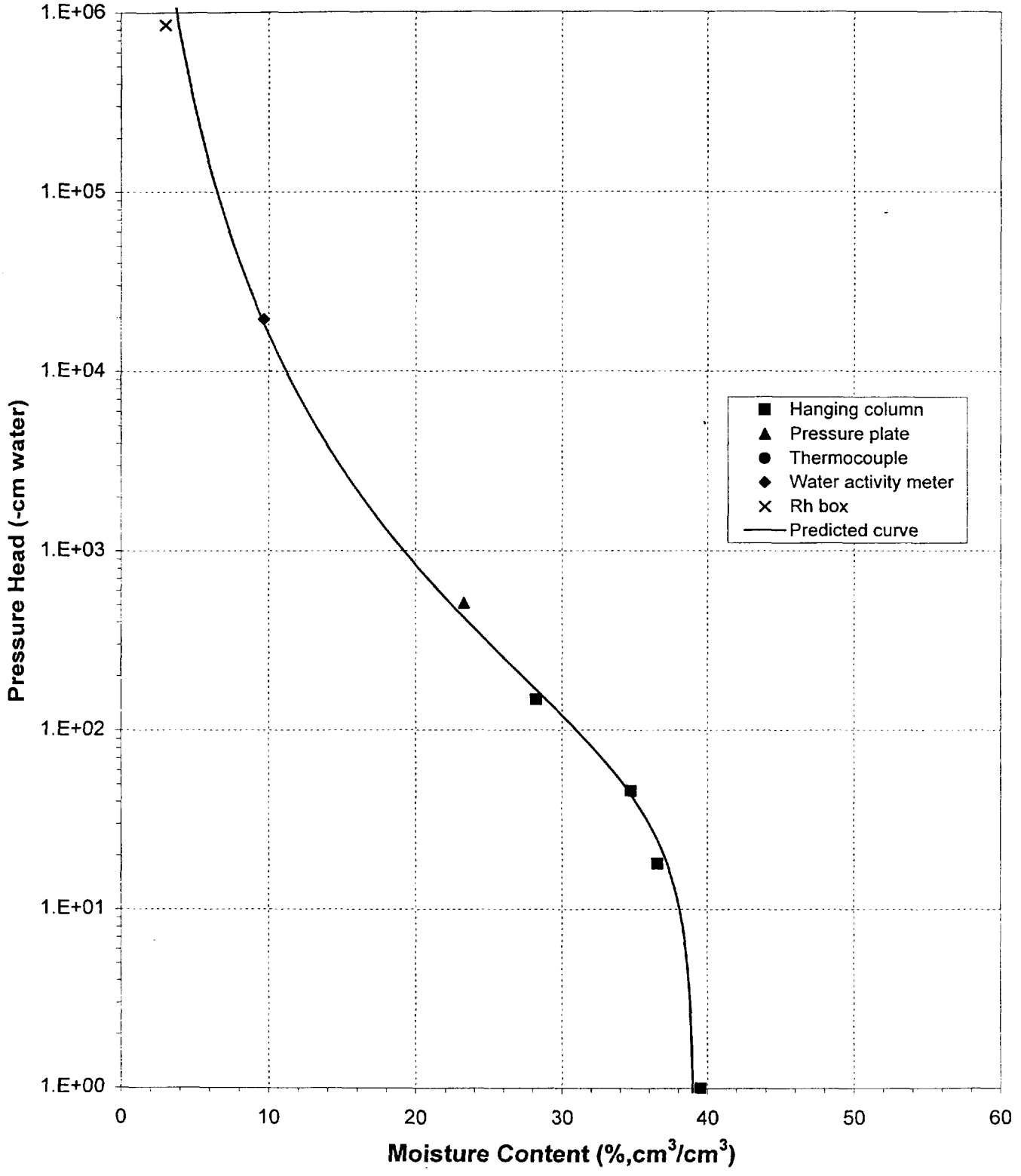
Water Retention Data Points

Sample Number: G-12



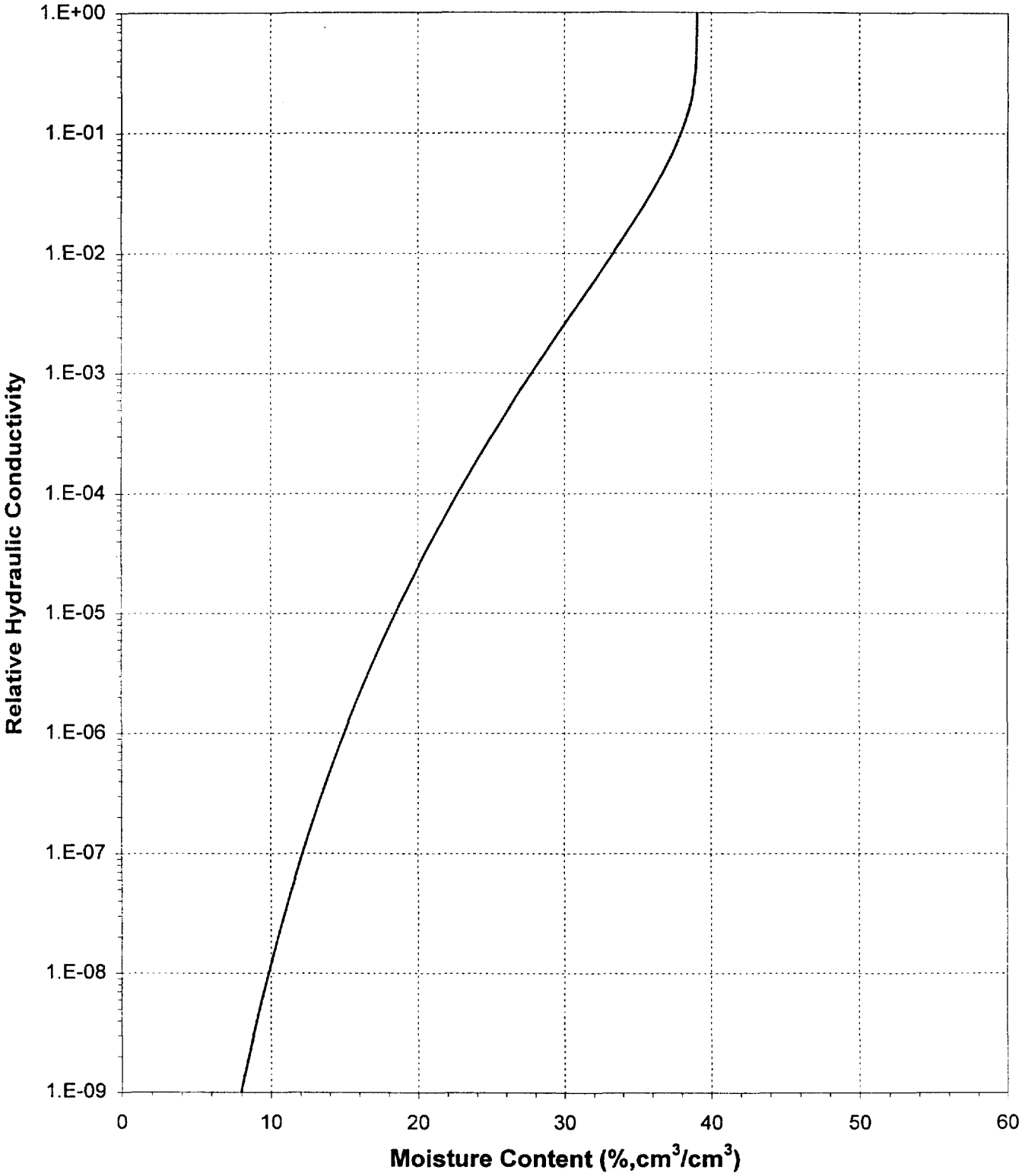
Predicted Water Retention Curve and Data Points

Sample Number: G-12



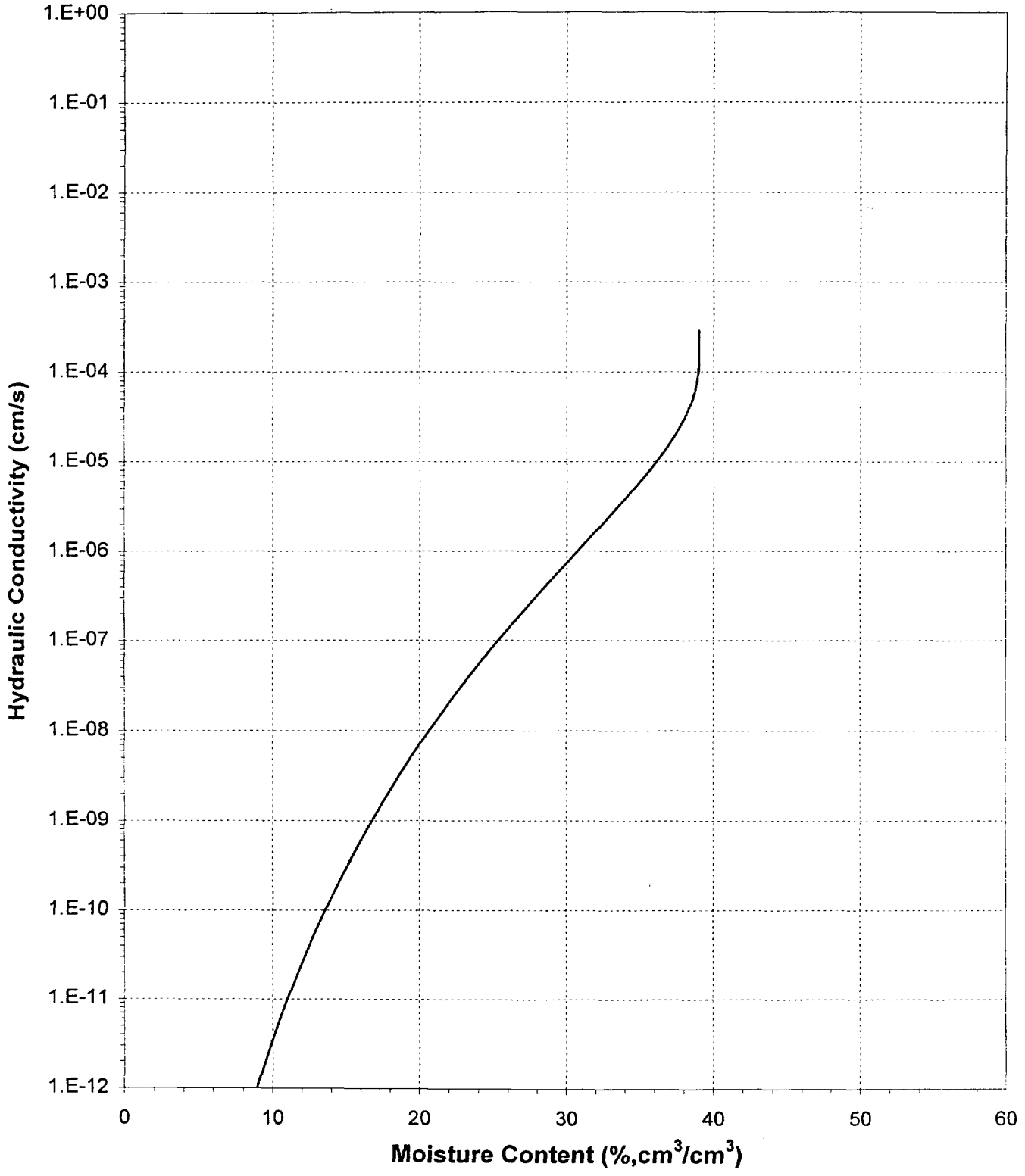
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: G-12



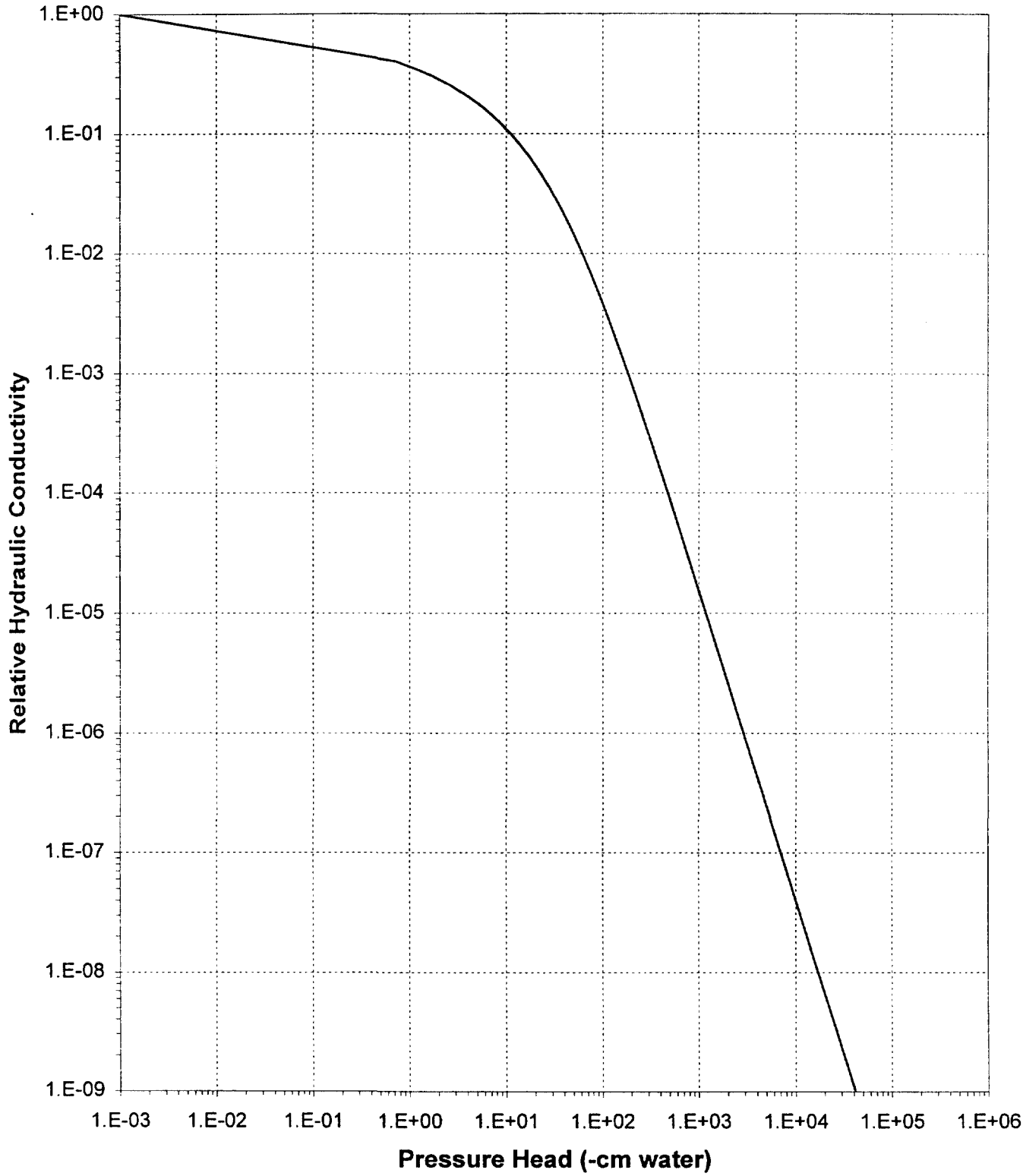
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: G-12



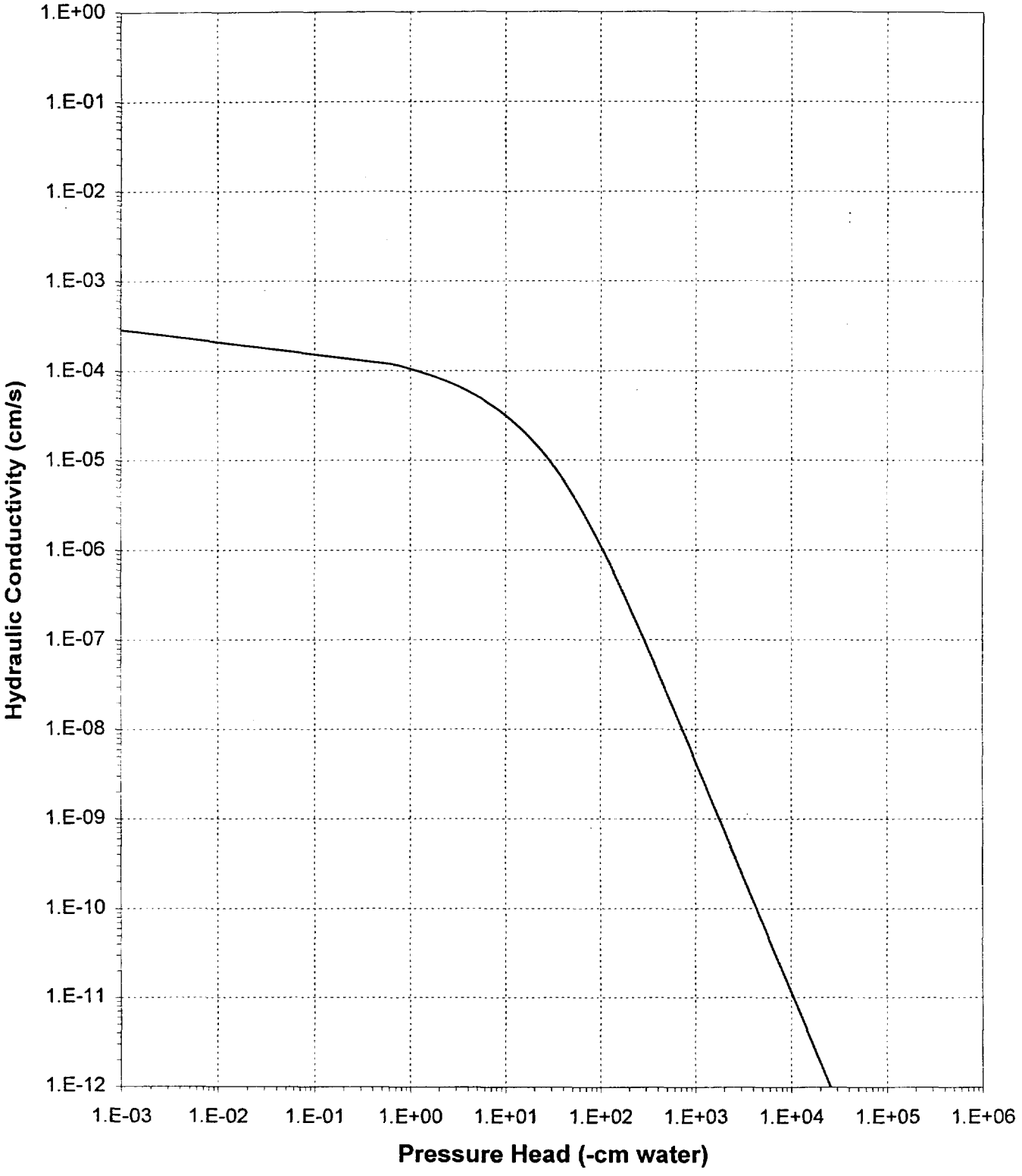
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: G-12



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: G-12



APPENDIX D.4

KEANTAN LABORATORY TEST DATA
HSA-1 TO HSA-8 (SHEAR TESTING)

KEANTAN LABORATORIES

www.keantanlabs.com
email: keantanlab@aol.com

March 20, 2002

TRC Environmental Solutions, Inc.
21 Technology Drive
Irvine, CA 92718

Attention: Mr. Allen Blodgett

Subject: Report/Laboratory Test Results
Project Name: WDI
Project No.: 94-256
KTL Project No.: 01-056-001

Dear Mr. Blodgett:

Enclosed are results of the laboratory testing program conducted on samples from the above referenced project. The testing performed for this program was conducted in general accordance with testing procedures as follows:

TYPE OF TEST	TEST PROCEDURE
Moisture-Density	ASTM D 2937
Unconfined Compression	ASTM D 2166
Direct Shear	ASTM D 3080
Sieve Analysis	ASTM D 422

Attached herewith are Summary of Unconfined Compression Test Results(1), Direct Shear Test Results(3), and Grain Size Distribution Curves(3).

We appreciate the opportunity to provide testing services to TRC Environmental Solutions, Inc. If you have any questions regarding the test results, please contact us.

Very truly yours,
Keantan Laboratories

Kean Tan, PE
Principal

Encls.

720 North Valley Street, Suite B, Anaheim, CA 92801 • Tel.: (714) 535-7616 • Fax: (714) 535-7568

KEANTAN LABORATORIES

www.keantanlabs.com
email: keantanlab@aol.com

SUMMARY OF UNCONFINED COMPRESSION STRENGTH TEST RESULTS

PROJECT NAME: WDI

KTL NO.: 01-056-001

PROJECT NO.: 94-256

CLIENT: TRC

DATE: 3-20-02

SUMMARIZED BY: K. Tan

SAMPLE ID	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	UCS (psi)
SA-1	20	9.2	93.6	5.6
SA-2	15	23.4	100.2	31.8
SA-2	40	22.3	102.9	39.4
SA-3	5	14.6	109.6	11.7
SA-4	15	12.5	104.0	7.1
SA-5	5	25.1	92.6	10.6
SA-5	20	12.8	115.6	18.0
SA-6	5	25.6	93.0	7.6
SA-6	35	8.3	88.6	1.3
SA-7	15	35.5	84.9	24.2
SA-8	10	15.7	115.9	74.9

c: \ My Documents \ TRC\UCS

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KEANTAN LABORATORIES

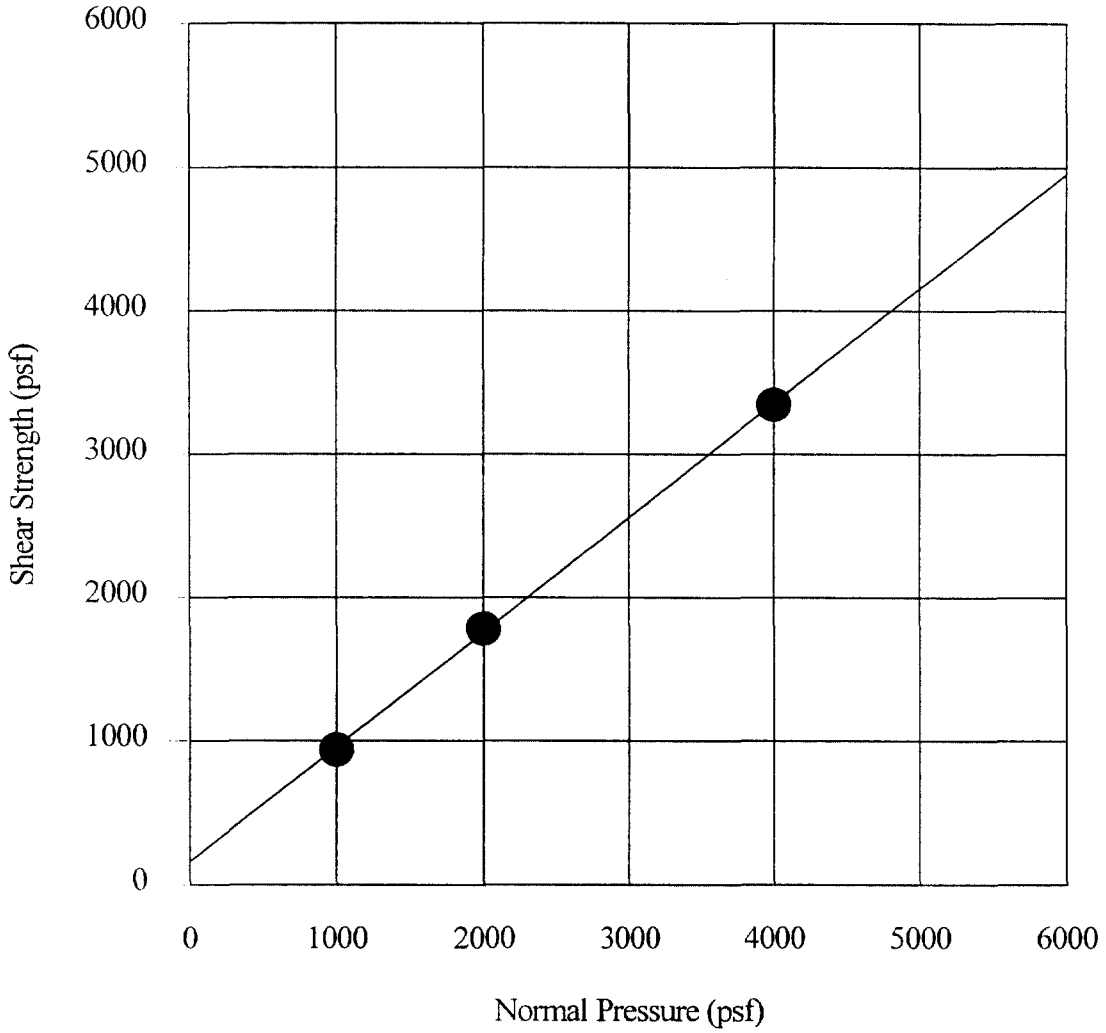
www.keantanlabs.com
email: keantanlab@aol.com

Direct Shear (CD) Test Results
ASTM D 3080

PROJECT NAME: WDI
PROJECT NO.: 94-256
DATE: MARCH 2002
BORING NO.: HSA-2
SAMPLE NO.: N/A
SAMPLE TYPE: RINGS
RING DIAMETER: 2.42 IN.
RING HEIGHT: 1.0 IN.
MOISTURE CONTENT: 5.6 percent

KTL NO.: 01-056-001
CLIENT: TRC
DEPTH (ft): 25
USCS CLASS.: SP-SM

SATURATED: YES
DRY DENSITY: 113.1 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	39	156

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KEANTAN LABORATORIES

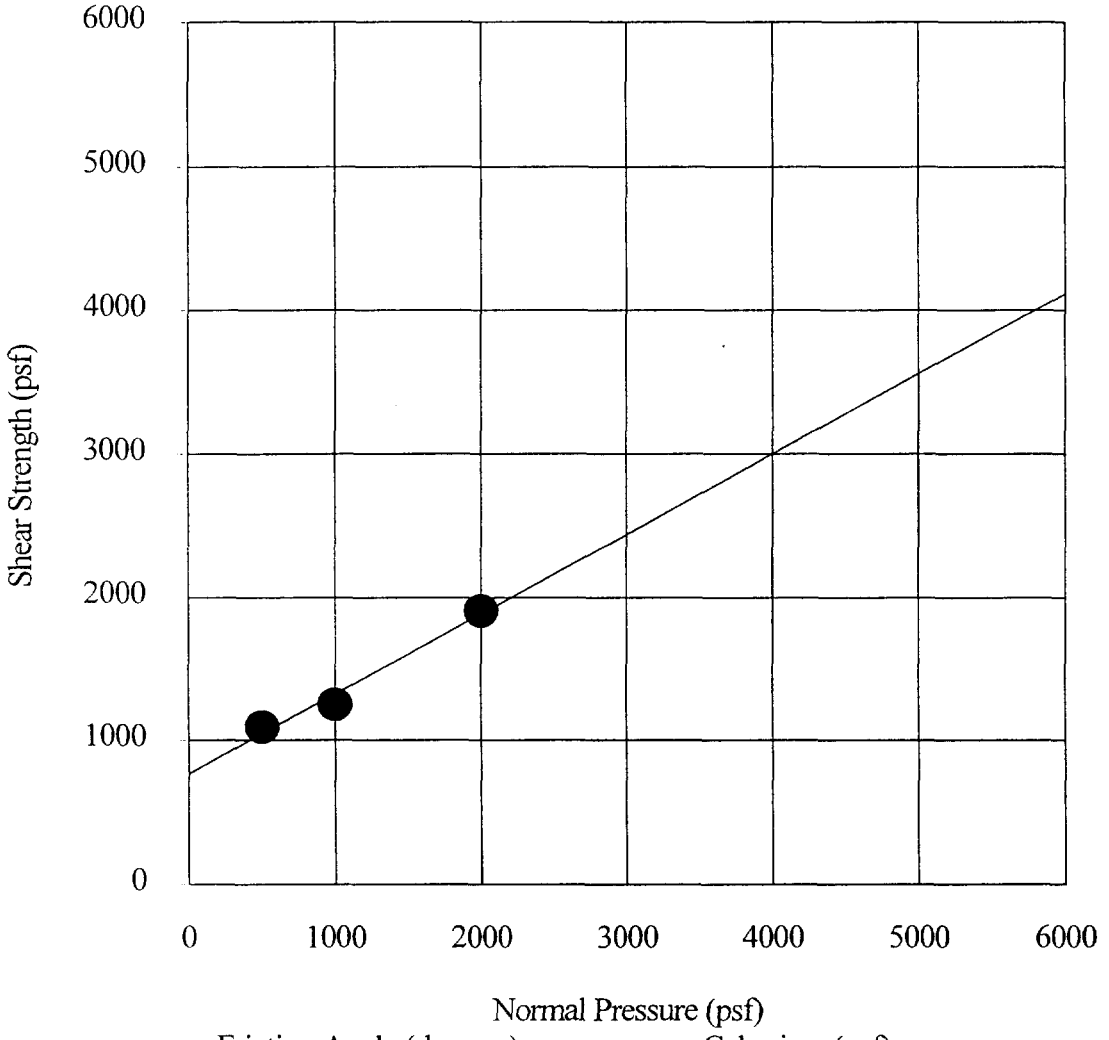
www.keantanlabs.com
email: keantanlab@aol.com

Direct Shear (CD) Test Results
ASTM D 3080

PROJECT NAME: WDI
PROJECT NO.: 94-256
DATE: MARCH 2002
BORING NO.: HSA-3
SAMPLE NO.: N/A
SAMPLE TYPE: RINGS
RING DIAMETER: 2.42 IN.
RING HEIGHT: 1.0 IN.
MOISTURE CONTENT: 15.9 percent

KTL NO.: 01-056-001
CLIENT: TRC
DEPTH (ft): 10
USCS CLASS.: CL

SATURATED: YES
DRY DENSITY: 116.7 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	29	766

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KEANTAN LABORATORIES

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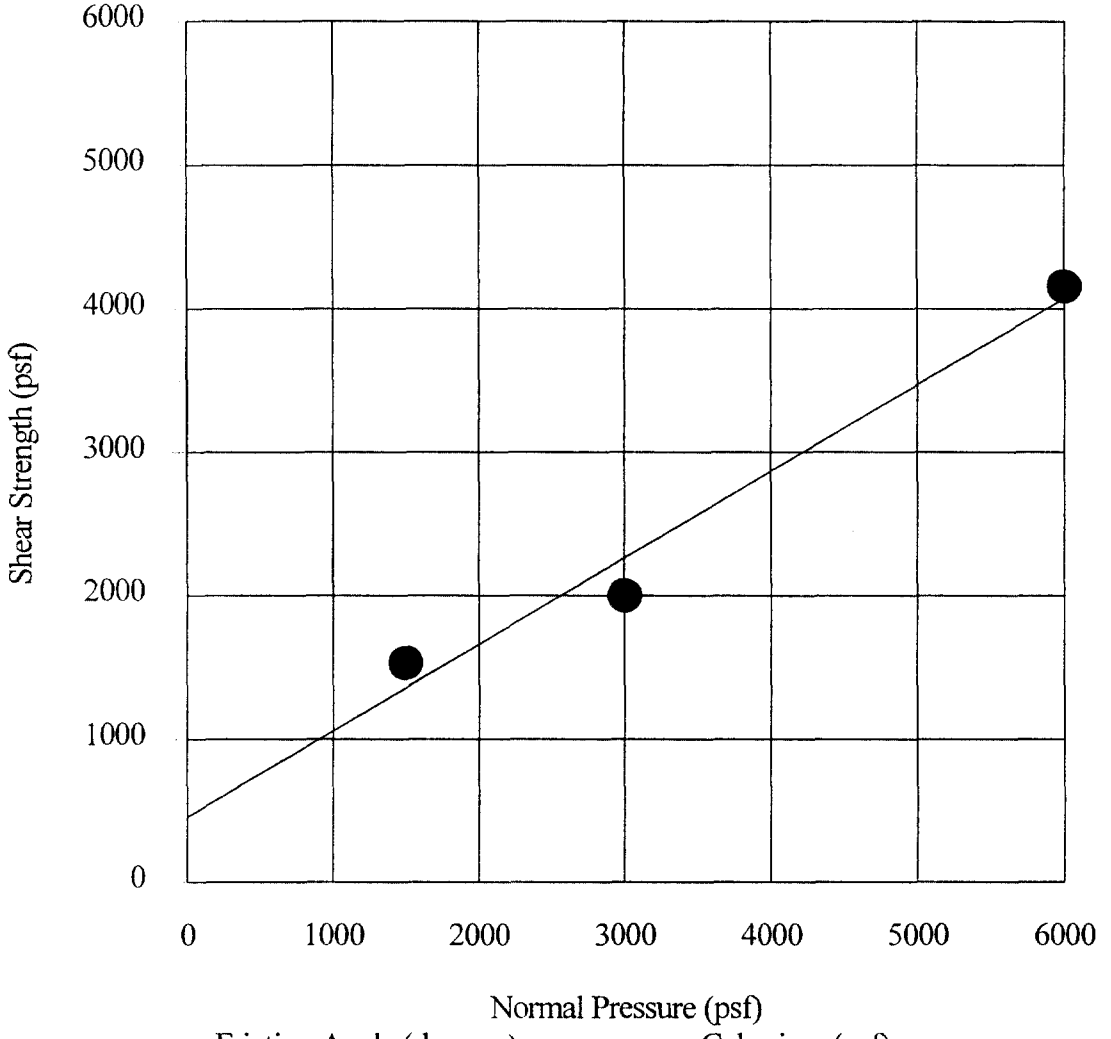
Direct Shear (CD) Test Results
ASTM D 3080

PROJECT NAME: WDI
PROJECT NO.: 94-256
DATE: MARCH 2002
BORING NO.: HSA-6
SAMPLE NO.: N/A
SAMPLE TYPE: RINGS
RING DIAMETER: 2.42 IN.
RING HEIGHT: 1.0 IN.
MOISTURE CONTENT: 4.2 percent

KTL NO.: 01-056-001
CLIENT: TRC
DEPTH (ft): 30
USCS CLASS.: SP-SM

SATURATED: YES
DRY DENSITY: 104.5 pcf



	Friction Angle (degrees)	Cohesion (psf)
Peak	31	453

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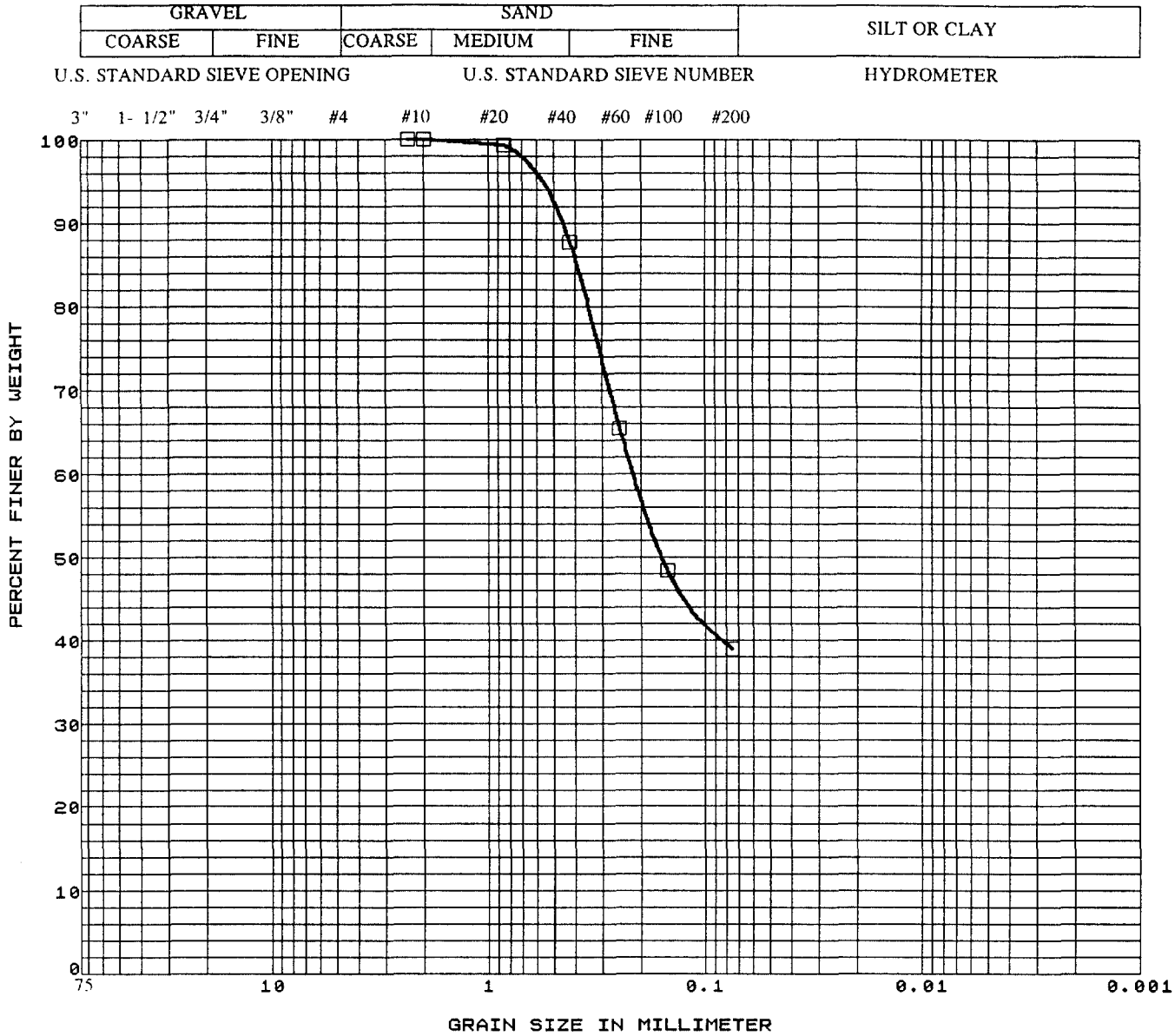


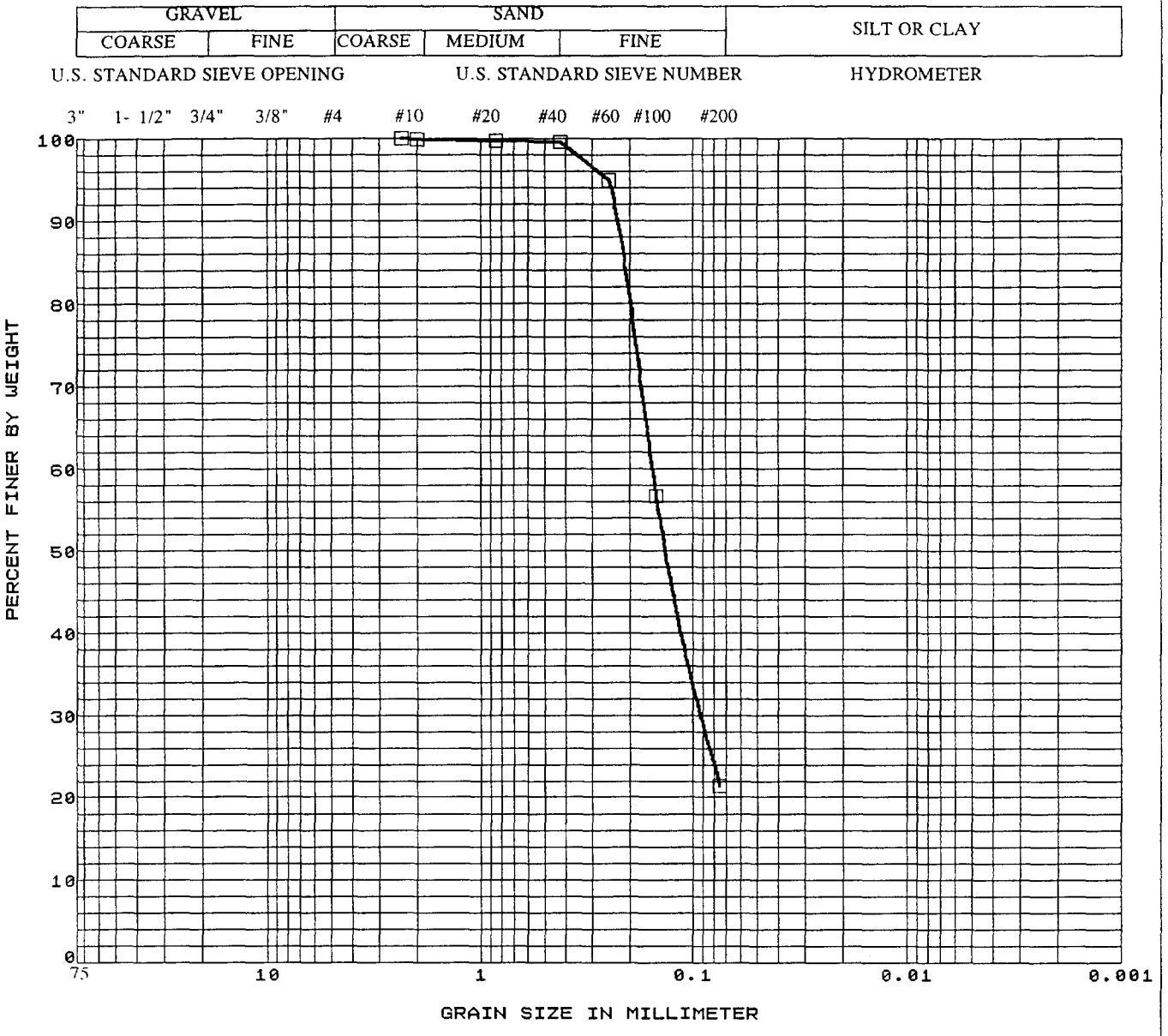
SYMBOL	SAMPLE ID.	DEPTH (ft)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	HSA-5	20	RING			

KEANTAN LABORATORIES	PROJECT NAME: WDI

GRAIN SIZE DISTRIBUTION CURVE

3/02

FIGURE



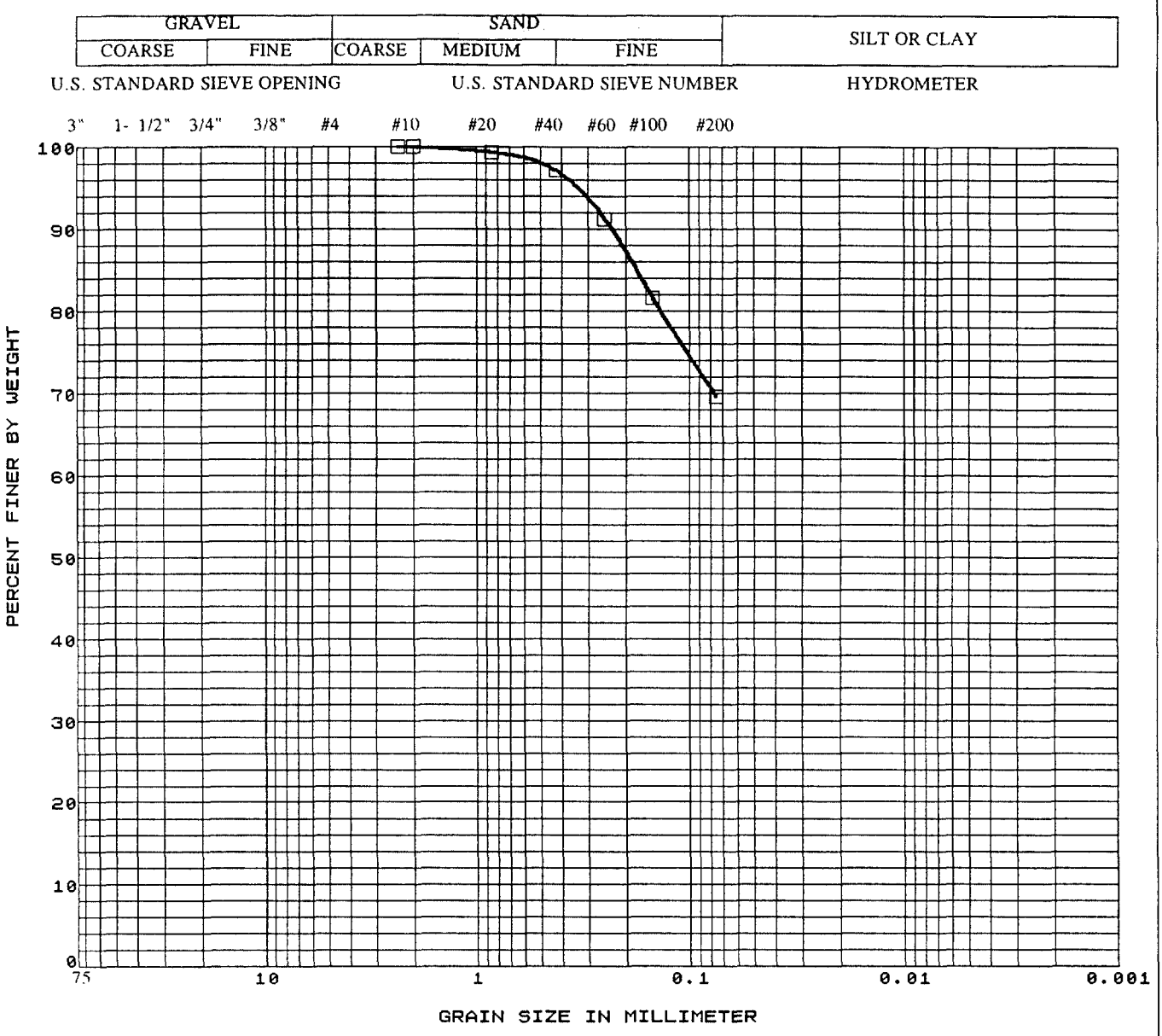
SYMBOL	SAMPLE ID.	DEPTH (ft)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	HSA-6	35	RING			

KEANTAN LABORATORIES	PROJECT NAME: WDI

GRAIN SIZE DISTRIBUTION CURVE

3/02

FIGURE



SYMBOL	SAMPLE ID.	DEPTH (ft)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	HSA-8	10	RING			

KEANTAN LABORATORIES	PROJECT NAME: WDI

GRAIN SIZE DISTRIBUTION CURVE

3/02

FIGURE

APPENDIX D.5

LOWNEY ASSOCIATES (TS-SAMPLES;
COMPACTION, GRADATION, PI, PERMEABILITY)

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

Mountain View
Oakland
San Ramon
Fullerton

January 18, 2002
1651-8

TRC SOLUTIONS, INC.
21 Technology Drive
Irvine, California 92618

Attention: Mr. Allen E. Blodgett, GE
Project Director

RE: GEOTECHNICAL LABORATORY TEST RESULTS FOR "WDI LANDFILL CONTAINMENT DESIGN" SANTA FE SPRINGS, CALIFORNIA

Gentlemen:

We are pleased to present results of our geotechnical laboratory testing for your "WDI" project. Geotechnical test results are presented in an "Appendix B" format for easy insertion into most standard geotechnical reports. Our geotechnical laboratory is licensed by the City of Los Angeles, Department of Building and Safety, Materials Control Division, as a "Soils Testing Agency" No. 10149. In accordance with our December 13, 2001 "FAX Confirmation of Requested Services," your samples will be disposed of in 30 days. We appreciate the opportunity to be of service. If you have any questions concerning these test results, please call or contact me by phone or e-mail at tbenson@lowney.com.

Sincerely,

LOWNEY ASSOCIATES

Thomas C. Benson, Jr., G.E. 2091
Vice President

REGISTERED PROFESSIONAL ENGINEER
THOMAS C. BENSON, JR.
No. 2091
Exp. 3/31/05
STATE OF CALIFORNIA

Copies: Addressee (2)

Enclosures: Appendix B, "Geotechnical Laboratory Testing" (8 pages)

C:\TCB\REPORTS\1600\1651-8.DOC

APPENDIX B
GEOTECHNICAL LABORATORY TESTING

The following geotechnical laboratory tests were performed on soil samples brought to the Lowney Associates geotechnical laboratory by TRC personnel.

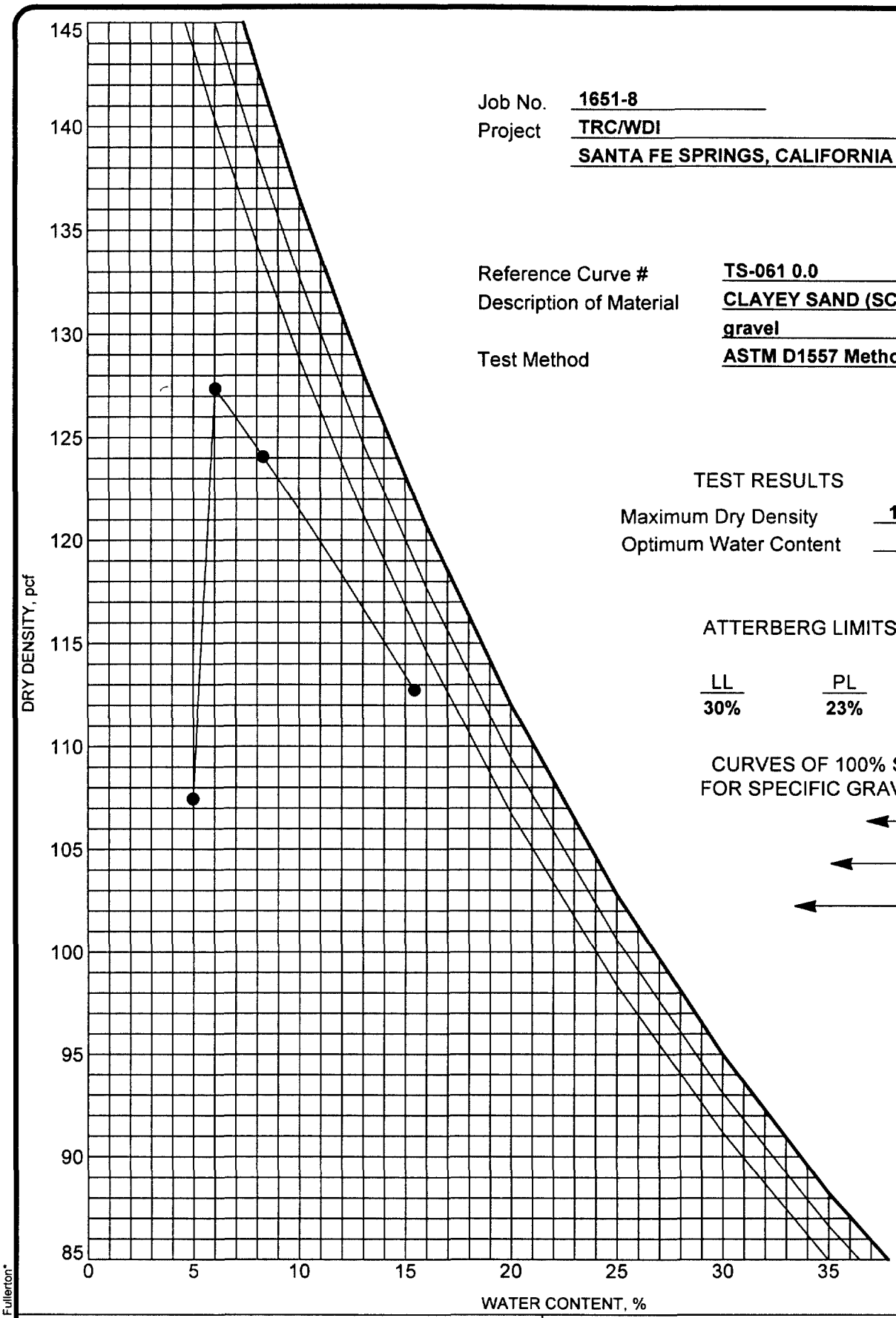
Compaction: Three laboratory compaction tests (ASTM D 1557-00) were performed on provided bulk soil samples to determine the maximum dry density and optimum moisture content. Results of these tests are presented graphically on the following "Moisture-Density Relationship" figures.

Gradations: Sieve and hydrometer analyses (ASTM D 422-63) were performed on the same three soil samples. These tests were performed to assist in the classification of the soil and to determine grain size distributions of the soils. Results of these tests are presented on the "Grain Size Distribution" figure.

Plasticity Index: Plasticity Index determinations (ASTM D 4318) were performed on the same three soil samples to measure the range of water contents over which these materials exhibit plasticity. The Atterberg Limits were used to classify the soil in accordance with the Unified Soil Classification System and to evaluate the soil expansion potential. Results of these tests are presented on the "Plasticity Chart and Data" figure.

Falling Head Permeability: Two falling head permeability tests were performed on remolded specimens, in general accordance with the ASTM D 5084-90 Standard Test Method. Specimen and test result data are presented on the attached two sheets titled "Hydraulic Conductivity."

* * * * * * * * *



Job No. 1651-8

Project TRC/WDI

SANTA FE SPRINGS, CALIFORNIA

Reference Curve # TS-061 0.0

Description of Material CLAYEY SAND (SC), trace fine gravel

Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 127.0 PCF

Optimum Water Content 6.0 %

ATTERBERG LIMITS

LL	PL	PI
30%	23%	7%

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

2.80

2.70

2.60

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

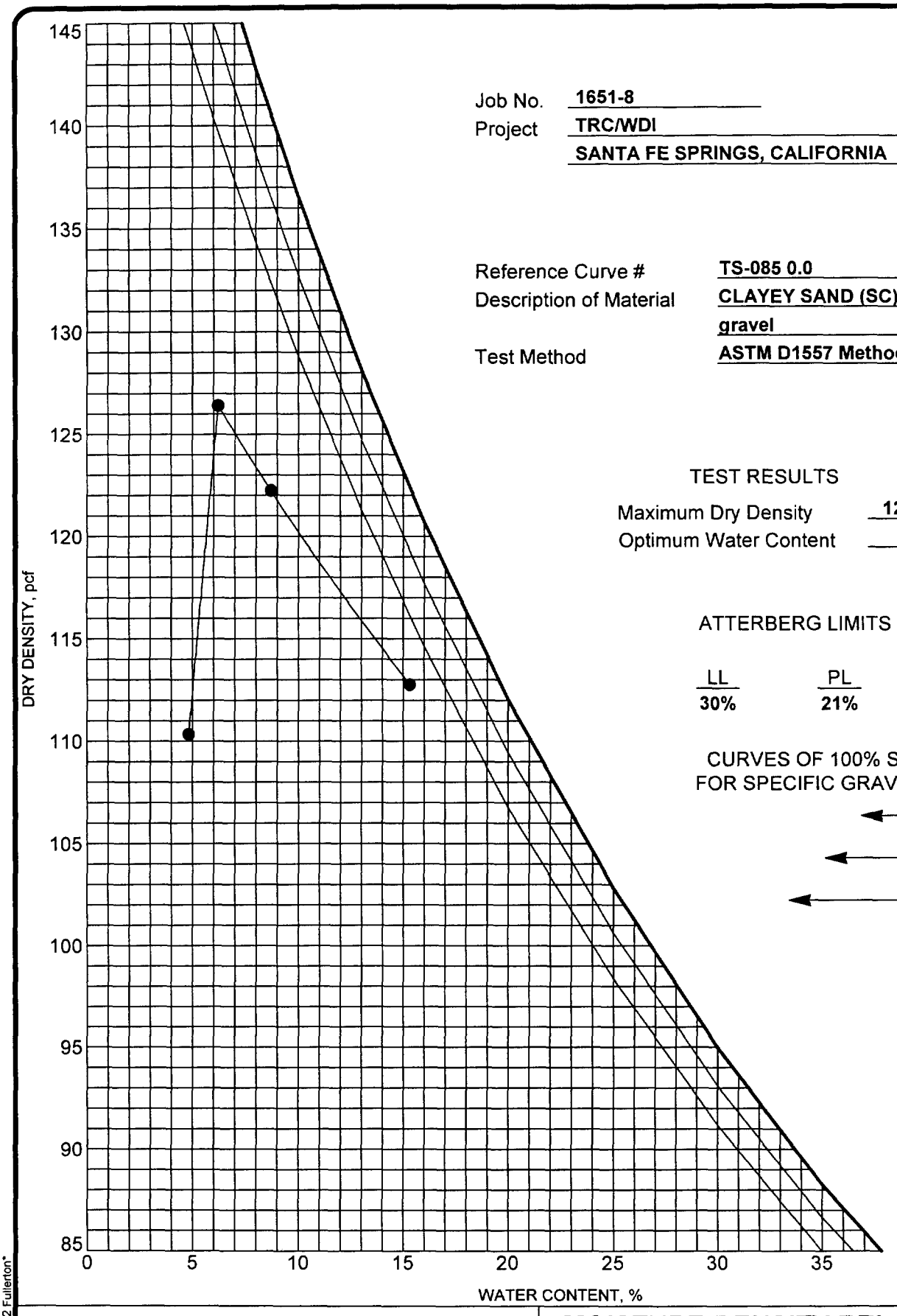
MOISTURE-DENSITY RELATIONSHIP

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

LA CORP.GDT 2/21/02 Fullerton*



Job No. 1651-8
Project TRC/WDI
SANTA FE SPRINGS, CALIFORNIA

Reference Curve # TS-085 0.0
Description of Material CLAYEY SAND (SC), trace fine gravel
Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 126.0 PCF
Optimum Water Content 6.0 %

ATTERBERG LIMITS

LL	PL	PI
30%	21%	9%

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

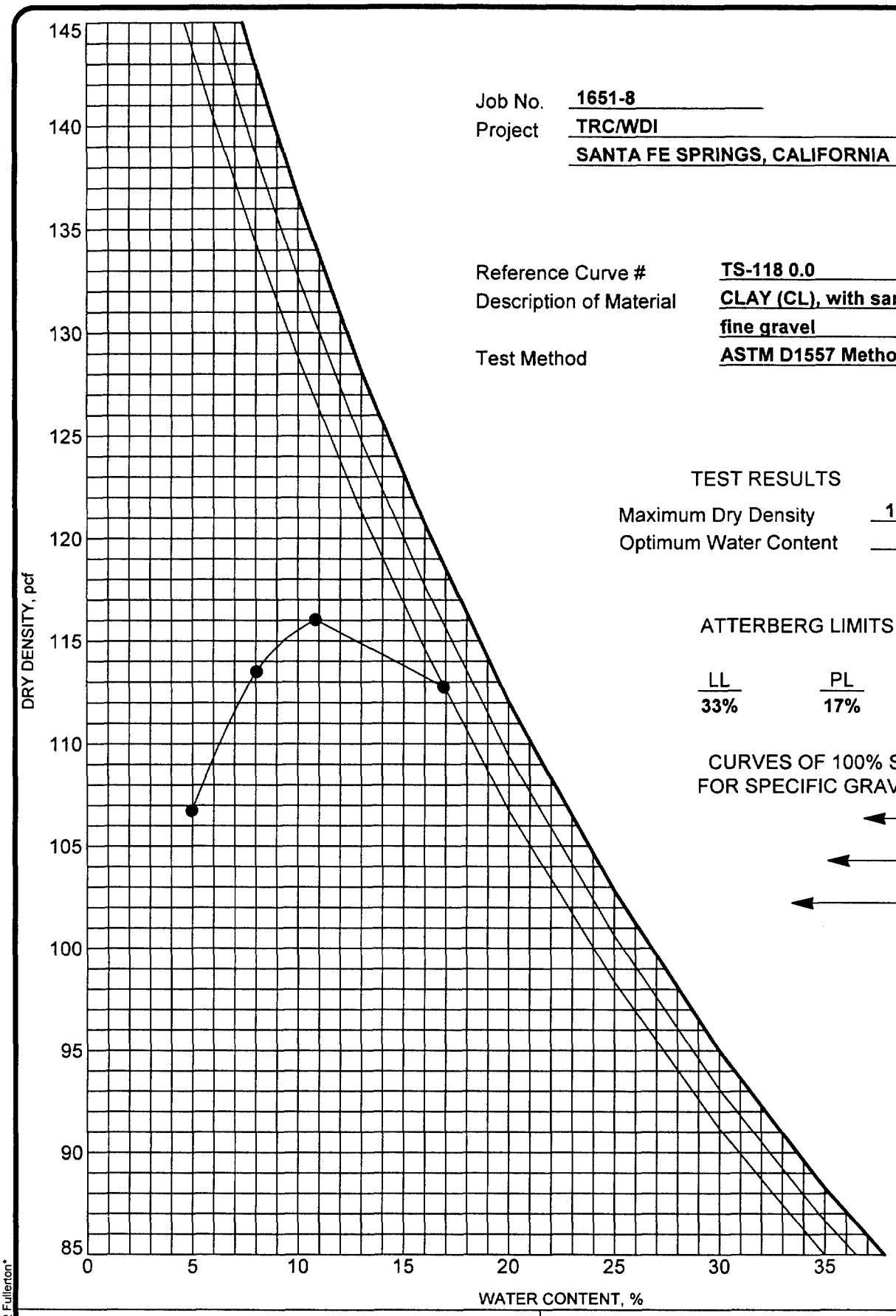
← 2.80
← 2.70
← 2.60

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

MOISTURE-DENSITY RELATIONSHI.

Project: TRC/WDI
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8

LA CORP.GDT 2/21/02 Fullerton*



Job No. 1651-8

Project TRC/WDI

SANTA FE SPRINGS, CALIFORNIA

Reference Curve # TS-118 0.0

Description of Material CLAY (CL), with sand and trace fine gravel

Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 116.0 PCF

Optimum Water Content 11.0 %

ATTERBERG LIMITS

LL	PL	PI
33%	17%	16%

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

2.80

2.70

2.60

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

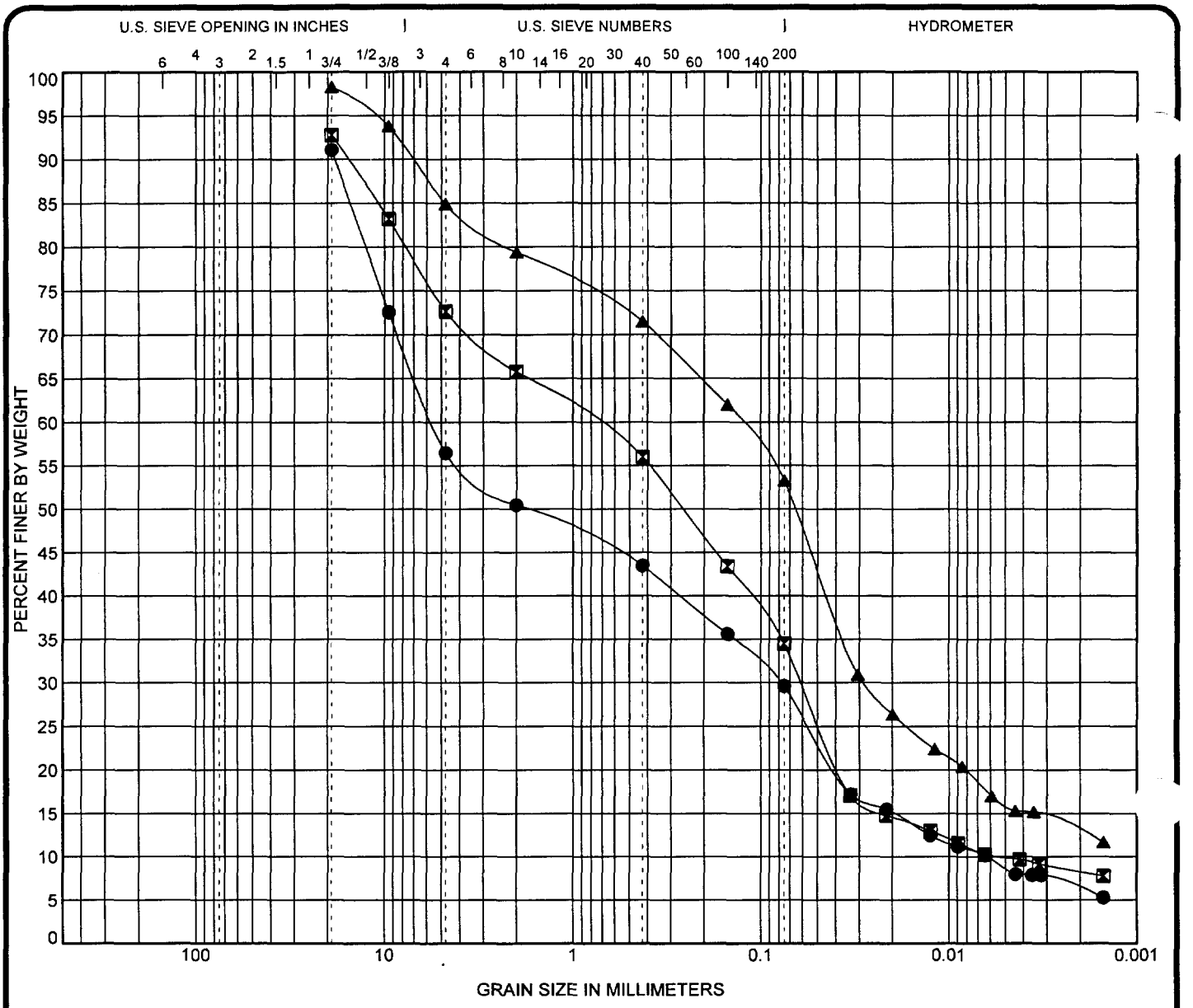
MOISTURE-DENSITY RELATIONSHIP

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

LA CORP GDT 2/21/02 Fullerton*



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	TS-061	0.0	CLAYEY SAND (SC), trace fine gravel	30	23	7	0.18	892.79
⊠	TS-085	0.0	CLAYEY SAND (SC), trace fine gravel	30	21	9	0.90	154.25
▲	TS-118	0.0	CLAY (CL), with sand and trace fine gravel	33	17	16		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TS-061	0.0	19	5.522	0.079	0.006	34.6	26.9	20.8	8.8
⊠	TS-085	0.0	19	0.8	0.061	0.005	20.1	38.2	24.6	9.9
▲	TS-118	0.0	19	0.128	0.028		13.4	31.6	37.3	16.0

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

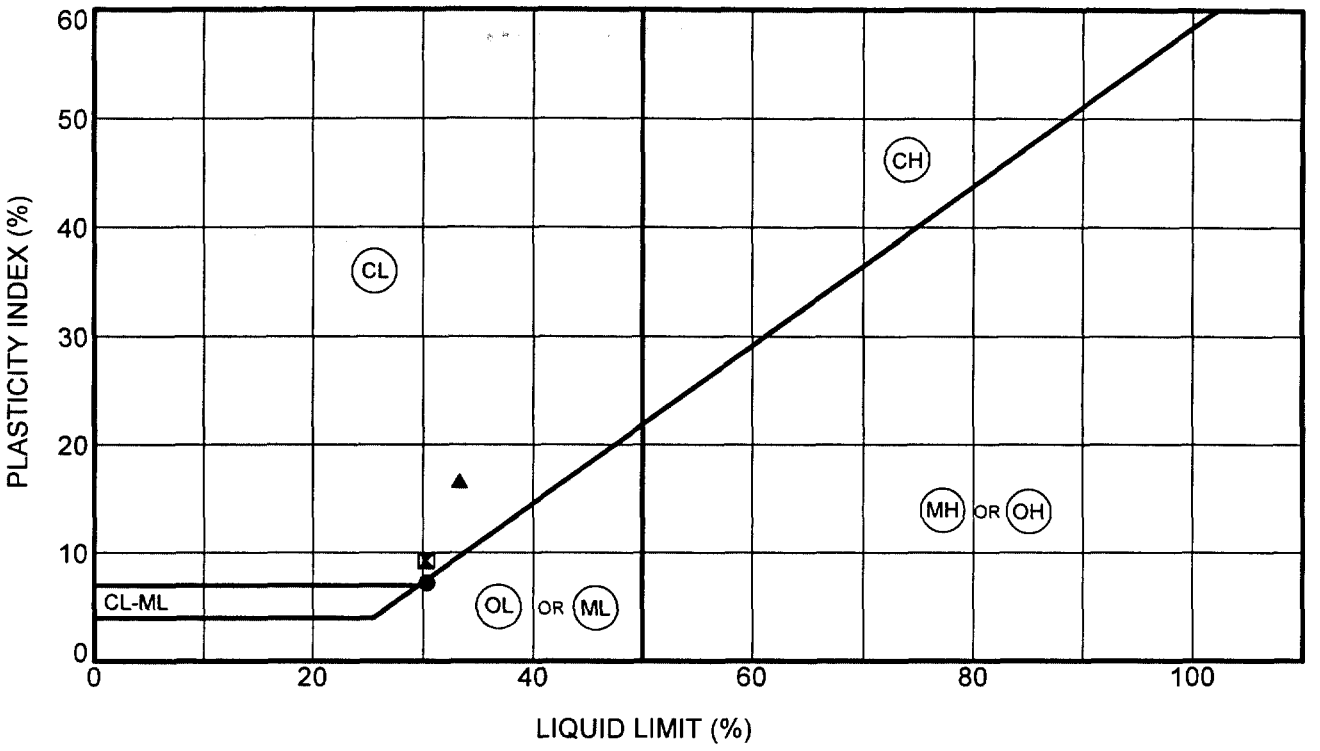
GRAIN SIZE DISTRIBUTION

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

LA CORP.GDT 2/21/02 Fullerton*



Symbol	Boring No.	Depth (ft.)	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing No. 200 Sieve	Unified Soil Classification Description
●	**TS-061**	**0.0**		**30**	**23**	**7**	**30**	**CLAYEY SAND (SC), trace fine gravel**
⊠	**TS-085**	**0.0**		**30**	**21**	**9**	**35**	**CLAYEY SAND (SC), trace fine gravel**
▲	**TS-118**	**0.0**		**33**	**17**	**16**	**53**	**CLAY (CL), with sand**

LA CORP.GDT 2/21/02 Fullerton*

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

PLASTICITY CHART AND DATA

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

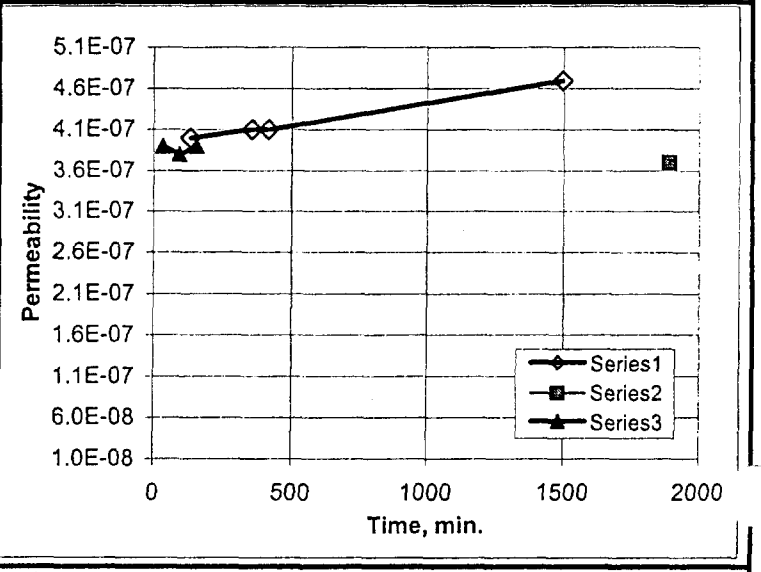
Hydraulic Conductivity
ASTM D 5084

Job No:	028-1056a	**Boring:**		**Date:**	01/16/02
Client:	Lowney	**Sample:**	T5-118	**By:**	MD
Project:	TRC/WDI	**Depth'**		**Checked By:**	DC
Soil Description:	brown sandy CLAY				

Sample Pressures:						***B: =**	1
Cell:	53.5 psi	**Bot. Cap:**	49 psi	**Top Cap:**	48 psi	**Gradient:**	13

Method C: Falling Head / Rising Tailwater

Date	Minutes	Head, (in)	K,cm/sec
1/11/02	0	51.69	Start of Test
	133	48.54	4.00E-07
	356	43.39	4.10E-07
	416	41.99	4.10E-07
1/12/02	1496	23.09	4.70E-07
	0	24	
1/13/02	1890	10.8	3.70E-07
	0	51.69	
1/14/02	33	50.89	3.90E-07
	93	49.54	3.80E-07
	155	48.09	3.90E-07



Average Permeability: 2.E-07 cm/sec

Sample Data:	Initial		Final
Height, in	4.32		4.37
Diameter, in	4.00		4.08
Area, in2	12.55		13.07
Volume in3	54.23		57.13
Total Volume, cc	888.71		936.25
Volume Solids, cc	618.52		618.52
Volume Voids, cc	270.19		317.73
Void Ratio	0.44		0.51
Porosity, %	30.40		33.94
Saturation, %	61.48		96.72
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	1836.1		1977.3
Dry Weight, gm	1670.0		1670.0
Tare, gm	0.00		0.00
Moisture, %	9.9		18.4
Dry Density, pcf	117.3		111.3

Note: *B=Delta Pore Press/Delta Cell Press (indication of saturation).

Hydraulic Conductivity
ASTM D 5084

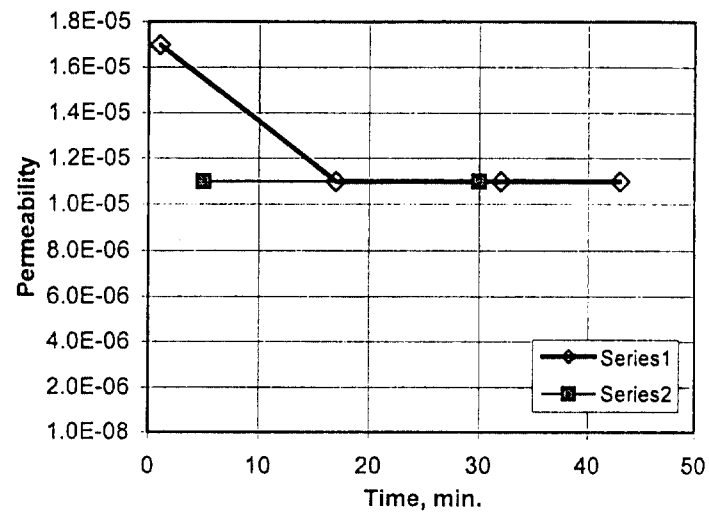
Job No:	028-1056	**Boring:**		**Date:**	01/16/02
Client:	Lowney	**Sample:**	T5-85	**By:**	MD
Project:	TRC/WDI	**Depth'**		**Checked By:**	DC

Soil Description: brown clayey SAND

Sample Pressures:						***B: =**	1
Cell:	53.5 psi	**Bot. Cap:**	49 psi	**Top Cap:**	48 psi	**Gradient:**	13

Method C: Falling Head / Rising Tailwater

Date	Minutes	Head, (in)	K,cm/sec
1/11/02	0	51.69	Start of Test
	1	50.69	1.70E-05
	17	41.59	1.10E-05
	32	34.69	1.10E-05
	43	30.04	1.10E-05
	0	51.69	
	5	48.59	1.10E-05
	30	35.19	1.10E-05



Average Permeability: 1.E-05 cm/sec

Sample Data:	Initial		Final
Height, in	4.52		4.59
Diameter, in	4.00		4.01
Area, in2	12.55		12.63
Volume in3	56.74		57.97
Total Volume, cc	929.85		949.93
Volume Solids, cc	616.07		616.07
Volume Voids, cc	313.78		333.85
Void Ratio	0.51		0.54
Porosity, %	33.74		35.15
Saturation, %	34.80		95.58
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	1772.6		1982.5
Dry Weight, gm	1663.4		1663.4
Tare, gm	0.00		0.00
Moisture, %	6.6		19.2
Dry Density, pcf	111.6		109.3

Note: *B=Delta Pore Press/Delta Cell Press (indication of saturation).

LOWNEYASSOCIATES
Environmental/Geotechnical/Engineering Services

Mountain View
Oakland
San Ramon
Fullerton

January 18, 2002
1651-8

TRC SOLUTIONS, INC.
21 Technology Drive
Irvine, California 92618

Attention: Mr. Allen E. Blodgett, GE
Project Director

RE: GEOTECHNICAL LABORATORY TEST RESULTS FOR "WDI LANDFILL CONTAINMENT DESIGN" SANTA FE SPRINGS, CALIFORNIA

Gentlemen:

We are pleased to present results of our geotechnical laboratory testing for your "WDI" project. Geotechnical test results are presented in an "Appendix B" format for easy insertion into most standard geotechnical reports. Our geotechnical laboratory is licensed by the City of Los Angeles, Department of Building and Safety, Materials Control Division, as a "Soils Testing Agency" No. 10149. In accordance with our December 13, 2001 "FAX Confirmation of Requested Services," your samples will be disposed of in 30 days. We appreciate the opportunity to be of service. If you have any questions concerning these test results, please call or contact me by phone or e-mail at tbenson@lowney.com.

Sincerely,

LOWNEY ASSOCIATES

Thomas C. Benson, Jr., G.E. 2091
Vice President

REGISTERED PROFESSIONAL ENGINEER
THOMAS C. BENSON, JR.
No. 2091
Exp. 3/31/05
GEOTECHNICAL
STATE OF CALIFORNIA

Copies: Addressee (2)

Enclosures: Appendix B, "Geotechnical Laboratory Testing" (8 pages)

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APPENDIX B
GEOTECHNICAL LABORATORY TESTING

The following geotechnical laboratory tests were performed on soil samples brought to the Lowney Associates geotechnical laboratory by TRC personnel.

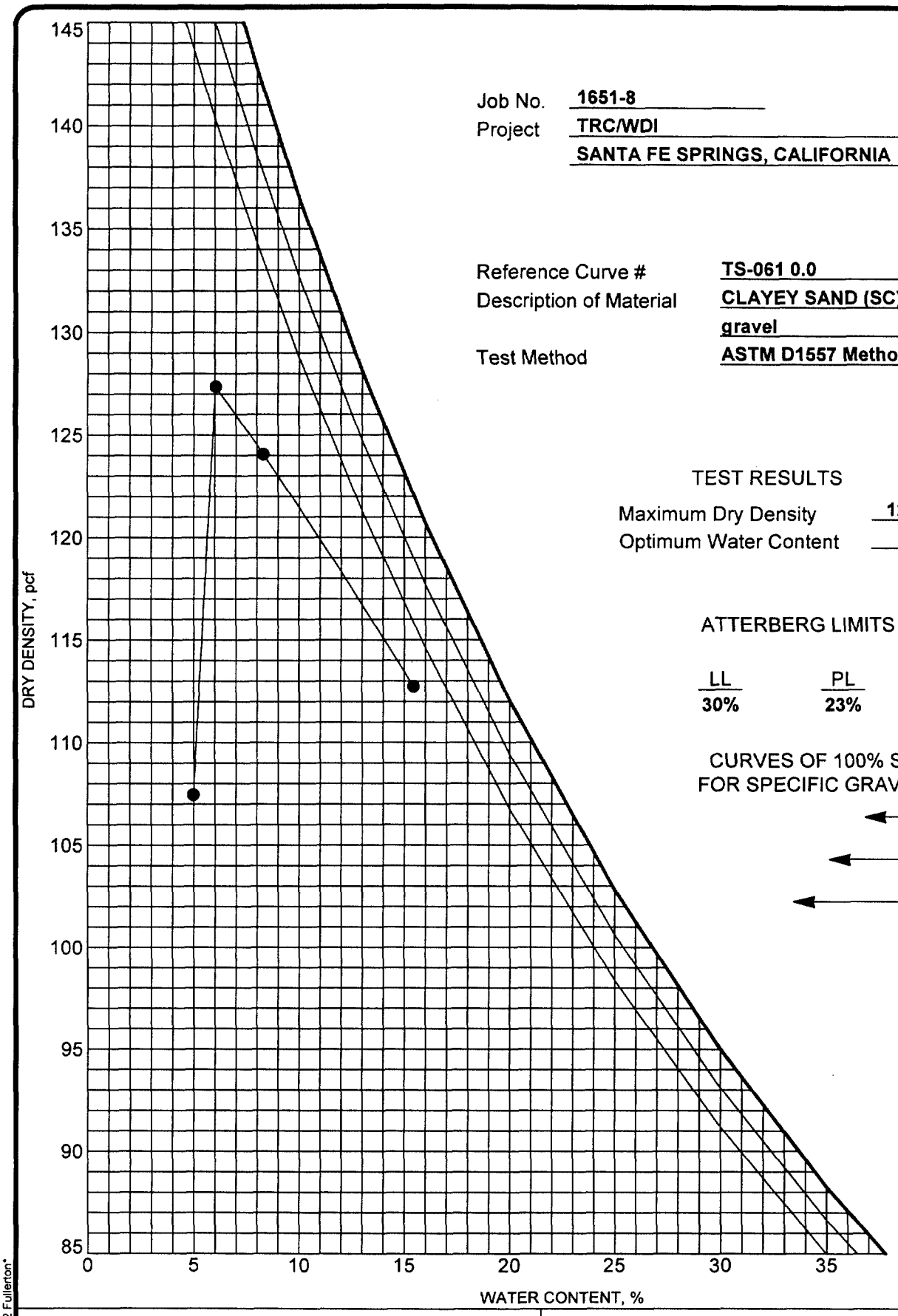
Compaction: Three laboratory compaction tests (ASTM D 1557-00) were performed on provided bulk soil samples to determine the maximum dry density and optimum moisture content. Results of these tests are presented graphically on the following "Moisture-Density Relationship" figures.

Gradations: Sieve and hydrometer analyses (ASTM D 422-63) were performed on the same three soil samples. These tests were performed to assist in the classification of the soil and to determine grain size distributions of the soils. Results of these tests are presented on the "Grain Size Distribution" figure.

Plasticity Index: Plasticity Index determinations (ASTM D 4318) were performed on the same three soil samples to measure the range of water contents over which these materials exhibit plasticity. The Atterberg Limits were used to classify the soil in accordance with the Unified Soil Classification System and to evaluate the soil expansion potential. Results of these tests are presented on the "Plasticity Chart and Data" figure.

Falling Head Permeability: Two falling head permeability tests were performed on remolded specimens, in general accordance with the ASTM D 5084-90 Standard Test Method. Specimen and test result data are presented on the attached two sheets titled "Hydraulic Conductivity."

* * * * * * * * *



Job No. 1651-8
Project TRC/WDI
SANTA FE SPRINGS, CALIFORNIA

Reference Curve # TS-061 0.0
Description of Material CLAYEY SAND (SC), trace fine gravel
Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 127.0 PCF
Optimum Water Content 6.0 %

ATTERBERG LIMITS

LL	PL	PI
30%	23%	7%

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

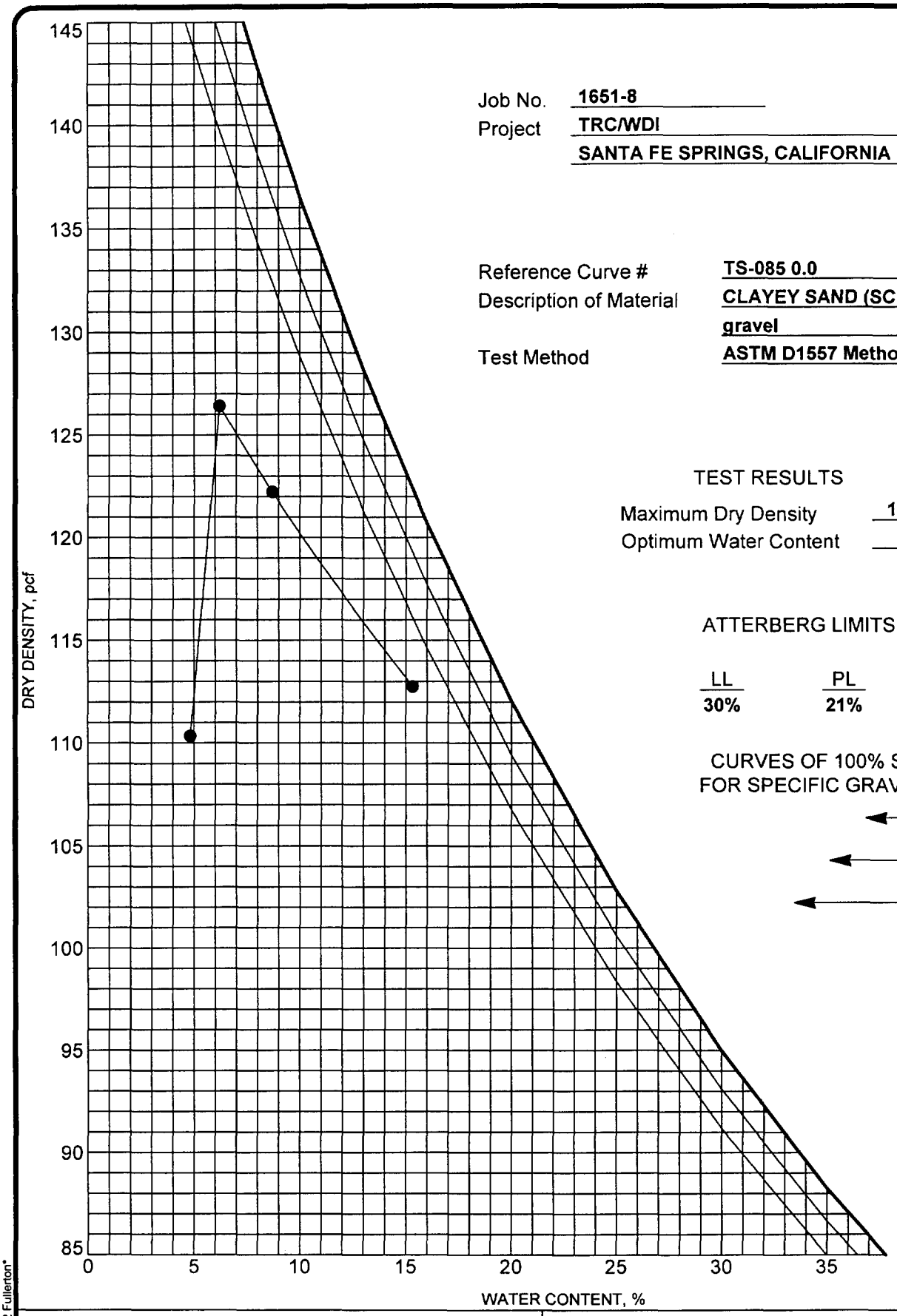
2.80
2.70
2.60

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

MOISTURE-DENSITY RELATIONSHIP

Project: TRC/WDI
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8

LA CORP GDT 2/21/02 Fullerton*



Job No. 1651-8
Project TRC/WDI
SANTA FE SPRINGS, CALIFORNIA

Reference Curve # TS-085 0.0
Description of Material CLAYEY SAND (SC), trace fine gravel
Test Method ASTM D1557 Method A

TEST RESULTS

Maximum Dry Density 126.0 PCF
Optimum Water Content 6.0 %

ATTERBERG LIMITS

LL	PL	PI
30%	21%	9%

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

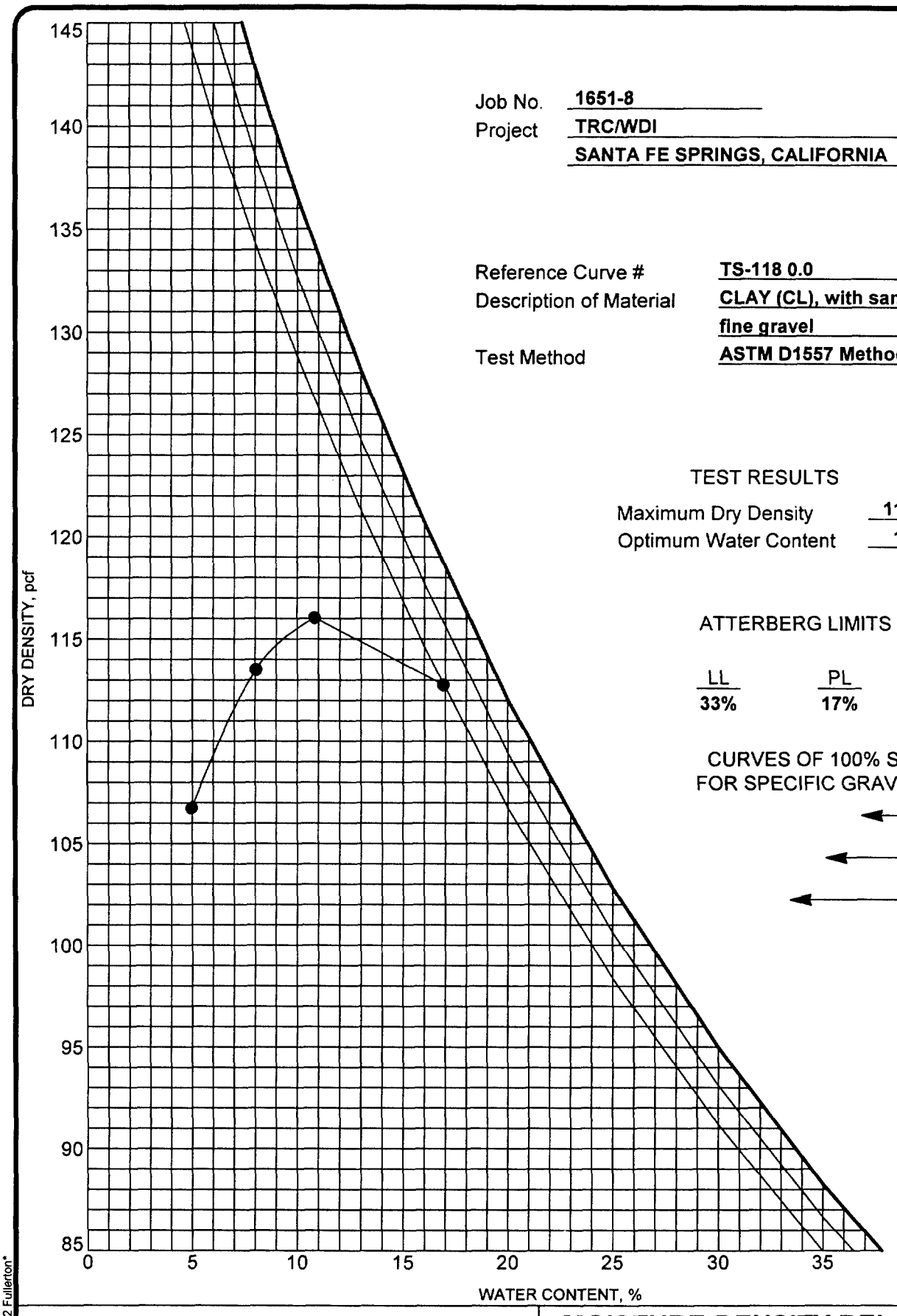
2.80
2.70
2.60

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

MOISTURE-DENSITY RELATIONSHI

Project: TRC/WDI
Location: SANTA FE SPRINGS, CALIFORNIA
Project No.: 1651-8

LA CORP.GDT 2/21/02 Fullerton*



Job No. **1651-8**

Project **TRC/WDI**

SANTA FE SPRINGS, CALIFORNIA

Reference Curve # **TS-118 0.0**

Description of Material **CLAY (CL), with sand and trace fine gravel**

Test Method **ASTM D1557 Method A**

TEST RESULTS

Maximum Dry Density	**116.0**	**PCF**
Optimum Water Content	**11.0**	**%**

ATTERBERG LIMITS

LL	PL	PI
33%	**17%**	**16%**

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

← 2.80

← 2.70

← 2.60

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

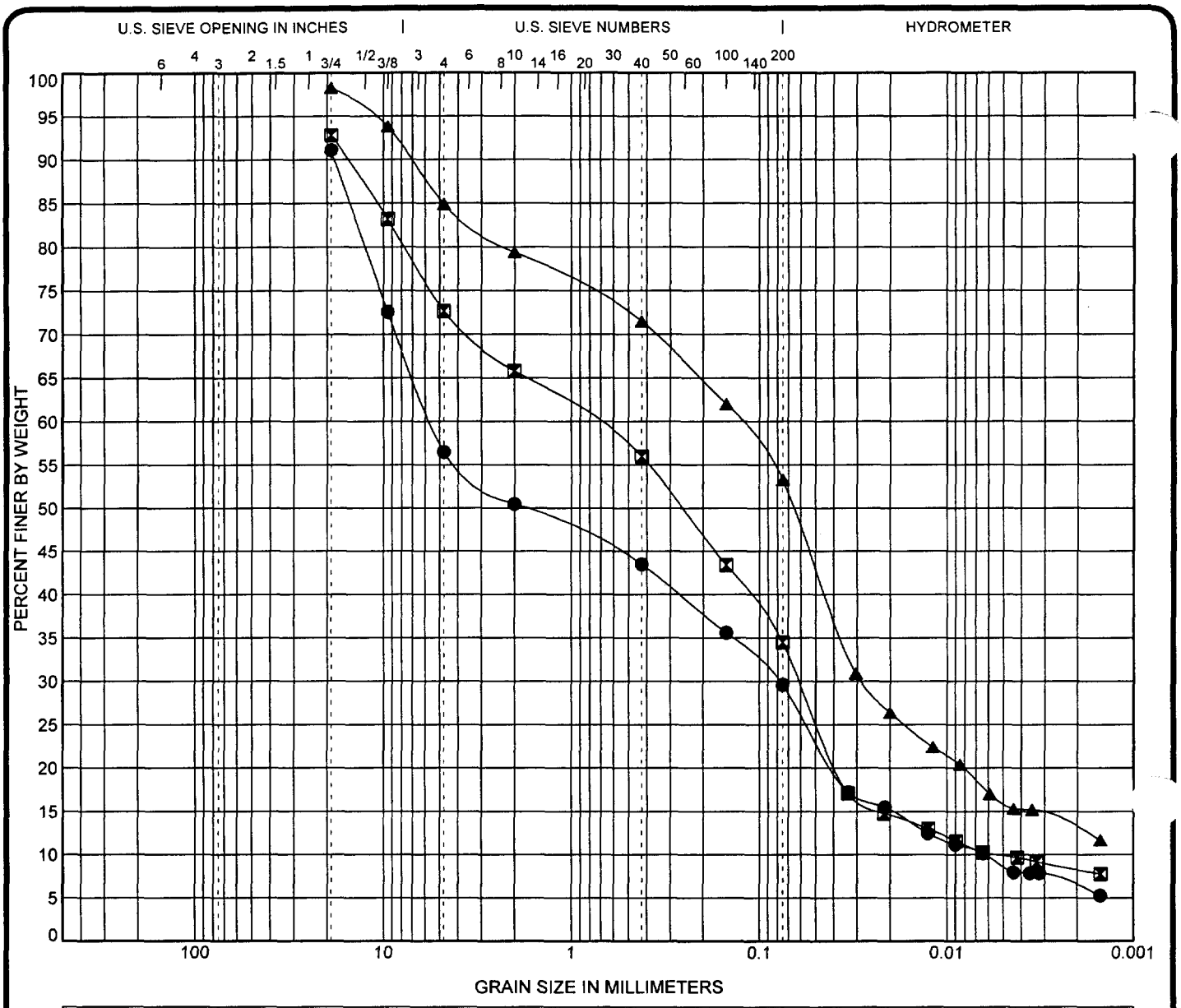
MOISTURE-DENSITY RELATIONSHIP

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

LA_CORP.GDT 2/21/02 Fullerton*



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**TS-061**	**0.0**	**CLAYEY SAND (SC), trace fine gravel**	**30**	**23**	**7**	**0.18**	**892.79**
⊠	**TS-085**	**0.0**	**CLAYEY SAND (SC), trace fine gravel**	**30**	**21**	**9**	**0.90**	**154.25**
▲	**TS-118**	**0.0**	**CLAY (CL), with sand and trace fine gravel**	**33**	**17**	**16**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TS-061**	**0.0**	**19**	**5.522**	**0.079**	**0.006**	**34.6**	**26.9**	**20.8**	**8.8**
⊠	**TS-085**	**0.0**	**19**	**0.8**	**0.061**	**0.005**	**20.1**	**38.2**	**24.6**	**9.9**
▲	**TS-118**	**0.0**	**19**	**0.128**	**0.028**		**13.4**	**31.6**	**37.3**	**16.0**

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

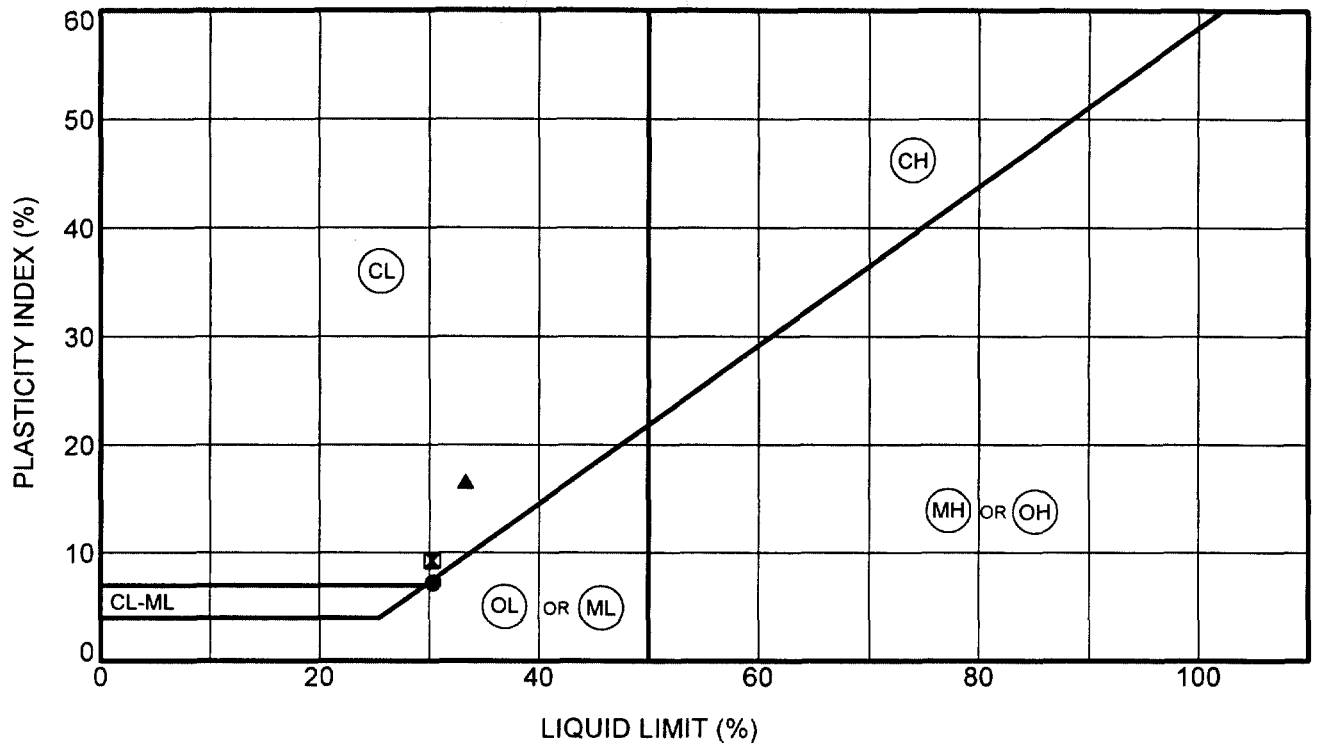
GRAIN SIZE DISTRIBUTION

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

LA CORP.GDT 2/21/02 Fullerton*



Symbol	Boring No.	Depth (ft.)	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing No. 200 Sieve	Unified Soil Classification Description
●	**TS-061**	**0.0**		**30**	**23**	**7**	**30**	**CLAYEY SAND (SC), trace fine gravel**
⊠	**TS-085**	**0.0**		**30**	**21**	**9**	**35**	**CLAYEY SAND (SC), trace fine gravel**
▲	**TS-118**	**0.0**		**33**	**17**	**16**	**53**	**CLAY (CL), with sand**

LA_CORP.GDT 2/21/02 Fullerton*

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

PLASTICITY CHART AND DATA

Project: TRC/WDI

Location: SANTA FE SPRINGS, CALIFORNIA

Project No.: 1651-8

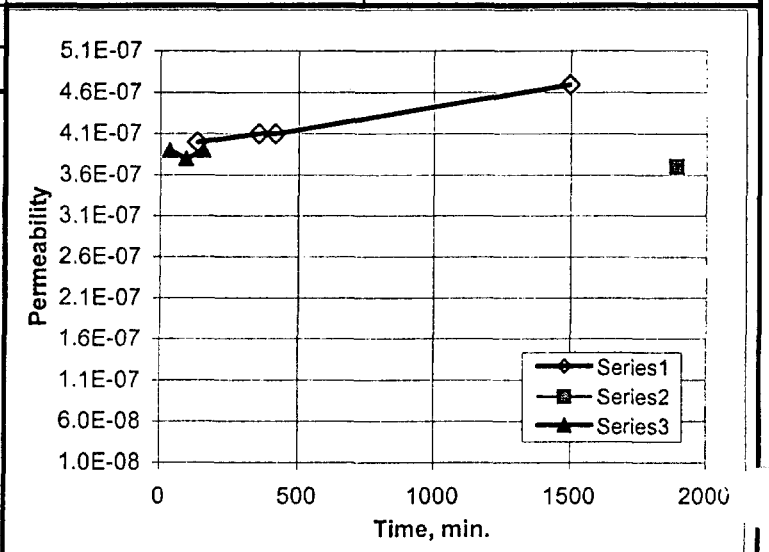
Hydraulic Conductivity
ASTM D 5084

Job No:	028-1056a	**Boring:**		**Date:**	01/16/02
Client:	Lowney	**Sample:**	T5-118	**By:**	MD
Project:	TRC/WDI	**Depth'**		**Checked By:**	DC
Soil Description:	brown sandy CLAY				

Sample Pressures:						***B: =**	1
Cell:	53.5 psi	**Bot. Cap:**	49 psi	**Top Cap:**	48 psi	**Gradient:**	13

Method C: Falling Head / Rising Tailwater

Date	Minutes	Head, (in)	K,cm/sec
1/11/02	0	51.69	Start of Test
	133	48.54	4.00E-07
	356	43.39	4.10E-07
	416	41.99	4.10E-07
1/12/02	1496	23.09	4.70E-07
	0	24	
1/13/02	1890	10.8	3.70E-07
	0	51.69	
1/14/02	33	50.89	3.90E-07
	93	49.54	3.80E-07
	155	48.09	3.90E-07



Average Permeability: **2.E-07** **cm/sec**

Sample Data:	**Initial**		**Final**
Height, in	4.32		4.37
Diameter, in	4.00		4.08
Area, in2	12.55		13.07
Volume in3	54.23		57.13
Total Volume, cc	888.71		936.25
Volume Solids, cc	618.52		618.52
Volume Voids, cc	270.19		317.73
Void Ratio	0.44		0.51
Porosity, %	30.40		33.94
Saturation, %	61.48		96.72
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	1836.1		1977.3
Dry Weight, gm	1670.0		1670.0
Tare, gm	0.00		0.00
Moisture, %	9.9		18.4
Dry Density, pcf	117.3		111.3

Note: *B=Delta Pore Press/Delta Cell Press (indication of saturation).

Hydraulic Conductivity
ASTM D 5084

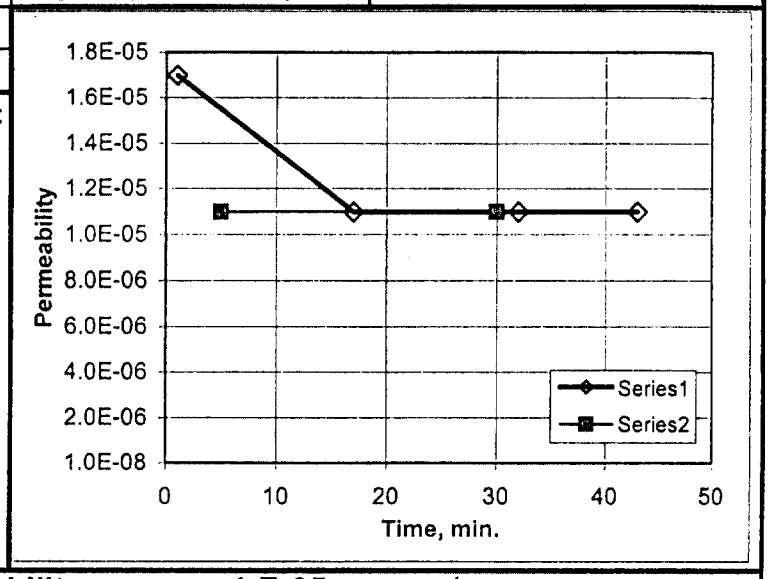
Job No:	028-1056	**Boring:**		**Date:**	01/16/02
Client:	Lowney	**Sample:**	T5-85	**By:**	MD
Project:	TRC/WDI	**Depth'**		**Checked By:**	DC

Soil Description: brown clayey SAND

Sample Pressures:						***B: =**	1
Cell:	53.5 psi	**Bot. Cap:**	49 psi	**Top Cap:**	48 psi	**Gradient:**	13

Method C: Falling Head / Rising Tailwater

Date	Minutes	Head, (in)	K,cm/sec
1/11/02	0	51.69	Start of Test
	1	50.69	1.70E-05
	17	41.59	1.10E-05
	32	34.69	1.10E-05
	43	30.04	1.10E-05
	0	51.69	
	5	48.59	1.10E-05
	30	35.19	1.10E-05



Average Permeability: **1.E-05** **cm/sec**

Sample Data:	Initial		Final
Height, in	4.52		4.59
Diameter, in	4.00		4.01
Area, in2	12.55		12.63
Volume in3	56.74		57.97
Total Volume, cc	929.85		949.93
Volume Solids, cc	616.07		616.07
Volume Voids, cc	313.78		333.85
Void Ratio	0.51		0.54
Porosity, %	33.74		35.15
Saturation, %	34.80		95.58
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	1772.6		1982.5
Dry Weight, gm	1663.4		1663.4
Tare, gm	0.00		0.00
Moisture, %	6.6		19.2
Dry Density, pcf	111.6		109.3

Note: *B=Delta Pore Press/Delta Cell Press (indication of saturation).

APPENDIX E

CPT LOGS

APPENDIX E
WDI SUPERFUND SITE
CPT STRENGTH CORRELATION

E.1 INTRODUCTION

In August 1988, 21 Cone Penetrometer Test (CPT) soundings were performed by The Earth Technology Corporation at the WDI site, in and around the waste filled reservoir, as documented in their September 1988 report to Ebasco Services Incorporated. Out of the 21 CPT soundings, only two were located within the reservoir, where shallow refusal at depths of 2.3 to 6.4 feet occurred in both. Data from these other 19 CPTs outside of the reservoir was used in combination with other drive sampling blow counts and current geotechnical laboratory strength data (summer 2002), to evaluate the shear strength of the bentonite waste. This shear strength was for use in evaluating the potential for bearing capacity failures during proposed cover earthwork (see Appendix F).

E.2 BACKGROUND

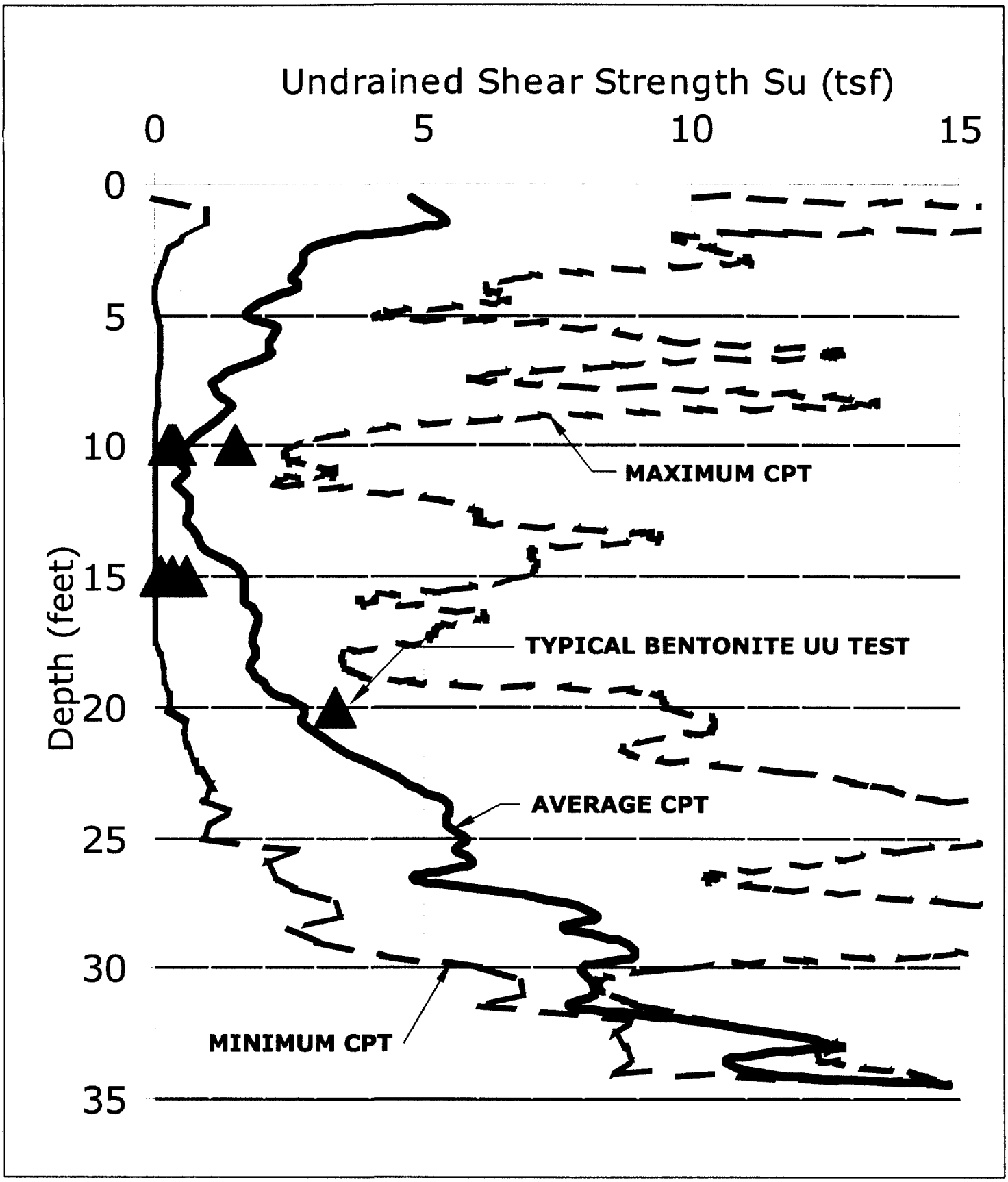
CPT data, including encountered tip refusals, were compared and qualified based on our understanding of the "waste" matrix consisting of non-organic rubble with voids filled by bentonite, and on empirical observations of the site topography over the decades during which bentonite waste has remained on-site, as demonstrated on Figure 6.5, *Topographic Difference Map*. In 1998, grading work was performed at the site and detailed in "*Technical Memo No. 11-Reservoir Area Grading Plans and Waste/Debris Management As-Built Report, Waste Disposal Inc. Superfund Site*" (TRC, December 1998). Now, minor new grading is proposed to provide an engineered cap over the waste, and possibly for redevelopment of the site including pavements and structures around the perimeter of the site. We are unaware of any bearing capacity failures during the 1998 grading. Based on the topographic and grading empirical data, in combination with the various CPT refusals, we consider this non-refusal CPT data to be indicative of the softer material at the site, and therefore, lower bound strength data.

E.3 KEY ASSUMPTION

The CPT tip resistance (q_c) to undrained shear strength (S_u) correlation is discussed on the attached March 8, 1999 Memorandum from GeoSyntec (provided by the California Department of Toxic Substance Control, DTSC). For oily waste, such as for this site, the material correlation factor N_k was assumed to be 20.

E.4 RESULTS

Results of the CPT tip resistance (q_c) to undrained shear (S_u) strength correlation are summarized on Figure 6.7.



Thomas C. Benson Jr., GE 9/26/2002 4:26 PM 1651-8A-D23.dwg

AVERAGE UNDRAINED SHEAR STRENGTH, FROM CPTs - OUTSIDE OF RESERVOIR

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE 6.4-1

1651-8A

RAM RAMANUJAM

GEOSYNTEC CONSULTANTS

MEMORANDUM

TO: Dr. R. Jeffrey Dunn, P.E., G.E., GeoSyntec Consultants

FROM: Paul Soltis, P.E. and Neven Matasovic, Ph.D., P.E., GeoSyntec Consultants

DATE: 8 March 1999

SUBJECT: **Casmalia Resources Hazardous Waste Management Facility: Evaluation of CPT shear strength factor N_k from the results of in-situ measurements**

Introduction

One of the key parameters for evaluation of seismic stability of the PCB, Heavy Metals Sludges, Caustics/Cyanide and Acids Landfills (Other Landfills) at the Casmalia Resources Hazardous Waste Management Facility (Casmalia) site is the undrained shear strength (S_u) of the on-site waste materials. S_u is commonly estimated from the results of the Cone Penetration Test (CPT) soundings using the following equation:

$$S_u = \frac{q_c - \sigma_{vo}}{N_k} \qquad (1)$$

where q_c is (uncorrected) CPT cone tip resistance, σ_{vo} is the initial total vertical stress, and N_k is an empirical constant. Equation (1) indicates that the undrained shear strength is inversely proportional to the N_k value, i.e., the undrained shear strength linearly decreases with increasing N_k.

Several attempts have been made to correlate N_k with various soil indices. A recent publication by Lunne et al. [1997] cites the Aas et al. [1986] correlation as the latest development. The Aas et al. [1986] correlation was developed for Norwegian onshore clays over a range of Plasticity Index (PI) values (see Figure 1). If we assume that the landfill mass at the Casmalia site underwent a similar consolidation process as the Norwegian onshore clays (i.e., the waste mass is normally consolidated to slightly

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RECYCLED AND RECYCLABLE

overconsolidated with no fissures) and a *PI* between 10 and 50 for the landfill mass (assumed based on available information on on-site sludges and soils), the Aas et al. [1986] correlation indicates that the N_k value for the landfill mass could range from 8 to 20.

Evaluation of N_k from Shear Wave Velocity

To further evaluate the on-site N_k value for the Other Landfills, we employed the results of Spectral Analysis of Surface Waves (SASW) soundings at the same landfills. These SASW soundings are documented in greater detail in GeoSyntec [1999a; 1999b]. As explained in GeoSyntec [1999a; 1999b], results of the SASW soundings are interpreted as the shear wave velocity (V_s) profiles. We employed a correlation between shear wave velocity, V_s, and S_u to substantiate the likely range of values for N_k, i.e., the correlation between q_c and S_u.

V_s is a small-strain parameter (strains on the order of 10^{-4} percent) while q_c and S_u are large-strain parameters. Despite the strain incompatibility of these parameters, all three parameters share functional dependence on similar quantities, including effective confining stress level, in-situ stress state, mineralogy, aging, and cementation. We explored this functional dependence to substantiate the likely range of values for N_k.

The general procedure to estimate the range of likely N_k values from the SASW measurements that we employed is outlined below:

(i.) Demonstrate that V_s and q_c are correlated for the on-site waste materials;

(ii.) Estimate S_u using the $S_u - V_s$ correlation by Dickenson and Seed [1994] for soft clays; and

(iii.) Using Eq. 1, the q_c profile estimated from the Mayne and Rix [1995] correlation, and the S_u profile estimated from the Dickenson and Seed [1994] correlation, develop a site-specific N_k profile.

In order to demonstrate that the site-specific V_s and q_c values correlate, GeoSyntec employed the Mayne and Rix [1995] correlation between V_s and q_c. Mayne and Rix base their correlation on more than 480 tests in intact and fissured clays at 31 sites (see inset in Figure 2). The correlation takes into account the normal stress dependency of q_c values and has a coefficient of correlation as high as 0.7. Comparison between the measured (uncorrected) q_c values and the q_c values calculated from the V_s profile using the Mayne and Rix [1995] correlation is shown in Figure 2. Figure 2 indicates that measured and calculated q_c values correlate reasonably well over the depth interval considered.

Given the demonstrated agreement between measured and calculated q_c values over the depth interval considered, we then estimated the range of N_k values from the results of SASW measurements. We followed the procedure outlined above, starting with an estimate of the S_u profile from V_s. To estimate the S_u profile from V_s, we used the Dickenson and Seed [1994] correlation. This correlation, developed for relatively shallow deposits of San Francisco Bay Mud, is reproduced as an inset in Figure 3. Figure 3 indicates, as expected, that in general the undrained shear strength increases with depth.

Using the V_s-derived q_c profile from Figure 2, the V_s-derived S_u profile from Figure 3 and Equation 1, we estimated an average N_k profile for the Other Landfills. This average N_k profile for the Other Landfills is shown in Figure 4. Figure 4 indicates that N_k value for Other Landfills ranges from approximately 21 at the top of the landfill to approximately 19 at a depth of 75 feet (23 m). However, given the uncertainty in the data employed to develop the V_s and q_c profiles, an average N_k value of 20 appears appropriate for the upper 75 ft (23 m) of waste at the site.

Summary and Conclusions

This memorandum documents evaluation of the cone penetrometer interpretive undrained shear strength parameter N_k for the Other Landfills. N_k was evaluated based upon the correlation with Plasticity Index developed by Aas et al. (1986) and from the results of site-specific SASW measurements. The SASW interpretation was based on two independent correlations that relate shear wave velocity to the large strain parameters of CPT tip resistance and undrained shear strength. The comparison with average CPT tip resistance was employed to demonstrate that the SASW measurements and CPT data are correlated. The undrained shear strength correlation was then employed to estimate the undrained shear strength profile of the Other Landfills waste from the results of the SASW soundings. This intermediate result was then used to estimate an average N_k profile of on-site wastes.

The results of evaluations documented herein indicate that within the range of Other Landfills waste thicknesses, an average N_k value of 20 is appropriate.

References

Aas, G., Lacasse, S., Lunne, T., and Hoeg, K. [1986], "Use of In Situ Tests for Foundation Design on Clay," Proc. ASCE Specialty Conference *In Situ '86: Use of In Situ Tests in Geotechnical Engineering*, Blacksburg, 1-30, American Society of Engineers (as quoted in Lunne et al., 1997).

Dickenson, S.E. and Seed, R.B. [1994]. "Preliminary Report on Correlations of Shear Wave Velocity and Engineering Properties for Soft Soil Deposits in the San Francisco Bay Region," *Research Report*, Dept. Of Civil Engineering, UCB/EERC-94/XX, Berkeley, CA.

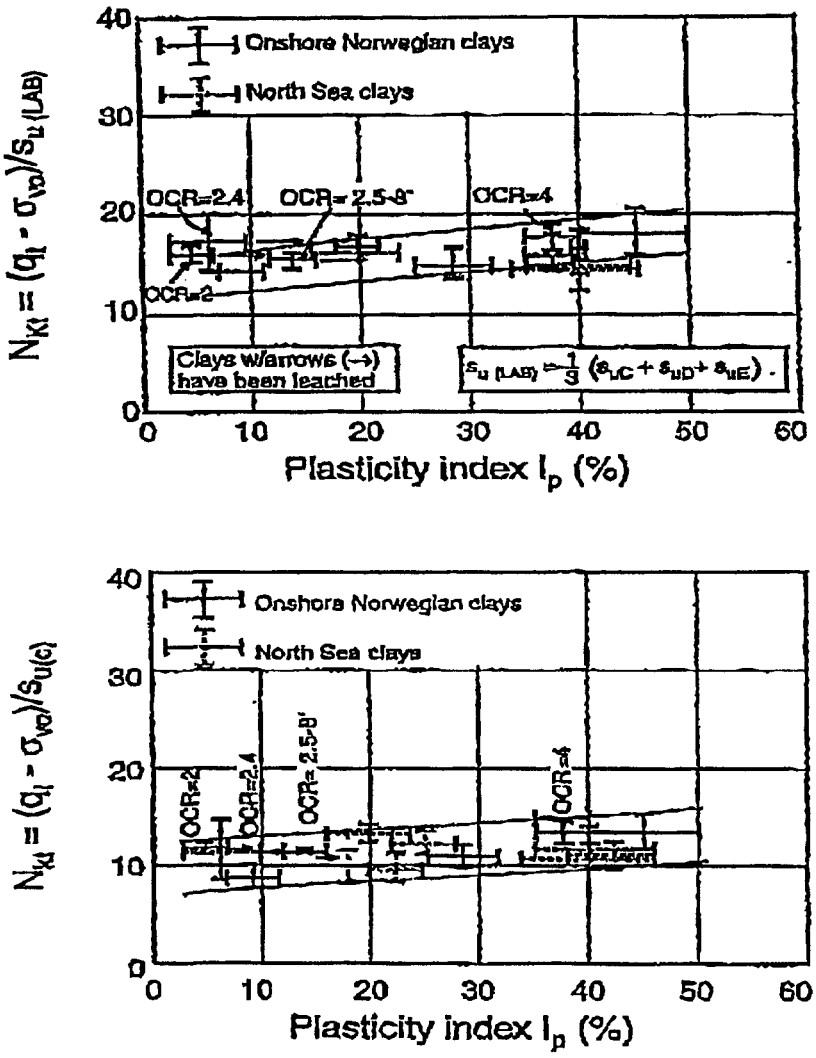
GeoSyntec [1999a], "Pesticides/Solvents (P/S) Landfill Cap, Revised Final Design Report, Casmalia Resources Hazardous Waste Management Facility, Santa Barbara County, California," *Technical Report*, GeoSyntec Consultants, Walnut Creek, California, January.

GeoSyntec [1999b], "Shear Wave Velocity and Undrained Shear Strength of Containerized Liquid Waste / Soil Matrix," *Letter Report*, GeoSyntec Consultants, Huntington Beach, California.

Lunne, T., Robertson, P.K., and Powell, J.J.M. [1997]. *Cone Penetration Testing in Geotechnical Practice*, published by Blackie Academic & Professional, London, 312 p.

Mayne, P. W., and Rix, G. J. [1995]. "Correlations Between Shear Wave Velocity and Cone Tip Resistance in Natural Clays," *Soils and Foundations*, Japanese Society of Soil Mechanics and Foundation Engineering, Vol. 35, No. 2, pp. 107-110.

* * * * *



Undrained shear strengths:
$s_{u\,(C)}$ triaxial compression
$s_{u\,(E)}$ triaxial extension
$s_{u\,(D)}$ direct simple shear

Figure 1 Aas et al. [1986] Correlation Between Cone Factor, N_k, nd Plasticity Index, I_p

TSC532331

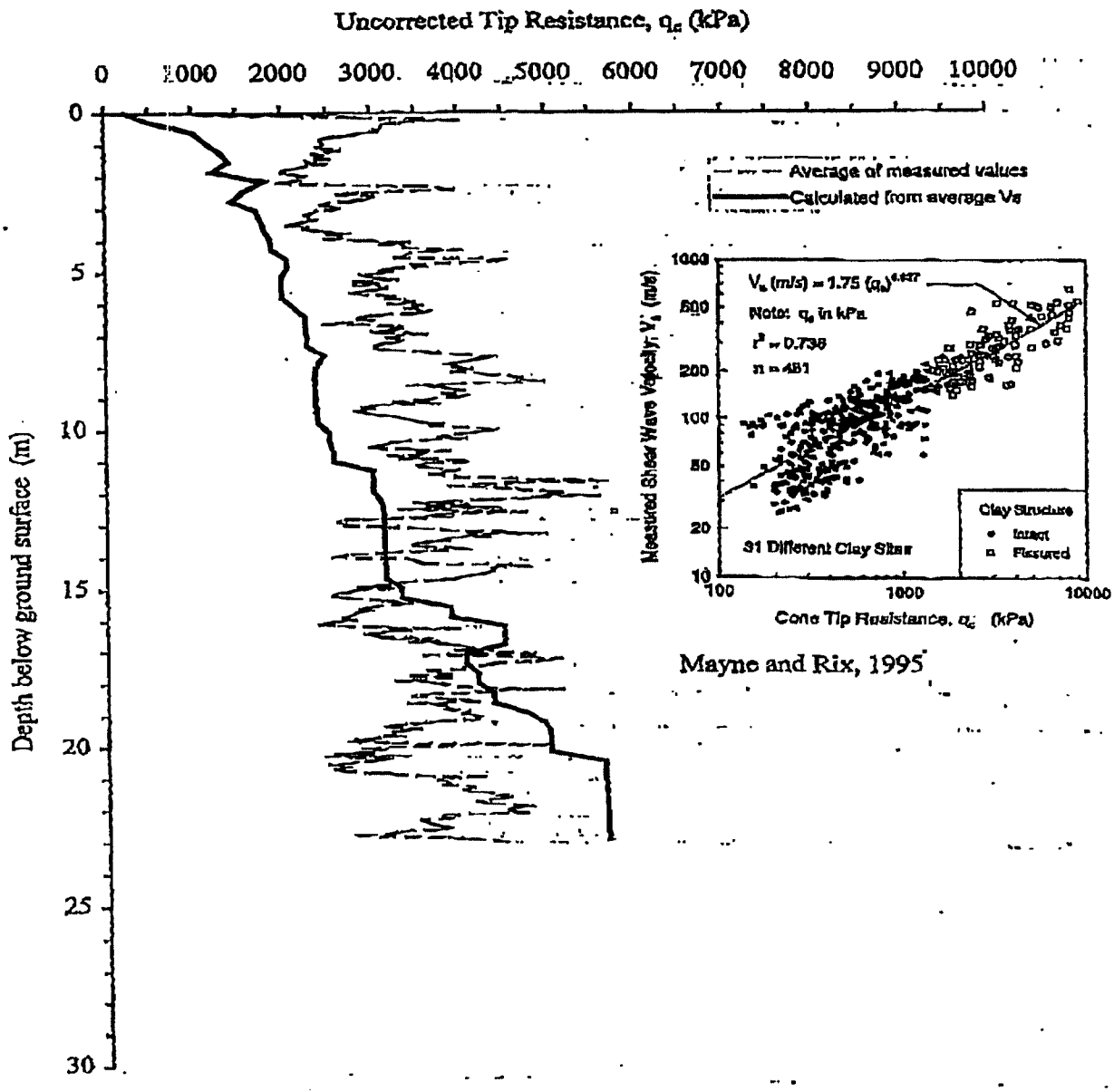


Figure 2 Comparison Between Measured (An Average of 30 Soundings at Four Landfills) and Estimated [Mayne and Rix, 1995 Correlation] q_c Profiles

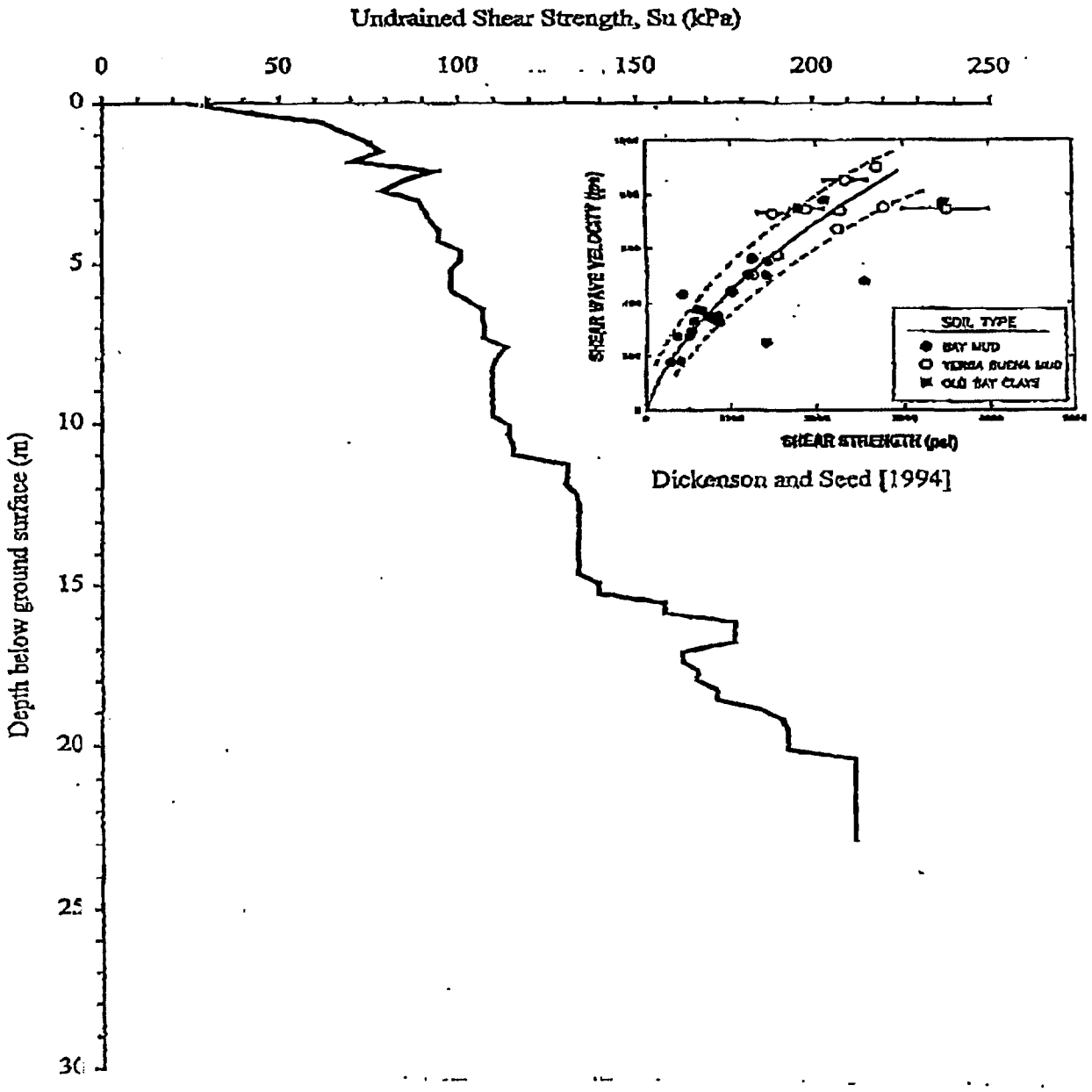


Figure 3 Undrained Shear Strength Profile Estimated from the Shear Wave Velocity Profile using the Dickenson and Seed [1994] Correlation

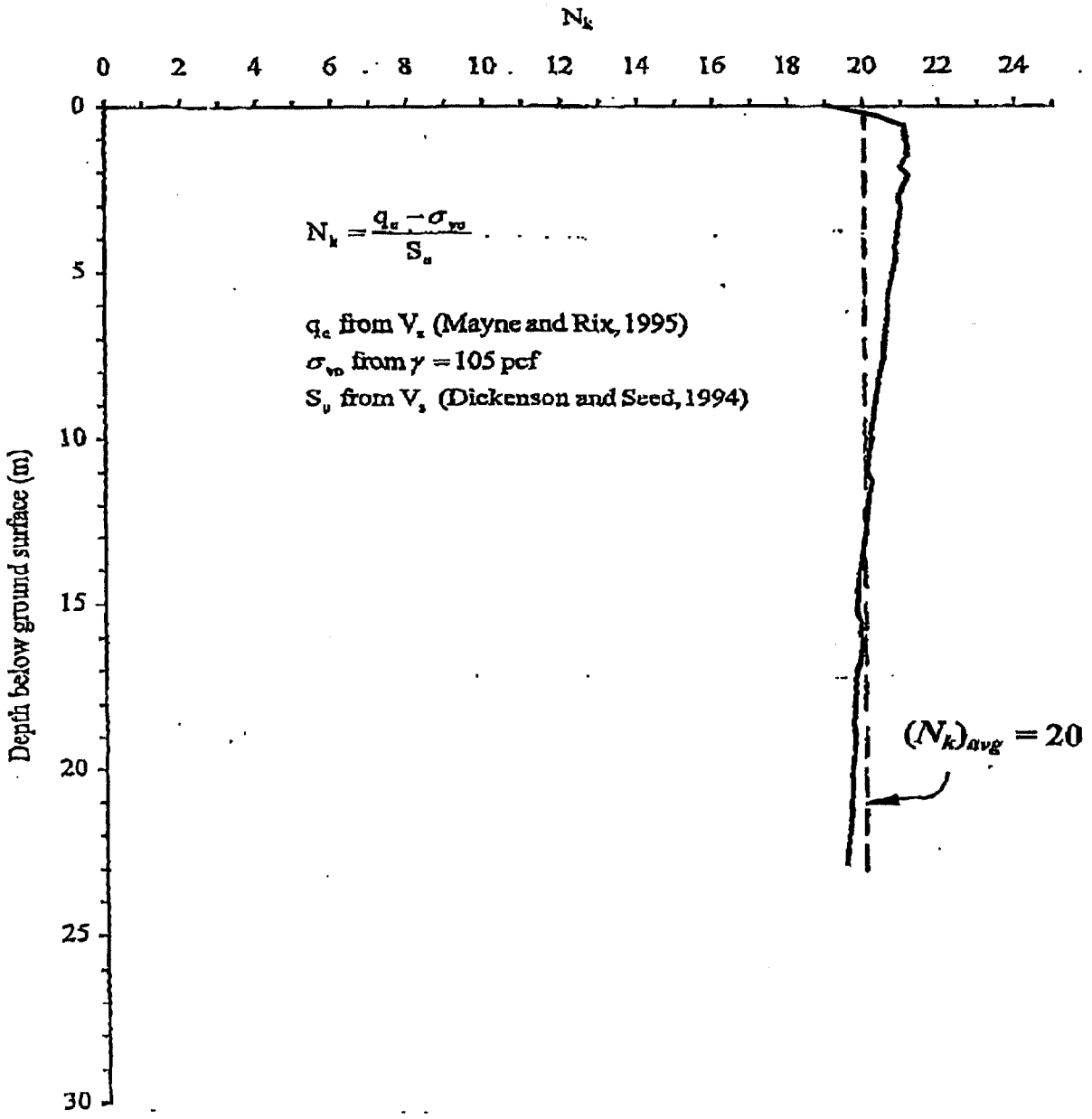
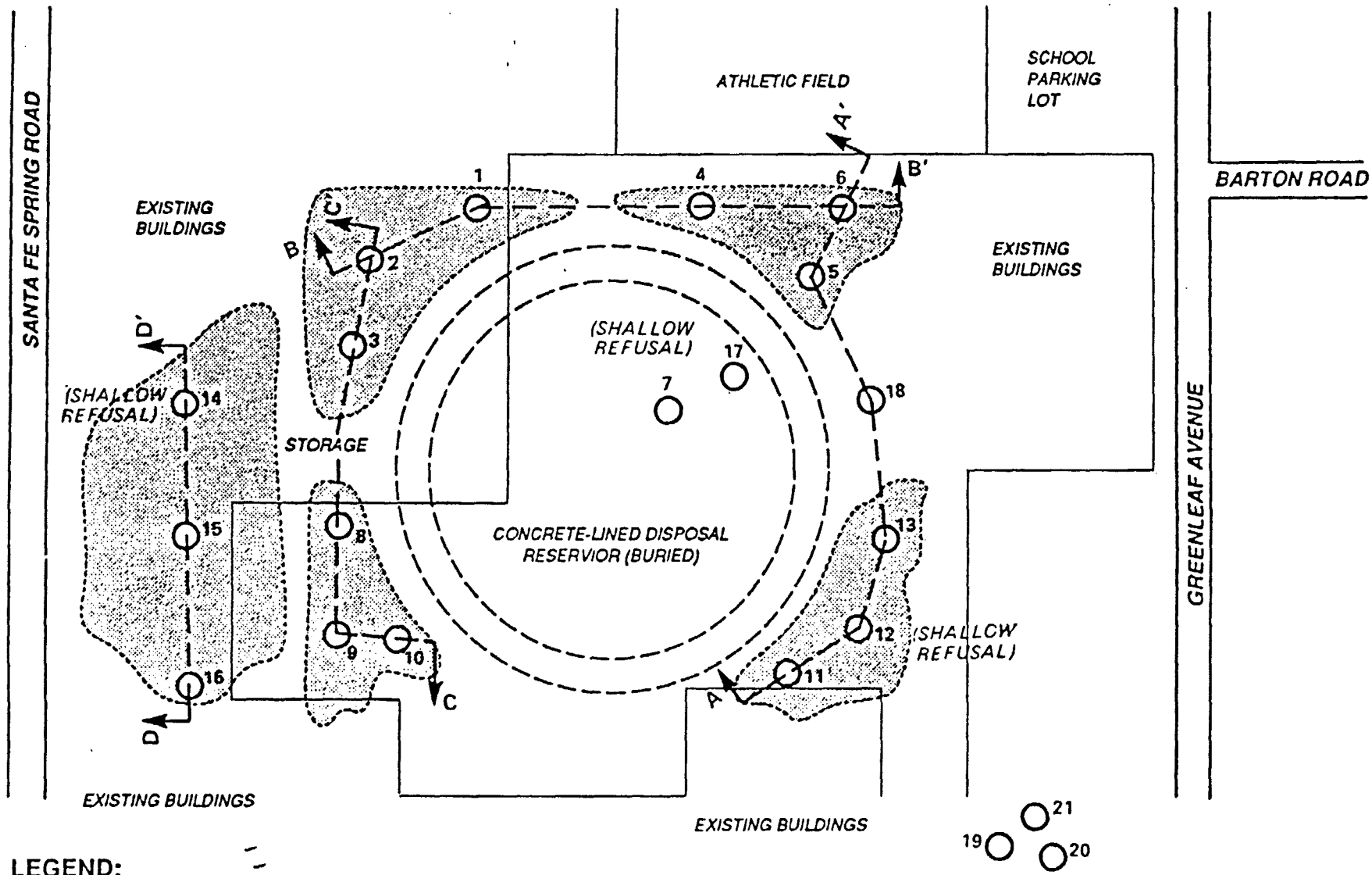


Figure 4 N_k Profile Estimated from the Results of SASW Measurements

TSC532334



LEGEND:

= SUMP (approx. location)

4 = CPT No. 4

The Earth Technology Corporation

PROJECT NO.: 89 230 2901

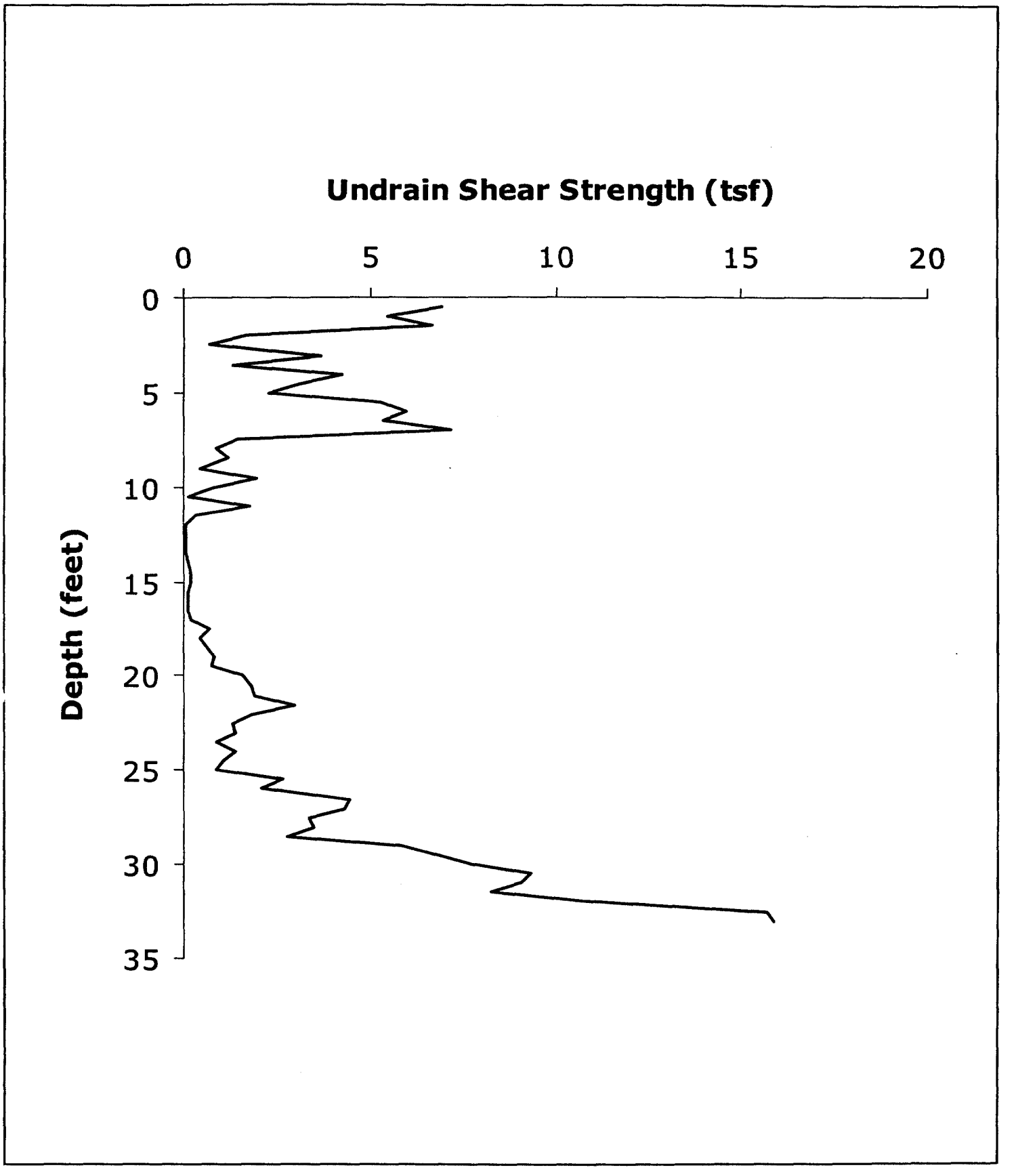
EBASCO-SANTA FE SPRINGS

APPROXIMATE LOCATIONS OF CPT SOUNDINGS

9-88

FIGURE 3

DIETERICH POST REORDER NO. 118131



UNDRAIN SHEAR STRENGTH - CPT-1

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

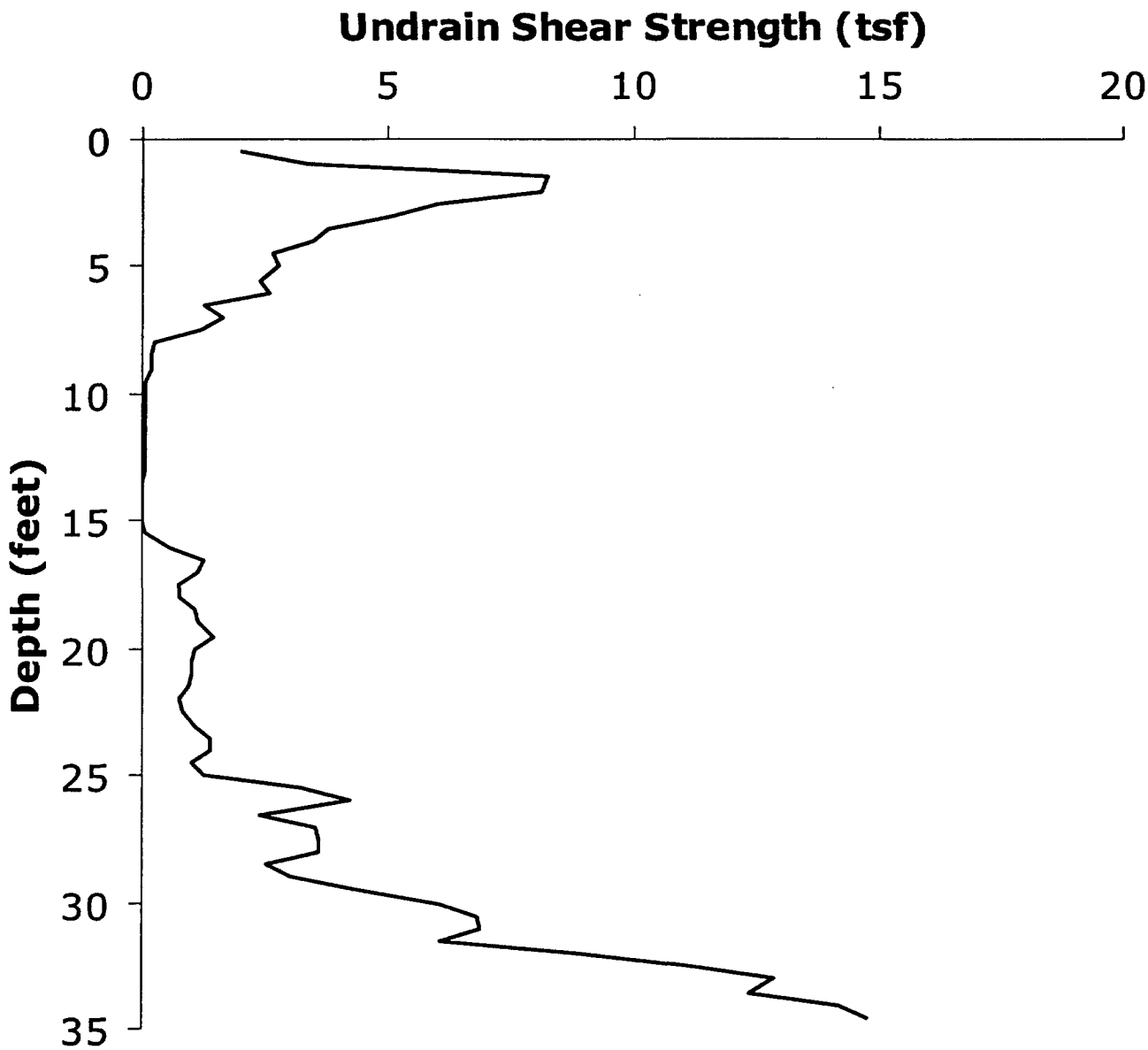
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-1

1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:05 PM 1651-8A-D1.dwg



UNDRAIN SHEAR STRENGTH - CPT-2D

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

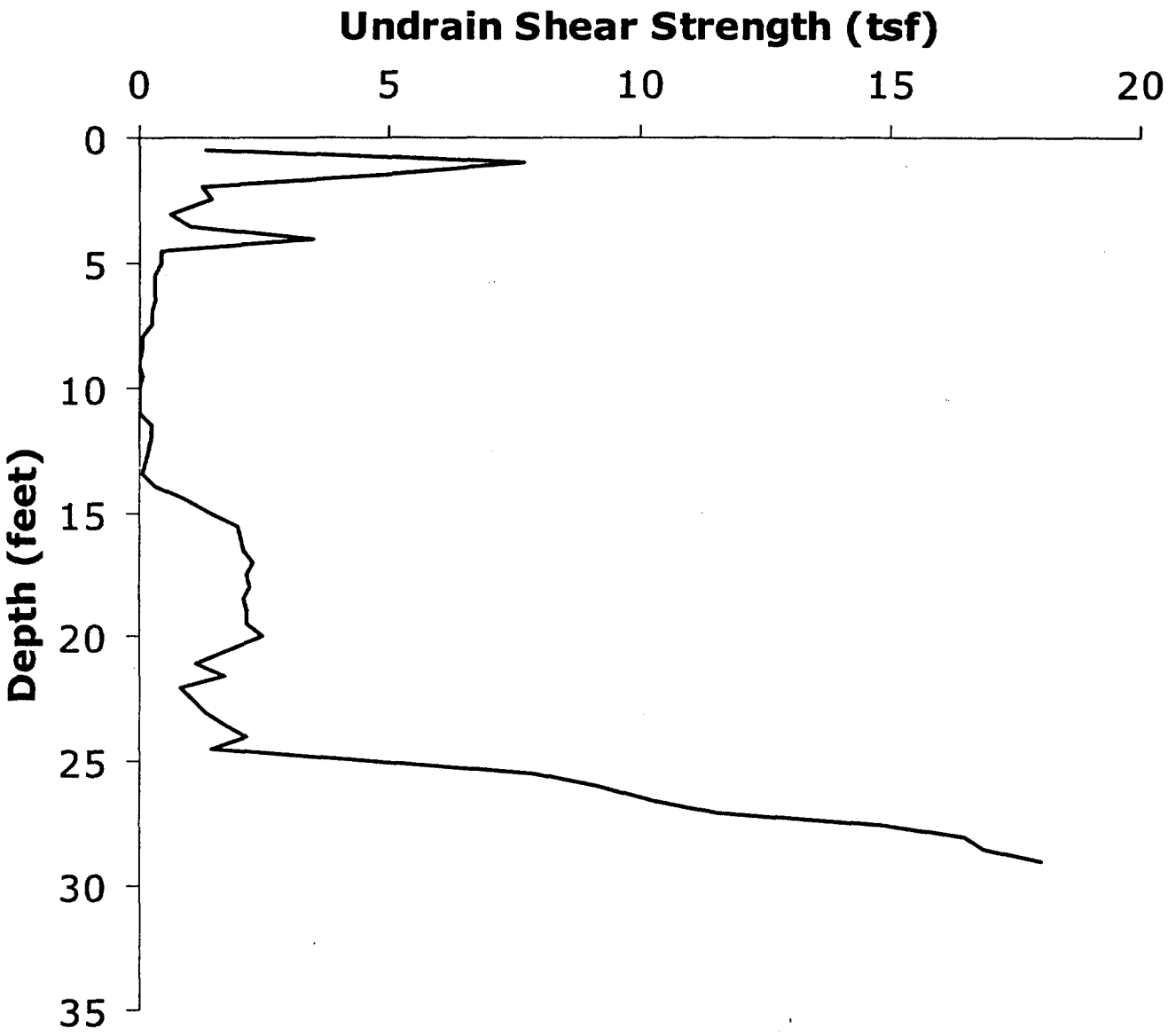
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-2

1651-8A

Tim Watson, Lowney Associates 09/17/2002 1:05 PM 8A-D1.dwg



UNDRAIN SHEAR STRENGTH - CPT-3

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

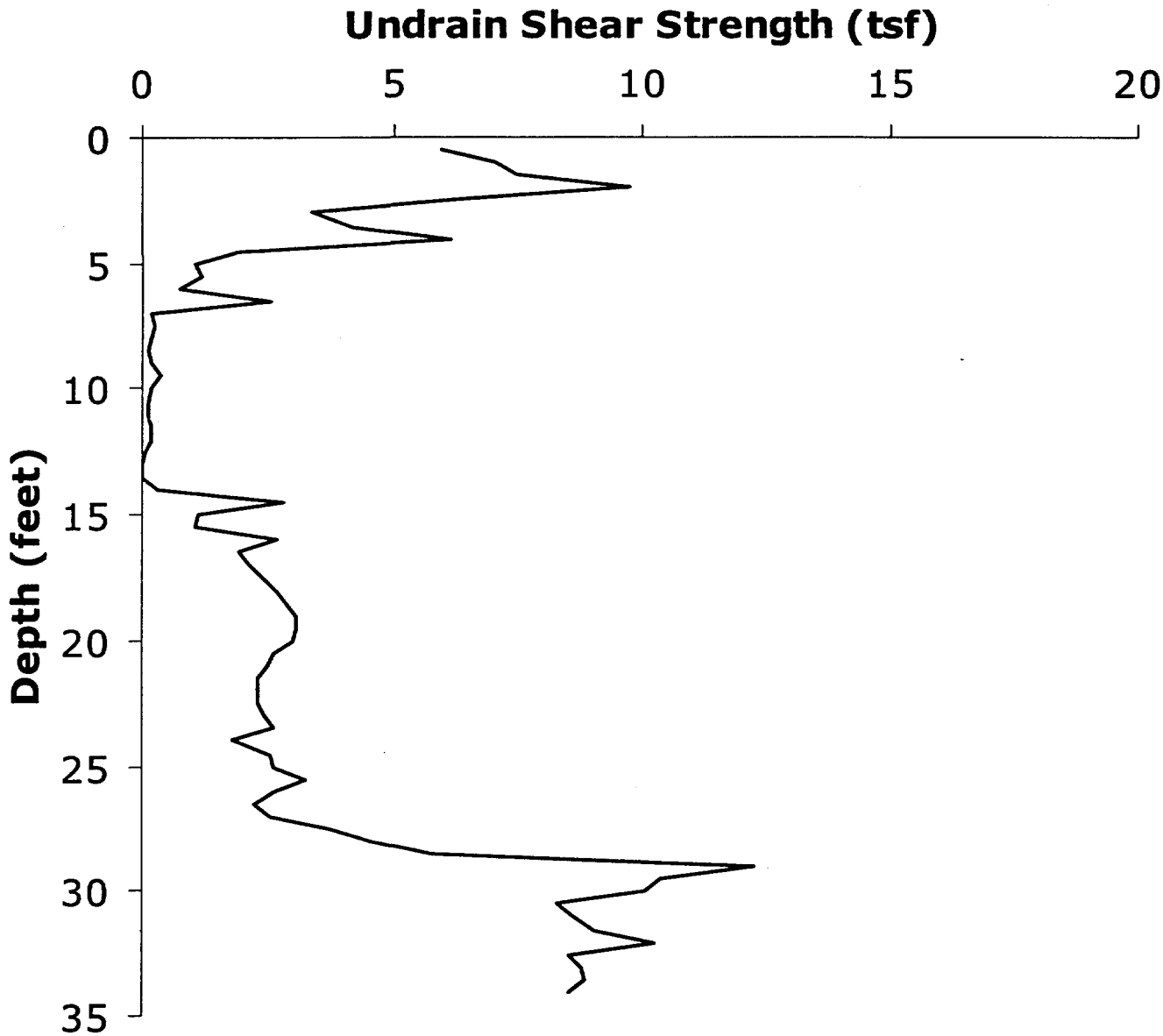
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-3

1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:12 PM 1651-8A-D3.dwg



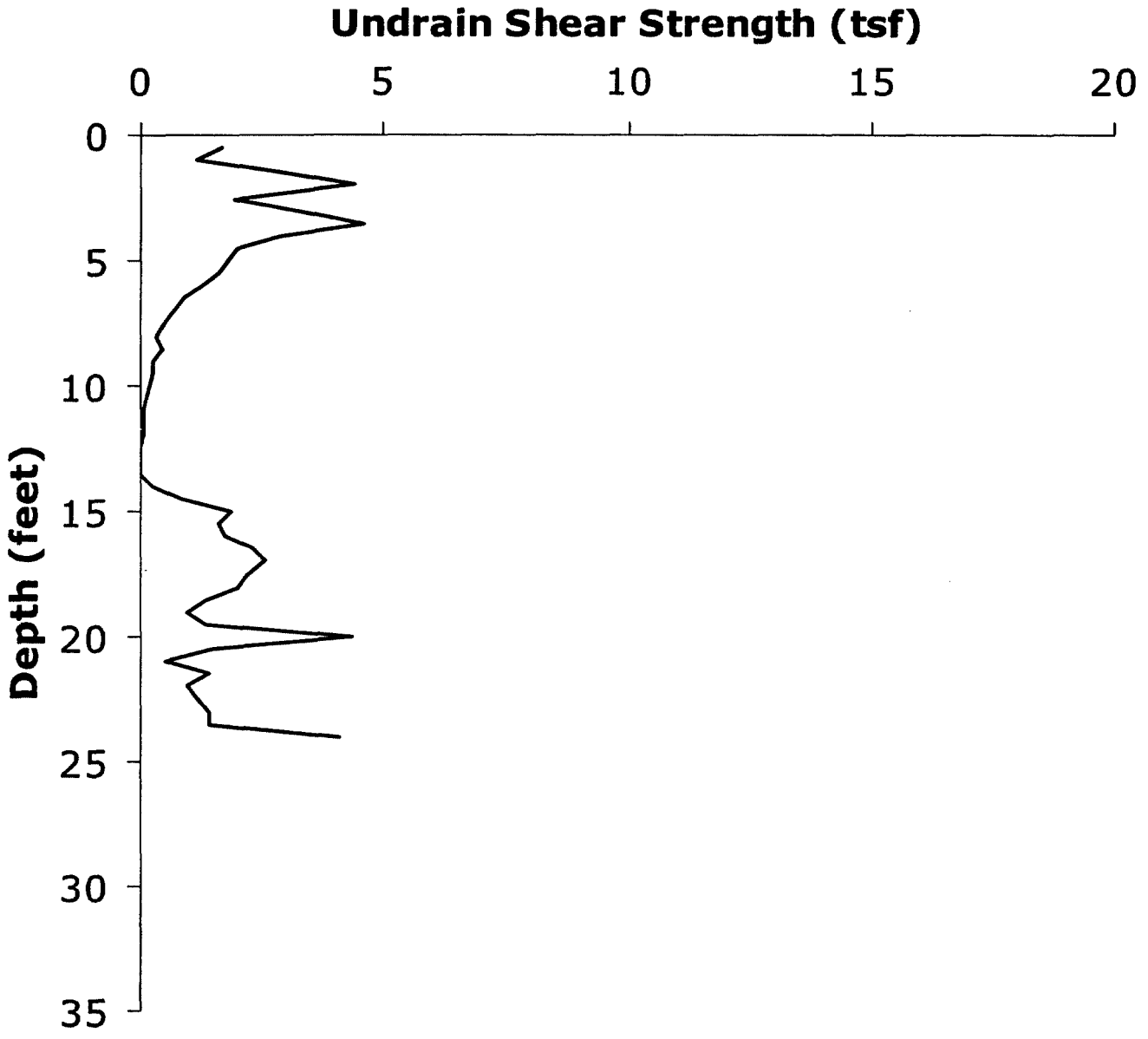
UNDRAIN SHEAR STRENGTH - CPT-4B

WASTE DISPOSAL INC. SUPERFUND SITE
Santa Fe Springs, California

LOVNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE D-4
1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:16 PM 8A-D4.dwg



UNDRAIN SHEAR STRENGTH - CPT-5

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

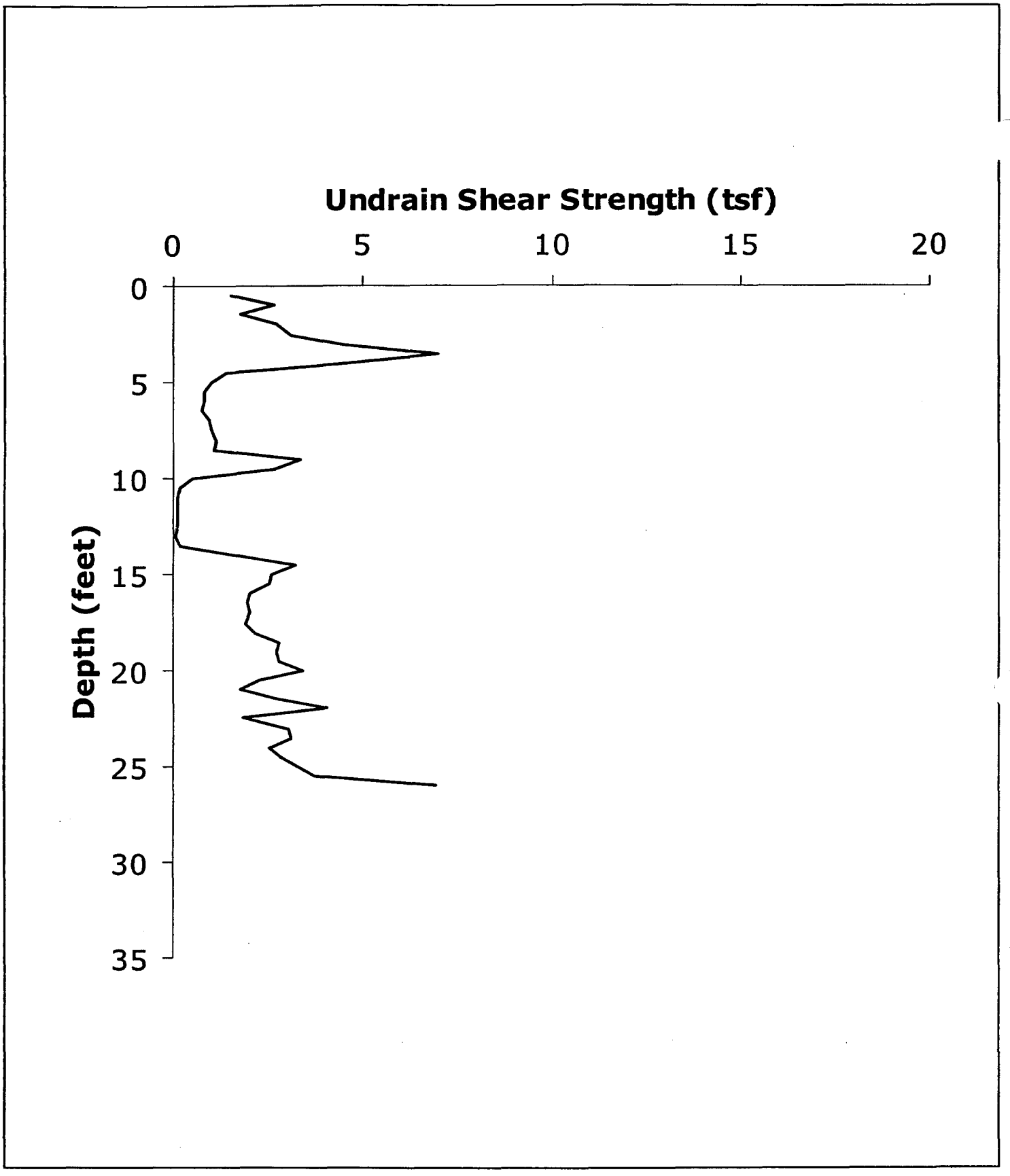
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-5

1651-8A

Tim Watson, Lowney Associates 09/17/2002 1:19 PM 1651-8A-D5.dwg



UNDRAIN SHEAR STRENGTH - CPT-6

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

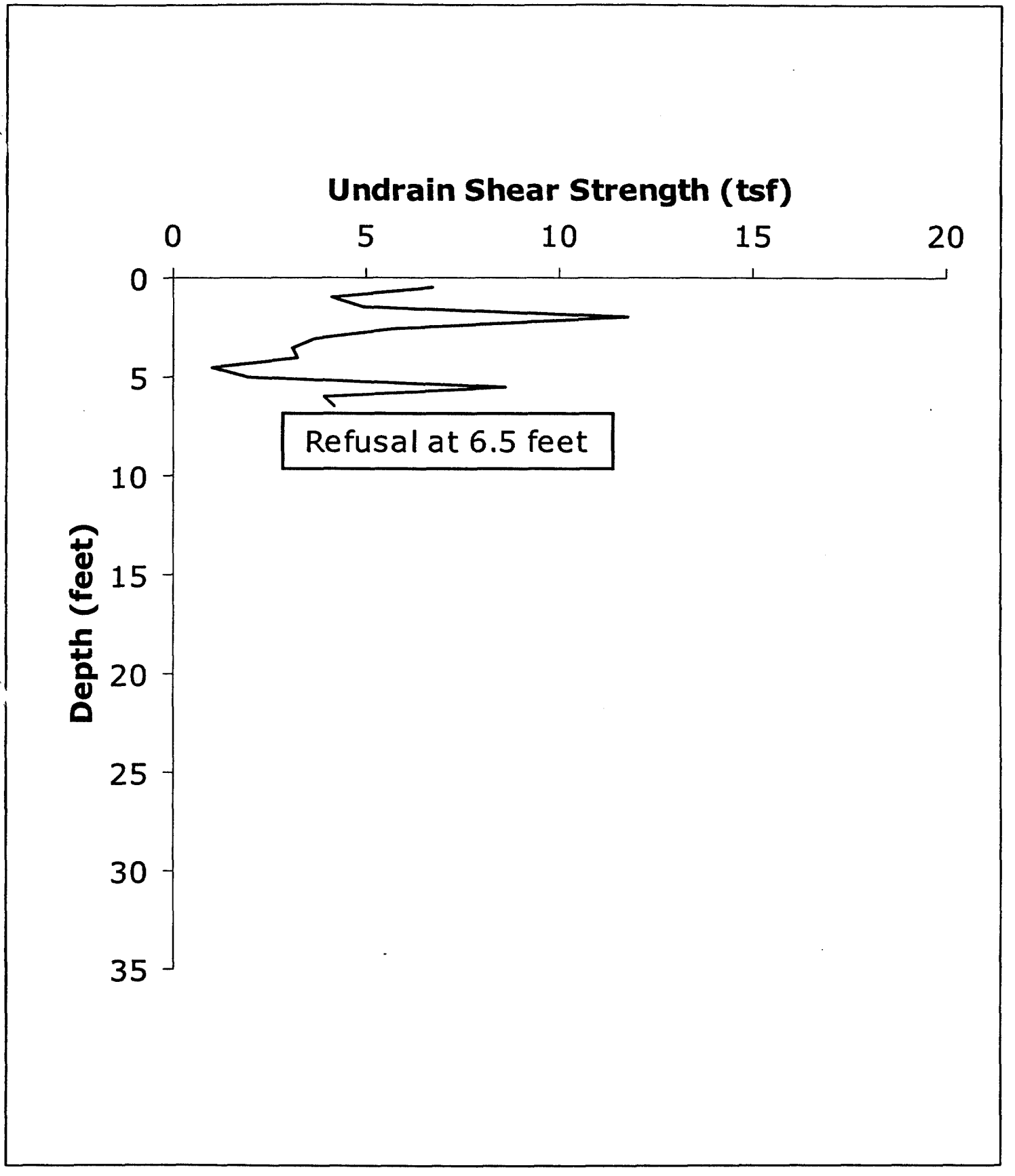
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-6

1651-8A

Tim Watson, Lowney Associates 09/17/2002 1:28 PM 8A-D6.dwg



UNDRAIN SHEAR STRENGTH - CPT-7D

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

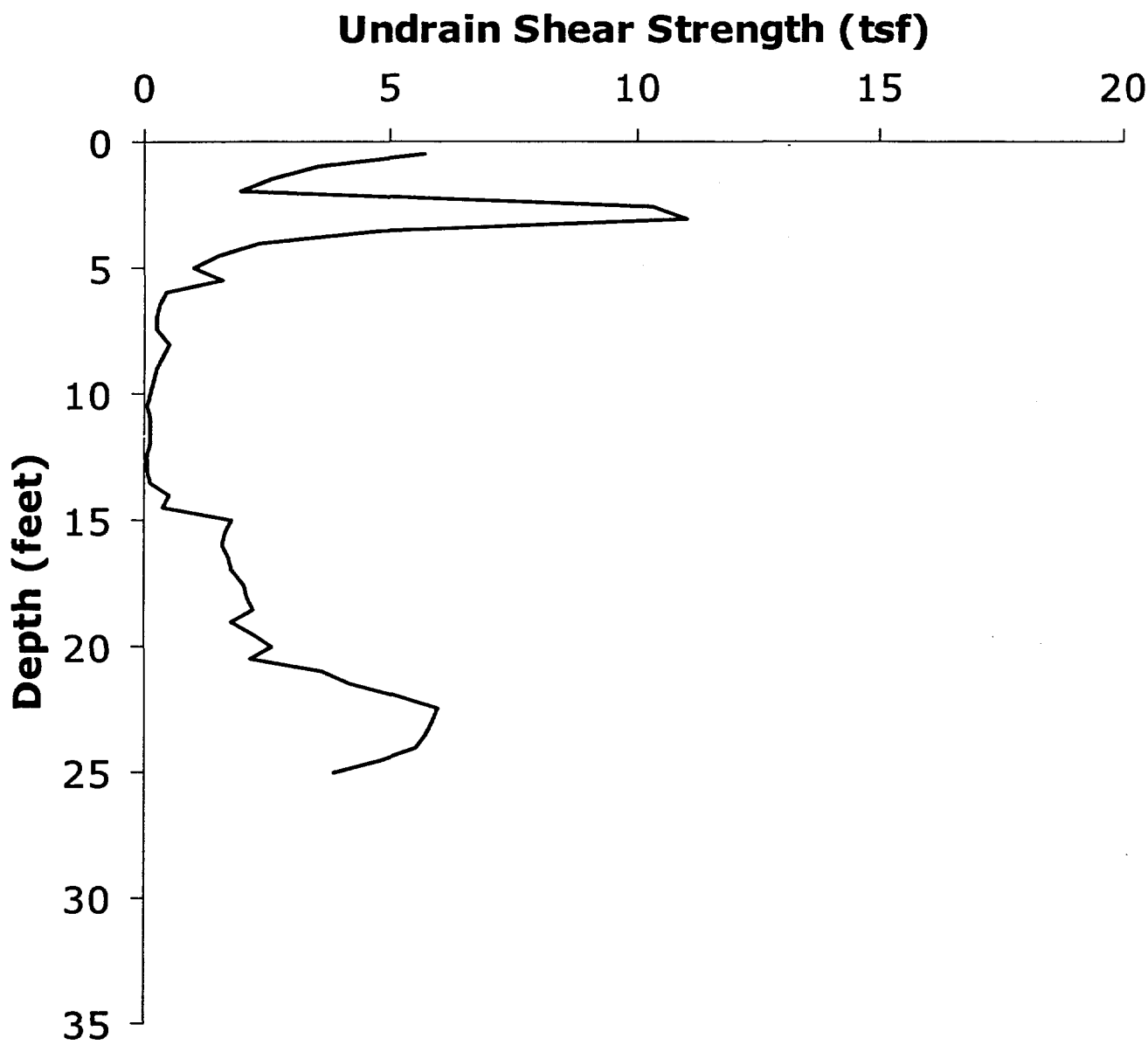
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-7

1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:43 PM 1651-8A-D7.dwg



UNDRAIN SHEAR STRENGTH - CPT-8B

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

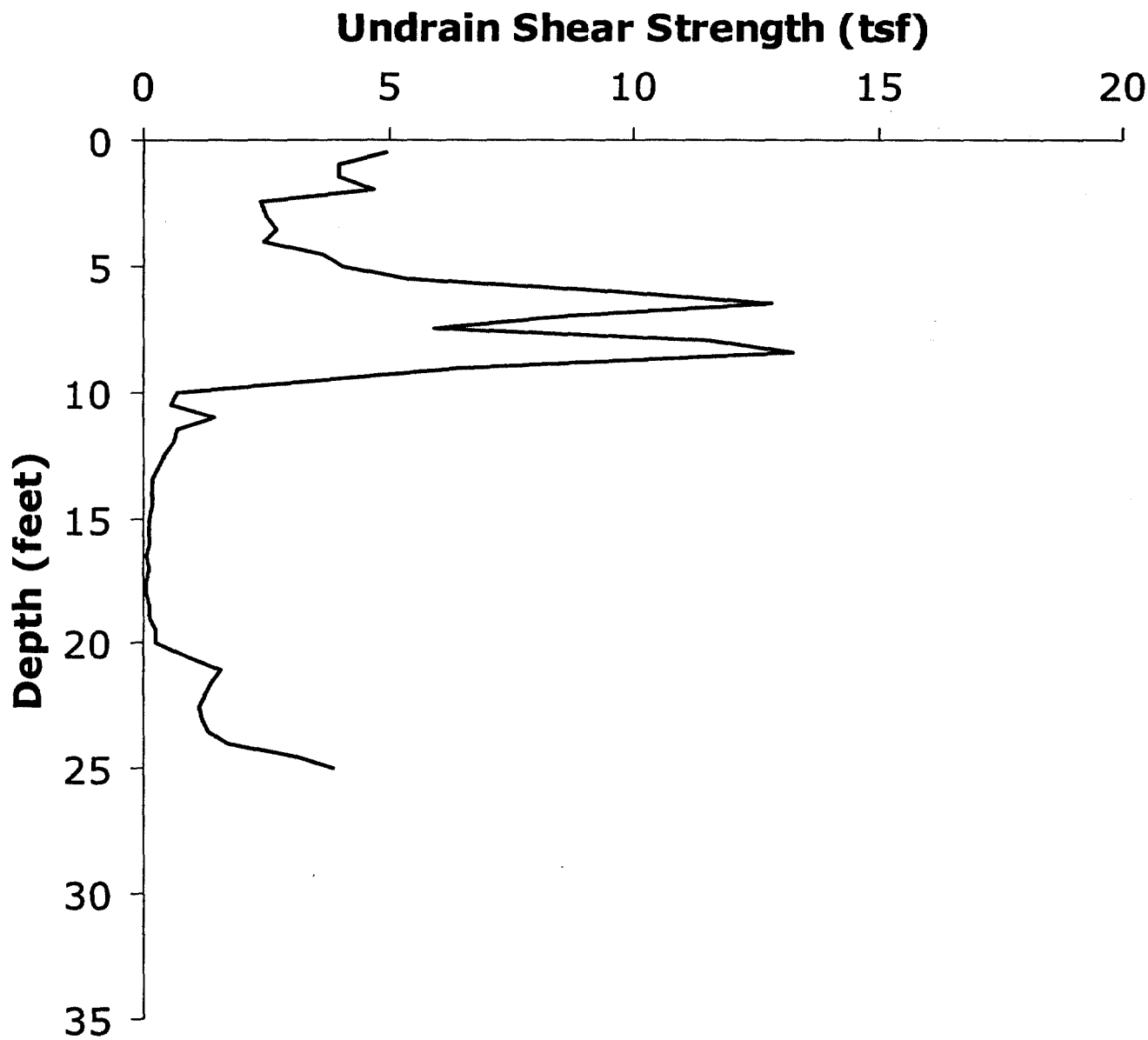
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-8

1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:52 PM 8A-D8.dwg



UNDRAIN SHEAR STRENGTH - CPT-9

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

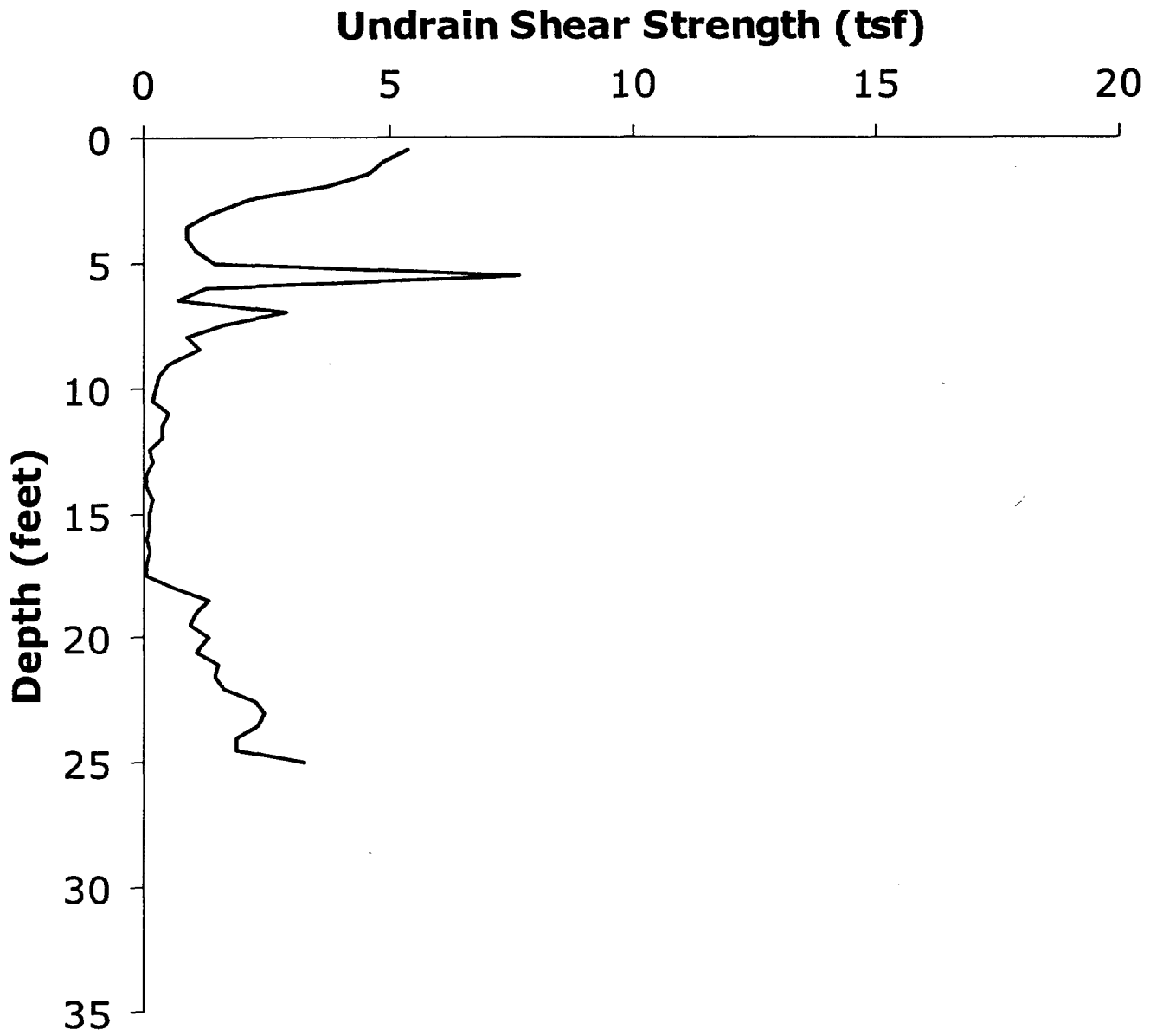
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-9

1651-8A

Tim Hutson, Lowney Associates 09/17/2002 1:54 PM 1651-8A-D9.dwg



UNDRAIN SHEAR STRENGTH - CPT-10

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

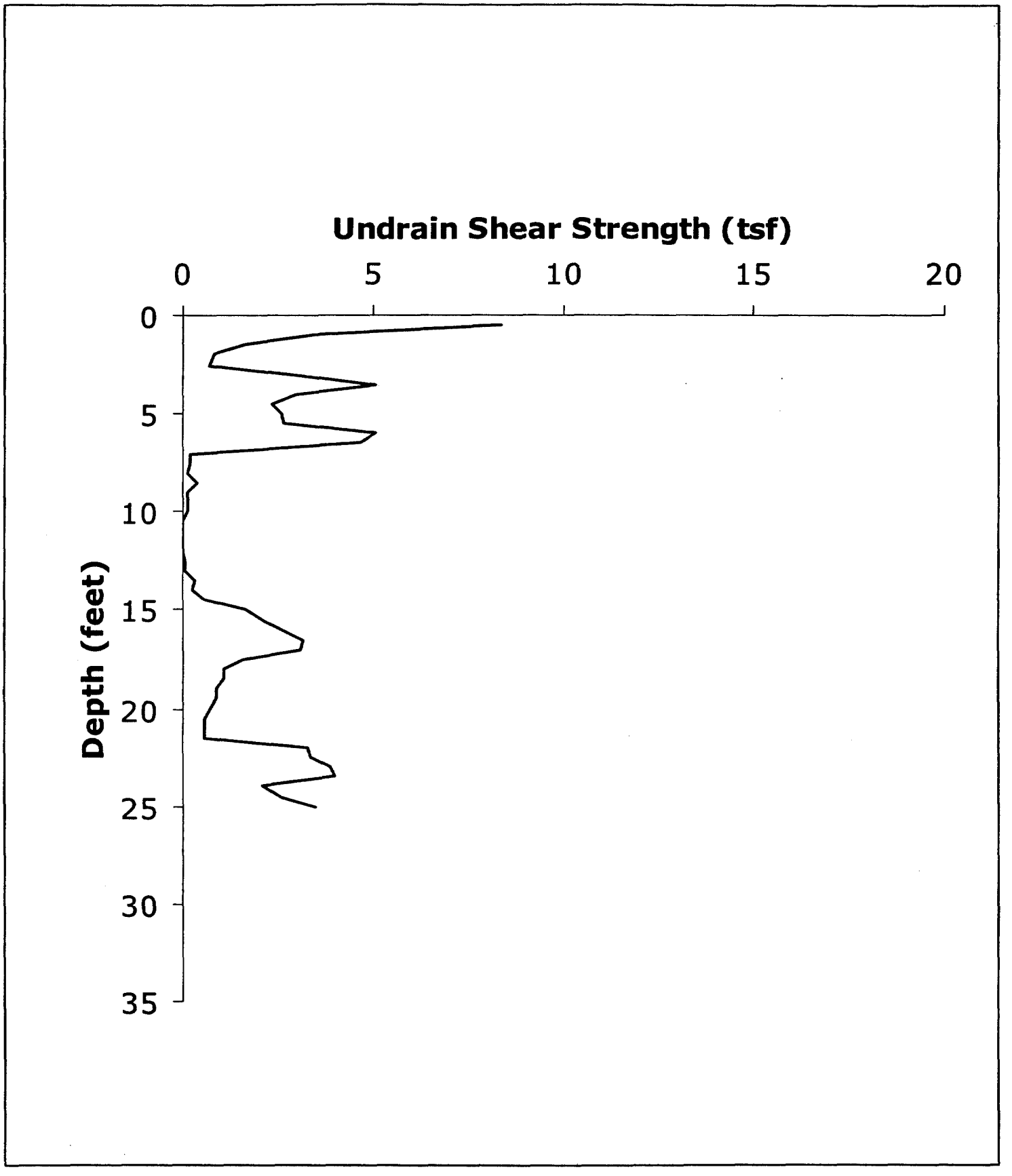
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-10

1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:57 PM 8A-D10.dwg



UNDRAIN SHEAR STRENGTH - CPT-11

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

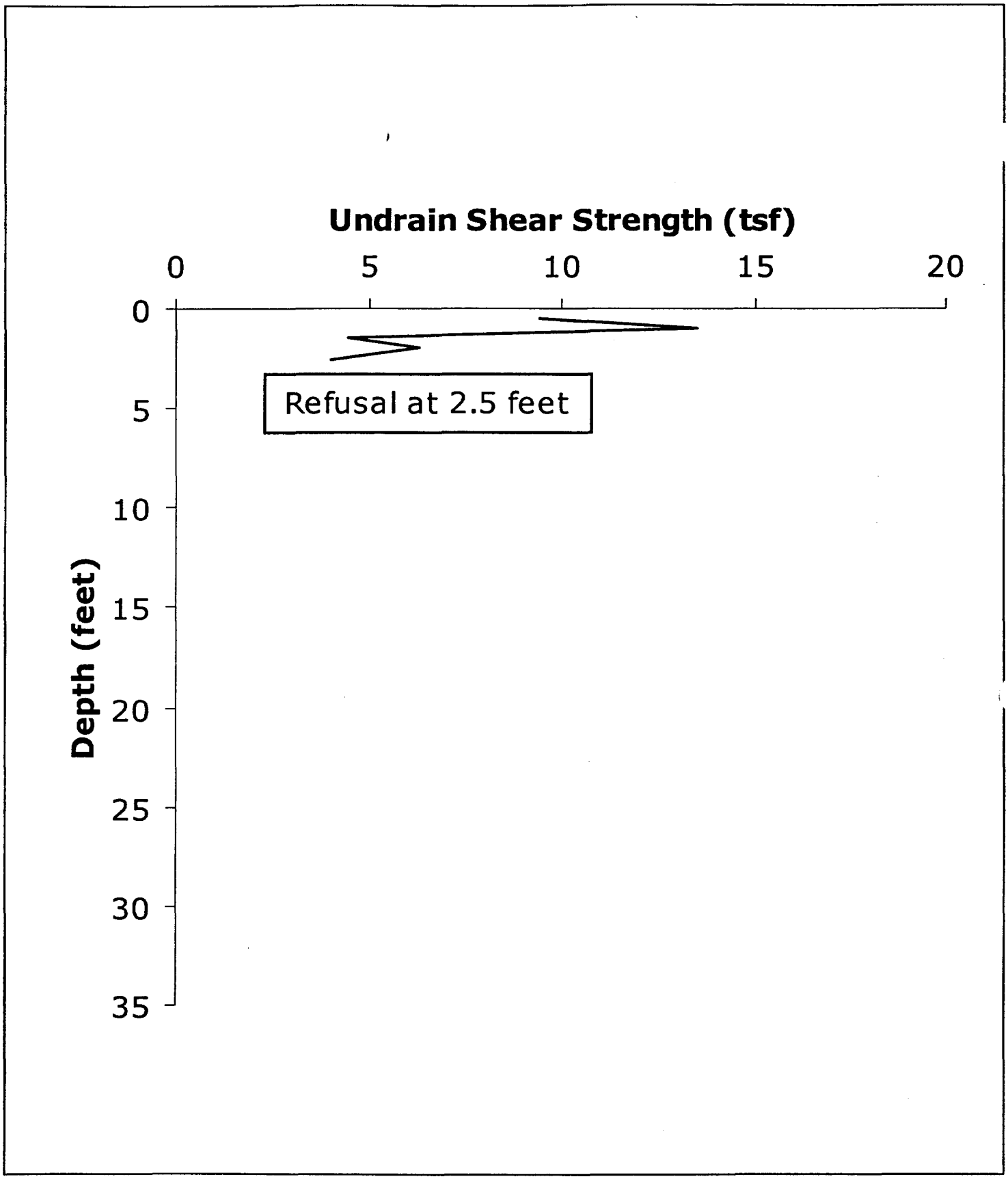
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-11

1651-8A

Tim Matson, Lowney Associates 09/17/2002 1:50 PM 1651-8A-D11.dwg



UNDRAIN SHEAR STRENGTH - CPT-12C

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

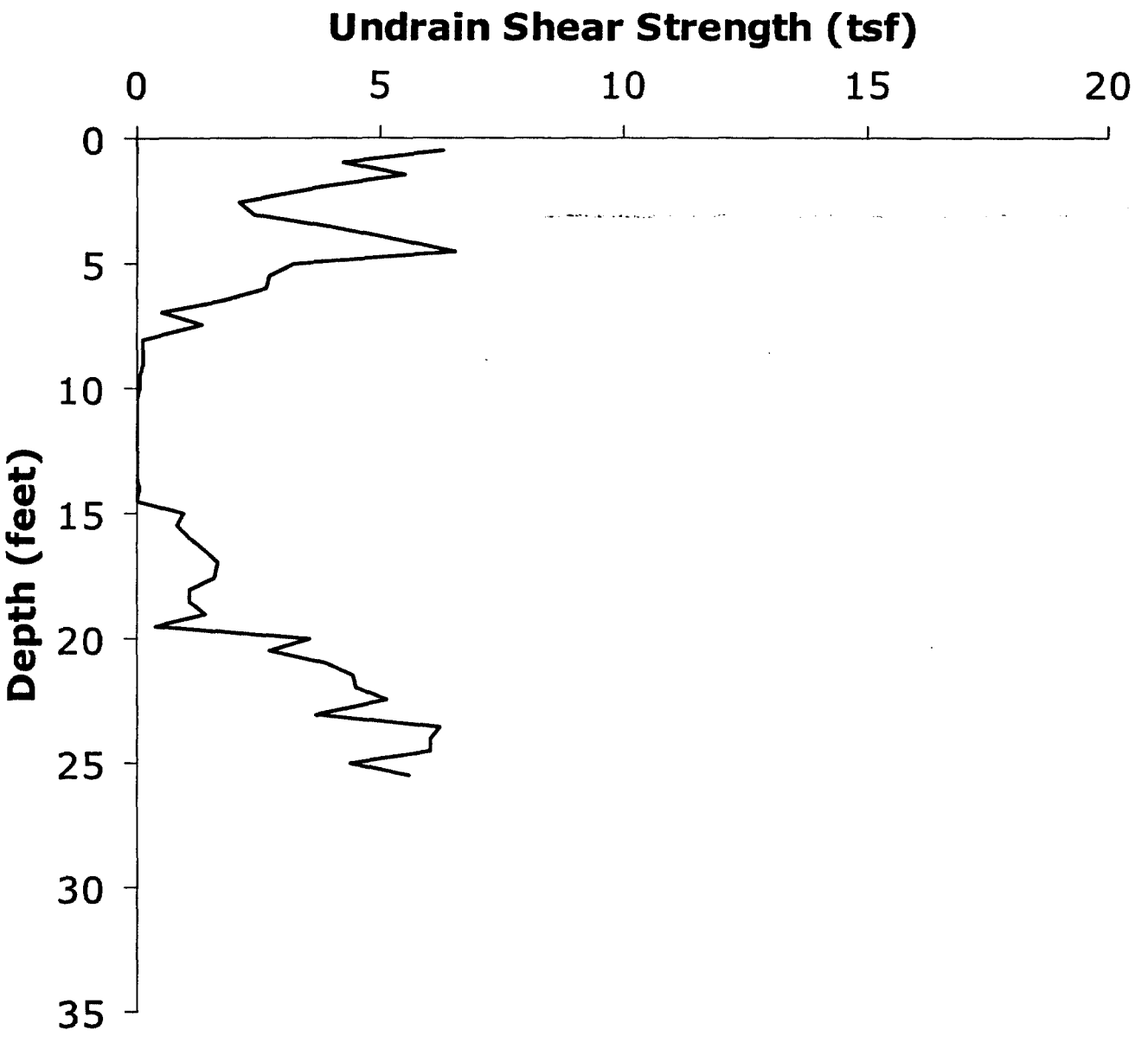
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-12

1651-8A

Tm Matson, Lowney Associates 09/17/2002 2:02 PM 8A-D12.dwg



UNDRAIN SHEAR STRENGTH - CPT-13B

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

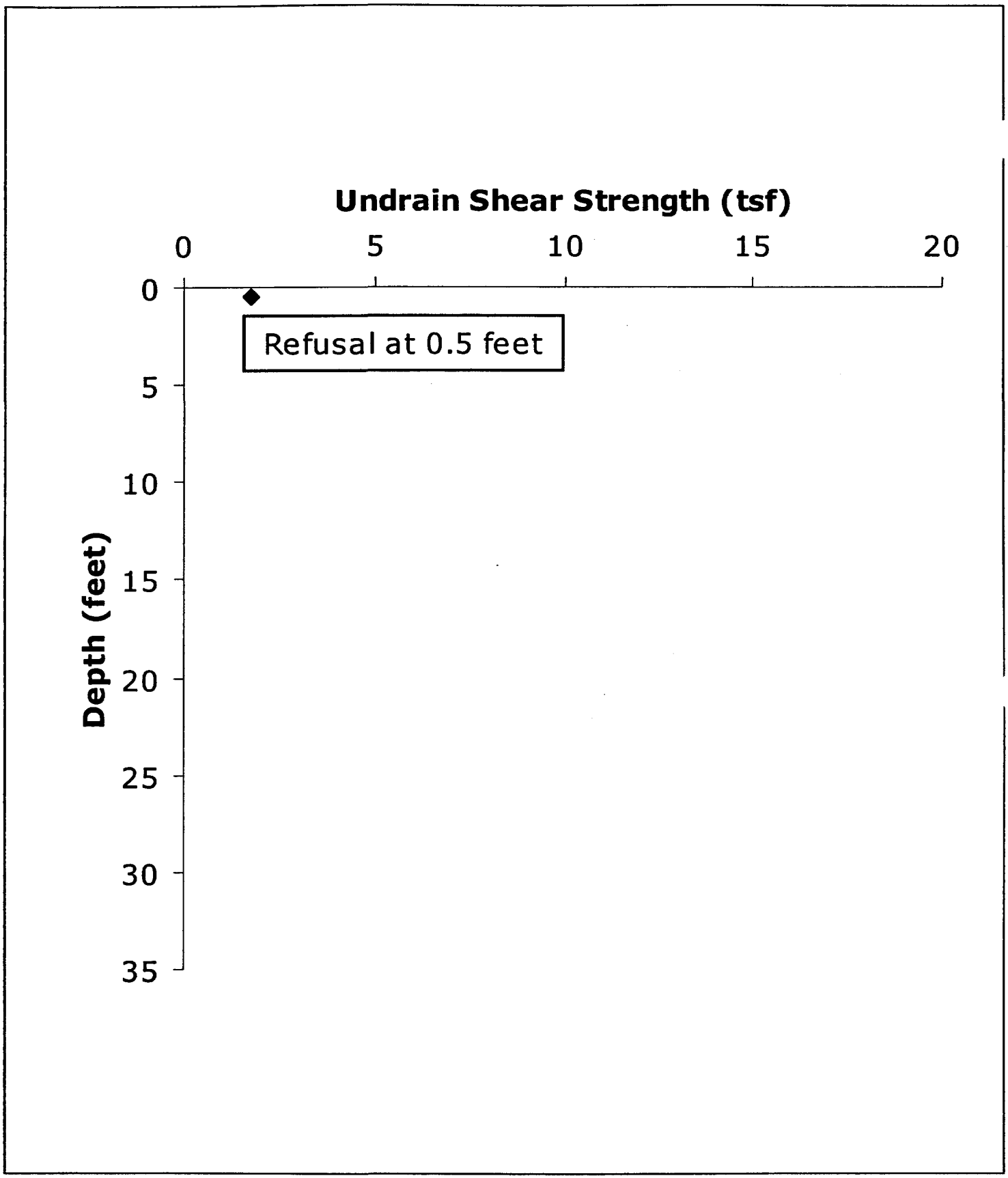
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-13

1651-8A

Tim Matson, Lowney Associates 09/17/2002 2:05 PM 1651-8A-D13.dwg



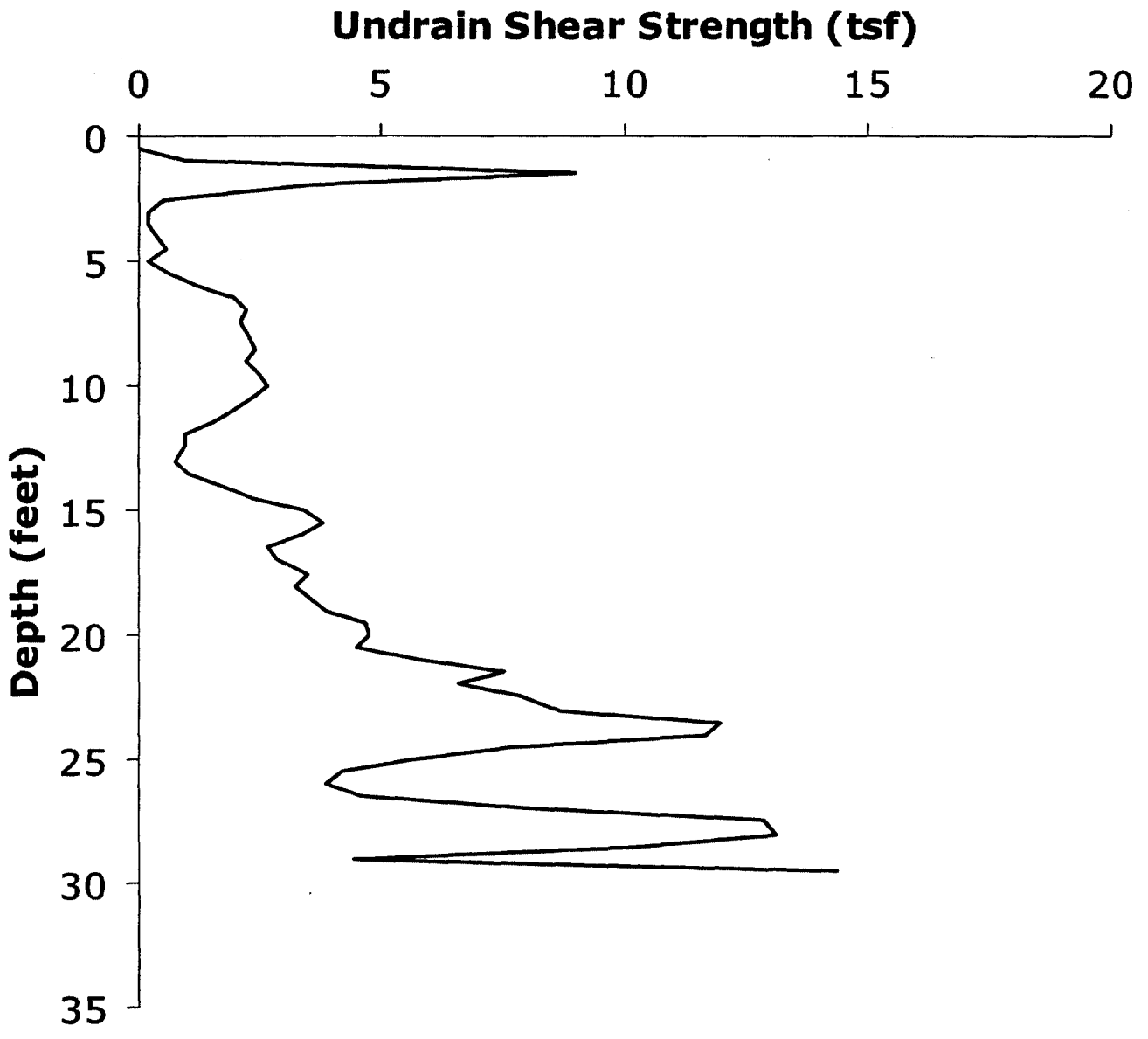
UNDRAIN SHEAR STRENGTH - CPT-14

WASTE DISPOSAL INC. SUPERFUND SITE
Santa Fe Springs, California

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE D-14
1651-8A

Th Matson, Lowney Associates 09/17/2002 2:07 PM 8A-D14.dwg



UNDRAIN SHEAR STRENGTH - CPT-15

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

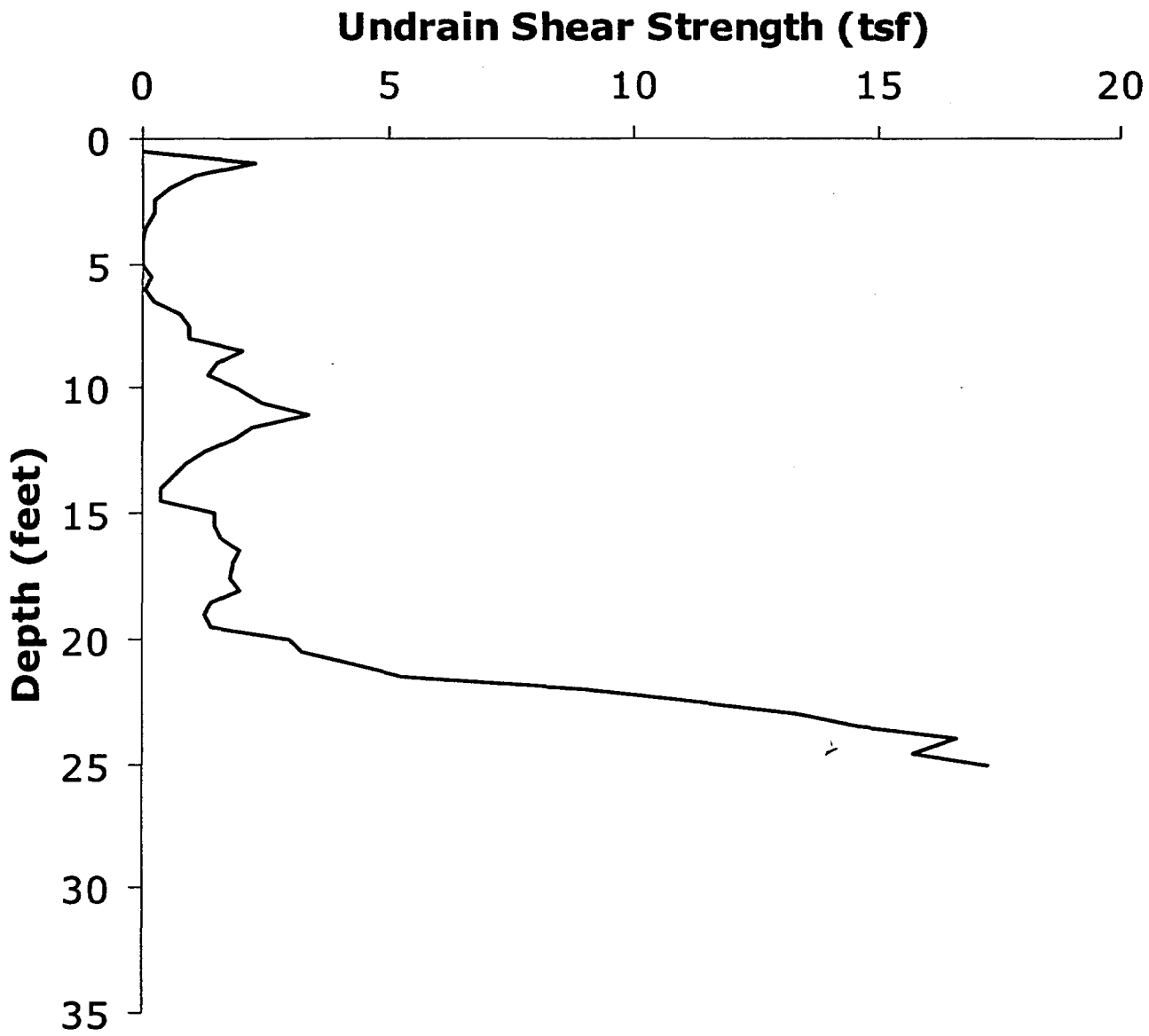
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-15

1651-8A

Tim Watson, Lowney Associates 09/17/2002 2:11 PM 1651-8A-D15.dwg



UNDRAIN SHEAR STRENGTH - CPT-16

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

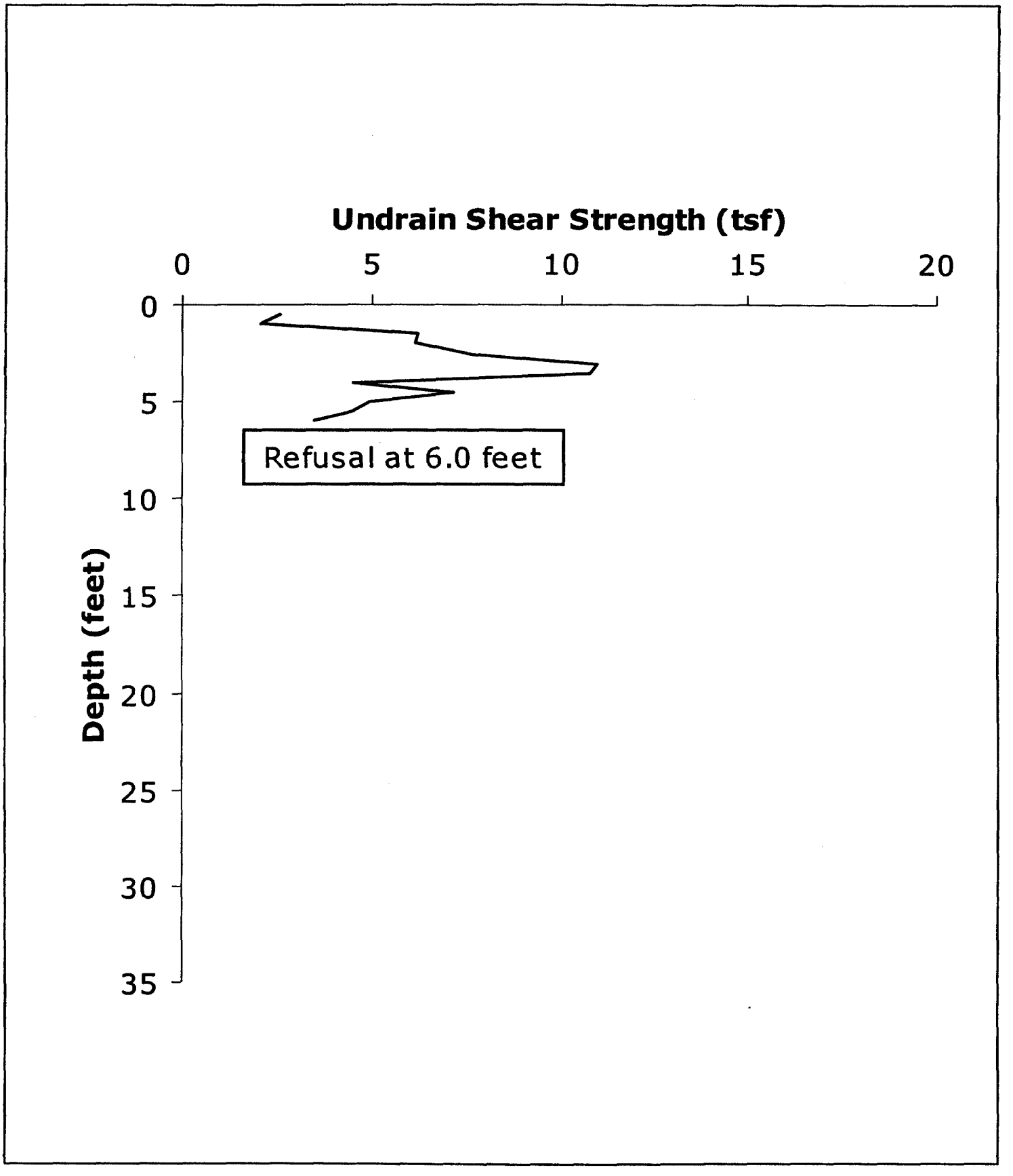
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-16

1651-8A

Th Matson, Lowney Associates 09/17/2002 2:13 PM :8A-D16.dwg



UNDRAIN SHEAR STRENGTH - CPT-17B

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

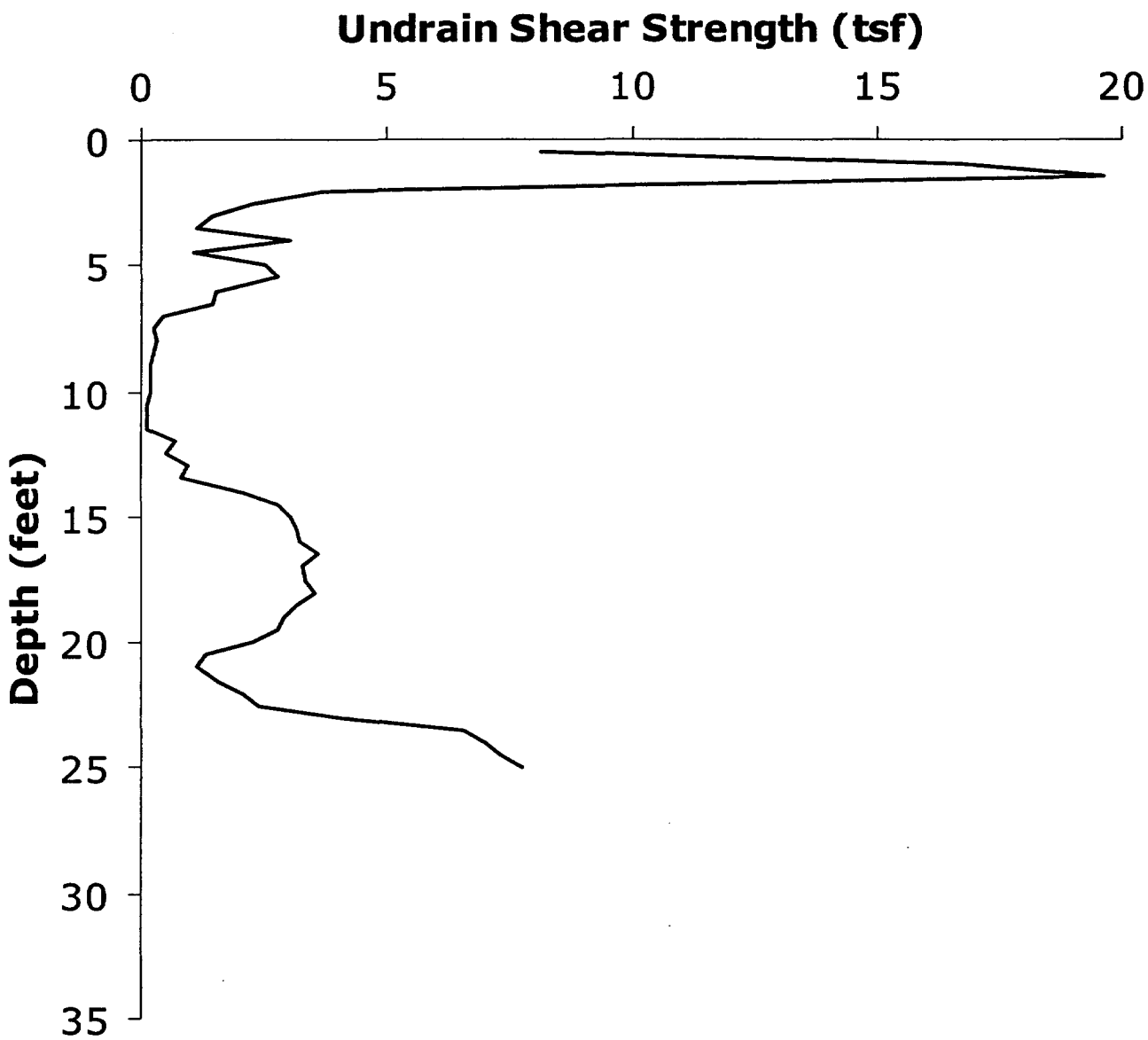
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-17

1651-8A

Tim Watson, Lowney Associates 09/17/2002 2:17 PM 1651-8A-D17.dwg



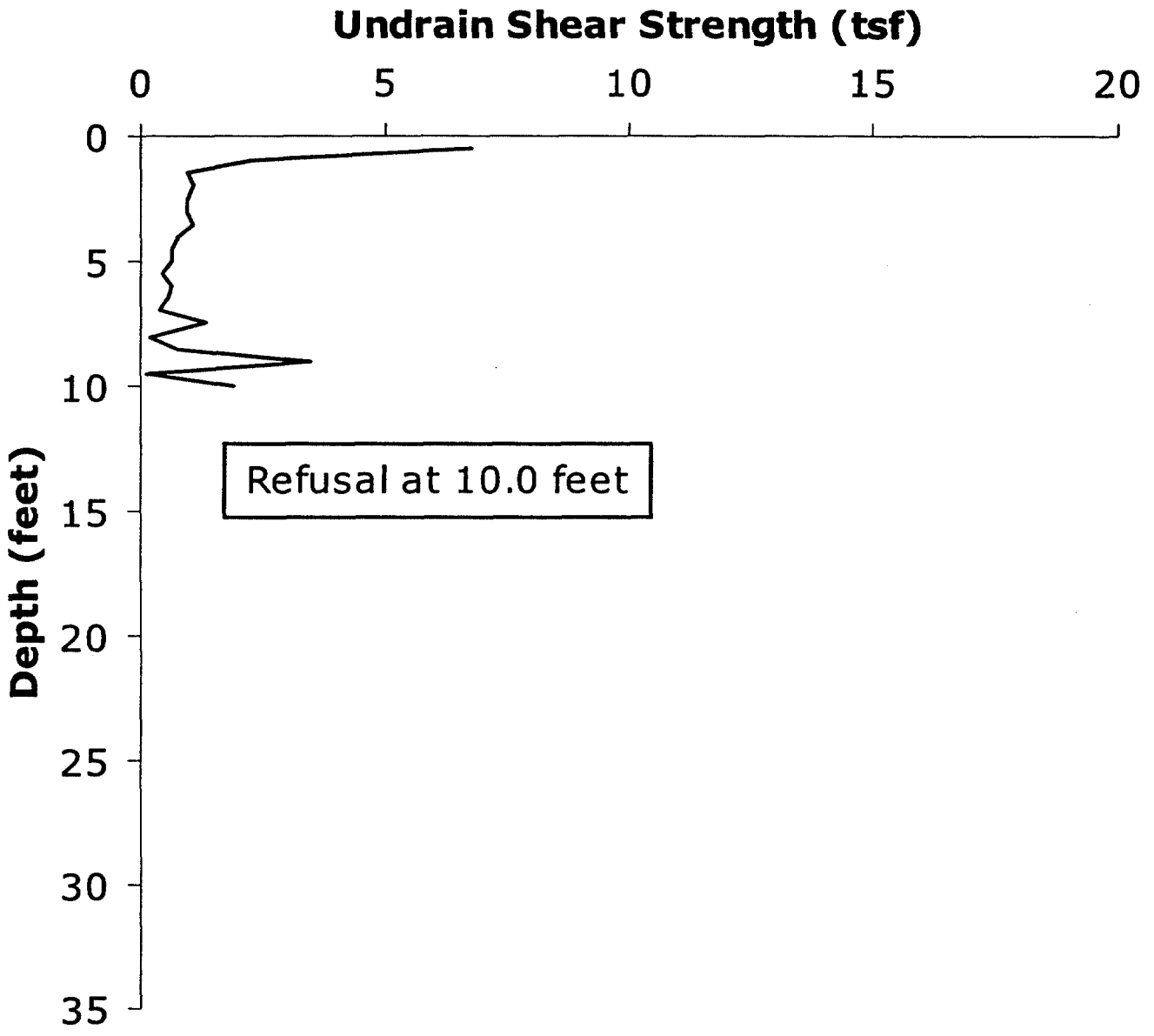
UNDRAIN SHEAR STRENGTH - CPT-18

WASTE DISPOSAL INC. SUPERFUND SITE
Santa Fe Springs, California

LOVNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE D-18
1651-8A

Tim Matson, Lowney Associates 09/17/2002 2:20 PM 8A-D18.dwg



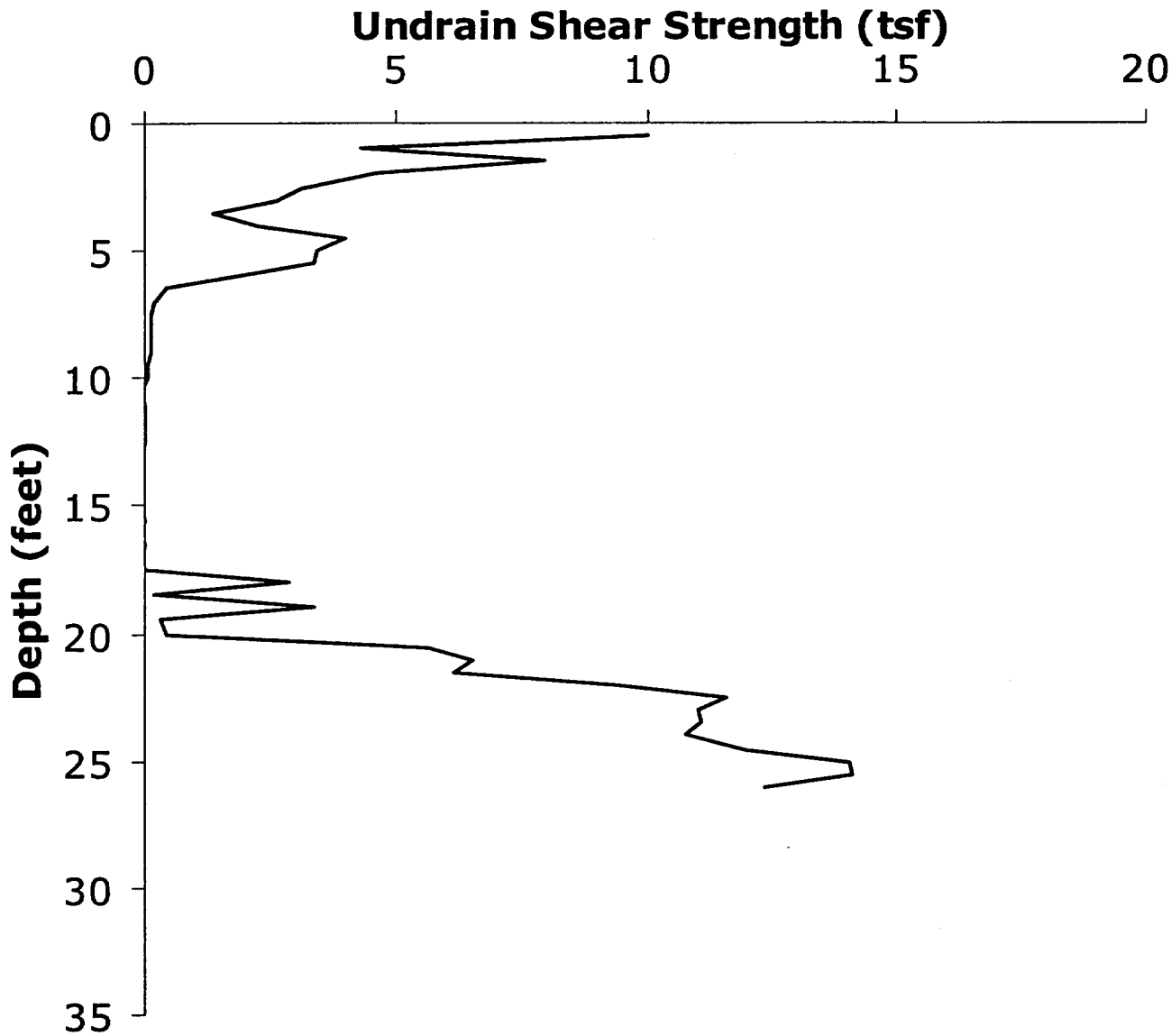
Tim Matson, Lowney Associates 09/17/2002 2:22 PM 1651-8A-D19.dwg

UNDRAIN SHEAR STRENGTH - CPT-19

WASTE DISPOSAL INC. SUPERFUND SITE
Santa Fe Springs, California

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

FIGURE D-19
1651-8A



UNDRAIN SHEAR STRENGTH - CPT-20

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

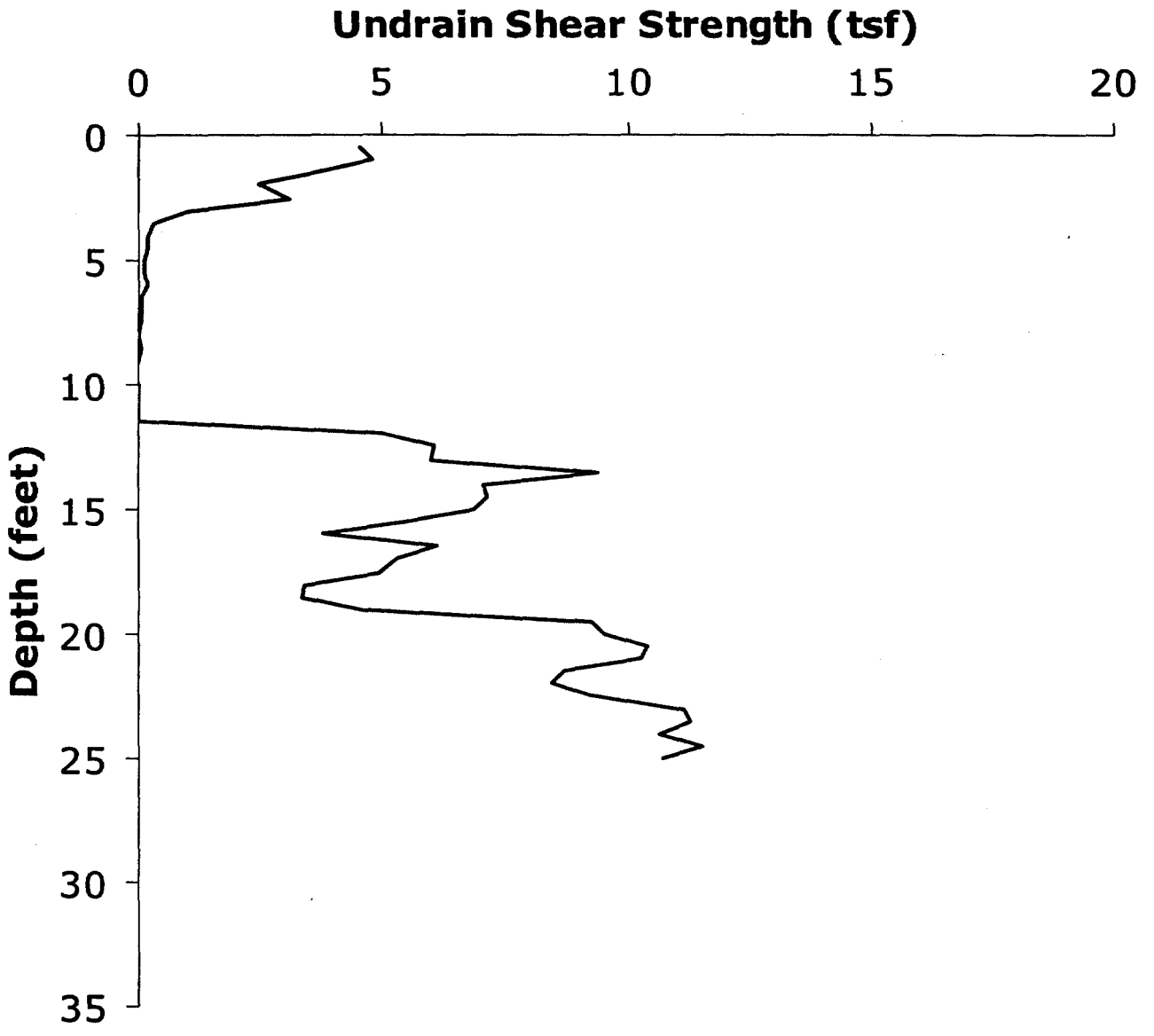
LOVNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-20

1651-8A

Tim Matson, Lowney Associates 09/17/2002 2:25 PM 8A-D20.dwg



UNDRAIN SHEAR STRENGTH - CPT-21

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

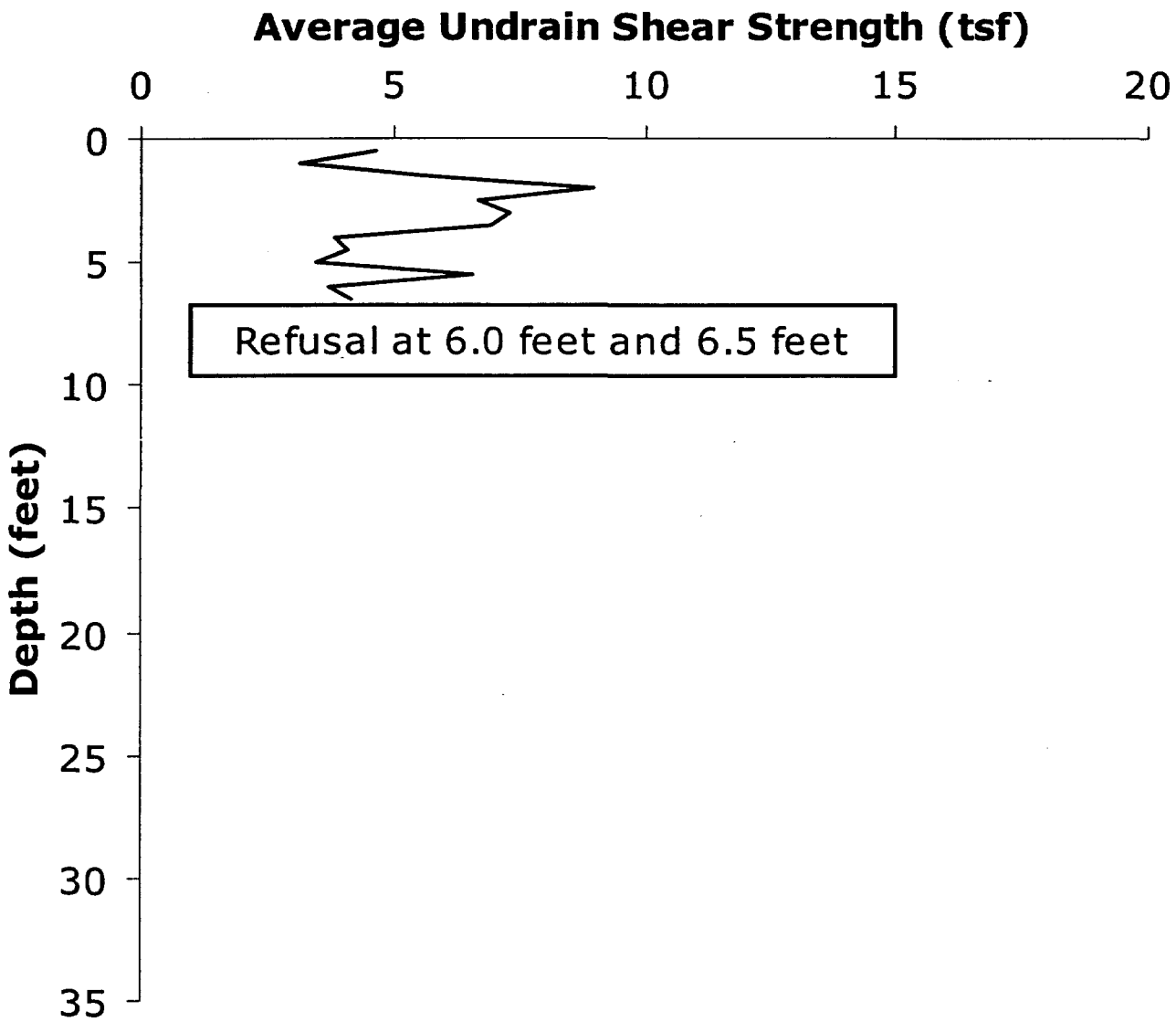
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-21

1651-8A

Tim Watson, Lowney Associates 09/17/2002 2:27 PM 1651-8A-D21.dwg



AVERAGE UNDRAIN SHEAR STRENGTH - INSIDE OF RING

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

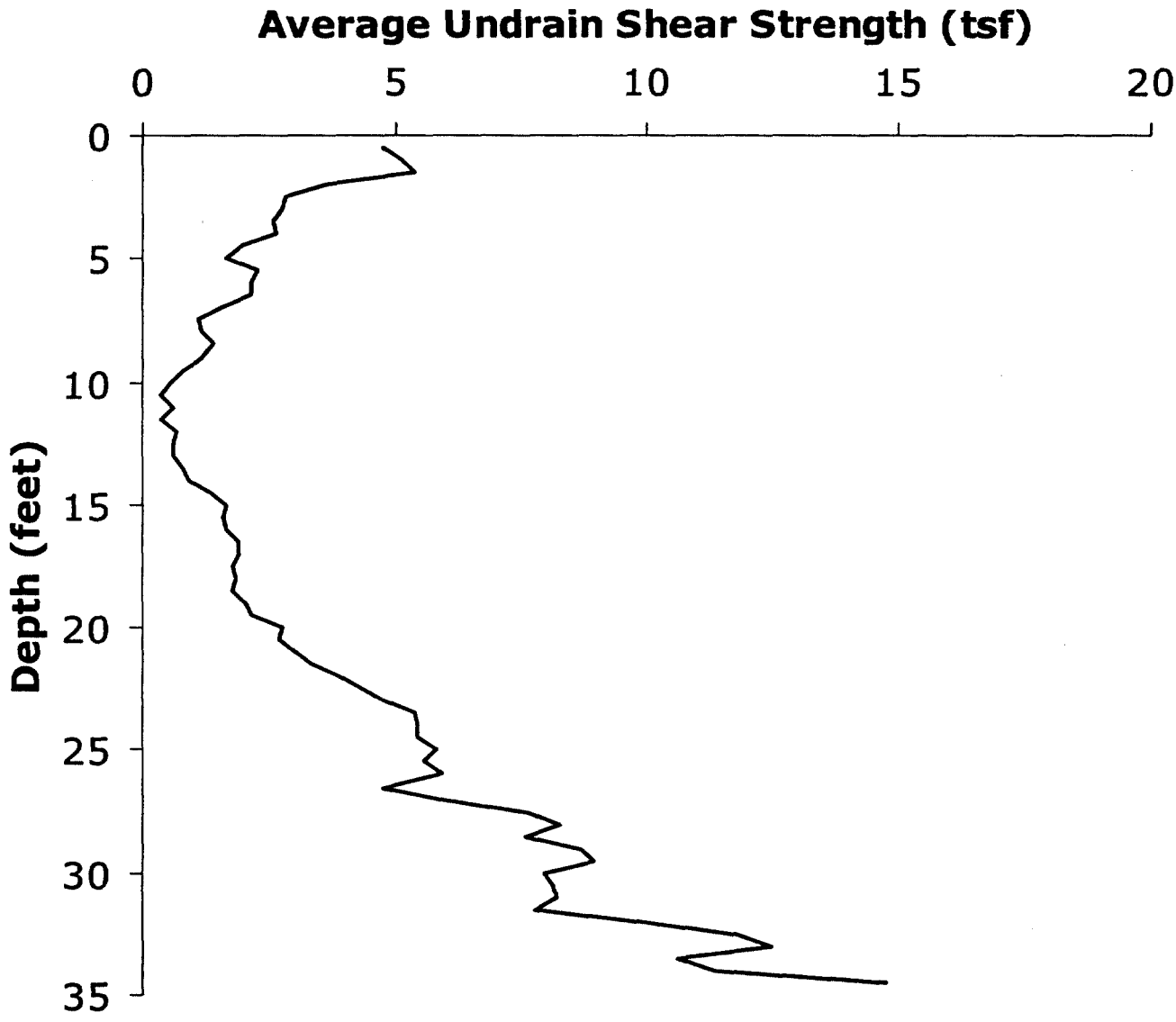
LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-22

1651-8A

Tim Matson, Lowney Associates 09/17/2002 2:31 PM -8A-D22.dwg



Tim Watson, Lowney Associates 09/17/2002 2:34 PM 1651-8A-D23.dwg

AVERAGE UNDRAIN SHEAR STRENGTH - OUTSIDE OF RING

WASTE DISPOSAL INC. SUPERFUND SITE

Santa Fe Springs, California

LOWNEY ASSOCIATES

Environmental/Geotechnical/Engineering Services

FIGURE D-23

1651-8A

APPENDIX F

GEOTECHNICAL CALCULATIONS

F.1 Settlement
F.2 Differential Settlement in Area 4
F.3 Bearing Capacity/Shear Strength Calculation
F.4 Slope Stability Calculations
F.5 Liquefaction Analyses

APPENDIX F.1

SETTLEMENT

APPENDIX F
WDI SUPERFUND SITE
SETTLEMENT CALCULATION

F.1.1 INTRODUCTION

Calculations were performed to estimate settlement of uncompacted bentonite fill material ("waste") underlying existing and proposed cover material at the WDI site in Santa Fe Springs, California. These calculations were performed using consolidation data measured at Keantan Laboratories in July and August 2002, for six Shelby Tube samples of the bentonite obtained in early July 2002. Tests results were compared and qualified based on our understanding of the "waste" matrix consisting of non-organic rubble with voids filled by bentonite, and on empirical observations of the site topography over the decades during which bentonite waste has remained on-site, as demonstrated on Figure 6.5, *Topographic Difference Map*.

F.1.2 BACKGROUND

In 1998, grading work was performed at the site and detailed in "*Technical Memo No. 11-Reservoir Area Grading Plans and Waste/Debris Management As-Built Report, Waste Disposal Inc. Superfund Site*" (TRC, December 1998). Now, minor new grading is proposed to provide an engineered cap over the waste, and possibly for redevelopment of the site including pavements and structures around the perimeter of the site. These calculations are performed to evaluate the impact of settlement on post grading drainage of the site, based on placement of new fill typically on the order of 2 feet, but possibly ranging up to 9 feet thick at the perimeter of the project to facilitate redevelopment.

F.1.3 KEY ASSUMPTION

Our settlement calculations are based on the following assumptions:

- Moist unit weight of existing cover fill material is 124 pounds-per-cubic-foot (pcf) and 100 pcf for bentonite,
- Thickness of new cover fill to be placed is 10 feet or less, compacted to 90% of the ASTM D 1557-00 laboratory maximum density (124 pcf), and
- Coefficients of compressibility as follows based on curve smoothing depicted on Figures F.1.1 through F.1.6 (disregarding first curve):

Table F.1.1. Results of Consolidation Tests

Compression Curve Type	Coefficient of Compressibility (feet^2/pounds)		
	Best Case	Worst Case	Average
Virgin	6.67×10^{-6}	3.60×10^{-5}	2.85×10^{-5}

F.1.4 RESULTS

As shown on the attached spreadsheets (13 pages), a parametric analyses was performed with 36 models varying:

- Bentonite thickness ranging from 32½ to 5 feet,
- Existing fill thickness ranging from 5 to 15 feet,
- Proposed fill thickness ranging from 2 to 10 feet, and
- Coefficient of compressibility (best and worse case, virgin compression).

Use of the virgin compression curve versus the rebound curve may be conservative, depending on the load history of the bentonite, particularly for smaller new fill thicknesses. Results are summarized on Table F.1.2 on the next page assuming only 4-feet of new fill is placed over the existing fill and bentonite to facilitate cover (without redevelopment):

Table F.1.2. Results of Settlement Calculations, 4-Feet Of New Fill

Compression Curve	Compression Curve Case	Existing Fill Thickness (feet)	Bentonite Thickness (feet)	Estimated Settlement (inches)*
Virgin compression curve (see consolidation tests)	Worst	5	32.5	4 ½
	Best			½
	Worst		30	4 ½
	Best			½
	Worst		25	4 ¼
	Best			½
	Worst		20	4
	Best			½
	Worst		15	3 ¼
	Best			¼
	Worst		10	2 ½
	Best			¼
	Worst		5	1 ½
	Best			¼
	Worst	15	32.5	3
	Best			¼
	Worst		15	2
	Best			¼
	Worst		5	¾
	Best			¼

***For 4-feet of new fill.**

F.1.5 CONCLUSION

As listed in the table above, estimated settlements based on placing 4-feet of new properly compacted fill above existing grade (excluding consideration of any construction or permanent cuts), range from 4½-inches to less-than ¼-inch. The worst-case data is based on consolidation tests from Shelby Tube samples of the bentonite. Resulting consolidation tests were irregular, often lacking the usual smooth concave curve. This may be due to gravel or coarse sand jammed into the consolidometer ring interface, causing the compression seat to be caught momentarily under lighter loads. In particular, we have discounted the sample from Boring G-01 at a depth of 20 feet, where a highly irregular curve was reported by Keantan Laboratories.

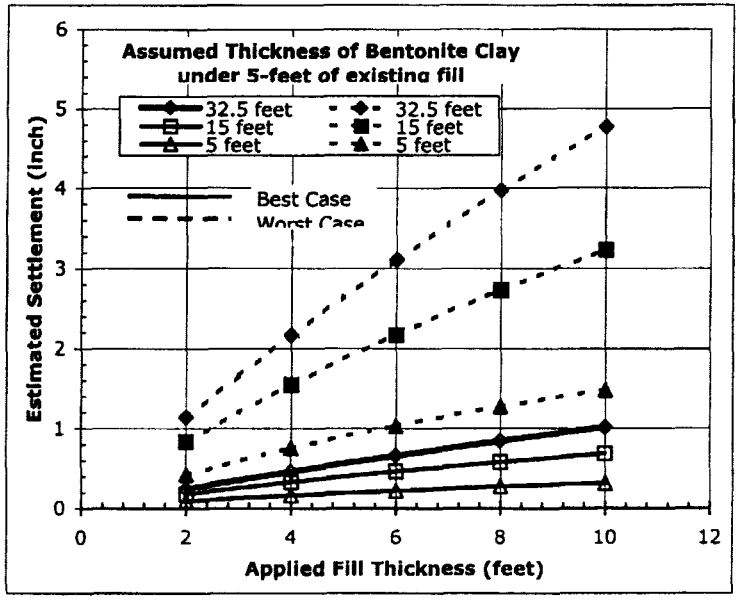
Undisturbed sampling of the construction rubble was not possible due to the cobble and gravel content. Therefore, to characterize the "waste" (bentonite within a rubble matrix) as consisting of solely bentonite, as represented by the remaining five consolidation test, is considerably conservative. Rubble should have migrated down through the bentonite acting as a viscous fluid, such that the rubble created a stable matrix, with bentonite filling the rubble void space. Further, if an average of the worst and best case consolidation test is used to characterize the waste

as a whole, then worst case virgin settlements of 2½-inches or less are calculated, with most of the calculated settlements on the order of an inch or less. Considering Figure 6.5, *Topographic Difference Map*, this empirical evidence suggests 0.7 feet (8-inches) in areas immediately northeast and west-northwest of the reservoir.

Attachments: KeanTan Consolidation Tests (Figures F.1.1 through F.1.6)
Settlement Calculation Spreadsheets (14 pages)
Example Hand Calculations

APPENDIX F.1

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT ESTIMATES WITH VIRGIN COMPRESSION CURVES



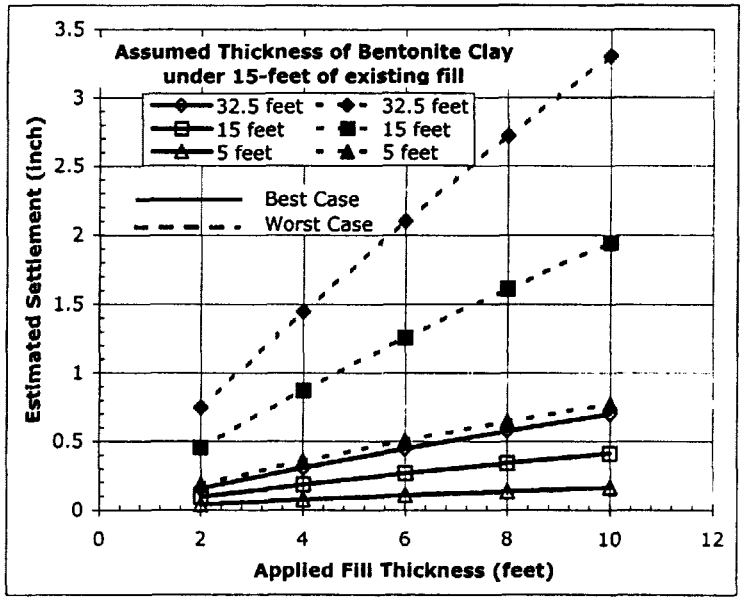


TABLE F.1.1

SUMMARY OF CONSOLIDATION RESULTS

Boring Number	Sample Depth (feet)	Percent Consolidation at 500 psf	Percent Consolidation at 2,000 psf	Coefficient of Consolidation ($feet^2$/pounds)
G-01	20*	6.50%	17.50%	7.33E-05
G-04	10	4.40%	8.40%	2.67E-05
G-06	15	5.00%	10.40%	3.60E-05
G-09	20	0.60%	2.15%	1.03E-05
G-10	10½	2.40%	5.10%	1.80E-05
G-12	15	0.60%	1.60%	6.67E-06
AVERAGE:				2.85E-05

*Sample discounted due to test disturbance

TABLE F.1.2

SUMMARY OF CONSOLIDATION TEST RESULTS (VOID RATIOS)

Boring Number	Sample Depth (feet)	Initial Void Ratio	C_c
G-01	20	1.84	0.384
G-04	10	3.08	0.262
G-06	15	1.26	0.163
G-09	20	0.47	0.024
G-10	10½	0.81	0.068
G-12	15	0.44	0.020
AVERAGE:			0.153

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	32.5

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Fill Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2245	0.095	1.1
4	124	496	2245	0.180	2.2
6	124	744	2245	0.259	3.1
8	124	992	2245	0.331	4.0
10	124	1240	2245	0.398	4.8

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2245	0.020	0.2
4	124	496	2245	0.038	0.5
6	124	744	2245	0.055	0.7
8	124	992	2245	0.070	0.8
10	124	1240	2245	0.084	1.0

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	30

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2120	0.092	1.1
4	124	496	2120	0.175	2.1
6	124	744	2120	0.251	3.0
8	124	992	2120	0.320	3.8
10	124	1240	2120	0.384	4.6

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2120	0.020	0.2
4	124	496	2120	0.037	0.4
6	124	744	2120	0.053	0.6
8	124	992	2120	0.068	0.8
10	124	1240	2120	0.081	1.0

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	25

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1870	0.087	1.0
4	124	496	1870	0.164	2.0
6	124	744	1870	0.233	2.8
8	124	992	1870	0.296	3.6
10	124	1240	1870	0.354	4.2

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1870	0.018	0.2
4	124	496	1870	0.035	0.4
6	124	744	1870	0.049	0.6
8	124	992	1870	0.063	0.8
10	124	1240	1870	0.075	0.9

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	20

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	\p (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1620	0.079	1.0
4	124	496	1620	0.149	1.8
6	124	744	1620	0.210	2.5
8	124	992	1620	0.266	3.2
10	124	1240	1620	0.316	3.8

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	\p (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1620	0.017	0.2
4	124	496	1620	0.031	0.4
6	124	744	1620	0.045	0.5
8	124	992	1620	0.056	0.7
10	124	1240	1620	0.067	0.8

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	15

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1370	0.069	0.8
4	124	496	1370	0.129	1.5
6	124	744	1370	0.181	2.2
8	124	992	1370	0.227	2.7
10	124	1240	1370	0.269	3.2

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1370	0.015	0.2
4	124	496	1370	0.027	0.3
6	124	744	1370	0.038	0.5
8	124	992	1370	0.048	0.6
10	124	1240	1370	0.057	0.7

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	10

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1120	0.056	0.7
4	124	496	1120	0.102	1.2
6	124	744	1120	0.142	1.7
8	124	992	1120	0.176	2.1
10	124	1240	1120	0.207	2.5

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	1120	0.012	0.1
4	124	496	1120	0.022	0.3
6	124	744	1120	0.030	0.4
8	124	992	1120	0.037	0.4
10	124	1240	1120	0.044	0.5

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
5	5

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	870	0.035	0.4
4	124	496	870	0.063	0.8
6	124	744	870	0.086	1.0
8	124	992	870	0.106	1.3
10	124	1240	870	0.123	1.5

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	870	0.007	0.1
4	124	496	870	0.013	0.2
6	124	744	870	0.018	0.2
8	124	992	870	0.022	0.3
10	124	1240	870	0.026	0.3

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
15	32.5

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	3485	0.062	0.7
4	124	496	3485	0.120	1.4
6	124	744	3485	0.175	2.1
8	124	992	3485	0.226	2.7
10	124	1240	3485	0.275	3.3

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	3485	0.013	0.2
4	124	496	3485	0.025	0.3
6	124	744	3485	0.037	0.4
8	124	992	3485	0.048	0.6
10	124	1240	3485	0.058	0.7

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
15	15

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2610	0.038	0.5
4	124	496	2610	0.073	0.9
6	124	744	2610	0.105	1.3
8	124	992	2610	0.134	1.6
10	124	1240	2610	0.162	1.9

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2610	0.008	0.1
4	124	496	2610	0.015	0.2
6	124	744	2610	0.022	0.3
8	124	992	2610	0.028	0.3
10	124	1240	2610	0.034	0.4

WASTE DISPOSAL INC. SUPERFUND SITE
SETTLEMENT CALCULATION WITH VIRGIN CURVE

Assumed Thickness of Fill (feet)	Assumed Thickness of Waste (feet)
15	5

Worst Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-01	4	20	3.08	0.261	2.67E-05

$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2110	0.015	0.2
4	124	496	2110	0.029	0.4
6	124	744	2110	0.042	0.5
8	124	992	2110	0.054	0.6
10	124	1240	2110	0.064	0.8

Best Case					
Boring Number	Sample Number	Depth (feet)	e_0	C_c	C_v (feet^2/pounds)
G-12	4	15	0.44	0.020	6.67E-06

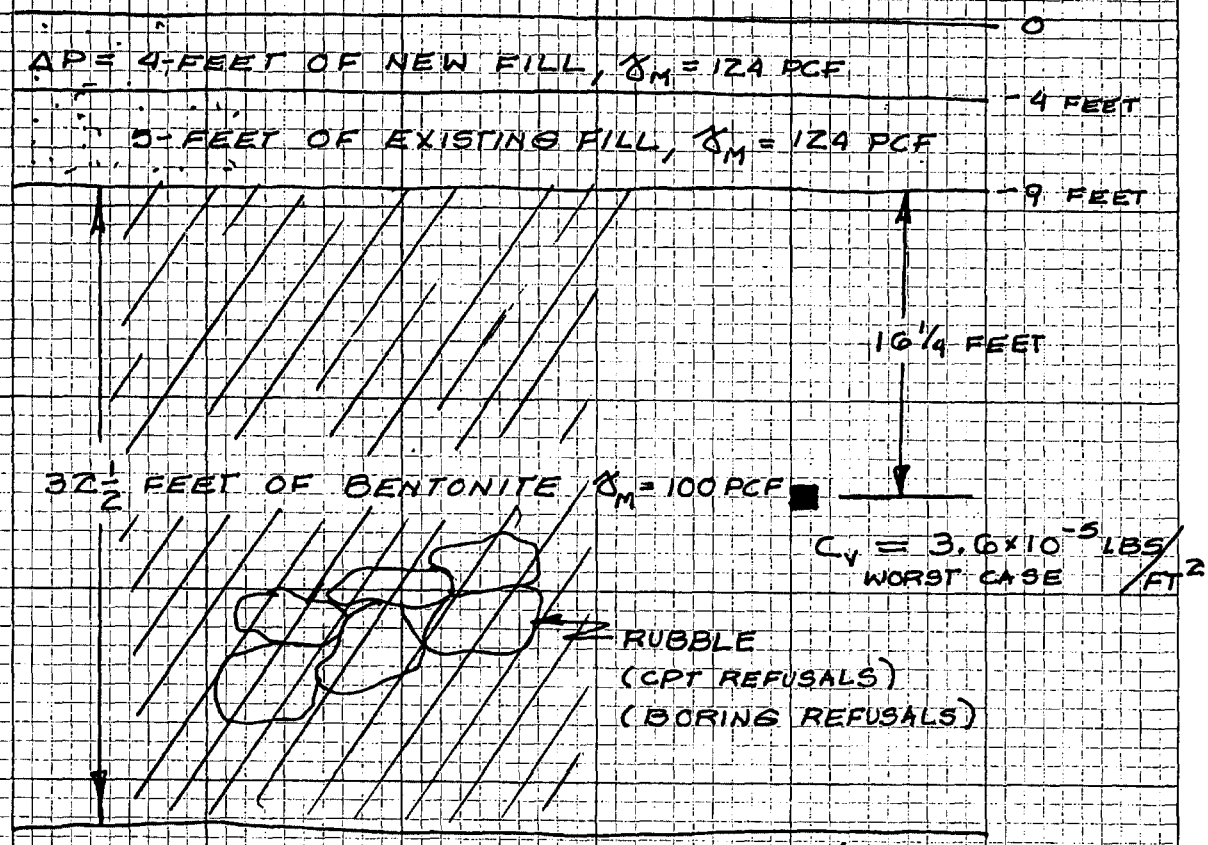
$t_{overburden}$ (feet)	Unit Weight (pcf)	Δp (psf)	p_0 (psf)	Settlement (feet)	Settlement (inch)
2	124	248	2110	0.003	0.0
4	124	496	2110	0.006	0.1
6	124	744	2110	0.009	0.1
8	124	992	2110	0.011	0.1
10	124	1240	2110	0.014	0.2

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

Project Name: WDI / SANTA FE SPRINGS
Subject: EXAMPLE SETTLEMENT CALCULATIONS
Project No.: 1651-8A Sheet No.: 1 Of 1
By: TB Date: 12/3/02 Chk'd by: Date:

EXAMPLE SETTLEMENT CALCULATIONS

ASSUME:



$$\Delta P = \gamma \cdot H = (124 \text{ PCF})\ 4 \text{ FEET} = 496 \text{ PSF}$$

$$P_o = \gamma_{BENT}(16\tfrac{1}{4} \text{ FEET}) + \gamma_{FILL}(5 \text{ FEET}) = 2{,}245 \text{ PCF}$$

$$(P_o = (100 \text{ PCF} \cdot 16\tfrac{1}{4} \text{ FEET}) + (124 \text{ PCF} \cdot 5 \text{ FEET}))$$

$$\delta = \frac{H \cdot (C_c)}{1 + e_o} \log\left((P_o + \Delta P)/P_o\right)$$

$$\delta = \frac{32\tfrac{1}{2}' (0.384)}{(1 + 1.84)} \log\left(\frac{2{,}245 \text{ PSF} + 496 \text{ PSF}}{2{,}245 \text{ PSF}}\right)$$

$$\boxed{\delta = 0.38 \text{ FEET} = 4.6 \text{ INCHES}}$$

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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-01/ 4 DEPTH : 20 ft.

INITIAL DRY DENSITY : 59.4 pcf. INITIAL MOISTURE CONTENT : 54.7 pct.

INITIAL VOID RATIO : 1.838

SPECIFIC GRAVITY : 2.70(ASSUMED)

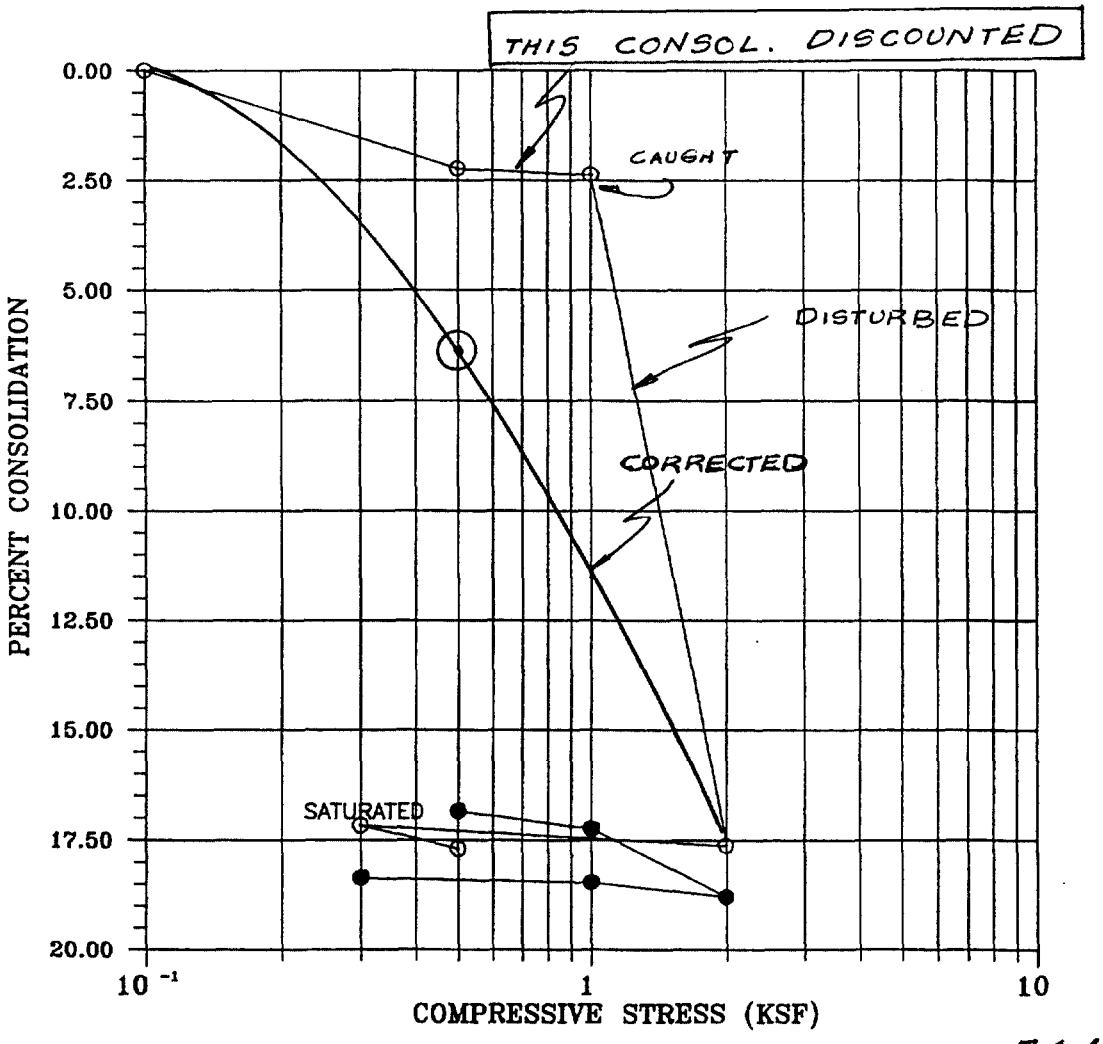

FIGURE NO. F.1.1

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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-04/ 3 DEPTH : 10 ft.

INITIAL DRY DENSITY : 41.3 pcf. INITIAL MOISTURE CONTENT : 103.9 pct.

INITIAL VOID RATIO : 3.081

SPECIFIC GRAVITY : 2.70(ASSUMED)

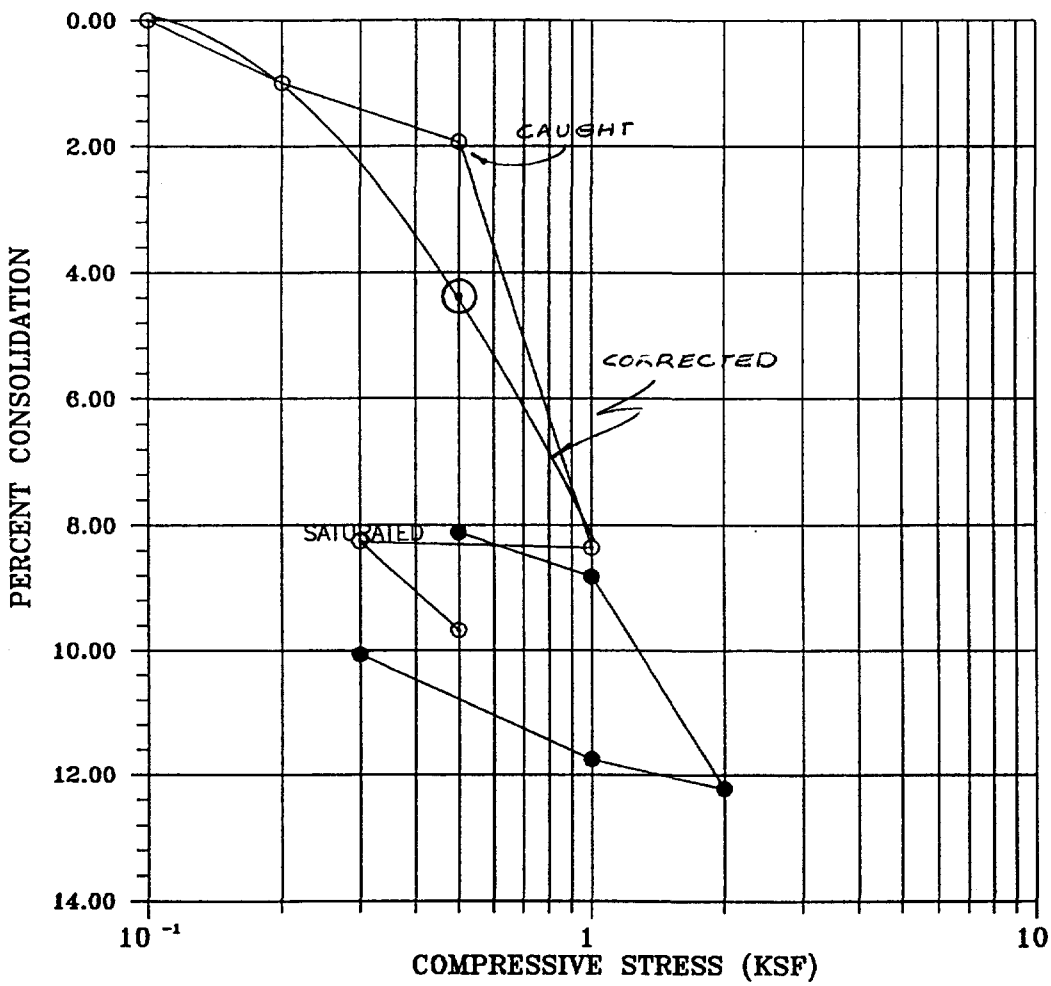

FIGURE NO. F.1, 2

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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-06/ 5 DEPTH : 15 ft.

INITIAL DRY DENSITY : 74.6 pcf. INITIAL MOISTURE CONTENT : 44.0 pct.

INITIAL VOID RATIO : 1.260

SPECIFIC GRAVITY : 2.70(ASSUMED)

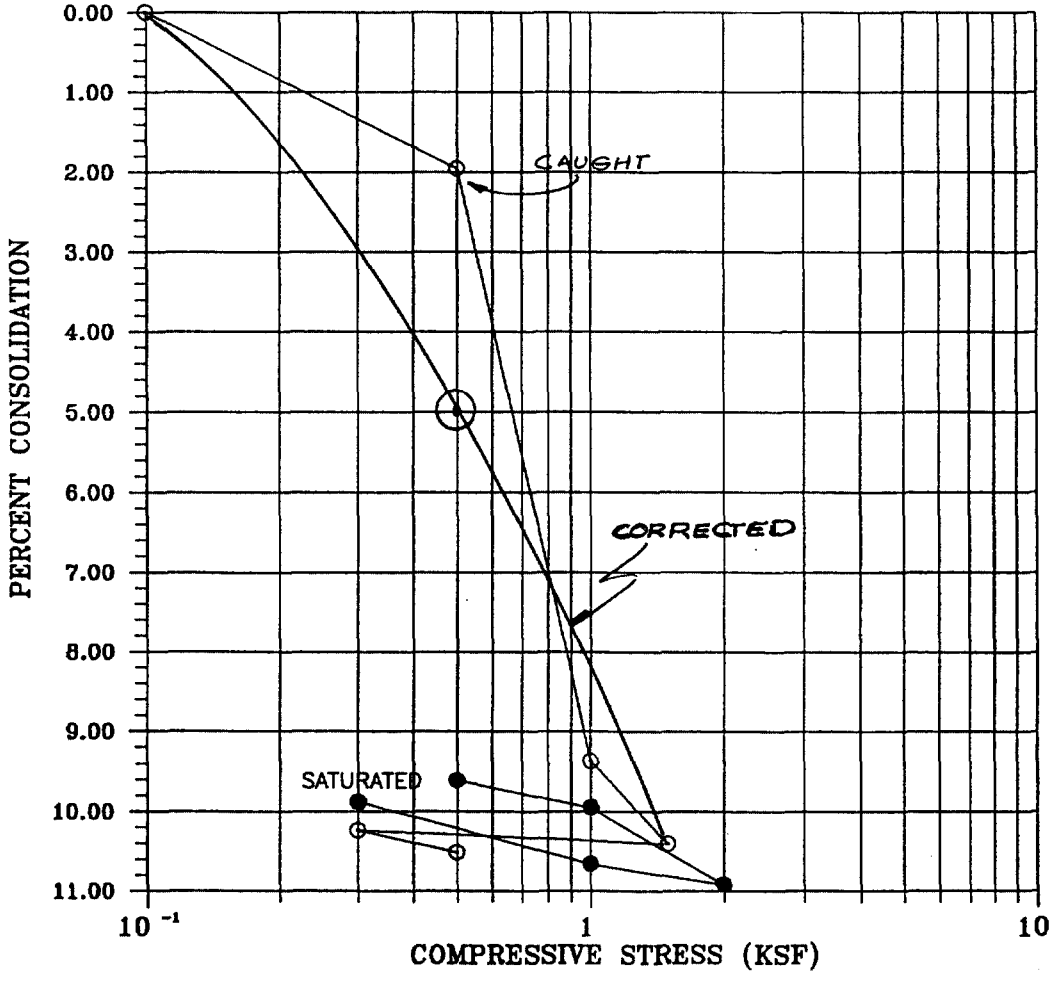

FIGURE NO. F.1.3

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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-09/ 4 DEPTH : 20 ft.

INITIAL DRY DENSITY : 114.6 pcf. INITIAL MOISTURE CONTENT : 13.4 pct.

INITIAL VOID RATIO : 0.471

SPECIFIC GRAVITY : 2.70(ASSUMED)

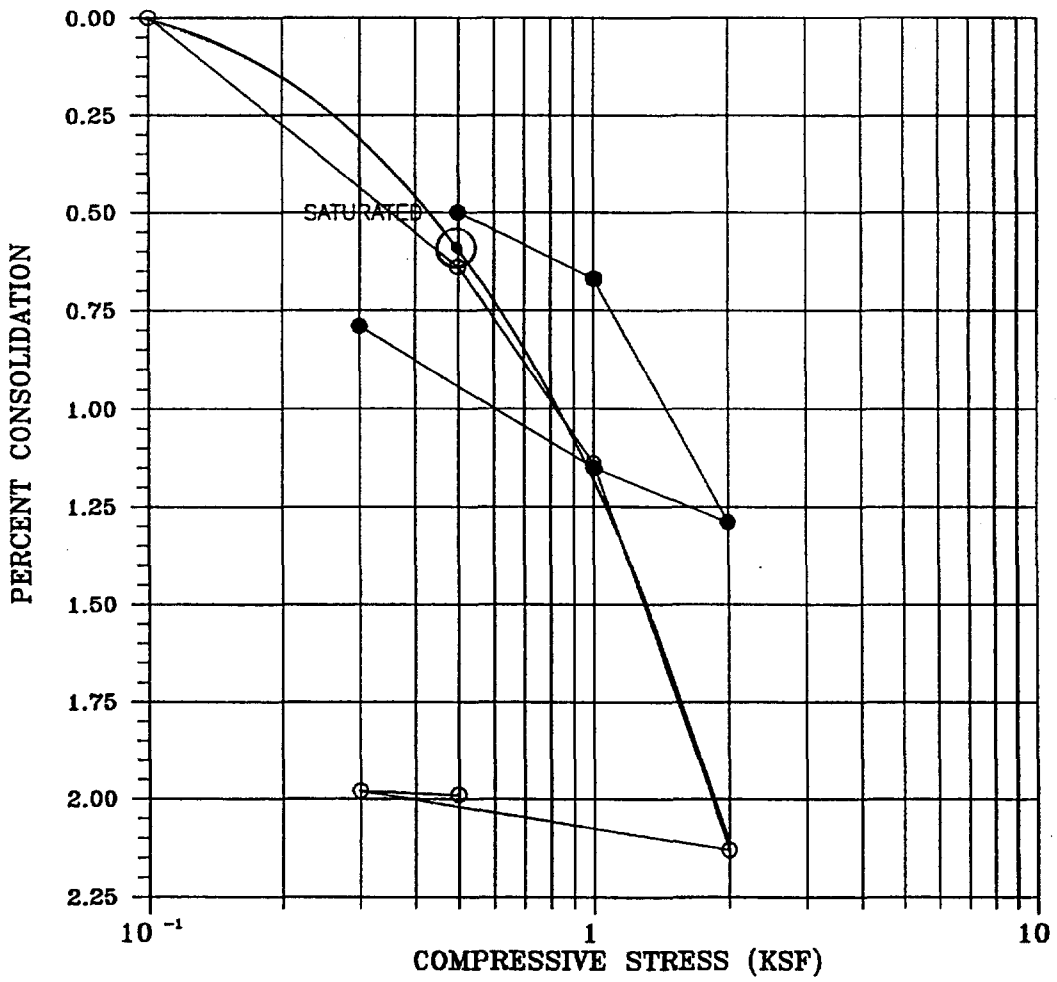

FIGURE NO. F.1.4

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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-10/ 3 DEPTH : 10.5 ft.

INITIAL DRY DENSITY : 92.9 pcf. INITIAL MOISTURE CONTENT : 27.5 pct.

INITIAL VOID RATIO : 0.814

SPECIFIC GRAVITY : 2.70(ASSUMED)

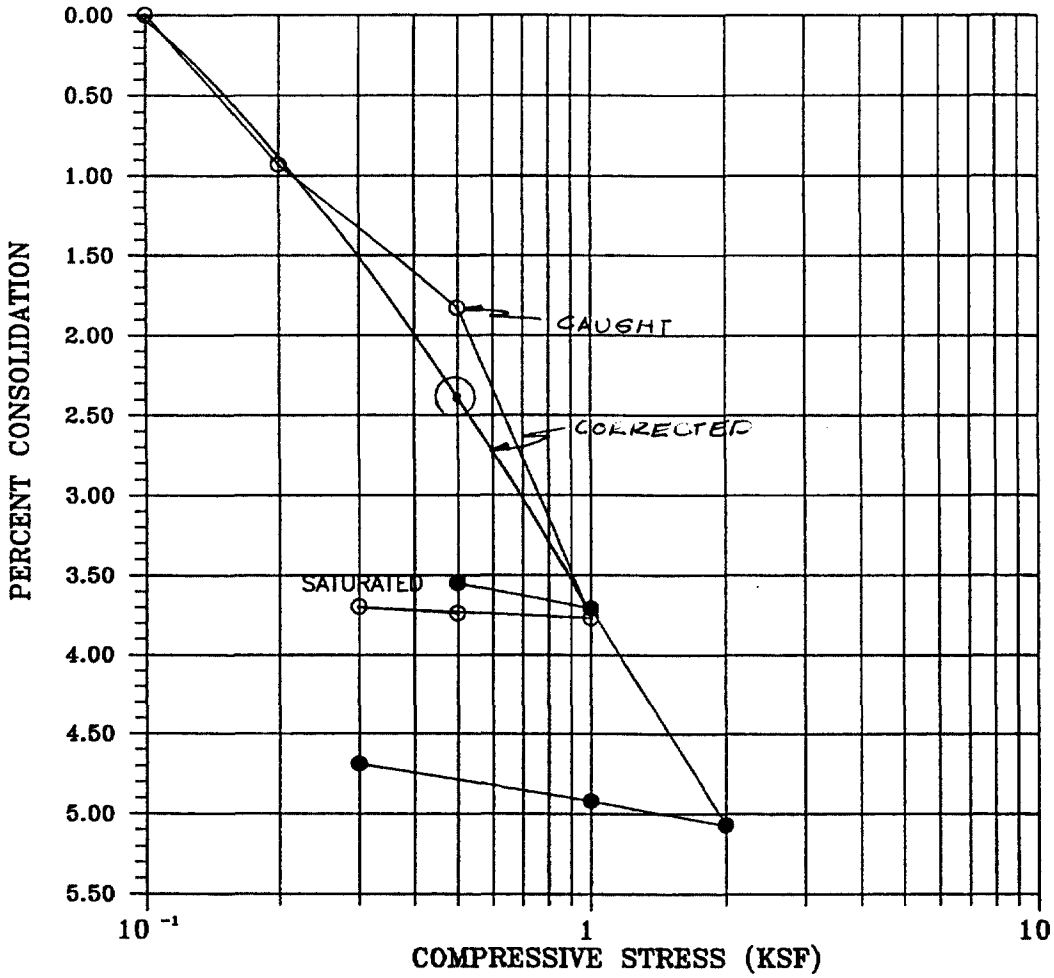

FIGURE NO. F.1.5

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CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-12/ 4 DEPTH : 15 ft.

INITIAL DRY DENSITY : 117.0 pcf. INITIAL MOISTURE CONTENT : 12.5 pct.

INITIAL VOID RATIO : 0.441

SPECIFIC GRAVITY : 2.70(ASSUMED)

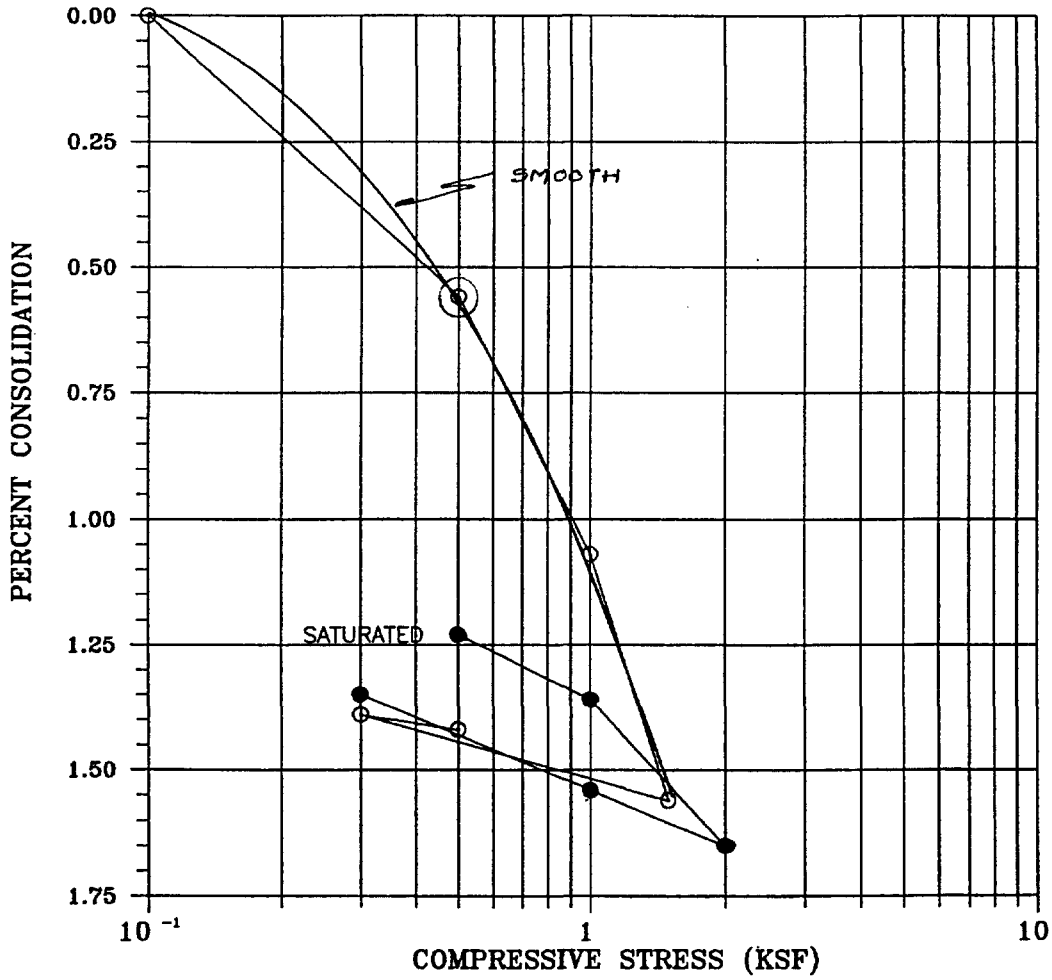

FIGURE NO. F.1.6

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APPENDIX F.2

DIFFERENTIAL SETTLEMENT IN AREA 4

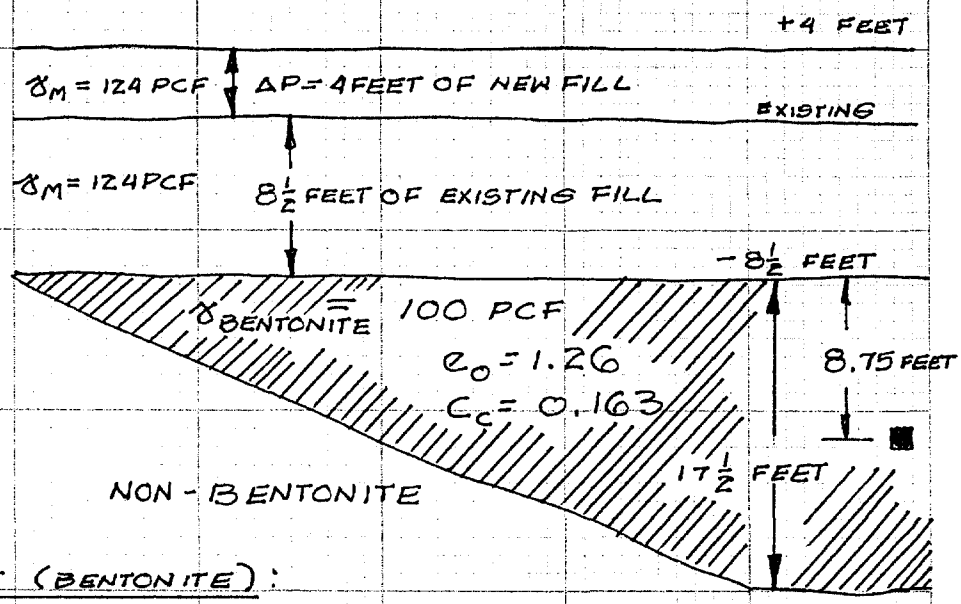
LOWNEY ASSOCIATES

Project Name: WDI/SANTA FE SPRINGS
Subject: AREA 4 SETTLEMENT ESTIMATE
Project No.: 1651-8A Sheet No. 1 Of 1
By: TB Date: 12/23/02 Chk'd by: Date:

AREA 4 SETTLEMENT ESTIMATE

(WORST CASE DIFFERENTIAL SETTLEMENT)

ASSUME:



TOTAL SETTLEMENT (BENTONITE):

$$\gamma_{M\ \text{COMPACTED FILL}\ (90\%)} = 0.9\,(124\ \text{PCF})\ 1.11 \cong 124\ \text{PCF}$$

$$\Delta P = \gamma H = 124\ \text{PCF} \cdot 4\ \text{FEET} = 496\ \text{PSF}$$

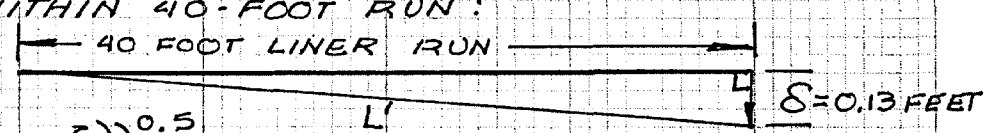
$$P_o = (\gamma_{FILL} \cdot 8\tfrac{1}{2}\ \text{FEET}) + (\gamma_{BENTONITE} \cdot 8.75\ \text{FEET}) = 1{,}929\ \text{PSF}$$

$$\delta_{TOTAL} = \frac{H \cdot C_c}{1 + e_o} \log\left(\frac{P_o + \Delta P}{P_o}\right) = \frac{17.5\ \text{FEET}\,(0.163)}{(1 + 1.26)} \log\left(\frac{1{,}929\ \text{PSF} + 496\ \text{PSF}}{1{,}929\ \text{PSF}}\right)$$

$$\delta_{TOTAL} = 0.13\ \text{FEET} = \underline{\underline{1.51\ \text{INCHES}}}$$

STRAIN ON GEOTEXTILE DUE TO DIFFERENTIAL SETTLEMENT:

ASSUME TOTAL BENTONITE SETTLEMENT IS DIFFERENTIAL SETTLEMENT WITHIN 40-FOOT RUN:



$$L' = ((40')^2 + (0.13^2))^{0.5}$$

$$L' = 40.0002\ \text{FEET}, \quad \underline{\underline{\text{STRAIN} = 0.0005\ \%}}$$

VERY LOW

EXPLORATORY BORING: G-06

DRILL RIG: LAYNE CHRISTENSEN COMPANY
BORING TYPE: 8-INCH HOLLOW STEM AUGER
LOGGED BY: TKK
START DATE: 7-10-02 FINISH DATE: 7-10-02

PROJECT NO: 1651-8A
PROJECT: WASTE DISPOSAL SUPERFUND SITE
LOCATION: SANTA FE SPRINGS, CALIFORNIA
COMPLETION DEPTH: 36.5 FT.

This log is a part of a report by Lowney Associates, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.

Undrained Shear Strength (ksf): ○ Pocket Penetrometer △ Torvane ● Unconfined Compression ▲ U-U Triaxial Compression (1.0, 2.0, 3.0, 4.0)

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE
158.0	0	SURFACE ELEVATION: 158 FT. (+/-)						
		FILL: CLAYEY SAND (SC), with medium to coarse gravel, medium dense to dense, dry, brown	SC	26		5	104	39
	5	**FILL: CLAY (CL),** traces of sand, soft, slightly moist, dark brown	CL	9		15	87	
		FILL: BENTONITE CLAY (CL), very soft, wet, black, weak petroleum odor	CL					
	10					126	46	
				16"		58		
		- too soft, only 6 inch recovery						
	15	- very soft, black to gray, weak petroleum odor (0.6 ppm)		36"		44	75	
	20	- dark gray, very weak petroleum odor (7.6 ppm)		36"		45	70	
	25			12"		5		
		NATIVE: SAND (SP), very dense, moist, greenish brown, no odor	SP					
128.0	30							

Continued Next Page

GROUND WATER OBSERVATIONS:
NO FREE GROUNDWATER ENCOUNTERED

LA CORP.GDT 12/23/02 Fullerton*

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

FIELD BORING LOG

OFS NUMBER:

SHEET 1

PROJECT NAME: WASTE DISPOSAL INC.
LOCATION: SANTA FE SPRINGS CALIFORNIA
CLIENT NAME: EPA
SITE MANAGER: D. MELCHIOR
LOGGED BY: G. GALLOWAY

BORING NUMBER: SB-029
BORING LOCATION: RESERVOIR AREA
DRILLING CONTRACTOR: DATUM
DRILLING METHOD: HSA
BIT SZ/HAMMER WT/DROP: 7"/140#/30"
SAMPLE RETRIEVAL SYS: SPLIT SPOON

DATE/TIME STARTED: 09/09/88 0938
DATE/TIME COMPLETED: 09/14/88 1200
TOTAL DEPTH: 67.50
SURFACE ELEVATION: 158.6310
WATER DEPTH: 51.00

DEPTH IN FT	GRAPHIC LOG (BOULDERS, COBBLES, CRS SAND, MED SAND, FINE SAND, SILT, CLAY)	SAMPLE #	BLOWS 6"	OVA PPM	CGI %LEL	ODOR	COLOR	MOISTURE	POR/PEM	USCS SYMB	HNU	DESCRIPTION
0			0 0 0	0.0	0						0.0	
0	CRS SAND, SILT, CLAY		4 5 12	0.0	0	N	RB	DR	L,M	SM	0.0	SILTY SAND WITH ROCKS AND PEBBLES, RED BROWN, DRY, MEDIUM DENSE. 134
5	CRS SAND, MED SAND, FINE SAND	01 02 03	8 8 4	0.0	0	N	G	DR	H,H	SP	0.0	MEDIUM COARSE GRAINED SAND, GRAY, DRY, MEDIUM DENSE, CHIPS AND BLOCKS OF TILE AND CEMENT. CLP SAMPLE. 140
10	CLAY	04 05 06	1 1 4	1.0	0	HC	DG	SM/MO	L,L	CL	0.0	AT 9.5 FEET SOFT, DARK GRAY CLAY (MUD), DAMP TO MOIST. NON CLP SAMPLE. 141
15	CLAY	07 08 09	2 2 3	300.0	100	HC	DG	MO	L,L	CL	40.0	HOLE IS ABOVE 100% LEL. FOR 45 MINUTES WE WILL ABANDON AND ALLOW TO VENT. NON CLP SAMPLE. 142
20	FINE SAND, SILT, CLAY	10	1 0 0	1.0	100	HC	DG-YB	SM-MO	LL-M M	CL-SP	30.0	MEDIUM GRAINED SANDS WITH CLAY. ALLUVIUM ALLUVIUM. POOR SAMPLE RECOVERY-ONLY ONE SAMPLE SLEEVE COLLECTED. NON CLP SAMPLE. 102
25	FINE SAND, SILT, CLAY	11 12 13	2 3 4	0.0	100	HC	DG	MO	MM	SC	17.0	DARK GRAY TO GRAY, SILTY CLAY WITH TRACES OF SUMP MATERIAL. 111
30	MED SAND, FINE SAND	14 15 16	17 34 48	0.0	75	SHC	G	SM-MO	MM	SM	0.0	DARK GRAY MEDIUM GRAINED SAND AND SILT. HYDROCARBON SUMP CONTAMINATION. 112
35	CRS SAND, MED SAND		25 50 0	0.0	70	N	T	SM-MO	HH	SP	35.0	GRAY TO TAN COARSE GRAINED SAND. MEDIUM DENSE, DAMP.
40	MED SAND		24 34 44	0.0	***	N	DG	SM-MO	M-H	SP	0.0	DARK GRAY SILTY FINE SAND AND CLAY. MEDIUM DENSE.

BENTONITE

FIELD BORING LOG

OFS NUMBER: SHEET 1

PROJECT NAME: WASTE DISPOSAL INC.
LOCATION: SANTA FE SPRINGS CALIFORNIA
CLIENT NAME: EPA
SITE MANAGER: D. MELCHIOR
LOGGED BY: T. TOMCZYK

BORING NUMBER: SB-041
BORING LOCATION: RESERVOIR AREA
DRILLING CONTRACTOR: DATUM
DRILLING METHOD: HSA
BIT SZ/HAMMER WT/DROP: 7"/140#/30"
SAMPLE RETRIEVAL SYS: SPLIT SPOON

DATE/TIME STARTED: 09/19/88 1105
DATE/TIME COMPLETED: 09/19/88 1340
TOTAL DEPTH: 40.00
SURFACE ELEVATION: 158.5018
WATER DEPTH: 0.00

DEPTH IN FT	GRAPHIC LOG (BOULDERS, COBBLES, CRS SAND, MED SAND, FINE SAND, SILT, CLAY)	SAMPLE #	BLOWS 6"	OVA PPM	CGI %LEL	ODOR	COLOR	MOISTURE	POR/PEM	USCS SYMB	HNU	DESCRIPTION
0	SILT, CLAY	01 02 03	8 11 17	0.0	0	N	BR	SM	M	SM	0.0	BROWN TO LIGHT BROWN FILL MATERIAL(OAF), SILTY SAND. CLP SAMPLE. 1111
5	FINE SAND, SILT, CLAY	04 05 06	7 5 11	1000.0	0	SH	BL	SM	M-L	OL-ML	1.8	BLACK, STIFF, CLAY LIKE, VISIBLE CONTAMINATION. LAST 6" BROWN SILT & SAND. NON CLP SAMPLE. 1122
10	FINE SAND		0 0 0	30.0	0	LH	BR	SM	M-L	SM	0.2	CONCRETE ENCOUNTERED AT 10'. NO SAMPLE POSSIBLE. DARK SILTY SAND IN TAILINGS. 1132
			CONCRETE									
15	CLAY; BENTONITE	07 08 09	3 4 5	1000.0	0	SH	BL	WT	L	OH	0.4	BLACK MUD, VISIBLE CONTAMINATION, SUMP MATERIAL. 1150
20	FINE SAND, SILT; BENTONITE	10 11 12	2 3 3	1000.0	0	SH	BL	SM	M	OH-ML	2.5	FIRST SLEEVE SAME AS PREVIOUS; SECOND AND THIRD WERE GRAY SILT WITH FINE SAND. ZERO IN BREATHABLE OVA ZONE. CLP SAMPLE. 1205
25	CLAY; BENTONITE	13 14 15	4 3 5	1000.0	0	SH	G	SM	M-L	CL-ML	4.0	GRAY SILTY CLAY AND CLAYEY SUMP MATERIAL WITH SOME BLACK STREAKS. CLP SAMPLE. 1222
30	FINE SAND, SILT		5 4 5	1000.0	10	N	G	SM	M	SM	7.0	GRAY SILTY SAND. NO VISIBLE CONTAMINATION. NO SAMPLE COLLECTED. 1240
35	COBBLES, CRS SAND, MED SAND, FINE SAND	16 17 18	38 60 6	1000.0	100	N	G	SM	M	SM	0.0	NO VISIBLE CONTAMINATION. GRAY FINE TO COARSE SAND. NON CLP SAMPLE. 1300
40	FINE SAND, SILT, CLAY	19 20 21	37 54 6	1000.0	60	N	G/GRN	SM	M-L	ML	0.0	GRAY GREEN SILT WITH CLAY AND MINOR FINE GRAINED SAND. ZERO OVA ON BREATHING ZONE. 1332

TABLE 8.1.3-1

SUMMARY OF CONSOLIDATION TEST RESULTS

WASTE DISPOSAL INC. SUPERFUND SITE

Location	Boring Number	Thickness of Bentonite (feet)	Sample Depth (feet)	Initial Void Ratio	C_c
(disturbed*)	G-01	15.0	20*	1.84	0.384
Area 7	G-04	11.5	10	3.08	0.262
Area 4	G-06	17.5	15	1.26	0.163
Within Rerservoir	G-09	16.0	20	0.47	0.024
	G-10	15.5	10½	0.81	0.068
Top of Slope	G-12	13.5	15	0.44	0.020
AVERAGE (Discounting G-01 at 20 feet):					0.107

*Sample discounted due to test disturbance

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email: keantanlab@aol.com

CONSOLIDATION TEST RESULTS
(ASTM D2435)

PROJECT: WDI/SANTA FE SPRINGS KTL NO.: 02-056-002

CLIENT PROJECT NO.: 1651-8A CLIENT : TRC

REPORT DATE : AUG 2002 SUMMARIZED BY : K. TAN

BORING NO. : G-06/ 5 DEPTH : 15 ft.

INITIAL DRY DENSITY : 74.6 pcf. INITIAL MOISTURE CONTENT : 44.0 pct.

INITIAL VOID RATIO : 1.260

SPECIFIC GRAVITY : 2.70(ASSUMED)

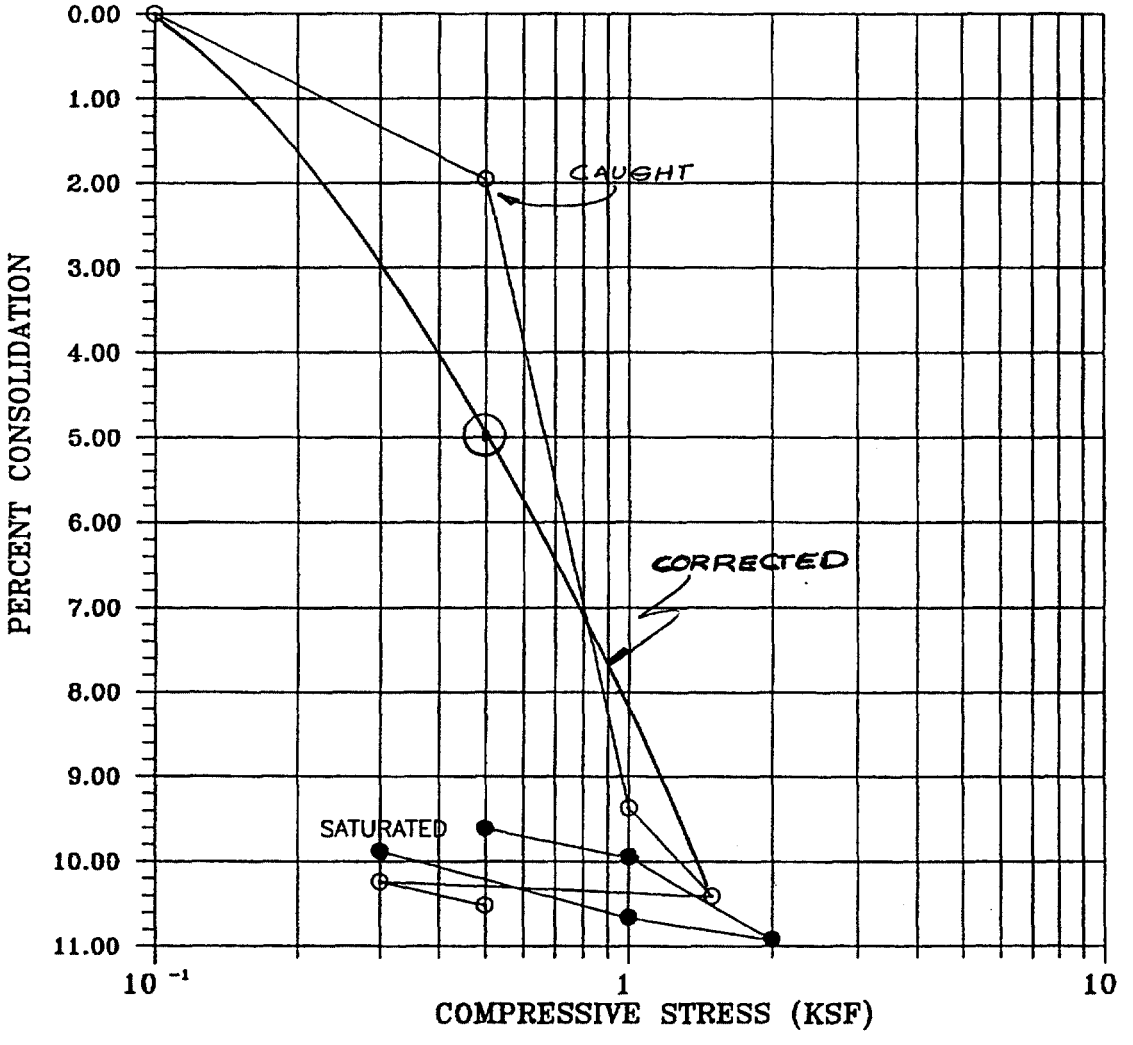

FIGURE NO. E.5.3

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APPENDIX F.3

BEARING CAPACITY/SHEAR STRENGTH CALCULATION

TRC

Customer-Focused Solutions

November 4, 2002

WDI Superfund Site – Waste Shear Strength Calculation

Introduction

A calculation was performed to estimate the prevailing shear strength of the waste underlying the cover material at the WDI site. This calculation was performed using a known loading condition for the site and back-calculating unconsolidated, undrained (UU) shear strength, given specified factors of safety.

Background

In 1998, grading work was performed at the site and detailed in "Technical Memo No. 11 – Reservoir Area Grading Plans and Waste/Debris Management As-Built Report, Waste Disposal Inc. Superfund Site" (TRC, December 1998). The equipment used for grading was a John Deere 762 Motor Scraper (that is no longer in production). The existing cover and underlying waste did not experience bearing capacity failure under the scraper loading; thus, the loaded scraper weight has been used in these calculations as a known loading condition. Given the variable nature and composition of the waste under the cover, it was determined that back-calculating shear strength of waste based on known performance would be representative of lower bound conditions present at the time of regrading in 1998.

Organization

This calculation is organized as follows:

Attachment A: Description of Bearing Capacity Model and Model Parameters
Attachment B: Model Calculation Spreadsheets
Attachment C: Coefficient of Punching Shear (Ks) as a function of ϕ
Attachment D: Copies of referenced pages from J.E. Bowles' *Foundation Analysis and Design, Fifth Ed.*
Attachment E: John Deere Scraper Specifications and Tire Contact Footprint
Attachment F: Site Plan Showing Cover and Waste Elevations

Approach

A range of values was assumed for the shear strength of the waste and corresponding ultimate bearing capacities for the two-layer soil model were calculated. The ratio of the ultimate bearing capacity to applied load, i.e. factor of safety, was calculated for each shear strength value, as depicted on Figure 1. The thickness of cover and factor of safety were plotted for each assumed value of shear strength. A factor of safety ranging from 1.5 to 2.0 was selected as being representative of the cover performance, given that bearing capacity failure, rutting or soft spots were not observed during the 1998 cover grading.

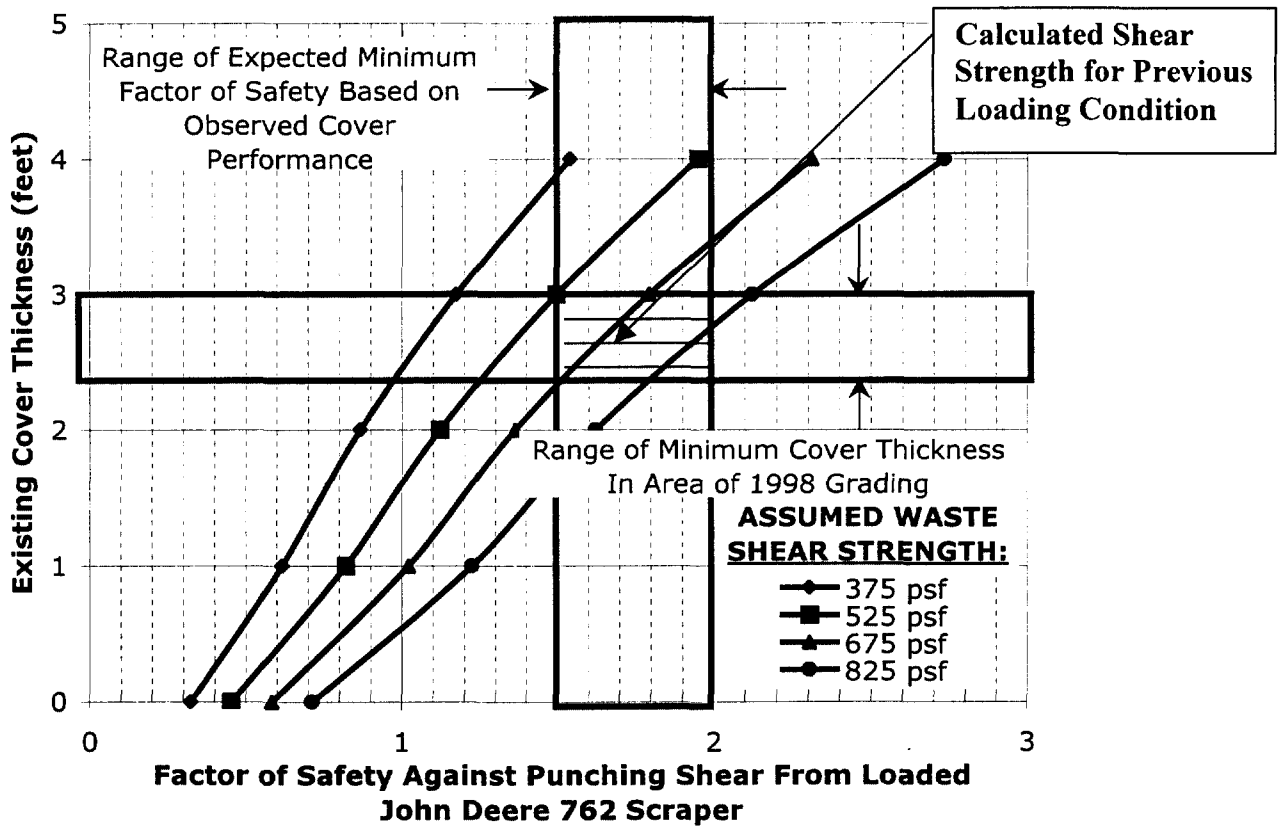
21 Technology Drive • Irvine, California 92618
Telephone 949-753-0101 • Fax 949-753-0111

Key Assumptions

- Minimum existing cover over waste is between 2.5 and 3.0 feet (see Attachment F: Cover thickness is the difference between the cover and waste elevations). Explanation on Attachment F
- Friction angle of the cover material is 31°
- Waste consists of a matrix of construction demolition debris with voids filled with bentonite clay (drilling mud)
- Applied load during grading can be modeled as the weight of a loaded John Deere 762 scraper bearing on four tires, each with an area 1.37 feet wide by 1.61 feet long

Conclusion

The ultimate shear strength of the waste can be estimated by calculating the combined ultimate bearing capacity of the waste and punching shear resistance of the cover. The assumed value for the shear strength of the waste can be checked for reasonableness by calculating the factor of safety for the previous loading condition during site grading operations. As the following Figure 1 illustrates, if the factor of safety was between 1.5 and 2.0 and the minimum depth of cover was between 2.5 and 3.0 feet, the gross shear strength of the waste was about 525 to 775 pounds-per-square-foot (psf).



Camilla Khan
Senior Project Engineer

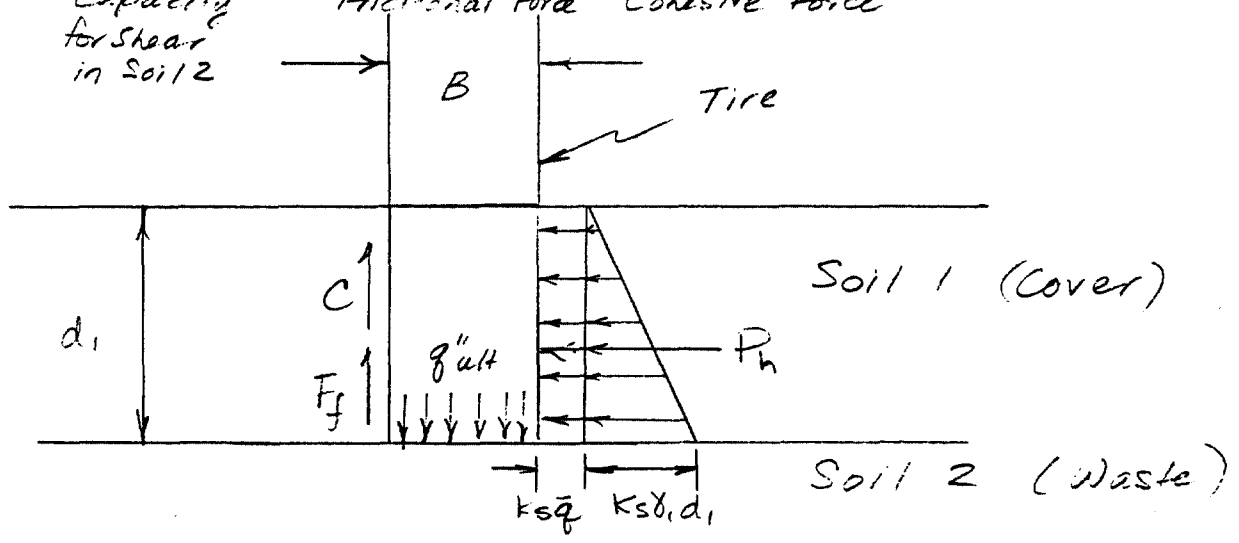
ATTACHMENT A

Description of Bearing Capacity Model and Model Parameters

Model Description:

The ultimate Bearing Capacity of the waste is modeled by assuming that the scraper tire causes a punching failure in Soil 1 (cover) and a general bearing capacity failure in Soil 2 (waste), as shown on the following diagram:

$$q'_{ult} = \underbrace{q''_{ult}}_{\text{Bearing Capacity for Shear in Soil 2}} + \overbrace{\underbrace{\frac{F_f}{A_f}}_{\text{Frictional Force}} + \underbrace{\frac{C}{A_f}}_{\text{Cohesive Force}}}^{\text{Resistive Force developed Along Punching Surface}}$$



$$q'_{ult} = c N_c S_c d_c + \bar{q} N_q s_q d_q + 0.5 \gamma B N_\gamma s_\gamma d_\gamma$$

(Hansen's formula for ultimate soil pressure)

$$F_f = p P_v K_s \tan\phi$$

$$C = p d_1 c_1$$

The ultimate bearing capacity will be the lesser of q_{ult} (assuming failure occurs in the cover) or q'_{ult} (punching failure in Soil + bearing capacity failure in Soil 2)

Model Parameters:

C = cohesion = 200 psf for sand (cover), assumed for clay (waste)

N_c, N_q, N_γ = Bearing Capacity Factors (Bowles, p. 223) = 5.14, 1.0, 0 for clay; 32.8, 20.8, 18.85 for sand (interpolated for $\phi = 31°$)

S_c, S_q, S_γ = Shape Factors for bearing area geometry (see Bowles, p. 222)

$S_c = 1 + 0.2 K_p B/L$
$S_q = 1 + 0.1 K_p B/L$ } * see below for definition of B, L

$\bar{q}$ = soil surcharge pressure

d_c, d_q, d_γ = depth factors (Bowles, p. 222)

$d_c = 1 + 0.2\sqrt{K_p}\, D/B$; $d_q = 1 + 0.1\sqrt{K_p}\, D/B$; $d_q = d_\gamma = 1.0$ (clay)

γ = unit weight of soil - 124 pcf for sand & clay

P = total perimeter length of bearing area = 2(B+L) = 5.95 feet

P_v = Vertical Thrust Force = $0.5 \gamma d_1^2$

K_s = coefficient of lateral pressure = based on soil angle of friction and q_1/q_2 (ratio of the ultimate bearing capacity of the stronger soil to the weaker soil (see Figure in Attachment C)

ϕ = Soil angle of friction = 31° for cover, 0° for bentonite clay

B = least lateral dimension of bearing area = 1.37 feet

L = bearing area length = 1.61 feet

Model Calculations

The calculations performed for the shear strength analysis are presented in this section and the results are summarized in the Excel spreadsheets contained in Attachment B.

1. The ultimate bearing capacity of the soil was evaluated for varying depths of cover:

TRC

By CAK Date 10/23/02 Subject WDI- Shear Strength Sheet No. 3 of 4

Chkd. By KF for TB Date 11/4/02 Proj. No. 30747

1. q_{ult} = ultimate bearing capacity assuming shear failure occurs in Soil 1:

$$q_{ult} = c_s N_c S_c d_c + \bar{q} N_q S_q d_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma$$

- Note that for bearing directly on the sand, $d_c = d_q = d_\gamma = 1.0$ (no embedment) and the surcharge $\bar{q} = \gamma D = 0$
- $K_p = \tan^2(45 + \phi/2) = 3.124$ (cover); $K_p = 1.0$ (waste)
- $S_c = 1 + 0.2(3.124)(1.37/1.61) = 1.53$ (cover)
  $= 1 + 0.2(1.0)(1.37/1.61) = 1.17$ (waste)
- $S_q = S_\gamma = 1 + 0.1(3.124)(1.37/1.61) = 1.27$ (cover)
  $= 1.0$ (waste)

$$q_{ult_{SOIL1}} = (200)(32.8)(1.53)(1.0) + 0 + 0.5(124)(1.37)(18.85)(1.27)(1.0)$$
$$= 12{,}070 \text{ pounds/s.f}$$

2. $q'_{ult} = q''_{ult} + p\frac{K_s p_v \tan\delta}{A_s} + \frac{p d_1 c}{A_s} \leq q_{ult}$

$$q''_{ult} = d_c S_c c N_c + d_q d_1 D N_q S_q + 0.5 d_\gamma B \gamma N_\gamma$$

Evaluate for $\phi = 0$, $c = 525$ psf, $d_1 = 3.0$

$d_c = 1 + 0.2\sqrt{1.0} \times 3.0/1.37 = 1.44$

$S_c = 1.53$ (use shape factors for cover since the load is bearing on cover)

$d_q = d_\gamma = 1.0$

$S_q = S_\gamma = 1.27$ (" " " " " " " ")

$$q''_{ult} = c_s N_c S_c d_c + \bar{q} N_q S_q d_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma$$

$$q''_{ult} = (525)(5.14)(1.53)(1.44) + (124)(3)(1.0)(1.27)(1.0) + (0.5)(124)(1.37)(0)(1.27)(1.0)$$
$$= 6{,}418 \text{ psf}$$

$K_s = 2.6$ for $q_{ult2}/q_{ult1} = (525)(5.14)(1.17)(1.0)/12{,}070 = 0.26$ (from Figure 6A.5)

$$q'_{ult} = q''_{ult} + p\frac{K_s p_v \tan\delta}{B \times L} + \frac{p d_1 c}{BL}$$

$$= 6{,}418 + \frac{(5.95)(2.6)(0.5)(124)(3)^2 \tan(31°)}{(1.37)(1.61)} + \frac{(5.95)(3)(200)}{(1.37)(1.61)}$$

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TRC

By CAK Date 10/23/02 Subject WDI - Shear Strength Sheet No. 4 of 4
Chkd. By KF for TB Date 11/4/02 Proj. No. 30747

$q'_{ult} = 6,418 + 2,352 + 1,618 = 10,388$ psf $< q_{ult}$ for Soil 1

Applied load from scraper $= \left(34,300^{*}\ \text{lb} + 11\ \text{cy} \times 90\ \frac{\text{lb}}{\text{cf}} \times 27\ \frac{\text{cf}}{\text{cy}}\right)/4$

(* see equipment specifications in Attach. E)

$= 15,258$ lb PER TIRE

Applied pressure $= 15,258\ \text{lb} / (1.61 \times 1.37)\ \text{ft}^2$
$= 6,918$ psf

∴ Factor of Safety against combined bearing capacity failure and punching shear failure of the wall

$$= \frac{q'_{ult\,2}}{\text{applied stress}} = \frac{10,388}{6,918} = 1.50 \cong 1.5$$

The factors of safety for various calculated values of shear strength are displayed in the spreadsheets in Attachment B.

Note: Due to rounding, values in this calculation may not match exactly with spreadsheet results.

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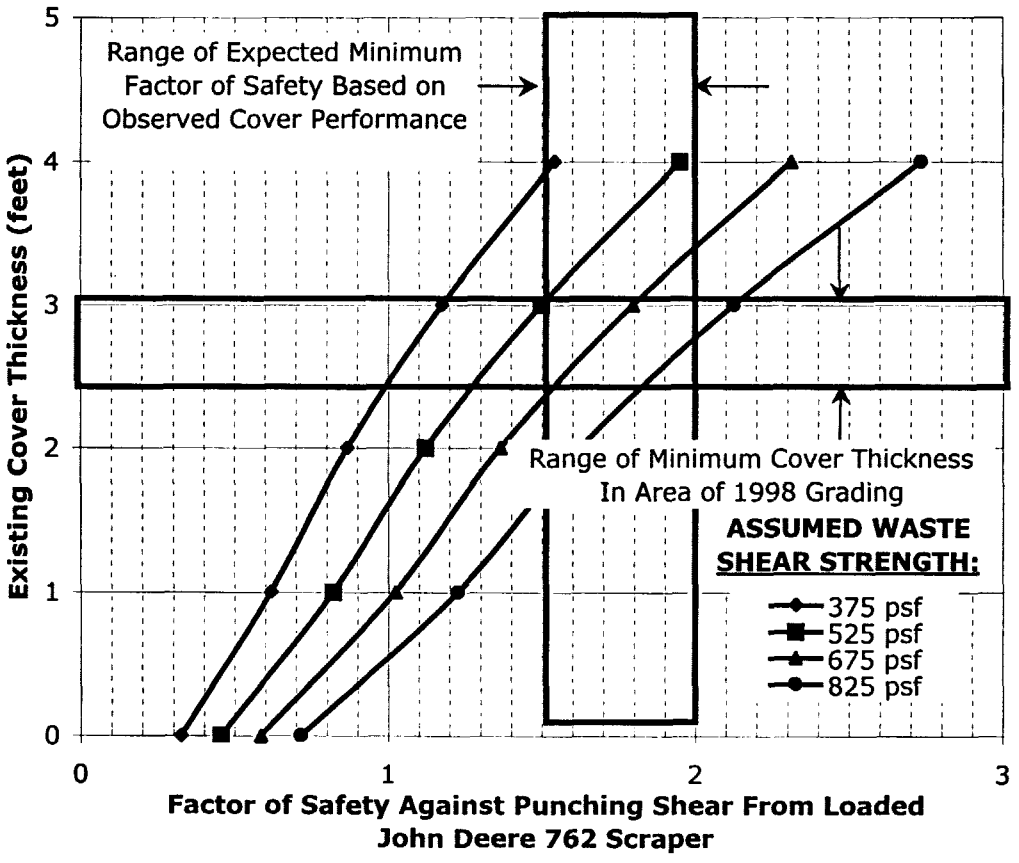
ATTACHMENT B

Model Calculation Spreadsheets

WASTE DISPOSAL INC. SUPERFUND SITE
FACTOR OF SAFETY VS. DEPTH FOR DIFFERENT SHEAR STRENGTH

Existing Cover Thickness (feet)	Factor of Safety For JD 762 Loading, For Assumed Strength				
	250 psf	375 psf	525 psf	675 psf	825 psf
4	1.25	1.54	1.95	2.31	2.73
3	0.93	1.18	1.50	1.80	2.12
2	0.67	0.87	1.12	1.36	1.62
1	0.45	0.62	0.82	1.02	1.23
0	0.22	0.32	0.45	0.58	0.71



WASTE DISPOSAL INC. SUPERFUND SITE
BEARING CAPACITY CALCULATION - PUNCHING SHEAR FAILURE

During Construction (Excavation)															
Existing Cover Thickness (feet)	Unit Weight (psf)	Cohesion (psf)	Friction Angle (degree)	Surcharge (psf)	$q_{u\,(max)}$ (psf)	p	P_u	tan φ	K_s	A_s	$pP_uK_s\tan\phi$	$pd\,q_u$	$Q_{u\,(max)}$ (psf)	$q_{u\,(max)}$ (psf)	Factor of Safety
4	124	200	31	0	12090.4	5.95	992	0.60	1.7	2.2	6029.1	4760.0	3746.5	8654.9	1.25
3	124	200	31	0	12090.4	5.95	558	0.60	1.7	2.2	3391.4	3570.0	3301.7	6468.7	0.93
2	124	200	31	0	12090.4	5.95	248	0.60	1.7	2.2	1507.3	2380.0	2856.8	4625.4	0.67
1	124	200	31	0	12090.4	5.95	62	0.60	1.7	2.2	376.8	1190.0	2412.0	3124.9	0.45
0	124	250	0	0	1504.4	5.95	0	0.00	1.7	2.2	0.0	0.0	1503.4	1503.4	0.22

Type of Equipment	Contact Width (feet)	Contact Length (feet)	Contact Area (feet²)	Load (lb)	Pressure (psf)
John Deere 762 Scraper	1.37	1.61	2.2	15257.5	6941.4

Friction Angle (degree)	N_f	N_c	N
30	30.13	18.4	15.7
31	32.8	20.8	18.85
32	35.47	23.2	22
0	5.14	1	0

Shape Factor	Sc	Sq	S
Sand	1.53	1.27	1.27
Waste	1.17	1	1

Existing Cover Thickness (feet)	Depth Factor*		
	dc	dq	d
4	1.59	1.00	1.00
3	1.44	1.00	1.00
2	1.29	1.00	1.00
1	1.15	1.00	1.00
0	1.00	1.00	1.00

*: ϕ=0 used

WASTE DISPOSAL INC. SUPERFUND SITE
BEARING CAPACITY CALCULATION - PUNCHING SHEAR FAILURE

During Construction (Excavation)															
Existing Cover Thickness (feet)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degree)	Surcharge (psf)	q_{u-ave} (psf)	p_o	P_o	$\tan\phi_i$	K_i	A_i	$pP_oK_i\tan\phi_i$	pd_iC_i	q_{u-ave} (psf)	q_{u-ave} (psf)	Factor of Safety
4	124	200	31	0	12090.4	5.95	992	0.60	2	2.2	7093.0	4760.0	5305.9	10698.4	1.54
3	124	200	31	0	12090.4	5.95	558	0.60	2	2.2	3989.8	3570.0	4717.1	8156.4	1.18
2	124	200	31	0	12090.4	5.95	248	0.60	2	2.2	1773.3	2380.0	4128.4	6017.9	0.87
1	124	200	31	0	12090.4	5.95	62	0.60	2	2.2	443.3	1190.0	3539.6	4282.7	0.62
0	124	375	0	0	2256.1	5.95	0	0.00	2	2.2	0.0	0.0	2255.1	2255.1	0.32

Type of Equipment	Contact Width (feet)	Contact Length (feet)	Contact Area (feet²)	Load (lb)	Pressure (psf)
John Deere 762 Scraper	1.37	1.61	2.2	15257.5	6941.4

Friction Angle (degree)	N_c	N_q	N_γ
30	30.13	18.4	15.7
31	32.8	20.8	18.85
32	35.47	23.2	22
0	5.14	1	0

Shape Factor	S_c	S_q	S_γ
Sand	1.53	1.27	1.27
Waste	1.17	1	1

Existing Cover Thickness (feet)	Depth Factor*		
	d_c	d_q	d_γ
4	1.59	1.00	1.00
3	1.44	1.00	1.00
2	1.29	1.00	1.00
1	1.15	1.00	1.00
0	1.00	1.00	1.00

*: ϕ=0 used

WASTE DISPOSAL INC. SUPERFUND SITE
BEARING CAPACITY CALCULATION - PUNCHING SHEAR FAILURE

Punching Shear Bearing Capacity Calculation Using C=525 psf For Waste															
Existing Cover Thickness (feet)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degree)	Surcharge (psf)	$q_{ultimate}$ (psf)	p	P_v	tan f_1	K_s	A_f	pP_vK_stan f	pd_1c_1	$q''_{ultimate}$ (psf)	$q'_{ultimate}$ (psf)	Factor of Safety
4	124	200	31	0	12090.4	5.95	992	0.60	2.6	2.2	9221.0	4760.0	7177.1	13537.7	1.95
3	124	200	31	0	12090.4	5.95	558	0.60	2.6	2.2	5186.8	3570.0	6415.6	10399.5	1.50
2	124	200	31	0	12090.4	5.95	248	0.60	2.6	2.2	2305.2	2380.0	5654.2	7785.7	1.12
1	124	200	31	0	12090.4	5.95	62	0.60	2.6	2.2	576.3	1190.0	4892.7	5696.3	0.82
0	124	525	0	0	3158.1	5.95	0	0.00	2.6	2.2	0.0	0.0	3157.1	3157.1	0.45

Type of Equipment	Contact Width (feet)	Contact Length (feet)	Contact Area (feet^2)	Tire Load (pounds)	Pressure (psf)
John Deere 762 Scraper	1.37	1.61	2.2	15,258	6,941

Friction Angle (degree)	N_c	N_q	N_γ
30	30.13	18.4	15.7
31	32.8	20.8	18.85
32	35.47	23.2	22
0	5.14	1	0

Shape Factor	Sc	Sq	S_γ
Sand	1.53	1.27	1.27
Waste	1.17	1	1

Existing Cover Thickness (feet)	Depth Factor*		
	dc	dq	d_γ
4	1.59	1.00	1.00
3	1.44	1.00	1.00
2	1.29	1.00	1.00
1	1.15	1.00	1.00
0	1.00	1.00	1.00

*: ϕ=0 used

WASTE DISPOSAL INC. SUPERFUND SITE
BEARING CAPACITY CALCULATION - PUNCHING SHEAR FAILURE

During Construction (Excavation)															
Existing Cover Thickness (feet)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degree)	Surcharge (psf)	q [illegible] (psf)	p	P	tan φ	K	A	pP K tan φ	pd(c)	q [illegible] (psf)	q' [illegible] (psf)	Factor of Safety
4	124	200	31	0	12090.4	5.95	992	0.60	3	2.2	10639.6	4760.0	9048.4	16054.4	2.31
3	124	200	31	0	12090.4	5.95	558	0.60	3	2.2	5984.8	3570.0	8114.2	12461.1	1.80
2	124	200	31	0	12090.4	5.95	248	0.60	3	2.2	2659.9	2380.0	7180.0	9472.9	1.36
1	124	200	31	0	12090.4	5.95	62	0.60	3	2.2	665.0	1190.0	6245.8	7089.7	1.02
0	124	675	0	0	4060.1	5.95	0	0.00	3	2.2	0.0	0.0	4059.1	4059.1	0.58

Type of Equipment	Contact Width (feet)	Contact Length (feet)	Contact Area (feet²)	Load (lb)	Pressure (psf)
John Deere 762 Scraper	1.37	1.61	2.2	15257.5	6941.4

Friction Angle (degree)	N_c	N_q	N_γ
30	30.13	18.4	15.7
31	32.8	20.8	18.85
32	35.47	23.2	22
0	5.14	1	0

Shape Factor	Sc	Sq	S
Sand	1.53	1.27	1.27
Waste	1.17	1	1

Existing Cover Thickness (feet)	Depth Factor*		
	dc	dq	d
4	1.59	1.00	1.00
3	1.44	1.00	1.00
2	1.29	1.00	1.00
1	1.15	1.00	1.00
0	1.00	1.00	1.00

*: ϕ=0 used

WASTE DISPOSAL INC. SUPERFUND SITE
BEARING CAPACITY CALCULATION - PUNCHING SHEAR FAILURE

Punching Shear Bearing Capacity Calculation Using C=825 psf For Waste															
Existing Cover Thickness (feet)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degree)	Surcharge (psf)	$q_{ultimate}$ (psf)	p	P_v	tan ϕ_1	K_s	A_f	$pP_vK_s\tan\phi_1$	pd_1c_1	$q''_{ultimate}$ (psf)	$q'_{ultimate}$ (psf)	Factor of Safety
4	124	200	31	0	12090.4	5.95	992	0.60	3.65	2.2	12944.8	4760.0	10919.7	18974.4	2.73
3	124	200	31	0	12090.4	5.95	558	0.60	3.65	2.2	7281.4	3570.0	9812.7	14749.6	2.12
2	124	200	31	0	12090.4	5.95	248	0.60	3.65	2.2	3236.2	2380.0	8705.8	11260.9	1.62
1	124	200	31	0	12090.4	5.95	62	0.60	3.65	2.2	809.0	1190.0	7598.8	8508.3	1.23
0	124	825	0	0	4962.2	5.95	0	0.00	3.65	2.2	0.0	0.0	4961.2	4961.2	**0.71**

Type of Equipment	Contact Width (feet)	Contact Length (feet)	Contact Area (feet^2)	Tire Load (pounds)	Pressure (psf)
John Deere 762 Scraper	1.37	1.61	2.2	15,258	6,941

Friction Angle (degree)	N	N_q	N_γ
30	30.13	18.4	15.7
31	32.8	20.8	18.85
32	35.47	23.2	22
0	5.14	1	0

Shape Factor	Sc	Sq	S_γ
Sand	1.53	1.27	1.27
Waste	1.17	1	1

Existing Cover Thickness (feet)	Depth Factor*		
	dc	dq	d_γ
4	1.59	1.00	1.00
3	1.44	1.00	1.00
2	1.29	1.00	1.00
1	1.15	1.00	1.00
0	1.00	1.00	1.00

*: ϕ=0 used

ATTACHMENT C

Coefficient of Punching Shear (Ks)

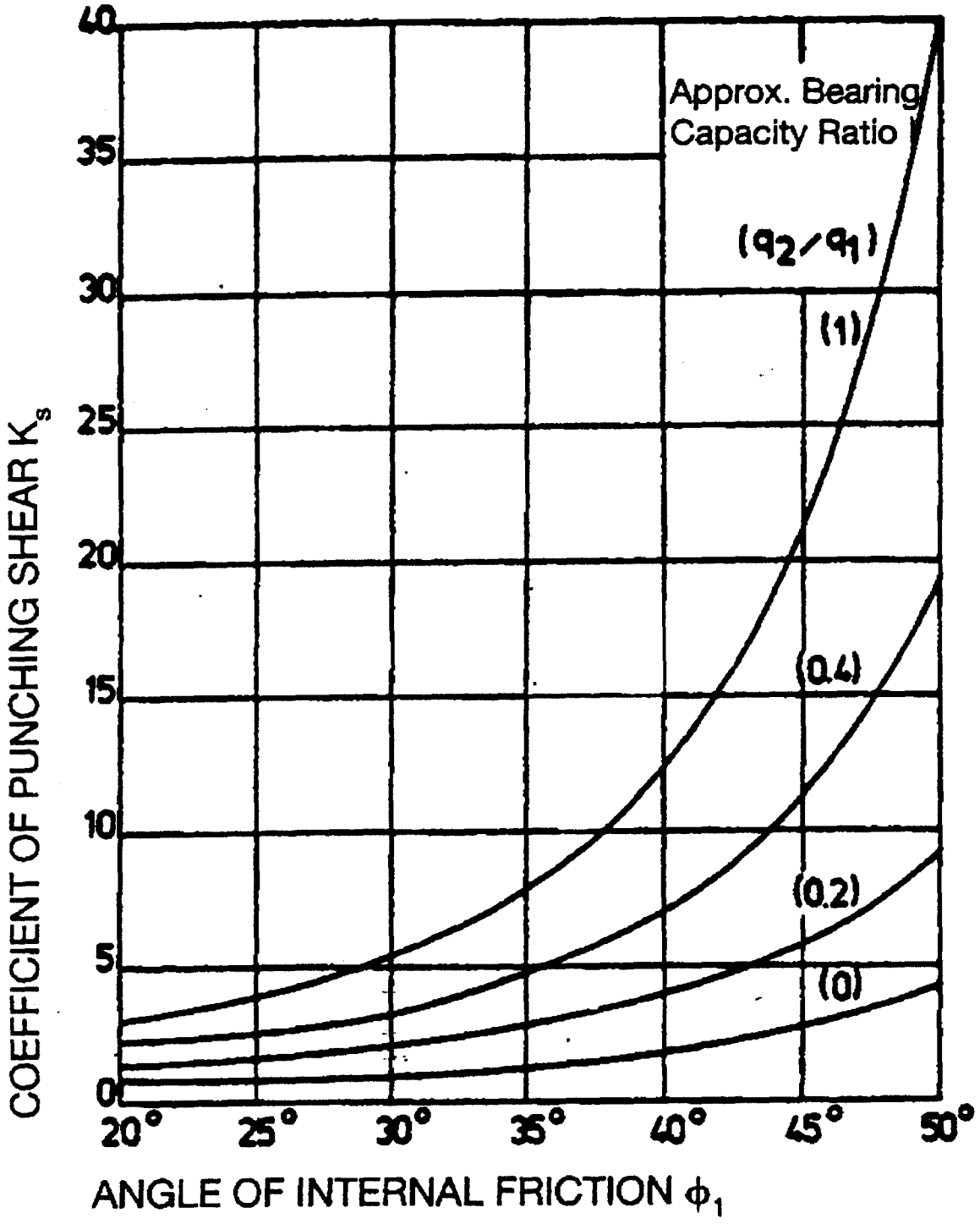


FIGURE 6A.5 Coefficients of punching shear resistance under vertical load (from Meyerhof and Hanna, 1978).

ATTACHMENT D

Copies of Referenced Pages from J.E. Bowles'
Foundation Analysis and Design, Fifth Edition

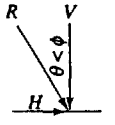
TABLE 4-2
Bearing-capacity factors for the Terzaghi equations

Values of N_γ for ϕ of 0, 34, and 48° are original Terzaghi values and used to back-compute $K_{p\gamma}$

ϕ, deg	N_c	N_q	N_γ	$K_{p\gamma}$
0	5.7*	1.0	0.0	10.8
5	7.3	1.6	0.5	12.2
10	9.6	2.7	1.2	14.7
15	12.9	4.4	2.5	18.6
20	17.7	7.4	5.0	25.0
25	25.1	12.7	9.7	35.0
30	37.2	22.5	19.7	52.0
34	52.6	36.5	36.0	
35	57.8	41.4	42.4	82.0
40	95.7	81.3	100.4	141.0
45	172.3	173.3	297.5	298.0
48	258.3	287.9	780.1	
50	347.5	415.1	1153.2	800.0

*$N_c = 1.5\pi + 1$. [See Terzaghi (1943), p. 127.]

TABLE 4-3
Shape, depth, and inclination factors for the Meyerhof bearing-capacity equations of Table 4-1

Factors	Value	For
Shape:	$s_c = 1 + 0.2K_p\frac{B}{L}$	Any ϕ
	$s_q = s_\gamma = 1 + 0.1K_p\frac{B}{L}$	$\phi > 10°$
	$s_q = s_\gamma = 1$	$\phi = 0$
Depth:	$d_c = 1 + 0.2\sqrt{K_p}\frac{D}{B}$	Any ϕ
	$d_q = d_\gamma = 1 + 0.1\sqrt{K_p}\frac{D}{B}$	$\phi > 10$
	$d_q = d_\gamma = 1$	$\phi = 0$
Inclination: 	$i_c = i_q = \left(1 - \frac{\theta°}{90°}\right)^2$	Any ϕ
	$i_\gamma = \left(1 - \frac{\theta°}{\phi°}\right)^2$	$\phi > 0$
	$i_\gamma = 0$ for $\theta > 0$	$\phi = 0$

Where $K_p = \tan^2(45 + \phi/2)$ as in Fig. 4-2
θ = angle of resultant R measured from vertical without a sign; if $\theta = 0$ all $i_i = 1.0$.
B, L, D = previously defined

so that the shear resistance along cd of Fig. 4-3a could be neglected. Table 4-1 lists the Terzaghi equation and the method for computing the several N_i factors and the two shape factors s_i. Table 4-2 is a short table of N factors produced from a computer program and edited for illustration and for rapid use by the reader. Terzaghi never explained very well how he obtained the $K_{p\gamma}$ used to compute the bearing-capacity factor N_γ. He did, however, give a small-scale curve of ϕ versus N_γ and three specific values of N_γ at $\phi = 0$, 34, and 48° as shown on Table 4-2. The author took additional points from this curve and used a computer to back-compute $K_{p\gamma}$ to obtain a table of best-fit values from which the tabulated values of N_γ shown in Table 4-2 could be computed from the equation for N_γ shown in Table 4-1. Inspection of Table 4-4 indicates that the Meyerhof $N_{\gamma(M)}$ values are fairly close except for angles of $\phi > 40°$. Other approximations for N_γ include the following:

$$N_\gamma = 2(N_q + 1)\tan\phi \qquad \text{Vesić (1973)}$$

$$N_\gamma = 1.1(N_q - 1)\tan 1.3\phi \qquad \text{Spangler and Handy (1982)}$$

The N_γ value has the widest suggested range of values of any of the bearing-capacity N factors. A literature search reveals

$$38 \le N_\gamma \le 192 \qquad \text{for } \phi = 40°$$

In this textbook values from Tables 4-2 and 4-4 give a range from about 79 to 109.

Recently Kumbhojkar (1993) presented a series of values of N_γ with the claim they are better representations of the Terzaghi values than those of Table 4-2. An inspection of these

N_γ values shows the following:

ϕ	Terzaghi* (1943)	Bolton and Lau (1993)	Kumbhojkar (1993)	Table 4-2 (this text)
34°	36	43.5	32	36
48	780	638	650.7	780.1

*See Terzaghi (1943), Fig. 38 and page 128.

Fortunately the N_γ term does not make a significant contribution to the computed bearing capacity, so any of the values from Tables 4-2 or 4-4 can be used (or perhaps an average).

Bolton and Lau (1993) produced new N_q and N_γ values for strip and circular footings for both smooth and rough ground interfacings. Their N_q values for either smooth or rough strips are little different from the Hansen values for rough strips. The N_q values for circular footings range to more than two times the strip values. The N_γ values for rough footings compare well with the Vesić values in Table 4-4. Since the Table 4-4 values have shape s_i and depth d_i factors to be applied, it appears that these "new" values offer little advantage and are certainly more difficult to compute (see comparison with Terzaghi values in preceding table).

Meyerhof's Bearing-Capacity Equation

Meyerhof (1951, 1963) proposed a bearing-capacity equation similar to that of Terzaghi but included a shape factor s_q with the depth term N_q. He also included depth factors d_i and

TABLE 4-4
Bearing-capacity factors for the Meyerhof, Hansen, and Vesić bearing-capacity equations
Note that N_c and N_q are the same for all three methods; subscripts identify author for N_γ

ϕ	N_c	N_q	$N_{\gamma(H)}$	$N_{\gamma(M)}$	$N_{\gamma(V)}$	N_q/N_c	$2\tan\phi(1-\sin\phi)^2$
0	5.14*	1.0	0.0	0.0	0.0	0.195	0.000
5	6.49	1.6	0.1	0.1	0.4	0.242	0.146
10	8.34	2.5	0.4	0.4	1.2	0.296	0.241
15	10.97	3.9	1.2	1.1	2.6	0.359	0.294
20	14.83	6.4	2.9	2.9	5.4	0.431	0.315
25	20.71	10.7	6.8	6.8	10.9	0.514	0.311
26	22.25	11.8	7.9	8.0	12.5	0.533	0.308
28	25.79	14.7	10.9	11.2	16.7	0.570	0.299
30	30.13	18.4	15.1	15.7	22.4	0.610	0.289
32	35.47	23.2	20.8	22.0	30.2	0.653	0.276
34	42.14	29.4	28.7	31.1	41.0	0.698	0.262
36	50.55	37.7	40.0	44.4	56.2	0.746	0.247
38	61.31	48.9	56.1	64.0	77.9	0.797	0.231
40	75.25	64.1	79.4	93.6	109.3	0.852	0.214
45	133.73	134.7	200.5	262.3	271.3	1.007	0.172
50	266.50	318.5	567.4	871.7	761.3	1.195	0.131

* = $\pi + 2$ as limit when $\phi \to 0°$.

Slight differences in above table can be obtained using program BEARING.EXE on diskette depending on computer used and whether or not it has floating point.

inclination factors i_i [both noted in discussion of Eq. (*j*)] for cases where the footing load is inclined from the vertical. These additions produce equations of the general form shown in Table 4-1, with select N factors computed in Table 4-4. Program BEARING is provided on disk for other N_i values.

Meyerhof obtained his N factors by making trials of the zone abd' with arc ad' of Fig. 4-3*b*, which include an approximation for shear along line cd of Fig. 4-3*a*. The shape, depth, and inclination factors in Table 4-3 are from Meyerhof (1963) and are somewhat different from his 1951 values. The shape factors do not greatly differ from those given by Terzaghi except for the addition of s_q. Observing that the shear effect along line cd of Fig. 4-3*a* was still being somewhat ignored, Meyerhof proposed depth factors d_i.

He also proposed using the inclination factors of Table 4-3 to reduce the bearing capacity when the load resultant was inclined from the vertical by the angle θ. When the i_γ factor is used, it should be self-evident that it does not apply when $\phi = 0°$, since a base slip would occur with this term—even if there is base cohesion for the i_c term. Also, the i_i factors all = 1.0 if the angle $\theta = 0$.

Up to a depth of $D \approx B$ in Fig. 4-3*a*, the Meyerhof q_{ult} is not greatly different from the Terzaghi value. The difference becomes more pronounced at larger D/B ratios.

Hansen's Bearing-Capacity Method

Hansen (1970) proposed the general bearing-capacity case and N factor equations shown in Table 4-1. This equation is readily seen to be a further extension of the earlier Meyerhof (1951) work. Hansen's shape, depth, and other factors making up the general bearing-capacity equation are given in Table 4-5. These represent revisions and extensions from earlier proposals in 1957 and 1961. The extensions include base factors for situations in which the footing is tilted from the horizontal b_i and for the possibility of a slope β of the ground supporting the footing to give ground factors g_i. Table 4-4 gives selected N values for the Hansen equations together with computation aids for the more difficult shape and depth factor terms. Use program BEARING for intermediate N_i factors, because interpolation is not recommended, especially for $\phi \gtrsim 35°$.

Any of the equations given in Table 4-5 not subscripted with a V may be used as appropriate (limitations and restrictions are noted in the table). The equations shown in this table for inclination factors i_i will be considered in additional detail in Sec. 4-6.

Note that when the base is tilted, V and H are perpendicular and parallel, respectively, to the base, compared with when it is horizontal as shown in the sketch with Table 4-5.

For a footing on a slope both the Hansen and Vesić g_i factors can be used to reduce (or increase, depending on the direction of H_i) the bearing capacity using N factors as given in Table 4-4. Section 4-9 considers an alternative method for obtaining the bearing capacity of footings on a slope.

The Hansen equation implicitly allows any D/B and thus can be used for both shallow (footings) and deep (piles, drilled caissons) bases. Inspection of the $\bar{q}N_q$ term suggests a great increase in q_{ult} with great depth. To place modest limits on this, Hansen used

$$\left.\begin{aligned} d_c &= 1 + 0.4\frac{D}{B} \\ d_q &= 1 + 2\tan\phi(1 - \sin\phi)^2\frac{D}{B} \end{aligned}\right\} \frac{D}{B} \leq 1$$

Step 2. Obtain bearing-capacity factors for the Hansen equation using Tables 4-1 and 4-4. Do not compute ϕ_{ps}, since footing is square. For $\phi = 35°$ use program BEARING on your diskette and obtain

$$N_q = 33 \qquad N_\gamma = 34 \qquad 2\tan\phi\cdots = 0.255 \qquad \text{(also in Table 4-4)}$$

$$s_q = 1 + \frac{B'}{L'}\sin\phi = 1.57 \qquad s_\gamma = 1 - 0.4\frac{B'}{L'} = 0.6$$

$$d_q = 1 + 2\tan\cdots\frac{D}{B}$$

$$d_q = 1 + 0.255\frac{1.1}{2.5} = 1.11 \qquad d_\gamma = 1.10$$

From Table 4-1 and dropping any terms that are not used or are 1.0, we have

$$q_{ult} = \gamma D N_q s_q d_q + 0.5\gamma_e B' N_\gamma s_\gamma d_\gamma$$

Substituting values (note γ = soil above base), we see

$$q_{ult} = 1.1(18.10)(33)(1.57)(1.11) + 0.5(14.86)(2.5)(34)(0.6)(1.0)$$
$$= 1145 + 379 = 1524 \text{ kPa}$$

$$q_a = \frac{1524}{2} = 762 \text{ kPa (a very large bearing pressure)}$$

It is unlikely that this large a bearing pressure would be allowed—a possible maximum is 500 kPa (about 10 ksf). We might simply neglect the $\gamma_e B N_\gamma$ term to obtain q_a = 570 kPa (still large). If the latter term is neglected, the computations are considerably simplified; and doing so has little effect on what would normally be recommended as q_a (around 500 kPa in most cases).

////

4-8 BEARING CAPACITY FOR FOOTINGS ON LAYERED SOILS

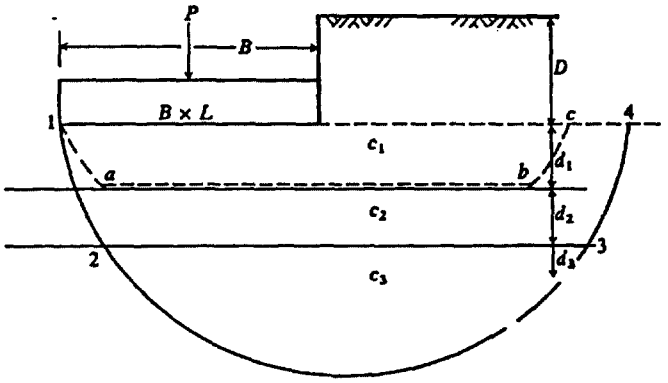
It may be necessary to place footings on stratified deposits where the thickness of the top stratum from the base of the footing d_1 is less than the H distance computed as in Fig. 4-2. In this case the rupture zone will extend into the lower layer(s) depending on their thickness and require some modification of q_{ult}. There are three general cases of the footing on a layered soil as follows:

Case 1. Footing on layered clays (all $\phi = 0$) as in Fig. 4-5*a*.
- *a.* Top layer weaker than lower layer ($c_1 < c_2$)
- *b.* Top layer stronger than lower layer ($c_1 > c_2$)

Case 2. Footing on layered ϕ–c soils with *a*, *b* same as case 1.

Case 3. Footing on layered sand and clay soils as in Fig. 4-5*b*.
- *a.* Sand overlying clay
- *b.* Clay overlying sand

Experimental work to establish methods to obtain q_{ult} for these three cases seems to be based mostly on models—often with $B < 75$ mm. Several analytical methods exist as well, and apparently the first was that of Button (1953), who used a circular arc to search for an approximate minimum, which was found (for the trial circles all in the top layer) to give $N_c = 5.5 < 2\pi$ as was noted in Sec. 4-2.



(a) Footing on layered clay soil. For very soft c_1 failure may occur along sliding block 1abc and not a circular arc and reduce N_c to a value less than 5.14.

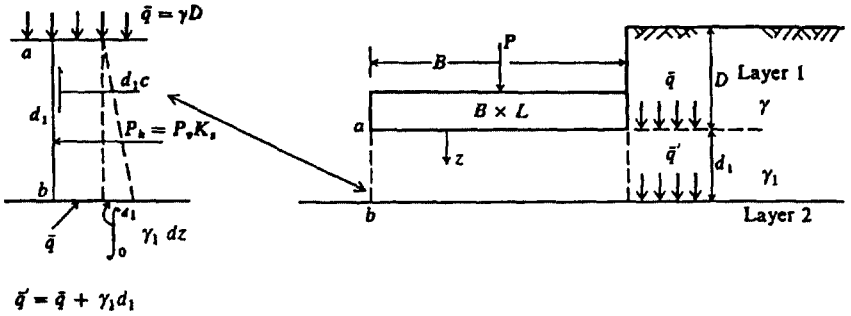


Figure 4-5 Footings on layered soil.

The use of trial circular arcs can be readily programmed for a computer (see program B-1 on diskette) for two or three layers using s_u for the layers. Note that in most cases the layer s_u will be determined form q_u tests, so the circle method will give reasonably reliable results. It is suggested that circular arcs be limited to cases where the strength ratio $C_R = c_2/c_1$ of the top two layers is on the order of

$$0.6 < C_R \leq 1.3$$

Where C_R is much out of this range there is a large difference in the shear strengths of the two layers, and one might obtain N_c using a method given by Brown and Meyerhof (1969) based on model tests as follows:

For $C_R \leq 1$

$$N_{c,s} = \frac{1.5d_1}{B} + 5.14C_R \qquad \leq 5.14 \qquad \text{(for strip footing)} \tag{4-5}$$

For a circular base with B = diameter

$$N_{c,r} = \frac{3.0d_1}{B} + 6.05C_R \qquad \leq 6.05 \qquad \text{(for round base)} \tag{4-6}$$

When $C_R > 0.7$ reduce the foregoing $N_{c,i}$ by 10 percent.

For $C_R > 1$ compute:

$$N_{1,s} = 4.14 + \frac{0.5B}{d_1} \quad \text{(strip)} \tag{4-7}$$

$$N_{2,s} = 4.14 + \frac{1.1B}{d_1} \tag{4-7a}$$

$$N_{1,r} = 5.05 + \frac{0.33B}{d_1} \quad \text{(round base)} \tag{4-8}$$

$$N_{2,r} = 5.05 + \frac{0.66B}{d_1} \tag{4-8a}$$

In the case of $C_R > 1$ we compute both $N_{1,i}$ and $N_{2,i}$ depending on whether the base is rectangular or round and then compute an averaged value of $N_{c,i}$ as

$$N_{c,i} = \frac{N_{1,i} \cdot N'_{2,i}}{N_{1,i} + N_{2,i}} \cdot 2 \tag{4-9}$$

The preceding equations give the following typical values of $N_{c,i}$, which are used in the bearing-capacity equations of Table 4-1 for N_c.

	$C_R = 0.4$		2.0		
d_1/B	Strip	Round	$N_{1,s}$	$N_{2,s}$	$N_{c,s}$
0.3	2.50	3.32	5.81	7.81	6.66
0.7	3.10	4.52	4.85	5.71	5.13
1.0	3.55	5.42	4.64	5.24	4.92

When the top layer is very soft with a small d_1/B ratio, one should give consideration either to placing the footing deeper onto the stiff clay or to using some kind of soil improvement method. Model tests indicate that when the top layer is very soft it tends to squeeze out from beneath the base and when it is stiff it tends to "punch" into the lower softer layer [Meyerhof and Brown (1967)]. This result suggests that one should check this case using the procedure of Sec. 4-2 that gave the "lower-bound" solution—that is, if $q_{ult} > 4c_1 + \bar{q}$ of Eq. (c) the soil may squeeze from beneath the footing.

Purushothamaraj et al. (1974) claim a solution for a two-layer system with ϕ–c soils and give a number of charts for N_c factors; however, their values do not differ significantly from N_c in Table 4-4. From this observation it is suggested for ϕ–c soils to obtain modified ϕ and c values as follows:

1. Compute the depth $H = 0.5B\tan(45 + \phi/2)$ using ϕ for the top layer.
2. If $H > d_1$ compute the modified value of ϕ for use as[5]

$$\phi' = \frac{d_1\phi_1 + (H - d_1)\phi_2}{H}$$

[5]This procedure can be extended to any number of layers as necessary, and "weighting" may be used.

3. Make a similar computation to obtain c'.
4. Use the bearing-capacity equation (your choice) from Table 4-1 for q_{ult} with ϕ' and c'.

If the top layer is soft (low c and small ϕ) you should check for any squeezing using Eq. (c) of Sec. 4-2.

For bases on sand overlying clay or clay overlying sand, first check if the distance H will penetrate into the lower stratum. If $H > d_1$ (refer to Fig. 4-5) you might estimate q_{ult} as follows:

1. Find q_{ult} based on top-stratum soil parameters using an equation from Table 4-1.
2. Assume a punching failure bounded by the base perimeter of dimensions $B \times L$. Here include the $\bar{q}$ contribution from d_1, and compute q'_{ult} of the lower stratum using the base dimension B. You may increase q'_{ult} by a fraction k of the shear resistance on the punch perimeter $(2B + 2L) \times ks_u$ if desired.
3. Compare q_{ult} to q'_{ult} and use the smaller value.

In equation form the preceding steps give the controlling q'_{ult} as

$$q'_{ult} = q''_{ult} + \frac{pP_vK_s \tan\phi}{A_f} + \frac{pd_1c}{A_f} \qquad \leq q_{ult} \tag{4-10}$$

where q_{ult} = bearing capacity of top layer from equations in Table 4-1

q''_{ult} = bearing capacity of lower layer computed as for q_{ult} but also using B = footing dimension, $\bar{q} = \gamma d_1$; c, ϕ of lower layer

p = total perimeter for punching [may use $2(B + L)$ or $\pi \times$ diameter]

P_v = total vertical pressure from footing base to lower soil computed as $\int_0^{d_1} \gamma h\, dh + \bar{q}d_1$

K_s = lateral earth pressure coefficient, which may range from $\tan^2(45 \pm \phi/2)$ or use K_o from Eq. (2-18a)

$\tan\phi$ = coefficient of friction between P_vK_s and perimeter shear zone wall

pd_1c = cohesion on perimeter as a force

A_f = area of footing (converts perimeter shear forces to a stress)

This equation is similar to that of Valsangkar and Meyerhof (1979) and applies to all soils.

Note that there will not be many cases of a two- (or three-) layer cohesive soil with clearly delineated strata. Usually the clay gradually transitions from a hard, overconsolidated surface layer to a softer one; however, exceptions may be found, primarily in glacial deposits. In these cases it is a common practice to treat the situation as a single layer with a worst-case s_u value. A layer of sand overlying clay or a layer of clay overlying sand is somewhat more common, and the stratification is usually better defined than for the two-layer clay.

A possible alternative for ϕ–c soils with a number of thin layers is to use average values of c and ϕ in the bearing-capacity equations of Table 4-1 obtained as

$$c_{av} = \frac{c_1H_1 + c_2H_2 + c_3H_3 + \cdots + c_nH_n}{\sum H_i} \tag{a}$$

$$\phi_{av} = \tan^{-1} \frac{H_1 \tan \phi_1 + H_2 \tan \phi_2 + \cdots + H_n \tan \phi_n}{\sum H_i} \qquad (b)$$

where c_i = cohesion in stratum of thickness H_i; c may be 0

ϕ_i = angle of internal friction in stratum of thickness H_i; ϕ may be zero

Any H_i may be multiplied by a weighting factor (1.0 is used in these equations) if desired. The effective shear depth of interest is limited to approximately $0.5B \tan(45° + \phi/2)$. One or two iterations may be required to obtain the best average ϕ–c values, since B is not usually fixed until the bearing capacity is established.

One can use a slope-stability program such as that written by Bowles (1974*a*) to obtain the bearing capacity for layered soils. The program given in that reference has been modified to allow the footing pressure as a surcharge (program B-22). An increase in shear strength with depth could be approximated by addition of "soils" with the same ϕ and γ properties but increased cohesion strength. The ultimate bearing capacity is that value of q_o producing $F = 1$.

Example 4-9. A footing of $B = 3 \times L = 6$ m is to be placed on a two-layer clay deposit as in Fig. E4-9.

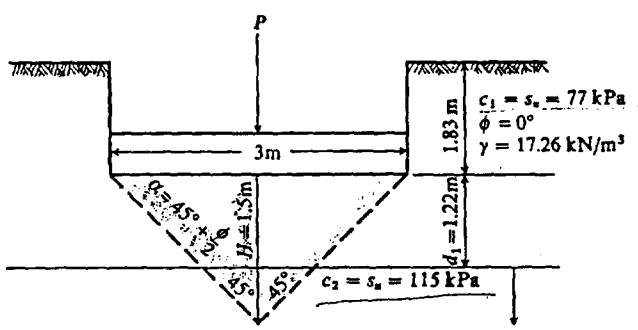


Figure E4-9

Required. Estimate the ultimate bearing capacity.

Solution.

$$H = 0.5B \tan\left(45° + \frac{\phi}{2}\right)$$

$$= 0.5(3) \tan 45 = 1.5 \text{ m}$$

$$C_R = \frac{c_2}{c_1} = \frac{115}{77} = 1.5 > 1.0$$

$$\frac{d_1}{B} = \frac{1.22}{3} = 0.4$$

Using Eqs. (4-7), (4-6*a*), and (4-8), we obtain (similar to table)

$N_{1,s} = 5.39 \qquad N_{2,s} = 6.89$

$N_c = 6.05$ (some larger than 5.14 that would be used for a one-layer soil)

Also

$$s'_c = \frac{0.2B}{L} = 0.2\left(\frac{3}{6}\right) = 0.1$$

$$d'_c = \frac{0.4D}{B} = 0.4\left(\frac{1.83}{3}\right) = 0.24$$

$$s_q = d_q = 1$$

Substituting values into Hansen's equation, we obtain

$$\begin{aligned} q_{ult} &= cN_c(1 + s'_c + d'_c) + \bar{q}N_q s_q d_q \\ &= 77(6.05)(1 + 0.1 + 0.24) + 1.83(17.26)(1)(1) \\ &= 624.2 + 31.5 = 655.7 \text{ kPa} \end{aligned}$$

Squeezing is not likely as d_1 is fairly large compared to H and we are not using an N_c value much larger than that for a one-layer soil.

////

Example 4-10. You are given the soil footing geometry shown in Fig. E4-10. Note that, with the GWT on clay, it would be preferable to keep the footing in sand if possible.

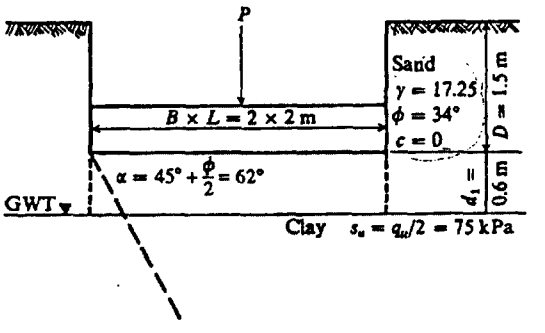


Figure E4-10

Required. What is ultimate bearing capacity and q_a if SF = 2 for sand and 3 for clay?

Solution. We will use Hansen's method. For the sand layer, we have

$$N_q = 29.4 \qquad N_\gamma = 28.7 \qquad \text{(using Table 4-4)}$$

$$s_q = 1 + \tan 34° = 1.67 \qquad s_\gamma = 0.6$$

$$d_q = 1 + 0.262\left(\frac{1.5}{2}\right) = 1.2 \qquad d_\gamma = 1$$

Substituting into Hansen's equation and rounding the N factors (and using $s_u = c = q_u/2 =$ 75 kPa), we may write

$$\begin{aligned} q_{ult} &= 1.5(17.25)(29)(1.67)(1.2) + 0.5(17.25)(2)(29)(0.6)(1) \\ &= 1804 \rightarrow \mathbf{1800} \text{ kPa} \end{aligned}$$

For clay, we have

$$N_c = 5.14 \qquad \text{(using Table 4-4)}$$

$$s'_c = 0.2\left(\frac{B}{L}\right) = 0.2\left(\frac{2}{2}\right) = 0.2 \qquad s_q = d_q = 1$$

$$d'_c = 0.4\tan^{-1}\frac{D}{B} = 0.4\tan^{-1}\left(\frac{2.1}{2}\right) = 0.32 \quad \left(\frac{D}{B} > 1\right)$$

$$q''_{ult} = 5.14(75)(1 + 0.2 + 0.32) + 2.1(17.25)(1)(1)$$
$$= \mathbf{622}\ \text{kPa}$$

Note: This s_u is common for the strength parameter for clay.

Now obtain the punching contribution. For the perimeter shear force on a strip 1 m wide, we write

$$P_v = \bar{q}d_1 + \int_0^{d_1} \gamma h\, dh \qquad \text{(kN/m)}$$

$$P_v = 1.5(17.25)(0.6) + 17.25\frac{h^2}{2}\Big|_0^{0.6}$$
$$= 15.5 + 3.1 = 18.6\ \text{kN/m}$$

Estimate $K_s = K_o = 1 - \sin\phi$ [from Eq. (2-18*a*)] $= 1 - \sin 34° = 0.44$. By inserting values into Eq. (4-10), the revised maximum footing pressure based on the clay soil and including punching is

$$q'_{ult} = q''_{ult} + \frac{pP_vK_s\tan 34°}{A_f} + \frac{pd_1c}{A_f}$$

But cohesion is zero in sand and the perimeter is $2(2 + 2) = 8$ m, so

$$q'_{ult} = 622 + \frac{8(18.6)(0.44)\tan 34°}{2 \times 2} = \mathbf{633}\ \text{kPa} < q_{ult}\ \text{of } 1800$$

The maximum footing pressure is controlled by the clay layer, giving $q_{ult} = 634$ kPa. The allowable footing contact soil pressure is

$$q = \frac{633}{3} = \mathbf{211} \qquad \text{(say, 200 kPa)}$$

////

FOOTINGS ON ANISOTROPIC SOIL. This situation primarily occurs in *cohesive* soils where the undrained vertical shear strength $s_{u,v}$ is different (usually larger) from the horizontal shear strength $s_{u,h}$. This is a frequent occurrence in cohesive field deposits but also is found in cohesionless deposits. To account for this situation ($\phi = 0$), Davis and Christian (1971) suggest the following:

When you measure both vertical and horizontal shear strength ($c = s_u$), compute the bearing capacity as

$$q_{ult} = 0.9N_c \cdot \frac{s_{u,v} + s_{u,h}}{2} + \bar{q}'$$

When you only have $s_{u,v}$, compute the bearing capacity as

$$q_{\text{ult}} = 0.85 s_{u,v} N_c + \overline{q'}$$

In these two equations take $N_c = 5.14$ (Hansen's value). You may include Hansen's s_i, d_i, and other factors at your own discretion, *but they were not included* by Davis and Christian (1971).

4-9 BEARING CAPACITY OF FOOTINGS ON SLOPES

A special problem that may be encountered occasionally is that of a footing located on or adjacent to a slope (Fig. 4-6). From the figures it can be seen that the lack of soil on the slope side of the footing will tend to reduce the stability of the footing.

The author developed Table 4-7 using program B-2 on your diskette to solve the footing on or adjacent to a slope as follows:

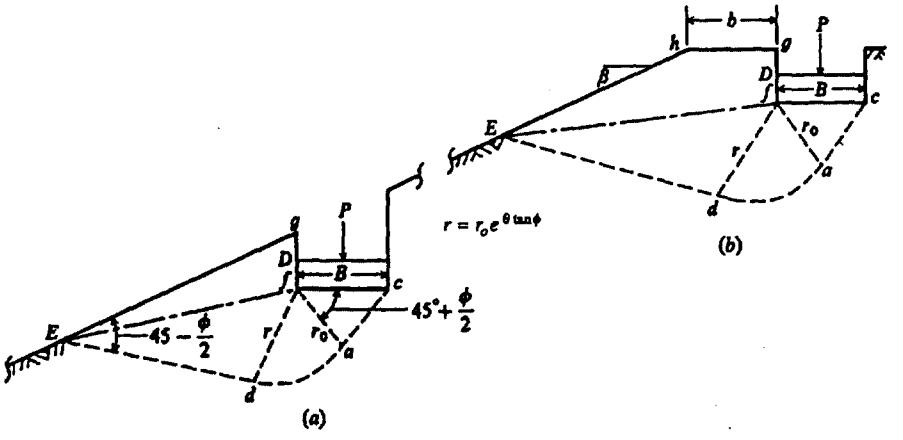
1. Develop the exit point E for a footing as shown in Fig. 4-6. The angle of the exit is taken as $45° - \phi/2$ since the slope line is a principal plane.
2. Compute a reduced N_c based on the failure surface $ade = L_0$ of Fig. 4-3 and the failure surface $adE = L_1$ of Fig. 4-6*a* to obtain

$$N_c' = N_c \frac{L_1}{L_0}$$

3. Compute a reduced N_q based on the ratio of area $ecfg$ (call it A_o) of Fig. 4-3 to the equivalent area $Efg = A_\phi$ of Fig. 4-6*a*, or the alternative $Efgh = A_\phi$ of Fig. 4-6*b*, to obtain the following:

$$N_q' = N_q \frac{A_1}{A_0}$$

Figure 4-6 Footings on or adjacent to a slope.



ATTACHMENT E

John Deere 762 Scraper Specifications

and

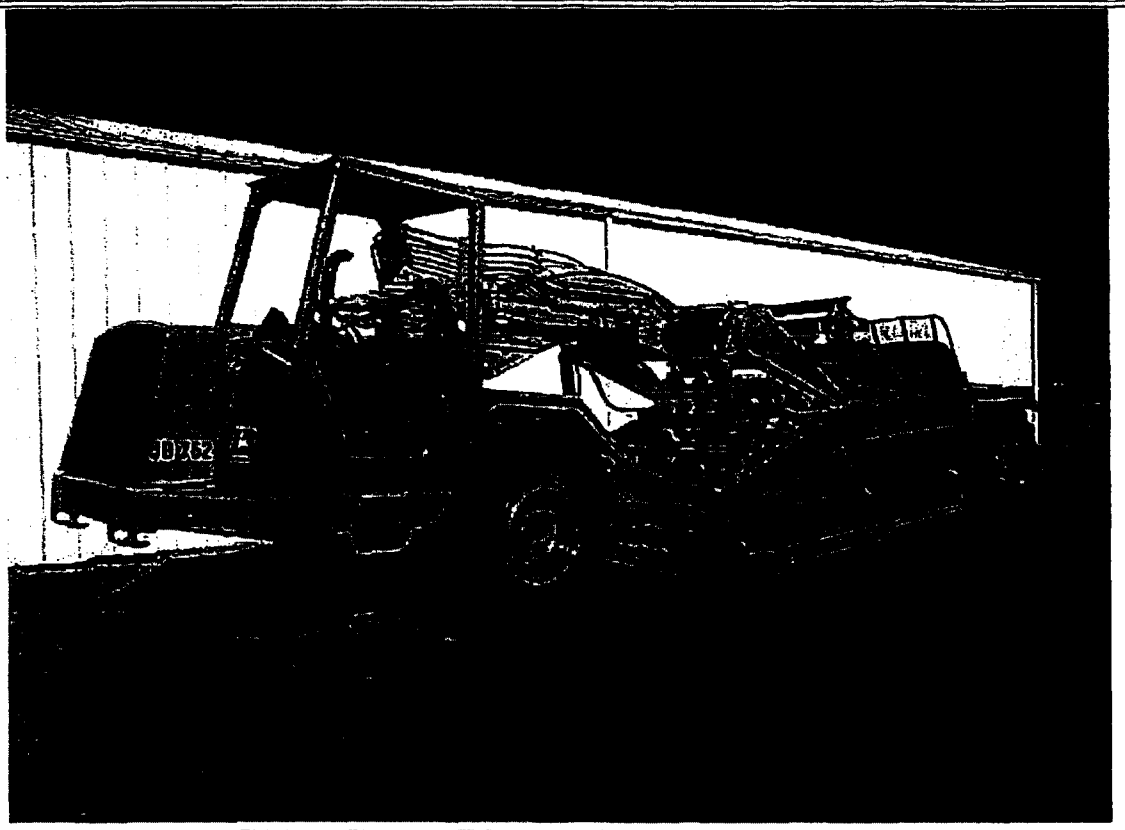
Tire Contact Footprint

Attachment E

M. Adams Equipment Co.

2104 N. Central Ave.
Rockford, IL 61107
815-968-0818

Picture 1 of Stock Number 6088



JOHN DEERE 762 11 YARD ELEVATING MOTOR SCRAPER, 175 H.P. DIESEL, CANOPY, 65% CHAINS & FLIGHTS, POWERSHIFT TRANSMISSION, 60% 23.5 X 25 TIRES, GOOD CONDITION, APPROXIMATE WEIGHT 34,300 LBS., 002500T SERIES	Rockford	$26,000.00

+ Soil. (11 yd^3 x 27 ft^3/yd^3 x 90 lb/ft^3)
= 61,000 lb.

Comments and questions to: EMail Sales@AdamsEquipment.com

LOAD/WHEEL = $\frac{61,000}{4}$
= 15,300

TRC

RECORD OF TELEPHONE CONVERSATION

☒ INCOMING CALL ☐ OUTGOING CALL

CONTACT INFO.* ~~Tim Lovell~~ Ken Boguski

TELEPHONE NO. 330-796-3989

COMPANY NAME Goodyear

COMPANY ADDRESS

STAFF INFO. Ken Floom

DATE 10/10/02

TIME

PROJECT NO. 30747

PROJECT NAME WDZ

PAGE ____ OF ____

SUBJECT Contact area of a 23.5 x 25 Tire Loaded at 15,500 lbs.

~~Tim~~ Ken indicates the contact area of the 23.5 x 25 tire loaded with 15,500 lbs is 340 sq. in.

~ shape is 16.4" (L) x 19.3" (W)

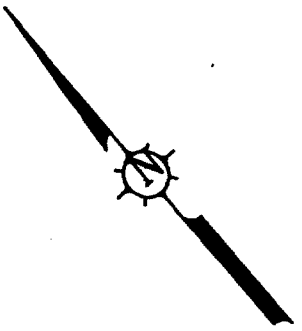
*Recommended Calling

ACTION REQUIRED

A-Gen Forms (3/8/96/bd)

ATTACHMENT F

Site Plan Showing Cover and Waste Elevations



GRAPHIC SCALE

(IN FEET)
1 inch = 60 ft.

REV	DATE	DESCRIPTION	DRAWN BY	CHK'D BY
B	02/07/02	ISSUED FOR 90% REVIEW ONLY NOT FOR CONSTRUCTION	AEC	AEB
A	12/06/01	ISSUED FOR "OVER THE SHOULDER" REVIEW	AEC	AEB

DRAWN BY A.E. CORNEJO | CHECKED BY | APPROVED BY

WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

SANTA FE SPRINGS CALIFORNIA

TITLE

ELEVATION OF UPPER SURFACE OF EXISTING BURIED WASTE

JOB NO.	SCALE	DRAWING NO.
30747	1" = 60'	30747exSht06

TRC

REVISION	SHEET
B	6

GRAPHIC SCALE

60 0 30 60 120 240

(IN FEET)
1 inch = 60 ft.

REV	DATE	DESCRIPTION	DRAWN BY	CHK'D BY
B	02/07/02	ISSUED FOR 90% REVIEW ONLY NOT FOR CONSTRUCTION	AEC	AEB
A	12/06/01	ISSUED FOR "OVER THE SHOULDER" REVIEW	AEC	AEB

DRAWN BY A.E. CORNEJO | CHECKED BY | APPROVED BY

WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

SANTA FE SPRINGS CALIFORNIA

TITLE

EARTH COVER THICKNESS

REGISTERED PROFESSIONAL ENGINEER
ROY L. ROBERSON
NO. 44160
EXP. 6-30-03
CIVIL
STATE OF CALIFORNIA

JOB NO.	SCALE	DRAWING NO.
30747	1" = 60'	30747exSht012

TRC

REVISION	SHEET
B	12

APPENDIX F.4

SLOPE STABILITY CALCULATIONS

APPENDIX F
WDI SUPERFUND SITE
SLOPE STABILITY CALCULATION

F.4.1 INTRODUCTION

Calculations were performed to evaluate static and seismic slope stability for the existing slope at the northeast boundary of the WDI site, adjacent to the high school, in Santa Fe Springs. This calculation was performed using recent direct shear data from Keantan Laboratories and past direct shear data as summarized on Figures 3.4.a, 3.4.b and 6.8, and recent unconsolidated undrained (UU) strength data for the bentonite summarized on Figure 3.3. These analyses were based on California standard of practice for landfills.

F.4.2 BACKGROUND

In 1998, grading work was performed at the site and detailed in "*Technical Memo No. 11-Reservoir Area Grading Plans and Waste/Debris Management As-Built Report, Waste Disposal Inc. Superfund Site*" (TRC, December 1998). The existing slope has been stable since grading work in 1998 without any documented failures, with the exception of some minor erosion. As shown on Figure 6.5, little has changed on the slope topography since the original site survey in 1988. There was no documentation of slope failure following the 1987 Whittier Narrows Earthquake, where the epicenter was relatively close to this site.

F.4.3 METHODS OF ANALYSES

As required for California landfills, slopes are to have a calculated factor-of-safety of at least 1.50 for static conditions, and manageable displacements during a Maximum Credible Earthquake (MCE) for the site. Static slope stability analyses were performed using the PCSTABL5M software, based on the Bishops circular failure method searching for the lowest factor of safety for a given section. In addition, pseudo-static calculations were performed using PCSTABL5M to estimate yield acceleration, defined as the horizontal acceleration input creating a slope stability factor-of-safety of 1.00, for use in dynamic displacement calculation.

MCE peak horizontal ground acceleration (PHGA) for this site has been probabilistically determined to be 0.7g using the probabilistic seismic hazard analyses (PSHA) software FRISKSP (licensed to Lowney Associates) based on the California Geological Surveys fault files for Southern California. Slope displacement during a MCE PHGA was estimated using both Bray and Rathje (1998) and Newmark (USGS OFR 02-201, *Java program for Using Newmark's Method to Model Slope performance During Earthquakes*, Version 1.0, by Jibson) methods and software.

These calculation are attached in this appendix as follows:

PCSTABL5M input and output for both static and yield acceleration analyses, and

Bray and Rathje (1998) Displacement Calculation Spreadsheets

F.4.4 KEY ASSUMPTION

The following key assumptions were made as part of our calculations:

The slope stability section depicted on Figure 6.6 was used to calculate both static and pseudo-static slope stability using lower bound ultimate shear strength depicted on Figure 6.8.

Friction angle and cohesion of the cover and native material were assumed to be homogeneous and isotropic ultimate strengths of 31 degree and 200 pounds-per-square feet (psf), respectively.

Homogeneous and isotropic undrained shear strength of bentonite waste used for these analyses was assumed to be 500 psf (3.47 pounds-per-square-inch), which is lower than all of the undrained (UU) shear strength results depicted on Figure 3.3 except for one. The sample at a depth of 15 feet in boring G-08, far from the slope, contained within the reservoir, and below the toe-of-slope had the lowest UU strength at 1.6 psi (or 230 psf). In the boring log, this material was described as black liquid with a strong petroleum odor.

Slope displacement was calculated at an MCE PHGA of 0.7g.

F.4.5 CONCLUSION

Static slope stability and yield acceleration was calculated using Bishop Circular method as shown in the attached calculations. Displacement was

calculated using both Newmark's and Bray and Rathje's (1998) methods, as shown in the attached spreadsheet and output. Results of these analyses are summarized in Tables 5.4.1 and 5.4.2, below. A static factor-of-safety of 3.06 was calculated, well in excess of the required 1.50. Further, estimate slope displacement from both methods was less-than 0.3 inch (less-than a centimeter).

Table 5.4.1. Results of Slope Stability Analysis

Undrained Shear Strength of Waste (psf)	Analysis Method	Factor of Safety	Yield Acceleration (g)
500	Bishop Circular Search	3.06	0.49

Table 5.4 2. Results of Slope Stability Analysis

Yield Acceleration (g)	Newmark Method Displacement (inches)			Bray (1998) Method Displacement (inches)
	Mean	Median	Standard Deviation	
0.49	0.28	0.20	0.30	0.22

ATTACHMENT A
COPIES OF INPUT AND OUTPUT FOR STABL5M SLOPE STABILITY ANALYSES

```
PROFIL        A:16518AF.DAT  PCSTABL Version 5M
WDI SUPERFUND SITE STATIC ANALYSIS with Su=500psf At G-12 Boring near
Cross-Section C-C'
11 6
0. 150. 10. 150. 3
10. 150. 36.1 159. 3
36.1 159. 60. 167.4 1
60. 167.4 65. 168.4 1
65. 168.4 70. 167.5 1
70. 167.5 150. 167.5 1
36.1 159. 61. 159. 3
61. 159. 150. 159. 2
36.1 159. 61. 159. 3
61. 159. 74. 146. 3
74. 146. 150. 146. 3
SOIL  Fill    Waste   Native
3
124. 124. 200. 31. 0. 0. 0
124. 124. 500. 0. 0. 0. 0
124. 124. 200. 31. 0. 0. 0
CIRCL2-Bishop circular, search.
10 10
0. 30. 60. 150. 0. 4. 0. 0.
```

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 11-04-02
Time of Run: 1:11pm
Run By: Tae Kuk Kim
Input Data Filename: A:16518AF.DAT
Output Filename: A:16518AF.OUT
Plotted Output Filename: A:16518AF.PLT

PROBLEM DESCRIPTION WDI SUPERFUND SITE STATIC ANALYSIS with Su=500 psf

At G-12 Boring near Cross-Section C-C'

BOUNDARY COORDINATES

6 Top Boundaries
11 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	150.00	10.00	150.00	3
2	10.00	150.00	36.10	159.00	3
3	36.10	159.00	60.00	167.40	1
4	60.00	167.40	65.00	168.40	1
5	65.00	168.40	70.00	167.50	1
6	70.00	167.50	150.00	167.50	1
7	36.10	159.00	61.00	159.00	3
8	61.00	159.00	150.00	159.00	2
9	36.10	159.00	61.00	159.00	3
10	61.00	159.00	74.00	146.00	3
11	74.00	146.00	150.00	146.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	124.0	124.0	200.0	31.0	0.00	0.0	0
2	124.0	124.0	500.0	0.0	0.00	0.0	0
3	124.0	124.0	200.0	31.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 0.00 ft.
and X = 30.00 ft.

Each Surface Terminates Between X = 60.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method
* *

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	150.00
2	13.94	149.30
3	17.91	148.82
4	21.90	148.56
5	25.90	148.52
6	29.90	148.71
7	33.88	149.12
8	37.83	149.74
9	41.74	150.59
10	45.59	151.65
11	49.39	152.92
12	53.10	154.40
13	56.73	156.09
14	60.26	157.97
15	63.68	160.05
16	66.97	162.31
17	70.14	164.75
18	73.17	167.37
19	73.31	167.50

Circle Center At X = 24.6 ; Y = 220.6 and Radius, 72.1

*** 3.055 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.33	150.00
2	7.26	149.22
3	11.22	148.68
4	15.21	148.37
5	19.21	148.29
6	23.20	148.45
7	27.18	148.85
8	31.13	149.48
9	35.04	150.35
10	38.89	151.44
11	42.67	152.75

12	46.36	154.29
13	49.95	156.04
14	53.44	158.01
15	56.80	160.17
16	60.04	162.53
17	63.12	165.07
18	66.05	167.79
19	66.39	168.15

Circle Center At X = 18.5 ; Y = 216.1 and Radius, 67.8

*** 3.063 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.67	150.00
2	10.20	148.13
3	13.88	146.55
4	17.67	145.27
5	21.55	144.31
6	25.50	143.67
7	29.48	143.35
8	33.48	143.36
9	37.47	143.69
10	41.42	144.35
11	45.30	145.32
12	49.08	146.62
13	52.75	148.21
14	56.28	150.10
15	59.64	152.27
16	62.81	154.70
17	65.77	157.39
18	68.51	160.31
19	70.99	163.44
20	73.22	166.77
21	73.63	167.50

Circle Center At X = 31.4 ; Y = 192.3 and Radius, 49.0

*** 3.183 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.00	150.00
2	3.94	149.32
3	7.91	148.81
4	11.90	148.47
5	15.89	148.30
6	19.89	148.30
7	23.89	148.47
8	27.87	148.82
9	31.84	149.33
10	35.78	150.00
11	39.69	150.85
12	43.56	151.86
13	47.39	153.04
14	51.16	154.38
15	54.86	155.87
16	58.51	157.53
17	62.08	159.33
18	65.56	161.29
19	68.97	163.40

20	72.27	165.64
21	74.77	167.50

Circle Center At X = 17.9 ; Y = 242.2 and Radius, 93.9

*** 3.223 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.67	150.00
2	10.19	148.11
3	13.86	146.51
4	17.64	145.20
5	21.51	144.19
6	25.45	143.48
7	29.43	143.09
8	33.43	143.01
9	37.42	143.24
10	41.38	143.78
11	45.29	144.64
12	49.12	145.79
13	52.85	147.25
14	56.45	148.99
15	59.90	151.00
16	63.19	153.28
17	66.28	155.82
18	69.17	158.58
19	71.84	161.57
20	74.26	164.75
21	76.03	167.50

Circle Center At X = 32.5 ; Y = 194.0 and Radius, 51.0

*** 3.229 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	150.00
2	13.77	148.66
3	17.61	147.55
4	21.52	146.68
5	25.47	146.05
6	29.45	145.67
7	33.45	145.53
8	37.44	145.64
9	41.43	145.99
10	45.38	146.59
11	49.30	147.43
12	53.15	148.50
13	56.93	149.82
14	60.62	151.36
15	64.21	153.13
16	67.68	155.11
17	71.02	157.30
18	74.23	159.70
19	77.28	162.28

20	80.17	165.05
21	82.42	167.50

Circle Center At X = 33.7 ; Y = 210.6 and Radius, 65.1

*** 3.244 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	16.67	152.30
2	20.48	151.08
3	24.37	150.14
4	28.31	149.49
5	32.30	149.14
6	36.30	149.08
7	40.29	149.31
8	44.25	149.83
9	48.17	150.65
10	52.02	151.75
11	55.77	153.13
12	59.41	154.78
13	62.93	156.69
14	66.29	158.86
15	69.48	161.27
16	72.49	163.91
17	75.29	166.76
18	75.92	167.50

Circle Center At X = 35.1 ; Y = 203.5 and Radius, 54.4

*** 3.252 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.33	154.60
2	27.26	153.86
3	31.25	153.48
4	35.25	153.46
5	39.23	153.81
6	43.17	154.51
7	47.03	155.57
8	50.77	156.98
9	54.37	158.71
10	57.81	160.77
11	61.04	163.13
12	64.04	165.77
13	66.30	168.17

Circle Center At X = 33.4 ; Y = 197.5 and Radius, 44.1

*** 3.267 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	153.45
2	23.98	153.05
3	27.98	152.94
4	31.98	153.13
5	35.95	153.60
6	39.88	154.35
7	43.74	155.39
8	47.52	156.71
9	51.19	158.30
10	54.74	160.14
11	58.14	162.24
12	61.38	164.58
13	64.45	167.15
14	65.62	168.29

Circle Center At X = 27.5 ; Y = 208.2 and Radius, 55.2

*** 3.278 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.00	150.00
2	3.81	148.77
3	7.66	147.71
4	11.56	146.83
5	15.50	146.12
6	19.47	145.60
7	23.45	145.27
8	27.45	145.11
9	31.45	145.14
10	35.45	145.35
11	39.43	145.74
12	43.38	146.32
13	47.31	147.08
14	51.20	148.01
15	55.04	149.13
16	58.83	150.41
17	62.55	151.87
18	66.21	153.50
19	69.78	155.30
20	73.27	157.25
21	76.67	159.37
22	79.96	161.63
23	83.15	164.05
24	86.22	166.61
25	87.20	167.50

Circle Center At X = 28.8 ; Y = 232.4 and Radius, 87.3

*** 3.302 ***

```
                    Y           A     X     I     S           F     T

                    0.00     37.05     74.10    111.15    148.19
185.24

        X      0.00 +---------+---------+---------+---------*---------+
                    -                                   ..2
                    -                                   ..*.
                    -                                  ..317
                    -                                 ...3178
                    -                                ....318..
               37.05 +                               .....3128*
                    -                               .....3618.
                    -                               .....53129.
                    -                              .......33129.
                    -                              ........33*2*
                    -                              ........0331*
        A     74.10 +                              ......*..6651
                    -                              ...........66
                    -                               ...........0
                    -                               ............
                    -                               ............
                    -                                ...........
        X    111.15 +                                 ..........
                    -                                 ..........
                    -                                   ........
                    -                                    .......
                    -                                     ......
                    -                                       ....
        I    148.19 +                                    *   *.*
                    -
                    -
                    -
                    -
                    -
        S    185.24 +
                    -
                    -
                    -
                    -
                    -
               222.29 +
                    -
                    -
                    -
                    -
                    -
        F    259.34 +
                    -
                    -
                    -
                    -
                    -
        T    296.39 +
```

** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 11-04-02
Time of Run: 1:23pm
Run By: Tae Kuk Kim
Input Data Filename: A:16518G.DAT
Output Filename: A:16518G.OUT
Plotted Output Filename: A:16518G.PLT

PROBLEM DESCRIPTION WDI SUPERFUND SITE YIELD ACCELERATION ANALYSIS Su=500 psf

At G-12 Boring near Cross-Section C-C'

BOUNDARY COORDINATES

6 Top Boundaries
11 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	150.00	10.00	150.00	3
2	10.00	150.00	36.10	159.00	3
3	36.10	159.00	60.00	167.40	1
4	60.00	167.40	65.00	168.40	1
5	65.00	168.40	70.00	167.50	1
6	70.00	167.50	90.00	167.50	1
7	36.10	159.00	61.00	159.00	3
8	61.00	159.00	90.00	159.00	2
9	36.10	159.00	61.00	159.00	3
10	61.00	159.00	74.00	146.00	3
11	74.00	146.00	90.00	146.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	124.0	124.0	200.0	31.0	0.00	0.0	0
2	124.0	124.0	500.0	0.0	0.00	0.0	0
3	124.0	124.0	200.0	31.0	0.00	0.0	0

A Horizontal Earthquake Loading Coefficient
Of0.490 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 0.00 ft.
and X = 20.00 ft.

Each Surface Terminates Between X = 60.00 ft.
and X = 90.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method
* *

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.22	150.00
2	6.13	149.16
3	10.07	148.46
4	14.03	147.92
5	18.01	147.52
6	22.01	147.27
7	26.01	147.16
8	30.01	147.21
9	34.00	147.41
10	37.99	147.75
11	41.96	148.25
12	45.90	148.89
13	49.83	149.67
14	53.72	150.60
15	57.57	151.68
16	61.38	152.90
17	65.14	154.26
18	68.85	155.76
19	72.50	157.40
20	76.08	159.17
21	79.60	161.07
22	83.05	163.11
23	86.41	165.27
24	89.62	167.50

Circle Center At X = 26.7 ; Y = 254.5 and Radius, 107.4

*** 1.047 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.44	150.00
2	8.30	148.92
3	12.19	148.02
4	16.13	147.30
5	20.09	146.76
6	24.08	146.41

7	28.07	146.23
8	32.07	146.24
9	36.07	146.43
10	40.05	146.80
11	44.01	147.35
12	47.94	148.09
13	51.84	149.00
14	55.69	150.09
15	59.48	151.35
16	63.22	152.79
17	66.88	154.40
18	70.47	156.17
19	73.97	158.10
20	77.38	160.19
21	80.69	162.44
22	83.89	164.83
23	86.98	167.37
24	87.13	167.50

Circle Center At X = 29.9 ; Y = 233.7 and Radius, 87.5

*** 1.053 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.67	150.00
2	10.52	148.93
3	14.42	148.05
4	18.37	147.37
5	22.34	146.90
6	26.33	146.63
7	30.33	146.56
8	34.33	146.70
9	38.31	147.04
10	42.27	147.58
11	46.20	148.33
12	50.09	149.27
13	53.92	150.42
14	57.69	151.75
15	61.39	153.28
16	65.01	154.99
17	68.53	156.89
18	71.95	158.96
19	75.26	161.21
20	78.45	163.62
21	81.52	166.19
22	82.93	167.50

Circle Center At X = 29.6 ; Y = 224.9 and Radius, 78.4

*** 1.061 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.44	150.00
2	8.19	148.60
3	12.01	147.41
4	15.88	146.41
5	19.80	145.61
6	23.76	145.02
7	27.74	144.63
8	31.74	144.45
9	35.74	144.48
10	39.73	144.72
11	43.70	145.16
12	47.65	145.81
13	51.56	146.67
14	55.42	147.72
15	59.22	148.98
16	62.94	150.43
17	66.59	152.07
18	70.15	153.90

19	73.61	155.91
20	76.95	158.10
21	80.18	160.45
22	83.29	162.98
23	86.26	165.66
24	88.09	167.50

Circle Center At X = 33.2 ; Y = 221.4 and Radius, 77.0

*** 1.070 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	13.33	151.15
2	17.12	149.85
3	20.97	148.77
4	24.87	147.91
5	28.82	147.27
6	32.80	146.85
7	36.80	146.66
8	40.80	146.70
9	44.79	146.97
10	48.76	147.46
11	52.69	148.18
12	56.58	149.12
13	60.41	150.27
14	64.17	151.65
15	67.84	153.23
16	71.42	155.02
17	74.89	157.01
18	78.24	159.19
19	81.46	161.57
20	84.54	164.11
21	87.47	166.84
22	88.11	167.50

Circle Center At X = 38.1 ; Y = 217.1 and Radius, 70.5

*** 1.088 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.89	150.00
2	12.60	148.50
3	16.38	147.21
4	20.24	146.14
5	24.15	145.29
6	28.10	144.66
7	32.08	144.26
8	36.07	144.09
9	40.07	144.15
10	44.06	144.43
11	48.03	144.95
12	51.96	145.68
13	55.84	146.64
14	59.66	147.83
15	63.41	149.22
16	67.07	150.83
17	70.64	152.65
18	74.09	154.66

19	77.43	156.87
20	80.63	159.27
21	83.69	161.84
22	86.60	164.59
23	89.35	167.49
24	89.35	167.50

Circle Center At X = 37.1 ; Y = 214.2 and Radius, 70.1

*** 1.090 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.00	150.00
2	3.82	148.82
3	7.71	147.86
4	11.64	147.11
5	15.60	146.58
6	19.59	146.27
7	23.59	146.18
8	27.58	146.31
9	31.57	146.66
10	35.53	147.23
11	39.45	148.02
12	43.32	149.02
13	47.13	150.23
14	50.87	151.65
15	54.53	153.28
16	58.09	155.11
17	61.54	157.12
18	64.88	159.33
19	68.09	161.72
20	71.16	164.28
21	74.09	167.00
22	74.57	167.50

Circle Center At X = 23.2 ; Y = 218.7 and Radius, 72.5

*** 1.092 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.89	150.00
2	12.59	148.47
3	16.37	147.16
4	20.22	146.08
5	24.12	145.23
6	28.08	144.60
7	32.06	144.22
8	36.05	144.06
9	40.05	144.14
10	44.04	144.46
11	48.00	145.01
12	51.92	145.80
13	55.79	146.81
14	59.60	148.05
15	63.32	149.51
16	66.95	151.19
17	70.48	153.08
18	73.88	155.18

19	77.16	157.47
20	80.30	159.95
21	83.29	162.61
22	86.11	165.44
23	87.94	167.50

Circle Center At X = 36.7 ; Y = 211.9 and Radius, 67.9

*** 1.096 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	152.68
2	21.75	152.20
3	25.74	151.87
4	29.73	151.68
5	33.73	151.63
6	37.73	151.74
7	41.72	151.99
8	45.70	152.38
9	49.67	152.92
10	53.61	153.61
11	57.52	154.44
12	61.40	155.41
13	65.24	156.52
14	69.04	157.77
15	72.79	159.16
16	76.49	160.69
17	80.13	162.35
18	83.70	164.14
19	87.21	166.06
20	89.63	167.50

Circle Center At X = 32.9 ; Y = 261.0 and Radius, 109.4

*** 1.097 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.00	150.00
2	3.81	148.77
3	7.68	147.75
4	11.60	146.97
5	15.56	146.41
6	19.54	146.08
7	23.54	145.98
8	27.54	146.11
9	31.52	146.48
10	35.48	147.07
11	39.39	147.90
12	43.25	148.94
13	47.05	150.21
14	50.76	151.70
15	54.38	153.39
16	57.90	155.30
17	61.30	157.40
18	64.58	159.70
19	67.71	162.18
20	70.70	164.84

```
21          73.35       167.50
Circle Center At X =   23.2 ; Y =  215.1  and Radius,   69.1

     ***     1.098   ***
```

```
                    Y            A     X     I     S            F     T

                    0.00     37.05     74.10    111.15    148.19
185.24

        X      0.00 +---------+---------+---------+---------*---------+
                    -                                     ..1
                    -                                     ..*5
                    -                                    ..419
                    -                                  ...419.
                    -                                  ...219.
             37.05 +                                   ...419.*
                    -                                  ...419..
                    -                                  ...417...
                    -                                   ...417...
                    -                                   ...417*.*
                    -                                    ...4177*
        A    74.10 +                                     *..1137
                    -                                      ..6113
                    -                                        ..21
                    -                                     *   * *
                    -
                    -
        X   111.15 +
                    -
                    -
                    -
                    -
                    -
        I   148.19 +
                    -
                    -
                    -
                    -
                    -
        S   185.24 +
                    -
                    -
                    -
                    -
                    -
            222.29 +
                    -
                    -
                    -
                    -
                    -
        F   259.34 +
                    -
                    -
                    -
                    -
                    -
        T   296.39 +
```

ATTACHMENT B
DISPLACEMENT CALCULATION SPREADSHEETS

ESTIMATION OF PERMANENT SEISMIC DISPLACEMENT USING THE BRAY AND RATHJE (1998) PROCEDURE.

INPUT PARAMETERS:

Yield Acceleration, ky (g):	0.49		Normalized MHEA Sigma:	0
Vertical Thickness, h (m):	4.5		Mean Period Sigma:	0
Shear Wave Vel., Vs (m/s):	300		Significant Duration Sigma:	0
Earthquake Magnitude, M:	6.92	*	Normalized Displacement Sigma:	0
Earthquake Accel., Rock (g):	0.7	*		
Earthquake Distance, r (km):	8	*	Allowable screen displacement (cm):	5 *

CALCULATIONS:

Site Period (s):	0.060
NRF Factor:	0.813
Mean Period (s):	0.505
Duration, D05-95 (s):	13.025
Ts/Tm:	0.1189
MHEA/MHA*NRF:	1.000
MHEA, kmax:	0.5692
ky/kmax:	0.8609
Normalized Disp. (cm/sec):	0.0753

(Input values marked with asterisks are used for calculation of seismic coefficient for screen)

Estimated Displacement (cm):	0.558	**Median f_{eq} for Screen Procedure:**	0.477 *
Estimated Displacement (in):	0.220	**Seismic Coefficient for Screen Procedure:**	0.334 *

APPENDIX F.5

LIQUEFACTION ANALYSES

APPENDIX F
WDI SUPERFUND SITE
LIQUEFACTION EVALUATION

F.5.1 INTRODUCTION

An evaluation was performed to assess the potential for liquefaction at the WDI site in Santa Fe Springs, California. This evaluation was performed using primarily Standard Penetration Test (SPT) N-values (blow counts) obtained from 108 boring drilled in and around the site in September and October 1988 by Ebasco Services, Inc.

F.5.2 BACKGROUND

Liquefaction analyses have been performed based on methods developed by Seed and Idriss and others, most recently updated as the Southern California standard of practice in the *Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyses and Mitigation of Liquefaction In California*, March 1999, by the Southern California Earthquake Center (SCEC). The updated liquefaction chart (cyclic stress ratio vs. N-value) is reproduced on Figure 6.1 (color).

Shallowest ground water elevations for the site were developed by the California Geologic Survey (CGS), as documented on Plate 1.2 from the CGS *Seismic Hazard Evaluation of the Whittier 7.5-Minute Quadrangle...*(CGS/CDMG OFR 98-28), reproduced on Figure 6.2. As depicted on Figure 6.2, shallowest historic ground water was 20 to 30 feet below grade. A considerable amount of SPT N-values have been obtain in and around the site, as reported by Ebasco Services, Inc., in their May 1989 report. A summary of their reported N-values outside of the reservoir is presented on Figure 6.3.

F.5.3 KEY ASSUMPTION

- As shown on Figure 6.2, shallowest historic ground water for this site was 20 to 30 feet below existing grade. Therefore, liquefaction can be ruled out in the upper 20 feet because these soils would not be saturated.

- Bentonite waste is a cohesive material, not susceptible to liquefaction.

- As shown on Figure 6.4, dense sands with N-values $\geq$30 will not liquefy, regardless of the ground shaking magnitude and duration.

- Based on numerous N-values obtained in deeper soils in and around the site in 1988, at depths greater than 20 feet, excluding bentonite waste, site sands had N-values well in excess of 30.

F.5.4 CONCLUSION

Liquefaction is not anticipated at this site due to the high N-values (and density) of the potentially submerged sands at this site, as demonstrated on Figure 6.4. Lower blow counts were obtained in bentonite above the historically shallowest ground water level, but bentonite and un-submerged sands will not liquefy. This is consistent with the findings depicted on the CGS March 25, 1999 *Seismic Hazard Zones Official Map of the Whittier Quadrangle* (Figure 6.1), which depicts the site as being outside of a potential liquefaction hazard zone.

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d made from recycled paper.

CERTIFICATION

FINAL DESIGN REPORT (REVISION 1.0) SOILS, SUBSURFACE GAS, AND GROUND WATER REMEDIAL DESIGN

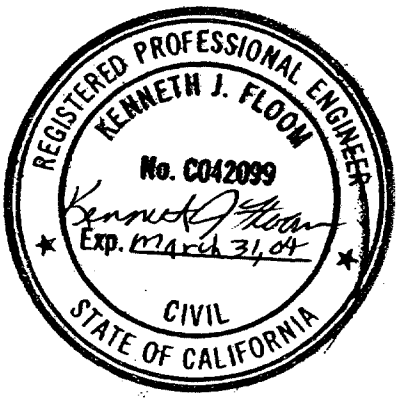
WASTE DISPOSAL, INC. SUPERFUND SITE SANTA FE SPRINGS, CALIFORNIA

This Drawing for the Waste Disposal, Inc., Superfund Site was prepared by TRC on behalf of the Waste Disposal, Inc. Group (WDIG) in a manner consistent with the level of care and skill ordinarily exercised by professional engineers. This report was prepared under the technical direction of the undersigned, a California Registered Civil Engineer.

Executed at Irvine, California this 25th day of March 2003.

Signature	Signature
Kenneth J. Floom, P.E.	Ian P.G. Hutchison, PhD., P.E.
Registration No. C042099	Registration No. C039319

SEAL:

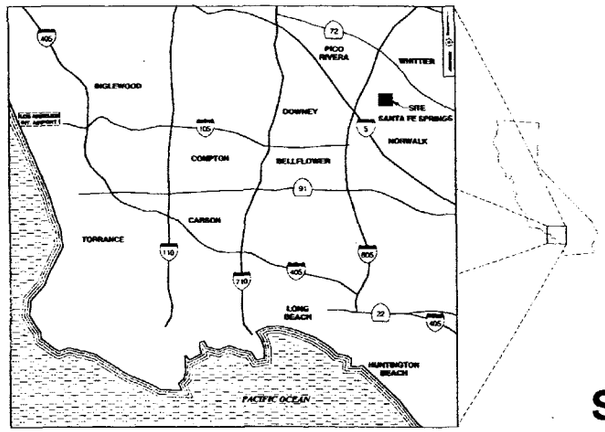


SEAL:

TRC
Customer-Focused Solutions

SOILS, SUBSURFACE GAS AND GROUND WATER REMEDY

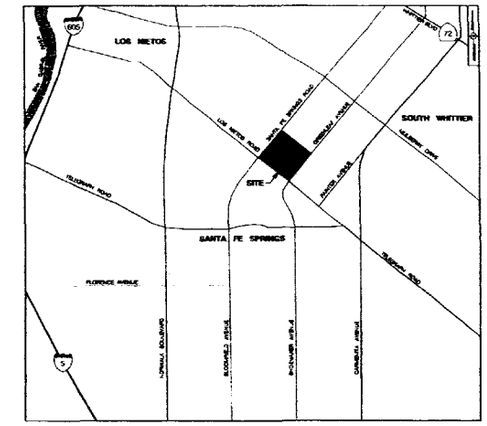
WASTE DISPOSAL, INC. SUPERFUND SITE SANTA FE SPRINGS, CALIFORNIA



VICINITY MAP

0 8 16 MILES

APPROXIMATE SCALE



SITE LOCATION MAP

0 2,000 4,000 FEET

SCALE

CERTIFICATION

FINAL DESIGN REPORT (REVISION 1.0)
SOILS, SUBSURFACE GAS, AND GROUND WATER
REMEDIAL DESIGN

WASTE DISPOSAL, INC. SUPERFUND SITE
SANTA FE SPRINGS, CALIFORNIA

These Drawings for the Waste Disposal, Inc., Superfund Site were prepared by TRC on behalf of the Waste Disposal, Inc. Group (WDIG) in a manner consistent with the level of care and skill ordinarily exercised by professional engineers. These Drawings were prepared under the technical direction of the undersigned, California Registered Civil Engineers.

Executed at Irvine, California this ____ day of March 2003.

Signature:	Signature:
Kenneth J. Flores, P.E.	Ian P.G. Hutchinson, PhD., P.E.
Registration No. C043099	Registration No. C039319
SEAL:	SEAL:

PREPARED FOR:
WASTE DISPOSAL, INC. GROUP (WDIG)

PREPARED BY:
TRC
21 TECHNOLOGY DRIVE
IRVINE, CALIFORNIA 92618
(949) 727-9336

INDEX OF DRAWINGS

SHEET NO.	FILE NO.	TITLE
1	E-30747-SG001	TITLE, INDEX, LEGEND AND GENERAL NOTES
2	E-30747-SG007	EXISTING TOPOGRAPHY
3	E-30747-SG008	EXISTING SURFACE COVER
4	E-30747-SG023	BORING LOCATIONS
5	E-30747-SG024	ISOPACH OF FILL THICKNESS ABOVE WASTE (INCLUDING ANOMOLIES)
6	E-30747-SG025	ISOPACH OF FILL THICKNESS ABOVE WASTE (INTERPRETED)
7	E-30747-SG019	SURFACE GRADING PLAN (TOP OF COVER)
8	E-30747-SG029	EXISTING EARTH COVER THICKNESS
9	E-30747-SG020	COVER TYPE PLAN, PAVEMENT REHAB PLAN
10	E-30747-SG005	SECTIONS AND DETAILS
11	E-30747-SG012	SOIL GAS EXTRACTION, VENTING AND TREATMENT SYSTEM SECTIONS AND DETAILS
12	E-30747-SG014	LOCATIONS OF LEACHATE COLLECTION WELLS, BIOVENT WELLS, VAPOR MONITORING WELLS, GROUND WATER MONITORING WELLS AND SETTLEMENT MONUMENTS
13	E-30747-SG013	BIOVENT WELL, VAPOR MONITORING WELL AND GROUND WATER MONITORING WELL DETAILS
14	E-30747-SG006	LANDSCAPING AND FENCING PLAN
15	E-30747-SG021	HYDROLOGY MAP 100 YEAR STORM
16	E-30747-SG022	CONSTRUCTION EROSION CONTROL PLAN

GENERAL NOTES

1. THE WORK SHOWN BY THIS DOCUMENT IS FOR THE WASTE DISPOSAL, INC. GROUP, HEREAFTER REFERRED TO AS THE WDIG.
2. THE PLANS AND OTHER DOCUMENTS (e.g., SPECIFICATIONS) SHALL GOVERN THE WORK AND SHALL BE CONSIDERED COMPLEMENTARY. ANYTHING FOUND IN THE PLANS AND NOT IN ANOTHER DOCUMENT OR FOUND IN ANOTHER DOCUMENT AND NOT IN THE PLANS SHALL BE CONSIDERED TO BE IN BOTH. IF THERE ARE DISCREPENCIES BETWEEN PLANS AND OTHER COMPLEMENTARY DOCUMENTS THE CONTRACTOR IS REQUIRED TO ASK THE WDIG SITE REPRESENTATIVE FOR CLARIFICATION.
3. CONTRACTOR SHALL ON DISCOVERING ANY ERROR OR OMISSION IN THE PLANS, IMMEDIATELY BRING IT TO THE ATTENTION OF THE WDIG SITE REPRESENTATIVE.
4. CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF PUBLIC AND PRIVATE PROPERTY ADJACENT TO THE WORK, AND SHALL EXERCISE DUE CAUTION TO AVOID DAMAGE TO SUCH PROPERTY.
5. CONTRACTOR SHALL REPAIR OR REPLACE ALL EXISTING IMPROVEMENTS WITHIN THE CONSTRUCTION AREA THAT ARE NOT DESIGNATED FOR REMOVAL. REPAIRS AND REPLACEMENTS SHALL BE AT LEAST EQUAL TO EXISTING IMPROVEMENTS AND SHALL MATCH THEIR FINISH AND DIMENSION.
6. CONTRACTOR SHALL KEEP THE WORK SITE CLEAN AND FREE FROM RUBBISH AND DEBRIS THROUGHOUT ALL STAGES OF CONSTRUCTION, INCLUDING SUSPENSION OF WORK, IF ANY, AND UNTIL FINAL ACCEPTANCE OF THE PROJECT.
7. CONTRACTOR SHALL KEEP A COPY OF THE PLANS AND OTHER DOCUMENTS AT THE WORK SITE.
8. CONTRACTOR SHALL ASCERTAIN THE EXISTENCE OF ANY CONDITIONS AFFECTING THE COST OF THE WORK WHICH WOULD HAVE BEEN DISCLOSED BY REASONABLE EXAMINATION OF THE SITE.
9. EXISTING IMPROVEMENTS VISIBLE AT THE JOB SITE, FOR WHICH NO SPECIFIC DISPOSITION IS MADE ON THE PLANS, BUT WHICH COULD REASONABLY BE ASSUMED TO INTERFERE WITH SATISFACTORY COMPLETION OF THE WORK, SHALL BE BROUGHT TO THE ATTENTION OF THE WDIG SITE REPRESENTATIVE.
10. SOIL MATERIAL REQUIRED FOR THE WORK SHALL BE STOCKPILED AT LOCATIONS SPECIFIED IN THESE PLANS OR AS DESIGNATED BY THE WDIG SITE REPRESENTATIVE.
11. CONTRACTOR SHALL PROVIDE AND MAINTAIN FACILITIES TO PROTECT ALL WORK AND EQUIPMENT WHETHER IN PLACE OR NOT.
12. CONTRACTOR SHALL NOT INTERRUPT THE SERVICE FUNCTION OR DISTURB THE SUPPORT OF ANY UTILITY WITHOUT AUTHORIZATION FROM THE WDIG SITE REPRESENTATIVE.
13. UPON LEARNING OF THE EXISTENCE OF ANY UTILITY OMITTED FROM OR SHOWN INCORRECTLY ON THE PLANS, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE WDIG SITE REPRESENTATIVE IN WRITING.
14. ALL IN-FIELD MODIFICATIONS REQUIRE APPROVAL BY THE WDIG SITE REPRESENTATIVE PRIOR TO IMPLEMENTATION.
15. NO SUBSTITUTION OF MATERIALS SHALL BE MADE BY CONTRACTOR WITHOUT PRIOR WRITTEN APPROVAL BY DESIGN ENGINEER.
16. COORDINATES SHOWN ON ALL PLAN SHEETS ARE BASED UPON THE CALIFORNIA STATE PLANE COORDINATE SYSTEM, ZONE 1.
17. BORING LOGS ARE AVAILABLE FOR REVIEW BY CONTRACTOR UPON REQUEST. SUBSURFACE DATA AND INFORMATION FURNISHED IN THESE DRAWINGS ARE INTERPRETATIONS OF INFORMATION GATHERED DURING INVESTIGATIONS MADE AT THE SITE. SUBSURFACE CONDITIONS FOUND AT THE TIME OF THE SUBSURFACE EXPLORATIONS MAY NOT BE THE SAME CONDITIONS WHEN WORK STARTS. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ASSUMPTIONS, DEDUCTIONS, OR CONCLUSIONS THE CONTRACTOR MAY DERIVE FROM THE SUBSURFACE INFORMATION OR DATA FURNISHED.

LEGEND

GENERAL LINES

- PROPERTY BOUNDARY
- MAIN TOPIC OF DRAWING
- SUBTOPIC OF DRAWING
- CENTER LINE
- HIDDEN LINE
- FLOW LINE
- EXISTING GRADE
- INDEX CONTOUR LINE
- INTERMEDIATE CONTOUR LINE
- EXISTING INDEX CONTOUR LINE
- EXISTING INTERMEDIATE CONTOUR LINE
- 6' HIGH FENCE
- LIMIT OF WASTE

FILL PATTERNS

- EXISTING SOIL COVER
- VEGETATIVE SOIL LAYER
- EXISTING CONCRETE
- CONCRETE
- EXISTING ASPHALT
- ENGINEERED ASPHALT COVER
- EXISTING BUILDING
- RCRA SUBTITLE C - EQUIVALENT CAP
- PLANTS ESTABLISHED FROM SEED
- SOIL GAS NONCOMPLIANCE AREA
- EXISTING GRADE
- DRAINAGE ROCK
- BURIED WASTE
- AGGREGATE BASE COURSE
- RCRA SUBTITLE D - EQUIVALENT COVER
- ENGINEERED ASPHALT COVER

ABBREVIATIONS

AC	ASPHALT CONCRETE	GAL.	GALLON	OC	ON CENTER
ADS	ADVANCED DRAINAGE SYSTEMS, INC.	GB	GRADE BREAK	oz.	OUNCE
APPROX.	APPROXIMATE	HDPE	HIGH DENSITY POLYETHYLENE	%	PERCENT
BGS	BELOW GROUND SURFACE	HP	HIGH POINT	PI	PRESSURE INDICATOR
℄	CENTER LINE	INV.	INVERT	PVC	POLYVINYL CHLORIDE
CY	CUBIC YARD	L	LENGTH	R	RADIUS
DIA.	DIAMETER	LF	LINEAL FEET	RED	REDUCING
DIM	DIMENSION	LACPW	LOS ANGELES COUNTY PUBLIC WORKS DEPT.	RV	RECREATIONAL VEHICLE
E	EASTING	LP	LOW POINT	RCP	REINFORCED CONCRETE PIPE
EL	ELEVATION	MH	MANHOLE	SCH.	SCHEDULE
FG	FINISH GRADE	MIN.	MINIMUM	SP	SAMPLE PORT
FIPT	FEMALE IRON PIPE THREAD	MSL	MEAN SEA LEVEL	STD.	STANDARD
FL	FLOW LINE	N	NORTHING	STA.	STATION
FM	FLOW METER	NTS	NOT TO SCALE	TC	TOP OF CURB
FT	FEET	NO.	NUMBER	TG	TOP OF GRATE
				TYP.	TYPICAL

KEY

SECTION (ALPHA) OR DETAIL (NUMERIC) IDENTIFICATION

SHEET NO. WHERE SECTION OR DETAIL IS SHOWN

SHEET NO. WHERE SECTION OR DETAIL IS CALLED OUT

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

D	3/21/03	ISSUED FOR 90% REMEDIAL DESIGN AGENCY APPROVAL	JRE	TP
C	1/6/03	ISSUED FOR AGENCY REVIEW	AJK	TP
B	3/8/97	ISSUED FOR RPA REVIEW	JRE	AEB
A	12/30/96	ISSUED FOR OVER THE SHOULDER REVIEW	JRE	AEB
REV	DATE	DESCRIPTION	BY	CHK

DRAWN BY ____ DESIGNED BY ____ APPROVED BY ____

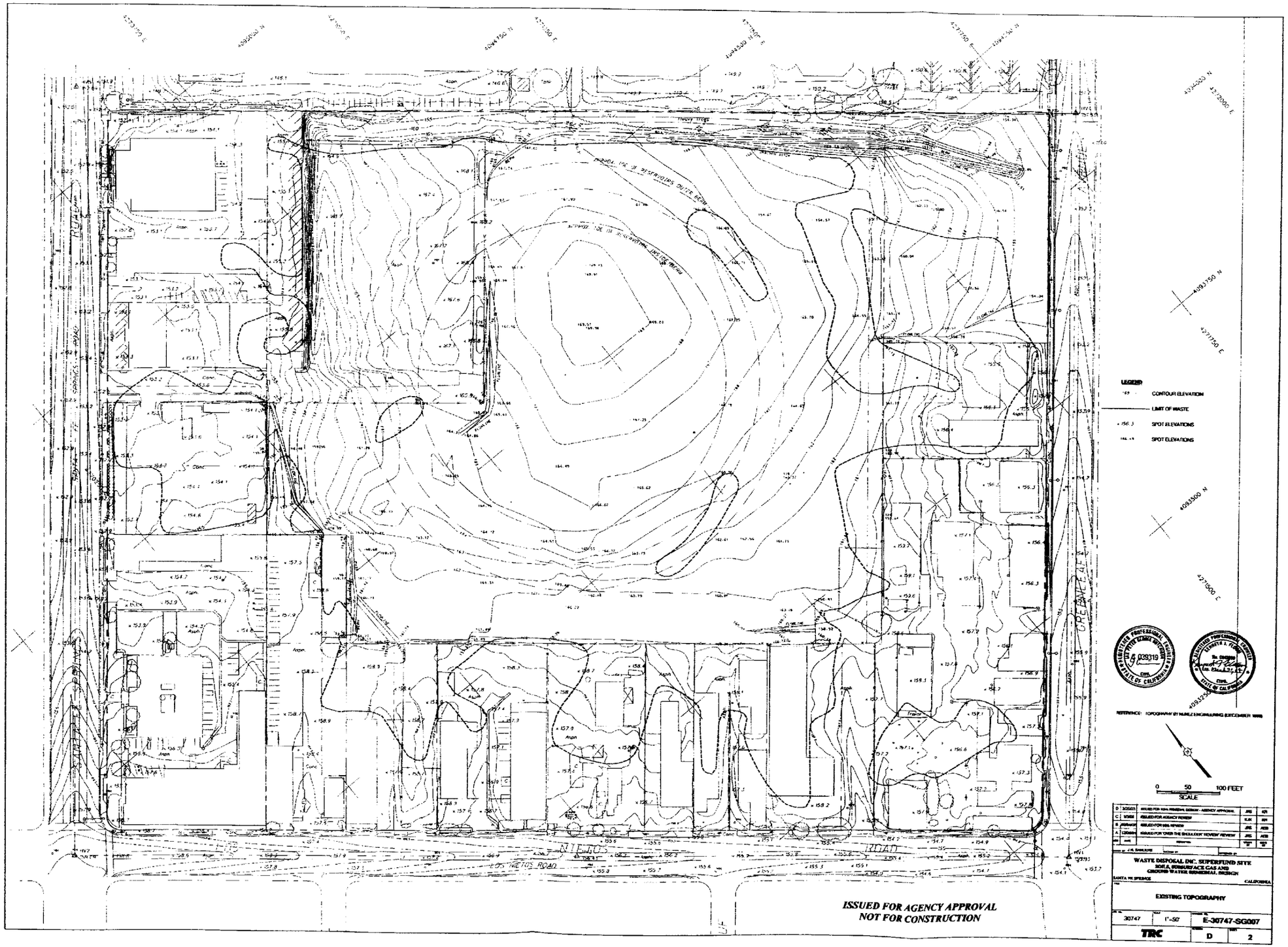
WASTE DISPOSAL, INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND
GROUND WATER REMEDIAL DESIGN

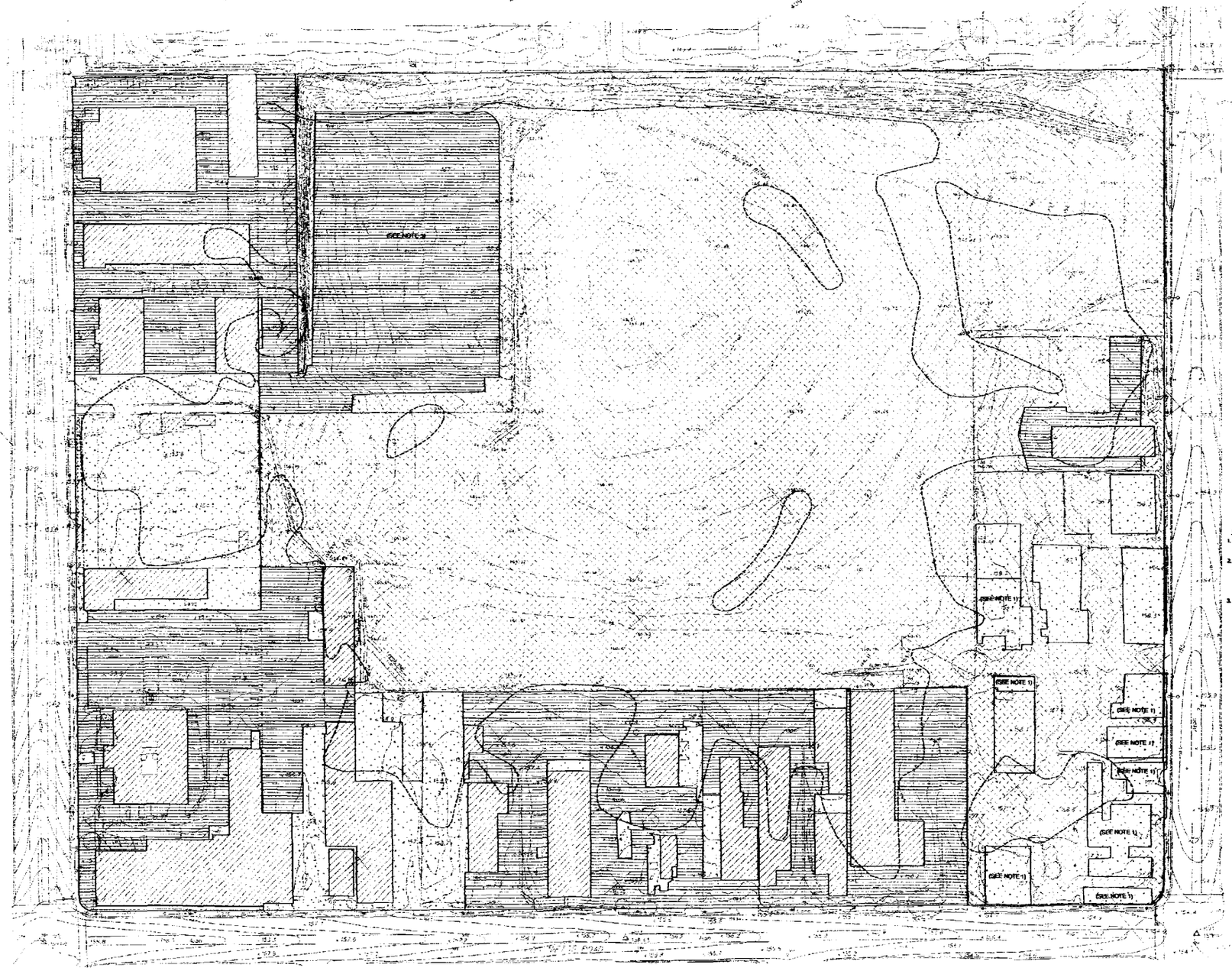
SANTA FE SPRINGS CALIFORNIA

TITLE, INDEX, LEGEND AND GENERAL NOTES

JOB NO.	SCALE	DRAWING NO.
30747	AS NOTED	E-30747-SG001

TRC | SHEET D | REV 1


LEGEND
CONTOUR ELEVATION
LIMIT OF WASTE
SPOT ELEVATIONS
SPOT ELEVATIONS
REFERENCE: TOPOGRAPHY BY NUNEZ ENGINEERING (DECEMBER 1998)
0 50 100 FEET
SCALE
WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND
GROUND WATER REMEDIAL DESIGN
SANTA FE SPRINGS
CALIFORNIA
EXISTING TOPOGRAPHY
30747
1"=50'
E-30747-SG007
TRC
D
2
ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION
LOS NIETOS ROAD
GREENLEAF
SANTA FE SPRINGS ROAD



LEGEND

- EXISTING SOIL COVER
- EXISTING ASPHALT
- EXISTING CONCRETE
- EXISTING BUILDING
- LIMIT OF WASTE

NOTES

1. EXISTING CONCRETE SLABS WITHIN LIMITS OF GRADING TO BE DEMOLISHED AND REMOVED FROM THE SITE.
2. EXISTING FENCES MAY BE REMOVED AS NECESSARY TO FACILITATE CONSTRUCTION AND WILL BE REINSTALLED AS DIRECTED BY THE ENGINEER. OTHER FENCING REMOVAL AND REPLACEMENT OR REHABILITATION WILL BE COMPLETED AS DIRECTED BY THE ENGINEER OR AS INCLUDED IN THE DESIGN.
3. EXISTING ASPHALT WITHIN LIMITS OF GRADING TO BE DEMOLISHED AND REMOVED FROM THE SITE.

REGISTERED PROFESSIONAL ENGINEER — STEVEN BRIAN SCHULTZ — C 039319 — CIVIL — STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER — KENNETH L. FLAGG — No. C053526 — CIVIL — STATE OF CALIFORNIA

REFERENCE: TOPOGRAPHY BY NUNEZ ENGINEERING (COLUMBIA 1998)

N

0 50 100 FEET
SCALE

D	3/7/2002	ISSUED FOR 90% REGIONAL DESIGN AGENCY APPROVAL	JRG	KR
C	10/2002	ISSUED FOR AGENCY REVIEW	KJF	KR
B	2/20/2002	ISSUED FOR 60% REVIEW	JRG	KGB
A	12/2001	ISSUED FOR OVER THE SHOULDER REVIEW	JRG	KGB
REV	DATE	DESCRIPTION	DRAWN BY	CHKD BY

Plot date: 3-8-2002 Version: P Layout: 1

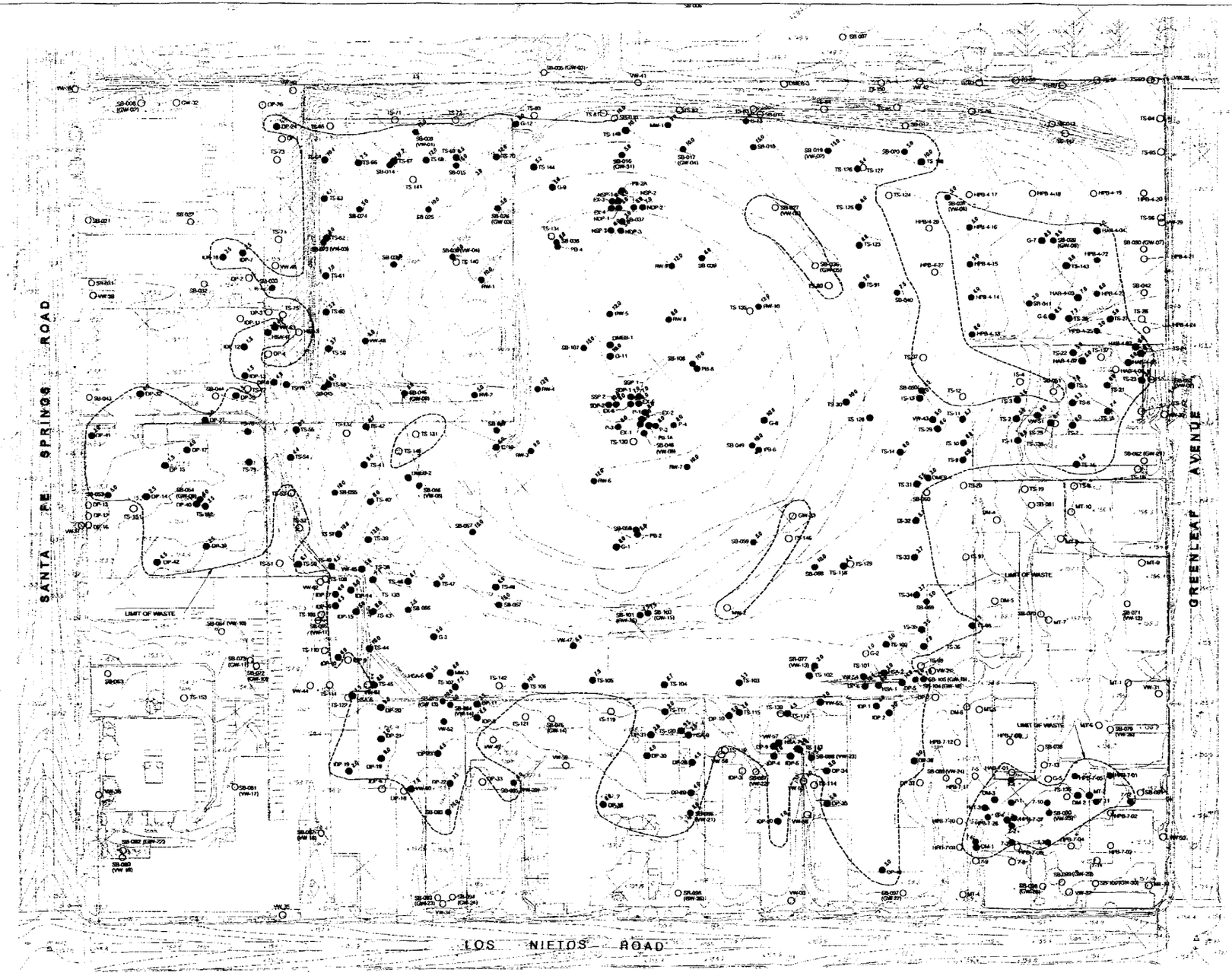
WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND
GROUNDWATER REMEDIAL DESIGN

SANTA FE SPRINGS CALIFORNIA

EXISTING SURFACE COVER

JOB NO.	SCALE	DRAWING NO.	
30747	1"=50'	E-30747-SG008	
TRC		REVISION D	SHEET 3

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION



LEGEND

- ● TS-24 APPROXIMATE LOCATION AND NUMBER OF TEST BORING OR MONITORING WELL THAT INDICATED PRESENCE OF WASTE
- 14.0 THICKNESS OF EXISTING FILL SOIL OVERLYING BURIED WASTE
- ○ SB-042 APPROXIMATE LOCATION AND NUMBER OF TEST BORING OR MONITORING WELL THAT INDICATED NO PRESENCE OF WASTE

0 50 100 FEET
SCALE

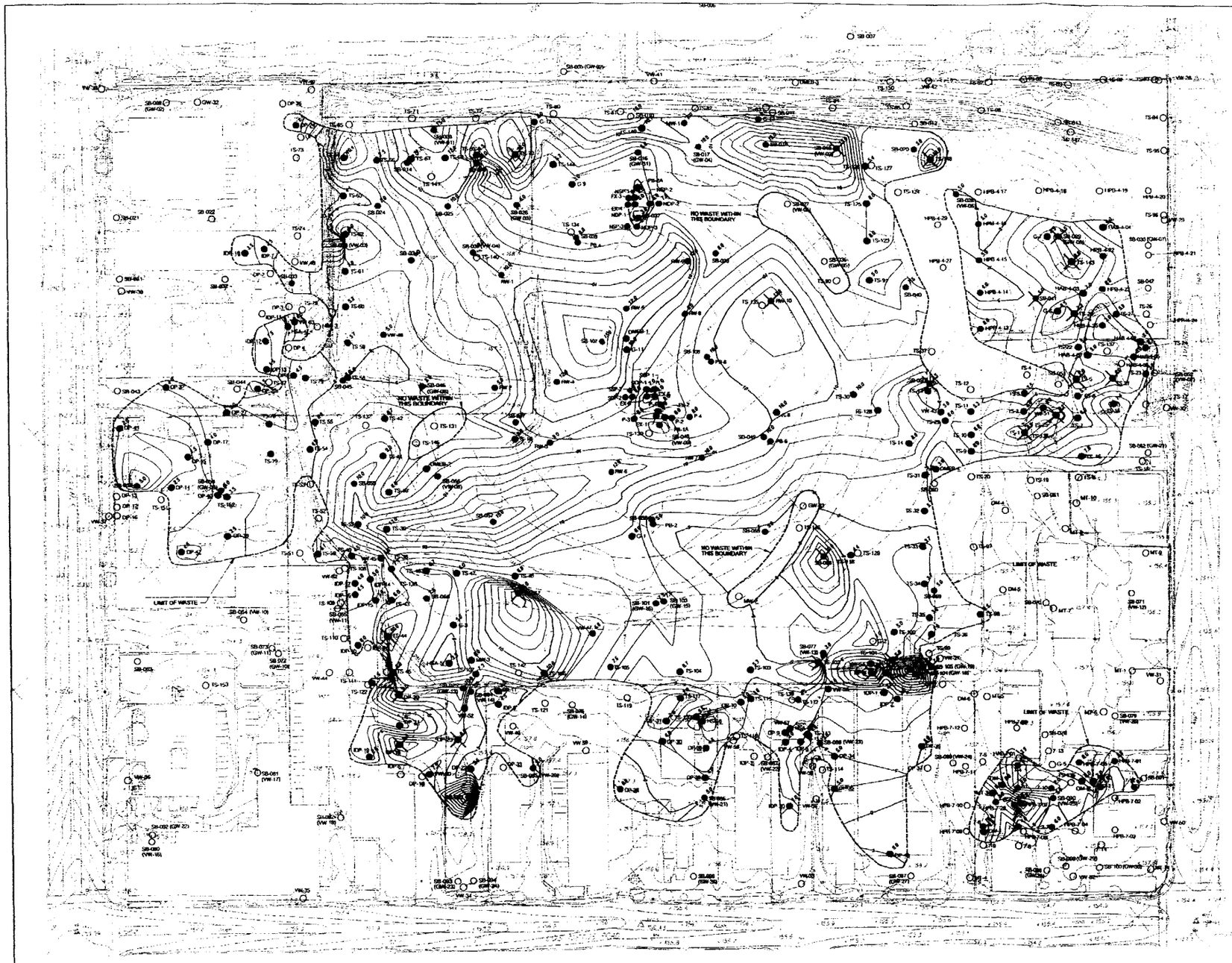
D	3/25/03	ISSUED FOR 'WAS REMEDIAL DESIGN - AGENCY APPROVAL	JRL	TP
C	10/03	ISSUED FOR AGENCY REVIEW	KJK	TP
B	03/29/02	ISSUED FOR WAS REVIEW ONLY NOT FOR CONSTRUCTION	ASC	ASB
A	12/20/01	ISSUED FOR 'OVER THE SHOULDER' REVIEW	ASC	ASB

WASTE DISPOSAL, INC., SUPERFUND SITE
SOILS, SUBSURFACE GAS AND
GROUND WATER REMEDIAL DESIGN
SANTA FE SPRINGS CALIFORNIA

BORING LOCATIONS

30747	1"=50'	E-30747-SG023	
TRC		D	4

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION



LEGEND

- ● TS-18 — APPROXIMATE LOCATION AND NUMBER OF TEST BORING OR MONITORING WELL THAT INDICATED PRESENCE OF WASTE
- 4.0 — THICKNESS OF EXISTING FILL SOIL OVERLYING BURIED WASTE
- ○ SB-042 — APPROXIMATE LOCATION AND NUMBER OF TEST BORING OR MONITORING WELL THAT INDICATED NO PRESENCE OF WASTE
- ╳ — DEPTHS TO WASTE PROVIDED BY THESE BORINGS WERE ELIMINATED TO PREPARE INTERPRETED SURFACE SHOWN ON SHEET 6 BECAUSE THEY APPEARED TO BE ISOLATED ANOMALIES.

REGISTERED PROFESSIONAL ENGINEER — C 039319 — CIVIL — STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER — MICHAEL J. FLANNERY — CIVIL — STATE OF CALIFORNIA

0 50 100 FEET
SCALE

REV	DATE	DESCRIPTION	DRN	APP
D	12/01/99	ISSUED FOR 100% REMEDIAL DESIGN - AGENCY APPROVAL	JRL	MF
C	1/05/99	ISSUED FOR AGENCY REVIEW	KJK	MF
B	12/23/98	ISSUED FOR 90% REVIEW ONLY - NOT FOR CONSTRUCTION	AEC	AKB
A	12/04/98	ISSUED FOR "OWN" SITE ENGINEER REVIEW	AEC	AKB

DRAWN BY: K J Kent — DESIGNED BY: — APPROVED BY: — DRAWING BY: AEC — CHECKED BY: AKB

WASTE DISPOSAL, INC., SUPERFUND SITE
SOIL, SUBSURFACE GAS AND
GROUND WATER REMEDIAL DESIGN

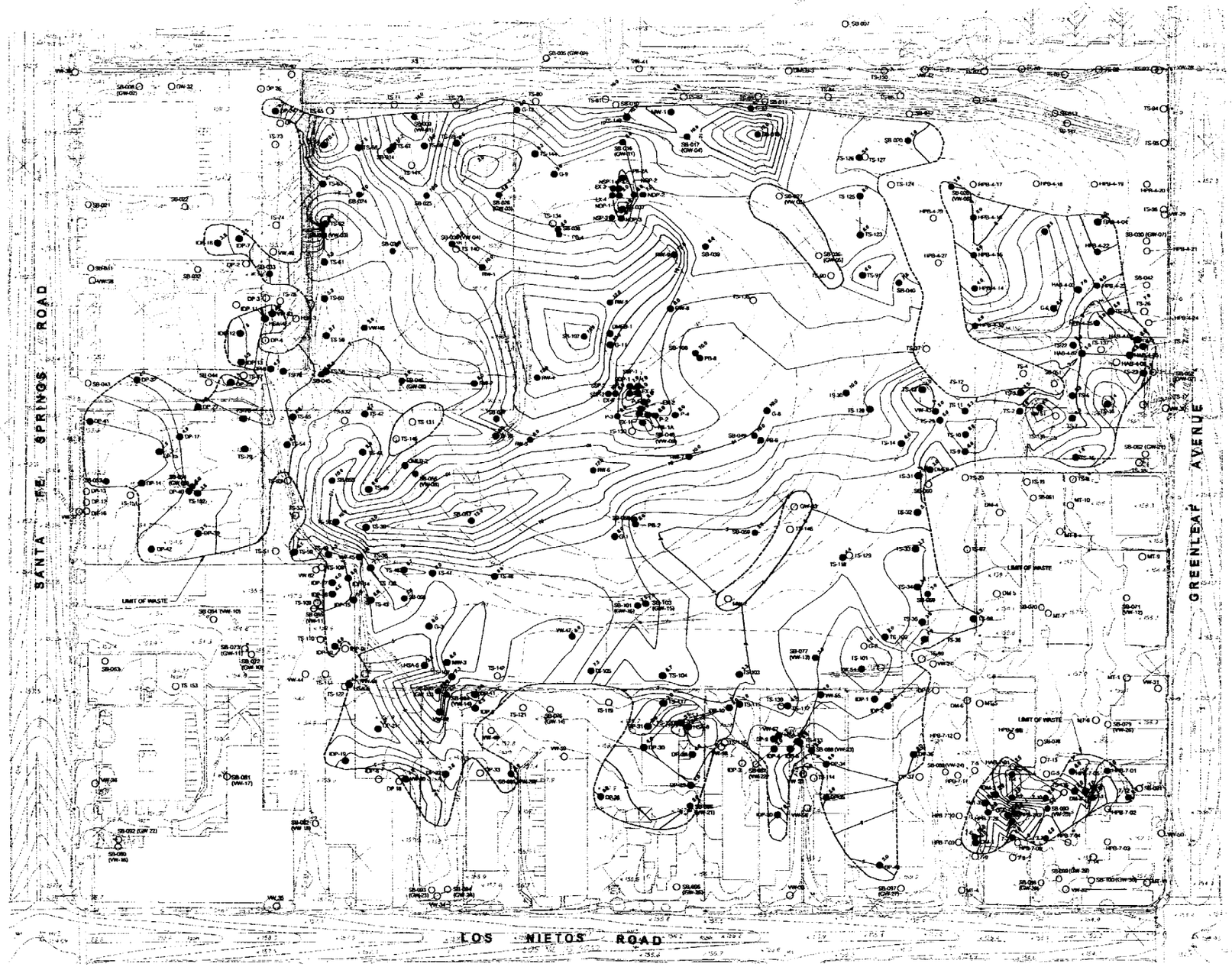
SANTA FA SPRINGS — CALIFORNIA

ISOPACH OF FILL THICKNESS ABOVE WASTE
(INCLUDING ANOMALIES)

JOB NO.	SCALE	DRAWING NO.
30/47	1"=50'	E-30747-SG024

TRC — REVISION D — SHEET 5

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION



LEGEND

- TS-18 APPROXIMATE LOCATION AND NUMBER OF TEST BORING OR MONITORING WELL THAT INDICATED PRESENCE OF WASTE
- 10.0 THICKNESS OF EXISTING FILL SOIL OVERLYING BURIED WASTE
- SB-042 APPROXIMATE LOCATION AND NUMBER OF TEST BORING OR MONITORING WELL THAT INDICATED NO PRESENCE OF WASTE

NOTE

1. THE CONTOURS SHOWN ON THIS PLAN REPRESENT THE APPROXIMATE DEPTH TO THE UPPER SURFACE OF THE EXISTING WASTE AS DETERMINED BY THE EXISTING SURFACE ELEVATIONS AND FIELD MEASURED BORING DEPTHS.
2. ANOMALIES NOTED ON SHEET 5 HAVE BEEN ELIMINATED TO PRODUCE THE INTERPRETED SURFACE PRESENTED IN THIS DRAWING.

0 50 100 FEET
SCALE

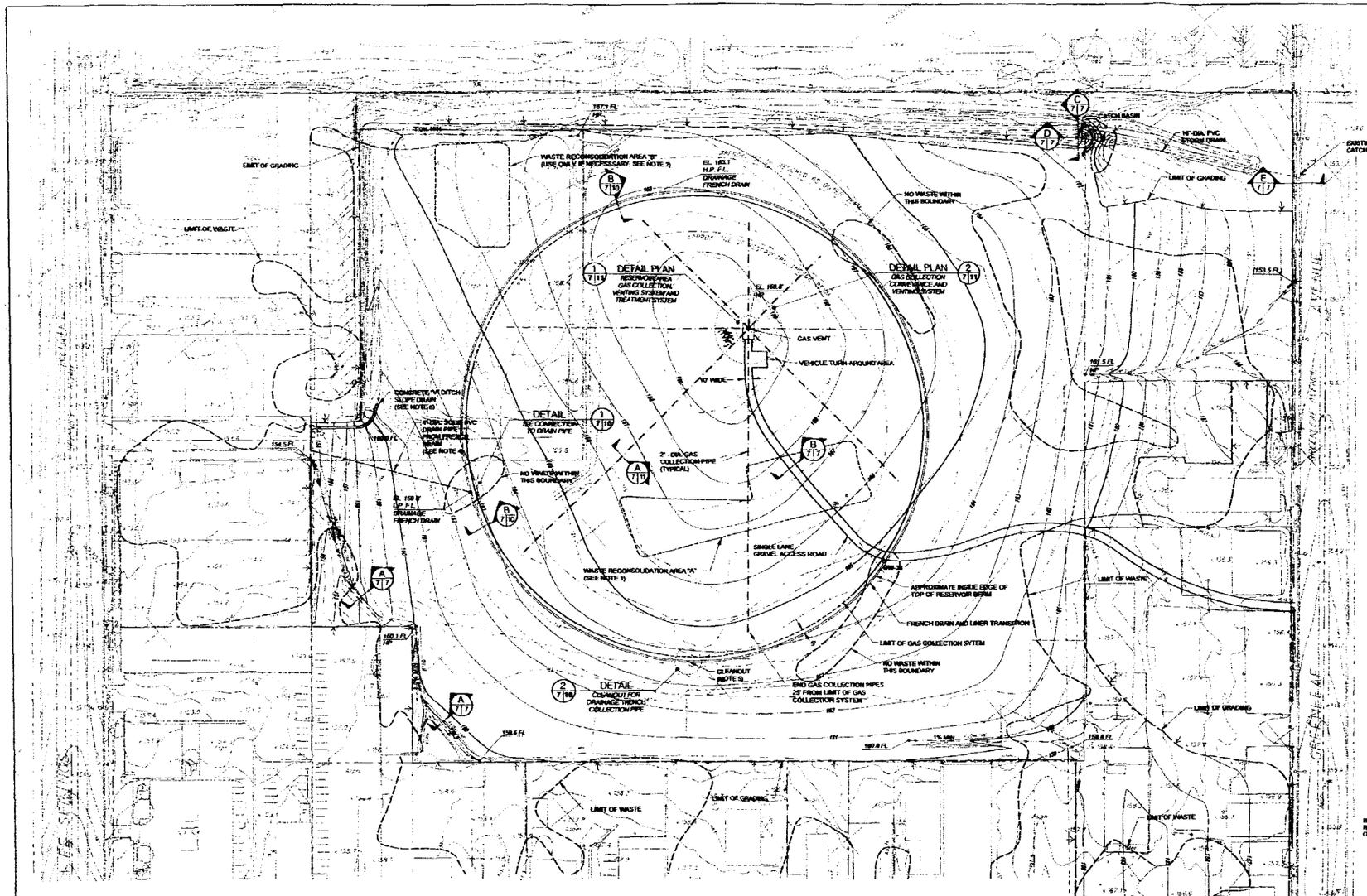
D	3/25/03	ISSUED FOR 100% REMEDIAL DESIGN - AGENCY APPROVAL	JHS	BP
C	1/2/03	ISSUED FOR AGENCY REVIEW	KJK	BP
B	12/2/02	ISSUED FOR 60% REVIEW ONLY NOT FOR CONSTRUCTION	AEC	ACB
A	12/2/02	ISSUED FOR "OVER THE SHOULDER" REVIEW	AEC	ACB

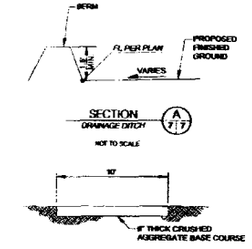
WASTE DISPOSAL, INC., SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN
SANTA FE SPRINGS CALIFORNIA

ISOPACH OF FILL THICKNESS ABOVE WASTE (INTERPRETED)

30747	1"=50'	E-30747-SG025
TRC	D	6

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION



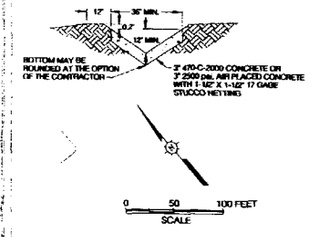


LEGEND

- GAS COLLECTION PIPE
- LIMIT OF GRADING

NOTES

1. EXCAVATED WASTE RECONSOLIDATION AREA "A". EXCAVATE TO APPROXIMATELY 7 FEET BELOW FINISHED GRADE TO PREPARE AREA FOR WASTE RECONSOLIDATION. MAXIMUM THICKNESS OF RECONSOLIDATION IS 4 FEET.
2. CONTINGENCY EXCAVATED WASTE RECONSOLIDATION AREA "B" USE ONLY IF NECESSARY AND AS DIRECTED BY ENGINEER. EXCAVATE TO APPROXIMATELY 7 FEET BELOW FINISHED GRADE OR TO TOP OF WASTE TO PREPARE AREA FOR WASTE RECONSOLIDATION. MAXIMUM THICKNESS OF RECONSOLIDATED WASTE IS TO WITHIN 3 FEET OF FINISHED GRADE.
3. TOP OF FOUNDATION LAYER IS A MINIMUM OF 2 FEET BELOW SURFACE GRADING PLAN (TOP OF COVER).
4. LENGTH AND SLOPE OF 4" DRAIN PIPE TO BE DETERMINED IN THE FIELD BY THE CONTRACTOR AND APPROVED BY THE CONSTRUCTION MANAGER.
5. A CLEANOUT SHALL BE PROVIDED FOR THE CAP DRAINAGE TRENCH COLLECTION PIPE A MINIMUM OF EVERY 100 FEET.
6. CONSTRUCT CONCRETE LINED V-DITCH ACCORDING TO THE FOLLOWING SECTION:



ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

D	3/25/03	ISSUED FOR 100% REVISIONS, DESIGN - AGENCY APPROVAL	JFG	MR
C	1/10/03	ISSUED FOR AGENCY REVIEW	KJE	MR
B	10/31/02	ISSUED FOR 60% REVIEW ONLY - NOT FOR CONSTRUCTION	AEC	ACB
A	12/20/01	ISSUED FOR UNDER THE SHOVELS REVIEW	AEC	ACB
No.	Date	Revision	Drawn by	Checked by

Drawn as: AS CONSLD | Scale: as | Date: 03/25/03

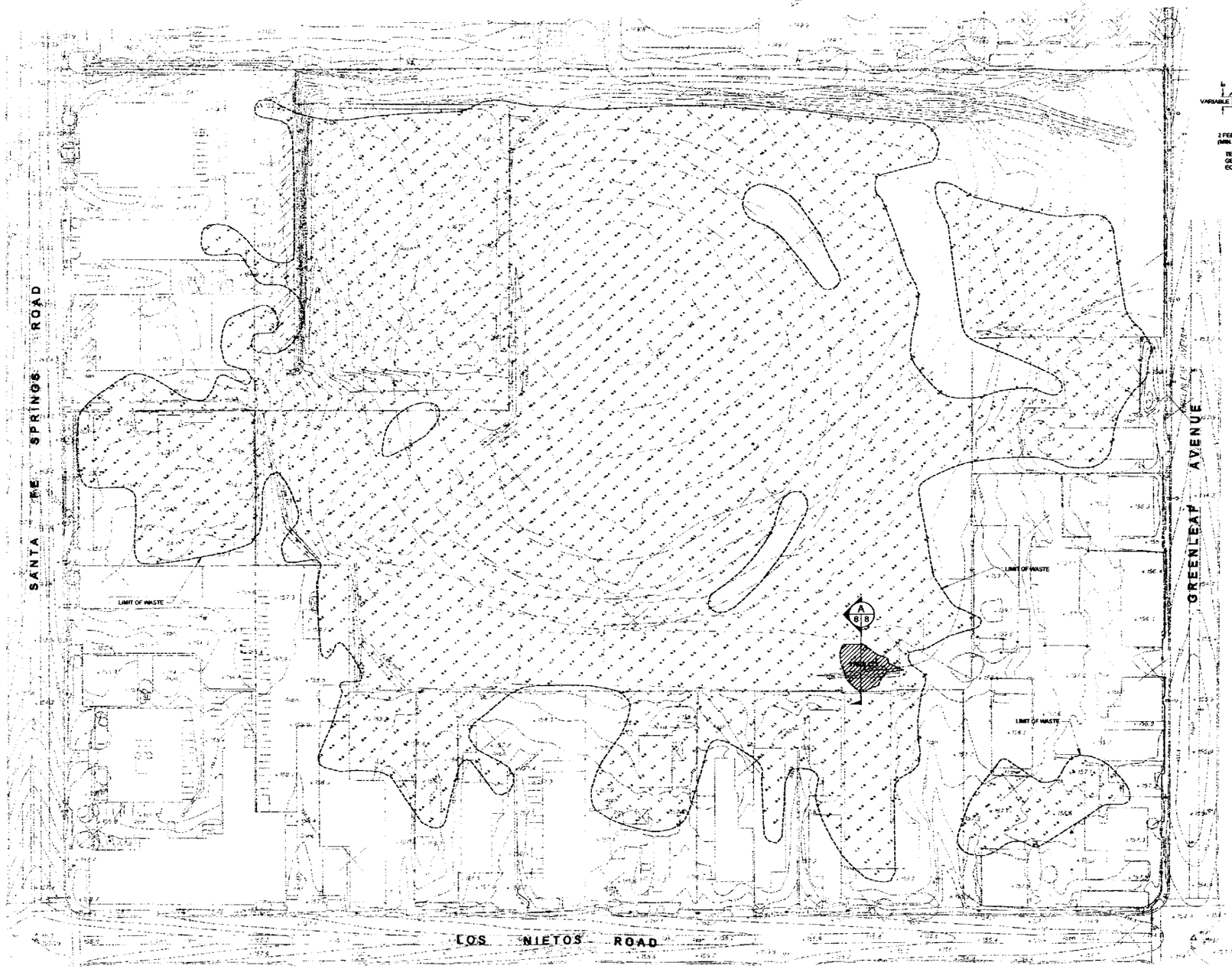
WASTE DISPOSAL, INC., SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

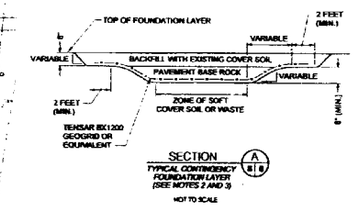
SANTA FE SPRINGS — CALIFORNIA

SURFACE GRADING PLAN (TOP OF COVER)

Job No.	Scale	Drawing No.
30747	AS NOTED	E-30747-SG019

TRC — Revision D — Sheet 7





SECTION A B B

TYPICAL CONTINGENCY FOUNDATION LAYER (SEE NOTES 2 AND 3)

NOT TO SCALE

LEGEND

APPROXIMATE THICKNESS OF EXISTING FILL SOIL OVERLYING BURIED WASTE

WASTE EXCAVATION ZONE (WASTE LOCATED WITHIN THIS AREA SHALL BE EXCAVATED TO A MINIMUM DEPTH (OF 2 FEET BELOW THE PROPOSED FINISH GRADE FOR THIS AREA.)

APPROXIMATE QUANTITY OF WASTE TO BE EXCAVATED FROM EACH AREA.

NOTES

1. THE SPOT FILL THICKNESSES SHOWN ON THIS PLAN REPRESENT THE APPROXIMATE DISTANCE DOWN TO THE UPPER SURFACE OF THE WASTE FROM THE EXISTING SURFACE ELEVATIONS.
2. TO BE USED OVER EXPOSED WASTE OR EXISTING COVER SOIL THAT EXHIBITS BEARING CAPACITY FAILURE DURING CONSTRUCTION (i.e., PUMPING RESULTING FROM CONSTRUCTION LOADS OR INABILITY TO ACHIEVE COVER LAYER COMPACTION).
3. DEPTH OF EXCAVATION AND THICKNESS OF BASE ROCK TO BE DETERMINED IN THE FIELD BY THE CONTRACTOR. IF CONSTRUCTION OF COVER ABOVE CONTINGENCY FOUNDATION LAYER DOES NOT MEET DESIGN AND SPECIFICATIONS CRITERIA, CONTRACTOR SHALL MODIFY CONTINGENCY FOUNDATION LAYER AT THEIR COST.

REGISTERED PROFESSIONAL ENGINEER — STEVEN L. TRAMP — C.E. 033319 — CIVIL — STATE OF CALIFORNIA

0 50 100 FEET

SCALE

D	3/25/08	ISSUED FOR 100% REVISION, DESIGN - AGENCY APPROVAL	JRG	SF
C	1/3/03	ISSUED FOR AGENCY REVIEW	KJK	SF
B	10/29/02	ISSUED FOR 95% REVIEW ONLY, NOT FOR CONSTRUCTION	ABC	ABB
A	10/25/02	ISSUED FOR OVER THE SHOULDER REVIEW	ABC	ABB
REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY

DRAWN BY: K.J.KIRK — DESIGN BY: — CHECKED BY:

WASTE MANAGEMENT, INC., SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

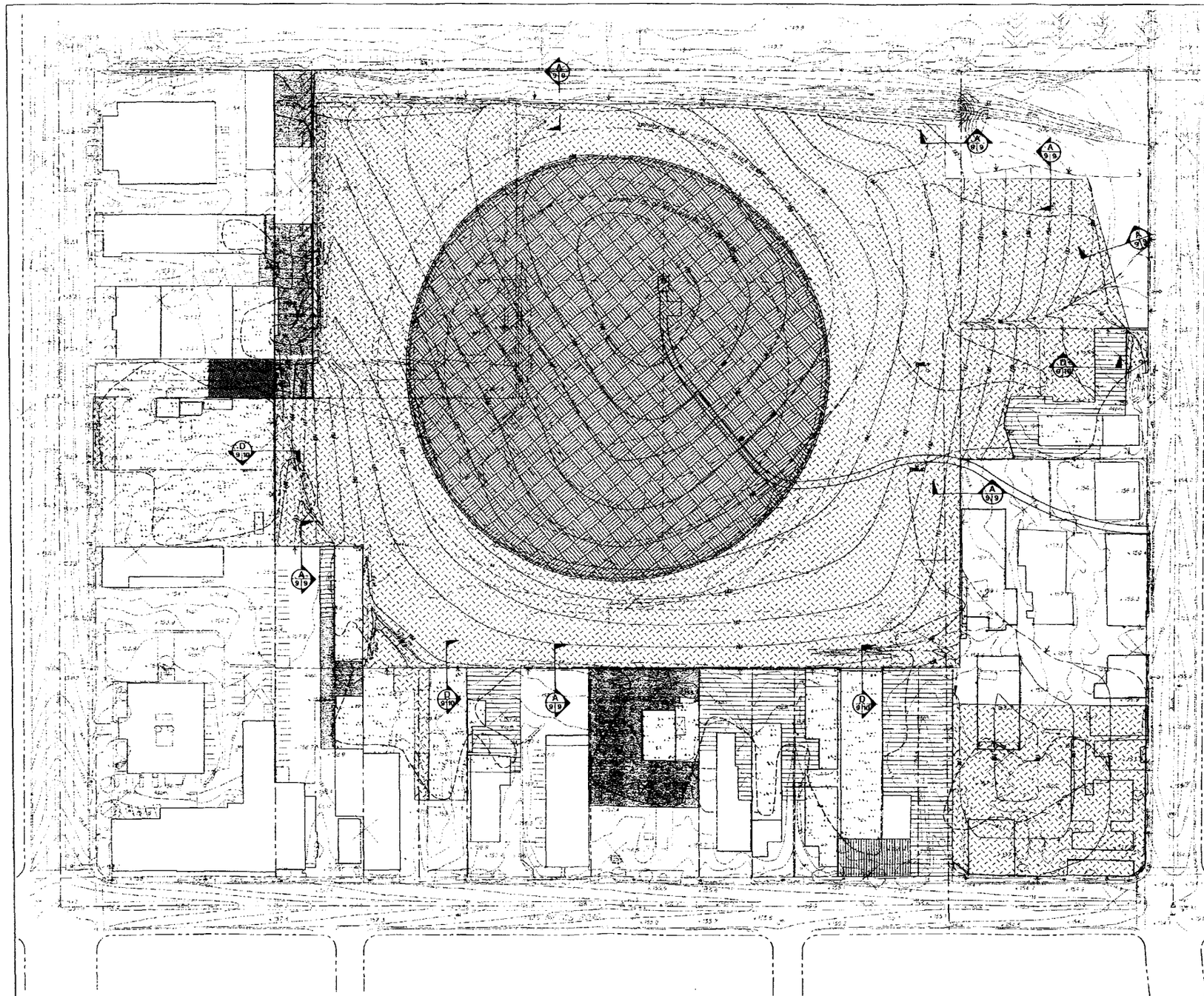
SANTA FE SPRINGS — CALIFORNIA

EXISTING EARTH COVER THICKNESS

JOB NO.	SCALE	DRAWING NO.
30747	1"=50'	E-30747-SG026

TRC — REVISION D — SHEET 8

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

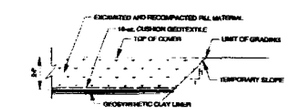


LEGEND

- RCRA SUBTITLE C-EQUIVALENT CAP AREA — DETAIL 4 / 9.10
- RCRA SUBTITLE D - EQUIVALENT COVER AREA — DETAIL 5 / 9.10
- REMOVE EXISTING ASPHALT AND REPLACE WITH ENGINEERED ASPHALT COVER — DETAIL 6 / 9.10
- 2" ASPHALT OVERLAY COVER — DETAIL 6A / 9.10
- REMOVE EXISTING CONCRETE AND REPLACE WITH ENGINEERED CONCRETE COVER — DETAIL 7 / 9.10
- ENGINEERED CONCRETE COVER WITH SEALED CRACKS — DETAIL 7A / 9.10
- SEAL ASPHALT AND RESTRIPE

LEGEND

- LIMIT OF WASTE
- LIMIT OF GRADING



TYPICAL SECTION A / 9.9

TRANSITION FROM COVERED AREA USING RCRA SUBTITLE D - EQUIVALENT COVER TO NON-COVERED SOIL AREAS

NOT TO SCALE

0 50 100 FEET

SCALE

D	3/23/93	SUBMITTED FOR TERMINAL DESIGN AGENCY APPROVAL	JRS	AGB
C	1/3/93	ISSUED FOR AGENCY REVIEW	SJK	KW
B	10/30/92	ISSUED FOR 90% REVIEW ONLY NOT FOR CONSTRUCTION	ABC	AGB
A	12/30/91	ISSUED FOR CRWR THE SHOULDER REVIEW	ARC	AGB
REV	DATE	DESCRIPTION	BY	CHK

DRAWN BY A.R. COMINGO CHECKED BY APPROVED BY

WASTE DISPOSAL, INC., SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

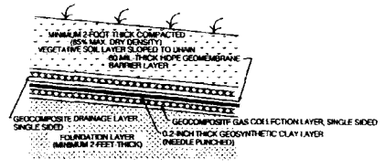
SANTA FE SPRINGS CALIFORNIA

COVER TYPE PLAN, PAVEMENT REHAB PLAN

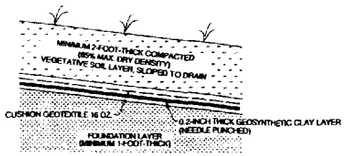
DWG. NO.	SCALE	DRAWING NO.
30747	1"=50'	E-30747-SG020

TRC REVISION D SHEET 9

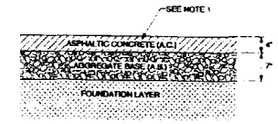
ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION



DETAIL 4 / 9|10
RCRA SUBTITLE C - EQUIVALENT CAP
NOT TO SCALE



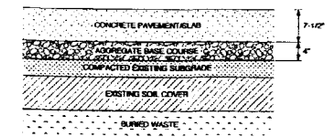
DETAIL 5 / 9|10
RCRA SUBTITLE D - EQUIVALENT COVER
NOT TO SCALE



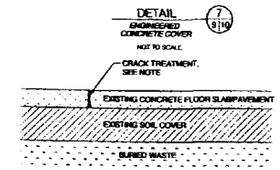
DETAIL 6 / 9|10
ENGINEERED ASPHALT COVER
NOT TO SCALE

DETAIL 6A / 9|10
2" ASPHALT OVERLAY COVER
NOT TO SCALE

NOTES:
1. A.C. MIX TO BE DESIGNED AS A HIGH-DENSITY, LOW AIR VOIDS MIX, COMPACTED TO 99% THEORETICAL MAXIMUM DENSITY (2% AIR VOIDS MAXIMUM #42) AND HAVE A HYDRAULIC CONDUCTIVITY OF 1 X 10⁻⁷ cm/sec OR LESS.
2. TERMINATE GEOTEXTILE WITHIN 6 INCHES OF BUILDING FOUNDATION. CONTRACTOR SHALL OBTAIN APPROVAL OF GEOTEXTILE BY ENGINEER.

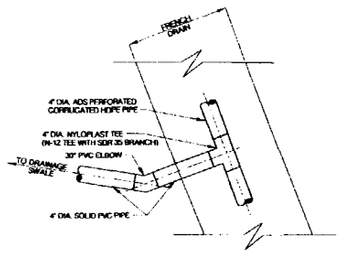


DETAIL 7 / 9|10
ENGINEERED CONCRETE COVER
NOT TO SCALE

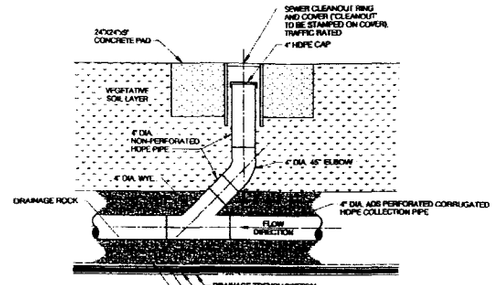


DETAIL 7A / 9|10
ENGINEERED CONCRETE COVER WITH SEALED CRACKS
TYPICAL SECTION
NOT TO SCALE

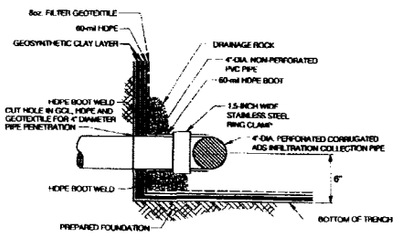
NOTE
REPAIR OF CRACKS IN EXISTING CONCRETE PAVEMENT SHALL BE PER CONCRETE DESIGN SPECIFICATION 03306.



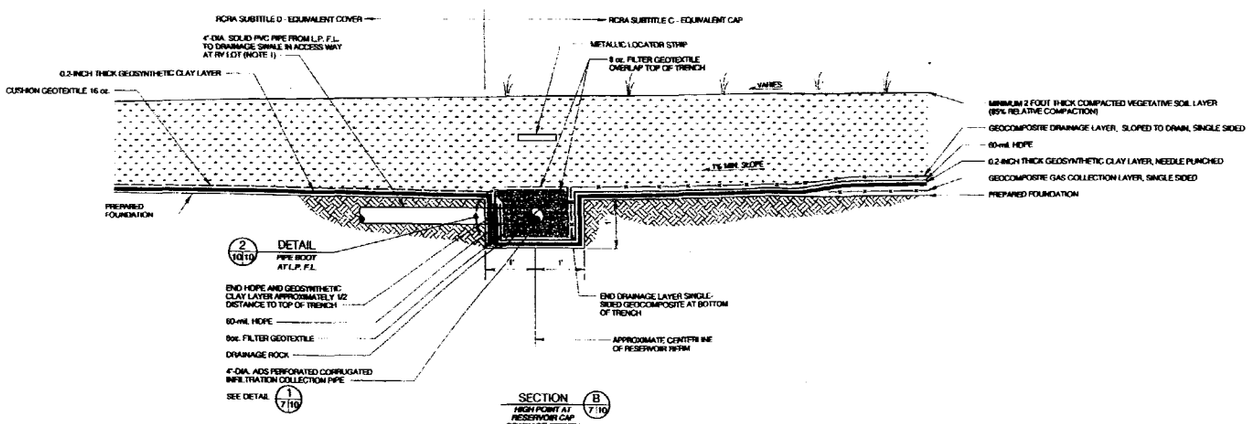
DETAIL 1 / 7|10
TRANSITION FROM HDPE TO PVC TEE CONNECTION TO DRAINAGE SWALE
0 1 2 FEET
SCALE



DETAIL 2 / 7|10
CLEANOUT FOR DRAINAGE TRENCH COLLECTION PIPE
0 9 18 INCHES
SCALE



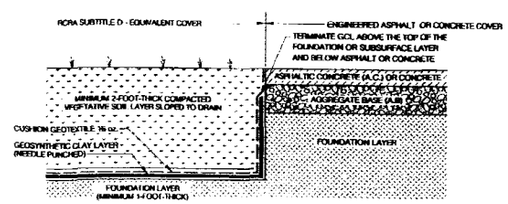
DETAIL 2 / 10|10
PIPE BOOT
0 0.5 FEET
HORIZONTAL AND VERTICAL SCALE



SECTION B / 7|10
HIGH POINT AT RESERVOIR CAP DRAINAGE TRENCH

NOTES:
1. 4"-DIA. SOLID PIPE IS IN SECTION ONLY AT L.P. F.L. TO DRAINAGE SWALE.
2. CONTRACTOR TO FOLLOW OSHA GUIDELINES FOR TRENCH EXCAVATION.

0 1 2 FEET
HORIZONTAL AND VERTICAL SCALE



TYPICAL SECTION D / 9|10
TRANSITION FROM RCRA SUBTITLE D - EQUIVALENT COVER TO ENGINEERED ASPHALT/CONCRETE COVER
0 1 2 FEET
HORIZONTAL AND VERTICAL SCALE

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

D	3/7/03	ISSUED FOR REMEDIAL DESIGN - AGENCY APPROVAL	JFC	MG
C	1/9/03	ISSUED FOR AGENCY REVIEW	JFC	MG
B	2/20/02	ISSUED FOR 60% REVIEW	JFC	AGB
A	1/25/01	ISSUED FOR REVIEW	JFC	JCS
REV.	DATE	DESCRIPTION	DR	CK

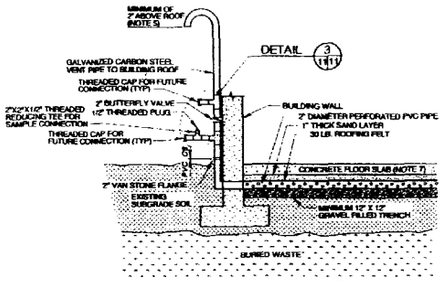
DRAWN J.R. Samples CHECKED BY Brian Gallagher

WASTE DISPOSAL, INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN
SANTA FE SPRINGS CALIFORNIA

SECTIONS AND DETAILS

DWG. NO.	SCALE	DRAWING NO.
30747	AS NOTED	E-30747-SG005

TRC | REVISION D | SHEET 10

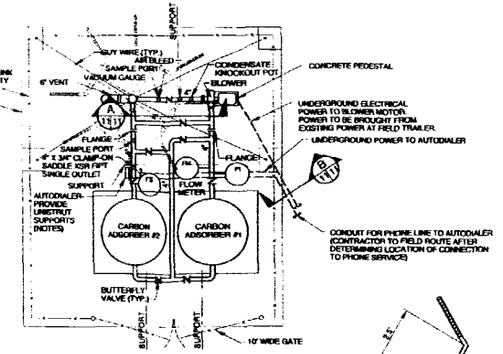


DETAIL 3 / 1 1 1

DETAIL 1 / 1 1 1
TYPICAL CROSS-SECTION FOUNDATION VENT PIPE (IF REQUIRED)
NOT TO SCALE

DETAIL 1 NOTES:

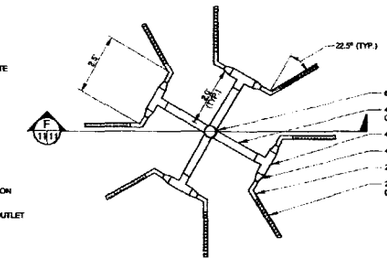
1. MINIMUM 12"X12" GRAVEL FILLED VENTILATION TRENCHES MUST BE NO FURTHER THAN 30 FEET APART OR 25 FEET FROM THE BUILDING FOUNDATION. VENTILATION TRENCHES MUST BE PROVIDED FOR EACH AREA ISOLATED BY A CONTINUOUS FOOTING.
2. PIPE PERFORATIONS. MINIMUM OF 2 PERCENT OF THE SURFACE AREA OF THE PIPE. PERFORATIONS MUST BE SYMMETRICAL AROUND THE PIPE. ENDS OF THE PIPE ARE TO BE CAPPED.
3. ALL HORIZONTAL VENTILATION PIPES ARE TO BE LOCATED AT THE HIGHEST POINT OF THE VENT TRENCHES.
4. VERTICAL VENTILATION PIPES MUST BE PROVIDED FOR EVERY 400 FEET OF VENTILATION TRENCH OR AT EACH END OF TRENCH, WHICHEVER IS LEAST.
5. ALL VERTICAL VENTILATION PIPES MUST BE TERMINATED AT A MINIMUM OF TWO FEET ABOVE THE HIGHEST POINT ON THE ROOF WITHIN A 10 FOOT RADIUS OF THE VENT PIPE AND AWAY FROM SOURCE(S) OF IGNITION. VENTS SHALL EXHAUST A MINIMUM DISTANCE OF 20 FEET AWAY FROM OPENINGS INTO BUILDINGS (i.e., WINDOWS OR AIR INTAKE VENTS). PIPES ARE TO BE SECURED TO THE EXTERIOR OF BUILDING WALLS AT MAXIMUM OF 5 FOOT VERTICAL INTERVALS.
6. ROOFING FELT SHALL EXTEND A MINIMUM OF 6" ON BOTH SIDES OVER THE WIDTH OF THE TRENCH.
7. MATCH EXISTING SLAB THICKNESS AND REINFORCING WHEN REPLACING CONCRETE AT TRENCHES INSIDE BUILDINGS
8. PROTECT VENTING SYSTEMS WITH BOLLARDS AS REQUIRED. SEE DETAIL 5 ON SHEET 13.



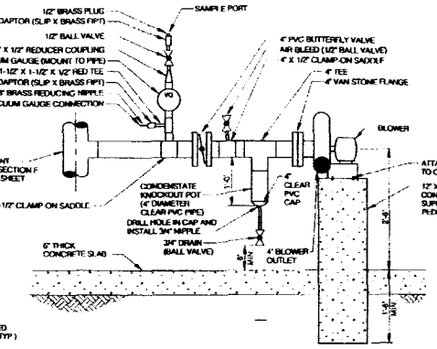
DETAIL PLAN 1 / 7 1 1
RESERVOIR AREA GAS COLLECTION, VENTING AND TREATMENT SYSTEM
0 3 8 FEET
SCALE

NOTES:

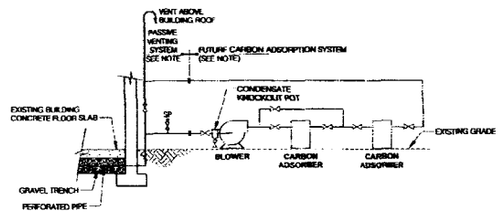
1. PIPE ROUTING MAY REQUIRE MODIFICATION DEPENDING ON LOCATION AND ELEVATION OF CONNECTIONS AT THE CARBON ADSORBERS.
2. BREAKOUT CONNECTIONS MUST BE INSTALLED AT THE INLET AND OUTLET OF THE CARBON ADSORBERS TO FACILITATE CHANGEOUT.
3. SEE DETAIL 4 / 1 1 1 FOR FLOW DIAGRAM.
4. SEE MATERIALS LIST ON THIS SHEET.
5. CONTRACTOR TO PROVIDE PHONE LINE TO AUTODIALER AND PROVIDE PLAN TO WDSI REPRESENTATIVE FOR NOTIFICATION OF SYSTEM FAILURE.



DETAIL PLAN 2 / 7 1 1
GAS COLLECTION CONVEYANCE AND VENTING SYSTEM
0 2 4 FEET
HORIZONTAL AND VERTICAL SCALE

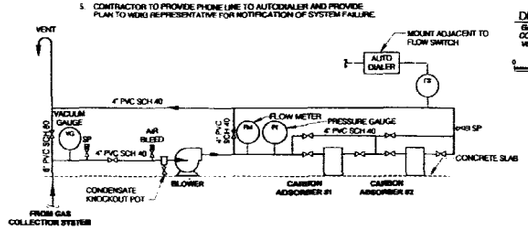


SECTION A / 1 1 1
BLOWER INLET PIPING, INSTRUMENTATION AND FOUNDATION
0 1 2 FEET
SCALE

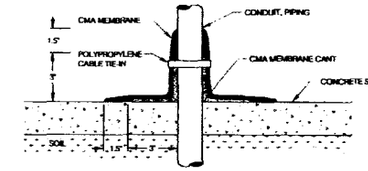


DETAIL 3 / 1 1 1
POTENTIAL GAS COLLECTION AND VENTING SYSTEM FLOW DIAGRAM FOR EXISTING BUILDINGS
NOT TO SCALE

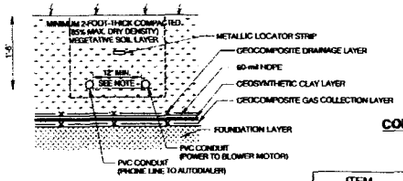
NOTE:
PASSIVE VENTING SYSTEM TO BE INSTALLED ONLY IF CONSTITUENTS-OF-CONCERN ARE DETECTED INSIDE BUILDINGS ABOVE THE INDOOR AIR THRESHOLD LEVELS (SEE AMENDED RECORD OF DECISION). CARBON ADSORPTION SYSTEM TO BE INSTALLED ONLY IF EXTRACTED GAS EXCEEDS ONE POUND PER DAY OF VOLATILE ORGANIC COMPOUNDS



DETAIL 4 / 1 1 1
RESERVOIR AREA GAS COLLECTION AND VENTING SYSTEM FLOW DIAGRAM
NOT TO SCALE



DETAIL
TYPICAL UTILITY PENETRATION TREATMENT
NOT TO SCALE



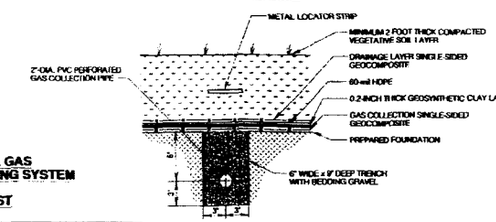
SECTION B / 1 1 1
CONDUIT TRENCH FOR POWER TO BLOWER MOTOR
0 1 2 FEET
SCALE

NOTE
A MINIMUM 12" SEPARATION MUST BE MAINTAINED BETWEEN ELECTRICAL CONDUIT AND COMMUNICATIONS CONDUIT

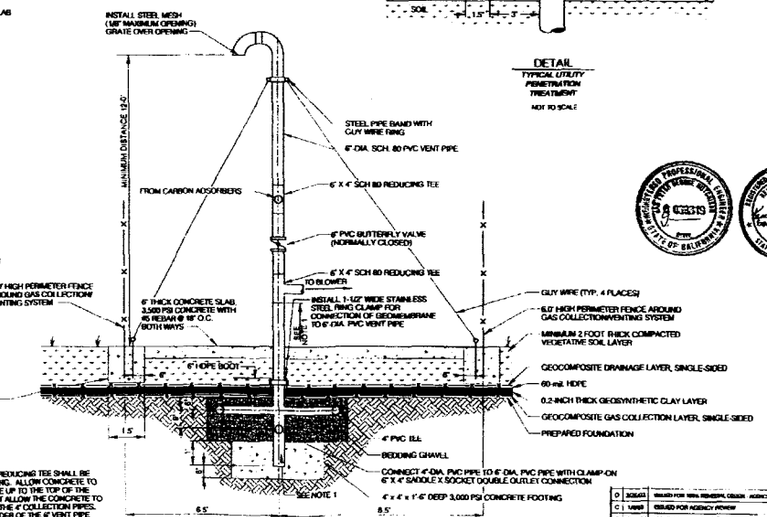
RESERVOIR AREA GAS COLLECTION AND VENTING SYSTEM

MATERIALS LIST

ITEM	DESCRIPTION	QTY
BLOWER	MCMASTER-CARR 1954K899 CAST ALUMINUM HIGH PRESSURE BLOWER, 1/3 HP, ODP MOTOR, 115/230 VOLT, 3450 RPM, 225CFM AT 1" STATIC PRESSURE WITH ANSI FLANGES OR EQUAL	1
CARBON ADSORBER	CARBTROL VAPOR PHASE ADSORBER MODEL G-4 OR EQUAL	2
VACUUM GAUGE	DWYER MAGNAHELIC #2010, RANGE 0-10" H_2O WITH A-610 PIPE MOUNTING KIT OR EQUAL	1
BUTTERFLY VALVE	HAYWARD 4" PVC OR EQUAL	8
BUTTERFLY VALVE	HAYWARD 6" PVC GEAR OPERATED OR EQUAL	1
BALL VALVE	SPEARS 1/2" TRUE UNION PVC OR EQUAL	2
BALL VALVE	SPEARS 3/4" TRUE UNION PVC OR EQUAL	1
FLOW METER	DWYER MODEL 166-6 CF PITOT TUBE AND DWYER SERIES 475 MK III HANDHELD DIGITAL MANOMETER	1
PRESSURE GAUGE	RANGE 0-60 psi	1
FLOW SWITCH	OMEGA MODEL NO. FST-323 OR EQUAL	1
AUTO DIALER	OMEGA OMA-GUARDIT AUTOMATIC ALARM DIALER OR EQUAL	1



SECTION A / 7 1 1
GAS COLLECTION PIPE
NOT TO SCALE



NOTES

1. THE 6" PIPE BELOW THE 6"X4" REDUCING TEE SHALL BE SET INTO A CONCRETE FOOTING. ALLOW CONCRETE TO FILL THE INSIDE OF THE 6" PIPE UP TO THE TOP OF THE CONCRETE FOOTING. DO NOT ALLOW THE CONCRETE TO RISE ABOVE THE BOTTOM OF THE 4" COLLECTION PIPES. DO NOT INSTALL THE REMAINDER OF THE 6" VENT PIPE UNTIL THE CONCRETE FOOTING HAS ACHIEVED A MINIMUM OF 70% OF THE DESIGN STRENGTH.
2. SECTION F INCLUDES SOME ABOVEGROUND ITEMS (i.e., VENT PIPE, GUY WIRES, FENCING) ALTHOUGH THEY ARE NOT INDICATED IN DETAIL PLAN 2.

SECTION F / 1 1 1
GAS COLLECTION CONVEYANCE AND VENTING SYSTEM (NOTE 2)
0 2 4 FEET
HORIZONTAL AND VERTICAL SCALE

REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

D	3/25/03	ISSUED FOR 100% REVIEW, DESIGN AGENCY APPROVAL	JRS	MG
C	1/14/03	ISSUED FOR AGENCY REVIEW	JRS	MG
B	12/20/02	ISSUED FOR 90% REVIEW	JRS	AGB
A	12/20/02	ISSUED FOR 10% PRE-SHOULDER REVIEW	JRS	AGB
REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY

DESIGNED BY: J.R. SANCHEZ DRAWN BY: M. GERMANOW CHECKED BY:

WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SURFACE GAS AND GROUND WATER REMEDIAL DESIGN

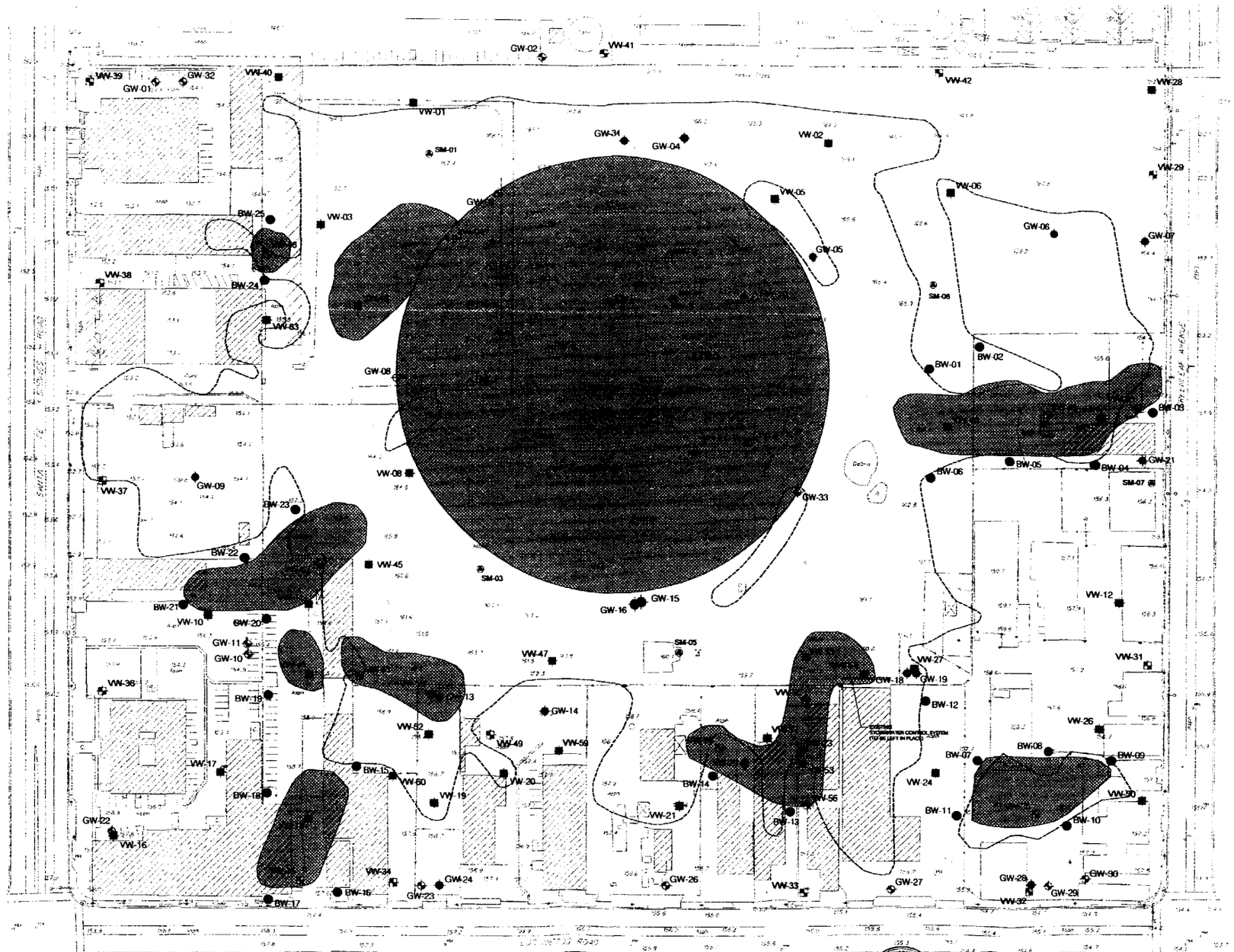
SANTA FE SPRINGS CALIFORNIA

SOIL GAS EXTRACTION, VENTING AND TREATMENT SYSTEM SECTIONS AND DETAILS

JOB NO.	SCALE	DRAWING NO.
30747	AS NOTED	E-30747-SG012

TRC

REVISION D SHEET 11


GW-02
VW-41
VW-39
GW-32
GW-01
VW-40
VW-42
VW-28
VW-01
GW-34
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VW-02
SM-01
VW-29
VW-05
VW-06
VW-03
BW-25
GW-06
GW-07
GW-05
VW-38
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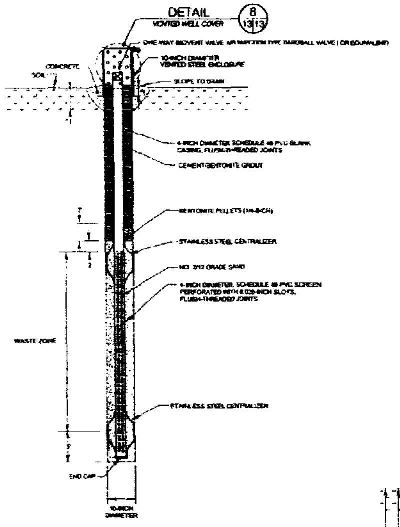
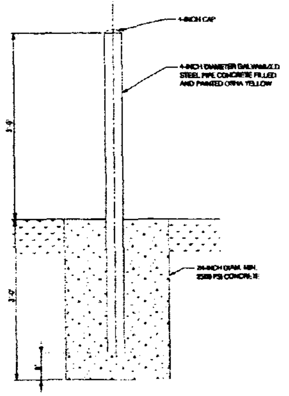
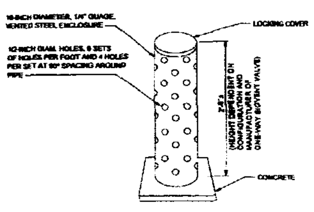
VW-34
GW-24
GW-26
GW-28
GW-30
BW-17
BW-16
GW-23
VW-33
GW-27
GW-29
VW-32
SANTA FE SPRINGS ROAD
SANTA FE AVENUE
LEGEND
SOIL GAS NONCOMPLIANCE AREA
EXISTING BUILDING SLAB
LIMIT OF WASTE
NEW BIOVENT WELL
EXISTING GROUND WATER WELL TO BE RETAINED FOR MONITORING
EXISTING GROUND WATER WELL TO BE ABANDONED (PENDING EPA APPROVAL)
EXISTING GROUND WATER WELL TO BE RETAINED (POSSIBLE FUTURE ABANDONMENT)
EXISTING VAPOR WELLS TO BE RETAINED FOR MONITORING
EXISTING VAPOR WELLS TO BE ABANDONED (PENDING EPA APPROVAL)
EXISTING VAPOR WELL TO BE RETAINED (POSSIBLE FUTURE ABANDONMENT)
NEW LEACHATE COLLECTION WELLS
TM NO. 13 WELLS TO BE ABANDONED (PENDING EPA APPROVAL)
NEW SETTLEMENT MONUMENTS
REFERENCE: TOPOGRAPHY BY NUNEZ ENGINEERING (DECEMBER 1999)
0 50 100 FEET
SCALE
D 10/24/01 ISSUED FOR 100% REMEDIAL DESIGN - AGENCY REVIEW JPE KSK
C 10/02/01 ISSUED FOR AGENCY REVIEW KJK KSK
B 09/04/01 ISSUED FOR 90% REVIEW KJK ACB
A 12/06/00 ISSUED FOR "OTHER THAN ENGINEER" REVIEW JPE KSK
WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN
SANTA FE SPRINGS CALIFORNIA
LOCATIONS OF LEACHATE COLLECTION WELLS, BIOVENT WELLS, VAPOR MONITORING WELLS, GROUND WATER MONITORING WELLS AND SETTLEMENT MONUMENTS
30747 1"=50' E-30747-SG014
TRC D 12
REGISTERED PROFESSIONAL ENGINEER
STATE OF CALIFORNIA
ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION



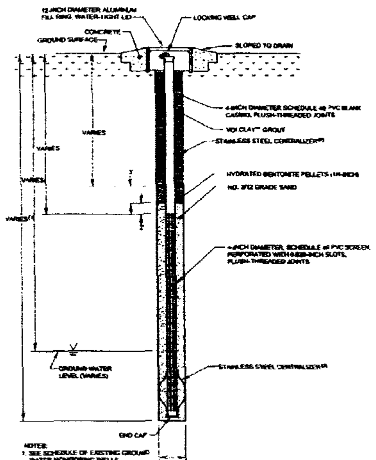
DETAIL 1 13|13
BIOVENT WELL CONSTRUCTION DIAGRAM
NOT TO SCALE



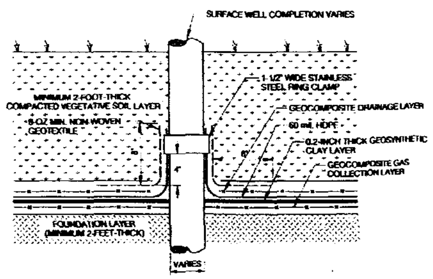
DETAIL 5 13|13
TYPICAL BOLLARD
NOT TO SCALE



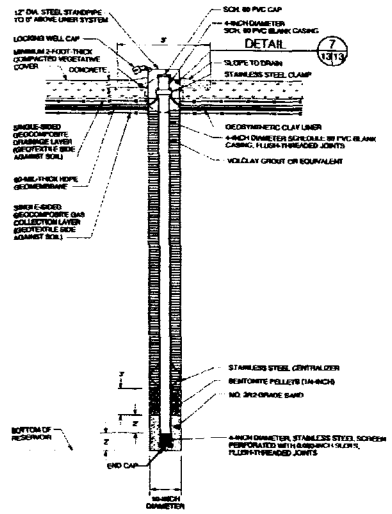
DETAIL 8 13|13
VENTED WELL COVER
NOT TO SCALE



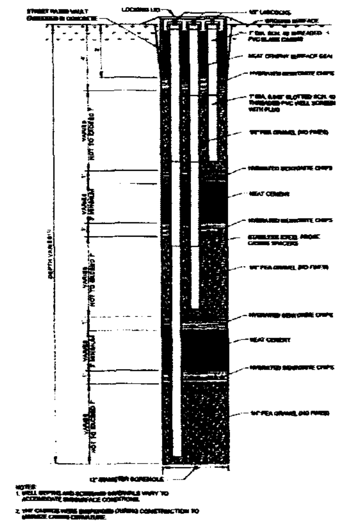
DETAIL 3 13|13
TYPICAL EXISTING GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM
NOT TO SCALE



DETAIL 7 13|13
TYPICAL WELL PENETRATION DETAIL THRU RCRA SUBTITLE C EQUIVALENT CAP
NOT TO SCALE



DETAIL 2 13|13
LEACHATE MONITORING/CONTROL WELL CONSTRUCTION DIAGRAM
NOT TO SCALE



DETAIL 4 13|13
TYPICAL EXISTING VAPOR WELL CONSTRUCTION DIAGRAM
NOT TO SCALE

SCHEDULE OF EXISTING SOIL VAPOR MONITORING WELLS TO BE RETAINED FOR MONITORING WASTE DISPOSAL, INC. SUPERFUND SITE

WELL NUMBER	TOP OF CASING ELEVATION (ft above msl)	WELL DEPTH (ft)	SCREENED INTERVAL (ft) AND MATERIAL TYPE[1]								WELL TYPE
			Shallow Probes	Material Type	Intermediate Probes	Material Type	Deep Probes	Material Type	RI Probes	Material Type	
VW-35	(2)	38	5-10	F	--	--	33-38	N	--	--	Perimeter
VW-36	(2)	30	5-10	F	--	--	25-30	N	--	--	Perimeter
VW-37	(2)	30	7-10	F	--	--	25-30	N	--	--	Perimeter
VW-38	(2)	35	5-10	F	--		29-34	N	--	--	Perimeter
VW-39	(2)	30	5-7	F	--	--	25-30	N	--	--	Perimeter
VW-46	(2)	30	4.5-6.5	F	12-15	N	22-27	N	--	--	Building Perimeter
VW-62	(2)	31	5-10	N	15-18	N	25-30	N	--	--	Building Perimeter
VW-41	(2)	30	5-7	F	--	--	15-20	N	--	--	Perimeter
VW-42	(2)	30	5-10	F	--	--	25-30	N	--		Perimeter
VW-29	(2)	35	7-10	F	18-23	N	30-35	N	--	--	Perimeter
VW-30	(2)	35	5-7	F	18-23	N	30-35	N			Perimeter
VW-51	(2)	35	5-8	F	13-18	W	25-30	N	--		Building Perimeter
VW-31	(3)	35	5-10	F	--	--	25-30	N	--	--	Perimeter
VW-25	156.7	35		--	--	--	--	--	5-35	A	Interior
VW-32	(2)	35	4.5-7.5	F	13-18	N	30-36	N	--	--	Perimeter
VW-33	(2)	35	5-10	F	--	--	30-35	N	--	--	Perimeter
VW-34	(2)	45	5-10	F	18-23	N	35-40	N	--	--	Perimeter
VW-48	(2)	35	5-10	F	15-18	F	25-30	N	--	--	Building Perimeter
VW-55	(2)	31	5-10	F,W	16-18	N	25-30	N	--	--	Building Perimeter
VW-66	(2)	31	5-8	F	16-20	N	25-30	N	--	--	Building Perimeter
VW-58	(2)	31	5-8	F	14-19	N	24-29	N	--	--	Building Perimeter
VW-61	(2)	34	5-9	F	14-18	N	25-30	N	--	--	Building Perimeter

(1) Material type: F = Fill Material, W = Waste Material, N = Native Material, A = All Material (fill, waste and native).
(2) Top of casing elevation not surveyed.
-- = Not Applicable.

SCHEDULE OF BIOVENT WELLS TO BE CONSTRUCTED

WELL NUMBER	SURFACE ELEVATION, ft msl (approximate)	TOP OF SCREEN[1] ELEVATION (ft, msl)	BOTTOM OF WELL SCREEN[2] ELEVATION (ft, msl)
BW-1	162.0	156.0	148.0
BW-2	161.5	155.5	146.5
BW-3	155.5	149.5	136.5
BW-4	156.4	150.5	142.0
BW-5	158.7	152.7	132.7
BW-6	161.7	155.7	140.7
BW-7	157.7	151.7	132.7
BW-8	157.5	149.5	134.5
BW-9	156.8	150.8	138.8
BW-10	158.8	150.8	131.8
BW-11	157.8	151.8	138.0
BW-12	160.5	152.5	138.0
BW-13	158.0	152.0	142.0
BW-14	160.5	153.5	135.6
BW-15	158.8	152.8	142.8
BW-16	157.5	151.5	147.5[3]
BW-17	158.2	152.2	148.2[3]
BW-18	158.5	152.6	148.5[3]
BW-19	158.0	152.0	148.0[3]
BW-20	157.5	151.5	139.6
BW-21	154.7	148.7	142.7
BW-22	155.5	149.5	140.5
BW-23	158.5	153.0	138.0
BW-24	156.5	149.5	130.5
BW-25	155.2	149.2	132.7

(1) MINIMUM OF 6 FT. FROM GROUND SURFACE TO ALLOW PLACEMENT OF SAND FILTER, BENTONITE SEAL, AND 1 FT. OF CEMENT GROUT TO BE PLACED ABOVE TOP OF SCREEN
(2) ELEVATION TO BOTTOM OF WELL SCREEN IS A MAXIMUM. WELL LENGTH MAY BE INCREASED BY A NOMINAL AMOUNT TO ACCOMMODATE CASING LENGTH.
(3) SCREEN LENGTH OF 4 FT. USED. NO WASTE WITHIN 20 FT. OF THIS LOCATION.

SCHEDULE OF EXISTING GROUND WATER MONITORING WELLS TO BE RETAINED FOR MONITORING WASTE DISPOSAL, INC. SUPERFUND SITE

WELL NUMBER	TOP OF WELL CASING ELEVATION (ft above msl)	WELL DEPTH	WELL SCREEN (ft bgs)	WELL TYPE
GW-01	153.5	Shallow	38 - 58	Background Well
GW-02	149.3	Shallow	33 - 53	Background Well
GW-10	164.7	Shallow	38 - 58	Near-Source Detection Well
GW-11	154.7	Deep	118 - 128	Background Well
GW-22	156.7	Shallow	58 - 78	Point-of-Compliance Well
GW-23	157.0	Shallow	43 - 63	Point-of-Compliance Well
GW-26	156.0	Shallow	44 - 64	Point-of-Compliance Well
GW-27	157.0	Shallow	43 - 63	Verification or Guard Well
GW-29	157.4	Shallow	44 - 64	Verification or Guard Well
GW-30	156.8	Deep	74 - 94	Verification or Guard Well
GW-32	153.6	Deep	115-125	Background Well
GW-33	163.7	Shallow	35-60	Near-Source Detection Well

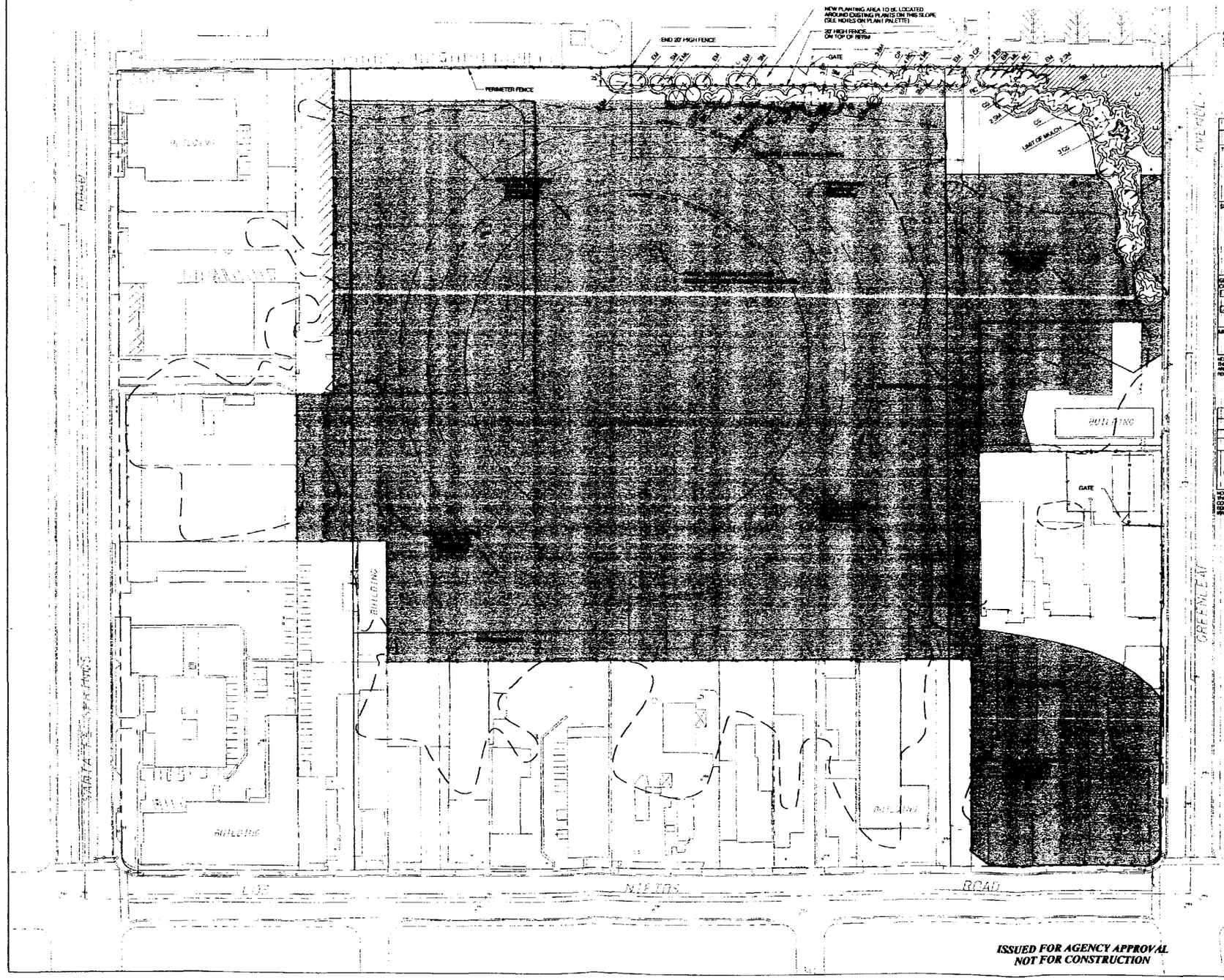
ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

D	3/25/03	ISSUED FOR 100% REMEDIAL DESIGN - AGENCY APPROVAL	JRS	
C		ISSUED FOR AGENCY REVIEW	JRS	
B		ISSUED FOR 90% REVIEW	JRS	
A		ISSUED FOR "OVER THE SHOULDER" REVIEW	JRS	

WASTE DISPOSAL, INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUNDWATER REMEDIAL DESIGN
SANTA FE SPRINGS, CALIFORNIA

BIOVENT WELL, VAPOR MONITORING WELL AND GROUND WATER MONITORING WELL DETAILS

30747 | AS NOTED | E-30747-SG013
TRC | D | 13



ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

PLANT PALETTE (SEE NOTE 1)

KEY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING	QUANTITY
TREES:					
CS	CERATONIA SILIQUA	CAROB TREE	15 GAL.	VARIABLE	8
EM	EUCALYPTUS MICROTHECA	COOLIBAH TREE	15 GAL.	VARIABLE	10
SM	SCHINUS MOLLE	CALIFORNIA PEPPER TREE	15 GAL.	VARIABLE	13
SHRUBS:					
CP	COTONEASTER PARNEYI	RED CLUSTERBERRY	5 GAL.	VARIABLE	11
EP	ELAEAGNUS PUNGENS	SILVERBERRY	5 GAL.	VARIABLE	9
ML	MYOPORUM LAETUM	(NO COMMON NAME)	5 GAL.	VARIABLE	22
RC	RHAMNUS CALIFORNICA	CALIFORNIA COFFEEBERRY	5 GAL.	VARIABLE	6
GROUND COVER:					
AR	ACACIA REDOLENS	PROSTRATE ACACIA	1 GAL.	VARIABLE	84
LJ	LONICERA JAPONICA "HALLIANA"	HALL'S HONEYSUCKLE	FLATS	18" O/C	5,580
MULCH	A 3 INCH DEEP LAYER OF FULLY COMPOSTED MULCH SHALL BE APPLIED AROUND NEW PLANTINGS AS INDICATED ON PLAN				250 CY

NOTES:
THESE PLANTS WILL CREATE A DENSE VISUAL SCREEN BETWEEN THE SITE REMEDIATION AREA AND THE EXISTING HIGH SCHOOL AND RESIDENTIAL AREAS. PLANTINGS WILL REQUIRE OCCASIONAL SUPPLEMENTAL IRRIGATION DURING SUMMER MONTHS.

PLANTS TO BE ESTABLISHED FROM SEED (SEE NOTE 1)

SEED MIX: MIXED GRASSES AND DROUGHT-TOLERANT SHRUBS

DROUGHT-TOLERANT SHRUBS TO INCLUDE:

BOTANICAL NAME	COMMON NAME
ACHILLEA MILLEFOLIUM	YARROW
ATRIPLEX GEMBACCATA	CREEPING SALTBUSH
ERIOGONUM FASCICULATUM	EASTERN MOJAVE BUCKWHEAT
ESCHSCHOLZIA CALIFORNICA	CALIFORNIA POPPY
LUPINUS HIMIUS	SKY LUPINE
MIMULUS LONGIFLORUS	MONKEY FLOWER

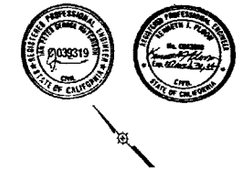
NOTES:
THESE PLANTS WILL PROVIDE EROSION PROTECTION FOR THE PORTION OF THE SITE COVERED WITH THE RCRA SUBTITLE C - EQUIVALENT CAP AND THE RCRA SUBTITLE D - EQUIVALENT CAP. AS WELL, YEAR ROUND VEGETATION WITH NO SUPPLEMENTAL IRRIGATION.

LEGEND

- AREA OF PLANTS TO BE ESTABLISHED FROM SEED
- EXISTING FENCE
- NEW PROJECT PERIMETER FENCE
- NEW STRAY BALL FENCE

NOTES

1. CONTRACTOR TO SUBMIT IRRIGATION PLAN FOR PLANTS THAT ARE DROUGHT TOLERANT BUT REQUIRE INITIAL WATER TO TAKE HOLD. SEE SECTION 02810 OF THE SPECIFICATIONS FOR SUBMITTAL REQUIREMENTS.
2. NO TREES OR SHRUBS TO BE PLANTED OVER AREAS COVERED WITH RCRA SUBTITLE C & D COVERS.



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C	10/8/01	ISSUED FOR AGENCY REVIEW	KJK	KR
B	9/28/01	ISSUED FOR 90% REVIEW	JRS	RCB
A	7/26/01	ISSUED FOR 30% PRELIMINARY REVIEW	JRS	RCB
No.	Date	Revision	Drawn by	Approved by

Drawn by: J. R. SANDERS | Checked by: | Approved by:

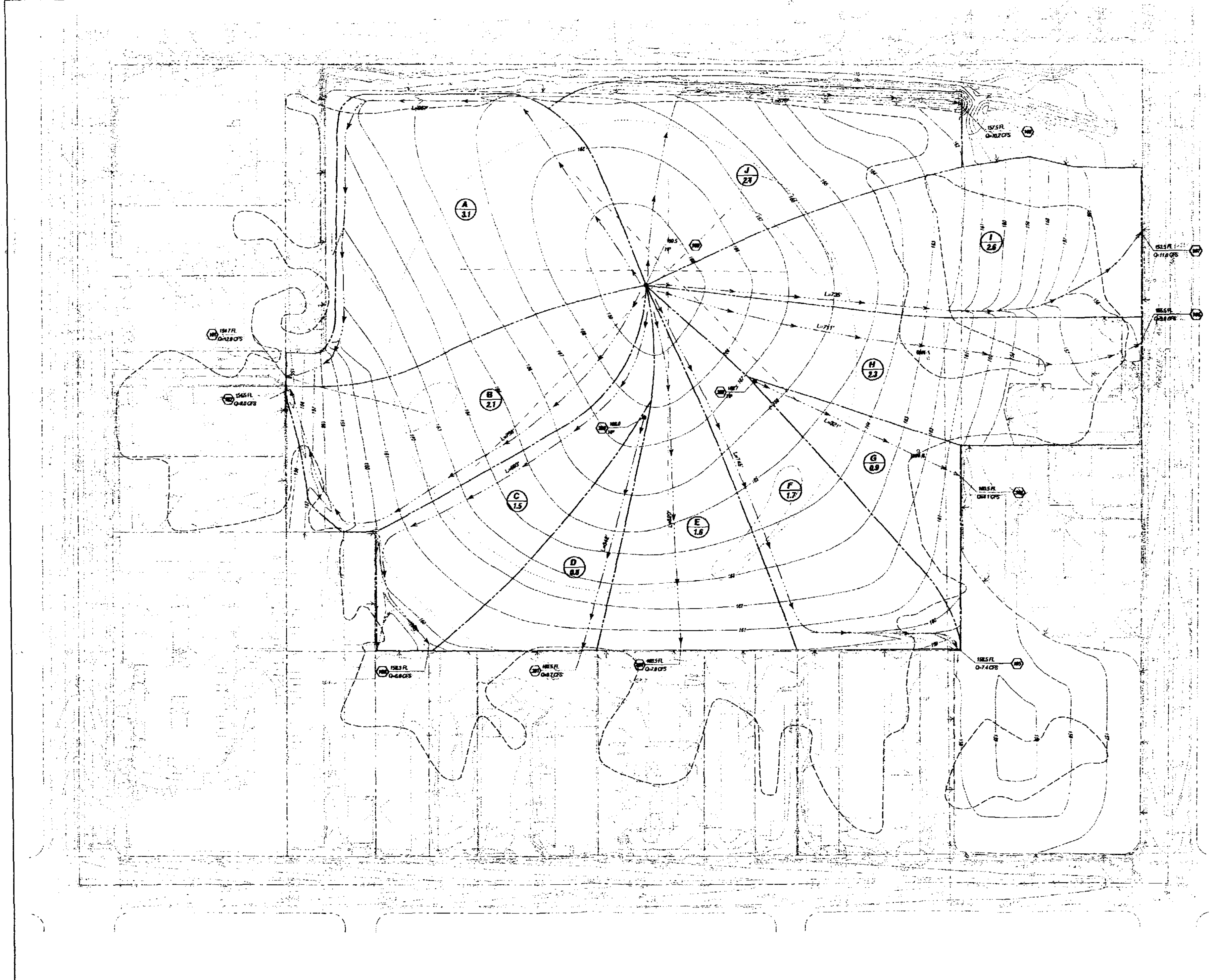
WASTE DISPOSAL INC. SUPERFUND SITE
SOIL, SUBSURFACE GAS AND GROUNDWATER REMEDIAL DESIGN

SANTA FE SPRINGS CALIFORNIA

LANDSCAPING AND FENCING PLAN

Job No.	Scale	Drawing No.
30747	AS NOTED	E-30747-SG006

TRC | Revision D | Sheet 14



LEGEND

D / 0.5	SUBAREA NUMBER / SUBAREA ACREAGE
160.5 FL	ELEVATION AT NODE
(hexagon)	NODE NUMBER
Q=9.4 CFS	Q AT NODE (100 YEAR STORM)
HP	HIGH POINT
L=415'	LENGTH OF FLOW PATH

0 50 100 FEET
SCALE

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION		
D	3/25/03	ISSUED FOR 100% REMEDIAL DESIGN - AGENCY APPROVAL	JRS	KR
C	[illegible]	ISSUED FOR AGENCY REVIEW	KJK	KB
B	[illegible]	ISSUED FOR 90% REVIEW ONLY NOT FOR CONSTRUCTION	ABC	AEB
A	[illegible]	ISSUED FOR OVER THE SHOULDER REVIEW	AEC	AEB

A.E. CORNEJO

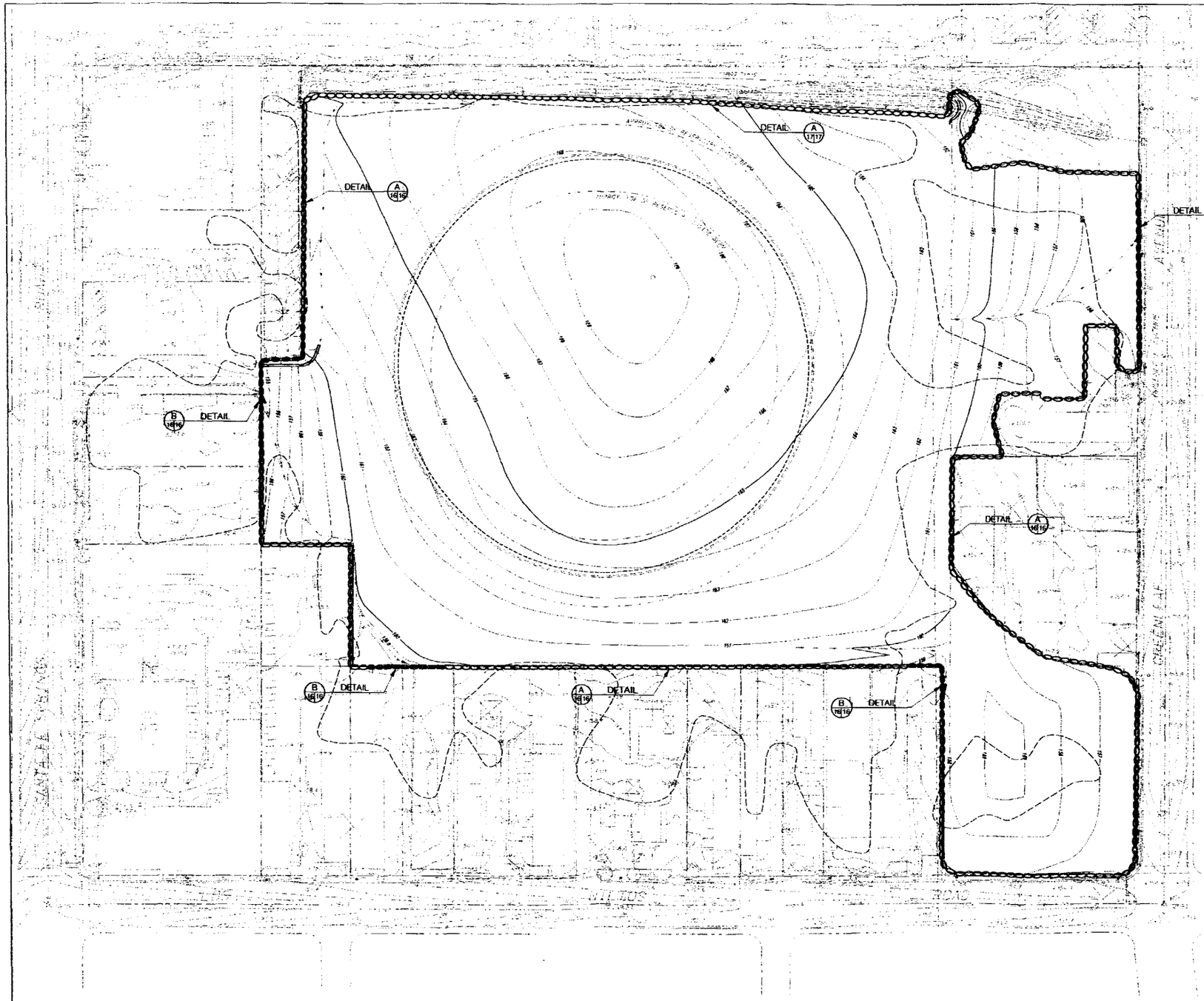
WASTE DISPOSAL, INC., SUPERFUND SITE
SOILS, SUBSURFACE GAS AND GROUND WATER REMEDIAL DESIGN

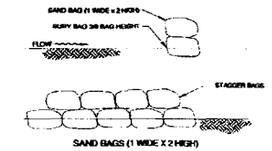
SANTA FE SPRINGS CALIFORNIA

HYDROLOGY MAP
100 YEAR STORM

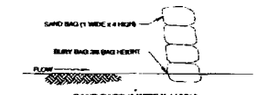
JOB NO.	SCALE	DRAWING NO.
30747	1" = 50'	E-30747-SG021

	REVISION	SHEET
TRC	D	15

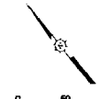




DETAIL A 16/16
NOT TO SCALE



DETAIL B 16/16
NOT TO SCALE



0 50 100 FEET
SCALE

D	3/23/01	ISSUED FOR THIS REVISED DESIGN - AGENCY APPROVAL	JTG	HS
C	1/2/01	ISSUED FOR AGENCY REVIEW	SJK	HS
B	10/31/00	ISSUED FOR RPL REVIEW ONLY NOT FOR CONSTRUCTION	HEC	ASB
A	12/28/99	ISSUED FOR "OWN THE INDUSTRY" REVIEW	ALC	ASB
REV	DATE	DESCRIPTION	DRAWN BY	APPR BY

DRAWN BY A.C. CORNEJO ISSUED BY APPROVED BY

WASTE DISPOSAL, INC., SUPERFUND SITE
SOIL & SUBSURFACE CAP AND
GROUND WATER REMEDIAL DESIGN

SANTA FE SPRINGS, CA CALIFORNIA

CONSTRUCTION EROSION CONTROL PLAN

JOB NO.	SCALE	DRAWING NO.
30747	1"=50'	E-30747-SG022

TRC

REVISION D SHEET 16

ISSUED FOR AGENCY APPROVAL
NOT FOR CONSTRUCTION

APPENDIX H

DESIGN CALCULATIONS

H.1 Hydrology and Storm Drain Hydraulics
H.2 Gas Flow Capacity
H.3 Blower Noise Level Analysis
H.4 Soil Loss Calculation
H.5 Cover Infiltration Analysis
H.6 Contingency Foundation Design (Geogrid Foundation)
H.7 Asphalt Structural Section Design
H.8 Concrete Structural Section Design
H.9 Flow Capacity of Geocomposite Drain Layer
H.10 Pipe Size Calculation for Drain Layer Outlet
H.11 Perforated Pipe Capacity
H.12 WDI Statistical Analysis of Soil Data

APPENDIX H.1

HYDROLOGY AND STORM DRAIN HYDRAULICS

TRC
Customer-Focused Solutions

WASTE DISPOSAL SUPERFUND SITE
SANTA FE SPRINGS, CA

HYDROLOGY
AND
STORM DRAIN HYDRAULICS

Prepared By:
TRC, INC.
21 TECHNOLOGY DRIVE
IRVINE, CA 92618
(949) 727-7354

JOB NO. 30747
March 19, 2003
Final (100%) Design Submittal

Originated by KM
Checked by TLP
# of pages 22

SUBJECT INDEX:

Discussion

Proposed Hydrology (100 year storm)

Proposed Hydraulics (100 year storm)

Berm Sizing Calculations

Inlet Basin Sizing

Hydrology Map

DISCUSSION

Project Description

The waste disposal Inc. site is located on the corner of Greenleaf Avenue and Los Nietos Road in the City of Santa Fe Springs, California. The site is a superfund site that contains a 42 million gallon concrete reservoir that had been filled with crude petroleum, wastes, and solid fill material. The reservoir was closed in 1964 and has been filled over with clean soil ranging from 5 to 15 feet in height.

The final remedy for this site includes general site grading to enhance the storm water runoff of the site.

Purpose

The purpose of this study is to compute the peak storm water runoff due to a 100-year storm event for the proposed condition and provide hydrology design information required for Los Angeles County Department of Public Works (LACDPW) to approve before connecting the projects storm drain system to the County storm drain facility. The existing hydrology was not analyzed due to the proposed grading being designed to maintain the same drainage patterns and boundaries as the existing condition.

The proposed flows from the hydrology study were used to size the proposed earthen berms and drainage piping that will be used on the site to convey the storm water runoff to specific discharge locations. There have been no changes to location of these specific discharge points between the existing and proposed conditions. The proposed flows were also used to check the capacity of the existing berms and ditches onsite.

Design Aids

LACDWP Small Area Method (LACDPW Hydrology Manual, December 1991; see Attachment) was used to calculate the 50-year storm runoff for the each of the drainage area hydrology calculations. The spreadsheet program provided by LACDPW through the internet was used with site specific data. As noted in the Manual, the small area method tends to calculate peak flow rates higher than those that would be calculated using, for example, the Rational Method.

Since the LACDPW spreadsheet program calculates the 50-year storm runoff only, Orange County's Rational Method program was used to calculate a relationship between the peak flow of 100 year and 50 year storms. The calculated relationship was then applied to the 50-year peak runoff to determine the 100-year peak runoff as shown in Table #1.

LACDWP data was also used to determine the 100 year 24-hour storm intensity (LACDPW Rainfall Frequency Analysis Report; April 1997). The 100 year 24 hour storm for the area is 5.4 inches.

Flow Master by Haestad Methods, Inc. was used for the hydraulic

calculations of the 15" pvc pipe. HELE1 by Advanced Engineering Software was used to calculate the berm sizes.

Results

The results of the 100-year stormwater runoff volumes are presented in Table 1 and in the attached hydrology map.

The results of the hydraulic calculations for 15" PVC pipe to convey runoff from Area J out to the stormdrain on Greenleaf Avenue indicates that such a pipe would be only 85% full under the 100 year condition. However, a 16" pipe was selected to avoid the need to manufacture custom pipe.

The HELE1 software indicates that a 1.5 ft high berm is okay with a safety factor of 2 (i.e., flow depth is less than 0.75 ft from each of the areas requiring a bermed ditch.

Los Angeles County Department of Public Works

HYDROLOGY MANUAL

Hydraulic/Water Conservation Division
December 1991

T. A. Tidemanson, Director

900 South Fremont Avenue
Alhambra, California 91803

4. RUNOFF CALCULATION METHODS

A. SELECTING THE PROPER METHOD

The Department uses two basic methods for converting rainfall to runoff, depending on the conditions. There are also three simplified versions of one of the basic methods. Some of these methods are available as software for use on a personal computer. See Section 6 for which programs are available for purchase. Choose a runoff method based on the following tables:

BASIC METHODS	USAGE
Modified Rational	For any size watershed; for any combination of laterals; for any combination of developed and undeveloped drainage areas; to create a hydrograph at any location and find the volume of runoff; to find peak subarea flow rates as well as peak mainline flow rates; recommended method for systems incorporating pumping or water impoundment.
Mountain Hydrology	For gaged, mountainous, undeveloped watersheds only; for watersheds with at least one raingage that records representative storms; for the PMP or 50-Year Frequency Design Storms; to find volume of runoff for sizing reservoirs.

There are three simplified versions of the Modified Rational Method:

SIMPLIFIED METHODS	USAGE
Rational	For drainage areas less than 100 acres only; to find the peak flow rate only; to find peak flow rates within a subarea; for any Department design storm; for developed and undeveloped watersheds; as a computerized option for finding times of concentration; does not create a hydrograph; does not find volume of runoff.
Small Developed Drainage Areas	For drainage areas less than 10 acres only; to find the peak flow in the mainline only; for the 10-year, 25-year, and 50-year design storms only; for developed watersheds only; does not create a hydrograph; does not find volume of runoff; tends to create peak flow rates higher than those from either Modified Rational or Rational methods
Urban Flood Q Equation	For any size watershed; to find the total peak flow for a combined drain and street urban system; for the 25-year design storm only; for developed watersheds only; does not create a hydrograph; does not find volume of runoff; for use with the hand calculation versions of the Modified Rational and Rational Methods.

D. SMALL DEVELOPED DRAINAGE AREA METHOD

D-1. Application

This method is a further simplification of the Modified Rational Method, applicable only to developed areas with total drainage areas of 10 acres or less. Runoff coefficients are generalized into two categories, Group A and Group B, and the rainfall zones are I, J, K, L, and M. The rainfall frequencies are limited to the Department's 50-Year, 25-Year, and 10-Year Frequency Design Storms.

The peak flow rate developed from this method tends to be larger than the flow rate developed from the Modified Rational or Rational Method for the same area. Also, this method does not produce a hydrograph. You may therefore prefer to use one of the other methods; however, this method is a much simpler procedure for finding peak runoff rates when the private engineer does not need to use the other, more detailed, methods.

D-2. Developing Input Data for the Small Developed Area Method

Use the following procedure for developing the input data for calculating peak Q's with the Small Developed Area Method:

(1) Outline the drainage area boundaries on a scaled topographic map and measure the area in acres.

(2) Determine the predominant soil type and the rainfall zone for the area from the maps in Appendix A.

(3) Determine if the project should be designed for the Capital Flood or the Urban Flood, as described by the Level of Protection policies in Section 2.

D-3. Finding the Peak Runoff Rate

(See the example in Appendix L)

Follow these steps using the tables in Appendix M to determine the peak runoff rate:

(1) From the soil type at your site, determine which group, A or B, applies to your project. The "Runoff Coefficient Curve Number," RC, is the same as the soil type number.

(2) From the Runoff Coefficient Group, find the peak Capital Flood flow rate for your rainfall zone and the drainage area size closest to yours. Interpolate to find the flow for your drainage area. This is the peak flow at the outlet.

(3) If your project requires protection from an Urban Flood, multiply the peak Capital Flood flow rate by the appropriate factor shown in the table. Multiply the Capital Flood flow rate by the 10-year flood factor to get the drain flow rate.

Los Angeles County Department of Public Works

RAINFALL FREQUENCY ANALYSIS

REPORT

Water Conservation Division

April 1997

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
Gumbel Extreme Value Type 1 Rainfall Frequency Analysis
STANDARD RAINGAGE RESULTS

Raingage No. 106 - WHITTIER CITY YARD

24 Hour Duration

Frequency (years)	Rainfall Depth (inches)
500.00	6.62
200.00	5.93
100.00	5.40
50.00	4.87
25.00	4.33
10.00	3.61
5.00	3.05
2.33	2.35
2.00	2.18
1.01	0.75
Mean:	2.3449
Standard Deviation:	0.9735

Number of Events:	**68**
Begin Date:	2/4/28
End Date:	1/10/95
# of Missing Seasons:	0
Missing Seasons:	N/A
Latitude:	33° 58' 57"
Longitude:	118° 2' 50"
Elevation:	300'

Raingage No. 107 - DOWNEY - FIRE DEPARTMENT

24 Hour Duration

Frequency (years)	Rainfall Depth (inches)
500.00	7.17
200.00	6.40
100.00	5.82
50.00	5.24
25.00	4.65
10.00	3.85
5.00	3.23
2.33	2.45
2.00	2.28
1.01	0.69
Mean:	2.4524
Standard Deviation:	1.0738

Number of Events:	**70**
Begin Date:	4/5/26
End Date:	1/10/95
# of Missing Seasons:	0
Missing Seasons:	N/A
Latitude:	33° 55' 48"
Longitude:	118° 8' 47"
Elevation:	110'

PROPOSED HYDROLOGY

(100-YEAR STORM)

HYDROLOGY CALCULATIONS
FOR
WASTE DISPOSAL SUPERFUND SITE

12/27/02

SUBAREA DATA		CLOSEST +/- 0.5 ACRE FLOW FROM CHART				ACTUAL SUBAREA PEAK RUNOFF			
NO.	AREA (ac.)	AREA (ac.)	Q-50 (cfs)	AREA (ac.)	Q-50 (cfs)	Q-100 (cfs)	Q-50 (cfs)	Q-25 (cfs)	Q-10 (cfs)
A	3.1 ac	3.0 ac	11.0 cfs	3.5 ac	13.0 cfs	12.9 cfs	11.4 cfs	9.7 cfs	7.9 cfs
B	2.1 ac	2.0 ac	7.6 cfs	2.5 ac	9.4 cfs	9.0 cfs	8.0 cfs	6.8 cfs	5.5 cfs
C	1.5 ac	1.5 ac	5.8 cfs	2.0 ac	7.6 cfs	6.6 cfs	5.8 cfs	5.0 cfs	4.0 cfs
D	0.8 ac	0.5 ac	2.1 cfs	1.0 ac	4.0 cfs	3.7 cfs	3.2 cfs	2.8 cfs	2.3 cfs
E	1.6 ac	1.5 ac	5.8 cfs	2.0 ac	7.6 cfs	7.0 cfs	6.2 cfs	5.3 cfs	4.3 cfs
F	1.7 ac	1.5 ac	5.8 cfs	2.0 ac	7.6 cfs	7.4 cfs	6.5 cfs	5.6 cfs	4.5 cfs
G	0.9 ac	0.5 ac	2.1 cfs	1.0 ac	4.0 cfs	4.1 cfs	3.6 cfs	3.1 cfs	2.5 cfs
H	2.3 ac	2.0 ac	7.6 cfs	2.5 ac	9.4 cfs	9.8 cfs	8.7 cfs	7.4 cfs	6.0 cfs
I	2.6 ac	2.5 ac	9.4 cfs	3.0 ac	11.0 cfs	11.0 cfs	9.7 cfs	8.3 cfs	6.8 cfs
J	2.4 ac	2.0 ac	7.6 cfs	2.5 ac	9.4 cfs	10.2 cfs	9.0 cfs	7.7 cfs	6.3 cfs

ASSUMPTIONS:

Los Angeles County Department of Public Works Small Area Method

Rainfall Zone	K
Soil Type	013
Runoff Coef. Group	B

PROPOSED HYDRAULICS

(100-YEAR STORM)

15" PVC PIPE
Worksheet for Circular Channel

Project Description	
Project File	c:\haestad\fmw\wdi.fm2
Worksheet	WASTE DISPOSAL INC. SUPERFUND SITE
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.011	
Channel Slope	0.016700	ft/ft
Diameter	15.00	in
Discharge	10.20	cfs

Results		
Depth	1.07	ft
Flow Area	1.12	ft^2
Wetted Perimeter	2.95	ft
Top Width	0.88	ft
Critical Depth	1.19	ft
Percent Full	85.39	OK
Critical Slope	0.015468	ft/ft
Velocity	9.14	ft/s
Velocity Head	1.30	ft
Specific Energy	2.37	ft
Froude Number	1.43	
Maximum Discharge	10.61	cfs
Full Flow Capacity	9.87	cfs
Full Flow Slope	0.017853	ft/ft
Flow is supercritical.		

BERM SIZING CALCULATIONS

(100-YEAR STORM)

```
*****************************************************************************
                HYDRAULIC ELEMENTS - I  PROGRAM PACKAGE
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                          Analysis prepared by:

                              TRC Solutions
                           21 Technology Drive
                             Irvine, CA 92618
                              (949) 727-9336

-----------------------------------------------------------------------------
  TIME/DATE OF STUDY: 15:06 12/04/2002
=============================================================================
 Problem Descriptions:
  Area 'A' Berm Sizing
  Waste Disposal Superfund Site
  Prepared By: KJM
*****************************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
-----------------------------------------------------------------------------
    CHANNEL Z1(HORIZONTAL/VERTICAL) =    2.00
            Z2(HORIZONTAL/VERTICAL) =   50.00
    BASEWIDTH(FEET) =     1.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.010000
    UNIFORM FLOW(CFS) =       12.90
    MANNINGS FRICTION FACTOR = 0.0250
=============================================================================
    NORMAL-DEPTH FLOW INFORMATION:
-----------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =  0.45  < 1.5' ∴ OK (SEE SECTION A-A')
    FLOW TOP-WIDTH(FEET) =        24.51
    FLOW AREA(SQUARE FEET) =           5.76
    HYDRAULIC DEPTH(FEET) =     0.24
    FLOW AVERAGE VELOCITY(FEET/SEC.) =     2.24
    UNIFORM FROUDE NUMBER =    0.813
    PRESSURE + MOMENTUM(POUNDS) =          112.27
    AVERAGED VELOCITY HEAD(FEET) =      0.078
    SPECIFIC ENERGY(FEET) =      0.530
=============================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
-----------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =        22.51
    CRITICAL FLOW AREA(SQUARE FEET) =           4.86
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =     0.22
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =     2.65
    CRITICAL DEPTH(FEET) =     0.41
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =          109.94
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =      0.109
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =      0.523
=============================================================================
```

```
*****************************************************************************
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                          Analysis prepared by:

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                              (949) 727-9336

-----------------------------------------------------------------------------
  TIME/DATE OF STUDY: 15:08 12/04/2002
=============================================================================
 Problem Descriptions:
  Area 'C' Berm Sizing
  Waste Disposal Superfund Site
  Prepared By: KJM
*****************************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
-----------------------------------------------------------------------------
    CHANNEL Z1(HORIZONTAL/VERTICAL) =    2.00
            Z2(HORIZONTAL/VERTICAL) =   30.00
    BASEWIDTH(FEET) =     0.10
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.010000
    UNIFORM FLOW(CFS) =        6.60
    MANNINGS FRICTION FACTOR = 0.0200
=============================================================================
    NORMAL-DEPTH FLOW INFORMATION:
-----------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =  0.40  < 1.5' ∴ OK (SEE SECTION C-C')
    FLOW TOP-WIDTH(FEET) =        12.86
    FLOW AREA(SQUARE FEET) =            2.58
    HYDRAULIC DEPTH(FEET) =     0.20
    FLOW AVERAGE VELOCITY(FEET/SEC.) =     2.56
    UNIFORM FROUDE NUMBER =    1.005
    PRESSURE + MOMENTUM(POUNDS) =            54.27
    AVERAGED VELOCITY HEAD(FEET) =      0.101
    SPECIFIC ENERGY(FEET) =      0.500
=============================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
-----------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =        12.88
    CRITICAL FLOW AREA(SQUARE FEET) =            2.59
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =     0.20
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =     2.55
    CRITICAL DEPTH(FEET) =     0.40
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =            54.27
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =      0.101
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =      0.500
=============================================================================
```

```
*****************************************************************************
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                          Analysis prepared by:

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                             Irvine, CA 92618
                              (949) 727-9336

-----------------------------------------------------------------------------
  TIME/DATE OF STUDY: 15:09 12/04/2002
=============================================================================
 Problem Descriptions:
  Existing Channel Size Check (Area 'J')
  Waste Disposal Superfund Site
  Prepared By: KJM
*****************************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
-----------------------------------------------------------------------------
    CHANNEL Z1(HORIZONTAL/VERTICAL) =     3.00
            Z2(HORIZONTAL/VERTICAL) =     3.00
    BASEWIDTH(FEET) =      2.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.015000
    UNIFORM FLOW(CFS) =        10.20
    MANNINGS FRICTION FACTOR = 0.0250
=============================================================================
    NORMAL-DEPTH FLOW INFORMATION:
-----------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =   0.64  < 2'  MIN. DEPTH OF CHANNEL = 2'
    FLOW TOP-WIDTH(FEET) =          5.86                          ∴ OK
    FLOW AREA(SQUARE FEET) =            2.53
    HYDRAULIC DEPTH(FEET) =      0.43
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      4.04
    UNIFORM FROUDE NUMBER =    1.084
    PRESSURE + MOMENTUM(POUNDS) =           122.20
    AVERAGED VELOCITY HEAD(FEET) =       0.253
    SPECIFIC ENERGY(FEET) =       0.896
=============================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
-----------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =          6.03
    CRITICAL FLOW AREA(SQUARE FEET) =            2.69
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =      0.45
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =      3.79
    CRITICAL DEPTH(FEET) =      0.67
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =           121.82
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =       0.223
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       0.894
=============================================================================
```

INLET BASIN SIZING

(100-YEAR STORM)

"ONSITE INLET"

CAPACITY GRATE INLETS

GRATE SIZE	AREA * (A)	PERIMETER* (P)	HEAD (FT) (H)	CAPACITY (cfs) (ORIFICE)	CAPACITY (cfs) (WEIR)
24"X36"	2.25	5.00	0.10	3.82	0.47
	2.25	5.00	0.20	5.40	1.34
	2.25	5.00	0.30	6.62	2.46
	2.25	5.00	0.40	7.64	3.79
	2.25	5.00	0.50	8.54	5.30
12"X12"	0.38	2.00	0.10	0.65	0.19
	0.38	2.00	0.20	0.91	0.54
	0.38	2.00	0.30	1.12	0.99
	0.38	2.00	0.40	1.29	1.52
	0.38	2.00	0.50	1.44	2.12
18"X18"	0.84	3.00	0.10	1.43	0.28
	0.84	3.00	0.20	2.02	0.80
	0.84	3.00	0.30	2.47	1.48
	0.84	3.00	0.40	2.85	2.28
	0.84	3.00	0.50	3.19	3.18
24"X24"	1.50	4.00	0.10	2.55	0.38
	1.50	4.00	0.20	3.60	1.07
	1.50	4.00	0.30	4.41	1.97
	1.50	4.00	0.40	5.09	3.04
	1.50	4.00	0.50	5.70	4.24
	1.50	4.00	1.00	8.06	12.00
	1.50	4.00	1.50	9.87	22.05
	1.50	4.00	2.00 1	11.39 2	33.94
36"X36"	3.38	6.00	0.10	5.74	0.57
	3.38	6.00	0.20	8.12	1.61
	3.38	6.00	0.30	9.94	2.96
	3.38	6.00	0.40	11.48	4.55
	3.38	6.00	0.50	12.83	6.36
48"X48"	6.00	8.00	0.10	10.19	0.76
	6.00	8.00	0.20	14.41	2.15
	6.00	8.00	0.30	17.65	3.94
	6.00	8.00	0.40	20.38	6.07
	6.00	8.00	0.50	22.78	8.49

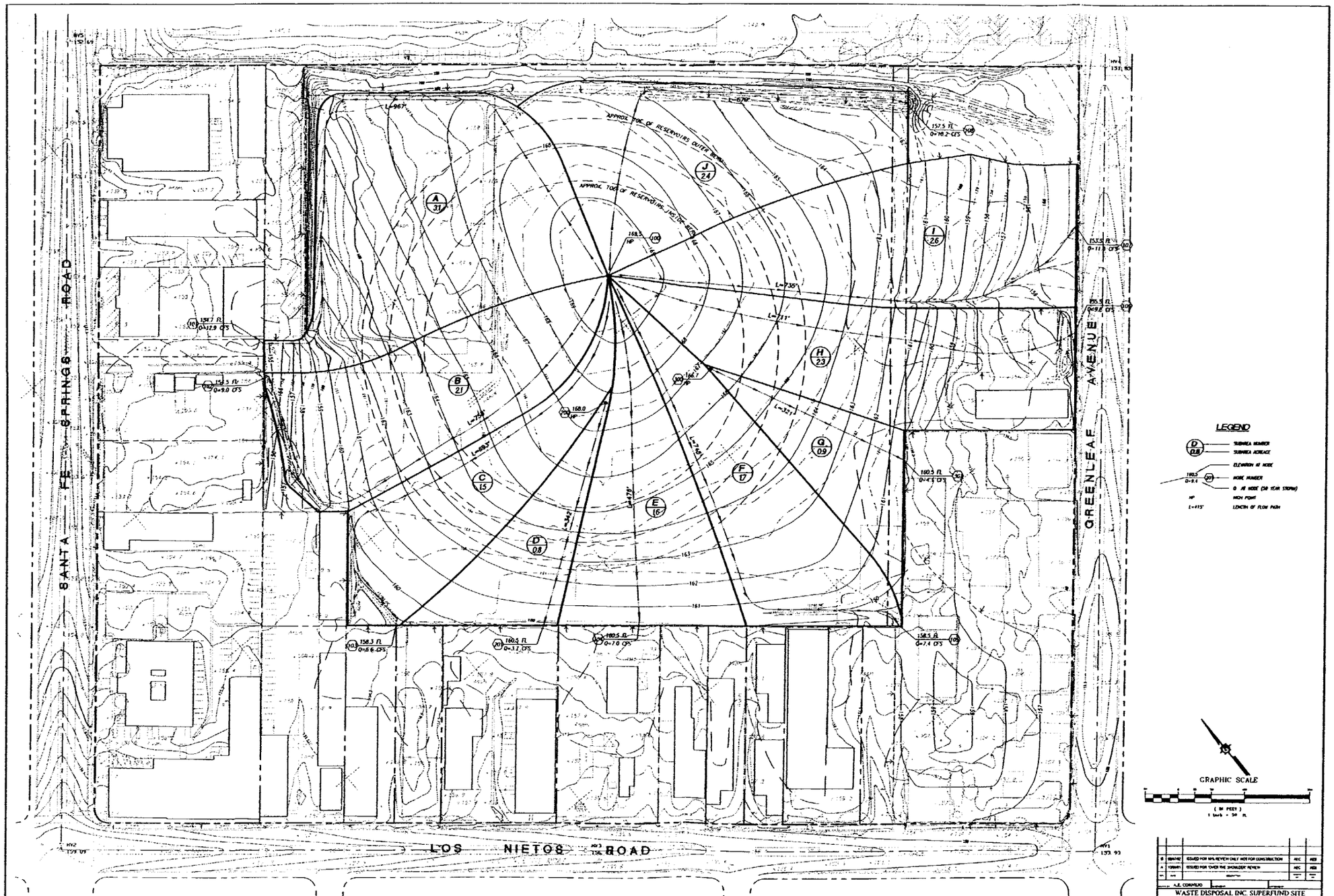
* ASSUME 50% CLOGGING

** BASED ON BUREAU OF PUBLIC ROADS CHART "CAPACITY OF GRATE INLET IN SUMP WATER PONDED ON GRATE"

1. 10.2 < 11.4 CFS (100 YR STORM)

2. 2' < 4' (EXIST. CHANNEL DEPTH)

HYDROLOGY MAP



ISSUED FOR 90% REVIEW ONLY
NOT FOR CONSTRUCTION

B	08/04/02	ISSUED FOR 90% REVIEW ONLY NOT FOR CONSTRUCTION	AEC	AEB
A	12/06/01	ISSUED FOR 'OVER THE SHOULDER' REVIEW	AEC	AEB
NO.	DATE	DESCRIPTION	DRAWN	CHECKED

A.E. CORNEJO

WASTE DISPOSAL INC. SUPERFUND SITE
SOILS, SUBSURFACE GAS AND
GROUND WATER REMEDIAL DESIGN

SANTA FE SPRINGS CALIFORNIA

HYDROLOGY MAP
100 YEAR STORM

30747	1" = 50'	30747exSbt20
TRC	B	20

TABLE 1

WDI NOISE CALCULATIONS

Site Number	Site Name	Site Type	County	City/Town	Distance to Nearest Receptor (1) (feet)	Land Use Category (2)	Estimated Ambient Noise Level (3) (dBA)	Noise Levels: Construction: Threshold / Restriction	Construction: Citation	Construction: Estimated Maximum Noise Level at the Nearest Receptor (4) (dBA)	Construction: Does the Estimated Max. Noise Level Exceed the Threshold for Daytime Hours?	Construction: Noise Mitigation Required? (feet)	Operations: Threshold (dBA)	Operations: Citation	Operations: Estimated Maximum Noise Level at the Nearest Receptor Without Additional Noise Insulation (5) (dBA)	Operations: Estimated Exterior Leq, Ldn or CNEL Noise Level without Additional Noise Insulation (6) (dBA)	Operations: Does the Estimated Leq, Ldn or CNEL Noise Level Exceed the Exterior Threshold for Daytime Hours?	Operations: Extra Noise Insulation Required?	Comment
1	WDI	REMED	Los Angeles	Sante Fe Springs	800	4	41	NA	NA	7	No Threshold	No	Maximum outdoor Ldn in residential areas where outdoor use is a major consideration and economically and aesthetically possible: 60 ; otherwise 65 ; Indoor Ldn in multi-family dwellings: 45.	Sante Fe Springs Code of Ordinances; Title XV; Chapter 155; Zoning	7	41	No	No	Assumes ambient noise level for daytime at 41 dBA and nearest residential receptor is in a n A-1, R-1, or R-3 zone. Actual Ambient level should be measured to confirm assumption

N/A = Not applicable.

(1) The distance to the nearest receptor is estimated from the site location map

(2) Shomer and Associates, "Proposed Revisions to Property-Line-Noise-Source Measurement Procedures", Report No. ILENR/RE-EA-91/10, June 1991.
Land Use Categories are as follows: 1 = Noisy commercial and industrial areas; 2 = Moderate commercial and industrial areas; 3 = Quiet commercial and industrial areas and moderate residential areas; 4 = Quiet residential; and 5 = Very quiet, sparse

(3) Agresti, Tony (TRC). Personal communication with noise levels computed from Schomer and Associates (1991) as follows: 59 dBA for 1, 52 dBA for 2, 47 dBA for 3, 41 dBA for 4, and 35 dBA for 5.

(4) Maximum potential noise is based on manufactures maximum reported level of 85dBA at the source.
The noise has been adjusted to the nearest receptor or to be consistent with the threshold noise level.

(5) Maximum potential operating noise includes both mechanical and exhaust sources.
The maximum noise level shown has been adjusted to the nearest receptor.

(6) CNEL = Community Noise Equivalent Level, 24-hour weighted average. Ldn = Day-Night Average Sound Level, 24-hour weighted average. Leq=Energy-equivalent noise level, hourly average.
Calculations of the Ldn and CNEL assume that the ambient sound level remains constant for the 24 hour period, and that the source operates continuously.
For an Leq threshold not specified as hourly, the source sound level, regardless of operating time, complies with the threshold.
Equations used to calculate Ldn and CNEL were obtained from Handbook of Acoustical Measurements and Noise Control, Third Edition, bu Cyril M. Harris, McGraw-Hill Inc., 1991.

APPENDIX H.2

GAS FLOW CAPACITY

ENVIRONMENTAL SOLUTIONS, INC.

By KVG Date 4/12/96 Subject Gas Flow Capacity In Gas Collection Sheet No. 1 of 3
Chkd. By RP Date 4/13/96 Piping System, WDI Superfund Site Proj. No. 94-256

Pipe Size: 2 inch dia. Inside dia. = 2.067 inches
sch. 40 Pipe

A_{cs} = Cross sectional area = 0.0233 ft^2

Gas: methane

density = $\rho_{0°C, 1atm.}$ = 0.0448 lb/ft^3 (Perry's Chemical Engineering Handbook, Fourth Edition, 1969, pg. 3-71.)

$$\rho_{60°F, 1atm} = \frac{0.0448\ lb/ft^3}{\left(\frac{552°R}{492°R}\right)} = 0.0399\ lbs/ft^3$$

Optimum Velocity For Turbulent Flow: For $\rho = 0.04\ lb/ft^3$ (Sizing Piping For Process Plants, Chemical Engr., June 17, 1968, 193)

V_{op} = 55 to 80 ft/sec.

Gas Flow Capacity:

$$Q_{op} = V_{op} A_{cs}$$

$$= (55 \text{ to } 80\ ft/sec)(0.0233\ ft^2)(60\ sec/min)$$

$$= \underline{76.9 \text{ to } 111.8\ ft^3/min}$$

Expected Gas Flux at Site

$1 \times 10^{-7} - 5 \times 10^{-7}$ scfm/ft^2 (Design Report)

Area internal cap = 5.5 acres

$\therefore 1 \times 10^{-7} - 5 \times 10^{-7}\ ft^3/min/ft^2 \times 5.5\ acres \times 43560\ ft^2/acre$

$$= \underline{0.02\ ft^3/min - 0.12\ ft^3/min}$$

$\therefore$ FACTOR OF SAFETY $\cong$ 100 - 1000

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P. 2 of 3

line sizes. These constraints, which provide the framework for most line sizing, can be outlined in the following way:

- EROSION LIMITATIONS
- PROCESS CONTROL
- PRESSURE DROP
- COMPRESSIBLE FLOW
- TWO-PHASE FLOW
- FLOW DISTRIBUTION

Erosion Limitations

Although high velocities sometimes cause passivity in piping materials,[4] the engineer is more frequently concerned with velocity-induced erosion. High velocities can shorten the potential life of a metal pipe, thereby making the installation economically unattractive. For example, some copper-nickel alloys in seawater service have acceptable erosion rates when the velocity is 5 to 10 ft./sec.; however, when velocity exceeds about 15 ft./sec., the erosion rate then becomes prohibitive.

The designer should be aware of the following conditions that can increase erosion and impose velocity limitation on the design:

1. Corrosive environment where products of corrosion form a scale of friable solid.
2. Soft metal (e.g., lead or copper).
3. Presence of abrasive solids in the process fluid.
4. Large number of pipe fittings, with resultant high levels of turbulence.

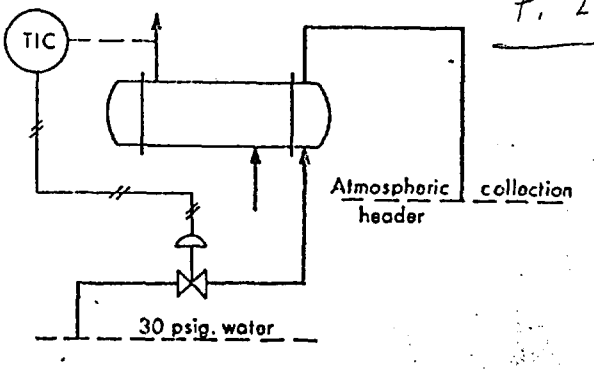
Ideally, the designer should consult corrosion specialists on erosion problems. Production engineers are also an excellent source of erosion know-how. When the designer has no historical data or consultants available but suspects erosion, he should arbitrarily limit the design velocity. For liquids, a maximum velocity of 5 ft./sec. is recommended.

Process Control

Accurate control of fluids is essential to many piping systems. Although sizing of control components should be left to those experienced in this field, the engineer who sizes the piping should familiarize himself with some aspects of process control.

To achieve good flow control in a pipeline, the control valve must dissipate considerable pressure drop. As a rough guide,[3] the control valve should take at least 30% of the total frictional pressure drop in the controlled system. (See the accompanying information elsewhere on page 196 for a better estimate of this pressure-drop percentage.) The reason is apparent. If comparatively little pressure drop is taken across a control valve, the valve stem will have to move a large percentage of its available stroke to change the flowrate. Throttling at lower flowrates, the control valve would then be nearly closed, and a small change in the valve opening would effect a large change in flowrate.

Control valves can be roughly sized with the familiar K that is equal to the number of velocity



CONTROL VALVE dissipates much pressure drop—Fig. 2

Optimum velocity for turbulent flow in steel pipe—Table I

Fluid Density Lb./Cu. Ft.	Optimum Velocity[1] Ft./Sec.	Optimum Velocity[2] Ft./Sec.
100	5.1	8
50	6.2	10
10	10.1	16
1	19.5	31
0.1	39	59
0.01	78	112

[1,2] Sources for these data are given in References 1 and 2.

See attached chart

heads. For turbulent incompressible flow of nonflashing fluids, the control-valve pressure drop (head loss) is:

$$E = -\frac{\Delta P}{\rho} = \frac{KV^2}{2g_c} \qquad (1)$$

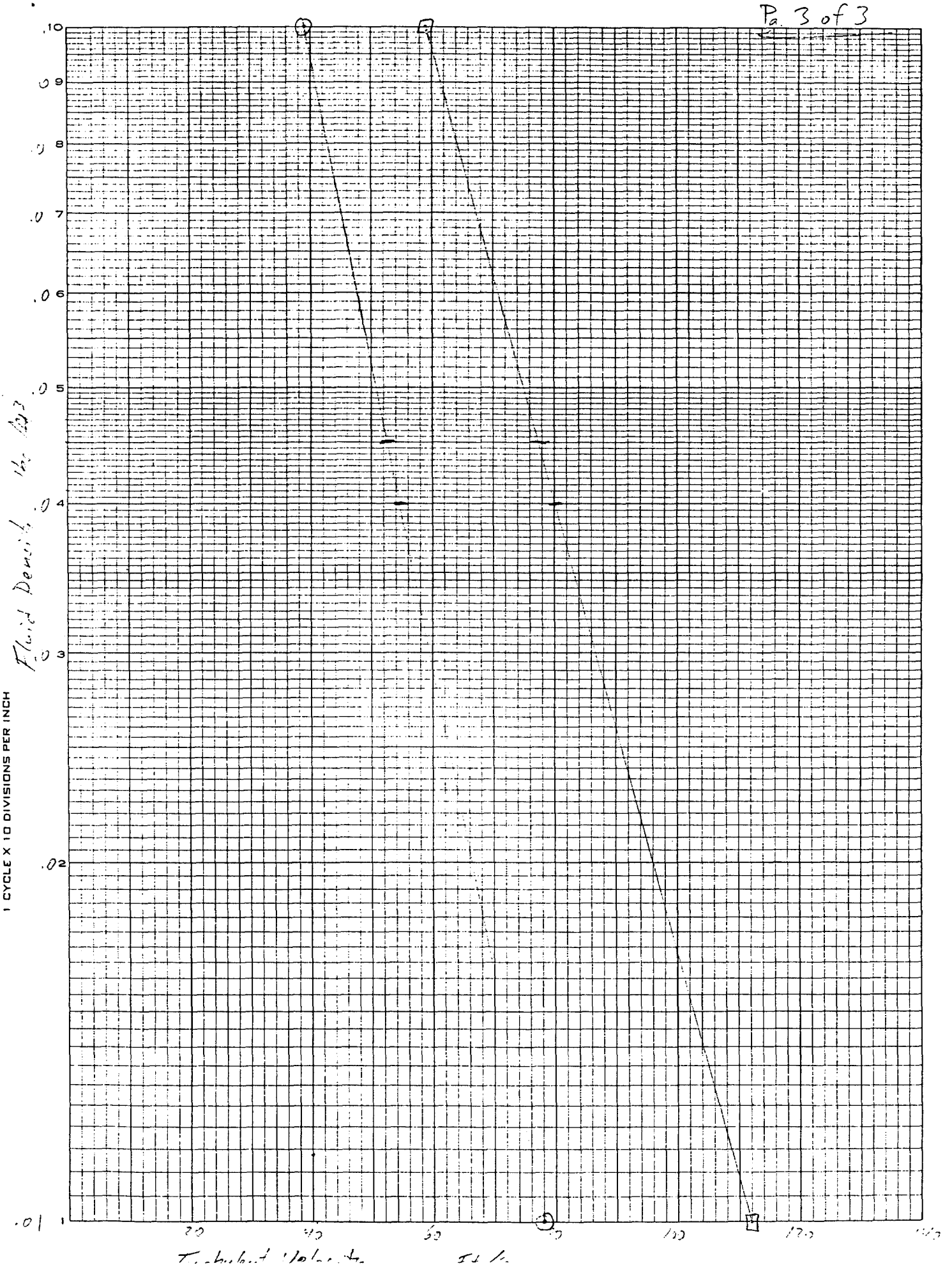
where V refers to velocity based on a nominal valve size, and E is defined later. For a conventional double-seated control valve, $K = 9$ approximately [or $C_v = 10\,(\text{in. dia.})^2$].[1,3]

Example: Control-Valve Size

The following simplified example illustrates the above principles. Water at 30 psig. flows through the heat exchanger shown in Fig. 2. The heat exchanger dissipates a pressure drop of 12 psi. when the flowrate is 100 gpm.

A 2-in. pipeline produces an estimated 14-psi. frictional pressure drop, whereas 3-in. piping causes only 2 psi. A 2-in. line is too small because the available pressure drop for the control valve is only (100) (30-12-14)/30 = 13% of the total system drop, and therefore the control valve would not have a useable range.

The use of 2½-in. piping is discounted because the plant does not inventory this size. The 3-in. line makes the pressure drop that is available for the motor valve:



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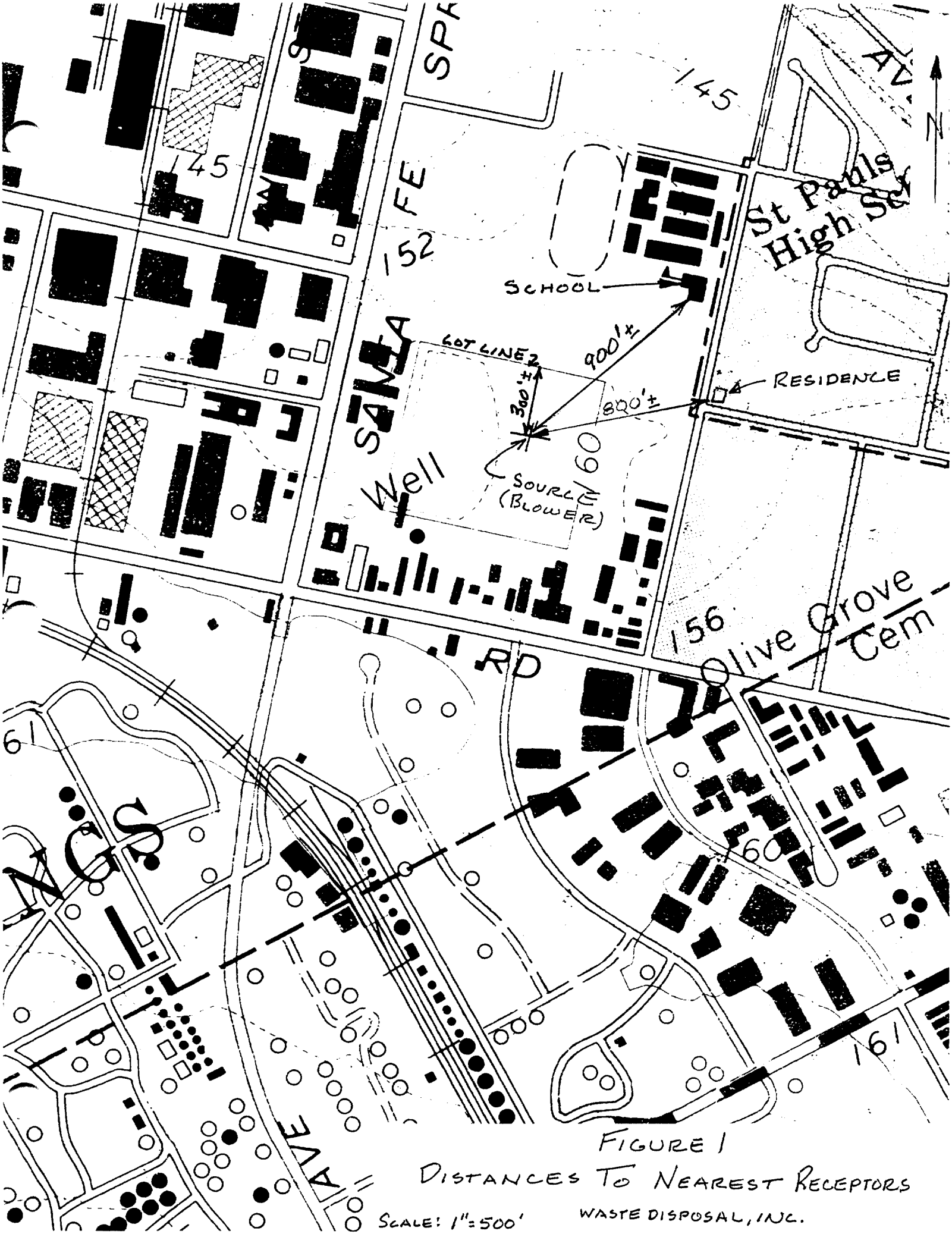

FIGURE 1

DISTANCES TO NEAREST RECEPTORS

SCALE: 1" = 500' WASTE DISPOSAL, INC.

APPENDIX H.3

BLOWER NOISE LEVEL ANALYSIS

TRC

By LBJ Date 12/18/01 Subject Noise Level Calculations Sheet No. 1 of ____
Chkd. By MJG Date 12/18/01 For Nearest Receptors (From Blower) Proj. No. 30747

PURPOSE: TO DETERMINE AFFECT, IF ANY, ON ABIENT NOISE LEVEL AT NEAREST RECPTORS AND TO DETERMINE IF NOISE INSULATION IS REQUIRED TO COMPLY WITH LOCAL SANTA FE SPRINGS NOISE ORDINANCES.

PROCEDURE: (1) BASED ON PROPOSED LOCATION OF BLOWER DETERMINE DISTANCE TO NEAREST RESIDENCE AND PROPERTY LINE AT SCHOOL BOUNDARY (SEE FIGURE 1)

(2) OBTAIN NOISE LEVEL OF BLOWER FROM MANUFACTURER

(3) DETERMINE THE APPROPRIATE LAND USE CATEGORY AND ESTIMATED AMBIENT NOISE LEVEL

(4) APPLY THE EQUATIONS TO CALCULATE Leq FROM THE HAND BOOK OF ACOUSTICAL MEASUREMENTS AND NOISE CONTROL

(5) COMPARE THE VALUES OBTAINED WITH THE REGULATORY LIMITS TO DETERMINE IF NOISE INSULATION IS REQUIRED

CALCULATIONS:

BLOWER NOISE - 85 dBA
LAND USE CATEGORY - QUIET RESIDENTIAL
AMBIENT NOISE LEVEL - 41 dBA (ESTIMATED BY SCHOMER AND ASSOC 1991)
DISTANCE TO NEAREST RESIDENCE - 800'
DISTANCE TO SCHOOL BUILDING - 900'
DISTANCE TO SCHOOL PROPERTY LINE - 300'
} FROM FIGURE 1

RESULTS:

TABLE - 1 NEAREST RESIDENCE CALCULATION Ldn = 41 dBA
TABLE - 2 PROPERTY LINE AT SCHOOL Ldn 44 dBA

SANTA FE NOISE ORDANCE (ATTACHMENT A) ALLOWS DAY AND NIGHT LEVELS OF 45 dBA FOR RESIDENTIAL AREAS A-1, R-1 OR R-3 ZONE, AND FOR ANY SCHOOL, CHURCH, OR HOSPITAL

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TRC

By LBT Date 12/18/01 Subject NOISE LEVEL CALCULATIONS Sheet No. 2 of ____

Chkd. By ____ Date 12/18/01 FOR NEAREST RECEPTORS (FROM BLOWER) Proj. No. 30747

CONCLUSIONS : RESIDENTIAL NO NOTICABLE SOUND INCREASE WILL BE DETECTED 800 FEET AWAY AND NOISE INSULATION IS NOT REQUIRED

AT THE NEAREST LOCATION OF THE SCHOOL BUILDING 900 FEET AWAY (FURTHER THAN THE RESIDENCE) NO SOUND INCREASE WILL BE DETECTABLE

AT THE NEAREST SCHOOL PROPERTY LOCATION THE AMBIENT LEVEL IS EXPECTED TO INCREASE FROM 41 dBA TO 44 dBA WHICH IS STILL BELOW THE REGULATORY LIMIT OF 45 dBA.

∴ NO NOISE ABATEMENT MEASURES WILL BE REQUIRED AROUND THE BLOWER.

Recyclable and made from recycled paper.

The blower noise level analysis for the reservoir area gas collection and venting system is based on McMaster-Carr blower Model Number 1954K41. Decibel level for the blower is 85 dBA, per a phone conversation with McMaster-Carr on December 18, 2001.

Distances to nearest receptors are shown in Figure 1. The closest residence is approximately 800 feet to the East. There is a school approximately 900 feet to the northeast. The property line between the site and the school is 300 feet to the north.

The noise level table from the City of Santa Fe Springs Zoning Ordinance is shown in Attachment A. The R-1 zoning designation was used as the permitted noise levels for the residence. The school, church or hospital permit levels were used for the school.

Table 1 shows calculations for noise level impact to the closest residence. Assumptions used in the calculation should be verified to confirm the data. An estimated ambient noise level of 41 dBA and a land use category 4 were assumed for the calculation.

Table 2 shows calculations for noise level impact to the school. Assumptions are the same as those for Table 1.

Section 155.423(B) (see Attachment B) requires outdoor noise be measured at the lot line. Therefore, Table 2 uses 300 feet as the distance to the nearest receptor for the school although the closest building at the school is approximately 900 feet away

The 41 dBA at the residence and the 44 dBA at the school property line both fall within acceptable levels as indicated in the noise level table (see Attachment A).

TABLE 2

WDI NOISE CALCULATIONS

Site Number	Site Name	Site Type	County	City/Town	Distance to Nearest Receptor (1) (feet)	Land Use Category (2)	Estimated Ambient Noise Level (3) (dBA)	Noise Levels: Construction: Threshold / Restriction	Construction: Citation	Construction: Estimated Maximum Noise Level at the Nearest Receptor (4) (dBA)	Construction: Does the Estimated Max. Noise Level Exceed the Threshold for Daytime Hours?	Construction: Noise Mitigation Required? (feet)	Operations: Threshold (dBA)	Operations: Citation	Operations: Estimated Maximum Noise Level at the Nearest Receptor Without Additional Noise Insulation (5) (dBA)	Operations: Estimated Exterior Leq, Ldn or CNEL Noise Level without Additional Noise Insulation (6) (dBA)	Operations: Does the Estimated Leq, Ldn or CNEL Noise Level Exceed the Exterior Threshold for Daytime Hours?	Operations: Extra Noise Insulation Required?	Comment
2	WDI	REMED	Los Angeles	Sante Fe Springs	300	4	41	NA	NA	15	No Threshold	No	Maximum outdoor Ldn in residential areas where outdoor use is a major consideration and economically and aesthetically possible: 60 ; otherwise 65 ; Indoor Ldn in multi-family dwellings: 45.	Sante Fe Springs Code of Ordinances; Title XV; Chapter 155; Zoning	15	44	No	No	Assumes ambient noise level for daytime at 41 dBA and a school lot line is 300' from the source location.

N/A = Not applicable.

(1) The distance to the nearest receptor is estimated from the site location map

(2) Shomer and Associates, "Proposed Revisions to Property-Line-Noise-Source Measurement Procedures", Report No. ILENR/RE-EA-91/10, June 1991.
Land Use Categories are as follows: 1 = Noisy commercial and industrial areas; 2 = Moderate commercial and industrial areas; 3 = Quiet commercial and industrial areas and moderate residential areas; 4 = Quiet residential; and 5 = Very quiet, sparse

(3) Agresti, Tony (TRC). Personal communication with noise levels computed from Schomer and Associates (1991) as follows: 59 dBA for 1, 52 dBA for 2, 47 dBA for 3, 41 dBA for 4, and 35 dBA for 5.

(4) Maximum potential noise is based on manufactures maximum reported level of 85dBA at the source.
The noise has been adjusted to the nearest receptor or to be consistent with the threshold noise level.

(5) Maximum potential operating noise includes both mechanical and exhaust sources.
The maximum noise level shown has been adjusted to the nearest receptor.

(6) CNEL = Community Noise Equivalent Level, 24-hour weighted average. Ldn = Day-Night Average Sound Level, 24-hour weighted average. Leq=Energy-equivalent noise level, hourly average.
Calculations of the Ldn and CNEL assume that the ambient sound level remains constant for the 24 hour period, and that the source operates continuously.
For an Leq threshold not specified as hourly, the source sound level, regardless of operating time, complies with the threshold.
Equations used to calculate Ldn and CNEL were obtained from Handbook of Acoustical Measurements and Noise Control, Third Edition, bu Cyril M. Harris, McGraw-Hill Inc., 1991.

Santa Fe Springs Code of Ordinances
TITLE XV: LAND USAGE
CHAPTER 155: ZONING

§ 155.424 PERMITTED NOISE LEVELS.

(A) The **noise** level caused by any device, instrument, vehicle, machinery, operation, use or activity shall not exceed the levels set forth in the table set out in division (E) of this section except as further provided in this chapter.

(B) In the event the ambient **noise** level exceeds a permitted **noise** level set forth in division (E) of this section, the permissible **noise** level for the corresponding duration and receiving area shall be the ambient level.

(C) **Noise** of impulsive character (hammering, and the like) or that contains a pure tone (such as a whine, screech, or hum), shall only be permitted at levels five dB(A) less than the permitted levels determined under this section.

(D) At a lot line separating properties with different permitted **noise** levels, the applicable permitted outdoor **noise** level shall be the arithmetic mean of the permitted outdoor **noise** levels set forth in division (E) of this section for the receiving areas on opposite sides of said lot line.

(E) **Noise** level table.

A-Weighted Sound Level in Decibels (dB(A))										
	Daytime (7:00 a.m. to 10:00 p.m.)					Nighttime (10:00 p.m. to 7:00 a.m.)				
	Maximum Cumulative Minutes Duration in Any 1-Hour Period				Absolute Maximum	Maximum Cumulative Minutes Duration in Any 1-Hour Period				Absolute Maximum
Receiving Area	30	15	5	1		30	15	5	1	
Outdoor Noise at Lot Line Of:										
Any school, church or hospital	45	50	55	60	65	45	50	55	60	65

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Any other use										
In the A-1, R-1 or R-3 Zone	50	55	60	65	70	45	50	55	60	65
In the C-1 or C-4 Zone	60	65	70	75	80	55	60	65	70	75
In the ML, PF or BP Zone	60	65	70	75	80	60	65	70	75	80
In the M-1 or M-2 Zone	70	75	80	85	90	70	75	80	85	90
Residential Building Interior:										
In the A-1 or R-1 Zone	45	50	55	60	65	45	50	55	60	65
In the R-3 Zone	45	50	55	60	65	45	50	55	60	65
Sound levels at or above each decibel level given in the table shall not occur for a duration longer than that given in the corresponding column heading.										

('64 Code, § 52.34) (Am. Ord. 712, passed 6-11-87) Penalty, see § 10.97

ATTACHMENT B

Santa Fe Springs Code of Ordinances
TITLE XV: LAND USAGE
CHAPTER 155: ZONING

§ 155.423 NOISE LEVEL MEASUREMENT PROCEDURES.

Any **noise** level measurement made pursuant to the provisions of this subchapter shall be measured with a sound level meter in accordance with the following:

(A) Measurements shall be made in decibels (dB) using the A-weighted scale with slow response, following the manufacturer's instructions, except the fast response shall be used for impulsive sounds.

(B) Outdoor **noise** shall be measured at the lot line and/or at any point with the land parcel receiving the **noise**, where possible, the microphone shall be positioned at least 10 feet from the nearest reflective surface. For the purpose of this measurement the boundaries of any lease agreement, or operating unit or group of contiguous fee properties operated as a unit, shall be considered as the lot line.

(C) Measurements shall be made with the microphone at a height not less than five feet above the ground or floor level for outdoor measurements and for measurements within a building or on a balcony or deck, respectively.

(D) Measurements within a building for determining the **noise** level from exterior **noises** shall be made with the microphone five feet from the window (closed) and/or wall of the structure.

(E) The ambient **noise** level shall be measured while the alleged intruding **noise** source is inoperative. If for any reason the alleged intruding **noise** source cannot be turned off, the ambient **noise** level shall be estimated, if possible, by performing a measurement in the same general area of the alleged intruding **noise** source but a sufficient distance such that the **noise** from the alleged intruding **noise** source is at least 10 dB below the ambient **noise** level in order that only the actual ambient **noise** level be measured. If a difference of 10 dB as specified in the preceding sentence cannot be obtained within the same general area, but the alleged intruding **noise** source is five to 10 dB below the ambient, then the level of the ambient **noise** level itself may be reasonably determined by subtracting a one decibel correction to account for the contribution of the alleged intruding **noise** source.
('64 Code, § 52.32) (Am. Ord. 712, passed 6-11-87)

APPENDIX H.4

SOIL LOSS CALCULATION

CALCULATION PACKAGE

SOIL LOSS DUE TO SHEET EROSION

Calculation Package Prepared by Advanced Earth Sciences, Inc.
December 2002

Prepared by: _____ **Reviewed by:** _____

P.J. ANANTHANATHAN. SUJI SOMASUNDARAM, GE.

CALCULATION PACKAGE FOR
SOIL LOSS DUE TO SHEET EROSION

Objective:

Calculate annual soil loss due to sheet erosion for the proposed cover

References:

US Army Engineer Waterways Experiment Station, "Evaluating Cover Systems for Solid and Hazardous Waste," 1982.

Nelson, J.D., Abt, S.R., Volpe, R.L., van Zyl, D., Hinkle, N.E., Staub, W.P., "Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments," 1986.

Assumptions:

- Surface layer for Subtitle C and Subtitle D equivalent covers are similar, and consists of site soils (predominantly SC) compacted to 85% to 90% relative compaction and vegetated with native plants.
- No irrigation
- Finish grades based on proposed grading plan for CERCLA Closure, Max site El. 169 ft.

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CALCULATIONS

Use Modified Universal Soil Loss Equation (MUSLE)

$$A = R \times K \times (LS) \times (VM)$$

where

A - Computed loss / Unit area / yr (Tons/acre/yr)

R - Rainfall factor

K - Soil Erodibility factor

LS - Topographic factor

VM - Dimensionless erosion control factor.

Slope of the Cover.

Identified critical slopes are

(1) $\frac{169 - 156}{9.5 \times 60}$ over 582 ft

$= 2.23\%$

choose L = 600 ft and S = 2.2%

(2) $\frac{165 - 161}{2.4 \times 60}$ over 144 ft

$= 2.78\%$

choose L = 150 ft and S = 2.8%

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Parameters for MUSLE

R = 50 for Southern CA (US WES, 1982)

K = 0.12 – 0.14 for loamy sand to sandy clay, 0.5% organic

LS = Calculated from L and S.

YM = 0.4 (during critical period of 0–60 days of permanent seeding)

Specimen Calculations

LS for L = 600 and S = 2.0 %

$$LS = \frac{650 + 450\,S + 65\,S^2}{10^4 + S^2}\left(\frac{L}{72.6}\right)^m.$$

where S = Slope (%)

L = Slope length (ft)

m = exponent (function of S)

m = 0.3 for S = 1% to 3 %

$$LS = \frac{650 + 450 \times 2.2 + 65 \times 2.2^2}{10^4 + 2.2^2}\left(\frac{600}{72.6}\right)^{0.3}.$$

$$= 0.308$$

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Soil loss with $K = 0.14$ case (Sandy clay)

$A = R \times K \times LS \times VM$.

$= 50 \times 0.14 \times 0.365 \times 0.4$

$= 1.030$ Tons / acre / yr.

$= 1.030 \times \frac{2000 \text{ (lb)}}{43560.17 \text{ (ft}^2)} \times \frac{1}{\text{yr}}$

$= 0.047$ lb / sqft / yr.

Assume $\gamma_d = 120$ pcf

Height loss in 100 yrs.

$\Delta h = \frac{0.047}{120} \times 100 \frac{\text{lb}}{\text{ft}^2 \cdot \text{yr.}} \times \frac{\text{ft}^3}{\text{lb}} \times 100 \text{ yr.}$

$= \underline{0.039}$ ft

Design Requirement

$\Delta h < 3$ ft in 100 yrs.

hence: Design requirement satisfied.

Summary

	Loamy sand		Sandy clay	
L (ft)	600	150	600	150
S (%)	2.2	2.8	2.2	2.8
m	0.3	0.3	0.3	0.3
R	50	50	50	50
K	0.12	0.12	0.14	0.14
VM	0.4	0.4	0.4	0.4
Unit weight (pcf)	120	120	120	120
LS	0.368	0.301	0.368	0.301
A (tons/acre/year)	0.884	0.721	1.031	0.842
A (lb/sq.ft/year)	0.041	0.033	0.047	0.039
Height. Loss in 100 yrs (ft)	0.034	0.028	0.039	0.032

Conclusions

Estimated soil loss per year for the proposed Subtitle C and D equivalent cover ranges from 0.721 to 1.031 Tons/acre/year

ATTACHMENTS

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NUREG/CR-4620
ORNL/TM-10067

Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments

Manuscript Completed: May 1986
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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
NRC FIN B0279

A2-

5. EVALUATING THE POTENTIAL FOR SURFACE SHEET EROSION

Due to their fine-grained noncohesive nature, uranium mill tailings have a high potential for sheet erosion when subjected to the forces of wind and water. Sheet erosion is defined and limited to that erosion which occurs as a result of: (1) the impact of raindrops striking the ground surface, (2) the lifting and transporting of material due to wind forces, or (3) the transporting of material due to water flowing in small ephemeral rills. Any of these forces acting individually, or in combination with each other, can detach and transport significant quantities of material from an area. The potential for sheet erosion and subsequent transportation of the eroded tailings away from the impoundment area are the principal concerns dictating the need for sound engineering design and proper construction of a stable cover material over abandoned tailings. This chapter presents a discussion of the analytical techniques that will be used in a followup study to evaluate sheet erosion and a recommended approach to estimate the life of different protective covers.

One of the existing methods used to estimate soil loss due to sheet erosion is based on experimental observation of soil erosion occurring primarily on agricultural lands. This observational approach lacks the mathematically rigorous concept of, for example, methods involving a tractive shear force. Nevertheless, it is believed that the extended period of time over which the observational approach of sheet erosion has been developed and used lends credibility to its consideration in evaluating protective covers for uranium tailings.

Historically, sheet erosion and gully erosion have not been viewed or treated separately. Indeed, the natural forces associated with gully and sheet erosion are similar; however, it is now recognized that the damage associated with gully erosion is potentially much greater than that of sheet erosion. Given the same potentially erosive material, both erosion phenomena are possible but usually only one will dominate the erosion process primarily as a function of ground slope and the frequency and intensity of rainfall. It is important, therefore, to put in proper perspective these different types of erosion phenomena and to treat them separately in the stabilization design process.

5.1 METHODOLOGIES

Soil particles can become detached when the impact of rainfall and/or the forces caused by wind or flowing water exceed the combination of factors that contribute to soil cohesion or stability. Factors which tend to stabilize the soil or resist such erosive forces include natural vegetation (ground cover) and protective rock covers. The design of any protective soil cover over uranium tailings must consider the soil particle detachment process and the erosion potential over the entire reclamation period.

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Two basic approaches exist for the design of suitable erosion-resistant covers for a tailings impoundment surface as originally described by Nelson et al. (1983). The first approach consists of providing a cover material that will resist material transport by flowing water using the concept of critical shear stress. The second approach is based on the Universal Soil Loss Equation, an empirical method originally developed during the 1930's. The methodologies involved with both of these methods are discussed below.

5.1.1 Critical Shear Stress Approach

The critical shear stress approach consists of providing a cover material with a d_{30} grain size (i.e., 70% of the material by weight is coarser than the d_{30}) that will resist movement when subjected to the sheet flow maximum permissible velocity resulting from the application of the PMP over the entire impoundment surface. Minimum d_{30} grain sizes should be determined using the critical shear stress approach similar to the procedures discussed in Simons and Senturk (1977) applicable to overland flow. A numerical solution for selecting an appropriate d_{30} to provide armoring has been developed by Shen and Lu (1983).

The design approach described above, in which the critical grain size is selected to resist the onset of sheet erosion, should evaluate the runoff from PMP storms of different durations, such as 0.5, 1, 2, 4, and 6 hours to select the maximum d_{30} required. Rainfall depths will usually be based on 2.5 to 15 minute durations for small drainage basins as presented in Section 2.1.2. Typically, the minimum construction layer thickness is specified to be at least two times the maximum particle size. If the above approach results in a cover thickness less than about 6 inches, then other considerations - such as nonuniform placement of cover and particle breakdown due to handling, placement and weathering - would suggest that a minimum cover thickness of 10 inches should be considered. If a self-armoring cover can be provided, and there is no major concern for weathering of the cover material, the design is independent of time and the cover should remain intact indefinitely.

5.1.2 Soil Loss Equation Approach

The concept of sheet erosion was recognized by early researchers and the Universal Soil Loss Equation (USLE) was developed in the late 1930's by the Agricultural Research Service to evaluate soil conservation practices for cropland throughout the United States. After its inception, the soil loss procedure was used and modified as field experience and data were obtained incorporating the basic parameters of field slope and length, precipitation, and crop management to estimate soil losses on an annual basis. Application of the USLE to non-cropland areas and specifically for construction sites became feasible when Wischmeier et al. (1971), using basic soil loss characteristics, developed and implemented a soil erodibility factor (K) in the soil loss computation. Subsequent efforts refined the parameters used in the USLE for mining and construction activities in the interior western United States.

The Modified Universal Soil Loss Equation (MUSLE) was developed by the Utah Water Research Laboratory in 1978 for the principal objective of estimating soil losses due to highway construction activities. Alterations were made to the USLE to accomodate unique or special conditions encountered in highway construction, including steep and deep cuts and fill slopes that could cause erosion affecting adjacent or nearby roadways, streams, lakes, or inhabited areas. It is apparent that the modifications made to the USLE extend to many construction and mining sites beyond the scope of highway construction.

The Modified Universal Soil Loss Equation (MUSLE) is a mathematical model based on field determined coefficients and provides the most rational approach to evaluate the long-term erosion potential from an upland area similar to that of the area covering a reclaimed tailings pond. Recent investigations into appropriate methods of modeling major types of sheet erosion (Abt and Ruff, 1978; Nelson et al. 1983; Nyhan and Lane, 1983; and NRC, 1983), indicate that although more rigorous mathematical models are available to simulate erosion as a function of time, the use of the USLE has a strong precedent because it has a 40-year history of runoff and soil loss data.

The MUSLE is used to evaluate average soil losses for certain types of slopes as a function of time. The MUSLE does not consider the potential for gully development or intrusion as discussed in Chapter 4 because the topographic features of the tailings area are assumed to remain constant with time. Also, the MUSLE does not incorporate the concept of the PMP but rather a rainfall factor based on historical rainfall values. The MUSLE is defined by Clyde et al. (1978) as follows:

$$A = R\ K\ (LS)\ (VM) \qquad (5.1)$$

where,

A = the computed loss per unit area in tons per acre per year with the units selected for K and R properly selected;

R = the rainfall factor which is the number for rainfall erosion index units plus a factor for snowmelt, if applicable;

K = the soil erodibility factor, which is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot that is defined as a 72.6-ft length of uniform 9% slope continuously maintained as clean tilled fallow;

LS = the topographic factor, which is the ratio of soil loss from the field slope length to that from a 72.6-ft length under otherwise identical conditions;

VM = the dimensionless erosion control factor relating to vegetative and mechanical factors. This factor replaces the cover management factor (C) and the support factor (P) of the original USLE.

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5.1.2.1 The Rainfall and Runoff Factor (R)

As noted by previous research at Los Alamos National Laboratory (Nyhan and Lane, 1983), the R factor as used in the MUSLE is often misinterpreted only as a rainfall factor. In reality, it must quantify both the raindrop impact and provide information on the amount and rate of runoff likely to be associated with the rain. More specifically, the R factor is described in terms of a rainfall storm energy (E) and the maximum 30-minute rainfall intensity (I_{30}). Generalized R factors applicable to the interior western United States are given in Table 5.1. For R factors in specific areas of the United States, it is recommended that erosion index distribution curves be obtained from local SCS offices.

Table 5.1. Generalized Rainfall and Runoff (R) Values.

State	Eastern Third	Central Third	Western Third
N. Dakota	50 - 75	40 - 50	40
S. Dakota	75 - 100	50	40
Montana	30 - 40	20	20 - 50
Wyoming	30 - 50	15 - 30	15 - 25
Colorado	75 - 100	40 - 50	20 - 40
Utah	20 - 30	20 - 50	15 - 40
New Mexico	75 - 100	40 - 50	20 - 40
Arizona	20 - 50	20 - 50	25 - 40

5.1.2.2 The Soil Erodibility Factor (K)

The soil erodibility factor (K) recognized the fact that the erodibility potential of a given soil is dependent on its compositional makeup, which in turn reflects the grain size distribution of the soil. To predict soil erodibility, five soil characteristics that include the percent silt and fine sand, percent sand greater than 0.1 mm, percent organic material, general soil structure and general permeability are determined. The K factor is then found by using the Wischmeier nomograph presented in Figure 5.1.

The makeup of the various soil fractions presented in Figure 5.1 is based on separating sand and silt at the 0.1 mm size. This differs from the Unified Soil Classification System which uses the No. 200 sieve size (0.075 mm) for the separation between sand and silt. The value to enter Figure 5.1 with should be the percentage of material finer than 0.1 mm in size, not the percentage passing the No. 200 sieve. Also, the determination of the Soil Erodibility Factor (K) as shown on Figure 5.1 does not specifically reference the percentage of clay (finer than 0.002 mm) contained in the material. The percentage of silt plus very fine sand to be used for Figure 5.1, therefore, is the percentage of material contained between 0.002 mm and 0.1 mm.

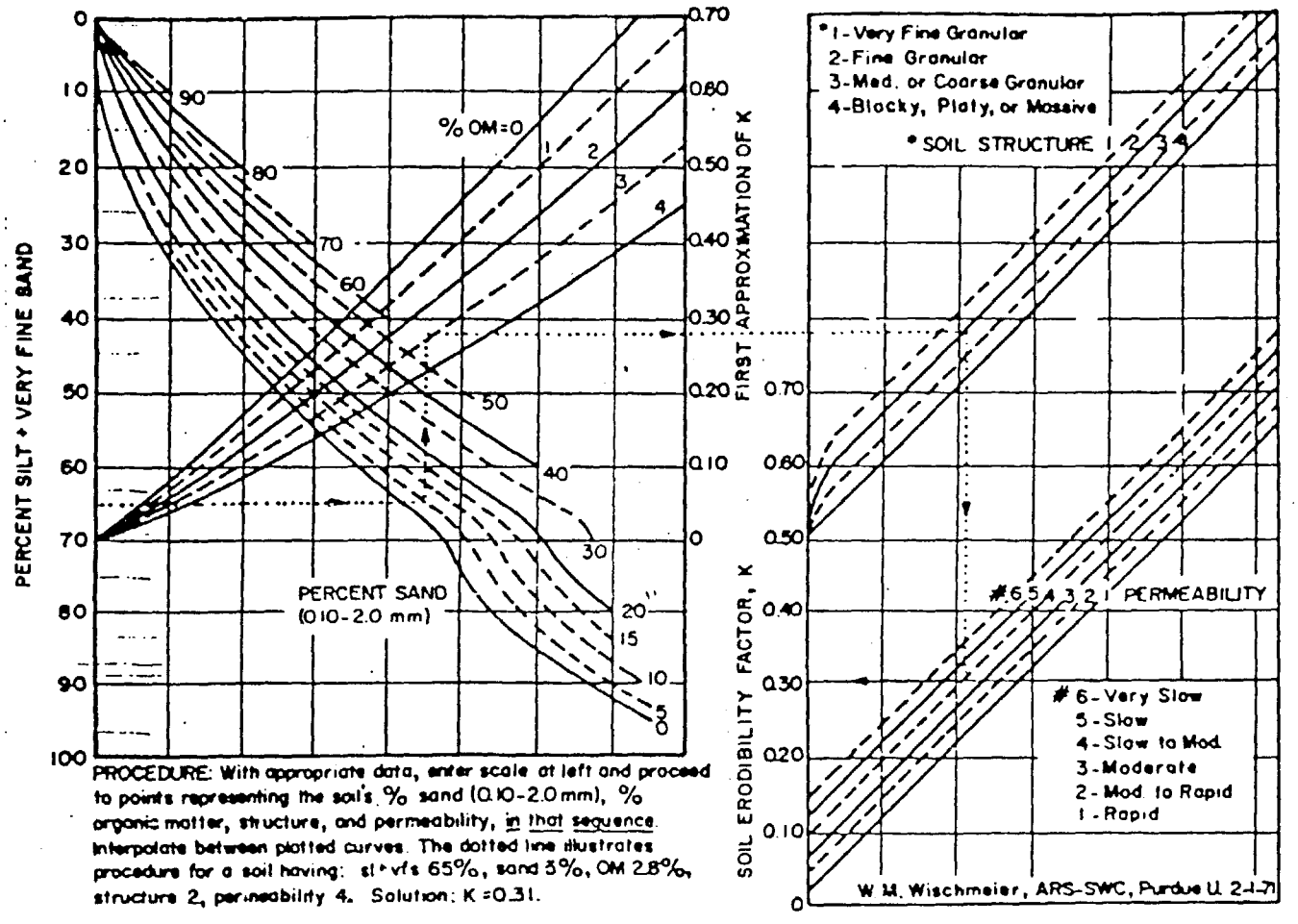

Fig. 5.1. Nomograph for determining soil erodibility factor K. *Source:* after Wischmeier et al., 1971.

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5.1.2.3 The Topographic Factor (LS)

Although the effects of both length and steepness of slope have been investigated separately in different research efforts, it is more convenient for analytical purposes to combine the two into one topographic factor, LS. Wischmeier and Smith (1978) developed plots correlating the topographic factor for slopes up to 500 meters in length at slope inclinations from 0.5% up to 50%. Note that flat, short slopes will have less erosion than long, steep slopes and it is to the benefit of the design engineer to optimize slope length and gradients to fit the topography.

The equation to determine the LS factor is as follows:

$$LS = \frac{650 + 450s + 65s^2}{10{,}000 + s^2} \left(\frac{L}{72.6}\right)^m \qquad (5.2)$$

where LS = topographic factor
L = slope length in feet
s = slope steepness in percent
m = exponent dependent upon slope steepness

The slope dependent exponent m is presented in Table 5.2.

Table 5.2 Slope Dependent Exponent

Slope (percent)	m
$s \leq 1.0$	0.2
$1.0 < s \leq 3.0$	0.3
$3.0 < s \leq 5.0$	0.4
$5.0 < s \leq 10.0$	0.5
$s > 10.0$	0.6

5.1.2.4 The VM Factor

The VM factor is the erosion control factor applied in place of the cover and erosion control factors found in the USLE. The erosion control factor accounts for measures implemented at the construction site to include vegetation, mulching, chemical treatments and sprayed emulsions to impede or reduce erosion due to the overland flow of water. Values of the VM factor relative to site-specific conditions are presented in Table 5.3.

The VM factor is perhaps the most sensitive factor to effect the computed erosion loss for a given site. As shown by the values presented

on Table 5.3, the development of a permanent vegetative cover can have a significant impact in reducing the computed erosion loss. However, the effectiveness of a vegetative cover over long-term periods should be questioned unless other protective schemes, such as armoring of the cover with the proper size material, are also included in the design.

5.1.2.5 Example Problem

An example problem in how to use the MUSLE is provided below.

Assumptions:

Site location:	Western Colorado
Site description:	Uncovered tailings pond
Pond size:	160 acres
Slope:	3%
Length:	2500 ft
Material:	42% sand greater than 0.10 mm; 58% fine sand and silt less than 0.10 mm; 5% clay less than 0.002 mm; 0% organics; (53% silt plus fine sand less than 0.1 mm); Consistency - fine granular; Permeability - slow to moderate.

The following factors have been determined for use in Equation 5.1.

R = 20 from Table 5.1

K = 0.50 from Figure 5.1

$$\frac{650 + 450 \times 3 + 65 \times (3)^2}{10{,}000 + (3)^2} \left(\frac{2500}{72.6}\right)^{0.3} = 0.747$$

LS = 0.747 from Equation 5.2 and Table 5.2

VM = 1.0 (average from Table 5.3 based on an undisturbed surface)

Using Equation 5.1, the annual soil loss (A) from the tailings pond due to sheet erosion caused by flowing water is computed to be 7.47 tons/acre/year, or 1195 tons/year from the facility. Therefore, the cover is estimated to erode at a rate of 0.003 ft per year, or 0.3 ft/century.

5.2 SUMMARY AND FUTURE STUDIES

The main application of the soil loss equation approach in the evaluation of cover integrity is to determine whether it is possible for sheet erosion to penetrate the tailings cover, thereby exposing bare tailings and constituting a failure of the cover. The followup study will concentrate

Table 5.3. Typical VM Factor Values Reported in the Literature.[a]

Condition	VM Factor
1. Bare soil conditions	
freshly disked to 6-8 inches	1.00
after one rain	0.89
loose to 12 inches smooth	0.90
loose to 12 inches rough	0.80
compacted bulldozer scraped up and down	1.30
same except root raked	1.20
compacted bulldozer scraped across slope	1.20
same except root raked across	0.90
rough irregular tracked all directions	0.90
seed and fertilizer, fresh	0.64
same after six months	0.54
seed, fertilizer, and 12 months chemical	0.38
not tilled algae crusted	0.01
tilled algae crusted	0.02
compacted fill	1.24 - 1.71
undisturbed except scraped	0.66 - 1.30
scarified only	0.76 - 1.31
sawdust 2 inches deep, disked in	0.61
2. Asphalt emulsion on bare soil	
1250 gallons/acre	0.02
1210 gallons/acre	0.01 - 0.019
605 gallons/acre	0.14 - 0.57
302 gallons/acre	0.29 - 0.60
151 gallons/acre	0.65 - 0.70
3. Dust binder	
605 gallons/acre	1.05
1210 gallons/acre	0.29 - 0.78
4. Other chemicals	
1000 lb. fiber Glass Roving with 60-150 gallons asphalt emulsion/acre	0.01 - 0.05
Aquatain	0.68
Aerospray 70, 10 percent cover	0.94
Curasol AE	0.30 - 0.48
Petroset SB	0.40 - 0.66
PVA	0.71 - 0.90
Terra-Tack	0.66
Wood fiber slurry, 1000 lb/acre fresh[b]	0.05
Wood fiber slurry, 1400 lb/acre fresh[b]	0.01 - 0.02
Wood fiber slurry, 3500 lb/acre fresh[b]	0.10
5. Seedings	
temporary, 0 to 60 days	0.40
temporary, after 60 days	0.05
permanent, 0 to 60 days	0.40
permanent, 2 to 12 months	0.05
permanent, after 12 months	0.01
6. Brush	
7. Excelsior blanket with plastic net	0.04 - 0.10

[a]Note the variation in values of VM factors reported by different researchers for the same measures. References containing details of research which produced these VM values are included in NCHRP Project 16-3 report, "Erosion Control During Highway Construction, Vol. III. Bibliography of Water and Wind Erosion Control References," Transportation Research Board, 2101 Constitution Avenue, Washington, DC 20418.

[b]This material is commonly referred to as hydromulch.

on using the MUSLE for several alternate cover designs in order to evaluate whether the proposed analytical approach can be successfully used to measure the long-term integrity of protective soil covers for uranium tailings reclamation. Alternative designs will be compared, both from a standpoint of overall integrity and construction difficulty. The covers will also be evaluated using the critical shear stress approach to determine, based on a given PMP, the minimum particle size necessary to protect the cover against long-term degradation.

P1-1

PB87-154894

EVALUATING COVER SYSTEMS FOR SOLID AND HAZARDOUS WASTE (REVISED)

(U.S.) Army Engineer Waterways Experiment Station, Vicksburg, MS

Sep 82

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
NTIS

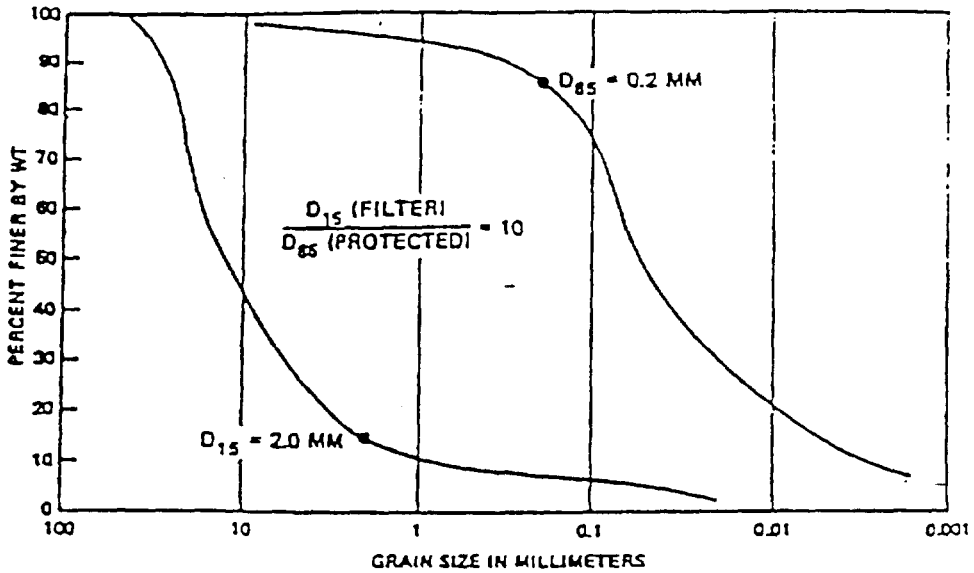

Figure 18. Hypothetical size gradation of ineffective filter soil.

Gas drainage layers and channels may have granular consistency and interconnections and general configuration similar to those of the water drainage layer or channel. Both layer types function to transmit preferentially. The position in the cover system is a main distinction. The gas drainage layer is placed on the lower side (Figure 19) to intercept gases rising from waste cells, whereas the drain for water is positioned on the upper side to intercept water percolating from the surface.

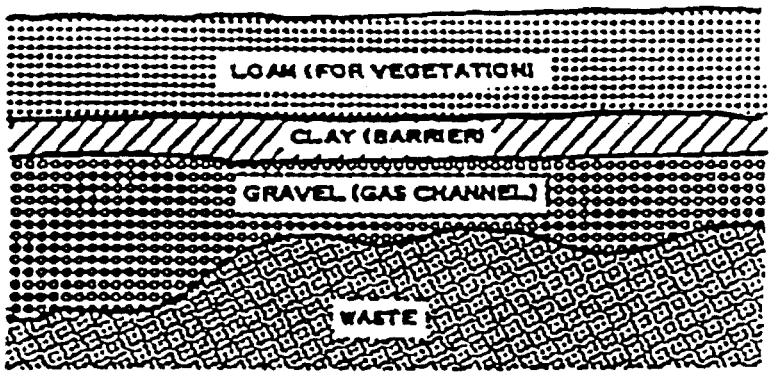

Figure 19. Cover layering suitable for conveying gases to vents.

Evaluate Topsoil — Step 16

A topsoil or a subsoil made amenable to supporting vegetation frequently forms the top of a layered cover system. Untreated subsoils are seldom suitable directly, so it has been necessary frequently to supplement

Not only is erosion objectionable in itself but erosion can degrade the cover and seriously reduce its effectiveness.

Evaluate Erosion Potential — Step 19

The USDA universal soil loss equation (USLE) is a convenient tool for use in evaluating erosion potential. The USLE predicts average annual soil loss as the product of six quantifiable factors. The equation is:

$$A = R\ K\ L\ S\ C\ P$$

where A = average annual soil loss, in tons/acre
R = rainfall and runoff erosivity index
K = soil erodibility factor, tons/acre
L = slope-length factor
S = slope-steepness factor
C = cover-management factor
P = practice factor

The data necessary as input to this equation are available to the evaluator in a figure and tables included below. Note that the evaluations in Step 8 on soil composition and Steps 25-32 on vegetation all impact on the evaluation of erosion also.

Factor R in the USLE can be calculated empirically from climatological data. For average annual soil loss determinations, however, R can be obtained directly from Figure 20. Factor K, the average soil loss for a given

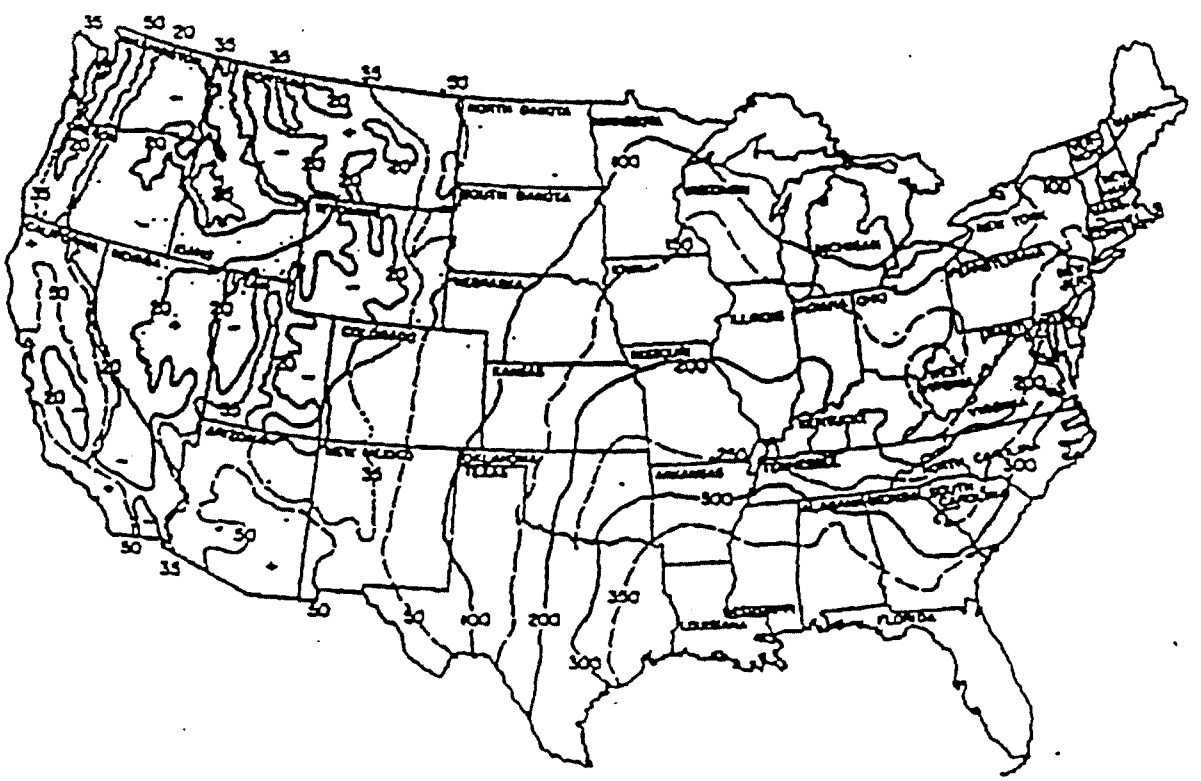

Figure 20. Average annual values of rainfall-erosivity factor R.[11]

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TABLE 6. VALUES OF THE FACTOR LS FOR SPECIFIC COMBINATIONS OF SLOPE LENGTH AND STEEPNESS[11]

% Slope	Slope length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.26
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.31	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.5	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.1	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0[4]	15.0	18.0	22.0	25.0	31.0	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

Values given for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the range of the research data and, therefore, less certain than the others.

overall effective LS value. If two segments are sufficient, multiply by 0.71 and 1.29.

Factor C in the USLE is the ratio of soil loss from land cropped under specified conditions to that from clean-tilled, continuous fallow. Therefore, C combines effects of vegetation, crop sequence, management, and agricultural (as opposed to engineering) erosion-control practices. On landfills, freshly covered and without vegetation or special erosion-reducing procedures of cover placement, C will usually be about unity. Where there is vegetative cover or significant amounts of gravel, roots, or plant residues or where cultural practices increase infiltration and reduce runoff velocity, C is much less than unity. Estimate C by reference to Table 7 for anticipated cover management, but also consider changes that may take place in time. Meadow values are usually most appropriate. See Reference 1 for additional guidance.

Factor P in the USLE is similar to C except that it accounts for additional erosion-reducing effects of land management practices that are superimposed on the cultural practices, e.g., contouring, terracing, and contour strip-cropping. Approximate values of P, related only to slope steepness,

are listed in Table 8. These values are based on rather limited field data, but P has a narrower range of possible values than the other five factors.

TABLE 8. VALUES OF FACTOR P[11]

Practice	Land slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

Example: An owner/operator proposes to close one section of his small landfill with a sandy clay subsoil cover having the surface configuration shown in Figure 21. The factor R has been established as 200 for this locality. The evaluator questions anticipated erosion along the steep side and assigns the following values to the other factors in the USLE after inspecting Tables 5 through 8:

$$K = 0.14 \quad LS = 8.3 \quad C = 1.00 \quad P = 0.90$$

The rate of erosion for the steep slope of the landfill is calculated as follows:

$$A = 200\ (0.14\ \text{tons/acre})\ (8.3)\ (1.00)\ (0.90) = 209\ \text{tons/acre}$$

This erosion not only exceeds a limit recommended by the permitting authority but also indicates a potential

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The vulnerability of knoll-like configurations to wind erosion can be evaluated by the use of Figure 22. An adjustment factor is obtained as an erosion loss percentage of 100 or more in comparison with erosion loss from a similar flat surface. This factor should be used to estimate the effects of sides of landfills that may present a knoll-like configuration toward the prevailing winds.

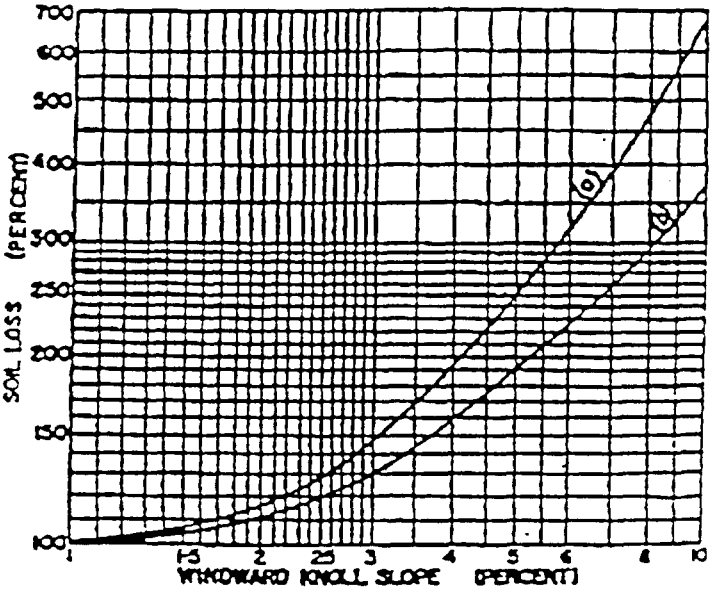

Figure 22. Knoll adjustment (a) from top of knoll and (b) from upper third of slope.[14] (Reproduced by permission of Soil Science Society of America.)

Another general rule of thumb[15] provides that 1V on 2H is the maximum slope on which vegetation can be established and maintained, assuming ideal soil with low erodibility and adequate moisture-holding capacity. In soils less than ideal, maximum vegetative stability cannot be attained on slopes steeper than about 1V on 3H. Optimum vegetative stability generally requires slopes of 1V on 4H or flatter. Similarly, there are limits to the inclination where mowing maintenance is planned. The limit can be as low as 1V on 6H for grassed ditches where two slopes meet at the bottom, but more commonly the limit is about 1V on 3H.

DRAINAGE EVALUATION PROCEDURE

Check Overall Surface Drainage System — Step 21

Examine the documentation to establish that drainage of surface runoff from the covered area and surroundings has been thoroughly addressed. Maps presenting topography or other descriptions of surface configuration should be carefully reviewed to see that rainfall or snow melt on any part of the site is free to move downslope without encountering obstacles that might

A1-7

TABLE 9. THRESHOLD VELOCITY FOR EROSION IN DITCHES

Soil	V_{max}, feet/second
GP	7-8
GW, GC	5-7
GM	2-5
SC	3-4
SM	2-3
SW, SP	1-2
CL, CH	2-3
ML, MH	3-5

of the structure to transmit the water. Where the capacity is too small, water will back up and form a pond, at least temporarily.

Check Gas Drainage

Step 24

Municipal waste usually generates methane and carbon dioxide. Industrial and hazardous wastes may also produce these gases and may contain sufficient other volatile components to be of concern (see Step 11). Depending on location, land use, and the proximity of buildings, there may be a need for a careful review of the routes of gas drainage.* Methane leakage occasionally threatens human life by potential for explosion. Volatile compounds such as HCB and PCB may present a health or environmental problem. More commonly landfill gases pose a serious threat to the success of vegetation in the long-term.[16] Guidance on the best soils for blocking gas or, at the other extreme, for conveying gas is given in Step 8. The effects of water content, thickness, and layering of cover are discussed in Steps 11 and 15. What remains is commonly to connect the broad collecting layers to surface vents, sometimes through linear drainage features consisting of gravel-filled trenches in which perforated collector pipes are embedded. See Step 15 for criteria on gravelly drains. Details of the system should be submitted with the permit application and should include the features for venting. Reference 17 reviews the passive and induced (pumped) venting systems.

VEGETATION EVALUATION PROCEDURE

Rapid establishment and maintenance of vegetation can be accomplished on soil covering solid waste only by carefully addressing soil type,

*Step 24 is unnecessary for wastes containing no garbage or volatile chemicals.

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APPENDIX H.5

COVER INFILTRATION ANALYSIS

CALCULATION PACKAGE

COVER INFILTRATION ANALYSES

Calculation Package Prepared by Advanced Earth Sciences, Inc.

December 2002

Prepared by: _____ **Reviewed by:** _____

P.J. ANANTHANATHAN SUJI SOMASUNDARAM, GE.

Calculation Packages

A. Laboratory Testing for Infiltration Analyses

B. Weather Data for Infiltration Analyses

C. RCRA Subtitle C Equivalent Cover

D. RCRA Subtitle D (CCR Title 27) Equivalent Engineered Soil Cover

E. RCRA Subtitle D (CCR Title 27) Equivalent GCL Cover

F. RCRA Subtitle D (CCR Title 27) Equivalent Asphalt and Concrete Cover

A. LABORATORY TESTING FOR INFILTRATION ANALYSES

A. Laboratory Testing for Infiltration Analyses

In order to select suitable representative samples for hydraulic characterization of the cover, bulk samples of soil were collected from the upper 5 feet of existing cover from each of 13 borings (G-01 through G-13). The borings, distributed within the Subtitle C 'Dial' area, and the surrounding Subtitle D area are considered representative of the existing cover soils within the project area. The thirteen bulk samples G-1 through G-13 are considered to be representative of the range of anticipated soil types for engineered soil covers and cover components proposed for the site. Results of geotechnical and hydraulic laboratory testing performed on these samples for infiltration analyses are summarized in Table A-1. Geotechnical testing was performed at the Kean Tan laboratory in Southern California. Unsaturated Hydraulic characteristics tests were performed at the Daniel B Stephens and Associates (DBSA) laboratory in New Mexico.

A.1 Geotechnical Characteristics

Laboratory geotechnical tests included classification tests (Atterberg limits and gradation) and Modified Proctor compaction tests, and flexible wall saturated hydraulic conductivity tests (ASTM D5084) on samples remolded to 85 percent and 90 percent of maximum dry density (ASTM D1557). Based on the laboratory test program the following conclusions may be made regarding the cover material characterization:

- Existing Cover soils within upper 5 ft are predominantly Clayey Sand (SC) with varying amounts of Gravel. Limited areas of Sandy Clay (CL) and Clayey Gravel (GC) were encountered.
- Gravel Content ranges from 13% to 50% (average 25%). Typically gravels are finer than ¾ - inch. Grain size curves show that up to 5% of particles are greater than ¾ - inch.
- Fines content ranges from 17% to 54% (average 34%). Fines are predominantly lean clays (CL) with LL= 23 to 30 and PI = 11 to 16.
- Maximum dry density (ASTM D1557) ranges from 121 pcf to 129 pcf (average = 124 pcf); optimum moisture content (OMC) ranges from 9% to 12% (average = 10%).

Flexible wall saturated hydraulic conductivity tests (ASTM D5084) were performed on four representative samples of soil (G-01, G-05, G-09 and G-13) remolded to 85% and 90% of maximum dry density (ASTM D1557). The samples were screened through the ¾ -inch sieve, remolded to 4-inch diameter samples and tested under confining pressure of 5 psi. The larger diameter remolded samples were used so that the significant gravel size component of the soil could be incorporated into the test sample, i.e. the sample diameter is greater than 5 times the maximum particle size.

The results (Table A-1) show that the average (geometric mean) saturated hydraulic conductivity (Ks) of material remolded to 85% relative compaction (RC) is 6.7E-05 cm/sec; the average Ks (geometric mean)

of material remolded to 90% RC is 3.5E-05 cm/sec. The Ks values decrease with increasing fines content; and decrease with decreasing gravel content. This is illustrated in Figures A-1 and A-2. These relationships of Ks with fines content and gravel content may be used as the basis of developing material specifications for the engineered cover soils.

Ks values were also determined on the five representative soil samples (G-03, G-04, G-06, G-08 and G-12) selected for unsaturated testing, as part of the suite of tests for unsaturated hydraulic characteristics. These tests were constant head hydraulic conductivity tests performed on samples remolded to 85% RC.

Constant Head hydraulic conductivity tests generally resulted in lower Ks values (geometric mean of 2.49E-04 cm/sec) than ASTM D5084 tests (on average by a factor of 4). The ASTM D5084 tests samples are enclosed in a flexible membrane and subjected to a confining pressure of 5 psi, prior to testing. The confining pressure of 5 psi was chosen to represent anticipated overburden pressures within the cover system, and be sufficiently large to prevent leakage of pore fluid between the sample and membrane. The constant head test samples on the other head were remolded in a fixed ring permeameter and tested with no confining pressure. The discrepancy of Ks values between the two test methods may be attributed to the following reasons:

- Because of the large gravel content in the soils tested, the contact between the constant head test sample and the sides of the rigid permeameter is expected to be such that leakage between the sample and the mold is very likely. In the ASTM D5084 test, the flexible membrane under confining pressure prevents any leakage, and therefore the measured Ks values are lower.

- Ks values generally decrease with increasing confining pressure; since the constant head tests were performed with zero confining pressure, constant head Ks values are expected to be slightly higher than ASTM D5084 values.

Since the ASTM D5084 is a more reliable test (controlled confining pressures and no leakage), and is the more accepted method by the regulatory community, the results of the ASTM D5084 tests will be used in lieu of the Constant Head Ks tests for infiltration modeling. The ASTM D5084 test will also be used as the QA/QC test method for Ks during construction.

A.2 Unsaturated Hydraulic Characteristics

The unsaturated hydraulic characteristics of soils may be represented by two functions: the moisture storage function relating volumetric moisture content to soil suction, and the hydraulic conductivity function relating hydraulic conductivity to soil suction.

The van Genuchten (1980) function was used to describe the volumetric water content/soil suction relationship, as

$$\theta = \theta_r + (\theta_s - \theta_r)\left[1 + (\alpha h)^n\right]^{-m}$$

Where:

m	=	$1 - 1/n$
θ	=	volumetric moisture content
θ_r	=	residual volumetric moisture content
θ_s	=	saturated volumetric moisture content
h	=	suction head
α and n	=	parameters that define the shape of the characteristic curve

The second function, relating the hydraulic conductivity to soil suction is based on the Mualem conductivity model (Mualem, 1976) and may be expressed as

$$K = K_s \frac{\left[1 - (\alpha h)^{n-1}\left\{1 + (\alpha h)^n\right\}^{-m}\right]^2}{\left\{1 + (\alpha h)^n\right\}^{\frac{m}{2}}}$$

Where K is the unsaturated hydraulic conductivity and K_s is the hydraulic conductivity at saturation. The unsaturated hydraulic characteristics of a soil can, therefore, be described by five (5) independent parameters: θ_r, θ_s, α, n, and K_s.

Five representative samples (G-03, G-04, G-06, G-08 and G-12) were selected and remolded to approximately 85% of the maximum dry density in a 6-inch diameter mold and tested to obtain unsaturated hydraulic characteristics (K_s, θ_r, θ_s, α and n). Testing was conducted at the Daniel B Stephens and Associates Laboratory in Albuquerque, New Mexico (DBS&A). The results of the laboratory testing on these five remolded samples are summarized in Table A-1. Detailed results are provided in Appendix --.

In order to cover the full range of pore pressure or suction values ranging from positive pore pressures (saturated conditions) to large values of negative pressure head (typically on the order of 1 x 10^6 cm of water for low values of moisture content), a single test setup is inadequate. Typically, different types of tests based on various Soil Science Society of America (SSSA) and ASTM methods are performed for different pressure head ranges on the same sample to obtain a complete characteristic curve. The suite of tests conducted on each sample were as follows:

Test	**Test Standard**	**Range of Negative Pore Pressure (cm of water)**
Hanging Column Method	Methods of Soil Analyses (MOSA), Ch. 26 (SSSA, 1986)	0-150
Pressure Plate Method	ASTM D2325/MOSA Ch. 26	150 to 5000

Water Activity Meter	MOSA, Ch. 24	5×10^3 to 5×10^4
Relative Humidity Box	MOSA, Ch. 26	$> 5 \times 10^4$

A total of 7 or 8 data points were generated from the above suite of tests. The volumetric water content functions were then derived by best-fitting the van Genuchten (1980) curve through the individual data points. The van Genuchten parameters in conjunction with the Ks value define the unsaturated hydraulic conductivity function for the material.

Previously (prior to the TM-15 program), a single bulk sample (TS-085) of the existing cover soils was remolded to approximately 85% and 90% of maximum dry density and tested for hydraulic characteristics. The sample tested (TS-085), had 27% gravel, 38% sand, and 35% fines (with liquid limit of 30 and PI of 9), and was classified as clayey sand with gravel (SC). The sample was remolded to 2.5 – inch diameter test specimens for testing. The hydraulic parameters for Sample TS-085 remolded to 85% and 90% RC are summarized in Table A-2.

The volumetric water storage functions and the relative hydraulic conductivity functions for all of the cover soil samples remolded to 85% RC are illustrated in Figures A-3 and A-4, respectively. The figures include the results for the five TM-15 samples and the previously tested sample (TS-085). The figures show that the moisture storage and relative hydraulic conductivity functions of all six 85% RC samples fall within a relatively narrow range. The plots also show the average of the five TM-15 samples (plotted based on the average van Genuchten parameters). The parameters representing the average curve were used to model the hydraulic characteristics of the engineered soil cover (Monocover).

The moisture storage function and hydraulic conductivity function for the two TS-085 samples (remolded to 85% and 90% RC, respectively) are shown in Figures A-5 and A-6. The results show that changing the degree of compaction from 85% to 90% has only a minor impact on the moisture storage and hydraulic conductivity functions.

The unsaturated hydraulic parameters described above will be used as input for the infiltration modeling of engineered soil covers constructed with existing on – site cover soils. The van Genuchten parameters will be used as input for the UNSAT-H model. The wilting point and field capacity values required for HELP Model simulations will be obtained from the soil moisture storage functions.

A.3 References

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Table A-1
Laboratory Test Program for Infiltration Analyses
WDI Superfund Site - TM 15

Boring	Location	Sample	Depth (ft)	USCS Class	Soil Description	Laboratory Test Results										
						Sieve Analyses GR:SA:FI	Atterberg Limits LL:PL:PI	Modified Proctor Compaction (ASTM D1557) Max DD	OMC	Sat. Hyd. Conductivity* (ASTM D5084) cm/sec 85% RC	90% RC	Unsaturated Parameters # Ks** (cm/sec)	α (1/cm)	n	θ_s	θ_r
G-01	RCRA Area	Bulk	0-5	CL/SC	sandy lean clay	13:33:54	31:15:16	123.0	12.0	1.60E-05	9.30E-06					
G-02	South	Bulk	0-5	SC	clayey sand w/ gravel	27:39:34			11.5							
G-03	South	Bulk	0-5	SC	clayey sand w/ gravel	25:40:35	31:15:16	120.5	11.5			1.60E-04	0.043	1.232	0.39	0
G-04	Southeast	Bulk	0-5	SC	clayey sand w/ gravel	20:43:37	26:15:11	123.0	11.5			6.50E-04	0.028	1.258	0.41	0
G-05	Southeast	Bulk	0-5	SC	clayey sand w/ gravel	15:45:40	23:12:11	125.0	10.0	3.20E-05	2.20E-05					
G-06	East	Bulk	0-5	SC	clayey sand w/ gravel	18:43:39	26:14:12	124.0	11.0			2.00E-04	0.020	1.231	0.40	0
G-07	East	Bulk	0-5	SC	clayey sand w/ gravel	25:48:27			10.0							
G-08	RCRA Area	Bulk	0-5	SC	clayey sand w/ gravel	15:42:43						1.60E-04	0.004	1.267	0.37	0
G-09	RCRA Area	Bulk	0-5	GC	clayey gravel w/ sand	50:29:21	30:17:13	128.5	9.0	1.60E-04	3.90E-05					
G-10	RCRA Area	Bulk	0-5	SC	clayey sand w/ gravel	34:40:26										
G-11	North	Bulk	0-5	SC	clayey sand w/ gravel	18:40:42										
G-12	North	Bulk	0-5	SC	clayey sand w/ gravel	28:47:25		125.0	9.5			2.90E-04	0.020	1.236	0.39	0
G-13	North	Bulk	0-5	SC/GC	clayey sand w/ gravel	41:42:17		126.5	9.0	2.40E-04	1.80E-04					
							Mean	***124.4***	***10.4***	***6.66E-05***	***3.46E-05***	***2.49E-04***	***0.023***	***1.245***	***0.39***	***0***

Undisturbed Samples

						Insitu Conditions Dry density (pcf)	Moisture (%)	Sat. Hyd. Conductivity (cm/sec)
G-08	RCRA Area	Drive	1.5	SC		94.3	8.1	3.70E-06
G-09	RCRA Area	Drive	5.5	SC		105.6	13.9	6.00E-07

Notes: * Saturated hydraulic conductivity tests (ASTM D5084) on bulk samples screened through 3/4 -inch sieve and remolded to 4-inch dia test samples at 90% and 85% of maximum dry density @ optimum moisture content (ASTM D1557)

Unsaturated hydraulic parameters obtained by SSSA methods on 6 - inch dia samples remolded to 85% of maximum dry density (ASTM D1557)

** Ks -saturated hydraulic conductivity by constant head method, performed as part of the unsaturated suite of tests

Table A-2
Unsaturated Hydraulic Characteristics for Sample TS-085
WDI Superfund Site

Sample #	Remolded Dry Density (pcf)	Initial Moisture Content (gravimetric %)	Approximate Relative Compaction (%)	Calculated Porosity (%)	K_s (cm/sec)	θ_r	θ_s	α (1/cm)	n
TS-085	106.7	6.6	85	35.5	2.70E-05	0.0163	0.3457	0.0118	1.2788
TS-085	112.3	7.1	90	32.2	5.40E-06	0.00	0.3237	0.0045	1.2814

Notes:

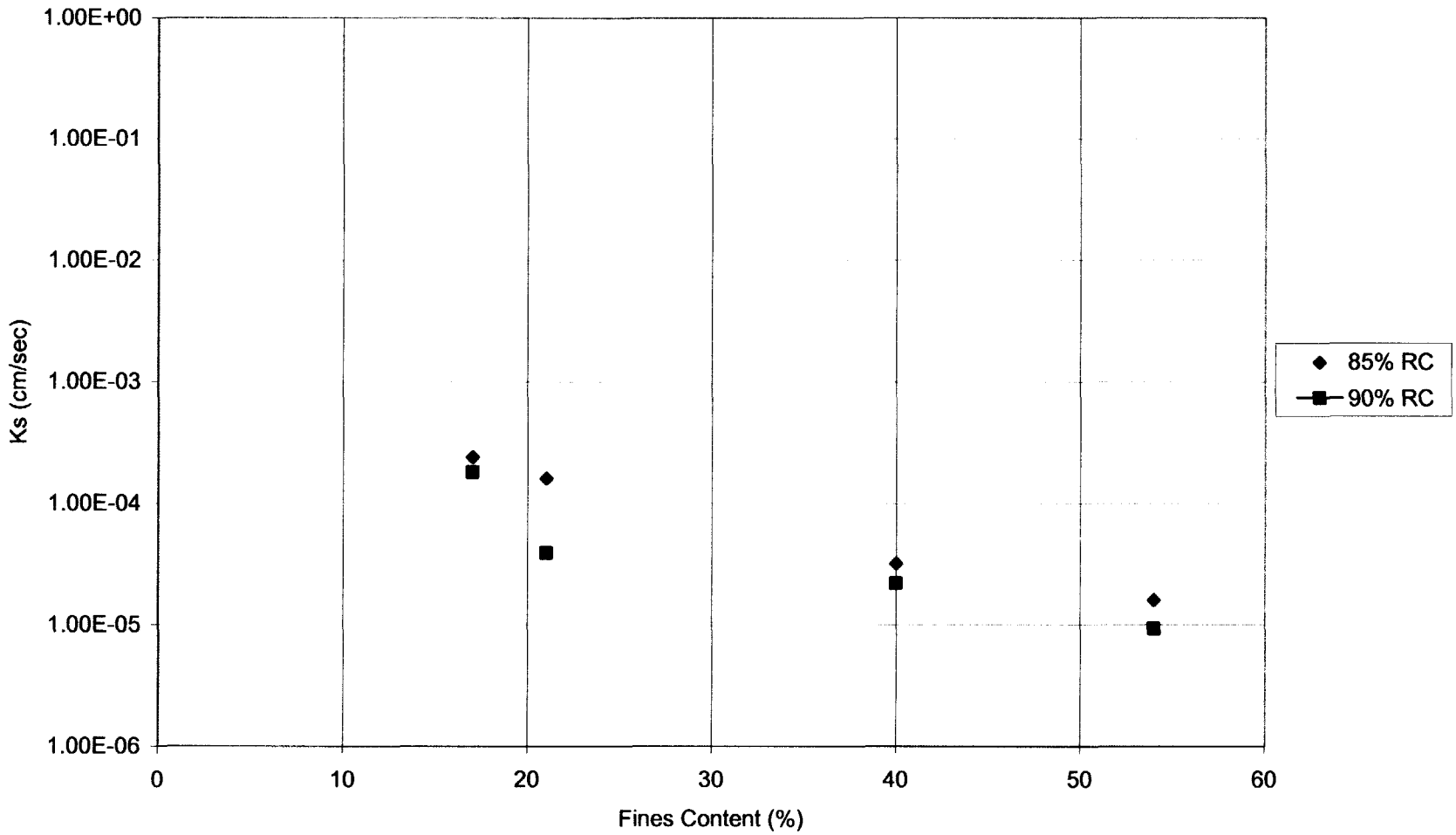
Samples were remolded to 2.5 - inch diameter test specimens

K_s Saturated Hydraulic Conductivity

θ_r Residual Volumetric Moisture Content

θ_s Saturated Volumetric Moisture Content

α, n Van Genuchten Parameters



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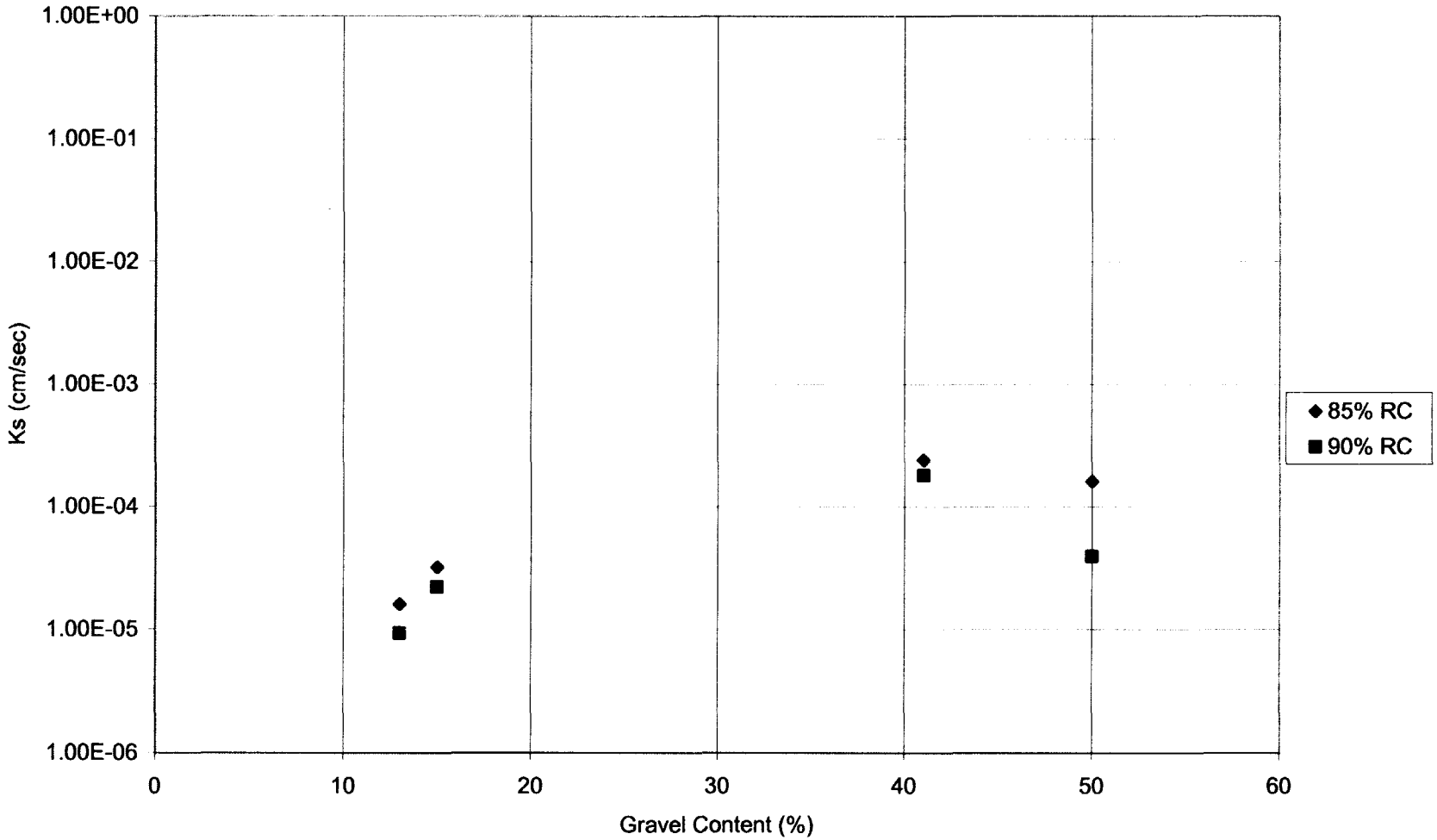
Unsaturated flow modeling

Ks (ASTM D5084) versus Fines Content

Date:

Figure A-1



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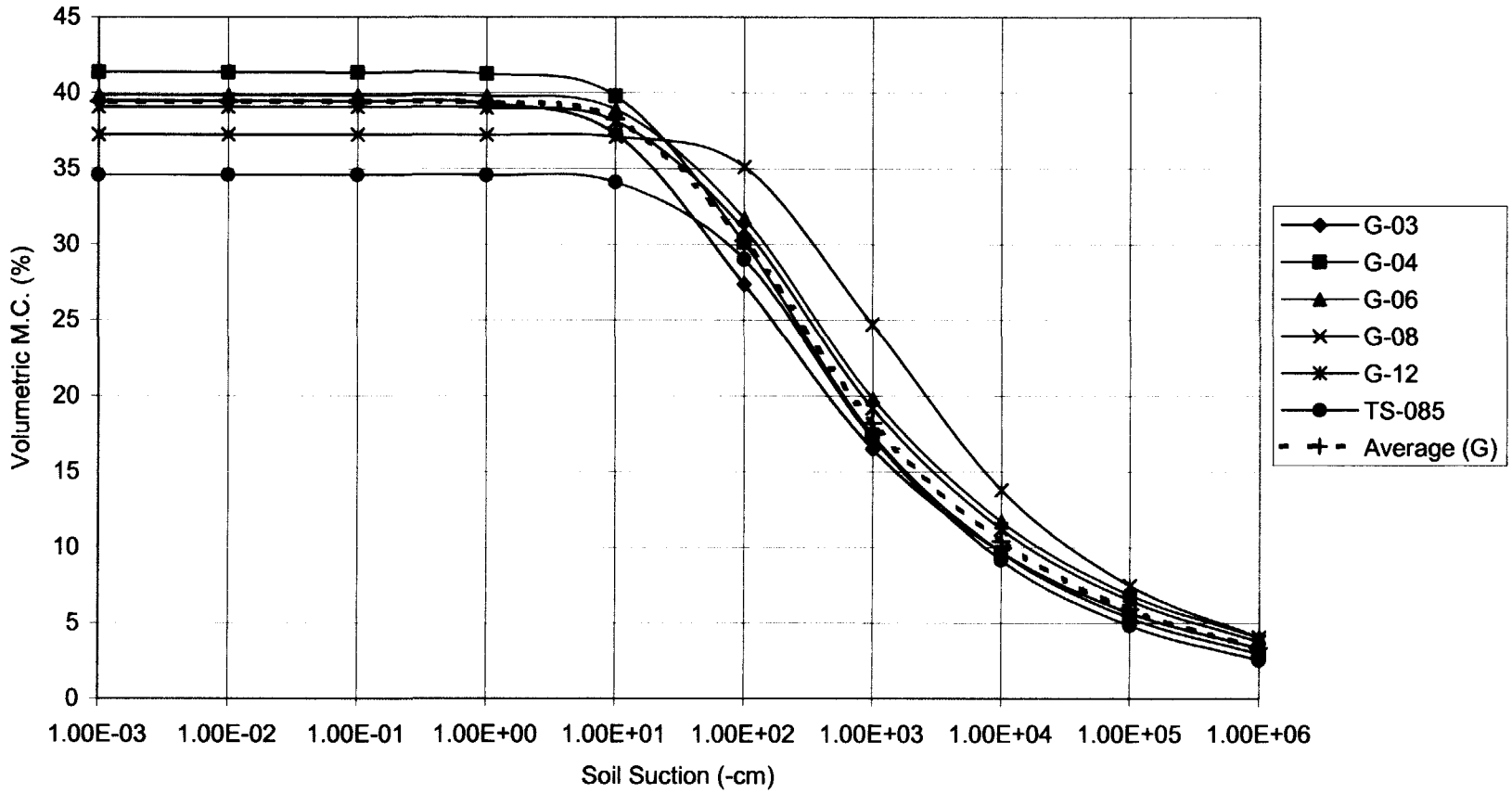
Ks (ASTM D5084) versus Gravel Content

Date:

Figure A-2



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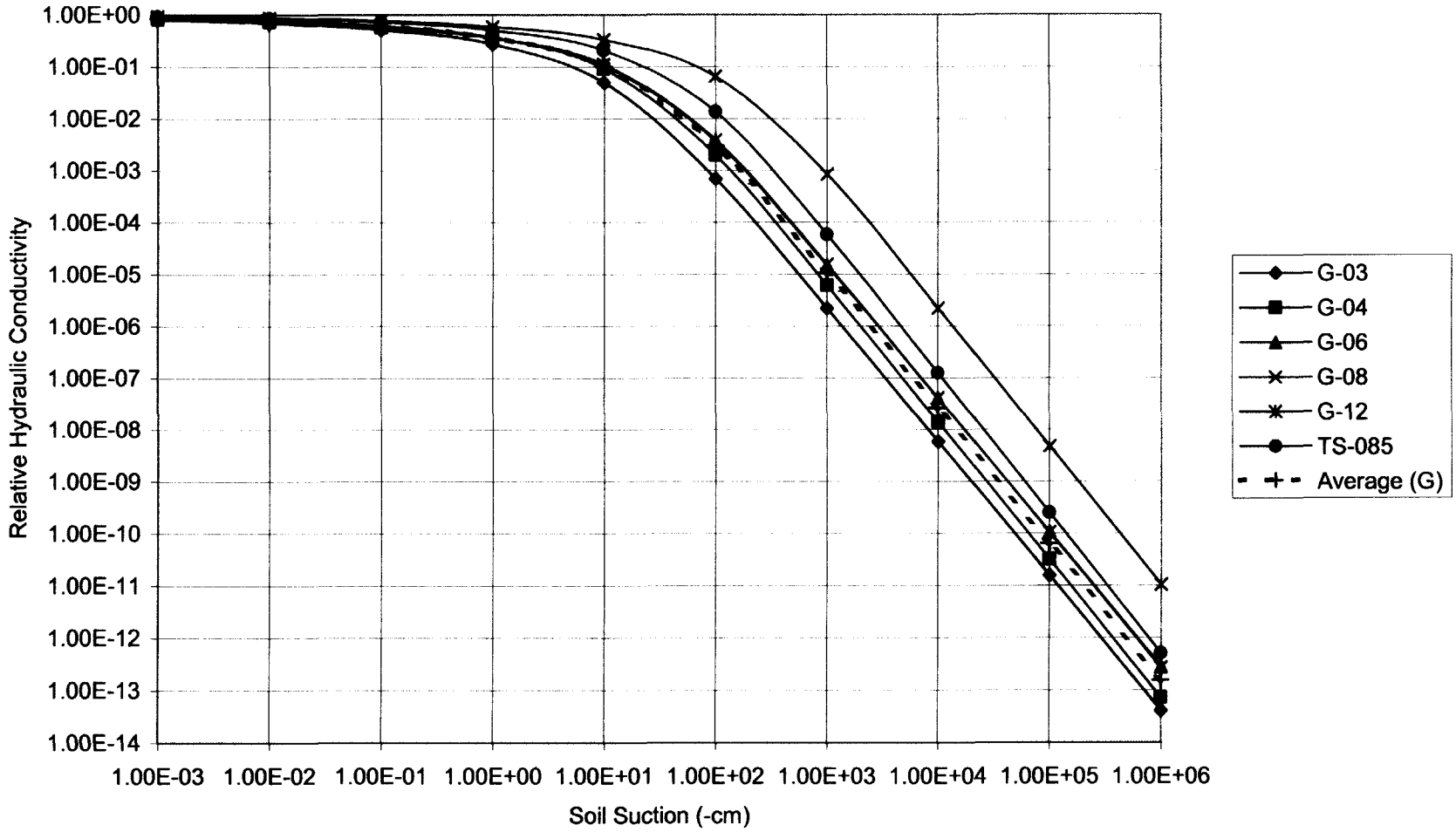
Unsaturated flow modeling

Volumetric Moisture Storage Functions

Date:

Figure A-3



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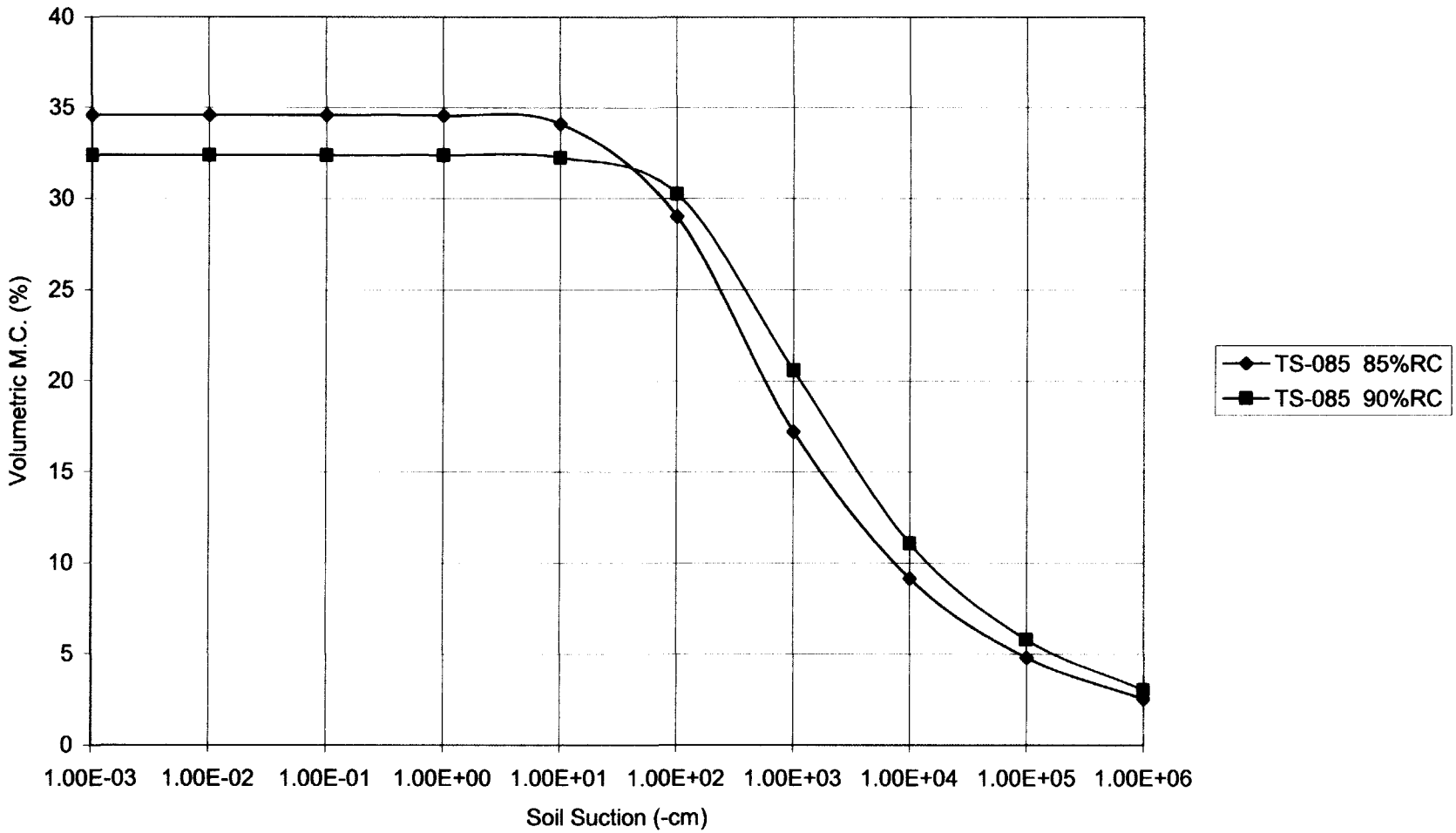
WDI Superfund site
Unsaturated flow modeling

Relative Hydraulic Conductivity Functions

Date:

Figure A-4



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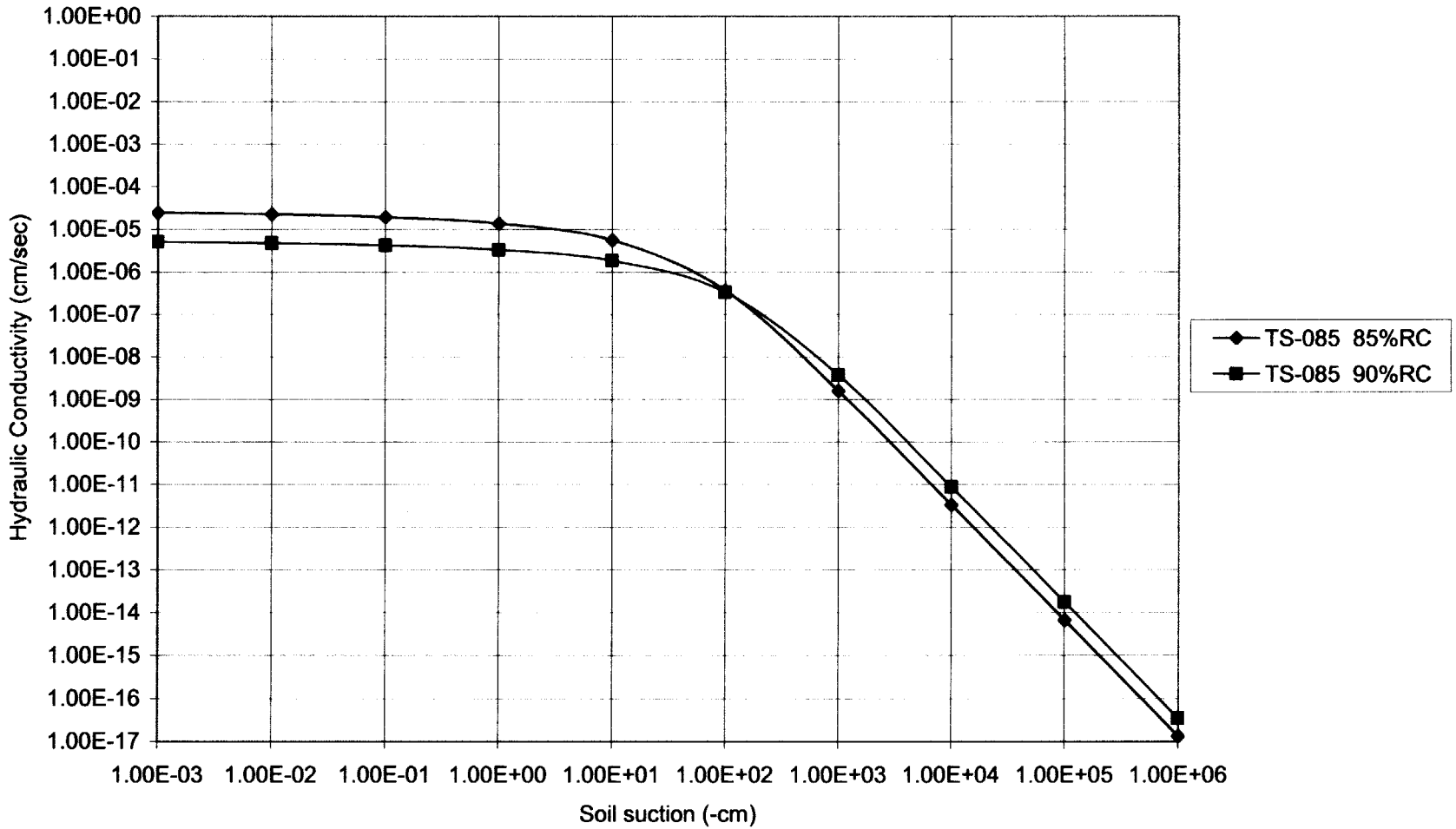
Unsaturated flow modeling

TS-O85 Moisture Storage Functions

Date:

Figure A-5



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WDI Superfund site
Unsaturated flow modeling

TS-085 Hydraulic Conductivity Functions

Date:

Figure A-6

B. Weather Data For Infiltration Analyses

B. WEATHER DATA

Weather and climate data required for the infiltration modeling includes daily values of precipitation, maximum and minimum temperature, dew point, solar radiation and wind speed. Two primary sources were reviewed and evaluated for relevant data from monitoring stations close to the WDI site. These sources included:

- The National Oceanic and Atmospheric Administration (NOAA) web site for long-term information on precipitation at National Weather Service stations in the vicinity of the project site
- The California Irrigation Management Information System (CIMIS) web site for records on precipitation, temperature, dew point, solar radiation and wind speed at California Department of Water Resources weather stations located in the vicinity of the project site.

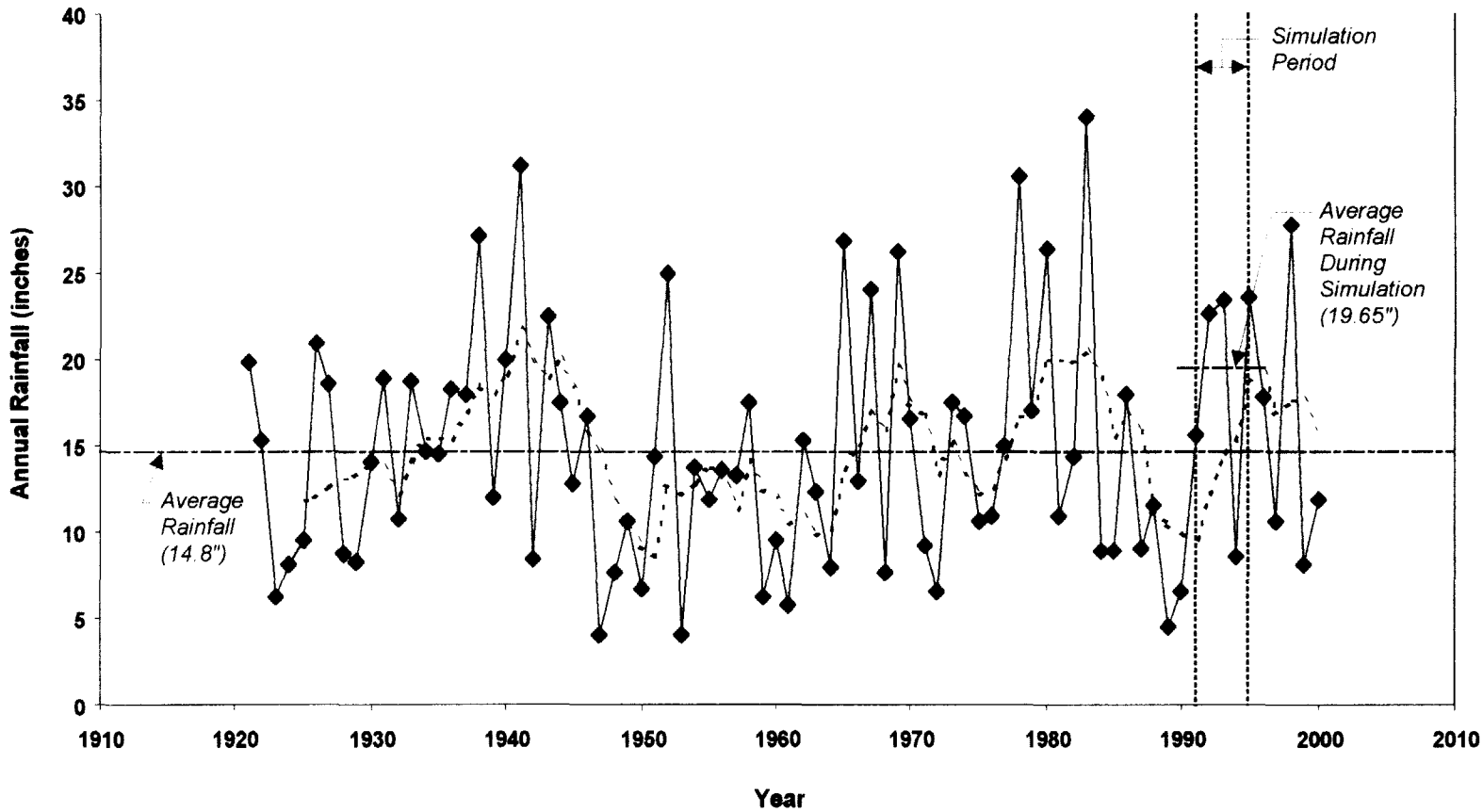
The NOAA weather station closest to the project site with long-term precipitation records is the Downtown Los Angeles station located approximately 13 miles away. Annual rainfall data for Downtown Los Angeles from 1920 to the present is shown on Figure B-1. The figure also shows the average rainfall for the 80-year period (14.8 inches), and the running 5-year average rainfall (average of the previous 5 years). The closest CIMIS weather station to the project site with all of the climate information required for unsaturated flow modeling (daily values of precipitation, maximum and minimum temperature, dew point, solar radiation and wind speed) is the Pomona Station located approximately 12 miles away. The Pomona station is located at an elevation of 730 feet above mean sea level (MSL), compared to the project site elevation of approximately 165 feet MSL. Daily weather records at the Pomona station are available from March 1989.

The data on Figure B-1 shows that the average annual rainfall for the Los Angeles basin is 14.8 inches. The wettest 5-year period on record at this station occurred from 1937 through 1941, with a 5-year average of 22.7 inches. However, the detailed daily weather data required for modeling purposes is not available for this period. The most recent period with a significant 5-year rainfall average for which detailed daily weather records are available, occurred in the early nineties (Figure B-1). Accordingly, the 5-year period from 1991 through 1995 was selected as the model design simulation period. The annual precipitation record at the Pomona weather station for this 5-year simulation period is shown in Figure B-2. The average rainfall during this period of 19.65 inches is only about 3 inches lower than the maximum recorded 5-year average of 22.7 inches. The simulation period includes 3 years for which the annual rainfall (22.28 inches, 27.96 inches and 23.04 inches) exceeded the 70-year mean + 1 standard deviation for the area.

The daily weather data for the 5-year design simulation period was used for both UNSAT-H and HELP model analyses

30-Year Simulation for HELP - Model Analyses

In addition to the 5-year design – simulation period described above, a long-term, 30-year simulation period was employed to evaluate the long-term performance of the alternative covers with the HELP Model. Daily weather data (precipitation, temperature and solar radiation) for the 30 – year simulation were stochastically generated by the HELP Model. The HELP Model generates this synthetic data based on the generation parameters available for the local region, and biased by the monthly average values for precipitation and rainfall for the site. The monthly averages for the site were obtained from the design 5-year simulation period described above. The minimum and maximum values of annual rainfall for the 30 – year simulation period were 9.45 inches and 34 inches, respectively. The 30-year precipitation data used for the simulations is shown in Figure B-3.



Explanation

Annual

5-year Average

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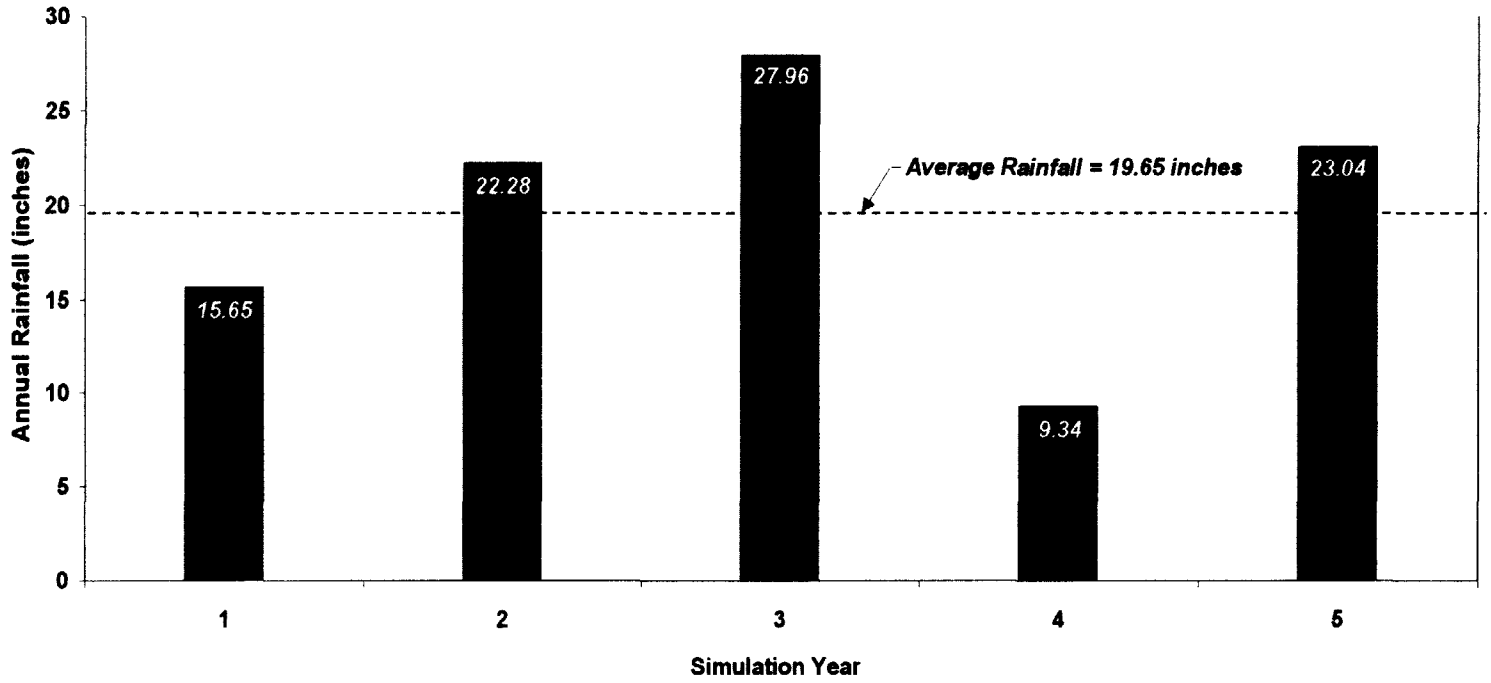
TRC

Annual Rainfall Downtown Los Angeles

2-02

Figure B-1



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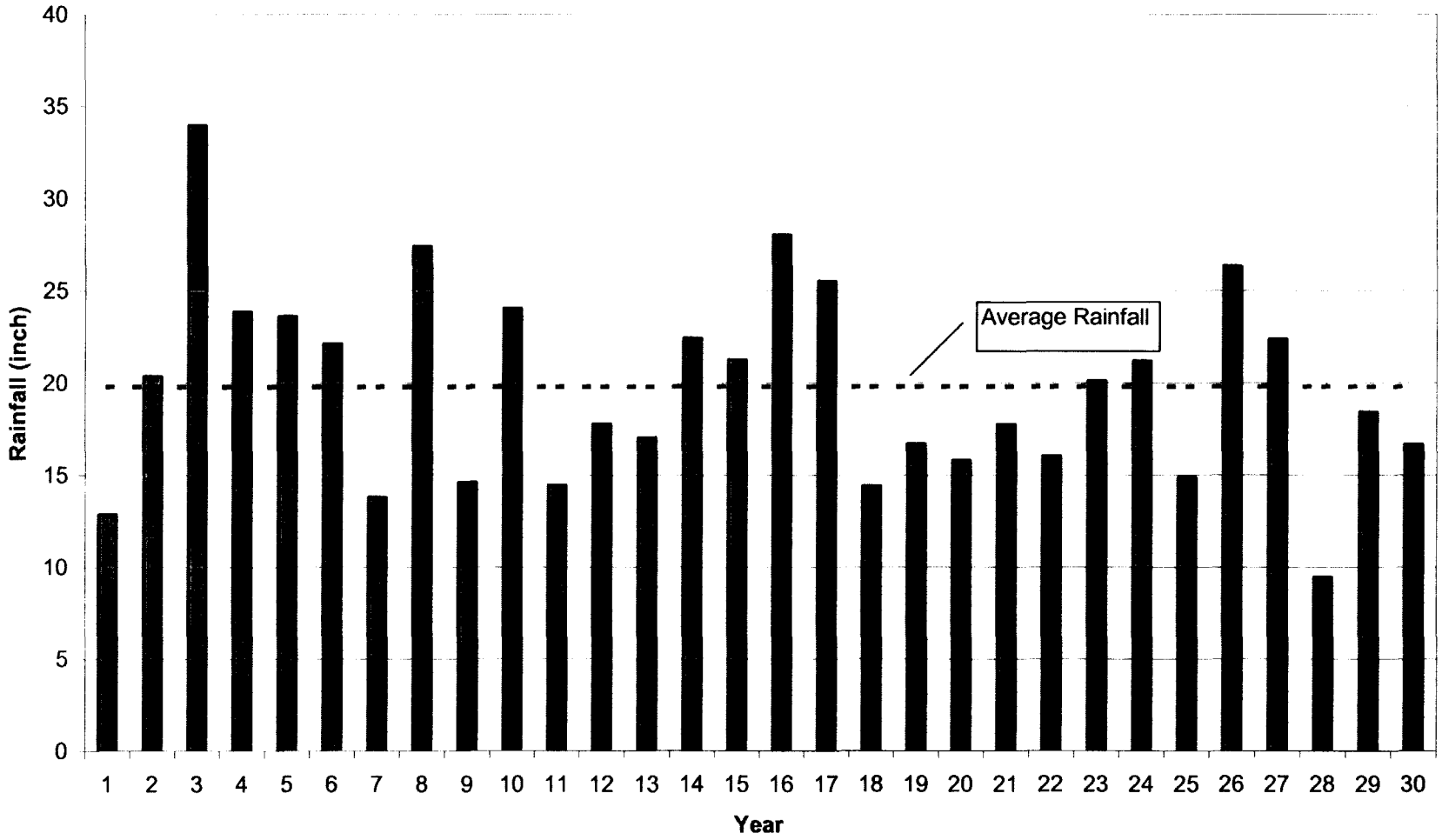
WDI Superfund Site
Unsaturated Flow Modeling
TRC

Rainfall During Simulation Period Pomona CIMIS Station

2-02

Figure B-2



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WDI Superfund site
Unsaturated flow modeling

30-Year Rainfall Data Generated by HELP Model

Date:

Figure B-3

C. RCRA SUBTITLE C EQUIVALENT COVER

C. RCRA SUBTITLE C EQUIVALENT COVER

C.1 Objective

To evaluate and compare hydraulic performance of alternative designs for the RCRA Subtitle C cover, and select an equivalent alternative cover design. The RCRA Subtitle C cover is proposed for the 'Dial' area of the WDI site. The evaluation of hydraulic performance and equivalence demonstration of alternative covers are performed using the HELP Model, Version 3.07 (Schroeder et al, 1997).

C.2 Alternative Cover Designs:

Three alternative cover designs to the RCRA Subtitle C cover were evaluated. The prescriptive Subtitle C cover and the three alternatives are illustrated in Figure C-1.

The prescriptive RCRA Subtitle C cover for the site consists of (from top to bottom): 2-foot thick vegetation / top soil layer; filter layer; 1-foot thick gravel drainage layer; geomembrane layer (minimum 20 mil thick); and a 2-foot thick low-permeability soil (barrier) layer with a hydraulic conductivity of 1.0E-07 cm/sec or lower; underlain by the gas collection system and foundation layer.

In Alternative 1, the 1-foot thick gravel drainage layer is replaced by a geocomposite drainage net, and the composite geomembrane / low-permeability soil layer is replaced with a composite 60-mil thick HDPE geomembrane / bentonite layer (i.e. 'Gundseal' or equivalent). The other layers remain unchanged.

Alternative 2 is similar to Alternative 1, except that the geomembrane / bentonite composite (Gundseal or equivalent) is replaced by a 60-mil thick HDPE geomembrane layer on a geosynthetic clay liner (GCL).

In Alternative 3, the composite geomembrane / low-permeability (Ks= 1.0E-07 cm/sec) soil layer of the prescriptive system is replaced by a 60 mil thick HDPE geomembrane on a 2-foot thick low-permeability layer consisting of selected site soils recompacted to 90% of maximum dry density (ASTM D1557) to give a hydraulic conductivity of 1.oE-05 cm/sec or smaller.

C.3 HELP Model Analyses

The infiltration analyses consisted of HELP model simulations of the prescriptive Subtitle C cover and the three alternatives under the design simulation period. Two different simulation periods were considered:

- A 5 – year sequence representing one of the wettest 5- year periods on record for the area
- A long-term 30 year simulation period

The water balance equation that forms the basis of the HELP Model analyses is:

$$\Delta S = P - ET - R - Perc - L$$

Where

ΔS	=	change in moisture storage in soil
P	=	precipitation
ET	=	evapotranspiration consisting of evaporation and transpiration
R	=	runoff
$Perc$	=	Percolation through the bottom of the cover
L	=	Lateral drainage

The water balance equation states that the change in the amount of water stored in the soil cover is equal to the total precipitation, minus the amount of water lost to surface runoff, evaporation, transpiration and percolation into the landfill. For the project site, precipitation consists of rainfall on the cover surface. It was assumed that no supplementary irrigation is applied on the cover surface to maintain/promote vegetation growth.

Percolation is the quantity of downward flow through the bottom of the cover system being simulated. This represents the quantity of flow into the landfill. Percolation is the parameter used to compare the performance and demonstrate equivalence of alternative cover systems.

The Input parameters for the HELP Model may be grouped into the following categories:

- Cover geometry (slope, layer thickness, drainage length)
- Weather related parameters (rainfall, temperature and solar radiation)
- Material parameters (porosity, wilting point, field capacity, saturated hydraulic conductivity, and initial moisture content)
- Vegetation characteristics (LAI, quality of vegetation, and rooting depth)

Each of the input categories is discussed below.

C.3.1 Cover Geometry

The cover layer system geometry of each of the 4 covers modeled is illustrated in Figure C-2. The upper 2-foot vegetative layer is the same for the prescriptive cover and all three of the alternatives. Each of the cover systems is underlain by a gas collection system and foundation layer. Since these two layers do not have a percolation control function, they were not included in the cover geometry simulated in the HELP Model analyses.

In order to calculate runoff, The Subtitle C 'Dial' was assumed to have a 2% slope and a maximum slope length of 335 feet. The Runoff Curve number was found to be in the range 80.1 to 85.6. The former (80.1) was obtained by modifying the curve number obtained from Figure 2 of the User's Guide for HELP (pp 36) to a slope of 2% and a slope length of 335 feet. The latter (85.6) was obtained by providing slope, slope length, soil texture and vegetation information (fair strand of grass). Both values were used in a parametric study, and the more conservative value of 80.1 was chosen for the simulations.

C.3.2 Weather Data

The weather and climate data used for the 5-year and 30-year design simulation periods is discussed in detail in Section B of this Calculation Package. The data required for the HELP model includes daily values of precipitation, temperature, solar radiation and evapotranspiration.

For the 5-year simulation, recorded data for the Pomona CIMIS weather station from 1991 through 1995 was used. For the 30-year, long-term simulation, stochastically generated (by the HELP Model based on monthly averages for the site) weather data was used.

C3.3 Material Parameters

Material properties required for the analyses include porosity, field capacity, wilting point and saturated hydraulic conductivity (Ks). The selected input parameters for the various components of the cover system are shown on Table C-1, and illustrated in Figure C-3. Results of laboratory testing for infiltration analyses are discussed in Section A of this calculation package.

The 2 –foot thick vegetative layer for all of the cover systems was assumed to consist of on-site cover soils recompacted to a relative compaction of 85% (ASTM D1557). The field capacity, wilting point and porosity of the vegetative cover was obtained as an average value from the 5 moisture storage curves developed for 85% RC remolded materials for the site (Table A-1). The Ks value for the vegetative soil layer was taken as the average of the ASTM D5084 hydraulic conductivity results, i.e. 6.70E-05 cm/sec (Table A-1). The Ks for the upper half of the vegetative soil layer was multiplied by 3 to allow for root channels (Table C-1, Figure C-3), as recommended by the HELP manual.

Material parameters for the gravel drainage layer, synthetic drainage net, bentonite layer, GCL and prescriptive low-permeability soil barrier layer (Ks=1.0E-07 cm/sec) were default values recommended by the HELP Manual. The Ks for bentonite and GCL was conservatively selected as 1.0E-08 cm/sec.

Field capacity, porosity and wilting point for the low-permeability layer of Alternative 3, was selected from the moisture storage curve for sample TS-085 remolded to 90% RC (Table A-2). The Ks value for this layer was assigned to be 1.0E-05 cm/sec, based on the results of the hydraulic conductivity tests on the sample.

The following quality assumptions were made for the HDPE geomembrane layer

Pinhole Density	= 1 hole/acre (0.5-1 range)
Installation defects	= 7 holes/acre (4-10 Fair)
Placement quality	= 3 (Good)

The HDPE/bentonite composite (Gundseal or equivalent) in Alternative 1 was modeled as two separate layers (HDPE and Bentonite), as in the case of the HDPE and GCL in Alternative 2. Therefore Alternatives 1 and 2 are hydrologically similar.

C.3.4 Vegetation Parameters

The following vegetation related parameters were used in the analyses

- Evaporative zone depth - vegetative cover depth
- Leaf Area Index - 2

- Growing season start day - 285
- Growing Season end day - 151
- Average wind speed - 3.03 (average of 5 year recorded data)

C.4 Results of Model Simulations

The results of the 5-year water balance analyses for the RCRA Subtitle C cover, consisting of annual and cumulative values of the various components of the water balance is shown in Figure C-4. Results of the 5-year water balance analyses for Alternatives 1 / 2, and Alternative 3 are shown in Figures C-5 and C-6, respectively. Alternatives 1 and 2 were modeled to be hydrologically the same, and therefore yielded identical results. The cumulative percolation for all four cover systems through the 5-year simulation period are compared in Figure C-7. The results of the long-term, 30-year simulation period are shown in figure C-8. The results show the percolation through all four cover systems is very small in comparison to the quantity of precipitation. However, the percolation through Alternatives 1 and 2 are smaller than the percolation through the prescriptive Subtitle C cover, whereas the percolation through Alternative 3 is more than an order of magnitude larger.

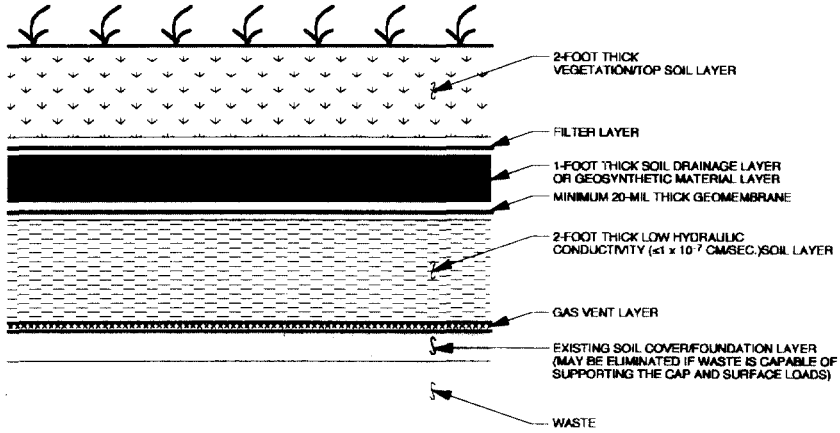
C.5 Conclusions and Recommendations

The results of the simulation show that either Alternative 1 or Alternative 2 may be used as an alternative to the prescriptive RCRA Subtitle C cover. Alternative 3 is not recommended. The choice of the appropriate alternative (between Alternatives 1 and 2) for the site may be based on economic and constructability considerations.

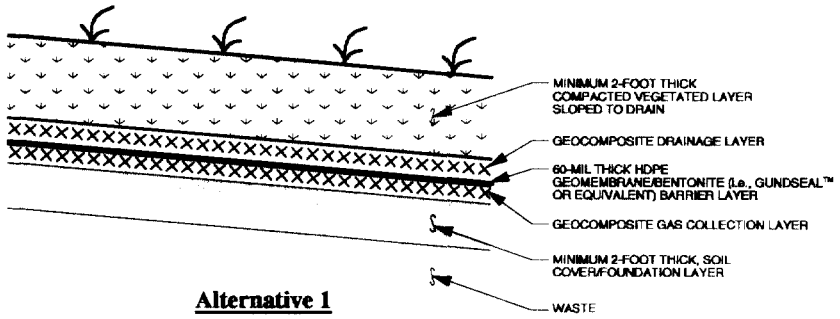
C.6 References

Shroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L. (1994, Updated 1997). "The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3," EPA 600/9-94/xxx, U.S. Environmental Protection Agency Risk reduction Engineering Laboratory, Cincinnati, OH.

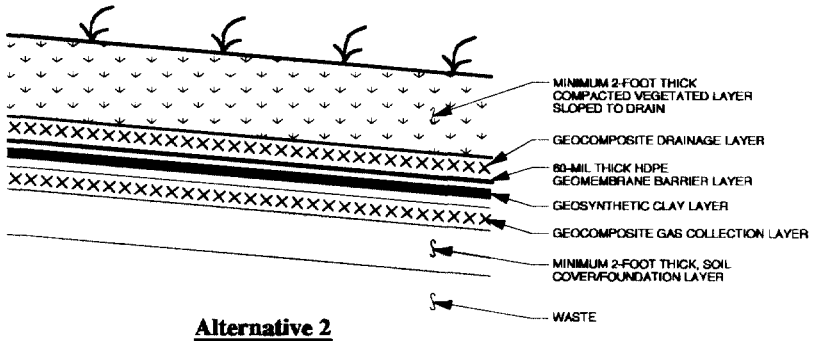
30747EPA6/12/02-01 REV. 06/12/02



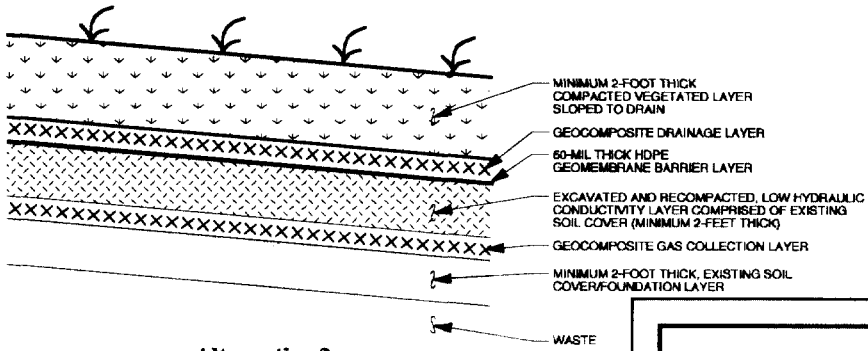
RCRA Subtitle C Prescriptive Cap



Alternative 1



Alternative 2



Alternative 3

Alternatives for RCRA-Equivalent Cap Design

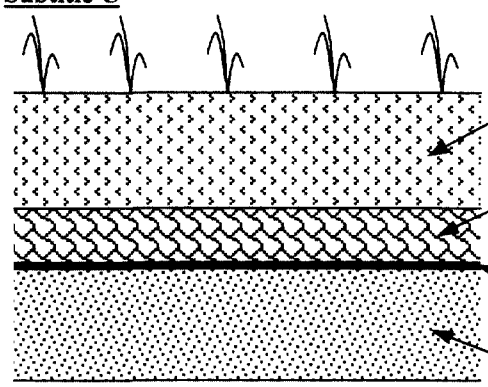
NOT TO SCALE

ALTERNATIVES FOR CONCEPTUAL DESIGN OF RCRA - EQUIVALENT CAP FOR HAZARDOUS WASTE

WASTE DISPOSAL, INC.
SANTA FE SPRINGS, CALIFORNIA

C-1

Subtitle C



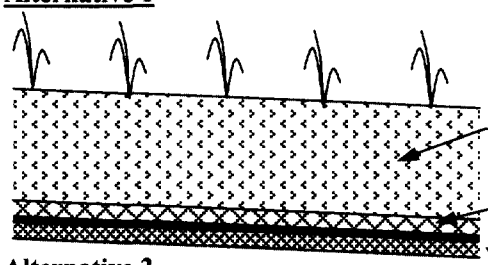
2 ft thick vertical percolation layer
Ks=6.7E-05 cm/s

1 ft thick lateral drainage layer (Gravel)
Ks=3.0E-01 cm/s

20 mil Geomembrane (HDPE)
Ks=2.0E-13 cm/s

2 ft thick barrier soil layer
Ks=1.0E-07 cm/s

Alternative 1

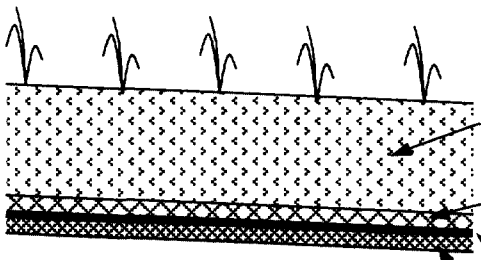


2 ft thick vertical percolation layer
Ks=6.7E-05 cm/s

Drainage net
Ks=1.0E+01 cm/s

60 mil Geomembrane (HDPE) /Bentonite (Gundseal or Equivalent)
Ks=2.0E-13 cm/s for HDPE / Ks=1.0E-08 cm/s for Bentonite

Alternative 2



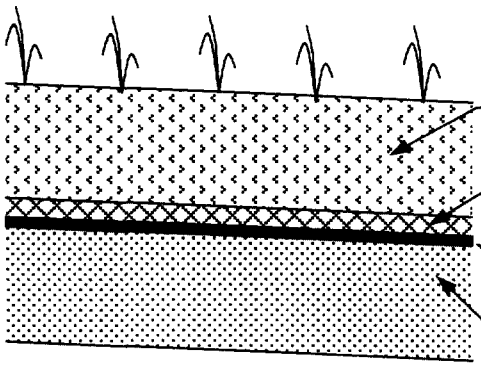
2 ft thick vertical percolation layer
Ks=6.7E-05 cm/s

Drainage net
Ks=1.0E+01 cm/s

60 mil Geomembrane (HDPE)
Ks=2.0E-13 cm/s

0.2 inch thick GCL
Ks=1.0E-08 cm/s

Alternative 3



2 ft thick vertical percolation layer
Ks=6.7E-05 cm/s

Drainage net
Ks=1.0E+01 cm/s

60 mil Geomembrane (HDPE)
Ks=2.0E-13 cm/s

2 ft thick barrier soil layer
Ks=1.0E-05 cm/s

NOT TO SCALE

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WDI Superfund site
Unsaturated flow modeling

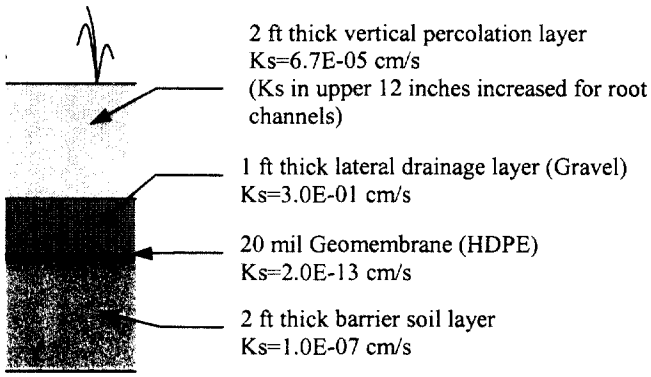
Subtitle C Alternatives

Date:

Figure C-2

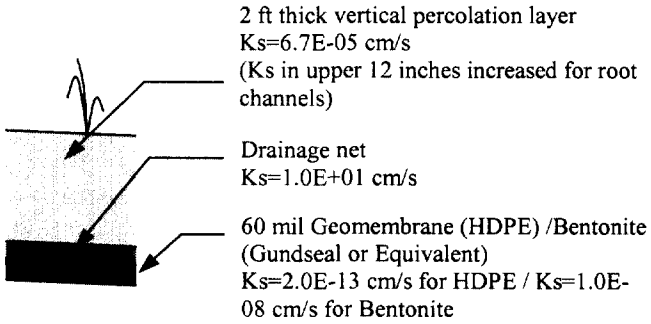
RCRA Subtitle C

Layer	t (in)	HELP model Texture	Ks (cm/s)	Description
1	12	50*	2.0E-4	Veg. layer w/roots
2	12	51*	6.7E-5	Veg. layer w/o roots
3	12	21	3.0E-1	Gravel
4	0.02	35	2.0E-13	FML (HDPE)
5	24	16	1.0E-7	Barrier soil



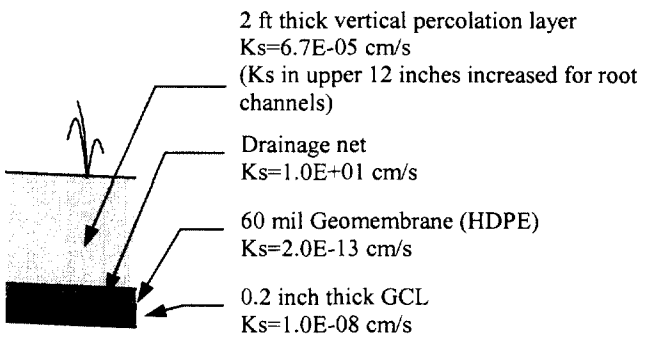
Alternative 1

Layer	t (in)	HELP model Texture	Ks (cm/s)	Description
1	12	50*	2.0E-4	Veg. layer w/roots
2	12	51*	6.7E-5	Veg. layer w/o roots
3	0.2	20	1.0E+1	Geonet
4	0.06	35	2.0E-13	FML (HDPE)
5	0.2	60*	1.0E-8	Bentonite



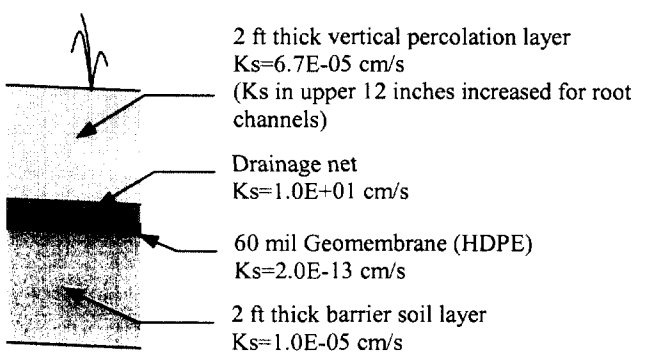
Alternative 2

Layer	t (in)	HELP model Texture	Ks (cm/s)	Description
1	12	50*	2.0E-4	Veg. layer w/roots
2	12	51*	6.7E-5	Veg. layer w/o roots
3	0.2	20	1.0E+1	Geonet
4	0.06	35	2.0E-13	FML (HDPE)
5	0.2	60*	1.0E-8	GCL



Alternative 3

Layer	t (in)	HELP model Texture	Ks (cm/s)	Description
1	12	50*	2.0E-4	Veg. layer w/roots
2	12	51*	6.7E-5	Veg. layer w/o roots
3	0.2	20	1.0E+1	Geonet
4	0.06	35	2.0E-13	FML (HDPE)
5	24	55*	1.0E-5	Low perm. layer



*-User defined Textures

Tex.#	Total Porosity	Field Capacity	Wilting Point	Satd. Hyd. Cond. (cm/s)
50	0.366	0.357	0.097	2.00E-4
51	0.366	0.357	0.097	6.66E-5
55	0.322	0.32	0.1	1.00E-5
56	0.32	0.318	0.1	1.00E-6
60	0 .75	0.747	0.4	1.00E-8

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Unsaturated flow modeling

HELP Model Input Parameters For Subtitle C Alternatives

Date:

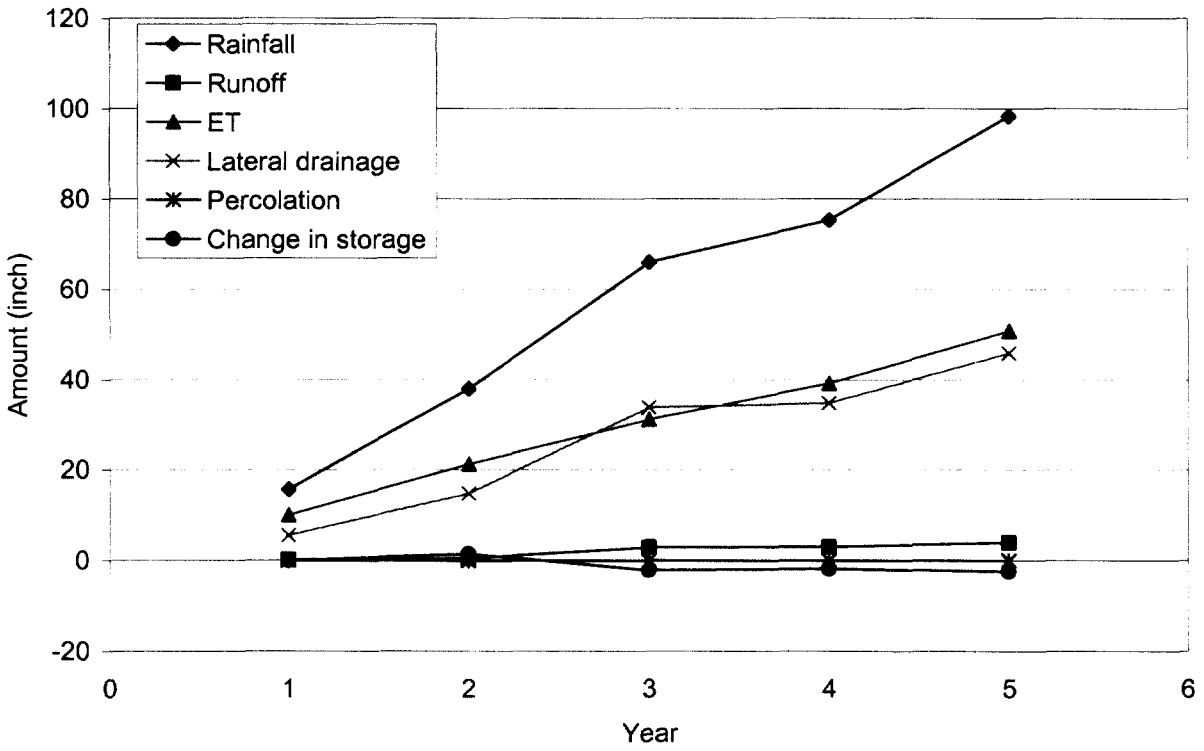
Figure C-3

Annual Water Budget for RCRA

Year	1	2	3	4	5
Precipitation (in)	15.65	22.28	27.96	9.34	23.04
Runoff (in)	0.18	0.311	2.473	0.023	1.016
Evapotranspiration (in)	9.948	11.256	9.97	7.996	11.567
Lateral drainage (in)	5.5301	9.2582	19.0795	1.0074	11.0421
Percolation (in)	0.000255	0.000405	0.000791	0.000052	0.000478
Change in water storage (in)	-0.009	1.455	-3.563	0.313	-0.586

Cumulative Water Budget

Year	1	2	3	4	5
Precipitation (in)	15.65	37.93	65.89	75.23	98.27
Runoff (in)	0.18	0.491	2.964	2.987	4.003
Evapotranspiration (in)	9.948	21.204	31.174	39.17	50.737
Lateral drainage (in)	5.5301	14.7883	33.8678	34.8752	45.9173
Percolation (in)	0.000255	0.00066	0.001451	0.001503	0.001981
Change in water storage (in)	-0.009	1.446	-2.117	-1.804	-2.39



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Cumulative Water Balance for RCRA Subtitle C Cover

Date:

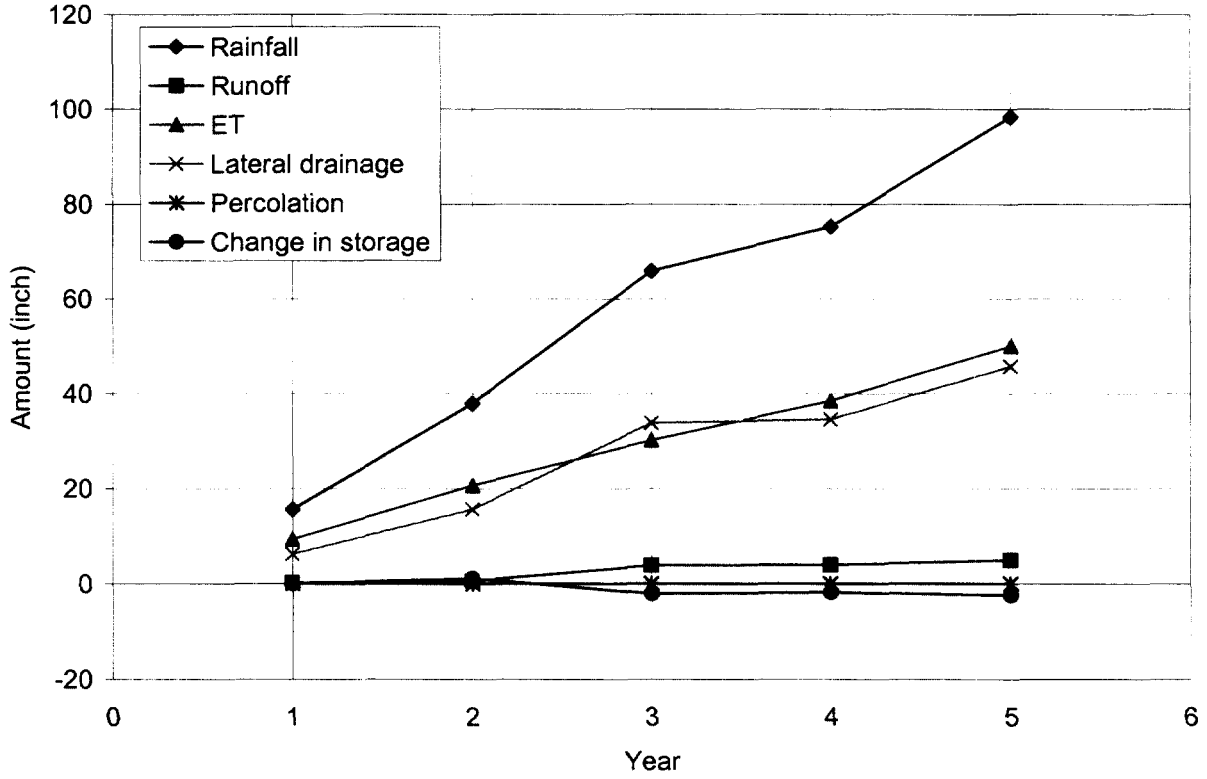
Figure C-4

Annual Water Budget for Alternative 1

Year	1	2	3	4	5
Precipitation (in)	15.65	22.28	27.96	9.34	23.04
Runoff (in)	0.19	0.356	3.343	0.023	1.04
Evapotranspiration (in)	9.265	11.338	9.577	8.264	11.511
Lateral drainage (in)	6.199	9.5079	18.231	0.7408	11.0743
Percolation (in)	0.000004	0.000072	0.000888	0.000001	0.000171
Change in water storage (in)	-0.005	1.078	-3.192	0.311	-0.586

Cumulative Water Budget

Year	1	2	3	4	5
Precipitation (in)	15.65	37.93	65.89	75.23	98.27
Runoff (in)	0.19	0.546	3.889	3.912	4.952
Evapotranspiration (in)	9.265	20.603	30.18	38.444	49.955
Lateral drainage (in)	6.199	15.7069	33.9379	34.6787	45.753
Percolation (in)	0.000004	0.000076	0.000964	0.000965	0.001136
Change in water storage (in)	-0.005	1.073	-2.119	-1.808	-2.394



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WDI Superfund site
Unsaturated flow modeling

Cumulative Water Balance for Alternatives 1/2

Date:

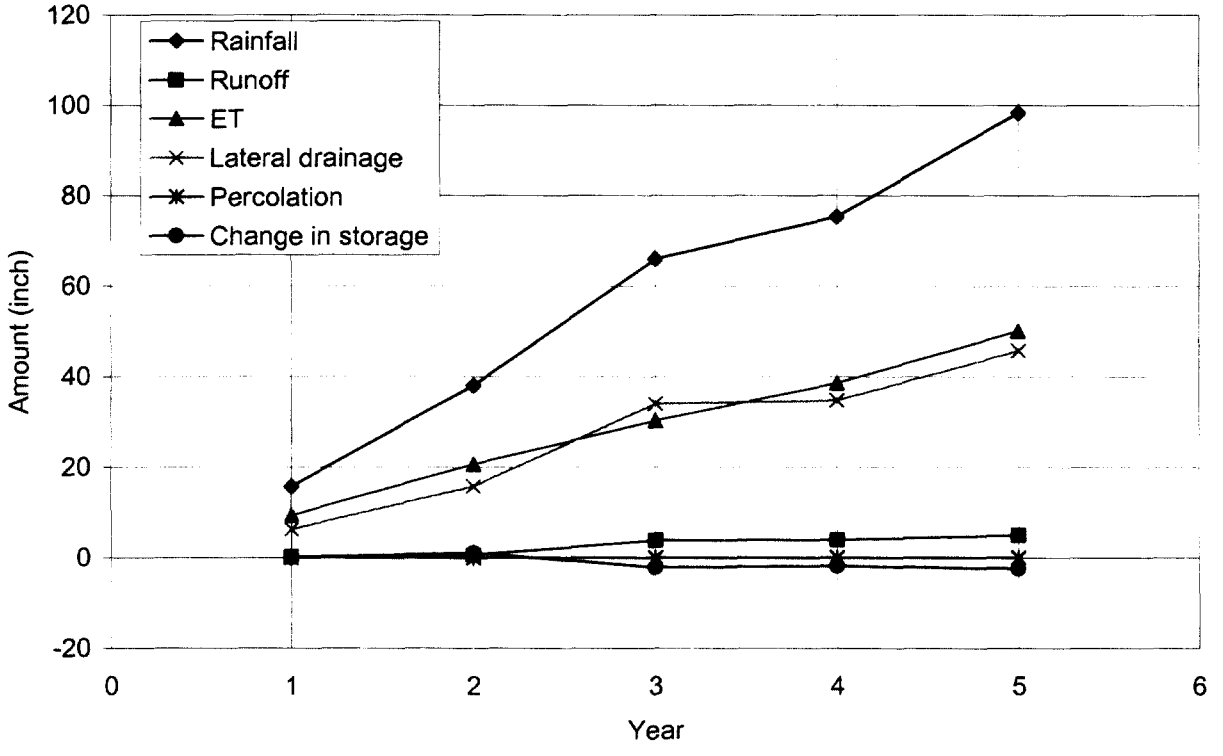
Figure C-5

Annual Water Budget for Alternative 3

Year	1	2	3	4	5
Precipitation (in)	15.65	22.28	27.96	9.34	23.04
Runoff (in)	0.19	0.356	3.339	0.023	1.04
Evapotranspiration (in)	9.237	11.339	9.583	8.307	11.502
Lateral drainage (in)	6.2266	9.5048	18.2072	0.6979	11.0788
Percolation (in)	0.000403	0.002604	0.021916	0.000041	0.005518
Change in water storage (in)	-0.004	1.078	-3.192	0.312	-0.586

Cumulative Water Budget

Year	1	2	3	4	5
Precipitation (in)	15.65	37.93	65.89	75.23	98.27
Runoff (in)	0.19	0.546	3.885	3.908	4.948
Evapotranspiration (in)	9.237	20.576	30.159	38.466	49.968
Lateral drainage (in)	6.2266	15.7314	33.9386	34.6365	45.7153
Percolation (in)	0.000403	0.003007	0.024923	0.024964	0.030482
Change in water storage (in)	-0.004	1.074	-2.118	-1.806	-2.392



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Cumulative Water Balance for Alternative 3

Date:

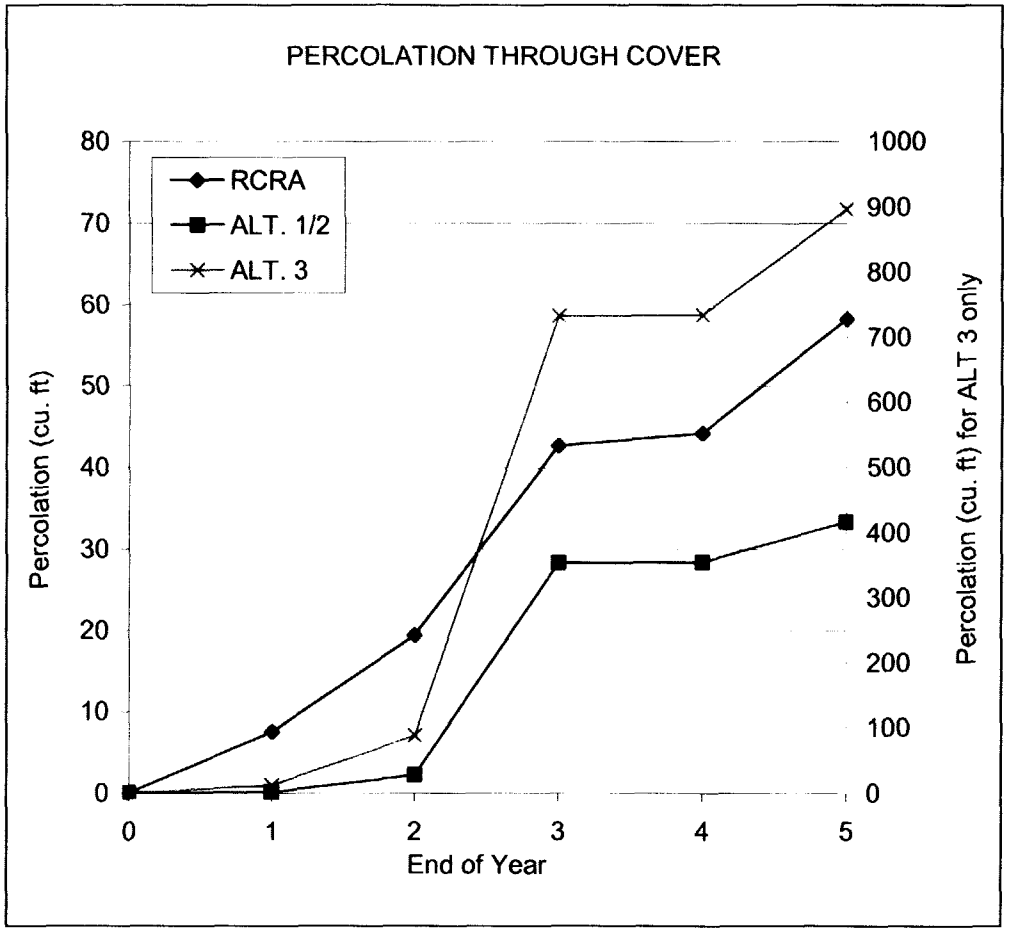
Figure C-6

ANNUAL PERCOLATION (cu. ft)

YEAR	RCRA	ALT. 1/2	ALT. 3
1	7.495	0.113	11.832
2	11.920	2.114	76.551
3	23.264	26.095	644.382
4	1.528	0.016	1.192
5	14.054	5.021	162.256

CUMULATIVE PERCOLATION (cu. ft)

END OF YEAR	RCRA	ALT. 1/2	ALT. 3
0	0	0	0
1	7.495	0.113	11.832
2	19.415	2.227	88.383
3	42.679	28.322	732.765
4	44.207	28.338	733.957
5	58.261	33.359	896.213



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

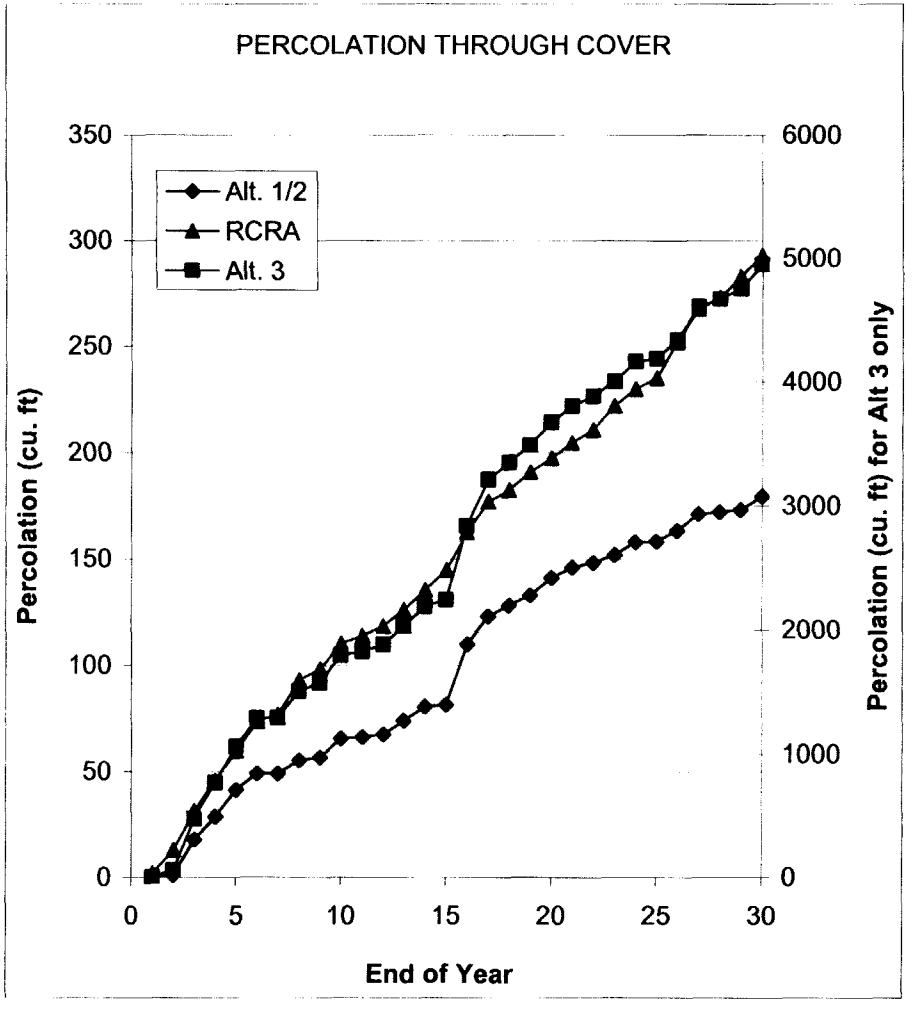
Equivalence Demonstration for Subtitle C Alternatives

Date:

Figure C-7

Annual and Cumulative Percolation (cu. ft)

	Alt # 1/2		Alt # 3		RCRA	
Year	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
1	0.02	0.02	1.89	1.89	1.87	1.87
2	1.06	1.08	53.72	55.62	11.20	13.07
3	16.76	17.84	419.54	475.15	18.43	31.49
4	10.86	28.70	289.39	764.55	14.20	45.70
5	12.78	41.48	295.14	1059.68	14.06	59.75
6	7.57	49.05	227.01	1286.69	14.01	73.77
7	0.03	49.08	2.30	1288.99	3.07	76.84
8	6.37	55.45	216.09	1505.09	16.54	93.37
9	1.30	56.74	69.14	1574.22	4.96	98.33
10	8.82	65.57	218.77	1793.00	11.94	110.27
11	0.66	66.22	31.52	1824.51	3.76	114.02
12	1.46	67.68	54.77	1879.28	4.57	118.59
13	6.46	74.15	151.13	2030.41	7.59	126.18
14	6.44	80.58	155.97	2186.37	9.30	135.48
15	0.97	81.55	54.91	2241.28	9.32	144.81
16	28.43	109.97	595.45	2836.73	17.93	162.73
17	13.10	123.08	372.37	3209.10	14.20	176.93
18	5.17	128.24	137.92	3347.02	5.35	182.28
19	4.75	133.00	137.61	3484.63	8.56	190.84
20	8.19	141.19	184.82	3669.45	6.59	197.43
21	4.86	146.05	134.03	3803.48	7.31	204.73
22	2.31	148.36	77.57	3881.05	6.08	210.81
23	3.53	151.89	119.93	4000.98	11.13	221.94
24	6.13	158.01	160.45	4161.43	8.18	230.12
25	0.32	158.33	20.01	4181.44	4.99	235.11
26	5.02	163.35	155.13	4336.58	17.02	252.13
27	7.79	171.14	267.13	4603.71	15.57	267.70
28	0.99	172.13	63.92	4667.63	5.18	272.88
29	0.97	173.09	84.93	4752.55	10.31	283.18
30	6.57	179.66	197.34	4949.89	9.87	293.05



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Geotechnical and Environmental Consultants

Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Equivalence Demonstration for Subtitle C Alternatives With 30-Year Simulation Period

Date:

Figure C-8

APPENDIX H.6

CONTINGENCY FOUNDATION DESIGN (GEOGRID FOUNDATION)

WDI SUPERFUND SITE
GEOGRID CALCULATION

E.5.1 INTRODUCTION

Calculations were performed to provide the earthwork contractor with preliminary guidance for stabilizing localized zones of exposed uncompacted bentonite fill material ("waste") during regarding of cover material at the WDI site in Santa Fe Springs, California. These calculations were performed using an assumed lowest possible California Bearing Ratio (CBR) of 1.0, for unconsolidated bentonite, based on a scraper axle load of 30.52 kips and a tire pressure of 40 pounds-per-square-inch (psi), as used for the bearing capacity calculations. Aggregate base with a CBR of 20 was assumed to be imported to the site. Calculated base thicknesses ranged from 15.6 to 4.6 inches thick, as shown on the attached SpectraPave2© output. SpectraPave2© was written by Tensar Earth Technologies, Inc.

E.5.2 BACKGROUND

In 1998, grading work was performed at the site and detailed in "*Technical Memo No. 11-Reservoir Area Grading Plans and Waste/Debris Management As-Built Report, Waste Disposal Inc. Superfund Site*" (TRC, December 1998). Now, minor new grading is proposed to provide an engineered cap over the waste, and possibly for redevelopment of the site including pavements and possibly structures around the perimeter of the site. We are unaware of any reported equipment rutting during grading in 1998. Nevertheless, we provide this suggested contingency for stabilizing the subgrade, should shallow bentonite be encountered during cut grading. This is a suggested methodology, and should not be considered a specification of means and methods of construction. The earthwork contractor may develop a more cost effective approach.

E.5.3 ORGANIZATION

Supporting data is organized as follows:

Portland Cement Association (PCA) CBR vs. Soil Classification Chart
SpectraPave2© output (4 pages)
Bearing Capacity Calculation (Su=500 psf)

E.5.4 KEY ASSUMPTION

- Scraper axle load is 30.52 kips
- Scraper tire pressure is 40 psi
- Bentonite is exposed, with Su=500 psf

E.5.5 RESULTS

SpectraPave2© shows that 4.6 to 15.6 inches of base with or without a geogrid, respectively, can be used to stabilize an extremely soft subgrade with a CBR of 1.0.

E.5.6 CONCLUSION

Exposed bentonite can be adequately stabilized to facilitate cover grading.

Attachments: Portland Cement Association (PCA) CBR vs. Soil Classification
SpectraPave2© output (4 pages)
Bearing Capacity Calculation (Su=500 psf)

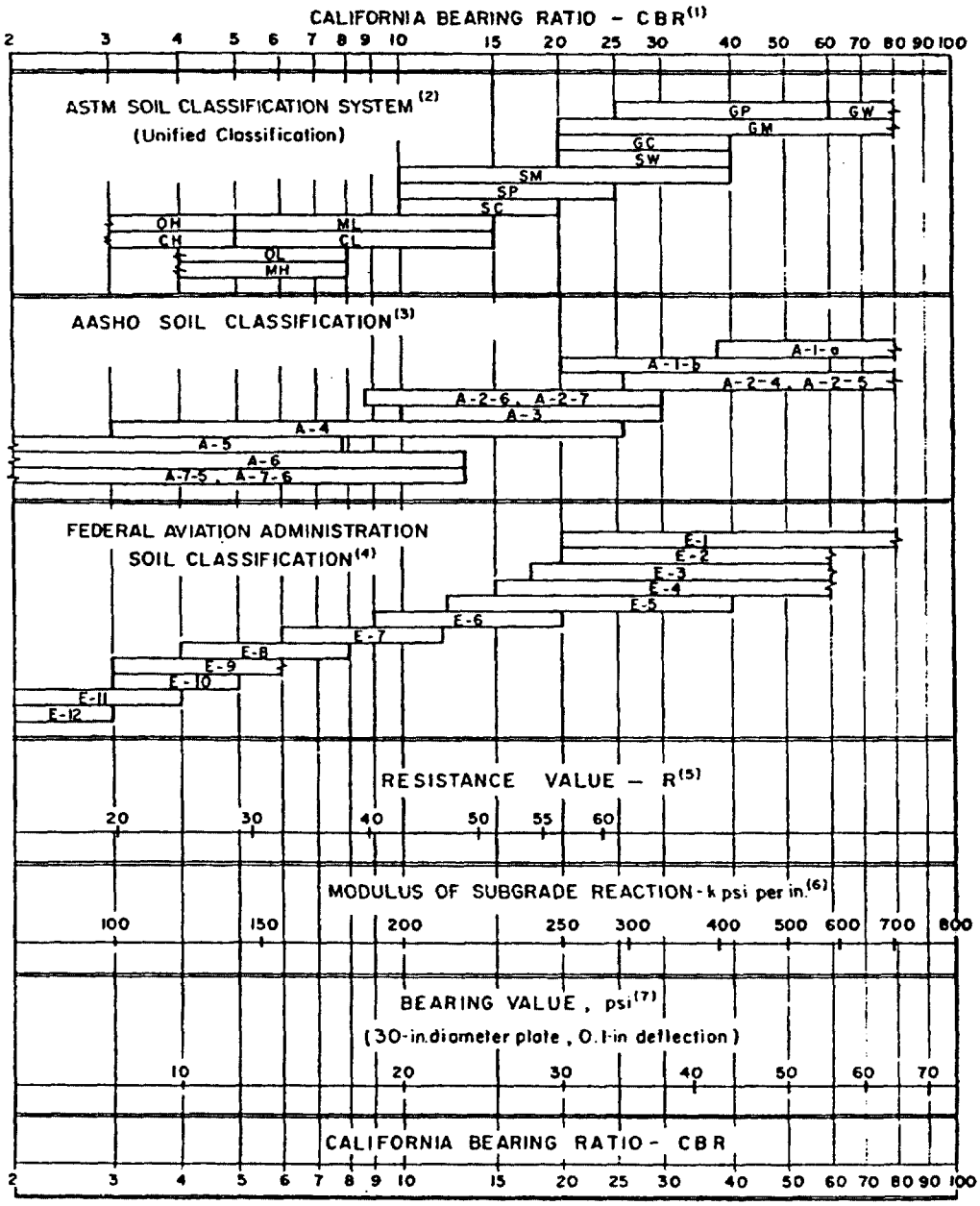


Fig. 3. Approximate interrelationships of soil classifications and bearing values.

(1) For the basic idea, see O. J. Porter, "Foundations for Flexible Pavements," Highway Research Board *Proceedings of the Twenty-second Annual Meeting*, 1942, Vol. 22, pages 100-136.

(2) "Characteristics of Soil Groups Pertaining to Roads and Airfields," Appendix B, *The Unified Soil Classification System*, U.S. Army Corps of Engineers, Technical Memorandum 3-357, 1953.

(3) "Classification of Highway Subgrade Materials," Highway Research Board *Proceedings of the Twenty-fifth Annual Meeting*, 1945, Vol. 25, pages 376-392.

(4) *Airport Paving*, U.S. Department of Commerce, Federal Aviation Agency, May 1948, pages 11-16. Estimated using values given in FAA *Design Manual for Airport Pavements*.

(5) F. N. Hveem, "A New Approach for Pavement Design," *Engineering News-Record*, Vol. 141, No. 2, July 8, 1948, pages 134-139. *R* is factor used in California Stabilometer Method of Design.

(6) See T. A. Middlebrooks and G. F. Bertram, "Soil Tests for Design of Runway Pavements," Highway Research Board *Proceedings of the Twenty-second Annual Meeting*, 1942, Vol. 22, page 152. *k* is factor used in Westergaard's analysis for design of concrete pavement.

(7) See reference (6), page 184.

SpectraPave2™ Software

For Subgrade Improvement and Base Reinforcement

(Release Version 2.0, October, 2001)

PROJECT INFOMATION

Project Name:	WDI Santa Fe Springs		
Project Number:	1651-8A		
Design Case:			
Client:			
City/County:	Santa Fe Springs	Telephone:	
State:	CA	Fax:	
Zip Code:		E-mail:	
Country:	Los Angeles		

Description:

Su=500 psf, solft zone repair during grading

Design Firm:	Lowney Associates
Address:	251 East Imperial Highway, Suite 470 Fullerton, CA, 92835-1063 United States
Telephone:	(714) 441-3090
Fax:	(714) 441-3091
E-mail:	

Designer: TB

Date: 12/3/02

Checked by:

Date:

SUBGRADE IMPROVEMENT

INPUT DATA

Axle Load =	30.52(kip)	Tire Pressure =	40(psi)
Number of Axle Passes =	100	Rut Depth =	3.0(in)
Field Subgrade CBR =	1 (%)	Field Subbase CBR =	20 (%)

GEOGRID PROPERTIES

	BX1100	BX1200	Other Geogrid
Geogrid Type	Integrally formed single layer	Integrally formed single layer	Woven
Rib Shape	Rectangular/Square	Rectangular/Square	Rounded
Rib Thickness (in)	0.03	0.05	0.02
Aperture Stability Modulus(cm-kg/deg)	3.2	6.5	2.0
Junction Efficiency (%) (Percent of Tult)	90	90	50
Aperture Dimensions (Inside to inside)			
MD (in)	1.0	1.0	0.75
XMD (in)	1.3	1.3	0.75

GEOTEXTILE PROPERTIES

All geotextile meeting or exceeding the requirements for AASHTO M288-96 Class 1 Geotextile are considered to have equivalent performance.

ANALYSIS RESULTS

	Unreinforced	BX1100	BX1200	Geotextile	Other Geogrid
Subbase Thickness (in) =	15.6	7.4	4.6	9.5	9.5
Subbase Saving (in) =		8.2	11.0	6.1	6.1

SUBGRADE IMPROVEMENT

INPUT DATA

Axle Load =	30.52(kip)	Tire Pressure =	80(psi)
Number of Axle Passes =	100	Rut Depth =	3.0(in)
Field Subgrade CBR =	1 (%)	Field Subbase CBR =	20 (%)

GEOGRID PROPERTIES

	BX1100	BX1200
Geogrid Type	Integrally formed single layer	Integrally formed single layer
Rib Shape	Rectangular/Square	Rectangular/Square
Rib Thickness (in)	0.03	0.05
Aperture Stability Modulus(cm-kg/deg)	3.2	6.5
Junction Efficiency (%) (Percent of Tult)	90	90
Aperture Dimensions (Inside to inside)		
MD (in)	1.0	1.0
XMD (in)	1.3	1.3

GEOTEXTILE PROPERTIES

All geotextile meeting or exceeding the requirements for AASHTO M288-96 Class 1 Geotextile are considered to have equivalent performance.

ANALYSIS RESULTS

	Unreinforced	BX1100	BX1200	Geotextile
Subbase Thickness (in) =	20.6	11.6	7.1	14.0
Subbase Saving (in) =		9.0	13.5	6.6

SUBGRADE IMPROVEMENT COST ANALYSIS

INPUT DATA

Project Dimension:

Length = 50 ft Width = 50 ft

Aggregate Information:

Unit Weight = 133 pcf Volume Conversion Factor = 0.85

Delivered to Site Cost = 23.83 $/cy Installation Cost = 3.00 $/cy

Total In-Place Cost = 31.04 $/cy

Finished Top Grade Information:

Finished Top Grade is 0.0 in. Above Existing Grade

Cut and Removal Cost = 11.00 $/cy

Subbase Thickness (in)

Unreinforced	BX1100	BX1200	Geotextile	Other Geogrid
15.6	7.4	4.6	9.5	9.5

Geogrid Information

No of 13ft Roll Width = 2 Actual Each Overlap = 1.4ft

No of 9.8ft roll width = 3 Installation Cost= 0.25$/sy

Delivered to Site Cost of Geosynthetics:

BX1100 = 1.50$/sy BX1200 = 3.00$/sy

Geotextile = 0.75$/sy Other Geogrid = 4.00$/sy

RESULTS

	Unreinforced	BX1100	BX1200	Geotextile	Other Geogrid
Unit Cost ($/sy)	18.22	10.59	8.99	12.21	15.82
Unit Savings ($/sy)		7.63	9.23	6.01	2.40
Project Cost ($)	5,060	2,941	2,496	3,391	4,394
Project Savings ($)		2,119	2,564	1,670	666

LOWNEY ASSOCIATES
Environmental/Geotechnical/Engineering Services

Project Name: WDI / SANTA FE SPRINGS
Subject: SOFT ZONE BEARING CAPACITY
Project No.: 1651-8A Sheet No.: 1 Of 1
By: TD Date: 12/3/02 Chk'd by: Date:

SOFT ZONE BEARING CAPACITY

ASSUME: $C_{BENT.} = 500$ PSF $C_{AGGREGATE} = -0-$

$\phi_{BENT.} = -0-$, $\phi_{AGGREGATE} = 45^\circ$

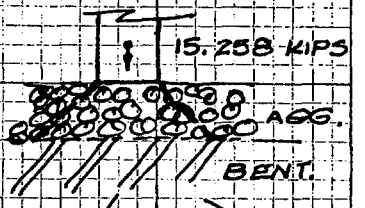
$\gamma^M_{BENT.} = 124$ PCF $\gamma_{AGGREGATE} = 127$ PCF

TIRE LOAD = 15.258 KIPS (SEE PRIOR CALCS.)

TIRE WIDTH (B) = 1.37 FEET

TIRE DEPTH (L) = 1.61 FEET (LENGTH)

CONVENTIONAL BEARING CAPACITY



$q_{ULT.} = c N_c + q N_q + \frac{1}{2} \gamma B N_\gamma$

$q_{ULT.} = (500 \text{ PSF}) 5.14 + 0 + 0$ (FOR $\phi = 0$)

$q_{ULT.} = 2{,}570$ PSF

FS = 2,570 PSF / (15,258 POUNDS / (1.37 × 1.61 FEET))

FS = 0.37 < 0 ∴ FAILURE

WITH 16-INCHES OF CRUSHED AGGREGATE BASE:

16-INCHES = 1.33 FEET, ASSUME PUNCH AT 45°
THEN CLAY BEARING AREA = (1.37+1.33) × (1.61+1.33) FEET
ALSO, q = (1.38 FEET)(127 PCF) = 169 PSF

$q_{ULT.} = c N_c + q N_q + 0$ (FOR $\phi = 0$)

$q_{ULT} = (500 \text{ PSF}) 5.14 + (169 \text{ PSF}) 1 = 2{,}739$ PSF

FS = 2,739 PSF / (15,258 POUNDS / (1.37+1.33)·(1.61+1.33) FEET)

FS = 1.42 > 1.25 ∴ OK FOR CONSTRUCTION

ADDITIONAL AGGREGATE CAN BE ADDED AS NECESSARY DURING GRADING

TD 12/3/02

APPENDIX H.7

ASPHALT STRUCTURAL SECTION DESIGN

TRC

By CAK Date 11/15/02 Subject WDI - Asphalt Pavement Design Sheet No. 1 of 6
Chkd. By ___ Date ___ Proj. No. 30747

Objectives:

1. Evaluate the asphalt pavement structural design sections recommended from the investigations for TRC performed by La Belle Marvin in their September 2002 report "Pavement Investigation of the Waste Disposal, Inc. Superfund Site within the City of Santa Fe Springs, California."
2. Verify the recommendations and provide an asphalt pavement design section for removal and replacement areas, as well as overlay and seal areas.

Reference: CalTrans Highway Design Manual, Fifth Edition, July 1995

1. Truck Traffic Projection

Vehicle Type	ESAL 20-yr Constants (A)	Expanded Av. Daily Trucks * (B)	Total 20-year ESAL (A x B)
2-axle trucks	1380	10 - 20	13,800 - 27,600
3-axle "	3680	1 - 2	3680 - 7,360
4-axle "	5880	0	0
5-axle	13 780	0	0
			17,480 - 34,960

* Estimated, based on existing businesses

⇒ Results in a T.I. of 5.5 to 6.0 (See Attachment A)

La Belle Marvin uses 5.0 to 6.0

Note: For the purposes of this evaluation, LBM's assessment of the Traffic Index for individual pavements is assumed.

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TRC

By CAK Date 11/15/02 Subject WDI - Asphalt Pavement Sheet No. 2 of 6

Chkd. By ___ Date ___ Proj. No. 30747

2. R-Value & Deflection Testing Results (LaBelle Marvin, 2002)

Address	R-Value	Req'd Gravel Equivalent (G.E)[1]
12811 Los Nietos	79	0.13 SB, 0 NB
12809 L.N.	30	0 EB, 0 WB
12807	52	–
12723	48	0 SB, 0.03 SB
12717	60	0.10 SB, 0.09
12637A	19 & 50	–
Storage Yard	58	0 SB, 0.01 SB
?	61	–
12741	70	0 SB, 0.19 SB, .05 WB
12801	41 & 40	–
12803	–	0.11 NB, 0.08 SB
12747	–	0.23 SB, 0.60 SB
9620	–	0 WB

3. Improvement Recommendations by Address (LBM, 2002)

Address	Recommendation (LBM)	Field Condition
12811 L.N.	4" AC on 7" AB[2]	Extensive failure, ravelling, crackin
12809 L.N.	Seal and Restripe	No deflection, rough
12803/12747	3" AC on 7.5" AB	Extensive failure
12747 LN	2" AC on fabric	Fair, ravelling, minor distress
12741 LN	4" AC on 7" AB	Poor, cracks
12723 LN	2" AC on fabric	Fair, ravelling, cracks
12707/12717	4" AC on 7" AB	Moderate distress, pothole
12707 LN	2" AC on fabric	Fair
12635 LN	4" AC on 8.5" AB	Extensive failures
9620 SFS	2" AC on fabric	Surface distress
RV Storage	2" AC on fabric	Failures, ravelling, cracking.

1 Additional equivalent pavement section req'd to reduce deflection.

2 A.C.: Asphaltic Concrete; A.B: Aggregate Base

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TRC

By CAK Date 11/15/02 Subject WDI- Asphalt Pavement Design Sheet No. 3 of 6
Chkd. By ____ Date ____ Proj. No. 30747

A. Check Pavement Design Sections (Remove & Replace)

Address	Recommendation	G.E.*
12811 L.N.	4" AC on 7" AB	209 + 182 = 391
12803/12747 L.N.	3" AC on 7.5" AB	174 + 198 = 372
12741 L.N.	4" AC on 7" AB	209 + 182 = 391
12707/12717 L.N.	4" AC on 7" AB	209 + 182 = 391
12635 L.N.	4" AC on 8½" AB	209 + 231 = 440

⇒ Use $\bar{x} \pm \sigma$ to estimate R: 51 − 17 = 34 ⇒ Use 34 for design
Req'd G.E = 0.975 (T.I)(100 − R) (See Attachment B)
Req'd G.E = 0.975(5.5)(100 − 34) = 354 mm
(LBM uses T.I. ranging from 5.0 to 6.0 ⇒ 5.5 most often)

* Determine G.E. for various depths of A.C. & A.B. from Table 608.4 (Attachment C). Standardize on 1 section to avoid confusion.

4" A.C.: G.E. = 209	∴ 3" A.C. on 7.5" A.B. will provide req'd. G.E.
3" A.C.: G.E. = 174	→ Check for R = 30, G.E. = 375 > 372
7" A.B: G.E. = 182	→ Use 4" A.C. on 7" AB
7.5" A.B: G.E. = 198	→ O.K. since OSM includes A.C. maintenance
8.5" A.B: G.E. = 231	

3. Overlay Sections - Check

A) 12747 L.N.: 2" AC existing; No AB; T.I = 5.0 (LBM, 2002)
"LANE F" (See Attachment D for location)

- Check whether 2" A.C. overlay is sufficient.

- 2-in A.C. overlay has G.E. of 104 (See Attachment C); This is adequate since deflection testing indicated that 0.04 ft A.C. (0.5 inches) is required

∴ 2" overlay is adequate

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TRC

By CAK Date 11/15/02 Subject WDI - Asphalt Pavement Design Sheet No. 4 of 6
Chkd. By ____ Date ____ Proj. No. 30747

B) 12723 L.N. Core 7-92 Lane J. & H
Existing A.C. = 2 1/8" AB = 2 3/4" T.I = 5.0 (LBM 2002)

Deflection testing on Lane J indicates G.E. of 0.03 ft (10 mm) is req'd or 0.02' AC; 2" AC provides G.E. of 104 mm; Deflections in Lane H were within allowable.
∴ 2" A.C. overlay is adequate.

C) 12707 L.N.; Lane I (No core)

G.E. Req'd = 0.18 ft (55 mm) < 104 ∴ 2" AC is O.K.

D) 9620 S.F.S.; Lanes R & Q; Measured Deflection < Allowable.

∴ 2" AC overlay is adequate; required for surface scarring.

E) RV Storage; Lanes O & P

G.E. Req'd = 0.01 ft ∴ 2" AC is O.K.

4. Check Seal and Restripe Section.

12809 L.N. Lane C & D. G.E. Req'd = 0

∴ Seal existing pavement for waterproofing.

5. Summary

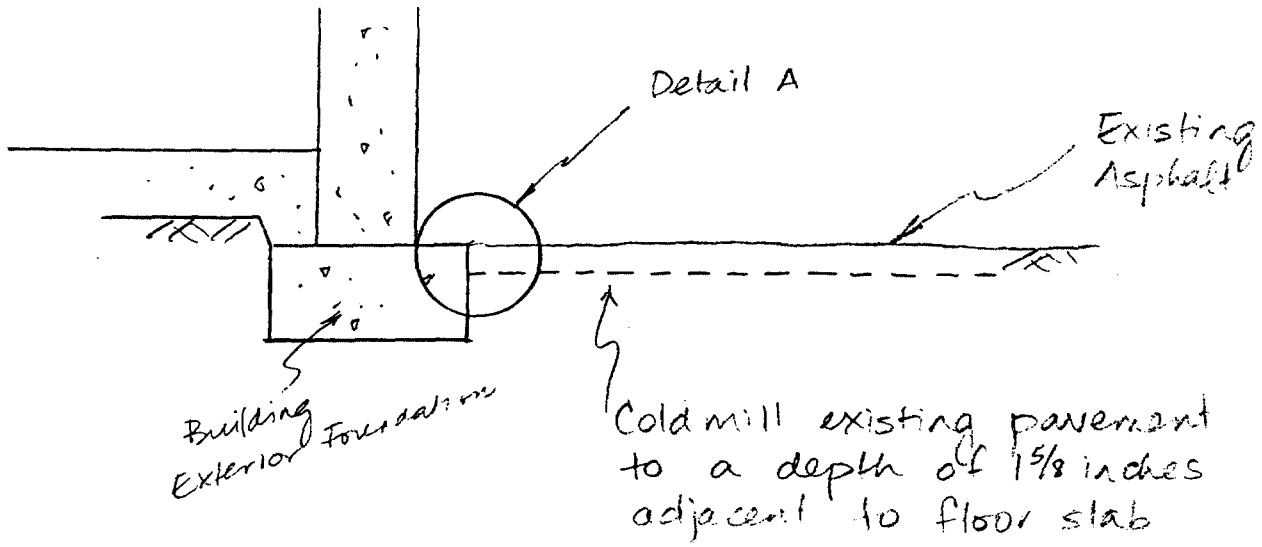
The asphalt pavement recommendations by LBM appear to be valid; however, to avoid confusion during paving, one section is recommended for all remove and replace areas: 4" AC on 7" A.B. Overlay sections as recommended by LBM, 2" A.C. on engineering fabric, are also adequate

Recyclable and made from recycled paper.

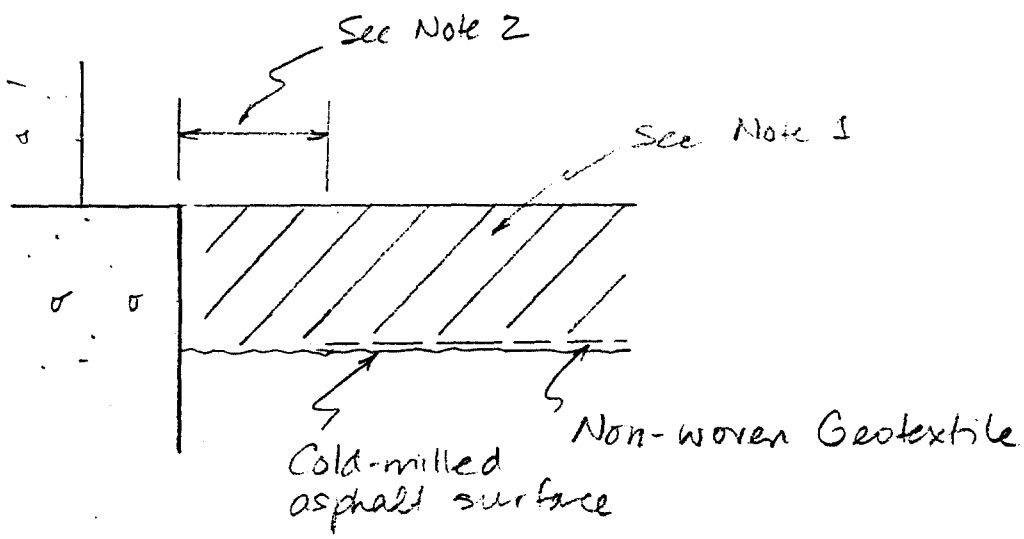
TRC

By CAK Date 11/15/02 Subject WD1- Asphalt Pavement Sheet No. 5 of 6

Chkd. By ____ Date ____ Proj. No. 30747



Detail of
Construction Joint Between Asphalt Pavement Overlay and Concrete Floor Slab



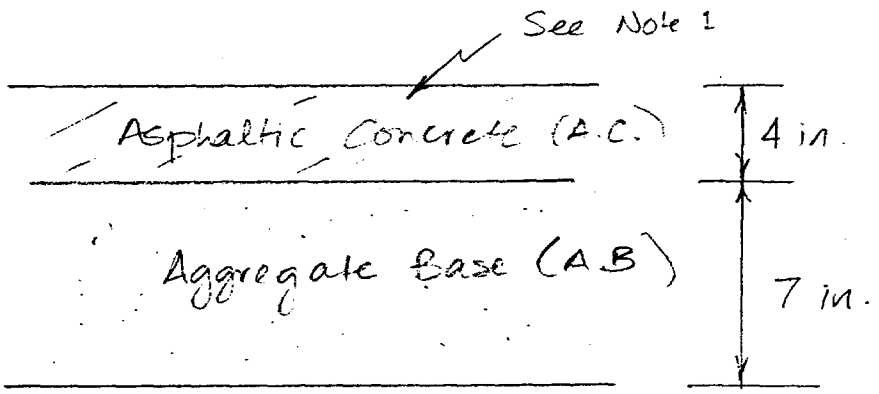
Detail A

Recyclable and made from recycled paper.

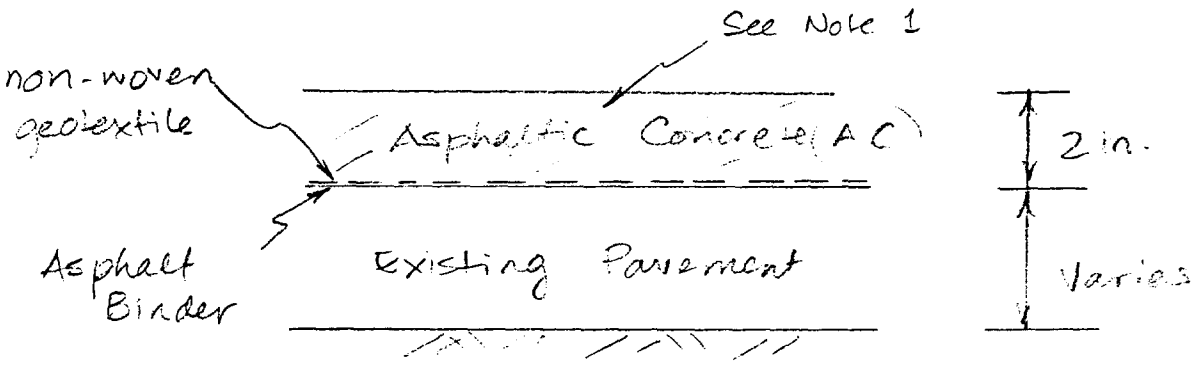
TRC

By CAK Date 11/18/02 Subject WD1- Asphalt Pavement Sheet No. 6 of 6

Chkd. By ____ Date ____ Proj. No. 30747



Asphalt Pavement Section
Remove and Replace



Asphalt Pavement Overlay Section

1. A.C. mix to be designed as a high-density, low air voids mix, compacted to 98% theoretical maximum density (2% air voids).

2. Terminate geotextile within 6 inches of foundation.

Recyclable and made from recycled paper.

Attachment A

Traffic Index

Table 603.4A
Conversion of ESAL to Traffic Index

ESAL	TI*	ESAL	TI*
48		1 270 000	
	3.0		9.5
194		1 980 000	
	3.5		10.0
646		3 020 000	
	4.0		10.5
1850		4 500 000	
	4.5		11.0
4710		6 600 000	
	5.0		11.5
10 900		9 490 000	
	5.5		12.0
23 500		13 500 000	
	6.0		12.5
47 300		18 900 000	
	6.5		13.0
89 800		26 100 000	
	7.0		13.5
164 000		35 600 000	
	7.5		14.0
288 000		48 100 000	
	8.0		14.5
487 000		64 300 000	
	8.5		15.0
798 000		84 700 000	
	9.0		15.5
1 270 000		112 000 000	

*NOTE:
The determination of the TI closer than 0.5 is not justified. No interpolations should be made.

Table 603.4B
Example Determination of the 20 Year Traffic Index for an 8-lane Freeway

		Outside Lanes		Median Lanes	
(1) Vehicle Type	(2) ESAL 20 Year Constants	(3) Expanded Average Daily Trucks	(4) Total 20 Year ESAL (Col.2 x Col.3)	(5) Expanded Average Daily Trucks	(6) Total 20 Year ESAL (Col.2 x Col.5)
2-axle trucks	1380	935	1 290 300	235	324 300
3-axle trucks	3680	550	2 024 000	140	515 200
4-axle trucks	5880	225	1 323 000	55	323 400
5-axle or more	13 780	1025	14 124 500	255	3 513 900
Totals	----	----	18 761 800	----	4 676 800

Traffic Index (TI) for 20 Year Design, From Table 603.4A = 12.5 11.0

Attachment B

Required Gravel Equivalent

Geotechnical Design Report or Materials Report based on availability and adequacy to meet the project requirements. The pavement type selection, which has a direct bearing on the base and subbase materials to be used, is discussed in Topics 602 and 609. As indicated in Topic 606, positive rapid drainage is very important. Any omission of the treated permeable base layers must be supported by appropriate written justification, see Index 602.1.

The projected truck traffic data and ultimately the TI for structural section design are developed as described in Topic 603. The R-value of the basement soil is provided in the Geotechnical Design Report or Materials Report. In some cases there may be significant variations in this R-value, particularly for projects that are several kilometers or more in length. More than one R-value may be designated, for economic reasons, to vary the structural section to fit local conditions on selected stretches within a project.

On projects utilizing ACP, with three or more lanes in one direction, separate lane designs are based on the different TI's for the median and outside lanes. Determination of the ESAL's and conversion to lane TI's is illustrated in Tables 603.4A and 603.4B. This results in variable structural section layer thicknesses, and in steps in the structural section layers at the lane lines where the thickness changes.

(1) *Basic Design Data.* The basic design data required for flexible pavement design includes:

(a) R-values from the Geotechnical Design Report or Materials Report, including that for basement soils, and subbase. When the basement soil is expansive, the R-value for that soil is the "expansion pressure R-value" (which will result in a thicker subbase but will not affect other layers).

(b) Number of lanes from the Project Report (or other project approval document).

(c) Expanded annual average daily truck traffic (AADTT) from the District Division of Planning, for the design period. This information is developed and transformed into the TI, as described in Topic 603, for use in the design of the structural section.

(2) *Structural Section Safety Factors.* Construction tolerances allowed by the contract specifications could result in a structural section that is slightly deficient in thickness. To compensate for this possibility, a safety factor is applied by increasing the design thickness of the pavement. For structural sections that include base and/or subbase layers, a safety factor of 60 mm is added to the required GE of the AC. Since application of the safety factor is not intended to increase the total GE of the structural section, a compensating thickness is subtracted from the GE thickness of the subbase layer. Where there is no subbase, the safety factor is subtracted from the base layer. In no case is the thickness of a layer to be reduced to less than the allowable minimum.

For structural sections that are essentially full depth AC, a safety factor of 30 mm is added to the required GE of the AC. When determining the appropriate safety factor to be added, ACB and ATPB should be considered as part of the AC layer. Full depth AC sections will therefore exceed the calculated required GE by the safety factor since there are no underlying layers to adjust.

(3) *Basic Rules for Designing Flexible Pavements.* When designing flexible structural sections, the following basic rules will apply:

(a) The TI is determined to the nearest 0.5.

(b) The following standard design formula is applied to determine the GE of the cover required over the basement soil and intermediate structural section layers with a known or assumed R-value:

$$GE = 0.975(TI)(100-R)$$

where:

GE = gravel equivalent in mm

TI = traffic index (See Index 603.4)

R = R-value of the material to be covered

(c) The GE to be provided by each material is determined in order by layer, starting with the AC and proceeding downwards.

Attachment C

Gravel Equivalents of Structural Layers

Table 608.4

Gravel Equivalents of Structural Layers (mm)

	ASPHALT CONCRETE (DGAC)											BASE AND SUBBASE					
	Traffic Index (TI)																
	5 & below	5.5 6.0	6.5 7.0	7.5 8.0	8.5 9.0	9.5 10.0	10.5 11.0	11.5 12.0	12.5 13.0	13.5 14.0	14.5 & up	ACB; LCB	CTPB; CTB (Cl. A)	ATPB	CTB (Cl. B)	AB	AS
Actual Thickness of Layer	Gravel Factor (G_f)																
	← G_f varies with TI[4] →											← G_f constant →					
(mm)	2.54	2.32	2.14	2.01	1.89	1.79	1.71	1.64	1.57	1.52	1.46	1.9	1.7	1.4	1.2	1.1	1.0
30	76	70	64	60	57	54	51	49	47	46	44	--	--	--	--	--	--
45	114	104	96	90	85	81	77	74	71	68	66	--	--	--	--	--	--
60	152	139	128	121	113	107	103	98	94	91	88	--	--	--	--	--	--
75	191	174	161	151	142	134	128	123	118	114	110	--	--	105[2]	--	--	--
90	229	209	193	181	170	161	154	148	141	137	131	--	--	126	--	--	--
105	267	244	225	211	198	188	180	172	165	160	153	200	180[2]	147	126	116	105
120	305	278	257	241	227	215	205	197	188	182	175	228	204	168	144	132	120
135	343	313	289	271	255	242	231	221	212	205	197	257	230	189	162	149	135
150	381	348	321	302	284	269	257	246	236	228	219	285	255	210	180	165	150
165	421	392	362	338	318	301	287	275	264	254	247	314	281	231	198	182	165
180	473	441	407	380	357	338	322	308	296	285	278	342	306	252	216	198	180
195	526	490	453	422	397	377	359	343	329	317	309	371	332	273	234	215	195
210	--	541	500	466	439	416	396	379	363	350	341	399	357	--	252	231	210
225	--	593	548	511	481	456	434	415	399	384	374	428	383	--	270	248	225
240	--	647	597	557	524	497	473	452	434	418	407	456	408	--	288	264	240
255	--	--	647	604	568	538	513	491	471	453	442	485	434	--	306	281	255
270	--	--	698	652	613	581	553	529	508	489	477	513	459	--	324	297	270
285	--	--	--	701	659	625	595	569	546	526	512	542	485	--	342	314	285
300	--	--	--	750	706	669	637	609	585	563	548	570	510	--	360	330	300
315	--	--	--	801	753	714	680	650	624	601	585	599	536	--	378	347	315
330	--	--	--	--	802	759	723	692	664	639	623	--	--	--	--	--	330
345	--	--	--	--	851	806	767	734	705	679	661	--	--	--	--	--	345
360	--	--	--	--	900	853	812	777	746	718	699	--	--	--	--	--	360
375	--	--	--	--	--	901	858	820	787	758	738	--	--	--	--	--	375
390	--	--	--	--	--	949	904	864	830	799	778	--	--	--	--	--	390
405	--	--	--	--	--	998	950	909	873	840	818	--	--	--	--	--	--
420	--	--	--	--	--	--	997	954	916	882	859	--	--	--	--	--	--
435	--	--	--	--	--	--	1045	1000	960	924	900	--	--	--	--	--	--
450	--	--	--	--	--	--	1094	1046	1004	967	942	--	--	--	--	--	--
465	--	--	--	--	--	--	--	1093	1049	1010	984	--	--	--	--	--	--
480	--	--	--	--	--	--	--	1140	1094	1054	1026	--	--	--	--	--	--
495	--	--	--	--	--	--	--	1188	1140	1098	1069	--	--	--	--	--	--
510	--	--	--	--	--	--	--	--	1187	1143	1113	--	--	--	--	--	--
525	--	--	--	--	--	--	--	--	1233	1188	1156	--	--	--	--	--	--
540	--	--	--	--	--	--	--	--	1280	1233	1201	--	--	--	--	--	--
555	--	--	--	--	--	--	--	--	--	1279	1245	--	--	--	--	--	--
570	--	--	--	--	--	--	--	--	--	1325	1290	--	--	--	--	--	--
585	--	--	--	--	--	--	--	--	--	1372	1336	--	--	--	--	--	--
600	--	--	--	--	--	--	--	--	--	--	1382	--	--	--	--	--	--

Notes:

1. See Tables 605.1 and 608.2 for subbase, base and asphalt concrete types, abbreviations, and gravel factors (G_f).
2. Standard layer thicknesses of 75 mm and 105 mm have been adopted respectively for ATPB and CTPB. These in turn correspond respectively to GEs of 105 mm and 180 mm. As discussed in Index 606.2(3), a thicker TPB drainage layer may be considered only under a unique combination of conditions.
3. OGAC may be substituted for up to 30 mm of DGAC, as a surface layer, when warranted by conditions discussed under Index 608.2(2), the difference in G_f not withstanding.
4. DGAC G_f also increases as the thickness increases, if the thickness is greater than 150mm - See Index 608.4(3)(g).

Attachment D

Site Plans

Improvement Plan, LaBelle Marvin, 2002

Recorded Owner List

Asphalt Deflectometer Testing and Corehole Location Map

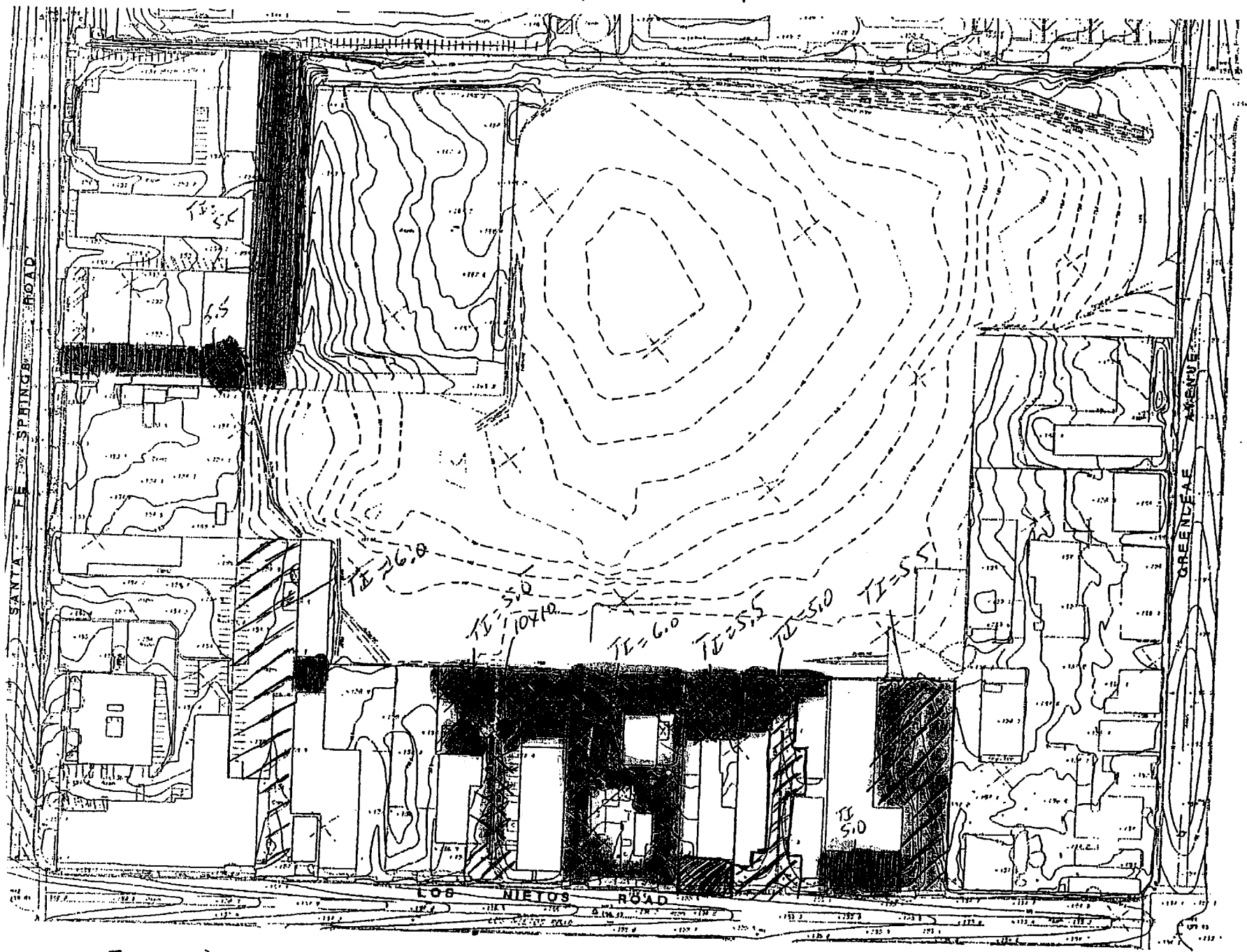
Parcel Map

Parcel Number	Recorded Owner	Owner Contact	Phone Number	Unit Number	Tenant	Tenant Contact	Tenant Address	Tenant Phone Number
3	Raymond Holbrook	Eileen Holbrook	562-402-8389	1	Metro Diesel Injection	Monty Torres	12631 Los Nietos Rd	562-944-4846
				2	R & R Sprouts	Rita and Robert Carlson	12633 Los Nietos Rd	562-906-0847
				3	storage for R & R and C & E Die		12635 Los Nietos Rd	
				4	Stansell Brothers	Vern Stansell	12635 Los Nietos Rd	562-946-6676
4	Air Liquide			1	Air Liquide	Bruce Beaton	9756 Santa Fe Springs Rd	562-906-8710
7	Eugene Welter			1	A & L Sweep Systems	Kim Goines	9610 Santa Fe Springs Rd	562-693-2971
				2	Unknown			
				3	Vincent Williams			
				1	ARPI	Jim West	9618 Santa Fe Springs Rd #1	562-946-5907
				2				
				3	Spyke, Inc.	Willie Lanham	9618 Santa Fe Springs Rd #3	562-693-2983
				4	ARPI	Jim West	9618 Santa Fe Springs Rd #1	562-946-5907
				5	Vacant			
				6	Nowever	Nowever	9618 Santa Fe Springs Rd #7	
				7				
				8				
				9	OMR Industrial Machining	Jesus/Marcos Orizaba	9618 Santa Fe Springs Rd #9	562-777-9119
				10	Unknown			
				11	ARPI	Jim West	9618 Santa Fe Springs Rd #11	562-946-5907
				12				
				13	Kinghill Electric Contractors		9618 Santa Fe Springs Rd #13	
				14	R & M Maintenance	Marty Marcum	9618 Santa Fe Springs Rd #14	562-906-0001
				15	D. A. Lovell Cabinets		9618 Santa Fe Springs Rd #15	
				16	Talon Manufacturing		9618 Santa Fe Springs Rd #16	
11	Ovil Proctor	Lewis Proctor	562-946-6324	1	storage for Bell Auto & Paint			
12	Ovil Proctor	Lewis Proctor	562-946-6324	1	Frontier Music Company		12645 Los Nietos Rd	
				2	Unknown		12647 Los Nietos Rd	
				3	Bell Autobody & Paint	Luis Reyna	12649 Los Nietos Rd	562-944-2707
21	John Maple	John Maple	805-481-7238	1	Action Maintenance Supply	Marshal Tierney	9620 Santa Fe Springs Rd	562-941-0035
	Lucille Ferris	Lucille Ferris	562-869-4143					
	Martin Ferris							
22	John Maple	John Maple	805-481-7238	1	Gold Coast Refractory	Robert Black	9630 Santa Fe Springs Rd	562-946-1942
	Lucille Ferris	Lucille Ferris	562-869-4143					
	Martin Ferris							
24	Raymond Holbrook	Eileen Holbrook	562-402-8389	1	Buffalo Bullet	Ronald Dahlitz	12637A Los Nietos Rd	562-944-0322
				2	C & E Metal Products, Inc.	Mark Ellis	12637B Los Nieto Rd	562-946-6661
25	Marvin C. Pitts							
	Adeline Bennet							
26	Marvin C. Pitts							
	Adeline Bennet							
28	James Mersits	Tom Mersits	562-946-1220	1	Mersits Equipment	Tom Mersits	9640 Santa Fe Springs Rd	562-946-5707 562-946-5806
	Joseph Caneer							
29	James Mersits	Tom Mersits	562-946-1220	1				
	Joseph Caneer							
30	Marvin C. Pitts			1	RV Storage Lot			
	Adeline Bennet							
32	David Neptune	Dave Neptune	562-946-6377	1	California Reamers	Dave/Lori Neptune	12747 Los Nietos Rd	562-946-6377
37	Jovita Ortega	Jovita Ortega	562-902-5343	1	Durango Designs	Mario Corral	12803 Los Nietos Rd	562-903-9088
	Lula Graziano	Lula Graziano	562-942-3672	2	Graziano's			
		John Graziano	707-554-5696					
41	Eugene Welter			1	Four C's Transmission	Julian Nieto	12807A Los Nietos Rd	562-946-9272
				2	Rick's Smog		12807B Los Nietos Rd	
				3	Unknown		12809A Los Nietos Rd	
				4	Bert's Automotive	Bert Lowell	12809B Los Nietos Rd	562-941-4502
				5	Unknown		12811A Los Nietos Rd	
				6	Unknown		12811B Los Nietos Rd	
				7	Leo's Lawnmower	Leo Rojas	12811C Los Nietos Rd	562-944-0538
				8	Hernandez Auto	Octavio Hernandez	12811D Los Nietos Rd	562-777-1197
				9	H & H Contractors	Roger Hall	12811E Los Nietos Rd	562-946-5108
				10			12811F Los Nietos Rd	
42	Meade Peoples	Danny Peoples	562-947-7725	1	Airbrake Associates	Daniel Wedge	12741 Los Nietos Rd	562-946-4960
43	Eddie Timmons	Eddie Timmons	562-946-5401	1	Timmon's Wood Products	Ed Timmons	12723 Los Nietos Rd	562-946-5401
44	Chasin Trust			1	Sisneros Office Furniture	Dave Hoffman	12717 Los Nietos Rd	562-777-9797
49	Phil Campbell							
50	Brothers Machine & Tool	Jose Razo	562-903-117	1	Brothers Machine & Tool	Jose Razo	9843 S. Greenleaf Ave.	562-903-1117
51	Marvin C. Pitts							
	Adeline Bennet							

Recorded Owner List
94-256

9/19/00

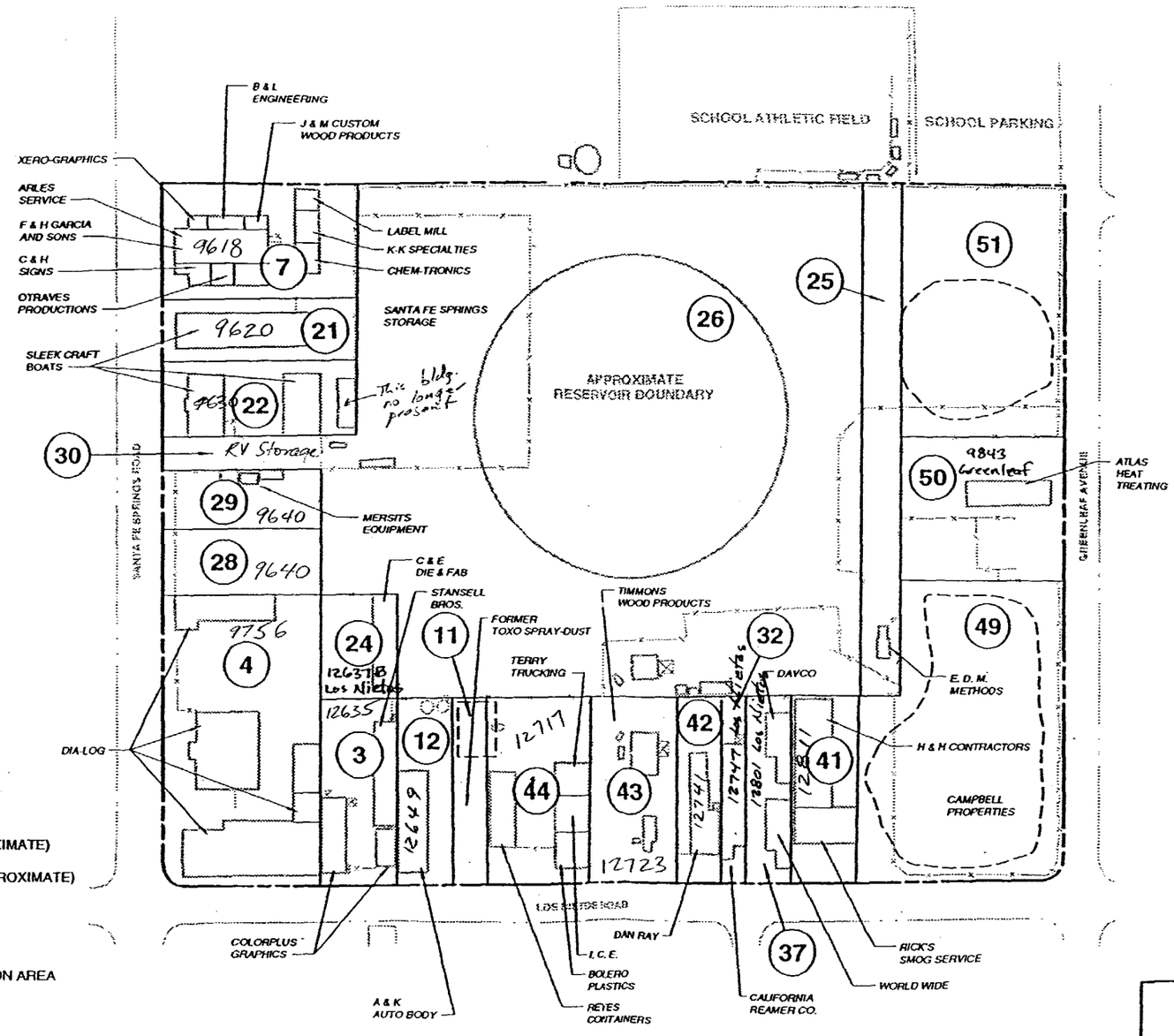
PROPOSED 2 pavement Plan



- Remove & reconstruct with
- Remove & reconstruct with
- Construct - asphalt concrete overlay & restripe cold mill perimeter areas prior to overlay
- Remove & reconstruct isolated areas with

Project No. 29071

JR-14 REV.10/10/95



PARCEL NUMBER/RECORDED OWNER [1]

3	RAYMOND HOLBROOK
4	DIA-LOG COMPANY
7	RALPH HOROWITZ
11	OVIL PROCTOR
12	OVIL PROCTOR
21	JOHN MAPLE, LUCILLE FERRIS
22	JOHN MAPLE, LUCILLE FERRIS
24	RAYMOND HALBROOK
25	JOE BENNETT
26	JOE BENNETT
28	JAMES MERSITS
29	JAMES MERSITS
30	JOE BENNETT
32	DAVID NEPTUNE
37	GEORGE ORTEGA
41	GENE WELTER
42	MEADE PEOPLES
43	ED TIMMONS
44	GALE SEARING
49	PHIL CAMPBELL
50	WILLIAM ELLIOT
51	JOE BENNETT

[1] BASED ON RI (EBASCO, 1989d)

LEGEND

- SITE BOUNDARY (APPROXIMATE)
- PARCEL BOUNDARY (APPROXIMATE)
- FENCE
- EXISTING BUILDING
- APPROXIMATE EXCAVATION AREA AS IDENTIFIED IN ROD
- CANOPY
- (4) PARCEL NUMBER
- CALIFORNIA REAMER CO. — CURRENT TENANT

REFERENCE: BASED ON FIGURES 3.1, TOPOGRAPHIC MAP, AND 3.2 LAND USE MAP, FINAL REMEDIAL INVESTIGATION REPORT, EBASCO, 1989d.

0 200 400 FEET
SCALE

FIGURE 1.3

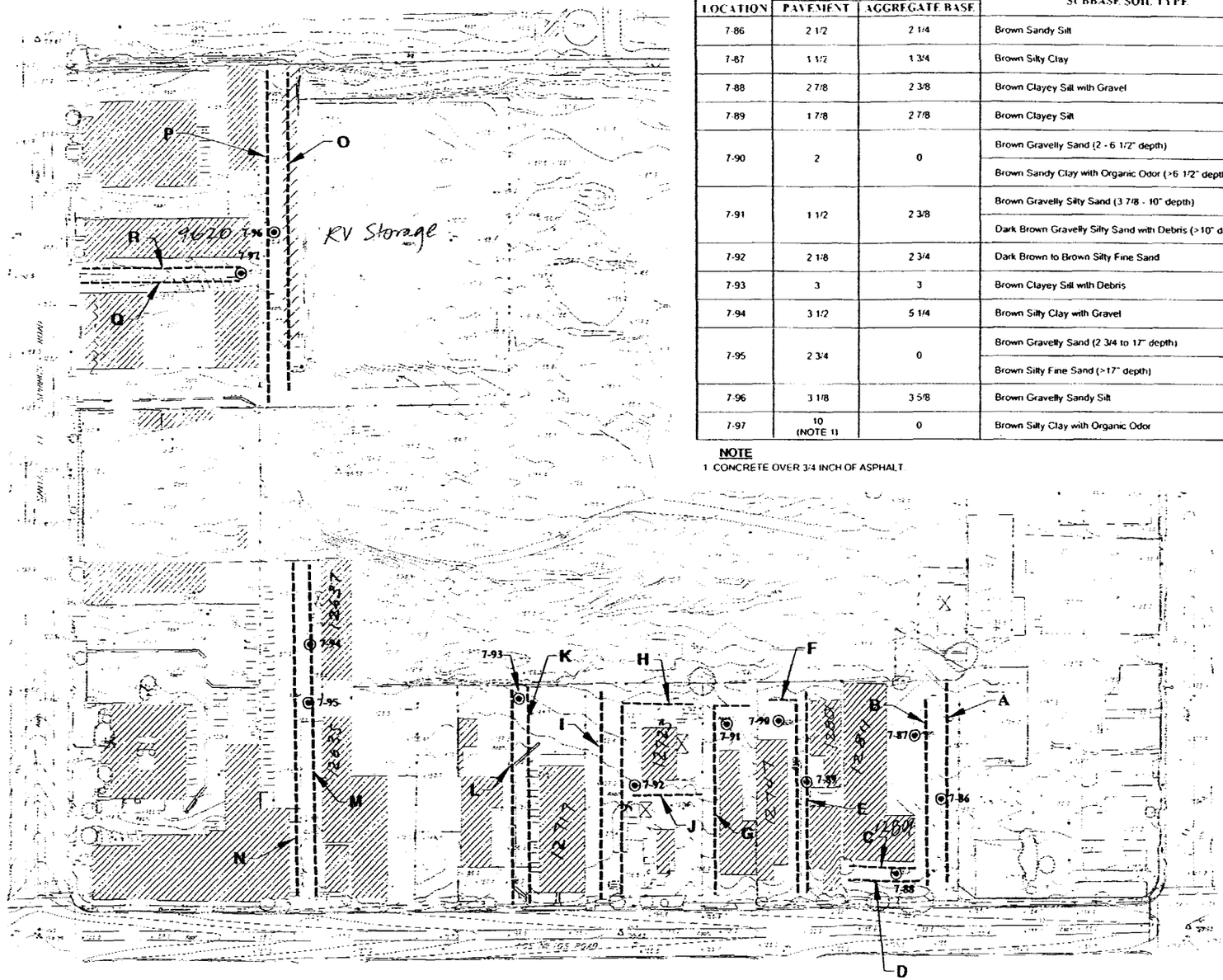
PARCEL MAP

WASTE DISPOSAL, INC.
SANTA FE SPRINGS, CALIFORNIA

ENVIRONMENTAL SOLUTIONS, INC.

REV. 09/19/02

30747MD9/11



ASPHALT CORING AND R-VALUE TEST RESUTS					
CORE LOCATION	THICKNESS (INCHES) PAVEMENT	THICKNESS (INCHES) AGGREGATE BASE	SUBBASE SOIL TYPE	MOISTURE CONTENT (%)	R-VALUE
7-86	2 1/2	2 1/4	Brown Sandy Silt	16.0	79
7-87	1 1/2	1 3/4	Brown Silty Clay	16.1	30
7-88	2 7/8	2 3/8	Brown Clayey Silt with Gravel	13.8	52
7-89	1 7/8	2 7/8	Brown Clayey Silt	17.4	40
7-90	2	0	Brown Gravelly Sand (2 - 6 1/2" depth)	9.2	-
			Brown Sandy Clay with Organic Odor (>6 1/2" depth)	22.4	41
7-91	1 1/2	2 3/8	Brown Gravelly Silty Sand (3 7/8 - 10" depth)	11.2	-
			Dark Brown Gravelly Silty Sand with Debris (>10" depth)	10.5	70
7-92	2 1/8	2 3/4	Dark Brown to Brown Silty Fine Sand	11.5 TO 14.2	48
7-93	3	3	Brown Clayey Silt with Debris	11.6	60
7-94	3 1/2	5 1/4	Brown Silty Clay with Gravel	15.1	19
7-95	2 3/4	0	Brown Gravelly Sand (2 3/4 to 17" depth)	9.1	-
			Brown Silty Fine Sand (>17" depth)	11.4	50
7-96	3 1/8	3 5/8	Brown Gravelly Sandy Silt	9.4	58
7-97	10 (NOTE 1)	0	Brown Silty Clay with Organic Odor	16.6	61

NOTE

1 CONCRETE OVER 3/4 INCH OF ASPHALT

LEGEND

7-98 COREHOLE LOCATION AND DESIGNATION

A DEFLECTION TEST STRIP AND DESIGNATION

0 150 300 FEET

SCALE

ASPHALT DEFLECTOMETER TESTING AND COREHOLE LOCATION MAP

WASTE DISPOSAL, INC.
SANTA FE SPRINGS, CALIFORNIA

TRC

FIGURE 3.2

APPENDIX H.8

CONCRETE STRUCTURAL SECTION DESIGN

LOWNEY ASSOCIATES
Environmental/Civil Engineering and Services

Project Name: WDI / SANTA FE SPRINGS
Subject: CONCRETE PAVEMENT CALCULATIONS
Project No.: 1651-8A Sheet No. 1 of 1
By: TB Date: 12/23/02 Checked by: Date:

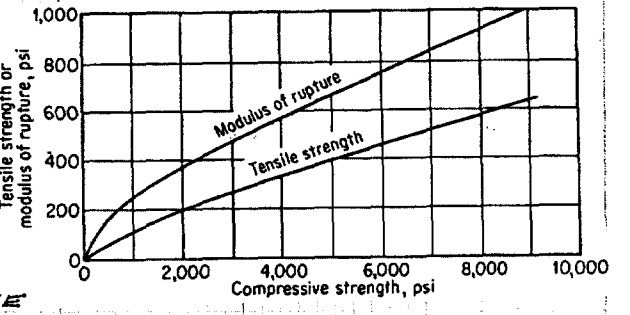
CONCRETE PAVEMENTS

ASSUME: TI = 6.0 (TRUCK PARKING)

$R_{SUBGRADE} = 30$

$M_{R\ CONCRETE} = 525$ PSI ($f_{c\,28} = 3{,}500$ PSI) (REF. 1:)

SEE BELOW:



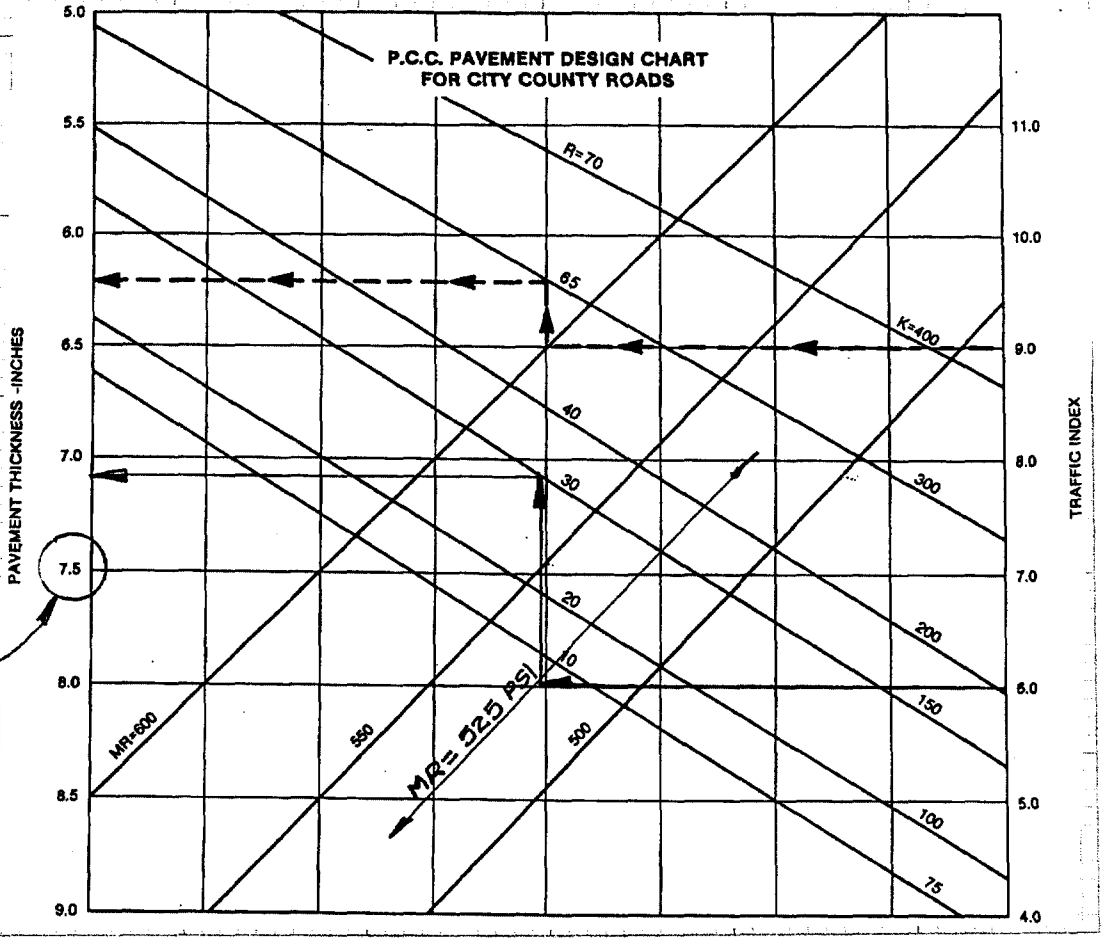
REFERENCES:

(1) TROXELL, DAVIS & KELLY, 1968
COMPOSITION AND PROPERTIES OF CONCRETE

(2) PCA, 1981, P-14 (THIRD PRINTING)
PORTLAND CEMENT CONCRETE PAVEMENT DESIGN IN CALIFORNIA

CALCULATION: $7\frac{1}{2}$ INCHES CONCRETE
OVER: 4 INCHES C.M.B. (SEE REF. 2 TEXT) (REF. 2:)

ROUND UP TO $7\frac{1}{2}$ INCHES CONCRETE



APPENDIX H.9

FLOW CAPACITY OF GEOCOMPOSITE DRAIN LAYER

TRC

By CAK Date 4-23-02 Subject FLOW CAPACITY OF Sheet No. 1 of 5

Chkd. By KF Date 4/30/02 GEOCOMPOSITE DRAINAGE LAYER Proj. No. 30747

PURPOSE: This calculation evaluates the flow capacity of the geocomposite drainage layer shown in Detail 4, Attachment A.

GIVEN: Attachment B provides specifications for the two geocomposites which are included in the WDI cover design. The minimum transmissivity of the geocomposite drainage net is specified to be 10^{-3} m²/m/sec based on ASTM D4716.

EVALUATION: The calculated allowable flow rate, q_{all}, will be compared to the cumulative infiltration along the longest flow line, from the high point to the low point of the cover to confirm that the specified geonet transmissivity of 1×10^{-3} m²/sec is adequate, i.e. the cumulative infiltration is less than 0.055 gal/min/ft measured at the outer edge of the Area 2 containment.

Recyclable and made from recycled paper.

TRC

By CAK Date 4-19-02 Subject CAP AND SOIL COVER @ WDI Site Sheet No. 2 of 5

Chkd. By KF Date 4-30-02 Proj. No. 30747

1. Reference:
Designing with Geosynthetics, Robert M. Koerner, 2nd Ed, 1990

P. 343:
In-plane hydraulic test to determine planar flow rate: ASTM D4716

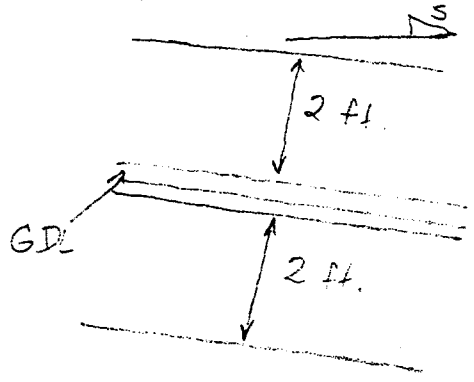
For saturated systems under laminar flow conditions

$$q = KiA = Ki(wt) = (Kt)iw$$

$$Kt = \frac{q}{iw} = \theta$$

where:
q = volumetric flow rate
K = coefficient of permeability
i = hydraulic gradient
A = flow cross-sectional area
θ = transmissivity
w = width
t = thickness

2. Application: WDI Superfund Site (See Attachment A)



i = hydraulic gradient
= Δ head / length

For a confined material,
$\frac{\Delta h}{l}$ = slope

$\therefore$ $i = 0.025$

Determine q for a 1-foot width of geocomposite ($w = 1.0$)

Recyclable and made from recycled paper.

TRC

By CAK Date 4-19-02 Subject WDI Sheet No. 3 of 5

Chkd. By KE Date 4-30-02 Proj. No. 30747

From specifications, $\theta = 1 \times 10^{-3} \frac{m^2}{s}$ at $15{,}000 \frac{lb}{ft^2}$
(see Attachment B)
i.e. the minimum transmissivity required at 15,000 psf load is $1 \times 10^{-3} \frac{m^2}{s}$ using ASTM D4716
This would equate to a flow rate of

$$q = \theta \cdot i W$$
$$= 1 \times 10^{-3} \frac{m^2}{s} \times 0.025 \times 1 ft \times (3.28)^2 \frac{ft^2}{m^2}$$
$$= 0.269 \times 10^{-3} \frac{ft^2}{sec} \times 7.46 \frac{gal}{ft^3} \times 60 \frac{sec}{min}$$
$$= 120.4 \times 10^{-3} \frac{gal}{min}$$
$$= 0.1204 \frac{gal}{min} \text{ per ft. length @ 15,000 psf}$$

At actual field conditions, what is q?

A. Load Effects

Assume compacted clay layer has a density of $120 \#/ft^3$

∴ Dead load on 1 sq. ft. of geonet is $120 \frac{lb}{ft^3} \times 2 ft^3 = 240$

If trucks are parking on the structure, the load will increase.

From The Asphalt Handbook (1989):
Estimate number of Equiv. axle loads (EAL):

For 4-axle Tractor semi-trailer,

Truck Factor = 0.62

For 1 truck, Load = Truck Factor × EAL
= 0.62 × 18,000 lb
= 11,160 lb

Recyclable and made from recycled paper.

TRC

By CAK Date 4/19 Subject WDI Sheet No. 4 of 5

Chkd. By KR Date 4-30-02 Proj. No. 30747

Assume total dead load of soil cover + pavement

For heavy trucks, use 6" pavement + 20' base course

Assume 135 lb/ft³ combined density

Asphalt	6"
B.C	20'

$$\text{Load} = \frac{26}{12}\ ft \times 1\ ft^2 \times 135\ \frac{lb}{ft^3} = 292.5\ lb/ft^3$$

∴ Total dead load = 240 + 293 = 533 lb/ft²/ft

Total live + dead load = 11,160 + 533 = 11,693 lb*

From Fig. 4.8 in "Designing with Geosynthetics,"

At i = 0.03, the flow rate remains constant

for increasing normal stress. ∴ The flow rate

at 11,700 lb = flow rate at 15,000 lb = 0.1204 gal/min

* Note that the effect of a parked truck only influences normal load at the truck location. Most areas of the cover will only experience a normal load of 533 psf.

B. Factor of Safety

From Koerner, must include FS to account for

FS_{IN} = FS for elastic deformation of the adjacent geosynthetics into the core space

FS_{CR} = FS for creep deformation of the geocomposite

FS_{CC} = FS for chemical clogging of core space

FS_{BC} = FS for biological clogging

q_{ult} = q from ASTM D4716

From Table 6.10*, surface water drains for landfill caps (*Koerner, See Attachment C)

FS_{IN} = 1.3 - 1.5 FS_{CR} = 1.2 - 1.4 FS_{CC} = 1.0 to 1.2 FS_{BC} = 1.2 - 1.5

Recyclable and made from recycled paper.

TRC

By CAK Date 4/19 Subject WDI Sheet No. 5 of 5

Chkd. By KF Date 4-30-02 Proj. No. 30747

$\therefore \quad q_{ALLOW} = q_{ULT} \left[\dfrac{1}{FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC}} \right]$

Use $FS_{IN} = 1.3$ because geotextile on 1 side only and most areas of the cover have a low (533) psf normal load.

Use $FS_{CC} = 1.0$ (not a factor)

Use $FS_{CR} = 1.4$ (creep could be significant due to load)

Use $FS_{BC} = 1.2$ since only rainwater infiltration will occur

$\therefore \quad q_{ALLOW} = 0.1204 \left[\dfrac{1}{1.3 \times 1.4 \times 1.0 \times 1.2} \right]$

$= 0.1204 / 2.18$

$= 0.055 \ \text{gal/min/ft}$

Recyclable and made from recycled paper.

TRC

By TLP Date 1/4/03 Subject Supplement to Geocomp Sheet No. 1 of 1
Chkd. By ___ Date ___ Drain Layer Capacity Calc. Proj. No. 30747

Purpose: Capacity of drain layer must be compared to expected peak flow of Infiltration through cover

Given

- Capacity of drain layer is 0.055 gpm/lf. of drain
- Peak daily infiltration flow estimated from HELP Model analysis (See HELP Model Output A-ALT1.OUT in infiltration analysis calc package) is: 20,174 ft^3/day
  = 150,904 gal/day
  = 105 gpm
- Diameter of RCRA Subtitle C cover is 585 ft
- HELP model results are overly conservative

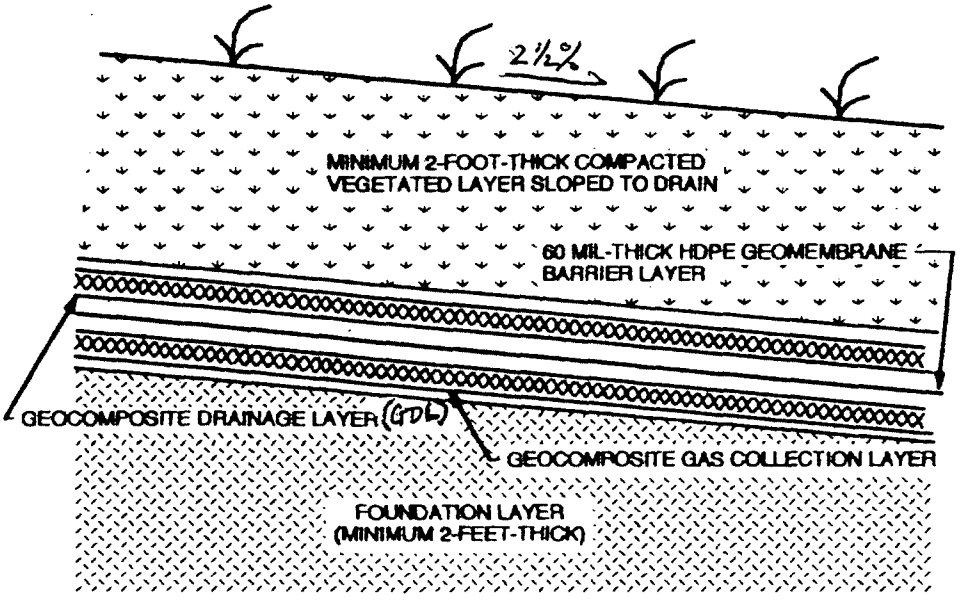
Evaluation

- Perimeter of drain layer = πd
  = 3.14 × 585 ft
  = 1838 ft
- Capacity at perimeter = perimeter × capacity flow
  = 1838' × 0.055 gpm/ft
  = 101 gpm
- Capacity at the perimeter is approximately the same as the estimated peak infiltration rate

∴ Capacity of drain layer is sufficient.

Recyclable and made from recycled paper.

Attachment (A)



DETAIL 4 / 13 14

RCRA SUBTITLE C - EQUIVALENT CAP

NOT TO SCALE

RCRA-EQUIVALENT CAP ← → ENGINEERE

8 oz. FILTER GEOTEXTILE

Attachment (B)

SECTION 02230
GEOCOMPOSITES

PART 1 GENERAL

1.01 DESCRIPTION

A. The Work includes installation of two single-sided geocomposites in the reservoir cap, one to serve as part of the gas venting system and the other as a drainage layer for surface infiltration.

1.02 QUALITY CONTROL

A. QC for geocomposite drainage nets consists of the following types of activities which are described in Part 3, Execution:

1. MANUFACTURERS' certifications that materials satisfy the standard ASTM properties and Specifications.
2. "As Received" material conformance tests.
3. Field inspections for defects, including related repairs.

B. The following ASTM Reference Standards shall be used for geocomposite drainage net:

1. ASTM D1505 - Polymer Density.
2. ASTM D1238E, Method E - Polymer Melt Index.
3. ASTM D1603 - Carbon Black Content.
4. ASTM D1777 - Nominal Thickness.
5. ASTM D3776 - Nominal Mass per Unit Area.
6. ASTM D4716 - Transmissivity at 15,000 psf.
7. ASTM D1682 - Tensile Strength/Machine Direction.

1.03 SUBMITTALS

A. No later than 15 days prior to the installation of geocomposite drainage net materials, CONTRACTOR shall submit a Geocomposite Placement Plan providing the following information:

1. Résumé of the Superintendent to be assigned to this project, including dates and durations for similar work.

2. A panel layout drawing showing the installation layout and any deviations from the Drawings. Each layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

Installation shall not begin for any material until the respective Placement Plan is approved by ENGINEER.

PART 2 MATERIALS

A. Geocomposite drainage net shall be Trevira 1125 geotextile thermally bonded to one side of Polynet 3000 geonet, or equivalent material approved by ENGINEER.

PART 3 EXECUTION

3.01 MATERIAL QUALITY CONTROL DOCUMENTATION

A. Geocomposites:

1. Certification

a. Prior to installation of any geocomposite, MANUFACTURER or CONTRACTOR shall provide CQA ENGINEER with the following information:

- Property values certified by MANUFACTURER to meet guaranteed specifications.
- Reports on tests conducted by MANUFACTURER to verify that the quality of the raw material used to manufacturer the geocomposite meets MANUFACTURER's specifications.
- Written certification that drainage net is manufactured by extruding two sets of strands to form a three-dimensional structure to provide planar water flow, and that the drainage net shall contain stabilizers to prevent ultraviolet light degradation.
- Written certification that the geocomposite shall be manufactured by heat bonding the geocomposite to the HDPE drainage net on one side. No burn-through geocomposites, glue or adhesives shall be permitted.
- A specification for the geocomposite which includes all properties associated with the Specifications stated in Table 02230-1 are guaranteed by MANUFACTURER, including a signed QC certificate(s).

- MANUFACTURER shall provide verification that the bond between the geotextile and the HDPE drainage net shall exhibit a minimum average peel strength of 2 pounds per inch, and a typical peel strength of 4 pounds per inch (per ASTM D413). Peel strength shall be tested approximately every 600 linear feet.
- MANUFACTURER shall submit samples of the geocomposite to ENGINEER and CQA ENGINEER. MANUFACTURER shall also furnish a complete set of written instructions for storage, handling, installation and joining.
- QC certificates, signed by responsible party employed by MANUFACTURER. The QC certificates shall indicate that the materials meet the designated specification.
- MANUFACTURER shall supply the geocomposite in rolls, marked or tagged with the following:
  - MANUFACTURER's name.
  - Production identification.
  - Lot number.
  - Roll number.
  - Roll dimensions.

b. CQA ENGINEER shall document that all of the geocomposite material received is appropriately certified by MANUFACTURER, prior to its installation.

2. Conformance Testing

a. CONTRACTOR shall collect all conformance samples as directed by CQA ENGINEER. Upon delivery of the rolls of geocomposite, CQA ENGINEER shall ensure that conformance test samples are obtained for the geocomposite. These samples shall then be forwarded to the geosynthetics QAL for testing to ensure conformance to the project specifications. CQA ENGINEER shall prepare Chain-of-Custody forms to be completed by all parties and returned to CQA ENGINEER for QA records.

b. At a minimum the following conformance tests shall generally be performed on geocomposites:

- Polymer density.
- Polymer melt.
- Carbon black content.
- Thickness.
- Mass permit area.
- Transmissivity.
- Tensile strength.
- Fabric weight.
- Grab strength and elongation.
- Trapezoidal tear strength.
- Puncture resistance.
- Mullen burst strength.
- Water flow rate.
- Permittivity.
- Permeability.
- Apparent opening size.

c. These conformance tests shall be performed in accordance with the test methods specified in the Specifications (Table 02230-1). Other conformance tests may be required by the project specifications.

3. The rolls to be sampled shall be selected by CQA ENGINEER. Samples shall be taken across the entire width of the roll and shall not include the first complete revolution of fabric on the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 feet long by the roll width. CQA ENGINEER shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

4. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by CQA ENGINEER based on a review of roll information including QC documentation and manufacturing records.

5. Unless otherwise specified, samples shall be taken at a rate of one per lot, not to exceed one conformance test per 100,000 square feet of geocomposite.

6. All conformance test results shall be reviewed and accepted or rejected by CQA ENGINEER prior to the deployment of the geocomposite.

7. CQA ENGINEER shall examine all results from laboratory conformance testing and shall report any nonconformance to OWNER. CQA ENGINEER shall be responsible for checking that test results meet or exceed the property values listed in the Specifications and review any nonconforming results with ENGINEER prior to acceptance or rejection.

8. If a test result is in nonconformance, all material from the lot represented by the failing test can be considered out of specification and rejected. Alternatively, at the option of the CQA ENGINEER , additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specifications (this procedure is valid only when all rolls onsite in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent (next smaller and next larger) to the roll that was sampled and failed. If both additional tests pass, only the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot, until passing tests are achieved on either side numerically from the original failed roll.

9. Supplier shall be responsible for shipment and onsite storage of geocomposite rolls. The geocomposites shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

3.02 INSTALLATION

A. Geocomposite Materials

1. Handling and Installation

a. Installer shall handle all geocomposites in such a manner as to ensure they are not damaged, and the following shall be complied with:

- Prior to installation, geocomposite materials shall be protected from ultraviolet light exposure by using relatively opaque and watertight wrappings and covers.
- On slopes, the geocomposites shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension.
- In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
- Geocomposites shall be cut using a geocomposite cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geocomposites.
- Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- During placement of geocomposites, care shall be taken not to entrap in or beneath the geocomposite, stones, excessive dust, or moisture that could damage the geocomposite, cause clogging of drains or filters, or hamper subsequent seaming.
- A visual examination of the geocomposite shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.
- Geocomposites shall be placed to the back wall of anchor trenches.

b. All adjacent geocomposite panels shall be overlapped a minimum of 4 inches and thermally bonded with the approval of CQA ENGINEER.

c. CONTRACTOR shall pay particular attention to ensure that no protective soil cover material could be inadvertently inserted beneath the geocomposite. In general, no horizontal seams shall be allowed on side slopes, except as part of a patch.

d. CQA ENGINEER shall preapprove geocomposite rolls for use in construction and give an approved roll list to CONTRACTOR. CQA ENGINEER shall observe geocomposite rolls for defects and damages as they are deployed and ensure that deployment methods do not damage the geocomposites.

e. Adjacent geocomposite shall be joined according to Drawings and Specifications. At a minimum, the following requirements shall be met:

- Adjacent rolls shall be overlapped by at least 4 inches.
- Overlaps shall be secured by tying.

- Tying can be achieved by plastic fasteners of polymer grade. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
- Tying shall be every 5 feet along the slope, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams on the base of the landfill.
- In general, no horizontal seams shall be allowed on sideslopes.

f. Each geocomposite shall be securely anchored by CONTRACTOR to ensure that no slippage occurs during construction or operations. Details of anchor trench construction are shown in the Drawings.

g. CONTRACTOR shall clean geomembrane layer surfaces prior to placing geocomposite.

2. Defects and Repairs

a. Holes or tears in the geocomposite shall be repaired as follows:

- On slopes, a patch made from the same geocomposite shall be thermally bonded into place a minimum of 6 inches beyond the hole in all directions, in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
- Care shall be taken to remove any soil or other material which may have penetrated the torn geocomposite.

3. Geocomposite Protection

a. All soil materials located on top of a geocomposite shall be deployed in such a manner as to ensure:

- The geocomposite and underlying geosynthetic materials are not damaged.
- Minimal slippage of the geocomposite on underlying layers occurs.
- No excess tensile stresses occur in the geocomposite.
- Soil does not contaminate the net.

b. Any noncompliance shall be noted by CQA ENGINEER and reported to OWNER.

c. CONTRACTOR shall be responsible for the condition of the geocomposite at all times until CQA ENGINEER accepts the material for placement of overlying layers.

TABLE 02230-1

MINIMUM PHYSICAL PROPERTIES OF GEOCOMPOSITE

DRAINAGE NET PROPERTY SPECIFICATION

PROPERTY	TEST METHOD	UNIT	QUALIFIER	VALUE
Polymer Density	ASTM D1505	g/cm^3	Minimum	0.937
Polymer Melt Index	ASTM D1238, Method E	g/10 min	Maximum	1.0
Carbon Black Content	ASTM D1603	%	Range	2 to 3
Nominal Thickness	ASTM D1777	mil	Minimum	220
Nominal Mass Per Unit Area	ASTM D3776	lb/ft^2	Minimum	0.18
Transmissivity at 15,000 psf	ASTM D4716	m/sec	Minimum	1×10^{-3}
Tensile Strength/Machine Direction	ASTM D1682	lb/in	Minimum	50

GEOTEXTILE PROPERTY SPECIFICATION

FABRIC PROPERTY	UNIT	TEST METHOD	QUALIFIER	SPECIFIED VALUES
Fabric Weight	oz/yd^2	ASTM D3776	Minimum	7.5
Thickness	mil	ASTM D1777	Minimum	110
Grab Strength	lb	ASTM D4632	Minimum	210
Grab Elongation	%	ASTM D4632	Minimum	50
Trapezoidal Tear Strength	lb	ASTM D4533	Minimum	75
Puncture Resistance	lb	ASTM D4833	Minimum	100
Mullen Burst Strength	psi	ASTM D3786	Minimum	380
Water Flow Rate	gpm/ft^2	ASTM D4491	Minimum	100
Permittivity (Y)	sec^{-1}	ASTM D4491	Minimum	1.25
Permeability (k = Yt)	cm/sec	ASTM D4491	Minimum	0.35
Apparent Opening Size	Sieve Size (mm)	ASTM D4751	Range	70 (0.210) - 100 (0.149)

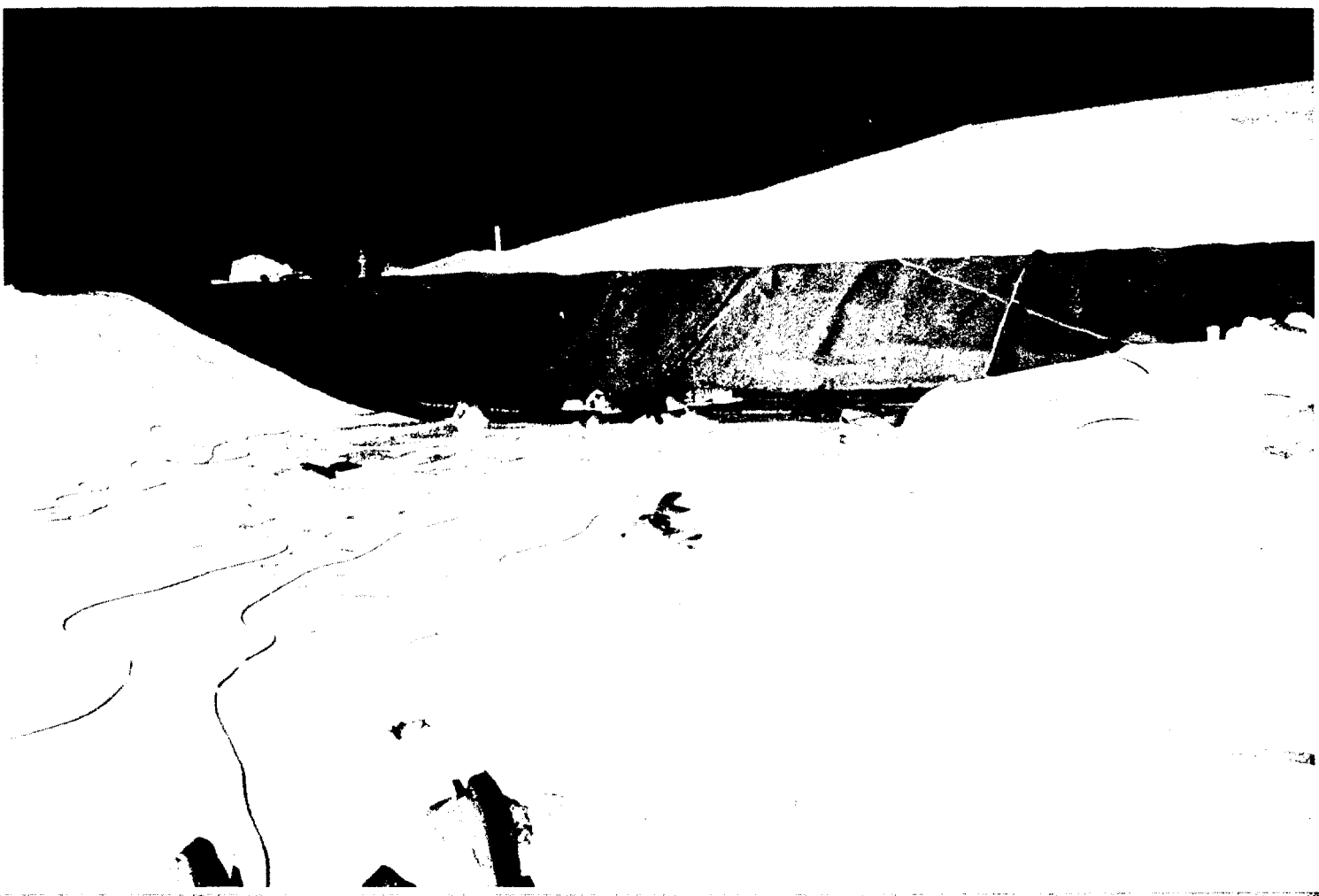
30747 (12/6/01/rm)

* * * END OF SECTION * * *

TRC
Customer-Focused Solutions

SECOND EDITION

DESIGNING WITH GEOSYNTHETICS



ROBERT M. KOERNER

TABLE 6.10 RECOMMENDED PRELIMINARY FACTOR OF SAFETY VALUES TO DETERMINE ALLOWABLE FLOW RATE OF GEOCOMPOSITES

	Factor of safety values for Equation 6.3			
Application area	FS_{IN}	FS_{CR}*	FS_{CC}	FS_{BC}
Sport fields, capillary breaks	1.0 to 1.2	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill caps	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfill)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfill)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Strip (wick) drains**	1.5 to 2.5	1.0 to 2.5	1.0 to 1.2	1.0 to 1.2
Highway edge drains	1.2 to 1.8	1.5 to 3.0	1.1 to 1.5	1.0 to 1.2

*These values assume that the q_{ult} value was obtained using an applied normal pressure of 2 to 3 times the field anticipated maximum value. If not, the values must be increased.

**An additional term for kinking must be included, where FS_{KG} = 1.0 to 4.0.

$$FS = \frac{q_{allow}}{q_{required}} \tag{6.4}$$

where

FS = the factor of safety (to handle unknown loading conditions or uncertainties in design methods, etc.),

q_{allow} = the allowable flow rate obtained from modifying q_{ult} as per Equation 6.3, and

$q_{required}$ = the required flow rate as obtained from design of the actual system.

Note that this procedure is exactly like that described in Chapter 4 for geonets. They are, indeed, competing geosynthetics in many application areas. An example illustrating the use of this procedure follows:

Example:

Recalculate the retaining wall drainage problem originally given in Chapter 2 for geotextiles (where FS = 0.078) and then again in Chapter 4 for geonets (where FS = 2.4) for the geocomposite whose response is given in Figure 6.10a. Recall that the required flow rate was 0.14 ft^3/min-ft.

APPENDIX H.10

PIPE SIZE CALCULATION FOR DRAIN LAYER OUTLET

TRC

By LBJ Date 1/2/03 Subject CALCULATION OF REQUIRED Sheet No. 1 of 11
Chkd. By TLP Date 1/3/03 LANDFILL DRAINAGE PIPE SIZE Proj. No. 30747

PURPOSE: TO DETERMINE PROPER DRAINAGE PIPE DIAMETER TO CONVEY DRAINAGE COLLECTED FROM LAYER 3 OF THE CAP DURING PEAK DAILY RAINFALL EVENT

PROCEDURE:

1) RUN HELP MODEL TO OBTAIN EXPECTED VALUE OF DRAINAGE FROM LAYER 3 (SEE ATTACHMENT "A" PAGE 8)

2) CONVERT VALUE TO GPM

3) DETERMINE PIPE DIAMETER CAPABLE OF CARRING THE FLOW AT MINIMAL PRESSURE DROP (SEE ATTACHMENT B)

CALCULATIONS:

FROM ATTACHMENT "A" PAGE 8 PEAK FLOW EXPECTED = 20,174.32 ft^3/day

1 ft^3 = 7.48 gal ∴ 20,174.32 ft^3/day × 7.48 gal/ft^3 ≅ 150,904 gal/day

1 day = 1440 min ∴ $\frac{150{,}904 \text{ gal/day}}{1440 \text{ min/day}}$ ≅ 105 gal/min PEAK FLOW

APPLY SAFETY FACTOR OF 25% ∴ 105 × 1.25 ≅ 130 gpm

FOR LAMINAR FLOW VEL SHOULD BE BELOW 5 ft/sec
KEEP PRESSURE DROP BELOW 0.5 psi/100 ft

FROM ATTACHMENT "B" CRITERIA MEET BY 4" DIA PIPE WHICH COULD CONVEY ≈ 150 gpm UNDER ABOVE CONDITIONS

Recyclable and made from recycled paper.

Attachment A


```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:     c:\HELP\DAT\PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\ET.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\ALT-1.D10
OUTPUT DATA FILE:            C:\HELP\OUT\A-ALT1.OUT

TIME:   8:43     DATE:  11/27/2002

******************************************************************************

     TITLE:  01-123-Alt #1

******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =      12.00   INCHES
          POROSITY                     =       0.3660 VOL/VOL
          FIELD CAPACITY               =       0.3570 VOL/VOL
          WILTING POINT                =       0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.2100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =      12.00   INCHES
          POROSITY                     =       0.3660 VOL/VOL
          FIELD CAPACITY               =       0.3570 VOL/VOL
          WILTING POINT                =       0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.2178 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  20
          THICKNESS                    =       0.20   INCHES
          POROSITY                     =       0.8500 VOL/VOL
          FIELD CAPACITY               =       0.0100 VOL/VOL
          WILTING POINT                =       0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.0100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
          SLOPE                        =       2.00   PERCENT
          DRAINAGE LENGTH              =     335.0    FEET

                                  LAYER  4
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
          THICKNESS                    =       0.06   INCHES
          POROSITY                     =       0.0000 VOL/VOL
          FIELD CAPACITY               =       0.0000 VOL/VOL
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WILTING POINT                  =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY            =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS       =      7.00   HOLES/ACRE
FML PLACEMENT QUALITY          =  3 - GOOD

                          LAYER  5
                          --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  60
THICKNESS                      =      0.20   INCHES
POROSITY                       =      0.7500 VOL/VOL
FIELD CAPACITY                 =      0.7470 VOL/VOL
WILTING POINT                  =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999994000E-08 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
         SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
         OF  2.% AND A SLOPE LENGTH OF  335. FEET.

SCS RUNOFF CURVE NUMBER              =     80.10
FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      8.100  ACRES
EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      5.134  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      8.784  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.328  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =      5.286  INCHES
TOTAL INITIAL WATER                  =      5.286  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         LOS ANGELES           CALIFORNIA

     STATION LATITUDE                          =  33.80 DEGREES
     MAXIMUM LEAF AREA INDEX                   =   2.00
     START OF GROWING SEASON (JULIAN DATE)     =    285
     END OF GROWING SEASON (JULIAN DATE)       =    151
     EVAPORATIVE ZONE DEPTH                    =  24.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =   3.03 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  67.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  74.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  75.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  67.00 %

NOTE:  PRECIPITATION DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

NOTE:  TEMPERATURE DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

NOTE:  SOLAR RADIATION DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

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           MONTHLY TOTALS (IN INCHES) FOR YEAR    1
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                         JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
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PRECIPITATION	3.15	3.31	5.72	0.04	0.00	0.00
	0.00	0.00	0.00	0.39	0.00	3.04
RUNOFF	0.011	0.075	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.097
EVAPOTRANSPIRATION	1.559	1.454	3.268	2.453	0.000	0.000
	0.000	0.000	0.000	0.044	0.153	0.334
LATERAL DRAINAGE COLLECTED FROM LAYER 3	2.4309	0.0000	3.6080	0.1601	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.032	0.000	0.050	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.084	0.000	0.126	0.006	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.65	460156.969	100.00
RUNOFF	0.190	5595.669	1.22
EVAPOTRANSPIRATION	9.265	272431.687	59.20
DRAINAGE COLLECTED FROM LAYER 3	6.1990	182269.609	39.61
PERC./LEAKAGE THROUGH LAYER 5	0.000004	0.113	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0069		
CHANGE IN WATER STORAGE	-0.005	-140.022	-0.03
SOIL WATER AT START OF YEAR	5.286	155438.719	
SOIL WATER AT END OF YEAR	5.282	155298.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.068	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.33	7.32	6.41	0.16	0.00	0.00
	0.24	0.00	0.00	1.39	0.00	4.43
RUNOFF	0.006	0.318	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.026

EVAPOTRANSPIRATION	1.534	2.191	2.929	3.138	0.009	0.000
	0.179	0.061	0.000	0.095	0.213	0.989
LATERAL DRAINAGE COLLECTED FROM LAYER 3	2.3671	3.8122	2.5257	0.1852	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.6177
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.023	0.741	0.024	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.006
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.037	2.495	0.036	0.004	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.014

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.28	655099.062	100.00
RUNOFF	0.356	10453.519	1.60
EVAPOTRANSPIRATION	11.338	333374.812	50.89
DRAINAGE COLLECTED FROM LAYER 3	9.5079	279559.375	42.67
PERC./LEAKAGE THROUGH LAYER 5	0.000072	2.114	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0663		
CHANGE IN WATER STORAGE	1.078	31709.016	4.84
SOIL WATER AT START OF YEAR	5.282	155298.687	
SOIL WATER AT END OF YEAR	6.360	187007.703	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.240	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	14.64	9.62	1.62	0.00	0.00	0.91
	0.00	0.00	0.00	0.15	0.55	0.47
RUNOFF	2.695	0.648	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.642	1.998	3.419	1.126	0.000	0.273
	0.287	0.261	0.089	0.108	0.160	0.214
LATERAL DRAINAGE COLLECTED FROM LAYER 3	12.1096	5.6275	0.4939	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0007	0.0002	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	5.356	1.424	0.005	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	7.004	3.948	0.012	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.96	822107.937	100.00
RUNOFF	3.343	98305.641	11.96
EVAPOTRANSPIRATION	9.577	281580.156	34.25
DRAINAGE COLLECTED FROM LAYER 3	18.2310	536047.000	65.20
PERC./LEAKAGE THROUGH LAYER 5	0.000888	26.095	0.00
AVG. HEAD ON TOP OF LAYER 4	0.5654		
CHANGE IN WATER STORAGE	-3.192	-93850.719	-11.42
SOIL WATER AT START OF YEAR	6.360	187007.703	
SOIL WATER AT END OF YEAR	3.168	93156.992	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.199	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.24	4.53	1.74	0.84	0.16	0.00
	0.00	0.00	0.00	0.44	0.67	0.72
RUNOFF	0.000	0.023	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.405	2.049	3.495	0.952	0.533	0.000
	0.000	0.000	0.000	0.191	0.295	0.344
LATERAL DRAINAGE COLLECTED	0.0000	0.6354	0.1054	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.006	0.001	0.000	0.000	0.000

TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.010	0.003	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.34	274624.000	100.00
RUNOFF	0.023	688.224	0.25
EVAPOTRANSPIRATION	8.264	243000.453	88.48
DRAINAGE COLLECTED FROM LAYER 3	0.7408	21782.455	7.93
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.016	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0006		
CHANGE IN WATER STORAGE	0.311	9152.819	3.33
SOIL WATER AT START OF YEAR	3.168	93156.992	
SOIL WATER AT END OF YEAR	3.480	102309.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.044	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	11.57	1.30	7.13	1.02	0.09	1.26
	0.00	0.00	0.08	0.00	0.00	0.59
RUNOFF	0.775	0.000	0.265	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.506	2.319	3.439	2.642	0.090	0.215
	0.323	0.282	0.272	0.245	0.003	0.176
LATERAL DRAINAGE COLLECTED	6.9561	0.3355	3.7827	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.223	0.004	0.364	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	3.322	0.006	1.447	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.04	677445.187	100.00
RUNOFF	1.040	30572.000	4.51
EVAPOTRANSPIRATION	11.511	338470.344	49.96
DRAINAGE COLLECTED FROM LAYER 3	11.0743	325616.312	48.07
PERC./LEAKAGE THROUGH LAYER 5	0.000171	5.021	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1325		
CHANGE IN WATER STORAGE	-0.586	-17218.283	-2.54
SOIL WATER AT START OF YEAR	3.480	102309.812	
SOIL WATER AT END OF YEAR	2.894	85091.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.198	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.39	5.22	4.52	0.41	0.05	0.43
	0.05	0.00	0.02	0.47	0.24	1.85
STD. DEVIATIONS	6.32	3.29	2.64	0.48	0.07	0.61
	0.11	0.00	0.04	0.54	0.34	1.79
RUNOFF						
TOTALS	0.698	0.213	0.055	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.025
STD. DEVIATIONS	1.165	0.274	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.042
EVAPOTRANSPIRATION						
TOTALS	1.329	2.002	3.310	2.062	0.126	0.098
	0.158	0.121	0.072	0.137	0.165	0.411
STD. DEVIATIONS	0.519	0.331	0.229	0.969	0.231	0.135
	0.154	0.140	0.118	0.080	0.107	0.331
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	4.7728	2.0821	2.1031	0.0691	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1236
STD. DEVIATIONS	4.8127	2.5021	1.7208	0.0950	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.2762
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	1.3267	0.4350	0.0888	0.0007	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
STD. DEVIATIONS	2.3122	0.6385	0.1549	0.0009	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.65	(7.242)	577886.6	100.00
RUNOFF	0.990	(1.3709)	29123.01	5.040
EVAPOTRANSPIRATION	9.991	(1.3969)	293771.47	50.835
LATERAL DRAINAGE COLLECTED FROM LAYER 3	9.15059	(6.43658)	269054.937	46.55843
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00023	(0.00038)	6.672	0.00115
AVERAGE HEAD ON TOP OF LAYER 4	0.154	(0.236)		
CHANGE IN WATER STORAGE	-0.479	(1.6314)	-14069.44	-2.435

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.47	102028.414
RUNOFF	1.565	46019.0508
DRAINAGE COLLECTED FROM LAYER 3	0.68613	20174.32030
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000124	3.63731
AVERAGE HEAD ON TOP OF LAYER 4	21.422	
MAXIMUM HEAD ON TOP OF LAYER 4	27.540	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	122.5 FEET	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3660	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0970	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5780	0.1315
2	1.1640	0.0970
3	0.0020	0.0100
4	0.0000	0.0000
5	0.1500	0.7500
SNOW WATER	0.000	

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Flow Velocity & Friction Loss — Schedule 40 Pipe

Gallons/Minute	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.
	½ in.			¾ in.																				
1	1.13	2.08	0.90	0.63	0.51	0.22	1 in.			1¼ in.			1½ in.											
2	2.26	4.16	1.80	1.26	1.02	0.44	0.77	0.55	0.24	0.44	0.14	0.06	0.33	0.07	0.03	2 in.			2½ in.			3 in.		
5	5.64	23.44	10.15	3.16	5.73	2.48	1.93	1.72	0.75	1.11	0.44	0.19	0.81	0.22	0.09	0.49	0.066	0.029	0.30	0.038	0.016	0.22	0.015	0.007
7	7.90	43.06	18.64	4.43	10.52	4.56	2.72	3.17	1.37	1.55	0.81	0.35	1.13	0.38	0.17	0.69	0.11	0.048	0.49	0.051	0.023	0.31	0.021	0.009
10	11.28	82.02	35.51	6.32	20.04	8.68	3.86	6.02	2.61	2.21	1.55	0.67	1.62	0.72	0.31	0.98	0.21	0.091	0.68	0.09	0.039	0.44	0.03	0.013
15	4 in.			9.48	42.46	18.39	5.79	12.77	5.53	3.31	3.28	1.42	2.42	1.53	0.66	1.46	0.45	0.19	1.03	0.19	0.082	0.66	0.07	0.030
20	0.51	0.03	0.013	12.65	72.34	31.32	7.72	21.75	9.42	4.42	5.59	2.42	3.23	2.61	1.13	1.95	0.76	0.33	1.37	0.32	0.14	0.88	0.11	0.048
25	0.64	0.04	0.017	5 in.			9.65	32.88	14.22	5.52	8.45	3.66	4.04	3.95	1.71	2.44	1.15	0.50	1.71	0.49	0.21	1.10	0.17	0.074
30	0.77	0.06	0.026	0.49	0.02	0.009	11.58	46.08	19.95	6.63	11.85	5.13	4.85	5.53	2.39	2.93	1.62	0.70	2.05	0.68	0.29	1.33	0.23	0.10
35	0.89	0.08	0.035	0.57	0.03	0.013				7.73	15.76	6.82	5.66	7.36	3.19	3.41	2.15	0.93	2.39	0.91	0.39	1.55	0.31	0.13
40	1.02	0.11	0.048	0.65	0.03	0.013				8.84	20.18	8.74	6.47	9.43	4.08	3.90	2.75	1.19	2.73	1.16	0.50	1.77	0.40	0.17
45	1.15	0.13	0.056	0.73	0.04	0.017	6 in.			9.94	25.10	10.87	7.27	11.73	5.08	4.39	3.43	1.49	3.08	1.44	0.62	1.99	0.50	0.22
50	1.28	0.16	0.069	0.81	0.05	0.022	0.56	0.02	0.009	11.05	30.51	13.21	8.08	14.25	6.17	4.88	4.16	1.80	3.42	1.75	0.76	2.21	0.60	0.26
60	1.53	0.22	0.095	0.97	0.07	0.030	0.67	0.03	0.013				9.70	19.98	8.65	5.85	5.84	2.53	4.10	2.46	1.07	2.65	0.85	0.37
70	1.79	0.30	0.13	1.14	0.10	0.043	0.79	0.04	0.017							6.83	7.76	3.36	4.79	3.27	1.42	3.09	1.13	0.49
75	1.92	0.34	0.15	1.22	0.11	0.048	0.84	0.05	0.022							7.32	8.82	3.82	5.13	3.71	1.61	3.31	1.28	0.55
80	2.05	0.38	0.16	1.30	0.13	0.056	0.90	0.05	0.022							7.80	9.94	4.30	5.47	4.19	1.81	3.53	1.44	0.62
90	2.30	0.47	0.20	1.46	0.16	0.069	1.01	0.06	0.026	8 in.						8.78	12.37	5.36	6.15	5.21	2.26	3.98	1.80	0.78
100	2.56	0.58	0.25	1.62	0.19	0.082	1.12	0.08	0.035	0.65	0.03	0.012				9.75	15.03	6.51	6.84	6.33	2.74	4.42	2.18	0.94
125	3.20	0.88	0.38	2.03	0.29	0.125	1.41	0.12	0.052	0.81	0.035	0.015							8.55	9.58	4.15	5.52	3.31	1.43
150	3.84	1.22	0.53	2.44	0.40	0.17	1.69	0.16	0.069	0.97	0.04	0.017							10.26	13.41	5.81	6.63	4.63	2.00
175	4.48	1.63	0.71	2.84	0.54	0.235	1.97	0.22	0.096	1.14	0.055	0.024	10 in.									7.73	6.16	2.67
200	5.11	2.08	0.90	3.25	0.69	0.30	2.25	0.28	0.12	1.30	0.07	0.030	0.82	0.027	0.012							8.83	7.88	3.41
250	6.40	3.15	1.36	4.06	1.05	0.45	2.81	0.43	0.19	1.63	0.11	0.048	1.03	0.035	0.015							11.04	11.93	5.17
300	7.67	4.41	1.91	4.87	1.46	0.63	3.37	0.60	0.26	1.94	0.16	0.069	1.23	0.05	0.022	12 in.								
350	8.95	5.87	2.55	5.69	1.95	0.85	3.94	0.79	0.34	2.27	0.21	0.091	1.44	0.065	0.028	1.01	0.027	0.012						
400	10.23	7.52	3.26	6.50	2.49	1.08	4.49	1.01	0.44	2.59	0.27	0.12	1.64	0.09	0.039	1.16	0.04	0.017						
450				7.31	3.09	1.34	5.06	1.26	0.55	2.92	0.33	0.14	1.85	0.11	0.048	1.30	0.05	0.022						
500				8.12	3.76	1.63	5.62	1.53	0.66	3.24	0.40	0.17	2.05	0.13	0.056	1.45	0.06	0.026						
750										4.86	0.85	0.37	3.08	0.28	0.12	2.17	0.12	0.052						
1000										6.48	1.45	0.63	4.11	0.48	0.21	2.89	0.20	0.087						
1250													5.14	0.73	0.32	3.62	0.31	0.13						
1500													6.16	1.01	0.44	4.34	0.43	0.19						
2000																5.78	0.73	0.32						
2500																7.23	1.11	0.49						

NOTE: In larger diameters, particularly 6" and greater, Harvel recommends velocities be maintained at or below 5 feet per second.

Attachment B

11 of 11

DWS-GZ

I. *HELP Model Input / Output Files For Subtitle C Alternatives With 5-Year Simulation Period*

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:     C:\HELP\DAT\PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\ET.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\RCRA-C.D10
OUTPUT DATA FILE:            C:\HELP\OUT\A-RCRA.OUT

TIME:   8:30     DATE:  11/27/2002

******************************************************************************

     TITLE:  01-123_RCRA-C

******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =      12.00   INCHES
          POROSITY                     =       0.3660 VOL/VOL
          FIELD CAPACITY               =       0.3570 VOL/VOL
          WILTING POINT                =       0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.2081 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =      12.00   INCHES
          POROSITY                     =       0.3660 VOL/VOL
          FIELD CAPACITY               =       0.3570 VOL/VOL
          WILTING POINT                =       0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.2194 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  21
          THICKNESS                    =      12.00   INCHES
          POROSITY                     =       0.3970 VOL/VOL
          FIELD CAPACITY               =       0.0320 VOL/VOL
          WILTING POINT                =       0.0130 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.0320 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.300000012000     CM/SEC
          SLOPE                        =       2.00   PERCENT
          DRAINAGE LENGTH              =     335.0    FEET

                                  LAYER  4
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
          THICKNESS                    =       0.02   INCHES
          POROSITY                     =       0.0000 VOL/VOL
          FIELD CAPACITY               =       0.0000 VOL/VOL
          WILTING POINT                =       0.0000 VOL/VOL
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INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      7.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD

                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4270 VOL/VOL
FIELD CAPACITY              =      0.4180 VOL/VOL
WILTING POINT               =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
         SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
         OF  2.% AND A SLOPE LENGTH OF  335. FEET.

SCS RUNOFF CURVE NUMBER             =     80.10
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      8.100  ACRES
EVAPORATIVE ZONE DEPTH              =     24.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      5.130  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      8.784  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.328  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     15.762  INCHES
TOTAL INITIAL WATER                 =     15.762  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR

           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         LOS ANGELES          CALIFORNIA

     STATION LATITUDE                          =  33.80 DEGREES
     MAXIMUM LEAF AREA INDEX                   =   2.00
     START OF GROWING SEASON (JULIAN DATE)     =    285
     END OF GROWING SEASON (JULIAN DATE)       =    151
     EVAPORATIVE ZONE DEPTH                    =  24.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =   3.03 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  67.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  74.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  75.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  67.00 %

NOTE:  PRECIPITATION DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

NOTE:  TEMPERATURE DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

NOTE:  SOLAR RADIATION DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

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              MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                            JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                            ------- ------- ------- ------- ------- -------

PRECIPITATION                 3.15    3.31    5.72    0.04    0.00    0.00
                              0.00    0.00    0.00    0.39    0.00    3.04

RUNOFF                        0.006   0.080   0.000   0.000   0.000   0.000
                              0.000   0.000   0.000   0.000   0.000   0.095

EVAPOTRANSPIRATION            1.537   1.451   3.268   3.150   0.000   0.000
```

	0.000	0.000	0.000	0.046	0.152	0.344
LATERAL DRAINAGE COLLECTED	2.2001	0.0119	2.9287	0.3890	0.0005	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.699	0.004	0.931	0.128	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.941	0.007	0.607	0.180	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.65	460156.969	100.00
RUNOFF	0.180	5292.130	1.15
EVAPOTRANSPIRATION	9.948	292514.000	63.57
DRAINAGE COLLECTED FROM LAYER 3	5.5301	162601.500	35.34
PERC./LEAKAGE THROUGH LAYER 5	0.000255	7.495	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1468		
CHANGE IN WATER STORAGE	-0.009	-258.088	-0.06
SOIL WATER AT START OF YEAR	15.762	463443.344	
SOIL WATER AT END OF YEAR	15.753	463185.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.065	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.33	7.32	6.41	0.16	0.00	0.00
	0.24	0.00	0.00	1.39	0.00	4.43
RUNOFF	0.006	0.274	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.025
EVAPOTRANSPIRATION	1.503	2.171	2.929	3.117	0.000	0.000
	0.180	0.060	0.000	0.094	0.214	0.987
LATERAL DRAINAGE COLLECTED	1.5123	5.3719	1.4857	0.6357	0.0001	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.2524
PERCOLATION/LEAKAGE THROUGH	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.481	1.890	0.472	0.209	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.080
STD. DEVIATION OF DAILY	0.714	2.202	0.663	0.365	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.224

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.28	655099.062	100.00
RUNOFF	0.311	9131.866	1.39
EVAPOTRANSPIRATION	11.256	330949.906	50.52
DRAINAGE COLLECTED FROM LAYER 3	9.2582	272217.437	41.55
PERC./LEAKAGE THROUGH LAYER 5	0.000405	11.920	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2610		
CHANGE IN WATER STORAGE	1.455	42787.590	6.53
SOIL WATER AT START OF YEAR	15.753	463185.250	
SOIL WATER AT END OF YEAR	17.208	505972.844	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.376	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	14.64	9.62	1.62	0.00	0.00	0.91
	0.00	0.00	0.00	0.15	0.55	0.47
RUNOFF	1.767	0.706	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.644	1.997	3.415	1.518	0.000	0.275
	0.287	0.261	0.087	0.109	0.160	0.216
LATERAL DRAINAGE COLLECTED	13.3083	5.0805	0.6895	0.0012	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0005	0.0002	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	4.230	1.788	0.219	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	2.700	1.723	0.365	0.001	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.96	822107.937	100.00
RUNOFF	2.473	72717.391	8.85
EVAPOTRANSPIRATION	9.970	293140.187	35.66
DRAINAGE COLLECTED FROM LAYER 3	19.0795	560996.000	68.24
PERC./LEAKAGE THROUGH LAYER 5	0.000791	23.264	0.00
AVG. HEAD ON TOP OF LAYER 4	0.5197		
CHANGE IN WATER STORAGE	-3.563	-104769.172	-12.74
SOIL WATER AT START OF YEAR	17.208	505972.844	
SOIL WATER AT END OF YEAR	13.645	401203.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.326	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.24	4.53	1.74	0.84	0.16	0.00
	0.00	0.00	0.00	0.44	0.67	0.72
RUNOFF	0.000	0.023	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.407	2.038	3.439	0.726	0.554	0.000
	0.000	0.000	0.000	0.192	0.297	0.343
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.8694	0.1380	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.000	0.295	0.044	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000	0.227	0.076	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.34	274624.000	100.00
RUNOFF	0.023	688.224	0.25

EVAPOTRANSPIRATION	7.996	235101.844	85.61
DRAINAGE COLLECTED FROM LAYER 3	1.0074	29620.041	10.79
PERC./LEAKAGE THROUGH LAYER 5	0.000052	1.528	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0283		
CHANGE IN WATER STORAGE	0.313	9212.245	3.35
SOIL WATER AT START OF YEAR	13.645	401203.687	
SOIL WATER AT END OF YEAR	13.958	410415.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.134	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	11.57	1.30	7.13	1.02	0.09	1.26
	0.00	0.00	0.08	0.00	0.00	0.59
RUNOFF	0.766	0.000	0.250	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.501	2.310	3.461	2.688	0.090	0.213
	0.323	0.282	0.273	0.245	0.005	0.177
LATERAL DRAINAGE COLLECTED FROM LAYER 3	6.9485	0.4668	3.5797	0.0472	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0003	0.0000	0.0002	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	2.208	0.164	1.138	0.016	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	1.868	0.185	1.184	0.029	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.04	677445.187	100.00
RUNOFF	1.016	29876.318	4.41
EVAPOTRANSPIRATION	11.567	340098.187	50.20
DRAINAGE COLLECTED FROM LAYER 3	11.0421	324672.250	47.93
PERC./LEAKAGE THROUGH LAYER 5	0.000478	14.054	0.00
AVG. HEAD ON TOP OF LAYER 4	0.2938		
CHANGE IN WATER STORAGE	-0.586	-17215.816	-2.54

SOIL WATER AT START OF YEAR	13.958	410415.937	
SOIL WATER AT END OF YEAR	13.373	393200.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.204	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.39	5.22	4.52	0.41	0.05	0.43
	0.05	0.00	0.02	0.47	0.24	1.85
STD. DEVIATIONS	6.32	3.29	2.64	0.48	0.07	0.61
	0.11	0.00	0.04	0.54	0.34	1.79
RUNOFF						
TOTALS	0.509	0.217	0.051	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.024
STD. DEVIATIONS	0.777	0.294	0.111	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.041
EVAPOTRANSPIRATION						
TOTALS	1.319	1.993	3.303	2.240	0.129	0.097
	0.158	0.121	0.072	0.137	0.165	0.414
STD. DEVIATIONS	0.513	0.327	0.222	1.074	0.241	0.135
	0.154	0.140	0.118	0.080	0.107	0.329
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	4.7938	2.3601	1.7643	0.2146	0.0001	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0505
STD. DEVIATIONS	5.4225	2.6359	1.4602	0.2861	0.0002	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1129
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	1.5236	0.8283	0.5607	0.0705	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0160
STD. DEVIATIONS	1.7234	0.9290	0.4641	0.0939	0.0001	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0359

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.65	(7.242)	577886.6	100.00
RUNOFF	0.801	(1.0091)	23541.18	4.074
EVAPOTRANSPIRATION	10.147	(1.4092)	298360.81	51.630
LATERAL DRAINAGE COLLECTED FROM LAYER 3	9.18347	(6.73773)	270021.469	46.72568
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00040	(0.00027)	11.652	0.00202
AVERAGE HEAD ON TOP OF LAYER 4	0.250	(0.183)		
CHANGE IN WATER STORAGE	-0.478	(1.8784)	-14048.65	-2.431

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.47	102028.414
RUNOFF	1.087	31958.1230
DRAINAGE COLLECTED FROM LAYER 3	0.91070	26777.41990
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000035	1.04154
AVERAGE HEAD ON TOP OF LAYER 4	8.973	
MAXIMUM HEAD ON TOP OF LAYER 4	13.450	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	83.8 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3202

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5768	0.1314
2	1.1640	0.0970
3	0.3840	0.0320
4	0.0000	0.0000
5	10.2480	0.4270
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:     c:\HELP\DAT\PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\ET.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\ALT-1.D10
OUTPUT DATA FILE:            C:\HELP\OUT\A-ALT1.OUT

TIME:   8:43     DATE:  11/27/2002

******************************************************************************

     TITLE:  01-123-Alt #1

******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2178 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  20
          THICKNESS                    =      0.20   INCHES
          POROSITY                     =      0.8500 VOL/VOL
          FIELD CAPACITY               =      0.0100 VOL/VOL
          WILTING POINT                =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
          SLOPE                        =      2.00   PERCENT
          DRAINAGE LENGTH              =    335.0    FEET

                                  LAYER  4
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
          THICKNESS                    =      0.06   INCHES
          POROSITY                     =      0.0000 VOL/VOL
          FIELD CAPACITY               =      0.0000 VOL/VOL
```

```
WILTING POINT                  =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY            =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS       =      7.00   HOLES/ACRE
FML PLACEMENT QUALITY          =  3 - GOOD
```

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 60

```
THICKNESS                      =      0.20   INCHES
POROSITY                       =      0.7500 VOL/VOL
FIELD CAPACITY                 =      0.7470 VOL/VOL
WILTING POINT                  =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.999999994000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 335. FEET.

```
SCS RUNOFF CURVE NUMBER              =     80.10
FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      8.100  ACRES
EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      5.134  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      8.784  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.328  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =      5.286  INCHES
TOTAL INITIAL WATER                  =      5.286  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM LOS ANGELES CALIFORNIA

```
STATION LATITUDE                          =  33.80 DEGREES
MAXIMUM LEAF AREA INDEX                   =   2.00
START OF GROWING SEASON (JULIAN DATE)     =    285
END OF GROWING SEASON (JULIAN DATE)       =    151
EVAPORATIVE ZONE DEPTH                    =  24.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   3.03 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  67.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  74.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  67.00 %
```

NOTE: PRECIPITATION DATA FOR SAN DIEGO CALIFORNIA WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR SAN DIEGO CALIFORNIA WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR SAN DIEGO CALIFORNIA WAS ENTERED BY THE USER.

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION	3.15	3.31	5.72	0.04	0.00	0.00
	0.00	0.00	0.00	0.39	0.00	3.04
RUNOFF	0.011	0.075	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.097
EVAPOTRANSPIRATION	1.559	1.454	3.268	2.453	0.000	0.000
	0.000	0.000	0.000	0.044	0.153	0.334
LATERAL DRAINAGE COLLECTED	2.4309	0.0000	3.6080	0.1601	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.032	0.000	0.050	0.002	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.084	0.000	0.126	0.006	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.65	460156.969	100.00
RUNOFF	0.190	5595.669	1.22
EVAPOTRANSPIRATION	9.265	272431.687	59.20
DRAINAGE COLLECTED FROM LAYER 3	6.1990	182269.609	39.61
PERC./LEAKAGE THROUGH LAYER 5	0.000004	0.113	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0069		
CHANGE IN WATER STORAGE	-0.005	-140.022	-0.03
SOIL WATER AT START OF YEAR	5.286	155438.719	
SOIL WATER AT END OF YEAR	5.282	155298.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.068	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.33	7.32	6.41	0.16	0.00	0.00
	0.24	0.00	0.00	1.39	0.00	4.43
RUNOFF	0.006	0.318	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.026

EVAPOTRANSPIRATION	1.534	2.191	2.929	3.138	0.009	0.000
	0.179	0.061	0.000	0.095	0.213	0.989
LATERAL DRAINAGE COLLECTED	2.3671	3.8122	2.5257	0.1852	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.6177
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.023	0.741	0.024	0.002	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.006
STD. DEVIATION OF DAILY	0.037	2.495	0.036	0.004	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.014

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.28	655099.062	100.00
RUNOFF	0.356	10453.519	1.60
EVAPOTRANSPIRATION	11.338	333374.812	50.89
DRAINAGE COLLECTED FROM LAYER 3	9.5079	279559.375	42.67
PERC./LEAKAGE THROUGH LAYER 5	0.000072	2.114	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0663		
CHANGE IN WATER STORAGE	1.078	31709.016	4.84
SOIL WATER AT START OF YEAR	5.282	155298.687	
SOIL WATER AT END OF YEAR	6.360	187007.703	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.240	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	14.64	9.62	1.62	0.00	0.00	0.91
	0.00	0.00	0.00	0.15	0.55	0.47
RUNOFF	2.695	0.648	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.642	1.998	3.419	1.126	0.000	0.273
	0.287	0.261	0.089	0.108	0.160	0.214
LATERAL DRAINAGE COLLECTED	12.1096	5.6275	0.4939	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0007	0.0002	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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                    MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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AVERAGE DAILY HEAD ON            5.356   1.424   0.005   0.000   0.000   0.000
  TOP OF LAYER  4                0.000   0.000   0.000   0.000   0.000   0.000

STD. DEVIATION OF DAILY          7.004   3.948   0.012   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  4        0.000   0.000   0.000   0.000   0.000   0.000
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                          ANNUAL TOTALS FOR YEAR    3
-----------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                         27.96          822107.937    100.00

  RUNOFF                                 3.343          98305.641     11.96

  EVAPOTRANSPIRATION                     9.577         281580.156     34.25

  DRAINAGE COLLECTED FROM LAYER  3      18.2310        536047.000     65.20

  PERC./LEAKAGE THROUGH LAYER  5         0.000888          26.095      0.00

  AVG. HEAD ON TOP OF LAYER  4           0.5654

  CHANGE IN WATER STORAGE               -3.192         -93850.719    -11.42

  SOIL WATER AT START OF YEAR            6.360         187007.703

  SOIL WATER AT END OF YEAR              3.168          93156.992

  SNOW WATER AT START OF YEAR            0.000              0.000      0.00

  SNOW WATER AT END OF YEAR              0.000              0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000            -0.199      0.00
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                  MONTHLY TOTALS (IN INCHES) FOR YEAR    4
-----------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    0.24    4.53    1.74    0.84    0.16    0.00
                                 0.00    0.00    0.00    0.44    0.67    0.72

RUNOFF                           0.000   0.023   0.000   0.000   0.000   0.000
                                 0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION               0.405   2.049   3.495   0.952   0.533   0.000
                                 0.000   0.000   0.000   0.191   0.295   0.344

LATERAL DRAINAGE COLLECTED       0.0000  0.6354  0.1054  0.0000  0.0000  0.0000
  FROM LAYER  3                  0.0000  0.0000  0.0000  0.0000  0.0000  0.0001

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  5                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-----------------------------------------------------------------------------
                    MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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AVERAGE DAILY HEAD ON            0.000   0.006   0.001   0.000   0.000   0.000
```

TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000	0.010	0.003	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.34	274624.000	100.00
RUNOFF	0.023	688.224	0.25
EVAPOTRANSPIRATION	8.264	243000.453	88.48
DRAINAGE COLLECTED FROM LAYER 3	0.7408	21782.455	7.93
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.016	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0006		
CHANGE IN WATER STORAGE	0.311	9152.819	3.33
SOIL WATER AT START OF YEAR	3.168	93156.992	
SOIL WATER AT END OF YEAR	3.480	102309.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.044	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	11.57	1.30	7.13	1.02	0.09	1.26
	0.00	0.00	0.08	0.00	0.00	0.59
RUNOFF	0.775	0.000	0.265	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.506	2.319	3.439	2.642	0.090	0.215
	0.323	0.282	0.272	0.245	0.003	0.176
LATERAL DRAINAGE COLLECTED FROM LAYER 3	6.9561	0.3355	3.7827	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	1.223	0.004	0.364	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	3.322	0.006	1.447	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.04	677445.187	100.00
RUNOFF	1.040	30572.000	4.51
EVAPOTRANSPIRATION	11.511	338470.344	49.96
DRAINAGE COLLECTED FROM LAYER 3	11.0743	325616.312	48.07
PERC./LEAKAGE THROUGH LAYER 5	0.000171	5.021	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1325		
CHANGE IN WATER STORAGE	-0.586	-17218.283	-2.54
SOIL WATER AT START OF YEAR	3.480	102309.812	
SOIL WATER AT END OF YEAR	2.894	85091.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.198	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.39	5.22	4.52	0.41	0.05	0.43
	0.05	0.00	0.02	0.47	0.24	1.85
STD. DEVIATIONS	6.32	3.29	2.64	0.48	0.07	0.61
	0.11	0.00	0.04	0.54	0.34	1.79
RUNOFF						
TOTALS	0.698	0.213	0.055	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.025
STD. DEVIATIONS	1.165	0.274	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.042
EVAPOTRANSPIRATION						
TOTALS	1.329	2.002	3.310	2.062	0.126	0.098
	0.158	0.121	0.072	0.137	0.165	0.411
STD. DEVIATIONS	0.519	0.331	0.229	0.969	0.231	0.135
	0.154	0.140	0.118	0.080	0.107	0.331
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	4.7728	2.0821	2.1031	0.0691	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1236
STD. DEVIATIONS	4.8127	2.5021	1.7208	0.0950	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.2762
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	1.3267	0.4350	0.0888	0.0007	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
STD. DEVIATIONS	2.3122	0.6385	0.1549	0.0009	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.65	(7.242)	577886.6	100.00
RUNOFF	0.990	(1.3709)	29123.01	5.040
EVAPOTRANSPIRATION	9.991	(1.3969)	293771.47	50.835
LATERAL DRAINAGE COLLECTED FROM LAYER 3	9.15059	(6.43658)	269054.937	46.55843
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00023	(0.00038)	6.672	0.00115
AVERAGE HEAD ON TOP OF LAYER 4	0.154	(0.236)		
CHANGE IN WATER STORAGE	-0.479	(1.6314)	-14069.44	-2.435

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.47	102028.414
RUNOFF	1.565	46019.0508
DRAINAGE COLLECTED FROM LAYER 3	0.68613	20174.32030
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000124	3.63731
AVERAGE HEAD ON TOP OF LAYER 4	21.422	
MAXIMUM HEAD ON TOP OF LAYER 4	27.540	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	122.5 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3660

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5780	0.1315
2	1.1640	0.0970
3	0.0020	0.0100
4	0.0000	0.0000
5	0.1500	0.7500
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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******************************************************************************

PRECIPITATION DATA FILE:     c:\HELP\DAT\PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\ET.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\ALT-3.D10
OUTPUT DATA FILE:            C:\HELP\OUT\A-ALT3.OUT

TIME:   8:59     DATE:  11/27/2002

******************************************************************************

     TITLE:  01-123-Alt #3

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2178 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                        TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER  20
          THICKNESS                    =      0.20   INCHES
          POROSITY                     =      0.8500 VOL/VOL
          FIELD CAPACITY               =      0.0100 VOL/VOL
          WILTING POINT                =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
          SLOPE                        =      2.00   PERCENT
          DRAINAGE LENGTH              =    335.0    FEET


                                  LAYER  4
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                        TYPE 4 - FLEXIBLE MEMBRANE LINER
                          MATERIAL TEXTURE NUMBER  35
          THICKNESS                    =      0.06   INCHES
          POROSITY                     =      0.0000 VOL/VOL
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FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      7.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD

                        LAYER  5
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                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  55
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3220 VOL/VOL
FIELD CAPACITY              =      0.3200 VOL/VOL
WILTING POINT               =      0.1000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3220 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-05 CM/SEC

          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
         SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
         OF  2.% AND A SLOPE LENGTH OF  335. FEET.

SCS RUNOFF CURVE NUMBER             =     80.10
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      8.100  ACRES
EVAPORATIVE ZONE DEPTH              =     24.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      5.135  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      8.784  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.328  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     12.865  INCHES
TOTAL INITIAL WATER                 =     12.865  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR

            EVAPOTRANSPIRATION AND WEATHER DATA
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NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         LOS ANGELES           CALIFORNIA

     STATION LATITUDE                          =  33.80 DEGREES
     MAXIMUM LEAF AREA INDEX                   =   2.00
     START OF GROWING SEASON (JULIAN DATE)     =    285
     END OF GROWING SEASON (JULIAN DATE)       =    151
     EVAPORATIVE ZONE DEPTH                    =  24.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =   3.03 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  67.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  74.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  75.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  67.00 %

NOTE:  PRECIPITATION DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

NOTE:  TEMPERATURE DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.

NOTE:  SOLAR RADIATION DATA FOR     SAN DIEGO          CALIFORNIA
         WAS ENTERED BY THE USER.
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              MONTHLY TOTALS (IN INCHES) FOR YEAR    1
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	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.15	3.31	5.72	0.04	0.00	0.00
	0.00	0.00	0.00	0.39	0.00	3.04

RUNOFF	0.011	0.075	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.097
EVAPOTRANSPIRATION	1.559	1.454	3.268	2.425	0.000	0.000
	0.000	0.000	0.000	0.044	0.153	0.334
LATERAL DRAINAGE COLLECTED	2.4116	0.0000	3.6266	0.1883	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0002	0.0000	0.0002	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.031	0.000	0.051	0.002	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.085	0.000	0.126	0.006	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.65	460156.969	100.00
RUNOFF	0.190	5595.832	1.22
EVAPOTRANSPIRATION	9.237	271597.469	59.02
DRAINAGE COLLECTED FROM LAYER 3	6.2266	183080.422	39.79
PERC./LEAKAGE THROUGH LAYER 5	0.000403	11.836	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0070		
CHANGE IN WATER STORAGE	-0.004	-128.539	-0.03
SOIL WATER AT START OF YEAR	12.865	378257.781	
SOIL WATER AT END OF YEAR	12.860	378129.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.037	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.33	7.32	6.41	0.16	0.00	0.00
	0.24	0.00	0.00	1.39	0.00	4.43
RUNOFF	0.006	0.319	0.006	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.026
EVAPOTRANSPIRATION	1.535	2.191	2.929	3.138	0.007	0.000
	0.179	0.061	0.000	0.095	0.213	0.989
LATERAL DRAINAGE COLLECTED	2.3676	3.8701	2.4627	0.1867	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.6176
PERCOLATION/LEAKAGE THROUGH	0.0001	0.0023	0.0001	0.0000	0.0000	0.0000

LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.023	0.742	0.023	0.002	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.006
STD. DEVIATION OF DAILY	0.037	2.494	0.036	0.004	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.014

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.28	655099.062	100.00
RUNOFF	0.356	10473.989	1.60
EVAPOTRANSPIRATION	11.339	333387.562	50.89
DRAINAGE COLLECTED FROM LAYER 3	9.5048	279469.250	42.66
PERC./LEAKAGE THROUGH LAYER 5	0.002604	76.551	0.01
AVG. HEAD ON TOP OF LAYER 4	0.0663		
CHANGE IN WATER STORAGE	1.078	31691.363	4.84
SOIL WATER AT START OF YEAR	12.860	378129.219	
SOIL WATER AT END OF YEAR	13.938	409820.594	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.349	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	14.64	9.62	1.62	0.00	0.00	0.91
	0.00	0.00	0.00	0.15	0.55	0.47
RUNOFF	2.691	0.648	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.642	1.999	3.419	1.132	0.000	0.273
	0.287	0.261	0.089	0.108	0.160	0.214
LATERAL DRAINAGE COLLECTED	12.0971	5.6225	0.4823	0.0052	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0175	0.0043	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	5.255	1.423	0.005	0.000	0.000	0.000

TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	6.891	3.948	0.012	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.96	822107.937	100.00
RUNOFF	3.339	98189.523	11.94
EVAPOTRANSPIRATION	9.583	281779.156	34.28
DRAINAGE COLLECTED FROM LAYER 3	18.2072	535345.125	65.12
PERC./LEAKAGE THROUGH LAYER 5	0.021916	644.382	0.08
AVG. HEAD ON TOP OF LAYER 4	0.5569		
CHANGE IN WATER STORAGE	-3.192	-93849.969	-11.42
SOIL WATER AT START OF YEAR	13.938	409820.594	
SOIL WATER AT END OF YEAR	10.746	315970.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.262	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.24	4.53	1.74	0.84	0.16	0.00
	0.00	0.00	0.00	0.44	0.67	0.72
RUNOFF	0.000	0.023	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.405	2.049	3.495	0.995	0.533	0.000
	0.000	0.000	0.000	0.191	0.295	0.344
LATERAL DRAINAGE COLLECTED	0.0000	0.5782	0.1052	0.0142	0.0002	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.006	0.001	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.010	0.003	0.001	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.34	274624.000	100.00
RUNOFF	0.023	688.224	0.25
EVAPOTRANSPIRATION	8.307	244253.297	88.94
DRAINAGE COLLECTED FROM LAYER 3	0.6979	20521.809	7.47
PERC./LEAKAGE THROUGH LAYER 5	0.000041	1.192	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0006		
CHANGE IN WATER STORAGE	0.312	9159.472	3.34
SOIL WATER AT START OF YEAR	10.746	315970.625	
SOIL WATER AT END OF YEAR	11.058	325130.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	11.57	1.30	7.13	1.02	0.09	1.26
	0.00	0.00	0.08	0.00	0.00	0.59
RUNOFF	0.775	0.000	0.265	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.506	2.319	3.439	2.632	0.090	0.214
	0.323	0.282	0.272	0.245	0.003	0.176
LATERAL DRAINAGE COLLECTED	6.9530	0.3373	3.7788	0.0097	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0042	0.0000	0.0013	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.223	0.004	0.363	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	3.322	0.006	1.444	0.001	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.04	677445.187	100.00
RUNOFF	1.040	30571.508	4.51
EVAPOTRANSPIRATION	11.502	338181.937	49.92

DRAINAGE COLLECTED FROM LAYER 3	11.0788	325749.562	48.09
PERC./LEAKAGE THROUGH LAYER 5	0.005518	162.256	0.02
AVG. HEAD ON TOP OF LAYER 4	0.1324		
CHANGE IN WATER STORAGE	-0.586	-17219.965	-2.54
SOIL WATER AT START OF YEAR	11.058	325130.094	
SOIL WATER AT END OF YEAR	10.472	307910.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.110	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.39	5.22	4.52	0.41	0.05	0.43
	0.05	0.00	0.02	0.47	0.24	1.85
STD. DEVIATIONS	6.32	3.29	2.64	0.48	0.07	0.61
	0.11	0.00	0.04	0.54	0.34	1.79
RUNOFF						
TOTALS	0.697	0.213	0.055	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.025
STD. DEVIATIONS	1.164	0.274	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.042
EVAPOTRANSPIRATION						
TOTALS	1.330	2.002	3.310	2.064	0.126	0.098
	0.158	0.121	0.072	0.136	0.165	0.411
STD. DEVIATIONS	0.519	0.331	0.229	0.951	0.231	0.135
	0.154	0.140	0.118	0.080	0.107	0.331
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	4.7659	2.0816	2.0911	0.0808	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1235
STD. DEVIATIONS	4.8099	2.5186	1.7231	0.0974	0.0001	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.2762
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0044	0.0013	0.0003	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0076	0.0020	0.0005	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4						
AVERAGES	1.3063	0.4348	0.0885	0.0008	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
STD. DEVIATIONS	2.2681	0.6383	0.1546	0.0010	0.0000	0.0000

0.0000	0.0000	0.0000	0.0000	0.0000	0.0026

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.65	(7.242)	577886.6	100.00
RUNOFF	0.990	(1.3691)	29103.81	5.036
EVAPOTRANSPIRATION	9.994	(1.3846)	293839.87	50.847
LATERAL DRAINAGE COLLECTED FROM LAYER 3	9.14305	(6.43936)	268833.219	46.52007
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00610	(0.00911)	179.243	0.03102
AVERAGE HEAD ON TOP OF LAYER 4	0.153	(0.232)		
CHANGE IN WATER STORAGE	-0.479	(1.6313)	-14069.53	-2.435

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.47	102028.414
RUNOFF	1.563	45964.2656
DRAINAGE COLLECTED FROM LAYER 3	0.68613	20174.32030
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.002246	66.04982
AVERAGE HEAD ON TOP OF LAYER 4	21.422	
MAXIMUM HEAD ON TOP OF LAYER 4	27.540	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	122.5 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3660

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

*** *Maximum heads are computed using McEnroe's equations.* ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5781	0.1315
2	1.1640	0.0970

3	0.0020	0.0100
4	0.0000	0.0000
5	7.7280	0.3220
SNOW WATER	0.000	

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D. RCRA SUBTITLE D (CCR TITLE 27) EQUIVALENT ENGINEERED SOIL COVER

D. RCRA Subtitle D (CCR Title 27) Equivalent Engineered Soil Cover

D.1 Objective

The purpose of the unsaturated flow modeling documented in this report is to:

(a) Evaluate the hydraulic performance of the proposed Engineered Soil Cover (Monocover);

(b) Evaluate if the proposed Monocover is hydrologically equivalent to the Title 27 prescriptive cover, and

(c) Develop preliminary specification requirements for the Monocover.

D.2 Introduction

This calculation package documents the analyses and results of the percolation modeling (unsaturated flow modeling) and analyses performed to evaluate the hydraulic performance of the proposed alternative engineered soil cover (Monocover) for portions of the WDI Superfund Site. The Monocover is designed to perform as an evapotranspirative cover, and is proposed over a 8.0-acre area (Project Area) surrounding the area of the proposed RCRA Subtitle C cover (Dial Area) at the site. The engineered soil cover is proposed as an alternative to the Title 27 prescriptive cover required for the Project Area.

The existing cover in the project area consists of varying thickness (in general exceeding 4 feet) of non-engineered soil cover. The proposed engineered soil cover (Monocover) will be constructed by excavating, processing and recompacting the upper four feet of existing soil cover to a minimum relative compaction of 90 percent (as per ASTM D1557). The Monocover will be underlain by a minimum 1-foot thick foundation layer that will be prepared by scarifying and recompacting the foundation soil below the 4-foot overexcavation. The cover will be graded to drain and planted with native vegetation consisting of grasses and shrub requiring no irrigation. The native vegetation will grow during the winter months and will lie dormant during the summer months. The project area will be maintained as an open area.

The Title 27 prescriptive cover consists of, from the top down, a minimum of 12-inch thick vegetative soil cover; a minimum 12-inch thick barrier layer (low - permeability layer) with a saturated hydraulic conductivity of 1×10^{-6} cm/sec or less; and a 24-inch-thick foundation layer. The Title 27 prescriptive cover relies on the barrier layer to impede percolation of moisture into the landfill. The Monocover controls percolation by relying on the moisture storage capacity of the soil to absorb and hold the moisture during precipitation and the evapotranspiration characteristics of the climate/vegetation system to release the stored water during dry periods and periods of vegetation growth. In arid and semi-arid areas including Southern California, evapotranspirative covers have been shown to perform as well as, or better than, the prescriptive barrier covers in controlling percolation into the landfill.

In order to evaluate hydraulic performance of the Monocover and compare it to the performance of a Title 27 prescriptive cover, both types of covers were modeled with an unsaturated flow/water balance model, under the same climatic conditions.

D.3 Water Balance Analyses

The water balance equation that forms the basis of the unsaturated flow model is

$$\Delta S = P - ET - R - Perc$$

where:

ΔS	=	change in moisture storage in soil
P	=	precipitation
ET	=	evapotranspiration consisting of evaporation and transpiration
R	=	runoff
$Perc$	=	Percolation through the bottom of the cover

The water balance equation states that the change in the amount of water stored in the soil cover is equal to the total precipitation, minus the amount of water lost to surface runoff, evaporation, transpiration and percolation into the landfill.

For the project site, precipitation consists of rainfall on the cover surface. It was assumed that no supplementary irrigation is applied on the cover surface to maintain/promote vegetation growth. The cover performance is impacted by both the amount and distribution of precipitation.

When the precipitation rate exceeds the infiltration rate, water begins to accumulate on the surface. It is assumed that the surface is sloped and graded such that any water that does not infiltrate the surface is carried away as surface runoff (i.e. no ponding).

Evapotranspiration is the process of water loss from soil and/or plant surface to the atmosphere. Evaporation of water from the soil surface is controlled by the flow of heat to and from the soil surface, the flow of moisture to the soil surface from below, and the transfer of water vapor from the soil surface to the atmosphere. Transpiration is the evaporation of the water from plants. When the soil surface is well vegetated, transpiration is the dominant mode of moisture loss to the atmosphere. However, on landfills, generally the quality of vegetation is poor.

Percolation is the quantity of downward flow through the bottom of the cover system being simulated. This represents the quantity of flow into the landfill. Percolation is the parameter used to compare the performance and demonstrate equivalence of alternative cover systems.

D.4 The WinUnsat-H Code

The computer code WinUnsat-H was selected for unsaturated flow modeling. WinUnsat-H, Version 1, developed at the University of Wisconsin, Madison, in 1998 is a Windows version of the 1-dimensional finite difference program UNSAT-H Version 2.03 (Fayer and Jones, 1990) developed by the Pacific Northwest Laboratory, Richland, Washington, for the U.S. Department of Energy (DOE). This program was originally developed to simulate water flow in unsaturated soil covers above the buried waste at DOE's Hanford Site, and has since been widely used to simulate unsaturated flow through alternate landfill covers at municipal solid waste and hazardous waste landfills.

The UNSAT-H computer code simulates 1-dimensional water and heat flow in unsaturated soils. The model is based on Richards' equation for liquid water flow in unsaturated systems (Richards 1931), Fick's law of diffusion for vapor flow and evaporation (Hillel 1980), and Fourier's law of heat conduction for soil heat flow (Campbell 1985). UNSAT-H can simulate the isothermal flow of liquid water and water vapor, the nonisothermal flow of water vapor, the flow of heat, the surface energy balance, and soil-water extraction by plants. The basic numerical scheme used in UNSAT-H is the Crank-Nicholson method. In the current application of the program, heat flow was not modeled.

Unsaturated flow is modeled using the Richards equation for transient vertical flow which can be expressed as (Fayer and Jones, 1990):

$$C(h)\frac{\partial h}{\partial t} = -\frac{\partial}{\partial z}\left[K(h)\left(\frac{\partial h}{\partial z}\right)\right] - S(z,t)$$

where:

z	=	depth below surface;
t	=	time;
h	=	suction head;
$C(h)$	=	$\partial\theta/\partial h$ where θ is the volumetric moisture content;
$K(h)$	=	unsaturated hydraulic conductivity as a function of suction head; and
$S(z,t)$	=	sink term as a function of depth and time to account for water uptake by plants.

C(h) and *K(h)* are based on relationships that express moisture content and hydraulic conductivity of the soil as functions of suction head. These hydraulic properties are obtained from laboratory unsaturated hydraulic tests on soil samples. The sink term describes the distribution of plant transpiration over the

root zone. This is based on vegetation growth and root density models/functions that are appropriate for the type of vegetation.

The input data required by UNSAT-H can be divided into five (5) categories (Fayer and Jones, 1990):

1. program control variables;
2. soil properties;
3. initial conditions;
4. plant data; and
5. boundary conditions.

The first category of input, the set of program control variables, formulates the problem in terms of options and parameter values chosen, maximum allowable mass-balance error, time-step control, amount of output data saved, and simulation time. This input category also includes specification of elevation and material type for each node.

The second category of input, soil properties, includes moisture content as a function of moisture potential or suction head (i.e., the soil water characteristic or desorption curve) and hydraulic conductivity as a function of suction head or moisture content.

The third category, initial conditions, consists of suction head values or moisture storage for each node at the beginning of the simulation. The fourth category, plant data, includes mature root-length distribution, vegetation growth, either as a function of time or germination and harvesting dates, and fraction of unvegetated surface area.

The final category of input is the boundary conditions. For water flow at the lower boundary of the simulated cover, input can be specified as a unit gradient, constant head, or daily flux values (such as drainage measured with a lysimeter). For water flow at the upper boundary (the soil surface), either a constant head or flux values (daily or hourly) can be specified or calculated. The flux values can be a specified precipitation rate or a specified evaporation rate that is calculated based on the weather (i.e., solar radiation, air temperature, wind speed, and atmospheric vapor density).

D.5 Model Input Parameters

Model input parameters include cover geometry, soil properties, initial conditions, weather data, vegetation parameters and boundary conditions. Each one of these input parameters is discussed below.

D.5.1 Cover Geometry

Unsaturated flow was modeled through two types of covers: the Title 27 prescriptive cover and the proposed evapotranspirative cover. The minimum dimensions of the prescriptive cover are 12 inches (30 cm) of vegetative soil underlain by 12 inches (30 cm) of low permeability soils with a saturated hydraulic conductivity of 1 x 10^{-6} cm/sec. The minimum thickness of evapotranspirative Monocover previously approved for other landfills in Southern California typically ranges from 3 to 4 feet (90 to 120 cm). The proposed Monocover for the project area consists of 48 inches (120 cm) of engineered soil cover, as described in Section 1.0. Both the Monocover and the Title 27 prescriptive cover are underlain by a foundation layer. The foundation layer is intended to provide a firm and competent base to support the cover soils. Since the foundation layer is not intended to provide a percolation control function, it was not included in the cover geometry simulated in the unsaturated flow model. Figure D-1 shows the cover configurations modeled.

The entire 4 feet of the Monocover cover will be engineered (processed, moisture conditioned and compacted in lifts) to a minimum relative compaction of 90 percent (as per ASTM D1557). However, with the introduction of vegetation, root penetration and weathering, the relative compaction of the upper portion of the engineered soil cover is expected to gradually decrease with time. For modeling purposes it was assumed that the relative compaction of the upper 12 inches of Monocover would degrade to 85 percent. The Monocover was therefore modeled as a 1-foot thick near-surface layer of 85 percent relative compaction underlain by a 3 – foot thick soil layer at 90 percent relative compaction.

The 48-inch-thick (120 cm) Monocover profile was discretized into 64 nodes for the numerical modeling. The first node (Node 1) was at the surface and Node 32 was at the bottom of the profile being simulated. The nodal spacing was kept very small (0.1 cm) near the surface and at the interface of the two different soil layers and was progressively increased with depth through the profile to a maximum of 10 cm. The smaller node spacing near the surface is necessary for a correct solution because very large and rapid changes in suction head are expected at the surface as it dries and wets in response to evaporation and precipitation (Fayer and Jones, 1990). Similarly, at the interface between different soil types, large differences in suction head or moisture content can occur, and smaller node spacing is required to accommodate these rapid changes without numerical instability.

The 24-inch thick (60 cm) Title 27 prescriptive cover was discretized into 52 nodes. As in the case of the monocover, nodal spacing near the surface was kept at 0.1 cm and progressively increased with depth. The prescriptive cover consists of a layered system with two soils (vegetative soil cover and low-permeability barrier layer) that are significantly different. Therefore, in order to be numerically stable and accommodate large differences in suction head or moisture content near the interface of the two layers, node spacing was reduced near the interface. This reduction to 0.1 cm at the interface was progressively achieved within both soil layers.

D.5.2 Soil Properties

The parameters representing the unsaturated hydraulic characteristics of a soil can be described by the five independent van Genuchten parameters: θ_r, θ_s, α, n, and K_s. These parameters and the moisture storage and hydraulic conductivity functions are described in Section A of the Cover Infiltration Analyses Calculation Package.

The laboratory test program for infiltration analyses is described in detail in Section A. Based on the laboratory test program discussed therein, soil properties were assigned for the various cover material types: surface layer and lower layer of the Monocover; and the vegetative soil layer and low-permeability barrier layer of the Title 27 cover. The selected model input parameters are shown in Figure D-1.

As explained in section D.2 above, the entire thickness of the Monocover will be recompacted to 90% RC, but the upper 12 –inch surface layer is assumed to have degraded to 85% RC due to root penetration and weathering. The discussion in Section A above shows that the unsaturated moisture characteristic between the 85% and 90% RC compaction samples are relatively minor. Therefore the mean values of the van Genuchten parameters from the five TM-15 samples (remolded to 85% RC) were used to represent the both the surface layer and lower layer of the Monocover. The Ks value of the surface layer of the Monocover was chosen as the average Ks value of the ASTM D5084 test results on the 85% RC samples (Table A-1), i.e. Ks = 6.7E-05 cm/sec. The Ks value for the lower layer of the Monocover was chosen as the average Ks value of the ASTM D5084 test results on the 90% RC samples, i.e. Ks = 3.5E-05 cm/sec.

Unsaturated soil properties for the low permeability barrier layer of the Title 27 cover are based on the results for the TS-085 sample remolded to approximately 90% RC (Table A-2). The corresponding Ks value, however, was reduced from the measured value of 5.4E-06 cm/sec to 1.0E-06 cm/sec to match the requirements for a prescriptive barrier layer. The Title 27 regulations do not specify any hydraulic property requirements for the vegetative soil cover component of the prescriptive cover. On relatively flat areas and top decks of landfills, the vegetative soil layer is typically placed at 85% RC or looser to facilitate vegetation growth. The average unsaturated hydraulic parameters for the samples remolded to approximately 85% RC (Table 4-1), with the Ks value increased slightly from 6.7×10^{-5} cm/sec to 1.0×10^{-4} cm/sec was selected to simulate the loose vegetative cover layer. The slightly higher Ks value was chosen to reflect the fact that the vegetative cover layer will be placed at 85% RC and would degrade to a less compact condition with root penetration and weathering.

D.5.3 Initial Conditions

For both cover types it was assumed that the initial gravimetric moisture content at the beginning of simulation was approximately equal to the optimum moisture content + 2 percent. This represents the typical moisture content at which cover soils are compacted to project specifications. The initial values of soil suction corresponding to these values of moisture content were evaluated from the volumetric moisture storage functions selected for each layer, and were provided as input for the UNSAT-H model simulations.

D.5.4 Weather Data

The weather and climate data used for the 5-year design simulation period is discussed in detail in Section B of this Calculation Package. The data required for the UNSAT-H model includes daily values of precipitation, maximum and minimum temperature, dew point, solar radiation and wind speed

D.5.5. Vegetation Parameters

The vegetation parameters govern the rate and efficiency of transpiration from the cover soil. The removal of moisture by plant roots is treated as a sink term in the flow equation. This process is modeled in three steps by the program (Fayer and Jones, 1990).

In the first step, the potential evapotranspiration (*PET*) is portioned into potential evaporation (*PE*) and potential transpiration (*PT*)

$$PET = PT + PE$$

In the second step, the *PT* is distributed over the root zone in proportion to the relative root density at each depth. In the final step, the actual transpiration at each depth (each node) is determined based on the potential transpiration and moisture content.

The UNSAT-H code has two methods available to partition the *PET* into *PT* and *PE*. One method is based on an empirical relationship developed by Ritchie and Burnett (1971) based on seasonal Leaf Area Index (LAI) data. The second is based on a model developed for cheatgrass at the Hanford site in Washington (Hinds, 1975).

A seasonal LAI model was developed for the site (Figure D-2). The model assumes that the LAI increases linearly from the day of germination to the first day of maximum transpiration, i.e., Day 90 (end of March), remains constant until Day 151 (end of May), and then linearly decreases from Day 151 to zero as the plant senesces. The start of germination was selected as Day 285 (mid-October) representing the start of the growing season for the vegetation on the landfill. The day of senescence was selected as Day 195 (mid-July) representing the day the plants reach the dormant state at the onset of summer. The model parameters were selected to roughly represent a relatively poor stand of native vegetation and grasses (typical for landfills with no supplementary irrigation) that grow during winter months and remain dormant through the dry summer months. The same LAI model parameters were used for both the Monocover and the Title 27 prescriptive cover.

Rooting depth was assumed to be 18 inches for the Monocover and 12 inches (thickness of vegetative soil layer) for the Title 27 prescriptive cover. A normalized root length density function, developed at Hanford for annual cheatgrass, was selected to distribute the *PT* over the depth of the root zone (Figure D-2). The *PT* rate at each node is multiplied by a factor α_f (varying from zero to 1) that relates actual transpiration rates to the moisture content of the soil. The factor α_f drops to zero when moisture content approaches saturation (anaerobic conditions) or when it drops below the wilting point. Between these two moisture values, a bi-linear distribution was assumed for α_f.

D.5.6 Boundary Conditions

The upper boundary condition for both the Monocover and Title 27 prescriptive cover was specified as an hourly flux equivalent to the hourly precipitation rate. If the suction head of the surface node becomes less than the minimum suction head specified (typically representing saturation), the program automatically changes the top boundary condition to a constant head (minimum suction head) condition until the precipitation rate becomes less than the potential infiltration rate. Precipitation applied during this interval becomes surface runoff.

The surface boundary condition during evaporation is also a flux boundary condition. Evaporation flux is calculated based on the daily weather data, consisting of maximum and minimum air temperature, average wind speed, solar radiation and average vapor density.

The lower boundary condition specified for both types of covers modeled was the unit gradient boundary condition. This condition corresponds to gravity-induced drainage at the bottom of the soil cover and is appropriate when applied to soil profiles that extend below the root zone and in which drainage is not impeded (Fayer and Jones, 1990).

D.6 Results of Model Simulations

Unsaturated flow simulations were run for the two cover systems, the proposed Monocover and the Title 27 prescriptive cover shown in Figure D-1. Each cover system model was first initialized by running the simulation for an "average" year. The average year was chosen as 1991 with an annual precipitation of 15.65 inches (37.6 cm). Following the initialization, water balance simulations were run for a period of 5 years using the input parameters described in the previous section.

Results of the water balance analyses presented in the form of annual and cumulative values of rainfall, storage change, runoff, evapotranspiration and percolation for the evapotranspirative cover and Title 27 cover are presented in Figures D-3 and D-4, respectively. The results of the analyses for the Monocover (Figure D-3) show that, at the end of the 5-year simulation period, the cumulative percolation through the bottom of the Monocover is approximately 0.34% of total precipitation. The annual percolation rates range from about 0.02% to 1.50% of precipitation

The results of the water balance simulations for the Title 27 cover are presented in Figure D-4. The 5-year cumulative percolation through the prescriptive cover is approximately 1.82% of precipitation. The annual percolation rates range from about 0.07% to 4.58% of precipitation.

Cumulative percolation through the Monocover and Title 27 cover are compared in Figure D-5. The results show that the percolation through the Monocover is significantly less than the percolation through the Title 27 cover for the 5 years simulated.

D.7 Parametric Analyses

A series of parametric analyses were performed to evaluate the sensitivity of the percolation through the Monocover to Ks values, total cover thickness and period of simulation. The results of the simulations were also used to develop specifications for Monocover.

Effect of Ks of surface Layer

The Ks value of the surface layer (upper 12 inches) was varied about the average value of 6.7E-05 cm/sec used in the equivalence demonstration simulations. The Ks value of the surface layer was incrementally changed from 5.0E-05 cm/sec to 1.0E-04 cm/sec while keeping all other hydraulic parameters unchanged. The cumulative percolation through the cover for each case was compared to the percolation through the Title 27 cover. The results are illustrated in Figure D-6. It is seen from this analysis that if the Ks of the surface layer is less than or equal to 8.0E-05 cm/sec, the Monocover percolation performance is superior to that of the Title 27 Cover.

Effect of Ks of Lower Layer

The Ks value of the lower layer of the Monocover (lower 3 feet) was increased from the average value of 3.50E-05 cm/sec used in the equivalence demonstration simulations. The Ks value of the lower layer was incrementally changed from 3.50E-05 cm/sec to 1.0E-04 cm/sec while keeping all other hydraulic parameters unchanged. The cumulative percolation through the cover for each case was compared to the percolation through the Title 27 cover. The results are illustrated in Figure D-7. It is seen from this analysis that although the cumulative percolation through the Monocover increases with increasing Ks values, its performance is still superior to that of the Title 27 cover for the range of Ks values considered.

Effect of Cover Thickness

The effect of cover thickness on cumulative percolation was evaluated by reducing the thickness of the Monocover incrementally from 4 feet (120 cm) to 2 feet (60 cm), while keeping the hydraulic characteristics unchanged. The results are illustrated in Figure D-8. The results show that the Monocover should be at least 3 feet thick to meet or exceed the performance of the Title 27 cover.

Results of 10 – Year Simulation

The period of simulation was increased from 5 years to 10 years, by repeating the design 5-year period, back to back. The results of the simulation represented in Figure D-9, shows that the results for the 10-year simulation period are similar to the results for the 5-year period although the percolation quantities are not identical, and that the proposed Monocover section is equivalent or superior to the Title 27 cover section.

D.8 Conclusions and Recommendations

Unsaturated flow modeling was undertaken to study the hydraulic performance of the proposed Monocover and to evaluate if the performance is equivalent to the Title 27 prescriptive cover. Model

simulations were performed for both types of covers for a period of 5 years representing one of the wetter 5-year sequences on record. The proposed Monocover consisted of 4 feet of engineered soil cover over a foundation layer of existing soil cover. Soil parameters for the model were based on laboratory unsaturated hydraulic testing on remolded samples of typical soils from the existing cover.

Based on the results of the unsaturated flow modeling, the following conclusions can be made:

- The proposed Monocover will perform as well as, or better than, the Title 27 prescriptive cover. The performance evaluation is based on the quantity of cumulative percolation through the cover.
- In order to meet the requirements of a suitable Monocover, the following conditions should be satisfied:
  - The Monocover should consist of an engineered soil cover that is at least 4 feet thick, and be supported on a suitable firm foundation.
  - The engineered cover soil should consist of existing cover soils that meet the material specifications below, and is free of waste, debris, organics and particles larger than 3 inches in size; the material should moisture conditioned close to optimum, placed in 6-inch thick lifts and compacted to at least 90% of maximum dry density (ASTM D1557). Overcompaction should be avoided so that potential for desiccation cracking is reduced and vegetation growth is enhanced.
  - The cover soils should be relatively uniform and consist predominantly of clayey sand (SC), and sandy clay (CL) materials with fines content of greater than or equal to 30%, plasticity index (PI) between 5 and 15, and gravel content less than 30%. The material should have a Ks value less than or equal to 8.0E-05 cm/sec when remolded to 85% relative compaction, based on ASTM D5084 at 5 psi confining pressure on a 4-inch diameter remolded samples screened through a ¾-inch sieve. Offsite soils should be tested and approved prior to placement as Monocover.
  - The cover should be vegetated with native species of grass and brush (with root depth to 18 inches) that germinate and grow during the rainy season and remain dormant during the dry summer months. The plant species should be selected such that supplementary irrigation is not required after the initial establishment of growth.
  - The finish surface should be well graded and maintained to drain and prevent any ponding.

D.9 References

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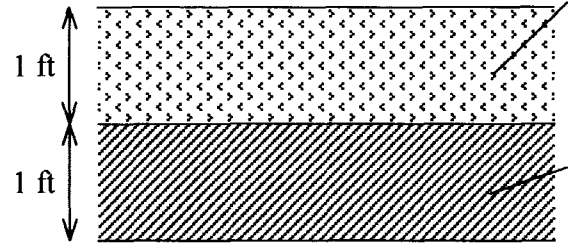
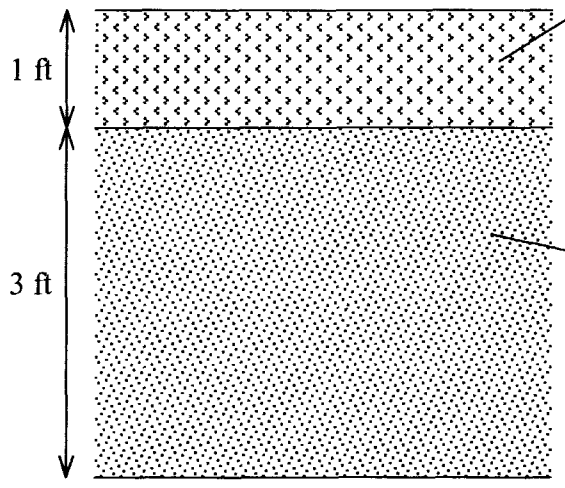
Title 27 Cover



Vegetative Layer
85 % RC
Ks=1.0E-4 cm/s
α=0.023, n=1.245, θ_r=0, θ_s=0.39

Low Permeability Layer
Ks=1.0E-6 cm/s
α=0.0045, n=1.28, θ_r=0, θ_s=0.324

Equivalent Engineered Soil Cover



Near Surface Layer
90 % RC (modeled at 85% RC to account for degradation of hydraulic parameters)
Ks=6.7E-5 cm/s
α=0.023, n=1.245, θ_r=0, θ_s=0.39

90 % RC
Ks=3.5E-5 cm/s
α=0.023, n=1.245, θ_r=0, θ_s=0.39

Advanced Earth Sciences, Inc.
Geotechnical and Environmental Consultants

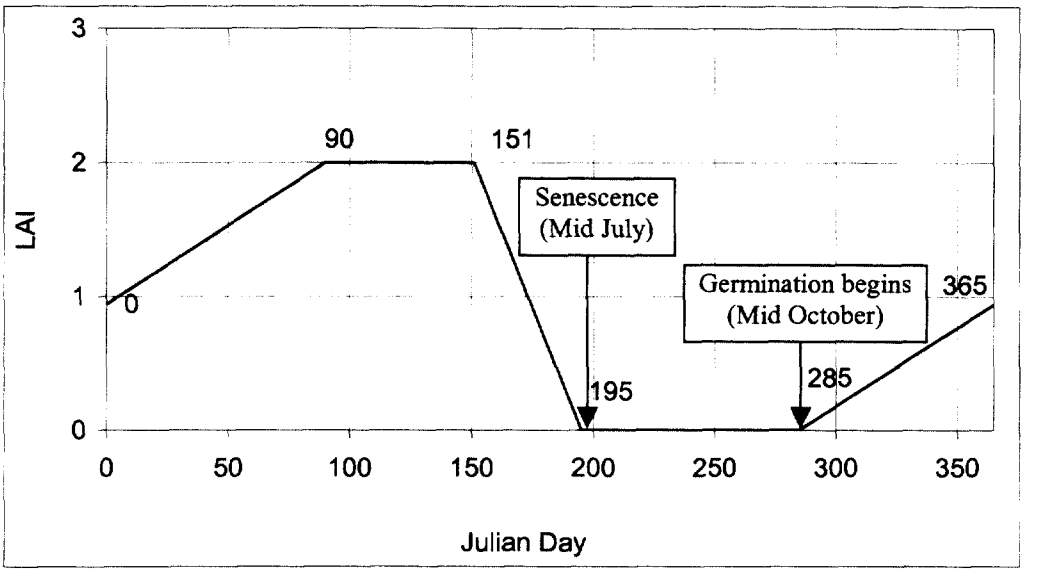
Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Cover Configurations Simulated

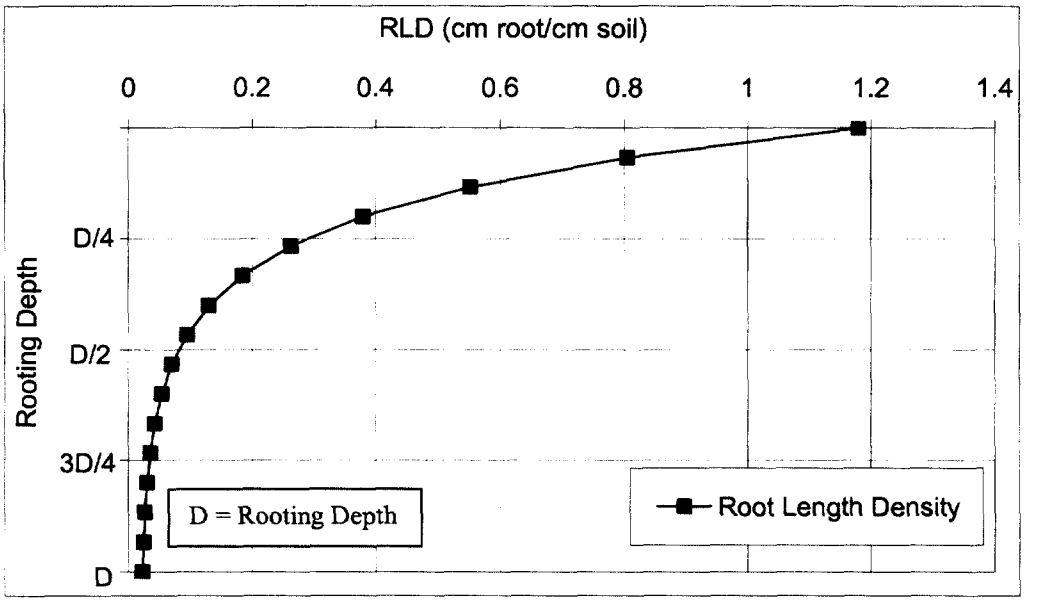
Date:

Figure D-1

VEGETATION GROWTH MODEL



ROOT DENSITY FUNCTION



Advanced Earth Sciences, Inc. Geotechnical and Environmental Consultants	Project No.: 01-123 WDI Superfund site Unsaturated flow modeling
Vegetation Model for Unsat-H Analysis	
Date:	Figure D-2

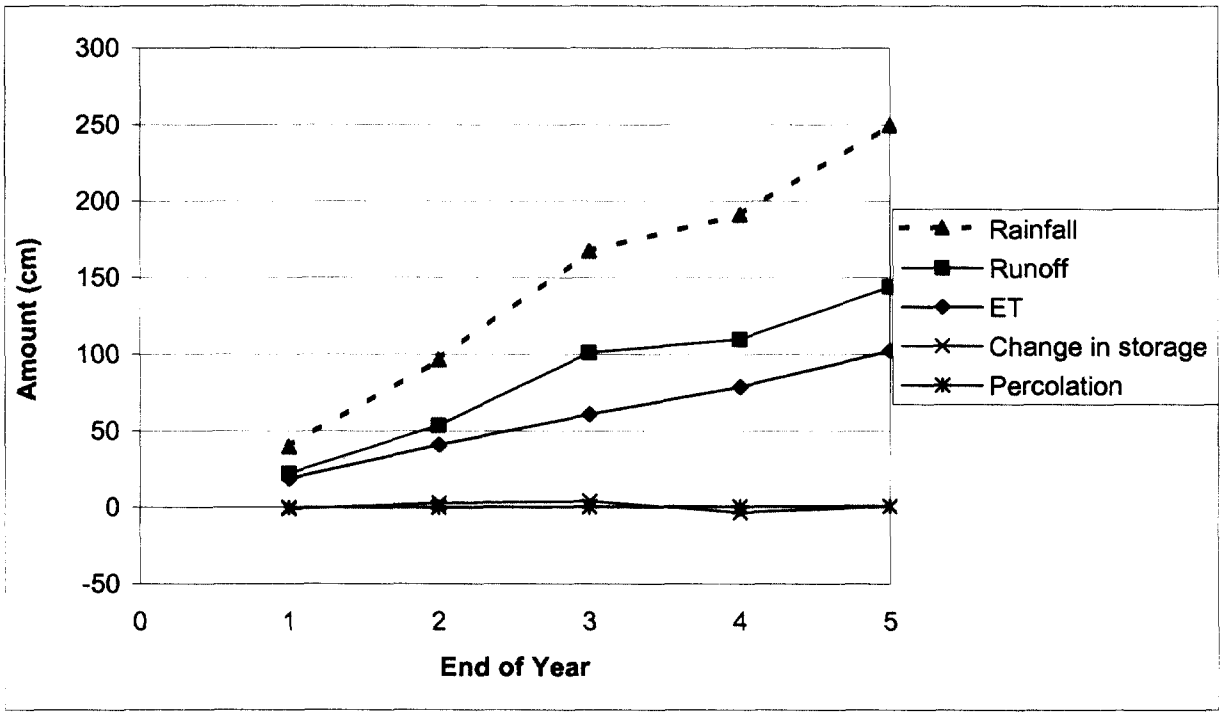
Ks =6.7E-05 cm/s for upper 12 inches and Ks =3.5E-05 for the lower 36 inches

Total Annual

Year	Rainfall (cm)	ET (cm)	Runoff (cm)	Storage (cm)	Percolation (cm)	Percolation (% of Rainfall)
1	39.75	18.56	22.16	18.80	0.01	0.03
2	56.59	22.27	31.49	21.54	0.01	0.02
3	71.02	19.88	47.22	25.40	0.29	0.41
4	23.72	17.91	8.74	21.95	0.36	1.50
5	58.52	23.38	34.28	22.53	0.19	0.33

Cumulative

Year	Rainfall (cm)	ET (cm)	Runoff (cm)	Δ Storage (cm)	Percolation (cm)	Percolation (% of Rainfall)
1	39.75	18.56	22.16	-1.03	0.01	0.03
2	96.34	40.82	53.65	2.74	0.02	0.02
3	167.36	60.70	100.87	3.87	0.31	0.19
4	191.08	78.61	109.61	-3.46	0.67	0.35
5	249.61	101.99	143.89	0.59	0.86	0.34



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Results of Monocover Simulation

Date:

Figure D-3

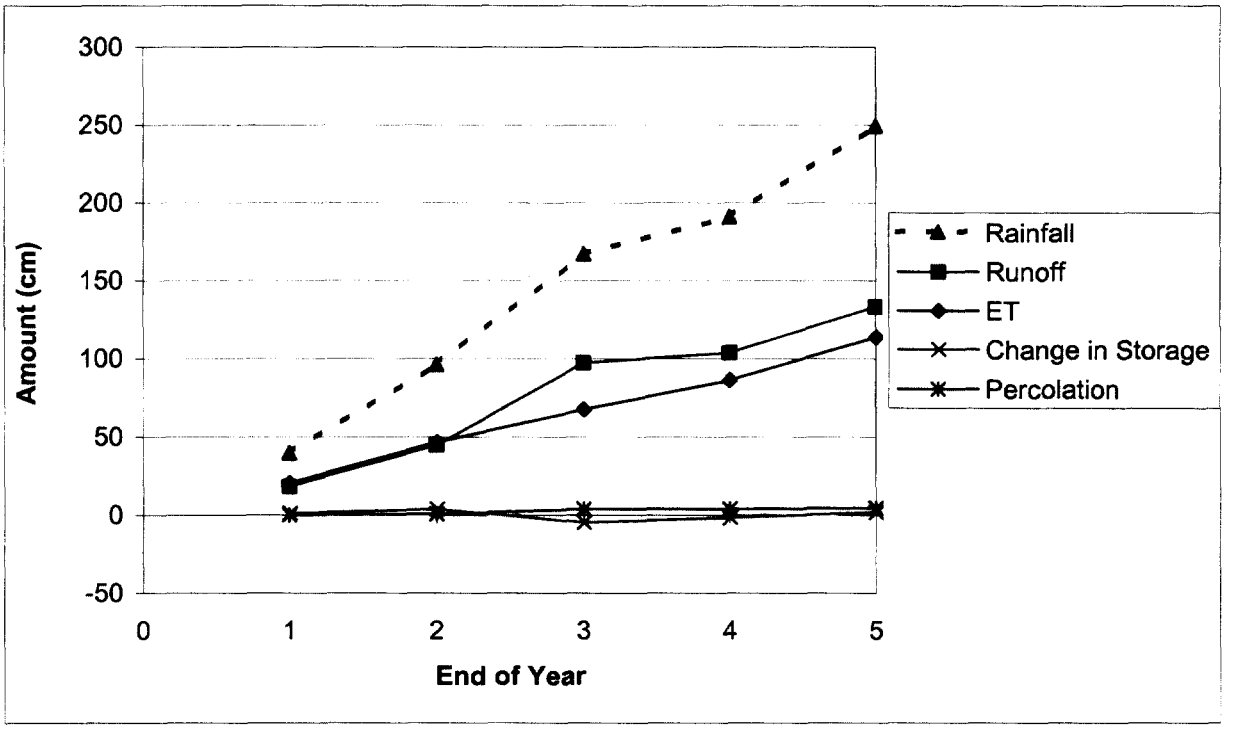
Ks =1.0E-04 cm/s for upper 12 inches and Ks =1.0E-06 for the lower 12 inches

Total Annual

Year	Rainfall (cm)	ET (cm)	Runoff (cm)	Storage (cm)	Percolation (cm)	Percolation (% of Rainfall)
1	39.75	20.49	18.17	11.415	0.03	0.07
2	56.59	26.02	26.51	15.153	0.56	0.99
3	71.02	20.89	52.61	10.302	3.25	4.58
4	23.72	18.82	6.55	8.4722	0.04	0.17
5	58.52	27.33	29.53	10.171	0.68	1.16

Cumulative

Year	Rainfall (cm)	ET (cm)	Runoff (cm)	Δ Storage (cm)	Percolation (cm)	Percolation (% of Rainfall)
1	39.75	20.49	18.17	1.02	0.03	0.07
2	96.34	46.51	44.68	3.74	0.59	0.61
3	167.36	67.40	97.29	-4.85	3.84	2.30
4	191.08	86.22	103.84	-1.83	3.88	2.03
5	249.61	113.56	133.37	1.70	4.56	1.83



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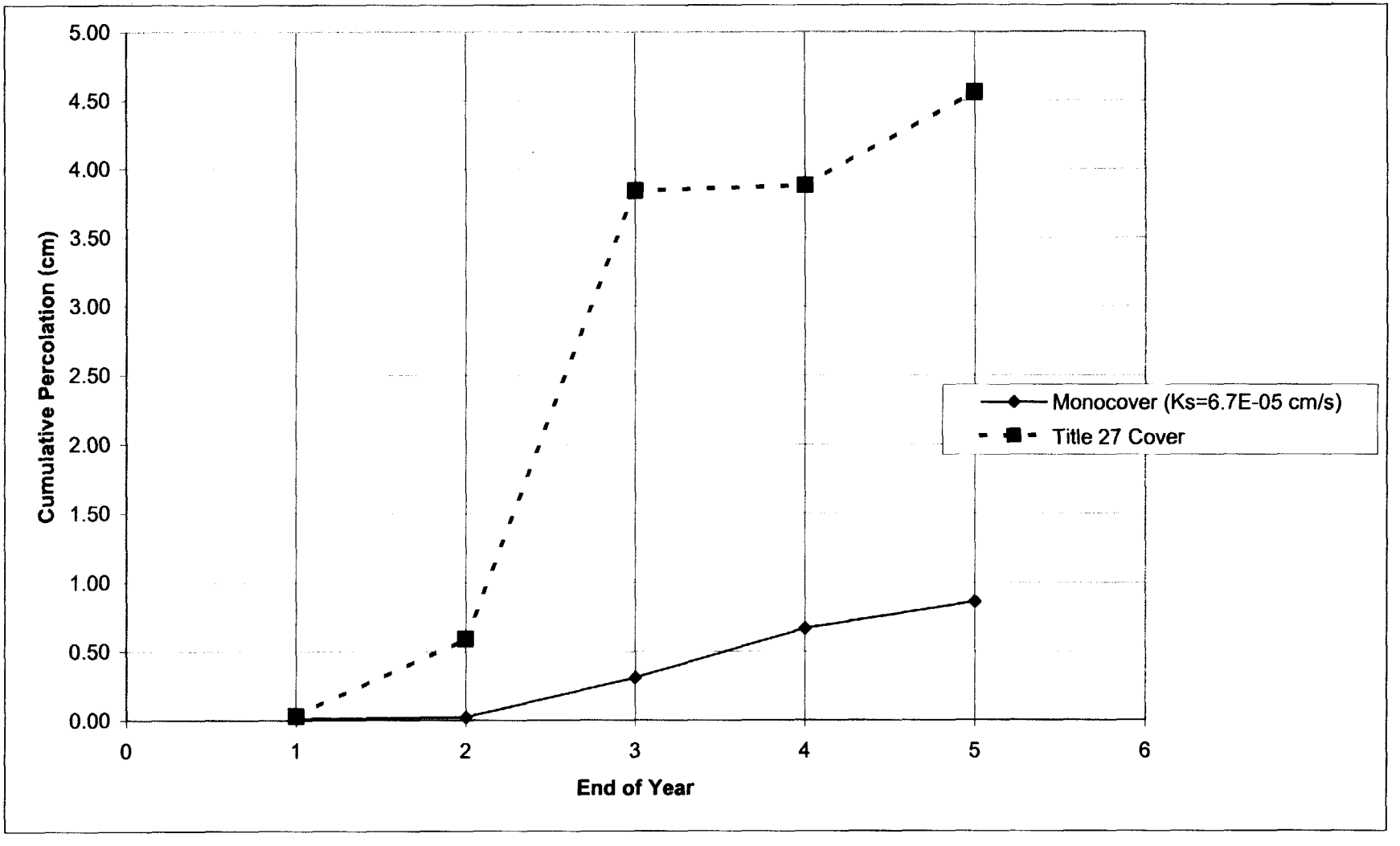
WDI Superfund site
Unsaturated flow modeling

Results of Title 27 Cover Simulation

Date:

Figure D-4



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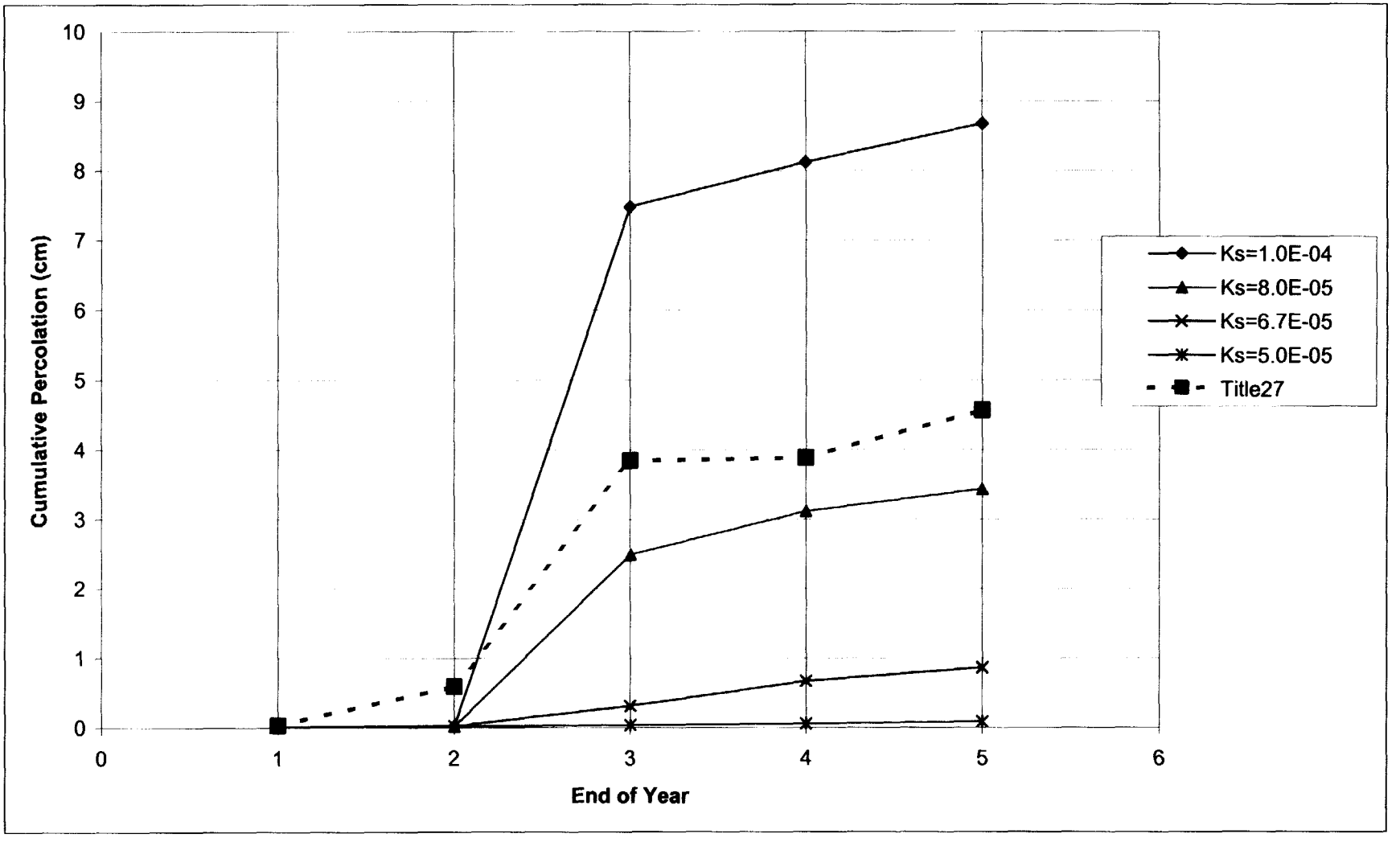
WDI Superfund site
Unsaturated flow modeling

Comparison of Monocover to Title 27 Cover

Date:

Figure D-5



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WDI Superfund site
Unsaturated flow modeling

Variation of Monocover Percolation with Ks of Surface Layer

Date:

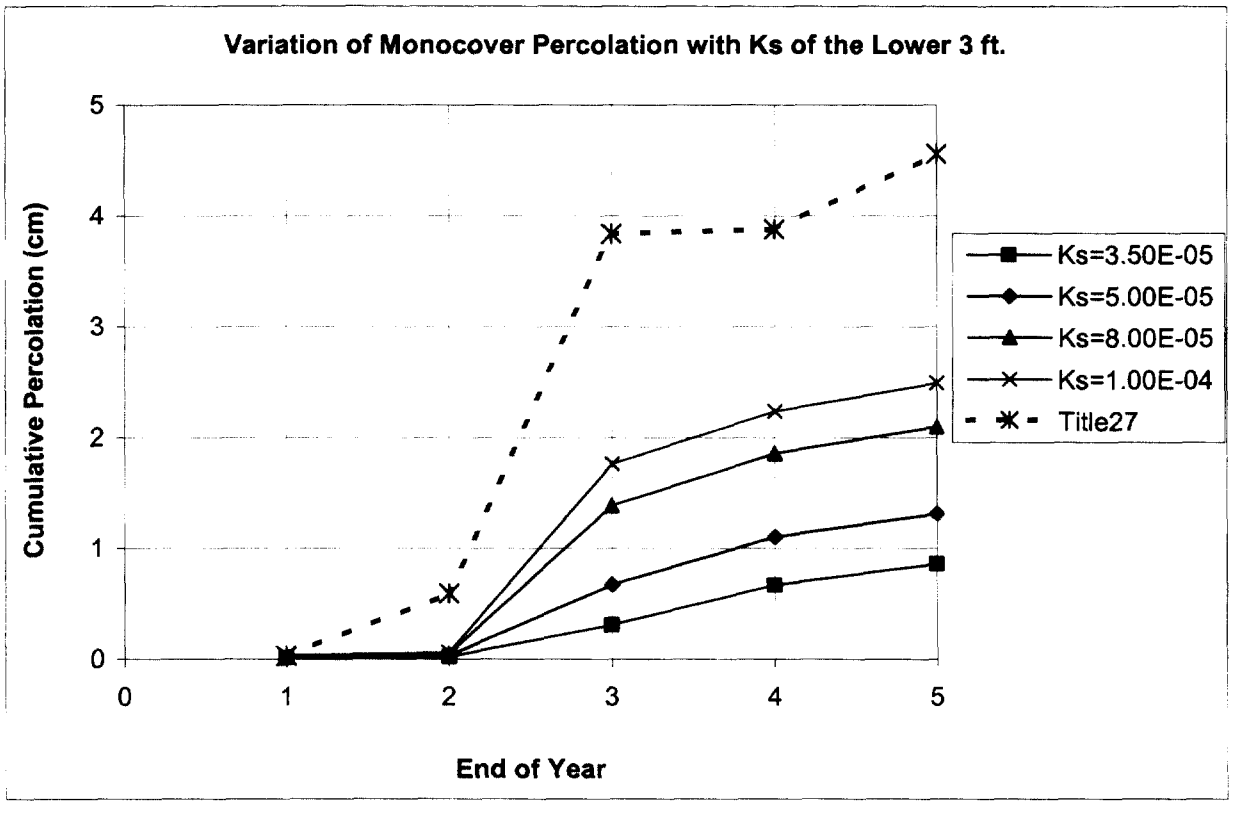
Figure D-6

Annual Percolation (cm)

Ks (cm/s)=	3.50E-05	5.00E-05	8.00E-05	1.00E-04
1	0.01	0.02	0.03	0.03
2	0.01	0.02	0.02	0.03
3	0.29	0.64	1.34	1.70
4	0.36	0.43	0.47	0.47
5	0.19	0.21	0.24	0.26

Cumulative Percolation (cm)

Ks (cm/s)=	3.50E-05	5.00E-05	8.00E-05	1.00E-04	Title 27
1	0.01	0.02	0.03	0.03	0.03
2	0.02	0.03	0.05	0.06	0.59
3	0.31	0.67	1.38	1.76	3.84
4	0.67	1.10	1.85	2.23	3.88
5	0.86	1.31	2.09	2.49	4.56



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Parametric Analysis
Effect of Ks of Lower 3 ft of Monocover

Date:

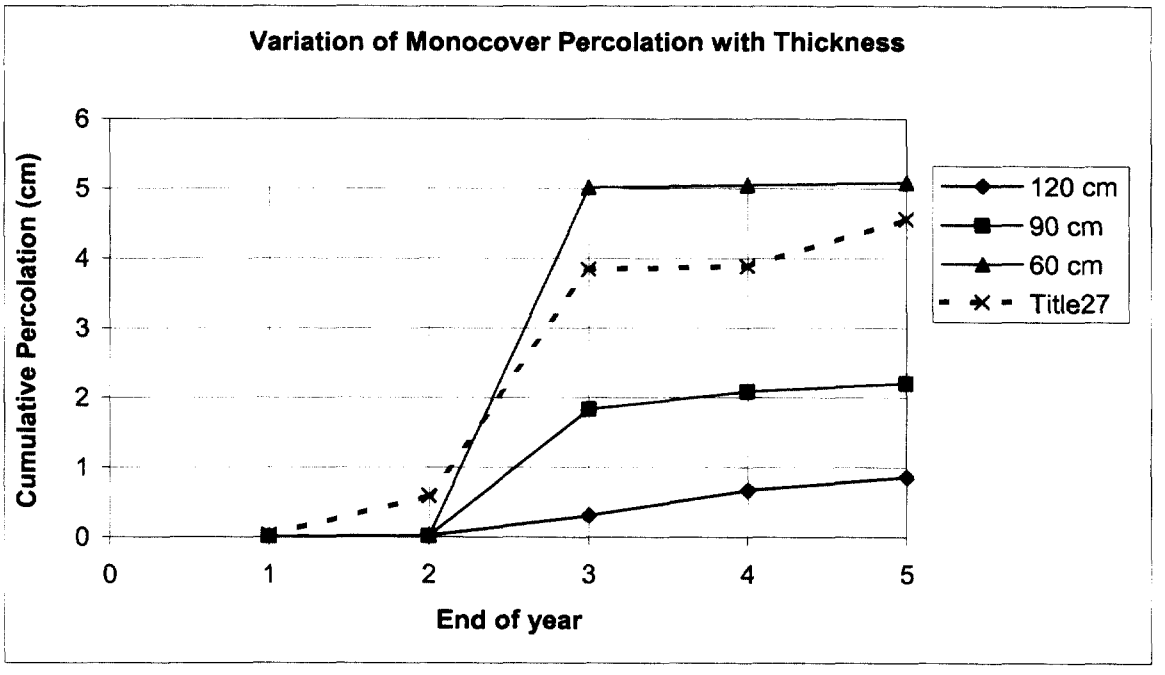
Figure D-7

Annual Percolation

Year	COVER THICKNESS		
	120 cm	90 cm	60 cm
1	0.01	0.01	0.00
2	0.01	0.01	0.00
3	0.29	1.82	5.00
4	0.36	0.25	0.03
5	0.19	0.12	0.03

Cumulative Percolation

Year	COVER THICKNESS			Title 27
	120 cm	90 cm	60 cm	
1	0.01	0.01	0.00	0.03
2	0.02	0.02	0.01	0.59
3	0.31	1.84	5.01	3.84
4	0.67	2.09	5.04	3.88
5	0.86	2.20	5.08	4.56



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

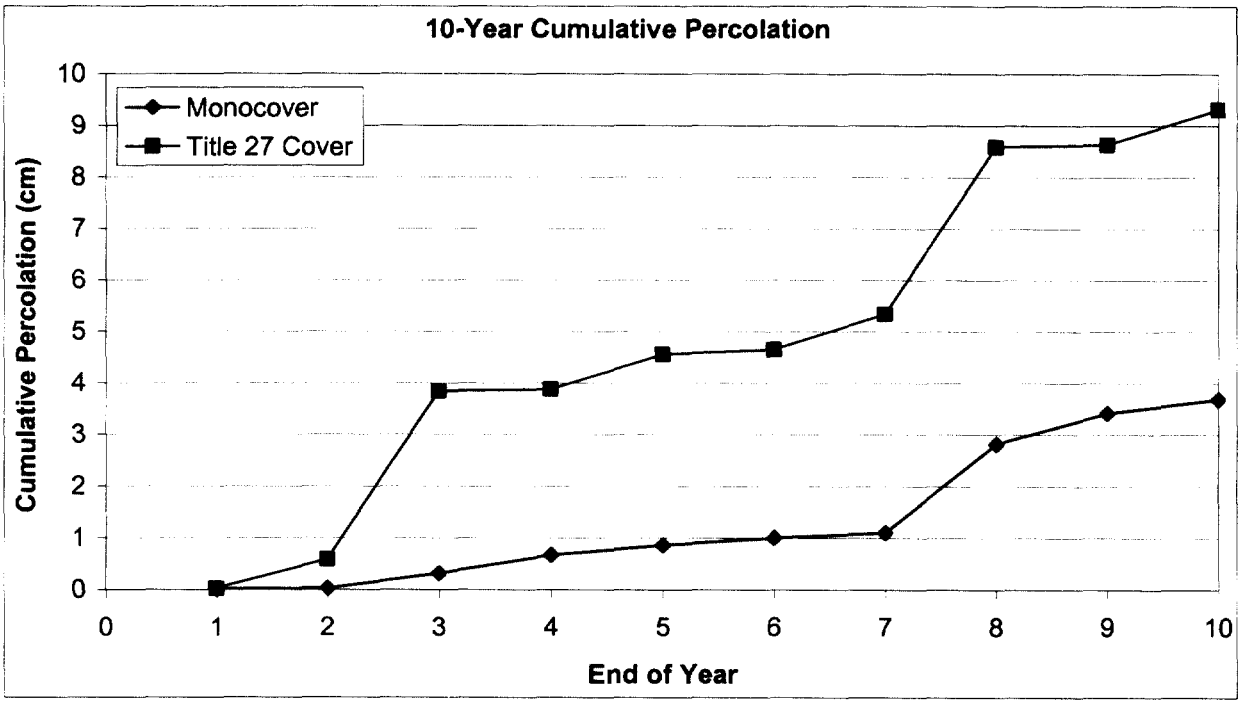
Sensitivity Analysis
Effect of thickness of Monocover

Date:

Figure D-8

Cumulative Percolation (cm)

Year	Monocover	Title 27 Cover
1	0.01	0.03
2	0.02	0.59
3	0.31	3.84
4	0.67	3.88
5	0.86	4.56
6	1.01	4.65
7	1.10	5.34
8	2.81	8.59
9	3.41	8.63
10	3.68	9.31



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Results of 10-Year Simulation

Date:

Figure D-9

II. *UNSAT-H INPUT FILE FOR SUBTITLE D COVER AND MONOCOVER*

```
-------------------------------------------------------------------------------

                              Program DATAINH
                                Version2.03

-------------------------------------------------------------------------------

 Input Filename: C:\Shared\WinUnsatH\project.inp
 Date Processed: 10-DEC-**
 Time Processed:  9: 1:37

-------------------------------------------------------------------------------
 Title:
 prescriptive cover 95 c5
-------------------------------------------------------------------------------

 Options chosen include:

 IPLANT =   1        LOWER  =   1        NGRAV  =   1        ISWDIF =   1
 IHEAT  =   0        UPPERH =   0        LOWERH =   1
 NPRINT =   0        DAYEND = 365        NDAYS  = 365        NYEARS =   1
 IRAIN  =   1        ICONVH =   0
 NSURPE =   1        NFHOUR =   2        ITOPBC =   0        ET_OPT =   1
 ICLOUD =   0
 KOPT   =   4        KEST   =   3        IVAPOR =   1        SH_OPT =   0
 INMAX  =   2        INHMAX =   1
 HIRRI  =   0.00     HDRY   =  1.000E+07 HTOP   =   0.00     DHMAX  =   0.00
 DMAXBA =  1.000E-04 DELMAX =   1.00     DELMIN =  1.000E-07 STOPHR =   24.0
 OUTTIM =   1.00
 TORT   =  0.660     TSOIL  =   291.     VAPDIF =  0.240     QHTOP  =   0.00

 IVAPOR = 1:  This option allows vapor flow
 Saturated vapor density (g/cm3)
  of soil when soil temperature is
  a constant equal to TSOIL        =  1.521E-05
 100*MOLAR*GRAV/GASCON (K/cm)      =  2.123E-04
 VC (cm5/g/h)                      =  5.702E+02
 TGRAD  =   0.00     TSMEAN =   0.00     TSAMP  =   0.00     QHLEAK =   0.00
 WTF    =  0.500     RFACT  =   1.25     RAINIF =  1.000E-07 DHFACT =   0.00
 MATN   =   2        NPT    =  52

-------------------------------------------------------------------------------
 KOPT = 4:  van Genuchten functions for soil hydraulic properties

 THETA vs H, MAT 1,
      AIRINT =   0.0000                          THET =  0.39400
        THTR =   0.0000                         ALPHA =  2.30000E-02
           N =   1.2500                             M =  0.20000
     K vs H, MAT 1,
      AIRINK =   0.0000                            SK =  0.36000
           A =  2.30000E-02                         N =   1.2500
           M =  0.20000                        KMODEL =   2.0000
        EPIT =  0.50000

 THETA vs H, MAT 2,
      AIRINT =   0.0000                          THET =  0.32400
        THTR =   0.0000                         ALPHA =  4.50000E-03
           N =   1.2800                             M =  0.21875
     K vs H, MAT 2,
      AIRINK =   0.0000                            SK =  3.60000E-03
           A =  4.50000E-03                         N =   1.2800
           M =  0.21875                        KMODEL =   2.0000
        EPIT =  0.50000

 Surface node hydraulic properties

 HIRRI =      0.0     , THETA = 0.3940, K =   3.6000E-01, C =  -1.8045E-08
 HDRY  =     1.00E+07, THETA = 0.0180, K =   1.2129E-16, C =  -4.4978E-10
 NDAY =   0
```

NODE	Z	MAT	HEAD	CONDUCTIVITY	CAPACITY	THETA	TEMP
1	0.00	1	1.7297E+06	1.2138E-14	-4.0322E-09	0.0279	291.0
2	0.05	1	1.6249E+06	1.4303E-14	-4.3599E-09	0.0283	291.0
3	0.10	1	1.5440E+06	1.6354E-14	-4.6473E-09	0.0287	291.0
4	0.20	1	1.3860E+06	2.1711E-14	-5.3185E-09	0.0295	291.0
5	0.40	1	1.1158E+06	3.8365E-14	-6.9748E-09	0.0311	291.0

6	0.60	1	8.7710E+05	7.2164E-14	-9.4230E-09	0.0331	291.0
7	1.00	1	4.6828E+05	3.7475E-13	-2.0647E-08	0.0387	291.0
8	1.50	1	2.8630E+04	5.7477E-10	-6.7892E-07	0.0778	291.0
9	2.00	1	3.9318E+03	1.0495E-07	-8.0891E-06	0.1277	291.0
10	3.00	1	2.6615E+03	2.9146E-07	-1.3139E-05	0.1407	291.0
11	4.00	1	2.5347E+03	3.3116E-07	-1.3960E-05	0.1424	291.0
12	6.00	1	2.8525E+04	5.8037E-10	-6.8206E-07	0.0778	291.0
13	8.00	1	1.2250E+05	1.2662E-11	-1.1036E-07	0.0541	291.0
14	10.00	1	1.5964E+05	6.3176E-12	-7.9260E-08	0.0506	291.0
15	12.00	1	1.6008E+05	6.2718E-12	-7.8986E-08	0.0506	291.0
16	14.00	1	1.3834E+05	9.2009E-12	-9.4799E-08	0.0525	291.0
17	16.00	1	1.0447E+05	1.9230E-11	-1.3466E-07	0.0563	291.0
18	18.00	1	6.4852E+04	6.7216E-11	-2.4437E-07	0.0634	291.0
19	20.00	1	2.4314E+04	8.8258E-10	-8.3272E-07	0.0810	291.0
20	22.00	1	7.7889E+03	1.7492E-08	-3.4504E-06	0.1077	291.0
21	24.00	1	4.8494E+03	6.0583E-08	-6.2297E-06	0.1212	291.0
22	26.00	1	3.5957E+03	1.3263E-07	-9.0405E-06	0.1305	291.0
23	27.44	1	3.0388E+03	2.0604E-07	-1.1144E-05	0.1361	291.0
24	28.29	1	2.7867E+03	2.5844E-07	-1.2410E-05	0.1391	291.0
25	28.86	1	2.6406E+03	2.9754E-07	-1.3268E-05	0.1410	291.0
26	29.24	1	2.5515E+03	3.2547E-07	-1.3845E-05	0.1422	291.0
27	29.49	1	2.4962E+03	3.4466E-07	-1.4227E-05	0.1430	291.0
28	29.66	1	2.4601E+03	3.5807E-07	-1.4487E-05	0.1435	291.0
29	29.78	1	2.4352E+03	3.6769E-07	-1.4670E-05	0.1438	291.0
30	29.85	1	2.4210E+03	3.7337E-07	-1.4777E-05	0.1440	291.0
31	29.90	1	2.4110E+03	3.7745E-07	-1.4854E-05	0.1442	291.0
32	30.00	1	2.3912E+03	3.8567E-07	-1.5006E-05	0.1445	291.0
33	30.10	2	2.3679E+03	2.7192E-07	-1.8647E-05	0.1653	291.0
34	30.20	2	2.3406E+03	2.8030E-07	-1.8910E-05	0.1658	291.0
35	30.40	2	2.2886E+03	2.9729E-07	-1.9430E-05	0.1668	291.0
36	30.60	2	2.2399E+03	3.1450E-07	-1.9939E-05	0.1678	291.0
37	31.00	2	2.1513E+03	3.4946E-07	-2.0929E-05	0.1696	291.0
38	32.00	2	1.9701E+03	4.3954E-07	-2.3249E-05	0.1736	291.0
39	33.00	2	1.8293E+03	5.3291E-07	-2.5387E-05	0.1770	291.0
40	34.00	2	1.7162E+03	6.2856E-07	-2.7367E-05	0.1800	291.0
41	35.00	2	1.6233E+03	7.2561E-07	-2.9210E-05	0.1826	291.0
42	36.00	2	1.5454E+03	8.2333E-07	-3.0928E-05	0.1850	291.0
43	37.00	2	1.4793E+03	9.2108E-07	-3.2533E-05	0.1871	291.0
44	38.00	2	1.4224E+03	1.0183E-06	-3.4035E-05	0.1890	291.0
45	40.00	2	1.3296E+03	1.2092E-06	-3.6760E-05	0.1922	291.0
46	42.00	2	1.2576E+03	1.3926E-06	-3.9151E-05	0.1950	291.0
47	44.00	2	1.2007E+03	1.5654E-06	-4.1239E-05	0.1973	291.0
48	46.00	2	1.1554E+03	1.7248E-06	-4.3049E-05	0.1992	291.0
49	48.00	2	1.1192E+03	1.8683E-06	-4.4595E-05	0.2008	291.0
50	50.00	2	1.0905E+03	1.9937E-06	-4.5888E-05	0.2020	291.0
51	55.00	2	1.0452E+03	2.2165E-06	-4.8073E-05	0.2042	291.0
52	60.00	2	1.0310E+03	2.2933E-06	-4.8795E-05	0.2049	291.0

Total Initial Storage = 8.4722 cm

IPLANT = 1

LEAF= 1, NFROOT= 1, NUPTAK= 1, NFPET= 1, NSOW=285, NHRVST=195

Total number of Growth Day - Leaf Area Index (LAI) data pairs = 6

Growth Day	LAI
0	0.940
90	2.000
151	2.000
195	0.000
285	0.000
365	0.940

BARE = 0.500

DAY	LAI	DAY	LAI	DAY	LAI	DAY	LAI	DAY	LAI	DAY	LAI
1	0.952	2	0.964	3	0.975	4	0.987	5	0.999	6	1.011
7	1.022	8	1.034	9	1.046	10	1.058	11	1.070	12	1.081
13	1.093	14	1.105	15	1.117	16	1.128	17	1.140	18	1.152
19	1.164	20	1.176	21	1.187	22	1.199	23	1.211	24	1.223
25	1.234	26	1.246	27	1.258	28	1.270	29	1.282	30	1.293
31	1.305	32	1.317	33	1.329	34	1.340	35	1.352	36	1.364
37	1.376	38	1.388	39	1.399	40	1.411	41	1.423	42	1.435
43	1.446	44	1.458	45	1.470	46	1.482	47	1.494	48	1.505

49	1.517	50	1.529	51	1.541	52	1.552	53	1.564	54	1.576
55	1.588	56	1.600	57	1.611	58	1.623	59	1.635	60	1.647
61	1.658	62	1.670	63	1.682	64	1.694	65	1.706	66	1.717
67	1.729	68	1.741	69	1.753	70	1.764	71	1.776	72	1.788
73	1.800	74	1.812	75	1.823	76	1.835	77	1.847	78	1.859
79	1.870	80	1.882	81	1.894	82	1.906	83	1.918	84	1.929
85	1.941	86	1.953	87	1.965	88	1.976	89	1.988	90	2.000
91	2.000	92	2.000	93	2.000	94	2.000	95	2.000	96	2.000
97	2.000	98	2.000	99	2.000	100	2.000	101	2.000	102	2.000
103	2.000	104	2.000	105	2.000	106	2.000	107	2.000	108	2.000
109	2.000	110	2.000	111	2.000	112	2.000	113	2.000	114	2.000
115	2.000	116	2.000	117	2.000	118	2.000	119	2.000	120	2.000
121	2.000	122	2.000	123	2.000	124	2.000	125	2.000	126	2.000
127	2.000	128	2.000	129	2.000	130	2.000	131	2.000	132	2.000
133	2.000	134	2.000	135	2.000	136	2.000	137	2.000	138	2.000
139	2.000	140	2.000	141	2.000	142	2.000	143	2.000	144	2.000
145	2.000	146	2.000	147	2.000	148	2.000	149	2.000	150	2.000
151	2.000	152	1.955	153	1.909	154	1.864	155	1.818	156	1.773
157	1.727	158	1.682	159	1.636	160	1.591	161	1.545	162	1.500
163	1.455	164	1.409	165	1.364	166	1.318	167	1.273	168	1.227
169	1.182	170	1.136	171	1.091	172	1.045	173	1.000	174	0.955
175	0.909	176	0.864	177	0.818	178	0.773	179	0.727	180	0.682
181	0.636	182	0.591	183	0.545	184	0.500	185	0.455	186	0.409
187	0.364	188	0.318	189	0.273	190	0.227	191	0.182	192	0.136
193	0.091	194	0.045	195	0.000	196	0.000	197	0.000	198	0.000
199	0.000	200	0.000	201	0.000	202	0.000	203	0.000	204	0.000
205	0.000	206	0.000	207	0.000	208	0.000	209	0.000	210	0.000
211	0.000	212	0.000	213	0.000	214	0.000	215	0.000	216	0.000
217	0.000	218	0.000	219	0.000	220	0.000	221	0.000	222	0.000
223	0.000	224	0.000	225	0.000	226	0.000	227	0.000	228	0.000
229	0.000	230	0.000	231	0.000	232	0.000	233	0.000	234	0.000
235	0.000	236	0.000	237	0.000	238	0.000	239	0.000	240	0.000
241	0.000	242	0.000	243	0.000	244	0.000	245	0.000	246	0.000
247	0.000	248	0.000	249	0.000	250	0.000	251	0.000	252	0.000
253	0.000	254	0.000	255	0.000	256	0.000	257	0.000	258	0.000
259	0.000	260	0.000	261	0.000	262	0.000	263	0.000	264	0.000
265	0.000	266	0.000	267	0.000	268	0.000	269	0.000	270	0.000
271	0.000	272	0.000	273	0.000	274	0.000	275	0.000	276	0.000
277	0.000	278	0.000	279	0.000	280	0.000	281	0.000	282	0.000
283	0.000	284	0.000	285	0.000	286	0.012	287	0.023	288	0.035
289	0.047	290	0.059	291	0.071	292	0.082	293	0.094	294	0.106
295	0.117	296	0.129	297	0.141	298	0.153	299	0.164	300	0.176
301	0.188	302	0.200	303	0.212	304	0.223	305	0.235	306	0.247
307	0.259	308	0.270	309	0.282	310	0.294	311	0.306	312	0.317
313	0.329	314	0.341	315	0.352	316	0.364	317	0.376	318	0.388
319	0.400	320	0.411	321	0.423	322	0.435	323	0.447	324	0.458
325	0.470	326	0.482	327	0.493	328	0.505	329	0.517	330	0.529
331	0.540	332	0.552	333	0.564	334	0.576	335	0.587	336	0.599
337	0.611	338	0.623	339	0.635	340	0.646	341	0.658	342	0.670
343	0.682	344	0.693	345	0.705	346	0.717	347	0.729	348	0.740
349	0.752	350	0.764	351	0.775	352	0.787	353	0.799	354	0.811
355	0.822	356	0.834	357	0.846	358	0.858	359	0.869	360	0.881
361	0.893	362	0.905	363	0.916	364	0.928	365	0.940		

NFROOT = 1: Negative exponential representation of root growth

AA (intersection of the curve at z=0 with abscissa) = 1.160
B1 (coefficient defining degree of curvature) = 0.13000
B2 (coefficient that determines the value of asymptote = 0.020

Root depth, density, and weight/node versus depth

DAY	MAX ROOT DEPTH	ROOT DENSITY (cm/cm)	NORMALIZED DENSITY (1/cm)
1	0.00	0.000	0.0000
1	0.05	1.172	0.1259
1	0.10	1.165	0.1251
1	0.20	1.150	0.1235
1	0.40	1.121	0.1204
1	0.60	1.093	0.1173
1	1.00	1.039	0.1115
1	1.50	0.974	0.1046
1	2.00	0.914	0.0982
1	3.00	0.805	0.0865
1	4.00	0.710	0.0762
1	6.00	0.552	0.0592
1	8.00	0.430	0.0462

1	10.00	0.336	0.0361
1	12.00	0.264	0.0283
1	14.00	0.208	0.0223
1	16.00	0.165	0.0177
1	18.00	0.132	0.0141
1	20.00	0.106	0.0114
1	22.00	0.086	0.0093
1	24.00	0.071	0.0076
1	26.00	0.059	0.0064
1	27.44	0.053	0.0057
1	28.29	0.049	0.0053
1	28.86	0.047	0.0051
1	29.24	0.046	0.0049
1	29.49	0.045	0.0048
1	29.66	0.045	0.0048
1	29.78	0.044	0.0047
1	29.85	0.044	0.0047
1	29.90	0.044	0.0047
1	30.00	0.043	0.0047

MXROOT (deepest node to which roots penetrate) = 32
NUPTAK = 1: Feddes et al. 1975 moisture dependent sink term

For Material No. 1

THETAW (wilting point moisture content) = 0.0907
THETAD (lower limit of optimum moisture content) = 0.1324
THETAN (upper limit of optimum moisture content) = 0.3825

For Material No. 2

THETAW (wilting point moisture content) = 0.0986
THETAD (lower limit of optimum moisture content) = 0.1500
THETAN (upper limit of optimum moisture content) = 0.3227

NFHOUR = 2: User subroutine for hourly PET distribution

0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0150	0.0440
0.0699	0.0911	0.1061	0.1139	0.1139	0.1061	0.0911	0.0699
0.0440	0.0150	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

ET_OPT = 1 and IHEAT = 0:
PET calculated from meteorological data
using subroutine CALPEN

ALBEDO = 2.000E-01
ALT = 1.650E+02 (m)
ZU = 8.000E+00 (m)
PMB = 1.010E+03 (mb)

ET_OPT = 1: Meteorological Data

IDAY	Temperature Max F	Min F	Dew F	Solar Rad ly/d	Wind Speed mph	Cloud Cover tenth	Prec. in
1.	65.	41.	31.1	232.	2.0	0.0	0.00
2.	63.	35.	29.6	258.	2.0	0.0	0.00
3.	56.	47.	45.6	97.	3.0	0.0	0.35
4.	55.	47.	49.8	40.	4.0	0.0	3.03
5.	61.	40.	29.8	285.	6.0	0.0	0.04
6.	61.	39.	43.9	248.	2.0	0.0	0.00
7.	53.	48.	27.8	62.	3.0	0.0	0.67
8.	58.	53.	34.4	57.	2.0	0.0	1.06
9.	65.	54.	41.6	148.	2.0	0.0	0.04
10.	56.	53.	39.2	40.	2.0	0.0	2.92
11.	59.	52.	39.3	69.	3.0	0.0	0.24
12.	59.	50.	38.2	102.	2.0	0.0	0.47
13.	58.	53.	38.7	41.	2.0	0.0	0.00
14.	60.	53.	38.1	95.	2.0	0.0	0.16
15.	59.	38.	44.7	260.	5.0	0.0	0.04
16.	57.	36.	41.0	278.	3.0	0.0	0.04
17.	61.	35.	38.8	297.	2.0	0.0	0.00
18.	64.	40.	30.5	292.	1.0	0.0	0.00
19.	60.	39.	31.4	215.	3.0	0.0	0.01
20.	58.	40.	37.0	227.	4.0	0.0	0.11

21.	55.	42.	43.6	182.	3.0	0.0	0.02
22.	58.	43.	42.2	176.	2.0	0.0	0.04
23.	58.	51.	48.2	64.	3.0	0.0	0.63
24.	63.	51.	40.6	139.	3.0	0.0	0.91
25.	55.	50.	29.6	53.	3.0	0.0	0.79
26.	60.	47.	33.4	299.	3.0	0.0	0.00
27.	59.	43.	47.5	144.	2.0	0.0	0.00
28.	71.	41.	47.9	319.	2.0	0.0	0.00
29.	76.	47.	47.3	329.	2.0	0.0	0.00
30.	78.	48.	32.5	352.	2.0	0.0	0.00
31.	81.	50.	33.6	346.	2.0	0.0	0.00
32.	87.	47.	41.2	353.	2.0	0.0	0.00
33.	89.	47.	40.2	350.	2.0	0.0	0.00
34.	89.	50.	39.3	367.	2.0	0.0	0.00
35.	88.	50.	36.0	376.	2.0	0.0	0.00
36.	83.	49.	38.1	369.	2.0	0.0	0.00
37.	76.	45.	46.3	349.	3.0	0.0	0.00
38.	63.	51.	53.1	221.	3.0	0.0	0.00
39.	59.	47.	49.9	115.	2.0	0.0	0.00
40.	65.	43.	48.1	301.	2.0	0.0	0.00
41.	67.	41.	47.1	357.	3.0	0.0	0.00
42.	60.	52.	51.7	152.	3.0	0.0	0.00
43.	64.	45.	49.3	368.	3.0	0.0	0.00
44.	57.	44.	48.3	74.	3.0	0.0	0.55
45.	59.	54.	52.7	62.	4.0	0.0	0.67
46.	69.	47.	52.4	376.	2.0	0.0	0.00
47.	73.	45.	44.3	351.	2.0	0.0	0.00
48.	75.	45.	47.0	395.	2.0	0.0	0.00
49.	76.	50.	40.3	445.	4.0	0.0	0.00
50.	89.	45.	31.4	455.	2.0	0.0	0.00
51.	88.	54.	42.9	446.	3.0	0.0	0.00
52.	62.	48.	41.3	98.	2.0	0.0	0.00
53.	66.	48.	53.3	217.	2.0	0.0	0.00
54.	68.	47.	53.8	231.	2.0	0.0	0.00
55.	72.	55.	57.9	349.	4.0	0.0	0.08
56.	63.	47.	41.8	112.	2.0	0.0	0.00
57.	68.	46.	41.0	268.	2.0	0.0	0.00
58.	64.	53.	43.3	191.	3.0	0.0	0.00
59.	62.	47.	38.1	176.	2.0	0.0	0.00
60.	59.	49.	39.8	133.	2.0	0.0	0.00
61.	59.	51.	44.3	119.	2.0	0.0	0.20
62.	60.	54.	47.1	94.	3.0	0.0	0.32
63.	66.	48.	40.8	276.	2.0	0.0	0.24
64.	61.	56.	49.8	60.	5.0	0.0	2.21
65.	70.	48.	40.8	470.	3.0	0.0	0.00
66.	72.	45.	37.1	452.	2.0	0.0	0.00
67.	74.	49.	38.0	451.	2.0	0.0	0.00
68.	75.	49.	37.4	401.	2.0	0.0	0.00
69.	63.	51.	36.2	105.	3.0	0.0	0.71
70.	62.	50.	42.7	189.	4.0	0.0	2.17
71.	65.	46.	37.8	404.	3.0	0.0	0.00
72.	71.	47.	38.8	480.	2.0	0.0	0.00
73.	79.	51.	43.1	483.	2.0	0.0	0.00
74.	79.	50.	43.2	477.	2.0	0.0	0.00
75.	76.	49.	43.8	479.	3.0	0.0	0.00
76.	71.	57.	46.2	349.	3.0	0.0	0.00
77.	73.	53.	45.1	406.	3.0	0.0	0.00
78.	69.	52.	44.5	185.	2.0	0.0	0.00
79.	62.	54.	55.3	149.	3.0	0.0	0.02
80.	57.	42.	42.8	237.	5.0	0.0	0.39
81.	63.	45.	38.3	515.	3.0	0.0	0.00
82.	57.	39.	41.2	228.	5.0	0.0	0.87
83.	63.	38.	38.2	578.	4.0	0.0	0.00
84.	65.	34.	35.6	582.	3.0	0.0	0.00
85.	71.	37.	39.4	590.	3.0	0.0	0.00
86.	73.	41.	42.0	581.	3.0	0.0	0.00
87.	72.	40.	42.8	577.	3.0	0.0	0.00
88.	74.	43.	44.3	542.	3.0	0.0	0.00
89.	76.	38.	43.6	589.	3.0	0.0	0.00
90.	79.	43.	44.0	589.	3.0	0.0	0.00
91.	75.	45.	50.9	546.	3.0	0.0	0.00
92.	75.	46.	51.9	554.	3.0	0.0	0.00
93.	83.	46.	51.7	597.	3.0	0.0	0.00
94.	81.	49.	55.3	588.	3.0	0.0	0.00
95.	74.	50.	54.0	553.	3.0	0.0	0.00
96.	67.	48.	49.2	327.	3.0	0.0	0.00
97.	64.	46.	48.9	198.	3.0	0.0	0.00
98.	71.	47.	50.7	422.	3.0	0.0	0.00
99.	72.	44.	46.5	550.	3.0	0.0	0.00

100.	76.	38.	39.2	629.	3.0	0.0	0.00
101.	79.	47.	46.8	608.	3.0	0.0	0.00
102.	81.	50.	51.0	549.	3.0	0.0	0.00
103.	73.	46.	50.1	566.	4.0	0.0	0.00
104.	67.	41.	45.5	509.	3.0	0.0	0.00
105.	65.	39.	43.5	516.	3.0	0.0	0.00
106.	49.	43.	43.1	134.	3.0	0.0	0.55
107.	60.	45.	45.2	270.	3.0	0.0	0.04
108.	57.	43.	44.6	206.	2.0	0.0	0.43
109.	64.	42.	45.7	479.	3.0	0.0	0.00
110.	60.	41.	45.7	225.	3.0	0.0	0.00
111.	68.	38.	43.0	642.	3.0	0.0	0.00
112.	81.	40.	47.0	669.	3.0	0.0	0.00
113.	86.	49.	48.8	669.	3.0	0.0	0.00
114.	87.	51.	52.9	667.	3.0	0.0	0.00
115.	78.	48.	54.4	640.	3.0	0.0	0.00
116.	75.	52.	55.8	561.	3.0	0.0	0.00
117.	69.	53.	54.3	313.	3.0	0.0	0.00
118.	66.	55.	54.9	168.	3.0	0.0	0.00
119.	73.	51.	54.9	514.	3.0	0.0	0.00
120.	69.	58.	58.6	267.	3.0	0.0	0.00
121.	77.	57.	58.7	456.	4.0	0.0	0.00
122.	72.	49.	53.3	398.	4.0	0.0	0.00
123.	74.	48.	52.4	509.	3.0	0.0	0.00
124.	66.	53.	51.3	341.	4.0	0.0	0.00
125.	64.	51.	46.5	345.	5.0	0.0	0.00
126.	63.	46.	45.1	338.	3.0	0.0	0.00
127.	63.	51.	49.2	208.	2.0	0.0	0.00
128.	67.	47.	49.3	386.	3.0	0.0	0.00
129.	74.	44.	50.5	639.	3.0	0.0	0.00
130.	73.	46.	52.3	623.	3.0	0.0	0.00
131.	69.	54.	55.3	338.	4.0	0.0	0.00
132.	64.	49.	48.5	249.	5.0	0.0	0.01
133.	65.	48.	49.8	397.	4.0	0.0	0.00
134.	66.	45.	46.2	476.	3.0	0.0	0.00
135.	69.	48.	50.2	415.	3.0	0.0	0.00
136.	66.	48.	50.1	322.	4.0	0.0	0.00
137.	72.	45.	51.2	539.	3.0	0.0	0.00
138.	76.	50.	55.0	476.	3.0	0.0	0.00
139.	80.	51.	51.7	569.	4.0	0.0	0.00
140.	74.	54.	54.0	497.	4.0	0.0	0.00
141.	70.	53.	52.9	372.	3.0	0.0	0.00
142.	62.	53.	51.7	177.	4.0	0.0	0.00
143.	61.	55.	51.3	128.	3.0	0.0	0.00
144.	62.	55.	52.4	173.	3.0	0.0	0.08
145.	66.	48.	49.7	261.	3.0	0.0	0.00
146.	75.	45.	52.3	672.	3.0	0.0	0.00
147.	74.	53.	56.8	501.	4.0	0.0	0.00
148.	78.	58.	59.4	593.	4.0	0.0	0.00
149.	87.	57.	61.1	675.	4.0	0.0	0.00
150.	88.	57.	62.6	663.	4.0	0.0	0.00
151.	85.	54.	60.7	644.	4.0	0.0	0.00
152.	64.	57.	56.2	129.	4.0	0.0	0.00
153.	65.	57.	54.2	140.	3.0	0.0	0.00
154.	71.	51.	53.3	381.	4.0	0.0	0.00
155.	79.	48.	55.3	687.	3.0	0.0	0.00
156.	73.	54.	57.4	357.	3.0	0.0	0.00
157.	76.	51.	52.8	680.	4.0	0.0	0.00
158.	70.	48.	50.5	483.	4.0	0.0	0.00
159.	70.	50.	51.8	574.	4.0	0.0	0.00
160.	81.	47.	54.0	702.	3.0	0.0	0.00
161.	90.	50.	58.1	706.	3.0	0.0	0.00
162.	96.	57.	62.6	713.	3.0	0.0	0.00
163.	91.	56.	62.7	713.	4.0	0.0	0.00
164.	84.	55.	61.3	704.	3.0	0.0	0.00
165.	76.	59.	59.5	610.	4.0	0.0	0.00
166.	66.	55.	54.9	188.	4.0	0.0	0.08
167.	59.	48.	48.7	180.	2.0	0.0	1.18
168.	72.	46.	51.4	670.	3.0	0.0	0.00
169.	82.	51.	57.0	722.	3.0	0.0	0.00
170.	82.	51.	57.2	727.	3.0	0.0	0.00
171.	79.	51.	57.5	703.	3.0	0.0	0.00
172.	80.	53.	58.2	640.	4.0	0.0	0.00
173.	86.	56.	61.6	702.	3.0	0.0	0.00
174.	87.	54.	61.9	695.	4.0	0.0	0.00
175.	89.	56.	63.8	673.	4.0	0.0	0.00
176.	79.	60.	62.7	662.	4.0	0.0	0.00
177.	84.	60.	64.4	462.	3.0	0.0	0.00
178.	87.	58.	63.2	648.	3.0	0.0	0.00

179.	88.	56.	63.3	620.	3.0	0.0	0.00
180.	84.	59.	62.7	649.	4.0	0.0	0.00
181.	87.	56.	61.4	690.	3.0	0.0	0.00
182.	80.	55.	59.5	702.	4.0	0.0	0.00
183.	84.	54.	59.9	713.	3.0	0.0	0.00
184.	78.	53.	58.1	664.	4.0	0.0	0.00
185.	78.	58.	60.3	435.	3.0	0.0	0.00
186.	89.	55.	63.7	673.	4.0	0.0	0.00
187.	84.	57.	63.7	666.	3.0	0.0	0.00
188.	91.	57.	65.3	647.	3.0	0.0	0.00
189.	93.	59.	67.0	614.	3.0	0.0	0.00
190.	93.	58.	64.9	678.	3.0	0.0	0.00
191.	94.	60.	66.3	605.	3.0	0.0	0.00
192.	90.	56.	62.8	714.	3.0	0.0	0.00
193.	87.	52.	58.3	731.	3.0	0.0	0.00
194.	87.	51.	59.2	705.	3.0	0.0	0.00
195.	90.	55.	64.3	682.	3.0	0.0	0.00
196.	90.	58.	65.9	664.	3.0	0.0	0.00
197.	89.	63.	67.6	327.	3.0	0.0	0.00
198.	91.	59.	65.3	684.	3.0	0.0	0.00
199.	93.	58.	66.1	686.	3.0	0.0	0.00
200.	91.	57.	64.9	694.	3.0	0.0	0.00
201.	90.	53.	60.4	708.	3.0	0.0	0.00
202.	88.	52.	60.3	699.	3.0	0.0	0.00
203.	86.	55.	62.5	679.	3.0	0.0	0.00
204.	88.	57.	64.8	692.	3.0	0.0	0.00
205.	89.	56.	65.2	682.	3.0	0.0	0.00
206.	90.	57.	65.8	674.	3.0	0.0	0.00
207.	97.	58.	68.5	654.	3.0	0.0	0.00
208.	104.	60.	70.5	677.	3.0	0.0	0.00
209.	100.	62.	70.7	664.	3.0	0.0	0.00
210.	102.	65.	74.3	654.	4.0	0.0	0.00
211.	91.	65.	71.1	655.	4.0	0.0	0.00
212.	91.	62.	70.1	628.	3.0	0.0	0.00
213.	93.	63.	69.7	624.	3.0	0.0	0.00
214.	92.	61.	68.9	637.	3.0	0.0	0.00
215.	94.	61.	69.6	635.	3.0	0.0	0.00
216.	91.	61.	68.3	643.	3.0	0.0	0.00
217.	93.	58.	66.8	652.	3.0	0.0	0.00
218.	94.	56.	66.3	650.	3.0	0.0	0.00
219.	95.	60.	69.2	601.	3.0	0.0	0.00
220.	95.	61.	69.7	631.	3.0	0.0	0.00
221.	93.	62.	69.6	603.	3.0	0.0	0.00
222.	88.	58.	65.0	629.	3.0	0.0	0.00
223.	97.	58.	66.9	622.	3.0	0.0	0.00
224.	96.	58.	67.5	636.	3.0	0.0	0.00
225.	95.	58.	65.1	644.	3.0	0.0	0.00
226.	90.	54.	62.1	653.	3.0	0.0	0.00
227.	88.	57.	64.2	650.	3.0	0.0	0.00
228.	84.	57.	59.8	613.	4.0	0.0	0.00
229.	86.	55.	56.1	629.	3.0	0.0	0.00
230.	89.	56.	57.5	637.	3.0	0.0	0.00
231.	90.	57.	59.2	625.	3.0	0.0	0.00
232.	88.	62.	61.5	520.	3.0	0.0	0.00
233.	90.	65.	62.0	584.	3.0	0.0	0.00
234.	92.	63.	60.9	597.	3.0	0.0	0.00
235.	92.	59.	59.6	616.	3.0	0.0	0.00
236.	95.	56.	58.4	616.	3.0	0.0	0.00
237.	94.	54.	55.4	621.	3.0	0.0	0.00
238.	93.	53.	53.7	638.	3.0	0.0	0.00
239.	96.	57.	53.3	609.	3.0	0.0	0.00
240.	99.	60.	54.1	610.	3.0	0.0	0.00
241.	101.	60.	58.1	609.	3.0	0.0	0.00
242.	101.	63.	61.9	611.	3.0	0.0	0.00
243.	100.	64.	63.4	567.	3.0	0.0	0.00
244.	99.	61.	62.2	379.	2.0	0.0	0.00
245.	101.	68.	64.9	543.	3.0	0.0	0.00
246.	97.	64.	62.1	564.	3.0	0.0	0.00
247.	97.	60.	60.0	589.	3.0	0.0	0.00
248.	99.	59.	57.8	572.	3.0	0.0	0.00
249.	94.	62.	60.8	488.	3.0	0.0	0.00
250.	92.	62.	60.1	554.	3.0	0.0	0.00
251.	88.	57.	57.5	569.	3.0	0.0	0.00
252.	86.	55.	54.9	554.	3.0	0.0	0.00
253.	86.	53.	54.1	554.	2.0	0.0	0.00
254.	90.	58.	36.6	480.	3.0	0.0	0.00
255.	96.	58.	57.3	544.	3.0	0.0	0.00
256.	97.	58.	60.5	532.	3.0	0.0	0.00
257.	99.	58.	61.1	525.	3.0	0.0	0.00

258.	96.	60.	63.1	511.	3.0	0.0	0.08
259.	82.	59.	60.5	444.	4.0	0.0	0.00
260.	83.	56.	55.0	489.	3.0	0.0	0.00
261.	87.	56.	56.8	512.	3.0	0.0	0.00
262.	89.	57.	58.8	500.	3.0	0.0	0.00
263.	88.	58.	57.8	490.	3.0	0.0	0.00
264.	87.	55.	56.3	503.	3.0	0.0	0.00
265.	87.	55.	56.8	484.	3.0	0.0	0.00
266.	84.	57.	57.5	486.	3.0	0.0	0.00
267.	86.	57.	57.0	492.	3.0	0.0	0.00
268.	84.	57.	57.3	476.	3.0	0.0	0.00
269.	82.	59.	61.0	472.	3.0	0.0	0.00
270.	79.	60.	55.3	468.	3.0	0.0	0.00
271.	70.	60.	53.7	145.	3.0	0.0	0.00
272.	78.	55.	52.5	444.	3.0	0.0	0.00
273.	90.	54.	51.8	494.	3.0	0.0	0.00
274.	90.	55.	52.7	501.	3.0	0.0	0.00
275.	99.	59.	52.1	498.	3.0	0.0	0.00
276.	89.	60.	40.0	486.	3.0	0.0	0.00
277.	87.	54.	54.2	457.	3.0	0.0	0.00
278.	90.	53.	49.4	458.	2.0	0.0	0.00
279.	81.	51.	52.1	410.	3.0	0.0	0.00
280.	79.	55.	53.4	429.	3.0	0.0	0.00
281.	78.	59.	55.3	436.	3.0	0.0	0.00
282.	81.	54.	54.0	386.	3.0	0.0	0.00
283.	87.	52.	53.7	419.	3.0	0.0	0.00
284.	77.	56.	54.8	313.	3.0	0.0	0.00
285.	79.	55.	53.6	332.	3.0	0.0	0.00
286.	84.	51.	53.5	337.	3.0	0.0	0.00
287.	85.	53.	55.2	399.	3.0	0.0	0.00
288.	77.	53.	52.4	345.	3.0	0.0	0.00
289.	75.	52.	51.7	378.	2.0	0.0	0.00
290.	80.	50.	52.0	400.	3.0	0.0	0.00
291.	76.	55.	54.9	232.	3.0	0.0	0.00
292.	80.	55.	54.5	319.	3.0	0.0	0.00
293.	82.	54.	53.5	386.	3.0	0.0	0.00
294.	70.	54.	52.0	185.	3.0	0.0	0.00
295.	76.	50.	49.2	358.	2.0	0.0	0.00
296.	82.	43.	39.9	417.	2.0	0.0	0.00
297.	80.	44.	40.6	400.	2.0	0.0	0.00
298.	80.	46.	44.7	399.	2.0	0.0	0.00
299.	81.	47.	46.9	367.	3.0	0.0	0.00
300.	86.	49.	50.5	349.	2.0	0.0	0.00
301.	75.	49.	49.4	188.	2.0	0.0	0.00
302.	75.	55.	54.0	226.	4.0	0.0	0.00
303.	74.	55.	52.8	268.	3.0	0.0	0.00
304.	64.	54.	51.6	56.	3.0	0.0	0.00
305.	66.	54.	50.5	152.	3.0	0.0	0.00
306.	71.	50.	48.7	317.	2.0	0.0	0.00
307.	75.	48.	48.7	315.	2.0	0.0	0.00
308.	76.	51.	49.5	300.	3.0	0.0	0.00
309.	82.	47.	44.4	355.	3.0	0.0	0.00
310.	70.	51.	49.1	256.	2.0	0.0	0.00
311.	78.	50.	48.2	324.	2.0	0.0	0.00
312.	77.	53.	41.9	327.	3.0	0.0	0.00
313.	72.	46.	46.8	299.	3.0	0.0	0.00
314.	73.	50.	49.3	263.	2.0	0.0	0.00
315.	83.	50.	49.7	328.	3.0	0.0	0.00
316.	75.	50.	41.1	321.	2.0	0.0	0.00
317.	82.	49.	49.1	302.	2.0	0.0	0.00
318.	71.	49.	49.4	197.	2.0	0.0	0.00
319.	69.	49.	49.2	176.	2.0	0.0	0.00
320.	69.	48.	51.2	93.	2.0	0.0	0.00
321.	77.	48.	51.1	274.	2.0	0.0	0.00
322.	82.	49.	52.3	292.	2.0	0.0	0.00
323.	79.	47.	50.6	294.	2.0	0.0	0.00
324.	80.	48.	51.1	284.	2.0	0.0	0.00
325.	71.	46.	49.2	197.	2.0	0.0	0.00
326.	76.	49.	50.2	276.	2.0	0.0	0.00
327.	86.	53.	51.1	298.	2.0	0.0	0.00
328.	88.	55.	54.3	264.	2.0	0.0	0.00
329.	82.	49.	50.8	248.	2.0	0.0	0.00
330.	67.	43.	47.5	207.	2.0	0.0	0.00
331.	75.	42.	41.9	288.	2.0	0.0	0.00
332.	74.	47.	24.8	275.	2.0	0.0	0.00
333.	84.	47.	46.0	296.	2.0	0.0	0.00
334.	81.	50.	51.6	280.	2.0	0.0	0.00
335.	76.	47.	49.0	261.	2.0	0.0	0.00
336.	68.	46.	48.4	192.	2.0	0.0	0.00

337.	68.	44.	48.5	201.	2.0	0.0	0.00
338.	72.	46.	49.8	229.	2.0	0.0	0.00
339.	78.	46.	49.9	218.	2.0	0.0	0.00
340.	75.	47.	50.6	191.	2.0	0.0	0.00
341.	65.	48.	50.6	106.	2.0	0.0	0.00
342.	73.	48.	50.3	221.	2.0	0.0	0.00
343.	77.	46.	48.2	257.	2.0	0.0	0.00
344.	76.	44.	46.8	258.	3.0	0.0	0.00
345.	68.	45.	46.8	163.	2.0	0.0	0.00
346.	61.	50.	49.3	65.	2.0	0.0	0.16
347.	64.	46.	50.8	105.	3.0	0.0	0.08
348.	68.	44.	45.6	283.	2.0	0.0	0.04
349.	70.	45.	45.7	242.	3.0	0.0	0.00
350.	64.	39.	40.2	215.	2.0	0.0	0.00
351.	66.	35.	35.6	282.	2.0	0.0	0.00
352.	65.	33.	35.5	272.	2.0	0.0	0.00
353.	63.	41.	41.3	240.	2.0	0.0	0.00
354.	58.	40.	37.8	219.	3.0	0.0	0.00
355.	64.	40.	40.6	273.	3.0	0.0	0.00
356.	59.	40.	32.7	253.	2.0	0.0	0.00
357.	52.	42.	39.1	122.	4.0	0.0	0.31
358.	60.	40.	34.6	169.	3.0	0.0	0.00
359.	65.	42.	33.8	179.	3.0	0.0	0.00
360.	71.	34.	33.9	296.	2.0	0.0	0.00
361.	72.	39.	37.8	274.	2.0	0.0	0.00
362.	64.	39.	39.2	252.	2.0	0.0	0.00
363.	66.	41.	40.7	165.	2.0	0.0	0.00
364.	68.	43.	45.4	224.	2.0	0.0	0.00
365.	65.	44.	48.6	227.	2.0	0.0	0.00

NFPET = 1:
PET is partitioned into PT and PE according to the relationship developed by Ritchie (1972)

DAY	PET	PTRANS	PEVAPO	DAY	PET	PTRANS	PEVAPO
1	0.1571	0.0371	0.1200	2	0.1588	0.0379	0.1209
3	0.0000	0.0000	0.0000	4	0.0000	0.0000	0.0000
5	0.2884	0.0706	0.2178	6	0.0981	0.0242	0.0739
7	0.0510	0.0127	0.0383	8	0.0196	0.0049	0.0146
9	0.0906	0.0229	0.0677	10	0.0000	0.0000	0.0000
11	0.0357	0.0092	0.0266	12	0.0388	0.0100	0.0287
13	0.0000	0.0000	0.0000	14	0.0430	0.0113	0.0317
15	0.1084	0.0287	0.0797	16	0.1170	0.0312	0.0858
17	0.1453	0.0390	0.1063	18	0.1732	0.0469	0.1263
19	0.1466	0.0400	0.1067	20	0.1417	0.0389	0.1028
21	0.0472	0.0131	0.0342	22	0.0563	0.0157	0.0406
23	0.0000	0.0000	0.0000	24	0.0965	0.0272	0.0693
25	0.0470	0.0134	0.0337	26	0.2319	0.0663	0.1657
27	0.0059	0.0017	0.0042	28	0.1811	0.0524	0.1287
29	0.2382	0.0694	0.1688	30	0.3118	0.0914	0.2204
31	0.3193	0.0941	0.2251	32	0.3197	0.0948	0.2249
33	0.3257	0.0972	0.2285	34	0.3529	0.1060	0.2470
35	0.3638	0.1099	0.2540	36	0.3348	0.1017	0.2331
37	0.2736	0.0836	0.1900	38	0.0861	0.0264	0.0596
39	0.0000	0.0000	0.0000	40	0.1482	0.0461	0.1022
41	0.2093	0.0654	0.1439	42	0.0306	0.0096	0.0210
43	0.2079	0.0657	0.1422	44	0.0000	0.0000	0.0000
45	0.0000	0.0000	0.0000	46	0.2216	0.0711	0.1505
47	0.2494	0.0805	0.1689	48	0.2839	0.0921	0.1918
49	0.4403	0.1436	0.2967	50	0.4315	0.1414	0.2901
51	0.4716	0.1554	0.3162	52	0.0260	0.0086	0.0174
53	0.0747	0.0249	0.0499	54	0.0875	0.0293	0.0582
55	0.2410	0.0810	0.1600	56	0.0352	0.0119	0.0233
57	0.1780	0.0604	0.1176	58	0.1374	0.0468	0.0906
59	0.0984	0.0337	0.0647	60	0.0548	0.0188	0.0359
61	0.0296	0.0102	0.0194	62	0.0235	0.0082	0.0153
63	0.1854	0.0647	0.1207	64	0.0179	0.0063	0.0116
65	0.3893	0.1371	0.2522	66	0.3557	0.1258	0.2299
67	0.3760	0.1336	0.2424	68	0.3377	0.1205	0.2172
69	0.0876	0.0314	0.0562	70	0.1392	0.0501	0.0891
71	0.3143	0.1136	0.2007	72	0.3783	0.1373	0.2410
73	0.4184	0.1525	0.2659	74	0.4085	0.1496	0.2590
75	0.4190	0.1540	0.2650	76	0.3071	0.1134	0.1938
77	0.3536	0.1311	0.2225	78	0.1175	0.0437	0.0738
79	0.0185	0.0069	0.0116	80	0.1222	0.0458	0.0763
81	0.3861	0.1454	0.2407	82	0.1128	0.0427	0.0702
83	0.4134	0.1570	0.2565	84	0.4012	0.1529	0.2483
85	0.4403	0.1685	0.2718	86	0.4547	0.1747	0.2801

87	0.4355	0.1679	0.2676	88	0.4276	0.1655	0.2621
89	0.4529	0.1760	0.2769	90	0.4979	0.1942	0.3037
91	0.4098	0.1598	0.2500	92	0.4164	0.1624	0.2540
93	0.5064	0.1975	0.3089	94	0.4825	0.1882	0.2944
95	0.4207	0.1640	0.2566	96	0.2075	0.0809	0.1266
97	0.0794	0.0310	0.0484	98	0.2935	0.1145	0.1791
99	0.4161	0.1623	0.2538	100	0.5078	0.1980	0.3098
101	0.5243	0.2045	0.3198	102	0.4791	0.1868	0.2923
103	0.4413	0.1721	0.2692	104	0.3409	0.1329	0.2079
105	0.3354	0.1308	0.2046	106	0.0000	0.0000	0.0000
107	0.1387	0.0541	0.0846	108	0.0627	0.0244	0.0382
109	0.3040	0.1186	0.1855	110	0.0820	0.0320	0.0500
111	0.4491	0.1751	0.2739	112	0.5455	0.2127	0.3327
113	0.6241	0.2434	0.3807	114	0.6210	0.2422	0.3788
115	0.5080	0.1981	0.3099	116	0.4350	0.1696	0.2653
117	0.1974	0.0770	0.1204	118	0.0625	0.0244	0.0381
119	0.3801	0.1482	0.2319	120	0.1523	0.0594	0.0929
121	0.3798	0.1481	0.2317	122	0.2848	0.1111	0.1737
123	0.3805	0.1484	0.2321	124	0.2400	0.0936	0.1464
125	0.2741	0.1069	0.1672	126	0.2125	0.0829	0.1296
127	0.0912	0.0356	0.0556	128	0.2503	0.0976	0.1527
129	0.4786	0.1866	0.2919	130	0.4594	0.1792	0.2803
131	0.2284	0.0891	0.1393	132	0.1637	0.0638	0.0999
133	0.2614	0.1019	0.1595	134	0.3275	0.1277	0.1998
135	0.2853	0.1112	0.1740	136	0.2034	0.0793	0.1241
137	0.3827	0.1493	0.2335	138	0.3587	0.1399	0.2188
139	0.5163	0.2013	0.3150	140	0.4136	0.1613	0.2523
141	0.2640	0.1030	0.1611	142	0.0751	0.0293	0.0458
143	0.0318	0.0124	0.0194	144	0.0662	0.0258	0.0404
145	0.1443	0.0563	0.0880	146	0.5083	0.1982	0.3101
147	0.3864	0.1507	0.2357	148	0.5156	0.2011	0.3146
149	0.6420	0.2504	0.3916	150	0.6262	0.2442	0.3820
151	0.5760	0.2246	0.3514	152	0.0266	0.0102	0.0164
153	0.0483	0.0183	0.0300	154	0.2767	0.1032	0.1736
155	0.5506	0.2021	0.3486	156	0.2417	0.0872	0.1544
157	0.5791	0.2056	0.3735	158	0.3606	0.1258	0.2348
159	0.4417	0.1514	0.2903	160	0.5799	0.1951	0.3848
161	0.6422	0.2120	0.4302	162	0.7126	0.2307	0.4820
163	0.6902	0.2189	0.4713	164	0.6122	0.1901	0.4221
165	0.5228	0.1588	0.3640	166	0.0896	0.0266	0.0630
167	0.0449	0.0130	0.0319	168	0.4987	0.1410	0.3577
169	0.6142	0.1692	0.4450	170	0.6175	0.1655	0.4519
171	0.5714	0.1489	0.4225	172	0.5458	0.1380	0.4078
173	0.6303	0.1544	0.4759	174	0.6304	0.1494	0.4810
175	0.6259	0.1431	0.4827	176	0.5754	0.1267	0.4486
177	0.3939	0.0833	0.3106	178	0.5891	0.1194	0.4697
179	0.5542	0.1072	0.4470	180	0.5958	0.1096	0.4862
181	0.6273	0.1093	0.5180	182	0.6081	0.0997	0.5083
183	0.6229	0.0956	0.5273	184	0.5526	0.0787	0.4738
185	0.3464	0.0454	0.3010	186	0.6185	0.0735	0.5450
187	0.5737	0.0608	0.5128	188	0.5953	0.0550	0.5403
189	0.5797	0.0451	0.5346	190	0.6501	0.0402	0.6099
191	0.5892	0.0261	0.5632	192	0.6631	0.0161	0.6470
193	0.6575	0.0000	0.6575	194	0.6201	0.0000	0.6201
195	0.6145	0.0000	0.6145	196	0.6078	0.0000	0.6078
197	0.2893	0.0000	0.2893	198	0.6463	0.0000	0.6463
199	0.6502	0.0000	0.6502	200	0.6442	0.0000	0.6442
201	0.6510	0.0000	0.6510	202	0.6216	0.0000	0.6216
203	0.5948	0.0000	0.5948	204	0.6206	0.0000	0.6206
205	0.6080	0.0000	0.6080	206	0.6109	0.0000	0.6109
207	0.6313	0.0000	0.6313	208	0.7070	0.0000	0.7070
209	0.6780	0.0000	0.6780	210	0.7001	0.0000	0.7001
211	0.6356	0.0000	0.6356	212	0.5789	0.0000	0.5789
213	0.6000	0.0000	0.6000	214	0.5967	0.0000	0.5967
215	0.6045	0.0000	0.6045	216	0.5996	0.0000	0.5996
217	0.6117	0.0000	0.6117	218	0.6059	0.0000	0.6059
219	0.5730	0.0000	0.5730	220	0.6071	0.0000	0.6071
221	0.5722	0.0000	0.5722	222	0.5654	0.0000	0.5654
223	0.6095	0.0000	0.6095	224	0.6126	0.0000	0.6126
225	0.6290	0.0000	0.6290	226	0.5942	0.0000	0.5942
227	0.5842	0.0000	0.5842	228	0.5695	0.0000	0.5695
229	0.5871	0.0000	0.5871	230	0.6127	0.0000	0.6127
231	0.6046	0.0000	0.6046	232	0.5072	0.0000	0.5072
233	0.5992	0.0000	0.5992	234	0.6178	0.0000	0.6178
235	0.6188	0.0000	0.6188	236	0.6247	0.0000	0.6247
237	0.6258	0.0000	0.6258	238	0.6382	0.0000	0.6382
239	0.6506	0.0000	0.6506	240	0.6806	0.0000	0.6806
241	0.6767	0.0000	0.6767	242	0.6810	0.0000	0.6810
243	0.6289	0.0000	0.6289	244	0.3859	0.0000	0.3859

245	0.6260	0.0000	0.6260	246	0.6141	0.0000	0.6141
247	0.6258	0.0000	0.6258	248	0.6234	0.0000	0.6234
249	0.5140	0.0000	0.5140	250	0.5724	0.0000	0.5724
251	0.5467	0.0000	0.5467	252	0.5221	0.0000	0.5221
253	0.4884	0.0000	0.4884	254	0.5427	0.0000	0.5427
255	0.5751	0.0000	0.5751	256	0.5542	0.0000	0.5542
257	0.5557	0.0000	0.5557	258	0.5257	0.0000	0.5257
259	0.4029	0.0000	0.4029	260	0.4482	0.0000	0.4482
261	0.4835	0.0000	0.4835	262	0.4786	0.0000	0.4786
263	0.4743	0.0000	0.4743	264	0.4718	0.0000	0.4718
265	0.4509	0.0000	0.4509	266	0.4430	0.0000	0.4430
267	0.4632	0.0000	0.4632	268	0.4346	0.0000	0.4346
269	0.4078	0.0000	0.4078	270	0.4268	0.0000	0.4268
271	0.0921	0.0000	0.0921	272	0.3864	0.0000	0.3864
273	0.4957	0.0000	0.4957	274	0.5039	0.0000	0.5039
275	0.5674	0.0000	0.5674	276	0.5463	0.0000	0.5463
277	0.4332	0.0000	0.4332	278	0.4311	0.0000	0.4311
279	0.3520	0.0000	0.3520	280	0.3730	0.0000	0.3730
281	0.3854	0.0000	0.3854	282	0.3353	0.0000	0.3353
283	0.3890	0.0000	0.3890	284	0.2528	0.0000	0.2528
285	0.2824	0.0000	0.2824	286	0.2927	0.0000	0.2927
287	0.3568	0.0000	0.3568	288	0.2808	0.0000	0.2808
289	0.2791	0.0000	0.2791	290	0.3328	0.0000	0.3328
291	0.1681	0.0000	0.1681	292	0.2703	0.0000	0.2703
293	0.3433	0.0000	0.3433	294	0.1117	0.0010	0.1107
295	0.2681	0.0040	0.2640	296	0.3487	0.0073	0.3414
297	0.3279	0.0087	0.3193	298	0.3217	0.0102	0.3114
299	0.3199	0.0118	0.3081	300	0.2920	0.0122	0.2797
301	0.1097	0.0051	0.1046	302	0.1824	0.0094	0.1730
303	0.2039	0.0114	0.1925	304	0.0000	0.0000	0.0000
305	0.0750	0.0049	0.0702	306	0.2135	0.0147	0.1988
307	0.2200	0.0160	0.2039	308	0.2420	0.0186	0.2234
309	0.3251	0.0263	0.2988	310	0.1591	0.0135	0.1456
311	0.2500	0.0221	0.2279	312	0.3140	0.0289	0.2850
313	0.2138	0.0205	0.1933	314	0.1720	0.0171	0.1549
315	0.2945	0.0303	0.2642	316	0.2607	0.0277	0.2330
317	0.2383	0.0261	0.2122	318	0.1033	0.0117	0.0916
319	0.0792	0.0092	0.0700	320	0.0000	0.0000	0.0000
321	0.1812	0.0222	0.1590	322	0.2162	0.0272	0.1890
323	0.2053	0.0265	0.1788	324	0.2022	0.0267	0.1755
325	0.0933	0.0126	0.0807	326	0.1872	0.0258	0.1613
327	0.2576	0.0363	0.2213	328	0.2290	0.0329	0.1961
329	0.1826	0.0268	0.1558	330	0.0844	0.0126	0.0718
331	0.2017	0.0307	0.1710	332	0.2436	0.0378	0.2058
333	0.2438	0.0385	0.2053	334	0.2083	0.0335	0.1749
335	0.1716	0.0280	0.1436	336	0.0822	0.0136	0.0686
337	0.0816	0.0138	0.0679	338	0.1210	0.0207	0.1003
339	0.1337	0.0232	0.1105	340	0.0996	0.0176	0.0820
341	0.0000	0.0000	0.0000	342	0.1232	0.0224	0.1009
343	0.1717	0.0316	0.1401	344	0.1881	0.0351	0.1530
345	0.0629	0.0119	0.0510	346	0.0000	0.0000	0.0000
347	0.0000	0.0000	0.0000	348	0.1633	0.0320	0.1313
349	0.1587	0.0315	0.1272	350	0.1021	0.0205	0.0816
351	0.1656	0.0336	0.1319	352	0.1484	0.0305	0.1179
353	0.1197	0.0249	0.0948	354	0.1150	0.0242	0.0908
355	0.1649	0.0350	0.1299	356	0.1479	0.0318	0.1162
357	0.0329	0.0071	0.0258	358	0.1013	0.0222	0.0791
359	0.1356	0.0300	0.1056	360	0.1956	0.0437	0.1519
361	0.1845	0.0416	0.1428	362	0.1349	0.0307	0.1041
363	0.0735	0.0169	0.0566	364	0.1125	0.0261	0.0864
365	0.0905	0.0212	0.0693				

Totals: PET = 130.3472
PTRANS = 20.1025
PEVAPO = 104.1221

IRAIN = 1

Rainfall/Irrigation Details

Day	Time (hr)	Amount (cm)	Application Type	Efficiency	Changes In Rate/Head
3	0.000	0.8890	1	1.000	2
	1.000	0.0000			
4	0.000	7.0000	1	1.000	3
	7.000	0.6962			
	8.000	0.0000			
5	0.000	0.1016	1	1.000	2

	1.000	0.0000			
7	0.000	1.0000	1	1.000	3
	1.000	0.7018			
	2.000	0.0000			
8	0.000	2.0000	1	1.000	3
	2.000	0.6924			
	3.000	0.0000			
9	0.000	0.1016	1	1.000	2
	1.000	0.0000			
10	0.000	7.0000	1	1.000	3
	7.000	0.4168			
	8.000	0.0000			
11	0.000	0.6096	1	1.000	2
	1.000	0.0000			
12	0.000	1.0000	1	1.000	3
	1.000	0.1938			
	2.000	0.0000			
14	0.000	0.4064	1	1.000	2
	1.000	0.0000			
15	0.000	0.1016	1	1.000	2
	1.000	0.0000			
16	0.000	0.1016	1	1.000	2
	1.000	0.0000			
19	0.000	0.0254	1	1.000	2
	1.000	0.0000			
20	0.000	0.2794	1	1.000	2
	1.000	0.0000			
21	0.000	0.0508	1	1.000	2
	1.000	0.0000			
22	0.000	0.1016	1	1.000	2
	1.000	0.0000			
23	0.000	1.0000	1	1.000	3
	1.000	0.6002			
	2.000	0.0000			
24	0.000	2.0000	1	1.000	3
	2.000	0.3114			
	3.000	0.0000			
25	0.000	2.0000	1	1.000	3
	2.000	0.0066			
	3.000	0.0000			
44	0.000	1.0000	1	1.000	3
	1.000	0.3970			
	2.000	0.0000			
45	0.000	1.0000	1	1.000	3
	1.000	0.7018			
	2.000	0.0000			
55	0.000	0.2032	1	1.000	2
	1.000	0.0000			
61	0.000	0.5080	1	1.000	2
	1.000	0.0000			
62	0.000	0.8128	1	1.000	2
	1.000	0.0000			
63	0.000	0.6096	1	1.000	2
	1.000	0.0000			
64	0.000	5.0000	1	1.000	3
	5.000	0.6134			
	6.000	0.0000			
69	0.000	1.0000	1	1.000	3
	1.000	0.8034			
	2.000	0.0000			
70	0.000	5.0000	1	1.000	3
	5.000	0.5118			
	6.000	0.0000			
79	0.000	0.0508	1	1.000	2
	1.000	0.0000			
80	0.000	0.9906	1	1.000	2
	1.000	0.0000			
82	0.000	2.0000	1	1.000	3
	2.000	0.2098			
	3.000	0.0000			
106	0.000	1.0000	1	1.000	3
	1.000	0.3970			
	2.000	0.0000			
107	0.000	0.1016	1	1.000	2
	1.000	0.0000			
108	0.000	1.0000	1	1.000	3
	1.000	0.0922			
	2.000	0.0000			
132	0.000	0.0254	1	1.000	2

```
        1.000    0.0000
144     0.000    0.2032        1          1.000          2
        1.000    0.0000
166     0.000    0.2032        1          1.000          2
        1.000    0.0000
167     0.000    2.0000        1          1.000          3
        2.000    0.9972
        3.000    0.0000
258     0.000    0.2032        1          1.000          2
        1.000    0.0000
346     0.000    0.4064        1          1.000          2
        1.000    0.0000
347     0.000    0.2032        1          1.000          2
        1.000    0.0000
348     0.000    0.1016        1          1.000          2
        1.000    0.0000
357     0.000    0.7874        1          1.000          2
        1.000    0.0000
```

NWATER (number of days of rain/irrigation) = 43

Total Water Applied = 58.5216 cm

```
-------------------------------------------------------------------------------

                              Program DATAINH
                                Version2.03

-------------------------------------------------------------------------------

Input Filename: C:\Shared\WinUnsatH\UnsatH_02\monocover\case 5\project.inp
Date Processed: 10-DEC-**
Time Processed:  9:46:57

-------------------------------------------------------------------------------
Title:
Monocover case 5 1995
-------------------------------------------------------------------------------

Options chosen include:

IPLANT =   1        LOWER  =   1        NGRAV  =   1        ISWDIF =   1
IHEAT  =   0        UPPERH =   0        LOWERH =   1
NPRINT =   0        DAYEND = 365        NDAYS  = 365        NYEARS =   1
IRAIN  =   1        ICONVH =   0
NSURPE =   1        NFHOUR =   2        ITOPBC =   0        ET_OPT =   1
ICLOUD =   0
KOPT   =   4        KEST   =   3        IVAPOR =   1        SH_OPT =   0
INMAX  =   2        INHMAX =   1
HIRRI  =   0.00     HDRY   =  1.000E+07 HTOP   =   0.00     DHMAX  =   0.00
DMAXBA =  1.000E-04 DELMAX =   1.00     DELMIN =  1.000E-07 STOPHR =   24.0
OUTTIM =   1.00
TORT   =  0.660     TSOIL  =   291.     VAPDIF =  0.240     QHTOP  =   0.00

IVAPOR = 1:  This option allows vapor flow
Saturated vapor density (g/cm3)
 of soil when soil temperature is
 a constant equal to TSOIL        =  1.521E-05
100*MOLAR*GRAV/GASCON (K/cm)      =  2.123E-04
VC (cm5/g/h)                      =  5.702E+02
TGRAD  =   0.00     TSMEAN =   0.00     TSAMP  =   0.00     QHLEAK =   0.00
WTF    =  0.500     RFACT  =   1.25     RAINIF =  1.000E-07 DHFACT =   0.00
MATN   =   2        NPT    =  64

-------------------------------------------------------------------------------
KOPT = 4:  van Genuchten functions for soil hydraulic properties

THETA vs H, MAT 1,
     AIRINT =   0.0000                          THET =  0.39400
       THTR =   0.0000                         ALPHA =  2.30000E-02
          N =   1.2500                             M =  0.20000
    K vs H, MAT 1,
     AIRINK =   0.0000                            SK =  0.24000
          A =  2.30000E-02                         N =   1.2500
          M =  0.20000                        KMODEL =   2.0000
       EPIT =  0.50000

THETA vs H, MAT 2,
     AIRINT =   0.0000                          THET =  0.39400
       THTR =   0.0000                         ALPHA =  2.30000E-02
          N =   1.2500                             M =  0.20000
    K vs H, MAT 2,
     AIRINK =   0.0000                            SK =  0.24000
          A =  2.30000E-02                         N =   1.2500
          M =  0.20000                        KMODEL =   2.0000
       EPIT =  0.50000

Surface node hydraulic properties

HIRRI =      0.0     , THETA = 0.3940, K =   2.4000E-01, C =  -1.8045E-08
HDRY  =     1.00E+07, THETA = 0.0180, K =   8.0860E-17, C =  -4.4978E-10
NDAY =   0
```

NODE	Z	MAT	HEAD	CONDUCTIVITY	CAPACITY	THETA	TEMP
1	0.00	1	1.3621E+06	1.5150E-14	-5.4354E-09	0.0296	291.0
2	0.10	1	1.2288E+06	1.9855E-14	-6.1825E-09	0.0304	291.0
3	0.20	1	1.1091E+06	2.5981E-14	-7.0271E-09	0.0312	291.0
4	0.30	1	9.9628E+05	3.4434E-14	-8.0357E-09	0.0320	291.0
5	0.40	1	8.9190E+05	4.6043E-14	-9.2281E-09	0.0329	291.0
6	0.50	1	7.9401E+05	6.2473E-14	-1.0671E-08	0.0339	291.0
7	0.60	1	7.0148E+05	8.6484E-14	-1.2459E-08	0.0350	291.0
8	0.80	1	5.3105E+05	1.7958E-13	-1.7643E-08	0.0375	291.0
9	1.00	1	3.7784E+05	4.3884E-13	-2.7000E-08	0.0408	291.0
10	1.20	1	2.3972E+05	1.4488E-12	-4.7683E-08	0.0457	291.0
11	1.60	1	5.9882E+03	2.3235E-08	-4.7894E-06	0.1150	291.0
12	2.00	1	3.1468E+03	1.2537E-07	-1.0671E-05	0.1350	291.0
13	3.00	1	2.4855E+03	2.3237E-07	-1.4303E-05	0.1431	291.0
14	4.00	1	2.8566E+03	1.6147E-07	-1.2034E-05	0.1382	291.0
15	5.00	1	3.1715E+04	2.9294E-10	-5.9744E-07	0.0758	291.0
16	10.00	1	1.8817E+05	2.7356E-12	-6.4538E-08	0.0486	291.0

17	15.00	1	1.4900E+05	5.0474E-12	-8.6395E-08	0.0515	291.0
18	20.00	1	4.8980E+04	9.3616E-11	-3.4706E-07	0.0680	291.0
19	25.00	1	3.4808E+03	9.6269E-08	-9.4133E-06	0.1316	291.0
20	26.00	1	2.9533E+03	1.4801E-07	-1.1547E-05	0.1371	291.0
21	27.00	1	2.5643E+03	2.1416E-07	-1.3760E-05	0.1420	291.0
22	28.00	1	2.2670E+03	2.9556E-07	-1.6031E-05	0.1464	291.0
23	28.40	1	2.1672E+03	3.3247E-07	-1.6952E-05	0.1481	291.0
24	28.80	1	2.0761E+03	3.7196E-07	-1.7878E-05	0.1496	291.0
25	29.00	1	2.0334E+03	3.9267E-07	-1.8343E-05	0.1504	291.0
26	29.20	1	1.9926E+03	4.1404E-07	-1.8810E-05	0.1512	291.0
27	29.40	1	1.9534E+03	4.3607E-07	-1.9277E-05	0.1519	291.0
28	29.50	1	1.9344E+03	4.4733E-07	-1.9512E-05	0.1523	291.0
29	29.60	1	1.9158E+03	4.5876E-07	-1.9746E-05	0.1527	291.0
30	29.70	1	1.8976E+03	4.7035E-07	-1.9981E-05	0.1530	291.0
31	29.80	1	1.8798E+03	4.8211E-07	-2.0216E-05	0.1534	291.0
32	29.90	1	1.8623E+03	4.9403E-07	-2.0451E-05	0.1537	291.0
33	30.00	1	1.8451E+03	5.0613E-07	-2.0687E-05	0.1541	291.0
34	30.10	2	1.8282E+03	5.1839E-07	-2.0923E-05	0.1544	291.0
35	30.20	2	1.8117E+03	5.3081E-07	-2.1159E-05	0.1548	291.0
36	30.30	2	1.7955E+03	5.4340E-07	-2.1395E-05	0.1551	291.0
37	30.40	2	1.7796E+03	5.5617E-07	-2.1632E-05	0.1555	291.0
38	30.50	2	1.7640E+03	5.6910E-07	-2.1868E-05	0.1558	291.0
39	30.60	2	1.7487E+03	5.8220E-07	-2.2105E-05	0.1561	291.0
40	30.80	2	1.7189E+03	6.0891E-07	-2.2580E-05	0.1568	291.0
41	31.00	2	1.6901E+03	6.3630E-07	-2.3055E-05	0.1575	291.0
42	31.20	2	1.6624E+03	6.6436E-07	-2.3531E-05	0.1581	291.0
43	31.60	2	1.6097E+03	7.2254E-07	-2.4484E-05	0.1594	291.0
44	32.00	2	1.5605E+03	7.8347E-07	-2.5441E-05	0.1606	291.0
45	33.00	2	1.4504E+03	9.4795E-07	-2.7840E-05	0.1635	291.0
46	34.00	2	1.3559E+03	1.1298E-06	-3.0247E-05	0.1663	291.0
47	35.00	2	1.2739E+03	1.3290E-06	-3.2658E-05	0.1689	291.0
48	40.00	2	9.8334E+02	2.6034E-06	-4.4840E-05	0.1799	291.0
49	45.00	2	8.0826E+02	4.3246E-06	-5.6916E-05	0.1888	291.0
50	50.00	2	6.9572E+02	6.3670E-06	-6.8222E-05	0.1958	291.0
51	55.00	2	6.2011E+02	8.5596E-06	-7.8334E-05	0.2013	291.0
52	60.00	2	5.6550E+02	1.0843E-05	-8.7454E-05	0.2058	291.0
53	65.00	2	5.2420E+02	1.3164E-05	-9.5705E-05	0.2096	291.0
54	70.00	2	4.9199E+02	1.5477E-05	-1.0316E-04	0.2128	291.0
55	75.00	2	4.6635E+02	1.7738E-05	-1.0988E-04	0.2155	291.0
56	80.00	2	4.4569E+02	1.9905E-05	-1.1589E-04	0.2179	291.0
57	85.00	2	4.2895E+02	2.1936E-05	-1.2120E-04	0.2199	291.0
58	90.00	2	4.1540E+02	2.3796E-05	-1.2583E-04	0.2215	291.0
59	95.00	2	4.0453E+02	2.5447E-05	-1.2977E-04	0.2229	291.0
60	100.00	2	3.9600E+02	2.6857E-05	-1.3303E-04	0.2240	291.0
61	105.00	2	3.8955E+02	2.7995E-05	-1.3559E-04	0.2249	291.0
62	110.00	2	3.8502E+02	2.8834E-05	-1.3744E-04	0.2255	291.0
63	115.00	2	3.8232E+02	2.9351E-05	-1.3856E-04	0.2259	291.0
64	120.00	2	3.8142E+02	2.9526E-05	-1.3894E-04	0.2260	291.0

Total Initial Storage = 21.3468 cm

IPLANT = 1

LEAF= 1, NFROOT= 1, NUPTAK= 1, NFPET= 1, NSOW=285, NHRVST=195

Total number of Growth Day - Leaf Area Index (LAI) data pairs = 6

Growth Day	LAI
0	0.940
90	2.000
151	2.000
195	0.000
285	0.000
365	0.940

BARE = 0.500

DAY	LAI	DAY	LAI	DAY	LAI	DAY	LAI	DAY	LAI	DAY	LAI
1	0.952	2	0.964	3	0.975	4	0.987	5	0.999	6	1.011
7	1.022	8	1.034	9	1.046	10	1.058	11	1.070	12	1.081
13	1.093	14	1.105	15	1.117	16	1.128	17	1.140	18	1.152
19	1.164	20	1.176	21	1.187	22	1.199	23	1.211	24	1.223
25	1.234	26	1.246	27	1.258	28	1.270	29	1.282	30	1.293
31	1.305	32	1.317	33	1.329	34	1.340	35	1.352	36	1.364
37	1.376	38	1.388	39	1.399	40	1.411	41	1.423	42	1.435
43	1.446	44	1.458	45	1.470	46	1.482	47	1.494	48	1.505
49	1.517	50	1.529	51	1.541	52	1.552	53	1.564	54	1.576
55	1.588	56	1.600	57	1.611	58	1.623	59	1.635	60	1.647
61	1.658	62	1.670	63	1.682	64	1.694	65	1.706	66	1.717
67	1.729	68	1.741	69	1.753	70	1.764	71	1.776	72	1.788
73	1.800	74	1.812	75	1.823	76	1.835	77	1.847	78	1.859
79	1.870	80	1.882	81	1.894	82	1.906	83	1.918	84	1.929
85	1.941	86	1.953	87	1.965	88	1.976	89	1.988	90	2.000
91	2.000	92	2.000	93	2.000	94	2.000	95	2.000	96	2.000

97	2.000	98	2.000	99	2.000	100	2.000	101	2.000	102	2.000
103	2.000	104	2.000	105	2.000	106	2.000	107	2.000	108	2.000
109	2.000	110	2.000	111	2.000	112	2.000	113	2.000	114	2.000
115	2.000	116	2.000	117	2.000	118	2.000	119	2.000	120	2.000
121	2.000	122	2.000	123	2.000	124	2.000	125	2.000	126	2.000
127	2.000	128	2.000	129	2.000	130	2.000	131	2.000	132	2.000
133	2.000	134	2.000	135	2.000	136	2.000	137	2.000	138	2.000
139	2.000	140	2.000	141	2.000	142	2.000	143	2.000	144	2.000
145	2.000	146	2.000	147	2.000	148	2.000	149	2.000	150	2.000
151	2.000	152	1.955	153	1.909	154	1.864	155	1.818	156	1.773
157	1.727	158	1.682	159	1.636	160	1.591	161	1.545	162	1.500
163	1.455	164	1.409	165	1.364	166	1.318	167	1.273	168	1.227
169	1.182	170	1.136	171	1.091	172	1.045	173	1.000	174	0.955
175	0.909	176	0.864	177	0.818	178	0.773	179	0.727	180	0.682
181	0.636	182	0.591	183	0.545	184	0.500	185	0.455	186	0.409
187	0.364	188	0.318	189	0.273	190	0.227	191	0.182	192	0.136
193	0.091	194	0.045	195	0.000	196	0.000	197	0.000	198	0.000
199	0.000	200	0.000	201	0.000	202	0.000	203	0.000	204	0.000
205	0.000	206	0.000	207	0.000	208	0.000	209	0.000	210	0.000
211	0.000	212	0.000	213	0.000	214	0.000	215	0.000	216	0.000
217	0.000	218	0.000	219	0.000	220	0.000	221	0.000	222	0.000
223	0.000	224	0.000	225	0.000	226	0.000	227	0.000	228	0.000
229	0.000	230	0.000	231	0.000	232	0.000	233	0.000	234	0.000
235	0.000	236	0.000	237	0.000	238	0.000	239	0.000	240	0.000
241	0.000	242	0.000	243	0.000	244	0.000	245	0.000	246	0.000
247	0.000	248	0.000	249	0.000	250	0.000	251	0.000	252	0.000
253	0.000	254	0.000	255	0.000	256	0.000	257	0.000	258	0.000
259	0.000	260	0.000	261	0.000	262	0.000	263	0.000	264	0.000
265	0.000	266	0.000	267	0.000	268	0.000	269	0.000	270	0.000
271	0.000	272	0.000	273	0.000	274	0.000	275	0.000	276	0.000
277	0.000	278	0.000	279	0.000	280	0.000	281	0.000	282	0.000
283	0.000	284	0.000	285	0.000	286	0.012	287	0.023	288	0.035
289	0.047	290	0.059	291	0.071	292	0.082	293	0.094	294	0.106
295	0.117	296	0.129	297	0.141	298	0.153	299	0.164	300	0.176
301	0.188	302	0.200	303	0.212	304	0.223	305	0.235	306	0.247
307	0.259	308	0.270	309	0.282	310	0.294	311	0.306	312	0.317
313	0.329	314	0.341	315	0.352	316	0.364	317	0.376	318	0.388
319	0.400	320	0.411	321	0.423	322	0.435	323	0.447	324	0.458
325	0.470	326	0.482	327	0.493	328	0.505	329	0.517	330	0.529
331	0.540	332	0.552	333	0.564	334	0.576	335	0.587	336	0.599
337	0.611	338	0.623	339	0.635	340	0.646	341	0.658	342	0.670
343	0.682	344	0.693	345	0.705	346	0.717	347	0.729	348	0.740
349	0.752	350	0.764	351	0.775	352	0.787	353	0.799	354	0.811
355	0.822	356	0.834	357	0.846	358	0.858	359	0.869	360	0.881
361	0.893	362	0.905	363	0.916	364	0.928	365	0.940		

NFROOT = 1: Negative exponential representation of root growth

AA (intersection of the curve at z=0 with abscissa) = 1.160
B1 (coefficient defining degree of curvature) = 0.13000
B2 (coefficient that determines the value of asymptote = 0.020

Root depth, density, and weight/node versus depth

DAY	MAX ROOT DEPTH	ROOT DENSITY (cm/cm)	NORMALIZED DENSITY (1/cm)
1	0.00	0.000	0.0000
1	0.10	1.165	0.1184
1	0.20	1.150	0.1169
1	0.30	1.136	0.1154
1	0.40	1.121	0.1140
1	0.50	1.107	0.1125
1	0.60	1.093	0.1111
1	0.80	1.065	0.1083
1	1.00	1.039	0.1056
1	1.20	1.012	0.1029
1	1.60	0.962	0.0978
1	2.00	0.914	0.0930
1	3.00	0.805	0.0819
1	4.00	0.710	0.0721
1	5.00	0.626	0.0636
1	10.00	0.336	0.0342
1	15.00	0.185	0.0188
1	20.00	0.106	0.0108
1	25.00	0.065	0.0066
1	26.00	0.059	0.0060
1	27.00	0.055	0.0056
1	28.00	0.050	0.0051
1	28.40	0.049	0.0050
1	28.80	0.047	0.0048
1	29.00	0.047	0.0048
1	29.20	0.046	0.0047
1	29.40	0.045	0.0046
1	29.50	0.045	0.0046
1	29.60	0.045	0.0045
1	29.70	0.044	0.0045

1	29.80	0.044	0.0045
1	29.90	0.044	0.0045
1	30.00	0.043	0.0044
1	30.10	0.043	0.0044
1	30.20	0.043	0.0044
1	30.30	0.043	0.0043
1	30.40	0.042	0.0043
1	30.50	0.042	0.0043
1	30.60	0.042	0.0042
1	30.80	0.041	0.0042
1	31.00	0.041	0.0041
1	31.20	0.040	0.0041
1	31.60	0.039	0.0040
1	32.00	0.038	0.0039
1	33.00	0.036	0.0036
1	34.00	0.034	0.0035
1	35.00	0.032	0.0033
1	40.00	0.026	0.0027
1	45.00	0.023	0.0024

MXROOT (deepest node to which roots penetrate) = 49
NUPTAK = 1: Feddes et al. 1975 moisture dependent sink term

For Material No. 1

THETAW (wilting point moisture content) = 0.0907
THETAD (lower limit of optimum moisture content) = 0.1324
THETAN (upper limit of optimum moisture content) = 0.3825

For Material No. 2

THETAW (wilting point moisture content) = 0.0907
THETAD (lower limit of optimum moisture content) = 0.1324
THETAN (upper limit of optimum moisture content) = 0.3825

NFHOUR = 2: User subroutine for hourly PET distribution

0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0150	0.0440
0.0699	0.0911	0.1061	0.1139	0.1139	0.1061	0.0911	0.0699
0.0440	0.0150	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

ET_OPT = 1 and IHEAT = 0:
PET calculated from meteorological data
using subroutine CALPEN

ALBEDO = 2.000E-01
ALT = 1.650E+02 (m)
ZU = 8.000E+00 (m)
PMB = 1.010E+03 (mb)

ET_OPT = 1: Meteorological Data

IDAY	Temperature Max F	Min F	Dew F	Solar Rad ly/d	Wind Speed mph	Cloud Cover tenth	Prec. in
1.	65.	41.	31.1	232.	2.0	0.0	0.00
2.	63.	35.	29.6	258.	2.0	0.0	0.00
3.	56.	47.	45.6	97.	3.0	0.0	0.35
4.	55.	47.	49.8	40.	4.0	0.0	3.03
5.	61.	40.	29.8	285.	6.0	0.0	0.04
6.	61.	39.	43.9	248.	2.0	0.0	0.00
7.	53.	48.	27.8	62.	3.0	0.0	0.67
8.	58.	53.	34.4	57.	2.0	0.0	1.06
9.	65.	54.	41.6	148.	2.0	0.0	0.04
10.	56.	53.	39.2	40.	2.0	0.0	2.92
11.	59.	52.	39.3	69.	3.0	0.0	0.24
12.	59.	50.	38.2	102.	2.0	0.0	0.47
13.	58.	53.	38.7	41.	2.0	0.0	0.00
14.	60.	53.	38.1	95.	2.0	0.0	0.16
15.	59.	38.	44.7	260.	5.0	0.0	0.04
16.	57.	36.	41.0	278.	3.0	0.0	0.04
17.	61.	35.	38.8	297.	2.0	0.0	0.00
18.	64.	40.	30.5	292.	1.0	0.0	0.00
19.	60.	39.	31.4	215.	3.0	0.0	0.01
20.	58.	40.	37.0	227.	4.0	0.0	0.11
21.	55.	42.	43.6	182.	3.0	0.0	0.02
22.	58.	43.	42.2	176.	2.0	0.0	0.04
23.	58.	51.	48.2	64.	3.0	0.0	0.63
24.	63.	51.	40.6	139.	3.0	0.0	0.91
25.	55.	50.	29.6	53.	3.0	0.0	0.79
26.	60.	47.	33.4	299.	3.0	0.0	0.00
27.	59.	43.	47.5	144.	2.0	0.0	0.00
28.	71.	41.	47.9	319.	2.0	0.0	0.00
29.	76.	47.	47.3	329.	2.0	0.0	0.00

30.	78.	48.	32.5	352.	2.0	0.0	0.00
31.	81.	50.	33.6	346.	2.0	0.0	0.00
32.	87.	47.	41.2	353.	2.0	0.0	0.00
33.	89.	47.	40.2	350.	2.0	0.0	0.00
34.	89.	50.	39.3	367.	2.0	0.0	0.00
35.	88.	50.	36.0	376.	2.0	0.0	0.00
36.	83.	49.	38.1	369.	2.0	0.0	0.00
37.	76.	45.	46.3	349.	3.0	0.0	0.00
38.	63.	51.	53.1	221.	3.0	0.0	0.00
39.	59.	47.	49.9	115.	2.0	0.0	0.00
40.	65.	43.	48.1	301.	2.0	0.0	0.00
41.	67.	41.	47.1	357.	3.0	0.0	0.00
42.	60.	52.	51.7	152.	3.0	0.0	0.00
43.	64.	45.	49.3	368.	3.0	0.0	0.00
44.	57.	44.	48.3	74.	3.0	0.0	0.55
45.	59.	54.	52.7	62.	4.0	0.0	0.67
46.	69.	47.	52.4	376.	2.0	0.0	0.00
47.	73.	45.	44.3	351.	2.0	0.0	0.00
48.	75.	45.	47.0	395.	2.0	0.0	0.00
49.	76.	50.	40.3	445.	4.0	0.0	0.00
50.	89.	45.	31.4	455.	2.0	0.0	0.00
51.	88.	54.	42.9	446.	3.0	0.0	0.00
52.	62.	48.	41.3	98.	2.0	0.0	0.00
53.	66.	48.	53.3	217.	2.0	0.0	0.00
54.	68.	47.	53.8	231.	2.0	0.0	0.00
55.	72.	55.	57.9	349.	4.0	0.0	0.08
56.	63.	47.	41.8	112.	2.0	0.0	0.00
57.	68.	46.	41.0	268.	2.0	0.0	0.00
58.	64.	53.	43.3	191.	3.0	0.0	0.00
59.	62.	47.	38.1	176.	2.0	0.0	0.00
60.	59.	49.	39.8	133.	2.0	0.0	0.00
61.	59.	51.	44.3	119.	2.0	0.0	0.20
62.	60.	54.	47.1	94.	3.0	0.0	0.32
63.	66.	48.	40.8	276.	2.0	0.0	0.24
64.	61.	56.	49.8	60.	5.0	0.0	2.21
65.	70.	48.	40.8	470.	3.0	0.0	0.00
66.	72.	45.	37.1	452.	2.0	0.0	0.00
67.	74.	49.	38.0	451.	2.0	0.0	0.00
68.	75.	49.	37.4	401.	2.0	0.0	0.00
69.	63.	51.	36.2	105.	3.0	0.0	0.71
70.	62.	50.	42.7	189.	4.0	0.0	2.17
71.	65.	46.	37.8	404.	3.0	0.0	0.00
72.	71.	47.	38.8	480.	2.0	0.0	0.00
73.	79.	51.	43.1	483.	2.0	0.0	0.00
74.	79.	50.	43.2	477.	2.0	0.0	0.00
75.	76.	49.	43.8	479.	3.0	0.0	0.00
76.	71.	57.	46.2	349.	3.0	0.0	0.00
77.	73.	53.	45.1	406.	3.0	0.0	0.00
78.	69.	52.	44.5	185.	2.0	0.0	0.00
79.	62.	54.	55.3	149.	3.0	0.0	0.02
80.	57.	42.	42.8	237.	5.0	0.0	0.39
81.	63.	45.	38.3	515.	3.0	0.0	0.00
82.	57.	39.	41.2	228.	5.0	0.0	0.87
83.	63.	38.	38.2	578.	4.0	0.0	0.00
84.	65.	34.	35.6	582.	3.0	0.0	0.00
85.	71.	37.	39.4	590.	3.0	0.0	0.00
86.	73.	41.	42.0	581.	3.0	0.0	0.00
87.	72.	40.	42.8	577.	3.0	0.0	0.00
88.	74.	43.	44.3	542.	3.0	0.0	0.00
89.	76.	38.	43.6	589.	3.0	0.0	0.00
90.	79.	43.	44.0	589.	3.0	0.0	0.00
91.	75.	45.	50.9	546.	3.0	0.0	0.00
92.	75.	46.	51.9	554.	3.0	0.0	0.00
93.	83.	46.	51.7	597.	3.0	0.0	0.00
94.	81.	49.	55.3	588.	3.0	0.0	0.00
95.	74.	50.	54.0	553.	3.0	0.0	0.00
96.	67.	48.	49.2	327.	3.0	0.0	0.00
97.	64.	46.	48.9	198.	3.0	0.0	0.00
98.	71.	47.	50.7	422.	3.0	0.0	0.00
99.	72.	44.	46.5	550.	3.0	0.0	0.00
100.	76.	38.	39.2	629.	3.0	0.0	0.00
101.	79.	47.	46.8	608.	3.0	0.0	0.00
102.	81.	50.	51.0	549.	3.0	0.0	0.00
103.	73.	46.	50.1	566.	4.0	0.0	0.00
104.	67.	41.	45.5	509.	3.0	0.0	0.00
105.	65.	39.	43.5	516.	3.0	0.0	0.00
106.	49.	43.	43.1	134.	3.0	0.0	0.55
107.	60.	45.	45.2	270.	3.0	0.0	0.04
108.	57.	43.	44.6	206.	2.0	0.0	0.43
109.	64.	42.	45.7	479.	3.0	0.0	0.00
110.	60.	41.	45.7	225.	3.0	0.0	0.00
111.	68.	38.	43.0	642.	3.0	0.0	0.00
112.	81.	40.	47.0	669.	3.0	0.0	0.00
113.	86.	49.	48.8	669.	3.0	0.0	0.00
114.	87.	51.	52.9	667.	3.0	0.0	0.00
115.	78.	48.	54.4	640.	3.0	0.0	0.00
116.	75.	52.	55.8	561.	3.0	0.0	0.00
117.	69.	53.	54.3	313.	3.0	0.0	0.00

118.	66.	55.	54.9	168.	3.0	0.0	0.00
119.	73.	51.	54.9	514.	3.0	0.0	0.00
120.	69.	58.	58.6	267.	3.0	0.0	0.00
121.	77.	57.	58.7	456.	4.0	0.0	0.00
122.	72.	49.	53.3	398.	4.0	0.0	0.00
123.	74.	48.	52.4	509.	3.0	0.0	0.00
124.	66.	53.	51.3	341.	4.0	0.0	0.00
125.	64.	51.	46.5	345.	5.0	0.0	0.00
126.	63.	46.	45.1	338.	3.0	0.0	0.00
127.	63.	51.	49.2	208.	2.0	0.0	0.00
128.	67.	47.	49.3	386.	3.0	0.0	0.00
129.	74.	44.	50.5	639.	3.0	0.0	0.00
130.	73.	46.	52.3	623.	3.0	0.0	0.00
131.	69.	54.	55.3	338.	4.0	0.0	0.00
132.	64.	49.	48.5	249.	5.0	0.0	0.01
133.	65.	48.	49.8	397.	4.0	0.0	0.00
134.	66.	45.	46.2	476.	3.0	0.0	0.00
135.	69.	48.	50.2	415.	3.0	0.0	0.00
136.	66.	48.	50.1	322.	4.0	0.0	0.00
137.	72.	45.	51.2	539.	3.0	0.0	0.00
138.	76.	50.	55.0	476.	3.0	0.0	0.00
139.	80.	51.	51.7	569.	4.0	0.0	0.00
140.	74.	54.	54.0	497.	4.0	0.0	0.00
141.	70.	53.	52.9	372.	3.0	0.0	0.00
142.	62.	53.	51.7	177.	4.0	0.0	0.00
143.	61.	55.	51.3	128.	3.0	0.0	0.00
144.	62.	55.	52.4	173.	3.0	0.0	0.08
145.	66.	48.	49.7	261.	3.0	0.0	0.00
146.	75.	45.	52.3	672.	3.0	0.0	0.00
147.	74.	53.	56.8	501.	4.0	0.0	0.00
148.	78.	58.	59.4	593.	4.0	0.0	0.00
149.	87.	57.	61.1	675.	4.0	0.0	0.00
150.	88.	57.	62.6	663.	4.0	0.0	0.00
151.	85.	54.	60.7	644.	4.0	0.0	0.00
152.	64.	57.	56.2	129.	4.0	0.0	0.00
153.	65.	57.	54.2	140.	3.0	0.0	0.00
154.	71.	51.	53.3	381.	4.0	0.0	0.00
155.	79.	48.	55.3	687.	3.0	0.0	0.00
156.	73.	54.	57.4	357.	3.0	0.0	0.00
157.	76.	51.	52.8	680.	4.0	0.0	0.00
158.	70.	48.	50.5	483.	4.0	0.0	0.00
159.	70.	50.	51.8	574.	4.0	0.0	0.00
160.	81.	47.	54.0	702.	3.0	0.0	0.00
161.	90.	50.	58.1	706.	3.0	0.0	0.00
162.	96.	57.	62.6	713.	3.0	0.0	0.00
163.	91.	56.	62.7	713.	4.0	0.0	0.00
164.	84.	55.	61.3	704.	3.0	0.0	0.00
165.	76.	59.	59.5	610.	4.0	0.0	0.00
166.	66.	55.	54.9	188.	4.0	0.0	0.08
167.	59.	48.	48.7	180.	2.0	0.0	1.18
168.	72.	46.	51.4	670.	3.0	0.0	0.00
169.	82.	51.	57.0	722.	3.0	0.0	0.00
170.	82.	51.	57.2	727.	3.0	0.0	0.00
171.	79.	51.	57.5	703.	3.0	0.0	0.00
172.	80.	53.	58.2	640.	4.0	0.0	0.00
173.	86.	56.	61.6	702.	3.0	0.0	0.00
174.	87.	54.	61.9	695.	4.0	0.0	0.00
175.	89.	56.	63.8	673.	4.0	0.0	0.00
176.	79.	60.	62.7	662.	4.0	0.0	0.00
177.	84.	60.	64.4	462.	3.0	0.0	0.00
178.	87.	58.	63.2	648.	3.0	0.0	0.00
179.	88.	56.	63.3	620.	3.0	0.0	0.00
180.	84.	59.	62.7	649.	4.0	0.0	0.00
181.	87.	56.	61.4	690.	3.0	0.0	0.00
182.	80.	55.	59.5	702.	4.0	0.0	0.00
183.	84.	54.	59.9	713.	3.0	0.0	0.00
184.	78.	53.	58.1	664.	4.0	0.0	0.00
185.	78.	58.	60.3	435.	3.0	0.0	0.00
186.	89.	55.	63.7	673.	4.0	0.0	0.00
187.	84.	57.	63.7	666.	3.0	0.0	0.00
188.	91.	57.	65.3	647.	3.0	0.0	0.00
189.	93.	59.	67.0	614.	3.0	0.0	0.00
190.	93.	58.	64.9	678.	3.0	0.0	0.00
191.	94.	60.	66.3	605.	3.0	0.0	0.00
192.	90.	56.	62.8	714.	3.0	0.0	0.00
193.	87.	52.	58.3	731.	3.0	0.0	0.00
194.	87.	51.	59.2	705.	3.0	0.0	0.00
195.	90.	55.	64.3	682.	3.0	0.0	0.00
196.	90.	58.	65.9	664.	3.0	0.0	0.00
197.	89.	63.	67.6	327.	3.0	0.0	0.00
198.	91.	59.	65.3	684.	3.0	0.0	0.00
199.	93.	58.	66.1	686.	3.0	0.0	0.00
200.	91.	57.	64.9	694.	3.0	0.0	0.00
201.	90.	53.	60.4	708.	3.0	0.0	0.00
202.	88.	52.	60.3	699.	3.0	0.0	0.00
203.	86.	55.	62.5	679.	3.0	0.0	0.00
204.	88.	57.	64.8	692.	3.0	0.0	0.00
205.	89.	56.	65.2	682.	3.0	0.0	0.00

206.	90.	57.	65.8	674.	3.0	0.0	0.00
207.	97.	58.	68.5	654.	3.0	0.0	0.00
208.	104.	60.	70.5	677.	3.0	0.0	0.00
209.	100.	62.	70.7	664.	3.0	0.0	0.00
210.	102.	65.	74.3	654.	4.0	0.0	0.00
211.	91.	65.	71.1	655.	4.0	0.0	0.00
212.	91.	62.	70.1	628.	3.0	0.0	0.00
213.	93.	63.	69.7	624.	3.0	0.0	0.00
214.	92.	61.	68.9	637.	3.0	0.0	0.00
215.	94.	61.	69.6	635.	3.0	0.0	0.00
216.	91.	61.	68.3	643.	3.0	0.0	0.00
217.	93.	58.	66.8	652.	3.0	0.0	0.00
218.	94.	56.	66.3	650.	3.0	0.0	0.00
219.	95.	60.	69.2	601.	3.0	0.0	0.00
220.	95.	61.	69.7	631.	3.0	0.0	0.00
221.	93.	62.	69.6	603.	3.0	0.0	0.00
222.	88.	58.	65.0	629.	3.0	0.0	0.00
223.	97.	58.	66.9	622.	3.0	0.0	0.00
224.	96.	58.	67.5	636.	3.0	0.0	0.00
225.	95.	58.	65.1	644.	3.0	0.0	0.00
226.	90.	54.	62.1	653.	3.0	0.0	0.00
227.	88.	57.	64.2	650.	3.0	0.0	0.00
228.	84.	57.	59.8	613.	4.0	0.0	0.00
229.	86.	55.	56.1	629.	3.0	0.0	0.00
230.	89.	56.	57.5	637.	3.0	0.0	0.00
231.	90.	57.	59.2	625.	3.0	0.0	0.00
232.	88.	62.	61.5	520.	3.0	0.0	0.00
233.	90.	65.	62.0	584.	3.0	0.0	0.00
234.	92.	63.	60.9	597.	3.0	0.0	0.00
235.	92.	59.	59.6	616.	3.0	0.0	0.00
236.	95.	56.	58.4	616.	3.0	0.0	0.00
237.	94.	54.	55.4	621.	3.0	0.0	0.00
238.	93.	53.	53.7	638.	3.0	0.0	0.00
239.	96.	57.	53.3	609.	3.0	0.0	0.00
240.	99.	60.	54.1	610.	3.0	0.0	0.00
241.	101.	60.	58.1	609.	3.0	0.0	0.00
242.	101.	63.	61.9	611.	3.0	0.0	0.00
243.	100.	64.	63.4	567.	3.0	0.0	0.00
244.	99.	61.	62.2	379.	2.0	0.0	0.00
245.	101.	68.	64.9	543.	3.0	0.0	0.00
246.	97.	64.	62.1	564.	3.0	0.0	0.00
247.	97.	60.	60.0	589.	3.0	0.0	0.00
248.	99.	59.	57.8	572.	3.0	0.0	0.00
249.	94.	62.	60.8	488.	3.0	0.0	0.00
250.	92.	62.	60.1	554.	3.0	0.0	0.00
251.	88.	57.	57.5	569.	3.0	0.0	0.00
252.	86.	55.	54.9	554.	3.0	0.0	0.00
253.	86.	53.	54.1	554.	2.0	0.0	0.00
254.	90.	58.	36.6	480.	3.0	0.0	0.00
255.	96.	58.	57.3	544.	3.0	0.0	0.00
256.	97.	58.	60.5	532.	3.0	0.0	0.00
257.	99.	58.	61.1	525.	3.0	0.0	0.00
258.	96.	60.	63.1	511.	3.0	0.0	0.08
259.	82.	59.	60.5	444.	4.0	0.0	0.00
260.	83.	56.	55.0	489.	3.0	0.0	0.00
261.	87.	56.	56.8	512.	3.0	0.0	0.00
262.	89.	57.	58.8	500.	3.0	0.0	0.00
263.	88.	58.	57.8	490.	3.0	0.0	0.00
264.	87.	55.	56.3	503.	3.0	0.0	0.00
265.	87.	55.	56.8	484.	3.0	0.0	0.00
266.	84.	57.	57.5	486.	3.0	0.0	0.00
267.	86.	57.	57.0	492.	3.0	0.0	0.00
268.	84.	57.	57.3	476.	3.0	0.0	0.00
269.	82.	59.	61.0	472.	3.0	0.0	0.00
270.	79.	60.	55.3	468.	3.0	0.0	0.00
271.	70.	60.	53.7	145.	3.0	0.0	0.00
272.	78.	55.	52.5	444.	3.0	0.0	0.00
273.	90.	54.	51.8	494.	3.0	0.0	0.00
274.	90.	55.	52.7	501.	3.0	0.0	0.00
275.	99.	59.	52.1	498.	3.0	0.0	0.00
276.	89.	60.	40.0	486.	3.0	0.0	0.00
277.	87.	54.	54.2	457.	3.0	0.0	0.00
278.	90.	53.	49.4	458.	2.0	0.0	0.00
279.	81.	51.	52.1	410.	3.0	0.0	0.00
280.	79.	55.	53.4	429.	3.0	0.0	0.00
281.	78.	59.	55.3	436.	3.0	0.0	0.00
282.	81.	54.	54.0	386.	3.0	0.0	0.00
283.	87.	52.	53.7	419.	3.0	0.0	0.00
284.	77.	56.	54.8	313.	3.0	0.0	0.00
285.	79.	55.	53.6	332.	3.0	0.0	0.00
286.	84.	51.	53.5	337.	3.0	0.0	0.00
287.	85.	53.	55.2	399.	3.0	0.0	0.00
288.	77.	53.	52.4	345.	3.0	0.0	0.00
289.	75.	52.	51.7	378.	2.0	0.0	0.00
290.	80.	50.	52.0	400.	3.0	0.0	0.00
291.	76.	55.	54.9	232.	3.0	0.0	0.00
292.	80.	55.	54.5	319.	3.0	0.0	0.00
293.	82.	54.	53.5	386.	3.0	0.0	0.00

294.	70.	54.	52.0	185.	3.0	0.0	0.00
295.	76.	50.	49.2	358.	2.0	0.0	0.00
296.	82.	43.	39.9	417.	2.0	0.0	0.00
297.	80.	44.	40.6	400.	2.0	0.0	0.00
298.	80.	46.	44.7	399.	2.0	0.0	0.00
299.	81.	47.	46.9	367.	3.0	0.0	0.00
300.	86.	49.	50.5	349.	2.0	0.0	0.00
301.	75.	49.	49.4	188.	2.0	0.0	0.00
302.	75.	55.	54.0	226.	4.0	0.0	0.00
303.	74.	55.	52.8	268.	3.0	0.0	0.00
304.	64.	54.	51.6	56.	3.0	0.0	0.00
305.	66.	54.	50.5	152.	3.0	0.0	0.00
306.	71.	50.	48.7	317.	2.0	0.0	0.00
307.	75.	48.	48.7	315.	2.0	0.0	0.00
308.	76.	51.	49.5	300.	3.0	0.0	0.00
309.	82.	47.	44.4	355.	3.0	0.0	0.00
310.	70.	51.	49.1	256.	2.0	0.0	0.00
311.	78.	50.	48.2	324.	2.0	0.0	0.00
312.	77.	53.	41.9	327.	3.0	0.0	0.00
313.	72.	46.	46.8	299.	3.0	0.0	0.00
314.	73.	50.	49.3	263.	2.0	0.0	0.00
315.	83.	50.	49.7	328.	3.0	0.0	0.00
316.	75.	50.	41.1	321.	2.0	0.0	0.00
317.	82.	49.	49.1	302.	2.0	0.0	0.00
318.	71.	49.	49.4	197.	2.0	0.0	0.00
319.	69.	49.	49.2	176.	2.0	0.0	0.00
320.	69.	48.	51.2	93.	2.0	0.0	0.00
321.	77.	48.	51.1	274.	2.0	0.0	0.00
322.	82.	49.	52.3	292.	2.0	0.0	0.00
323.	79.	47.	50.6	294.	2.0	0.0	0.00
324.	80.	48.	51.1	284.	2.0	0.0	0.00
325.	71.	46.	49.2	197.	2.0	0.0	0.00
326.	76.	49.	50.2	276.	2.0	0.0	0.00
327.	86.	53.	51.1	298.	2.0	0.0	0.00
328.	88.	55.	54.3	264.	2.0	0.0	0.00
329.	82.	49.	50.8	248.	2.0	0.0	0.00
330.	67.	43.	47.5	207.	2.0	0.0	0.00
331.	75.	42.	41.9	288.	2.0	0.0	0.00
332.	74.	47.	24.8	275.	2.0	0.0	0.00
333.	84.	47.	46.0	296.	2.0	0.0	0.00
334.	81.	50.	51.6	280.	2.0	0.0	0.00
335.	76.	47.	49.0	261.	2.0	0.0	0.00
336.	68.	46.	48.4	192.	2.0	0.0	0.00
337.	68.	44.	48.5	201.	2.0	0.0	0.00
338.	72.	46.	49.8	229.	2.0	0.0	0.00
339.	78.	46.	49.9	218.	2.0	0.0	0.00
340.	75.	47.	50.6	191.	2.0	0.0	0.00
341.	65.	48.	50.6	106.	2.0	0.0	0.00
342.	73.	48.	50.3	221.	2.0	0.0	0.00
343.	77.	46.	48.2	257.	2.0	0.0	0.00
344.	76.	44.	46.8	258.	3.0	0.0	0.00
345.	68.	45.	46.8	163.	2.0	0.0	0.00
346.	61.	50.	49.3	65.	2.0	0.0	0.16
347.	64.	46.	50.8	105.	3.0	0.0	0.08
348.	68.	44.	45.6	283.	2.0	0.0	0.04
349.	70.	45.	45.7	242.	3.0	0.0	0.00
350.	64.	39.	40.2	215.	2.0	0.0	0.00
351.	66.	35.	35.6	282.	2.0	0.0	0.00
352.	65.	33.	35.5	272.	2.0	0.0	0.00
353.	63.	41.	41.3	240.	2.0	0.0	0.00
354.	58.	40.	37.8	219.	3.0	0.0	0.00
355.	64.	40.	40.6	273.	3.0	0.0	0.00
356.	59.	40.	32.7	253.	2.0	0.0	0.00
357.	52.	42.	39.1	122.	4.0	0.0	0.31
358.	60.	40.	34.6	169.	3.0	0.0	0.00
359.	65.	42.	33.8	179.	3.0	0.0	0.00
360.	71.	34.	33.9	296.	2.0	0.0	0.00
361.	72.	39.	37.8	274.	2.0	0.0	0.00
362.	64.	39.	39.2	252.	2.0	0.0	0.00
363.	66.	41.	40.7	165.	2.0	0.0	0.00
364.	68.	43.	45.4	224.	2.0	0.0	0.00
365.	65.	44.	48.6	227.	2.0	0.0	0.00

NFPET = 1:

PET is partitioned into PT and PE according to the relationship developed by Ritchie (1972)

DAY	PET	PTRANS	PEVAPO	DAY	PET	PTRANS	PEVAPO
1	0.1571	0.0371	0.1200	2	0.1588	0.0379	0.1209
3	0.0000	0.0000	0.0000	4	0.0000	0.0000	0.0000
5	0.2884	0.0706	0.2178	6	0.0981	0.0242	0.0739
7	0.0510	0.0127	0.0383	8	0.0196	0.0049	0.0146
9	0.0906	0.0229	0.0677	10	0.0000	0.0000	0.0000
11	0.0357	0.0092	0.0266	12	0.0388	0.0100	0.0287
13	0.0000	0.0000	0.0000	14	0.0430	0.0113	0.0317
15	0.1084	0.0287	0.0797	16	0.1170	0.0312	0.0858
17	0.1453	0.0390	0.1063	18	0.1732	0.0469	0.1263

19	0.1466	0.0400	0.1067	20	0.1417	0.0389	0.1028
21	0.0472	0.0131	0.0342	22	0.0563	0.0157	0.0406
23	0.0000	0.0000	0.0000	24	0.0965	0.0272	0.0693
25	0.0470	0.0134	0.0337	26	0.2319	0.0663	0.1657
27	0.0059	0.0017	0.0042	28	0.1811	0.0524	0.1287
29	0.2382	0.0694	0.1688	30	0.3118	0.0914	0.2204
31	0.3193	0.0941	0.2251	32	0.3197	0.0948	0.2249
33	0.3257	0.0972	0.2285	34	0.3529	0.1060	0.2470
35	0.3638	0.1099	0.2540	36	0.3348	0.1017	0.2331
37	0.2736	0.0836	0.1900	38	0.0861	0.0264	0.0596
39	0.0000	0.0000	0.0000	40	0.1482	0.0461	0.1022
41	0.2093	0.0654	0.1439	42	0.0306	0.0096	0.0210
43	0.2079	0.0657	0.1422	44	0.0000	0.0000	0.0000
45	0.0000	0.0000	0.0000	46	0.2216	0.0711	0.1505
47	0.2494	0.0805	0.1689	48	0.2839	0.0921	0.1918
49	0.4403	0.1436	0.2967	50	0.4315	0.1414	0.2901
51	0.4716	0.1554	0.3162	52	0.0260	0.0086	0.0174
53	0.0747	0.0249	0.0499	54	0.0875	0.0293	0.0582
55	0.2410	0.0810	0.1600	56	0.0352	0.0119	0.0233
57	0.1780	0.0604	0.1176	58	0.1374	0.0468	0.0906
59	0.0984	0.0337	0.0647	60	0.0548	0.0188	0.0359
61	0.0296	0.0102	0.0194	62	0.0235	0.0082	0.0153
63	0.1854	0.0647	0.1207	64	0.0179	0.0063	0.0116
65	0.3893	0.1371	0.2522	66	0.3557	0.1258	0.2299
67	0.3760	0.1336	0.2424	68	0.3377	0.1205	0.2172
69	0.0876	0.0314	0.0562	70	0.1392	0.0501	0.0891
71	0.3143	0.1136	0.2007	72	0.3783	0.1373	0.2410
73	0.4184	0.1525	0.2659	74	0.4085	0.1496	0.2590
75	0.4190	0.1540	0.2650	76	0.3071	0.1134	0.1938
77	0.3536	0.1311	0.2225	78	0.1175	0.0437	0.0738
79	0.0185	0.0069	0.0116	80	0.1222	0.0458	0.0763
81	0.3861	0.1454	0.2407	82	0.1128	0.0427	0.0702
83	0.4134	0.1570	0.2565	84	0.4012	0.1529	0.2483
85	0.4403	0.1685	0.2718	86	0.4547	0.1747	0.2801
87	0.4355	0.1679	0.2676	88	0.4276	0.1655	0.2621
89	0.4529	0.1760	0.2769	90	0.4979	0.1942	0.3037
91	0.4098	0.1598	0.2500	92	0.4164	0.1624	0.2540
93	0.5064	0.1975	0.3089	94	0.4825	0.1882	0.2944
95	0.4207	0.1640	0.2566	96	0.2075	0.0809	0.1266
97	0.0794	0.0310	0.0484	98	0.2935	0.1145	0.1791
99	0.4161	0.1623	0.2538	100	0.5078	0.1980	0.3098
101	0.5243	0.2045	0.3198	102	0.4791	0.1868	0.2923
103	0.4413	0.1721	0.2692	104	0.3409	0.1329	0.2079
105	0.3354	0.1308	0.2046	106	0.0000	0.0000	0.0000
107	0.1387	0.0541	0.0846	108	0.0627	0.0244	0.0382
109	0.3040	0.1186	0.1855	110	0.0820	0.0320	0.0500
111	0.4491	0.1751	0.2739	112	0.5455	0.2127	0.3327
113	0.6241	0.2434	0.3807	114	0.6210	0.2422	0.3788
115	0.5080	0.1981	0.3099	116	0.4350	0.1696	0.2653
117	0.1974	0.0770	0.1204	118	0.0625	0.0244	0.0381
119	0.3801	0.1482	0.2319	120	0.1523	0.0594	0.0929
121	0.3798	0.1481	0.2317	122	0.2848	0.1111	0.1737
123	0.3805	0.1484	0.2321	124	0.2400	0.0936	0.1464
125	0.2741	0.1069	0.1672	126	0.2125	0.0829	0.1296
127	0.0912	0.0356	0.0556	128	0.2503	0.0976	0.1527
129	0.4786	0.1866	0.2919	130	0.4594	0.1792	0.2803
131	0.2284	0.0891	0.1393	132	0.1637	0.0638	0.0999
133	0.2614	0.1019	0.1595	134	0.3275	0.1277	0.1998
135	0.2853	0.1112	0.1740	136	0.2034	0.0793	0.1241
137	0.3827	0.1493	0.2335	138	0.3587	0.1399	0.2188
139	0.5163	0.2013	0.3150	140	0.4136	0.1613	0.2523
141	0.2640	0.1030	0.1611	142	0.0751	0.0293	0.0458
143	0.0318	0.0124	0.0194	144	0.0662	0.0258	0.0404
145	0.1443	0.0563	0.0880	146	0.5083	0.1982	0.3101
147	0.3864	0.1507	0.2357	148	0.5156	0.2011	0.3146
149	0.6420	0.2504	0.3916	150	0.6262	0.2442	0.3820
151	0.5760	0.2246	0.3514	152	0.0266	0.0102	0.0164
153	0.0483	0.0183	0.0300	154	0.2767	0.1032	0.1736
155	0.5506	0.2021	0.3486	156	0.2417	0.0872	0.1544
157	0.5791	0.2056	0.3735	158	0.3606	0.1258	0.2348
159	0.4417	0.1514	0.2903	160	0.5799	0.1951	0.3848
161	0.6422	0.2120	0.4302	162	0.7126	0.2307	0.4820
163	0.6902	0.2189	0.4713	164	0.6122	0.1901	0.4221
165	0.5228	0.1588	0.3640	166	0.0896	0.0266	0.0630
167	0.0449	0.0130	0.0319	168	0.4987	0.1410	0.3577
169	0.6142	0.1692	0.4450	170	0.6175	0.1655	0.4519
171	0.5714	0.1489	0.4225	172	0.5458	0.1380	0.4078
173	0.6303	0.1544	0.4759	174	0.6304	0.1494	0.4810
175	0.6259	0.1431	0.4827	176	0.5754	0.1267	0.4486
177	0.3939	0.0833	0.3106	178	0.5891	0.1194	0.4697
179	0.5542	0.1072	0.4470	180	0.5958	0.1096	0.4862
181	0.6273	0.1093	0.5180	182	0.6081	0.0997	0.5083
183	0.6229	0.0956	0.5273	184	0.5526	0.0787	0.4738
185	0.3464	0.0454	0.3010	186	0.6185	0.0735	0.5450
187	0.5737	0.0608	0.5128	188	0.5953	0.0550	0.5403
189	0.5797	0.0451	0.5346	190	0.6501	0.0402	0.6099
191	0.5892	0.0261	0.5632	192	0.6631	0.0161	0.6470
193	0.6575	0.0000	0.6575	194	0.6201	0.0000	0.6201

195	0.6145	0.0000	0.6145	196	0.6078	0.0000	0.6078
197	0.2893	0.0000	0.2893	198	0.6463	0.0000	0.6463
199	0.6502	0.0000	0.6502	200	0.6442	0.0000	0.6442
201	0.6510	0.0000	0.6510	202	0.6216	0.0000	0.6216
203	0.5948	0.0000	0.5948	204	0.6206	0.0000	0.6206
205	0.6080	0.0000	0.6080	206	0.6109	0.0000	0.6109
207	0.6313	0.0000	0.6313	208	0.7070	0.0000	0.7070
209	0.6780	0.0000	0.6780	210	0.7001	0.0000	0.7001
211	0.6356	0.0000	0.6356	212	0.5789	0.0000	0.5789
213	0.6000	0.0000	0.6000	214	0.5967	0.0000	0.5967
215	0.6045	0.0000	0.6045	216	0.5996	0.0000	0.5996
217	0.6117	0.0000	0.6117	218	0.6059	0.0000	0.6059
219	0.5730	0.0000	0.5730	220	0.6071	0.0000	0.6071
221	0.5722	0.0000	0.5722	222	0.5654	0.0000	0.5654
223	0.6095	0.0000	0.6095	224	0.6126	0.0000	0.6126
225	0.6290	0.0000	0.6290	226	0.5942	0.0000	0.5942
227	0.5842	0.0000	0.5842	228	0.5695	0.0000	0.5695
229	0.5871	0.0000	0.5871	230	0.6127	0.0000	0.6127
231	0.6046	0.0000	0.6046	232	0.5072	0.0000	0.5072
233	0.5992	0.0000	0.5992	234	0.6178	0.0000	0.6178
235	0.6188	0.0000	0.6188	236	0.6247	0.0000	0.6247
237	0.6258	0.0000	0.6258	238	0.6382	0.0000	0.6382
239	0.6506	0.0000	0.6506	240	0.6806	0.0000	0.6806
241	0.6767	0.0000	0.6767	242	0.6810	0.0000	0.6810
243	0.6289	0.0000	0.6289	244	0.3859	0.0000	0.3859
245	0.6260	0.0000	0.6260	246	0.6141	0.0000	0.6141
247	0.6258	0.0000	0.6258	248	0.6234	0.0000	0.6234
249	0.5140	0.0000	0.5140	250	0.5724	0.0000	0.5724
251	0.5467	0.0000	0.5467	252	0.5221	0.0000	0.5221
253	0.4884	0.0000	0.4884	254	0.5427	0.0000	0.5427
255	0.5751	0.0000	0.5751	256	0.5542	0.0000	0.5542
257	0.5557	0.0000	0.5557	258	0.5257	0.0000	0.5257
259	0.4029	0.0000	0.4029	260	0.4482	0.0000	0.4482
261	0.4835	0.0000	0.4835	262	0.4786	0.0000	0.4786
263	0.4743	0.0000	0.4743	264	0.4718	0.0000	0.4718
265	0.4509	0.0000	0.4509	266	0.4430	0.0000	0.4430
267	0.4632	0.0000	0.4632	268	0.4346	0.0000	0.4346
269	0.4078	0.0000	0.4078	270	0.4268	0.0000	0.4268
271	0.0921	0.0000	0.0921	272	0.3864	0.0000	0.3864
273	0.4957	0.0000	0.4957	274	0.5039	0.0000	0.5039
275	0.5674	0.0000	0.5674	276	0.5463	0.0000	0.5463
277	0.4332	0.0000	0.4332	278	0.4311	0.0000	0.4311
279	0.3520	0.0000	0.3520	280	0.3730	0.0000	0.3730
281	0.3854	0.0000	0.3854	282	0.3353	0.0000	0.3353
283	0.3890	0.0000	0.3890	284	0.2528	0.0000	0.2528
285	0.2824	0.0000	0.2824	286	0.2927	0.0000	0.2927
287	0.3568	0.0000	0.3568	288	0.2808	0.0000	0.2808
289	0.2791	0.0000	0.2791	290	0.3328	0.0000	0.3328
291	0.1681	0.0000	0.1681	292	0.2703	0.0000	0.2703
293	0.3433	0.0000	0.3433	294	0.1117	0.0010	0.1107
295	0.2681	0.0040	0.2640	296	0.3487	0.0073	0.3414
297	0.3279	0.0087	0.3193	298	0.3217	0.0102	0.3114
299	0.3199	0.0118	0.3081	300	0.2920	0.0122	0.2797
301	0.1097	0.0051	0.1046	302	0.1824	0.0094	0.1730
303	0.2039	0.0114	0.1925	304	0.0000	0.0000	0.0000
305	0.0750	0.0049	0.0702	306	0.2135	0.0147	0.1988
307	0.2200	0.0160	0.2039	308	0.2420	0.0186	0.2234
309	0.3251	0.0263	0.2988	310	0.1591	0.0135	0.1456
311	0.2500	0.0221	0.2279	312	0.3140	0.0289	0.2850
313	0.2138	0.0205	0.1933	314	0.1720	0.0171	0.1549
315	0.2945	0.0303	0.2642	316	0.2607	0.0277	0.2330
317	0.2383	0.0261	0.2122	318	0.1033	0.0117	0.0916
319	0.0792	0.0092	0.0700	320	0.0000	0.0000	0.0000
321	0.1812	0.0222	0.1590	322	0.2162	0.0272	0.1890
323	0.2053	0.0265	0.1788	324	0.2022	0.0267	0.1755
325	0.0933	0.0126	0.0807	326	0.1872	0.0258	0.1613
327	0.2576	0.0363	0.2213	328	0.2290	0.0329	0.1961
329	0.1826	0.0268	0.1558	330	0.0844	0.0126	0.0718
331	0.2017	0.0307	0.1710	332	0.2436	0.0378	0.2058
333	0.2438	0.0385	0.2053	334	0.2083	0.0335	0.1749
335	0.1716	0.0280	0.1436	336	0.0822	0.0136	0.0686
337	0.0816	0.0138	0.0679	338	0.1210	0.0207	0.1003
339	0.1337	0.0232	0.1105	340	0.0996	0.0176	0.0820
341	0.0000	0.0000	0.0000	342	0.1232	0.0224	0.1009
343	0.1717	0.0316	0.1401	344	0.1881	0.0351	0.1530
345	0.0629	0.0119	0.0510	346	0.0000	0.0000	0.0000
347	0.0000	0.0000	0.0000	348	0.1633	0.0320	0.1313
349	0.1587	0.0315	0.1272	350	0.1021	0.0205	0.0816
351	0.1656	0.0336	0.1319	352	0.1484	0.0305	0.1179
353	0.1197	0.0249	0.0948	354	0.1150	0.0242	0.0908
355	0.1649	0.0350	0.1299	356	0.1479	0.0318	0.1162
357	0.0329	0.0071	0.0258	358	0.1013	0.0222	0.0791
359	0.1356	0.0300	0.1056	360	0.1956	0.0437	0.1519
361	0.1845	0.0416	0.1428	362	0.1349	0.0307	0.1041
363	0.0735	0.0169	0.0566	364	0.1125	0.0261	0.0864
365	0.0905	0.0212	0.0693				

Totals: PET = 130.3472

PTRANS = 20.1025
PEVAPO = 104.1221

IRAIN = 1

Rainfall/Irrigation Details

Day	Time (hr)	Amount (cm)	Application Type	Efficiency	Changes In Rate/Head
3	0.000	0.8890	1	1.000	2
	1.000	0.0000			
4	0.000	7.0000	1	1.000	3
	7.000	0.6962			
	8.000	0.0000			
5	0.000	0.1016	1	1.000	2
	1.000	0.0000			
7	0.000	1.0000	1	1.000	3
	1.000	0.7018			
	2.000	0.0000			
8	0.000	2.0000	1	1.000	3
	2.000	0.6924			
	3.000	0.0000			
9	0.000	0.1016	1	1.000	2
	1.000	0.0000			
10	0.000	7.0000	1	1.000	3
	7.000	0.4168			
	8.000	0.0000			
11	0.000	0.6096	1	1.000	2
	1.000	0.0000			
12	0.000	1.0000	1	1.000	3
	1.000	0.1938			
	2.000	0.0000			
14	0.000	0.4064	1	1.000	2
	1.000	0.0000			
15	0.000	0.1016	1	1.000	2
	1.000	0.0000			
16	0.000	0.1016	1	1.000	2
	1.000	0.0000			
19	0.000	0.0254	1	1.000	2
	1.000	0.0000			
20	0.000	0.2794	1	1.000	2
	1.000	0.0000			
21	0.000	0.0508	1	1.000	2
	1.000	0.0000			
22	0.000	0.1016	1	1.000	2
	1.000	0.0000			
23	0.000	1.0000	1	1.000	3
	1.000	0.6002			
	2.000	0.0000			
24	0.000	2.0000	1	1.000	3
	2.000	0.3114			
	3.000	0.0000			
25	0.000	2.0000	1	1.000	3
	2.000	0.0066			
	3.000	0.0000			
44	0.000	1.0000	1	1.000	3
	1.000	0.3970			
	2.000	0.0000			
45	0.000	1.0000	1	1.000	3
	1.000	0.7018			
	2.000	0.0000			
55	0.000	0.2032	1	1.000	2
	1.000	0.0000			
61	0.000	0.5080	1	1.000	2
	1.000	0.0000			
62	0.000	0.8128	1	1.000	2
	1.000	0.0000			
63	0.000	0.6096	1	1.000	2
	1.000	0.0000			
64	0.000	5.0000	1	1.000	3
	5.000	0.6134			
	6.000	0.0000			
69	0.000	1.0000	1	1.000	3
	1.000	0.8034			
	2.000	0.0000			
70	0.000	5.0000	1	1.000	3
	5.000	0.5118			
	6.000	0.0000			
79	0.000	0.0508	1	1.000	2
	1.000	0.0000			
80	0.000	0.9906	1	1.000	2
	1.000	0.0000			
82	0.000	2.0000	1	1.000	3
	2.000	0.2098			
	3.000	0.0000			
106	0.000	1.0000	1	1.000	3
	1.000	0.3970			

	2.000	0.0000			
107	0.000	0.1016	1	1.000	2
	1.000	0.0000			
108	0.000	1.0000	1	1.000	3
	1.000	0.0922			
	2.000	0.0000			
132	0.000	0.0254	1	1.000	2
	1.000	0.0000			
144	0.000	0.2032	1	1.000	2
	1.000	0.0000			
166	0.000	0.2032	1	1.000	2
	1.000	0.0000			
167	0.000	2.0000	1	1.000	3
	2.000	0.9972			
	3.000	0.0000			
258	0.000	0.2032	1	1.000	2
	1.000	0.0000			
346	0.000	0.4064	1	1.000	2
	1.000	0.0000			
347	0.000	0.2032	1	1.000	2
	1.000	0.0000			
348	0.000	0.1016	1	1.000	2
	1.000	0.0000			
357	0.000	0.7874	1	1.000	2
	1.000	0.0000			

NWATER (number of days of rain/irrigation) = 43

Total Water Applied = 58.5216 cm

E. RCRA SUBTITLE D (CCR TITLE 27) EQUIVALENT GCL COVER

E. RCRA SUBTITLE D (CCR TITLE 27) EQUIVALENT GCL COVER

E.1 Objective

To evaluate and compare hydraulic performance of an alternative GCL cover design for the RCRA Subtitle D (CCR Title 27) cover. The Title 27 cover is proposed for the area outside the 'Dial' at the WDI site. The evaluation of hydraulic performance and equivalence demonstration of alternative covers are performed using the HELP Model, Version 3.07 (Schroeder et al, 1997).

E.2 Alternative Cover Design:

The prescriptive Subtitle D cover and the proposed GCL engineered soil cover alternative are illustrated in Figure E-1.

The prescriptive Title 27 cover for the site consists of (from top to bottom): 1-foot thick vegetation / top soil layer; filter layer; 1-foot thick low-permeability soil (barrier) layer with a hydraulic conductivity of 1.0E-06 cm/sec or lower; underlain by the foundation layer.

The Alternative GCL cover consists of (from top to bottom): 2-foot thick vegetative cover layer, 16-oz cushion geotextile and GCL, underlain by a properly prepared foundation layer.

E.3 HELP Model Analyses

The infiltration analyses consisted of HELP model simulations of the prescriptive Title 27 cover and the alternative GCL cover under the design simulation period. Two different simulation periods were considered:

- A 5 – year sequence representing one of the wettest 5-year periods on record for the area
- A long-term 30 year simulation period

The water balance equation that forms the basis of the HELP Model analyses is:

$$\Delta S = P - ET - R - Perc$$

Where

ΔS	=	change in moisture storage in soil
P	=	precipitation
ET	=	evapotranspiration consisting of evaporation and transpiration
R	=	runoff
$Perc$	=	Percolation through the bottom of the cover

The water balance equation states that the change in the amount of water stored in the soil cover is equal to the total precipitation, minus the amount of water lost to surface runoff, evaporation, transpiration, and percolation into the landfill. For the project site, precipitation consists of rainfall on the cover surface. It was assumed that no supplementary irrigation is applied on the cover surface to maintain/promote vegetation growth.

Percolation is the quantity of downward flow through the bottom of the cover system being simulated. This represents the quantity of flow into the landfill. Percolation is the parameter used to compare the performance and demonstrate equivalence of alternative cover systems.

The Input parameters for the HELP Model may be grouped into the following categories:

- Cover geometry (slope, layer thickness, drainage length)
- Weather related parameters (rainfall, temperature and solar radiation)
- Material parameters (porosity, wilting point, field capacity, saturated hydraulic conductivity, and initial moisture content)
- Vegetation characteristics (LAI, quality of vegetation, and rooting depth)

Each of the input categories is discussed below.

E.3.1 Cover Geometry

The cover layer system geometry for each of the two cover systems modeled is illustrated in Figure E-2. Each cover systems is underlain by a foundation layer. Since the foundation layer, and the cushion geotextile (for the Alternative GCL cover) do not have a percolation control function, they were not included in the cover geometry simulated in the HELP Model analyses.

In order to calculate runoff, Title 27 cover area was assumed to have a minimum slope of 2% and a maximum slope length of 335 feet. The Runoff Curve number was found to be in the range 80.1 to 85.6. The former (80.1) was obtained by modifying the curve number obtained from Figure 2 of the User's Guide for HELP (pp 36) to a slope of 2% and a slope length of 335 feet. The latter (85.6) was obtained by providing slope, slope length, soil texture and vegetation information (fair strand of grass). Both values were used in a parametric study, and the more conservative value of 80.1 was chosen for the simulations.

E.3.2 Weather Data

The weather and climate data used for the 5-year and 30-year design simulation periods is discussed in detail in Section B of this Calculation Package. The data required for the HELP model includes daily values of precipitation, temperature, solar radiation and evapotranspiration.

For the 5-year simulation, recorded data for the Pomona CIMIS weather station from 1991 through 1995 was used. For the 30-year, long-term simulation, stochastically generated (by the HELP Model based on monthly averages for the site) weather data was used.

E.3.3 Material Parameters

Material properties required for the analyses include porosity, field capacity, wilting point and saturated hydraulic conductivity (Ks). The selected input parameters for the various components of the cover system are shown on Table E-1, and illustrated in Figure E-3. Results of laboratory testing for infiltration analyses are discussed in Section A of this calculation package.

The vegetative layer for both cover systems was assumed to consist of on-site cover soils recompacted to a relative compaction of 85% (ASTM D1557). The field capacity, wilting point and porosity of the vegetative cover was obtained as an average value from the 5 moisture storage curves developed for 85% RC remolded materials for the site (Table A-1). The Ks value for the vegetative soil layer was taken as the average of the ASTM D5084 hydraulic conductivity results, i.e. 6.70E-05

cm/sec (Table A-1). The Ks for the upper half of the vegetative soil layer was multiplied by 3 to allow for root channels (Table E-1, Figure E-3), as recommended by the HELP manual.

Field capacity, porosity and wilting point for the Title 27 low-permeability layer was selected from the moisture storage curve for sample TS-085 remolded to 90% RC (Table A-2). The Ks value for this layer was assigned to be 1.0E-06 cm/sec as per regulatory requirements.

Material parameters for the GCL were default values recommended by the HELP Manual. The Ks for GCL was conservatively selected as 1.0E-08 cm/sec.

E.3.4 Vegetation Parameters

The following vegetation related parameters were used in the analyses

- Evaporative zone depth - depth of vegetative layer
- Leaf Area Index - 2
- Growing season start day - 285
- Growing Season end day - 151
- Average wind speed - 3.03 (average of 5 year recorded data)

E.4 Results of Model Simulations

The results of the 5-year water balance analyses for the Title 27 and the alternative GCL covers, consisting of annual and cumulative values of the various components of the water balance is shown in Figure E-4. The cumulative percolation for the two cover systems, through the 5-year simulation period are compared in Figure E-5. The results of the long-term, 30-year simulation period are compared in Figure E-6. The results show that the cumulative percolation through the alternative GCL cover is smaller than that through the Title 27 cover.

E.5 Conclusions and Recommendations

The results of the infiltration analyses show that the performance of the alternative GCL cover is equivalent to or superior to the Title 27 cover.

If the GCL alternative is selected, appropriate specifications should be developed for the foundation layer and the cover soil above the GCL, so as to remove oversize materials, construction debris, angular rocks and any other materials that may damage or puncture the GCL.

E.6 References

Shroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L. (1994, Updated 1997). "The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3," EPA 600/9-94/xxx, U.S. Environmental Protection Agency Risk reduction Engineering Laboratory, Cincinnati, OH.

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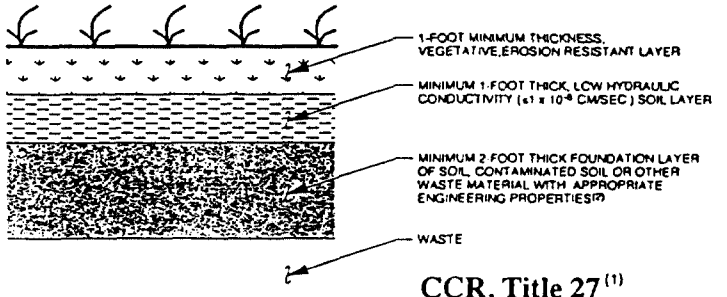
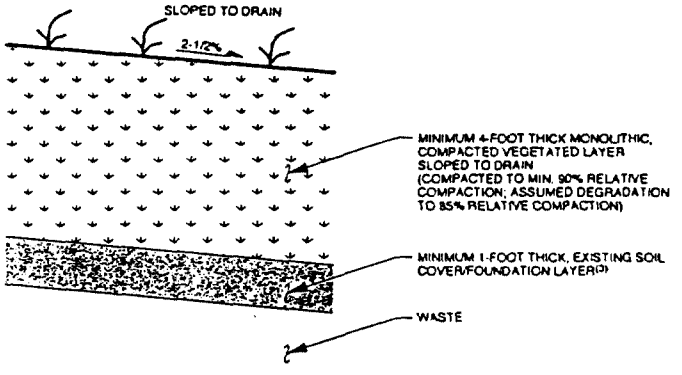
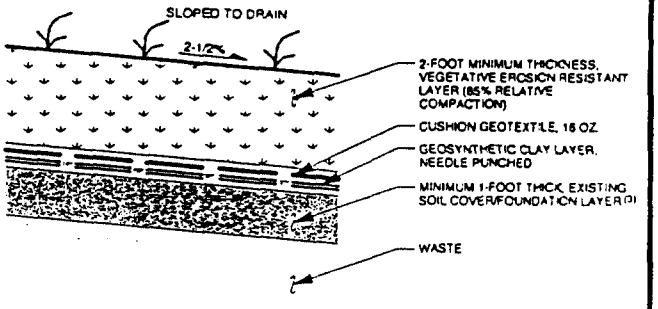
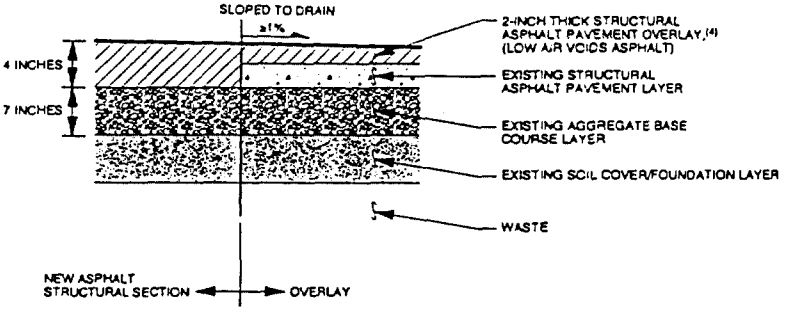


CCR, Title 27 (1)
Prescriptive Cap

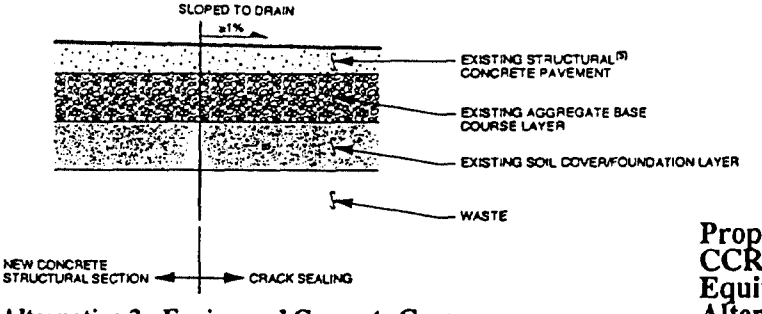




Alternative 1 - Engineered Soil Covers



Alternative 2 - Engineered Asphalt Cover



Alternative 3 - Engineered Concrete Cover

Proposed WDI CCR, Title 27 Equivalent Cap Alternatives to be Evaluated

NOT TO SCALE

NOTES:
(1) SUBTITLE D, 40 CFR PART 258 REQUIRES A COVER WITH THE FOLLOWING COMPONENTS FROM TOP TO BOTTOM.
- MINIMUM 6-INCH THICK EROSION LAYER
- MINIMUM 18-INCH THICK INFILTRATION LAYER WITH A HYDRAULIC CONDUCTIVITY OF ≤1 x10⁻⁶ cm/sec

(2) A LESSER THICKNESS MAY BE USED IF DIFFERENTIAL SETTLEMENT AND LAND USE WILL NOT AFFECT STRUCTURAL INTEGRITY OF THE FINAL COVER.
(3) SCARIFIED AND RECOMPACTED. UNSUITABLE SOIL TO BE REMOVED AND REPLACED
(4) ASPHALT OVERLAY HAS A LOW HYDRAULIC CONDUCTIVITY.
(5) REHABILITATED AS APPROPRIATE.

WORKING DRAFT

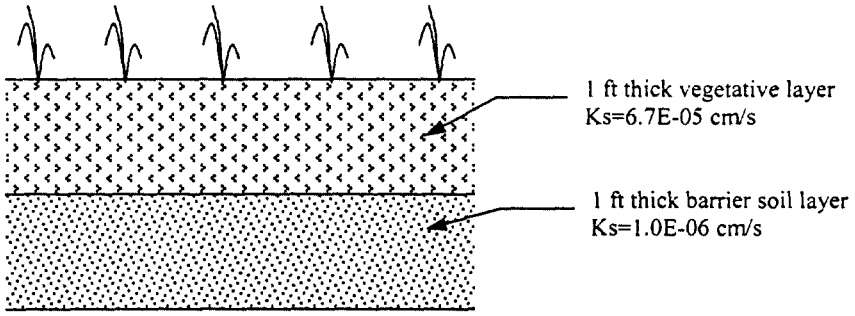
GEOTECHNICAL MODELS TO ASSESS INFILTRATION THROUGH RCRA SUBTITLE D COVERS

WASTE DISPOSAL, INC.
SANTA FE SPRINGS, CALIFORNIA

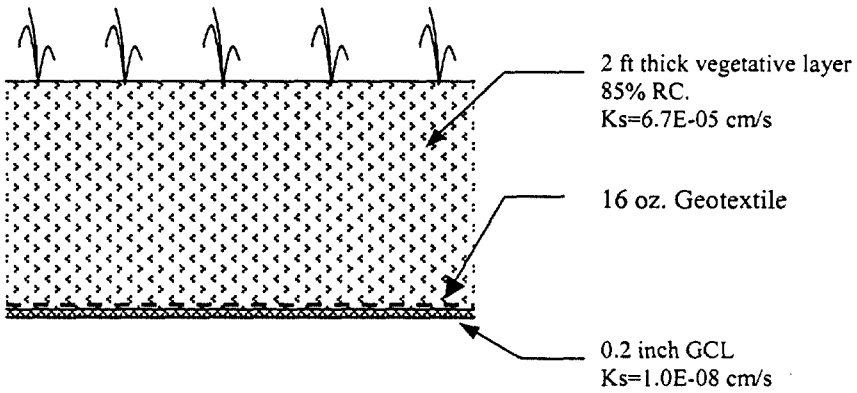
TRC

FIGURE E-1

Title 27 Cover



GCL Cover



Advanced Earth Sciences, Inc. Geotechnical and Environmental Consultants	Project No.: 01-123 WDI Superfund site Unsaturated flow modeling

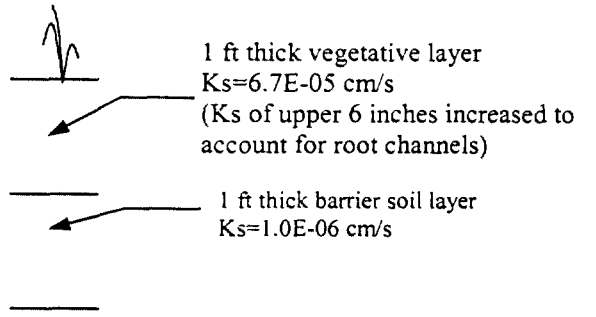
HELP Infiltration Model

Date:

Figure E-2

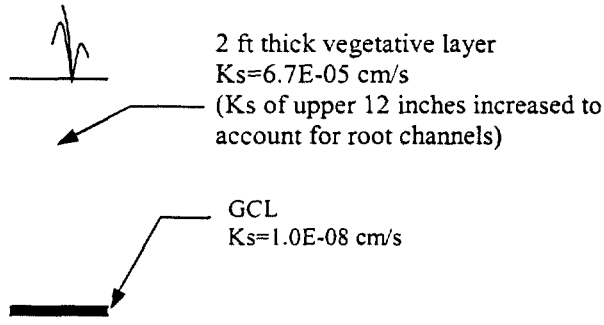
Title 27

Layer	t (in)	HELP model Texture	Ks (cm/s)	Description
1	6	50*	2.0E-4	Veg. layer w/roots
2	6	51*	6.7E-5	Veg. layer w/o roots
3	12	56*	1.0E-6	Barrier layer



GCL Cover

Layer	t (in)	HELP model Texture	Ks (cm/s)	Description
1	12	50*	2.0E-4	Veg. layer w/roots
2	12	51*	6.7E-5	Veg. layer w/o roots
3	0.2	60*	1.0E-8	GCL



*-User defined Textures

Tex.#	Description	Total Porosity	Field Capacity	Wilting Point	Satd. Hyd. Cond. (cm/s)
50	85% RC Vegetative layer w/ roots	0.366	0.357	0.097	2.00E-4
51	85% RC Vegetative layer w/o roots	0.366	0.357	0.097	6.66E-5
55	90% RC Barrier soil layer	0.322	0.32	0.1	1.00E-5
56	Low perm. Layer	0.32	0.318	0.1	1.00E-6
60	GCL	0 .75	0.747	0.4	1.00E-8

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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

HELP Model Input Parameters for Subtitle D Alternatives

Date:

Figure E-3

Annual values for GCL cover

Year	Precipitation (in)	Runoff (in)	ET (in)	Percolation (in)
1	15.65	1.77	13.12	0.74
2	22.28	5.11	13.47	1.28
3	27.96	17.81	13.11	1.60
4	9.34	0.02	8.90	0.12
5	23.04	7.51	14.79	1.32

Annual values for Title 27 cover

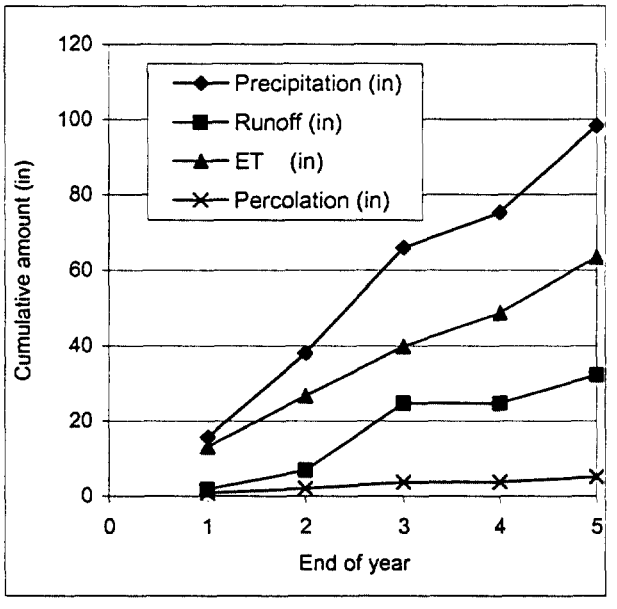
Year	Precipitation (in)	Runoff (in)	ET (in)	Percolation (in)
1	15.65	4.05	9.42	2.22
2	22.28	7.06	11.29	3.44
3	27.96	17.70	9.91	2.84
4	9.34	0.24	8.35	0.44
5	23.04	9.41	11.66	2.41

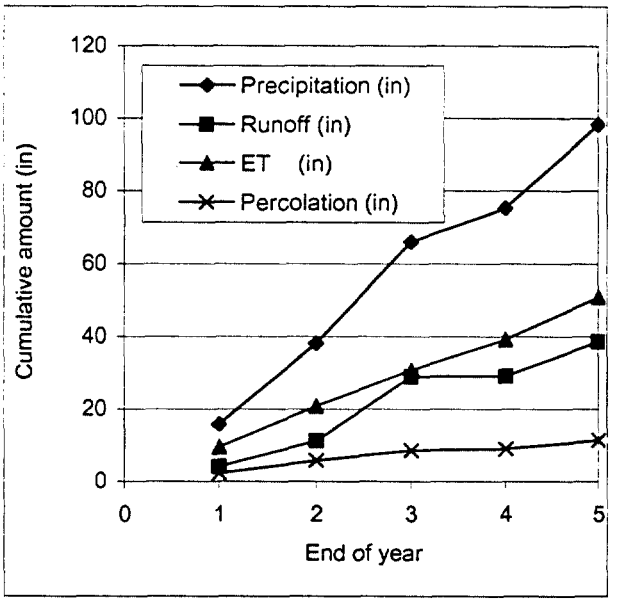
Cumulative values for GCL cover

Year	Precipitation (in)	Runoff (in)	ET (in)	Percolation (in)
1	15.65	1.77	13.12	0.74
2	37.93	6.88	26.59	2.02
3	65.89	24.69	39.70	3.62
4	75.23	24.71	48.60	3.74
5	98.27	32.22	63.39	5.06

Cumulative values for Title 27 cover

Year	Precipitation (in)	Runoff (in)	ET (in)	Percolation (in)
1	15.65	4.05	9.42	2.22
2	37.93	11.11	20.71	5.66
3	65.89	28.81	30.62	8.50
4	75.23	29.05	38.97	8.94
5	98.27	38.46	50.63	11.35





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Unsaturated flow modeling

Cumulative Water Balance for GCL and Title 27 Covers

Date:

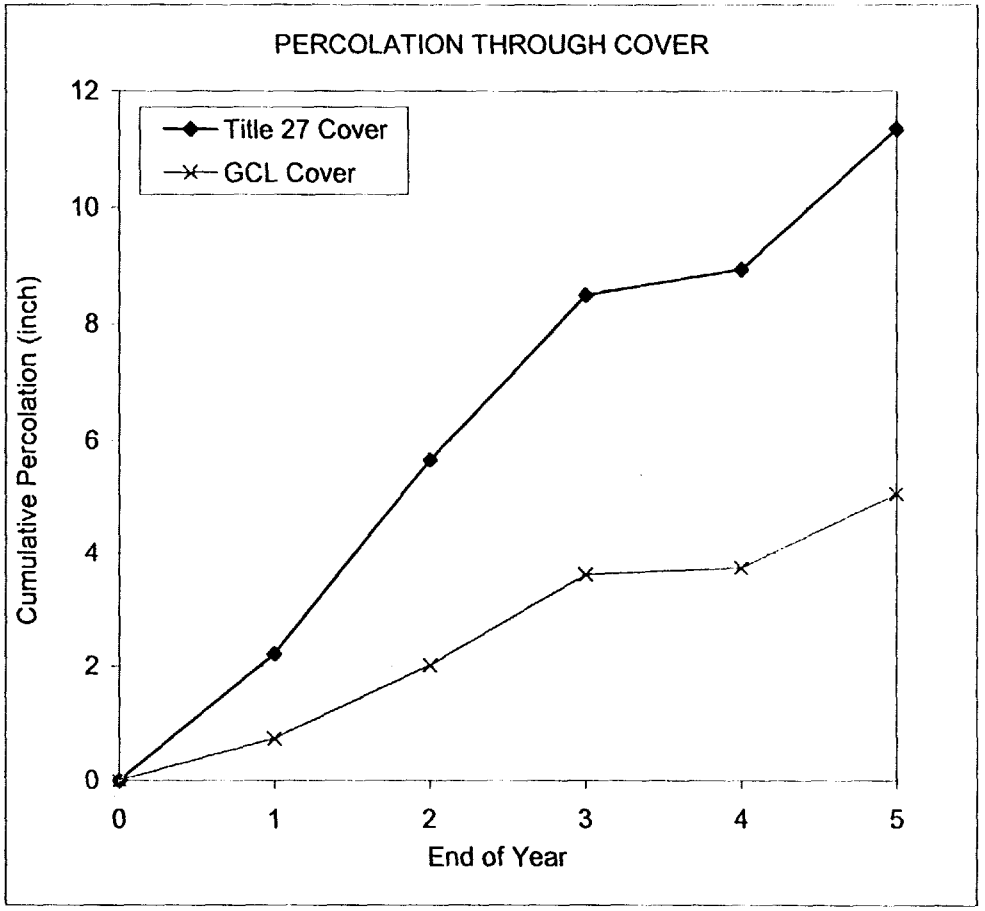
Figure E-4

ANNUAL PERCOLATION

YEAR	Title 27 Cover		GCL Cover	
	(inch)	(%)	(inch)	(%)
1	2.22	14.20	0.74	4.71
2	3.44	15.44	1.28	5.73
3	2.84	10.15	1.60	5.72
4	0.44	4.76	0.12	1.26
5	2.41	10.45	1.32	5.73

CUMULATIVE PERCOLATION

END OF YEAR	Title 27 Cover		GCL Cover	
	(inch)	(%)	(inch)	(%)
0	0.00	0.00	0.00	0.00
1	2.22	14.19	0.74	4.71
2	5.66	14.92	2.02	5.33
3	8.50	12.90	3.62	5.49
4	8.94	11.88	3.74	4.97
5	11.35	11.55	5.06	5.15



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

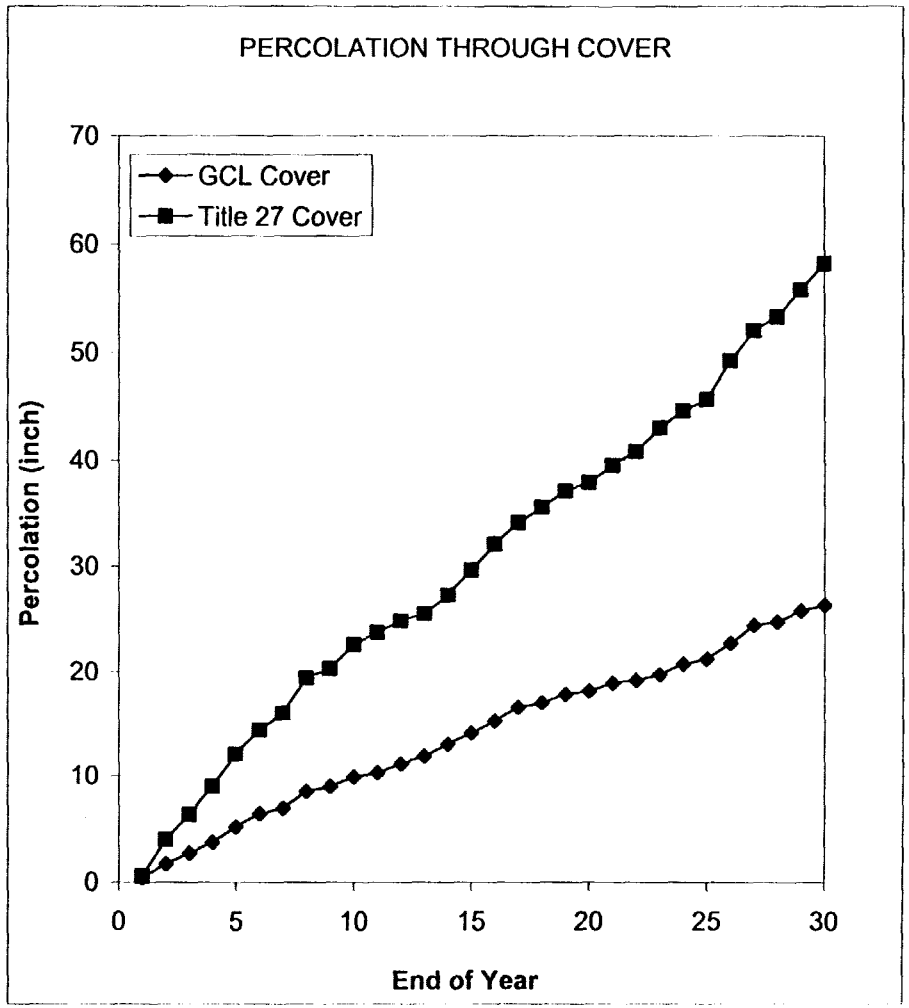
Equivalence Demonstration for GCL Cover

Date:

Figure E-5

Annual and Cumulative Percolation (inches)

	GCL Cover		Title 27 Cover	
Year	Annual	Cumulative	Annual	Cumulative
1	0.45	0.45	0.57	0.57
2	1.27	1.72	3.41	3.98
3	0.99	2.70	2.39	6.36
4	1.03	3.73	2.64	9.01
5	1.45	5.18	3.08	12.08
6	1.23	6.41	2.29	14.38
7	0.50	6.92	1.66	16.03
8	1.62	8.54	3.40	19.43
9	0.47	9.00	0.86	20.29
10	0.91	9.91	2.31	22.60
11	0.41	10.32	1.17	23.77
12	0.85	11.17	1.11	24.88
13	0.74	11.91	0.67	25.55
14	1.14	13.05	1.75	27.30
15	1.08	14.14	2.34	29.65
16	1.15	15.28	2.45	32.10
17	1.31	16.59	2.04	34.14
18	0.44	17.03	1.43	35.57
19	0.80	17.84	1.55	37.13
20	0.33	18.17	0.82	37.94
21	0.78	18.95	1.59	39.54
22	0.25	19.19	1.31	40.85
23	0.58	19.78	2.20	43.06
24	1.02	20.79	1.63	44.68
25	0.44	21.24	1.04	45.72
26	1.52	22.75	3.57	49.29
27	1.68	24.44	2.75	52.04
28	0.33	24.77	1.26	53.30
29	1.04	25.80	2.47	55.77
30	0.59	26.39	2.42	58.19



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Project No.: 01-123
WDI Superfund site
Unsaturated flow modeling

Equivalence Demonstration for GCL Cover With 30-Year Simulation Period

Date:

Figure E-6

III. *HELP Model Input / Output Files For Subtitle D Alternatives With 5-Year Simulation Period*

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

PRECIPITATION DATA FILE:     c:\HELP\DAT\PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\ET.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\TITLE27.D10
OUTPUT DATA FILE:            C:\HELP\OUT\TITLE27.OUT

TIME:  16: 7     DATE:  11/27/2002

******************************************************************************

     TITLE:  Subtitle D cover

******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2815 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3568 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  56
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3200 VOL/VOL
          FIELD CAPACITY               =      0.3180 VOL/VOL
          WILTING POINT                =      0.1000 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3200 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999997000E-06 CM/SEC

                   GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                   ----------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
                 SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
                 OF  2.% AND A SLOPE LENGTH OF  335. FEET.

      SCS RUNOFF CURVE NUMBER              =     80.10
      FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE   =      8.100  ACRES
      EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
      INITIAL WATER IN EVAPORATIVE ZONE    =      3.830  INCHES
      UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.392  INCHES
      LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.164  INCHES
      INITIAL SNOW WATER                   =      0.000  INCHES
      INITIAL WATER IN LAYER MATERIALS     =      7.670  INCHES
      TOTAL INITIAL WATER                  =      7.670  INCHES
      TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LOS ANGELES CALIFORNIA

STATION LATITUDE	=	33.80	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	285	
END OF GROWING SEASON (JULIAN DATE)	=	151	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	3.03	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	67.00	%

NOTE: PRECIPITATION DATA FOR SAN DIEGO CALIFORNIA
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR SAN DIEGO CALIFORNIA
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR SAN DIEGO CALIFORNIA
WAS ENTERED BY THE USER.

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.15	3.31	5.72	0.04	0.00	0.00
	0.00	0.00	0.00	0.39	0.00	3.04
RUNOFF	1.849	0.135	1.988	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.077
EVAPOTRANSPIRATION	1.599	1.558	3.265	2.349	0.000	0.000
	0.000	0.000	0.000	0.051	0.204	0.390
PERCOLATION/LEAKAGE THROUGH	0.8914	0.0440	1.2071	0.0012	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0792

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	4.419	0.150	5.579	0.002	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.221
STD. DEVIATION OF DAILY	4.788	0.670	4.429	0.009	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.968

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.65	460156.969	100.00
RUNOFF	4.048	119037.875	25.87
EVAPOTRANSPIRATION	9.415	276843.437	60.16
PERC./LEAKAGE THROUGH LAYER 3	2.222897	65359.852	14.20
AVG. HEAD ON TOP OF LAYER 3	0.8643		
CHANGE IN WATER STORAGE	-0.037	-1084.327	-0.24
SOIL WATER AT START OF YEAR	7.670	225517.703	
SOIL WATER AT END OF YEAR	7.633	224433.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.147	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.33	7.32	6.41	0.16	0.00	0.00
	0.24	0.00	0.00	1.39	0.00	4.43
RUNOFF	1.238	4.055	1.222	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.547
EVAPOTRANSPIRATION	1.563	2.210	2.929	2.969	0.000	0.000
	0.197	0.043	0.000	0.100	0.230	1.048
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.8700	0.7887	0.9483	0.0552	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0668	0.7103

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	4.016	4.012	4.364	0.175	0.000	0.000
	0.000	0.000	0.000	0.000	0.029	2.500
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.404	4.767	4.460	0.699	0.000	0.000
	0.000	0.000	0.000	0.000	0.051	2.938

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.28	655099.062	100.00
RUNOFF	7.061	207626.437	31.69
EVAPOTRANSPIRATION	11.290	331971.344	50.67
PERC./LEAKAGE THROUGH LAYER 3	3.439195	101122.656	15.44
AVG. HEAD ON TOP OF LAYER 3	1.2579		
CHANGE IN WATER STORAGE	0.489	14378.414	2.19
SOIL WATER AT START OF YEAR	7.633	224433.375	
SOIL WATER AT END OF YEAR	8.122	238811.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.224	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	14.64	9.62	1.62	0.00	0.00	0.91
	0.00	0.00	0.00	0.15	0.55	0.47
RUNOFF	12.387	5.310	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.718	2.054	3.399	1.293	0.000	0.310
	0.308	0.270	0.022	0.109	0.156	0.271
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.6302	1.1418	0.0660	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	8.292	6.086	0.215	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	3.975	4.497	1.092	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.96	822107.937	100.00
RUNOFF	17.697	520331.562	63.29
EVAPOTRANSPIRATION	9.909	291353.875	35.44
PERC./LEAKAGE THROUGH LAYER 3	2.838069	83447.758	10.15
AVG. HEAD ON TOP OF LAYER 3	1.2161		
CHANGE IN WATER STORAGE	-2.484	-73025.469	-8.88
SOIL WATER AT START OF YEAR	8.122	238811.781	
SOIL WATER AT END OF YEAR	5.638	165786.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.252	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.24	4.53	1.74	0.84	0.16	0.00
	0.00	0.00	0.00	0.44	0.67	0.72
RUNOFF	0.000	0.235	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.496	2.153	3.498	0.827	0.490	0.000
	0.000	0.000	0.000	0.226	0.321	0.383
PERCOLATION/LEAKAGE THROUGH	0.0000	0.3883	0.0561	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	1.739	0.108	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	3.366	0.381	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.34	274624.000	100.00
RUNOFF	0.235	6914.645	2.52
EVAPOTRANSPIRATION	8.395	246843.859	89.88

PERC./LEAKAGE THROUGH LAYER 3	0.444471	13068.770	4.76
AVG. HEAD ON TOP OF LAYER 3	0.1539		
CHANGE IN WATER STORAGE	0.265	7796.741	2.84
SOIL WATER AT START OF YEAR	5.638	165786.312	
SOIL WATER AT END OF YEAR	5.904	173583.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	11.57	1.30	7.13	1.02	0.09	1.26
	0.00	0.00	0.08	0.00	0.00	0.59
RUNOFF	6.950	0.000	2.460	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.571	2.412	3.466	2.653	0.090	0.234
	0.338	0.289	0.253	0.227	0.000	0.127
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.5803	0.0733	0.7389	0.0153	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	7.714	0.188	3.418	0.023	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	3.534	0.679	4.287	0.125	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.04	677445.187	100.00
RUNOFF	9.410	276685.250	40.84
EVAPOTRANSPIRATION	11.659	342802.844	50.60
PERC./LEAKAGE THROUGH LAYER 3	2.407715	70794.047	10.45
AVG. HEAD ON TOP OF LAYER 3	0.9453		
CHANGE IN WATER STORAGE	-0.437	-12836.937	-1.89
SOIL WATER AT START OF YEAR	5.904	173583.062	
SOIL WATER AT END OF YEAR	5.467	160746.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

PRECIPITATION						
TOTALS	6.39	5.22	4.52	0.41	0.05	0.43
	0.05	0.00	0.02	0.47	0.24	1.85
STD. DEVIATIONS	6.32	3.29	2.64	0.48	0.07	0.61
	0.11	0.00	0.04	0.54	0.34	1.79
RUNOFF						
TOTALS	4.485	1.947	1.134	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.125
STD. DEVIATIONS	5.151	2.537	1.126	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.238
EVAPOTRANSPIRATION						
TOTALS	1.389	2.078	3.311	2.018	0.116	0.109
	0.169	0.120	0.055	0.142	0.182	0.444
STD. DEVIATIONS	0.503	0.319	0.232	0.917	0.212	0.151
	0.163	0.146	0.111	0.079	0.118	0.354
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.9944	0.4872	0.6033	0.0143	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0134	0.1579
STD. DEVIATIONS	0.6638	0.4735	0.5220	0.0237	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0299	0.3107

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	4.8885	2.4350	2.7367	0.0399	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0059	0.5442
STD. DEVIATIONS	3.3336	2.5773	2.4727	0.0761	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0131	1.0973

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.65	(7.242)	577886.6	100.00
RUNOFF	7.690	(6.5635)	226119.16	39.129
EVAPOTRANSPIRATION	10.134	(1.3465)	297963.06	51.561
PERCOLATION/LEAKAGE THROUGH LAYER 3	2.27047	(1.12288)	66758.617	11.55220
AVERAGE HEAD ON TOP OF LAYER 3	0.888	(0.444)		
CHANGE IN WATER STORAGE	-0.441	(1.1936)	-12954.32	-2.242

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.47	102028.414
RUNOFF	3.085	90716.2266
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.068031	2000.31470
AVERAGE HEAD ON TOP OF LAYER 3	12.000	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3660

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	0.9749	0.1625
2	0.6521	0.1087
3	3.8400	0.3200
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************
PRECIPITATION DATA FILE:     C:\HELP\DAT\PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\ET.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\GCLCOVER.D10
OUTPUT DATA FILE:            C:\HELP\OUT\GCLCOVER.OUT

TIME:  16:31     DATE:  11/27/2002

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     TITLE:  GCL COVER

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2045 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2210 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  60
          THICKNESS                    =      0.20   INCHES
          POROSITY                     =      0.7500 VOL/VOL
          FIELD CAPACITY               =      0.7470 VOL/VOL
          WILTING POINT                =      0.4000 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999994000E-08 CM/SEC

                  GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                  ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
                SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
                OF  2.% AND A SLOPE LENGTH OF  335. FEET.

     SCS RUNOFF CURVE NUMBER              =     80.10
     FRACTION OF AREA ALLOWING RUNOFF     =    100.0     PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE   =      8.100   ACRES
     EVAPORATIVE ZONE DEPTH               =     24.0     INCHES
     INITIAL WATER IN EVAPORATIVE ZONE    =      5.106   INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE   =      8.784   INCHES
     LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.328   INCHES
     INITIAL SNOW WATER                   =      0.000   INCHES
     INITIAL WATER IN LAYER MATERIALS     =      5.256   INCHES
     TOTAL INITIAL WATER                  =      5.256   INCHES
     TOTAL SUBSURFACE INFLOW              =      0.00    INCHES/YEAR

                  EVAPOTRANSPIRATION AND WEATHER DATA
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NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LOS ANGELES CALIFORNIA

STATION LATITUDE	=	33.80	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	285	
END OF GROWING SEASON (JULIAN DATE)	=	151	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	3.03	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	67.00	%

NOTE: PRECIPITATION DATA FOR SAN DIEGO CALIFORNIA
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA FOR SAN DIEGO CALIFORNIA
WAS ENTERED BY THE USER.

NOTE: SOLAR RADIATION DATA FOR SAN DIEGO CALIFORNIA
WAS ENTERED BY THE USER.

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.15	3.31	5.72	0.04	0.00	0.00
	0.00	0.00	0.00	0.39	0.00	3.04
RUNOFF	0.002	0.109	1.567	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.095
EVAPOTRANSPIRATION	1.923	1.637	3.268	3.811	1.481	0.365
	0.099	0.000	0.000	0.044	0.152	0.335
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.1456	0.0087	0.5568	0.0075	0.0181	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	2.667	0.179	10.350	0.127	0.303	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.220	0.945	5.951	0.432	0.743	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.65	460156.969	100.00
RUNOFF	1.772	52106.629	11.32
EVAPOTRANSPIRATION	13.116	385653.312	83.81
PERC./LEAKAGE THROUGH LAYER 3	0.736623	21658.932	4.71
AVG. HEAD ON TOP OF LAYER 3	1.1355		
CHANGE IN WATER STORAGE	0.025	738.148	0.16
SOIL WATER AT START OF YEAR	5.256	154538.875	
SOIL WATER AT END OF YEAR	5.281	155277.016	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.053	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.33	7.32	6.41	0.16	0.00	0.00
	0.24	0.00	0.00	1.39	0.00	4.43
RUNOFF	0.006	3.210	1.848	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.042
EVAPOTRANSPIRATION	1.529	2.189	2.929	3.138	0.774	0.385
	0.360	0.278	0.243	0.244	0.264	1.133
PERCOLATION/LEAKAGE THROUGH	0.1214	0.3272	0.5784	0.1079	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.1426

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	2.203	6.687	10.794	2.046	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	2.566
STD. DEVIATION OF DAILY	3.290	7.279	8.141	4.292	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	2.448

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.28	655099.062	100.00
RUNOFF	5.106	150120.062	22.92
EVAPOTRANSPIRATION	13.467	395967.281	60.44
PERC./LEAKAGE THROUGH LAYER 3	1.277404	37559.500	5.73
AVG. HEAD ON TOP OF LAYER 3	2.0245		
CHANGE IN WATER STORAGE	2.430	71451.953	10.91
SOIL WATER AT START OF YEAR	5.281	155277.016	
SOIL WATER AT END OF YEAR	7.711	226728.969	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.273	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	14.64	9.62	1.62	0.00	0.00	0.91
	0.00	0.00	0.00	0.15	0.55	0.47
RUNOFF	11.822	5.988	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.811	2.081	3.534	3.954	0.324	0.281
	0.287	0.261	0.082	0.120	0.160	0.216
PERCOLATION/LEAKAGE THROUGH	0.7405	0.6665	0.1648	0.0275	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	13.831	13.781	3.034	0.485	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	7.774	6.585	4.814	0.929	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.96	822107.937	100.00
RUNOFF	17.810	523660.281	63.70
EVAPOTRANSPIRATION	13.111	385499.656	46.89
PERC./LEAKAGE THROUGH LAYER 3	1.599246	47022.633	5.72
AVG. HEAD ON TOP OF LAYER 3	2.5942		
CHANGE IN WATER STORAGE	-4.560	-134074.391	-16.31
SOIL WATER AT START OF YEAR	7.711	226728.969	
SOIL WATER AT END OF YEAR	3.151	92654.586	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.203	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.24	4.53	1.74	0.84	0.16	0.00
	0.00	0.00	0.00	0.44	0.67	0.72
RUNOFF	0.000	0.023	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.404	1.966	3.537	1.592	0.544	0.000
	0.000	0.000	0.000	0.198	0.306	0.354
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0817	0.0358	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	1.569	0.618	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	1.846	1.157	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.34	274624.000	100.00
RUNOFF	0.023	688.224	0.25
EVAPOTRANSPIRATION	8.900	261677.828	95.29

PERC./LEAKAGE THROUGH LAYER 3	0.117512	3455.212	1.26
AVG. HEAD ON TOP OF LAYER 3	0.1823		
CHANGE IN WATER STORAGE	0.299	8802.827	3.21
SOIL WATER AT START OF YEAR	3.151	92654.586	
SOIL WATER AT END OF YEAR	3.451	101457.414	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.066	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	11.57	1.30	7.13	1.02	0.09	1.26
	0.00	0.00	0.08	0.00	0.00	0.59
RUNOFF	4.430	0.000	3.077	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.479	2.274	3.478	3.743	2.207	0.297
	0.323	0.281	0.277	0.237	0.000	0.194
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.6895	0.1370	0.4401	0.0524	0.0002	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	12.904	2.763	8.161	0.955	0.003	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	8.982	4.675	6.937	1.641	0.018	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.04	677445.187	100.00
RUNOFF	7.507	220735.078	32.58
EVAPOTRANSPIRATION	14.790	434866.125	64.19
PERC./LEAKAGE THROUGH LAYER 3	1.319242	38789.664	5.73
AVG. HEAD ON TOP OF LAYER 3	2.0655		
CHANGE IN WATER STORAGE	-0.576	-16945.607	-2.50
SOIL WATER AT START OF YEAR	3.451	101457.414	
SOIL WATER AT END OF YEAR	2.874	84511.805	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.053	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

PRECIPITATION						
TOTALS	6.39	5.22	4.52	0.41	0.05	0.43
	0.05	0.00	0.02	0.47	0.24	1.85
STD. DEVIATIONS	6.32	3.29	2.64	0.48	0.07	0.61
	0.11	0.00	0.04	0.54	0.34	1.79
RUNOFF						
TOTALS	3.252	1.866	1.298	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.027
STD. DEVIATIONS	5.160	2.681	1.314	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.042
EVAPOTRANSPIRATION						
TOTALS	1.429	2.029	3.349	3.248	1.066	0.266
	0.214	0.164	0.120	0.169	0.176	0.446
STD. DEVIATIONS	0.603	0.248	0.259	0.977	0.772	0.155
	0.156	0.150	0.132	0.085	0.119	0.390
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.3394	0.2442	0.3552	0.0391	0.0037	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0285
STD. DEVIATIONS	0.3478	0.2639	0.2429	0.0435	0.0081	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0638

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	6.3208	4.9957	6.5915	0.7225	0.0612	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.5131
STD. DEVIATIONS	6.5190	5.4767	4.5438	0.8272	0.1351	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	1.1474

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.65	(7.242)	577886.6	100.00
RUNOFF	6.444	(6.9848)	189462.05	32.785
EVAPOTRANSPIRATION	12.677	(2.2213)	372732.78	64.499
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.01001	(0.58856)	29697.186	5.13893
AVERAGE HEAD ON TOP OF LAYER 3	1.600	(0.950)		
CHANGE IN WATER STORAGE	-0.476	(2.5488)	-14005.41	-2.424

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.47	102028.414
RUNOFF	2.797	82242.0781
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.041199	1211.38330
AVERAGE HEAD ON TOP OF LAYER 3	24.000	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3660

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5604	0.1300
2	1.1640	0.0970
3	0.1500	0.7500
SNOW WATER	0.000	

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III. *HELP MODEL INPUT/OUTPUT FILES FOR SUBTITLE D ALTERNATIVES WITH 30-YEAR SIMULATION PERIOD*

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**                                                                          **
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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP\DAT\30PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\30TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\30SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\TITLE27.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\TITLE27.D10
OUTPUT DATA FILE:            C:\HELP\OUT\30t27.OUT

TIME:  13:59     DATE:  12/ 7/2002

******************************************************************************
     TITLE:  Subtitle D cover
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1328 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.3660 VOL/VOL
          FIELD CAPACITY               =      0.3570 VOL/VOL
          WILTING POINT                =      0.0970 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1578 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  56
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3200 VOL/VOL
          FIELD CAPACITY               =      0.3180 VOL/VOL
          WILTING POINT                =      0.1000 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3200 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999997000E-06 CM/SEC

                   GENERAL DESIGN AND EVAPORATIVE ZONE DATA
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         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
                  SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
                  OF  2.% AND A SLOPE LENGTH OF  335. FEET.

        SCS RUNOFF CURVE NUMBER              =     80.10
        FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE   =      8.100  ACRES
        EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE    =      1.743  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.392  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.164  INCHES
        INITIAL SNOW WATER                   =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS     =      5.583  INCHES
        TOTAL INITIAL WATER                  =      5.583  INCHES
        TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

                     EVAPOTRANSPIRATION AND WEATHER DATA
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NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LOS ANGELES CALIFORNIA

STATION LATITUDE	=	33.80 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	285
END OF GROWING SEASON (JULIAN DATE)	=	151
EVAPORATIVE ZONE DEPTH	=	12.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	3.03 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	67.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SAN DIEGO CALIFORNIA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.39	5.22	4.52	0.52	0.13	1.09
0.24	0.00	0.08	0.59	0.61	1.85

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LOS ANGELES CALIFORNIA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
52.60	56.60	57.20	61.20	63.20	68.10
72.70	75.00	72.90	66.70	58.80	53.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LOS ANGELES CALIFORNIA
AND STATION LATITUDE = 33.80 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.34	0.60	6.27	0.77	0.00	1.02
	0.00	0.00	0.00	0.44	0.38	1.06
RUNOFF	0.000	0.000	0.877	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.710	2.353	2.488	3.157	0.407	0.268
	0.319	0.278	0.155	0.133	0.307	0.422
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0544	0.4601	0.0527	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.142	2.178	0.162	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.590	3.792	0.853	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.88	378710.656	100.00
RUNOFF	0.877	25794.000	6.81
EVAPOTRANSPIRATION	10.997	323335.156	85.38

PERC./LEAKAGE THROUGH LAYER 3	0.567160	16676.221	4.40
AVG. HEAD ON TOP OF LAYER 3	0.2068		
CHANGE IN WATER STORAGE	0.439	12905.370	3.41
SOIL WATER AT START OF YEAR	5.583	164163.062	
SOIL WATER AT END OF YEAR	6.022	177068.437	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.081	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.63	1.74	7.14	0.00	0.18	0.00
	0.00	0.00	0.00	1.47	0.71	1.51
RUNOFF	2.906	0.000	2.865	0.000	0.000	0.000
	0.000	0.000	0.000	0.001	0.000	0.000
EVAPOTRANSPIRATION	1.476	2.221	3.251	1.862	0.180	0.000
	0.000	0.000	0.000	0.244	0.307	0.872
PERCOLATION/LEAKAGE THROUGH	1.1574	0.6105	1.1494	0.0287	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.4625

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	5.101	2.761	4.942	0.040	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.921
STD. DEVIATION OF DAILY	4.207	3.597	4.142	0.155	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	1.483

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	20.38	599233.187	100.00
RUNOFF	5.773	169734.937	28.33
EVAPOTRANSPIRATION	10.414	306200.844	51.10
PERC./LEAKAGE THROUGH LAYER 3	3.408494	100219.961	16.72
AVG. HEAD ON TOP OF LAYER 3	1.1471		
CHANGE IN WATER STORAGE	0.785	23077.441	3.85
SOIL WATER AT START OF YEAR	6.022	177068.437	
SOIL WATER AT END OF YEAR	6.807	200145.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.049	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION	9.32	15.91	3.32	0.43	0.22	0.18
	0.00	0.00	0.00	3.13	0.47	0.99
RUNOFF	5.809	14.079	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.012	0.000	0.000
EVAPOTRANSPIRATION	1.776	2.418	3.275	1.368	0.220	0.023
	0.157	0.000	0.000	1.933	0.671	0.530
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.0930	0.9273	0.0361	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.3126	0.0000	0.0161

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	5.545	5.042	0.036	0.000	0.000	0.000
	0.000	0.000	0.000	0.970	0.000	0.006
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	5.098	4.973	0.140	0.000	0.000	0.000
	0.000	0.000	0.000	1.903	0.000	0.032

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.97	998820.000	100.00
RUNOFF	19.901	585135.875	58.58
EVAPOTRANSPIRATION	12.372	363778.844	36.42
PERC./LEAKAGE THROUGH LAYER 3	2.385155	70130.711	7.02
AVG. HEAD ON TOP OF LAYER 3	0.9666		
CHANGE IN WATER STORAGE	-0.688	-20225.221	-2.02
SOIL WATER AT START OF YEAR	6.807	200145.875	
SOIL WATER AT END OF YEAR	6.119	179920.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.196	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.11	7.65	4.02	0.53	0.00	0.00
	0.00	0.00	0.22	1.04	1.10	1.20
RUNOFF	5.179	4.288	1.022	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.903	2.364	3.363	2.002	0.000	0.000
	0.000	0.000	0.122	0.263	0.369	1.209
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3465	1.1871	0.7400	0.0305	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.3405

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	1.815	5.957	3.095	0.063	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.727
STD. DEVIATION OF DAILY	3.901	4.266	3.784	0.345	0.000	0.000

HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	1.160

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.87	701849.750	100.00
RUNOFF	10.488	308389.375	43.94
EVAPOTRANSPIRATION	10.595	311513.812	44.38
PERC./LEAKAGE THROUGH LAYER 3	2.644681	77761.570	11.08
AVG. HEAD ON TOP OF LAYER 3	0.9714		
CHANGE IN WATER STORAGE	0.142	4184.990	0.60
SOIL WATER AT START OF YEAR	6.119	179920.656	
SOIL WATER AT END OF YEAR	6.261	184105.641	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.12	4.26	7.59	0.15	0.11	0.00
	0.00	0.00	0.00	1.47	0.54	0.37
RUNOFF	6.442	0.211	3.127	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.571	2.374	3.105	2.807	0.175	0.000
	0.000	0.000	0.000	0.132	0.271	0.301
PERCOLATION/LEAKAGE THROUGH	0.7811	0.3897	1.4213	0.0845	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.4006

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	3.755	1.476	6.371	0.192	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.605
STD. DEVIATION OF DAILY	4.623	2.820	3.510	0.643	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.888

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.61	694204.750	100.00
RUNOFF	9.779	287544.750	41.42
EVAPOTRANSPIRATION	10.735	315646.656	45.47
PERC./LEAKAGE THROUGH LAYER 3	3.077229	90479.781	13.03
AVG. HEAD ON TOP OF LAYER 3	1.0333		
CHANGE IN WATER STORAGE	0.018	533.506	0.08
SOIL WATER AT START OF YEAR	6.261	184105.641	

SOIL WATER AT END OF YEAR	6.280	184639.141	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.084	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 6

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.92	4.11	6.25	0.61	0.12	0.00
	0.00	0.00	0.07	0.52	0.19	2.35
RUNOFF	4.475	2.382	2.669	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.949	2.536	3.588	1.345	0.143	0.000
	0.000	0.000	0.048	0.234	0.285	0.666
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.6500	0.8262	0.7220	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0948

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	3.220	3.994	3.071	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.181
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.611	4.127	4.018	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.663

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.14	650982.687	100.00
RUNOFF	9.527	280113.531	43.03
EVAPOTRANSPIRATION	9.794	287981.937	44.24
PERC./LEAKAGE THROUGH LAYER 3	2.293025	67421.828	10.36
AVG. HEAD ON TOP OF LAYER 3	0.8721		
CHANGE IN WATER STORAGE	0.526	15465.110	2.38
SOIL WATER AT START OF YEAR	6.280	184639.141	
SOIL WATER AT END OF YEAR	6.806	200104.266	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.273	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 7

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.00	2.23	1.69	0.39	0.22	0.88
	2.60	0.00	0.00	0.90	0.47	1.44
RUNOFF	0.000	0.405	0.000	0.000	0.000	0.000
	0.006	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	1.675	2.253	3.359	0.390	0.220	0.181
	2.151	0.979	0.000	0.107	0.345	0.354
PERCOLATION/LEAKAGE THROUGH	0.3960	0.6016	0.0309	0.0000	0.0000	0.0000
LAYER 3	0.1634	0.0000	0.0000	0.0000	0.0000	0.4643

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.263	2.866	0.062	0.000	0.000	0.000
TOP OF LAYER 3	0.550	0.000	0.000	0.000	0.000	0.749
STD. DEVIATION OF DAILY	2.218	3.903	0.295	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	1.662	0.000	0.000	0.000	0.000	0.955

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.82	406349.437	100.00
RUNOFF	0.411	12075.880	2.97
EVAPOTRANSPIRATION	12.015	353287.969	86.94
PERC./LEAKAGE THROUGH LAYER 3	1.656175	48696.516	11.98
AVG. HEAD ON TOP OF LAYER 3	0.4575		
CHANGE IN WATER STORAGE	-0.262	-7710.740	-1.90
SOIL WATER AT START OF YEAR	6.806	200104.266	
SOIL WATER AT END OF YEAR	6.543	192393.516	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.165	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 8

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.30	7.17	6.49	0.84	0.02	0.90
	0.00	0.00	0.00	3.57	0.15	0.00
RUNOFF	4.652	2.606	2.703	0.000	0.000	0.000
	0.000	0.000	0.000	0.297	0.000	0.000
EVAPOTRANSPIRATION	1.757	2.720	3.564	3.287	0.136	0.321
	0.321	0.258	0.000	0.177	1.755	0.642
PERCOLATION/LEAKAGE THROUGH	1.1851	0.8619	0.6883	0.1992	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.1389	0.3219	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	5.234	4.213	3.063	0.490	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.710	1.352	0.000
STD. DEVIATION OF DAILY	4.329	4.139	4.298	1.075	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	2.562	2.927	0.000

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.44	806818.500	100.00
RUNOFF	10.257	301583.469	37.38
EVAPOTRANSPIRATION	14.939	439252.406	54.44
PERC./LEAKAGE THROUGH LAYER 3	3.395277	99831.320	12.37
AVG. HEAD ON TOP OF LAYER 3	1.2552		
CHANGE IN WATER STORAGE	-1.151	-33848.746	-4.20
SOIL WATER AT START OF YEAR	6.543	192393.516	
SOIL WATER AT END OF YEAR	5.392	158544.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.070	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 9

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.79	2.37	8.31	0.65	0.14	0.00
	0.00	0.00	0.00	0.00	0.81	1.55
RUNOFF	0.000	0.014	3.382	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.562	1.718	3.540	2.426	0.131	0.009
	0.000	0.000	0.000	0.000	0.271	0.310
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.0789	0.7553	0.0301	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	0.244	3.445	0.063	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	0.936	4.366	0.343	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.62	429871.969	100.00
RUNOFF	3.397	99868.945	23.23
EVAPOTRANSPIRATION	8.968	263698.719	61.34
PERC./LEAKAGE THROUGH LAYER 3	0.864333	25413.977	5.91
AVG. HEAD ON TOP OF LAYER 3	0.3126		
CHANGE IN WATER STORAGE	1.391	40890.262	9.51
SOIL WATER AT START OF YEAR	5.392	158544.781	
SOIL WATER AT END OF YEAR	6.783	199435.031	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.068	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.44	10.74	1.38	0.73	0.11	5.34
	0.00	0.00	0.00	1.36	0.19	0.77
RUNOFF	0.746	8.482	0.000	0.000	0.000	1.861
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.727	2.330	3.316	0.614	0.226	2.007
	0.706	0.430	0.139	0.219	0.315	0.360
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.5176	1.1103	0.1099	0.0000	0.0000	0.1979
	0.0000	0.0000	0.0000	0.0614	0.0440	0.2688

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	2.600	5.795	0.300	0.000	0.000	0.855
	0.000	0.000	0.000	0.025	0.019	0.095
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.344	4.425	1.074	0.000	0.000	2.625
	0.000	0.000	0.000	0.053	0.026	0.136

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.06	707436.250	100.00
RUNOFF	11.088	326034.656	46.09
EVAPOTRANSPIRATION	11.389	334880.406	47.34
PERC./LEAKAGE THROUGH LAYER 3	2.309873	67917.211	9.60
AVG. HEAD ON TOP OF LAYER 3	0.8074		
CHANGE IN WATER STORAGE	-0.728	-21395.982	-3.02
SOIL WATER AT START OF YEAR	6.783	199435.031	
SOIL WATER AT END OF YEAR	6.055	178039.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.021	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 11

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.10	2.27	3.07	1.80	0.00	0.00
	0.00	0.00	0.00	1.98	0.24	4.00
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.568
EVAPOTRANSPIRATION	1.325	2.125	3.477	2.233	0.115	0.000
	0.000	0.000	0.000	0.323	0.295	1.169
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0171	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.3754	0.1322	0.6472

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.023	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.595	0.064	3.061
STD. DEVIATION OF DAILY	0.128	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.912	0.151	4.311

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.46	425167.437	100.00
RUNOFF	1.568	46115.828	10.85
EVAPOTRANSPIRATION	11.061	325236.500	76.50
PERC./LEAKAGE THROUGH LAYER 3	1.171914	34457.793	8.10
AVG. HEAD ON TOP OF LAYER 3	0.3119		
CHANGE IN WATER STORAGE	0.658	19357.270	4.55
SOIL WATER AT START OF YEAR	6.055	178039.047	
SOIL WATER AT END OF YEAR	6.713	197396.328	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.049	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 12

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.00	10.77	1.66	1.77	0.04	1.60
	0.00	0.00	0.04	1.12	0.52	0.28
RUNOFF	0.000	4.985	0.000	0.000	0.000	0.013
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.409	2.224	3.430	2.750	0.040	0.400
	0.353	0.298	0.259	0.258	1.030	0.681
PERCOLATION/LEAKAGE THROUGH	0.0320	0.7726	0.3061	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.065	3.953	1.255	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.352	4.568	2.948	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.80	523373.469	100.00
RUNOFF	4.997	146938.219	28.08
EVAPOTRANSPIRATION	13.133	386155.406	73.78

PERC./LEAKAGE THROUGH LAYER 3	1.110745	32659.229	6.24
AVG. HEAD ON TOP OF LAYER 3	0.4394		
CHANGE IN WATER STORAGE	-1.441	-42379.527	-8.10
SOIL WATER AT START OF YEAR	6.713	197396.328	
SOIL WATER AT END OF YEAR	5.272	155016.797	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.133	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 13

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	12.96	0.54	1.55	0.27	0.13	0.00
	0.00	0.00	0.12	1.32	0.03	0.12
RUNOFF	8.307	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.504	2.165	2.482	0.310	0.209	0.072
	0.000	0.000	0.119	0.238	0.251	0.302
PERCOLATION/LEAKAGE THROUGH	0.3288	0.3244	0.0162	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.567	1.608	0.023	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	3.334	3.368	0.126	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.04	501027.156	100.00
RUNOFF	8.307	244247.047	48.75
EVAPOTRANSPIRATION	7.653	225008.391	44.91
PERC./LEAKAGE THROUGH LAYER 3	0.669445	19683.687	3.93
AVG. HEAD ON TOP OF LAYER 3	0.2665		
CHANGE IN WATER STORAGE	0.411	12088.104	2.41
SOIL WATER AT START OF YEAR	5.272	155016.797	
SOIL WATER AT END OF YEAR	5.683	167104.906	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.037	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 14

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION	5.45	8.00	3.71	1.05	0.00	2.57
	0.00	0.00	0.00	0.26	0.05	1.35
RUNOFF	1.933	4.523	0.079	0.000	0.000	0.121
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.591	2.433	3.709	2.682	0.265	2.058
	0.315	0.000	0.000	0.200	0.110	0.371
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.9554	0.5281	0.1622	0.0286	0.0000	0.0759
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	4.567	2.584	0.502	0.061	0.000	0.151
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.605	4.011	1.524	0.334	0.000	0.555
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.44	659803.437	100.00
RUNOFF	6.656	195694.172	29.66
EVAPOTRANSPIRATION	13.735	403837.094	61.21
PERC./LEAKAGE THROUGH LAYER 3	1.750301	51464.090	7.80
AVG. HEAD ON TOP OF LAYER 3	0.6554		
CHANGE IN WATER STORAGE	0.300	8807.951	1.33
SOIL WATER AT START OF YEAR	5.683	167104.906	
SOIL WATER AT END OF YEAR	5.983	175912.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.151	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.67	1.18	4.93	0.66	0.10	1.98
	0.00	0.00	0.00	0.00	1.24	1.51
RUNOFF	5.496	0.000	1.239	0.000	0.000	0.001
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.151	2.010	2.816	2.875	0.100	0.554
	1.395	0.029	0.000	0.000	0.207	0.315
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.2580	0.2744	0.2550	0.0437	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.5137

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	6.478	0.980	0.850	0.083	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.827
STD. DEVIATION OF DAILY	4.853	2.361	2.182	0.350	0.000	0.000

HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.969

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.27	625401.750	100.00
RUNOFF	6.737	198082.766	31.67
EVAPOTRANSPIRATION	11.453	336753.937	53.85
PERC./LEAKAGE THROUGH LAYER 3	2.344767	68943.180	11.02
AVG. HEAD ON TOP OF LAYER 3	0.7682		
CHANGE IN WATER STORAGE	0.735	21621.965	3.46
SOIL WATER AT START OF YEAR	5.983	175912.859	
SOIL WATER AT END OF YEAR	6.718	197534.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.091	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 16

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	18.60	3.49	0.55	0.29	0.01	1.49
	1.79	0.00	0.21	0.02	0.35	1.25
RUNOFF	14.965	0.582	0.000	0.000	0.000	0.005
	0.033	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.629	2.350	2.257	0.682	0.010	1.485
	0.218	0.381	0.315	0.295	0.329	0.481
PERCOLATION/LEAKAGE THROUGH	1.4155	0.7056	0.0582	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.2723	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	6.707	2.987	0.116	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.220	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	4.349	3.642	0.529	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.488	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.05	824754.375	100.00
RUNOFF	15.585	458255.406	55.56
EVAPOTRANSPIRATION	10.431	306707.844	37.19
PERC./LEAKAGE THROUGH LAYER 3	2.451542	72082.687	8.74
AVG. HEAD ON TOP OF LAYER 3	0.8358		
CHANGE IN WATER STORAGE	-0.418	-12291.920	-1.49
SOIL WATER AT START OF YEAR	6.718	197534.812	

SOIL WATER AT END OF YEAR	6.300	185242.891	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.393	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 17

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	13.89	2.74	6.97	0.31	0.18	0.00
	0.00	0.00	0.00	0.00	0.46	0.97
RUNOFF	9.747	0.000	2.402	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.775	2.259	3.659	3.325	0.180	0.000
	0.000	0.000	0.000	0.000	0.170	0.347
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.5322	0.2732	0.1772	0.0567	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	7.361	0.864	0.952	0.194	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	3.861	1.787	2.962	1.020	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.52	750364.687	100.00
RUNOFF	12.149	357212.781	47.61
EVAPOTRANSPIRATION	11.716	344475.594	45.91
PERC./LEAKAGE THROUGH LAYER 3	2.039256	59960.234	7.99
AVG. HEAD ON TOP OF LAYER 3	0.7809		
CHANGE IN WATER STORAGE	-0.384	-11284.103	-1.50
SOIL WATER AT START OF YEAR	6.300	185242.891	
SOIL WATER AT END OF YEAR	5.916	173958.797	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.182	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 18

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.17	7.22	1.91	1.24	0.04	0.20
	0.00	0.00	0.00	0.14	0.40	0.11
RUNOFF	0.461	4.697	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	1.310	2.059	2.697	1.546	0.287	0.200
	0.000	0.000	0.000	0.080	0.265	0.244
PERCOLATION/LEAKAGE THROUGH	0.8142	0.6205	0.0000	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	3.429	3.097	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	3.935	4.099	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.43	424285.312	100.00
RUNOFF	5.158	151661.703	35.75
EVAPOTRANSPIRATION	8.689	255490.047	60.22
PERC./LEAKAGE THROUGH LAYER 3	1.434626	42182.301	9.94
AVG. HEAD ON TOP OF LAYER 3	0.5438		
CHANGE IN WATER STORAGE	-0.852	-25048.617	-5.90
SOIL WATER AT START OF YEAR	5.916	173958.797	
SOIL WATER AT END OF YEAR	5.064	148910.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.084	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 19

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.24	6.04	0.02	0.78	0.07	0.00
	0.00	0.00	0.00	0.74	1.02	0.81
RUNOFF	2.534	3.211	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.989	2.028	3.050	0.476	0.373	0.000
	0.000	0.000	0.000	0.240	0.365	0.354
PERCOLATION/LEAKAGE THROUGH	0.8395	0.6468	0.0619	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0063

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	3.612	3.090	0.208	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.003
STD. DEVIATION OF DAILY	4.036	3.925	1.084	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.015

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.72	491618.156	100.00
RUNOFF	5.745	168915.219	34.36
EVAPOTRANSPIRATION	7.877	231617.562	47.11
PERC./LEAKAGE THROUGH LAYER 3	1.554550	45708.434	9.30
AVG. HEAD ON TOP OF LAYER 3	0.5761		
CHANGE IN WATER STORAGE	1.543	45377.000	9.23
SOIL WATER AT START OF YEAR	5.064	148910.172	
SOIL WATER AT END OF YEAR	6.608	194287.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.035	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.93	9.51	0.72	0.49	0.21	1.90
	0.00	0.00	0.02	0.00	0.66	0.37
RUNOFF	0.000	7.097	0.000	0.000	0.000	0.049
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.619	2.444	1.727	0.551	0.211	1.851
	0.000	0.000	0.020	0.000	0.036	0.296
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3428	0.4723	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	1.130	2.451	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	2.210	4.372	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.81	464861.500	100.00
RUNOFF	7.146	210116.703	45.20
EVAPOTRANSPIRATION	8.754	257403.219	55.37
PERC./LEAKAGE THROUGH LAYER 3	0.815163	23968.250	5.16
AVG. HEAD ON TOP OF LAYER 3	0.2984		
CHANGE IN WATER STORAGE	-0.906	-26626.617	-5.73
SOIL WATER AT START OF YEAR	6.608	194287.172	
SOIL WATER AT END OF YEAR	5.702	167660.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.035	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 21

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.08	5.42	3.11	0.83	0.13	0.32
	0.00	0.00	0.11	0.00	0.67	2.09
RUNOFF	1.930	3.624	0.033	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.701	2.125	3.393	1.926	0.141	0.190
	0.131	0.000	0.110	0.000	0.110	0.600
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.5671	0.8000	0.0290	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1988

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	2.679	3.715	0.059	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.306
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.176	3.959	0.330	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.651

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ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.76	522197.312	100.00
RUNOFF	5.586	164248.953	31.45
EVAPOTRANSPIRATION	9.426	277152.594	53.07
PERC./LEAKAGE THROUGH LAYER 3	1.594892	46894.617	8.98
AVG. HEAD ON TOP OF LAYER 3	0.5633		
CHANGE IN WATER STORAGE	1.153	33901.168	6.49
SOIL WATER AT START OF YEAR	5.702	167660.562	
SOIL WATER AT END OF YEAR	6.855	201561.719	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.011	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 22

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.32	2.08	7.12	0.01	0.36	1.76
	0.00	0.00	0.06	0.12	0.40	1.81
RUNOFF	0.025	0.000	4.116	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.582	2.208	3.342	0.932	0.137	1.323
	0.536	0.032	0.034	0.060	0.234	0.277
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3363	0.2233	0.6154	0.0000	0.0000	0.0918
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0468

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.090	0.790	2.611	0.000	0.000	0.141
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.063
STD. DEVIATION OF DAILY	2.372	1.684	4.035	0.000	0.000	0.445
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.311

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ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.04	471624.156	100.00
RUNOFF	4.141	121764.922	25.82
EVAPOTRANSPIRATION	10.697	314536.875	66.69
PERC./LEAKAGE THROUGH LAYER 3	1.313724	38627.414	8.19
AVG. HEAD ON TOP OF LAYER 3	0.3913		
CHANGE IN WATER STORAGE	-0.112	-3305.166	-0.70
SOIL WATER AT START OF YEAR	6.855	201561.719	
SOIL WATER AT END OF YEAR	6.743	198256.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.154	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 23

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.16	9.38	4.73	0.19	0.12	0.00
	0.42	0.00	0.00	0.00	1.99	0.14
RUNOFF	0.789	5.853	1.642	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.012	2.541	3.948	1.209	0.121	0.000
	0.277	0.143	0.000	0.000	0.271	0.262
PERCOLATION/LEAKAGE THROUGH	0.8205	0.7072	0.6762	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	3.155	3.664	3.046	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	3.781	4.240	4.050	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
PRECIPITATION	20.13	591882.437	100.00
RUNOFF	8.285	243596.953	41.16
EVAPOTRANSPIRATION	9.784	287670.375	48.60

PERC./LEAKAGE THROUGH LAYER 3	2.203857	64800.023	10.95
AVG. HEAD ON TOP OF LAYER 3	0.8221		
CHANGE IN WATER STORAGE	-0.142	-4184.906	-0.71
SOIL WATER AT START OF YEAR	6.743	198256.562	
SOIL WATER AT END OF YEAR	6.600	194071.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 24

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.00	2.17	3.76	0.09	0.16	5.25
	0.00	0.00	0.00	0.33	0.07	2.36
RUNOFF	4.065	0.007	0.000	0.000	0.000	1.475
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.067	2.444	3.693	1.959	0.160	2.387
	0.706	0.430	0.108	0.030	0.239	0.294
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.7352	0.1914	0.4398	0.0158	0.0000	0.1442
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1007

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	2.781	0.649	1.396	0.023	0.000	0.598
	0.000	0.000	0.000	0.000	0.000	0.149
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	3.897	1.540	2.457	0.127	0.000	1.873
	0.000	0.000	0.000	0.000	0.000	0.484

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ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.19	623049.687	100.00
RUNOFF	5.547	163103.984	26.18
EVAPOTRANSPIRATION	13.515	397390.500	63.78
PERC./LEAKAGE THROUGH LAYER 3	1.627094	47841.437	7.68
AVG. HEAD ON TOP OF LAYER 3	0.4662		
CHANGE IN WATER STORAGE	0.500	14713.643	2.36
SOIL WATER AT START OF YEAR	6.600	194071.656	
SOIL WATER AT END OF YEAR	7.101	208785.297	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.130	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 25

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION	3.65	2.25	1.12	0.63	0.06	3.39
	1.20	0.00	0.00	0.01	1.09	1.48
RUNOFF	2.129	0.813	0.000	0.000	0.000	0.503
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.745	2.304	1.540	1.239	0.041	1.849
	1.598	0.584	0.012	0.010	0.171	0.285
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.5483	0.4297	0.0000	0.0000	0.0000	0.0452
	0.0175	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	2.326	2.129	0.000	0.000	0.000	0.140
	0.023	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	3.716	3.739	0.000	0.000	0.000	0.712
	0.129	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.88	437516.687	100.00
RUNOFF	3.445	101287.547	23.15
EVAPOTRANSPIRATION	10.378	305133.750	69.74
PERC./LEAKAGE THROUGH LAYER 3	1.040760	30601.461	6.99
AVG. HEAD ON TOP OF LAYER 3	0.3848		
CHANGE IN WATER STORAGE	0.017	493.940	0.11
SOIL WATER AT START OF YEAR	7.101	208785.297	
SOIL WATER AT END OF YEAR	7.118	209279.234	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 26

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	10.35	4.23	3.20	1.35	0.08	0.00
	0.00	0.00	0.00	0.00	0.22	6.92
RUNOFF	6.654	2.020	1.387	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.917
EVAPOTRANSPIRATION	1.499	2.331	3.027	1.870	0.085	0.000
	0.000	0.000	0.000	0.000	0.073	1.077
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.2031	0.8988	0.3489	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	1.1164

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	5.234	4.627	1.509	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	5.210
STD. DEVIATION OF DAILY	4.156	4.479	3.178	0.000	0.000	0.000

HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	4.469

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.35	774769.187	100.00
RUNOFF	11.978	352177.594	45.46
EVAPOTRANSPIRATION	9.962	292902.031	37.81
PERC./LEAKAGE THROUGH LAYER 3	3.567257	104888.070	13.54
AVG. HEAD ON TOP OF LAYER 3	1.3817		
CHANGE IN WATER STORAGE	0.844	24801.451	3.20
SOIL WATER AT START OF YEAR	7.118	209279.234	
SOIL WATER AT END OF YEAR	7.961	234080.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.091	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 27

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.99	6.77	3.20	0.09	0.00	0.00
	0.00	0.00	0.06	0.30	0.54	1.43
RUNOFF	7.299	3.632	0.400	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.769	2.235	3.542	1.382	0.000	0.000
	0.000	0.000	0.027	0.071	0.208	0.316
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.9008	1.0176	0.8288	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	4.208	4.983	3.592	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.514	3.983	3.952	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.38	658039.125	100.00
RUNOFF	11.331	333178.531	50.63
EVAPOTRANSPIRATION	9.550	280811.281	42.67
PERC./LEAKAGE THROUGH LAYER 3	2.747174	80775.156	12.28
AVG. HEAD ON TOP OF LAYER 3	1.0653		
CHANGE IN WATER STORAGE	-1.249	-36725.699	-5.58
SOIL WATER AT START OF YEAR	7.961	234080.687	

SOIL WATER AT END OF YEAR	6.712	197354.984	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.084	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 28

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.74	2.10	1.50	0.00	0.26	0.00
	0.53	0.00	0.00	0.23	0.02	1.07
RUNOFF	0.994	1.714	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.557	2.305	2.216	0.000	0.044	0.216
	0.196	0.245	0.089	0.124	0.126	0.056
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.6688	0.5938	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	1.984	3.086	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	3.438	4.525	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.45	277858.344	100.00
RUNOFF	2.708	79621.070	28.66
EVAPOTRANSPIRATION	6.174	181528.797	65.33
PERC./LEAKAGE THROUGH LAYER 3	1.262639	37125.367	13.36
AVG. HEAD ON TOP OF LAYER 3	0.4225		
CHANGE IN WATER STORAGE	-0.694	-20416.754	-7.35
SOIL WATER AT START OF YEAR	6.712	197354.984	
SOIL WATER AT END OF YEAR	6.018	176938.234	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.109	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 29

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.72	6.05	3.06	0.87	0.00	0.00
	0.00	0.00	0.18	0.23	0.55	0.78
RUNOFF	2.380	3.508	0.418	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	1.449	2.183	3.430	1.873	0.000	0.000
	0.000	0.000	0.145	0.053	0.228	0.250
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.3577	0.8702	0.2449	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	6.299	4.653	1.075	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	4.013	4.725	2.904	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.44	542191.375	100.00
RUNOFF	6.306	185408.344	34.20
EVAPOTRANSPIRATION	9.611	282601.531	52.12
PERC./LEAKAGE THROUGH LAYER 3	2.472854	72709.336	13.41
AVG. HEAD ON TOP OF LAYER 3	1.0023		
CHANGE IN WATER STORAGE	0.050	1472.077	0.27
SOIL WATER AT START OF YEAR	6.018	176938.234	
SOIL WATER AT END OF YEAR	6.068	178410.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.084	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.54	6.91	5.59	0.83	0.00	0.00
	0.00	0.00	0.24	0.00	1.07	1.49
RUNOFF	0.000	3.566	3.294	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.308	1.096	3.762	1.309	0.000	0.000
	0.000	0.000	0.159	0.081	0.344	0.367
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.6224	0.9759	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.8171

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	2.946	4.398	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.655
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	4.223	4.251	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.538

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ANNUAL TOTALS FOR YEAR 30

	30T27.OUT INCHES	CU. FEET	PERCENT
PRECIPITATION	16.67	490148.094	100.00
RUNOFF	6.861	201719.328	41.15
EVAPOTRANSPIRATION	7.426	218355.109	44.55
PERC./LEAKAGE THROUGH LAYER 3	2.415445	71021.328	14.49
AVG. HEAD ON TOP OF LAYER 3	0.7499		
CHANGE IN WATER STORAGE	-0.032	-947.726	-0.19
SOIL WATER AT START OF YEAR	6.068	178410.312	
SOIL WATER AT END OF YEAR	6.036	177462.594	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.070	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.22	5.20	3.80	0.62	0.10	0.96
	0.22	0.00	0.04	0.69	0.55	1.39
STD. DEVIATIONS	4.39	3.65	2.38	0.48	0.09	1.49
	0.60	0.00	0.08	0.92	0.44	1.34
RUNOFF						
TOTALS	3.331	2.743	1.055	0.000	0.000	0.134
	0.001	0.000	0.000	0.010	0.000	0.116
STD. DEVIATIONS	3.611	3.201	1.343	0.000	0.000	0.430
	0.006	0.000	0.000	0.054	0.000	0.444
EVAPOTRANSPIRATION						
TOTALS	1.237	2.239	3.135	1.680	0.145	0.513
	0.313	0.136	0.062	0.184	0.332	0.467
STD. DEVIATIONS	0.434	0.287	0.603	0.950	0.106	0.780
	0.529	0.233	0.084	0.347	0.325	0.285
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.6933	0.5873	0.3770	0.0190	0.0000	0.0185
	0.0060	0.0091	0.0000	0.0296	0.0166	0.1832
STD. DEVIATIONS	0.4562	0.3152	0.3936	0.0405	0.0000	0.0477
	0.0299	0.0497	0.0000	0.0901	0.0629	0.2895

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	3.1076	2.8449	1.6052	0.0457	0.0000	0.0628
	0.0191	0.0073	0.0000	0.0766	0.0478	0.4853
STD. DEVIATIONS	2.2072	1.6923	1.7623	0.1015	0.0000	0.1886
	0.1004	0.0401	0.0000	0.2365	0.2466	1.1039

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.79	(5.388)	581807.0	100.00

RUNOFF	7.391	(4.3171)	217320.75	37.353
EVAPOTRANSPIRATION	10.442	(1.9628)	307011.50	52.769
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.93965	(0.83942)	57031.445	9.80247
AVERAGE HEAD ON TOP OF LAYER 3	0.692	(0.319)		
CHANGE IN WATER STORAGE	0.015	(0.7737)	443.32	0.076

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	6.02	177006.062
RUNOFF	5.779	169906.8280
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.068031	2000.31470
AVERAGE HEAD ON TOP OF LAYER 3	12.000	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3660

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.7530	0.1255
2	1.4426	0.2404
3	3.8400	0.3200
SNOW WATER	0.000	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP\DAT\30PR.D4
TEMPERATURE DATA FILE:       C:\HELP\DAT\30TM.D7
SOLAR RADIATION DATA FILE:   C:\HELP\DAT\30SR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\DAT\GCLCOVER.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\COV\GCLCOVER.D10
OUTPUT DATA FILE:            C:\HELP\OUT\30GCL.OUT

TIME:  13:14     DATE:  12/ 7/2002

******************************************************************************
     TITLE:  GCL COVER
******************************************************************************

     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  50
         THICKNESS                    =     12.00   INCHES
         POROSITY                     =      0.3660 VOL/VOL
         FIELD CAPACITY               =      0.3570 VOL/VOL
         WILTING POINT                =      0.0970 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.1497 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.199999995000E-03 CM/SEC

                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  51
         THICKNESS                    =     12.00   INCHES
         POROSITY                     =      0.3660 VOL/VOL
         FIELD CAPACITY               =      0.3570 VOL/VOL
         WILTING POINT                =      0.0970 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.2616 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.665999978000E-04 CM/SEC

                                  LAYER  3
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  60
         THICKNESS                    =      0.20   INCHES
         POROSITY                     =      0.7500 VOL/VOL
         FIELD CAPACITY               =      0.7470 VOL/VOL
         WILTING POINT                =      0.4000 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.999999994000E-08 CM/SEC

                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                 ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
                SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
                OF  2.% AND A SLOPE LENGTH OF  335. FEET.

      SCS RUNOFF CURVE NUMBER              =     80.10
      FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE   =      8.100  ACRES
      EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
      INITIAL WATER IN EVAPORATIVE ZONE    =      4.936  INCHES
      UPPER LIMIT OF EVAPORATIVE STORAGE   =      8.784  INCHES
      LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.328  INCHES
      INITIAL SNOW WATER                   =      0.000  INCHES
      INITIAL WATER IN LAYER MATERIALS     =      5.086  INCHES
      TOTAL INITIAL WATER                  =      5.086  INCHES
      TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR

                 EVAPOTRANSPIRATION AND WEATHER DATA
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NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LOS ANGELES CALIFORNIA

STATION LATITUDE	=	33.80 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	285
END OF GROWING SEASON (JULIAN DATE)	=	151
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	3.03 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	67.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SAN DIEGO CALIFORNIA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.39	5.22	4.52	0.52	0.13	1.09
0.24	0.00	0.08	0.59	0.61	1.85

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LOS ANGELES CALIFORNIA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
52.60	56.60	57.20	61.20	63.20	68.10
72.70	75.00	72.90	66.70	58.80	53.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LOS ANGELES CALIFORNIA
AND STATION LATITUDE = 33.80 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.34	0.60	6.27	0.77	0.00	1.02
	0.00	0.00	0.00	0.44	0.38	1.06
RUNOFF	0.001	0.000	0.214	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.010	2.362	3.094	3.238	0.794	0.605
	0.323	0.279	0.242	0.243	0.279	0.758
PERCOLATION/LEAKAGE THROUGH	0.0642	0.1152	0.1906	0.0579	0.0211	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.119	2.265	3.509	1.079	0.349	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	1.535	2.029	4.835	2.529	0.801	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.88	378710.656	100.00
RUNOFF	0.215	6329.397	1.67

EVAPOTRANSPIRATION	13.226	388892.406	102.69
PERC./LEAKAGE THROUGH LAYER 3	0.449050	13203.422	3.49
AVG. HEAD ON TOP OF LAYER 3	0.6935		
CHANGE IN WATER STORAGE	-1.011	-29714.578	-7.85
SOIL WATER AT START OF YEAR	5.085	149527.000	
SOIL WATER AT END OF YEAR	4.075	119812.430	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.63	1.74	7.14	0.00	0.18	0.00
	0.00	0.00	0.00	1.47	0.71	1.51
RUNOFF	0.910	0.000	3.337	0.000	0.000	0.000
	0.000	0.000	0.000	0.001	0.000	0.000
EVAPOTRANSPIRATION	1.629	2.298	3.284	4.071	1.353	0.138
	0.000	0.000	0.000	0.243	0.362	0.783
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3299	0.3363	0.5869	0.0132	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	6.153	6.855	10.921	0.234	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	7.106	4.798	6.705	0.727	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	20.38	599233.187	100.00
RUNOFF	4.248	124906.891	20.84
EVAPOTRANSPIRATION	14.162	416403.656	69.49
PERC./LEAKAGE THROUGH LAYER 3	1.266363	37234.867	6.21
AVG. HEAD ON TOP OF LAYER 3	2.0137		
CHANGE IN WATER STORAGE	0.704	20687.895	3.45
SOIL WATER AT START OF YEAR	4.075	119812.430	
SOIL WATER AT END OF YEAR	4.778	140500.328	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.088	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.32	15.91	3.32	0.43	0.22	0.18
	0.00	0.00	0.00	3.13	0.47	0.99
RUNOFF	3.705	14.627	0.009	0.000	0.000	0.000
	0.000	0.000	0.000	0.010	0.000	0.000
EVAPOTRANSPIRATION	1.565	2.377	3.322	4.066	0.840	0.031
	0.149	0.000	0.000	1.798	0.735	0.548
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3785	0.3790	0.2164	0.0153	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	7.073	7.822	3.951	0.270	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	8.729	8.909	3.667	0.792	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.97	998820.000	100.00
RUNOFF	18.351	539577.000	54.02
EVAPOTRANSPIRATION	15.431	453721.562	45.43
PERC./LEAKAGE THROUGH LAYER 3	0.989221	29086.078	2.91
AVG. HEAD ON TOP OF LAYER 3	1.5930		
CHANGE IN WATER STORAGE	-0.801	-23564.658	-2.36
SOIL WATER AT START OF YEAR	4.778	140500.328	
SOIL WATER AT END OF YEAR	3.977	116935.664	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.026	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.11	7.65	4.02	0.53	0.00	0.00
	0.00	0.00	0.22	1.04	1.10	1.20
RUNOFF	2.458	4.881	1.333	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.905	2.376	3.390	4.035	1.402	0.000
	0.000	0.000	0.132	0.254	0.419	0.935
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.1059	0.5317	0.3891	0.0021	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.975	10.570	7.189	0.032	0.000	0.000

TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	5.084 0.000	6.893 0.000	7.170 0.000	0.133 0.000	0.000 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.87	701849.750	100.00
RUNOFF	8.672	254980.344	36.33
EVAPOTRANSPIRATION	13.849	407188.625	58.02
PERC./LEAKAGE THROUGH LAYER 3	1.028862	30251.641	4.31
AVG. HEAD ON TOP OF LAYER 3	1.6472		
CHANGE IN WATER STORAGE	0.321	9429.078	1.34
SOIL WATER AT START OF YEAR	3.977	116935.664	
SOIL WATER AT END OF YEAR	4.298	126364.742	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.053	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.12 0.00	4.26 0.00	7.59 0.00	0.15 1.47	0.11 0.54	0.00 0.37
RUNOFF	4.018 0.000	0.876 0.000	3.776 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	1.363 0.000	2.278 0.000	3.109 0.000	4.079 0.154	2.073 0.299	0.029 0.360
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.1899 0.0000	0.3022 0.0000	0.7754 0.0000	0.1417 0.0000	0.0380 0.0000	0.0000 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	3.504 0.000	6.200 0.000	14.492 0.000	2.614 0.000	0.693 0.000	0.000 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	6.152 0.000	6.348 0.000	6.487 0.000	2.537 0.000	1.341 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.61	694204.750	100.00
RUNOFF	8.671	254949.250	36.73
EVAPOTRANSPIRATION	13.745	404144.594	58.22
PERC./LEAKAGE THROUGH LAYER 3	1.447091	42548.805	6.13
AVG. HEAD ON TOP OF LAYER 3	2.2918		
CHANGE IN WATER STORAGE	-0.253	-7437.649	-1.07

SOIL WATER AT START OF YEAR	4.298	126364.742	
SOIL WATER AT END OF YEAR	4.045	118927.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.207	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 6

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.92	4.11	6.25	0.61	0.12	0.00
	0.00	0.00	0.07	0.52	0.19	2.35
RUNOFF	1.922	2.793	3.173	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.845	2.207	3.613	3.711	1.081	0.000
	0.000	0.000	0.051	0.209	0.262	0.571
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3247	0.4175	0.4687	0.0219	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	6.073	8.559	8.717	0.377	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	8.310	5.859	7.090	0.769	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.14	650982.687	100.00
RUNOFF	7.887	231900.594	35.62
EVAPOTRANSPIRATION	12.550	369004.125	56.68
PERC./LEAKAGE THROUGH LAYER 3	1.232894	36250.797	5.57
AVG. HEAD ON TOP OF LAYER 3	1.9772		
CHANGE IN WATER STORAGE	0.470	13826.794	2.12
SOIL WATER AT START OF YEAR	4.045	118927.094	
SOIL WATER AT END OF YEAR	4.515	132753.891	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.365	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 7

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.00	2.23	1.69	0.39	0.22	0.88
	2.60	0.00	0.00	0.90	0.47	1.44

RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.005	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.267	2.010	3.535	2.032	0.220	0.165
	1.857	1.298	0.154	0.102	0.329	0.346
PERCOLATION/LEAKAGE THROUGH	0.0952	0.3191	0.0890	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.712	6.495	1.582	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	1.907	4.366	2.101	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.82	406349.437	100.00
RUNOFF	0.005	146.546	0.04
EVAPOTRANSPIRATION	13.316	391534.687	96.35
PERC./LEAKAGE THROUGH LAYER 3	0.503310	14798.820	3.64
AVG. HEAD ON TOP OF LAYER 3	0.8157		
CHANGE IN WATER STORAGE	-0.004	-130.657	-0.03
SOIL WATER AT START OF YEAR	4.515	132753.891	
SOIL WATER AT END OF YEAR	4.511	132623.234	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.047	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 8

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.30	7.17	6.49	0.84	0.02	0.90
	0.00	0.00	0.00	3.57	0.15	0.00
RUNOFF	2.897	3.512	3.061	0.000	0.000	0.000
	0.000	0.000	0.000	0.145	0.000	0.000
EVAPOTRANSPIRATION	1.254	2.686	3.534	3.767	0.980	0.407
	0.323	0.279	0.242	0.396	1.884	0.679
PERCOLATION/LEAKAGE THROUGH	0.3374	0.3595	0.3144	0.3761	0.0432	0.0000
LAYER 3	0.0001	0.0000	0.0000	0.0215	0.1455	0.0217

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	6.277	7.101	5.845	7.203	0.729	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.397	2.758	0.381
STD. DEVIATION OF DAILY	6.712	6.696	7.617	6.951	1.108	0.000
HEAD ON TOP OF LAYER 3	0.002	0.000	0.000	1.608	4.216	0.916

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.44	806818.500	100.00
RUNOFF	9.615	282708.406	35.04
EVAPOTRANSPIRATION	16.432	483144.969	59.88
PERC./LEAKAGE THROUGH LAYER 3	1.619554	47619.754	5.90
AVG. HEAD ON TOP OF LAYER 3	2.5576		
CHANGE IN WATER STORAGE	-0.226	-6654.523	-0.82
SOIL WATER AT START OF YEAR	4.511	132623.234	
SOIL WATER AT END OF YEAR	4.284	125968.711	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.074	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 9

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.79	2.37	8.31	0.65	0.14	0.00
	0.00	0.00	0.00	0.00	0.81	1.55
RUNOFF	0.000	0.018	1.481	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.702	1.865	3.557	4.042	1.666	0.269
	0.000	0.000	0.000	0.000	0.284	0.335
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0073	0.0406	0.3603	0.0373	0.0200	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.101	0.790	6.685	0.684	0.340	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.265	1.403	6.999	1.631	0.809	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.62	429871.969	100.00
RUNOFF	1.499	44076.793	10.25
EVAPOTRANSPIRATION	12.721	374022.687	87.01
PERC./LEAKAGE THROUGH LAYER 3	0.465631	13690.944	3.18
AVG. HEAD ON TOP OF LAYER 3	0.7167		
CHANGE IN WATER STORAGE	-0.065	-1918.642	-0.45
SOIL WATER AT START OF YEAR	4.284	125968.711	
SOIL WATER AT END OF YEAR	4.219	124050.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.195	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.44	10.74	1.38	0.73	0.11	5.34
	0.00	0.00	0.00	1.36	0.19	0.77
RUNOFF	0.026	6.799	0.023	0.000	0.000	1.269
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.670	2.158	3.417	3.293	0.899	1.960
	0.729	0.434	0.332	0.311	0.317	0.361
PERCOLATION/LEAKAGE THROUGH	0.0000	0.6236	0.1927	0.0388	0.0000	0.0485
LAYER 3	0.0066	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	12.882	3.505	0.708	0.000	0.883
TOP OF LAYER 3	0.094	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	5.281	3.827	1.552	0.000	1.403
HEAD ON TOP OF LAYER 3	0.270	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.06	707436.250	100.00
RUNOFF	8.117	238678.516	33.74
EVAPOTRANSPIRATION	14.882	437564.562	61.85
PERC./LEAKAGE THROUGH LAYER 3	0.910139	26760.809	3.78
AVG. HEAD ON TOP OF LAYER 3	1.5060		
CHANGE IN WATER STORAGE	0.151	4432.199	0.63
SOIL WATER AT START OF YEAR	4.219	124050.070	
SOIL WATER AT END OF YEAR	4.370	128482.266	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.181	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 11

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.10	2.27	3.07	1.80	0.00	0.00
	0.00	0.00	0.00	1.98	0.24	4.00
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.046
EVAPOTRANSPIRATION	1.326	2.138	3.952	2.600	0.115	0.000
	0.000	0.000	0.000	0.303	0.295	1.058
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.4083

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	7.597
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	6.908

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.46	425167.437	100.00
RUNOFF	0.046	1338.247	0.31
EVAPOTRANSPIRATION	11.788	346594.562	81.52
PERC./LEAKAGE THROUGH LAYER 3	0.408255	12003.931	2.82
AVG. HEAD ON TOP OF LAYER 3	0.6331		
CHANGE IN WATER STORAGE	2.219	65230.676	15.34
SOIL WATER AT START OF YEAR	4.370	128482.266	
SOIL WATER AT END OF YEAR	6.588	193712.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.041	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 12

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.00	10.77	1.66	1.77	0.04	1.60
	0.00	0.00	0.04	1.12	0.52	0.28
RUNOFF	0.000	4.529	0.006	0.000	0.000	0.013
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.403	2.224	3.451	4.340	1.547	0.352
	0.342	0.289	0.274	0.330	0.861	0.722
PERCOLATION/LEAKAGE THROUGH	0.0395	0.3687	0.3292	0.1107	0.0008	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.702	7.275	6.077	2.057	0.012	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	1.717	6.584	4.929	2.636	0.065	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.80	523373.469	100.00
RUNOFF	4.548	133736.937	25.55

EVAPOTRANSPIRATION	16.136	474443.187	90.65
PERC./LEAKAGE THROUGH LAYER 3	0.848988	24962.793	4.77
AVG. HEAD ON TOP OF LAYER 3	1.3436		
CHANGE IN WATER STORAGE	-3.733	-109769.633	-20.97
SOIL WATER AT START OF YEAR	6.588	193712.937	
SOIL WATER AT END OF YEAR	2.855	83943.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.186	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 13

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	12.96	0.54	1.55	0.27	0.13	0.00
	0.00	0.00	0.12	1.32	0.03	0.12
RUNOFF	5.396	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.318	2.128	3.834	2.139	0.213	0.060
	0.000	0.000	0.118	0.267	0.243	0.307
PERCOLATION/LEAKAGE THROUGH	0.2654	0.2102	0.2625	0.0000	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	4.915	4.264	4.862	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	7.318	4.353	6.130	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.04	501027.156	100.00
RUNOFF	5.396	158657.781	31.67
EVAPOTRANSPIRATION	10.627	312478.281	62.37
PERC./LEAKAGE THROUGH LAYER 3	0.738206	21705.467	4.33
AVG. HEAD ON TOP OF LAYER 3	1.1701		
CHANGE IN WATER STORAGE	0.278	8185.549	1.63
SOIL WATER AT START OF YEAR	2.855	83943.312	
SOIL WATER AT END OF YEAR	3.133	92128.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.095	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 14

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.45	8.00	3.71	1.05	0.00	2.57
	0.00	0.00	0.00	0.26	0.05	1.35
RUNOFF	0.088	3.953	0.141	0.000	0.000	0.121
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.244	2.400	3.724	4.091	1.681	2.144
	0.703	0.000	0.000	0.169	0.141	0.354
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.4847	0.3187	0.3172	0.0124	0.0120	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	9.029	6.487	5.845	0.221	0.199	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	6.441	5.279	5.286	0.744	0.585	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.44	659803.437	100.00
RUNOFF	4.303	126517.477	19.18
EVAPOTRANSPIRATION	16.652	489619.750	74.21
PERC./LEAKAGE THROUGH LAYER 3	1.144950	33664.965	5.10
AVG. HEAD ON TOP OF LAYER 3	1.8150		
CHANGE IN WATER STORAGE	0.340	10000.972	1.52
SOIL WATER AT START OF YEAR	3.133	92128.859	
SOIL WATER AT END OF YEAR	3.473	102129.836	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.273	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.67	1.18	4.93	0.66	0.10	1.98
	0.00	0.00	0.00	0.00	1.24	1.51
RUNOFF	2.948	0.000	1.027	0.000	0.000	0.001
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.104	1.967	3.225	4.135	1.822	0.704
	1.455	0.045	0.000	0.000	0.267	0.379
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.4725	0.1623	0.3111	0.1209	0.0172	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	8.832	3.294	5.712	2.249	0.294	0.000

TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	8.418	4.431	4.671	2.612	0.774	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.27	625401.750	100.00
RUNOFF	3.975	116887.531	18.69
EVAPOTRANSPIRATION	15.102	444052.437	71.00
PERC./LEAKAGE THROUGH LAYER 3	1.083926	31870.691	5.10
AVG. HEAD ON TOP OF LAYER 3	1.6985		
CHANGE IN WATER STORAGE	1.108	32591.309	5.21
SOIL WATER AT START OF YEAR	3.473	102129.836	
SOIL WATER AT END OF YEAR	4.582	134721.141	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.217	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 16

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	18.60	3.49	0.55	0.29	0.01	1.49
	1.79	0.00	0.21	0.02	0.35	1.25
RUNOFF	12.817	0.987	0.000	0.000	0.000	0.005
	0.033	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.415	2.086	3.035	3.547	0.010	1.397
	0.577	0.894	0.465	0.139	0.138	0.340
PERCOLATION/LEAKAGE THROUGH	0.6446	0.4018	0.0658	0.0348	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	12.063	7.959	1.162	0.618	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	8.998	6.897	2.064	1.083	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.05	824754.375	100.00
RUNOFF	13.842	407002.219	49.35
EVAPOTRANSPIRATION	14.043	412893.656	50.06
PERC./LEAKAGE THROUGH LAYER 3	1.146985	33724.805	4.09
AVG. HEAD ON TOP OF LAYER 3	1.8169		
CHANGE IN WATER STORAGE	-0.982	-28866.369	-3.50

SOIL WATER AT START OF YEAR	4.582	134721.141	
SOIL WATER AT END OF YEAR	3.600	105854.773	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.126	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 17

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	13.89	2.74	6.97	0.31	0.18	0.00
	0.00	0.00	0.00	0.00	0.46	0.97
RUNOFF	7.534	0.261	3.112	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.263	1.974	3.225	3.840	1.297	0.375
	0.319	0.277	0.240	0.185	0.135	0.252
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3725	0.3950	0.2512	0.1621	0.0792	0.0489
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	6.937	8.125	4.661	3.052	1.366	0.856
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	8.023	6.746	6.918	3.817	1.440	1.259
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.52	750364.687	100.00
RUNOFF	10.907	320709.750	42.74
EVAPOTRANSPIRATION	13.383	393487.906	52.44
PERC./LEAKAGE THROUGH LAYER 3	1.308959	38487.324	5.13
AVG. HEAD ON TOP OF LAYER 3	2.0830		
CHANGE IN WATER STORAGE	-0.079	-2320.369	-0.31
SOIL WATER AT START OF YEAR	3.600	105854.773	
SOIL WATER AT END OF YEAR	3.521	103534.398	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.070	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 18

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.17	7.22	1.91	1.24	0.04	0.20
	0.00	0.00	0.00	0.14	0.40	0.11

RUNOFF	0.051	2.561	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.614	2.235	2.886	3.717	1.120	0.200
	0.000	0.000	0.000	0.079	0.264	0.211
PERCOLATION/LEAKAGE THROUGH	0.1160	0.1095	0.1815	0.0330	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	2.093	2.225	3.308	0.595	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	2.698	4.586	2.939	1.209	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.43	424285.312	100.00
RUNOFF	2.612	76790.242	18.10
EVAPOTRANSPIRATION	12.325	362391.250	85.41
PERC./LEAKAGE THROUGH LAYER 3	0.440036	12938.390	3.05
AVG. HEAD ON TOP OF LAYER 3	0.6851		
CHANGE IN WATER STORAGE	-0.947	-27834.613	-6.56
SOIL WATER AT START OF YEAR	3.521	103534.398	
SOIL WATER AT END OF YEAR	2.575	75699.789	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.075	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 19

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.24	6.04	0.02	0.78	0.07	0.00
	0.00	0.00	0.00	0.74	1.02	0.81
RUNOFF	0.658	2.800	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.937	1.911	3.123	3.461	0.550	0.001
	0.000	0.000	0.000	0.222	0.385	0.361
PERCOLATION/LEAKAGE THROUGH	0.2059	0.4661	0.1320	0.0003	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	3.805	9.578	2.397	0.004	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	4.846	6.762	4.176	0.022	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.72	491618.156	100.00
RUNOFF	3.459	101703.711	20.69
EVAPOTRANSPIRATION	10.951	322002.844	65.50
PERC./LEAKAGE THROUGH LAYER 3	0.804355	23650.453	4.81
AVG. HEAD ON TOP OF LAYER 3	1.3154		
CHANGE IN WATER STORAGE	1.505	44260.937	9.00
SOIL WATER AT START OF YEAR	2.575	75699.789	
SOIL WATER AT END OF YEAR	4.080	119960.727	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.219	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.93	9.51	0.72	0.49	0.21	1.90
	0.00	0.00	0.02	0.00	0.66	0.37
RUNOFF	0.000	4.729	0.000	0.000	0.000	0.049
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.309	2.325	3.027	2.530	0.211	1.851
	0.000	0.000	0.020	0.000	0.062	0.300
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.2293	0.0972	0.0035	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	4.542	1.724	0.053	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	6.702	2.059	0.212	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.81	464861.500	100.00
RUNOFF	4.778	140496.609	30.22
EVAPOTRANSPIRATION	11.635	342108.125	73.59
PERC./LEAKAGE THROUGH LAYER 3	0.329989	9702.668	2.09
AVG. HEAD ON TOP OF LAYER 3	0.5266		
CHANGE IN WATER STORAGE	-0.933	-27445.924	-5.90
SOIL WATER AT START OF YEAR	4.080	119960.727	
SOIL WATER AT END OF YEAR	3.146	92514.805	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 21

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.08	5.42	3.11	0.83	0.13	0.32
	0.00	0.00	0.11	0.00	0.67	2.09
RUNOFF	0.057	3.056	0.068	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.670	1.821	3.434	3.187	1.078	0.414
	0.308	0.271	0.247	0.237	0.093	0.591
PERCOLATION/LEAKAGE THROUGH	0.1507	0.2518	0.3332	0.0430	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	2.806	5.117	6.145	0.776	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	4.975	5.459	5.419	1.496	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.76	522197.312	100.00
RUNOFF	3.181	93540.828	17.91
EVAPOTRANSPIRATION	12.350	363138.781	69.54
PERC./LEAKAGE THROUGH LAYER 3	0.778764	22898.008	4.38
AVG. HEAD ON TOP OF LAYER 3	1.2370		
CHANGE IN WATER STORAGE	1.449	42619.465	8.16
SOIL WATER AT START OF YEAR	3.146	92514.805	
SOIL WATER AT END OF YEAR	4.596	135134.266	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.244	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 22

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.32	2.08	7.12	0.01	0.36	1.76
	0.00	0.00	0.06	0.12	0.40	1.81
RUNOFF	0.013	0.000	1.483	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.924	2.304	3.424	3.223	1.132	1.276
	0.519	0.220	0.039	0.064	0.244	0.284
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.2484	0.0011	0.0000	0.0000

LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	4.582	0.015	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	5.884	0.080	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.04	471624.156	100.00
RUNOFF	1.496	43980.133	9.33
EVAPOTRANSPIRATION	14.653	430828.375	91.35
PERC./LEAKAGE THROUGH LAYER 3	0.249438	7334.229	1.56
AVG. HEAD ON TOP OF LAYER 3	0.3831		
CHANGE IN WATER STORAGE	-0.358	-10518.572	-2.23
SOIL WATER AT START OF YEAR	4.596	135134.266	
SOIL WATER AT END OF YEAR	4.238	124615.695	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 23

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.16	9.38	4.73	0.19	0.12	0.00
	0.42	0.00	0.00	0.00	1.99	0.14
RUNOFF	0.000	4.838	2.068	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.914	2.245	3.953	3.686	1.055	0.000
	0.230	0.190	0.000	0.000	0.304	0.278
PERCOLATION/LEAKAGE THROUGH	0.0054	0.3291	0.2350	0.0119	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.097	6.727	4.317	0.205	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.539	6.098	5.812	0.570	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
PRECIPITATION	20.13	591882.437	100.00

RUNOFF	6.905	203041.156	34.30
EVAPOTRANSPIRATION	12.855	377968.875	63.86
PERC./LEAKAGE THROUGH LAYER 3	0.581342	17093.203	2.89
AVG. HEAD ON TOP OF LAYER 3	0.9455		
CHANGE IN WATER STORAGE	-0.212	-6220.731	-1.05
SOIL WATER AT START OF YEAR	4.238	124615.695	
SOIL WATER AT END OF YEAR	4.027	118394.961	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.039	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 24

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	7.00	2.17	3.76	0.09	0.16	5.25
	0.00	0.00	0.00	0.33	0.07	2.36
RUNOFF	1.271	0.133	0.006	0.000	0.000	0.469
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.986	2.083	3.694	4.184	1.416	2.251
	0.729	0.434	0.332	0.314	0.319	0.364
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.2206	0.3524	0.3464	0.0258	0.0000	0.0701
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	4.129	6.938	6.410	0.468	0.000	1.314
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	7.825	5.087	6.034	1.221	0.000	2.532
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.19	623049.687	100.00
RUNOFF	1.878	55230.820	8.86
EVAPOTRANSPIRATION	17.107	502983.281	80.73
PERC./LEAKAGE THROUGH LAYER 3	1.015255	29851.557	4.79
AVG. HEAD ON TOP OF LAYER 3	1.6050		
CHANGE IN WATER STORAGE	1.190	34984.008	5.61
SOIL WATER AT START OF YEAR	4.027	118394.961	
SOIL WATER AT END OF YEAR	5.216	153378.969	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.65	2.25	1.12	0.63	0.06	3.39
	1.20	0.00	0.00	0.01	1.09	1.48
RUNOFF	0.547	0.186	0.000	0.000	0.000	0.503
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.863	2.402	2.970	2.976	0.038	1.870
	0.906	0.434	0.332	0.309	0.344	0.404
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0760	0.3026	0.0425	0.0227	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	1.396	6.148	0.750	0.387	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	3.102	5.149	1.658	0.736	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.88	437516.687	100.00
RUNOFF	1.237	36370.020	8.31
EVAPOTRANSPIRATION	13.847	407147.719	93.06
PERC./LEAKAGE THROUGH LAYER 3	0.443842	13050.276	2.98
AVG. HEAD ON TOP OF LAYER 3	0.7235		
CHANGE IN WATER STORAGE	-0.648	-19051.260	-4.35
SOIL WATER AT START OF YEAR	5.216	153378.969	
SOIL WATER AT END OF YEAR	4.569	134327.719	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.054	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 26

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	10.35	4.23	3.20	1.35	0.08	0.00
	0.00	0.00	0.00	0.00	0.22	6.92
RUNOFF	4.005	2.222	1.557	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.038
EVAPOTRANSPIRATION	1.614	2.357	3.634	3.865	0.883	0.000
	0.000	0.000	0.000	0.000	0.089	0.997
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.4590	0.4907	0.2137	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.3545

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	8.564	10.094	3.919	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	6.587
STD. DEVIATION OF DAILY	8.069	7.601	5.034	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	6.638

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.35	774769.187	100.00
RUNOFF	7.822	229999.781	29.69
EVAPOTRANSPIRATION	13.439	395152.437	51.00
PERC./LEAKAGE THROUGH LAYER 3	1.517892	44630.586	5.76
AVG. HEAD ON TOP OF LAYER 3	2.4303		
CHANGE IN WATER STORAGE	3.571	104986.211	13.55
SOIL WATER AT START OF YEAR	4.569	134327.719	
SOIL WATER AT END OF YEAR	8.139	239313.922	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.242	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 27

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	9.99	6.77	3.20	0.09	0.00	0.00
	0.00	0.00	0.06	0.30	0.54	1.43
RUNOFF	7.366	4.102	0.807	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.584	2.122	3.509	3.351	1.153	0.035
	0.000	0.000	0.031	0.081	0.195	0.328
PERCOLATION/LEAKAGE THROUGH	0.4750	0.5958	0.5195	0.0936	0.0000	0.0000
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	8.800	12.298	9.659	1.720	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	6.803	5.437	7.021	2.153	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.38	658039.125	100.00
RUNOFF	12.274	360888.875	54.84
EVAPOTRANSPIRATION	12.389	364282.594	55.36
PERC./LEAKAGE THROUGH LAYER 3	1.683820	49509.348	7.52
AVG. HEAD ON TOP OF LAYER 3	2.7065		

CHANGE IN WATER STORAGE	-3.967	-116641.766	-17.73
SOIL WATER AT START OF YEAR	8.139	239313.922	
SOIL WATER AT END OF YEAR	4.172	122672.148	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.119	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 28

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.74	2.10	1.50	0.00	0.26	0.00
	0.53	0.00	0.00	0.23	0.02	1.07
RUNOFF	0.000	0.262	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.577	2.166	2.864	2.836	0.071	0.189
	0.175	0.211	0.144	0.135	0.115	0.086
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0071	0.1838	0.1381	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.127	3.623	2.517	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.708	5.682	3.305	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.45	277858.344	100.00
RUNOFF	0.262	7690.569	2.77
EVAPOTRANSPIRATION	9.570	281387.937	101.27
PERC./LEAKAGE THROUGH LAYER 3	0.328936	9671.715	3.48
AVG. HEAD ON TOP OF LAYER 3	0.5223		
CHANGE IN WATER STORAGE	-0.711	-20891.898	-7.52
SOIL WATER AT START OF YEAR	4.172	122672.148	
SOIL WATER AT END OF YEAR	3.462	101780.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.052	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 29

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.72	6.05	3.06	0.87	0.00	0.00
	0.00	0.00	0.18	0.23	0.55	0.78

RUNOFF	0.056	4.206	0.522	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	1.247	1.962	3.610	3.759	1.287	0.000
	0.000	0.000	0.145	0.061	0.212	0.238
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.3212	0.3694	0.2349	0.1102	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	5.944	7.561	4.308	2.075	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	6.160	7.131	4.853	3.095	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.44	542191.375	100.00
RUNOFF	4.783	140641.312	25.94
EVAPOTRANSPIRATION	12.521	368159.719	67.90
PERC./LEAKAGE THROUGH LAYER 3	1.035676	30451.973	5.62
AVG. HEAD ON TOP OF LAYER 3	1.6574		
CHANGE IN WATER STORAGE	0.100	2938.307	0.54
SOIL WATER AT START OF YEAR	3.462	101780.250	
SOIL WATER AT END OF YEAR	3.561	104718.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.067	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.54	6.91	5.59	0.83	0.00	0.00
	0.00	0.00	0.24	0.00	1.07	1.49
RUNOFF	0.000	0.842	3.922	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.295	0.987	3.723	4.013	0.581	0.000
	0.000	0.000	0.172	0.068	0.424	0.404
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.1005	0.4174	0.0730	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	2.075	7.740	1.357	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	5.718	6.568	2.183	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.67	490148.094	100.00
RUNOFF	4.764	140076.234	28.58
EVAPOTRANSPIRATION	10.666	313627.094	63.99
PERC./LEAKAGE THROUGH LAYER 3	0.590904	17374.346	3.54
AVG. HEAD ON TOP OF LAYER 3	0.9310		
CHANGE IN WATER STORAGE	0.649	19070.488	3.89
SOIL WATER AT START OF YEAR	3.561	104718.562	
SOIL WATER AT END OF YEAR	4.210	123789.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.065	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.22	5.20	3.80	0.62	0.10	0.96
	0.22	0.00	0.04	0.69	0.55	1.39
STD. DEVIATIONS	4.39	3.65	2.38	0.48	0.09	1.49
	0.60	0.00	0.08	0.92	0.44	1.34
RUNOFF						
TOTALS	1.958	2.439	1.038	0.000	0.000	0.081
	0.001	0.000	0.000	0.005	0.000	0.003
STD. DEVIATIONS	3.025	3.070	1.346	0.000	0.000	0.256
	0.006	0.000	0.000	0.026	0.000	0.011
EVAPOTRANSPIRATION						
TOTALS	1.161	2.149	3.405	3.527	0.952	0.557
	0.321	0.185	0.124	0.222	0.343	0.464
STD. DEVIATIONS	0.373	0.291	0.303	0.617	0.574	0.751
	0.458	0.296	0.135	0.319	0.337	0.246
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.2050	0.3021	0.2753	0.0521	0.0077	0.0056
	0.0002	0.0000	0.0000	0.0007	0.0048	0.0261
STD. DEVIATIONS	0.1883	0.1633	0.1676	0.0771	0.0177	0.0173
	0.0012	0.0000	0.0000	0.0039	0.0266	0.0969

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	3.8076	6.1290	5.0831	0.9685	0.1327	0.1018
	0.0031	0.0000	0.0000	0.0132	0.0919	0.4855
STD. DEVIATIONS	3.5200	3.3466	3.1403	1.4679	0.3058	0.3178
	0.0172	0.0000	0.0000	0.0724	0.5035	1.8021

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	19.79	(5.388)	581807.0	100.00
RUNOFF	5.525	(4.4379)	162451.80	27.922
EVAPOTRANSPIRATION	13.412	(1.8606)	394345.66	67.779
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.87975	(0.41353)	25867.420	4.44605
AVERAGE HEAD ON TOP OF LAYER 3	1.401	(0.661)		
CHANGE IN WATER STORAGE	-0.029	(1.4552)	-857.93	-0.147

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	6.02	177006.062
RUNOFF	5.876	172777.8440
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.041199	1211.38330
AVERAGE HEAD ON TOP OF LAYER 3	24.000	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3660

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0970

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.7866	0.1489
2	2.2736	0.1895
3	0.1500	0.7500
SNOW WATER	0.000	

****
****

F. RCRA Subtitle D (CCR Title 27) Equivalent Asphalt and Concrete Cover

CALCULATION PACKAGE FOR
INFILTRATION ANALYSIS THROUGH THE AC AND CONCRETE COVER

Objectives:

- Infiltration analysis and equivalence assessment of proposed AC cover and concrete cover using Darcy's law.
- Compare infiltration through proposed AC cover, concrete cover and CCR Title 27 cover.

References:

See attachment

Assumptions:

- AC consists of high-density low-air void mix (98% maximum density and 2% air voids) with Ks $\leq 1.0 \times 10^{-7}$ cm/s.
- Concrete has a minimum depth of 4 inches and a Ks $\leq 5.0 \times 10^{-9}$ cm/s.
- AC and concrete are free of cracks and ruts.
- Although AC and concrete are graded to drain, conservatively assume 6 inches of standing water for infiltration analysis.

Approach:

- Flow through Title 27 cover was calculated assuming that the vegetative layer was fully saturated. (i.e. 12- inch head on low-permeability layer)
- Two AC cover scenarios were considered (Figure F-1 and F-2)
    - New 4-inch thick high density AC on aggregate base.
    - 2-inch thick high density AC overlay on existing pavement.

  For the latter case the barrier layer properties of the existing pavement was not considered in the analyses.
- Assume 4-inch thickness for the concrete cover

References:

Koerner, R.M., Daniel, E.G., "Technical Equivalency Assessment of GCLs to CCLs," Proceedings of the 7th GRI Seminar.

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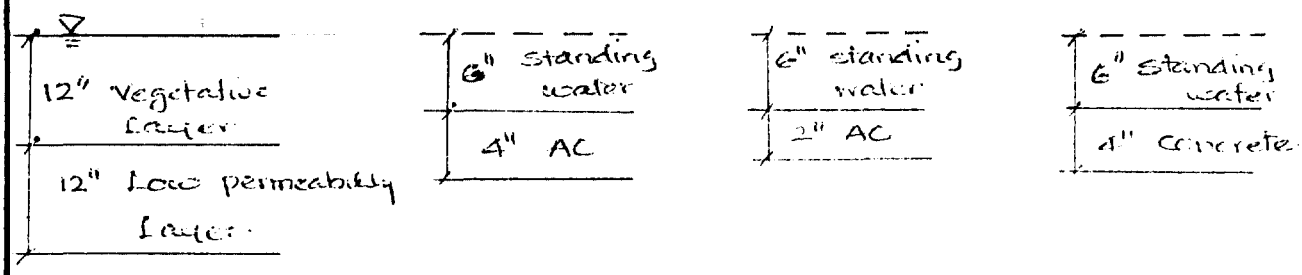
Project _____

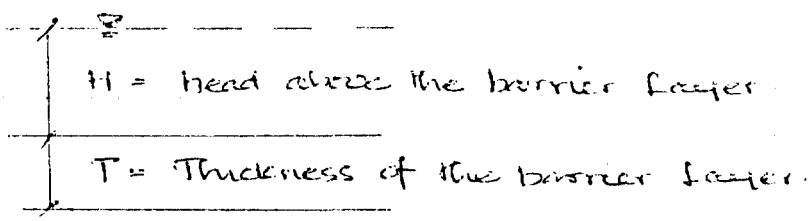
Cover Systems Considered.



(1) Title 27 | (2) New 4" AC | (3) 2" AC Overlay | (4) 4" Concrete.

Calculations

Flow through barrier layer.



Let q be the flux through the barrier layer per unit area.

$$q = K\, i\, A$$

where K = Saturated hydraulic conductivity of the barrier layer.

i = Hydraulic gradient

A = Area

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Project _____

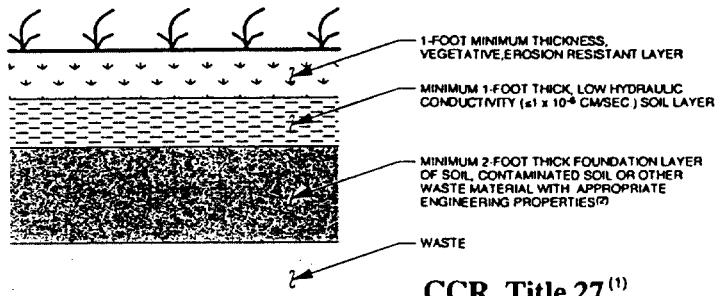
$i = \frac{H+T}{T}$ (Koerner and Daniel,

$q = K\left(\frac{H+T}{T}\right)$

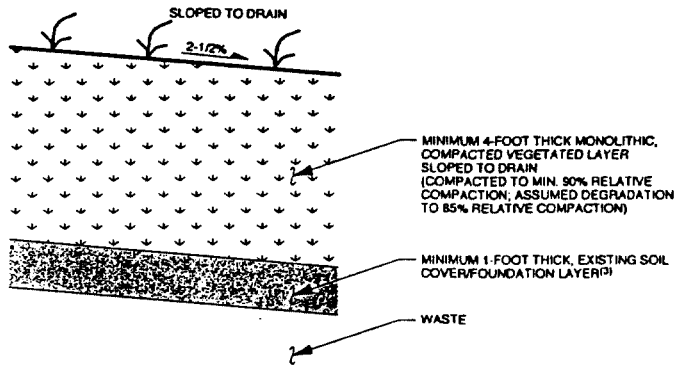
	Title 27	New 4" AC	2" AC overlay	4" Concrete
H (in)	12	6	6	6
T (in)	12	4	2	4
K_s (cm/s)	1×10^{-6}	1×10^{-7}	1×10^{-7}	5×10^{-9}
q (cm³/s/cm²)	2×10^{-6}	2.5×10^{-7}	4×10^{-7}	1.25×10^{-8}
$q_{T\text{-}27}/q$	1	8	5	160

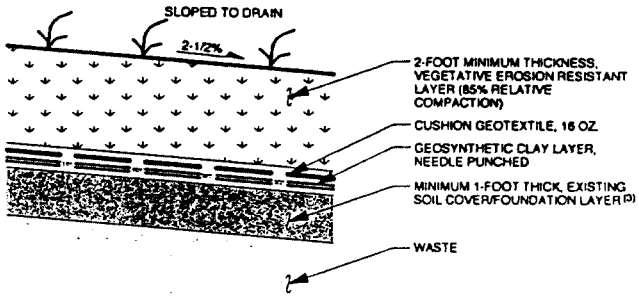
ATTACHMENTS

3074790%DR-07 REV. 12/02/02

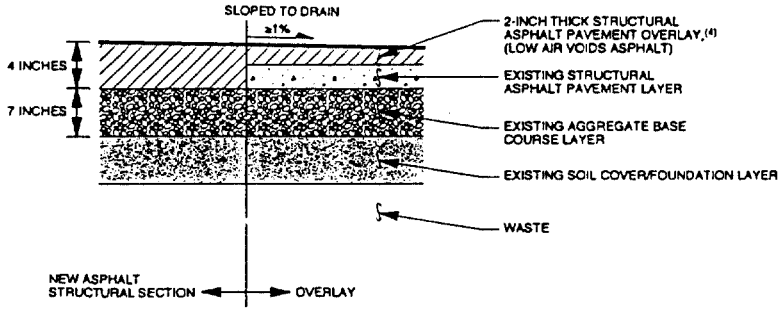


CCR, Title 27 (1)
Prescriptive Cap

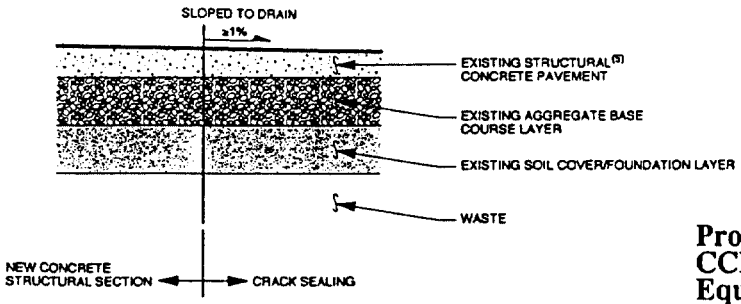




Alternative 1 - Engineered Soil Covers



Alternative 2 - Engineered Asphalt Cover



Alternative 3 - Engineered Concrete Cover

Proposed WDI CCR, Title 27 Equivalent Cap Alternatives to be Evaluated

NOT TO SCALE

NOTES:
(1) SUBTITLE D, 40 CFR PART 258 REQUIRES A COVER WITH THE FOLLOWING COMPONENTS FROM TOP TO BOTTOM:
- MINIMUM 6-INCH THICK EROSION LAYER
- MINIMUM 18-INCH THICK INFILTRATION LAYER WITH A HYDRAULIC CONDUCTIVITY OF ≤1 x10^{-5} cm/sec

(2) A LESSER THICKNESS MAY BE USED IF DIFFERENTIAL SETTLEMENT AND LAND USE WILL NOT AFFECT STRUCTURAL INTEGRITY OF THE FINAL COVER.
(3) SCARIFIED AND RECOMPACTED. UNSUITABLE SOIL TO BE REMOVED AND REPLACED
(4) ASPHALT OVERLAY HAS A LOW HYDRAULIC CONDUCTIVITY.
(5) *REHABILITATED AS APPROPRIATE.*

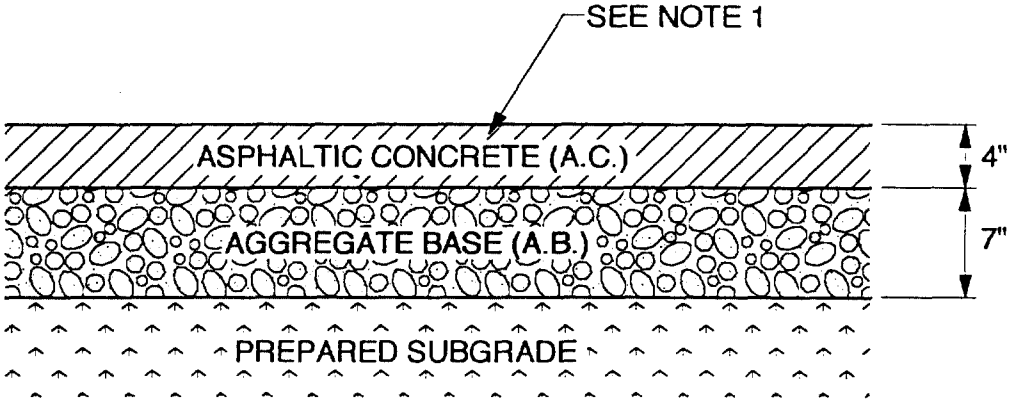
WORKING DRAFT

GEOTECHNICAL MODELS TO ASSESS INFILTRATION THROUGH RCRA SUBTITLE D COVERS

WASTE DISPOSAL, INC.
SANTA FE SPRINGS, CALIFORNIA

TRC

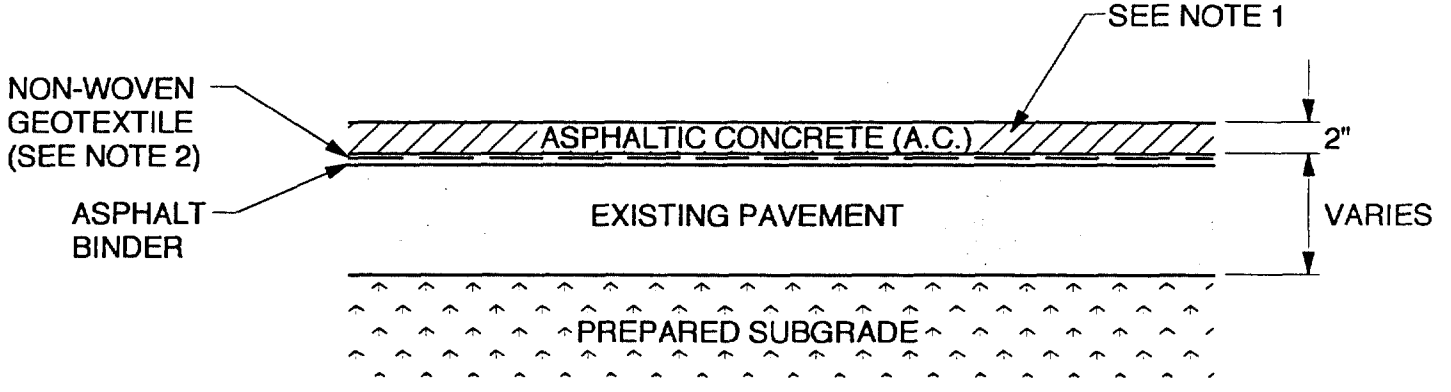
FIGURE 10 F-1



DETAIL 6 (13/14)

ENGINEERED ASPHALT COVER

NOT TO SCALE



DETAIL 6A (13/14)

ASPHALT PAVEMENT OVERLAY SECTION

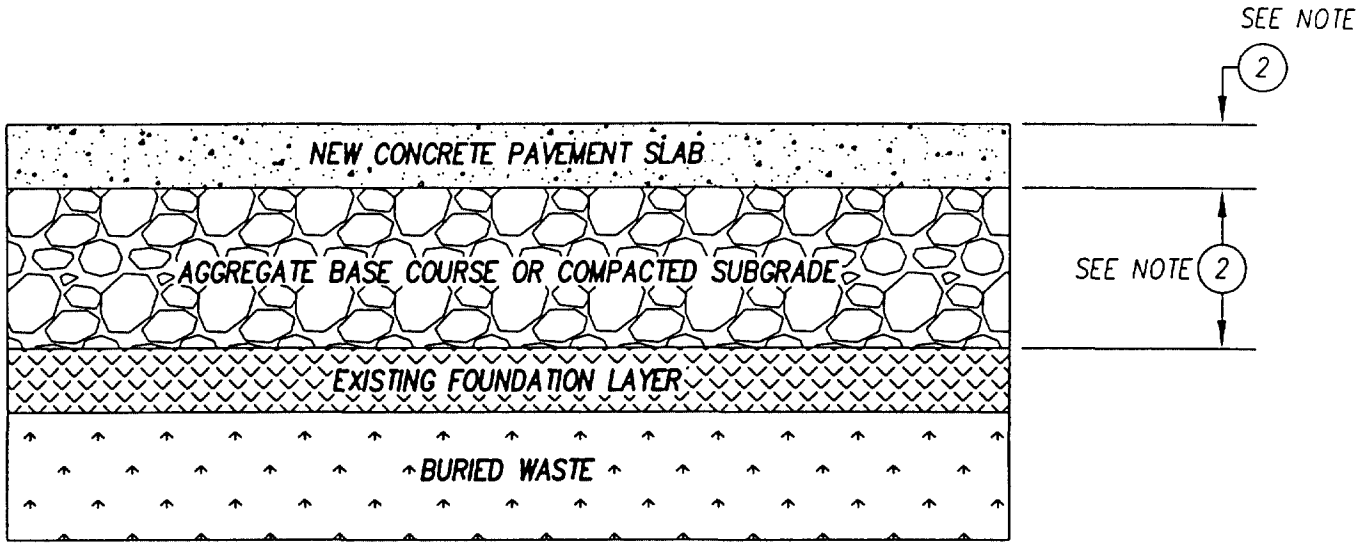
NOT TO SCALE

NOTES

1. A.C. MIX TO BE DESIGNED AS A HIGH-DENSITY, LOW AIR VOIDS MIX, COMPACTED TO 98% THEORETICAL MAXIMUM DENSITY (2% AIR VOIDS [MAXIMUM 4%]).

2. TERMINATE GEOTEXTILE WITHIN 6 INCHES OF FOUNDATION.

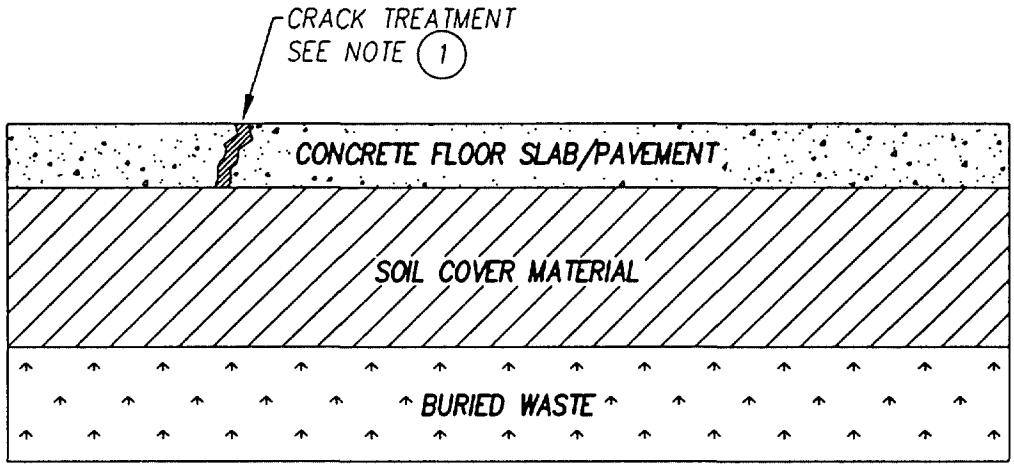
Fisure F-2



DETAIL 7 / 13 14

ENGINEERED CONCRETE PAVEMENT/SLAB COVER

NOT TO SCALE



DETAIL 7A / 13 14

CONCRETE PAVEMENT / FLOOR SLAB OVER BURIED WASTE CRACK/JOINT SEALING DETAIL

NOT TO SCALE

NOTES:

1. CRACKS AND JOINTS SHALL BE FILLED ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS FOR THE SPECIFIC PRODUCT. CRACKS ARE TO BE SEALED PRIOR TO INJECTION WITH CCS GROUT SEAL, MANUFACTURED BY CHEMCO SYSTEMS, OR EQUIVALENT. CRACKS WIDER THAN 1/4-INCH SHALL BE INJECTED WITH AN EPOXY PASTE ADHESIVE MEETING THE REQUIREMENTS OF ASTM C 881 TYPE 1 GRADE 3 (CCS BONDER PASTE, LONG WORKING LIFE OR EQUIVALENT). CRACKS LESS THAN 1/4-INCH WIDE SHALL BE INJECTED WITH A TWO-COMPONENT EPOXY PASTE ADHESIVE MEETING THE REQUIREMENTS OF ASTM C 881 TYPE IV GRADE 1 (CCS GROUT, SLUMP PUMPING OR EQUIVALENT). CONTROL JOINTS SHALL BE FILLED WITH AN EPOXY MEETING THE REQUIREMENTS OF ASTM C 881 TYPE III GRADE 2 (CCS GROUT, CONTROL JOINT OR EQUIVALENT).

2. TBD - TO BE DETERMINED

Figure F-3

HYDRAULIC CONDUCTIVITY CHARACTERISTICS OF ASPHALT AND CONCRETE

- Asphalt[1]
  - Design Target: 1×10^{-7} cm/sec
  - Measured Performance = $<9.1 \times 10^{-10}$ cm/sec, 6×10^{-11} cm/sec

- Concrete
  - Literature Value[2]: 5×10^{-9} cm/sec (150×10^{-12} ft/sec)

---

(1) Asphalt Institute case studies; 2 percent maximum air voids, 95% compaction.

(2) Composition and properties of Concrete, 2nd Edition Traxell, Davis, and Kelly, Eds. 1993.

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Tacoma Asphalt Landfill Cap Is Tough and Impermeable

By Edward D. Schlect, District Engineer, Asphalt Institute

The City of Tacoma needed a cap on a three-acre portion of its 190-acre refuse landfill for use as a solid waste processing station. The cap had to be structurally adequate, impermeable to water and environmentally acceptable.

The majority of the 190-acre landfill is being capped and closed over the next 24 years with drainage and protective layers.

After examining several options, the Tacoma Public Works Department decided that a hot-mix asphalt (HMA) cap was the answer. It was designed to be impermeable to the intrusion of surface water as well as structurally adequate for the support of refuse trucks.

Design

Consoer, Townsend & Associates, Inc. of Tacoma designed the cap and protective structure. The asphalt mix was designed by the City of Tacoma in conjunction with the Asphalt Institute and Woodworth & Company, the paving contractor.

First, 12 inches of sand was placed on top of the refuse. One layer of high-density polyethylene membrane (HDPE) was placed on the sand. Then another 12-inch layer of sand was placed over the liner to protect it and to serve as a working platform. Finally, 8 inches of dense-graded aggregate were placed on the sand and topped with 3 inches of HMA.

A Washington State DOT 5/8-inch maximum-size aggregate mixture was used for the 3-inch-thick HMA cap. A 75-blow Marshall mix design using 6.5 percent asphalt cement provided stability of 2500, flow of 15, 0.7 percent air-voids and a maximum permeability of 1×10^{-7}cm/sec. A seal coat of emulsified asphalt was applied to the paved HMA surface.

A drainage system, designed to catch any moisture that might intrude the cap, was constructed between the membrane and the HMA pavement. This provided the means to monitor the integrity of the cap.

Cross-Section of Paved Area of Refuse Landfill with Synthetic Cover

Click Above To View The Graphic

Exceeded Requirements

Both the EPA and the Washington State Department of Ecology criteria required a maximum permeability of 1×10^{-7} cm/sec. Six cores from the completed pavement had permeability values of 9.1×10^{-10} cm /sec or less under a constant 5.5 foot head of water for a minimum of 24 hours.

Mary L. Henley, Project Engineer for the City of Tacoma, says that the landfill cap is working well. A key test, she says, was the 100-year rainstorm that hit Tacoma in November 1990. "There was no leakage," said Henley. "No water was collected in the monitoring system: "She added that there is little or no ponding on the surface of the HMA pavement.

Construction of the landfill cap was completed in June 1990 and opened for use in July.

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Asphalt Used for Environmental Caps in Texas

By Dr. Jeán M. E. Audibert and Dr. Laurence R. Lew, Eriviroplex, Houston, Texas

The Approach | HMA Design | Environmental Standards

First time use of hot-mix asphalt (HMA) for environmental land caps has been recently approved by the Texas Water Commission (TWC).

As part of a remedial action program developed with the Water Commission, PPG Industries, Inc. needed to cap five areas around an active chemical plant in Beaumont, Texas. The caps were required to provide impermeable barriers to prevent infiltration of rain water, which could carry contaminants into the groundwater.

Conventional capping techniques, such as requiring three feet of compacted clay, placed with minimum slopes of 5 percent would have seriously impaired plant traffic and operations. The environmental consultants, together with PPG, proposed that TWC use hot-mix asphalt to construct the required caps in a way which would not interfere with plant activities.

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The Approach

In each of the five areas, the contractor was required to remove the top two feet of topsoil and dispose of it at a hazardous waste landfill. Clean backfill was placed in each area to create an appropriate subbase.

Four of the areas were relatively simple to cap because contamination levels in the shallow soils were low. In these areas the subbase was constructed from clean, select fill which was proof-rolled and compacted before placing the HMA cap.

The fifth area was a 400-foot-long by 50-foot-wide strip along two railroad tracks that serviced the shipping and receiving area of the plant. Environmental considerations called for an expedient approach to backfilling. A low-strength concrete was used to create a subbase, then cement-stabilized sand was placed above the concrete to build the appropriate slopes. The HMA cap was then placed on top of the stabilized sand.

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HMA Design

The consulting engineers asked Asphalt Institute Regional Engineer R. B. McGennis of Austin for guidance and suggestions on the best design for a cap that would have the following qualities:

- very low permeability with a free-draining surface;
- sufficient strength to support light plant vehicle traffic;
- durability with low maintenance; and
- ease of construction.

In order to achieve these characteristics, McGennis suggested:

- dense-graded surface course (100 percent passing the 1/2-inch sieve) conforming to Texas Department of Transportation master gradings;
- two percent maximum design air void content;
- minimum 95 percent in-place compaction; and
- measured permeability lower than 1×10^{-7} cm/sec.

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Environmental Standards

To meet the strict environmental standards of the TWC, the environmental consultants implemented a rigorous quality assurance/quality control program. They required temperature checks of each truck load and extraction and gradation tests at specific intervals. In-place density and air voids were checked on a tightly spaced grid. A simple field indicator showing that air voids approached zero was the tendency for the asphalt to bleed slightly at the surface at the termination of pneumatic compaction.

Although hydraulic asphalt with 8 percent asphalt cement had been used for pond liners in the past with EPA approval the design team needed special approval by TWC to use hot-mix asphalt for an impermeable cap. So they set up a special test to gain TWC's final approval.

They used a flexible wall permeameter to measure the permeability of a specimen prepared to the asphalt mix specifications proposed for the caps. The test lasted several weeks, and resulted in a permeability measurement of 6×10^{-11} cm/sec. This value significantly exceeded the regulatory requirements for environmental caps and consequently won the TW'C's approval.

Although the environmental cap was a first for the TWC, its use opens the door for a number of environmental and landfill purposes.

Dr. Jean Audibert and Dr. Laurence Lew are owner-managers of Enviroplex in Houston, Texas. They also worked on the development of the environmental cap in a previous affiliation with Woodward-Clyde Consultants. They would like to thank PPG Industries, Inc. for its willingness to assume leadership in developing this innovative environmental technique.

This article appeared in the Winter 1991/92, Volume 5, No. 3, ASPHALT magazine.

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Asphalt Pavement Doubles as Hazardous Soils Cap and Loading Area

By Roger Smith, Asphalt Institute Regional Engineer

DEEP SOIL MIXING	TWO PHASE DESIGN	THREE LAYERS, THREE MIXES

It was a problem that could only be solved by asphalt. How do you construct a cap for a contaminated soil site that is both impervious to water and tough enough to carry heavy truck loads? The cap's primary function is to prevent surface water penetration from percolation and runoff.

Barney Vallerga, Consulting Civil Engineer of Oakland, California, and Geomatrix Consultants of San Francisco had the answer. Vallerga believed a Full-Depth asphalt pavement of minimum overall thickness was the logical choice. The critical question was how that asphalt could perform the dual function of waterproof cap and traffic bearing pavement.

The consultants were aware that an asphalt pavement designed to be waterproof may not have the strength to withstand heavy wheel loadings.

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DEEP SOIL MIXING

The Bay Road site, located in an industrial area of East Palo Alto, California, was found to have contaminated soil and groundwater. After a study of the site was completed, it was determined soil remediation and capping were necessary. Geomatrix had to determine whether the soil should be removed or remediated on-site. They decided to remediate the spoiled earth on-site by deep-soil mixing.

"We found a Hazmat remediation firm that mixed the earth with silicates and portland cement to a depth of 26 feet," says Michael Rafferty, Principal Engineer and environmental scientist for Geomatrix Consultants. This reduced the leachability of the arsenic and raised the pH of the cement. The mixed earth then behaved much like a cement treated base.

There were other potential complications. "The site had a high water line and was close to the bay," says Vallerga. "Our design had to ensure that no water would percolate through the soil to the underlying groundwater." At the same time, the caps had to structurally sustain the weight of a number of 18 wheel trucks.

"We initially looked at using a high density polyethylene liner capped with several layers of sand and soil," says Raffeny. "But a thorough cost evaluation revealed that asphalt was not only more economical but more effective than a soils cap." One reason was that little or no soil had to be imported to the site.

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TWO PHASE DESIGN

Vallerga and Geomatrix did a two phase design for the manufacturing facility. In the first phase they specified a 9-inch asphalt cap over one portion of the remediated site. In the second phase, they specified a 6-inch-thick cap for the back portion of the site.

Both caps were waterproof and ensured that rain water or runoff would not leach through the caps to the remediated soil beneath. Both caps were designed to structurally sustain the weight of 18-wheel trucks and heavy forklifts used at the site.

A 9-inch-thick asphalt cap was used on Phase I of the site because the underlying soil had a lower support, or R value. R

values on the Phase I site ranged from 19 to 86. R values on the second site, which required a lesser, 6-inch cap, were much higher; having an average support value of about 75.

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THREE LAYERS, THREE MIXES

After considering all factors, Vallerga and Geomatrix decided upon a three layer hot-mix asphalt pavement for the cap. They specified a 3-inch-thick hydraulic mix for the bottom layer. The mix, designed with high asphalt content and low air voids, is impervious to water but has sufficient strength to serve as a base course without deforming under traffic loads. The hydraulic mix was compacted to 98 percent theoretical maximum density (2 percent air voids). This type of mix will typically offer permeability less than 10-7 cm/sec (ASTM 2434).

The second or middle layer was a 3-inch-thick asphalt drainage layer that served as a drainage path for water entering the pavement through the surface layer or from any other source. "Any water that came through the surface course was collected by the open graded drainage course and drained from the site toward the bay," says Vallerga.

This layer also prevented hydrostatic pressures developing on the bottom layer of hydraulic asphalt. It had no density requirement.

"An anti-strip additive in the open graded mix ensured that stripping did not occur," says Frank Szerdy, Principal Engineer for Geomatrix. "The anti-strip promotes a superior bond between the aggregate and the asphalt and made the mix virtually hydrophobic." The drainage layer mix was also highly resistant to deformation under traffic loads.

The top or surface layer was a conventional 3-inch-thick dense-graded asphalt used for heavy-duty highways and industrial pavements. It sustains light vehicular traffic with a moderate number of two axle and three axle trucks, as well as some fully loaded five axle trucks. Forklift vehicles with 100 psi tire pressures travel the surface daily without scarring or deforming the pavement. The dense-graded surface mix was compacted to 92 percent theoretical miximum density (8 percent air voids).

The site was a originally a wetland and was therefore regulated by the U.S. Environmental Protection Agency. Because it was a Superfund project, however; standard EPA permits were waived. Construction of the cap for Phase I began in late 1992 and was completed early in 1993. "Performance of both the drainage and loading aspects of the pavement cap have been excellent," says Szerdy. "So far; there is no visible deformation and no visible wear and tear on the surface."

Asphalt capping systems can prove very economical because cover soil does not have to be imported and simple asphalt

paving techniques minimize construction time. Additionally, the paved surface gives a second life to the site.

This article appeared in the Winter 1995-96, Volume 9, No. 3, ASPHALT magazine.

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Shear Strength

Property	MatCon	Conventional Asphalt
Vertical Permeability (cm/sec)	< 1.0 x 10 -8	5.4 x 10 -5
Tensile Strength (% strain at failure)	**2.4**	**1.38**
Flexural Properties (mm deflection)	0.15 at the edges 17.51 at the center No cracking	1.08 at the edge 25.92 at the center 3.5 mm-wide crack
Void Space (%)	2.0	10.5
Density (lbs/ft 3)	149	144.2
Shear Strength (kilo Pascals)	**4.17**	**1.9**

COMPOSITION AND PROPERTIES OF CONCRETE

SECOND EDITION

GEORGE EARL TROXELL
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University of California, Berkeley

HARMER E. DAVIS
Professor of Civil Engineering
University of California, Berkeley

JOE W. KELLY
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McGRAW-HILL BOOK COMPANY New York St. Louis
San Francisco Toronto London Sydney

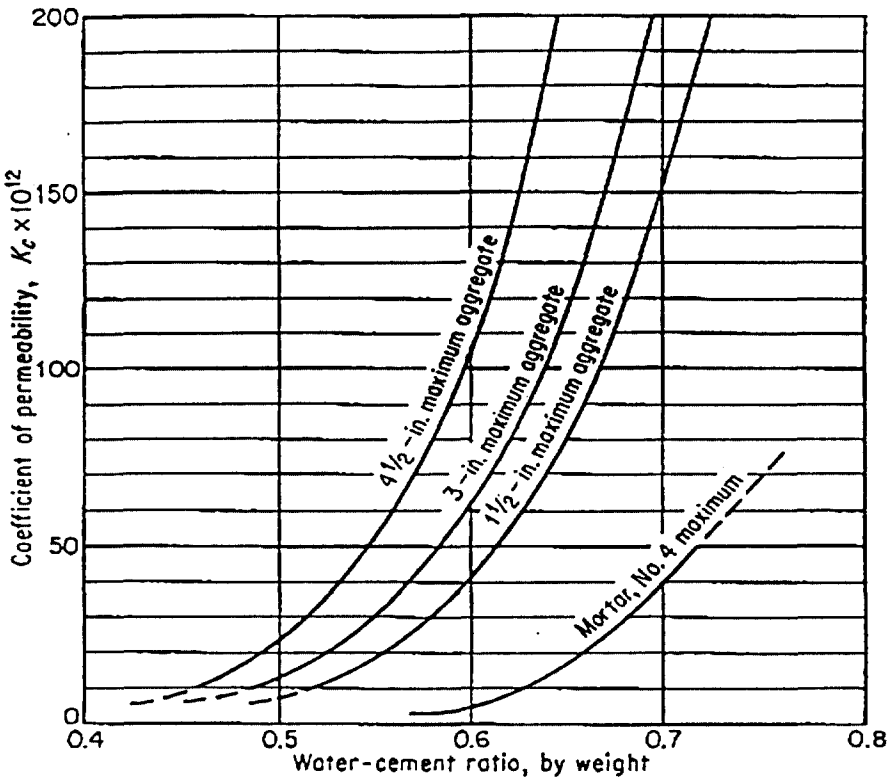


Fig. 11.2. Effect of water-cement ratio upon permeability. (*From Ruettgers, Vidal, and Wing* [1103].)

11.6 Effect of aggregates. As shown in Fig. 11.2, the greater the maximum size of aggregate for a given water-cement ratio, the greater the flow, probably because of the relatively large water voids developed on the underside of the coarser aggregate particles. Aggregates should be sound and of low porosity. A well-graded aggregate is even more important from the standpoint of watertightness than it is from the standpoint of strength, as dense concrete is essential. Sufficient fines must be used, but the mix should not be oversanded.

11.7 Effect of curing. It has been stated that continued hydration of the cement results in gel development which reduces the size of the voids and increases the watertightness of the concrete. Figure 11.3 shows the very great increase in watertightness with curing, the change being even greater than the increase in strength with curing.

11.8 Effect of admixtures and coatings. Various materials are sold for use as admixtures to improve the watertightness of concrete, and some "waterproof" cements are sold for the same purpose. Results of tests on lean-mass concretes containing pozzolans indicate increased resistance to the flow of water when these finely ground materials are used [106]. Al-

law for viscous flow

$$\frac{Q}{A} = K_c \frac{H}{L}$$

where Q = rate of flow, cu ft/sec
A = area of cross section under pressure, sq ft
$\frac{H}{L}$ = ratio of head of fluid to percolation length
K_c = permeability coefficient for concrete

11.4 Factors affecting watertightness. As shown in Fig. 11.1, the several factors affecting the permeability of concrete fall into three groups:

1. The influence of the constituent materials
2. The effect of methods of preparing the concrete
3. The influence of subsequent treatment of the concrete

In general, other things being equal and for normal concrete, any factor tending to improve the compressive strength of the concrete will have a beneficial effect upon the watertightness. Therefore, the better the quality of the constituent materials, the less permeable the concrete.

11.5 Effect of water and cement. The water-cement ratio and the consistency of concrete are so interrelated that their effects must be considered together. For plastic workable mixes the permeability increases with the water-cement ratio as shown in Fig. 11.2. A water-cement ratio of not more than about 6 gal of water per sack of cement has been recommended for use in thin sections, and one of not more than 7 gal per sack for more massive structures [100]. As dry mixes do not consolidate very readily, more water is required for minimum permeability than for maximum strength. For hand-rodded concrete the permeability increases when the water is reduced below that which will produce a slump of about 2 to 3 in. [1101].

Permeability decreases as the cement-voids ratio increases, and this relationship appears to be more definite than that between permeability and water-cement ratio [1101].

With well-cured concrete and the optimum quantity of mixing water, an increase of cement content above that in a 1:2:4 mix does not materially affect permeability. However, very wet consistencies require a richer mix and tend to produce water gain under the aggregate particles, which increases the permeability.

Greater fineness of the cement improves watertightness in the same way that it improves strength and durability of the concrete.

APPENDIX H.11

PERFORATED PIPE CAPACITY

TRC

By TLP Date 3/23/03 Subject WDL Drain Sheet No. 1 of 2

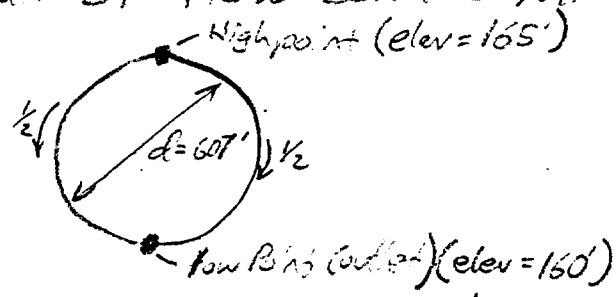
Chkd. By LBJ Date 3/24/03 Perforated Pipe Capacity Proj. No. 30747

Purpose

- Determine if 4 inch perforated HDS pipe has capacity for flow of the drain at a slope of less than 1%

Basis

- Hazen Williams formula determines the resistance to flow given pipe diameter, flow, and roughness coefficient
- Pipe diameter is 4 inch HDS corrugated and perforated
- Flow of drain from HELP model analysis (see PIC drain pipe calculation) is 105 gpm for entire area of cover
- Assume half of flow comes through each side of drain:



- Assume roughness coefficient of 80 (similar to 30 yr old unlined cast iron pipe, see attached)

Calculations

- Hazen Williams: $Q = A k C R_h^{0.63} S^{0.54}$

  where Q = flow (cfs)

  A = pipe x-section area (ft^2)

  k = constant (1.318 for units of ft & seconds)

  C = roughness coefficient

  R_h = hydraulic radius (D/4 for circular pipe)

  S = Energy Slope (ft/ft) $= \frac{h_f}{L} = \frac{\text{Head loss}}{\text{length}}$

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TRC

By TLP Date 3/23/03 Subject WDI Drain Sheet No. 2 of 2
Chkd. By LCS Date 3/24/03 Perforated Pipe Capacity Proj. No. 30747

- $Q = \frac{105}{2}$ gpm $= 0.12$ cfs

$$S = \frac{(165-160)}{(607 \times \pi)/2} = 0.0052 \frac{ft}{ft} \quad (0.5\%)$$

- $D = 0.34$ ft using Hazen Williams formula
  (= Diameter of pipe that can handle 0.12 cfs at a slope of 0.5% and a roughness factor of 80)

$= 4.1''$

Results:

- Corrugated perforated ADS pipe of 4 inches in diameter can handle the area flow
  - Flow of 105 gpm is conservatively high considering the limitations of the field work. In reality flow will not be this high.
  - Hazen Williams formula is based on simplifying assumptions that underestimate flow capacity.
- Flow calculation does not consider the flow capacity of the gravel bed surrounding the perforated pipe.

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Minor Loss Coefficients, Hazen-Williams Coefficients, and Surface Roughness

Quick links to tables on this page:
Minor Loss Coefficients Hazen-Williams Coefficients Surface Roughness

Values compiled from the references listed under Discussion and References for Closed Conduit Flow

To LMNO Engineering Home Page and Interactive Calculations

Table of Minor Loss Coefficients (K has no units)

Fitting	K	Fitting	K
Valves:		*Elbows:*	
Globe, fully open	10	Regular 90°, flanged	0.3
Angle, fully open	2	Regular 90°, threaded	1.5
Gate, fully open	0.15	Long radius 90°, flanged	0.2
Gate 1/4 closed	0.26	Long radius 90°, threaded	0.7
Gate, 1/2 closed	2.1	Long radius 45°, threaded	0.2
Gate, 3/4 closed	17	Regular 45°, threaded	0.4
Swing check, forward flow	2		
Swing check, backward flow	infinity	*Tees:*	
		Line flow, flanged	0.2
180° return bends:		Line flow, threaded	0.9
Flanged	0.2	Branch flow, flanged	1.0
Threaded	1.5	Branch flow, threaded	2.0

Table of Hazen-Williams Coefficients (C has no units)

To top of page

Material	C	Material	C
Asbestos Cement	140	Copper	130-140
Brass	130-140	Galvanized iron	120
Brick sewer	100	Glass	140
Cast-Iron:		Lead	130-140
New, unlined	130	Plastic	140-150
10 yr. old	107-113	*Steel:*	
20 yr. old	89-100	Coal-tar enamel lined	145-150

30 yr. old	75-90	New unlined	140-150
40 yr. old	64-83	Riveted	110
Concrete/Concrete-lined:			
Steel forms	140	Tin	130
Wooden forms	120	Vitrif. clay (good condition)	110-140
Centrifugally spun	135	Wood stave (avg. condition)	120

Table of Surface Roughnesses

To top of page

Material	**Surface Roughness, e**	
	feet	meters
PVC, plastic, glass	0.0	0.0
Commercial Steel or Wrought Iron	1.5e-4	4.5e-5
Galvanized Iron	5.0e-4	1.5e-4
Cast Iron	8.5e-4	2.6e-4
Asphalted Cast Iron	4.0e-4	1.2e-4
Riveted Steel	0.003 to 0.03	9.0e-4 to 9.0e-3
Drawn Tubing	5.0e-6	1.5e-6
Wood Stave	6.0e-4 to 3.0e-3	1.8e-4 to 9.0e-4
Concrete	0.001 to 0.01	3.0e-4 to 3.0e-3

APPENDIX H.12

WDI STATISTICAL ANALYSIS OF SOIL DATA

TRC

By TLP Date 3/23/03 Subject WDI Statistical Analysis of Soil Data Sheet No. 1 of 4
Chkd. By ___ Date ___ Proj. No. 30747

Purpose

- To compare chemical characterization data for the fill and waste at the WDI site. The comparison is to determine the feasibility of or need for sampling of fill soils during construction to assure that they are not waste or contaminated.

Basis

- Fill soil data from the top five feet are provided in Attachment 1. Most of this data resulted from the 1988/1989 RI activities by EBASCO.
- Waste data (from all depths, as determined from boring log information) are provided in Attachment 2.
- The comparison is only performed on COCs identified in the 1993 ROD:
  - Arsenic, beryllium, Cadmium, Chromium, lead, thallium, benzene, dieldrin, DDT, DDD, DDE, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, Indeno (1,2,3)pyrene, Arochlors 1016, 1221, 1232, 1242, 1248, 1254 and 1260
- A t-test will be attempted as suggested by EPA to compare fill soil and waste levels
- Alternative, distribution-free tests (based on the central limit theorem) can also be used. Graphical comparison of the cumulative distributions is useful
- Compare the upper percentile levels in the fill with risk-based levels (i.e., background and PRGs)
- Non-detect values are set at zero. This was done to simplify the analysis as available data tables did not report detection limits. The detection limits are

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By TLP Date 3/23/03 Subject WDI Statistical Analysis of Soil Data Sheet No. 2 of 4

Chkd. By ____ Date ____ Proj. No. 30747

Method

- Fill and Waste data are in an Excel Spreadsheet
- Use the t-test function in Excel to perform the calculation; test option of allowing unequal variances is used
- t-test output are provided in Attachment 3
- As indicated by the output, only DDT indicated a difference between fill and waste
- Close inspection of the results indicate that the data are not normally distributed because of the high frequency of non-detects. The high frequency of non-detects prevents using assumptions regarding distribution (i.e., from creating a normal distribution using Aitchions and Cohen's approximation). The high frequency of non-detects also renders the t-test results relatively meaningless.

- As a check of the t-test results, the cumulative distributions were estimated using the PERCENTILE function in Excel. Results are presented in Attachment 4
- Inspection of the charts indicates there may be differences in waste and fill soil concentrations of: Benzene, DDT, DDD, DDE, and PAHs (as indicated by the separation of the curves. Differences are small and may not be statistically significant. Significance generally related to what percentile the curve leaves Ocon
- Results of statistical comparisons indicate that the fill and waste chemistry is not significantly different.

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By TCP Date 3/23/03 Subject WDI Statistical Analysis of Soil Data Sheet No. 3 of 4

Chkd. By ___ Date ___ Proj. No. 30747

- Concentration comparison to risk-based Levels:

Constituent	Fill (mg/kg) 95th percentile(2) level	90th percentile(2) level	PRG(1)	Background
Arsenic	18	11	1.6	10 (from 1993 RI)
Beryllium	0.9	0.6	1900	
Cadmium	2.1	1.7	7.4	
Chromium	48	38	450	
Lead	690	390	750	
Thallium	20	17	67	
Benzene	0.01	0	1.3	
Dieldrin	0	0	0.11	
DDT	0.07	0.02	10	
DDD	0.009	0	7	
DDE	0.07	0.01	7	
Benz(a)anthracene	0.05	0	2.1	
Benzo(b)fluoranthene	0.14	0	2.1	
Benzo(K)fluoranthene	0.014	0	1.3	
Benzo(a)pyrene	0.20	0.06	0.21	
Chrysene	0.29	0.10	13	
Benz(a,h)anthracene	All ND		0.21	
Indeno(1,2,3-cd)pyrene	0	0	2.1	
Arochlor 1016	All ND		21	
" 1221	All ND		0.74	
" 1232	All ND		0.74	
" 1242	0	0	0.74	
" 1248	0	0	0.74	
" 1254	0	0	0.74	
" 1260	0	0	0.74	

(1) Preliminary remediation goal for industrial soils. EPA Region IX PRG Table, October 2002.

(2) Value of zero indicates all non-detect values at this percentile, but detections at higher percentile.

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By TCP Date 3/23/03 Subject WDI Statistical Evaluation of Soil Data Sheet No. 4 of 4

Chkd. By ____ Date ____ Proj. No. 30747

Conclusions

- No significant difference can be discerned from available site characterization data between concentrations of ROD constituents of concern in fill soils and waste.
- Possible differences between concentrations may exist for: Benzene, DDT, DDE, DDD, and PAHs.
- Upper limit concentrations (i.e. 95th percentile) in fill soil are less than PRGs for all constituents of concern except arsenic.
  - For arsenic, the 90th percentile concentration is approximately the same as the upper limit of site background as defined in the 1993 ROD

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Positive values indicate concentrations above reporting limits
0 = non-detected above reporting limits
Blue highlighted values indicate concentrations above the 1993 ROD Cleanup standards
Blank Cells indicated that analysis for the specific constituent was not performed.

		Parameter and concentration (mg/kg)															
Sample No.	Depth (feet)	Arsenic	Beryllium	Cadmium	Chromium	Lead	Thallium	Benzene	Dieldrin	DDT	DDD	DDE	Benz[a]anthracene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Chrysene
SB-016-001	0	0	0	0	0.0	0	0	0	0	0	0	0.015	0	0	0	0	0
SB-016-003	0	15.5	0.92	1	28.3	85.4	10.9	0	0	0	0	0	0	0	0	0	0
SB-016-005	5	10.6	0.19	1.15	34.6	398	0	0	0	0	0	0	0	0	0	0	0.5
SB-016-006	5	10.6	0.19	1.15	34.6	398	0	0	0	0	0	0	0	0	0	0	0
SB-017-001	0	0	0	0	0	0	0	0	0.026	0	0	0	0	0	0.12	0	0
SB-018-001	0	0	0	0	0	0	0	0	0	0.017	0	0	0	0	0	0	0
SB-018-002	0	6.9	0.57	1.1	21.4	10.6	0	0	0	0	0	0	0	0	0	0	0
SB-019-002	0	9.5	0.8	1.3	23.7	98	0	0	0	0	0	0	0	0	0	0	0
SB-020-001	0	0	0	0	0	0	0	0	0	0.012	0	0	0	0	0	0	0
SB-026-001	5	0	0	0	0	0	0	1.4	0	0	0	0	0	0	0	0	0
SB-027-001	0	0	0	0	0	0	0	0	0	0	0	0.023	0	0	0	0	0
SB-027-003	0	7.6	0.48	0	26.0	21	0	0	0	0	0	0	0	0	0	0	0
SB-027-004	0	0	0	0	0	0	0	0	0	0	0	0.028	0	0	0	0	0
SB-028-001	0	0	0	0	0	0	0	0	0	0	0	0	0.18	0.34	0	0.21	0.2
SB-029-001	5	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0.091	0.11	0.097
SB-033-002	5	20.7	0.19	0.61	22.3	75.6	20	0	0	0	0	0	0	0	0	0	0
SB-036-001	0	0	0	0	0	0	0	0	0	0.16	0	0.11	0	0	0	0	0
SB-037-002	0	11.3	0.67	0	25.8	19.5	0	0	0	0	0	0	0	0	0	0	0
SB-038-001	0	0	0	0	0	0	0	0	0	0.018	0	0	0	0	0	0	0
SB-038-004	5	0	0	0	0	0	0	0.85	0	0	0	0	0	0	0	0	0.17
SB-038-005	5	32.3	0.21	2.05	63.7	394	11.6	0	0	0	0	0	0	0	0	0	0
SB-039-005	5	85	0.18	3.21	32.6	2790	11.3	0	0	0	0	0	0	0	0	0	0
SB-041-001	0	0	0	0	0	0	0	0	0.035	0	0	0	0	0	0	0	0
SB-041-005	5	3.67	0.24	1.24	18.4	13.8	13.3	0	0	0	0	0	0	0	0	0	0
SB-046-001	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0	0
SB-047-004	0	0	0	0	0	0	0	0.26	0	0	0	0	0	0.31	0.34	0.28	0.49
SB-048-001	0	0	0	0	0	0	0	0	0	0.072	0	0.0063	0	0	0	0	0
SB-048-002	0	0	0	0	0	0	0	0	0.0078	0	0.0098	0	0	0	0	0	0
SB-048-005	5	0	0	0	0	0	0	0	0	0	0.0025	0	0	0	0	0	0
SB-051-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0.045	0.048	0.055	0.036
SB-053-005	5	5.28	0.15	0.57	33.9	4.78	20.1	0	0	0	0	0	0	0	0	0	0
SB-054-002	5	4.98	0.30	0.39	27.2	5.92	14.8	0	0	0	0	0	0	0	0	0	0
SB-055-001	0	4.1	1.20	0.86	23.7	5.4	0	0	0	0	0	0	0	0	0	0	0
SB-055-002	0	8.6	0.82	1.3	20.9	33.3	0	0	0	0	0	0	0	0	0	0	0
SB-055-004	5	0	0	0	0	0	0	0	0	0.066	0	0	0	0	0	0	0
SB-055-005	5	9.4	0.59	2.1	34.2	110	0	0	0	0	0	0	0	0	0	0	0
SB-058-002	0	5.87	0.15	0.69	13.0	80.1	12.1	0	0	0	0	0	0	0	0	0	0
SB-058-005	5	9.12	0.22	18.2	149.0	1600	17.7	0	0	0	0	0	0	0	0	0	0
SB-059-002	0	85.1	0.31	0.84	34.4	122	18.7	0	0	0	0	0	0	0	0	0	0
SB-062-001	0	0	0	0	0	0	0	0	0	0.022	0	0	0	0	0	0	0
SB-063-001	0	0	0	0	0	0	0	0	0	0	0.0091	0.0073	0	0	0	0	0
SB-064-001	0	0	0	0	0	0	0	0	0	0	0.023	0	0.076	0.13	0	0.13	0.17
SB-064-004	0	0	0	0	0	0	0	0	0	0	0	0.0084	0	0	0	0	0
SB-066-002	5	4.61	0.21	0.77	24.4	27.3	16.7	0	0	0	0	0	0	0	0	0	0
SB-067-001	0	0	0	0	0	0	0	0	0	0.16	0	0.073	0	0	0	0	0
SB-067-004	0	9.5	1.00	2.2	25.5	52.8	0	0	0	0	0	0	0	0	0	0	0
SB-068-001	0	0	0	0	0	0	0	0	0	0.0065	0	0	0.41	0.37	0	0.37	0.63
SB-069-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SB-069-005	5	12.2	0.18	0.77	40.8	10.9	10.1	0	0	0	0	0	0	0	0	0	0
SB-072-001	0	0	0	0	0	0	0	0	0	0.036	0.036	0.013	0	0	0	0	0
SB-073-001	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.48	0.62
SB-073-002	5	11	0.22	1.19	44.4	59.6	27.7	0	0	0	0	0	0	0	0	0	0
SB-075-002	0	5.31	0.21	0.89	22.3	48.4	16.7	0	0	0	0	0	0	0	0	0	0
SB-075-006	5	5.66	0.25	1.84	38.1	13.1	20.2	0	0	0	0	0	0	0	0	0	0
SB-077-002	5	4.87	0.36	1.87	38.1	19.1	22.8	0	0	0	0	0	0	0	0	0	0
SB-079-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SB-083-004	5	6.1	1.00	0	20.8	11.9	0	0	0	0	0	0	0	0	0	0	0
SB-084-002	5	4.2	1.20	1.7	27.0	6.6	0	0	0	0	0	0	0	0	0	0	0
SB-088-003	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.28
SB-090-001	0	0	0	0	0	0	0	0	0	0	0	0	0.042	0.085	0.085	0.066	0.092

Attachment 1

Positive values indicate concentratic
0 = non-detected above reporting lir
Blue highlighted values indicate con
Blank Cells indicated that analysis f

Sample No.	Depth (feet)	Dibenz[a,h]anthracene	Indeno [1,2,3-cd] pyrene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
SB-016-001	0	0	0	0	0	0	0	0	0	0
SB-016-003	0	0	0	0	0	0	0	0	0	0
SB-016-005	5	0	0	0	0	0	0.08	0	0	0.13
SB-016-006	5	0	0	0	0	0	0	0	0	0
SB-017-001	0	0	0	0	0	0	0	0	0	0
SB-018-001	0	0	0	0	0	0	0	0	0	0
SB-018-002	0	0	0	0	0	0	0	0	0	0
SB-019-002	0	0	0	0	0	0	0	0	0	0
SB-020-001	0	0	0	0	0	0	0	0	0	0
SB-026-001	5	0	0	0	0	0	0	0	0	0
SB-027-001	0	0	0	0	0	0	0	0	0	0
SB-027-003	0	0	0	0	0	0	0	0	0	0
SB-027-004	0	0	0	0	0	0	0	0	0	0
SB-028-001	0	0	0	0	0	0	0	0	0	0
SB-029-001	5	0	0.074	0	0	0	0	0	0	0
SB-033-002	5	0	0	0	0	0	0	0	0	0
SB-036-001	0	0	0	0	0	0	0	0	0	0
SB-037-002	0	0	0	0	0	0	0	0	0	0
SB-038-001	0	0	0	0	0	0	0	0	0	0
SB-038-004	5	0	0	0	0	0	0	0	0	0.38
SB-038-005	5	0	0	0	0	0	0	0	0	0
SB-039-005	5	0	0	0	0	0	0	0	0	0
SB-041-001	0	0	0	0	0	0	0	0	0	0
SB-041-005	5	0	0	0	0	0	0	0	0	0
SB-046-001	0	0	0	0	0	0	0	0	0	0
SB-047-004	0	0	0	0	0	0	0	0	0	0.1
SB-048-001	0	0	0	0	0	0	0	0	0	0
SB-048-002	0	0	0	0	0	0	0	0	0	0
SB-048-005	5	0	0	0	0	0	0	0	0	0
SB-051-001	0	0	0	0	0	0	0	0	0	0
SB-053-005	5	0	0	0	0	0	0	0	0	0
SB-054-002	5	0	0	0	0	0	0	0	0	0
SB-055-001	0	0	0	0	0	0	0	0	0	0
SB-055-002	0	0	0	0	0	0	0	0	0	0
SB-055-004	5	0	0	0	0	0	0	0	0	0
SB-055-005	5	0	0	0	0	0	0	0	0	0
SB-058-002	0	0	0	0	0	0	0	0	0	0
SB-058-005	5	0	0	0	0	0	0	0	0	0
SB-059-002	0	0	0	0	0	0	0	0	0	0
SB-062-001	0	0	0	0	0	0	0	0	0	0
SB-063-001	0	0	0	0	0	0	0	0	0	0
SB-064-001	0	0	0	0	0	0	0	0	0	0
SB-064-004	0	0	0	0	0	0	0	0	0	0
SB-066-002	5	0	0	0	0	0	0	0	0	0
SB-067-001	0	0	0	0	0	0	0	0	0	0
SB-067-004	0	0	0	0	0	0	0	0	0	0
SB-068-001	0	0	0	0	0	0	0	0	0	0
SB-069-001	0	0	0	0	0	0	0	0	0	0
SB-069-005	5	0	0	0	0	0	0	0	0	0
SB-072-001	0	0	0	0	0	0	0	0	0	0
SB-073-001	5	0	0	0	0	0	0	0	0	0
SB-073-002	5	0	0	0	0	0	0	0	0	0
SB-075-002	0	0	0	0	0	0	0	0	0	0
SB-075-006	5	0	0	0	0	0	0	0	0	0
SB-077-002	5	0	0	0	0	0	0	0	0	0
SB-079-001	0	0	0	0	0	0	0	1.7	0	0
SB-083-004	5	0	0	0	0	0	0	0	0	0
SB-084-002	5	0	0	0	0	0	0	0	0	0
SB-088-003	5	0	0	0	0	0	0	0	0	0
SB-090-001	0	0	0	0	0	0	0	0	0	0

Positive values indicate concentrations above reporting limits
0 = non-detected above reporting limits
Blue highlighted values indicate concentrations above the 1993 ROD Cleanup standards
Blank Cells indicated that analysis for the specific constituent was not performed.

		Parameter and concentration (mg/kg)															
Sample No.	Depth (feet)	Arsenic	Beryllium	Cadmium	Chromium	Lead	Thallium	Benzene	Dieldrin	DDT	DDD	DDE	Benz[a]anthracene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Chrysene
SB-090-004	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.96	0.3
SB-090-005	5	4.4	0.23	1.64	55.8	24.9	13.1	0	0	0	0	0	0	0	0	0	0
SB-096-001	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.18	0	0.18	0
SB-098-001	0	0	0	0	0	0	0	0	0	0	0	0	0.092	0	0	0.2	0
SB-103-002	0	6.3	0.25	1.03	27.1	174	15	0	0	0	0	0	0	0	0	0	0
SB-103-007	5	0	1.40	0	39.0	495	0	0	0	0	0	0	0	0	0	0	0
SB-107-001	0	7.4	0	0	0	0	0	0	0	0.07	0	0	0	0	0	0	0
HPB-7-01-05	5		0.11				0						0	0	0	0	0
HPB-7-02-05	5		0.22				0						0	0	0	0	0
HPB-7-03-05	5		0.49				0						0	0	0	0	0
HPB-7-04-05	5		0.5				0						0	0	0	0	0
HPB-7-05-05	5		0.11				0						0	0	0	0	0
HPB-7-06-05	5		0.45				0						0	0	0	0	0
HPB-7-07-05	5		0.23				0						0	0	0	0	0
HPB-7-09-05	5		0.62				0						0	0	0	0	0
HPB-7-10-05	5		0.39				0						0	0	0	0	0
HPB-7-11-05	5		0.3				0						0	0	0	0	0
HPB-7-12-05	5		0.28				0						0	0	0	0	0
HPB-4-13-05	5		0.12				0						0	0	0	0	0
HPB-4-14-05	5	5.7	0.21	5.1	16	93	0	0									
HPB-4-15-05	5		0.2				0										
HPB-4-16-05	5		0.28				0										
HPB-4-17-05	5		0.32				0										
HPB-4-18-05	5		0.14				12										
HPB-4-19-05	5		0.38				0										
HPB-4-20-05	5		0.39				0										
HPB-4-21-05	5		0.64				0										
HPB-4-22-05	5		0.37				0										
HPB-4-23-05	5		0.28				0										
HPB-4-24-02	2		0.95				0										
HPB-4-24-05	5		0.29				0										
HPB-4-25-05	5		0.32				0										
HPB-4-26-05	5		0.37				0										
HPB-4-27-05	5		0.32				0										
HPB-4-28-05	5		0.41				0						0	0	0	0	0
HPB-4-29-05	5		0.51				0										
HAB-4-05-05	5	8.6	0.16	0.7	16	41	0	0									
TS-127-3.4	3.4-4.8	5	0.52	1.1	26	1700	0	0									
TS-128-3.6	3.6-4.8	1.9	0.43	1.7	27	300	0	0									
TS-129-3.8	3.6-3.8	6.9	0.25	10	42	1600	0	0									
TS-130-4.1	3.8-4.1	13	0.59	0	51	460	0	0	0	0	0.0045	0.082	0	0	0	0	0
TS-131-2.6	2.6-3.0	5.2	0.64	0	24	10	0	0.804	0	0	0	0	0	0	0	0	0
TS-132-3.1	2.9-3.1	23	0.45	0	64	850	0		0	0	0	0					
TS-133-4.8	3.8-4.8	4.9	0.57	0	14	100	0	0	0	0	0	0.0026	0	0	0	0	0
TS-134-3.8	2.8-3.8	1.8	0.22	0	13	41	0	0	0	0	0	0	0	0	0	0	0
TS-135-2.4	2.4-3.6	5	0.38	0	15	62	0	0	0	0.023	0	0	0	0	0	0	0
TS-136-2.6	2.6-3.3	3	0.34	0	13	31	0	0	0	0	0	0	0	0	0	0	0
TS-137-3.15	3.15-4	3.8	0.33	0	24	60	0	0	0	0	0	0.0051	0	0	0	0	0
TS-138-3.9	2.9-3.9	0.55	0.42	0	25	14	0	0	0	0	0	0	0	0	0	0	0
TS-139-2.8	2.8-3.9	3.9	0.36	0	15	15	0						0	0	0	0	0
TS-140-3.3	3.3-4	11	0.45	0	25	160	0	0					0	0	0	0	0
TS-141-3	2-3	2.9	0.15	0	4.6	30	0	0	0	0	0	0					
TS-142-5	4-5	3.5	0.18	0	5.1	92	0	0	0	0.37	0	0.1					
DP-2-5	5	2.8	0	0	22	5.1	0	0	0	0	0	0	0	0	0	0	0
DP-22-3	3	5.5	0	0	22	15	0	0	0	0.32	0	0.15	0	0	0	0	0
DP-27-3	3	0	0	0	23	5.5	0	0.015	0	0	0	0	0	0	0	0	0
IDP-3-5	5	3.8	0	0	20	3.8	0	0	0	0	0	0	0	0	0	0	0
IDP-6-5	5	8	0.59	0.65	28	10	0	0	0	0	0	0	0	0	0	0	0
Mean		6.19	0.27	0.79	17.84	143.42	2.58	0.04	0.00	0.02	0.00	0.01	0.01	0.02	0.01	0.03	0.04
Standard Deviation		13.21	0.30	2.27	21.67	422.01	6.20	0.19	0.00	0.06	0.01	0.03	0.05	0.07	0.04	0.12	0.12

Positive values indicate concentratic
0 = non-detected above reporting lir
Blue highlighted values indicate con
Blank Cells indicated that analysis fr

Sample No.	Depth (feet)	Dibenz[a,h]anthracene	Indeno [1,2,3-cd] pyrene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
SB-090-004	5	0	0	0	0	0	0	0	0	0
SB-090-005	5	0	0	0	0	0	0	0	0	0
SB-096-001	0	0	0	0	0	0	0	0	0	0
SB-098-001	0	0	0	0	0	0	0	0	0	0
SB-103-002	0	0	0	0	0	0	0	0	0	0
SB-103-007	5	0	0	0	0	0	0	0	0	0
SB-107-001	0	0	0	0	0	0	0	0	0	0
HPB-7-01-05	5	0	0	0	0	0	0	0	0	0
HPB-7-02-05	5	0	0	0	0	0	0	0	0	0
HPB-7-03-05	5	0	0	0	0	0	0	0	0	0
HPB-7-04-05	5	0	0	0	0	0	0	0	0	0
HPB-7-05-05	5	0	0	0	0	0	0	0	0	0
HPB-7-06-05	5	0	0	0	0	0	0	0	0	0
HPB-7-07-05	5	0	0	0	0	0	0	0	0	0
HPB-7-09-05	5	0	0	0	0	0	0	0	0	0
HPB-7-10-05	5	0	0	0	0	0	0	0	0	0
HPB-7-11-05	5	0	0	0	0	0	0	0	0	0
HPB-7-12-05	5	0	0	0	0	0	0	0	0	0
HPB-4-13-05	5	0	0	0	0	0	0	0	0	0
HPB-4-14-05	5									
HPB-4-15-05	5									
HPB-4-16-05	5									
HPB-4-17-05	5									
HPB-4-18-05	5									
HPB-4-19-05	5									
HPB-4-20-05	5									
HPB-4-21-05	5									
HPB-4-22-05	5									
HPB-4-23-05	5									
HPB-4-24-02	2									
HPB-4-24-05	5									
HPB-4-25-05	5									
HPB-4-26-05	5									
HPB-4-27-05	5									
HPB-4-28-05	5	0	0	0	0	0	0	0	0	0
HPB-4-29-05	5									
HAB-4-05-05	5									
TS-127-3.4	3.4-4.8									
TS-128-3.6	3.6-4.8									
TS-129-3.8	3.6-3.8									
TS-130-4.1	3.8-4.1	0	0	0	0	0	0	0	0	0
TS-131-2.6	2.6-3.0	0	0	0	0	0	0	0	0	0
TS-132-3.1	2.9-3.1			0	0	0	0	0	1.8	0
TS-133-4.8	3.8-4.8	0	0	0	0	0	0	0	0	0
TS-134-3.8	2.8-3.8	0	0	0	0	0	0	0	0	0
TS-135-2.4	2.4-3.6	0	0	0	0	0	0	0	0	0
TS-136-2.6	2.6-3.3	0	0	0	0	0	0	0	0	0
TS-137-3.15	3.15-4	0	0	0	0	0	0	0	0	0
TS-138-3.9	2.9-3.9	0	0	0	0	0	0	0	0	0
TS-139-2.8	2.8-3.9	0	0							
TS-140-3.3	3.3-4	0	0							
TS-141-3	2-3			0	0	0	0	0	0	0
TS-142-5	4-5			0	0	0	0	0	0	0
DP-2-5	5	0	0	0	0	0	0	0	0	0
DP-22-3	3	0	0	0	0	0	0	0	0	0
DP-27-3	3	0	0	0	0	0	0	0	0	0
IDP-3-5	5	0	0	0	0	0	0	0	0	0
IDP-6-5	5	0	0	0	0	0	0	0	0	0
Mean		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01
Standard Deviation		0.00	0.01	0.00	0.00	0.00	0.01	0.17	0.18	0.04

Positive values indicate concentrations above reporting limits
0 = non-detected above reporting limits (reporting limits unknown)
Blue highlighted values indicate concentrations above the 1993 ROD Cleanup standards
Blank Cells indicated that analysis for the specific constituent was not performed.

Waste data

Sample No.	Depth (feet)	Parameter and concentration (mg/kg) Arsenic	Beryllium	Cadmium	Chromium	Lead	Thallium	Benzene	Dieldrin	DDT	DDD	DDE	Benz[a]anthracene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Chrysene	Dibenz[a,h]anthracene
SB-033-006	10	6.7	0.19	0.66	39.7	7.3	20.5	0	0	0	0	0	0	0	0	0	0	0
SB-033-010	15	17.4	0.18	0.36	15.2	5.8	18	0	0	0	0	0	0	0	0	0	0	0
SB-017-007	15	17.3	0.23	0.97	37.2	502	12.6	0	0	0	0	0	0	0	0	0	0	0
SB-017-004	10	0	0	0	0	0	0	0	0.019	0	0	0	0	0	0	0	0.29	0
SB-017-006	15	0	0	0	0	0	0	0.006	0	0	0	0	0	0	0	0	0.55	0
SB-018-011	15	6.22	0.26	1.03	29.9	55.2	14.8	0	0	0	0	0	0	0	0	0	0	0
SB-019-011	10	3.52	0.17	0.6	27.3	5.09	9.45	0	0	0	0	0	0	0	0	0	0	0
SB-084-005	10	3.4	0.23	0.81	34.2	24.3	18.1	0	0	0	0	0	0	0	0	0	0	0
SB-104-005	10	3.3	0.97	0	15.8	4.4	0	0	0	0	0	0	0	0	0	0	0	0
SB-083-010	15	6.53	0.17	0.33	28.1	12.3	13.7	0	0	0	0	0	0	0	0	0	0	0
SB-083-013	20	5.8	1.10	0	21.8	3.9	0	0	0	0	0	0	0	0	0	0	0	0
SB-084-009	20	2.4	1.10	0	17.5	2.1	0	0	0	0	0	0	0	0	0	0	0	0
SB-083-016	35	12.2	0.20	0.41	30.5	7.15	15.7	0	0	0	0	0	0	0	0	0	0	0
SB-083-002	40	15.1	1.10	0	21.6	2640	0	0	0	0	0	0	0	0	0	0	0	0
SB-083-019	40	3.53	0.20	0.39	10.3	6.47	16.2	0	0	0	0	0	0	0	0	0	0	0
SB-040-004	10	0	0	0	0	0	0	3.1	0	0	0	0	0	0	0	0	0	0
SB-040-008	15	4.07	0.20	1.19	30.0	7.65	11.2	0	0	0	0	0	0	0	0	0	0	0
SB-040-010	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SB-038-007	10	0	0	0	0	0	0	12	0	0	0	0	4.3	3	0	3.1	7.4	0
SB-038-008	10	13	0.2	0.89	30.1	218	11.2	0	0	0	0	0	0	0	0	0	0	0
SB-038-016	18	0	0	0	0	0	0	1.8	0	0	0	0	0	0	0	1.7	2.6	0
SB-039-010	15	0	0	0	0	0	0	2.4	0	0	0	0	0	0.66	0.44	0	2	0
SB-039-011	15	23.6	0.23	5.21	44.7	470	13	0	0	0	0	0	0	0	0	0	0	0
SB-041-008	15	6.16	0.27	1.03	35.4	23.1	27.9	0	0	0	0	0	0	0	0	0	0	0
SB-029-004	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.41	0
SB-029-007	15	0	0	0	0	0	0	6.7	0	0	0	0	0	0	0	0	1.4	0
SB-041-010	20	0	0	0	0	0	0	0	0	0	0	0	1.5	0	0	0	2.1	0
SB-029-011	25	0	0	0	0	0	0	0.56	0	0	0	0	0	0	0	0	1.3	0
SB-041-013	25	0	0	0	0	0	0	6.6	0	0	0	0	0	0	0	0	8	0
SB-047-005H	10	6.95	0.22	10.8	39.4	1060	17.7	0	0	0	0	0	0	0	0	0	0	0
SB-047-006	10	0	0	0	0	0	0	4.5	0	0	0	0	1.1	0.41	0.41	0.64	1	0
SB-047-007	15	14.2	0.36	1.49	40.6	1050	20.1	0	0	0	0	0	0	0	0	0	0	0
SB-047-008	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SB-047-009H	15	9.94	0.32	0.53	26.5	56.9	17.9	0	0	0	0	0	0	0	0	0	0	0
SB-048-011	15	0	0	0	0	0	0	7.1	0	0	0	0	0	0	0	0	1.4	0
SB-048-012	15	0	0	0	0	0	0	2.6	0	0	0	0	0.57	0	0	0	0.78	0
SB-048-013	15	10.9	0.32	1.03	31.1	45.8	18	0	0	0	0	0	0	0	0	0	0	0
SB-049-011	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.46	0.12	0
SB-049-012	15	9.66	1.05	1.4	27.6	15.5	39.2	0	0	0	0	0	0	0	0	0	0	0
SB-049-014H	15	20.5	3.28	4.76	94.6	107	99.1	0	0	0	0	0	0	0	0	0	0	0
SB-053-015	20	8.88	0.2	0.54	31.4	6.63	27.7	0	0	0	0	0	0	0	0	0	0	0
SB-054-006	10	5.1	1.1	0	22.2	5.5	0	0	0	0	0	0	0	0	0	0	0	0
SB-054-009	20	7.5	1.2	0	37	6.9	0	0	0	0	0	0	0	0	0	0	0	0
SB-057-005	15	337	0.35	2.23	58.1	1880	28.3	0	0	0	0	0	0	0	0	0	0	0
SB-057-007	20	8.3	1.4	1.1	39.7	10.1	0	0	0	0	0	0	0	0	0	0	0	0
SB-057-009	25	0	0	0	0	0	0	7.7	0	0	0	0	0	0	0	0	0	0
SB-057-013	25	14.6	1.1	1.3	36.6	8.5	0	0	0	0	0	0	0	0	0	0	0	0
SB-058-008	15	0	0	0	0	0	0	0.0018	0	0	0	0	0	0	0	0	0.0022	0
SB-058-012	20	0	0	0	0	0	0	0.0042	0	0	0	0	0	0	0	0	0	0
SB-059-009	10	5.63	0.2	0.39	33.2	6.52	22.2	0	0	0	0	0	0	0	0	0	0	0
SB-059-016	20	9.95	0.21	0.65	37.0	6.73	16.8	0	0	0	0	0	0	0	0	0	0	0
SB-069-009	10	9.62	0.21	0.68	27.5	7.56	11.7	0	0	0	0	0	0	0	0	0	0	0
SB-068-013		0	0	0	0	0	0	0.84	0	0	0	0	0	0	0	0	0	0
SB-068-013	25	6.33	0.2	0.6	17.0	3.41	11.2	0	0	0	0	0	0	0	0	0	0	0
SB-103-009	10	0	0.53	0.37	32.7	6.18	15.4	0	0	0	0	0	0	0	0	0	0	0
SB-103-012	15	4.79	0.16	0.72	32.9	9.67	12.6	0	0	0	0	0	0	0	0	0	0	0
SB-107-005	15	0	0	0	0	0	0	0.44	0	0	0.028	0.017	0	0	0	0	0	0
SB-107-006	15	0	0	0	0	0	0	0.002	0	0	0	0	0	0	0	0	0	0
SB-107-008	20	0	0	0	0	0	0	0	0	0.044	0	0	0	0	0	0	0	0
SB-108-006	10	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0.025	0
SB-108-007	15	0	0	0	0	0	0	0.012	0	0	0	0	0.027	0	0	0.018	0.03	0
SB-108-010	18	0	0	0	0	0	0	0.032	0	0	0	0	0	0	0	0	0.053	0
SB-055-008	10	12.8	0.19	1.94	33.5	543	19.8	0	0	0	0	0	0	0	0	0	0	0
SB-066-004	20	7.36	0.79	1.98	31.4	836	22.4	0	0	0	0	0	0	0	0	0	0	0
SB-066-005	20	3.21	0.19	0.37	11.3	53.9	15.4	0	0	0	0	0	0	0	0	0	0	0
SB-066-007	25	1.5	0.23	0	6.60	1.6	0	0	0	0	0	0	0	0	0	0	0	0
SB-066-010	30	1.1	0.25	0.26	4.48	4.33	10.8	0	0	0	0	0	0	0	0	0	0	0
SB-067-015	30	2.91	0.28	0.36	6.57	5.98	14.9	0	0	0	0	0	0	0	0	0	0	0
SB-066-013	35	5.9	1	0	15.2	4	0	0	0	0	0	0	0	0	0	0	0	0
SB-067-018	35	12.8	0.20	0.45	41.3	10.7	15.9	0	0	0	0	0	0	0	0	0	0	0
SB-067-002	40	18.5	1.30	0	30.7	11.4	0	0	0	0	0	0	0	0	0	0	0	0
HPB-7-01-08	8	3.1	0.15	3.4	23	100	0	0					0	0	0	0	0	0
HPB-7-01-15	15	13	0.55	3.7	29	12	0	0					0	0	0	0	0	0
HPB-7-05-08	8	5.6	0.096	15	1400	63	0	0					0	0	0	0	0	0
HPB-7-05-10	10	2.2	0.082	2.4	17	33	0	0					0	0	0	0	0	0
HPB-7-05-13	13	9.8	0.41	3	23	9.3	0	0					0	0	0	0	0	0
HPB-7-07-09	9		0.29				0						0	0	0	0	0	0

Attachment 2

Positive values indicate concentrati
0 = non-detected above reporting lir
Blue highlighted values indicate cor
Blank Cells indicated that analysis f

Sample No.	Depth (feet)	Indeno [1,2,3-cd] pyrene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
SB-033-006	10	0	0	0	0	0	0	0	0
SB-033-010	15	0	0	0	0	0	0	0	0
SB-017-007	15	0	0	0	0	0	0	0	0
SB-017-004	10	0	0	0	0	0	0	0	0
SB-017-006	15	0	0	0	0	0	0	0	0
SB-018-011	15	0	0	0	0	0	0	0	0
SB-019-011	10	0	0	0	0	0	0	0	0
SB-084-005	10	0	0	0	0	0	0	0	0
SB-104-005	10	0	0	0	0	0	0	0	0
SB-083-010	15	0	0	0	0	0	0	0	0
SB-083-013	20	0	0	0	0	0	0	0	0
SB-084-009	20	0	0	0	0	0	0	0	0
SB-083-016	35	0	0	0	0	0	0	0	0
SB-083-002	40	0	0	0	0	0	0	0	0
SB-083-019	40	0	0	0	0	0	0	0	0
SB-040-004	10	0	0	0	0	0	0	0	0
SB-040-008	15	0	0	0	0	0	0	0	0
SB-040-010	15	0	0	0	0	0	0	0.12	0
SB-038-007	10	0	0	0	0	0	0	0	1.1
SB-038-008	10	0	0	0	0	0	0	0	0
SB-038-016	18	0	0	0	0	0	0	0	0.42
SB-039-010	15	0	0	0.091	0	0	0	0.29	0.25
SB-039-011	15	0	0	0	0	0	0	0	0
SB-041-008	15	0	0	0	0	0	0	0	0
SB-029-004	10	0	0	0	0	0	0	0	0
SB-029-007	15	0	0	0	0	0	0	0	0
SB-041-010	20	0	0	0	0	0	0	0	0
SB-029-011	25	0	0	0	0	0	0	0	0
SB-041-013	25	0	0	0	0	0	0	0	0
SB-047-005H	10	0	0	0	0	0	0	0	0
SB-047-006	10	0	0	0	0	0	0	0.086	0
SB-047-007	15	0	0	0	0	0	0	0	0
SB-047-008	15	0	0	0	0	0	0	0.57	0
SB-047-009H	15	0	0	0	0	0	0	0	0
SB-048-011	15	0	0	0	0	0	0	0.33	0
SB-048-012	15	0	0	0	0	0	0	0	0
SB-048-013	15	0	0	0	0	0	0	0	0
SB-049-011	15	0	0	0	0	0	0	0	0
SB-049-012	15	0	0	0	0	0	0	0	0
SB-049-014H	15	0	0	0	0	0	0	0	0
SB-053-015	20	0	0	0	0	0	0	0	0
SB-054-006	10	0	0	0	0	0	0	0	0
SB-054-009	20	0	0	0	0	0	0	0	0
SB-057-005	15	0	0	0	0	0	0	0	0
SB-057-007	20	0	0	0	0	0	0	0	0
SB-057-009	25	0	0	0	0	0	0	0	0
SB-057-013	25	0	0	0	0	0	0	0	0
SB-058-008	15	0	0	0	0	0	0	0	0
SB-058-012	20	0	0	0	0	0	0	0	0
SB-059-009	10	0	0	0	0	0	0	0	0
SB-059-016	20	0	0	0	0	0	0	0	0
SB-069-009	10	0	0	0	0	0	0	0	0
SB-068-013		0	0	0	0	0	0	0	0
SB-068-013	25	0	0	0	0	0	0	0	0
SB-103-009	10	0	0	0	0	0	0	0	0
SB-103-012	15	0	0	0	0	0	0	0	0
SB-107-005	15	0	0	0	0	0	0	0	0
SB-107-006	15	0	0	0	0	0	0	0	0
SB-107-008	20	0	0	0	0	0	0	0	1.3
SB-108-006	10	0	0	0	0	0	0.045	0	0.079
SB-108-007	15	0	0	0	0	0	0	0	0
SB-108-010	18	0	0	0	0	0	0.037	0	0.067
SB-055-008	10	0	0	0	0	0	0	0	0
SB-066-004	20	0	0	0	0	0	0	0	0
SB-066-005	20	0	0	0	0	0	0	0	0
SB-066-007	25	0	0	0	0	0	0	0	0
SB-066-010	30	0	0	0	0	0	0	0	0
SB-067-015	30	0	0	0	0	0	0	0	0
SB-066-013	35	0	0	0	0	0	0	0	0
SB-067-018	35	0	0	0	0	0	0	0	0
SB-067-002	40	0	0	0	0	0	0	0	0
HPB-7-01-08	8	0	0	0	0	0	0	0	0
HPB-7-01-15	15	0	0	0	0	0	0	0	0
HPB-7-05-08	8	0	0	0	0	0	0	0	0
HPB-7-05-10	10	0	0	0	0	0	0	0	0
HPB-7-05-13	13	0	0	0	0	0	0	0	0
HPB-7-07-09	9	0	0	0	0	0	0	0	0

Positive values indicate concentrations above reporting limits
0 = non-detected above reporting limits (reporting limits unknown)
Blue highlighted values indicate concentrations above the 1993 ROD Cleanup standards
Blank Cells indicated that analysis for the specific constituent was not performed.

Waste data

		Parameter and concentration (mg/kg)																
Sample No.	Depth (feet)	Arsenic	Beryllium	Cadmium	Chromium	Lead	Thallium	Benzene	Dieldrin	DDT	DDD	DDE	Benz[a]anthracene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Chrysene	Dibenz[a,h]anthracene
HPB-7-07-10	10	2.8	0.17	0.56	7.4	0	0	0					0	0	0	0	0	0
HPB-7-28-10	10		0.36				0						0	0	0	0	0	0
HPB-7-28-15	15	3.2	0.4	4.5	19	9.7	0	0										
HAB-7-01-10	10	5.5	0.48	1.9	26	18	0	0					0	0	0	0	0	0
HPB-4-13-15	15	1.6	0.24	3.2	18	6.3	0	0					0	0	0	0	0	0
HPB-4-14-10	10	7.4	0.25	8	16	74	0	0										
HPB-4-15-10	10	8.5	0.28	1.6	8.1	37	0	0										
HPB-4-16-10	10		0.27				0											
HPB-4-16-15	15		0.2				0											
HPB-4-16-20	16	4.8	0.32	5.5	29	20	0	0.11										
HPB-4-22-10	10		0.41				0											
HPB-4-22-15	15		0.12				0											
HPB-4-23-10	10		0.33				0											
HPB-4-23-15	15	2.4	0.25	3.6	16	12	0											
HPB-4-25-11	11		0.51				0	0										
HPB-4-25-10	10	3.3	0.21	3.2	14	15	0	0										
HPB-4-29-10	10	2.4	0.25	3.7	12	6.9	0	0										
HPB-4-29-15	15		0.65				0											
HPB-4-29-20	20		0.37				0											
HAB-4-04-15	15	4.3	0.07	2.2	16	13	0	0.99										
HAB-4-04-20	20	4.3	0.07	0.9	15	8.7	0	0										
HAB-4-03-10	10	4.2	0.25	1.8	18	32	0	0										
HAB-4-03-25	25	6.7	0.49	2.6	31	23	0	0										
HAB-4-02-15	15	2	0.36	1.6	22	11	0	0										
HAB-4-02-10	10	3.7	0.44	1.6	22	28	0	0										
HAB-4-02-20	20	6.9	0.74	2.8	33	22	0	0										
HAB-4-05-10	10	3.3	0.36	2	24	11	0	0										
HAB-4-07-15	15	2.9	0	1.3	14	15	0	0										
HAB-4-07-20	20	2.1	0	0.3	13	0	0	0										
TS-127-8.11	8.11-9.11	13	0.39	1.1	17	51	0	0										
TS-127-19.8	18.4-19.8	4.4	0.60	0	21	7.4	0	0										
TS-128-13.8	12-13.8	1.6	0.41	0	18	98	0	0										
TS-128-19.8	18-19.8	3.6	0.64	0	21	5.5	0	0										
TS-129-9.8	8.6-9.8	2.7	0.29	0	10	18	0	1.1										
TS-129-17.8	16.4-17.8	8.4	0.81	0	24	8.6	0	0										
TS-130-13	12-13	3.9	0.23	2.3	58	320	0	19.59	0	0	0	0.019	0	0	0	0	0	0
TS-132-11	10-11	21	0.37	1.6	68	760	0	7.75	0	0	0	0	0	0	0	0	0	0
TS-132-18	17.2-18	8.8	0.83	0	33	13	0	0	0	0	0	0	0	0	0	0	0	0
TS-133-11.2	10.5-11.2	4.5	0.3	4.5	44	2500	0	7	0	0	0	0.02	0	0	0	0	0	0
TS-133-19.3	19.3-20	6.9	0.54	0	22	10	0	0	0	0	0	0	0	0	0	0	0	0
TS-134-11.3	11.3-12	5.4	0.31	0	21	260	0	0.82	0	0	0	0	0	0	0	0	0	0
TS-135-13	12-13	40	0.23	5.1	40	450	0	0	0	0	0	0	0	0	0	0	0	0
TS-136-13	12-13	1.5	0.3	0	17	24	0	0	0	0	0	0	0	0	0	0	0	0
TS-136-18	18-19	12	0.45	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
TS-137-11	10-11	1.4	0.28	0	17	54	0	0	0	0	0	0	0	0	0	0	0	0
TS-137-32.2	32.2-33	2.3	0	0	7	6.1	0	0	0	0	0	0	0	0	0	0	0	0
TS-138-13.2	12-113.2	3.8	0.28	0	15	19	0	0	0	0	0	0	0	0	0	0	0	0
TS-138-24.6	24.6-25.1	3.1	0.1	0	7.4	6.6	0	0	0	0	0	0	0	0	0	0	0	0
TS-139-9	8-9	3.1	0.5	0	21	66	0	0					0	0	0	0	0	0
TS-139-15	15-16	16	0.8	0	28	11	0	0					0	0	0	0	0	0
TS-140-11	10.6-11	7.1	0.67	0	26	29	0	0					0	0	0	0	0	0
TS-141-15.6	15.6-16	3.1	0.21	0	15	190	0	0	0	0	0	0.018						
TS-141-19	19-20	0	0.78	0	28	8.2	7.1	0	0	0	0	0						
TS-142-13	12.6-13	3	0.3	0	10	5.1	0	0	0	0	0	0						
TS-142-17	17-8	2.7	0.89	0	30	0	0	0	0	0	0	0						
SB-DP-9-7	7	7	0	0.96	44	110	0	0	0	0	0	0	0	0	0	0	0	0
SB-DP-20-10	10	3.2	0	0	16	5	0	0	0	0	0	0	0	0	0	0	0	0
SB-DP-22-8	8	5.6	0	0.71	26	6.5	0	0	0	0.17	0.087	0.15	0	0	0	0	0	0
SB-DP-24-9	9	6.9	0	0	19	35	0	0	0	0	0	0	0	0	0	0	0	0
SB-DP-25-10	10	2.7	0.68	0.53	29	8	0	0	0	0	0	0	0	0	0	0	0	0
SD-DP-29-6	6	0	0	0	24	5.4	0	0	0	0	0	0	0	0	0	0	0	0
SD-DP-31-5	5	0	0	0	41	9.9	0	0	0	0	0	0	0	0	0	0	0	0
SD-DP-34-8	8	4	0	0	26	6.3	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-1-5	5	4.9	0.54	0	24	15	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-2-9	9	4.1	0	0.52	21	41	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-4-4	4	8.9	0	1	28	470	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-5-6	6	6.1	0	0.66	29	93	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-7-5	5	4	0	1.1	20	48	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-8-5	5	2.9	0	0.66	19	6	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-8-9	9	5.5	0.52	0.62	27	9.9	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-10-11	11	0	0	0	33	29	0	0	0	0	0	0	0	0	0	0	0	0
SB-IDP-13-10	10	0	0	0	32	11	0	0.0042	0	0	0	0	0	0	0	0	0	0
SB-IDP-14-5	5	6.1	0	1.2	27	29	0	0.014	0	0	0	0	0	0	0	0	0	0
SB-IDP-14-10	10	11	0	1.6	17	210	0	0.099	0	0	0	0	0	0	0	0	0	0
Mean		7.72	0.31	1.08	30.63	116.36	4.41	0.67	0.00	0.00	0.00	0.00	0.06	0.04	0.01	0.05	0.25	0.00
Standard Deviation		28.53	0.40	2.01	117.17	377.39	10.95	2.42	0.00	0.02	0.01	0.01	0.44	0.29	0.06	0.33	1.08	0.00

Positive values indicate concentrati
0 = non-detected above reporting li
Blue highlighted values indicate co
Blank Cells indicated that analysis f

Sample No.	Depth (feet)	Indeno [1,2,3-cd] pyrene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
HPB-7-07-10	10	0	0	0	0	0	0	0	0
HPB-7-28-10	10	0	0	0	0	0	0	0	0
HPB-7-28-15	15								
HAB-7-01-10	10	0	0	0	0	0	0	0	0
HPB-4-13-15	15	0	0	0	0	0	0	0	0
HPB-4-14-10	10								
HPB-4-15-10	10								
HPB-4-16-10	10								
HPB-4-16-15	15								
HPB-4-16-20	16								
HPB-4-22-10	10								
HPB-4-22-15	15								
HPB-4-23-10	10								
HPB-4-23-15	15								
HPB-4-25-11	11								
HPB-4-25-10	10								
HPB-4-29-10	10								
HPB-4-29-15	15								
HPB-4-29-20	20								
HAB-4-04-15	15								
HAB-4-04-20	20								
HAB-4-03-10	10								
HAB-4-03-25	25								
HAB-4-02-15	15								
HAB-4-02-10	10								
HAB-4-02-20	20								
HAB-4-05-10	10								
HAB-4-07-15	15								
HAB-4-07-20	20								
TS-127-8.11	8.11-9.11								
TS-127-19.8	18.4-19.8								
TS-128-13.8	12-13.8								
TS-128-19.8	18-19.8								
TS-129-9.8	8.6-9.8								
TS-129-17.8	16.4-17.8								
TS-130-13	12-13	0	0	0	0	0	0	0	0
TS-132-11	10-11	0	0	0	0	0	0	0	0
TS-132-18	17.2-18	0	0	0	0	0	0	0	0
TS-133-11.2	10.5-11.2	0	0	0	0	0	0	0	0
TS-133-19.3	19.3-20	0	0	0	0	0	0	0	0
TS-134-11.3	11.3-12	0	0	0	0	0	0	0	0
TS-135-13	12-13	0	0	0	0	0	0	0	0
TS-136-13	12-13	0	0	0	0	0	0	0	0
TS-136-18	18-19	0	0	0	0	0	0	0	0
TS-137-11	10-11	0	0	0	0	0	0	0	0
TS-137-32.2	32.2-33	0	0	0	0	0	0	0	0
TS-138-13.2	12-113.2	0	0	0	0	0	0	0	0
TS-138-24.6	24.6-25.1	0	0	0	0	0	0	0	0
TS-139-9	8-9	0							
TS-139-15	15-16	0							
TS-140-11	10.6-11	0							
TS-141-15.6	15.6-16		0	0	0	0	0	0	0
TS-141-19	19-20		0	0	0	0	0	0	0
TS-142-13	12.6-13		0	0	0	0	0	0	0
TS-142-17	17-8		0	0	0	0	0	0	0
SB-DP-9-7	7	0	0	0	0	0	0	0	0
SB-DP-20-10	10	0	0	0	0	0	0	0	0
SB-DP-22-8	8	0	0	0	0	0	0	0	0
SB-DP-24-9	9	0	0	0	0	0	0	0	0
SB-DP-25-10	10	0	0	0	0	0	0	0	0
SD-DP-29-6	6	0	0	0	0	0	0	0	0
SD-DP-31-5	5	0	0	0	0	0	0	0	0
SD-DP-34-8	8	0	0	0	0	0	0	0	0
SB-IDP-1-5	5	0	0	0	0	0	0	0	0
SB-IDP-2-9	9	0	0	0	0	0	0	0	0
SB-IDP-4-4	4	0	0	0	0	0	0	0	0
SB-IDP-5-6	6	0	0	0	0	0	0	0	0
SB-IDP-7-5	5	0	0	0	0	0	0	0	0
SB-IDP-8-5	5	0	0	0	0	0	0	0	0
SB-IDP-8-9	9	0	0	0	0	0	0	0	0
SB-IDP-10-11	11	0	0	0	0	0	0	0	0
SB-IDP-13-10	10	0	0	0	0	0	0	0	0
SB-IDP-14-5	5	0	0	0	0	0	0	0	0
SB-IDP-14-10	10	0	0	0	0	0	0	0	0
Mean		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
Standard Deviation		0.00	0.00	0.01	0.00	0.00	0.01	0.07	0.16

WDI Statistical Analysis 95% confidence Attachment 3

if $t_{stat} < t_{critical}$ two-tail
then means are ~~different~~ same statistically

if $t_{stat} > t_{critical}$ two-tail
then means are statistically different

t-Test: Two-Sample Assuming Unequal Variances
Arsenic

	Fill	*Waste*
Mean	6.193555556	7.718865248
Variance	174.4788816	813.7019401
Observations	90	141
Hypothesized Mean Difference	0	
df	212	
t Stat	-0.54934147	
P(T<=t) one-tail	0.291674653	
t Critical one-tail	1.652074388	
P(T<=t) two-tail	0.583349305	
t Critical two-tail	1.971216079	

t-Test: Two-Sample Assuming Unequal Variances
Beryllium

	Fill	*Waste*
Mean	0.272118644	0.313344371
Variance	0.087668123	0.160534907
Observations	118	151
Hypothesized Mean Difference	0	
df	266	
t Stat	-0.97005865	
P(T<=t) one-tail	0.166449241	
t Critical one-tail	1.650601007	
P(T<=t) two-tail	0.332898482	
t Critical two-tail	1.968924153	

t-Test: Two-Sample Assuming Unequal Variances
Cadmium

	Fill	*Waste*
Mean	0.787888889	1.080496454
Variance	5.164156167	4.038177609
Observations	90	141
Hypothesized Mean Difference	0	
df	173	
t Stat	-0.9976729	
P(T<=t) one-tail	0.159915699	
t Critical one-tail	1.653709205	
P(T<=t) two-tail	0.319831397	
t Critical two-tail	1.973771759	

t-Test: Two-Sample Assuming Unequal Variances
Chromium

	Fill	*Waste*
Mean	17.84111111	30.62659574
Variance	469.4478414	13728.15604
Observations	90	141
Hypothesized Mean Difference	0	
df	155	
t Stat	-1.26237442	
P(T<=t) one-tail	0.104355061	
t Critical one-tail	1.654743755	
P(T<=t) two-tail	0.208710122	
t Critical two-tail	1.975386112	

t-Test: Two-Sample Assuming Unequal Variances
Lead

	Fill	*Waste*
Mean	143.4155556	116.3614894
Variance	178089.2196	142424.6612
Observations	90	141
Hypothesized Mean Difference	0	
df	174	
t Stat	0.494855967	
P(T<=t) one-tail	0.310663035	
t Critical one-tail	1.653656909	
P(T<=t) two-tail	0.62132607	
t Critical two-tail	1.973689905	

t-Test: Two-Sample Assuming Unequal Variances
Thallium

	Fill	*Waste*
Mean	2.583050847	4.414238411
Variance	38.44996668	119.9004126
Observations	118	151
Hypothesized Mean Difference	0	
df	245	
t Stat	-1.73039486	
P(T<=t) one-tail	0.042409464	
t Critical one-tail	1.651096682	
P(T<=t) two-tail	0.084818928	
t Critical two-tail	1.969692676	

t-Test: Two-Sample Assuming Unequal Variances
Benzene

	Fill	*Waste*
Mean	0.037829545	0.666065248
Variance	0.037595476	5.872479947
Observations	88	141
Hypothesized Mean Difference	0	
df	143	
t Stat	-3.062706017	
P(T<=t) one-tail	0.001310746	
t Critical one-tail	1.65558049	
P(T<=t) two-tail	0.002621493	
t Critical two-tail	1.976691237	

t-Test: Two-Sample Assuming Unequal Variances
Dieldrin

	Fill	*Waste*
Mean	0.000828916	0.00017757
Variance	2.32294E-05	3.37383E-06
Observations	83	107
Hypothesized Mean Difference	0	
df	101	
t Stat	1.167212122	
P(T<=t) one-tail	0.122936509	
t Critical one-tail	1.660080216	
P(T<=t) two-tail	0.245873017	
t Critical two-tail	1.983730726	

t-Test: Two-Sample Assuming Unequal Variances
DDT

	Fill	*Waste*
Mean	0.016295181	0.002
Variance	0.003487915	0.000286868
Observations	83	107
Hypothesized Mean Difference	0	
df	93	
t Stat	2.138041218	
P(T<=t) one-tail	0.017567564	
t Critical one-tail	1.66140353	
P(T<=t) two-tail	0.035135129	
t Critical two-tail	1.985799827	

t-Test: Two-Sample Assuming Unequal Variances

DDD

	Fill	*Waste*
Mean	0.00174578	0.001074766
Variance	6.5578E-05	7.76359E-05
Observations	83	107
Hypothesized Mean Difference	0	
df	183	
t Stat	0.54504448	
P(T<=t) one-tail	0.29319328	
t Critical one-tail	1.65322263	
P(T<=t) two-tail	0.58638657	
t Critical two-tail	1.97301233	

t-Test: Two-Sample Assuming Unequal Variances

DDE

	Fill	*Waste*
Mean	0.00751446	0.002093458
Variance	0.00065695	0.000220803
Observations	83	107
Hypothesized Mean Difference	0	
df	124	
t Stat	1.7161094	
P(T<=t) one-tail	0.04431964	
t Critical one-tail	1.65723577	
P(T<=t) two-tail	0.08863929	
t Critical two-tail	1.97927875	

t-Test: Two-Sample Assuming Unequal Variances

Benz[a]anthracene

	Fill	*Waste*
Mean	0.00978947	0.06462931
Variance	0.00238617	0.189487853
Observations	95	116
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.3465452	
P(T<=t) one-tail	0.09034294	
t Critical one-tail	1.65775873	
P(T<=t) two-tail	0.18068588	
t Critical two-tail	1.9800973	

t-Test: Two-Sample Assuming Unequal Variances

Benzo[b]fluoranthene

	Fill	*Waste*
Mean	0.017157895	0.03508621
Variance	0.004341305	0.08226869
Observations	95	116
Hypothesized Mean Difference	0	
df	130	
t Stat	-0.652516644	
P(T<=t) one-tail	0.257610057	
t Critical one-tail	1.656658242	
P(T<=t) two-tail	0.515220114	
t Critical two-tail	1.97837835	

t-Test: Two-Sample Assuming Unequal Variances

Benzo[k]fluoranthene

	Variable 1	*Variable 2*
Mean	0.0072	0.00732759
Variance	0.001520055	0.00309106
Observations	95	116
Hypothesized Mean Difference	0	
df	204	
t Stat	-0.019536929	
P(T<=t) one-tail	0.492215936	
t Critical one-tail	1.652356332	
P(T<=t) two-tail	0.984431873	
t Critical two-tail	1.971661732	

t-Test: Two-Sample Assuming Unequal Variances

Benzo[a]pyrene

	Variable 1	*Variable 2*
Mean	0.032010526	0.05101724
Variance	0.015136564	0.11147482
Observations	95	116
Hypothesized Mean Difference	0	
df	151	
t Stat	-0.567852604	
P(T<=t) one-tail	0.285489218	
t Critical one-tail	1.655007509	
P(T<=t) two-tail	0.570978435	
t Critical two-tail	1.975799933	

t-Test: Two-Sample Assuming Unequal Variances

Chrysene

	Fill	*Waste*
Mean	0.037736842	0.253967241
Variance	0.015122153	1.167303592
Observations	95	116
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.138679878	
P(T<=t) one-tail	0.01725276	
t Critical one-tail	1.65775873	
P(T<=t) two-tail	0.03450552	
t Critical two-tail	1.980097295	

t-Test: Two-Sample Assuming Unequal Variances

Dibenz[a,h]anthracene

	Fill	*Waste*
Mean	0	0
Variance	0	0
Observations	95	116
Hypothesized Mean Difference	0	
df	0	
t Stat	65535	
P(T<=t) one-tail	#NUM!	
t Critical one-tail	#NUM!	
P(T<=t) two-tail	#NUM!	
t Critical two-tail	#NUM!	

t-Test: Two-Sample Assuming Unequal Variances

Indeno [1,2,3-cd] pyrene

	Fill	*Waste*
Mean	0.000778947	0
Variance	5.76421E-05	0
Observations	95	116
Hypothesized Mean Difference	0	
df	94	
t Stat	1	
P(T<=t) one-tail	0.159938903	
t Critical one-tail	1.661226179	
P(T<=t) two-tail	0.319877806	
t Critical two-tail	1.985522431	

t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1016

	Fill	*Waste*
Mean	0	0
Variance	0	0
Observations	96	117
Hypothesized Mean Difference	0	
df	0	
t Stat	65535	
P(T<=t) one-tail	#NUM!	
t Critical one-tail	#NUM!	
P(T<=t) two-tail	#NUM!	
t Critical two-tail	#NUM!	

t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1221

	Fill	*Waste*
Mean	0	0.000778
Variance	0	7.08E-05
Observations	96	117
Hypothesized Mean Difference	0	
df	116	
t Stat	-1	
P(T<=t) one-tail	0.159696	
t Critical one-tail	1.658095	
P(T<=t) two-tail	0.319392	
t Critical two-tail	1.980625	

t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1232

	Fill	*Waste*
Mean	0	0
Variance	0	0
Observations	96	117
Hypothesized Mean Difference	0	
df	0	
t Stat	65535	
P(T<=t) one-tail	#NUM!	
t Critical one-tail	#NUM!	
P(T<=t) two-tail	#NUM!	
t Critical two-tail	#NUM!	

t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1242

	Fill	*Waste*
Mean	0.000833333	0
Variance	6.66667E-05	0
Observations	96	117
Hypothesized Mean Difference	0	
df	95	
t Stat	1	
P(T<=t) one-tail	0.159925427	
t Critical one-tail	1.661051101	
P(T<=t) two-tail	0.319850854	
t Critical two-tail	1.985249583	

t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1248

	Fill	*Waste*
Mean	0.017708333	0.000700855
Variance	0.030104167	2.87632E-05
Observations	96	117
Hypothesized Mean Difference	0	
df	95	
t Stat	0.960046076	
P(T<=t) one-tail	0.169734567	
t Critical one-tail	1.661051101	
P(T<=t) two-tail	0.339469135	
t Critical two-tail	1.985249583	

t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1254

	Fill	*Waste*
Mean	0.01875	0.011931624
Variance	0.03375	0.004508961
Observations	96	117
Hypothesized Mean Difference	0	
df	116	
t Stat	0.34521736	
P(T<=t) one-tail	0.365278081	
t Critical one-tail	1.658095243	
P(T<=t) two-tail	0.730556163	
t Critical two-tail	1.980624802	

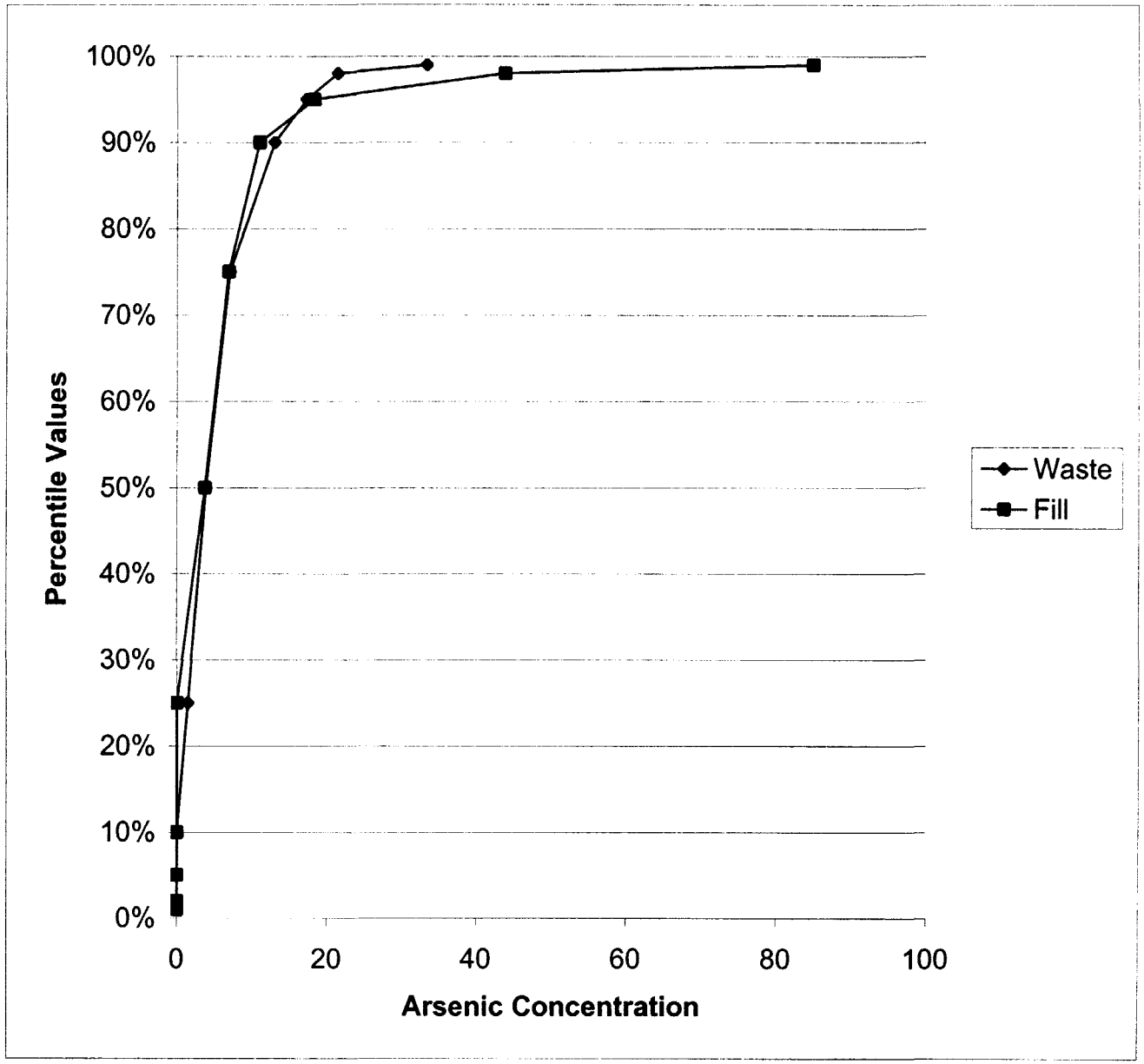
t-Test: Two-Sample Assuming Unequal Variances

Aroclor 1260

	Fill	*Waste*
Mean	0.00635417	0.027487179
Variance	0.00176236	0.026389924
Observations	96	117
Hypothesized Mean Difference	0	
df	135	
t Stat	-1.35314433	
P(T<=t) one-tail	0.08913557	
t Critical one-tail	1.65621941	
P(T<=t) two-tail	0.17827113	
t Critical two-tail	1.97769168	

Arsenic (mg/kg)

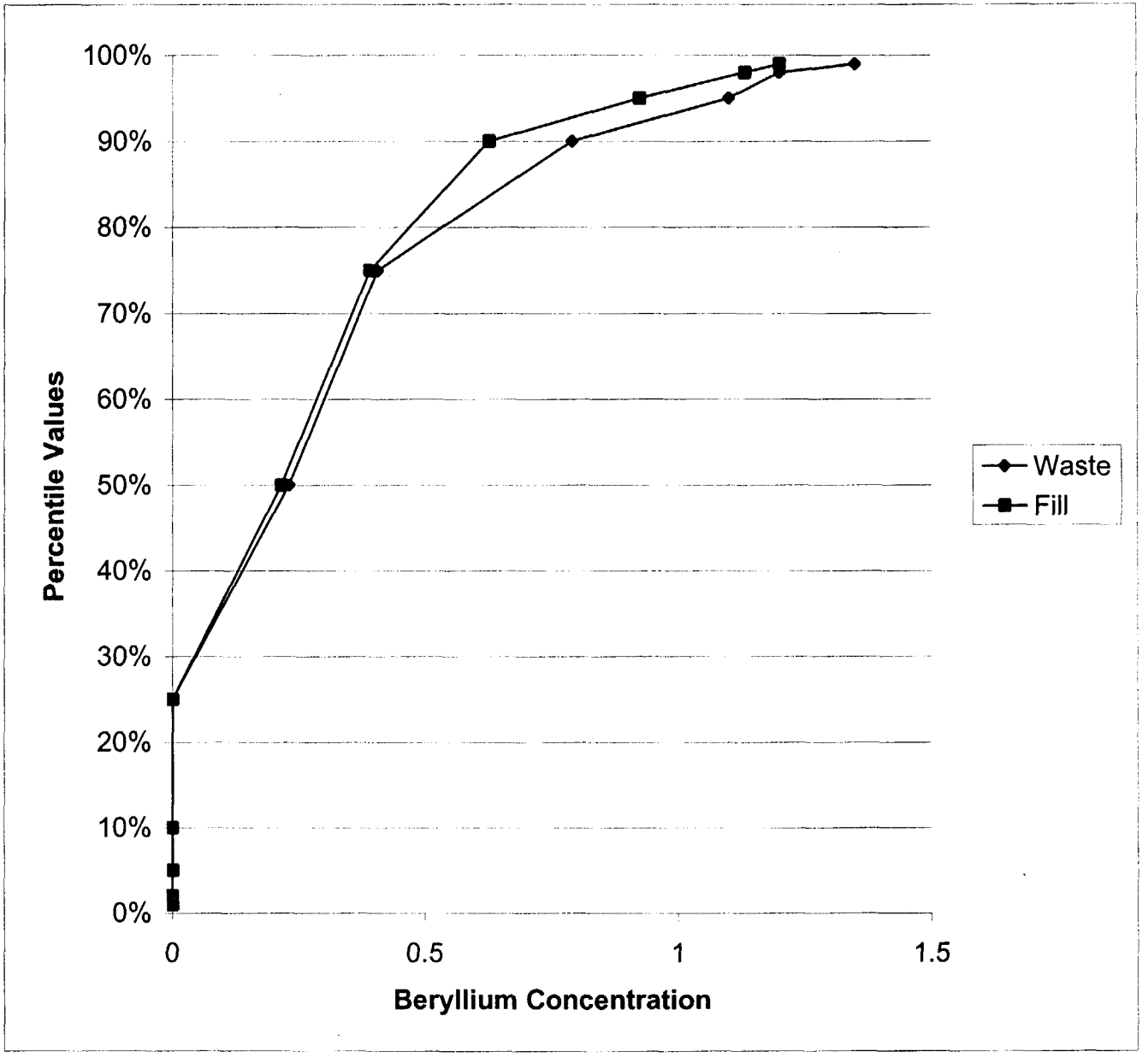
Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	1.5	25%
3.735	3.9	50%
6.9	7.1	75%
11.03	13	90%
18.36	17.3	95%
43.894	21.52	98%
85.011	33.44	99%



Attachment 4

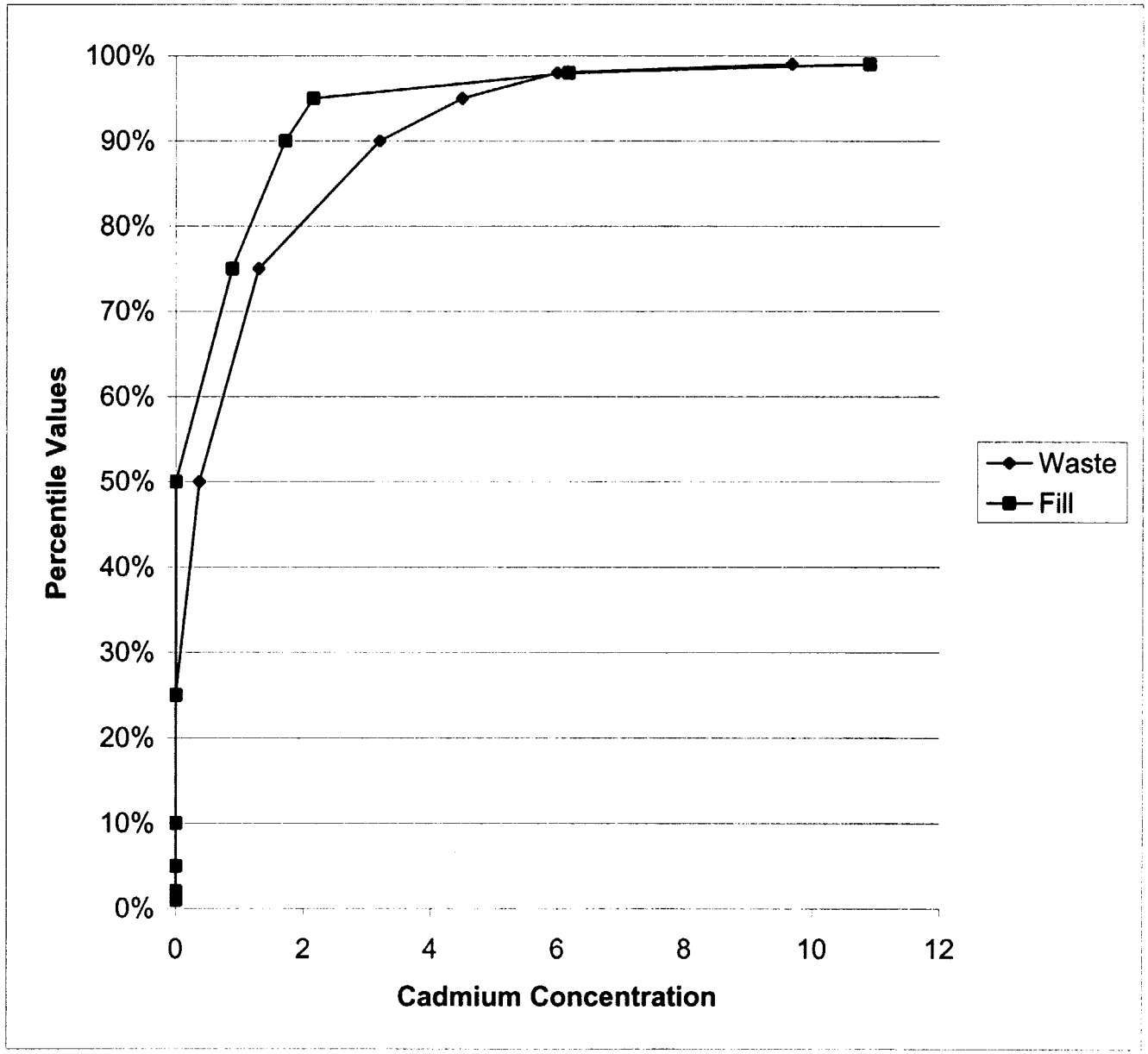
Beryllium (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0.215	0.23	50%
0.39	0.405	75%
0.626	0.79	90%
0.9245	1.1	95%
1.132	1.2	98%
1.2	1.35	99%



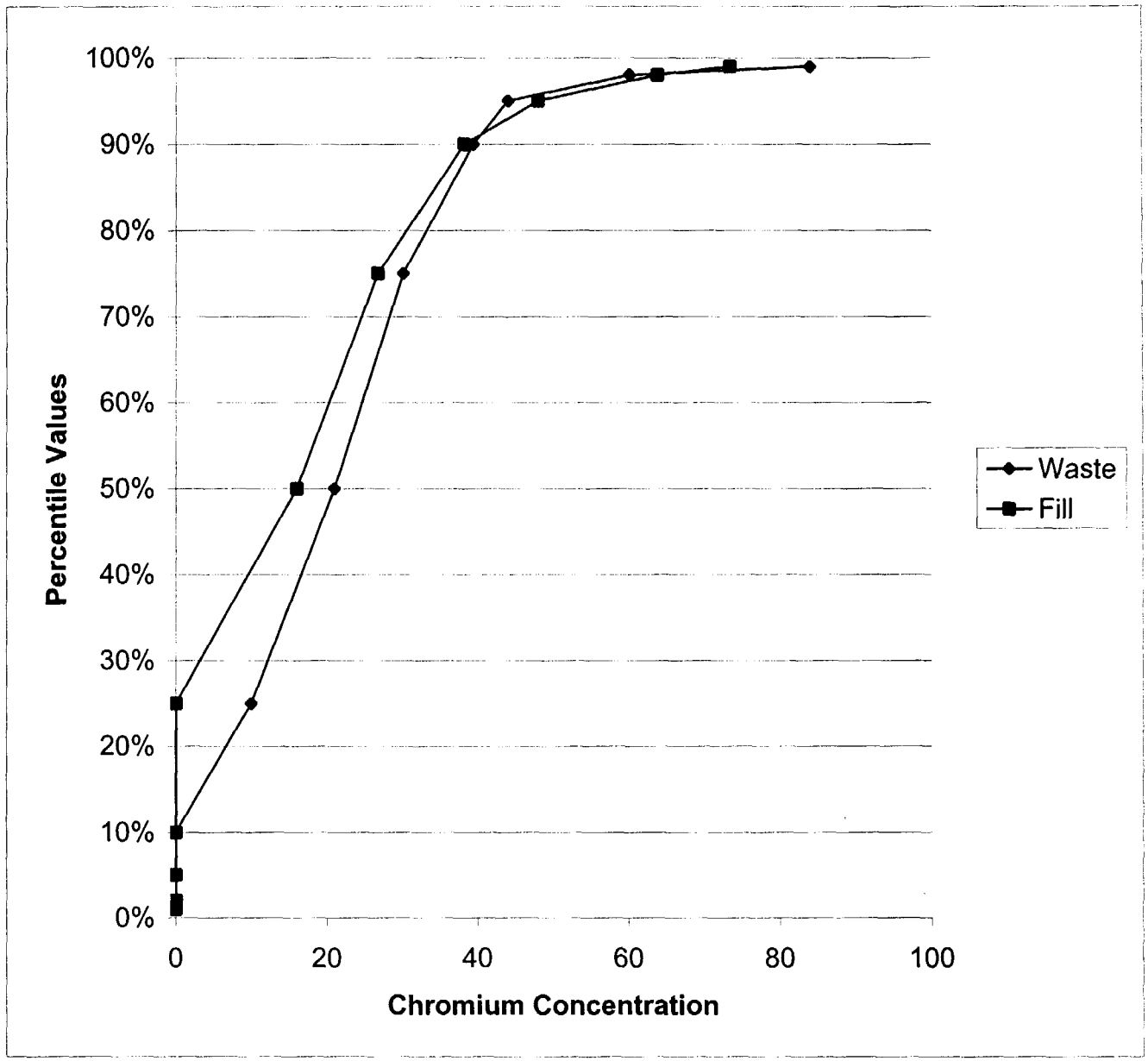
Cadmium (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0.37	50%
0.8825	1.3	75%
1.714	3.2	90%
2.155	4.5	95%
6.178	6	98%
10.902	9.68	99%



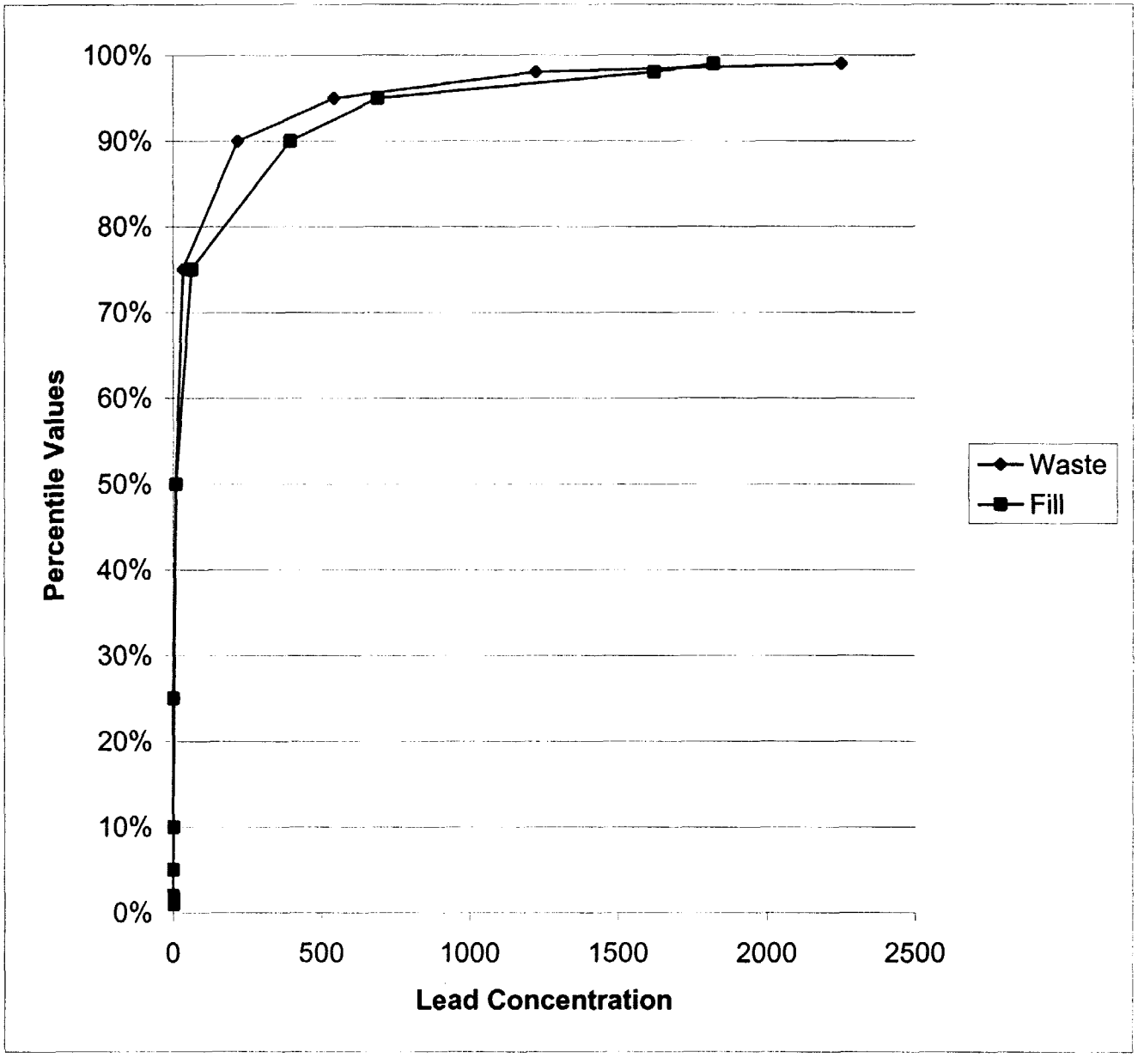
Chromium (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	10	25%
16	21	50%
26.75	30.1	75%
38.19	39.4	90%
48.03	44	95%
63.766	60.08	98%
73.35	83.96	99%



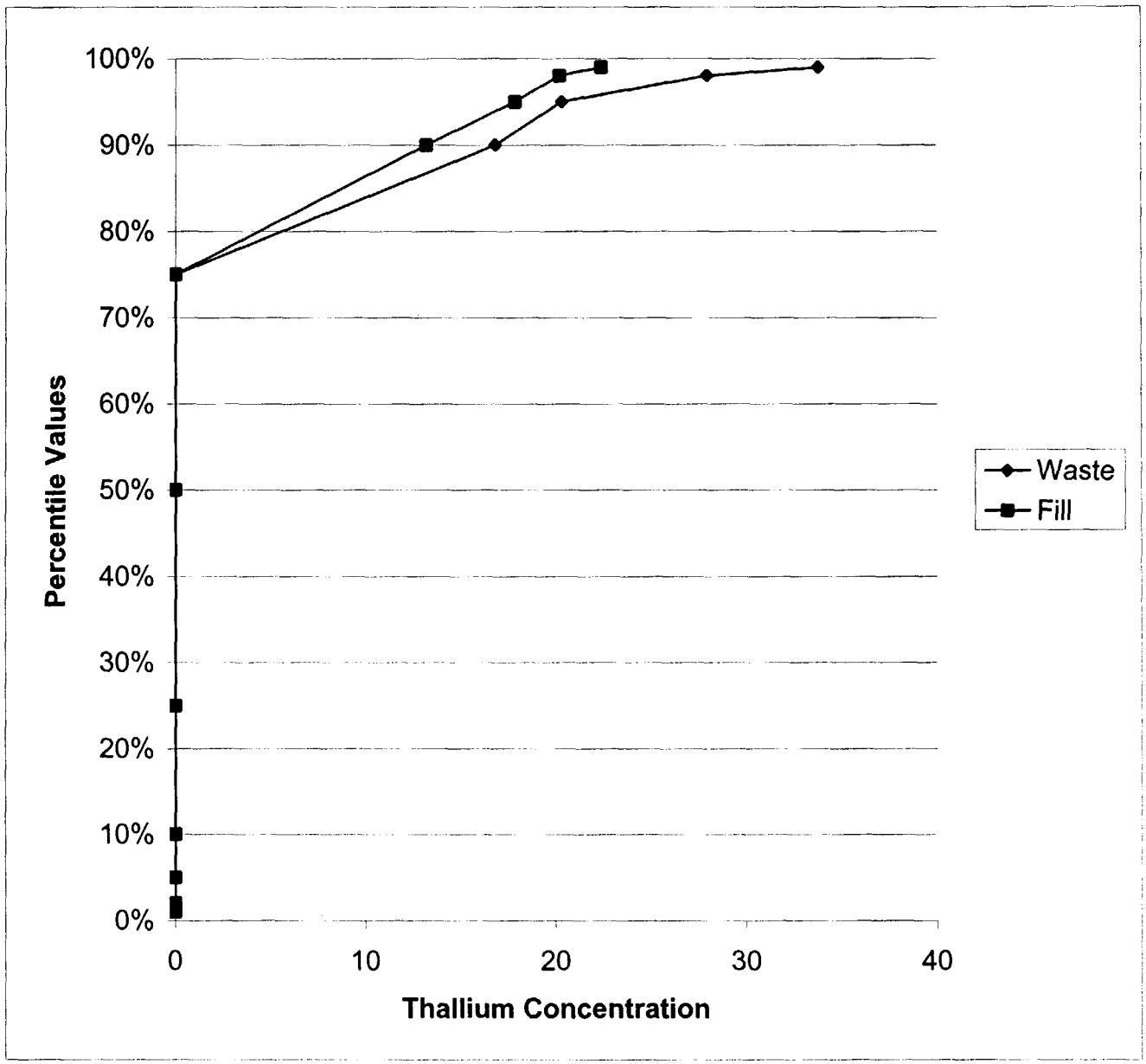
Lead (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	4	25%
10.3	9.67	50%
61.5	33	75%
394.4	218	90%
690.25	543	95%
1622	1224	98%
1819.9	2252	99%



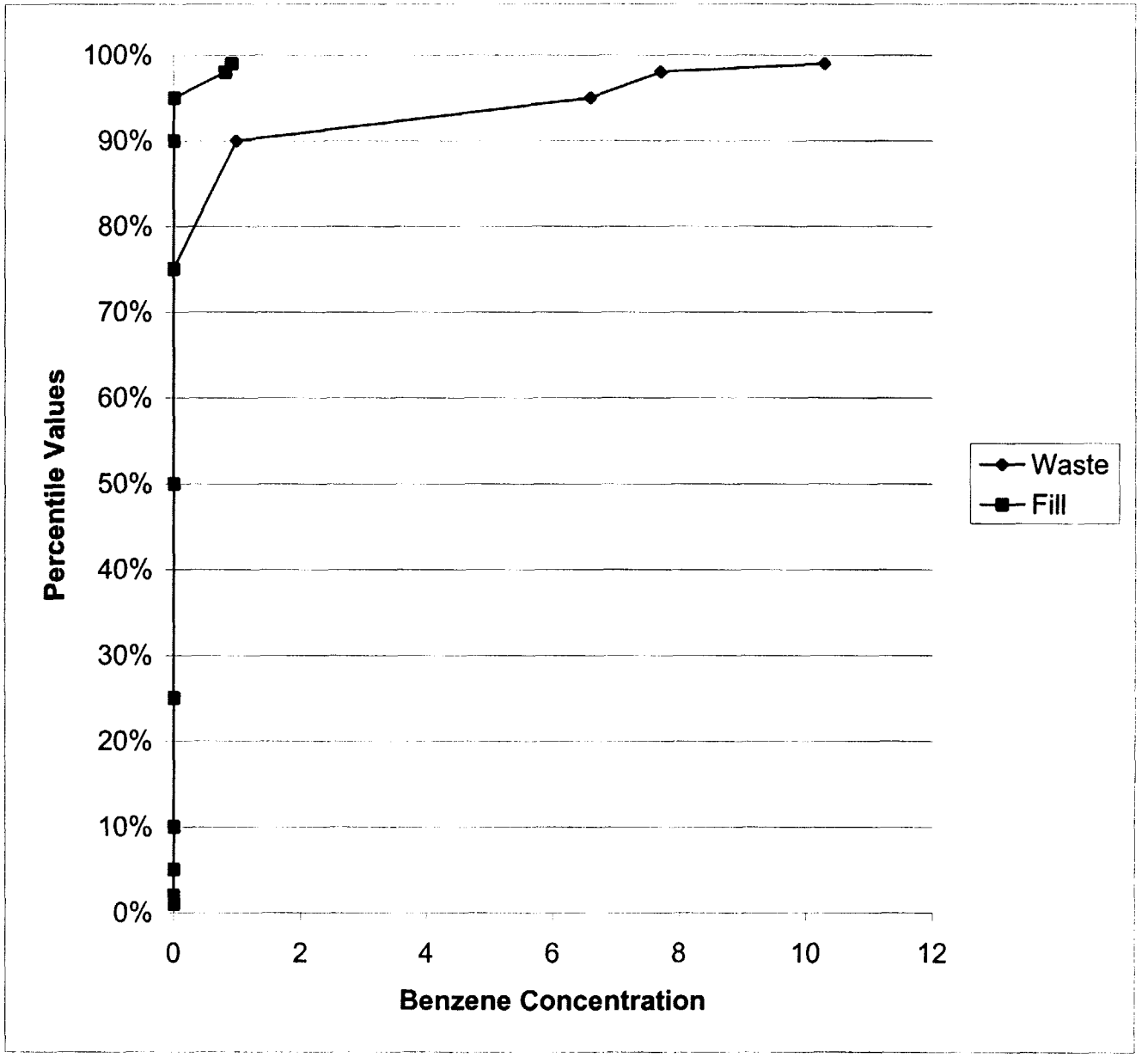
Thallium (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
13.16	16.8	90%
17.85	20.3	95%
20.166	27.9	98%
22.358	33.75	99%



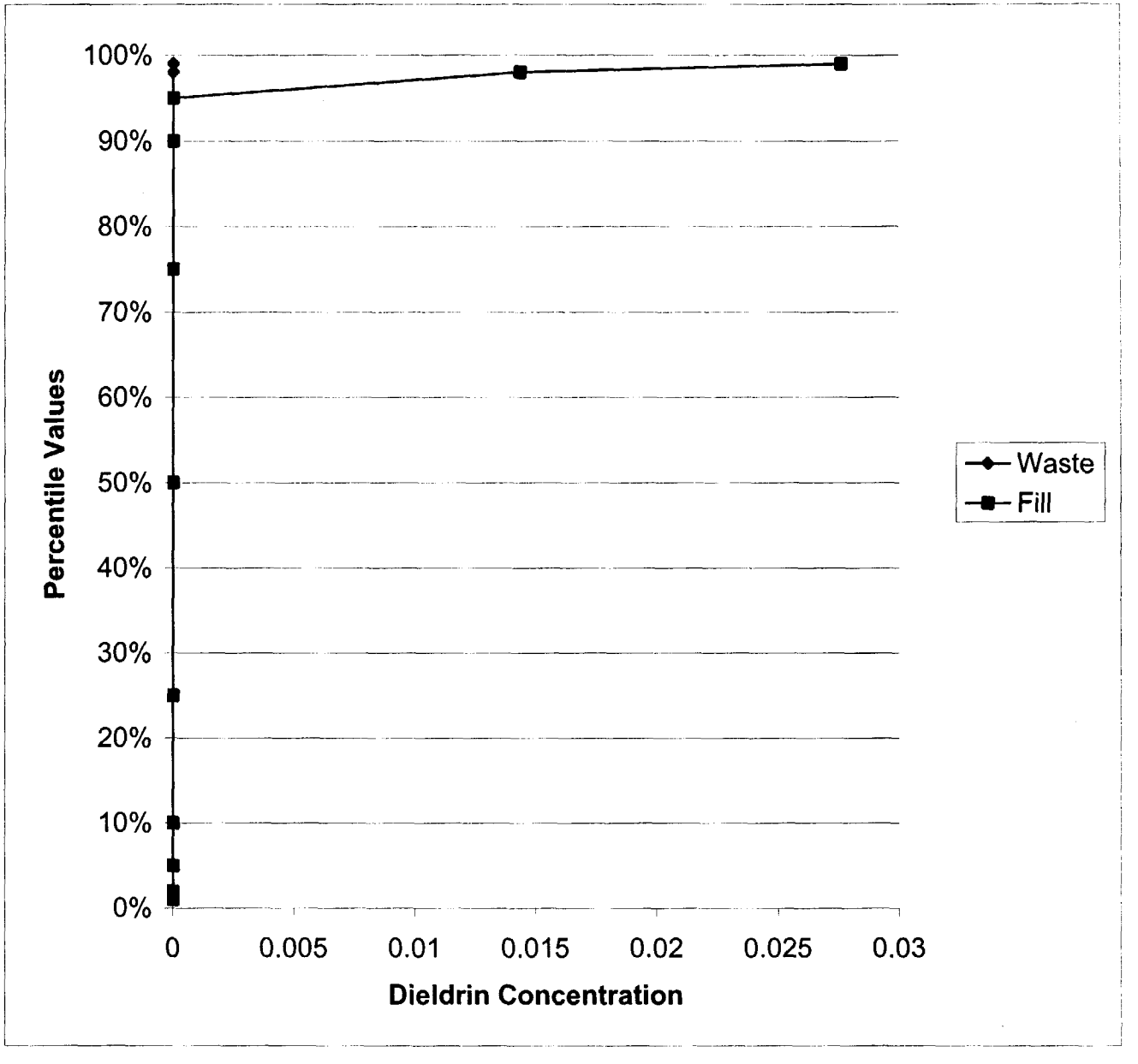
Benzene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0.99	90%
0.00975	6.6	95%
0.81596	7.71	98%
0.9215	10.3	99%



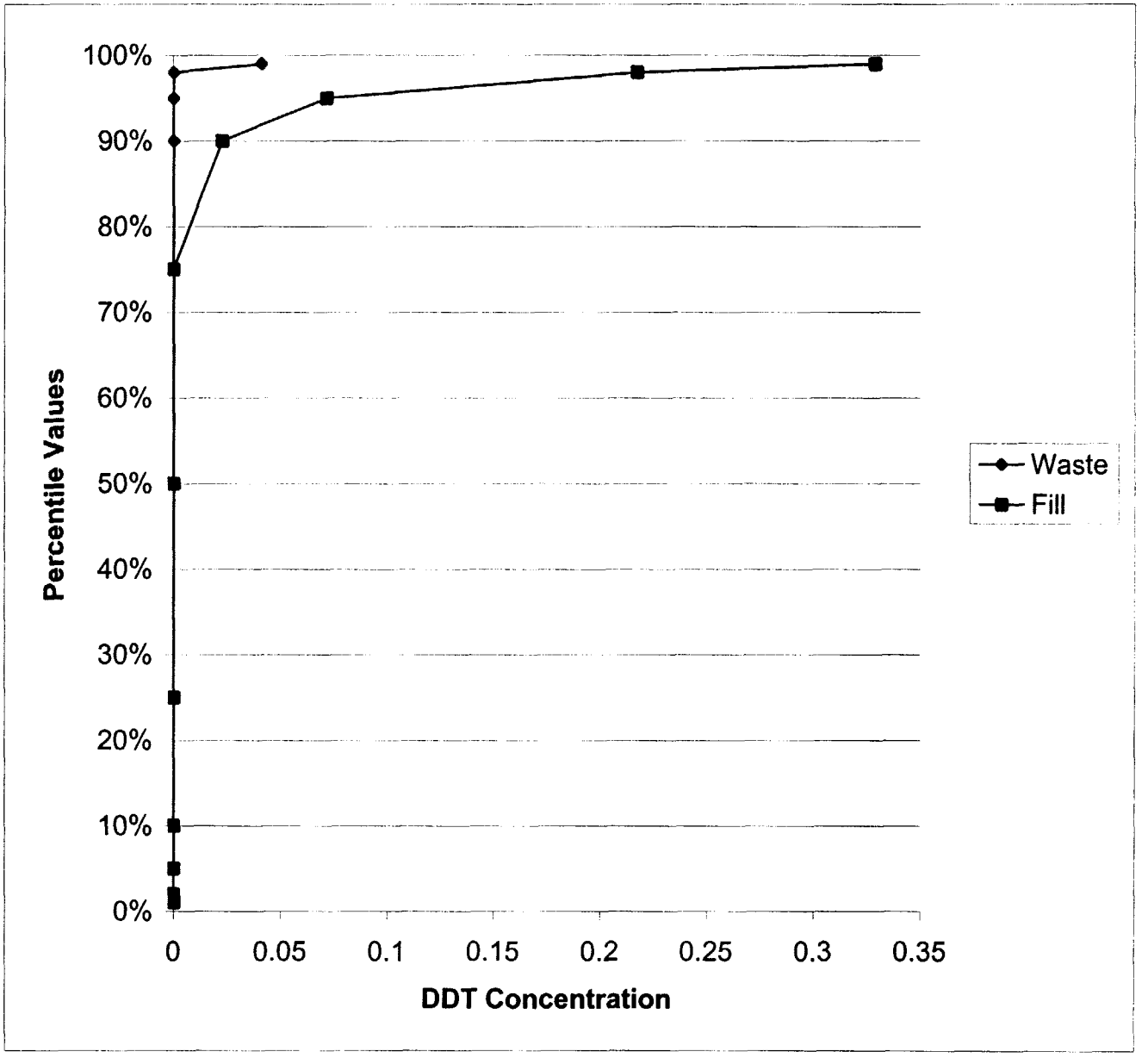
Dieldrin (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0	0	95%
0.014352	0	98%
0.02762	0	99%



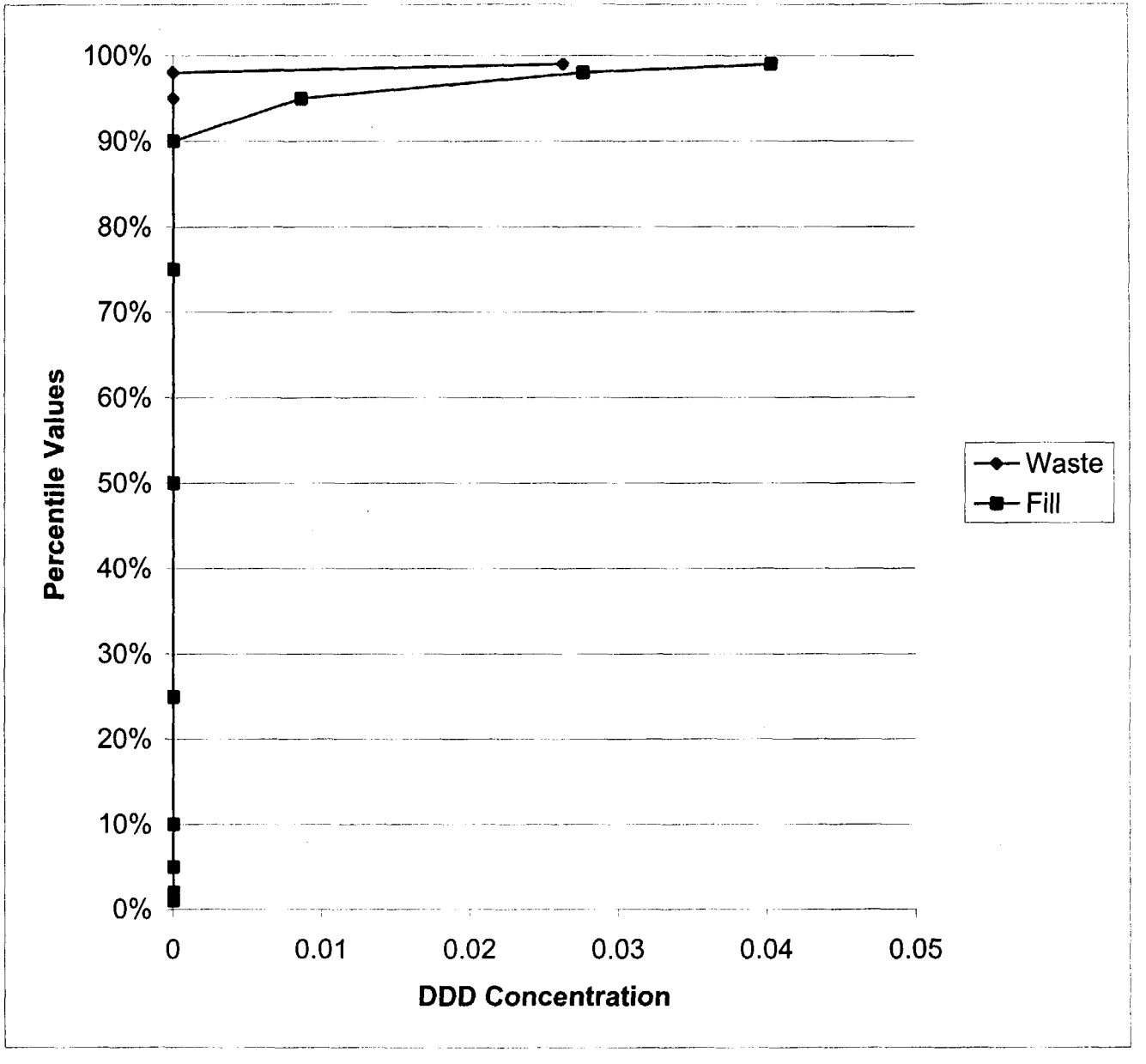
DDT (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0.0228	0	90%
0.0718	0	95%
0.2176	0	98%
0.329	0.04136	99%



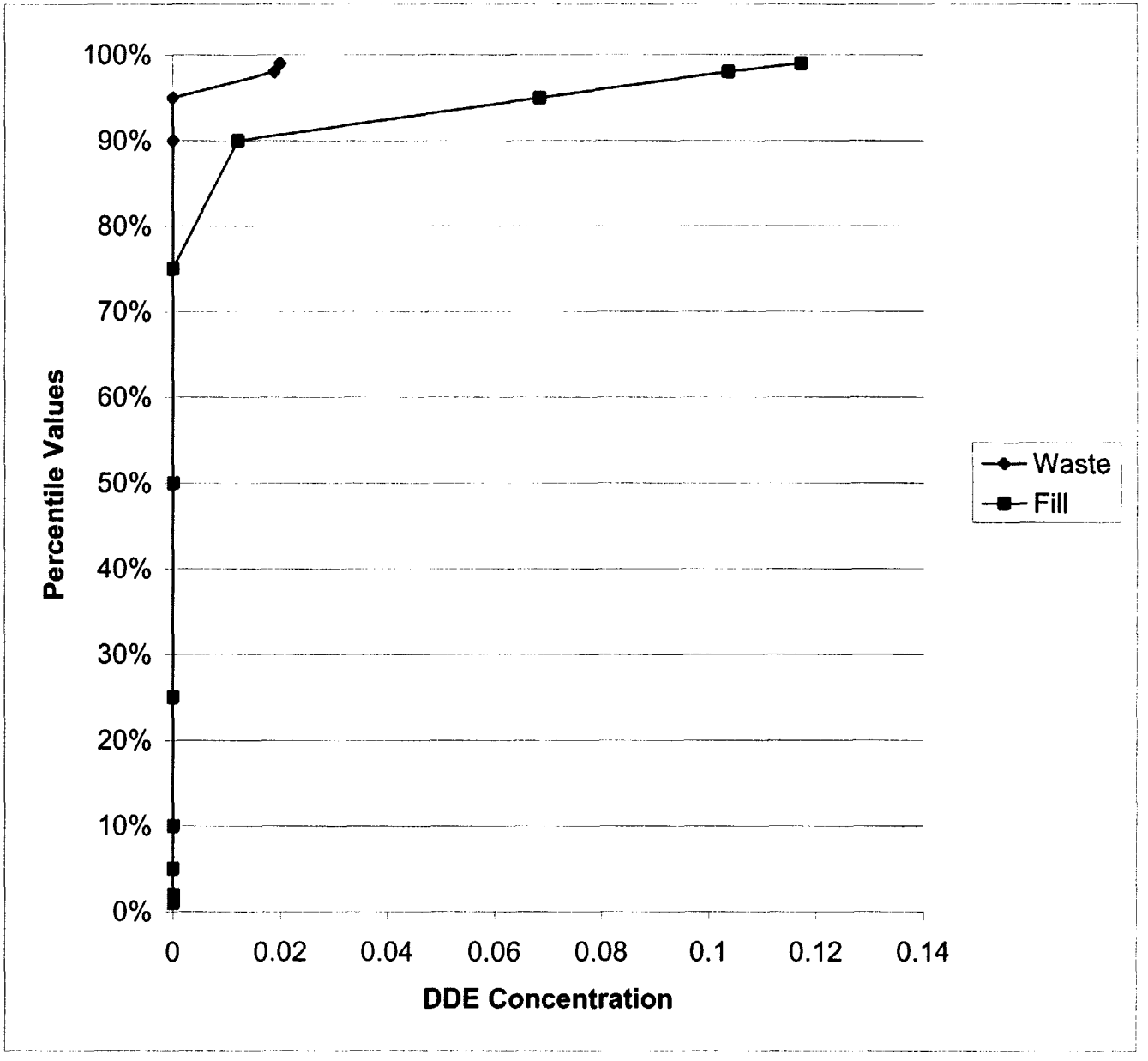
DDD (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0.00864	0	95%
0.02768	0	98%
0.04032	0.02632	99%



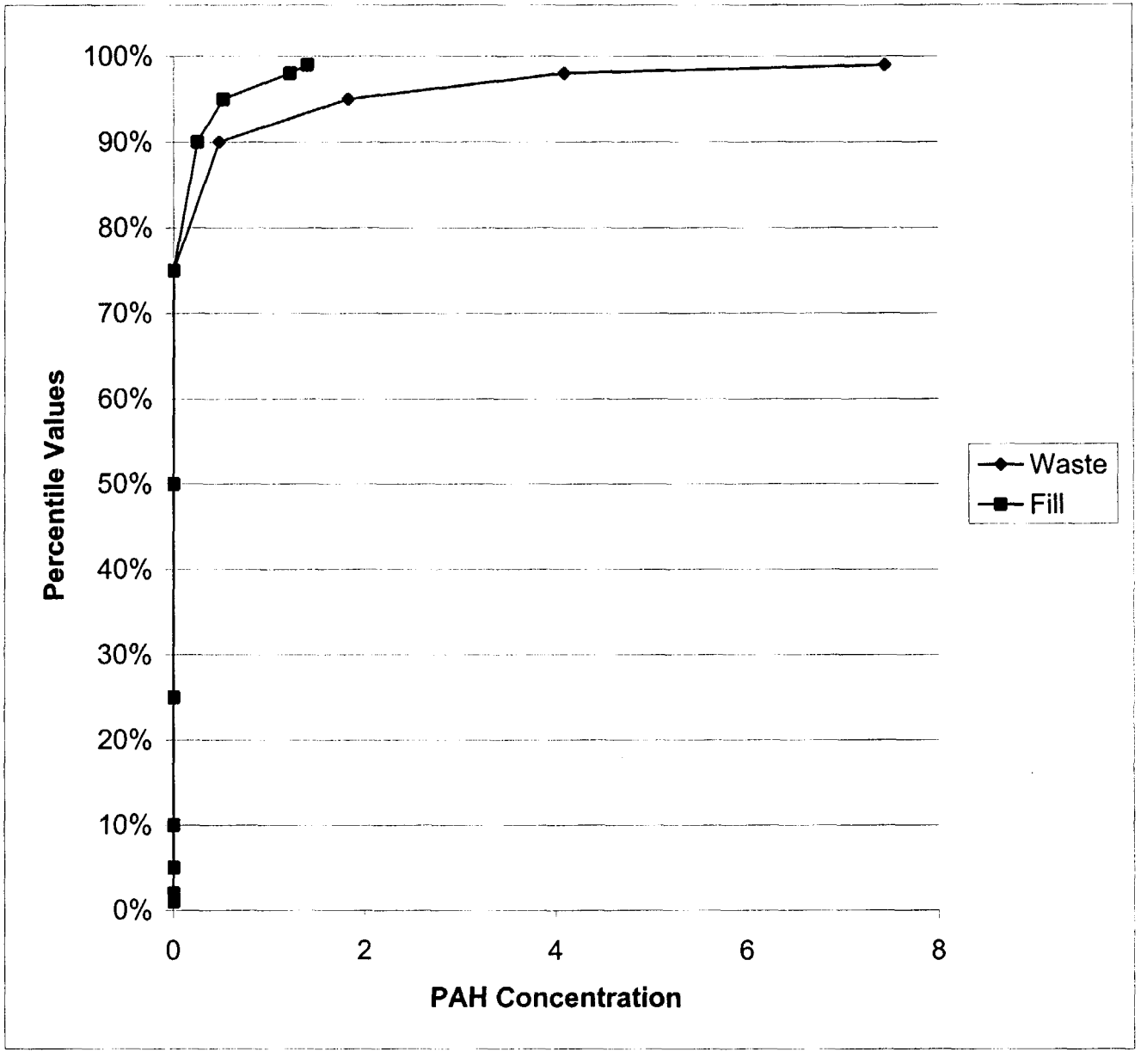
DDE (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0.01208	0	90%
0.0685	0	95%
0.1036	0.01888	98%
0.1172	0.01994	99%



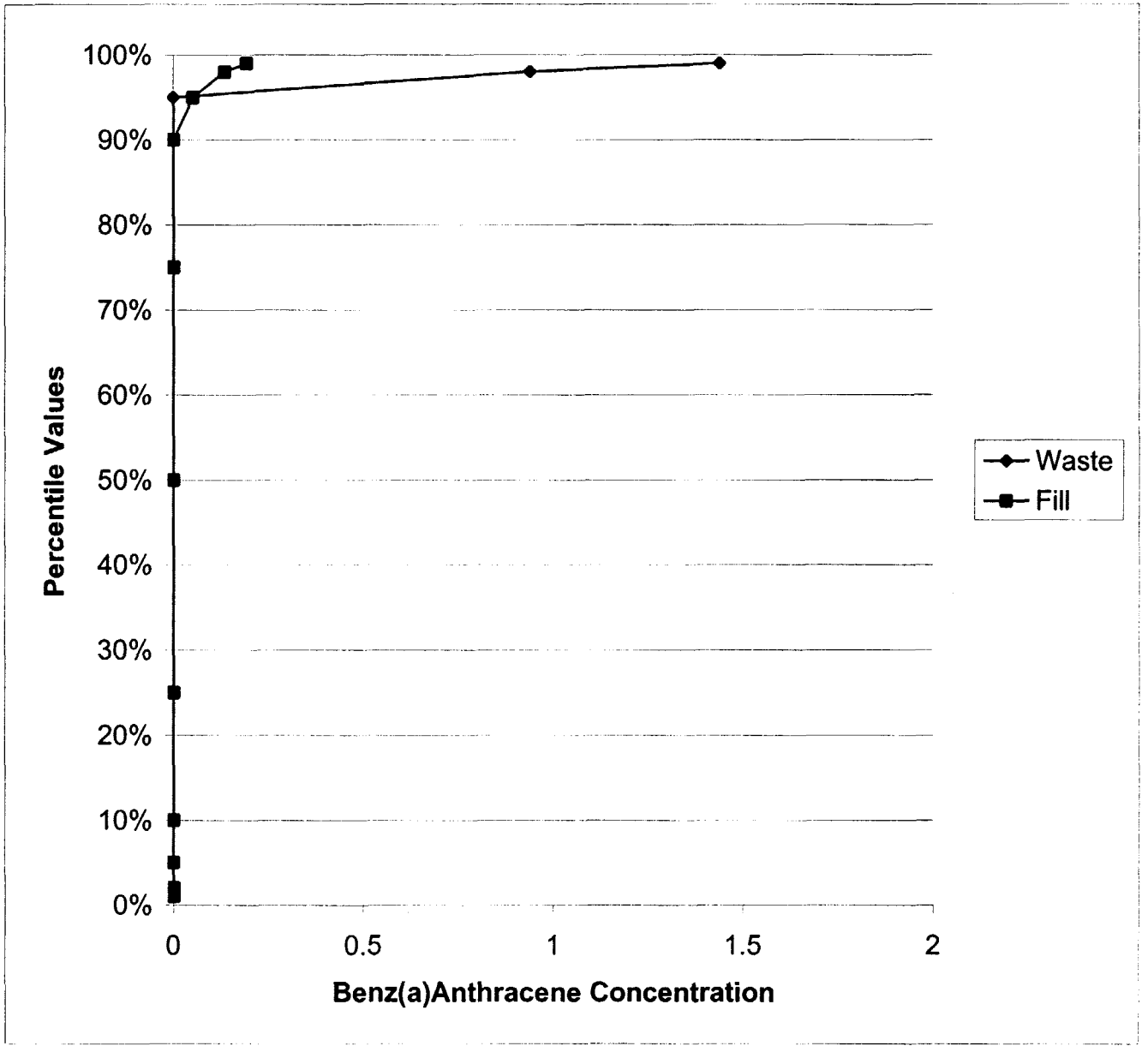
Total PAH (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0.2512	0.48	90%
0.5186	1.825	95%
1.2184	4.09	98%
1.3992	7.445	99%



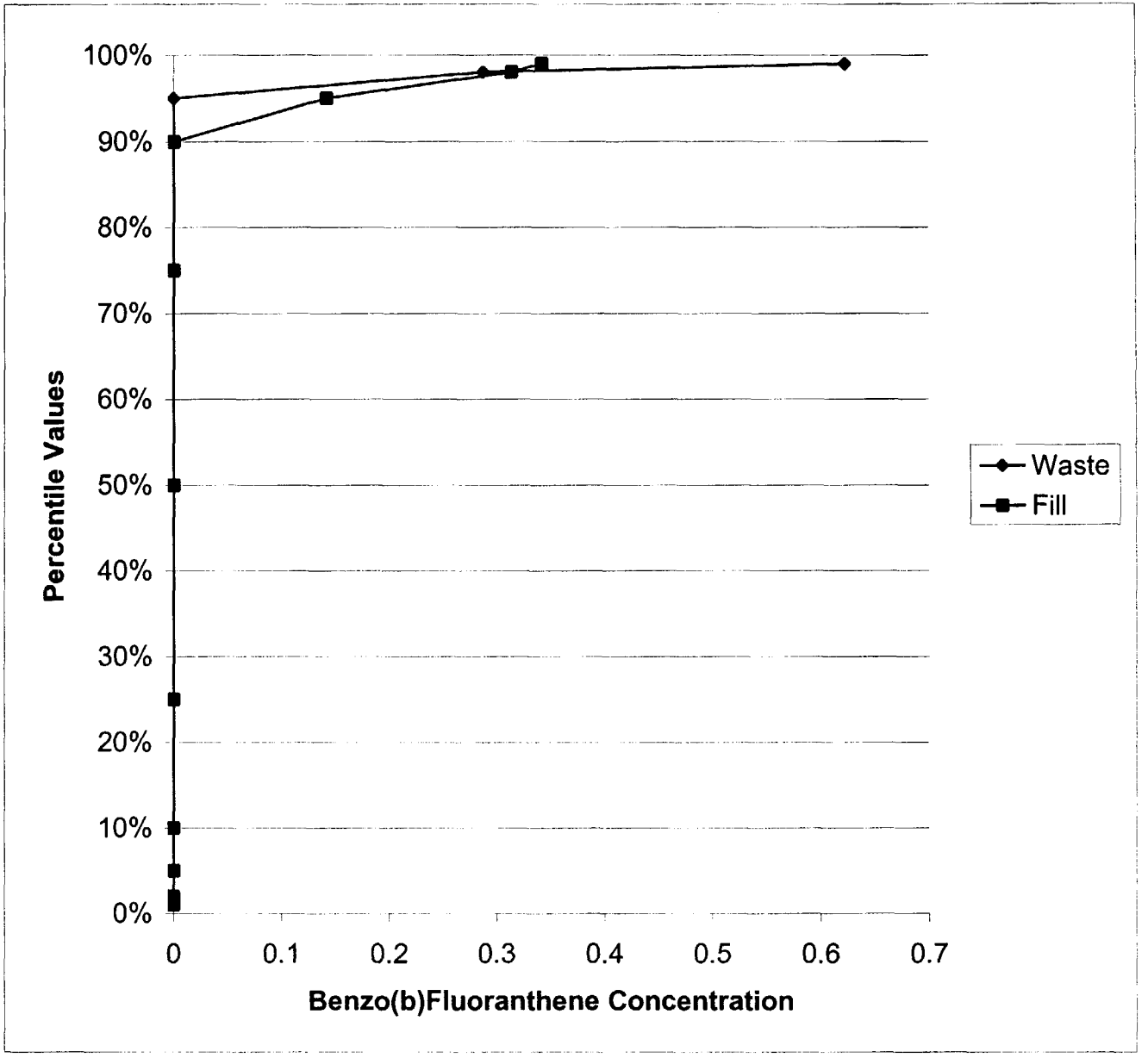
Benz[a]anthracene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0.0522	0	95%
0.136	0.941	98%
0.1938	1.44	99%



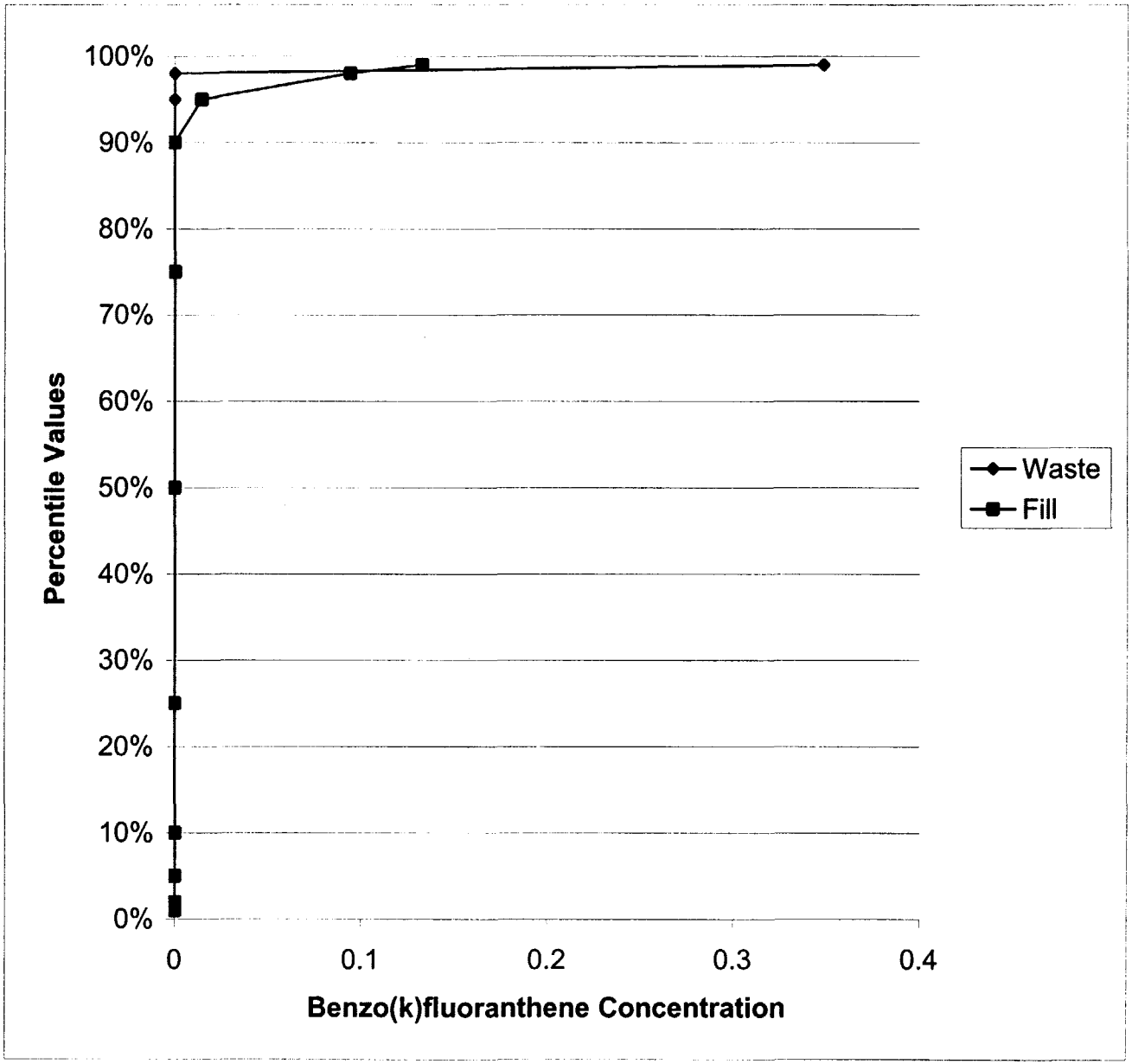
Benzo[b]fluoranthene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0.142	0	95%
0.3136	0.287	98%
0.3418	0.6225	99%



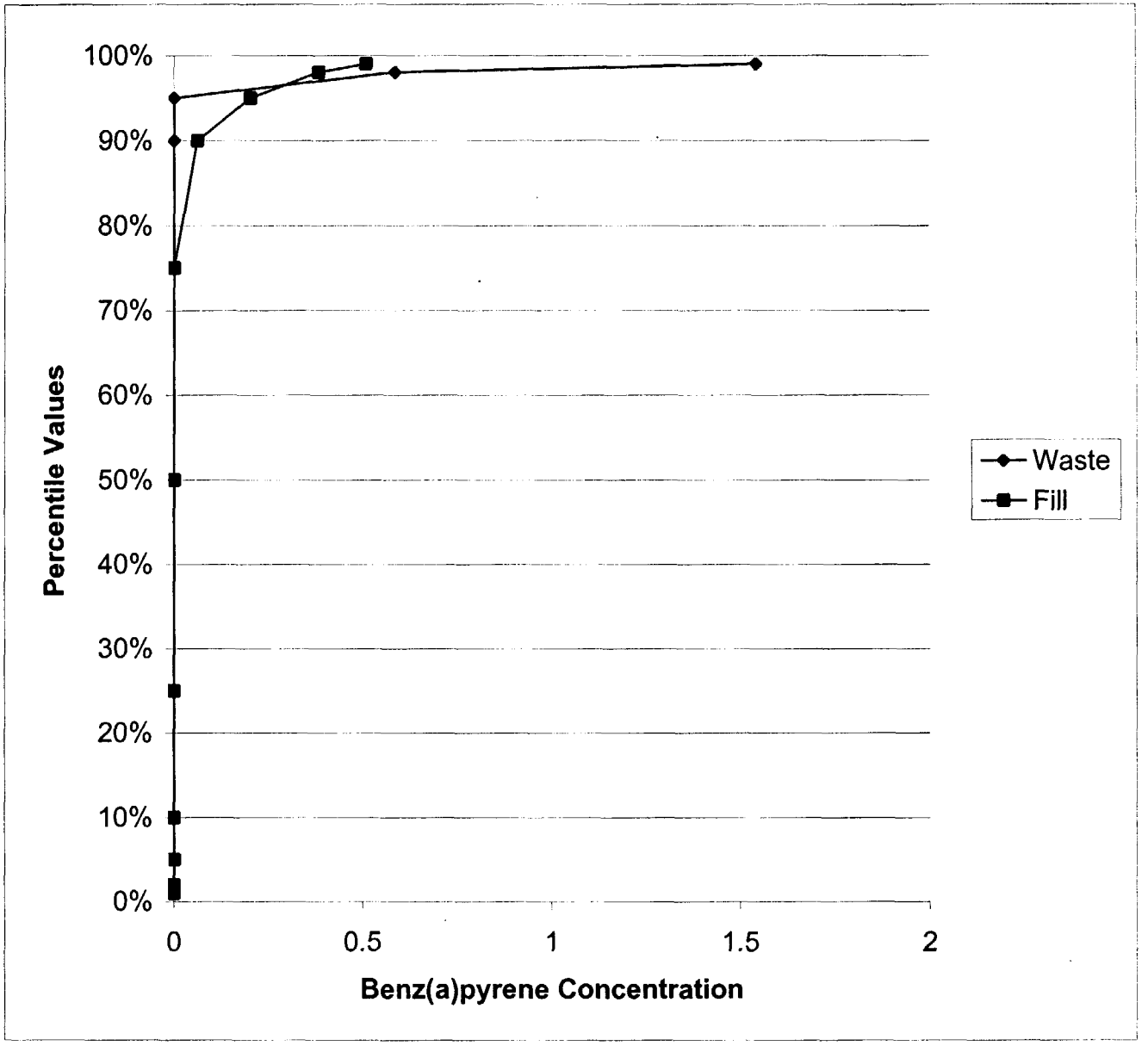
Benzo[k]fluoranthene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0.0144	0	95%
0.09448	0	98%
0.1332	0.3485	99%



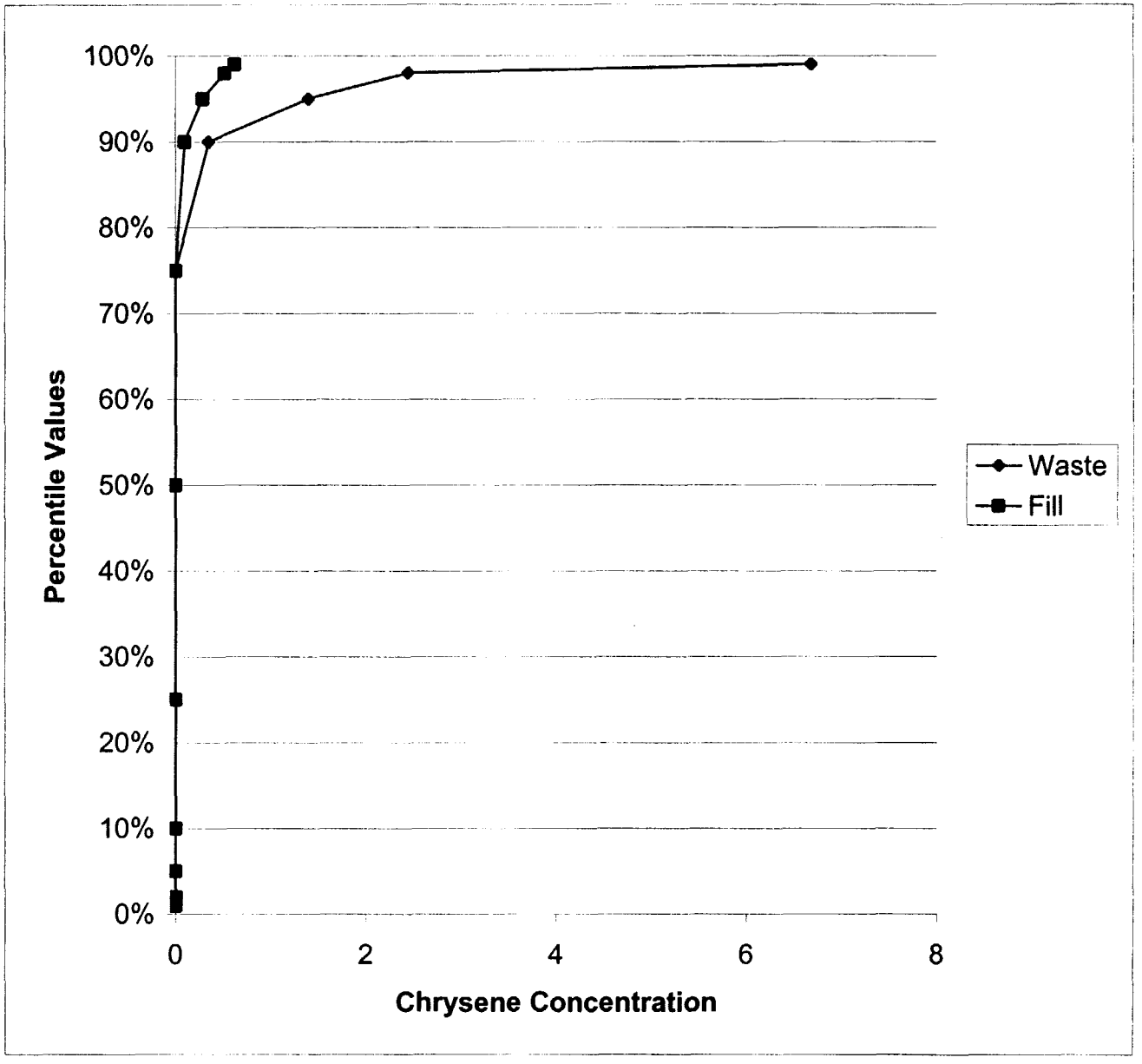
ne
Benzo[a]pyrene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0.0616	0	90%
0.203	0	95%
0.3832	0.586	98%
0.5088	1.541	99%



Chrysene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0.095	0.35	90%
0.286	1.4	95%
0.5144	2.45	98%
0.6206	6.68	99%

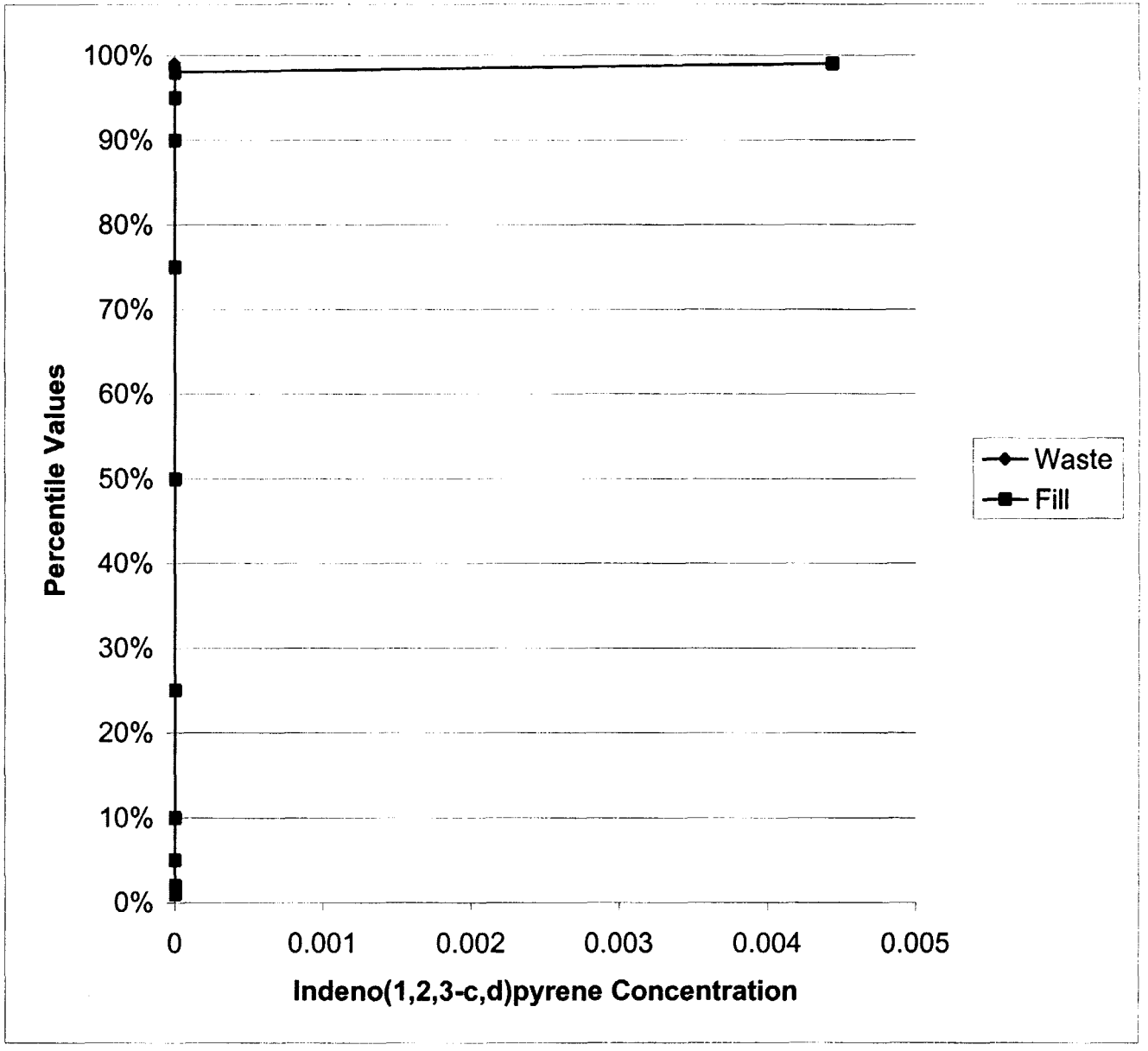


Dibenz[a,h]anthracene (mg/kg)

Fill	Waste	Percentile	
0	0	1%	**All Non-Detect**
0	0	2%	
0	0	5%	
0	0	10%	
0	0	25%	
0	0	50%	
0	0	75%	
0	0	90%	
0	0	95%	
0	0	98%	
0	0	99%	

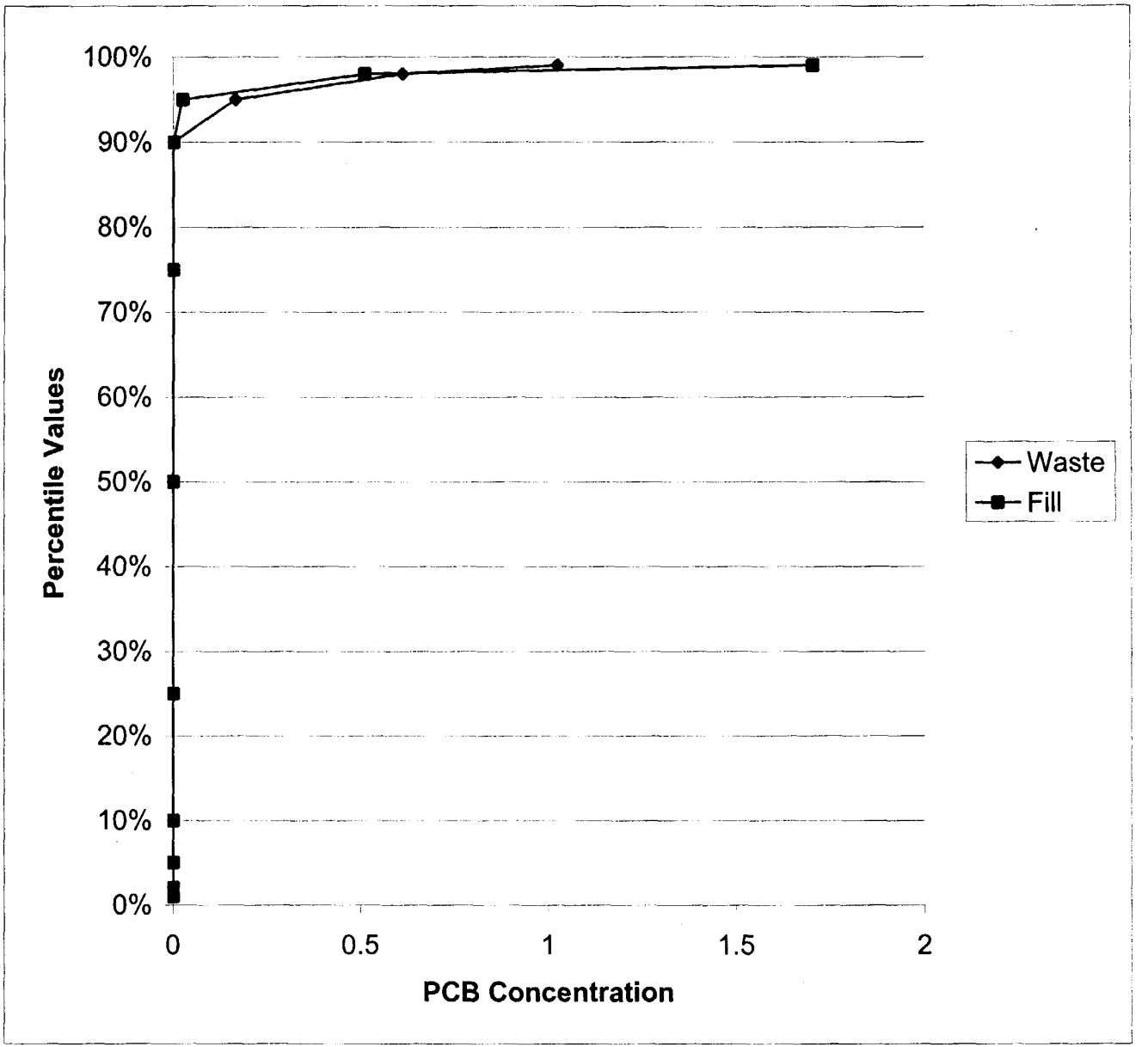
Indeno [1,2,3-cd] pyrene (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0	0	95%
0	0	98%
0.00444	0	99%



PCBs (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0.025	0.1652	95%
0.512	0.61148	98%
1.705	1.02496	99%



Arochlor 1016 (mg/kg)

Fill	Waste	Percentile	
0	0	1%	**All Non-Detect**
0	0	2%	
0	0	5%	
0	0	10%	
0	0	25%	
0	0	50%	
0	0	75%	
0	0	90%	
0	0	95%	
0	0	98%	
0	0	99%	

Arochlor 1221 (mg/kg)

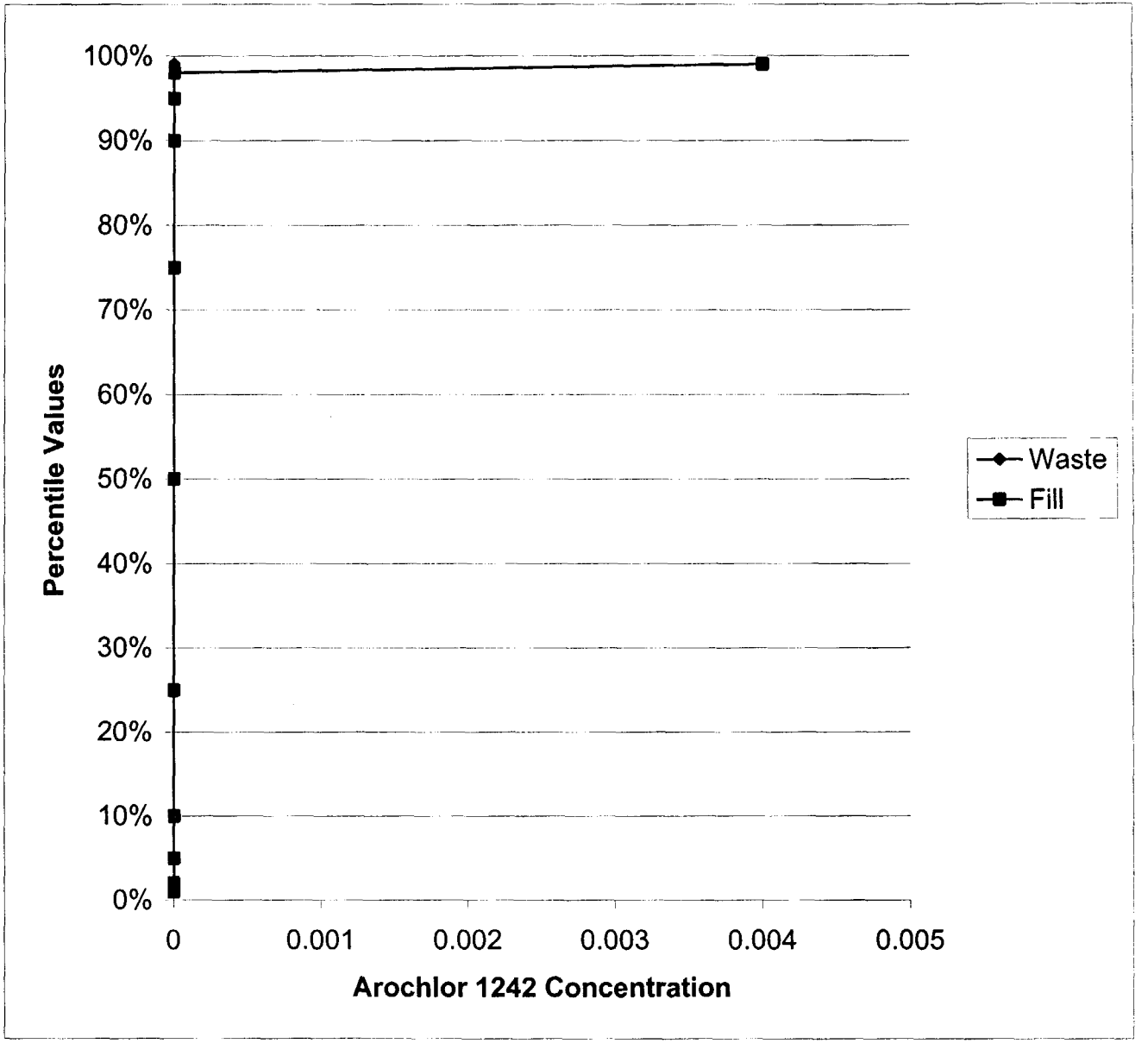
Fill	Waste	Percentile	
0	0	1%	**All Non-Detect**
0	0	2%	
0	0	5%	
0	0	10%	
0	0	25%	
0	0	50%	
0	0	75%	
0	0	90%	
0	0	95%	
0	0	98%	
0	0	99%	

Arochlor 1232 (mg/kg)

Fill	Waste	Percentile	
0	0	1%	**All Non-Detect**
0	0	2%	
0	0	5%	
0	0	10%	
0	0	25%	
0	0	50%	
0	0	75%	
0	0	90%	
0	0	95%	
0	0	98%	
0	0	99%	

Arochlor 1242 (mg/kg)

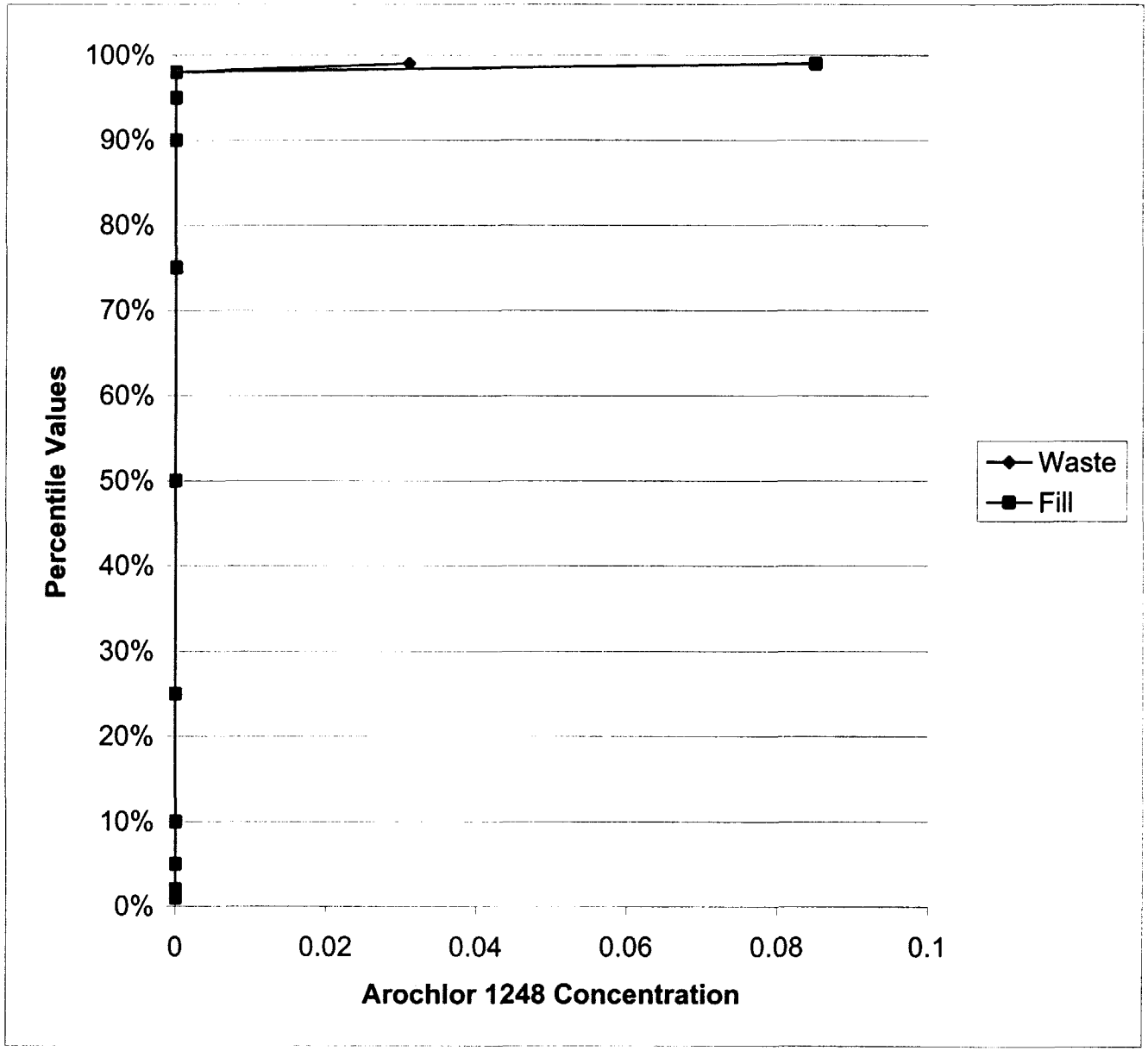
Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0	0	95%
0	0	98%
0.004	0	99%



3

Arochlor 1248 (mg/kg)

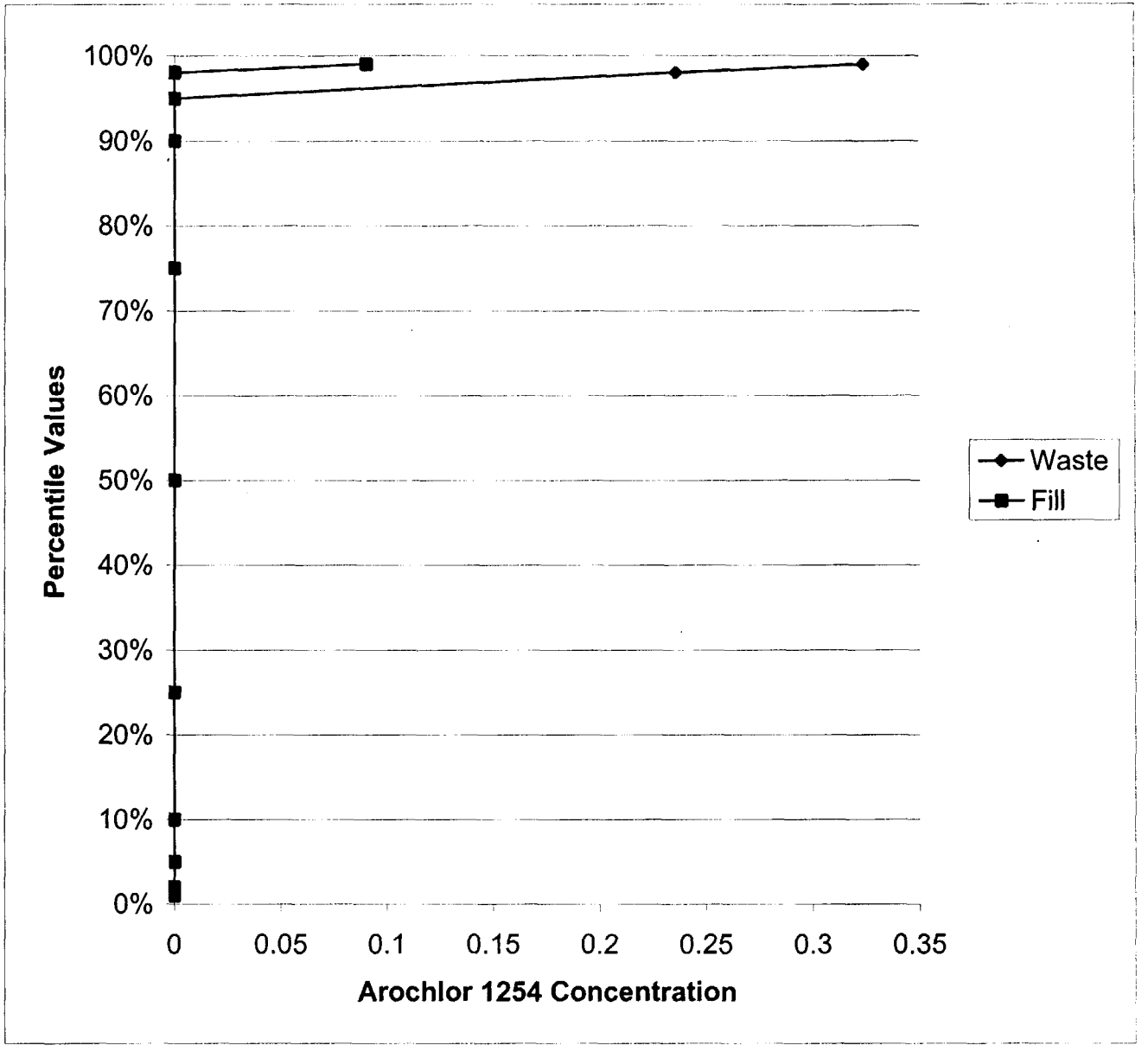
Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0	0	95%
0	0	98%
0.085	0.03108	99%



4 | |

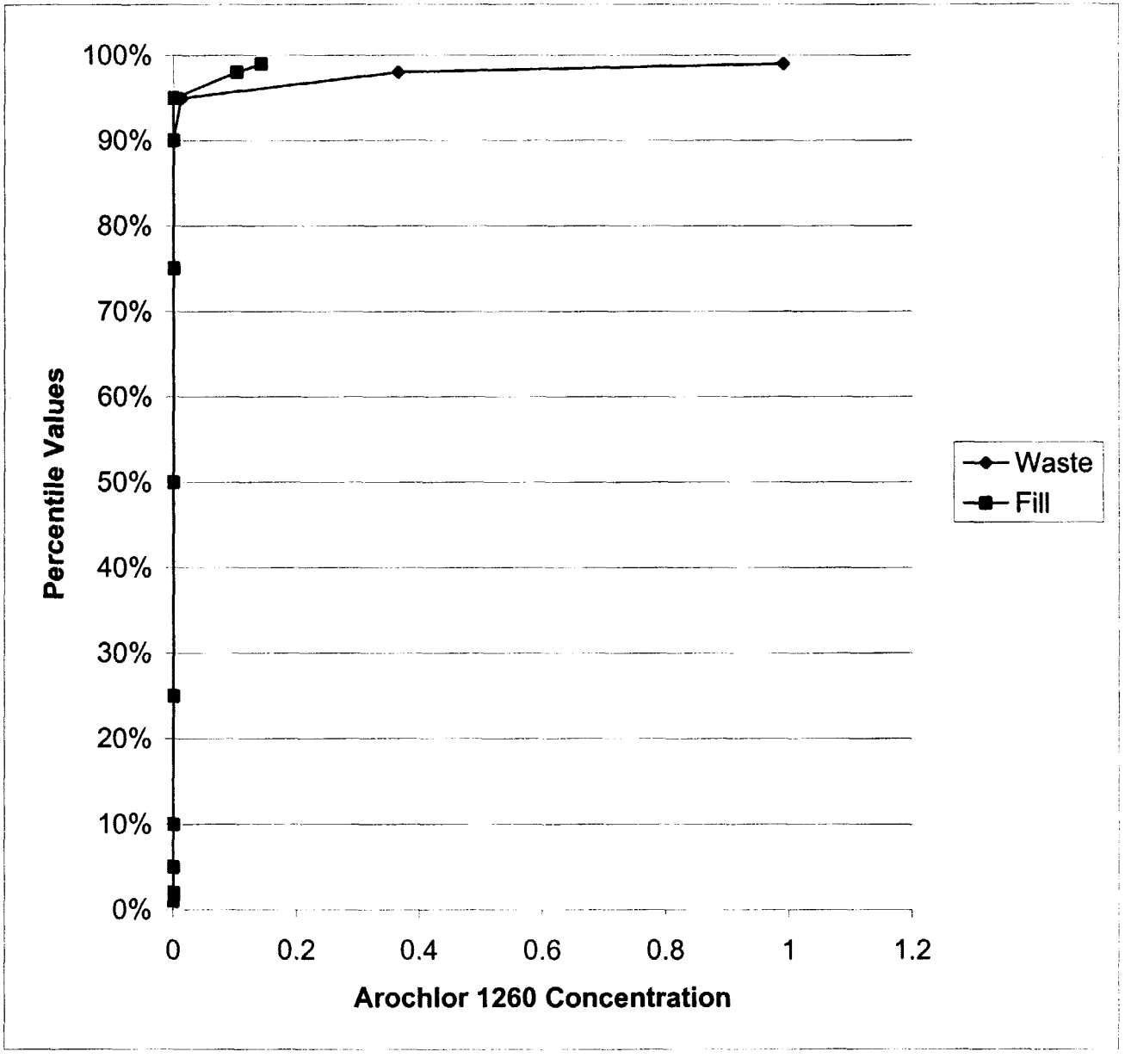
Arochlor 1254 (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0	0	95%
0	0.2356	98%
0.09	0.3236	99%



Arochlor 1260 (mg/kg)

Fill	Waste	Percentile
0	0	1%
0	0	2%
0	0	5%
0	0	10%
0	0	25%
0	0	50%
0	0	75%
0	0	90%
0	0.0134	95%
0.103	0.3656	98%
0.1425	0.9912	99%



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CERTIFICATION

FINAL DESIGN REPORT (REVISION 1.0)
SOILS, SUBSURFACE GAS, AND GROUND WATER
REMEDIAL DESIGN

WASTE DISPOSAL, INC. SUPERFUND SITE
SANTA FE SPRINGS, CALIFORNIA

These Specifications for the Waste Disposal, Inc., Superfund Site were prepared by TRC on behalf of the Waste Disposal, Inc. Group (WDIG) in a manner consistent with the level of care and skill ordinarily exercised by professional engineers. These Specifications were prepared under the technical direction of the undersigned California Registered Civil Engineers.

Executed at Irvine, California this 25th day of March 2003.

Signature	Signature
Kenneth J. Floom, P.E.	Ian P.G. Hutchison, PhD., P.E.
Registration No. C042099	Registration No. C039319

SEAL:

SEAL:

TRC
Customer-Focused Solutions

FINAL (100%) REMEDIAL DESIGN SPECIFICATIONS
WASTE DISPOSAL, INC. SUPERFUND SITE

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FINAL (100%) REMEDIAL DESIGN SPECIFICATIONS
WASTE DISPOSAL, INC. SUPERFUND SITE

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SECTION 01000
INTRODUCTION, SCOPE OF WORK AND GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. The work (Work) described by these construction documents is to be performed on behalf of the Waste Disposal, Inc. Group, hereafter referred to as "OWNER." The OWNER shall be represented during construction by the PROJECT COORDINATOR as defined in the Consent Decree. OWNER's design engineer is either TRC or the Engineer(s) of Record and are hereafter referred to as "ENGINEER."

B. The Work shall be performed in accordance with the reference standards outlined in Section 01010.

1.02 SCOPE OF WORK

A. The scope of work described here is intended as a summary and does not relieve CONTRACTOR'S responsibility to inspect all construction documents in order to submit a complete bid. Work covered in these specifications encompasses the following activities:

1. Establish staging areas, site access, onsite roads and other facilities required for construction.
2. Demolish and remove pavement and other items (e.g., fences) on the site which shall inhibit construction activities.
3. Provide stormwater runoff control, as necessary during construction.
4. Provide dust control during construction activities.
5. Rough grade site and subgrade preparation including removal of deleterious materials.
6. Reconsolidate any waste encountered/excavated during subgrade preparation in designated disposal areas within the site.
7. Install perforated polyvinyl chloride (PVC) pipes for gas venting in a 6-inch-wide by 9-inch-deep gravel-filled trench with extension of PVC pipe at the high point of the cap area.
8. Compact structural fill (comprised of onsite soil) and/or install geogrid to provide a foundation for the cover systems.
9. Install PVC drainpipe from low point of reservoir cap French drain (drainage trench) to daylight at concrete paving in property along Santa Fe Springs Road.
10. Install geosynthetic clay liner (GCL) in areas outside the reservoir where waste is buried that are not covered with existing asphalt or concrete.

11. Place geotextile cushion over GCL.
12. Place and compact 2 feet of vegetative soil layer over geotextile cushion layer to achieve final grades.
13. Install single-sided geocomposite for gas venting over prepared subgrade over the reservoir. This shall not extend into the cap French drain (drainage trench).
14. Construct French drain (drainage trench) around outside perimeter of the reservoir.
15. Install geosynthetic clay layer over the single-sided geocomposite and extend into French drain (drainage trench).
16. Install 60-mil high-density polyethylene (HDPE) over geosynthetic clay layer and extend into French drain (drainage trench).
17. Install single-sided drainage layer geocomposite over 60-mil HDPE and extend into French drain (drainage trench).
18. Install 4-inch-diameter perforated corrugated HDPE pipe into French drain (drainage trench).
19. Backfill French drain (drainage trench) with drain rock.
20. Place and compact vegetative soil layer over reservoir area.
21. Install aboveground gas collection venting system piping, blower, carbon adsorbers and concrete pad at the high point of the cap area.
22. Install precast concrete catch basin at low point of brow ditch.
23. Install storm drainpipe from catch basin to existing catch basin in Greenleaf Avenue.
24. Rehabilitate and/or remove and replace existing asphalt pavement in the engineered asphalt pavement cover areas.
25. Rehabilitate and/or remove and replace existing concrete pavement in the engineered concrete pavement cover areas.
26. Install sentinel biovent gas control wells around perimeter of buried waste.
27. Install leachate monitoring/control wells in reservoir area.
28. Extend and install boots around existing soil vapor wells and ground water monitoring wells as necessary due to regrading of the Site and placement of the cap.
29. Abandon designated existing soil gas and ground water monitoring wells.
30. Reinstall fence along recreational storage lot adjacent to the reservoir.
31. Install fence around gas collection venting system equipment and piping at high point of cap system.
32. Install stray ball fence adjacent to recreational field.
33. Install hardened drainage V-ditch on west side of Site.
34. Replace or install new fence around Site remove to facilitate work.
35. Install 10-foot wide Site access road from Greenleaf Avenue to gas extraction/venting system.

36. Seal cracks in floor slabs and boot around utility penetration in existing buildings.
37. Install settlement monuments.
38. Install landscaping and reseed graded soil areas.
39. Clean up site and remove all unused material, equipment, rubbish and debris.
40. Demobilization.

B. The Contractor, herein referred to as "CONTRACTOR," is responsible for providing construction services, temporary facilities and related materials and equipment for the Work described herein.

1.03 FORM OF SPECIFICATIONS

A. These specifications (Specifications) are written in the Construction Specifications Institute (CSI) three-part format (General, Materials, and Execution). For some sections all three parts are not necessary.

B. These Specifications are written in imperative and abbreviated form. This imperative language of technical sections is directed at CONTRACTOR unless specifically noted otherwise.

C. CONTRACTOR shall perform or provide items of the Work stated and comply with the requirements stated in each section, unless the items are specifically assigned to other contractors, ENGINEER, CONSTRUCTION QUALITY ASSURANCE (CQA) ENGINEER or OWNER.

D. The term "provide" or "provided" shall mean "furnished and installed by CONTRACTOR."

1.04 STANDARD SPECIFICATIONS

A. These Specifications are to be used in conjunction with the Standard Specifications For Public Works Construction, latest edition often referred to as the "Green Book" except Section 1 which is not applicable and Standard Specifications, State of California, Department of Transportation, July 1984, or later editions.

B. The Work is to be performed in accordance with the accepted Contractor's Health and Safety Plan.

1.05 INACCURACIES IN THE DRAWINGS OR SPECIFICATIONS

A. The written dimensions in the Drawings or in the Specifications are presumed to be correct, but CONTRACTOR shall be required to check carefully all dimensions before beginning the Work. If inaccuracies are discovered, ENGINEER shall be advised in writing immediately and shall make the proper corrections. No extra work shall be performed on this contract without written authorization by OWNER or his designated representative.

1.06 MATERIAL SUBSTITUTIONS

A. Whenever a specific brand name or model number is used, an "approved equal" is implied. The specific name is used to clearly identify the item, its intended use, and its level of quality. All proposed substitutions require the approval of ENGINEER.

B. Unless specifically requested in the submittal section of these Specifications, submittal approvals are not required if materials are identical to those specified in this document.

C. Where equipment, materials, or articles are referred to in the Contract Documents as "or equivalent" and "equal to" a particular standard, ENGINEER shall determine equality.

1.07 PROJECT MEETINGS

A. Project meetings shall be held and conducted as described in Section 01020.

1.08 WORK SEQUENCE

A. CONTRACTOR or a geosynthetics subcontractor shall not place geosynthetic layers over prepared subgrade before CQA ENGINEER, CONTRACTOR, geosynthetics subcontractor, and the regulatory agencies, if required, have approved the surface to be covered.

B. CONTRACTOR shall not place vegetative soil layer or other materials before CQA ENGINEER and the regulatory agencies, if required, have approved underlying layers.

1.09 QUALITY ASSURANCE

A. CQA ENGINEER shall monitor and document the Work completed by CONTRACTOR in accordance with Section 01200 and the CQA Plan. Performance criteria are set forth in these Specifications and the Drawings.

1.10 GENERAL CONDITIONS AND CONTRACTOR'S RESPONSIBILITIES

A. All Work shall be coordinated with PROJECT COORDINATOR, CONSTRUCTION PROJECT MANAGER, CQA ENGINEER, and necessary subcontractors. The purpose of this coordination is to foster good communications between all parties involved in the project and responsible for the operations of the site, and to identify potential problems that could impact the Work schedule.

B. The Specifications, Drawings and other documents shall govern the Work and shall be considered complimentary. Anything indicated in the Specifications and not in the Drawings or another document, or in the Drawings or another document and not in the Specifications, shall be considered to be contained in each.

C. CONTRACTOR shall, upon discovering any discrepancies in the Specifications, Drawings or other documents, immediately bring the discrepancies to the attention of ENGINEER.

D. CONTRACTOR shall furnish and maintain in good condition all material, equipment, and facilities necessary for the proper execution and inspection of the Work. The Work, equipment, and materials shall be protected from the weather, vandalism and other damage by CONTRACTOR until final acceptance of the entire project by CQA ENGINEER, PROJECT COORDINATOR, and OWNER. Such material, equipment, and facilities shall conform to all applicable ordinances and laws.

E. CONTRACTOR shall provide all required surveying services for performance of the Work. CQA ENGINEER or designee shall provide surveying services required for quality assurance activities.

F. The project site, including all staging and stockpile areas, shall be maintained by CONTRACTOR in a neat and orderly fashion, free of rubbish and debris.

G. Materials and equipment shall be removed from the site when no longer required for the Work. Prior to final inspection and acceptance of the Work, the site shall be cleared of equipment, unused materials and rubbish.

H. The cost of maintaining the site in a neat and orderly fashion and preparing the site for final inspection shall be included as part of CONTRACTOR's bid.

I. CONTRACTOR shall provide, at his expense, temporary water, power, sanitation, telephone, and other utilities necessary for the Work, and shall remove such temporary utilities upon completion of the Work unless otherwise directed by OWNER.

J. Existing improvements/facilities that must be removed for the project, but are not designated for permanent removal, shall be repaired or replaced by CONTRACTOR, and shall be at least equal to the existing improvements/facilities and match them in finish and dimension.

K. CONTRACTOR shall prepare and have available onsite an approved Health and Safety Plan.

L. CONTRACTOR shall be responsible for the protection of public and private property adjacent to the Work and shall exercise due caution to avoid damage to such property.

M. CONTRACTOR shall provide signs, barricades, flagmen and other necessary safety personnel or items, such that the Work may be performed in a safe manner.

N. CONTRACTOR shall provide dust control as necessary to assure project compliance with provisions of the Health and Safety Plan, EPA, STATE, South Coast Air Quality Management District (SCAQMD), and other regulatory agency requirements.

O. CONTRACTOR shall clean public and private streets at the project site and any offsite borrow sources as necessary to maintain compliance with EPA, STATE, and other regulatory agency requirements.

P. As this is a Superfund remediation project, local permits for onsite activities are not usually required. However, should the local agencies, EPA and/or STATE require such permits, CONTRACTOR shall be responsible for obtaining any and all permits required for the Work.

* * * END OF SECTION * * *

SECTION 01010
REFERENCE STANDARDS, DEFINITIONS AND ABBREVIATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section summarizes the reference standards, definitions and abbreviations used in the preparation of these Specifications and the Drawings.

B. Except as specifically stated otherwise in the Contract Documents, CONTRACTOR shall pay, at his own expense, all costs and fees for permits, licenses, certificates, etc., required by regulatory agencies, utilities, etc., for execution of work under this Contract.

C. Whenever any product is specified by references to Federal Specifications, American Society for Testing and Materials (ASTM) Standards, or other association standards, CONTRACTOR shall present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. All references are to be latest edition of standards at time of bid closing. When necessary, requested or specified, supporting test data shall be submitted to substantiate compliance.

1.02 REFERENCE STANDARDS

A. The following industry standards, reports and other documents shall be considered minimum requirements under this specification, unless otherwise noted:

1. The rules and regulations of the Occupational Safety and Health Act (OSHA).
2. California Occupational Safety and Health Administration (Cal OSHA) Regulations, California Code of Regulations (CCR), Title 8, Part 5194.
3. Standards of the American Concrete Institute (ACI).
4. Standards and Specifications of the Concrete Reinforcing Steel Institute (CRSI).
5. Standards of the American Institute of Steel Construction (AISC).
6. Standards and specifications of the ASTM.
7. Standards and specifications of the American National Standards Institute (ANSI).
8. Standards and Specifications of the American Plywood Association (APA).
9. Uniform Building Code (UBC), 1997 edition.

10. Standards and specifications of the Plastic Piping Institute (PPI).
11. Standards and specifications of the National Sanitation Foundation, Standard 54 - For Flexible Membrane Liners (NSF54).
12. Standard Specifications for Public Works Construction, 2003 Edition.
13. Los Angeles County Department of Public Works Standard Plans and Specifications.
14. Title 40, Code of Federal Regulations (CFR), Part 264, Subpart N: RCRA Requirements for Design and Construction of Hazardous Waste Landfills.
15. Title 22, California Code of Regulations (CCR), Chapter 14, Article 14.
16. Background Document on Bottom Liner Performance in Double-Lined Landfills and Surface Impoundments (EPA, April 1987).
17. Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments (EPA, July 1989).
18. Earth Manual (Bureau of Reclamation E-13 Standard).
19. Environmental Protection Agency Air Superfund National Technical Guidance Study Series, Air Pathway Analysis, July 1989.
20. Title 27, CCR, Subdivision 1, Chapter 3.
21. South Coast Air Quality Management District Rules.

1.03 DEFINITIONS

A. Whenever the following terms are used in these Specifications, the intent and meaning shall be interpreted as follows:

1. OWNER: Waste Disposal, Inc. Group.
2. PROJECT COORDINATOR: The designated coordination representative of the OWNER.
3. ENGINEER: The designated technical representative of the OWNER, TRC or the Engineer(s) of Record, prepared the Specifications presented herein in conjunction with the Drawings.
4. CONSTRUCTION QUALITY ASSURANCE (CQA) ENGINEER: A firm retained by OWNER to provide CQA services required in these Specifications and the Quality Assurance Plan.
5. CONTRACTOR(S): Individual(s), firm(s), or corporation(s) who have entered into an agreement with OWNER. For these Specifications, the term CONTRACTOR is interchangeable with Subcontractor.
6. MANUFACTURER(S): Individual(s), firm(s), or corporation(s) who fabricate or produce materials, equipment, other products and supply them to CONTRACTOR for construction.
7. CONTRACT DOCUMENTS: Includes these Specifications, Drawings, and attachments incorporated by reference.
8. PROJECT SITE: The space available to CONTRACTOR for performance of construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the PROJECT

SITE may or may not be identical with the description of the land on which the Project is to be built.

9. REGULATION: The term "REGULATION" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
10. CALENDAR DAY: Any day of the year.
11. WORKING DAY: A calendar day, excluding Saturday, Sundays, and OWNER's recognized legal holidays, on which weather and other conditions not under the control of CONTRACTOR permit construction operations to proceed for the major part of the day, with the normal working force engaged in performing the controlling item or items of Work which would be in progress at that time.
12. REGULAR WORKING HOURS: Work shall be confined to a period between 7:00 a.m. and 6:00 p.m. on allowable work days. No work shall be performed outside of this time period without the express authorization by OWNER or designated representative.

1.04 ABBREVIATIONS

A. The following abbreviations may be in the Contract Documents and represent the organization or topic named. The names are believed to be correct as of the date of the Contract Documents.

AASHTO - American Association of State Highway and Transportation Officials
ACI - American Concrete Institute
AISC - American Institute of Steel Construction
AISI - American Iron and Steel Institute
ANSI - American National Standards Institute
ASCE - American Society of Civil Engineers
ASME - American Society of Mechanical Engineers
ASTM - American Society for Testing and Materials

Cal-OSHA - California Occupational Safety and Health Administration
CCR - California Code of Regulations
CFR - Code of Federal Regulations
CMP - Corrugated Metal Pipe
CQA - Construction Quality Assurance
CRSI - Concrete Reinforcing Steel Institute
CS - Carbon Steel

DOT - Department of Transportation
DTSC - Department of Toxic Substances Control

El. or Elev. - Elevation
EPA - United States Environmental Protection Agency

FG - Finished Grade
FL - Flow Line
FML - Flexible Membrane Liner
FS - Finished Surface

HDPE - High Density Polyethylene
HSO - Health and Safety Officer

Inv.	-	Invert
LADPW	-	Los Angeles Department of Public Works
MCL	-	Maximum Contaminant Level
NEC	-	National Electric Code
NEMA	-	National Electrical Manufacturers Association
NFPA	-	National Fire Protection Association
NSF	-	National Sanitation Foundation
NWWA	-	National Water Well Association
OSHA	-	Occupational Safety and Health Administration
PCA	-	Portland Cement Association
PPI	-	Plastic Piping Institute
PVC	-	Polyvinyl Chloride
QA/QC	-	Quality Assurance/Quality Control
QAPP	-	Quality Assurance Project Plan
RWQCB	-	Regional Water Quality Control Board
SCAQMD	-	South Coast Air Quality Management District
SD	-	Storm Drain
SDR	-	Standard Dimension Ratio
SPI	-	Society of the Plastics Industry
SS	-	Stainless Steel
UL	-	Underwriter's Laboratories, Inc.

* * * END OF SECTION * * *

SECTION 01020
PROJECT COORDINATION AND MEETINGS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes a description of the following:
   1. Project coordination by the PROJECT COORDINATOR.
   2. Schedules.
   3. Project Meetings.

1.02 RELATED SECTIONS

A. The following specifications sections should be referred to:
   1. Section 01000 - Introduction, Scope of Work and General Requirements.
   2. Section 01200 - Quality Assurance/Quality Control.

1.03 PROJECT COORDINATION

A. The overall PROJECT COORDINATOR shall be determined prior to beginning of closure activities.

B. The CONTRACTOR shall cooperate with the PROJECT COORDINATOR in allocation of mobilization areas of site; for field offices and sheds, for access, traffic, and parking facilities.

C. During construction, the CONTRACTOR shall coordinate use of the site and facilities through the PROJECT COORDINATOR.

D. The CONTRACTOR shall comply with PROJECT COORDINATOR's procedures for intra-project communications; submittals, reports and records, schedules, drawings, and recommendations; and resolution of ambiguities and conflicts.

E. The CONTRACTOR shall comply with instructions of the PROJECT COORDINATOR for use of temporary utilities and construction facilities.

F. The CONTRACTOR shall coordinate field engineering and layout work under instructions of the PROJECT COORDINATOR.

1.04 SCHEDULES

A. The CONTRACTOR shall submit a preliminary Construction Progress Schedule in accordance with Section 01400.

1.05 PROJECT MEETINGS

A. Representatives of CONTRACTOR, subcontractors, and suppliers attending meetings shall be authorized to act on behalf of the entity each represents.

B. Preconstruction Conference:

1. The conference shall be held at a location and time selected by OWNER.

2. The conference shall be held immediately after award of contract to assure expeditious execution of the Work.

3. The conference shall be attended by:
   - PROJECT COORDINATOR.
   - CONTRACTOR's office representative.
   - CONTRACTOR's resident superintendent.
   - Any subcontractors' or suppliers' representatives whom CONTRACTOR may desire to invite or ENGINEER may request be present.
   - CQA ENGINEER's representative.
   - ENGINEER's representatives.
   - EPA's representatives, and other parties as required by EPA.

4. A suggested format would include, but not be limited to, the following subjects:
   - Presentation of a proposed Construction Progress Schedule in accordance with Section 01400.
   - Check of required insurance certifications prior to Notice to Proceed.
   - CONTRACTOR's proposal for locating soil and drain rock materials and for preconstruction testing of these materials.
   - CONTRACTOR's proposals for staging area, equipment and personnel decontamination, and Health and Safety Plan with associated monitoring.
   - Direction of correspondence, and coordinating responsibility between OWNER, CONTRACTOR, ENGINEER, CQA ENGINEER, and EPA.
   - Future weekly job meetings for parties involved.
   - Laboratory testing of material requirements.
   - Review of submittals and due dates.

- Review, discussions and approval, if appropriate, of substitutions.
- Discussion of health and safety requirements.
- Review of security, access and parking procedures.
- Discussion of critical path items and required actions.
- Schedule of values, application for payment, and progress payment procedures.
- OWNER's site regulations.

C. Progress Meetings

1. PROJECT COORDINATOR shall schedule and administer progress meetings a minimum of once per week and such additional meetings as may be required.

2. Attendance:

   - PROJECT COORDINATOR.
   - CONTRACTOR's superintendent.
   - CQA ENGINEER.
   - EPA representatives, as necessary.
   - ENGINEER, as appropriate to the agenda.
   - Subcontractors, as appropriate to the agenda.
   - Suppliers, as appropriate to the agenda.

3. Meeting Requirements:

   - PROJECT COORDINATOR shall administer the following general requirements for progress meetings:
     - Prepare an agenda for the meetings.
     - Make physical arrangements for the meetings.
     - Preside at the meetings.
     - Take the meeting minutes.
     - Reproduce and distribute copies of the meeting record as part of the weekly report required in Section 01400 within one day after each meeting to participants in the meeting and to parties affected by decisions made at the meeting.

4. Suggested Agenda:

   - Review and approval of record of the previous meeting.
   - Review of the Work progress since the previous meeting.
   - Field observations, problems, and conflicts.
   - Problems which could potentially impede the Work schedule.
   - Review of offsite delivery schedules.
   - Corrective measures and procedures to regain the projected schedule, if necessary.
   - Revisions to the construction progress schedule.
   - Planned progress during the upcoming Work period.
   - Review of health and safety issues, including monitoring.
   - Coordination of the schedules.
   - Review of submittal schedules; expedition as required.
   - Maintenance of quality and safety standards.
   - Pending changes and substitutions.

- Review proposed changes for effect on construction schedule and completion date, and on other contracts of projects.
- Other business.

* * * END OF SECTION * * *

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SECTION 01100
SURVEYING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes a description of the following:

1. Survey.
2. Quality control of survey.
3. Submittals.
4.. Project record documents related to surveying.

1.02 RELATED SECTIONS

A. Section 01300 - Measurement and Payment: Measurement for Work requiring unit price payment.

B. Section 01010 - Referenced Standards, Definitions and Abbreviations.

C. Section 01200 - QA/QC.

D. Section 01700 - Project Record Documents.

1.03 QUALITY ASSURANCE

A. CONTRACTOR shall employ a Land Surveyor (SURVEYOR) registered in the State of California and acceptable to ENGINEER, to perform survey work of this section.

1.04 SUBMITTALS FOR REVIEW

A. CONTRACTOR shall submit name, address, and telephone number of SURVEYOR before starting survey work or shop drawings.

B. On request, CONTRACTOR shall submit documentation verifying accuracy of survey work.

C. CONTRACTOR shall submit a copy of site drawing and certificate signed by the Land Surveyor, that the elevations and locations of the Work are in conformance with Contract Documents.

D. CONTRACTOR shall submit evidence of SURVEYOR's Errors and Omissions insurance coverage in the form of an Insurance Certificate.

1.05 PROJECT RECORD DOCUMENTS.

A. CONTRACTOR shall maintain a complete and accurate log of control and survey work as it progresses.

B. CONTRACTOR shall submit Record Documents under provisions of Section 01700.

1.06 EXAMINATION

A. CONTRACTOR and ENGINEER shall verify locations of survey control points prior to starting work.

B. CONTRACTOR shall promptly notify ENGINEER of any discrepancies discovered.

1.07 SURVEY REFERENCE POINTS

A. CONTRACTOR shall locate and protect survey control and reference points.

B. CONTRACTOR and SURVEYOR shall protect survey control points prior to starting site work; preserve permanent reference points during construction.

C. CONTRACTOR shall promptly report to PROJECT COORDINATOR the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

D. CONTRACTOR shall replace dislocated survey control points based on original survey control and make no changes without prior written notice to ENGINEER.

1.08 SURVEY REQUIREMENTS

A. CONTRACTOR's SURVEYOR shall establish two permanent bench marks on site, referenced to established control points. SURVEYOR shall record locations, with horizontal and vertical data, on project record documents.

B. SURVEYOR shall establish elevations, lines and levels as shown in the Drawings.

1.09 SURVEYS FOR MEASUREMENT AND PAYMENT

A. SURVEYOR shall perform surveys to determine quantities of unit cost work, including control surveys to establish measurement reference lines. SURVEYOR shall notify PROJECT COORDINATOR prior to starting work.

1.10 SURVEY ACCURACY

A. Survey accuracy for rough grading shall be ±0.1 foot. All other survey work shall be accurate to ±0.1 feet horizontal and vertical.

* * * END OF SECTION * * *

SECTION 01200
QUALITY ASSURANCE/QUALITY CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes an overview of quality control of construction and installation, tolerances, references, inspecting and testing laboratory services, and MANUFACTURER's field services and reports.

B. Refer to the CQA Plan, which must be approved by the ENGINEER for procedures and documentation requirements for CQA. The CQA Plan shall include, as a minimum, the following:

1. A statement of the purpose and objectives of CQA.
2. Description of the roles, responsibilities and authority of each party (i.e., CONTRACTOR, ENGINEER, CQA ENGINEER, PROJECT COORDINATOR, and OWNER).
3. An outline of the process for implementation (e.g., flow diagram).
4. Reference to the relevant standards, codes and methods to be used for quality control testing.
5. A description of the observations, testing, notification, corrective action and documentation requirements.
6. A procedure for formal design change requests and approvals.
7. Discussion of the necessary coordination between CONTRACTOR, ENGINEER, CQA ENGINEER, PROJECT COORDINATOR, OWNER and reviewing agencies.

1.02 QUALITY CONTROL OF CONSTRUCTION AND INSTALLATION

A. Construction quality control includes:

1. Monitoring by CQA ENGINEER of suppliers, manufacturers, materials, services, site conditions and workmanship, to produce work of specified quality.
2. CONTRACTOR compliance with MANUFACTURER's instructions, including each step in sequence.
3. Should MANUFACTURER's instructions conflict with Contract Documents (Specifications and Drawings), the CONTRACTOR shall request clarification from the ENGINEER before proceeding.

4. CONTRACTOR compliance with specified standards as a minimum quality for the Work except where more stringent tolerances, codes or specified requirements indicate higher standards or more precise workmanship.
5. Work performed by persons qualified to produce workmanship of specified quality.

B. Testing standards and frequencies for specific work elements (e.g., structural fill, geosynthetics) are provided in individual Division 2 - Site Work Specification sections.

C. Quality Assurance Procedures are provided in the CQA Plan.

1.03 TOLERANCES

A. Tolerances shall be controlled during construction and installation of materials to produce acceptable work. Specific work element tolerances are provided in relevant Division 2-Site Work Specification sections. Tolerances shall not be permitted to accumulate.

B. CONTRACTOR shall comply with MANUFACTURER's tolerances. Should MANUFACTURER's tolerances conflict with Contract Documents, the CONTRACTOR shall request clarification from ENGINEER before proceeding.

C. Materials shall be adjusted to appropriate dimensions and positioned before securing in-place.

1.04 REFERENCES

A. Refer to Section 01010 and individual Specification sections for specific reference standards.

B. CONTRACTOR shall conform to reference standard by date of current issue except where a specified date is given in a code.

C. CONTRACTOR shall obtain copies of standards where required by material Specification sections.

D. Retesting required because of nonconformance to specified requirements shall be performed on instructions by ENGINEER. Payment for retesting shall be charged to CONTRACTOR by deducting inspecting or testing charges from the contract sum/price.

1.05 CONSTRUCTION ACCEPTANCE

A. CONTRACTOR shall retain ownership and responsibility for the materials used in construction until acceptance by OWNER. At OWNER'S discretion, the Work may be accepted in sections or at points of substantial completion. CQA ENGINEER is responsible for determining and documenting the Work complies with the Construction Documents.

B. The construction shall not be accepted by ENGINEER and OWNER before:
   1. The installation of a construction element, or section thereof, is finished.
   2. Verification of the adequacy of testing is completed.
   3. Documentation of construction and test results are completed and reviewed.

C. CQA ENGINEER shall certify that construction has proceeded in accordance with the Construction Documents except as noted to ENGINEER and OWNER.

* * * END OF SECTION * * *

SECTION 01300
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR, in compliance with the invitation to bid for this project, acknowledges examining the Contract Documents. In addition, the CONTRACTOR acknowledges having inspected the site of the proposed Work, and being familiar with the conditions surrounding the project, including the availability of equipment, materials, and labor. Hereby, CONTRACTOR shall furnish all labor, materials, equipment and supplies to complete the project in accordance with the Contract Documents within the duration set forth in Section 01400, at the prices stated in the Bid Schedule. These unit prices are to cover all expenses incurred in performing the Work required under the Contract Documents.

B. Unit prices shall be presented in both words and figures. In case of discrepancy, the unit price shown in words shall govern.

C. The unit price shall include all labor, products, materials (as specified), temporary facilities, taxes, equipment, hauling, excavating, onsite cuttings and buried waste reconsolidation, offsite rubbish and debris disposal, installation of the Work, overhead, profit, insurance, bonds, etc., necessary to complete the finished Work specified.

1.02 AUTHORITY

A. Measurement methods delineated in the Bid Schedule are intended to complement the criteria of this section. In the event of a conflict, the requirements of the individual Specification section shall govern.

B. CONTRACTOR shall measure and compute the quantities of all Bid work items. PROJECT COORDINATOR or his REPRESENTATIVE shall verify measurements and quantities.

1.03 MEASUREMENT OF QUANTITIES

A. PROJECT COORDINATOR or his REPRESENTATIVE shall compute final in-place quantities based upon survey data and observation for each item listed in the Bid Schedule. The following methods shall be used for the computations.

1. Measurement for payment of lump sum Work items listed in the Bid Schedule shall be based upon an estimated percent complete of the work item.
2. Measurement for payment of Work items listed in the Bid Schedule to be paid at a unit price per lineal foot shall be based on the length shown in the Drawings unless the length has been modified and approved by the ENGINEER and PROJECT COORDINATOR. Modified lengths shall be determined by survey made jointly by both CONTRACTOR and PROJECT COORDINATOR. Any discrepancies in measured lengths shall be resolved prior to submittal of quantities for payment.
3. Measurement for payment of Work items listed in the Bid Schedule to be paid at a unit price per square foot shall be based on the area in square feet as calculated from dimensions shown in the Drawings, except geosynthetics, unless the dimensions have been modified and approved by ENGINEER and PROJECT COORDINATOR. Modified dimensions shall be determined by survey made jointly by both CONTRACTOR and PROJECT COORDINATOR. Geosynthetics (geomembrane, geocomposite, filter fabric) quantities actually placed shall be determined by survey. The square footage shall be calculated independently by both CONTRACTOR and PROJECT COORDINATOR and any discrepancies resolved prior to submittal of quantities for payment.
4. Measurement for payment of Work items listed in the Bid Schedule to be paid at a unit price per cubic foot or cubic yard shall be based on the volume in cubic feet or cubic yards as calculated from dimensions shown in the Drawings, unless the dimensions have been modified and approved by ENGINEER and PROJECT COORDINATOR. Modified dimensions shall be determined by survey. The volume shall be calculated independently by both CONTRACTOR and PROJECT COORDINATOR and any discrepancies resolved prior to submittal of quantities for payment.

1.04 PAYMENT

A. Payment for the Work governed by unit prices shall be made on the basis of the actual measurements and quantities accepted by the PROJECT COORDINATOR multiplied by the unit prices shown on the Bid Schedule for the Work, less any liquidated damages or subcontractor costs related to repair of damaged systems.

1.05 DEFECT ASSESSMENT

A. CONTRACTOR shall replace the Work or portions of the Work not conforming to specified requirements at no additional cost.

B. If, in the opinion of the ENGINEER or OWNER, it is not practical to remove and replace the Work:

- The defective Work shall be repaired in accordance with the instructions of ENGINEER, and the lump sum/unit price shall be adjusted to a new lump sum/unit price at the discretion OWNER.

1.06 NONPAYMENT FOR REJECTED PRODUCTS

A. Payment shall not be made for any of the following reasons:

- Products wasted or used in a manner that is not acceptable.
- Products determined to be unacceptable before or after placement.
- Products not completely unloaded from the transporting vehicle.
- Products placed beyond the lines and levels of the required Work.
- Products remaining on hand after completion of the Work.
- Loading, hauling and disposing of rejected or surplus products.

PART 2 EXECUTION

2.01 METHOD OF MEASUREMENT AND PAYMENT

A. All Work to be paid for at a contract unit price shall be verified by the PROJECT COORDINATOR in accordance with United States Standard measures in the specified units. For each bid item described in the Bid Schedule, it is understood that the CONTRACTOR shall include with that item all labor, equipment, material, painting, cleanup, safety measures, or anything else that may be required to successfully complete the Work. It is also understood that all work is to be completed in compliance with the Contract Documents.

B. Full compensation for all expenses shall be considered to be included in the unit prices paid for the bid items being measured. No additional compensation shall be allowed.

C. The method of measurement and payment, as described herein is for each item that appears in the Bid Schedule.

* * * END OF SECTION * * *

SECTION 01400
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 DESCRIPTION

A. An estimated Construction Progress Schedule shall be prepared by CONTRACTOR and submitted to PROJECT COORDINATOR for review.

1. An estimated Construction Progress Schedule shall be submitted to PROJECT COORDINATOR with the bid.

2. PROJECT COORDINATOR and CONTRACTOR shall review the schedule and make revisions (if necessary) to meet project deadlines.

1.02 CONSTRUCTION PROGRESS SCHEDULE

A. Form of Schedule:

1. The Construction Progress Schedule shall be prepared in form of a horizontal bar chart. The schedule shall include the following items:

   a. A separate horizontal bar for each Work activity.
   b. A horizontal time scale which divides the Work into weekly periods.

2. Work activities shall be arranged in chronological order of start for each item of the Work.

B. The Construction Progress Schedule shall include the following items:

1. A complete sequence of construction by Work activity.

2. Dates for beginning and completion of each major element of construction and installation dates for major items. Elements shall include, but not be limited to, the following:
   a. Project start date.
   b. Preconstruction meeting.
   c. Mobilization.
   d. Preconstruction testing of soil, drain rock and other materials.
   e. Shop drawing receipt from supplier/manufacturer submitted to ENGINEER, review and return to supplier/manufacturer.
   f. All submittals called for in these Specifications.
   g. Material order, manufacturer, delivery, installation, and checkout, including allowance items.
   h. Site access construction.

i. Installation of temporary facilities (field offices and materials storage).
j. Subgrade preparation.
k. Structural fill placement.
l. Brow ditch construction.
m. French drain (drainage trench) construction.
n. Gas barrier single-sided geocomposite installation.
o. Gas collection piping systems installation.
p. Geosynthetic clay layer installation.
q. Flexible membrane cover installation.
r. Drainage single-sided geocomposite (drainage layer) installation.
s. Drainage trench pipe installation.
t. 8-ounce filter geotextile installation.
u. Drain rock backfilling in drainage trench.
v. Rehabilitation of existing asphalt pavement in the engineered asphalt pavement cover areas.
w. Rehabilitation of existing concrete pavement in the engineered concrete pavement cover areas.
x. Installation of biovent passive gas control wells.
y. Installation of existing building foundation passive gas vent systems, if required.
z. Installation of leachate monitoring/control wells.
aa. Extension of existing soil gas and ground water monitoring wells.
bb. Abandonment of designated existing soil gas and ground water monitoring wells.
cc. Precast catch basin installation.
dd. Storm drain pipe installation.
ee. Catch basin tie-in construction.
ff. Fence construction.
gg. Surface vegetation placement.
hh. Irrigation system installation.
ii. Site cleanup and demobilization.

C. A Preliminary Schedule for the Waste Disposal, Inc. site closure is provided in Figure 5 for reference. CONTRACTOR shall review this schedule in the course of preparation of the Construction Progress Schedule.

D. Schedule Revisions:

1. CONTRACTOR shall submit a revised Construction Progress Schedule every seven days and shall show the following:

   a. Progress of each activity upon date of schedule revision.
   b. Major changes in scope.
   c. Activities modified since previous submittal.
   d. Revised projections of progress and completion.
   e. Other identifiable changes.

2. All schedule revisions shall be submitted to PROJECT COORDINATOR for review and approval and subsequently distributed to the CQA ENGINEER, and regulatory authorities as required by OWNER.

1.03 CONSTRUCTION WORK SCHEDULE

A. CONTRACTOR shall prepare and submit detailed weekly work schedules to PROJECT COORDINATOR by Friday afternoon at 2:00 p.m. for the following week's work.

1.04 DELAYS AND RECOVERY

A. If, at any time during the Project, CONTRACTOR fails to complete an activity by its latest scheduled completion date, CONTRACTOR shall, within three working days, submit to PROJECT COORDINATOR a written statement as to how and when CONTRACTOR shall reorganize the work force to return to the current construction schedule.

B. Whenever it becomes apparent from progress evaluation and updated schedule data that milestone completion dates and/or contract completion dates shall not be met, CONTRACTOR shall take some or all of the following actions:

1. Increase construction staffing in such quantities and crafts as shall substantially eliminate backlog of work.
2. Increase number of working hours per shift, shifts per work day, work days per week, amount of construction equipment, or combination of foregoing sufficient to substantially eliminate backlog of the Work.
3. Reschedule the Work items to achieve concurrence of accomplishment.

C. Under no circumstances shall the addition of equipment or construction forces, increasing working hours or any other method, manner or procedure to return to current Construction Progress Schedule be considered justification for additional payment, contract modification or treated as an acceleration.

D. To the fullest extent permitted by law, CONTRACTOR shall indemnify, save, defend and hold harmless OWNER, its parents and affiliates, and all of their officers, directors, employees and agents, from and against any required payment of any stipulated or other penalty or fine pursuant to any applicable governmental requirements or orders, or legal instrument or process of any court, agency or other governmental entity, which arises out of CONTRACTOR's negligence or any failure of CONTRACTOR to perform in accordance with the provisions of the Contract. The amount of any such penalty or fine may, at OWNER's election, be deducted from any amount due and owing to CONTRACTOR under this Bid Document and Contract.

* * * END OF SECTION * * *

SECTION 01410
SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies procedural requirements for Work-Related submittals including Shop Drawings, substitutions, product/material data, samples, and other miscellaneous Work-Related submittals.

B. Types of Work-Related Submittals:

1. Substitutes or "Or Equal" Items:

   a. Includes material or equipment the CONTRACTOR requests the ENGINEER to accept as a substitute for items specified or described by using proprietary name or name of a particular Supplier.

2. Shop Drawings:

   a. Includes technical data and drawings specially prepared for this project, including fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports, instructions, design mix formulas, measurements, and similar information not in standard printed form.

3. Product/Material Data:

   a. Includes standard printed information on manufactured products, and systems that have not been specially prepared for this project, including manufacturer's product specifications and installation instructions, catalog cuts, standard wiring diagrams, printed performance curves, mill reports, and standard color charts.

4. Samples:

   a. Includes natural materials (soil and drain rock), examples of fabricated and manufactured materials, products, and units of work, includes complete units, partial cuts of manufactured or fabricated work, and units of work to be used for independent inspection and testing.

5. Miscellaneous Submittals:

   a. Work-related submittals that do not fit in the four previous categories, including guarantees, warranties, certifications, experience records, maintenance agreements, workmanship bonds, survey data and reports, physical work records, quality testing and certifying reports, copies of industry standards, record drawings, field measurement data, and materials applicable to the Work.

C. The CONTRACTOR'S responsibilities shall include the following.

1. Review Shop Drawings, product data, and samples prior to submittal.

2. Determine and verify:

   a. Field measurements.
   b. Field construction criteria.
   c. Catalog numbers and similar data.
   d. Conformance with Specifications.

3. Coordinate each submittal with requirements of the Work and Contract Documents.

4. Notify the PROJECT COORDINATOR in writing, at the time of the submittal, of deviations from requirements of Contract Documents.

5. Designate in the Construction Progress Schedule (see Section 01400), dates for submittal and receipt of review.

1.02 SUBMITTAL PROCEDURES

A. Scheduling:

1. The CONTRACTOR shall include a submittal schedule in the Construction Progress Schedule.

2. Each submittal shall be prepared and transmitted to the PROJECT COORDINATOR sufficiently in advance of the scheduled performance of the related work and other applicable activities.

B. Coordination:

1. Preparation and processing of submittals shall be coordinated with the performance of the Work. Coordinate each separate submittal with other submittals and related activities such as substitution requests, testing, purchasing, fabrication, delivery, and similar activities that require sequential activity.

2. Submittal of different units of interrelated work shall be coordinated so that one submittal shall not be delayed by the ENGINEER'S need to review a related submittal.

ENGINEER reserves the right to withhold action on any submittal requiring coordination with other submittals until the related submittals are forthcoming.

C. Submittal Preparation:

1. Stamp and sign each submittal certifying review of submittal, verification of products, field measurement, field construction criteria, and coordination of information within submittal with requirements of the Work and the Contract Documents.

2. Transmittal form must contain the following:

   a. Date of submittal and dates of previous submittals.
   b. Project title and number.
   c. Contract identification.
   d. Names of:
      - CONTRACTOR
      - Supplier
      - Manufacturer
   e. Summary of items contained in the submittal.
   f. Identification of the product with identification numbers, and the Drawing and Specification section numbers.
   g. Clearly identified field dimensions.
   h. Details required on the Drawings and in the Specifications.
   i. Manufacturer, model number, dimensions, and clearances, where applicable.
   j. Relation to adjacent or critical features of the Work or materials.
   k. Applicable standards, such as ASTM numbers.
   l. Identification of deviations from Contract Documents.
   m. Identification of revisions on resubmittals.
   n. Blank space for ENGINEER's stamp.

3. Refer to individual Specification sections for specific requirements. A submittal is the final submittal unless returned by ENGINEER or PROJECT COORDINATOR, marked with "Action" indicating observed noncompliance.

4. In addition to copies desired for CONTRACTOR'S use, furnish three executed copies.

D. Other Submittals:

1. Plans and Schedules:

   a. Health and Safety Plan (see Section 01600) shall be prepared and submitted at least 15 days prior to commencing site work.

   b. Stormwater Runoff Control Plan (see Section 02030) shall be prepared and submitted at least 15 days prior to commencing site work.

   c. Construction Progress Schedule (see Section 01400) shall be prepared and submitted with CONTRACTOR's bid.

d. Geomembrane, Geocomposite and Geotextile Placement Plans shall be submitted no later than 15 days prior to the installation of geotextile materials (see Sections 02200, 02210, and 02230).

e. Fencing plan shall be submitted no later than 20 days prior to the system installation.

2. Guarantees and Warranties:

a. Refer to individual Specification sections for specific requirements. A submittal is the final submittal unless returned by ENGINEER or PROJECT COORDINATOR, marked with "Action" indicating observed noncompliance.

b. In addition to copies desired for CONTRACTOR'S use, furnish three executed copies.

3. Survey Data:

a. CONTRACTOR shall submit an As-Built Survey of the construction facilities, grades, etc. prepared by an independent survey company approved by PROJECT COORDINATOR.

4. Standards:

a. Where a copy of a submittal is indicated, and except where copies of standards are specified as an integral part of a "Product Data" submittal, submit a single copy to ENGINEER. Where workmanship at the Project Site or elsewhere is governed by the standard, furnish additional copies to fabricators, installers, and others involved in the work performance.

5. Certifications and Conformance and Destructive Test Results:

a. Refer to individual specification sections for specific requirements on submittal of certifications and conformance test results. Certifications are submitted for review of conformance with specified requirements and information. Submittal is final unless returned by the CQA ENGINEER or PROJECT COORDINATOR, marked for "Action."

* * * END OF SECTION * * *

SECTION 01500
CONSTRUCTION SITE MAINTENANCE, TEMPORARY CONSTRUCTION FACILITIES AND UTILITIES

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall maintain the construction site surface, access, fencing and other security controls, material stockpiles, partially completed work, equipment and any other items onsite in a neat, orderly and safe condition at all times. Particular attention and care shall be given to dust control, as described in Section 02050.

B. CONTRACTOR shall furnish, install, and maintain temporary facilities and utilities required for construction, and remove such items upon completion of the Work.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. CONTRACTOR shall comply with the relevant portions of National Fire Protection Association (NFPA) regulations and National Electric Code.

B. CONTRACTOR shall comply with federal, state, and local codes and regulations, as well as utility company requirements.

1.03 CONSTRUCTION SITE MAINTENANCE

A. It is the intent of these Specifications that throughout construction, the CONTRACTOR shall keep all areas clear of debris, refuse or construction materials that render the construction area visually and/or odor offensive.

B. Throughout the period of construction CONTRACTOR shall keep the work site clean of rubbish and debris, and shall promptly remove from any portion of the site unused materials, surplus materials and debris.

C. Upon completion of the work, and prior to final acceptance (within the allowable construction time), CONTRACTOR shall remove from the vicinity of the Work all surplus material and equipment belonging to CONTRACTOR or used under his direction (e.g., by subcontractors) during construction, shall clean the site, and remove rubbish and debris.

PART 2 MATERIALS

2.01 TEMPORARY ELECTRICITY AND LIGHTING

A. General:

1. The CONTRACTOR shall be responsible for providing extensions to existing electric power drops for necessary temporary electrical power, including temporary wiring, distribution, inspection and safety and removal of such temporary facility upon completion of the Work. CONTRACTOR shall pay for electrical power necessary for performance of the Work.

2. Temporary lighting shall be supplied by CONTRACTOR and must be sufficient to enable CONTRACTOR to complete the Work, and for OWNER and CQA ENGINEER to check the Work as it is being performed.

2.02 TELEPHONE SERVICE

A. CONTRACTOR shall be required to supply its own telephone services.

2.03 SAFETY EQUIPMENT

A. CONTRACTOR shall provide and install first aid kits and other safety equipment for its employees' use in readily accessible locations and in accordance with the requirements of the Occupational Safety and Health Administration (OSHA) and Project Health and Safety Plan.

B. CONTRACTOR shall provide fire extinguishers of the type and capacity required by pertinent safety and other regulations to protect the site and ancillary facilities in the vicinity of the Work. Fire extinguishers shall be placed in readily accessible locations.

2.04 WATER FOR CONSTRUCTION

A. Water for construction shall be provided by CONTRACTOR at existing public sources (e.g. fire hydrants).

B. CONTRACTOR shall be responsible to haul water from these locations for use to accomplish the Work.

C. Potable water shall be supplied by CONTRACTOR.

D. Water should be used conservatively and only for purposes identified herein.

E. CONTRACTOR is responsible for sampling and testing prior to disposal and for disposing all wastewater generated during execution of the Work which has come in contact with contaminated soils.

2.05 WARNING DEVICES AND BARRICADES

A. For the duration of construction, CONTRACTOR shall provide and maintain warning signs and devices and, where necessary, physical barriers and barricades and other temporary construction controls necessary for protection of persons and property in accordance with pertinent safety and other regulations.

2.06 TEMPORARY SANITARY FACILITIES

A. CONTRACTOR shall provide temporary sanitary toilet facilities conforming to state and local health and sanitation regulations, in sufficient number for use by CONTRACTOR's employees, OWNER, ENGINEER, subcontractor and other site visitors.

B. CONTRACTOR shall maintain the facilities in sanitary condition and supplied with toilet paper.

C. CONTRACTOR shall remove the facilities from the site upon completion of the Work.

2.07 DAMAGE TO EXISTING PROPERTY

A. CONTRACTOR shall be responsible for replacing or repairing damage to existing buildings, sidewalks, roads, parking lot surfacing, site facilities and buildings, stored lumber and other existing assets.

B. All structures, utilities, sidewalks, pavements, and other facilities shall be protected from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Work.

2.08 SECURITY

A. CONTRACTOR shall be held responsible for loss or injury to persons or property where Work performed by CONTRACTOR is concerned. CONTRACTOR shall provide such security and take such precautionary measures, as deemed necessary, to protect CONTRACTOR's and OWNER's interests.

2.09 TEMPORARY PARKING

A. Designated areas onsite may be used for parking of construction personnel's private vehicles and the CONTRACTOR's light-weight vehicles.

   1. Heavy vehicles or construction equipment shall not be allowed in the parking areas.

B. The CONTRACTOR(s) shall make arrangements with the PROJECT COORDINATOR for use of onsite parking areas.

2.10 FIELD OFFICES AND BUILDINGS

A. As directed by OWNER, CONTRACTOR shall erect an approved area of the site and maintain in good condition temporary field offices and tool storage building(s) for use by CONTRACTOR, OWNER, ENGINEER, CQA ENGINEER and subcontractors. Building and facilities to be provided include:

   1. Two office/conference rooms (one for CONTRACTOR, one for ENGINEER), at least 20 feet by 12 feet.
   2. Water for washing and decontamination of sampling and other equipment.

3. Indoor and outdoor space lighting.

B. Tool storage building(s) shall be of ample size to provide space for tools and equipment. Building(s) shall be neat and well constructed, surfaced with plywood, drop siding, masonite or equivalent material, well painted and void of advertisements.

PART 3 EXECUTION

3.01 GENERAL

A. Temporary construction facilities and utilities shall be maintained and operated to ensure continuous service.

B. Facilities and utilities may be modified and extended as the Work progress requires.

3.02 DUST CONTROL

A. During grading, trenching and/or drilling, all working areas, excavated material and unpaved roadways shall be watered down until the surface is moist, and then maintained in a moist condition to minimize dust. Specification Section 02050 provides more detail for dust control requirements.

3.03 STORMWATER RUNOFF CONTROL

A. Stormwater runoff control shall be furnished by CONTRACTOR during execution of the Work as described in Section 02030. The objective of the stormwater control is to prevent sediment runoff from disturbed areas, prevent runoff from the soil excavation areas, and to prevent contact between rainwater and contaminated soils.

3.04 TEMPORARY SITE ACCESS

A. Designated temporary site access shall be prepared by CONTRACTOR during construction activities. Specification Section 02070 provides details.

3.05 PROTECTION OF THE PUBLIC AND PROPERTY

A. The CONTRACTOR shall adopt every practical means and comply with all laws and regulations in order to minimize interferences to traffic, and inconveniences and discomfort to the public, including provisions for adequate dust control measures.

B. The CONTRACTOR shall not trespass upon private property and shall be responsible for all injury or damage to persons or property directly or indirectly resulting from its operations in completing the Work. The CONTRACTOR shall comply with the laws and regulations of the OWNER, County, and State relating to the safety of persons and property, and shall be held responsible for, and required to make good on, any injury or damage to persons or property caused by carelessness or neglect on the part of the CONTRACTOR or its subcontractor(s), or agent or employee of either during the progress of the Work and until its final acceptance.

C. The CONTRACTOR shall protect pipes, sewer conduits, electrical conduits, lawns, gardens, shrubbery, trees, fences, overhead lines, or other structures, utilities or property, public and/or private, encountered in this Work against injury except as stipulated elsewhere herein. The CONTRACTOR shall be responsible and liable for any injury to such pipe, structures, utilities, vegetation and property and shall restore them to a condition equal to or better than the original at the CONTRACTOR's expense.

3.06 REMOVAL

A. Temporary facilities and utilities no longer in use shall be removed.

B. CONTRACTOR shall clean and repair damage caused by temporary installations or use of temporary facilities.

C. CONTRACTOR shall restore existing or permanent facilities used for temporary services to specified or original condition.

* * * END OF SECTION * * *

SECTION 01510
MATERIAL AND EQUIPMENT STORAGE AND HANDLING

PART 1 GENERAL

1.01 DESCRIPTION

A. Material incorporated into the Work must:

1. Conform to applicable Specifications and standards.
2. Comply with size, make, type, and quality specified or as specifically approved by ENGINEER in writing.

B. Manufactured and fabricated materials must be:

1. Designed, fabricated, and assembled in accordance with referenced standards.
2. Manufactured so that like items are standard sizes and gauges and can be interchanged.
3. Manufactured so that two or more items of same kind are identical and produced by the same manufacturer.

C. Material sizes, dimensions, and properties shown or specified shall be adhered to, unless variations are specifically approved, in writing, in accordance with Section 01410, Submittals.

D. Material shall be designed, stored and maintained for operations in hot weather and heavy rain. As required, insulation, waterproofing, protective covers, shall be provided for each material.

E. CONTRACTOR shall use material or equipment only for the purpose for which it is designed or specified.

1.02 REUSE OF EXISTING MATERIAL

A. Except as specifically indicated or specified, materials removed from existing structure(s) shall not be used in new work.

1.03 MANUFACTURER'S INSTRUCTIONS

A. When the Contract Documents require that installation of furnished materials shall comply with manufacturer's instructions, printed copies of such instructions shall be obtained and distributed to parties involved in the installation, including two copies to ENGINEER.

1. One set of complete instructions shall be maintained at the job site during installation and until completion of the Work.

B. Materials shall be installed, connected, cleaned, conditioned, and adjusted in accordance with manufacturer's written instructions and in conformity with the Specifications.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, ENGINEER shall be consulted for further instructions. Work shall not proceed without written instructions from ENGINEER.
2. Instructions and operations and maintenance procedures shall be submitted to PROJECT COORDINATOR.

1.04 TRANSPORTATION AND HANDLING

A. Deliveries of materials shall be arranged and coordinated, in accordance with the Construction Progress Schedule, to avoid conflict with the Work and conditions at the site.

1. Materials shall be delivered in undamaged condition, in the manufacturer's original containers or packaging, with the identifying labels intact and legible.
2. Immediately upon delivery, shipments shall be inspected to ensure compliance with Contract Documents and approved submittals, and to ensure that products have been protected and are undamaged.
3. PROJECT COORDINATOR shall be notified prior to delivery of materials.

B. Equipment and personnel required to handle materials shall be supplied by CONTRACTOR. Methods recommended by manufacturer to prevent soiling or damage to materials or packaging shall be employed during handling.

1.05 STORAGE AND PROTECTION

A. Contractor shall make all arrangements and provisions necessary for the storage of materials. All excavated materials, construction equipment, and materials to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities and so that free access can be had at all times to all parts of the Work and to all utility service company

installations in the vicinity of the Work. Materials shall be kept neatly and compactly stored in locations that shall cause a minimum of inconvenience to other contractors, tenants and occupants.

B. Onsite storage areas shall provide protection of materials from inclement weather including high winds, heavy rain and ultraviolet light.

C. Areas available on the construction site for storage of material shall be as shown, specified or approved by PROJECT COORDINATOR.

D. OWNER assumes no responsibility for materials stored onsite. CONTRACTOR assumes full responsibility for damage due to storage of materials.

E. Do not open manufacturer's containers until time of installation unless recommended by the manufacturer or otherwise specified.

F. Exterior storage requirements are as follows:

1. Fabricated materials shall be stored above ground, on blocking or skids, to prevent soiling or staining. Materials subject to deterioration shall be covered with impervious sheet coverings, adequate ventilation shall be provided to avoid condensation under the covering.

2. Loose granular materials shall be stored in a well-drained area on solid surfaces to prevent mixing with foreign matter.

3. Materials such as pipe shall be stored on pallets or racks, aboveground.

G. Storage should be arranged in a manner which provides easy access for inspection and inventory. Periodic inspections of stored materials shall be made by the CONTRACTOR and CQA ENGINEER to assure materials are maintained under specified conditions and are free from damage or deterioration, and to assure coverings are in-place and provide the required protection.

H. CONTRACTOR shall assume responsibility for protection of completed construction, and shall repair and restore damage to completed Work equal to the original condition.

* * * END OF SECTION * * *

SECTION 01600
HEALTH AND SAFETY

PART 1 GENERAL

A. It shall be the responsibility of CONTRACTOR to develop a site-specific Health and Safety Plan for the Work. The plan must conform to 29 CFR 1910.120. The Health and Safety Plan shall address, but is not limited to:

1. Introduction and Purpose
2. Applicable Laws and Regulations
3. Onsite Organization and Coordination
4. Medical Surveillance Program
5. Chemicals of Concern
6. Activities Hazard Analysis
7. Site Control, Work Zones, and Security Measures
8. General Safe Work Practices
9. Training
10. Personnel Protective Equipment
11. Onsite Workplans
12. Standard Operating Safety Procedures
13. Communication Procedures
14. Monitoring Plan (Personnel and Environment)
15. Decontamination Procedures
16. Work Disruption Notification Procedures
17. Onsite Worker and Community Safety
18. Emergency Response Plan, including:
    a. Contingency Plan
    b. Identification and responsibilities of an Emergency Coordinator
    c. Coordination with persons or organizations responsible for offsite emergency response (e.g., fire departments)
19. Recordkeeping
20. Requirements for Subcontractors
21. Procedures for Special Activities

The monitoring portion of the Health and Safety Plan shall include monitoring programs to assure effective dust control.

B. Summary information regarding onsite potential chemical hazards is included in the Health and Safety Plan, which is provided as a reference to the CONTRACTOR. Additional data or relevant information of onsite chemical hazards can be obtained by CONTRACTOR as necessary from the PROJECT MANAGER.

C. CONTRACTOR shall prepare the Health and Safety Plan for submittal to the Department of Toxic Substances Control (DTSC) and EPA for their approval. The Health and Safety Plan shall be reviewed by the ENGINEER and OWNER and approved prior to submittal to the relevant agencies. Approval by OWNER, however, does not relieve CONTRACTOR of the responsibility to obtain approval of the plan from the review agencies. Revisions to the plan as required by OWNER or EPA shall be the responsibility of CONTRACTOR.

* * * END OF SECTION * * *

SECTION 01700
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. OWNER shall have the right to access all records, such as correspondence and claims that are maintained onsite or at any other locations by CONTRACTOR.

B. One current record copy of the following shall be maintained for OWNER:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change orders and other modifications to the Contract.
5. Field orders, written instructions, or clarifications.
6. Approved submittals.
7. Field test records.
8. All associated permits.
9. Certificates of inspection and approvals.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Documents shall be maintained in a clean, dry, legible condition and in good order. Record documents shall not be used for construction purposes.

B. Documents and samples shall be available at all times for inspection by PROJECT MANAGER, CQA ENGINEER or ENGINEER.

C. Failure to properly maintain the record documents may be reason to delay a portion of the progress payments until the records comply with the Contract Documents.

1.03 RECORD DOCUMENTS

A. A record set of as-built drawings and specifications that have been legibly changed to transfer approved modifications in the completed Work that differs from the Contract Documents shall be maintained by CONTRACTOR.

B. Each document shall be labeled "PROJECT RECORD" in neat, large printed letters.

C. Information shall be recorded concurrently with construction progress.

1. No Work shall be covered over or concealed until the required information is recorded.
2. Changes made by written amendment, field order, change order, or a work directive change shall be recorded.

D. As-built drawings shall include the following information:

1. Horizontal and vertical locations of underground facilities and appurtenances, referenced to permanent surface improvements.
2. Field changes.
3. Details not on the original Drawings.
4. Location and identification of the exposed underground piping.

E. At completion of the Work:

1. Using data accumulated on blue line prints, CONTRACTOR shall have drafted a set of record drawings of the project, placing all information on reproducible mylar for the OWNER's final record. These drawings shall be suitable for ENGINEER's use in revising the CAD Drawings (as necessary) to reflect the as-built conditions.

1.04 SUBMITTALS

A. At Substantial Completion:

1. One set of record drawings shall be delivered to OWNER.
2. Documents described in Paragraph 1.01 shall be delivered to OWNER.

B. Submittals shall be accompanied with a transmittal letter, in duplicate, which contains the following:

1. Date.
2. Project title and number.
3. CONTRACTOR's name and address.
4. Title of record document.
5. Signature of CONTRACTOR or authorized representative, and approval by ENGINEER.

* * * END OF SECTION * * *

SECTION 01710
CONSTRUCTION PHOTOGRAPHS/VIDEO

PART 1 GENERAL

1.01 DESCRIPTION

A. Construction record photographs and/or video shall be taken by CQA ENGINEER periodically during the course of the Work.

1.02 PHOTOGRAPHY REQUIRED

A. Photographs and/or video shall be taken at each major stage of construction.

B. Negative and print requirements shall be as follows:

1. Negatives shall remain the property of OWNER.
2. Furnish 1 print and 1 slide to OWNER at commercial rates applicable at the time of purchase.
3. Furnish the original and one copy of each video record to OWNER.

C. OWNER shall be notified at least 5 days prior to taking the construction photographs or videos.

1.03 COSTS OF PHOTOGRAPHY

A. All costs for the specified photography and/or video and prints shall be paid for by CQA ENGINEER.

1. Additional photography, prints or videos shall be paid for by party requiring the photos.

PART 2 MATERIALS

2.01 PRINTS

A. Color print requirements shall be as follows:

1. Paper: Single weight, white base.
2. Finish: Smooth surface, glossy.
3. Size: 3-inch by 5-inch

B. Video shall be standard size for VCR playback.

C. Identify each print on the back (or label each video) by listing the following:

1. Project name.
2. Date and time of the photo.
3. Location from which the photo was taken.
4. Description of the photo.

PART 3 EXECUTION

3.01 VIEWS REQUIRED

A. Photograph or videos shall be taken from locations which adequately illustrate each phase throughout the project.

1. Consult with OWNER at each period of the photography/video for instructions concerning required views.
2. Use the same vantage point for progress photos and supply a map showing the locations of the camera for each photo.

3.02 DELIVERY OF PRINTS

A. Deliver negatives and one set of prints and slides or video to OWNER.

* * * END OF SECTION * * *

SECTION 02000
SITE PREPARATION

PART 1 GENERAL

1.01 DESCRIPTION

A. At least 10 working days before construction is to begin, CONTRACTOR shall obtain PROJECT MANAGER's approval for the location of equipment and material staging areas, temporary access, onsite roads, parking, personnel office and sanitary facilities, soil and drain rock stockpile areas, piping and geosynthetics storage areas, construction water storage areas, temporary fences and gates, and all other facilities which shall be required for construction. The proposed locations for these facilities shall be provided on a map of the site at a scale of 1 inch equals 50 feet.

B. The areas selected for temporary facilities shall be located to prevent conflicts with existing infrastructure or other adjacent operations.

C. CONTRACTOR shall prepare the cell area, adjacent graded areas, stockpile area, and staging area as required by the Contract Documents.

D. CONTRACTOR shall locate and protect existing onsite and adjacent public utilities and improvements. Damage caused to existing utilities and improvements shall be repaired by CONTRACTOR at no additional cost to OWNER.

E. CONTRACTOR shall conduct operations and maintain the project site so as to minimize dust creation and dispersion. See Section 02050 for more detail.

F. CONTRACTOR shall recognize that the regulatory authorities regard dust control as a high priority item.

PART 2 MATERIALS

A. Materials and equipment shall be new and of adequate capacity for the required usage and meet the requirements of applicable codes and standards and approval of OWNER.

PART 3 EXECUTION

A. CONTRACTOR shall provide methods, means, and facilities required to prevent contamination of soil, water, atmosphere, uncontaminated structures, equipment or material by discharge of wastes from spills due to CONTRACTOR's operations.

B. CONTRACTOR shall provide equipment and personnel to perform emergency measures required to contain any spillages and to remove spilled materials and soils or liquids that become contaminated due to spillage. Collected spill material shall be properly disposed at no additional cost to OWNER.

* * * END OF SECTION * * *

SECTION 02020
DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall remove or protect all aboveground and belowground structures located in the Contract Documents, and as further determined in the field during construction.

B. Should additional buried utilities be discovered beyond those indicated in the Drawings, CONTRACTOR shall immediately contact ENGINEER for instructions on how to proceed.

PART 2 EXECUTION

2.01 GENERAL

A. CONTRACTOR shall demolish or otherwise remove items that are uncovered during subgrade preparation and trenching.

B. CONTRACTOR shall also protect buried utilities or structures discovered during site Work as directed by ENGINEER.

C. Concrete rubble, concrete slabs and asphalt concrete shall be broken into pieces of appropriate size for disposal as designated by ENGINEER. Typically the sizes should be less than 2 feet by 2 feet by 2 feet.

D. Tin, plaster board, plywood, etc. shall be folded, broken or cut to appropriate size for disposal as designated by ENGINEER.

E. Fences are to be removed from site except where shown on the Drawings to be replaced or protected in place.

2.02 PROTECTION OF UTILITIES

A. Contractor shall locate existing utilities prior to execution of the Work.

B. For each utility line to be retained, CONTRACTOR shall protect the line from damage during all site Work. During excavation, CONTRACTOR shall use extreme care including hand excavation, shoring, padding, and other activities as required to prevent damage.

C. All work shall comply with OSHA, NEC and other relevant safety standards.

D. Backfilling under, around and over protected utility lines shall be performed using equipment and methods which shall not damage the pipes or conduits. Adequate backfill thickness (typically 3 feet at a minimum) must be in place and compacted over each pipe or conduit prior to allowing any vehicular traffic to cross over the alignment.

* * * END OF SECTION * * *

SECTION 02021
WASTE DISPOSAL

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes the disposal of various existing wastes at the site by the CONTRACTOR.

B. Waste includes but is not limited to drummed liquids at the Campbell property, investigation wastes, other identified impacted soils, demolition and construction debris, and construction rubble.

1.02 SUBMITTAL

A. CONTRACTOR shall submit a Waste Disposal Plan to be approved by the ENGINEER and EPA which provides for the characterization of waste, appropriate disposal sites, permitting, and final disposal.

PART 2 MATERIALS

2.01 GENERAL

A. CONTRACTOR shall provide a description of required materials and supplies in the Waste Disposal Plan.

PART 3 EXECUTION

3.01 GENERAL

A. CONTRACTOR shall remove and dispose of drummed liquids, investigation wastes, impacted soils, demolition and construction debris, and construction debris in accordance with all applicable regulations, codes, and ordinances.

B. A Waste Reconsolidation area is provided at the Site for reconsolidation of dry solid waste.

3.02 FEES AND PERMITS

A. CONTRACTOR shall obtain all required permits.

3.03 WASTE DISPOSAL PLAN

A. Prior to the start of work, the CONTRACTOR shall submit to the ENGINEER, a Waste Disposal Plan that at a minimum, addresses the following:
   1. Worker Safety.
   2. Worker qualifications (HAZWOPER).
   3. Protection of the public.
   4. Protection of the environment.
   5. Work sequence and schedule.
   6. Disposal site, procedures and required permits. All CONTRACTOR provided disposal sites shall be subject to approval of the EPA and the ENGINEER.

* * * END OF SECTION * * *

SECTION 02025
BUILDING DEMOLITION AND REMOVALS

PART 1 GENERAL

1.01 DESCRIPTION

A. BUILDING DEMOLITION AND REMOVALS consists of furnishing transportation, labor, materials, equipment, and incidentals necessary to demolish, remove, dispose, and/or salvage existing improvements.

B. Work includes but is not limited to the following:

1. Demolish, remove, and dispose of building, including foundation, asbestos containing material (if present), concrete walk and curb, concrete steps, and appurtenances.
2. Remove, dispose, reuse and/or salvage as indicated on the Drawings: asphalt concrete and concrete paving.
3. Cap and abandon utilities as indicated on the Drawings.

1.02 RELATED WORK

A.	Introduction, Scope of Work and General Requirements	Section 01000
B.	Reference Standards, Definitions and Abbreviations	Section 01010
C.	Dust Control	Section 02050
D.	Structure Fill	Section 02150

1.03 SUBMITTALS

A. Submit demolition procedures and operational sequences to the ENGINEER for review 21 days prior to start of demolition work.

B. Final capping locations shall be in accordance with the Los Angeles County Department of Public Works and shall be submitted to the ENGINEER upon completion of work. Capping locations shall be shown per Project Record Documents Section 01700.

C. Copies of required permits and certifications shall be submitted to the ENGINEER prior to performing work requiring permits and certifications.

1.04 SAFETY AND PROTECTION

A. CONTRACTOR shall verify that the electrical system involved in the demolition work is deenergized. Otherwise, CONTRACTOR shall arrange with the utility company having jurisdiction to deenergize the electrical system prior to proceeding with the work.

B. Exercise care in removing and handling existing structures, equipment, and substructures that may be required to be relocated or reinstalled.

C. Protect buildings and structures on adjacent properties, and other items which are to remain. CONTRACTOR shall repair damages at no cost to the OWNER.

D. Provide, erect, and maintain barriers, barricades, lighting, and guard rails as required to protect general public, workers, and adjoining properties.

E. Protect pipelines, wires, cables, electrical panels, and conduits located above or below ground if such items are to remain. Damage to said items if caused by actions or omissions of CONTRACTOR shall be repaired by the CONTRACTOR.

   1. Pipelines damaged at a joint shall be repaired or replaced at the next joint (beyond the damaged joint).

F. Coordinate with appropriate utility providers to have water service meters, electrical power lines, and electrical power meter devices attached to the buildings removed prior to demolition.

G. Coordinate with appropriate telephone service provider to have telephone lines attached to the buildings removed prior to demolition.

H. Provide and place bracing and shoring to prevent movement or damage to structures and improvements that are to remain. Restore damaged improvements to their original condition at no cost to the OWNER or OWNER of the structure.

I. Cease operation and notify ENGINEER immediately if the work appears to endanger life, facilities, or property. Do not resume operations until safe conditions have been restored.

1.05 SALVAGE

A. No onsite sale of salvage shall be allowed. No removals shall be made from the site by any person other than CONTRACTOR or employees of the CONTRACTOR.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.01 GENERAL

A. Perform work in accordance with applicable Federal, State, County, and City of Santa Fe Springs Building Codes and Regulations. The work shall meet safety standards and requirements including those of CAL/OSHA. The CONTRACTOR shall have at the work site copies of applicable extracts of CAL/OSHA Construction Safety Orders and General Industrial Safety Orders.

B. Demolition work shall not exceed the limits shown on the Drawings. CONTRACTOR shall repair CONTRACTOR damaged items which are not a part of the demolition work to the satisfaction of the ENGINEER.

C. Control dust to meet the South Coast Air Quality Management District regulations.

D. Items not shown on the Drawings or mentioned in the Specifications, which are encountered during the CONTRACTOR'S operations shall be brought to the attention of the ENGINEER. The ENGINEER shall determine the disposition of the items.

E. Obtain permission from the ENGINEER if outriggers, swinging cranes, or other equipment might pass adjacent properties.

F. Should the CONTRACTOR decide to move any large items intact off the site, arrangements for permits, clearances, and utilities are the CONTRACTOR'S responsibility.

G. Remove from site, vermin infested and harmful materials. Dispose of in accordance with applicable regulations so as not to endanger the health of workers, tenants, or the public.

H. Perform demolition under ENGINEER'S inspection. Work shall meet applicable safety standards and requirements.

I. Burning of material on site shall not be permitted.

J. Abandoned utilities shall be capped/plugged as applicable. Record these locations on the Record Drawings per Project Record Documents Section 01700.

K. Cap sewer lines 4 feet below the finished surface.

3.02 OWNERSHIP AND DISPOSAL

A. Materials removed other than those specified and shown on the drawings to remain or salvage, or reuse, shall become the property of the CONTRACTOR and disposed of off site.

3.03 SALVAGE ITEMS

A. Items to be salvaged and/or reused shall be as indicated on the Drawings.

3.04 BACKFILL EXCAVATIONS

A. Areas excavated as a result of removals shall be mechanically backfilled and compacted in accordance with Specification Section 02150. CONTRACTOR shall provide backfill material per Section 02180 at no additional cost to the OWNER.

B. The CONTRACTOR shall notify the ENGINEER 24 hours in advance of when the compacted material shall be ready for testing by the OWNER.

3.05 ABANDONED CONDUITS AND SUBSTRUCTURES

A. Abandoned conduits and substructures encountered or called to be abandoned shall be handled per Specification Section 02020.

B. Capping locations shall be provided to the ENGINEER in the form of a dimensioned drawing per the Project Record Document Specification Section 01700.

C. If abandoned substructures must be removed, the following shall be done before removing or cutting the same:

1. Tap the line and determine if the line contains any king of liquid or gaseous material.
2. If the line is empty or filled with concrete or mud slurry, if may be cut, capped, or plugged, or removed as directed by the ENGINEER.
3. If the line is found to contain a liquid or gaseous material, the material shall be identified, removed, and disposed in accordance with applicable regulations. Such work shall be considered a change of work and payment shall be determined in accordance with the General Requirements.

3.06 BITUMINOUS PAVEMENT REMOVALS

A. Removal of asphalt concrete pavement as shown on the Drawings. Where the removal line shall be a join line, the line shall be saw cut to a 2-inch minimum depth to provide a butt join.

3.07 HIGH VOLTAGE POWER POLES

A. Exercise extreme caution while working around power poles and light poles that are required to remain.

3.08 CONCRETE REMOVALS

A. Removal of concrete as shown on the Drawings. Where the removal line shall be a join line, the line shall be saw cut to a 2-inch minimum depth to provide a butt join.

3.09 LEAD BASE PAINT ABATEMENT (IF ANY)

A. The lead related work must comply with all applicable safety standards and requirements including those to CAL/OSHA Construction Safety Orders and General Industrial Safety Orders, where applicable including but not limited to 29CFR 1926.62.

B. All work must be performed by lead abatement workers who are trained, knowledgeable and qualified in the techniques of cleaning, removal, handling, and disposal of lead contaminated material.

C. The abatement CONTRACTOR shall supply all labor, materials, services, insurance, permits, licenses, the technical lead abatement specifications, and all other contract documents to perform lead abatement work in accordance with applicable federal, state, and local requirements.

D. The abatement CONTRACTOR is required to provide area and personal air monitoring to determine airborne concentrations of lead to which employees may be exposed. Ensure that all analyses of samples are performed in accordance with 29CFR 1910.1025, 29CFR 1926.62 and CCR Title 8 15532.1.

* * * END OF SECTION * * *

SECTION 02030
TEMPORARY STORMWATER RUN-OFF CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. Stormwater run-off control shall be furnished by CONTRACTOR during execution of the Work. The objective of the stormwater control is to prevent sediment run-off from the site.

B. To prevent run-off to adjacent properties and public improvements, CONTRACTOR shall provide diversion ditches, berms and other facilities, as necessary. To prevent sedimentation of run-off from disturbed areas, CONTRACTOR shall provide straw bales, detention basins, or other facilities, as required.

C. Details of CONTRACTOR stormwater run-off control measures shall be provided in a written plan as outlined in Section 01410.

PART 2 MATERIALS

A. The CONTRACTOR shall have available onsite sandbags and other erosion control devices during the rainy season (October 15 to April 15).

PART 3 EXECUTION

A. Upon the indication of rain and as instructed by the PROJECT MANAGER or ENGINEER, CONTRACTOR shall stop activities to allow sufficient time for placement of erosion control devices (e.g., sandbags and straw bales). CONTRACTOR shall have erosion control devices that can be installed and secured within one hour of receipt of instructions from OWNER or ENGINEER.

* * * END OF SECTION * * *

SECTION 02050
DUST CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes dust control procedures to be employed by CONTRACTOR during site Work.

B. Dust control procedures shall be performed by CONTRACTOR in compliance with Health and Safety Plan requirements.

PART 2 MATERIALS

A. CONTRACTOR shall identify the source of water to be used during construction activities.

B. If a water permit is required, a copy of the permit obtained by CONTRACTOR at his cost shall be provided to OWNER. Daily consumption records shall also be provided to PROJECT MANAGER. The cost of the water shall be the responsibility of the CONTRACTOR.

C. Submittals shall be in accordance with Section 01410.

PART 3 EXECUTION

3.01 GENERAL

A. Water shall be applied to areas actively being used by construction equipment. Dust control shall be increased by the CONTRACTOR with instructions from the PROJECT MANAGER if complaints are made by adjacent property representatives or regulatory agencies.

B. CONTRACTOR shall use discretion in the quantity of water used for dust control during soil removal activities. Overwatering may result in difficult working conditions and requirements to clean vehicles and equipment prior to traveling on public access roads.

3.02 MONITORING

A. CONTRACTOR, PROJECT MANAGER, and CQA ENGINEER shall monitor regularly and frequently to observe for visual evidence of dust generation during construction activities. Any visual evidence shall require CONTRACTOR to immediately implement further dust control measures.

* * * END OF SECTION * * *

SECTION 02070
TEMPORARY SITE ACCESS AND ONSITE ROADS

PART 1 GENERAL

1.01 DESCRIPTION

A. Designated temporary site access and onsite roads shall be prepared by CONTRACTOR during construction activities. These temporary site access and onsite roads shall be made available for use by others involved with the closure activities.

B. CONTRACTOR shall prepare site access and onsite roads as shown in the Drawings and as follows.

1. Site access and onsite roads shall be maintained to provide positive drainage, dust control, mud control, and vehicle access. Concrete cracking and other damage at the temporary site access shall be repaired by CONTRACTOR.
2. Onsite roads shall be graded, compacted, filled and otherwise prepared to accommodate equipment to be used on the roads.

PART 2 MATERIALS

A. The onsite roads shall be constructed primarily by compacting existing soils along their routes; where necessary, placement of aggregate base shall be utilized to improve soft areas.

PART 3 EXECUTION

A. Road preparation shall include removal of soft spots as necessary, rough grading, and moisture conditioning.

B. It shall be CONTRACTOR's responsibility to maintain the road and provide dust control as outlined in Section 02050 until completion of the project.

C. The temporary site access road shall be provided with signs by CONTRACTOR indicating restricted use of the road.

D. If, during construction activities, PROJECT COORDINATOR or regulatory agency feels it is necessary to provide additional monitoring of construction traffic, additional flagperson(s) shall be provided by CONTRACTOR at no added cost to OWNER. The CONTRACTOR shall be solely responsible for providing adequate traffic control during and associated with the work to maintain safe working conditions onsite and on local streets around the site.

E. Following the completion of construction activities, the site access shall be cleaned of any residual soil by CONTRACTOR to the extent required by PROJECT COORDINATOR or the regulatory agencies.

* * * END OF SECTION * * *

SECTION 02100
IMPORTED SOIL AND ROCK MATERIALS

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall supply the imported soil and drain rock materials required for the Work. These include, but are not limited to:

1. Structural fill - soil to be used to achieve the required foundation grade.
2. Drain rock/bedding gravel.
3. Vegetative soil layer.
4. Aggregate base.
5. No. 2/12 Grade sand.

B. CONTRACTOR shall locate suitable sources for these materials, and provide PROJECT COORDINATOR and ENGINEER with information describing the sources and the result of independent tests including chemical characterization (as described in Part 2) demonstrating suitability of the materials at least 10 days prior to the material being required for construction. Sources should be appropriately permitted to supply the material. The PROJECT COORDINATOR reserves the right to reject any and all materials.

PART 2 MATERIALS

2.01 STRUCTURAL FILL

A. Structural fill material shall meet the following specifications:

1. USCS classification CL, ML, SC, SM, GC or GM.
2. Maximum particle size of 2 inches.
3. Between 12 and 70 passing No. 200 sieve.
4. Plasticity index ≤ 15.

B. Structural fill shall be soils free of organics, roots, wood, peat, cinders, deleterious matter or other rubbish.

C. Structural fill shall be free of chemical contaminants including Title 22 metals (below background levels), petroleum hydrocarbons, benzene, toluene, xylene, ethyl benzene, poly-chlorinated biphenyls, pesticides, herbicides, and chlorinated volatile organic compounds.

2.02 DRAIN ROCK/BEDDING GRAVEL

A. Drain rock/bedding gravel shall consist of subangular-to-rounded washed gravel meeting the following gradation requirements.

U.S. Standard Sieve	Percent Passing
1-1/2 inch	100
1 inch	90-100
3/4 inch	55-85
3/8 inch	8-20
No. 4	0-5
No. 8	0-5
No. 200	0-2

2.03 SAND BEDDING

A. Bedding material shall be fine sand meeting the following grain size requirements:

U.S. Standard Sieve	Percent Passing
3/8 inch	100
No. 4	95-100
No. 8	75-90
No. 16	55-75
No. 30	30-50
No. 50	10-25
No. 100	2-10
No. 200	0-10

B. Bedding material shall be free of nonsoil material including broken concrete, broken pavement, wood, organic material, refuse or other deleterious material.

2.04 SELECT BACKFILL

B. Storm drain backfill around and above the pipe shall be select backfill material meeting the following grain size requirements:

U.S. Standard Sieve	Percent Passing
1-1/2 inch	100
1 inch	90-100
3/4 inch	55-85
3/8 inch	8-20
No. 4	0-5
No. 8	0-5
No. 200	0-2

2.05 VEGETATIVE SOIL LAYER

A. Material shall be classified as CL, ML, SC, or SM with no particle larger than 2 inches in the largest dimension.

B. The soil should be capable of supporting growth of the landscaping as specified in Section 02600.

C. Vegetation soil layer material shall be free of chemical contaminants including Title 22 metals (below background levels), petroleum hydrocarbons, benzene, toluene, xylene, ethyl benzene, poly-chlorinated biphenyls, pesticides, herbicides, and chlorinated volatile organic compounds.

D. If required by PROJECT COORDINATOR or ENGINEER, CONTRACTOR shall supply necessary test results demonstrating that soil shall support a healthy vegetative growth.

* * * END OF SECTION * * *

SECTION 02110
TEMPORARY STOCKPILES

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall use the temporary stockpile for excavated soils and imported materials to be utilized in the cover soil layer and other closure components.

PART 2 MATERIALS

A. Temporary stockpiles shall be used to store excess excavated soil and imported material.

PART 3 EXECUTION

A. CONTRACTOR shall place excavated soil and imported material in temporary stockpiles as approved by PROJECT COORDINATOR.

B. CONTRACTOR shall grade the temporary stockpiles to drain and not construct slopes steeper than 3 horizontal to 1 vertical.

* * * END OF SECTION * * *

SECTION 02130
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Subgrade preparation (foundation layer) consists of excavating, filling, moisture conditioning and compacting areas of the site as shown in the Drawings.

1.02 QUALITY CONTROL

A. The CQA ENGINEER shall observe subgrade preparation by CONTRACTOR to verify removal of rubbish, vegetation, lumber or wood, root matter or other deleterious material and proof-rolling. During proof-rolling, the CQA ENGINEER shall carefully observe for excessive deformations indicating soft spots and request that CONTRACTOR repair the soft spot.

B. Structural fill shall be compacted by the CONTRACTOR and observed by the CQA ENGINEER per requirements in Section 02150.

C. Following preparation of subgrade the area shall be protected by the CONTRACTOR. Any areas that are subsequently damaged shall be restored to conditions required in the Drawings and Specifications prior to placement of overlying materials.

PART 2 MATERIALS

A. The subgrade shall consist of native soils from the site area and imported soil per requirements in Section 02150.

B. Native subgrade material shall be free of waste, vegetation, lumber or wood, root matter or other deleterious material.

C. Existing rocks or construction demolition material (e.g., concrete or asphalt) exceeding 3 inches in size shall be removed and stockpiled at a location approved by PROJECT COORDINATOR.

PART 3 EXECUTION

A. CONTRACTOR shall prepare the subgrade by removing the vegetation and any other deleterious material. Existing topsoil shall be removed and stockpiled at a location approved by PROJECT COORDINATOR for later use for the vegetative soil layer.

B. The entire subgrade area shall be proof-rolled with a compactor a minimum of two to three perpendicular passes to achieve an 85 percent relative maximum density. Soft areas, if any, shall be excavated and backfilled with structural fill (per requirements in Section 02150).

C. Final surfaces shall be graded to the elevations shown in the Drawings with a tolerance of ±0.1 feet. Areas where final grades are achieved using structural fill shall be proof-rolled.

D. Excavated soil shall be stockpiled for future use at a location designated by the PROJECT COORDINATOR.

E. Excavated soil will be monitored for volatile organics using an OVA calibrated for methane. One test per 500 cubic yards shall be taken by measuring the concentration of vapors 10 centimeters above the surface. Soils measured in excess of 50 ppm may not be used for cover soils and shall be disposed as required by these Specifications.

F. Final surfaces shall be free of loose material, clods, and other debris including grade stakes and hubs.

G. The construction site shall be graded to be free-draining. In the event of rainfall, CONTRACTOR shall remove ponded water from the construction area and condition and compact any disturbed soil to suit structural fill requirements (in Section 02150).

H. Excavated material not suitable for backfilling or site grading and other unsuitable materials shall be placed in designated spoil areas and graded to drain. Location of designated spoil areas are to be designated by PROJECT COORDINATOR.

I. Excavated soils shall be tested every 500 cubic yards prior to excavation with a pocket penetrometer. Soils measured for bearing capacity of less than 0.5 tons per square foot shall be considered unsuitable for backfilling or site grading.

* * * END OF SECTION * * *

SECTION 02150
STRUCTURAL FILL

PART 1 GENERAL

1.01 DESCRIPTION

A. Structural fill includes all earthwork required to increase the elevation of any site areas to elevations shown in the Drawings.

1.02 QUALITY CONTROL

A. Structural fill density and moisture content requirements for each soil type used shall be determined based on five-point Proctor tests (ASTM D1557) performed by the CQA ENGINEER. In-place density tests of compacted structural fill shall be conducted by the CQA ENGINEER at the rate of one per 120 cubic yards or each lift of material placed per requirements in Part 3 of this section. The CQA ENGINEER may make exceptions to the test frequency requirement for small fill areas, based on observations of material behavior under operating equipment.

B. Structural fill shall meet maximum particle size, USCS classification, plasticity, percentage passing No. 200 sieve, and maximum particle size requirements specified in Section 02100.

PART 2 MATERIALS

A. Structural fill shall consist of soil from borrow sources/areas preselected by CONTRACTOR and approved by CQA ENGINEER and PROJECT COORDINATOR. The soil shall be free of wood, organic material, refuse or other deleterious material. The largest size rock particle in structural fill soil shall be 2 inches in its maximum dimension.

PART 3 EXECUTION

A. Structural fill materials shall be placed in a maximum uncompacted lift thickness of 8 inches and compacted to 90 percent of maximum dry density as determined by ASTM D1557 and with a moisture content within ± 2 percent of optimum.

B. Final surfaces shall be graded to lines and elevations shown in the Drawings with a tolerance of 0.1 foot.

C. Material not meeting the specified density as determined by the CQA ENGINEER shall be additionally compacted to meet the Specifications, or removed. Material not within the specified moisture content range shall be scarified, moisture conditioned, and recompacted or removed.

* * * END OF SECTION * * *

SECTION 02170
BROW DITCH

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall grade and compact a brow ditch at the top of slope adjacent to the recreation field at the northeast corner of the site.

PART 2 MATERIALS

A. CONTRACTOR shall grade brow ditch into native soil material.

PART 3 EXECUTION

A. CONTRACTOR shall construct brow ditch at top of the slope adjacent to the recreation field. The brow ditch shall be compacted to a minimum 85 percent of maximum dry density (ASTM D1557) and sloped to drain toward the proposed catch basin as shown in the Drawings.

* * * END OF SECTION * * *

SECTION 02180
TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes methods and equipment used to excavate, backfill, and compact reservoir cap drainage trenches, trenches for storm drain piping, and gas collection pipe trenches.

B. Trenches shall be filled with materials as indicated in the Drawings. Reservoir cap drainage trenches shall receive drain rock. The 16-inch-diameter PVC storm drain trench backfill shall consist of fine sand bedding, select backfill around and covering the pipe followed by native soil backfill. The gas collection pipe trench shall receive bedding gravel.

1.02 QUALITY CONTROL

A. Monitoring shall be provided by CQA ENGINEER to verify construction meets the requirements of the Drawings and Specifications.

B. Requirements for trenching tolerances are as follows:

1. CONTRACTOR shall excavate so that HDPE geomembrane and pipes can be laid straight at uniform grade, without sags or humps, between the elevations shown in the Drawings.
2. Clearance to other pipes and regulated boundaries shall be checked by CQA ENGINEER. If clearances are found to be inadequate, CONTRACTOR shall backfill trenches to compaction specifications and recut the trenches at no additional cost to OWNER.

C. CONTRACTOR shall, upon request, submit the name and address of imported materials suppliers and use materials from that source throughout the work. Change of source requires ENGINEER'S approval.

D. CONTRACTOR shall submit samples and grain size analyses of sand bedding, select backfill, and drain rock material to the CQA ENGINEER for approval of the materials ten days in advance of backfilling.

E. The CQA ENGINEER shall observe all prepared excavations for evidence of soft spots, uneven bottom, clumps, improper grade, etc. and CONTRACTOR shall be required at his expense to correct any deficiencies prior to placement of pipe or backfill.

F. Backfill placement procedures shall be observed by the CQA ENGINEER and moisture content and compaction tests performed (except for drain rock backfill which does not require compaction) to verify material placement in accordance with the Specifications.

1.03 JOB CONDITIONS

A. CONTRACTOR shall perform trench excavations and backfill operations in a manner so as not to damage adjacent synthetic materials or in-place pipes. CONTRACTOR shall repair or replace materials damaged during backfilling operations at no additional cost to OWNER.

PART 2 MATERIALS

2.01 BEDDING

A. Sand bedding material shall be sand meeting the grain size requirements:

U.S. Standard Sieve	Percent Passing
3/8 inch	100
No. 4	95-100
No. 8	75-90
No. 16	55-75
No. 30	30-50
No. 50	10-25
No. 100	2-10
No. 200	0-10

B. Bedding material shall be free of nonsoil material including broken concrete, broken pavement, wood, organic material, refuse or other deleterious material.

2.02 BACKFILL

A. Drain rock/bedding gravel backfill shall meet the grain size requirements:

U.S. Standard Sieve	Percent Passing
1-1/2 inch	100
1 inch	90-100
3/4 inch	55-85
3/8 inch	8-20
No. 4	0-5
No. 8	0-5
No. 200	0-2

B. Storm drain backfill around and above the pipe shall be select backfill material meeting the following grain size requirements:

U.S. Standard Sieve	Percent Passing
1-1/2 inch	100
1 inch	90-100
3/4 inch	55-85
3/8 inch	8-20
No. 4	0-5
No. 8	0-5
No. 200	0-2

C. Soil excavated from the trench which is free of deleterious material (e.g. broken concrete, wood, organic material) may be used for backfill above the select material as approved by the CQA ENGINEER.

PART 3 EXECUTION

3.01 INSPECTION

A. Trenches shall be examined by CONTRACTOR and CQA ENGINEER to determine existence of areas loosened by excavation, softened by flooding or weather, or of unsuitable materials.

3.02 PREPARATION

A. CONTRACTOR shall remove and replace or compact soils softened by flooding or weather as required by CQA ENGINEER.

B. CONTRACTOR shall remove unsuitable material (e.g. broken concrete, asphalt, wood, organic material, refuse or other deleterious material) from within trenches.

C. Dewatering requirements are as follows:
   1. Construction site shall be free-draining.
   2. Excavations shall be free from standing water.
   3. Adjacent properties shall be protected from damage resulting from dewatering operations.

3.03 EXCAVATION

A. Excavation shall be undertaken to elevations and dimensions necessary to complete construction as shown in the Drawings.

B. Excavations shall not be made until subsequent construction steps are scheduled.

C. Upon completion of excavation, CQA ENGINEER shall be notified before proceeding with further Work.

3.04 PLACING FILL

A. CQA ENGINEER shall be notified before placing fill material.

B. Fill shall not be placed in standing water.

C. Drain rock shall be placed in pipe trenches so as not to damage the pipe or underlying geosynthetics.

D. Where designated, geotextile shall be sized and placed in the trench with the remaining portion extending beyond the trench; the pipe shall be placed; backfill shall be placed; and geotextile shall be wrapped over the top of the backfill with a minimum overlap, as shown in the Drawings.

E. Storm drain trench backfill (i.e., onsite excavated soils) shall be placed at optimum ±2 percent moisture content and compacted to a minimum of 90 percent of maximum dry density as determined by ASTM D1557-78.

F. The storm drain trench width shall be at least 12 inches wider than the pipe. The trench shall be over excavated vertically 4 to 6 inches and backfilled with clean sand compacted to a minimum 90 percent of maximum dry density per ASTM D1557-78 for the pipe bedding. After pipe placement the select backfill shall be placed in 6-inch layers and extend to 12 inches above the top of the pipe. This material shall be placed at optimum ±2 percent moisture content and compacted to a minimum of 90 percent of maximum dry density per ASTM D1557. The final backfill shall be excavated soils free of unsuitable material, compacted to a minimum of 90 percent of maximum dry density determined in accordance with ASTM D1557-78.

* * * END OF SECTION * * *

SECTION 02200
HDPE GEOMEMBRANE LAYER

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes materials, testing, installation procedures and documentation requirements for placement of the HDPE geomembrane layer portion of the reservoir area cap.

1.02 QUALITY CONTROL

A. QC for geomembranes consists of the following types of activities which are described in Part 3, Execution:

1. Manufacturers' certifications that materials satisfy the standard ASTM properties and Specifications.
2. "As Received" material conformance tests.
3. Implementation and testing of periodic trial seams to assure seaming equipment is performing adequately.
4. Nondestructive field seam testing.
5. Destructive testing of seam samples.
6. Field inspections for defects, including related repairs.

B. Placement of materials over the geomembrane layer shall be done in such a manner that geomembrane damage is unlikely.

C. The following ASTM Reference Standards shall be used for HDPE geomembrane materials, as appropriate:

1. ASTM D1593 - Thickness.
2. ASTM D1505 or D792 - Density.
3. ASTM D1238E - Melt Flow Index.
4. ASTM D638, Die C - Tensile Properties.
5. ASTM D1004, Type IV Modified - Tear Strength.
6. ASTM D4833 - Puncture Resistance.
7. ASTM D746, Procedure B - Low Temperature Brittleness.
8. ASTM D1603 - Carbon Black Content.
9. ASTM D3015 - Carbon Black Dispersion.
10. ASTM D1204, 212°F 1 hour - Dimensional Stability.
11. ASTM D1693, 10% Igepal, 50°C - Environmental Stress Crack.

D. The following ASTM Reference Standards shall be used for destructive field testing of geomembrane seams:

1. ASTM D4437 - Shear Extrusion.
2. ASTM D4437 - Shear Fusion.
3. ASTM D4437 - Peel Extrusion.
4. ASTM D4437 - Peel Fusion.
5. ASTM D4437 - Shear Strength (film tear bond).

1.03 SUBMITTALS

A. No later than 15 days prior to the installation of geomembrane materials, CONTRACTOR shall submit a Geomembrane Placement Plan (per Section 01410) providing the following information:

1. Résumé of the Superintendent to be assigned to this project, including dates and durations for similar work.
2. A panel layout drawing showing the installation layout, identifying field seams and any deviations from the Drawings. Each layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

B. Installation shall not begin for any material until the respective Panel Layout Plan is approved by the ENGINEER.

PART 2 MATERIALS

A. The HDPE geomembrane shall be 60-mil HDPE, or equivalent material approved by the ENGINEER.

PART 3 EXECUTION

3.01 MATERIAL QUALITY CONTROL DOCUMENTATION

A. Geomembrane Materials:

1. MANUFACTURER'S Certification

a. The MANUFACTURER of each geosynthetic material shall provide ENGINEER with the following information:

- The resin supplier's name and production plant.
- Production dates of the resin.
- Quality test reports which verify adequacy of the resin.
- A list of the materials which comprise the geomembrane, expressed as a percent by weight of polyethylene, carbon black, other additives.
- A specification for the geomembrane which includes all properties associated with the ASTM Reference Standards stated in Section 1.02 C, including a written certification that minimum values given in Table 02200-1 are guaranteed by the MANUFACTURER, including signed QC certificates.

b. CQA ENGINEER shall document that all of the geomembrane material received is appropriately certified by the MANUFACTURER, prior to its installation.

2. Conformance Testing

a. Upon delivery the ENGINEER shall obtain conformance test samples from the geomembrane. The samples shall be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples shall be submitted to an appropriate laboratory for testing to assure conformance to the Specifications in Table 02200-1 for the following characteristics:

- Thickness.
- Density.
- Melt flow index.
- Tensile properties.
- Tear strength.
- Puncture resistance.
- Low temperature brittleness.
- Carbon black content.
- Carbon black dispersion.
- Dimensional stability.
- Environmental stress crack.

b. If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected, unless, as approved by the CQA ENGINEER, the MANUFACTURER conducts tests on samples from the two rolls with numbers immediately adjacent to the roll with the failed sample. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected.

3.02 INSTALLATION

A. Geomembrane Materials

1. Panel Nomenclature

   a. Each geomembrane field panel shall be given an identification number consistent with the layout plan provided by the material supplier or site construction personnel. The field panel identification code shall be used for all quality assurance records. The CQA ENGINEER shall verify that geomembrane field panels are installed at the locations indicated on the layout plan.

2. Installation Weather Conditions

   a. Geomembrane deployment shall not proceed at an ambient temperature below 32° F (0° C) or above 104° F (40° C). Geomembrane placement shall not be performed during inclement weather conditions, and especially in the presence of high winds, which shall preclude immediate material seaming.

3. Installation Procedures

   a. CQA ENGINEER shall verify that geomembrane handling equipment to be used shall not cause damage to the material. During handling, CQA ENGINEER shall verify that the handling procedures are being accomplished without damage.

   b. CQA ENGINEER shall verify the following:

      - The prepared surface underlying the geomembrane has not deteriorated since its previous acceptance.
      - Installation and CQA personnel do not smoke or wear damaging shoes while working on the geomembrane.
      - Unrolling procedures do not cause excessive scratches or crimps in the geomembrane.
      - The installation procedures do not cause excessive wrinkles in individual or adjacent panels.
      - Adequate temporary loading (e.g., sand bags) has been placed to prevent wind uplift.

4. Damage Inspection

   a. CQA ENGINEER shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Damaged portions of panels shall be removed and replaced using procedures described in Section 3.02 A.6.h.

5. Writing on the Geomembrane

   a. To avoid confusion, the Installer and CQA ENGINEER shall use different colored markers for writing on the geomembrane which shall not cause damage. The Installer and CQA ENGINEER shall use white and yellow markers, respectively.

6. Field Seaming Methods

a. Extrusion Seaming Process

1. CQA ENGINEER shall verify that:

- Exposed grinding marks adjacent to an extrusion weld shall not extend more than 0.25 inch from the seamed area.
- The geomembrane panels shall be aligned to have a nominal overlap of 3 inches for extrusion welding, unless approved otherwise by CQA ENGINEER. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
- No solvent or adhesive shall be used unless the product is approved by CQA ENGINEER
- Any procedure used to temporarily bond adjacent panels shall not damage the geomembrane (e.g., the temperature of hot air at the nozzle of any temporary welding apparatus shall not be located where it could damage or degrade the geomembrane).
- Seaming equipment, including the electric generator shall not damage the geomembrane.
- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.
- Prior to beginning a seam, the extruder barrel is purged until all heat-degraded extrudate has been removed.
- Clean and dry welding rods or extrudate pellets are used.
- Grinding shall be completed no more than one hour prior to seaming.

b. Fusion Seaming Process

1. CQA ENGINEER shall verify that:

- A movable protective layer is used directly below each geomembrane overlap to be seamed to prevent moisture buildup between sheets and debris buildup around the pressure rollers.
- The geomembrane panels shall be aligned to have a nominal overlap of 5 inches for fusion welding unless approved otherwise by CQA ENGINEER. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
- No solvent or adhesive shall be used unless the product is approved by CQA ENGINEER.
- Equipment, including the electric generator, used for seaming shall not damage the geomembrane.
- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

- The edges of cross seams are ground to an incline prior to welding.

c. Seam Preparation

1. All seam areas shall be clean and free of moisture, dust, dirt, debris or foreign material of any kind.
2. All seam overlap grinding shall be completed according to the MANUFACTURER'S instructions within one hour of the seaming operation.
3. Seams shall be aligned to minimize wrinkles and "fishmouths."

d. Trial Seams

1. Trial seams shall be made on geomembrane fragments at the beginning of each seaming period, and at least once each five hours, to verify that conditions are adequate for production seaming.
2. Each trial seam sample shall be at least 36 inches by 12 inches wide, with the seam centered lengthwise.
3. Peel tests shall be conducted on two specimens cut at random locations from the sample with a 1 inch-wide die using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of 2 inches per minute. If a specimen fails (Section 3.02 A.6), the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved.

e. Weather Condition Considerations

1. Unless approved by CQA ENGINEER, required seaming weather conditions are:
   - Ambient temperature between 0° C (32° F) and 40° C (104° F).
   - No precipitation.
   - No high winds.
2. No seaming of the geomembrane shall occur at ambient temperatures above 40° C (104° F) unless CQA ENGINEER verifies that geomembrane seam quality shall not be compromised. To accomplish this verification, trial seaming (Section 3.02 A.6.d) shall be conducted at the same ambient temperature.
3. CONTRACTOR shall provide for methods to protect the placed materials from wind damage prior to covering.

f. Nondestructive Seam Testing

1. General

a. To check the continuity of seams, nondestructively testing shall be performed on the full length of all field seams using a vacuum test unit, air pressure test (for double fusion seams only), or other method approved by CQA ENGINEER. Nondestructive testing shall be carried out as the seaming work progresses.

b. Any seams that cannot be nondestructively tested shall be cap-stripped with the same geomembrane material.

2. Vacuum Testing

a. Vacuum testing equipment shall consist of the following:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft bottom neoprene gasket, a porthole or valve assembly, and a vacuum gauge.
- A pump assembly, including a pressure controller.
- A rubber hose, with fittings and connections.
- A soapy solution, including an applicator brush.

b. The vacuum testing procedures shall consist of the following:

- Energizing the vacuum pump and reducing the tank pressure to approximately 5 psi on the gauge.
- Applying a strip of the soapy solution on the geomembrane approximately 12 inches by 48 inches.
- Placing the box over the area wetted with the soapy solution.
- Closing the bleed valve and opening the vacuum valve.
- Assuring that a leak-tight seal is created.
- Applying the vacuum and examining the geomembrane through the viewing window for the presence of soap bubbles, for a period of not less than 10 seconds.
- If no bubbles appear after 10 seconds, the vacuum and bleed valves shall be opened and the box shall be moved to the adjoining area with a minimum 3-inch overlap.
- All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.02 A.6.h.

3. Air Pressure Testing

a. Air pressure testing equipment shall consist of the following:

- An air pump, equipped with pressure gauge capable of sustaining between 25 and 30 psi.
- A rubber hose with fittings and connections.
- An approved pressure feed device, such as a sharp hollow needle.

b. The air pressure test procedures shall consist of the following:

- Both ends of the seams to be tested shall be sealed.
- An approved pressure feed device (e.g., needle) shall be inserted into the channel created by the fusion weld.
- A protective cushion shall be inserted between the air pump and the geomembrane.
- Pressurize the air pump to between 25 and 30 psi, close the valve, allow two minutes for the pressure to stabilize, and then assure that the pressure is sustained for at least 5 minutes.
- If loss of pressure exceeds 4 psi or does not stabilize within the 5-minute test, repairs to the faulty area shall commence in accordance with Section 3.02 A.6.h.
- Cut the opposite end of the tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate the blockage and retest the unpressurized area.
- Remove the pressure feed device and seal the openings.

4. Test Failure Procedures

a. All required repairs shall be completed in accordance with Section 3.02 A.6.h. At each repair area, CQA ENGINEER shall:

- Observe the repair and retesting.
- Mark on the geomembrane that the repair has been made.
- Document the repair procedures and test results.

g. Destructive Seam Testing

1. Location and Frequency

a. CQA ENGINEER shall select seam locations for cutting out samples for laboratory testing. Those locations shall be established based on the following criteria:

- A minimum of one test per 650 feet of seam length performed by each welder, determined as an average taken throughout the construction area.
- At areas prompted by suspicion of overheating, contamination, offset welds, or any other potential cause of imperfect welding.

2. Sampling Procedures

   a. Samples shall be removed and tested so that laboratory test results are available before the geomembrane is covered by another material. CQA ENGINEER shall:

      - Record reason for taking the sample at this location.
      - Assign a number to each sample, and mark it accordingly.
      - Record sample location on layout drawing.

   b. All holes resulting from sampling shall be repaired immediately in accordance with Section 3.02 A.6.h. New seams in the repaired area shall be tested according to Section 3.02 A.6.

3. Sample Dimensions

   a. Two samples for field testing should be taken at each sampling location. Each shall be cut with a 1-inch-wide die centered above the seam. The distance between these two samples shall be 42 inches. If both samples pass the field test described in Section 3.02 A.6.g. a sample for laboratory testing shall be taken.

   b. The laboratory testing sample shall be located between the field testing samples and shall be 12 inches wide by 42 inches long, centered on the seam. The sample shall be cut into three parts and distributed as follows:

      - One 12-inch by 12-inch portion to the Installer for optional laboratory testing.
      - One 12-inch by 18-inch portion for CQA ENGINEER testing.
      - One 12-inch by 12-inch portion for archive storage.

4. Field Testing Procedures

   a. The two 1-inch field testing samples shall be tested using a tensiometer capable of maintaining a constant jaw separation rate of 2 inches per minute for peel, based on the criteria in Table 02200-2.

   b. If the field test passes, CQA ENGINEER's laboratory sample qualifies for testing. If the field test fails, the seam shall be repaired in accordance with Section 3.02 A.6.h.

5. Laboratory Testing Procedures

   a. Laboratory testing shall include "Seam Strength" and "Peel Adhesion." Minimum acceptable values are those shown in Table 02200-2. At least five specimens shall be tested, alternating between peel and shear methods. In order to pass, a test shall meet the minimum acceptable values in at least four of the five specimens tested for each method.

6. Procedures for Failed Test

   a. Either of the following two procedures may be followed at locations of failed destructive tests at the discretion of CQA ENGINEER:

      - The seam may be repaired between any two passing test locations.
      - The welding path may be traced to an intermediate location and a sample may be taken with a 1-inch-wide die for additional field tests. If these additional field tests pass, then additional full laboratory samples shall be taken. If these samples pass, the seam shall be repaired between that location and the next passing test location. If either sample fails, then the process shall be repeated to eventually establish the appropriate repair zone.

   b. All acceptable repaired seams shall be bounded by locations with passing laboratory destructive tests.

   c. If any repaired seam exceeds 130 feet in length, that zone shall be retested using the same destructive testing procedures.

h. Defects and Repairs

   1. All seams and nonseam areas of the geomembrane shall be examined by CQA ENGINEER for identification of defects, holes, blisters, and any sign of defective material. The geomembrane surface shall be clean at the time of examination.

   2. Any area which appears to be damaged or defective shall be tested using the nondestructive procedures described in Section 3.02 A.6.f, as determined to be appropriate by CQA ENGINEER. Each location which fails the nondestructive testing shall be repaired.

   3. The type of repair shall be specified by CQA ENGINEER, using one of the following procedures:

      - Patching for large holes or areas of defective materials.
      - Spot welding or seaming for small holes or localized flaws.
      - Capping for large lengths of failed seams.
      - Extrusion welding for areas with failed fusion seams, which have an exposed edge.
      - Seam removal and replacement.

   4. Any repair activity must satisfy the following provisions:

      - All repaired surfaces shall be clean and dry.
      - Surfaces to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
      - All repairs shall extend at least 6 inches beyond the edge of any defect, unless otherwise approved by CQA ENGINEER.

TABLE 02200-1

FML PROPERTY SPECIFICATION

PROPERTY	UNIT	TEST METHOD	SPECIFIED VALUE FOR 60-MIL HDPE(1)
Thickness		ASTM D1593	
• Minimum Average	mil		60
• Minimum	mil		54
Density	g/cc	ASTM D1505 or D792	0.94
Melt Flow Index	g/10 min	ASTM D1238E	<0.3
Tensile Properties		ASTM D638 Type IV Modified	
• Yield Strength	lb/in		130
• Break Strength	lb/in		288
• Elongation at Yield	%		12
• Elongation at Break	%		560
Tear Strength	lb	ASTM D1004 Die C	42
Puncture Resistance	lb	ASTM D4833	80
Low Temperature Brittleness	° F	ASTM D746 Procedure B	-60
Carbon Black Content	%	ASTM D1603	2.0 to 3.0
Carbon Black Dispersion	N/A	ASTM D3015	A-1, A-2, B-1
Dimensional Stability	% Change	ASTM D1204 212° F 1 hour	± 2
Environmental Stress Crack	Minutes	ASTM D1693 10% Igepal, 50° C	1,500

30747-4000/Fi(100%)/SPECS (3/19/03/rw)

(1) Values are minimum acceptable unless specified otherwise.

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TABLE 02200-2

FML SEAM PROPERTY SPECIFICATION

PROPERTY	TEST METHOD	UNIT	QUALIFIER	SPECIFIED VALUE(1) FOR 60-MIL HDPE
Shear Extrusion	ASTM D4437 NSF Modified	lb/in	Minimum	126
Shear Fusion	ASTM D4437 NSF Modified	lb/in	Minimum	126
Peel Extrusion	ASTM D4437 NSF Modified	lb/in	Minimum	70
Peel Fusion	ASTM D4437 NSF Modified	lb/in	Minimum	98
Shear Strength (film tearbond)	ASTM D4437 NSF Modified	lb/in	Minimum	120

30747-4000/Fi(100%)/SPECS (3/19/03/rw)

(1) Based on NSF 54 Standards.

* * * END OF SECTION * * *

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SECTION 02210
FILTER AND CUSHION GEOTEXTILES

PART 1 GENERAL

1.01 DESCRIPTION

A. The Work includes:

1. Installation of 8-oz. filter geotextile wrap in the drainage trenches for the reservoir cap.
2. Installation of 16-oz. cushion geotextile between the GCL and the vegetative soil layer in the engineered soil cover areas.

1.02 QUALITY CONTROL

A. QC for geotextiles consists of the following types of activities which are described in Part 3, Execution:

1. MANUFACTURERS' certifications that materials satisfy the standard ASTM properties and Specifications.
2. "As Received" material conformance tests.
3. Field inspections for defects, including related repairs.

B. The following ASTM Reference Standards shall be used for geotextile materials:

1. ASTM D3776 - Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
2. ASTM D1777 - Standard Test Method for Thickness of Textile Materials.
3. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
4. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
5. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
6. ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragms Bursting Strength Test Method.
7. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
8. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

1.03 SUBMITTALS

A. No later than 15 days prior to the installation of geotextile materials, CONTRACTOR shall submit a Geotextiles Placement Plan providing the following information:

   1. Résumé of the Superintendent to be assigned to this project, including dates and durations for similar work.
   2. A panel layout drawing showing the installation layout and any deviations from the Drawings. Each layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

B. Installation shall not begin for any material until the respective Placement Plan is approved by ENGINEER.

PART 2 MATERIALS

A. Filter geotextile shall be an 8 oz. per square yard polypropylene geotextile material approved by ENGINEER.

B. Cushion geotextile shall be a 16 oz. per square yard material approved by ENGINEER.

PART 3 EXECUTION

3.01 MATERIAL QUALITY CONTROL DOCUMENTATION

A. Geotextiles:

   1. MANUFACTURER'S Certification
      a. The MANUFACTURER of each geotextile material shall provide CQA ENGINEER with the following information:
         - The resin supplier's name and production plant.
         - Production dates of the resin.
         - Quality test reports which verify adequacy of the resin.
         - A list of the materials which comprise the geotextile, expressed as percent by weight of base polymer, carbon black, other additives.

- A specification for the geotextile which includes all properties associated with the ASTM specifications stated in Section 1.02 B, including written certification that minimum values given in Table 02210-1 are guaranteed by the MANUFACTURER, including signed QC certificates.

b. The CQA ENGINEER shall document that all of the geotextile material received is appropriately certified by the MANUFACTURER, prior to its installation.

2. Conformance Testing

a. Upon delivery, CQA ENGINEER shall obtain conformance test samples from the geotextile. The samples shall be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples shall be submitted to an appropriate laboratory for testing to assure conformance to the specifications in Table 02210-1 for the following characteristics:

- Fabric weight.
- Thickness.
- Grab strength.
- Grab elongation.
- Trapezoidal tear strength.
- Puncture resistance.
- Mullen burst strength.
- Water flow rate.
- Permittivity.
- Permeability.
- Apparent opening size.
- UV Resistance

b. If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected unless, as approved by the CQA ENGINEER, the MANUFACTURER conducts tests from samples from the two rolls with numbers immediately adjacent to the roll with the failed sample. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected.

3.02 INSTALLATION

A. Geotextile Materials

1. Handling and Installation

a. Prior to installation, geotextile materials shall always be protected from ultraviolet light exposure by using relatively opaque and watertight wrappings and covers.

b. All geotextiles shall be handled to prevent damage, considering the following types of activities:

- The geotextiles shall be secured and rolled into place in such a manner which continually keeps the sheet in tension.
- All geotextiles shall be weighted with sandbags (or the equivalent) during deployment in a manner which prevents wind damage. The weights shall remain in place until the geotextile is covered.
- The geotextile installation should be conducted using procedures which prevent damage to underlying materials, including the prevention of trapping of rock particles.

2. Seaming Procedures

a. All geotextiles on slopes steeper than 10:1 (horizontal to vertical) shall be continuously sewn. All geotextiles shall have a minimum overlap of 3 inches. No horizontal seams shall be located on side slopes except as part of a patch.

b. On flatter areas, geotextiles shall be either sewn or thermally bonded.

c. All sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile.

3. Defects and Repairs

a. All holes or tears in the geotextile shall be repaired as follows:

- On slopes greater than 10:1, a patch made from the same geotextile shall be sewn into place.
- On flatter areas, a patch made from the same geotextile shall be sewn or thermally bonded into place.

TABLE 02210-1

GEOTEXTILE PROPERTY SPECIFICATION

FABRIC PROPERTY	UNIT	TEST METHOD	SPECIFIED VALUES (8 oz. filter)	SPECIFIED VALUES (16 oz. cushion)
Fabric Weight	oz/yd^2	ASTM D3776	>7.5	>16
Thickness	mil	ASTM D1777	>110	>160
Grab Strength	lb	ASTM D4632	>210	>400
Grab Elongation	%	ASTM D4632	>50	>60
Trapezoidal Tear Strength	lb	ASTM D4533	>75	>150
Puncture Resistance	lb	ASTM D4833	>100	>240
Burst Strength	psi	ASTM D3786	>380	>750
Water Flow Rate	gpm/ft^2	ASTM D4491	>100	>50
Permittivity (Y)	sec^{-1}	ASTM D4491	>1.25	>0.7
Permeability (k = Yt)	cm/sec	ASTM D4491	>0.35	>0.20
Apparent Opening Size	Sieve Size (mm)	ASTM D4751	70 (0.210) - 100 (0.150)	100 (0.150)
UV Resistance	% (Retained grab tensile strength at 500 hours)	ASTM D4355	70	70

30747-4000/Fi(100%)/SPECS (3/19/03/rw)

* * * END OF SECTION * * *

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SECTION 02220
GEOSYNTHETIC CLAY LINERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes the requirements for selection, installation and protection of GCL.

1.02 REFERENCES

A. American Society for Testing Materials (ASTM)

1. ASTM D5261, Test Method for Measuring Mass per Unit Area of Geotextiles.
2. ASTM D4643 (modified), Test Method for Determination of Water Content of Soil.
3. ASTM D5084, Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (modified).
4. ASTM D5321, Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
5. ASTM D5890, Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
6. ASTM D4632, Test Method for Grab Breaking Load and Elongation of Geotextiles.
7. ASTM D3786, Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
8. ASTM D5891, Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
9. ASTM D5993, Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
10. ASTM D5887, Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
11. ASTM D6243, Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Methods.

B. U.S. Pharmacopoeia - National Formulary XVII, page 1210

1. USP-NF-XVII, Test Method for the Free Swell of Bentonite Clay.

C. Geosynthetics Research Institute, Drexel University

1. GRI-GCL-1, Test Method for the Confined Swell of Geosynthetic Clay Liners.

1.03 SUBMITTALS

A. Preinstallation: Submit the following to the ENGINEER for approval prior to GCL deployment:

1. Manufacturer's specification for GCL which includes properties contained in Tables 02220-1 and 02220-2.
2. Written certification that states the GCL meets the properties listed in Tables 02220-1 and 02220-2.
3. Written certification from the GCL Manufacturer that states the bentonite shall not shift during transportation or installation thereby causing thin spots in the body of the GCL.
4. QC certificates signed by a responsible entity of the GCL Manufacturer. Each QC certificate shall include roll identification numbers, and results of QC tests. At a minimum, results shall be given for tests and corresponding methods specified in Tables 02220-1 and 02220-2.
5. The QC certificates shall be notarized.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

A. The CQA ENGINEER shall review Manufacturer and CONTRACTOR submittals and qualifications and verify conformance to Specifications. Discrepancies shall be reported to the PROJECT COORDINATOR. The CQA ENGINEER shall verify that:

1. Property values certified by Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by Manufacturer are properly documented and that the test methods used are acceptable.
3. QC certificates have been provided at the specified frequency for all rolls and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum properties meet the project Specifications as shown in Tables 02220-1 and 02220-2.
6. Conformance results are received and measured properties must meet the project Specifications.

B. Manufacturer shall identify all rolls of GCL with the following:

1. Manufacturer's name.
2. Product ID number.
3. Roll number.
4. Roll dimensions.
5. Roll weight.

C. CQA ENGINEER shall prepare an approved roll list for each GCL prior to installation based upon review of submittals and test results. Upon delivery, CQA ENGINEER shall conduct an observation of all rolls for defects and/or damages. CQA ENGINEER shall:

1. Match delivered rolls to the packing slip.
2. Record roll information on QA inventory lists.
3. Advise CONTRACTOR of any rolls or portions of rolls which shall be rejected and removed from the Site.

D. For storage and protection precautions, CONTRACTOR shall:

1. Provide onsite storage area for GCL rolls from time of delivery up to installation.
2. Store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage after CONTRACTOR mobilization. Do not allow GCL to be exposed to rain or other sources of wetting.
3. Preserve integrity and readability of GCL roll labels.

E. CONFORMANCE TESTING

1. At a minimum, the following conformance tests shall be performed by the CQA ENGINEER on all GCL:
   a. Internal Shear Strength.
   b. Bentonite content at 20 percent moisture content.
2. These conformance tests shall be performed in accordance with the tests methods and frequencies specified in Table 02220-2.

PART 2 PRODUCTS

2.01 MATERIALS

A. The active ingredient of the GCL shall be natural sodium bentonite. The bentonite shall be encapsulated between a slit-film woven and a virgin staple fiber nonwoven geotextile (GSE Bentofix CNSL or equivalent).

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetic materials. CONTRACTOR shall provide ENGINEER with a subgrade surface acceptance document.

B. Acceptance of proper subgrade preparation requires the following:

1. Verification that line and grades shown in Drawings have been met.
2. Verification that subgrade soil meets the density required by the specifications.
3. A surface free of irregularities, protrusions, loose soil, and abrupt changes in grade.
4. The subgrade surface does not contain stones, excessive dust or moisture that could damage the GCL.
5. There are no areas excessively softened by high water content
6. There are no areas where surface soil contains desiccation cracks with dimensions exceeding those allowed by the specifications.

C. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the GCL or other synthetic liner materials.

D. CONTRACTOR shall ensure that rutting or raveling is not caused by installation equipment and that the surface is free of debris, roots or angular stones larger than 3/4-inch in diameter.

E. Prior to installation, CONTRACTOR shall ensure that the subgrade has been rolled to provide smooth surface.

3.02 DEPLOYMENT AND SEAMING

A. CONTRACTOR shall handle all GCL in such a manner as to ensure that these materials are not damaged, and the following conditions shall be complied with:

1. On slopes, the GCL shall be securely anchored and then rolled down the slope in such a manner as to continually keep the GCL sheet in tension.
2. In the presence of wind, GCL shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3.03 DEFECTS AND REPAIRS

A. Holes or tears in the GCL shall be repaired as follows:

1. Care shall be taken to remove any soil or other material which may have penetrated the torn GCL.
2. Damaged areas shall be repaired by placing a patch of the same material extending at least 2 inches beyond the flaw or damaged area. Seams shall be repaired by overlapping GCLs at least 1 foot.

B. The CQA ENGINEER shall observe any repairs and report any nonconformance to the PROJECT COORDINATOR in writing.

3.04 GCL PROTECTION

A. All soil materials located on top of GCL shall be deployed in such a manner as to ensure:

1. The GCL and underlying lining materials are not damaged.
2. Minimal slippage of the GCL on underlying layers occurs.
3. No excess tensile stresses occur in the GCL.

B. Any noncompliance shall be noted by CQA ENGINEER and reported to the PROJECT COORDINATOR.

C. CONTRACTOR shall be responsible for the condition of the GCL at all times until CQA ENGINEER accepts the material for placement of overlying layers.

1. GCL shall be cut using a geotextile cutter (hook blade), scissors, or other approved device. Adjacent materials shall be protected to prevent potential damage due to cutting of GCL.
2. CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the GCL.
3. During placement of GCL, care shall be taken not to entrap in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.
4. A visual examination of the GCL shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.
5. GCL shall not be placed in the rain or at times of impending rain or ponded water.
6. GCL that becomes hydrated before placement of overlying geomembrane or a minimum of 12 inches of approved cover soil shall be replaced.

7. Generally, the amount of GCL that shall be deployed shall be limited to the amount that can be covered during that day by geomembrane or a minimum of 12 inches of approved cover soil.
8. The preferred GCL surface shall be oriented in relation to prepared soil or other geosynthetics as directed by CQA ENGINEER.

D. On slopes, GCL shall be overlapped to Manufacturer's match line.

E. Generally, no horizontal seams are allowed on sideslopes. At sumps, overlap GCLs at least 1 foot.

F. GCL shall overlap low permeability soil at least 5 feet.

G. If needle-punch GCL is used, the seams shall be treated with 1/4-pound per linear foot of powdered bentonite.

H. If white colored GCL is used, precautions shall be taken against "snowblindness" of personnel.

J. CQA ENGINEER shall preapprove GCL rolls for use in construction and give an approved roll list to CONTRACTOR. CQA ENGINEER shall observe GCL rolls for defects and damages as they are deployed and ensure the deployment methods do not damage the GCL.

TABLE 02220-1

GCL PROPERTY REQUIREMENTS

PROPERTY	UNIT	TEST METHOD	VALUE
Bentonite			
Swell	ml/2g	ASTM D5890	24 (min.)
Fluid Loss	ml	ASTM D5891	18 (max.)
Moisture Content	%	ASTM D4643	12 (max.)
Textile Backings			
Weight	oz/sy	ASTM D5261	6.0
GCL (Composite Product)			
Grab Tensile	lb.	ASTM D4632	95 (min.)
Grab Elongation	%	ASTM D4632	100 typical
Peel Strength	lb.	ASTM D4632	15 (min.)
Permeability	cm/sec	ASTM D5084	5×10^{-10} (max.)
Bentonite Mass per Unit Area	lb/ft^2	ASTM D5993	0.75 (min.) @ 0% moisture
Index Flux	cm/sec.	ASTM D5887	5×10^{-9} (max.)
Peak Internal Shear Strength(2)	psf	ASTM D6243	500 typical @ 200 psf normal load

30747-4000/Fi(100%)Specs (3/25/03/rw)

(1) For MQC Testing of geosynthetics, values shall be Minimum Average Roll Values (MARV).
(2) The confining pressures shall be 100, 200 and 400 psf and the shear rate of 1 mm/min.

TABLE 02220-2

CONFORMANCE TESTING

PROPERTY	TEST METHOD	REQUIRED VALUE	UNITS	MIN. TEST FREQ.
Bentonite Content @ 20% Moisture Content	Weigh 12" x roll width	0.9	lbs/sq. ft.	1/20,000 sf
Peak Internal Shear Strength	ASTM D6243	500 @ 200 psf normal load	psf	2/40,000 sf

37047-4000/Fi(100%)Specs (03/25/03/rw)

** END OF SECTION **

SECTION 02230
GEOCOMPOSITES

PART 1 GENERAL

1.01 DESCRIPTION

A. The Work includes installation of two single-sided geocomposites in the reservoir cap, one to serve as part of the gas venting system and the other as a drainage layer for surface infiltration.

1.02 QUALITY CONTROL

A. QC for geocomposite drainage nets consists of the following types of activities which are described in Part 3, Execution:

1. MANUFACTURERS' certifications that materials satisfy the standard ASTM properties and Specifications.
2. "As Received" material conformance tests.
3. Field inspections for defects, including related repairs.

B. The following ASTM Reference Standards shall be used for geocomposite drainage net:

1. ASTM D1505 - Polymer Density.
2. ASTM D1238E, Method E - Polymer Melt Index.
3. ASTM D1603 - Carbon Black Content.
4. ASTM D1777 - Nominal Thickness.
5. ASTM D3776 - Nominal Mass per Unit Area.
6. ASTM D4716 - Transmissivity at 15,000 psf.
7. ASTM D1682 - Tensile Strength/Machine Direction.

1.03 SUBMITTALS

A. No later than 15 days prior to the installation of geocomposite drainage net materials, CONTRACTOR shall submit a Geocomposite Placement Plan providing the following information:

1. Résumé of the Superintendent to be assigned to this project, including dates and durations for similar work.

2. A panel layout drawing showing the installation layout and any deviations from the Drawings. Each layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

B. Installation shall not begin for any material until the respective Placement Plan is approved by ENGINEER.

PART 2 MATERIALS

A. Geocomposite drainage net shall be Fabrinet or equivalent with an 8-ounce polypropylene geotextile thermally bonded to one side, or equivalent material approved by ENGINEER.

PART 3 EXECUTION

3.01 MATERIAL QUALITY CONTROL DOCUMENTATION

A. Geocomposites:

1. Certification
   a. Prior to installation of any geocomposite, MANUFACTURER or CONTRACTOR shall provide CQA ENGINEER with the following information:
      - Property values certified by MANUFACTURER to meet guaranteed specifications.
      - Reports on tests conducted by MANUFACTURER to verify that the quality of the raw material used to manufacturer the geocomposite meets MANUFACTURER's specifications.
      - Written certification that drainage net is manufactured by extruding two sets of strands to form a three-dimensional structure to provide planar water flow, and that the drainage net shall contain stabilizers to prevent ultraviolet light degradation.
      - Written certification that the geocomposite shall be manufactured by heat bonding the geocomposite to the HDPE drainage net on one side. No burn-through geocomposites, glue or adhesives shall be permitted.
      - A specification for the geocomposite which includes all properties associated with the Specifications stated in Table 02230-1 are guaranteed by MANUFACTURER, including a signed QC certificate(s).
      - MANUFACTURER shall provide verification that the bond between the geotextile and the HDPE drainage net shall exhibit a minimum peel strength of 0.5 pounds per inch, and an average peel strength of 1 pound per inch (per ASTM D413). Peel strength shall be tested approximately every 600 linear feet.

- MANUFACTURER shall submit samples of the geocomposite to ENGINEER and CQA ENGINEER. MANUFACTURER shall also furnish a complete set of written instructions for storage, handling, installation and joining.
- QC certificates, signed by responsible party employed by MANUFACTURER. The QC certificates shall indicate that the materials meet the designated specification.
- MANUFACTURER shall supply the geocomposite in rolls, marked or tagged with the following:
  - MANUFACTURER's name.
  - Production identification.
  - Lot number.
  - Roll number.
  - Roll dimensions.

b. CQA ENGINEER shall document that all of the geocomposite material received is appropriately certified by MANUFACTURER, prior to its installation.

2. Conformance Testing

a. CONTRACTOR shall collect all conformance samples as directed by CQA ENGINEER. Upon delivery of the rolls of geocomposite, CQA ENGINEER shall ensure that conformance test samples are obtained for the geocomposite. These samples shall then be forwarded to the geosynthetics QAL for testing to ensure conformance to the project specifications. CQA ENGINEER shall prepare Chain-of-Custody forms to be completed by all parties and returned to CQA ENGINEER for QA records.

b. At a minimum the following conformance tests shall generally be performed on geocomposites:

- Polymer density.
- Polymer melt.
- Carbon black content.
- Thickness.
- Mass permit area.
- Transmissivity.
- Tensile strength.
- Fabric weight.
- Grab strength and elongation.
- Trapezoidal tear strength.
- Puncture resistance.
- Mullen burst strength.
- Water flow rate.
- Permittivity.
- Permeability.
- Apparent opening size.

c. These conformance tests shall be performed in accordance with the test methods specified in the Specifications (Table 02230-1). Other conformance tests may be required by the project specifications.

3. The rolls to be sampled shall be selected by CQA ENGINEER. Samples shall be taken across the entire width of the roll and shall not include the first complete revolution of fabric on the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 feet long by the roll width. CQA ENGINEER shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

4. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by CQA ENGINEER based on a review of roll information including QC documentation and manufacturing records.

5. Unless otherwise specified, samples shall be taken at a rate of one per lot, not to exceed one conformance test per 100,000 square feet of geocomposite.

6. All conformance test results shall be reviewed and accepted or rejected by CQA ENGINEER prior to the deployment of the geocomposite.

7. CQA ENGINEER shall examine all results from laboratory conformance testing and shall report any nonconformance to OWNER. CQA ENGINEER shall be responsible for checking that test results meet or exceed the property values listed in the Specifications and review any nonconforming results with ENGINEER prior to acceptance or rejection.

8. If a test result is in nonconformance, all material from the lot represented by the failing test can be considered out of specification and rejected. Alternatively, at the option of the CQA ENGINEER , additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specifications (this procedure is valid only when all rolls onsite in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent (next smaller and next larger) to the roll that was sampled and failed. If both additional tests pass, only the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot, until passing tests are achieved on either side numerically from the original failed roll.

9. Supplier shall be responsible for shipment and onsite storage of geocomposite rolls. The geocomposites shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

3.02 INSTALLATION

A. Geocomposite Materials

1. Handling and Installation

   a. Installer shall handle all geocomposites in such a manner as to ensure they are not damaged, and the following shall be complied with:

      - Prior to installation, geocomposite materials shall be protected from ultraviolet light exposure by using relatively opaque and watertight wrappings and covers.
      - On slopes, the geocomposites shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension.
      - In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
      - Geocomposites shall be cut using a geocomposite cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geocomposites.
      - Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
      - During placement of geocomposites, care shall be taken not to entrap in or beneath the geocomposite, stones, excessive dust, or moisture that could damage the geocomposite, cause clogging of drains or filters, or hamper subsequent seaming.
      - A visual examination of the geocomposite shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

   b. All adjacent geocomposite panels shall be overlapped a minimum of 4 inches.

   c. CONTRACTOR shall pay particular attention to ensure that no protective soil cover material could be inadvertently inserted beneath the geocomposite. In general, no horizontal seams shall be allowed on side slopes, except as part of a patch.

   d. CQA ENGINEER shall preapprove geocomposite rolls for use in construction and give an approved roll list to CONTRACTOR. CQA ENGINEER shall observe geocomposite rolls for defects and damages as they are deployed and ensure that deployment methods do not damage the geocomposites.

   e. Adjacent geocomposite shall be joined according to Drawings and Specifications. At a minimum, the following requirements shall be met:

      - Adjacent rolls shall be overlapped by at least 4 inches.
      - Overlaps shall be secured by tying.

- Tying can be achieved by plastic fasteners of polymer grade. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
- Tying shall be every 5 feet along the slope, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams on the base of the landfill.
- In general, no horizontal seams shall be allowed on sideslopes.

f. Each geocomposite shall be securely anchored by CONTRACTOR to ensure that no slippage occurs during construction or operations. Details of anchor trench construction are shown in the Drawings.

g. CONTRACTOR shall clean geomembrane layer surfaces prior to placing geocomposite.

2. Defects and Repairs

a. Holes or tears in the geocomposite shall be repaired as follows:

- On slopes, a patch made from the same geocomposite shall be thermally bonded into place a minimum of 6 inches beyond the hole in all directions, in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
- Care shall be taken to remove any soil or other material which may have penetrated the torn geocomposite.

3. Geocomposite Protection

a. All soil materials located on top of a geocomposite shall be deployed in such a manner as to ensure:

- The geocomposite and underlying geosynthetic materials are not damaged.
- Minimal slippage of the geocomposite on underlying layers occurs.
- No excess tensile stresses occur in the geocomposite.
- Soil does not contaminate the net.

b. Any noncompliance shall be noted by CQA ENGINEER and reported to OWNER.

c. CONTRACTOR shall be responsible for the condition of the geocomposite at all times until CQA ENGINEER accepts the material for placement of overlying layers.

TABLE 02230-1

MINIMUM PHYSICAL PROPERTIES OF GEOCOMPOSITE

DRAINAGE NET PROPERTY SPECIFICATION

PROPERTY	TEST METHOD	UNIT	QUALIFIER	VALUE
Polymer Density	ASTM D1505	g/cm^3	Minimum	0.937
Polymer Melt Index	ASTM D1238, Method E	g/10 min	Maximum	1.0
Carbon Black Content	ASTM D1603	%	Range	2 to 3
Nominal Thickness	ASTM D1777	mil	Minimum	220
Nominal Mass Per Unit Area	ASTM D3776	lb/ft^2	Minimum	0.18
Transmissivity at 15,000 psf	ASTM D4716	m/sec^2	Minimum	1×10^{-3}
Tensile Strength/Machine Direction	ASTM D1682	lb/in	Minimum	50

GEOTEXTILE PROPERTY SPECIFICATION

FABRIC PROPERTY	UNIT	TEST METHOD	QUALIFIER	SPECIFIED VALUES
Fabric Weight	oz/yd^2	ASTM D3776	Minimum	7.5
Thickness	mil	ASTM D1777	Minimum	110
Grab Strength	lb	ASTM D4632	Minimum	210
Grab Elongation	%	ASTM D4632	Minimum	50
Trapezoidal Tear Strength	lb	ASTM D4533	Minimum	75
Puncture Resistance	lb	ASTM D4833	Minimum	100
Mullen Burst Strength	psi	ASTM D3786	Minimum	380
Water Flow Rate	gpm/ft^2	ASTM D4491	Minimum	100
Permittivity (Y)	sec^{-1}	ASTM D4491	Minimum	1.25
Permeability (k = Yt)	cm/sec	ASTM D4491	Minimum	0.35
Apparent Opening Size	Sieve Size (mm)	ASTM D4751	Range	70 (0.210) - 100 (0.149)

30747-4000/Fi(100%)/SPECS (3/19/03/rw)

* * * END OF SECTION * * *

SECTION 02260
VEGETATIVE SOIL LAYER

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall place vegetative soil cover layer over the drainage layer single-sided geocomposite in the reservoir area and the cushion geotextile in the RCRA Subtitle D-equivalent areas following approval from CQA ENGINEER.

PART 2 MATERIALS

A. The vegetative layer shall be topsoil material and/or soil meeting the requirements of Specification Section 02100 capable of providing the proper base for establishing surficial grasses for exterior protection as required in Section 02600.

B. The material shall be free of rock or other pieces greater than 2 inches in any direction.

PART 3 EXECUTION

A. The layer shall be placed in two 1-foot lifts and compacted to a minimum of 85 percent of maximum dry density as determined by ASTM D1557.

B. No equipment shall be operated on the top surface of geosynthetics without permission from the ENGINEER. Select fill shall be pushed out over geosynthetics in an upward tumbling motion so that wrinkles in geosynthetics do not fold over. Soil shall not be dropped directly onto geosynthetics from a height greater than 3 feet. On slopes, select fill shall be placed from the bottom of the slope upward.

C. The first lift of soil placed over geosynthetics shall be a minimum of 12 inches in loose thickness. Low ground pressure equipment with ground pressures less than 7 psi shall be used to place and traffic compact the first lift of select fill. Traffic compaction shall consist of a minimum of 2 passes over all areas.

D. The loose lift thickness of each subsequent lift shall be no greater than 12 inches. Low ground pressure equipment shall be used to place the second lift of select fill. Full scale placement and compaction equipment shall be allowed on areas underlain by geosynthetics only after the second loose lift of soil has been placed.

* * * END OF SECTION * * *

SECTION 02270
GEOGRIDS

PART 1 GENERAL

1.01 DESCRIPTION

A. The work includes installation of a geogrid as part of the contingency foundation layer in areas over exposed waste or existing soil cover that exhibit bearing capacity failure during construction or an inability to place and/or compact overlying layers according to the Specifications.

1.02 QUALITY CONTROL

A. QC for geogrids consists of the following types of activities which are described in Part 3, Execution:

1. MANUFACTURERS' certifications that materials satisfy the standard ASTM properties and Specifications.
2. "As Received" material conformance tests.
3. Field inspections for defects, including related repairs.

B. The following Reference Standards shall be used for geogrid materials:

1. ASTM D4759 – Standard Practice for Determining the Specification Conformance of Geosynthetics.
2. ASTM D1388-96 – Standard Test Method for Stiffness of Fabrics, Option A.
3. ASTM D5732-95 – Standard Test Method for Stiffness of Nonwoven Fabrics using the cantilever test.
4. ASTM D5262-97 – Standard Test Method for Evaluating Unconfined Tensile Creep Behavior of Geosynthetics.
5. ASTM D5818-95 – Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage.
6. ASTM D6637-01 – Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-rib Tensile Method.
7. GRI GG2-87 – Standard Test Method for Geogrid Junction Strength.

1.03 SUBMITTALS

A. Prior to installation of geogrid materials, CONTRACTOR shall submit geogrid product samples and MANUFACTURER'S Specifications to the ENGINEER for approval.

B. CONTRACTOR shall submit a placement plan to the ENGINEER for approval prior to installation of the geogrid.

PART 2 MATERIALS

A. Geogrid shall be Tensor BX1200 or equivalent material approved by ENGINEER and shall meet the specifications below for Tensor BX1200

1. The structural geogrid shall be an integrally formed grid structure manufactured of a stress resistant polypropylene material with molecular weight and molecular characteristics which impart: (a) high resistance to loss of load capacity or structural integrity when the geogrid is subjected to mechanical stress in installation; (b) high resistance to deformation when the geogrid is subjected to applied force in use; and (c) high resistance to loss of load capacity or structural integrity when the geogrid is subjected to long-term environmental stress.

The structural geogrid shall have the following characteristics:

Product Type:	**Integrally Formed Structural Geogrid**		
Load Transfer Mechanism:	**Positive Mechanical Interlock**		
Product Properties	**Units**	**MD Values(1)**	**XMD Values(1)**
Index Properties			
• Aperture Dimensions(2)	mm (in)	25 (1.0)	33 (1.3)
• Minimum Rib Thickness (2)	mm (in)	1.27 (0.05)	1.27 (0.05)
Load Capacity			
• True Initial Modulus in Use(3)	kN/m(lb/ft)	400 (27,420)	650 (44,550)
• True Tensile Strength @2% Strain(3)	kN/m(lb/ft)	6.0 (410)	8.6 (590)
• True Tensile Strength @5% Strain(3)	kN/m(lb/ft)	11.8 (810)	19.6 (1,340)
Structural Integrity			
• Junction Efficiency(4)	%	93	
• Flexural Stiffness(5)	mg-cm	750,000	
• Aperture Stability(6)	kg-cm/deg	6.5	
Durability			
• Resistance to Installation Damage(7)	%SC / %SW / %GP	91 / 91/ 85	
• Resistance to Long-Term Degradation(8)	%	100	

(1) Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D-4759. Brief descriptions of test procedures are given in the following notes.

(2) Nominal Dimensions.

(3) True resistance to elongation when initially subjected to a load measured via ASTM D6637 without deforming test materials under load before measuring such resistance or employing "secant" or "offset" tangent methods of measurement so as to overstate tensile properties.

(4) Load transfer capability measured via GRI-GG2-87. Expressed as a percentage of ultimate tensile strength.

(5) Resistance to bending force measured via ASTM D-5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a "ladder"), and of length sufficiently long to enable measurement of the overhang dimension. The overall Flexural Stiffness is calculated as the square root of the product of machine-and cross-machine-direction Flexural Stiffness values.

(6) Resistance to in-plane rotational movement measured by applying a 20 kg-cm moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter (U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity).

(7) Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818 and load capacity shall be measured in accordance with ASTM D6637.

(8) Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments measured via EPA 9090 immersion testing.

PART 3 EXECUTION

3.01 MATERIAL QUALITY CONTROL DOCUMENTATION

A. Geogrid

1. MANUFACTURER'S Certifications
   a. CONTRACTOR shall provide CQA ENGINEER with MANUFACTURERS Certification that the geogrid is in compliance with this specification including actual test results for tension/creep, durability/aging, construction damage, joint strength and tensile testing per Reference Standards in Section 1.02 and per MANUFACTURER'S Specifications for Tensor BX1200.

2. Examination By CONTRACTOR
   a. CONTRACTOR shall verify that the proper material has been received and that it is free of flaws or damage incurred during manufacturing, shipping or handling.

3.02 INSTALLATION

A. Follow the MANUFACTURER'S recommendations regarding protection from exposure to sunlight.

B. Geogrid shall be laid as shown on the construction drawings or as directed by the ENGINEER. Geogrid may be temporarily secured in place with staples, pins, sand bags, or backfill as required by fill properties, fill placement procedures, or weather conditions, or as directed by the ENGINEER.

C. Geogrid soil reinforcement shall be connected/spliced when required to provide continuity of tensile resistance. Geogrids manufactured using polyolefins (e.g., HDPE and PP) shall be connected with a mechanical polymer bar.

D. Overlap connections may be used if the CONTRACTOR provides the ENGINEER independent test documentation which demonstrates that the load/deformation characteristics of the overlap of geogrid materials is equal to or exceeds those of the geogrid. The minimum overlap shall be 5 feet.

E. Tracked construction equipment shall not be operated directly on the geogrid. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles over the geogrid shall not be permitted until a fill thickness above the geogrid of 12 inches is achieved to prevent tracks from displacing the fill and damaging the geogrid.

* * * END OF SECTION * * *

SECTION 02300
BURIED PVC PIPE INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes:

1. The 2-inch-diameter perforated, 4-inch-diameter and 6-inch-diameter PVC pipe to be used in the passive gas venting systems over the reservoir and beneath existing buildings.
2. The 4-inch and 16-inch-diameter PVC pipe to be used in the storm drain system.

1.02 QUALITY CONTROL

A. The following Reference Standards shall be used:

1. American Society for Testing and Materials (ASTM):
   a. ASTM D638-99 - Test Method for Tensile Properties of Plastics
   b. ASTM D790-99 - Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   c. ASTM D1238-99 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   d. ASTM D1505-98 - Test Method for Density of Plastics by the Density-Gradient Technique.
   e. ASTM D1693-00 - Test Method for Environmental Stress Cracking of Ethylene Plastics.
   f. ASTM D-1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   g. ASTM D-1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   h. ASTM D-2466 - Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   i. ASTM D-2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   j. ASTM D-2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   k. ASTM D-2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   l. ASTM D-2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

B. CQA ENGINEER shall verify the proper manufacturer's certifications and identifiers and that conformance test results meet specifications for all piping prior to acceptance for placement. CQA ENGINEER shall observe pipe placement and connection procedures to confirm that the CONTRACTOR has completed the work in accordance with the Drawings and Specifications, and has not damaged the piping or left a loose/leaking connection. Details of field quality control are given in Subsection 3.02.

1.03 SUBMITTALS

A. CONTRACTOR shall submit manufacturers test data showing conformance with Specifications in Section 1.02A.

B. Submittals by CONTRACTOR shall be in accordance with Section 01410.

C. If MANUFACTURER'S test data is inadequate or unavailable, the ENGINEER reserves the right to reject shipments. Costs of shipment shall be borne by CONTRACTOR.

PART 2 MATERIALS

2.01 RESERVOIR CAP GAS VENTING SYSTEM AND STORM DRAIN SYSTEM PIPE

A. Pipe sizes, type and location are designated in the Drawings. Acceptable manufacturers in the U.S. include:

1. Harvel Plastics, Inc., Bakersfield, California.
2. Asahi America, Malden, Massachusetts.
3. Harrington Industrial plastics, Inc., Chino, California.
4. Or equivalent, as approved by ENGINEER.

B. Perforated pipe:

1. The 2-inch-diameter reservoir gas extraction system pipe shall be Schedule 40 socket type PVC with twenty 0.05-inch uniformly-spaced perforations per foot. Four perforations shall be placed at 90 degree separations around the pipe.
2. The 2-inch-diameter gas extraction system pipe beneath existing buildings shall be Schedule 40 PVC with perforations making up a minimum of 5 percent of the surface area of the pipe and symmetrical around the pipe.

C. Nonperforated pipe:

1. The 4-inch- and 6-inch-diameter gas venting pipe shall be Schedule 80 socket type PVC.
2. The 4-inch- and 16-inch-diameter storm drain pipe shall be Schedule 40 socket type PVC.

D. Marking shall be at intervals of 5 feet or less and include the following information:

1. MANUFACTURER'S name or trademark.
2. Nominal pipe size.
3. Material type, HDPE, PVC, etc.
4. Legend: pipe grade, SDR (if applicable).
5. ASTM designation (as appropriate).
6. Extrusion date, period of manufacture or lot number (plastic pipe).

2.02 FITTINGS AND BOOTS

A. Fittings shall be molded from PVC (Polyvinyl Chloride) having cell classification equal to or exceeding that used in pipe conforming to ASTM D1784.

B. Fittings shall be of same manufacturer as pipe being provided.

C. Manufacturers Markings shall include the following information:

1. Manufacturer's name or trademark.
2. Nominal size.
3. Material designation "PVC."
4. ASTM D1785.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe trenches shall be excavated, backfilled and compacted in accordance with Section 02180.

B. The PVC pipe and pipe fittings shall be joined by use of solvent-based cement manufactured in accordance with ASTM D2564.

C. Joining of PVC pipe shall be performed by a qualified person. Thermal expansion shall be accounted for during placement of the PVC pipe.

D. Pipe shall be cleaned and inspected on the inside prior to assembly. Open pipe ends shall be capped or equivalently taped at the end of each working day.

E. The pipe boot at the low point in the reservoir cap drainage trench shall be prefabricated as one piece by an HDPE manufacturer, or other specialist in plastic fabrication, approved by the CQA ENGINEER and supplied by CONTRACTOR. The liner boot shall be fabricated to match the constructed grades as shown on the Drawings, and shall be tested to assure water tightness prior to delivery. CONTRACTOR shall provide certification of the test prior to installation as per requirements in Section 01410.

F. The pipe boot shall be secured to the pipes with a 1.5-inch wide stainless steel (Type A316) ring clamp. A 1.5-inch wide double-sided mastic tape (3M or equivalent) shall be placed between the pipe and the pipe boot, directly beneath the ring clamp. The boot shall be secured to the HDPE geomembrane at locations shown on the Drawing by HDPE fusion welds performed by a qualified fusion welder.

G. CONTRACTOR shall verify integrity of piping systems in accordance with Section 3.02 of these specifications.

3.02 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications for the following reasons.

1. Fractures or cracks passing through pipe wall, except a single crack not exceeding 5 centimeters (2 inches) in length at either end of pipe which could be cut off and discarded. All pipes within one shipment shall be rejected if defects exist in more than 5 percent of the shipment or delivery.
2. Cracks sufficient to impair strength, durability or serviceability of the pipe.
3. Defects indicating improper proportioning, mixing or molding.
4. Damaged ends, whereas such damage would prevent making a satisfactory joint.

B. Acceptance of fittings, stubs or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation that they conform to these Specifications.

* * * END OF SECTION * * *

SECTION 02310
FRENCH DRAIN TRENCH PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes:

1. The 4-inch diameter perforated pipe to be used in the French drain trench.

1.02 QUALITY CONTROL

A. The following Reference Standards shall be used:

1. American Society for Testing and Materials (ASTM):
   a. ASTM D3350 - Standard Specification for polyethylene plastics pipe and fittings materials.
   b. ASTM D2412 - Standard Test method for determination of external loading characteristics of plastic pipe by parallel-plate loading.
   c. ASTM F477 - Standard Specification for elastomeric seals (gashets) for joining plastic pipe.
   d. ASTM D2321 - Standard practice for underground installation of thermoplastic pipe for sewers and other gravity-flow applications.
   e. ASTM F405 – Standard Specification for corrugated polyethylene (PE) tubing and fittings.

2. American Association of State Highway and Transportation Officials (AASHTO)
   a. AASHTO M252 – Corrugated polyethylene drainage tubing.
   b. AASHTO M294 – Corrugated polyethylene plastic pipe.

B. CQA ENGINEER shall verify the proper MANUFACTURER'S certifications and identifiers and that conformance test results meet Specifications for all piping prior to acceptance for placement. CQA ENGINEER will observe pipe placement and connection procedures to confirm that the CONTRACTOR has completed the work in accordance with the Drawings and Specifications, and has not damaged the piping. Details of field quality control are given in Subsection 3.02.

1.03 SUBMITTALS

A. CONTRACTOR shall submit MANUFACTURER'S Test data showing conformance with Specifications in Section 1.02A.

B. Submittals by CONTRACTOR shall be in accordance with Section 01410.

C. If MANUFACTURER'S Test data is inadequate or unavailable, the ENGINEER reserves the right to reject shipments. Costs of shipment shall be borne by CONTRACTOR.

PART 2 MATERIALS

2.01 RESERVOIR FRENCH DRAIN PIPE

A. The 4-inch-diameter French drain trench pipe shall be smooth interior perforated corrugated HDPE pipe by Advanced Drainage Systems (ADS) or equal. Perforations shall be per ADS Standard Pipe Perforations for 4-inch pipe or equal (.875-inch length x .125-inch width). Perforations shall be placed on each side of the pipe 60 degrees from the bottom.

B. Markings shall be at intervals of 5 feet or less and shall include the following information:
   1. MANUFACTURER'S name or trademark.
   2. Nominal pipe size.
   3. Material type.
   4. Pipe stiffness.
   5. ASTM designation (ASTM D3350).
   6. Period of manufacture or lot number.

2.02 FITTINGS

A. Fittings shall be of the same MANUFACTURER as pipe being provided.

B. MANUFACTURER'S Markings shall include the following information:
   1. MANUFACTURER'S name or trademark.
   2. Nominal size.
   3. Material type.
   4. ASTM designation (ASTM D3350).

3.01 INSTALLATION

A. Pipe trenches shall be excavated, backfilled and compacted in accordance with Section 02180.

B. Fittings may be installed by various methods such as snap-on, bell and spigot, bell-bell or wrap around couplers. Couplers shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Only fittings supplied by the MANUFACTURER shall be used.

C. Pipe shall be cleaned and inspected prior to assembly. Perforated pipe shall be stored in a manner to keep dirt or foreign material from entering the inside of the pipe or clogging the perforations.

D. Pipe shall be installed in accordance with the Design Drawings.

E. CONTRACTOR shall verify the integrity of the piping system in accordance with Section 3.02 of this Specification.

3.02 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications for the following reasons.

1. Fractures or cracks passing through pipe wall, except a single crack not exceeding 5 centimeters (2 inches) in length at either end of pipe which could be cut off and discarded. All pipes within one shipment shall be rejected if defects exist in more than 5 percent of the shipment or delivery.
2. Cracks sufficient to impair strength, durability or serviceability of the pipe.
3. Defects indicating improper proportioning, mixing or molding.
4. Damaged ends, whereas such damage would prevent making a satisfactory joint.

B. Acceptance of fittings, stubs or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation that they conform to these Specifications.

* * * END OF SECTION * * *

SECTION 02230
GEOCOMPOSITES

PART 1 GENERAL

1.01 DESCRIPTION

A. The Work includes installation of two single-sided geocomposites in the reservoir cap, one to serve as part of the gas venting system and the other as a drainage layer for surface infiltration.

1.02 QUALITY CONTROL

A. QC for geocomposite drainage nets consists of the following types of activities which are described in Part 3, Execution:

1. MANUFACTURERS' certifications that materials satisfy the standard ASTM properties and Specifications.
2. "As Received" material conformance tests.
3. Field inspections for defects, including related repairs.

B. The following ASTM Reference Standards shall be used for geocomposite drainage net:

1. ASTM D1505 - Polymer Density.
2. ASTM D1238E, Method E - Polymer Melt Index.
3. ASTM D1603 - Carbon Black Content.
4. ASTM D1777 - Nominal Thickness.
5. ASTM D3776 - Nominal Mass per Unit Area.
6. ASTM D4716 - Transmissivity at 15,000 psf.
7. ASTM D1682 - Tensile Strength/Machine Direction.

1.03 SUBMITTALS

A. No later than 15 days prior to the installation of geocomposite drainage net materials, CONTRACTOR shall submit a Geocomposite Placement Plan providing the following information:

1. Résumé of the Superintendent to be assigned to this project, including dates and durations for similar work.

2. A panel layout drawing showing the installation layout and any deviations from the Drawings. Each layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

B. Installation shall not begin for any material until the respective Placement Plan is approved by ENGINEER.

PART 2 MATERIALS

A. Geocomposite drainage net shall be Fabrinet or equivalent with an 8-ounce polypropylene geotextile thermally bonded to one side, or equivalent material approved by ENGINEER.

PART 3 EXECUTION

3.01 MATERIAL QUALITY CONTROL DOCUMENTATION

A. Geocomposites:

1. Certification
   a. Prior to installation of any geocomposite, MANUFACTURER or CONTRACTOR shall provide CQA ENGINEER with the following information:
      - Property values certified by MANUFACTURER to meet guaranteed specifications.
      - Reports on tests conducted by MANUFACTURER to verify that the quality of the raw material used to manufacturer the geocomposite meets MANUFACTURER's specifications.
      - Written certification that drainage net is manufactured by extruding two sets of strands to form a three-dimensional structure to provide planar water flow, and that the drainage net shall contain stabilizers to prevent ultraviolet light degradation.
      - Written certification that the geocomposite shall be manufactured by heat bonding the geocomposite to the HDPE drainage net on one side. No burn-through geocomposites, glue or adhesives shall be permitted.
      - A specification for the geocomposite which includes all properties associated with the Specifications stated in Table 02230-1 are guaranteed by MANUFACTURER, including a signed QC certificate(s).
      - MANUFACTURER shall provide verification that the bond between the geotextile and the HDPE drainage net shall exhibit a minimum peel strength of 0.5 pounds per inch, and an average peel strength of 1 pound per inch (per ASTM D413). Peel strength shall be tested approximately every 600 linear feet.

- MANUFACTURER shall submit samples of the geocomposite to ENGINEER and CQA ENGINEER. MANUFACTURER shall also furnish a complete set of written instructions for storage, handling, installation and joining.
- QC certificates, signed by responsible party employed by MANUFACTURER. The QC certificates shall indicate that the materials meet the designated specification.
- MANUFACTURER shall supply the geocomposite in rolls, marked or tagged with the following:
  - MANUFACTURER's name.
  - Production identification.
  - Lot number.
  - Roll number.
  - Roll dimensions.

b. CQA ENGINEER shall document that all of the geocomposite material received is appropriately certified by MANUFACTURER, prior to its installation.

2. Conformance Testing

a. CONTRACTOR shall collect all conformance samples as directed by CQA ENGINEER. Upon delivery of the rolls of geocomposite, CQA ENGINEER shall ensure that conformance test samples are obtained for the geocomposite. These samples shall then be forwarded to the geosynthetics QAL for testing to ensure conformance to the project specifications. CQA ENGINEER shall prepare Chain-of-Custody forms to be completed by all parties and returned to CQA ENGINEER for QA records.

b. At a minimum the following conformance tests shall generally be performed on geocomposites:

- Polymer density.
- Polymer melt.
- Carbon black content.
- Thickness.
- Mass permit area.
- Transmissivity.
- Tensile strength.
- Fabric weight.
- Grab strength and elongation.
- Trapezoidal tear strength.
- Puncture resistance.
- Mullen burst strength.
- Water flow rate.
- Permittivity.
- Permeability.
- Apparent opening size.

c. These conformance tests shall be performed in accordance with the test methods specified in the Specifications (Table 02230-1). Other conformance tests may be required by the project specifications.

3. The rolls to be sampled shall be selected by CQA ENGINEER. Samples shall be taken across the entire width of the roll and shall not include the first complete revolution of fabric on the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 feet long by the roll width. CQA ENGINEER shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

4. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by CQA ENGINEER based on a review of roll information including QC documentation and manufacturing records.

5. Unless otherwise specified, samples shall be taken at a rate of one per lot, not to exceed one conformance test per 100,000 square feet of geocomposite.

6. All conformance test results shall be reviewed and accepted or rejected by CQA ENGINEER prior to the deployment of the geocomposite.

7. CQA ENGINEER shall examine all results from laboratory conformance testing and shall report any nonconformance to OWNER. CQA ENGINEER shall be responsible for checking that test results meet or exceed the property values listed in the Specifications and review any nonconforming results with ENGINEER prior to acceptance or rejection.

8. If a test result is in nonconformance, all material from the lot represented by the failing test can be considered out of specification and rejected. Alternatively, at the option of the CQA ENGINEER , additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specifications (this procedure is valid only when all rolls onsite in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent (next smaller and next larger) to the roll that was sampled and failed. If both additional tests pass, only the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot, until passing tests are achieved on either side numerically from the original failed roll.

9. Supplier shall be responsible for shipment and onsite storage of geocomposite rolls. The geocomposites shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

3.02 INSTALLATION

A. Geocomposite Materials

1. Handling and Installation

a. Installer shall handle all geocomposites in such a manner as to ensure they are not damaged, and the following shall be complied with:

- Prior to installation, geocomposite materials shall be protected from ultraviolet light exposure by using relatively opaque and watertight wrappings and covers.
- On slopes, the geocomposites shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension.
- In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
- Geocomposites shall be cut using a geocomposite cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geocomposites.
- Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- During placement of geocomposites, care shall be taken not to entrap in or beneath the geocomposite, stones, excessive dust, or moisture that could damage the geocomposite, cause clogging of drains or filters, or hamper subsequent seaming.
- A visual examination of the geocomposite shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

b. All adjacent geocomposite panels shall be overlapped a minimum of 4 inches.

c. CONTRACTOR shall pay particular attention to ensure that no protective soil cover material could be inadvertently inserted beneath the geocomposite. In general, no horizontal seams shall be allowed on side slopes, except as part of a patch.

d. CQA ENGINEER shall preapprove geocomposite rolls for use in construction and give an approved roll list to CONTRACTOR. CQA ENGINEER shall observe geocomposite rolls for defects and damages as they are deployed and ensure that deployment methods do not damage the geocomposites.

e. Adjacent geocomposite shall be joined according to Drawings and Specifications. At a minimum, the following requirements shall be met:

- Adjacent rolls shall be overlapped by at least 4 inches.
- Overlaps shall be secured by tying.

- Tying can be achieved by plastic fasteners of polymer grade. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
- Tying shall be every 5 feet along the slope, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams on the base of the landfill.
- In general, no horizontal seams shall be allowed on sideslopes.

f. Each geocomposite shall be securely anchored by CONTRACTOR to ensure that no slippage occurs during construction or operations. Details of anchor trench construction are shown in the Drawings.

g. CONTRACTOR shall clean geomembrane layer surfaces prior to placing geocomposite.

2. Defects and Repairs

a. Holes or tears in the geocomposite shall be repaired as follows:

- On slopes, a patch made from the same geocomposite shall be thermally bonded into place a minimum of 6 inches beyond the hole in all directions, in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
- Care shall be taken to remove any soil or other material which may have penetrated the torn geocomposite.

3. Geocomposite Protection

a. All soil materials located on top of a geocomposite shall be deployed in such a manner as to ensure:

- The geocomposite and underlying geosynthetic materials are not damaged.
- Minimal slippage of the geocomposite on underlying layers occurs.
- No excess tensile stresses occur in the geocomposite.
- Soil does not contaminate the net.

b. Any noncompliance shall be noted by CQA ENGINEER and reported to OWNER.

c. CONTRACTOR shall be responsible for the condition of the geocomposite at all times until CQA ENGINEER accepts the material for placement of overlying layers.

* * * END OF SECTION * * *

SECTION 02350
CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide concrete including formwork as required to complete the Work as shown in drawings and reinforcement for foundations.

1.02 REFERENCES

A. The construction shall be governed by the latest version of the following codes and standards. The publications are referred to in the text by basic designation only.

B. American Concrete Institute (ACI)

1. ACI 304R - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
2. ACI 305R - Hot Weather Concreting
3. ACI 306R - Cold Weather Concreting
4. ACI 308.1R - Standard Practice for Curing Concrete
5. ACI SP-66 - ACI Detailing Manual
6. ACI 503R - Use of Epoxy Compounds With Concrete

C. American Plywood Association (APA): Grades and Specifications.

D. American Society for Testing and Materials (ASTM)

1. ASTM A82-97a - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
2. ASTM A185-97 - Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
3. ASTM A615 - Standard Specification for Deformed Billet-Steel Bars for Concrete Reinforcement
4. ASTM C31 - Standard Method of Making and Curing Concrete Test Specimens in the Field
5. ASTM C33 - Concrete Aggregates
6. ASTM C94 - Ready-Mixed Concrete
7. ASTM C143 - Standard Test Method for Hydraulic Cement Concrete
8. ASTM C150 - Portland Cement

9. ASTM C172 - Standard Method of Sampling Freshly Mixed Concrete
10. ASTM C231 - Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method
11. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
12. ASTM C494 - Chemical Admixtures for Concrete
13. ASTM D994 - Performed Expansion Joint Filler for Concrete (Bituminous Type)
14. ASTM D1751 - Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
15. ASTM E1155 - Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System
16. ASTM C260 - Air Entraining Admixtures for Concrete
17. ASTM C920 - Elastomeric Joint Sealants
18. ASTM D4259 - Standard Practice for Abrading Concrete
19. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

E. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI - Concrete Reinforcing Steel Institute Manual of Practice
2. CRSI 63 - Recommended Practice for Placing Reinforcing Bars
3. CRSI 65 - Recommended Practice for Placing Bar Supports, Specifications and Nomenclature

1.03 QUALITY ASSURANCE

A. Construction Quality Assurance pertaining to construction items in this Section shall be the responsibility of the CQA ENGINEER, unless specifically identified to be performed by CONTRACTOR.

B. CONTRACTOR shall accommodate the CQA ENGINEER efforts to perform inspections, observations and tests as deemed necessary at no additional cost to OWNER.

C. Deficiencies in CONTRACTOR's work shall be identified to the CONTRACTOR by the ENGINEER. Repairs, replacements, rework or other corrective action shall be made prior to proceeding with ensuing Work that may be affected by the Work inspected.

D. The CONTRACTOR shall attend quality control meetings and make submittals in accordance with the specifications or as otherwise required by contract documents.

1.04 SUBMITTALS

A. Submit under provisions of Section 01410. This will include providing data on joint devices, attachment accessories, and admixtures.

1.05 DELIVERY AND STORAGE

A. Deliver reinforcement bundled and tagged to identify placement and certify testing.

B. Reinforcing steel shall be transported to the site, stored and covered in a manner which will ensure that no damage shall occur from moisture, dirt, grease, or any other cause that might impair steel integrity or bond to concrete. A sufficient supply of approved reinforcing steel shall be stored on the site at all times to ensure that there will be no delay of the work. Identification of steel shall be maintained after bundles are broken.

C. Replacements: In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the project.

PART 2 MATERIALS

2.01 FORM MATERIALS

A. Materials not specifically described but required for proper completion of concrete formwork.

2.02 REINFORCEMENT

A. Reinforcing Steel: New, deformed billet steel bars, plain finish, conforming to ASTM A615, Grade 60, unless noted otherwise on the drawings.

B. Tie Wire: Tie wire for reinforcement shall be 16 gauge or heavier, where noted or specified, black or galvanized steel wire, conforming to ASTM A82.

C. All other materials, not specifically described but required for a complete and proper installation of concrete reinforcement.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C150, Type II.

B. Regular Weight Concrete Aggregates: ASTM C33

1. Fine aggregate shall be washed clean, uniformly screen graded, and contain not more than 2 percent by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth, loam, mica or similar materials. Fine aggregate shall be graded uniformly from fine to coarse.
2. Coarse aggregate shall consist of clean, hard, crushed rock or washed gravel, free from organic materials or soft friable materials and shall not contain more than 2 percent by weight of shale or cherty material and not more than 15 percent by weight of elongated fragments.

C. Water: Clean and not detrimental to concrete.

D. Admixtures: All concrete shall contain an admixture of a type that increases workability and reduces water demand of concrete, but will not increase shrinkage. Admixture shall comply with the requirements of ASTM C494.

E. Curing Compound: ASTM C309, liquid membrane forming, with fugitive dye for identification. Compound shall be compatible with finish to be applied.

F. Concrete strength shall be 3,500 psi.

PART 3 EXECUTION

3.01 FORMWORK

A. CONTRACTOR shall direct the construction of formwork and shall be responsible for the maintenance and safety of all formwork during the entire construction period.

B. Forms will be placed as required to complete Work shown in Drawings.

C. General

1. Construct wood forms of sound material, of the correct shape and dimensions, mortar tight, and of sufficient strength to prevent movement by all loads imposed during placement. Construct forms so they may be easily removed without damage to the concrete.
2. Before concrete is placed in any form, the horizontal and vertical position of the form shall be carefully verified and all inaccuracies corrected. Concrete out of line, level, or plumb will be cause for rejection of the whole Work affected.
3. Tolerances: Construct formwork so that concrete surfaces will conform to Drawings.
4. Chamfer all exposed corners 3/4 inch, unless shown otherwise in the Drawings.
5. Any movement or bellying of forms during construction or variations in excess of specified tolerances will be considered just cause for the removal and replacement of the forms and the concrete affected. Reconstruction of forms and new concrete shall be furnished at no additional cost to the project.

D. Embedded Piping and Rough Hardware: Coordinate with other construction activities to permit the fastening of Work to the forms, and the accurate setting of anchors, or other rough hardware.

E. Form Removal: Formwork for slabs and other parts that support the weight of concrete shall remain in place until the concrete has reached its specified 28-day strength.

3.02 REINFORCEMENT

A. Fabrication

1. Fabricate concrete reinforcing in accordance with CRSI Manual of Practice.
2. Fabricate steel reinforcement in accordance with tolerances given in ACI 315 and the details shown in the Drawings.
3. Accurately bend, cut and place bars as indicated on the drawings. Bend bars cold. Heating of bars will not be permitted. Bars shall not be bent or straightened in any manner that will adversely affect material strength.
4. Locate reinforcing splices not indicated in Drawings, at point of minimum stress. Review location of splices with ENGINEER for acceptance.

B. Placement

1. General: Reinforcing steel shall be placed in accordance with ACI 301 Chapter 5 and the Drawings. Install reinforcement accurately and secure against movement, particularly under the weight and the placement of concrete.

2. Embedded Items: Check architectural, structural, mechanical and electrical drawings for anchor bolt schedules and locations, anchors, inserts, conduits, sleeves, and any other items which are required to be cased in concrete, and make necessary provisions as required so that reinforcing steel will not interfere with the placement of such embedded items.

3. Reinforcing Supports: Bars and welded wire fabric larger than eight-gauge shall be supported on metal chairs, spacers or metal hangers, accurately placed and securely fastened to steel reinforcement in place. Support legs of accessories in forms without embedding in form surface. Spacing of chairs and accessories shall conform with CRSI's "Recommended Practice for Placing Bar Supports." Wood will not be permitted inside forms. Precast concrete cubes may be used to support reinforcement in footings and slabs on ground.

4. Placing and Tying: Reinforcing shall be set in place, spaced, and rigidly and securely tied or wired with 16-gauge steel tie wire at all splices and at crossing points and intersections.

5. Spacing: Bars shall be spaced as indicated in the Drawings. Where not shown, the minimum clear spacing for main longitudinal column reinforcement shall not be less than 1-1/2 times the nominal bar diameter, nor 1-1/2 inches, nor 1-1/3 times the maximum size aggregate. For all other parallel bars, where spacing is not shown, the minimum clear spacing shall not be less than the nominal bar diameter, nor 1 inch, nor 1-1/3 times the maximum size aggregate. The clear distance limitations above also apply between the bars being spliced at a contact lap splice and adjacent bars.

6. Splices: Except for temperature bars in slabs and horizontal wall reinforcing, no splicing will be allowed for reinforcing bars unless detailed locations are given for these splices in the Drawings. Stagger lapped splices for horizontal wall reinforcing and slab temperature bars by the required lap splice length minimum. Whenever possible, splices of adjacent bars shall be staggered.

7. Dowels: Dowels shall be tied securely in place before concrete is deposited. In the event there are no bars in position to which dowels may be tied, No. 3 minimum shall be added to provide proper support and anchorage. Bending of dowels after placement of concrete will not be permitted unless indicated in the Drawings.

C. Cleaning

1. Reinforcement, at a time of pour, shall be free of coatings that would impair bond to concrete.

D. Inspection

1. Concrete shall not be placed until all reinforcing steel has been installed. Reinforcing shall be complete by the end of the working day prior to concrete placing.

E. Defective Work

1. The following reinforcing steel work will be considered defective and shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.
   a. Bars with kinks or bends not shown in the Drawings.
   b. Bars damaged due to bending or straightening.
   c. Bars heated for bending.
   d. Reinforcement not placed in accordance with the Drawings and/or Specifications.

3.03 CONCRETE

A. Examination

1. Verify requirements for concrete cover over reinforcement.
2. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

B. Mixing

1. Ready mixed concrete shall be used and shall be mixed and transported in accordance with "Specifications for Ready Mixed Concrete," ASTM C94.
2. Retempering: Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall be discarded and shall not be retempered.
3. Indiscriminate addition of water to increase slump shall be prohibited. When concrete arrives at the project with slump below that suitable for placing, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. The water must be incorporated by additional mixing equal to at least half of the total time required. Any addition of water above that permitted by the limitation of water-cement ratio must be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio.

C. Conveying and Placing Concrete

1. Pour Schedule:
   a. CONTRACTOR shall prepare and maintain a one-week pour schedule which shall be subject to ENGINEER approval. Schedule shall be for the purpose of scheduling inspections by CQA ENGINEER.

2. Preparation Before Placing:
   a. Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.
   b. Formwork shall have been completed; excess water shall have been removed; reinforcement shall have been secured in place; expansion joint material, anchors and other embedded items shall have been positioned; and the entire preparation shall have been approved by ENGINEER on the day prior to the placing of concrete.
   c. Semiporous subgrades shall be sprinkled sufficiently with water to eliminate suction and extremely porous subgrades shall be sealed in an approved manner.
   d. Before placing of any concrete, forms shall be thoroughly cleaned, washed out with water, and made tight. Before reinforcing steel is placed on top of and/or adjacent to forms which have been sealed, the surface sealer shall be wiped off so that none may be tracked over, or in any other way come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.
   e. Encrustations shall be removed from forms and reinforcing steel at construction joints. Concrete which has been previously placed shall be prepared by sandblasting to roughen surface and washed down.
   f. Depositing Against Other Concrete: Before depositing new concrete on or against hardened concrete, retighten forms and roughen surface of hardened concrete as follows. Thoroughly clean off foreign matter, and moisten with water. Apply bonding agent in accordance with manufacturer's instructions.
   g. In locations where new concrete is dowelled to existing Work, drill holes in existing concrete, insert steel dowels and pack solid with nonshrink grout.
3. Placement
   a. Place concrete in accordance with ACI 304.
   b. Notify CQA ENGINEER minimum 24 hours prior to commencement of operations.
   c. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent separation or loss of ingredients.
   d. Conveying equipment shall be of size and design to ensure a continuous flow of concrete at the delivery end.
   e. Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams, planes, or weakness within the section, or visible pour lines in the finish surface.
   f. Ensure reinforcement, insets, embedded parts, formed joint fillers, and joint devices are not disturbed during concrete placement.
   g. Concrete shall be consolidated by vibration, spading, rodding, or forking, so that the concrete is thoroughly worked around the reinforcement, around the embedded items, and into corners of forms, eliminating air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
   h. Other requirements: As required in ACI 301.

4. Slabs on Grade
   a. Joints in slabs on grade shall be located and detailed as indicated in the Drawings.
   b. Other requirements: As specified in ACI 301.
5. Hot Weather Placement:
   a. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection and curing to prevent excessive concrete temperatures or water evaporation which will impair the required strength or serviceability of the member of structure.
   b. Concrete deposited during hot weather shall have a temperature of not more than 75 to 80 degrees Fahrenheit.
   c. Work shall conform to Hot Weather concreting, ACI 305R.
6. Cold Weather Placement:
   a. Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing or near-freezing weather.
   b. Concrete materials and all reinforcement, forms, fillers and ground with which the concrete is to come in contact shall be free of frost.
   c. No frozen materials or materials containing ice shall be used. The temperature of the concrete shall be not less than 60 degrees Fahrenheit at time of placing in the form, and shall be maintained between 50 to 70 degrees Fahrenheit for required curing period.
   d. Work shall conform to Cold Weather Concreting, ACI 306R.

D. Repair of Surface Defects

1. Removal: After forms have been removed, any concrete which is not formed as shown on the plans, or which is out of alignment or level beyond required tolerances shall be removed and replaced at no additional cost to the project. Defective surfaces may be repaired and patched in accordance with the following procedure.
2. Repair Procedure
   a. Form tie holes shall be filled and repairable defective areas patched immediately after the forms have been removed. Remove fins and burrs.
   b. Honeycombed and other defective concrete shall be removed to sound concrete, but in no case to a depth of less than one inch. The area to be patched and an area of at least six inches wide surrounding it shall be dampened to prevent adsorption of water from the patching mortar. A bond of neat Portland cement and water shall be mixed to the consistency of thick cream and shall then be well brushed into the surface. Other concrete bonding agents may be used when approved.
   c. The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the

gray Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.

d. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

e. After surface water has evaporated from the areas to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before final finishing. The patched area shall be kept damp for seven days.

f. Other requirements: As specified in ACI 301.

E. Concrete Finishes

1. Finishes for Formed Surfaces:

a. As-Cast Surfaces: After surface defects have been repaired, as specified, concrete shall be left with finish imparted by forms. Use for all concrete below grade.

b. Surface Preparation for Exposed Concrete: Fins, rough spots, stains and hardened mortar shall be removed by carefully rubbing with a fine abrasive stone to a smooth event surface. Excess form sealer shall be removed by carefully scrubbing surface with 5 to 10 percent solution of muriatic acid. Fill all holes and rub smooth.

2. Finishes for Slabs on Grade:

a. Light broom finish shall be used at support slabs. Immediately after trowelling, the surface shall be broomed uniformly, using a broom with moderately fine, soft bristles.

3. Flatness and Levelness of Slabs:

a. Concrete slabs shall be finished per the slope and level as shown in the Drawings.

F. Protection, Curing and Handling

1. Cure concrete surfaces in accordance with ACI 308.

2. General: Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures, and shall be maintained without drying at a relatively constant temperature for the period of time necessary for the hydration of the cement and proper hardening of the concrete.

3. Initial Curing: Initial curing shall immediately follow the finishing operation. Concrete shall be kept continuously moist at least overnight. One of the following materials or methods shall be used.
   a. Ponding or continuous sprinkling.
   b. Absorptive mat or fabric kept continuously wet.
   c. Sand or other covering kept continuously wet.
   d. Curing compound applied in accordance with the recommendations of the manufacturer. Do not use on any surfaces against which additional concrete or other cementitious finishing materials are to be bonded, or surfaces to receive hardener and clear sealer.
4. Final Curing: Immediately following the initial curing and before the concrete has dried, additional curing shall be accomplished by one of the following materials or methods.
   a. Continuing the method used in initial curing.
   b. Waterproof paper covering.
   c. Other moisture-retaining coverings as approved.
5. Duration of Curing: The final curing shall continue for a total of seven days. If high early strength of concrete has been used, the final curing shall continue for a total of three days. Rapid drying at the end of the curing period shall be prevented.
6. Formed Surfaces: Steel forms heated by the sun and all wood forms in contact with the concrete during the final curing period shall be kept wet. If forms are to be removed during the curing period, one of the above curing materials or methods shall be employed immediately. Such curing shall be continued for the remainder of the curing period.
7. Protection from Mechanical Injury: During the curing period, protect from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration. Protect finished concrete surfaces from damage caused by construction equipment, materials, or methods, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete. In no case shall be concrete be loaded before seven days after pouring.

G. Repair of Cracks and Joints in Existing Concrete Paving

1. Work to be performed by a CONTRACTOR specializing in concrete crack repair.
2. Prepare cracks by blowing clean with oil-free compressed air or by flushing with an appropriate cleansing solution as required to remove foreign substances and contaminants. Prepare exposed surfaces for bonding in accordance with ASTM D4259 or ACI 503R and ChemCo Systems' specific recommendations. CONTRACTOR shall be responsible for making crack surface bondable.
3. Cracks and joints shall be filled according to the manufacturer's instructions for the specific product. Cracks are to be sealed prior to injection with CCS Grout Seal, manufactured by ChemCo Systems, or equivalent. Cracks wider than 1/4-inch shall be injected with an epoxy paste adhesive meeting the requirements of ASTM C 881 Type I Grade 3 (CCS Bonder Paste, Long Working Life or equivalent). Cracks less than

1/4-inch wide shall be injected with a two-component epoxy paste adhesive meeting the requirements of ASTM C 881 Type IV Grade 1 (CCS Grout, Slump Pumping or equivalent). Control joints shall be filled with an epoxy meeting the requirements of ASTM C 881 Type III Grade 2 (CCS Grout, Control Joint or equivalent).

4. All crack and joint fillers shall be ground off to provide a finished surface that is level and flush with adjoining concrete, with no excess material or uneven surfaces remaining.

5. Cracks extending under existing equipment or other items that would be too costly to move or would disrupt work for an extended period of time may be repaired by sealing around the perimeter of the equipment. CONTRACTOR shall provide a procedure for sealing around equipment and obtain approval from the ENGINEER prior to doing the work.

H. Concrete Floor Slab Over Buried Waste Utility Penetrations Treatment

1. All penetrations through the floor slab shall be cleaned and CMA (chloroprene modified asphalt) membrane applied as shown. The CMA membrane shall be equivalent to LIQUID BOOT®, as manufactured by LBI Technologies, Inc.

2. The concrete shall be free of dirt, debris, loose material or curing compounds prior to membrane application.

3. Provide a 3/4-inch thick minimum cant of CMA membrane at all horizontal to vertical transitions. Extend the membrane at an 80 mil thickness 3 inches around the base of the penetration and up the penetration a minimum of 3 inches. Allow to cure overnight. Spray apply CMA membrane to an 80 mils minimum dry thickness around the penetration and to a height 1 1/2-inches minimum above the CMA membrane cant.

4. Wrap penetration with polypropylene cable at a point 2 inches above the base of the penetration. Tighten the cable tie firmly so as to squeeze the cured membrane collar.

3.04 QUALITY CONTROL

A. Perform concrete reinforcement Work in accordance with CRSI 63, 65 and Manual of Practice.

B. Acquire cement and aggregate from same source for all Work.

C. Conform to ACI 305R when concreting during hot weather.

D. Conform to ACI 306R when concreting during cold weather.

E. Design, construct and maintain forms and shoring true to line, grade and configurations shown in the Drawings, and so as to provide finish concrete within the specified tolerances.

F. CONTRACTOR shall use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work in this Section.

G. CONTRACTOR shall use equipment adequate in size, capacity and numbers to accomplish the Work in this Section in a timely manner.

H. In addition to complying with requirements of REGULATORY AUTHORITIES having jurisdiction, CONTRACTOR shall comply with the directions of ENGINEER.

* * * END OF SECTION * * *

SECTION 02355
SEALING OF EXISTING CONCRETE PAVING AND FLOOR SLABS

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall prepare a plan and Specifications for Sealing of Existing Concrete Paving and Floorslabs.

1.02 SUBMITTALS

A. CONTRACTOR shall submit a plan for Sealing of Existing Concrete Paving and Floorslabs to be approved by the ENGINEER which provides for accepted methods of repair.

PART 2 MATERIALS

2.01 GENERAL

A. CONTRACTOR shall provide a description of methods, products cut-sheets and other pertinent information relating to materials.

PART 3 EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall complete work under this Specification as described and approved in the Sealing of Existing Concrete Paving and Floorslabs Plan.

* * * END OF SECTION * * *

SECTION 02360
COLD PLANING EXISTING PAVEMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. COLD PLANING EXISTING PAVEMENT shall consist of furnishing transportation, labor, materials, equipment, and incidentals necessary to cold plane (or cold mill) existing asphalt concrete pavement.

1.02 RELATED WORK

A.	DEMOLITION	Section 02020
B.	ASPHALT CONCRETE PAVING	Section 02370

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.01 GENERAL

A. Remove existing asphalt pavement to provide asphalt overlay shown on the Drawings and as directed by the ENGINEER. The resulting cuttings shall be disposed in an area designated in the field by the ENGINEER.

B. Cold planing shall not tear, grout or otherwise damage remaining underlying pavement.

C. The planed surface shall be uniform in texture and smoothness and be such that a 10 foot straight edge laid in any direction at any location reveals less than a 0.04 foot variation.

D. Where the pavement is to be resurfaced unless otherwise directed by the ENGINEER, a 1-1/2 inch minimum shoulder shall be cut along join lines to eliminate the necessity of feathering edging and providing a butt join.

E. Prior to starting cold planing, CONTRACTOR shall walk area to be cold planed with a metal detector to locate unmarked utilities, fence posts, and other interferences.

3.02 EQUIPMENT

A. Planing equipment shall be self-propelled and capable of cutting flush to curbs, gutters, catch basins, manholes, utility vaults, and other structures within the paved area. Equipment for mini cold planing may also be required.

B. Planing equipment shall include a dust suppression system that meets air quality regulations.

C. Planing machine shall be capable of cutting to daylight while maintaining desired profile.

D. The cutting drum shall be adjustable to grade and slope by either manual or automatic controls.

* * * END OF SECTION * * *

SECTION 02370
ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.01 DESCRIPTION

A. ASPHALT CONCRETE PAVING consists of furnishing transportation, labor, materials, equipment and incidentals necessary to construct asphalt concrete paving.

1.02 RELATED WORK

A. COLD PLANING Section 02360

1.03 REFERENCE STANDARDS

A. Standard Specifications for Public Works Construction.

B. American Society for Testing Materials (ASTM):

1. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
2. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
3. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method.
4. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.

1.04 QUALITY ASSURANCE

A. Testing and inspection of asphalt pavement mix and testing of placed asphalt pavement will be performed by the CQA ENGINEER.

B. CONTRACTOR shall allow CQA ENGINEER access to the mixing plant for verification of weights or proportions, character of materials used and determination of temperatures used in the preparation of asphalt concrete mix.

C. The CONTRACTOR shall have major equipment items available for inspection by the ENGINEER. Deficiencies in quality, quantity, or types of equipment shall be corrected prior to commencing work. This inspection and approval shall in no way relieve the CONTRACTOR from the obligation to provide the equipment required to perform the work.

D. When areas to be repaved have been cold planed in accordance with the Specification, notify the ENGINEER for approval. Do not place asphalt pavement until cold planed areas have been approved.

E. If compaction tests indicate that the asphalt concrete paving does not meet specified requirements, retest costs will be the responsibility of the CONTRACTOR.

F. Paving shall only be performed during daylight hours.

1.05 SUBMITTALS

A. A copy of the asphalt test report required by Section 203-1 of the Standard Specifications for Public Works Construction shall be submitted to the ENGINEER for forwarding to the CQA ENGINEER.

B. A list of equipment to be used for placing asphalt concrete shall be submitted to the ENGINEER prior to utilization on the job.

C. A copy of the job mix formula and test data shall be submitted to the ENGINEER for approval.

1.06 EQUIPMENT

A. CONTRACTOR shall provide and maintain in operating condition equipment, tools, and machines used in the performance of the work.

PART 2 PRODUCTS

2.01 ASPHALT CONCRETE

A. The asphalt concrete material used shall comply with the requirements of a Type C2 AR4000 material per Section 203-6 of the Standard Specifications for Public Works Construction, 2003 ed., for all pavements placed at less than 2 inches thick. The Design Air Void content shall be 2.0 to a maximum 4.0.

B. The asphalt concrete material used shall comply with the requirements of a Type B AR4000 material per Section 203-6 of the Standard Specifications for Public Works Construction, 203 ed., for all pavements placed greater than 2 inches thick. The design air void content shall be 2.0 to a maximum 4.0 Air Void content.

C. The asphalt concrete must be demonstrated by the Contractor to achieve a hydraulic conductivity of 1×10^{-7} cm/sec or less. Testing methods and results must be submitted to CQA Engineer prior to placing asphalt.

D. The Contractor may propose any asphalt concrete mix design which is demonstrated to provide equivalent or better performance with regard to durability, strength and hydraulic conductivity compared to the above requirements. Testing data and results must be submitted to the CQA Engineer by the Contractor for approval of alternate mix designs.

2.02 AGGREGATE BASE

A. All aggregate base materials used on site shall meet the minimum standards of a Crushed Miscellaneous Base (CMB) product and shall have a minimum R-value of 80. Certification of the stockpile R-value testing must be recent (i.e., maximum of three months at the time of construction). The CMB shall be approved by the Engineer prior to use on site. The CMB must also meet the requirements stated in the SSPWC, Section 200, 2003 ed.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. The surface on which the asphalt paving is to be placed shall be prepared in conformation with Section 02360.

B. The surface on which the asphalt paving is to be placed shall be cleaned and swept, free of dirt, water, oil, and vegetation.

3.02 CONSTRUCTION

A. No pavement shall be laid until the surface on which the asphalt pavement is to be placed has been approved by the ENGINEER. Paving shall be continued as expeditiously as possible once commenced.

B. The required thickness of the paving shall be as directed by the ENGINEER.

C. Pavement shall not be laid on concrete or timber substrate, or on previously surfaced areas, unless such surfaces are clean and dry to the satisfaction of the ENGINEER.

D. Wherever asphalt concrete pavement does not terminate against a curb, gutter, or another pavement, the CONTRACTOR shall provide and install a header board at the line of termination.

E. The ENGINEER reserves the right to specify varying combinations of pavement sections.

3.03 ASPHALT CONCRETE PAVING

A. Asphalt concrete shall be placed in lifts of a maximum of four (4) inches each. A tack coat shall be applied between successive lifts of asphalt concrete, as well as between any course and the new asphalt concrete if a satisfactory bond could not otherwise be attained. All mix designs shall be submitted for approval by the Engineer at least two (2) weeks prior to construction. All pavement thickness identifications are considered measurements. The minimum compaction required for all aggregate base materials shall be 94 percent of the Rice Specific Gravity per ASTM D2726. All asphalt concrete material shall be placed and compacted in accordance with Section 302 of the SSPWC, 2003 ed.

B. Asphalt concrete overlays utilizing an engineering fabric shall be constructed in the following manner. Leveling courses required shall be placed prior to the placement of the engineering fabric. The asphalt concrete leveling course shall be placed after all header cuts have been constructed. Cold milling of the perimeter edges at a depth of 1-5/8 inches is required. In the event that the cold milling grinds completely through the 1-5/8-inch depth the contractor shall remove the exposed base and/or subgrade material to a depth of two (2) additional inches and

place new asphalt concrete material in the excavated area. All asphalt concrete shall be placed to a point no closer than six inches and no greater than one foot from all gutters and construction limits. The asphalt concrete overlay shall be constructed on the same day the engineering fabric is placed, in no case shall more fabric be placed than can be covered in one day. All work shall be performed in accordance with Section 302-5 of the Standard Specifications for Public Works Construction, 2003 ed and as indicated herein. A tack coat of SS-1h shall be placed between all lifts.

3.04 JOINING PAVEMENT

A. Carefully lay joints between existing and new pavements or between successive days' work in such a manner as to ensure a continuous bond between existing and new sections. Expose, clean, and cut edges to straight, vertical surfaces. Paint joints with a uniform coat of tack coat before the fresh mixture is placed.

3.05 QUALITY ASSURANCE/QUALITY CONTROL

A. Construction of the asphalt concrete will be observed and tested by CQA ENGINEER to verify subgrade conditions, moisture content and compaction, and drainage and finished grades are in compliance with these Specifications and Drawings.

B. CQA ENGINEER will perform moisture content and in place density tests on the prepared subgrade at the rate of one test for every 1,500 square feet of compacted 6-inch lift or more frequently, if necessary, based on observations of subgrade conditions and weather conditions. CQA ENGINEER will require samples and determine the maximum dry density and optimum moisture content (per ASTM D1557) of subgrade material for use in monitoring as-built moisture and relative compaction.

C. At least ten days prior to construction of the asphalt concrete and subbase, CONTRACTOR shall provide CQA ENGINEER and ENGINEER with samples from the proposed source of Caltrans Class 2 aggregate base material for grain size analysis and maximum dry density determination.

D. ENGINEER will perform moisture content and in place density tests on the Caltrans Class 2 aggregate base at the rate of one test for every 1,500 square feet per lift of material placed or more frequently, if necessary, based on observations of material and placement

conditions/procedures and weather conditions. CQA ENGINEER will require samples and determine the maximum dry density and optimum moisture content (per ASTM D1557) of the material for use in monitoring as-built moisture and relative compaction.

E. CONTRACTOR shall supply certificates of the materials and mix design from the asphalt concrete plant to CQA ENGINEER and ENGINEER prior to pavement construction. This will include laboratory determination of the theoretical maximum density (at 8 percent air voids).

F. During placement, CQA ENGINEER will check the temperature and gradation of the asphalt concrete for compliance with Section 39 requirements of Standard Specifications, California Department of Transportation.

G. SURVEYOR shall provide grade control survey data to ENGINEER for checking and verification prior to placement of the overlying layer and finishing of the final surface.

3.06 DEFECTIVE MATERIALS

A. Materials not complying with the specified requirements are not acceptable. Remove and replace defective materials as directed by the ENGINEER.

3.07 FLOOD TEST

A. Flood asphalt pavement with water to check for positive drainage. Provide materials and equipment for flood testing. Test shall be performed in the ENGINEER'S presence.

* * * END OF SECTION * * *

SECTION 02400
CHAIN-LINK FENCING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes the installation of a 6-foot chain link fence around the reservoir cap gas vent collection system.

B. The 6-foot high chain link fence specifications are also included for existing fences that are damaged or require reinstallation by CONTRACTOR.

PART 2 MATERIALS

A. The 6-foot high fence shall be from the material obtained from the demolishment activities or the following:

1. Intermediate posts shall be 2-3/8-inch diameter Type I round.
2. Terminal and corner posts shall be 2-7/8-inch diameter Type I round.
3. Top and brace rails shall be 1-5/8-inch diameter plain end.
4. Fabric shall be 2-inch diamond mesh interwoven wire 9 gauge thick, top salvage twisted tight, bottom salvage knuckle end closed.
5. Hardware shall be galvanized to ASTM A153, 1.8 ounces per square foot.
6. Fabric wire steel shall be zinc coated wire fabric.
7. Framing shall be Schedule 40 steel.

PART 3 EXECUTION

A. A 6-foot high fence shall be installed with the following procedures:

1. Install framework, fabric, accessories (and gates) in accordance with ASTM F567 manufacturer's instructions.
2. Set intermediate terminal and posts plumb, in concrete footings with top of footing 6 inches below finish grade.
3. Line post footing depth below finish grade: ASTM F567, 2.5 feet.
4. Corner, terminal post footing depth below finish grade: ASTM F567, 2.5 feet.
5. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail, one bay from end and gate posts.
6. Provide top rail through line post tops and splice with 6-inch long rail sleeves.

7. Install bottom brace rail on corner gate leaves.
8. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
9. Position bottom of fabric 2 inches above finished grade.
10. Fasten fabric to top rail, line posts, braces and bottom tension wire with tie wire at maximum 15 inches on centers.
11. Attach fabric to end, corner and gate posts with tension bars and tension bar clips.
12. Install bottom tension wire stretched taut between terminal posts.

* * * END OF SECTION * * *

SECTION 02410
STRAY BALL FENCE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes the installation of a 20-foot-high stray ball nylon mesh fence by CONTRACTOR as shown in the drawings.

1.02 SUBMITTALS

A. CONTRACTOR shall submit a plan for construction of the 20-foot-high, approximately 525-feet long nylon fence including proposed cable and anchoring systems as per requirements in Section 01400 of the specifications.

PART 2 MATERIALS

A. The 20-foot high fence shall be installed from the following materials:
   1. Intermediate, corner and terminal posts shall be 3-inch diameter Type I round.
   2. Top and bottom cable systems shall be incorporated for netting connection.
   3. Netting shall be 100 percent nylon twine with latex treatment and 1-3/4-inch mesh.
   4. Hardware shall be galvanized to ASTM A153, 1.8 ounces per square foot.

PART 3 EXECUTION

A. CONTRACTOR shall provide the design and describe in detail the installation of the 20-foot high fence in a submittal for approval by the Engineer.

* * * END OF SECTION * * *

SECTION 02500
PRECAST CONCRETE CATCH BASIN

PART 1 GENERAL

1.01 DESCRIPTION

A. As shown in the Drawings, CONTRACTOR shall construct catch basin inlet for the surface drainage system. The basin shall be precast concrete and provided with a landscape grate.

1.02 QUALITY CONTROL

A. CQA ENGINEER shall observe installation of the catch basin to verify conformance with the contract documents.

1.03 SUBMITTALS

A. A CONTRACTOR shall submit MANUFACTURER's certifications for the precast concrete catch basin as outlined in Section 01410.

PART 2 MATERIALS

A. Catch basin shall be precast concrete Brooks products, or equivalent with landscape grate. Size of catch basin is indicated in the Drawings.

PART 3 EXECUTION

A. The placement of the precast concrete catch basin and landscape grate shall be performed in accordance with procedures in Standard Specifications for Public Work Construction and the Drawings.

* * * END OF SECTION * * *

SECTION 02510
CATCH BASIN TIE-IN

PART 1 GENERAL

1.01 DESCRIPTION

A. The CONTRACTOR shall connect the onsite storm drain system into an existing Los Angeles County Department of Public Works (LACDPW) catch basin along Greenleaf Avenue.

PART 2 EXECUTION

A. The CONTRACTOR shall excavate a trench behind the existing LACDPW catch basin to construct the connection with the onsite 16-inch-diameter PVC storm drain pipe.

B. The CONTRACTOR shall construct the connection as shown in the Drawings and pursuant to LACDPW standards.

* * * END OF SECTION * * *

SECTION 02520
LEACHATE MONITORING/CONTROL SYSTEM WELL INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes:

1. The procedures used to construct the leachate monitoring/control system wells within the reservoir.

1.02 QUALITY CONTROL

A. CQA ENGINEER shall observe casing placement and connection procedures to confirm that the CONTACTOR has completed the work in accordance with the Drawings and Specifications, and has not damaged the casing or left a loose/leaking connection. Details of field quality control are given in Section 3.02.

1.03 SUBMITTALS

A. CONTRACTOR shall submit manufacturer literature on casing and screen, including supplier design tensile and compression strength estimates, inside and outside diameter of casing and slot size of screen.

B. Submittals by CONTRACTOR shall be in accordance with Section 01410.

C. If manufacturer's test data is inadequate or unavailable, the PROJECT MANAGER reserves the right to reject shipments. Costs of shipment shall be borne by the CONTRACTOR.

PART 2 MATERIALS

2.01 LEACHATE MONITORING/CONTROL SYSTEM CASING

A. Pipe sizes, types and locations are designated in the Drawings.

B. Slotted Pipe: the 4-inch-diameter pipe shall be Schedule 80 flush-threaded PVC with factory slotted 0.02-inch slots.

C. Nonslotted pipe: the 4-inch-diameter pipe shall be Schedule 80 flush-threaded PVC.

2.02 OTHER MATERIALS

A. No. 2/12 Monterey Sand filter pack (or equivalent).

B. Volclay grout (or equivalent).

C. Bentonite pellets (1/4-inch).

D. Concrete.

E. Twelve-inch diameter, 3 feet long, 1/4-inch gauge steel standpipes and locking well caps.

PART 3 EXECUTION

3.01 INSTALLATION

A. The monitoring wells shall be drilled using a hollow-stem auger drill rig. The borings shall be drilled to the bottom of the reservoir using a 10-inch-diameter hollow-stem auger.

B. The wells shall be constructed using 4-inch-diameter, Schedule 80 PVC flush-threaded casings with stainless steel centralizers placed towards the bottom of the well casing. The well screen shall consist of 0.020-inch factory slotted, 4-inch-diameter stainless steel casing. Two feet of screen shall be flush-threaded on the end closest to the ground surface and capped on the bottom. While the screen is slightly above ground, flush-threaded 4-inch-diameter Schedule 80 PVC blank casing shall be securely attached to the screen.

C. The annulus of the well shall be filled via tremie pipe with No. 2/12 filter pack sand to 2 feet above the screened zone. A 3-foot-thick seal of hydrated 1/4-inch bentonite pellets shall be placed over the sand filter, and a bentonite grout shall be used to fill the remainder of the

annulus to the surface. The wellheads shall be constructed with steel standpipe completion and a locking cap, and set in concrete as shown in the Drawings.

D. Soil cuttings generated during drilling, as well as equipment decontamination activities, shall be placed in 55-gallon DOT-approved drums. The drums shall be covered with lids and properly labeled. The drums shall be placed on pallets, covered and stored onsite in a secure area. The contents of the drums shall be incorporated into the reservoir area subgrade during final remedy construction.

E. Water generated during equipment decontamination shall be discharged to the onsite Baker Tank currently storing ground water monitoring purge water.

F. CONTRACTOR shall verify integrity of pipes in accordance with Section 3.02 of these specifications.

3.02 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications for the following reasons:
   1. Fractures or cracks passing through the pipe wall. All pipes within one shipment shall be rejected if defects exists in more than 5 percent of the shipment or delivery.
   2. Damaged ends, whereas such damage would prevent making a satisfactory joint.

* * * END OF SECTION * * *

SECTION 02530
SENTINEL BIOVENT WELL INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes the procedures used to construct the biovent wells.

1.02 QUALITY CONTROL

A. CQA ENGINEER shall observe casing placement and connection procedures to confirm that the CONTACTOR has completed the work in accordance with the Drawings and Specifications, and has not damaged the casing or left a loose/leaking connection. Details of field quality control are given in Section 3.02.

1.03 SUBMITTALS

A. CONTRACTOR shall submit manufacturer literature on casing and screen, including supplier design tensile and compression strength estimates, inside and outside diameter of casing, and slot size of screen.

B. Submittals by CONTRACTOR shall be in accordance with Section 01410.

C. If manufacturer's test data is inadequate or unavailable, the ENGINEER reserves the right to reject shipments. Costs of shipment shall be borne by the CONTRACTOR.

PART 2 MATERIALS

2.01 BIOVENT WELL CASING

A. Pipe sizes, types and locations are designated in the Drawings.

B. Slotted Pipe: the 4-inch-diameter pipe shall be Schedule 40 flush-threaded PVC with factory slotted 0.02-inch slots.

C. Nonslotted pipe: the 4-inch-diameter pipe shall be Schedule 40 flush-threaded PVC.

2.02 OTHER MATERIALS

A. No. 2/12 Monterey Sand filter pack (or equivalent).

B. Volclay grout (or equivalent).

C. Bentonite pellets (1/4-inch), premium grade Wyoming Sodium Montmorillonite, or equal.

D. Concrete (Cement: ASTM C150, Type II).

E. 10-Inch-diameter steel standpipes and locking well caps.

F. One-way biovent valve, air injection type, BaroBall valve by Durham Geo Enterprises (or equivalent).

PART 3 EXECUTION

3.01 INSTALLATION

A. The biovent wells shall be drilled using a hollow-stem auger drill rig. The borings shall be drilled to the depth as shown in the drawings using a 10-inch-diameter hollow-stem auger.

B. The wells shall be constructed using 4-inch-diameter, Schedule 40 PVC flush-threaded casings with stainless steel centralizers placed at the top and bottom of the waste zone. The well screen shall consist of 0.020-inch slotted, Schedule 40, flush-threaded PVC casing. Two feet of screen shall be flush-threaded on the end closest to the ground surface and capped on the bottom. While the screen is slightly above ground, flush-threaded 4-inch-diameter Schedule 40 PVC blank casing shall be securely attached to the screen. The blank casing shall extend to a minimum of 12 inches above the surface. A one-way biovent valve shall be installed at the top of the blank casing.

C. The annulus of the well shall be filled via tremie pipe with No. 2/12 filter pack sand to 2 feet above the screened zone. A 3-foot-thick seal of hydrated 1/4-inch bentonite pellets shall be placed over the sand filter, and a bentonite grout shall be used to fill the remainder of the annulus to the surface. The wellheads shall be constructed with steel standpipe completion and a locking cap, and set in concrete as shown in the Drawings. The steel pipe shall be vented by drilling 1/2-inch diameter holes, 6 holes per foot and 4 holes spaced at 90 degrees around the standpipe. Wells located in parking or traffic areas or subject to damage in any way shall have bollands installed as necessary to protect the well.

D. Soil cuttings generated during drilling, as well as equipment decontamination activities, shall be placed in 55-gallon DOT-approved drums. The drums shall be covered with lids and properly labeled. The drums shall be placed on pallets, covered and stored onsite in a secure area. The contents of the drums shall be incorporated into the reservoir area subgrade during final remedy construction.

E. Water generated during equipment decontamination shall be discharged to the onsite Baker Tank currently storing ground water monitoring purge water.

F. CONTRACTOR shall verify integrity of pipes in accordance with Section 3.02 of these specifications.

3.02 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications for the following reasons:
   1. Fractures or cracks passing through the pipe wall. All pipes within one shipment shall be rejected if defects exists in more than 5 percent of the shipment or delivery.
   2. Damaged ends, whereas such damage would prevent making a satisfactory joint.

* * * END OF SECTION * * *

SECTION 02540
EXISTING BUILDING FOUNDATION VENT SYSTEM PIPE AND EQUIPMENT INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes:

1. The procedures used to install the passive vent system at existing buildings if indoor air monitoring shows constituents of concern above the Interim Threshold Screening Levels (ITSLs).
2. The procedures used to install the Carbon Adsorption System if Volatile Organic Compound (VOC) emissions exceed 1 pound per day per foundation vent system.

1.02 AGENCY APPROVALS

A. The proposed system must be approved by the City of Santa Fe Springs Fire Chief and shall comply with Ordinance No. 829, an ordinance of the City of Santa Fe Springs amending the City Code with respect to oil and gas regulations.

1.03 QUALITY CONTROL

A. The following Reference Standards shall be used:

1. American Society for Testing and Materials (ASTM):
   a. ASTM D638-99 - Test Method for Tensile Properties of Plastics
   b. ASTM D790-99 - Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   c. ASTM D1238-99 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   d. ASTM D1505-98 - Test Method for Density of Plastics by the Density-Gradient Technique.
   e. ASTM D1693-00 - Test Method for Environmental Stress Cracking of Ethylene Plastics.
   f. ASTM D-1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   g. ASTM D-1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   h. ASTM D-2466 - Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   i. ASTM D-2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

j. ASTM D-2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
k. ASTM D-2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
l. ASTM D-2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
m. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
n. ANSI B16.5 - Steel Pipe Flanges, Flanged Valves, and Fittings.
o. ANSI B31.1 - Safety Code for Pressure Piping.
p. ASTM D-226-97 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

B. Concrete and reinforcement shall be in accordance with Section 02350. Where trenching inside existing buildings requires replacement of the concrete floor, CONTRACTOR shall match the existing floor slab thickness and return the floor to its original condition.

C. Trenching, backfilling and compacting shall be in accordance with Section 02180.

D. CQA ENGINEER shall verify the proper manufacturer's certifications and identifiers and that conformance test results meet specifications for all piping prior too acceptance for placement. CQA ENGINEER shall observe pipe placement and connection procedures to confirm that the CONTRACTOR has completed the work in accordance with the Drawings and Specifications, and has not damaged the piping or left a loose/leaking connection. Details of field quality control are given in Subsection 3.02.

1.04 SUBMITTALS

A. CONTRACTOR shall submit pipe manufacturing data listing stock density, melt flow, flexural modulus, tensile strength, environmental stress crack resistance and coloration.
B. Submittals by CONTRACTOR shall be in accordance with Section 01410.

C. If pipe manufacturer's test data is inadequate or unavailable, the PROJECT COORDINATOR reserves the right to reject shipments. Costs of shipment shall be borne by CONTRACTOR.

PART 2 MATERIALS

2.01 EXISTING BUILDING FOUNDATION VENT SYSTEM PIPE

A. Pipe sizes, types and location are designated in the Drawings. Acceptable manufacturers in the U.S. include:

1. Harvel Plastics, Inc., Bakersfield, California.
2. Asahi America, Malden, Massachusetts.
3. Harrington Industrial Plastics, Inc., Chino, California.
4. Or equivalent, as approved by ENGINEER.

B. Perforated Pipe:

1. The 2-inch diameter gas extraction system pipe shall be Schedule 40 socket type PVC with perforations making up a minimum of 2 percent of the surface area of the pipe and symmetrical around the pipe.

C. Nonperforated Pipe:

1. The 2-inch diameter vent piping and carbon adsorption system piping shall be Schedule 40 seamless or electric-resistance welded galvanized carbon steel, conforming to ASTM A53, Grade B, Type E or S.

D. Marking shall be at intervals of 5 feet or less and include the following information:

1. MANUFACTURER'S name or trademark.
2. Nominal pipe size.
3. Material type, HDPE, PVC, etc.
4. Legend: pipe grade, SDR (if applicable).
5. ASTM designation (as appropriate).
6. Extrusion date, period of manufacture or lot number (plastic pipe).

2.02 FITTINGS

A. PVC fittings shall be molded from PVC having cell classification equal to or exceeding that used in pipe conforming to ASTM D1784.

B. PVC fittings shall be of same manufacturer as pipe being provided.

C. Manufacturers Markings shall include the following information:

1. Manufacturer's name or trademark.
2. Nominal size.
3. Material designation "PVC."
4. ASTM D1785.

D. Steel fittings shall be welded or flanged 150 psig forged steel, conforming to ANSI B16.5.

2.03 EQUIPMENT

A. Blower:

1. McMaster-Carr Supply Company Blower Model No. 1954K999, cast aluminum high-pressure blower, 1/3 HP with ANSI flanges or equivalent, as approved by ENGINEER.

B. Carbon Adsorbers:

1. Carbtrol Carbon Adsorber Model G-4, flow rate 600 cfm.
2. Or equivalent, as approved by ENGINEER.

2.04 TRENCH MATERIALS AND BACKFILL

A. Roofing felt shall be in accordance with ASTM D226-97a.

B. Gravel and sand backfill materials shall be in accordance with Section 02180.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe Trenches:

1. Ventilation trenches inside buildings must be no further than 50 feet apart or 25 feet from the building foundation.
2. Ventilation trenches must be provided for each area isolated by a continuous footing.
3. Trench depth shall be a minimum of 13 inches below existing floor slab bottom.
4. Trench width shall be a minimum of 12 inches wide.
5. Horizontal vent pipe shall be located at the highest point of the gravel portion of the trench.
6. Vertical ventilation pipes must be provided for every 400 feet of ventilation trench or at each end of trench, whichever is least.
7. All vertical ventilation pipes must be terminated at a minimum of 2 feet above the highest point on the roof within a 10 foot radius of the vent pipe and away from sources of ignition.
8. Roofing felt shall extend a minimum of 6 inches on both sides over the width of the trench.

B. The PVC pipe and pipe fittings shall be joined by use of solvent-based cement manufactured in accordance with ASTM D2564.

C. Joining of PVC pipe shall be performed by a qualified person. Thermal expansion shall be accounted for during placement of the PVC pipe.

D. Pipe shall be cleaned and inspected on the inside prior to assembly. Open pipe ends shall be capped or equivalency taped at the end of each working day.

E. Vent piping shall be adequately supported using manufacturer's recommended support spacing.

F. CONTRACTOR shall provide unions or other breakout fittings at all equipment connections, as necessary, to facilitate easy installation/removal/changeout.

G. CONTRACTOR shall verify integrity of piping systems in accordance with Section 3.02 of these specifications.

3.02 PRESSURE TEST

A. Before pressure testing, blow the pipe clean of dirt and debris and remove from systems equipment which would be damaged by test pressure. Replace equipment after testing. Systems may be tested in sections. Perform system pressure testing on completed pipe systems as follows:

   1. Pressurize piping with an equivalent of 10-feet of hydrostatic pressure (4.3 psi) for at least 15 minutes. Do not use compressed air or gas to test PVC pipe. Vent all trapped air prior to pressurizing pipe.

B. Locate and repair all leaks. Correct leaks by replacing faulty materials with new material.

C. Repeat pressure testing until the piping system passes. Perform additional pressure tests after repair of each system.

3.03 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications for the following reasons:

1. Fractures or cracks passing through the pipe wall, except a single crack not exceeding 5 centimeters (2 inches) in length at either end of pipe which could be cut off and discarded. All pipes within one shipment shall be rejected if defects exists in more than 5 percent of the shipment or delivery.
2. Cracks sufficient to impair strength, durability or serviceability of the pipe.
3. Defects indicating improper proportioning, mixing or molding.
4. Damaged ends, whereas such damage would prevent making a satisfactory joint.

B. Acceptance of fittings, stubs or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation that they conform to these Specifications.

* * * END OF SECTION * * *

SECTION 02545
RCRA CAP GAS VENTING SYSTEM PIPE AND EQUIPMENT INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes:

1. The procedures used to install the vent system at the high point of the RCRA Subtitle C-Equivalent Cap.

1.02 QUALITY CONTROL

A. The following Reference Standards shall be used:

1. American Society for Testing and Materials (ASTM):
   a. ASTM D638-99 - Test Method for Tensile Properties of Plastics.
   b. ASTM D790-99 - Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   c. ASTM D1238-99 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   d. ASTM D1505-98 - Test Method for Density of Plastics by the Density-Gradient Technique.
   e. ASTM D1693-00 - Test Method for Environmental Stress Cracking of Ethylene Plastics.
   f. ASTM D-1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   g. ASTM D-1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   h. ASTM D-2466 - Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   i. ASTM D-2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   j. ASTM D-2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   k. ASTM D-2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   l. ASTM D-2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

B. Concrete and reinforcement shall be in accordance with Section 02350.

C. CQA ENGINEER shall verify the proper manufacturer's certifications and identifiers and that conformance test results meet specifications for all piping prior too acceptance for placement. CQA ENGINEER shall observe pipe placement and connection procedures to confirm that the CONTRACTOR has completed the work in accordance with the Drawings and Specifications, and has not damaged the piping or left a loose/leaking connection. Details of field quality control are given in Subsection 3.02.

1.03 SUBMITTALS

A. CONTRACTOR shall submit pipe manufacturing data listing stock density, melt flow, flexural modulus, tensile strength, environmental stress crack resistance and coloration.

B. Submittals by CONTRACTOR shall be in accordance with Section 01410.

C. If pipe manufacturer's test data is inadequate or unavailable, the PROJECT COORDINATOR reserves the right to reject shipments. Costs of shipment shall be borne by CONTRACTOR.

PART 2 MATERIALS

2.01 VENT SYSTEM PIPE

A. Pipe sizes, types and location are designated in the Drawings. Acceptable manufacturers in the U.S. include:

1. Harvel Plastics, Inc., Bakersfield, California.
2. Asahi America, Malden, Massachusetts.
3. Harrington Industrial Plastics, Inc., Chino, California.
4. Or equivalent, as approved by ENGINEER.

B. Pipe:

1. The 1/2 through 4-inch diameter vent piping and carbon adsorption system piping shall be Schedule 40 socket type PVC with UV protection.
2. The 12-inch diameter vent pipe shall be Schedule 80 socket type PVC with UV protection.
3. Condensate Knockout Pot pipe and cap shall be 4-inch Schedule 40 Clear PVC.

C. Marking shall be at intervals of 5 feet or less and include the following information:

1. MANUFACTURER'S name or trademark.
2. Nominal pipe size.
3. Material type, HDPE, PVC, etc.
4. Legend: pipe grade, SDR (if applicable).
5. ASTM designation (as appropriate).
6. Extrusion date, period of manufacture or lot number (plastic pipe).

2.02 FITTINGS

A. Fittings shall be molded from PVC having cell classification equal to or exceeding that used in pipe conforming to ASTM D1784.

B. Fittings shall be of same manufacturer as pipe being provided.

C. Manufacturers Markings shall include the following information:

1. Manufacturer's name or trademark.
2. Nominal size.
3. Material designation "PVC."
4. ASTM D1785.

2.03 VALVES

A. valves shall be as indicated in the Design Drawings.

2.04 EQUIPMENT

A. Blower:

1. McMaster-Carr Supply Company Blower Model No. 1954K999, cast aluminum high-pressure blower, 1/3 HP with ANSI flanges or equivalent, as approved by ENGINEER.

B. Carbon Adsorbers:

1. Carbtrol Carbon Adsorber Model G-4, flow rate 600 cfm or equivalent, as approved by ENGINEER.

PART 3 EXECUTION

3.01 INSTALLATION

A. The PVC pipe and pipe fittings shall be joined by use of solvent-based cement manufactured in accordance with ASTM D2564.

B. Joining of PVC pipe shall be performed by a qualified person. Thermal expansion shall be accounted for during placement of the PVC pipe.

C. Pipe shall be cleaned and inspected on the inside prior to assembly. Open pipe ends shall be capped or equivalency taped at the end of each working day.

D. All piping shall be adequately supported using manufacturer's recommended support spacing.

E. Contractor shall provide unions or other breakout fittings at all equipment connections, as necessary, to facilitate easy installation/removal/changeout.

F. CONTRACTOR shall provide unions or other breakout fittings at all equipment connections, as necessary, to facilitate easy installation/removal/changeout.

3.02 PRESSURE TEST

A. Before pressure testing, blow the pipe clean of dirt and debris and remove from systems equipment which would be damaged by test pressure. Replace equipment after testing. Systems may be tested in sections. Perform system pressure testing on completed pipe systems as follows:

   1. Pressurize piping with ambient air at 50 pounds per square inch. Pressure drop shall not exceed pressure changes caused by temperature changes of the compressed air, in a 24-hour period.

B. Locate and repair all leaks. Correct leaks by replacing faulty materials with new material.

C. Repeat pressure testing until the piping system passes. Perform additional pressure tests after repair of each system.

3.03 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications for the following reasons:

1. Fractures or cracks passing through the pipe wall, except a single crack not exceeding 5 centimeters (2 inches) in length at either end of pipe which could be cut off and discarded. All pipes within one shipment shall be rejected if defects exists in more than 5 percent of the shipment or delivery.
2. Cracks sufficient to impair strength, durability or serviceability of the pipe.
3. Defects indicating improper proportioning, mixing or molding.
4. Damaged ends, whereas such damage would prevent making a satisfactory joint.

B. Acceptance of fittings, stubs or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation that they conform to these Specifications.

* * * END OF SECTION * * *

SECTION 02550
ABANDON EXISTING SOIL VAPOR, GROUND WATER MONITORING, TM NO. 6, TM NO. 12 AND TM NO. 13 EXTRACTION WELLS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes:

1. The requirements for performing the abandonment of existing monitoring/extraction wells.
2. Locations of the monitoring/extraction wells to be abandoned are shown on the Drawings.

PART 2 PRODUCTS AND LABOR

2.01 MATERIALS

A. All products for abandoning the monitoring wells shall be provided by the CONTRACTOR.

1. Ten-inch diameter hollow-stem augers
2. Volclay grout (or equivalent).
3. Tremie pipes to place grout into borings.

2.02 LABOR

A. The CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals for doing all the work involved in performing the abandonment of monitoring/extraction wells shown on the Drawings.

PART 3 EXECUTION

3.01 ABANDONMENT PROCEDURE

A. Monitoring/extraction wells shall be abandoned in accordance with State of California Department of Water Resources Bulletin 74, California Water Well Standards. Monitoring wells shall be abandoned during site clearing activities.

1. The CONTRACTOR shall obtain well destruction permits from the County of Los Angeles Environmental Health Department.
2. In abandoning monitoring/extraction wells, demolish the well box and remove any traffic bollards.
3. Remove the top 5 feet of well casing.
4. Drill out the total depth of the well.
5. Place soil cuttings into 55-gallon drums for later onsite disposal.
6. Backfill the open holes with Volclay grout or equivalent.
7. After each well location is abandoned, the ground surface shall be regarded to match the surrounding ground elevations.
8. The CONTRACTOR shall dispose of the removed well screens, casings and any debris generated from the well abandonment.

PART 4 MEASUREMENT

4.01 MEASUREMENT

A. Abandonment of monitoring wells shall be measured per linear foot.

* * * END OF SECTION * * *

SECTION 02600
LANDSCAPING

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall furnish all labor, materials, equipment, appliances and necessary incidentals for the complete installation of all landscaping as shown in the Drawings and as specified herein:

- Grades in all planting areas shall be established prior to beginning of landscape construction.
- All weeds, grasses and debris over 2 inches in diameter shall be removed and disposed at a municipal/solid waste landfill (Class III).

B. Contractor shall furnish all labor, materials, equipment, appliances and necessary incidentals for the complete installation of all landscape planting as shown in the Drawings and as specified herein. Work includes, but is not limited to, the following:

- Fine grading.
- Soil preparation and fertilization.
- Furnishing of trees, shrubs, ground covers, mulch and seed mix.
- Installation of trees, shrubs, ground covers, mulch and seed mix.
- Application of pre-emergent to ground cover areas.
- Staking of trees.
- Protection, maintenance and guarantee as specified.
- All work of every description mentioned in the Specifications and/or amendments thereto and all other satisfactory completion of the work including clean-up of the site.

C. CONTRACTOR shall furnish all labor, materials, equipment, appliances and necessary incidentals for the complete safe, neat and efficient installation of all landscape irrigation systems as shown in the Drawings and as specified herein. CONTRACTOR shall prepare and submit in Irrigation System Plan as described below in Submittals, Section 1.02, which shall provide sufficient water to sustain proper growth of the irrigated trees, shrubs, and ground cover.

D. The CONTRACTOR shall maintain a qualified supervisor on the site at all times during construction through completion of maintenance work.

E. Landscape work shall not begin until all construction adjacent to the planting areas has been completed and until the irrigation systems have been installed and approved.

F. Soil samples shall be taken by the ENGINEER prior to planting to determine the viability of the soils to support plant growth, and whether soil amendments may be required. The ENGINEER shall collect samples at six locations, spaced in approximately equal increments to be generally representative of the planting areas.

1.02 SUBMITTALS

A. Irrigation Plan and Material List:

- The CONTRACTOR shall prepare and submit no later than 15 days prior to commencing the landscaping work a detailed Irrigation System Plan. The Plan shall include Drawings, a complete description of the type of system (e.g., sprinkler and drip or combination) and all required elements (e.g., tie-in to city water main, trench locations, material requirement, placement procedures), and Specifications for materials and construction procedures. The Plan shall also address adjustment and testing of the system. The Irrigation System Plan shall be reviewed and approved by the ENGINEER prior to implementation.
- The CONTRACTOR shall furnish the articles, equipment, materials, or processes specified by name in the Drawings, Specifications and Irrigation System Plan. No substitution shall be allowed without prior written approval by the ENGINEER.
- A complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, model number and description of materials and equipment to be used.
- Equipment or materials installed or furnished without prior approval of the PROJECT MANAGER may be rejected and the CONTRACTOR may be required to remove such materials at CONTACTOR'S expense.

1.03 REQUIREMENTS

A. All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these Specifications, and their provisions shall be carried out by the CONTRACTOR. However, when these Specifications and Drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these Specifications and Drawings shall take precedence.

B. CONTRACTOR shall obtain and pay for any and all permits and inspections required by permitting agencies.

C. CONTRACTOR shall arrange for tie-in to the city water main and installation of a water meter and pay for any and all permits, fees and inspections required.

D. All work called for in the Drawings by notes or details shall be furnished and installed whether or not specifically mentioned in these Specifications.

E. Prior to installation, the CONTRACTOR shall stake out the location of all the city water main, gas line and other underground utilities. CONTRACTOR shall also stake out routing of trenching, and location of valves and irrigation elements (e.g., sprinklers, drip lines).

1.04 PROTECTION

A. All damage to existing property (buildings, utilities, etc.) or planting (trees, shrubs or ground cover) caused by the CONTRACTOR's employees, subcontractors, vendors or suppliers during its operation or as a result of malfunction of installed work during the warranty period shall be repaired at CONTRACTOR's expense. All such repair work is not considered to be complete until approved by the PROJECT MANAGER and CQA ENGINEER.

B. CONTRACTOR shall protect, at all times, all existing utilities, structures and other features intended to remain on, and adjacent to, the project site.

C. CONTRACTOR, in the course of work performance, is to keep the project site safe and neat.

1.05 STORAGE AND HANDLING

A. Any storage or staging of materials or equipment by the CONTRACTOR shall be in a location on the project site preapproved by the PROJECT MANAGER. No materials or equipment shall be staged or stored in the surrounding area of the project site, nor in an unapproved location on the project site.

B. The CONTRACTOR is cautioned to exercise care in the handling, loading, unloading, and storing of PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged shall be discarded and, if installed, shall be replaced with new piping.

1.06 QUALITY ASSURANCE

A. The CQA ENGINEER shall randomly check the finish grading, plant types, planting operation, staking, mulching operation and materials for conformance with the Drawings and Specifications.

B. The CQA ENGINEER shall also verify the soil sampling for conformance with the Specifications.

C. The CQA ENGINEER shall inspect construction of the Irrigation System to verify conformance with the Irrigation System Plan and Specifications.

PART 2 MATERIALS

2.01 GENERAL

A. CONTRACTOR shall use only new materials or brands and types noted in the Drawings, specified herein, or OWNER-approved equivalents.

B. All PVC pipe must bear the following markings:

- Manufacturer's name.
- Nominal pipe size.
- Schedule or class.
- Pressure rating in psi.
- National Sanitation Foundation (NSF) approval.
- Date of extrusion.

2.02 SOIL MATERIALS

A. Planter materials shall conform to the materials specified in the Drawings and the recommendations made by the ENGINEER following review of the soil sampling analytical results.

B. All topsoil imported for landscape purposes shall meet the following minimum specifications:

- Same relative composition and structure as the existing site soil. It shall be free of roots, clods, and stones larger than 1 inch in greatest dimension, pockets of coarse sand, noxious weeds, sticks, brush, herbicides, hydrocarbons and other litter.
- pH range in saturation extract - 6.0 to 7.9 (Method 21A USDA).
- Salinity range of saturation extract - 0.5 to 2.0 ds/m. If calcium ions and sulfate ions both exceed 20 millequivalents per liter in the saturation extract, the maximum ECe shall be 4.0 ds/m.
- Boron - Maximum boron in saturation extract shall be 1 mg/L (parts per million). Maximum extractable boron shall be 1 mg/kilogram dry soil (parts per million).
- Sodium - Maximum soluble sodium in saturation extract shall be 100 mg/L (parts per million).

2.03 STAKING MATERIALS

A. Stakes shall be lodge-pole pine, 2-inch-diameter by 10-foot-long minimum and pointed at one end. Stakes shall be pressure treated with preservative colored green.

B. Ties shall be V.I.T. tree ties as specified on planting detail in the Drawings.

2.04 PLANT MATERIALS

A. Plant materials shall be furnished by the CONTRACTOR upon approval by the ENGINEER or designee in quantities as indicated or noted for each location and shall be of species, types, etc. as symbolized and described in the plant list. If conflicts arise between size of areas and plants, CONTRACTOR to contact the ENGINEER or designee for resolution. Failure to make such conflicts known to ENGINEER or designee shall result in CONTRACTOR's liability to relocate the materials.

B. The CONTRACTOR shall furnish and pay for all container grown trees, shrubs, and vines, including flatted ground covers. The CONTRACTOR shall also be responsible and pay for

planting of all plant materials, the specified guarantee of trees and the continuous protection of all plant materials upon their arrival at the site, and up to 90 days after their installation in the project site.

C. Plants shall be protected in transit and after delivery to the project site. Plants in broken containers shall not be accepted, and plants with broken branches or injured trunks shall be rejected.

D. Plants that are specified by container size shall be first class material equal to the size of similar material in local wholesale nurseries.

E. All plant materials shall be the appropriate size for their container, healthy, vigorous, with a good root system, and shall be free from pests and disease. Heavily rootbound plants shall be rejected.

F. All trees shall have well-spaced branches. Trees with branches radiating from the same location on the upper half of the tree may be rejected.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. The soil shall not be worked when soil moisture content is so great that excessive compaction shall occur, or when the soil is so dry that excessive dust shall occur.

B. Finish grade shall be a smooth, even, and uniform plane with no abrupt change of surface and conform to the lines and grades shown in the Drawings. Low spots and pockets shall be graded to drain properly.

C. CONTRACTOR shall request inspections at least twenty-four hours in advance of the time inspection is desired. Inspection is required when finish grading is completed.

3.02 BACKFILL SOIL MIX

A. Excavated material suitable for plant backfill can be used for planting backfill mix as approved by the ENGINEER.

B. A 12-12-12 commercial fertilizer or a backfill soil mix recommended by the ENGINEER following review of the soil sampling analytical results shall be used on on-grade planting areas.

C. The above material should be uniformly blended prior to use.

3.03 GENERAL PLANTING

A. Prior to planting, apply a preapproved nonselective systemic herbicide on all perennial weeds and turf. All chemicals must be recommended by a certified pest control adviser and approved by the ENGINEER or designee and the EPA. Clear and grub all areas. Remove weeds and turf grass and debris to a legal municipal solid waste landfill.

B. Ongrade plant pits shall be excavated to a minimum of two times the diameter and height of the container to permit handling. CONTRACTOR shall excavate pits with vertical sides for all plants. Plants shall not be planted in dry soil. Soil shall be moist to a depth of at least 18 inches. Backfill shall be made for each area as specified.

C. Plants shall be planted immediately after plants are removed from containers. CONTRACTOR shall cut or remove kinked or circling roots. Containers shall be regularly removed so as not to present a hazard to those persons using the areas.

D. CONTRACTOR shall set plants in center of pit, in a vertical position so that the crown of the plant shall bear the same relationship to the finish grades that it did to soil surface in place of growth, allowing for watering and settling of soil.

E. CONTRACTOR shall backfill with specified soil mix as recommended by the ENGINEER following review of the soil sampling analytical results. No soil in a muddy condition shall be used to backfill. No filling shall be permitted around the trunk of the plants.

F. Plants shall be watered as they are planted, and basins shall be built around each plant in an ongrade planting area to retain water. CONTRACTOR shall remove basin prior to top dressing.

G. Any plant material damaged in planting operation shall be replaced at once.

H. CONTRACTOR shall Prune plants according to International Society of Agriculture practices. Trees with flush cuts shall be rejected.

I. CONTRACTOR shall stake trees. CONTRACTOR shall remove upper portion of stakes so that they do not interfere with branch structure.

3.04 IRRIGATION SYSTEM

A. Irrigation system shall be connected to the water supply point of connection (POC) as indicated in the Drawings.

B. Electrical connections for automatic controller(s) shall be made to electrical points of connection at the power supply as shown in the Irrigation System Plan.

C. Trenching:

- CONTRACTOR shall dig trenches straight and support pipe continuously on bottom of trench. CONTRACTOR shall lay pipe to an even grade. Trenching excavation shall follow the layout indicated in the Irrigation System Plan and as noted in these Specifications.
- CONTRACTOR shall provide for a minimum cover of 24 inches for all pressure main line piping.
- All electric valve wire shall be placed under irrigation pipe at a minimum depth of 24 inches.

D. Backfilling:

- The trenches shall not be backfilled until all irrigation tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling.
- If settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawn or planting, or other construction are necessary, the contractor shall make all required adjustments at CONTRACTOR's expense.

E. Backfill Under Paving:

- Trenches located under areas where concrete shall be placed shall be backfilled with sand - a layer 6 inches below the pipe and 3 inches above the pipe and compacted in layers to 95-percent compaction, using manual or mechanical tamping devices. The CONTRACTOR shall set in place, cap and pressure test all piping under paving prior to the paving work.

F. Assemblies:

- In the absence of detail Drawings or Specifications pertaining to specific items required to complete the Work, CONTRACTOR shall perform such Work in accordance with best standard practice with prior approval of the ENGINEER.
- PVC pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before installation. Installation and solvent welding methods shall be as recommended by the pipe and fitting manufacturer.
- On PVC to metal connections, the CONTRACTOR shall work the metal connections first. Teflon tape or an approved equivalent shall be used on all threaded PVC-to-PVC, and on all threaded PVC-to-metal joints.

* * * END OF SECTION * * *

SECTION 02610
VEGETATION COVER AND SEEDING

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall furnish all parts, tools and equipment, labor, supervision, technical and professional services, materials, supplies and articles necessary for the cover system in accordance with the Technical specifications and Design Drawings.

B. These specifications are to be used in conjunction with the Design Drawings.

C. The Work shall include, but not be limited to the items described in the sections below.

D. CONTRACTOR shall furnish all labor and equipment necessary to complete the revegetation and seeding requirements as shown in the Drawings and as specified herein.

E. Upon completion of the Work or as approved by PROJECT MANAGER, CONTRACTOR shall demobilize and remove from the site all labor, equipment, temporary facilities, utilities, temporary fencing and barricades, construction light stands, office and storage facilities and any other accouterments mobilized to the site for the purpose of completing the Work. Demobilization shall include final cleanup of CONTRACTOR's work area and the removal from the site of all debris, garbage, etc., belonging to CONTRACTOR. CONTRACTOR shall leave the work area in a clean and neat manner.

F. CONTRACTOR shall maintain a qualified supervisor on the site at all times during construction through completion of the work.

PART 2 MATERIALS

2.01 VEGETATION COVER

A. Provide topsoil material and/or soil to be used for establishing protection of the cover components and to provide erosion protection. Topsoil shall meet the specifications as indicated in Section 02600.

2.02 SEEDING

A. CONTRACTOR shall provide a native seed mixture (or an equivalent mixture approved by ENGINEER).

B. CONTRACTOR shall apply 40 pounds of seed per acre.

C. CONTRACTOR shall apply commercial ammonium phosphate, 16-20-0, at the rate of 400 pounds of fertilizer per acre.

D. CONTRACTOR shall provide 600 pounds of mulch per acre with wood cellulose fiber to retain moisture during seed germination.

E. CONTRACTOR shall place dry, nonmildewed straw at a rate of 1.5 tons per acre. At least 50 percent of the applied straw shall be more than 6 inches in length.

F. CONTRACTOR shall place 600 pounds of mulch (i.e., wood cellulose fiber) in combination with 150 pounds of M binder, or equivalent, and water. The mixture shall be uniformly sprayed, using proper hydroseeding equipment, to keep straw in place.

PART 3 EXECUTION

3.01 VEGETATION PLACEMENT

A. CONTRACTOR shall prepare an area to be seeded that is weed-free and have a firm seed bed which has previously been roughened by scarifying, disking, harrowing, or otherwise worked

to a depth of 2 to 4 inches. The seed bed may be prepared when earthmoving work is completed.

B. CONTRACTOR shall evenly supply seed at the ratio described above.

3.02 FERTILIZER

A. CONTRACTOR shall apply fertilizer to be distributed uniformly over the seed bed and incorporated into the soil. Fertilizing may be done as part of the seed bed preparation or as part of the seeding operation unless the seed is broadcast. If fertilizing is a part of the seed bed preparation, it shall not be performed more than 15 days prior to seeding.

3.03 MULCH AND STRAW

A. CONTRACTOR shall apply a mulch and straw combination immediately after seeding. If necessary, to prevent removal of straw by wind, the mulch shall be anchored using either mulching rollers or disks. If disks are used for anchoring, they shall be dull and run straight.

* * * END OF SECTION * * *

SECTION 02700
SURVEY MONUMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. This work shall consist of constructing cast-in-place Portland cement concrete survey monuments at the locations shown on the plans or directed by the Engineer.

1.02 REFERENCES

A. Caltrans Type A Survey Monument.

PART 2 MATERIALS

2.01 CONCRETE

A. The concrete portion of monuments shall be 3,000 psi concrete and constructed in conformance with the provisions in Sections 02350.

B. Concrete shall be thoroughly compacted and shall be cured in conformance with Section 02350.

2.02 MARKER DISKS

A. Survey marker disks for survey monuments shall be brass survey hubs furnished by the CONTRACTOR.

2.03 REINFORCEMENT

A. Rebar shall be #4 by 16-inches long.

PART 3 EXECUTION

A. Survey monuments may be cast-in-place in neat holes without the use of forms.

B. Survey monument shall be flush with the ground surface and protected from damage during construction.

C. Survey marker disks shall be placed in survey monuments before the concrete has acquired its initial set and shall be firmly bedded in the concrete. The concrete monument shall be so located that when the disk is placed in the center of the monument, the point being referenced shall fall within a one inch circle in the center of the disk.

D. The concrete monument shall be 24 inches in diameter by 18 inches deep with a total of four 16 inch long #4 rebars evenly spaced.

E. After the monuments have been constructed as specified, any resultant space around them shall be filled with vegetative soil cover and shall be watered and tamped into place.

* * * END OF SECTION * * *

SECTION 02800
ELECTRICAL

PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish and install complete functioning systems specified, indicated, or implied in Contract Documents.

B. Elements of Work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

C. All general provision of the Contract Documents apply to all work specified in this Specification.

D. Furnish all necessary labor, materials, equipment and incidentals required to install a complete and operational electrical system according to the intent of this specification and the accompanying drawings, whether itemized or not.

E. Examine the Specifications and Drawings and provide all electrical equipment including conduit, wire and cable and make connections required to place all equipment in complete operation.

F. The extent of the electrical work includes furnishing and installing of the following items:
   1. Complete circuiting and connections for the blower motor conduit, trenching, pullboxes, and junction boxes.
   2. Power to the Autodialer, installation of the Autodialer including supports, instrumentation wiring to the Flow Switch and connection of telephone line.
   3. Complete grounding systems.
   4. Coordination for connection of power and telephone utility companies.

1.02 COORDINATION

A. Drawings are intended to cover layout and design of Work. Do not scale for exact measurements. Take measurements required for proper installation of electrical Work. Coordinate with other Work on project.

B. CONTRACTOR shall be responsible for repairing any of the existing utilities or existing facility due to damage caused by CONTRACTOR during the course of this Work. Repair and/or replacement shall be as directed by ENGINEER and CONTRACTOR shall bear the cost of all materials and labor without reimbursement.

1.03 INTENT OF DRAWINGS AND DESIGN

A. CONTRACTOR shall provide complete and operational systems. Drawings serve as working drawings for general layout of various items of equipment, layout of the equipment, conduit, and piping systems are diagrammatic unless specifically dimensioned.

B. Any error or omissions of detail in either the drawings or the specifications shall not relieve CONTRACTOR from correctly installing all materials necessary for a complete and operating electrical system.

C. Blower and Autodialer manufacturers shown on the drawings are recommendations only. CONTRACTOR shall verify the electrical power requirements for the actual equipment purchased and provide power specified by manufacturer.

1.04 SERVICE FOR ELECTRIC POWER AND TELEPHONE

A. Provide required electrical service to sites as shown on drawings.

B. Provide telephone service to site where shown on drawings.

C. Pay all costs charged by Power Company and Telephone Company for new services and any existing facility alterations required for new services. Coordinate activities with ENGINEER.

1.05 FEES, PERMITS, AND REGULATIONS

A. Where Contract Documents require higher standards than applicable ordinances or statutes, the Contract Documents take priority. Where Contract Documents violate applicable ordinances or statutes, the latter takes priority.

B. Contract Documents: Not to be construed to permit work in violation of applicable codes.

C. References to codes, standards, specifications, and recommendations (of technical societies, trade organizations, and governmental agencies) are intended to be considered a part of this Specification as though fully repeated herein.

D. Perform work in accordance with applicable requirements of governing codes, rules, and regulations, including the following minimum standards, whether statutory or not:

1. NFPA 70 - National Electrical Code (NEC) - Latest Edition
2. National Fire Protection Association (NFPA)
3. Building Officials and Code Administrators (BOCA)
4. State of California Administrative Code
5. Electrical Regulations of the State of California Office of the State Fire Marshal
6. Uniform Building Code - Latest Edition

E. Equipment and materials shall conform to the following standards where applicable:

1. Underwriters' Laboratories (UL)
2. American Society for Testing Materials (ASTM)
3. Insulated Power Cable Engineers Association (IPCEA)
4. National Electrical Manufacturers Association (NEMA)
5. American National Standards Institute (ANSI)
6. Electrical Testing Laboratories (ETL)
7. National Electrical Contractors Association (NECA)
8. Factory Mutual (FM)

F. CONTRACTOR shall furnish without extra charge any additional material and labor which may be required for compliance with these laws, rules, and regulations, even though the Work is not mentioned in these particular specifications or shown in the Drawings.

G. Contractor shall obtain and pay for all required permits to install and operate power and telephone service.

1.06 GUARANTEE

A. CONTRACTOR shall guarantee systems and elements against defects due to faulty workmanship, design, and materials; conduit free from obstructions, holes or breaks; conduit seals are effective; electrical system free from short-circuits and improper grounds.

B. Remedy defects occurring within one year of final acceptance date. Perform remedial Work promptly, upon written notice from WDIG's REPRESENTATIVE.

C. Guarantee includes labor, equipment adjustments, transportation charges, and materials.

D. Employ only service technicians in the trade who have had experience with the type of Work included in this Contract that is required for safe and successful completion of the Work.

1.07 TRAINING, MAINTENANCE AND OPERATING MANUALS

A. At time of completion, instruct maintenance personnel in the use of electrical systems. Provide O & M manuals, product literature and application guides for user's reference. Pay costs for training services.

PART 2 MATERIALS

2.01 SUBMITTALS

A. General: Submittals shall be made in accordance with Section 01410. Submit to ENGINEER, make, model, and specifications of all devices, equipment, and hardware, that are not specifically identified in these specifications, for approval.

2.02 MATERIAL AND MANUFACTURE

A. Material and equipment shall be new, of the best quality and design, free from defects and imperfections, and have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size, and capacity. All material and equipment of the same type shall be made by the same manufacturer whenever practical.

B. PVC conduit shall be minimum 1/2-inch rigid heavy weight type, Schedule 80. PVC conduit shall be supplied complete with PVC fittings. Carlon, PW Pipe, or equal.

C. Underground pullboxes, where shown or required by length of conduit runs, shall be prefabricated concrete type, Christy Concrete Products, Brooks or equal. All underground pullboxes shall have standard brass holddown bolts and hardware. Boxes located in paved areas or other areas over which vehicles normally may travel shall have traffic covers. All covers shall be labeled, i.e., ELECTRICAL, SIGNAL, TELEPHONE, etc.

D. All pullboxes and cabinets shall be code gauge galvanized steel. Pullboxes shall be galvanized NEMA 12 with threaded hubs.

PART 3 EXECUTION

3.01 WORKMANSHIP

A. Preparation, handling, and installation of material and equipment shall be in accordance with the manufacturer's written instructions and technical data particular to the product specified and/or accepted equivalent, except as otherwise specified. Coordinate Work and cooperate with others in furnishing and placing this Work.

B. Conform to the National Electrical Contractors Association's "Standard of Installation" for general installation practice.

C. Instrumentation and controls installation personnel shall have thorough working knowledge of systems and devices they install and shall become familiar with new devices prior to installation.

D. CONTRACTOR performing the Work shall hold a valid CIO License for the duration of the project.

E. Maintain at least 12 inches reparation between power and instrumentation cables and intercommunication cables.

F. A ground wire shall be installed in all PVC and flexible conduit.

G. All pullboxes shall be sized by CONTRACTOR in accordance with NEC Article 370-18.

H. Underground precast concrete pullboxes shall be complete with steel traffic covers, in traffic areas, extension rings and concrete bases. Entire box shall be sealed to prevent entrance of mud and rainwater. Conduits shall enter box horizontally, not vertically. Conduit entry shall be grouted in place with approved insulated bushings. Seals shall be installed in conduits around conductors to prevent water from entering the conduit system.

3.02 SUPERVISION

A. Constantly supervise, personally or through an authorized and competent representative, the Work from beginning to completion; within reason, keep the same workmen and foreman on the project throughout the project duration.

3.03 PROTECTION

A. Keep conduits, junction boxes, and other openings closed to prevent entry of foreign matter. Cover equipment, devices, apparatus, and protect them against dirt, paint, water, chemical, or mechanical damage before and during construction period. Restore to original condition apparatus, or equipment damaged prior to final acceptance. Protect bright finished surfaces and similar items until in service. No rust or damage shall be permitted.

3.04 INSPECTION

A. CONTRACTOR shall cooperate with CQA ENGINEER and shall provide assistance at all times for the inspection of the electrical work. Remove covers, operate machinery, or perform any reasonable Work which, in the opinion of ENGINEER, shall be necessary to determine the quality or adequacy of the Work.

B. If any material does not conform with these Specifications, CONTRACTOR shall, within three days after being notified by ENGINEER, remove the materials from the premises.

C. Work shall not be closed in or covered before inspection and approval by ENGINEER. Cost of uncovering and making repairs where uninspected work has been closed in shall be borne by CONTRACTOR.

3.05 ADJUSTING, ALIGNING, TESTING, CALIBRATING

A. Adjust, align, and test electrical equipment including motors, protective devices, etc.

B. Perform tests as specified to prove installation is in accordance with contract requirements. Conduct tests during construction period and at completion to determine conformity with applicable codes and these Specifications. Tests, in addition to specific system test described elsewhere, include:

1. Insulation Resistance: Perform 1,000-volt DC tests for thirty seconds on feeders. Make typed record of readings and include in the maintenance instructions. Repair or replace circuits showing less than 10-megohms resistance to ground.
2. Circuit Continuity: Test feeder and branch circuits for continuity. Test neutrals for presence of a single point ground connection.
3. Equipment Operations: Test motors for correct operation. All systems shall test free from short-circuits and ground, and be free from mechanical and electrical defects. All circuits shall be tested for the proper neutral connection, and rotation.
4. Alarm and Control Systems: Produce malfunction symptoms in operating systems to test alarms and control devices.
5. Product Failure: Replace, repair, or correct, as prescribed by ENGINEER and at expense of CONTRACTOR, products which fail during tests or are ruled unsatisfactory by ENGINEER. Retest, repair, replace, or correct product.
6. Verify color code and phasing of power conductors with phase rotation at meter/main.
7. Miscellaneous: Include test results in the Maintenance Manual. Pay costs for all tests.
8. Prepare formal test procedures and start-up forms.

C. CONTRACTOR shall be responsible for calibration, configuration, and/or programming of all instruments, control or alarm devices and equipment. CONTRACTOR shall demonstrate to ENGINEER that all such devices function properly. CONTRACTOR shall furnish document containing final instructions, setpoints, configuration, or program at conclusion of construction.

D. Upon completion of the Work and adjustments of all equipment, all systems shall be tested under the direction of the ENGINEER to demonstrate that all equipment furnished, installed and/or connected under the provisions of these specifications shall function in the required manner.

E. Where tests indicate faulty installation or other defects, they shall be located, repaired, and retested at the CONTRACTOR's expense.

3.06 SPARE PARTS

A. CONTRACTOR shall supply all spare parts prior to start-up. All parts shall be sealed in plastic bags and delivered to the site in a plywood or heavy duty plastic storage box.

* * * END OF SECTION * * *

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