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ERM-MIDWEST, INC., REMEDIAL INVESTIGATION & RISK ASSESSMENT REPORT, PADDYS RUN ROAD SITE, CROSBY TOWNSHIP, HAMILTON, OHIO, REV 1 VOL 5 OF 5, APPENDICES D-N - (USED AS A REFERENCE IN OU 5 RI REPORT)

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ERM-MIDWEST INC
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REPORT

007361

Remedial Investigation and Risk Assessment Report

Paddys Run Road Site (PRRS)
Crosby Township, Hamilton, Ohio

Volume 5 of 5: Appendices D through N

Revision 1
May 27, 1994

Submitted to:

The Ohio EPA,

Southwest District Office

401 E. Fifth Street
Dayton, Ohio 45402-2911

Submitted by:

The PRRS Companies

P.O. Box 26683
Richmond, Virginia 23261-6683

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REV. 1: MAY 1994

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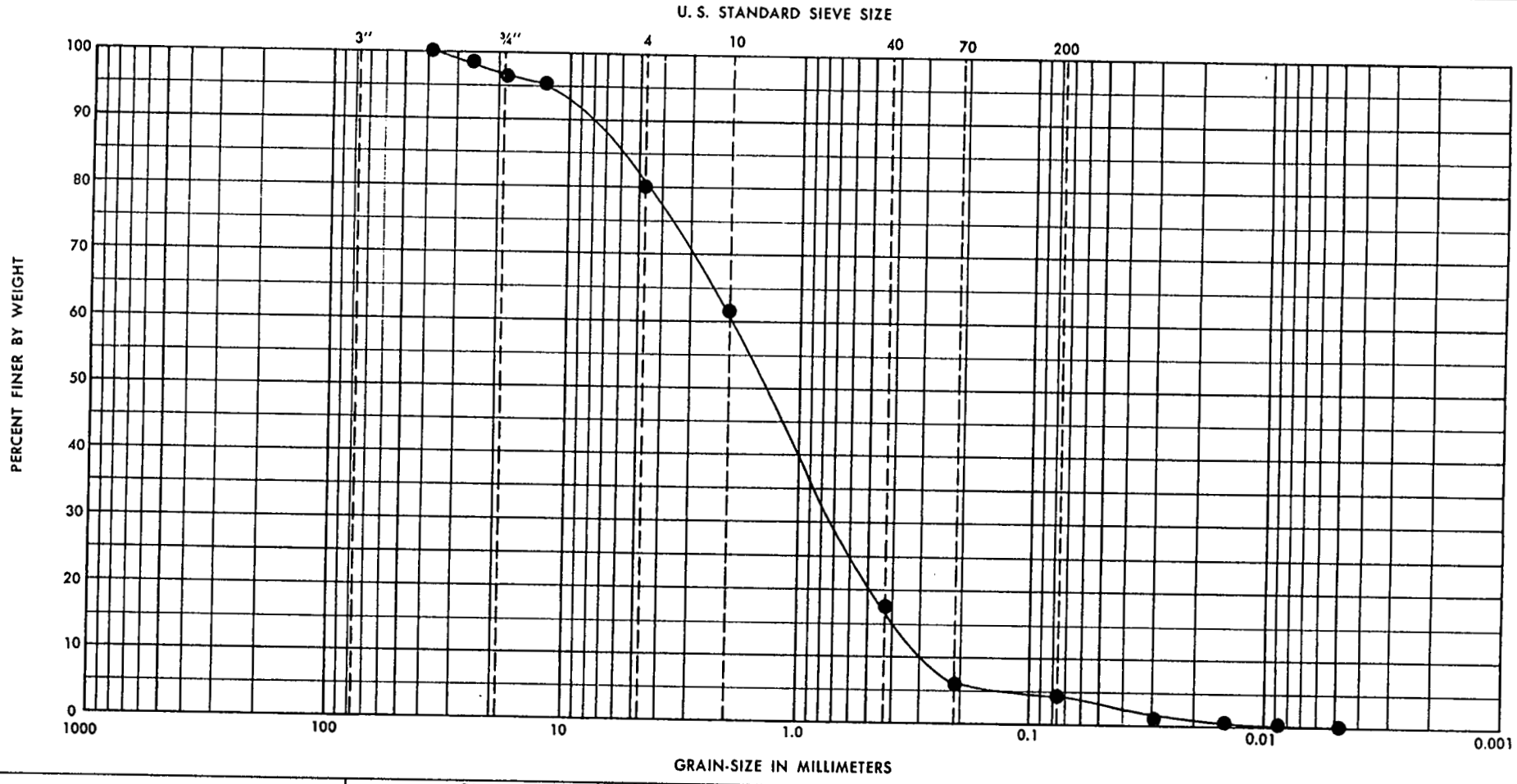
Particle Size Analysis Curves

APPENDIX D

PARTICLE-SIZE ANALYSES CURVES

SEDIMENTS

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
		Brown fine to coarse sand, little fine to coarse gravel, trace silt.		

SEDIMENT STATION NO. 2

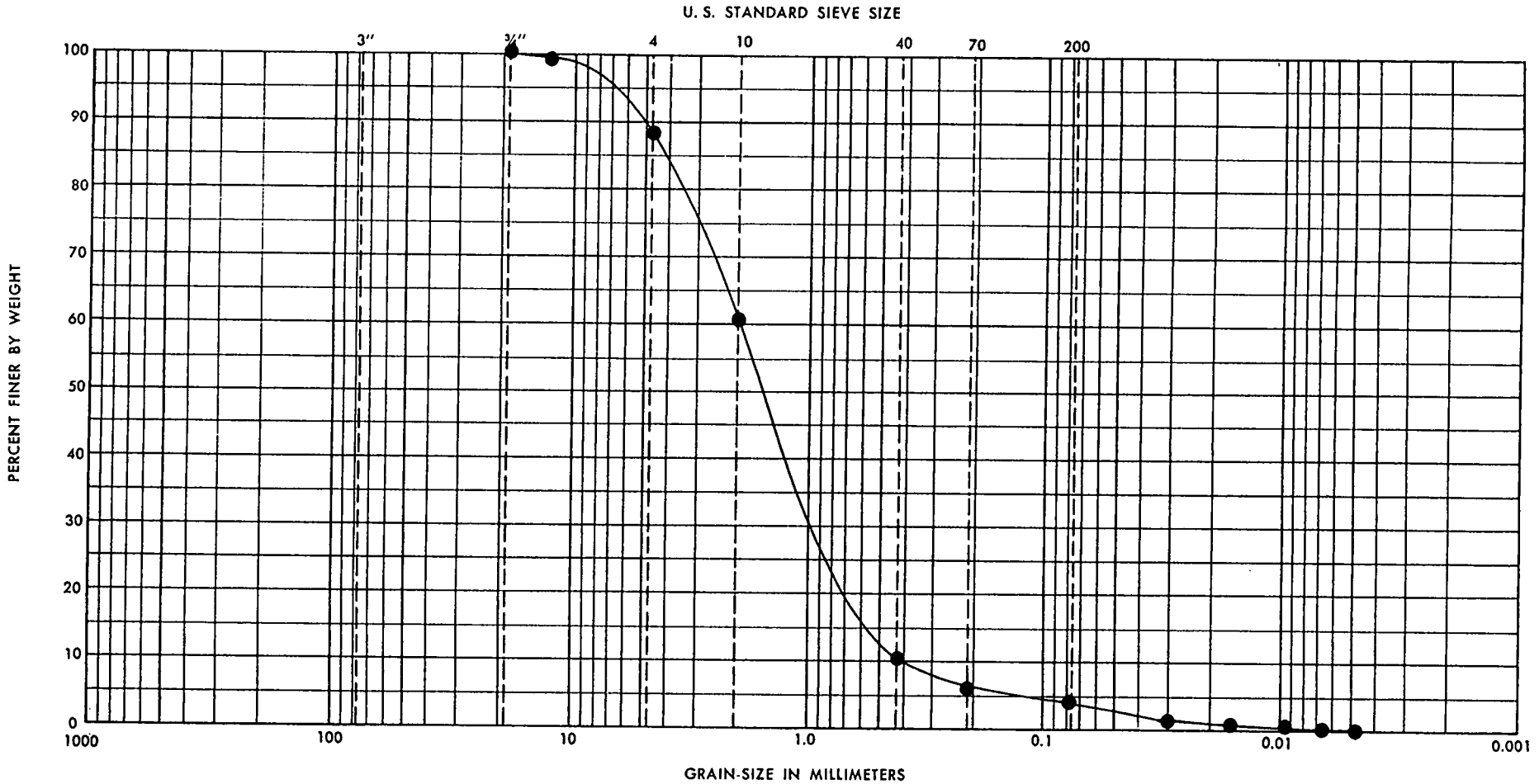
BORING:

PLATE 3

00072361

00072361

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

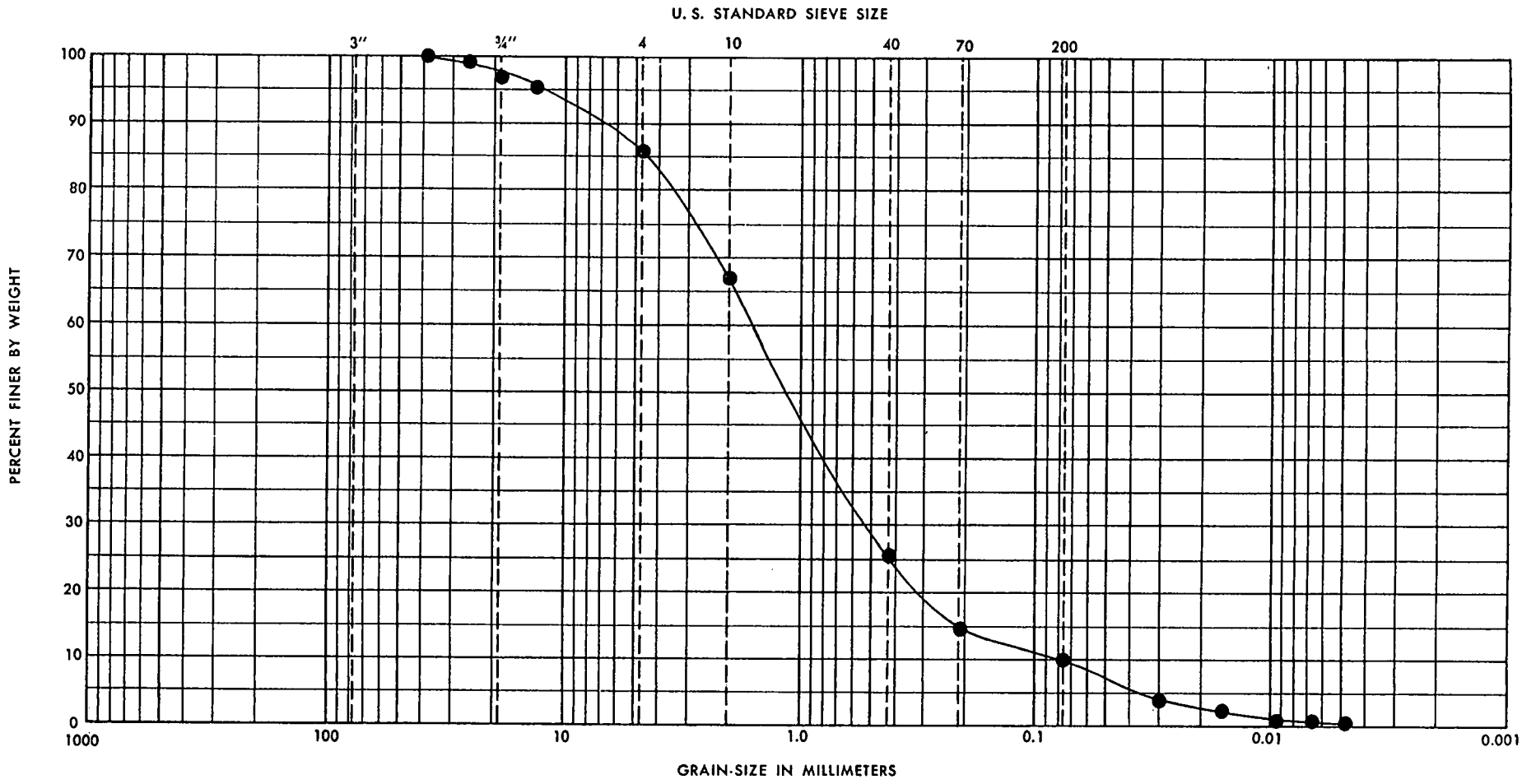
Sample	Depth	IDENTIFICATION	LL	PL
		Brown fine to coarse sand, little fine gravel, trace silt.		

SEDIMENT STATION NO. 6

BORING:

PLATE 4

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
		Brown fine to coarse sand, little fine to coarse gravel, trace silt.		

SEDIMENT STATION NO. 8

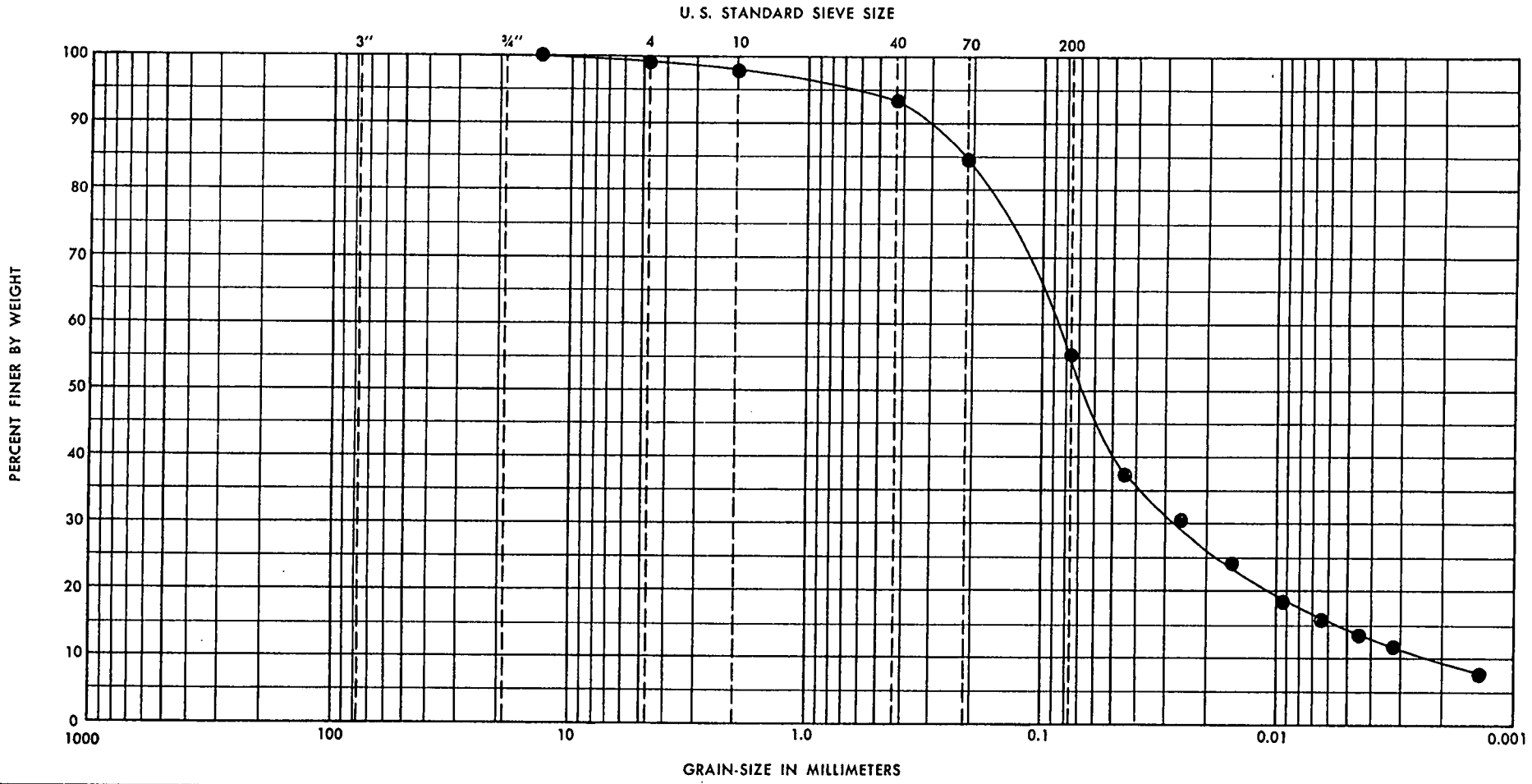
BORING:

PLATE 5

0002361

00030

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

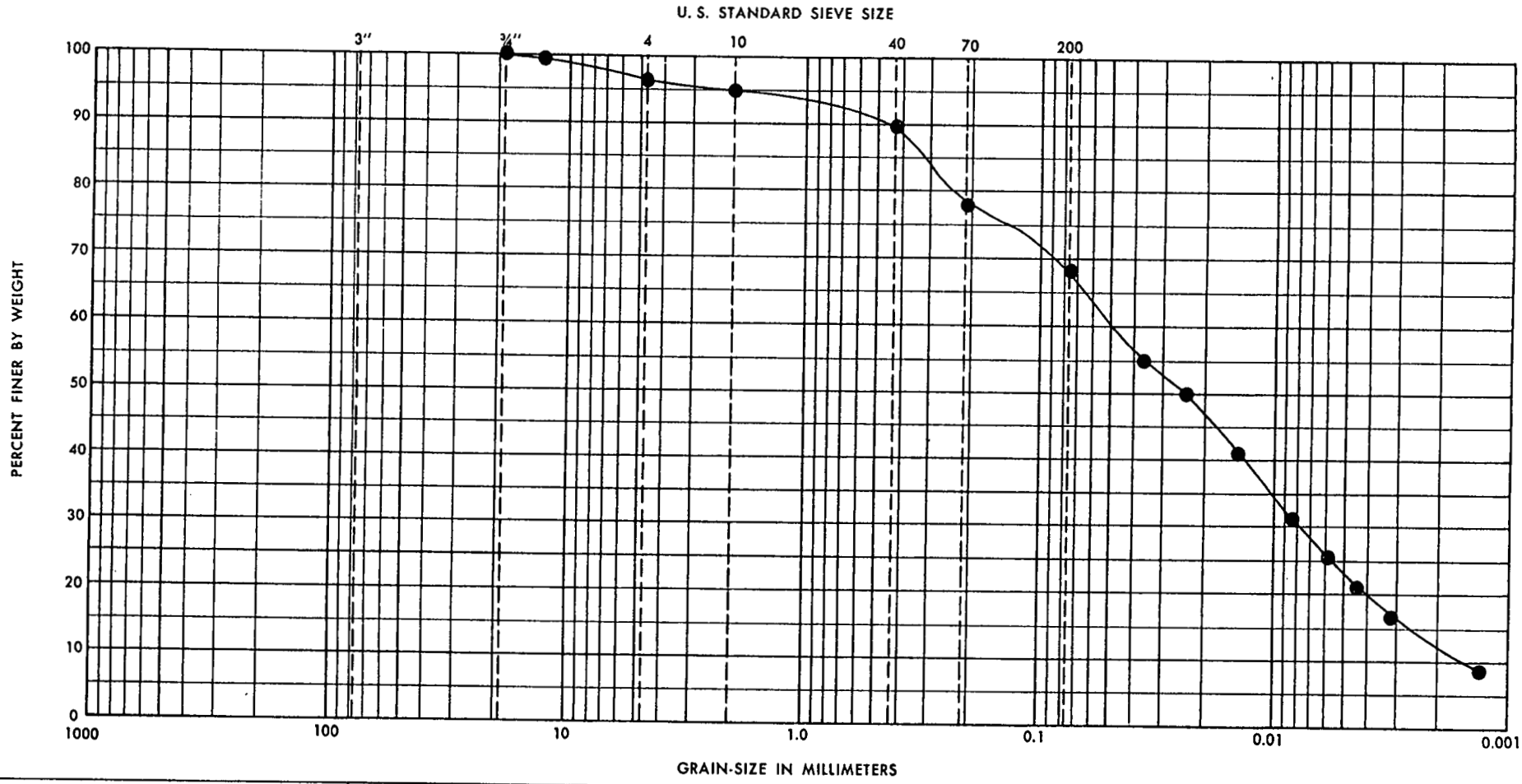
Sample	Depth	IDENTIFICATION	LL	PL
		Brown clayey silt, "and" fine to medium sand, trace coarse sand, trace fine gravel.		

SEDIMENT STATION NO. 11

BORING:

PLATE 9

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
000038		Gray organic clayey silt, some fine to coarse sand, trace fine gravel.		

SEDIMENT STATION NO. 12

BORING:

PLATE 7

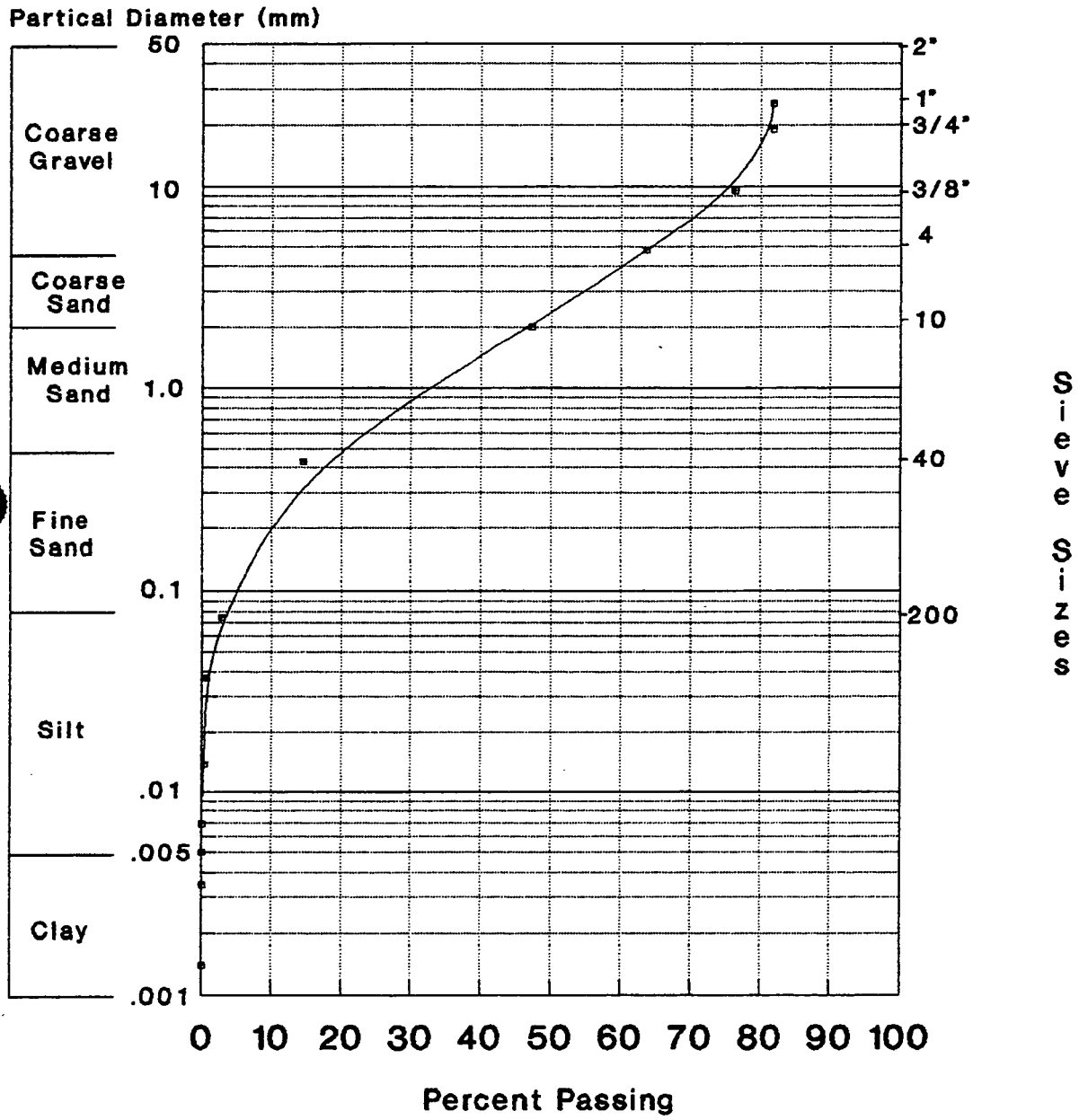
002306

SURFACE SOILS

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 4-01 Depth:

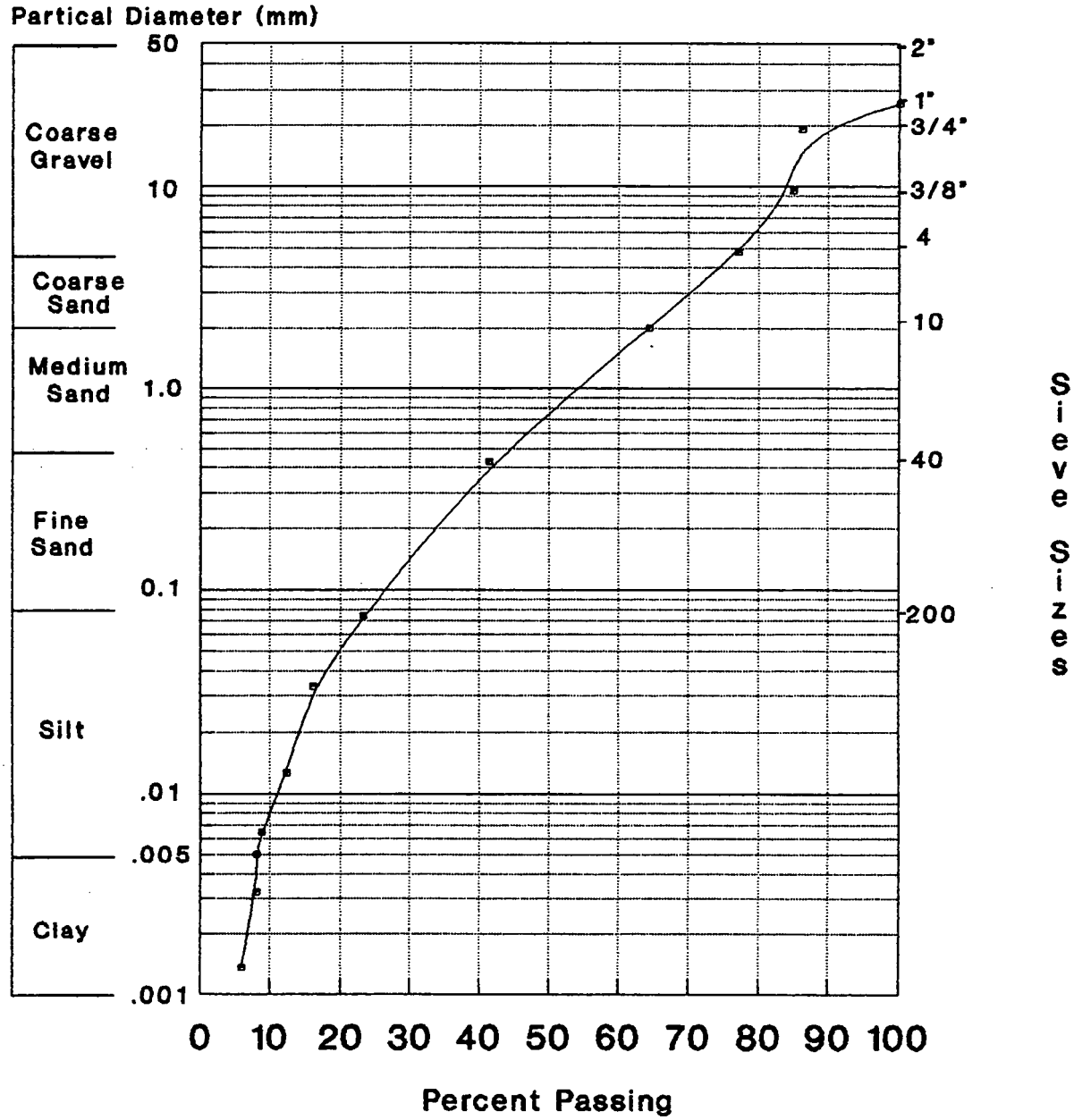


Atterberg Limits: LL= NP PL= NP PI= NP
Description: GRAVELLY F\C SAND, trace silt

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 8-01 Depth:



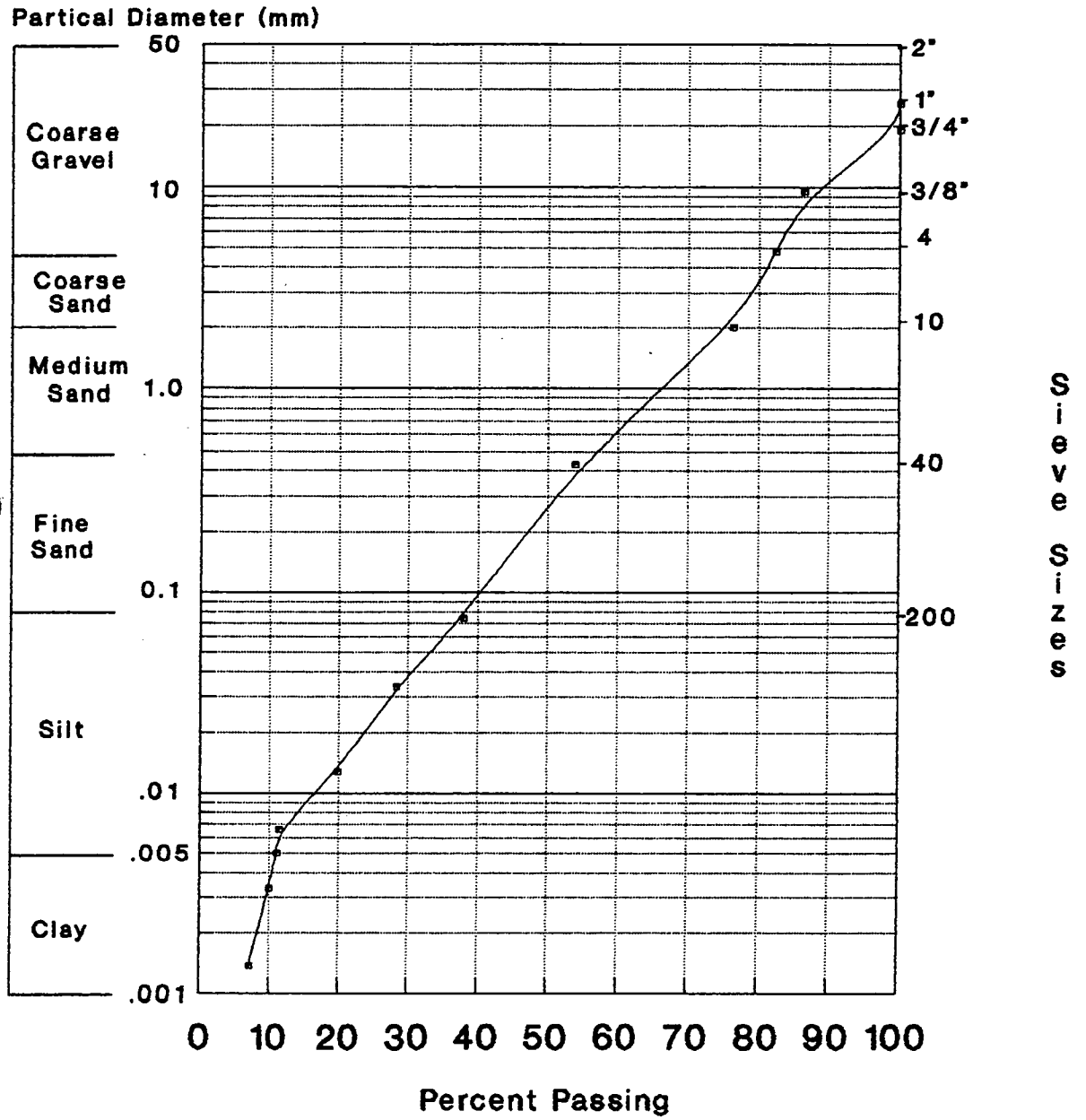
Atterberg Limits: LL= NP PL= NP PI= NP
Description: SILTY, GRAVELLY F\C SAND, trace clay

00034

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 12-01 Depth:

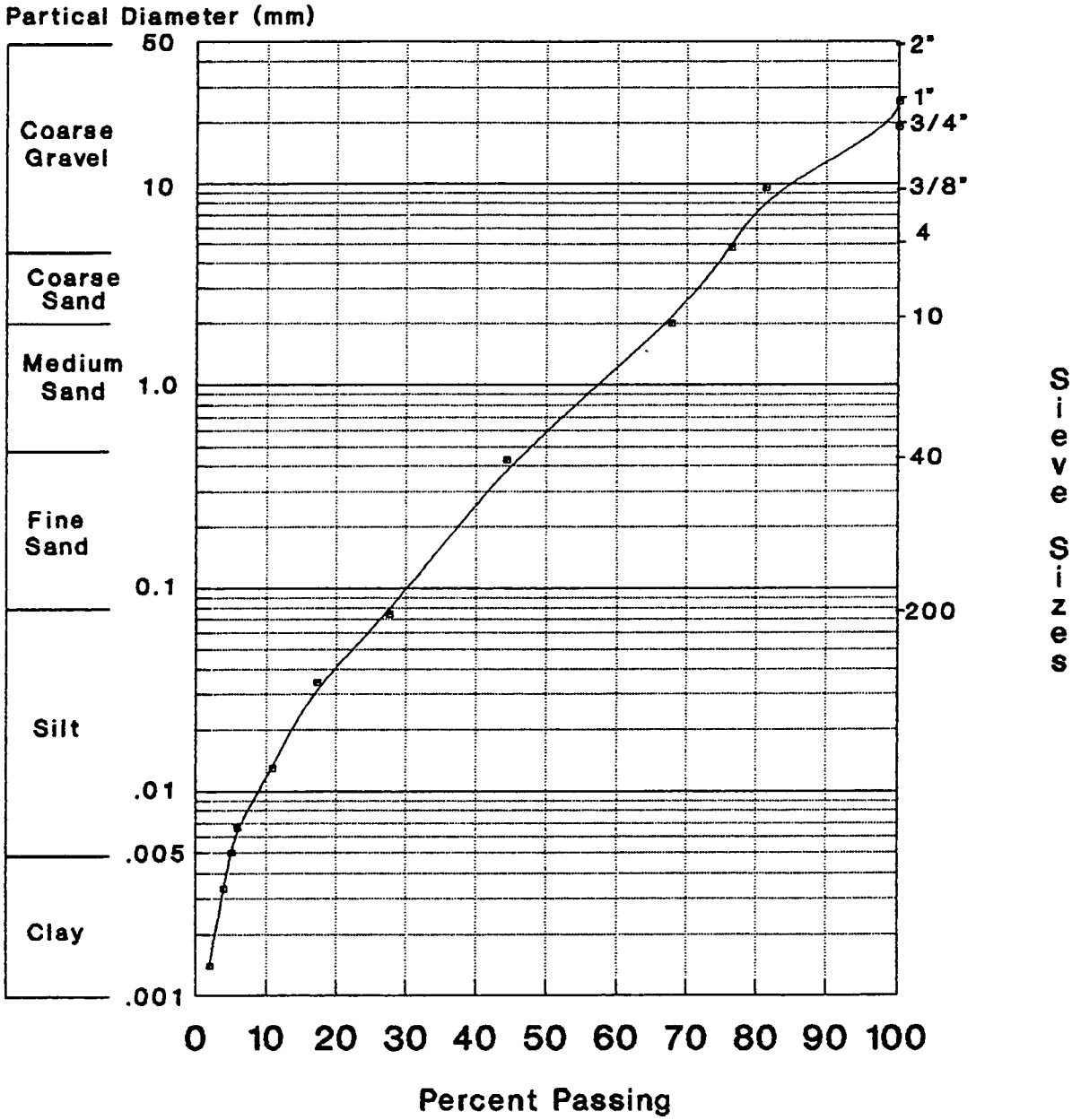


Atterberg Limits: LL= NP PL= NP PI= NP
Description: SILTY F\C SAND, little gravel, little clay

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 15-01 Depth:



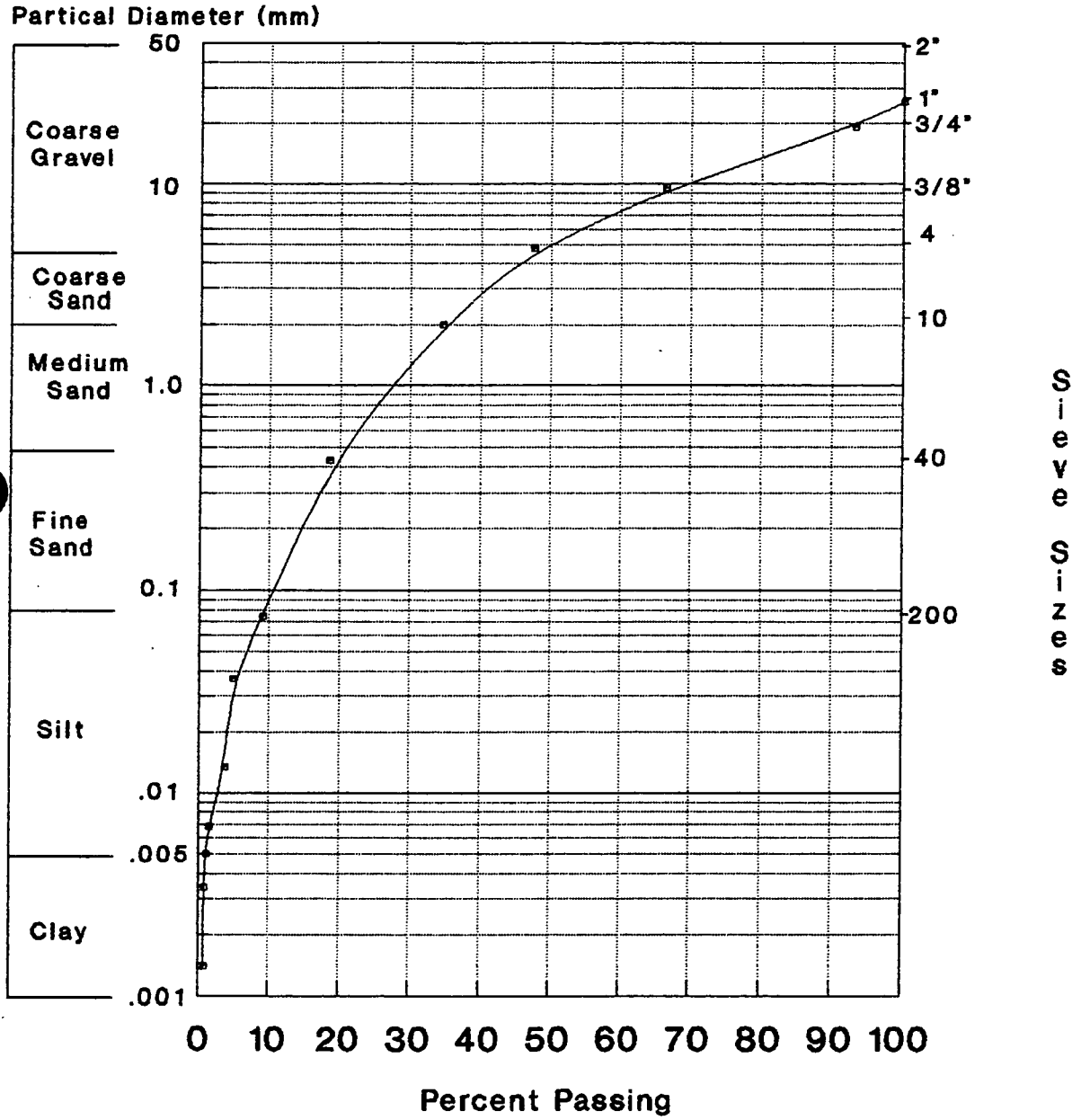
Atterberg Limits: LL= NP PL= NP PI= NP
Description: SILTY, GRAVELLY F\C SAND, trace clay

000036

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 19-01 Depth:



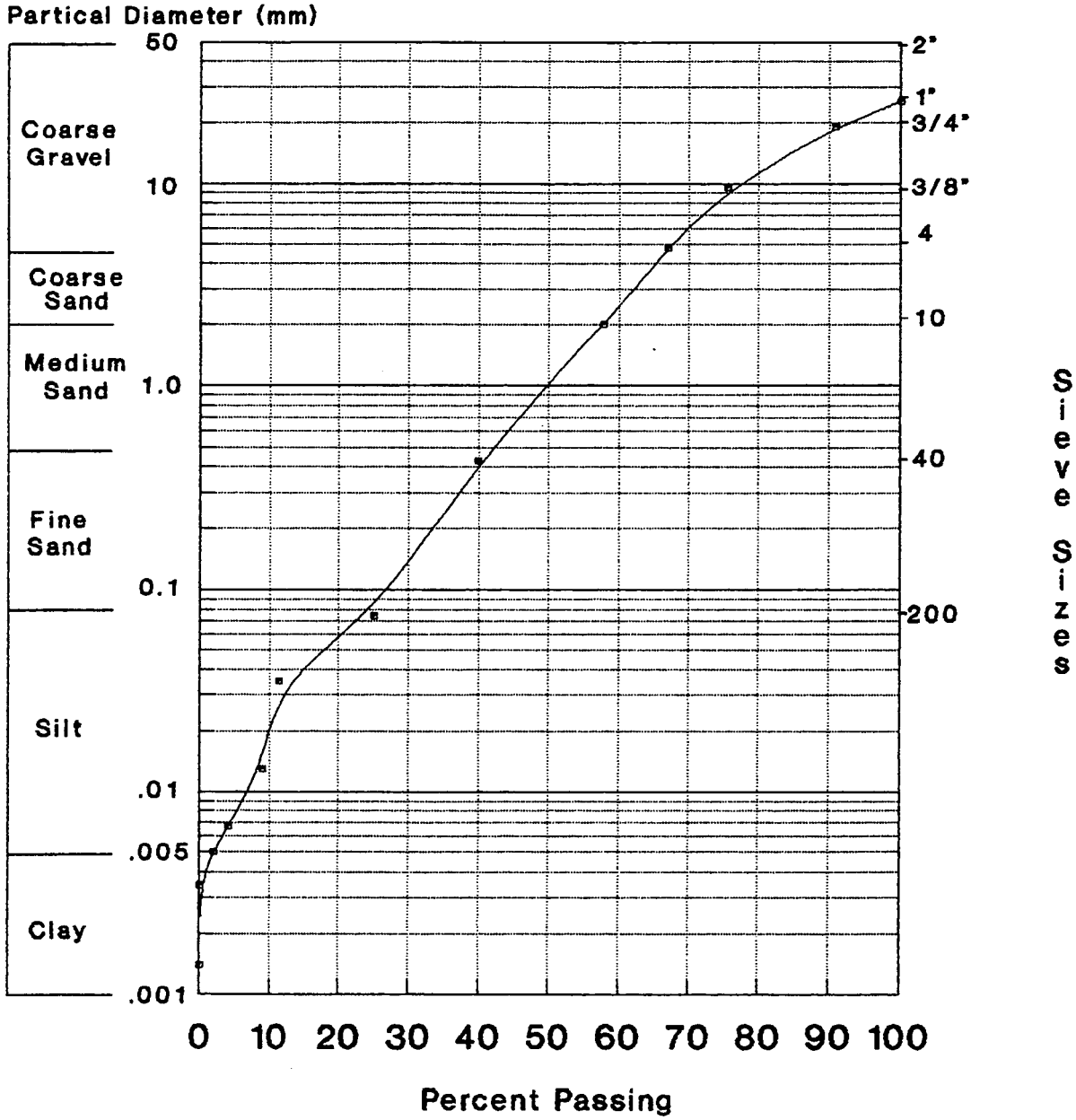
Atterberg Limits: LL= NP PL= NP PI= NP

Description: SANDY GRAVEL, trace silt, trace clay

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 23-01 Depth:



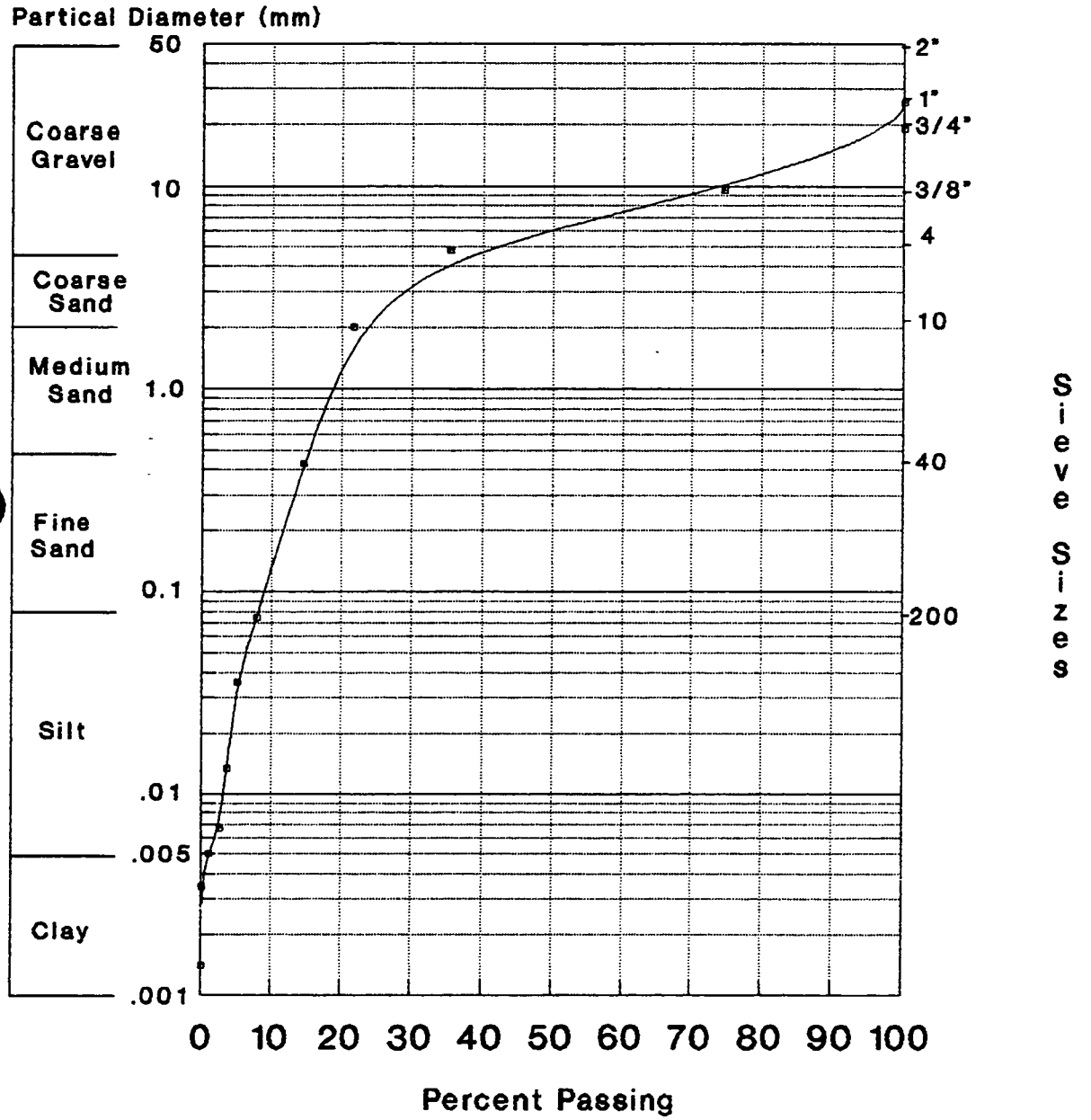
Atterberg Limits: LL= NP PL= NP PI= NP
Description: SILTY, GRAVELLY F\C SAND, trace clay

000038

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# PRSS Sample# 25-01 Depth:



Atterberg Limits: LL= NP PL= NP PI= NP

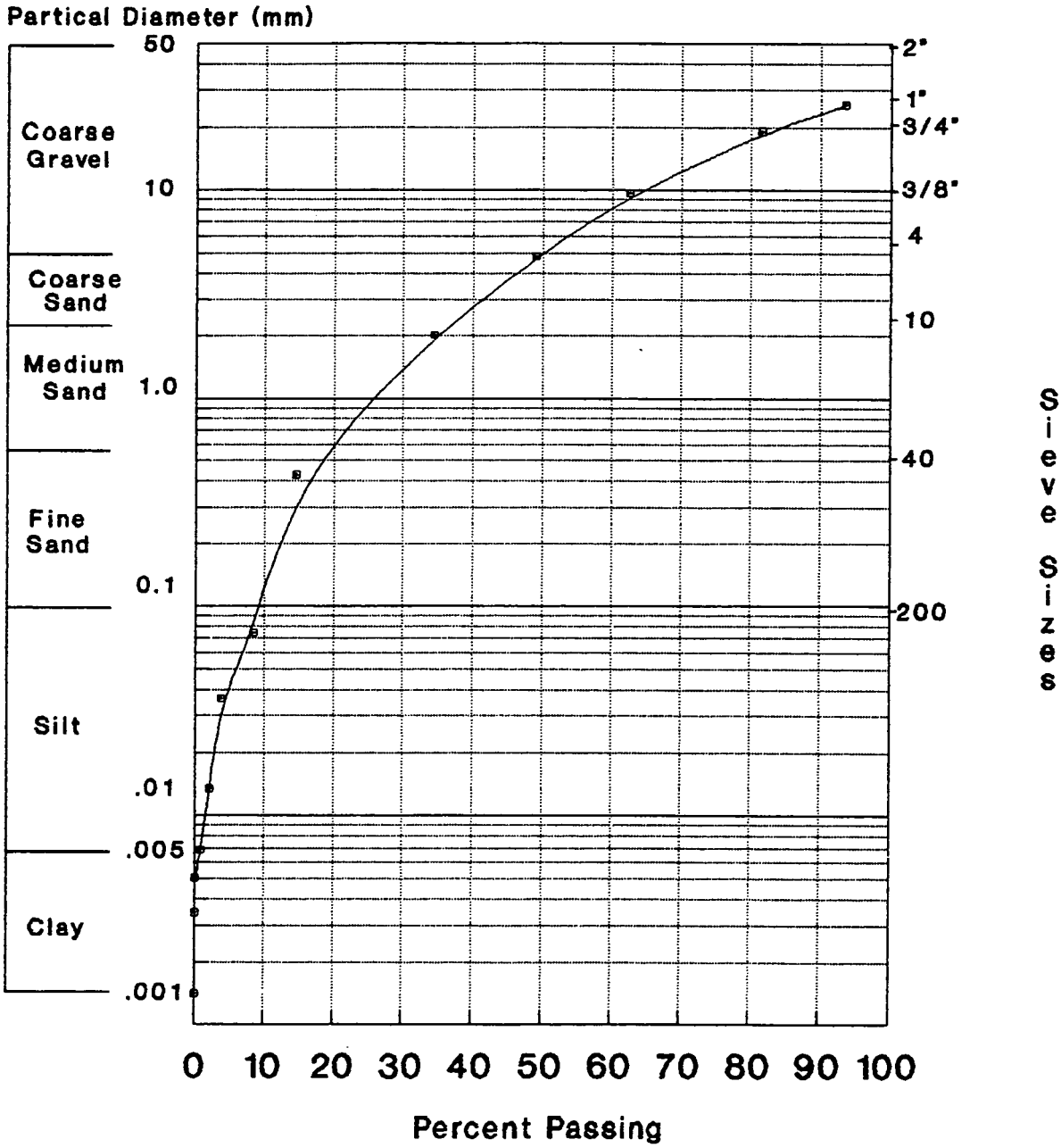
Description: SANDY GRAVEL, trace silt, trace clay

SOIL BORINGS

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth: 15'-17'



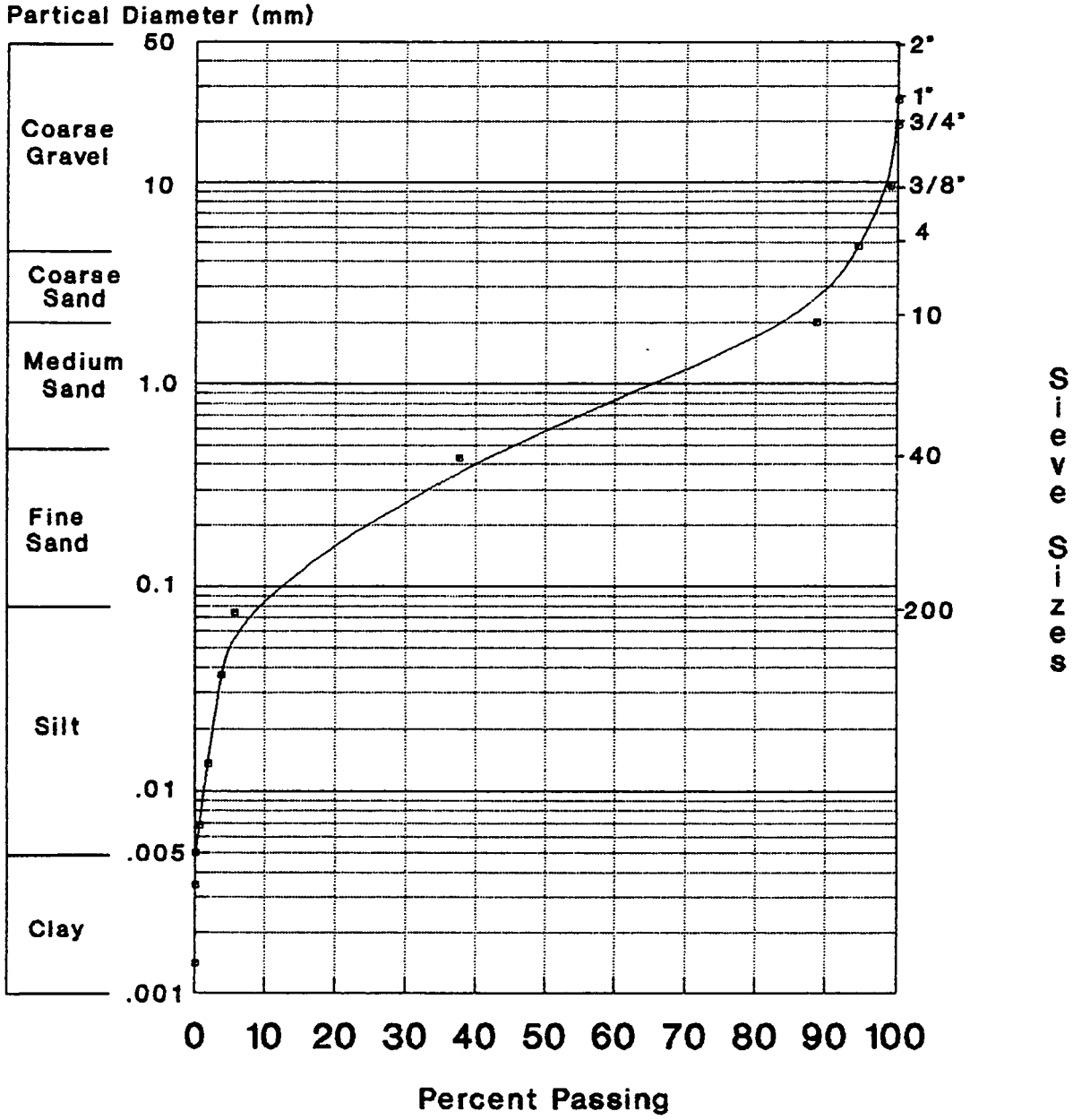
Atterberg Limits: LL= NP PL= NP PI= NP

Description: SANDY GRAVEL, trace silt

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth: 24'-25'



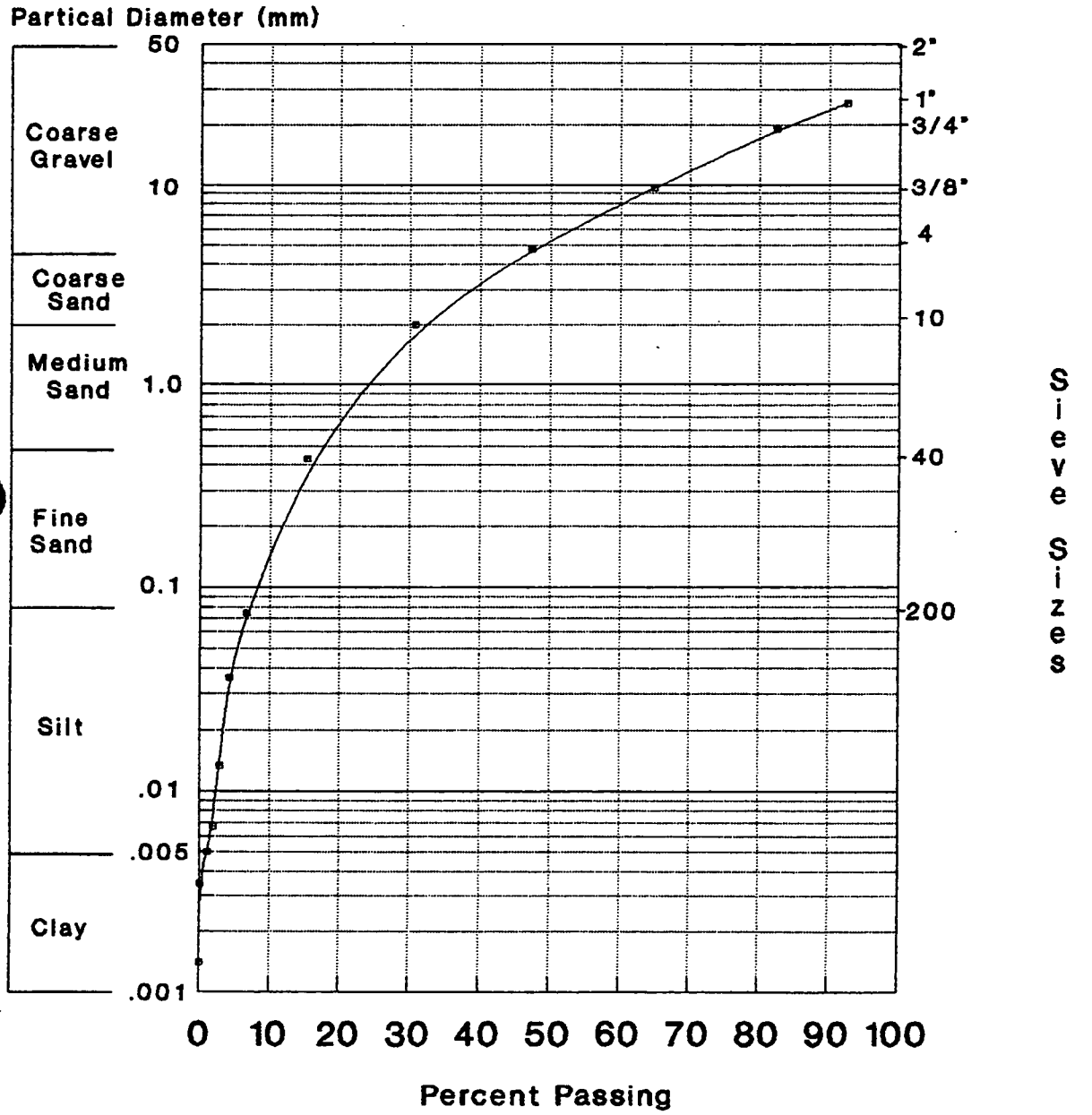
Atterberg Limits: LL= NP PL= NP PI= NP
Description: F\C SAND, trace gravel, trace silt

000042

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth: 31.7'-33'

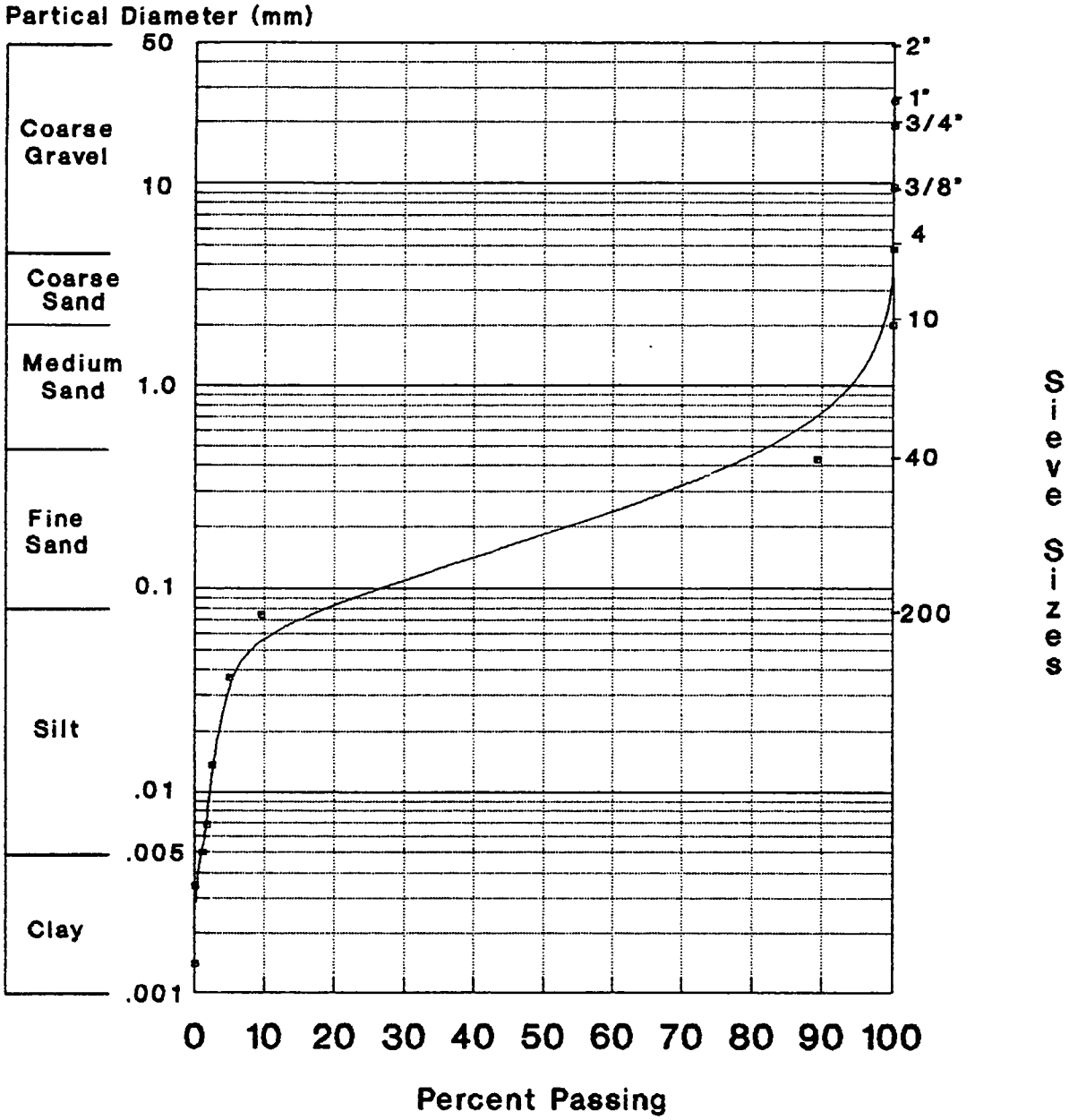


Atterberg Limits: LL= NP PL= NP PI= NP
Description: SANDY GRAVEL, trace silt, trace clay

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth:45'-47'



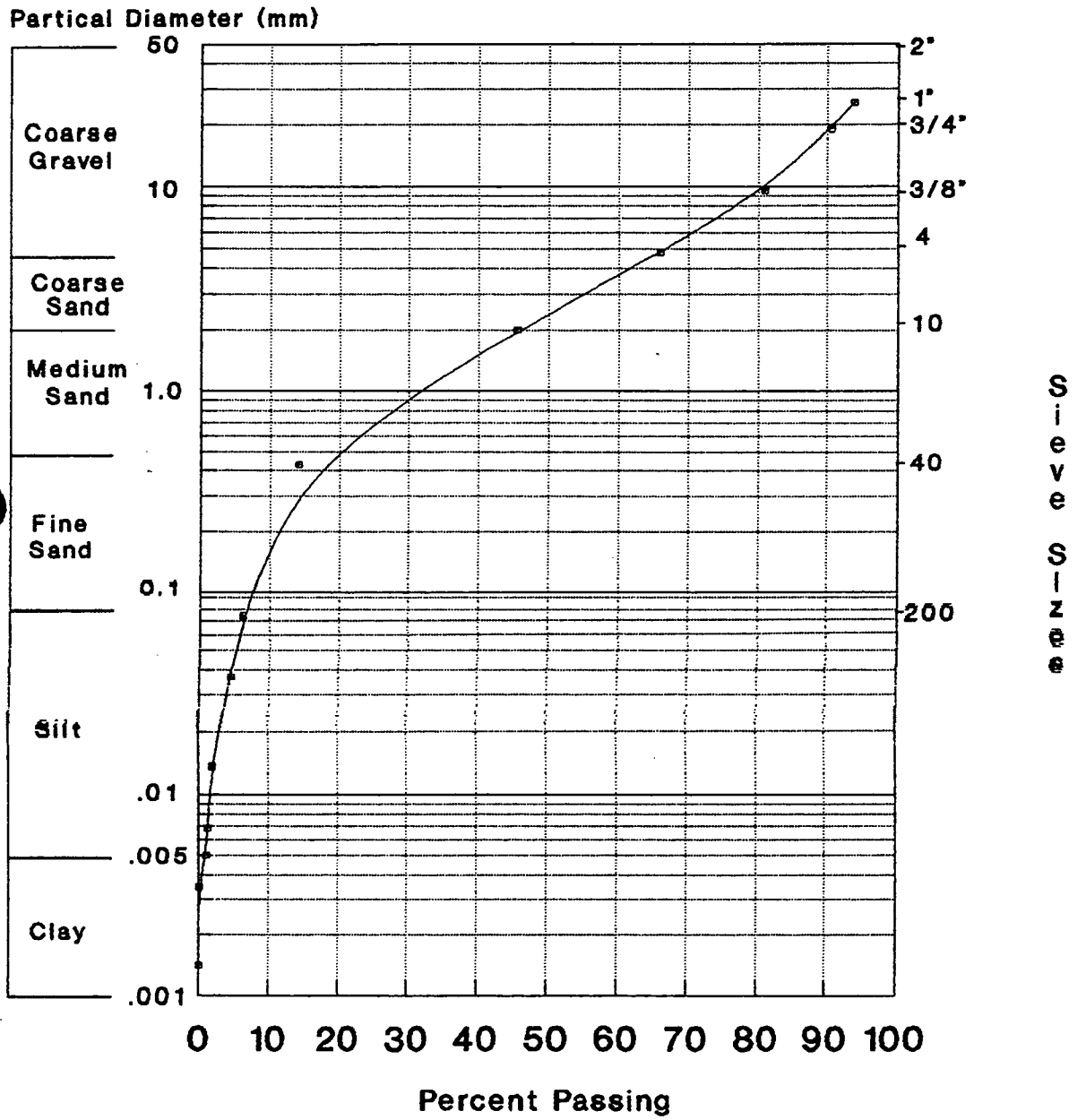
Atterberg Limits: LL= NP PL= NP PI= NP
Description: F/M SAND, trace silt, trace clay

000014

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth: 55'-57'

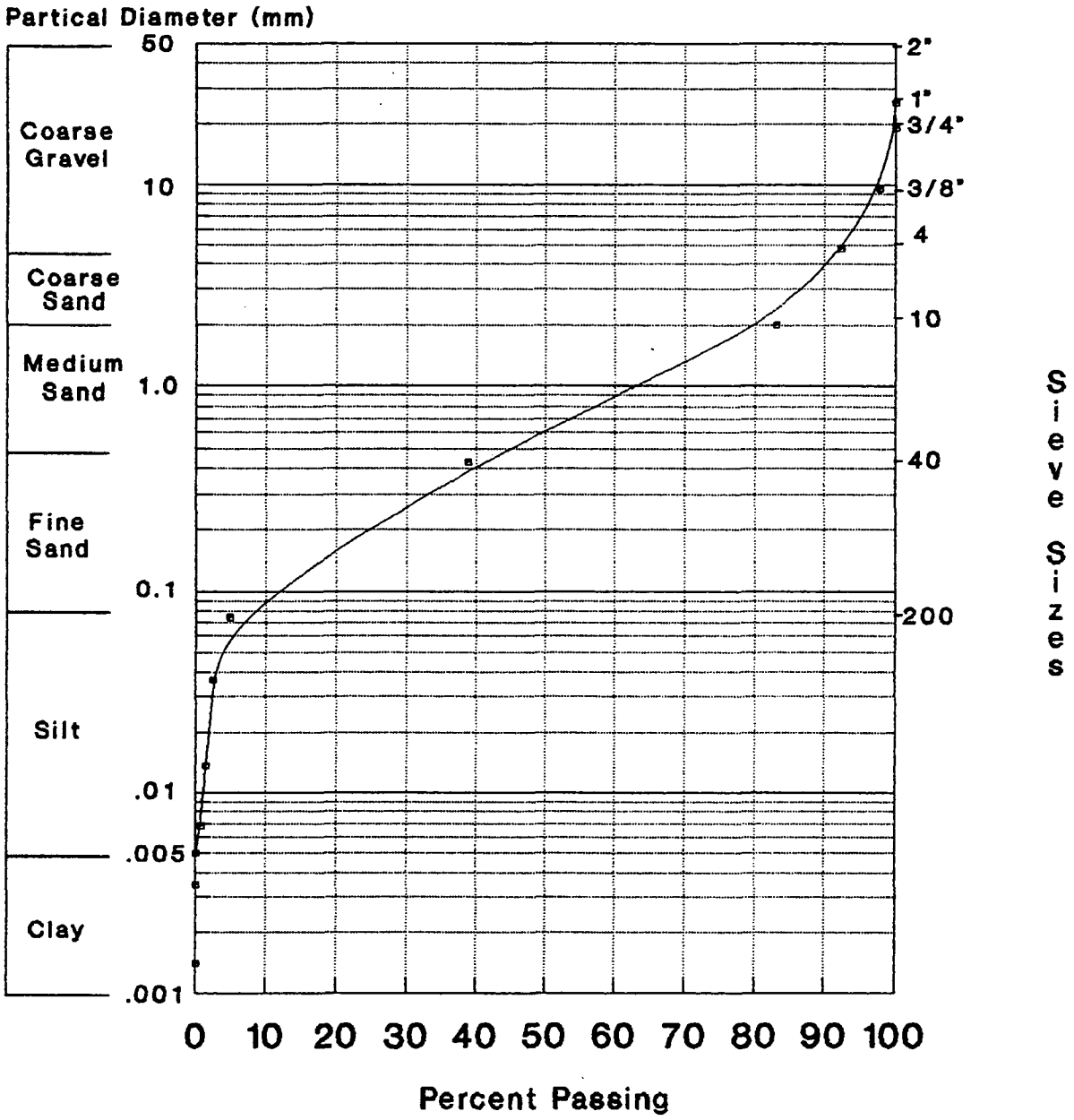


Atterberg Limits: LL= NP PL= NP PI= NP
Description: GRAVELLY F\C SAND, trace silt, trace clay

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth: 83'-85'



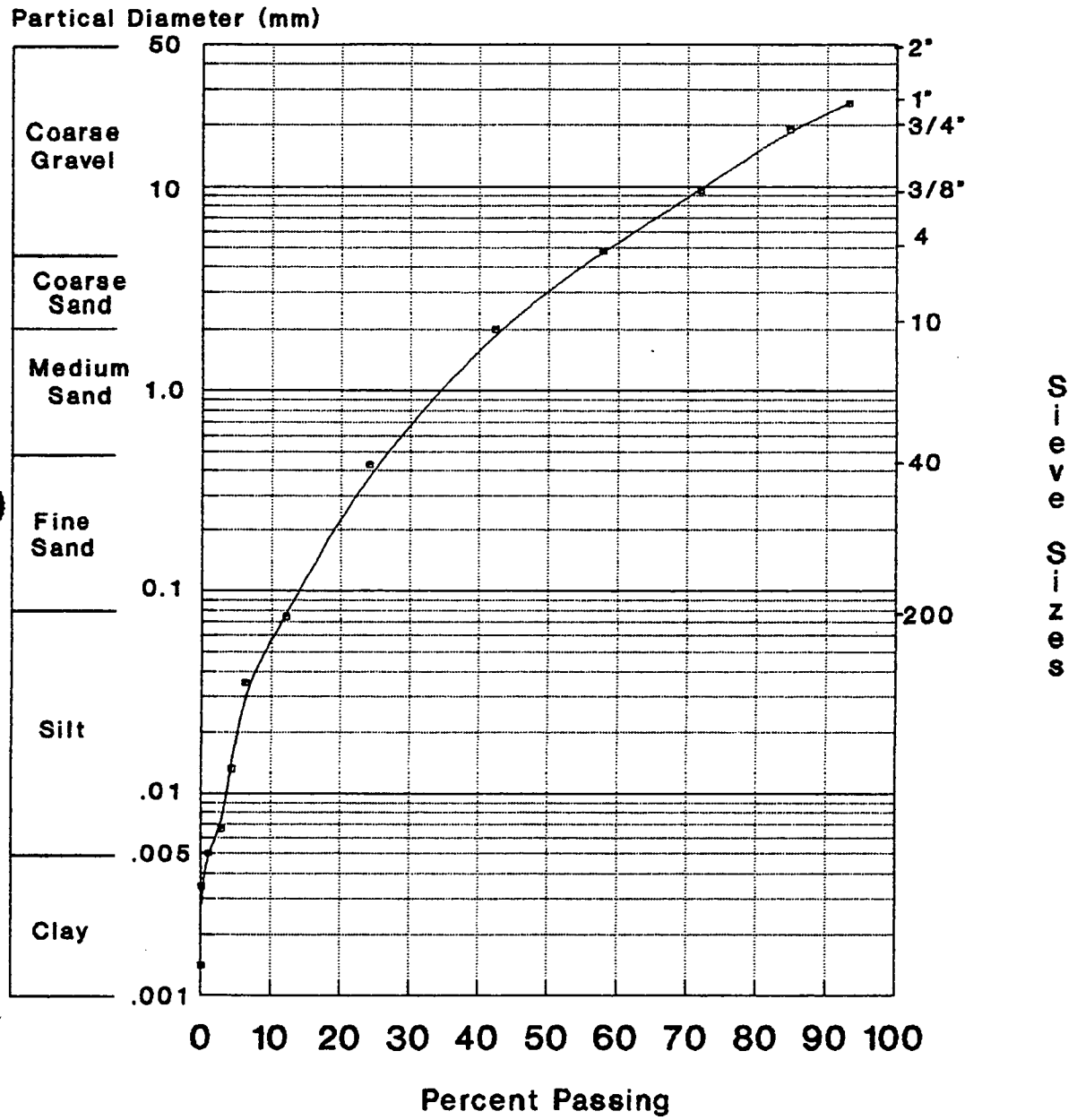
Atterberg Limits: LL= NP PL= NP PI= NP
Description: F\C SAND, trace gravel, trace silt

000046

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-9D Sample# Depth: 95'-96.5'



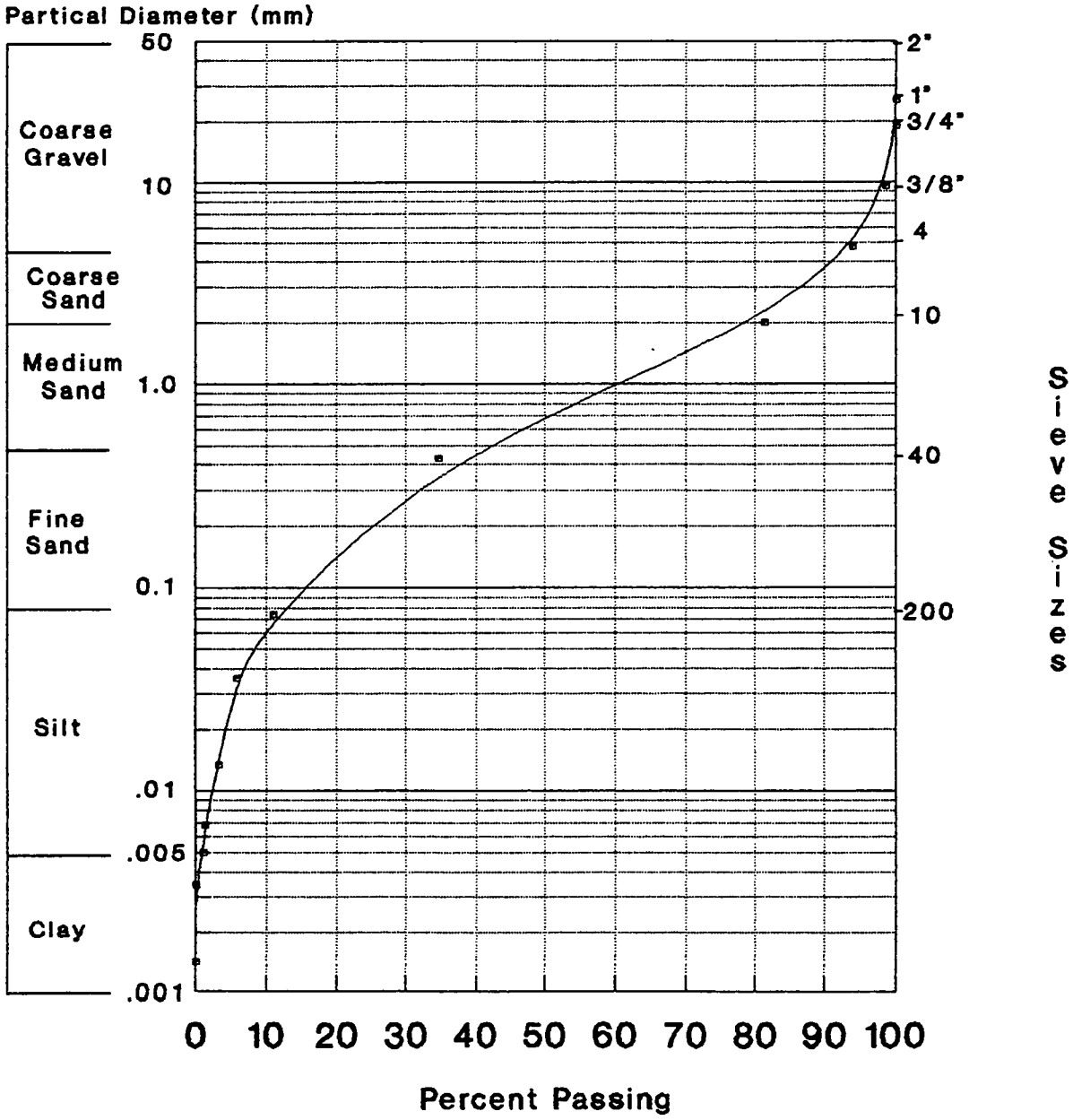
Atterberg Limits: LL= NP PL= NP PI= NP

Description: SILTY, F\C SAND and GRAVEL, trace clay

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-18D Sample# Depth:22.7'-24.5'



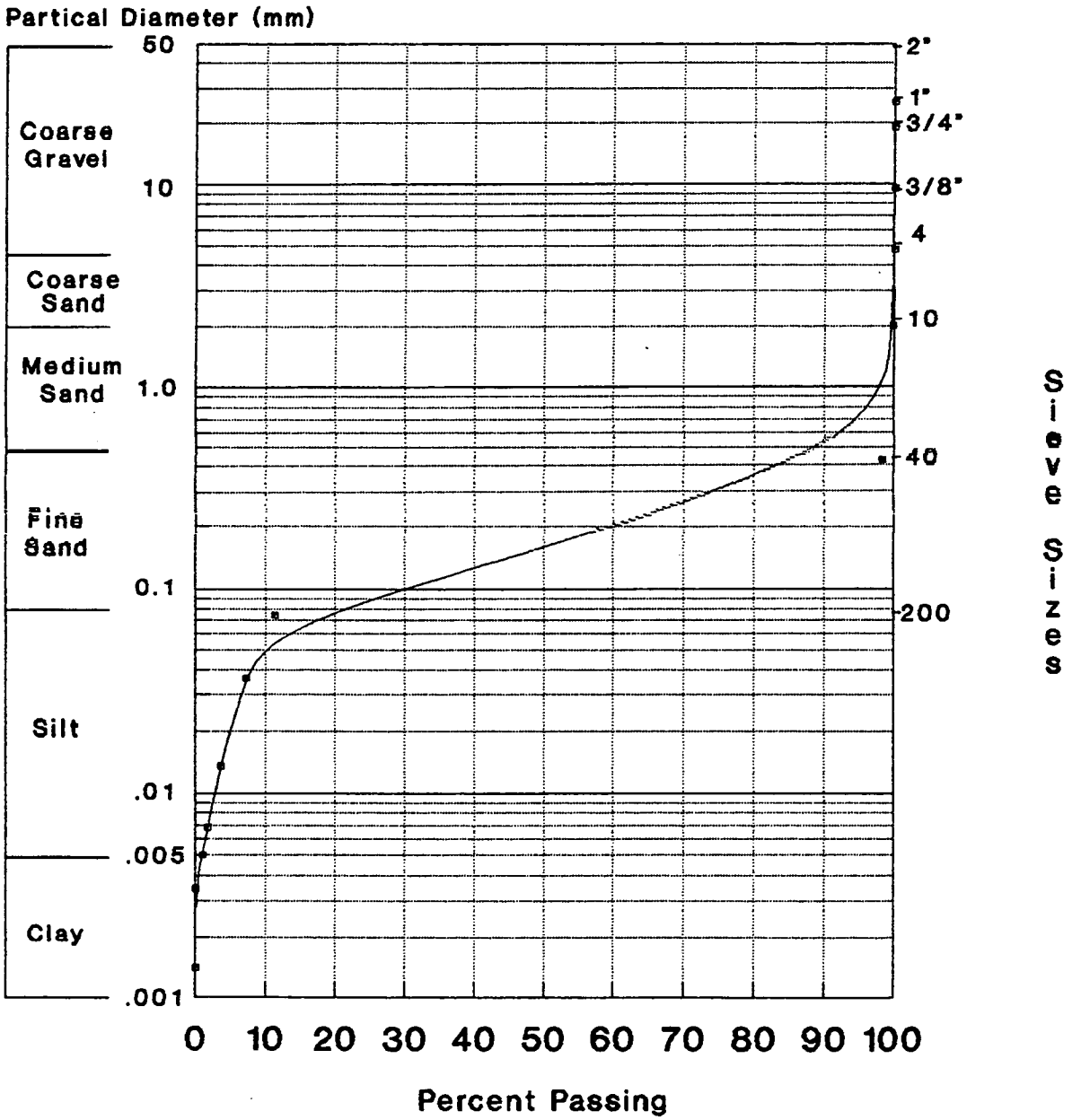
Atterberg Limits: LL= NP PL= NP PI= NP
Description: F\C SAND, trace silt, trace gravel, trace clay

000048

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-18D Sample# Depth:72.5'-74.6'

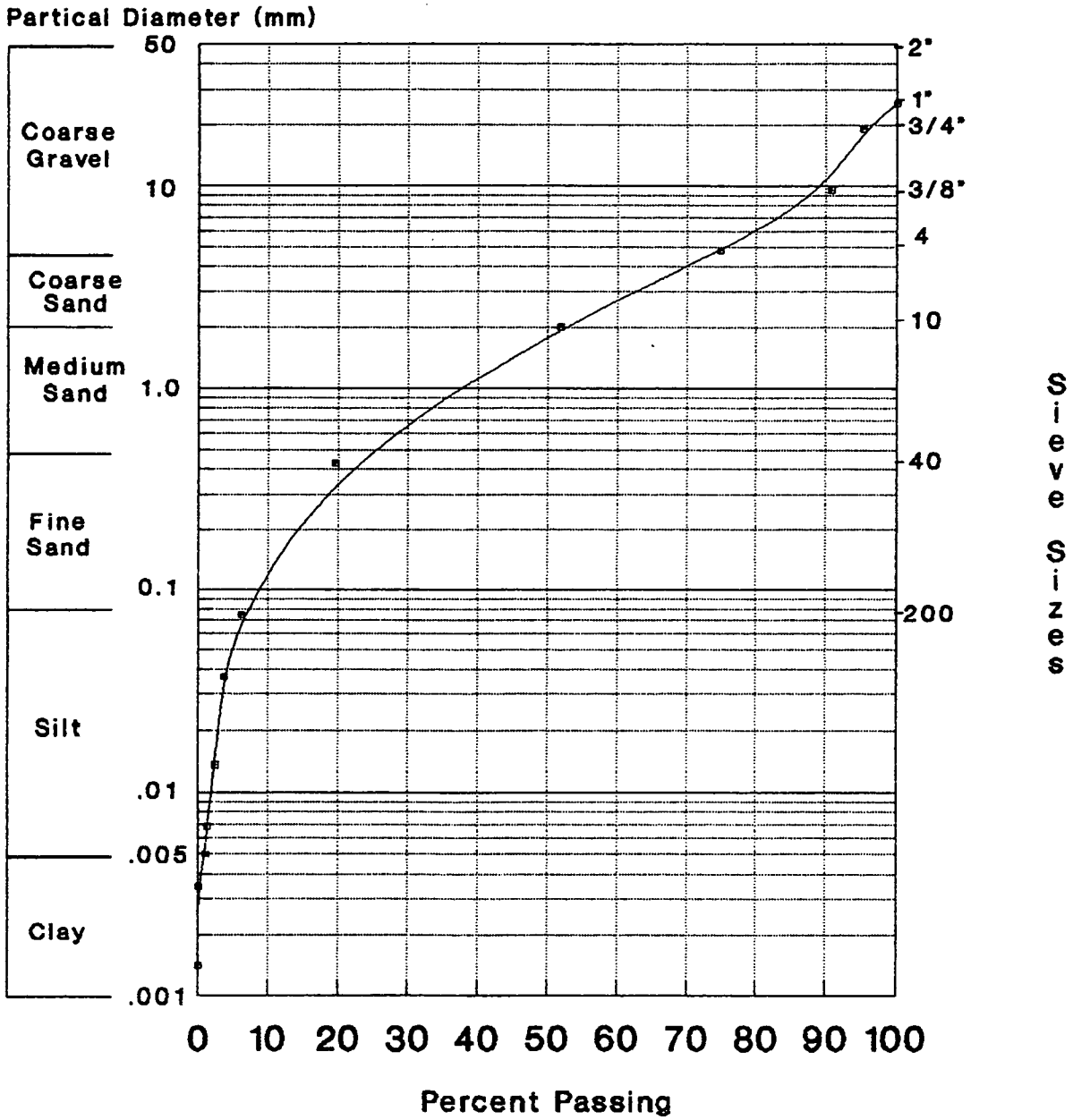


Atterberg Limits: LL= NP PL= NP PI= NP
Description: FINE SAND, little silt,
trace m sand, trace clay

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-20D Sample# Depth:72'-74'



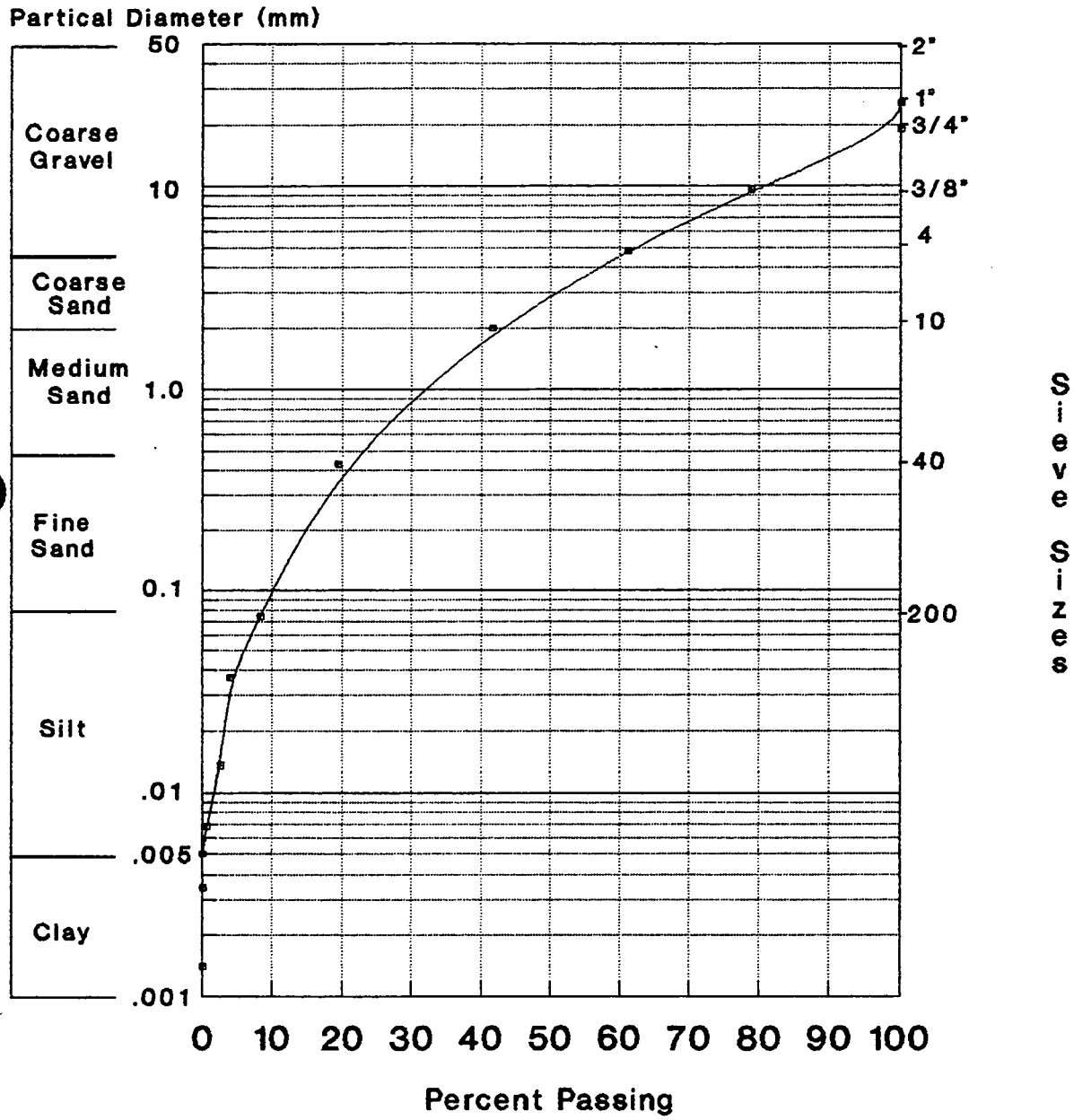
Atterberg Limits: LL= NP PL= NP PI= NP
Description: GRAVELLY F\C SAND, trace silt, trace clay

000050

SIEVE ANALYSIS-GRAIN SIZE ACCUMULATION

Project:ERM-MIDWEST, INC. WORTHINGTON

Boring# MW-21D Sample# Depth: 65'-67'



Atterberg Limits: LL= NP PL= NP PI= NP

Description:GRAVELLY F\C SAND, trace silt

Appendix E
Soil Boring, Well Construction & Piezometer Construction Logs

APPENDIX E

SOIL BORING, WELL CONSTRUCTION AND PIEZOMETER CONSTRUCTION LOGS

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-01 Sh 1 of 1
Date Started 3/01/90 Completed 3/22/90 Ground Elev. 527.5
Total Depth 14.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
					Top Soil	
	01	6 16 17 20	0-2	2		0 Units no odor no visual
2						
	02	5 8 8 22	2-4	2	Stiff, brown, clay with some coarse sand, moist	1.4 Units no odor no visual
4						
	03	16 33 31 20	4-6	1.5		0 Units no odor no visual
6						
	04	11 13 13 21	6-8	1.5	Dense, brown, medium, sand moist	4 Units no odor no visual
8						
	05	6 4 4 5	8-10	2		1.6 Units no odor no visual
10					Stiff, brown to tan clay with Some sand, moist-to-wet	
	06	3 3 4 34	10-12	2		>10 Units no odor no visual
12						
	07	16 37 34 25	12-14	2	Dense, tan, medium to coarse fine gravels; moist to wet	0 Units no odor no visual
14						
					Ground Water encountered at approximately 14 feet.	
16						
18						
20						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-02 Sh 1 of 1
Date Started 2/22/90 Completed 2/22/90 Ground Elev. 527.7
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	12 34 37 14	0-2	1.5	Very stiff, black, sand	0 Units no odor asphalt noted
4	02	13 20 30 34	2-4	2	Very stiff, brown, silty, clay	0 Units no odor no visual
6	03	20 25 15 18	4-6	2		0 Units no odor no visual
8	04	17 25 34 21	6-8	2		0 Units no odor no visual
10	05	43 45 39 27	8-10	2	Very stiff, tan, sandy clay with gravel and sand	0 Units no odor no visual
12	06	27 43 42 41	10-12	2	Very dense, tan, fine gravels with sand and clay	0 Units no odor no visual
14					Ground Water encountered at approximately 12.0 feet.	
16						
18						
20						

ENSR

000054

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-03 Sh 1 of 1
Date Started 2/22/90 Completed 2/22/90 Ground Elev. 528.1
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	5 20 51 34	0-2	1.5	Top Soil	0 Units no odor no visual
2						
	02	12 15 21 27	2-4	2		4 Units no odor no visual
4						
	03	7 14 15 15	4-6	2	Stiff to medium stiff, tan to brown clay with trace to some gravels, sand and silt, moist	0 Units no odor no visual
6						
	04	10 9 10 12	6-8	2		1.8 Units no odor no visual
8						
	05	12 16 23 28	8-10	2	Very dense, gray, medium to coarse sand	1 Unit gray stain slight odor
10						
	06	14 16 21 23	10-12	1.8	Moist, stiff, gray to green, clay with some sand, moist	1 Unit gray stain slight odor
12						
14					Dense, medium sand and gravel, wet	
16						
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-04 Sh 1 of 1
Date Started 2/23/90 Completed 2/23/90 Ground Elev. 528.0
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	7 12 17 17	0-2	.75	Stiff, brown, clay	0 Units no odor no visual
4	02	10 8 10 9	2-4	2	Medium dense, brown, fine to medium Sand, moist	0 Units no odor no visual
6	03	07 16 30 30	4-6	2	Very stiff, brown, clay	0 Units no odor no visual
8	04	06 14 12 10	6-8	.75		0 Units no odor no visual
10	05	09 25 33 41	8-10	2	Very dense, brown, gravel with some clay and fine to medium sand	0 Units no odor no visual
12	06	12 46 46 35	10-12	2		0 Units no odor no visual
14	07	22 40 42 61	12-14	2		0 Units no odor no visual
16					Ground water encountered at approximately 12 feet.	
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-05 Sh 1 of 1
Date Started 2/23/90 Completed 2/23/90 Ground Elev. 528.0
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	25 33 33 25	0-2	2	Very stiff, light brown clay with some gravel	5 Units no odor asphalt chips observed
2	02	5 22 18 11	2-4	1.5	Very stiff, brown clay with some fine gravel Clay absent gravel beyond 4 ft.	1 Units no odor no visual
4	03	15 14 16 25	4-6	2		0 Units no odor no visual
6	04	08 11 13 15	6-8	2		1 Units no odor no visual
8	05	07 18 20 24	8-10	1.7		3.5 Units no odor no visual
10	06	14 21 30 33	10-12	2	Very dense, yellow to brown, fine gravel, some clay	3 Units no odor no visual
12					Ground Water encountered at approximately 12 feet.	
14						
16						
18						
20						

ENSR

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-06 Sh 1 of 1
Date Started 2/23/90 Completed 2/23/90 Ground Elev. 528.0
Total Depth 14.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	50 81 36 46	0-2	2	Very dense, brown, gravel with medium sand	0 Units no odor black charcoal like substance
4	02	10 10 13 15	2-4	2	Stiff to very stiff, brown, clay, moist	0 Units no odor no visual
6	03	17 30 41 34	4-6	2		0 Units no odor no visual
8	04	18 20 19 19	6-8	2		0 Units no odor no visual
10	05	08 13 20 20	8-10	1.8		0 Units no odor no visual
12	06	18 33 32 21	10-12	1.8		0 Units no odor no visual
14	07	24 32 49 77	12-14	2	Very dense, yellow, gravel and coarse sand with some clay.	0 Units no odor
16					Ground Water encountered at approximately 12.0 ft.	
18						
20						

ENSR 000058

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007361

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-07 Sh 1 of 1
Date Started 2/27/90 Completed 2/28/90 Ground Elev. 528.0
Total Depth 18.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks SB-07 completed as monitoring well MW-07S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	4 5 22 39	0-2	0	Asphalt and subgrade	
2	02	22 46 53 18	2-4	1	Very stiff, brown, clau. Some sand at 6 to 8 feet.	0 Units no odor no visual
4	03	10 12 15 78	4-6	2		0 Units no odor no visual
6	04	29 30 47 68	6-8	2		0 Units no odor no visual
8	05	50 119 114 75	8-10	1.5	Very dense, tan, fine to medium gravels with coarse sand and clay	0 Units no odor no visual
10	06	44 44 44 87	10-12	1.5		0 Units no odor no visual
12	07	51 58 106 2	12-14	1.5		2 Units slight odor Gray staining 13.5-14 ft.
14	08	52 61 70 60	14-16	1.5		1 Unit slight odor no visual
16	09		16-18	1.5		
18					Ground Water encountered at 12.0 ft.	
20						

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000059

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-08 Sh 1 of 1
Date Started 2/28/90 Completed 2/28/90 Ground Elev. 528.6
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	10 14 15 22	0-2	2	Medium dense, gravel with some sand and clay	0 Units no odor no visual
4	02	12 14 13 11	2-4	2	Medium stiff to stiff, brown, clay with trace of sand, moist	0 Units no odor no visual
6	03	3 9 13 18	4-6	2	Medium dense, tan, fine to medium sand, moist	0 Units no odor no visual
8	04	17 21 48 87	6-8	2		0 Units slight nat. gas odor no visual
10	05	4 90 114	8-10	1.5	Very dense, tan, medium to coarse gravels, with sand, and clay, moist	0 Units slight nat. gas odor no visual
12	06 07	24 109 44 84	10-12	2.0		1 Unit no odor no visual
14					Ground Water encountered at approximately 11.0 feet.	
16						
18						
20						

ENSR 000060

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-09 Sh 1 of 1
Date Started 2/28/90 Completed 2/28/90 Ground Elev. 528.2
Total Depth 14.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	1 7 13 32	0-2	1	Loose, light brown, fine gravel, moist	0 Units no odor no visual
2					Stiff, tan, clay, moist	
	02	9 13 18 27	2-4	2		0 Units no odor no visual
4						
	03	24 70 69 18	4-6	2		0 Units no odor no visual
6						
	04	20 25 40 41	6-8	2	Dense to very dense, tan medium to coarse sand with trace of fine gravel, moist	>10 Units slight odor no visual
8						
	05	48 59 100 57	8-10	2		1 Unit slight odor no visual
10						
	06	48 91 72 61	10-12	0.5	Dense to very dense, gray, very coarse sand to cobbles, moist to wet	0 Units no odor black stains
12						
	07	60 57 80	12-14	2		3 Units slight odor gray staining
14						
					Ground Water encountered at approximately 11 feet.	
16						
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-10 Sh 1 of 1
Date Started 2/28/90 Completed 2/28/90 Ground Elev. 528.9
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	22 113 47/1"	0-2	1	Very dense, fine gravel with some clay	0 Units no odor no visual
4	02	7 6 6 8	2-4	2	Medium stiff, tan, clay, moist	0 Units no odor no visual
6	03	8 7 6 5	4-6	2		0.8 Units no odor orange staining
8	04	8 14 27 48	6-8	2		0.6 Units no odor no visual
10	05	27 32 31 91	8-10	2	Very dense, tan to gray, fine to coarse sand with some gravel, trace of clay, moist to wet	1 Unit no odor black staining (9-10 ft)
12	06	28 31 45 47	10-12	2	Very dense,brown,fine to gravels with trace of coarse sand	0 Units no odor no visual
14					Ground Water encountered at approximately 12 feet.	
16						
18						
20						

ENSR 000062

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-11 Sh 1 of 1
Date Started 2/28/90 Completed 2/28/90 Ground Elev. 529.1
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	8 5 5 4	0-2	2	Gravel and sand fill	0 Units no odor no visual
2	02	24 4 5 7	2-4	2	Medium stiff, dark brown, clay	0 Units no odor no visual
4	03	3 3 5 7	4-6	2		0 Units no odor no visual
6	04	6 6 5 4	6-8	2	Medium, dense, brown, fine to medium sand, with trace of clay, moist	0 Units no odor no visual
8	05	2 2 3 4	8-10	2		0 Units no odor
10	06	2 2 11 13	10-12	2	Medium dense, brown, gravel with coarse sand	0 Units no odor orange stains
12					Ground Water encountered at approximately 12.0 feet.	
14						
16						
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-12 Sh 1 of 1
Date Started 3/01/90 Completed 3/01/90 Ground Elev. 528.0
Total Depth 16.0 Ft Location Logged by B. Berg
Remarks SB-12 completed as monitoring well MW-05S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	4 4 3 2	0-2	2	Fine, gray, gravel (fill)	0 Units no odor no visual
2					Soft, brown, clay	
	02	3 2 1 2	2-4	2		0 Units no odor gray staining
4						
	03	7 14 12 11	4-6	2		0 Units no odor no visual
6						
	04	18 21 15 20	6-8	2	Medium dense to dense, tan, fine to medium sand, with some clay and trace gravels, moist to wet	30 Units gas odors gray staining
8						
	05	24 27 36 18	8-10	2		50 Units gas odors gray staining
10						
	06	42 140/ 4"	10-12	.5		7 Units slight odor gray staining
12					Very dense, brown, medium to coarse gravels, wet	
	07	36 43 84/ 4"	12-14	.5		0 Units slight odor gray staining
14						
	08	98 114/ 4"	14-16	.5		0 Units slight odor gray staining
16						
					Ground Water encountered at approximately 10.5 feet.	
18						
20						

ENSR 000064

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-13 Sh 1 of 1
Date Started 3/01/90 Completed 3 01/90 Ground Elev. 527.7
Total Depth 10.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	7 21 47 27	0-2	2	Medium dense, gray, fine gravel with some sand, trace clay	0 Units strong odor gray stain
2						
	02	9 16 12 18	2-4	2		0 Units no odor no visual
4					Soft, gray-green clay with trace of silt and gravels, moist.	
	03	3 2 2 3	4-6	2		0 Units no odor no visual
6						
	04	2 2 3 4	6-8	2		1 Unit no odor no visual
8						
	05	4 10 46 51	8-10	2	Very dense, gray, coarse, sand, with fine gravels, wet	1.5 Units no odor no visual
10					Ground water encountered at approximately 10 feet.	
12						
14						
16						
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-14 Sh 1 of 1
Date Started 3/02/90 Completed 3/02/90 Ground Elev. 528.3
Total Depth 12.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	5 5 6 4	0-2	1	Soft, brown to green-gray clay, with trace of fine gravels, moist to wet	0 Units no odor no visual
4	02	6 5 5 3	2-4	2		0 Units no odor no visual
6	03	1 0 1 0	4-6	1		50 Units slight odor green stain
8	04	2 1 0 3	6-8	1		0 Unit slight odor green stain
10	05	5 6 7 6	8-10	1.5	Medium dense, tan, fine to medium sand and fine to medium gravels with some coarse sand and clay, moist to wet	90 Units slight odor green stain
12	06	8 10 12 20	10-12	.5		150 Units slight odors slight green stain
14					Ground Water encountered at approximately 12 feet.	
16						
18						
20						

ENSR 000066

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-15 Sh 1 of 1
Date Started 3/02/90 Completed 3/02/90 Ground Elev. 528.1
Total Depth 8.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	11 6 4 5	0-2	1.8	Gravel Fill	0 Units no odor black stain
2	02	7 11 6 6	2-4	2	Medium stiff,brown,clay,with some fine sand, moist	0 Units no odor no visual
4	03	6 21 18 31	4-6	2		0 Units no odor no visual
6	04	8 24 33 67	6-8	2	Dense to very dense, tan to brown, fine to coarse, sand with some fine gravels & clay	3 Unit slight odor no visual
8					Ground water encountered at approximately 7.5 feet.	
10						
12						
14						
16						
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-16 Sh 1 of 1
Date Started 3/05/90 Completed 3/05/90 Ground Elev. 528.7
Total Depth 16.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	1 3 4 4	0-2	1.5	Top soil, brown, soft	0 Units no odor no visual
4	02	4 5 6 5	2-4	1.5	Soft, brown, clay, with trace of fine gravel, moist	100 Units no odor no visual
6	03	2 2 3 2	4-6	2		>1000 Units strong odor gray stains
8	04	4 4 3 5	6-8	1.5		>1000 Units strong odor gray stain
10	05	7 12 8 8	8-10	2	Medium dense, dark gray, medium to coarse sand with some fine gravel, moist.	950 Units strong odor gray stains
12	06	6 9 14 16	10-12	2		1000 Units strong odor black stains
14	07	16 36 52 31	12-14	.75		400 Units strong odor black stains
16	08	18 25 32 50	14-16	2	Very dense, gray, fine to medium gravel with trace to some coarse sand and clay, moist to wet	50 Units strong odor black stain tarry appearance
18					Ground Water encountered at approximately 14 feet.	
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-17 Sh 1 of 2
Date Started 3/05/90 Completed 3/05/90 Ground Elev. _____
Total Depth 22.0 Ft Location RNCC Logged by B. Berg
Remarks Soil boring SB-17 is completed as monitoring well MW-16S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	3 4 2 4	0-2	0.5	Medium stiff, lite brown to brown clay with trace of silt and fine sand	0 Units no visual
2	02	2 2 4 5	2-4	1.5		0 Units no visual
4	03	2 4 2 4	4-6	2.0		18 Units gray stain
6	04	2 3 2 3	6-8	1.8		40 Units gray stain
8	05	2 1 1 1	8-10	2.0		480 Units gray-black stain
10	06	1 1 3 8	10-12	1.8		650 Units black stain
12	07	8 8 16 12	12-14	2.0	Dense to very dense, gray to medium gravels, and cobbles, with some clay	10 Units black stain
14	08	12 17 19 16	14-16	2.0		5 Units black tarry stain
16	09	27 46 91/5"	16-18			no recovery
18	10		18-20	0	Clay content decreasing	4 units black stain
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-17 Sh 2 of 2
Date Started 3/5/90 Completed 3/5/90 Ground Elev. _____
Total Depth 22 ft. Location RNCC Logged by B.Berg
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description Dense, black, medium to fine sand, wet	OVA Readings (in Units) & Remarks
22					Dense, black, fine to medium gravel with some coarse sand, wet	7 Units black to green-gray stain
					Ground Water encounterd at approximately 16 feet.	

ENSR 000070

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-18 Sh 1 of 1
Date Started 3/06/90 Completed 3/06/90 Ground Elev. 530.4
Total Depth 16.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
					Topsoil, Brown	
2	01	2 3 5 3	0-2	1		0 Units no odor no visual
4	02	2 2 3 2	2-4	1	Soft to medium stiff, brown to gray clay, with trace of silt, sand and fine gravels, moist	0 Units no odor no visual
6	03	3 5 8 6	4-6	2		450 Units strong odor black stains
8	04	6 10 10 12	6-8	2		2 Units slight odor slight stain
10	05	1 3 2 2	8-10	2		1.5 Units no odor no visual
12	06	3 5 2 3	10-12	2		0 Units no odor no visual
14	07	9 11 16 22	12-14	2	Dense to very dense, tan, fine to med.gravel,with some clay and coarse sand, moist to wet.	0 Units no odor green stain
16	08	11 26 24 112	14-16	2		1.0 Units slight odor dk.gray to black stain (15.5 to 16) feet
18					Ground Water encountered at approximately 15.5 to 16 feet	
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-19 Sh 1 of 1
Date Started 3/06/90 Completed 3/06/90 Ground Elev. 530.8
Total Depth 16.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	5 9 7 4	0-2	1.5		0 Units no odor no visual
2						
	02	3 5 3 3	2-4	1.5	Medium stiff,brown,clay, moist.	0 Units slight odor no visual
4						
	03	2 3 2 2	4-6	1.5		100 Units strong odor black stain (5.5')
6						
	04	10 14 14 15	6-8	1.8		950 Units strong odor black stains
8						
	05	13 10 8 8	8-10	1.8		>1000 ppm strong odor black stains
10					Medium dense to very dense, fine to medium Gravel with some coarse black, sand, trace of clay, moist to wet.	
	06	7 8 7 7	10-12	1.8		>1000 Units strong odor bl.tarry stain
12						
	07	10 14 12 19	12-14	1.8		>1000 Units strong odor bl.tarry stain
14						
	08	24 36 67 51	14-16	2.0		>1000 Units strong odor black stains
16						
					Ground Water encountered at approximately 16 feet.	
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-20 Sh 1 of 1
Date Started 3/06/90 Completed 3/06/90 Ground Elev. 531.3
Total Depth 12.0 Ft Location Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	2 3 3 4	0-2	1	Gravel fill	0 Units no odor slight gray stain
2					Soft, brown, clay	
	02	2 4 4 7	2-4	1	Loose, brown, fine to medium sand and coarse gravels, with some coarse sand, wet	0 Units no odor no visual
4						
	03	2 3 2 1	4-6	1		6 Units no odor green-gray stain
6						
	04	1 0 0 1	6-8	1.5		30 Units slight odor gray stain
8					Soft,brown,clay,with some green mottling, wet	
	05	1 0 0 0	8-10	.5		100 Units slight odor staining
10						
	06	1 1 1 0	10-12	1		400 Units strong odor green stain
12						
					Ground Water encountered at approximately 10 feet.	
14						
16						
18						
20						

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-21 Sh 1 of
Date Started 3/06/90 Completed 3/06/90 Ground Elev. 529.0
Total Depth 16.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	17 12 9 9	0-2	1.75	Dense, brown, fine to medium gravel, with fine sand.	85 Units Ammonia Odor green stains
4	02	6 5 5 6	2-4	1.75		450 Units Ammonia Odor black stains
6	03	3 3 5 9	4-6	2	Medium stiff, brown, clay, moist	30 Units Ammonia Odor black stains
8	04	4 5 6 9	6-8	2	Medium dense, brown, fine to coarse sand with trace of gravels, moist	100 Units Ammonia Od no visual
10	05	5 3 2 3	8-10	2	Soft, tan, clay, with some sand and silt, moist	50 Units Ammonia Odor green-gray stain
12	06	1 2 3 5	10-12	2		150 Units Ammonia Odor green-gray stain
14	07	2 2 8 8	12-14	2	Dense to very dense, black, fine to medium gravel, and cobbles, with some coarse sand and clay, moist to wet	650 Units Ammonia Odor tarry stain
16	08	6 30 34 61	14-16	2		600 Units Ammonia Odor tarry stain
18					Ground Water encountered at approximately 14 feet.	
20						

ENSR 000074

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-22 Sh 1 of 1
Date Started 3/7/90 Completed 3/07/90 Ground Elev. 529.89
Total Depth 14.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	24 21 13 10	0-2	1.8	Gravel Fill	400 Units sour odor Staining
2						
	02	12 15 13 9	2-4	1.8	Dense, brown, fine to medium sand and fine gravels, with some large cobbles, trace of clay, moist	500 Units strong odor no visual
4						
	03	1 2 5 6	4-6	0		No recovery
6						
	04	3 3 5 7	6-8	2	Soft, brown, clay, moist	90 Units strong odor green-gray stain
8						
	05	10 12 9 12	8-10	2		1000 Units strong odor slight gray stain
10						
	06	7 12 9 11	10-12	2		1000 Units strong odor slight gray stain
12						
	07	5 10 17 11	12-14	2	Medium dense, tan, medium to coarse sand and fine to medium gravels, with trace of clay, moist to wet	1000 Units slight odor no visual
14						
					Ground Water encountered at approximately 12 feet.	
16						
18						
20						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-23 Sh 1 of
Date Started 3/07/90 Completed 3/07/90 Ground Elev. 529.0
Total Depth 14.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	12 24 10 9	0-2	1.5	Dense,gray,fine,to medium sand & fine gravel,moist	25 Units no odor asphalt 0-0.5 ft.
4	02	11 13 12 5	2-4	1.8	Med.stiff,tan,clay,with trace of gravel. Med.dense,gray,coarse sand with some fine gravel	120 Units strong odor dk.gray stain
6	03	2 4 4 7	4-6	1.8		1000 Units Slight odor black stain
8	04	3 3 5 3	6-8	2	Soft,brown to gray green, clay,with some fine sand and trace silt, moist to wet	1000 Units Strong Odo Slight sta
10	05	3 4 4 4	8-10	2		680 Units Slight Odor black stain
12	06	2 1 2 3	10-12	2		150 Units Strong Odor black stain
14	07	2 1 1 6	12-14	2	Loose,gray,medium sand,wet	100 Units Slight odor black stain
16					Ground water encountered at approximately 12 to 13 feet.	
18						
20						

ENSR 000076

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-24 Sh 1 of 1
Date Started 3/7/90 Completed 3/07/90 Ground Elev. 529.1
Total Depth 12.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	6 8 12 7	0-2	1.5	Gravel Fill	0 Units Slight odor no visual
2					Medium, stiff, brown, clay	
	02	12 18 11 14	2-4	2	Med.dense,tan,fine to med.gravel,with some coarse sand and trace of clay, moist	0 Units Slight odor no visual
4						
	03	4 5 7 4	4-6	2		300 Units Slight odor no visual
6						
	04	4 6 4 6	6-8	2		2 Units No Odor no visual
8					Medium stiff, brown, clay, with some silt, moist	
	05	2 2 3 3	8-10	2		35 Units Slight Odor gray stain
10						
	06	3 4 8 11	10-12	2		2 Units Slight Odor green-gray stain
12						
14					Ground Water encountered at approximately 12 feet.	
16						
18						
20						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-25 Sh 1 of 1
Date Started 3/07/90 Completed 3/07/90 Ground Elev. 532.6
Total Depth 18.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	2 4 5 4	0-2	1	Soft, brown, clay with some silt	0 Units no odor no visual
4	02	3 2 4 3	2-4	1.75		0 Units no odor no visual
6	03	2 5 5 7	4-6	2		0 Units no odor no visual
8	04	2 5 4 4	6-8	2		2.5 Units no odor green stain
10	05	6 14 19 15	8-10	2	Dense to very dense, gray-green, fine to coarse gravels, with some coarse sand, moist to wet	0 Units no odor green-gray stain
12	06	14 22 28 19	10-12	2		10 Units no odor green-gray stain
14	07	8 8 9 6	12-14	2		0 Units no odor green-gray stain
16	08	10 20 26 31	14-16	2		650 Units no odor black stain
18	09	45 35 38 35	16-18	2		1000 Units strong odor black stain
20					Ground Water encountered at approximately 17 feet.	

ENSR 000078

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-26 Sh 1 of 1
Date Started 3/08/90 Completed 3/08/90 Ground Elev. 530.1
Total Depth 16.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	9 6 7 8	0-2	1.5	Concrete and gravel fill	180 Units strong odor black stain
2					Medium stiff, gray, clay	
	02	6 11 7 8	2-4	2		80 Units slight odor no visual
4						
	03	8 15 21 17	4-6	2	Dense to very dense, tan to orange, fine to medium, gravel with some coarse sand, trace of clay, moist to wet.	200 Units no odor no visual
6						
	04	15 15 18 19	6-8	2		110 Units slight odor no visual
8						
	05	12 22 24 21	8-10	2		60 Units slight odor gray stain
10						
	06	21 30 38 23	10-12	2		55 Units slight odor no visual
12						
	07	28 32 31 22	12-14	2		20 Units slight odor no visual
14						
	08		14-16	2		25 Units slight odor black stain
16						
					Ground Water encountered at approximately 15 feet.	
18						
20						

ENSR

DRAFT

000079

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-27 Sh 1 of
Date Started 3/08/90 Completed 3/08/90 Ground Elev. 529.6
Total Depth 14.0 Ft Location RNCC Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	10 12 13 10	0-2	1.7	Asphalt Gravel Fill	100 Units slight odor
2						
	02	4 7 5 6	2-4	2	Medium stiff, green-brown to gray, silty, clay, moist	400 Units slight odor staining
4						
	03	3 6 6 10	4-6	2		300 Units slight odor black stain
6						
	04	8 12 10 12	6-8	1.5		20 Units slight odor gray stain
8						
	05	10 14 09 12	8-10	1.5		150 Units slight odor gray stain
10						
	06	10 16 20 10	10-12	1.7		900 Units strong odor black stain
12						
	07	20 18 20 24	12-14	2	Medium dense to dense, gray, fine to medium gravel with some coarse sand, trace of clay, moist to wet	1000 Units strong odor black stain
14						
					Ground Water encountered at approximately 14 feet.	
16						
18						
20						

ENSR 000080

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-28 Sh 1 of 1
Date Started 3/12/90 Completed 3/12/90 Ground Elev. 529.6
Total Depth 14.5 Ft Location Logged by M.Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
			0-1.5		Concrete	
2	01	3,5, 8	1.5-3.0		Medium dense to very dense, gray to black, gravels, and cobbles, with some sand, trace of clay, moist to wet	>1000 Units odor no visual
4	02	5,2,5	3.0-4.5			700 Units slight odor no visual
6	03	4 3 5	4.5-6.0			>1000 units strong odor black stains
8	04	9 7 6 8	6.0-8.0			>1000 units strong odor no visual
10	05	8 17 14 14	8.0-10.0			>1000 units strong odor black stain
12	06	16 16 14	10.0-11.5			>1000 units strong odor black stain
14	07	21 17 23	11.5-13.0			>1000 units strong odor black stain
16	08	58 48 41	13.0-14.5			>1000 units strong odor black stain
18						
20						

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-29 Sh 1 of 1
Date Started 3/09/90 Completed 3/09/90 Ground Elev. 528.8
Total Depth 16.0 Ft Location Logged by B. Berg
Remarks

Depth Feet	Sample Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	5 3 4 5	0-2	1	Topsoil	0 Units no odor cinders
4	02	5 5 6 5	2-4	1.75	Medium stiff, brown, clay, with some silt	0 Units no odor no visual
6	03	3 6 5 6	4-6	1.75		0 Units slight odor no visual
8	04	5 7 8 6	6-8	2		0 Units slight odor no visual
10	05	5 10 11 10	8-10	2		0 Units no odor no visual
12	06	9 12 18 15	10-12	2	Medium dense to dense, light brown, medium to fine gravels and coarse sand, with some clay, moist to wet	4 Units slight odor no visual
14	07	10 18 23 21	12-14	2		0 Units no odor slight stain
16	08	12 18 21 27	14-16	2		100 Units moderate odor Black stain
18					Ground Water encountered at approximateley 14 feet.	
20						

ENSR 000082

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-30 Sh 1 of 2
Date Started 3/09/90 Completed 3/09/90 Ground Elev. 528.9
Total Depth 22.0 Ft Location RNCC Logged by B. Miller
Remarks SB-30 completed as monitoring well MW-15S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2		2 2 4 4	0-2	2	Soft, brown, silt with some clay, damp	0 Units no odor no visual
4		2 4 3 4	2-4	2	Soft to medium stiff, yellow-brown clay with some silt and sand, damp	0 Units no odor no visual
6		3 6 6 5	4-6	2		0 Units no odor no visual
8		3 5 5 9	6-8	2	Medium dense, yellow-brown, fine sand, trace of clay, damp	0 Units no odor no visual
10		8 10 19 19	8-10	2		3 Units slight odor no visual
12		12 16 14 15	10-12	2		3 Units slight odor no visual
14		12 14 16 27	12-14	2	Dense to very dense, brown to black, gravel with some sand, damp to wet	1 Unit slight odor no visual
16		12 14 18 30	14-16	2		5 Units slight odor no visual
18		34 54 56 39	16-18	0.5"		10 Units strong odor no visual

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-30 Sh 2 of
Date Started 3/09/90 Completed 3/09/90 Ground Elev. 528.9
Total Depth 22.0 Ft Location RNCC Logged by B. Miller
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
		30 101 97 47	18-20	2		200 Units Strong odor no visual
20		18 21 14 21	20-22	2	Dense, brown, medium sand, wet	1000 PPM Strong odor no visual
22						

000084

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-31 Sh 1 of 1
Date Started 3/13/90 Completed 3/13/90 Ground Elev. 528.9
Total Depth 8.0 Ft Location A & W/Mobil Logged by M.Ferlin
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	6 5 5 4	0-2	1.7		0.2 Units odor no visual
4	02	2 3 2 4	2-4	2.0	Soft, brown, clay with some silt, trace of fine sand and gravels, moist	0.1 Units odor no visual
6	03		4-6	2.0	Medium to coarse sand and gravels	0 Units no odor no visual
8					Auger refusal at approximately 7 feet.	
10						
12						
14						
16						
18						
20						

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-32 Sh 1 of
Date Started 3/14/90 Completed 3/14/90 Ground Elev. 528.2
Total Depth 15.0 Ft Location A & W/Mobil Logged by M.Cousino
Remarks SB-32 completed as monitoring well MW-02S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	1 4 2 4	0-2	1.7	Soft, brown, silt and clay, damp	0 Units no odor
2	02	3 3 3 3	2-4	1.7	Soft, brown to gray, clay, with some silt trace of sand, damp	0 Units no odor
4	03	1,4 34	4-5.5	1.0		0 Units no odor no visual
6	04	2,4 3	5.5-7.0	1.2		0 Units no odors no visual
8	05	8 2 4	7.0-8.5	0.9	Loose, gray, coarse sand with some clay, and trace of gravels, wet	0.2 unit no odors no visual
	06	2 1 1	8.5 - 10	1.0		0 Units no odors no visual
10	07	4 6 4	10 - 11.5	1.1		0.2 Units no odors no visual
12	08	2 1 1	11.5-13.0	1.0		0 Units no odors no visual
14					Ground Water encountered at approximately 7 feet.	
16						
18						
20						

000086

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING SB-33 Sh 1 of 1
Date Started 3/19/90 Completed 3/19/90 Ground Elev. 531.0
Total Depth 17.0 Ft Location Logged by M.Ferlin
Remarks SB -33 completed as monitoring well MW-01S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
		6			Top Soil	
	01	11	0-2	1.4		0.6 Units no odor no visual
		13				
2		21				
		22				
	02	32	2-4	1.8		2.0 Units no odor no visual
		21				
4		14				
		31				
	03	61	4-6	1.4		0.6 Units no odor no visual
		27			Dense, tan, medium to coarse sand and fine gravels, moist to 10 feet Wet from 10 feet to 17 feet	
6		38				
		10				
	04	15	6-8	2		3.2 Units no odor no visual
		20				
8		20				
		11				
	05	14	8-10	1.5		3.8 Units no odor no visual
		14				
10		8				
		7				
	06	6	10-12	1.6		0.4 Units no odor no visual
		8				
12		11				
		11				
	07	11	12-13.5	1.4		1.2 Units no odor no visual
		9				
14		19				
	08	12	13.5-15	1.5		0.9 Units no odor no visual
		13				
		12				
16	09	12	15-17	1.6		0.4 Units no odor no visual
		8				
		7				
17						
					Ground Water encountered at approximately 10 feet.	
18						

ENSR

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** SB-34 Sh 1 of
Date Started 3/19/90 Completed 3/19/90 Ground Elev. 528.0
Total Depth 15.5 Ft Location A & W/Mobil Logged by M.Ferliin
Remarks SB-34 completed as monitoring well MW-03S

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	2 4 2 4	0-2		Concrete	
2						
	02	1 2 5 3	2-4	.2	Soft, brown to orange clay, trace of silt	0 Units no odor no visual
4						
	03	1 2 5 3	4-6	1.4		0 Units no odor no visual
6						
	04	125, 77 54	6.0- 7.5	1.5		0 Units no odor no visu
8					Very dense brown medium to coarse sand and gravels with trace of clay	
	05	NR	7.5- 9.0	1.2		0 Units no odor no visual
10	06 (a)	100/3"	9.0- 9.3	0.2		
12						
	07	40 110/4 ?	12- 14	1.8		0 Units no odors no visual
14						
	08	13 44 98/3	14 - 15.5	1.5		0.2 Units no odors no visual
16						
18					Ground Water encountered at approximately 11 feet.	
20					(a) Could not advance split spoon drilled to 12 feet	

000088

ENSR

DRAFT

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-35	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/07/91	WEATHER ▶ Sunny, Cool, 60F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.74 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL ☐ B.G.S. ☐ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 16 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			Bituminous Aspalt.
1	Dry	Compact	0.05	0.0	1	1.5'	58, 48, 38, 20	Gray-brown SAND and GRAVEL.
2	Moist	Medium Dense to Loose	0.0	0.0	3	1.0'	11, 11, 6	
3	Moist	Soft to Very Soft	0.0	0.0	5	0.6'	6, 5, 2, 2, 2	Medium to dark brown CLAY with gravel and some sand.
4	Moist	Very Soft	0.0	0.0	7	0.3'	3, 2, 1, 1	
5	Moist	Very Soft	0.0	0.0	9	0.2'	2, 2, 3, 2	
6	Wet	Soft	0.0	0.0	11	0.5'	4, 7, 8, 5	
7	Wet	Stiff	0.0	0.0	13	1.1'	14, 17, 21, 23	Brown-gray CLAY stained with product.
8	Sat.	Dense	0.0	0.0	15	0.8'	14, 16, 18, 20	Coarse GRAVEL with clayey sand stained with oily product.
9					17			Sampled soil to 16.0 FT. Sampled groundwater at 16 FT. with Hydropunch II.
10					19			

GRAPHIC LOG

PROJECT\539-13\53913B35.DRW

LOCATION MAP

ERM—MIDWEST SOIL BORING LOG

BORE NUMBER ▶ **SB-36**	LOCATION ▶ **Paddy's Run Road Site**
DATE ▶ **10/08/91**	WEATHER ▶ **Cold, Clear, 40'sF**
LOGGED BY ▶ **D. Jakim**	DRILLED BY ▶ **Mathes & Associates**
DRILLING METHOD ▶ **4 1/4" Hollow Stem Auger**	SAMPLING METHOD ▶ **3 IN. Split Spoon**
ELEVATION ▶ **529.04 FT.**	GROUT ▶ **Bentonite**
WATER LEVEL INITIAL **15.35 FT.** ■ B.G.S. □ B.M.P.	HOLE DIA. **8.25 IN.**
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH **17.75 FT.**

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
					0			Bituminous Asphalt	
1	Dry	Very Compact	0.05	0.0	1	1.6'	26, 55, 120, 98	Brown-gray coarse SAND and GARVEL, some clay.	
2	Moist	Stiff	0.0	0.5	2, 3	1.7'	13, 15, 14, 15	Brown CLAY with black mottled stains, few gravels.	
3	Moist	Loose to Medium Dense	0.0	0.5	4, 5	1.5'	6, 8	Push shelby tube.	
4	Moist	Medium Dense	0.0	0.0	6, 7	1.5'	8, 13, 6, 14, 11, 16	Brown SAND and GRAVEL, clay lenses.	
5	Moist	Soft to Firm to Stiff	0.0	0.0	8, 9	1.75'	5, 9, 12, 20	Brown-gray SANDY CLAY with sand lenses.	
6	Moist	Compact	0.0	10-20	10, 11	1.5'	33, 40, 33, 28	Brown-gray coarse SAND and GRAVEL, 6 IN. layer of yellow brown staining.	
7	Moist	Compact	0.0	0.0	12, 13	1.3'	30, 20, 27, 24	Coarse SAND and GRAVEL, black stained.	
8	Wet to Sat.	Loose to Compact	0.0	0.0	14, 15	1.3'	6, 9, 40, 40		
9					16, 17			Sampled soil to 16.0 FT. Augered to 17.75 FT. Sampled groundwater at 17.75 FT. with Hydropunch II.	
10					18, 19, 20				

PROJECT539-(3Sep91)SB36.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-37	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/10/91	WEATHER ▶ Cloudy, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.75 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14.7 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 21FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			6 IN. concrete paving
1	Moist	Medium Dense	0.0	800	1	0.6'	11, 13, 11, 10	Black stained GRAVEL and SAND,
2	Moist	Very Soft	0.0	10.0	3	1.7'	3, 5, 7, 11	Gray CLAY with minor sand and gravel lenses changing to brown clayey sand with black mottling stain.
3	Moist	Firm	0.0	300	5	1.7'	3, 9, 7, 11	Brown-black stained CLAYEY SAND.
4	Moist	Soft to Stiff	0.0	200	7	1.7'	7, 6, 13, 11	Gray coarse SAND with black staining; lenses of clayey sand.
5	Moist	Loose	0.0	500	9	1.6'	8, 9, 9, 5	
6	Wet	Very Soft to Stiff	0.0	400	11	2.0'	3, 3, 2, 23	Gray-black stained CLAY and sandy clay to medium grain sand, few gravels.
7	Wet	Loose	0.0	600	13	1.5'	10, 16, 7, 6	Gray SANDY CLAY and medium sands with black staining.
8	Wet	Dense	0.0	400	15	1.5'	5, 16, 32, 9	Medium grain SAND with black staining.
9	Sat.	Compact to Very Compact	0.0	10	17	1.3'	50, 40, 48, 50	Coarse SAND and coarse GRAVEL
10					18			Sampled soil to 18 FT. Augered to 21.0 FT. Sampled groundwater at 21.0 FT. with Hydropunch II.
					19			
					20			

GRAPHIC LOG

PROJECT\539-13\53913B37.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-38	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/10/91	WEATHER ▶ Rainy, 60F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 530.10 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL ☐ B.G.S. ☐ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 23 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1					1			Augered- sample collected and describes during surface soil investigation.
					2			
2	Dry	Soft	0.0	0.0	3	2.0'	5, 8, 10, 8	Brown to dark brown SILTY CLAY, sand very fine to fine grain, minor gravel.
					4			
3	Moist	Soft	0.0	0.0	5	2.0'	4, 5, 5, 6	Black staining.
					6			
4	Moist	Dense	0.0	5.0	7	1.75'	3, 4, 5, 16	Gray-tan SILTY SAND, fine to medium grain.
					8			
5	Moist	Dense	0.0	60	9	1.0'	5, 17, 21, 23	Gray-tan GRAVEL, fine to coarse grain with medium to coarse SAND, abundant black staining.
					10			
6	Moist	Medium Dense to Dense	0.0	110	11	1.4'	12, 15, 22, 15	
					12			
7	Moist	Loose to Dense	0.0	250	13	1.5'	2, 5, 6, 20	
					14			
8	Moist	Compact	0.0	180	15	0.7'	21, 50, Ref, Ref	
					16			
9	Wet	Compact	0.0	220	17	1.3'	4, 13, 27, 34	
					18			
10					19			Sampled soil to 18.0 FT. Augered to 23.0 FT. Sampled groundwater at 23.0 FT. with Hydropunch II
					20			

GRAPHIC LOG

PROJECT\539-13\53913B38.DRW

000092

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-39	LOCATION ► Paddy's Run Road Site
DATE ► 10/07/91	WEATHER ► Clear, 55F
LOGGED BY ► P. Gebhard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 3 IN. Split Spoon
ELEVATION ► 529.49 FT.	GROUT ► Bentonite
WATER LEVEL INITIAL 15.35 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 18 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Dense to Compact	0.0	100	0–2	1.4'	12, 20, 36, 38	Light gray-brown coarse to medium SAND and GRAVEL.
2	Moist	Compact	0.0	120	2–4	1.7'	10, 30, 40, 45	
3	Wet	Stiff	0.0	2	4–6	1.0'	5, 18	Dark gray CLAY.
4	Moist	Medium Dense	0.0	4	6–8	1.25'	5, 15, 6, 10, 10, 10	Light gray-brown medium to coarse grain SAND and GRAVEL.
5	Moist	Loose	0.0	0	8–10	1.1'	1, 3, 4, 5	Brown-gray SILTY SAND, fine grain.
6	Moist	Medium Dense to Compact	0.0	0.0	10–12	1.0'	3, 8, 18, 28	Light gray medium to coarse SAND and GRAVEL.
7	Moist	Dense to Compact	0.0	10	12–14	1.5'	10, 17, 25, 30	
8	Moist	Dense to Compact	0.0	4	14–16	1.1'	10, 20, 40, 25	Black staining.
9	Wet	Dense	0.0	0.0	16–18	1.5'	9, 18, 19, 20	
10					18–20			Sampled soil to 18.0 FT. Sampled groundwater at 18.0 FT. with Hydropunch II

GRAPHIC LOG

PROJECT\539-13\53913B38.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-40	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/08/91	WEATHER ▶ Sunny, Cool, 60F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.11 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.1 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 22.8 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
							10	Brown coarse SAND and GRAVEL stained black.
							48	
1	Dry	Compact	0.0	20	1	1.0'	50	
							25	
					2		16	
		Compact to Dense					34	
2	Wet		0.0	50	3	0.6'	34	
							12	
					4		5	
		Soft to Compact					7	Brown sandy CLAY.
3	Sat.		0.0	190	5	1.4'	33	Coarse SAND and GRAVEL, black staining.
							29	
					6		7	Brown and yellow brown SANDY CLAY.
		Stiff to Firm					18	
4	Moist		0.0	400	7	0.8'	11	
							7	
					8		53	
							5	
5	Wet	Soft	0.0	50	9	2.0'	5	
							7	
					10		3	
		Very Soft					3	
6	Wet		0.0	500	11	2.0'	3	
							4	Mottled yellow, trace black staining.
					12		8	Brown to gray brown coarse SAND and GRAVEL.
		Compact to Very Compact					4	
7	Wet		0.0	1200	13	0.9'	20	
							53	
					14		8	
		Compact to Very Compact					24 ▼	
8	Wet		0.0	900	15	1.2'	44	
							62	
					16			Black staining.
9	Sat.		0.0	200	17	1.2'		
					18			Sampled soil to 18.0 FT. Augered to 22.8 FT.
10					19			Sampled groundwater at 22.8 FT. with Hydropunch II
					20			

GRAPHIC LOG

PROJECT\539-13\53913B40.DRW

000094

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-42	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/09/91	WEATHER ▶ Clear, Cool
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.69 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 16.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 23 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1					0, 1, 2			Augered-sample collected and described during surface soil investigation.
2	Dry		0.0	0.0	2–4	1.0'	7, 10, 11, 9, 5	Topsoil and FILL.
3	Moist	Soft	0.0	0.0	4–6	1.4'	5, 6, 6, 2	Gray to greenish gray CLAY, minor gravel and coarse sand.
4	Moist	Very Soft	0.0	0.0	6–8	1.6'	2, 3, 5, 2	
5	Moist	Soft	0.0	0.0	8–10	2.0'	5, 7, 43, 13	
6	Moist	Compact	0.0	0.0	10–12	1.3'	31, 31, 29, 27	Light gray to gray medium to coarse SAND and fine to coarse GRAVEL, sample stained black.
7	Moist	Compact	0.0	0.0	12–14	1.0'	31, 32, 41, 18	
8	Moist	Compact	0.0	1.0	14–16	1.1'	43, 50, Ref. ▼	
9	Sat.	Compact			16–18	0.6'	16, 38, 50, Ref.	
10					18–20			Sampled soil to 18.0 FT. Augered to 23.0 FT. Sampled groundwater at 23.0 FT. with Hydropunch II

GRAPHIC LOG

PROJECT\539-13\53913B42.DRW

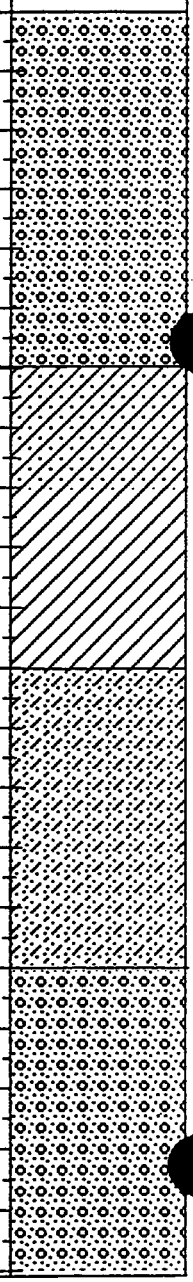
LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-43	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/09/91	WEATHER ▶ Clear, Sunny 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 532.15 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 20.3 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 27.65 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
							12	Grayish brown coarse SANDS and GRAVEL, root fragments.
1	Dry	Compact	0.0	0.0	1		27	
							32	
					2		43	
							49	
2	Dry	Very Compact	0.0	0.0	3		50	
							58	
					4		69	
							50	
3	Moist	Compact to Dense	0.0	0.0	5		35	
							27	
							20	Becoming grayish brown clayey sand.
					6		10	Brown SANDY CLAY with trace gravel.
4	Moist	Stiff	0.0	0.0	7	1.7'	11	
							16	Grading to brown clay.
					8		20	
							10	Brown CLAY.
5	Moist	Firm to Stiff to Soft	0.0	0.0	9		9	
							15	
					10		13	
							5	
6	Moist	Loose to Dense	0.0	0.0	11		4	
							5	Grayish brown CLAYEY SAND.
					12		5	
							3	
7	Moist	Dense	0.0	0.0	13		3	
							5	
					14		12	
							10	
8	Moist	Compact to Very Compact	0.0	0.0	15		25	Grayish brown CLAYEY SAND with sand and gravel lenses.
							27	
					16		13	
							66	Grayish brown SAND and GRAVEL grading to coarse SAND and GRAVEL yellowish brown.
9	Wet	Dense	0.0	0.0	17		120	
							13	
					18		19	
							21	
10	Wet to Sat.	Compact	0.0	0.0	19		17	Black stained clay rich coarse SAND and GRAVEL.
							10	
							28	
					20		31	▼
					21		27	Sampled soil to 21.0 FT. Augered to 27.65 FT. Sampled groundwater at 27.65 FT. with Hydropunch II

GRAPHIC LOG



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PROJECT\539-13\53913B43.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-44	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/09/91	WEATHER ▶ Sunny, Breezy, 70F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.59 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 16.55 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Compact to Stiff	0.0	0.0	0–1	1.2'	28, 53, 31	FILL
2	Moist	Soft	0.0	0.0	1–3	1.3'	17, 7, 7, 5, 7	Gray to black stained SANDY CLAY, changing to brown SANDY CLAY, trace gravel.
3	Moist	Firm to Hard	0.0	0.0	3–5	1.4'	5, 10, 16, 40	Yellowish brown SANDY CLAY with trace gravel.
4	Moist	Compact to Very Comoact	0.0	0.0	5–7	1.25'	32, 45, 62, 50	Light grayish brown GRAVEL with sand.
5	Moist	Very Compact	0.0	0.0	7–9	1.5'	51, 63, 67, 52	Brown coarse SAND and GRAVEL.
6	Moist	Compact	0.0	0.0	9–11	1.3'	25, 50, 55, 26	
7	Wet	Very Compact	0.0	600	11–13	1.2'	26, 66, 90, Ref.	Black and gray staining.
8	Wet	Very Compact	0.0	700	13–15	0.6'	36, 91, Ref., Ref.	Occasional black staining, mostly brown to yellowish brown, coarse SAND and GRAVEL.
9	Sat.	Very Compact	0.0	500	15–17	0.4'	106, 100, Ref., Ref.	▼ Black staining.
10					17–20			Sampled soil to 18.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II

GRAPHIC LOG

PROJECT\539-13\53913B44.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-45	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/08/91	WEATHER ▶ Clear, 37F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.96 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 16.5 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry		0.0	0.0	0, 1, 2	2.0'	12, 18, 24, 15	Topsoil and FILL
2	Dry	Medium Dense	0.0	0.0	2, 3, 4	1.75'	10, 15, 12, 10	Light gray medium to coarse GRAVEL with medium grain sand 25% brown silty, fine sand.
3	Moist	Soft	0.0	0.0	4, 5	1.75'	5, 8	Brown CLAYEY SILT.
4	Moist	Dense	0.0	0.0	5, 6, 7	1.5'	12, 23, 6, 16, 23, 17	Light gray to brown medium to coarse GRAVEL with fine to medium sand.
5	Moist	Medium Dense	0.0	2.0	8, 9, 10	1.0'	3, 7, 10, 15	
6	Moist	Dense	0.0	5.0	10, 11, 12	1.3'	6, 18, 28, 18	
7	Moist	Medium Dense	0.0	0.0	12, 13, 14	1.2'	5, 10, 14, 20	
8	Moist	Compact	0.0	105	14, 15, 16	1.2'	9, 45, 48, 43	Black staining on 60% of sample.
9	Sat.	Compact	0.0	40	16, 17, 18	1.5'	20, 32, 50, 65	Black staining 100%
10	Sat.	Very Compact	0.0	40	18, 19, 20	0.5'	63, 70, Ref., Ref.	

GRAPHIC LOG

Sampled soil to 20.0 FT.
Sampled groundwater at 20.0 FT. with Hydropunch II

PROJECT\539-13\53913B4S.DRW

000038

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-46	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/08/91	WEATHER ▶ Clear, 65F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.45 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 17.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Dense	0.0	0.0	0, 1	1.9'	20, 28, 23, 21	Brown medium to coarse SAND with 10% light gray medium to coarse gravel.
2	Dry	Dense	0.0	0.0	2, 3	2.0'	9, 16, 19, 21	Dark brown SILTY SAND with trace clay.
3	Moist	Loose	0.0	0.0	4, 5	2.0'	6, 7, 7, 7	
4	Moist	Loose	0.0	0.0	6, 7	1.75'	4, 6, 8, 7	
5	Moist	Medium Dense	0.0	0.0	8, 9	2.0'	3, 5, 12, 15	
6	Wet	Loose to Compact	0.0	0.0	10, 11	1.5'	8, 8, 30, 30	Brown to dark gray SILTY SAND with trace fine to coarse gravel.
7	Moist	Very Compact	0.0	0.0	12, 13	1.2'	15, 41, 55, Ref.	Light gray to gray fine to coarse GRAVEL and medium SAND, 5% stained black.
8	Moist	Compact	0.0	0.0	14, 15	1.0'	8, 40, 50, Ref.	Black stained 50%
9	Wet	Compact	0.0	0.0	16, 17	1.0'	12, 20, 27, 55	Black stained 100%
10	Sat.	Very Compact	0.0	0.0	18, 19, 20	0.5'	29, 54, Ref., Ref.	

GRAPHIC LOG

Sampled soil to 20.0 FT.
Sampled groundwater at 20.0 FT. with Hydropunch II

PROJECT\539-13\53913B46.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-47	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/09/91	WEATHER ▶ Clear, 65F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.20 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 16.5 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 22 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry		0.0	0.0	0, 1, 2	1.75'	11, 13, 12, 6	Topsoil and FILL
2	Dry	Loose	0.0	0.0	2, 3, 4	1.9'	3, 4, 5, 5	Dark brown SILTY SAND fine to medium grain trace gravel
3	Dry	Medium Dense	0.0	0.0	4, 5, 6	1.75'	1, 7, 12, 13	Light gray-tan fine to coarse GRAVEL with fine to medium clayey sand.
4	Moist	Dense	0.0	0.0	6, 7, 8	1.5'	5, 11, 20, 23	
5	Moist	Compact	0.0	1.0	8, 9, 10	1.6'	8, 12, 28, 30	Black stained 50%
6	Moist	Compact	0.0	5.0	10, 11, 12	2.0'	6, 18, 28, 36	Black stained 80%
7	Moist	Compact	0.0	200	12, 13, 14	1.2'	2, 18, 28, 50	No staining
8	Moist	Compact	0.0	250	14, 15, 16	0.3'	11, 48, 50, Ref.	Black stained 50%
9	Wet	Very Compact	0.0	500	16, 17, 18	0.3'	5 ▼, 50, Ref., Ref.	Black stained 100%
10					18, 19, 20			Sampled soil to 18.0 FT. Augered to 22.0 FT. Sampled groundwater at 22.0 FT. with Hydropunch II.

GRAPHIC LOG

PROJECT\539-13\53913B47.DRW

000100

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-48	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/11/91	WEATHER ▶ Cloudy, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.57 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.5 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 19.5 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Stiff to Hard	0.0	0.0	0–2	1.6'	8, 20, 33, 30	Brown SANDY CLAY to clayey sand with gravels.
2	Moist	Stiff to Hard	0.0	2.0	2–4	1.8'	8, 14, 35, 39	Brown CLAYEY SAND with gravel.
3	Moist	Stiff to Hard	0.0	0.0	4–6	1.9'	6, 17, 35, 46	Brown SANDY CLAY.
4	Moist	Stiff to Hard	0.0	0.0	6–8	1.9'	9, 19, 26, 36	Brown SANDY CLAY to clay mottled.
5	Moist to Wet	Soft	0.0	0.0	8–10	1.9'	5, 6, 7, 8	Brown SANDY CLAY to brown fine sand.
6	Wet	Soft	0.0	0.0	10–12	1.9'	3, 2, 7, 7	Gray to brownish gray CLAY mottled orange, gravels, fossil material.
7	Wet	Very Soft	0.0	0.0	12–14	2.0'	1, 2, 1, 2	Brownish gray CLAY and clayey sand seams.
8	Sat.	Compact to Very Compact	0.0	0.0	14–16	1.0'	19, 21, 62 ▼, 42	Gray brown clay changing to light brown SAND and GRAVEL.
9					16–18			Sampled soil to 16.0 FT. Augered to 19.5 FT. Sampled groundwater at 19.5 FT. with Hydropunch II.
10					18–20			

GRAPHIC LOG

PROJECT\539-13\53913B48.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-49	LOCATION ► Paddy's Run Road Site
DATE ► 10/11/91	WEATHER ► Overcast, 60F
LOGGED BY ► P. Gebhard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 3 IN. Split Spoon
ELEVATION ► 527.89 FT.	GROUT ► Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1					1			Not sampled.
					2		6	Brown SILTY CLAY, mottled, rootlets.
2	Dry	Stiff	0.0	5.0	3	2.0'	12	
							12	
					4		14	
3	Moist	Firm to Stiff	0.0	0.0	5	2.0'	4	
							8	
							14	
					6		16	
4	Moist	Loose	0.0	2.0	7	2.0'	3	
							5	
							7	Brown SILTY SAND fine grain, mottled. Brown SILTY fine to medium SAND.
					8		9	
5	Moist	Loose	0.0	0.0	9	2.0'	2	
							3	
							4	
					10		6	
6	Moist	Loose	0.0	0.0	11	1.7'	1	
							3	
							5	Trace gravel and coarse sand.
					12		4	
7	Moist	Loose to Medium Dense	0.0	0.0	13	1.5'	1	
							1	
							7	
					14		13	Gray coarse to fine GRAVEL with coarse to fine SAND.
8	Wet	Loose to Medium Dense	0.0	0.0	15	1.7'	2	
							4 ▼	
							6	
							14	
					16			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
9					17			
					18			
10					19			
					20			

GRAPHIC LOG

PROJECT\539-13\53913B49.DRW

000102

LOCATION MAP

ERM—MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-50	LOCATION ► Paddy's Run Road Site
DATE ► 10/10/91	WEATHER ► Cloudy, 60F
LOGGED BY ► P. Gebhard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 3 IN. Split Spoon
ELEVATION ► 527.80 FT.	GROUT ► Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.5 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1					0, 1			Not sampled.
2	Dry	Firm	0.0	0.0	2, 3, 4	2.0'	6, 13, 15, 15	Dark brown to grayish green SILTY CLAY mottled.
3	Moist	Soft to Firm	0.0	0.0	4, 5, 6	2.0'	5, 6, 10, 11	Brown to gray SILTY CLAY mottled, rootlets.
4	Moist	Loose to Soft	0.0	0.0	6, 7	2.0'	1, 3, 3, 6	Brown SILTY SAND. Black to gray SILTY CLAY with fine sand.
5	Moist	Soft	0.0	0.0	8, 9	2.0'	3, 4, 3, 8	
6	Moist	Loose to Medium Dense	0.0	0.0	10, 11	1.8'	4, 4, 5, 14	Gray to white medium to coarse SAND to medium GRAVEL, 50% stained black, trace silty clay.
7	Moist	Dense to Medium Dense	0.0	0.0	12, 13	2.0'	7, 18, 18, 12	Tan to gray medium to coarse GRAVEL with medium to coarse sand, 30% stained black.
8	Wet	Loose to Dense	0.0	0.0	14, 15	1.0'	4, 6, 17, 25	No staining.
9					16, 17			Sampled soil to 16.0 FT. Augered to 20.5 FT. Sampled groundwater at 20.5 FT. with Hydropunch II.
10					18, 19, 20			

GRAPHIC LOG

PROJECT\539-13\53913B50.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-51	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/10/91	WEATHER ▶ Cloudy, Post Rain Cool, 60F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 527.70 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 13.85 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0		4	TOPSOIL
1	Moist	Dense to Compact	0.0	0.0	1	1.5'	43, 60, 22	Grayish brown SAND and GRAVEL.
2	Moist	Medium Dense	0.0	0.0	2, 3	1.5'	8, 8, 11, 13	Gray-brown CLAYEY SAND.
3	Moist	Soft to Stiff	0.0	3.0	4, 5	2.0'	4, 8, 13, 16	Gray-brown SANDY CLAY with seams of yellow brown mottled clay.
4	Moist	Soft	0.0	8.0	6, 7	1.3'	3, 6, 7, 6	
5	Wet	Loose	0.0	8.0	8, 9	1.8'	3, 4, 5, 6	Dark brown CLAYEY SAND fine to coarse.
6	Wet	Medium Dense to Compct	0.0	0.0	10, 11	1.6'	3, 12, 33, 27	Brown to grayish brown SAND and GRAVEL.
7	Wet	Compact	0.0	13.0	12, 13	2.0'	10, 25, 38, 33 ▼	
8	Sat.	Very Compact	0.0	8.0	14, 15	1.0'	46, 58, 58, 60	
9					16, 17			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
10					18, 19, 20			

GRAPHIC LOG

000104

PROJECT\539-13\53913B51.DRW

LOCATION MAP

ERM—MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-52	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/14/91	WEATHER ▶ Clear, 60F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 527.73 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
1					0, 1, 2			No sample	
2	Moist	Very Soft to Soft	0.0	0.0	2, 3	2.0'	3, 3, 5, 5	Dark gray SILTY CLAY.	
3	Moist	Soft to Firm	0.0	0.0	4, 5	2.0'	1, 6, 9, 10	Brown to dark brown SILTY CLAY mottled.	
4	Moist	Soft	0.0	0.0	6, 7	2.0'	1, 4, 4, 7	Brown SILTY CLAY trace fine sand.	
5	Moist	Loose to Medium Dense	0.0	0.0	8, 9	1.7'	4, 6, 9, 13	Light gray to brown coarse to medium GRAVEL and SAND.	
6	Moist	Dense to Compct	0.0	0.0	10, 11	1.2'	8, 23, 35, 35	Same as above with trace clay.	
7	Moist	Dense	0.0	0.0	12, 13	1.0'	5, 14, 22, 26		
8	Wet	Compact to Dense	-	-	14, 15	0	10, 30, 20, 16	No recovery.	
9					16, 17, 18			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II	
10					19, 20				

PROJECT\539-13\53913B52.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-53	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/14/91	WEATHER ▶ Sunny, Cool, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.0 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 13.7 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1					1			No sample
					2			
2	Moist	Soft to Firm	0.0	0.0	3	1.3'	4, 4, 8, 10	Brown CLAY with trace fine sand.
					4			
3	Moist	Soft to Stiff	0.0	0.0	5	1.6'	5, 7, 10, 13	
					6			
4	Moist	Soft	0.0	0.0	7	0.8'	3, 4, 8, 6	Gradation to clayey fine sand.
					8			
5	Wet	Medium Dense to Dense	0.0	0.0	9	1.2'	13, 14, 82, 17	Brown CLAYEY fine SAND, trace gravel.
					10			
6	Dry	Compct	0.0	4.0	11	1.2'	8, 28, 27, 37	
					12			
7	Moist	Very Compact	0.0	4.0	13	0.75'	11, 54, 50, Ref.	Coarse SAND and GRAVEL.
					14			
8	Sat.	Medium Dense to Loose	0.0	5.0	15	1.0'	15, 15, 13, 8	Some staining.
					16			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II
9					17			
					18			
10					19			
					20			

GRAPHIC LOG

000106

PROJECT\539-13\53913B53.DRW

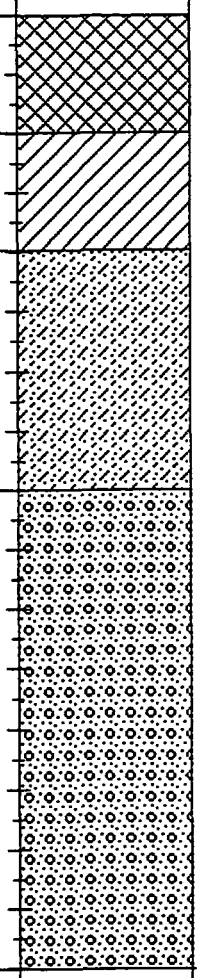
LOCATION MAP

ERM—MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-54	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/21/91	WEATHER ▶ Sunny, 40F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.40 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 21.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			Aspalt
1	Dry	Very Compact	0.0	0.0	1	1.3'	80, 57, 62, 30	Black-gray slag FILL with coarse sand with few pebbles.
2	Moist	Firm	0.0	0.0	3	1.5'	10, 11, 12, 13	Dark olive brown CLAY with trace dark brown fine sand, black staining.
3	Moist	Loose	0.0	0.0	5	1.7'	5, 8, 9, 8	Yellowish brown CLAYEY SAND mottled gray.
4	Moist	Loose to Medium Dense	0.0	0.0	7	1.8'	3, 6, 8, 10	Lenses of olive brown gray.
5	Dry	Compact	0.0	0.0	9	1.75'	12, 36, 38, 45	Olive brown coarse SAND and GRAVEL, occassional mottling, black staining.
6	Moist	Compact to Very Compact	0.0	0.0	11	1.3'	11, 27, 80, 50	
7	Moist	Very Compact	0.0	0.0	13	0.5'	40, 50, 50, Ref. ▼	
8	Sat.	Compact	0.0	0.0	15	0.8'	9, 22, 28, 26	Yellowish brown coarse SAND and GRAVEL.
9					17			Sampled soil to 16.0 FT. Augered to 21.0 FT. Sampled groundwater at 21.0 FT. with Hydropunch II.
10					19			

GRAPHIC LOG



PROJECT\539-13\53913B53.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-55	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/14/91	WEATHER ▶ Cloudy, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.68 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 21.7 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			Asphalt
1	Dry	Very Compact	0.0	0.0	1	0.1'	50	Gravel FILL.
					2			
2	Damp	Loose	0.0	0.0	3	0.7'	4, 8, 9, 9	Brownish gray fine CLAYEY SAND.
					4			
3	Damp	Loose	0.0	0.0	5	0.7'	4, 4, 9, 7	Brownish fine CLAYEY SAND mottled reddish brown.
					6			
4	Moist	Compact to Loose	0.0	0.0	7	1.3'	16, 27, 14, 8	Brownish CLAYEY SAND with gravel.
					8			
5	Moist	Medium Dense to Compact	0.0	0.0	9	0.7'	10, 14, 16, 27	Gray GRAVEL and SAND.
					10			
6	Moist	Dense to Compact	0.0	0.0	11	1.2'	16, 18, 26, 37	Brownish gray SAND and GRAVEL.
					12			
7	Damp	Compact to Very Compact	0.0	4.0	13	0.7'	23, 33, 54, Ref.	Coarse SAND and GRAVEL.
					14			
8	Sat.	Compact	0.0	0.0	15	0.8'	23, 33 ▼, 35, 45	
					16			
9					17			Sampled soil to 16.0 FT. Augered to 21.7 FT. Sampled groundwater at 21.7 FT. with Hydropunch II.
					18			
10					19			
					20			
					21			

GRAPHIC LOG

PROJECT\539-13\53913B55.DRW 000108

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-56	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/14/91	WEATHER ▶ Overcast, 50F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.36 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1	Moist	Loose to Medium Dense to Very Soft	0.0	0.0	1	1.9'	4, 14, 3, 1	Gravel FILL Black SILTY CLAY shows mottling.
					2		3	Light gray GRAVEL with medium coarse SAND.
2	Moist	Soft	0.0	0.0	3	1.5'	4, 7, 7	Brown to gray SILTY CLAY mottled.
					4			
3	Moist	Loose	0.0	0.0	5	1.7'	2, 4, 6, 2	Brown SILTY CLAY with very fine sand.
					6			
4	Moist	Loose to Medium Dense	0.0	0.0	7	1.7'	2, 3, 14	
					8		6, 10	Brown GRAVEL with coarse to fine sand.
5	Moist	Medium Dense	0.0	0.0	9	1.2'	12, 8, 10	Clay stringers.
					10		12	
6	Moist	Dense	0.0	0.0	11	1.5'	15, 23, 26	
					12		14	
7	Moist	Dense	0.0	4.0	13	1.5'	19, 23, 31	15% reddish stain on gravel.
					14		12	
8	Wet	Dense	0.0	0.0	15	1.2'	16 ▼, 22, 20	
					16			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II
9					17			
					18			
10					19			
					20			
					21			

GRAPHIC LOG

PROJECT\539-13\53913BS6.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-57	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/21/91	WEATHER ▶ Sunny, 60F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.20 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL - ☐ B.G.S. ☐ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 21.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
					0			Asphalt	
1	Moist	Very Compact	0.0	2.0	1	0.6'	80, 80, Ref., Ref.	Slag and coarse sand FILL (strong sulfur odor).	
2	Moist	Soft	0.0	0.0	2, 3, 4	0.7'	4, 4, 4, 4	Olive brown SANDY CLAY with yellow coarse sand.	
3	Moist	Soft to Loose	0.0	0.0	4, 5	1.7'	2, 3, 4, 4	Olive brown SANDY CLAY grading to clayey sand grading to olive brown clayey sand grading to coarse sand and gravel.	
4	Moist	Compact	0.0	0.0	6, 7	1.5'	2, 27, 28, 24		
5	Moist	Dense to Compact	0.0	0.0	8, 9	1.0'	6, 17, 27, 31	Brown SAND and GRAVEL.	
6	Moist	Compact	0.0	0.0	10, 11	1.0'	8, 32, 36, 50	Reddish brown staining.	
7	Wet	Very Compact	0.0	4.0	12, 13	0.6'	18, 50, Ref., Ref.		
8	Sat.	Dense to Compact	0.0	0.0	14, 15	1.2'	13, 15, 17, 30		
9					16, 17			Sampled soil to 16.0 FT. Augered to 21.0 FT. Sampled groundwater at 21.0 FT. with Hydropunch II.	
10					18, 19, 20, 21				

PROJECT\539-13\53913B57.DRW

000110

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-58	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/17/91	WEATHER ▶ Clear, 30F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 529.03 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14.4 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 18.4 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Medium Dense to Dense	0.0	0.0	0–2	0.6'	5, 14, 21, 20	Brown SAND with some clay, trace pebbles.
2	Moist	Medium Dense to Loose	0.0	0.0	2–4	0.8'	7, 10, 9, 8	Brown CLAYEY SAND with sand lenses.
3	Moist	Soft to Loose	0.0	2.0	4–6	0.75'	2, 2, 3, 4	Gray CLAY and SAND.
4	Moist	Loose	0.0	0.0	6–8	0.8'	1, 2, 1, 2	Gray CLAYEY SAND trace pebbles.
5	Moist	Loose	0.0	0.0	8–10	0.9'	1, 2, 1, 2	Grayish brown CLAYEY SAND with lenses of gray sand.
6	Wet	Loose	0.0	0.0	10–12	0.8'	1, 1, 2, 4	Olive gray mottling.
					12		1	Olive brown CLAY, trace pebbles.
7	Wet	Very Compact	0.0	50.0	12–14	1.0'	10, 70, Ref.	7 IN. black stained lenses of SAND and GRAVEL.
8	Sat.	Very Compact	0.0	0.0	14–16	1.5'	24 ▼, 60, 52, 70	Gray coarse SAND and GRAVEL.
9					16–18			Sampled soil to 16.0 FT. Augered to 18.40 FT. Sampled groundwater at 18.4 FT. with Hydropunch II
10					18–21			

GRAPHIC LOG

PROJECT\539-13\53913BS8.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-59	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/15/91	WEATHER ▶ Overcast, 50F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.11 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0		10	Gravel FILL.
1	Moist	Very Soft	0.0	0.0	1	0.5'	3, 2, 2	Dark gray silty CLAY.
2	Moist	Very Soft	0.0	0.0	2, 3	1.0'	2, 2, 3, 2, 2	Mottling, trace coarse sand.
3	Moist	Very Soft	0.0	0.0	4, 5	1.0'	1, 2, 3, 3	
4	Moist	Loose to Very soft	0.0	0.0	6, 7	1.1'	1, 2, 3, 5	Dark red to brown coarse SAND and GRAVEL. Brown mottled SILTY CLAY
5	Moist	Soft	0.0	0.0	8, 9	1.25'	1, 3, 7, 9	
6	Moist	Firm to Stiff to Dense to Compact	0.0	0.0	10, 11	1.0'	11, 17, 24, 28	Dark brown to black SILTY CLAY. Light gray to brown coarse to fine GRAVEL and medium to coarse SAND, trace clay.
7	Moist	Dense to Compact	0.0	0.0	12, 13	1.6'	13, 17, 27, 29	
8	Wet	Medium Dense	0.0	0.0	14, 15	1.2'	3, 9, 14, 11	
9					16, 17			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II
10					18, 19, 20, 21			

GRAPHIC LOG

PROJECT\539-13\53913BS9.DRW

OCCLLS

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-60	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/16/91	WEATHER ▶ Clear, 38F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 527.88 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Soft to Loose	0.0	0.0	0–1	1.8'	20, 15, 8, 7	Gravel FILL. Black SILTY CLAY.
2	Moist	Soft to Loose	0.0	0.0	2–3	0.8'	1, 2, 2, 3	Dark brown medium SAND and GRAVEL. Black mottled CLAY.
3	Moist	Soft	0.0	0.0	4–5	1.1'	1, 2, 3, 3	Dark brown medium SAND and GRAVEL. Brown to light brown CLAY.
4	Moist	Loose	0.0	0.0	6–7	0.2'	W/R, 1, 1, 2	Brown SILTY CLAY, very fine to fine sand.
5	Moist	Soft	0.0	0.0	8–9	1.1'	W/R, 2, 4, 5	Brown silty SANDY CLAY.
6	Moist	Loose to Dense	0.0	0.0	10–11	1.8'	2, 5, 15, 22	Gray silty medium SAND with clay seams. Light gray to gray, red-brown coarse SAND and GRAVEL.
7	Moist	Compact	0.0	0.0	12–13	1.8'	15, 29, 40, 40	Light gray to gray, red-brown coarse SAND and GRAVEL.
8	Wet	Dense	0.0	0.0	14–15	1.0'	6, 26, 16, 22	Reddish brown GRAVEL and SAND.
9					16–17			Sampled soil to 16.0 FT. Augered to 20.0 FT. Groundwater sampled at 20.0 FT. with Hydropunch II
10					18–19			
					20–21			

GRAPHIC LOG

PROJECT\539-13\53913B60.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-61	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/16/91	WEATHER ▶ Foggy, 40F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.19 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 17.9 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1	Moist	Very Compact	0.0	0.0	1	1.7'	23, 96, 56, 26	Yellowish brown coarse SAND and GRAVEL with lenses of gray-black clay.
					2			
2	Moist	Stiff to Very Stiff	0.0	0.0	3	1.0'	17, 26, 19, 21	Olive CLAY, trace fine sand.
					4			
3	Moist	Soft to Stiff	0.0	0.0	5	1.2'	5, 8, 11, 14	Dark olive brown CLAY with trace fine sand.
					6			
4	Moist	Stiff	0.0	0.0	7	1.2'	11, 13, 16, 18	Gray mottling.
					8			
5	Moist	Firm	0.0	0.0	9	1.3'	9, 10, 10, 11	
					10			
6	Moist	Dense to Very Compact	0.0	0.0	11	1.5'	9, 24, 87, 46	Brown SAND interbedded in grayish brown clay, fine gravel.
					12			
7	Wet	Very Compact	0.0	0.0	13	0.6'	19, 50, Ref., Ref. ▼	Gray SAND and fine gravel.
					14			
8	Sat.	Very Compact to Compact	0.0	0.0	15	0.8'	83, 60, 44, 48	Light brownish gray SAND and gravel.
					16			
9					17			Sampled soil to 16.0 FT. Augered to 17.9 FT. Sampled groundwater at 17.9 FT. with Hydropunch II.
					18			
10					19			
					20			
					21			

GRAPHIC LOG

PROJECT\539-13\53913B61.DRW

000114

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-62	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/15/91	WEATHER ▶ Overcast, 40F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.05 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 13.2 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 22.5 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Very Compact	0.0	2.0	0–1	0.2'	80	CONCRETE
2	Damp	Very Compact	0.0	0.0	2–3	0.8'	80, 90, 100, 97	Grayish brown CLAYEY SAND with gravel.
3					4–5	NR	122, 80	No recovery, auger cuttings gray CLAY with coarse sand and gravel.
4	Moist	Very Compact	0.0	65.0	6–7	NR	100	
5	Moist	Very Compact	0.0	20	8–9	0.75'	70, 80, 80, 100	Grayish brown coarse SAND and GRAVEL mottled black and gray staining.
6	Wet	Very Compact	0.0	150.0	10–11	0.7'	6, 100	
7	Wet	Very Compact	0.0	100.0	12–13	0.4'	14, 100 ▼	
8	Sat.	Very Compact	0.0	170	14–15	1.2'	53, 80	Sampled soil to 15.0 FT. Augered to 22.5 FT. Sampled groundwater at 22.5 FT. with Hydropunch II.
9					16–17			
10					18–19			
					20–21			

GRAPHIC LOG

PROJECT\539-13\53913B62.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-63	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/17/91	WEATHER ▶ Sunny, 60F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 3 IN. Split Spoon
ELEVATION ▶ 528.60 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 13.6 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 21.4 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			Asphalt
1	Dry	Dense to Very Compact	0.0	0.0	1	0.25'	20, 30, 70	Gray slag and coarse sand FILL.
					2			
2	Moist	Firm to Very Hard	0.0	0.0	3	1.0'	10, 70, Ref., Ref.	Yellow SANDY CLAY.
					4			
3	Moist	Very Compact	0.0	0.0	5	0.3'	48, 52, Ref., Ref.	Gray CLAYEY SAND trace pebbles.
					6			
4	-	Very Compact	-	-	7	-		
					8			
5	-	Very Compact	-	-	9	-	50	No sample, split spoon refusal.
					10			
6	Moist	Very Compact	0.0	0.0	11	0.1'	50	Gray coarse SAND rock fragments.
					12			
7	-	Very Compact	-	-	13	-	50	
					14			
8	Sat.	Very Compact	0.0	0.0	15	0.25'	36, 50	Gray coarse SAND and GRAVEL.
					16			Sampled soil to 15.0 FT. Augered to 21.4 FT. Sampled groundwater at 21.4 FT. with Hydropunch II.
9					17			
					18			
10					19			
					20			
					21			

GRAPHIC LOG

PROJECT\539-13\53913B63.DRW 000125

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-64	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/15/91	WEATHER ▶ Clear, 45F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.09 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1					1			No sample collected.
					2			
2	Moist	Very Soft	0.0	0.0	3	0.2'	1, 1, 3, 4	Dark gray to brown SILTY CLAY.
					4			
3	Moist	Very Soft	0.0	0.0	5	0.2'	1, 2, 3, 3	
					6			
4	Moist	-	0.0	0.0	7	0.2'		Push shelby tube.
					8			
5	Moist	Very Soft to Medium Dense	-	-	9	1.8'	2, 2, 13, 14	Brown SILTY CLAY, mottled. Light brown coarse to fine SAND.
					10			
6	Moist	Dense	0.0	0.0	11	1.0'	11, 15, 20, 20	Light brown coarse to fine GRAVEL with medium to coarse SAND, trace clay.
					12			
7	Moist	Dense to Compact	0.0	0.0	13	1.8'	8, 16, 23, 30	
					14			
8	Wet	Compact	0.0	0.0	15	1.0'	18, 25, 32, 36	
					16			
9					17			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
					18			
10					19			
					20			
					21			

GRAPHIC LOG

PROJECT\539-13\53913B64.DRW

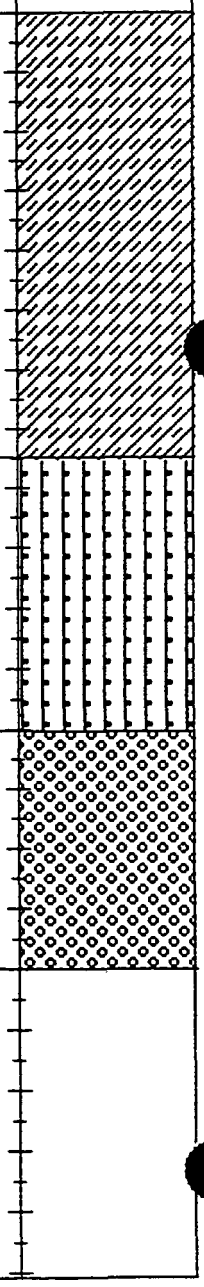
LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-65	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/15/91	WEATHER ▶ Clear, 45F
LOGGED BY ▶ P. Gephard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.15 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Very Soft	0.0	0.0	0, 1, 2	1.0'	-, -, WR, WR	Brownish gray to black SILTY CLAY.
2	Moist	Very Soft	0.0	0.0	3, 4	1.5'	1, 1, 4, 4	Dark gray to greenish gray SILTY CLAY, trace gravel.
3	Moist	Very Soft	0.0	0.0	5, 6	1.25'	2, 3, 6, 2	
4	Moist	Very Soft	0.0	0.0	7	1.5'	1, 2, 2	
5	Moist	Loose	0.0	0.0	8, 9, 10	2.0'	1, 1, 1, 1, 1	Dark gray to gray SILTY fine SAND, trace gravel coarsening with depth.
6	Moist	Loose	0.0	0.0	11	1.0'	WR, 1, 3, 2	
7	Moist	Very Compact	0.0	0.0	12, 13	1.8'	9, 50, Ref., Ref.	Gray to medium gray, medium to coarse GRAVEL with coarse to medium sand.
8	Wet	Very Compact	0.0	0.0	14, 15	1.0'	30, 50, Ref., Ref.	
9					16, 17			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
10					18, 19, 20, 21			

GRAPHIC LOG



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PROJECT\539-13\53913B65.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-66	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/15/91	WEATHER ▶ Cloudy, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.15 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 13.3 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 21.8 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1					0, 1, 2			
2	Dry	Loose	0.0	0.0	2–4	0.4'	3, 3, 4, 4	Brown CLAYEY SAND, gray mottling, trace pebbles.
3	Dry	Very Compact	0.0	0.0	4–6	0.25'	3, 50, Ref., Ref.	Yellowish brown SAND with clay layers.
4	Moist	Dense to Very Compact	0.0	0.0	6–8	1.2'	11, 22, 74, Ref.	Yellowish brown coarse SAND with clay lenses.
5	Moist	Compact to Dense	0.0	0.0	8–10	1.3'	17, 42, 18, 19	Clayey SAND.
6	Moist	Very Compact	0.0	0.0	10–12	1.1'	56, 68, 50, Ref.	Gray coarse SAND with trace gravel.
7	Wet	Very Compact	0.0	0.0	12–14	0.2'	85, Ref., Ref., Ref.	▼ Yellowish brown coarse SAND.
8	Sat.	Very Compact	0.0	0.0	14–16	0.2'	100, Ref., Ref., Ref.	
9					16–18			Sampled soil to 16.0 FT. Augered to 21.8 FT. Sampled groundwater at 21.8 FT. with Hydropunch II.
10					18–21			

GRAPHIC LOG

PROJECT\539-13\53913B66.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-67	LOCATION ► Paddy's Run Road Site
DATE ► 10/15/91	WEATHER ► Partly Cloudy, 60F
LOGGED BY ► D.Jakim	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 2 IN. Split Spoon
ELEVATION ► 527.88 FT.	GROUT ► Bentonite
	WATER LEVEL INITIAL ☐ B.G.S. ☐ B.M.P. / HOLE DIA. 8.25 IN.
	WATER LEVEL AT COMPLETION H.M.P. / TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Dense	0.0	0.0	0–1	1.5'	14, 80, 17, 22	Crushed limestone FILL, some brown CLAYEY SAND.
2	Dry	Medium Dense to Dense	0.0	0.0	2–3	0.8'	8, 9, 15, 20	Reddish brown CLAYEY SAND with clay layers.
3	Moist	Dense to Compact	0.0	0.0	4–5	1.0'	6, 16, 32, 50	Brownish gray coarse SAND.
4	Moist	Very Compact	0.0	0.0	6–7	0.25'	100, Ref., -, -	Grayish brown to brown coarse SAND, trace gravel.
5	Wet	Very Compact	0.0	0.0	8–9	0.2'	100, Ref., Ref., Ref.	Gray to yellow brown CLAYEY SAND, trace gravel.
6	Wet	Very Compact	0.0	0.0	10–11	0.25'	100	Gray coarse SAND and GRAVEL.
7	Sat.	Very Compact to Dense	0.0	0.0	12–13	0.7'	48, 58, 58, 20	Yellow brown GRAVEL and coarse SAND.
8					14–15			Sampled soil to 14.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
9					16–17			
10					18–19			
					20–21			

GRAPHIC LOG

PROJECT\539-13\53913867.DRW

0001.0

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-68	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/18/91	WEATHER ▶ Sunny 40-50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 527.89 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 12.95 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 18.4 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
					0			Slag railroad track bed.	
1	Sat.	Dense to Medium Dense	0.0	0.0	1	1.2'	15, 16, 10, 12	Olive to dark olive brown SAND, trace pebbles.	
2	Sat.	Loose to Dense	0.0	0.0	3	1.5'	4, 3, 4, 18	CLAYEY fine to coarse SAND, clay layers.	
3	Wet	Dense to Very Compact	0.0	0.0	5	1.1'	10, 26, 53	Yellowish brown coarse SAND, trace pebbles.	
4	Sat.	Very Compact	0.0	0.0	7	0.25'	70		
5	Sat.	Very Compact	0.0	0.0	9	0.3'	70	Light brownish gray coarse SAND and fine GRAVEL.	
6	Sat.	Very Compact	0.0	0.0	11	1.1'	50		
7	-	Very Compact	-	-	13	NR	50 ▼		
8					15			Sampled soil to 14.0 FT. Augered to 18.4 FT. Sampled groundwater at 18.4 FT. with Hydropunch II.	
9					17				
10					19				
					20				
					21				

PROJECT\539-13\53913B68.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-69	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/17/91	WEATHER ▶ Clear, 38F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.77 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL ☐ B.G.S. ☐ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Medium Dense to Loose	0.0	0.0	0–2	1.3'	13, 10, 6, 4	Gravel FILL
2	Moist	Dense to Medium Dense	0.0	0.0	2–4	0.8'	59, 25, 17	
3	Moist	Compact to Very Compact	0.0	0.0	4–6	1.0'	10, 15, 35, 50, Ref.	Gray CLAYEY SAND medium to fine grain to gray silty sand medium to fine grain.
4	Moist	Compact	0.0	0.0	6–8	1.2'	15, 27, 35, 50	
5		Very Compact	0.0	0.0	8–10	NR	50, Ref., Ref., Ref.	Gray to light gray coarse to fine grain SAND.
6	Moist	Very Compact	0.0	0.0	10–12	0.2'	50, Ref., Ref., Ref.	Same as above with trace clay.
7	Moist	Very Compact	0.0	0.0	12–14	0.2'	50, Ref., Ref., Ref.	
8		Very Compact	0.0	3.0	14–16	NR	50, Ref., Ref., Ref.	Sampled soil to 15.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
9					16–18			
10					18–21			

GRAPHIC LOG

PROJECT\539-13\53913B69.DRW

007361

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-70	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/16/91	WEATHER ▶ Sunny, 50F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 527.83 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0		14, 5	Gravel FILL.
1	Moist		0.0	0.0	1	2.0'	11, 5	Brown SILTY CLAY mottled.
					2		4, 3, 3, 3	
2	Moist		0.0	0.0	3	1.2'		
					4		2, 7	Black SILTY SAND with minor clay layers.
3	Moist		0.0	0.0	5	1.0'	8, 9	Brown medium to coarse SAND with minor clay.
					6		4, 6	Black to dark brown SILTY SAND, medium to fine.
4	Moist		0.0	0.0	7	1.2'	6, 11	Brown to light brown medium to coarse SAND.
					8		12, 29	Black to dark brown, medium to coarse CLAYEY SAND.
5	Moist		0.0	0.0	9	1.0'	53, 53	Light gray to gray, coarse to fine GRAVEL with medium SAND, some clay.
					10		53, Ref., Ref., Ref.	
6	Moist		0.0	0.0	11	1.0'		
					12		12, 30, 17, 50, 20, 50 ▼	
7	Moist		0.0	0.0	13	1.0'		
					14			
8	Wet		0.0	0.0	15	0.5'	Ref., Ref.	Sampled soil to 15.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
					16			
9					17			
					18			
10					19			
					20			
					21			

GRAPHIC LOG

PROJECT\539-13\53913B70.DRW

000123

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-71	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/18/91	WEATHER ▶ Sunny, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.97 FT.	GROUT ▶ Bentonite
	WATER LEVEL INITIAL ☐ B.G.S. ☐ B.M.P. / HOLE DIA. 8.25 IN.
	WATER LEVEL AT COMPLETION H.M.P. / TOTAL DEPTH 11.5 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			Asphalt
1	Dry	Medium Dense to Loose	0.0	0.0	1	1.1'	18, 17, 8	Gray pebbles and coarse SAND.
							9	CLAY interlayered.
2	Dry	Very Compact	0.0	3.0	2, 3, 4	0.2'	50, Ref., Ref., Ref.	Coarse SAND and rock fragments.
3	Dry	Very Compact	0.0	12.0	4, 5, 6	0.2'	50, Ref., Ref., Ref.	
4	Dry	Very Compact	0.0	2.0	6, 7, 8	0.25'	50, Ref., Ref., Ref.	Yellowish brown coarse SAND and GRAVEL.
5	Dry	Very Compact	0.0	0.0	8, 9, 10	0.1'	50, Ref., Ref., Ref.	Augered from 10-11.5 FT. in rock. Moved rig 2 times and met resistane at same depth. Could not collect a water sample.
6					10, 11, 12			Sampled soil to 10.0 FT. Augered to 11.5 FT.
7					12, 13, 14			
8					14, 15, 16			
9					16, 17, 18			
10					18, 19, 20, 21			

GRAPHIC LOG

000124

PROJECT\539-13\53913B71.DRW

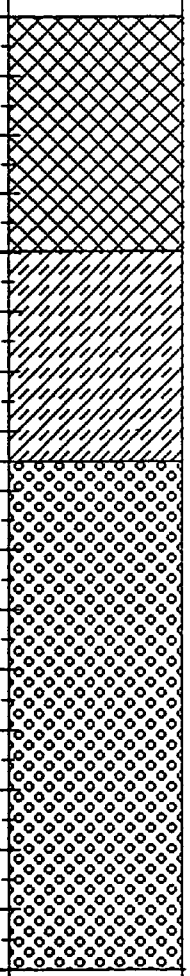
LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-72	LOCATION ► Paddy's Run Road Site
DATE ► 10/17/91	WEATHER ► Clear, 50F
LOGGED BY ► P. Gebhard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 2 IN. Split Spoon
ELEVATION ► 529.12 FT.	GROUT ► Bentonite
WATER LEVEL INITIAL 15 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Very Compact	0.0	0.0	0–2	0.5'	32, 58, Ref., Ref.	Gravel FILL
2	Moist	Loose	0.0	0.0	2–4	0.1'	5, 4, 3, 2	
3	Moist	Very Soft	0.0	0.0	4–6	0.5'	1, 1, 1, 1	Brown SILTY CLAY, mottled lenses brown gravel and coarse sand.
4	Moist	Stiff to Hard	0.0	0.0	6–8	1.7'	11, 19, 32	Brown SILTY CLAY with trace pebbles.
5	Moist	Dense to Loose	0.0	0.0	8–10	1.2'	54, 15, 23, 4, 3	Light gray to gray, coarse to medium GRAVEL with layers of medium sand and clay. Reddish brown staining.
6	Wet	Very Compact	0.0	0.0	10–12	0.2'	53, Ref., Ref., Ref.	
7	-	-	-	-	12–14	NR	Ref., Ref., Ref., Ref.	
8	Wet	Very Compact	0.0	0.0	14–16	0.4'	53, Ref., Ref., Ref.	Same as above with reddish brown staining.
9					16–18			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
10					18–21			

GRAPHIC LOG



PROJECT\539-13\53913B72.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-73	LOCATION ► Paddy's Run Road Site
DATE ► 10/17/91	WEATHER ► Clear, 60F
LOGGED BY ► P. Gebhard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 2 IN. Split Spoon
ELEVATION ► 528.67 FT.	GROUT ► Bentonite
WATER LEVEL INITIAL 15 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 17.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Very Compact	0.0	0.0	0, 1	0.5'	53, Ref., Ref., Ref.	Gravel FILL
2	-				2, 3	NR	5, 7, 3, 9	
3	Moist	Loose to Medium Dense	0.0	0.0	4, 5	1.2'	5, 6, 8	Brown medium SAND.
4	Moist	Medium Dense to Dense	0.0	0.0	6, 7	1.25'	18, 8, 10, 16, 21	Brown to reddish brown silty GRAVEL coarse to medium with medium SAND clayey throughout.
5	Moist	Very Compact	0.0	0.0	8, 9	0.7'	20, 50, Ref., Ref.	
6	Moist	Very Compact	0.0	0.0	10, 11	1.0'	47, 53, Ref., Ref.	
7	Moist	Very Compact	0.0	0.0	12, 13	0.25'	5, Ref., Ref.	
8	Wet	Very Compact	0.0	0.0	14, 15	0.2'	50, Ref. ▼, Ref., Ref.	
9					16, 17			Sampled soil to 16.0 FT. Augered to 17.0 FT. Sampled groundwater at 17.0 FT. with Hydropunch II.
10					18, 19, 20, 21			

GRAPHIC LOG

000126

PROJECT\539-13\53913B73.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-74	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/18/91	WEATHER ▶ Clear, 50F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.05 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 13 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 18.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
					0				
1	-	-	-	-	1			Augered-sample collected and described during surface soil investigation.	
					2				
2	Moist	Loose	0.0	0.0	3	1.0'	6, 6, 8, 9	Brown to dark brown CLAYEY SAND fine to medium, and gravel.	
					4				
3	Moist	Dense to Medium Dense	0.0	0.0	5	1.25'	8, 15, 16, 7		
					6				
4	Moist	Dense to Very Compact	0.0	0.0	7	1.3'	10, 20, 40, 53		
					8			Light gray to gray GRAVEL medium to coarse with coarse sand and trace clay.	
5	Moist	Very Compact	0.0	0.0	9	0.3'	25, 50, Ref., Ref.		
					10				
6	Moist	Very Compact	0.0	0.0	11	0.2'	50, Ref., Ref., Ref.		
					12				
7	Wet	Very Compact	0.0	0.0	13	0.25'	50, Ref., Ref., Ref.		
					14				
8	Wet	Very Compact	0.0	0.0	15	0.25'	45, 50, Ref., Ref.	▼	
					16				
9					17			Sampled soil to 16.0 FT. Augered to 18.0 FT. Sampled groundwater at 18.0 FT. with Hydropunch II.	
					18				
10					19				
					20				
					21				

PROJECT\539-13\53913B74.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-75	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/18/91	WEATHER ▶ Clear, 60F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.36 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
					0				
1					1			Augered-sample collected and described during surface soil investigation.	
					2				
2	Moist	Loose	0.0	0.0	3	0.6'	3, 3, 3, 3, 4	Brown to gray gravel FILL.	
					4				
3	Moist	Loose	0.0	0.0	5	0.7'	2, 1, 9	Brown to dark brown CLAYEY SAND medium to coarse with gravel.	
					6				
4	Wet	Dense to Very Compact	0.0	0.0	7	1.2'	10, 19, 40, 50		
					8				
5	Moist	Very Compact	0.0	0.0	9	0.3'	50, Ref., Ref., Ref.	Brown to dark gray coarse to medium GRAVEL with medium to coarse sand.	
					10				
6	Moist	Very Compact	0.0	0.0	11	0.2'	25, 50, Ref., Ref.		
					12			25% reddish brown staining.	
7	Moist	Very Compact	0.0	0.0	13	0.8'	35, 50, Ref., Ref. ▼		
					14				
8	Wet	Very Compact	0.0	0.0	15	0.5'	50, Ref.		
					16			Sampled soil to 15.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.	
9					17				
					18				
10					19				
					20				
					21				

000128

PROJECT\539-13\53913B75.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-76	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/17/91	WEATHER ▶ Sunny, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 527.76 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14.1 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 15.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
1					0–2			Augered-sample collected and described during surface soil investigation.	
2	Dry	Medium Dense to Dense	0.0	0.0	2–4	1.5'	5, 9, 14, 18	Brown CLAYEY SAND medium to fine, trace pebbles.	
3	Dry	Dense to Very Compact	0.0	0.0	4–6	1.3'	10, 19, 29, 80	Brown to light brown coarse SAND with trace pebbles.	
4	Dry	Dense to Very Compact	0.0	0.0	6–8	0.2'	80		
5	Dry	Dense to Very Compact	0.0	0.0	8–10	0.2'	78	Gray to light brown GRAVEL and coarse SAND.	
6	Wet	Loose	0.0	0.0	10–12	0.5'	6, 7, 8, 2		
7					12–14			Sampled soil to 12.0 FT. Augered to 15.0 FT. Sampled groundwater at 15.0 FT. with Hydropunch II.	
8					14–16				
9					16–18				
10					18–21				

PROJECT\539-13\53913B76.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-77	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/16/91	WEATHER ▶ Clear, 60F
LOGGED BY ▶ P. Gebhard	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.98 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
					0			
1	Moist	Loose	0.0	0.0	1	2.0'	3, 4, 5, 4	Dark brown CLAYEY SAND fine to medium, mottled.
					2		3, 7	
2	Moist	Soft	0.0	0.0	3	1.0'	5, 5	Dark brown SILTY CLAY.
					4		4, 4	
3	Moist	Very Soft to Loose	0.0	0.0	5	1.2'	3, 2	Brown to light brown medium to coarse SAND, trace pebbles.
					6		6, 5, 7, 6	
4	Moist	Loose	0.0	0.0	7	1.2'		Interbedded clay layers.
					8		10, 17	
5	Moist	Dense	0.0	0.0	9	1.9'	19, 23	Light gray to gray GRAVEL with medium to coarse sand trace clay.
					10		3, 19	
6	Moist	Dense to Compact	0.0	0.0	11	1.0'	29, 31	20% reddish brown staining.
					12		21, 29	
7	Moist	Compact to Very Compact	0.0	0.0	13	1.0'	32, 54	
					14		15, 19 ▼	
8	Wet	Compact	0.0	0.0	15	2.0'	31, 32	
					16			Sampled soil to 16.0 FT. Augered to 20.0 FT.
9					17			Sampled groundwater at 20.0 FT. with Hydropunch II.
					18			
10					19			
					20			
					21			

GRAPHIC LOG

000120

PROJECT\539-13\53913B77.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-78	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/16/91	WEATHER ▶ Sunny, 60F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 530.05 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 14.1 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 22.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
1					0–2			Augered-sample collected and described during surface soil investigation.	
2	Dry	Soft	0.0	0.0	2–4	1.7'	7, 7, 7, 8	Brown CLAY with fine sand.	
3	Moist	Very Soft to Soft	0.0	0.0	4–6	1.0'	3, 3, 6, 4	Olive brown CLAY trace gray mottling.	
4	Moist	Very Soft to Soft	0.0	0.0	6–8	1.0'	2, 3, 6, 9	Same as above with trace sand.	
5	Moist	Soft to Firm	0.0	0.0	8–10	1.2'	7, 7, 11, 12	Gray CLAY grading to sand and fine gravel.	
6	Moist	Compact	0.0	0.0	10–12	1.25'	26, 32, 27, 31	Brown to brownish gray coarse SAND and GRAVEL.	
7	Wet	Compact	0.0	8.0	12–14	1.3'	42, 36, 27, 38	Yellowish brown coarse SAND and GRAVEL.	
8					14–16			Sampled soil to 14.0 FT. Augered to 22.0 FT. Sampled groundwater at 22.0 FT. with Hydropunch II.	
9					16–18				
10					18–21				

PROJECT\539-13\53913B78.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-79	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/16/91	WEATHER ▶ Sunny, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.72 FT.	GROUT ▶ Bentonite

WATER LEVEL INITIAL 18.7 FT. ■ B.G.S. □ B.M.P. — HOLE DIA. 8.25 IN.

WATER LEVEL AT COMPLETION H.M.P. — TOTAL DEPTH 22.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG
					0				
1					1			Augered-sample collected and described during surface soil investigation.	
					2				
2	Dry	Dense	0.0	0.0	3	0.7'	12, 18, 21, 17	Brown clayey SAND with trace pebbles.	
					4				
3	Moist	Loose to Medium Dense	0.0	0.0	5	0.6'	3, 3, 7, 13		
					6				
4	Moist	Medium Dense to Dense	0.0	0.0	7	0.5'	9, 11, 16, 20	Brown medium coarse SAND trace pebbles.	
					8				
5	Moist	Very Compact	0.0	0.0	9	0.3'	21, 50, Ref., Ref.		
					10				
6	Moist	Very Compact	0.0	0.0	11	0.3'	60, Ref., Ref., Ref.		
					12				
7	Wet	Very Compact	0.0	0.0	13	0.2'	80, Ref., Ref., Ref.	Yellowish brown coarse SAND and GRAVEL	
					14				
8	Wet	Very Compact	-	-	15	0.1'	80, Ref., Ref., Ref.	Yellowish brown coarse SAND with trace pebbles.	
					16				
9	Sat.	Very Compact	0.0	0.0	17	0.8'	37, 80, Ref., Ref.		
					18				
10					19			Sampled soil to 18.0 FT. Augered to 22.0 FT. Sampled groundwater at 22.0 FT. with Hydropunch II.	
					20				
					21				

000132

PROJECT\539-13\53913B79.DRW

LOCATION MAP

ERM—MIDWEST SOIL BORING LOG

BORE NUMBER ► SB-80	LOCATION ► Paddy's Run Road Site
DATE ► 10/11/91	WEATHER ► Cloudy, 50F
LOGGED BY ► P. Gebhard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 3 IN. Split Spoon
ELEVATION ► 528.27 FT.	GROUT ► Bentonite
WATER LEVEL INITIAL 15.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1					0, 1, 2			Augered-sample collected and described during surface soil investigation.
2	Dry	Soft to Stiff	0.0	0.0	2, 3, 4	2.0'	4, 5, 13, 15	Dark brown to brown SILTY CLAY, mottled.
3	Dry	Soft to Loose	0.0	0.0	4, 5, 6	1.7'	5, 6, 5, 8	Brown medium to fine GRAVEL with medium to coarse SAND.
4	Dry	Loose	0.0	0.0	6, 7, 8	1.5'	3, 4, 4, 4	Brown to light brown, medium to coarse SAND with pebbles.
5	Moist	Loose	0.0	0.0	8, 9, 10	2.0'	2, 3, 5, 5, 5	Same as above, gray, trace pebbles.
6	Moist	Dense to Compact	0.0	0.0	10, 11, 12	1.0'	18, 25, 31	Brown coarse to fine GRAVEL with medium to coarse SAND, trace clay.
7	Moist	Dense	0.0	0.0	12, 13, 14	1.4'	5, 18, 23, 25	Gray coarse to fine GRAVEL with medium to coarse SAND.
8	Wet	Medium Dense to Dense	0.0	0.0	14, 15, 16	0.2'	5, 10, 15, 19	
9					16, 17, 18			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
10					18, 19, 20, 21			

GRAPHIC LOG

000133

PROJECT\539-13\53913880.DRW

LOCATION MAP

ERM–MIDWEST SOIL BORING LOG

BORE NUMBER ▶ SB-81	LOCATION ▶ Paddy's Run Road Site
DATE ▶ 10/11/91	WEATHER ▶ Clear, 50F
LOGGED BY ▶ D. Jakim	DRILLED BY ▶ Mathes & Associates
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger	SAMPLING METHOD ▶ 2 IN. Split Spoon
ELEVATION ▶ 528.20 FT.	GROUT ▶ Bentonite
WATER LEVEL INITIAL 15.5 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8.25 IN.
WATER LEVEL AT COMPLETION H.M.P.	TOTAL DEPTH 20.0 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	DOSIMETER	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Dense to Medium Dense	0.0	0.0	0–2	1.4'	10, 16, 17, 14	CLAYEY SAND and pebbles.
2	Moist	Stiff	0.0	0.0	2–4	0.8'	10, 12, 16, 17	Brown SANDY CLAY with trace pebbles.
3	Moist	Soft	0.0	0.0	4–6	1.5'	3, 5, 6, 8	Brown CLAY.
4	Moist	Very Soft to Soft	0.0	0.0	6–8	1.7'	4, 3, 8, 5	Brown SANDY CLAY.
5	Moist	Soft	0.0	0.0	8–10	1.1'	3, 6, 7	Same as above with trace pebbles.
6	Moist	Loose to Dense	0.0	0.0	10–12	1.1'	5, 6, 8, 14, 20	Brown GRAVEL with SAND, trace clay.
7	Wet	Dense to Compact	0.0	7.0	12–14	1.0'	6, 15, 28, 40	Yellowish orange SAND AND GRAVEL
8	Sat.	Compact to Very Compact	0.0	2.0	14–16	1.0'	8, 40, 50 ▼, Ref.	
9					16–17			Sampled soil to 16.0 FT. Augered to 20.0 FT. Sampled groundwater at 20.0 FT. with Hydropunch II.
10					17–21			

GRAPHIC LOG

000134

PROJECT\539-13\53913B81.DRW

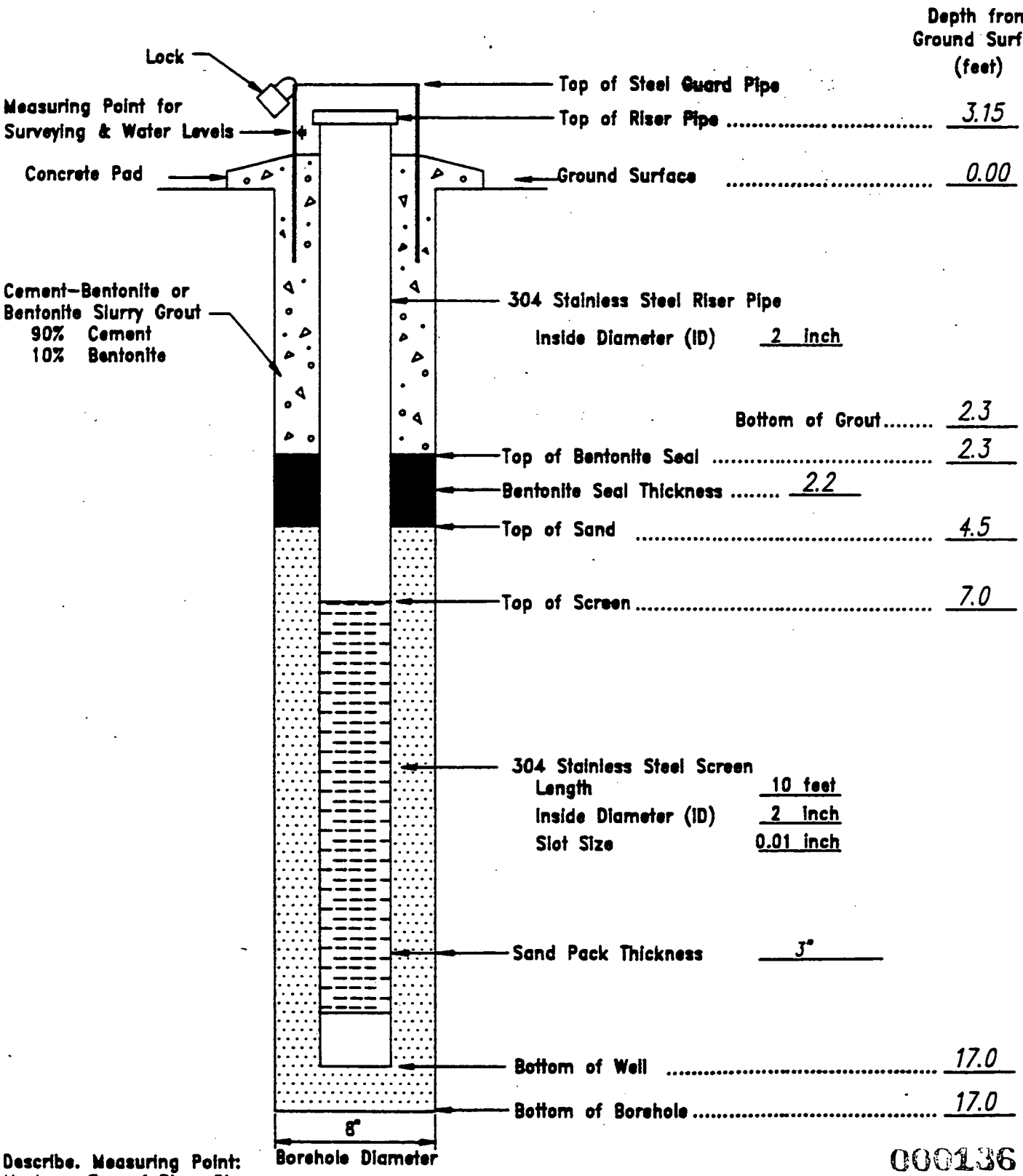
MONITOR WELL CONSTRUCTION

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-01S
Well Location: Off Site
Date Of Installation: 3/19/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 533.39
Geologist/Engineer: M.A.F.
Project Number: 4700-016



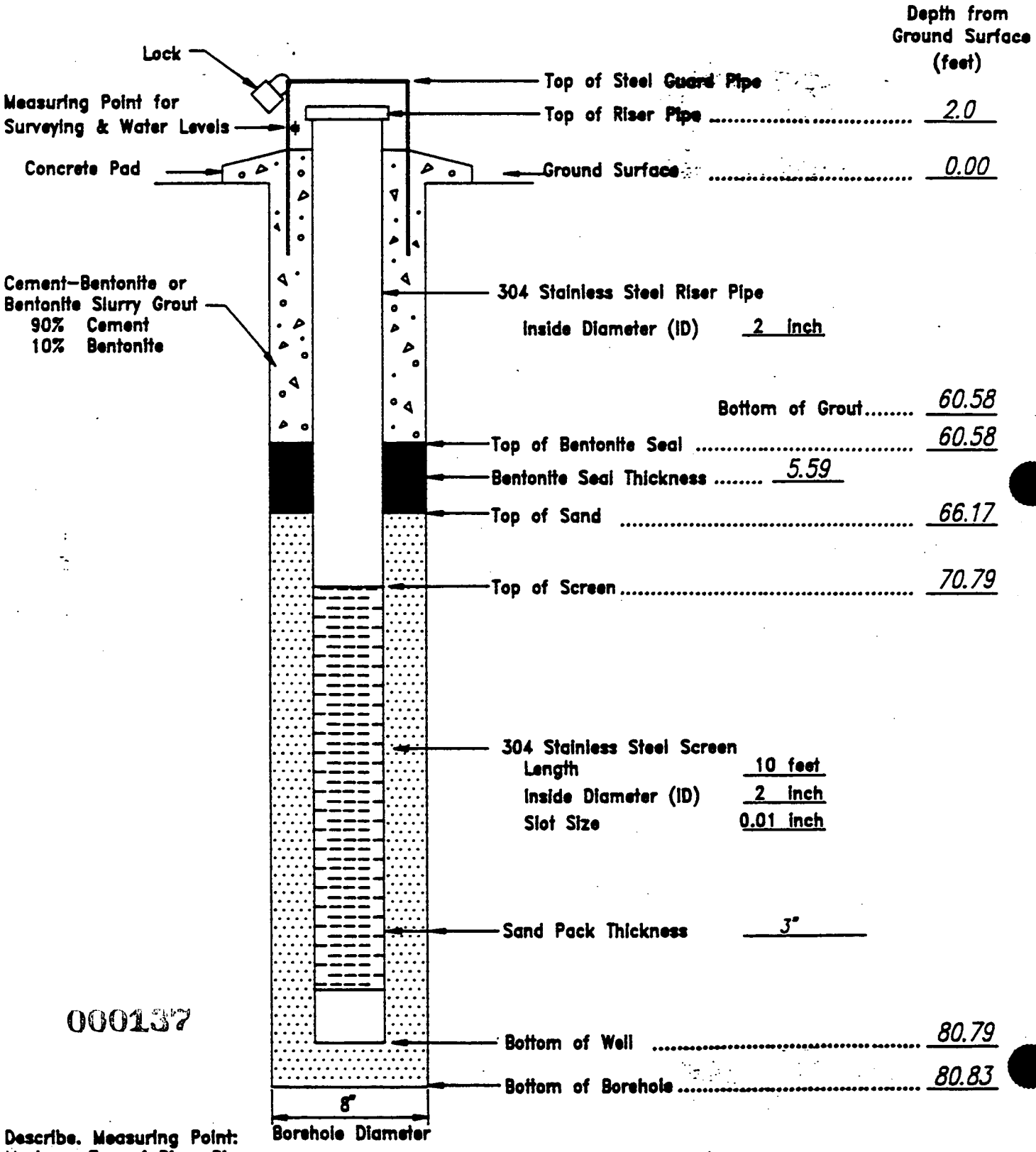
* Describe. Measuring Point: Mark on Top of Riser Pipe

000136

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-01D
Well Location: Off Site
Date Of Installation: 3/21/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 533.00
Geologist/Engineer: J.S.
Project Number: 4700-016



000137

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-01D Sh 1 of 4
Date Started 3/20/90 Completed 3/21/90 Ground Elev. 531.0
Total Depth 81.0 Ft Location Off Site Logged by J.Starkes
Remarks See SB-33 Log for Lithology above 17 Ft.

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
					Previously logged to 17 feet from MW-1S	
17						
	SS-1	50	17-19	1.7		1.7 Units
19						
	SS-2	25	19-21	1.9		1.9 Units
21						
	SS-3	26	21-23	1.4		1.4 Units
23						
	SS-4	47	23-25	2		2 Units
25						
	SS-5	38	25-27	1.4		1.4 Units
27						
	SS-6	22	27-29	1.5		1.5 Units
29						
	SS-7	138	29-31	1.8	Brown, fine to coarse sand some clay and silt, trace of medium gravel, moist to wet	1.8 Units
31						
	SS-8	26	31-33	1		
32						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-01D Sh 2 of 4
Date Started 3/20/90 Completed 3/21/90 Ground Elev. 531.0
Total Depth 81.0 Ft Location Off Site Logged by J. Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
33	SS-8	26	31-33	1		1 Unit
35	SS-9	67	33-35	2		2 Unit
37	SS-10	24	35-37	1.3		2.8 Units
39	SS-11	46	37-39	1.3	Brown, fine sand, some clay and fine gravel, wet	2 Units
41	SS-12	24	39-41	0		0 Units
43	SS-13	39	41-43	.7	Brown, medium to coarse sand some fine sand, wet	0 Units
45	SS-14	158	43-45	1.8		0 Units
47	SS-15	56	47-49	1.5	Brown, gravelly sand, some silt and clay, moist to wet	3 Units
	SS-16	58	47-49	1.3		1.4 Units

ENSR 000139

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-1D Sh 3 of 4
Date Started 3/20/90 Completed 3/21/90 Ground Elev. 531.0
Total Depth 81.0 Ft Location Off Site Logged by J.Starkes
Remarks See SB-33 Log for Lithology above 17 Ft.

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
49						
	SS-17	28	48-50	1.3	Brown, coarse sand, some fine to medium sand, some silt, wet	1 Units
51						
	SS-18	23	50-52	1.6		.2 Units
53						
	SS-19	83	52-54	1.9	Brown, fine to coarse sand and fine to medium gravel, trace of silt, wet	2 Units
55						
	SS-20	49	54-57	2		4 Units
57						
	SS-21	61	57-59	1.7	Brown, fine to coarse sand, some silt, trace fine gravel, wet	2 Units
59						
	SS-22	29	59-61	1.5		.4 Units
61						
	SS-23	30	61-63	1		.6 Units
63						

ENSR

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000140

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-01D Sh 4 of 4
Date Started 3/20/90 Completed 3/21/90 Ground Elev. 531.0
Total Depth 81.0 Ft Location _____ Logged by J. Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
65	SS-24	--	63-65	--	Drilled thru sample	0 Units
67	SS-25	53	65-67	1.7	Brown, fine sand, some silt trace of medium gravel, wet	.4 Units
69	SS-26	40	67-69	1.5	Brown, fine to coarse sand, trace fine gravel, wet	1 Unit
71	SS-27	77	69-71	1.6	Brown, fine to coarse sand, and fine to medium gravel, some claay, silt and fine sand, wet	1.4 Units
73	SS-28	37	71-73	1.7		1 Units
75	SS-29	46	73-75	1.6		1 Units
77	SS-30	123	75-77	1.8	Brown, fine to coarse sand, some fine to coarse gravel, silt and clay, brown, wet	1.2 Units
79	SS-31	67	77-79	1.8		.8 Units
81	SS-32	69	79-81	1.4		1.4 Units

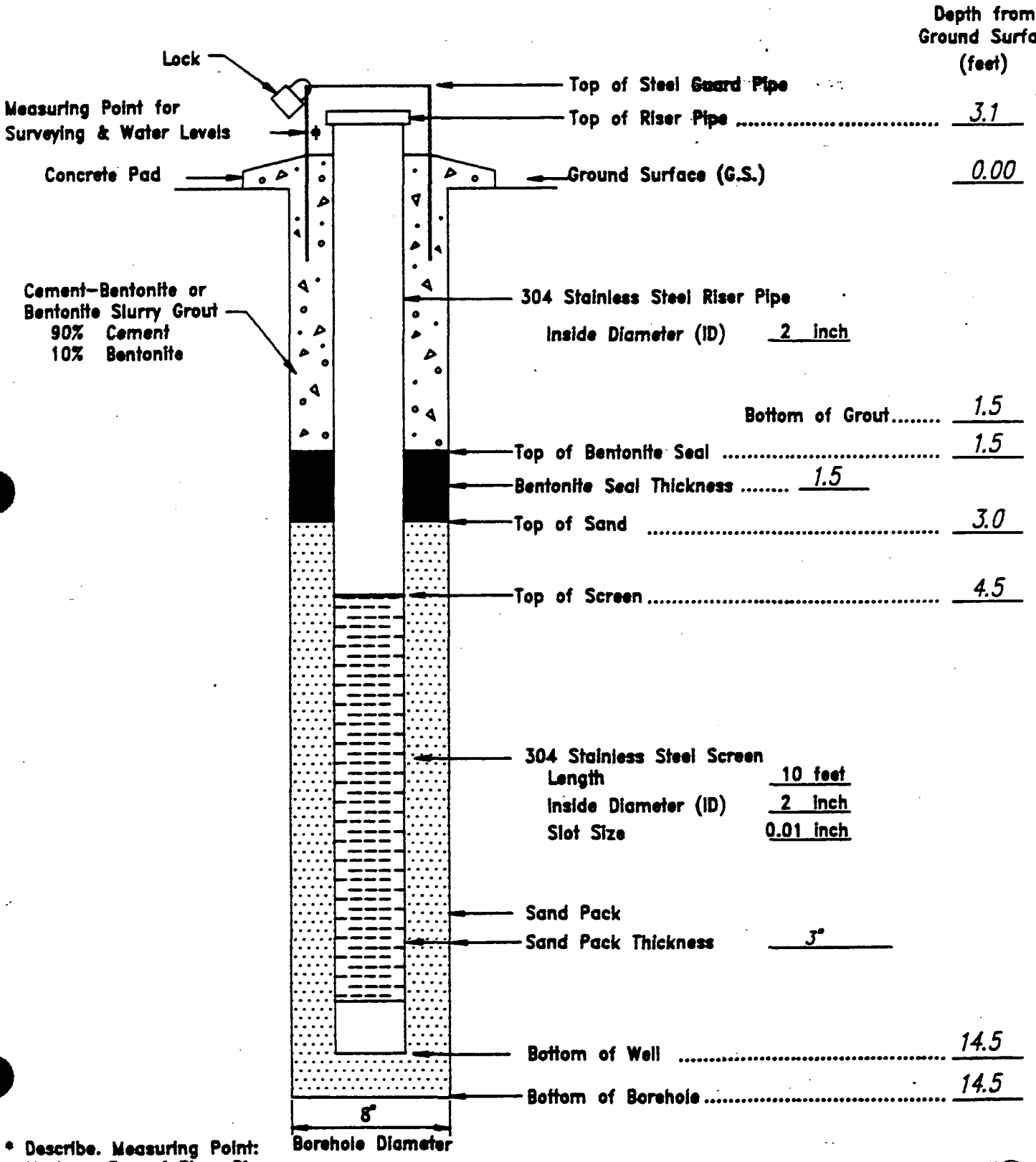
ENSR 000141 DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-02S
Well Location: A & W
Date Of Installation: 3/20/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 531.29
Geologist/Engineer: M.A.C.
Project Number: 4700-016



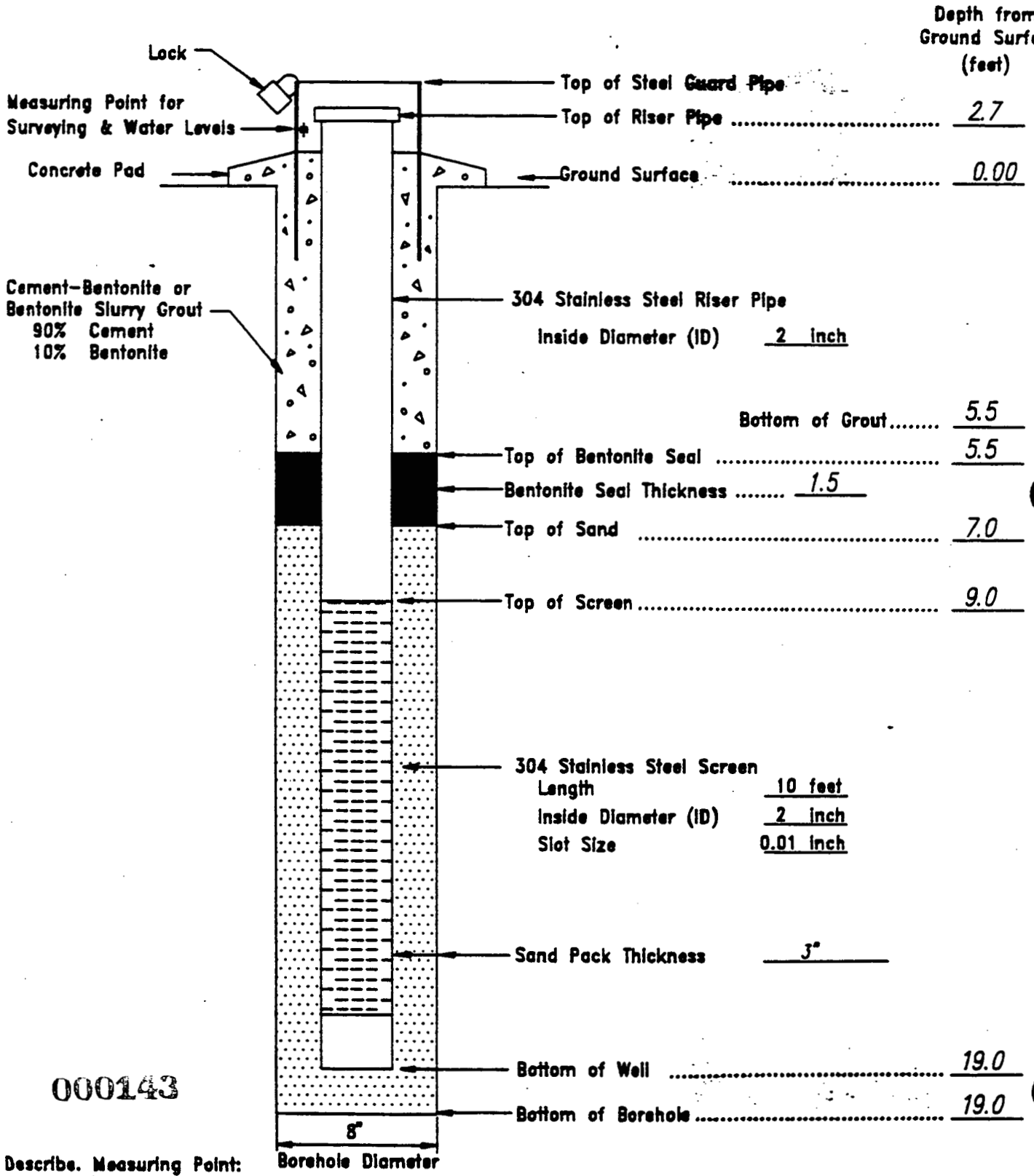
* Describe. Measuring Point: Mark on Top of Riser Pipe

000142

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-03S
Well Location: A & W
Date Of Installation: 3/19/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 530.53
Geologist/Engineer: B.E.M.
Project Number: 4700-016



000143

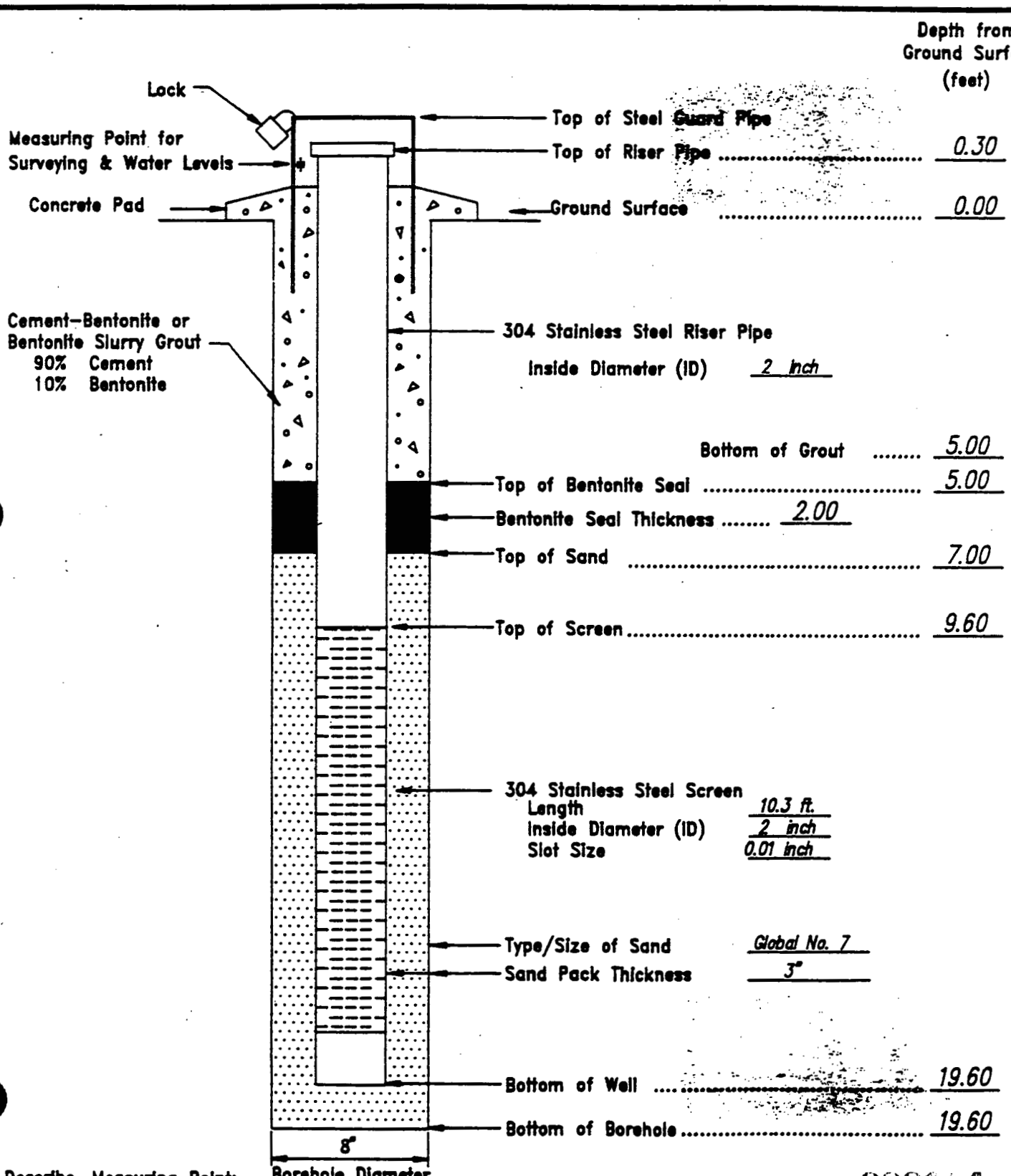
• Describe. Measuring Point: Mark on Top of Riser Pipe

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-04S
Well Location: A & W
Date Of Installation: 12/14/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Auger Rig
Top Of Casing Elev.(MSL): 528.35
Geologist/Engineer: B.E.M.
Project Number: 4700-062



* Describe. Measuring Point: Ground Surface

000144

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-04S Sh 1 of 1
Date Started 12/14/90 Completed 12/14/90 Ground Elev. 527.50
Total Depth 20 Feet Location Off-Site Logged by BEM
Remarks See Soil Boring Log SB-31 for 0-6 Foot Interval

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
6	1	210/ 0.8	6-8	0.8	Very dense, medium to coarse sand and coarse gravels and boulders	0 Units no odor
8	2	226/ 0	8-10	0		no recovery
10	3	254 0.1	10-12	0.1		0 Units no odor
12	4	270/ 0.1	12-14	0		no recovery
14	5	186/ 0.5	14-16	0		no recovery
16	6	190/ 1.0	16-18	0.8	Light brown, very dense medium sand and coarse gravels, wet	0 Units no odor
18	7	-	18-20	-		drilled interval to install well
20					Ground water encountered at 10.7 ft.	

ENSR

000145

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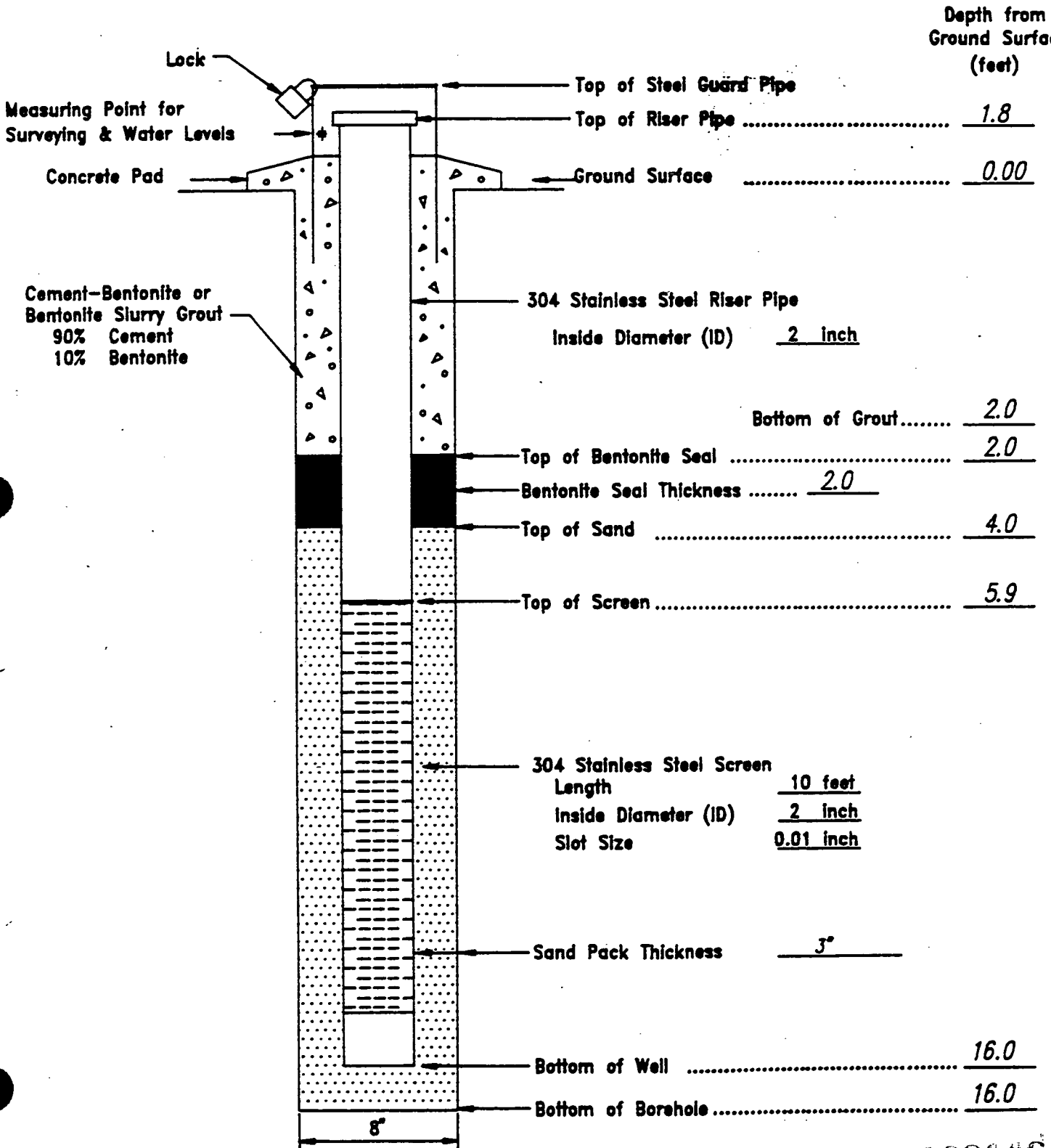
MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-05S
Well Location: A & W
Date Of Installation: 3/1/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 530.04
Geologist/Engineer: W.R.B.
Project Number: 4700-016



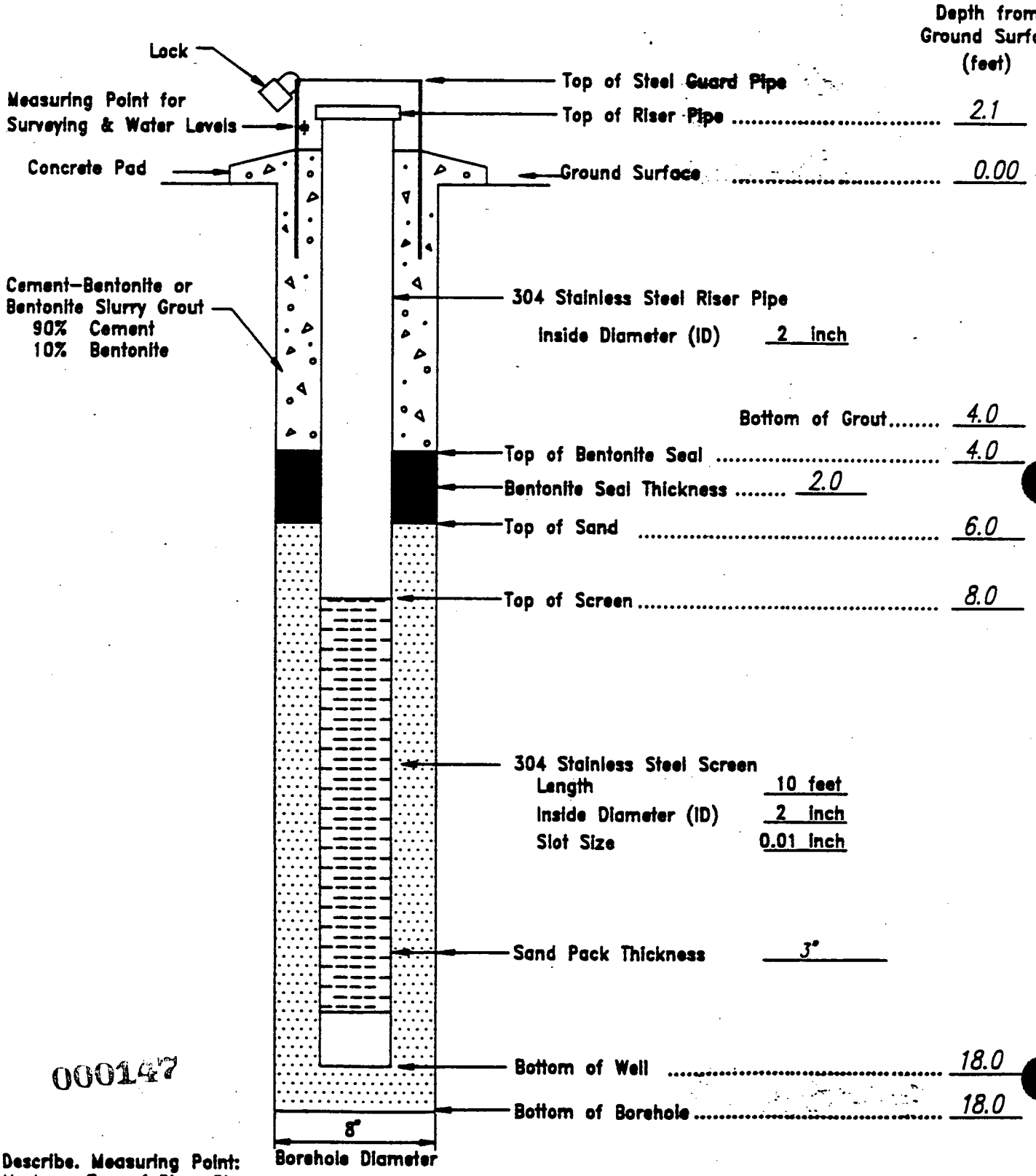
• Describe. Measuring Point: Mark on Top of Riser Pipe

000146

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-06S
Well Location: A & W
Date Of Installation: 3/1/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 530.53
Geologist/Engineer: W.R.B.
Project Number: 4700-016



000147

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-06S Sh 1 of 1
Date Started 3/01/90 Completed 3/01/90 Ground Elev. 528.3
Total Depth 18.0 Ft Location A & W/Mobil Logged by B. Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	10 20 13 9	0-2	1.5	Sand and Gravel, Gray Asphalt Sand, hard	0 Units No odor
2	02	6 9 7 7	2-4	1.5	Medium stiff, dark green to brown, clay, moist to wet	45 Units Sour Odor green stain
4	03	2 4 5 5	4-6	2		500 Units Sour Odor green stain
6	04	2 3 5 7	6-8	2		>1000 Units Sour Odor grn-bl.stain
8	05	3 5 5 7	8-10	2		500 Units Sour Odor green stain
10	06	15 37 36 51	10-12	2		300 Units Sour Odor green stain
12	07	17 48 59 49	12-14	2		50 Units Sour Odor green stain
14	08	17 27 23 13	14-16	2	Dense to very dense brown, fine to medium gravel and coarse sand with trace of clay, Moist to wet	100 Units No Odor green stain
16	09	6 5 6 11	16-18	1		0 Units No Odor no visual
18					Ground Water encounterd at approximately 11 feet.	

ENSR

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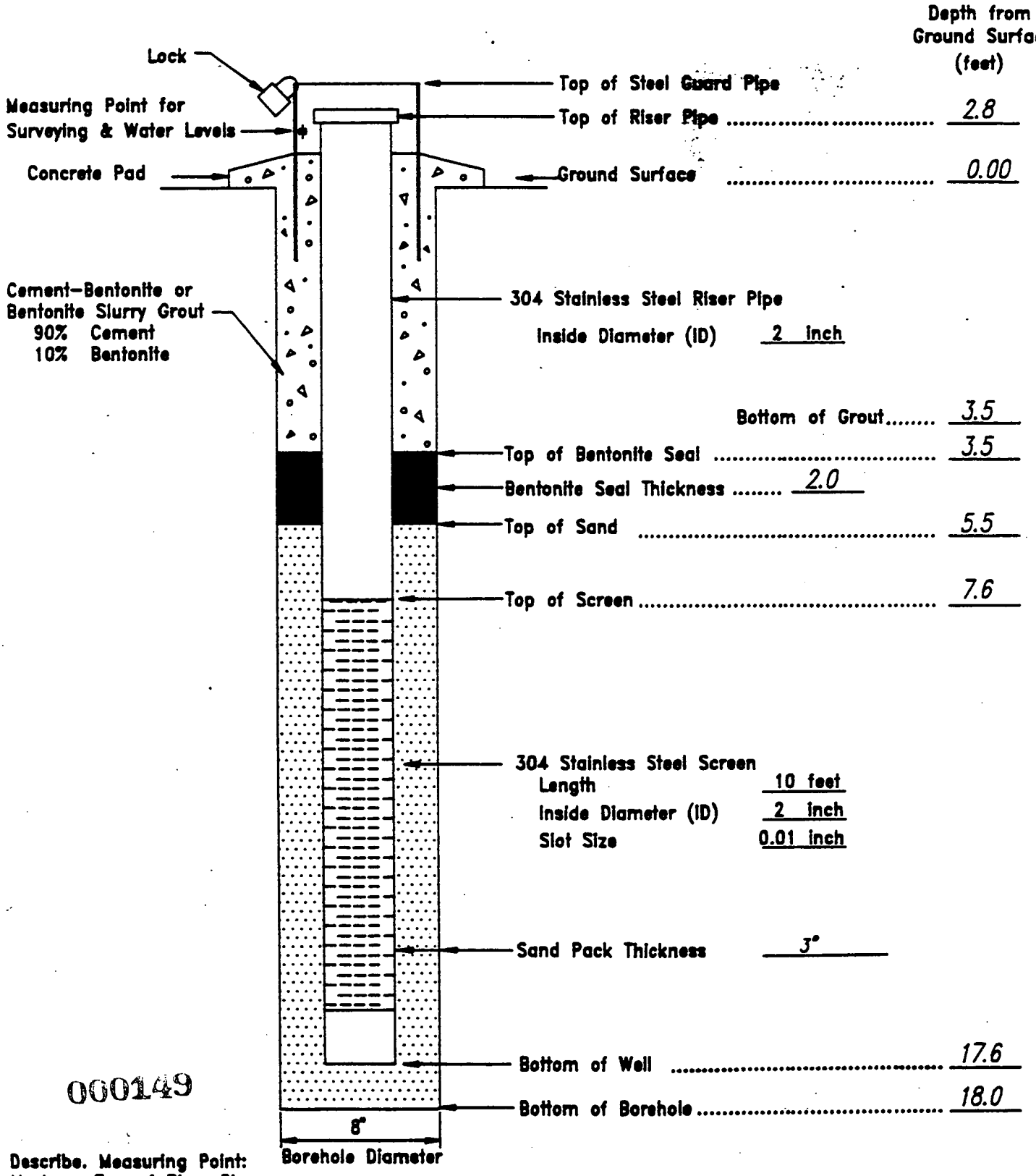
MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-07S
Well Location: A & W
Date Of Installation: 2/27/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 531.29
Geologist/Engineer: W.R.B.
Project Number: 4700-016



000149

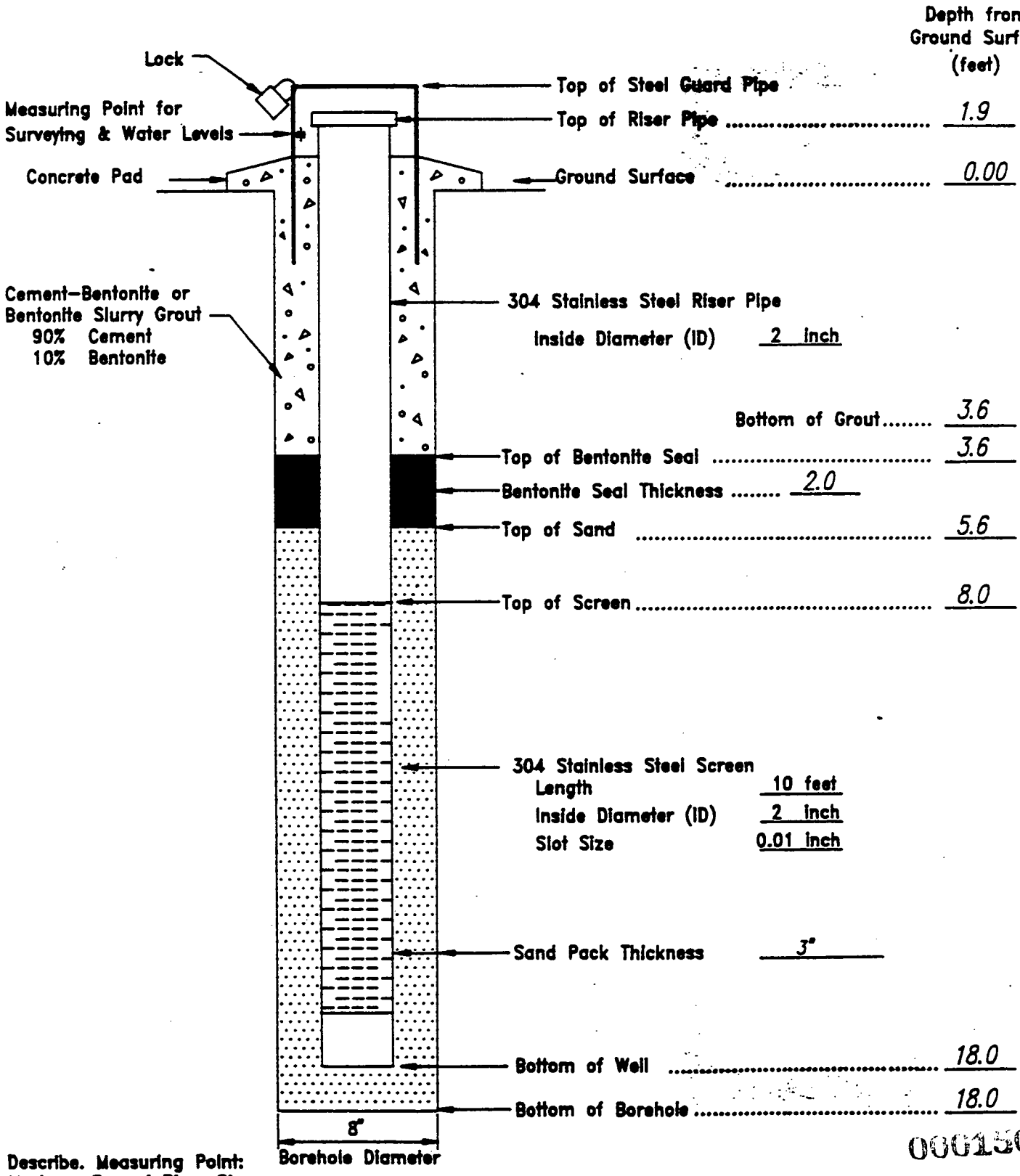
* Describe. Measuring Point: Mark on Top of Riser Pipe

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-08S
Well Location: A & W
Date Of Installation: 3/2/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 529.60
Geologist/Engineer: B.E.M.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000150

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-08S Sh 1 of 1
Date Started 3/02/90 Completed 3/20/90 Ground Elev. 527.6
Total Depth 18.0 Ft Location A & W/Mobil Logged by B.Miller
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	6 5 5 9	0-2	2	Gravel Fill Silt, and some clay, damp	0 Units no odor no visual
2	02	3 5 5 7	2-4	2	Medium stiff, yellow, clay, damp	0 Units no odor no visual
4	03	3 4 5 5	4-6	2	Medium stiff, yellow-brown sandy silt, trace of sand, damp.	.5 Units no odor no visual
6	04	3 3 5 7	6-8	2		.5 Units no odor no visual
8	05	4 5 16 15	8-10	2		4 Units no odor no visual
10	06	8 12 9 8	10-12	2	Medium dense to dense, yellow to brown, gravel, with some coarse sand, trace of cobbles (~17 feet), damp to wet	4 Units no odor no visual
12	07	7 14 9 8	12-14	2		4 Units no odor no visual
14	08	11 19 24 19	14-16	2		4 Units no odor no visual
16	09	18 24 19 22	16-18	2		4 Units no odor no visual
18					Ground Water encountered at approximately 11.0 feet	

000151

ENSR

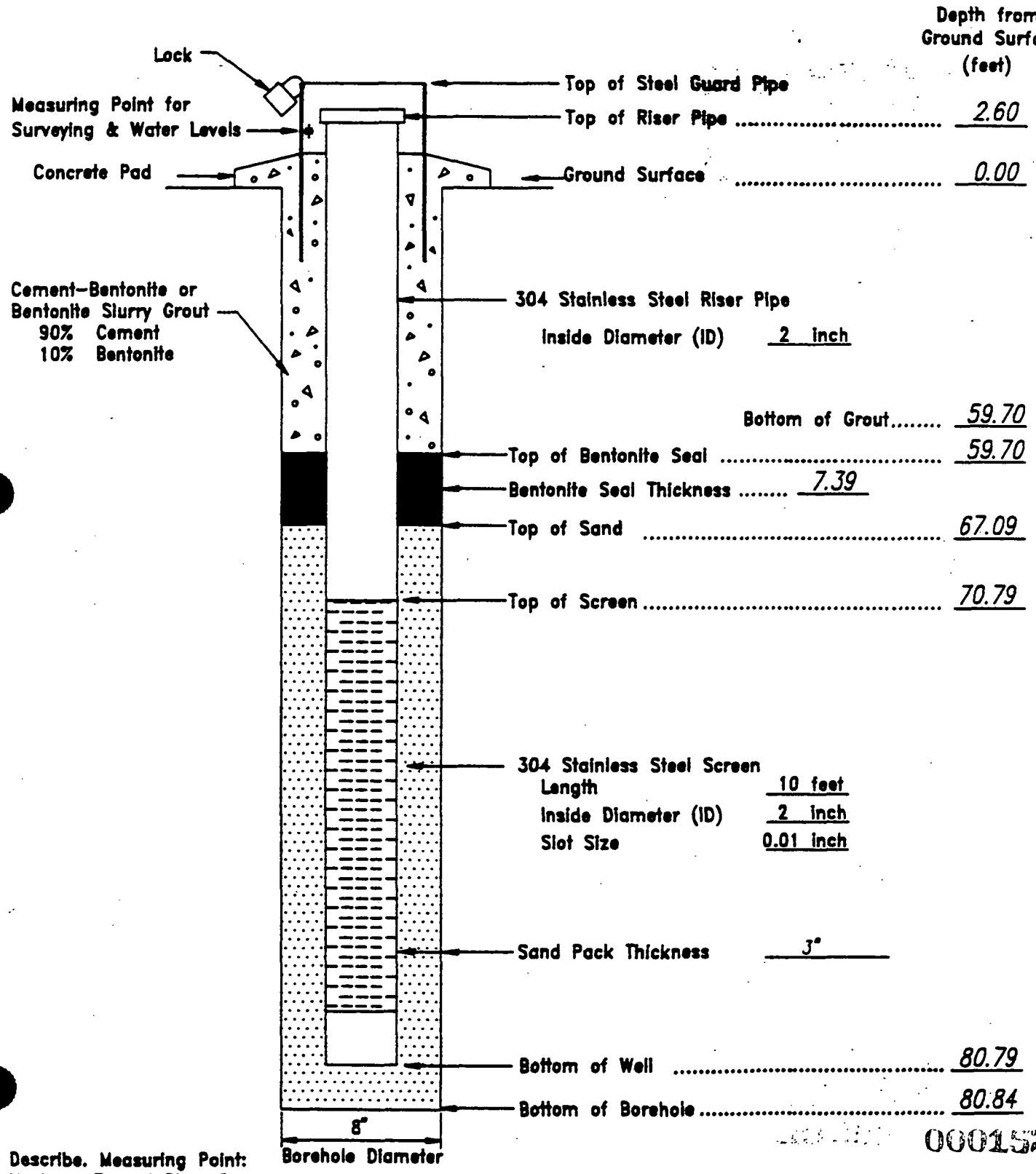
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-09D
Well Location: A & W
Date Of Installation: 3/5/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 530.51
Geologist/Engineer: J.S.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000152

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-09D Sh 1 of 4
Date Started 2/28/90 Completed _____ Ground Elev. 527.9
Total Depth 101.0 Ft Location A & W/Mobil Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
					Previously logged to 14' SB-04	
15						
	SS-01	15-17	166	2	Brown, medium coarse sand with some fine to medium gravel and silt, wet	1 Units
17						
	SS-02	17-19	84	1.6	Sand, medium to coarse grained some fine gravel, reddish brown, trace clay	3 Units
19						
	SS-03	19-21	26	1.7	Reddish brown, medium to coarse sand, some fine gravel, trace of clay, wet	3 Units
21						
	SS-04	21-23	35	2		.6 Units
23						
	SS-05	23-25	40	2	Brown, fine sand, trace of silt wet	.2 Units
25						
	SS-06	27-29	40	2		.4 Units
27						
	SS-07	27-29	30	2		.4 Units
29						

ENSR 000153

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-09D Sh 2 of 5
Date Started 2/28/90 Completed Ground Elev. 527.9
Total Depth 101.0 Ft Location A & W/Mobil Logged by J.Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	SS-08	45	29-31	2		
31						
	SS-09	100	31-33	2	Fine gravel, trace of silt Gray to brown, fine to coarse sand and fine to medium gravel trace of silt	.4 Units
33						
	SS-10	135	33-35	2		0 Units
35						
	SS-11	111	35-37	2		.4 Units
37						
	SS-12	75	35-39	2	Brown, fine sand, some medium gravel and clay, moist	1 Units
39						
	SS-13	40	39-41	2		1 Units
41						
	SS-14	69	41-43	2		3 Units
43						
	SS-15	75	43-45	2	Brown, fine gravel and fine sand Stiff, gray, silt, moist	2 Units
45						
	SS-16	30	43-45	2	Brown, fine sand, moist	2 Units
47						

ENSR

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-09D Sh 3 of 5
Date Started 2/28/90 Completed _____ Ground Elev. 527.9
Total Depth 101.0 Ft Location A & W/Mobil Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
49	SS-17	35	47-49	1.3		.4 Units
51	SS-18	30	49-51	1.8		1 Unit
53	SS-19	-	51-53	0	No sample	0 Units
55	SS-20	27	53-55	1	Gray, coarse sand, some fine gravel, trace silt	.6 Units
57	SS-21	27	55-57	2		1.2 Units
59	SS-22	100	57-59	2	Gray, fine to medium gravel, some fine sand, some silt and clay, wet	2 Units
61	SS-23	100	59-61	2	Gray, fine to coarse sand, trace of fine gravel to silt, wet	.4 Units
63	SS-24	65	61-63	1.7		1 Units
65	SS-25	65	63-65	1.7		.6 Units

ENSR 000155

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-09D Sh 4 of 5
Date Started 2/28/90 Completed Ground Elev. 527.9
Total Depth 101.0 Ft Location A & W/Mobil Logged by J.Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
67	SS-26	45	65-67	2	Gray, fine to medium gravel, some coarse sand, wet	.8 Units
69	SS-27	75	67-69	1.5		2 Unit
71	SS-28	90	67-71	1.7	Gray, fine sand and silt, moist	1 Units
73	SS-29	96	71-73	2	Gray, medium to coarse sand some silt, trace fine gravel	3 Units
75	SS-30	50	73-75	2	Gray, medium sand, and fine gravel, trace of silt, moist to wet	1 Units
77	SS-31	50	75-77	.5		.6 Units
79	SS-32	65	77-79	2	Gray, fine sand, trace silt, wet	2 Units
81	SS-33	45	79-81	2		4 Units
83	SS-34	50	81-83	1.6		2 Units

ENSR

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SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-09D Sh 5 of 5
Date Started 2/28/90 Completed _____ Ground Elev. 527.9
Total Depth 101.0 Ft Location A & W/Mobil Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	SS-35	45	83-85	1.8		.2 Units
85					Gray, fine to coarse sand, some fine gravel, trace of silt, wet	
	SS-36	50	85-87	2		.2 Unit
87						
	SS-37	75	87-89	2		2 Units
89						
	SS-38	40	89-91	2		0 Units
81						
	SS-39	91	91-93	2		3 Units
93						
	SS-40	119	93-95	1.7	Gray to tan, coarse sand, and coarse gravel, some clay, trace of silt, moist	4 Units
95						
	SS-41	200	95-97	1.5		6 Units
97						
	SS-42	45	97-99	2	Stiff to hard, gray to dark gray, clayey silt, moist	0 Units
99						
	SS-43	20	99-101	1.8	Gray, medium to coarse sand, some silt and clay, wet	0 Units
101						

ENSR 000157

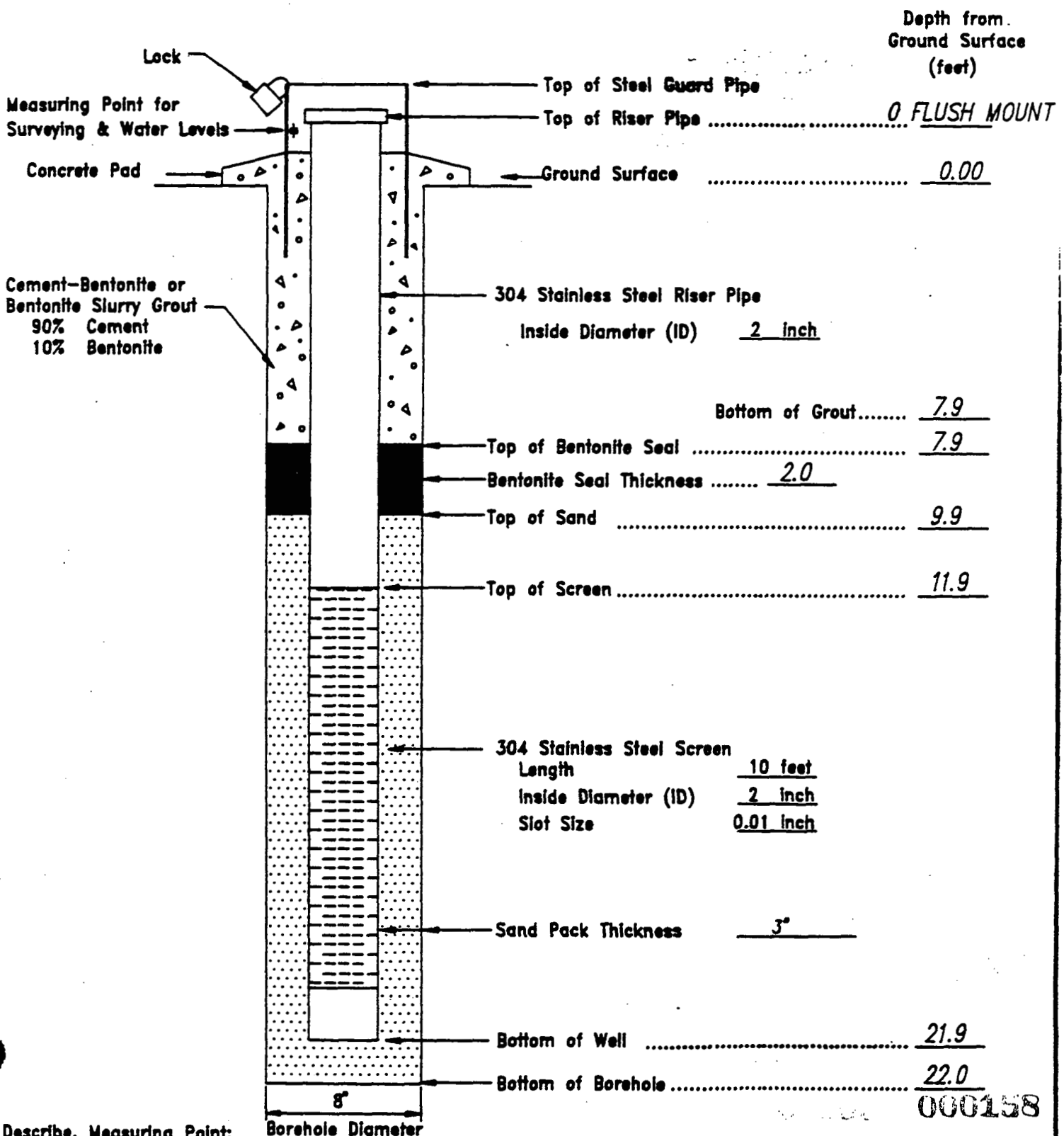
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-10S
Well Location: RNCC
Date Of Installation: 3/13/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 529.45
Geologist/Engineer: M.A.C.
Project Number: 4700-016



000158

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-10S Sh 1 of 2
Date Started 3/13/90 Completed 3/13/90 Ground Elev. 529.8
Total Depth 22.0 Ft Location Logged by M.Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	2 7 10 4	0-2	0.7"	Medium stiff, brown, clay, and silt, with a trace of gravels damp	0 Units no odor no visual
4	02	3 4 4 4	2-4	1.7"		> 10 Units slight odor no visual
6	03	2 3 5 3	4-6	1.1"		21 Units slight odor no visual
8	04	3 4 4 7	6-8	0.7"		77 Units slight odor no visual
10	05	4 4 11 13	8-10	1.1"		270 Units slight odor no visual
12	06	11 13 9 9	10-12	1.0"		92 Units slight odor no visual
14	07	13 44 37 42	12-14	1.5"		>1000 Units strong odor black stain
16	08	9 23 31 33	14-16	1.3"		>1000 Units strong odor black stain
18	09	16 18	16-18	0.7"	Dense, brown, coarse gravels and cobbles with trace of fine sand and trace to some silt and clay moist to wet	>1000 Units strong odor black stain

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-10S Sh 2 of 2
Date Started 3/13/90 Completed 3/13/90 Ground Elev. 529.8
Total Depth 22.0 Ft Location Logged by M.Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	09	16 17 19 19	16-18	0.7		>1000 Units strong odor black stains
18	010	44 31 33 27	18-20	1.1"		400 Units strong odor black stains
20	011	44 22 18 19	20-32	1.2"		450 Units strong odor black stains
22						

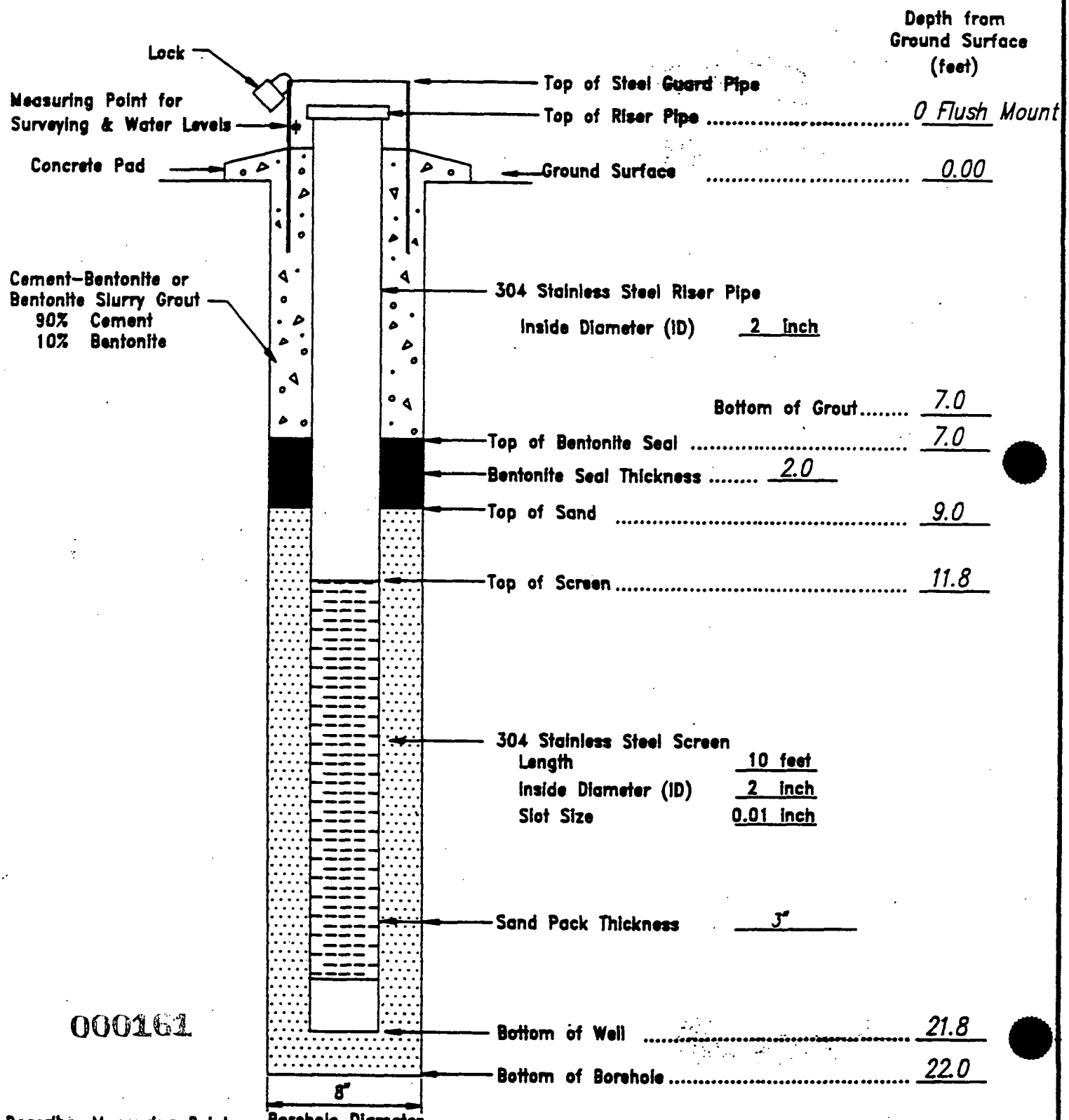
ENSR

DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-11S
Well Location: RNCC
Date Of Installation: 3/13/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 529.71
Geologist/Engineer: M.A.C.
Project Number: 4700-016



000161

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-11S Sh 1 of 2
Date Started 3/13/90 Completed 3/13/90 Ground Elev. 530.1
Total Depth 22.0 Ft Location Logged by M.Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	01	5 4 5 5	0-2	0.5"	Asphalt and Gravel Fill Loose, gravel fill and clay, wet	No reading no odor no visual
2	02	2 3 3 4	2-4	0.3"		12 Units Slight Odor no visual
4	03	1 0 1 0	4-6	0.3	Soft, silt and clay, moist to wet with trace of sand.	>1000 Units Slight Odor no visual
6	04	1 0 0 0	6-8	10"		>1000 Units Slight Odor
8	05	1 0 0 5	8-10	0-8"		>1000 Units Strong Odor black stain
10	06	4 3 5 6	10-12	1.0"	Sand, stained black	>1000 Units Strong Odor Stains
12	07	7 16 12 27	12-14	1.3"	Dense coarse gravel and cobbles with some coarse sand and trace of clay, moist to wet	>1000 Units Strong Odor Black stain
14	08	3 7 17 12	14-16	1.5"		>1000 Units Strong Odor
16	09	7 18 21 18	16-18	1.5"		>1000 Units Strong Odor
18						

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-11S Sh 1 of 2
Date Started 3/13/90 Completed 3/13/90 Ground Elev. 530.1
Total Depth 22.0 Ft Location Logged by M.Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	10	4 12 18	18-19.5	1.0		>1000 Units Strong Odor Black Stains
20	11	5 4 22	19.5-21	1.1		>1000 Units Strong Odor Black Stains
22					Ground Water encountered at approximately 15 feet.	

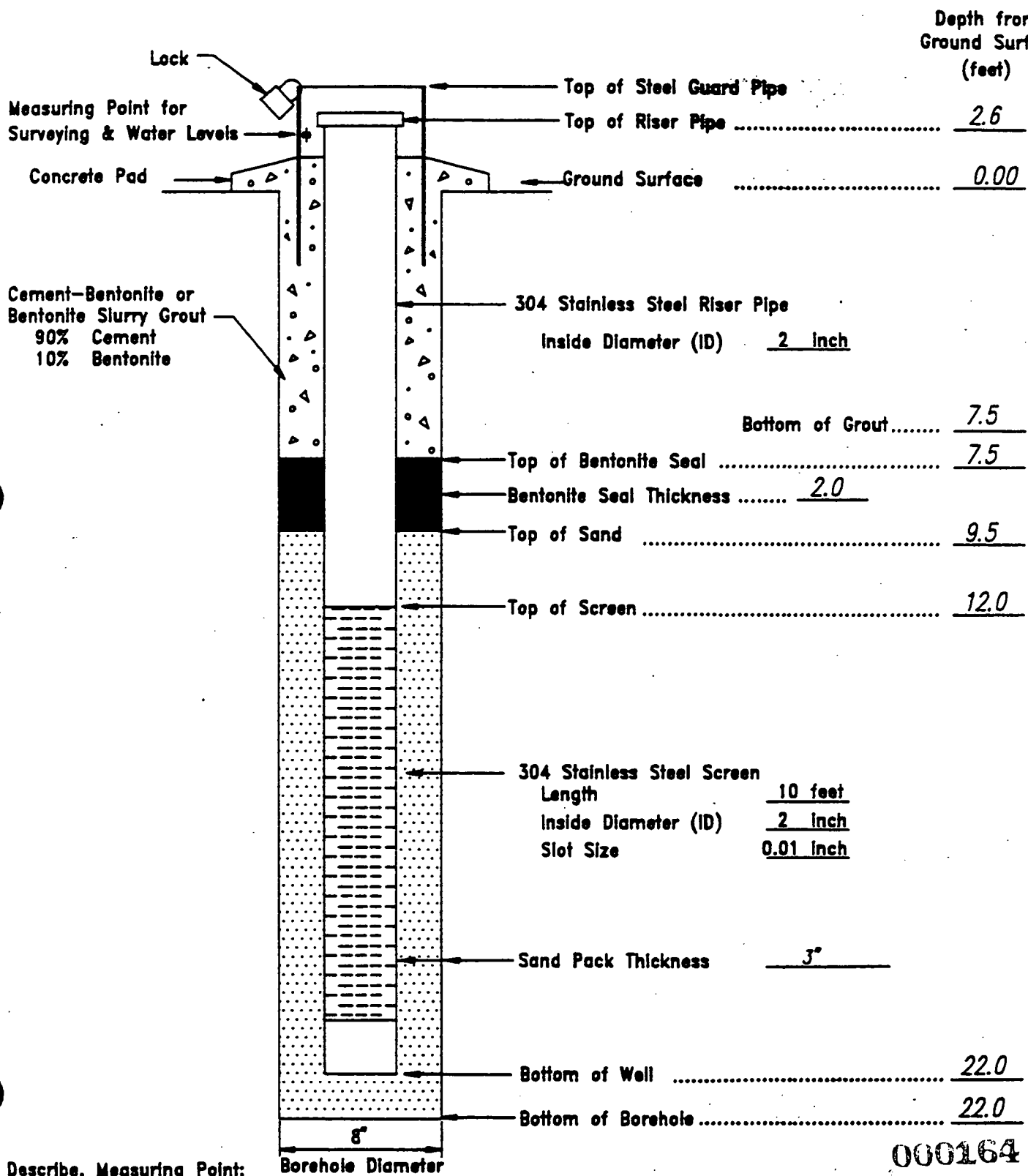
ENSR 000163

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-12S
Well Location: RNCC
Date Of Installation: 3/12/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 533.06
Geologist/Engineer: M.A.C.
Project Number: 4700-016



• Describe. Measuring Point: Mark on Top of Riser Pipe

000164

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-12S Sh 1 of 2
Date Started 3/12/90 Completed 3/12/90 Ground Elev. 530.2
Total Depth 21.5 Ft Location Logged by M. Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	1 2 3 3	0-2	0.8	Sand and silt, brown, damp (Fill Material)	0 Units no odor
4	02	2 3 3 4	2-4	0.6	Soft, brown, clay and silt, moist	700 Units Slight Odor no visual
6	03	3 4 3 3	4-6	0.6		>1000 Units Solvent Odor black stain white crystals
8	04	1 3 4 8	6-8	1.3	Sand, gray, damp, black Staining Medium stiff, brown, clay, wet	>1000 Units Solvent Odo
10	05	4 11 10 9	8-10	1.2		>1000 Units Strong Odor
12	06	6 4 2 2	10-12	0.6	Dense, to very dense, gray to black gravels and cobbles with some coarse sand and trace of clay, moist to wet	800 Units Solvent Odor
14	07	7 8 11 14	12-14	1.2	Clay, some gravel, brown wet, stained black	>1000 Units Solvent Odor black stain
16	08	5 15 30 20	14-16	1.1	Gravel and cobbles, some silt, black stained and water at 15.5'	>1000 Units Solvent Odor black stain
18	09	58 69 30 21	16-18	1.3		>1000 Units Solvent Odor

ENSR 000165

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

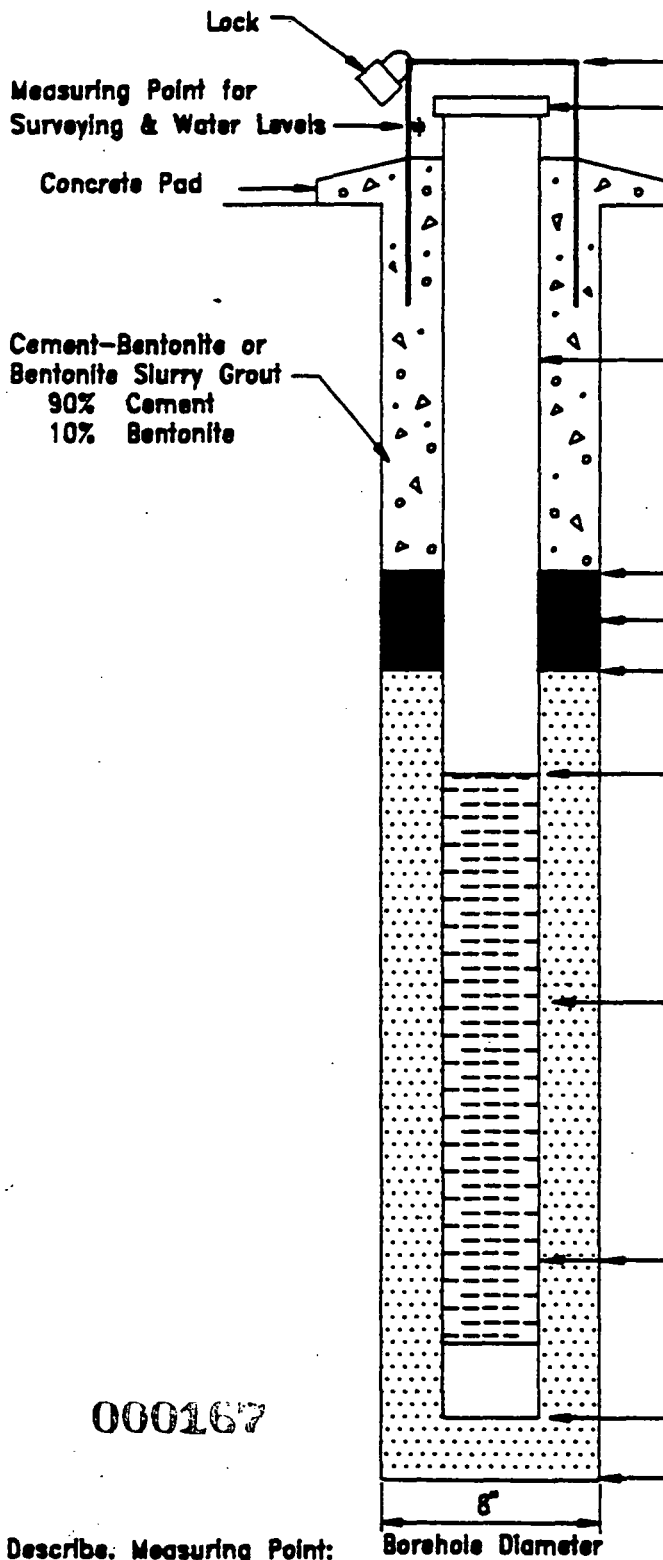
Project 4700-016 Site PRRS BORING MW-12S Sh 2 of 2
Date Started 3/12/90 Completed 3/12/90 Ground Elev. 530.2
Total Depth 21.5 Ft Location Logged by M. Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
18						
	010	16 32 37 58	18-20	1.8"		>1000 units solvent odor black stain
20	011	17 21 27	20-21.5	1.3"		>1000 units solvent odor black stain
22						

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-13S
Well Location: RNCC
Date Of Installation: 3/12/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 531.89
Geologist/Engineer: B.E.M.
Project Number: 4700-016



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.9
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	3.2
Top of Bentonite Seal	3.2
Bentonite Seal Thickness 1.8	
Top of Sand	5.0
Top of Screen	10.0
304 Stainless Steel Screen — Length 10 feet; Inside Diameter (ID) 2 inch; Slot Size 0.01 inch	
Sand Pack Thickness 3"	
Bottom of Well	20.0
Bottom of Borehole	20.0

000167

• Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-13S Sh 1 of 2
Date Started 3/10/90 Completed 3/10/900 Ground Elev. 528.9
Total Depth 20.0 Ft Location RNCC Logged by M.Ferlin
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	2 3 3 5	0-2	0.5	Soft, brown, clay and gravel	0 Units no odor no visual
4	02	2 3 3 4	2-4	0.5		0 Units no odor
6	03	4 6 7 10	4-6	1.2		0 Units no odor
8	04	4 14 15 10	6-8	1.3	Dense, brown, medium to coarse sand and gravels, moist to wet	0 Units no odor
10	05	5 17 27 20	8-10	1.3		7 Units no odor
12	06	11 29 28 20	10-12	1.5		7.4 Units slight odor
14	07	32 32 19 21	12-14	1.1		>1000 Units strong solvent odor product observed
16	08	11 54 56 40	14-16	1.5		>1000 Units strong solvent odor
18	09	6 12 15 20	16-18	1.2	Cobbles	>1000 Units strong solvent odor

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-13S Sh 2 of 2
Date Started 3/10/90 Completed 3/10/90 Ground Elev. 528.9
Total Depth 20.0 Ft Location RNCC Logged by M. Ferlin
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
18						
	010	7 35 17 21	18-21	1.7"	Cobbles	>1000 units strong solvent odor black stain and material
20					Ground Water encountered at approximatey 14 feet.	

ENSR 000169

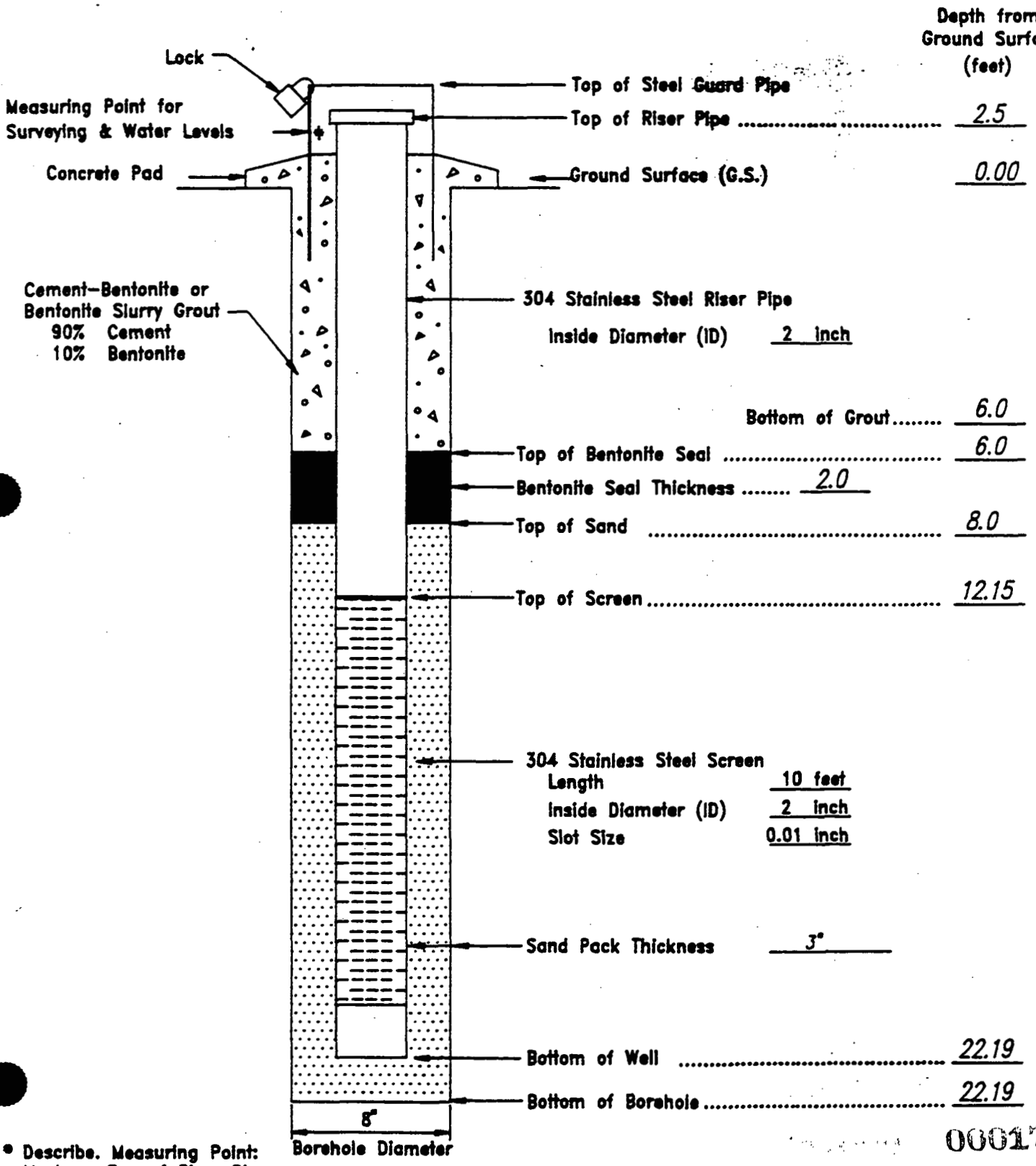
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-14S
Well Location: Off Site
Date Of Installation: 3/20/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 532.12
Geologist/Engineer: J.S.
Project Number: 4700-016



• Describe. Measuring Point: Mark on Top of Riser Pipe

000170

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-14S Sh 1 of 2
Date Started 3/20/90 Completed 3/20/90 Ground Elev. 529.7
Total Depth 22.0 Ft Location Logged by J.Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	2 1 2 1	0-2	1.3	Topsoil, silty,-sand, brown Damp	0 Units no odor
4	02	4 4 6 7	2-4	0	Large cobble in spoon tip	0 Units no odor
6	03	4 8 8 8	4-6	1.8	Medium dense, brown, medium sand with some gravel and silt, moist	0.6 Units slight odor
8	04	4 5 6 8	6-8	1.5		3 Units slight odor
10	05	5 6 6 10	8-10	1.3		22 Units slight odor no visual
12	06	12 12 12 8	10-12	1.5	Dense to very dense, coarse gravels and fine sand with some silt, moist	10 Units slight odor
14	07	21 23 28 32	12-14	0.8	Very dense, brown, fine to coarse sand and coarse gravels with some silt, moist	2 Units slight odor
16	08	16 31 35 43	14-16	1.8		>1000 Units strong odor black staining
18	09	5 11 12 15	16-18	1.5		>1000 Units strong odor black staining

ENSR 000171

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-14S Sh 2 of 2
Date Started 3/20/90 Completed 3/20/90 Ground Elev. 529.7
Total Depth 22.0 Ft Location Logged by J. Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
18						
	010	8 13 107	18-20	2.0	Sand	>1000 Units Strong odor
20						
	011	20 22 22 24	20-22	2.0	Gravel, fine, some fine to coarse sand, black staining saturated	>1000 Units Strong odor
22						
					Ground Water encountered at approximatley 15 feet	

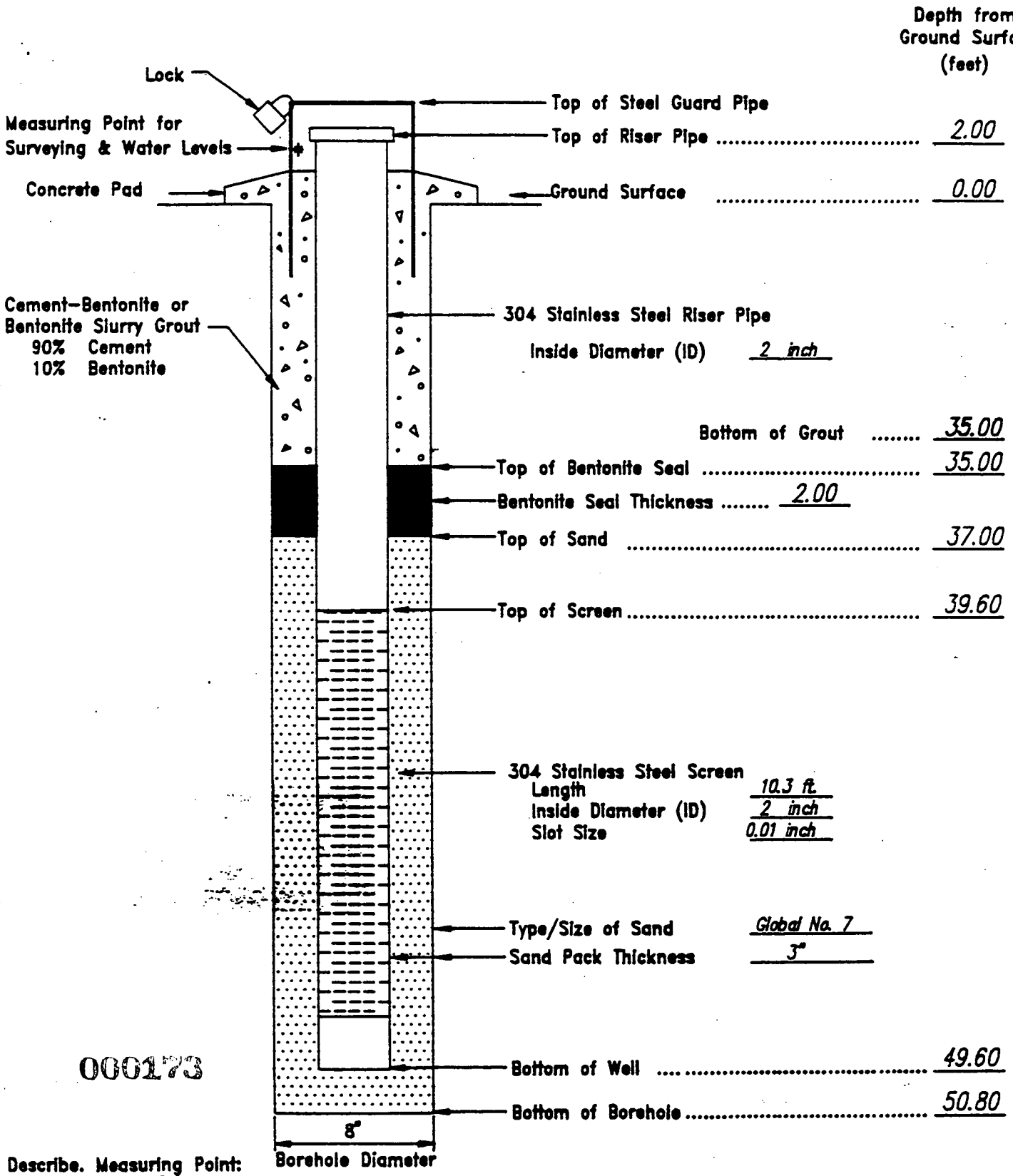
ENSR

DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-14I
Well Location: Off-Site
Date Of Installation: 12/10/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 531.84
Geologist/Engineer: B.E.M.
Project Number: 4700-062



000173

* Describe. Measuring Point: Mark at Top of Riser

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-14I Sh 1 of 2
Date Started 12/10/90 Completed 12/10/90 Ground Elev. 529.89
Total Depth 50.0 Feet Location Off-Site Logged by BEM
Remarks See Soil Boring Log MW-14S for 0-22 Foot Interval

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	1	40	22-24	1.3	Brown-gray, dense, fine to coarse sand and fine gravel, wet	25 Units strong organic odor
24	2	60	24-26	1.7		30 Units slight organic odor
26	3	31	26-28	1.7		30 Units slight organic odor
28	4	38	30-32	1.7	Brown, dense, fine to coarse sand, silty, wet	20 Units slight organic odor
30	5	23	32-34	1.3		25 Units slight organic odor
32	6	81	32-34	1.3	Brown, dense fine to coarse sand, trace of fine gravels, wet	20 Units slight organic odor
34	7	15	34-36	1.3		15 Units slight organic odor
36	8	15	36-38	1.5		10 Units slight organic odor
38	9	15	38-40	1.7	Brown, medium dense, fine sand, wet	8 Units slight organic odor
40	10	51	40-42	1.5		0.8 Units
42						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-14I Sh 2 of 2
Date Started 12/10/90 Completed 12/10/90 Ground Elev. 529.89
Total Depth 50.0 Feet Location Off-Site Logged by BEM
Remarks See Soil Boring Log MW-14S for 0-22 Foot Interval

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	11	41	42-44	1.5		1.0 Units
44					Brown, dense, fine to medium sand and fine gravel, wet	
	12	23	44-46	1.7		0 Units
46						
	13	27	46-48	1.5		0 Units
48						
	14	26	48-50	1.3		0 Units
50						

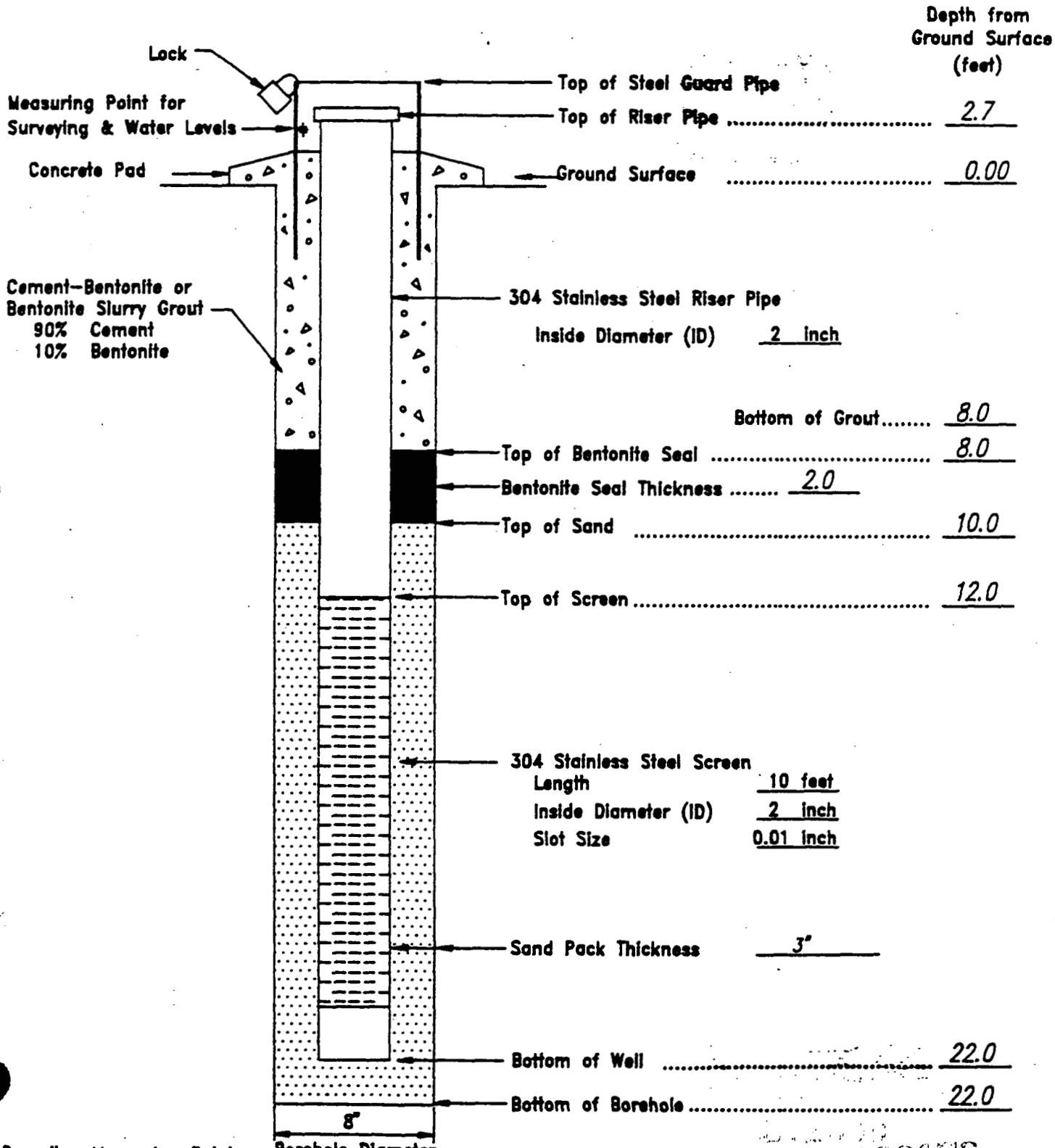
ENSR 000175 DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-15S
Well Location: RNCC
Date Of Installation: 3/9/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 531.73
Geologist/Engineer: B.E.M.
Project Number: 4700-016



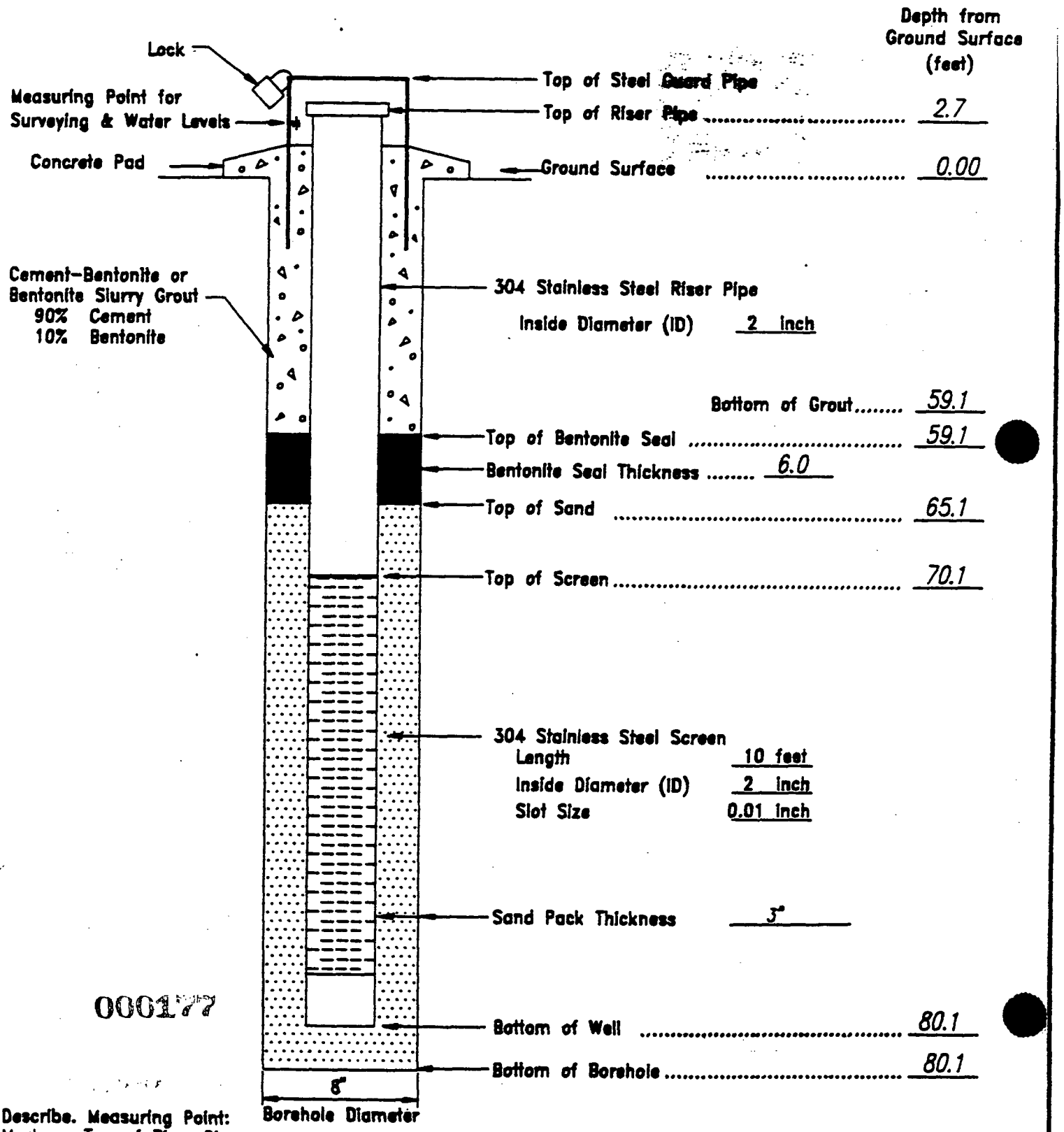
* Describe. Measuring Point: Mark on Top of Riser Pipe

000176

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-15D
Well Location: RNCC
Date Of Installation: 3/24/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 530.96
Geologist/Engineer: J.S.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000177

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-15D Sh 1 of 4
Date Started 3/22/90 Completed 3/22/90 Ground Elev. 528.4
Total Depth 81.0 Ft Location RNCC Logged by
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
23						
25						
27					Running sands No sample taken	
29						
31						
33						
35						
37						
39						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-15D Sh 2 of 4
Date Started 3/22/90 Completed 3/22/90 Ground Elev. 528.4
Total Depth 81.0 Ft Location RNCC Logged by M. Ferlin
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
41						
		20	41-43	1.5	Gray, fine to coarse sand, some silt, trace fine to coarse gravel, wet	40 Units
43						
		140	43-45	1.8		18 Units
45						
		70	45-47	2	Greenish-brown, fine gravel trace medium to coarse gravel, some silty clay	10 Units
47						
		70	47-49	2	Gray, fine silty sand, some clay, trace fine gravel, wet	20 Units
49						
		55	49-51	2	Gray, fine to coarse sand, trace fine gravel, wet	10 Units slight odor no visual
51						
		36	51-53	2		10 Units slight odor no visual
53						
		75	53-55	2		.6 Units solvent odor no visual
55						
		53	55-57	2		1.2 Units solvent odor no visual
57						

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-15D Sh 3 of 4
Date Started 3/22/90 Completed 3/22/90 Ground Elev. 528.4
Total Depth 81.0 Ft Location RNCC Logged by M.Ferlin
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
59		52	57-59	2	Gray, fine sand, trace of clay wet	1.4 Units Slight Odor
61		52	59-61	1.8		1.8 Units Slight Odor
63		41	61-63	1.4	Gray, fine to medium sand, some fine gravel, wet	0 Units Slight Odor
65		22	63-65	.9	Gray, medium to coarse sand and fine gravel, wet	1.2 Units Slight Odor
67		32	65-67	2		2.4 Units Slight Odor
69		4	67-69	1		0 Units Slight Odor
71		115	69-71	2		10 Units Slight Odor
73		38	71-78	2		20 Units Slight Odor
75		26	73-75	1.2	Gray, medium to coarse sand soem fine gravel, wet	11 Units Slight Odor

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-15D Sh 4 of 4
Date Started 3/22/90 Completed 3/22/90 Ground Elev. 529.7
Total Depth 81.0 Ft Location RNCC Logged by M.Cousino
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
77		87	75-77	2	Gray, meidum to coarse sand, wet	6.2 Units Slight Odor
79		91	77-79	2		1.8 Units Slight Odor
81		33	79-81	1.3		3.2 Units Slight Odor

000181

ENSR

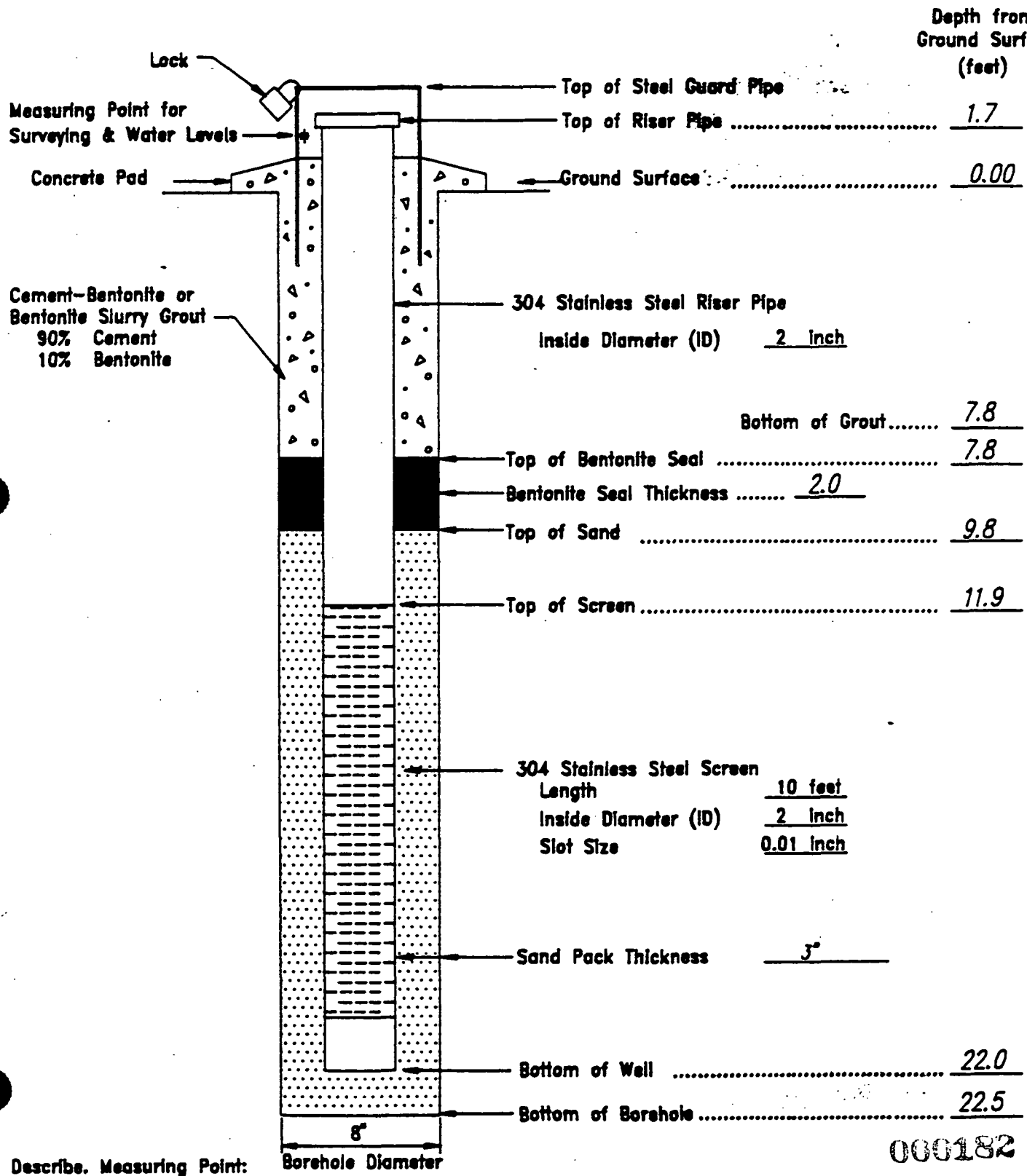
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-16S
Well Location: RNCC
Date Of Installation: 3/5/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 532.69
Geologist/Engineer: W.R.B.
Project Number: 4700-016



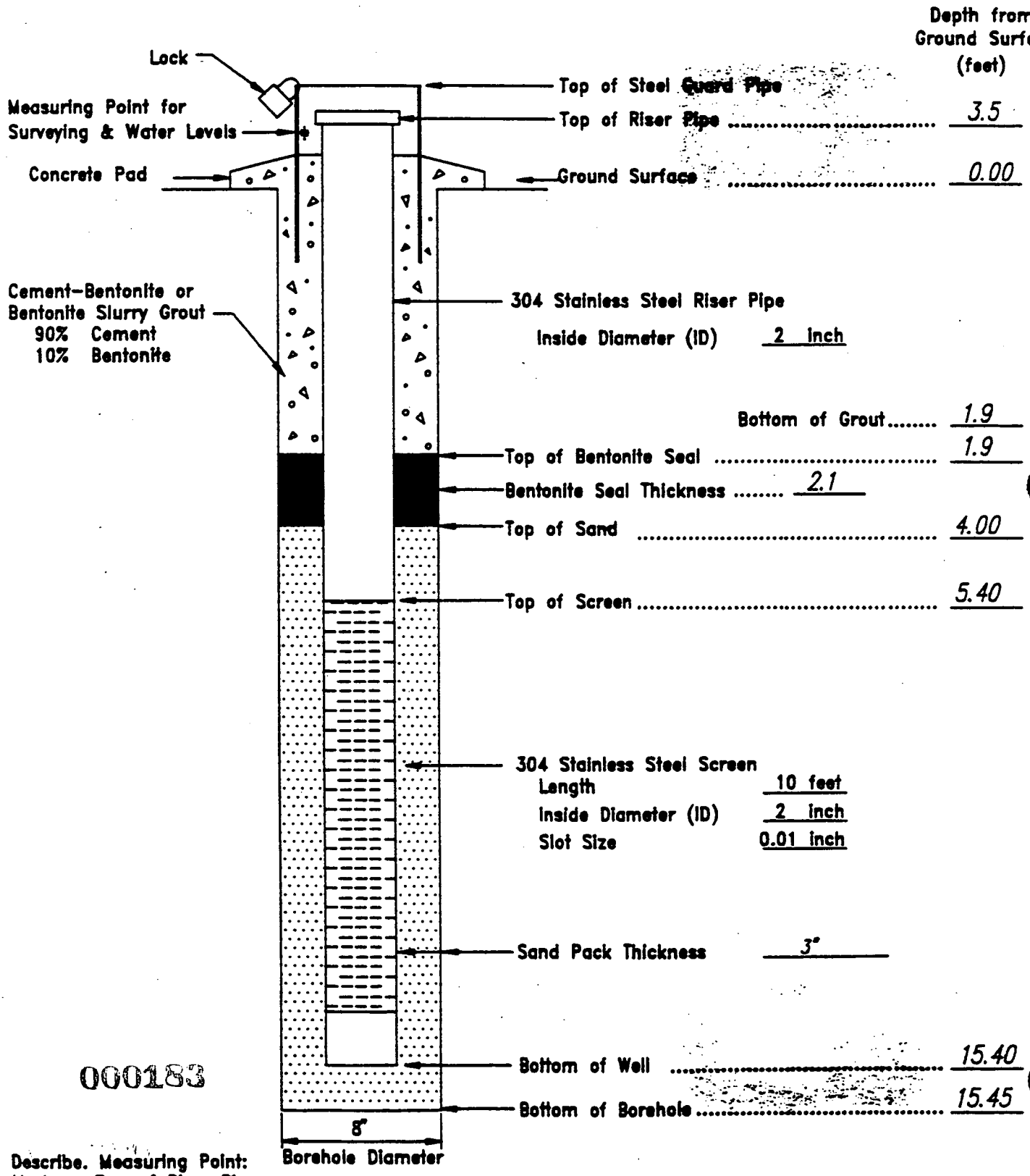
• Describe. Measuring Point: Mark on Top of Riser Pipe

000182

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-18S
Well Location: Off Site
Date Of Installation: 3/7/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 531.75
Geologist/Engineer: J.S.
Project Number: 4700-016



000183

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-18S Sh 1 of 1
Date Started 3/06/90 Completed 3/06/90 Ground Elev. 528.4
Total Depth 16.0 Ft Location Off Site Logged by J.Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	SS-1	16	0-2	1.7	Silt-sandy, fine grained, some clay, hard brown, moist	0 Units No odor
2	SS-2	9	2-4	1.5	Brown, fine sand and silt, moist	0 Units no odor
4	SS-3	36	4-6	1		4 Units no odor
6	SS-4	50	6-8	1.8		2 Units no odor
8	SS-5	70	8-10	2	Brown, fine to coarse sand with some medium gravels, trace of silt and clay	10 Units Petroleum Odor
10	SS-6	65	10-12	1.6	Gravels	10 Units Petroleum Odor
12	SS-7	80	12-14	2	Brown, fine to coarse sand, and fine gravels with trace ofsome silt and clay, wet	10 Units Petroleum Odor
14	SS-8	102	14-16	1.7		10 Units Petroleum Odor
16					Ground Water encountered at approimately 8.4 feet.	
18						

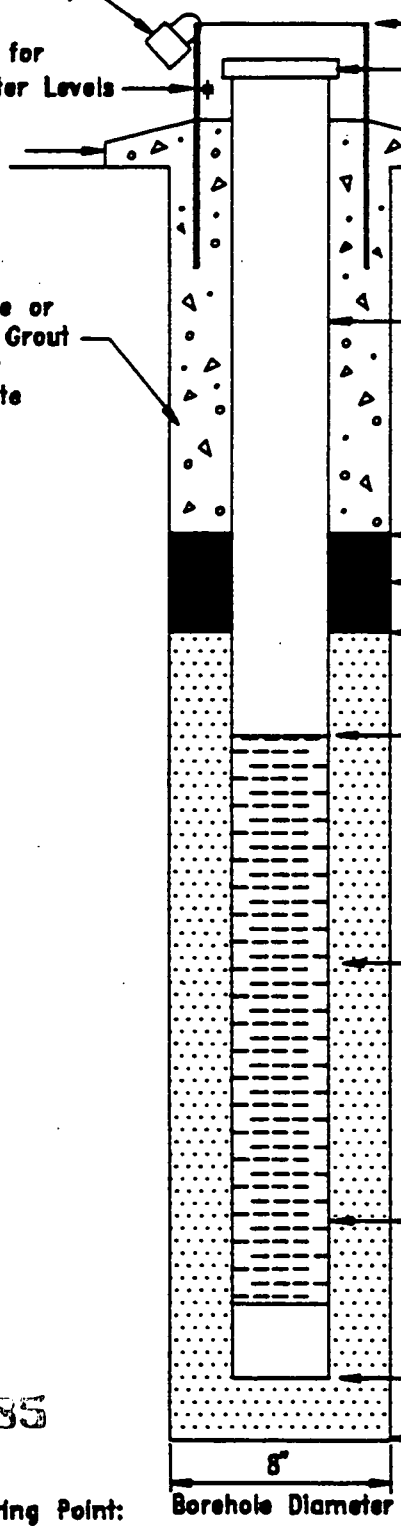
ENSR

DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-18D
Well Location: Off Site
Date Of Installation: 3/10/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 531.08
Geologist/Engineer: J.S.
Project Number: 4700-016



	Depth from Ground Surface (feet)
Lock	
Measuring Point for Surveying & Water Levels	
Concrete Pad	
Top of Steel Guard Pipe	
Top of Riser Pipe	2.72
Ground Surface	0.00
Cement-Bentonite or Bentonite Slurry Grout 90% Cement 10% Bentonite	
304 Stainless Steel Riser Pipe Inside Diameter (ID) 2 inch	
Bottom of Grout	59.90
Top of Bentonite Seal	59.90
Bentonite Seal Thickness 5.10	
Top of Sand	65.00
Top of Screen	68.27
304 Stainless Steel Screen Length 10 feet; Inside Diameter (ID) 2 inch; Slot Size 0.01 inch	
Sand Pack Thickness 3"	
Bottom of Well	78.27
Bottom of Borehole	78.34

000185

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-18D Sh 1 of 4
Date Started 3/08/90 Completed _____ Ground Elev. 528.3
Total Depth 79.0 Ft Location Off Site Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
					Logged previously at MW-18S	
16						
18	SS-1	67	16-18	1.8	Brown, medium to coarse gravel and fine to coarse sand, some silt and clay, wet	3 Units Petroleum Odor
20	SS-2	65	18-20	1.6	Brown to gray, fine to coarse sand some medium gravl , silt trace of clay	30 Units no odor
21	SS-3	44	20-22	1.6		.6 Units no odor
23	SS-4	12	21-23	0		.8 Units no odor
25	SS-5	42	23-25	1.8		.4 Units no odor
27	SS-6	40	27-28	2	Brown, fine to coarse sand, some silt and clay, trace of fine gravel, moist to wet	1.2 Units no odor
29	SS-7	43	28-29	2		2.2 Units no odor

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-18D Sh 2 of 4
Date Started 3/08/90 Completed _____ Ground Elev. 528.3
Total Depth 79.0 Ft Location _____ Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
31	SS-8	60	29-31	2	Brown, fine to medium sand, some fine gravel, some silt wet	2.2 Units
33	SS-9	75	31-33	1.8		3.8 Units
35	SS-10	-	33-35	2	Reddish-Brown, sand, fine to coarse, some silt, trace of clay, wet	2 Units
37	SS-11	50	35-37	1.8		0 Units
39	SS-12	50	37-39	2	Brown, fine to medium sand, trace medium gravel, wet	0 Units
41	SS-13	50	39-41	1.3	Brown, medium to coarse sand trace of fine gravel, trace of silt wet	0 Units
43	SS-14	65	41-43	1.9		0 Units
45	SS-15	35	43-45	1		0 Units
47	SS-16	50	45-47	1.7		0 Units

ENSR 000187

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-18D Sh 3 of 4
Date Started 3/08/90 Completed _____ Ground Elev. 528.3
Total Depth 79.0 Ft Location _____ Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
49	SS-17	24	47-49	1.7	Brown, fine to coarse sand, trace of fine gravel and silt, wet	0 Units
51	SS-18	62	49-51	1.7		0 Units
	SS-19	45	51-53	1.7	Brown, fine to coarse gravel, moist	0 Units
53					Brown, fine to coarse sand some silt, trace of clay, wet	
55	SS-20	50	53-55	1.7		0 Units
57	SS-21	46	55-57	1.6	Brown, fine to medium gravel, some medium sand, wet	0 Units
59	SS-22	50	57-59	1.8		0 Units
61	SS-23	74	59-61	1.6	Brown, fine to coarse sand, some gravel, trace of silt and clay, wet	0 Units
63	SS-24	85	61-63	1.7		3 Units Slight odor
65	SS-25	85	63-65	1.7		3 Units

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-18D Sh 4 of 4
Date Started 3/08/90 Completed _____ Ground Elev. 528.3
Total Depth 79.0 Ft Location Off Site Logged by J.Starkes
Remarks _____

Depth Feet	Sample: Split Spoon #	Blows Per 6"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
	SS-26	70	65-67	2		3.2 Units
67						
	SS-27	50	67-69	1.8		0 Units
69						
	SS-28	60	69-71	1.7		0 Units
71						
	SS-29	80	71-73	1.8		3.6 Units
73					Brown and gray, fine to coarse sand, some fine to medium gravel, some silt & clay, wet	
	SS-30	60	73-75	1.6		0 Units
75						
	SS-31	0	75-77	0	Brown to gray, very fine sand and silt, some clay	0 Units
77						
	SS-32	50	77-79	1.4	Sand, medium to coarse trace fine gravel, trace silt	1 Units
79						

ENSR 000189

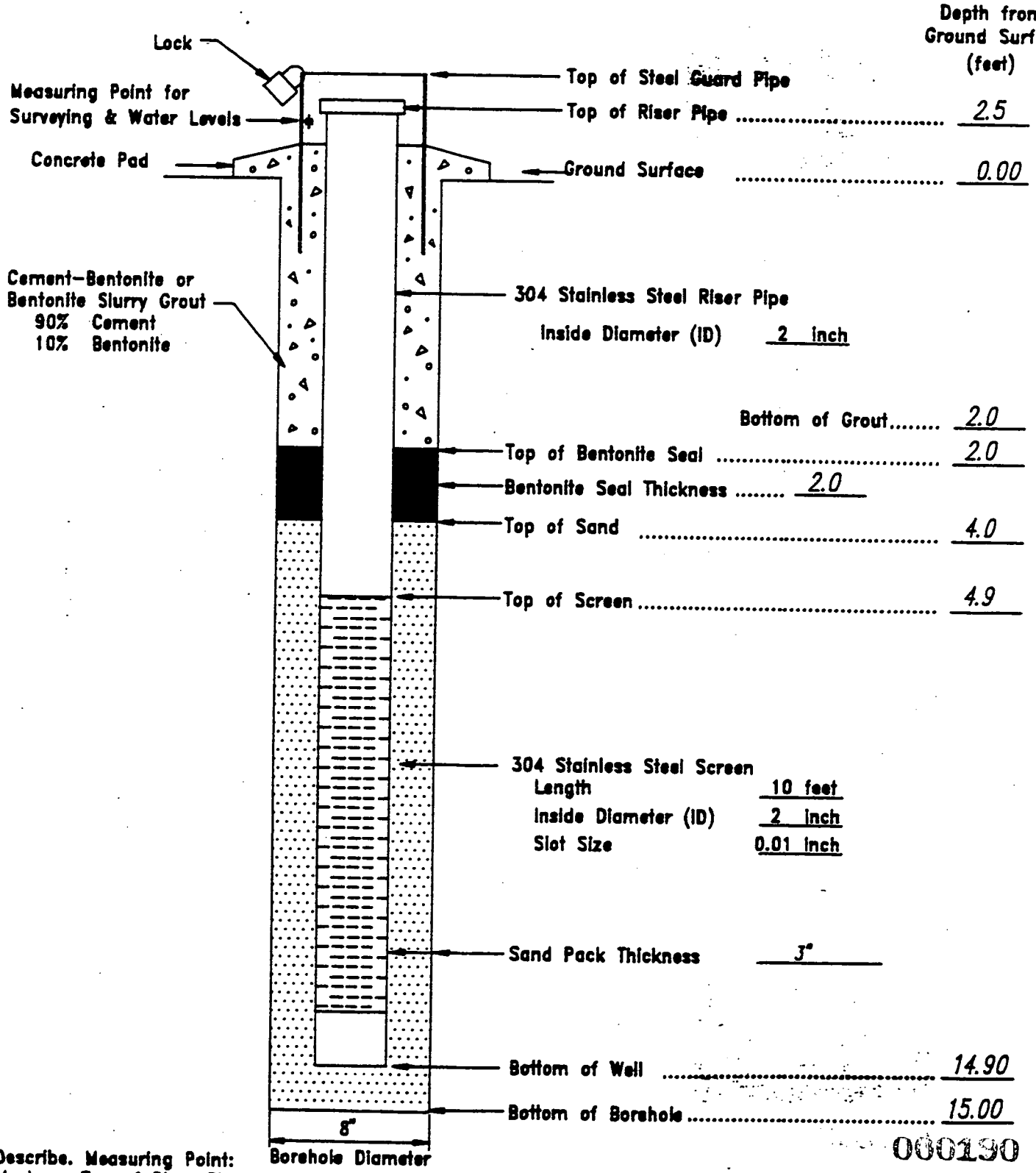
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-19S
Well Location: Off Site
Date Of Installation: 2/26/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 522.20
Geologist/Engineer: W.R.B.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000130

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-19S Sh 1 of 1
Date Started 2/26/90 Completed 2/26/90 Ground Elev. 519.0
Total Depth 16.0 Ft Location OFF SITE Logged by B.Berg
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2		2 6 6 5	0-2	.5	Topsoil, soft, dark brown moist	0 Units no odor no visual
4		6 10 21 23	2-4	.7	Medium stiff to stiff, brown clay	0 Units no odor no visual
6		4 6 9 9	4-6	.7		0 Units no odor no visual
8		5 5 9 10	6-8	1		0 Units no odor no visual
10		1 1 2 4	8-10	1	Loose to dense, brown, fine to medium sand and fine gravels, wet	0 Units no odor no visual
12		3 6 13 15	10-12	2		0 Units no odor no visual
14		13 18 15 22	12-14	2		0 Units no odor no visual
16		12 16 16 22	14-16	2		0 Units no odor no visual
					Ground Water encountered at approximately 7.5 feet	

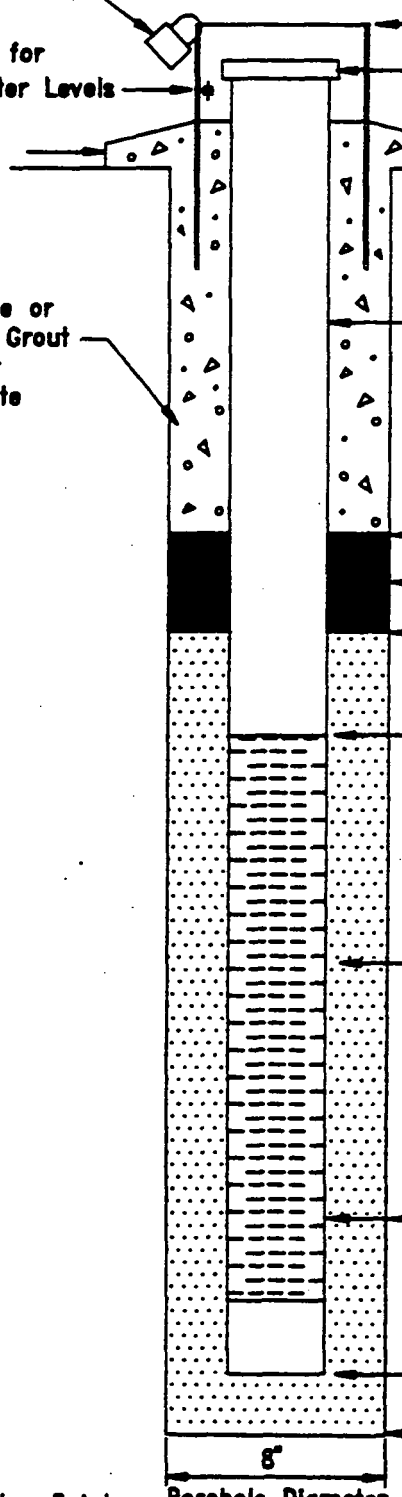
ENSR 000191

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-20S
Well Location: Off Site
Date Of Installation: 2/21/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 521.65
Geologist/Engineer: W.R.B.
Project Number: 4700-016



	Depth from Ground Surface (feet)
Lock	
Measuring Point for Surveying & Water Levels	
Concrete Pad	
Top of Steel Guard Pipe	
Top of Riser Pipe	3.0
Ground Surface	0.00
Cement-Bentonite or Bentonite Slurry Grout 90% Cement 10% Bentonite	
304 Stainless Steel Riser Pipe Inside Diameter (ID) 2 inch	
Bottom of Grout	2.0
Top of Bentonite Seal	2.0
Bentonite Seal Thickness	1.9
Top of Sand	3.90
Top of Screen	4.90
304 Stainless Steel Screen Length 10 feet; Inside Diameter (ID) 2 inch; Slot Size 0.01 inch	
Sand Pack Thickness	3"
Bottom of Well	15.15
Bottom of Borehole	15.15

* Describe. Measuring Point: Mark on Top of Riser Pipe

000192

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-20S Sh 1 of 1
Date Started 2/21/90 Completed 2/21/90 Ground Elev. 518.8
Total Depth 16.0 Ft Location Logged by B.BERG
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
		2 5 8 2	0-2	1	Top soil, soft, brown	0 Units No odor no visual
2		8 13 23 20	2-4	2	Stiff, brown, clay	0 Units No odor no visual
4		2 3 5 8	4-6	2		0 Units No odor no visual
6		4 9 24 25	6-8	2	Sandy	0 Units No odor no visual
8		10 24 35 60	8-10	1		0 Units No odor no visual
10			10-12	-	Dense to very dense, medium to coarse sand and fine to mediuum gravel, wet	No recovery
12			12-14	1		0 Units No odor no visual
14		5 10 23 18	14-16	2		0 Units No odor no visual
16					Ground Water encountered at approximately 7.5 feet.	

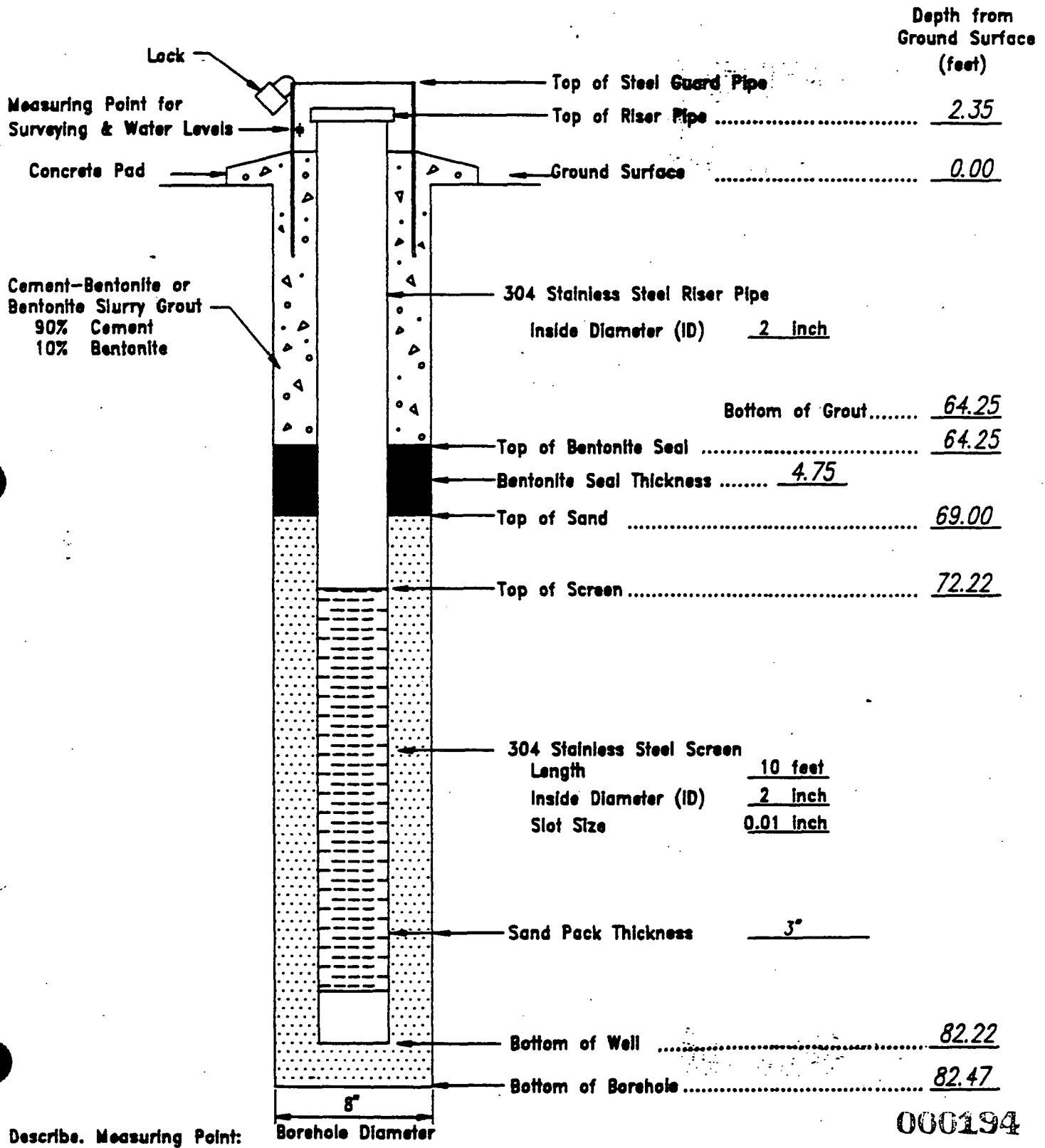
000193

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-20D
Well Location: Off Site
Date Of Installation: 2/26/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 521.31
Geologist/Engineer: J.S.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000194

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-20D Sh 1 of 4
Date Started 2/23/90 Completed 2/24/90 Ground Elev. 518.9
Total Depth 80.5 Ft Location Logged by M.Ferlin
Remarks See MW-20S Log for lithology above 16 ft.

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 24"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
16	1	50	16-18		Sand, fine to medium, some silt trace gravel, brown wet	0 Units No odor
18	2	45	18-20		Gravel, medium some sand and silt, brown saturated	0 Units No Odor
20	3	47	20-22	1	- some clay	0 Units No odor
22	4	49	22-24	1.3		0 Units No odor
24	5	51	24-26	1.2	Sand, coarse, and gravel trace clay	0 Units No odor
26	6		26-28	0		No recovery
28	7		30-31.5	0.3	Gravel and sand, brown and gray	0 Units No odor
30	8				Some clay	0 Units No odor
32						

ENSR 000195

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-20D Sh 2 of 4
Date Started 2/23/90 Completed 2/24/90 Ground Elev. 518.9
Total Depth 80.5 Ft Location Logged by M.Ferlin
Remarks See MW-20S Log for lithology above 16 ft.

Depth Feet	Sample: Split Spoon #	Blows Per 24"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
32	9	56	31.5-33.5	.7		0 Units No odor
33	10	76	33.5-35.5	1.3	Sand, medium to coarse, and gravel some clay, trace cobbles, gray	0 Units No odor
35	11		35.5 - 37.5	.7		0 Units No odor
37			37.5-40	0	No recovery, drilled through sample	No Recovery
39	12		40-42	1.3	Sand, fine, some gravel, gray saturated	0 Units No odor
41	13	75	42-44	1.6		0 Units No odor
43	14	45	44-46	1	Sand, medium to coarse, and gravel, some silt, trace cobbles, brown	0 Units No odor
45	15	85	46-48	1.6		
46						
49						

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-20D Sh 3 of 4
Date Started 2/23/90 Completed 2/24/90 Ground Elev. 518.9
Total Depth 80.5 Ft Location Logged by M.Ferlin
Remarks See MW-20S Log for lithology above 16 ft.

Depth Feet	Sample: Split Spoon #	Blows Per 24"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
48	16		48-50	1.5		0 Units No odor
50	17	20	50-52	.5	Sand, medium to coarse, some fine gravel, gray	0 Units No odor
52	18	80	52-54	1.5	Trace clay	0 Units No odor
54	19	67	54-56	1.5		No Recovery
56	20	55	56-58	1.5	Sand, fine to medium, trace clay, gray	0 Units No odor
58			58-60		No recovery, drilled through sample	
60	21	50	60-62	1.5	Sand, fine to medium some gravel, gray	0.8 Units No odor
62	22	120	62-64	1.5	Sand, medium to coarse, some gravel, fine, gray	0.6 Units No odor
64						

000197

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

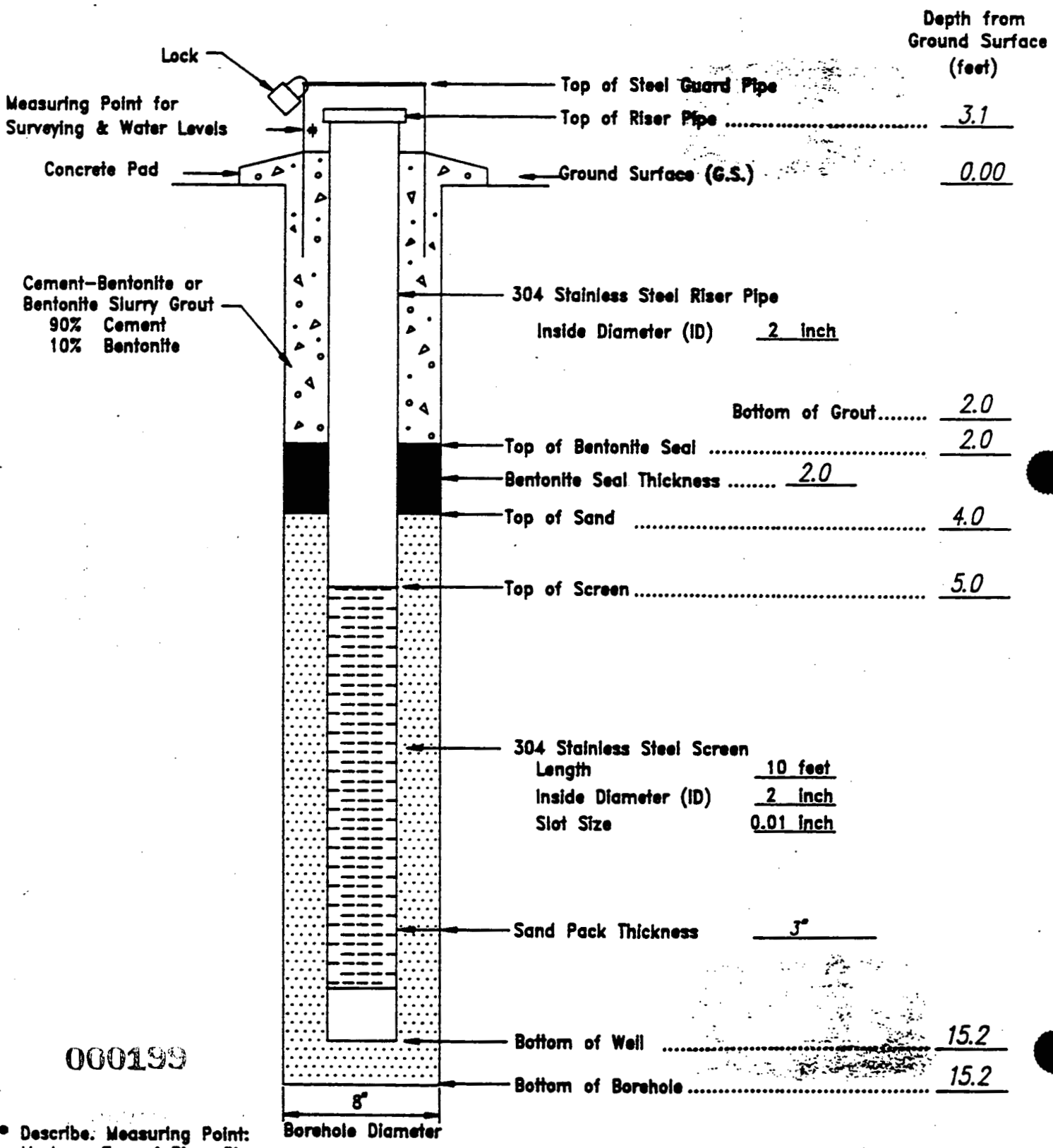
Project 4700-016 Site PRRS BORING MW-20D Sh 4 of 4
Date Started 2/23/90 Completed 2/24/90 Ground Elev. 518.9
Total Depth 80.5 Ft Location Logged by M.Ferlin
Remarks See MW-20S Log for lithology above 16 ft.

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 24"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
64	23	75	64-65	1.4		0.2 Units No odor
66	24	70	66-68	1		0 Units No odor
68	25	45	68-70	1.3		2.5 Units No odor
70	6	25	70-72	1.3		1.0 Units No odor
72	27	100	72-74	1.5		0 Units No odor
74	28	75	74-76	1.3	Sand, coarse, and gravel, fine gray	0 Units Natural Gas odor
76	29	100	76-78	1.3		0 Units No odor
78	30	80	78-80	1.5		Equipment Malfunction
79						
80						

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-21S
Well Location: Off Site
Date Of Installation: 3/14/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 521.90
Geologist/Engineer: W.R.B.
Project Number: 4700-016



000199

• Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-21S Sh 1 of 1
Date Started 2/26/90 Completed 2/28/90 Ground Elev. 518.7
Total Depth 16.0 Ft Location Off-Site Logged by B.BERG
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
		2 4 9 11	0-2	.75	Top soil, clayey, stiff brown	0 Units No odor
2		6 12 15 17	2-4	.75	Soft-to stiff, brown to green-gray, clay	0 Units No odor no visual
4		7 11 17 17	4-6	1		0 Units No odor no visual
6		4 3 4 5	6-8	1		0 Units No odor no visual
8		2 1 1 2	8-10	2		0 Units No odor
10		9 17 22 19	10-12	2		200 Units Strong odor dark stain at 11 feet
12		9 11 17 21	12-14	1.7	Dense, brown, medium to coarse sand, and fine gravels, wet	100 Units Strong odor dark stain
14		21 39 17 18	14-16	1.7		300 Units Strong odor dark stain
16					Ground Water encountered at approximatley 9 feet.	

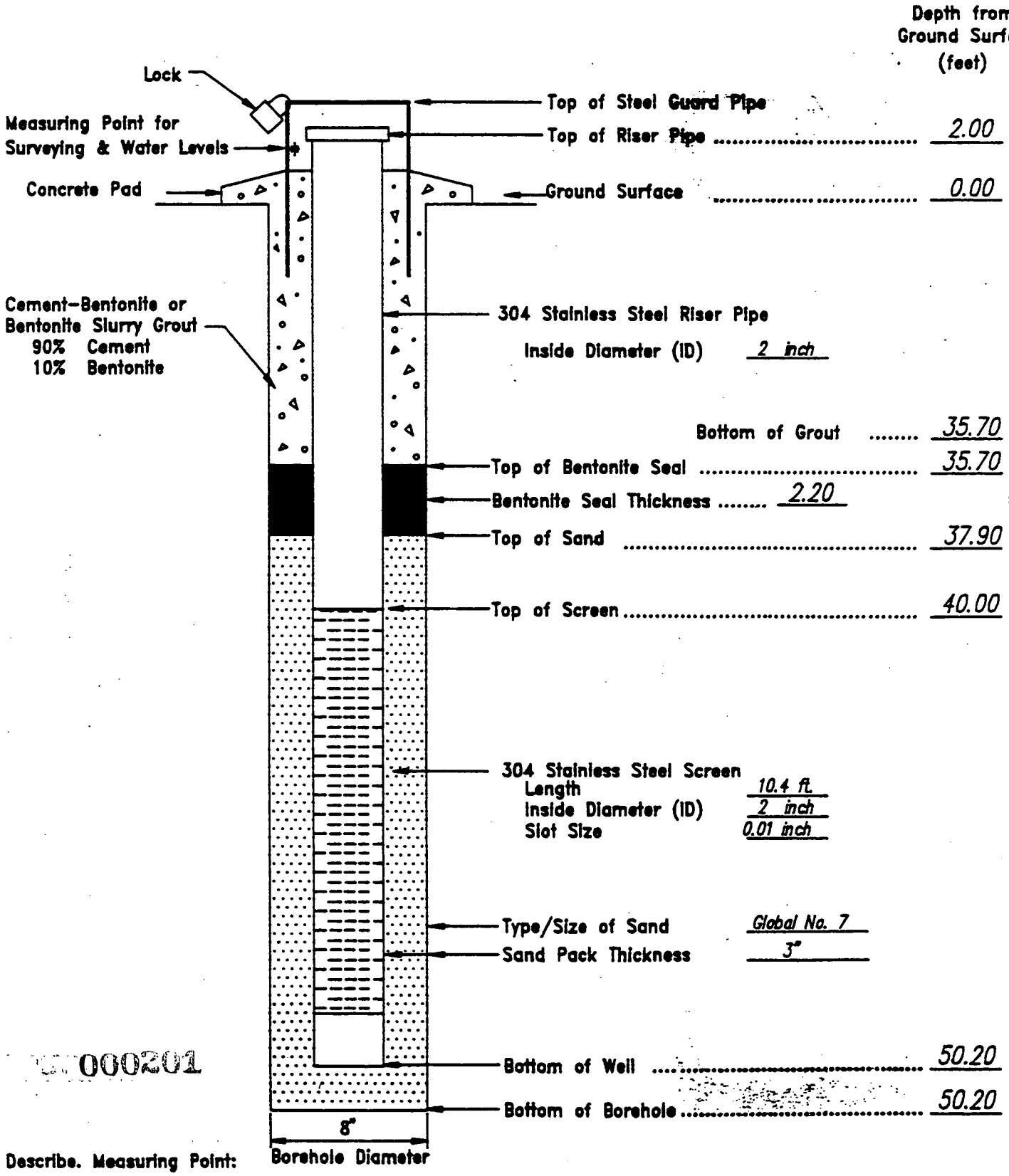
000200

DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-21I
Well Location: Off-Site
Date Of Installation: 12/10/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 520.45
Geologist/Engineer: M.A.F.
Project Number: 4700-062



000201

* Describe. Measuring Point:

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-21I Sh 1 of 1
Date Started 12/18/90 Completed 12/10/90 Ground Elev. 518.55
Total Depth 50 Feet Location Off-Site Logged by
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 2 ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units)
					See Soil Boring Logs From MW-21S and MW-21D For Geologic Record at Location MW-21I	

ENSR

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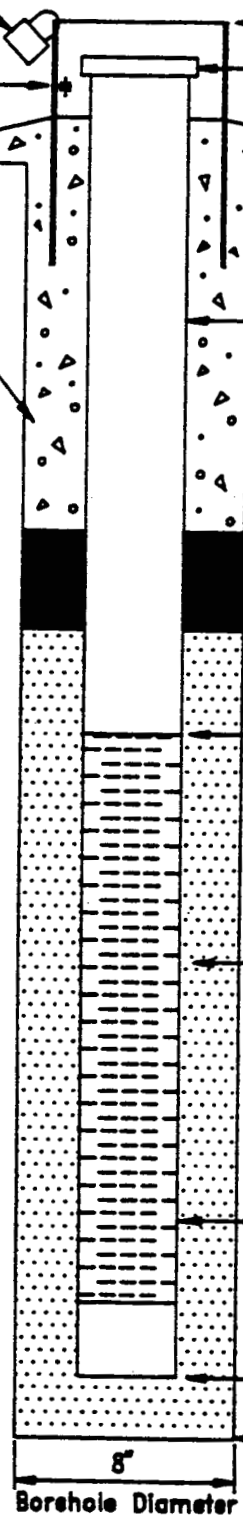
MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-21D
Well Location: Off Site
Date Of Installation: 3/14/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 521.00
Geologist/Engineer: J.S.
Project Number: 4700-016



	Depth from Ground Surface (feet)
Lock	
Measuring Point for Surveying & Water Levels	
Concrete Pad	
Top of Steel Guard Pipe	
Top of Riser Pipe	2.88
Ground Surface	0.00
Cement-Bentonite or Bentonite Slurry Grout 90% Cement 10% Bentonite	
304 Stainless Steel Riser Pipe Inside Diameter (ID) 2 inch	
Bottom of Grout	61.00
Top of Bentonite Seal	61.00
Bentonite Seal Thickness 7.0	
Top of Sand	68.00
Top of Screen	71.39
304 Stainless Steel Screen Length 10 feet; Inside Diameter (ID) 2 inch; Slot Size 0.01 inch	
Sand Pack Thickness 3"	
Bottom of Well	81.39
Bottom of Borehole	81.43

* Describe. Measuring Point: Mark on Top of Riser Pipe

000203

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-21D Sh 1 of 4
Date Started 3/13/90 Completed 3/14/90 Ground Elev. 518.5
Total Depth 80.0 Ft Location Logged by J. Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Blows Per 24"	Depth Range	Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
16–17	1	20	16-18	1.5	Sand, medium to coarse some clay and silt, greenish -brown, black staining	100 Units Slight Odor
18–19	2	36	18-20	0.7		20 Units Slight odor
20–21	3	25/1"	20-21	1.0	Sand, fine to medium, some fine gravel, some clay, greenish-brown, some black staining wet.	70 Units
22–23	4	50	21-23	2.0		56 Units Slight odor
24–25	5	59	23-25	1.7		3 Units No odor
26–27	6	29	25-27	1.1		7 Units No odor
28–29	7	65	27-29	1.7	Sand, fine, trace coarse, some clay, trace medium gravel, trace silt, brown, wet	26 Units slight odor
30–31	8	65	29-31	2.0		4 Units

DRAFT

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-21D Sh 2 of 4
Date Started 3/13/90 Completed 3/14/90 Ground Elev. 518.5
Total Depth 80.0 Ft Location Logged by J. Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 24"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
31	9	100	31-33	2	Sand, fine to coarse, trace fine gravel, some silty brown, wet	25 Units
33	10	90	33-35	2		12 Units
35	11	80	35-37	2		18 Units
37	12	73	37-39	1.7	Sand, fine to medium, some clay, some gravel, trace silt, gray, wet	40 Units Strong Odor
39	13	70	39-41	1.7		20 Units Slight odor
41	14	65	41-43	2		9 Units No odor
43	15	90	43-45	2		40 Units Slight odor
45	16	81	45-47	2		18 Units Slight odor
47						

000205

DRAFT

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-21D Sh 3 of 4
Date Started 3/13/90 Completed 3/14/90 Ground Elev. 518.5
Total Depth 80.0 Ft Location Logged by J. Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 24"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
47	17	100	47-49	2		7 Units
49	18	39	49-51	1.5	Gravel, fine, some sand, fine to coarse, gray to brown, wet	18 Units Slight odor
51	19	89	51-53	2	Sand, fine to medium, some Gravel, medium, some clay, trace silt, brown to gray wet	3 Units slight odor
53	20	76	53-55	2		3 Units Slight odor
55	21	60	55-57	1.8		1 Unit slight odor
57	22	64	57-59	1.9		2 Units slight odor
59	23	41	59-61	1.7	Sand, fine, some silt, gray moist	1 Unit
61	24	75	61-63	1.5		2 Units
63						

DRAFT

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-21D Sh 4 of 4
ate Started 3/13/90 Completed 3/14/90 Ground Elev. 518.5
Total Depth 80.0 Ft Location Logged by J. Starkes
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 24"	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
63	25	75	63-65	1.7		18 Units
65	26	68	65-67	1.5		18 Units
67	27	60	67-69	2	Gravel, fine to coarse, some sand, fine to coarse, brownish-gray, wet	3 Units
69	28	60	69-71	1.6	Sand, fine, some silt, trace clay, brownish-gray, moist to wet	2 Units
71	29	60	71-73	1.8		10 Units
73	30	75	73-75	1.7	Gravel, fine some sand, fine to medium, some clay, brownish-gray, wet	14 Units
75	31	80	75-77	1.6	Sand, coarse, some gravel, fine to medium, trace clay, brownish-gray, moist to wet	8 Units
77	32	65	77-79	1.5		6 Units
79	33	35/1'	79-80	0.8		4 Units
80						

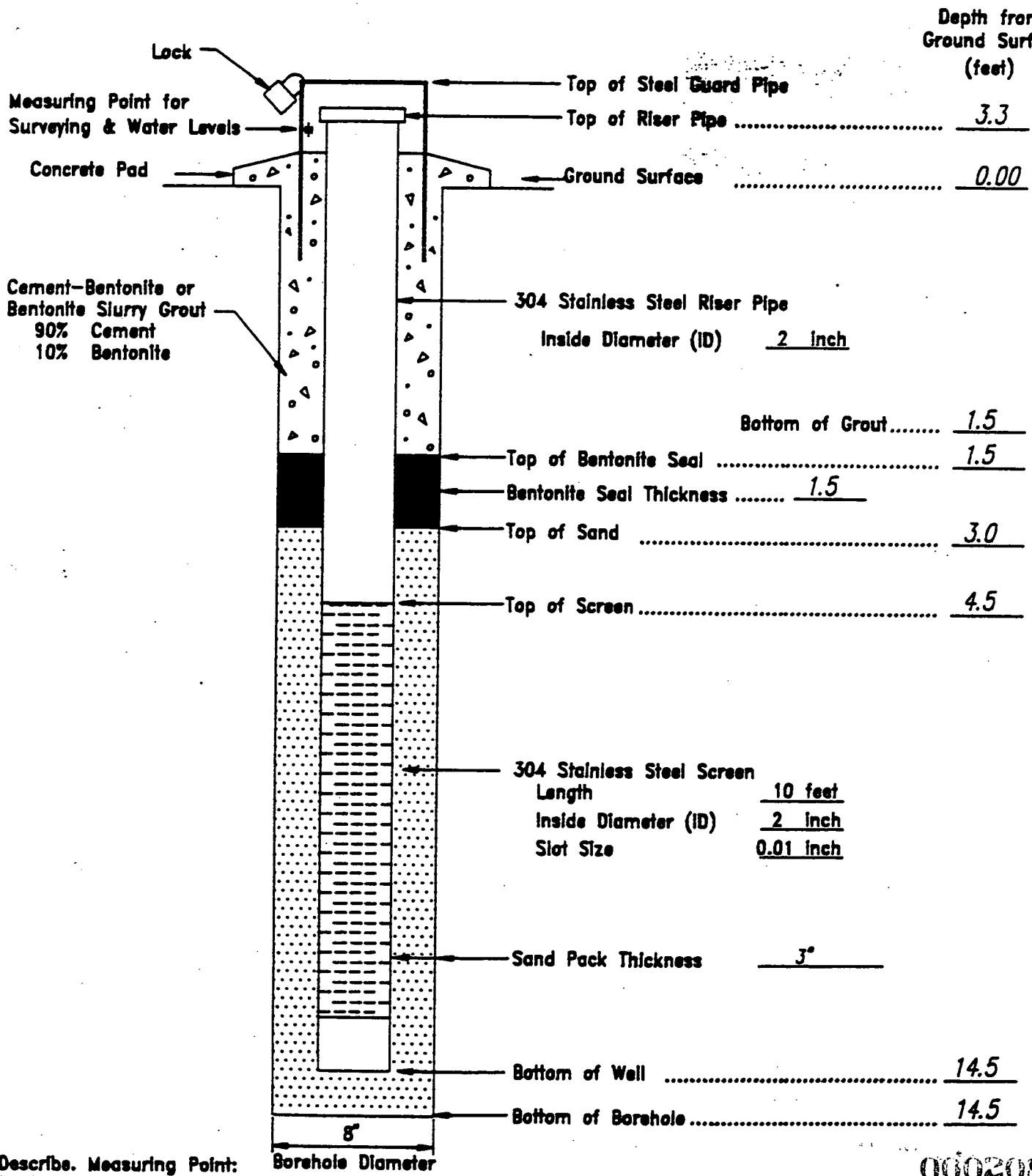
000207

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-22S
Well Location: Off Site
Date Of Installation: 3/14/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 520.41
Geologist/Engineer: M.A.F.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000208

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS BORING MW-22S Sh 1 of 1
Date Started 3/14/90 Completed 3/14/90 Ground Elev. 517.0
Total Depth 14.0 Ft Location OFF-SITE Logged by M.Ferlin
Remarks

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	1 1 2 3	0-2	0.3		0 Units No odor no visual
4	02	2 2 4 3	2-4	0.6	Soft, brown, clay and silt, moist	0 Units No odor no visual
6	03	1 2 2 2	4-6	1.5		0 Units No odor no visual
8	04	2 4 2 4	6-8	1.5		0 Units No odor no visual
10	05	1 2 4 3	8-10	1.1		0 Units No odor no visual
12	06	2 4 4 3	10-12	1.1		0 Units No odor no visual
14	07	3 6 6 3	12-14	0.6	Loose, medium to coarse sand and fine gravels with cobbles, wet	0 Units No odor no visual
16					Ground Water encountered at approximately 7.0 feet	

000209

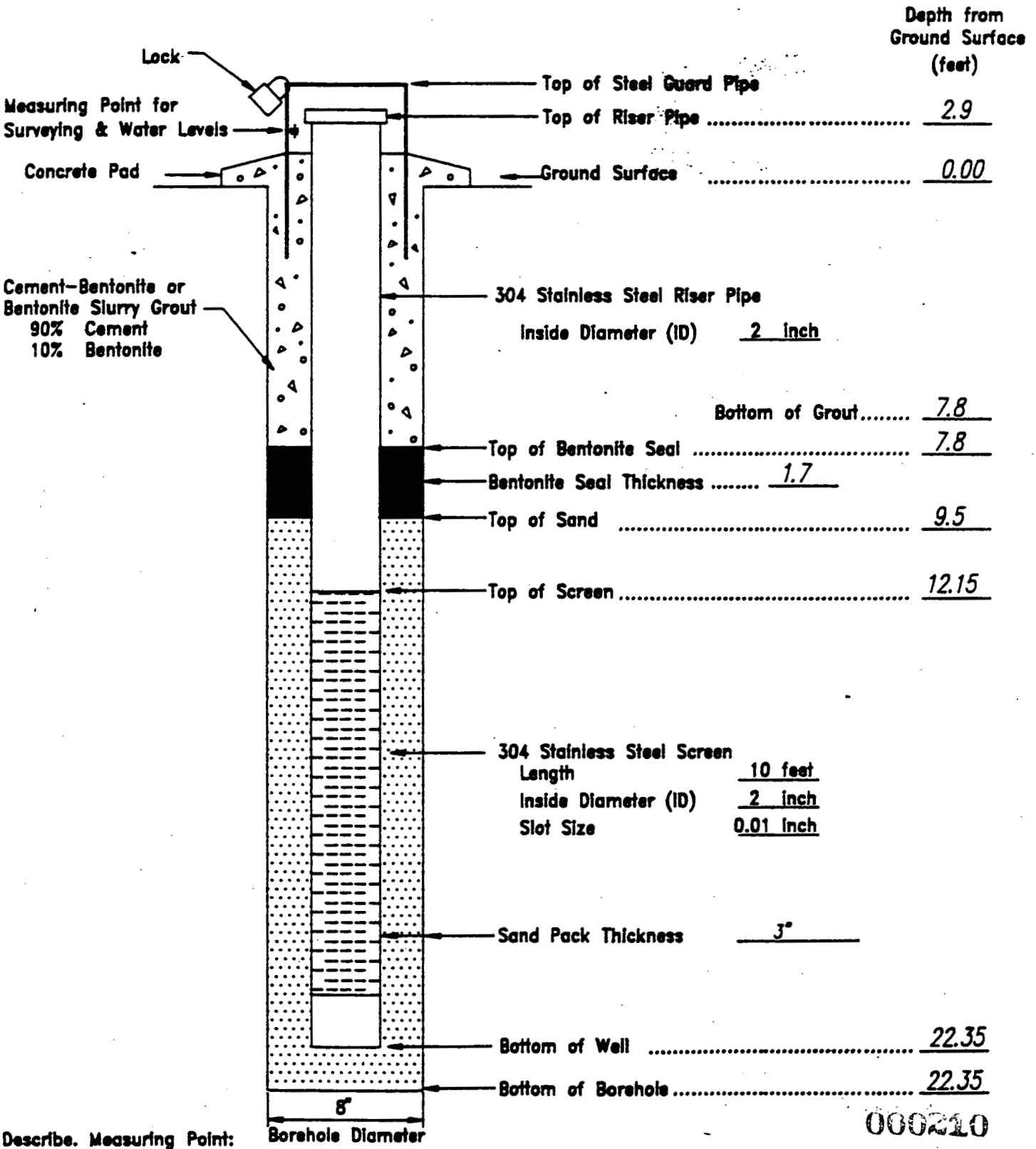
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-23S
Well Location: Off Site
Date Of Installation: 6/14/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 526.15
Geologist/Engineer: M.A.F.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000210

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-23S Sh 1 of 1
Date Started 2/26/90 Completed 2/26/90 Ground Elev. _____
Total Depth 6.0 Ft Location Off-site Logged by M.Ferlin
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	4 7 7 20	0-2	1.1	Medium, stiff, brown, silt and clay	0 Units No odor
4	02	4 5 5 5	2-4	1.3	Medium stiff, tan, silt and fine sand, moist	0 Units No odor no visual
6	03	4 4 4 5	4-6	2	Loose, tan, fine sand with some silt, moist	0.2 Units No odor no visual
8	04	31 20 14 21	6-8	2		0.4 Units No odor no visual
10	05	7 4 21 26	8-10		Very dense, gray, medium, to coarse sand and gravel, moist to wet	3.2 Units Natural Gas Odor no visual
12	06	6 36 65 25/1"	10-12	1.5		7.0 Units No odor no visual
14	07	28 38 78/6"	12-14	1.1		0.6 Units No odor no visual
16	08	18 17 26 76	14-16	1.3		1.6 Units No odor no visual
18	09	16 54 102/6"	16-18	1.5		6.4 Units No odor no visual
20	10	43 26 16 12	18-20	1.2		3.0 Units No odor no visual
22	11		20-22	2	Very dense, brown, medium, to coarse sand with trace of gravel, wet	0.8 Units No odor no visual

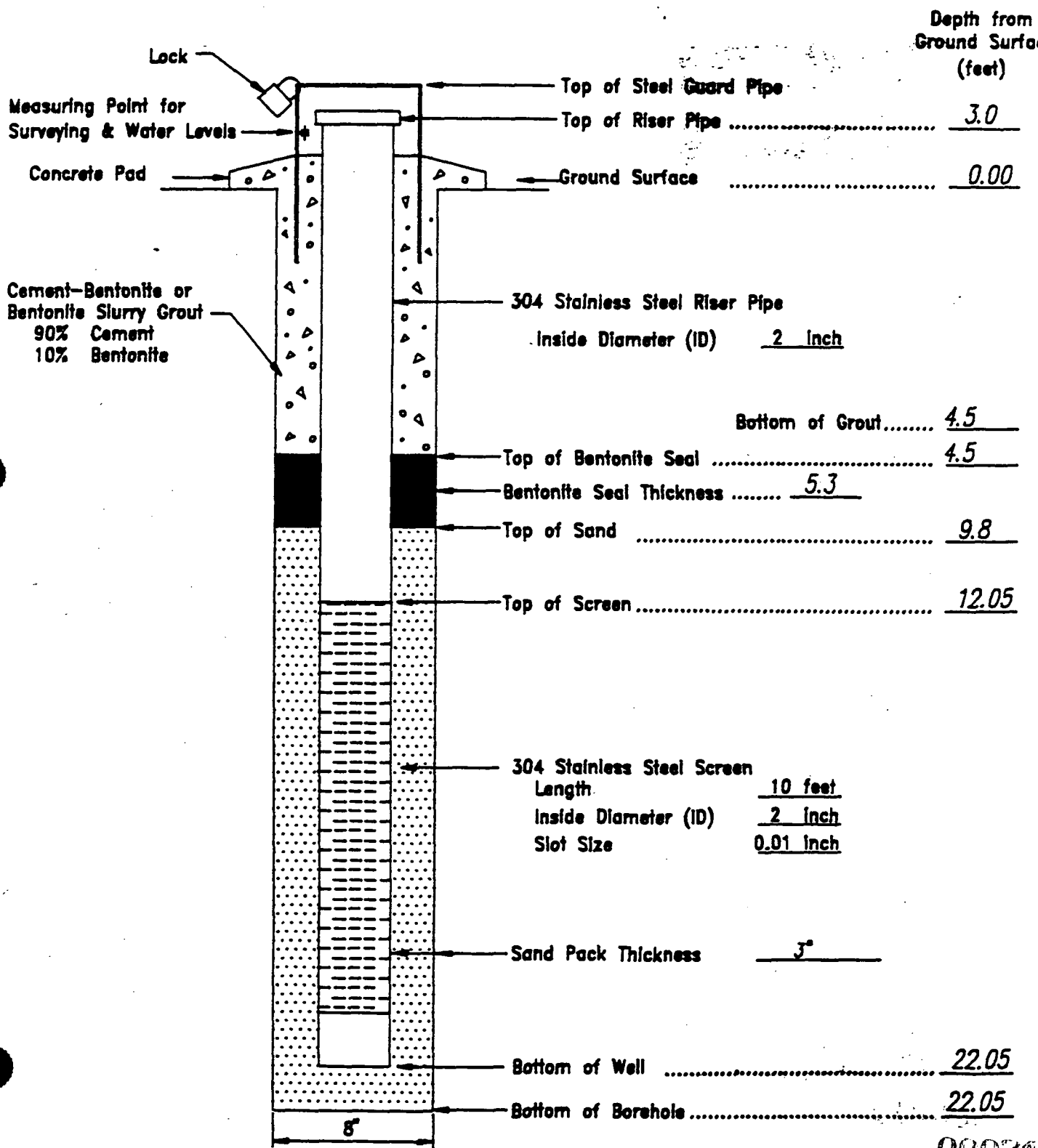
Ground Water encountered at approximately 15 feet.

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-24S
Well Location: Off Site
Date Of Installation: 6/13/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Hollow Stem Auger
Top Of Casing Elev.(MSL): 524.28
Geologist/Engineer: M.A.F.
Project Number: 4700-016



* Describe. Measuring Point: Mark on Top of Riser Pipe

000212

SOIL BORING LOG
PADDY'S RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-016 Site PRRS **BORING** MW-24S Sh 1 of 1
Date Started 6/13/90 Completed 6/13/90 Ground Elev. _____
Total Depth 22.0 Ft Location Off-site Logged by M.Ferlin
Remarks _____

Depth Feet	Sample: Split Spoon #	Sample: Blows Per 6	Sample: Depth Range	Sample: Rec. (Ft)	Lithologic Description	OVA Readings (in Units) & Remarks
2	01	4 6 4 5	0-2	0.8	Soft, brown, silt and clay	0 Units No odor no visual
4	02	3 3 3 4	2-4	2	Soft, tan, silt with some fine sand	0 Units No odor no visual
6	03	3 3 7 20	4-6	2		0.2 Units Natural Gas Odor no visual
8	04	15 26 45 62	6-8	1		1.0 Units Natural Gas Odor no visual
10	05	26 62 68/2"	8-10	0.8	Very dense, gray to tan, medium to coarse sand with some fine gravel, wet	0.8 Units Natural Gas Odor no visual
12	06	45 47 60/6"	10-12	1.1		2.2 Units Natural Gas Odor no visual
14	07	12 24 12 78	12-14	1.4	Dense, gray, medium to coarse sand and fine gravel, wet	0.6 Units Natural Gas Odor no visual
16	08	24 35 41 31	14-16	0.9		42 Units Natural Gas Odor no visual
18	09	13 14 17 20	16-18	1.0		78 Units Natural Gas Odor no visual
20	10	31 14 17 20	18-20	1.1		28 Units Natural Gas Odor no visual
22	11		20-22	2		42 Units Natural Gas Odor no visual

000213

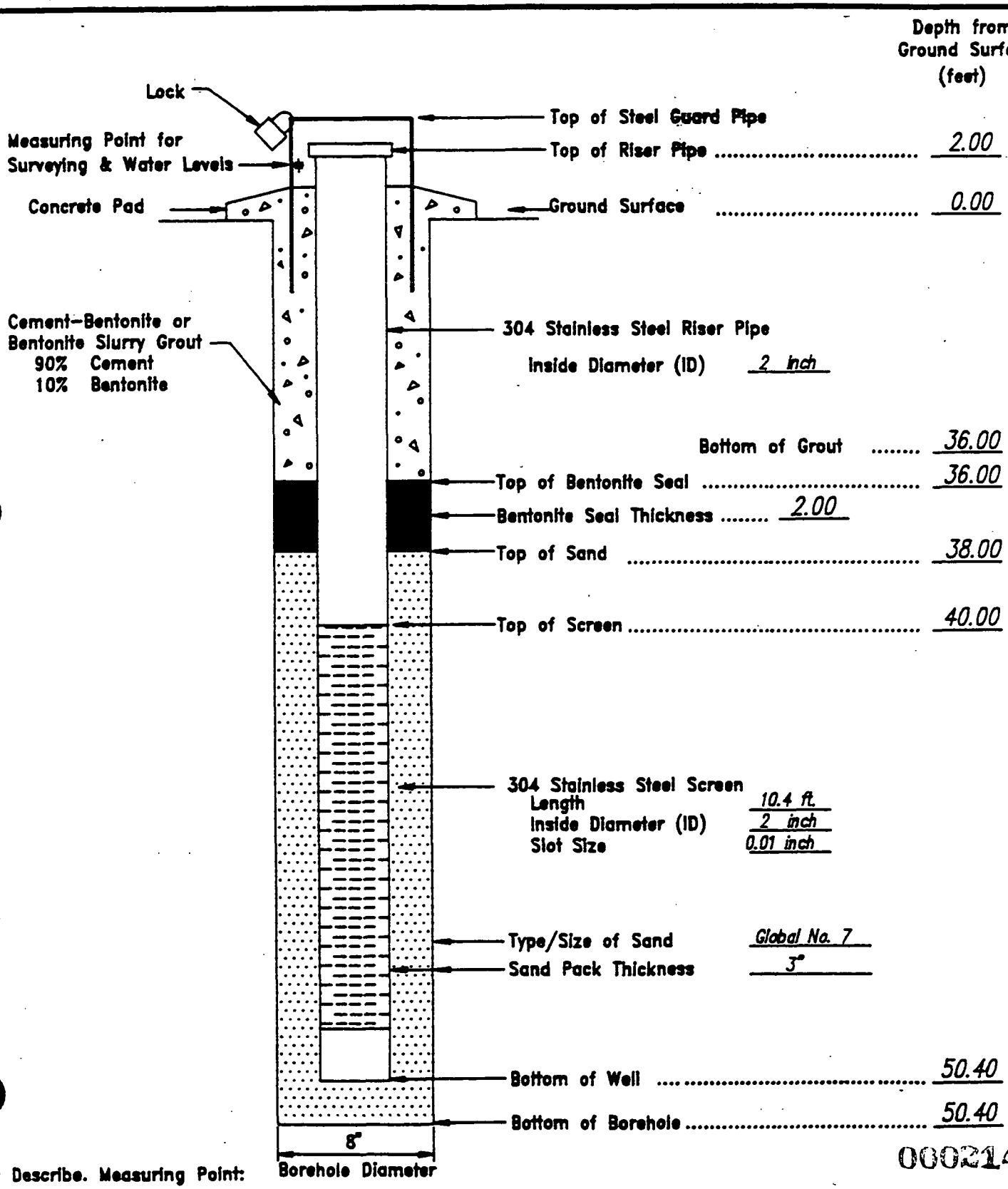
Ground Water encountered at approximately 14.6 feet.

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-24I
Well Location: Off-Site
Date Of Installation: 12/11/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 523.38
Geologist/Engineer: B.E.M.
Project Number: 4700-062



* Describe. Measuring Point:

000214

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-24I Sh 1 of 2
ate Started 12/10/90 Completed 12/11/90 Ground Elev. 521.31
.otal Depth 50.0 Feet Location Off-Site Logged by MAF
Remarks See Soil Boring Log MW-24S for 0-24 Foot Interval

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
24	1	100	24-26	1.0	Gray to dark gray, very dense, medium to coarse sand, fine to coarse gravel, and cobbles, with some silt, wet	120 Units moderate organic odor
26	2	-	26-28	-		Drilled through this interval
28	3	48	28-30	0.8	Gray, medium dense to dense, medium to coarse sand and fine gravels, with trace of silt, wet	30 Units slight organic odor
30	4	29	30-32	1.4		120 Units slight organic odor
32	5	18	32-34	1.1	Gray, medium dense, medium to coarse sand and fine to coarse gravels, with some silt, wet	20 Units slight organic odor
34	6	20	34-36	1.2		38 Units very slight organic odor
36	7	54	36-38	1.4	Gray, very dense, medium to coarse sand trace of silt wet	58 Units no odors
38	8	62	38-40	1.6		24 Units no odors
40	9	16	40-42	1.0		12 Units no odors
42	10	18	42-44	1.3		18 Units no odors
44						

ENSR 000215 DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-24I Sh 1 of 2
Date Started 12/10/90 Completed 12/11/90 Ground Elev. 521.31
Total Depth 50.0 Feet Location Off-Site Logged by MAF
Remarks See Soil Boring Log MW-24S for 0-24 Feet Interval.

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
46	11	8	44-46	0.8	Gray, medium dense, medium to coarse sand and fine to coarse gravels trace of silt, wet (running sands)	4 Units no odors
48	12	-	46-48	0.7	Brown, loose, medium to coarse sand and fine gravels, some silt, wet	7 Units no odors
50	13	10	48-50	0.7	Gray, loose, medium to coarse sand, some fine gravels, wet	1.8 Units no odors

ENSR

DRAFT

LOCATION MAP

ERM—MIDWEST WELL LOG

BORE NUMBER ►	MW-24D	LOCATION ►	PRRS - Fernald, Ohio
DATE ►	10/21/91	WEATHER ►	Clear, Cool
LOGGED BY ►	P.L.G.	DRILLED BY ►	Mathes & Associates
DRILLING METHOD ►	4 1/4" Hollow Stem Auger	SAMPLING METHOD ►	Drill Cuttings
ELEVATION ►	T.O.C. 523.46 FT. Ground 521.58 FT.	GRAVEL PACK ►	#7 80-68 FT.
SEAL ►	Bentonite Slurry 68-4.5 FT.		

CASING ► TYPE 306 S.S.	DIAMETER 2 IN. LENGTH 70 FT.	WATER LEVEL INITIAL 25.0 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8 IN.
SCREEN ► TYPE 306 S.S.	SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 10 FT.	WATER LEVEL AT COMPLETION 25.0 FT. H.M.P.	TOTAL DEPTH 80 FT.

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG	WELL COMPLETION
						0			0-50 FT IS DESCRIBED IN SOIL BORINGS MW-24S AND MW-24I		GROUT
						1					GROUT
						2					
						3					
						4					
						5					BENTONITE SLURRY
						6					STAINLESS STEEL RISER
						7					
						8					
						9					
						10					BENTONITE SLURRY
						11					
						12					
						13					
						14					
						15					
						16					
						17					
						18					
						19					
						20					

000217

PROJECT\539-13\5391324D.DWG

WELL NUMBER ▶ **MW-24D**

ERM—MIDWEST WELL LOG

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG	WELL COMPLETION
						20					BENTONITE SLURRY
						21					STAINLESS STEEL RISER
						22					
						23					
						24					
						25					
						26					
						27					
						28					
						29					
						30					
						31					
						32					
						33					
						34					
						35					
						36					
						37					
						38					
						39					
						40					
						41					
						42					
						43					
						44					
						45					BENTONITE SLURRY

PROJECT\539-13\5391324D.DWG

WELL NUMBER ▶ **MW-24D**

ERM–MIDWEST WELL LOG

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG	WELL COMPLETION
						45					
						46					
						47					
						48					
						49					
						50			Because of heaving sands no split spoon samples could be collected. Therefore, the lithology was described from the cuttings. SAND and GRAVEL.		
						51					
						52					
						53					
						54					
						55					BENTONITE SLURRY; STAINLESS STEEL RISER; BENTONITE SLURRY
						56					
						57					
						58					
						59					
						60					
						61					
						62					
						63					
						64					
						65					
						66					
						67					
						68					SAND PACK; SAND PACK
						69					
						70					

000219

PROJECT\539-13\5391324D.DWG

WELL NUMBER ▶ **MW-24D**

ERM—MIDWEST WELL LOG

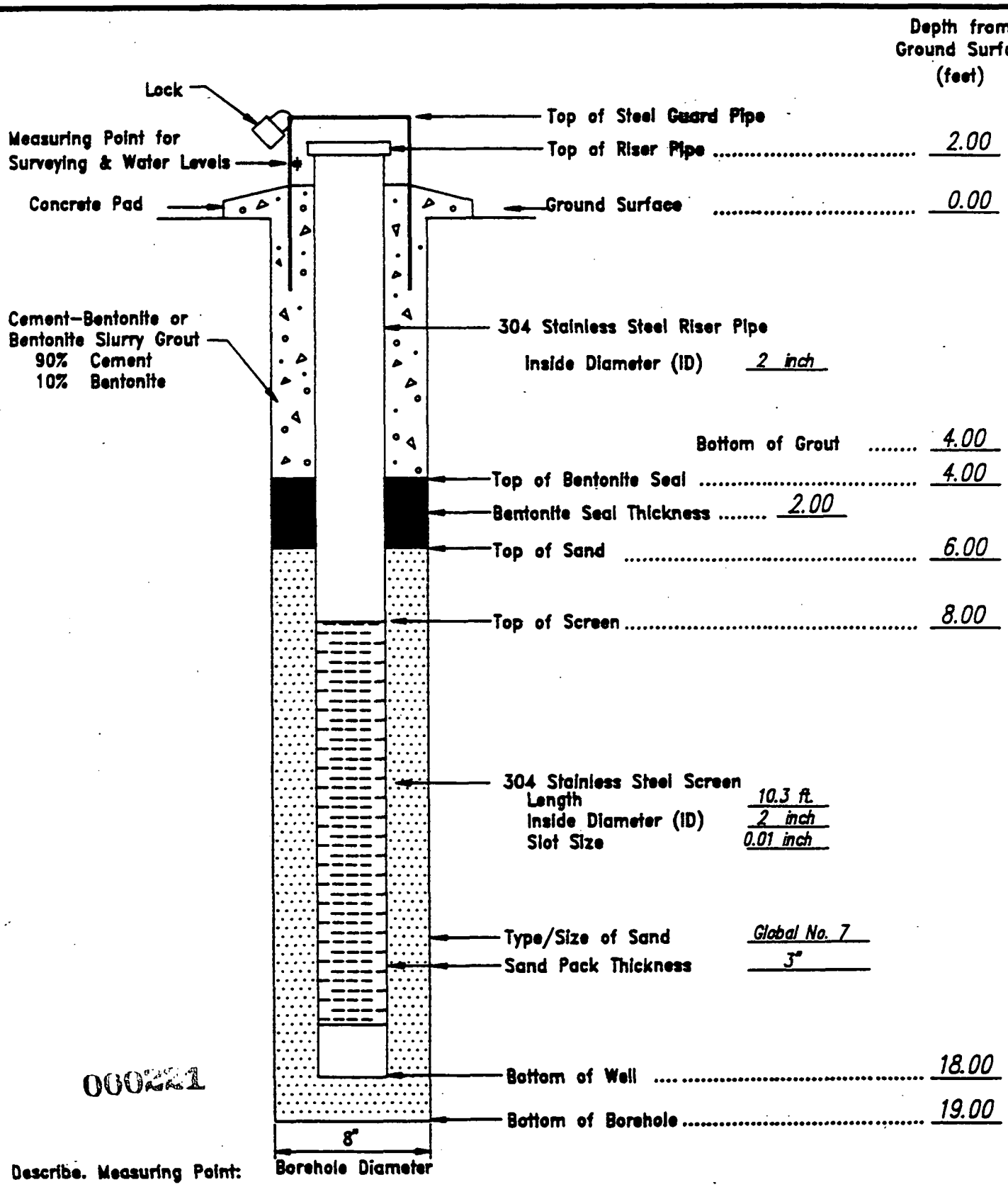
MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG	WELL COMPLETION
						70			SAND and GRAVEL		SAND PACK / STAINLESS STEEL SCREEN / SAND PACK
						71					
						72					
						73					
						74					
						75					
						76					
						77					
						78					
						79					
						80			End of Boring 80 FT.		
						81					
						82					
						83					
						84					
						85					
						86					
						87					
						88					
						89					
						90					
						91					
						92					
						93					
						94					
						95					

PROJECT\539-13\5391324D.DWG

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-25S
Well Location: Off-Site
Date Of Installation: 12/12/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 518.44
Geologist/Engineer: B.E.M.
Project Number: 4700-062



000221

* Describe. Measuring Point: _____

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-25S Sh 1 of 1
Date Started 12/12/90 Completed 12/12/90 Ground Elev. 516.58
Total Depth 18 Feet Location Off-Site Logged by BEM
Remarks

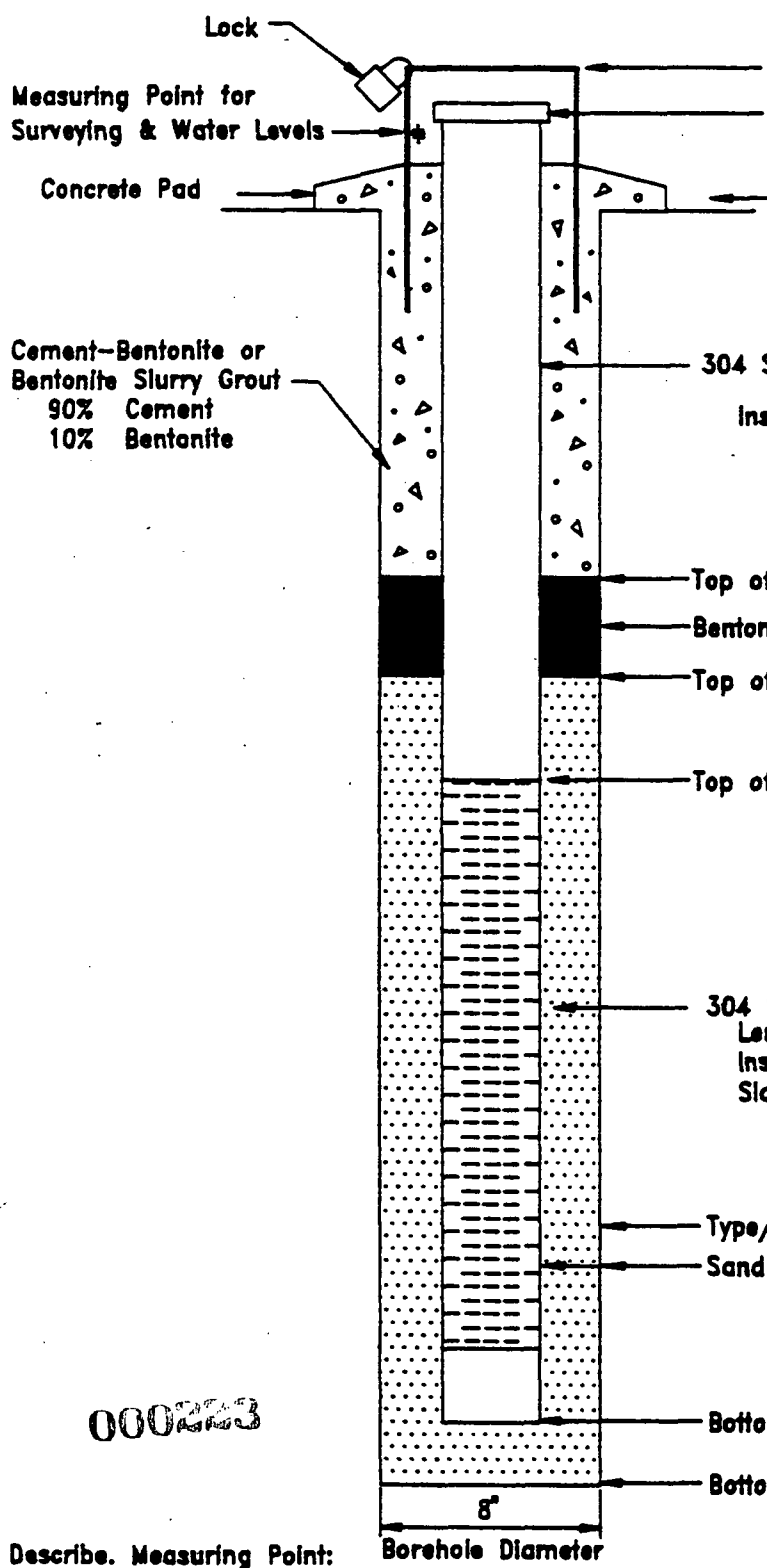
Depth Feet	Sample: Split Spoon Number	Blows Per 2Ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	1	4	0-2	1.3	Brown, soft, silt with trace to some sand, moist	0 Units
2	2	7	2-4	1.5		0 Units
4	3	4	4-6	2.0	Brown, loose, sand, with some silt, moist Grading into sand and gravel	0 Units
6	4	13	6-8	1.7	Brown, medium dense, fine to coarse sand and fine to medium gravels, moist to wet	0 Units
8	5	18	8-10	1.5		0 Units
10	6	18	10-12	1.3		0 Units
12	7	14	12-14	1.5		0 Units
14	8	22	14-16	1.7		3 Units slight organic odor
16	9	19	16-18	1.3		20 Units moderate organic odor
18					Groundwater encountered at 9.8 Feet.	

ENSR

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-26S
Well Location: Off-Site
Date Of Installation: 12/5/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 516.49
Geologist/Engineer: B.E.M.
Project Number: 4700-062



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.00
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	4.00
Top of Bentonite Seal	4.00
Bentonite Seal Thickness 2.00	
Top of Sand	6.00
Top of Screen	7.30
304 Stainless Steel Screen — Length 10 feet; Inside Diameter (ID) 2 inch; Slot Size 0.01 inch	
Type/Size of Sand: Global No. 7	
Sand Pack Thickness: 3"	
Bottom of Well	17.30
Bottom of Borehole	20.00

000243

* Describe. Measuring Point: Mark on Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-26S Sh 2 of 2
Date Started 12/04/90 Completed 12/04/90 Ground Elev. 514.47
Total Depth 22.0 Feet Location Off-Site Logged by BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	2	0-2	-	Brown, soft, silt, with trace to some fine sand	0 Units
2	2	2	2-4	1.5		0 Units
4	3	2	4-6	1.2		0 Units
6					Brown, very loose, fine sand, with some silt, damp	
	4	5	6-8	1.5		0 Units
8	5	5	8-10	1.5		0 Units
10	6	8	10-12	1.3	Brown, medium dense, medium sand and fine gravel, some medium gravel,damp to wet	0 Units
12	7	10	12-14	1.3		0 Units
14	8	25	14-16	1.7		0 Units
16	9	20	16-18	1.6		0 Units
18	10	21	18-20	1.5		0 Units
20						

ENSR

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-26S Sh 1 of 2
ate Started 12/14/90 Completed 12/14/90 Ground Elev. 514.47
.otal Depth 22.0 Feet Location Off-Site Logged by BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	11	21	20-22	1.5		0 Units
22					Ground water encountered at approximately 12 feet.	

ENSR 000225

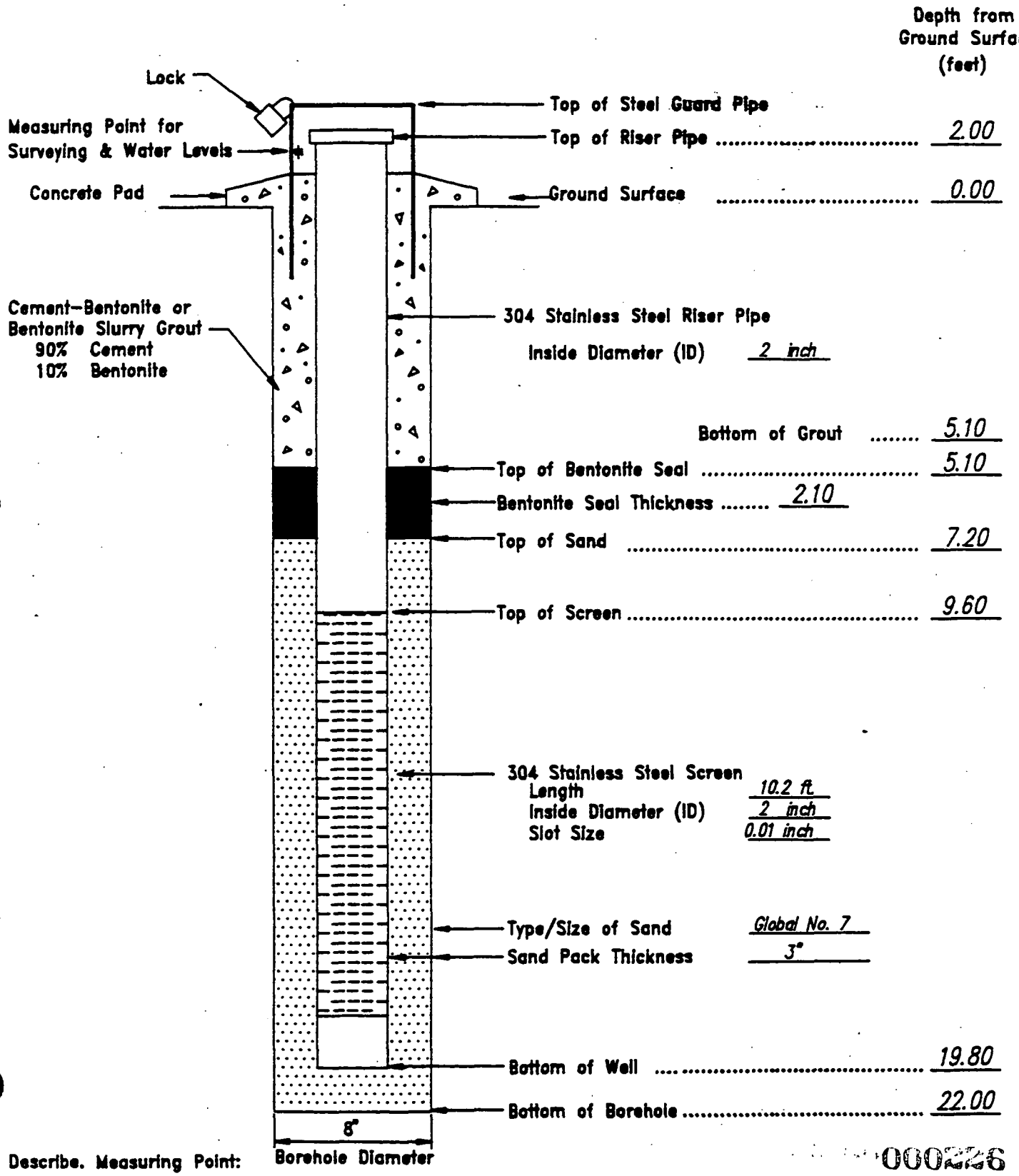
DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-27S
Well Location: Off-Site
Date Of Installation: 12/5/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 518.64
Geologist/Engineer: M.A.F.
Project Number: 4700-062



* Describe. Measuring Point:

000226

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-27S Sh 1 of 2
Date Started 12/04/90 Completed 12/04/90 Ground Elev. 516.88
Total Depth 22.0 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2Ft	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	14	0-2	1.0	Tan, medium dense, medium sand and silt, with some fine gravels, moist	0 Units
2	2	26	2-4	1.0	Brown, soft, clay, with some silt, moist	0 Units
4	3	14	4-6	0.9		0.1 Units
6	4	11	6-8	1.1	Brown, medium stiff silt and medium to coarse sand and fine gravels, moist	3.2 Units "natural gas odor"
8	5	20	8-10	1.1	Lite gray, medium dense, fine to coarse sand and fine gravels, with some silt and clay, moist to wet Coarse gravels from 12-14 feet	0.8 Units "natural gas odor"
10	6	45	10-12	1.0		6.4 Units no odor
12	7	18	12-14	1.2		10.0 Units "natural gas odor"
14	8	18	14-16	0.7		1.3 Units no odors
16	9	16	16-18	1.7	Brown, loose, medium sand, trace of silt, wet	0.4 Units no odors
18	10	10	18-20	2.0		30 Units " natural gas odor"
20						

ENSR 000227

DRAFT

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-27S Sh 2 of 2
Date Started 12/04/90 Completed 12/04/90 Ground Elev. 516.88
Total Depth 22 Feet Location Off-Site Logged by MAF
Remarks

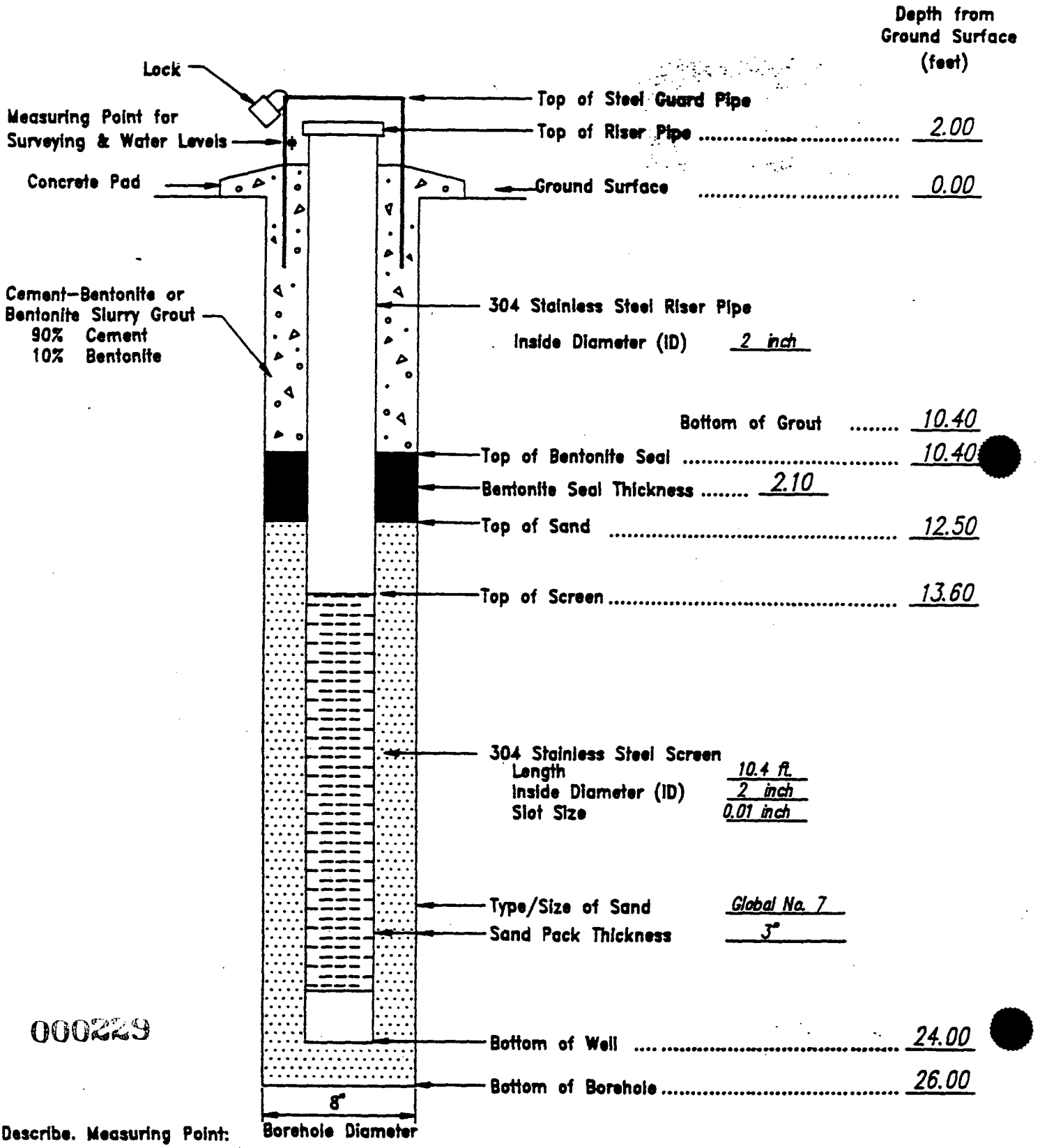
Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	11	20	20-22	2.0	Brown, loose, medium to coarse sand and fine gravels, wet	20 Units "natural gas odor"
					Ground water encountered at approximately 16 feet	

ENSR

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-28S
Well Location: Off-Site
Date Of Installation: 12/6/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 524.17
Geologist/Engineer: M.A.F.
Project Number: 4700-062



000229

• Describe. Measuring Point: _____

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS BORING MW-28S Sh 1 of 2
Date Started 12/05/90 Completed 12/05/90 Ground Elev. 522.22
Total Depth 26 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	-	0-2	1.1	Brown, silt and clay moist	0 Units no odors
2	2	-	2-4	0.5	Gray, loose, medium to coarse sand and fine gravels trace of silt, moist	2.6 Units no odors
4	3	15	4-6	1.6	Tan,medium dense, fine to medium sand, trace of silt, moist	6.6 Units no odors
6	4	43	6-8	2.0		0.7 Units no odors
8	5	23	8-10	1.4	Gray, medium dense, Medium to coarse sand and fine to coarse gravels, moist	2.4 Units no odors
10	6	27	10-12	1.3		1.6 Units no odors
12	7	40	12-14	1.2	Gray, medium dense, medium to coarse sand and fine to coarse gravels, moist	0.2 Units no odors
14	8	20	14-16	0.9	Cobbles from approximately 11.5 to 16 feet.	0.6 Units no odors
16	9	-	16-18	1.2	Gray, medium dense, medium to coarse sand and fine to coarse gravels moist to wet	1.2 Units no odors
18	10	-	18-20	0.9		10 Units "natural gas odor"
20						

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-28S Sh 2 of 2
Date Started 12/05/90 Completed 12/05/90 Ground Elev. 522.22
Total Depth 26 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	11	-	20-22	0.6		40 Units "natural gas odor"
22						
	12	16	22-24	1.2	Brown, medium dense, medium to coarse sand and fine gravels, trace of silt, wet	0.1 Units no odor
24						
	13	17	24-46	0.8		0.1 Units no odor
26						
					Ground water encountered at approximately 19 feet.	

ENSR

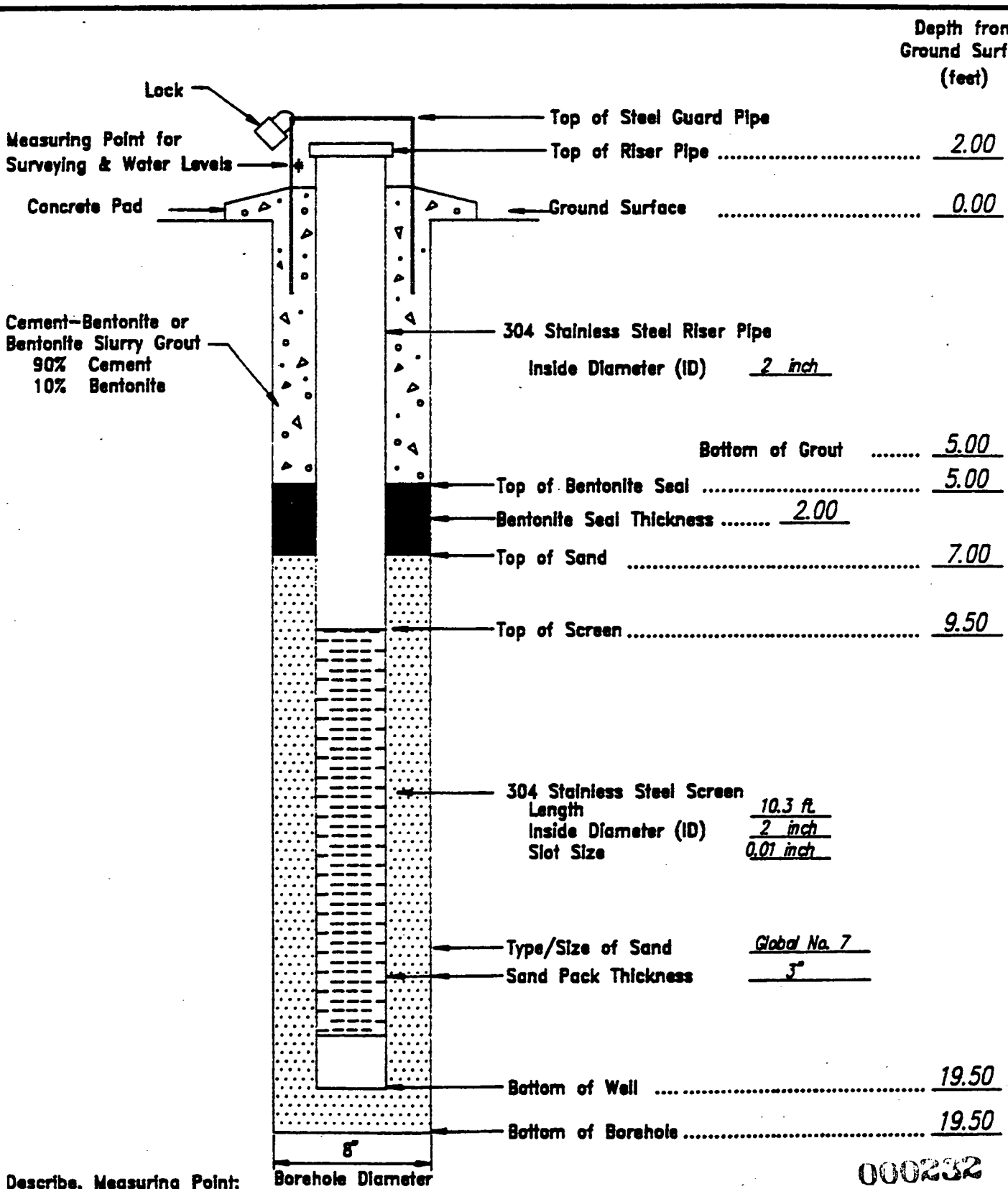
000221

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-29S
Well Location: Off-Site
Date Of Installation: 12/6/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 515.61
Geologist/Engineer: B.E.M.
Project Number: 4700-062



• Describe. Measuring Point: Mark on Top of Riser Pipe

000232

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-29S Sh 1 of 1
Date Started 12/05/90 Completed 12/05/90 Ground Elev. 513.54
Total Depth 18 Feet Location Off-Site Logged by BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	1	2	0-2	1.4		0 Units
2	2	4	2-4	1.3	Brown, soft, clayey silt, moist to damp	0 Units
4	3	2	4-6	1.3		0 Units
6	4	5	6-8	1.3		0 Units
8	5	18	8-10	1.5		0 Units
10	6	18	10-12	2.0		0 Units
12	7	18	12-14	1.0	Brown, medium dense medium sand and fine gravel, damp to wet	0 Units
14	8	20	14-16	2.0	Cherty limestone encountered at approximately 14.5 -16 feet	0 Units
16	9	30	16-18	1.7	Very dense, sand, gravel, and fractured rock	0 Units
18					Ground water encountered at approximately 12 feet.	

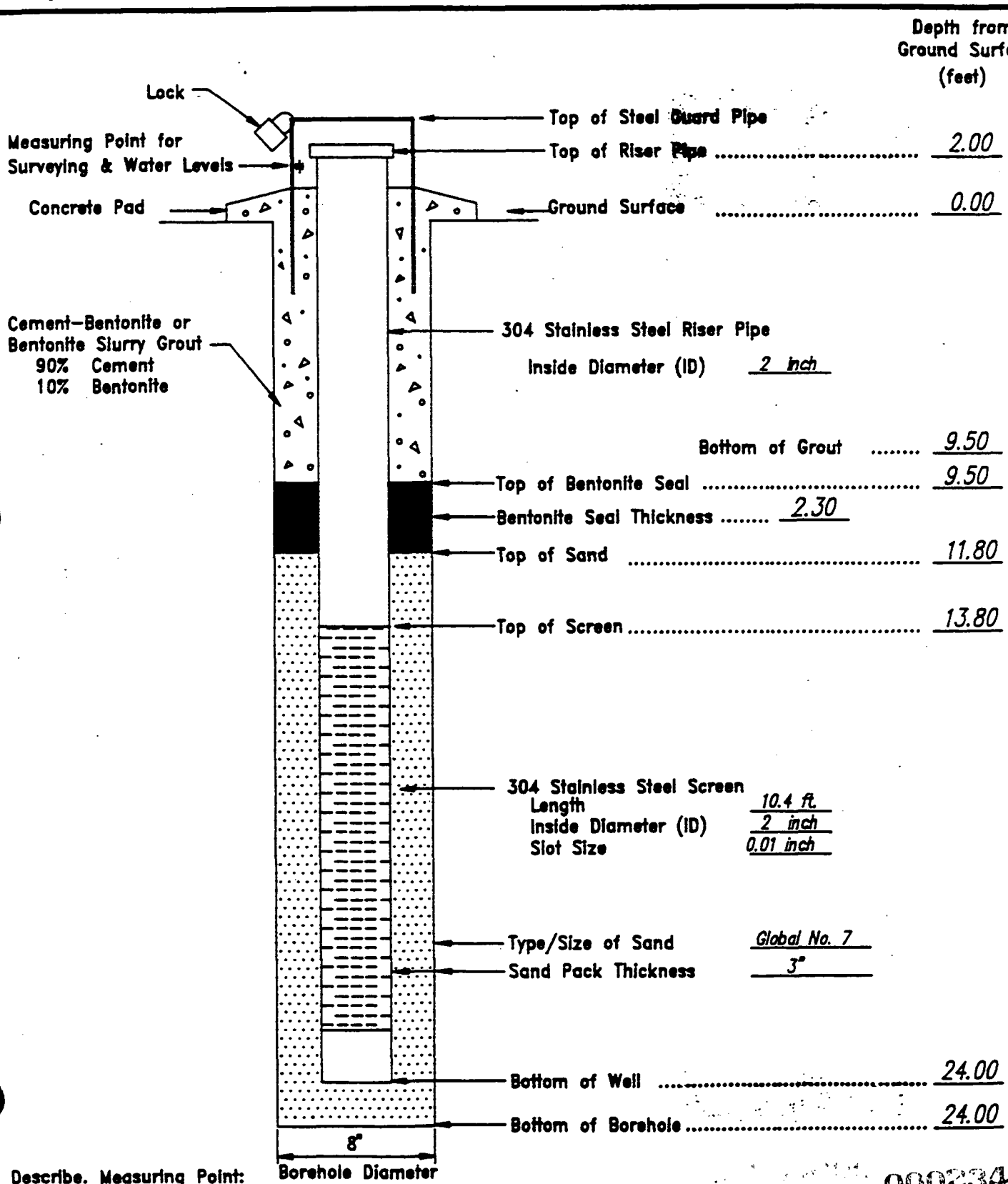
ENSR 000233

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-30S
Well Location: Off-Site
Date Of Installation: 12/7/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 533.13
Geologist/Engineer: M.A.F.
Project Number: 4700-062



• Describe. Measuring Point:

000234

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-30S Sh 1 of 2
ate Started 12/06/90 Completed 12/06/90 Ground Elev. 531.18
Total Depth 24 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	9	0-2	0.4	Brown, soft, silt, cobble in tip	0 Units no odor
2	2	17	2-4	1.3	Gray, very dense, medium to coarse sand and fine to coarse gravels, with some silt and clay, moist Cobbles from 6 to 22 feet	0.9 Units no odor
4	3	48	4-6	1.6		100 Units no odor
6	4	38	6-8	1.7		1.4 Units "natural ga odor"
8	5	42	8-10	1.3		0.6 Units no odor
10	6	18	10-12	1.6	Dark gray, dense to very dense, medium to coarse sand and fine to coarse gravels, with some silt, moist to wet	0.8 Units "natural gas odor"
12	7	18	12-14	1.2		35 Units "natural gas odor"
14	8	20	14-16	1.0		14 Units "natural gas odor"
16	9	39	16-18	0.9		4 Units "natural gas odor"
18	10	45	18-20	1.2		25 Units "natural gas odor"
20						

ENSR 000235

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-30S Sh 2 of 2
Date Started 12/06/90 Completed 12/06/90 Ground Elev. 531.18
Total Depth 24 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	11	27	20-22	0.9	Silt content increasing	14 Units "natural gas odor"
22	12	26	22-24	1.0	Brown to light orange, dense, medium to coarse sand and fine gravels, wet	5 Units "natural gas odor"
24					Ground water encountered at approximately 17 feet.	

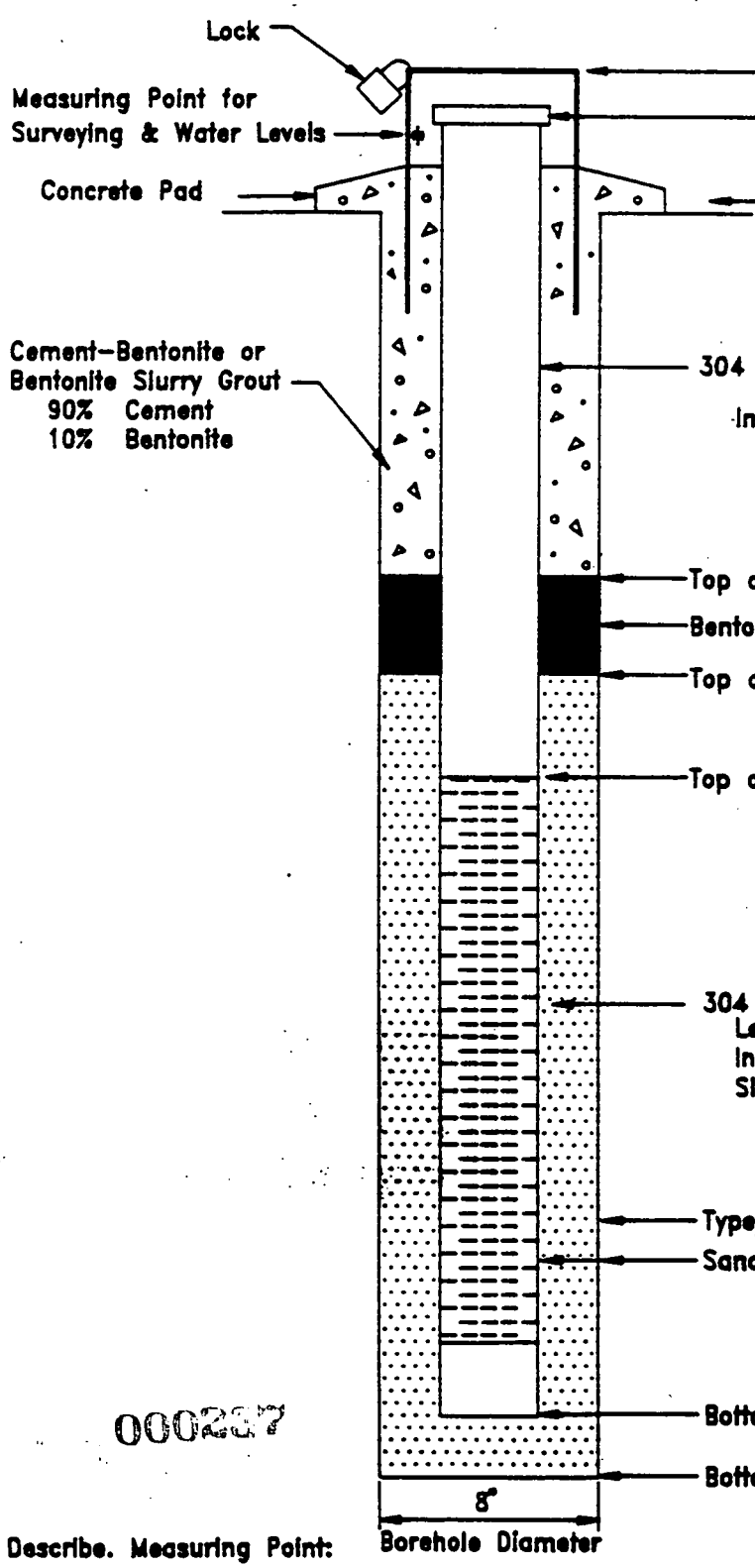
ENSR

DRAFT

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-30
Well Location: Off-Site
Date Of Installation: 1/8/91
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 533.42
Geologist/Engineer: B.E.M.
Project Number: 4700-062



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.00
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	34.70
Top of Bentonite Seal	34.70
Bentonite Seal Thickness 3.30	
Top of Sand	38.00
Top of Screen	40.00
304 Stainless Steel Screen — Length 10.0 ft. — Inside Diameter (ID) 2 inch — Slot Size 0.01 inch	
Type/Size of Sand: Global No. 7	
Sand Pack Thickness: 3"	
Bottom of Well	50.00
Bottom of Borehole	50.00

000237

* Describe. Measuring Point: _____

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-30I Sh 1 of 2
Date Started 1/07/91 Completed 1/08/91 Ground Elev. 531.61
Total Depth 50 Feet Location Off-Site Logged by BEM
Remarks See Soil Boring Log MW-30S for 0-24 Foot Interval

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
26	1	24	24-26	1.4	Brown, medium dense, medium to coarse sand and fine to medium gravel, trace to some silt, wet	1.0 Units
28	2	30	26-28	1.4	Cobbles from 24-26 feet	1.0 Units
30	3	28	28-30	1.5		1.0 Units
32	4	28	30-32	1.8		2.0 Units
34	5	18	32-34	1.0	Brown, medium dense, medium sand, wet	0.5 Units
36	6	65	34-36	1.1		0 Units
38	7	13	36-38	1.1		0 Units
40	8	21	38-40	1.5	Brown, medium dense, very fine to fine sand, wet	0 Units
42	9	20	40-42	1.6		0 Units
43	10	17	42-44	1.7		0 Units

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-30I Sh 2 of 2
ate Started 1/07/91 Completed 1/08/91 Ground Elev. 531.61
Total Depth 50 Feet Location Off-Site Logged by BEM
Remarks See Soil Boring Log MW-30S for 0-24 Foot Interval

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	11	31	44-46	1.8	Brown, medium dense, medium to coarse sand and medium gravel, wet	0 Units
46						
	12	19	46-48	1.7		0 Units
48						
	13	18	48-50	1.7		0 Units
50						
					Ground water encountered at 17.2 feet	

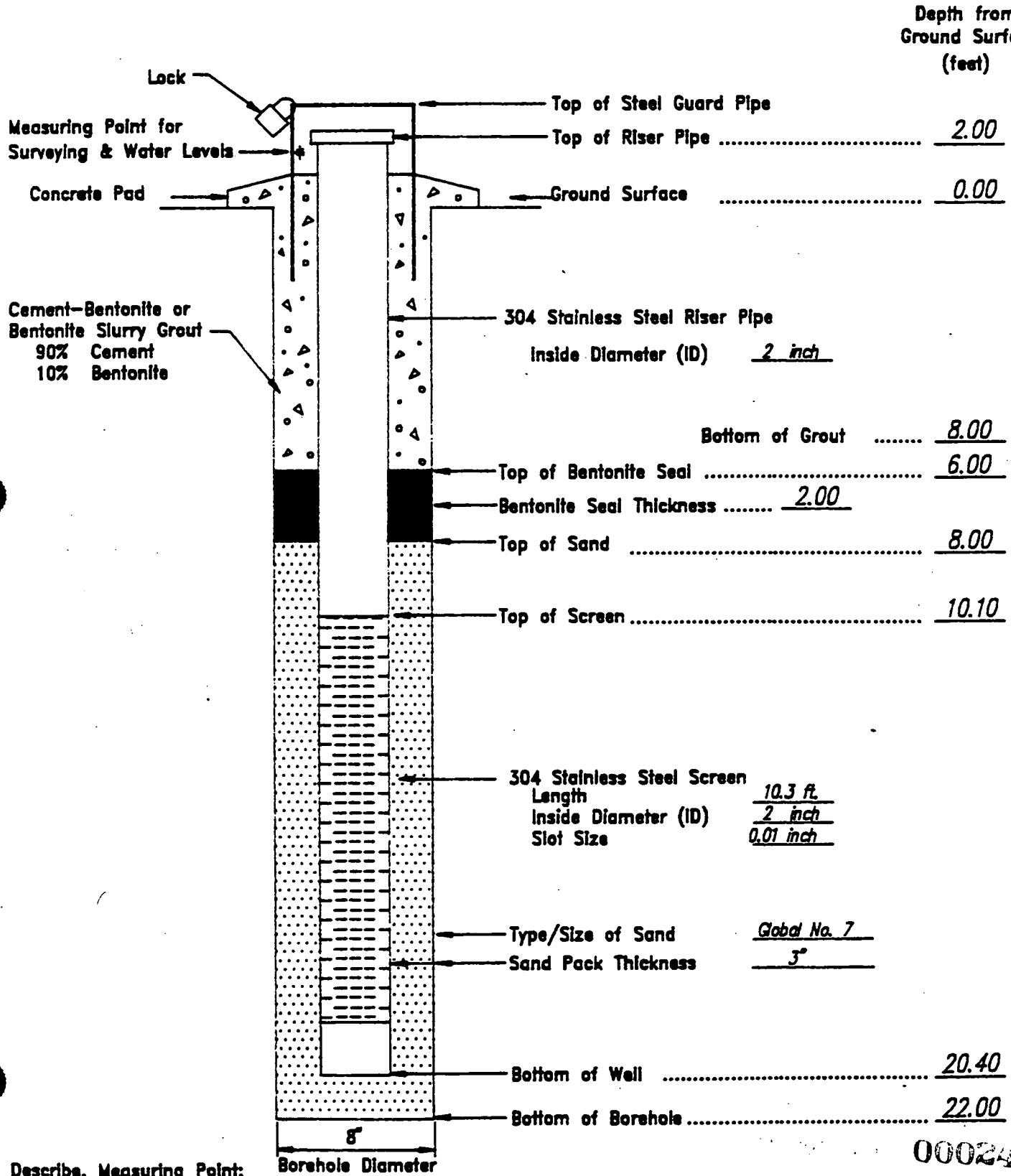
ENSR 000229

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-31S
Well Location: Off-Site
Date Of Installation: 12/7/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 528.20
Geologist/Engineer: B.E.M.
Project Number: 4700-062



* Describe. Measuring Point: Mark at Top of Riser

000240

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-31S Sh 1 of 2
ate Started 12/06/90 Completed 12/06/90 Ground Elev. 526.20
Total Depth 22 Feet Location Off-Site Logged by BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
2	1	9	0-2	1.7	Brown, soft, silt with some clay, damp	0 Units
4	2	9	2-4	1.7		0 Units
6	3	9	4-6	1.3	Brown, loose, silty, fine to medium sand, moist to wet	0 Units
8	4	10	6-8	1.7		0 Units
10	5	18	8-10	1.3		0 Units
12	6	38	10-12	1.3		2 Units odor
14	7	42	12-14	2.0		10 Units organic odor
16	8	42	14-16	1.3	Gray to Black, dense, fine to medium sand and fine to medium gravels, some silt from 11-14 feet, damp to wet	900 Units strong organic odor
18	9	60	16-18	1.3		100 Units strong organic odor
20	10	23	18-20	1.7		80 Units strong organic odor

ENSR 000241

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-31S Sh 2 of 2
Date Started 12/06/90 Completed 12/06/90 Ground Elev. 526.20
Total Depth 22 Feet Location Off-Site Logged by BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
	11	22	20-22	1.5	Brown, medium dense, medium sand, trace of fine gravel	30 moderate organic odor
22						
					Ground water encountered at 12.8 feet	

ENSR

LOCATION MAP

ERM–MIDWEST WELL LOG

BORE NUMBER ► MW-31I	LOCATION ► PRRS Site; Fernald, Ohio
DATE ► 04/18/91	WEATHER ► Sunny, 50F
LOGGED BY ► JDK	DRILLED BY ► Bowser Morner
DRILLING METHOD ► 4 1/4 IN. Hollow Stem Auger	SAMPLING METHOD ► 300 lb. Hammer 3 IN. Split Spoon
ELEVATION ► Ground 525.78 FT. Top of Casing 527.76 FT.	GRAVEL PACK ► #7 Sand 49.5-36.5 FT. / SEAL ► Bentonite 36.5-6.0 FT.

CASING ► TYPE S.S. 306 DIAMETER 2 IN. LENGTH 39.5 FT. | WATER LEVEL INITIAL ▼ 12.80 FT. ■ B.G.S. □ B.M.P. | HOLE DIA. 8 IN.

SCREEN ► TYPE S.S. 306 SLOT 0.01 IN. DIAMETER 2 IN. LENGTH 10 FT. | WATER LEVEL AT COMPLETION ▽ 10.55 FT. B.M.P. | TOTAL DEPTH 50 FT.

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG	WELL COMPLETION
						0			*Brown, soft, SILT with some clay.*		GROUT; STAINLESS STEEL RISER; GROUT
						1					
						2					
						3					
						4					
						5			*Brown, loose, silty, fine to medium SAND.*		
						6					
						7					
						8					
						9					
						10		▽			
						11			*Gray-black, dense, fine to medium SAND and fine to medium GRAVELS, some silt from 11-14 feet. damp to wet.*		BENTONITE SLURRY; BENTONITE SLURRY
						12					
						13		▼			
						14					
						15					
						16					
						17					
						18			*NOTE: All descriptions in italics are taken from ENSR Well Log, MW-31S.*		
						19					
						20					

000243

PROJECT\539-12\-06\120631L.DRW 9106171730

WELL NUMBER ▶ MW-31I

ERM—MIDWEST WELL LOG

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
						20			*Brown, medium dense, medium SAND, trace of fine gravel.*
						21			*NOTE: All descriptions in italics are taken from ENSR Well Log, MW-31S.*
						22		45	
Wet	Poor	Hard	Non	1	72	23	2.0'	57 42 67	Very poorly sorted, gray SAND and GRAVELS, fine to cobble size. No sheen visible or discoloration.
						24		12	
Wet	Mod.	Stiff	Non	2	25	25	1.0'	15 25 22	Gray SAND, fine to coarse grained with some GRAVELS. Mean grain size finer than 22-24 IN. No sheen or discoloration.
						26		13	
Wet	Mod. to Poor	Stiff	Non	3	2.0	27	1.2'	21 27 36	Same as 24-26 FT. Bottom 3 IN. color is light to medium brown.
						28		15	
Wet	Mod.	Hard	Non	4	2.0	29	1.0'	35 35 47	Gray SAND with GRAVEL, fine to coarse grain, bottom 1 IN. brown SAND.
						30		8	
Wet	Mod.	Stiff	Non	5	9.0	31	0.7'	13 21 24	Brown and gray SAND, fine to coarse grain, not as many gravels.
						32		10	
Wet	Poor	Stiff	Non	6	2.0	33	0.7'	12 10 12	Brown SAND, fine to coarse grain.
						34		19	
Wet	Poor	Stiff	Non	7	1.0	35	0.7'	14 14 21	Brown SAND, fine to coarse grained, with GRAVELS.
						36		14	
Wet	Poor	Stiff	Non	8	1.0	37	0.7'	17 18 20	Same, bottom 1 IN. dry.
						38		57	
Wet	Poor	Hard	Non	9	1.0	39	0.4'	37 37 37	Same as above.
						40		4	
Wet	Mod.	Soft	Non	10	0.0	41	1.0'	5 6 9	Gray SAND, silt to very coarse grain, some pebbles at bottom of spoon.
						42			Because of heaving sands filling the augers, augered borehole to 50 FT.
						43			
						44			
						45			

GRAPHIC LOG

WELL COMPLETION: BENTONITE SLURRY; STAINLESS STEEL RISER; BENTONITE SLURRY; SAND; SAND

PROJECT\539-12\-06\120631I.DRW 9106171730

WELL NUMBER ▶ MW-31I

ERM–MIDWEST WELL LOG

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS	GRAPHIC LOG	WELL COMPLETION
						45			Cuttings gray SAND with some pebbles.		SAND
						46					
						47					S.S. SCREEN
						48					
						49					SAND
						50			End of Boring 50 FT.		
						51					
						52					
						53					
						54					
						55					
						56					
						57					
						58					
						59					
						60					
						61					
						62					
						63					
						64					
						65					
						66					
						67					
						68					
						69					
						70					

000245

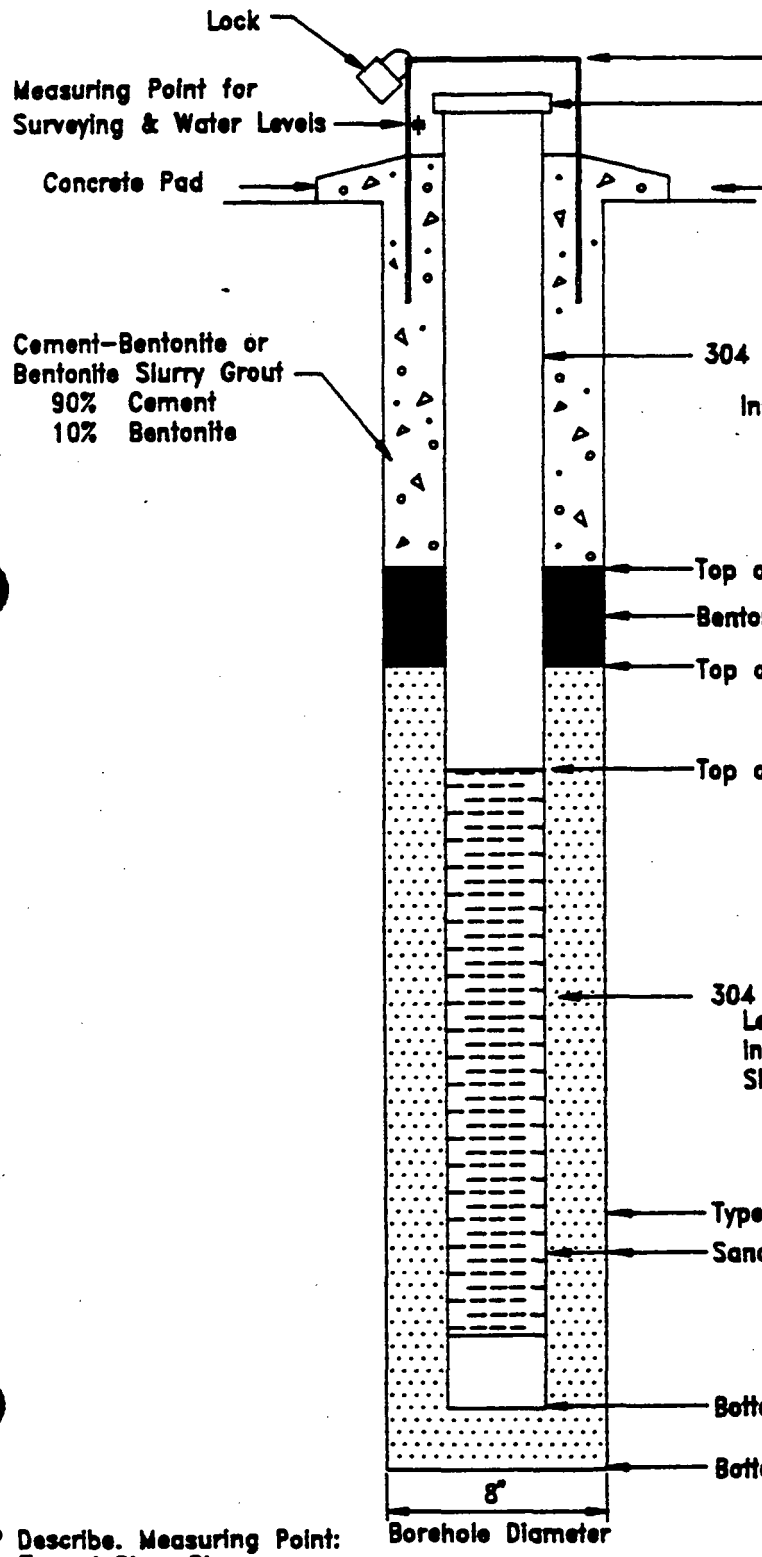
PROJECT\539-12-06\12061IP2.DRW

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-32S
Well Location: Off-Site
Date Of Installation: 12/11/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 527.98
Geologist/Engineer: B.E.M.
Project Number: 4700-062



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.00
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	3.00
Top of Bentonite Seal	3.00
Bentonite Seal Thickness 2.00	
Top of Sand	5.00
Top of Screen	7.40
304 Stainless Steel Screen — Length 10.3 ft. — Inside Diameter (ID) 2 inch — Slot Size 0.01 inch	
Type/Size of Sand: Global No. 7	
Sand Pack Thickness: 3"	
Bottom of Well	17.40
Bottom of Borehole	17.40

000246

• Describe. Measuring Point: Top of Riser Pipe

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-32S Sh 1 of 1
Date Started 12/11/90 Completed 12/11/90 Ground Elev. 526.16
Total Depth 18 Feet Location Off-Site Logged by
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	17	0-2	1.7	Yellow-brown, stiff clay and silt, moist	0 Units
2	2	35	2-4	1.3		0 Units
4	3	-	4-6	1.5	Light brown, fine to coarse sand, dry	0 Units
6	4	18	6-8	1.5		0.5 Units
8	5	25	8-10	1.3	Light brown to yellow, medium dense, fine to medium sand and fine to medium gravels, dry to wet	0.3 Units
10	6	95	10-12	1.5		5 Units
12	7	18	12-14	1.0		5 Units
14	8	49	14-16	1.3		1 Unit
16	9	44	16-18	1.3	Fine to coarse gravels	0 Units
18					Ground water encountered at approximately 10 feet	

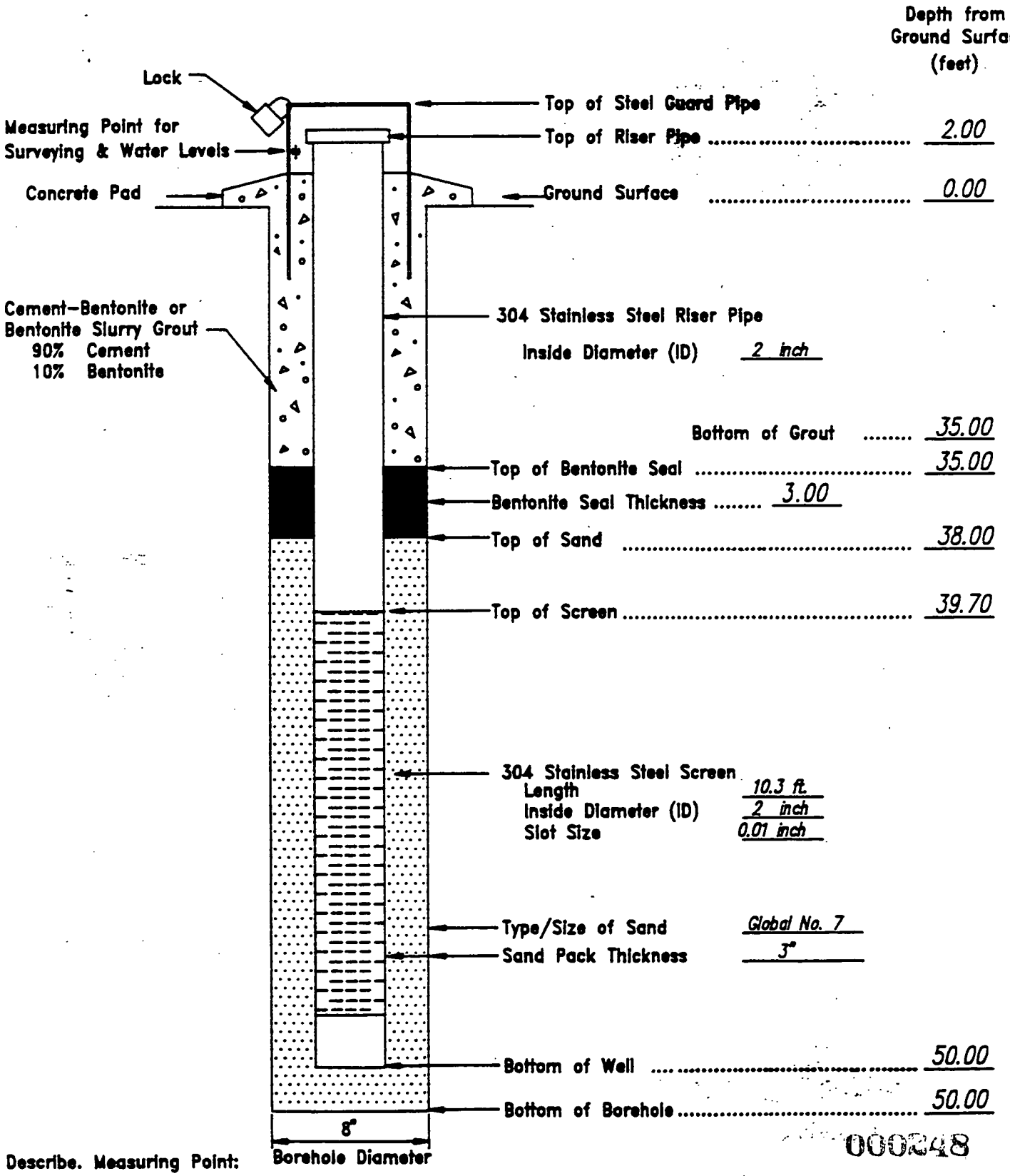
ENSR 000247

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-331
Well Location: A & W
Date Of Installation: 12/13/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 529.74
Geologist/Engineer: B.E.M.
Project Number: 4700-062



* Describe. Measuring Point:

000248

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-33I Sh 1 of 3
ate Started 12/12/90 Completed 12/12/90 Ground Elev. 527.79
Total Depth 50 Feet Location A & W/Mobil Logged by MAF & BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	-	0-2	1.0	Brown, soft, silt and clay, moist	0 Units no odor
2	2	-	2-4	1.5		0 Units no odor
4	3	15	4-6	1.5	Tan, medium stiff, clay, moist	0 Units no odor
6	4	14	6-8	1.5	Brown, medium stiff, silt, with some fine sand, moist	0 Units no odor
8	5	24	8-10	1.5	Black, medium dense, medium to coarse sand, with some silt, moist	0.6 Units no odor
10	6	27	10-12	1.5		2.0 Units no odor
12	7	-	12-14	1.0		2.5 Units no odor
14	8	93	14-16	1.4		2.2 Units no odor
16	9	47	16-18	0	Brown, very dense, medium to coarse sand and fine to coarse gravels, with some silt, wet	4.0 Units no odor
18	10	27	18-20	1.2		3.2 Units no odor
20						

ENSR 000249

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-33I Sh 2 of 3
Date Started 12/12/90 Completed 12/12/90 Ground Elev. 527.79
Total Depth 50 Feet Location A & W/Mobil Logged by MAF & BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	11	37	20-22	1.4		2.0 Units no odor
24	12	25	22-24	1.5		1.8 Units no odor
26	13	27	24-26	1.2		3.2 Units no odor
26	14	30	26-28	1.3		0.2 Units no odor
28	15	60	28-30	1.3	Brown, very dense, medium sand, trace of fine gravel, wet	0 Units no odor
30	16	18	30-32	1.0		0 Units no odor
32	17	59	32-34	1.3		0 Units no odor
34	18	64	34-36	1.1	Brown, very dense, coarse sand,trace fine sand and gravels, wet	0 Units no odor
36	19	60	36-38	1.3	Brown, very dense, fine to medium gravel, with some fine to medium sand and silt, wet	0 Units no odor
38	20	58	38-40	1.3		0 Units no odor
40						

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-33I Sh 3 of 3
Date Started 12/12/90 Completed 12/12/90 Ground Elev. 527.79
Total Depth 50 Feet Location A & W/Mobil Logged by MAF & BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
42	21	22	40-42	1.3		0 Units no odor
44	22	22	42-44	1.3	Brown-gray, dense, fine sand, wet	0 Units no odor
46	23	23	44-46	1.3		0 Units no odor
48	24	20	46-48	1.7	Grading into a medium sand from 46 to 50 feet	0 Units no odor
50	25	30	48-50	1.5		0 Units no odor
					Ground water encountered at approximately 12 feet.	

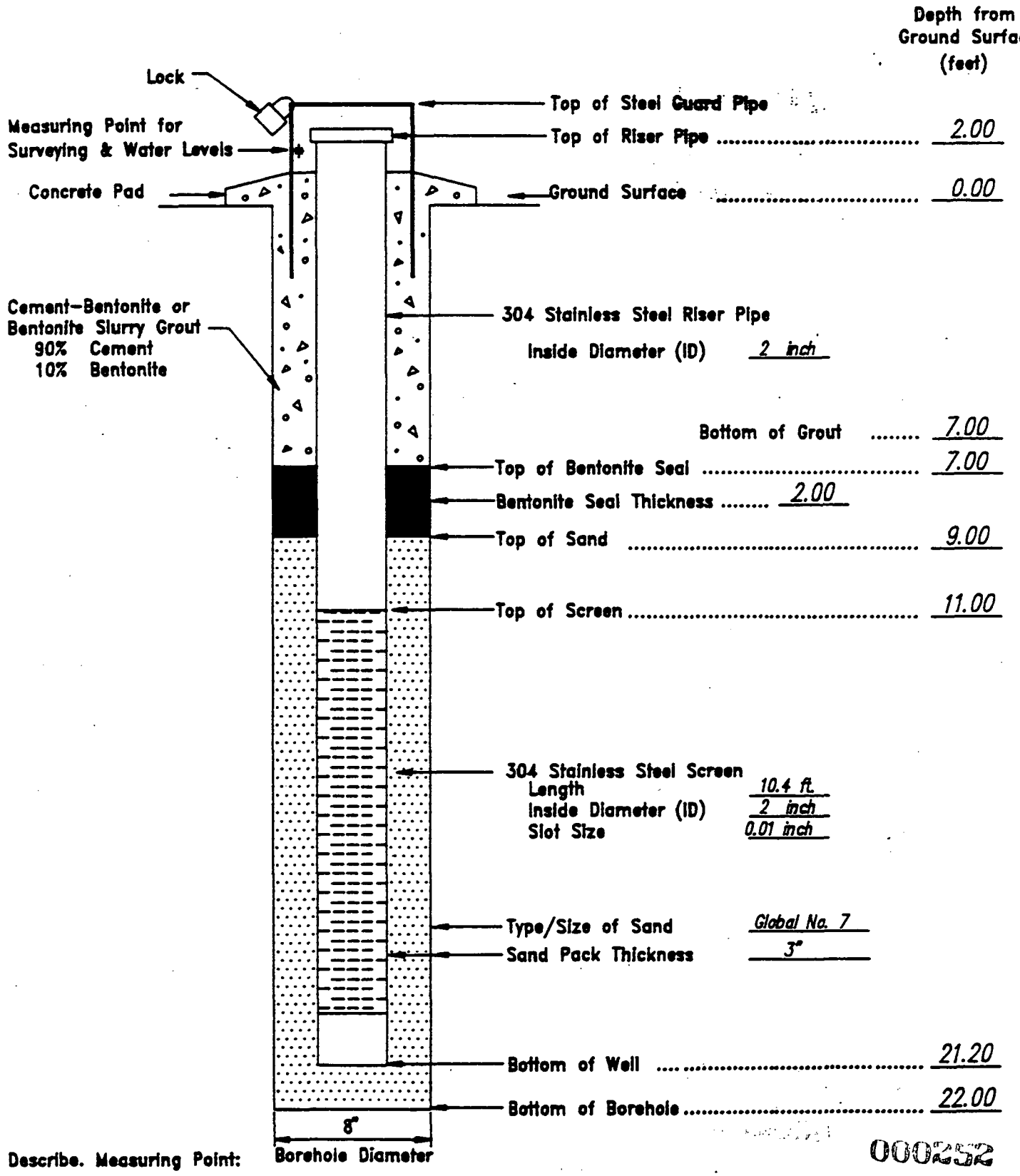
ENSR 000251

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-34S
Well Location: RNCC
Date Of Installation: 12/12/90
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 532.89
Geologist/Engineer: M.A.F.
Project Number: 4700-062



• Describe. Measuring Point:

000252

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-34S Sh 1 of 2
Date Started 12/12/90 Completed 12/12/90 Ground Elev. 530.69
Total Depth 22 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	17	0-2	1.5	Brown, stiff, clay and silt, trace of fine sand, moist	0 Units no odor
2	2	23	2-4	1.5		0 Units no odor
4	3	-	4-6	1.8		0.2 Units no odor
6	4	43	6-8	1.8		0.2 Units no odor
8	5	22	8-10	1.4		2.8 Units no odor
10	6	47	10-12	1.5	Brown, medium to coarse sand and fine to coarse gravels, with trace to some silt, moist to wet	0.6 Units no odor
12	7	-	12-14	1.0		0.4 Units no odor
14	8	45	14-16	1.7		Flame out organic odor black stains
16	9	53	16-18	1.5		120 Units organic odor black stains
18	10	59	18-20	1.3		>1000 Units strong organic odor black stains
20						

ENSR 000253

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-34S Sh 2 of 2
Date Started 12/12/90 Completed 12/13/90 Ground Elev. 530.68
Total Depth 22 Feet Location RNCC Logged by MAF
Remarks

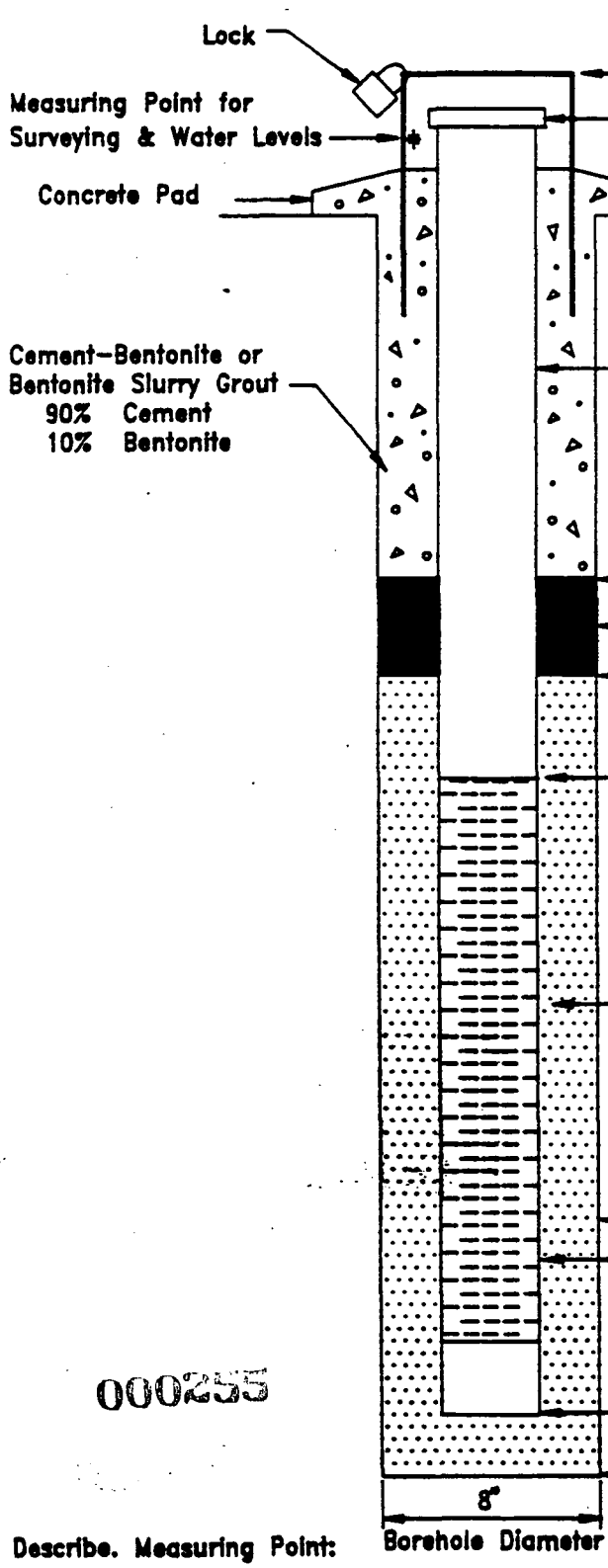
Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	11	48	20-22	0.5	Medium sand from 21.5 feet to 22 feet	>1000 strong organic odor black stains
					Ground water encountered at approximately 10 feet on 12/12/90. Ground water was measured at 8.5 feet on morning of 12/13/90.	

ENSR

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-35S
Well Location: Off-Site
Date Of Installation: 1/8/91
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 525.98
Geologist/Engineer: B.E.M.
Project Number: 4700-062



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.00
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	13.00
Top of Bentonite Seal	13.00
Bentonite Seal Thickness 2.00	
Top of Sand	15.00
Top of Screen	17.00
304 Stainless Steel Screen — Length 10.4 ft. — Inside Diameter (ID) 2 inch — Slot Size 0.01 inch	
Type/Size of Sand Global No. 7	
Sand Pack Thickness 3"	
Bottom of Well	27.00
Bottom of Borehole	27.00

000255

• Describe. Measuring Point: _____

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-35S Sh 1 of 2
Date Started 1/08/91 Completed 1/09/91 Ground Elev. 523.97
Total Depth 26 Feet Location Off-Site Logged by BEM
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	3	0-2	2.0	Brown-black, very loose, silt and medium sand, moist	0 Units
2	2	7	2-4	1.9	Brown, loose, medium sand, moist	0 Units
4	3	11	4-6	1.8	Brown-Black, soft, silt moist	0 Units
6	4	12	6-8	2.0		0 Units
8	5	8	8-10	2.0	Brown, soft, sandy (fine), silt, moist	0 Units
10	6	12	10-12	1.7	Brown, loose medium gravel and some fine sand, moist	0 Units
12	7	13	12-14	2.0	Brown, loose, sandy (fine) silt trace of fine gravels, moist "shells noted"	0 Units
14	8	28	14-16	1.3	Brown, dense, fine to medium sand and medium to coarse gravels, moist to wet	0 Units
16	9	55	16-18	1.9		0 Units
18	10	30	18-20	1.0		0 Units
20						

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-35S Sh 2 of 2
ate Started _____ Completed _____ Ground Elev. 523.97
Total Depth _____ Feet Location Off-Site Logged by BEM
Remarks _____

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	11	52	20-22	1.0		0 Units
24	12	21	22-24	1.0	Brown, medium dense, medium to coarse sand, wet	0 Units
26	13	15	24-26	1.0	Trace of fine gravels from 24 to 26 feet	0 Units
					Ground water encountered at approximately 19.5 feet	

ENSR

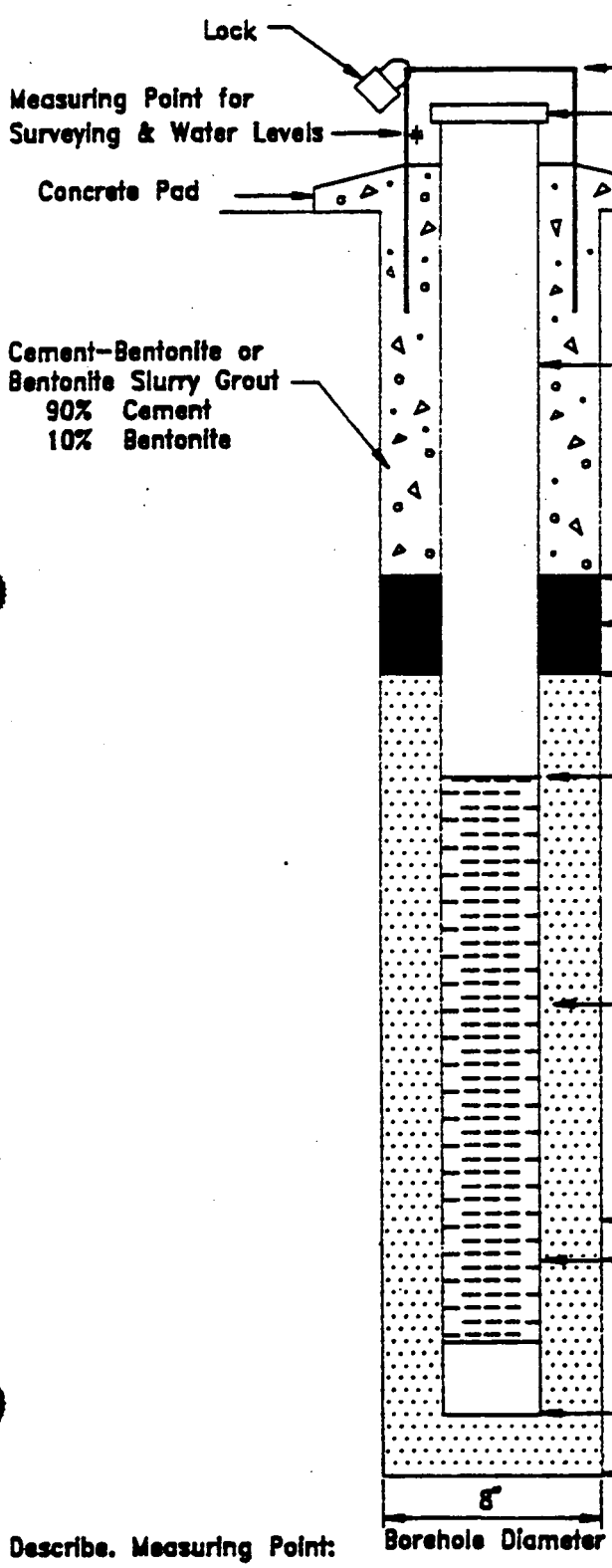
000257

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

007361

Well Identification: MW-36S
Well Location: Off-Site
Date Of Installation: 1/7/91
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 518.15
Geologist/Engineer: B.E.M.
Project Number: 4700-062



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.00
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	9.00
Top of Bentonite Seal	9.00
Bentonite Seal Thickness 2.40	
Top of Sand	11.40
Top of Screen	13.35
304 Stainless Steel Screen — Length 10.15 ft. — Inside Diameter (ID) 2 inch — Slot Size 0.01 inch	
Type/Size of Sand: Global No. 7	
Sand Pack Thickness: 3"	
Bottom of Well	23.50
Bottom of Borehole	23.50

• Describe. Measuring Point: _____

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-36S Sh 1 of 2
ate Started 1/07/91 Completed 1/07/91 Ground Elev. 516.19
Total Depth 26 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	10	0-2	1.2	Brown, soft, silt, with some fine sand, moist	0 Units
2	2	12	2-4	1.5		0.1 Units no odor
4	3	9	4-6	1.2		0.9 Units no odor
6	4	7	6-8	0.9	Brown, loose, fine to medium sand, moist	0.3 Units no odor
8	5	8	8-10	0.9		0.8 Units no odor
10	6	22	10-12	0.3		0.6 Units "natural gas odor"
12	7	56	12-14	0.8		1.7 Units no odor
14	8	53	14-16	0.9	Brown, very dense, medium to coarse sand and fine to coarse gravels, moist	1.0 Units no odor
16	9	68	16-18	1.0		2.6 Units no odor
18	10	93	18-20	2.6		1.5 Units "natural gas odor"
20						

ENSR 000259

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-36S Sh 2 of 2
Date Started 1/07/91 Completed 1/07/91 Ground Elev. 516.19
Total Depth 24 feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Sample: Blows Per 2ft.	Sample: Depth Range Feet	Sample: Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	11	48	20-22	.8	Tan, very dense, medium to coarse sand and fine to coarse gravels, with trace to some silt, wet	6.2 Units "natural gas odor"
24	12	23	22-24	1.3		2.6 Units "natural gas odor"
					Ground water encountered at 16.7 feet.	

ISR

LOCATION MAP

ERM—MIDWEST WELL LOG

BORE NUMBER ► MW-36I		LOCATION ► PRRS, Fernald, Ohio	
DATE ► 10/01/91		WEATHER ► Clear, Sunny, 60'sF	
LOGGED BY ► D. Jakim		DRILLED BY ► Mathes & Associates	
DRILLING METHOD ► 4 1/4" Hollow Stem Auger		SAMPLING METHOD ► Split Spoon	
ELEVATION ► Ground 516.31 FT. T.O.C. 518.44 FT.	GRAVEL PACK ► #7 36-19 FT.	SEAL ► Bentonite Slurry, 19-9 FT.	

CASING ► TYPE 306 S.S. DIAMETER 2 IN. LENGTH 21 FT. WATER LEVEL INITIAL 23.0 FT. ■ B.G.S. □ B.M.P. HOLE DIA. 8 IN.

SCREEN ► TYPE 306 S.S. SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 15 FT. WATER LEVEL AT COMPLETION 23.0 FT. H.M.P. TOTAL DEPTH 36.5 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Loose	0	0–1	0.2'	2, 4, 6, 4	Brown SAND and roots organics.
2	Moist	Loose	0	2–3	0.7'	4, 3, 3, 4	Brown SAND and organics.
3	Moist	Loose	0	4–5	1.0'	4, 5, 5, 4	Brown SAND trace organics.
4	Damp	Loose	0	6–7	0.7'	2, 4, 4, 3	Brown SAND.
5	Moist to Dry	Loose	2	8–9	0.8'	2, 2, 4, 3	Fine SAND and clay.
6	Moist to Dry	Loose	0	10–11	1.5'	3, 4, 4, 4	Fine to coarse SAND and brown to gray GRAVEL, slight odor.
7	Damp	Medium Dense	0	12–13	0.5'	4, 7, 15, 41	Brownish gray, well sorted, coarse SAND and GRAVEL, slight odor.
8	Damp	Compact	0	14–15	1.0'	22, 33, 36, 37	Brownish gray, well sorted GRAVEL and sand, slight odor. GRAVEL and coarse sand, odor.
9	Damp	Dense	0	16–17	1.3'	5, 15, 23, 21	
10	Damp	Medium Dense	0	18–19	1.7'	8, 14, 16, 10	Gray to brownish GRAVEL and coarse sand, slight odor.

GRAPHIC LOG

WELL COMPLETION: GROUT; STAINLESS STEEL RISER; BENTONITE SLURRY; SAND

000261

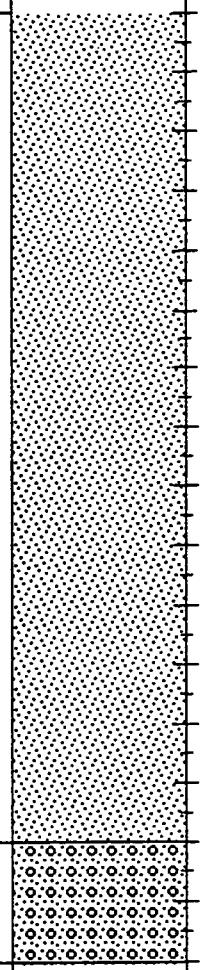
PROJECT\539-13\5391336I.DRW

WELL NUMBER ▶ MW-36I

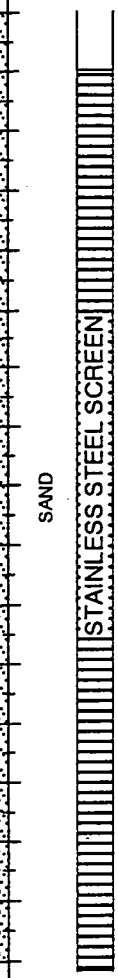
ERM–MIDWEST WELL LOG

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
				20			
11	Damp	Dense	0	21	0.7'	9, 18, 12, 23	Brown-grayish coarse SAND and pebbles and gravel, rounded pebbles and gravel, odor.
				22			
12	Moist	Medium Dense	0	23	1.7'	6, 7, 12, 16	Brown GRAVEL, pebbles and coarse sand. ▼
				24			
13	Wet	Medium Dense	0	25	1.5'	6, 6, 15, 16	Brown coarse SAND, pebbles and gravel, well sorted, slight odor.
				26			
14	Wet	Dense	0	27	1.5'	10, 20, 20, 24	Coarse, poorly sorted SAND to fine well sorted sand and gravel, trace odor.
				28			
15	Wet	Medium Dense	0	29	2.0'	20, 15, 10, 14	Coarse SANDS and pebbles, rare brown gravel, trace odor.
				30			
16	Wet	Medium Dense	0	31	2.0'	4, 4, 13, 15	Coarse SAND and pebbles rare brown gravel, no odor.
				32			
17	Wet	Dense	0	33	1.7'	6, 15, 19, 24	Brown medium to coarse SAND and pebbles, no odor.
				34			
18	Wet	Dense	0	35	2.0'	14, 7, 16, 20	Coarse SAND and GRAVEL, few gravel, brown well sorted sand.
				36			Total Depth 36.0 FT.
				37			
				38			
				39			
				40			
				41			
				42			
				43			
				44			
				45			

GRAPHIC LOG



WELL COMPLETION

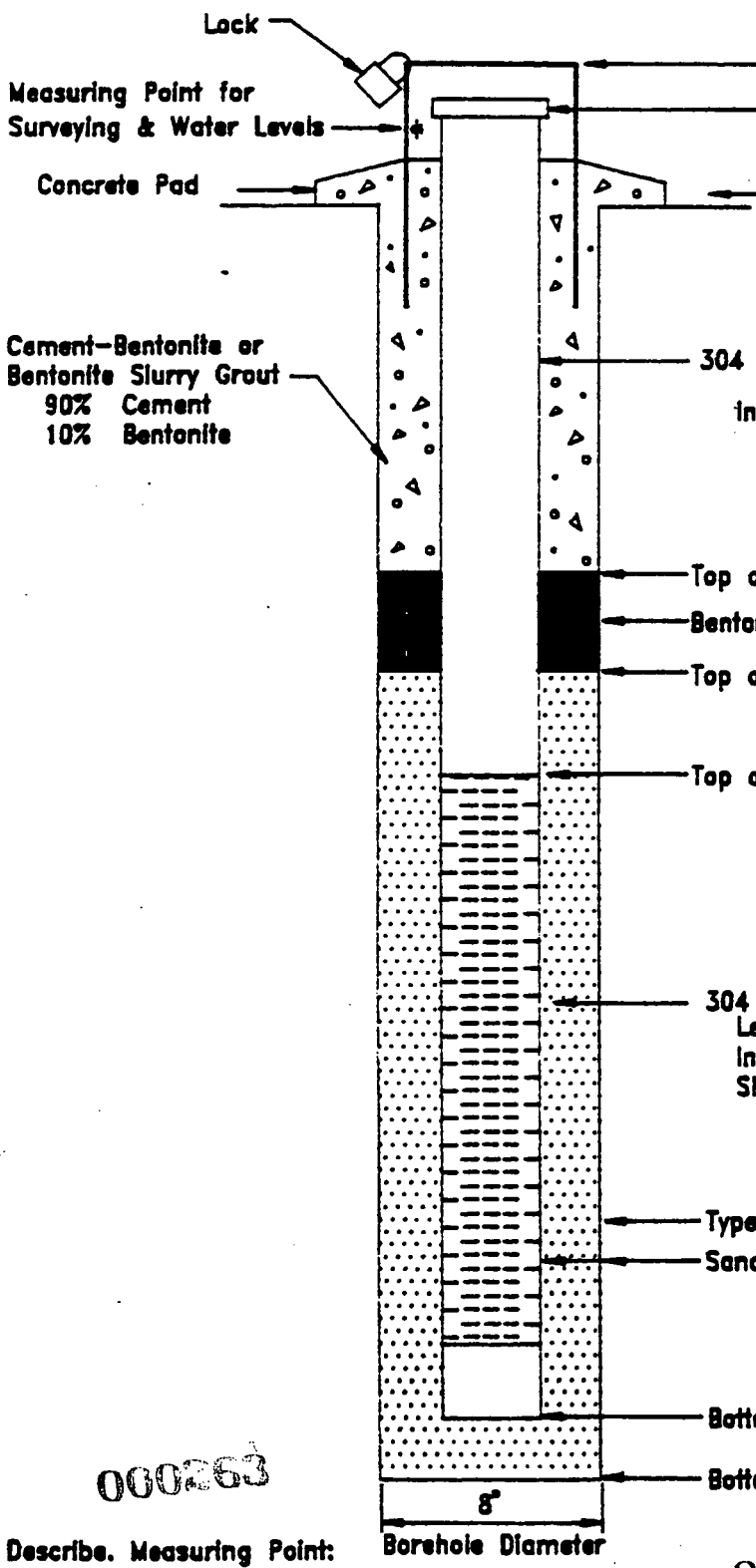


PROJECT\539-13\5391336I.DRW

MONITORING WELL CONSTRUCTION DETAIL
PADDYS RUN ROAD SITE RI/FS
CROSBY TOWNSHIP, OHIO

Well Identification: MW-37S
Well Location: Off-Site
Date Of Installation: 1/8/91
Drilling Contractor: BOWSER-MORNER

Drilling Method: Cable Tool
Top Of Casing Elev.(MSL): 518.95
Geologist/Engineer: B.E.M.
Project Number: 4700-062



	Depth from Ground Surface (feet)
Top of Steel Guard Pipe	
Top of Riser Pipe	2.00
Ground Surface	0.00
304 Stainless Steel Riser Pipe — Inside Diameter (ID) 2 inch	
Bottom of Grout	8.50
Top of Bentonite Seal	8.50
Bentonite Seal Thickness 2.30	
Top of Sand	11.80
Top of Screen	13.90
304 Stainless Steel Screen — Length 10.1 ft. — Inside Diameter (ID) 2 inch — Slot Size 0.01 inch	
Type/Size of Sand: Global No. 7	
Sand Pack Thickness: 3"	
Bottom of Well	24.00
Bottom of Borehole	24.00

000263

* Describe. Measuring Point:

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS BORING MW-37S Sh 1 of 2
Date Started 1/08/91 Completed 01/08/91 Ground Elev. 517.13
Total Depth 26 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
0	1	9	0-2	1.3	Brown, medium stiff silt with some fine to medium sand, moist	0 Units no odor
2	2	12	2-4	1.6		0.1 Units no odor
4	3	4	4-6	2.0	Medium sand from 5.0-5.3 feet Browm, medium stiff, clay	8.8 Units no odor
6	4	21	6-8	.9	Brown, loose, medium to coarse sand, and fine gravels, moist	2.2 Units no odor
8	5	7	8-10	1.4		4.8 Units no odor
10	6	6	10-12	.8		2.6 Units "natural gas odor"
12	7	11	12-14	0	Tan, loose, medium sand, with trace of silt, moist	no recovery
14	8	23	14-16	1.7		1.7 Units "natural gas odor"
16	9	22	16-18	0.9		5.5 Units "natural gas odor"
18	10	60	18-20	0.7	Brown, very dense, medium to coarse sand and fine to coarse gravels, trace to some silt, moist to wet	3.2 Units no odor
20						

ENSR

SOIL BORING LOG
PADDYS RUN ROAD SITE RI/FS - CROSBY TOWNSHIP, OHIO

Project 4700-062 Site PRRS **BORING** MW-37S Sh 2 of 2
Date Started 1/08/91 Completed 1/08/91 Ground Elev. 517.13
Total Depth 26 Feet Location Off-Site Logged by MAF
Remarks

Depth Feet	Sample: Split Spoon Number	Blows Per 2ft.	Depth Range Feet	Rec. Feet	Lithologic Description	OVA Readings (in Units) & Remarks
22	11	70	20-22	1.0	Brown, very dense, medium to coarse sand and fine gravels, wet	1.0 Units no odor
24	12	18	22-24	1.3	Brown, medium dense, medium sand, trace of silt,wet	0.1 Units no odor
26	13	18	24-26	2.0	Brown, medium dense, medium to coarse sand with trace of silt, wet	0.1 Units no odor
					Ground water encountered at 17.6 feet.	

ENSR

000265

LOCATION MAP

ERM—MIDWEST WELL LOG

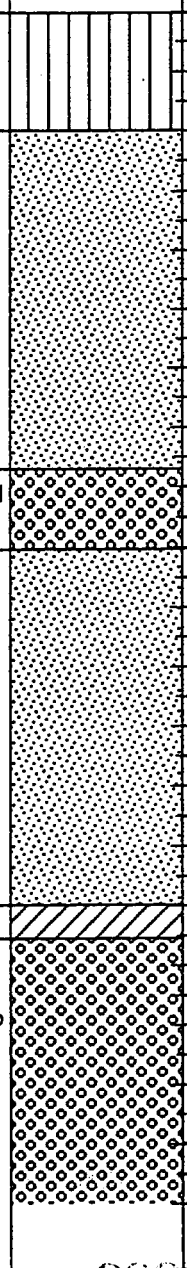
BORE NUMBER ► MW-37I	LOCATION ► PRRS, Fernald, Ohio
DATE ► 10/01/91	WEATHER ► Clear, Dry, Warm
LOGGED BY ► P. Gephard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► Split Spoon
ELEVATION ► Ground 517.42 FT. T.O.C. 519.15 FT.	GRAVEL PACK ► #7 36-19 FT. / SEAL ► Bentonite Slurry 19-9 FT.

CASING ► TYPE 306 S.S. DIAMETER 2 IN. LENGTH 21 FT. | WATER LEVEL INITIAL 25 FT. ■ B.G.S. □ B.M.P. | HOLE DIA. 8 IN.

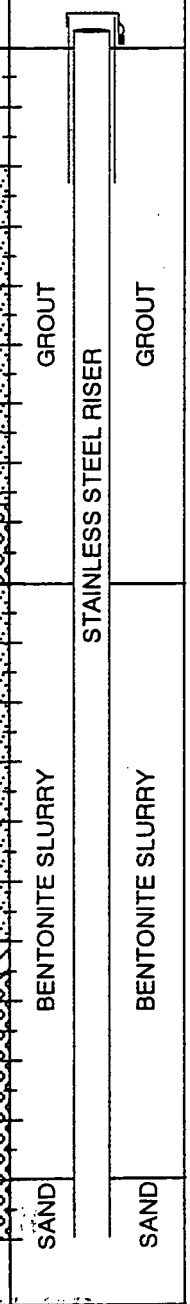
SCREEN ► TYPE 306 S.S. SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 15 FT. | WATER LEVEL AT COMPLETION 25 FT. H.M.P. | TOTAL DEPTH 36 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Dry	Stiff	0	0–1	1.2'	11, 25, 13, 14	Brown SILT, some fine sand.
2	Dry	Medium Dense	0	2–3	1.8'	11, 9, 12	Brown medium SAND, friable minor amount of silt.
3	Dry	Loose	0	3–5	1.2'	9, 7, 8, 7	Brown medium SAND.
4	Dry	Loose	0	5–7	1.4'	8, 7, 8, 5	Brown fine SAND, minor amount of silt.
5	Dry	Loose	2	7–9	1.2'	5, 7, 8, 5	Brown Medium GRAVEL to coarse sand poorly sorted.
6	Dry	Loose	0	9–11	1.4'	5, 5, 6, 5, 9, 8	Light brown medium SAND. Light brown medium SAND. Lower 2 IN. Brown, medium gravel, poorly sorted.
7	Dry	Loose	1	11–13	1.6'	6, 7, 9, 9	Brown, medium SAND, minor silt.
8	Dry	Very Stiff	1	13–15	1.2'	9, 20, 23	Brown, medium SAND. Dark brown CLAY, moist.
9	Dry to Moist	Compact	0	15–17	1.5'	28, 18, 19, 30, 32	Brown coarse GRAVEL to coarse sand, poorly sorted. Light brown to white, coarse GRAVEL to medium sand.
10	Moist	Dense	0	17–20	0.1'	18, 27, 18, 22	Light gray medium GRAVEL.

GRAPHIC LOG



WELL COMPLETION



PROJECT\539-13\53913371.DRW

WELL NUMBER ▶ **MW-37I**

ERM–MIDWEST WELL LOG

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
				20			
11	Moist	Dense	0	21	1.5'	10, 22, 23, 27	Brown, medium SAND, minor amounts of medium gravel and coarse SAND.
12	Moist	Dense	0	22, 23	1.6'	19, 15, 15, 20	Dark brown to brown medium SAND, minor coarse sand and 1-1/2 FT. medium gravel, poorly sorted. 6 IN. light brown, medium SAND, good sorting.
13	Wet	Medium Dense	2	24, 25	1.8'	7, 10, 13, 20	Brown, medium SAND, minor amounts of medium gravel.
14	Wet	Medium Dense	2	26, 27	1.7'	9, 13, 14, 19	6 IN. of brown, fine SAND, good sorting. 1-1/2 FT. of brown, medium to coarse SAND, with coarse to medium gravel, poorly sorted.
15	Wet	Dense	0	28, 29	2.0'	5, 23, 23, 28	1 FT. brown to dark brown, medium to coarse SAND, minor medium gravel. 1 FT. brown, medium SAND, medium sorting.
16	Wet	Dense to Compact	0	30, 31	2.0'	18, 18, 22, 38	Brown, medium SAND, minor amounts of coarse SAND to fine gravel.
17	Wet	Compact	2	32, 33	2.0'	10, 22, 32, 37	Brown, medium to coarse SAND, minor fine gravel.
				34			No Sample
				35, 36			
				37			Total Depth 36.0 FT.
				38, 39, 40, 41, 42, 43, 44, 45			

GRAPHIC LOG

WELL COMPLETION: SAND; STAINLESS STEEL SCREEN; SAND

000267

PROJECT\539-13\5391337I.DRW

007361

LOCATION MAP

ERM—MIDWEST WELL LOG

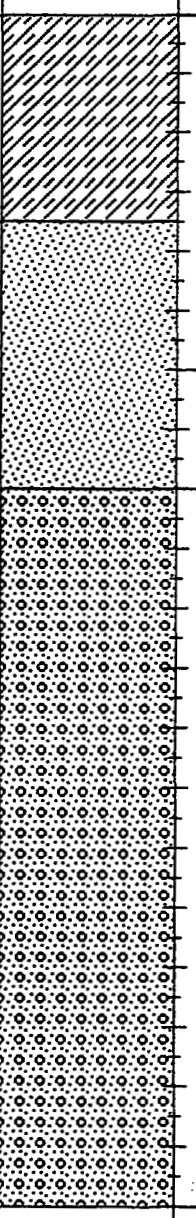
BORE NUMBER ►	MW-38S	LOCATION ►	PRRS Site; Fernald, Ohio
DATE ►	04/17/91	WEATHER ►	Sunny, 75F
LOGGED BY ►	JDK	DRILLED BY ►	Bowser Morner
DRILLING METHOD ►	4 1/4 IN. Hollow Stem Auger	SAMPLING METHOD ►	300 lb. Hammer 3IN. Split Spoon
ELEVATION ►	Ground 526.32 FT. Top of Casing 528.36 FT.	GRAVEL PACK ►	#7 Sand 20-8 FT.
SEAL ►	Bentonite 8.0-6.0 FT.		

CASING ► TYPE S.S. 306 DIAMETER 2 IN. LENGTH 10 FT. | WATER LEVEL INITIAL ▼ 13.20 FT. ■ B.G.S. □ B.M.P. | HOLE DIA. 8 IN.

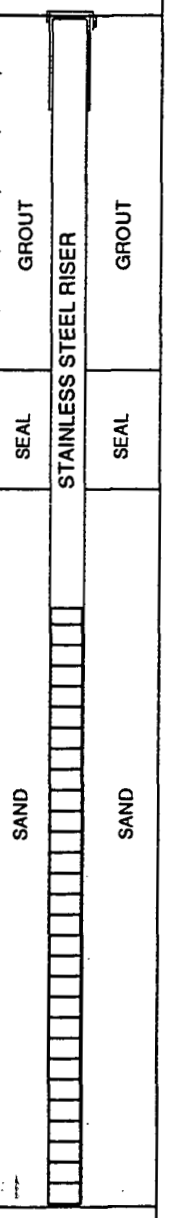
SCREEN ► TYPE S.S. 306 SLOT 0.01 IN. DIAMETER 2 IN. LENGTH 10 FT. | WATER LEVEL AT COMPLETION ▽19.20 FT. T.O.C. | TOTAL DEPTH 20 FT.

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
Dry		Soft	Slight	1	0.0	0–1	0.6'	2, 2, 3, 4	Medium brown to dark brown SILTY CLAY with some roots.
Dry		Soft	Slight	2	0.0	2–3	1.6'	3, 3, 5	Orange-brown SILTY CLAY.
Damp to Moist	Well to Poor	Soft	Slight	3	0.0	4–5	1.6'	2, 5, 5, 3, 7	Light brown/buff color clayey fine SAND, very moist. same but with zones of coarse SAND at 4.5-4.6 FT. and 5.9-6.0 FT., sand is dry.
Damp	Well	Soft	Slight	4	0.0	6–7	0.6'	5, 12, 17, 11	same brown-buff colored clayey silt/fine SAND, some coarse SAND at top and minor gravels at bottom.
Damp	Poor	Stiff	Non	5	0.2	8–9	1.2'	16, 16, 12, 13	Orange-brown SAND and GRAVELS, fine to coarse grained with gravels of varying sizes, some fairly well rounded, rock fragments at bottom.
Dry	Poor	Stiff	Non	6	0.0	10–11	1.7'	12, 12, 14, 11	Same, SAND and GRAVEL but more buff colored. Gravels are angular to fairly well rounded.
Wet	Poor	Stiff	Non	7	0.0	12–13	0.1'	12, 16, 23, 23	Wet SAND and GRAVEL, fine to coarse gravels, well rounded.
Wet	Poor	Soft	Non	8	0.4	14–15	1.3'	13, 9, 14, 12	Brown-rust colored SAND and GRAVEL, fine to coarse, gravels well rounded.
Wet	Poor	Soft	Non	9	0.0	16–17	1.8'	6, 10, 11, 10	Same, but not as many gravels.
Wet	Poor	Soft	Non	10	0.0	18–19	2.0'	5, 11, 14, 14	Same as above.
						20			End of Boring 20.0 FT.

GRAPHIC LOG



WELL COMPLETION



PROJECT\539-12-06\120638S.DRW 9106170900

000268

LOCATION MAP

ERM—MIDWEST WELL LOG

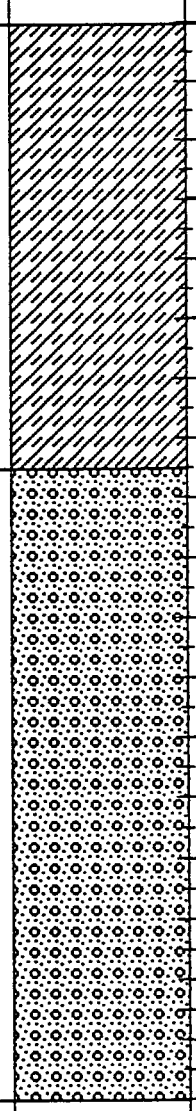
BORE NUMBER ► MW-39S	LOCATION ► PRRS, Fernald, Ohio
DATE ► 04/22/91	WEATHER ► Hot, Clear
LOGGED BY ► RAF	DRILLED BY ► Bowser Morner
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 300 lb. Hammer 3 IN. Split Spoon
ELEVATION ► Ground 524.71 FT. Top of Casing 527.64 FT.	GRAVEL PACK ► #7 Sand 17-5 FT. / SEAL ► Bentonite 5-3 FT.

CASING ► TYPE S.S. 306 DIAMETER 2 IN. LENGTH 10 FT. WATER LEVEL INITIAL 9.0 FT. ■ B.G.S. □ B.M.P. HOLE DIA. 8 IN.

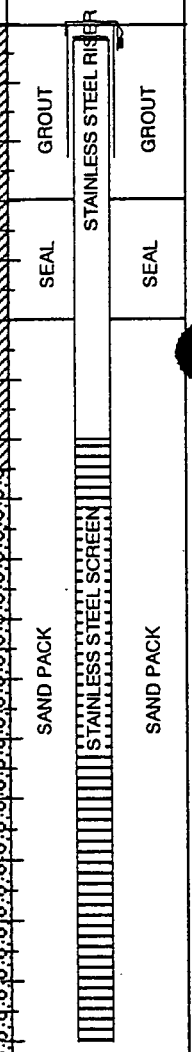
SCREEN ► TYPE S.S. 306 SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 10 FT. WATER LEVEL AT COMPLETION 9.0 FT. H.M.P. TOTAL DEPTH 18 FT.

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
Dry	Poor	Soft	Slight	1	0	0–1	1.2'	2, 2, 5, 5	Brown SILTY CLAY, roots, vertical holes.
Damp	Poor	Soft	Slight	2	0	2–3	1.25'	4, 6, 7, 6	Chocolate brown SILTY CLAY, trace silt, light brown mottles.
Damp	Poor	Soft	Slight	3	0	4–5	2.0'	3, 3, 6, 6	Brown SILTY CLAY with fine sand/clayey fine sand.
Damp	Poor	Soft	Slight	4	25, 3	6–7	1.7'	2, 5, 5	Brown SILTY CLAY trace sand, gravel.
Wet	Poor	Stiff	Non	5	12	8–9	1.25'	4, 5, 10, 10, 11	Angular GRAVEL and brown silty clay. ▼ Angular GRAVEL and coarse SAND, no visual contamination.
Wet	Poor	Stiff	Non	6	0	10–11	1.0'	6, 8, 9, 8	Same as above. No visual contamination.
Wet	Poor	Stiff	Non	7	0	12–13	1.5'	6, 15, 12, 9	Same, large 3 IN. cobbles, angular flint, no visual contamination.
Wet	Poor	Stiff	Non	8	0	14–15	1.0'	7, 5, 5, 4	Same with 6 IN. of brown medium to coarse SAND, no visual contamination.
Wet	Poor	Stiff	Non	9	0	16–17	2.0'	5, 9, 11, 15	Same, all coarse SAND, some GRAVEL, no visual contamination.
						18			Total Depth 18.0 FT.
						19			
						20			

GRAPHIC LOG



WELL COMPLETION



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PROJECT\539-12\-06\MW-39S.DRW 9105010900

LOCATION MAP

ERM–MIDWEST WELL LOG

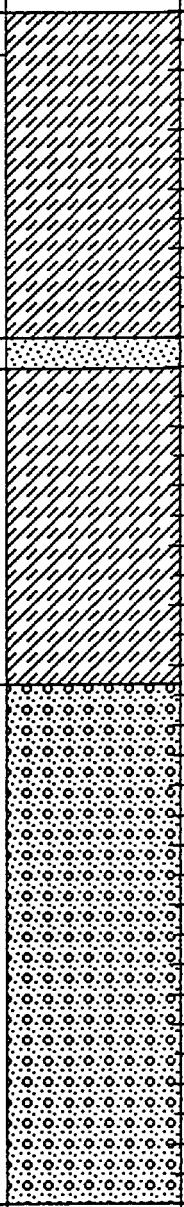
BORE NUMBER ► MW-40S	LOCATION ► PRRS, Fernald, Ohio
DATE ► 04/22/91	WEATHER ► Clear, Cool
LOGGED BY ► RAF/SGB	DRILLED BY ► Bowser Morner
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 3 IN. Split Spoon/ 300 lb Hammer
ELEVATION ► Ground 525.79 FT. Top of Casing 527.94 FT.	GRAVEL PACK ► #7 Sand 19-7 FT. / SEAL ► Bentonite 7-5 FT.

CASING ► TYPE S.S. 306 DIAMETER 2 IN. LENGTH 12 FT. | WATER LEVEL INITIAL 11.0 FT. ■ B.G.S. □ B.M.P. | HOLE DIA. 8 IN.

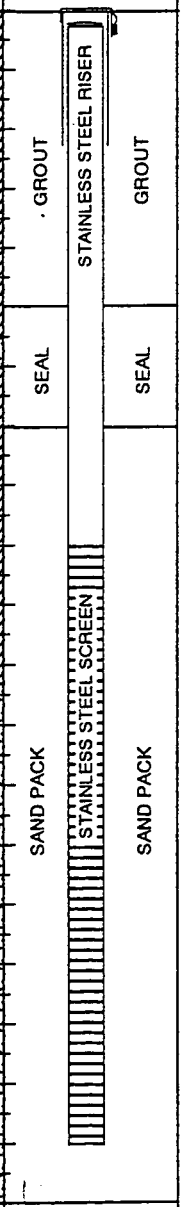
SCREEN ► TYPE S.S. 306 SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 10 FT. | WATER LEVEL AT COMPLETION 11.0 FT. H.M.P. | TOTAL DEPTH 19 FT.

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
						0		1	Gray SILTY CLAY roots.
					0			1	
Damp	Poor	Soft	Slight	1		1	1.8'	2	Grades Brown.
					25			2	
						2		3	Same, trace roots, trace fine sand.
					0			4	
Damp	Well	Soft	Slight	2		3	1.8'	3	
					1.5			4	
						4		3	Same as above.
								3	
Dry	Poor	Soft	Non	3	10	5	1.3'	6	
						6		6	Brown medium grain SAND.
					25			3	Brown SILTY CLAY.
								5	
Dry	Poor	Hard	Non	4		7	1.9'	5	Clayey fine sand, damp.
					4			7	4 IN. medium grain sand, damp
						8		9	2 IN. brown SILTY CLAY, trace sand.
								11	Gray cobbles, intermixed with brown and
Dry	Poor	Hard	Non	5	8	9	1.6'	12	gray SILTY CLAY.
								12	
						10		12	Same as above.
								12	
Wet	Poor	Hard	Non	6	>1000	11	1.9'	19 ▼	
								21	Angular SAND and GRAVEL, sweet odor.
						12		25	
								11	
Wet	Poor	Hard	Non	7	430	13	1.2'	14	Same 4 IN. of brown silty clay with GRAVEL, sweet odor, flint GRAVEL.
								11	
						14		11	
								16	Brown coarse SAND and GRAVEL, oily sheen on water, sweet odor, flint GRAVEL.
								8	
Wet	Poor	Hard	Non	8	>1000	15	1.9'	18	
								19	
						16		10	Black coarse SAND and GRAVEL.
								17	
Wet	Well	Hard	Non	9	200	17	1.8'	15	
								15	
						18		6	
								9	Same as above.
Wet	Well	Hard	Non	10	-	19	1.9'	12	
								10	
						20			Total Depth 20.0 FT.

GRAPHIC LOG



WELL COMPLETION



PROJECT\539-12\-06\MW-40S.DRW 9105010945

LOCATION MAP

ERM–MIDWEST WELL LOG

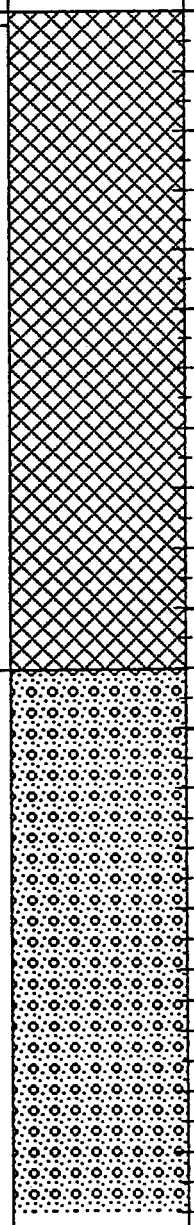
BORE NUMBER ► MW-41S	LOCATION ► PRRS, Fernald, Ohio
DATE ► 04/24/91	WEATHER ► Cool, Clear
LOGGED BY ► RAF/SGB	DRILLED BY ► Bowser Morner
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► 300 lb. Hammer 3 IN. Split Spoon
ELEVATION ► Ground 529.40 FT. Top of Casing 529.14 FT.	GRAVEL PACK ► #7 Sand 24-12 FT. / SEAL ► Bentonite 12-10 FT.

CASING ► TYPE S.S. 306 DIAMETER 2 IN. LENGTH 14 FT. | WATER LEVEL INITIAL 16.0 FT. ■ B.G.S. □ B.M.P. | HOLE DIA. 8 IN.

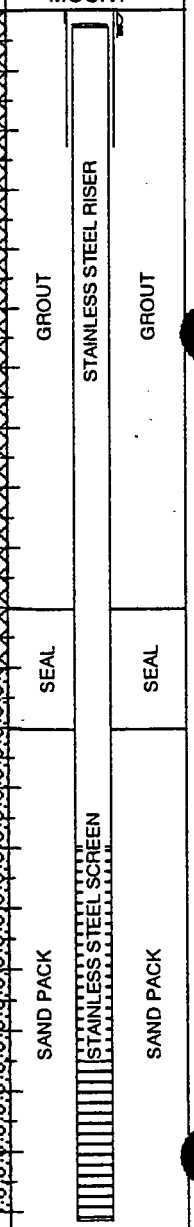
SCREEN ► TYPE S.S. 306 SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 10 FT. | WATER LEVEL AT COMPLETION 16.0 FT. H.M.P. | TOTAL DEPTH 24 FT.

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
						0		4	3 IN. CONCRETE
Damp	Poor	Soft	Non	1	>1000	1	0.5'	8 4 2	Black sand and gravel FILL. Sweet odor.
						2		4	Same as above.
Damp	Poor	Soft	Non	2	>1000	3	1.5'	3 9 7	
						4		4	Pea gravel, black mixed with black SILTY CLAY (Fill).
Damp	Poor	Soft	Non	3	>1000	5	1.25'	5 9 6	
						6		6	Same as above, sand medium grain, black oil on sand and gravel (Fill).
Dry	Poor	Soft	Non	4	600	7	1.5'	7 10 9	
						8		4	
Damp	Poor	Soft	Non	5	>1000	9	1.25'	5 6 11	Same, abundant black oil on FILL material.
						10		13	FILL, same as above.
Damp	Poor	Soft	Non	6	>1000	11	2.0'	15 22 25	
						12		8	Gray SAND and GRAVEL, angular flint cobble.
Damp	Poor	Soft	Non	7	>1000	13	2.0'	18 28 37	Same, sweet odor, oily sheen on sediments.
						14	200	5"	Obstruction, clayey SAND and GRAVEL, odor, oil,
Damp	Poor	Soft	Non	8	>1000	15	0.25'		drill to 16 FT. to avoid cobbles that blocked spoon.
						16		47	Fine SAND and small pea sized GRAVEL, black stain, oily sheen, sweet odor.
Wet	Well	Soft	Non	9	>1000	17	1.8'	19 4 12	
						18		9	Same, oily sheen, sweet odor, trace large GRAVEL >3 IN.
Wet	Well	Soft	Non	10	>1000	19	2.0'	12 16 21	
						20			

GRAPHIC LOG



WELL COMPLETION



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PROJECT\539-12\-06\MW-41S.DRW 9105010800

WELL NUMBER ▶ **MW-41S**

ERM—MIDWEST WELL LOG

MOISTURE CONTENT	SORTING	DENSITY	PLASTICITY	SAMPLE NO.	OVA (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
						20		7	(18 IN. fine grain SAND, 6 IN. coarse SAND and GRAVEL).
Wet	Well	Soft	Non	11	750	21	2.0'	8	Same, trace large well rounded GRAVEL >2 IN.
					25			15	
								20	
						22		12	Fine grain to medium grain SAND with GRAVEL, black stain.
Wet	Well	Soft	Non	12	9	23	2.0'	19	
								17	
						24		22	
						25			Total Depth 24.0 FT.
						26			
						27			
						28			
						29			
						30			
						31			
						32			
						33			
						34			
						35			
						36			
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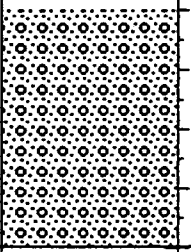
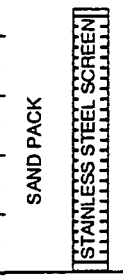
						41			
						42			
						43			
						44			
						45			

GRAPHIC LOG



WELL COMPLETION



LOCATION MAP

ERM–MIDWEST WELL LOG

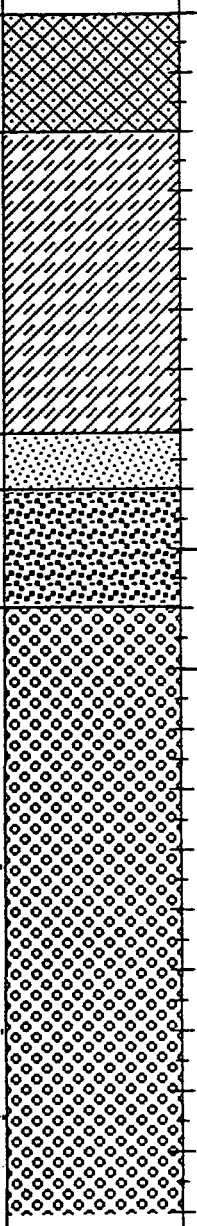
BORE NUMBER ► MW-42S	LOCATION ► PRRS, Fernald, Ohio
DATE ► 10/01/91-10/02/91	WEATHER ► Clear, Dry, Warm
LOGGED BY ► P. Gephard	DRILLED BY ► Mathes & Associates
DRILLING METHOD ► 4 1/4" Hollow Stem Auger	SAMPLING METHOD ► Split Spoon
ELEVATION ► Ground 511.82 FT. T.O.C. 514.04 FT.	GRAVEL PACK ► #7 30-11 FT. / SEAL ► Bentonite 11-8.5 FT.

CASING ► TYPE 306 S.S. DIAMETER 2 IN. LENGTH 13 FT. WATER LEVEL INITIAL 18.5 FT. ■ B.G.S. □ B.M.P. HOLE DIA. 8 IN.

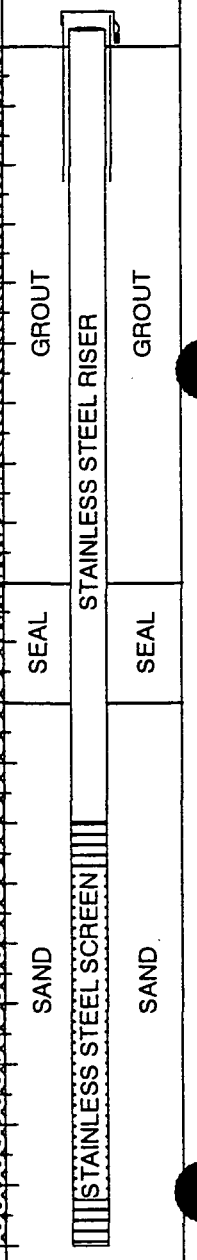
SCREEN ► TYPE 306 S.S. SLOT 0.010 IN. DIAMETER 2 IN. LENGTH 15 FT. WATER LEVEL AT COMPLETION 18.5 FT. H.M.P. TOTAL DEPTH 30 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Loose	0	0–1	0.9'	4, 5, 5, 6	TOPSOIL, dark brown-black, silty clay in rootlets.
2	Moist	Soft	0	2–3	1.0'	4, 4, 4, 6	Dark brown, CLAYEY SILT, poor sorting.
3	Moist	Very Soft	0	4–5	0.9'	5, 3, 3, 4	Dark brown CLAYEY SILT.
4	Moist	Very Soft	0	6–7	1.2'	4, 4, 3, 6	Dark brown CLAYEY SILT.
							Brown MEDIUM SAND, minor silt.
5	Moist	Loose	0	8–9	1.0'	5, 4, 5, 9	Brown medium to COARSE SAND, minor clayey silt (<0.5 IN.) minor fine gravel.
6	Moist	Medium Dense	0	10–11	0.1'	12, 10, 8, 7	Brown medium to fine GRAVEL with minor sand and silt.
7	Moist	Dense	0	12–13	1.3'	6, 10, 18, 18	Tan to light brown, medium to coarse GRAVEL, minor medium sand, minor clay.
8	Moist	Dense	0	14–15	1.5'	7, 18, 18, 24	Tan to light gray, coarse to fine GRAVEL, minor medium sand.
9	Moist	Dense	0	16–17	1.4'	6, 15, 18, 28	Tan to light gray, coarse to fine GRAVEL, minor medium to fine sand
10	Wet	Medium Dense	0	18–19	1.0'	7, 12, 7, 18	▼ Tan to light gray, coarse to fine GRAVEL, minor medium to fine sand.

GRAPHIC LOG



WELL COMPLETION



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PROJECT\539-13\5391342S.DRW

WELL NUMBER ▶ **MW-42S**

ERM—MIDWEST WELL LOG

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
				20			
11	Wet	Medium Dense	0	21	1.1'	5, 12, 13, 13	Tan to gray, medium to coarse GRAVEL, 25% coarse to fine sand.
12	Wet	Medium Dense	0	22–23	1.1'	6, 9, 12, 24	Tan to gray, medium to coarse GRAVEL, 25% fine to coarse sand.
13	Wet	Very Compact	0	24–25	0.5'	+50, -, -, -	Tan to gray, medium to fine GRAVEL, minor medium sand, sanstone refuasl at 24.5 FT. bored to 26. FT.
14	Wet	Dense	2	26–27	0.8'	8, 18, 20, 26	Greenish gray CLAY, mottled.
15	Wet	Dense	2	28–29	1.5'	20, 13, 14, 26	Greenish gray CLAY, mottled.
				30			Total Depth 30.0 FT.
				31			
				32			
				33			
				34			
				35			
				36			
				37			
				38			
				39			
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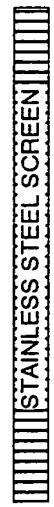
				45			

GRAPHIC LOG

WELL COMPLETION



REV. 1: MAY 1994

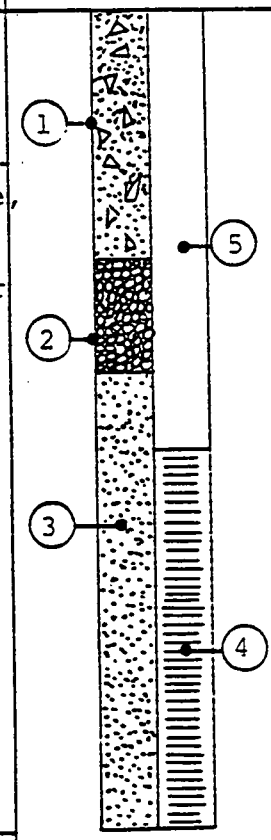
PIEZOMETER CONSTRUCTION

Project 4700-016 Site PRRS PZ-01 Sh 1 of 1
Date Started 6-18-89 Completed 6-18-89 TOC Elevation 532.19 FT.
Total Depth 21.7' Location R-N Site Logged by M. Ferlin
Casing I.D. 2-inch PVC Contractor Bowser-Morner
Remarks Water level during drilling - 14.5 feet

Elev. Feet	Depth Feet	Sample Type & Number	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.	OVA/SM VALUES	Sample Description
			1-2-2-5	0'-2'	0.2	ND/ND	Clay, brown, with some fine sand, wet
	5		3-5-7-13	4'-6'	1.3	ND/ND	Sand, medium to coarse, and Gravel, tan to gray to black, wet (2" organic silt layer found above sand and gravel)
	10		4-8-10-9	9'-11'	0.8	NR	
	15		-	14'-16'	1.7	94/ND	
	20		-	19'-21'	1.1	6/ND	
							Total Depth - 21.7'

ND-Indicates no deflection on the linear display scale.
OVA-Value represents equivalent concentrations of methane (in ppm).
SM-Counts per minute as noted on the linear display scale.
NR - Value not recorded.

Equipment Installed



ENSR

Project 4700-016 Site PRRS PZ-02 Sh 1 of 1

Date Started 6-20-89 Completed 6-20-89 TOC Elevation 531.34 FT.

Total Depth 22.0' Location R-N Site Logged by M. Ferlin

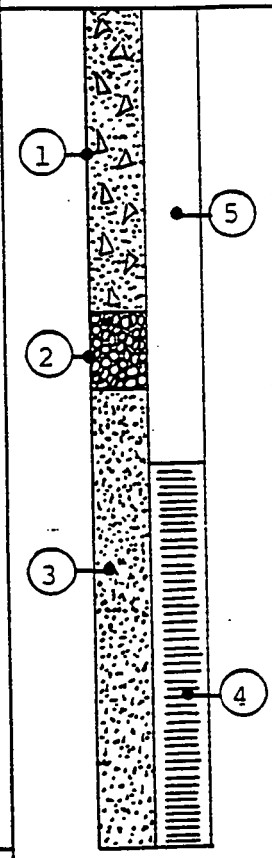
Casing I.D. 2-inch PVC Contractor Bowser-Morner

Remarks Water level during drilling - 13.3 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 in.	Depth Range	Rec.	OVA/SM VALUES	Sample Description
			4-11-16-14	0'-2'	1.4	0.3/ND	Clay, brown, with trace to some fine sand/silt, moist
	5		8-23-70	4'-6'	0.8	1.8/ND	Sand, medium to coarse, and Gravel, large, tan to light gray, moist to wet
	10		25-37-37-30	9'-11'	0.7	0.6/ND	
							Water level 13.3'
	15		16-21-50-42	14'-16'	0.8	0.6/NR	
	20		35-15-27-27	19'-21'	0.9	0.2/ND	
							Total Depth - 22.0'

ND- No deflection on the linear display scale.
NR-Value not recorded.
OVA-Value represents equivalent concentrations of methane (in ppm).
SM-Counts per minute as noted on the linear display scale.

Equipment Installed



Stick up - 2.5

000277

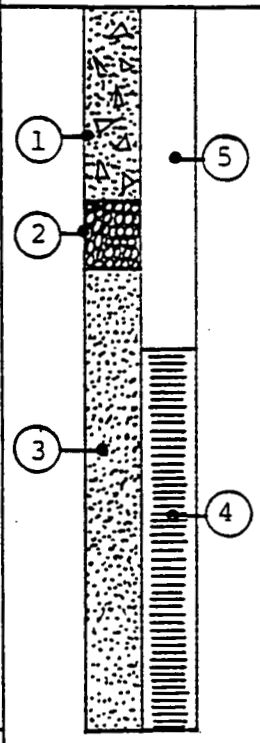
ENSR

Project 4700-016 Site PRRS PZ-03 Sh 1 of 1
Date Started 6-20-89 Completed 6-20-89 TOC Elevation 528.83 FT.
Total Depth Location A&W Site Logged by M. Ferlin
Casing I.D. 2-inch PVC Contractor Bowser-Morner
Remarks Water level during drilling - 10.5 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 In.	Depth Range	Rec.	OVA/SM VALUES	Sample Description
			4-6-9-10	0'-2'	2.0	ND/ND	Silt, brown, with some clay, trace sand, moist
	5		9-11-9-11	4'-6'	1.2	ND/ND	Sand, medium to coarse, and Gravel, fine to medium to large, tan to orange, damp to wet
	10		18-82	9'-11'	0.7	ND/ND	
	15		17-23-82/0.4	14'-16'	0.5	0.2/ND	
	20						Total Depth - 19.0'

ND-No deflection on the linear display scale.
OVA-Value represents equivalent concentrations of methane (in ppm).
SM-Counts per minute as noted on the linear display scale.

Equipment Installed



Stick up-1.6'

ENSR

Project 4700-016 Site PRRS PZ-04 Sh 1 of 1

Date Started 6-20-89 Completed 6-20-89 TOC Elevation 528.94 FT.

Total Depth 21.5 Location Harrisons Foundations Logged by M. Ferlin

Casing I.D. 2-inch PVC Contractor Bowser-Morner

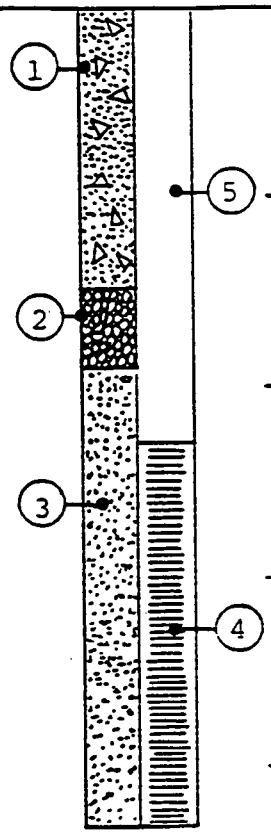
Remarks Water level during drilling - 12.8 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 In.	Depth Range	Rec.	OVA/SM VALUES	Sample Description
			10-31-17-21	0'-2'	2.0	ND/407	Silt, brown, with gravel and sand, moist; to Clay, light tan, with fine sand and silt, moist to wet
	5		5-8-7-6	4'-6'	0.7	0.1/395	
	10		15-50-50	9'-11'	1.2	0.4/385	Sand, medium to coarse, and Gravel, wet
	15		15-35-41-36	14'-16'	1.1	0.3/377	
	20		6-5-8-21	19'-21'	0.0	NR	

Total Depth - 21.5'

ND-Indicates no deflection on the linear display scale.
OVA-Value represents equivalent concentrations of methane (in ppm).
SM-Cumulative counts per 0.10 minutes as recorded on the digital readout.
NR-No recovery.

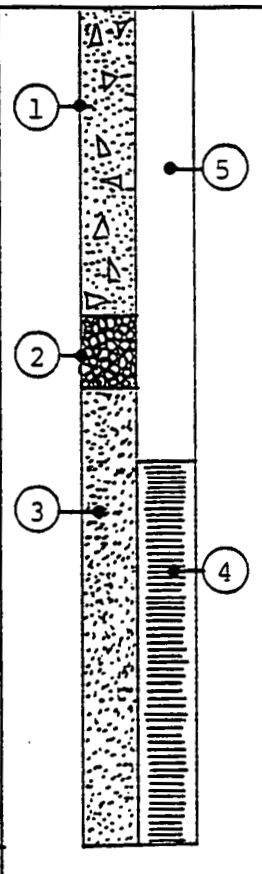
Equipment Installed



Project 4700-016 Site PRRS PZ-05 Sh 1 of 1
Date Started 6-21-89 Completed 6-21-89 TOC Elevation 531.82 FT.
Total Depth 22.0 Location Harrison's Foundation Logged by M. Ferlin
Casing I.D. 2-inch PVC Contractor Bowser-Morner
Remarks Water level during drilling - 14.0 feet

Elev. Feet	Depth Feet	Sample Type & Number	Sample Blows per 6 in.	Sample Depth Range	Sample Rec.	OVA/SM VALUES	Sample Description	Equipment Installed
			5-10-17-24	0'-2'	0.8	ND/485	Clay, with trace to some silt, and trace sand at bottom, dark brown to light brown to tan, some orange mottling at bottom, moist	
	5		3-4-6-9	4'-6'	1.7	ND/471		
	10		3-4-6-9	9'-11'	2.0	ND/540		
							Sand, medium to coarse, and Gravel, orange, moist to wet	
	15		13-13-18-23	14'-16'	0.2	ND/515		
	20		13-31-48-52	19'-21'	0.9	ND/654		
							Total Depth - 22.0'	

ND-Indicates no deflection on the linear display scale.
OVA-Value represents equivalent concentrations of methane (in ppm).
SM-Cumulative counts per 0.10 minute as recorded on the digital readout.



ENSR

Project 4700-016 Site PRRS PZ-06 Sh 1 of 1

Date Started 6-21-89 Completed TOC Elevation 539.61 FT.

Total Depth 24.5 Location Delta Steel Logged by M. Ferlin

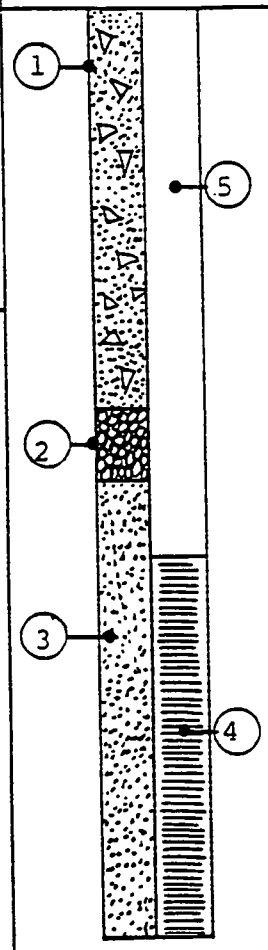
Casing I.D. 2-inch PVC Contractor Bowser-Morner

Remarks Water level during drilling - 16.5 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 In.	Depth Range	Rec.	OVA/ SM VALUES	Sample Description
			5-5-10 -12	0'-2'	1.2	ND/ 522	Clay, with trace silt, brown to tan, moist
	5		3-3-4-	4'-6'	0.6	ND/ 514	
	10		8-12- 16-22	9'-11'	1.3	0.3/ 580	Sand, medium to coarse, and Gravel, fine to coarse, tan to orange to gray to orange brown, moist to wet
	15		24-36- 40-60	14'-16'	1.8	1.2/ 542	
	20		18-24- 28-31	19'-21'	1.0	0.3/ 545	
	25		15-30- 40-38	24'-26'	1.3	3.2/ 513	Total Depth - 26.0'

ND-No deflection on the linear display scale.
OVA-Value represents equivalent concentrations of methane (in ppm).
SM-Cumulative counts per 0.10 minute as recorded on the digital readout.

Equipment Installed

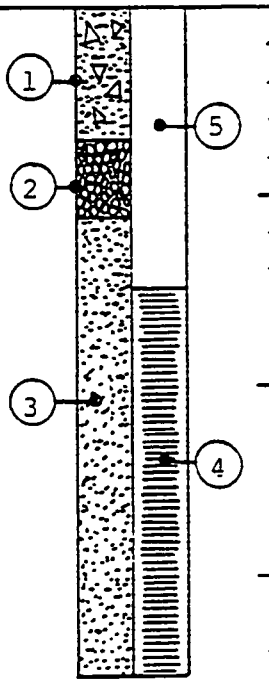


ENSR 000081

Project 4700-016 Site PRRS PZ-07 Sh 1 of 1
Date Started 6-21-89 Completed 6-21-89 TOC Elevation 529.09 FT.
Total Depth 17.5' Location Logged by M. Ferlin
Casing I.D. 2-inch PVC Contractor Bowser-Morner
Remarks Water level during drilling - 9.2 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 In.	Depth Range	Rec.	OVA/SM VALUES	Sample Description
			3-3-4-5	0'-2'	1.7	ND/483	Silt, with trace fine sand, brown, moist
	5		3-3-5-7	4'-6'	1.2	ND/503	Sand, medium to fine to medium, with some fine gravel and coarse sand, gray, moist to wet
	10		3-4-5-7	9'-11'	1.3	ND/469	
	15		11-7-14-13	14'-16'	-	0.1/559	
	20						Total Depth - 17.5' ND-No deflection on the linear display scale. OVA-Value represents equivalent concentrations of methane (in ppm). SM-Cumulative counts per 0.10 minute as recorded on the digital readout.

Equipment Installed



ENSR

Project 4700-016 Site PRRS PZ-08 Sh 1 of 1

Date Started 6-22-89 Completed 6-22-89 TOC Elevation 530.84 FT.

Total Depth 21.5' Location Logged by M. Ferlin

Casing I.D. 2-inch PVC Contractor Bowser-Morner

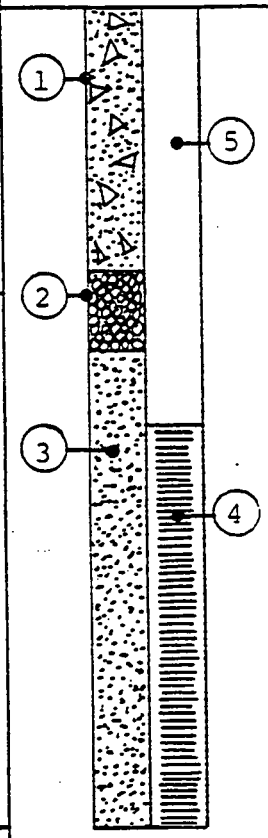
Remarks Water level during drilling - 12.4 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 In.	Depth Range	Rec.	OVA/SM VALUES	Sample Description
			5-7-15-7	0'-2'	1.2	*/460	Silt, with trace fine sand to trace to some clay, brown, moist
	5		10-21-20-9	4'-6'	1.2	*/461	
	10		10-90	9'-11'	0.4	*/470	Sand, medium to coarse and Gravel, fine to medium to coarse, tan to orange, wet
	15		45-50/0.3	14'-16'	0.5	*/597	
	20		25-40-48-30	19'-21'	-	*/443	
							Total Depth - 21.5'

*OVA readings not taken due to pump malfunction.

SM-Cumulative counts per 0.10 minute as recorded on the digital readout.

Equipment Installed



000283

ENSR

Project 4700-016 **Site** PRRS PZ-09 **Sh 1 of** 1
Date Started 6-22-89 **Completed** 6-22-89 **TOC Elevation** 528.02 FT.
Total Depth 18.2' **Location** CSX **Logged by** M. Ferlin
Casing I.D. 2-inch PVC **Contractor** Bowser-Morner
Remarks Water level during drilling - 11.1 feet

Elev. Feet	Depth Feet	Sample Type & Number	Blows per 6 In.	Depth Range	Rec.	OVA/ SM VALUES	Sample Description
			5-6-11 -12	0'-2'	1.2	*/551	Clay and Silt, with trace very find sand, brown, moist to Sand, medium and Gravel fine, with clay, light brown, wet
	5		4-4-11 -11	4'-6'	1.3	*/610	
	10		18-40- 60	9'-11'	1.0	*/579	Sand, medium to coarse, and Gravel, fine to coarse, tan to light gray to orange, wet
	15		94-27- 27-24	14'-16'	0.9	*/593	
	20		11-9- 18-30	19'-21'	0.0	NR	

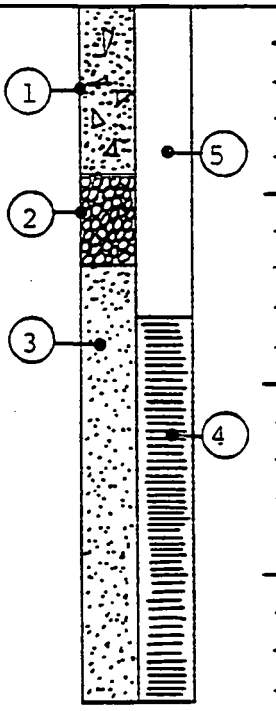
Total Depth - 21.0'

*OVA readings not taken due to pump malfunction.

SM-Cumulative counts per 0.10 minute as recorded on the digital readout.

NR-No recovery.

Equipment Installed



ENSR

Project 4700-016 Site PRRS PZ-10 Sh 1 of 1

Date Started 6-22-89 Completed 6-22-89 TOC Elevation 529.94 FT.

Total Depth 19.0 Location Logged by M. Ferlin

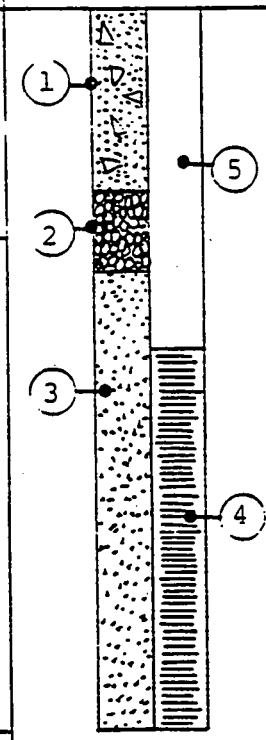
Casing I.D. 2-inch PVC Contractor Bowser-Morner

Remarks

Elev. Feet	Depth Feet	Sample Type & Number	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.		Sample Description	Equipment Installed
			8-7-16 -19	0'-2'	1.2	*/438	Silt and Clay, brown, moist, to Sand, fine to medium with trace silt, dark tan, moist	
	5		4-8-15-21	4'-6'		*/582	Sand, medium to coarse, and Gravel, fine to coarse, tan to gray to brown, with trace of silt, wet	
	10			9'-11'	0.9	*/550		
	15		18-42 -58	14'-16'	1.0	*/751	Very large cobbles from 16.0	
	20						Total Depth - 19.0'	

*OVA readings not taken due to pump malfunction.

SM-Cumulative counts per 0.10 minute as recorded on the digital readout.

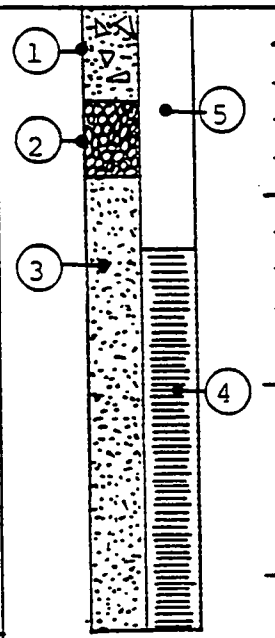


000285

ENSR

Project 4700-016 Site PRRS PZ-11 Sh 1 of 1
Date Started 6-23-89 Completed 6-23-89 TOC Elevation 529.65 FT.
Total Depth Location Logged by M. Ferlin
Casing I.D. 2-inch PVC Contractor Bowser-Morner
Remarks Water level during drilling - 8.4 feet

Elev. Feet	Depth Feet	Sample Type & Number	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.		Sample Description	Equipment Installed
			3-4-5-6	0'-2'	2.0	*/766	Clay, with some silt, and trace to some fine sand, gray to brown, moist to wet, with some orange mottling	
	5		3-3-3-4	4'-6'		*/652		
	10		1/1.5-4	9'-11'	2.0	*/693	Sand, medium to coarse, and Gravel, tan to brown, wet	
	15		-	14'-16'	0.6	*/810		
	20						Total Depth - 16.5' *OVA readings not taken due to pump malfunction. SM-Cumulative counts per 0.10 minute as recorded on the digital readout.	



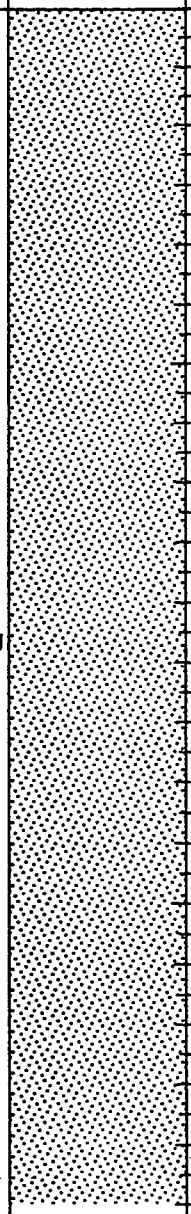
LOCATION MAP

ERM–MIDWEST WELL LOG

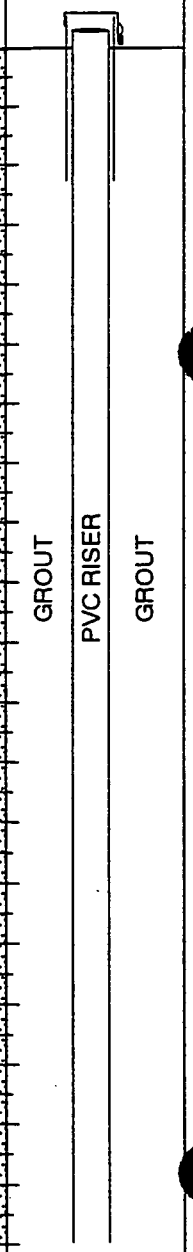
BORE NUMBER ▶ PZ-12		LOCATION ▶ PRRS, Fernald, Ohio	
DATE ▶ 10/01/91		WEATHER ▶ Sunny, 80sF	
LOGGED BY ▶ D. Jakim		DRILLED BY ▶ Mathes & Associates	
DRILLING METHOD ▶ 4 1/4" Hollow Stem Auger		SAMPLING METHOD ▶ Cuttings	
ELEVATION ▶ Ground 520.05 FT. T.O.C. 521.99 FT.	GRAVEL PACK ▶ #7 43-26 FT.	SEAL ▶ Bentonite 26-24 FT.	
CASING ▶ TYPE PVC	DIAMETER 2 IN. LENGTH 30 FT.	WATER LEVEL INITIAL 20 FT. ■ B.G.S. □ B.M.P.	HOLE DIA. 8 IN.
SCREEN ▶ TYPE PVC SLOT 0.010 IN.	DIAMETER 2 IN. LENGTH 15 FT.	WATER LEVEL AT COMPLETION 20 FT. H.M.P.	TOTAL DEPTH 45 FT.

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
1	Moist	Compact		0–5			Dark brown fine SAND with clay, organics, SAND fine well sorted.
2	Moist	Compact		5–10			Brown fine SAND with clay, some organic matter, SAND well sorted.
3	Damp to Moist	Compact		10–15			Brown fine SAND, well sorted, becoming SAND with gravel and pebbles, gravel and pebbles well rounded.
4	Damp to Moist	Compact		15–20			Brown fine SAND, with pebbles and gravel, rare cobble, gravel and pebbles well rounded.

GRAPHIC LOG



WELL COMPLETION



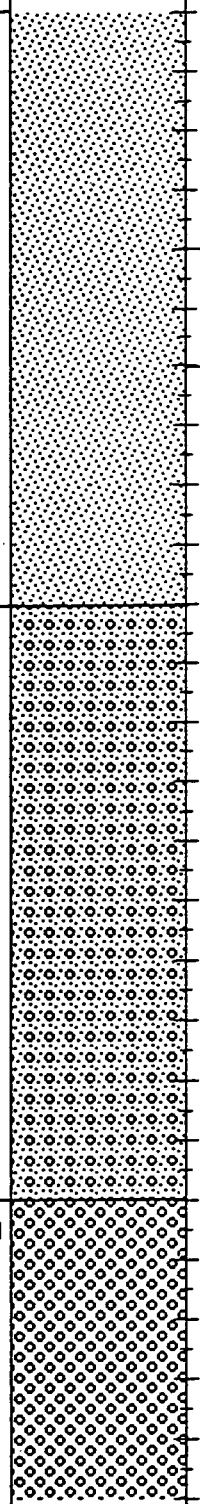
PROJECT\539-13\53913P12.DRW

WELL NUMBER ▶ PZ-12

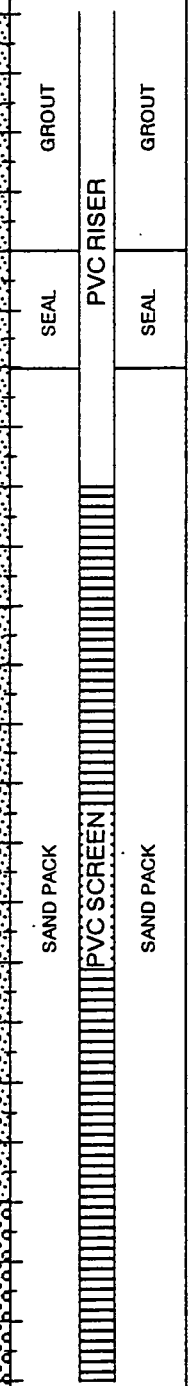
ERM—MIDWEST WELL LOG

SAMPLE NO.	MOISTURE CONTENT	CONSISTENCY	Hnu (ppm)	DEPTH	SAMPLE RECOVERY	PENETRATION RESISTANCE	LITHOLOGY / REMARKS
				20			Fine SAND and gravel with pebbles rare cobble, brown well sorted and rounded.
				21			
				22			
5	Wet	Compact		23			
				24			
				25			Fine SAND and gravel with pebbles rare cobble, brown well sorted and rounded.
				26			
				27			
6	Wet	Compact		28			
				29			
				30			Fine SAND and GRAVEL with few pebbles, rare cobbles, brown, well sorted and rounded.
				31			
				32			
7	Wet	Compact		33			
				34			
				35			Fine SAND and GRAVEL with few pebbles, rare cobbles, brown, well sorted and rounded.
				36			
				37			
8	Wet	Compact		38			
				39			
				40			GRAVEL and COBBLES with fine sand and pebbles.
				41			
				42			
9	Wet	Compact		43			
				44			
				45			

GRAPHIC LOG



WELL COMPLETION



PROJECT\539-13\53913P12.DRW

Appendix F
Laboratory Results for Bulk Density & Permeability

APPENDIX F

LABORATORY RESULTS FOR BULK DENSITY AND PERMEABILITY

FO[illegible]2

JOB NO: T-45 DATE ASSIGNED: 10-11[illegible]

JOB NAME: ERM Midwest, Inc.

RETURN TO: JB/DL

SHEET 1 OF 1

SUMMARY OF LABORATORY TEST RESULTS

BORING	Section	IDENTIFICATION	NATURAL MOISTURE CONTENT	ATTERBERG LIMITS		RELATIVE DENSITY			LOI	PH	Consolidation	UNCONFINED COMPRESSION	TRIAXIAL COMPRESSION	GRADATION		COMPACTION	Perm.
				LIQUID	PLASTIC	MAXIMUM	MINIMUM	Dry Unit Weight						SIEVE	HYDROMETER		
			%	%	%	PCF	PCF	PCF	%		* SEE INDIVIDUAL TEST CURVES						cm/sec
SB-37	1A/II	Gray SICL inm/w CLSI, "and" FM SA	17	25	14				2.3	9.3				*	*		
SB-37	4	Gray Brown F-C SA, lit F-C Gr, lit sicl, inm/w clsi	9	NL	NP			95.6	1.2	8.8				*	*		1.7×10^{-4}
SB-37	1B	Gray Brown SICL inm/w CLSI, "and" F-M SA	19	22	15			107.9						*	*		8.8×10^{-8}
SB-64	II	Gray Brown SICL, tr-lit F-C SA (% varies)	29	32	18			92.2	3.4	8.3				*	*		3.7×10^{-8}

2

PLATE

0002380

0023961

Job No. F45

LABORATORY LOG OF SHELBY TUBES

539-13

Boring SB-37	Sample	Boring SB-64	Sample	Boring	Sample
Depth	Recovery 20"	Depth	Recovery 24"	Depth	Recovery

Boring SB-37 — Depth / Recovery 20"

0 — V, O, 1D, OUT

12 — 1A (MC, AL, MA); 1B (MC, AL, MA, P); 2

GY BR SICL, INM/W CLSI, "AND" FM SA

24 — 3A; 3B P; 4 (MC, AL, MA)

GY BL FC SA, LIT SICL, LIT F-C GR.

36

NOTE: JAR #4 CONTAINS TRIMMINGS FROM S-3B, TRIMMINGS FROM S-1B IS SAVED W/ MATERIAL DISCARDED FROM TOP OF TUBE.

Boring SB-64 — Depth / Recovery 24"

Vo, 1D; OUT

I — H=2.5-2.7

II (MC, AL, MA), P — MST-VST GY BR SICL, TR-LIT FC SA (% VARIES)

III

IV — H=0.5-0.7

LEGEND

- Consolidation, vertical
- Consolidation, horizontal
- Unconfined Compression Test
- Triaxial Test

AL - Atterberg Limits
MA - Mechanical Analysis
SG - Specific Gravity

P - Permeability
MC - Moisture Content
D_R - Relative Density

Form L-1

3

PERMEABILITY TEST RESULTS - FLEXIBLE MEMBRANE METHOD

PROJECT:ERM Midwest Inc.
JOB:T-45 DATE(s) TESTED:10/25-27/91
BORING:SB 64 SAMPLE:II DEPTH:
MATERIAL:Gray Brown Silty Clay, trace fine to coarse sand

SAMPLE DIMENSIONS

CIRC.(cm)	DIA.(cm)	AREA (sq cm)	HEIGHT (cm)	VOLUME (cc)
23.11	7.36	42.50	6.60	280.50

MOISTURE CONTENT

	WET WEIGHT	DRY WEIGHT	WEIGHT OF WATER	PERCENT MOISTURE
BEFORE TEST	534.37	414.45	119.92	28.93
AFTER TEST	537.16	414.45	122.71	29.61

SAMPLE UNIT WEIGHT

UNIT WET WEIGHT = 118.9 pcf
UNIT DRY WEIGHT = 92.2 pcf

TEST CONDITIONS

CHAMBER PRESSURE: 50 psi
BACK PRESSURE: 48 psi
CONFINING PRESSURE: 2 psi

PIPETTE PRESSURES DURING TEST
TOP : 48 psi
BOTTOM : 46 psi

TEST READINGS

DAY	CLOCK TIME	ELAPSED TIME (sec)	TOP PIPETTE (cc)	CHANGE (cc)	BOTTOM PIPETTE (cc)	CHANGE (cc)
1	07:30AM	0.0	15.5	0.0	42.7	0.0
2	12:30PM	104400.0	19.0	3.5	39.2	3.5

COEFFICIENT OF PERMEABLITY (k) = 3.7E-08cm/sec

TESTED BY: JB/DL

PERMEABILITY TEST RESULTS - FLEXIBLE MEMBRANE METHOD

PROJECT:ERM Midwest Inc.
JOB:T-45 DATE(s) TESTED:10/15-21/91
BORING:SB 37 SAMPLE:1B DEPTH:
MATERIAL:Gray Clayey Silt "and" Fine to Medium Sand

SAMPLE DIMENSIONS

CIRC.(cm)	DIA.(cm)	AREA (sq cm)	HEIGHT (cm)	VOLUME (cc)
22.94	7.30	41.88	6.73	281.83

MOISTURE CONTENT

	WET WEIGHT	DRY WEIGHT	WEIGHT OF WATER	PERCENT MOISTURE
BEFORE TEST	577.43	487.21	90.22	18.52
AFTER TEST	575.88	487.21	88.67	18.20

SAMPLE UNIT WEIGHT

UNIT WET WEIGHT = 127.8 pcf
UNIT DRY WEIGHT = 107.9 pcf

TEST CONDITIONS

CHAMBER PRESSURE: 50 psi
BACK PRESSURE: 48 psi
CONFINING PRESSURE: 2 psi

PIPETTE PRESSURES DURING TEST
TOP : 48 psi
BOTTOM : 46 psi

TEST READINGS

DAY	CLOCK TIME	ELAPSED TIME (sec)	TOP PIPETTE (cc)	CHANGE (cc)	BOTTOM PIPETTE (cc)	CHANGE (cc)
1	08:11AM	0.0	38.7	0.0	11.7	0.0
1	14:12PM	21660.0	37.4	1.3	13.0	1.3
1	16:30PM	8280.0	36.6	0.8	14.3	1.3

COEFFICIENTS OF PERMEABILITY , k

FIRST TIME INTERVAL: k= 6.9E-08cm/sec
NEXT TIME INTERVAL: k= 1.4E-07cm/sec

TIME WEIGHTED AVERAGE: k= 9.0E-08cm/sec

TESTED BY: DL/JB

000293

PERMEABILITY TEST RESULTS - FLEXIBLE MEMBRANE METHOD

PROJECT:ERM Midwest Inc
JOB:T-45 DATE(s) TESTED:10/14-16/91
BORING:SB-37 SAMPLE:3B DEPTH:
MATERIAL:Gray Brown Fine to Coarse Sand little fine gravel little silt trace clay

SAMPLE DIMENSIONS

CIRC.(cm)	DIA.(cm)	AREA (sq cm)	HEIGHT (cm)	VOLUME (cc)
22.94	7.30	41.88	6.73	281.83

MOISTURE CONTENT

	WET WEIGHT	DRY WEIGHT	WEIGHT OF WATER	PERCENT MOISTURE
BEFORE TEST	506.00	431.51	74.49	17.26
AFTER TEST	529.58	431.51	98.07	22.73

SAMPLE UNIT WEIGHT

UNIT WET WEIGHT = 112.0 pcf
UNIT DRY WEIGHT = 95.5 pcf

TEST CONDITIONS

CHAMBER PRESSURE: 50 psi
BACK PRESSURE: 48 psi
CONFINING PRESSURE: 2 psi

PIPETTE PRESSURES DURING TEST
TOP : 48 psi
BOTTOM : 46 psi

TEST READINGS

DAY	CLOCK TIME	ELAPSED TIME (sec)	TOP PIPETTE (cc)	CHANGE (cc)	BOTTOM PIPETTE (cc)	CHANGE (cc)
1	08:00AM	0.0	0.0	0.0	70.0	0.0
1	08:04AM	240.0	27.0	27.0	43.0	-27.0
1	08:08AM	240.0	65.4	38.4	4.6	-38.4

COEFFICIENTS OF PERMEABILITY , k

FIRST TIME INTERVAL: k= 1.3E-04cm/sec
NEXT TIME INTERVAL: k= 1.8E-04cm/sec

TIME WEIGHTED AVERAGE: k= 1.6E-04cm/sec

TESTED BY: JB

Appendix G
Groundwater Flow Direction Study

APPENDIX G

GROUNDWATER FLOW METER STUDY

GROUNDWATER FLOWMETER STUDY
PADDYS RUN ROAD SITE
FERNALD, OHIO

PREPARED FOR:

ERM-Midwest
450 West Wilson Bridge Road
Columbus, Ohio

PREPARED BY:

K-V Associates, Inc.
281 Main Street
Falmouth, MA 02540

Job # 842

April 1991

GROUNDWATER FLOWMETER STUDY
PADDYS RUN ROAD SITE, FERNALD, OHIO

Introduction

This report presents the results of a groundwater flowmeter study of eleven monitoring wells at the companies' plants and downgradient of the companies. The study took place on April 17 through 18, 1991. Depth to groundwater averaged 10 ft. The wells are in glacial till composed of sandy clay to gravels. Magnetic declination is 2.5° west of north.

Procedure

The wells are 2" diameter stainless steel with 10 feet of .010 inch screen. A 3-inch thickness of sand pack fills the annulus around each screen (from ENSR installation logs). Total depth of the wells was confirmed by pushing the probe to the bottom of the well. Three measurements of groundwater flow were made in each screen, the first at 2 feet above the bottom of the well, the second at 5 feet above bottom and the third at 7 feet above bottom. Measurements were made using a Model 30 flowmeter with 150 feet of cable and two Model 40 flowmeters with 50 feet of cable, one 1.75 inches in diameter (designated as "2 inch" on the Worksheets and the following Table) and the other 1.25 inches in diameter (designated "1.5 inch"). Methodology for the flowmeter is Appendix A.

The table below presents the measurements for each of the wells. "Poor" or "bad" in parentheses indicates the quality of the vector pattern for that measurement. Flowmeter worksheets are Appendix B.

Table 1. Flowmeter Measurements

Well	Depth (ft)	Direction Magnetic N		Flowmeter reading "machine units"	ft/day
10-S	Bottom of well: 21.6 feet				
(40	19.6	276°	(poor)	7	.6
1.5")*	16.6	237°	(poor)	26	2.2
	13.6	212°		28	2.3
		average: 229°			1.7
11-S	Bottom of well: 21.3 feet				
(40	19.3	320°		64	4.9
2")**	16.3	153°	(poor)	81	6.2
	13.3	303°	(bad)	26	2.0
		average: 249.5°			4.4

* Model 40 flowmeter, 1.25 inch diameter probe
** Model 40, 1.75 inch diameter probe

Well	Depth (ft)	Direction Magnetic N		Flowmeter reading "machine units"	ft/day
13-S (30)***	Bottom of well: 22.9 feet below top of casing				
	19	237°	(poor)	57	4.1
	16	64°	(bad)	6	.4
	14	249°		6	.4
		average: 237°			1.6
14-S (40 2")	Bottom of well: 24.7 feet from top of casing				
	24	267°	(poor)	10	.8
	22	13°	(poor)	11	.9
	19	22°	(bad)	5	.4
		average: 345.5°			.7
14-I (40 1.5")	Bottom of well: 51.6 feet from top of casing				
	48	139°		56	4.7
	45	185°		61	5.1
	42.5	86°		33	2.8
		average: 147.5°			4.2
15-S (40 2")	Bottom of well: 24.7 feet below top of casing				
	22.5	105°		26	2.0
	19.5	116°	(poor)	49	3.8
	16.5	212°	(bad)	184	14 ??
		average: 113°			2.9
15-D (30)	Bottom of well: 82.4 feet below top of casing				
	80.4	186°	(poor)	23	1.6
	77.4	128°	(poor)	28	2.0
	74.4	188°		90	6.4
		average: 177°			3.3
16-S (40 2")	Bottom of well: 23.7 feet below top of casing				
	21.7	26°	(poor)	157	12 ??
	19	342°	(poor)	74	5.7
	16	148°		19	1.5
		average: 148°			1.5
30-S (40 2")	Bottom of well: 26 feet from top of casing				
	23.5	113°		10	.8
	21.5	139°		9	.7
	18.5	214°		20	1.5
		average: 170°			1.0

*** Model 30 flowmeter

000298

Well	Depth (ft)	Direction Magnetic N	Flowmeter reading "machine units"	ft/day
30-I	Bottom of well: 52 feet from top of casing			
(30)	50	130° (poor)	102	7.3 ??
	46.75	146°	53	3.8
	44.75	172°	43	3.1
		average: 157°	3.5	
31-S	Bottom of well: 22.5 feet from top of casing			
(40 2")	20	188°	13	1.0
	18	176°	88	6.8
	15	109°	40	3.1
		average: 160.5	3.6	

Discussion

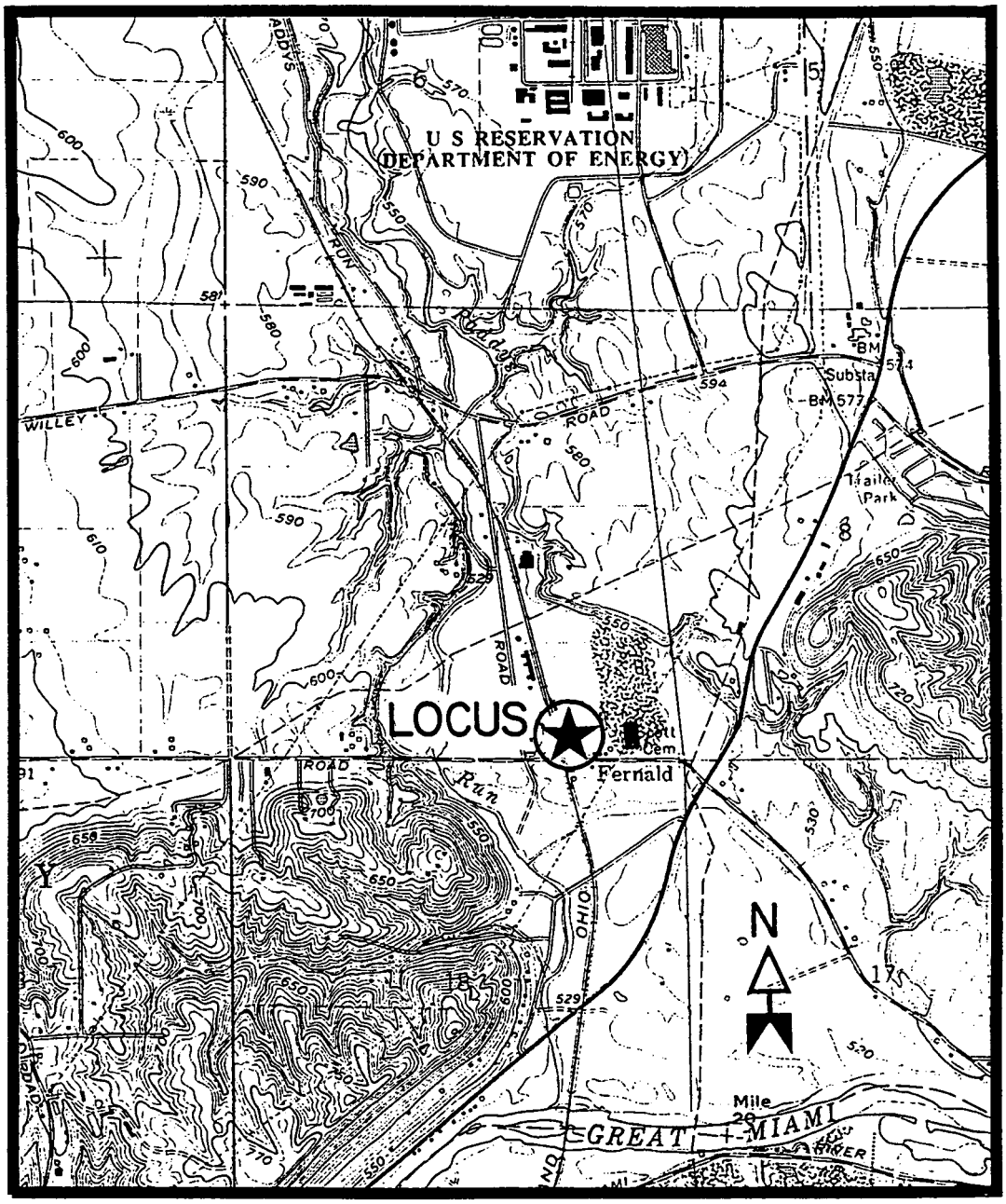
Groundwater flow direction in the majority of the wells was south to southeast. "Bad" measurements are perhaps the result either of a poorly fitting packer (packer loose) or poor flow as a result of fine grained layer at the depth being measured. All measurements in well 14-S were poor probably as a result of fine grained material in the well: the packer, removed after the measurements were made, was covered with black silt. In some wells, as in well 15-S at 16.5 ft, 15-D at 74.4 ft and 16-S at 21.7 ft, high flow velocity may also be due to low flow conditions: the heat building up around the thermistors would result in high readings. These measurements were disregarded when computing the average flow direction and rate.

The northwest flow direction recorded in well 11-S may be due either to outflow from the fire pond or from a leaking underground fire hydrant supply line in the vicinity of the well. The southwest and northeast measurements in well 13-S may be due to local water table fluctuations induced by the passage of a train. During the three hours measuring this well, a locomotive was constantly on the siding east of the well, shunting cars. Experience has shown that this movement can induce oscillation within a shallow aquifer.

Conclusions

Average flow direction relative to magnetic North for each well is shown on Figure 2. Average flow direction of all wells (Figure 3) is southeast (154° True North); average rate of flow is 2.7 ft/day. Flow direction and rate of flow for each well is shown on Figure 4. Flow rate is shown by the vector. The high average rate of flow is some of the wells, for example, 30-I and 31-S, may indicate that there is more gravel in these wells. Overall flow direction is toward the Great Miami River.

Figures



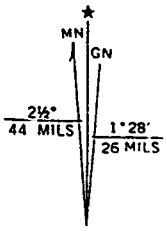


Figure 1. Site Location

000301

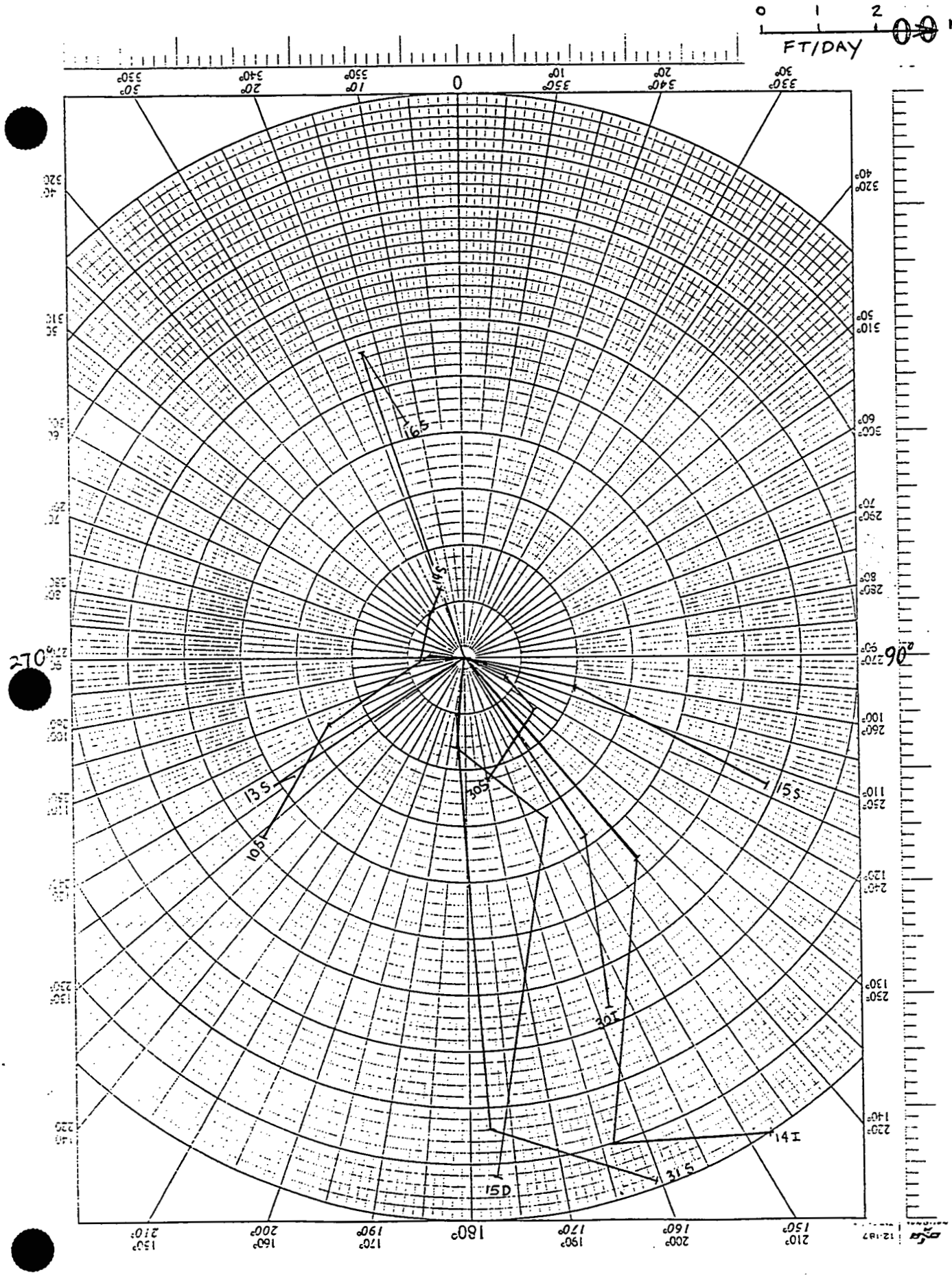


Figure 2. Average Flow Direction, Individual Wells. (Magnetic North)

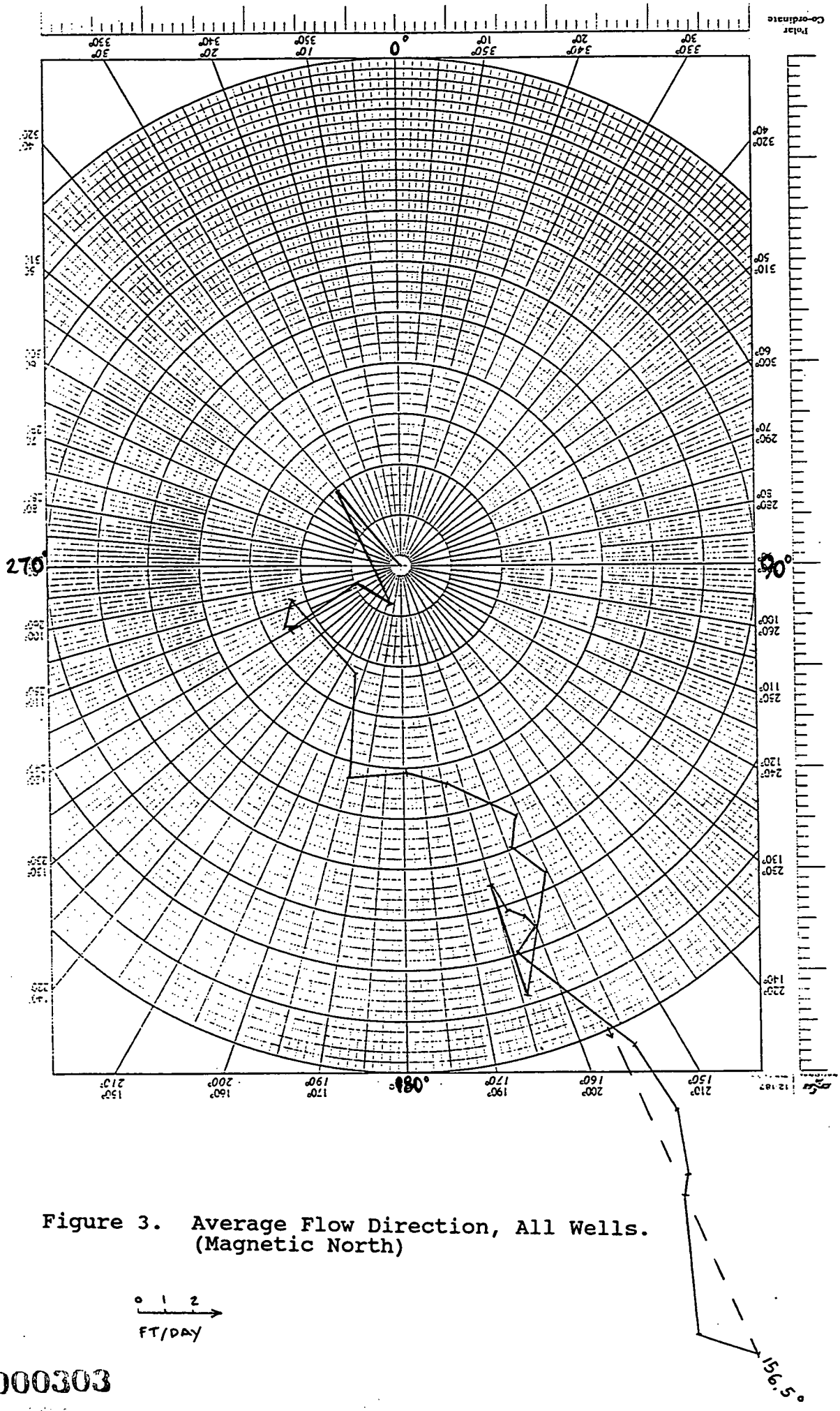


Figure 3. Average Flow Direction, All Wells. (Magnetic North)

000303

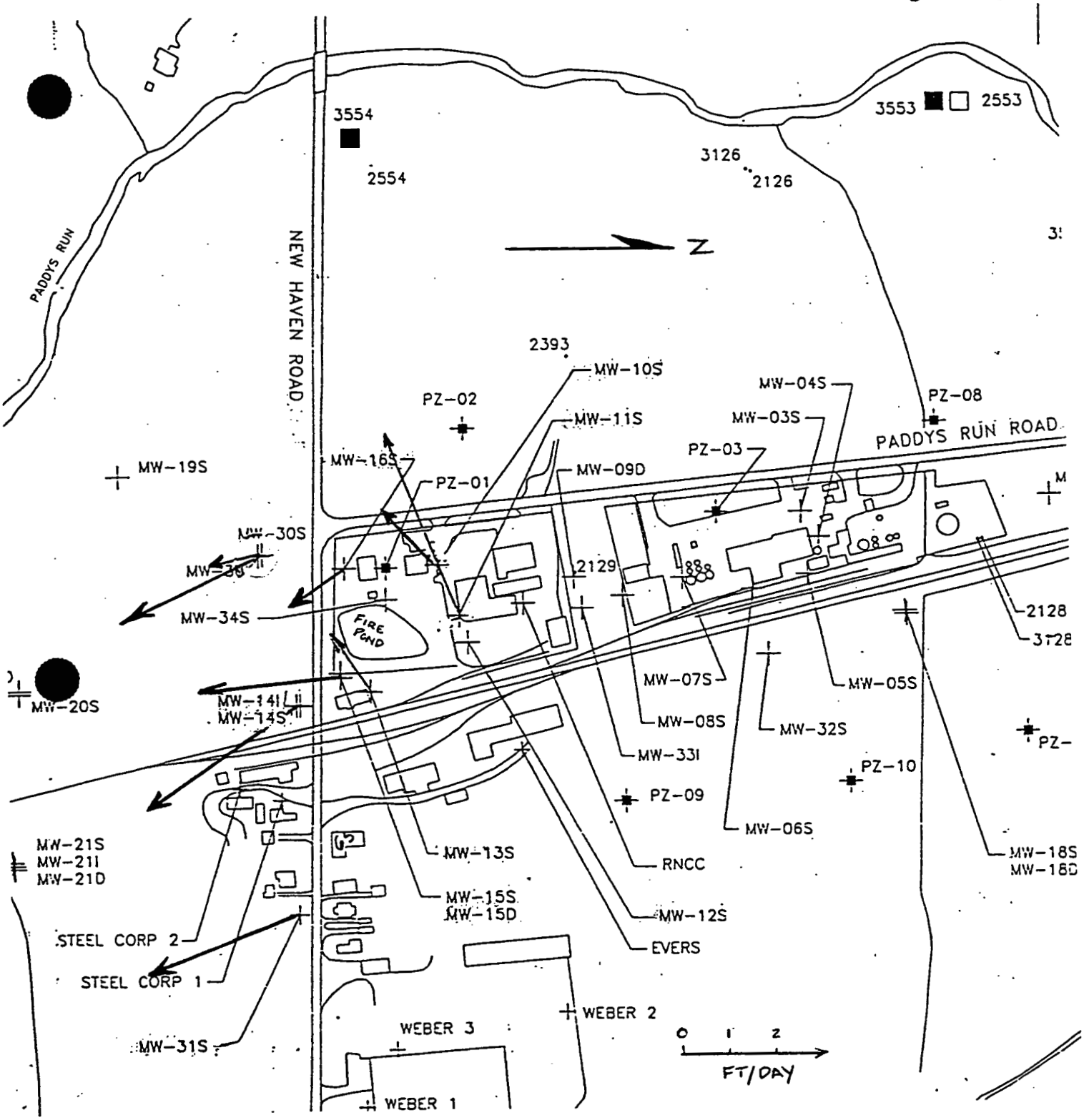


Figure 4. Flow Directions, Ruetgers-Nease Site. (True North)

007361

Appendix A. Flowmeter Methodology

000305

Methodology

The KVA Model 40 and Model 30 GeoFlow groundwater flowmeters were used to determine groundwater flow direction and rate in a monitoring well. The flowmeter operates by emitting a heat pulse and measuring the subsequent temperature differential around the circumference of the well. The heat pulse propagates outward in all directions, and is carried in one direction by the movement of soil pore water. The measured temperature differential is plotted as vectors, determining the direction of groundwater flow. The magnitude of the vectors, when plotted on a calibration curve obtained under laboratory conditions, determines the rate of groundwater flow.

Equipment Description

The instrument consists of a probe with a central heat source surrounded by paired thermal sensors, or thermistors, connected by cable to a control box. The Model 30 has five pairs of thermistors and the Model 40 has four pairs. The relative thermal difference of each pair is displayed on an LCD at the control box, and the + or - sign indicates which of the two thermistors is "reading" the higher temperature. For example, a + value on the 1-6 channel indicates flow (heat) is in the direction of the #1 thermistor. A rotary switch on the control box selects which pair of thermistors is being read and displayed.

A fuzzy packer, a synthetic plush-covered perforated cylinder of the same inside diameter as the monitoring well, filled with glass beads to provide a porous medium through which the flow will stabilize, is screwed onto the probe. The assembly is lowered into the well screen by 10-foot aluminum rods which join together by snap buttons. A modified grip wrench holds the probe at the desired depth. Once the probe is at that depth, the #1 thermistor is oriented to the north, using a compass mounted on the topmost rod.

Operating Procedure

After a wait of 30 minutes to allow static water head conditions to be reestablished, the value for each of the channels is recorded on a Groundwater Flow Worksheet in Column A of the "1-N" box. The heat pulse is activated for 25 seconds by pressing the START button. When a beeper sounds after 2.25 minutes, values from the respective channels are recorded in Column B. The end reading in Column B is subtracted from the first reading in Column A. That value is recorded in Column C.

The probe is then oriented to the south to cancel any bias in the probe, i.e. thermistors closer or farther apart, or less/more sensitive. In a stainless steel screen, the ribs do not allow the packer to be turned at the depth of interest. The probe assembly must be withdrawn into the riser, turned 180°, and reinserted into the screen. After a 30 minute wait, allowing the heat to dissipate and flow to reestablish,

measurements are made as before and recorded in the "1-S" box on the worksheet. The South readings are then subtracted from the North readings, divided by 2 and entered in Column F. Each reading in Column F is then divided by the largest absolute value in this column. These values are recorded in Column G and plotted as vectors on the circular diagram on the worksheet.

The flow direction is found by resolving the vectors, plotting them head to tail, keeping their respective lengths and directions the same. A line is then drawn from the origin to the head of the last vector. This direction is relative to magnetic North (MN), and must be corrected by the magnetic declination of the study area. Alternatively, the KVA Vector Addition Program for the Hewlett-Packard or Texas Instruments programmable calculator can be used.

To determine flow rate for the Model 40, the magnitude of the vectors is found by the calculation:

$$\sqrt{\frac{(\text{1-6 value})^2 + (\text{2-7 value})^2 + (\text{3-8 value})^2 + (\text{4-9 value})^2}{2}}$$

or using the calculator program. For the Model 30, the divisor is 2.5. This resulting value, in "machine units", is then plotted against a calibration curve obtained in the lab to determine flow rate.

Calibration

The flowmeter was calibrated, using the same operating procedure, in an 8" diameter flow chamber packed with soil from the 30-I well. A short length of 2" 010 stainless steel well screen was inserted in the sand and a 3" thickness of #7 sand was then poured around the screen. The chamber was then filled with room-temperature water which is allowed to circulate through the chamber at a known flow rate using a laboratory pump. The probe is fixed in the well screen with the 1-6 thermistor pair oriented parallel to the flow.

Flow is measured in milliliters/minute and converted to ft/day by the formula: ft/day = 0.42 x ml/min. Three readings at increasing flow rates were made and the results plotted on graph paper. A straight line starting at 0,0 is then fitted through these points.

The small diameter Model 40 probe (labelled 1 1/2" on the Flowmeter Worksheets) was damaged by water invasion during the study and could not be calibrated later in the lab. An earlier calibration curve obtained for this instrument in fine sand to gravel with a sand pack was substituted.

In the NO FLOW condition (i.e. there is no water head potential), Fig. a, the center of the expanding heat ring remains stationary. All thermistors see the same temperature rise with time and there is no net difference between opposed pairs of thermistors.

In the FLOW condition, Fig. b., the center of propagation is displaced in the direction of flow, at the flow rate of the water. The propagation rate of the heat wave is much faster than the water; its rise and decay short lived also. The effect of even a very slow flow rate is thus magnified greatly.

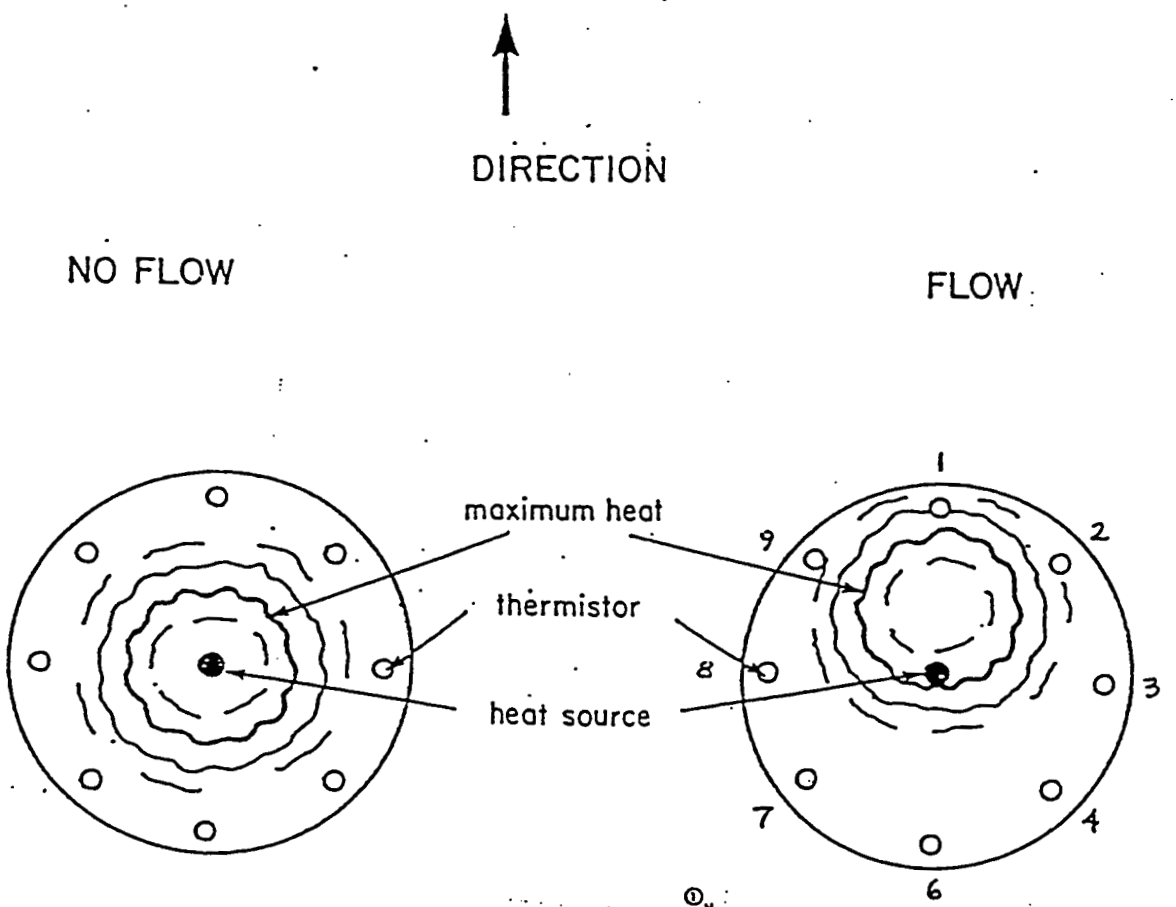


Figure a.

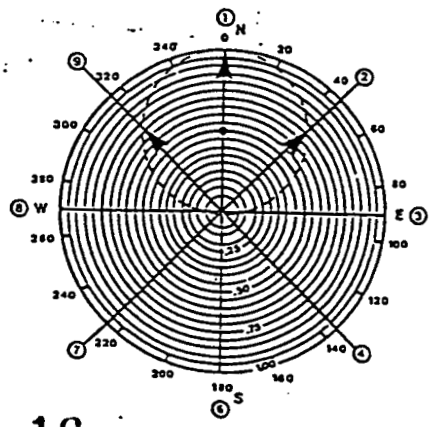
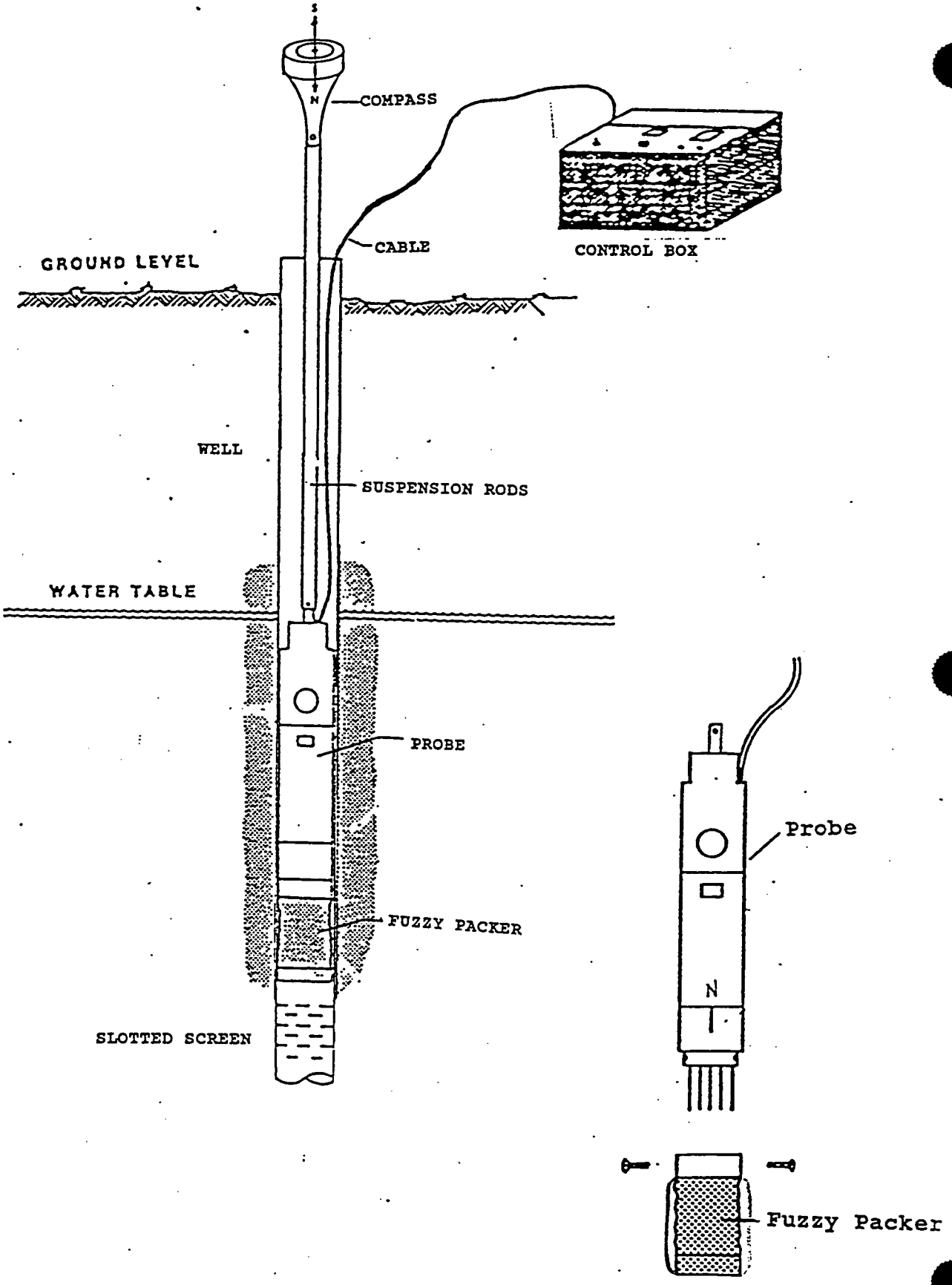


Figure b.



Downwell Setup for the Model 40 Geo Flowmeter

Inset: Attachment of Fuzzy Packer to Probe

000309

meter Worksheets

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: GB Date: 4/17/91 #842

Station: 31-S Time: 9:20

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 20 ft in TOC

TD 22.5 in TOC

Table of LCD Readout

1→N

10:15

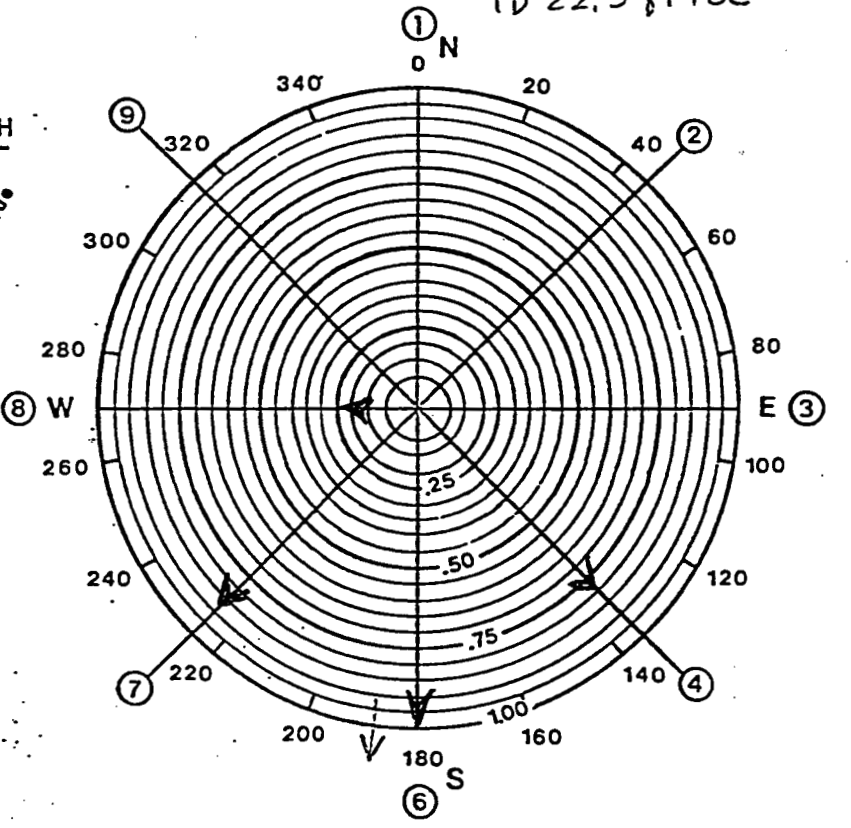
Probe pair	A start	B end	C B-A
+1/-6	+7	$\overline{9}$	$\overline{16}$
+2/-7	+10	$\overline{34}$	$\overline{44}$
+3/-8	+5	$\overline{7}$	$\overline{12}$
+4/-9	+11	0	$\overline{11}$

ROTATE PROBE 180° AT SAME DEPTH

1→S

9:45

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+5	+13	+8	$\overline{12}$	$\overline{1}$
+2/-7	+11	$\overline{12}$	$\overline{23}$	$\overline{10.5}$	$\overline{.88}$
+3/-8	+7	+1	$\overline{6}$	$\overline{3}$	$\overline{.25}$
+4/-9	+14	$\overline{16}$	$\overline{30}$	+9.5	+.79

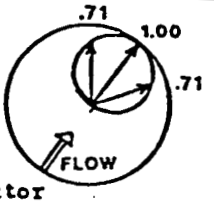


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 188° (MN) Velocity: 13

Form 104 available from your local K-V Associates, Inc. dealer.

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair 10:55	A start	B end	C B-A
+1/-6	+18	-175	-193
+2/-7	+15	+64	+49
+3/-8	+2	+277	+275
+4/-9	+1	+300	+299

Operator: GB Date: 4/17/91 #842

Station: 31-S Time: 10:30

Location: Paddys Run Road Fernald, OH

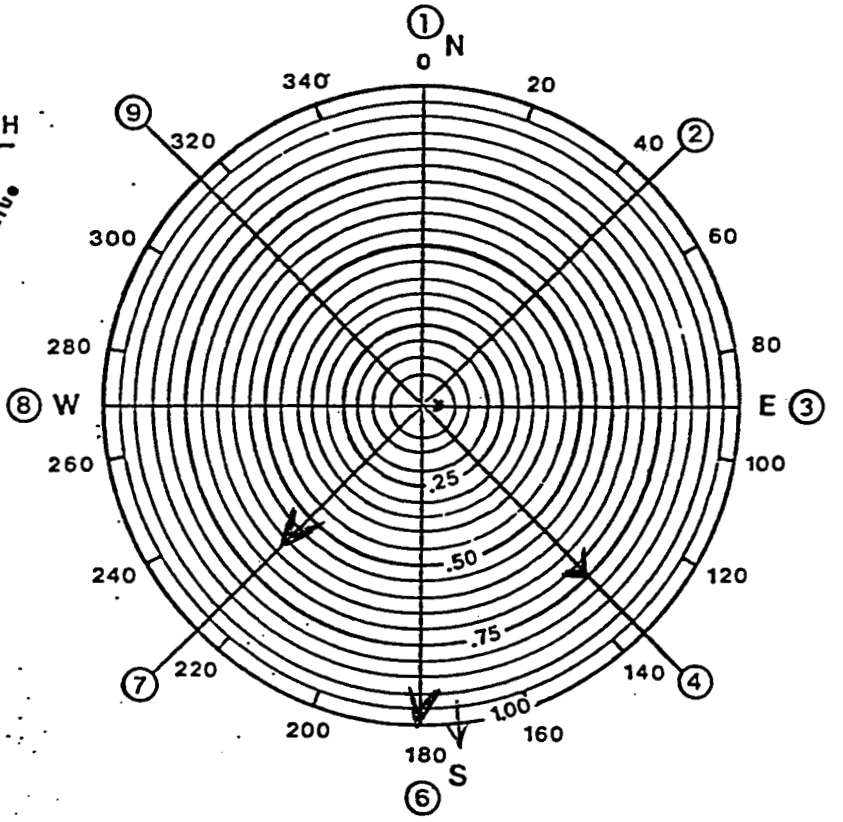
Soil Conditions: silt to medium Gravel

Depth to Measurement: 18 ft to TOC

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair 11:25	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+14	0	-14	-89.5	-1
+2/-7	+29	+189	+160	-55.5	-.62
+3/-8	+26	+295	+269	+3	+.03
+4/-9	+21	+186	+165	+67	+.75

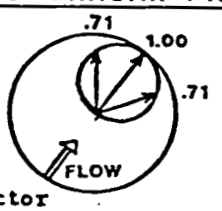


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 176° (MN) Velocity: 88

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/17/91 #842

Station: 31-S Time: 11:35

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 15 ft bTOC

Table of LCD Readout

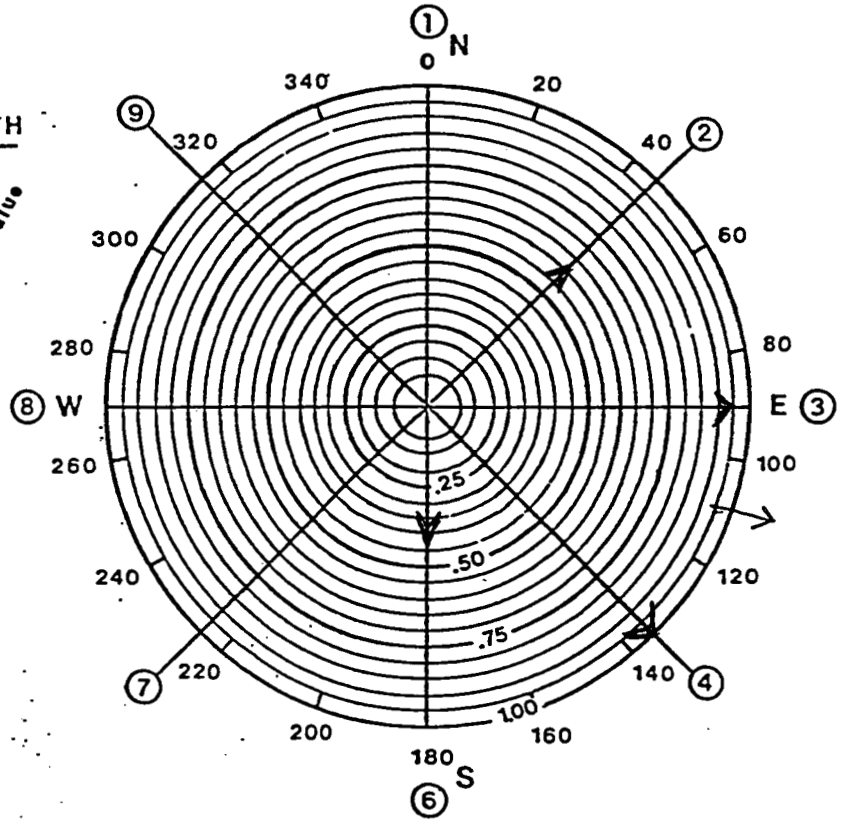
1→N

Probe pair (12:35)	A start	B end	C B-A	12:55 repeat		
+1/-6	0	$\overline{90}$	$\overline{90}$	0	-81	-81
+2/-7	+14	+131	+117	+15	+130	+115
+3/-8	+22	+234	+212	+21	+225	+204
+4/-9	+24	+196	+172	+23	+182	+159

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair (12:00)	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+13	$\overline{45}$	$\overline{58}$	$\overline{16}$	$\overline{.44}$
+2/-7	+25	+97	+72	+22.5	+.62
+3/-8	+22	+164	+142	+35	+.96
+4/-9	+16	+115	+99	+36.5	+1

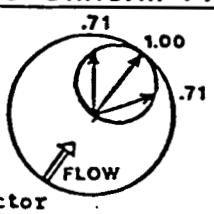


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 109° (MN) Velocity: 40

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000313

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB	Date: 4/17/91	#842
Station: 14 I	Time: 2:00	
Location: Paddys Run Road Fernald, OH		
Soil Conditions: silt to medium Gravel		
Depth to Measurement: 50 ft below TOC		1 1/2"

Table of LCD Readout

1→N

2:30

Probe pair	A start	B end	C B-A
+1/-6	+7	−60	−67
+2/-7	0	−12	−12
+3/-8	+14	+171	+157
+4/-9	0	+104	+104

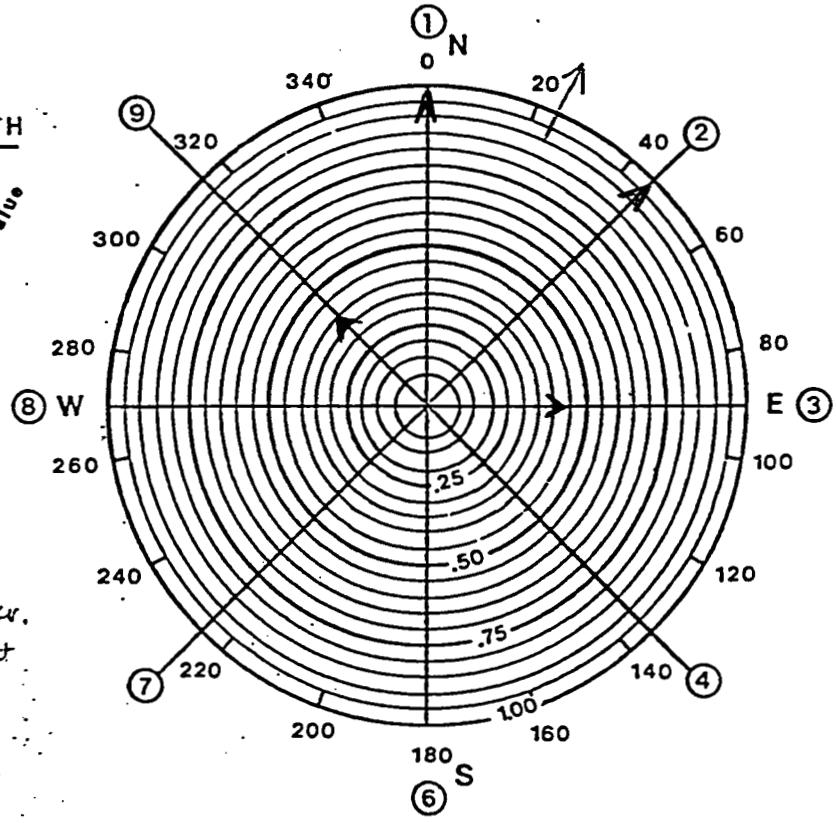
ROTATE PROBE 180° AT SAME DEPTH

1→S

3:00

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+8	−241	−249	+91	+1
+2/-7	0	−190	−190	+89	+.98
+3/-8	+15	+92	+77	+40	+.44
+4/-9	0	+177	+177	−36.5	−.40

Much play in pkr. Prob in silt trap at btm, no flow —

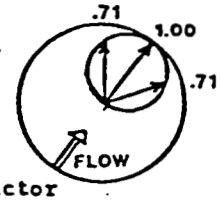


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 23°	Velocity: 98

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

3:50

Probe pair	A start	B end	C B-A
+1/-6	+9	$\bar{1}62$	$\bar{1}71$
+2/-7	0	$\bar{1}36$	$\bar{1}36$
+3/-8	+14	+91	+77
+4/-9	0	+119	+119

Operator: GB Date: 4/17/91 #842

Station: 14 I Time: 3:20

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 48 ft below TOC 1½"

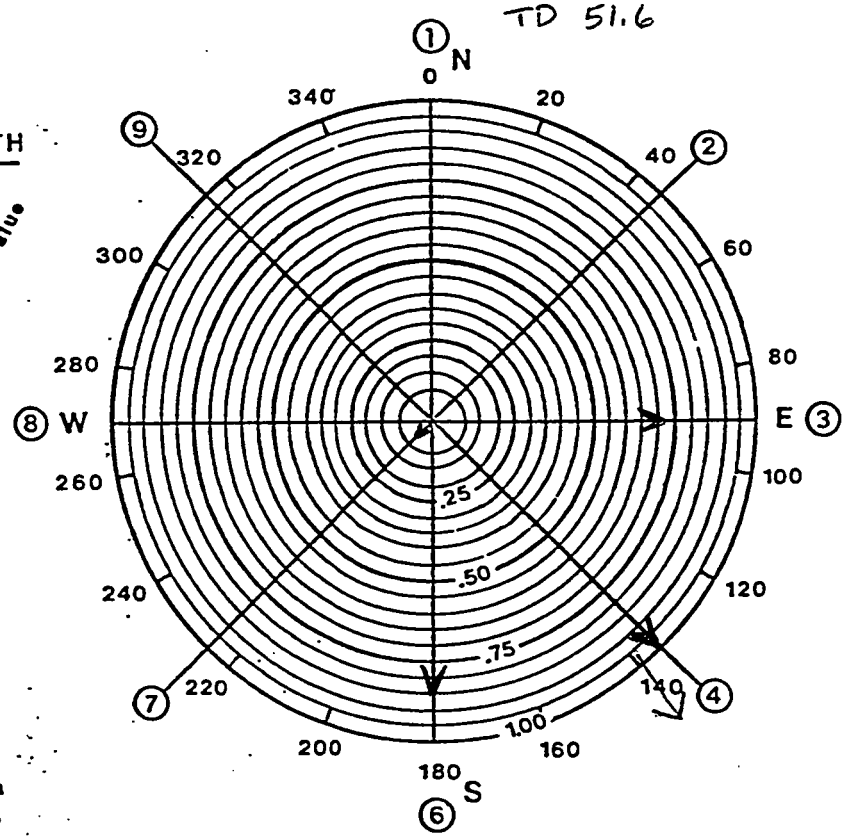
TD 51.6

ROTATE PROBE 180° AT SAME DEPTH

1→S

4:20

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+6	$\bar{7}6$	$\bar{8}2$	$\bar{4}4.5$	$\bar{.}85$
+2/-7	0	$\bar{1}30$	$\bar{1}30$	$\bar{3}$	$\bar{.}06$
+3/-8	+12	+13	+1	+38	+.72
+4/-9	0	+14	+14	+52.5	+1

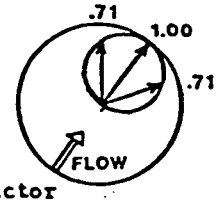


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 139° Velocity: 56

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000315

GROUNDWATER FLOW WORKSHEET 007361

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/17/91 #842

Station: 14-I Time: 4:35

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 45 ft below TOC 1½"

Table of LCD Readout

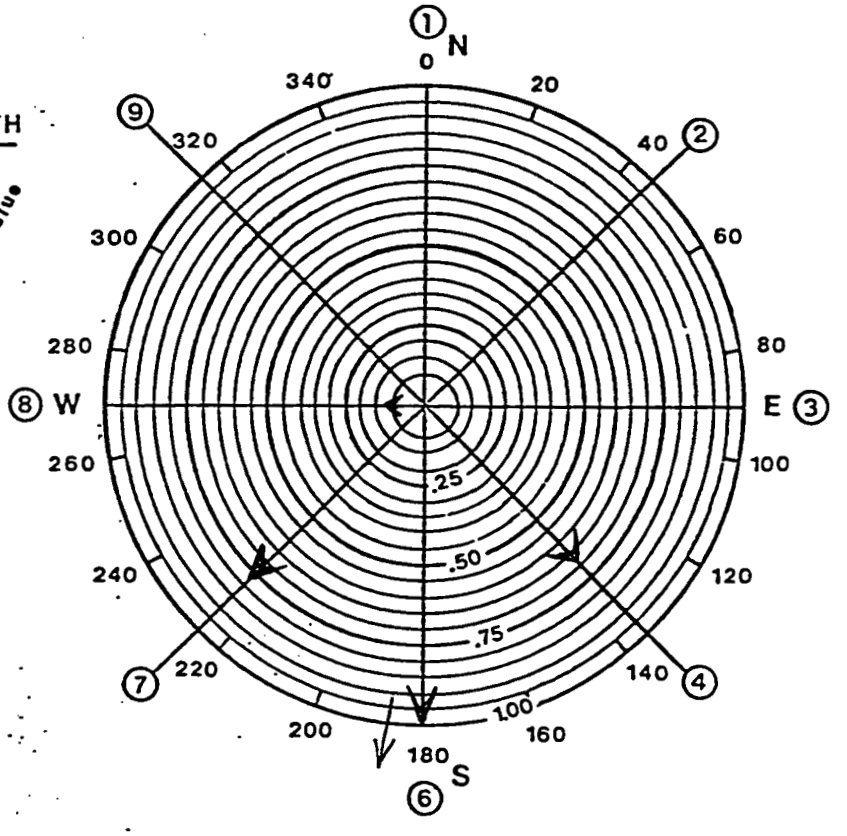
1→N 5:00

Probe pair	A start	B end	C B-A
+1/-6	+5	−198	−203
+2/-7	−6	−164	−158
+3/-8	+12	+85	+73
+4/-9	0	+162	+162

ROTATE PROBE 180° AT SAME DEPTH

1→S 5:30

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+8	−73	−81	−61	−1
+2/-7	0	−68	−68	−45	−.79
+3/-8	+13	+101	+88	−7.5	−.12
+4/-9	0	+80	+80	+41	+.67

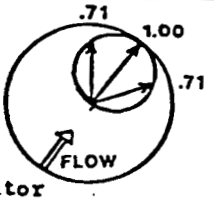


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 185° (MN) Velocity: 61

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000316

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/17/91 #842

Station: 14-I Time: 5:35

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 42.5 ft below TOC 1½"

Table of LCD Readout

1→N

6:25

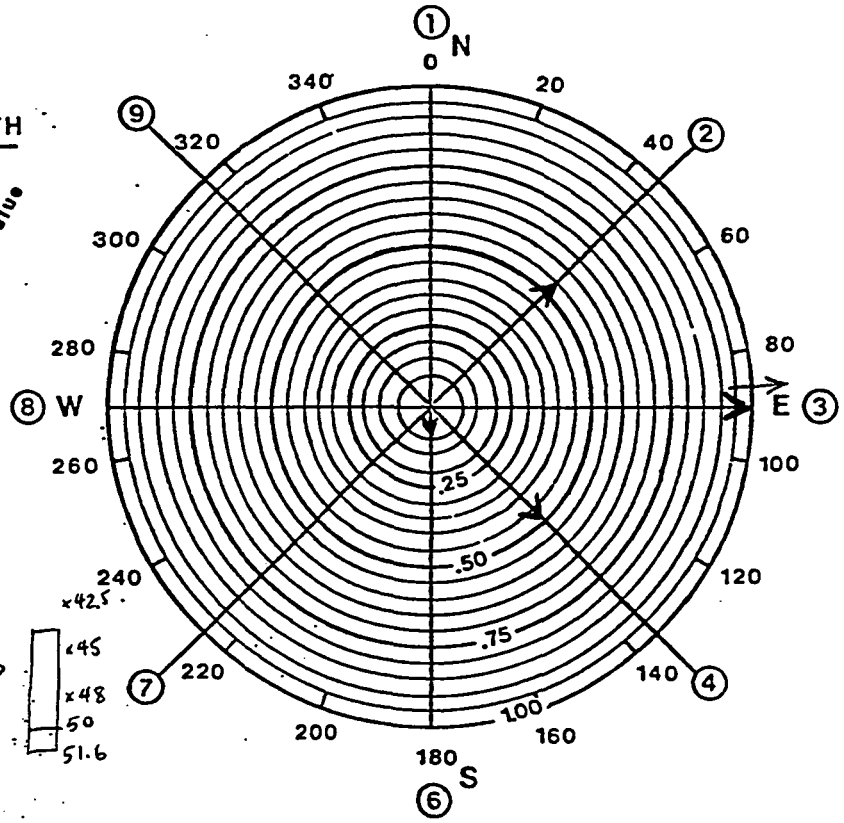
Probe pair	A start	B end	C B-A
+1/-6	+1	−168	−169
+2/-7	−9	−139	−130
+3/-8	+13	+109	+96
+4/-9	+3	+136	+133

ROTATE PROBE 180° AT SAME DEPTH

1→S

6:05

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+6	−170	−176	+3.5	+.09
+2/-7	0	−171	−171	+20.5	+.54
+3/-8	+12	+32	+20	+38	+1
+4/-9	0	+96	+96	+18.5	+.49



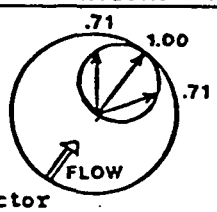
packer moves too easily. 5' screen?

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 86° (MN) Velocity: 33

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000317

GROUNDWATER FLOW WORKSHEET 007361

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: GB Date: 4/17/91 #842

Station: 14-S Time: 2:05

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 24 ft below TOC 2"

TD 24.7 ft

Table of LCD Readout

1→N

3:05

Probe pair	A start	B end	C B-A
+1/-6	0	+18	+18
+2/-7	+2	-36	-38
+3/-8	+2	-29	-31
+4/-9	+15	-14	-29

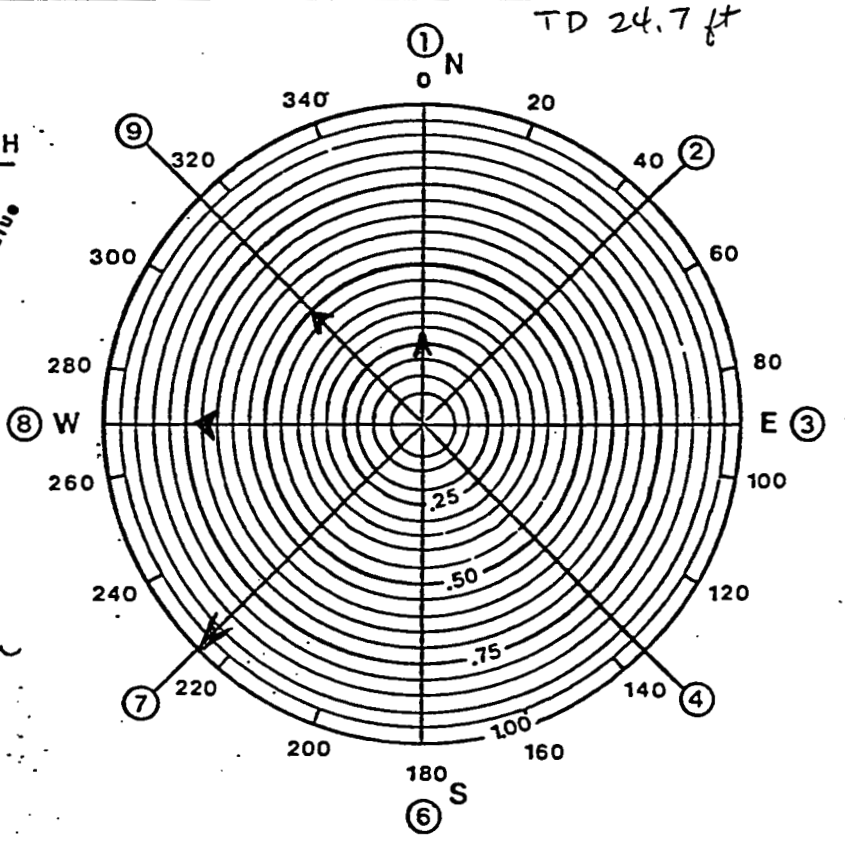
ROTATE PROBE 180° AT SAME DEPTH

1→S

2:35

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+8	+20	+12	+3	+.27
+2/-7	+11	-5	-16	-11	-1
+3/-8	+5	-10	-15	-8	-.73
+4/-9	+9	-9	-18	-5.5	-.5

Poor pattern

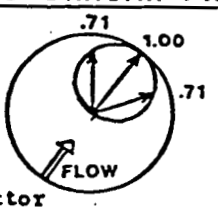


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 267° (MN) Velocity: 10

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: GB Date: 4/17/91 #842

Station: 14-S Time: 3:25

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 22 ft below Toc 2"

Table of LCD Readout

1→N 4:25

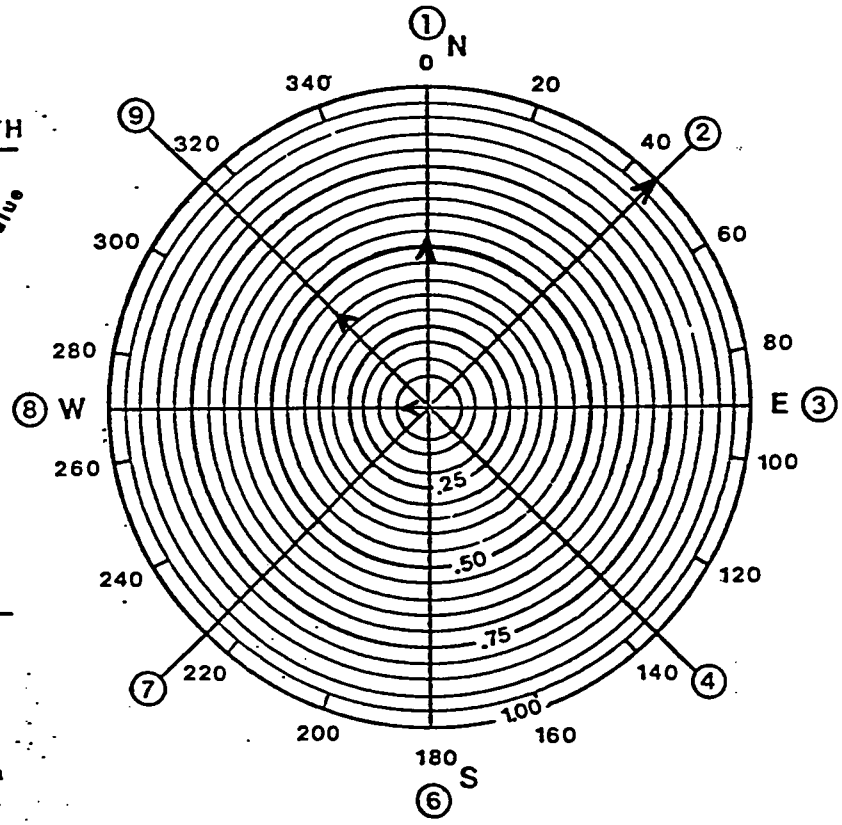
Probe pair	A start	B end	C B-A
+1/-6	+3	+26	+23
+2/-7	+9	-6	-15
+3/-8	+7	-9	-16
+4/-9	+12	-9	-21

ROTATE PROBE 180° AT SAME DEPTH

1→S 3:55

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+6	+14	+8	+7.5	+.52
+2/-7	+8	-36	-44	+14.5	+1
+3/-8	+3	-11	-14	-1	-.07
+4/-9	+10	+1	-9	-6	-.41

poor pattern —

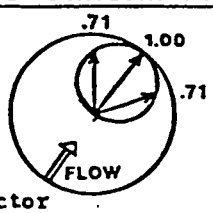


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 13° (MN) Velocity: 11

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000319

GROUNDWATER FLOW WORKSHEET 007361

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

5:05

Probe pair	A start	B end	C B-A
+1/-6	+2	+13	+11
+2/-7	+6	-10	-16
+3/-8	+3	-14	-17
+4/-9	+11	-13	-24

Operator: GB Date: 4/17/91 #842

Station: 14-S Time: 4:40

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19 ft below Toc 2"

ROTATE PROBE 180° AT SAME DEPTH

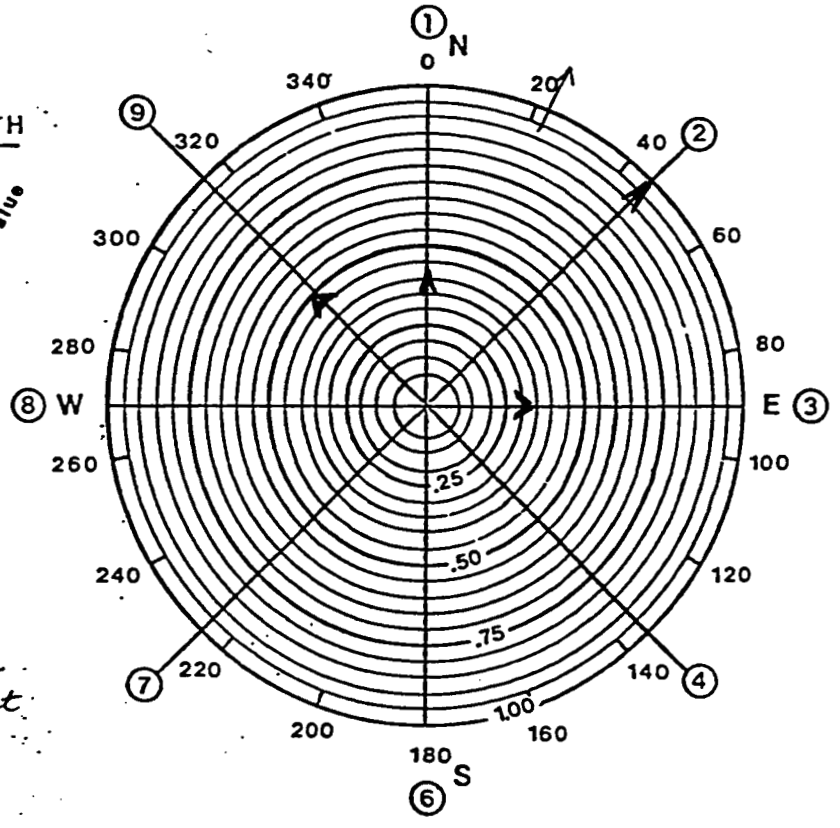
1→S

5:40

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+3	+9	+6	+2.5	+.42
+2/-7	+6	-22	-28	+6	+1
+3/-8	+1	-20	-21	+2	+.33
+4/-9	+9	-8	-17	-3.5	-.5

Bad Pattern

When removed, packer covered w/ black silt

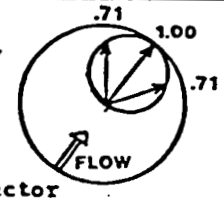


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 22° (MN) Velocity: 5

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair 8:40	A start	B end	C B-A
+1/-6	+8	−22	−30
+2/-7	0	−42	−42
+3/-8	+12	+76	+64
+4/-9	0	+10	+10

Operator: GB Date: 4/18/91

Station: 10-S Time: 8:05

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19.6 ft

#842

HNu: 0.4ppm when well opened

1½"

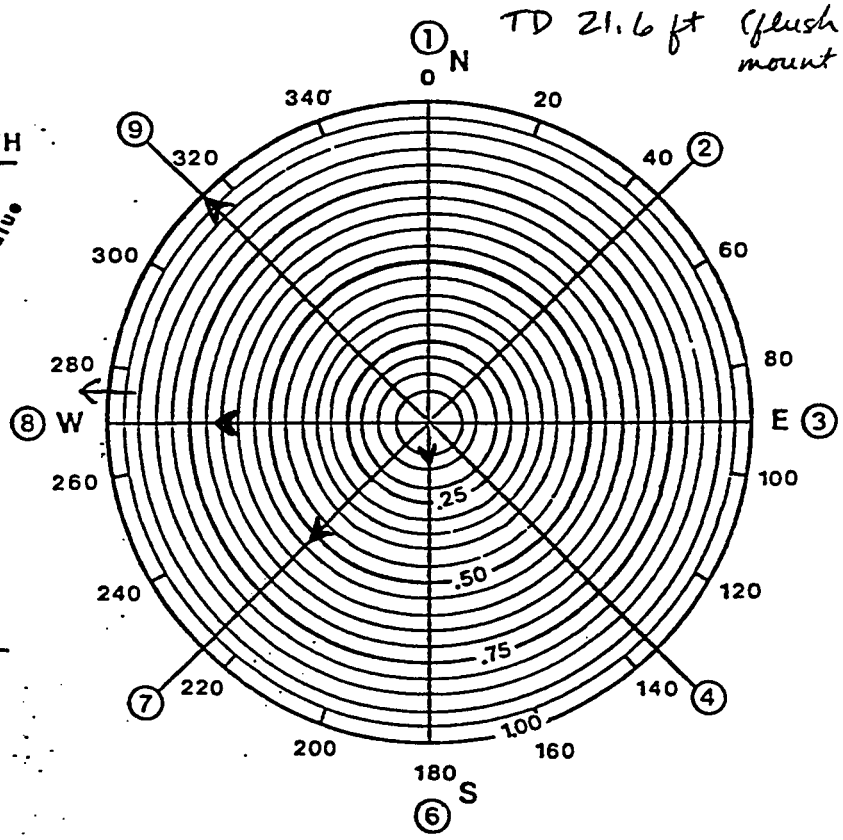
TD 21.6 ft (flush mount)

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+11	−17	−28	−1	−.13
+2/-7	0	−34	−34	−4	−.53
+3/-8	+12	+86	+74	−5	−.67
+4/-9	0	+25	+25	−7.5	−1

Poor Pattern

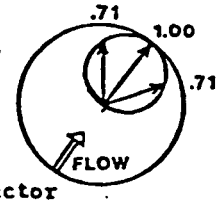


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 276° (MN) Velocity: 7

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000321

GROUNDWATER FLOW WORKSHEET

007361

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

10:15

Probe pair	A start	B end	C B-A
+1/-6	+9	$\overline{14}$	$\overline{23}$
+2/-7	0	$\overline{51}$	$\overline{51}$
+3/-8	+15	+67	+52
+4/-9	0	0	0

Operator: GB Date: 4/18/91 #842

Station: 10-S Time: 9:15

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 16.6 ft 1½"

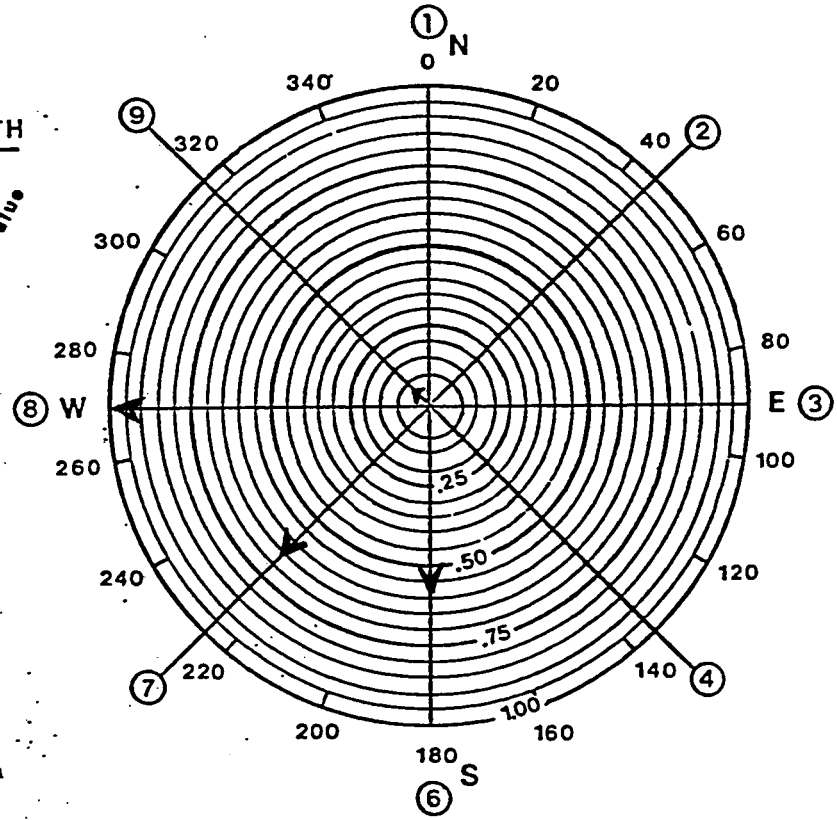
ROTATE PROBE 180° AT SAME DEPTH

1→S

9:45

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+11	+21	+10	$\overline{16.5}$	$\overline{.57}$
+2/-7	0	$\overline{13}$	$\overline{13}$	$\overline{19}$	$\overline{.66}$
+3/-8	+14	+124	+110	$\overline{29}$	$\overline{1}$
+4/-9	0	+4	+4	$\overline{2}$	$\overline{.07}$

Poor pattern

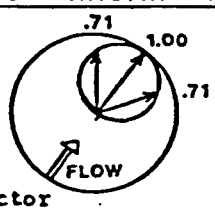


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 237° (MN) Velocity: 26

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000322

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: GB Date: 4/18/91 #842

Station: 10-S Time: 10:20

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel 1½"

Depth to Measurement: 13.6 ft

Table of LCD Readout

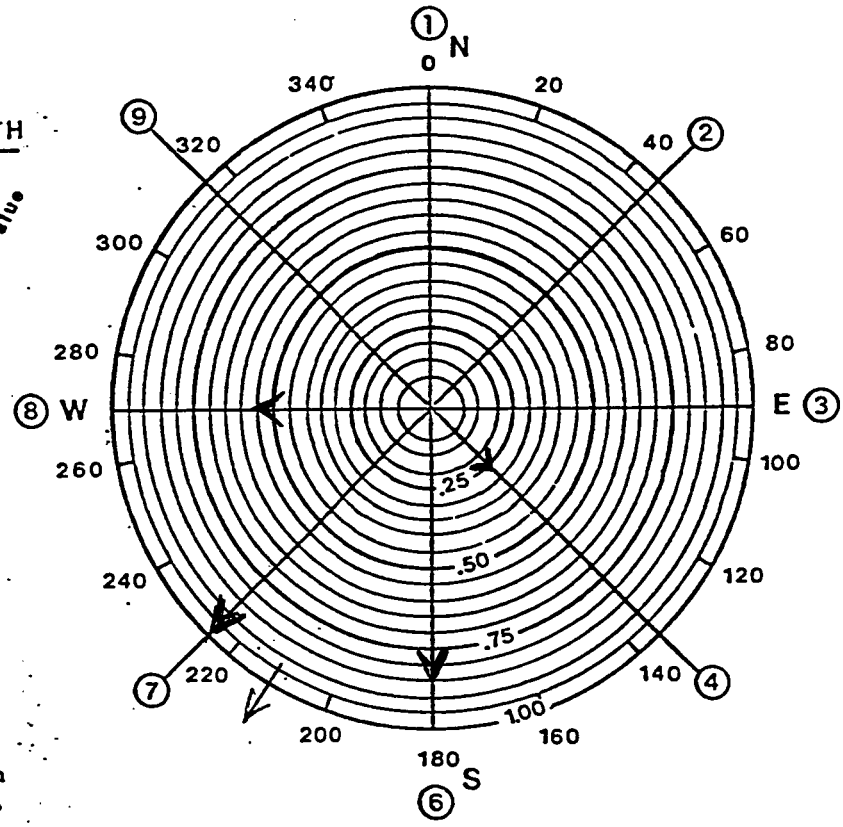
1→N 10:50

Probe pair	A start	B end	C B-A
+1/-6	+11	−26	−37
+2/-7	0	−43	−43
+3/-8	+14	+94	+80
+4/-9	0	+28	+28

ROTATE PROBE 180° AT SAME DEPTH

1→S 11:25

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+11	+20	+9	−23	−.85
+2/-7	0	+11	+11	−27	−1
+3/-8	+15	+125	+110	−15	−.56
+4/-9	0	+14	+14	+7	+.26

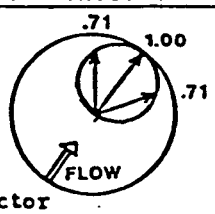


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 212° (MN) Velocity: 28

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000323

007361

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

8:50

Probe pair	A start	B end	C B-A	9:05 repeat	
+1/-6	+3	+32	+29	0 +30	+30
+2/-7	+8	+5	-3	+5 +2	-3
+3/-8	+4	-12	-16	+1 -15	-16
+4/-9	+11	-26	-37	+12 -27	-39

Operator: GB Date: 4/18/91

Station: 11-S Time: 8:20

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19.3

#842

HNu wellhead: 400 ppm

working area 0.6

2"

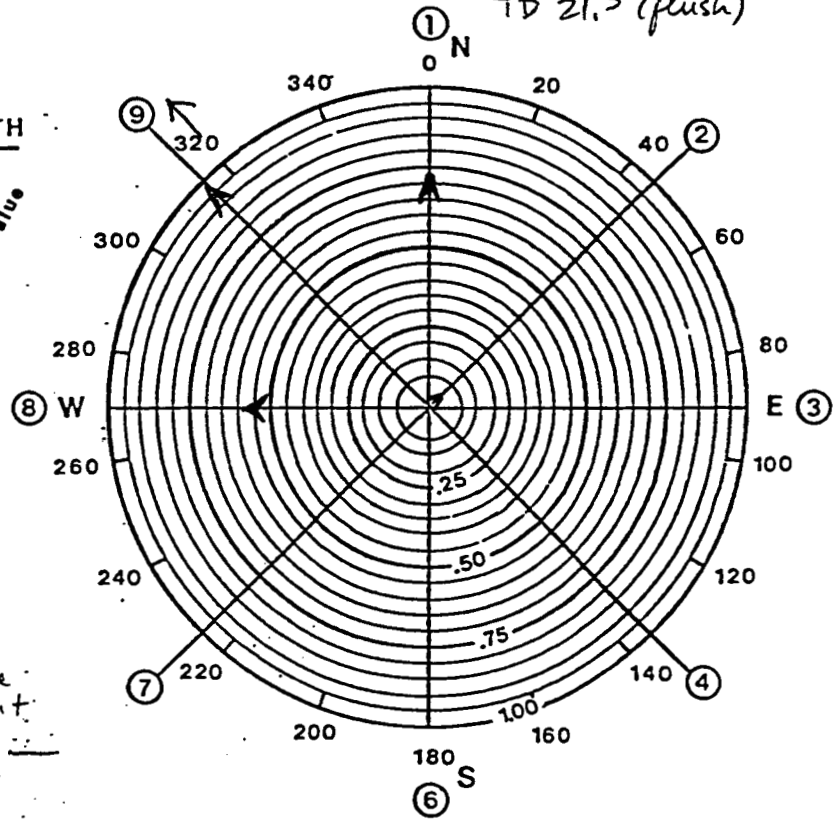
TD 21.3 (flush)

ROTATE PROBE 180° AT SAME DEPTH

1→S

9:35

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+6	-62	-68	+48.5	+.73
+2/-7	+9	0	-9	+3	+.05
+3/-8	+4	+65	+61	-38.5	-.58
+4/-9	+11	+106	+95	-66	-1



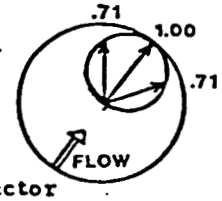
RNCC: pumping well ~300' to NW. "Deadheads" all the time. No meter, don't know when pumps

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 320° (MN) Velocity: 64

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/18/91 #842

Station: 11-S Time: 9:40

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 16.3 ft 2"

Table of LCD Readout

1→N 10:35

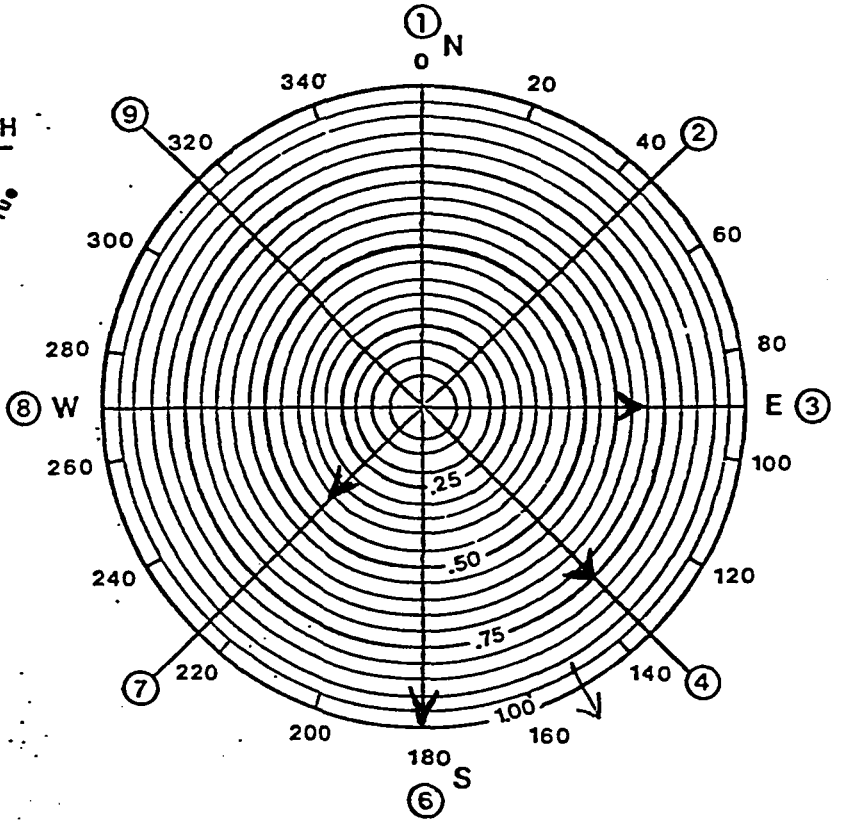
Probe pair	A start	B end	C B-A
+1/-6	+10	−102	−112
+2/-7	+11	−16	−27
+3/-8	+3	+108	+105
+4/-9	+7	+172	+165

ROTATE PROBE 180° AT SAME DEPTH

1→S 10:05

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+6	+53	+47	−79.5	−1
+2/-7	+10	+49	+39	−33	−.42
+3/-8	+5	+2	−3	+54	+.68
+4/-9	+13	+58	+45	+60	+.75

Poor pattern

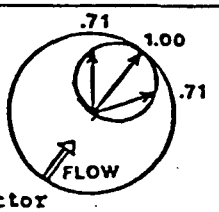


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 153° (MN) Velocity: 81

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000325

007361

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: GB Date: 4/18/91 #842

Station: 11 S Time: 10:40

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 13.3 ft 2"

Table of LCD Readout

1→N 11:05

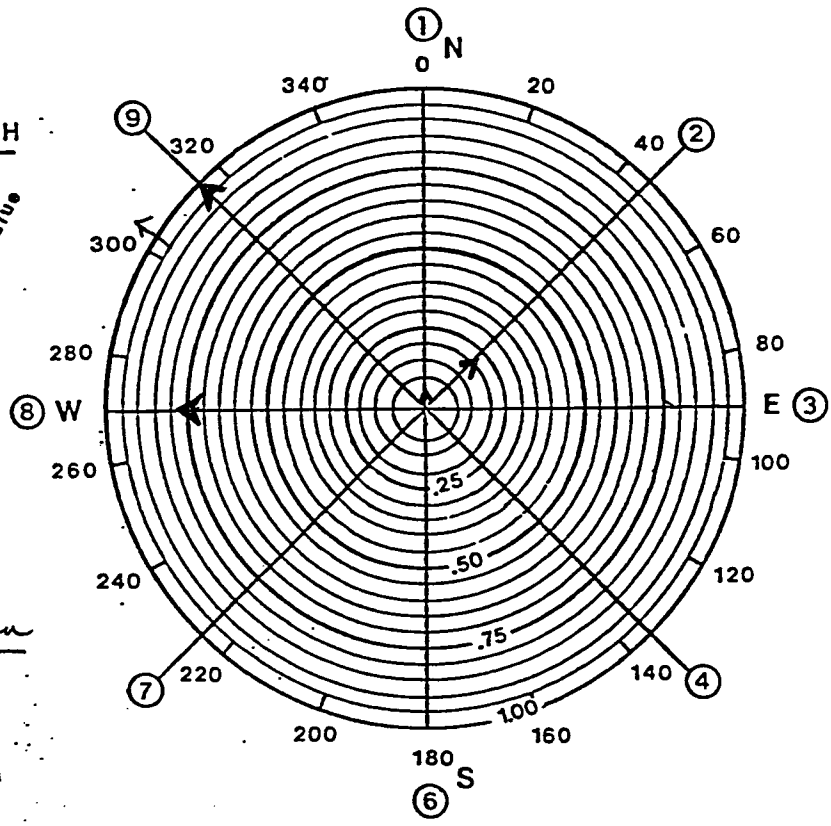
Probe pair	A start	B end	C B-A
+1/-6	+6	+60	+54
+2/-7	+9	+21	+12
+3/-8	+5	-23	-28
+4/-9	+13	-33	-46

ROTATE PROBE 180° AT SAME DEPTH

1→S 11:35

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+3	+56	+53	+.5	+.02
+2/-7	+7	+5	-2	+7	+.21
+3/-8	+4	+28	+24	-26	-.79
+4/-9	+11	+31	+20	-33	-1

Bad pattern

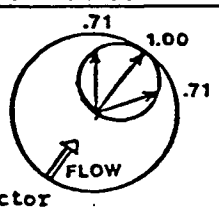


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 303° (MN) Velocity: 26

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000326

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/18/91 #842

Station: 30 S Time: 13:20

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 23.5 ft below TOC 2"

TD 26 ft

Table of LCD Readout

1→N

13:50

Probe pair	A start	B end	C B-A
+1/-6	+5	+31	+26
+2/-7	+9	+5	-4
+3/-8	+6	-26	-32
+4/-9	+12	-27	-39

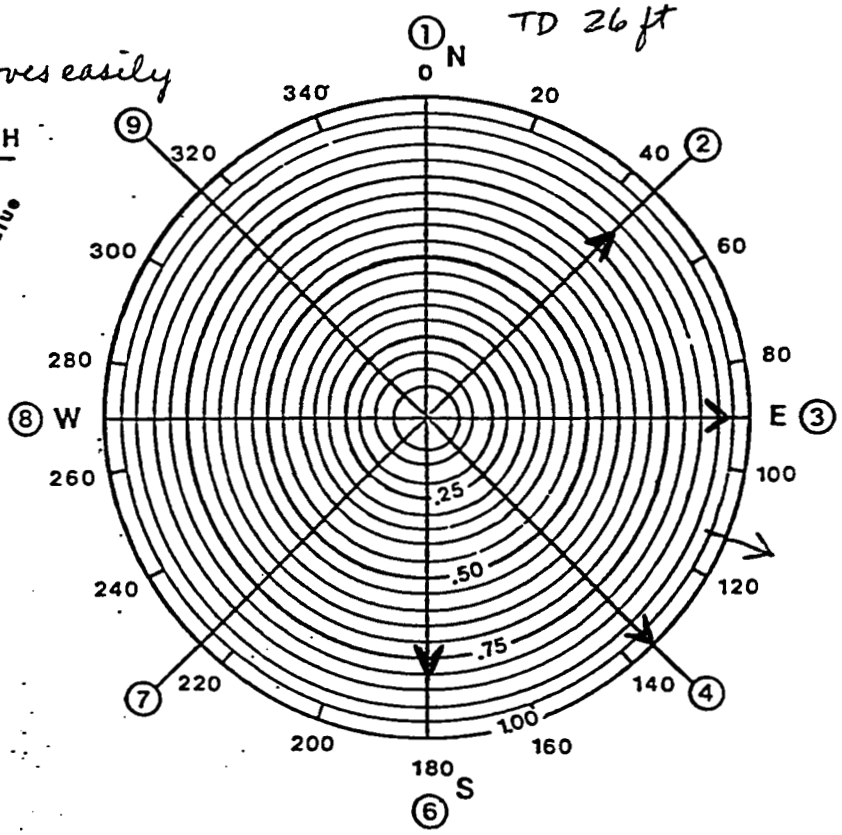
Packer moves easily

ROTATE PROBE 180° AT SAME DEPTH

1→S

14:30

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+3	+42	+39	-6.5	-.81
+2/-7	+8	-9	-17	+6.5	+.81
+3/-8	+4	-43	-47	+7.5	+.94
+4/-9	+12	-43	-55	+8	+1



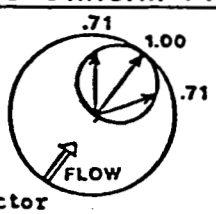
Poor pattern

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 113° (MN) Velocity: 10

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000327

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe 007361

Table of LCD Readout

1→N

15:20

Probe pair	A start	B end	C B-A
+1/-6	+2	+11	+9
+2/-7	+6	-6	-12
+3/-8	+5	-18	-23
+4/-9	+13	+4	-9

@320°

Operator: GB Date: 4/18/91 #842

Station: 30 S Time: 14:35

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 21.5 ft below TOC 2"

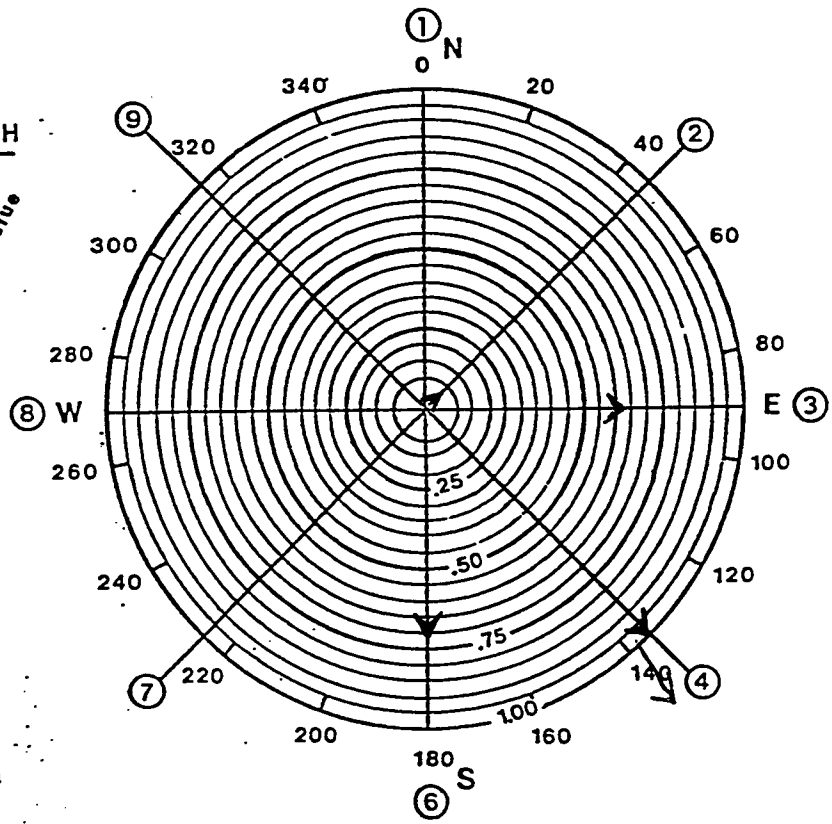
ROTATE PROBE 180° AT SAME DEPTH

1→S

15:00

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+7	+29	+22	-6.5	-.72
+2/-7	+10	0	-10	-1	-.11
+3/-8	+5	-30	-35	+6	+.63
+4/-9	+11	-17	-28	+9.5	+1

@135°

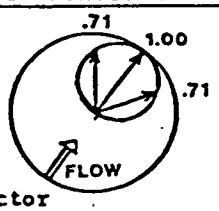


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 139° (MN) Velocity: 9

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000328

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

3:50

Probe pair	A start	B end	C B-A
+1/-6	0	$\bar{1}6$	$\bar{1}6$
+2/-7	+2	$\bar{5}6$	$\bar{5}8$
+3/-8	+5	$\bar{4}6$	$\bar{5}1$
+4/-9	+14	0	$\bar{1}4$

Operator: GB Date: 4/18/91 #842

Station: 30 S Time: 15:25

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

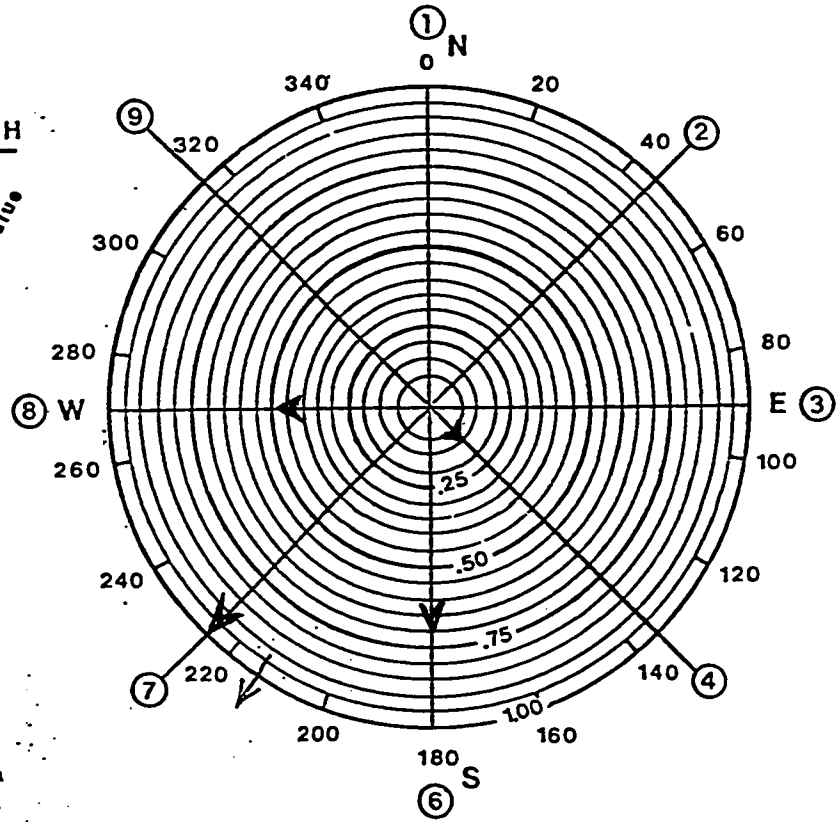
Depth to Measurement: 18.5 ft below Toc

ROTATE PROBE 180° AT SAME DEPTH

1→S

4:10

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	$\bar{7}$	+9	+16	$\bar{1}6$	$\bar{.70}$
+2/-7	+2	$\bar{1}5$	$\bar{1}7$	$\bar{2}0.5$	$\bar{.1}$
+3/-8	+8	$\bar{2}3$	$\bar{3}1$	$\bar{1}0$	$\bar{.49}$
+4/-9	+20	0	$\bar{2}0$	+3	+.15

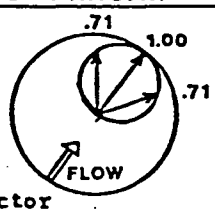


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 214° (MN) Velocity: 20

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000329

GROUNDWATER FLOW WORKSHEET 007361

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

14:05

Probe pair	A start	B end	C B-A
+1/-6	+8		
+2/-7	0		
+3/-8	+14		
+4/-9			

Operator: GB Date: 4/18/91 #842

Station: 30 I Time: 13:35

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 50 ft below TOC 1½"

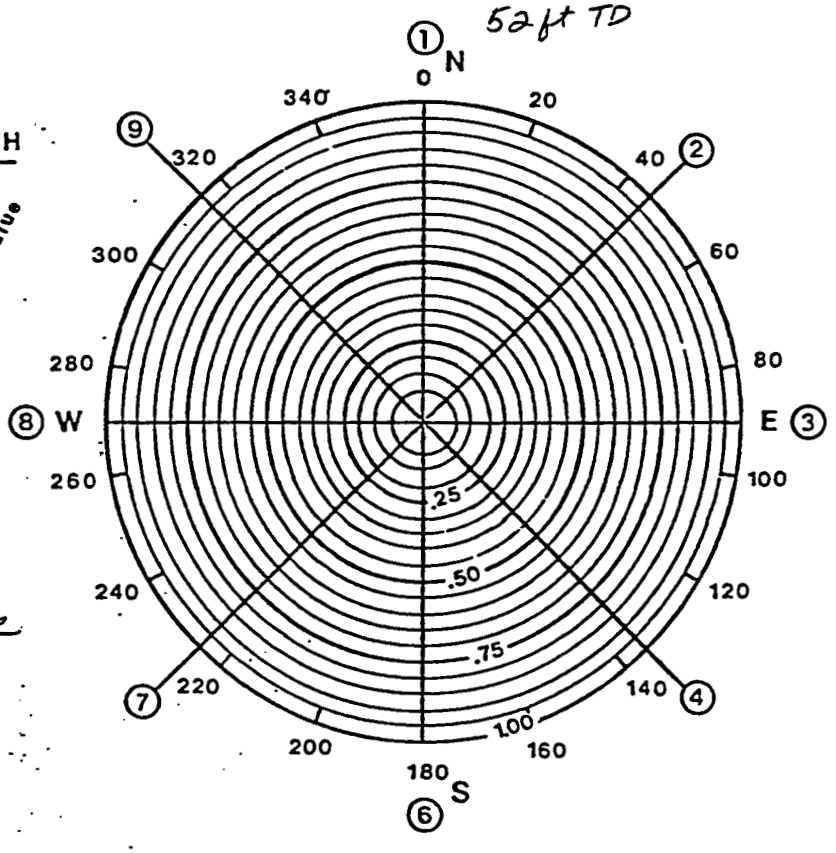
52 ft TD

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6					
+2/-7					
+3/-8					
+4/-9					

Break in cable just above probe — 4/9 channel shorted out

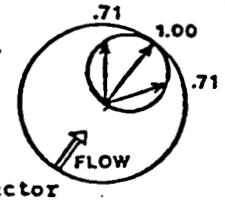


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: _____ Velocity: _____

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006330

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/18/91

Station: 30I Time: 14:25

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 50 ft from TOC

TD 52 ft

Table of LCD Readout

1→N

14:50

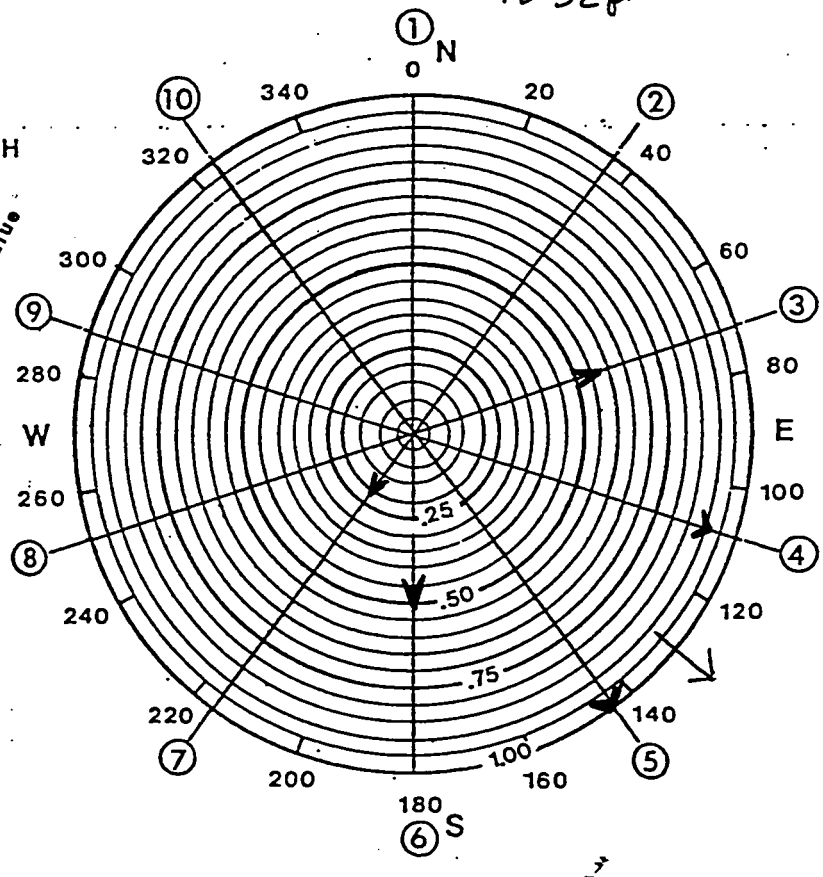
Probe pair	A (start)	B (end)	N (B-A)
+1/-6	+13	−75	−87
+2/-7	+18	−24	−42
+3/-8	+7	+74	+67
+4/-9	+14	+98	+84
+5/-10	+22	+132	+110

ROTATE PROBE 180° AT SAME DEPTH

1→S

15:10

Probe pair	D (start)	E (end)	S (E-D)	F (N-S / 2)	G (F / max. value)
+1/-6	+1	+19	+18	−52.5	−.51
+2/-7	+2	+3	+1	−21.5	−.21
+3/-8	−16	−66	−50	+58.5	+.57
+4/-9	0	−105	−105	+94.5	+.92
+5/-10	+17	−79	−96	+103	+1

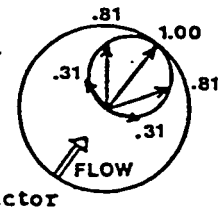


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 130°(MN) Velocity: 102

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000331

GROUNDWATER FLOW WORKSHEET

007361

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/18/91

Station: 30 I Time: 15:20

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 46.75 ft below TOC

Table of LCD Readout

1→N

16:10

Probe pair	A start	B end	N B-A
+1/-6	+1	$\bar{8}8$	$\bar{8}9$
+2/-7	+6	$\bar{7}3$	$\bar{7}9$
+3/-8	0	$\bar{5}2$	$\bar{5}2$
+4/-9	+14	+1	$\bar{1}3$
+5/-10	+28	+50	+22

@330°

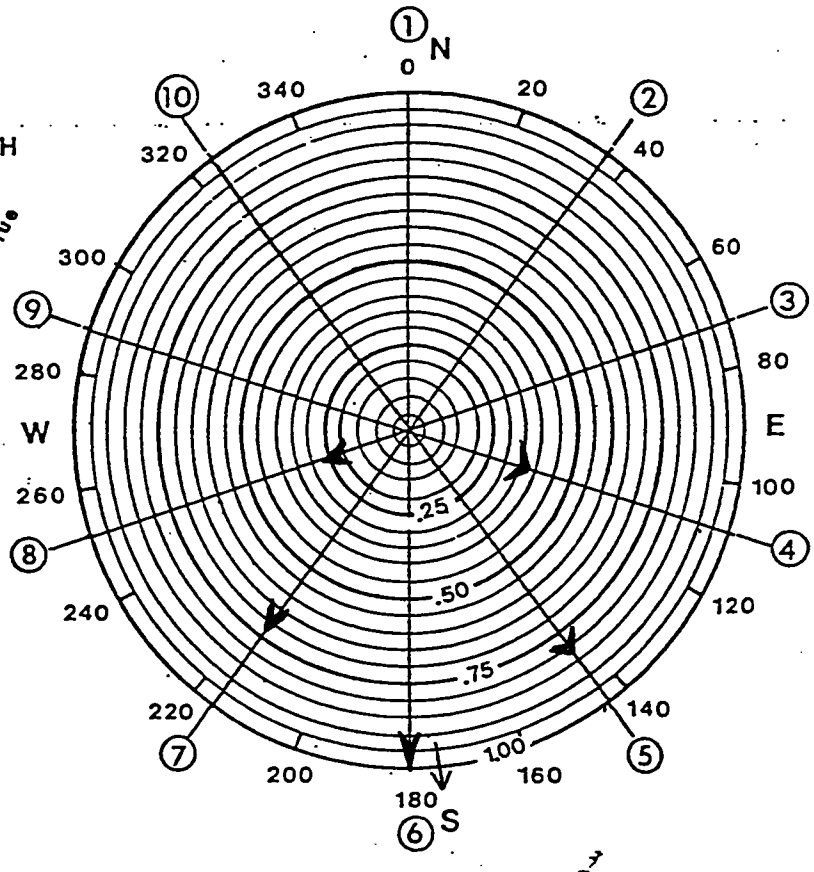
ROTATE PROBE 180° AT SAME DEPTH

1→S

15:45

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+14	+34	+20	$\bar{5}4.5$	$\bar{1}$
+2/-7	+15	+15	0	$\bar{3}9.5$	$\bar{.}72$
+3/-8	+1	$\bar{2}3$	$\bar{2}4$	$\bar{1}4$	$\bar{.}26$
+4/-9	+9	$\bar{4}4$	$\bar{5}3$	+20	+.37
+5/-10	+18	$\bar{5}0$	$\bar{6}8$	+45	+.83

@ 150°

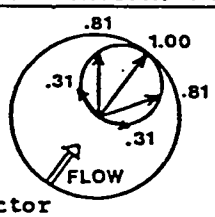


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 176°-30° Velocity: 53

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4-8-82

000332

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/18/91

Station: 30I Time: 16:20

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 44.75 ft below Toc

Table of LCD Readout

1→N

16:50

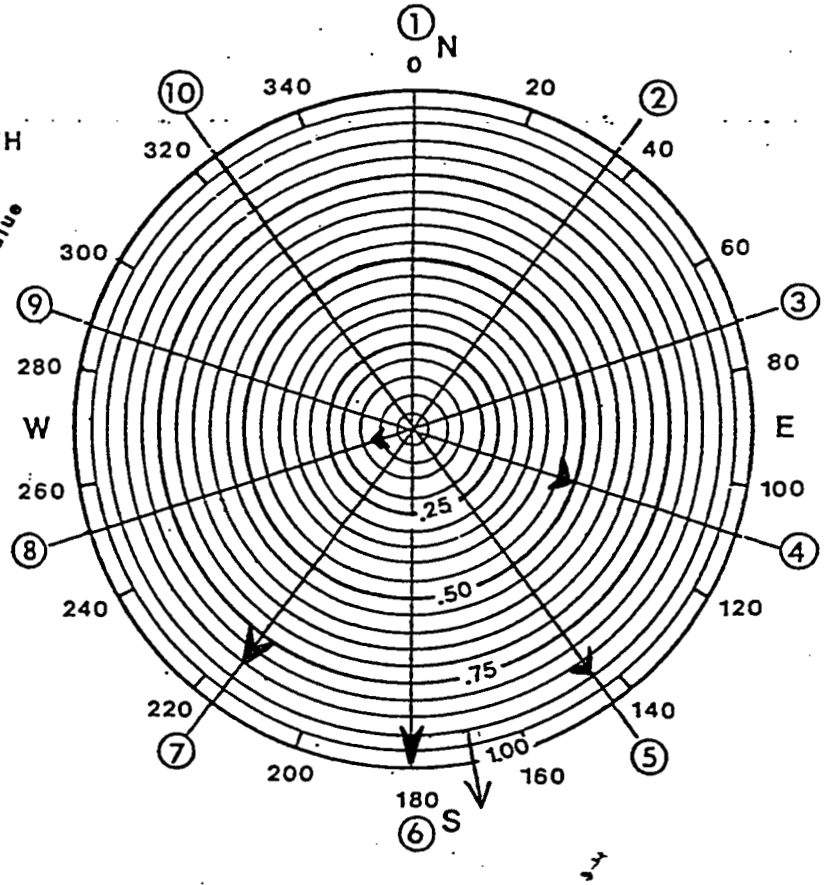
Probe pair	A start	B end	N B-A
+1/-6	+13	$\bar{3}2$	$\bar{4}5$
+2/-7	+14	$\bar{1}9$	$\bar{3}3$
+3/-8	0	$\bar{3}6$	$\bar{3}6$
+4/-9	+9	$\bar{-}9$	$\bar{1}8$
+5/-10	+19	+13	$\bar{-}6$

ROTATE PROBE 180° AT SAME DEPTH

1→S

17:10

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+14	+51	+37	$\bar{4}1$	$\bar{-}1$
+2/-7	+19	+56	+37	$\bar{3}5$	$\bar{-}.85$
+3/-8	0	$\bar{2}5$	$\bar{2}5$	$\bar{-}5$	$\bar{-}.12$
+4/-9	+7	$\bar{5}1$	$\bar{5}8$	+20	+.49
+5/-10	+16	$\bar{6}3$	$\bar{7}9$	+36.5	+.89

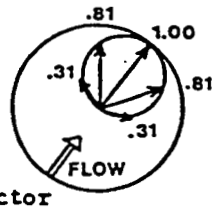


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 172° (MN) Velocity: 43

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000333

GROUNDWATER FLOW WORKSHEET 007361

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N
8:50

Probe pair	A start	B end	C B-A
+1/-6	+13	-5	-18
+2/-7	+19	+31	+12
+3/-8	+12	+39	+27
+4/-9	+9	+32	+23

Operator: GB Date: 4/19/91 #842

Station: 15S Time: 8:20

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel Rain

Depth to Measurement: 22.5 ft below TOC

TD 24.7 ft

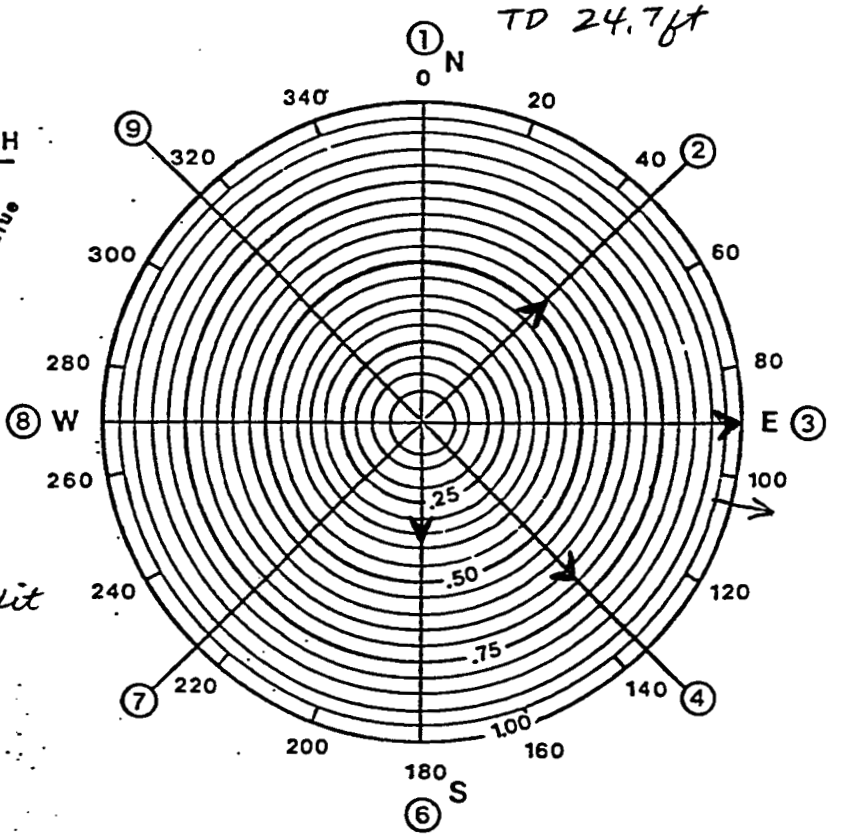
ROTATE PROBE 180° AT SAME DEPTH

1→S
9:20

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+7	+10	+3	-10.5	-.38
+2/-7	-26	-43	-17	+14.5	+.53
+3/-8	-45	-73	-28	+27.5	+1
+4/-9	-13	-27	-14	+18.5	+.67

packer not tight fit

Pond influence?

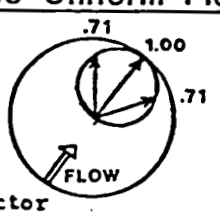


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 105° (MN) Velocity: 26

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000334

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/19/91 #842

Station: 15 S Time: 9:30

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19.5 ft below TOC

Table of LCD Readout

1→N

10:25

Probe pair	A start	B end	C B-A
+1/-6	+10	0	-10
+2/-7	+4	+123	+119
+3/-8	-7	+164	+171
+4/-9	+4	+122	+118

ROTATE PROBE 180° AT SAME DEPTH

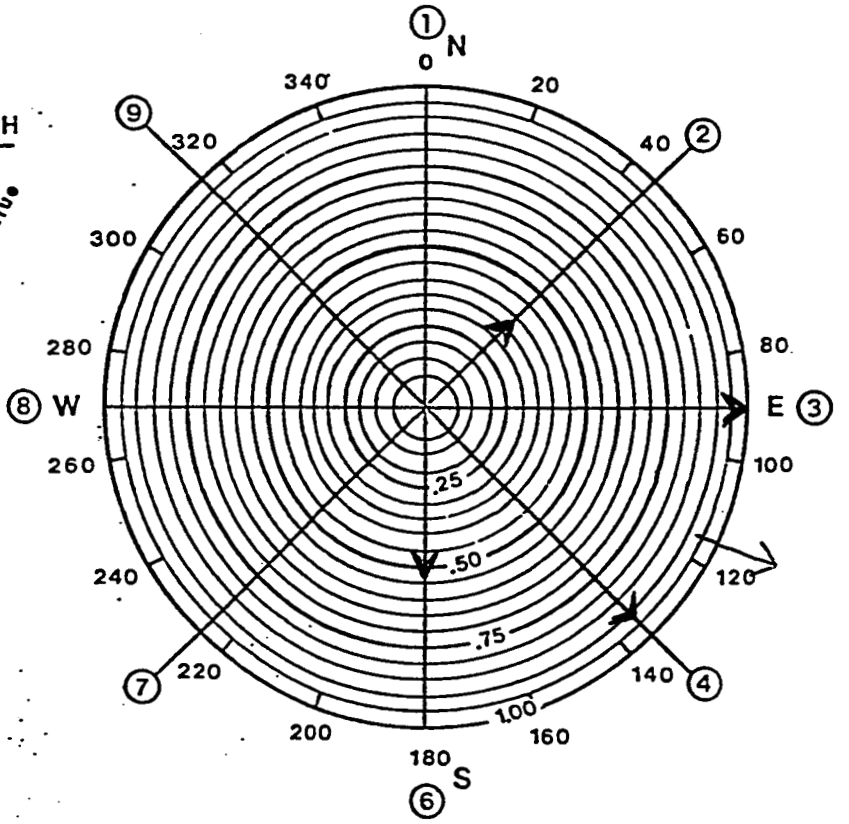
1→S

10:00

Probe pair	D start	E end	S E-D	F (N-S)/2	G F/max. value
+1/-6	+5	+45	+40	-25	-.54
+2/-7	0	+85	+85	+17	+.37
+3/-8	-6	+72	+78	+46.5	+1
+4/-9	+9	+41	+32	+43	+.92

Not a tight fit

Poor pattern

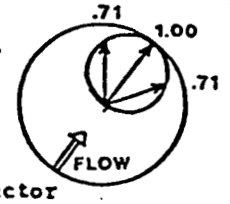


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: .116° (MN) Velocity: 49

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000335

GROUNDWATER FLOW WORKSHEET

007361

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N
11:00

Probe pair	A start	B end	C B-A
+1/-6	+25	-50	-75
+2/-7	+15	+9	-6
+3/-8	-6	+57	+63
+4/-9	-5	+77	+82

Operator: GB Date: 4/19/91 #842

Station: 15 S Time: 10:30

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 16.5 ft below TOC

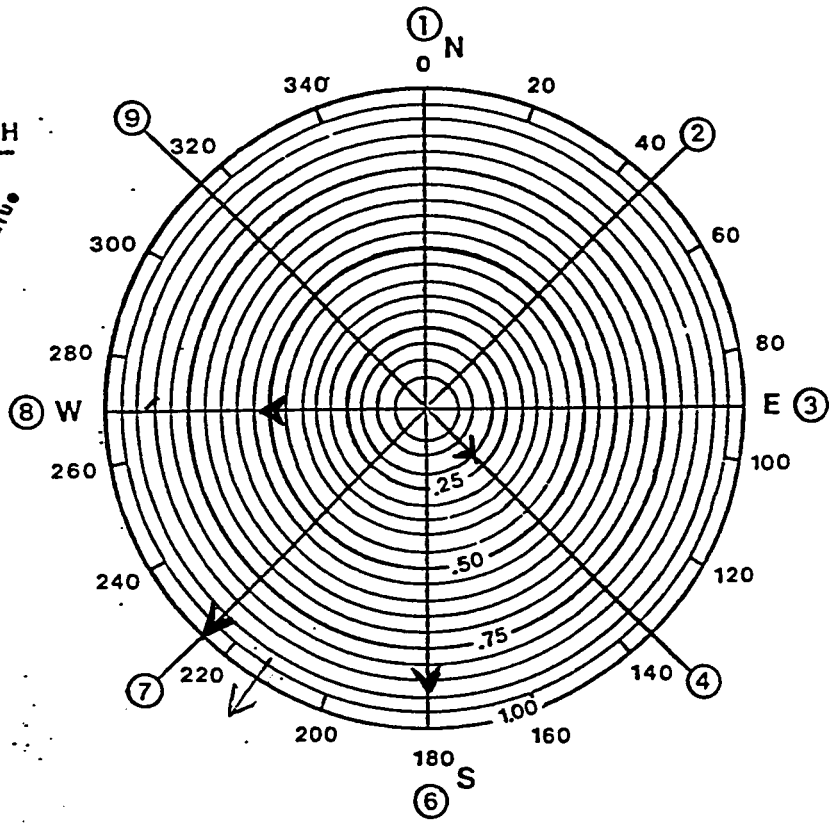
ROTATE PROBE 180° AT SAME DEPTH

1→S
11:15

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	-14	+224	+238	-156.5	-.87
+2/-7	-8	+347	+355	-180.5	-1
+3/-8	+2	+258	+256	-96.5	-.53
+4/-9	+28	+34	+6	+38	+.21

+1/-6 +399 @ 1:15 min

Not tight fit

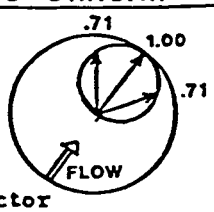


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 212° (MN) Velocity: 184

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000336

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/19/91

Station: 15 D Time: 8:30

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 80.4 ft below TOC

TD 82.4 ft

Table of LCD Readout

1→N

9:00

Probe pair	A start	B end	N B-A
+1/-6	+8	$\bar{6}1$	$\bar{6}9$
+2/-7	+14	$\bar{6}7$	$\bar{8}1$
+3/-8	+1	$\bar{1}6$	$\bar{1}7$
+4/-9	+8	+10	+2
+5/-10	+26	+40	+14

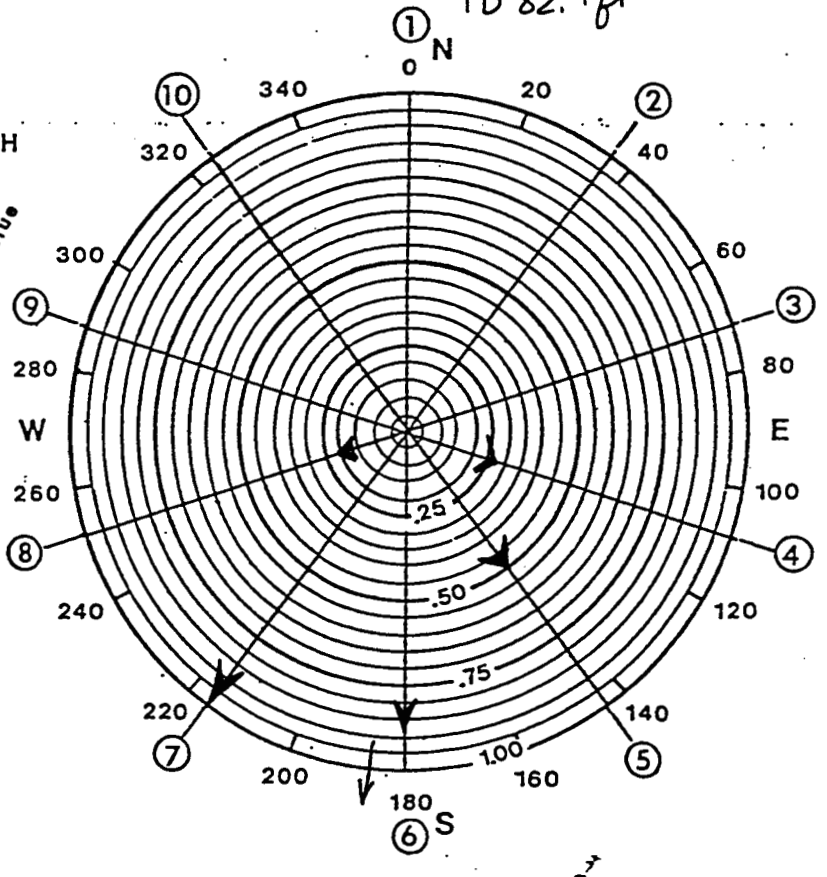
ROTATE PROBE 180° AT SAME DEPTH

1→S

9:25

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+7	$\bar{1}6$	$\bar{2}3$	$\bar{2}3$	$\bar{.}88$
+2/-7	+13	$\bar{1}6$	$\bar{2}9$	$\bar{2}6$	$\bar{1}$
+3/-8	+7	+1	$\bar{6}$	$\bar{5}.5$	$\bar{.}21$
+4/-9	+12	0	$\bar{1}2$	+7	+.27
+5/-10	+27	+15	$\bar{1}2$	+13	+.5

poor pattern

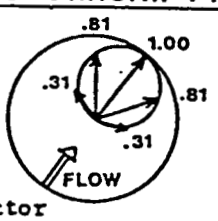


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 186° (MN) Velocity: 23

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000337

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

007361

Operator: GB Date: 4/19/91

Station: 15D Time: 9:25

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 77.4 ft from TOC

Table of LCD Readout

1→N 10:30

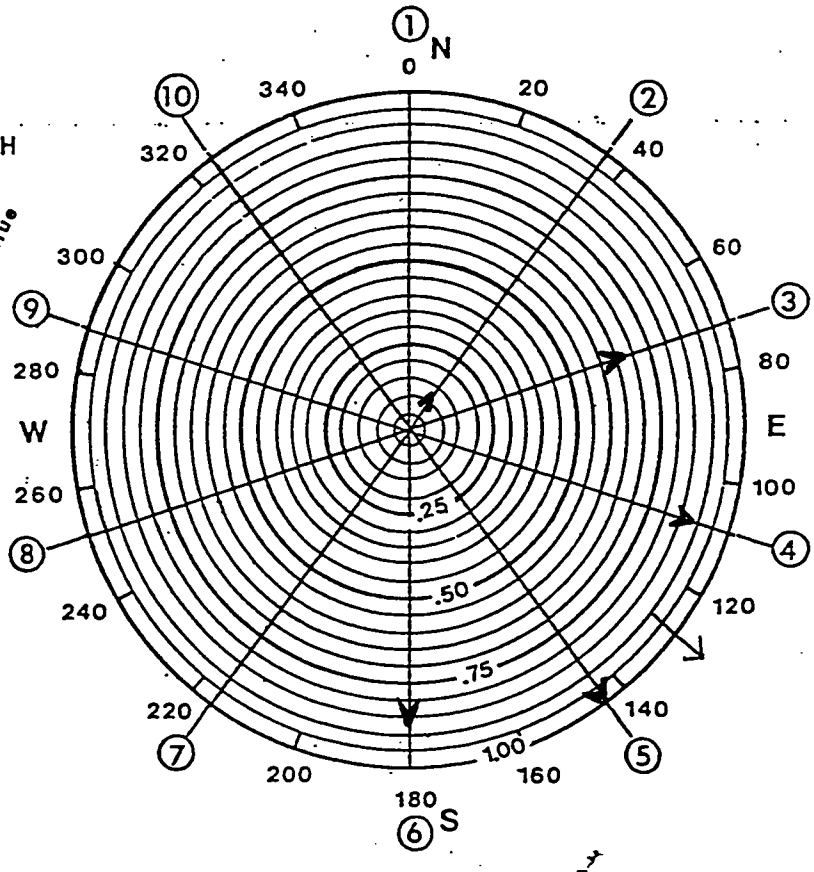
Probe pair	A start	B end	N B-A
+1/-6	+3	-71	-74
+2/-7	+14	-68	-82
+3/-8	+9	+18	+9
+4/-9	+13	+48	+35
+5/-10	+35	+68	+33

ROTATE PROBE 180° AT SAME DEPTH

1→S 9:55

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+7	-22	-29	-22.5	-.88
+2/-7	+13	-75	-88	+3	+.12
+3/-8	+3	-22	-25	+17	+.67
+4/-9	+10	0	-10	+22.5	+.88
+5/-10	+26	+8	-18	+25.5	+1

poor pattern

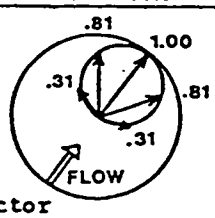


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 128°(MN) Velocity: 28

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4-8-82

000358

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/19/91

Station: 15D Time: 10:35

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 74.4 ft fr TOC

Table of LCD Readout

1→N

11:05

Probe pair	A start	B end	N B-A
+1/-6	0	$\bar{162}$	$\bar{162}$
+2/-7	+11	$\bar{126}$	$\bar{137}$
+3/-8	+10	$\bar{30}$	$\bar{40}$
+4/-9	+16	+44	+28
+5/-10	+34	+117	+83

ROTATE PROBE 180° AT SAME DEPTH

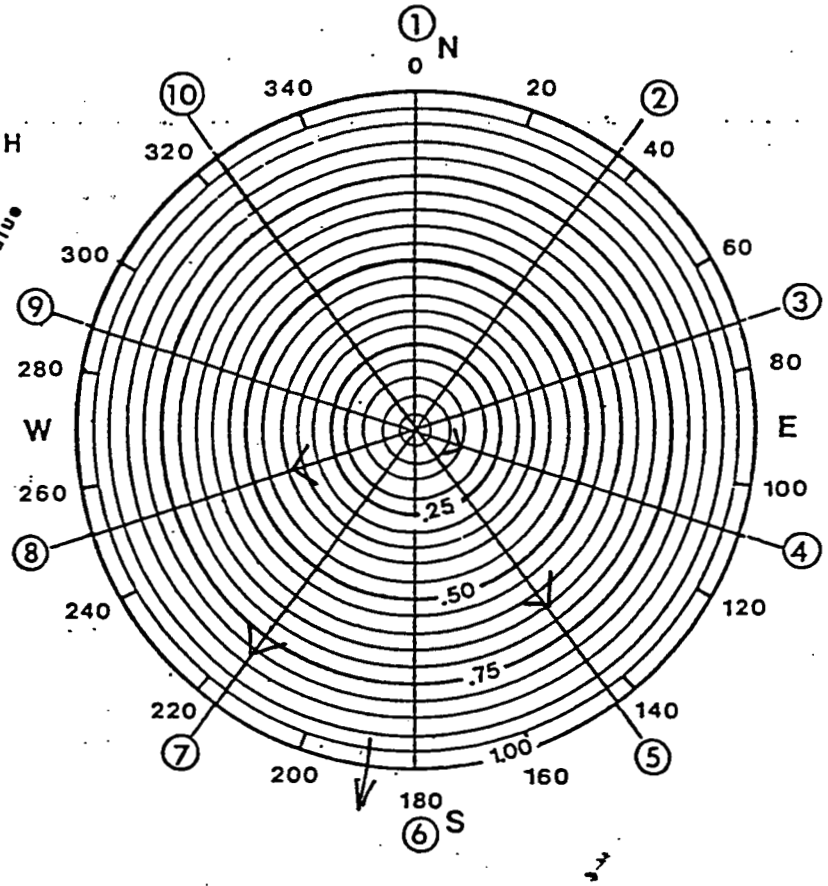
1→S

11:25

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
* +1/-6				($\bar{90}$)	
+2/-7	+8	+35	+27	$\bar{82}$	
+3/-8	+18	+54	+36	$\bar{38}$	
+4/-9	+21	+20	$\bar{1}$	+14.5	
+5/-10	+46	0	$\bar{46}$	+64.5	

*Channel out – broken wire

$$\cdot 81\left(\frac{82+64.5}{2}\right) = 90$$

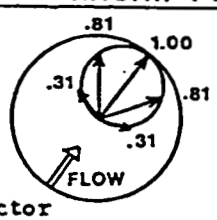


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 188° Velocity: 90

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000339

GROUNDWATER FLOW WORKSHEET

007361

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/19/91

Station: 13S Time: 13:45

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19 ft from TOC

22.9 ft TD

Table of LCD Readout

1→N

14:15

Probe pair	A start	B end	N B-A
+1/-6	0	$\bar{6}6$	$\bar{6}6$
+2/-7	+11	$\bar{3}5$	$\bar{4}6$
+3/-8	+16	$\bar{4}5$	$\bar{6}1$
+4/-9	+19	$\bar{4}0$	$\bar{5}9$
+5/-10	+40	+14	$\bar{2}6$

Packer broke when turning 180°. Back in @ 14:45

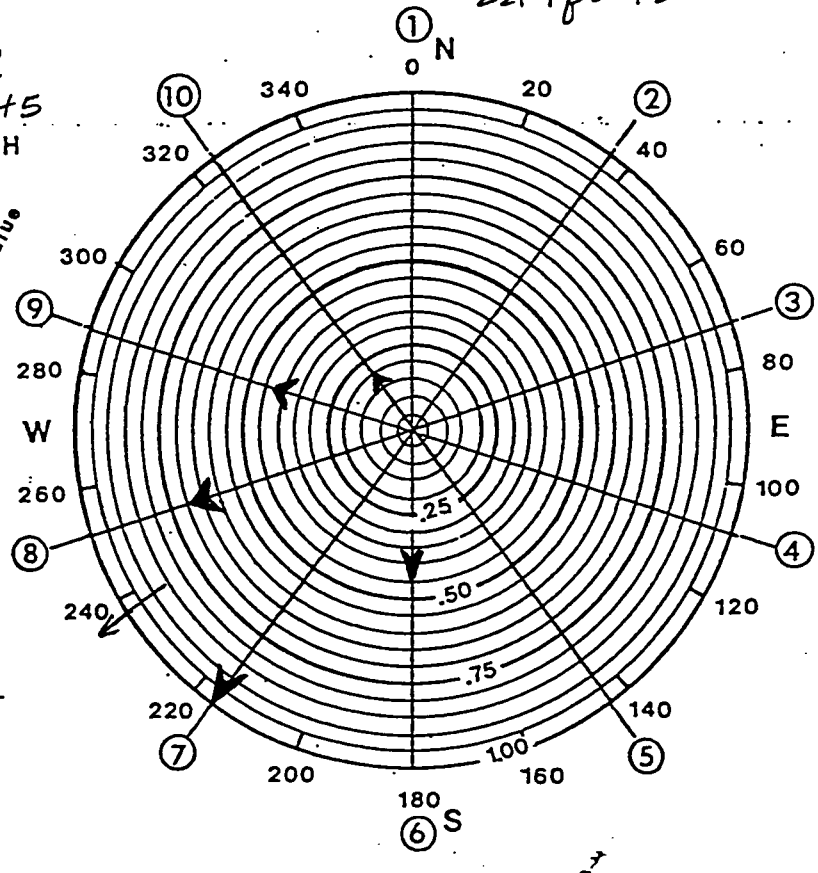
ROTATE PROBE 180° AT SAME DEPTH

1→S

15:15

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	$\bar{6}$	$\bar{1}2$	$\bar{6}$	$\bar{3}0$	$\bar{.}45$
+2/-7	+7	+94	+87	$\bar{6}6.5$	$\bar{1}$
+3/-8	+11	+42	+31	$\bar{4}6$	$\bar{.}69$
+4/-9	+18	+18	0	$\bar{2}9.5$	$\bar{.}44$
+5/-10	+38	+38	0	$\bar{1}3$	$\bar{.}2$

Train. Pon pattern —

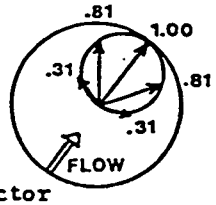


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 237° Velocity: 57

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4-8-82

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB	Date: 4/19/91
Station: 13 S	Time: 15:25
Location: Paddy's Run Road Fernald, Ohio	
Soil Conditions: silt to medium Gravel	
Depth to Measurement: 16 ft from TOC	

Table of LCD Readout

1→N 16:25

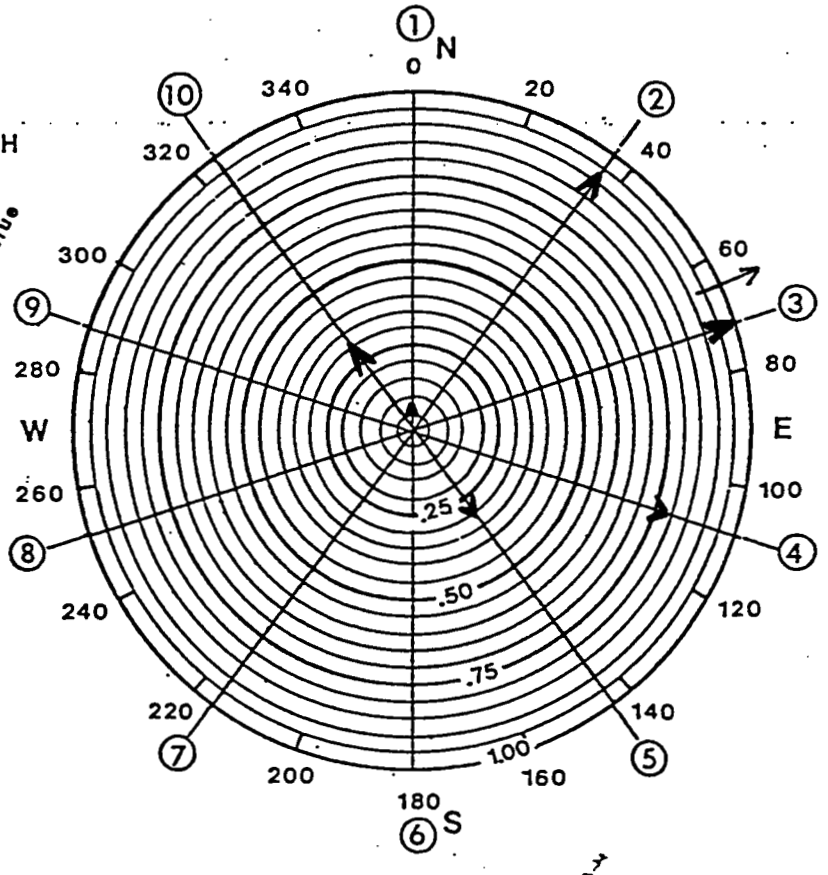
Probe pair	A start	B end	N B-A
+1/-6	0	$\bar{3}8$	$\bar{3}8$
+2/-7	+11	+7	$\bar{4}$
+3/-8	+12	$\bar{6}$	$\bar{1}8$
+4/-9	+17	$\bar{3}5$	$\bar{5}2$
+5/-10	+37	+12	$\bar{2}5$

ROTATE PROBE 180° AT SAME DEPTH

1→S 15:55

Probe pair	D start	E end	S E-D	F N-S/2	G F max. value
+1/-6	$\bar{5}$	$\bar{4}4$	$\bar{3}9$	+.5	+.08
+2/-7	+7	$\bar{9}$	$\bar{1}6$	+6	+.92
+3/-8	+6	$\bar{2}5$	$\bar{3}1$	+6.5	+1
+4/-9	+14	$\bar{4}8$	$\bar{6}2$	+5	+.77
+5/-10	+34	+11	$\bar{2}3$	$\bar{1}$	$\bar{.}31$

Bad pattern

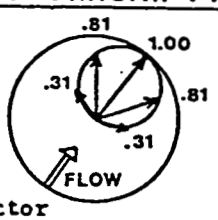


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 64°	Velocity: 6

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000341

GROUNDWATER FLOW WORKSHEET 007361

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: GB Date: 4/19/91

Station: 13 S Time: 16:25

Location: Paddy's Run Road Fernald, Ohio

Soil Conditions: silt to medium Gravel

Depth to Measurement: 14 ft fr TOC

Table of LCD Readout

1→N 16:55

Probe pair	A start	B end	N B-A
+1/-6	+2	−138	−140
+2/-7	+10	−140	−150
+3/-8	+7	−53	−60
+4/-9	+9	−104	−113
+5/-10	+29	+24	−5

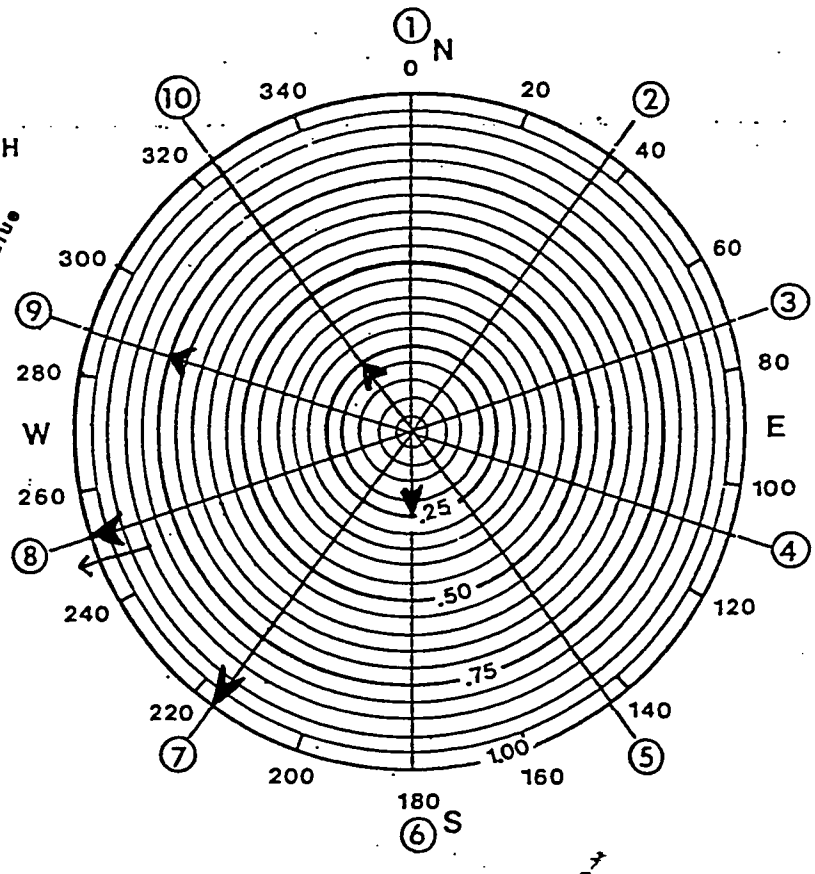
ROTATE PROBE 180° AT SAME DEPTH

1→S 17:25

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	0	−137	−137	−1.5	−.25
+2/-7	+7	−131	−138	−6	−1
+3/-8	+5	−43	−48	−6	−1
+4/-9	+8	−96	−104	−4.5	−.75
+5/-10	+28	+26	−2	−1.5	−.25

17:35 out. Packer w/HNu: 400 ppm

Poor pattern

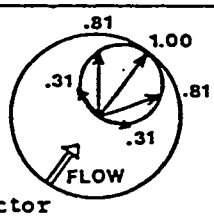


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 249° Velocity: 6

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: GB Date: 4/19/91 #842

Station: 16 S Time: 13:55

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 21.7 ft fr TOC

23.7 ft TD

Table of LCD Readout

1→N

14:25

Probe pair	A start	B end	C B-A
+1/-6	+8	+166	+158
+2/-7	+1	+20	+19
+3/-8	-9	-104	-95
+4/-9	+7	-162	-169

ROTATE PROBE 180° AT SAME DEPTH

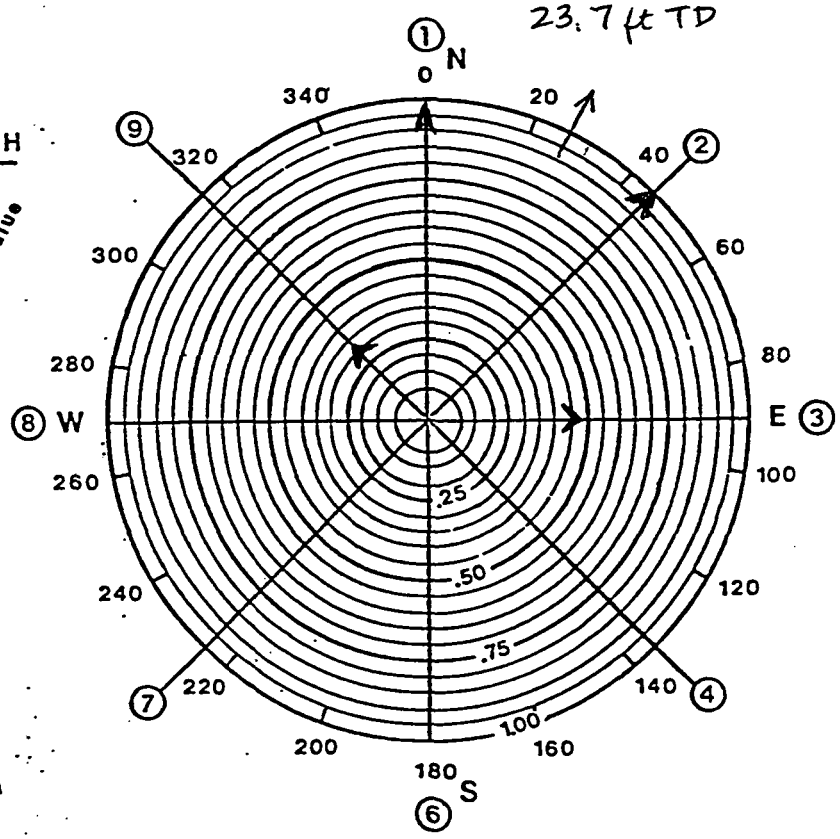
1→S

14:55

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+5	-126	-131	+144.5	+.99
+2/-7	-5	-278	-273	+146	+1
+3/-8	-14	-247	-233	+69	+.47
+4/-9	+8	-62	-70	-49.5	-.34

poor pattern

Not tight fit

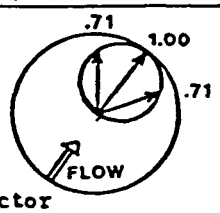


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 26°(MN) Velocity: 157

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000343

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

007361

Table of LCD Readout

1→N
16:00

Probe pair	A start	B end	C B-A
+1/-6	+6	+42	+36
+2/-7	-7	+26	+33
+3/-8	-47	-60	-13
+4/-9	+13	+29	+16

Operator: GB Date: 4/19/91 #842

Station: 16 S Time: 15:00

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19 ft fr TOC

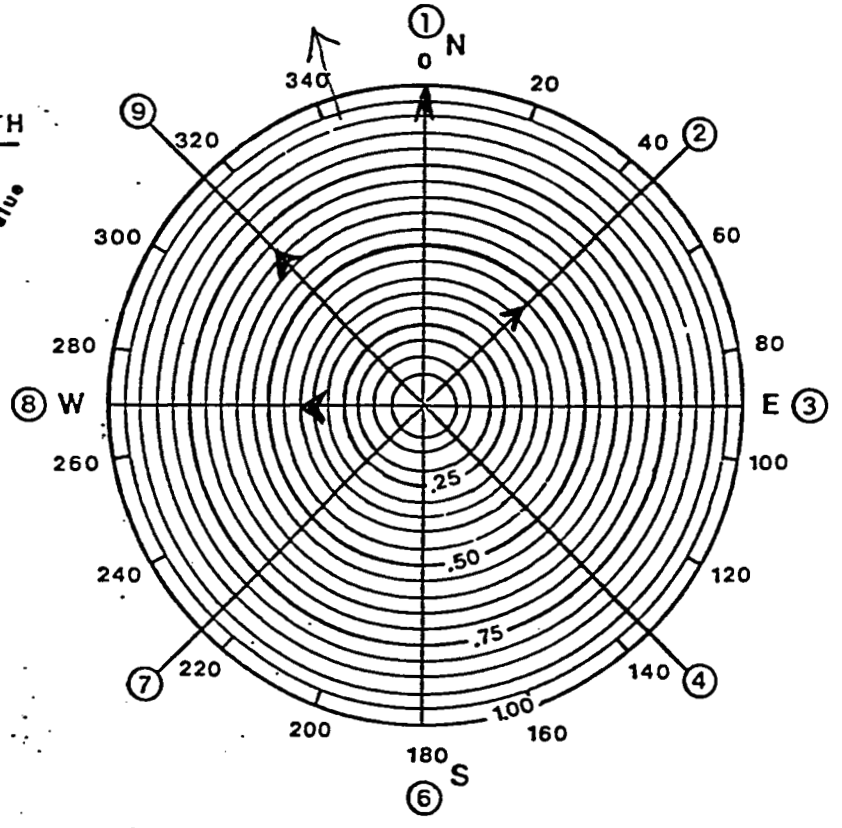
ROTATE PROBE 180° AT SAME DEPTH

1→S
15:30

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+8	-113	-121	+78.5	+1
+2/-7	-26	-60	-34	+33.5	+.43
+3/-8	-27	+23	+50	-31.5	-.40
+4/-9	+10	+133	+123	-53.5	-.68

Not tight fit

Poor pattern

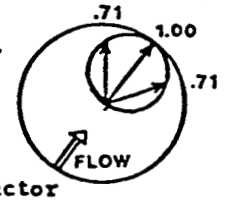


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 342° (MN) Velocity: 74

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N
16:40

Probe pair	A start	B end	C B-A
+1/-6	+3	+63	+60
+2/-7	+2	+52	+50
+3/-8	+2	+3	+1
+4/-9	+6	-22	-28

Operator: GB Date: 4/19/91 #842

Station: 16 S Time: 16:10

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 16 ft from TOC

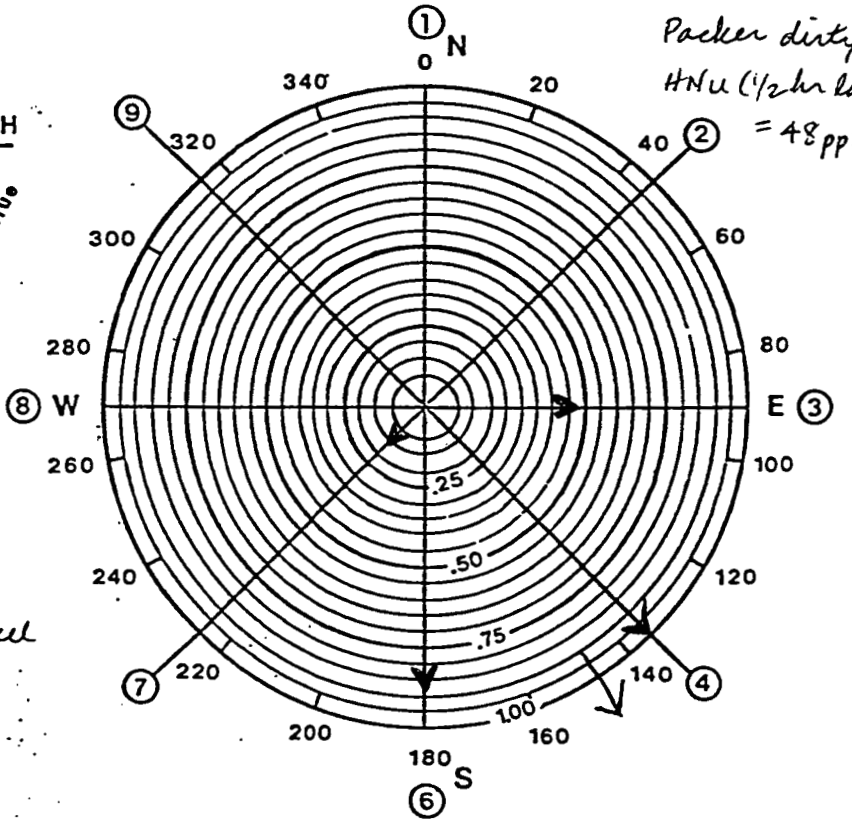
Packer dirty. HNU (1/2 hr later) = 48 ppm

ROTATE PROBE 180° AT SAME DEPTH

1→S
17:00

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+7	-100	+93	-16.5	-.87
+2/-7	+2	+58	+56	-3	-.16
+3/-8	-5	-22	-17	+9	+.47
+4/-9	+2	-64	-66	+19	+1

Not tight fit, but careful screen ribs

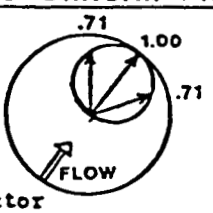


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 148°(MN) Velocity: 19

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000345

GROUNDWATER FLOW WORKSHEET

007361

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: GB Date: 4/19/91 #842

Station: 16 S Time: 15:00

Location: Paddys Run Road Fernald, OH

Soil Conditions: silt to medium Gravel

Depth to Measurement: 19 ft fr TOC

Table of LCD Readout

1→N
16:00

Probe pair	A start	B end	C B-A
+1/-6	+6	+42	+36
+2/-7	-7	+26	+33
+3/-8	-47	-60	-13
+4/-9	+13	+29	+16

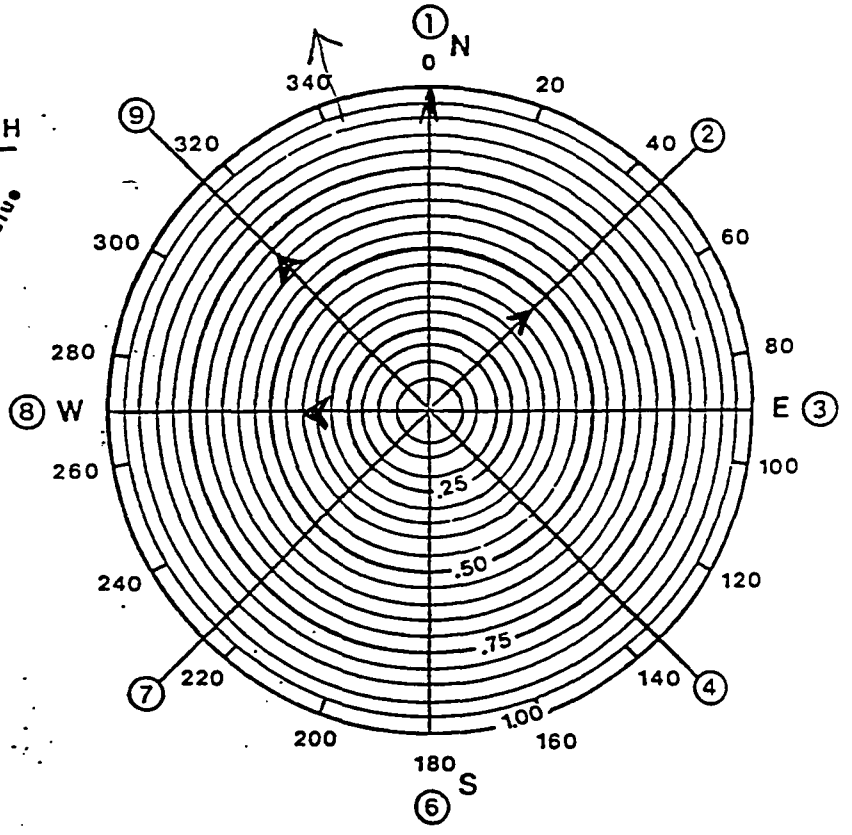
ROTATE PROBE 180° AT SAME DEPTH

1→S
15:30

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	+8	-113	-121	+78.5	+1
+2/-7	-26	-60	-34	+33.5	+.43
+3/-8	-27	+23	+50	-31.5	-.40
+4/-9	+10	+133	+123	-53.5	-.68

Not tight fit

Poor pattern

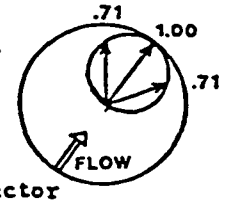


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 342° (MN) Velocity: 74

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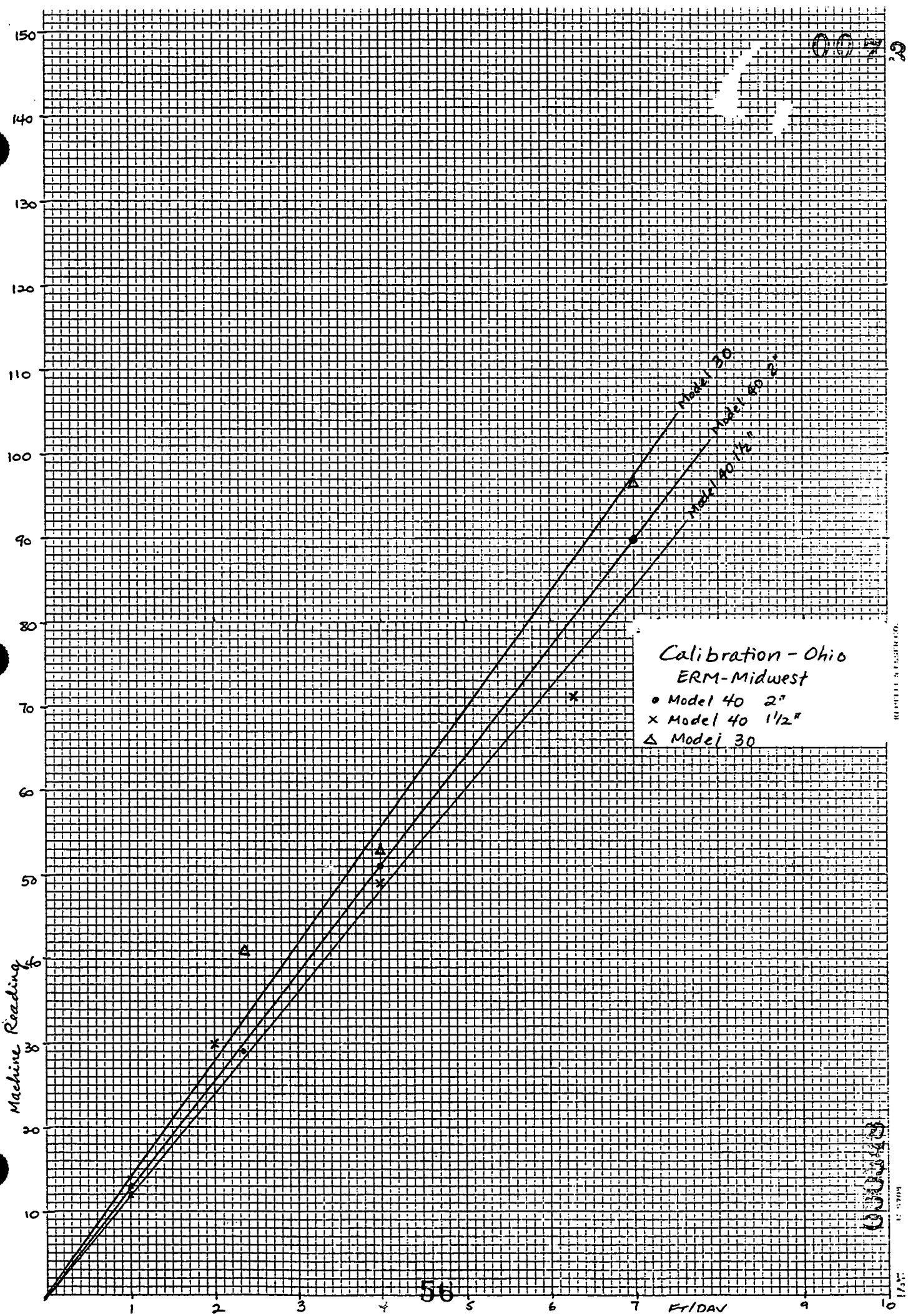
Calibration


Calibration - Ohio
ERM-Midwest
• Model 40 2"
× Model 40 1 1/2"
△ Model 30
Model 30
Model 40 2"
Model 40 1 1/2"
Machine Reading
FT/DAY
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
9
10

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

16.8 ml/min
x .42
7.056 ft/day

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	$\overline{57}$	$^{+}77$	$^{+}134$
+2/-7	$\overline{50}$	$^{+}40$	$^{+}90$
+3/-8	$\overline{13}$	$^{+}3$	$^{+}16$
+4/-9	$^{+}46$	$\overline{35}$	$\overline{81}$

Operator: _____ Date: _____

Station: _____ Time: _____

Location: _____

Soil Conditions: silt to gravel

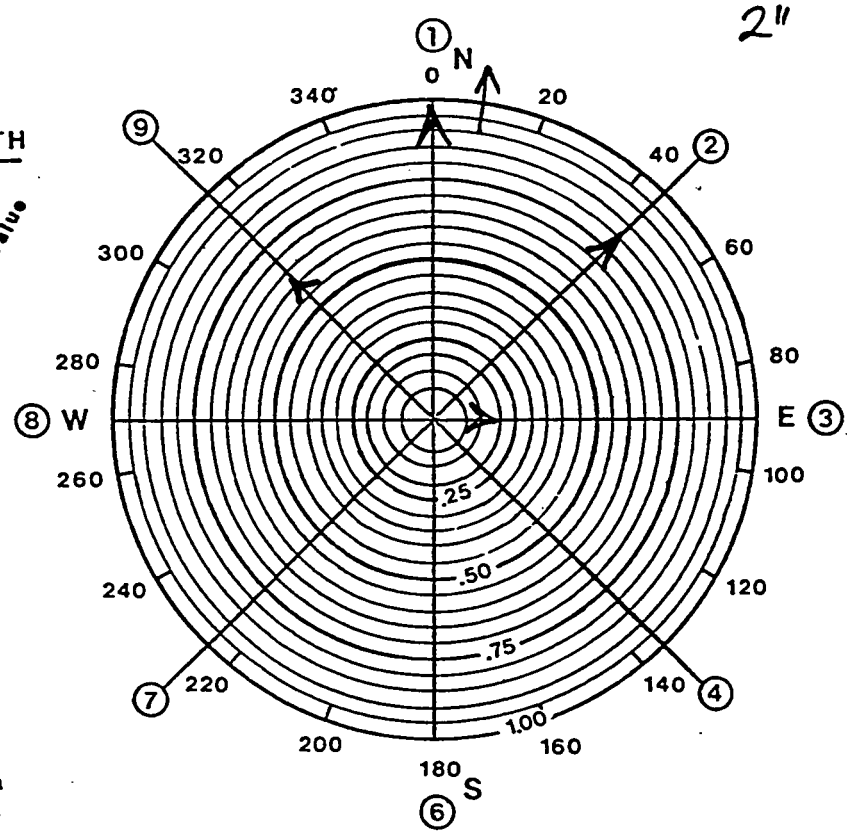
Depth to Measurement: 7 ft/day

2"

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	$^{+}44$	0	$\overline{44}$	$^{+}89$	+1
+2/-7	$^{+}35$	$\overline{20}$	$\overline{55}$	$^{+}72.5$	$^{+}.81$
+3/-8	0	$\overline{14}$	$\overline{14}$	$^{+}15$	$^{+}.17$
+4/-9	$\overline{16}$	$^{+}11$	$^{+}27$	$\overline{54}$	$\overline{.61}$

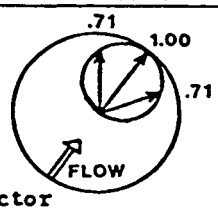


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 90° Velocity: 90

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000349

007361

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	$\bar{51}$	$\bar{8}$	$^{+}43$
+2/-7	$^{+}40$	$^{+}62$	$^{+}22$
+3/-8	$\bar{7}$	0	$^{+}7$
+4/-9	$^{+}24$	$\bar{16}$	$\bar{40}$

Operator: _____ Date: 4/26/91

Station: _____ Time: _____

Location: _____

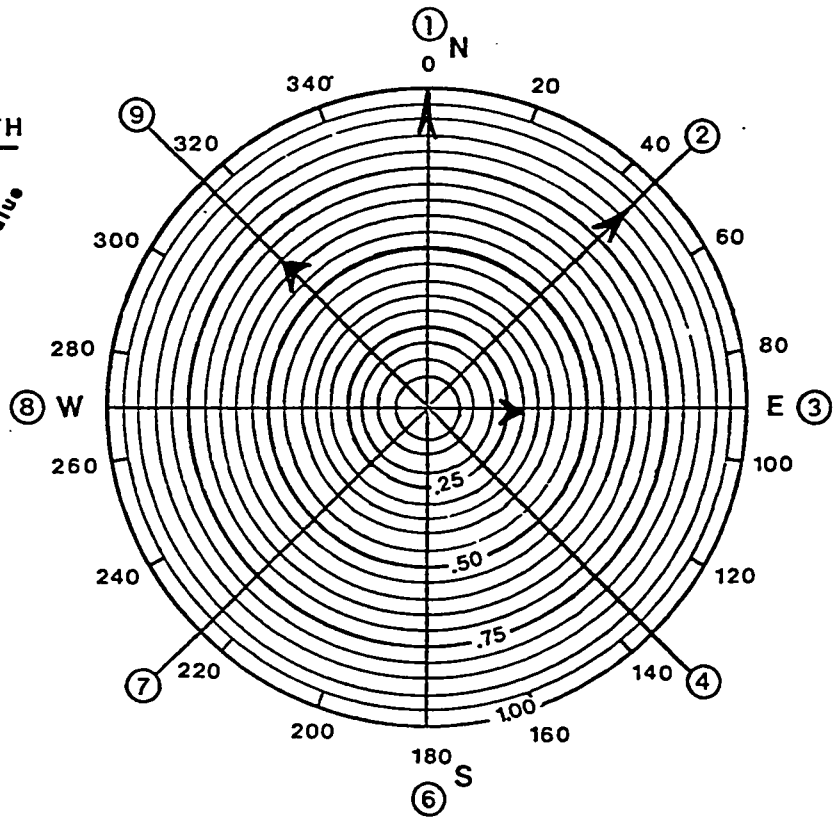
Soil Conditions: fine to gravel

Depth to Measurement: 4 ft/day

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	$\bar{19}$	$\bar{78}$	$\bar{59}$	$^{+}51$	$^{+}1$
+2/-7	$^{+}71$	$^{+}4$	$\bar{67}$	$^{+}44.5$	$^{+}.87$
+3/-8	0	$\bar{20}$	$\bar{20}$	$^{+}13.5$	$^{+}.3$
+4/-9	$^{+}3$	$^{+}28$	$^{+}25$	$\bar{32.5}$	$\bar{.64}$

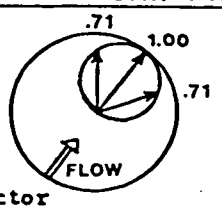


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 120° Velocity: 54

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000350

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	$\bar{3}1$	$\bar{1}5$	$^{+}16$
+2/-7	$^{+}61$	$^{+}62$	$^{+}1$
+3/-8	$^{+}2$	$^{+}2$	0
+4/-9	$^{+}17$	$^{+}3$	$\bar{1}4$

Operator: _____ Date: 4/26/91

Station: _____ Time: _____

Location: _____

Soil Conditions: fine to gravel

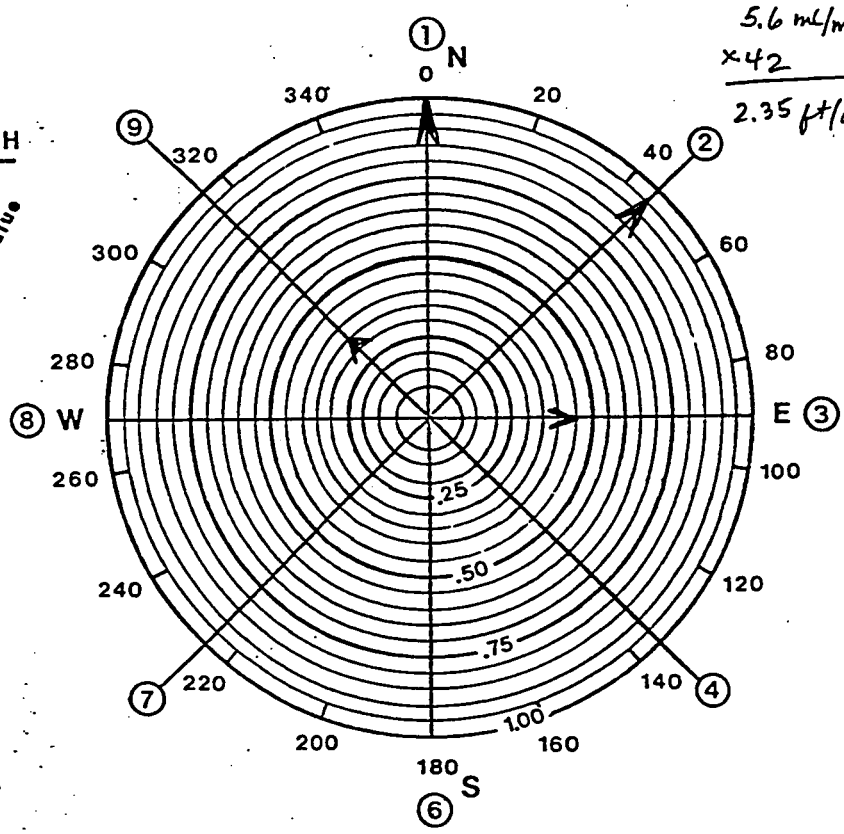
Depth to Measurement: 2.35 ft/day

5.6 ml/min
×42
2.35 ft/day

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	$\bar{1}4$	$\bar{5}3$	$\bar{3}9$	$^{+}27.5$	$^{+}1$
+2/-7	$^{+}67$	$^{+}15$	$\bar{5}2$	$^{+}26.5$	$^{+}.96$
+3/-8	$^{-}6$	$\bar{3}1$	$\bar{2}5$	$^{+}12.5$	$^{+}.45$
+4/-9	0	$^{+}5$	$^{+}5$	$\bar{9}.5$	$\bar{.}35$

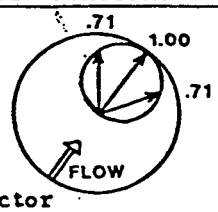


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 25° Velocity: 29

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000351

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: _____ Date: 4/26/91

Station: _____ Time: _____

Location: _____

Soil Conditions: _____

Depth to Measurement: 2.35 ft/day

Table of LCD Readout

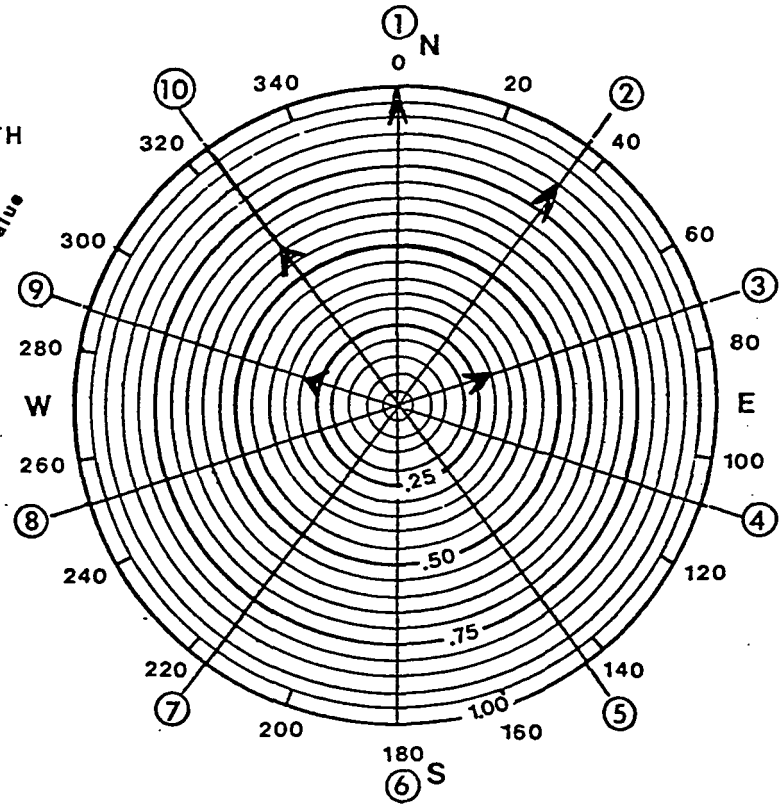
1→N

Probe pair	A start	B end	N B-A
+1/-6	$\bar{4}2$	$\bar{5}9$	$\bar{1}7$
+2/-7	+42	+73	+31
+3/-8	$\bar{1}3$	0	+13
+4/-9	+13	$\bar{1}6$	$\bar{2}9$
+5/-10	+38	+24	$\bar{1}4$

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	+5	$\bar{9}9$	$\bar{1}04$	+43.5	+1
+2/-7	+48	+5	$\bar{4}3$	+37	+.85
+3/-8	0	$\bar{1}3$	$\bar{1}3$	+13	+.30
+4/-9	0	$\bar{4}$	$\bar{4}$	$\bar{1}2.5$	$\bar{.}29$
+5/-10	0	+39	+39	$\bar{2}6.5$	$\bar{.}61$

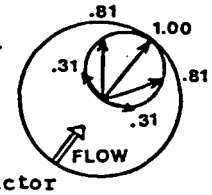


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 4° Velocity: 41

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GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: _____ Date: 4/26/91

Station: _____ Time: _____

Location: _____

Soil Conditions: _____

Depth to Measurement: 4 ft/day

9.6 mil/min
×.42
4.03

Table of LCD Readout

1→N

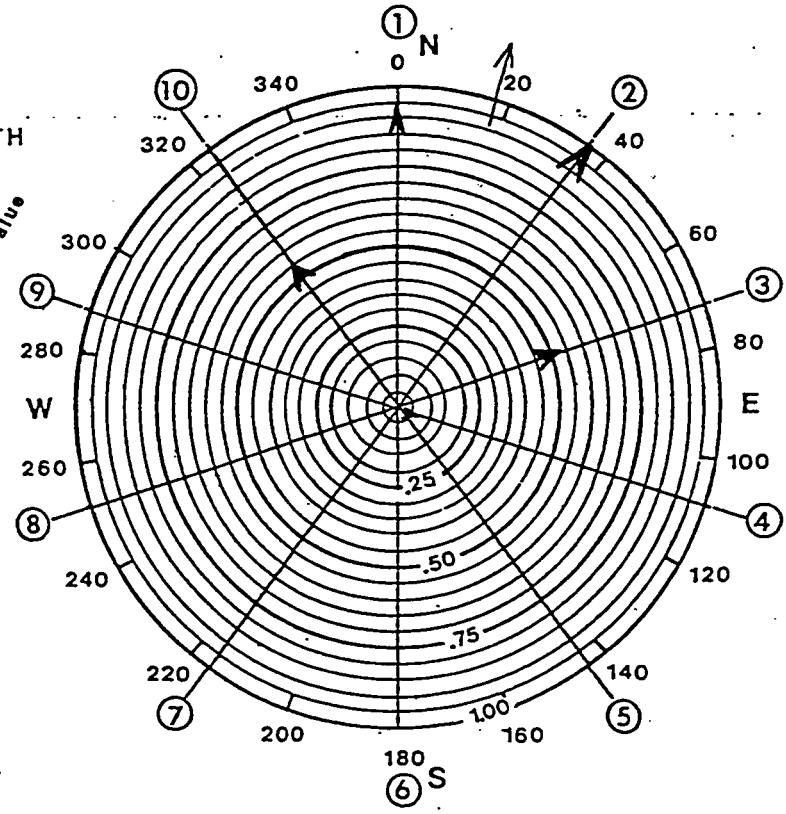
Probe pair	A start	B end	N B-A
+1/-6	$\bar{4}7$	$\bar{4}6$	$^{+}1$
+2/-7	$^{+}36$	+81	+45
+3/-8	$\bar{1}7$	-7	$^{+}10$
+4/-9	+12	0	$\bar{1}2$
+5/-10	+40	+20	$\bar{2}0$

Model 30

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	0	$\bar{1}01$	$\bar{1}01$	$^{+}51$	$^{+}.95$
+2/-7	$^{+}77$	+14	$\bar{6}3$	$^{+}54$	+1
+3/-8	+4	-24	$\bar{4}8$	$^{+}29$	$^{+}.54$
+4/-9	+5	-9	$\bar{1}4$	+1	$^{+}.02$
+5/-10	+7	+44	$^{+}37$	$\bar{2}8.5$	$\bar{.}53$

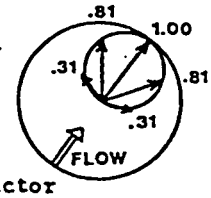


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program for TI-58/59 and HP41C calculators.

OR

2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 19° Velocity: 53

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4-8-82

000353

GROUNDWATER FLOW WORKSHEET

FOR 180° ROTATIONAL DATA MEASUREMENTS

Operator: _____ Date: 4/26/91

Station: _____ Time: _____

Location: _____

Soil Conditions: silt to gravel

Depth to Measurement: 7 ft/day

Table of LCD Readout

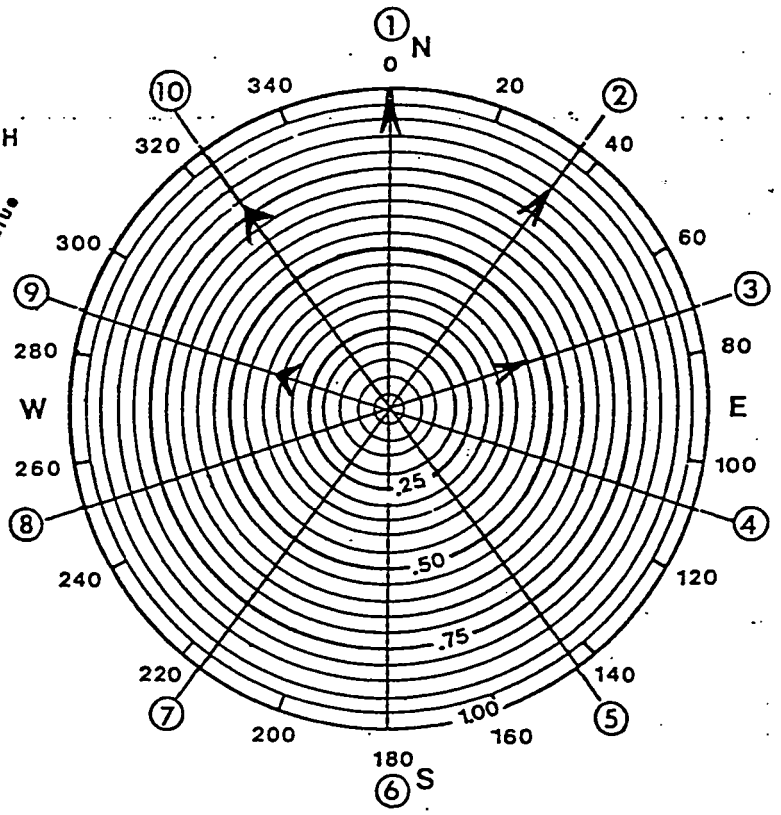
1→N

Probe pair	A start	B end	N B-A
+1/-6	$\bar{98}$	$\bar{17}$	$^{+}81$
+2/-7	$^{+}27$	$^{+}94$	$^{+}67$
+3/-8	0	$^{+}20$	$^{+}20$
+4/-9	$^{+}32$	0	$\bar{32}$
+5/-10	$^{+}63$	$\bar{18}$	$\bar{81}$

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	0	$\bar{110}$	$\bar{110}$	$^{+}95.5$	$^{+}1$
+2/-7	$^{+}92$	0	$\bar{92}$	$^{+}79.5$	$^{+}.83$
+3/-8	$^{+}12$	$\bar{54}$	$\bar{66}$	$^{+}43$	$^{+}.45$
+4/-9	$\bar{11}$	$^{+}25$	$^{+}36$	$\bar{34}$	$\bar{.36}$
+5/-10	0	$^{+}65$	$^{+}65$	$\bar{73}$	$\bar{.76}$

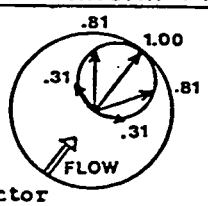


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 5 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KYA Vector Addition Program for TI-58/59 and HP41C calculators.

OR 2. Solve graphically by placing 5 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 3° Velocity: 97

Form 105. available from your local K-V Associates, Inc. dealer.

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	$^{-}42$	$^{-}50$	$^{-}8$
+2/-7	$^{+}50$	$^{+}73$	$^{+}23$
+3/-8	$^{-}10$	$^{-}25$	$^{-}15$
+4/-9	$^{-}12$	$^{+}1$	$^{+}13$

Operator: GB Date: 10/10/90

Station: Calibration Time: 12:00

Location: 1½"

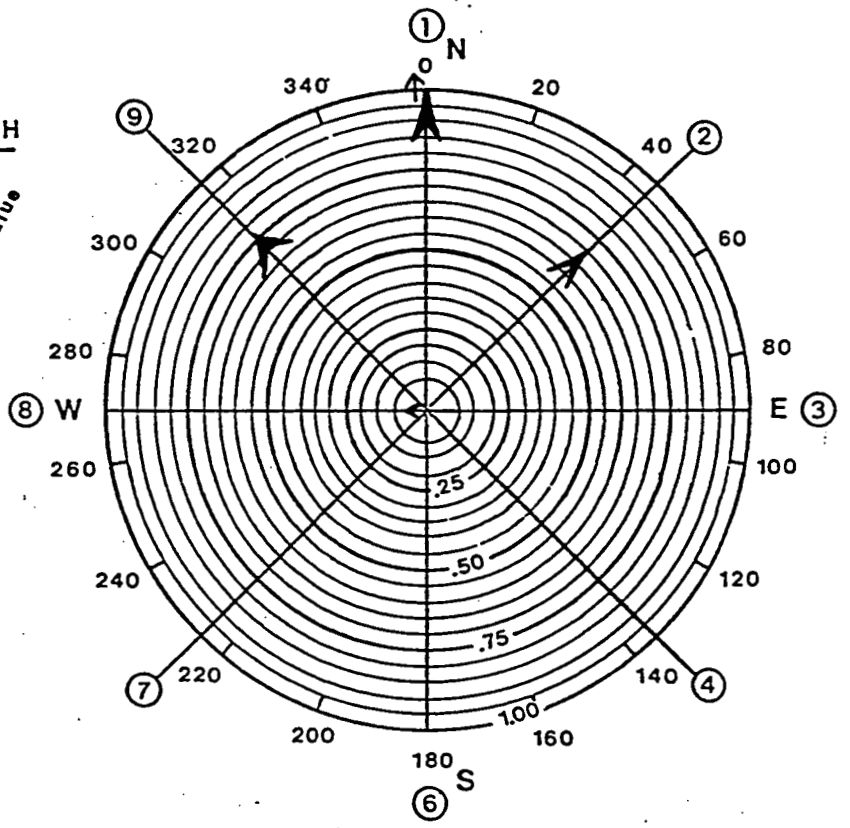
Soil Conditions: Quincy Bay w/ Sand pack

Depth to Measurement: 4.8 ml/min ⇒ 2 ft/day

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	$^{-}43$	$^{-}110$	$^{-}67$	$^{+}29.5$	+1
+2/-7	$^{+}52$	$^{+}33$	$^{-}19$	$^{+}21$	$^{+}.71$
+3/-8	$^{-}6$	$^{-}18$	$^{-}12$	$^{-}1.5$	$^{-}.05$
+4/-9	$^{-}6$	$^{+}52$	$^{+}58$	$^{-}22.5$	$^{-}.76$

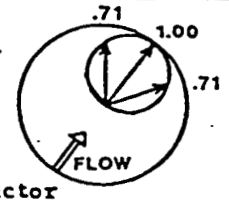


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 358° Velocity: 30

Form 104 available from your local K-V Associates, Inc. dealer.

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GROUNDWATER FLOW WORKSHEET 007361

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	-30	0	+30
+2/-7	+65	+120	+55
+3/-8	-8	-9	-1
+4/-9	-23	-27	-4

Operator: GB Date: 10/10/90

Station: Calibration Time: 1:30

Location: 1½"

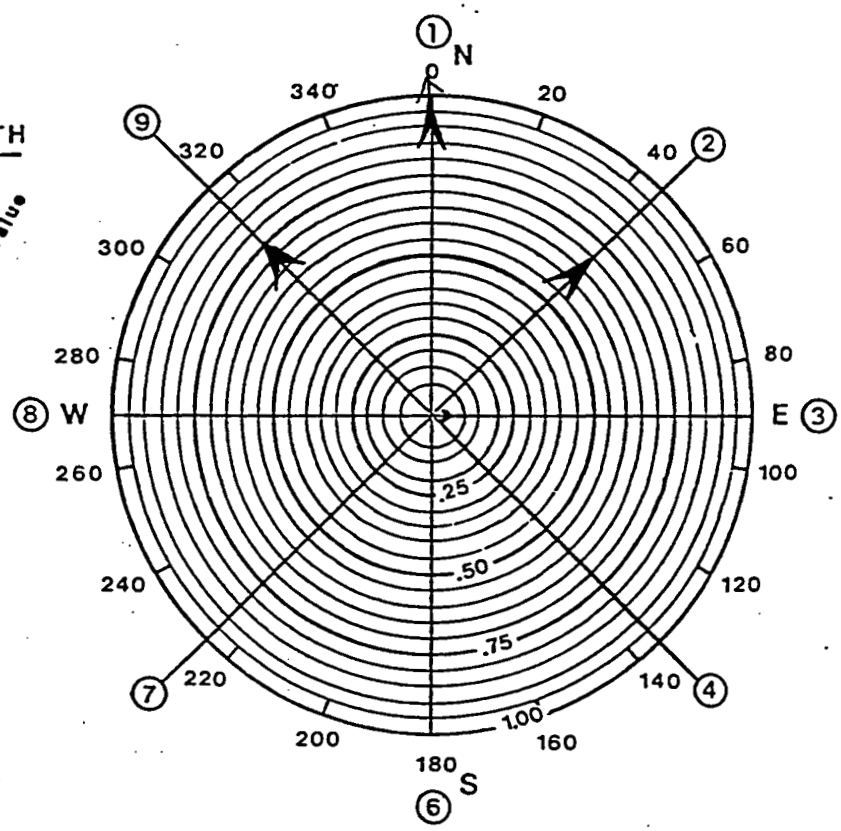
Soil Conditions: w/ sand pack

Depth to Measurement: 15 ml/min ⇒ 6.3 ft/day

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S / 2	G F / max. value
+1/-6	-57	-167	-110	+70	+1
+2/-7	+36	-7	-43	+49	+.70
+3/-8	-5	0	-5	+2	+.03
+4/-9	+4	+105	+101	-52.5	-.75

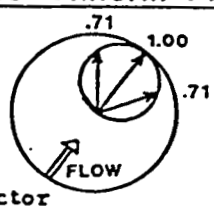


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 360° Velocity: 71

Form 104 available from your local K-V Associates, Inc. dealer.

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GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	-35	-28	+7
+2/-7	+59	+98	+39
+3/-8	-7	-10	-3
+4/-9	-15	-6	+9

Operator: GB Date: 10/10/90

Station: Calibration Time: 1:00

Location: 1½"

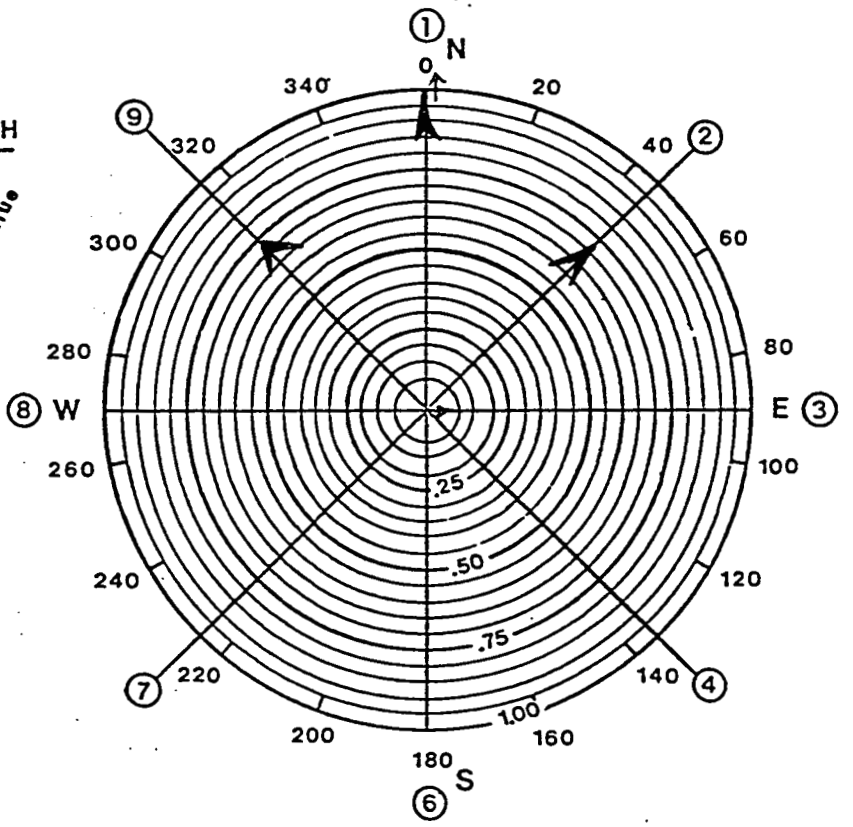
Soil Conditions: sand pack

Depth to Measurement: 9.6 ml/min ⇒ 4 ft/day

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	-52	-141	-89	+48	+1
+2/-7	+47	+15	-32	+35.5	+.74
+3/-8	-5	-13	-8	+2.5	+.05
+4/-9	+1	+80	+79	-35	-.73

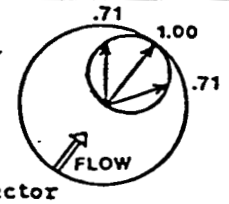


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 2° Velocity: 49

Form 104 available from your local K-V Associates, Inc. dealer.

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000357

Appendix H
Analytical Results of Free-floating Hydrocarbon Product

APPENDIX H

ANALYTICAL RESULTS OF FREE-FLOATING HYDROCARBON PRODUCT

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill/Nelson Highway Research Triangle Park, NC 27709 (919) 549-8263

November 18, 1991

Mr. Tim Sainey
ERM Midwest
450 West Wilson Bridge Road
Columbus, OH 43085

Dear Mr. Sainey:

We at CompuChem® are pleased to provide our report for the analysis you requested. Data for the following sample are enclosed.

Your ID Number	Our ID Number	Analysis Code	Order Number	Description of Work Requested
PRRSMW11	456189	936	24148	Volatiles + Library Search, Method 8240 - 3rd Ed. (Style 1)

Unless noted by Quality Assurance Notices included in this report of data, all Quality Control requirements associated with the preparation and analysis of these samples have been met.

Release of the analytical data contained in this data package has been authorized by the Technical Review Manager or her designee, as verified by the signature below.

Thank you for selecting CompuChem® Laboratories for your sample analysis. If you have questions concerning this report or the analytical methods employed please contact your Sales Representative at 919-549-8263.

We hope you will consider CompuChem® Laboratories for your future analytical support and service requirements.

Sincerely,

Stephanie W Winfield

for Anh Chan
Manager, Final Technical Review

COMPUCHEM LABORATORIES, INC.

- TABLE OF CONTENTS -

Method Reference

Data Summary

- Data Qualifiers
- Volatile Organics
- Tentatively Identified Compounds (TIC) List

Quality Assurance Notices*

Chain of Custody**

*These notices are included where appropriate for data qualification.

**When the original chain of custody is submitted with the sample(s), a copy of it is included with the report.

METHOD REFERENCE

To determine the concentration of Volatile organic compounds in a variety of waste matrices, CompuChem® employs the methods stated in the RCRA Method 8240.

As a point of information, the analytes present on the enclosed compound list have been validated for Method 8240 as required by SW-846.

Method Summary

The volatile compounds are introduced to the gas chromatograph by the Purge-and-Trap Method (RCRA Method 5030). The components are separated via the gas chromatograph and detected using a mass spectrometer which is used to provide both qualitative and quantitative information. The chromatographic conditions as well as typical mass spectrometer operating parameters are given in the RCRA Method 8240.

A library search is performed by automated comparison of the unknown peak spectrum to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards) mass spectral library. Estimated concentration is calculated using the known concentration and peak area of the closest internal standard while assuming a response factor of one for the unknown compound.

DATA REPORTING QUALIFIERS

COMPUCHEM POLICY FOR REPORTING GC/MS VOLATILE ORGANIC ANALYSES

Compuchem utilizes the Finnigan Formaster software program to generate summary forms for many of our GC/MS analytical service products. In so doing, we have adopted the EPA's Contract Laboratory Program (CLP) policy as it relates to the the application of the "Dilution Factor." An EPA directive has stated that the dilution factor is intended to account only for deviations from SOW specifications for the extract volume. For volatile analyses, the "Sample wt/vol" field is incorporated into calculations by the software when less than the SOW specified sample size (5 ml or 5 g) is taken for analysis. Less than the specified sample size would be taken in order to achieve on-column concentrations of analytes within the initial calibration range.

DATA REPORTING QUALIFIERS

VALUE – If the result is a value greater than or equal to the detection limit, report the value.

U – Indicates compound was analyzed but not detected. The sample Quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U)}{D} \times df \qquad \text{Where } D = \frac{100 - \%\ \text{Moisture}}{100}$$

and df = dilution factor

$$\text{At 24\% moisture, } D = \frac{100-24}{100} = 0.76$$

$$\frac{(330\ U)}{0.76} \times 10 = 4300\ U$$ rounded to the appropriate number of significant figures

For soil sample subjected to GPC clean-up procedures, the CRQL is also multiplied by 2, to account for the fact that only half of the extract is recovered.

J – Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero. For example, if the sample quantitation limit is 10 ug/l, but a concentration is 3 ug/l is calculated, report it as 3J. The sample quantitation limit must be adjusted for both dilution and percent moisture as discussed for the U flag, so that if a sample with 24% moisture and a 1 to 10 dilution factor has a calculated concentration of 300 ug/l and a sample quantitation limit of 430 ug/kg, report the concentration as 300J on Form I.

C - This flag applies to pesticides results where the identification has been confirmed by GC/MS. Single component pesticides >10 ng/ul in the final extract shall be confirmed by GC/MS.

B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified TCL compound.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticides/PCBs analyzed by GC/EC methods. If one or more compounds have a response greater than full scale, the sample or extract must be diluted and re-analyzed according to the specifications. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate Forms I. The Form I for the diluted sample shall have the "DL" suffix appended to the sample number.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re-analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form I for the diluted sample and all concentration values reported on that Form I are flagged with the "D" flag.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

X - This flag refers to indistinguishable isomers.

FIDL - Refer to Form I for correct detection limits.

Y & Z - Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative. Begin by using "Y". If more than one flag is required, use "Z" as needed. If more than five qualifiers are required for a sample result, use the "Y" or "Z" flag to combine several flags, as needed. For instance, the "Y" or "Z" flag might combine the "A", "B", and "D" flags for some sample.

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW11

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456189

Sample wt/vol: 4.0 (g/mL) G Lab File ID: CR056189B03

Level: (low/med) MED Date Received: 10/19/91

% Moisture: not dec. ____ Date Analyzed: 10/24/91

GC Column: CAP ID: _____(mm) Dilution Factor: 1.0

Soil Extract Volume: 14000(uL) Soil Aliquot Volume: 100 (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	1700	U
74-83-9	Bromomethane	870	U
75-01-4	Vinyl Chloride	1700	U
75-00-3	Chloroethane	1700	U
75-09-2	Methylene Chloride	1100	BJ
67-64-1	Acetone	1700	U
75-15-0	Carbon Disulfide	870	U
75-35-4	1,1-Dichloroethene	870	U
75-34-3	1,1-Dichloroethane	870	U
540-59-0	1,2-Dichloroethene (total)	870	U
67-66-3	Chloroform	870	U
107-06-2	1,2-Dichloroethane	870	U
78-93-3	2-Butanone	1700	U
71-55-6	1,1,1-Trichloroethane	870	U
56-23-5	Carbon Tetrachloride	870	U
108-05-4	Vinyl Acetate	1700	U
75-27-4	Bromodichloromethane	870	U
78-87-5	1,2-Dichloropropane	870	U
10061-01-5	cis-1,3-Dichloropropene	870	U
79-01-6	Trichloroethene	870	U
124-48-1	Dibromochloromethane	870	U
79-00-5	1,1,2-Trichloroethane	870	U
71-43-2	Benzene	870	U
10061-02-6	Trans-1,3-Dichloropropene	870	U
110-75-8	2-Chloroethylvinylether	1700	U
75-25-2	Bromoform	1700	U
108-10-1	4-Methyl-2-Pentanone	2700	U
591-78-6	2-Hexanone	2700	U
127-18-4	Tetrachloroethene	870	U
79-34-5	1,1,2,2-Tetrachloroethane	1700	U
108-88-3	Toluene	1600	
108-90-7	Chlorobenzene	870	U
100-41-4	Ethylbenzene	5300	

SAMPLE NO.

PRRSMW11

1X
ORGANICS ANALYSIS DATA SHEET

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456189

Sample wt/vol: 4.0 (g/mL) G Lab File ID: CR056189B03

Level: (low/med) MED Date Received: 10/19/91

% Moisture: not dec. ____ Date Analyzed: 10/24/91

GC Column: CAP ID: _____(mm) Dilution Factor: 1.0

Soil Extract Volume: 14000(uL) Soil Aliquot Volume: 100 (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
100-42-5	Styrene	870	U
1330-20-7	Total Xylenes	32000	
74-88-4	Iodomethane	1700	U
107-02-8	Acrolein	15000	U
107-13-1	Acrylonitrile	21000	U
75-69-4	Trichlorofluoromethane	870	U
107-05-1	3-Chloropropene	2700	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluo	1700	U
354-58-5	1,1,1-Trichloro-2,2,2-trifluo	1700	U
74-95-3	Dibromomethane	1700	U
4170-30-3	Crotonaldehyde	17000	U
106-93-4	1,2-Dibromoethane	870	U
630-20-6	1,1,1,2-Tetrachloroethane	870	U
764-41-0	cis-1,4-Dichloro-2-butene	2700	U
96-18-4	1,2,3-Trichloropropane	2700	U
764-71-0	trans-1,4-Dichloro-2-butene	2700	U
96-18-4	Ethylmethacrylate	1700	U
96-12-8	1,2-Dibromo-3-chloropropane	1700	U

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: VOLATILE

DATA FILENAME: CR056189B03 SAMPLE # 456189

ITEM	SCAN NUMBER	CAS #	COMPOUND NAME	ESTIMATED CONC.(ug/l)
1.	1148	98-82-8	BENZENE,(1-METHYLETHYL)-	80000 J
2.	1235	95-63-6	BENZENE,1,2,4-TRIMETHYL- TRIMETHYL BENZENE	1000 J
3.	1495	4706-89-2	BENZENE,2,4-DIMETHYL-1-(1-METHYLETHYL)- METHYL ETHYL BENZENE	1400 J
4.	1557	99-62-7	BENZENE,1,3-BIS(1-METHYLETHYL)- METHYL ETHYL BENZENE	19000 J
5.	1591	100-18-5	BENZENE,1,4-BIS(1-METHYLETHYL)- METHYL ETHYL BENZENE	24000 J

175.000 50.00

SPECTROSCOPIST _____DB_____

DATE ___11/18/91___

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

000368

LABORATORY NOTICE

COMPUCHEM # 456189
CLIENT ID# PRRSMW11
CASE # 24148

Sample 456189 was received in three 40ml VOA vials. The sample was screened and from this information the sample was analyzed as a medium level sample. Four grams of the sample was taken and extracted with ten mls of methanol. This extraction formed only one layer therefore yielding a fourteen ml solution instead of a ten ml solution. The surrogates are corrected to an amount of 35.7 for amount spiked in and the correction factor has also been adjusted to take into account the volume in the extraction process.

Approved by Susan W Bass 11/4/91
Susan W. Bass
VOA Data Review Manager

Approved by Stephanie W Winfield 11/25/91
Final Technical Review

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE
CompuChem ID# 456185
Blank ID# 457307
Case # 24148

CompuChem offers various types of analytical services. The above sample was analyzed according to the protocol checked:

( ) "Contract Laboratory Program (CLP)--Volatile / Semivolatile analysis". Analytical requirements were derived from the EPA.

(X) "Volatile Analysis by GC/MS--Method 8240" / "Semivolatile Analysis by GC/MS--Method 8270". Many of the Quality Control requirements of these methods were derived from the EPA's Contract Laboratory Program.

( ) Clean Water Act " Purgeable Volatile Analysis--Method 624" / "Base Neutrals and Acids--Method 625". Requirements were established in the Federal Register of October 26, 1984, 40 CFR Part 136.

( ) "Lower Detection Limit / ResWell Volatile or Semivolatile". CLP requirements have been modified for application to this method.

The CLP protocols allow certain levels of common laboratory solvents (Acetone, Methylene Chloride, and Toluene), the solvent-related artifact 2-Butanone, and phthalates to be present in blanks, up to five times the Contract Required Quantitation Limit (CRQL). CompuChem has a more stringent policy for liquid samples, allowing up to a maximum of twice the CRQL for these commonly occuring contaminants. An exception is made in the case of liquid Instrument Blanks where the analyses of three successive blanks indicate a consistent background level of Methylene Chloride. The concentration of Methylene Chloride in Low Level Soil Method Blanks may not exceed 25 ug/kg; Acetone may not exceed 50 ug/kg (Medium Level Soil methodology applies a correction factor of 125 to the concentrations to yield the reported amounts). Exception to our policy is made only when the volatile analysis or extraction holding times are in jeopardy of being exceeded (although the CLP requirements must be met).

Analysis of the Method Blank (and/or Instrument Blank) associated with the above sample indicated the following common laboratory contaminants were present at the indicated levels:

common laboratory contaminant	concentration	units
methylene chloride	5	ug/kg

The reporting convention used in the CLP is to "flag" with a "B" all allowable target compounds present in the sample when also found in its associated blank. No adjustments are made to the analytical results.

This notice serves to explain the use of the "B" flag in reporting analytical results, while presenting the actual levels of the common laboratory solvents or phthalates seen in the associated blank.

Data Usability: General Guidelines

In evaluating data usability, the following general guidelines originating from the US EPA are offered for assessing the significance of common laboratory artifacts in samples. If the concentration of an analyte in a sample is less than three times that in the blank, it may be negated due to laboratory contamination. If the concentration of an analyte in a sample is greater than five times that in the blank, it may be considered an actual sample component. If the concentration of an analyte in a sample is greater than three times but less than five times that in the blank, the presence of that compound in the sample may be considered suspect.

Reviewer's initials/ID SWB / 633
date 11/4/91

ERM-Midwest, inc.

450 W. Wilson Bridge Road • Worthington, OH 43085 • (614) 433-7900 • Telefax: (614) 433-0886

007361

CHAIN OF CUSTODY RECORD

Project No./I.D. 539-13 Sheet 1 of 1
Sampled By ERM MIDWEST Bottles Supplied By Compuchem
NOTE: When analyses are complete return this form to:
Name: Tim Sainey @ ERM-Midwest, Inc., Columbus, Ohio

Sample I.D.	Sample Description ID USED	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
PRRS MW-11	Free Product PRRSMW11	10-17-91 1600	3	8240 Full List	Free Product
PRRS MW-12	" PRRSMW12	10-17-91 1600	1	"	456189
					191

Shipping package opened by: TJD Date: 10-17-91 Time: 0730
Employer: ERM MIDWEST Containers intact (Y/N) yes

Samples packaged & sealed by: TJS Date: 10-19-91 Time: 1400
Employer: ERM Midwest Method of Shipment: Federal Express

Received in laboratory by: Mark Bryan Date: 10/19/91 Time: 8:30
Employer: Compuchem Seals intact (Y/N)
Containers intact (Y/N) If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
Tim Sainey	ERM Midwest							

COMMENTS: MTB 10/19/91

RECEIVED IN GOOD CONDITION

000371

Copies: White - Project file; Yellow - Client; Pink - Sampler

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill/Nelson Highway Research Triangle Park, NC 27709 (919) 549-8263

November 11, 1991

Mr. Tim Sainey
ERM Midwest
450 West Wilson Bridge Road
Columbus, OH 43085

Dear Mr. Sainey:

We at CompuChem® are pleased to provide our report for the analysis you requested. Data for the following sample are enclosed.

Your ID Number	Our ID Number	Analysis Code	Order Number	Description of Work Requested
PRRSMW12	456191	936	24148	Volatiles + Library Search, Method 8240 - 3rd Ed. with Dry Weight Determination (Style 1)

Unless noted by Quality Assurance Notices included in this report of data, all Quality Control requirements associated with the preparation and analysis of these samples have been met.

Release of the analytical data contained in this data package has been authorized by the Technical Review Manager or her designee, as verified by the signature below.

Thank you for selecting CompuChem® Laboratories for your sample analysis. If you have questions concerning this report or the analytical methods employed please contact your Sales Representative at 919-549-8263.

We hope you will consider CompuChem® Laboratories for your future analytical support and service requirements.

Sincerely,

Patricia B. Hopkins

for Anh Chan
Manager, Final Technical Review

COMPUCHEM LABORATORIES, INC.

- TABLE OF CONTENTS -

Method Reference

Data Summary

- Data Qualifiers
- Volatile Organics
- Tentatively Identified Compounds (TIC) List

Quality Assurance Notices*

Chain of Custody**

*These notices are included where appropriate for data qualification.

**When the original chain of custody is submitted with the sample(s), a copy of it is included with the report.

METHOD REFERENCE

To determine the concentration of Volatile organic compounds in a variety of waste matrices, CompuChem® employs the methods stated in the RCRA Method 8240.

As a point of information, the analytes present on the enclosed compound list have been validated for Method 8240 as required by SW-846.

Method Summary

The volatile compounds are introduced to the gas chromatograph by the Purge-and-Trap Method (RCRA Method 5030). The components are separated via the gas chromatograph and detected using a mass spectrometer which is used to provide both qualitative and quantitative information. The chromatographic conditions as well as typical mass spectrometer operating parameters are given in the RCRA Method 8240.

A library search is performed by automated comparison of the unknown peak spectrum to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards) mass spectral library. Estimated concentration is calculated using the known concentration and peak area of the closest internal standard while assuming a response factor of one for the unknown compound.

DATA REPORTING QUALIFIERS

COMPUCHEM POLICY FOR REPORTING GC/MS VOLATILE ORGANIC ANALYSES

Compuchem utilizes the Finnigan Formaster software program to generate summary forms for many of our GC/MS analytical service products. In so doing, we have adopted the EPA's Contract Laboratory Program (CLP) policy as it relates to the the application of the "Dilution Factor." An EPA directive has stated that the dilution factor is intended to account only for deviations from SOW specifications for the extract volume. For volatile analyses, the "Sample wt/vol" field is incorporated into calculations by the software when less than the SOW specified sample size (5 ml or 5 g) is taken for analysis. Less than the specified sample size would be taken in order to achieve on-column concentrations of analytes within the initial calibration range.

DATA REPORTING QUALIFIERS

VALUE – If the result is a value greater than or equal to the detection limit, report the value.

U – Indicates compound was analyzed but not detected. The sample Quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U) \times df}{D} \quad \text{Where } D = \frac{100 - \%\ \text{Moisture}}{100}$$

and df = dilution factor

$$\text{At 24\% moisture, } D = \frac{100-24}{100} = 0.76$$

$$\frac{(330\ U)}{0.76} \times 10 = 4300\ U$$ rounded to the appropriate number of significant figures

For soil sample subjected to GPC clean-up procedures, the CRQL is also multiplied by 2, to account for the fact that only half of the extract is recovered.

J – Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero. For example, if the sample quantitation limit is 10 ug/l, but a concentration is 3 ug/l is calculated, report it as 3J. The sample quantitation limit must be adjusted for both dilution and percent moisture as discussed for the U flag, so that if a sample with 24% moisture and a 1 to 10 dilution factor has a calculated concentration of 300 ug/l and a sample quantitation limit of 430 ug/kg, report the concentration as 300J on Form I.

C – This flag applies to pesticides results where the identification has been confirmed by GC/MS. Single component pesticides >10 ng/ul in the final extract shall be confirmed by GC/MS.

B – This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified TCL compound.

E – This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticides/PCBs analyzed by GC/EC methods. If one or more compounds have a response greater than full scale, the sample or extract must be diluted and re–analyzed according to the specifications. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate Forms I. The Form I for the diluted sample shall have the "DL" suffix appended to the sample number.

D – This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re–analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form I for the diluted sample and all concentration values reported on that Form I are flagged with the "D" flag.

A – This flag indicates that a TIC is a suspected aldol–condensation product.

X – This flag refers to indistinguishable isomers.

FIDL – Refer to Form I for correct detection limits.

Y & Z – Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative. Begin by using "Y". If more than one flag is required, use "Z" as needed. If more than five qualifiers are required for a sample result, use the "Y" or "Z" flag to combine several flags, as needed. For instance, the "Y" or "Z" flag might combine the "A", "B", and "D" flags for some sample.

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW12

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456191

Sample wt/vol: 0.10 (g/mL) G Lab File ID: CR056191B03

Level: (low/med) MED Date Received: 10/19/91

% Moisture: not dec. _____ Date Analyzed: 10/24/91

GC Column: CAP ID: _____(mm) Dilution Factor: 1.0

Soil Extract Volume: 10000(uL) Soil Aliquot Volume: 100 (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	1200	U
74-83-9	Bromomethane	620	U
75-01-4	Vinyl Chloride	1200	U
75-00-3	Chloroethane	1200	U
75-09-2	Methylene Chloride	760	BJ
67-64-1	Acetone	1200	U
75-15-0	Carbon Disulfide	620	U
75-35-4	1,1-Dichloroethene	620	U
75-34-3	1,1-Dichloroethane	620	U
540-59-0	1,2-Dichloroethene (total)	620	U
67-66-3	Chloroform	620	U
107-06-2	1,2-Dichloroethane	620	U
78-93-3	2-Butanone	1200	U
71-55-6	1,1,1-Trichloroethane	620	U
56-23-5	Carbon Tetrachloride	620	U
108-05-4	Vinyl Acetate	1200	U
75-27-4	Bromodichloromethane	620	U
78-87-5	1,2-Dichloropropane	620	U
10061-01-5	cis-1,3-Dichloropropene	620	U
79-01-6	Trichloroethene	620	U
124-48-1	Dibromochloromethane	620	U
79-00-5	1,1,2-Trichloroethane	620	U
71-43-2	Benzene	620	U
10061-02-6	Trans-1,3-Dichloropropene	620	U
110-75-8	2-Chloroethylvinylether	1200	U
75-25-2	Bromoform	1200	U
108-10-1	4-Methyl-2-Pentanone	1900	U
591-78-6	2-Hexanone	1900	U
127-18-4	Tetrachloroethene	620	U
79-34-5	1,1,2,2-Tetrachloroethane	1200	U
108-88-3	Toluene	170	J
108-90-7	Chlorobenzene	620	U
100-41-4	Ethylbenzene	140	J

SAMPLE NO.

1X
ORGANICS ANALYSIS DATA SHEET

PRRSMW12

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456191

Sample wt/vol: 0.10 (g/mL) G Lab File ID: CR056191B03

Level: (low/med) MED Date Received: 10/19/91

% Moisture: not dec. ____ Date Analyzed: 10/24/91

GC Column: CAP ID: _____(mm) Dilution Factor: 1.0

Soil Extract Volume: 10000(uL) Soil Aliquot Volume: 100 (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
100-42-5	Styrene	620	U
1330-20-7	Total Xylenes	1000	
74-88-4	Iodomethane	1200	U
107-02-8	Acrolein	11000	U
107-13-1	Acrylonitrile	15000	U
75-69-4	Trichlorofluoromethane	620	U
107-05-1	3-Chloropropene	1900	U
76-13-1	1,1,2-Trichloro-1,2,2-trifluo	1200	U
354-58-5	1,1,1-Trichloro-2,2,2-trifluo	1200	U
74-95-3	Dibromomethane	1200	U
4170-30-3	Crotonaldehyde	12000	U
106-93-4	1,2-Dibromoethane	620	U
630-20-6	1,1,1,2-Tetrachloroethane	620	U
764-71-0	cis-1,4-Dichloro-2-butene	1900	U
96-18-4	1,2,3-Trichloropropane	1900	U
764-71-0	trans-1,4-Dichloro-2-butene	1900	U
96-18-4	Ethylmethacrylate	1200	U
96-12-8	1,2-Dibromo-3-chloropropane	1200	U

LABORATORY NAME: COMPUCHEM

CASE NO:

SAMPLE NUMBER

COMPUCHEM FILE CR056191B03

ORGANICS ANALYSIS DATA SHEET

TENTATIVELY IDENTIFIED COMPOUNDS

	CAS NUMBER	COMPOUND NAME	FRACTION	SCAN NUMBER	ESTIMATED CONC. (UG/L OR UG/KG)	
1	98-82-8	BENZENE,(1-METHYLETHYL)-	NAST	1151	91.	J
2	99-62-7	BENZENE,1,3-BIS(1-METHYLETHYL)-	NAST	1559	80.	J
3	100-18-5	BENZENE,1,4-BIS(1-METHYLETHYL)-	NAST	1594	110.	J

1.000 50.00

SPECTROSCOPIST

DATE 12/3/91

25

000181

VERSION 2/90

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE
CompuChem ID# 496191
Blank ID# 457307
Case # 241018

CompuChem offers various types of analytical services. The above sample was analyzed according to the protocol checked:

( ) "Contract Laboratory Program (CLP)--Volatile / Semivolatile analysis". Analytical requirements were derived from the EPA.

(/) "Volatile Analysis by GC/MS--Method 8240" / "Semivolatile Analysis by GC/MS--Method 8270". Many of the Quality Control requirements of these methods were derived from the EPA's Contract Laboratory Program.

( ) Clean Water Act " Purgeable Volatile Analysis--Method 624" / "Base Neutrals and Acids--Method 625". Requirements were established in the Federal Register of October 26, 1984, 40 CFR Part 136.

( ) "Lower Detection Limit / ResWell Volatile or Semivolatile". CLP requirements have been modified for application to this method.

The CLP protocols allow certain levels of common laboratory solvents (Acetone, Methylene Chloride, and Toluene), the solvent-related artifact 2-Butanone, and phthalates to be present in blanks, up to five times the Contract Required Quantitation Limit (CRQL). CompuChem has a more stringent policy for liquid samples, allowing up to a maximum of twice the CRQL for these commonly occuring contaminants. An exception is made in the case of liquid Instrument Blanks where the analyses of three successive blanks indicate a consistent background level of Methylene Chloride. The concentration of Methylene Chloride in Low Level Soil Method Blanks may not exceed 25 ug/kg; Acetone may not exceed 50 ug/kg (Medium Level Soil methodology applies a correction factor of 125 to the concentrations to yield the reported amounts). Exception to our policy is made only when the volatile analysis or extraction holding times are in jeopardy of being exceeded (although the CLP requirements must be met).

Analysis of the Method Blank (and/or Instrument Blank) associated with the above sample indicated the following common laboratory contaminants were present at the indicated levels:

common laboratory contaminant	concentration	units
methylene chloride	640	µg/kg

The reporting convention used in the CLP is to "flag" with a "B" all allowable target compounds present in the sample when also found in its associated blank. No adjustments are made to the analytical results.

This notice serves to explain the use of the "B" flag in reporting analytical results, while presenting the actual levels of the common laboratory solvents or phthalates seen in the associated blank.

Data Usability: General Guidelines

In evaluating data usability, the following general guidelines originating from the US EPA are offered for assessing the significance of common laboratory artifacts in samples. If the concentration of an analyte in a sample is less than three times that in the blank, it may be negated due to laboratory contamination. If the concentration of an analyte in a sample is greater than five times that in the blank, it may be considered an actual sample component. If the concentration of an analyte in a sample is greater than three times but less than five times that in the blank, the presence of that compound in the sample may be considered suspect.

QAN-VSV-15
901001.r1

Reviewer's initials/ID SCH, TM
date 10/30/97

ERM-Midwest, inc.

450 W. Wilson Bridge Road • Worthington, OH 43085 • (614) 433-7900 • Telefax: (614) 433-0886

CHAIN OF CUSTODY RECORD

Project No./I.D. 539-13 Sheet 1 of 1
Sampled By ERM MIDWEST Bottles Supplied By Compuchem
NOTE: When analyses are complete return this form to:
Name: Tim Sainey @ ERM-Midwest, Inc., Columbus, Ohio

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
PRRS MW-11	ID USED Free Product PRRSmw11	10-17-91 1600	3	8240 Full List	Free Product
PRRS MW-12	" PRRSmw12	10-17-91 1600	1	"	456189
					191

Shipping package opened by: TJD Date: 10-17-91 Time: 0730
Employer: ERM MIDWEST Containers intact (Y/N) yes

Samples packaged & sealed by: TJS Date: 10-19-91 Time: 1400
Employer: ERM Midwest Method of Shipment: Federal Express

Received in laboratory by: Mark Bryan Date: 10/19/91 Time: 8:30
Employer: Compuchem Seals intact (Y/N)
Containers intact (Y/N) If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
Tim Sainey	ERM Midwest							

COMMENTS: MTB 10/19/91

RECEIVED IN GOOD CONDITION

000383

Copies: White - Project file; Yellow - Client; Pink - Sampler

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill/Nelson Highway Research Triangle Park, NC 27709 (919) 549-8263

December 2, 1991

Mr. Tim Sainey
ERM MIDWEST
450 West Wilson Bridge Road
Columbus, IL 60015

Dear Mr. Sainey:

We at CompuChem® are pleased to provide our report for the analysis you requested. Data for the following sample are enclosed:

Your ID Number	Our ID Number	Analysis Code	Order Number	Description of Work Requested
PRRSMW13	456712	939	24148	Semi-Volatiles + Library Search, Method 8270 - 3rd Ed. with Dry Weight Determination (Style 1)

Unless noted by Quality Assurance Notices included in this report of data, all Quality Control requirements associated with the preparation and analysis of these samples have been met.

Release of the analytical data contained in this data package has been authorized by the Technical Review Manager or her designee, as verified by the signature below.

Thank you for selecting Compuchem® Laboratories for your sample analysis. If you have questions concerning this report or the analytical methods employed please contact your Sales Representative at 919-549-8263.

We hope you will consider Compuchem® Laboratories for your future analytical support and service requirements.

Sincerely,

Tonay C. Spinell for

Anh Chan
Manager, Final Technical Review

COMPUCHEM LABORATORIES, INC.

- TABLE OF CONTENTS -

Method Reference

Data Summary

- Sample Data Qualifiers
- Method 8270 Semi-Volatile Compound List
- Tentatively Identified Compound (TIC) List

Quality Assurance Notices*

Chain of Custody**

*These notices are included where appropriate for data qualification.

**When the original chain of custody is submitted with the sample(s), a copy of it is included with the report.

000385

METHOD REFERENCE

To determine the concentration of semi-volatile organic compounds in solid matrices CompuChem® employs the methods as outline in SW-846, for sample preparation (Method 3550) and analysis (Method 8270). These methods are approved for obtaining data to satisfy the requirement of 40CFR Part 261, Identification and Listing of Hazardous Waste.

Method Summary

After the pH and percent moisture determinations, a weighed sample (30 grams) of the solid waste is extracted with a 1:1 methylene chloride:acetone solution using an ultrasonic probe. The extract is dried and concentrated for analysis. Analysis is performed by separation of the components by gas chromatography followed by qualitative and quantitative identification by mass spectrometry using internal standard techinques.

A library search is performed by automated comparison of the unknown peak spectrum to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards) mass spectral library. Estimated concentration is calculated using the known concentration and peak area of the closest internal standard while assuming a response factor of one for the unknown compound.

DATA REPORTING QUALIFIERS

DATA REPORTING QUALIFIERS

VALUE – If the result is a value greater than or equal to the detection limit, report the value.

U – Indicates compound was analyzed but not detected. The sample Quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U)}{D} \times df \qquad \text{Where } D = \frac{100 - \%\ \text{Moisture}}{100}$$

and df = dilution factor

$$\text{At 24\% moisture, } D = \frac{100-24}{100} = 0.76$$

$$\frac{(330\ U)}{0.76} \times 10 = 4300\ U$$ rounded to the appropriate number of significant figures

For soil sample subjected to GPC clean-up procedures, the CRQL is also multiplied by 2, to account for the fact that only half of the extract is recovered.

J – Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero. For example, if the sample quantitation limit is 10 ug/l, but a concentration is 3 ug/l is calculated, report it as 3J. The sample quantitation limit must be adjusted for both dilution and percent moisture as discussed for the U flag, so that if a sample with 24% moisture and a 1 to 10 dilution factor has a calculated concentration of 300 ug/l and a sample quantitation limit of 430 ug/kg, report the concentration as 300J on Form I.

C – This flag applies to pesticides results where the identification has been confirmed by GC/MS. Single component pesticides >10 ng/ul in the final extract shall be confirmed by GC/MS.

B – This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified TCL compound.

E – This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticides/PCBs analyzed by GC/EC methods. If one or more compounds have a response greater than full scale, the sample or extract must be diluted and re–analyzed according to the specifications. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate Forms I. The Form I for the diluted sample shall have the "DL" suffix appended to the sample number.

D – This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re–analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form I for the diluted sample and all concentration values reported on that Form I are flagged with the "D" flag.

A – This flag indicates that a TIC is a suspected aldol–condensation product.

X – This flag refers to indistinguishable isomers.

FIDL – Refer to Form I for correct detection limits.

Y & Z – Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative. Begin by using "Y". If more than one flag is required, use "Z" as needed. If more than five qualifiers are required for a sample result, use the "Y" or "Z" flag to combine several flags, as needed. For instance, the "Y" or "Z" flag might combine the "A", "B", and "D" flags for some sample.

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056712A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
62-75-9	N-Nitrosodimethylamine	1600	U
110-86-1	Pyridine	1600	U
97-63-2	Ethyl methacrylate	1600	U
123-63-7	Paraldehyde	1600	U
109-06-8	2-Picoline	3200	U
10595-95-6	Nitrosomethylethylamine	1600	U
66-27-3	Methyl methanesulfonate	1600	U
55-18-5	N-Nitrosodiethylamine	1600	U
62-50-0	Ethyl methanesulfonate	1600	U
108-95-2	Phenol	1600	U
62-53-3	Aniline	1600	U
76-01-7	Pentachloroethane	1600	U
111-44-4	bis(2-Chloroethyl)Ether	3200	U
95-57-8	2-Chlorophenol	1600	U
541-73-1	1,3-Dichlorobenzene	1600	U
100-44-7	Benzyl Chloride	1600	U
106-46-7	1,4-Dichlorobenzene	1600	U
100-51-6	Benzyl Alcohol	1600	U
95-50-1	1,2-Dichlorobenzene	1600	U
95-48-7	2-Methylphenol	1600	U
39638-32-9	bis(2-Chloroisopropyl)Ether	1600	U
108-39-4	3-Methylphenol	1600	U
106-44-5	4-Methylphenol	1600	U
930-55-2	N-Nitrosopyrrolidine	1600	U
59-89-2	N-Nitrosomorpholine	1600	U
98-86-2	Acetophenone	1600	U
621-64-7	N-Nitroso-Di-n-Propylamine	1600	U
636-21-5	o-Toluidine hydrochloride	1600	U
67-72-1	Hexachloroethane	1600	U
98-95-3	Nitrobenzene	1600	U
100-75-4	N-Nitrosopiperidine	1600	U
78-59-1	Isophorone	1600	U
88-75-5	2-Nitrophenol	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056712A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
105-67-9	2,4-Dimethylphenol	1600	U
108-70-3	1,3,5-Trichlorobenzene	1600	U
98-87-3	Benzal Chloride	1600	U
65-85-0	Benzoic Acid	16000	U
111-91-1	bis(2-Chloroethoxy)Methane	1600	U
120-83-2	2,4-Dichlorophenol	1600	U
120-82-1	1,2,4-Trichlorobenzene	1600	U
91-20-3	Naphthalene	200	J
106-47-8	4-Chloroaniline	1600	U
87-65-0	2,6-Dichlorophenol	3200	U
95-54-5	o-Phenylenediamine	1600	U
122-09-8	dimethylphenylethylamine	1600	U
1888-71-7	Hexachloropropene	1600	U
87-68-3	Hexachlorobutadiene	1600	U
87-61-6	1,2,3-Trichlorobenzene	1600	U
98-07-7	Benzotrichloride	3200	U
924-16-3	N-Nitroso-di-n-butylamine	1600	U
59-50-7	4-Chloro-3-Methylphenol	1600	U
106-50-3	P-Phenylenediamine	1600	U
94-59-7	Safrole	1600	U
106-50-3	m-Phenylenediamine	1600	U
91-57-6	2-Methylnaphthalene	190	J
90-12-0	1-Methylnaphthalene	1600	U
95-94-3	1,2,4,5-Tetrachlorobenzene	1600	U
634-90-2	1,2,3,5-Tetrachlorobenzene	1600	U
77-47-4	Hexachlorocyclopentadiene	1600	U
88-06-2	2,4,6-Trichlorophenol	3200	U
95-95-4	2,4,5-Trichlorophenol	3200	U
120-58-1	Isosafrole	3200	U
91-58-7	2-Chloronaphthalene	1600	U
90-13-1	1-Chloronaphthalene	1600	U
634-66-2	1,2,3,4-Tetrachlorobenzene	1600	U
88-74-4	2-Nitroaniline	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056712A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
130-15-4	1,4-Naphthoquinone	3200	U
100-25-4	1,4-Dinitrobenzene	3200	U
131-11-3	Dimethyl Phthalate	1600	U
208-96-8	Acenaphthylene	1600	U
606-20-2	2,6-Dinitrotoluene	1600	U
99-09-2	3-Nitroaniline	3200	U
83-32-9	Acenaphthene	1600	U
51-28-5	2,4-Dinitrophenol	6400	U
100-02-7	4-Nitrophenol	1600	U
132-64-9	Dibenzofuran	1600	U
121-14-2	2,4-Dinitrotoluene	1600	U
608-93-5	Pentachlorobenzene	1600	U
91-59-8	2-Naphthylamine	3200	U
134-32-7	1-Naphthylamine	3200	U
58-90-2	2,3,4,6-Tetrachlorophenol	3200	U
84-66-2	Diethylphthalate	1600	U
297-97-2	Zinophos	1600	U
7005-72-3	4-Chlorophenyl-phenylether	1600	U
86-73-7	Fluorene	280	J
100-01-6	4-Nitroaniline	3200	U
99-55-8	5-Nitro-o-toluidine	3200	U
122-66-7	1,2-Diphenylhydrazine	1600	U
534-52-1	4,6-Dinitro-2-Methylphenol	4900	U
86-30-6	N-Nitrosodiphenylamine (1)	1600	U
122-39-4	Diphenylamine	1600	U
99-35-4	1,3,5-Trinitrobenzene	3200	U
62-44-2	Phenacetin	1600	U
101-55-3	4-Bromophenyl-phenylether	1600	U
2303-16-4	Diallate	1600	U
60-51-5	Dimethoate	1600	U
118-74-1	Hexachlorobenzene	1600	U
92-67-1	4-Aminobiphenyl	1600	U
23950-58-5	Pronamide	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056712A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 2.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
87-86-5	Pentachlorophenol	3200	U
82-68-8	Pentachloronitrobenzene	1600	U
85-01-8	Phenanthrene	610	J
120-12-7	Anthracene	1600	U
84-74-2	Di-n-Butylphthalate	1600	U
91-80-5	Methapyrilene	3200	U
50-18-0	Cyclophosphamide	7900	U
206-44-0	Fluoranthene	510	J
92-87-5	Benzidine	1600	U
129-00-0	Pyrene	800	J
60-11-7	p-Dimethylaminoazobenzene	1600	U
510-15-6	Chlorobenzilate	1600	U
119-93-7	3,3'-Dimethylbenzidine	3200	U
85-68-7	Butylbenzylphthalate	1600	U
53-96-3	2-Acetylaminofluorene	1600	U
101-14-4	Methylene-bis(2-Chloroaniline	1600	U
91-94-1	3,3'-Dichlorobenzidine	1600	U
119-90-4	3,3'-Dimethoxybenzidine	1600	U
56-55-3	Benzo(a)Anthracene	310	J
218-01-9	Chrysene	420	J
117-81-7	bis(2-Ethylhexyl)Phthalate	170	J
117-84-0	Di-n-Octyl Phthalate	1600	U
205-99-2	Benzo(b)Fluoranthene	410	JX
57-97-6	7,12-Dimethylbenzanthracene	1600	U
207-08-9	Benzo(k)Fluoranthene	410	JX
50-32-8	Benzo(a)Pyrene	230	J
56-49-5	3-Methylcholanthrene	1600	U
224-42-0	Dibenzo(a,j)acridine	1600	U
193-39-5	Indeno(1,2,3-cd)Pyrene	1600	U
53-70-3	Dibenz(a,h)Anthracene	1600	U
191-24-2	Benzo(g,h,i)Perylene	1600	U

000393

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: SEMI-VOLATILE

DATA FILENAME: GD056712A02 SAMPLE # 456712

ITEM	SCAN NUMBER	CAS #	COMPOUND NAME	ESTIMATED CONC. (ug/l)
1.	673	108-38-3	BENZENE, 1,3-DIMETHYL- DIMETHYLBENZENE	32. J
2.	706	108-38-3	BENZENE, 1,3-DIMETHYL- DIMETHYLBENZENE	14. J
3.	763	20019-64-1	2(5H)-FURANONE, 5,5-DIMETHYL- ALDOL	17. JA*
4.	786	4032-93-3	HEPTANE, 2,3,6-TRIMETHYL- UNKNOWN ALKANE	8. J
5.	795	620-14-4	BENZENE, 1-ETHYL-3-METHYL- ETHYLMETHYLBENZENE	17. J
	805	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMEHYLBENZENE	16. J
7.	819	620-14-4	BENZENE, 1-ETHYL-3-METHYL- ETHYLMEHTYLBENZENE	14. J
8.	838	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMEHYLBENZENE	31. J
9.	860	62108-25-2	DECANE, 2,6,7-TRIMETHYL- UNKNOWN HYDROCARBON	7. J
10.	874	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	14. J
11.	880	62108-27-4	DECANE, 2,4,6-TRIMETHYL- UNKNOWN HYDROCARBON	12. J
12.	903	135-98-8	BENZENE, (1-METHYLPROPYL)- METHYLPROPYLBENZENE & UNKNOWN	21. J
	1.000	40.000		

SPECTROSCOPIST _____MSS_____

DATE __11/25/91____

- Indicates an estimated concentration which is determined assuming a 1:1 response.
* - See Quality Assuarance Notice.

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: SEMI-VOLATILE

DATA FILENAME: GD056712A02 SAMPLE # 456712

13.	910	105-05-5	BENZENE, 1,4-DIETHYL- DIETHYLBENZENE	15. J
14.	944	25155-15-1	BENZENE, METHYL(1-METHYLETHYL)- ETHYLDIMETHYLBENZENE	12. J
15.	1023	7525-62-4	BENZENE, 1-ETHENYL-3-ETHYL- UNKNOWN	8. J
16.	1223	3891-98-3	DODECANE, 2,6,10-TRIMETHYL- UNKNOWN HYDROCARBON	7. J
17.	1297	18344-37-1	HEPTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	16. J
18.	1450	18344-37-1	HEPTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	16. J
19.	1493	1921-70-6	PENTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	28. J
20.	1570	18344-37-1	HEPTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	26. J
21.	1627	1560-93-6	PENTADECANE, 2-METHYL- UNKNOWN HYDROCARBON	9. J

1.000 40.000

SPECTROSCOPIST _____MSS_____

DATE __11/25/91____

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

SAMPLE NO.

PRRSMW13RE

1X
ORGANICS ANALYSIS DATA SHEET

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GJD56712B02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/20/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
62-75-9	N-Nitrosodimethylamine	1600	U
110-86-1	Pyridine	1600	U
97-63-2	Ethyl methacrylate	1600	U
123-63-7	Paraldehyde	1600	U
109-06-8	2-Picoline	3200	U
10595-95-6	Nitrosomethylethylamine	1600	U
66-27-3	Methyl methanesulfonate	1600	U
55-18-5	N-Nitrosodiethylamine	1600	U
62-50-0	Ethyl methanesulfonate	1600	U
108-95-2	Phenol	1600	U
62-53-3	Aniline	1600	U
76-01-7	Pentachloroethane	1600	U
111-44-4	bis(2-Chloroethyl)Ether	3200	U
95-57-8	2-Chlorophenol	1600	U
541-73-1	1,3-Dichlorobenzene	1600	U
100-44-7	Benzyl Chloride	1600	U
106-46-7	1,4-Dichlorobenzene	1600	U
100-51-6	Benzyl Alcohol	1600	U
95-50-1	1,2-Dichlorobenzene	1600	U
95-48-7	2-Methylphenol	1600	U
39638-32-9	bis(2-Chloroisopropyl)Ether	1600	U
108-39-4	3-Methylphenol	1600	U
106-44-5	4-Methylphenol	1600	U
930-55-2	N-Nitrosopyrrolidine	1600	U
59-89-2	N-Nitrosomorpholine	1600	U
98-86-2	Acetophenone	1600	U
621-64-7	N-Nitroso-Di-n-Propylamine	1600	U
636-21-5	o-Toluidine hydrochloride	1600	U
67-72-1	Hexachloroethane	1600	U
98-95-3	Nitrobenzene	1600	U
100-75-4	N-Nitrosopiperidine	1600	U
78-59-1	Isophorone	1600	U
88-75-5	2-Nitrophenol	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13RE

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GJD56712B02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/20/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
105-67-9	2,4-Dimethylphenol	1600	U
108-70-3	1,3,5-Trichlorobenzene	1600	U
98-87-3	Benzal Chloride	1600	U
65-85-0	Benzoic Acid	16000	U
111-91-1	bis(2-Chloroethoxy)Methane	1600	U
120-83-2	2,4-Dichlorophenol	1600	U
120-82-1	1,2,4-Trichlorobenzene	1600	U
91-20-3	Naphthalene	270	J
106-47-8	4-Chloroaniline	1600	U
87-65-0	2,6-Dichlorophenol	3200	U
95-54-5	o-Phenylenediamine	1600	U
122-09-8	dimethylphenylethylamine	1600	U
1888-71-7	Hexachloropropene	1600	U
87-68-3	Hexachlorobutadiene	1600	U
87-61-6	1,2,3-Trichlorobenzene	1600	U
98-07-7	Benzotrichloride	3200	U
924-16-3	N-Nitroso-di-n-butylamine	1600	U
59-50-7	4-Chloro-3-Methylphenol	1600	U
106-50-3	P-Phenylenediamine	1600	U
94-59-7	Safrole	1600	U
106-50-3	m-Phenylenediamine	1600	U
91-57-6	2-Methylnaphthalene	290	J
90-12-0	1-Methylnaphthalene	1600	U
95-94-3	1,2,4,5-Tetrachlorobenzene	1600	U
634-90-2	1,2,3,5-Tetrachlorobenzene	1600	U
77-47-4	Hexachlorocyclopentadiene	1600	U
88-06-2	2,4,6-Trichlorophenol	3200	U
95-95-4	2,4,5-Trichlorophenol	3200	U
120-58-1	Isosafrole	3200	U
91-58-7	2-Chloronaphthalene	1600	U
90-13-1	1-Chloronaphthalene	1600	U
634-66-2	1,2,3,4-Tetrachlorobenzene	1600	U
88-74-4	2-Nitroaniline	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13RE

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GJD56712B02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/20/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
130-15-4	1,4-Naphthoquinone	3200	U
100-25-4	1,4-Dinitrobenzene	3200	U
131-11-3	Dimethyl Phthalate	1600	U
208-96-8	Acenaphthylene	1600	U
606-20-2	2,6-Dinitrotoluene	1600	U
99-09-2	3-Nitroaniline	3200	U
83-32-9	Acenaphthene	250	J
51-28-5	2,4-Dinitrophenol	6400	U
100-02-7	4-Nitrophenol	1600	U
132-64-9	Dibenzofuran	1600	U
121-14-2	2,4-Dinitrotoluene	1600	U
608-93-5	Pentachlorobenzene	1600	U
91-59-8	2-Naphthylamine	3200	U
134-32-7	1-Naphthylamine	3200	U
58-90-2	2,3,4,6-Tetrachlorophenol	3200	U
84-66-2	Diethylphthalate	1600	U
297-97-2	Zinophos	1600	U
7005-72-3	4-Chlorophenyl-phenylether	1600	U
86-73-7	Fluorene	360	J
100-01-6	4-Nitroaniline	3200	U
99-55-8	5-Nitro-o-toluidine	3200	U
122-66-7	1,2-Diphenylhydrazine	1600	U
534-52-1	4,6-Dinitro-2-Methylphenol	4900	U
86-30-6	N-Nitrosodiphenylamine (1)	1600	U
122-39-4	Diphenylamine	1600	U
99-35-4	1,3,5-Trinitrobenzene	3200	U
62-44-2	Phenacetin	1600	U
101-55-3	4-Bromophenyl-phenylether	1600	U
2303-16-4	Diallate	1600	U
60-51-5	Dimethoate	1600	U
118-74-1	Hexachlorobenzene	1600	U
92-67-1	4-Aminobiphenyl	1600	U
23950-58-5	Pronamide	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW13RE

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456712

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GJD56712B02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/20/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
87-86-5	Pentachlorophenol	3200	U
82-68-8	Pentachloronitrobenzene	1600	U
85-01-8	Phenanthrene	850	J
120-12-7	Anthracene	320	J
84-74-2	Di-n-Butylphthalate	1600	U
91-80-5	Methapyrilene	3200	U
50-18-0	Cyclophosphamide	7900	U
206-44-0	Fluoranthene	830	J
92-87-5	Benzidine	1600	U
129-00-0	Pyrene	870	J
60-11-7	p-Dimethylaminoazobenzene	1600	U
510-15-6	Chlorobenzilate	1600	U
119-93-7	3,3'-Dimethylbenzidine	3200	U
85-68-7	Butylbenzylphthalate	1600	U
53-96-3	2-Acetylaminofluorene	1600	U
101-14-4	Methylene-bis(2-Chloroaniline	1600	U
91-94-1	3,3'-Dichlorobenzidine	1600	U
119-90-4	3,3'-Dimethoxybenzidine	1600	U
56-55-3	Benzo(a)Anthracene	330	J
218-01-9	Chrysene	420	J
117-81-7	bis(2-Ethylhexyl)Phthalate	1600	U
117-84-0	Di-n-Octyl Phthalate	1600	U
205-99-2	Benzo(b)Fluoranthene	530	JX
57-97-6	7,12-Dimethylbenzanthracene	1600	U
207-08-9	Benzo(k)Fluoranthene	530	JX
50-32-8	Benzo(a)Pyrene	310	J
56-49-5	3-Methylcholanthrene	1600	U
224-42-0	Dibenzo(a,j)acridine	1600	U
193-39-5	Indeno(1,2,3-cd)Pyrene	1600	U
53-70-3	Dibenz(a,h)Anthracene	1600	U
191-24-2	Benzo(g,h,i)Perylene	1600	U

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: SEMI-VOLATILE

DATA FILENAME: GJD56712B02 SAMPLE # 456712

ITEM	SCAN NUMBER	CAS #	COMPOUND NAME	ESTIMATED CONC.(ug/l)
1.	671	108-38-3	BENZENE, 1,3-DIMETHYL- DIMETHYLBENZENE	41. J
2.	703	95-47-6	BENZENE, 1,2-DIMETHYL- DIMETHYLBENZENE	18. J
3.	760	20019-64-1	2(5H)-FURANONE, 5,5-DIMETHYL- ALDOL	21. JAB*
4.	783	4032-93-3	HEPTANE, 2,3,6-TRIMETHYL- UNKNOWN ALKANE	11. J
5.	792	620-14-4	BENZENE, 1-ETHYL-3-METHYL- ETHYLMETHYLBENZENE	22. J
6.	802	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	21. J
7.	816	611-14-3	BENZENE, 1-ETHYL-2-METHYL- ETHYLMETHYLBENZENE	18. J
8.	830	124-18-5	DECANE UNKNOWN HYDROCARBON	11. J
9.	835	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	30. J
10.	857	62108-25-2	DECANE, 2,6,7-TRIMETHYL- UNKNOWN HYDROCARBON	10. J
11.	871	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	18. J
12.	877	62108-27-4	DECANE, 2,4,6-TRIMETHYL- UNKNOWN HYDROCARBON	18. J
	1.000	40.000		

SPECTROSCOPIST _____MSS_____

DATE __11/25/91____

J - Indicates an estimated concentration which is determined assuming a 1:1 response.
* - See Quality Assurance Notice.

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: SEMI-VOLATILE

DATA FILENAME: GJD56712B02 SAMPLE # 456712

13.	900	5398-10-7	PROPANEDIOIC ACID, HEXYL-, DIETHYL ESTER UNKNOWN	29. J
14.	907	105-05-5	BENZENE, 1,4-DIETHYL- DIETHYLBENZENE	20. J
15.	941	25155-15-1	BENZENE, METHYL(1-METHYLETHYL)- METHYLMETHYLETHYLBENZENE	17. J
16.	1220	3891-98-3	DODECANE, 2,6,10-TRIMETHYL- UNKNOWN HYDROCARBON	9. J
17.	1283	- -	ALPHA-METHOXY-BETA,BETA-DIMETHYLSTYRENE UNKNOWN	10. J
18.	1294	18344-37-1	HEPTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	21. J
19.	1447	18344-37-1	HEPTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	21. J
20.	1490	54105-67-8	HEPTADECANE, 2,6-DIMETHYL- UNKNOWN HYDROCARBON	38. J
21.	1567	18344-37-1	HEPTADECANE, 2,6,10,14-TETRAMETHYL- UNKNOWN HYDROCARBON	35. J

1.000 40.000

SPECTROSCOPIST _____MSS_____

DATE __11/25/91____

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

000401

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE
Appendix IX, Method 8270 Analysis

The calibration, surrogate, spike and internal standard solutions used in all organic extractables methods, including Method 8270, are prepared from individually-weighed neat materials (not solutions) by a Sr. Standards Chemist at CompuChem Laboratories, Inc. The prepared standards are then compared to certified reference materials to verify their traceability to EPA or NIST-certified sources. This procedure was instituted years ago because of the general unavailability of high-quality standard solutions from commercial vendors.

The only known commercial source for aramite, as a pure material, is no longer producing this compound. CompuChem is currently evaluating the commercial sources for prepared standard solutions containing aramite, but until this study is completed, we are no longer able to include the analyte in the Appendix IX calibration standards. The software that produces the quantitation report from the GC/MS instrument has not been altered, so aramite still appears on this raw data output, <u>even though the analyte is not identifiable or quantifiable</u>. Aramite has been omitted from the compound list in the final data report.

Robert J. Whitehead
Manager, Quality Assurance
September 20, 1990

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill [illegible]ay Research Triangle Park, NC 27709 (919) 549-8263

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE

CompuChem ID# 456712
Client ID# PRRSMW13
Case # 24148

Due to severe matrix interferences present in the semivolatile fraction of this sample, the following Internal Standard(s) had responses which varied considerably from the associated Continuing Calibration Standard responses.

d12-chrysene
d12-perylene

This sample was reanalyzed to confirm the matrix effects, and initial results were verified. Depending on the degree of interference, surrogate recoveries may also be affected for those compounds quantitated using the affected internal standard(s). Under some circumstances, depending on the client's requirements, both sets of data will be reported. When only one report is required, the analyst considers whether or not the repreparation was completed within holding time specifications in deciding which set of data to report. If holding times were met in both preparations, the analysis that appears to be least affected by the sample matrix will be reported.

Additional Comments: Although d12-chrysene met criteria in the reanalysis, it did confirm a high trend.

Reviewer's Initials/ID [illegible] / 1595

Date 11/25/91

QAN-VSV-5
901001

000403

COMPUCHEM LABORATORIES

007361

QUALITY ASSURANCE NOTICE

CompuChem ID# 456712
Client ID# PRR3MW13
Case # 24148

Peaks on the Reconstructed Ion Chromatogram (RIC) of the semivolatile fraction of this sample at the scan numbers listed below were identified as non-target list compounds introduced by the laboratory during sample preparation or analysis. This was concluded from a comparison of tentatively identified compound spectra and retention times found by the Library Search routine of the sample and its associated method blank (also referred to as an extraction blank or a preparation blank) and/or leachate blank. When present in the blank, a "B" flag is added to the corresponding compound on the Tentatively Identified Compound (TIC) forms for the associated samples.

The EPA has not established criteria for the evaluation of non-TCL (Target Compound List) contamination in blanks analyzed under the Contract Laboratory Program (CLP) protocols. Our policy is to allow up to three (3) non-TCL contaminants with peak heights greater than 25% of the height of the nearest-eluting internal standard peak. An exception is made for certain acetone contaminants which are known to be present in the solvent system used in the extraction of solid samples and blanks. This acetone / methylene chloride solvent mixture can produce several contaminants. Peaks that are suspected as aldol-condensation reaction products (i.e., 4-methyl-4-hydroxy-2-pentanone and 4-methyl-3-pentene-2-one) are flagged with an "A" on the Tentatively Identified Compound forms and are listed below.

scan: 763 760 _____ _____ _____ _____

_____ _____ _____ _____ _____ _____

When concentrations of these compounds are not sufficient in the method blank and/or leachate blank to require a Library Search but are in the associated samples, a mass spectral comparison is made to ensure the tentative identity of the TIC. The TIC is assessed as a contaminant in the same manner described above and labeled with a "B" flag in the samples to indicate its presence in the blank. The following scans indicate these TICs for this sample.

method blank scan: _____ _____ _____ _____ _____ _____

leachate blank scan: _____ _____ _____ _____ _____ _____

sample scan: _____ _____ _____ _____ _____ _____

These flagged compounds should not be considered actual constituents of this sample fraction. Therefore, they are included in the total number of TIC's found, but are not counted as part of the twenty most intense non-TCL semivolatile compounds requiring Library Search.

Reviewer's initials/ID _____/_____

QAN-SV-14
901001

Date _____

000404

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE

CompuChem ID# 456712
Client ID# PRRSMW13
Case # 24148

A dilution of the Semivolatile fraction of this sample was required in order to achieve accurate and discernible results by GC analysis (usually to prevent detector saturation). As a result, detection limits are elevated, while surrogate concentrations may be diluted below these limits. In such cases, surrogate recovery data cannot be calculated. A method blank prepared and analyzed with this sample was not diluted and met all surrogate recovery criteria.

Reviewer's initials/ID JL / 817

date 12/3/91

QAN-GC-8
901001

000405

ERM-Midwest, inc.

450 W. Wilson Bridge Road • Worthington, OH 43085 • (614) 433-7900 • Telefax: (614) 433-0886

007361

CHAIN OF CUSTODY RECORD

Project No./I.D. 539-13 Sheet 1 of 1
Sampled By TJS / JDK Bottles Supplied By Compuchem
NOTE: When analyses are complete return this form to:
Name: Tim Sainey @ ERM-Midwest, Inc., Columbus, Ohio

Sample I.D.	Sample Description (ID's used: PRRSMW41)	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
PRRS MW-41	Free Product	10-21-91 —	3	Full 8240	456710 Free Product
PRRS MW 13	" PRRSmw13	10-21-91 1430	2	Full 8240	456711 "
PRRSMW41S	" PRRSmw41S	10-21-91 1015	1	Full 8270	456713 "
PRRS MW 13	PRRSmw13	10-21-91 1430	1	Full 8270	456712 head
PRRS MW13	" ↓	10-21-91 1430	1	Specific Gravity	" space 456706
PRRS Mix	" PRRSmix	10-21-91 —	1	Specific Gravity	456708

Shipping package opened by: TJS/JDK Date: 10-21-91 Time: 0830
Employer: ERM Midwest Containers intact (Y/N) yes

Samples packaged & sealed by: TJS/JDK Date: 10-21-91 Time: 1730
Employer: ERM Midwest Method of Shipment: Federal Express

Received in laboratory by: [signature] Date: 10/22/91 Time: 9:00 am
Employer: Compuchem Seals intact (Y/N)
Containers intact (Y/N) If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
Tim Sainey		[signature]	Compuchem					

COMMENTS:

MTB 10/22/91

Free Product

RECEIVED IN GOOD CONDITION

Copies: White - Project file; Yellow - Client; Pink - Sampler

000406

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill/Nelson Highway Research Triangle Park, NC 27709 (919) 549-8263

November 28, 1991

Mr. Tim Sainey
ERM MIDWEST
450 West Wilson Bridge Road
Columbusd, IL 60015

Dear Mr. Sainey:

We at CompuChem® are pleased to provide our report for the analysis you requested. Data for the following sample are enclosed:

Your ID Number	Our ID Number	Analysis Code	Order Number	Description of Work Requested
PRRSMW13	456711	936	24148	Volatiles + Library Search, Method 8240 - 3rd Ed. with Dry Weight Determination (Style 1)

Unless noted by Quality Assurance Notices included in this report of data, all Quality Control requirements associated with the preparation and analysis of these samples have been met.

Release of the analytical data contained in this data package has been authorized by the Technical Review Manager or her designee, as verified by the signature below.

Thank you for selecting Compuchem® Laboratories for your sample analysis. If you have questions concerning this report or the analytical methods employed please contact your Sales Representative at 919-549-8263.

We hope you will consider Compuchem® Laboratories for your future analytical support and service requirements.

Sincerely,

Tony C. Spurell for
Ann Chan
Manager, Final Technical Review

COMPUCHEM LABORATORIES, INC.

- TABLE OF CONTENTS -

Method Reference

Data Summary

- Sample Data Qualifiers
- Method 8240 Volatile Compound List
- Tentatively Identified Compound (TIC) List

Quality Assurance Notices*

Chain of Custody**

*These notices are included where appropriate for data qualification.

**When the original chain of custody is submitted with the sample(s), a copy of it is included with the report.

000408

METHOD REFERENCE

To determine the concentration of volatile organic compounds in a variety of waste matrices, CompuChem® employs the methods stated in the RCRA Method 8240.

As a point of information, the analytes present on the enclosed compound list have been validated for Method 8240 as required by SW-846.

Method Summary

The volatile compounds are introduced to the gas chromatograph by the Purge-and-Trap Method (RCRA Method 5030). The components are separated via the gas chromatograph and detected using a mass spectrometer which is used to provide both qualitative and quantitative information. The chromatographic conditions as well as typical mass spectrometer operating parameters are given in the RCRA Method 8240.

A library search is performed by automated comparison of the unknown peak spectrum to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards) mass spectral library. Estimated concentration is calculated using the known concentration and peak area of the closest internal standard while assuming a response factor of one for the unknown compound.

DATA REPORTING QUALIFIERS

COMPUCHEM POLICY FOR REPORTING GC/MS VOLATILE ORGANIC ANALYSES

Compuchem utilizes the Finnigan Formaster software program to generate summary forms for many of our GC/MS analytical service products. In so doing, we have adopted the EPA's Contract Laboratory Program (CLP) policy as it relates to the the application of the "Dilution Factor." An EPA directive has stated that the dilution factor is intended to account only for deviations from SOW specifications for the extract volume. For volatile analyses, the "Sample wt/vol" field is incorporated into calculations by the software when less than the SOW specified sample size (5 ml or 5 g) is taken for analysis. Less than the specified sample size would be taken in order to achieve on-column concentrations of analytes within the initial calibration range.

DATA REPORTING QUALIFIERS

VALUE – If the result is a value greater than or equal to the detection limit, report the value.

U – Indicates compound was analyzed but not detected. The sample Quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U)}{D} \times df \qquad \text{Where } D = \frac{100 - \%\ Moisture}{100}$$

and df = dilution factor

$$\text{At 24\% moisture, } D = \frac{100-24}{100} = 0.76$$

$$\frac{(330\ U)}{0.76} \times 10 = 4300\ U$$ rounded to the appropriate number of significant figures

For soil sample subjected to GPC clean-up procedures, the CRQL is also multiplied by 2, to account for the fact that only half of the extract is recovered.

J – Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero. For example, if the sample quantitation limit is 10 ug/l, but a concentration is 3 ug/l is calculated, report it as 3J. The sample quantitation limit must be adjusted for both dilution and percent moisture as discussed for the U flag, so that if a sample with 24% moisture and a 1 to 10 dilution factor has a calculated concentration of 300 ug/l and a sample quantitation limit of 430 ug/kg, report the concentration as 300J on Form I.

007361

C - This flag applies to pesticides results where the identification has been confirmed by GC/MS. Single component pesticides >10 ng/ul in the final extract shall be confirmed by GC/MS.

B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified TCL compound.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticides/PCBs analyzed by GC/EC methods. If one or more compounds have a response greater than full scale, the sample or extract must be diluted and re-analyzed according to the specifications. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate Forms I. The Form I for the diluted sample shall have the "DL" suffix appended to the sample number.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re-analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form I for the diluted sample and all concentration values reported on that Form I are flagged with the "D" flag.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

X - This flag refers to indistinguishable isomers.

FIDL - Refer to Form I for correct detection limits.

Y & Z - Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative. Begin by using "Y". If more than one flag is required, use "Z" as needed. If more than five qualifiers are required for a sample result, use the "Y" or "Z" flag to combine several flags, as needed. For instance, the "Y" or "Z" flag might combine the "A", "B", and "D" flags for some sample.

000413

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PRSSMW13

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456711

Sample wt/vol: 4.0 (g/mL) G Lab File ID: C2R56711B03

Level: (low/med) MED Date Received: 10/22/91

% Moisture: not dec. ____ Date Analyzed: 10/30/91

GC Column: CAP ID: _____ (mm) Dilution Factor: 17000

Soil Extract Volume: 10000 (uL) Soil Aliquot Volume: 0 (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	20000000	U
74-83-9	Bromomethane	10000000	U
75-01-4	Vinyl Chloride	20000000	U
75-00-3	Chloroethane	20000000	U
75-09-2	Methylene Chloride	19000000	BJ
67-64-1	Acetone	20000000	U
75-15-0	Carbon Disulfide	10000000	U
75-35-4	1,1-Dichloroethene	10000000	U
75-34-3	1,1-Dichloroethane	10000000	U
540-59-0	1,2-Dichloroethene (total)	10000000	U
67-66-3	Chloroform	10000000	U
107-06-2	1,2-Dichloroethane	10000000	U
78-93-3	2-Butanone	20000000	U
71-55-6	1,1,1-Trichloroethane	10000000	U
56-23-5	Carbon Tetrachloride	10000000	U
108-05-4	Vinyl Acetate	20000000	U
75-27-4	Bromodichloromethane	10000000	U
78-87-5	1,2-Dichloropropane	10000000	U
10061-01-5	cis-1,3-Dichloropropene	10000000	U
79-01-6	Trichloroethene	10000000	U
124-48-1	Dibromochloromethane	10000000	U
79-00-5	1,1,2-Trichloroethane	10000000	U
71-43-2	Benzene	3200000	J
10061-02-6	Trans-1,3-Dichloropropene	10000000	U
110-75-8	2-Chloroethylvinylether	20000000	U
75-25-2	Bromoform	20000000	U
108-10-1	4-Methyl-2-Pentanone	32000000	U
591-78-6	2-Hexanone	32000000	U
127-18-4	Tetrachloroethene	10000000	U
79-34-5	1,1,2,2-Tetrachloroethane	20000000	U
108-88-3	Toluene	140000000	
108-90-7	Chlorobenzene	10000000	U
100-41-4	Ethylbenzene	100000000	
100-42-5	Styrene	10000000	U

1330-20-7-------Total Xylenes	320000000	B
74-88-4---------Iodomethane	20000000	U
107-02-8--------Acrolein	180000000	U
107-13-1--------Acrylonitrile	250000000	U
75-69-4---------Trichlorofluoromethane	10000000	U
107-05-1--------3-Chloropropene	32000000	U
76-13-1---------1,1,2-Trichloro-1,2,2-trifluo	20000000	U
354-58-5--------1,1,1-Trichloro-2,2,2-trifluo	20000000	U
74-95-3---------Dibromomethane	20000000	U
4170-30-3-------Crotonaldehyde	200000000	U
106-93-4--------1,2-Dibromoethane	10000000	U
630-20-6--------1,1,1,2-Tetrachloroethane	10000000	U
764-41-0--------cis-1,4-Dichloro-2-butene	32000000	U
96-18-4---------1,2,3-Trichloropropane	32000000	U
764-71-0--------trans-1,4-Dichloro-2-butene	32000000	U
96-18-4---------Ethylmethacrylate	20000000	U
96-12-8---------1,2-Dibromo-3-chloropropane	20000000	U

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: VOLATILE

DATA FILENAME: C2R56711B03 SAMPLE # 456711

ITEM	SCAN NUMBER	CAS #	COMPOUND NAME	ESTIMATED CONC.(ug/l)
1.	1142	98-82-8	BENZENE,(1-METHYLETHYL)-	135200000 J

2080000.0 50.00

SPECTROSCOPIST _____SAH_____

DATE ____11/01/91__

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

000416

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE

CompuChem ID# 456711
Client ID# PRR5MW13
Case # 24146

Depending on the type of analysis performed on this sample for the determination of volatile organic compounds, either a dilution was performed or less than the method-specified amount of sample was analyzed. This was necessary in order to achieve more accurate and discernible results by GC/MS or to prevent detector saturation. As a result, detection limits are elevated above those normally achieved for the method. Depending on the level of dilution required of a medium level extract, surrogates may be diluted to concentrations below detection limits and recovery data unavailable.

Reviewer's initials/ID Sadt / 714
date 11/1/91

QAN-V-1
901001.r1

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE
CompuChem ID# 45671
Blank ID# CF 9/1630A03
Case # 24148

CompuChem offers various types of analytical services. The above sample was analyzed according to the protocol checked:

( ) "Contract Laboratory Program (CLP)--Volatile / Semivolatile analysis". Analytical requirements were derived from the EPA.

(✓) "Volatile Analysis by GC/MS--Method 8240" / "Semivolatile Analysis by GC/MS--Method 8270". Many of the Quality Control requirements of these methods were derived from the EPA's Contract Laboratory Program.

( ) Clean Water Act " Purgeable Volatile Analysis--Method 624" / "Base Neutrals and Acids--Method 625". Requirements were established in the Federal Register of October 26, 1984, 40 CFR Part 136.

( ) "Lower Detection Limit / ResWell Volatile or Semivolatile". CLP requirements have been modified for application to this method.

The CLP protocols allow certain levels of common laboratory solvents (Acetone, Methylene Chloride, and Toluene), the solvent-related artifact 2-Butanone, and phthalates to be present in blanks, up to five times the Contract Required Quantitation Limit (CRQL). CompuChem has a more stringent policy for liquid samples, allowing up to a maximum of twice the CRQL for these commonly occuring contaminants. An exception is made in the case of liquid Instrument Blanks where the analyses of three successive blanks indicate a consistent background level of Methylene Chloride. The concentration of Methylene Chloride in Low Level Soil Method Blanks may not exceed 25 ug/kg; Acetone may not exceed 50 ug/kg (Medium Level Soil methodology applies correction factor of 125 to the concentrations to yield the reported amounts). Exception to our policy is made <u>only</u> when the volatile analysis or extraction holding times are in jeopardy of being exceeded (although the CLP requirements must be met).

Analysis of the Method Blank (and/or Instrument Blank) associated with the above sample indicated the following common laboratory contaminants were present at the indicated levels:

common laboratory contaminant	concentration	units
methylene chloride	750	ug/kg
m,p xylene	350	ug/L

The reporting convention used in the CLP is to "flag" with a "B" all allowable target compounds present in the sample when also found in its associated blank. No adjustments are made to the analytical results.

This notice serves to explain the use of the "B" flag in reporting analytical results, while presenting the actual levels of the common laboratory solvents or phthalates seen in the associated blank.

<u>Data Usability: General Guidelines</u>

In evaluating data usability, the following general guidelines originating from the US EPA are offered for assessing the significance of common laboratory artifacts in samples. If the concentration of an analyte in a sample is less than three times that in the blank, it may be negated due to laboratory contamination. If the concentration of an analyte in a sample is greater than five times that in the blank, it may be considered an actual sample component. If the concentration of an analyte in a sample is greater than three times but less than five times that in the blank, the presence of that compound in the sample may be considered suspect.

QAN-VSV-15
901001.r1

Reviewer's initials/ID [illegible]
date 11/1/91

000418

ERM-Midwest, inc.

450 W. Wilson Bridge Road • Worthington, OH 43085 • (614) 433-7900 • Telefax: (614) 433-0886

007361

CHAIN OF CUSTODY RECORD

Project No./I.D. 539-13 Sheet 1 of 1

Sampled By TJS / JDK Bottles Supplied By Compuchem

NOTE: When analyses are complete return this form to:

Name: Tim Sainsin @ ERM-Midwest, Inc., Columbus, Ohio

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
PRRS MW-41	ID's used: PRRSMW41 Free Product	10-21-91 —	3	Full 8240	456710 Free Product
PRRS MW 13	" PRRSMW13	10-21-91 1430	2	Full 8240	456711 "
PRRS MW41S	" PRRSMW41S	10-21-91 1015	1	Full 8270	456713 "
PRRS MW 13	PRRSMW13	10-21-91 1430	1	Full 8270	456712 head
PRRS MW13	" ✓	10-21-91 1430	1	Specific Gravity	" space 456706
PRRS Mix	" PRRSMIX	10-21-91 —	1	Specific Gravity	456708

Shipping package opened by: TJS / JDK Date: 10-21-91 Time: 0830

Employer: ERM Midwest Containers intact (Y/N) yes

Samples packaged & sealed by: TJS / JDK Date: 10-21-91 Time: 1730

Employer: ERM Midwest Method of Shipment: Federal Express

Received in laboratory by: [signature] Date: 10/22/91 Time: 9:00 am

Employer: Compuchem Seals intact (Y/N)

Containers intact (Y/N) If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
[signature]		[signature]	Compuchem					

COMMENTS:

WTB 10/22/91

Free Product

RECEIVED IN GOOD CONDITION

Copies: White - Project file; Yellow - Client; Pink - Sampler

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill/Nelson Highway Research Triangle Park, NC 27709 (919) 549-8263

November 28, 1991

Mr. Tim Sainey
ERM MIDWEST
450 West Wilson Bridge Road
Columbusd, IL 60015

Dear Mr. Sainey:

We at CompuChem® are pleased to provide our report for the analysis you requested. Data for the following sample are enclosed:

Your ID Number	Our ID Number	Analysis Code	Order Number	Description of Work Requested
PRRSMW41	456710	936	24148	Volatiles + Library Search, Method 8240 - 3rd Ed. with Dry Weight Determination (Style 1)

Unless noted by Quality Assurance Notices included in this report of data, all Quality Control requirements associated with the preparation and analysis of these samples have been met.

Release of the analytical data contained in this data package has been authorized by the Technical Review Manager or her designee, as verified by the signature below.

Thank you for selecting Compuchem® Laboratories for your sample analysis. If you have questions concerning this report or the analytical methods employed please contact your Sales Representative at 919-549-8263.

We hope you will consider Compuchem® Laboratories for your future analytical support and service requirements.

Sincerely,

Tony C. Spurell for

Anh Chan
Manager, Final Technical Review

COMPUCHEM LABORATORIES, INC.

- TABLE OF CONTENTS -

Method Reference

Data Summary

- Sample Data Qualifiers
- Method 8240 Volatile Compound List
- Tentatively Identified Compound (TIC) List

Quality Assurance Notices*

Chain of Custody**

*These notices are included where appropriate for data qualification.

**When the original chain of custody is submitted with the sample(s), a copy of it is included with the report.

000421

METHOD REFERENCE

To determine the concentration of volatile organic compounds in a variety of waste matrices, CompuChem® employs the methods stated in the RCRA Method 8240.

As a point of information, the analytes present on the enclosed compound list have been validated for Method 8240 as required by SW-846.

Method Summary

The volatile compounds are introduced to the gas chromatograph by the Purge-and-Trap Method (RCRA Method 5030). The components are separated via the gas chromatograph and detected using a mass spectrometer which is used to provide both qualitative and quantitative information. The chromatographic conditions as well as typical mass spectrometer operating parameters are given in the RCRA Method 8240.

A library search is performed by automated comparison of the unknown peak spectrum to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards) mass spectral library. Estimated concentration is calculated using the known concentration and peak area of the closest internal standard while assuming a response factor of one for the unknown compound.

DATA REPORTING QUALIFIERS

COMPUCHEM POLICY FOR REPORTING GC/MS VOLATILE ORGANIC ANALYSES

Compuchem utilizes the Finnigan Formaster software program to generate summary forms for many of our GC/MS analytical service products. In so doing, we have adopted the EPA's Contract Laboratory Program (CLP) policy as it relates to the the application of the "Dilution Factor." An EPA directive has stated that the dilution factor is intended to account only for deviations from SOW specifications for the extract volume. For volatile analyses, the "Sample wt/vol" field is incorporated into calculations by the software when less than the SOW specified sample size (5 ml or 5 g) is taken for analysis. Less than the specified sample size would be taken in order to achieve on-column concentrations of analytes within the initial calibration range.

DATA REPORTING QUALIFIERS

VALUE – If the result is a value greater than or equal to the detection limit, report the value.

U – Indicates compound was analyzed but not detected. The sample Quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U)}{D} \times df \qquad \text{Where } D = \frac{100 - \%\ \text{Moisture}}{100}$$

and df = dilution factor

$$\text{At 24\% moisture, } D = \frac{100-24}{100} = 0.76$$

$$\frac{(330\ U)}{0.76} \times 10 = 4300\ U$$ rounded to the appropriate number of significant figures

For soil sample subjected to GPC clean-up procedures, the CRQL is also multiplied by 2, to account for the fact that only half of the extract is recovered.

J – Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero. For example, if the sample quantitation limit is 10 ug/l, but a concentration is 3 ug/l is calculated, report it as 3J. The sample quantitation limit must be adjusted for both dilution and percent moisture as discussed for the U flag, so that if a sample with 24% moisture and a 1 to 10 dilution factor has a calculated concentration of 300 ug/l and a sample quantitation limit of 430 ug/kg, report the concentration as 300J on Form I.

C - This flag applies to pesticides results where the identification has been confirmed by GC/MS. Single component pesticides >10 ng/ul in the final extract shall be confirmed by GC/MS.

B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified TCL compound.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticides/PCBs analyzed by GC/EC methods. If one or more compounds have a response greater than full scale, the sample or extract must be diluted and re-analyzed according to the specifications. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate Forms I. The Form I for the diluted sample shall have the "DL" suffix appended to the sample number.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re-analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form I for the diluted sample and all concentration values reported on that Form I are flagged with the "D" flag.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

X - This flag refers to indistinguishable isomers.

FIDL - Refer to Form I for correct detection limits.

Y & Z - Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative. Begin by using "Y". If more than one flag is required, use "Z" as needed. If more than five qualifiers are required for a sample result, use the "Y" or "Z" flag to combine several flags, as needed. For instance, the "Y" or "Z" flag might combine the "A", "B", and "D" flags for some sample.

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PRRSMW41

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456710

Sample wt/vol: 4.0 (g/mL) G Lab File ID: C4R56710B03

Level: (low/med) MED Date Received: 10/22/91

% Moisture: not dec. ____ Date Analyzed: 10/30/91

GC Column: CAP ID: _____ (mm) Dilution Factor: 10000

Soil Extract Volume: 10000 (uL) Soil Aliquot Volume: 0 (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	12000000	U
74-83-9	Bromomethane	6200000	U
75-01-4	Vinyl Chloride	12000000	U
75-00-3	Chloroethane	12000000	U
75-09-2	Methylene Chloride	15000000	B
67-64-1	Acetone	12000000	U
75-15-0	Carbon Disulfide	6200000	U
75-35-4	1,1-Dichloroethene	6200000	U
75-34-3	1,1-Dichloroethane	6200000	U
540-59-0	1,2-Dichloroethene (total)	6200000	U
67-66-3	Chloroform	6200000	U
107-06-2	1,2-Dichloroethane	6200000	U
78-93-3	2-Butanone	12000000	U
71-55-6	1,1,1-Trichloroethane	6200000	U
56-23-5	Carbon Tetrachloride	6200000	U
108-05-4	Vinyl Acetate	12000000	U
75-27-4	Bromodichloromethane	6200000	U
78-87-5	1,2-Dichloropropane	6200000	U
10061-01-5	cis-1,3-Dichloropropene	6200000	U
79-01-6	Trichloroethene	6200000	U
124-48-1	Dibromochloromethane	6200000	U
79-00-5	1,1,2-Trichloroethane	6200000	U
71-43-2	Benzene	3100000	J
10061-02-6	Trans-1,3-Dichloropropene	6200000	U
110-75-8	2-Chloroethylvinylether	12000000	U
75-25-2	Bromoform	12000000	U
108-10-1	4-Methyl-2-Pentanone	19000000	U
591-78-6	2-Hexanone	19000000	U
127-18-4	Tetrachloroethene	6200000	U
79-34-5	1,1,2,2-Tetrachloroethane	12000000	U
108-88-3	Toluene	120000000	
108-90-7	Chlorobenzene	6200000	U
100-41-4	Ethylbenzene	81000000	
100-42-5	Styrene	6200000	U

1330-20-7-------Total Xylenes	200000000	B
74-88-4---------Iodomethane	12000000	U
107-02-8--------Acrolein	110000000	U
107-13-1--------Acrylonitrile	150000000	U
75-69-4---------Trichlorofluoromethane	6200000	U
107-05-1--------3-Chloropropene	19000000	U
76-13-1---------1,1,2-Trichloro-1,2,2-trifluo	12000000	U
354-58-5--------1,1,1-Trichloro-2,2,2-trifluo	12000000	U
74-95-3---------Dibromomethane	12000000	U
4170-30-3-------Crotonaldehyde	120000000	U
106-93-4--------1,2-Dibromoethane	6200000	U
630-20-6--------1,1,1,2-Tetrachloroethane	6200000	U
764-41-0--------cis-1,4-Dichloro-2-butene	19000000	U
96-18-4---------1,2,3-Trichloropropane	19000000	U
764-71-0--------trans-1,4-Dichloro-2-butene	19000000	U
96-18-4---------Ethylmethacrylate	12000000	U
96-12-8---------1,2-Dibromo-3-chloropropane	12000000	U

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: VOLATILE

DATA FILENAME: C4R56710B03 SAMPLE # 456710

ITEM	SCAN NUMBER	CAS #	COMPOUND NAME	ESTIMATED CONC.(ug/l)
1.	1142	98-82-8	BENZENE,(1-METHYLETHYL)-	97500000 J

1250000.00 50.00

SPECTROSCOPIST _____SAH_____

DATE ____11/1/91___

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

000429

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE

CompuChem ID# L56710
Client ID# PRR5MW41
Case # 24148

Depending on the type of analysis performed on this sample for the determination of volatile organic compounds, either a dilution was performed or less than the method-specified amount of sample was analyzed. This was necessary in order to achieve more accurate and discernible results by GC/MS or to prevent detector saturation. As a result, detection limits are elevated above those normally achieved for the method. Depending on the level of dilution required of a medium level extract, surrogates may be diluted to concentrations below detection limits and recovery data unavailable.

Reviewer's initials/ID Scott / 714

date 11/1/91

QAN-V-1
901001.r1

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE
CompuChem ID# 456710
Blank ID# C F 911030 A03
Case # 24148

CompuChem offers various types of analytical services. The above sample was analyzed according to the protocol checked:

( ) "Contract Laboratory Program (CLP)--Volatile / Semivolatile analysis". Analytical requirements were derived from the EPA.

( ) "Volatile Analysis by GC/MS--Method 8240" / "Semivolatile Analysis by GC/MS--Method 8270". Many of the Quality Control requirements of these methods were derived from the EPA's Contract Laboratory Program.

( ) Clean Water Act " Purgeable Volatile Analysis--Method 624" / "Base Neutrals and Acids--Method 625". Requirements were established in the Federal Register of October 26, 1984, 40 CFR Part 136.

( ) "Lower Detection Limit / ResWell Volatile or Semivolatile". CLP requirements have been modified for application to this method.

The CLP protocols allow certain levels of common laboratory solvents (Acetone, Methylene Chloride, and Toluene), the solvent-related artifact 2-Butanone, and phthalates to be present in blanks, up to five times the Contract Required Quantitation Limit (CRQL). CompuChem has a more stringent policy for liquid samples, allowing up to a maximum of twice the CRQL for these commonly occuring contaminants. An exception is made in the case of liquid Instrument Blanks where the analyses of three successive blanks indicate a consistent background level of Methylene Chloride. The concentration of Methylene Chloride in Low Level Soil Method Blanks may not exceed 25 ug/kg; Acetone may not exceed 50 ug/kg (Medium Level Soil methodology applies correction factor of 125 to the concentrations to yield the reported amounts). Exception to our policy is made only when the volatile analysis or extraction holding times are in jeopardy of being exceeded (although the CLP requirements must be met).

Analysis of the Method Blank (and/or Instrument Blank) associated with the above sample indicated the following common laboratory contaminants were present at the indicated levels:

common laboratory contaminant	concentration	units
methylene chloride	750	ug/kg
mp xylene	350	

The reporting convention used in the CLP is to "flag" with a "B" all allowable target compounds present in the sample when also found in its associated blank. No adjustments are made to the analytical results.

This notice serves to explain the use of the "B" flag in reporting analytical results, while presenting the actual levels of the common laboratory solvents or phthalates seen in the associated blank.

Data Usability: General Guidelines

In evaluating data usability, the following general guidelines originating from the US EPA are offered for assessing the significance of common laboratory artifacts in samples. If the concentration of an analyte in a sample is less than three times that in the blank, it may be negated due to laboratory contamination. If the concentration of an analyte in a sample is greater than five times that in the blank, it may be considered an actual sample component. If the concentration of an analyte in a sample is greater than three times but less than five times that in the blank, the presence of that compound in the sample may be considered suspect.

QAN-VSV-15
901001.r1

Reviewer's initials/ID SAH / 714
date 11/1/91

000431

ERM-Midwest, inc.

450 W. Wilson Bridge Road • Worthington, OH 43085 • (614) 433-7900 • Telefax: (614) 433-0886

007361

CHAIN OF CUSTODY RECORD

Project No./I.D. 539-13 Sheet 1 of 1

Sampled By TJS / JDK Bottles Supplied By Compuchem

NOTE: When analyses are complete return this form to:

Name: Tim Sauer @ ERM-Midwest, Inc., Columbus, Ohio

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
PRRS MW-41	ID's used: PRRSMW41 Free Product	10-21-91 —	3	Full 8240	456710 Free Product
PRRS MW 13	" PRRSMW13	10-21-91 1430	2	Full 8240	456711 "
PRRSMW41S	" PRRSMW41S	10-21-91 1015	1	Full 8270	456713 "
PRRS MW 13	PRRSMW13	10-21-91 1430	1	Full 8270	456712 - head
PRRS MW13	" ↓	10-21-91 1430	1	Specific Gravity	" space 456706
PRRS Mix	" PRRSMIX	10-21-91 —	1	Specific Gravity	456708

Shipping package opened by: TJS/JDK Date: 10-21-91 Time: 0830

Employer: ERM Midwest Containers intact (Y/N) yes

Samples packaged & sealed by: TJS/JDK Date: 10-21-91 Time: 1730

Employer: ERM Midwest Method of Shipment: Federal Express

Received in laboratory by: Mark Berg Date: 10/22/91 Time: 9:00 Am

Employer: Compuchem Seals intact (Y/N)

Containers intact (Y/N) If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
Tim Sauer		Mark Berg	Compuchem					

COMMENTS:

MTB 10/22/91

Free Product

RECEIVED IN GOOD CONDITION

Copies: White - Project file; Yellow - Client; Pink - Sampler

000432

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill/Nelson Highway Research Triangle Park, NC 27709 (919) 549-8263

November 26, 1991

Mr. Tim Sainey
ERM MIDWEST
450 West Wilson Bridge Road
Columbus, IL 60015

Dear Mr. Sainey:

We at CompuChem® are pleased to provide our report for the analysis you requested. Data for the following sample are enclosed:

Your ID Number	Our ID Number	Analysis Code	Order Number	Description of Work Requested
PRRSMW41S	456713	939	24148	Semi-Volatiles + Library Search, Method 8270 - 3rd Ed. with Dry Weight Determination (Style 1)

Unless noted by Quality Assurance Notices included in this report of data, all Quality Control requirements associated with the preparation and analysis of these samples have been met.

Release of the analytical data contained in this data package has been authorized by the Technical Review Manager or her designee, as verified by the signature below.

Thank you for selecting Compuchem® Laboratories for your sample analysis. If you have questions concerning this report or the analytical methods employed please contact your Sales Representative at 919-549-8263.

We hope you will consider Compuchem® Laboratories for your future analytical support and service requirements.

Sincerely,

Tony C. Spindell for

Anh Chan
Manager, Final Technical Review

COMPUCHEM LABORATORIES, INC.

- TABLE OF CONTENTS -

Method Reference

Data Summary

- Sample Data Qualifiers
- Method 8270 Semi-Volatile Compound List
- Tentatively Identified Compound (TIC) List

Quality Assurance Notices*

Chain of Custody**

*These notices are included where appropriate for data qualification.

**When the original chain of custody is submitted with the sample(s), a copy of it is included with the report.

METHOD REFERENCE

To determine the concentration of semi-volatile organic compounds in solid matrices CompuChem® employs the methods as outline in SW-846, for sample preparation (Method 3550) and analysis (Method 8270). These methods are approved for obtaining data to satisfy the requirement of 40CFR Part 261, Identification and Listing of Hazardous Waste.

Method Summary

After the pH and percent moisture determinations, a weighed sample (30 grams) of the solid waste is extracted with a 1:1 methylene chloride:acetone solution using an ultrasonic probe. The extract is dried and concentrated for analysis. Analysis is performed by separation of the components by gas chromatography followed by qualitative and quantitative identification by mass spectrometry using internal standard techinques.

A library search is performed by automated comparison of the unknown peak spectrum to the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards) mass spectral library. Estimated concentration is calculated using the known concentration and peak area of the closest internal standard while assuming a response factor of one for the unknown compound.

DATA REPORTING QUALIFIERS

DATA REPORTING QUALIFIERS

VALUE – If the result is a value greater than or equal to the detection limit, report the value.

U – Indicates compound was analyzed but not detected. The sample Quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U)}{D} \times df \qquad \text{Where } D = \frac{100 - \%\ \text{Moisture}}{100}$$

and df = dilution factor

$$\text{At 24\% moisture, } D = \frac{100-24}{100} = 0.76$$

$$\frac{(330\ U)}{0.76} \times 10 = 4300\ U$$ rounded to the appropriate number of significant figures

For soil sample subjected to GPC clean-up procedures, the CRQL is also multiplied by 2, to account for the fact that only half of the extract is recovered.

J – Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero. For example, if the sample quantitation limit is 10 ug/l, but a concentration is 3 ug/l is calculated, report it as 3J. The sample quantitation limit must be adjusted for both dilution and percent moisture as discussed for the U flag, so that if a sample with 24% moisture and a 1 to 10 dilution factor has a calculated concentration of 300 ug/l and a sample quantitation limit of 430 ug/kg, report the concentration as 300J on Form I.

C - This flag applies to pesticides results where the identification has been confirmed by GC/MS. Single component pesticides >10 ng/ul in the final extract shall be confirmed by GC/MS.

B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified TCL compound.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticides/PCBs analyzed by GC/EC methods. If one or more compounds have a response greater than full scale, the sample or extract must be diluted and re-analyzed according to the specifications. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form I for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate Forms I. The Form I for the diluted sample shall have the "DL" suffix appended to the sample number.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re-analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form I for the diluted sample and all concentration values reported on that Form I are flagged with the "D" flag.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

X - This flag refers to indistinguishable isomers.

FIDL - Refer to Form I for correct detection limits.

Y & Z - Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative. Begin by using "Y". If more than one flag is required, use "Z" as needed. If more than five qualifiers are required for a sample result, use the "Y" or "Z" flag to combine several flags, as needed. For instance, the "Y" or "Z" flag might combine the "A", "B", and "D" flags for some sample.

007361
SAMPLE NO.

1X
ORGANICS ANALYSIS DATA SHEET

PRRSMW41S

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456713

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056713A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
62-75-9	N-Nitrosodimethylamine	1600	U
110-86-1	Pyridine	1600	U
97-63-2	Ethyl methacrylate	1600	U
123-63-7	Paraldehyde	1600	U
109-06-8	2-Picoline	3200	U
10595-95-6	Nitrosomethylethylamine	1600	U
66-27-3	Methyl methanesulfonate	1600	U
55-18-5	N-Nitrosodiethylamine	1600	U
62-50-0	Ethyl methanesulfonate	1600	U
108-95-2	Phenol	1600	U
62-53-3	Aniline	1600	U
76-01-7	Pentachloroethane	1600	U
111-44-4	bis(2-Chloroethyl)Ether	3200	U
95-57-8	2-Chlorophenol	1600	U
541-73-1	1,3-Dichlorobenzene	1600	U
100-44-7	Benzyl Chloride	1600	U
106-46-7	1,4-Dichlorobenzene	1600	U
100-51-6	Benzyl Alcohol	1600	U
95-50-1	1,2-Dichlorobenzene	1600	U
95-48-7	2-Methylphenol	210	J
39638-32-9	bis(2-Chloroisopropyl)Ether	1600	U
108-39-4	3-Methylphenol	1600	U
106-44-5	4-Methylphenol	390	J
930-55-2	N-Nitrosopyrrolidine	1600	U
59-89-2	N-Nitrosomorpholine	1600	U
98-86-2	Acetophenone	1600	U
621-64-7	N-Nitroso-Di-n-Propylamine	1600	U
636-21-5	o-Toluidine hydrochloride	1600	U
67-72-1	Hexachloroethane	1600	U
98-95-3	Nitrobenzene	1600	U
100-75-4	N-Nitrosopiperidine	1600	U
78-59-1	Isophorone	1600	U
88-75-5	2-Nitrophenol	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW41S

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456713

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056713A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
105-67-9	2,4-Dimethylphenol	1600	U
108-70-3	1,3,5-Trichlorobenzene	1600	U
98-87-3	Benzal Chloride	1600	U
65-85-0	Benzoic Acid	16000	U
111-91-1	bis(2-Chloroethoxy)Methane	1600	U
120-83-2	2,4-Dichlorophenol	1600	U
120-82-1	1,2,4-Trichlorobenzene	1600	U
91-20-3	Naphthalene	10000	
106-47-8	4-Chloroaniline	1600	U
87-65-0	2,6-Dichlorophenol	3200	U
95-54-5	o-Phenylenediamine	1600	U
122-09-8	dimethylphenylethylamine	1600	U
1888-71-7	Hexachloropropene	1600	U
87-68-3	Hexachlorobutadiene	1600	U
87-61-6	1,2,3-Trichlorobenzene	1600	U
98-07-7	Benzotrichloride	3200	U
924-16-3	N-Nitroso-di-n-butylamine	1600	U
59-50-7	4-Chloro-3-Methylphenol	1600	U
106-50-3	P-Phenylenediamine	1600	U
94-59-7	Safrole	1600	U
106-50-3	m-Phenylenediamine	1600	U
91-57-6	2-Methylnaphthalene	6800	
90-12-0	1-Methylnaphthalene	1600	U
95-94-3	1,2,4,5-Tetrachlorobenzene	1600	U
634-90-2	1,2,3,5-Tetrachlorobenzene	1600	U
77-47-4	Hexachlorocyclopentadiene	1600	U
88-06-2	2,4,6-Trichlorophenol	3200	U
95-95-4	2,4,5-Trichlorophenol	3200	U
120-58-1	Isosafrole	3200	U
91-58-7	2-Chloronaphthalene	1600	U
90-13-1	1-Chloronaphthalene	1600	U
634-66-2	1,2,3,4-Tetrachlorobenzene	1600	U
88-74-4	2-Nitroaniline	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW41S

Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456713

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056713A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
130-15-4	1,4-Naphthoquinone	3200	U
100-25-4	1,4-Dinitrobenzene	3200	U
131-11-3	Dimethyl Phthalate	1600	U
208-96-8	Acenaphthylene	1600	U
606-20-2	2,6-Dinitrotoluene	1600	U
99-09-2	3-Nitroaniline	3200	U
83-32-9	Acenaphthene	1600	U
51-28-5	2,4-Dinitrophenol	6400	U
100-02-7	4-Nitrophenol	1600	U
132-64-9	Dibenzofuran	1600	U
121-14-2	2,4-Dinitrotoluene	1600	U
608-93-5	Pentachlorobenzene	1600	U
91-59-8	2-Naphthylamine	3200	U
134-32-7	1-Naphthylamine	3200	U
58-90-2	2,3,4,6-Tetrachlorophenol	3200	U
84-66-2	Diethylphthalate	1600	U
297-97-2	Zinophos	1600	U
7005-72-3	4-Chlorophenyl-phenylether	1600	U
86-73-7	Fluorene	1600	U
100-01-6	4-Nitroaniline	3200	U
99-55-8	5-Nitro-o-toluidine	3200	U
122-66-7	1,2-Diphenylhydrazine	1600	U
534-52-1	4,6-Dinitro-2-Methylphenol	4900	U
86-30-6	N-Nitrosodiphenylamine (1)	1600	U
122-39-4	Diphenylamine	1600	U
99-35-4	1,3,5-Trinitrobenzene	3200	U
62-44-2	Phenacetin	1600	U
101-55-3	4-Bromophenyl-phenylether	1600	U
2303-16-4	Diallate	1600	U
60-51-5	Dimethoate	1600	U
118-74-1	Hexachlorobenzene	1600	U
92-67-1	4-Aminobiphenyl	1600	U
23950-58-5	Pronamide	1600	U

1X
ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.

PRRSMW41S

Lab Name: COMPUCHEM,RTP Contract: 500143

Lab Code: COMPU Case No.: 24148 SAS No.: _____ SDG No.: _____

Matrix: (soil/water) SOIL Lab Sample ID: 456713

Sample wt/vol: 30.5 (g/mL) G Lab File ID: GD056713A02

Level: (low/med) LOW Date Received: 10/22/91

% Moisture: _____ decanted: (Y/N) N Date Extracted: 11/01/91

Concentrated Extract Volume: 1000(uL) Date Analyzed: 11/19/91

Injection Volume: 1.0(uL) Dilution Factor: 5.0

GPC Cleanup: (Y/N) N pH: ____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
87-86-5	Pentachlorophenol	3200	U
82-68-8	Pentachloronitrobenzene	1600	U
85-01-8	Phenanthrene	350	J
120-12-7	Anthracene	1600	U
84-74-2	Di-n-Butylphthalate	1600	U
91-80-5	Methapyrilene	3200	U
50-18-0	Cyclophosphamide	7900	U
206-44-0	Fluoranthene	1600	U
92-87-5	Benzidine	1600	U
129-00-0	Pyrene	1600	U
60-11-7	p-Dimethylaminoazobenzene	1600	U
510-15-6	Chlorobenzilate	1600	U
119-93-7	3,3'-Dimethylbenzidine	3200	U
85-68-7	Butylbenzylphthalate	1600	U
53-96-3	2-Acetylaminofluorene	1600	U
101-14-4	Methylene-bis(2-Chloroaniline	1600	U
91-94-1	3,3'-Dichlorobenzidine	1600	U
119-90-4	3,3'-Dimethoxybenzidine	1600	U
56-55-3	Benzo(a)Anthracene	1600	U
218-01-9	Chrysene	1600	U
117-81-7	bis(2-Ethylhexyl)Phthalate	1600	U
117-84-0	Di-n-Octyl Phthalate	1600	U
205-99-2	Benzo(b)Fluoranthene	1600	U
57-97-6	7,12-Dimethylbenzanthracene	1600	U
207-08-9	Benzo(k)Fluoranthene	1600	U
50-32-8	Benzo(a)Pyrene	1600	U
56-49-5	3-Methylcholanthrene	1600	U
224-42-0	Dibenzo(a,j)acridine	1600	U
193-39-5	Indeno(1,2,3-cd)Pyrene	1600	U
53-70-3	Dibenz(a,h)Anthracene	1600	U
191-24-2	Benzo(g,h,i)Perylene	1600	U

000442

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: SEMI-VOLATILE

DATA FILENAME: GD056713A02 SAMPLE # 456713

ITEM	SCAN NUMBER	CAS #	COMPOUND NAME	ESTIMATED CONC.(ug/l)
1.	656	100-41-4	BENZENE, ETHYL- ETHYLBENZENE	5200. J
2.	669	108-38-3	BENZENE, 1,3-DIMETHYL- DIMETHYLBENZENE	25000. J
3.	701	95-47-6	BENZENE, 1,2-DIMETHYL- PROPYLBENZENE	13000. J
4.	781	103-65-1	BENZENE, PROPYL- PROPYLBENZENE	8500. J
5.	790	620-14-4	BENZENE, 1-ETHYL-3-METHYL- ETHYLMETHYLBENZENE	23000. J
	795	611-14-3	BENZENE, 1-ETHYL-2-METHYL- ETHYLMETHYLBENZENE	11000. J
7.	800	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	12000. J
8.	814	611-14-3	BENZENE, 1-ETHYL-2-METHYL- ETHYLMETHYLBENZENE	10000. J
9.	834	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	33000. J
10.	869	108-67-8	BENZENE, 1,3,5-TRIMETHYL- TRIMETHYLBENZENE	13000. J
11.	888	611-15-4	BENZENE, 1-ETHENYL-2-METHYL- ALKYNYLBENZENE	5400. J
12.	894	105-05-5	BENZENE, 1,4-DIETHYL- DIETHYLBENZENE	5700. J

164.000 40.000

SPECTROSCOPIST _____EB_____

DATE __11/25/91____

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

COMPUCHEM ORGANICS ANALYSIS DATA SHEET
LIBRARY SEARCH RESULTS OF EXTRANEOUS PEAKS &
ESTIMATED CONCENTRATION OF TENTATIVELY IDENTIFIED COMPOUNDS
ANALYTICAL FRACTION: SEMI-VOLATILE

DATA FILENAME: GD056713A02 SAMPLE # 456713

13.	899	1074-43-7	BENZENE, 1-METHYL-3-PROPYL- METHYLPROPYLBENZENE	13000. J
14.	905	105-05-5	BENZENE, 1,4-DIETHYL- DIETHYLBENZENE	21000. J
15.	918	1074-43-7	BENZENE, 1-METHYL-3-PROPYL- METHYLPROPYLBENZENE	4300. J
16.	928	934-80-5	BENZENE, 4-ETHYL-1,2-DIMETHYL- ETHYLDIMETHYLBENZENE	7200. J
17.	932	2870-04-4	BENZENE, 2-ETHYL-1,3-DIMETHYL- ETHYLDIMETHYLBENZENE	6400. J
18.	939	934-80-5	BENZENE, 4-ETHYL-1,2-DIMETHYL- ETHYLDIMETHYLBENZENE	23000. J
19.	981	527-53-7	BENZENE, 1,2,3,5-TETRAMETHYL- TETRAMETHYLBENZENE	4100. J
20.	1018	7525-62-4	BENZENE, 1-ETHENYL-3-ETHYL- UNKNOWN	~~5904.~~ J 5900

Del 12/5/91

164.000 40.000

SPECTROSCOPIST EB

DATE 11/25/91

J - Indicates an estimated concentration which is determined assuming a 1:1 response.

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE

CompuChem ID# 45713
Client ID# PRRSMW41S
Case # 24128

A dilution of the SV fraction of this sample was required in order to achieve accurate and discernible results by GC/MS analysis, usually to prevent detector saturation or to bring target list compound concentrations into the instrument calibration range. As a result, detection limits are elevated. Depending on the level of dilution required, surrogate compounds may be diluted to concentrations below the detection limits. In such cases, surrogate recovery data cannot be calculated. A method blank prepared and analyzed with this sample met all surrogate recovery criteria.

Reviewer's initials/ID [illegible]

date 11/25/91

QAN-SV-3
901001

COMPUCHEM LABORATORIES

QUALITY ASSURANCE NOTICE
Appendix IX, Method 8270 Analysis

The calibration, surrogate, spike and internal standard solutions used in all organic extractables methods, including Method 8270, are prepared from individually-weighed neat materials (not solutions) by a Sr. Standards Chemist at CompuChem Laboratories, Inc. The prepared standards are then compared to certified reference materials to verify their traceability to EPA or NIST-certified sources. This procedure was instituted years ago because of the general unavailability of high-quality standard solutions from commercial vendors.

The only known commercial source for aramite, as a pure material, is no longer producing this compound. CompuChem is currently evaluating the commercial sources for prepared standard solutions containing aramite, but until this study is completed, we are no longer able to include the analyte in the Appendix IX calibration standards. The software that produces the quantitation report from the GC/MS instrument has not been altered, so aramite still appears on this raw data output, <u>even though the analyte is not identifiable or quantifiable</u>. Aramite has been omitted from the compound list in the final data report.

Robert J. Whitehead
Manager, Quality Assurance
September 20, 1990

000446

COMPUCHEM LABORATORIES, INC. P.O. Box 12652 3308 Chapel Hill [illegible] Research Triangle Park, NC 27709 (919) 549-8263

ERM-Midwest, inc.

450 W. Wilson Bridge Road • Worthington, OH 43085 • (614) 433-7900 • Telefax: (614) 433-0886

007361

CHAIN OF CUSTODY RECORD

Project No./I.D. 539-13 Sheet 1 of 1

Sampled By TJS / JDK Bottles Supplied By Compuchem

NOTE: When analyses are complete return this form to:

Name: Tim Sauer @ ERM-Midwest, Inc., Columbus, Ohio

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
PRRS MW-41	ID's used: PRRSMW41 Free Product	10-21-91 —	3	Full 8240	456710 Free Product
PRRS MW 13	" PRRSmw13	10-21-91 1430	2	Full 8240	456711 "
PRRSMW41S	" PRRSmw41S	10-21-91 1015	1	Full 8270	456713 "
PRRS MW 13	PRRSmw13	10-21-91 1430	1	Full 8270	456712 head
PRRS MW13	" ✓	10-21-91 1430	1	Specific Gravity	" space 456706
PRRS Mix	" PRRSmix	10-21-91 —	1	Specific Gravity	456708

Shipping package opened by: TJS/JDK Date: 10-21-91 Time: 0830

Employer: ERM Midwest Containers intact (Y/N) yes

Samples packaged & sealed by: TJS/JDK Date: 10-21-91 Time: 1730

Employer: ERM Midwest Method of Shipment: Federal Express

Received in laboratory by: [illegible] Date: 10/22/91 Time: 9:00 am

Employer: Compuchem Seals intact (Y/N)

Containers intact (Y/N) If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
Tim Sauer		[illegible]	Compuchem					

COMMENTS:

WTA 10/22/91

Free Product

RECEIVED IN GOOD CONDITION

Copies: White - Project file; Yellow - Client; Pink - Sampler

000447

Appendix I
Procedures for Estimating Future Concentrations in the Groundwater

REV. 1: MAY 1994

APPENDIX I

ESTIMATING RISK FOR FUTURE GROUNDWATER EXPOSURE CONCENTRATIONS OF CHEMICALS OF CONCERN IN GROUNDWATER

APPENDIX I
ESTIMATING RISK FOR FUTURE GROUNDWATER EXPOSURE CONCENTRATIONS OF CHEMICALS OF CONCERN IN GROUNDWATER

To estimate the future concentrations of the inorganic and organic chemicals of concern identified in the groundwater at PRRS, two solute transport models were utilized. The procedures described in this appendix were used to identify the reasonable maximum exposure (RME) concentrations of the modeled chemicals of concern in groundwater from wells located in the concentration center of the dissolved inorganic and organic chemical plumes, and in groundwater from hypothetical wells located downgradient of the Companies' properties boundary. These procedures are consistent with the approach used to calculate the exposure point concentrations for the current groundwater scenarios and follow the U. S. EPA, Region V policy memorandum entitled "Future Residential Land Use Groundwater Exposure Point Concentrations for the Baseline Risk Assessment" (May 1991).

The migration of both dissolved inorganic and organic chemicals in groundwater was evaluated with the solute transport models, as described in Section 4.3 of the RI. The model provided two 30-year prediction runs (one for sodium and one ethylbenzene) starting at the beginning of 1995. Output solute concentrations were obtained annually from both solute transport models. These solute concentrations, which are averaged concentrations for the saturated model cells, were then standardized to reflect the concentrations at the midpoints of the monitoring well screens. Several groundwater monitoring well clusters at the PRRS were used to estimate linear dissolved chemical concentration gradients, which were used to estimate (from model output concentrations) the solute concentrations at the saturated midpoints of the monitoring well screens.

Solute concentrations of other inorganic chemicals (potassium, potassium-40 and arsenic) and organic chemicals (benzene, toluene, xylene, and cumene) were calculated using the same regression equation methods as outlined in Appendix C.

These simulated inorganic concentrations are presented in Attachment 1 for monitoring wells 4S and 6S, and locations 700 feet and 1800 feet south of the Companies' properties. The simulated organic concentrations are presented in Attachment 2 for monitoring wells 10S, 11S, 12S, 13S, and 41S, and locations 700 feet and 1800 feet south of the Companies' properties.

Reasonable Maximum Exposure - Concentration Center of Plume

The RME represents the maximum future potential risk due to potential groundwater exposures by predicting groundwater concentrations in wells located in the concentration centers of the inorganic and organic plumes. The monitor wells selected for this analysis are 4S and 6S for the inorganic plume and 10S, 11S, 12S, 13S and 41S for the organic plume. For purposes of estimating the potential future risk due to potential groundwater exposure over time, the concentration of each modeled chemical for the selected wells was generated annually for 30 years, a time period which represents the standard exposure duration. The annual concentrations for each chemical in each well were then used to calculate the 95% UCL of the mean. A statistical software package, Statistica™, was used to calculate the 95% UCL of the mean for each chemical. Those values are shown in Table 1. Because the wells selected for the inorganic and organic plumes are not the same, and an exposed individual is not expected to drink from two sources, the group of chemicals of concern which poses the higher potential risk was used to represent the future RME and was included in the risk characterization of the RA.

Reasonable Maximum Exposure - Downgradient Future Groundwater Risk

Using the procedure described above for deriving future groundwater concentrations, the maximum potential future risk due to groundwater exposure for the wells located outside of the Companies' property boundaries also were evaluated. The projected concentrations of the modeled inorganic and organic chemicals of concern were identified at a hypothetical well used for drinking located 700 feet south of the property boundary.

TABLE 1

THE 95% UCL FOR MODELED INORGANIC AND ORGANIC CHEMICALS

Modeled Chemicals	Concentration Center of Plume	Hypothetical Well 700' South	Hypothetical Well 1800' South
Inorganics			
Arsenic	0.020 mg/l	0.005 mg/l	0.004 mg/l
Sodium*	50.1 mg/l	6.9 mg/l	5.4 mg/l
Potassium*	39.8 mg/l	3.8 mg/l	2.9 mg/l
Organics			
Ethylbenzene	7.4 mg/l	4.2 mg/l	2.5 mg/l
Cumene	4.9 mg/l	5.7 mg/l	3.4 mg/l
Toluene	12.0 mg/l	4.9 mg/l	2.9 mg/l
Xylene	10.5 mg/l	5.8 mg/l	3.4 mg/l
Benzene	1.1 mg/l	0.5 mg/l	0.3 mg/l

* Sodium and potassium are evaluated qualitatively for risk assessment purposes.

In the same fashion, the projected concentrations of the modeled inorganic and organic chemicals of concern for a hypothetical well located in the geographic center of the plume at a future time was determined for a location 1800 feet south of the property boundary. The 95% UCL values (as calculated by Statistica™) for both sets also are presented in Table 1.

For each of the modeled chemicals of concern, the potential risk for each pathway was calculated and summed.

Calculation Used for Predicting the Future Groundwater Risk for Chemicals of Concern Not Simulated by the Solute Transport Model

The method used to calculate the estimated potential future groundwater risk for the inorganic and organic chemicals of concern detected in the groundwater plumes that were not simulated by the solute transport models is described below. Only the selected groundwater chemicals of concern are included in this calculation to estimate the potential future risk.

This method assumed that the ratio between the potential risk of the modeled chemicals of concern and the potential risk of all chemicals of concern is the same for the current and future groundwater scenarios.

Thus,

$$\frac{CM}{TC} = \frac{FM}{TF}$$

where:

CM = Current Risk of Modeled Chemicals of Concern (organic and inorganic)
The calculated risk, based on the current observed (1991-1992) groundwater concentrations for the modeled parameters, e.g., arsenic.

TC = Total Current Risk of All Chemicals of Concern
Total risk calculated for all chemicals of concern within the groundwater plume (which is also based on the current observed groundwater concentrations.)

FM = Future Risk of Modeled Chemicals of Concern
The calculated risk, based on the predicted future groundwater concentrations from the solute transport model.

TF = Total Future Risk of All Chemicals of Concern
= Solved for given values of CM, TC and FM.

As an example, the ratio between the potential risk (i.e., hazard index) of the modeled organic chemicals of concern and the potential risk of all organic chemicals of concern for an adult's ingestion of noncarcinogenic chemicals from groundwater in the hypothetical residential well located 700' downgradient of the property is as follows:

$$\frac{CM}{TC} = \frac{FM}{TF}$$

$$\frac{0.55}{0.86} = \frac{8.11}{X}$$

"X" = 12.67 (Hazard Index - HI)

where:

0.55 = HI for current risk of modeled organic chemicals of concern
0.86 = HI for total current risk of all organic chemicals of concern
8.11 = HI for future risk of modeled organic chemicals of concern
12.67 = HI for total future risk of all organic chemicals of concern

This calculation was done for each applicable exposure route using the intake assumptions for the residential scenario. Risk calculations are provided in Appendix M.

REV. 1: MAY 1994

ATTACHMENT 1

SIMULATED INORGANIC CONCENTRATIONS FOR MONITORING WELLS 4S AND 6S AND LOCATIONS 700 FEET AND 1800 FEET SOUTH OF THE COMPANIES' PROPERTY BOUNDARIES

Simulated Groundwater Inorganic Data

YEAR	Na MW-4S (ppb)	Na MW-6S (ppb)	Na 700 FEET (ppb)	Na 1800 FEET (ppb)	K MW-4S (ppb)	K MW-6S (ppb)	K 700 FEET (ppb)	K 1800 FEET (ppb)	As MW-4S (ppb)	As MW-6S (ppb)	As 700 FEET (ppb)	As 1800 FEET (ppb)
1995	91733	961209	44522	36277	87374	894522	26950	21741	164	99	27	23
1996	66940	750133	34628	28032	62788	689712	20706	16590	125	80	22	18
1997	48346	587766	26383	21436	44634	534042	15568	12522	94	65	17	14
1998	35949	467615	21436	16490	32714	420167	12522	9510	73	53	14	11
1999	26032	373443	16490	13192	23320	331896	9510	7526	55	44	11	9
2000	19834	298754	13192	9894	17534	262647	7526	5566	43	36	9	7
2001	14876	243550	11543	8245	12967	211994	6542	4597	34	30	8	6
2002	11157	198087	9894	6596	9590	170696	5566	3638	26	25	7	5
2003	8677	165614	8245	6596	7368	141474	4597	3638	21	22	6	5
2004	6198	139635	6596	4947	5178	118295	3638	2691	16	19	5	4
2005	4959	116904	6596	4947	4097	98184	3638	2691	13	16	5	4
2006	3719	100667	4947	3298	3030	83934	2691	1759	10	14	4	3
2007	2479	84431	4947	3298	1981	69796	2691	1759	7	12	4	3
2008	2479	74689	4947	3298	1981	61375	2691	1759	7	11	4	3
2009	1240	64947	3298	3298	957	53008	1759	1759	4	10	3	3
2010	1240	58452	3298	1649	957	47463	1759	850	4	9	3	2
2011	1240	51957	3298	1649	957	41948	1759	850	4	8	3	2
2012	1240	45463	3298	1649	957	36466	1759	850	4	7	3	2
2013	1240	42215	3298	1649	957	33740	1759	850	4	7	3	2
2014	1240	38968	3298	1649	957	31023	1759	850	4	6	3	2
2015	0	35721	1649	1649	0	28318	850	850	0	6	2	2
2016	0	32473	1649	1649	0	25624	850	850	0	5	2	2
2017	0	29226	1649	1649	0	22944	850	850	0	5	2	2
2018	0	25979	1649	1649	0	20278	850	850	0	4	2	2
2019	0	25979	1649	1649	0	20278	850	850	0	4	2	2
2020	0	22731	1649	1649	0	17628	850	850	0	4	2	2
2021	0	22731	1649	1649	0	17628	850	850	0	4	2	2
2022	0	22731	1649	1649	0	17628	850	850	0	4	2	2
2023	0	22731	1649	1649	0	17628	850	850	0	4	2	2
2024	0	22731	1649	1649	0	17628	850	850	0	4	2	2

REV. 1: MAY 1994

ATTACHMENT 2

SIMULATED ORGANIC CONCENTRATIONS FOR MONITORING WELLS 10S, 11S, 12S, 13S AND 41S AND LOCATIONS 700 FEET AND 1800 FEET SOUTH OF THE COMPANIES' PROPERTY BOUNDARIES

Simulated Groundwater Organic Data

YEAR	Ethylbenzene MW-10S (ppb)	Ethylbenzene MW-11S (ppb)	Ethylbenzene MW-12S (ppb)	Ethylbenzene MW-13S (ppb)	Ethylbenzene MW-41S (ppb)	Ethylbenzene 700 FEET (ppb)	Ethylbenzene 1800 FEET (ppb)	Benzene MW-10S (ppb)	Benzene MW-11S (ppb)	Benzene MW-12S (ppb)	Benzene MW-13S (ppb)	Benzene MW-41S (ppb)
1995	5876	124710	19557	13149	13377	9777	3534	363	29689	1669	1076	2995
1996	5360	115626	17730	11668	12292	9507	4077	335	27796	1532	969	2782
1997	4947	106524	16428	10370	11540	8964	4347	312	25879	1433	875	2633
1998	4535	98729	14864	9446	10755	8148	4620	289	24222	1314	806	2476
1999	4123	92243	13558	8335	9966	7604	4347	266	22829	1213	723	2317
2000	3814	85738	12515	7594	9442	7061	4347	249	21420	1131	667	2211
2001	3504	79252	11472	6853	8917	6248	4077	231	20001	1048	610	2103
2002	3196	74056	10429	6296	8132	5975	3803	213	18854	965	566	1941
2003	2990	68860	9649	5742	7608	5432	3534	201	17696	902	523	1831
2004	2784	63663	8865	5185	7083	4889	3260	189	16527	837	478	1721
2005	2578	59757	8085	4815	6819	4619	2990	177	15640	773	448	1665
2006	2371	55869	7563	4444	6294	4076	2717	165	14749	729	418	1553
2007	2165	51963	7042	4074	6034	3802	2447	152	13847	685	388	1497
2008	2061	48075	6258	3704	5509	3532	2173	146	12940	618	357	1383
2009	1855	45476	5999	3333	5245	3259	2173	133	12328	596	325	1325
2010	1753	41570	5477	3149	4985	2989	1904	126	11400	551	310	1267
2011	1649	38972	4956	2963	4460	2716	1904	120	10777	505	294	1150
2012	1547	36374	4693	2593	4196	2446	1630	113	10148	481	261	1091
2013	1443	33776	4172	2409	3936	2446	1630	107	9514	434	245	1031
2014	1341	32486	3913	2222	3672	2173	1360	100	9196	411	229	971
2015	1237	29888	3650	2038	3672	2173	1360	93	8552	387	212	971
2016	1135	28579	3391	1852	3411	1903	1087	87	8225	363	195	911
2017	1031	25981	3129	1852	3147	1630	1087	80	7570	338	195	849
2018	1031	24691	2870	1668	2887	1630	1087	80	7241	314	178	787
2019	928	23383	2870	1481	2623	1630	817	73	6906	314	161	724
2020	928	22093	2607	1298	2623	1360	817	73	6573	288	143	724
2021	825	20785	2348	1298	2362	1360	817	66	6232	263	143	661
2022	780	19990	2250	1200	2250	1200	817	63	6000	250	130	625
2023	700	19900	2100	1120	2100	1120	817	60	5500	230	120	600
2024	660	19850	2000	1050	2000	1050	817	58	5200	210	115	590

Simulated Groundwater Organic Data

YEAR	Benzene 700 FEET (ppb)	Benzene 1800 FEET (ppb)	Toluene MW-10S (ppb)	Toluene MW-11S (ppb)	Toluene MW-12S (ppb)	Toluene MW-13S (ppb)	Toluene MW-41S (ppb)	Toluene 700 FEET (ppb)	Toluene 1800 FEET (ppb)	Xylene MW-10S (ppb)	Xylene MW-11S (ppb)	Xylene MW-12S (ppb)
1995	1043	430	11071	437180	83104	35690	1166	11763	4164	14120	161506	32656
1996	1018	487	10080	404709	75190	31592	1070	11432	4818	12845	149408	29519
1997	967	515	9289	372225	69561	28011	1003	10766	5144	11829	137313	27291
1998	890	543	8500	344455	62808	25465	933	9766	5474	10815	126981	24619
1999	838	515	7712	321379	57184	22412	864	9102	5144	9804	118401	22396
2000	786	515	7124	298272	52699	20382	817	8439	5144	9050	109815	20624
2001	706	487	6534	275266	48222	18355	771	7449	4818	8294	101272	18857
2002	679	458	5947	256862	43753	16834	702	7116	4488	7543	94443	17095
2003	625	430	5556	238484	40415	15324	656	6457	4164	7043	87628	15779
2004	570	401	5166	220135	37067	13809	610	5799	3835	6543	80828	14461
2005	543	372	4776	206361	33741	12803	586	5473	3512	6045	75727	13152
2006	487	342	4386	192670	31521	11799	540	4817	3184	5548	70659	12280
2007	458	312	3997	178934	29305	10797	518	4487	2862	5052	65579	11409
2008	430	281	3802	165283	25980	9796	472	4163	2536	4803	60533	10103
2009	401	281	3414	156173	24883	8797	449	3834	2536	4309	57167	9673
2010	372	251	3222	142497	22678	8303	426	3511	2215	4065	52119	8809
2011	342	251	3028	133415	20477	7801	380	3183	2215	3817	48768	7947
2012	312	219	2836	124346	19371	6807	357	2861	1891	3573	45425	7514
2013	312	219	2642	115289	17177	6315	335	2861	1891	3327	42088	6656
2014	281	187	2451	110798	16090	5817	312	2535	1572	3084	40434	6231
2015	281	187	2258	101764	14989	5326	312	2535	1572	2839	37109	5801
2016	251	154	2067	97221	13905	4829	289	2214	1250	2597	35438	5378
2017	219	154	1874	88211	12807	4829	266	1890	1250	2353	32126	4949
2018	219	154	1874	83744	11727	4340	244	1890	1250	2353	30485	4528
2019	219	120	1685	79219	11727	3846	221	1890	934	2113	28823	4528
2020	187	120	1685	74762	10633	3359	221	1571	934	2113	27188	4102
2021	187	120	1493	70248	9557	3359	199	1571	934	1870	25532	3684
2022	180	120	1400	65000	9000	3000	190	1400	934	1800	24000	3450
2023	180	120	1350	60000	8200	2900	180	1350	934	1750	22500	3200
2024	180	120	1280	58000	7800	2800	175	1280	934	1700	20000	3000

YEAR	Xylene MW-13S (ppb)	Xylene MW-41S (ppb)	Xylene 700 FEET (ppb)	Xylene 1800 FEET (ppb)	Cumene MW-10S (ppb)	Cumene MW-11S (ppb)	Cumene MW-12S (ppb)	Cumene MW-13S (ppb)	Cumene MW-41S (ppb)	Cumene 700 FEET (ppb)	Cumene 1800 FEET (ppb)
1995	38606	5655	13763	4827	8357	41417	16298	7280	7759	12670	4810
1996	34136	5183	13373	5593	7657	38541	14846	6497	7158	12337	5511
1997	30234	4857	12587	5974	7095	35648	13806	5807	6741	11665	5858
1998	27463	4517	11408	6362	6531	33161	12552	5314	6304	10652	6208
1999	24143	4177	10626	5974	5965	31084	11501	4717	5863	9975	5858
2000	21937	3951	9845	5974	5539	28995	10657	4317	5569	9295	5858
2001	19737	3725	8681	5593	5110	26903	9810	3915	5274	8274	5511
2002	18088	3388	8290	5207	4681	25222	8960	3612	4831	7929	5159
2003	16451	3163	7515	4827	4393	23535	8320	3309	4534	7242	4810
2004	14811	2939	6742	4443	4105	21842	7676	3003	4236	6551	4455
2005	13723	2826	6360	4065	3815	20564	7031	2798	4086	6206	4103
2006	12638	2602	5591	3683	3524	19289	6599	2593	3786	5510	3745
2007	11555	2492	5205	3307	3232	18003	6165	2387	3637	5157	3390
2008	10475	2269	4826	2927	3084	16719	5510	2180	3335	4809	3029
2009	9398	2157	4442	2927	2790	15858	5293	1972	3183	4454	3029
2010	8865	2047	4064	2553	2643	14559	4854	1868	3032	4102	2670
2011	8325	1826	3681	2553	2494	13691	4413	1763	2728	3744	2670
2012	7256	1714	3306	2176	2346	12821	4190	1552	2574	3389	2303
2013	6726	1605	3306	2176	2196	11948	3746	1447	2422	3389	2303
2014	6191	1494	2926	1807	2048	11514	3524	1341	2267	3028	1939
2015	5664	1494	2926	1807	1897	10635	3299	1235	2267	3028	1939
2016	5131	1385	2553	1434	1747	10192	3076	1127	2114	2669	1566
2017	5131	1275	2176	1434	1595	9308	2849	1127	1958	2303	1566
2018	4608	1166	2176	1434	1595	8868	2624	1020	1803	2303	1566
2019	4078	1057	2176	1069	1444	8420	2624	911	1646	2303	1194
2020	3558	1057	1806	1069	1444	7977	2395	803	1646	1938	1194
2021	3558	949	1806	1069	1289	7527	2168	803	1490	1938	1194
2022	3558	900	1800	1069	1180	7000	2000	750	1420	1938	1194
2023	3558	850	1750	1069	1100	6750	1900	710	1350	1938	1194
2024	3558	800	1700	1069	1050	6200	1800	690	1300	1938	1194

Appendix J
Potential for Plant Uptake of Chemicals of Concern

APPENDIX J

POTENTIAL FOR THE PLANT UPTAKE OF THE PRRS CHEMICALS OF CONCERN

APPENDIX J
POTENTIAL FOR THE PLANT UPTAKE OF THE PRRS CHEMICALS OF CONCERN

In order for plant uptake to occur, the PRRS chemicals of concern must migrate from soils or be transported by the air pathway from the Companies' properties to areas outside of the properties and be deposited where crops are grown. Both situations are not likely to occur.

A literature search was conducted to compile available information regarding the potential for plant uptake of the PRRS chemicals of concern. The findings, summarized in this appendix, were generated from laboratory or field studies that may not reflect actual environmental conditions present at the PRRS.

Soil provides essential nutrients for plant growth. Essential nutrients are categorized as macronutrients, which are needed by plants in substantial levels in soil, and as micronutrients, which need to be available in soil in trace quantities. Macronutrients are carbon, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. Since carbon, hydrogen, and oxygen are obtained from the atmosphere, the remaining nutrients must be obtained from the soil. Essential plant micronutrients include ammonia, boron, chloride, copper, iron, manganese, molybdenum, sodium, vanadium, and zinc. Most of these nutrients are involved in enzyme function and possibly photosynthesis (Manahan 1991).

Because many of these nutrients are considered as chemicals of concern in the soil medium at the PRRS, a brief discussion of the potential for plant uptake is provided.

The macronutrients, phosphorus, potassium, calcium and magnesium are considered as chemicals of concern. Phosphorus must be present in a simple inorganic form before it can be taken up in plants. Potassium is used in relatively high levels by plants where it aids in water balance and the activation of some enzymes. In potassium-deficient soils, crop yields are significantly reduced. Potassium easily

binds to silicate minerals, which makes it unavailable for plant uptake. However, exchangeable potassium held by clay minerals is relatively more available for plant uptake (Manahan 1991). Soil liming is a common practice to treat acid soils to restore the pH to near-neutrality to provide an adequate supply of calcium for plants. Magnesium availability is dependent upon the calcium/magnesium ratio in soils. If the ratio is too high, then magnesium may not be readily available to the plants.

Micronutrients that are considered as chemicals of concern at the PRRS are ammonia, copper, manganese, sodium, vanadium, and zinc.

The ammonium ion is an essential nutrient to the growth of plants. Normally, ammonia does not have a very long lifetime in soil because it is rapidly taken up by plants, bioconverted by the microbial population, or volatilized to the atmosphere (ATSDR 1990).

Mobility and displacement of copper is low because of its strong bonding with organic matter and clay minerals. Root tissues have a strong ability to retain copper. In mature leaf tissue of various plants, the normal range is 5-30 ppm with excessive or toxic levels at 20-100 ppm (U.S. EPA 1992).

The solubility of manganese in soil is highly dependent on pH and Eh, while its mobility is dependent upon its oxidation-reduction potential. Hydrous oxides of manganese are common in soil. Trivalent forms are less mobile. Plants with long roots extract manganese from the soil. Normal levels in mature leaf tissue of various plants range from 20 to 300 ppm; excessive or toxic levels for plants range from 300 to 500 ppm (U.S. EPA 1992). Humans are exposed to manganese primarily through food, where the average daily intake is 3.8 mg of manganese per day. Human intake varies greatly depending upon dietary habits. For instance, a cup of tea may contain 0.4 to 1.3 mg of manganese; therefore, consumption of 3 cups of tea per day provides up to 4 mg per day from one source alone (ATSDR 1991).

Most foods have naturally-occurring low levels of vanadium; however, some foods such as ground parsley (1,800 ng/g), wild mushrooms (50 - 2,000 ng/g dry weight) contain elevated levels of vanadium. For most plants, vanadium does not appear to bioconcentrate in the aboveground portions of the plant (ASTDR 1990).

Zinc is relatively soluble and mobile in soil compared to other heavy metals. The zinc fraction associated with iron and manganese oxides is likely to be the form most available to plants. Zinc may occur in leaf tissue of plants at 27-150 ppm; its toxic range is 100-400 ppm (U.S. EPA 1992). Uptake of zinc into the edible portion of plants, such as corn, appears to be unlikely. In general, zinc will produce phytotoxicity before the concentration in plant tissue reaches a level that may pose a risk to human or animal health (U.S. EPA 1983).

Other Inorganic Chemicals

Inorganic chemicals of concern present at PRRS that are not inherent to plant growth are discussed below in terms of their affinity for plant uptake. These include:

- Aluminum
- Antimony
- Arsenic
- Barium
- Cadmium
- Chromium
- Cobalt
- Mercury
- Nickel

Aluminum does not bioconcentrate in plants, indicating that the concentration in soil is greater than the concentration in the plant tissue. Acidic conditions enhance the uptake of aluminum in plant materials. The aluminum content of cultivated plants (e.g., lima beans, cabbage soy beans, tomatoes) ranged from 50 to 30,000 mg/kg. The level reported in corn ranged from 50 to 3000 mg/kg (ASTDR 1990a).

Antimony usually occurs in the trivalent form, may be relatively mobile, and can be associated with iron hydroxides. In mature leaf tissue of various plants, antimony

ranges from 7 to 50 ppm. Toxic or excessive limits for plants are 150 ppm or more (U.S. EPA 1992). Studies conducted near a smelter site indicated that uptake of antimony from soil to plant material is minimal, thus suggesting that bioconcentration in the food chain is not likely to occur (ATSDR 1990b).

Most plants contain <0.5 ppm of arsenic but can accumulate as much as 14 ppm. Excessive toxic ranges in various plants are 5-20 ppm. Plant toxicity is dependent on the soil properties. In clayey soils, it has been found that significant growth reduction occurs at 1000 ppm in the plant tissue, but in sandy soils 100 ppm is equally toxic (U.S. EPA 1992).

Barium may be taken up in certain plant material; however, the extent to which plants bioconcentrate barium from soil is not well defined.

Barium intake for humans is estimated at 650 to 1,770 ug per day, with food being the primary source. Barium is found in low levels in many foods. Barium was reported in corn plants ranging from 5 to 150 ppm and in cultivated plants (lima beans, cabbage, soybeans, and tomatoes) ranging from 7 to 1500 ppm (ATSDR 1990).

Hemphill et al. (1973) reported that the level of cadmium decreased from 1.51 to <0.5 ug/g in grass samples obtained from 0 to 200 yards from a roadside. A number of factors may influence the movement of cadmium from soil to plants, such as the growth rate of plants, and the availability of other metals in the soil. An increase in pH has been shown to reduce the cadmium uptake in plants. Lettuce, tomatoes, eggplant, and cantaloupes show an increase in cadmium content in various parts of the plant when grown in cadmium-rich soils, whereas no increase in cadmium is observed in broccoli, potatoes, or string beans. There appears to be variation in the levels of cadmium found in plant tissue. Corn grains contain a smaller amount than the leaf, whereas the grain of soybeans, wheat, oats and sorghum have cadmium levels closer to those found in the leaf (Nriagu 1980).

Plants do not take up and accumulate cadmium from the soils as readily as from solution because the cadmium ions are not as available in soil. The availability of soil cadmium and its uptake and accumulation by plants are affected by many soil factors, including pH, cation exchange capacity, organic matter content, soil moisture and temperature, phosphorus level, and concentrations of other cations and trace elements in the soil (Nriagu 1980a). In mature leaf tissue of various plants, the normal range of cadmium is 0.05 - 0.2 ppm; excessive or toxic levels in plants range from 5-30 ppm (U.S. EPA 1992). Cadmium uptake varies among different food crops. Crops such as lettuce and carrots are expected to readily accumulate cadmium, while beans, peas, tomatoes, and fruit trees have a very low cadmium uptake (U.S. EPA 1983).

Fresh vegetables were reported to have concentrations ranging from 0.03 to 0.14 ppm. U.S. EPA (1992) reports that chromium is rarely taken up by plants at usual prevailing soil pH and Eh values. At low pH, it has little effect on plants, but in high concentrations in solution, it can stop plant development. Most chromium absorbed by plants is retained in the roots, thus not within the edible portion of the plants.

The availability of cobalt, which is typically found in soils as divalent cobalt, is primarily regulated by pH. Adsorption of divalent cobalt on soil colloids is high between the pH of 6 & 7, whereas leaching and plant uptake of cobalt are enhanced by a lower pH. Few plants accumulate cobalt above the 100 ppm concentration which may cause phytotoxicity.

Elevated levels of cobalt have been found in the roots of sugar beets and potato tubers in soil with high cobalt concentrations; however, the movement of cobalt from the roots to the aboveground parts of the plant is not significant in most soils. This is shown by the lack of cobalt in the seeds of many grain species. In highly acidic soils (i.e., pH 3.3), the concentration of cobalt in the foliage of rye grass, oats and barley is increased (ATSDR 1990).

Mercury is strongly bound to humus, especially under acid conditions. Through microbal transformation, metallic mercury may be converted to methylated or

ethylated mercury. Methylated mercury may accumulate in the food chain. Symptoms of mercury toxicity include stunting of seedling growth, reduced root development and inhibition of photosynthesis (U.S. EPA 1992).

The bioconcentration factor of mercury is 1000 for freshwater plants (Callahan 1979). In general, the availability of mercury in soil to plant roots is low and there is a root barrier to translocation of mercury to plant tops. Wood decomposers and several species of mycorrhizal fungi accumulate mercury at a very low rate. Some mycorrhizal species and all humus decomposers may accumulate up to 100 ug/l dry weight of mercury and at contaminated sites, up to 63 times as much mercury as the substratum. In mineralized areas, the concentration factor rarely exceeds 1 (Bargagli and Baldi 1984).

The uptake of nickel in plants is dependent upon soil pH, metal interactions, and the concentration of nickel in soil. The uptake of nickel is enhanced by reducing the pH below 6.5. The concentration of one metal may affect the accumulation of other metals or may modify the toxic effects of other elements. Studies have shown that the nickel-zinc interaction and nickel-copper interaction are additive; where varying concentrations of zinc or copper neither reduce or increase the effects of nickel. Another study reported that zinc reduces the toxic effects of nickel. Most studies conclude that nickel accumulates in the plant root system, but will eventually move into the remaining portions of the plant (Nriagu 1980b). In general, nickel will produce phytotoxicity before the concentration in plant tissue reaches a level that may pose a risk to human or animal health (U.S. EPA 1983).

Other Organic Chemicals

Organic chemicals do not tend to be taken into plant matter; however, some organic chemicals have been detected in plant tissue. The following chemicals of concern have been reported in the literature as affecting plants: acetone, benzene, methylphenols and polynuclear aromatic hydrocarbons. Acetone is identified as a naturally occurring, volatile metabolite and has been reported in onions, apples, grapes, cauliflower, tomatoes, morning glories, and wild mustard (Howard 1990).

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A variety of plants are capable of absorbing benzene vapor through their leaves where metabolic detoxification takes place with eventual cleavage of the benzene ring (Canada EHD 1979)

Methylphenols are widely distributed natural compounds and may be found in plant lipids. Methylphenols have been detected in tomatoes, cooked asparagus, various cheeses, butter, oil, red wine, coffee, tea, and smoked food. There is no information available regarding the absorption of methylphenols into plant material. Methylphenols are not expected to bioaccumulate in the food chain (ATSDR 1990).

Polynuclear aromatic hydrocarbons (PAHs) may be taken up in plants with uptake rates dependent upon the PAH concentration in soil, the solubility, and the molecular weight. About 30-70% of atmospheric PAHs deposited onto forests are sorbed by the trees and eventually deposited as litter. Vaughan (1984) reported that atmospheric deposition of PAHs onto leaves generally exceeds uptake from soils via plant root systems. This theory is supported by a study conducted in the United Kingdom (Wild et al. 1992) that found that elevated levels of PAHs in soil do not correlate to the amount taken up in plant tissue. PAH concentrations found in the aboveground portion of plants are probably due to atmospheric deposition. Normal cleaning of edible portions of plant matter usually removes such chemicals. Several other studies report the same conclusion (O'Connor et al. 1991). The presence of PAHs in root tissue is probably due to adsorption onto the root surface (ATSDR 1993).

No field studies of phenol uptake by plants growing in soils were identified (O'Connor et al. 1991). Likewise, relatively few reports of plant uptake of volatile aromatics were identified.

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Appendix K
Air Dispersion Models

REV. 1: MAY 1994

APPENDIX K

AIR DISPERSION MODELS
INHALATION OF FUGITIVE DUST,
VOLATILE EMISSIONS FROM SOIL
AND
CALCULATIONS OF VOLATILE ORGANIC EMISSIONS
DURING SHOWERING

APPENDIX K
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APPENDIX K

AIR DISPERSION MODELS INHALATION OF FUGITIVE DUST, VOLATILE EMISSIONS FROM SOIL AND CALCULATIONS OF VOLATILE ORGANIC EMISSIONS DURING SHOWERING

1.0 AIR DISPERSION MODELING

Screening level calculations were performed to evaluate the significance of the air pathway, and to determine whether it was necessary to include this route of exposure in the human health risk characterization presented in Section 6.1.4. The screening procedure required first the estimation of ambient concentrations at the site, and then the evaluation of potential risks associated with the predicted air concentrations.

A box model was used to predict Study Area ambient air concentrations of chemicals of concern based on their measured concentrations in soil. The predicted air concentrations were compared to calculated acceptable air concentrations based on protection of human health. Potential risks were also calculated, assuming that a maximally exposed individual resided at the fenceline of the Companies' properties.

This appendix presents the results of the screening work. It is organized as follows:

- Calculation of Predicted Ambient Air Concentrations (1.1)
- Comparison of Predicted Ambient Air Concentrations to Calculated Acceptable Air Concentrations (1.2)
- Estimation of Potential Risks (1.3).

1.1 Calculation of Study Area Ambient Air Concentrations

Both volatile and fugitive dust emissions have been considered in the calculation of ambient chemical concentrations in Study Area air. Volatile and semivolatile organic chemicals (VOCs and SVOCs) were evaluated for both volatile emissions and for fugitive dust. Inorganic

chemicals were only considered for fugitive dust emissions, except for mercury, which may volatilize under specific chemical and physical conditions.

The following subsections describe the methods used to estimate volatile emission rates and fugitive dust emission rates. The final section describes the box model used to derive ambient air concentrations on-site, based on the calculated emission rates.

1.1.1 Calculation of Volatile Emission Rates

In order to determine the average (mean) air concentrations, average surface soil concentrations were used to derive emission rates. Emission rates were calculated using the Hwang and Falco model (U.S. EPA 1991):

where:

$$VF(m^3/kg) = \frac{(LS \times V \times DH)}{A} \times \frac{(3.14 \times \alpha \times T)^{1/2}}{(2 \times D_{ei} \times E \times Kas \times 10^{-3} kg/g)}$$

$$\alpha(cm^2/s) = \frac{(D_{ei} \times E)}{E + (P_s)(1-E)/K_{as}}$$

where:

VF = volatilization factor (m^3/kg)
LS = length of side of contaminated area (m)
V = wind speed in mixing zone (m/s)
DH = diffusion height (m)
A = area of contamination (cm^2)
D_{ei} = effective diffusivity (cm^2/s)
E = true soil porosity (unitless)
K_{as} = soil/air partition coefficient (g soil/cm^3 air)
P_s = true soil density or particulate density (g/cm^3)
T = exposure interval (s)
D_i = molecular diffusivity (cm^2/s)
H = Henry's law constant (atm-m^3/mol)
K_d = soil-water partition coefficient (cm^3/g)
K_{oc} = organic carbon partition coefficient (cm^3/g)
OC = organic carbon content of soil (fraction)

The factors used in the calculation and the volatile emission rates are provided in Table 1.

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TABLE 1
SOIL TO AIR VOLATILIZATION EMISSIONS
PADDYS RUN ROAD SITE

VARIABLE	DESCRIPTION	UNITS	Mercury	Xylene	Cumene
LS	Length of Area	(m)	205.27	205.27	205.27
V	Wind Speed in Mixing Zone	(m/s)	2.26	2.26	2.26
DH	Diffusion Height	(m)	2.00	2.00	2.00
A	Contamination Area	(sq cm)	4.21E+08	4.21E+08	4.21E+08
Um	Mean Annual Wind Speed	(m/s)	4.10	4.10	4.10
Ut	Equivalent Threshold Wind Speed at 7m	(m/s)	4.95	4.95	4.95
E	Porosity		35.00%	35.00%	35.00%
OC	Organic Content of Soil		1.00%	1.00%	1.00%
Ps	Soil Density	(g/cm3)	2.19	2.19	2.19
Koc	Organic Carbon Partitioning Coefficient	(cm3/g)	1,000	240	2,820
H	Henry's Law Constant	(atm-m3/mol)	9.46E-03	7.04E-03	6.43E-03
Di	Molecular Diffusivity	(cm2/sec)	0.0109	0.0674	0.1200
a	Alpha	(cm2/sec)	3.66E-05	1.36E-03	1.94E-04
T	Exposure Interval	(sec/yr)	3.15E+07	3.15E+07	3.15E+07
Dei	Effective Diffusivity	(cm2/sec)	0.0077	0.0475	0.0845
Kas	Soil-Air Partitioning Coefficient	(g soil/cc air)	1.94E-02	1.20E-01	9.35E-03
c	Concentration in Soil	(mg/kg)	4.41E-01	3.34E-03	4.72E-03
VF	Volatilization Factor	(cu m/kg)	1.27E+04	2.02E+03	5.52E+03
1/VF	Emission Rate Factor	(mg/cu m)	7.90E+01	4.94E+02	1.81E+02
C	Emission Rate	(mg/cu m)	3.48E-05	1.65E-06	8.56E-07

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The following assumptions were used:

- Porosity was assumed to be 35% (U.S. EPA 1991).
- The mid-point of sample depth was assumed to be 6 inches or 0.15 m, because the sample depth range was 0 to 12 inches.
- The organic fraction of the soil was assumed to be 1% (technical judgment).
- The mean annual temperature for the Cincinnati airport is 12°C and was used to determine the absolute temperature (Ruffner 1985).
- All values that were reported as non-detects in soil were converted to half the detection limit and averaged with positively detected values.

1.1.2 Calculation of Fugitive Dust Emissions Rates

The approach outlined in EPA's guidance document for fugitive dust emissions at TSDF facilities (U.S. EPA 1989c) was used to determine the emission rate of dust from soils on Companies' properties. The equation used to derive the emission rate was:

$$E = a \sum_{i=1}^{N} P_i$$

where:

E = fugitive dust emission rate ($g/m^2/year$)

a = particle size multiplier (0.5)

N = number of disturbances per year (1 disturbance/year)

P_i = erosion potential corresponding to the observed fastest wind mile for the i-th period between disturbances ($g/m^2/disturbance$)

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The erosion potential was determined using the following empirical formula:

$$P = 58 \times (u' - u_t')^2 + 25 \times (u' - u_t')$$

where:

u' = friction velocity = $0.053 \times u^+ 10$
u'_t = threshold friction velocity (0.5 m/s)
$u^+ 10$ = fastest wind mile (46 mph = 20.7 m/sec, Cincinnati Airport and DOE meteorological data)

In order to calculate the ambient concentration for the given chemicals, the dust emission rate was multiplied by the concentration of the chemical on the dust:

$$E_i = E \times C_s \times CF$$

where:

E_i = emission rate of specific chemical ($mg/m^2/year$)
E = fugitive dust emissions rate ($mg/m^2/year$)
C_s = constituent concentration (mg/kg)
CF = conversion factor (10^{-6} kg/mg)

1.1.3 Box Model

Estimated emission rates were used in a box model to determine the ambient air concentration of each chemical of concern on the Companies' properties. The box model is represented by the following equation:

$$C_a = \frac{(E_i \times W \times L)}{(W_s \times H \times u)} \times CF$$

where:

C_a = average annual ambient air concentration (mg/m^3)

W = width of the site as measured perpendicular to the length of the site (m)

L = length of the site (m)

W_s = square root of the area of the site (m)

H = height of human inhalation (1.5 m)

u = average wind speed (m/sec).

CF = conversion factor (3.17×10^{-8} yr/sec)

The mean annual wind speed used for the site was based on meteorological data from the Cincinnati Airport and DOE. It is estimated as 9.1 mph or 4.1 m/sec (Ruffner 1985).

1.2 Comparison of Ambient Air Concentrations to Acceptable Air Concentrations

The evaluation of results for this site was undertaken in a two-tiered manner. The first tier was the comparison of predicted screening levels to the acceptable levels. The second tier involved calculation of total potential risks associated with predicted concentrations.

Acceptable air concentrations for this site were determined using chronic reference concentrations (RfCs) and chronic reference doses (RfDs) for noncarcinogens, and cancer potency factors (CPFs) for carcinogens. The acceptable air concentration was calculated to be protective of the maximally exposed individual to a target hazard index of 1.0 or a target 10^{-6} carcinogenic risk, as appropriate. The acceptable concentration was generated assuming lifetime exposure at the point of maximum concentration:

$$C_{aa} = \frac{10^{-6}}{CPF} \times \frac{BW}{IR} \quad \text{(for carcinogens)}$$

$$C_{aa} = RfC \text{ for noncarcinogens}$$

where:

C_{aa} = acceptable air concentration (mg/m^3)

CPF = cancer potency factor $(mg/kg/day)^{-1}$

RfC = reference concentration (mg/m^3)

BW = 70 kg for an adult

IR = 20 m^3/day for an adult.

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In some instances, the reference concentration is presented as the reference dose: in these instances, it was necessary to convert the dose to a concentration based on the assumption that an adult inhales 20 m^3 of air per day and weighs 70 kg. Where the CPF was reported as a unit risk $(\mu g/m^3)^{-1}$ the acceptable air concentration is the ratio of the target incremental excess lifetime cancer risk (10^{-6}) to the unit risk. The exposure assumptions are listed in Table 2. The calculated acceptable air concentrations based on chronic toxicity and risk-specific concentrations are listed in Table 3.

The comparison between predicted concentrations and acceptable air concentrations for volatile chemicals is shown in Table 4. Table 5 provides a comparison between predicted concentrations and acceptable air concentrations for fugitive dust emissions. The data provided in Tables 4 and 5 show all chemicals have predicted concentrations lower than the acceptable maximum levels.

Predicted air concentrations produced as a result of fugitive dust emissions were significantly below the acceptable air concentrations. Thus, no refined analysis was performed for fugitive dust emissions.

1.3 Calculation of Hazard Index and Carcinogenic Risk Values

Risk characterization is the final step of the screening process. In this step, the toxicity factors (RfDs and cancer potency factors) for the chemicals of concern are used in conjunction with estimated chemical intakes to predict potential noncarcinogenic and carcinogenic health risks to the maximally exposed individual.

The potential for noncarcinogenic effects is characterized by comparing estimated chemical intakes with chemical-specific RfDs. Potential carcinogenic effects are characterized in terms of the incremental or excess probability that an individual will develop cancer in his or her lifetime, due to the modeled exposure. Excess cancer risk is estimated from the projected lifetime intakes and the cancer potency factor, which represents an upper-bound estimate of the dose-response relationship. The methods used to characterize noncarcinogenic and carcinogenic risks are described further in this section. Potential health risks associated with the estimated chemical exposures and uncertainties inherent in the risk assessment process are also presented in this section.

TABLE 2
EXPOSURE ASSUMPTIONS
PADDYS RUN ROAD SITE

Population	Route	Intake Equation	Equation Parameters
Onsite Resident (adult)*	Inhalation	IF=IR x ET x EF x ED/(BW x AT)	IF = Intake factor (m^3/kg/day) IR = Inhalation rate (0.83 m3/hr) ET = Exposure time (24 hr/day) EF = Exposure frequency (350/days/yr) ED = Exposure duration (30 yrs) BW = Body weight (70 kg) AT = Averaging time 10,950 days, noncarcinogens 25,550 days, carcinogens

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* Exposure assumptions for each scenario for adults and children, as applicable, are provided in Tables 6-18 and 6-19 in Section 6.0 of the RI/RA Report.

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TABLE 3
ACCEPTABLE AIR CONCENTRATION CALCULATIONS
BASED ON CHRONIC TOXICITY AND RISK SPECIFIC CONCENTRATIONS
PADDYS RUN ROAD SITE

Chemical of Concern	Inhalation RfD (mg/kg/day)	Inhalation Carcinogenic Potency Factor (mg/kg/day)$^{-1}$	Acceptable Air (mg/m^3)	Source
Xylenes (Total)	NA	NA	NA	A
Cumene	2.57E-03	NA	9.00E-03	B
Arsenic *	NA	1.50E+01	2.33E-07	A
Calcium	NA	NA	NA	A
Copper	NA	NA	NA	A
Magnesium	NA	NA	NA	A
Mercury	8.58E-05	NA	3.00E-04	B
Potassium	NA	NA	NA	A
Sodium	NA	NA	NA	A

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NA - Not Available

A- IRIS, accessed March 1994

B- HEAST, FY'93

* An absorption factor of 30% has been applied to the CPF for arsenic.

TABLE 4
PREDICTED VALUES FOR VOLATILE CHEMICALS
ASSUMING FUTURE LANDUSE OF RESIDENTIAL OR AGRICULTURAL CATEGORIES
PADDYS RUN ROAD SITE

Chemical of Concern	Site Average (mg/kg)	Emission Rate (mg/m^3)	Predicted Concentration (mg/m^3)	Acceptable Air Concentration (mg/m^3)
Xylenes (Total)	3.34E-03	1.65E-06	1.65E-06	NA
Cumene	4.72E-03	8.56E-07	8.56E-07	9.00E-03
Mercury	4.41E-01	3.48E-05	3.48E-05	3.00E-04

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NA - Not Available

TABLE 5
PREDICTED VALUES FOR CHEMICAL CONCENTRATIONS IN FUGITIVE DUST ASSUMING FUTURE LANDUSE OF RESIDENTIAL OR AGRICULTURAL CATEGORIES PADDYS RUN ROAD SITE

Chemical of Concern	Site Average (mg/kg)	Ei (mg/m² sec)	Predicted Concentration (mg/m³)	Acceptable Air (mg/m³)
Xylenes (Total)	3.34E-03	1.89E-12	6.30E-11	NA
Cumene	4.73E-03	2.67E-12	8.92E-11	9.00E-03
Arsenic	1.18E+01	6.66E-09	2.23E-07	2.33E-07
Calcium	1.10E+05	6.21E-05	2.08E-03	NA
Copper	2.07E+01	1.17E-08	3.91E-07	NA
Magnesium	3.08E+05	1.74E-04	5.81E-03	NA
Mercury	4.41E-01	2.49E-10	8.32E-09	3.00E-04
Potassium	1.68E+03	9.48E-07	3.17E-05	NA
Sodium	1.01E+03	5.70E-07	1.91E-05	NA

NA - Cannot be calculated

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1.3.1 Intake Factor Calculation

The intake factor is necessary to calculate how much potential risk each constituent represents. Intakes are calculated following guidance in *Risk Assessment Guidance for Superfund* (U.S. EPA 1989a), *Exposure Factors Handbook* (U.S. EPA 1989b), and other U.S. EPA guidance documents as appropriate. Intakes are estimated using reasonable estimates of body weight, inhalation rates, and frequency and duration of exposure. The general equation for calculating intake in terms of $m^3/kg/day$ is shown below:

$$\text{Intake Factor} = \frac{\text{Inhalation Rate x Exposure Time x Exposure Frequency x Exposure Duration}}{\text{Body Weight x Averaging Time}}$$

For noncarcinogenic chemicals, intakes are calculated by averaging over the period of exposure to yield an average daily intake. For carcinogens, intakes are calculated by prorating the total cumulative dose over a lifetime, yielding a "lifetime average daily intake." Different averaging times are used for carcinogens and noncarcinogens because it is thought that their effects occur by different mechanisms. The approach for carcinogens is based on the current scientific opinion that a high dose received over a short period of time is equivalent to a corresponding low dose spread over a lifetime. Therefore, the intake of a carcinogen, for whatever duration, is averaged over a 70-year lifetime (U.S. EPA 1986). Intake of noncarcinogens is averaged over the exposure period. All exposures are assumed to be chronic. The intake factor may then be multiplied by the concentration of each chemical to obtain the pathway-specific average daily intake of that chemical.

1.3.2 Carcinogenic Risk

Potential carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the predicted chemical concentration by the intake factor for an adult by the cancer potency factor (CPF) as follows:

$$CR = C_a \times IF \times CPF$$

where:

CR = Carcinogenic risk

C_a = Predicted air concentration (mg/m^3)

IF = Intake $Factor_{adult}$ ($m^3/kg/d$)

CPF = Cancer Potency Factor $(mg/kg/d)^{-1}$.

The U.S. EPA potency factors are upper 95th percentile confidence limits of the probability of response per unit intake of chemical over a lifetime. Potency factors are based on experimental animal data and limited epidemiological studies when available. A linear nonthreshold mathematical model for low-dose extrapolation, the linearized multistage model, is used to calculate the numerical potency factor value. U.S. EPA states that carcinogenic risks estimated using this approach are upper-bound estimates. This means that the actual risk is likely to be less than the predicted risk (U.S. EPA 1989a).

U.S. EPA guidance for evaluating cancer risk from simultaneous exposure to several carcinogens assumes that incremental cancer risks are additive. The concept that cancer risks are additive is based on a number of assumptions. If these assumptions are incorrect, over- or under-estimation of the actual risk could result (U.S. EPA 1989a). The total cancer risk is estimated by summing the risks estimated for each chemical of concern and for each pathway.

U.S. EPA policy must be considered in order to interpret the significance of the cancer risk estimates. In the *National Oil and Hazardous Substances Pollution Contingency Plan* (U.S. EPA 1990), U.S. EPA states that: "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-6} and 10^{-4}." The U.S. EPA further states that the 10^{-6} (a probability of one in a million) excess risk level be used as a point of departure for establishing preliminary remediation goals protective of human health. Site-specific target risk levels may vary from the one in a million departure point, depending upon site-specific factors and assumptions made in the risk assessment.

1.3.3 Noncarcinogenic Risk

The potential for adverse noncarcinogenic effects resulting from exposure to a chemical of concern is evaluated by comparing the average daily intake of the chemical (expressed as mg/kg/day) to a reference dose (expressed as mg/kg/day). The resulting ratio is called a hazard quotient (U.S. EPA 1989b). It is derived in the following manner:

$$HQ = \frac{C_a \times IF}{RfD}$$

where:

HQ = Hazard quotient

C_a = Predicted air concentration (mg/m^3)

IF = Intake $Factor_{adult}$ ($m^3/kg/d$)

RfD = Reference Dose (mg/kg/d).

Use of the RfD assumes that there is a level of intake (the RfD) below which it is unlikely that even sensitive individuals will experience adverse health effects. If the average daily intake exceeds the RfD (i.e., if the hazard quotient exceeds 1.0), there may be cause for concern for potential noncarcinogenic effects. It should be noted, however, that the level of concern does not increase linearly as the RfD is approached or exceeded. This is because all RfDs are not equally accurate and are not based on the same severity of toxic effects. Thus, the slopes of the dose-response curve in excess of the RfD can vary widely, depending on the substance. Furthermore, it must be emphasized that the hazard quotient does not represent a statistical probability of an effect occurring.

To assess the overall potential for adverse health effects posed by exposure to multiple chemicals, the hazard quotients for each chemical of concern associated with a given exposure pathway are summed. The resulting sum is referred to by U.S. EPA as the hazard index (HI). The HI approach assumes that multiple subthreshold exposures to several chemicals could result in an adverse health effect. The HI is expressed as follows:

$$HI = E_1 / RfD_1 + E_2 / RFD_2 + \ldots + E_1 / RfD_i$$

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where:

E_1 = Exposure level (or intake) for toxicant i

RfD_1 = Reference does for toxicant i

In cases where a receptor may be subject to multiple exposure pathways (e.g., inhalation of VOCs and dermal contact with soils), the individual hazard indices from all relevant pathways are summed to obtain the total potential HI for that receptor. For multiple chemical exposures, the total potential HI can exceed 1.0, even if no single chemical intake exceeds its RfD. If the total potential HI is less than 1.0, cumulative exposures to the chemicals of concern at the site are judged unlikely to result in an adverse effect. If the sum is greater than 1.0, a more detailed and critical evaluation of the risks, including consideration of specific target organs affected and mechanisms of toxic action of the chemicals of concern, is required to ascertain if the cumulative exposure would in fact be likely to harm exposed individuals.

The assumption of additive effects reflected in the cumulative potential HI is most properly applied to substances that induce the same effect by the same mechanism (U.S. EPA 1986). Consequently, application of the equation to a mixture of substances that are not expected to induce the same type of effects could overestimate the potential for adverse health effects. The potential HI provides a rough measure of potential toxicity, but it is conservative and dependent on the quality of the experimental evidence. Because the HI does not define dose-response relationships, its numerical value cannot be constructed as a direct estimate of risk (U.S. EPA 1986).

The calculated adult intake factors, hazard indices and carcinogenic risks are shown in Table 6 for volatile emissions and Table 7 for fugitive dust emissions.

1.3.4 Results of Comparison to Acceptable Air Concentrations

The hazard index values and carcinogenic risk totals were used as an additional screening method. The results of both indicate that health risk associated with inhalation of chemical constituents does not warrant including the air pathway in the baseline risk assessment for the site.

The potential hazard index for adults for all volatile emissions is 0.11, which is below the threshold of 1. The potential hazard index for all fugitive dust emissions is 0.00002. The combination of these two release mechanisms has a total hazard index of 0.11. The total carcinogenic risk for the fugitive dust pathway is 9.12×10^{-7}. There are no carcinogenic chemicals present in the volatile emission pathway. The potential hazard indices and cancer risks for the industrial, trespassing, and farm/residential scenarios are provided in Tables 6-28 through 6-32 in Section 6.0 of the RI/RA Report.

These hazard index and carcinogenic risk estimates were calculated using worst-case assumptions in a screening analysis designed to yield conservative results which overestimate potential health impacts.

TABLE 6
PREDICTED RISK VALUES FOR VOLATILE CHEMICALS
ASSUMING FUTURE LANDUSE OF RESIDENTIAL OR AGRICULTURAL CATEGORIES
PADDYS RUN ROAD SITE

Chemical of Concern	Site Average (mg/kg)	Emission Rate (mg/m^3)	Intake Factor (adult) ($m^3/kg/d$)	Hazard Index	Carcinogenic Risk
Xylenes (Total)	3.34E-03	1.65E-06	2.73E-01	NA	NA
Cumene	4.72E-03	8.56E-07	2.73E-01	9.09E-05	NA
Mercury	4.41E-01	3.48E-05	2.73E-01	1.10E-01	NA
			Totals	1.10E-01	NA

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NA - Risk cannot be calculated because inhalation toxicity values are not available.

TABLE 7
PREDICTED RISK VALUES FOR FUGITIVE DUST EMISSIONS
ASSUMING FUTURE LANDUSE OF RESIDENTIAL OR AGRICULTURAL CATEGORIES
PADDYS RUN ROAD SITE

Chemical of Concern	Site Average (mg/kg)	Ei (mg/m^2 sec)	Predicted Concentration (mg/m^3)	Acceptable Air (mg/m^3)	Intake Factor (adult) (m^3/kg/day)	Hazard Index	Carcinogenic Risk
Xylenes (Total)	3.34E-03	1.89E-12	6.30E-11	NA	0.273	NA	NA
Cumene	4.73E-03	2.67E-12	8.92E-11	9.00E-03	0.273	9.47E-09	NA
Arsenic	1.18E+01	6.66E-09	2.23E-07	2.33E-07	0.273	NA	9.12E-07
Calcium	1.10E+05	6.21E-05	2.08E-03	NA	0.273	NA	NA
Copper	2.07E+01	1.17E-08	3.91E-07	NA	0.273	NA	NA
Magnesium	3.08E+05	1.74E-04	5.81E-03	NA	0.273	NA	NA
Mercury	4.41E-01	2.49E-10	8.32E-09	3.00E-04	0.273	2.65E-05	NA
Potassium	1.68E+03	9.48E-07	3.17E-05	NA	0.273	NA	NA
Sodium	1.01E+03	5.70E-07	1.91E-05	NA	0.273	NA	NA
					Total	2.65E-05	9.12E-07

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NA - Risk cannot be calculated because inhalation toxicity values are not available.

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CALCULATIONS OF VOLATILE ORGANIC EMISSIONS DURING SHOWERING

000491

Inhalation of ammonia during showering (Hypothetical Scenario)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.0348373414
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	795
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.000321
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0560868132
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.0211648352
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of benzene during showering (Hypothetical Scenario)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.0503649709
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	66
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00559
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0810857143
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.3685714286
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of cumene during showering (Hypothetical Scenario)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.0003010104
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	63
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.000035
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0004846154
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.0023076923
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of ethylbenzene during showering (Hypothetical Scenario)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.2203218339
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	251
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00643
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.3547098901
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.423956044
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

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Inhalation of toluene during showering (Hypothetical Scenario)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.2782673513
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	320
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00637
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.448
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.42
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of xylenes during showering (Hypothetical Scenario)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.060546083
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	63
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00704
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0974769231
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.4641758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

000497

Inhalation of benzene during showering (future scenario – well 700' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.2930079854
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	498
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00431
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.4717318681
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.2841758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of cumene during showering (future scenario - well 700' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.0270527085
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	µg/L	Ct	=	5662
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.000035
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0435538462
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.0023076923
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

000499

Inhalation of ethylbenzene during showering (future scenario – well 700' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	3.6506713436
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	µg/L	Ct	=	4159
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00643
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	5.877443956
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.423956044
<<---------- Constants ----------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of toluene during showering (future scenario – well 700' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	4.2783605259
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	4920
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00637
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	6.888
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.42
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

000501

Inhalation of xylenes during showering (future scenario - well 700' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	5.529875583
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	5754
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00704
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	8.9028923077
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.4641758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of benzene during showering (future scenario – well 1800' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.1859247458
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	316
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00431
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.2993318681
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.2841758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of cumene during showering (future scenario – well 1800' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.0164170093
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	3436
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.000035
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0264307692
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.0023076923
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of ethylbenzene during showering (future scenario – well 1800' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	2.1795183809
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	2483
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00643
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	3.5089428571
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.423956044
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

000505

Inhalation of toluene during showering (future scenario – well 1800' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	2.5252762129
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	2904
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00637
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	4.0656
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.42
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of xylenes during showering (future scenario - well 1800' downgradient)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	3.2262412812
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	3357
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00704
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	5.1941274725
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.4641758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of benzene during showering (future scenario - center of plume)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.6307320489
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	1072
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00431
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	1.0154549451
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.2841758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of cumene during showering (future scenario - center of plume)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	0.0234023607
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	4898
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.000035
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	0.0376769231
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.0023076923
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

000509

Inhalation of ethylbenzene during showering (future scenario – center of plume)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	6.5069551985
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	µg/L	Ct	=	7413
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00643
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	10.4759538462
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.423956044
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

Inhalation of toluene during showering (future scenario – center of plume)

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	10.4550261389
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	12023
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00637
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	16.8322
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.42
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

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Inhalation of xylenes during showering (future scenario – center of plume)

007361

2.2.1.1. Shower

ref. is Andelman, J.B., 1984; 1985a; 1985b

description	units	variable		value
<<---------- Output ---------->>				
average conc of a volatile compound in the shower air over a duration of ts minutes	mg/m3	Cs	=	10.0631434185
<<---------- Input Variables -->>				
time from beginning of shower	min	ts	=	12
flow rate of shower	L/min	Fw	=	8
conc in shower water	μg/L	Ct	=	10471
flow rate of air in shower	m3/min	Fa	=	2.4
volume of bathroom	m3	Vb	=	12
Henry's law constant for organic compound	m3-atm/mol	H	=	0.00704
<<---------- Intermediates (auto-calc) --->>				
asymptotic conc in air if shower ran for a long time	mg/m3	C_inf	=	16.201283516
rate constant for exponential function	1/min	k	=	0.2
efficiency of release of compounds from	-	E	=	0.4641758242
<<---------- Constants ---------->>				
efficiency of TCE release from water to air	-	E_TCE	=	0.6
Henry's law constant for TCE	m3-atm/mol	H_TCE	=	0.0091

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REV. 1: MAY 1994

APPENDIX L

TOXICITY PROFILE ASSESSMENT FOR PRRS CHEMICALS OF CONCERN

POTASSIUM HEALTH EFFECTS SUMMARY

ADDITIONAL TOXICOLOGICAL INFORMATION ON ARSENIC, BENZENE AND MANGANESE

TOXICITY PROFILE ASSESSMENT
FOR PRRS CHEMICALS OF CONCERN

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APPENDIX L
TOXICITY PROFILE ASSESSMENT
FOR PRRS CHEMICALS OF CONCERN

Summarized below is the available toxicological information for the chemicals of concern at the Paddy's Run Road Site. A brief toxicological evaluation is provided for the chemicals that have been evaluated quantitatively and qualitatively in the PRRS risk assessment. The purpose of the toxicological evaluation is not to conduct a comprehensive literature search and review, but to summarize available toxicological information on each chemical of concern in light of the exposure routes identified at the PRRS site. In compiling this information, emphasis was placed on authoritative reviews and reports where available. Available toxicity information is provided for various forms of each chemical; however, in some cases, this information may not be directly related to the chemical form found at PRRS. Nevertheless, such toxicity information is relevant for the conduct of the toxicity assessment and is included within this summary.

Each summary presents a brief description of the chemical and information on absorption, metabolism, excretion, acute and chronic toxicity, teratogenicity, mutagenicity and carcinogenicity. Ecological toxicity information, as available, is also provided to describe the potential effects associated with exposures of the chemicals of concern to flora and fauna found in the Study Area. Included at the end of these summaries is a glossary of toxicological terms and measurements to aid the reader in understanding the technical information presented. A bibliography follows the glossary.

Applicable standards, guidelines and toxicological criteria for the chemicals of concern are presented in Section 6 of the RI report.

Acetone

Acetone is a widely used industrial solvent as well as the basis for many solvents used domestically. Since it readily dissolves shellac, acetone has been used as the main ingredient for nail polish remover. It is not very toxic through this or other limited dermal applications, with the major drawback being drying and defattening of skin.

Exposure to high concentrations of acetone fumes can be narcotic, with the potential for coma and death. Chronic exposure to lower concentrations in air has been associated with central nervous system depression, although these effects are controversial. Since acetone is metabolized to 2-propanol in the liver, high concentrations may also be hepatotoxic. Perhaps the most subtle hepatotoxicity of

acetone occurs through its potentiation of liver toxicity by other hepatoxins, such as chloroform. In this regard acetone toxicity resembles chronic alcohol intoxication.

Since acetone is lipolytic, it may cause corneal dulling when splashed into the eye. This effect is reversible.

As a common metabolic intermediate, acetone is produced metabolically by most cells. Hence, its subtle introduction into environmental media is without adverse effect. The reference dose (RfD) for acetone has been set by EPA at 0.1 mg/kg/day.

Although acetone is highly soluble, it is not very toxic to aquatic organisms in the environment. Fortunately, acetone has a very low toxicity to ecosystems. The oral LD50 in rats is 10.7 ml/kg, a concentration which would only be realized in the environment under conditions of extreme contamination. Limited data are available for aquatic organisms. The 24-48 hour median threshold limit for *Daphnia magna* is reported at 10 mg/l and 5,500 for *Gammarus pulex*. The 96 hour LC50 for bluegill sunfish (*Lepomis macrochirus*) is 8300 mg/l (Verschueren, 1983). Since acetone does not bioaccumulate, and presumably would be quickly metabolized by intermediate organisms, there is minimal risk from human consumption of aquatic life which has been exposed to acetone (Howard 1990).

Aluminum

Aluminum is a silvery-white, flexible, amphoteric metal. It is a naturally occurring element found primarily in the ores cryolite and bauxite. It is nature's third most abundant metal and makes up about 8% of the earth's crust. Aluminum is never found naturally in the elemental state.

Daily exposure to aluminum is inevitable due to its abundance and ubiquitous occurrence in nature and its diverse use by man. Humans are exposed to aluminum through consumption of food and drinking water and inhalation of airborne dust particulates as well as through the use of such consumer items as antiperspirants, cosmetics, and antacids which contain aluminum compounds (ATSDR 1990). People normally consume about 10 milligrams of aluminum per day. The concentration of aluminum in natural waters and drinking water is generally below 0.1 ppm (ATSDR 1990).

Human and animal studies indicate that absorption is low following oral exposure. Absorption is affected by the chemical form of aluminum, by Vitamin D, parathyroid hormone, and by other ions. Human and animal studies give indirect evidence of absorption following inhalation exposure to aluminum. However, the rate and extent of absorption of inhaled aluminum have not been well determined.

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There is little to no data regarding dermal absorption of aluminum in humans or animals.

Aluminum is an element and is always found attached to other chemicals in the human body. Aluminum is believed to exist in four different forms in living organisms; as free ions, as low molecular weight complexes, as reversible macromolecular complexes, and as irreversible macromolecular complexes. The kidney is the major route of excretion of absorbed aluminum.

Aluminum is not believed to cause adverse health effects except at extremely high doses. Studies indicate that aluminum may be a lung irritant when inhaled. However, epidemiological studies have not determined aluminum to be the single causative agent in lung fibrosis found in workers exposed to aluminum dusts. These workers were also exposed to other occupational toxicants and many were cigarette smokers. Aluminum has not been found to cause adverse effects in humans through oral exposure. Aluminum is found in a variety of foodstuffs and drinking water. There is little indication that it is toxic by the oral route.

Aluminum has been associated with Alzheimer's disease in humans. It is not known whether aluminum is a causal agent in this neurodegenerative disease. A number of factors other than aluminum exposure are known to be associated with Alzheimer's, including genetic factors, viral infections, and immune system dysfunction (ATSDR 1990).

Bioconcentration of aluminum has been documented in several aquatic species. Brook trout accumulates more aluminum at pH 5.6 to 5.7 than at 6.5 to 6.6. Concentration in trout body tissue also decreases as the fish increases in age (ATSDR 1991).

Aluminum is fatal to laboratory animals at very high doses. The LD50 for rats given aluminum nitrate is 261 mg/kg and the chloride form is 770 mg/kg (ATSDR 1990).

Skin damage was reported on mice, rabbits, and pigs after 10% aluminum chloride and nitrate was applied to the skin (ATSDR 1990).

Ammonia

Ammonia is a colorless, strongly alkaline, and extremely soluble gas with a characteristic pungent odor. Ammonia is produced by both man and in nature. Ammonia is used as a nitrogen source for many nitrogen-containing compounds. It is used in the production of ammonium sulfate and ammonium nitrate for fertilizers and in the manufacture of nitric acid, soda, synthetic fibers, dyes, and plastics. Ammonia is very important for animal and human life. It is found in water, soil, and

air, and is a source of much-needed nitrogen for plants and animals. Most of the ammonia in the environment comes from the natural breakdown of manure and dead plants and animals.

Ammonia is primarily absorbed through inhalation and ingestion. Ammonia is not readily absorbed through the skin. Upon inhalation, ammonia is almost completely retained in the nasal mucosa and upper respiratory tract. Only small amounts of inhaled ammonia are absorbed into the systemic circulation. Ingested ammonia is readily absorbed from the digestive tract where it enters the portal circulation and is delivered to the liver. Ammonia is metabolized to urea and glutamine mainly in the liver. However, it can be rapidly converted to glutamine in the brain and other tissues as well. Ammonia that is inhaled is temporarily dissolved in the mucous of the airway, then a high percentage of it is released back into the expired air. Absorbed ammonia is excreted by the kidneys as urea and urinary ammonium compounds, as urea in feces, and as components of sweat.

Contact with anhydrous liquid ammonia or with aqueous ammonia solutions is intensely irritating to the mucous membranes , eyes, and skin. Inhalation of acute doses of anhydrous ammonia have caused blocked airways, respiratory failure, bronchopneumonia, and/or renal failure. Ingestion of lethal doses of ammonium compounds in animal studies has produced serious respiratory effects including increased rate and depth of respiration, pulmonary edema, and death by respiratory failure.

There are no recognized primary systemic effects from exposure to ammonia gas or ammonia solutions, most likely due to limited absorption and rapid metabolism. Repeated oral exposure to high doses of ammonium acidifying salts results in metabolic acidosis and secondary effects on bone and electrolyte metabolism. Prolonged exposures result in mild kidney injury. Other systemic effects that have been observed in animals exposed to ammonia include effects on the adrenal gland and weight loss. Extensive skin burns or injury to the respiratory or gastrointestinal tracts due to ammonia exposure may lead to secondary effects including infections and kidney failure.

No information was located regarding the developmental or reproductive effects of ammonia in humans or animals. No information was located regarding the genotoxicity of ammonia in humans. In vivo and in vitro animal data are inconclusive. Carcinogenic potential of ammonia has not been established in humans or animals. However, lifetime exposure studies have not been conducted for inhalation or dermal exposure.

Depending on the pH of the exposure medium, ammonia will exist as either the ammonium ion (NH_4^{+1}) or un-ionized ammonia (NH_3), or a combination of both forms. Un-ionized ammonia (NH_3) has been demonstrated to be the more toxic

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form of ammonia; therefore, the potential for ecotoxicity will be related to pH. Temperature has also been related to the toxicity of ammonia, but the available data on temperature effects are somewhat limited and variable. U.S. EPA (1986) indicates that ammonia toxicity apparently increases with decreasing temperature.

Antimony and Compounds

Antimony is a silvery white, soft metal that is insoluble in water and organic solvents. Antimony is widely used in the production of alloys. Pure antimony compounds are used as abrasives, pigments, flameproofing compounds, plasticizers, and catalysts in organic synthesis. Small amounts of antimony are present in the earth's crust and can enter the environment during the mining and processing of its ores.

No quantitative data are available regarding oral, dermal or inhaled absorption of antimony in humans. However, animal studies indicate that absorption does occur in the gastrointestinal tract and via the lungs. Absorption from the respiratory tract is a function of particle size. Differences among antimony compounds are related to the solubility of the compound. Animal studies suggest that certain forms of antimony are probably absorbed from the gastrointestinal tract. Absorption is likely to be affected by numerous factors including: chemical form, particle size, solubility, age and diet.

Antimony is a metal and, therefore, does not undergo catabolism in the body. The metabolism of antimony consists of interaction with sulfhydryl groups and phosphate and numerous, reversible binding interactions with endogenous ligands (e.g., proteins). Blood is the main vehicle for the transport of absorbed antimony. The major sites of accumulation are the liver, kidney, bone, spleen and thyroid. Antimony is excreted through both the urine and feces.

Adverse health effects have been observed in humans and animals following exposure to antimony and antimony compounds. Antimony compounds are generally less toxic than antimony. Antimony trisulfide, however, has been reported to cause myocardial changes in man and animals. Antimony trichloride and pentachloride are highly toxic and can irritate and corrode the skin. Antimony fluoride is extremely toxic, particularly to the lungs and skin. Antimony and its compounds are generally regarded as primary skin irritants. Lesions generally appear on exposed, moist areas of the body. Antimony trioxide causes a dermatitis known as "antimony spots." Pneumoconiosis, impaired pulmonary function and respiratory irritation have been observed in workers exposed to antimony dust. Alterations in EKG readings and increased blood pressure have been reported in workers exposed to antimony trioxide (Brieger et al. 1954).

Antimony induced pneumoconiosis is associated with serious lung pathology in animals and it is believed that, with sufficiently high or prolonged exposures, serious lung disease would occur in humans.

Acute oral antimony poisoning induces violent irritation of the nose, mouth, stomach, and intestines, bloody stools, slow, shallow respiration, pulmonary congestion, coma and, sometimes, death. Chronic oral poisoning present symptoms of dry throat, nausea, headache, sleeplessness, loss of appetite and dizziness. Liver and kidney degenerative changes are also late manifestations.

The likelihood of antimony induced developmental and reproductive effects in humans is not known. Because of limited in vitro genotoxicity data and little in vivo data, the genotoxicity of antimony in humans cannot be determined. No information of the carcinogenic potential of antimony in humans is available. Inhalation exposure to antimony trioxide or antimony trisulfide produced lung tumors in rats (Groth et al. 1986; Watt, 1983; Wong et al. 1979). Antimony has not produced cancer in rats or mice exposed by the oral route. No information of carcinogenic potential of antimony following dermal exposure is available.

Acute toxicity of antimony to an annelid, amphipod, caddisfly and rainbow trout does not occur below the limits of solubility of antimony salts (U.S. EPA 1988). Chronic effects were not reported for a freshwater invertebrate species (cladoceran) exposed to 2,940 ug/l or fathead minnows exposed to 1,130 ug/l. The lowest observed effect concentrations for these two species were 4,160 and 2,310 ug/l, respectively (U.S. EPA 1988). Negligible uptake of antimony was also reported for bluegill sunfish.

Arsenic

Elemental arsenic exists in several forms; the ordinary form is metallic or gray arsenic. Arsenic forms a steel gray crystalline mass with a metallic luster, is brittle and rather soft and is insoluble in water. The inorganic compounds (3+ or 5+) are usually colorless, water soluble crystalline solids or powders. The trioxide, calcium salts and the yellow-orange sulfides have a limited and low water solubility. Arsenic compounds are often unstable and are in many cases not well defined materials.

As a result of its natural occurrence, exposure to arsenic is universal (WHO/IPCS 1981). It is present in most foodstuffs in concentrations below 1 ppm. Arsenic can be found in some waters at naturally high concentrations.

Studies in experimental animals as well as in man have shown that over 90% of an ingested dose of dissolved inorganic trivalent or pentavalent arsenic is absorbed from the gastrointestinal tract. Particles containing inorganic arsenic which are

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inhaled will most likely be absorbed from either the respiratory or the gastrointestinal tract. Systemic toxic effects have resulted from occupational accidents where arsenic acid or arsenic trichloride have been splashed on workers, indicating that the skin is a possible route for absorption of arsenic (Ishinish et al. 1986).

No data are available which indicate long-term accumulation of arsenic. In-vivo methylation of inorganic arsenic has been demonstrated in both animals and man. Following ingestion or inhalation of inorganic arsenic, the major forms of arsenic excreted in human urine are dimethylarsinic acid and methylarsonic acid. Most studies indicate that elimination of arsenic, in both animals and man, takes place mainly via the kidneys.

The acute toxicity of arsenic depends on the solubility of the administered compound. Common acute symptoms includes, inflammation of the lining of the stomach, fever, insomnia, anorexia, liver swelling, and disturbed heart function. Peripheral nervous disturbances, primarily of sensory types, are frequently encountered in individuals surviving acute poisoning, and there also may be transient effects on the blood.

Chronic arsenic toxicity is chiefly related to the skin, mucous membranes, lungs, gastrointestinal and nervous systems. Involvements of the circulatory system and liver are less common. The skin is a common critical organ in humans exposed to inorganic arsenicals. Chronic arsenic poisoning from ingestion of contaminated food, beverages, and water has resulted in skin lesions as well as vascular disorders resulting in gangrene of lower extremities, commonly called Blackfoot disease. In occupational exposure, skin lesions are frequently found in the palm of the hand and on the sole of the foot. An allergic type of contact dermatitis is also frequently seen among workers exposed to arsenic trioxide. Hyperkeratosis, warts, and melanosis of the skin are the most commonly observed lesions in chronic exposure. Anemia, disturbance of the hematopoietic system, conjunctivitis and perforation of the nasal septum have also been found with occupational exposure to arsenic-containing dust.

Arsenic has been classified as a Group A human carcinogen. Arsenic has been found to induce several types of skin cancer with epithelioma as the most common. Studies of smelter worker populations have found an association between occupational arsenic exposure and lung cancer mortality. Both proportionate mortality and cohort studies of pesticide manufacturing workers have also shown excess lung cancer deaths among exposed workers (Ott et al. 1974; Mabuchi et al. 1979). There seems little doubt that exposure to arsenic by inhalation increases the risk of lung cancer. However, a strong multiplicative effect of arsenic exposure and smoking has been unequivocally established (Pershagen et al. 1981).

Available literature indicates that arsenite (As^{3+}) is more toxic to aquatic organisms than arsenate (As^{5+}). In the aquatic environment, toxicity could be abated by the oxidation of As^{3+} to As^{5+} under aerobic conditions or increasing pH. Arsenic is lipophilic and has been detected in muscle tissue. The half-life of arsenic in the muscle tissue of green sunfish (*Lepomis cyanellus*) was reported as seven days (EPA 1978, EPA 1980). Overall, arsenic does not usually accumulate at appreciable levels in freshwater species.

Arsenic as an herbicide is toxic to certain plants. Certain algae are affected by both arsenate and arsenite compounds.

Chronic toxicity data are limited for arsenic. No data regarding arsenic's effects on terrestrial species were identified.

Barium

Barium is a yellowish-white metal of the alkaline earth group which occurs in nature chiefly as barite ($BaSO_4$) and witherite ($BaCO_3$), both of which are highly insoluble salts. Barium is stable in dry air, but readily oxidizes in humid air or in water. Industrial applications of barium salts include metallurgy, paints, glass making, electronics and medicine.

Soluble barium salts are readily absorbed from the digestive system as well as from all segments of the respiratory tract. Barium sulfate, however, is virtually insoluble and is therefore not readily absorbed following ingestion or inhalation. As with other alkaline earth metals, barium accumulates in the skeletal system, preferentially onto bone surfaces (Elsser et al. 1969). The availability of barium for bone uptake is greater than that of either calcium or strontium (Domanski et al. 1980). Barium is not bioaccumulated. Of excreted barium, 90% is found in the feces.

The basic mechanisms of barium toxicity appear to involve antagonism to potassium, the latter, of course, being an essential element in cellular osmotic balance and therefore central in many homeostatic functions, including neurotransmission.

The symptoms of barium poisoning are muscular stimulation followed by paralysis. In severe cases respiratory paralysis is sufficient to cause death by asphyxiation. The acute oral LD_{50} in humans has been estimated to be 70 mg/kg.

Barium-containing dusts have been associated with a form of pneumoconiosis termed "baritosis." This has been seen among workers chronically exposed to barium sulfate dust and is accompanied by slightly diminished pulmonary function.

Rats given radioactively-tagged barium sulfate particles by intratracheal administration have been reported to develop bronchiogenic carcinoma (Amber and Watson 1958). However, these experiments are unconvincing, both on the basis of increases which are not 95% statistically significant and that there were no controls for radiation carcinogenesis alone in the absence of barium.

It should be noted that barium is a prevalent contaminant of the average human diet. It is found naturally almost everywhere calcium is found (ubiquitously) and travels similarly to calcium through the food chain. Some foods (especially brazil nuts) are quite high in barium, and the average human diet has been reported to contain 1 mg barium per day (Schroeder et al. 1972).

Experimental data indicate that the soluble barium salt concentration in freshwater supplies would have to exceed 50 mg/l before aquatic life is adversely affected. When combined with sulfate and carbonate anions to form insoluble salts, the potential toxicity is reduced.

Mortality has been observed after acute and chronic exposures of barium chloride and barium acetate to test animals. One acute toxicity study reported LD50 values of 269 and 277 mg/kg for male and female rats, respectively. Intermediate and chronic affects from oral exposure to barium in experimental animals is generally associated with cardiovascular effects, specifically an increase in blood pressure. However, another study with rats exposed to intermediate and chronic oral doses of barium chloride and carium acetate in drinking water did not result in any changes to the heart weight or any gross or microscopic lesions of the heart (ATSDR 1991). No dermal studies were found.

Benzene

Benzene is a clear, colorless, volatile and highly flammable liquid. It has widespread use in a variety of manufacturing processes and is a constituent of motor fuel. Benzene is also widely used as a solvent and as a chemical intermediate.

Benzene may be absorbed by inhalation, ingestion and upon skin contact. However, experimental investigations have shown dermal absorption to be slow, and in most situations inhalation is by far the most important route of absorption. Benzene is rapidly distributed throughout the organism and - as with other lipophilic solvents - preferentially concentrated in fatty tissues. In mammals, including man, an appreciable fraction of the absorbed dose (10-50%) is excreted unchanged in the expired air. Benzene is metabolized by oxidation to an unstable epoxide (principally in the liver). The metabolites are excreted in the urine. The elimination of benzene

from the mammalian organism is relatively rapid and most of the absorbed dose is excreted within 48 hours following acute exposure.

Benzene displays a low acute toxicity in mammals. It exerts mainly a narcotic action at high concentration levels in both animals and man. Signs of acute toxicity include central nervous system depression: staggering walk, stimulation followed by drowsiness, and coma followed by respiratory failure and circulatory collapse. Chronic intoxication in man may give rise to severe bone marrow toxicity, eventually resulting in leukemia.

Benzene - or more probably hydroquinone - a metabolite of benzene, inhibits maturation of early blood cell precursors in the bone marrow. It has long been recognized that benzene, upon long-term exposure of man and experimental animals to high concentrations, may elicit signs of severe damage to the blood system including anemia, reduced number of circulating white blood cells and platelets. These effects are accompanied by clinical signs like general weakness, pallor, and an increased susceptibility to infection. The bone marrow may exhibit increased or decreased cell production. A number of fatal cases of aplastic anemia (pancytopenia) due to exposure to benzene have been reported in the literature.

Epidemiologic studies have shown that exposure of workers to benzene is associated with increased risk of aplastic anemia and of leukemia (IARC 1982; Infante 1978; Infante and White 1983; Grossenbacher and Lob 1982; Decoufle et al. 1983; Aksoy 1985; Infante and White 1985; Rinsky et al. 1987). Benzene-associated leukopenia has been reported in humans, AKR/S mice, CD mice and Wistar rats.

Negative results have been obtained with benzene in the Ames' Salmonella test, using a number of different tester strains. However, this compound seems to induce chromosome aberrations and sister chromatid exchanges in mammalian cells in vitro, and a number of positive reports have been published on an increased incidence of such aberrations in bone marrow cells of mammals.

Evidence from experimental animals indicate that benzene may cause toxic effects to the fetus at 50 ppm and above. However, there seem to be no evidence that benzene is teratogenic.

Benzene is considered a proven human carcinogen. The association between chronic occupational exposure to high concentrations of benzene and the development of leukemias - mainly acute myelogenous leukemia - has been firmly established. The carcinogenic action of this compound has also been corroborated by findings in experimental animals.

Benzene may cause adverse effects on aquatic life, with acute toxic responses elicited in freshwater aquatic species at concentrations as low as 5.3 mg/l (U.S.

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EPA, 1986). Although benzene is only slightly soluble and highly volatile, there is a cycling that occurs between the atmosphere and the water, which may provide a means for prolonged bioavailablity. Numerous studies have been performed on single species exposed to benzene in laboratory media; however, insufficient data exist regarding the effects of benzene contamination on the higher levels of the ecosystem.

Benzene has inhibited cell multiplication in the bacteria *Psuedomonas putida* at 92 mg/l, in the algae, *Microcystis aeruginosa* at > 1400 mg/l, in the green algae, *Scenedesmus quadricauda* at >1400 mg/l and in the protozoans *Entosiphon sulcatum* and *Uronema parduczi* at >700 mg/l and 486 mg/l, respectively (Verschueren 1983; Canada EPS 1984).

Benzene exposure caused an inhibition of photosynthesis through decreased carbon fixation in the algae, *Selenastrum capricornutum*. A 48-hour EC50 values of 525 mg/l was reported for an alga, *Chlorella vulgaris*. Growth inhibition was observed in a marine dinoflagellate, *Amphidinium carterae*, in a diatom, *Skeltonema costatum*, and in an alga *Circosphaera carterae*, at benzene levels between 10 and 1000 mg/l (Canada EPS 1984).

Benzene is lipophilic and may bioaccumulate in organisms where the target tissues are the brain, liver, and any tissue with high lipid content. Benzene has been reported to accumulate in fish tissue at levels 1000 times the concentration in the ambient environment.

In laboratory studies with invertebrates, the *cladocerans*, *Dauphin magna* and *D. pulex* reached LC50 concentrations at 178 and 265 mg/l, respectively (U.S. EPA 1980). LD50 values of 59 ppm and 210 ppm were reported for mosquito larvae (4th instar) and grain weevils, respectively.

Fish species appear to be more susceptible to the toxic effects of benzene than invertebrates. The early life stages in fish development and salmonid species are more sensitive to benzene than adults or non-game fish (i.e. catfish, suckers, etc.). An LC50 values of 12 mg/l was reported for a one hour static bioassay with brown trout (*Salmo trutta*) yearlings. Exposure of herring (*Clupea pallasi*) and anchovy (*Engraulis mordex*) larvae to benzene caused a delay in larvae development, decrease in feeding and growth, and an increase in respiration rate at 10-35 ppm. Delayed egg development and abnormal larvae occurred at 35-45 ppm. Young coho salmon (Oncorhynchus kisutch) exposed to benzene in artificial seawater, experienced no significant mortalities at 10 ppm after 96 hours, 60% mortality at 50 mg/l after 24 to 96 hours, and 100% mortality at 100 mg/l after 24 hours (Verschueren 1983).

In a softwater static bioassay, Pickering (1966) determined the 28- 48- and 96-hour Median Tolerance Limit (TLm) for fathead minnows were 35.5 mg/l, 35 mg/l and 33.5 mg/l. Pickering conducted the same test in hardwater and reported 24- 48- and 96-hour TLm's for bluegills (*Lepomis macrochirus*) were all 22.5 mg/l. Additional studies of bluegills exposed to benzene revealed a 24- and 48-hour LD50 of 20 mg/l. The 96-hour LC50 for the channel catfish (*Ictalurus punstatus*) and rainbow trout (*Salmo gairdneri*) were reported as 425 mg/l and 9.2 mg/l, respectively (Canada EPS 1984). The difference in LC50 values for these two fish species support the postulate that salmonids are considerably more sensitive to benzene contamination than rough fish species.

Gross Beta

Gross Beta is a light-particle electron, which carries a single negative charge. Risks from radioactive compounds are different than other chemical substances. Radioactivity presents a health risk because radioactive materials emit particles or waves that can damage or kill living cells. Alpha particles cannot penetrate the skin, but once absorbed, through inhalation or ingestion, they can travel short distances in the body causing cell destruction. Gamma rays is another type of radiation hazard. Gamma rays can penetrate the skin and pass into the body. Radiation dose to the body or internal organs is measured in rads or rems. Rads indicate absorbed dose, which is the amount of radiation imparted to body tissue. The rem is a dose unit that accounts for the relative effectiveness of the particular type of radiation for causing biological effects. A rem = a rad x Q, where Q is the quality factor that accounts for the type of radiation.

Cadmium

Cadmium and cadmium compounds have a moderately acute toxicity by ingestion and inhalation. Cadmium is excreted very slowly, thus, accumulation in the body after chronic may cause several severe toxic reactions in humans. The primary target organ from ingestion is the kidney. Inhalation of cadmium over long periods of time may result in emphysema. There is some evidence of lung cancer in heavily exposed workers.

Acute cadmium exposure through inhalation to high concentrations induces chemical pneumonitis and sometimes pulmonary edema. Gastroenteritis may result from acute intoxication by ingestion.

Chronic cadmium intoxication appears after long-term low level exposure. After inhalation, a chronic obstructive lung disease develops (at 100 ug/m3) as well as renal tubular dysfunction (20-50 ug/m3). Other symptoms may include mild anemia

and liver function disturbances. The kidney is the organ most affected by cadmium where aminoaciduria, glucosuria and phosphaturia have been documented.

Cadmium compounds are poorly absorbed from the gastrointestinal tract, ranging from 4-7%. Animal studies and available data on humans indicate that absorption is high when inhaled in the form of aerosols or fumes. Uptake through the skin appears to be negligible.

Cadmium is considered a B1 carcinogen by the U.S. EPA. Intramuscular injections of cadmium compounds in rats showed a rise in sarcoma at the site of injection. In a study conducted by Tanaka et al. (1983) rats were exposed to cadmium chloride aerosols at concentrations ranging from 12.5 to 50 ug/m^3. A significant increase in the incidence of carcinomas of the lung was observed. This study was used to derive the carcinogenic slope factor for cadmium compounds.

Cadmium is considered to be one of the most toxic metals in the aquatic environment; however, the availability and toxicity is dependent on the chemistry of the system. Toxicity is affected by the ionic form, the presence of other pollutants, the presence of other stressors (such as low dissolved oxygen, low pH) and the fitness of the organism.

Cadmium is readily accumulated by marine and freshwater species through both food and water with either producing a toxic response. In fish, cadmium tends to accumulate in the kidney and liver. Chronic low levels may cause nephrotic damage, decreases in reproductive success, decreased growth, and disruption of enyzmatic activity (Phillips 1980). Oxygen uptake may be decreased by the presence of cadmium thereby facilitating death.

Finfish are more sensitive to cadmium in the larval stage of development than in either egg and adult stages. Freshwater fish are more susceptible than marine species (Moore and Ramamoorthy 1984).

Calcium

Calcium is a silver-white, soft alkaline earth metal found naturally only in the form of its compounds, never in its elemental form. It reacts with water, alcohols or acids to liberate hydrogen and can develop explosive pressure in containers. It is an essential constituent of bones, shells and teeth. Calcium constitutes approximately 2% of the human body. Ninety-nine percent of the calcium of the body is present in the bones and teeth. The remaining 1% of calcium is widely distributed in the soft tissues and the extracellular fluids.

Absorption of calcium salts occurs in the upper part of the small intestine. Only 20 to 30% of the calcium in the average diet is absorbed from the intestinal tract and taken into the bloodstream. Calcium absorption is dependent upon the calcium needs of the body, the type of food and the amount of calcium ingested. After absorption through the intestines, most of the calcium is stored in the bones, especially the spongy bones, from which it is withdrawn in time of need. Excess calcium is excreted in the feces, urine and sweat.

Calcium deficiency can result in stunting of growth, poor quality bones and teeth, malformation of bones (rickets), and kidney stones. Excess calcium in the blood may lead to pathological calcification of the kidneys and other internal organs. Continuous high dietary calcium intake may cause a hypersecretion of calcitonin and bone abnormalities such as osteopetrosis (dense bone). High calcium intakes have also been associated with the formation of kidney stones.

The toxicity of calcium varies widely based on the calcium compound. Therefore, without specific data regarding the chemical form of the calcium compound, a comprehensive toxicological assessment cannot be made.

Calcium and, to a lesser extent, magnesium are the predominant dissolved cations in freshwater and are primarily responsible for water hardness. Hardness values measured in Paddys Run during the PRRS RI were all above the 300 mg/l (as $CaCO_3$) threshold for very hard water. According to Sprague (1985), hard water streams are productive; therefore, these naturally dissolved salts are not harmful to aquatic organisms. Associated with these cations are higher levels of carbonates, bicarbonates and some sulfates which are active in complexing metals and reducing metal cation bioavailability. Further, calcium is an important mineral nutrient for osmoregulation in aquatic organisms.

Chloride

Compounds of chloride ions vary widely in form and toxicity, with the chloride ion posing little, if any, toxicity. Sodium chloride (table salt) has a very low toxicity and carbonyl chloride (phosgene) is extremely toxic in small doses. Without specific data regarding the chemical form of the chloride, a comprehensive toxicological assessment cannot be made.

Chromium

Chromium is a steel gray, lustrous metal. Chromium may exist in one of three valence states in compounds, 2+, 3+ and 6+. The biological activity of chromium

is dependent on its valence state. Hexavalent chromium is, in general, considerably more toxic than the metal in its trivalent state.

Chromium compounds are poorly absorbed from the human gastrointestinal tract. Only about 0.5-3% of the total intake of trivalent chromium is absorbed from the gastrointestinal tract. Oral absorption of hexavalent chromium seems to be somewhat greater. In the form of respirable particles, inhaled chromium compounds are trapped in the lung tissues, and the concentration of this metal increases with age in the lungs. Larger particles are moved to the larynx by ciliary action and will be ingested. Soluble chromates are more rapidly cleared from the lungs to other tissues than trivalent chromic chloride. Chromium absorbed from the gastrointestinal tract is transported by plasma proteins, and is subsequently accumulated in bone, spleen, testes, and epididymis of experimental animals; much less is retained in liver, lungs, brain, heart, and pancreas. Absorbed chromium is mainly excreted with the urine.

Hexavalent chromium is reduced to the trivalent state upon contact with biological material during its passage through membranes and cells. Therefore, it may be difficult to toxicologically distinguish between these two oxidation states.

The acute oral toxicity of chromium compounds to humans is not accurately known. A dose of 50-70 mg/kg of soluble chromates has been judged to be lethal for an adult (IPCS, 1988). There are some indications, however, that children may be more sensitive (Kaufman et al. 1970). Corrosive ulceration in the gastrointestinal tract after ingestion of concentrated solutions may considerably increase absorption, and enhance the toxic action of hexavalent chromium. Due to its corrosive properties, concentrated solutions of hexavalent chromium compounds may induce local as well as systemic toxic effects upon direct contact with skin and mucous membranes.

Hexavalent, and possibly to a lesser degree trivalent chromium, induce irritant as well as allergic dermatitis in man. A number of reports on occupational dermatitis has been published where sensitization to Cr^{6+} has occurred as a result of long-term exposure to products (e.g., cement) contaminated with low concentrations of the metal.

When inhaled in significant concentrations, hexavalent chromium compounds cause severe irritation of the respiratory tract. Ulceration and perforation of the nasal septum have occurred frequently in workers chronically exposed to chromates and similar compounds. Rhinitis, bronchospasm, pneumonia, and emphysema accompanied by impairment of pulmonary function may result from chronic exposure to hexavalent chromium.

Because Cr^{6+} can cross both the outer plasma membrane and the nuclear membrane of the cell before being reduced, it may readily cause DNA-damage intracellularly. A large number of chromium compounds have been assayed in in-vitro genetic toxicology assays. In general, hexavalent chromium has been found to be mutagenic in bacterial assays, whereas trivalent chromium has not. Likewise Cr^{6+}, but not Cr^{3+}, was found to be mutagenic in yeast and in V79 cells.

The carcinogenic properties of chromium compounds have been extensively investigated in mice, rats and rabbits. In rodents, calcium chromate induced bronchial carcinomas and intramuscular sarcomas. Similarly, the chromates of strontium and zinc have been demonstrated to induce bronchial carcinomas in rats after intrabronchial implantation. Injection site sarcomas were produced in rats and mice after intramuscular, intrapleural or subcutaneous injections of chromite ore, strontium chromate, chromium trioxide, lead chromate and zinc chromate. Few or no sarcomas were induced by barium chromate, sodium chromate or dichromate. No adequate support for carcinogenic activity has been obtained in experimental animals for trivalent chromium. In addition, evidence of carcinogenicity is lacking for chromium compounds (tri- as well as hexavalent) administered by the oral route (IARC 1980, 1987).

There is clear evidence from epidemiological investigations that long term inhalation exposure to hexavalent chromium is associated with an increased incidence of bronchiogenic carcinoma. A number of epidemiological studies in the U.S., Great Britain, Japan, and West Germany have demonstrated an increased risk of lung cancer among workers engaged in the bichromate-producing industry as well as in the manufacture of chromate pigments. There is also evidence of a similar risk among chromium platers and chromium alloy workers. The latent periods have been estimated to vary from 10 to 20 years (IARC 1980, 1987; IRIS 1988).

An increased incidence of tumors at other sites has occasionally been reported for chromate paint workers (gastrointestinal tract), chromate-pigment users (stomach and pancreas), as well as chrome platers (gastrointestinal tract). Since the observed incidences are small, the significance of these findings need further verification (IARC 1987).

Although a clear distinction between the relative carcinogenicity of chromium compounds of different oxidation states or solubilities has been difficult to achieve, it is commonly believed that trivalent chromium lacks significant carcinogenic activity in humans (IPCS 1988; NRCC 1984). Further, available evidence seems to indicate that hexavalent chromates of intermediate solubility, like zinc chromate, have the highest carcinogenic potency (NRCC 1984).

In general, toxicity for most microorganisms occurs in the range of 0.05 - 5 mg chromium/kg of a specific medium. Trivalent chromium is less toxic than

hexavalent. Biological oxidation by microorganisms in sewage sludge has been reported to be adversely affected by as little as 50 ppm Cr^{3+}, or by 5 ppm Cr^{6+} (NRCC 1976). Invertebrate species, such as insects and crustaceans, are more sensitive than vertebrates such as fish. Exposure of salmon fingerlings to 0.2 ppm Cr^{6+} for 12 weeks in stream water resulted in a 53% lethality, while the same concentration of the trivalent chromium was below the mortality threshold (EPA 1986).

Cobalt

Cobalt is a silver-grey, hard, brittle, magnetic metal. Mineral sources of cobalt include; arsenides, sulfides, and the oxidized forms. Cobalt is insoluble in water but soluble in acids. Cobalt is a component of Vitamin B12 and is therefore an essential element found in most body tissues. Because it is a metal, cobalt is not metabolized. Pharmacokinetic data in humans indicate that cobalt is absorbed through both the lungs and the gastrointestinal tract. Cobalt is distributed throughout the body with highest concentrations found in the liver. The major route of excretion of cobalt is through the feces.

The primary target organ systems affected by cobalt in humans are the respiratory system following inhalation, the cardiac and hematopoietic systems following oral exposure and the immunological system following dermal exposure.

Oral cobalt exposure in humans and/or animals results in respiratory, cardiovascular, gastrointestinal, hematological, muscoloskeletal, liver, kidney, vision, thyroid, hypothermic, and body weight effects. Beer-cobalt cardiomyopathy was observed in people who heavily consumed beer containing cobalt sulfate as a foam stabilizer (Alexander 1969, 1972; Morin et al. 1971).

Chronic occupational exposures to cobalt have led to respiratory irritation, wheezing, asthma, pneumonia and eventually, fibrosis. Since cobalt dust is usually combined with other dusts, the role cobalt plays in these effects are not quantified. Occupational exposure to cobalt dust has also been shown to cause cardiomyopathy, characterized by functional effects on the ventricles and enlargement of the heart (Barbouk and Dusek 1972; Horowitz et al. 1988). The exposure level associated with these effects have not been determined.

Cobalt dust is mildly irritating to the eyes and to a lesser extent, the skin. It is an allergen and has caused dermatitis in occupational exposures.

No studies are available regarding the genotoxicity and reproductive toxicity of cobalt in humans. Oral studies in male animals have demonstrated adverse effects

on the reproductive system. There is no evidence that cobalt causes cancer by the oral, inhalation or dermal routes.

Information regarding the ecotoxicity of cobalt is limited. While higher animal forms require cobalt (vitamin B_{12}) for blood formation (Schmidt-Neilsen 1983), it is uncertain whether excess cobalt could elicit an adverse response, or at what level such a response would occur. It should be noted that cobalt deficiency has been documented to cause severe anemia in range animals, a problem that has been contraindicated with dietary cobalt amendments. Neither U.S. EPA nor Ohio EPA has developed criteria for cobalt.

Copper and Compounds

Copper is a reddish-brown metal which occurs free or in ores such as malachite, cuprite, and chalcopyrite. Copper is naturally occurring in plants and animals and is an essential element for all known living organisms. Metallic copper is an excellent conductor of electricity and is widely used in the electrical industry. Copper forms many important alloys including brass and bronze. Copper is widely used in insecticides, algicides, fungicides, and molluscicides.

Copper is an essential element and is necessary for good health. However, very large single or daily intakes of copper can be harmful. Copper is absorbed in the stomach and small intestines. The amount of copper absorbed is inversely related to the amount of copper present in the gastrointestinal tract. No studies are available regarding the rate and extent of absorption following inhalation and dermal exposure. Absorbed copper loosely binds to plasma albumin and amino acids in the blood and is transported to the liver where it is stored bound to metallothionein and amino acids. Bile is the major pathway for the excretion of copper.

Acute oral poisoning results in gastrointestinal irritation including: vomiting, nausea, diarrhea and anorexia. Cell damage in the liver and kidney have been observed in individuals dying from copper poisoning. Hematological effects have also been observed in humans exposed to high levels of copper. Dermal exposure to copper results in contact allergic dermatitis in some individuals.

Inhalation of high concentrations of copper fumes and dust result in irritation of the upper respiratory tract, nausea and in some instances discoloration of the skin and hair. Inhalation of dusts, fumes and salts may cause congestion of the nasal mucous membranes.

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Chronic copper toxicity results in hepatotenticular degeneration (Wilson's disease), a genetic disorder that affects normal copper homeostasis. The disease is characterized by excessive absorption, retention and storage of copper by the body.

Developmental and reproductive effects have not been observed in humans; however, they have been demonstrated in animal studies. There are no data on the mutagenicity of copper in humans; however, in vivo studies and mammalian system in vitro studies suggest that copper is a potential human carcinogen. An elevated incidence of cancer has not been observed in humans or animals exposed to copper via inhalation, oral, or dermal routes of exposure.

Copper is ranked second to mercury in the magnitude of its ecotoxic effects on aquatic organisms. The principal toxic copper species is cupric ion (Cu^{2+}), although two hydroxyl complexes ($CuOH^{1+}$) and $Cu2OH2^{2+}$) have also proven to be toxic (Howarth and Sprague 1978). The toxicity of copper in water is controlled primarily by alkalinity (which includes hardness), dissolved oxygen, chelating agents, humic acids, pH and suspended solids. In studies using several fish species, the maximum tissue concentrations of copper were detected in the liver, followed by the gill, kidney and muscle. In chronic studies encompassing a complete life cycle, brook trout (*Salvelinus fontinalis*), fathead minnows (*Pimephales promelas*), and bluegills (*Lepomis macrochirus*) were most sensitive to copper in their early life stages (larval and juvenile). In addition to its effects on survival, copper also produces deleterious results in growth and reproduction. Inhibition of spawning and marked decreases in egg hatchability were observed in fish exposed to copper concentrations of 162 ug/l and 32 ug/l, respectively (U.S. EPA 1980).

According to freshwater data, the lowest copper concentration at which acute or chronic effects may occur is 10 ug/l. LC50 values for freshwater invertebrates range form 5 ug/l (*Daphnia hyalina*) to 9,300 ug/l for the snail (*Amnicola lycorias*). Additionally, copper sulfate, which inhibits photosynthesis and plant growth, has been an important biocide used to control algae blooms in nutrient-sensitive waters. In aquatic ecosystems, copper contamination generally occurs in a melange with other heavy metals. The association of these trace metals with other zenobiotics poses the additional complexities of synergistic, antagonistic and additive toxic responses (U.S. EPA 1980).

Cumene (Isopropylbenzene)

Isopropylbenzene, also known as cumene, is a colorless liquid with a relatively high boiling point and low vapor pressure. It is soluble in many organic solvents but is insoluble in water. Cumene is a naturally occurring constituent of crude oil and as such is a minor component of finished hydrocarbon fuels. Cumene is also used in

the production of acetone, phenol, and alpha-methyl styrene and as a solvent. It is used as a thinner for paints and lacquers and as a component of high-octane aviation fuel.

Available data indicate that cumene is absorbed following oral, dermal, and inhalation exposure. Cumene is metabolized in a variety of species primarily to glucuronide conjugates. Cumene is excreted in the urine.

Cumene has a relatively low order of acute toxicity based on reported lethality studies. Acute oral LD_{50} values reported for rats range from 1400-2900 mg/kg. Cumene may cause irritation of the eyes and mucous membranes upon dermal contact. Inhalation of high concentrations results in dizziness, incoordination, and unconsciousness.

Animal studies have shown that inhalation of cumene results in narcosis which is characterized by slow induction and long duration, suggesting a cumulative action. Chronic studies in animals have shown evidence of hyperemia and congestion of the lungs, liver, and kidneys with no evidence of hematologic abnormalities.

Cumene was reported to be nonmutagenic both in the presence and absence of metabolic activation when tested by the Salmonella microsome assay in several strains. Negative results were also reported in mitotic recombination assays.

There have been no chronic toxicity and teratogenicity, reproductive effects testing of orally administered cumene. In addition, no health advisories or carcinogenicity references exist for cumene at this time.

Cumene may be released to the environment from production or processing of petroleum products; however, little information is available regarding its ecotoxicity. Most studies performed have involved a single species tested under laboratory conditions. The lowest reported toxic concentration for fish is reported an LC50 of 20-30 mg/l for fathead minnows (*Pimepahles promelas*). Several other studies have been conducted reporting variable results. In these tests, the cumene solutions were aerated, probably leading to volatilization, thus reducing the exposure concentration. Little information is available for chronic toxicity of cumene to aquatic organisms. However, one study reported that concentrations up to 50 mg/l did not significantly affect the mussel, *Mytilus edulis* (U.S. EPA 1987). One study on a terrestrial species, *Agelaius phoeniceus* (red-winged blackbird), reported an LD50 of 98 mg/kg (Schafer 1983). Cumene may only slightly bioaccumulate in animal tissue.

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2,4-Dimethylphenol

2,4-Dimethylphenol (2,4-DMP) is a colorless crystalline solid with a melting point of 27° to 28° C. The 2,4 isomer is one of five isomers of this compound. 2,4-DMP is used commercially as a chemical feedstock or constituent for the manufacture of a wide range of commercial products for industry and agriculture. It is used in the manufacture of phenolic antioxidants, disinfectants, solvents, pharmaceuticals, insecticides, fungicides, plasticizers, rubber chemicals and others. 2,4-DMP is a naturally occurring, substituted phenol derived from the cresol fraction of petroleum or coal tars by fractional distillation and extraction (Verscheren 1983).

There is very little data available regarding the toxic effects of 2,4-DMP. As a phenol, 2,4-DMP is expected to be a contact irritant to the eyes, mucous membranes and skin. Adverse health effects in humans following oral exposure have not been located. The oral LD_{50} is 809 mg/kg in mice and 3200 mg/kg in rats. The dermal LD_{50} is 1040 mg/kg in mice. 2,4-DMP was tested for mutagenicity in the *Salmonella* microsome preincubation assay using the standard protocol of the National Toxicology Program and results were negative.

In a dermal carcinogenicity study in mice, 2,4-DMP was found to be carcinogenic, but only in the presence of an initiator. 2,4-DMP appears to be a topical cocarcinogen, but its role as a primary cancer-producing agent is uncertain. EPA has not classified 2,4-DMP regarding its carcinogenicity.

2,4-Dimethylphenol is released to the environment as fugitive emissions from coal tar refining or other related processes. Although 2,4-dimethylphenol may adsorb onto soil or sediment particles, it is not expected to significantly bioconcentrate in fish species. The log bioconcentration factor in *Lepomis macrochirus* (bluegills) was reported at 1.18 after a flow through 28 day study. In aquatic species, toxicity appears to be low to moderate. The LC50 in *Pimephales promelas* (fathead minnow) is reported as 1 mg/l after a 96 hour flow-through study. The LC50 for *Lepomis macrochirus* (bluegill) is reported at 7,750 ug/l after a static 96-hour study (U.S. EPA, 1980). The LC50 for *Lemina minor* (duckweed) is reported at 292,800 ug/l in a 48-hour static test.

Ethylbenzene

Ethylbenzene is a colorless, aromatic liquid used primarily in the production of styrene; in gasoline; and as an industrial solvent. It is volatile and only slightly soluble in water.

Ethylbenzene may be absorbed through oral, dermal and inhalation routes of exposure. The major metabolites of ethyl benzene differ for humans and rodents.

The major metabolites in humans are mandelic acid and phenylglyoxylic acid, which are minor metabolites in rats and rabbits.

Ethylbenzene is an irritant of the skin and mucous membranes. Target organs for acute, high-level exposure are the lungs and central nervous system. However, chronic, low-level exposures result in effects on the visceral organs.

No data are available implicating ethylbenzene as a carcinogen. Both ethylbenzene and its common metabolites have produced negative responses in mutagenicity assays. There is no conclusive evidence implicating ethylbenzene as a reproductive or developmental toxin.

Ethylbenzene is widely distributed in the environment but there is a limited amount of information available on its ecotoxicity. All studies on ethylbenzene have been performed utilizing single species in laboratory situations; therefore, the ramifications of ethylbenzene contamination on the higher levels of the ecosystem are currently unknown.

Although ethylbenzene has not demonstrated the properties of bioaccumulation and bioconcentration, it has been reported to elicit some toxic responses in aquatic life at low concentrations. In tests conducted with microorganisms, ethylbenzene inhibited cell multiplication in bacteria (*Pseudomonas aeruginosa*) at 12 mg/l; algae (*Microcystis aeruginosa*) at 33 mg/l; green algae (*Scenedesmus quadricauda*) at 160 mg/l; and protozoa (*Entosiphon sulcatum*) at 140 mg/l (Canada EPS 1984). However, no adverse impacts on cell number or chlorophyll 2 production were reported for *Selenastrum capricornutum* or *Skeletonema costae* at ethylbenzene concentrations up to 438 mg/l (U.S. EPA 1980).

Magnesium

Metallic magnesium is a silvery-white crystal or metal with a melting point of 651°F and a boiling point of 1107°F. The density is 1.74 at 5°C, and the vapor pressure is 1 mm of mercury at 621°F. Magnesium is an essential mineral that accounts for about 0.05% of the body's total weight. Nearly 60% of this is located in the bones in the form of phosphates and carbonates, while 28% of it is found in the soft tissues and 2% in the body fluids.

Thirty to fifty percent of ingested magnesium is absorbed in the small intestine. Magnesium is generally reabsorbed in the kidneys, thus minimizing the loss of body reserves. The main route of excretion of magnesium is the urine.

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Magnesium is involved in many functions, it is a constituent of bones and teeth, it is and essential element of cellular metabolism, and it acts as an enzyme activator. Magnesium also relaxes nerve impulses and muscle contraction.

A deficiency of magnesium is characterized by muscle spasms and rapid heartbeat, confusion, hallucination, and disorientation, lack of appetite, listlessness, nausea, and vomiting. Magnesium deficiency has been observed in alcoholics, in severe kidney disease, and acute diarrhea. An excess of magnesium upsets calcium and phosphorus metabolism. Symptoms of chronic, excessive magnesium intake include slowed breathing, coma, and sometimes death.

Manganese

Manganese is a reddish-grey or silvery soft metal. It decomposes in water and is soluble in dilute acid. Most of the manganese produced is used in the iron and steel industry. Although manganese does not occur naturally as a free metal, it is ubiquitous in the environment where it is cycled between the atmosphere, land surfaces, aquatic systems and the ocean. Manganese is an essential micro-nutrient for plants and animals.

The respiratory and gastrointestinal tracts constitute the major routes of absorption of manganese. Although quantitative data are not available, it seems highly unlikely that the skin is an important route of absorption for inorganic manganese. The degree of absorption upon ingestion appears to be below 5% in healthy adults, but there is evidence of a considerably higher absorption rate with iron deficiency. The extent of absorption of manganese following inhalation is evidently considerable but is not accurately known. A certain percentage of manganese particles is evidently removed by mucociliary clearance and swallowed.

Manganese is transported in the plasma and widely distributed throughout the body, where it is mainly found in the liver, pancreas, kidney, and in the intestines. Manganese penetrates the blood-brain barrier as well as the placental barrier. The normal brain load is low, but since the retention time is long, manganese is progressively accumulated in this organ after high-level exposure. Urinary excretion is low, and absorbed manganese is mainly secreted with the bile to the intestinal tract.

The acute toxicity of manganese compounds to mammals is low. The chronic toxicity aspect of manganese compounds is considerably more serious. Irreversible toxic effects on the central nervous system have been induced in various animal species, including the rat and monkey, mainly by the administration of manganese dioxide or dichloride. Symptoms of CNS-toxicity, including tremor, instability and paralysis of the hind limbs are often present. Biochemical and histopathological

changes have been reported in other organ systems, notably the liver. Pulmonary lesions, like inflammatory changes and fibrosis, have been described upon high level exposures to manganese oxide. Testicular changes have been induced in the rat upon intravenous administration of high doses (50 mg/kg) of permanganate.

Typical signs of central nervous system effects have been induced by the inhalation exposure of monkeys to manganese dioxide aerosol at concentrations of 0.8-3.0 mg/m^3 for 95 one hour periods over 4 months. Administration by the oral route seems far less effective, presumably because of poor gastrointestinal absorption. Signs of neurotoxicity have only been observed upon oral exposure to very high concentrations.

In humans, an increased morbidity and mortality rate from pneumonia has been described among workers occupationally exposed to high levels of manganese containing dusts, and there are reports of populations living close to manganese-emitting plants that have exhibited an increased incidence or respiratory disease. However, it is difficult to determine to what extent other confounding factors have been involved.

An irreversible chronic manganese intoxication syndrome, known as manganism - and which resembles Parkinson's disease - has been known for a considerable time to occur among workers employed in mining, ore-processing plants, and in ferromanganese plants. The clinical signs of this poisoning, characterized by both psychiatric and neurological manifestations may develop after only a few months of exposure.

Little information is available concerning the mutagenicity of manganese. Whereas manganese deficiency may cause malformations in experimental animals, there seem to be no adequate evidence of teratogenic activity (IPCS 1981). Manganese is essential for normal development of the fetus and the newborn. In experimental animals deficiency will cause skeletal abnormalities and impaired growth in mice, rats, rabbits, and chickens (IPCS 1981).

Studies on induction of tumors following subcutaneous, intramuscular, or intraperitoneal injection of manganese compounds have been reported (Sunderman et al. 1974 and 1976; DiPaolo 1964; Furst 1978) and manganous sulfate has also been tested in a mouse lung adenoma screening bioassay (Stoner et al. 1976). However, no convincing evidence of carcinogenicity has been obtained from these investigations. Further, there seem to be no epidemiological indications of such effects. In view of the fact that no long-term oral or inhalation study of experimental animals that would fulfill present day requirements seems to have been conducted, the data base must be considered inadequate to evaluate the potential carcinogenic action of inorganic manganese.

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Manganese is a vital micronutrient for both plants and animals. In acid soils, concentrations of slightly less than 1 mg/l to a few milligrams per liter may be toxic to plants, but hardly so at a neutral or basic pH. In its divalent state, manganese usually has a low toxicity to aquatic organisms. Permanganates have been reported to be lethal to fish at 2-4 ppm (8-18 hrs), but permanganates are rapidly reduced in the presence of organic matter and are not persistent. Tolerance values reported for various manganese compounds range from 1.5 ppm to over 1,000 ppm (McKee and Wolf 1963).

Manganese is rarely found in freshwater at levels above 1.0 mg/l, while the tolerance limits range from 1.5 to over 1,000 mg/l (U.S. EPA 1976; 1986). Thus, manganese is not expected to yield adverse effects in aquatic systems. Higher organisms appear to homeostatically regulate manganese while lower organisms (algae, molluscs) may bioconcentrate high levels (U.S. EPA 1984).

Mercury

Mercury is a silvery-white, heavy, liquid metal. It is used in electrical apparatus, as a liquid cathode in cells and in control instruments (switches, thermometers and barometers).

Conversion of biochemical forms of mercury is central to the toxicity of this metal. Elemental mercury is oxidized, predominantly by catalyses, to form the divalent cation (inorganic), which in turn may be reduced back to the metallic state under appropriate conditions. The other fate of divalent inorganic mercury in methylation to CH_3HgCH_3 (dimethyl mercury), most often by anaerobic bacteria. This form of organic mercury is by far the most dangerous environmentally.

Although the toxic manifestation of the various forms of mercury are solely due to its cationic (metal) component, the partitioning of these compounds in and out of cells and within tissues is mainly a manifestation of with which anions mercury is complexed (Suzuki 1977; Berlin 1983; Clarkson 1983). Inhaled elemental mercury vapors easily cross the alveolar walls and equilibrate with lipoproteins in blood. Ingested elemental mercury, however, is minimally absorbed (about 0.01 percent). Inorganic salts (mercurous or mercuric) are absorbed 700 times better by the gastrointestinal tract (7%), while methyl mercury is absorbed at 90-95% (Goyer 1986). The more absorbable forms of mercury also partition better to red blood cells.

Inorganic mercury mainly accumulates in kidneys, whereas organic mercury is found mostly accumulated in brain tissues. It is this "organ-targeting" by the anionic component which characterizes the variable toxicities of mercury salts. Mercury possesses a high central nervous system toxicity at low levels of exposure. Perhaps

more than any other substance, mercury manifests different degrees of toxicity depending upon its biochemical state.

Elemental mercury vaporizes at room temperature. Hence, most human exposure to elemental mercury is via inhalation. Inhaled mercury vapor is corrosive and, if intense enough, first yields bronchitis and pneumonitis and eventually CNS effects, such as tremor and excitability. Chronic exposure to vaporized elemental mercury profoundly affects the CNS as a syndrome termed "asthenic-vegetative" (Friberg and Vostal 1972). Adverse effects, in addition to tremor, are thyroid enlargement as well as increased iodine uptake, increased heart rate, skin rashes, gingivitis and hematologic changes. Fine motor functions begin to decline first then tremors extending to all muscular control. Personality changes include excitability, depression, hallucinations and delirium. Frequently, these bouts are devoid of recall.

Mercuric salts are corrosive when ingested resulting in abdominal cramping, bloody diarrhea and urinary suppression (Goldwater 1972). If concentrated, ingestion leads to death in 24 hours mainly due to kidney damage.

Mercurous salts are less soluble in water and therefore less corrosive than mercuric salts. Chronic use of mercurous salts may result in hypersensitivity of mucous membranes and skin known as "pink disease" (Matheson et al. 1980).

Methyl mercury is well-known epidemiologically from major environmental spills in Minamata Bay and the Agano River, Japan (WHO 1976). During the Minamata and Agano epidemics, fresh fish contained an average of about 10 mg/kg methyl mercury and were the major source of human exposure. Many persons suffered profound paralysis and/or partial or complete losses of hearing, speech and/or vision. For reasons that are not well understood, some portions of the cerebral cortex appear selectively sensitive to chronic low levels of alkyl mercury poisoning (Clarkson 1983). Other epidemics have occurred in Iraq after wheat preserved as seed stock with methyl mercurial fungicide was inadvertently used to bake bread, resulting in 500 deaths and 6000 hospitalizations (Bakir et al. 1973) and in Pakistan in 1963 and Guatemala in 1966 (Goyer 1986).

Under most conditions, organic mercury is more toxic to aquatic plants than inorganic forms. Growth inhibition by mercuric chloride may occur at concentrations of 2-250 ug/l (Moore and Ramamoorthy 1984). Fish tend to be more resistant, and molluscs and crustaceans tend to be more sensitive to the acute toxic effects of mercury. Mercuric chloride had 24-hr LC50 values of 0.4 mg/l and 0.08 mg/l, respectively to goldfish (Spehar et al. 1982).

Bioconcentration factors of mercury for freshwater fish range from 180 for Rainbow trout to 4,994 for fathead minnows.

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Black ducks fed a diet containing 3 ppm of mercury experienced decreased hatchability of eggs and poor duckling survival (Finley and Stendell 1978). Concentrations of methyl mercury at 1 ppm resulted in increased growth of mice but decreased fertility and viability of offspring (EPA 1978). Spontaneous hypertensive rats were fed oral concentrations of 2 mg/kg/day of methylmercury chloride for 26 days. Neurological disturbances in male rats began after 23 days with all males succumbing after 29 days. Neurologic disturbances began in the female rats on day 30 or 31 with no deaths occurring (Tamashiro et al. 1986).

2-Methylphenol/4-Methylphenol

2-Methylphenol, which is also known as o-Cresol and 4-Methylphenol which is also known as p-Cresol, are crystalline substance that darkens with age. O-Cresol has a melting point of 30.9^{o} C and a boiling point of 191^{0} C. P-Cresol has a melting point of 34.7^{o} C and a boiling point of 85.7^{o} C. Cresols have a medicinal smell and when dissolved in water, have a medicinal taste. Cresols are natural products that are present in many foods and in animal and human urine. They are present in wood and tobacco smoke, crude oil, and coal tar.

There are no studies available regarding the toxicokinetics of any of the cresols. The occurrence of coma, death, and systemic effects in two humans dermally exposed to cresols indicates that these compounds can be absorbed through the skin.

The existing information on the health effects of cresols in humans comes almost entirely from case reports of people who either swallowed cresol-containing substances or had these substances spilled on them. The primary targets for cresol toxicity in humans appear to be the blood, kidneys, and nervous system. Acute effects have been reported when humans ingested high concentrations of cresols. LD_{50} values in animals were 1,350, 1800 and 2,020 mg/kg for o-, p- and m-cresol, respectively. The lethal oral exposure level for humans appears to be at or above 2 g/kg based on crude estimates of cases of accidental or intentional ingestion of cresol-containing formulations. Death following cresol exposure is apparently caused by intravascular hemolysis and thrombosis. When inhaled as a concentrated aerosol, o-cresol is a respiratory irritant in humans.

When exposures are extended form the acute to intermediate range, o-cresol appears to be substantially more toxic than p- and m-cresol. No studies were located regarding the developmental, reproductive or genotoxic effects of cresols in humans. Animal studies have shown that exposure to o- and p-cresols at maternally toxic doses result in mild fetotoxic effects. The genotoxic effects of cresols have been well studied. Test results in mammalian cells indicate that cresols, with the possible exception of the m-isomer, can react with the DNA of humans and other

mammals to produce genotoxic effects in vitro. In vivo tests of sister chromatid exchange in the bone marrow, alveolar macrophages, and regenerating liver of mice were negative for all three isomers. No studies were located regarding cancer in humans following oral, dermal or inhalation exposures.

Cell multiplication inhibition tests on were reported as follows: the bacteria (*Pseudomonas putida*) 33 mg/l of 2-methylphenol, 53 mg/l of 3-methylphenol; algae (*Mycrocystis aeruginosa*) 6.8 mg/l of 2-methylphenol, 13 mg/l of 3-methylphenol; and the protozoan (*Entosiphon sulcatum*) 17 mg/l of 2-methylphenol, 31 mg/l of 3-methylphenol.

The TLm (24-96 hour) test in hard water for fathead minnow is reported at 18.0 - 13.4 mg/l of 2-methylphenol. The 96-hour TLm for bluegill is reported at 10-13.6 mg/l of 3-methylphenol.

The LD50 for rats exposed to 2-methlyphenol is 1.35 g/kg and 0.8 g/kg for rabbits. Exposures of 3-methylphenol to rats resulted in a LD50 of 2.02 g/kg and 1.1 g/kg in rabbits (Verscheren 1983).

Nickel

Nickel is a hard, ductile, magnetic metal with a silver-white color. It is insoluble in water and soluble in acids. Nickel is found in nature as a component of silicate, sulfide, or occasionally, arsenide ores. Nickel may occur in many oxidation states, the most prevalent being Ni^{2+}. Nickel forms alloys with copper, magnesium, zinc, chromium, iron, etc. Stainless steel is the most commonly used nickel alloy. Exposure to nickel occurs in manufacturing processes, mining, smelting, and refining operations. The route to which the general population is most commonly exposed to nickel is through food. Routes of nickel intake for man and animals are inhalation, ingestion and percutaneous absorption.

In experimental animals about 10% of ingested nickel is absorbed, while in man even lower amounts appear to be taken up in the diet. Absorbed nickel is carried by the blood. It is rapidly cleared from plasma and subsequently eliminated predominantly within urine. A secondary route of excretion is via perspiration.

Insoluble nickel deposited in the lungs is very slowly absorbed with accumulation over time. Animal data indicate that rate of clearance depends on the compound solubility with inert compounds having slower clearance and more rapid clearance with the soluble nickel salts. Dermal absorption of nickel occurs and is related to nickel-induced hypersensitivity and skin disorders; however, the extent to which nickel enters the bloodstream by way of the skin is not clear.

The most acutely toxic nickel compound is nickel carbonyl, $Ni(CO)_4$. Acute nickel carbonyl poisoning is clinically manifested by constrictive chest pain, dry coughing, hyperpnea, cyanosis, gastrointestinal symptoms, sweating and severe weakness. The lung is the target organ in nickel carbonyl poisoning.

Nickel dermatitis and other dermatological effects have been documented with both occupational exposure and in the general population (jewelry, coins, tools, cooking utensils).

Exposure to nickel has been shown to cause both reproductive and developmental effects in experimental animals; however, such effects have not been noted in man. Teratogenic effects of nickel carbonyl in mammals have been demonstrated in two rodent species.

Various inorganic compounds of nickel have been tested for mutagenicity and other genotoxic effects; however, the evidence that nickel may induce mutations is fairly weak.

There is evidence in both humans and animals for the carcinogenicity of nickel. Occupational exposure to nickel fumes or dust has been shown to cause respiratory and nasal cancers in workers (Doll et al. 1977). Laryngeal cancers may also be increased among nickel workers (Dedersen et al. 1978). Other cancers have also been reported to be increased in epidemiologic studies of refinery workers exposed to nickel, including gastric and renal carcinomas and soft tissue sarcomas. There is no evidence for nickel carcinogenicity by ingestion.

In aquatic systems, the divalent cation (Ni^{2+}) is the dominant species of nickel; however, the formation of inorganic salts or organic complexes may enhance or reduce toxicity.

Bioconcentration of nickel into biota is not a significant process. Similar to other metals, low levels of nickel may be controlled homeostatically; however, exceedance of this system may lead to liver and kidney damage. Aquatic plants have shown growth inhibition when exposed to nickel concentrations as low as 100 ug/l. Acute toxicity of *Daphnia magna* and the stonefly have been reported from 510 to 33,500 ug/l (EPA 1980). LC50 values for fish species range from 2,840 ug/l for the rock bass to 46,200 ug/l for the banded killfish. Water hardness seems to decrease toxicity where bluegills exposed to nickel in hard and soft water reached LC50 concentrations at 39,600 ug/l and 5,720 ug/l, respectively (EPA 1980).

Phenol

Phenol is a white, crystalline solid which, in liquid form, has a characteristic sweet odor. It is highly water soluble with low volatility. It is used in the manufacture of phenolic resins and other chemicals. It is also used as a disinfectant in germicidal paints and slimicides.

Phenol is absorbed readily following inhalation, oral and dermal routes of exposure. There is no evidence in humans of distribution of phenol once absorbed. Animal studies indicate that orally administered phenol is distributed rapidly with peak tissue concentration achieved in most tissues within 1 hour of dosing. Highest concentration were found in the liver; with >90% of the administered dose eliminated from tissues within 24 hours. Many different tissues contribute to the metabolism of phenol. The metabolites formed depend on the dose level as well as on the metabolic pathway utilized. Conjugation with sulfate and glucuronide can be considered competitive metabolic pathways in most mammalian species. Phenol is excreted primarily in the urine.

Phenol vapors are an irritant of the eyes, mucous membranes and skin. The skin is a primary route of entry for the vapor, liquid, and solid forms. The vapor readily penetrates the skin with an absorption efficiency equal to that for inhalation. Skin absorption can occur at low vapor concentrations. Contact with the solid or liquid form of phenol can also result in chemical burns. Erythema, edema, tissue necrosis, and gangrene have also been reported, and prolonged contact with dilute solutions may result in deposition of dark pigment in the skin.

The acute toxicity of phenol is similar in humans and animals regardless of the route of exposure, and phenol is rapidly absorbed via all major exposure routes. In acute poisoning in humans, the heart rate is initially increased and then slows and becomes irregular; blood pressure increased initially and rapidly decreased, followed by salivation, labored breathing and eventually death by respiratory failure.

Chronic inhalation studies in animal models and human epidemiologic data are lacking for phenol. Renal toxicity has been reported in laboratory animals for all routes of exposure, but has not been reported in humans. Developmental effects have not been determined in humans. Animal studies indicate fetal toxicity at doses below those that resulted in maternal toxicity. Teratogenic effects were observed only at dose levels that resulted in maternal toxicity. Both negative and positive genotoxicity results have been reported for phenol. Due to the positive results reported in in-vivo genotoxicity studies, phenol may have some genotoxic potential. No evidence was found for carcinogenicity of phenol in humans. In an NCI study of rats and mice, a significant increased incidence of tumors occurred in male rats exposed to the lowest dose level, but not in the high-dose group. Since tumors occurred only in males in one of the two species tested and a positive dose-response

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relationship was not established, this study does not provide sufficient evidence to conclude that phenol is carcinogenic when administered by the oral route.

Phenol is a common industrial chemical and may enter the environment from wastewater discharges and/or spills. The bioconentration factor ranges from 1.9 in goldfish to 200 in a species of algae. Toxicity also appears to be low. The LC50 for rainbow trout ranged from 5.6 to 11.3 mg/l in a 24-hour static bioassay while the LC50 for the fathead minnow ranged from > 50 mg/l in a 1-hour bioassay to 32 mg/l in a 96-hour static bioassay using Lake Superior water. Studies on *Daphnia magna* reported TLm ranging from 16 mg/l to 100 mg/l after a 25 to 50-hour bioassay. Phenol was toxic to an algae, *Chlorella pyrenoidosa*, at 233 mg/l (Verschueren, 1983).

Phosphorus/Phosphoric Acid

White phosphorus is either a yellow or colorless, volatile, crystalline solid which darkens when exposed to light and ignites in air to form white fumes and greenish light. Phosphorus exists in nature only in combined forms, usually with calcium, in such sources as bone and rock phosphates. White and red phosphorus are used in the manufacture of munitions, pyrotechnics, and explosives. Organic phosphate is used in artificial fertilizers, rodenticides and in nerve gas production. Organic combinations of phosphorus are constituents of the body's cells and fluids.

Inorganic phosphorus compounds are variable in toxicity. Most inorganic phosphates have low toxicity but in large doses they may cause serious disturbances, particularly in calcium metabolism. Phosphorus is closely associated with calcium in human nutrition. Both function in the major task of building bones and teeth; are related to vitamin D in the absorption process; both are regulated metabolically by the parathyroid hormone and calcitonin and both exist in the blood serum. Phosphorus comprises about 1% of the adult body weight. Eighty percent of the phosphorus is in the skeleton, in inorganic combination with calcium. The remaining 20% is distributed in the soft tissues.

Phosphorus is absorbed primarily in the upper small intestine. The amount absorbed is dependent on several factors, such as source, calcium/phosphorus ratio, intestinal pH, lactose intake, and dietary levels of calcium, phosphorus, vitamin D, iron, aluminum , manganese, potassium, and fat. Seventy percent of ingested phosphorus is absorbed and 30% is excreted in the feces. Phosphorus is absorbed as inorganic salts.

Phosphorus absorbed from the intestine is circulated through the body and is readily withdrawn from the blood for use by the bones and teeth during periods of growth. Phosphorus is excreted primarily through the kidneys.

Phosphorus is essential to life. It is found throughout the body in every cell and is involved in almost all metabolic reactions. Phosphorus deficiency is rare. Severe deficiencies may be manifested in rickets and phosphorus related diseases. There is no known phosphorus toxicity per se. However, excess phosphate consumption may cause hypocalcemia (a deficiency of calcium in the blood) and result in enhanced neuroexcitability, tetany, and convulsions.

For humans, white phosphorus is acutely toxic via dermal, oral, subcutaneous, and inhalation routes of entry. If white phosphorus is ingested, it can be absorbed from the gastrointestinal tract or through the lungs. It is acutely toxic via ingestion with a probable lethal dose of less than 5 mg/kg for a 70 kg person. Acute ingestion affects the liver, kidney, hematopoietic system, brain, intestines, circulatory system and the myocardium resulting in electrocardiographic changes (Davidson et al. 1987). Deaths usually occur within the first 24 hours. Dermal contact with white phosphorus results in severe burns. White phosphorus fumes cause severe eye irritation.

Chronic absorption of small amounts of phosphorus can result in necrosis of the mandible or lower jaw (phossy jaw). Cases of this disease have been observed in workers in the phosphorus match industry, firecracker manufacture, and white phosphorus production. The disease often takes years to develop and its pathogenesis currently is uncertain. Long-continued absorption, particularly through the lung and the gastrointestinal tract, can cause chronic poisoning. This gives rise to a generalized form of weakness demonstrated by anemia, loss of appetite, gastrointestinal weakness and pallor. There are no animal or human data available on the carcinogenicity of phosphorus.

The acute toxicity of phosphoric acid is an inhalation TClo of 100 mg/m^3 in humans producing irritating effects. The oral LD50 for rats is 1530 mg/kg and the dermal LD50 for rabbits is 2740 mg/kg. Phosphoric acid is considered moderately toxic through oral and dermal routes. It is used a a common food additive.

Phosphorus as phosphate is an important nutrient required for plant growth and is essential for all life; whereas, elemental phosphorus can be toxic and bioaccumulate (U.S. EPA 1986). The focus of water quality information regarding phosphorus relates to accelerating nuisance plant growth, rather than direct toxicity to aquatic life.

To this end, Ohio Water Quality Standards have indicated that total phosphorus shall be limited to the extent necessary to prevent nuisance growth of algae, weeds, and slimes. To attain this goal, point source discharges shall not exceed a daily average total phosphorus concentration of 1.0 mg/l. While this criterion is of limited significance for an ephemeral, lentic ecosystem, which discharges to a major river, it will be used for screening purposes in the RA for the PRRS.

PAHs (Polynuclear Aromatic Hydrocarbons)

The polynuclear aromatic hydrocarbons (PAHs) constitute a class of compounds which exist in a wide variety of forms from naphthalene, which contains only two fused benzene rings, to complex polycyclics which contain ten or more benzene rings.

PAHs can be formed in any hydrocarbon combustion process. The less efficient the combustion process, the higher the PAH emission factor. PAHs are also released in large quantities during coal conversion or combustion. They are found in cigarette smoke, automobile exhaust and suspended air particulates in urban environments. PAHs are also major constituents of tar and asphalt. PAHs occur ubiquitously in the environment. Ingestion of food constitutes a primary source of exposure to humans. Benzo(a)pyrene (BaP) is the prototypic member of the PAHs. BaP is the most extensively studied PAH and is also the most hazardous.

The metabolism of PAHs is complex. Metabolism of PAHs occur in a number of tissues like the liver, bronchus, epithelium, esophagus, kidney, colon, placenta and the skin. It has been observed that PAHs are highly soluble in adipose tissue and lipids.

The acute toxicity of PAHs is moderate to low. The main concern related to this group of substances has been the established carcinogenic properties of several members of this category. Some complex mixtures (mineral oils, shale-oils, coal tars, coke oven emission) containing PAHs are proven human carcinogens. In addition, carcinogenic PAHs exhibit several other toxicological effects including bone marrow depression, immuno-toxicological, teratogenic as well as fetotoxic effects.

Several PAHs are strongly implicated in the proven association between smoking and lung cancer, between occupational exposure to coke-oven emissions, coal-tar, pitch, mineral oils and similar products and cancer of the skin, lung, bladder, and gastrointestinal tract. However, because of the fact that exposure involves complex mixtures where, clearly, there is interaction between a number of initiators and promoters, it is more difficult to assess the activity of individual members of this group.

Table 1 summarizes the evaluation of carcinogenicity of individual PAHs by the Carcinogen Risk Assessment Verification Endeavor (CRAVE) and IRIS.

BaP has been shown to be a local, as well as a systemic carcinogen by several routes of administration. It is well known as a complete carcinogen when applied to the skin of mice, rats and rabbits. Subcutaneous or intramuscular benzo(a)pyrene

injection has been shown to result in local tumors in mice, rats, guinea pigs, monkeys and hamsters.

The acute toxicity to aquatic life occurs at concentrations as low as 300 ug/l and may occur at lower levels for those species that are more sensitive than those tested. No data are available concerning the chronic toxicity of PAHs to sensitive saltwater species (U.S.EPA 1986).

Pyrene and other mildly aromatic small PAHs (such as naphthalene) are quite noxious to insects and may be used as repellants. Higher concentrations of vapors in a confined area may be lethal to insect larval development.

The primary response in vertebrates to PAH intoxication is the induction of microsomal oxidase. This occurs mainly in the liver, hence, chronic intoxication with PAHs may eventually lead to hepatotoxicity.

Potassium/Potassium - 40

Potassium, an essential nutrient, has an established adequate daily requirement of 3500 mg/day for adults. Of the three isotopes of potassium, potassium-40 is the only radioactive form and is present in its natural abundance of 0.012%. The human body cannot biochemically discriminate between the specific isotopes of potassium, thus the uptake and removal mechanisms are identical for all isotopes (Trinity Engineering and MAI 1994).

The natural body content of potassium remains constant throughout the adult lifetime. Under normal circumstances, additional intake of potassium is not cumulative over any period because the body regulates the potassium content continuously. Through homeostasis any increase in intake is balanced with a rapid removal of excess potassium from body fluids. The residence time of excess potassium is negligible due to the homeostatic process (Trinity Engineering and MAI 1994).

Absorption of ingested potassium is very efficient; more than 90% is absorbed. Absorption takes place primarily in the small intestine. The kidneys provide the major regulatory mechanism for maintaining potassium balance. Excess potassium is excreted in the urine and feces. Potassium, along with sodium, are closely interrelated in the maintenance of proper osmotic pressure within cells. Both are involved in the maintenance of proper acid-base balance and the transfer of nutrients in and out of individual cells. Potassium is also required for the secretion of insulin by the pancreas, in enzyme reactions, carbohydrate metabolism and protein synthesis.

Table 1

Carcionogenicity of PAHs
As Evaluated by CRAVE and Listed in IRIS*

PAH Compound	Classification	Weight of Evidence
Acenaphthylene	D	Not Classifiable
Anthracene	D	Not Classifiable
Benz(a)anthracene	B2	Probable
Benzo(b)fluoranthene	B2	Probable
Benzo(k)fluoranthene	B2	Probable
Benzo(a)pyrene	B2	Probable
Benzo(ghi)perylene	D	Not Classifiable
Chrysene	B2	Probable
Dibenz(ah)anthracene	B2	Probable
Fluoranthene	D	Not Classifiable
Fluorene	D	Not Classifiable
Indeno(123-cd)pyrene	B2	Probable
Naphthalene	D	Not Classifiable
Phenanthrene	D	Not Classifiable
Pyrene	D	Not Classifiable

* Carcinogen Risk Assessment Verification Endeavor
Integrated Risk Information System

Potassium deficiency may cause rapid and irregular heartbeats, abnormal electrocardiograms, muscle weakness, irritability, occasional paralysis, nausea, vomiting, diarrhea and swollen abdomen. Hypokalemia, a decreased serum potassium, is a prolonged wasting disease with tissue destruction and malnutrition and is caused by prolonged gastro-intestinal loss of potassium as in diarrhea, vomiting, or by continuous use of diuretic drugs. In extreme cases, the heart muscle may stop. Excessive levels of potassium interfere with magnesium absorption. Large excesses of potassium may also slow the heart to a standstill when the kidneys are unable to excrete the surplus in the urine.

The toxicity of potassium compounds is always that of the anion. Potassium pyrophosphate has an acute LD50 of 1600 mg/kg for mice. It is moderately toxic through the oral route for humans. Potassium hydroxide has an acute LD50 of 365 mg/kg in rats and is considered to be highly toxic to humans through the oral route as well as exposures to skin, eyes and mucous membranes.

Potential health effects of potassium are further described in the Potassium Health Effects Summary, which is provided separately in this appendix. The discussion details the homeostatic process that occurs in the body to regulate internal levels of potassium. Sensitive populations (i.e., those who may be affected by increased levels of potassium) are also discussed.

Potassium-40 is a primordial, long-lived radionuclide of potassium which occurs naturally in the environment. It is abundant and ubiquitously distributed in living and nonliving matter. Potassium-40 has a half-life of 1.26×10^9 years. It is homogenously mixed with stable potassium. Due to its ubiquitous distribution, abundance, and penetrating gamma rays, potassium-40 accounts for a significant fraction of the natural background radiation exposure.

A detailed discussion of potassium and potassium-40 is provided in Appendix N.

Potassium-40 is chemically analogous to the essential nutrient element and will tend to follow the ecological movement of the nutrient analog (Whicker and Schultz 1982). The isotopic difference between potassium-40 and stable K is so slight that behavior is essentially identical and the isotopic abundance is preserved in biotic and abiotic materials.

Sodium and Sodium Compounds

Sodium is a soft, ductile silvery-white metallic element. In its elemental form, it is highly reactive, especially with moisture with which it reacts violently to yield NaOH. Metallic sodium reacts exothermally with the moisture of body or tissue surfaces causing thermal and chemical burns.

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Sodium, in the form of sodium chloride, is the primary form of sodium in the human diet. The body contains about .2% sodium. Approximately 50% of the sodium is in the extracellular fluids, 40% is in the skeleton, and only about 10% is within the cells.

Virtually all sodium ingested in the diet is readily absorbed from the gut, following which it is carried by the blood to the kidneys, where it is filtered out and returned to the blood in amounts needed to maintain the levels required by the body. Excess sodium is excreted by the kidneys as chloride and phosphate.

Sodium is the major positively charged ion in the fluid outside the cells , where it helps to maintain the balance of water, acids, and bases. Sodium is also a constituent of pancreatic juice, bile, sweat, ant tears. Sodium deficiencies are rare but may occur due to heavy, prolonged sweating, diarrhea, vomiting, or adrenal cortical insufficiency. Excess sodium may be toxic when accompanied by a restriction of water, when the body is adapted to a chronic low salt diet or when fed to infants or other whose kidneys cannot excrete the excess in the urine.

Sulfates

The characteristics and toxicological properties of sulfates are highly variable and depend on the material (cation) with which the sulfate (anion) is combined. Therefore, the sulfates are not assessed as a group.

All species of aquatic biota must tolerate a range of dissolved solids (salts) concentrations to survive the inherent natural variability of water chemistry. The problem of osmoregulation is for aquatic organisms to maintain the proper salt concentrations in their body fluids when these levels almost invariably differ from those of the surrounding environment (Schmidt-Nielsen 1983). In areas such as Paddys Run where total dissolved solids (TDS or salinity) does not vary greatly, changes in salinity can act as a barrier to the distribution of many species. The fish species identified in Paddys Run are representative of active osmoregulators whose internal salt content exceeds the external environment and must be actively maintained.

Tentatively Identified Compounds (TICs)

A variety of TICs were identified in the Study Area; however, as described in Section 4.4, the detections of these compounds are considered as estimates of the identification and quantification. In addition, toxicity information for most of the

estimated TICs is not available. However, general toxicity information may be acquired from similar constituents that are included within the qualitative toxicity.

Toluene

Toluene is a clear, colorless, flammable, noncorrosive liquid with a sweet, pungent, benzene-like odor. It is a monocyclic aromatic compound used in the manufacture of benzene. It is also commonly used as a solvent, in chemical feeds and as a component of automotive and aviation fuels.

Due to its small size and lipophilicity, toluene is readily absorbed through the respiratory and gastrointestinal tracts and, to a somewhat lesser extent, through the skin. Experimental animals exposed to high concentrations of radiolabelled toluene orally or though inhalation accumulated unmetabolized chemical in adipose tissue and bone marrow and metabolic products of toluene in their liver and kidneys.

Although toluene and benzene differ by only a methyl group, their catabolic pathways are unique. Unlike benzene, toluene catabolism does not produce the ultimate carcinogen hydroquinone. Toluene is first hydroxylated in the methyl position which is subsequently oxidized to form benzoic acid. This is then conjugated with glycine to form the highly soluble hippuric acid, which is easily excreted in urine. Hippuric acid excretion is the metabolic fate of 60-75 percent of ingested or inhaled toluene within 12 hours of exposure. Of the remainder, much is exhaled unchanged and a minority is catabolized to benzoyl glucuronide (ATSDR 1989).

Many of the epidemiologic studies of adverse human health effects from toluene exposure are confounded by the mixed nature of solvents used in industry, especially prior to 1960. This is especially true of the earlier studies which attempted to link toluene exposure with blood disorders and even leukemia, effects which subsequently have been shown to be due to benzene exposure rather than toluene.

Toluene may cause irritation of the eyes, respiratory tract and skin. Repeated or prolonged contact with toluene may cause fissured dermatitis. Acute exposure to toluene predominantly results in central nervous system depression. Symptoms include headache, dizziness, fatigue, muscular weakness, drowsiness, incoordination with eventual collapse and coma.

In short-term studies, toluene is not mutagenic. This lack of genotoxic activity is supported through the study of lymphocytic cytogenetics in workers exposed to toluene vapors (Forni et al. 1971; Maki-Paakkanen et al. 1980; Haglund et al. 1980). However, there are two more recent studies of toluene workers which do indicate

significant increases in chromosomal abnormalities (Bauchinger et al. 1982; Schmid et al. 1985).

Previous studies which implicated toluene in blood disorders and leukemia have been shown to be due to benzene contamination of industrial solvents. At present there are neither epidemiologic nor experimental studies to support any carcinogenic potential for toluene by any route of exposure.

Toluene is moderately lipophilic and tends to bioaccumulate in fatty tissues of aquatic species. Bioconcentration has been estimated at a factor of 10.7 in fish and 4.2 in freshwater mussels. In addition to lipophilicity, how much toluene is retained by various species depends upon their concentration of catabolic enzymes. Some aquatic species are both rich in lipoidal tissue and poor in toluene catabolism and, hence, have higher than normal concentrations of toluene in environments which have been contaminated. These aquatic species include eels, crabs, and herring, (EPA 1981).

Acute toxicity to freshwater aquatic life from toluene is seen as low as 17.5 mg/l and might occur at lower concentrations if more species had been tested (EPA 1986). No data are available concerning chronic toxicity of toluene to freshwater biota. Lower concentrations may adversely affect species which have not yet been tested. However, the ambient water quality criterion of 14.3 mg/l is based upon human health rather than aquatic life adverse effects (EPA 1986).

Vanadium

Vanadium is a white to gray metal, often found as crystals. Elemental vanadium does not occur in nature but its compounds exist in over 50 different mineral ores and in association with fossil fuels. It is widely distributed at low concentrations in the earth's crust and is usually combined with other elements such as oxygen, sodium, sulfur, or chloride. Vanadium oxide, a man-made form of vanadium, is most often used in industry in the making of steel. Smaller amounts are used in making rubber, plastics, ceramics, and other chemicals.

Studies in humans have found that vanadium is absorbed following inhalation exposure. However, the rate and extent of absorption is not known. Acute animal studies suggest that there is an initial accumulation of vanadium in the lungs, kidneys, and liver of rats, as well as high levels in the blood. However, retention of vanadium occurs primarily in the bone. Data indicate that vanadium is poorly absorbed through the gastrointestinal tract and skin. Animal studies indicate that oral exposure to vanadium results in rapid distribution, primarily in the bones.

Vanadium is an element, and therefore is not metabolized. In the body, there is an interconversion of two oxidation states of vanadium, the tetravalent form, vanadyl, and the pentavalent form, vanadate. Vanadate is considered more toxic than vanadyl. Epidemiological studies and animal studies suggest that elimination of vanadium following inhalation and oral exposure is primarily in the urine.

The major adverse health effect in humans for vanadium has been seen in industrial exposures to large amounts of vanadium pentoxide dusts. Toxic effects include coughs, chest pains, sore throats, and irritated eyes, but symptoms disappear soon after exposure ceases. No other significant health effects of vanadium have been found in humans.

Specific tests for carcinogenicity have not been performed in humans or animals by any route. Available occupational data using the inhalation route and chronic animal studies in two species using the oral route have not indicated any evidence of carcinogenicity. There are no human data on genotoxic, reproductive or developmental toxicity of vanadium. Animal studies have indicated positive genotoxic effects. There is no evidence supporting reproductive or developmental effects through animal studies.

Chronic exposures up to 4.1 mg/kg of vanadium (as vanadyl sulfate) in food does not affect mortality in rats and mice. The LD50 for rats given vanadium (as sodium metavanadate) is 41 mg/kg. The LD50 for mice is 31 mg/kg (ATSDR 1991).

Studies in animals report that vanadium primarily affected the respiratory system where damage occurs to alveolar macrophages. No studies were found which reported the dermal effects of vanadium (ASTDR 1991).

Xylenes

Xylene is a colorless, flammable liquid which exists in three isomeric forms, ortho-, meta- and para-xylene. Xylene is widely used as a solvent, a constituent of paint, lacquers and varnishes. It is widely used in the manufacturing of various products including perfumes, insect repellants, pharmaceuticals and leather.

Xylenes are readily absorbed through inhalation and ingestion. Dermal penetration is slow through intact skin. After absorption, these hydrocarbons tend to accumulate in fatty tissues and are metabolized by the mammalian liver mainly to the corresponding toluic acids and excreted in the urine. A minor part (about 5%) is eliminated unchanged in the exhaled air.

The acute toxicity of xylenes to mammals is very low, with oral LD_{50}'s for rodents in the range of several grams per kg of body weight. Like other low molecular weight

aromatic hydrocarbons, inhalation of xylenes in higher concentrations has a depressing action on the central nervous system, demonstrated by respiratory depression and narcosis. The low toxicity of these hydrocarbons in man has been substantiated by experience from extensive occupational use.

In rabbits xylenes have been reported to induce mild toxic effects on the hematopoietic system upon subchronic exposure to high dose levels recognized as a reversible decrease in red and white blood cell count. No similar findings have been adequately documented in humans. Neither were any signs of bone marrow toxicity evident in a two-year chronic study recently conducted by NTP in rats and mice.

Mixed xylenes have not been found to induce mutations in the Ames' test, nor do they induce any significant increase of chromosome aberrations in bone marrow of rats exposed to high levels of these compounds. Negative findings have also been obtained in a number of other short-term tests.

The effects of xylenes on reproduction have recently been reviewed, and it has been concluded that no clear evidence exists for a teratogenic effect from these compounds.

Xylenes have been tested for carcinogenicity in mice and rats by gavage at dose levels up to 1000 mg/kg body weight. No evidence of carcinogenicity was found in these studies.

Xylenes may enter the environment as fugitive emissions from sources related to petroleum refining and products. Xylenes have a low-to-moderate ability to sorb onto soil or sediment particles, thus, little bioconcentration is expected in animal tissue. The log bioconcentration factor in fish is calculated at 2.14 to 2.20. The bioconcentration factor in the eel is 1.3 Toxicity studies in goldfish and rainbow trout were conducted resulting in LD50 of 13.5 mg/l for 96 hours in goldfish and 46 mg/l for 1 hour in the rainbow trout. An LC50 study for the fathead minnow reported 46 mg/l toxicity after 1 hour (Verschueren 1983).

Zinc

Zinc is a metal that occurs naturally in the environment. Zinc compounds are found naturally in the air, soil, and water and are present in all foods. It is an essential food element needed by the body in low doses.

Quantitative studies of inhalation absorption of zinc or zinc compounds are limited. However, case studies of workers occupationally exposed to zinc oxide fumes suggest that absorption by this route may occur. Absorption of zinc through the gastrointestinal tract is influenced by many factors The body's natural homeostatic

mechanisms control zinc absorption. Studies indicate that dermal absorption of zinc occurs, but its mechanism is not clearly understood. Once absorbed, zinc is distributed to muscle and bone, with lower amounts distributed to the prostate, retina, sperm, liver, gastrointestinal tract, kidney, brain, skin, lung, heart, and pancreas. Information regarding specific pharmacokinetic parameters of zinc is limited in humans. It is clear that absorption, distribution and elimination of zinc is homeostatically controlled. Zinc does not undergo any significant metabolic transformation. The principal route of excretion of zinc in humans is through the intestine. Urinary excretion is usually very low.

Acute inhalation of high doses of zinc chloride, a corrosive inorganic salt, results in damage to the mucous membranes of the nasopharynx and respiratory tract upon contact. Inhalation of zinc oxide is a common occupation exposure and can produce serious injury to the respiratory system upon direct contact. Metal fume fever, a well documented acute disease induced by intense inhalation of metal oxides, especially zinc, temporarily impairs pulmonary function but does not progress to chronic lung disease. The most prominent respiratory effects of metal fume fever include reduced lung volumes and a decreased diffusing capacity of carbon monoxide. Acute inhalation of 600 mg zinc oxide/m^3 in men has been associated with moderate leukocytosis.

The primary effects in humans or animals following acute, intermediate or chronic ingestion of zinc are pancreatic abnormalities and gastrointestinal irritation. Ingestion of high levels of zinc or zinc-containing compounds has resulted in a variety of systemic effects in the gastrointestinal and hematopoietic systems of humans and animals. In addition, lesions have been described in the liver and kidneys of animals. Oral exposure to zinc in levels much higher than the Recommended Daily Allowance (RDA) has been reported to impair immune and inflammatory responses.

Zinc is an essential trace element for normal fetal growth and development. Fetal health risks may result from zinc deficiency. Oral exposure to high doses of zinc resulted in reduced fetal growth and altered fetal and maternal concentration of zinc and copper in rats. Genotoxicity studies conducted in a variety of test systems have failed to provide evidence for mutagenicity of zinc. However, there is evidence of weak clastogenic effects following zinc exposure. The carcinogenicity of zinc following oral exposure has been evaluated in a single study with mice. The investigation was not adequate for evaluating the carcinogenicity of zinc because of several study limitations. No studies were located regarding carcinogenicity in experimental animals following inhalation or dermal exposure to zinc and its compounds.

Zinc is an essential nutrient for the biosynthesis of numerous enzymes; therefore, biological variability in homeostatic control among different genus and species may

account for differences in tolerance. In addition, toxicity is affected by a number of physical parameters such as pH, alkalinity, salinity, and hardness.

The LC50 values for freshwater aquatic plants range form 0.0075 to 750 mg/l (Moore and Ramamoorthy 1984). Acute effects are reported for freshwater invertebrates at concentrations from 100 to 58,000 ug/l The most sensitive species are cladocerans, where acute toxicity increased with increasing temperature (U.S. EPA 1980). The concentration range for acute effects in fish are similar to the levels for invertebrates (90 to 40,900 ug/l and 100 to 58,100 ug/l, respectively. Cutthroat trout was the most sensitive fish tested with an LC50 of 90 ppb (U.S. EPA 1980).

GLOSSARY OF TOXICOLOGICAL TERMS AND MEASUREMENTS

TERMS

Acidosis - A condition in which the acidity of body fluids and tissues is abnormally high due to a failure in the bodily mechanism which maintains the acid-base balance.

Acute - Describing a disease with rapid onset, severe symptoms and/or short duration.

Anemia - A reduction in the quantity of the oxygen-carrying pigment (hemoglobin) in the blood. Main symptoms include fatigue, breathlessness upon exertion, paleness and poor resistance to infection.

Anion - A negatively charged ion, which is a free electron or other charged sub-atomic particle.

Aplastic anemia - A severe form of anemia which is a result of the failure of the bone marrow to produce blood cells.

Benign - Describing a tumor that does not invade and destroy the tissue in which it originates or spread to distant sites in the body, i.e. a tumor that is not cancerous.

Bioaccumulation - The accumulation of a substance in a living organism.

Bioconcentration Factor - The concentration of a chemical in aquatic organisms at a specific time or during a discrete time period of exposure divided by the concentration in the surrounding water at the same time or during the same period.

Biological Oxidation - A process which occurs within the body where an oxygen molecule is bound to a substance.

Biosynthesis - The production of a chemical compound by a living organism by either synthesis or degradation.

Bronchospasm - A narrowing of bronchi (air passages in the lungs) by muscular contraction in response to some stimulus, as in asthma and bronchitis.

Carcinogenicity - The ability of a chemical to significantly increase the incidence of malignant lesions in animals or humans, or induce the formation of tumors or neoplasms. These tumors are characterized by cells that multiply in an uncontrollable progressive manner.

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Carcinoma - A malignant tumor consisting of epithelial cells lying within the connective tissue framework of an organ or other structure of a human or an animal body.

Cation - A positively charged ion, which is a free electron or other charged subatomic particle.

Catabolism - The chemical decomposition of complex substances by the body to form simpler ones, accompanied by the release of energy.

Chronic - Describing a disease of long duration involving very slow changes, often of gradual onset.

Dermatitis - Inflammation of the skin due to an outside agent. Often characterized by red, itchy and sometimes, blistered skin.

Ecotoxicity - The degree to which a substance is poisonous to plants and animals.

Edema - Excessive accumulation of fluid in the body tissues. Subcutaneous edema is characterized by fluid accumulation under the skin.

Enzymatic - Of, relating to, or produced by an enzyme.

Enzyme - Any of a large class of complex, proteinaceous substances that are produced by living cells and are essential to life.

Epidemiology - The study of epidemic disease, with a view to finding means of control and future prevention. Studies focus on exposed populations as compared to an unexposed, or control, population.

Fetotoxic - Denotes toxic to a developing fetus.

Genotoxic - Denotes toxicity to the genetic makeup of a cell or organism.

Hematopoietic - Relating to the production of blood or its constituents.

Hepatic - Relating to the liver. Hepatotoxic refers to damage to the liver cells.

Homeostatic - A tendency toward maintenance of a relatively stable internal environment in the bodies of higher animals through a series of interacting physiological processes.

Hyperkeratosis -Thickening of the outer layer of the skin.

In Vitro - A Latin term describing biological phenomena that are made to occur outside the living body.

In Vivo - A Latin term describing biological phenomena that occur or are observed occurring within the bodies of living organisms.

LC_{50} - The median lethal concentration or the concentration which would kill half of all tested animals.

LD_{50} - The medial lethal dose or the dose which would kill half of all tested animals.

Leukomogenesis - A malignant disease in which the bone marrow and other blood-forming organs produce increased numbers of certain types of white blood cells (leukocytes).

Lipophilic - Relating to or having strong affinity for fats or other lipids.

Lipolysis - The process by which lipids (fats) are broken down into their constituent fatty acids in the body. A compound is lipolytic if it breaks down fats.

Melanosis - An unusually pronounced darkening of body tissues caused by excessive production of the pigment melanin (a dark brown to black pigment occurring in hair, skin and eyes).

Micronutrient - An organic compound essential in minute amounts only to the growth and welfare of an animal.

Mutagenicity - The capacity to cause inheritable changes in the genetic makeup of a cell. Mutagens are the outside agents that cause genetic mutations.

Myocardial - Affecting the cardiac muscle that forms the greater part of the heart wall.

Nephrotic Syndrome - A condition in which there is a loss of protein in the urine, reduced levels of albumin in the blood and generalized swelling of tissues.

Neurotoxicity - Effects of toxic substances on various structures of the nervous system.

Osmoregulation - Regulation of osmotic pressure in the body of a living person.

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Osteomalacia - Softening of the bones caused by a deficiency of vitamin D. The effects are caused by decalcification of bony tissues due to the fact that vitamin D is necessary for calcium uptake.

Osteoporosis - Loss of bony tissue that occurs at sites of cartilage degeneration or destruction near joints and intervertebral disks.

Photosynthesis - The process whereby green plants and some bacteria manufacture carbohydrates from carbon dioxide and water, using energy absorbed from sunlight by the green pigment chlorophyll.

Pica - The indiscriminate eating of non-nutritious or harmful substances, such as grass, stones, or dirt. It is common in early childhood but may also be found in mentally handicapped and psychotic patients.

Pneumoconiosis - A lung disease caused by inhaling dust where the dust particles are small enough to reach the depths of the lung. There is usually a long period after initial exposure before effects are apparent.

Radionuclide - A nuclide that undergoes spontaneous emission of radiations.

Renal - Relating to or affecting the kidneys.

Rhinitis - Inflammation of the mucous membrane of the nose. It may be caused by virus infection (common cold) or an allergic reaction.

Sarcoma - Any cancer of connective tissue that may occur in any part of the body.

Systemic - Relating to or affecting the body as a whole, rather than individual parts or organs.

Teratogenicity - Detrimental affects on the developmental process of the fetus.

Toxicity - The degree to which a substance is poisonous.

Valence - The combining capacity of an element defined as the number of hydrogen atoms that one atom of an element can combine with or take the place of in forming compounds.

MEASUREMENTS

mg/kg - unit of measure, milligrams per kilogram

ml/kg - unit of measure, milliliters per kilogram

mg/l - unit of measure, milligrams per liter

ug/l - unit of measure, micrograms per liter

ug/m^3 - unit of measure, micrograms per cubic meter

ppm - unit of measure, parts per million

mm - unit of measure, millimeter

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POTASSIUM HEALTH EFFECTS SUMMARY

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Potassium is the seventh most abundant metallic element naturally found in the earth's crust. It is an essential nutrient with an established adequate daily adult requirement of 3,500 mg/day. This adequate daily intake is required to maintain the muscular and CNS systems, as well as overall health. In addition to maintenance of bodily systems, considerable evidence exists which indicates that dietary potassium exerts a beneficial effect on hypertension (NRC 1989).

All naturally occurring potassium exhibits the following isotopic ratio: 93.26% ^{39}K, 0.012% ^{40}K, and 6.73% ^{41}K. Total potassium exhibits a radioactivity of 850 pCi/g (picocuries per gram) due to the potassium-40 isotope. Enrichment of potassium to altered $^{39}K/^{40}K/^{41}K$ ratios is not plausible without highly controlled processes designed specifically for that purpose. Therefore, potassium in various environmental media and foodstuffs has equal natural radioactivity levels.

Natural potassium content of a 70 Kg male of 30 to 40 years is approximately 140 g (Leggett and Williams 1986). Of this 140 g, 0.016 g is ^{40}K, which disintegrates at the rate of about 251,000 atoms/minute. Eighty-nine of 100 disintegrations result in β (BETA) particle release with a maximum energy of 1.33 MeV (Mega electron volts), and 11 out of 100 result in γ (GAMMA) photons with an energy of 1.46 MeV. All β particles and 50% of the gamma ray energy are absorbed in the body, giving annual doses of 18 mrad (millirad) from β particles and 2 mrad from gamma rays. This body burden and associated background exposure to radioactivity are constant throughout adult lifetime. Additional potassium intake is not cumulative due to the homeostatic control of body potassium levels.

The body regulates potassium content continuously at the cellular level. Therefore, any increase in intake, detected by the body as a change in potassium levels, is balanced with a removal of potassium via urine and fecal excretion. Normally, this process is so efficient at excreting excess potassium that chronic hyperkalemia, a greater than normal concentration of potassium ions in the circulating blood (Stedman's Medical Dictionary 1976), cannot manifest unless there is a defect in excretion. Normal subjects can maintain a potassium balance if intake is chronically increased to levels of 500 mEq/day (milliequivalents per day) or more (Rose 1989).

In the event of the breakdown of homeostatic processes associated with removal of excess potassium, hyperkalemia will result from sudden enteral or parenteral increases in potassium intake levels about 12 g/m^2 (grams per square meter) of surface area per day - approximately 18 g for an adult. Although urinary excretion provides some protection, acute hyperkalemia can prove fatal by potentially causing cardiac arrest (NRC 1989). Total potassium body stores in adults are approximately 3,000-4,000 mEq or 50-55 mEq/Kg. Ninety-eight percent is contained in cells at a concentration of about 140 mEq/L (milliequivalents per liter) (Rose 1989). Less than 2% is found in extracellular fluid (60-70 mEq). However, this potassium store is extremely important to neuromuscular excitability and is controlled within tight limits of 3.5-5 mEq/L (Sterns et al. 1981; Brown 1984). Concentration in extracellular fluid must be maintained within these tight limits to prevent life-threatening toxicity (Rose 1989; Guyton 1991). Levels of 5 to 6.5 mEq/L yield minimal toxicity and rarely produce cardiovascular symptoms. Levels of 6.5 to 8 mEq/L are associated with moderate toxicity, including lassitude, weakness, fatigue, decreased reflex response, incipient

ascending paralysis and some cardiovascular abnormalities. Levels greater than 8 mEq/L yield severe toxicity often producing complete neuromuscular paralysis, and major life-threatening cardiovascular toxicity. Death from cardiac arrest usually appears between 10 to 12 mEq/L, but may be seen at lower levels (Micromedex System: Poisindex Database 1993).

Systemic effects associated with excessive ingestion of potassium, the most serious being cardiac arrest, mainly stem from hyperkalemia, which cannot occur unless renal functioning is impaired. Since all naturally occurring potassium exhibits the same concentration of potassium-40, receptors with normal renal functioning would not be exposed to excess levels of radiation even though excess levels of potassium were consumed. Receptors exhibiting normal renal functioning would not be susceptible to radiological effects of ingesting excess potassium. The effects of excess potassium and potassium-40 on sensitive receptors such as burn victims, dialysis patients, and populations/individuals with high blood pressure is best addressed qualitatively.

Dialysis patients would have a higher susceptibility to excess potassium consumption due to insufficient renal functioning. However, any increased risk would be virtually eliminated with more frequent dialysis treatments. Therefore, ingestion of excess potassium by dialysis patients could result in additional dialysis treatments to remove the excess potassium, but would not pose significant risks provided that regular blood monitoring for the need to have dialysis treatment is performed.

Certain sensitive individuals, such as burn victims, could benefit from excess potassium intake. Burn victims which lose a large quantity of body fluid due to blisters also lose a significant fraction of the necessary potassium in their body. Consuming extra potassium would replace potassium body stores depleted through this fluid loss. In certain cases, burn victims have such extensive tissue damage that renal functioning is impaired as the kidneys lose efficiency trying to filter the damaged tissue out of the blood. In such severe cases, the burn patient is treated with dialysis until renal functioning resumes. Excess potassium would pose the same risk to the burn patient on dialysis as to any other dialysis patient.

Other sensitive populations would definitely benefit from the ingestion of excess potassium. This sensitive population consists of those individuals whose bodies are hypokalemic (i.e., lacking in the necessary amount of potassium to sustain normal health). Hypokalemia is most often produced in the medical treatment of edema caused by renal, hepatic, or cardiac failure, or by diuretics used in hypertension and other cardiovascular diseases. Potassium is given orally and intravenously to hypokalemic patients. In such cases, the ingestion of excess potassium helps alleviate the hypokalemia, thus helping the hypokalemic patient return to normal health.

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ADDITIONAL TOXICOLOGICAL INFORMATION ON ARSENIC, BENZENE AND MANGANESE

APPENDIX

TOXICOLOGICAL PROFILES FOR SELECTED CHEMICALS OF CONCERN AT PADDY'S RUN ROAD SITE

- **ARSENIC** pp. 2 - 13
- **BENZENE** pp. 14 - 24
- **MANGANESE** pp. 25 - 30

TOXICOLOGICAL PROFILE FOR ARSENIC

Introduction

Elemental arsenic exists in several allotropic modifications; the ordinary form is metallic or gray arsenic. It forms a steel gray crystalline mass with a metallic luster, is brittle and rather soft, and is insoluble in water. The inorganic compounds (+3 or +5) are usually colorless, water soluble crystalline solids or powders; the trioxide, the calcium salts as well as the yellow-orange sulphides have a limited to low water solubility. Elemental arsenic sublimes at 613C without melting and is easily volatilized in various combustion processes involving arsenic containing materials.

Arsenic-containing compounds are often unstable, and in many cases are not well-defined materials. For example, the arsenites of alkali metals are slowly converted in solution to arsenates by atmospheric oxygen.

Pure arsenic occurs occasionally in native form, *e.g.*, as "Scherbenkobalt", but is found chiefly in the form of its compounds with metals (arsenides), which usually occur in isomorphous mixture with sulphides. The most commonly found is arsenopyrite with the approximate composition FeAsS. Naturally occurring sulphides are realgar (AsS) and orpiment (As_2S_3). High levels of arsenic may be present in some coals, *e.g.*, those mined in Czechoslovakia with levels up to 1,500 ppm, in gold deposits and in peat.

As a result of its natural occurrence, exposure to arsenic is universal (WHO/IPCS, 1981). It is present in most foodstuffs in concentrations below 1 ppm. However, marine fish may contain up to 5 ppm and the arsenic concentration in some crustacea and bottom-feeding fish may reach several tens of milligrams per kg. However, in marine organisms arsenic is predominantly present as organic arsenic, which has a totally different toxicological profile than the inorganic forms. It has been estimated that 5 - 10% of the total concentration of arsenic in marine organisms exist in the inorganic state. In the environment a number of organisms (*e.g.*, fungi and bacteria in soil) have the capacity to methylate inorganic arsenic with the formation of dimethyl- and trimethylarsines. Fish from arsenic polluted waters appear to accumulate organic arsenic compounds via their food chain (Norin and Vahter, 1984).

Arsenic can be found in some natural waters in high concentrations. Whereas a survey of the drinking water in 18,000 communities in the U.S. (McCabe et al., 1970) indicated that less than 1% have arsenic levels

exceeding 10 µg/L, levels of 70 - 1,700 µg/L have been found in wells in Oregon (Goldblatt et al, 1963). It has been estimated that more than 100,000 people in the U.S. are receiving drinking water from public water supplies with arsenic levels above 50 µg/L, the current USEPA Maximum Contamination Level (MCL), of which approximately 84% consume water from groundwater supplies (USEPA, 1986). In several areas, such as Cordoba, Argentina (900 - 3,400 µg/L) and the Tainan province in Taiwan (up to 1,800 µg/L) the natural high arsenic content of the drinking water has caused endemic chronic arsenic poisoning.

In man the total daily intake of arsenic is greatly influenced by the amount of seafood in the diet, but is usually less than 200 µg/day (normally about 50 µg/day).

Arsenic is a known human carcinogen, although the mechanisms by which arsenic is carcinogenic remains unknown. Inhaled arsenic differs in its carcinogenic potency and target organ sites from ingested arsenic. However, the following points must be kept in mind in order to keep arsenic carcinogenicity in an overall perspective:

- Arsenic is prevalent in the earth's crust and is commonly found in soils at 1-50 mg/kg (ppm). It also frequently contaminates drinking water. Western U.S. ground water supplies with 150 µg/l (ppb) arsenic have not been associated with adverse health effects.
- The maximum contamination level (MCL) for arsenic has been set by USEPA at 50 µg/l. There are studies which show this level of arsenic to be beneficial to mammalian health.
- Arsenic is primarily carcinogenic by inhalation, with the evidence for human carcinogenesis by ingestion being much weaker. Inhaled arsenic leads to lung cancer whereas ingested arsenic is associated with increased skin carcinogenesis.
- USEPA recently lowered the carcinogenic potency of arsenic by ingestion from 15 to 1.75 $(mg/kg/day)^{-1}$ and is at present considering an additional lowering of this ingestion potency (IRIS, 1994). The inhalation carcinogenic potency of arsenic remains at 50 $(mg/kg/day)^{-1}$.
- It also appears that arsenic by ingestion has a threshold below which it fails to exacerbate the frequency of skin cancer. It is probable that ingestible arsenic only acts to promote skin cancer at doses which lead to keratosis.

Like other metallic inhalation carcinogens, such as hexavalent chromium, cadmium and nickel, arsenic by ingestion has an entirely different pathology. There is no lung cancer associated with ingested arsenic, either epidemiologically or in experimental animals (ATSDR, 1989). Instead, paradoxically, the target organ for carcinogenesis of ingested arsenic is the skin. Hence, the carcinogenic effects of arsenic are discussed below according to these two separate exposure routes: Inhalation and ingestion.

- ***Carcinogenic Effects by Inhalation***

Inhaled arsenic, often in particulate form, appears to initiate lung carcinogenesis in a manner similar to the other carcinogenic metals. In fact, carcinogenic initiation by inhaled arsenic may require the presence of other metals (one never finds arsenic alone in mining dusts).

Studies of smelter worker populations (Tacoma, WA; Magma, UT; Anaconda, MT; Rinnskor, Sweden; Saganoseki-Machii, Japan) have all found an association between occupational arsenic exposure and lung cancer mortality (Enterline and Marsh, 1982; Lee-Feldstein, 1983; Axelson et al., 1978; Tokudome and Kuratsune, 1976; Rencher et al., 1977). Both proportionate mortality and cohort studies of pesticide manufacturing workers have also shown excess lung cancer deaths among exposed persons (Ott et al., 1974; Mabuchi et al., 1979). Case reports of arsenical pesticide applicators have further demonstrated an association between arsenic exposure and lung cancer (Roth, 1958). There seems little doubt that exposure to arsenic by inhalation increases the risk of lung cancer. However, a strong multiplicative effect of arsenic exposure and smoking has been unequivocally established (Pershagen et al., 1981) and poses special problems for assessing risk from airborne arsenic.

- ***Carcinogenic Effects by Ingestion***

Whereas inhaled arsenic is associated with lung cancer, which may require the presence of other metallic carcinogens, ingestion of high levels of arsenic has been linked to excess risk for skin cancer. The mechanisms by which skin cancer frequency is exacerbated by arsenic ingestion appear to require arsenic-induced keratosis, a skin thickening which is caused by overreplication of one skin cell component, the keratinocytes. It is this type of skin cell which is at risk in populations with high oral arsenic exposure, resulting in an increased frequency of squamous cell carcinoma of the skin.

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In classical two-stage carcinogenesis experiments, arsenic acts as a promoter rather than an initiator. Oral administration of sodium arsenite enhanced the incidence of renal tumors induced in rats by intraperitoneal injection of the carcinogenic initiator N-nitrosodiethylamine (Kroes et al, 1974) The same appears true for skin carcinogenesis by arsenic which requires keratosis and arsenic by ingestion may act predominantly as a promoter rather than an initiator of skin carcinogenesis. This realization has potentiated adoption of a threshold concept for arsenic by ingestion, as discussed further below.

Among the several types of skin cancer induced by arsenic, epithelioma developing at the site of keratoses is the most common. The keratotic lesions may exist for many years before they change to a malignant form of epithelioma which is usually of the squamous type. Basal cell carcinoma of a low-grade malignancy, *in situ*, accompanied by chronic "precancerous dermatitis" (Bowen's disease) is also found in cases of chronic arsenical dermatitis. In people exposed to inorganic arsenic via medication, insecticides, contaminated wine or drinking water, malignant tumors have developed in other organs, frequently accompanied by skin cancers. However, the relationship between arsenic exposure and a higher risk of cancer in organs other than skin and lungs is unclear (IARC, 1980).

A cross-sectional study of 40,000 Taiwanese exposed to arsenic in drinking water found significant excess skin cancer prevalence by comparison to 7500 residents of Taiwan and Matsu who consumed relatively arsenic-free water (Tseng, 1977). Arsenic-induced skin cancer has also been attributed to water supplies in Chile, Argentina and Mexico. No excess skin cancer incidence has been observed in U.S. residents consuming relatively high levels of arsenic in drinking water (Morton et al., 1976). These U.S. studies, however, are not inconsistent with the existing findings from the foreign populations. The statistical powers of the U.S. studies are considered to be inadequate because of small sample sizes.

Murphy et al (1989) and Petito Boyce et al (1992) have summarized evidence that arsenic oral carcinogenicity is nonlinear at low doses due to detoxification by methylation and excretion at low levels of exposure to soil and other media which may be ingested. In addition, the mechanism of exacerbation of skin carcinogenesis by ingested arsenic, *i.e.*, proliferation of keratinocytes leading to enhanced frequency of squamous cell carcinoma of the skin, suggests that there is an additional threshold for keratinozation. Epidemiologic studies of arsenic promoted skin carcinogenesis suggest that ultraviolet light is normally the initiating carcinogen.

The first sign of chronic arsenic exposure by ingestion is a thickening of the skin, followed by keratosis (a proliferation, then scaling by keratinocytes, those epithelial cells which manufacture the cuticle of the skin which is enriched in keratin). Belatedly, this keratosis results in an increased risk of skin cancer (squamous cell carcinoma). Contemporary toxicologic explication of skin carcinogenesis by ingested arsenic requires that there is enhanced replication of keratinocytes in response to arsenic exposure. In turn, these arsenic-stimulated keratinocytes represent enhanced targets for carcinogenic initiation by other agents, such as the UVB component of sunlight, for two reasons:

- They are replicating at a faster rate and, hence, entrap DNA lesions (mainly thymine dimers) more frequently than normally quiescent skin keratinocytes.
- There are more target cells for carcinogenic initiation. A doubling of skin keratinocytes presents twice as many targets for cancers which escape immunologic surveillance.

In addition, there is some evidence that high levels of arsenic may inhibit one type of DNA repair, which inhibition would also lead to an increase in skin carcinogenesis by sunlight and other environmental carcinogens.

- *Animal Studies*

There has been no consistent demonstration of carcinogenicity in test animals for various chemical forms of arsenic administered by the oral route or by skin application to several species (IARC, 1980). However, there are some data to indicate that arsenic may produce animal tumors, if retention time in the lung can be increased. Thus, arsenic trioxide produced lung adenomas in mice after perinatal treatment and induced low incidences of carcinomas, adenomas, papillomas and adenomatoid lesions of the respiratory tract in hamsters after intratracheal instillation. A high incidence of lung carcinomas was induced in rats following a single intratracheal instillation of a pesticide mixture containing calcium arsenate (IARC, 1987).

- *Non-Carcinogenic Effects*

Arsenic has a high acute as well as chronic toxicity. Systemic chronic poisoning is primarily characterized by skin lesions such as as dermatoses, which may include eruptions, pigmentation, or hyperkeratosis, that may ultimately lead to the development of skin cancer. Effects on the nervous system (*e.g.*, peripheral nervous disturbance) as well as on the heart and circulatory system (*e.g.*, abnormal electrocardiograms, and peripheral vascular disturbances with gangrene of the extremities - the Blackfoot disease) have also been reported following chronic exposure to arsenic.

Hematological changes following arsenic exposure are characterized by anemia and leukopenia.

The acute toxicity of inorganic arsenic is dependent on the solubility of the administered compound. In man the smallest recorded fatal dose is in the range of 70-180 mg, but recovery has been reported after much larger doses. Death occurs after a period of 12 to 48 hrs (Stokinger, 1981). Common acute symptoms include gastritis, fever, insomnia, anorexia, liver swelling, and disturbed heart function. Peripheral nervous disturbances, primarily of sensory type, are frequently encountered in individuals surviving poisoning, and there may also be transient effects on the blood. Irritant and vesicant arsenical compounds, such as arsenic trioxide, arsenic trichloride, and the arsenical war gases, have been known to cause severe damage to the respiratory system upon inhalation.

Signs of chronic arsenic toxicity are chiefly related to the skin, mucous membranes, lungs, gastrointestinal and nervous systems. Involvements of the circulatory system and liver are less common.

Chronic arsenic poisoning from ingestion of contaminated food, beverages, and water has been reported in many countries. An incident in the United Kingdom involved 6000 people who had ingested beer contaminated by arsenic. Reports of regional endemic chronic arsenism caused by drinking water with high concentrations of arsenic in and around Cordoba, Argentina, date back as far as 1931. The primary criteria for diagnosis of chronic poisoning were symmetrical palmar and plantar hyperkeratosis. Similar skin lesions have also been observed in populations exposed to arsenic-contaminated drinking water in Chile. An endemic disease, also associated with arsenic in drinking water, was discovered in Taiwan in 1963. The major manifestation was hyperkeratotic skin lesions as well as a vascular disorder resulting in gangrene of the lower extremities - commonly called Blackfoot disease - which has not been observed among the people with skin lesions in Chile. Clinical differences between populations with endemic arsenic exposure appear to be mediated by other as yet undefined environmental factors (Ishinishi, et al., 1986).

The skin is a common critical organ in humans exposed to inorganic arsenicals. The accumulation of arsenic in skin is probably related to the abundance of proteins containing sulfhydryl groups, with which arsenic readily reacts. Eczematoid symptoms develop with varying degrees of severity. In occupational exposure, skin lesions are frequently found in the palm of the hand and on the sole of the foot. An allergic type of contact dermatitis is also frequently seen among workers who are exposed to arsenic trioxide. Chronic dermal lesions may follow this type of initial

reaction, depending on the concentration and duration of exposure. Hyperkeratosis, warts, and melanosis of the skin are the most commonly observed lesions in chronic exposure. Grossly, the hyperkeratoses are usually small, non-tender corn-like elevations, 0.4 to 1 cm in diameter. The small nodules may coalesce to form plaques, diffuse keratosis or large verrucous growths. Skin lesions may develop long after cessation of exposure, when dermal arsenic concentrations have returned to normal levels.

Conjunctivitis characterized by redness, swelling and pain has often been associated with occupational exposure to arsenic-containing dust. Perforation of the nasal septum as a result of irritation of the upper respiratory organs by arsenic dust is a common finding among arsenic-exposed workers. Like lesions caused by other chemical irritants such as chromium, the perforation is confined to the cartilaginous portion of the septum and does not lead to deformity of the nose. There are no other apparent subjective symptoms once inflammation has subsided.

Peripheral neuritis affecting mainly the upper and lower extremities is one of the symptoms of chronic arsenical poisoning. This neuritis is mostly symmetrical, widespread and painful. Abnormal electromyograms (EMGs) have been reported among people who had lived near an arsenic mine and smelter and who showed no subjective symptoms. Abnormal EMGs have also been reported among people drinking well water with high arsenic contents (Ishinishi, et al., 1986). The neurotoxic action of arsenic, involving demyelination of peripheral nerves, optic nerves and optic tracts, has also been demonstrated in pigs given doses of arsanilic acid in excess of about 100 ppm (Ledet et al., 1973).

Anemia and disturbance of the hematopoietic system have been observed in chronic occupational exposure to arsenic and in treatment with arsenical drugs. Chronic arsenic poisoning with skin lesions is often accompanied by moderate anemia and leukopenia.

Inorganic arsenic compounds have long been considered capable of damaging the liver under certain circumstances, but there are only a few reports of this occurring in arsenic-exposed workers. Alcohol consumption may have been a complicating factor in cirrhosis among vineyard workers who used arsenic as a pesticide.

The epidemiological and clinical evidence for primary cardiac injury in arsenic workers is not very definitive, but electrocardiograms have revealed abnormalities. Abnormal electrocardiograms indicating a toxic myocardial effect were also seen in vineyard workers who used arsenical insecticides and suffered from chronic arsenical poisoning.

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The USEPA Risk Assessment Forum has completed a reassessment of the carcinogenic risk associated with ingestion of inorganic arsenic. Risk estimates were adjusted for survival times and for the larger water consumption of Taiwanese as compared with U.S. males. Further, instead of using upper bound estimates based on the the linearized multistage model, a maximum likelihood approach was utilized together with the Weibull model. The report concluded, that the most appropriate basis for an oral estimate was the study by Tseng et al, (1977), which reported increased prevalence of skin cancers in humans as a consequence of arsenic exposure in drinking water. Based on this study a unit risk of 5.0E-05/μg/L was proposed, which is an order of magnitude lower than the previous estimate (carcinogenic slope factor of 1.75). However, it should be noted, that even when applying this lower estimate, practically no drinking water consumed in the U.S. will fulfill the 1.0E-06 risk goal. USEPA soon may promulgate a once again lowered oral carcinogenic slope factor for arsenic and, in addition, introduce a threshold below which ingested arsenic is not carcinogenic.

Use of the keratotic threshold for skin carcinogenesis by arsenic has precedence. USEPA has set a precedent for thresholds in the prediction of carcinogenic dose-response relationships for goitrogens, such as thiourea, phenobarbital, perchlorate and KSCN (Hill et al, 1989; Paynter et al, 1988; and USEPA, 1988). Thyroid goiters serve as a prototype for the clonal expansion of stem cells in carcinogenic promotion. If the resulting thyroid gland contains 10 times as much thyroid epithelium (10 times as many stem cell initiation targets), it is 10 times as likely as the normal thyroid to undergo a genotoxic event which leads to thyroid carcinoma. It is likely that many other hormonally-mediated tumors act according to similar threshold mechanisms, including gonadal tumors and other tumors responsive to diethylstibestrol and other synthetic hormones (Li and Li, 1990). Another well-studied threshold dose-response system for experimental carcinogenesis under hormonal control requires accumulation of alpha-2μ-globulin and the formation of hyaline droplets in renal carcinoma of male rats (Dietrich and Swenberg, 1991; Barrett and Huff, 1991).

An understanding of these mechanisms of skin carcinogenesis by ingested arsenic has profound implications for risk assessment. *There is no enhanced risk of skin cancer from ingested arsenic unless keratosis takes place.* Keratosis, in turn, cannot occur unless arsenic is ingested at or above a critical concentration. This keratotic level of ingested arsenic is a carcinogenic threshold below which exposure is safe. USEPA's linearized no threshold

model of carcinogenic risk fails to account for this mechanism of carcinogenesis by ingested arsenic.

The fate of ingested arsenic is much different than when the metal is inhaled. Bioavailability of arsenic from ingestion of contaminated soil is about 28 percent (Petito Boyce et al, 1992). Furthermore, at ingestion of less than 250 µg per day, arsenic methylases are 90 percent active in detoxification, reducing effective doses by an order of magnitude (USEPA, 1991). Hence, only about 3 percent of arsenic in soil is effectively bioavailable for stimulation of keratosis. All told, bioinavailability, methyl inactivation and sufficiency for keratotic stimulation create an oral threshold concentration below which there is insufficient arsenic to exacerbate the frequency of skin cancer. Petito Boyce et al (1992) estimate this oral threshold to occur at a soil contamination equivalent level of 2,500 mg/kg. Keratosis in a Taiwanese epidemiologic study was used as the basis for establishing USEPA's oral RfD of 0.001 mg/kg/day. This threshold is very similar to that referenced by Petito Boyce et al (1992) of 0.003 mg/kg/day, as based upon other threshold arguments for arsenic's carcinogenic effects. That the two doses are similar lends credence to the necessity of keratosis for manifestation of arsenic-promoted skin carcinogenesis.

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TOXICOLOGICAL PROFILE FOR BENZENE

Introduction

Benzene is a ubiquitous chemical in the environment, in human tissues and exhaled in normal human breath (Wallace, 1989a). It is produced naturally in the human body as a metabolite of benzoate of soda and other compounds in the diet. As seen in the following table, benzene is a very common environmental chemical.

Human Exposures to Benzene in the U.S.
(Adapted from Wallace, 1989b)

Situation	Number Exposed*	Total Benzene (grams)**
Gasoline Station Attendants	100,000	80.00
Gasoline Self-Service	30,000,000	0.50
Truck Drivers	500,000	5.00
Car Drivers & Passengers	200,000,000	0.50
Metropolitan Residents	75,000,000	6.00

*Mainly by inhalation **Assuming 20 years occupational exposures, 70 year lifetimes.

Due to its proven epidemiologic association with acute myelogenous leukemia (AML) in exposed workers, benzene has been classified as one of the few known human carcinogens (USEPA Class A, IARC Class I). Although the causal link between benzene exposure and onset of acute myelogenous leukemia in humans is clear from epidemiologic studies, neither the dosimetry nor the mechanisms by which benzene is leukemogenic can be fathomed from these studies.

As will be demonstrated herein, the carcinogenic mechanism of benzene is unique and requires high levels of exposure. However, if one ignores the carcinogenic mechanism of benzene and assesses human risks from all background exposures to benzene according to USEPA's linearized multistage model, a lifetime leukemia risk of 1-in-10,000 (10^{-4}) derives (Hattemer-Frey et al, 1990). This is higher than the observed rate of AML and, hence, the USEPA risk assessment model must be flawed.

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- *Carcinogenic Effects*

The carcinogenesis of benzene is limited to the induction of acute myelogenous leukemia (AML) in humans. Although the epidemiology of this causal connection is based upon only a handful of highly exposed workers, it is well accepted by the toxicological community. There is no adequate experimental animal model in which to mimic benzene induction of AML in the laboratory.

Extensive research into benzene toxicology has revealed the following:

- It is not benzene itself, but benzene metabolites which are leukemogenic.
- Benzene leukemogenesis requires myelotoxicity, *i.e.*, bone marrow must be suppressed in its activity by benzene metabolites in order for leukemia to occur.
- Benzene is uniquely genotoxic for bone marrow cells and no other mammalian cells when tested either *in vivo* or *in vitro*.

A synthesis of the mechanism by which benzene induces AML follows.

1. In sufficient concentration, benzene is metabolized in bone marrow by myeloperoxidase to hydroquinone and cathecol, which metabolites, in critical concentrations, inhibit stromal cell elicitation of cytokines.
2. Bone marrow stromal cell cytokine inhibition results in the paralysis of developing myelogenous lymphocytes, *i.e.*, the immunocompetent component of immature bone marrow.
3. Pre-B-cells within this paralyzed lymphocyte population continue to scramble their immunoglobulin precursor genes inordinately beyond that time normally required for immunoglobulin generation of diversity, causing illegitimate recombination events to occur involving oncogenes at a higher than normal frequency.
4. An occasional recombination event in this B-lymphocyte population so affected gives rise to a clone of cells which replicates without ceasing. This clone forms the basis of AML.
5. Given the requirement for myelotoxicity, it is unlikely that there is any leukemogenic activity of benzene at background levels of exposure.

Benzene is a known human leukemogen. Workers who have been exposed to airborne concentrations of benzene at ≥40 ppm for 10 years in

the workplace are 12-66 times more likely to develop acute myelogenous leukemia (AML) than unexposed workers (Rinsky et al, 1987). The average benzene exposure levels to these workers has been estimated at 22.9 ppm in air (73.2 mg/m^3), which, for workers, translates to be a dose of about 10 mg/kg/day. Their average exposure to benzene occurred over a 9 year period (range 1 month to 20 years), with the latency period (time from initial exposure until onset of AML) averaging 16 years (range 2-37 years).

Unlike most initiating carcinogens, benzene is not genotoxic in the majority of short-term test systems evaluated (Parodi et al, 1992). Short-term tests which are negative for benzene include mutagenesis in microorganisms (*e.g.*, Ames test), invertebrates (*e.g.*, *Drosophila*) and mammalian cells in culture. On the other hand, after *in vivo* exposure to benzene, chromosomal aberrations, sister chromatid exchanges and micronuclei are all seen in bone marrow-derived cells (Erexson et al, 1985; ATSDR, 1988). Hence, it appears that chromosomal effects of benzene exposure are limited to cells derived from bone marrow. Indeed, it has been known for nearly a century that benzene exposure adversely affects bone marrow as the target organ, resulting in a constellation of hematopoietic effects, including aplastic anemia, pancytopenia and leukopenia.

Are the leukemogenic effects of benzene exposure linked to these pervasive effects on bone marrow in general? It seems likely. A hint of what may be happening is found in B-cell leukemias in which the normal joining of variable and constant genes has gone awry and incorporates an oncogene (Tsujimoto et al, 1985; Haluska et al, 1986). As will be seen below, chromosomal translocations are the hallmarks of leukemia. There is the thorny problem of cancers at additional organ sites which arise when animals are exposed to high concentrations of benzene (NTP, 1986), but this apparently anomalous result may be explained in terms of immunosuppression of natural killer lymphocytes which are active in cancer surveillance.

Leukocytes are produced in bone marrow from a pluripotent stem cell which differentiates in dedicated pathways according to specific cytokines elicited by stromal cells of the marrow matrix. These cytokines include interleukins (ILs), colony stimulating factors (CSFs) and hematopoietin. Interleukins and other cytokines attach to specific leukocyte receptors and transmit their differentiation signals to the nucleus via transmembrane tyrosine kinases. This is the same differentiation signal which goes awry during leukemogenic transformation. The transformation to chronic myelogenous leukemia (CML) must occur at the pluripotent stem cell precursor level, since CML cells may differentiate to either granulocytic

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progeny or lymphoblasts during blast crisis (Greaves, 1986). A spectrum of cell lineages is also seen in acute myelogenous leukemia (AML), which is the leukemia most frequently associated with occupational exposure to benzene (Keinanen et al, 1988).

The pluripotent effects of benzene exposure on bone marrow may be understood in terms of reduced production of cytokines by stromal and other supportive cells of the bone marrow matrix. Benzene metabolites, including hydroquinone, have been reported to inhibit cytokine synthesis by bone marrow stromal cells (Gaido and Wierda, 1984; Gad-El-Karim et al, 1985; Gaido and Wierda, 1987). It is postulated that imbalance of this highly orchestrated cascade of growth factors disrupts normal leukocyte ontogeny, leading to the inadvertent rare translocation of oncogenes, an event which is normally confined to immunoglobulin loci of differentiating lymphocytes. It is probable that many other illicit chromosomal translocations are also induced in developing leukocytes by benzene exposure at doses which inhibit stromal cells. However, in humans, only leukemogenic translocations have been noted in that these patients become diseased and amenable to clinical analysis.

In order to understand how benzene may be affecting bone marrow to induce leukemia, it is helpful to look at that spectrum of leukemias seen among exposed workers. There is a common misperception that acute myelogenous leukemia (AML) is the sole malignancy seen among benzene workers. Although AML is certainly prominent (and the only malignancy which by itself is statistically significant), many other leukemias have been reported to be elevated among workers exposed to benzene, including chronic myelogenous leukemia (CML), lymphocytic leukemias, monocytic leukemia, multiple myeloma and lymphomas (for reviews see Crump, 1992; Molholt, 1992; Florida Petroleum Council, 1986 and Goldstein et al, 1989).

Although AML is more strongly associated with human exposure to leukemia, CML is discussed here due to the stunning molecular genetic evidence regarding its genesis. The rationale is that similar genetic mechanisms, *i.e.*, chromosomal translocations, may control the onset of AML, however, the CML story is better understood, and therefore will be used as a prototype for benzene leukemogenesis.

It appears as if chromosomal translocations involving oncogenes are common mechanisms of leukemogenesis, including induction of AML, as shown in the table on the following page which is taken from Solomon et al (1991).

The onset of CML is associated with a chromosomal marker of diagnostic significance, the Philadelphia chromosome (Ph'). This pattern of an

elongated chromosome 9 and shortened 22 is virtually diagnostic for CML. Ph' is also seen in other leukemias, such as acute lymphoblastic leukemia (ALL) and sometimes AML, although other translocations, such as 6p23 x 9q34 are more common to AML (Solomon et al, 1991).

ONCOGENE TRANSLOCATIONS OF HUMAN LEUKEMIAS
(Solomon et al, 1991)

Leukemia	Translocation	Oncogene(s)
CML, B-ALL	9q34 x 22q11	*abl/bcr*
AML (M2 or M4)	**9q34 x 6p23**	***dek/can***
APL	15q22 x 17q11	*pml/rara*
Pre-B ALL	1q23 x 19p13	*e2a/pbx*
B-CLL	14q32 x 11q13	*bcl1 (prad1?)*
	14q32 x 19q13	*bcl3*
	8q24 x 12q22	*btg1*
T-ALL	14q11 x 8q24	*myc**
	14q11 x 1p32	*tcl5*
	14q11 x 10q24	*tcl3*
	14q11 x 11p15	*rbnt1*
	14q11 x 11p13	*rbnt2*

*T-ALL oncogenes are juxtaposed with T-cell receptor gene *tcr*.

A closer examination of the 9 x 22 translocation by chromosomal banding in CML patients shows that the terminal band on the long arm of chromosome 9 (9q34) replaces most of the long arm of chromosome 22 (22q12-13) in the Philadelphia chromosome (Ph'). Many ALLs are also Ph'+ and it is believed that lymphoblastic transformation ("blast crisis") of CML is essentially a conversion of CML cells to ALL (Desforges and Miller, 1986). DNA analysis of the 9 x 22 Ph' translocation reveals juxtaposition of an oncogene (*abl*), which originates on chromosome 9, with a break cluster region (*bcr*) on chromosome 22. This *abl/bcr* fusion results in a new gene which now produces a larger, autocatalytic tyrosine kinase (p210) of 210,000 daltons molecular weight (Ben-Neriah et al, 1986).

Transmembrane tyrosine kinases normally mediate the action of intercellular growth factors, including cytokines. Their activation by stromal-elicited growth factors is required for normal leukocyte

differentiation, including the generation of antibody diversity in lymphocytes. The genetic activation of latent tyrosine kinase genes is frequently involved in oncogenic transformations. Activation of the p150 tyrosine kinase product of the normal *abl* oncogene (*c-abl*) requires that it bind its cognate growth factor on the exterior side of the leukocyte plasma membrane. This extracellular signal is transmitted via the transmembrane p150 kinase, resulting in its ability to phosphorylate tyrosines of phospholipase C inside the affected leukocyte. Once thus activated, phospholipase C in turn forms inositol triphosphate, that intracellular messenger responsible for activation of differentiation genes in the nucleus. Two modified *abl* oncogenes are known which, unlike *c-abl*, encode enzymes which permanently behave as if they are activated, *i.e.*, they always possess tyrosine kinase activity. One of these is *v-abl*, the gene carried by Abelson Murine Leukemia Virus, which induces leukemia in rodents. The other is the *abl/bcr* fusion gene characteristic of CML. These salient points are summarized below:

Molecular Genetics of the Ph' Translocation in CML

- 9q34 (*abl*) x 22q11 (*bcr*) -> 9q+ x 22q- (Ph', *bcr/abl*)
- The *abl* oncogene encodes a tyrosine kinase
-

Gene	Kinase	Phosphorylation Activity
v-abl	p160	autophosphorylates
c-abl	p150	no autophosphorylation
bcr/abl	p210	autophosphorylates

Hence, like the virally activated p160 kinase gene, *v-abl*, the fused *bcr/abl* oncogene also encodes a kinase (p210) which autophosphorylates and always is active in growth promotion. This fundamental genetic change leads to ceaseless replication of all daughter cells in an infinite clonal expansion inimical to the well-being of the host.

A useful test system has already been partially defined in that infection of irradiated mice by retroviruses carrying the human *abl/bcr* gene fusion develop CML (Kelliher et al, 1990). Furthermore, this system may be used to study the dosimetry of benzene leukemogenesis, as will be outlined further below. It is anticipated that benzene will behave in a transgenic mouse system to promote the leukemogenic *abl/bcr* translocation in a dose-responsive manner similar to that of other carcinogenic promoters. This system will allow detection of that threshold concentration below which

benzene fails to impair stromal cell synthesis of cytokines and, hence, promote leukemogenesis.

- *Non-Carcinogenic Effects*

Like many other organic solvents, benzene, in nearly concentrated form by dermal contact, may cause defattening and dehydration of skin and mucous membranes. Upon ingestion of very high doses, the main acute damage is to the liver and kidneys. Also, in very high doses (in excess of 10,000 ppm), benzene depolarizes neurons to elicit an anaesthetic effect, which, if prolonged can lead to coma and death. However, the acute toxicity of benzene is low (LC_{50}, 7 hrs inhalation, for the rat 10,000 ppm; LD_{50}, oral for the rat 6 g/kg). Signs of depression of the central nervous system represents main acute symptoms of exposure to benzene levels of 1000-10,000 ppm, whereas liver and kidney damage predominate for chronic exposures to 100-1000 ppm (ATSDR, 1988).

The chronic toxicity of benzene for bone marrow has been amply proven in both occupationally exposed workers and experimental animals. Apparently, given ample benzene exposure, a metabolite of benzene inhibits maturation of early blood cell precursors in the bone marrow (Gad-El-Karim et al, 1985). It has long been recognized that benzene, upon long-term exposure of man and experimental animals to high concentrations, may elicit signs of severe damage to the haematopoietic system including anemia and reduced number of circulating white blood cells and platelets. These effects are accompanied by clinical signs such as general weakness, pallor, purpura, and an increased susceptibility to infection. The bone marrow may exhibit hyperplasia as well as aplasia. A number of fatal cases of aplastic anemia due to high exposure to benzene have been reported in the literature. It must be emphasized that these sequelae of bone marrow toxicity require prolonged exposures to benzene in air at ≥ 35 mg/m^3 or in water at ≥ 100 mg/L.

Provisional Toxicological Indices

Carcinogenic risk assessment is a relatively new discipline which has been addressed mainly by the U.S. Environmental Protection Agency (USEPA) over the past decade. For simplicity and as a default for public health protection, USEPA has assumed that all carcinogens act by causing mutations in DNA and that *the frequency of such DNA mutations is directly proportional to carcinogen concentration down through infinite dilution.* Hence, by USEPA's dose-response model for carcinogens (which has been termed LMS for "linearized multi-stage"), there is no threshold concentration below which cancer induction fails to occur. Clearly, USEPA's LMS dose-response model is overly protective for benzene and other carcinogens

which do not react with DNA and which must exceed a certain threshold concentration to elicit cellular responses (see, for example, Bailer and Hoel, 1989; Swaen and Meijers, 1989; and Lamm et al, 1989).

The upshot of the above mechanistic argument is that there is a given level (threshold) of benzene in soil or groundwater which is required to induce those events which lead to myelotoxicity and potential leukemogenicity. This threshold is orders of magnitude higher than those imaginary levels corresponding to a "10^{-6}" or "10^{-5}" risk according to USEPA (these concepts are meaningless for benzene).

A useful indication of which levels of benzene exposure result in bone marrow effects comes from the experiments of Li et al (1986) in which blood leukocyte alkaline phosphatase increases correlate well with leukopenia. Rats were exposed by inhalation to 0, 20, 50, 100, 300, 1000 or 3000 ppm benzene for 7 days and peripheral leukocyte alkaline phosphatase levels assessed. Enzyme levels remained at the control (0 ppm benzene) level in animals exposed to 20 and 50 ppm benzene. At 100 and 300 ppm benzene, there was a dose-dependent and statistically significant increase in leukocyte alkaline phosphatase, which remained high in animals treated with 1000 and 3000 ppm benzene. This experiment suggests that the inhalation benzene threshold for bone marrow toxicity is between 50 and 100 ppm (160 and 320 mg/m^3). A similar threshold (100 ppm in air) has been seen for myelogenous leukemia induction in CBA/Ca mice (Cronkite et al, 1985). Taking the lower value (50 ppm) to be conservative, this benzene threshold for bone marrow toxicity would correspond to a daily dose in humans of 45 mg/kg/day. As is normally the case in risk assessment, this value which has been derived from experimental data is adjusted with safety factors for animal-to-human extrapolation (10X), route-to-route extrapolation (10X) and for potential sensitive persons within exposed populations (10X), resulting in a provisional No Observed Adverse Effect Level (NOAEL) of 0.045 mg/kg/day.

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TOXICOLOGICAL PROFILE FOR MANGANESE

Introduction

Manganese is a vital micronutrient for both plants and animals and functions as a required cofactor in many enzymatic reactions. It is an essential element in the human diet (Schroeder et al, 1966). Manganese is found in most foods, especially vegetables. Whereas no recommended daily allowance has been issued for dietary manganese, the Food and Nutrition Board of the National Research Council (NRC, 1989) has determined that up to 5 mg per day dietary manganese is an "adequate and safe" intake. Similar recommendations have been made by the World Health Organization (WHO, 1973).

Manganese and its compounds are poorly absorbed from both the digestive and respiratory tracts of man and of other mammals. The inhalation toxicity is in general low. Due to its corrosive action, permanganates may damage the lining of the respiratory tract when inhaled in concentrated dusts.

Human Toxicology

The toxicology of manganese has been summarized by the World Health Organization (IPCS, 1981) and USEPA (1984). Unfortunately the database is poor for both relevant epidemiologic and experimental studies from which to derive safe human levels of manganese in various environmental media.

- *Carcinogenic Effects*

Studies on induction of tumors following subcutaneous, intramuscular, or intraperitoneal injection of manganese compounds have been reported (Sunderman et al., 1974, 1976; DiPaolo, 1964; Furst, 1978) and manganous sulfate has also been tested in a mouse lung adenoma screening bioassay (Stoner et al., 1976). However, no convincing evidence of carcinogenicity has been obtained from these investigations. Further, there are no epidemiological indications of carcinogenicity in exposed workers. No adequate long-term oral or inhalation studies in experimental animals that fulfills present day requirements has been conducted; hence, the database must be considered inadequate to evaluate the potential carcinogenic

action of inorganic manganese. There is no evidence of manganese carcinogenicity, either from animal experiments or from epidemiological studies, nor do manganese or its compounds seem to have any appreciable genotoxic action.

- *Non-Carcinogenic Effects*

Manganese and its compounds are poorly absorbed from the gastrointestinal tract of man and of other mammals, and the oral toxicity is in general low. Due to its corrosive action, permanganates may damage the lining of the esophagus and gastrointestinal tract when ingested in concentrated solutions (> 4%). Upon high-level exposure via inhalation manganese may concentrate in the central nervous system, where it can elicit a severe and irreversible brain disease, to some extent similar to Parkinson's disease.

The acute toxicity of manganese compounds to mammals is low; for the rat an oral LD_{50} of 1.3-1.5 g/kg has been determined for the soluble divalent chloride (Holbrook et al, 1975).

The chronic toxicity of manganese compounds is more serious. Irreversible toxic effects on the central nervous system have been induced in various animal species, including the rat and monkey, mainly by repeated administration of high doses of manganese dioxide or dichloride. Typical pathological lesions include degenerative changes primarily in the striatum and pallidum, but lesions in the subthalamic nucleus, cortex, cerebellum and in the brain stem have also been described. Symptoms of CNS-toxicity, including tremor, ataxia and paralysis of the hind limbs are often present. Biochemical and histopathological changes have been reported in other organ systems, notably the liver. Pulmonary changes, such as inflammation and fibrosis, have been described following high level exposures to manganese oxide. Testicular changes have been induced in the rat upon intravenous administration of high doses (50 mg/kg) of permanganate.

In humans an increased morbidity and mortality rate from pneumonia has been described among workers occupationally exposed to high levels of manganese containing dusts, and there are reports of populations living close to manganese-emitting plants that have exhibited an increased incidence of respiratory disease. However, it is difficult to determine to what extent other confounding factors have been involved.

An irreversible chronic manganese intoxication syndrome, known as manganism - and which resembles Parkinson's disease - has been known for a considerable time to occur among workers employed in mining, ore-

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processing plants, and in ferromanganese plants. The clinical picture of this poisoning - characterized by both psychiatric and neurological manifestations mainly related to the extrapyramidal system - may develop after only a few months of exposure. In the absence of reliable biological indicators of exposure the early diagnosis of manganese poisoning is difficult. Measurement of manganese in feces may be useful. Initial subjective symptoms, such as weakness and apathy, are later followed by staggering gait, incoherent and slow talk as well as aggressiveness. At further exposure these signs become more pronounced; patients will develop a fixed facial expression, and increasing clumsiness and inability to make certain movements becomes apparent. In general, neurological examination at this stage will reveal no distinct pathological changes. The fully developed manganism is characterized by severe difficulties in walking caused by muscular hypertonia and tremor mainly in the upper limbs as well as by difficulties in writing and a severe speech impediment. It should be noted, that the EEG may still be normal. Autopsy reports have shown, that lesions of the central nervous system are most severe in the striatum and pallidum and may also be found in the substantia nigra. In addition, a severe reduction in dopamine levels in the caudate nucleus, putamen, and substantia nigra has been detected. This biochemical effect may, in part, explain some of the CNS symptoms caused by manganese.

Only one early instance of chronic intoxication caused by manganese ingestion has been reported in the literature (Kawamura et al., 1941). Well water had been contaminated with manganese dissolved from dry cell batteries buried near the well. Analyzed one month after the outbreak, the water had manganese and zinc concentrations of about 15 mg/L, but were probably at least 20-30 mg/L at the onset of the exposure. Sixteen people showed various CNS symptoms such as lethargy, increased muscle tonus and tremor, as well as mental disturbances. The most severe symptoms were seen in elderly people, whereas children were affected only to a small degree. Three persons died, one from suicide. Upon autopsy elevated manganese concentrations were found in liver, and macroscopic and microscopic pathological changes were detected in the brain, especially in the globus pallidus.

Provisional Toxicological Indices

Typical signs of central nervous system effects have been induced by inhalation exposure of monkeys to manganese dioxide aerosol at concentrations of 0.8-3.0 mg/m^3 for 95 one hour periods over 4 months. Administration by the oral route seems far less effective, presumably because of poor gastrointestinal absorption. Signs of neurotoxicity have only been observed upon oral exposure to very high concentrations. Since no long-term feeding study which satisfies modern regulatory

requirements has been conducted, a NOAEL for this exposure route is not available.

Manganese at an average airborne concentration of 0.11 mg/m^3, is well below the TLV/PEL of 1.0 mg/m^3. The TLV/PEL may be converted to an acceptable daily occupational dose of 0.11 mg/kg, assuming an 8-hour day and a 70 kg worker.

The induction of neurotoxic effects in man constitutes the most relevant toxic endpoint for assessment of risk to humans. The WHO has compiled data on air concentrations and neurological effects of manganese, and has estimated that risk for neurological damage may occur already at concentrations of 2-5 mg/m^3 (IPCS, 1981). Considering some of the studies and observations in ferromanganese plants, where workers are exposed to dusts and fumes containing mainly manganese dioxide particles in the respirable range, a value of 0.3 mg of respirable manganese particles per m^3 of air (time-weighted average) has been recommended as the health-based limit for occupational exposure (WHO, 1980). Assuming 100% absorption in the lungs and a respiratory volume of 25 L/hr/kg, exposure to 0.3 mg/m^3 during a working day of 8 hrs (light work) will correspond to an absorbed dose of 3.0 mg/day for a 70 kg man when adjusted for continuous exposure. Using this value, a safety factor of 100, a 5% absorption by the oral route, as well as an assumed daily water consumption of 2L, a provisional No Observed Adverse Effect Level (NOAEL) of 300 µg/L manganese is obtained. The maximum concentration limit proposed in the USEPA Water Quality Criteria (1986) of 50 µg/L manganese, although based upon objectionable taste, especially in the presence of iron, offers adequate protection of public health.

USEPA (1994) has derived a much lower reference dose of 0.005 mg/kg/day for manganese in drinking water as based upon a flawed epidemiologic study by Kondakis et al (1989). They have issued a separate reference dose of 0.14 mg/kg/day for manganese in food, which is 28 times higher than the water ingestion value and comparable to the 0.3 mg/L drinking water provisional NOAEL for manganese derived above.

The Kondakis et al (1989) study examined 188 Greek nationals in three areas with distinct manganese profiles in groundwater. Study area A (62 persons) had 3.6-14.6 µg/L manganese, study area B (49 persons) had 81.6-252.6 µg/L manganese and study area C (77 persons) had 1600-2300 µg/L manganese. There are some limitations of the Kondakis et al (1989) study which may make it an unsuitable database for formulation of a human reference dose for manganese, including the following deficiencies:

- Only persons ≥50 years of age were chosen for this study, which may represent a population which has been sensitized to the neurotoxic effects of manganese.
- Subjective criteria were utilized to assess neurotoxicity, such as weakness, fatigue, disturbances in gait, etc. These subjective criteria may be a source of unintentional study bias (the study was not conducted blind; all subjects and analysts knew if individuals came from low, medium or high manganese populations).
- Manganese concentrations in blood were not different for the three study areas and, hence, actual differences in manganese exposures are questionable.
- Much more manganese was ingested in food than from well water in all three study groups. Even in the highest groundwater group, approximately 10 times as much manganese may have been ingested from food as from water.

The latter limitation is by far the most serious and renders dubious any interpretation of manganese contributions from groundwater in the Kondakis et al (1989) study.

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Appendix M
Estimated Risk Calculations

APPENDIX M

ESTIMATED RISK CALCULATIONS

REV. 1: MAY 1994

INDUSTRIAL EXPOSURE SCENARIO

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Industrial Exposure:

Ingestion of Chemicals in Soil (0-10')

Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
antimony	4.89	50	0.000001	1	5	25	70	9125	4.78E-08	4.00E-04	1.20E-04
arsenic	6.36	50	0.000001	1	5	25	70	9125	6.22E-08	3.00E-04	2.07E-04
chromium	14.2	50	0.000001	1	5	25	70	9125	1.39E-07	5.00E-03	2.78E-05
copper	13.8	50	0.000001	1	5	25	70	9125	1.35E-07	3.70E-02	3.65E-06
mercury	0.12	50	0.000001	1	5	25	70	9125	1.17E-09	3.00E-04	3.91E-06
ethylbenzene	0.091	50	0.000001	1	5	25	70	9125	8.90E-10	1.00E-01	8.90E-09
cumene	0.199	50	0.000001	1	5	25	70	9125	1.95E-09	4.00E-02	4.87E-08
toluene	0.068	50	0.000001	1	5	25	70	9125	6.65E-10	2.00E-01	3.33E-09
xylene	0.191	50	0.000001	1	5	25	70	9125	1.87E-09	2.00E+00	9.34E-10
ammonia	17.37	50	0.000001	1	5	25	70	9125	1.70E-07	9.70E-01	1.75E-07
aluminum	9968.9	50	0.000001	1	5	25	70	9125	9.75E-05	2.90E+00	3.36E-05
2,4-dimethylphenol	0.216	50	0.000001	1	5	25	70	9125	2.11E-09	2.00E-02	1.06E-07
2-methylphenol	0.2	50	0.000001	1	5	25	70	9125	1.96E-09	5.00E-02	3.91E-08
4-methylphenol	0.2	50	0.000001	1	5	25	70	9125	1.96E-09	5.00E-03	3.91E-07

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 3.97E-04

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (technical judgement; facility workers exposed to subsurface soils no more than five times per year.)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Indusrtrial Exposure:
Dermal Contact with
Chemicals in Soil (0-10')
Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED	REFERENCE	HAZARD INDEX
	(mg/kg)	(10-6)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	DOSE	DOSE	
		(kg/mg)								(mg/kg-day)	(mg/kg-day)	
antimony	4.89	0.000001	3120	1.4	0.01	5	25	70	9125	4.18E-08	2.00E-05	2.09E-03
arsenic	6.36	0.000001	3120	1.4	0.01	5	25	70	9125	5.44E-08	2.97E-04	1.83E-04
chromium	14.2	0.000001	3120	1.4	0.01	5	25	70	9125	1.21E-07	2.00E-04	6.07E-04
copper	13.8	0.000001	3120	1.4	0.01	5	25	70	9125	1.18E-07	3.70E-02	3.19E-06
mercury	0.12	0.000001	3120	1.4	0.01	5	25	70	9125	1.03E-09	4.50E-05	2.28E-05
ethylbenzene	0.091	0.000001	3120	1.4	0.25	5	25	70	9125	1.94E-08	9.70E-02	2.00E-07
cumene	0.199	0.000001	3120	1.4	0.25	5	25	70	9125	4.25E-08	3.60E-02	1.18E-06
toluene	0.068	0.000001	3120	1.4	0.25	5	25	70	9125	1.45E-08	2.00E-01	7.27E-08
xylenes	0.191	0.000001	3120	1.4	0.25	5	25	70	9125	4.08E-08	1.94E+00	2.10E-08
ammonia	17.37	0.000001	3120	1.4	0.1	5	25	70	9125	1.48E-06	9.70E-01	1.53E-06
aluminum	9968.9	0.000001	3120	1.4	0.01	5	25	70	9125	8.52E-05	1.45E+00	5.88E-05
2,4-dimethylphenol	0.216	0.000001	3120	1.4	0.1	5	25	70	9125	1.85E-08	1.60E-02	1.15E-06
2-methyl phenol	0.2	0.000001	3120	1.4	0.1	5	25	70	9125	1.71E-08	4.00E-02	4.27E-07
4-methyl phenol	0.2	0.000001	3120	1.4	0.1	5	25	70	9125	1.71E-08	4.00E-03	4.27E-06

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.97E-03

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (technical judgement; facilitiy workers exposed to subsurface soils no more than five times per year.)
ED = exposure duration (OSWER:9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Industrial Exposure:
Ingestion of
Chemicals in Soil (0-10')
Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	RISK
benzene	0.039	50	0.000001	1	5	25	70	25550	1.36E-10	2.90E-02	3.95E-12
arsenic	6.36	50	0.000001	1	5	25	70	25550	2.22E-08	1.75E+00	3.89E-08

TOTAL CARCINOGENIC RISK 3.89E-08

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)
IR = ingestion rate (OSWER: 9285.6-03,1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (technical judgement; facility workers exposed to subsurface soils no more than five times per year.)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Industrial Exposure:

Dermal Contact with Chemicals in Soil (0-10')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER
Chemical	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	RISK
benzene	0.039	0.000001	3120	1.4	0.25	5	25	70	25550	2.98E-09	2.90E-02	8.63E-11
arsenic	6.36	0.000001	3120	1.4	0.01	5	25	70	25550	1.94E-08	1.77E+00	3.44E-08

TOTAL CARCINOGENIC RISK 3.45E-08

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (technical judgement; facilility workers exposed to subsurface soils no more than five times per year.)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

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REV. 1: MAY 1994

TRESPASSING SCENARIO

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Scenario:
Ingestion of Chemicals
in Surface Water (while wading in Paddys Run)
Adults

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	30	70	10950	3.38E-06	5.00E-03	6.77E-04

TOTAL NONCARCINOGENIC RISK 6.77E-04

where:

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CF = chemical concentration in surface water (95% U.C.L. of mean)
CR = contact rate (EFH, 1989)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Scenario:

Ingestion of Chemicals

in Surface Water (while wading in Paddys Run)

Children

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW xAT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	6	15	2190	1.58E-05	5.00E-03	3.16E-03

TOTAL NONCARCINOGENIC RISK 3.16E-03

where: g:\project\539-15\scen2\chinsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)

CR = contact rate (EFH, 1989)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Scenario:
Dermal Contact with
Chemicals in Surface Water
(wading in Paddys Run)
Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
Chemical	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	8620	0.0015	2.6	7	30	0.001	70	10950	8.75E-07	2.00E-04	4.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.37E-03

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where:
CW = chemical concentration in water (95% U. C. L. of mean)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Scenario:
Dermal Contact with
Chemicals in Surface Water
(wading in Paddys Run)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
Chemical	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	3535	0.0015	2.6	7	6	0.001	15	2190	1.67E-06	2.00E-04	8.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 8.37E-03

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where:
CW = chemical concentration in water (95% U. C. L. of mean)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Scenario:
Ingestion of
Chemicals in Sediment
(while wading in Paddys Run)
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
manganese	456	200	0.000001	1	7	6	15	2190	1.17E-04	5.00E-03	2.33E-02

TOTAL NONCARCINOGENIC RISK 2.33E-02

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where:
CS = chemical concentration in sediment (95% U. C. L. of mean)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (RAGS, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Dermal Contact with Chemicals in Sediment
(while wading in Paddys Run)
Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
Chemical	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	456	0.000001	8620	1.4	0.01	7	30	70	10950	1.51E-05	2.00E-04	7.54E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.54E-02

where:

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CS = chemical concentration in soil (95% of U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Dermal Contact with
Chemicals in Sediment
(while wading in Paddys Run)
Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6 kg/mg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (events\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
manganese	456	0.000001	3535	1.4	0.01	7	6	15	2190	2.89E-05	2.00E-04	1.44E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.44E-01

scan2/chdrmsd.xls

where:

CS = chemical concentration in sediment (95% of U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)
ED = exposure duration (OSWER:9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Ingestion of
Chemicals in Soil (0-2')
Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
arsenic	10.39	1	0.000001	1	7	24	70	8760	2.85E-09	3.00E-04	9.49E-06
copper	22.13	1	0.000001	1	7	24	70	8760	6.06E-09	3.70E-02	1.64E-07
mercury	0.36	1	0.000001	1	7	24	70	8760	9.86E-11	3.00E-04	3.29E-07
cumene	0.004	1	0.000001	1	7	24	70	8760	1.10E-12	4.00E-02	2.74E-11
xylenes	0.004	1	0.000001	1	7	24	70	8760	1.10E-12	2.00E+00	5.48E-13

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 9.98E-06

where: g:\project\539-15\scen2\adslin.xls

CS = chemical concentration in soil (95% U.C.L. of mean)
IR = ingestion rate (EFH, 1989; Level 1 ingestion)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (technical judement, no more than 7 event/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Ingestion of
Chemicals in Soil (0-2')
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
arsenic	10.39	5	0.000001	1	7	6	15	2190	6.64E-08	3.00E-04	2.21E-04
copper	22.13	5	0.000001	1	7	6	15	2190	1.41E-07	3.70E-02	3.82E-06
mercury	0.36	5	0.000001	1	7	6	15	2190	2.30E-09	3.00E-04	7.67E-06
cumene	0.004	5	0.000001	1	7	6	15	2190	2.56E-11	4.00E-02	6.39E-10
xylenes	0.004	5	0.000001	1	7	6	15	2190	2.56E-11	2.00E+00	1.28E-11

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.33E-04

where: g:\project\539-15\scen2\chslin.xls

CS = chemical concentration in soil (95% U. C. L. of mean)
IR = ingestion rate (EFH, 1989; Level 1 soil ingestion)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (technical judgment, no more than 7 events/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Dermal Contact with
Chemicals in Soil (0-2')
Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
Chemical	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(ets\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	10.39	0.000001	8620	1.4	0.01	7	30	70	10950	3.44E-07	2.97E-04	1.16E-03
copper	22.13	0.000001	8620	1.4	0.01	7	30	70	10950	7.32E-07	3.70E-02	1.98E-05
mercury	0.36	0.000001	8620	1.4	0.01	7	30	70	10950	1.19E-08	4.50E-05	2.65E-04
cumene	0.004	0.000001	8620	1.4	0.25	7	30	70	10950	3.31E-09	3.60E-02	9.18E-08
xylenes	0.004	0.000001	8620	1.4	0.25	7	30	70	10950	3.31E-09	1.94E+00	1.70E-09

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.44E-03

where:

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CS = chemical concentration in soil (95% of U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (technical judgement, no more than 7 events/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Dermal Contact with
Chemicals in Soil (0-2')
Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6 kg/mg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (events\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
arsenic	10.39	0.000001	3535	1.4	0.01	7	6	15	2190	6.57E-07	2.97E-04	2.21E-03
copper	22.13	0.000001	3535	1.4	0.01	7	6	15	2190	1.40E-06	3.70E-02	3.78E-05
mercury	0.36	0.000001	3535	1.4	0.01	7	6	15	2190	2.28E-08	4.50E-05	5.06E-04
cumene	0.004	0.000001	3535	1.4	0.25	7	6	15	2190	6.33E-09	3.60E-02	1.76E-07
xylenes	0.004	0.000001	3535	1.4	0.25	7	6	15	2190	6.33E-09	1.94E+00	3.26E-09

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.76E-03

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (technical judgment, no more than 7 event/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Ingestion of
Chemicals in Soil (0-2')
Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	1	0.000001	1	7	24	70	25550	9.76E-10	1.75E+00	1.71E-09

TOTAL CARCINOGENIC RISK 1.71E-09

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)
IR = ingestion rate (EFH, 1989: Level 1 ingestion)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (technical judgement; no more than 7 events/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:
Ingestion of
Chemicals in Soil (0-2')
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	5	0.000001	1	7	6	15	25550	5.69E-09	1.75E+00	9.96E-09

TOTAL CARCINOGENIC RISK 9.96E-09

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)
IR = ingestion rate (EFH, 1989; Level 1 soil ingestion)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (technical judgement, no more than 7 events/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:

Dermal Contact with Chemicals in Soil (0-2')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	0.000001	8620	1.4	0.01	7	30	70	25550	1.47E-07	1.77E+00	2.61E-07

TOTAL CARCINOGENIC RISK 2.61E-07

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

000644

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Trespassing Exposure:

Dermal Contact with Chemicals in Soil (0-2')

Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	0.000001	3535	1.4	0.01	7	6	15	25550	5.64E-08	1.77E+00	9.97E-08

TOTAL CARCINOGENIC RISK 9.97E-08

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (technical judgement; no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

HYPOTHETICAL FARM/RESIDENTIAL SCENARIO

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Ingestion of Chemicals
in Surface Water (while wading in Paddys Run)
Adults

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	30	70	10950	3.38E-06	5.00E-03	6.77E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 6.77E-04

where: g:\project\539-15\scen3\adinsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)
CR = contact rate (EFH, 1989)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Ingestion of Chemicals
in Surface Water (while wading in Paddys Run)
Children

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	6	15	2190	1.58E-05	5.00E-03	3.16E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 3.16E-03

where: g:\project\539-15\scen3\chinsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)
CR = contact rate (EFH, 1989)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Surface Water
(wading in Paddys Run)
Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	8620	0.0015	2.6	7	30	0.001	70	10950	8.75E-07	2.00E-04	4.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.37E-03

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where:
CW = chemical concentration in water (95% U. C. L. of mean)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Surface Water
(wading in Paddys Run)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs	(L/cc)	(kg)	(days	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	3535	0.0015	2.6	7	6	0.001	15	2190	1.67E-06	2.00E-04	8.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 8.37E-03

g:\project\539-15\scen3\chdmsfw.xls

where:
CW = chemical concentration in water (95% U. C. L. of mean)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

000650

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Ingestion of
Chemicals in Sediment
(while wading in Paddys Run)
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
manganese	456	200	0.000001	1	7	6	15	2190	1.17E-04	5.00E-03	2.33E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.33E-02

g:\project\539-15\scen3\chsdin.xls

where:
CS = chemical concentration in sediment (95% U. C. L. of mean)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (RAGS, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Dermal Contact with Chemicals in Sediment (while wading in Paddys Run) Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6) (mg/kg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (events\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
manganese	456	0.000001	8620	1.4	0.01	7	30	70	10950	1.51E-05	2.00E-04	7.54E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.54E-02

where: g:\project\539-15\scen3\addrmsd.xls

CS = chemical concentration in soil (95% of U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000652

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Sediment
(while wading in Paddys Run)
Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
Chemical	(mg/kg)	(10-6)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
		(kg/mg)										
manganese	456	0.000001	3535	1.4	0.01	7	6	15	2190	2.89E-05	2.00E-04	1.44E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.44E-01

where:

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CS = chemical concentration in sediment (95% of U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER:9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Ingestion of Chemicals in Soil (0-2')

Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / BW x AT

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	10.39	100	0.000001	1	350	24	70	8760	1.42E-05	3.00E-04	4.74E-02
copper	22.13	100	0.000001	1	350	24	70	8760	3.03E-05	3.70E-02	8.19E-04
mercury	0.36	100	0.000001	1	350	24	70	8760	4.93E-07	3.00E-04	1.64E-03
cumene	0.004	100	0.000001	1	350	24	70	8760	5.48E-09	4.00E-02	1.37E-07
xylenes	0.004	100	0.000001	1	350	24	70	8760	5.48E-09	2.00E+00	2.74E-09

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.99E-02

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)

IR = ingestion rate (OSWER 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm\Residential Scenario:

Ingestion of

Chemicals in Soil (0-2')

Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	10.39	200	0.000001	1	350	6	15	2190	1.33E-04	3.00E-04	4.43E-01
copper	22.13	200	0.000001	1	350	6	15	2190	2.83E-04	3.70E-02	7.65E-03
mercury	0.36	200	0.000001	1	350	6	15	2190	4.60E-06	3.00E-04	1.53E-02
cumene	0.004	200	0.000001	1	350	6	15	2190	5.11E-08	4.00E-02	1.28E-06
xylenes	0.004	200	0.000001	1	350	6	15	2190	5.11E-08	2.00E+00	2.56E-08

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.66E-01

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

IR = ingestion rate (OSWER 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Dermal Contact with Chemicals in Soil (0-2')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6 kg/mg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (ents\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
arsenic	10.39	0.000001	8620	1.4	0.01	350	30	70	10950	1.72E-05	2.97E-04	5.78E-02
copper	22.13	0.000001	8620	1.4	0.01	350	30	70	10950	3.66E-05	3.70E-02	9.89E-04
mercury	0.36	0.000001	8620	1.4	0.01	350	30	70	10950	5.95E-07	4.50E-05	1.32E-02
cumene	0.004	0.000001	8620	1.4	0.25	350	30	70	10950	1.65E-07	3.60E-02	4.59E-06
xylenes	0.004	0.000001	8620	1.4	0.25	350	30	70	10950	1.65E-07	1.94E+00	8.52E-08

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.21E-02

where:

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CS = chemical concentration in soil (95% of U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER 9285.6-03, 1991)

ED = exposure duration (OSWER 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000656

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Dermal Contact with Chemicals in Soil (0-2')

Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6 kg/mg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (ents\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
arsenic	10.39	0.000001	3535	1.4	0.01	350	6	15	2190	3.29E-05	2.97E-04	1.11E-01
copper	22.13	0.000001	3535	1.4	0.01	350	6	15	2190	7.00E-05	3.70E-02	1.89E-03
mercury	0.36	0.000001	3535	1.4	0.01	350	6	15	2190	1.14E-06	4.50E-05	2.53E-02
cumene	0.004	0.000001	3535	1.4	0.25	350	6	15	2190	3.16E-07	3.60E-02	8.79E-06
xylenes	0.004	0.000001	3535	1.4	0.25	350	6	15	2190	3.16E-07	1.94E+00	1.63E-07

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.38E-01

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where:

CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Ingestion of

Chemicals in Soil (0-2')

Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	100	0.000001	1	350	24	70	25550	4.88E-06	1.75E+00	8.54E-06

TOTAL CARCINOGENIC RISK 8.54E-06

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

000658

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Ingestion of
Chemicals in Soil (0-2')
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	200	0.000001	1	350	6	15	25550	1.14E-05	1.75E+00	1.99E-05

TOTAL CARCINOGENIC RISK 1.99E-05

where:
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CS = chemical concentration in soil (95% U. C. L. of mean)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Dermal Contact with Chemicals in Soil (0-2')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	0.000001	8620	1.4	0.01	350	30	70	25550	7.36E-06	1.77E+00	1.30E-05

TOTAL CARCINOGENIC RISK 1.30E-05

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER: 9285.6-03,1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

000660

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Dermal Contact with Chemicals in Soil (0-2')

Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	10.39	0.000001	3535	1.4	0.01	350	6	15	25550	2.82E-06	1.77E+00	4.99E-06

TOTAL CARCINOGENIC RISK 4.99E-06

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER: 9285.6-03,1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Ingestion of Chemicals in Groundwater

Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
aluminum	2.81	2	350	30	70	10950	7.70E-02	2.90E+00	2.65E-02
arsenic	0.038	2	350	30	70	10950	1.04E-03	3.00E-04	3.47E+00
barium	0.173	2	350	30	70	10950	4.74E-03	7.00E-02	6.77E-02
chromium	0.016	2	350	30	70	10950	4.38E-04	5.00E-03	8.77E-02
copper	0.03	2	350	30	70	10950	8.22E-04	3.70E-02	2.22E-02
manganese	1.37	2	350	30	70	10950	3.75E-02	5.00E-03	7.51E+00
mercury	0.00015	2	350	30	70	10950	4.11E-06	3.00E-04	1.37E-02
vanadium	0.015	2	350	30	70	10950	4.11E-04	7.00E-03	5.87E-02
ethylbenzene	0.25	2	350	30	70	10950	6.85E-03	1.00E-01	6.85E-02
cumene	0.63	2	350	30	70	10950	1.73E-02	4.00E-02	4.32E-01
toluene	0.32	2	350	30	70	10950	8.77E-03	2.00E-01	4.38E-02
xylenes	0.63	2	350	30	70	10950	1.73E-02	2.00E+00	8.63E-03
phenol	0.008	2	350	30	70	10950	2.19E-04	6.00E-01	3.65E-04
2-methylphenol	0.03	2	350	30	70	10950	8.22E-04	5.00E-02	1.64E-02
4-methylphenol	0.05	2	350	30	70	10950	1.37E-03	5.00E-03	2.74E-01
2,4-dimethylphenol	0.015	2	350	30	70	10950	4.11E-04	2.00E-02	2.05E-02
ammonia	0.795	2	350	30	70	10950	2.18E-02	9.70E-01	2.25E-02

TOTAL NONCARCINOGENIC RISK 1.21E+01

where: g:\project\539-15\scen3\adinwtr1.xls

CW = chemical concentration in water (95% U.C.L. of mean within plumes)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)

BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000662

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Ingestion of Chemicals in Groundwater — Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)

Children — Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
aluminum	2.81	1	350	6	15	2190	1.80E-01	2.90E+00	6.19E-02
arsenic	0.038	1	350	6	15	2190	2.43E-03	3.00E-04	8.10E+00
barium	0.173	1	350	6	15	2190	1.11E-02	7.00E-02	1.58E-01
chromium	0.016	1	350	6	15	2190	1.02E-03	5.00E-03	2.05E-01
copper	0.03	1	350	6	15	2190	1.92E-03	3.70E-02	5.18E-02
manganese	1.37	1	350	6	15	2190	8.76E-02	5.00E-03	1.75E+01
mercury	0.00015	1	350	6	15	2190	9.59E-06	3.00E-04	3.20E-02
vanadium	0.015	1	350	6	15	2190	9.59E-04	7.00E-03	1.37E-01
ethylbenzene	0.25	1	350	6	15	2190	1.60E-02	1.00E-01	1.60E-01
cumene	0.63	1	350	6	15	2190	4.03E-02	4.00E-02	1.01E+00
toluene	0.32	1	350	6	15	2190	2.05E-02	2.00E-01	1.02E-01
xylenes	0.63	1	350	6	15	2190	4.03E-02	2.00E+00	2.01E-02
phenol	0.008	1	350	6	15	2190	5.11E-04	6.00E-01	8.52E-04
2-methylphenol	0.03	1	350	6	15	2190	1.92E-03	5.00E-02	3.84E-02
4-methylphenol	0.05	1	350	6	15	2190	3.20E-03	5.00E-03	6.39E-01
2,4-dimethylphenol	0.015	1	350	6	15	2190	9.59E-04	2.00E-02	4.79E-02
ammonia	0.795	1	350	6	15	2190	5.08E-02	9.70E-01	5.24E-02

TOTAL NONCARCINOGENIC RISK 2.83E+01

where: g:\project\539-15\scen3\chinwtr1.xls

CW = chemical concentration in water (95% U.C.L. of mean within plumes)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)

BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Groundwater
(showering)
Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/yr	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
aluminum	2.81	18150	0.0015	0.2	350	30	0.001	70	10950	2.10E-04	1.45E+00	1.45E-04
arsenic	0.038	18150	0.0015	0.2	350	30	0.001	70	10950	2.83E-06	2.85E-04	9.95E-03
barium	0.173	18150	0.0015	0.2	350	30	0.001	70	10950	1.29E-05	3.50E-03	3.69E-03
chromium	0.016	18150	0.0015	0.2	350	30	0.001	70	10950	1.19E-06	2.00E-04	5.97E-03
copper	0.03	18150	0.0015	0.2	350	30	0.001	70	10950	2.24E-06	1.85E-03	1.21E-03
manganese	1.37	18150	0.0015	0.2	350	30	0.001	70	10950	1.02E-04	2.00E-04	5.11E-01
mercury	0.00015	18150	0.0015	0.2	350	30	0.001	70	10950	1.12E-08	4.50E-05	2.49E-04
vanadium	0.015	18150	0.0015	0.2	350	30	0.001	70	10950	1.12E-06	7.00E-05	1.60E-02
ethylbenzene	0.25	18150	0.11	0.2	350	30	0.001	70	10950	1.37E-03	8.00E-02	1.71E-02
cumene	0.63	18150	0.11	0.2	350	30	0.001	70	10950	3.45E-03	3.60E-02	9.57E-02
toluene	0.32	18150	0.11	0.2	350	30	0.001	70	10950	1.75E-03	2.00E-01	8.75E-03
xylenes	0.63	18150	0.11	0.2	350	30	0.001	70	10950	3.45E-03	1.84E+00	1.87E-03
phenol	0.008	18150	0.11	0.2	350	30	0.001	70	10950	4.38E-05	5.40E-01	8.10E-05
2-methylphenol	0.03	18150	0.11	0.2	350	30	0.001	70	10950	1.64E-04	4.00E-02	4.10E-03
4-methylphenol	0.05	18150	0.11	0.2	350	30	0.001	70	10950	2.73E-04	4.00E-03	6.84E-02
2,4-dimethylphenol	0.015	18150	0.11	0.2	350	30	0.001	70	10950	8.20E-05	1.60E-02	5.13E-03
ammonia	0.795	18150	0.11	0.2	350	30	0.001	70	10950	4.35E-03	9.70E-01	4.48E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.54E-01

where: g:\project\539-15\scen3\addmwtr1.xls

CW = chemical concentration in water (95% U. C. L. of mean within plumes)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Groundwater
(showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW (mg/L)	SA (cm2)	PC (cm/hr)	ET hr/day	EF days/yr	ED (yrs)	CF (L/cc)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
aluminum	2.81	7195	0.0015	0.2	350	6	0.001	15	2190	3.88E-04	1.45E+00	2.67E-04
arsenic	0.038	7195	0.0015	0.2	350	6	0.001	15	2190	5.24E-06	2.85E-04	1.84E-02
barium	0.173	7195	0.0015	0.2	350	6	0.001	15	2190	2.39E-05	3.50E-03	6.82E-03
chromium	0.016	7195	0.0015	0.2	350	6	0.001	15	2190	2.21E-06	2.00E-04	1.10E-02
copper	0.03	7195	0.0015	0.2	350	6	0.001	15	2190	4.14E-06	1.85E-03	2.24E-03
manganese	1.37	7195	0.0015	0.2	350	6	0.001	15	2190	1.89E-04	2.00E-04	9.45E-01
mercury	0.00015	7195	0.0015	0.2	350	6	0.001	15	2190	2.07E-08	4.50E-05	4.60E-04
vanadium	0.015	7195	0.0015	0.2	350	6	0.001	15	2190	2.07E-06	7.00E-05	2.96E-02
ethylbenzene	0.25	7195	0.11	0.2	350	6	0.001	15	2190	2.53E-03	8.00E-02	3.16E-02
cumene	0.63	7195	0.11	0.2	350	6	0.001	15	2190	6.37E-03	3.60E-02	1.77E-01
toluene	0.32	7195	0.11	0.2	350	6	0.001	15	2190	3.24E-03	2.00E-01	1.62E-02
xylenes	0.63	7195	0.11	0.2	350	6	0.001	15	2190	6.37E-03	1.84E+00	3.46E-03
phenol	0.008	7195	0.11	0.2	350	6	0.001	15	2190	8.10E-05	5.40E-01	1.50E-04
2-methylphenol	0.03	7195	0.11	0.2	350	6	0.001	15	2190	3.04E-04	4.00E-02	7.59E-03
4-methylphenol	0.05	7195	0.11	0.2	350	6	0.001	15	2190	5.06E-04	4.00E-03	1.26E-01
2,4-dimethylphenol	0.015	7195	0.11	0.2	350	6	0.001	15	2190	1.52E-04	1.60E-02	9.49E-03
ammonia	0.795	7195	0.11	0.2	350	6	0.001	15	2190	8.04E-03	9.70E-01	8.29E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.39E+00

where: g:\project\539-15\scen3\chdmwtr1.xls

CW = chemical concentration in water (95% U. C. L. of mean within plumes)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.038	2	350	30	70	25550	4.46E-04	1.75E+00	7.81E-04
benzene	0.066	2	350	30	70	25550	7.75E-04	2.90E-02	2.25E-05

TOTAL CARCINOGENIC RISK 8.03E-04

where:

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CW = chemical concentration in water (95% U.C.L. of mean within plumes)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.038	1	350	6	15	25550	2.08E-04	1.75E+00	3.64E-04
benzene	0.066	1	350	6	15	25550	3.62E-04	2.90E-02	1.05E-05

TOTAL CARCINOGENIC RISK 3.75E-04

where: g:\project\539-15\scen3\chinwtc1.xls

CW = chemical concentration in water (95% U.C.L. of mean within plumes)
IR = ingestion rate (EFH,1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Groundwater
(showering)
Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.038	18150	0.0015	0.2	350	30	0.001	70	25550	1.21E-06	1.84E+00	2.24E-06
benzene	0.066	18150	0.11	0.2	350	30	0.001	70	25550	1.55E-04	3.22E-02	4.98E-06

TOTAL CARCINOGENIC RISK 7.22E-06

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where:
CW = chemical concentration in water (95% U.C.L. of mean within plumes)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Dermal Contact with
Chemicals in Groundwater
(showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.038	7195	0.0015	0.2	350	6	0.001	15	25550	4.49E-07	1.84E+00	8.27E-07
benzene	0.066	7195	0.11	0.2	350	6	0.001	15	25550	5.72E-05	3.22E-02	1.84E-06

TOTAL CARCINOGENIC RISK 2.67E-06

where:

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CW = chemical concentration in water (95% U.C.L. of mean within plumes)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Inhalation of Airborne (Vapor Phase) Chemicals (showering) Adults

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	0.27	0.83	0.2	350	30	70	10950	6.14E-04	1.14E-01	5.39E-03
ethylbenzene	0.22	0.83	0.2	350	30	70	10950	5.00E-04	2.86E-01	1.75E-03
cumene	0.003	0.83	0.2	350	30	70	10950	6.82E-06	2.57E-03	2.65E-03
xylenes	0.61	0.83	0.2	350	30	70	10950	1.39E-03	2.00E-01	6.94E-03
ammonia	0.035	0.83	0.2	350	30	70	10950	7.96E-05	2.86E-02	2.78E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.95E-02

where:

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CA = chemical concentration in air (calculated from Andelman, 1985)

IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)

ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration ((OSWER: 9285.6-03,1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:

Inhalation of Airborne (Vapor Phase) Chemicals (showering) Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	0.27	0.83	0.2	350	6	15	2190	2.87E-03	1.14E-01	2.51E-02
ethylbenzene	0.22	0.83	0.2	350	6	15	2190	2.33E-03	2.86E-01	8.16E-03
cumene	0.003	0.83	0.2	350	6	15	2190	3.18E-05	2.57E-03	1.24E-02
xylenes	0.61	0.83	0.2	350	6	15	2190	6.47E-03	2.00E-01	3.24E-02
ammonia	0.035	0.83	0.2	350	6	15	2190	3.71E-04	2.86E-02	1.30E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 9.10E-02

where: scen3/chnhsh.xls

CA = chemical concentration in air (calculated from Andelman, 1985)

IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)

ET = exposure time (RAGS, 1989, 12 minutes)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration ((OSWER: 9285.6-03,1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Adults

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.05	0.83	0.2	350	30	70	25550	4.87E-05	2.90E-02	1.41E-06

TOTAL CARCINOGENIC RISK 1.41E-06

where: g:\project\539-15\scen3\adnhshc.xls

CW = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Hypothetical Farm/Residential Scenario:
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.05	0.83	0.2	350	6	15	25550	4.55E-05	2.90E-02	1.32E-06

TOTAL CARCINOGENIC RISK 1.32E-06

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where:
CW = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

FUTURE SITUATION - FARM/RESIDENTIAL SCENARIO

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Ingestion of Chemicals in Surface Water (while wading in Paddys Run)

Adults

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	30	70	10950	3.38E-06	5.00E-03	6.77E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 6.77E-04

where:

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CF = chemical concentration in surface water (95% U.C.L. of mean)

CR = contact rate (EFH, 1989)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Ingestion of Chemicals in Surface Water (while wading in Paddys Run)

Children

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	6	15	2190	1.58E-05	5.00E-03	3.16E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 3.16E-03

where: g:\project\539-15\scen4\chinsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)

CR = contact rate (EFH, 1989)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000676

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Dermal Contact with

Chemicals in Surface Water

(wading in Paddys Run)

Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	8620	0.0015	2.6	7	30	0.001	70	10950	8.75E-07	2.00E-04	4.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.37E-03

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where: g:\project\539-15\scen4\addmsfw.xls

CW = chemical concentration in water (95% U. C. L. of mean)

SA = skin surface area available for contact (EFH, 1989)

PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

CF = volumetric conversion factor for water

BW = body weight (OSWER: 9285.6-03, 1991)

AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Dermal Contact with

Chemicals in Surface Water

(wading in Paddys Run)

Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(cm2)	(cm/hr)	hr/day	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	3535	0.0015	2.6	7	6	0.001	15	2190	1.67E-06	2.00E-04	8.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 8.37E-03

where: g:\project\539-15\scen4\chdmsfw.xls

CW = chemical concentration in water (95% U. C. L. of mean)

SA = skin surface area available for contact (EFH, 1989)

PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

CF = volumetric conversion factor for water

BW = body weight (OSWER: 9285.6-03, 1991)

AT - averaging time (ED x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Ingestion of Chemicals in Sediment (while wading in Paddys Run) Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	456	200	0.000001	1	7	6	15	2190	1.17E-04	5.00E-03	2.33E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.33E-02

where:

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CS = chemical concentration in sediment (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (RAGS, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991; technical judgement, no more than 7 events/yr)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Exposure:

Dermal Contact with Chemicals in Sediment (while wading in Paddys Run) Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6 kg/mg)	SA (cm2/event	AF (mg/cm2)	ABS	EF (events\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
manganes	456	0.000001	3535	1.4	0.01	7	6	15	2190	2.89E-05	2.00E-04	1.44E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.44E-01

where:

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CS = chemical concentration in sediment (95% of U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Exposure:

Dermal Contact with Chemicals in Sediment (while wading in Paddys Run) Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6 kg/mg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (events\yr)	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
manganese	456	0.000001	8620	1.4	0.01	7	30	70	10950	1.51E-05	2.00E-04	7.54E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.54E-02

where:

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CS = chemical concentration in soil (95% of U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm-Residential Scenario:

Ingestion of Chemicals in Soil (0-10')

Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
antimony	4.89	100	0.000001	1	350	24	70	8760	6.70E-06	4.00E-04	1.67E-02
arsenic	6.36	100	0.000001	1	350	24	70	8760	8.71E-06	3.00E-04	2.90E-02
chromium	14.2	100	0.000001	1	350	24	70	8760	1.95E-05	5.00E-03	3.89E-03
copper	13.8	100	0.000001	1	350	24	70	8760	1.89E-05	3.70E-02	5.11E-04
mercury	0.12	100	0.000001	1	350	24	70	8760	1.64E-07	3.00E-04	5.48E-04
ethylbenzene	0.091	100	0.000001	1	350	24	70	8760	1.25E-07	1.00E-01	1.25E-06
cumene	0.199	100	0.000001	1	350	24	70	8760	2.73E-07	4.00E-02	6.82E-06
toluene	0.068	100	0.000001	1	350	24	70	8760	9.32E-08	2.00E-01	4.66E-07
xylene	0.191	100	0.000001	1	350	24	70	8760	2.62E-07	2.00E+00	1.31E-07
ammonia	17.37	100	0.000001	1	350	24	70	8760	2.38E-05	9.70E-01	2.45E-05
aluminum	9968.9	100	0.000001	1	350	24	70	8760	1.37E-02	2.90E+00	4.71E-03
2,4-dimethylphenol	0.216	100	0.000001	1	350	24	70	8760	2.96E-07	2.00E-02	1.48E-05
2-methylphenol	0.2	100	0.000001	1	350	24	70	8760	2.74E-07	5.00E-02	5.48E-06
4-methylphenol	0.2	100	0.000001	1	350	24	70	8760	2.74E-07	5.00E-03	5.48E-05

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 5.56E-02

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm-Residential Scenario:

Ingestion of Chemicals in Soil (0-10')

Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
antimony	4.89	200	0.000001	1	350	6	15	2190	6.25E-05	4.00E-04	1.56E-01
arsenic	6.36	200	0.000001	1	350	6	15	2190	8.13E-05	3.00E-04	2.71E-01
chromium	14.2	200	0.000001	1	350	6	15	2190	1.82E-04	5.00E-03	3.63E-02
copper	13.8	200	0.000001	1	350	6	15	2190	1.76E-04	3.70E-02	4.77E-03
mercury	0.12	200	0.000001	1	350	6	15	2190	1.53E-06	3.00E-04	5.11E-03
ethylbenzene	0.091	200	0.000001	1	350	6	15	2190	1.16E-06	1.00E-01	1.16E-05
cumene	0.199	200	0.000001	1	350	6	15	2190	2.54E-06	4.00E-02	6.36E-05
toluene	0.068	200	0.000001	1	350	6	15	2190	8.69E-07	2.00E-01	4.35E-06
xylene	0.191	200	0.000001	1	350	6	15	2190	2.44E-06	2.00E+00	1.22E-06
ammonia	17.37	200	0.000001	1	350	6	15	2190	2.22E-04	9.70E-01	2.29E-04
aluminum	9968.9	200	0.000001	1	350	6	15	2190	1.27E-01	2.90E+00	4.40E-02
2,4-dimethylphenol	0.216	200	0.000001	1	350	6	15	2190	2.76E-06	2.00E-02	1.38E-04
2-methylphenol	0.2	200	0.000001	1	350	6	15	2190	2.56E-06	5.00E-02	5.11E-05
4-methylphenol	0.2	200	0.000001	1	350	6	15	2190	2.56E-06	5.00E-03	5.11E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 5.19E-01

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Dermal Contact with Chemicals in Soil (0-10')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED	REFERENCE	HAZARD INDEX
	(mg/kg)	(10-6)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	DOSE	DOSE	
		(kg/mg)								(mg/kg-day)	(mg/kg-day)	
antimony	4.89	1E-06	8620	1.4	0.01	350	30	70	10950	8.08E-06	2.00E-05	4.04E-01
arsenic	6.36	1E-06	8620	1.4	0.01	350	30	70	10950	1.05E-05	2.97E-04	3.54E-02
chromium	14.2	1E-06	8620	1.4	0.01	350	30	70	10950	2.35E-05	2.00E-04	1.17E-01
copper	13.8	1E-06	8620	1.4	0.01	350	30	70	10950	2.28E-05	3.70E-02	6.17E-04
mercury	0.12	1E-06	8620	1.4	0.01	350	30	70	10950	1.98E-07	4.50E-05	4.41E-03
ethylbenzene	0.091	1E-06	8620	1.4	0.25	350	30	70	10950	3.76E-06	9.70E-02	3.88E-05
cumene	0.199	1E-06	8620	1.4	0.25	350	30	70	10950	8.22E-06	3.60E-02	2.28E-04
toluene	0.068	1E-06	8620	1.4	0.25	350	30	70	10950	2.81E-06	2.00E-01	1.41E-05
xylenes	0.191	1E-06	8620	1.4	0.25	350	30	70	10950	7.89E-06	1.94E+00	4.07E-06
ammonia	17.37	1E-06	8620	1.4	0.1	350	30	70	10950	2.87E-04	9.70E-01	2.96E-04
aluminum	9968.9	1E-06	8620	1.4	0.01	350	30	70	10950	1.65E-02	1.45E+00	1.14E-02
2,4-dimethylphenol	0.216	1E-06	8620	1.4	0.1	350	30	70	10950	3.57E-06	1.60E-02	2.23E-04
2-methylphenol	0.2	1E-06	8620	1.4	0.1	350	30	70	10950	3.31E-06	4.00E-02	8.27E-05
4-methylphenol	0.2	1E-06	8620	1.4	0.1	350	30	70	10950	3.31E-06	4.00E-03	8.27E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 5.75E-01

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER:9285.6-03, 1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000684

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
Dermal Contact with Chemicals in Soil (0-10')
Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED	REFERENCE	HAZARD INDEX
	(mg/kg)	(10-6)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	DOSE	DOSE	
		(kg/mg)								(mg/kg-day)	(mg/kg-day)	
antimony	4.89	1E-06	3535	1.4	0.01	350	6	15	2190	1.55E-05	2.00E-05	7.74E-01
arsenic	6.36	1E-06	3535	1.4	0.01	350	6	15	2190	2.01E-05	2.97E-04	6.77E-02
chromium	14.2	1E-06	3535	1.4	0.01	350	6	15	2190	4.49E-05	2.00E-04	2.25E-01
copper	13.8	1E-06	3535	1.4	0.01	350	6	15	2190	4.37E-05	3.70E-02	1.18E-03
mercury	0.12	1E-06	3535	1.4	0.01	350	6	15	2190	3.80E-07	4.50E-05	8.44E-03
ethylbenzene	0.091	1E-06	3535	1.4	0.25	350	6	15	2190	7.20E-06	9.70E-02	7.42E-05
cumene	0.199	1E-06	3535	1.4	0.25	350	6	15	2190	1.57E-05	3.60E-02	4.37E-04
toluene	0.068	1E-06	3535	1.4	0.25	350	6	15	2190	5.38E-06	2.00E-01	2.69E-05
xylenes	0.191	1E-06	3535	1.4	0.25	350	6	15	2190	1.51E-05	1.94E+00	7.79E-06
ammonia	17.37	1E-06	3535	1.4	0.1	350	6	15	2190	5.50E-04	9.70E-01	5.67E-04
aluminum	9968.9	1E-06	3535	1.4	0.01	350	6	15	2190	3.15E-02	1.45E+00	2.18E-02
2,4-dimethylphenol	0.216	1E-06	3535	1.4	0.1	350	6	15	2190	6.83E-06	1.60E-02	4.27E-04
2-methylphenol	0.2	1E-06	3535	1.4	0.1	350	6	15	2190	6.33E-06	4.00E-02	1.58E-04
4-methylphenol	0.2	1E-06	3535	1.4	0.1	350	6	15	2190	6.33E-06	4.00E-03	1.58E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.10E+00

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Ingestion of

Chemicals in Soil (0-10')

Adults

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	100	0.000001	1	350	24	70	25550	1.83E-08	2.90E-02	5.31E-10
arsenic	6.36	100	0.000001	1	350	24	70	25550	2.99E-06	1.75E+00	5.23E-06

TOTAL CARCINOGENIC RISK 5.23E-06

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

000686

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Ingestion of

Chemicals in Soil (0-10')

Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	200	0.000001	1	350	6	15	25550	4.27E-08	2.90E-02	1.24E-09
arsenic	6.36	200	0.000001	1	350	6	15	25550	6.97E-06	1.75E+00	1.22E-05

TOTAL CARCINOGENIC RISK 1.22E-05

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE, FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Dermal Contact with Chemicals in Soil (0-10')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg	10-6 kg/mg	cm2/event	(mg/cm2)		(events\y	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.04	0.000001	8620	1.4	0.25	350	30	70	25550	6.91E-07	2.90E-02	2.00E-08
arsenic	6.36	0.000001	8620	1.4	0.01	350	30	70	25550	4.51E-06	1.77E+00	7.98E-06

TOTAL CARCINOGENIC RISK 8.00E-06

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER: 9285.6-03,1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE, FERNALD, OHIO

Future Situation - Farm/Residential Scenario:

Dermal Contact with Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Chemicals in Soil (0-10') Cancer Risk = Absorbed Dose x Slope Factor

Children

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(10-6 kg/mg)	(cm2/event)	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	0.000001	3535	1.4	0.25	350	6	15	25550	2.64E-07	2.90E-02	7.67E-09
arsenic	6.36	0.000001	3535	1.4	0.01	350	6	15	25550	1.72E-06	1.77E+00	3.05E-06

TOTAL CARCINOGENIC RISK 3.05E-06

where: g:\project\539-15\scen4\chsldmc.xls

CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER: 9285.6-03,1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	0.0054	2	350	30	70	10950	1.48E-04	3.00E-04	4.93E-01
ethylbenzene	4.159	2	350	30	70	10950	1.14E-01	1.00E-01	1.14E+00
cumene	5.662	2	350	30	70	10950	1.55E-01	4.00E-02	3.88E+00
toluene	4.92	2	350	30	70	10950	1.35E-01	2.00E-01	6.74E-01
xylenes	5.754	2	350	30	70	10950	1.58E-01	2.00E+00	7.88E-02

TOTAL NONCARCINOGENIC RISK 8.60E+00

where:

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CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	0.0054	1	350	6	15	2190	3.45E-04	3.00E-04	1.15E+00
ethylbenzene	4.159	1	350	6	15	2190	2.66E-01	1.00E-01	2.66E+00
cumene	5.662	1	350	6	15	2190	3.62E-01	4.00E-02	9.05E+00
toluene	4.92	1	350	6	15	2190	3.15E-01	2.00E-01	1.57E+00
xylenes	5.754	1	350	6	15	2190	3.68E-01	2.00E+00	1.84E-01

TOTAL NONCARCINOGENIC RISK 1.70E+01

where: g:\project\539-15\scen4\chinwtr1.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Dermal Contact with
Chemicals in Groundwater (while showering)
Adult

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/yr	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
arsenic	0.0054	18150	0.0015	0.2	350	30	0.001	70	10950	4.03E-07	2.85E-04	1.41E-03
ethylbenzene	4.159	18150	0.11	0.2	350	30	0.001	70	10950	2.27E-02	8.00E-02	2.84E-01
cumene	5.662	18150	0.11	0.2	350	30	0.001	70	10950	3.10E-02	3.60E-02	8.60E-01
toluene	4.92	18150	0.11	0.2	350	30	0.001	70	10950	2.69E-02	2.00E-01	1.35E-01
xylenes	5.754	18150	0.11	0.2	350	30	0.001	70	10950	3.15E-02	1.84E+00	1.71E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.30E+00

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where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Dermal Contact with
Chemicals in Groundwater (while showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/yr	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
arsenic	0.0054	7195	0.0015	0.2	350	6	0.001	15	2190	7.45E-07	2.85E-04	2.61E-03
ethylbenzene	4.159	7195	0.11	0.2	350	6	0.001	15	2190	4.21E-02	8.00E-02	5.26E-01
cumene	5.662	7195	0.11	0.2	350	6	0.001	15	2190	5.73E-02	3.60E-02	1.59E+00
toluene	4.92	7195	0.11	0.2	350	6	0.001	15	2190	4.98E-02	2.00E-01	2.49E-01
xylenes	5.754	7195	0.11	0.2	350	6	0.001	15	2190	5.82E-02	1.84E+00	3.16E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.40E+00

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where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0054	2	350	30	70	25550	6.34E-05	1.75E+00	1.11E-04
benzene	0.498	2	350	30	70	25550	5.85E-03	2.90E-02	1.70E-04

TOTAL CARCINOGENIC RISK 2.81E-04

where:
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CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0054	1	350	6	15	25550	2.96E-05	1.75E+00	5.18E-05
benzene	0.498	1	350	6	15	25550	2.73E-03	2.90E-02	7.91E-05

TOTAL CARCINOGENIC RISK 1.31E-04

where: g:\project\539-15\scen4\chinwtc1.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Dermal Contact with
Chemicals in Groundwater
(showering)
Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0054	18150	0.0015	0.2	350	30	0.001	70	25550	1.73E-07	1.84E+00	3.18E-07
benzene	0.498	18150	0.11	0.2	350	30	0.001	70	25550	1.17E-03	3.22E-02	3.76E-05

TOTAL CARCINOGENIC RISK 3.79E-05

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where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Dermal Contact with
Chemicals in Groundwater
(showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0054	7195	0.0015	0.2	350	6	0.001	15	25550	6.39E-08	1.84E+00	1.18E-07
benzene	0.498	7195	0.11	0.2	350	6	0.001	15	25550	4.32E-04	3.22E-02	1.39E-05

TOTAL CARCINOGENIC RISK 1.40E-05

where:
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CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Inhalation of Airborne (Vapor Phase) Chemicals (showering)
Adults

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	4.3	0.83	0.2	350	30	70	10950	9.78E-03	5.70E-01	1.72E-02
ethylbenzene	3.7	0.83	0.2	350	30	70	10950	8.41E-03	2.85E-01	2.95E-02
cumene	0.03	0.83	0.2	350	30	70	10950	6.82E-05	2.60E-03	2.62E-02
xylenes	5.5	0.83	0.2	350	30	70	10950	1.25E-02	8.60E-02	1.45E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.18E-01

where: g:\project\539-15\scen4\adnhsh2.xls

CA = chemical concentration in air (calculated from Andelman, 1985)
IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration ((OSWER: 9285.6-03,1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Inhalation of Airborne (Vapor Phase) Chemicals (showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	4.3	0.83	0.2	350	6	15	2190	4.56E-02	5.70E-01	8.01E-02
ethylbenzene	3.7	0.83	0.2	350	6	15	2190	3.93E-02	2.85E-01	1.38E-01
cumene	0.03	0.83	0.2	350	6	15	2190	3.18E-04	2.60E-03	1.22E-01
xylenes	5.5	0.83	0.2	350	6	15	2190	5.84E-02	8.60E-02	6.79E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.02E+00

where: g:\project\539-15\scen4\chnhsh2.xls

CA = chemical concentration in air (calculated from Andelman, 1985)
IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration ((OSWER: 9285.6-03,1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Adult

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.3	0.83	0.2	350	30	70	25550	2.92E-04	2.90E-02	8.48E-06

TOTAL CARCINOGENIC RISK 8.48E-06

where:
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CA = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 700' South of Site)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.3	0.83	0.2	350	6	15	25550	2.73E-04	2.90E-02	7.91E-06

TOTAL CARCINOGENIC RISK 7.91E-06

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where:
CA = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	0.0043	2	350	30	70	10950	1.18E-04	3.00E-04	3.93E-01
ethylbenzene	2.483	2	350	30	70	10950	6.80E-02	1.00E-01	6.80E-01
cumene	3.436	2	350	30	70	10950	9.41E-02	4.00E-02	2.35E+00
toluene	2.904	2	350	30	70	10950	7.96E-02	2.00E-01	3.98E-01
xylenes	3.357	2	350	30	70	10950	9.20E-02	2.00E+00	4.60E-02

TOTAL NONCARCINOGENIC RISK 6.21E+00

where: g:\project\539-15\scen4\adinwtr2.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	0.0043	1	350	6	15	2190	2.75E-04	3.00E-04	9.16E-01
ethylbenzene	2.483	1	350	6	15	2190	1.59E-01	1.00E-01	1.59E+00
cumene	3.436	1	350	6	15	2190	2.20E-01	4.00E-02	5.49E+00
toluene	2.904	1	350	6	15	2190	1.86E-01	2.00E-01	9.28E-01
xylenes	3.357	1	350	6	15	2190	2.15E-01	2.00E+00	1.07E-01

TOTAL NONCARCINOGENIC RISK 1.14E+01

where: g:\project\539-15\scen4\chinwtr2.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Dermal Contact with
Chemicals in Groundwater (while showering)
Adult

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/yr	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
arsenic	0.0043	18150	0.0015	0.2	350	30	0.001	70	10950	3.21E-07	2.85E-04	1.13E-03
ethylbenzene	2.483	18150	0.11	0.2	350	30	0.001	70	10950	1.36E-02	8.00E-02	1.70E-01
cumene	3.436	18150	0.11	0.2	350	30	0.001	70	10950	1.88E-02	3.60E-02	5.22E-01
toluene	2.904	18150	0.11	0.2	350	30	0.001	70	10950	1.59E-02	2.00E-01	7.94E-02
xylenes	3.357	18150	0.11	0.2	350	30	0.001	70	10950	1.84E-02	1.84E+00	9.98E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.82E-01

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where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Dermal Contact with
Chemicals in Groundwater (while showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/y	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
arsenic	0.0043	7195	0.0015	0.2	350	6	0	15	2190	5.93E-07	2.85E-04	2.08E-03
ethylbenzene	2.483	7195	0.11	0.2	350	6	0	15	2190	2.51E-02	8.00E-02	3.14E-01
cumene	3.436	7195	0.11	0.2	350	6	0	15	2190	3.48E-02	3.60E-02	9.66E-01
toluene	2.904	7195	0.11	0.2	350	6	0	15	2190	2.94E-02	2.00E-01	1.47E-01
xylenes	3.357	7195	0.11	0.2	350	6	0	15	2190	3.40E-02	1.84E+00	1.85E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.45E+00

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where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Dermal Contact with
Chemicals in Groundwater
(showering) Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Adults Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0043	18150	0.0015	0.2	350	30	0.001	70	25550	1.37E-07	1.84E+00	2.53E-07
benzene	0.316	18150	0.11	0.2	350	30	0.001	70	25550	7.41E-04	3.22E-02	2.39E-05

TOTAL CARCINOGENIC RISK 2.41E-05

where: g:\project\539-15\scen4\addmwtc2.xls
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

000708

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Dermal Contact with
Chemicals in Groundwater
(showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0043	7195	0.0015	0.2	350	6	0.001	15	25550	5.09E-08	1.84E+00	9.36E-08
benzene	0.316	7195	0.11	0.2	350	6	0.001	15	25550	2.74E-04	3.22E-02	8.83E-06

TOTAL CARCINOGENIC RISK 8.92E-06

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where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0043	2	350	30	70	25550	5.05E-05	1.75E+00	8.84E-05
benzene	0.316	2	350	30	70	25550	3.71E-03	2.90E-02	1.08E-04

TOTAL CARCINOGENIC RISK 1.96E-04

where:
g:\project\539-15\scen4\adinwtc2.xls
CW = chemical concentration in water (extrapolated from groundwater data)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

000708

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.0043	1	350	6	15	25550	2.36E-05	1.75E+00	4.12E-05
benzene	0.316	1	350	6	15	25550	1.73E-03	2.90E-02	5.02E-05

TOTAL CARCINOGENIC RISK 9.14E-05

where: g:\project\539-15\scen4\chinwtc2.xls
CW = chemical concentration in water (extrapolated from groundwater data)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Adults

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	2.5	0.83	0.2	350	30	70	10950	5.68E-03	5.70E-01	9.97E-03
ethylbenzene	2.2	0.83	0.2	350	30	70	10950	5.00E-03	2.85E-01	1.76E-02
cumene	0.02	0.83	0.2	350	30	70	10950	4.55E-05	2.60E-03	1.75E-02
xylenes	3.2	0.83	0.2	350	30	70	10950	7.28E-03	8.60E-02	8.46E-02

TOTAL NONCARCINOGENIC RISK 1.30E-01

where: g:\project\539-15\scen5\adnhsh.xls

CA = chemical concentration in air (calculated from Andelman, 1985)
IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration ((OSWER: 9285.6-03,1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 350 days)

000710

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	2.5	0.83	0.2	350	6	15	2190	2.65E-02	5.70E-01	4.65E-02
ethylbenzene	2.2	0.83	0.2	350	6	15	2190	2.33E-02	2.85E-01	8.19E-02
cumene	0.02	0.83	0.2	350	6	15	2190	2.12E-04	2.60E-03	8.16E-02
xylenes	3.2	0.83	0.2	350	6	15	2190	3.40E-02	8.60E-02	3.95E-01

TOTAL NONCARCINOGENIC RISK 6.05E-01

where: g:\project\539-15\scen5\chnhsh.xls

CA = chemical concentration in air (calculated from Andelman, 1985)
IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration ((OSWER: 9285.6-03,1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 350 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Inhalation of Airborne
(Vapor Phase) Chemicals — Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
(showering) — Cancer Risk = Intake x Slope Factor
Adults

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.2	0.83	0.2	350	30	70	25550	1.95E-04	2.90E-02	5.65E-06

TOTAL CARCINOGENIC RISK 5.65E-06

where: g:\project\539-15\scen5\adnhshc.xls

CW = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

000712

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential Scenario:
(Downgradient Well 1800' South of Site)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)

Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.2	0.83	0.2	350	6	15	25550	1.82E-04	2.90E-02	5.28E-06

TOTAL CARCINOGENIC RISK 5.28E-06

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where:
CW = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

FUTURE SITUATION - FARM/RESIDENTIAL (WORST CASE) SCENARIO

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
Ingestion of Chemicals
in Surface Water (while wading in Paddys Run)
Adults

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	30	70	10950	3.38E-06	5.00E-03	6.77E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 6.77E-04

where: g:\project\539-15\scen5\adinsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)
CR = contact rate (EFH, 1989)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Ingestion of Chemicals

in Surface Water (while wading in Paddys Run) Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)

Children Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
manganese	0.095	0.05	2.6	7	6	15	2190	1.58E-05	5.00E-03	3.16E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 3.16E-03

where: g:\project\539-15\scen5\chinsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)

CR = contact rate (EFH, 1989)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000716

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Surface Water

(wading in Paddys Run)

Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW (mg/L)	SA (cm2)	PC (cm/hr)	ET (hr/day)	EF days/yr	ED (yrs)	CF (L/cc)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
manganese	0.095	8620	0.0015	2.6	7	30	0.001	70	10950	8.75E-07	2.00E-04	4.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.37E-03

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where:

CW = chemical concentration in water (95% U. C. L. of mean)

SA = skin surface area available for contact (EFH, 1989)

PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

CF = volumetric conversion factor for water

BW = body weight (OSWER: 9285.6-03, 1991)

AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Surface Water

(wading in Paddys Run)

Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW (mg/L)	SA (cm2)	PC (cm/hr)	ET (hr/day)	EF (days/yr	ED (yrs)	CF (L/cc)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
manganese	0.095	3535	0.0015	2.6	7	6	0.001	15	2190	1.67E-06	2.00E-04	8.37E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 8.37E-03

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where:

CW = chemical concentration in water (95% U. C. L. of mean)

SA = skin surface area available for contact (EFH, 1989)

PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

CF = volumetric conversion factor for water

BW = body weight (OSWER: 9285.6-03, 1991)

AT - averaging time (ED x 365 days)

000718

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Ingestion of

Chemicals in Sediment

(while wading in Paddys Run)

Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD
Chemical	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	DOSE
manganese	456	200	0.000001	1	7	6	15	2190	1.17E-04	5.00E-03	2.33E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.33E-02

where:

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CS = chemical concentration in sediment (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (RAGS, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Sediment

(while wading in Paddys Run)

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD
Chemical	(mg/kg)	10-6 kg/mg	(cm2/event	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
manganese	456	0.000001	8620	1.4	0.01	7	30	70	10950	1.51E-05	2.00E-04	7.54E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 7.54E-02

where:

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CS = chemical concentration in sediment (95% of U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000720

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Sediment

(while wading in Paddys Run)

Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD
Chemical	(mg/kg)	10-6 kg/mg	(cm2/event	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
manganese	456	0.000001	3535	1.4	0.01	7	6	15	2190	2.89E-05	2.00E-04	1.44E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.44E-01

where:

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CS = chemical concentration in sediment (95% of U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Ingestion of Chemicals

in Surface Water

(while wading in Pond)

Adults

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)

Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
ammonia	8.16	0.05	2.6	7	30	70	10950	2.91E-04	9.70E-01	3.00E-04
manganese	0.12	0.05	2.6	7	30	70	10950	4.27E-06	5.00E-03	8.55E-04
zinc	0.06	0.05	2.6	7	30	70	10950	2.14E-06	3.00E-01	7.12E-06
acetone	1.55	0.05	2.6	7	30	70	10950	5.52E-05	1.00E-01	5.52E-04
xylenes	0.29	0.05	2.6	7	30	70	10950	1.03E-05	2.00E+00	5.16E-06
2,4-dimethylphenol	0.15	0.05	2.6	7	30	70	10950	5.34E-06	2.00E-02	2.67E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.99E-03

where:

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CF = chemical concentration in surface water (95% U.C.L. of mean)

CR = contact rate (EFH, 1989)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

000722

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
Ingestion of Chemicals
in Surface Water
(while wading in Pond)
Children

Intake (mg/kg-day) = CF x CR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CF	CR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
ammonia	8.16	0.05	2.6	7	6	15	2190	1.36E-03	9.70E-01	1.40E-03
manganese	0.12	0.05	2.6	7	6	15	2190	1.99E-05	5.00E-03	3.99E-03
zinc	0.06	0.05	2.6	7	6	15	2190	9.97E-06	3.00E-01	3.32E-05
acetone	1.55	0.05	2.6	7	6	15	2190	2.58E-04	1.00E-01	2.58E-03
xylenes	0.29	0.05	2.6	7	6	15	2190	4.82E-05	2.00E+00	2.41E-05
2,4-dimethylphenol	0.15	0.05	2.6	7	6	15	2190	2.49E-05	2.00E-02	1.25E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 9.27E-03

where: g:\project\539-15\scen5\chinpsfw.xls

CF = chemical concentration in surface water (95% U.C.L. of mean)
CR = contact rate (EFH, 1989)
ET = exposure time (EFH, 1989)
EF = exposure frequency (EFH, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Water

(in Pond)

Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(d/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
ammonia	8.16	8620	0.0015	2.6	7	30	0.001	70	10950	7.52E-05	9.70E-01	7.75E-05
manganese	0.12	8620	0.0015	2.6	7	30	0.001	70	10950	1.11E-06	2.00E-04	5.53E-03
zinc	0.06	8620	0.0015	2.6	7	30	0.001	70	10950	5.53E-07	1.50E-02	3.68E-05
acetone	1.55	8620	0.11	2.6	7	30	0.001	70	10950	1.05E-03	1.00E-01	1.05E-02
xylenes	0.29	8620	0.11	2.6	7	30	0.001	70	10950	1.96E-04	1.84E+00	1.06E-04
2,4-dimethylphenol	0.15	8620	0.11	2.6	7	30	0.001	70	10950	1.01E-04	1.60E-02	6.33E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.25E-02

where:

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CW = chemical concentration in surface water (95% U. C. L. of mean)

SA = skin surface area available for contact (EFH, 1989)

PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)

ET = exposure time (RAGS, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

CF = volumetric conversion factor for water

BW = body weight (OSWER: 9285.6-03, 1991)

AT - averaging time (ED x 365 days)

000724

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Surface Water

(wading in Pond)

Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(d/yr)	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
ammonia	8.16	3535	0.0015	2.6	7	6	0.001	15	2190	1.44E-04	9.70E-01	1.48E-04
manganese	0.12	3535	0.0015	2.6	7	6	0.001	15	2190	2.12E-06	2.00E-04	1.06E-02
zinc	0.06	3535	0.0015	2.6	7	6	0.001	15	2190	1.06E-06	1.50E-02	7.05E-05
acetone	1.55	3535	0.11	2.6	7	6	0.001	15	2190	2.00E-03	1.00E-01	2.00E-02
xylenes	0.29	3535	0.11	2.6	7	6	0.001	15	2190	3.75E-04	1.84E+00	2.04E-04
2,4-dimethylphenol	0.15	3535	0.11	2.6	7	6	0.001	15	2190	1.94E-04	1.60E-02	1.21E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 4.32E-02

where: g:\project\539-15\scen5\chdmpsfw.xls

CW = chemical concentration in surface water (95% U. C. L. of mean)

SA = skin surface area available for contact (EFH, 1989)

PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)

ET = exposure time (EFH, 1989)

EF = exposure frequency (EFH, 1989)

ED = exposure duration (OSWER: 9285.6-03, 1991)

CF = volumetric conversion factor for water

BW = body weight (OSWER: 9285.6-03, 1991)

AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
Ingestion of
Chemicals in Sediment
(while wading in Pond)
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
barium	229	200	0.000001	1	7	6	15	2190	5.86E-05	7.00E-02	8.37E-04
chromium	53.5	200	0.000001	1	7	6	15	2190	1.37E-05	5.00E-03	2.74E-03
copper	518.7	200	0.000001	1	7	6	15	2190	1.33E-04	3.70E-02	3.58E-03
nickel	72.8	200	0.000001	1	7	6	15	2190	1.86E-05	2.00E-02	9.31E-04
zinc	350	200	0.000001	1	7	6	15	2190	8.95E-05	3.00E-01	2.98E-04
acetone	20	200	0.000001	1	7	6	15	2190	5.11E-06	1.00E-01	5.11E-05
ethylbenzene	69.7	200	0.000001	1	7	6	15	2190	1.78E-05	1.00E-01	1.78E-04
cumene	0.123	200	0.000001	1	7	6	15	2190	3.15E-08	4.00E-02	7.86E-07
toluene	23.33	200	0.000001	1	7	6	15	2190	5.97E-06	2.00E-01	2.98E-05
xylenes	505.3	200	0.000001	1	7	6	15	2190	1.29E-04	2.00E+00	6.46E-
2,4-dimethylphenol	0.75	200	0.000001	1	7	6	15	2190	1.92E-07	2.00E-02	9.59E-
phenol	9.9	200	0.000001	1	7	6	15	2190	2.53E-06	6.00E-01	4.22E-06
ammonia	320	200	0.000001	1	7	6	15	2190	8.18E-05	9.70E-01	8.44E-05
cadmium	7	200	0.000001	1	7	6	15	2190	1.79E-06	5.00E-04	3.58E-03
fluoranthene	2.48	200	0.000001	1	7	6	15	2190	6.34E-07	4.00E-02	1.59E-05
fluorene	1.5	200	0.000001	1	7	6	15	2190	3.84E-07	4.00E-02	9.59E-06
4-methylphenol	1.9	200	0.000001	1	7	6	15	2190	4.86E-07	5.00E-03	9.72E-05
pyrene	1.8	200	0.000001	1	7	6	15	2190	4.60E-07	3.00E-02	1.53E-05
mercury	1.5	200	0.000001	1	7	6	15	2190	3.84E-07	3.00E-04	1.28E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.38E-02

where:

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CS = chemical concentration in sediment (95% U. C. L. of mean or highest concentration)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (RAGS, 1989)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

000726

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
Dermal Contact with
Chemicals in Sediment
(while wading in Pond)
Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	REFERENCE DOSE	HAZARD
Chemical	(mg/kg)	10-6 kg/m	cm2/event	(mg/cm2)		(events\yr	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	INDEX
barium	229	0.000001	8620	1.4	0.01	7	30	70	10950	7.57E-06	3.50E-03	2.16E-03
chromium	53.5	0.000001	8620	1.4	0.01	7	30	70	10950	1.77E-06	2.00E-04	8.84E-03
copper	518.7	0.000001	8620	1.4	0.01	7	30	70	10950	1.71E-05	1.85E-03	9.27E-03
nickel	72.8	0.000001	8620	1.4	0.01	7	30	70	10950	2.41E-06	2.00E-03	1.20E-03
zinc	350	0.000001	8620	1.4	0.01	7	30	70	10950	1.16E-05	1.50E-02	7.71E-04
acetone	20	0.000001	8620	1.4	0.25	7	30	70	10950	1.65E-05	1.00E-01	1.65E-04
ethylbenzene	69.7	0.000001	8620	1.4	0.25	7	30	70	10950	5.76E-05	8.00E-02	7.20E-04
cumene	0.123	0.000001	8620	1.4	0.25	7	30	70	10950	1.02E-07	3.60E-02	2.82E-06
toluene	23.33	0.000001	8620	1.4	0.25	7	30	70	10950	1.93E-05	2.00E-01	9.64E-05
xylenes	505.3	0.000001	8620	1.4	0.25	7	30	70	10950	4.18E-04	1.84E+00	2.27E-04
2,4-dimethylphenol	0.75	0.000001	8620	1.4	0.1	7	30	70	10950	2.48E-07	1.60E-02	1.55E-05
phenol	9.9	0.000001	8620	1.4	0.1	7	30	70	10950	3.27E-06	5.40E-01	6.06E-06
ammonia	320	0.000001	8620	1.4	0.25	7	30	70	10950	2.65E-04	9.70E-01	2.73E-04
cadmium	7	0.000001	8620	1.4	0.01	7	30	70	10950	2.31E-07	3.50E-05	6.61E-03
fluoranthene	2.48	0.000001	8620	1.4	0.1	7	30	70	10950	8.20E-07	2.40E-02	3.42E-05
fluorene	1.5	0.000001	8620	1.4	0.1	7	30	70	10950	4.96E-07	2.40E-02	2.07E-05
4-methylphenol	1.9	0.000001	8620	1.4	0.1	7	30	70	10950	6.28E-07	4.00E-03	1.57E-04
pyrene	1.8	0.000001	8620	1.4	0.1	7	30	70	10950	5.95E-07	1.80E-02	3.31E-05
mercury	1.5	0.000001	8620	1.4	0.01	7	30	70	10950	4.96E-08	4.50E-05	1.10E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 3.17E-02

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where:

CS = chemical concentration in sediment (95% of U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)
ED = exposure duration (OSWER:9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Sediment

(while wading in Pond)

Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF 10-6 kg/m	SA cm2/event	AF (mg/cm2)	ABS	EF (events\yr	ED (yr)	BW (kg)	AT (days	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
barium	229	0.000001	3535	1.4	0.01	7	6	15	2190	1.45E-05	3.50E-03	4.14E-03
chromium	53.5	0.000001	3535	1.4	0.01	7	6	15	2190	3.39E-06	2.00E-04	1.69E-02
copper	518.7	0.000001	3535	1.4	0.01	7	6	15	2190	3.28E-05	1.85E-03	1.77E-02
nickel	72.8	0.000001	3535	1.4	0.01	7	6	15	2190	4.61E-06	2.00E-03	2.30E-03
zinc	350	0.000001	3535	1.4	0.01	7	6	15	2190	2.21E-05	1.50E-02	1.48E-03
acetone	20	0.000001	3535	1.4	0.25	7	6	15	2190	3.16E-05	1.00E-01	3.16E-04
ethylbenzene	69.7	0.000001	3535	1.4	0.25	7	6	15	2190	1.10E-04	8.00E-02	1.38E-03
cumene	0.123	0.000001	3535	1.4	0.25	7	6	15	2190	1.95E-07	3.60E-02	5.40E-06
toluene	23.33	0.000001	3535	1.4	0.25	7	6	15	2190	3.69E-05	2.00E-01	1.85E-04
xylenes	505.3	0.000001	3535	1.4	0.25	7	6	15	2190	7.99E-04	1.84E+00	4.34E-0
2,4-dimethylphenol	0.75	0.000001	3535	1.4	0.1	7	6	15	2190	4.75E-07	1.60E-02	2.97E-0
phenol	9.9	0.000001	3535	1.4	0.1	7	6	15	2190	6.26E-06	5.40E-01	1.16E-05
ammonia	320	0.000001	3535	1.4	0.25	7	6	15	2190	5.06E-04	9.70E-01	5.22E-04
cadmium	7	0.000001	3535	1.4	0.01	7	6	15	2190	4.43E-07	3.50E-05	1.27E-02
fluoranthene	2.48	0.000001	3535	1.4	0.1	7	6	15	2190	1.57E-06	2.40E-02	6.54E-05
fluorene	1.5	0.000001	3535	1.4	0.1	7	6	15	2190	9.49E-07	2.40E-02	3.95E-05
4-methylphenol	1.9	0.000001	3535	1.4	0.1	7	6	15	2190	1.20E-06	4.00E-03	3.01E-04
pyrene	1.8	0.000001	3535	1.4	0.1	7	6	15	2190	1.14E-06	1.80E-02	6.33E-05
mercury	1.5	0.000001	3535	1.4	0.01	7	6	15	2190	9.49E-08	4.50E-05	2.11E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 6.07E-02

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where:

CS = chemical concentration in sediment (95% U.C.L. of mean or highest concentration)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et. al., 1989)

ABS = absorption factor (Ryan et. al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER:9285.6-03. 1991)

AT = averaging time (ED x 365 days)

000728

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
Ingestion of
Chemicals in Sediment
(while wading in Pond)
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	RISK
benzo(a) pyrene	1.3	200	0.000001	1	7	6	15	25550	2.85E-08	7.30E+00	2.08E-07

TOTAL CARCINOGENIC RISK 2.08E-07

where:

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CS = chemical concentration in soil (95% U. C. L. of mean or highest concentration)
IR = ingestion rate (OSWER: 9285.6-03,1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (RAGS, 1989; technical judgement, no more than 7 events/yr)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE, FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Sediment

(while wading in Pond)

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	B	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER
	mg/kg	10-6 kg/mg	(cm2/event	(mg/cm2)		(events\yr)	(yr)	(kg	(days)	(mg/kg-day)	(mg/kg-day)-1	RISK
benzo(a) pyrene	1.3	0.000001	8620	1.4	0.1	7	30	70	25550	1.84E-07	1.22E+01	2.25E-06

TOTAL CARCINOGENIC RISK 2.25E-06

where:

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CS = chemical concentration in soil (95% U. C. L. of mean or highest concentration)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

000750

PADDYS RUN ROAD SITE, FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Sediment

(while wading in Pond)

Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER
Chemical	(mg/kg)	10-6 kg/mg	(cm2/event	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	RISK
benzo(a) pyrene	1.3	0.000001	3535	1.4	0.1	7	6	15	25550	7.05E-08	1.22E+01	8.60E-07

TOTAL CARCINOGENIC RISK 8.60E-07

where:

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CS = chemical concentration in soil (95% U. C. L. of mean or highest concentration)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (EFH, 1989; technical judgement, no more than 7 events/yr)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm-Residential (Worst Case) Scenario:

Ingestion of Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Chemicals in Soil (0-10') Hazard Index = Intake/Reference Dose

Adults

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
antimony	4.89	100	0.000001	1	350	24	70	8760	6.70E-06	4.00E-04	1.67E-02
arsenic	6.36	100	0.000001	1	350	24	70	8760	8.71E-06	3.00E-04	2.90E-02
chromium	14.2	100	0.000001	1	350	24	70	8760	1.95E-05	5.00E-03	3.89E-03
copper	13.8	100	0.000001	1	350	24	70	8760	1.89E-05	3.70E-02	5.11E-04
mercury	0.12	100	0.000001	1	350	24	70	8760	1.64E-07	3.00E-04	5.48E-04
ethylbenzene	0.091	100	0.000001	1	350	24	70	8760	1.25E-07	1.00E-01	1.25E-06
cumene	0.199	100	0.000001	1	350	24	70	8760	2.73E-07	4.00E-02	6.82E-06
toluene	0.068	100	0.000001	1	350	24	70	8760	9.32E-08	2.00E-01	4.66E-07
xylene	0.191	100	0.000001	1	350	24	70	8760	2.62E-07	2.00E+00	1.31E-07
ammonia	17.37	100	0.000001	1	350	24	70	8760	2.38E-05	9.70E-01	2.45E-05
aluminum	9968.9	100	0.000001	1	350	24	70	8760	1.37E-02	2.90E+00	4.71E-03
2,4-dimethylphenol	0.216	100	0.000001	1	350	24	70	8760	2.96E-07	2.00E-02	1.48E-05
2-methylphenol	0.2	100	0.000001	1	350	24	70	8760	2.74E-07	5.00E-02	5.48E-06
4-methylphenol	0.2	100	0.000001	1	350	24	70	8760	2.74E-07	5.00E-03	5.48E-05

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 5.56E-02

where: g:\project\539-15\scen5\adslin.xls

CS = chemical concentration in soil (95% U.C.L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm-Residential (Worst Case) Scenario:
Ingestion of
Chemicals in Soil (0-10')
Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
antimony	4.89	200	0.000001	1	350	6	15	2190	6.25E-05	4.00E-04	1.56E-01
arsenic	6.36	200	0.000001	1	350	6	15	2190	8.13E-05	3.00E-04	2.71E-01
chromium	14.2	200	0.000001	1	350	6	15	2190	1.82E-04	5.00E-03	3.63E-02
copper	13.8	200	0.000001	1	350	6	15	2190	1.76E-04	3.70E-02	4.77E-03
mercury	0.12	200	0.000001	1	350	6	15	2190	1.53E-06	3.00E-04	5.11E-03
ethylbenzene	0.091	200	0.000001	1	350	6	15	2190	1.16E-06	1.00E-01	1.16E-05
cumene	0.199	200	0.000001	1	350	6	15	2190	2.54E-06	4.00E-02	6.36E-05
toluene	0.068	200	0.000001	1	350	6	15	2190	8.69E-07	2.00E-01	4.35E-06
xylene	0.191	200	0.000001	1	350	6	15	2190	2.44E-06	2.00E+00	1.22E-06
ammonia	17.37	200	0.000001	1	350	6	15	2190	2.22E-04	9.70E-01	2.29E-04
aluminum	9968.9	200	0.000001	1	350	6	15	2190	1.27E-01	2.90E+00	4.40E-02
2,4-dimethylphenol	0.216	200	0.000001	1	350	6	15	2190	2.76E-06	2.00E-02	1.38E-04
2-methylphenol	0.2	200	0.000001	1	350	6	15	2190	2.56E-06	5.00E-02	5.11E-05
4-methylphenol	0.2	200	0.000001	1	350	6	15	2190	2.56E-06	5.00E-03	5.11E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 5.19E-01

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
CF = conversion factor
FI = fraction ingested from medium (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with Chemicals in Soil (0-10')

Adults

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED	REFERENCE	HAZARD INDEX
	(mg/kg)	(10-6)	(cm2/event)	(mg/cm2)		(events\yr	(yr)	(kg)	(days)	DOSE	DOSE	
		(kg/mg)								(mg/kg-day)	(mg/kg-day)	
antimony	4.89	0.000001	8620	1.4	0.01	350	30	70	10950	8.08E-06	2.00E-05	4.04E-01
arsenic	6.36	0.000001	8620	1.4	0.01	350	30	70	10950	1.05E-05	2.97E-04	3.54E-02
chromium	14.2	0.000001	8620	1.4	0.01	350	30	70	10950	2.35E-05	2.00E-04	1.17E-01
copper	13.8	0.000001	8620	1.4	0.01	350	30	70	10950	2.28E-05	3.70E-02	6.17E-04
mercury	0.12	0.000001	8620	1.4	0.01	350	30	70	10950	1.98E-07	4.50E-05	4.41E-03
ethylbenzene	0.091	0.000001	8620	1.4	0.25	350	30	70	10950	3.76E-06	9.70E-02	3.88E-05
cumene	0.199	0.000001	8620	1.4	0.25	350	30	70	10950	8.22E-06	3.60E-02	2.28E-04
toluene	0.068	0.000001	8620	1.4	0.25	350	30	70	10950	2.81E-06	2.00E-01	1.41E-05
xylenes	0.191	0.000001	8620	1.4	0.25	350	30	70	10950	7.89E-06	1.94E+00	4.07E-06
ammonia	17.37	0.000001	8620	1.4	0.1	350	30	70	10950	2.87E-04	9.70E-01	2.96E-04
aluminum	9968.9	0.000001	8620	1.4	0.01	350	30	70	10950	1.65E-02	1.45E+00	1.14E-02
2,4-dimethylphenol	0.216	0.000001	8620	1.4	0.1	350	30	70	10950	3.57E-06	1.60E-02	2.23E-04
2-methylphenol	0.2	0.000001	8620	1.4	0.1	350	30	70	10950	3.31E-06	4.00E-02	8.27E-05
4-methylphenol	0.2	0.000001	8620	1.4	0.1	350	30	70	10950	3.31E-06	4.00E-03	8.27E-04

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 5.75E-01

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Driver, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER:9285.6-03, 1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (ED x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
Dermal Contact with Chemicals in Soil (0-10') Children

Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CS (mg/kg)	CF (10-6) (kg/mg)	SA (cm2/event)	AF (mg/cm2)	ABS	EF (events\yr	ED (yr)	BW (kg)	AT (days)	ABSORBED DOSE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
antimony	4.89	0.000001	3535	1.4	0.01	350	6	15	2190	1.55E-05	2.00E-05	7.74E-01
arsenic	6.36	0.000001	3535	1.4	0.01	350	6	15	2190	2.01E-05	2.97E-04	6.77E-02
chromium	14.2	0.000001	3535	1.4	0.01	350	6	15	2190	4.49E-05	2.00E-04	2.25E-01
copper	13.8	0.000001	3535	1.4	0.01	350	6	15	2190	4.37E-05	3.70E-02	1.18E-03
mercury	0.12	0.000001	3535	1.4	0.01	350	6	15	2190	3.80E-07	4.50E-05	8.44E-03
ethylbenzene	0.091	0.000001	3535	1.4	0.25	350	6	15	2190	7.20E-06	9.70E-02	7.42E-05
cumene	0.199	0.000001	3535	1.4	0.25	350	6	15	2190	1.57E-05	3.60E-02	4.37E-04
toluene	0.068	0.000001	3535	1.4	0.25	350	6	15	2190	5.38E-06	2.00E-01	2.69E-05
xylenes	0.191	0.000001	3535	1.4	0.25	350	6	15	2190	1.51E-05	1.94E+00	7.79E-06
ammonia	17.37	0.000001	3535	1.4	0.1	350	6	15	2190	5.50E-04	9.70E-01	5.67E-04
aluminum	9968.9	0.000001	3535	1.4	0.01	350	6	15	2190	3.15E-02	1.45E+00	2.18E-02
2,4-dimethylphenol	0.216	0.000001	3535	1.4	0.1	350	6	15	2190	6.83E-06	1.60E-02	4.27E-04
2-methylphenol	0.2	0.000001	3535	1.4	0.1	350	6	15	2190	6.33E-06	4.00E-02	1.58E-04
4-methylphenol	0.2	0.000001	3535	1.4	0.1	350	6	15	2190	6.33E-06	4.00E-03	1.58E-03

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.10E+00

where:

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CS = chemical concentration in soil (95% U.C.L. of mean)
CF = conversion factor
SA = skin surface area available for contact (EFH, 1989)
AF = soil to skin adherence factor (Driver, et al., 1989)
ABS = absorption factor (Ryan, et al., 1987)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Ingestion of

Chemicals in Soil (0-10') Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Adults Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	100	0.000001	1	350	24	70	25550	1.83E-08	2.90E-02	5.31E-10
arsenic	6.36	100	0.000001	1	350	24	70	25550	2.99E-06	1.75E+00	5.23E-06

TOTAL CARCINOGENIC RISK (Sum of Cancer Risk) 5.23E-06

where: g:\project\539-15\scen5\adslinc.xls

CS = chemical concentration in soil (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Ingestion of

Chemicals in Soil (0-10')

Children

Intake (mg/kg-day) = CS x IR x CF x FI x EF x ED / (BW x AT)

Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Chemical	CS	IR	CF	FI	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	(mg/day)	(10-6 kg/mg)		(day/yr)	(yrs)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	200	0.000001	1	350	6	15	25550	4.27E-08	2.90E-02	1.24E-09
arsenic	6.36	200	0.000001	1	350	6	15	25550	6.97E-06	1.75E+00	1.22E-05

TOTAL CARCINOGENIC RISK (Sum of Cancer Risk) 1.22E-05

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

IR = ingestion rate (OSWER: 9285.6-03, 1991)

CF = conversion factor

FI = fraction ingested from medium (RAGS, 1989)

EF = exposure frequency (OSWER: 9285.6-03, 1991)

ED = exposure duration (OSWER: 9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Soil (0-10') Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Adults Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg	(10-6 kg/mg	cm2/event	(mg/cm2)		(events\yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	0.000001	8620	1.4	0.25	350	30	70	25550	6.91E-07	2.90E-02	2.00E-08
arsenic	6.36	0.000001	8620	1.4	0.01	350	30	70	25550	4.51E-06	1.77E+00	7.98E-06

TOTAL CARCINOGENIC RISK 8.00E-06

where:

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CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER: 9285.6-03,1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

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PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:

Dermal Contact with

Chemicals in Soil (0-10') Absorbed Dose (mg/kg-day) = CS x CF x SA x AF x ABS x EF x ED / (BW x AT)

Children Cancer Risk = Absorbed Dose x Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Chemical	CS	CF	SA	AF	ABS	EF	ED	BW	AT	ABSORBED DOSE	SLOPE FACTOR	CANCER RISK
	(mg/kg)	10-6 kg/mg	(cm2/event	(mg/cm2)		(events\yr	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.039	0.000001	3535	1.4	0.25	350	6	15	25550	2.64E-07	2.90E-02	7.67E-09
arsenic	6.36	0.000001	3535	1.4	0.01	350	6	15	25550	1.72E-06	1.77E+00	3.05E-06

TOTAL CARCINOGENIC RISK 3.05E-06

where:

g:\project\539-15\scen5\chsldmc.xls

CS = chemical concentration in soil (95% U. C. L. of mean)

CF = conversion factor

SA = skin surface area available for contact (EFH, 1989)

AF = soil to skin adherence factor (Davis, et al., 1989)

ABS = absorption factor (Ryan, et al., 1987)

EF = exposure frequency (OSWER: 9285.6-03,1991)

ED = exposure duration (OSWER:9285.6-03, 1991)

BW = body weight (OSWER: 9285.6-03, 1991)

AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	0.02	2	350	30	70	10950	5.48E-04	3.00E-04	1.83E+00
ethylbenzene	7.413	2	350	30	70	10950	2.03E-01	1.00E-01	2.03E+00
cumene	4.898	2	350	30	70	10950	1.34E-01	4.00E-02	3.35E+00
toluene	12.023	2	350	30	70	10950	3.29E-01	2.00E-01	1.65E+00
xylenes	10.471	2	350	30	70	10950	2.87E-01	2.00E+00	1.43E-01

TOTAL NONCARCINOGENIC RISK 1.13E+01

where:

g:\project\539-15\scen4\adinwt2c.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

000740

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)	
arsenic	0.02	1	350	6	15	2190	1.28E-03	3.00E-04	4.26E+00
ethylbenzene	7.413	1	350	6	15	2190	4.74E-01	1.00E-01	4.74E+00
cumene	4.898	1	350	6	15	2190	3.13E-01	4.00E-02	7.83E+00
toluene	12.023	1	350	6	15	2190	7.69E-01	2.00E-01	3.84E+00
xylenes	10.471	1	350	6	15	2190	6.69E-01	2.00E+00	3.35E-01

TOTAL NONCARCINOGENIC RISK 2.33E+01

where: g:\project\539-15\scen4\chinwt2c.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER: 9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER: 9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Ingestion of Chemicals
in Groundwater
Adults

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.02	2	350	30	70	25550	2.35E-04	1.75E+00	4.11E-04
benzene	1.072	2	350	30	70	25550	1.26E-02	2.90E-02	3.65E-04

TOTAL CARCINOGENIC RISK 7.76E-04

where: g:\project\539-15\scen4\adinwt1c.xls
CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

000742

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Ingestion of Chemicals
in Groundwater
Children

Intake (mg/kg-day) = CW x IR x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	IR	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/L)	(L/day)	(days/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.02	1	350	6	15	25550	1.10E-04	1.75E+00	1.92E-04
benzene	1.072	1	350	6	15	25550	5.87E-03	2.90E-02	1.70E-04

TOTAL CARCINOGENIC RISK 3.62E-04

where: g:\project\539-15\scen4\chinwt1c.xls

CW = chemical concentration in water (extrapolated from groundwater model data)
IR = ingestion rate (OSWER:9285.6-03, 1991)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (EFH, 1989; OSWER:9285.6-03, 1991)
BW = body weight (EFH, 1989; OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Dermal Contact with
Chemicals in Groundwater (while showering)
Adult

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/y	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
arsenic	0.02	18150	0.0015	0.2	350	30	0.001	70	10950	1.49E-06	2.85E-04	5.23E-03
ethylbenzene	7.413	18150	0.11	0.2	350	30	0.001	70	10950	4.05E-02	8.00E-02	5.07E-01
cumene	4.898	18150	0.11	0.2	350	30	0.001	70	10950	2.68E-02	3.60E-02	7.44E-01
toluene	12.023	18150	0.11	0.2	350	30	0.001	70	10950	6.58E-02	2.00E-01	3.29E-01
xylenes	10.471	18150	0.11	0.2	350	30	0.001	70	10950	5.73E-02	1.84E+00	3.11E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.62E+00

where:
g:\project\539-15\scen4\addmwt2c.xls
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

000744

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Dermal Contact with
Chemicals in Groundwater (while showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Hazard Index = Absorbed Dose/Reference Dose

ABSORBED DOSE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED DOSE	REFERENCE	HAZARD
	(mg/L)	(cm2)	(cm/hr)	hr/day	days/yr	(yrs)	(L/cc)	(kg)	(days)	(mg/kg-day)	DOSE	INDEX
											(mg/kg-day)	
arsenic	0.02	7195	0.0015	0.2	350	6	0.001	15	2190	2.76E-06	2.85E-04	9.68E-03
ethylbenzene	7.413	7195	0.11	0.2	350	6	0.001	15	2190	7.50E-02	8.00E-02	9.38E-01
cumene	4.898	7195	0.11	0.2	350	6	0.001	15	2190	4.96E-02	3.60E-02	1.38E+00
toluene	12.023	7195	0.11	0.2	350	6	0.001	15	2190	1.22E-01	2.00E-01	6.08E-01
xylenes	10.471	7195	0.11	0.2	350	6	0.001	15	2190	1.06E-01	1.84E+00	5.76E-02

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 2.99E+00

g:\project\539-15\scen4\chdmwt2c.xls

where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT - averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Dermal Contact with
Chemicals in Groundwater
(showering)
Adults

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.02	18150	0.0015	0.2	350	30	0.001	70	25550	6.39E-07	1.84E+00	1.18E-06
benzene	1.072	18150	0.11	0.2	350	30	0.001	70	25550	2.51E-03	3.22E-02	8.09E-05

TOTAL CARCINOGENIC RISK 8.21E-05

g:\project\539-15\scen4\addmwt1c.xls

where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Dermal Contact with
Chemicals in Groundwater
(showering)
Children

Absorbed Dose (mg/kg-day) = CW x SA x PC x ET x EF x ED x CF / (BW x AT)
Cancer Risk = Absorbed Dose * Slope Factor

ABSORBED DOSE OF CARCINOGENIC CHEMICALS

Reference Chemical	CW	SA	PC	ET	EF	ED	CF	BW	AT	ABSORBED	SLOPE	CANCER
	(mg/L)	(cm2)	(cm/hr)	(hr/day)	(days/yr)	(yrs)	(L/cc)	(kg)	(days)	DOSE	FACTOR	RISK
										(mg/kg-day)	(mg/kg-day)-1	
arsenic	0.02	7195	0.0015	0.2	350	6	0.001	15	25550	2.37E-07	1.84E+00	4.35E-07
benzene	1.072	7195	0.11	0.2	350	6	0.001	15	25550	9.30E-04	3.22E-02	2.99E-05

TOTAL CARCINOGENIC RISK 3.04E-05

g:\project\539-15\scen4\chdmwt1c.xls

where:
CW = chemical concentration in water (extrapolated from groundwater model data)
SA = skin surface area available for contact (EFH, 1989)
PC = chemical -specific dermal permeability constant (Blank & McAuliffe, 1985)
ET = exposure time (RAGS, 1989)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration (OSWER:9285.6-03, 1991)
CF = volumetric conversion factor for water
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Inhalation of Airborne (Vapor Phase) Chemicals (showering)
Adults

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	10.5	0.83	0.2	350	30	70	10950	2.39E-02	5.70E-01	4.19E-02
ethylbenzene	6.5	0.83	0.2	350	30	70	10950	1.48E-02	2.85E-01	5.19E-02
cumene	0.02	0.83	0.2	350	30	70	10950	4.55E-05	2.60E-03	1.75E-02
xylenes	10.1	0.83	0.2	350	30	70	10950	2.30E-02	8.60E-02	2.67E-01

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 3.78E-01

where: g:\project\539-15\scen4\adnhs2h.xls

CA = chemical concentration in air (calculated from Andelman, 1985)
IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration ((OSWER: 9285.6-03,1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Hazard Index = Intake/Reference Dose

INTAKE OF NONCARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	REFERENCE DOSE	HAZARD INDEX
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/Kg-day)	
toluene	10.5	0.83	0.2	350	6	15	2190	1.11E-01	5.70E-01	1.95E-01
ethylbenzene	6.5	0.83	0.2	350	6	15	2190	6.90E-02	2.85E-01	2.42E-01
cumene	0.02	0.83	0.2	350	6	15	2190	2.12E-04	2.60E-03	8.16E-02
xylenes	10.1	0.83	0.2	350	6	15	2190	1.07E-01	8.60E-02	1.25E+00

TOTAL NONCARCINOGENIC RISK (Sum of Hazard Indices) 1.77E+00

where: g:\project\539-15\scen4\chnhs2h.xls

CA = chemical concentration in air (calculated from Andelman, 1985)
IR= inhalation rate (OSWER: 9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989; RAGS, 1989, 12 minutes)
EF = exposure frequency (OSWER: 9285.6-03, 1991)
ED = exposure duration ((OSWER: 9285.6-03,1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (ED x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Children

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.6	0.83	0.2	350	6	15	25550	5.46E-04	2.90E-02	1.58E-05

TOTAL CARCINOGENIC RISK 1.58E-05

where:
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CW = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

PADDYS RUN ROAD SITE (PRRS), FERNALD, OHIO

Future Situation - Farm/Residential (Worst Case) Scenario:
(Concentration Center of Plume)
Inhalation of Airborne
(Vapor Phase) Chemicals
(showering)
Adult

Intake (mg/kg-day) = CA x IR x ET x EF x ED / (BW x AT)
Cancer Risk = Intake x Slope Factor

INTAKE OF CARCINOGENIC CHEMICALS

Reference Chemical	CA	IR	ET	EF	ED	BW	AT	INTAKE	SLOPE FACTOR	CANCER RISK
	(mg/m3)	(m3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(days)	(mg/kg-day)	(mg/kg-day)-1	
benzene	0.6	0.83	0.2	350	30	70	25550	5.85E-04	2.90E-02	1.70E-05

TOTAL CARCINOGENIC RISK 1.70E-05

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where:
CW = chemical concentration in water (calculated from Andelman, 1985)
IR = inhalation rate (OSWER:9285.6-03, 1991, 20m3/day)
ET = exposure time (EFH, 1989, 12 minutes)
EF = exposure frequency (OSWER:9285.6-03, 1991)
ED = exposure duration (OSWER: 9285.6-03, 1991)
BW = body weight (OSWER: 9285.6-03, 1991)
AT = averaging time (70 yrs x 365 days)

Appendix N
Potassium-40 Slope Factors

APPENDIX N

VALIDITY OF POTASSIUM-40 SLOPE FACTORS FOR NATURALLY OCCURRING POTASSIUM

TRINITY
Engineering Associates

Radiological Engineering
Consulting Services

Validity of Potassium-40 Slope Factors For Naturally Occurring Potassium

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FINAL Report

April 15, 1994

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ABBREVIATIONS DEFINED

A* -angstrom, a unit of length almost one-hundred-millionth (10^{-8}) centimeter used in stating distances between atoms, dimensions of molecules, wave-lengths of short-wave radiation, etc.

Al -elemental symbol for aluminum

As -elemental symbol for arsenic

ATP* -adenosine triphosphate, a nucleotide which serves as a source of energy for biochemical transformations in plants (photosynthesis) and also for many chemical reactions in the body.

B -elemental symbol for boron

Br -elemental symbol for bromium

C -elemental symbol for carbon

Ca -elemental symbol for calcium

Cl -elemental symbol for chlorine

CNS -abbreviation for central nervous system

Co -elemental symbol for cobalt

Cr -elemental symbol for chromium

Cs -elemental symbol for cesium

Cu -elemental symbol for copper

F -elemental symbol for fluorine

Fe -elemental symbol for iron

g -gram, metric unit for mass

H -elemental symbol for hydrogen

Hg -elemental symbol for mercury

I -elemental symbol for iodine

K -elemental symbol for potassium

kg -kilogram, equal to 1,000 grams

L -liter, the metric unit for volume

Li -elemental symbol for lithium

µg -microgram, one millionth of a gram

M -molar, expression of solute concentrations in solution in units of moles of solute per liter of solution (mol/L)

mEq* -milliequivalent, one-thousandth of the equivalent weight of a substance

Mg -elemental symbol for magnesium

mg -milligram, one-thousandth of a gram

mL -milliliter, one-thousandth of a liter

Mn -elemental symbol for manganese

Mo -elemental symbol for molybdenum

msec -millisecond, one-thousandth of a second

mV -millivolt, one-thousandth of a volt

N -elemental symbol for nitrogen

Na -elemental symbol for sodium

NH_4 -chemical symbol for ammonia

Ni -elemental symbol for nickel

O -elemental symbol for oxygen

pCi* -picocurie, 10^{-12} curie, unit of radioactivity

pH* -a value taken to represent the acidity or alkalinity of an aqueous solution

Rb -elemental symbol for rubidium

S -elemental symbol for sulfur

Se -elemental symbol for selenium

Si -elemental symbol for silicon

Ti -elemental symbol for titanium

V -elemental symbol for vanadium

Zn -elemental symbol for zinc

* Definitions obtained from The Condensed Chemical Dictionary, Tenth Edition, revised by Gessner G. Hawley. Van Nostrand Reinhold Company, New York, 1981.

000755

I. INTRODUCTION

This analysis examines the validity of using the U.S. EPA ingestion slope factor (USEPA, 1993) to evaluate the risk posed by the radioactive isotope potassium-40, when the potassium-40 exists as part of naturally occurring isotopic ratios of potassium, such as that present at the Paddys Run Road Site Study Area (PRRS). The U.S. EPA risk assessment method relies upon the slope factor to evaluate a risk from a given concentration of radionuclide in the environmental media of concern. The current potassium-40 slope factor for ingestion, listed in the Health Effects Assessment Summary Tables, HEAST, (USEPA, 1993), is relevant to the ingestion of ***pure*** potassium-40 only and does not account for the homeostatic regulation of potassium levels that is performed by the human body.

Potassium Intake

Potassium is the seventh most abundant metallic element naturally found in the earth's crust. Potassium is an essential nutrient, with an established adequate daily requirement of 3500 mg/day for adults (NRC, 1989). Potassium is also a required element for plant cellular function. The natural isotopic abundance ratios for potassium are 93.26% potassium-39, 6.73% potassium-41, and 0.012% potassium-40. Of the three predominant isotopes of potassium, only potassium-40 is radioactive, with a half-life of 1.28E+9 years. Hence, any intake of natural potassium will have an extremely low fraction of radioactive potassium. The human body cannot biochemically discriminate between the specific isotopes of potassium, thus the uptake and removal mechanisms of potassium are identical for all isotopes.

The natural potassium content of a 70 kg male of age 30-40 years is 140 g (Leggett and Williams, 1986). Of this 140 g of potassium, 0.016 g consists of the potassium-40 isotope. This amount of potassium-40 disintegrates at the rate of about 251,000 atoms per minute. Of every 100 disintegrations, 89 result in the release of β particles with a maximum energy of 1.33 MeV, and 11 result in γ photons with an energy of 1.46 MeV. All of the β particle energy and 50% of the energy of the γ rays are absorbed in the body, giving annual doses of 18 mrad from the β particles and 2 mrad from the γ rays (Shapiro, 1979; Turner, 1986).

The natural body content of potassium, known as the body burden, remains constant throughout the adult lifetime. The additional intake of potassium for normal dietary

requirements is not cumulative over any period under normal circumstances. The body regulates the potassium content continuously, hence any increase in intake is balanced with a removal of excess potassium from body fluids; this regulation process is rapid, and excess quantities are removed via urine and fecal excretion. The self-regulation is a process known as **Homeostasis** (see section II for thorough discussion). The homeostatic process initiates the removal mechanism when a noted change in the concentration level occurs. The residence time of excess potassium in the body is negligible as the homeostatic process rapidly discards potassium from the whole body as soon as an increased level of potassium is noted.

U.S. EPA Slope Factors

The slope factors presented in the Health Effects Assessment Summary Tables (USEPA, 1993) use an analysis of potassium-40 dose to determine a level of excess risk from potassium-40 intake. The U.S. EPA determination of the risk associated with potassium-40, which is quantified in the slope factors, has been based on an earlier dose assessment analysis using the RADRISK computer code (Dunning et al, 1984), performed by the Oak Ridge National Laboratories. The dose assessment models in the RADRISK computer code do not account for the homeostatic process inherent in potassium metabolism, and hence overstate the risk from potassium intake. The U.S. EPA published slope factor for potassium-40 was developed for the situation where *pure* potassium-40 is present.

The U.S. EPA published slope factor for pure potassium-40 assumes that any intake of potassium-40 resides in the body with a biological half-life of 30 days. In contrast, the kinetics of potassium are regulated by the body via the homeostatic process, whereby any excess levels are removed from the body organs and blood, thus maintaining a consistent potassium concentration. The homeostatic process maintains a constant level of potassium in the body; excessive levels of potassium are removed from the body in a period of 6 to 8 hours (Rose, 1989). Since the U.S. EPA slope factor for the ingestion of potassium-40 does not account for the homeostatic process, this slope factor does not accurately estimate of the risk posed by ingested potassium-40 when that potassium-40 exists as part of potassium containing normal isotopic abundance ratios.

II. BASIC PRINCIPLES

Atomic Structure

Atoms are the fundamental unit of matter important to the radiation process, and all atoms are comprised of various numbers of protons, neutrons, and electrons. Protons, the subatomic particles which carry a positive electric charge, and neutrons, the subatomic particles with no electric charge, make up the nucleus of an atom, and are often referred to by the generic term *nucleons*. Electrons, the subatomic particle carrying a negative electric charge, exist outside the nucleus of an atom in a number of allowed orbits but are bound to the atom by the strength of the positive-negative electric attraction. The number of electrons must equal the number of protons for the atom to have a zero net electric charge (a *neutral atom*). The vast majority of the mass of an atom resides in the nucleus, although the nucleus occupies only a very small percentage of the atomic volume. This is caused by the distribution of mass between protons, neutrons, and electrons. Protons and neutrons have essentially equal mass, and each have a mass approximately 1,836 times greater than that of electrons. The nucleus, however, occupies less than 0.001% of the volume taken up by the atom.

The nucleus of an atom of atomic number Z and mass number A consists of Z protons and N neutrons, where $N=A-Z$. The atomic mass A of an individual atom is nearly an integer value when expressed in terms of atomic mass units (e.g., potassium-40), and A gives the total number of nucleons in that atom. Any type of atom can be described in terms of the three atomic values A, Z, and N. The shorthand description for an atom is the chemical symbol from the periodic table with a superscript A and a subscript Z. For example, potassium-40 would be described as ${}^{40}_{19}K$. The subscript is often dropped as redundant with the name.

The chemical properties of an atom are primarily determined by the number of electrons it carries, which for an electrically neutral atom is determined by the number of protons in the atom's nucleus. Elements are grouped in the periodic table according to their chemical properties. From a nuclear perspective, an <u>element</u> is defined as any atoms having the same number of protons in their neutral atom. This definition of an element does not address atomic mass A, only the atomic number Z. It is possible for an element to consist of atoms having different masses if those atoms contain different numbers of neutrons in combination with a given number of protons. <u>Isotopes</u> are defined as atoms

of an element containing different numbers of neutrons. It is common in nature for elements to consist of multiple isotopes, all of which act the same chemically but have different atomic mass.

Concepts of Dose

The property of radiation that is considered to be the basis of a defined risk is the deposition of energy to individual molecules in the region through which radiation passes. The basic quantity that characterizes the amount of energy imparted to matter is the absorbed dose. The absorbed dose in a region is determined by dividing the energy imparted to the matter in that region by the mass of the matter in the region. Absorbed dose is expressed in terms of a unit called the ***rad***; this unit is usually prefixed as mrad (1/1000 rad).

Although the risk from a given type of radiation depends on the amount of energy imparted to matter, some types of radiations produce greater effects than others for the same amount of energy. The physical measure for gauging the relative effectiveness of equal absorbed doses from different particles in producing a dose is the Linear Energy Transfer factor, or LET. The higher the LET, the greater the dose. The factors expressing the relative effectiveness of a given particle are known as the Quality Factors. For the three principal radiation types, the quality factors are 1 for gamma and beta radiations, and 20 for alpha particles. When the absorbed dose is evaluated for purposes of radiation protection, it must be multiplied by the quality factor. The resultant quantity is known as the ***dose equivalent***. The dose equivalent is designed to express on a common scale for all ionizing radiations incurred by the exposed individual. The dose equivalent is expressed in units of ***rem***.

Dose Equivalent (rem) = Absorbed Dose (rad) x Quality Factor

The current generally accepted quantification of natural background from sources such as radon, cosmic radiation, terrestrial, and internal radiations is 300 mrem per year. This value has been researched by the National Council on Radiation Protection and Measurements (NCRP) and is published as part of the 1990 Committee on the Biological Effects of Ionizing Radiations report (BEIR V, 1990).

For doses received from internal radiations, the dose response becomes more complex. The kinetics of the radionuclide depends on the chemical form of the element, and on the element itself. Certain elements will accumulate in specific organs in the body, thus

delivering doses to certain organs only. Other radionuclides such as tritium, which is an isotope of hydrogen, will disperse throughout the body, delivering a dose to the whole body.

To account for the radiosensitivity of organs to radiation, each critical organ is assigned a weighting factor. The weighting factors represent the proportion of the total dose that results from a dose to a specific organ when the whole body is irradiated. This weighting factor accounts for the dose when a specific organ is dosed, and can be used to evaluate the ***effective dose equivalent***. The dose to each organ is calculated and then multiplied by its weighting factor. These weighted doses are then summed to calculate the effective dose equivalent.

Homeostasis

Dr. Bernard found in the first half of the 20th century that the blood sugar concentration and indeed all substances dissolved in the fluid that bathes the cells of the body are regulated within narrow limits. The self-regulatory activities carried out by the multitude of cells, tissues and organs that make up the body were further elaborated by the American physiologist Walter Cannon. Cannon coined the term homeostasis to describe the operation of coordinated physiological processes that maintain stability. Homeostasis in its simplest form requires the detection of environmental change, which in turn automatically initiates a reaction that will compensate for the change and restores the function to its normal state. Such self-regulating life processes involve a feedback control caused by the environmental change with a corresponding controlled compensatory response. Each is a cause and each an effect on the other. Physiology is a science which is in large part concerned with homeostatic mechanisms at all levels of organization. Homeostasis at the cellular level and at the organismic level for potassium are illustrated in the following sections of this report.

Potassium possesses two major physiologic functions: (1) cell metabolism, helping to regulate processes such as protein and glycogen synthesis (Knochel, 1982) and (2) maintenance of resting membrane potential, which depends on the ratio of intracellular vs. extracellular fluid concentration (DeVoe, et al., 1980). Total body stores of potassium in a healthy adult range between 3000-4000 mEq or 50-55 mEq/kg. It is mainly an intracellular cation with 98% of total body stores contained in the cells at a concentration of about 140 mEq/L (Rose, 1989). Extracellular fluid represents less than 2% (60-70 mEq) of total body stores but is extremely important to neuromuscular excitability and is

controlled within tight limits of 3.5-5 mEq/L (Sterns, et al., 1981; Brown, 1984). The concentration of the extracellular fluid must be maintained within these tight limits to prevent life-threatening cardiac toxicity (Rose, 1989; Guyton, 1991). Levels between 5-6.5 mEq/L are associated with only minimal toxicity and rarely produce cardiovascular symptoms. Levels between 6.5-8 mEq/L are associated with moderate toxicity including lassitude, weakness, fatigue, decreased reflex response, incipient ascending paralysis and some cardiovascular abnormalities. Levels above 8 mEq/L are associated with severe toxicity often producing complete neuromuscular paralysis and major, life-threatening cardiovascular toxicity. Death from cardiac arrest usually appears between 10-12 mEq/L but may be seen at lower levels (Micromedex System: Poisindex Database, 1993).

The distribution of potassium between the intracellular and extracellular compartments is balanced by the body internally. Regulation of the internal potassium distribution is of paramount importance, since movement of as little as 1.5-2% of cell potassium into extracellular fluid could lead to potentially fatal levels (Rose, 1989; Guyton, 1991). As serum potassium levels increase, an increasing proportion of total potassium load enters the extracellular compartment (Brown, 1984). It is estimated that a rise in plasma from 4 mEq/L to 5 mEq/L will increase total body potassium 100-200 mEq (Scribner and Burnell, 1956). Above 5 mEq/L, the serum level rises rapidly with only small additions of total body load (Brown, 1984). A major mechanism of internal balance revolves around the sodium-potassium adenosine triphosphatase (Na+,K+-ATPase) pump which exchanges sodium for potassium to maintain electrical potentials in excitable cells (Rose, 1989; Sterns, et al., 1981). Other factors influencing potassium distribution include various hormones (e.g., aldosterone, insulin, glucagon, catecholamines) (Sterns, et al, 1981), acid-base status (Brown, 1984), osmolality, and plasma potassium concentration (Rose, 1989).

External potassium balance deals with the uptake and excretion of potassium. Similar to sodium excretion, excretion of potassium is carefully controlled by the body so that it exactly matches daily intake minus uptake (Guyton, 1991). The normal intake of potassium is 50-100 mEq/day, and is easily absorbed from the GI tract. If the kidney is functioning normally, 90% is excreted in the urine, 10% excreted in the feces, with perspiration normally being an insignificant route (Rose, 1989; Sterns, et al., 1981; Brown, 1984; Guyton, 1991). When potassium enters the body, there is an initial movement of the potassium load into the cells, followed within 6-8 hours by excretion of the excess potassium (Rose, 1989). Potassium is freely filtered at the glomerulus and

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then almost completely reabsorbed in the proximal tubule and loop of Henle. Potassium is then secreted in the distal portions of the nephron. A potassium exchange pool is created in the tubular cells of the late distal tubule and principal cells of the cortical collecting duct. This pool is created by active transport of potassium by Na+,K+-ATPase at the basolateral membrane into the cells. Potassium may then passively diffuse into the tubular lumen and be excreted (Rose, 1989; Guyton, 1991). Normally, this process is so efficient at excreting excess potassium, that chronic hyperkalemia cannot manifest unless there is a defect in excretion. Normal subjects can maintain potassium balance if intake is chronically increased to levels of 500 mEq/day or more (Rose, 1989).

The two major physiologic regulators of potassium secretion are aldosterone and the plasma potassium level itself (Rose, 1989; Guyton, 1991). Aldosterone appears to open potassium channels in the luminal membrane and increase the activity of the Na+,K+-ATPase pump. These mechanisms serve to increase potassium secretion by increasing the size of the potassium exchange pool and increasing luminal permeability (Sansom, et al., 1987; Sansom and O'Neil, 1985). Aldosterone is directly stimulated by increases in serum potassium levels. As little as a 0.1-0.2 mEq/L rise in potassium may induce a significant elevation in aldosterone release (Rose, 1989). An increase in plasma potassium concentration will stimulate its own secretion. Mechanisms appear to be similar to those of aldosterone (Rose, 1989; Young, 1982). This means of regulation appears minimal below 4.1 mEq/L, but becomes increasingly powerful above that level in an attempt to normalize plasma potassium levels (Guyton, 1991). Other mechanisms include distal flow rate, concentration gradient, electrical gradient and luminal membrane permeability (Rose, 1989).

Adaptation occurs with chronic dietary potassium loading by increasing potassium excretion rates in the distal portions of the nephron. A proposed mechanism is an increase in the number and activity of the Na+,K+-ATPase pumps in both the distal portions of the nephron and the large intestine (Hayslett and Binder, 1982; Rastegar, et al., 1980). Schultze et al. describe increases in potassium excretion rates of 600% in functioning nephrons after contralateral nephrectomy (Schultze, et al., 1973). Young reported a 51% increase in excretion rates for every 1% increase in plasma potassium concentration between 4.18-4.75 mEq/L (Young, 1982). The ability of the kidneys to excrete a potassium load is enhanced in humans chronically challenged with increasing potassium intake (Knochel, 1982; Guyton, 1991). Even with chronic renal insufficiency, the increased efficiency per nephron allows potassium balance even in advanced disease,

when intake is not excessive (Rose, 1989). With normal potassium intake, there is no accumulation until the glomerular filtration rate reaches 5 to 10 mL/min. If potassium intake is increased, hyperkalemia may occur with glomerular filtration rates between 10 to 40 mL/min. In patients with chronic renal failure there also appears to be a 200% increase in colon potassium excretion (Knochel, 1982; Guyton, 1991).

Potassium levels are maintained by a combination of internal and external balances. Daily potassium excretion is equivalent to daily potassium intake minus uptake. Homeostatic mechanisms efficiently maintain potassium balance even with chronic increases in intake or partially compromised renal function.

Biological Mechanisms Involving Potassium

Potassium is an important cation of the intracellular fluid and functions, as is sodium, and is a major contributor to normal fluid pH and osmolarity. The human body contains about 2.6 g of potassium per kg fat-free body weight. Nerve and muscle cells are especially rich in potassium, but all cells, both plant and animal, tend to concentrate the mineral.

The ion is found in small amounts in extracellular fluid; serum level is 5 mEq/L (14-22 mg/100 mL). Apparently potassium is capable of transferring across the cell membrane with somewhat greater ease than sodium. During muscle contraction and nerve transmission, potassium diffuses out of the cell as sodium enters and is transported back into the cell when sodium is extruded.

The potassium ion is necessary for carbohydrate and protein metabolism, but the mechanisms by which it acts are not clear. Both glycogen formation and glucose degradation require potassium. Protein synthesis also requires potassium. The effect of the ion, however, appears to be on amino acid uptake by the cell rather than on the incorporation of amino acids into the protein molecule.

A deficiency of potassium is unlikely to occur as a result of dietary inadequacy. Body potassium may be depleted, however, in conditions resulting in excessive excretion through the kidney: renal disease, hyperfunction of the adrenal cortex, diabetic acidosis, and treatment with mercurial diuretics. Losses through the gastrointestinal tract may result from excessive vomiting or diarrhea.

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The effect of potassium deficiency is primarily on the muscles and is characterized by muscular weakness that, in skeletal muscle, may result in paralysis. Diarrhea and intestinal distention are common manifestation of potassium deficiency on gastrointestinal smooth muscle. Weakness of vascular and cardiac muscle leads to tachycardia and hypotension.

Potassium therapy is tricky, particularly if solutions are given by intravenous route. Too rapid infusion of potassium salts into the bloodstream may result in hyperkalemia. Muscle weakness and central nervous system changes result and, if unchecked, may lead to death. The ratios of trace elements including K can be found in Tables 1 through 3.

The pairs of major elements Na+ and K+, and Ca2+ and Mg2+ are so similar chemically that it is surprising that they differ so greatly in their biological functions. The ions Ca2+ and Na+ are concentrated in body fluids outside of cells. Calcium forms solid skeletal material such as bones, stabilizes conformations of proteins, and triggers muscle contraction and the release of hormones. The ions Mg2+ and K+ are concentrated in cells. The magnesium ion forms a complex with ATP and is required for most enzymatic reactions involving ATP within the cell.

In most animal cells, the concentration of K+ is about 0.15 M and that of Na+ is about 0.01 M. In fluids outside the cells, the concentration of Na+ is about 0.15 M and that of K+ is <0.004 M (concentrations rather close to those of seawater). Maintenance of these large-concentration gradients requires a "sodium pump" (really, an Na+-K+ pump, see Figures 1 and 2). The energy of transport of the ions is provided by the hydrolysis of ATP. Kidney and brain cells use about 70% of the energy from ATP for this transport. In some cells, each ATP molecule hydrolyzed transports 3 Na+ out of the cell and 2 K+ (+H+) into the cell. The K+ is required in the cell for glucose metabolism, protein synthesis and activation of some enzymes.

Nerve impulses are electrical signals produced by the flow of ions across the plasma membrane of neurons. The interior of a neuron, like those of most other cells, has a high concentration of K+ and a low concentration of Na+. These ionic gradients are generated by the Na+-K+ ATPase pump. In the resting state, the nerve-axon membrane is much more permeable to K+ than to Na+, and so the membrane potential is largely determined by the ratio of the internal to the external concentration of K+. The membrane potential of -60 mV in unstimulated axons is near the -75 mV level (the K+ equilibrium potential)

that would be given by a membrane permeable to only K+. A nerve impulse or action potential is generated when the membrane potential is depolarized beyond a critical threshold value (e.g., from -60 to -40 mV). The membrane potential becomes positive within about a millisecond and attains a value of about +30 mV before turning negative again. This amplified depolarization is propagated along the nerve terminal. The giant axons of squids played an important role in the discovery of the nature of the action potential. Electrodes can be readily inserted into these unusually large axons, which have a diameter of about a millimeter, and so squid axons have been favorite objects of inquiry.

Alan Hodgkin and Andrew Huxley carried out ingenious studies that revealed that the action potential arises from large, transient changes in the permeability of the axon membrane to Na+ and K+ ions. The conductance of the membrane to Na+ changes first. Depolarization of the membrane beyond the threshold level leads to an opening of Na+ channels. Sodium ions begin to flow into the cell because of the large electrochemical gradient across the plasma membranae. The entry of Na+ further depolarizes the membrane, and so more gates for Na+ are opened. This positive feedback between depolarization and Na+ entry leads to a very rapid and large change in membrane potential, from about -60 mV to +30 mV in a millisecond. The entry of Na+ stops at about +30 mV because this is the Na+ equilibrium potential. In other words, the thermodynamic driving force for the entry of Na+ vanishes when this potential is attained. The Na+ channels spontaneously close and the K+ gates begin to open at about this time. Consequently, potassium ions flow inward and so the membrane potential returns to a negative value. At about 2 msec, the membrane potential is -75 mV, the K+ equilibrium potential. The resting level of -60 mV is restored in a few milliseconds as the K+ conductance decreases to the value characteristic of the unstimulated state. It is important to stress that a very small proportion of the sodium and potassium ions in a nerve cell, of the order of one in a million, flows across the plasma membrane during the action potential. In other words, only a tiny fraction of the Na+-K+ gradient is dissipated by a single nerve impulse. Clearly, the action potential is a very efficient means of signaling over large distances.

The Na+ channel favors the passage of Na+ over K+ by a factor of 11 (Table 4). Electrophysiological studies of the relative permeability of alkali cations and organic cations provide some clues. The dependence of permeability on ionic size indicates that the channel is narrow. Ions having diameters greater than 5 A are excluded. However,

conductance is not governed solely by size. For example, methylamine (H3CNH3+) has nearly the same dimensions as hydrazine (H2NNH3+) and hydroxylamine (OHNH3+), yet it is much less permeable. A likely reason for this difference is that the methyl group of methylamine, in contrast with the amino group of hydrazine or the hydroxyl group of hydroxylamine, cannot form a hydrogen bond with an oxygen atom in the channel. Hence, methylamine does not fit. Another significant finding is that the conductance of the Na+ channel to all permeant cations decreases markedly when the pH is lowered. In fact, the relative permeability follows a titration curve for an acid with a pH of 5.2, which suggests that the active form of the channel contains a negatively charged carboxylate group. Thus, the Na+ channel selects for Na+ by providing a negatively charged site with a small radius. A K+ ion cannot readily pass through this region because it is larger than Na+.

The resting potential of a postsynaptic membrane or of a motor end plate is about - 75 mV. The interaction of acetylcholine with specific receptors produces a large change in the permeability properties of these membranes (Figure 3). The conductance of both Na+ and K+ increases markedly within 0.1 msec, and there is a large inward current of Na+ and a smaller outward current of K+. The inward Na+ current depolarizes the postsynaptic membrane and triggers an action potential in the adjacent axon or muscle membrane. Acetylcholine opens a single kind of cation channel, which is almost equally permeable to Na+ and K+. The flow of Na+ is larger than the flow of K+ because the electrochemical gradient across the membrane is steeper for Na+.

Two molecules of acetylcholine bind to a receptor and produce a conformational change that opens a channel. A kinetic scheme that is consistent with experimental data is

$$2\,A + R \rightleftharpoons A2R \rightleftharpoons A2R^*$$

in which A is an acetylcholine molecule, R is a closed channel, and R* is an open one. About 104 ions flow through a single open channel during its millisecond lifetime. Prolonged exposure of the receptor to acetylcholine results in its desensitization--that is, the channel closes and does not respond to acetylcholine for a long interval.

Ion-carrying transport antibiotics have some common structural features, as shown by x-ray crystallographic and spectroscopic studies. The carriers studied thus far have a shape like that of a donut. A single metal ion is coordinated to several oxygen atoms that surround a central cavity. The number of oxygen atoms that bind the metal ion is

typically six or eight. The periphery of the carrier consists of hydrocarbon groups (Figure 4).

The roles of the central oxygen atoms of the hydrocarbon exterior are evident. In an aqueous medium, a metal ion such as K+ binds several water molecules through their oxygen atoms. A carrier competes with water for binding the ion by chelating it to several appropriately arranged oxygen atoms in its central cavity. The hydrocarbon periphery makes the ion-carrier complex soluble in the lipid interior of the membranes. In essence, these antibiotics catalyze the transport of ions across membranes by making them soluble in lipid.

III. POTASSIUM-40 RISK CHARACTERIZATION

Federal Regulatory Information Regarding Potassium

A number of rules and regulations regarding potassium and potassium-40 have been promulgated by federal regulatory agencies. Summaries, as stated by Federal Registers, are listed below.

- The Food and Drug Administration (FDA) has approved the classification of potassium chloride as *generally recognized as safe* (GRAS) as a direct food ingredient.

> SUMMARY: The Safety and Inspection Service (FSIS) amends the Federal meat and poultry products inspection regulations to permit the use of potassium chloride, and calcium chloride, and magnesium chloride as tenderizing agents. The Food and Drug Administration (FDA) has determined these substances to be generally recognized as safe (GRAS) for use in foods.
>
> 49 FR 18997
> May 4, 1984

- The FDA is also aware of the homeostatic process associated with potassium.

> Potassium chloride, a major constituent of plant and animal cells, is an essential constituent of the body and is rapidly adjusted to homeostatic levels following ingestion in amounts that can be tolerated without causing nausea and vomiting.
> The available evidence indicates that in normal individuals potassium chloride is well tolerated, and that metabolism quickly and efficiently adjusts potassium in the body to narrow homeostatic levels.
>
> 47 FR 36440
> August 20, 1982

- Additional information from the FDA regarding the GRAS status of potassium also addressed the potassium-40 concentrations in natural potassium.

> The agency is aware of the fact that all potassium compounds contain minute amounts of K-40. The agency is also aware that some scientists believe K-40 to be the main source of naturally occurring whole body radiation. Potassium is an essential nutrient, and there is no practical way to separate the radioactive from the nonradioactive species. Although K-40 concentration can vary

with body fat and fluid content, there is no evidence that it accumulates in the body. Furthermore, low level radiation has always been a part of the human environment, and there is no reason to believe that exposure to low level radiation will be significantly increased by the promulgation of this rule. However, this rule does not mean that the agency is approving K-40 as an isolated isotope for low level radiation.

47 FR 37931
August 27, 1982

It is evident from the above quotes from Federal Registers, that the FDA is aware of the natural radioactive content of potassium, and its regulation by the homeostatic process. The FDA has dismissed the risk presented by K-40, in its natural content of total potassium, and has ***not*** classified the element as a carcinogen when it is a constituent of naturally occurring potassium.

An example of the U.S. EPA treatment of low isotopic abundance, naturally occurring radionuclides, is carbon-14. The U.S. EPA, when evaluating the risks from organic chemical compounds containing natural carbon, does not require a separate evaluation of the risk posed by the small fraction of carbon-14 present in the natural carbon. Enacting such a requirement would force radioactive risk assessments for all foods, since carbon is the fundamental building block of all foodstuffs.

Potassium Slope Factors

The Environmental Protection Agency (EPA) characterizes all radionuclides as Class A carcinogens; the EPA considers ionizing radiation to be both an initiator and promoter of cancer in nearly every tissue or organ. Slope factors for ingestion, inhalation, and external exposure from radionuclides in environmental media, are best estimates (median or 50th percentile values) of the age-averaged, lifetime excess cancer incidence, and are presented as unit risk per pCi intake (USEPA, 1993). The evaluation of a slope factor requires two components:

1. A determination of dose from a given intake.

2. Extrapolation of risk for an induced dose using a dose-response mathematical model.

These risk responses are interpolated primarily from the Japanese atomic weapon survivors. However, a point of contention still exists as to the characteristics of the dose-response relationship. The Committee on the Biological Effects of Ionizing Radiations

(BEIR, 1980) recognizes that there is a great deal of uncertainty with regard to the shape characteristics of the dose-response curve. However, the applicability of the dose-response curve is not the point of concern when evaluating potassium slope factors. The relevant issue here is the quantification of dose for a given intake.

The radiation dose component of the published U.S. EPA slope factors for potassium-40 was evaluated using the RADRISK computer code. The U.S. EPA uses this computer code exclusively in the determination of slope factors for radionuclides (USEPA, 1993). This code evaluates the dose from a unit exposure; this value is converted into a risk using the cancer risk estimates and the life table analysis. The RADRISK code (Dunning et al, 1984) was developed to estimate dose rates and subsequent health effects to a group of persons due to continuous inhalation or ingestion of a radionuclide. The code primarily uses methods proposed by the International Commission on Radiological Protection (ICRP, 1979) in its Publication 30. This methodology is based on a series of ordinary differential equations used to describe concentrations within an organ with respect to time. Energy deposition in organs, from sources in the organ of interest, and from sources in adjoining organs is calculated, and a dose evaluation is made based upon this energy deposition. For ingested radionuclides, the initial transfer is from the gastrointestinal tract (stomach, small intestine, upper large intestine, and lower large intestine) to the blood stream, and eventually to the systemic organs.

The body organs which retain a radioactive substance, or target organs, are element dependent. For potassium, which is extremely soluble, transfer occurs throughout the body. The ICRP model assumes a 95% transfer of ingested potassium from the gastrointestinal tract to the blood stream. Radioactive material that enters an organ may be removed by both radioactive decay (which is negligible for potassium), and by the biological removal process. These removal mechanisms determine the time that a radionuclide resides in an organ, and hence determines the exposure duration and dose. However, the RADRISK model fails to account for the biological equilibrium that exists for the normal potassium body burden; it assumes that potassium is resident with a biological half life of 30 days (Leggett and Williams, 1986). Assuming ten half-lives for full element clearance, this biological half life equates to a retention time of approximately 300 days. In comparison, the whole body response is virtually instantaneous resulting in a near zero retention time, as the biokinetics of the human body for potassium are homeostatically regulated. The RADRISK code, and hence the U.S.

EPA slope factor for potassium-40, will greatly overstate the residence time of potassium-40 in the body, if potassium-40 is ingested as a component of natural potassium.

Potassium is a natural component of body and cellular structure and is a component of daily mineral requirements for human sustenance. However, the intake and retention of potassium is governed by the process of homeostasis. This process regulates the body content of potassium; any intake greater than the requirement is rapidly removed from the primary body organs and tissue through the urinary tract via urine. Some removal does occur by the gastrointestinal tract and is transferred to fecal material for excretion; however, this is a small fraction (<10%) of the total excretion of potassium from the body. The overall retention time for the homeostatic control process is between 6 and 8 hours (Rose, 1989) and is not comparable to the 30 day biological half-life used by the RADRISK computer code in determining the published U.S. EPA ingestion slope factor for potassium-40. The RADRISK evaluation, and hence the U.S. EPA slope factor, thus produce an inaccurate calculation of the risk posed by potassium-40.

Discussions with Dr. Neil Nelson of the Office of Radiation Programs (U.S. EPA) confirms that the U.S. EPA is aware of the inapplicability of the potassium-40 slope factor for use in calculating risk from naturally occurring potassium-40 concentrations. The potassium-40 slope factors were developed for evaluating the risk from pure, or highly enriched concentrations of potassium-40 only. The intent of the slope factor was to have available a risk factor for use in evaluating the risk from events such as nuclear power facility releases, not for use as a basis to conclude that an excess risk is present from naturally occurring potassium.

IV. CONCLUSIONS

The slope factor employed by the U.S. EPA (USEPA, 1993) inaccurately represents the risk from potassium-40 ingested in a natural isotopic mix. The U.S. EPA published slope factor was determined using the RADRISK computer program, and was based on the existing kinetics models specified by the International Commission on Radiological Protection (ICRP), Publication 30. These models do not account for the homeostatic elimination of potassium, and hence significantly overestimate the risk from the ingestion of naturally occurring potassium. The risk calculated by the RADRISK code would be applicable to situations such as nuclear facility accidents, where the potassium ingested may consist of enriched or pure potassium-40. There is no enriched potassium-40 at the PRRS (Trinity Engineering Associates report of Dec. 23, 1993). This report has already been submitted to the Ohio EPA under a separate cover. Inconsistencies with the use of the RADRISK slope factor for estimating the risk from the ingestion of natural potassium are summarized below.

- Potassium content in the human body is controlled by the homeostatic process which ensures a constant level of potassium in the body fluids and organs. No accumulation beyond the body requirement is maintained; excess levels of potassium are rapidly removed from the body by the homeostatic process and are discharged by urinary and fecal excretion. When natural potassium is consumed, homeostasis removes natural potassium from the body to accommodate the consumed potassium, thus there is no net gain of potassium or potassium-40. In the case where *pure* potassium-40 is the only isotope of potassium being ingested, the body removes natural potassium to accommodate the new potassium, which results in an increase of potassium-40 in the body. This is the only scenario for which the original RADRISK slope factor is applicable.

- The Food and Drug Administration (FDA) states that there is no accumulation of potassium-40 in the body in response to an intake of potassium containing potassium-40 in natural isotopic abundance. The FDA is also aware of the homeostatic process which regulates potassium levels in the body. Since there is no preferential accumulation of potassium-40, no excess risk is induced.

All naturally occurring potassium will contain minute quantities of radioactive potassium-40; this potassium-40 content is a natural component of the body burden. Potassium is an

essential component of the human body, and since the body does not discriminate by isotope, potassium-40 is also present in the body at a constant level. The homeostatic process regulates the levels of potassium in the human body. This process shows that there is no accumulation of potassium beyond the body burden.

The U. S. EPA slope factors for the ingestion of potassium-40 do not account for this process in any way. The slope factors were generated using the RADRISK code, which is a computer program used to model the ICRP biokinetic responses. The homeostatic process is not included in any ICRP calculations, and hence is not included in the calculation of the potassium-40 ingestion slope factor. Thus utilizing the U.S. EPA ingestion slope factor will produce an inaccurate calculation of the risk with respect to potassium-40 in its natural ratios.

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V. TABLES

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Table 1
Chemical Selectivity in the Human Body[a]
(percent of total number of atoms)

Composition of Earth's Crust		Composition of Seawater		Composition of Human Body[b]	
O	46.6%	H	66%	H	63%
Si	27.1	O	33	O	25.5
Al	8.1	Cl	0.33	C	9.5
Fe	5.0	Na	0.28	N	1.4
Ca	3.6	Mg	0.033	Ca	0.31
Na	2.8	S	0.017	P	0.22
K	2.6	Ca	0.006	Cl	0.03
Mg	2.1	K	0.006	K	0.06
Ti	0.46	C	0.0014	S	0.05
H	0.22	Br	0.0005	Na	0.03
C	0.19			Mg	0.01
Others	< 0.1	Others	< 0.1	Others	< 0.1

Notes:

[a]E. Frieden, "The Chemical of Life," Sci. Am. July 1972, 52.

[b]Other elements, commonly referred to as trace elements, shown to be essential to some form of life include: B, F. Si, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, and I (See H. J. Saunders, "Nutrition and Health," Chem. Eng. News 1979, p27.

Table 2
Compositional Ratios and Derivations

Ratio or Derivation	Abbreviation	Dimensions	Normal Range[a]
Total body fat	TBF	kg or % B. Wt.[b]	12-20% B. Wt.
Total body fluids	TBS	kg or % B. Wt.	40-60% B. Wt.
Fat-free solids	FFS	kg or % B. Wt.	25-40% B. Wt.
Intracellular water	ICW	L. or % B. Wt.	30-40% B. Wt.
Residual sodium	Res Na	mEq or % Na_e	8-15 % Na_e
Average intracellular potassium concentration	Av. ICK conc.	mEq/liter	140-160 mEq/L
Ratio of whole body hematocrit to large vessel hematocrit	WBH/LVH	% / %	0.85-0.91
Ratio of total exchangeable sodium to total exchangeable potassium	Na_e / K_e	mEq/mEq	0.85-1.00
Ratio of sum of total exchangeable sodium plus total exchangeable potassium to body weight	Na_e+K_e/B. Wt.	mEq/kg	70-90 mEq/kg
Concentration of total exchangeable cation (sodium plus potassium) in total body water	Na_e+K_e/TBW	mEq/liter	150-160 mEq/L
Body cell mass	BCM	kg or % B. wt.	35-45 % B. Wt.
Ratio of intracellular water to total body water; relative predominance of the cell	ICW/TBW	liter/liter x 100	50-55%
Ratio of red cell volume to total exchangeable potassium	RV/K_e	ml/mEq	0.50-0.55ml/mEq
Ratio of total exchangeable potassium to dry body weight	K_e/DBW	mEq/kg	90-110 mEq/kg
Ratio of total exchangeable potassium to fat-free solids	K_e/FFS	mEq/kg	200-250 mEq/kg
Ratio of red cell volume to plasma volume	RV/PV	ml/ml	0.70-0.80
Ratio of plasma volume to total exchangeable sodium	PV/Na_e	ml/mLq	0.95-1.10 ml/mLq
Dry fat-free, marrow-free whole bone (matrix plus mineral)	B	kg or % B. Wt.	6-8 % B. Wt. (10.3 % FFB)
Ratio of total exchangeable potassium to resting 24-hour creatinine excretion	K_e/ Creatinine	mEq/mg	1.75-2.25 mEq/mg

Note:

From F. D. Moore et al., The Body Cell Mass and Its Supporting Environment, W. B. Saunders Co., Philadelphia, Pa., 1963, p20.

[a]Broad range only

[b]The term "B. Wt." is used for body weight throughout.

Table 3
Constituents of Plasma

Component	Example	Approximate Concentration	Example of Function
Water		90%	Universal solvent, transport
Proteins	Albumin	3.2-4.5 g/100 mL	Osmotic pressure, pH regulation
	Globulin	2.0-3.5 g/100 mL	Immune response
	Fibrinogen	0.2-0.4 g/100 mL	Clotting + hemostasis
Carbohydrates	Glucose	60-100 mg/100 mL	Source of energy
Lipids	Cholesterol	115-340 mg/100 mL	Structural units (cell membranes)
	Triglycerides	10-190 mg/100 mL	Cell membrane
Gases	Oxygen (PO_2)	80-90 mm Hg/L	Regulation of breathing; aerobic glycosis
	Carbon dioxide (PCO_2)	34-45 mm Hg/L	Regulation of breathing, pH regulation
Ions	Sodium	136-142 meq/L	Osmosis
	Calcium (total)	9.0-10.5 mg/100 mL	Clotting
	Calcium (ionized)	4.2-5.2 mg/100 mL	
	Magnesium	1.8-3.0 mg/100 mL	Enzyme cofactor
	Potassium	4.0-4.8 meq/L	Nerve transmission
	Fluoride	28 mg/100 mL	Hardening of teeth and bone
	Iodine	4.0-8.0 meq/L	Thyroid hormone
	Chloride	350 mg/100 mL	Osmosis
Metabolic products	Urea nitrogen	8-20 mg/100 mL	
	Uric acid	2.1-7.8 mg/100 mL	
	Lactic acid	5-20 mg/100 mL	
Other substances	Iron	50-150 μg/100 mL	Hemoglobin
	Vitamin A (fasting)	15-60 μg/100 mL	Vision
	Vitamin C	0.5-1.5 mg/100 mL	Maintains connective tissue
	Amino acid nitrogen	4-6 mg/100 mL	Metabolism

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Table 4
Relative Permeabilities of the Sodium and Potassium Channels in Axon Membranes

Ion	Na^+ Channel	K^+ Channel
Li^+	0.93	<0.01
Na^+	1.00	<0.01
K^+	0.09	1.00
Rb^+	<0.01	0.91
Cs^+	<0.01	<0.08
NH_4^+	0.16	0.13
$OHNH_3^+$	9,84	<0.03
$H_2NNH_3^+$	0.59	<0.03
$H_3CNH_3^+$	<0.01	<0.02

VI. FIGURES

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FIGURE 1

Diagram of the Sodium/Potassium Pump

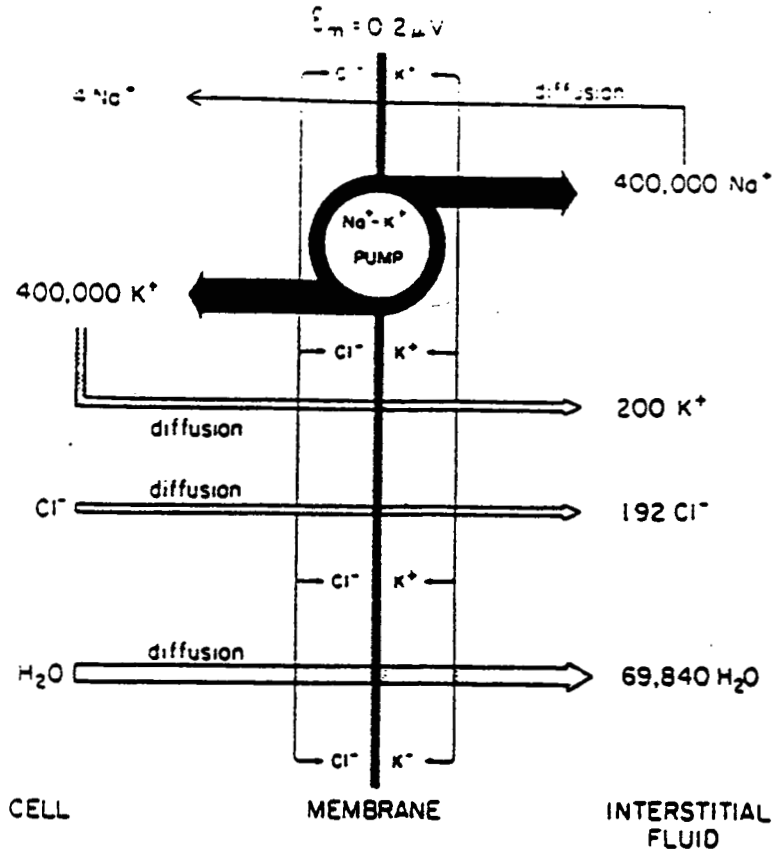

FIGURE 2

Influence of the ratio of intracellular potassium ion concentration [Ki] to extracellular potassium ion concentration [Ko] on resting potential at 25 C. The ratio [Ki]/[Ko] is altered by increasing or decreasing [Ko]. Solid line is theoretical value calculated from Nernst equation. Dashes illustrate deviation from theory found in biological materials.

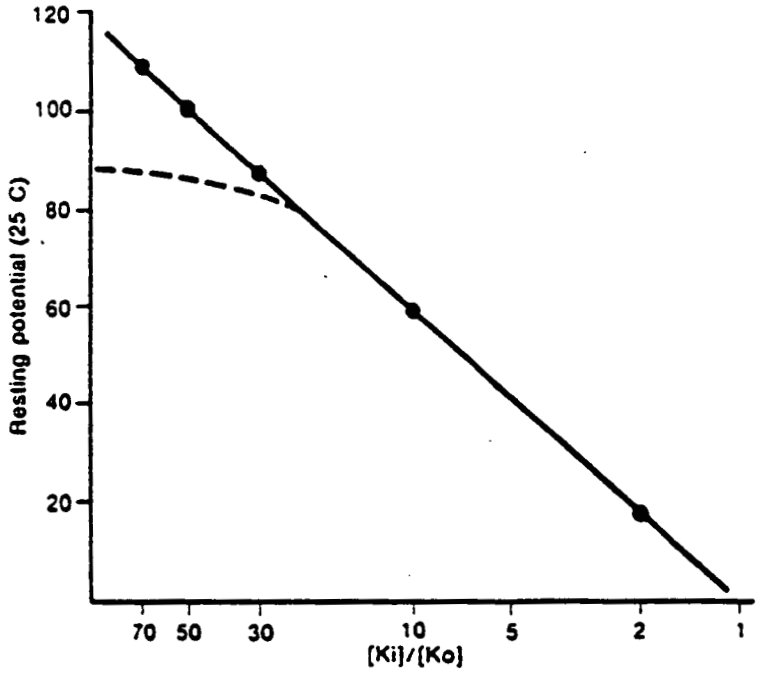

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FIGURE 3

Acetylcholine depolarizes the postsynaptic membrane by increasing the conductance of Na+ and K+.

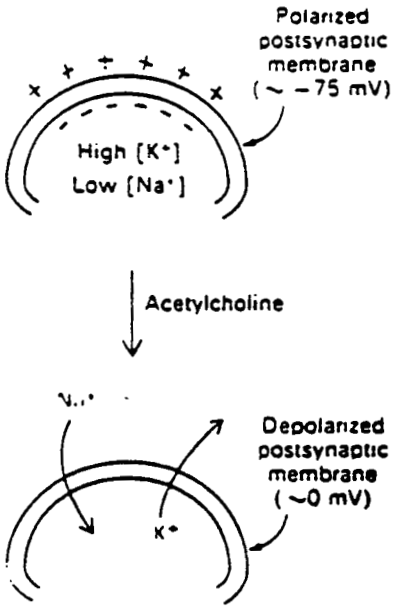
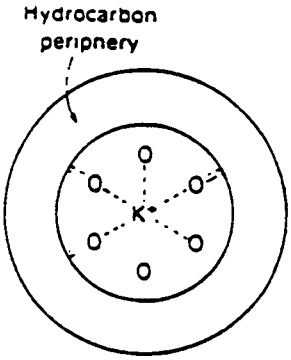


FIGURE 4

Schematic diagram of the chelation of K+ by oxygen atoms of a carrier transport antibiotic.



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