X

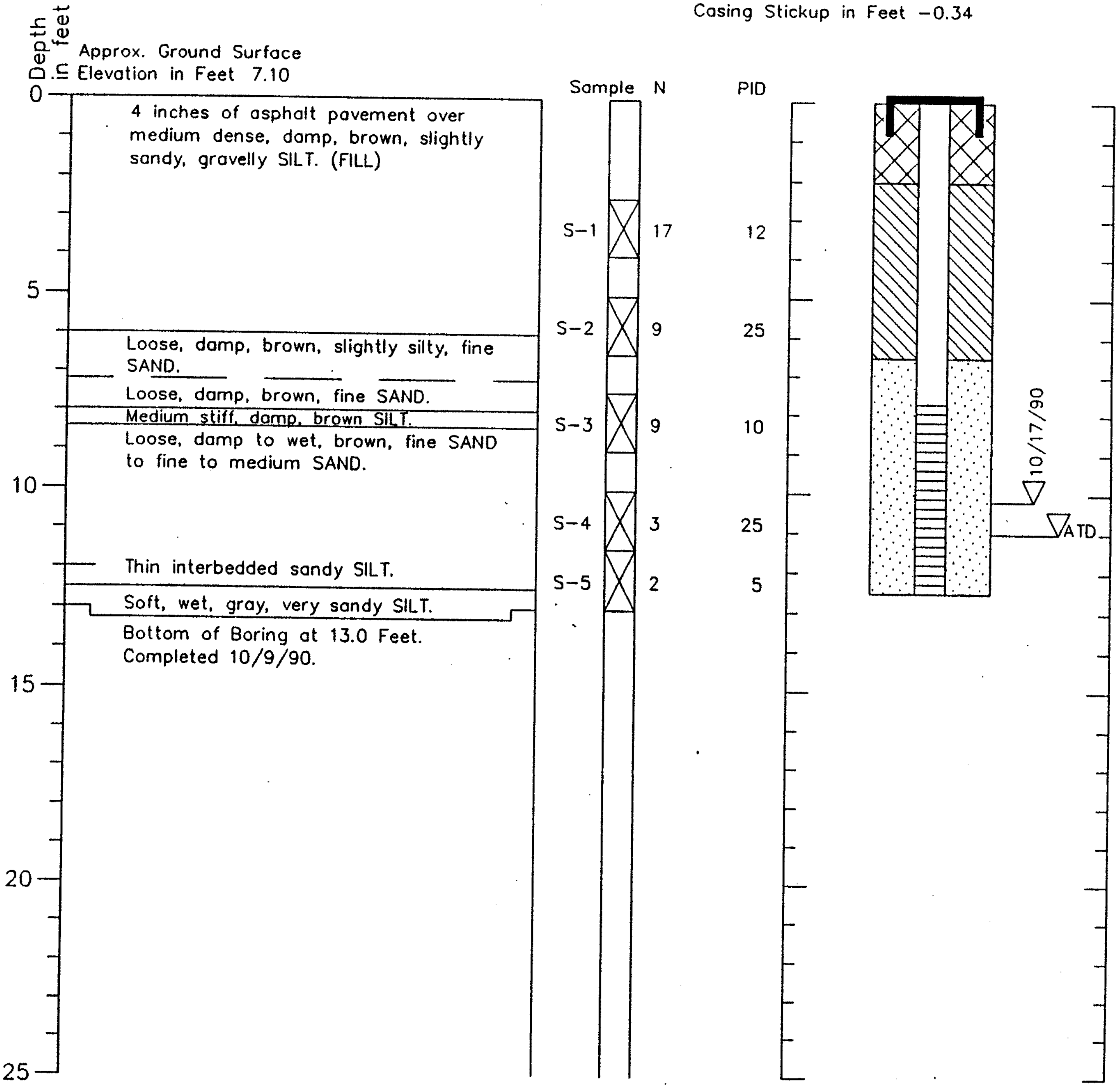
Boring Log and Construction Data for Monitoring Well B-13

Geologic Log

Monitoring Well Design

Casing Stickup in Feet –0.34

Approx. Ground Surface Elevation in Feet 7.10



4 inches of asphalt pavement over medium dense, damp, brown, slightly sandy, gravelly SILT. (FILL)

Loose, damp, brown, slightly silty, fine SAND.

Loose, damp, brown, fine SAND.

Medium stiff, damp, brown SILT.

Loose, damp to wet, brown, fine SAND to fine to medium SAND.

Thin interbedded sandy SILT.

Soft, wet, gray, very sandy SILT.

Bottom of Boring at 13.0 Feet.
Completed 10/9/90.

Sample	N	PID
S–1	17	12
S–2	9	25
S–3	9	10
S–4	3	25
S–5	2	5

1. Refer to Figure A–1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-04 10/90

Figure A-13

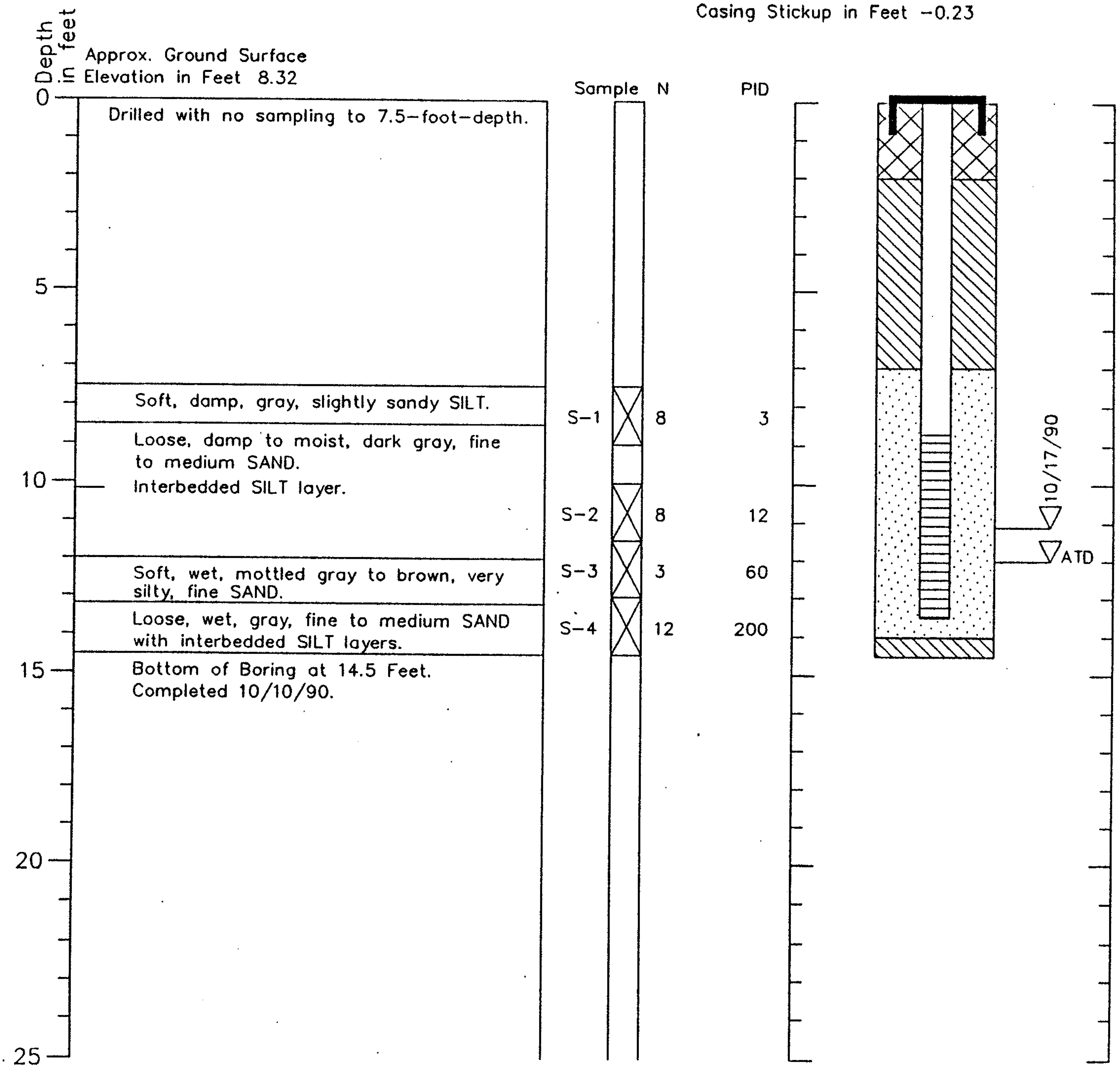
Boring Log and Construction Data for Monitoring Well B-14

Geologic Log

Monitoring Well Design

Casing Stickup in Feet -0.23

Approx. Ground Surface Elevation in Feet 8.32



Drilled with no sampling to 7.5-foot-depth.

Soft, damp, gray, slightly sandy SILT.

Loose, damp to moist, dark gray, fine to medium SAND.
Interbedded SILT layer.

Soft, wet, mottled gray to brown, very silty, fine SAND.

Loose, wet, gray, fine to medium SAND with interbedded SILT layers.

Bottom of Boring at 14.5 Feet.
Completed 10/10/90.

Sample	N	PID
S-1	8	3
S-2	8	12
S-3	3	60
S-4	12	200

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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J-2489-04 10/90

Figure A-14

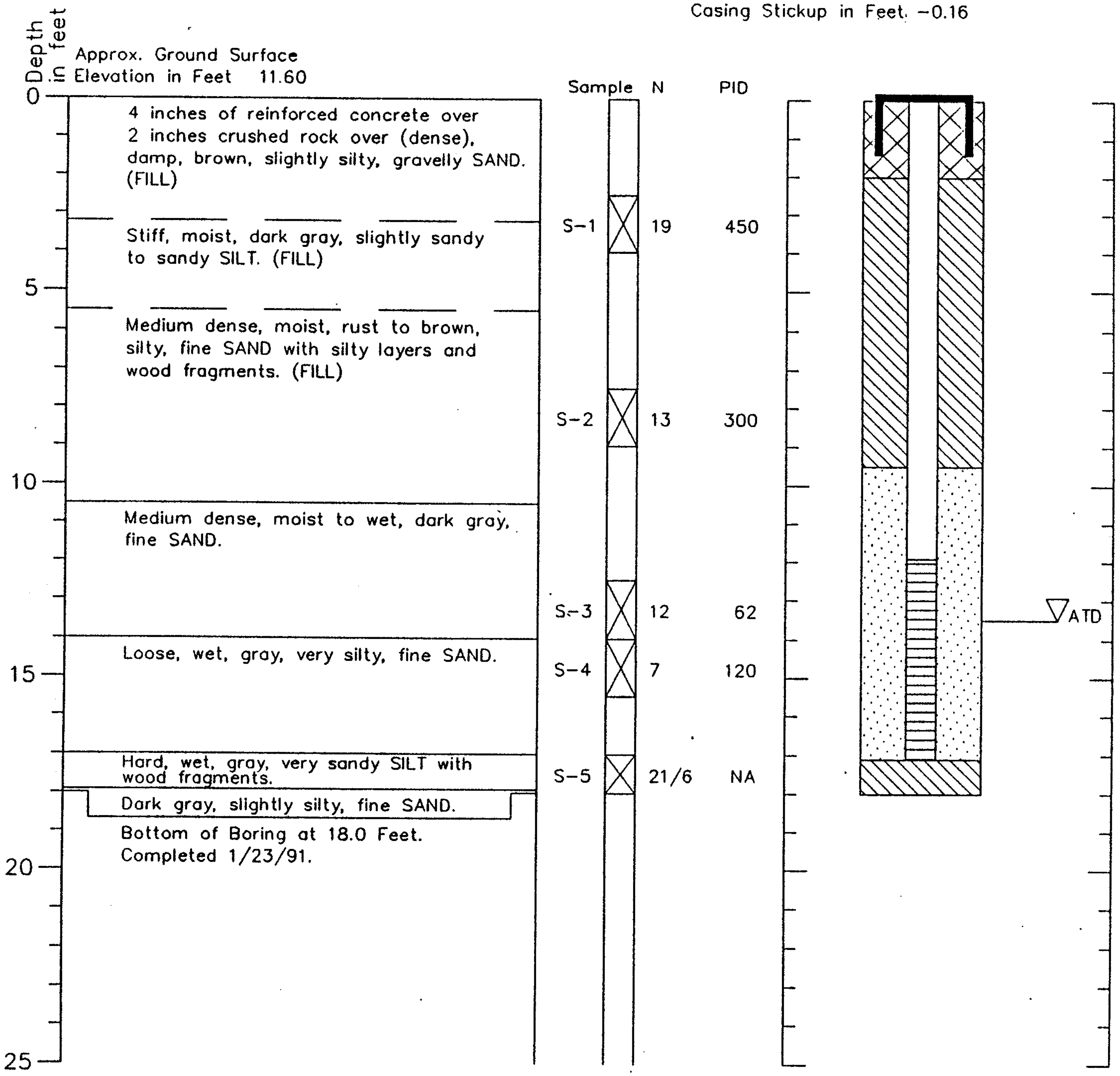
Boring Log and Construction Data for Monitoring Well B-15

Geologic Log

Monitoring Well Design

Casing Stickup in Feet. -0.16

Approx. Ground Surface Elevation in Feet 11.60



4 inches of reinforced concrete over 2 inches crushed rock over (dense), damp, brown, slightly silty, gravelly SAND. (FILL)

Stiff, moist, dark gray, slightly sandy to sandy SILT. (FILL)

Medium dense, moist, rust to brown, silty, fine SAND with silty layers and wood fragments. (FILL)

Medium dense, moist to wet, dark gray, fine SAND.

Loose, wet, gray, very silty, fine SAND.

Hard, wet, gray, very sandy SILT with wood fragments.

Dark gray, slightly silty, fine SAND.

Bottom of Boring at 18.0 Feet.
Completed 1/23/91.

Sample	N	PID
S-1	19	450
S-2	13	300
S-3	12	62
S-4	7	120
S-5	21/6	NA

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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J-2489-04 1/91

Figure A-15

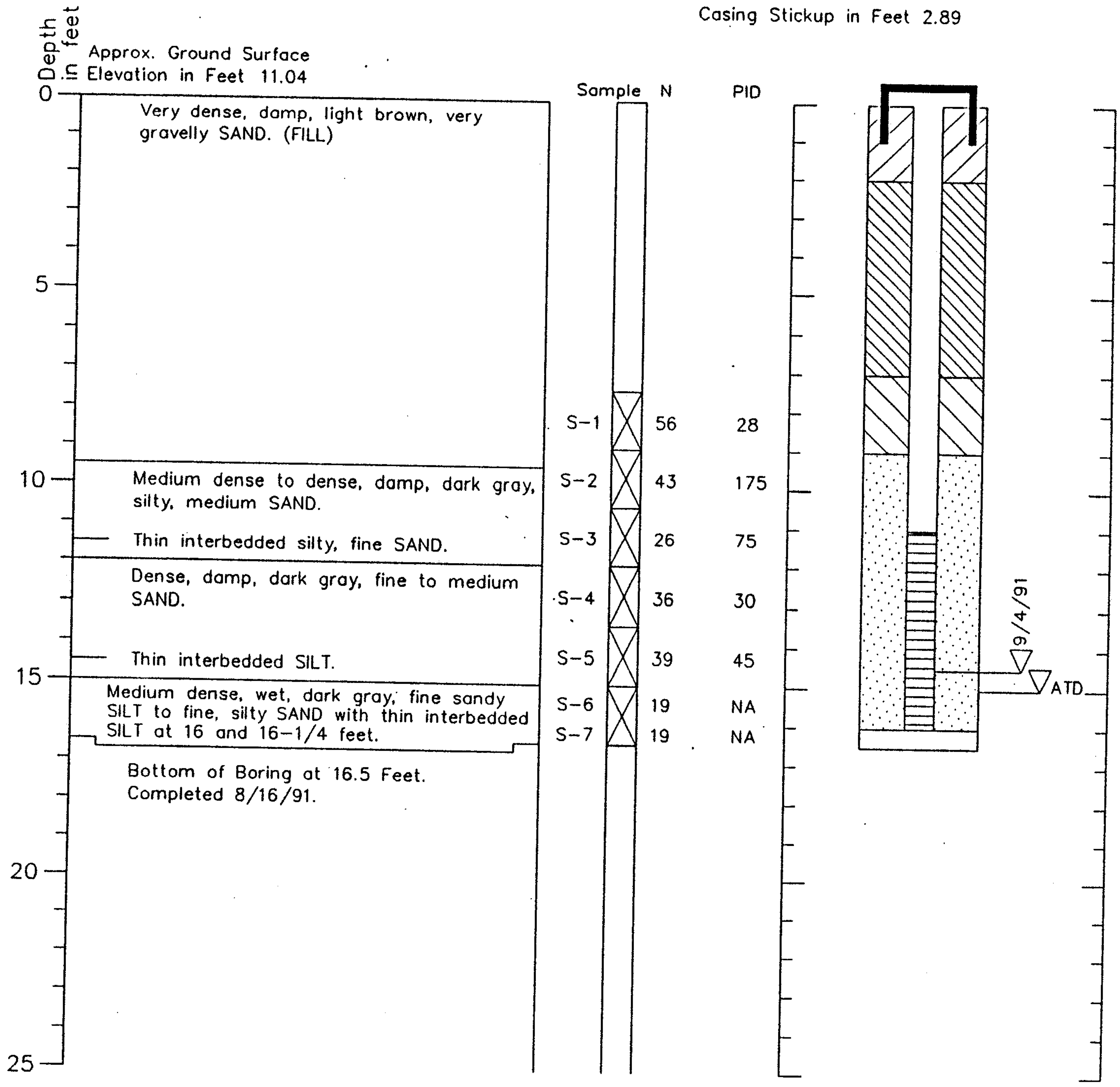
Boring Log and Construction Data for Monitoring Well B-16

Geologic Log

Monitoring Well Design

Casing Stickup in Feet 2.89

Approx. Ground Surface Elevation in Feet 11.04



Very dense, damp, light brown, very gravelly SAND. (FILL)

Medium dense to dense, damp, dark gray, silty, medium SAND.

Thin interbedded silty, fine SAND.

Dense, damp, dark gray, fine to medium SAND.

Thin interbedded SILT.

Medium dense, wet, dark gray, fine sandy SILT to fine, silty SAND with thin interbedded SILT at 16 and 16-1/4 feet.

Bottom of Boring at 16.5 Feet.
Completed 8/16/91.

Sample	N	PID
S-1	56	28
S-2	43	175
S-3	26	75
S-4	36	30
S-5	39	45
S-6	19	NA
S-7	19	NA

1. Refer text for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. No head space PID reading obtained for S-7.
5. Sample S-6 is split of S-7.

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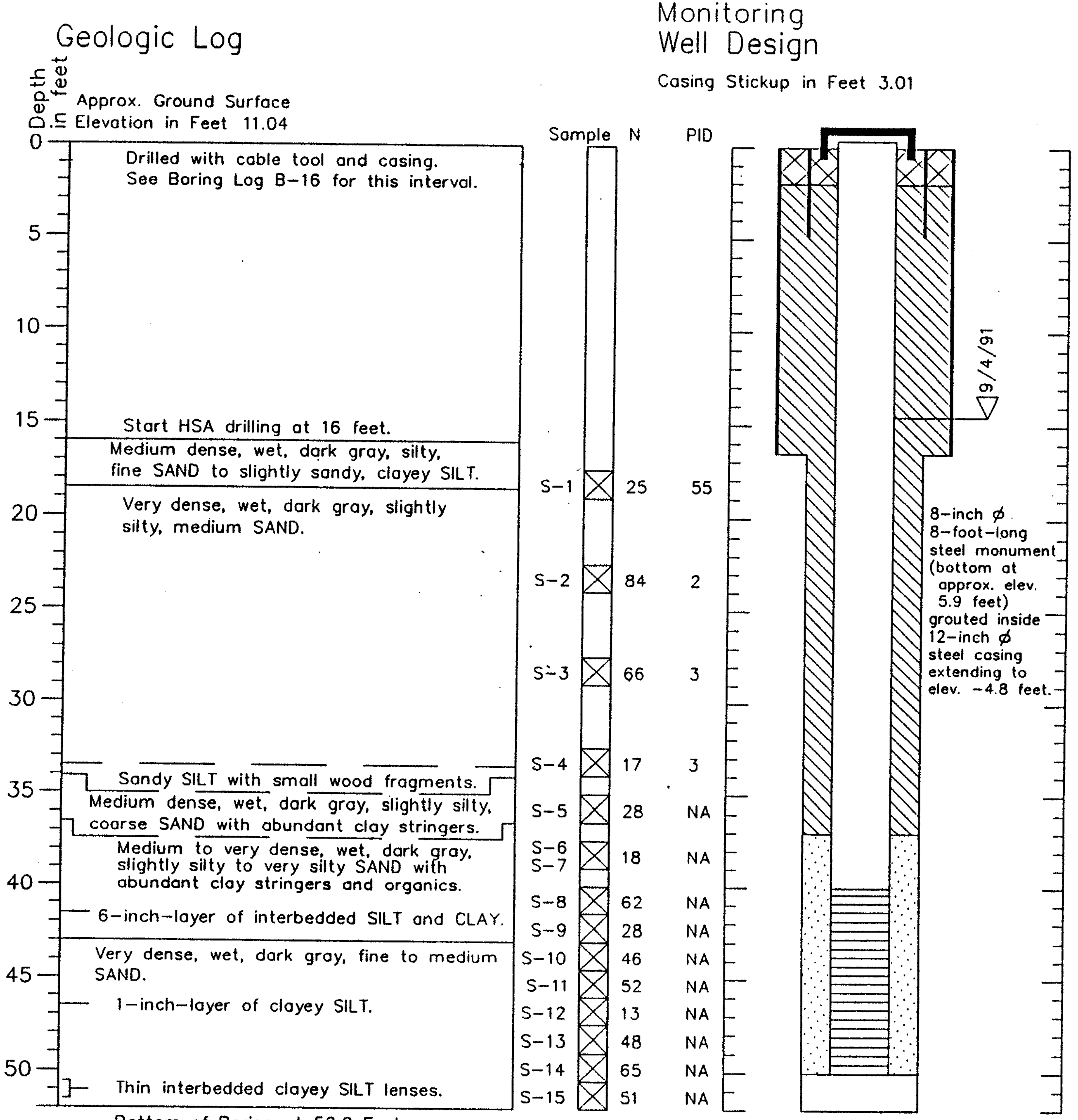
J-2489-08 8/91

Figure A-16

Boring Log and Construction Data for Monitoring Well B-17



Sample	N	PID
S-1	25	55
S-2	84	2
S-3	66	3
S-4	17	3
S-5	28	NA
S-6 S-7	18	NA
S-8	62	NA
S-9	28	NA
S-10	46	NA
S-11	52	NA
S-12	13	NA
S-13	48	NA
S-14	65	NA
S-15	51	NA

Bottom of Boring at 52.0 Feet.
Completed 8/19/91.

1. Refer to text for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Sample S-7 is split of S-6.
5. Beginning with S-5, only PID readings of 1.5 (background) were obtained, instrument malfunction suspected.

489 Feet to B33A/B34

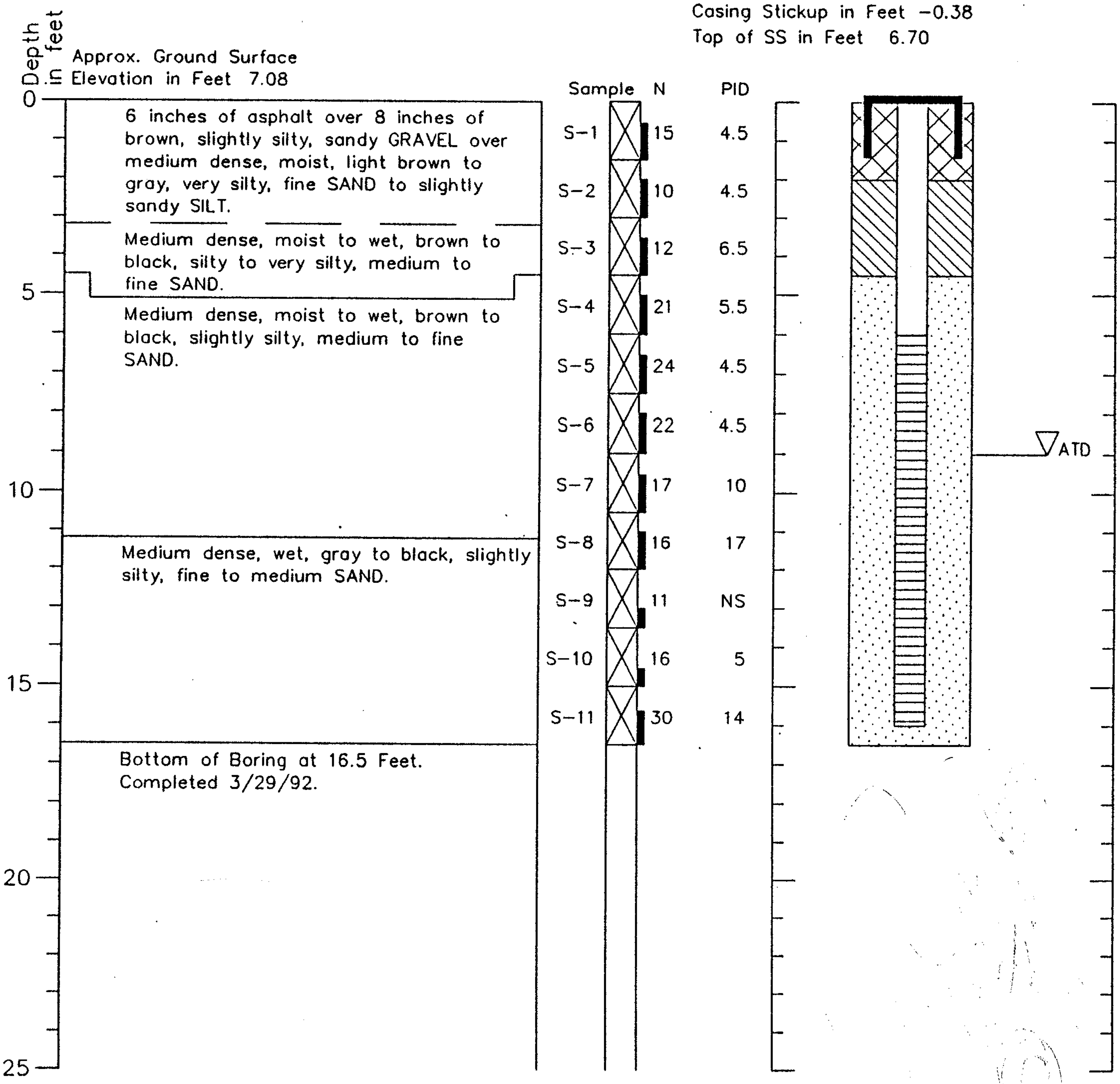
Boring Log and Construction Data for Monitoring Well B-18

Geologic Log

Monitoring Well Design

Casing Stickup in Feet −0.38
Top of SS in Feet 6.70

Approx. Ground Surface Elevation in Feet 7.08



6 inches of asphalt over 8 inches of brown, slightly silty, sandy GRAVEL over medium dense, moist, light brown to gray, very silty, fine SAND to slightly sandy SILT.

Medium dense, moist to wet, brown to black, silty to very silty, medium to fine SAND.

Medium dense, moist to wet, brown to black, slightly silty, medium to fine SAND.

Medium dense, wet, gray to black, slightly silty, fine to medium SAND.

Bottom of Boring at 16.5 Feet.
Completed 3/29/92.

Sample	N	PID
S−1	15	4.5
S−2	10	4.5
S−3	12	6.5
S−4	21	5.5
S−5	24	4.5
S−6	22	4.5
S−7	17	10
S−8	16	17
S−9	11	NS
S−10	16	5
S−11	30	14

1. Refer to Figure A−1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. NS means Not Sampled due to poor sample recovery.
5. Two sample numbers per sampling interval indicates duplicate sample.

HARTCROWSER
J-2489-10 **3/92**

Figure A-18

489 Feet to B33A/B34

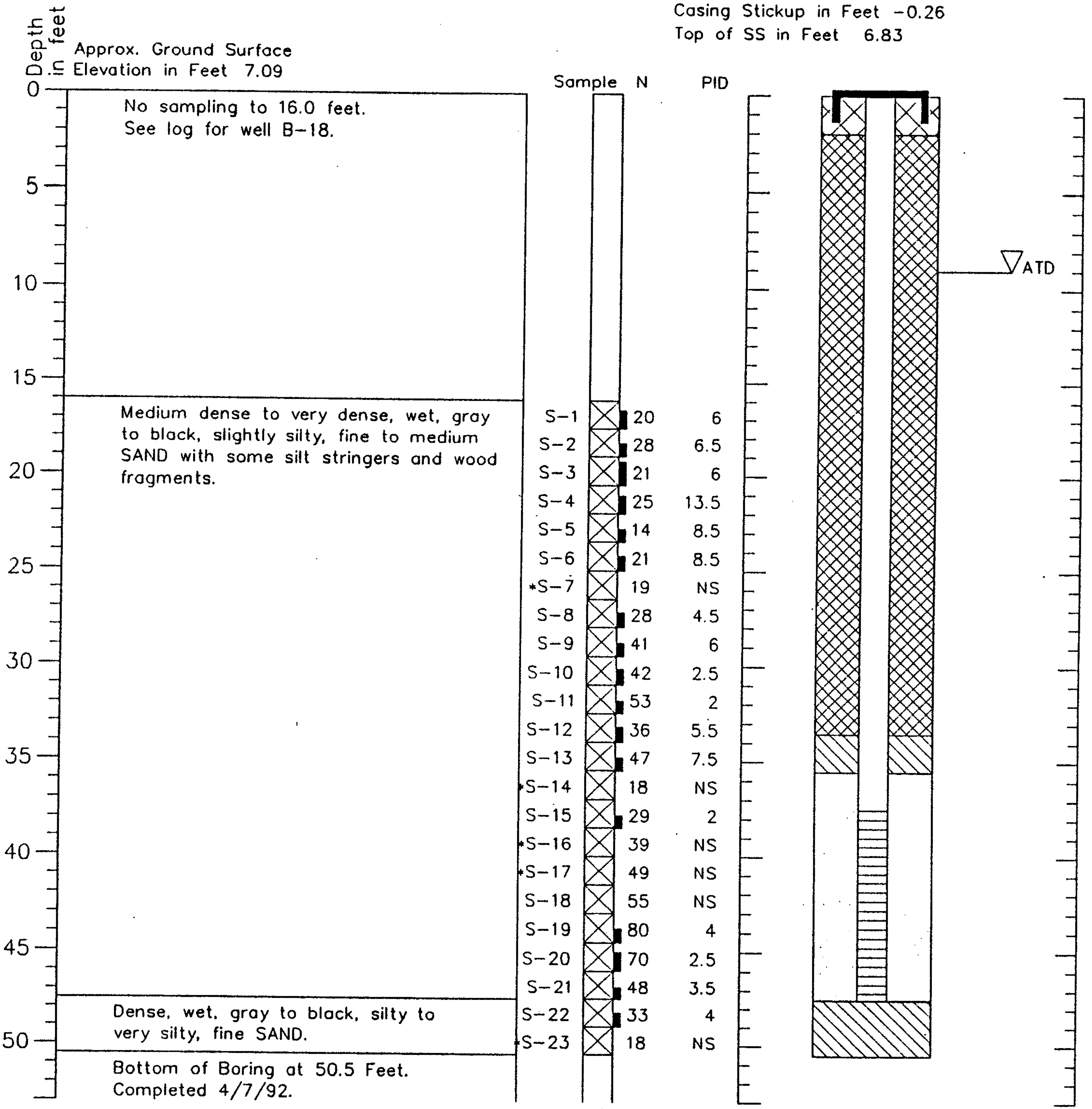
Boring Log and Construction Data for Monitoring Well B-19

Geologic Log

Monitoring Well Design

Casing Stickup in Feet -0.26
Top of SS in Feet 6.83

Approx. Ground Surface Elevation in Feet 7.09



No sampling to 16.0 feet. See log for well B-18.

Medium dense to very dense, wet, gray to black, slightly silty, fine to medium SAND with some silt stringers and wood fragments.

Dense, wet, gray to black, silty to very silty, fine SAND.

Bottom of Boring at 50.5 Feet. Completed 4/7/92.

Sample	N	PID
S-1	20	6
S-2	28	6.5
S-3	21	6
S-4	25	13.5
S-5	14	8.5
S-6	21	8.5
*S-7	19	NS
S-8	28	4.5
S-9	41	6
S-10	42	2.5
S-11	53	2
S-12	36	5.5
S-13	47	7.5
*S-14	18	NS
S-15	29	2
*S-16	39	NS
*S-17	49	NS
S-18	55	NS
S-19	80	4
S-20	70	2.5
S-21	48	3.5
S-22	33	4
*S-23	18	NS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. NS means Not Sampled due to poor sample recovery.
5. Two sample number per sampling interval indicates duplicate sample.

HARTCROWSER

J-2489-10 **4/92**

Figure A-19

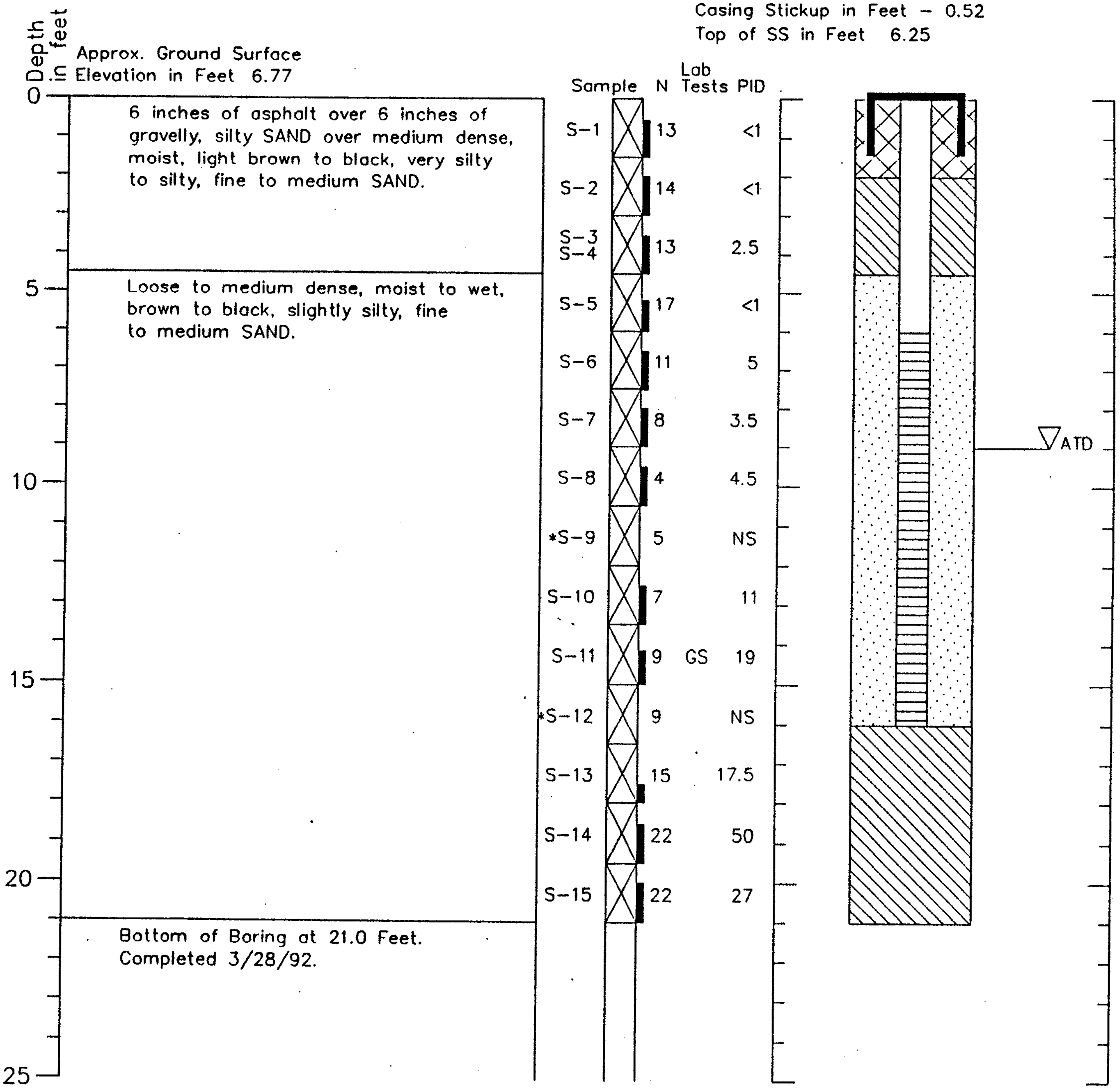
Boring Log and Construction Data for Monitoring Well B-20

Geologic Log

Approx. Ground Surface
Elevation in Feet 6.77

Monitoring Well Design

Casing Stickup in Feet – 0.52
Top of SS in Feet 6.25



6 inches of asphalt over 6 inches of gravelly, silty SAND over medium dense, moist, light brown to black, very silty to silty, fine to medium SAND.

Loose to medium dense, moist to wet, brown to black, slightly silty, fine to medium SAND.

Bottom of Boring at 21.0 Feet.
Completed 3/28/92.

Sample	N	Lab Tests	PID
S-1	13		<1
S-2	14		<1
S-3 S-4	13		2.5
S-5	17		<1
S-6	11		5
S-7	8		3.5
S-8	4		4.5
*S-9	5		NS
S-10	7		11
S-11	9	GS	19
*S-12	9		NS
S-13	15		17.5
S-14	22		50
S-15	22		27

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. NS means Not Sampled due to poor sample recovery.
5. Two sample numbers per sampling interval indicates duplicate sample.

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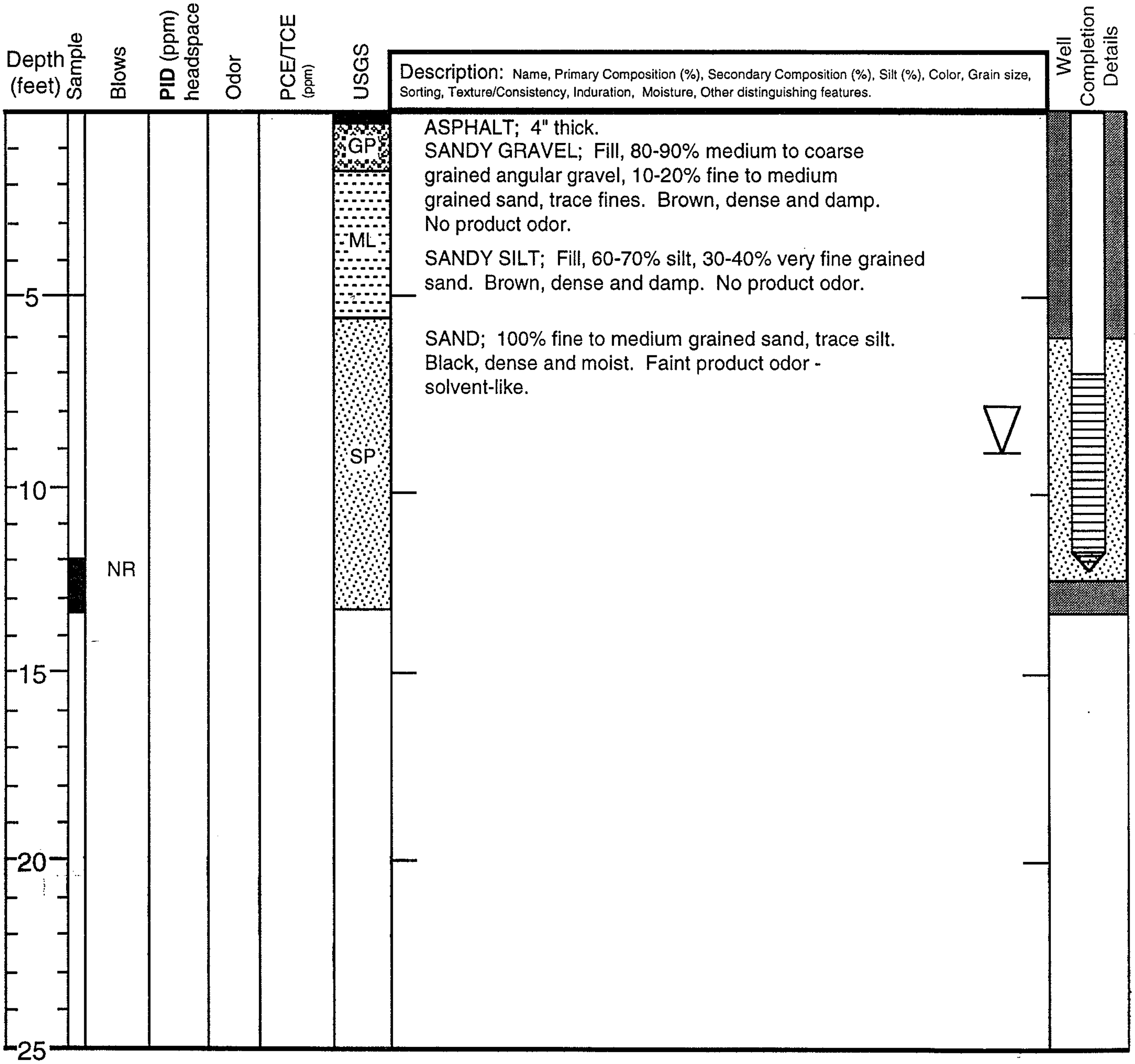
J-2489-10 **3/92**

Figure A-20

TERRA VAC

Date Drilled: 9/10/99 **Boring/Well Number:** B-20A Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Mod - Cal
Total Depth: 13.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

ASPHALT; 4" thick.
SANDY GRAVEL; Fill, 80-90% medium to coarse grained angular gravel, 10-20% fine to medium grained sand, trace fines. Brown, dense and damp. No product odor.

SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand. Brown, dense and damp. No product odor.

SAND; 100% fine to medium grained sand, trace silt. Black, dense and moist. Faint product odor - solvent-like.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed. NR = Not Recorded.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Boring Log and Construction Data for Monitoring Well B-21

Geologic Log

Depth in feet

Approx. Ground Surface Elevation in Feet 6.70

No sampling to 21.0 feet. See Log for well B-20.

Medium dense to dense, wet, gray to black, slightly silty, fine to medium SAND.

Medium dense, wet, gray to black, very silty to silty, fine SAND with silt stringers.

Medium dense to dense, wet, gray to black, slightly silty to silty, medium SAND.

Medium stiff to very stiff, wet, gray, clayey to sandy SILT.

Very sandy SILT to very silty SAND.

Dense to very dense, wet, gray to black, slightly silty to silty, medium to fine SAND.

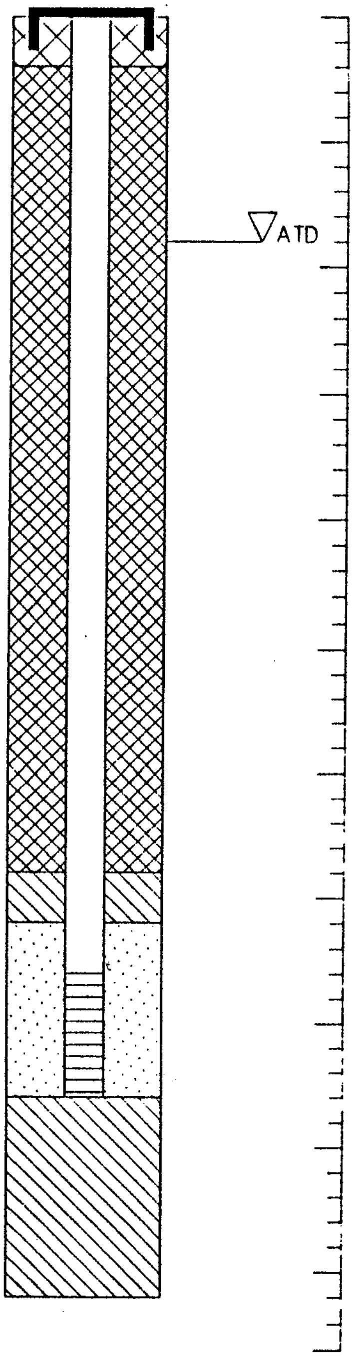
Bottom of Boring at 51.0 Feet. Completed 4/8/92.

Sample	N	Lab Tests	PID
S-1	35		27
S-2	43		82
*S-3	11		NS
*S-4	15		NS
S-5	41		52
S-6	42		35
*S-7	14		NS
S-8	29		53
S-9	28		77
S-10	15		85
S-11	24		25
S-12	27		85
S-13	49	GS	73
*S-14	21		NS
S-15	6		80
S-16	19		66
S-17	8		58
S-18	24		55
S-19	55		29
S-20	42		15

Monitoring Well Design

Casing Stickup in Feet -0.29

Top of SS in Feet 6.41



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. NS means Not Sampled due to poor sample recovery.
5. Two sample numbers per sampling interval indicates duplicate sample.

HARTCROWSER

J-2489-10 4/92

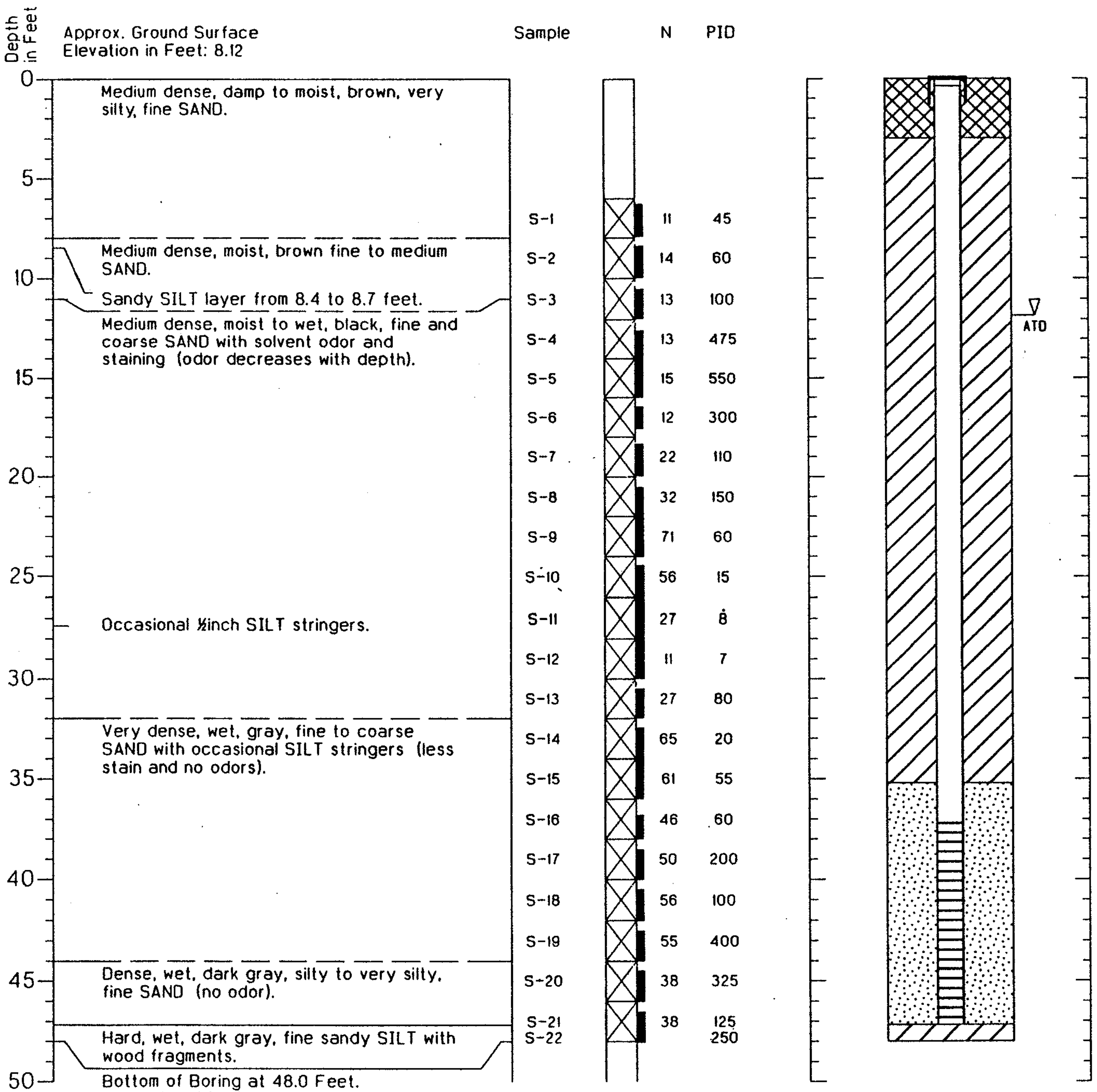
Figure A-21

Boring Log and Construction Data for Monitoring Well B-45

Geologic Log

Monitoring
Well Design

Casing Stickup in Feet: -0.38
Top of SS in Feet 7.74



Approx. Ground Surface
Elevation in Feet: 8.12

Medium dense, damp to moist, brown, very silty, fine SAND.

Medium dense, moist, brown fine to medium SAND.

Sandy SILT layer from 8.4 to 8.7 feet.

Medium dense, moist to wet, black, fine and coarse SAND with solvent odor and staining (odor decreases with depth).

Occasional ½inch SILT stringers.

Very dense, wet, gray, fine to coarse SAND with occasional SILT stringers (less stain and no odors).

Dense, wet, dark gray, silty to very silty, fine SAND (no odor).

Hard, wet, dark gray, fine sandy SILT with wood fragments.

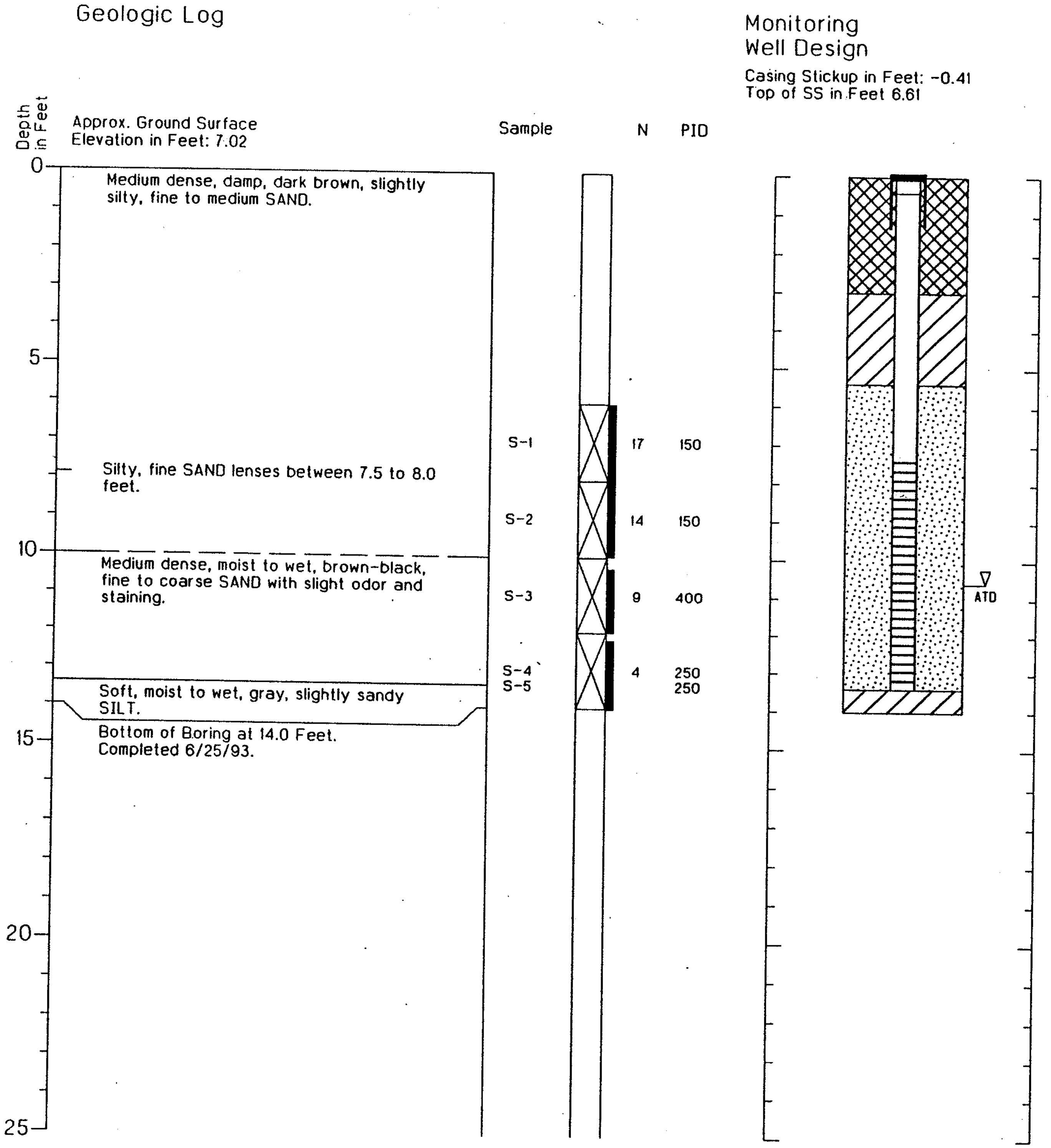
Bottom of Boring at 48.0 Feet.
Completed 6/25/93.

Sample	N	PID
S-1	11	45
S-2	14	60
S-3	13	100
S-4	13	475
S-5	15	550
S-6	12	300
S-7	22	110
S-8	32	150
S-9	71	60
S-10	56	15
S-11	27	8
S-12	11	7
S-13	27	80
S-14	65	20
S-15	61	55
S-16	46	60
S-17	50	200
S-18	56	100
S-19	55	400
S-20	38	325
S-21	38	125
S-22		250

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-27 **6/93**
Figure A-4

Boring Log and Construction Data for Monitoring Well B-46



Medium dense, damp, dark brown, slightly silty, fine to medium SAND.

Silty, fine SAND lenses between 7.5 to 8.0 feet.

Medium dense, moist to wet, brown-black, fine to coarse SAND with slight odor and staining.

Soft, moist to wet, gray, slightly sandy SILT.

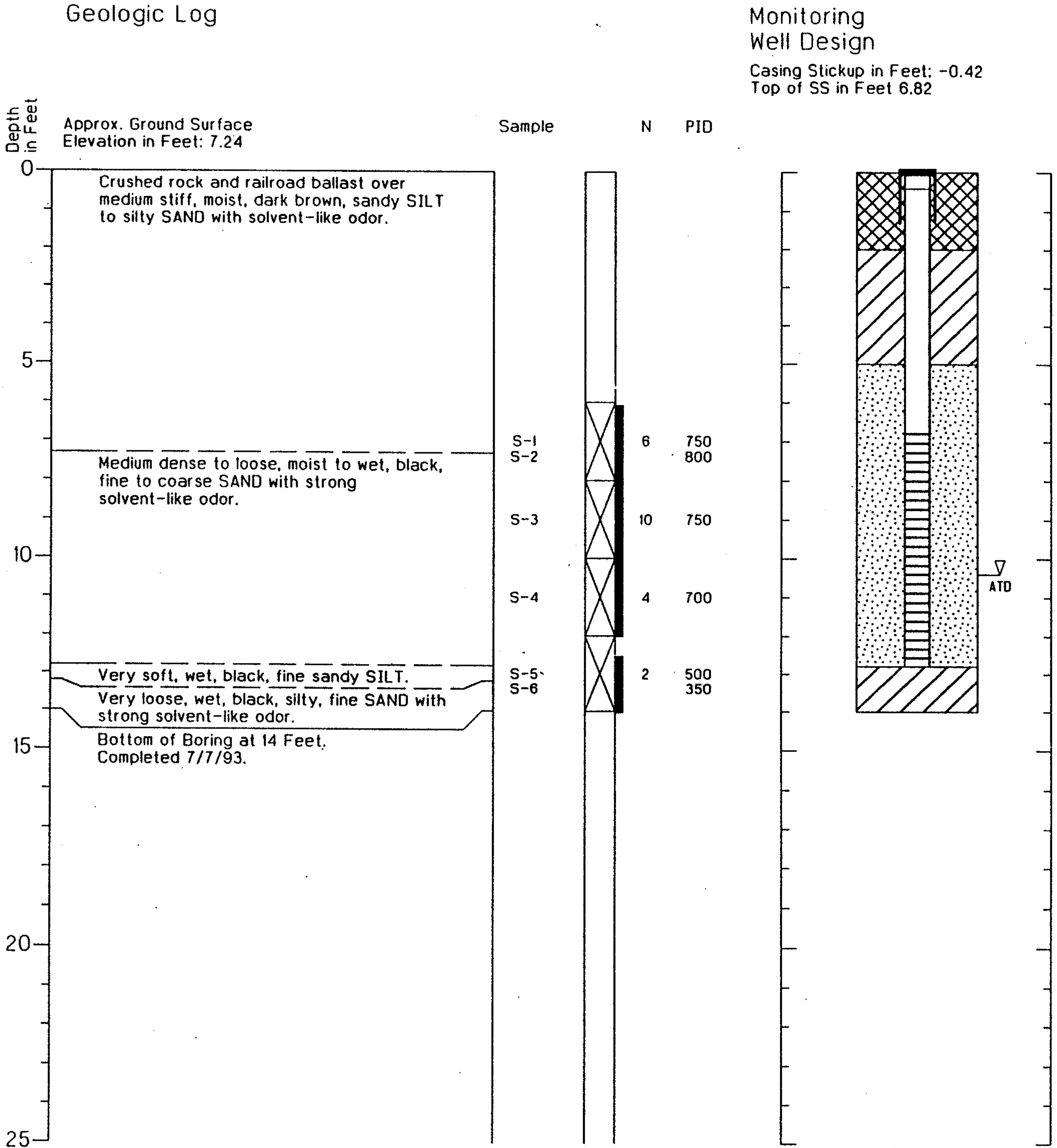
Bottom of Boring at 14.0 Feet.
Completed 6/25/93.

Sample	N	PID
S-1	17	150
S-2	14	150
S-3	9	400
S-4	4	250
S-5		250

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-27 6/93
Figure A-5

Boring Log and Construction Data for Monitoring Well B-47



Casing Stickup in Feet: -0.42
Top of SS in Feet 6.82

Approx. Ground Surface Elevation in Feet: 7.24

Crushed rock and railroad ballast over medium stiff, moist, dark brown, sandy SILT to silty SAND with solvent-like odor.

Medium dense to loose, moist to wet, black, fine to coarse SAND with strong solvent-like odor.

Very soft, wet, black, fine sandy SILT.

Very loose, wet, black, silty, fine SAND with strong solvent-like odor.

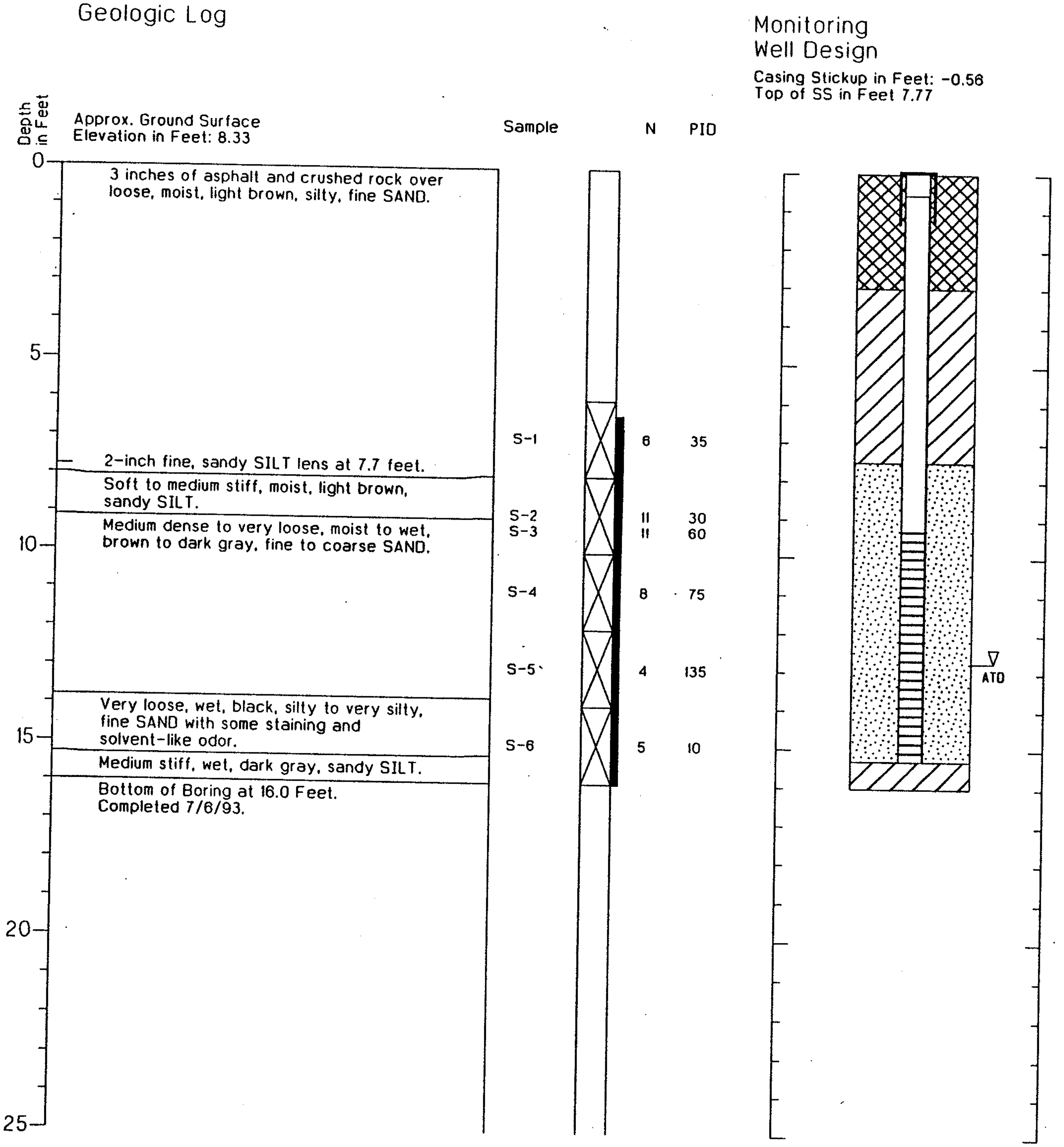
Bottom of Boring at 14 Feet.
Completed 7/7/93.

Sample	N	PID
S-1	6	750
S-2		800
S-3	10	750
S-4	4	700
S-5	2	500
S-6		350

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-27 *7/93*
Figure A-6

Boring Log and Construction Data for Monitoring Well B-48



Geologic Log

Approx. Ground Surface Elevation in Feet: 8.33

3 inches of asphalt and crushed rock over loose, moist, light brown, silty, fine SAND.

2-inch fine, sandy SILT lens at 7.7 feet.

Soft to medium stiff, moist, light brown, sandy SILT.

Medium dense to very loose, moist to wet, brown to dark gray, fine to coarse SAND.

Very loose, wet, black, silty to very silty, fine SAND with some staining and solvent-like odor.

Medium stiff, wet, dark gray, sandy SILT.

Bottom of Boring at 16.0 Feet.
Completed 7/6/93.

Sample	N	PID
S-1	6	35
S-2	11	30
S-3	11	60
S-4	8	75
S-5	4	135
S-6	5	10

Monitoring Well Design

Casing Stickup in Feet: -0.56
Top of SS in Feet 7.77

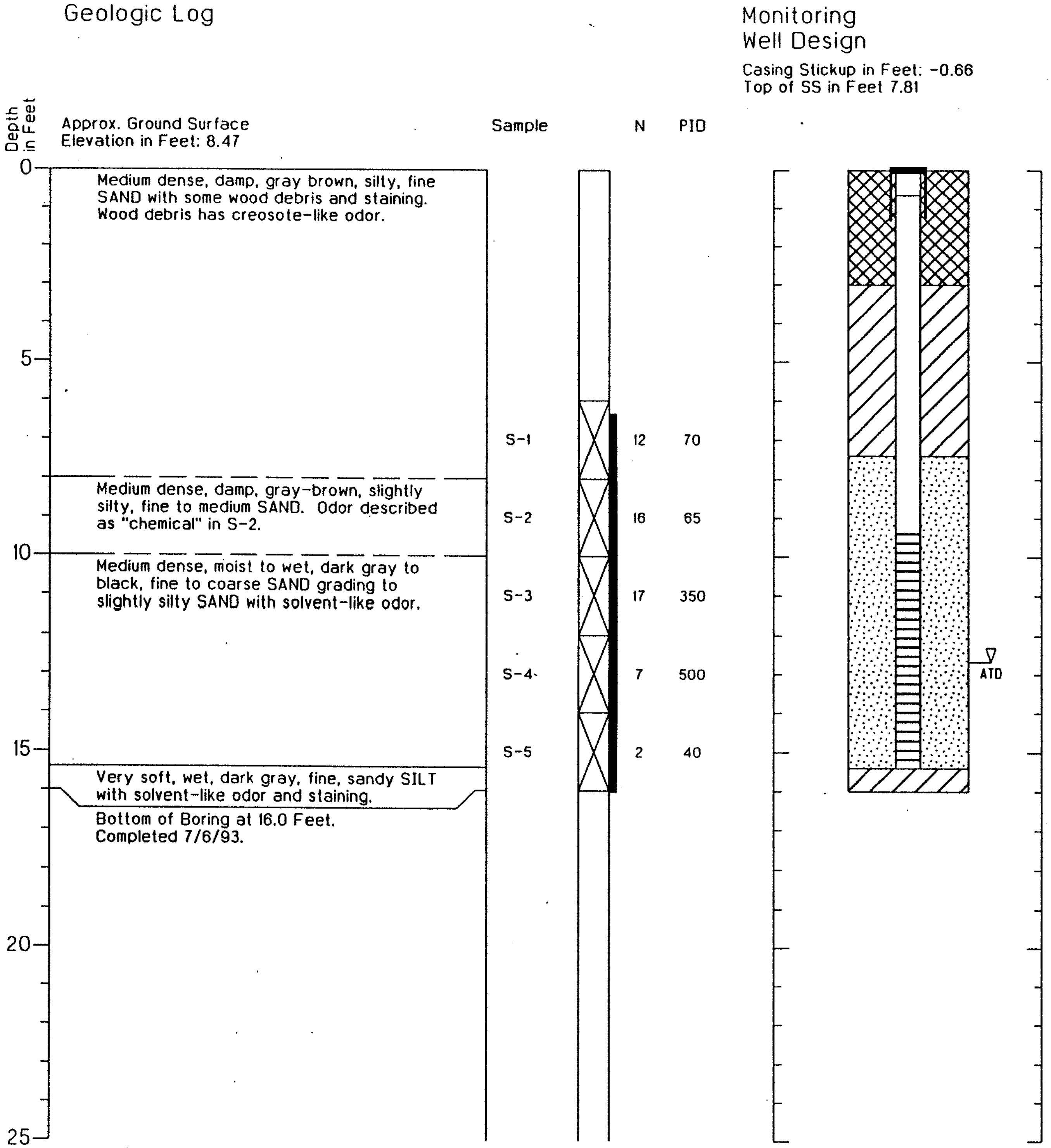
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-27 7/93

Figure A-7

Boring Log and Construction Data for Monitoring Well B-49



Casing Stickup in Feet: -0.66
Top of SS in Feet 7.81

Approx. Ground Surface
Elevation in Feet: 8.47

Medium dense, damp, gray brown, silty, fine SAND with some wood debris and staining. Wood debris has creosote-like odor.

Medium dense, damp, gray-brown, slightly silty, fine to medium SAND. Odor described as "chemical" in S-2.

Medium dense, moist to wet, dark gray to black, fine to coarse SAND grading to slightly silty SAND with solvent-like odor.

Very soft, wet, dark gray, fine, sandy SILT with solvent-like odor and staining.

Bottom of Boring at 16.0 Feet.
Completed 7/6/93.

Sample	N	PID
S-1	12	70
S-2	16	65
S-3	17	350
S-4	7	500
S-5	2	40

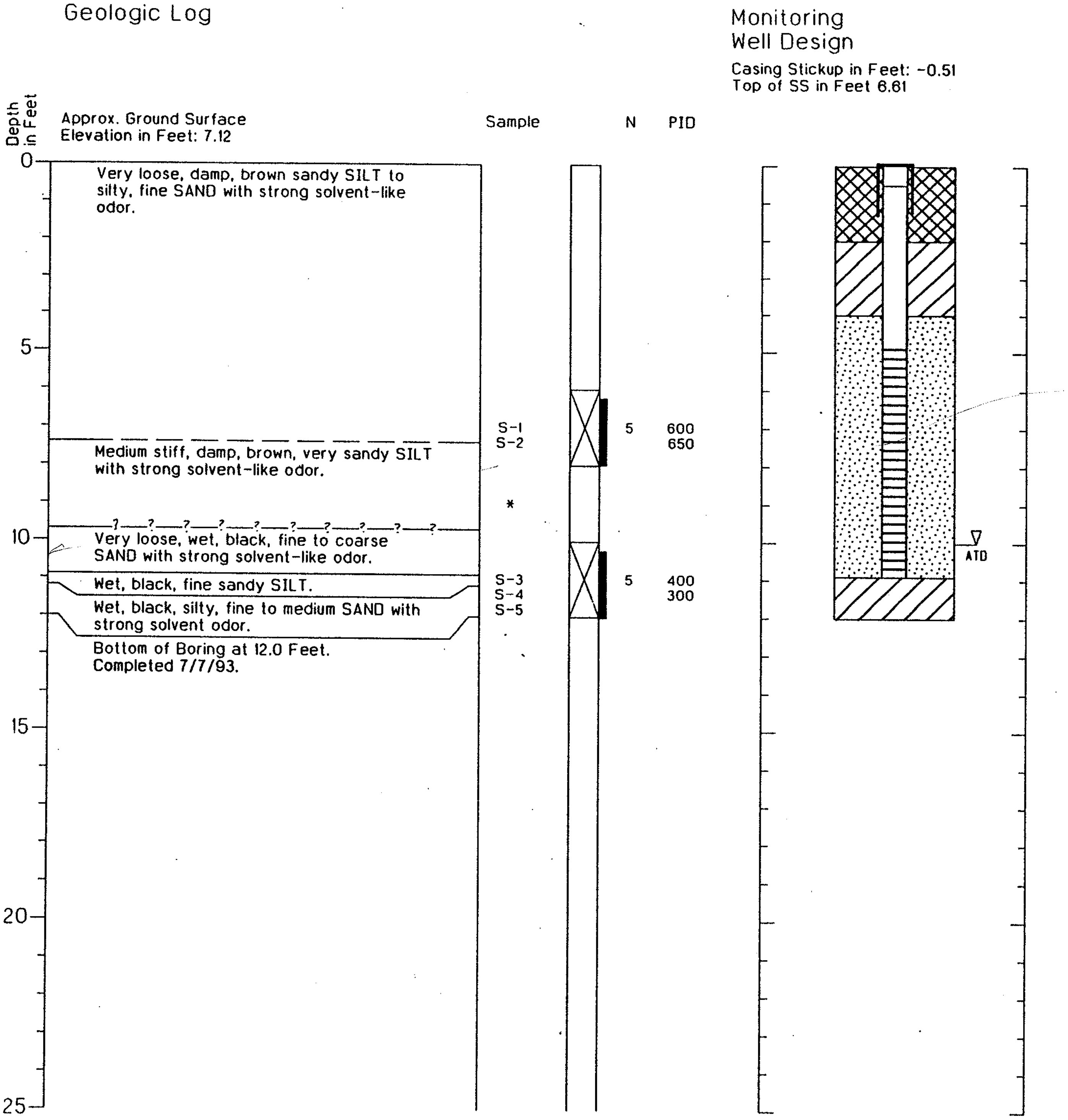
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-27 **6/93**

Figure A-8

Boring Log and Construction Data for Monitoring Well B-50



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-27 **7/93**
Figure A-9

Boring Log and Construction Data for Monitoring Well B-51

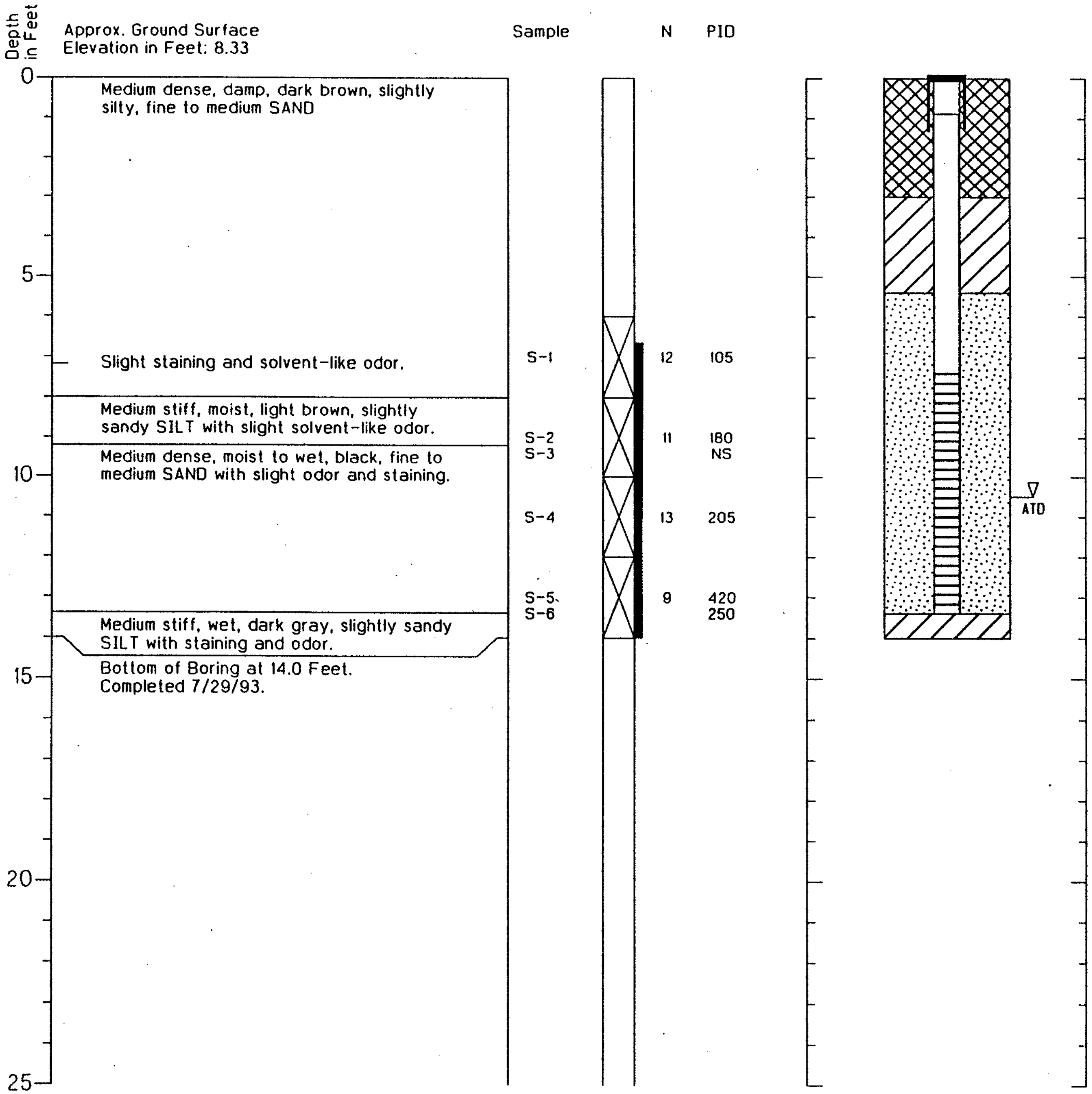
Abandoned

Geologic Log

Monitoring Well Design

Casing Stickup in Feet: -0.88
Top of SS in Feet 7.45

Approx. Ground Surface Elevation in Feet: 8.33



Medium dense, damp, dark brown, slightly silty, fine to medium SAND

Slight staining and solvent-like odor.

Medium stiff, moist, light brown, slightly sandy SILT with slight solvent-like odor.

Medium dense, moist to wet, black, fine to medium SAND with slight odor and staining.

Medium stiff, wet, dark gray, slightly sandy SILT with staining and odor.

Bottom of Boring at 14.0 Feet.
Completed 7/29/93.

Sample	N	PID
S-1	12	105
S-2	11	180
S-3		NS
S-4	13	205
S-5	9	420
S-6		250

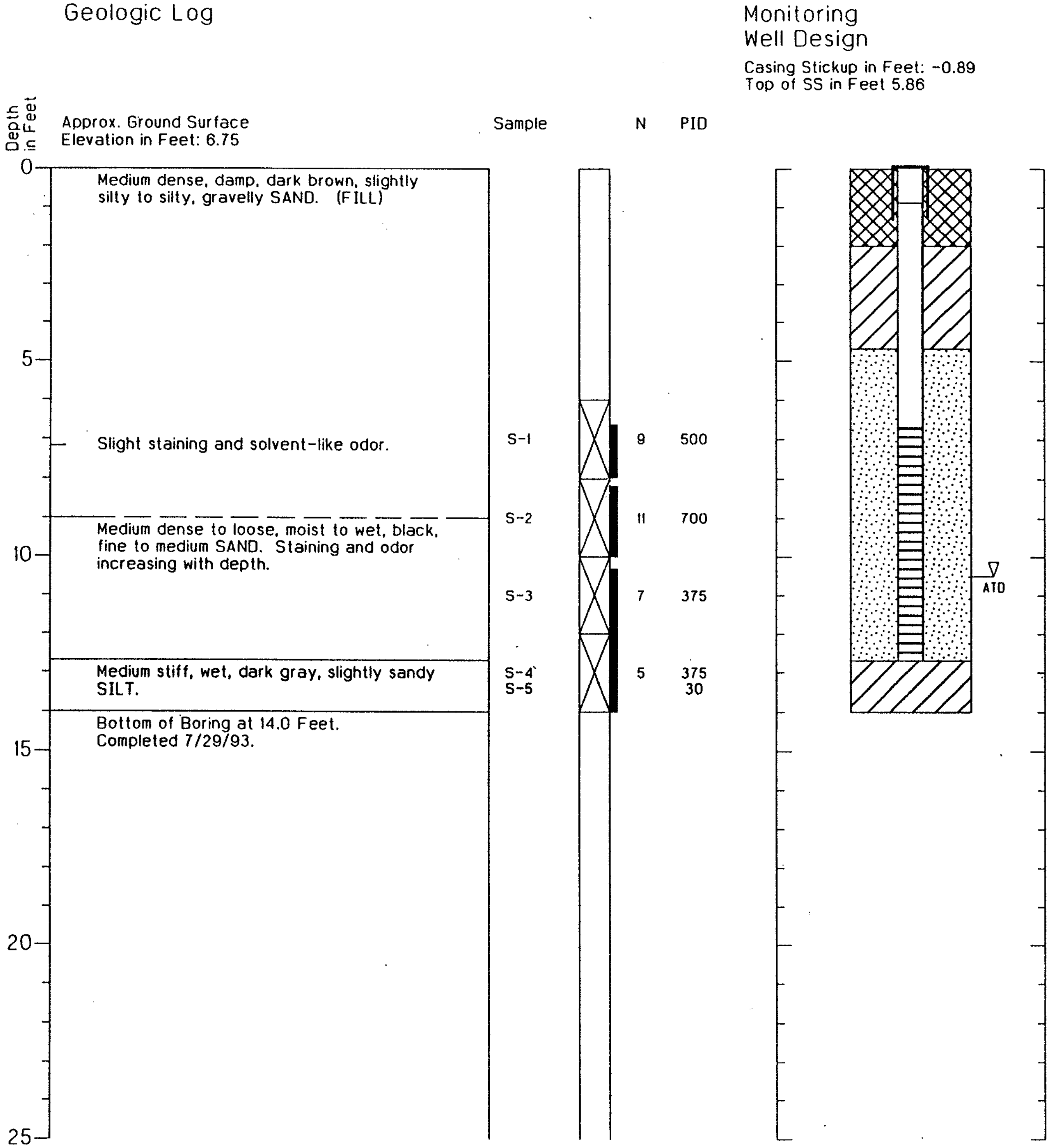
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-27 7/93

Figure A-10

Boring Log and Construction Data for Monitoring Well B-52



Geologic Log

Monitoring Well Design

Casing Stickup in Feet: -0.89
Top of SS in Feet 5.86

Approx. Ground Surface
Elevation in Feet: 6.75

Medium dense, damp, dark brown, slightly silty to silty, gravelly SAND. (FILL)

Slight staining and solvent-like odor.

Medium dense to loose, moist to wet, black, fine to medium SAND. Staining and odor increasing with depth.

Medium stiff, wet, dark gray, slightly sandy SILT.

Bottom of Boring at 14.0 Feet.
Completed 7/29/93.

Sample	N	PID
S-1	9	500
S-2	11	700
S-3	7	375
S-4	5	375
S-5		30

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-27 *7/93*

Figure A-11

TERRA VAC

Date Drilled: 2/3/99 **Boring/Well Number:** B-53 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

Drill Rig: Limited Access CME-75

Drilling Contractor: Cascade Drilling, Inc.

Log by: J. Orr

Auger Size/Type: 6" HSA

Sample Method: Split Spoon

Total Depth: 15 feet

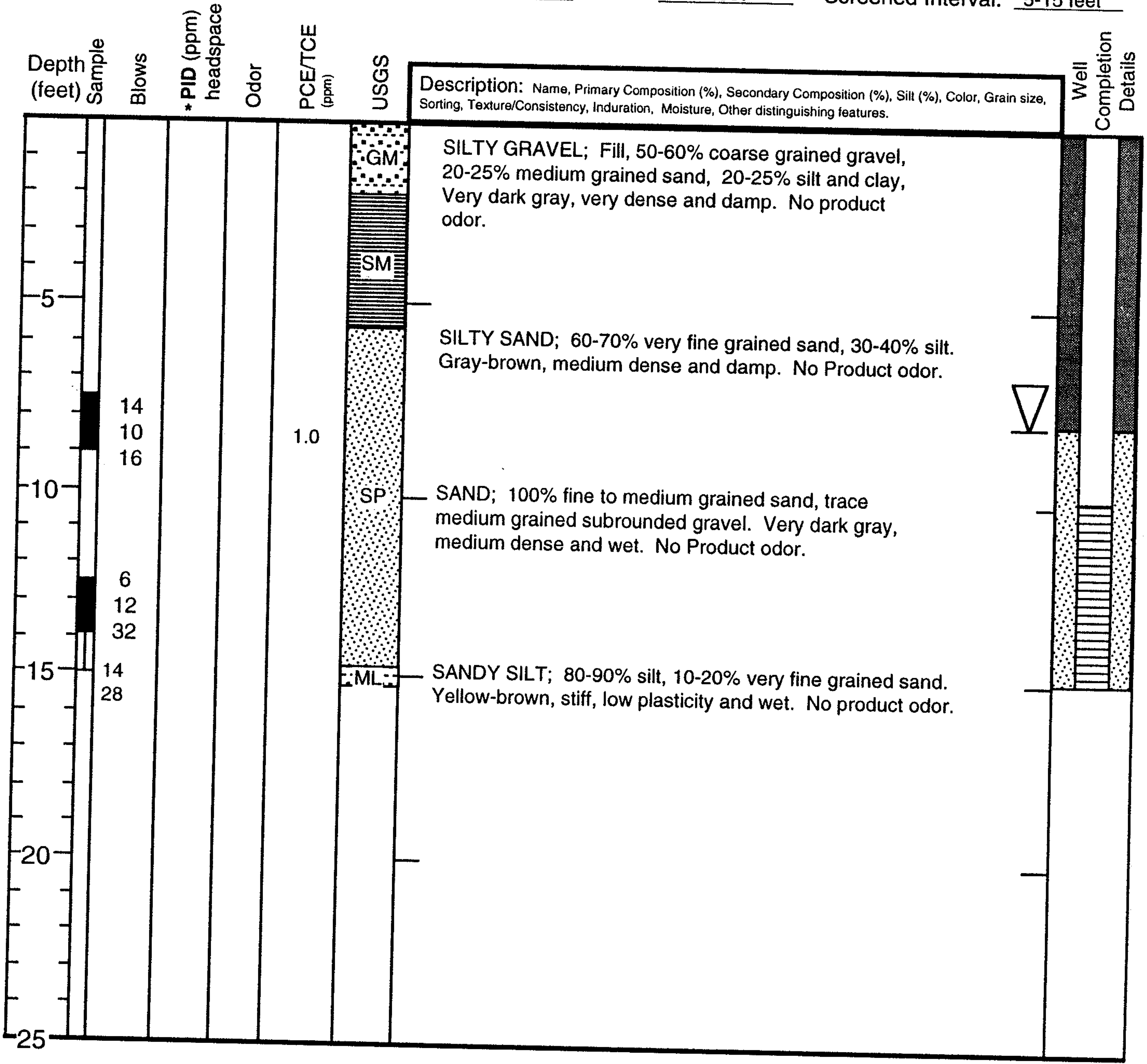
Depth to Groundwater: 8 feet

Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC

Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-8 feet Screened Interval: 5-15 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 50-60% coarse grained gravel, 20-25% medium grained sand, 20-25% silt and clay, Very dark gray, very dense and damp. No product odor.

SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Gray-brown, medium dense and damp. No Product odor.

SAND; 100% fine to medium grained sand, trace medium grained subrounded gravel. Very dark gray, medium dense and wet. No Product odor.

SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Yellow-brown, stiff, low plasticity and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 2/3/99 **Boring/Well Number:** B-54 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

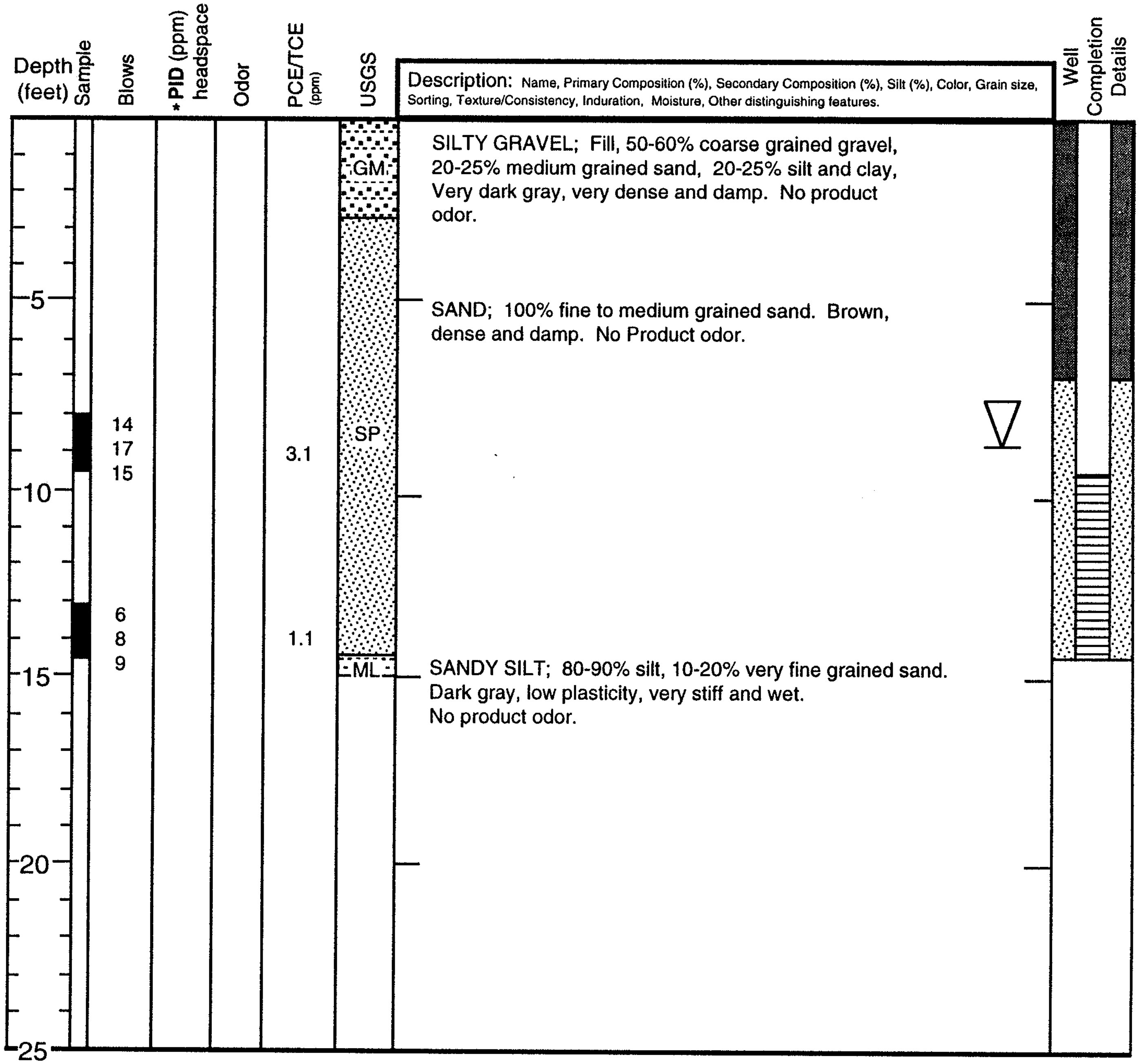
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon

Total Depth: 14.5 feet Depth to Groundwater: 9 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-7 feet Screened Interval: 9-14 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 50-60% coarse grained gravel, 20-25% medium grained sand, 20-25% silt and clay, Very dark gray, very dense and damp. No product odor.

SAND; 100% fine to medium grained sand. Brown, dense and damp. No Product odor.

SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Limited Access

Date Drilled: 2/3/99

Boring/Well Number: B-55

Page 1 of 1

Project: Great Western Chemical Company

Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

Drilling Contractor: Cascade Drilling, Inc.

Log by: J. Orr

Drill Rig: CME-75

Auger Size/Type: 6" HSA

Sample Method: Split Spoon

Total Depth: 15 feet

Depth to Groundwater: 8 feet

Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC

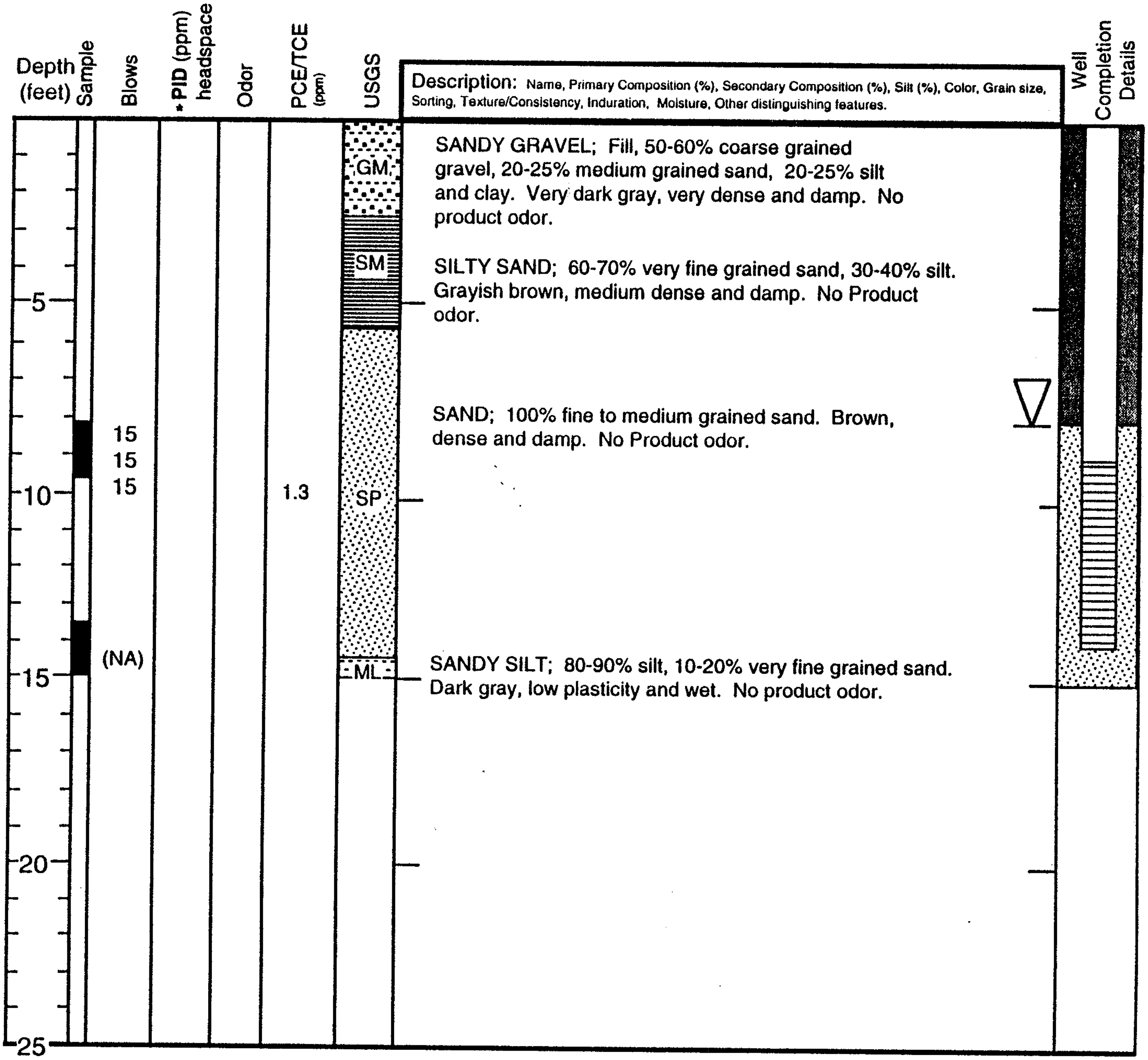
Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in.

Slot Size: 0.01"

Seal: 0-7 feet

Screened Interval: 9-14 feet



Blows	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
		GM	SANDY GRAVEL; Fill, 50-60% coarse grained gravel, 20-25% medium grained sand, 20-25% silt and clay. Very dark gray, very dense and damp. No product odor.
		SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Grayish brown, medium dense and damp. No Product odor.
15 15 15	1.3	SP	SAND; 100% fine to medium grained sand. Brown, dense and damp. No Product odor.
(NA)		ML	SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Limited Access

Date Drilled: 2/3/99 **Boring/Well Number:** B-56 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

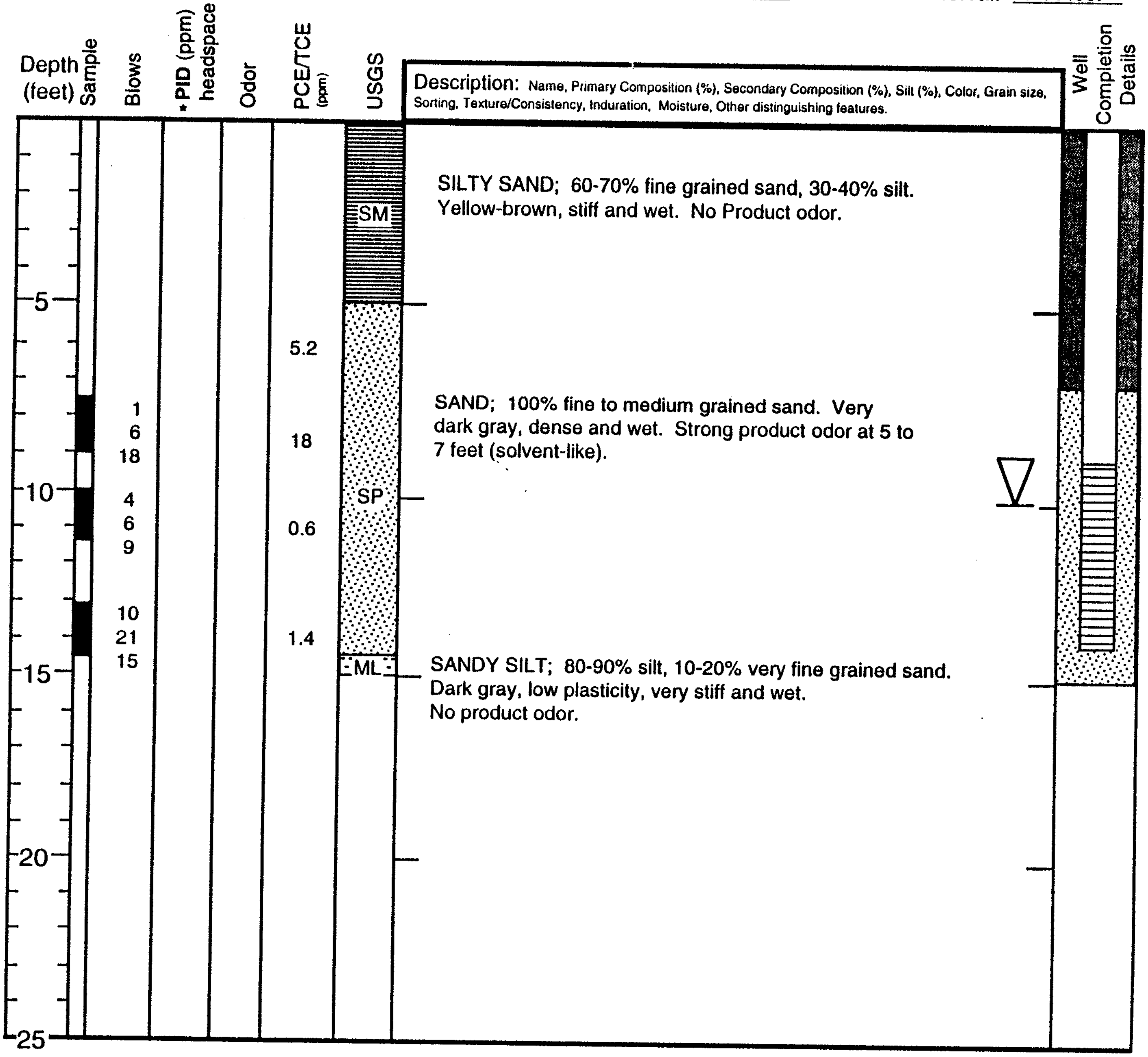
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon

Total Depth: 15 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-7 feet Screened Interval: 9-14 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY SAND; 60-70% fine grained sand, 30-40% silt. Yellow-brown, stiff and wet. No Product odor.

SAND; 100% fine to medium grained sand. Very dark gray, dense and wet. Strong product odor at 5 to 7 feet (solvent-like).

SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.

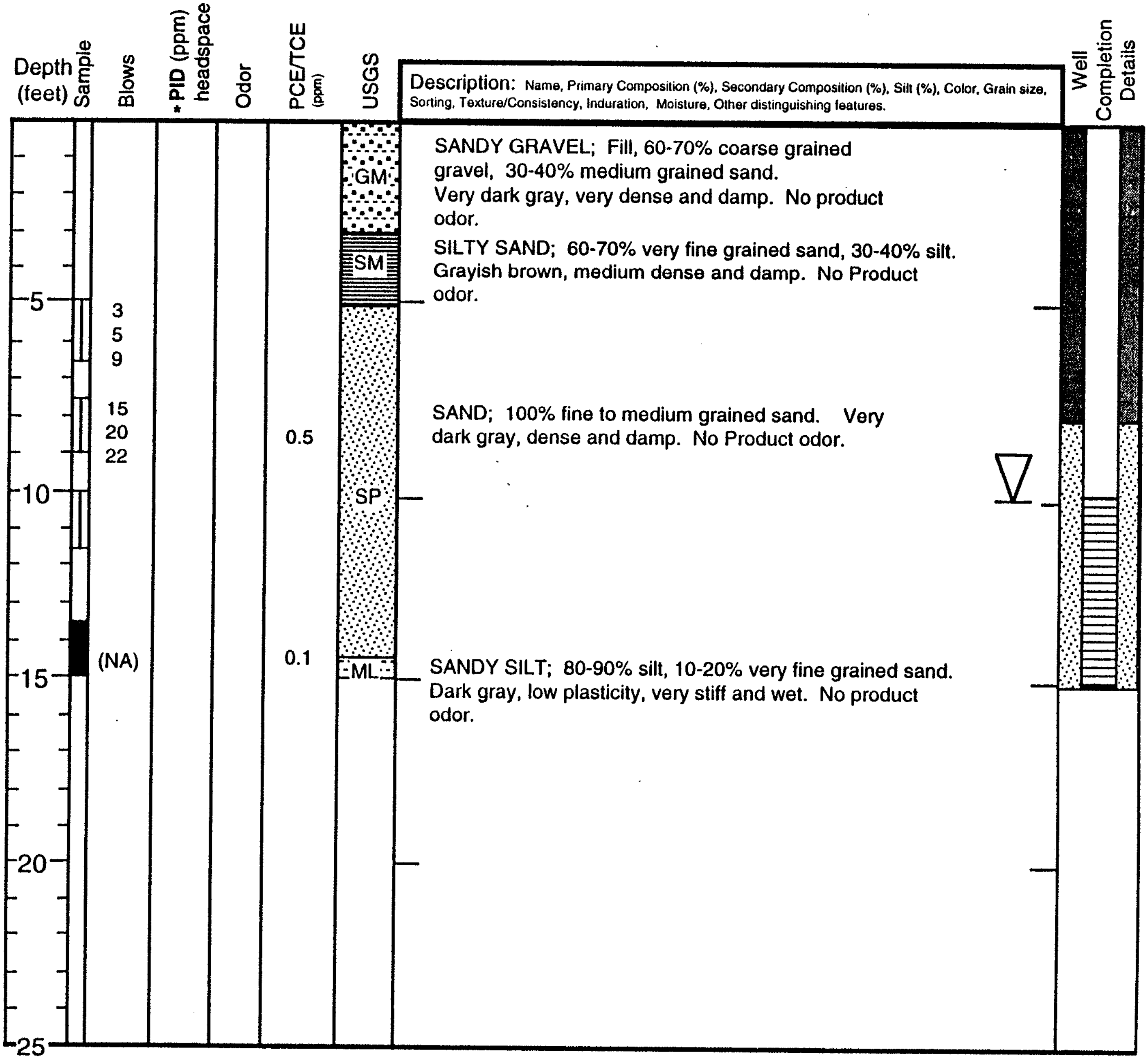
General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 2/3/99 **Boring/Well Number:** B-57 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon
Total Depth: 15 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-8 feet Screened Interval: 10-15 feet



Depth (feet)	Sample	Blows	* PID (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GM	SANDY GRAVEL; Fill, 60-70% coarse grained gravel, 30-40% medium grained sand. Very dark gray, very dense and damp. No product odor.
						SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Grayish brown, medium dense and damp. No Product odor.
5		3 5 9					
		15 20 22			0.5	SP	SAND; 100% fine to medium grained sand. Very dark gray, dense and damp. No Product odor.
10							
15		(NA)			0.1	ML	SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.
20							
25							

Well Completion Details

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/7/99 **Boring/Well Number:** B-58 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington 98188

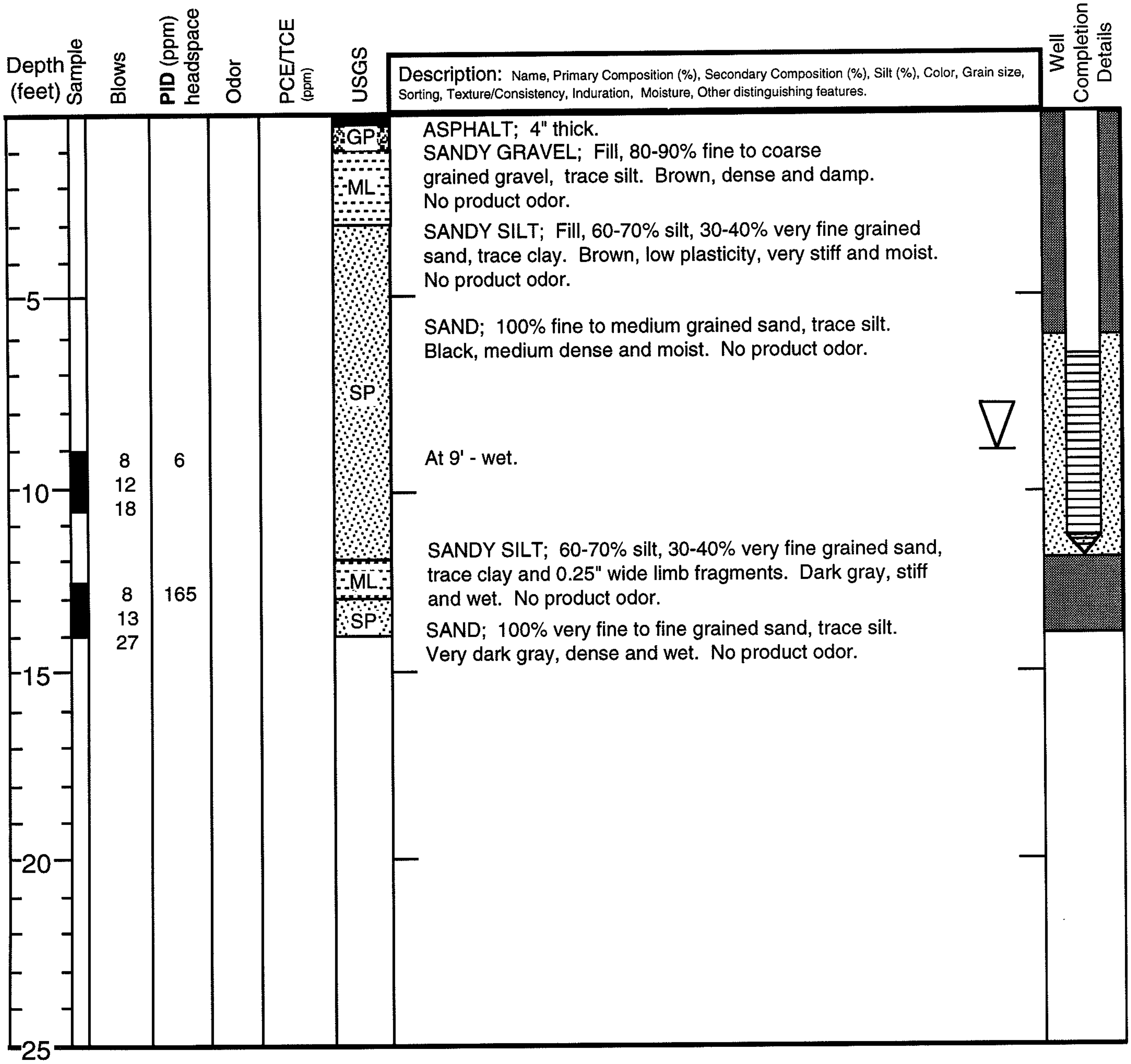
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Mod - Cal

Total Depth: 14 feet Depth to Groundwater: 9 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet



Depth (feet)	Sample	Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
						GP	ASPHALT; 4" thick. SANDY GRAVEL; Fill, 80-90% fine to coarse grained gravel, trace silt. Brown, dense and damp. No product odor.	
						ML	SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand, trace clay. Brown, low plasticity, very stiff and moist. No product odor.	
5						SP	SAND; 100% fine to medium grained sand, trace silt. Black, medium dense and moist. No product odor.	
								▽
	■	8 12 18	6				At 9' - wet.	
10								
						ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand, trace clay and 0.25" wide limb fragments. Dark gray, stiff and wet. No product odor.	
	■	8 13 27	165			SP	SAND; 100% very fine to fine grained sand, trace silt. Very dark gray, dense and wet. No product odor.	
15								
20								
25								

General Remarks:

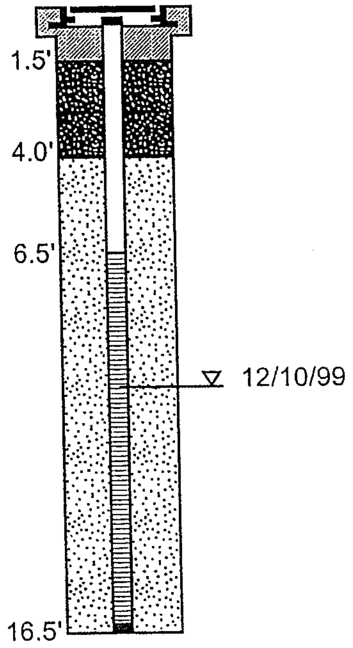
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

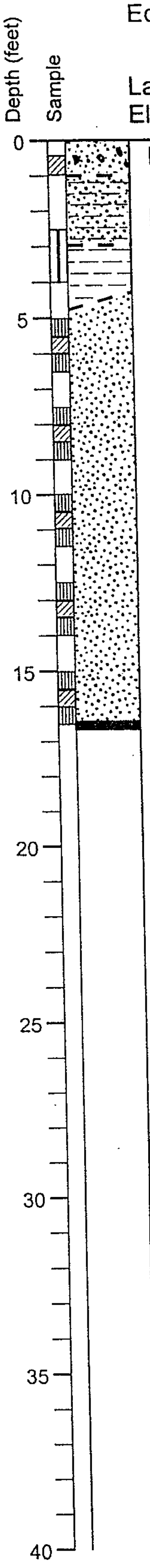
Equipment Mobile B-59

Land Surface Elevation Approx. 20 feet MSL 16.662 City Seattle Datum

Date 12/1/99



OVM	Blows per Foot
0	4
2	10
0	3
0	1
0	9
0	16



BROWN SANDY GRAVEL (GP) very dense, moist; with some silt (Fill).

DARK BROWN SILTY SAND (SM) dense, moist.

BROWN SANDY SILT (ML) soft, wet; fine-grained sand.

DARK BROWN/BLACK SAND (SP) loose, moist; fine grained, with trace silt.

Without silt.

Becomes very loose, saturated; medium grained.

Becomes loose.

Becomes medium dense, 6-inch-thick iron-stained zone at 15.5 feet bgs.

Boring terminated at 16.5 feet bgs.
Groundwater encountered at 10 feet bgs during drilling.

AGI TECHNOLOGIES

6311.001.cdr

Log of Monitoring Well MW2

Emerson/6851 E. Marginal Way S.
Seattle, Washington

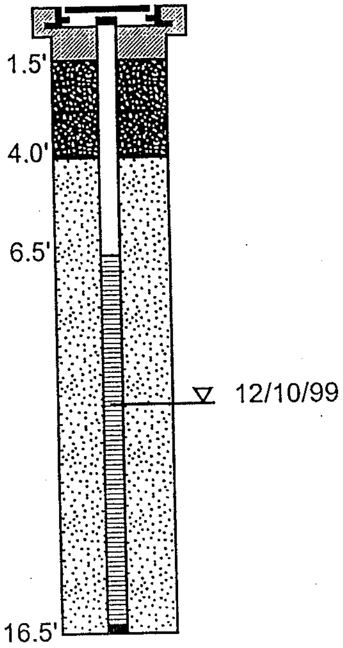
PLATE **B4**

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
16,311.001	PJS	12/15/99			

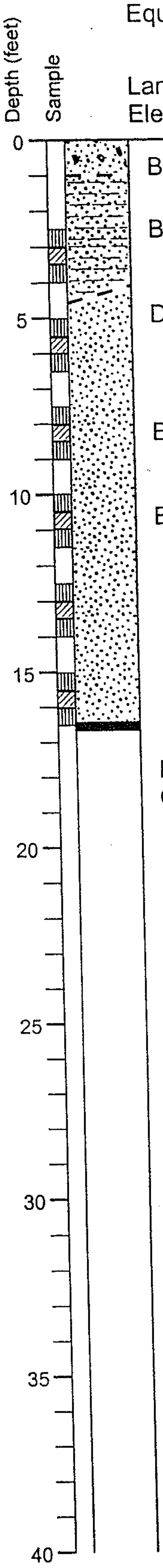
Equipment Mobile B-59

Land Surface Elevation Approx. 20 feet MSL 17.301 City of Seattle Datum

Date 12/1/99



OVM	Blows per Foot
2	5
2	8
2	7
2	9
0	7
0	10



BROWN SANDY GRAVEL (GP) very dense, moist; with some silt (Fill).

BROWN SILTY SAND (SM) loose, wet.

DARK BROWN SAND (SP) loose, moist; fine grained, with some silt.

Becomes dark brown/black, medium grained.

Becomes saturated.

Boring terminated at 16.5 feet bgs.
Groundwater encountered at 10 feet bgs during drilling.

AGI
TECHNOLOGIES

Log of Monitoring Well MW3

Emerson/6851 E. Marginal Way S.
Seattle, Washington

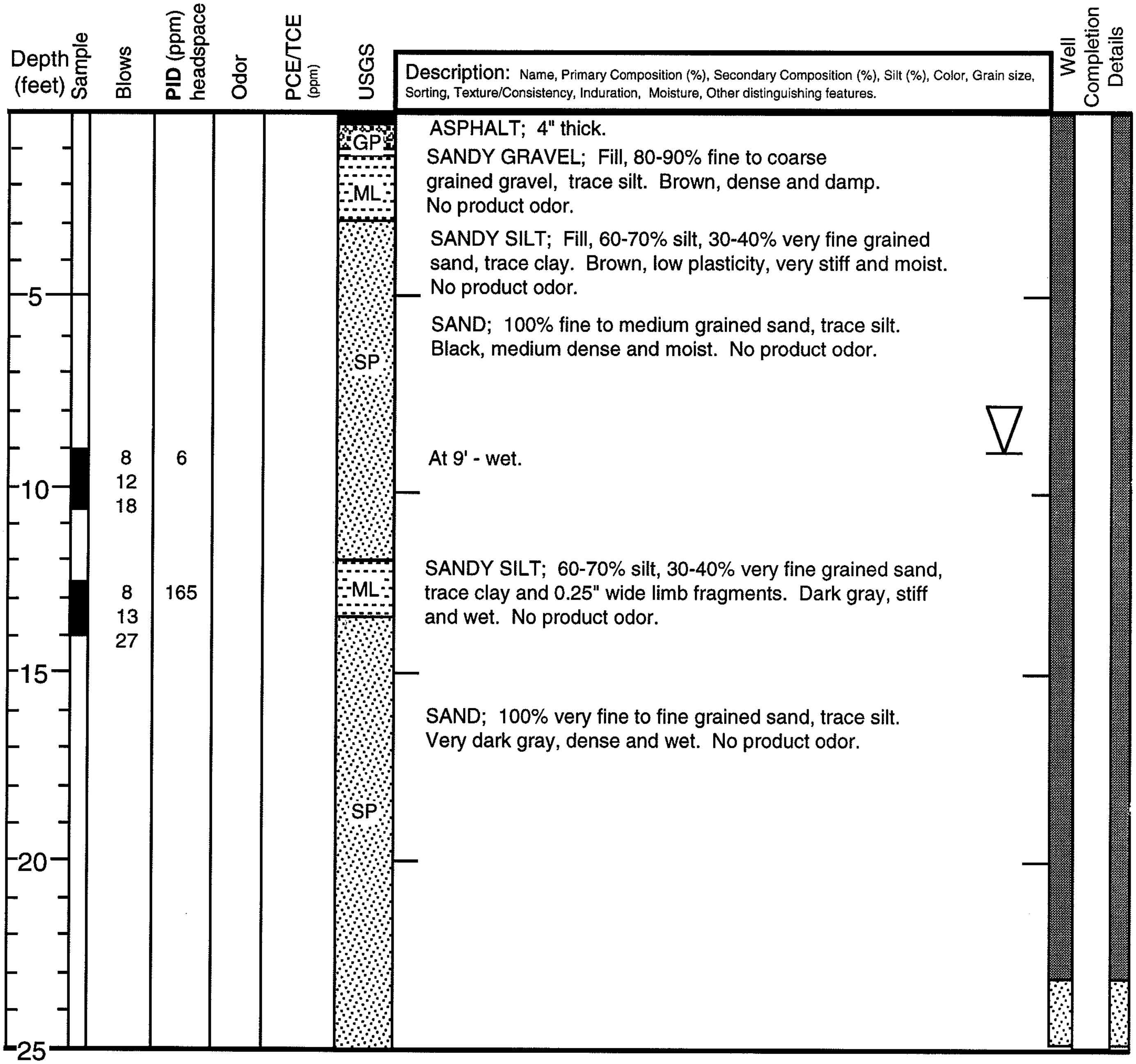
PLATE
B5

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
6311.001.cdr	16,311.001	PJS	12/15/99			

TERRA VAC

Limited Access

Date Drilled: 7/9/99 **Boring/Well Number:** B-59 Page 1 of 2
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Mod - Cal / Std. Pen.
Total Depth: 35 feet Depth to Groundwater: 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-23 feet Screened Interval: 25-30 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

ASPHALT; 4" thick.

SANDY GRAVEL; Fill, 80-90% fine to coarse grained gravel, trace silt. Brown, dense and damp. No product odor.

SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand, trace clay. Brown, low plasticity, very stiff and moist. No product odor.

SAND; 100% fine to medium grained sand, trace silt. Black, medium dense and moist. No product odor.

At 9' - wet.

SANDY SILT; 60-70% silt, 30-40% very fine grained sand, trace clay and 0.25" wide limb fragments. Dark gray, stiff and wet. No product odor.

SAND; 100% very fine to fine grained sand, trace silt. Very dark gray, dense and wet. No product odor.

Blows	PID (ppm) headspace
8 12 18	6
8 13 27	165

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

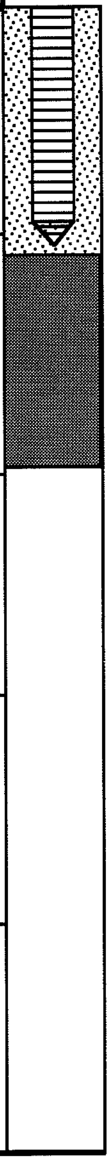
TERRA VAC

Date Drilled: 7/9/99 **Boring/Well Number:** B-59 Page 2 of 2

Project: Great Western Chemical Company Project Number: 32-0039

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						SP	SAND; 100% fine to medium grained sand. Black, dense and wet. No product odor.
30	■	5 6 7	19	N		ML	SANDY SILT; 50-60% silt, 40-50% very fine grained sand. Dark gray, stiff and wet. No product odor.
						SP	SAND; 100% very fine to fine grained sand, trace silt. Black, dense and wet. No product odor.
35							
40							
45							
50							

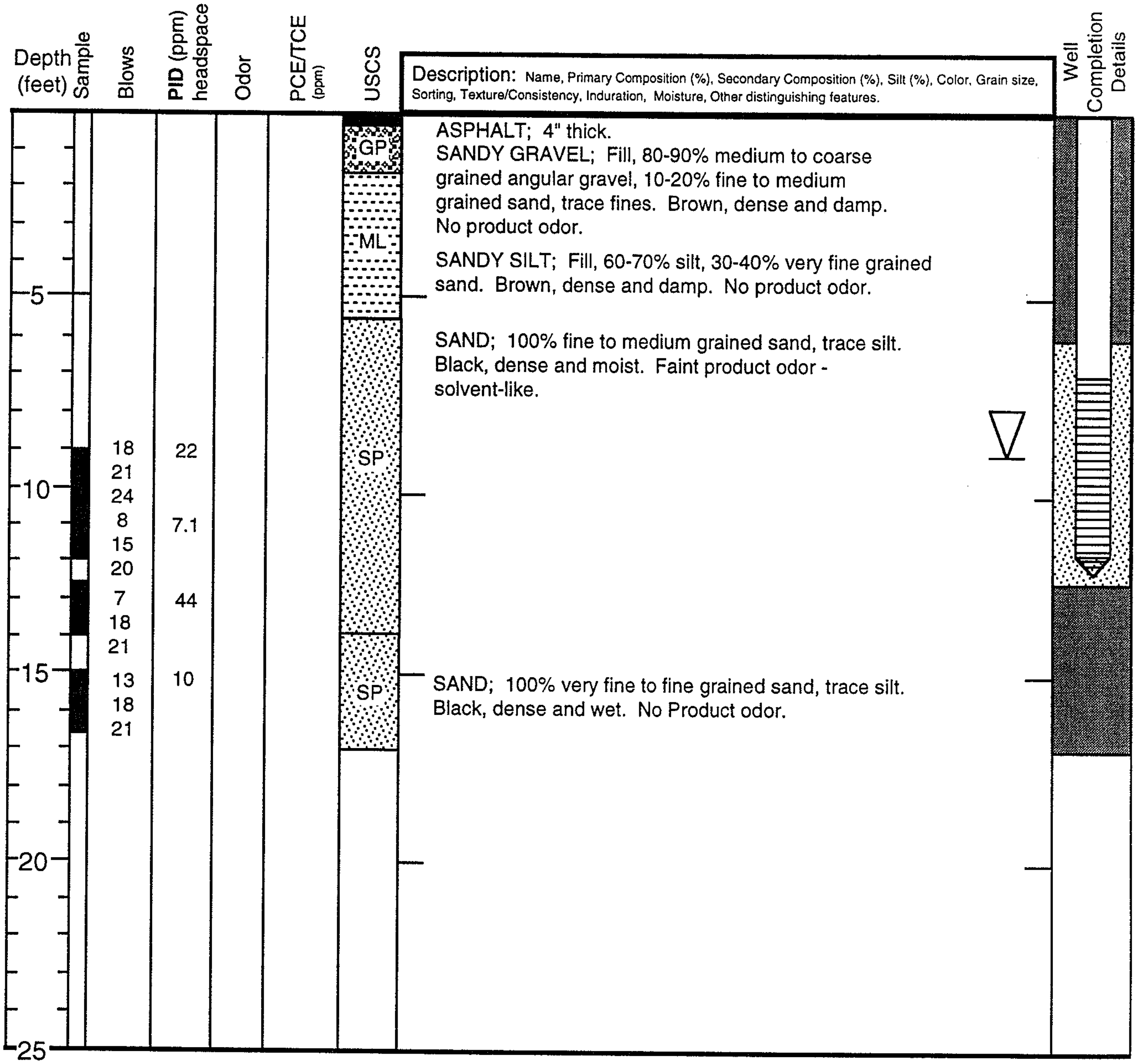
Well Completion Details



Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/7/99 **Boring/Well Number:** B-60 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drill Rig: CME-55
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Auger Size/Type: HSA Sample Method: Mod - Cal
Total Depth: 16.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet



Blows	PID (ppm) headspace
18	22
21	
24	
8	7.1
15	
20	
7	44
18	
21	
13	10
18	
21	

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

ASPHALT; 4" thick.
SANDY GRAVEL; Fill, 80-90% medium to coarse grained angular gravel, 10-20% fine to medium grained sand, trace fines. Brown, dense and damp. No product odor.

SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand. Brown, dense and damp. No product odor.

SAND; 100% fine to medium grained sand, trace silt. Black, dense and moist. Faint product odor - solvent-like.

SAND; 100% very fine to fine grained sand, trace silt. Black, dense and wet. No Product odor.

General Remarks:
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Limited Access

Date Drilled: 7/9/99 **Boring/Well Number:** B-61 Page 1 of 2

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington 98188

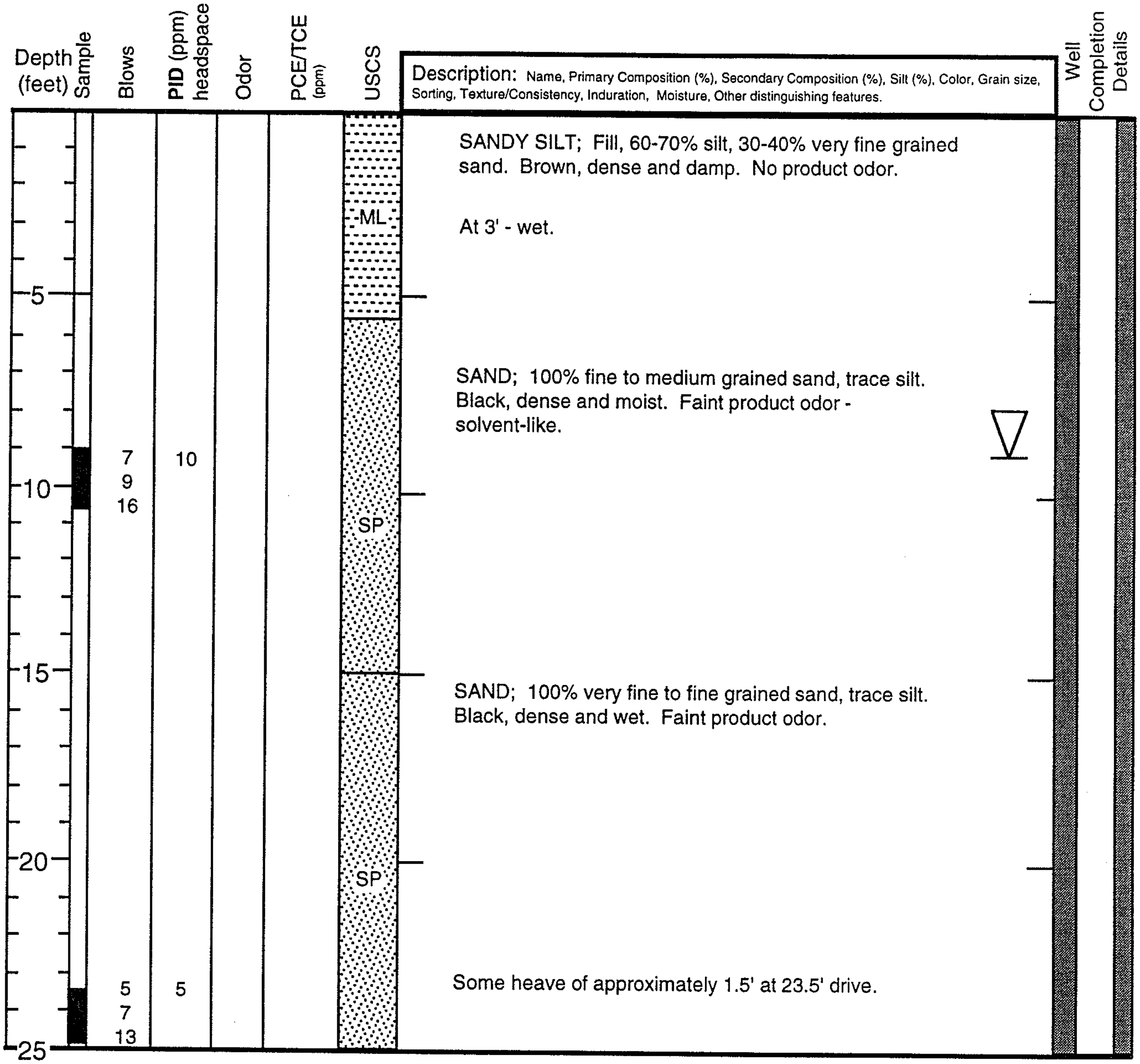
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-55 Auger Size/Type: 8 HSA Sample Method: Mod - Cal / Std. Pen.

Total Depth: 45 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-37 feet Screened Interval: 39-44 feet



Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
0-5						ML	SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand. Brown, dense and damp. No product odor. At 3' - wet.
5-15						SP	SAND; 100% fine to medium grained sand, trace silt. Black, dense and moist. Faint product odor - solvent-like.
9-10.5	■	7 9 16	10				▽
15-25						SP	SAND; 100% very fine to fine grained sand, trace silt. Black, dense and wet. Faint product odor.
23.5-25	■	5 7 13	5				Some heave of approximately 1.5' at 23.5' drive.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

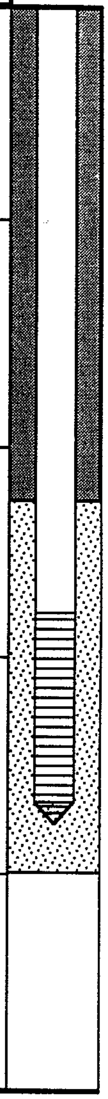
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/9/99 **Boring/Well Number:** B-61 Page 2 of 2
Project: Great Western Chemical Company Project Number: 32-0039

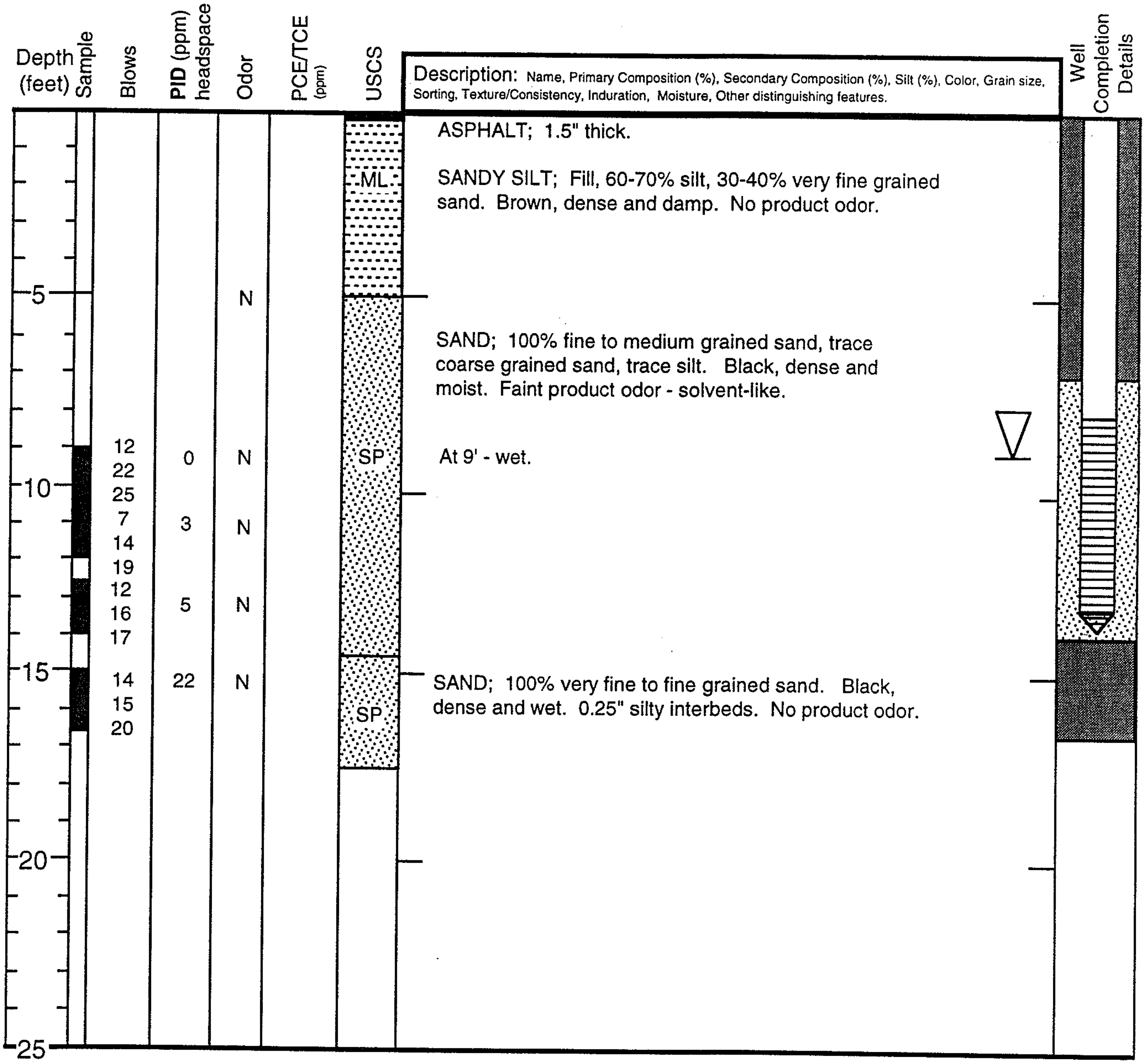
Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
							SAND; 100% very fine to fine grained sand, trace silt. Black, dense and wet. Faint product odor.
30							
35						SP	
40							
	☒	Grab off Augers	104				
45							
50							

Well Completion Details



TERRA VAC

Date Drilled: 7/7/99
Boring/Well Number: TW-4/B-62
Page 1 of 1
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drill Rig: CME-55
Drilling Contractor: Cascade Drilling, Inc.
Log by: J. Orr
Auger Size/Type: HSA
Sample Method: Mod - Cal
Total Depth: 16.5 feet
Depth to Groundwater: Approx. 9 feet
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in.
Slot Size: 0.01"
Seal: 0-7 feet
Screened Interval: 8-13 feet



Blows	PID (ppm) headspace	Odor
		N
12 22 25	0	N
7 14 19	3	N
12 16 17	5	N
14 15 20	22	N

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

ASPHALT; 1.5" thick.

SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand. Brown, dense and damp. No product odor.

SAND; 100% fine to medium grained sand, trace coarse grained sand, trace silt. Black, dense and moist. Faint product odor - solvent-like.

At 9' - wet.

SAND; 100% very fine to fine grained sand. Black, dense and wet. 0.25" silty interbeds. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/8/99
Boring/Well Number: B-63
Page 1 of 2
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drill Rig: CME-55
Drilling Contractor: Cascade Drilling, Inc.
Log by: J. Orr
Auger Size/Type: HSA
Sample Method: Mod - Cal / Spt.
Total Depth: 45 feet
Depth to Groundwater: Approx. 9 feet
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in.
Slot Size: 0.01"
Seal: 0-37 feet
Screened Interval: 39-44 feet

Depth (feet)	Sample	Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
							ASPHALT; 1.5" thick.	
						ML	SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand. Brown, dense and damp. No product odor.	
5								
							SAND; 100% fine to medium grained sand, trace coarse grained sand, trace silt. Black, dense and moist. Faint product odor - solvent-like.	
						SP	At 9' - wet. ∇	
10								
15								
20	■	13 17 21	700	N		SP	SAND; 100% very fine to fine grained sand. Black, dense and wet. 0.25" silty interbeds. No product odor.	
25								

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

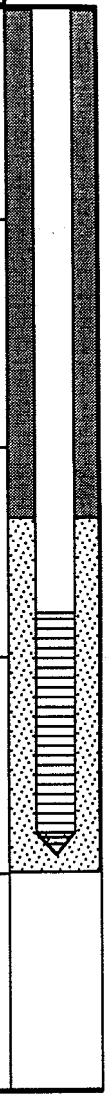
TERRA VAC

Date Drilled: 7/8/99 **Boring/Well Number:** B-63 Page 2 of 2

Project: Great Western Chemical Company Project Number: 32-0039

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
		14 16 18	1500	N		SP	
30	X	No Sample					At 30' sample 4' heave in augers.
35	X	No Sample					
40	X	No Sample				SM	SILTY SAND; 90% very fine to fine grained sand, 10% silt. Black dense and wet. No Product odor.
45	X	No Sample					
50							

Well Completion Details



TERRA VAC

Date Drilled: 7/6/99 **Boring/Well Number:** B-64 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington 98188

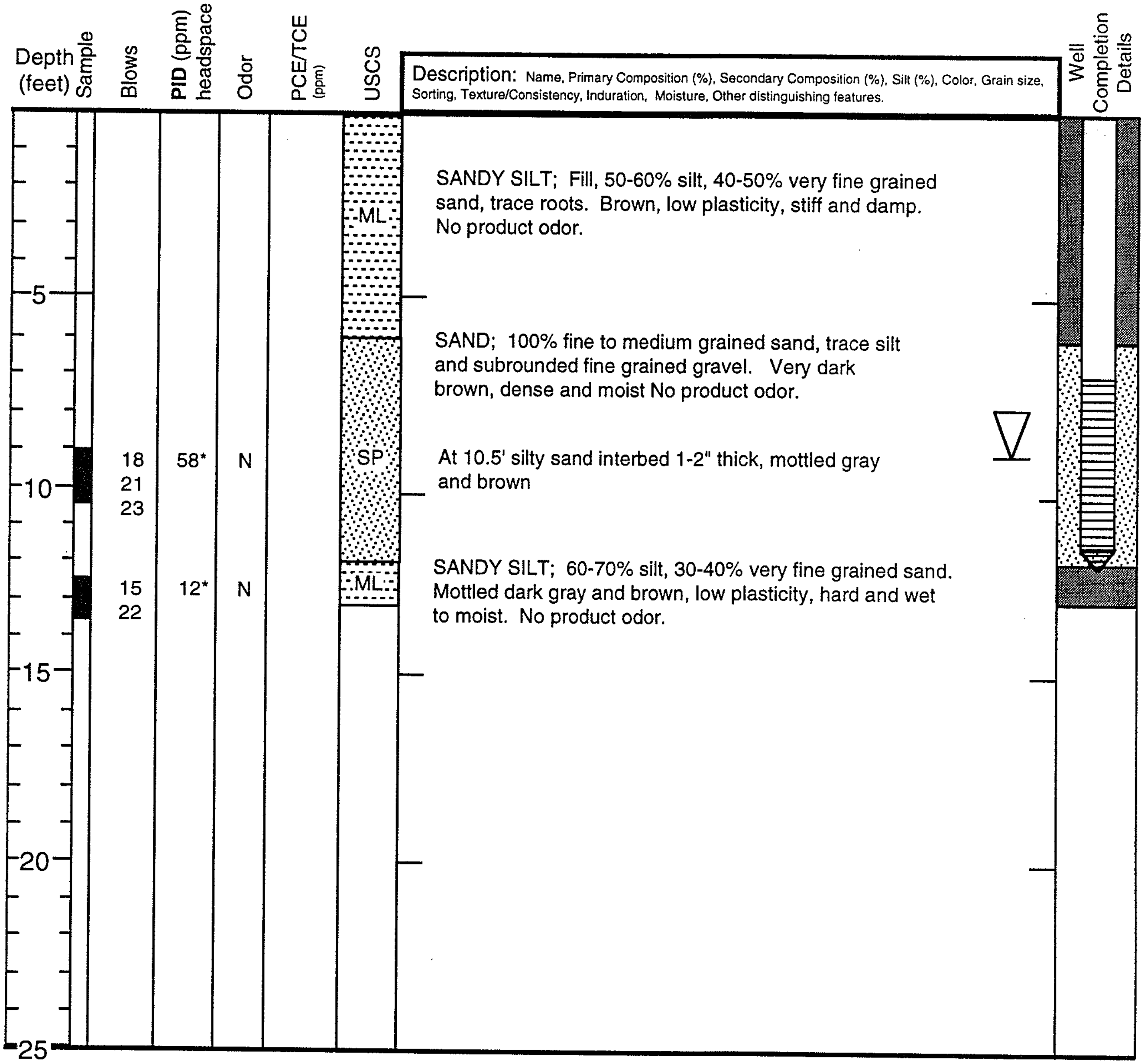
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: Limited Access CME-55 Auger Size/Type: HSA Sample Method: Dames & Moore

Total Depth: 13 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description
				ML	SANDY SILT; Fill, 50-60% silt, 40-50% very fine grained sand, trace roots. Brown, low plasticity, stiff and damp. No product odor.
				SP	SAND; 100% fine to medium grained sand, trace silt and subrounded fine grained gravel. Very dark brown, dense and moist No product odor.
18 21 23	58*	N			At 10.5' silty sand interbed 1-2" thick, mottled gray and brown
15 22	12*	N		ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Mottled dark gray and brown, low plasticity, hard and wet to moist. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

* Note - Reading taken approximately 1 hour after jar pierced once and resealed. Had to replace PID by Instrumentation Northwest.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Limited Access

Date Drilled: 7/6/99 **Boring/Well Number:** B-65 Page 1 of 2

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington 98188

Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Dames & Moore

Total Depth: 35.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-27 feet Screened Interval: 30-35 feet

Depth (feet)	Sample	Blows	**PID (ppm)** headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
						SP	GRAVELLY SAND; Fill, 60-70% fine to coarse grained sand, 30-40% fine to coarse grained gravel, trace subrounded cobbles. Brown, dense and damp. No product odor.	
5				N		ML	SANDY SILT; Fill, 50-60% silt, 40-50% very fine grained sand, trace roots. Brown, low plasticity, stiff and damp. No product odor.	
10				N		SP	SAND; 100% fine to medium grained sand, trace silt. Very dark gray-brown, dense and moist. No product odor.	
15		50		N		ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Mottled dark gray and brown, low plasticity, hard and wet to moist. No product odor. At 15' - 5' sand heave into augers.	
20		50 for 6"	36	N		SP	SAND; 100% fine to medium grained sand. Black, very dense and wet. No product odor. At 20' and 25' - 4' sand heave into augers.	
25								

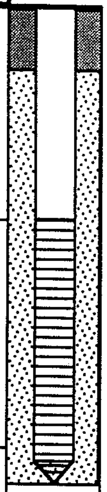
General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/6/99
Boring/Well Number: B-65
Page 2 of 2
Project: Great Western Chemical Company
Project Number: 32-0039

Depth (feet)	Sample	Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
				N			SAND; 100% fine to medium grained sand. Black, very dense and wet. No product odor. Sand heaves 4' into augers.	
30		50 for 6"				SP		
35				N				
40								
45								
50								

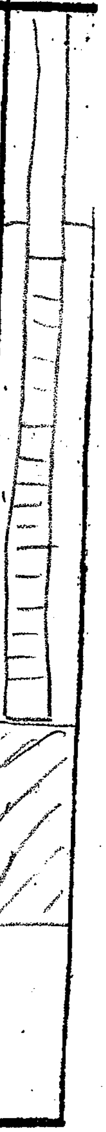
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 12-20-00
Boring/Well Number B66
Page 1 of 1
Project: GWCC
Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig Limited Access
Auger Size/Type: 8" HSA
Sample Method: Mod. Cal.
Total Depth: 20.5
Depth to Groundwater: 13
Backfill or Grout Material: Bentonite
Well/Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Pacific 2-12
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-5 Screened Interval: 6-16
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

	Depth (feet)	Samples	Blows	[illegible]	Odor	TPH	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
	Jars			Warm ≈30 min	70	F		Concrete 6" thick
							SP	SAND-Fill. 100% fine grained sand, trace coarse grained gravel, dk yell brn (10YR4/4) dense + Damp NPO
366-2.5 751	2		Grab sample	0				
366-4.5 800	5		25 27 22 ㊾	71			ML	SANDY SILT-Fill 70-80% Silt 20-30% v. fine grained sand, trace clay, dk yell brn (10YR4/4), low plast, hard + damp, NPO
B66-6.5 809	2	X	8 19 22 ㊶	78				@ 5' v. dk grayish brown (10YR 3/2)
B66-8 812	2	X	27 31 36 (67)	8			SM	SILTY SAND-Fill; 60-70% v. fine sand, 30-40% Silt, v. dk brn, dense + Damp NPO
B66-9 816	2	X	7 18 22 ㊵	0				
B66-10.5 820	10 2	X	9 17 21 ㊳	29			SP	SAND; 100 fine to med grained sand, trace coarse grained sand, v. dk brn (10YR 2/2) v. dense and moist
B66-12.5 825	2	X	25 37 31 (68)	30	-	∇		
366-13.5 829	2	X	14 18 19 ㊲	0				@ 13' wet
366-15 834	15 2	X	15 17 15 ㉜	0			ML	SANDY SILT; 60-70% silt, 30-40% v. fine grained sand, trace clay, dk yell. brn (10YR4/6), low plast. v. stiff and wet to moist NPO
B66-17 848	3	X	7 14 25 ㊴	2				@ 17.5 v. dk gray
B66-18.5 853	1	X	17 20 23 ㊸	0			SP	SAND; 100% v. fine grained sand
366-19.5 904	20 1	X	14 21 24 ㉟	0				v. dk brn (10YR2/2) v. dense + wet
	25							

Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

B66-17 Grain Size

4.5 Bags Sand
2 Bags Bent

TERRA VAC

Page 1 of 1

Date Drilled: 12-19-00 Boring/Well Number B-67
Project: GWCC Project Number: 32-0039
Address: 8900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Limited Access Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 19.5 Depth to Groundwater: 13 Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size:
Well A: Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0—6.5 Screened Interval: 8.5-18.5
Well B: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Sample	Time	Depth (feet)	Blows	[illegible]	Odor	TPH	USCS
				Warm Sam 115 95F ↓ 30 min			SP
B67-2.5	1213			0			
B67-4.5	1309	5	10 14	42			ML
B67-5.5	1311		7 11 19 (30)	56			
B67-7.5	1313		28 28 36 (64)	10			SM
B67-8.5	1320		19 18 (47)	6			SP
B67-	1502	10	29 24 32 21 (57)	13			
B67-12	1510		19 29 20 (57)	16		▽	
B67-13.5	1515		17 13 14 (27)	43			
B67-14.5	1522	15	14 10 (21)	8			
B67-15.5 Sieve Silt	1524		11 8 8 10 (18)	8			ML SP
B67-16.5	1527		27 50	8			
B67-17.5	1536		15 16 20 (36)				
B67-18.5	1547						ML
B67-19	1552	20					SP
		25					

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

Concrete 6" thick

SAND-Fill 100% fine grained sand, dk yell brown (10YR 4/4) dense and damp NPO

SANDY SILT; -Fill 70-80% silt, 20-30 v. fine sand trace clay, dk brn (10YR 3/3) low plast, v. stiff, damp, NPO

SILTY SAND; ~~-S~~ Fill ~~70~~-80 % v. fine grained sand, 20-30 % silt, v. dk gr-brn (10YR 3/2) v. dense and damp NPO

SAND; 100% v. fine grained sand, v. dk brn (10YR 2/2) v. dense + damp NPO

@11-12.5 v. fine + med grained sand, trace coarse grained sand

@13' med dense and wet

SANDY SILT, 60-70% silt 30-40% v. fine sand trace clay, v. dk gray (10YR 3/1), low plast, stiff and wet NPO

SAND 100% v. fine to med grained sand, v. dk brn (10YR 2/2) med dense to v dense ~~wet~~ wet, 0.25 to 0.5" thick sandy silt interbeds throughout

SANDY SILT; 70-80% silt, 20-30% v. fine grn. sand v. dk gray (10YR 3/1) low plast, v. stiff and moist NPO

SAND (SAA)

B67-18.5 → 1547
B67-21 @ 1600 > Dup of Silt Sample

B67-19 Silt for Gain Size

Completion Details

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ______ for ______.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Page 1 of 1

TERRA VAC

Date Drilled: 12-19-00 Boring/Well Number B-68
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Limited Access Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 19 Depth to Groundwater: 12.5 Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific 2/12
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-6 Screened Interval: 8-18
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Warm Samples @ 70F

		Depth (feet)	Sample	Blows	[illegible]	Odor	TPH	USCS
					20min ↓			
			X	Grain Size Hand Sample 4 Jars	0			SP
368-2.5	905		X	19 24 19	20			ML
68-4.5	1005	5	X	10 10 (50)	20			
B68-5.5	1000		X	21 36 40 (76)	12			
B68-7.5	1021		X	10 29 50 (79)	7			SP
B68-9	1028		X	19 21 36 (57)	7			
368-	1032	10	X	31 33 40 (73)	3			
B68-11.5	1040		X					
368-13.5	1046		X	22 27 33 (60)	3		▽	
368-14.5	1050		X	20 23	4			
		15		6 10 9 (19)	4			
B68-16	1058		X	33	5			ML
B68-17	1109		X	24 22 (26)	5			SP
368-17.5	1110		X	30	5			
B68-18	1119		X	50	5			ML
B68-18.5	1120	20						SP
		25						

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

Concrete 6" thick

SAND+FILL 100% fine grained sand trace fine grained rounded gravel, dk yell brn (10YR4/4) dense + damp NPO

SANDY SILT (FILL?), 70-80% silt, 20-30% v. fine sand, trace clay, dk brn (10YR 3/3) v. stiff + damp, platty soil peds, low plast. NPO
@ 6.5 trace angular coarse gravel, 60-70% silt, 30-40% v fine grained sand, Hard + damp

SAND; 100% v. fine grained sand, v. dk brn (10YR 2/2) v. dense, moist, NPO
@ 9.5 trace coarse grained rounded gravel v fine to med grained sand
@ 12.5-13 fine to med. grained sand, trace coarse grained sand, wet
@ 14-15 v. fine grained, trace silt

SANDY SILT (3" thick); 60-70% silt, 30-40% v. fine grained sand, v dk gray (10YR 3/1) v. stiff and wet, NPO
SAND; 100% v. fine grained sand, v. dk brn. (10YR 2/2)

SANDY SILT; 60-70% silt, 15-20 v. fine grained sand, 15-20 clay, v. dk gray (10YR3/1) low plast, v. stiff-Hard and moist to wet NPO

SAND; 100 v. fine grained sand, trace silt v dk brn (10YR 2/2), v. dense and wet, NPO

Completion Details

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ______ for ______.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

4.5 Bags Sand
2 Bags Bent

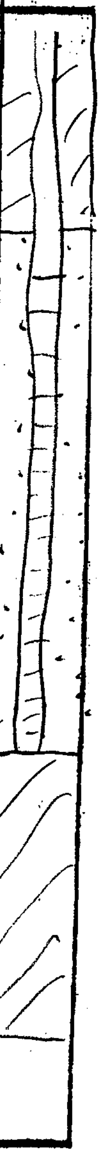
TERRA VAC

Page 1 of 1

Date Drilled: 12-20-00 Boring/Well Number B-69
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Limited Access Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: ______ Depth to Groundwater: 13 Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific 2-12
Well A: Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-5 Screened Interval: 6.5-16.5
Well B: Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well C: Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well D: Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________

		Jars	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						Warm ≈ 30 min ↓	70 F			Concrete 6" thick
B69-2.5	1000	2		X	Grab Sample	0			SP	SAND-Fill; 100% fine grained sand trace fine to coarse grained rounded gravel, dk yell brn (10YR4/4), dense, damp NPO
B69-4.5	1009	1	5	X	80 (6")	0				
				X	13 23 26 (49)	11			SM	SILTY SAND-Fill; 70-80% v. fine sand, 20-30% silt, trace brick frags and angular rock fragments, v. dense + damp oil like oder, v. dk brn (10YR2/2)
B69-5.5	1011	2		X	50 47 34 (81)	30				
B69-6.5	1020	1								
B69 5	1025	2		X	7 8 8 (16)	18				C.8-11' Voids in Soil? v. low counts oily Oder 0
B69-10.5	1028	2	10	X	5 4 4 (9)	21				
369-12	1034	2		X	16 25 26 (45)	2			SP	SAND; 100% fine grained sand, trace coarse grained sand, v. dk brn (10YR2/2) dense + damp NPO
369-13.5	1040	2		X	18 25 29 (54)	15		▽		@13' Dense + wet
69-14.5	1043	2	15	X	17 22 24 (46)	17				
169-16.5	1046	2		X	10 11 20 (31)	6			ML	SANDY SILT; 60-70% silt, 30-40% v. fine grained sand, trace clay, dk yell. brn (10YR4/6), low plast, hard and wet, NPO - moist
69-18.5	1056	2		X	25 36 40 (76)	4			SP	
B69-19.5	1104	2	20	X	24 18 15 (33)	4			SP	SAND; 100% fine grained sand, v. dk brn (10YR2/2), v. dense + wet 0.25-2" thick sandy silt beds throughout trace med grained rounded gravel
369-21	1114			X Sand	5 5 7 (12)	2			SP	
B69-22	1125	2		X	21 31	2			SP SP	
			25							

Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method __________ for __________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

4.5 Bags Sand
2 Bags Bent

TERRA VAC

Date Drilled: 12-18-00		Boring/Well Number	B-70
Project: GWCC		Project Number:	32-0039
Address: 8900 Fox Ave. S. Seattle WA			
Drilling Contractor: Cascade Drilling		Log by:	J. ORR
Drill Rig Limited Access	Auger Size/Type: 8" HSA	Sample Method:	Mod. Cal.
Total Depth: 18.5	Depth to Groundwater: 13	Backfill or Grout Material:	Bentonite
WellCasing/Screen Material: Sch. 40 PVC	Filter Material/Size: Pacific 2/12		
Well A:Casing/Screen Diameter: 2"	Slot Size: 0.01 Seal: 0-6	Screened Interval:	8-18
Well B:Casing/Screen Diameter: ___	Slot Size: ___ Seal: ___	Screened Interval:	___
Well C:Casing/Screen Diameter: ___	Slot Size: ___ Seal: ___	Screened Interval:	___
Well D:Casing/Screen Diameter: ___	Slot Size: ___ Seal: ___	Screened Interval:	___

	Depth (feet)	Sample	Blows	OVM (ppm)	Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
	Jars			Allow to Warm 30 min ↓	@70°F			Concrete 6" thick	
		X	Hand Sample	.11			SP	SAND; Fill, 100% fine grained sand, dk yell. brown (10YR 4/4), dense + damp, NPO	
B70-2.5 1322		2							
370-4.5 1333		2 X	15 45	12				@5' trace coarse grained subrounded gravel	
	5								
B70-5.5 1335		2 X	17 35 (75)	13					
370-6.5 1342		X	40 70 (6")	13					
370-8.5 1350		2 X	50 55 (112) 57	14			SP	SAND; 100% v. fine grained sand, v. dk brown (10YR 2/2) v. dense and damp NPO	
	10	X	13 22 (50) 28	18					
370- 1356		2							
B70-12.5 1406		2 X	27 36 (86) 50	16				@12' trace coarse grained sand and trace subrounded fine grained gravel	
						∇		@13' wet	
B70-13.5 1422		2 X	13 16 (40) 24	13				@14' fine to med. grained sand	
	15	2 X	9 12 (27) 15	15				@15.5 2 ½" thick ~~SPM~~/ sandy silt beds stiff + wet	
70-15.5 1427			20 23 (40) 17	15			ML	@ 6.5 2 - 2" thick yell. brn (10YR 5/6) sandy silt beds	
B70-16.5 1442		2 X	14 29 (50) 21	17			SP	SAND SAA	
B70-18 1452		2 X					ML	8" thick Sandy silt, 60-70% silt, 30-40% v. fine grained sand, v. dk gray (10YR 3/1) v. stiff and damp trace organics, NPO	
							SP		
	20							SANDS 100% v. fine grained sand, v. dk brown (10YR 2/2) v. dense and wet, NPO	
	25								

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ____________ for ____________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

5 Bags Sand

2 Bags Bent

Page 1 of 1

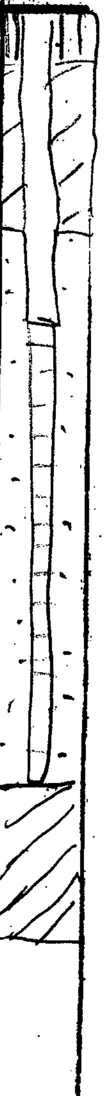
TERRA VAC

Date Drilled: 12-20-00 Boring/Well Number B-71
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Limited Access Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 20.5 Depth to Groundwater: 13 Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific 2/12
Well A: Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-5 Screened Interval: 7-17
Well B: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Warm @ 70°F

	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
	Jars			For 30 min				Concrete 6" thick
371-2.5 1300	3	☒	Grab sample	2			SP	SAND - Fill; 100% fine grained sand, trace fine grained rounded gravels, dk yell. brn (10YR4/4), v. dense and damp NPO
B71-4.5 1305	2		40 41					
	5	X	13	5				
B71-5.5 1320 1 Ring, 1 Jar	Dames + Moore Sample	X	21 27 (48) No Recovery 50 (0")	9				@ 7.5' trace coarse grained subrounded gravel,
		X	100 (6")	9				
B71-7.5 1327								
B71 1337		X	60 75 (135)	7				
371-10 1340	10	X	21 23 19 (42)	8				
B71-11.5 1347		X	18 26 (57) 21	10				
B71-12- 1351		X X	70 (3")	15				
B71-12.5 1359				11		▽	Tar	@ 12.5 to 13 6" thick black tar like substance (See 12' Sample) fiborous tar paper like
B71-14 1403		▽ X	25 25 (56) 31	11			SP	SAND; 100% fine grained sand v. dk brn (10YR2/2) v. dense and wet NPO
371-15.5 1406	15 Dames + Moore	X	21 35 (66) 31	14				
B71-17.5 1414 Carbon Jar	3	▽	19 23 (52) 29	11			ML	SANDY SILT; 60-70% silt, 30-40% v. fine grained sand, trace Clay, dk yell. brn (10YR4/6) low plast. hard + wet to moist, NPO
B71-19 1425	2	X	23 31 (69) 38	10			SP ML	SAND - 100% fine grained sand v. dk brn (10YR2/2) v. dense + wet 1-3" thick sandy silt beds + throughout trace fine grained subrounded gravel
371-20 1433	20	X	7 19 (42) 23	18				
							SP	SAND - 100% v. fine grained sand v. dk brn, dense and wet
	25							

Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Dames + Moore Sampler 5-6.5 and 14.5-16 with 2 2½x6" Rings (All others Mod. Cal)

TERRA VAC

Page 1 of 1

Date Drilled: 12-21-00 Boring/Well Number B-72
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Limited Access Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: ______ Depth to Groundwater: 13 Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific 2/12
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0—4.5 Screened Interval: 5.5—15.5
Well B:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well C:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well D:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________

	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH [illegible]	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
								Concrete 6" thick	
B72-2.5 730	2	X	Grab Sample	2			SP	SAND-Fill; 90% fine grained sand 10% fine to coarse grained subrounded gravel, dk yell brn (10YR 4/4) dense+damp NPO	
B72-4 741	1	X	31 50 40 (90)	3					
	5								
B72-6 747	2	X	15 24 33 (57)	8			ML	SANDY SILT-Fill; 60-70% silt 30-40% v. fine grained sand, low plast., v.dk. brown (10YR 2/2) hard and moist NPO @ 8.5 dk yell brn. (10YR 4/6) @ 9.5 - 1" thick sand interbeds	
B72-8 752	2	X	25 33 39 (72)	4					
B72-9.5 756	2	X	21 25 31 (56)	3					
	10								
B72-11 800	2	X	17 21 33 (54)	2			SP	SAND; 100 fine grained sand, trace coarse sand v. v.dk brn (10YR 2/2), v dense + moist NPO @ 13' wet	
B72-12.5 833 *Dup Note	3	X	25 50 50 (100)	2		▽			
B72-13.5 839	2	X	21 30 31 (61)	4					
B72-14.5 840	2	X		3					
	15								
B72-15.5 845	2	X	12 12 13 (25)	8			ML	SANDY SILT-6" thick, 60-70% silt 30-40% v. fine grained sand, dk yell brn (10YR 4/6) and v. dk brown (10YR 2/2), low plast. v. stiff and moist NPO	
	20								
	25							4 Bags Sand 1.5 Bags Bent	

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ____________ for ____________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

*Dup B72-12.5 1 Jar Label as B72-23 0900

TERRA VAC

Date Drilled: 12-18-00
Boring/Well Number B-73
Page 1 of 1
Project: GWCC
Project Number: 32-0039
Address: 8900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig Limited Access
Auger Size/Type: 8" HSA
Sample Method: Mod. Cal.
Total Depth: 20.5
Depth to Groundwater: ≃13
Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC
Filter Material/Size: R Pacific 2/12
Well A:Casing/Screen Diameter: 2"
Slot Size: 0.01
Seal: 0-5
Screened Interval: 7-17
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
	Jars							Concrete 6" thick	
B73-2.5 926			Hand Sample 2 Jars	3	0		SP	SAND-Fill 100% fine grained Sand grayish brn (10YR 5/3) v. dense and damp, NPO	
@4' Refusal No Sample							SM	SILTY SAND; 70-80% v. fine grained sand, 10-15% silt, 10-15% fine to coarse grained rounded to angular gravel, v. dense and damp, NPO	
B73-5 1000	5	1	50(4") 1 Jar	1	4				
B73-7 1012		2	13 23 27 (50)	8	11		ML	SILT; 100% silt, trace v. fine grained sand, trace clay, brn (10YR 4/3), hard and moist, 0.25' thick linear beds, NPO	
B73-?? 1018		2	39 32 31 (63)	8	8				
B73-9.0 1021		1	5 13 (18)	8	10		SP	SAND; 100% v. fine grained sand, v. dk brn (10YR 2/2) v. dense and damp, NPO	
B73-10.5 1026	10	2	13 24 27 (51)	10	10				
B73-12 1035		2	40 60 60 (120)	11	9	▽		@12' trace coarse grained sand ~~[illegible]~~	
B73-13.5 1045		2	25 29 35 (64)	6	10			@13' trace coarse grained sand and wet	
73-15.5 1050	15	2	14 19 30 (49)	11	16		ML	SANDY SILT; 60-70% silt, 30-40% v. fine grained sand, brn (10YR 4/3) stiff and wet, NPO ← (SP SAA)	
373-17 1107		2	18 19 22 (41)	12	17		SP ML	SANDY SILT, 60-70% silt 30-40% v. fine grained sand, v. dk gray (10YR 3/1), v. stiff and moist, NPO	
B73-18.5 1115		2	18 21 24 (45)	22	28		SP	SAND; 100% v. fine grained sand, trace silt trace coarse grained sand, v. dk brn (10YR 2/2), dense and wet, NPO.	
73-20 1139	20	2	6 19 32 (51)	7	17				
	25			WARMED FOR 15 MINS @ 70°				4.5 Bags Sand 2 Bags Bent.	

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

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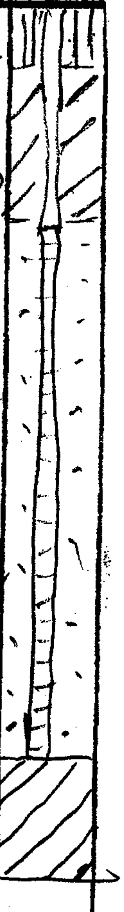
Page 1 of 1

TERRA VAC

Date Drilled: 12-22-00 Boring/Well Number B74
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Limited Access Auger Size/Type: 8" HSA Sample Method: Mod. Cal. / Dames Moore
Total Depth: ______ Depth to Groundwater: 13 Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific 2/12
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-5 Screened Interval: 6-16
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ______ Screened Interval: ______
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ______ Screened Interval: ______
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ______ Screened Interval: ______

Warm Sample 70°F

	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
	Jars			30 min			|||	Concrete 6" thick	
B74-2.5 850	2	X	Grab sample	4			SP	SAND-FILL; 100% fine grained sand, trace fine to med grained rounded to subrounded gravel, dk yell brn. (10YR4/4) v.dense and damp NPO	
B74-4.5 0800	5 2	X		123				@4-5' trace coarse grained gravel, trace brick frags.	
B74-6 809 1 Ring Only	1 Dames + Moore	X	34 39 34 (73)	8				Silty Sand bed in bottom of Ring Sample	
B74-7.5 813		X	9 13 19 (32)	39			ML	SANDY SILT - Fill?, 55-60% silt, 40-45% v. fine grained sand; v.dk brn dk yell. brn, 10YR4/4) low plast, hard + moist NPO	
B74 815		X	17 23 24 (47)	26					
B74-10.5 818	10 2	X	9 13 16 (28)	33				@10.5' 1" thick sandy clay interbeds and silty sand beds Native soil	
B74-12.5 829 Ring + 1 Jar	Dames + Moore	X	37 46 50 (96)	42				Dames + Moore Ring has silt in bottom	
B74-13.5 834 Dup	3	X	12 20 25 (45)	33		▽	SP	@13' 1" thick and 2.5" thick sandy silt bed 2.5" bed plane @ 45°	
B74-15 0900	15 Dames + Moore 2	X	24 37 35 (72)	20				SAND; 100 fine grained sand v dk brn (10YR 2/2) v.dense + wet FPO solvent like	
B74-16.5 0910 No Ring	Dames + Moore	X	13 23 23 (46)	14			ML SP	Sand SAA	
	2 Jars Dames + Moore	X	14 26 30 (56)	40			ML	SANDY SILT; 3" thick @ 16' (Top) 60-70% silt, 30-40 v. fine grained sand, v.dkgray (10YR 3/1), low plast. v. stiff, wet-moist, NPO	
B74-17.5 920	2						SP	SANDY SILT SAA 5" thick @ 17.5" top, wet	
B74-18 925	1							SAND; 100% v. fine grained sand, v.dk.brn, v. dense + wet	
1 No Ring	20								
	25							B74-17.5 Silt Grain Size SAMPLE	

General Remarks:
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ____________ for ____________.
- ND = not detected or levels were below analytical detection limits of _____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Dup B74-13.5 call it B74-22 @1000hr

TERRA VAC

Page 1 of 1

Date Drilled: 12-21-00
Boring/Well Number B-75
Project: GWCC
Project Number: 32-0039
Address: 3900 Fox Ave S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig Limited Access
Auger Size/Type: 8" HSA
Sample Method: Mod. Cal.
Total Depth: 18
Depth to Groundwater: 13
Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC
Filter Material/Size: Pacific 2/12
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-4.5 Screened Interval: 5.5-15.5
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Warm 70°F for 30 min

Jars

Sample	Depth (feet)	Blows	[illegible]	Odor	TPH	USCS
B75-2.5 930			2			SP
B75-5.5 932	5	40 40 (80)	3			
B75-6.5 939		29 31 31 (62)	12			
B75-9.5 946		39 50 55 (105)	6			ML
B75-10 952	10	17 19 19 (38)	12			SP
B75-11.0 956		17 49 40 (89)	5			
B75-13 1004		22 33 35 (68)	9		∇	
B75-14 1009		14 11 10 (21)	4			
Dup	15	7	7			
B75-15 1015		11 11 (22)	6			ML
B75-15.5 1016		17	8			SP
B75-17 1021		31				ML
B75-17.5 1022		22 (53)	8			SP
Dup	20					
	25					

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

Concrete 6" thick

SAND - Fill 100 % fine grained sand, trace fine to coarse grained subrounded gravel dk yell. brn. (10YR 4/4) dense and moist, NPO

@ 6' Brick fragments, trace tar like frags.

SANDY SILT - Fill; 60-70 % silt, 30-40% v. fine grained sand, low plast., v. dk brn (10YR 2/2) hard and moist NPO

SAND; 100 v. fine grained sand trace silt v. dk brn (10YR 2/2) v. dense and damp NPO

@ 9' fine grained sand,

@ 13' wet trace coarse grained sand

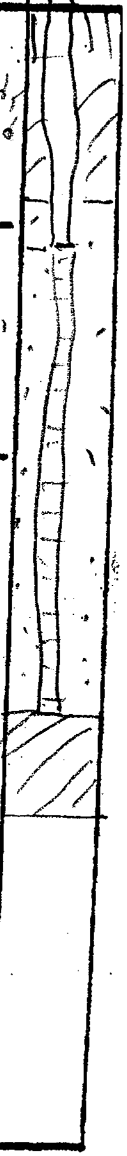
SAND SAA with trace fine grained subr. gravel

SANDY SILT; 6" thick 60-70% silt, 30-40% v. fine grained sand v. dk gry (10YR 3/1) low plast. v. stiff, wet-moist, 0.25" sand beds throughout FPO

SANDY SILT - 6" thick, 55-60% silt 40-45% v. fine grained sand, v. dk brn (10YR 2/2) low plast, hard and wet NPO

SAND; 100 % v. fine grained sand, v. dk brn dense and wet NPO

Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ___ for ___.
- ND = not detected or levels were below analytical detection limits of ___ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

* Dup B75-14 call it B75-22 @ 1100 hr

* Dup B75-17.5 call it B75-23 @ 1110

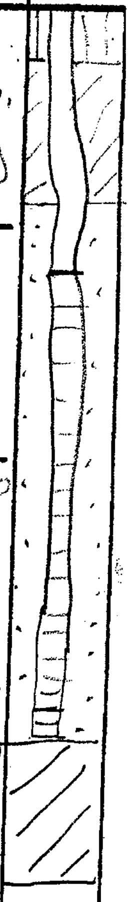
TERRA VAC

Page 1 of 1

Date Drilled: 12-21-00
Boring/Well Number B-76
Project: GWCC
Project Number: 32-0039
Address: 3900 Fox Ave S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig Limited Access
Auger Size/Type: 8" HSA
Sample Method: Mod. Cal.
Total Depth: ______
Depth to Groundwater: 13
Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC
Filter Material/Size: Pacific 2/12
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0-4.5 Screened Interval: 5.5-15.5
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

	Depth (feet)	Sample	Blows	OVM (ppm)	Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
				Warm 70°F For 30 min ↓				
							|||	Concrete 6" thick
B76-2.5 1205		☒	Grab sample	3			SP	SAND- Fill; 100% fine grained sand, trace fine to coarse grained rounded to subrounded gravel, dk yell. brn (10YR4/4) v. dense + damp
No Recovery	5		38 46 31 (77)	31				
~~B76-5.5 1218~~ No sample only headspace		X	18 31 44 (75)	5				(Poor Recover due to rocks)
								@ 8-9' 0.5-2" thick Sandy silt beds
B76-9 1225	2	X	39 50 50 (100)	26				
B76-10 1230	10		21 31 33 (64)	9			SP	SAND; 100% v. fine grained sand, v. dk brn (10YR2/2) v. dense and moist NPO trace coarse grained sand
B76-12.5 1239	2	X	50 70 40 (110)	51				
B76-13 1246	2	X	33 26 29 (55)	6		∇		@ 13' wet FPO (Solvent Like)
B76-14.5 1256 x-Dup	3 15	X	10 10 13 (23)	6			ML	SANDY SILT, 6" thick, 60-70% silt, 30-40 v. fine grained sand, v. dk gry (10YR3/1) low plast. v. stiff and wet to moist, MPO (oil, diesel like)
							SP	SAND (SAA)
							ML	SANDY SILT, 6" thick, 60-70% silt, 30-40% v. fine grained sand, v. dk brn 10YR2/2) low plast, wet to moist, stiff FPO solvent like.
B76-16 1306	2	X	7 8 9 (17)	10				
B76-17.5 1335		X	19 21 21 (42)	21			SM	SILTY SAND; 60-70 v. fine grained sand, 30-40% silt, v. dk brn (10YR2/2) dense + wet FPO (solvent like) 1-2" thick silty interbeds throughout trace wood frag's.
							SP	SAND, 100% v. fine grained sand, v. dk brn (10YR2/2) dense + wet
	20							
	25							

Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Dup B76-14.5 call it B76-23 @ 1330

4 Bags Sand
2 Bags Bent.

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BOREHOLE LOG

Site Id: BT-01
Page 1 of 1

Project Number: 0021460.101.***

Project Name: Fox Avenue B-12

Location: Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: CME-25

Sampling Method: GeoProbe Direct Push

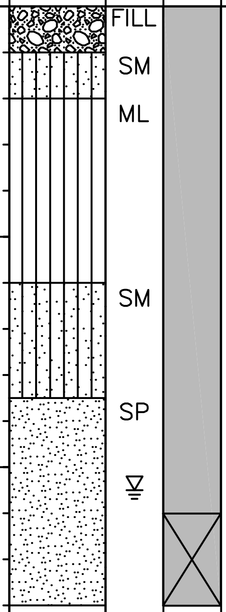
Total Depth: 13.00'

Borehole Dia.: 2.00in

Logged By: M. Mendes

Initial Water Level: 10.50'

Date(s): 07/24/07



Depth (ft)	Graphic Log	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
		FILL			Asphalt and subbase crushed gravel material.
		SM		4.1	SILTY SAND (SM): brown, some gravel, loose, damp (fill).
		ML		1.8	SANDY SILT (ML): brown, fine sand, medium stiff, damp.
				3.2	
				2.1	SANDY SILT (ML): brown, fine sand, medium stiff, damp.
5				4.6	
		SM		8.7	SILTY SAND (SM): brown, fine sand, with interbedded silt, medium stiff, damp.
				6.9	
				52.7	
		SP		22.5	SAND (SP): dark brown, fine to medium sand, trace silt, damp. SAND (SP): as above, 2.0" lense of stiff silt at 9.0'.
10		▽		36.7	SAND (SP): dark brown, very fine to fine, with trace to some silts, apparent hydrocarbon odor, wet at 10.5'.
				44.1	Collected for Bio-treatability, 1-2 foot core.
				567	
				60.5	Total Depth – 13.0' bgs
15					
20					

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BOREHOLE LOG

Site Id: BT-02
Page 1 of 2

Project Number: 0021460.101.***

Project Name: Fox Avenue B-12

Location: Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: CME-25

Sampling Method: GeoProbe Direct Push

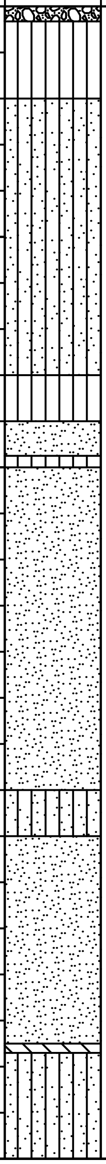
Total Depth: 49.00'

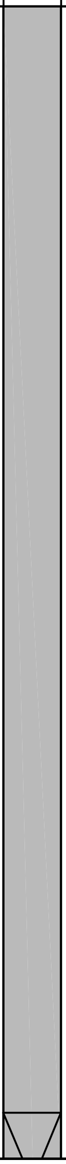
Borehole Dia.: 2.00in

Logged By: M. Mendes

Initial Water Level: 10.50'

Date(s): 07/24/07





Depth (ft)	USCS Code	PID (ppm)	Description/Soil Classificiation
	ML	1.2	Fill/Worked Surface Coat. SANDY SILT (ML): fine sand, medium stiff, dry.
		0.8	
	SM	0.8	SILTY SAND (SM): brown, fine sand, low cohesion, no staining or odor, dry.
		0.8	
		0.5	SILTY SAND (SM): brown/gray, very fine to fine sand, damp.
5		0.5	
		0.5	
		0.8	SILTY SAND (SM): brown/gray. very fine to fine sand, interbedded with medium stiff silt lenses (2.0" thick).
	ML	0.4	SANDY SILT (ML): brown/gray, fine sand, moist.
	SP	0.4	SAND (SP): dark brown, fine to medium sand, moist.
10	ML		SANDY SILT (ML): very fine sand, dense, stiff.
	∇ SP	0.4	SAND (SP): medium grained, trace fine grained, trace silt, wet at 10.5'.
		0.4	
		0.8	SAND (SP): dark brown/gray, poorly to medium graded, trace rounded gravel, trace silt, slight odor.
		0.8	
		5.9	
15		2.4	
		10.2	SAND (SP): dark brown/gray, medium grained, trace fine sand, poorly graded, wet.
	SM	12.1	SILTY SAND (SM): fine to medium sand, some silt.
	SP	12.1	SAND (SP): dark brown/gray, medium grained, trace fine sand, low cohesion, wet.
		8.2	
20		2.2	SAND (SP): dark gray to dark brown, speckled, medium grained, trace fines, low cohesion, wet.
		2.1	SAND (SP): as above.
	CL		SILTY CLAY (CL): gray, soft, plastic.
	SM	2.1	SILTY SAND (SM): dark brown/gray, medium grained, some fine sand, low cohesion, wet.

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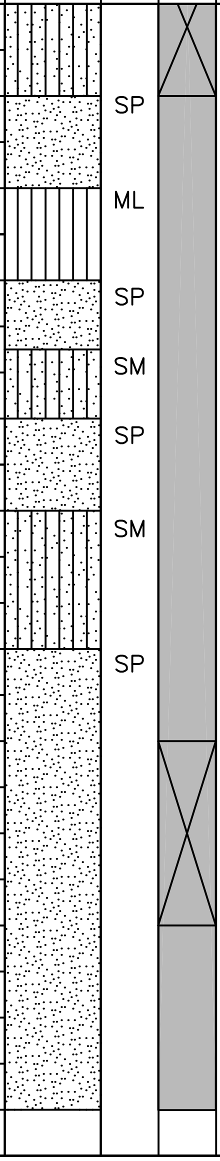
BOREHOLE LOG

Site Id: BT-02
Page 2 of 2

Project Number: 0021460.101.***
Project Name: Fox Avenue B-12
Location: Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: CME-25
Sampling Method: GeoProbe Direct Push

Total Depth: 49.00'
Borehole Dia.: 2.00in
Logged By: M. Mendes
Initial Water Level: 10.50'
Date(s): 07/24/07



Depth (ft)	USCS Code	PID (ppm)	Description/Soil Classificiation
			Biotreatability – collected 3-1 foot cores.
	SP	2.1	SAND (SP): dark gray/brown, medium grained, trace fines, poorly graded, low cohesion, wet.
30	ML	1.8 1.9	SANDY SILT (ML): dark gray/brown, fine sand, with interbedded thin clay lenses (1.0–2.0" thick), soft, discontinuous.
	SP	2.1	SAND (SP): dark gray to brown, medium grained, trace fine sand and silt, poorly graded, low cohesion, wet.
		1.0	SAND (SP): dark gray to brown, fine to medium grained, trace silt.
	SM	0.8	SILTY SAND (SM): dark brown gray, fine to medium grained, interbedded silt, low cohesion, wet.
35	SP	0.8 1.0	SAND (SP): dark brown/gray, fine to medium grained, trace silt, poorly graded, low cohesion, wet.
	SM	0.8 0.9 1.1	SILTY SAND (SM): dark brown/gray, fine to medium sand, some silt, low cohesion, wet.
40	SP	1.2 1.1	SAND (SP): fine to medium grained, trace silt, poorly graded, low cohesion, wet.
			Biotreatability – collected 3-1 foot cores.
45		1.1 1.1 1.1 0.8	SAND (SP): fine to medium grained, trace silt, poorly graded, wood fragments, few clayey silt nodules.
			Total Depth – 49.0' bgs

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BOREHOLE LOG

Site Id: BT-03
Page 1 of 2

Project Number: 0021460.101.***

Project Name: Fox Avenue B-12

Location: Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: CME-25

Sampling Method: GeoProbe Direct Push

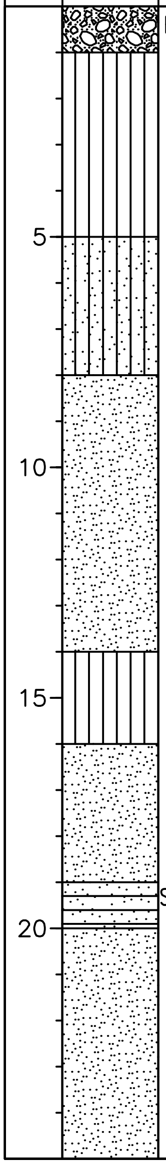
Total Depth: 40.00'

Borehole Dia.: 2.00in

Logged By: M. Mendes

Initial Water Level: 10.00'

Date(s): 07/24/07



USCS Code	PID (ppm)	Description/Soil Classificiation
FILL		Asphalt, subbase surface.
ML	0.3	SILT (ML): mottled dark brown to brown gray, some to trace fine sand, soft, low plasticity, damp.
	0.3	
	0.3	
	0.3	
	0.3	SANDY SILT (ML): mottled dark brown and gray, low plasticity, moist.
SM	0.3	SAND WITH SILT (SM): salt and pepper, dark gray speckled, interbedded silts at 7.0' bgs, low cohesion, dry.
	0.4	
	0.3	
SP	0.7	SAND (SP): dark brown/gray, medium to coarse grained, trace silt, trace rounded gravel, some oxidation present between 8.0-10.0' bgs, low cohesion, wet at 10.0' bgs.
	0.8	
▽		
	0.7	
	2.3	
	0.4	SAND (SP): dark brown/gray, medium to coarse grained, some rounded to angular gravel, trace to no silt, low cohesion, wet.
	0.4	
ML	0.5	CLAYEY SILT (ML): organic, some wood fragments, soft, wet.
	0.6	
SP	8.9	SAND (SP): dark brown/gray, medium to coarse grained, trace to no fines, low cohesion, wet.
	3.3	
	2.1	
SP/CL	2.1	INTERBEDDED SAND AND SILTY CLAY (SP/CL): medium grained sand, interbedded silty clay lenses, wet.
SP	2.6	SAND (SP): dark gray brown, fine to medium grained, trace to no silt, poorly graded, low cohesion, wet.
	1.1	
	2.3	
	2.6	
		Biotreatability - collected 2-1 foot cores.

Sample Recovery

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BOREHOLE LOG

Site Id: BT-03

Project Number: 0021460.101.***

Project Name: Fox Avenue B-12

Location: Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: CME-25

Sampling Method: GeoProbe Direct Push

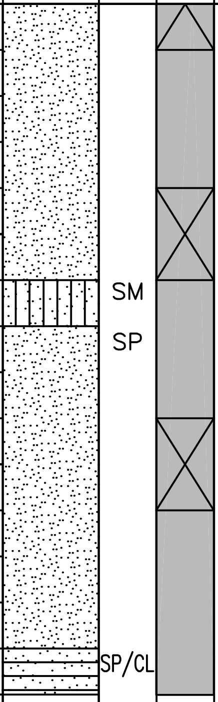
Total Depth: 40.00'

Borehole Dia.: 2.00in

Logged By: M. Mendes

Initial Water Level: 10.00'

Date(s): 07/24/07



Depth (ft)	USCS Code	PID (ppm)	Description/Soil Classificiation
		2.3	SAND (SP): dark gray, brown, speckled (salt and pepper), fine to medium grained, trace to no silt, low cohesion, wet.
		2.4	
		7.9	
30			Biotreatability – collected 2-1 foot cores.
	SM	122	SILTY SAND (SM): dark brown/gray, fine to medium grained, low cohesion, wet.
	SP	13.9	SAND (SP): dark brown/gray, speckled (salt and pepper), fine to medium grained, trace to little silt, low cohesion, wet.
		14.8	
35			Biotreatability – collected 2-1 foot cores.
		9.6	SAND (SP): dark gray brown, medium to coarse grained, trace to no silt, hard packed.
		4.4	
		4.2	
	SP/CL	1.1	INTERBEDDED SAND AND SILTY CLAY (SP/CL): medium to coarse grained sand, interbedded thin silty clay lenses (1.0" thick). Total Depth – 40.0' bgs
40			
45			

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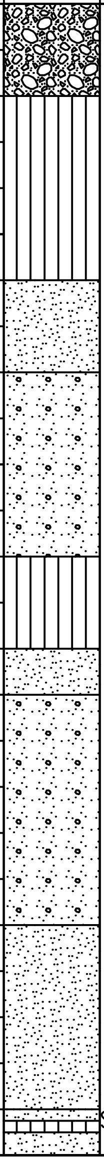
BOREHOLE LOG

Site Id: BT-04
Page 1 of 2

Project Number: 0021460.101.***
Project Name: Fox Avenue B-12
Location: Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: CME-25
Sampling Method: GeoProbe Direct Push

Total Depth: 36.00'
Borehole Dia.: 2.00in
Logged By: M. Mendes
Initial Water Level: 10.00'
Date(s): 07/24/07



Depth (ft)	Graphic Log	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
		FILL		0.4	FILL: brown, fine to coarse sand, fine to coarse gravel, trace cobbles, dense, damp.
				0.5	
		ML		0.5	SANDY SILT (ML): brown/gray, medium stiff, low plasticity, damp.
				0.6	
				0.4	SANDY SILT (ML): brown, soft, low plasticity, moist.
5				0.4	
		SP		0.3	SAND (SP): very dark gray/brown, medium grained, trace silt, low cohesion, moist.
				0.2	
		SW		0.4	SAND (SW): very dark gray/brown, fine to coarse grained, trace silt, moist, wet at 10.0' bgs.
				0.4	
10		▽		0.3	SAND (SW): mottled very dark gray and brown, fine to coarse grained, little to no silt, no odor, wet.
				0.4	
		ML		0.4	SANDY SILT (ML): dark gray/black/brown, some wood fragments, oxidized (reddish orange) silt lense (2.0" thick), wet.
				0.2	
		SP		0.3	SAND (SP): dark gray/brown/black, some to no silt, trace rounded gravel, wet.
15		SW		0.2	SAND (SW): dark gray brown, angular gravel/cobbles, hard, dense.
				0.3	SAND (SW): mottled dark brown/gray/black, fine to coarse grained, trace to no silt, low cohesion, no odor, wet.
				0.2	
				0.3	SAND (SW): as above.
				0.2	
20		SP		5.8	SAND (SP): dark brown/gray, fine to medium grained, trace silt, trace angular to subrounded gravel, thin silt lense (0.5" thick) at 23.0', low cohesion, wet.
				9.8	
				6.7	SAND (SP): as above.
				6.8	
		SP/ML		6.9	SAND INTERBEDDED WITH SILT (SP/ML): dark brown/gray, fine to medium grained, some thin silt lenses (1.0" thick), trace gravel, low cohesion, wet.

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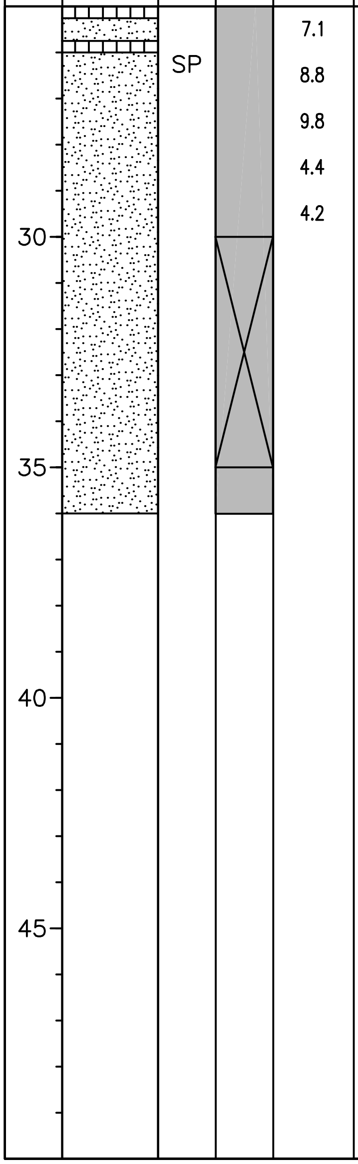
BOREHOLE LOG

Site Id: BT-04
Page 2 of 2

Project Number: 0021460.101.***	Total Depth: 36.00'
Project Name: Fox Avenue B-12	Borehole Dia.: 2.00in
Location: Seattle, Washington	Logged By: M. Mendes
Contractor: Cascade Drilling	Initial Water Level: 10.00'
Drilling Method: CME-25	Date(s): 07/24/07
Sampling Method: GeoProbe Direct Push	

Depth (ft) | Graphic Log | USCS Code | Sample Recovery | PID (ppm) | Description/Soil Classificiation



SAND (SP): dark brown/gray, fine to medium sand, trace silt, low cohesion, wet.

SAND (SP): dark brown/gray, fine sand, poorly graded, trace silt, low cohesion, wet.

Biotreatability – collected 5–1 foot cores.

Total Depth – 36.0' bgs

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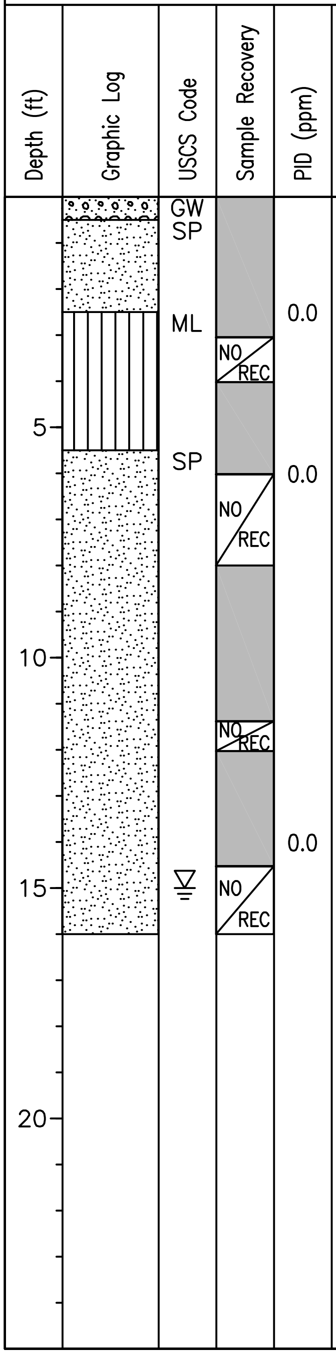
BOREHOLE LOG

Site Id: GP-1
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 16.00'
Borehole Dia.: 2.00in
Logged By: M. Arnold
Date(s): 07/23/03



Description/Soil Classificiation

0.0–0.5' SANDY GRAVEL (GW): brown, fine to coarse gravel, little silt, loose, dry to moist (fill).

0.5–2.5' SAND (SP): brown, fine grained, trace to little silt and gravel, scattered cinders/ slag, loose, moist (fill).

2.5–5.5' SILT (ML): brown, trace fine grained sand, soft, moist.

5.5–16.0' SAND (SP): gray, fine grained, loose, moist.

1.0" layer of silty fine sand at 9.0'.

Water encountered at 15.0', increasing silt content below 15.5'.

Bottom of Boring – 16.0'
Ground water sample collected with screen at 12.0–16.0'.

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BOREHOLE LOG

Site Id: GP-2
Page 1 of 1

Project Number: 5303.12

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

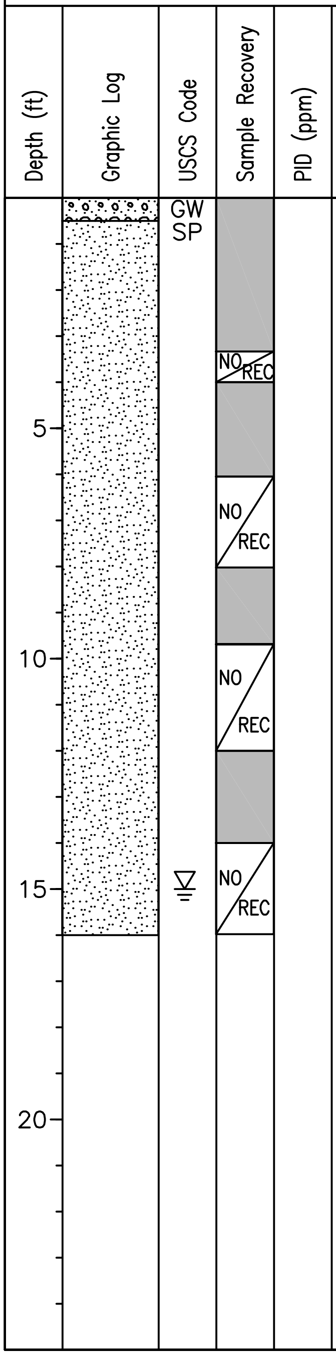
Drilling Method: Direct-Push

Total Depth: 16.00'

Borehole Dia.: 2.00in

Logged By: Z. Clements

Date(s): 07/23/03



Description/Soil Classificiation

0.0–0.5' SANDY GRAVEL (GW): brown, fine to coarse gravel, little silt, loose, dry to moist (fill).

0.5–7.8' GRAVELLY SAND (SP): fine grained, loose, dry to moist (fill).

7.8–16.0' SAND (SP): brown, fine grained, trace to little silt, loose, moist.

3.0" of silty fine sand at 9.5', 0.25" dark, organic layer at 9.6'
No silt below 9.7'.

Water encountered at 15.0'.

Bottom of Boring – 16.0'
Ground water sample collected with screen at 12.0–16.0'.

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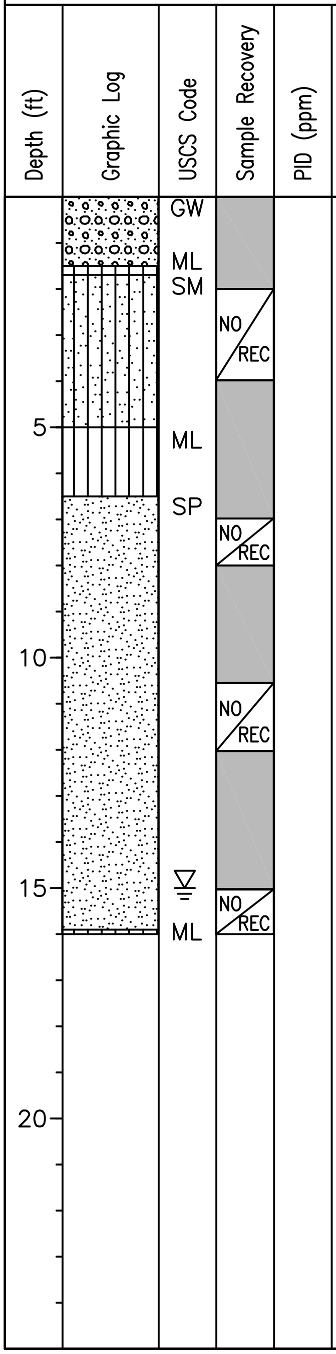
BOREHOLE LOG

Site Id: GP-3
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 16.00'
Borehole Dia.: 2.00in
Logged By: Z. Clements
Date(s): 07/23/03



Description/Soil Classificiation

0.0–1.5' SANDY GRAVEL (GW): brown, fine to coarse gravel, little silt, loose, dry to moist (fill).
1.5–1.7' SILT (ML): loose, moist.
1.7–5.0' SILTY SAND (SM): brown, loose, moist.

5.0–6.5' SILT (ML): brown, trace sand, soft, moist.

6.5–15.9' SAND (SP): brown, fine grained, loose, moist.

Water encountered at 15.0'.

15.9–16.0' SILT (ML): moist.
Bottom of Boring – 16.0'
Ground water sample collected with screen at 12.0–16.0'.

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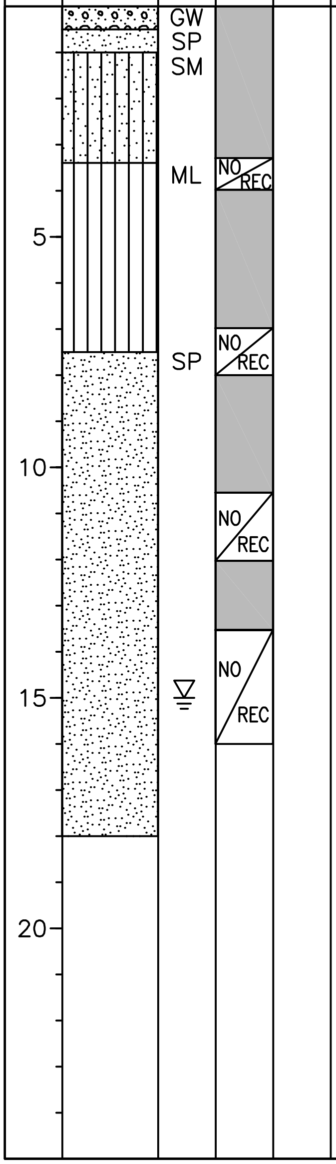
BOREHOLE LOG

Site Id: GP-4
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 16.00'
Borehole Dia.: 2.00in
Logged By: Z. Clements
Date(s): 07/23/03

Depth (ft) | Graphic Log | USCS Code | Sample Recovery | PID (ppm) | Description/Soil Classificiation



0.0–0.5' SANDY GRAVEL (GW): brown, fine to coarse gravel, little silt, loose, dry to moist (fill).
0.5–1.0' SAND (SP): brown, fine grained, loose, moist (fill).
1.0–3.4' SILTY SAND (SM): gray, fine grained sand, 0.5" layer of peat at 3.0', loose, moist (fill).
3.0–3.4' Dark gray slag (fill).
3.4–7.0' SILT (ML): brown, soft, moist.

7.0–7.5' SILT (ML): brown, little fine grained sand, soft, moist.
7.5–18.0' SAND (SP): brown, fine grained, loose, moist.

Color grades to gray at 10.0'.

Water encountered at 15.0'.

Bottom of Boring – 18.0'
Ground water sample collected with screen at 14.0–18.0'.

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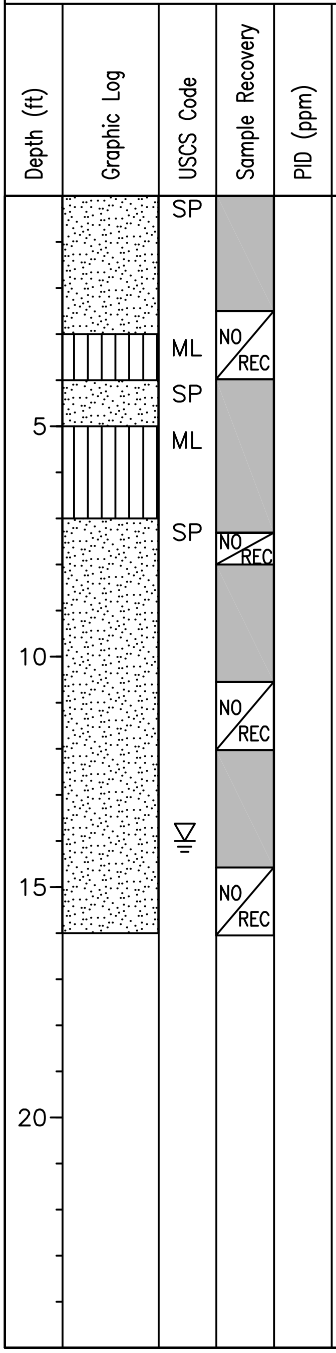
BOREHOLE LOG

Site Id: GP-5
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 16.00'
Borehole Dia.: 2.00in
Logged By: Z. Clements
Date(s): 07/23/03



Description/Soil Classificiation

0.0–3.0' SAND (SP): brown, little silt, loose, dry to moist (fill).

3.0–4.0' SILT (ML): dark brown, soft, moist.

4.0–5.0' SAND (SP): brown, fine grained, little silt, loose, dry to moist.

5.0–7.0' SILT (ML): brown, little fine grained sand, soft, moist.

7.0–16.0' SAND (SP): brown, fine grained, loose, moist.

Color grades to gray at 10.5'.

Water encountered at 14.0'.

Scattered 0.5" layers of silty sand at 15.0', increasingly silty.

Bottom of Boring – 16.0'
Ground water sample collected with screen at 12.0–16.0'.

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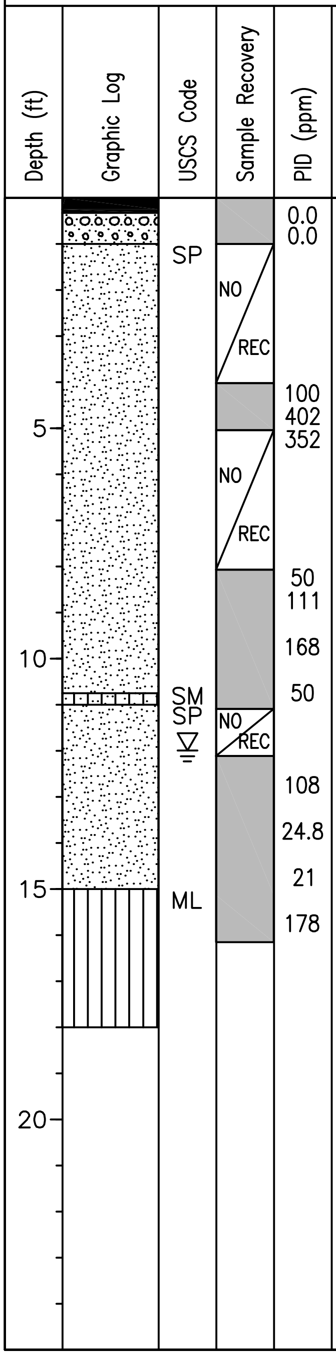
BOREHOLE LOG

Site Id: GP-6
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 18.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 08/27/03



Description/Soil Classificiation

Asphalt.
Gravelly sand, road base (fill).

GRAVELLY SAND (SP): tan, medium grained sand, pea-sized gravel, dry.
SAND (SP): grayish brown, fine grained, 4.0" layer, slight petroleum odor, dry.

SAND (SP): mixed light and dark colored (grayish brown), slightly moist.

SILTY SAND (SM): gray, 3.0" layer, cohesive, strong odor. Sudan IV (No)

SAND (SP): grayish brown, fine to medium grained, strong odor, saturated.

GRAVELLY SAND (SP): pea-sized, 6.0" layer.
SAND (SP): grayish brown, fine to medium grained, strong odor, saturated.
Sudan IV (No)
SANDY SILT (ML): gray, fine grained, slightly cohesive, no visible sheen, moist to wet.

Bottom of Boring – 18.0'
Soil collected for bench testing from 9.0–11.0' and 12.5–15.0'.
No NAPL visually observed. No sheen observed.
FLUTE DNAPL sleeve installed to 18.0' bgs. No product observed with FLUTE.

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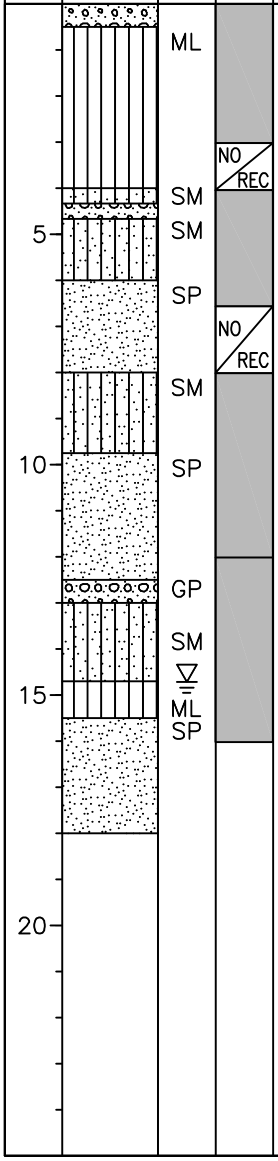
BOREHOLE LOG

Site Id: GP-7
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 18.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/27/03



USCS Code	PID (ppm)	Description/Soil Classificiation
		Sandy, gravelly road base (fill).
ML	23 18	SANDY SILT (ML): brown to reddish brown, fine grained, grades to silty sand, dry.
	28	SANDY SILT (ML): as above, tan to gray.
SM	36	SILTY SAND (SM): reddish brown, very fine grained, 4.0" layer, dry.
SM	30	Road Base, gravelly, silty, sandy, well graded (slough).
	55	SILTY SAND (SM): brown, very fine grained, dry to slightly moist, a few small wet spots.
SP	27	SAND (SP): mixed light and dark colored, fine to medium grained, dry.
SM	27 30	SILTY SAND (SM): brown, fine grained, dry to slightly moist (possibly slough from above).
SP	17 40	SAND (SP): mixed light and dark colored (gray), medium grained, moist.
	26	SAND (SP): mixed light and dark colored (gray), medium grained, moist.
GP		SANDY GRAVEL (GP): brown, slightly moist.
SM	42	
▽ ML	23	SANDY SILT (ML): gray, fine grained, saturated.
SP	24 90	SAND (SP): gray to black, medium grained, moist.

Bottom of Boring - 18.0'
FLUTE DNAPL sleeve installed to 18.0' bgs. No product observed with FLUTE.

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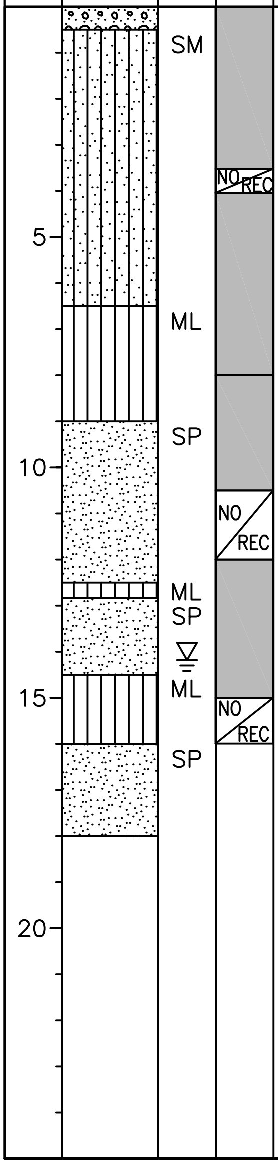
BOREHOLE LOG

Site Id: GP-8
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 18.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/27/03



USCS Code	PID (ppm)	Description/Soil Classificiation
	39	Gravel road base.
SM		SILTY SAND (SM): dark brown to light brown, fine grained, dry.
	50	
	55	
	25	
	26	SILTY SAND (SM): as above.
	27	
ML	9.0	SANDY SILT (ML): brown, interbedded with silty sand, fine grained, dry.
	55	Slough
	45	SANDY SILT (ML): brown, fine grained, dry.
SP	33	SAND (SP): mixed light and dark colored (brown to gray), medium grained, dry.
	112	
	37	SAND (SP): mixed light and dark colored (brown to gray), medium grained, moist.
ML		SANDY SILT (ML)
SP	56	SAND (SP): mixed light and dark colored (gray), medium grained, moist.
⊻	67	SAND (SP): gray, trace silt, fine grained, odor, saturated.
ML	20	SILT (ML): gray, with fine sand, odor, saturated.
SP		SAND (SP): black, medium grained, slight odor, saturated.
	36.3	
	32.8	Bottom of Boring – 18.0'
		FLUTE DNAPL sleeve installed to 18.0' bgs. No product observed with FLUTE.

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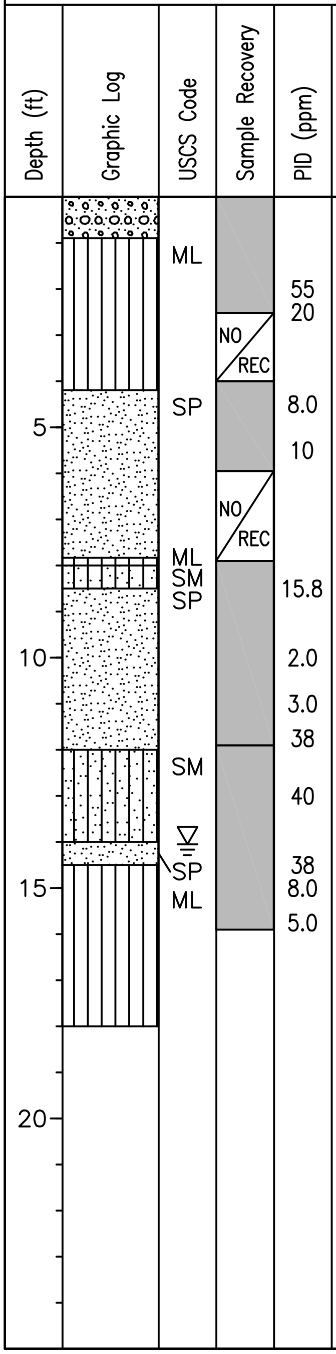
BOREHOLE LOG

Site Id: GP-9
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 18.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/27/03



Description/Soil Classificiation

Gravel road base, light brown, some fine grained sand, dry.

SILT (ML): dark brown, with trace sand, fine grained, slightly cohesive, dry.

SILT (ML): dark brown, with trace sand, fine grained, slightly cohesive, dry.

SAND WITH GRAVEL (SP): light brown, fine grained.

SAND (SP): mixed light and dark colored (brown and gray), fine to medium grained, slightly moist.

SAND (SP): as above, reddish brown, finer grained.

SILT (ML): reddish brown, fine grained, slightly cohesive.

SILTY SAND (SM): brown, fine grained.

SAND WITH GRAVEL (SP): light brown, fine grained.

SAND (SP): mixed light and dark colored (dark brown), fine to medium grained, slightly moist.

SAND (SP): dark brown to reddish brown, intermingled gravel.

SILTY SAND (SM): fine to medium grained, well graded gravel throughout, rounded, up to 1.0" in size, dry.

SAND (SP): gray, medium grained, saturated.

SILT (ML): gray, some fine grained sand, slightly clayey, slightly cohesive, saturated.

Bottom of Boring – 18.0'

FLUTE DNAPL sleeve installed to 18.0' bgs. No product observed with FLUTE.

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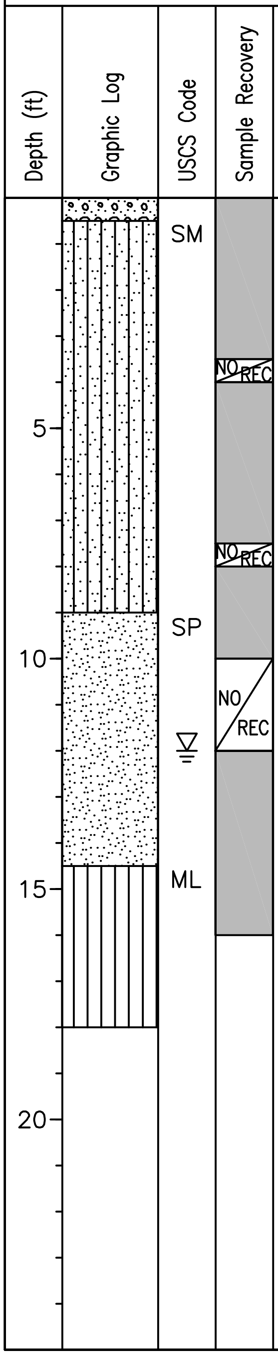
BOREHOLE LOG

Site Id: GP-10
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 18.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 08/28/03



PID (ppm)	Description/Soil Classificiation
36	Gravel road base.
78	SILTY SAND (SM): tan, fine grained, thin stringers of coarse sand, loose, dry.
22	
178	SILTY SAND (SM): tan, fine grained, stringers of silt and medium grained sand, loose, dry.
35	
45	
	SILTY SAND (SM): tan, slightly cohesive, moist.
273	SAND (SP): black to dark brown, medium grained, clean.
59	SAND (SP): dark brown, slightly silty, wet
375	SAND (SP): black to dark brown, medium grained, some silt, solvent odor, slight sheen, saturated. Sudan IV (Yes?)
	Sudan IV (No)
86	SILT (ML): gray, with fine grained sand, soft, slightly cohesive, wet.
12	Decreasing moisture with depth.
	Bottom of Boring – 18.0' FLUTE DNAPL sleeve installed to 18.0' bgs.

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BOREHOLE LOG

Site Id: GP-11
Page 1 of 1

Project Number: 5303.12

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

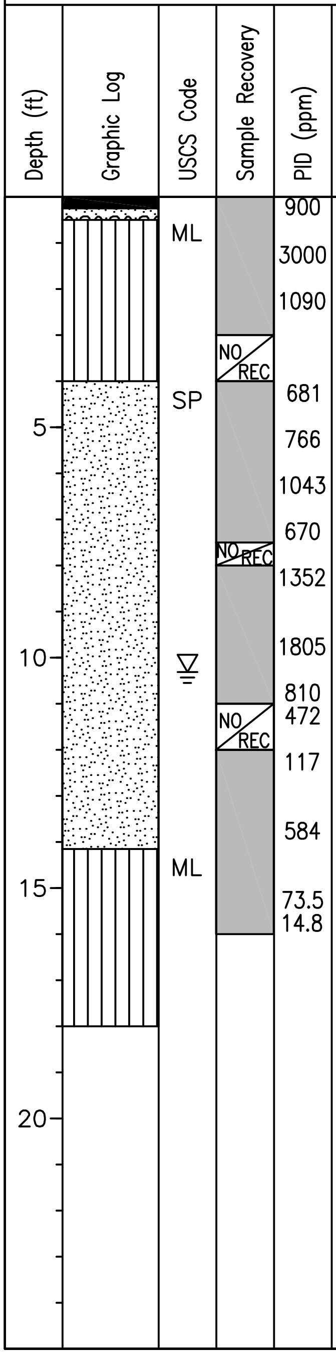
Drilling Method: Direct-Push

Total Depth: 18.00'

Borehole Dia.: 2.25in

Logged By: B. Magee

Date(s): 08/29/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
			900	Asphalt, gravel base.
	ML		3000	SANDY SILT (ML): tan, fine grained sand, dry.
			1090	
		NO REC		
	SP		681	SAND (SP): brown, fine grained, slightly silty, moist.
5			766	
			1043	SAND (SP): gray to brown, fine grained, moist.
			670	
		NO REC		
			1352	SAND (SP): as above.
10	∇		1805	SAND (SP): black, slightly silty, strong odor, saturated.
			810	
		NO REC	472	
			117	SAND (SP): black, slightly silty, clean, strong odor, no sheen, saturated.
			584	
	ML			SANDY SILT (ML): gray, fine grained sand, slightly cohesive, wet.
15			73.5	
			14.8	
				Bottom of Boring – 18.0' FLUTE DNAPL sleeve installed to 18.0' bgs. No NAPL visually observed.
20				

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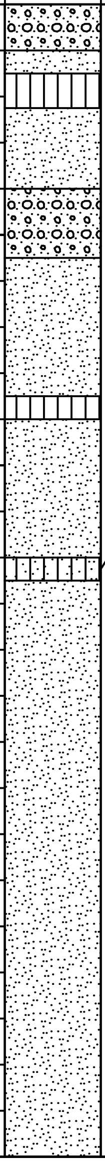
BOREHOLE LOG

Site Id: GP-12
Page 1 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 50.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/28/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
				Sandy gravel, road base material.
	SP		224	SAND (SP): dark brown with black, fine grained, slightly silty, dry.
	ML		230	SANDY SILT (ML): brown, fine grained, increasing sand content with depth, dry.
	SP		246	SAND (SP): brown, fine grained, dry.
		NO REC		
			89	Slough from above, silty sand and road base with gravel, dry.
5				
	SP		118	SAND (SP): light brown to light gray, becoming reddish brown with depth, fine grained, dry.
			30	
		NO REC		
			240	SAND (SP): as above.
	ML			SANDY SILT (ML): brown, interbedded gravel, well graded, rounded, up to 0.5" in size, dry.
	SP		160	SAND (SP): speckled, dark brown, medium grained, moisture content increasing.
10				
			240	
			310	
		NO REC		
	SM ▽		190	SILTY SAND (SM): brown, dry (slough).
	SP		393	SAND (SP): gray, medium to coarse grained, poorly graded, odor, saturated.
15			228	SAND (SP): gray/black, fine grained, trace silt, saturated.
			72	
			6.8	SAND (SP): gray, medium grained, trace silt, saturated.
			2.5	
			3.2	
			2.7	
		NO REC		
20				SAND (SP): as above, becoming finer with depth.
				Piece of wood in probe shoe.
		NO REC		
				SAND (SP): as above.

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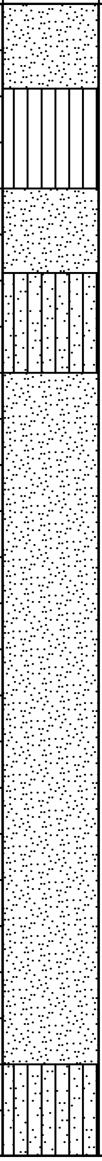
BOREHOLE LOG

Site Id: GP-12
Page 2 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 50.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/28/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
			2.0	1.0" silt layer Chunk of wood.
	ML	NO REC		SILT (ML): bottom of shoe, brown to gray, trace fine grained sand, moderately cohesive, saturated.
				SILT (ML): as above.
	SP			SAND (SP): gray, fine to medium grained, trace silt, saturated.
30			0.7	
	SM	NO REC		SILTY SAND (SM): gray, slightly cohesive, saturated.
			10.8	SILTY SAND (SM): as above.
	SP			SAND (SP): gray, fine to medium grained, saturated.
			8.5	
			11.8	
35			12	
		NO REC		
		NO REC		
40				SAND (SP): black, medium grained, saturated.
			2.8	
				SAND (SP): as above.
45				
				SAND (SP): black, fine grained, saturated.
	SM			SILTY SAND (SM): black/gray, fine grained, with gray silt stringers, saturated.
				Bottom of Boring – 50.0' FLUTE DNAPL sleeve installed to 47.0' bgs.

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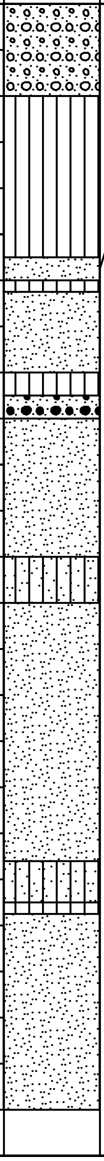
BOREHOLE LOG

Site Id: GP-13
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 24.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/29/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
			240	Homogenous fill material SANDY GRAVEL: black, tar-like, similar to asphalt, with a 1.0" layer of tar-like sandy silt at 1.0' bgs, 4.0" layer of white powder-like material at 1.5' bgs, weathered, dry.
			101	
			97	
	ML			SILT (ML): gray, slightly sandy, high organic content.
		NO REC		
				SILT (ML): gray, slightly sandy, medium stiff, cohesive.
5			265	
	SP ∇		18.6	SAND (SP): gray, fine grained, saturated.
	ML		67.4	SILT (ML): gray, sandy, medium stiff, cohesive.
	SP		104	SAND (SP): gray to dark brown, medium grained, moist.
		NO REC		
	ML		337	SILT (ML): mottled black and gray, medium stiff.
	GP			SANDY GRAVEL (GP): gravel is slightly tarry with white spots.
	SP			SAND (SP): brown, medium grained, wet.
10			536	
			132	
		NO REC		
	SM		41	SILTY SAND (SM): gray brown, slightly moist.
	SP		2758	SAND (SP): mixed light and dark colored (brown).
			5900	SAND (SP): black, silty, strong odor, saturated.
15		NO REC		
			568	SAND (SP): mixed light and dark colored (black to dark brown), moist.
				SAND (SP): as above, silty.
	SM		64.9	SILTY SAND (SM): gray, strong odor, wet.
	ML		426	SILT (ML): gray, medium stiff, strong odor, slightly moist.
20	SP		34	SAND (SP): black, fine to medium grained, strong odor, saturated.
			76	
			2407	
			588	
		NO REC		Bottom of Boring – 24.0'
				FLUTE DNAPL sleeve installed to 24.0' bgs.

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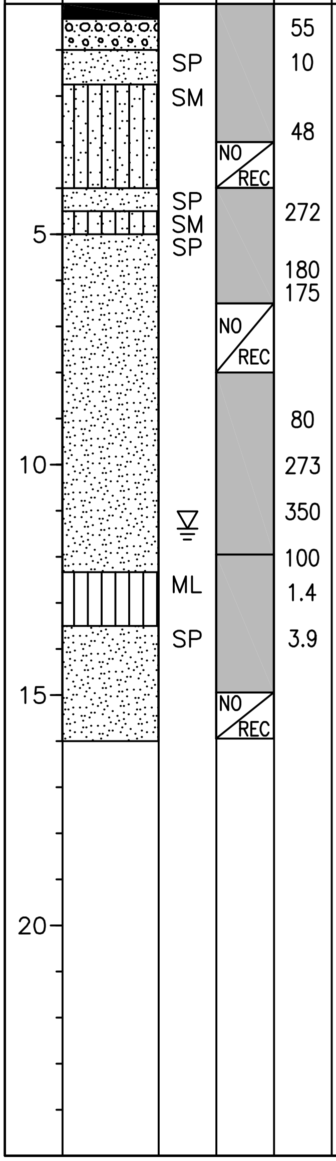
BOREHOLE LOG

Site Id: GP-14
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 16.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/28/03



USCS Code	PID (ppm)	Description/Soil Classificiation
	55	Asphalt ~4.0".
		Homogenous road base/fill with gravel, brown, dry.
SP	10	SAND (SP): light gray/light brown, with small gravel, rounded, 1/8" in size, dry.
SM		SILTY SAND (SM): brown, fine grained, dry.
	48	
SP	272	SAND (SP): light gray/light brown, with small gravel, rounded, 1/8" in size (slough).
SM		SILTY SAND (SM): brown, fine grained, with gravel, dry.
SP	180 175	SAND (SP): mixed light and dark colored (gray/brown), medium grained, slightly moist.
		SAND (SP): light gray/light brown, with small gravel, rounded, 1/8" in size (slough).
	80	SAND (SP): mixed light and dark colored (reddish brown), medium grained, odor, moisture increases with depth.
	273	
∇	350	SAND (SP): black/gray, fine to medium grained, odor, saturated.
	100	SAND (SP): black/gray, fine to medium grained, saturated.
ML	1.4	SILT (ML): gray, fine grained, moderately cohesive, saturated.
SP	3.9	SILT (ML): black, fine to medium grained, saturated.

Bottom of Boring – 16.0'
FLUTE DNAPL sleeve installed to 16.0' bgs.

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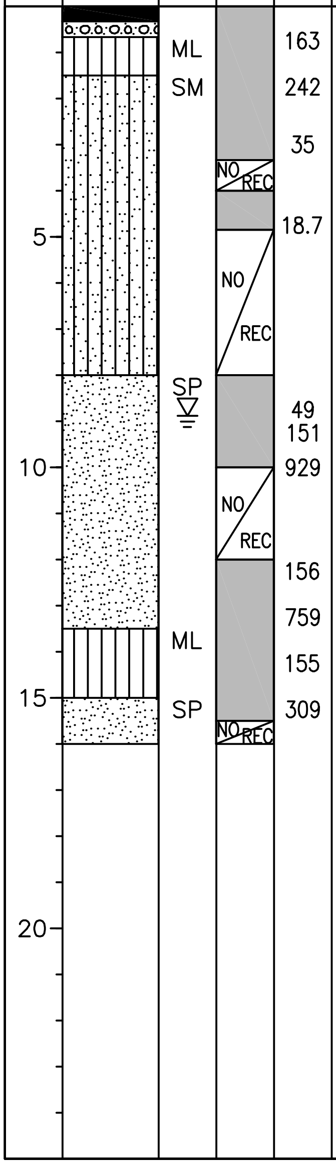
BOREHOLE LOG

Site Id: GP-15
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 16.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 08/28/03



USCS Code	PID (ppm)	Description/Soil Classificiation
		Asphalt ~4.0".
	163	Road base.
ML		SANDY SILT (ML): tan, very fine grained, loose, slightly moist.
SM	242 35	SILTY SAND (SM): tan, very fine grained, several thin (~1.0") stringers of medium sand, loose, slightly moist.
	18.7	SILTY SAND (SM): gray, loose, dry. Very hard gray mineral in shoe, slight reaction with HCl, and turned HCl green.
SP		SAND (SP): gray, medium grained, clean, slightly moist.
▽	49 151	SAND (SP): as above, saturated.
	929	Becomes coarser grained with depth. Plastic chunk in shoe.
	156	SAND (SP): black, medium grained, clean, strong solvent odor, no sheen.
	759	Sudan IV (No)
ML	155	SANDY SILT (ML): gray, very fine grained, some very fine bits of organic matter, stiff, strong odor.
SP	309	SAND (SP): black, fine grained, slightly silty, saturated. Bottom of Boring – 16.0' FLUTE DNAPL sleeve installed to 16.0' bgs.

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BOREHOLE LOG

Site Id: GP-16
Page 1 of 1

Project Number: 5303.12

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

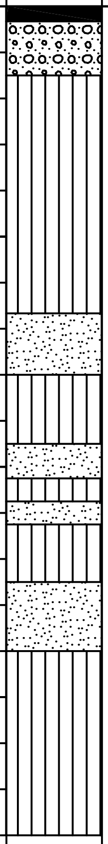
Drilling Method: Direct-Push

Total Depth: 18.00'

Borehole Dia.: 2.25in

Logged By: Z. Clements

Date(s): 08/27/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
			600	Asphalt ~4.0". Sandy, gravelly road base.
	ML	NO REC		
				SANDY SILT (ML): tan to gray, slightly cohesive, strong odor, moist.
5			3600	Strong odor, slight sheen from 5.0–6.0'.
			32	Sudan IV (No)
	SP		350	SAND (SP): tan, medium grained, strong odor, dry.
		NO REC		
	ML		10,000	SANDY SILT (ML): tan to gray, very fine grained sand, slightly cohesive, strong odor, moist.
			1200	
10	SP			SAND (SP): dark brown, medium grained, organic carbon chunk at 10.25'.
	ML		50	SANDY SILT (ML): tan, slightly cohesive.
	SP			SAND (SP): multicolored (dark brown to black), very coarse grained, organic particles, stain(?).
	ML	NO REC	48	SILT (ML): gray to brown, slightly cohesive, soft, moist.
			15.4	SILT (ML): light brown, some fine grained sand, slightly cohesive, slightly moist.
	SP			SAND (SP): brown with light colored particles, fine to medium grained, slightly moist.
	▽		20.2	SAND (SP): black, medium grained, some fine to coarse gravel, rounded, up to 1.0" in size, visible sheen, strong odor, saturated.
	ML		1.6	SANDY SILT (ML): brown gray to light brown, fine grained, slightly cohesive, soft, odor.
15			4.1	Sudan IV (Yes)
				Bottom of Boring – 18.0' FLUTE DNAPL sleeve installed to 18.0' bgs. No product observed with FLUTE.
20				

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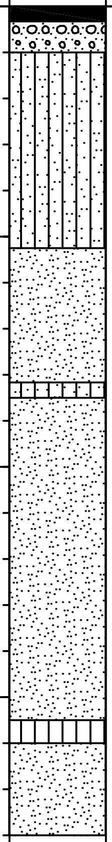
BOREHOLE LOG

Site Id: GP-17
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 18.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 08/27/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
			9.0	Asphalt ~4.0". Road base, sandy, silty, with gravel, light brown, dry.
	SM		36	SILTY SAND (SM): brown, fine grained.
		NO REC		
			125	SILTY SAND (SM): as above, with intermingled gravel (slough?)
5	SP		91 82	SAND (SP): mixed light and dark colored (brown to gray), fine to medium grained, dry.
		NO REC		
				SAND (SP): as above.
	SM		86	SILTY SAND (SM): brown, fine grained, dry.
	SP		105	SAND (SP): mixed light and dark colored (brown to gray), medium grained, slightly moist.
	∇		2000	SAND (SP): as above, saturated.
10		NO REC		
			650	SAND (SP): mixed light and dark colored (black), medium grained, strong odor, sheen on water, saturated, water content decreases with depth.
			61	
15			250	Sudan IV (No)
	ML	NO REC	73	SILT(ML): gray, fine grained, firm, slightly cohesive.
	SP		5.0	SAND (SP): mixed light and dark colored (black), medium grained, slight odor, moist.
			8.0 7.0	
				Bottom of Boring – 18.0' FLUTE DNAPL sleeve installed to 18.0' bgs. No product observed with FLUTE. Strong odor and sheen on water noted.
20				

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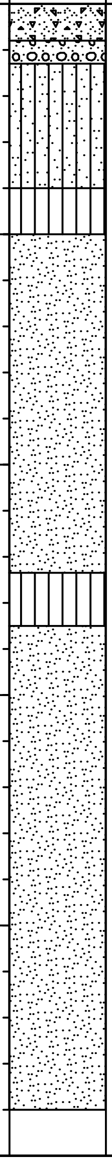
BOREHOLE LOG

Site Id: GP-18
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 24.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 08/29/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
				Concrete.
			0.3	Gravel base.
	SM		0.5	SILTY SAND (SM): gray, fine grained, slightly moist.
		NO REC	0.3	
	ML		0.2	SANDY SILT (ML): gray, soft, moist.
5	SP		0.4	SAND (SP): mixed light and dark colored (brown), medium grained, moist.
			0.3	
		NO REC		
			0.3	SAND (SP): as above. Ground water sample (GP-18-12) was taken from 8.0-12.0'.
10			0.9	
	∇		1.8	SAND (SP): as above, saturated.
		NO REC		
			1.5	SAND (SP): brown, medium grained, saturated.
	ML			SILT (ML): gray, some fine grained sand, soft, slightly cohesive.
			1.6	
	SP			SAND (SP): brown to black, medium grained, saturated.
			3.6	SAND (SP): brown to black, medium grained, trace silt, clean, saturated.
15				
			1.6	
				SAND (SP): mixed light and dark colored (brown to black), medium grained, saturated.
			13.5	
			5.3	
		NO REC	19	
20				Ground water sample (GP-18-24) was taken from 20.0-24.0'.
			3.4	SAND (SP): as above, saturated.
			15.8	
			8.9	
			7.9	
		NO REC		
				Bottom of Boring - 24.0'

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BOREHOLE LOG

Site Id: GP-19
Page 1 of 1

Project Number: 5303.12

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

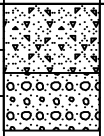
Drilling Method: Direct-Push

Total Depth: 2.75'

Borehole Dia.: 2.25in

Logged By: B. Magee

Date(s): 08/29/03



Depth (ft)	Graphic Log	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
					Concrete.
					Sandy, silty gravel (fill).
			NO REC		Concrete in shoe. Unable to push through. Direct-Push refusal at 2.75' on concrete.
5					
10					
15					
20					

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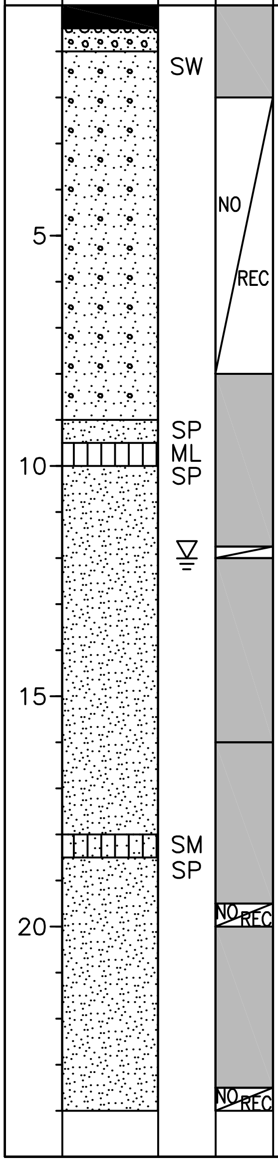
BOREHOLE LOG

Site Id: GP-19
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 24.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 09/30/03



USCS Code	PID (ppm)	Description/Soil Classificiation
	0.0	Asphalt.
	0.0	Gravel base.
SW	0.0	SILTY GRAVELLY SAND (SW): brown, unconsolidated, dry.
	0.0	
	0.0	
SP	0.0	SAND (SP): brown with light specks, medium grained.
ML		CLAYEY SILT (ML): brown, stiff, moist.
SP	0.0	SAND (SP): brown with light specks, medium grained, moist.
	0.0	
⊻		SAND (SP): as above, wet.
	0.0	SAND (SP): brown to black, medium grained, some gravel (to 1.0"), saturated.
	0.0	Set temporary well screen from 12.0–16.0'.
	0.0	SAND (SP): gray, fine grained, with some silt, no odor, saturated.
	0.0	SAND (SP): as above, some rust-colored stains.
		SAND (SP): gray to black, fine to medium grained, wet.
	0.0	SAND (SP): brown, fine to medium grained, saturated.
	0.0	
SM	0.0	SAND (SM): black, fine grained, saturated.
SP		SAND (SP): brown with white specks, medium grained, saturated.
	0.0	
		SAND (SP): brown with white specks, medium grained, saturated.
	0.0	
	0.0	
	0.0	
	0.0	Set temporary well screen from 20.0–24.0'.
		Total Depth – 24.0' bgs

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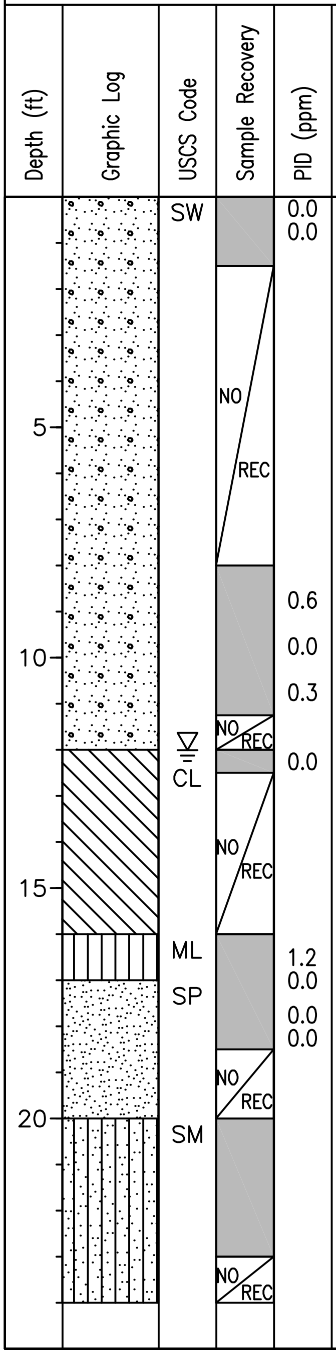
BOREHOLE LOG

Site Id: GP-20
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 24.00'
Borehole Dia.: 2.25in
Logged By: Z. Clements
Date(s): 09/30/03



Description/Soil Classificiation

GRAVELLY SAND (SW): brown, fine to medium grained, dry.

Chunk/shaving of wood (redwood) in bottom of shoe.

Wood (redwood).

3.5' section of wood recovered in sampler. Decaying organic-like odor.

Moist at bottom of shoe, nail located in wood in shoe.

GRAVELLY CLAY (CL): reddish brown, decaying organic-like odor, saturated.
Black and white paper/plastic-like material, organic material, decaying organic-like odor.

Set temporary well screen from 12.0-16.0'

SANDY SILT (ML): black, saturated.

SAND (SP): black, fine to medium grained, organic layers, slightly silty, very wet.
SAND (SP): as above, gray.

SILTY CLAYEY SAND (SM): dark gray to black, with organics throughout.

Set temporary well screen from 20.0-24.0'
Total Depth - 24.0' bgs

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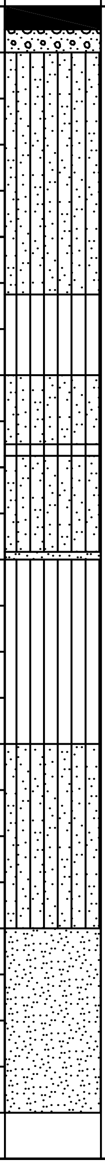
BOREHOLE LOG

Site Id: GP-22
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 24.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 10/13/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
			0.0	Asphalt.
				SANDY GRAVEL (GW): base fill.
	SM		0.0	SILTY SAND (SM): brown, fine grained, some pea-sized gravel, dry.
			0.0	
		NO REC	0.0	
			0.0	SILTY SAND (SM): as above.
			0.0	
5			0.0	
			0.0	
	ML	NO REC		SANDY SILT (ML): gray, some rust staining at top, stiff, moist.
	SM		0.0	SILTY SAND (SM): brown, fine to medium grained, some pea-sized gravel, dry.
	∇		0.0	
	ML			SANDY SILT (ML): wet.
10	SM		0.0	SILTY SAND (SM): brown to gray, medium grained, wet.
			0.0	SILTY SAND (SM): as above, saturated.
	SP	NO REC		SAND (SP): gray brown, saturated.
	ML		0.0	SANDY SILT (ML): brown, high organic content, fine to very fine grained sand, no to rare clay, soft, slight decaying odor.
			0.0	
			0.0	Set temporary well screen from 10.0–14.0'
15		NO REC	0.0	SANDY SILT (ML): as above, increasing sand.
	SM		0.0	SILTY SAND (SM): gray, medium grained, some organics, saturated.
			0.0	
			0.0	
		NO REC		
20	SP		0.0	SAND (SP): gray to black, medium grained, saturated.
			0.0	3.0" plug of wood in sampler, no odor.
			0.0	
		NO REC		Set temporary well screen from 20.0–24.0'
				Total Depth – 24.0' bgs

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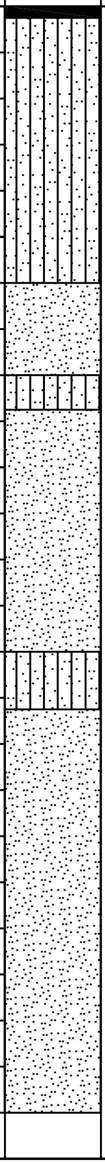
BOREHOLE LOG

Site Id: GP-23
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct-Push

Total Depth: 24.00'
Borehole Dia.: 2.25in
Logged By: B. Magee
Date(s): 10/13/03



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classificiation
	SM		0.0	Asphalt.
			0.0	GRAVELLY SILTY SAND (SM): fill, dry.
		NO REC		
			0.0	SILTY SAND (SM): tan to brown, fine grained, moist.
5			0.0	
	SP		0.0	SAND (SP): gray brown, fine to medium grained, moist.
		NO REC		
	SM		0.0	SILTY SAND (SM): brown, fine grained, slightly moist.
	▽ SP		0.0	SAND (SP): gray brown, some rust staining, medium grained, wet.
10			0.0	
		NO REC		
			0.0	SAND (SP): rusty brown, medium grained, slightly silty, saturated.
			0.0	
	SM		0.0	SILTY SAND (SM): gray, very fine grained, cohesive, saturated.
15			0.0	
	SP		0.0	SAND (SP): gray to brown, with white specks (10%), medium grained, saturated.
			0.0	Set temporary well screen from 12.0–16.0'
			0.0	
			0.0	
		NO REC		
20				
			0.0	SAND (SP): as above.
			0.0	
				Silt/fine grained sand laminations (<1.0") throughout lower 2.0'.
			0.0	
			0.0	Set temporary well screen from 20.0–24.0'
				Total Depth – 24.0' bgs

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BOREHOLE LOG

Site Id: GP-24
Page 1 of 1

Project Number: 5303.12

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

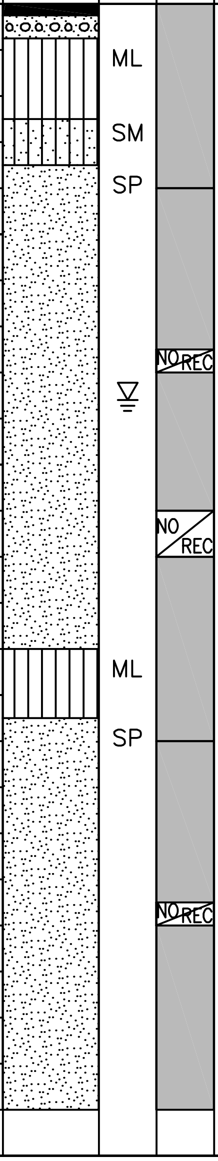
Drilling Method: Direct-Push

Total Depth: 24.00'

Borehole Dia.: 2.25in

Logged By: B. Magee

Date(s): 10/13/03



Depth (ft)	USCS Code	PID (ppm)	Description/Soil Classificiation
		0.0	Asphalt.
			Gravel base.
	ML	0.0	SILT (ML): tan, with fine grained sand, low cohesion, slightly moist.
		0.0	
	SM		SILTY SAND (SM): gray, fine grained, low cohesion, dry to slightly moist.
		0.0	
	SP		SAND (SP): gray to black, with rust staining, with white grains (5%), slightly moist.
		0.0	SAND (SP): tan, fine grained, dry.
5			
		0.0	
		0.0	
		0.0	
		0.0	SAND (SP): as above.
	⊻		SAND (SP): black, with white grains (10%), medium grained, wet.
		0.0	
10			
		0.0	
		0.0	
		4.6	SAND (SP): brown to black, medium grained, saturated.
		14.7	
	ML	14.6	SANDY SILT (ML): gray, fine grained sand, soft, saturated.
15		2.4	Set temporary well screen from 12.0–16.0'
	SP		SAND (SP): gray to black, medium grained, saturated.
		0.8	SAND (SP): as above.
		4.3	
		4.7	
		4.4	
20			SAND (SP): as above.
			Set temporary well screen from 20.0–24.0'
			Total Depth – 24.0' bgs

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Drill Date: 6/18/2009
Weather Cond.: Sunny, 70
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade

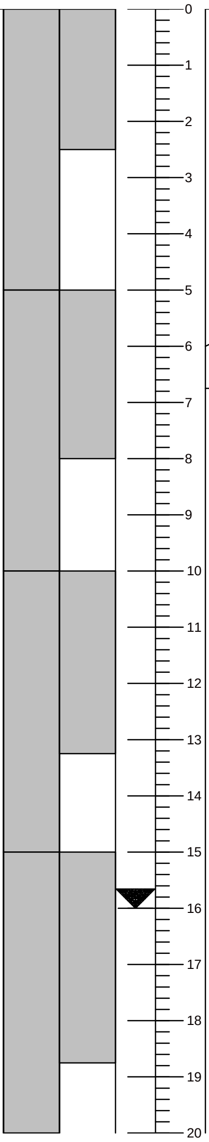
Boring ID: GP-82

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.54
Latitude/Northing: 200682.6
Longitude/Easting: 1271856.3
Boring Location: Production Area

Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 70'
Groundwater ATD (ft bgs): 16'

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.
Soil and groundwater samples collected. Retractable screen = 3.0', symbol at top of screen.



PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
22		S			SW/SM	Concrete surfacing 6" thick. Dark grayish brown well graded SAND with gravel and silt, moist. (FILL)
		S			ML	Brown SILT, wet.
2.5					SP	Grayish brown poorly graded fine SAND with trace silt grading to dark gray.
1.4		S				
12		S		▼		Brownish gray well graded SAND with trace rounded gravel. Silt lenses at 17', wet.

Notes:
FT BGS = feet below ground surface
ppm = parts per million
🟥 = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
▨ = Permanganate Staining Observed in Sample
S = Soil sample
W = Groundwater sample via peristaltic, symbol denotes top of screen.

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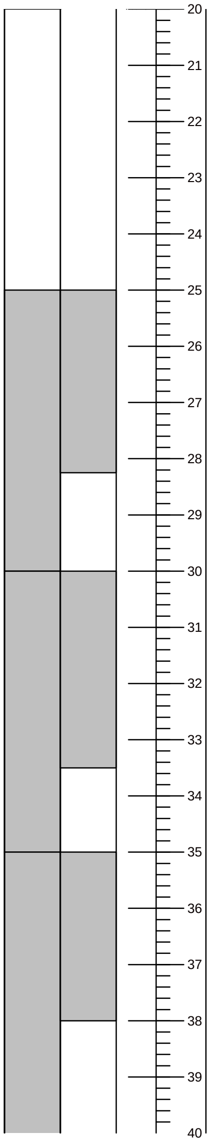
Drill Date: 6/18/2009
Weather Cond.: Sunny, 70
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 70'
Groundwater ATD (ft bgs): 16'

Boring ID: GP-82

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.54
Latitude/Northing: 200682.6
Longitude/Easting: 1271856.3
Boring Location: Production Area

Remarks: PID readings via screening of split core at ambient temperature.
Soil and groundwater samples collected. Retractable screen = 3.0', symbol at top of screen.



PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
						No soil core recovered.
						Same as above. Dark gray poorly graded fine SAND.
0.5						
						Grayish brown SILT layer at 26.75'. Low plasticity, wet.
						Same as above.
0.1-0.2						
						Same as above.
		S				
0.1-0.2						

Notes:
FT BGS = feet below ground surface
ppm = parts per million
🟥 = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
▨ = Permanganate Staining Observed in Sample
S = Soil sample
W = Groundwater sample via peristaltic, symbol denotes top of screen.

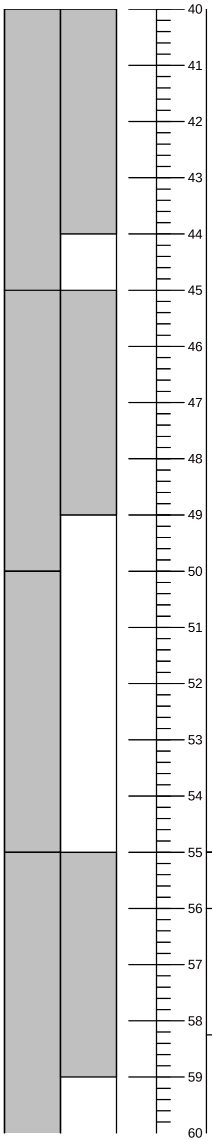
Boring ID: GP-82

Drill Date: 6/18/2009
Weather Cond.: Sunny, 70
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 70'
Groundwater ATD (ft bgs): 16'

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.54
Latitude/Northing: 200682.6
Longitude/Easting: 1271856.3
Boring Location: Production Area

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.
Soil and groundwater samples collected. Retractable screen = 3.0', symbol at top of screen.



PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
			40		Thin lenses of fine sand with silt at 40'.
0.1					
		S			
6.2					
			45		Brownish gray well graded SAND. Slight chemical odor.
11.7					
		S			
			50		Water sample only. No soil core.
		W			
35			55	ML	Dark grayish brown non-plastic sandy SILT, wet.
		S			
			56	SM	Dark gray silty fine SAND, wet.
8.5					
			58	ML	Dark gray medium stiff SILT.
0.9					

Notes:
FT BGS = feet below ground surface
ppm = parts per million
🟥 = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
▨ = Permanganate Staining Observed in Sample
S = Soil sample
W = Groundwater sample via peristaltic, symbol denotes top of screen.

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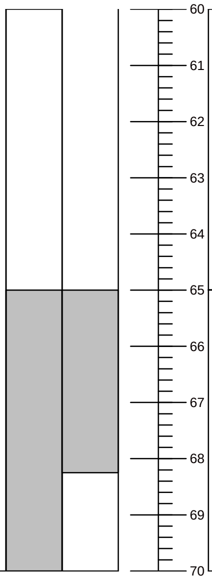
Drill Date: 6/18/2009
Weather Cond.: Sunny, 70
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 70'
Groundwater ATD (ft bgs): 16'

Boring ID: GP-82

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.54
Latitude/Northing: 200682.6
Longitude/Easting: 1271856.3
Boring Location: Production Area

Remarks: PID readings via screening of split core at ambient temperature.
Soil and groundwater samples collected. Retractable screen = 3.0', symbol at top of screen.



PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
		W		60		Water sample only. No soil core.
				65	SM/SP	Dark gray silty fine SAND with beds of fine SAND with silt and fine SAND, wet.
		S		66		
0				67		
				70		

Notes:
FT BGS = feet below ground surface
ppm = parts per million
🟥 = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
▨ = Permanganate Staining Observed in Sample
S = Soil sample
W = Groundwater sample via peristaltic, symbol denotes top of screen.

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BOREHOLE LOG

Site Id: MW-1
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 10/27/03
Initial Water Level: 10.00'

Total Depth: 14.00'
Completed Depth: 12.00'
Borehole Dia.: 2.00in

Blank Casing:

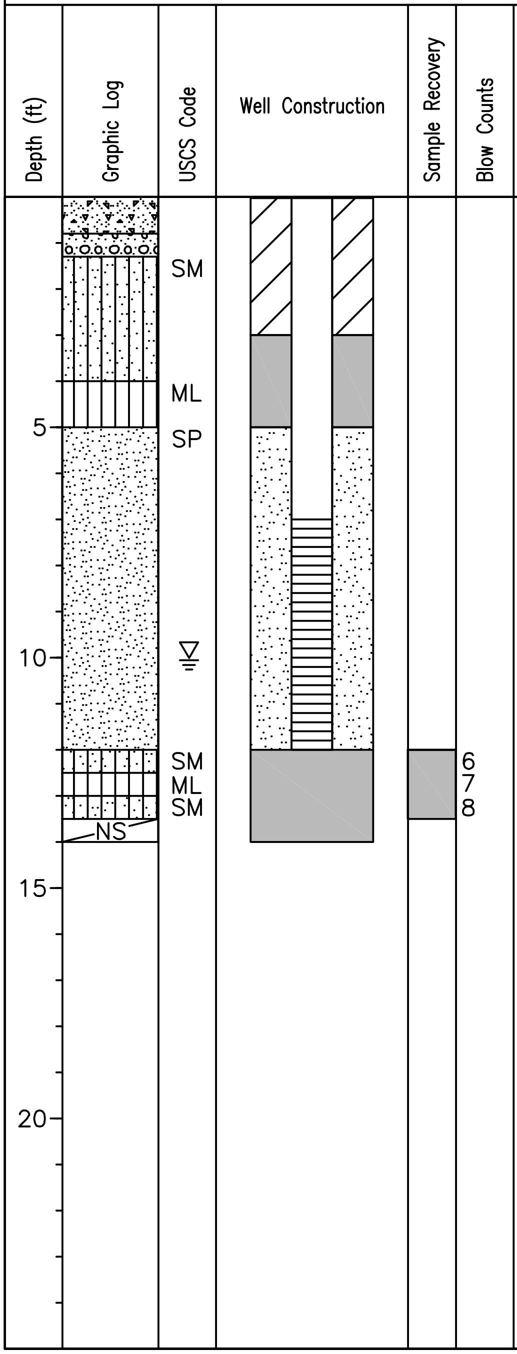
type	size	dia	fm	to
PVC		2.00in	0.0'	7.00'

Screens:

type	size	dia	fm	to
Slotted	0.010in	2.00in	7.00'	12.00'

Annular Fill:

type	fm	to
Cement/Grout	0.00'	3.00'
Bentonite Chips	3.00'	5.00'
#10-20 Sand Filter	5.00'	12.00'
Bentonite Chips	12.00'	14.00'



Description/Soil Classification

Concrete.
Gravel base.
SILTY SAND (SM): gray, fine grained, slightly moist.

SANDY SILT (ML): gray, soft, moist.

SAND (SP): mixed light and dark colored (brown), medium grained, moist.

SAND (SP): as above.

SAND (SP): as above.

SILTY SAND (SM): brown, saturated.
SILT (ML): brown, medium stiff, saturated.
SILTY SAND (SM): brown, saturated.

Total Depth - 14.0'

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BOREHOLE LOG

Site Id: MW-2
Page 1 of 2

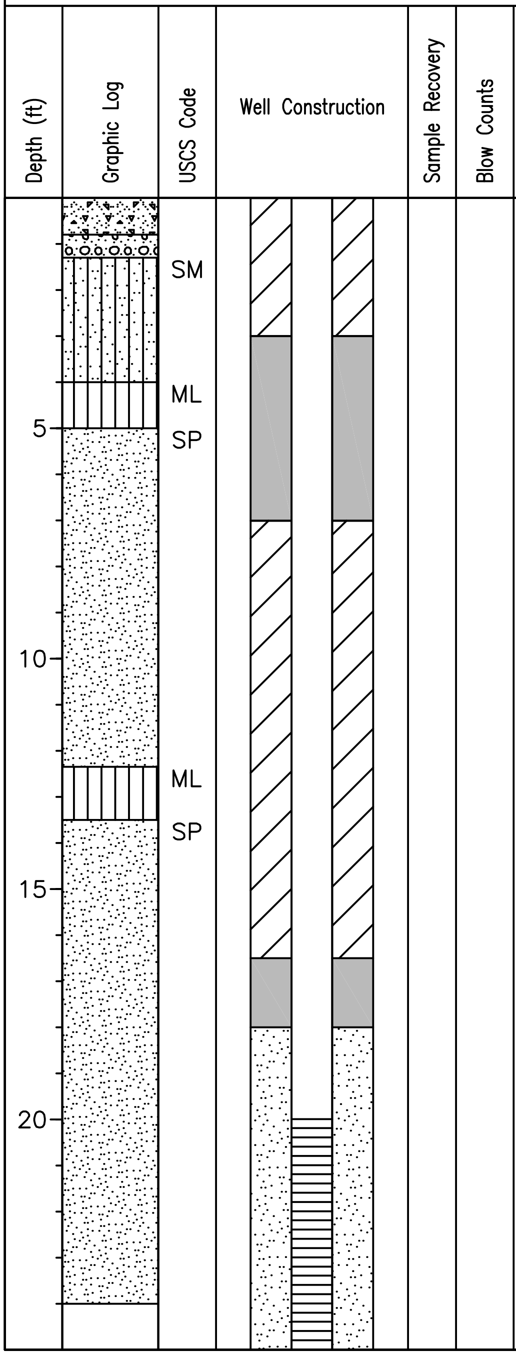
Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: B. Magee
Date(s): 10/27/03
Initial Water Level: NA

Total Depth: 40.00'
Completed Depth: 40.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 40.00'

Annular Fill:
type: Cement/Grout fm: 0.00' to: 3.00'
type: Bentonite Chips fm: 3.00' to: 7.00'
type: Grout fm: 7.00' to: 16.50'
type: Bentonite Chips fm: 16.50' to: 18.00'
type: Prepacked Sand fm: 18.00' to: 40.00'



Description/Soil Classification

Concrete.
Gravel base.
SILTY SAND (SM): gray, fine grained, slightly moist.

SANDY SILT (ML): gray, soft, moist.

SAND (SP): mixed light and dark colored (brown), medium grained, moist.

SAND (SP): as above.

SAND (SP): as above, saturated.

SAND (SP): brown, medium grained, saturated.
SILT (ML): gray, some fine grained sand, soft, slightly cohesive.

SAND (SP): brown to black, medium grained, saturated.
SAND (SP): brown to black, medium grained, trace silt, clean, saturated.

SAND (SP): as above.

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BOREHOLE LOG

Site Id: MW-2
Page 2 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: B. Magee
Date(s): 10/27/03
Initial Water Level: NA

Total Depth: 40.00'
Completed Depth: 40.00'
Borehole Dia.: 2.00in

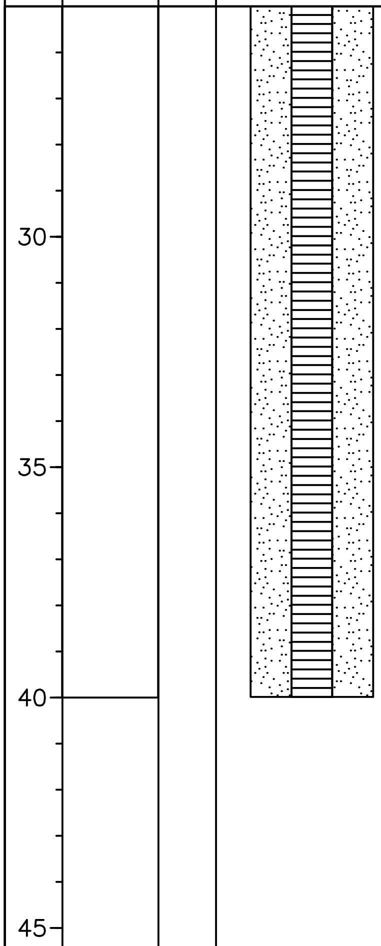
Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 40.00'

Annular Fill:

type: Cement/Grout	fm: 0.00'	to: 3.00'
type: Bentonite Chips	fm: 3.00'	to: 7.00'
type: Grout	fm: 7.00'	to: 16.50'
type: Bentonite Chips	fm: 16.50'	to: 18.00'
type: Prepacked Sand	fm: 18.00'	to: 40.00'

Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	Description/Soil Classification



Total Depth – 40.0'

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BOREHOLE LOG

Site Id: MW-3
Page 1 of 1

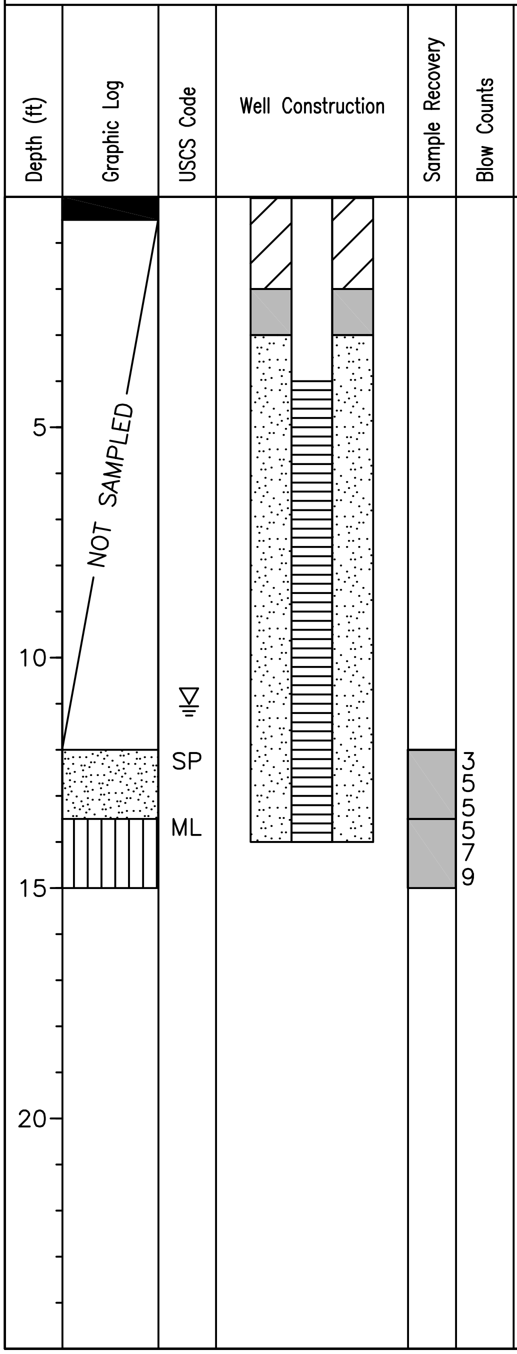
Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 10/28/03
Initial Water Level: ~11.00'

Total Depth: 15.00'
Completed Depth: 14.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 4.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 4.00' to: 14.00'

Annular Fill:
type: Cement/Grout fm: 0.00' to: 2.00'
type: Bentonite Chips fm: 2.00' to: 3.00'
type: #2/12 Sand Filter fm: 3.00' to: 14.00'



Description/Soil Classification

Asphalt, ~4.0–6.0" thick.

SAND (SP): black and white, fine to medium grained, low cohesion, wet.

SAND (SP): as above.
SILT (ML): gray, trace fine grained sand, wet.

SAND (SP): in shoe, dark and light color, fine to medium grained, low cohesion, wet.
Total Depth – 15.0'
]

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BOREHOLE LOG

Site Id: MW-4
Page 1 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 10/28/03
Initial Water Level: ~10.00'

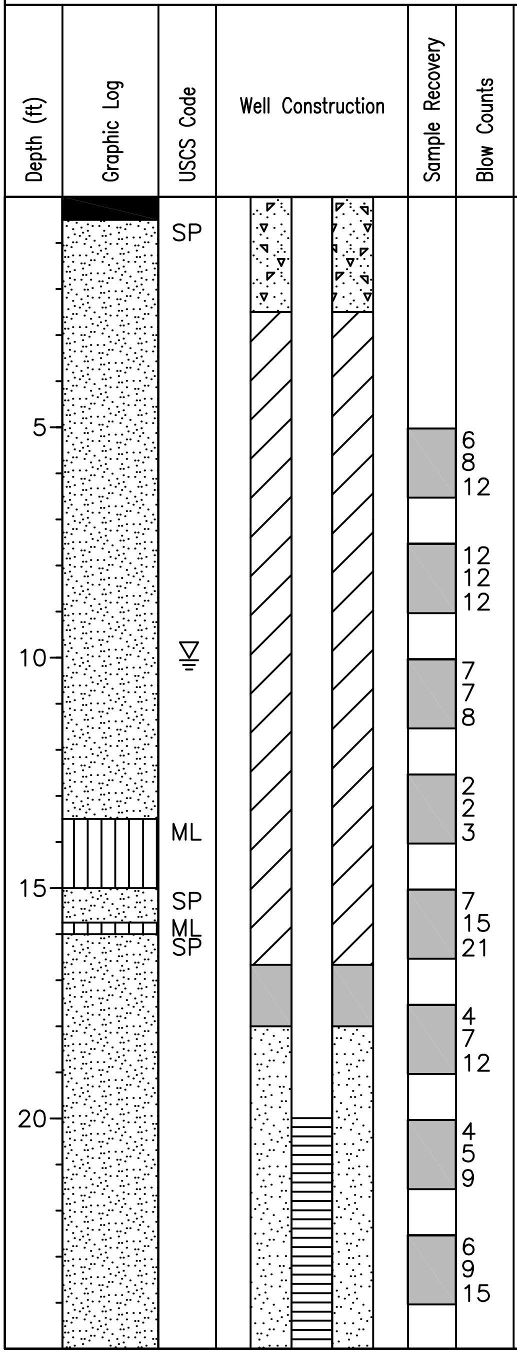
Total Depth: 41.50'
Completed Depth: 40.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 40.00'

Annular Fill:

type: Concrete	fm: 0.0'	to: 2.50'
type: Grout	fm: 2.50'	to: 16.66'
type: Bentonite Chips	fm: 16.66'	to: 18.00'
type: #2/12 Sand	fm: 18.00'	to: 40.00'



Depth (ft)	USCS Code	Blow Counts	Description/Soil Classification
			Asphalt, 4.0–6.0" thick.
	SP		
5		6 8 12	SAND (SP): brown, fine grained, trace silt, interbedded with 2.0" layers of fine grained brown sand,low cohesion, slightly moist.
		12 12 12	SAND (SP): light and dark colored, fine to medium grained, low cohesion, slightly moist. SAND (SP): light and dark colored, with some orange/yellow grains, fine to medium grained, low cohesion, very slightly moist.
10	∇	7 7 8	SAND (SP): light and dark colored, with some orange/yellow grains, medium grained, low cohesion, moist.
		2 2 3	SAND (SP): as above, no orange/yellow grains.
	ML		SILT (ML): gray, trace fine grained sand, wet.
15	SP ML SP	7 15 21	SAND (SP): light and dark colored, fine to medium grained, low cohesion, wet. SILT (ML): gray and brown, with sand, wet. Wood in shoe.
		4 7 12	SAND (SP): light and dark colored, fine to medium grained, low cohesion, wet.
20		4 5 9	SAND (SP): as above.
		6 9 15	SAND (SP): as above.

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BOREHOLE LOG

Site Id: MW-4
Page 2 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 10/28/03
Initial Water Level: ~10.00'

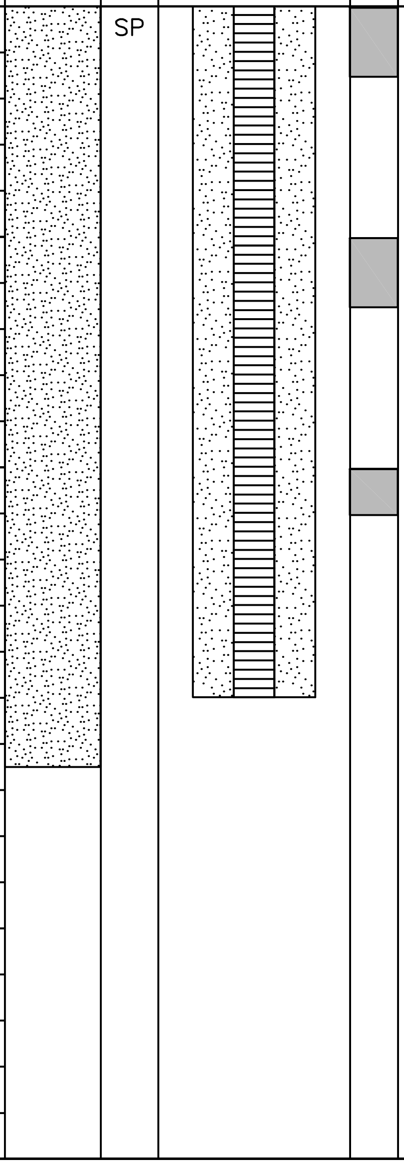
Total Depth: 41.50'
Completed Depth: 40.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 40.00'

Annular Fill:

type	fm	to
type: Concrete	fm: 0.0'	to: 2.50'
type: Grout	fm: 2.50'	to: 16.66'
type: Bentonite Chips	fm: 16.66'	to: 18.00'
type: #2/12 Sand	fm: 18.00'	to: 40.00'



Depth (ft)	USCS Code	Blow Counts	Description/Soil Classification
	SP	7 11 12	SAND (SP): as above, saturated.
30		10 8 10	SAND (SP): as above.
35		12 14	SAND (SP): as above.
40			SAND (SP): as above.
			Total Depth – 41.5'
45			

Graphic Log | Well Construction | Sample Recovery

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BOREHOLE LOG

Site Id: MW-5
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 10/29/03
Initial Water Level: NA

Total Depth: 15.00'
Completed Depth: 15.00'
Borehole Dia.: 2.00in

Blank Casing:

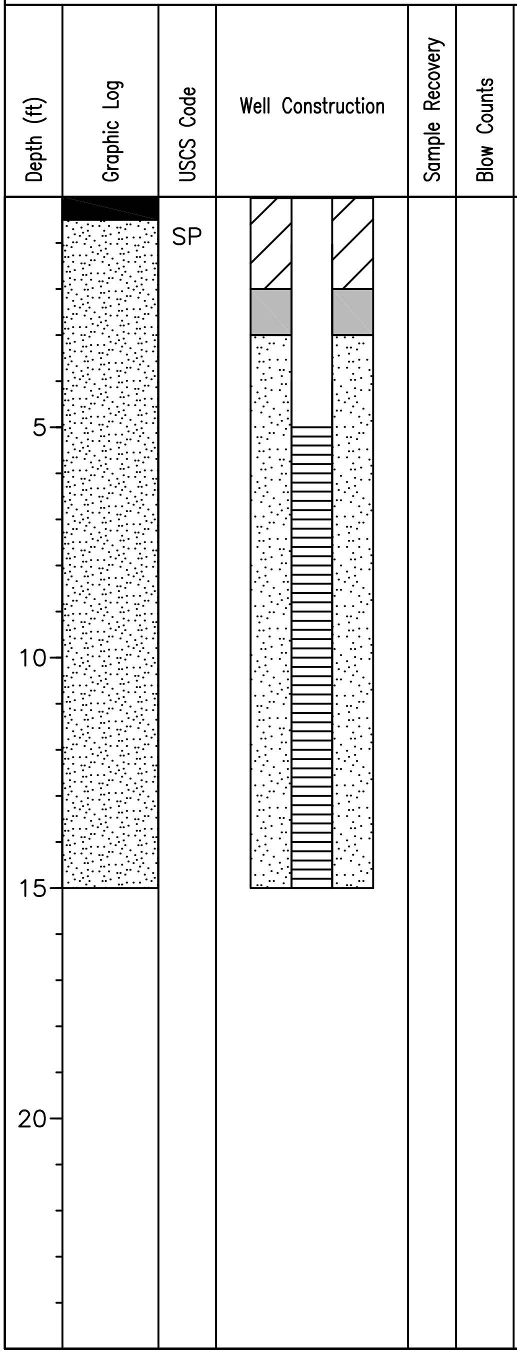
type	size	dia	fm	to
PVC		2.00in	0.0'	5.00'

Screens:

type	size	dia	fm	to
Slotted	0.010in	2.00in	5.00'	15.00'

Annular Fill:

type	fm	to
Cement/Grout	0.00'	2.00'
Bentonite Chips	2.00'	3.00'
#2/12 Sand Filter	3.00'	15.00'



Description/Soil Classification

Asphalt, 4.0–6.0" thick.

SAND (SP): brown, fine to medium grained, mixed with gravel (angular and round, possibly rip–rap material/fill), very slightly moist.

SAND (SP): brown, fine to medium grained, mixed with round gravel, trace silt, moist to wet (fill).

SAND (SP): in shoe, light colored, medium grained.

SAND (SP): light brown and dark colored, fine to medium grained, some small gravel/pebbles, wet.

SAND (SP): light brown and dark colored, fine to medium grained, low cohesion, wet.

SAND (SP): as above.

Total Depth – 15.0'

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BOREHOLE LOG

Site Id: MW-6
Page 1 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 10/29/03
Initial Water Level: ~9.00'

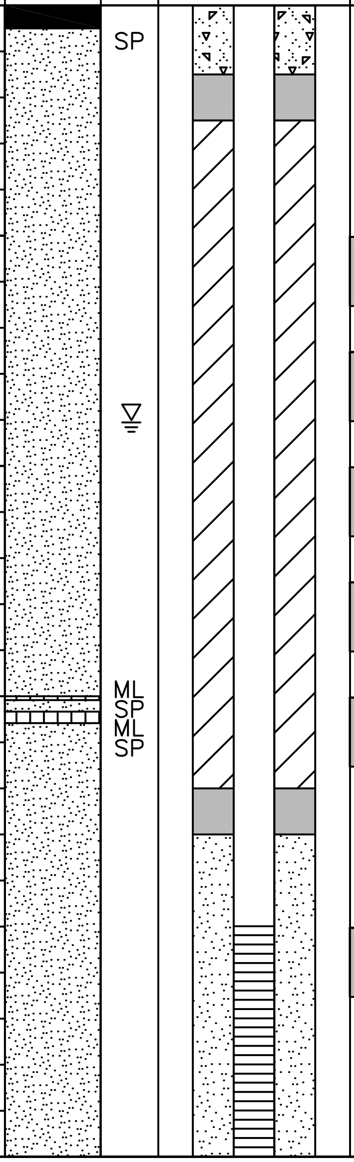
Total Depth: 41.50'
Completed Depth: 40.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 40.00'

Annular Fill:

type	fm	to
Concrete	0.0'	1.50'
Bentonite Chips	1.50'	2.50'
Grout	2.50'	17.00'
Bentonite Chips	17.00'	18.00'
Prepacked Sand	18.00'	40.00'



Depth (ft)	USCS Code	Blow Counts	Description/Soil Classification
			Asphalt, 4.0-6.0" thick.
	SP		SAND (SP): brown, fine to medium grained, mixed with gravel (angular and round possibly rip-rap material/fill), very slightly moist.
5		9 7 9	SAND (SP): brown, fine to medium grained, mixed with round gravel, trace silt, moist to wet (fill).
	▽	11 8 13	SAND (SP): in shoe, light colored, medium grained.
10		6 4 5	SAND (SP): light brown and dark colored, fine to medium grained, some small gravel/pebbles, wet. SAND (SP): light brown and dark colored, fine to medium grained, low cohesion, wet.
		8 9 10	SAND (SP): as above.
			SANDY SILT (ML): brown to gray, wet.
15	ML SP ML SP	10 21 30	SAND (SP): light and dark colored, fine to medium grained, low cohesion, wet. SILT (ML): gray, trace sand, wet. SAND (SP): yellow to orange, mixed with black and white, fine grained, low cohesion, wet.
			SAND (SP): mixed light and dark colored (brown), fine to medium grained, low cohesion.
			SAND (SP): mixed light and dark colored (black), fine grained, low cohesion, wet.
20		10 21 30	SAND (SP): as above. SAND (SP): as above.

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BOREHOLE LOG

Site Id: MW-6

Project Number: 5303.12

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Hollow Stem Auger

Logged By: Z. Clements

Date(s): 10/29/03

Initial Water Level: ~9.00'

Total Depth: 41.50'

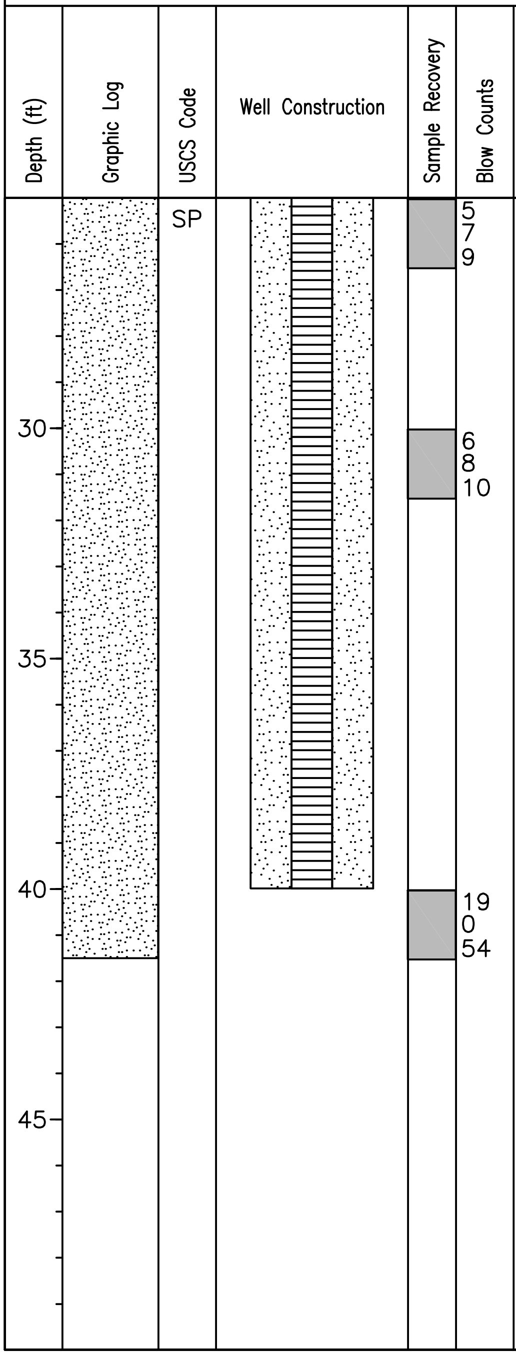
Completed Depth: 40.00'

Borehole Dia.: 2.00in

Blank Casing:				
type: PVC		dia: 2.00in	fm: 0.0'	to: 20.00'

Screens:				
type: Slotted	size: 0.010in	dia: 2.00in	fm: 20.00'	to: 40.00'

Annular Fill:		
type: Concrete	fm: 0.0'	to: 1.50'
type: Bentonite Chips	fm: 1.50'	to: 2.50'
type: Grout	fm: 2.50'	to: 17.00'
type: Bentonite Chips	fm: 17.00'	to: 18.00'
type: Prepacked Sand	fm: 18.00'	to: 40.00'



Depth (ft)	USCS Code	Blow Counts	Description/Soil Classification
	SP	5 7 9	SAND (SP): as above.
30		6 8 10	SAND (SP): as above.
40		19 0 54	SAND (SP): as above. Total Depth – 41.5'

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BOREHOLE LOG

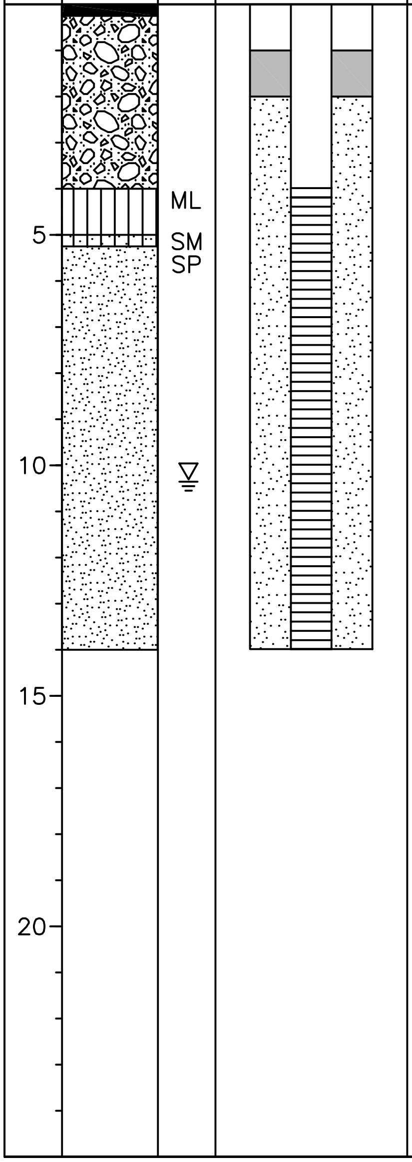
Site Id: MW-7
Page 1 of 1

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.32'

Total Depth: 14.00'
Completed Depth: 14.00'
Borehole Dia.: 2.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 4.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 4.00'	to: 14.00'
Annular Fill: type: Bentonite Chips			fm: 1.00'	to: 2.00'
type: #2/12 Sand Filter Pack			fm: 2.00'	to: 14.00'

Depth (ft) | Graphic Log | USCS Code | Well Construction | Sample Recovery | Blow Counts | Description/Soil Classification



Asphalt, 3.0" thick.
SANDY GRAVEL (FILL): brown, coarse gravel, fill material, moist.

SANDY GRAVEL (FILL): brown, with some fine silt, moist.
SILT (ML): light brown, with some fine grained sand, firm, wet.

SILTY SAND (SM): light brown, fine grained, with fine gravel, medium dense, moist.
SAND (SP): dark and light colored, fine to medium grained, loose, moist.

SAND (SP): as above, with fine sandy silt mixed in top 2.0", soft to firm, moist.
SAND (SP): dark and light colored, fine to medium grained, loose, moist.

SAND (SP): as above.
0.5–1.0" layer of brown silt, firm, moist.

SAND (SP): as above.

SAND (SP): black, dark and light colored, fine to medium grained, loose, moist.
Total Depth – 14.0'

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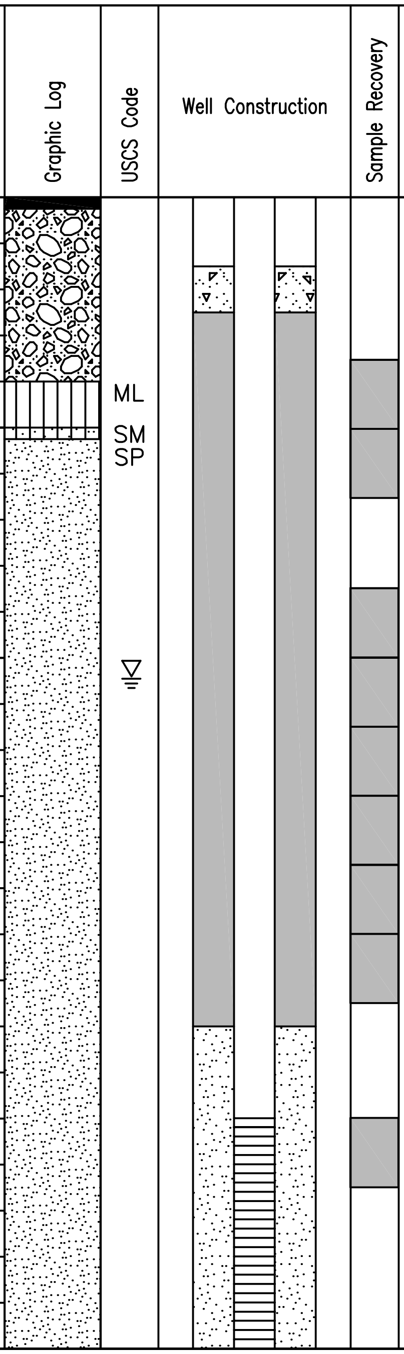
BOREHOLE LOG

Site Id: MW-8
Page 1 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.42'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 2.00in

Blank Casing:				
type: PVC		dia: 2.00in	fm: 0.0'	to: 20.00'
Screens:				
type: Slotted	size: 0.010in	dia: 2.00in	fm: 20.00'	to: 30.00'
Annular Fill:				
type: Concrete			fm: 1.0'	to: 2.50'
type: Bentonite Chips			fm: 2.50'	to: 18.00'
type: #2/12 Sand Filter Pack			fm: 18.00'	to: 30.00'



Depth (ft)	USCS Code	Blow Counts	Description/Soil Classification
			Asphalt, 3.0" thick.
			SANDY GRAVEL (FILL): brown, coarse gravel, fill material, moist.
		6	SANDY GRAVEL (FILL): brown, with some fine silt, moist.
	ML	3	SILT (ML): light brown, with some fine grained sand, firm, wet.
		4	
5	SM	6	SILTY SAND (SM): light brown, fine grained, with fine gravel, medium dense, moist.
	SP	6	SAND (SP): dark and light colored, fine to medium grained, loose, moist.
		7	
		7	SAND (SP): as above, with fine sandy silt mixed in top 2.0", soft to firm, moist.
		7	SAND (SP): dark and light colored, fine to medium grained, loose, moist.
		10	
10	∇	9	SAND (SP): as above.
		14	0.5–1.0" layer of brown silt, firm, moist.
		15	
		10	SAND (SP): as above.
		10	
		10	
		10	SAND (SP): black, dark and light colored, fine to medium grained, loose, moist.
		9	
		9	In shoe, gray silt, firm, with some fine grained sand, moist.
15		9	SAND (SP): black, dark and light colored, fine to medium grained, loose, moist.
		9	0.5–1.0" layer of gray silt, moist.
		8	
		11	SAND (SP): black, dark and light colored, fine to medium grained, loose, moist.
		16	0.5–1.0" layer of gray silt, firm to stiff, moist.
		17	
20		14	SAND (SP): as above.
		17	
		19	

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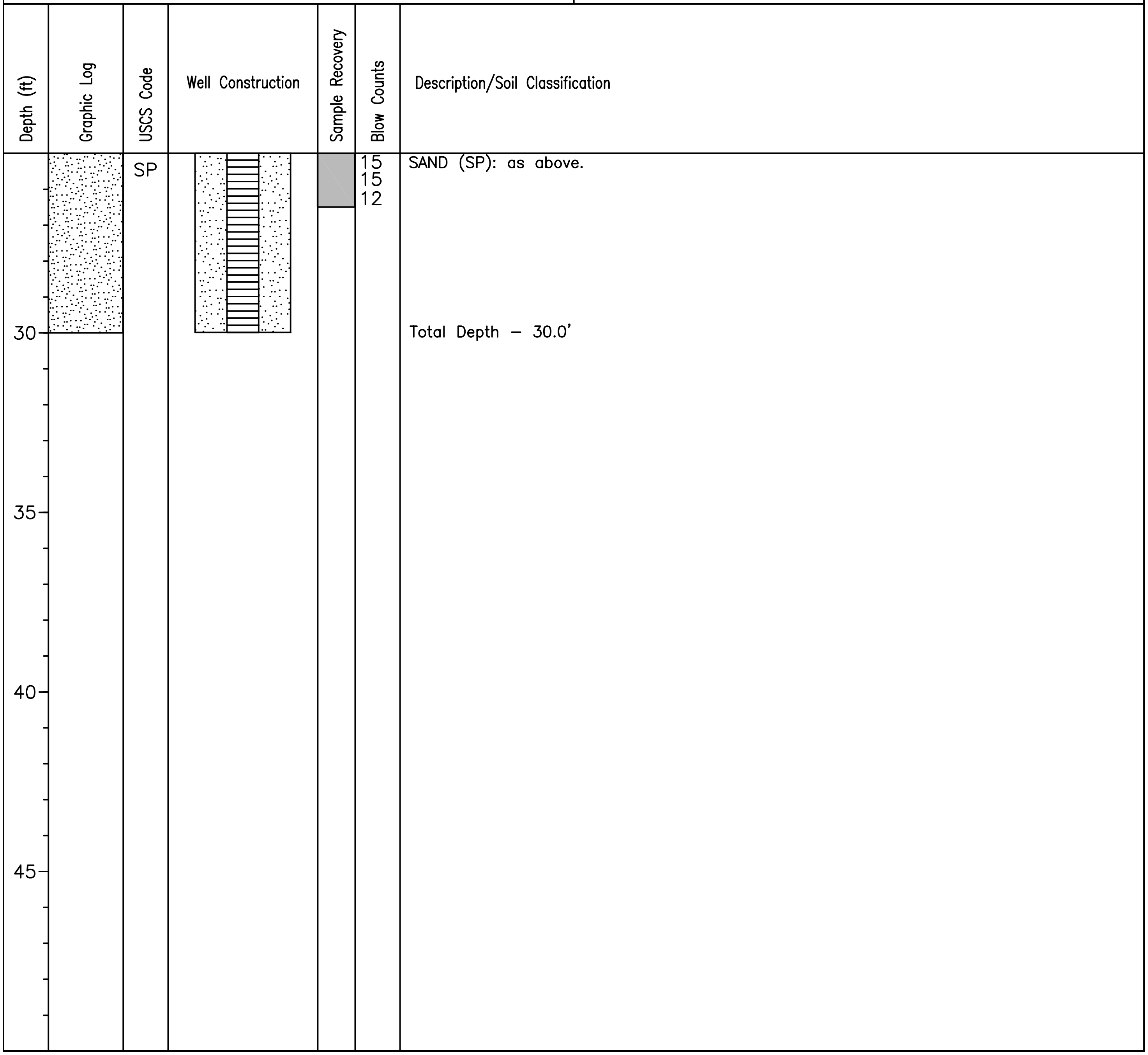
BOREHOLE LOG

Site Id: MW-8
Page 2 of 2

Project Number: 5303.12
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.42'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 2.00in

Blank Casing:				
type: PVC		dia: 2.00in	fm: 0.0'	to: 20.00'
Screens:				
type: Slotted	size: 0.010in	dia: 2.00in	fm: 20.00'	to: 30.00'
Annular Fill:				
type: Concrete			fm: 1.0'	to: 2.50'
type: Bentonite Chips			fm: 2.50'	to: 18.00'
type: #2/12 Sand Filter Pack			fm: 18.00'	to: 30.00'



Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	Description/Soil Classification
		SP			15 15 12	SAND (SP): as above.
30						Total Depth – 30.0'
35						
40						
45						

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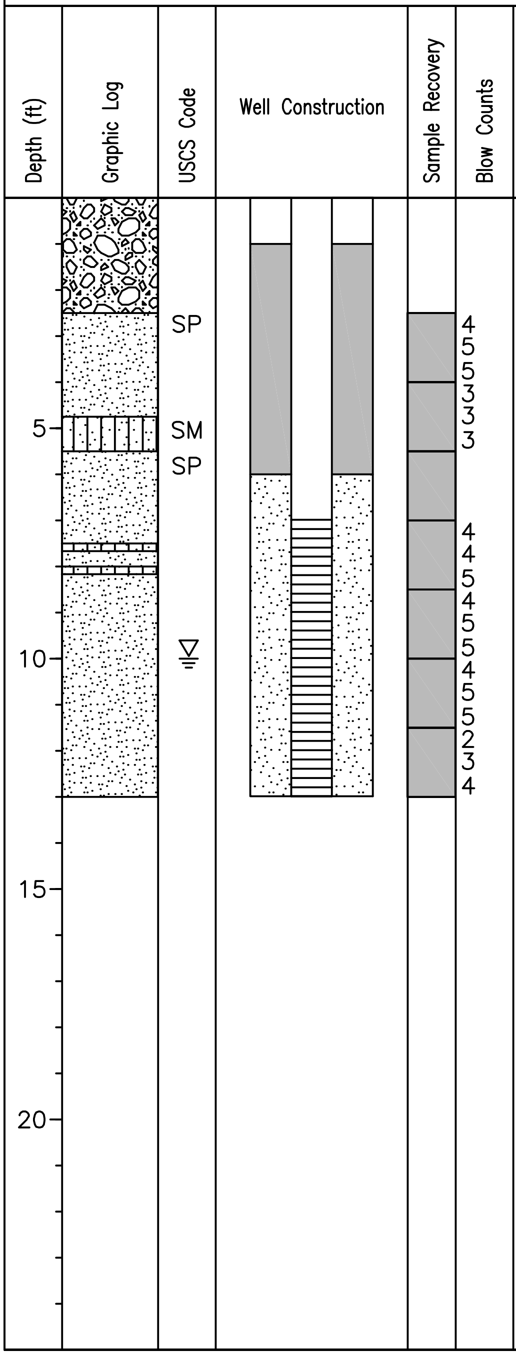
BOREHOLE LOG

Site Id: MW-9
Page 1 of 1

Project Number: 0021460.63
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 08/15/05
Initial Water Level: 10.00'

Total Depth: 13.00'
Completed Depth: 13.00'
Borehole Dia.: 8.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 8.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 8.00'	to: 13.00'
Annular Fill: type: Bentonite Cement			fm: 1.00'	to: 6.00'
type: RMC Pacific #2/12			fm: 6.00'	to: 13.00'



Description/Soil Classification

SANDY GRAVEL (FILL): industrial fill, rocks.

SAND (SP): brown, very fine grained, loose, trace silt, dry to slightly moist.

SAND (SP): brown, very fine grained, loose, slightly moist.

SILTY SAND (SM): brown, very fine, loose, slightly moist (silt decreasing with depth).

SAND (SP): gray, white speckles, fine to medium grained, slightly moist.

SAND (SP): brown to gray, white speckles, fine to medium grained, slightly moist.
2" SILTY SAND (SM): brown, fine grained, slightly moist.
2" SILTY SAND (SM): brown, fine grained, slightly moist.
SAND (SP): black, white speckles, fine to medium grained, moist.

SAND (SP): as above, wet.

SAND (SP): black, white speckles, medium to coarse grained, wet.

SAND (SP): dark brown, white speckles, medium to coarse grained, wet.
Total Depth – 13.0'

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BOREHOLE LOG

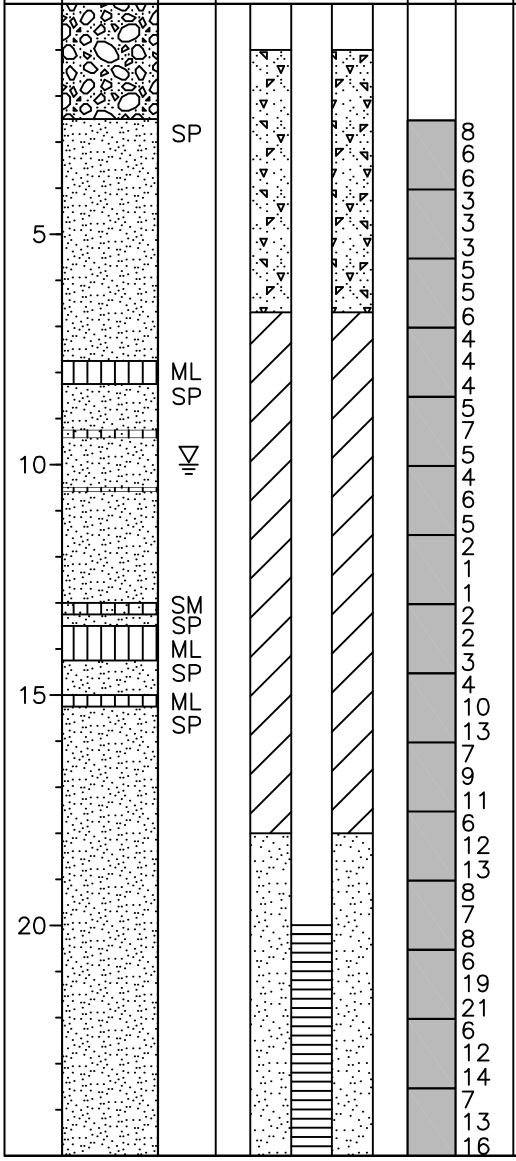
Site Id: MW-10
Page 1 of 2

Project Number: 0021460.63
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 08/15/05
Initial Water Level: 10.00'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 8.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 20.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 20.00'	to: 30.00'
Annular Fill: type: Cement			fm: 1.0'	to: 4.00'
type: Grout			fm: 4.00'	to: 18.00'
type: RMC Pacific #2/12			fm: 18.00'	to: 30.00'

Depth (ft) | Graphic Log | USCS Code | Well Construction | Sample Recovery | Blow Counts | Description/Soil Classification



Blow Counts: 8, 6, 6, 3, 3, 3, 5, 5, 6, 4, 4, 4, 5, 7, 5, 4, 6, 5, 2, 1, 1, 2, 2, 3, 4, 10, 13, 7, 9, 11, 6, 12, 13, 8, 7, 8, 6, 19, 21, 6, 12, 14, 7, 13, 16

SANDY GRAVEL (FILL): industrial fill, rocks.
SAND (SP): brown and gray, very fine grained, loose, dry to slightly moist.
SAND (SP): as above, trace silt.
SAND (SP): brown and gray, very fine grained, loose, moist.
SAND (SP): brown, very fine grained, loose, trace silt, moist.
SAND (SP): as above, no silt.
SAND (SP): gray, white speckles, fine to medium grained, loose, dry to slightly moist
SAND (SP): as above, increasing gray silt, wet.
SILT (ML): gray, soft to stiff, slightly sandy, fine grained, wet.
SAND (SP): gray, white speckles, fine to medium grained, loose, moist.
2" SILTY SAND (SM): gray, fine grained, moist.
SAND (SP): gray to black, white speckles, fine to medium grained, loose, wet.
1" SILTY SAND (SM): gray, fine grained, wet.
SAND (SP): black to dark brown, medium to coarse grained, loose, wet.
SILTY SAND (SM): gray, fine grained, loose, wet.
SAND (SP): black, medium to coarse grained, loose, wet.
SILT (ML): gray, soft to stiff, trace fine sand, wet.
SAND (SP): dark gray, fine grained, loose, trace silt, wet.
SILT (ML): gray, soft to stiff, trace fine sand, wet.
SAND (SP): black, white speckles, fine to medium grained, loose, wet.
Wood debris (1 – 2") at 17.5'.
Wood debris (1") at 20.5'.
Wood debris (0.5") at 22.75'.
Wood debris (2") at 23.5'.
At 24.75', 0.5–1.0" layer containing trace gray silt.

BOREHOLE LOG

Site Id: MW-10
Page 2 of 2

Project Number: 0021460.63

Project Name: Fox Avenue Building LLC

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Hollow Stem Auger

Logged By: Z. Clements

Date(s): 08/15/05

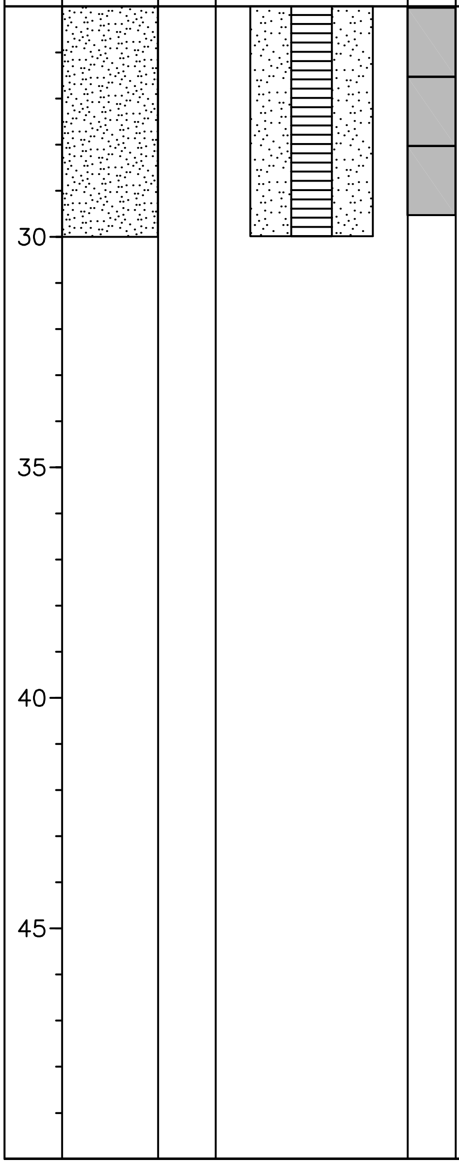
Initial Water Level: 10.00'

Total Depth: 30.00'

Completed Depth: 30.00'

Borehole Dia.: 8.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 20.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 20.00'	to: 30.00'
Annular Fill: type: Cement type: Grout type: RMC Pacific #2/12			fm: 1.0' fm: 4.00' fm: 18.00'	to: 4.00' to: 18.00' to: 30.00'



Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	Description/Soil Classification
					5 8 10	SAND (SP): as above, wood debris intermingled throughout. SAND (SP): black, white speckles, fine to coarse grained, loose, wet.
					4 9 13	
					9 10 12	In shoe, trace gray silt.
30						Total Depth – 30.0'

Mirco-Well

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Drill Date: 6/17/2009
Weather Cond.: Overcast, 60 degrees
Logged By: John LaManna
Drilled By: Noel Knopf / ESN

Boring ID: GP-81 (MW-12)

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.51
Latitude/Northing: 200719
Longitude/Easting: 1271886.4
Boring Location: Production Area

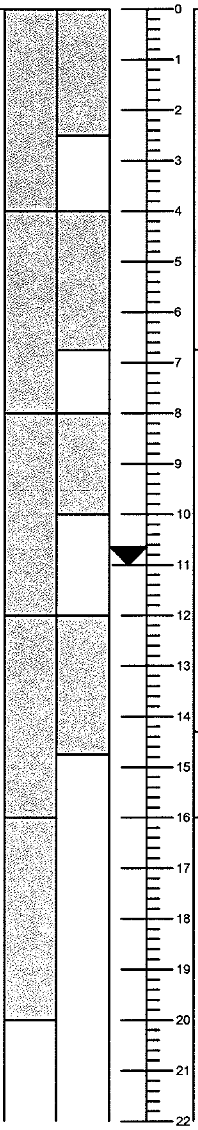
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 64'
Groundwater ATD (ft bgs): 11'

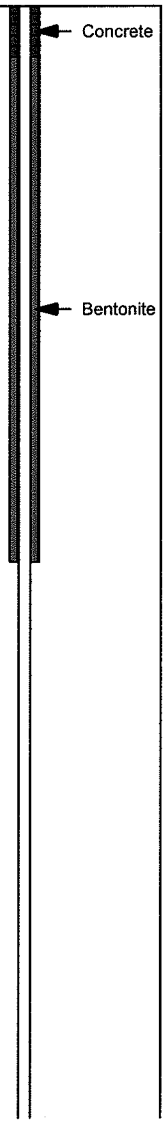
Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.

Installed 3/4" microwell (MW-12) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS	WELL COMPLETION
0.1 0.1		☒ ☒			SW	Concrete surfacing 9" thick. Light to medium brown well graded SAND with gravel, dry. (FILL)	Concrete Bentonite
0		☒			SP	Orange brownish poorly graded SAND with gravel grading to medium brown poorly graded SAND, moist.	
					SM	Medium brown poorly graded silty SAND, moist.	
					NA	Pushed to 52'. No soil samples collected.	
					NA	Pushed to 52'. No soil samples collected.	





Notes:
FT BGS = feet below ground surface
ppm = parts per million
▇ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
▇ = Permanganate Staining Observed in Sample
☒ = Soil sample
☒ = Groundwater sample via peristaltic, symbol denotes top of screen.

Micro-Well

Drill Date: 6/17/2009
Weather Cond.: Overcast, 60 degrees
Logged By: John LaManna
Drilled By: Noel Knopf / ESN

Boring ID: GP-81 (MW-12)

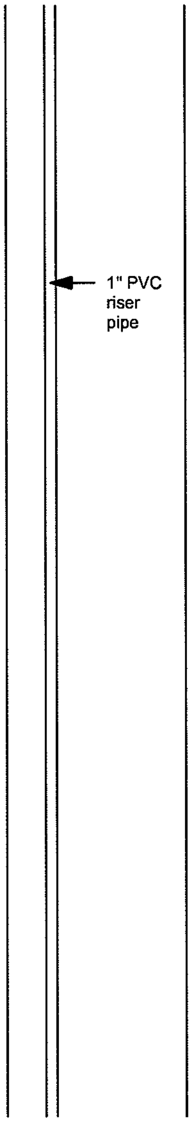
Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.51
Latitude/Northing: 200719
Longitude/Easting: 1271886.4
Boring Location: Production Area

Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 64'
Groundwater ATD (ft bgs): 11'

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.

Installed 3/4" microwell (MW-12) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS	WELL COMPLETION
				22			
				23			
				24			
				25			
				26			
				27			
				28			
				29			
				30			
				31			
				32			
				33			
				34			
				35			
				36			
				37			
				38			
				39			
				40	NA	Pushed to 52'. No soil samples collected.	
				41			
				42			
				43			
				44			

Notes:
FT BGS = feet below ground surface
ppm = parts per million
■ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
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Micro-Well

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Drill Date: 6/17/2009
Weather Cond.: Overcast, 60 degrees
Logged By: John LaManna
Drilled By: Noel Knopf / ESN
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 64'
Groundwater ATD (ft bgs): 11'

Boring ID: GP-81 (MW-12)

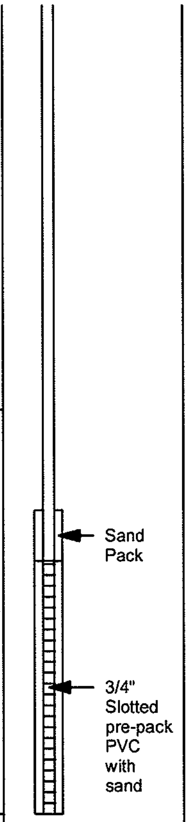
Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.51
Latitude/Northing: 200719
Longitude/Easting: 1271886.4
Boring Location: Production Area

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.

Installed 3/4" microwell (MW-12) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
			44–52		
260 16		🅂	52–56	SM/ML	Dark gray poorly graded SAND with silt grading to sandy SILT, wet. Sheen and strong odor.
16.5 0.6		🅂	56–60	ML	Dark gray poorly graded sandy SILT, moist.
4.1 0.4		🅂	60–62	SM	Dark gray fine silty SAND, low plasticity, wet.
			62–64		



Notes:
FT BGS = feet below ground surface
ppm = parts per million
■ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
■ = Permanganate Staining Observed in Sample
☒ = Soil sample
☒ = Groundwater sample via peristaltic, symbol denotes top of screen.

Microwell

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Drill Date: 6/18/2009
Weather Cond.: Overcast, 60 degrees
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 70'
Groundwater ATD (ft bgs): 12'

Boring ID: GP-77 (MW-13)

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.079
Latitude/Northing: 200616.5
Longitude/Easting: 1271844.9
Boring Location: See remarks

Remarks: PID readings via screening of split core at ambient temperature.
Between the Alkaline Shed and the Flammables Shed.
Installed 3/4" microwell (MW-13) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS	WELL COMPLETION
			0–1.5	GW	Concrete surfacing 9" thick. Brownish gray GRAVEL with sand, dry. (FILL)	Concrete
		S	1.5–5	SP/SM	Gray and brown SAND with gravel grading to reddish brown poorly graded fine SAND, moist. Trace coarse. (FILL)	
200 1000		S	5–6.2	SW/SM	Dark grayish brown SAND with gravel, moist. (FILL)	Bentonite
300			6.2–7.7	ML	Brownish gray SILT, wet.	
86		S	7.7–15.2 ▼ 12	SP	Dark grayish brown poorly graded fine SAND, moist. Dark brownish gray grades at 12' to dark reddish brown poorly graded fine SAND, moist to wet.	
1000	■	S	15.2–17	ML/SM	0.3' to 0.4' beds of SILT and SAND, wet. Dark brown oil blebs and strong odor below 15.5'.	
	■		17–20	ML	Brownish gray SILT, wet.	
1000		S	20–24	SP	Dark gray poorly graded fine SAND, wet. Strong solvent odor.	

Notes:
FT BGS = feet below ground surface
ppm = parts per million
■ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
■ = Permanganate Staining Observed in Sample
S = Soil sample
W = Groundwater sample via peristaltic, symbol denotes top of screen.

Micro-well

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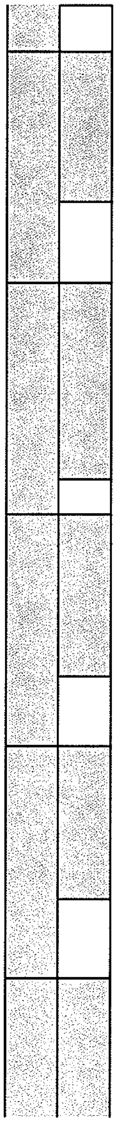
Drill Date: 6/18/2009
Weather Cond.: Overcast, 60 degrees
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 70'
Groundwater ATD (ft bgs): 12'

Boring ID: GP-77 (MW-13)

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.079
Latitude/Northing: 200616.5
Longitude/Easting: 1271844.9
Boring Location: See remarks

Remarks: PID readings via screening of split core at ambient temperature.
Between the Alkaline Shed and the Flammables Shed.
Installed 3/4" microwell (MW-13) directly after collecting soil samples at depth.



PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS	WELL COMPLETION
			24			
			25		Same as above. Coarsening downward.	
800		S	26			
			27		Silty SAND at 26.5'. Strong solvent odor.	
			28			
			29			
			30		Same as above.	
300		S	31			
			32			1" PVC riser pipe
			33			
			34			
			35			
			36			
			37		2" lense of SILT at 36.5'. Solvent odor.	
10		S	38			
			39			
			40		Same as above. Solvent odor.	
			41			
			42			
			43	ML/SM	Dark gray sandy SILT grading to silty SAND.	
			44			
		S	45	SP	Dark gray poorly graded fine SAND, wet. Trace rip-up clasts. Strong solvent odor.	
30			46			
			47			
			48			

Notes:
FT BGS = feet below ground surface
ppm = parts per million
■ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
■ = Permanganate Staining Observed in Sample
S = Soil sample
W = Groundwater sample via peristaltic, symbol denotes top of screen.

Micro-well

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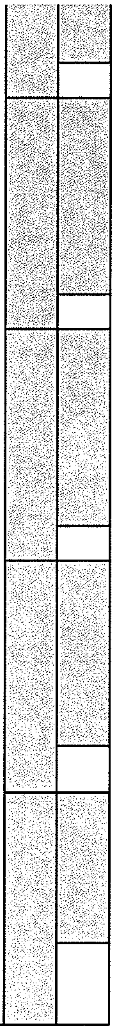
Coordinate System: NAD83/98 NAVD88	**Drill Date:** 6/18/2009	**Boring ID: GP-77 (MW-13)**
Ground Surface Elevation: 21.079	**Weather Cond.:** Overcast, 60 degrees	**Client:** Fox Avenue LLC
Latitude/Northing: 200616.5	**Logged By:** John LaManna	**Project:** Add'l Source Geoprobes
Longitude/Easting: 1271844.9	**Drilled By:** Kasey Goble / Cascade	**Task:** T5: FS DGI
Boring Location: See remarks	**Drill Type:** Direct Push Geoprobe	**Address:** 6900 Fox Avenue Seattle, WA
	Sample Method: direct push 2"x5' core	
	Boring Diameter: 2"	
	Boring Depth (ft bgs): 70'	
	Groundwater ATD (ft bgs): 12'	

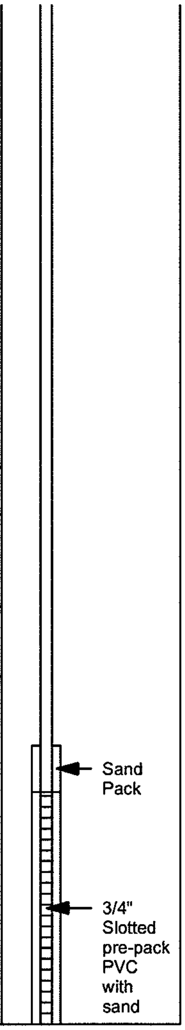
Remarks: PID readings via screening of split core at ambient temperature.
Between the Alkaline Shed and the Flammables Shed.
Installed 3/4" microwell (MW-13) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
10 20			48 49 50 51 52 53 54		Same as above. Slight odor.
3.6		☒S	55 56 57	SM/ML	Dark gray silty fine SAND, wet grading to dark gray sandy SILT, wet.
16			58	SP	Dark gray poorly graded fine SAND, wet.
3		☒S	59 60	ML	Gray sandy SILT, wet.
1			61 62	SP	Dark gray poorly graded fine SAND, wet.
0.5			63 64 65	SM/ML	Silty fine SAND grading to silty SAND.
3.3 3		☒S	66 67 68 69 70	SP	Dark gray poorly graded fine SAND, wet.

DRIVEN / RECOVERED



WELL COMPLETION



Notes:
FT BGS = feet below ground surface
ppm = parts per million
■ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
■ = Permanganate Staining Observed in Sample
☒S = Soil sample
☒W = Groundwater sample via peristaltic, symbol denotes top of screen.

Micro-well

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Drill Date: 6/22/2009
Weather Cond.: Sunny, 70 degrees
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade

Boring ID: GP-80A (MW-14)

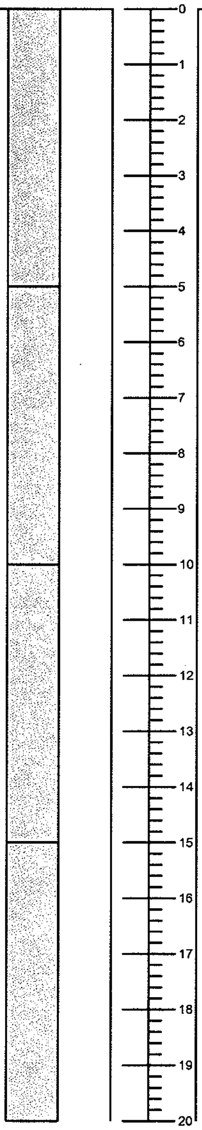
Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.1
Latitude/Northing: 200646.6
Longitude/Easting: 1271733.5
Boring Location: In Alkaline Shed

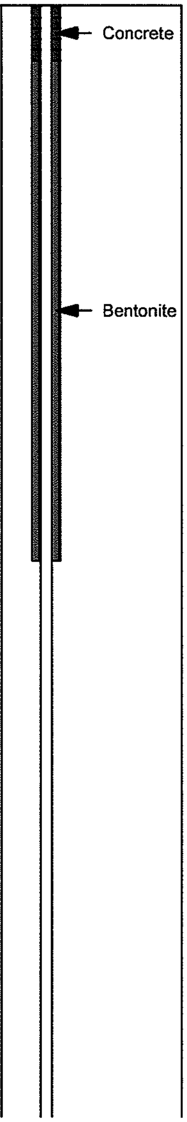
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 60'
Groundwater ATD (ft bgs): NA

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.
Located 2' NW of GP-80
Installed 3/4" microwell (MW-14) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS	WELL COMPLETION
					NA	See log GP-80 for geology.	





Notes:
FT BGS = feet below ground surface
ppm = parts per million
■ = NAPL Observed in Sample
--- Dashed contact line in soil description indicates a gradational or unknown contact
USCS = Unified Soil Classification System
▼ = groundwater table at time of drilling
■ = Permanganate Staining Observed in Sample
☒ = Soil sample
☒ = Groundwater sample via peristaltic, symbol denotes top of screen.

Microwell

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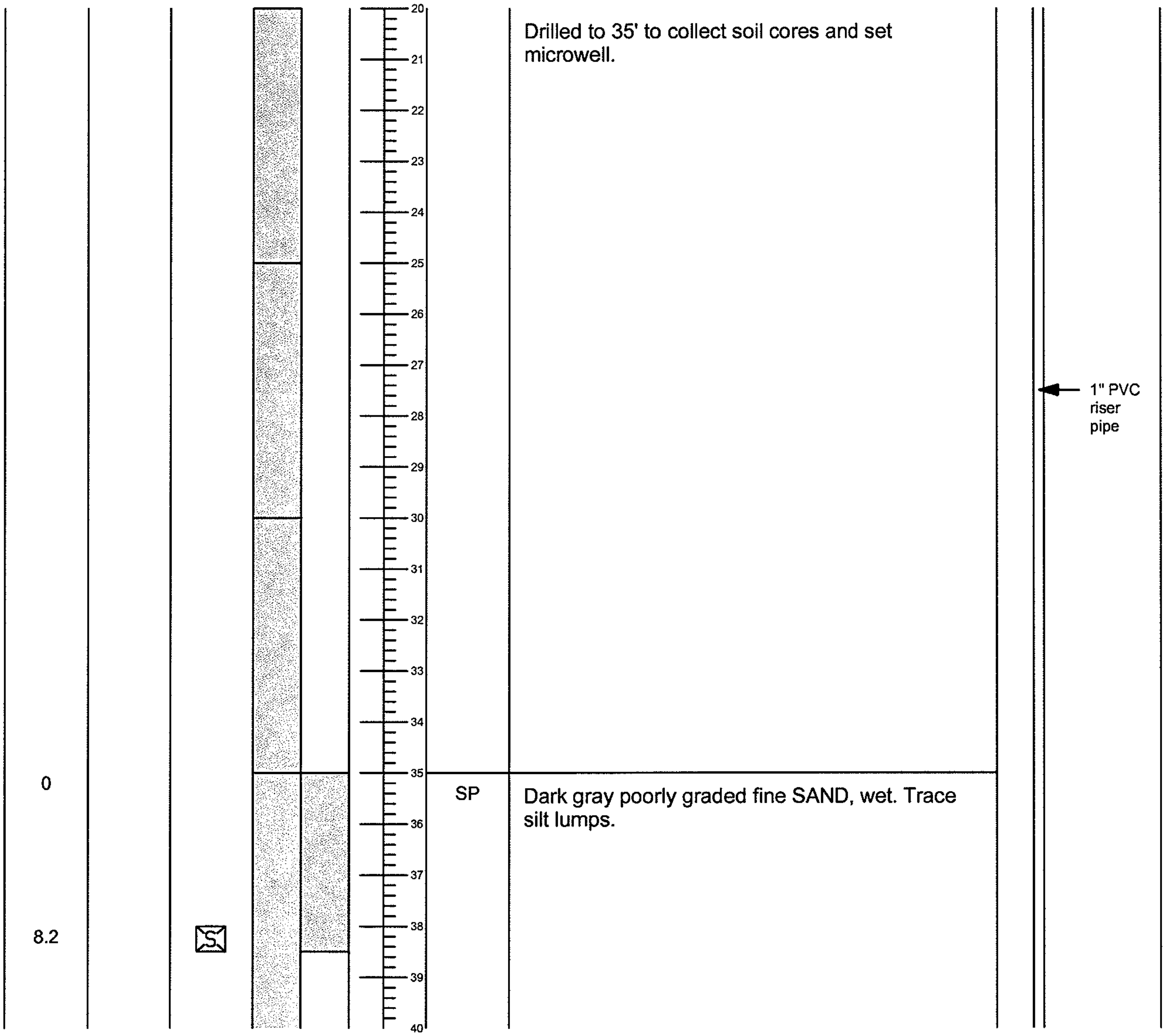
Drill Date: 6/22/2009
Weather Cond.: Sunny, 70 degrees
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 60'
Groundwater ATD (ft bgs): NA

Boring ID: GP-80A (MW-14)

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.1
Latitude/Northing: 200646.6
Longitude/Easting: 1271733.5
Boring Location: In Alkaline Shed

Remarks: PID readings via screening of split core at ambient temperature.
Located 2' NW of GP-80
Installed 3/4" microwell (MW-14) directly after collecting soil samples at depth.



PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS	WELL COMPLETION
				20		Drilled to 35' to collect soil cores and set microwell.	1" PVC riser pipe
0				35	SP	Dark gray poorly graded fine SAND, wet. Trace silt lumps.	
8.2		☒		38			

Notes:
FT BGS = feet below ground surface
ppm = parts per million
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☒ = Groundwater sample via peristaltic, symbol denotes top of screen.
■ = NAPL Observed in Sample
■ = Permanganate Staining Observed in Sample

Microwell

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Drill Date: 6/22/2009
Weather Cond.: Sunny, 70 degrees
Logged By: John LaManna
Drilled By: Kasey Goble / Cascade
Drill Type: Direct Push Geoprobe
Sample Method: direct push 2"x5' core
Boring Diameter: 2"
Boring Depth (ft bgs): 60'
Groundwater ATD (ft bgs): NA

Boring ID: GP-80A (MW-14)

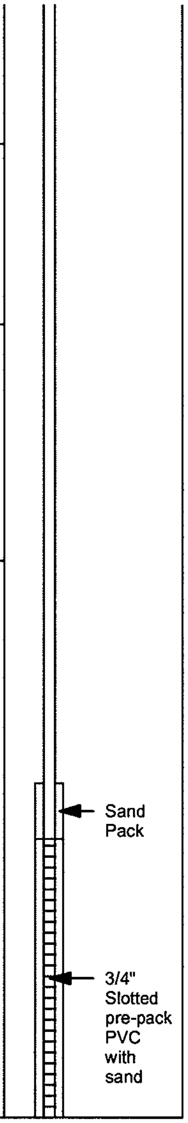
Coordinate System: NAD83/98 NAVD88
Ground Surface Elevation: 21.1
Latitude/Northing: 200646.6
Longitude/Easting: 1271733.5
Boring Location: In Alkaline Shed

Client: Fox Avenue LLC
Project: Add'l Source Geoprobes
Task: T5: FS DGI
Address: 6900 Fox Avenue
Seattle, WA

Remarks: PID readings via screening of split core at ambient temperature.
Located 2' NW of GP-80
Installed 3/4" microwell (MW-14) directly after collecting soil samples at depth.

PID (ppm)	NAPL and PERMANG. INDICAT.	SAMPLE COLLECTED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS
			40		
40		☒	41		
			42		
18			43	SM	Dark gray silty fine SAND, wet. Trace peat.
			44		
23			45		
60		☒	46	SP/SM	2" lense dark gray SILT at 46'. Dark gray poorly graded fine SAND grading to silty fine SAND, wet.
16			47		
			48		
			49		Resistivity sample from 49' to 49.5'
			50	SP	Dark gray poorly graded fine SAND, wet.
			51		
2		☒	52		Peat layers. Slight chemical odor noted.
			53		
			54		
			55		
			56		
6.8		☒	57		
			58		SILT layer at 57.5'. Resistivity sample from 58' to 59'
			59		
			60		

WELL COMPLETION



Notes:
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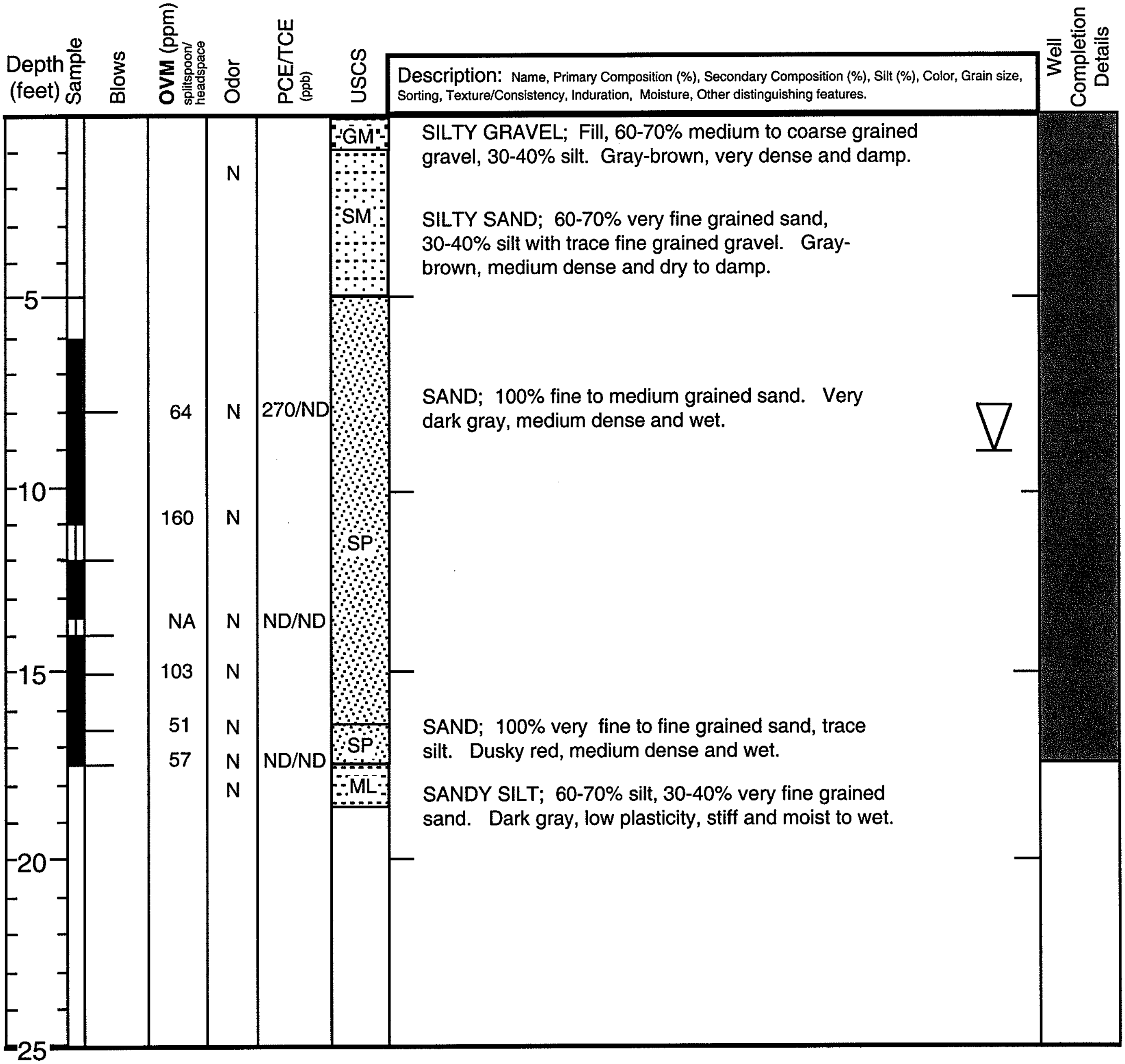
TERRA VAC

Date Drilled: 7/13/00 **Boring/Well Number:** NW-1 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 17.8 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 15-17.5 feet



OVM (ppm) splitspoon/headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
			GM	SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 30-40% silt. Gray-brown, very dense and damp.
	N		SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt with trace fine grained gravel. Gray-brown, medium dense and dry to damp.
64	N	270/ND	SP	SAND; 100% fine to medium grained sand. Very dark gray, medium dense and wet.
160	N			
NA	N	ND/ND		
103	N			
51	N		SP	SAND; 100% very fine to fine grained sand, trace silt. Dusky red, medium dense and wet.
57	N	ND/ND		
	N		ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Dark gray, low plasticity, stiff and moist to wet.

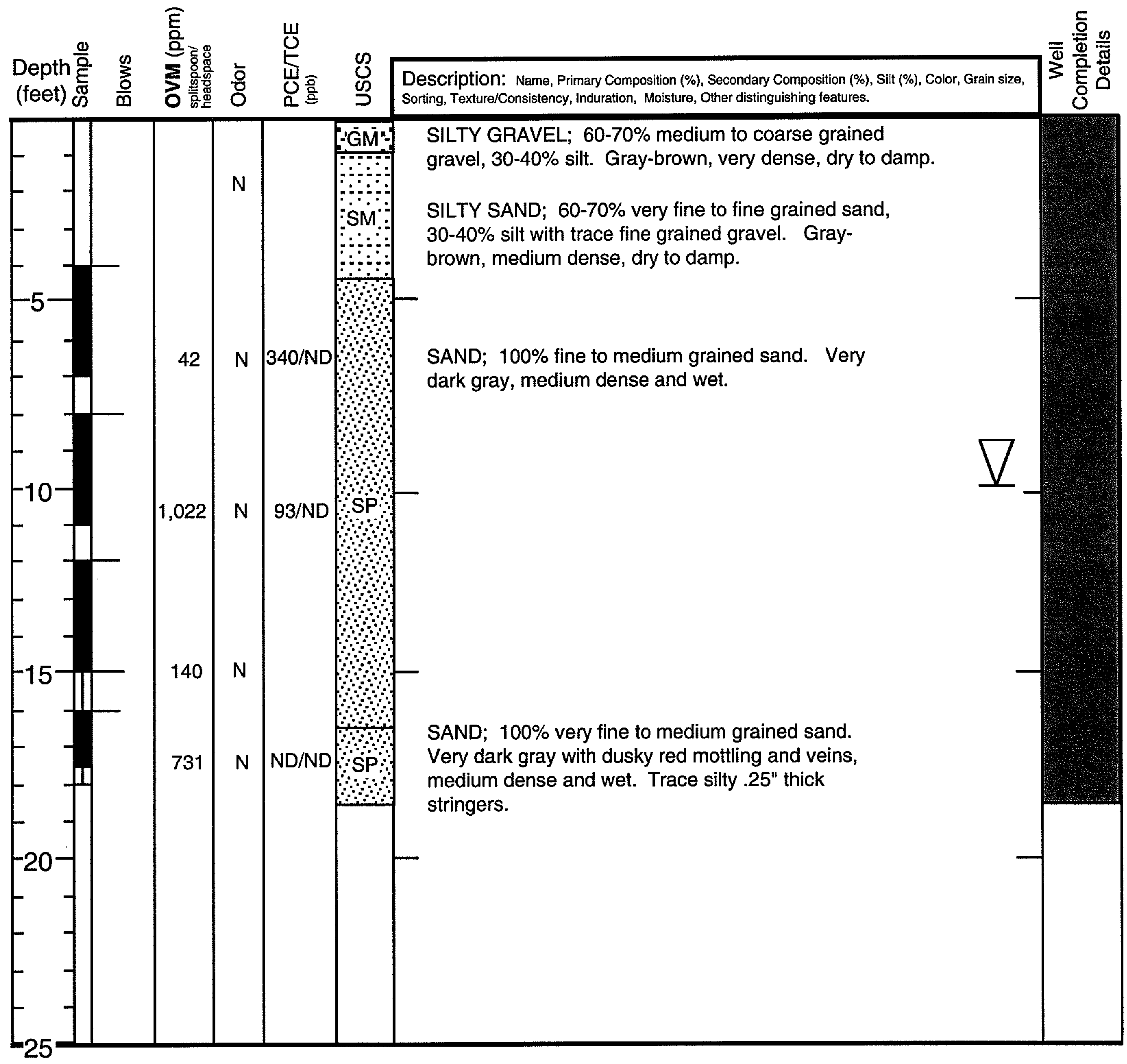
General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion (ppb).
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/13/00 **Boring/Well Number:** NW-2 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 18.3 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: NA Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 15.5-18 feet



SILTY GRAVEL; 60-70% medium to coarse grained gravel, 30-40% silt. Gray-brown, very dense, dry to damp.

SILTY SAND; 60-70% very fine to fine grained sand, 30-40% silt with trace fine grained gravel. Gray-brown, medium dense, dry to damp.

SAND; 100% fine to medium grained sand. Very dark gray, medium dense and wet.

SAND; 100% very fine to medium grained sand. Very dark gray with dusky red mottling and veins, medium dense and wet. Trace silty .25" thick stringers.

General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion (ppb).
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/13/00 **Boring/Well Number:** NW-3 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 18.3 feet Depth to Groundwater: Approx. 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 15.5-18 feet

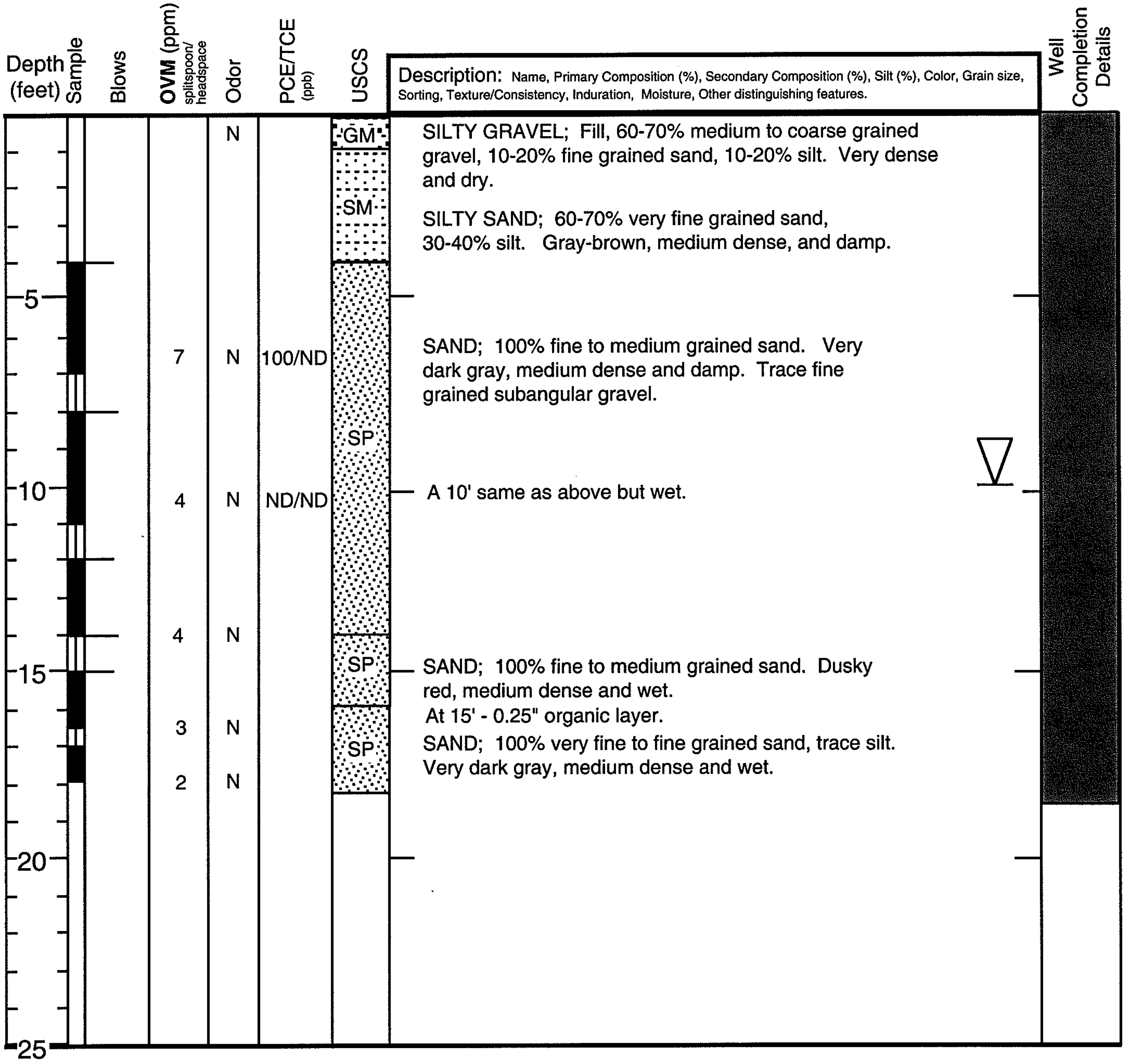
Depth (feet)	Sample	Blows	OVM (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
				N		GM	SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 10-20% silt sand, 10-20% silt. Gray-brown, very dense and dry.	
						SM	SILTY SAND; 60-70% silt, 30-40% very fine grained sand. Gray-brown, medium dense and damp.	
5								
			1,020	N	61/ND			
						SP	SAND; 100% fine to medium grained sand. Very dark gray, medium dense and wet.	∇
10							At 10.5' trace fine grained subrounded gravel.	
			1,003	N	74/ND			
15			180	N	ND/ND	SP	SAND; 100% very fine to fine grained sand. Very dark gray, medium dense and wet.	
			236	N				
20								
25								

General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion (ppb).
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

TERRA VAC

Date Drilled: 7/13/00 **Boring/Well Number:** NW-4 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 18.3 feet Depth to Groundwater: Approx. 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 15.5-18 feet



Depth (feet)	Sample	Blows	OVM (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
				N		GM	SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 10-20% fine grained sand, 10-20% silt. Very dense and dry.	
						SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Gray-brown, medium dense, and damp.	
5								
			7	N	100/ND	SP	SAND; 100% fine to medium grained sand. Very dark gray, medium dense and damp. Trace fine grained subangular gravel.	
10			4	N	ND/ND		A 10' same as above but wet.	∇
			4	N				
15						SP	SAND; 100% fine to medium grained sand. Dusky red, medium dense and wet. At 15' - 0.25" organic layer.	
			3	N		SP	SAND; 100% very fine to fine grained sand, trace silt. Very dark gray, medium dense and wet.	
			2	N				
20								
25								

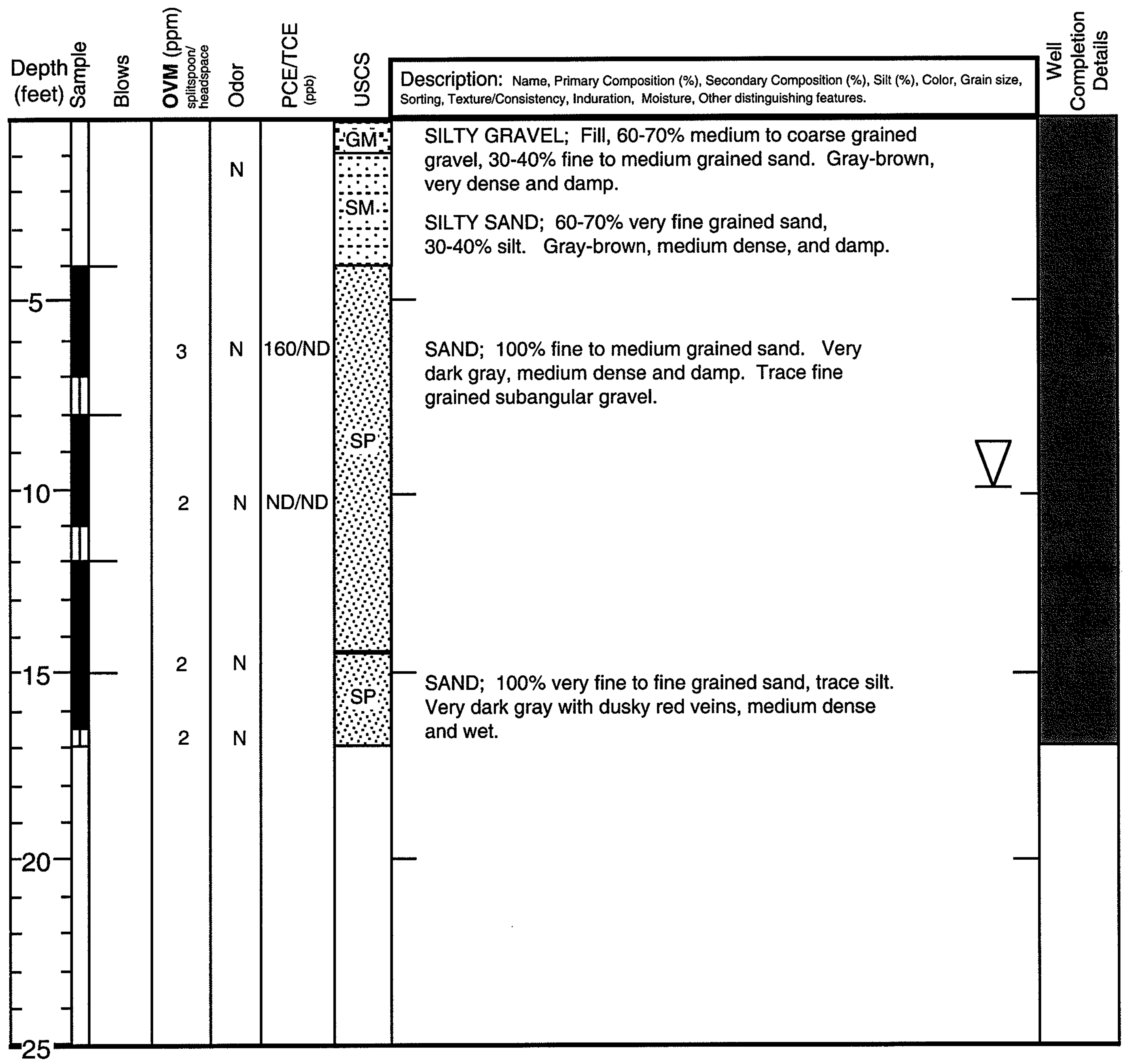
General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion (ppb).
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/13/00 **Boring/Well Number:** NW-5 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 17.3 feet Depth to Groundwater: Approx. 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 14.5-17 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 30-40% fine to medium grained sand. Gray-brown, very dense and damp.

SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Gray-brown, medium dense, and damp.

SAND; 100% fine to medium grained sand. Very dark gray, medium dense and damp. Trace fine grained subangular gravel.

SAND; 100% very fine to fine grained sand, trace silt. Very dark gray with dusky red veins, medium dense and wet.

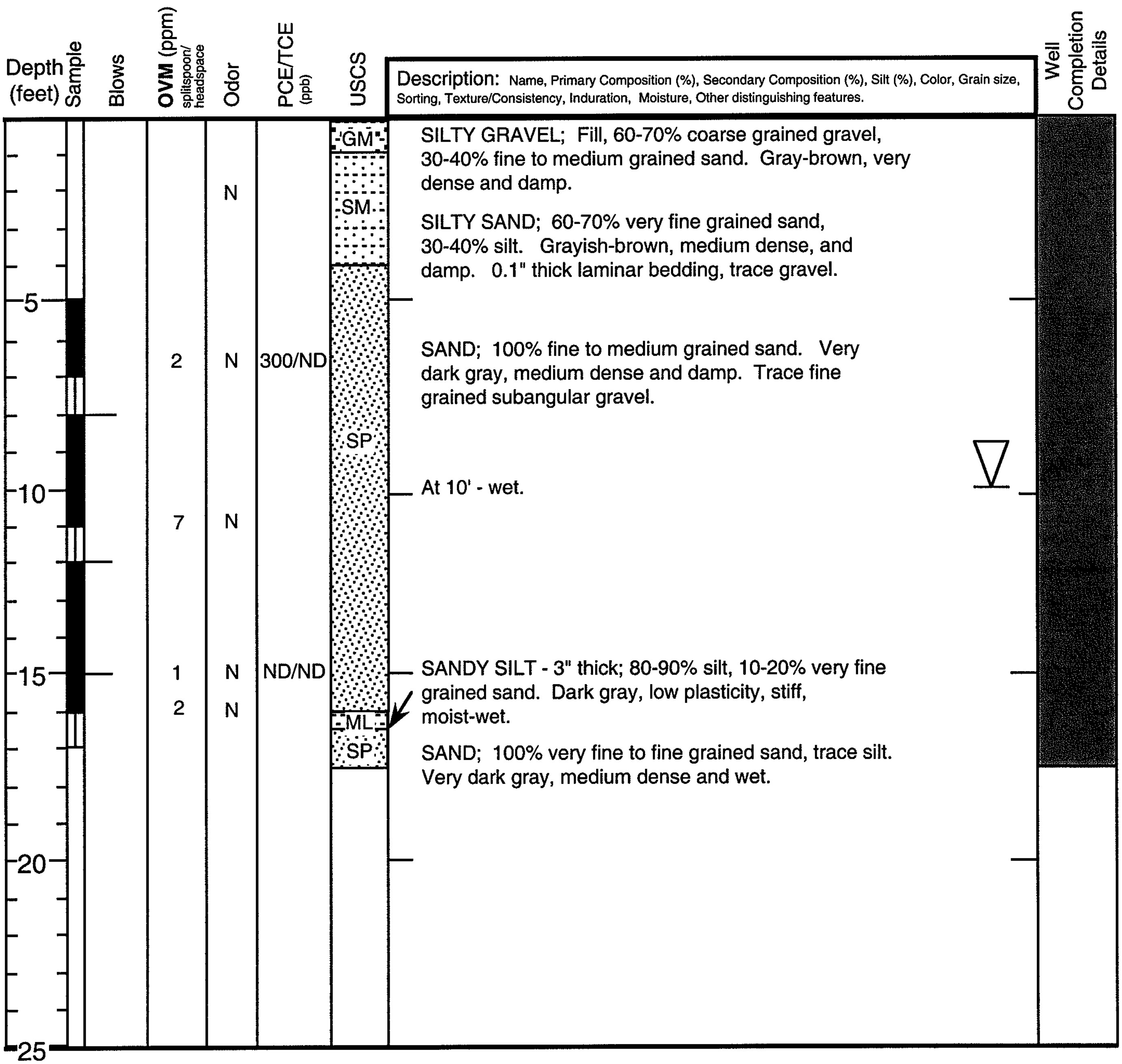
General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/13/00 **Boring/Well Number:** NW-6 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 17.3 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 13.5-16 feet



Depth (feet)	Sample	Blows	OVM (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GM	SILTY GRAVEL; Fill, 60-70% coarse grained gravel, 30-40% fine to medium grained sand. Gray-brown, very dense and damp.
				N		SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Grayish-brown, medium dense, and damp. 0.1" thick laminar bedding, trace gravel.
			2	N	300/ND	SP	SAND; 100% fine to medium grained sand. Very dark gray, medium dense and damp. Trace fine grained subangular gravel.
10							At 10' - wet.
			7	N			
15			1	N	ND/ND		
			2	N		ML	SANDY SILT - 3" thick; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, stiff, moist-wet.
						SP	SAND; 100% very fine to fine grained sand, trace silt. Very dark gray, medium dense and wet.

General Remarks:
- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/14/00 **Boring/Well Number:** NW-7 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 17.3 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 15-17.5 feet

Depth (feet)	Sample	Blows	**OVM** (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
						GM	SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 30-40% silt. Gray-brown, very dense and damp.	
				N		SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt, trace fine grained gravel. Gray-brown, medium dense, and dry to damp.	
5								
			1	N	86/ND	SP	SAND; 100% fine to medium grained sand. Very dark gray, medium dense and damp-wet.	
10							At 10' wet.	▽
			0	N	200/ND		4" thick very fine grained sandy silt bed. Light gray.	
						SP	SAND; 100% fine to medium grained sand. Dark gray, medium dense and wet.	
15			0	N				
			1	N	ND/ND	ML	SANDY SILT - 60-70% silt, 30-40% very fine grained sand. Dark gray, low plasticity, stiff, moist-wet.	
20								
25								

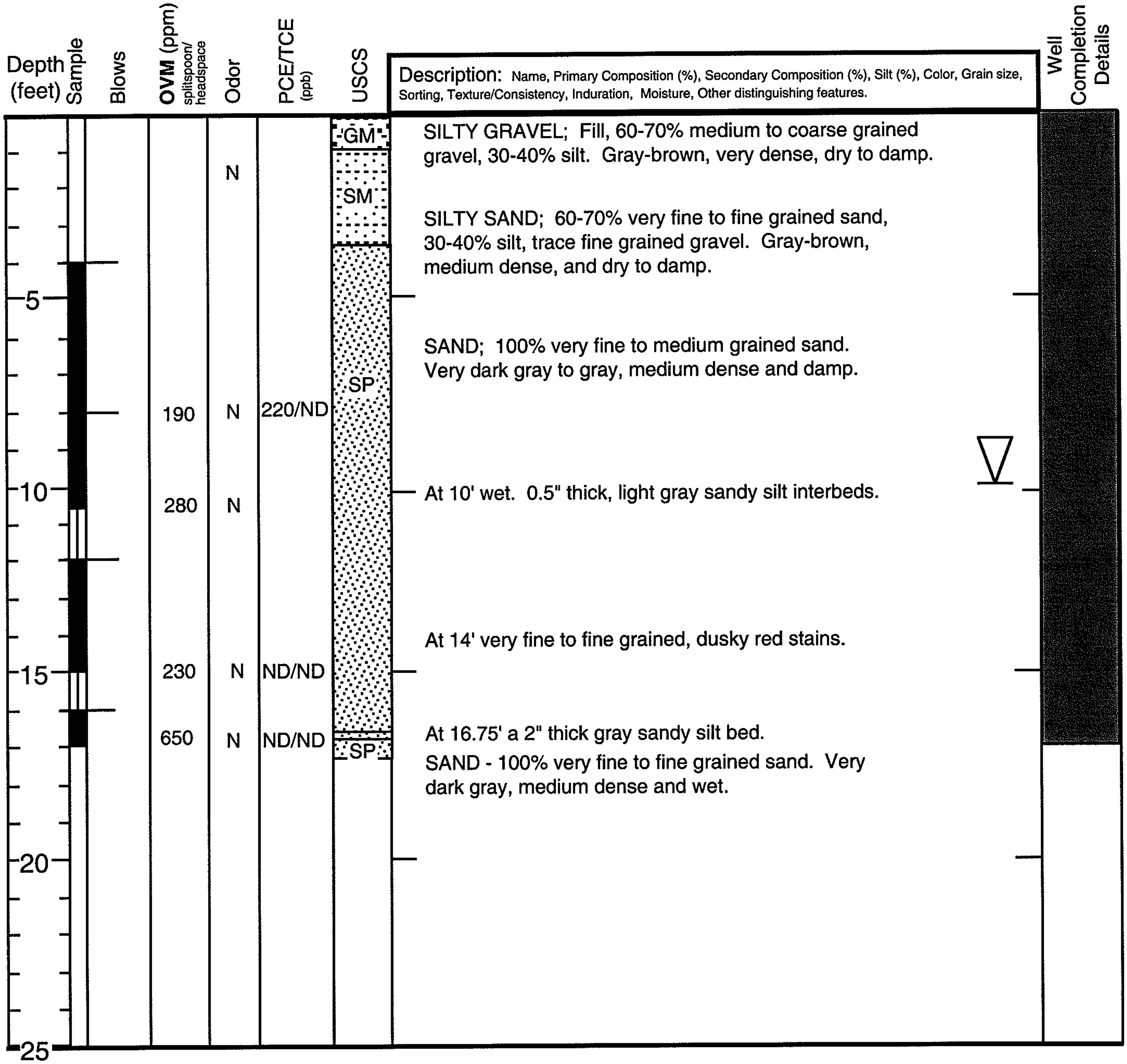
General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/14/00 **Boring/Well Number:** NW-8 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 17.3 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 15.5-17 feet



OVM (ppm)	Odor	PCE/TCE (ppb)
	N	
190	N	220/ND
280	N	
230	N	ND/ND
650	N	ND/ND

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 30-40% silt. Gray-brown, very dense, dry to damp.

SILTY SAND; 60-70% very fine to fine grained sand, 30-40% silt, trace fine grained gravel. Gray-brown, medium dense, and dry to damp.

SAND; 100% very fine to medium grained sand. Very dark gray to gray, medium dense and damp.

At 10' wet. 0.5" thick, light gray sandy silt interbeds.

At 14' very fine to fine grained, dusky red stains.

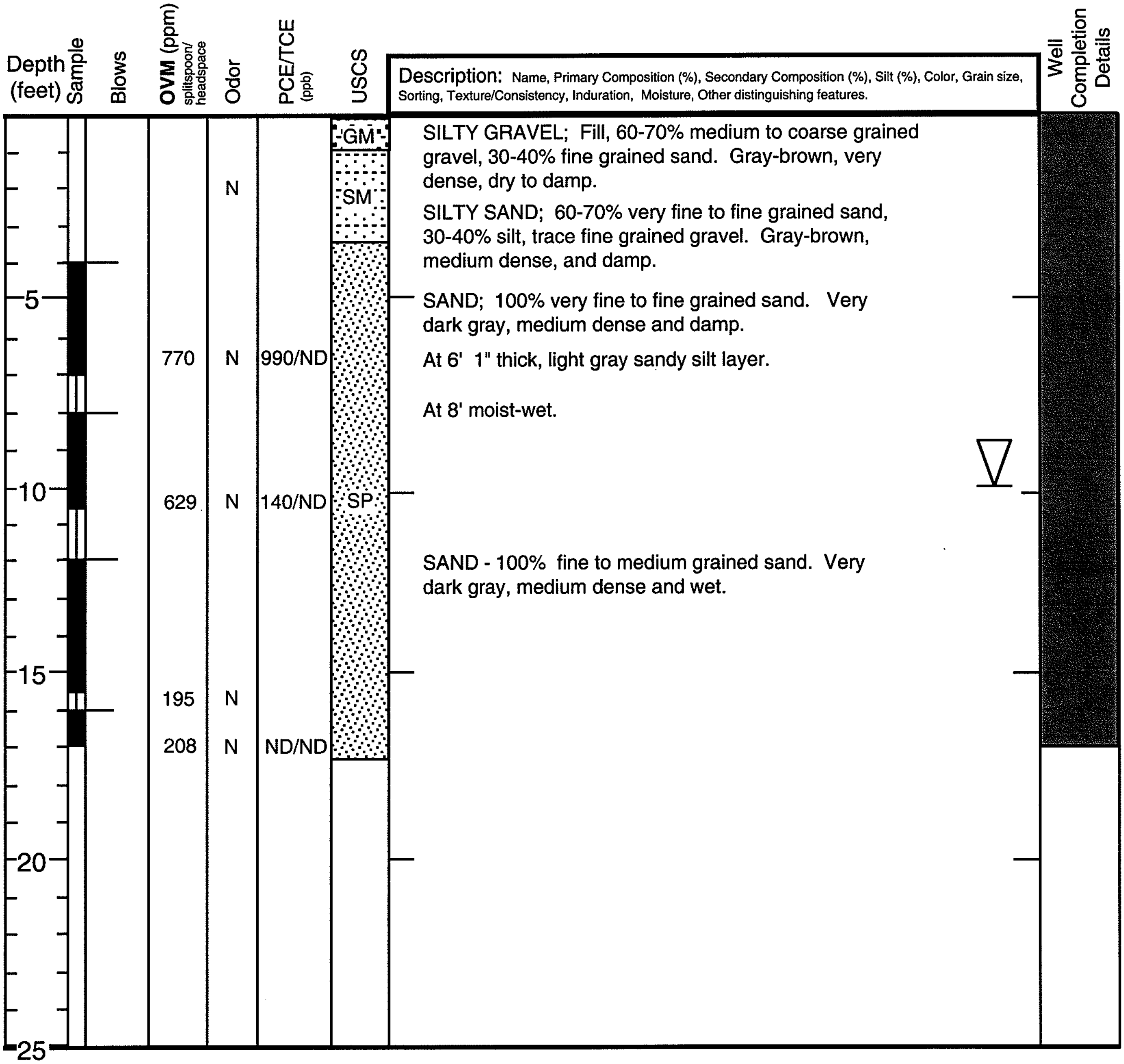
At 16.75' a 2" thick gray sandy silt bed.
SAND - 100% very fine to fine grained sand. Very dark gray, medium dense and wet.

General Remarks:
- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/14/00 **Boring/Well Number:** NW-9 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 17.3 feet Depth to Groundwater: Approx. 10 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 14.5-17 feet



Depth (feet)	Sample	Blows	OVM (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
						GM	SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 30-40% fine grained sand. Gray-brown, very dense, dry to damp.	
				N		SM	SILTY SAND; 60-70% very fine to fine grained sand, 30-40% silt, trace fine grained gravel. Gray-brown, medium dense, and damp.	
5							SAND; 100% very fine to fine grained sand. Very dark gray, medium dense and damp.	
			770	N	990/ND		At 6' 1" thick, light gray sandy silt layer.	
							At 8' moist-wet.	
10			629	N	140/ND	SP		∇
							SAND - 100% fine to medium grained sand. Very dark gray, medium dense and wet.	
15								
			195	N				
			208	N	ND/ND			
20								
25								

General Remarks:
- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/14/00 **Boring/Well Number:** NW-10 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington 98188

Drilling Contractor: TEG Log by: J. Orr

Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston

Total Depth: 17.3 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe

Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 14.5-17 feet

Depth (feet)	Sample	Blows	OVM (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
						GM	SILTY GRAVEL; Fill, 60-70% medium to coarse grained gravel, 30-40% fine grained sand. Gray-brown, very dense, dry to damp.	
				N		SM	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Gray-brown, medium dense, and damp.	
5			1211	N	680/ND	SP	SAND; 100% fine to medium grained sand. Very dark gray, medium dense and damp to moist. Trace fine grained subangular gravel.	
						SP	At 12' same as above with trace coarse grained sand and subangular fine grained gravel.	▽
10			1301	N		SP	SAND - 100% very fine to fine grained sand, trace silt. Very dark gray, medium dense and wet.	
15			937	N	ND/ND	SP	SAND - 100% very fine to fine grained sand. Dusky red, medium dense and wet.	
			1311	N	ND/ND	SP	SAND - 100% very fine to fine grained sand, trace silt. Very dark gray, medium dense and wet.	
20								
25								

General Remarks:

- PCE/TCE = Concentrations analyzed using EPA Method 8260 for volatiles in parts per billion.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

TERRA VAC

Date Drilled: 7/14/00 **Boring/Well Number:** NW-11 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 16.3 feet Depth to Groundwater: 6' and 11' feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 13.5-16 feet

Depth (feet)	Sample	Blows	OVM (ppm) splitspoon/ headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
						GM	SILTY GRAVEL; Fill, 60-70% coarse grained gravel, 30-40% fine to medium grained sand. Gray-brown, very dense and damp.	
				N		SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Gray-brown, medium dense, damp.	
5								▽
			6	N	1,600/ ND	SP	At 6' pearched water. Wet. SAND; 100% fine to medium grained sand. Very dark gray, medium dense, moist to damp. Trace fine grained angular gravel.	
10			72	N	ND/ND	SP	At 11' wet. Same as above.	▽
15			58	N	ND/ND		At 15' trace dusky red veins.	
			102	N		ML	SANDY SILT; - 60-70% silt, 30-40% very fine grained sand, trace clay. Low plasticity, yellow-brown, stiff and moist. Trace organics - wood fragments.	
20								
25								

General Remarks:

- PCE/TCE = Concentrations analyzed using Method 8260 for volatiles in parts per billion (ppb).
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

ERM
915 118th Avenue SE
Suite 130
Bellevue, WA 98005
(425) 462-8591

BOREHOLE LOG

Site Id: NW1-1
Page 1 of 1

Project Number: 0021460.51

Project Name: Fox Avenue

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Hollow Stem Auger

Logged By: M. Alves

Date(s): 11/08/04

Initial Water Level: NA

Total Depth: 14.00'

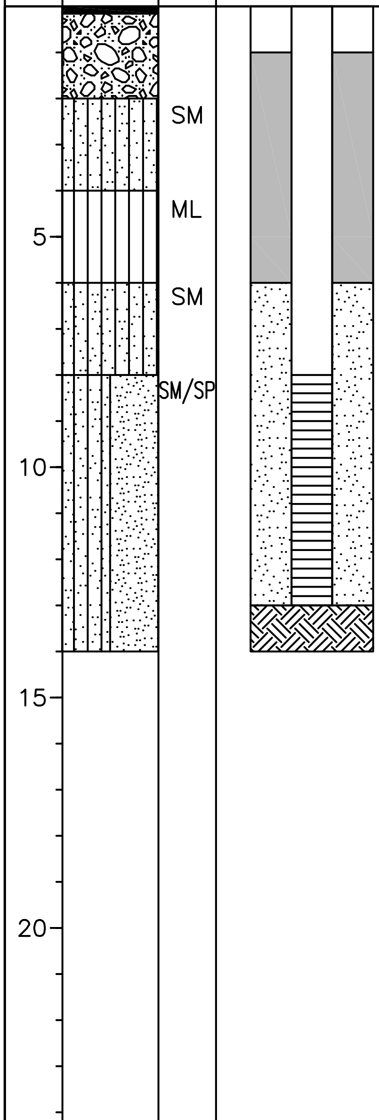
Completed Depth: 13.00'

Borehole Dia.: 8.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 8.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 8.00' to: 13.00'

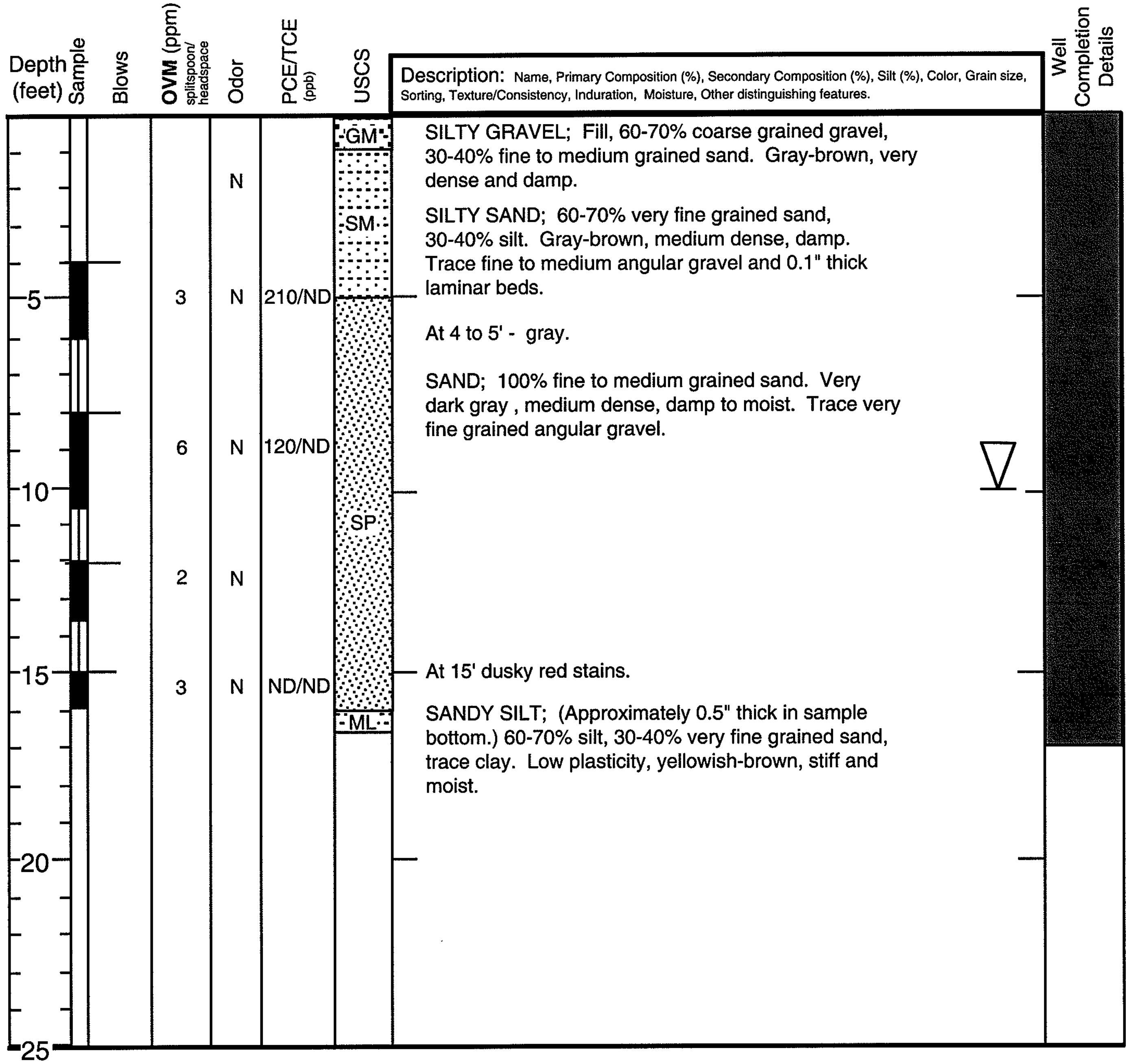
Annular Fill:
type: Bentonite Chips fm: 1.00' to: 6.00'
type: Sand Filter Pack fm: 6.00' to: 13.00'
type: Backfill fm: 13.00' to: 14.00'



USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classification
			Asphalt, 1.0-2.0".
			FILL: dark olive brown (2.5Y 3/3), gravelly sand, medium to coarse, loose, poorly sorted.
SM			SILTY SAND (SM): olive brown (2.5Y 4/3), fine grained, well sorted, dry.
ML			SILT (ML): gray and gray/brown with oxidized lenses, interbedded silty fine sands, very fine grained, well sorted, stiff, moist to wet.
SM			SILTY SAND (SM): olive brown, fine grained, loose, interbedded with finer silty sand and some clay, dry to moist.
SM/SP			SAND (SM/SP): black with brown grains (2.5YR 3/1 and 10YR 4/3), medium grained, very loose, moist.
			SAND (SM/SP): black, medium grained, wet.
			Total Depth - 14.0' bgs

TERRA VAC

Date Drilled: 7/14/00 **Boring/Well Number:** NW-12 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: TEG Log by: J. Orr
Drill Rig: Strataprobe Auger Size/Type: N/A Sample Method: Dual Tube & Piston
Total Depth: 16.3 feet Depth to Groundwater: 10' feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A - Temp. Pushed Probe
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: 13.5-16 feet



OVM (ppm)	Odor	PCE/TCE (ppb)
	N	
3	N	210/ND
6	N	120/ND
2	N	
3	N	ND/ND

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 60-70% coarse grained gravel, 30-40% fine to medium grained sand. Gray-brown, very dense and damp.

SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Gray-brown, medium dense, damp. Trace fine to medium angular gravel and 0.1" thick laminar beds.

At 4 to 5' - gray.

SAND; 100% fine to medium grained sand. Very dark gray , medium dense, damp to moist. Trace very fine grained angular gravel.

At 15' dusky red stains.

SANDY SILT; (Approximately 0.5" thick in sample bottom.) 60-70% silt, 30-40% very fine grained sand, trace clay. Low plasticity, yellowish-brown, stiff and moist.

General Remarks:

- PCE/TCE = Concentrations analyzed using Method 8260 for volatiles in parts per billion (ppb).
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

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BOREHOLE LOG

Site Id: NW1-2
Page 1 of 1

Project Number: 0021460.51
Project Name: Fox Avenue
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: M. Alves
Date(s): 11/08/04
Initial Water Level: 10.59'

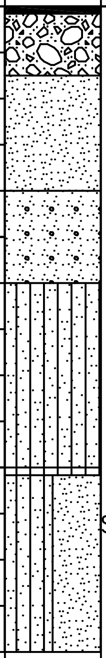
Total Depth: 14.00'
Completed Depth: 13.00'
Borehole Dia.: 8.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 8.00'

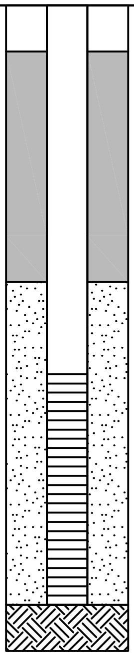
Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 8.00' to: 13.00'

Annular Fill:
type: Bentonite Chips fm: 1.00' to: 6.00'
type: Sand Filter Pack fm: 6.00' to: 13.00'
type: Backfill fm: 13.00' to: 14.00'

Graphic Log



Well Construction



Depth (ft)	USCS Code	Sample Recovery	PID (ppm)	Description/Soil Classification
				Asphalt, 1.0–2.0".
				FILL: Gravelly sand, dark olive brown (2.5Y 3/3), medium to coarse gravels, angular and broken, loose, well graded.
	SP		0.0	SAND (SP): dark yellowish brown (10YR 4/3), medium grained, poorly graded, with some rounded gravels (1/4" to 2.0"), loose.
			0.0	
	SW		0.0	SAND (SW): olive brown (2.5Y 4/3), very fine to medium grained, silty, with gravel (1/4" to 2.0"), well graded.
5			0.0	
	SM		0.0	SAND (SM): light olive brown to yellowish brown, fine to medium grained, some gravels (up to 1/4"), loose, with 1.0" lense of black sand at 7.6'.
			0.0	
				SILTY SAND (SM): 3.0" thick, gray (10YR 5/1), fine, interbedded with silt, very fine grained, dense, trace moist.
			0.0	
				SAND (SM): yellowish brown to black at 9.5' bgs, loose, well sorted, dry to slightly moist.
			0.0	SAND (SM): black with white and reddish brown specks, loose, well sorted, moist to wet.
10	ML			SILT (ML): 2.0" thick, gray (10YR 5/1), dense, wet.
	∇		0.0	SAND (SM/SP): black and reddish brown, medium grained, loose, poorly graded, wet to saturated.
	SM/SP		0.0	
			0.0	SAND (SM/SP): black with white and light brown specks, fine to medium grained, loose, wet.
			0.0	
			0.0	Total Depth – 14.0' bgs
15				
20				

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BOREHOLE LOG

Site Id: NW2-1
Page 1 of 2

Project Number: 0021460.51

Project Name: Fox Avenue

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Continuous Core

Logged By: M. Alves

Date(s): 11/08/04

Initial Water Level: 9.70'

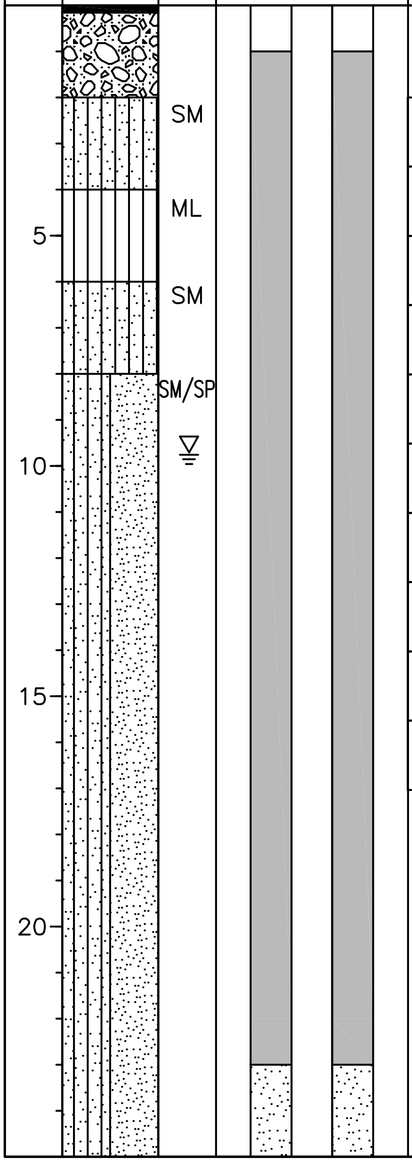
Total Depth: 32.00'

Completed Depth: 30.00'

Borehole Dia.: 8.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 25.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 25.00'	to: 30.00'
Annular Fill: type: Bentonite Chips			fm: 1.00'	to: 23.00'
type: Sand Filter Pack			fm: 23.00'	to: 30.00'
type: Backfill			fm: 30.00'	to: 32.00'

Depth (ft) | Graphic Log | USCS Code | Well Construction



USCS Code	Blow Count	PID (ppm)	Description/Soil Classification
		0.0 0.0	Asphalt, 1.0–2.0". FILL: dark olive brown (2.5Y 3/3), gravelly sand, medium to coarse, loose, poorly sorted.
SM	9 10 10		SILTY SAND (SM): olive brown (2.5Y 4/3), fine grained, well sorted, dry.
ML	11 20 22	0.0	SILT (ML): gray and gray/brown with oxidized lenses, interbedded silty fine sands, very fine grained, well sorted, stiff, moist to wet.
SM	19 17 15	0.0	SILTY SAND (SM): olive brown, fine grained, loose, interbedded with finer silty sand and some clay, dry to moist.
	19 15 15	0.0	
SM/SP	8 10 10	0.0	SAND (SM/SP): black with brown grains (2.5YR 3/1 and 10YR 4/3), medium grained, very loose, moist.
▽	8 7 6	0.0	SAND (SM/SP): black, medium grained, wet.
	9 10 7	0.0	
	9 10 9	0.0	
	8 8 8	0.0	SAND (SM/SP): black, medium grained, some light brown silty inclusions (in shoe: silt, dark gray, dense, may be slough).
	4 4 4	0.0	SAND (SM/SP): black with white/brown specks, fine to medium grained, loose, trace silt inclusions, some gravels, wet.
			2" diameter silt inclusion, dark gray, dense.

BOREHOLE LOG

Project Number: 0021460.51

Project Name: Fox Avenue

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Continuous Core

Logged By: M. Alves

Date(s): 11/08/04

Initial Water Level: 9.70'

Total Depth: 32.00'

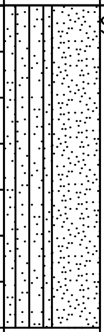
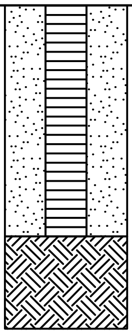
Completed Depth: 30.00'

Borehole Dia.: 8.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 25.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 25.00' to: 30.00'

Annular Fill:
type: Bentonite Chips fm: 1.00' to: 23.00'
type: Sand Filter Pack fm: 23.00' to: 30.00'
type: Backfill fm: 30.00' to: 32.00'

Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	PID (ppm)	Description/Soil Classification
		SM/SP				SAND (SM/SP): black with white and reddish brown specks, medium grained, very loose, poorly graded, wet.
30						
						Total Depth – 32.0' bgs
35						
40						
45						

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BOREHOLE LOG

Site Id: NW2-2

Project Number: 0021460.51

Project Name: Fox Avenue

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Hollow Stem Auger

Logged By: M. Alves

Date(s): 11/08/04

Initial Water Level: 10.55'

Total Depth: 32.00'

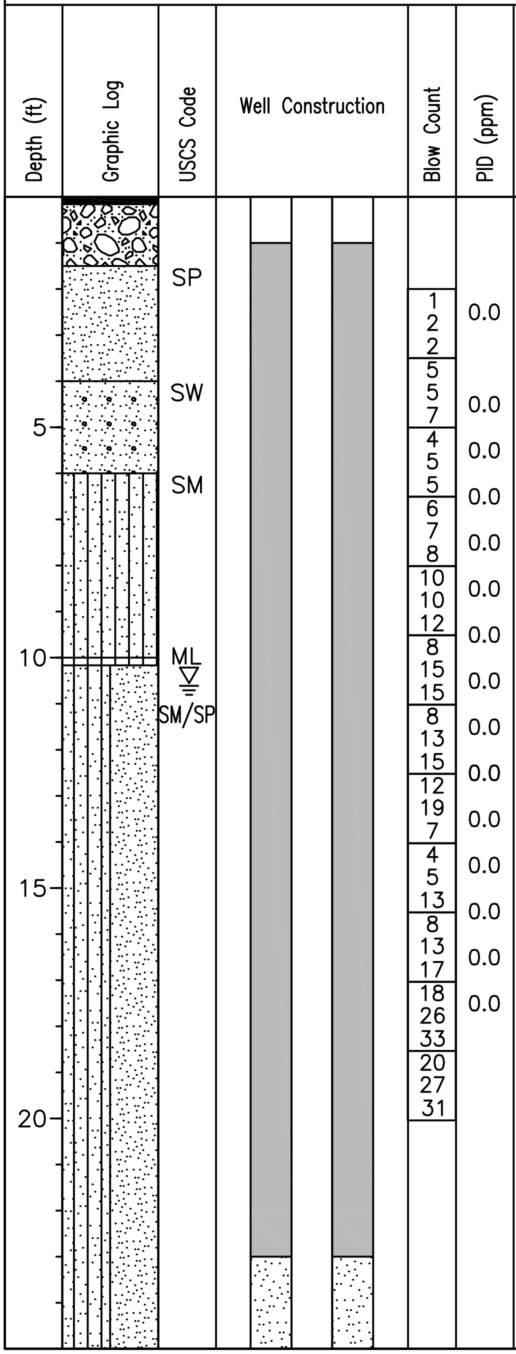
Completed Depth: 30.00'

Borehole Dia.: 8.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 25.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 25.00' to: 30.00'

Annular Fill:
type: Bentonite Chips fm: 1.00' to: 23.00'
type: Sand Filter Pack fm: 23.00' to: 30.00'
type: Backfill fm: 30.00' to: 32.00'



Description/Soil Classification

Asphalt, 1.0–2.0".

FILL: Gravelly sand, dark olive brown (2.5Y 3/3), medium to coarse gravels, angular and broken, loose, well graded.

SAND (SP): dark yellowish brown (10YR 4/3), medium grained, poorly graded, with some rounded gravels (1/4" to 2.0"), loose.

SAND (SW): olive brown (2.5Y 4/3), very fine to medium grained, silty, with gravel (1/4" to 2.0"), well graded.

SAND (SM): light olive brown to yellowish brown, fine to medium grained, some gravels (up to 1/4"), loose, with 1.0" lense of black sand at 7.6'.

SILTY SAND (SM): 3.0" thick, gray (10YR 5/1), fine, interbedded with silt, very fine grained, dense, trace moist.

SAND (SM): yellowish brown to black at 9.5' bgs, loose, well sorted, dry to slightly moist.

SAND (SM): black with white and reddish brown specks, loose, well sorted, moist to wet.

SILT (ML): 2.0" thick, gray (10YR 5/1), dense, wet.

SAND (SM/SP): black and reddish brown, medium grained, loose, poorly graded, wet to saturated.

SAND (SM/SP): black with white and light brown specks, fine to medium grained, loose, wet.

SAND (SM/SP): black, medium grained, loose, wet/saturated.

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BOREHOLE LOG

Site Id: NW2-2
Page 2 of 2

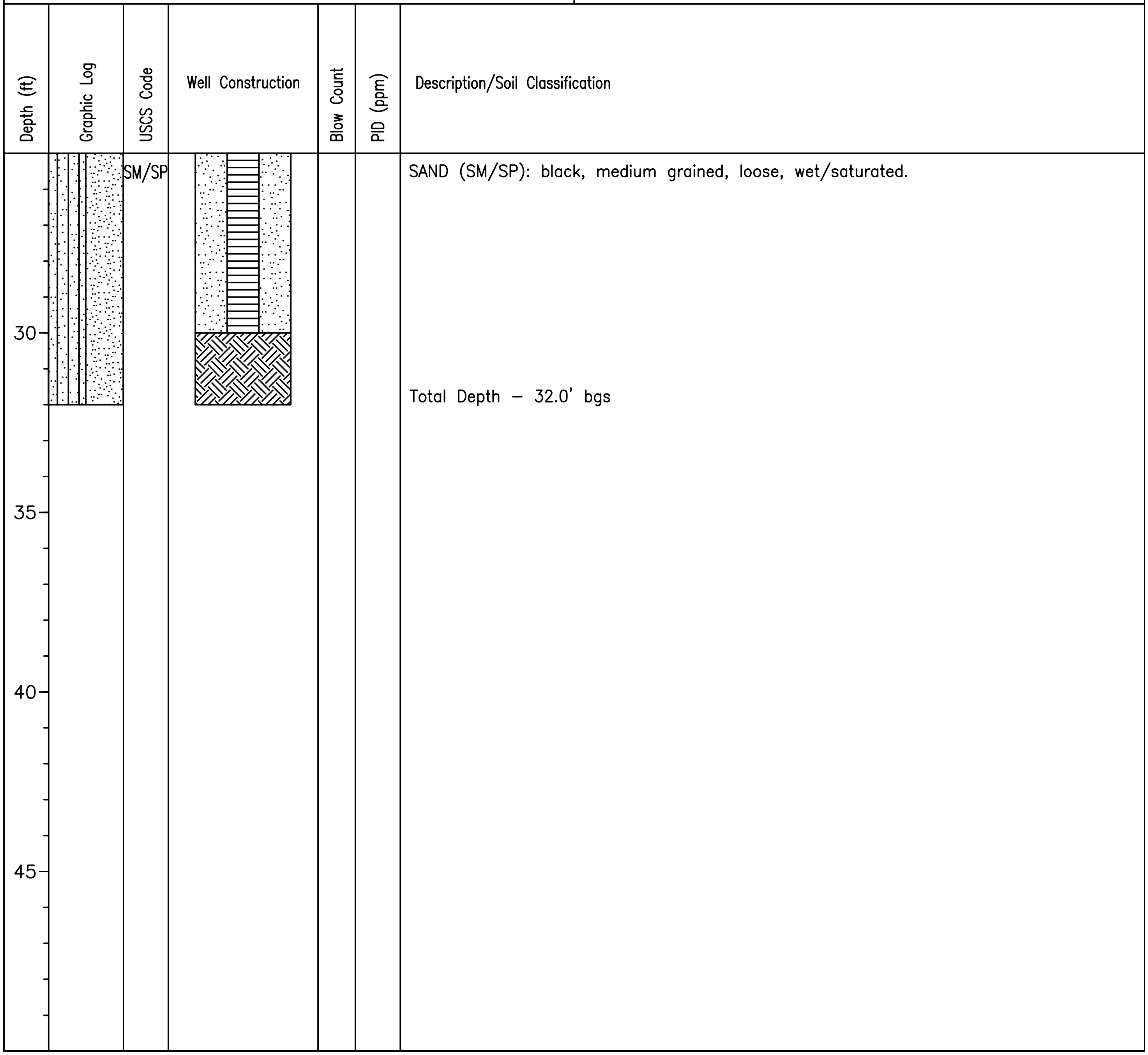
Project Number: 0021460.51
Project Name: Fox Avenue
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: M. Alves
Date(s): 11/08/04
Initial Water Level: 10.55'

Total Depth: 32.00'
Completed Depth: 30.00'
Borehole Dia.: 8.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 25.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 25.00' to: 30.00'

Annular Fill:
type: Bentonite Chips fm: 1.00' to: 23.00'
type: Sand Filter Pack fm: 23.00' to: 30.00'
type: Backfill fm: 30.00' to: 32.00'



SAND (SM/SP): black, medium grained, loose, wet/saturated.

Total Depth – 32.0' bgs

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BOREHOLE LOG

Site Id: PTM-1L

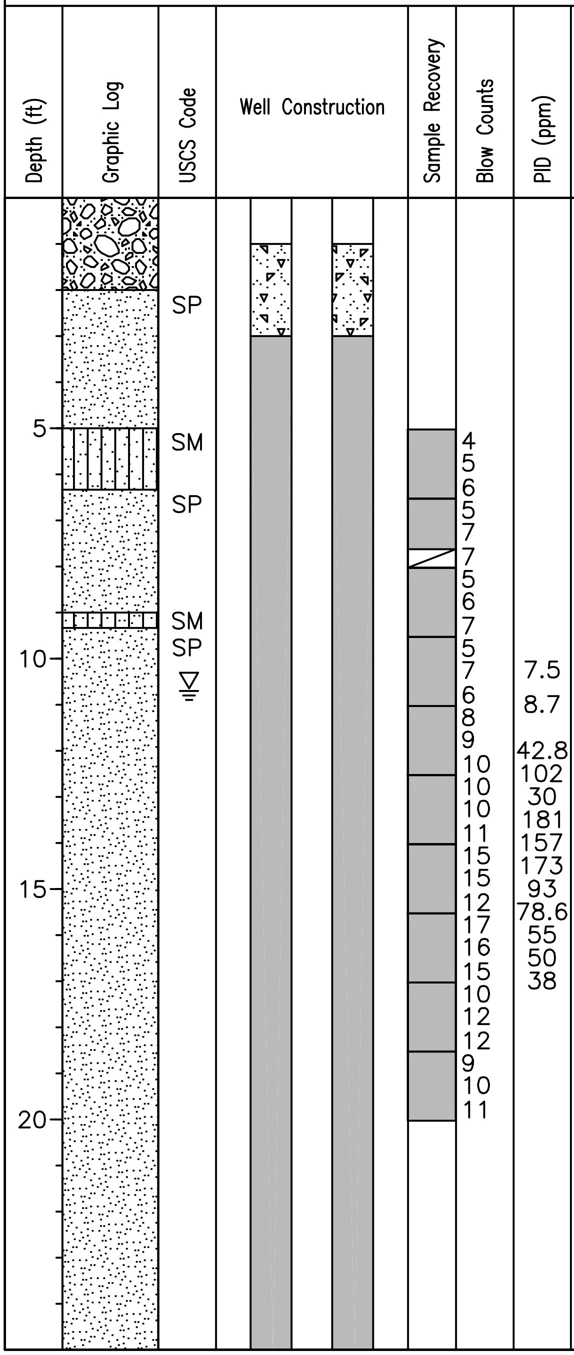
Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.64'

Total Depth: 55.00'
Completed Depth: 55.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 45.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 45.00' to: 55.00'

Annular Fill:
type: Concrete fm: 1.0' to: 3.00'
type: Bentonite Chips fm: 3.00' to: 42.00'
type: #2/12 Sand Filter Pack fm: 42.00' to: 55.00'



Description/Soil Classification

SANDY GRAVEL (FILL): gray to brown, industrial fill material, coarse gravel, some organics, scrap wood, moist.

SAND (SP): brown, fine grained, trace silt, medium dense, moist.

SILTY SAND (SM): light brown/tan, fine to medium grained, medium dense, moist.

SAND (SP): brown, some mixed dark and light colored, fine grained, loose, moist.

SAND (SP): dark and light colored, medium to coarse grained, very loose, moist.

SAND (SP): brown, fine to medium grained, loose, moist.

SILTY SAND (SM): brown, fine grained, medium dense, moist.

SAND (SP): dark and light colored, medium to coarse grained, very loose, odor, moist to wet.

1.0" brown silty sand, fine grained, medium dense, wet.

SAND (SP): dark and light colored, medium to coarse grained, very loose, wet.

SAND (SP): brown, fine grained, intermixed with dark and light colored, medium to coarse grained, medium dense, trace firm silt, odor, wet.

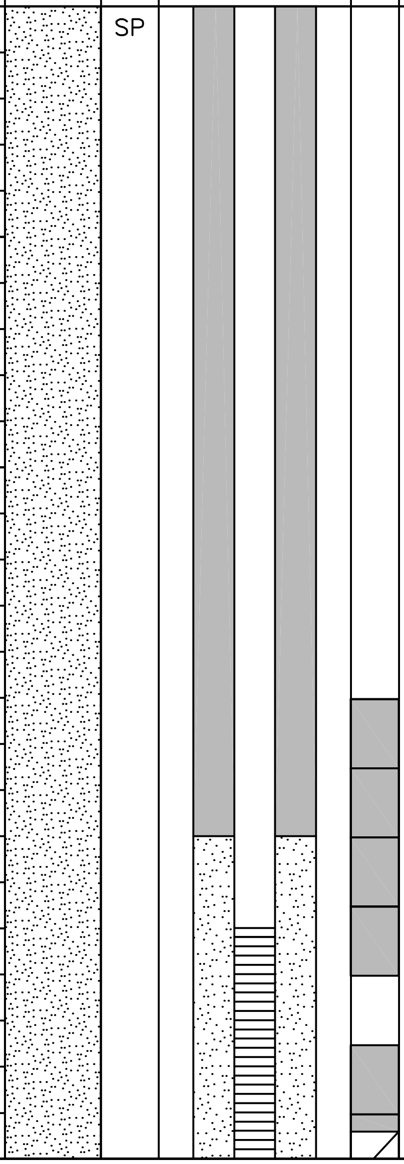
SAND (SP): dark and light colored, medium to coarse grained, loose, odor, wet.

BOREHOLE LOG

Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.64'

Total Depth: 55.00'
Completed Depth: 55.00'
Borehole Dia.: 2.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 45.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 45.00'	to: 55.00'
Annular Fill: type: Concrete			fm: 1.0'	to: 3.00'
type: Bentonite Chips			fm: 3.00'	to: 42.00'
type: #2/12 Sand Filter Pack			fm: 42.00'	to: 55.00'



Depth (ft)	USCS Code	Blow Counts	PID (ppm)	Description/Soil Classification
	SP			
30				
35				
40		12 9 12 17 20 20 20 20 20		SAND (SP): black, dark and light colored, medium grained, very loose, odor, wet.
45		12 8 5		SAND (SP): black, dark and light colored, fine to medium grained, loose, odor, wet.
		4 4 5		In shoe, trace gray silt, firm, with black, dark and light colored sand, fine to medium grained, loose, wet. SAND (SP): black, dark and light colored, fine to medium grained, very loose, saturated.

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BOREHOLE LOG

Site Id: PTM-1L
Page 3 of 3

Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.64'

Total Depth: 55.00'
Completed Depth: 55.00'
Borehole Dia.: 2.00in

Blank Casing: type: PVC		dia: 2.00in	fm: 0.0'	to: 45.00'
Screens: type: Slotted	size: 0.010in	dia: 2.00in	fm: 45.00'	to: 55.00'
Annular Fill: type: Concrete			fm: 1.0'	to: 3.00'
type: Bentonite Chips			fm: 3.00'	to: 42.00'
type: #2/12 Sand Filter Pack			fm: 42.00'	to: 55.00'

Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	PID (ppm)	Description/Soil Classification
		SP			20+ 20+ 50		SAND (SP): black, dark and light colored, fine to medium grained, loose, wet/saturated.
		ML			20 20 20		SILT (ML): gray, with trace fine grained sand, stiff to hard, moist. Total Depth – 55.0'
55							
60							
65							
70							

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BOREHOLE LOG

Site Id: PTM-1U
Page 1 of 2

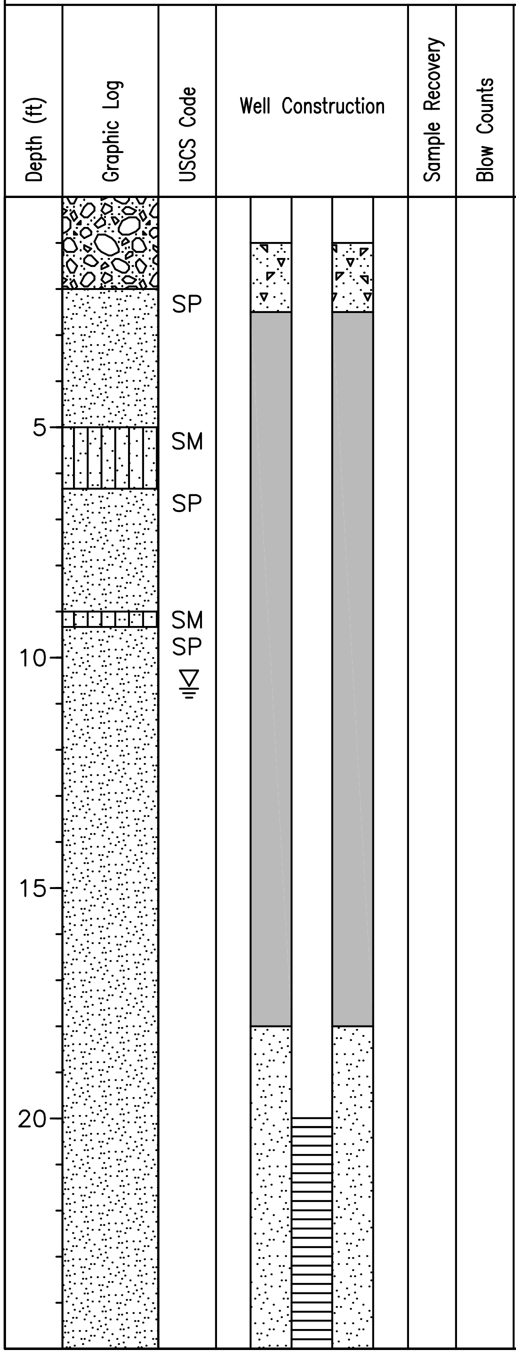
Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.62'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 30.00'

Annular Fill:
type: Concrete fm: 1.0' to: 2.50'
type: Bentonite Chips fm: 2.50' to: 18.00'
type: #2/12 Sand Filter Pack fm: 18.00' to: 30.00'



Description/Soil Classification

SANDY GRAVEL (FILL): gray to brown, industrial fill material, coarse gravel, some organics, scrap wood, moist.

SAND (SP): brown, fine grained, trace silt, medium dense, moist.

SILTY SAND (SM): light brown/tan, fine to medium grained, medium dense, moist.

SAND (SP): brown, some mixed dark and light colored, fine grained, loose, moist.

SAND (SP): dark and light colored, medium to coarse grained, very loose, moist.

SAND (SP): brown, fine to medium grained, loose, moist.

SILTY SAND (SM): brown, fine grained, medium dense, moist.

SAND (SP): dark and light colored, medium to coarse grained, very loose, odor, moist to wet.

1.0" brown silty sand, fine grained, medium dense, wet.

SAND (SP): dark and light colored, medium to coarse grained, very loose, wet.

SAND (SP): brown, fine grained, intermixed with dark and light colored, medium to coarse grained, medium dense, trace firm silt, odor, wet.

SAND (SP): dark and light colored, medium to coarse grained, loose, odor, wet.

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BOREHOLE LOG

Site Id: PTM-1U
Page 2 of 2

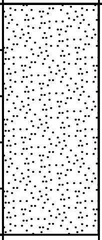
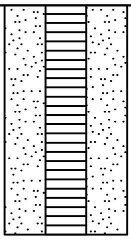
Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/02/03
Initial Water Level: 10.62'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 30.00'

Annular Fill:
type: Concrete fm: 1.0' to: 2.50'
type: Bentonite Chips fm: 2.50' to: 18.00'
type: #2/12 Sand Filter Pack fm: 18.00' to: 30.00'

Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	Description/Soil Classification
		SP				
30						Total Depth – 30.0'
35						
40						
45						

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BOREHOLE LOG

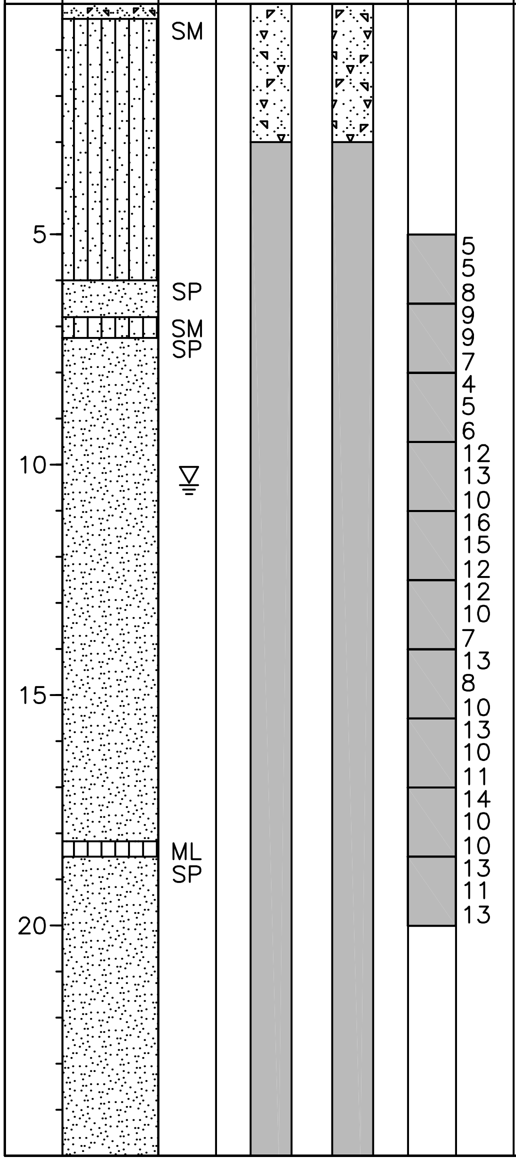
Site Id: PTM-2L
Page 1 of 2

Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/03/03
Initial Water Level: 10.41'

Total Depth: 48.00'
Completed Depth: 48.00'
Borehole Dia.: 2.00in

Blank Casing:				
type: PVC		dia: 2.00in	fm: 0.0'	to: 38.00'
Screens:				
type: Slotted	size: 0.010in	dia: 2.00in	fm: 38.00'	to: 48.00'
Annular Fill:				
type: Concrete			fm: 0.0'	to: 3.00'
type: Bentonite Chips			fm: 3.00'	to: 35.00'
type: #2/12 Sand Filter Pack			fm: 35.00'	to: 48.00'

Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	Description/Soil Classification



Blow Counts: 5, 5, 8, 9, 9, 7, 4, 5, 6, 12, 13, 10, 16, 15, 12, 12, 10, 7, 13, 8, 10, 13, 10, 11, 14, 10, 10, 13, 11, 13

Concrete, 4.0" thick.
CLAYEY SILTY SAND (SM): brown, fine grained, soft to stiff, dry to moist.

SILTY SAND (SM): brown, fine grained, loose to medium dense, moist.

SAND (SP): brown, fine grained, trace silt, loose, moist.

SILTY SAND (SM): brown, fine grained, loose to medium dense, moist.
SAND (SP): brown with light colored, fine grained, loose, moist.
SAND (SP): brown, fine grained, trace silt, loose, moist.
SAND (SP): brown with light colored, fine grained, loose, moist.

SAND (SP): brown with light colored, fine to medium grained, loose, moist.

SAND (SP): dark and light colored, medium grained, loose, slight odor, wet.

SAND (SP): as above, fine to medium grained.
SAND (SP): as above, trace amounts of brown silt (small clumps), firm, odor.
SAND (SP): black, dark and light colored, fine to medium grained, loose, odor, wet.

SAND (SP): as above.

SAND (SP): as above.

SILT (ML): gray, some fine grained sand, soft to stiff, odor, wet.
SAND (SP): black, dark and light colored, fine to medium grained, loose, odor, wet.

BOREHOLE LOG

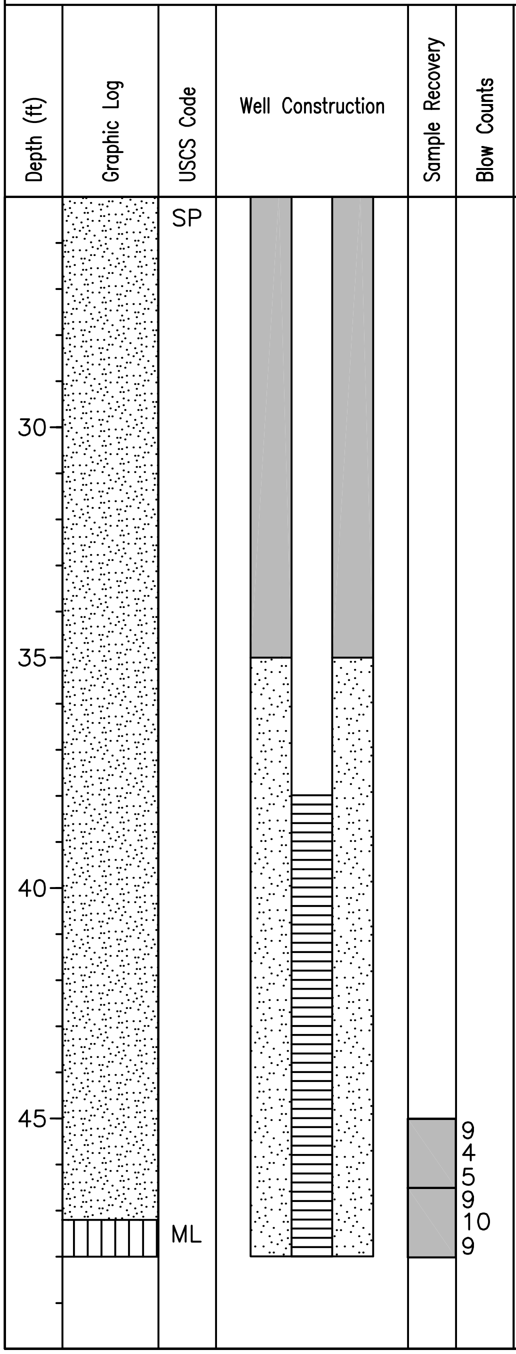
Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/03/03
Initial Water Level: 10.41'

Total Depth: 48.00'
Completed Depth: 48.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 38.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 38.00' to: 48.00'

Annular Fill:
type: Concrete fm: 0.0' to: 3.00'
type: Bentonite Chips fm: 3.00' to: 35.00'
type: #2/12 Sand Filter Pack fm: 35.00' to: 48.00'



Depth (ft)	USCS Code	Blow Counts	Description/Soil Classification
	SP		
45		9 4	SAND (SP): black, dark and light colored, fine to medium grained, loose, odor, wet.
		5 9	SAND (SP): as above.
	ML	10 9	SILT (ML): gray, trace fine grained sand, stiff, moist. Total Depth - 48.0'

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BOREHOLE LOG

Site Id: PTM-2U

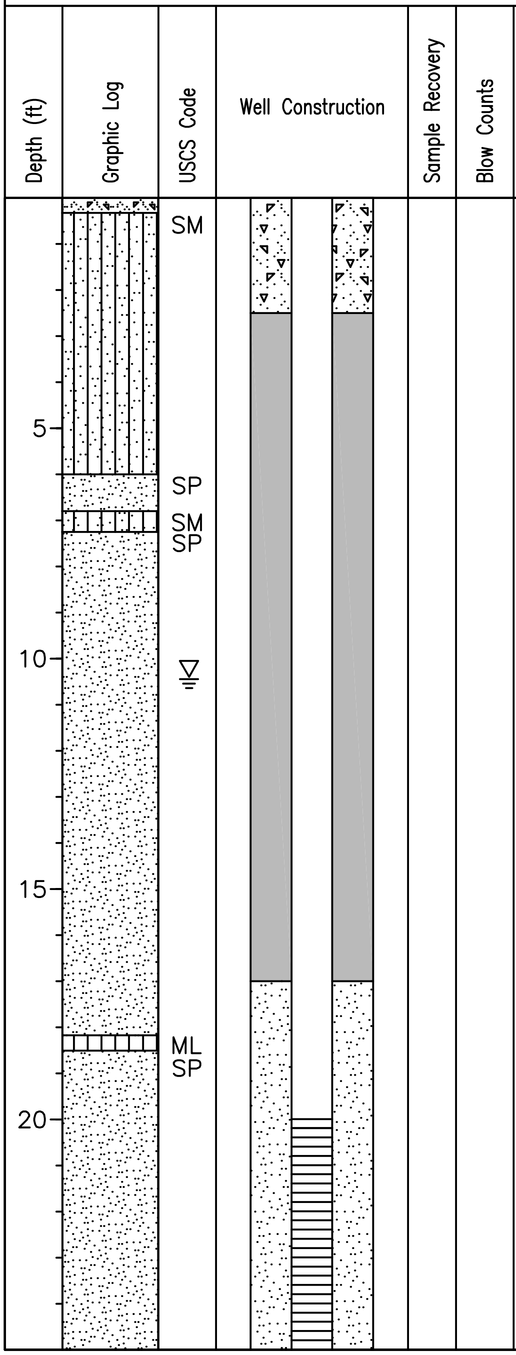
Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/03/03
Initial Water Level: 10.57'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 2.00in

Blank Casing:
type: PVC dia: 2.00in fm: 0.0' to: 20.00'

Screens:
type: Slotted size: 0.010in dia: 2.00in fm: 20.00' to: 30.00'

Annular Fill:
type: Concrete fm: 0.0' to: 2.50'
type: Bentonite Chips fm: 2.50' to: 17.00'
type: #2/12 Sand Filter Pack fm: 17.00' to: 30.00'



Description/Soil Classification

Concrete, 4.0" thick.
CLAYEY SILTY SAND (SM): brown, fine grained, soft to stiff, dry to moist.

SILTY SAND (SM): brown, fine grained, loose to medium dense, moist.

SAND (SP): brown, fine grained, trace silt, loose, moist.

SILTY SAND (SM): brown, fine grained, loose to medium dense, moist.
SAND (SP): brown with light colored, fine grained, loose, moist.
SAND (SP): brown, fine grained, trace silt, loose, moist.
SAND (SP): brown with light colored, fine grained, loose, moist.

SAND (SP): brown with light colored, fine to medium grained, loose, moist.

SAND (SP): dark and light colored, medium grained, loose, slight odor, wet.

SAND (SP): as above, fine to medium grained.
SAND (SP): as above, trace amounts of brown silt (small clumps), firm, odor.

SAND (SP): black, dark and light colored, fine to medium grained, loose, odor, wet.

SAND (SP): as above.

SAND (SP): as above.

SILT (ML): gray, some fine grained sand, soft to stiff, odor, wet.
SAND (SP): black, dark and light colored, fine to medium grained, loose, odor, wet.

BOREHOLE LOG

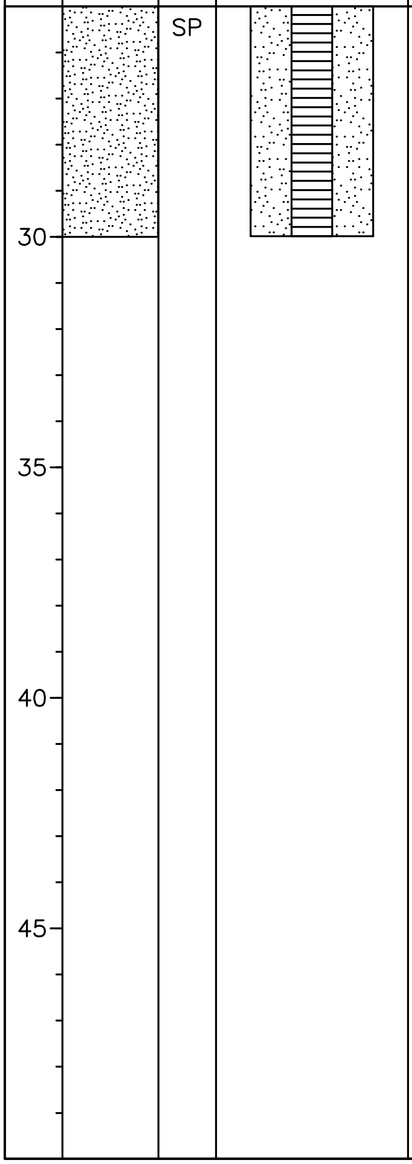
Site Id: PTM-2U

Project Number: 5303.13
Project Name: Fox Avenue Building LLC
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Hollow Stem Auger
Logged By: Z. Clements
Date(s): 12/03/03
Initial Water Level: 10.57'

Total Depth: 30.00'
Completed Depth: 30.00'
Borehole Dia.: 2.00in

Blank Casing:				
type: PVC		dia: 2.00in	fm: 0.0'	to: 20.00'
Screens:				
type: Slotted	size: 0.010in	dia: 2.00in	fm: 20.00'	to: 30.00'
Annular Fill:				
type: Concrete			fm: 0.0'	to: 2.50'
type: Bentonite Chips			fm: 2.50'	to: 17.00'
type: #2/12 Sand Filter Pack			fm: 17.00'	to: 30.00'

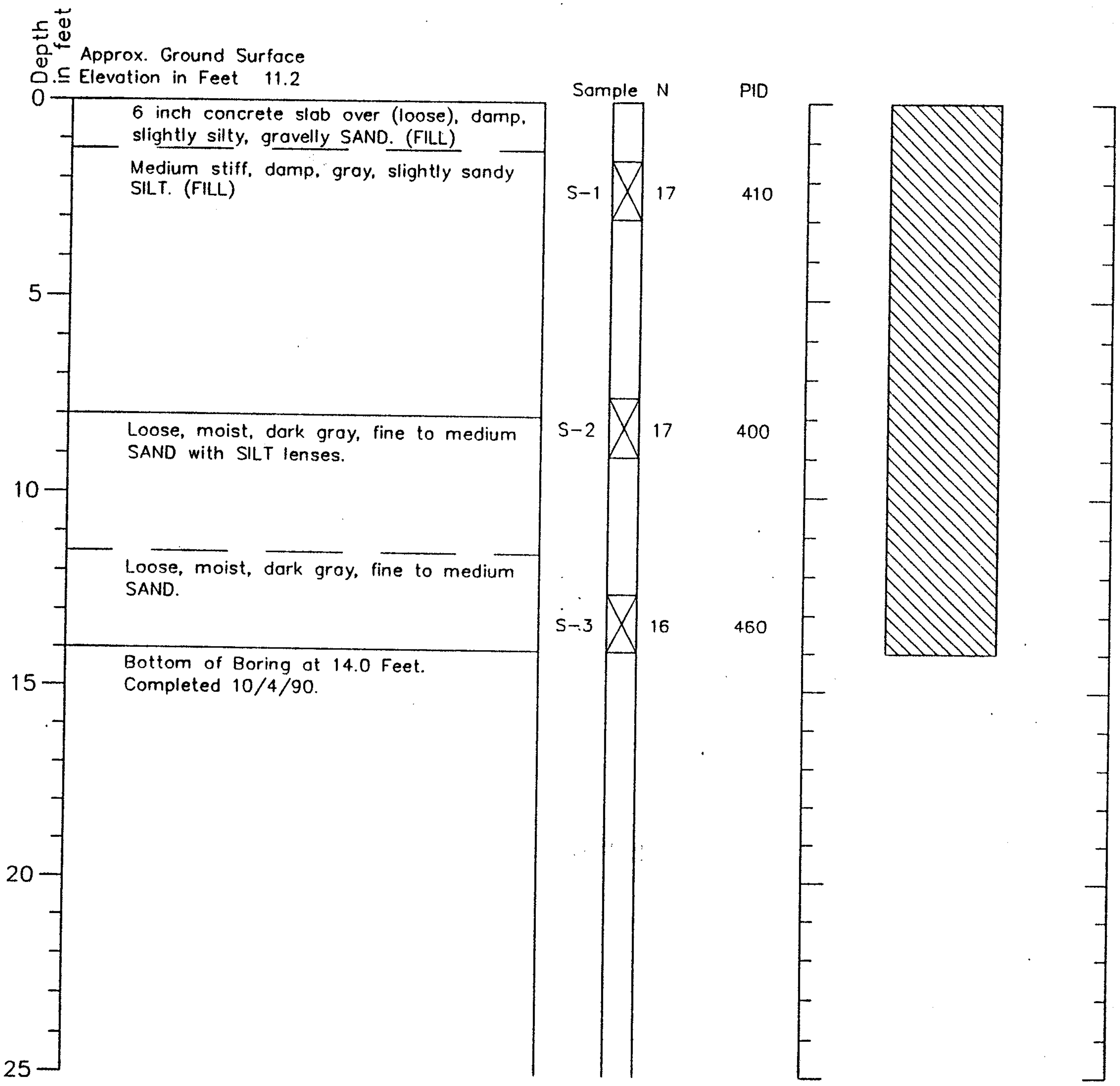
Depth (ft)	Graphic Log	USCS Code	Well Construction	Sample Recovery	Blow Counts	Description/Soil Classification
		SP				
30						Total Depth – 30.0'
35						
40						
45						



Boring Log SB-1

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 11.2

6 inch concrete slab over (loose), damp, slightly silty, gravelly SAND. (FILL)

Medium stiff, damp, gray, slightly sandy SILT. (FILL)

Loose, moist, dark gray, fine to medium SAND with SILT lenses.

Loose, moist, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet.
Completed 10/4/90.

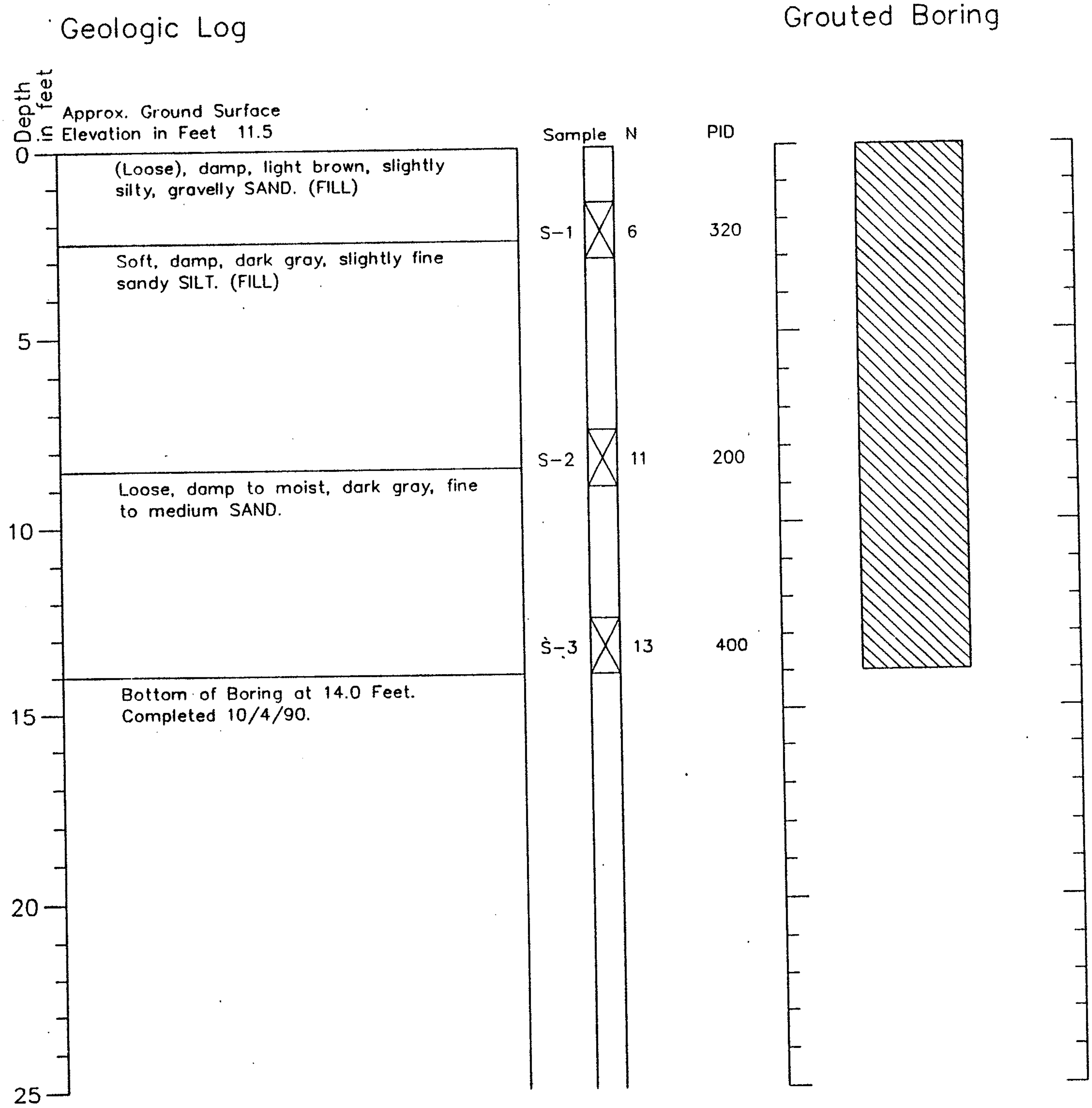
Sample	N	PID
S-1	17	410
S-2	17	400
S-3	16	460

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-04 **10/90**

Figure A-44

Boring Log SB-2


Geologic Log

Grouted Boring

Approx. Ground Surface Elevation in Feet 11.5

(Loose), damp, light brown, slightly silty, gravelly SAND. (FILL)

Soft, damp, dark gray, slightly fine sandy SILT. (FILL)

Loose, damp to moist, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet. Completed 10/4/90.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

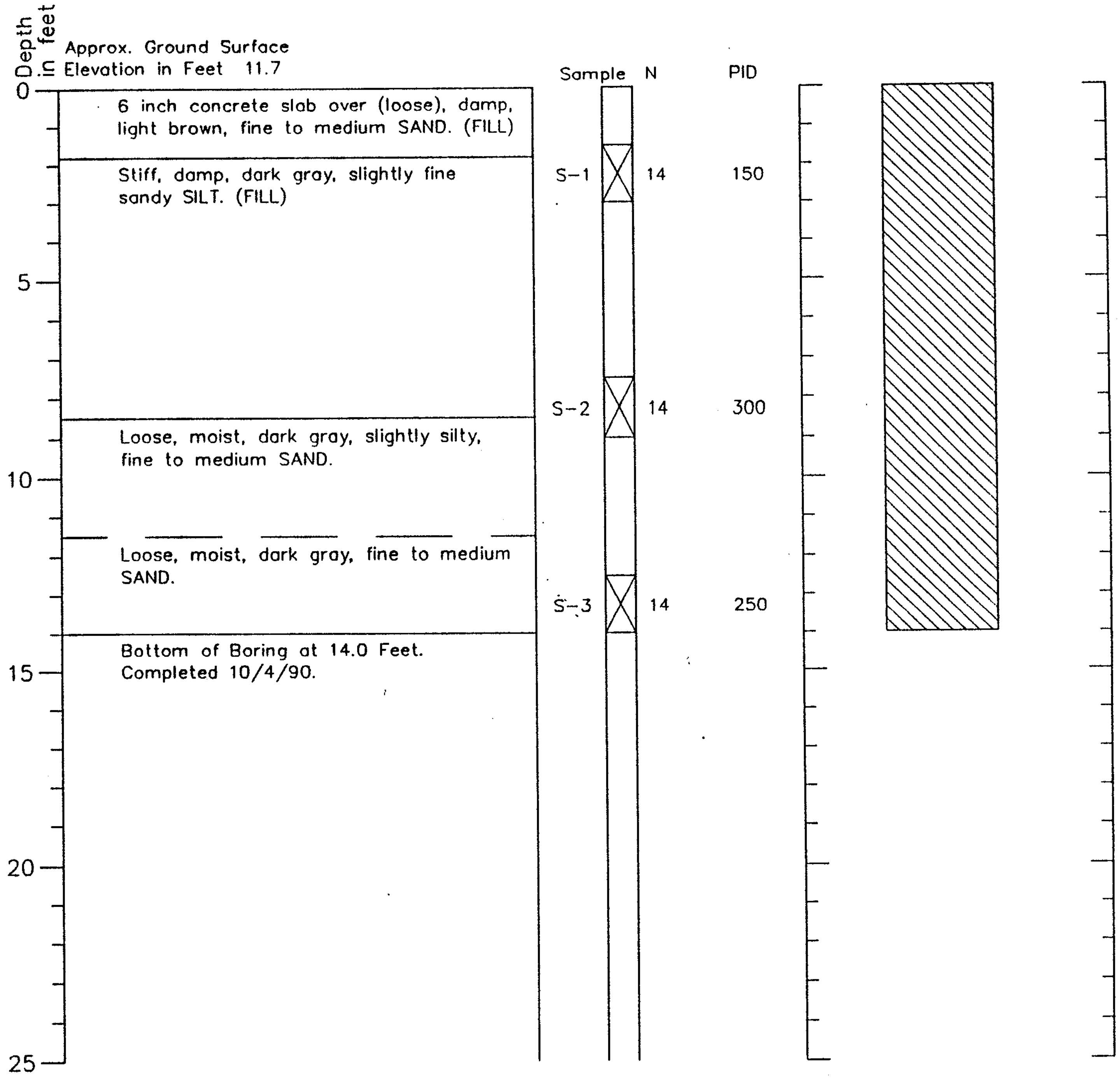
J-2489-04 10/90

Figure A-45

Boring Log SB-3

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 11.7

6 inch concrete slab over (loose), damp, light brown, fine to medium SAND. (FILL)

Stiff, damp, dark gray, slightly fine sandy SILT. (FILL)

Loose, moist, dark gray, slightly silty, fine to medium SAND.

Loose, moist, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet.
Completed 10/4/90.

Sample	N	PID
S-1	14	150
S-2	14	300
S-3	14	250

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

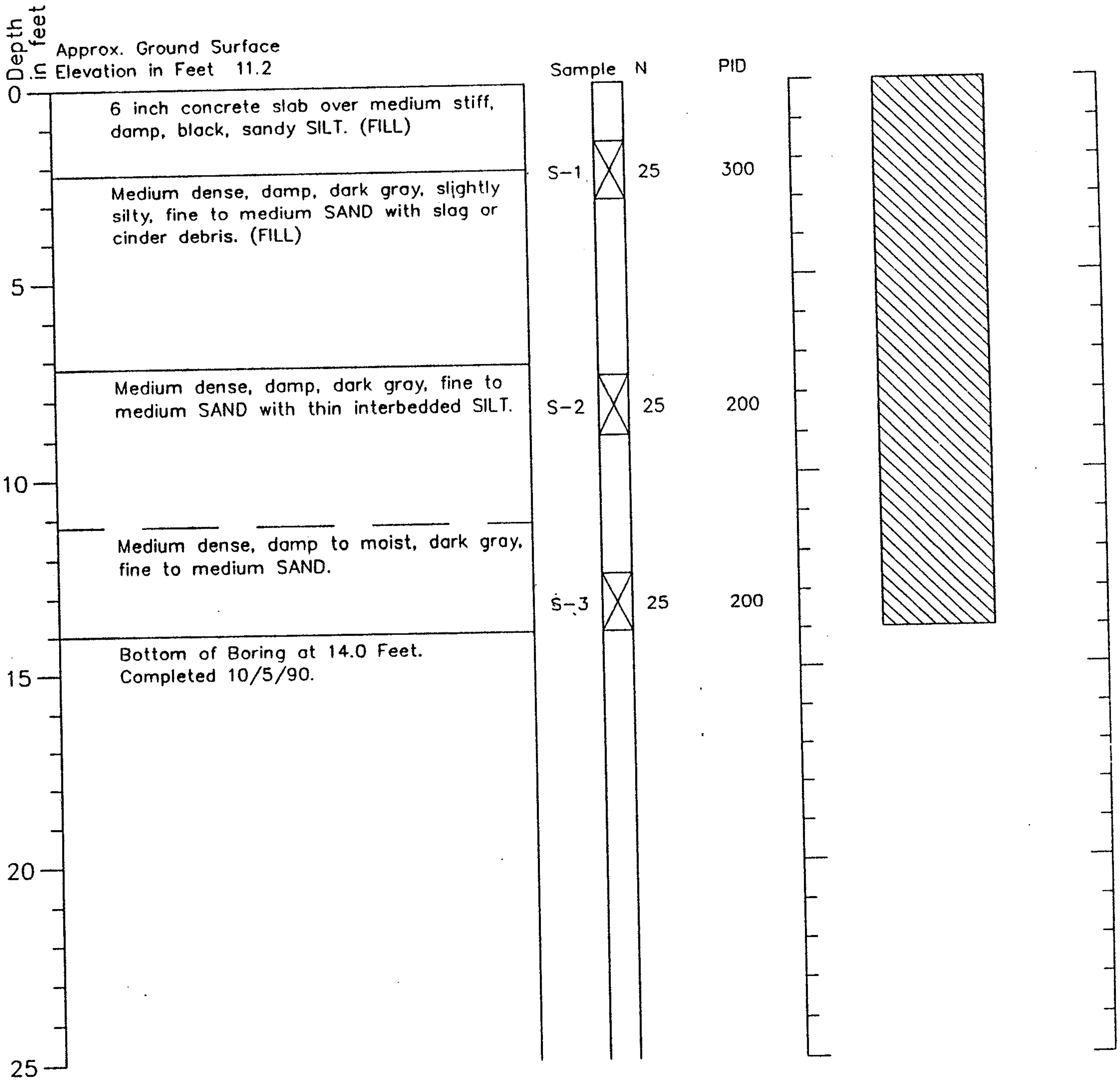
J-2489-04 **10/90**

Figure A-46

Boring Log SB-4

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 11.2

6 inch concrete slab over medium stiff, damp, black, sandy SILT. (FILL)

Medium dense, damp, dark gray, slightly silty, fine to medium SAND with slag or cinder debris. (FILL)

Medium dense, damp, dark gray, fine to medium SAND with thin interbedded SILT.

Medium dense, damp to moist, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet.
Completed 10/5/90.

Sample	N	PID
S-1	25	300
S-2	25	200
S-3	25	200

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

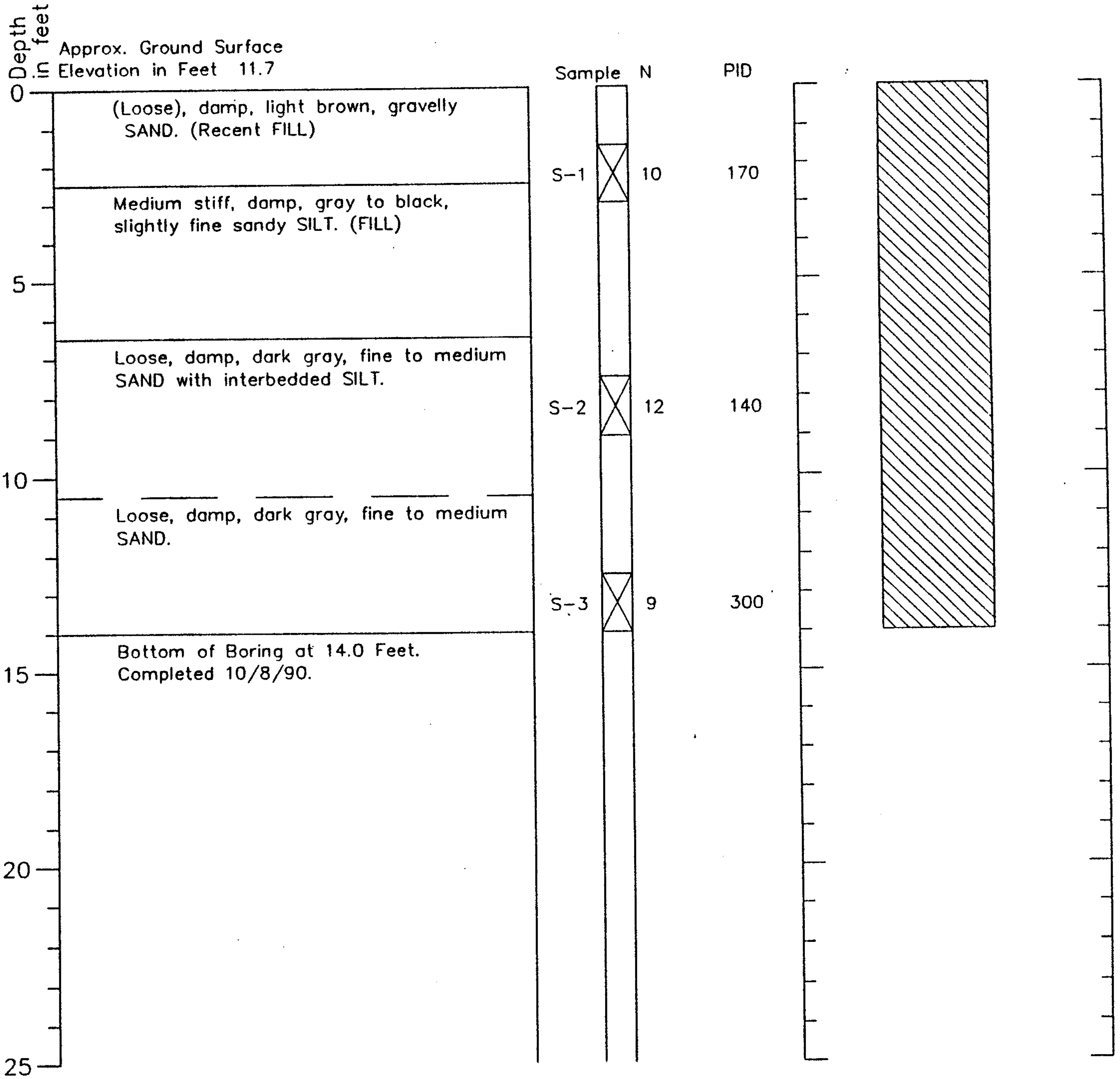
J-2489-04 10/90

Figure A-47

Boring Log SB-5

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 11.7

(Loose), damp, light brown, gravelly SAND. (Recent FILL)

Medium stiff, damp, gray to black, slightly fine sandy SILT. (FILL)

Loose, damp, dark gray, fine to medium SAND with interbedded SILT.

Loose, damp, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet. Completed 10/8/90.

Sample	N	PID
S-1	10	170
S-2	12	140
S-3	9	300

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

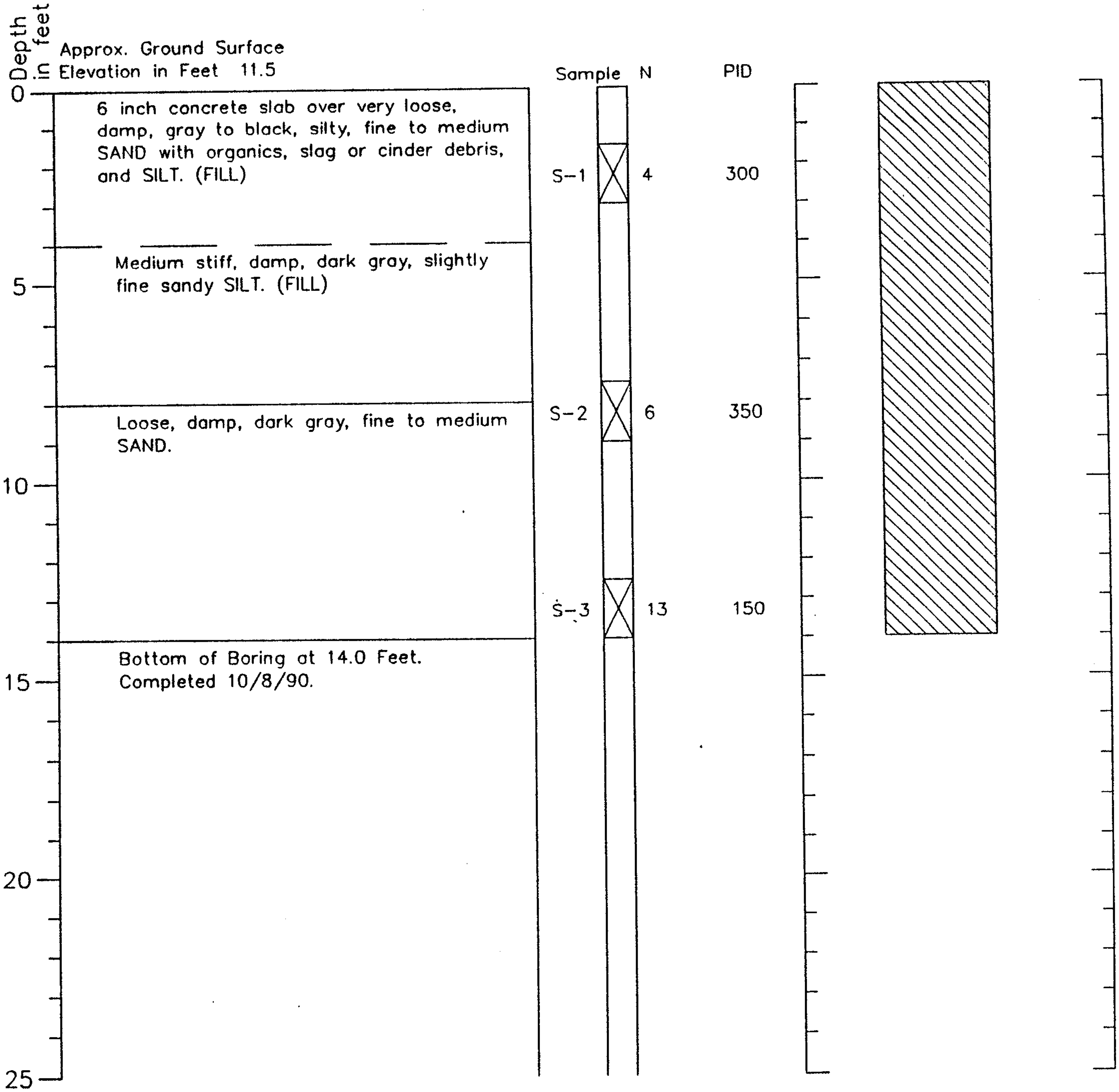
J-2489-04 10/90

Figure A-48

Boring Log SB-6

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 11.5

6 inch concrete slab over very loose, damp, gray to black, silty, fine to medium SAND with organics, slag or cinder debris, and SILT. (FILL)

Medium stiff, damp, dark gray, slightly fine sandy SILT. (FILL)

Loose, damp, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet. Completed 10/8/90.

Sample	N	PID
S-1	4	300
S-2	6	350
S-3	13	150

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

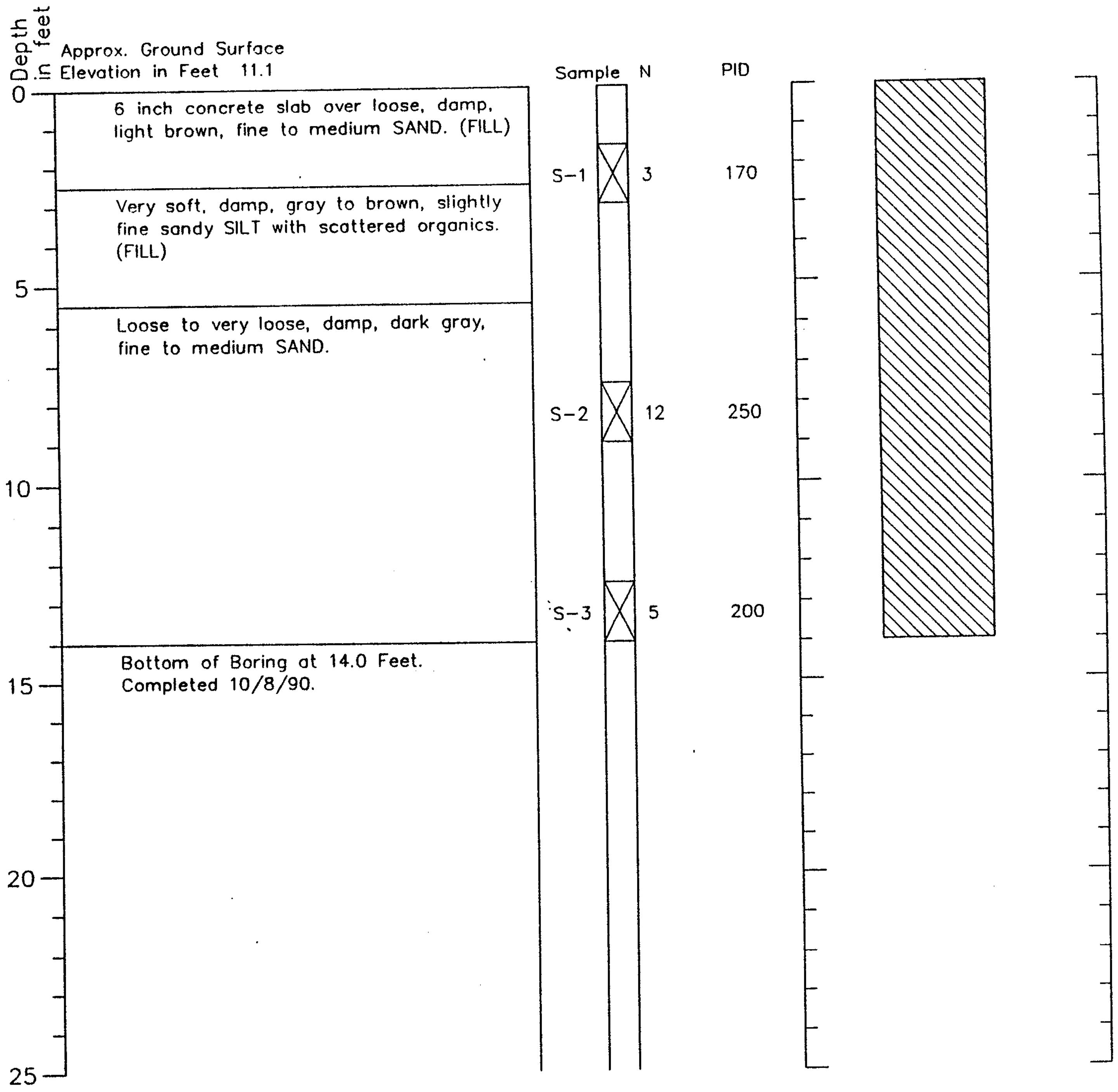
J-2489-04 **10/90**

Figure A-49

Boring Log SB-7

Geologic Log

Grouted Boring



6 inch concrete slab over loose, damp, light brown, fine to medium SAND. (FILL)

Very soft, damp, gray to brown, slightly fine sandy SILT with scattered organics. (FILL)

Loose to very loose, damp, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet. Completed 10/8/90.

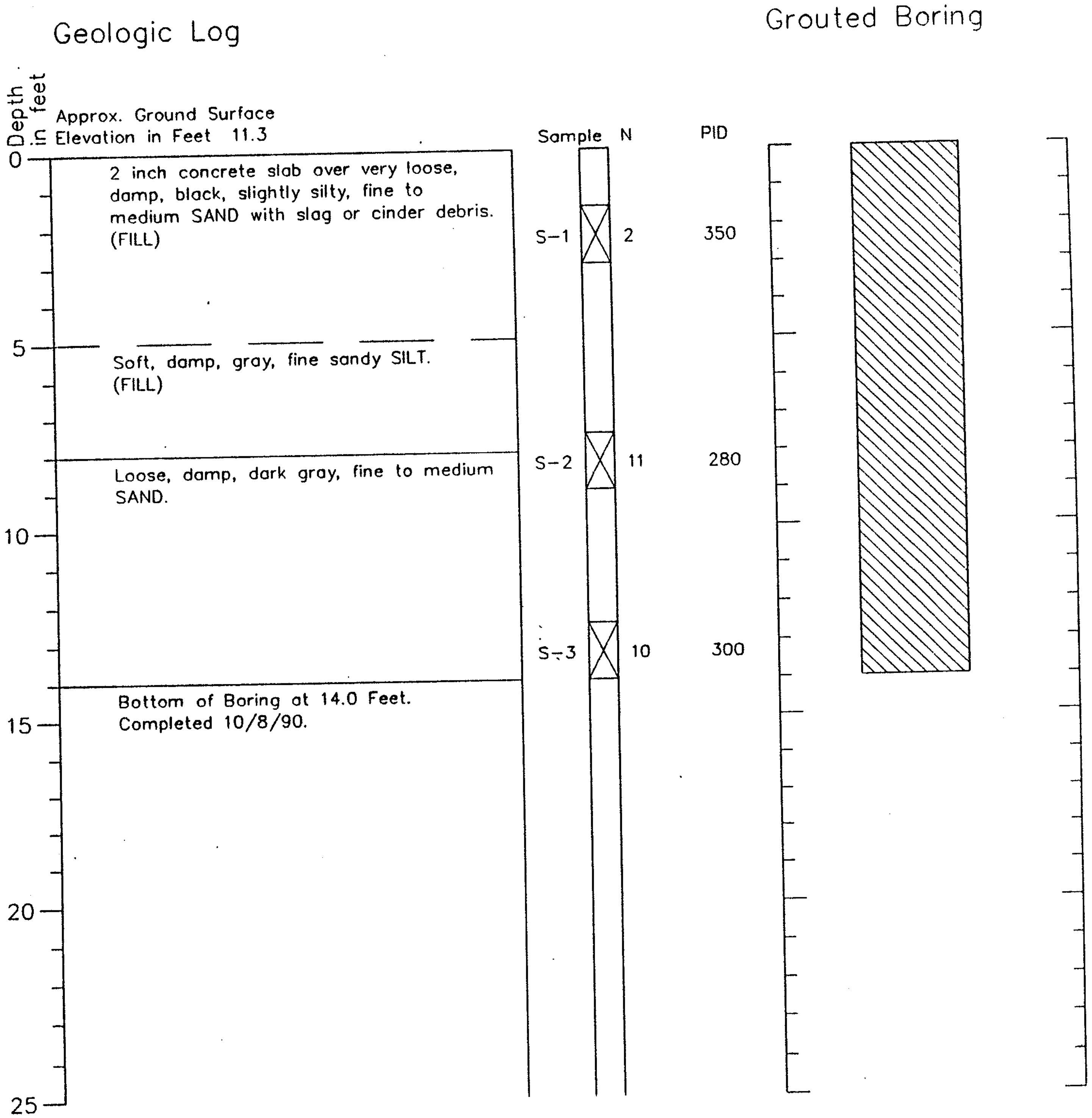
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-04 10/90

Figure A-50

Boring Log SB-8



Approx. Ground Surface Elevation in Feet 11.3

2 inch concrete slab over very loose, damp, black, slightly silty, fine to medium SAND with slag or cinder debris. (FILL)

Soft, damp, gray, fine sandy SILT. (FILL)

Loose, damp, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet. Completed 10/8/90.

Sample	N	PID
S-1	2	350
S-2	11	280
S-3	10	300

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

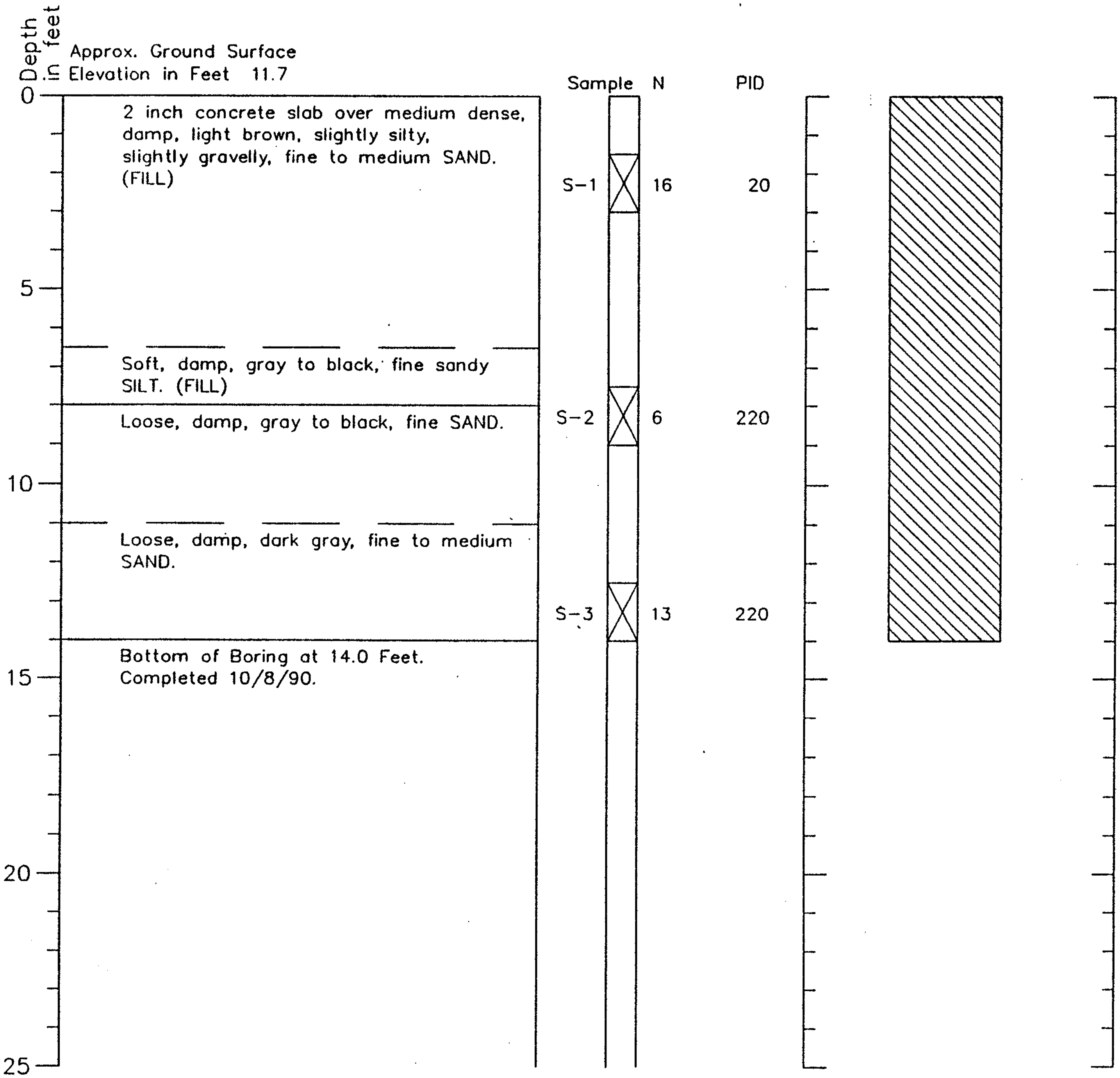
J-2489-04 **10/90**

Figure A-51

Boring Log SB-9

Geologic Log

Grouted Boring



2 inch concrete slab over medium dense, damp, light brown, slightly silty, slightly gravelly, fine to medium SAND. (FILL)

Soft, damp, gray to black, fine sandy SILT. (FILL)

Loose, damp, gray to black, fine SAND.

Loose, damp, dark gray, fine to medium SAND.

Bottom of Boring at 14.0 Feet. Completed 10/8/90.

Sample	N	PID
S-1	16	20
S-2	6	220
S-3	13	220

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

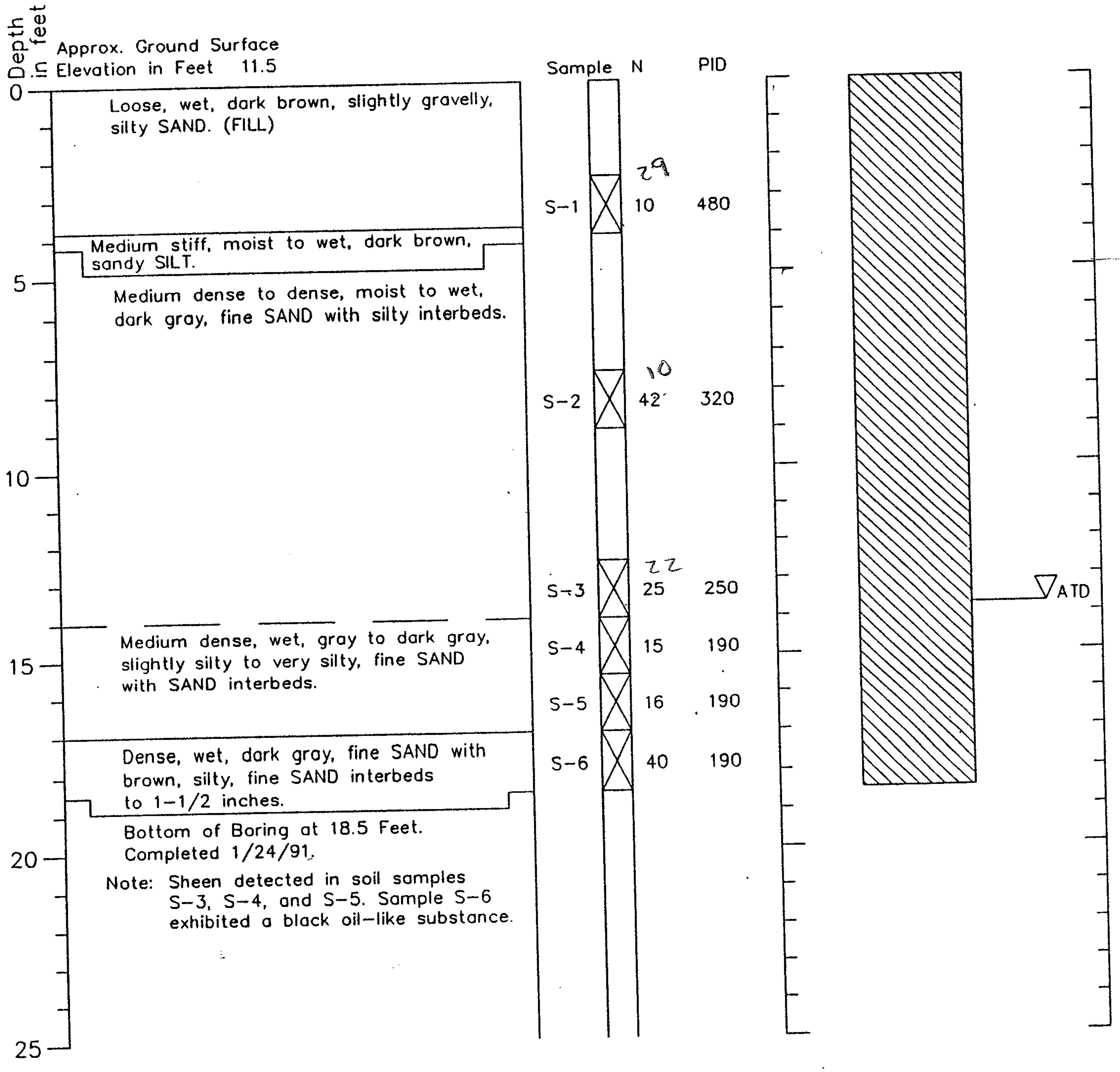
HARTCROWSER
J-2489-04 **10/90**

Figure A-52

Boring Log SB-10

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 11.5

Loose, wet, dark brown, slightly gravelly, silty SAND. (FILL)

Medium stiff, moist to wet, dark brown, sandy SILT.

Medium dense to dense, moist to wet, dark gray, fine SAND with silty interbeds.

Medium dense, wet, gray to dark gray, slightly silty to very silty, fine SAND with SAND interbeds.

Dense, wet, dark gray, fine SAND with brown, silty, fine SAND interbeds to 1-1/2 inches.

Bottom of Boring at 18.5 Feet. Completed 1/24/91.

Note: Sheen detected in soil samples S-3, S-4, and S-5. Sample S-6 exhibited a black oil-like substance.

Sample	N	PID
S-1	29 10	480
S-2	10 42	320
S-3	22 25	250
S-4	15	190
S-5	16	190
S-6	40	190

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

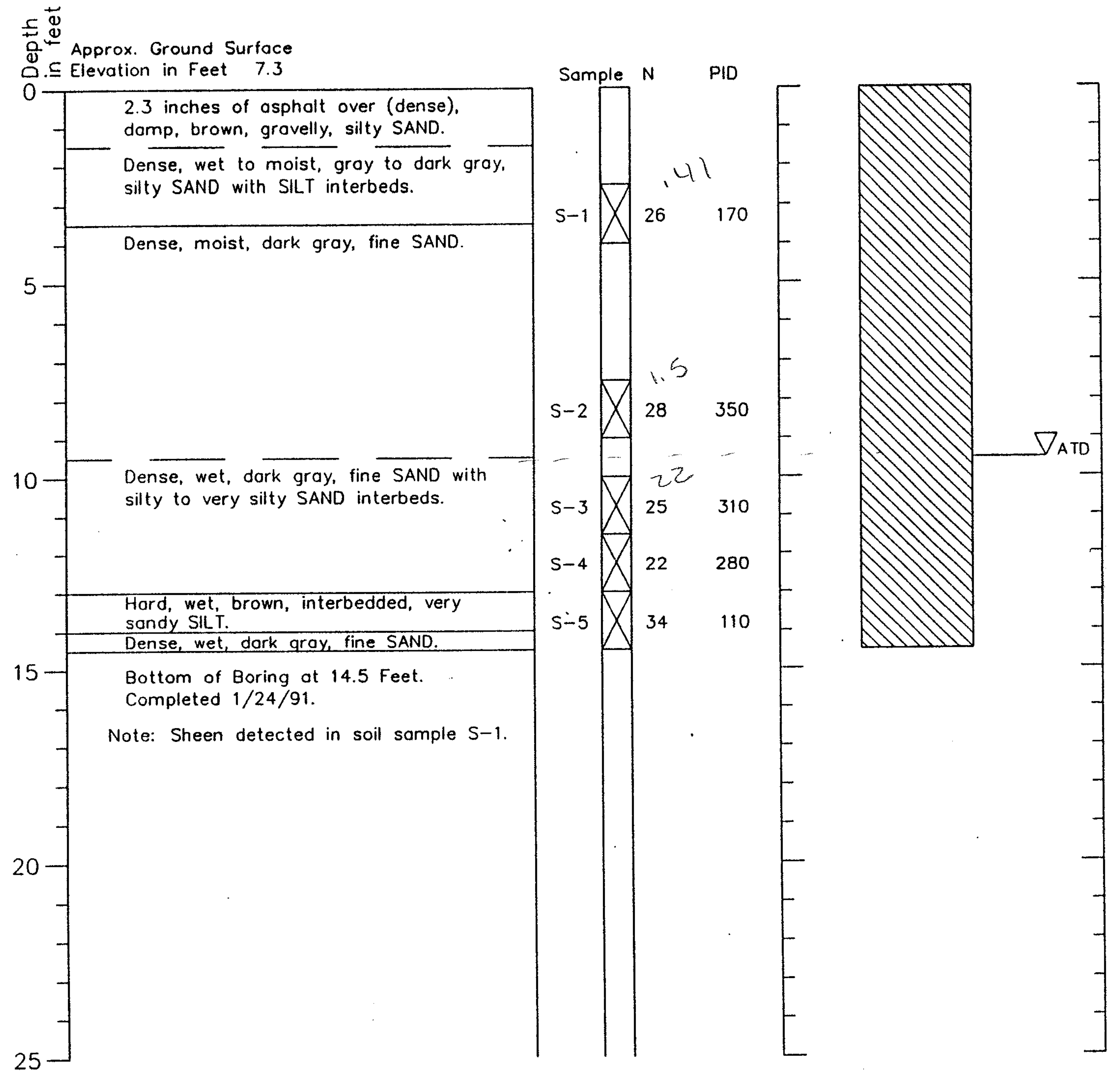
J-2489-07 1/91

Figure A-53

Boring Log SB-11

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 7.3

2.3 inches of asphalt over (dense), damp, brown, gravelly, silty SAND.

Dense, wet to moist, gray to dark gray, silty SAND with SILT interbeds.

Dense, moist, dark gray, fine SAND.

Dense, wet, dark gray, fine SAND with silty to very silty SAND interbeds.

Hard, wet, brown, interbedded, very sandy SILT.

Dense, wet, dark gray, fine SAND.

Bottom of Boring at 14.5 Feet.
Completed 1/24/91.

Note: Sheen detected in soil sample S-1.

Sample	N	PID	
S-1	26	170	.41
S-2	28	350	1.5
S-3	25	310	22
S-4	22	280	
S-5	34	110	

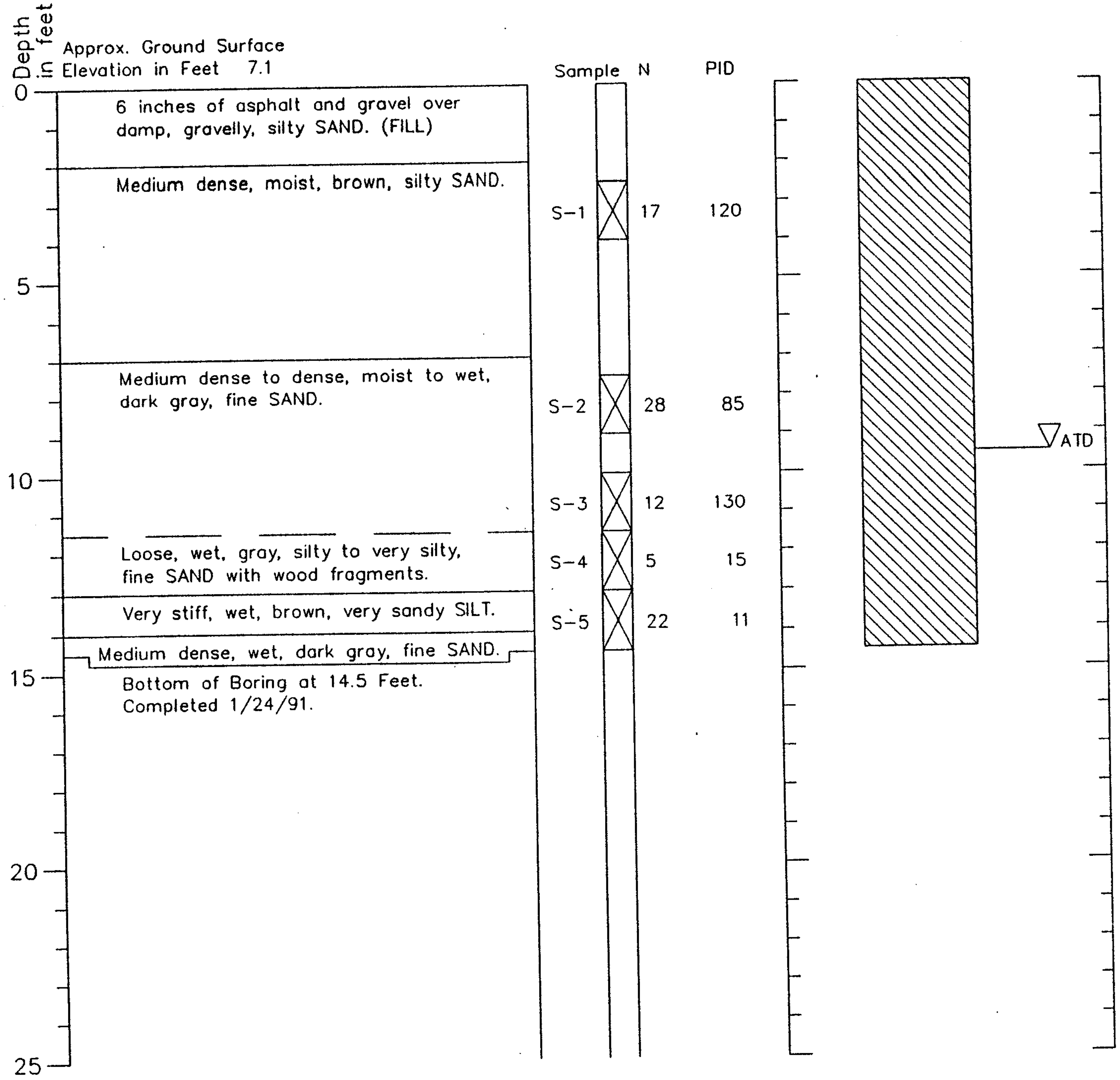
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-07 1/91
Figure A-54

Boring Log SB-12

Geologic Log

Grouted Boring



Approx. Ground Surface Elevation in Feet 7.1

6 inches of asphalt and gravel over damp, gravelly, silty SAND. (FILL)

Medium dense, moist, brown, silty SAND.

Medium dense to dense, moist to wet, dark gray, fine SAND.

Loose, wet, gray, silty to very silty, fine SAND with wood fragments.

Very stiff, wet, brown, very sandy SILT.

Medium dense, wet, dark gray, fine SAND.

Bottom of Boring at 14.5 Feet.
Completed 1/24/91.

Sample	N	PID
S-1	17	120
S-2	28	85
S-3	12	130
S-4	5	15
S-5	22	11

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-2489-07 **1/91**

Figure A-55

Page 1 of 1

TERRA VAC

Geoprobe

Date Drilled: ~~[illegible]~~ 1-15-01

Boring/Well Number: SB13

Project: GWCC

Project Number: 32-0039

Address: 3900 Fox Ave. S. Seattle WA

Drilling Contractor: Cascade Drilling

Log by: J. ORR

Drill Rig: ~~[illegible]~~ Limited

Auger Size/Type: ~~[illegible]~~

Sample Method: ~~[illegible]~~

Total Depth: 17

Depth to Groundwater: 10.5

Backfill or Grout Material: Bentonite

WellCasing/Screen Material: Sch. 40 PVC

Filter Material/Size: NA

Well A: Casing/Screen Diameter: 2" Slot Size: .020 Seal: 0— Screened Interval:

Well B: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Well C: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Well D: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
							GP	SANDY GRAVEL - Fill; 50-60 coarse grn. sub. gravel, 40-50 % med to coarse grn. sand, v. dk brn. (10YR 2/2) dense + damp NPO	Native
SB13-2.5 1210		X	Grab sample	51			SP	SAND; Fill; 100% med grained sand trace silt, trace coarse subrounded gravel, yell. brn (10YR5/6) dense + damp NPO	
B13-4,5 1226	5	X		20					
SB13-7 1230		X		3			SP	SAND - 100% v. fine to med grained sand, v. dk brn (10YR2/2) dense + damp, NPO	
B13-9 1232	10	X		6		▽		@ 8' trace coarse grained sand @ 10.5 wet.	
SB13-11 1237		X		5					
SB13-13 1238		X	HS only	1				@ 13' ½" thick sandy silt bed gray (10YR5/1)	
	15			1			ML	SANDY SILT - 60-70% silt, 30-40% v. fine grn. sand, dk gry (10YR 4/1) low plast., stiff + wet, NPO	
SB13-16 1255		X		0			SP	SAND - 100% v. fine grained sand, v. dk brn (10YR 2/2) dense + wet	
	20								
	25							Grout By Pump 3.5-17 1/4 Bag Powder	

General Remarks:

- Blow counts are recorded for ~~6~~ NA inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ______ for ______.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

1-15-01

Page 1 of 1

TERRA VAC

Geoprobe

Date Drilled: ~~[illegible]~~ Boring/Well Number SB-14
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig ~~[illegible]~~ Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 16 Depth to Groundwater: ____ Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC Filter Material/Size: NA
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: 0— Screened Interval: ____
Well B:Casing/Screen Diameter: ____ Slot Size: ____ Seal: ____ Screened Interval: ____
Well C:Casing/Screen Diameter: ____ Slot Size: ____ Seal: ____ Screened Interval: ____
Well D:Casing/Screen Diameter: ____ Slot Size: ____ Seal: ____ Screened Interval: ____

	Depth (feet)	Samples	Blows	[illegible]	Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
							GP	SANDY GRAVEL – Fill 50-60 med to coarse grained subrounded gravel, 40-50 med to coarse grained sand, trace silt, v. dk brn (10YR 2/2) dense + damp NO	Native
SB14-2.5 1430		X	Grab Sample (Two Jars) 1(full) 1(½)	312			ML	SANDY SILT - Fill; 80-90% silt, 10-20% v. fine grained sand, Pale brn (10YR 6/3)	
B14-5 1448	5	X		27			SP	low plast., very stiff and moist, Strong product odor solvent like.	
								SAND; 100 v. fine to med grained sand v. dk brn, dense + wet	
B14- 1453		X		27					
B14-9 1456		X		48				@ 8' trace coarse grained gravel	
	10					▽			
B14-11 1500		X		1.6				@10.5' wet	
B14-13.5 1504		X		2			SP		
		X		1					
	15						ML	Silt 4" thick	
SB14-14.5 1510		X		0			SP	SAND SAA	
							ML	Silt 2" thick	
							SP	SILT; 60-70% silt 20-30% v. fine grained sand, dk gray (10YR 4/1) and yell. brown (10YR 5/3), low plast stiff and damp to wet.	
	20								
								SAND; 100 v. fine grained sand, v. dk brn (10YR 2/2) dense + wet.	
	25								

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ____ for ____
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Grout by Pump 3.5-16'
1/4 Bag Powder

1-15-01

TERRA VAC
Geoprobe

Date Drilled: ~~[illegible]~~ 1-15-01
Boring/Well Number SB-15
Page 1 of ____
Project: GWCC
Project Number: 32-0039
Address: 3900 Fox Ave S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig Limited [illegible]
Auger Size/Type: [illegible]
Sample Method: Mod. Cal.
Total Depth: 16
Depth to Groundwater: ____
Backfill or Grout Material: Bentonite
WellCasing/Screen Material: [illegible]
Filter Material/Size: NA
Well A:Casing/Screen Diameter: [illegible] Slot Size: [illegible] Seal: [illegible] Screened Interval: NA
Well B:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well C:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well D:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________

	Depth (feet)	Sample	Blows	OVM (ppm) [illegible]	Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
1546 SB15-2.5		X	Grab Samp.	231			GP ML	SANDY GRAVEL - Fill, 50-60% med to coarse grained gravel, 40-50 med grained sand, trace silt v. dk brn (10YR 2/2) dense + damp mod. product odor solvent like	Native
SB15-5 1557	5	X		16				SANDY SILT - Fill 80-90% silt, 10-20% v. fine grained sand, pale brn (10YR 6/3) low plast, v. stiff and moist, NPO	
SB15-7.5 1600		X		10			SP		
SB15-9 1604		X		109				SAND; 100 v. fine to med grained sand v dk brn (10YR 2/2) damp + dense NPO	
SB15-11 1606	10	X		20					
SB15-13 1612		X		1				@13' 0.25-0.5" thick sandy silt beds	
SB15-15 1615	15	X		2			ML SP	SILT - 60-70% silt, 20-30% v.fine grained sand, dk gry (10YR 4/1) low plast., stiff and damp to wet SAND - 100% v. fine grained sand - v dk brn (10YR 2/2) dense + wet.	
	20								
	25								

General Remarks:

- Blow counts are recorded for [illegible] inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ____________ for ____________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

1-15-01

Date Drilled: ~~2000~~ Boring/Well Number SB-16 Page 1 of 1
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Geoprobe
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig ~~[illegible]~~ Limited Auger Size/Type: ~~[illegible]~~ Sample Method: Mod. Cal.
Total Depth: 16 Depth to Groundwater: 10.5 Backfill or Grout Material: Bentonite
WellCasing/Screen Material: ~~SCH 40 PVC~~ Filter Material/Size:
Well A:Casing/Screen Diameter: ~~2~~ Slot Size: ~~.010~~ Seal: ~~[illegible]~~ Screened Interval: NA
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

		Depth (feet)	Sample	Blows	[illegible]	Odor	TPH [illegible]	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
								GP	SANDY GRAVEL – Fill, 50-60% coarse to med grained subrounded gravel, 40-50% med to coarse grn sand, trace silt, v dk brn (10YR 2/2), dense + damp.	Native
B16-2.5	1320		x	Grab Sample	.12			---	SAND – Fill; 100% med grained sand, trace subrounded med. grained gravel, yell brn (10YR 5/6), dense + damp NPO	
								SP		
B16-5 B16-5	1342 1400	5			11				@ 6-7 Sandy Silt bed	
B16-7	1345		x		22					
B16-9	1349		x		12			SP	SAND; 100% v fine to med grn sand, v. dk brn (10YR 2/2), dense + damp.	
		10					∇			
B16-11	1353		x		53				@ 10.5 wet trace coarse grn sand.	
B16-13	1355		x		7				@13-13.5' 0.25 to 1" thick sandy silt beds	
		15	x		3			ML	SANDY SILT; 70-80% silt, 20-30% v. fine grained sand, dk gry (10YR 4/1) low plast, v. stiff, wet to moist, NPO	
B16-15	1400							SP	SAND; 100% v. fine grained sand, v. dk brn, (10YR 2/2), dense + wet	
		20								
									Grout by Pump 3.5-16 1/4 Bag Bent Powder	
		25								

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Page 1 of 1

Date Drilled: ~~[illegible]~~ 1-15-01
Boring/Well Number: SB-17
Project: GWCC
Project Number: 32-0039
Address: 8900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig: ~~[illegible]~~ Geoprobe
Auger Size/Type: ~~[illegible]~~
Sample Method: ~~[illegible]~~
Total Depth: 13.5
Depth to Groundwater: 10.5
Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC
Filter Material/Size: Native
Well A:Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: None Screened Interval: 13.5 – 9.5
Well B:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D:Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

Depth (feet)	Sample	Blows		Odor	TPH (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
0							Asphalt 2" thick	
		Na						
OK? ~~[illegible]~~ ~~SB17-3 855~~ ↑ OK	X	60				SM	SILTY SAND; - Fill 60-70% v. fine grained sand, 30-40% silt mottled grayish Brn (10YR 5/2) and yell. brn (10YR 5/8) med. dense + damp NPO	
5								
B17-6 0900	X	16				SP	SAND - 100% fine to med. grained v. dk brn (10YR 2/2), dense + damp, NPO	
B17-7.5 905	X	56						
B17-... 909	X	48						
10						▽	@ 13' 2" silty sand bed, brownish yell. (10YR 6/8) @ 10.5' trace coarse grained sand and wet	
B17-11.5 912	X	25						
B17-13 915	X	7				ML	SANDY SILT; 70-80% silt, 20-30% v. fine grained sand, dk gray (10YR 4/1) low plast., stiff + wet	
15								
20							Note: Abandon Well Same Day Pump full of Bentonite Slurry	
25								

General Remarks:
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

1-15-01

Page 1 of 1

TERRA VAC

Date Drilled: ~~[illegible]~~ Boring/Well Number SB-18
Project: GWCC Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling Log by: J. ORR
Drill Rig Geoprobe ~~Limited~~ Auger Size/Type: [illegible] Sample Method: [illegible]
Total Depth: 14.5 Depth to Groundwater: @ 10.5 Backfill or Grout Material: Bentonite
WellCasing/Screen Material: Sch. 40 PVC Filter Material/Size: Native
Well A:Casing/Screen Diameter: 2" Slot Size: 0.0[illegible] Seal: None Screened Interval: 9.5 13.5
Well B:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well C:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________
Well D:Casing/Screen Diameter: ___ Slot Size: ____ Seal: ________ Screened Interval: ________

Sample ID	Depth (feet)	Sample	Blows	PID	Odor	TPH	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
								Asphalt 3" thick	
							SM	SILTY SAND, [illegible] 70-80% v. fine grn. sand, 20-30% silt gry bn (10YR 5/2) med. dense + damp	
B18-3.5 943		X	9						
	5						SP	@ 5.5' 6" thick redish brn (2.5YR 4/8)	
B18-5.5 947		X	10						
SB18-7.5 950		X	4					SAND 100 v. fine to med grained sand brown to redish brn, dense + damp	
953 B18-9.5		X	4					@ 10.5 wet	
	10					▽			
B18-11.5 958		X	33					@ 11.5 1.5' Sandy Silt bed gry brn.	
SB18-13 1003		X	17						
SB18-14 1015		X	28				ML	SANDY SILT, 70-80% silt, 20-30% v. fine grn. sand dk gry (10YR 4/1) low plast, stiff + wet	
↑ Part Sample Silt	15								
	20							Note: Abandon Well Same Day Pump full of Bentonite Slurry	
	25								

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ________ for ________.
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

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TERRA VAC

Geoprobe

Page 1 of 1

Date Drilled: ~~[illegible]-00~~ 1-15-01
Boring/Well Number SB-19
Project: GWCC
Project Number: 32-0039
Address: 3900 Fox Ave. S. Seattle WA
Drilling Contractor: Cascade Drilling
Log by: J. ORR
Drill Rig ~~[illegible]~~ Limited
Auger Size/Type: [illegible]
Sample Method: [illegible]
Total Depth: 14.5
Depth to Groundwater: 10.5
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Native
Well A: Casing/Screen Diameter: 2" Slot Size: 0.01 Seal: ~~ON~~ NONE Screened Interval: 10.5-14.5
Well B: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well C: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___
Well D: Casing/Screen Diameter: ___ Slot Size: ___ Seal: ___ Screened Interval: ___

	Depth (feet)	Sample	Blows	[illegible]	Odor	TPH	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
								Asphalt 3" thick	
SB19-3.5 1028		X	22				ML	SANDY SILT - Fill, 60-90% silt, 30-40% v. fine grained sand, yell brn (10YR 5/8) with redish brown (2.5YR 4/8) laminations, low plast, stiff ~~and~~ damp to wet, NPO	
SB19-5.5 1033	5	X	27						
SB19-7.5 1038		X	11				SP	SAND; 100% v. fine to med. grained v. dk brn (10YR 2/2) dense + damp NPO	
SB19-9.5 1041	10	X	48			▽		@ 10.5 wet	
SB19-11.5 1045		X	32					@ 12.5 trace med to course grn sand	
SB19-13 1049		X	15						
SB19-14 1055		X	6						
	15						ML	@ 14.5 2" thick SANDY SILT; 70-80% silt 20-30% v. fine grn. sand, brn. yell. (10YR 6/8) to dk gray (10YR 4/1), low plast., stiff + wet	
	20							Note: Abandon well same day Pump full Bentonite Slurry	
	25								

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- TPH = Total Petroleum Hydrocarbon concentrations analyzed using EPA Method ______ for ______
- ND = not detected or levels were below analytical detection limits of ____ parts per million (ppm).

This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

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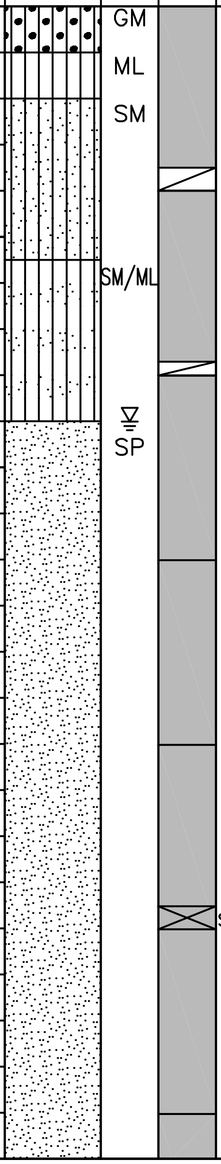
Suite 130
Bellevue, Washington 98005
(425) 462-8591

BOREHOLE LOG

Site Id: SOD-1
Page 1 of 2

Project Number: 0021460.14
Project Name: Fox Avenue LLC Phase III EPS
Location: Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct Push
Sampling Method: Macro-core

Total Depth: 50.00'
Borehole Dia.: 2.00in
Logged By: B. Magee
Initial Water Level: 9.00'
Date(s): 08/22/06



Depth (ft)	USCS Code	Sample Number	Description/Soil Classificiation
	GM		SILTY GRAVEL (GM): tan, some grass.
	ML		SANDY SILT (ML): brown, moist.
	SM		SILTY SAND (SM): fine grained, moist.
5	SM/ML		SILTY SAND/SANDY SILT (SM/ML): tan to brown, laminated, moist to wet.
			Some moisture in silt laminations (0.25"–2" thick), some rust colored bands.
			Slough.
10	▽ SP		SAND (SP): black with approx. 5% light color (silica?) grains, fine to medium, wet.
			Slough.
			SAND (SP): black with 5–10% light colored grains, medium to fine, slightly silty <5%, saturated.
15			SAND (SP): black, fine to <5% coarse sand and up to 1/2" sub-rounded gravel (granite?), no silt, slight sulfur odor, saturated.
			As above, light sulfur odor.
		SOD-1-19	Wood fragments to 1" (2" thick layer at bottom of sample).
20			SAND (SP): black with approx. 5% light and red colored grains, little to no silt, light sulfur and "organic" odor, saturated.
			SAND (SP): black with 5–10% light and red grains, medium to fine with coarse sand, slight sulfur and "organic" odor, saturated.

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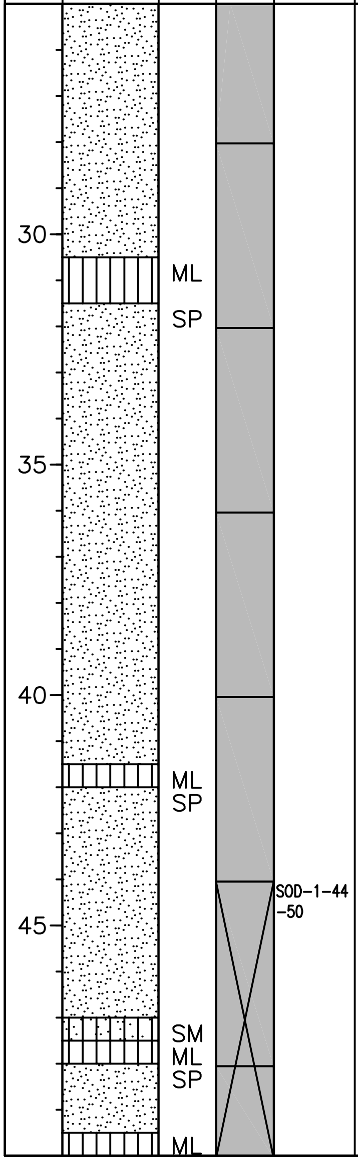
BOREHOLE LOG

Site Id: SOD-1
Page 2 of 2

Project Number: 0021460.14
Project Name: Fox Avenue LLC Phase III EPS
Location: Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct Push
Sampling Method: Macro-core

Total Depth: 50.00'
Borehole Dia.: 2.00in
Logged By: B. Magee
Initial Water Level: 9.00'
Date(s): 08/22/06

Depth (ft) | Graphic Log | USCS Code | Sample Recovery | Sample Number | Description/Soil Classificiation



As above, increasing coarse sand (to 10%).

SAND (SP): black with light grains, very slight silt, slight sulfur/"organic" odor, saturated.

SILT (ML): dark gray, some fine sand, plastic, cohesive, saturated.

SAND (SP): black, medium to fine, saturated.

SILT (ML): gray, 1" lense at 33.5'.
SILT (ML): gray, 1" lense at 34.0'.

SILT (ML): gray, some very fine sand, slightly plastic, cohesive.
SAND (SP): black, medium to fine, slight sulfur odor, saturated.

SILTY SAND (SM): black, some gray 0.1" silt strings, cohesive.
SILT (ML): gray, some very fine sand, stiff, low cohesion.
SAND (SP)

SILT (ML)
Total Depth - 50.0 ft bgs

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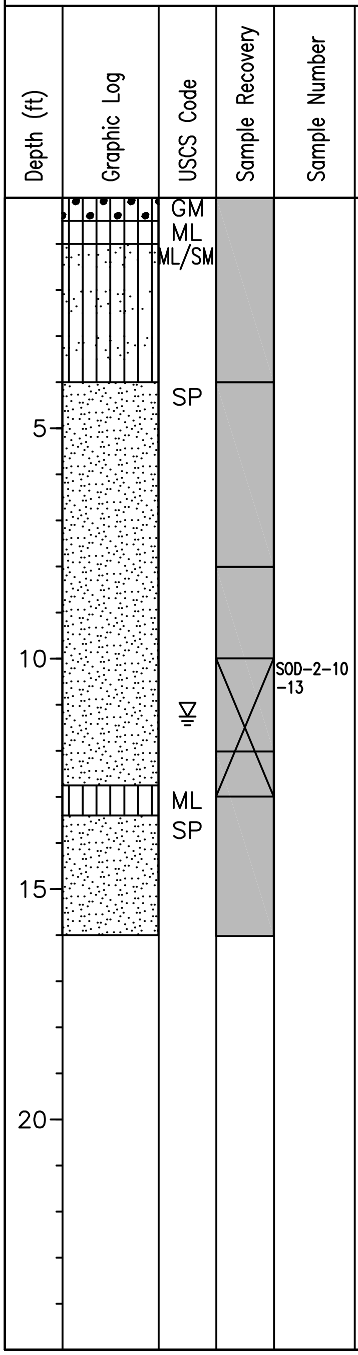
BOREHOLE LOG

Site Id: SOD-2
Page 1 of 1

Project Number: 0021460.14
Project Name: Fox Avenue LLC Phase III EPS
Location: Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct Push
Sampling Method: Macro-core

Total Depth: 16.00'
Borehole Dia.: 2.00in
Logged By: B. Magee
Initial Water Level: 11.25'
Date(s): 08/22/06



Description/Soil Classificiation

Grass
SILTY GRAVEL (GM): tan, brown, and black.
SANDY SILT (ML): tan, fine grain, slightly moist.
SANDY SILT/SILTY SAND (ML/SM): tan with orange bands throughout, laminated.

As above, very moist.
SAND (SP): brown with white, medium grain, little to no silt, moist.

Slough.
SAND (SP): brown with white and yellow, medium grain, no silt, moist.

SAND (SP): darker brown with white and yellow, medium grain, no silt, saturated.

SAND (SP): brown, medium grain, saturated.

SILT (ML): olive gray, fine sands, low plasticity, stiff.
SAND (SP): black with some white grain, sulfur odor, saturated.

Total Depth – 16.0ft bgs

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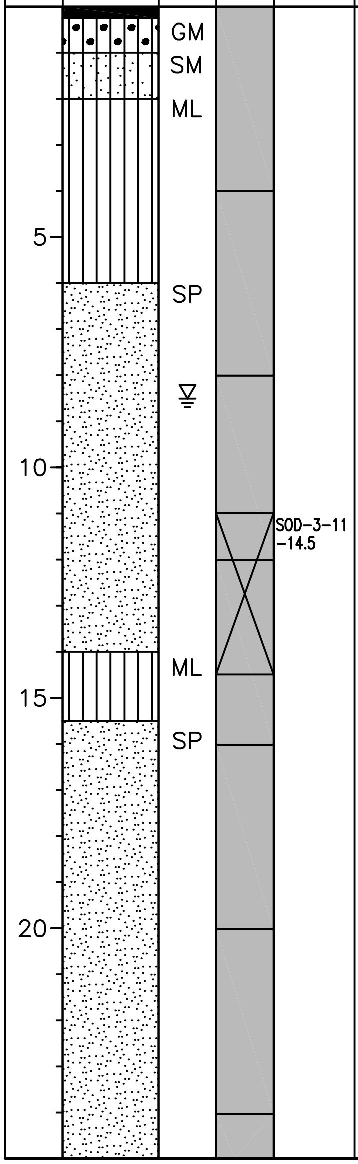
BOREHOLE LOG

Site Id: SOD-3
Page 1 of 2

Project Number: 0021460.14	Total Depth: 44.00'
Project Name: Fox Avenue LLC Phase III EPS	Borehole Dia.: 2.00in
Location: Seattle, Washington	Logged By: B. Magee
Contractor: Cascade Drilling	Initial Water Level: 8.50'
Drilling Method: Direct Push	Date(s): 08/22/06
Sampling Method: Macro-core	

Depth (ft) | Graphic Log | USCS Code | Sample Recovery | Sample Number | Description/Soil Classificiation



Asphalt
GRAVEL (GM): silty, sandy.
SILTY SAND (SM): brown, fine grain, cohesive.
SANDY SILT (ML): gray with orange mottling, cohesive, moist.

As above, wet.

SAND (SP): brown with yellow and white rust colored bands throughout, medium to fine grain, wet.

As above, saturated.

SILT (ML): gray, 1" lense at 10.0'.
SAND (SP): as above, increasingly dark color.

SILT (ML): gray, stiff, cohesive, slight sulfur odor, saturated.

SAND (SP): black, fine to medium grain with approx. 5% coarse grain, little to no silt, light sulfur/"organic" odor.

SAND (SP): black with approx. 5% white and yellow grains, medium grain, slight sulfur odor, saturated.

BOREHOLE LOG

Site Id: SOD-3
Page 2 of 2

Project Number: 0021460.14

Project Name: Fox Avenue LLC Phase III EPS

Location: Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: Direct Push

Sampling Method: Macro-core

Total Depth: 44.00'

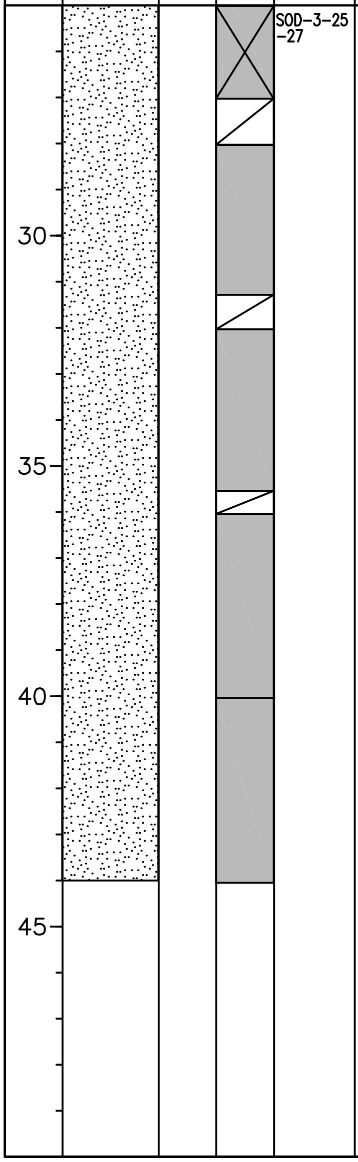
Borehole Dia.: 2.00in

Logged By: B. Magee

Initial Water Level: 8.50'

Date(s): 08/22/06

Depth (ft)	Graphic Log	USCS Code	Sample Recovery	Sample Number	Description/Soil Classificiation



4" zone with some woody inclusions at 25.8'.

SAND (SP): black, medium grain, slight sulfur/"organic" odor, saturated.

SILT (ML): gray, stiff, 1" lense at 30.5'.

SAND (SM): grayish tint, slightly silty, some cohesion.
SAND (SP): black, medium grain, slight sulfur/"organic" odor, saturated.

SAND (SM): black with some white sand (<5%), slightly silty.

SAND (SM): black with some white sand (<5%), increasingly silty, slight cohesion.

Total Depth - 44.0ft bgs

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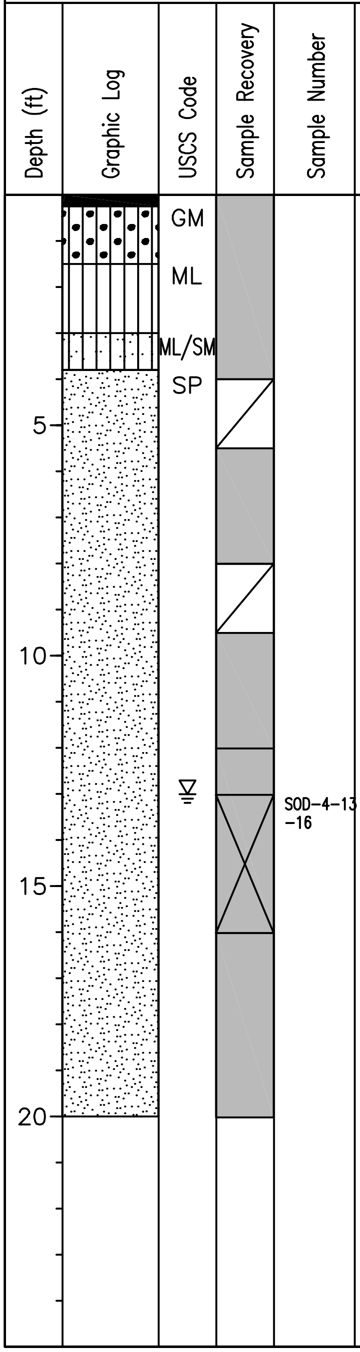
BOREHOLE LOG

Site Id: SOD-4
Page 1 of 1

Project Number: 0021460.14
Project Name: Fox Avenue LLC Phase III EPS
Location: Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: Direct Push
Sampling Method: Macro-core

Total Depth: 20.00'
Borehole Dia.: 2.00in
Logged By: Z. Clements
Initial Water Level: 13.00'
Date(s): 08/22/06



Description/Soil Classificiation

Asphalt
SANDY GRAVEL (GP): black and brown.
SANDY SILT (ML): tan, fine grain, slightly moist.
As above, wet.
SANDY SILT/SILTY SAND (ML/SM): tan with orange bands throughout, very moist.
SAND (SP): brown with white, medium grained, no silt, moist.

Slough.

SAND (SP): brown with white, medium grained, no silt, moist.

SAND (SP): brown with white and yellow, no silt, moist.

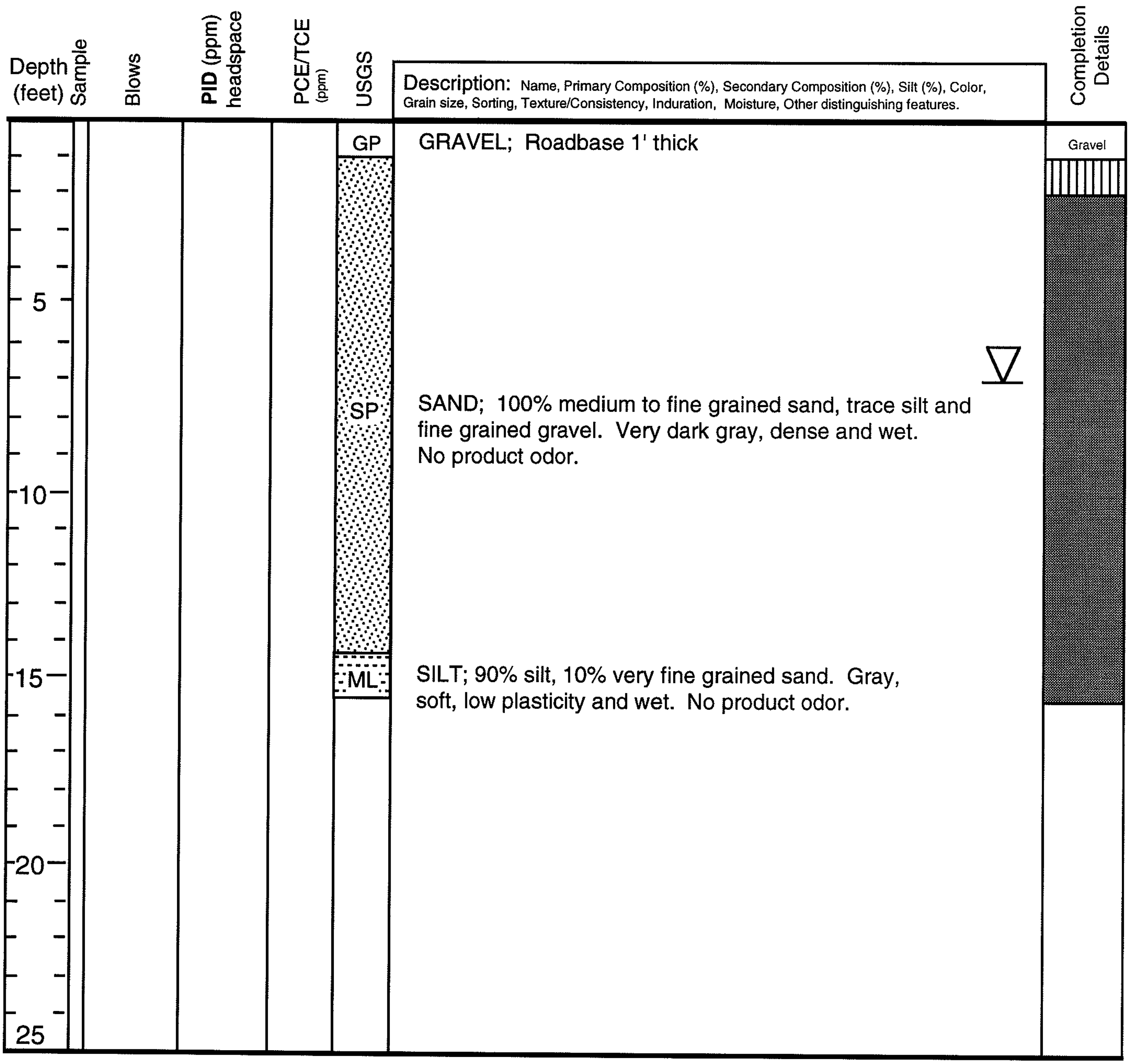
SAND (SP): brown, medium grained, saturated.
SAND (SP): darker brown to black, medium grained, saturated.

At 16.0', 1" lense, intermingled/marbled with SILT (ML): tan, soft, no plasticity, saturated.

Total Depth – 20.0ft bgs

TERRA VAC

Date Drilled: 1/22/99
Boring/Well Number: TB-1
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, WA
Drilling Contractor: Cascade
Log by: Jim Orr
Drill Rig: CME-75
Auger Size/Type: 6" Hollow stem
Sample Method: Grab
Total Depth: 15.5
Depth to Groundwater: 7' ATOB
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A
Filter Material/Size: N/A
Well A: Casing/Screen Diameter: N/A
Slot Size: N/A
Seal: N/A
Screened Interval: N/A



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

GRAVEL; Roadbase 1' thick

SAND; 100% medium to fine grained sand, trace silt and fine grained gravel. Very dark gray, dense and wet. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor.

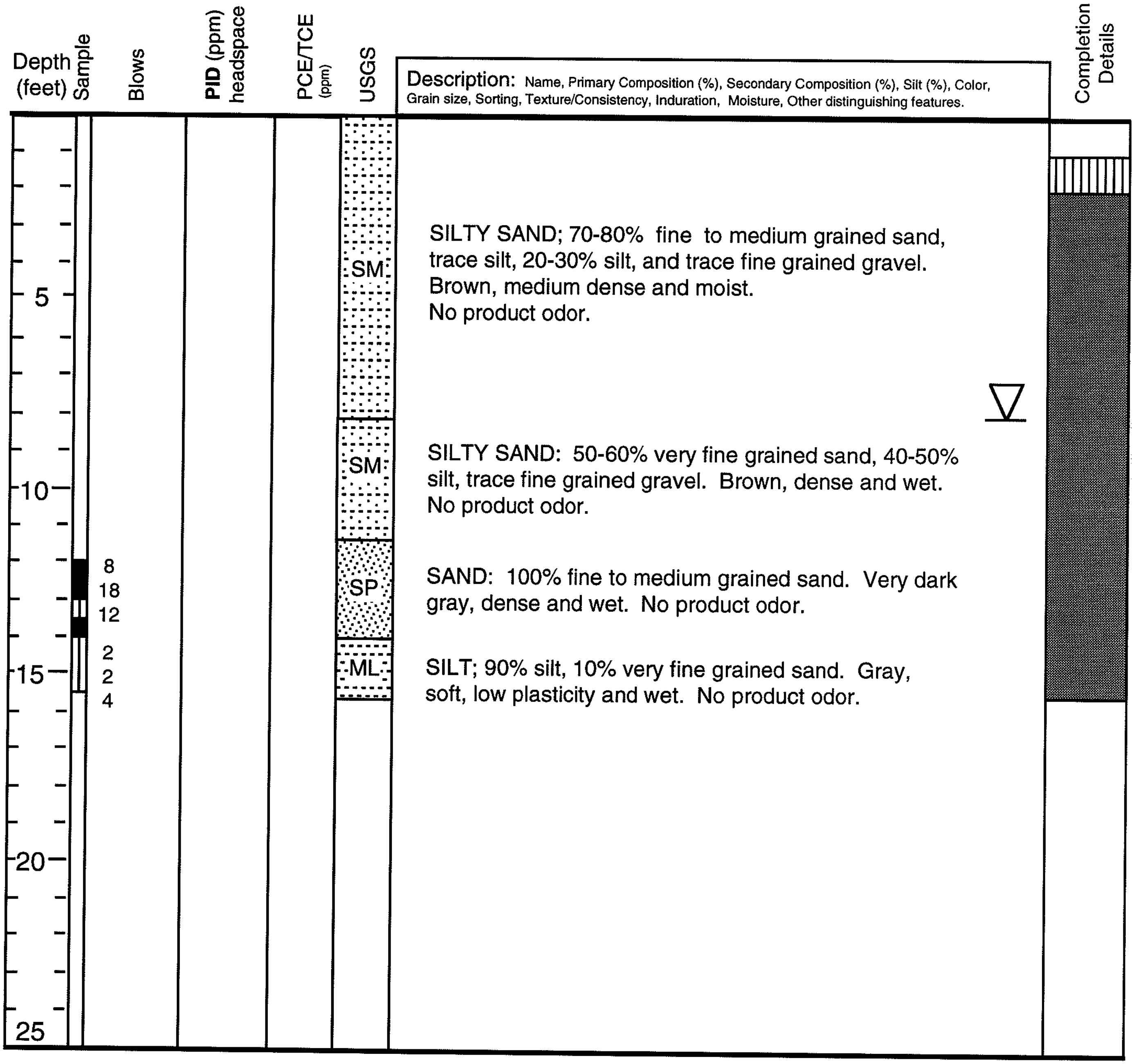
General Remarks:

- Blow counts are recorded for NA inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 1/22/99 **Boring/Well Number:** TB-2
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, WA
Drilling Contractor: Cascade Log by: Jim Orr
Drill Rig: CME-75 Auger Size/Type: 6" Hollow Stem Sample Method: Split Spoon
Total Depth: 15.5 Depth to Groundwater: 8' ATOB Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: N/A



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY SAND; 70-80% fine to medium grained sand, trace silt, 20-30% silt, and trace fine grained gravel. Brown, medium dense and moist. No product odor.

SILTY SAND: 50-60% very fine grained sand, 40-50% silt, trace fine grained gravel. Brown, dense and wet. No product odor.

SAND: 100% fine to medium grained sand. Very dark gray, dense and wet. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor.

General Remarks:

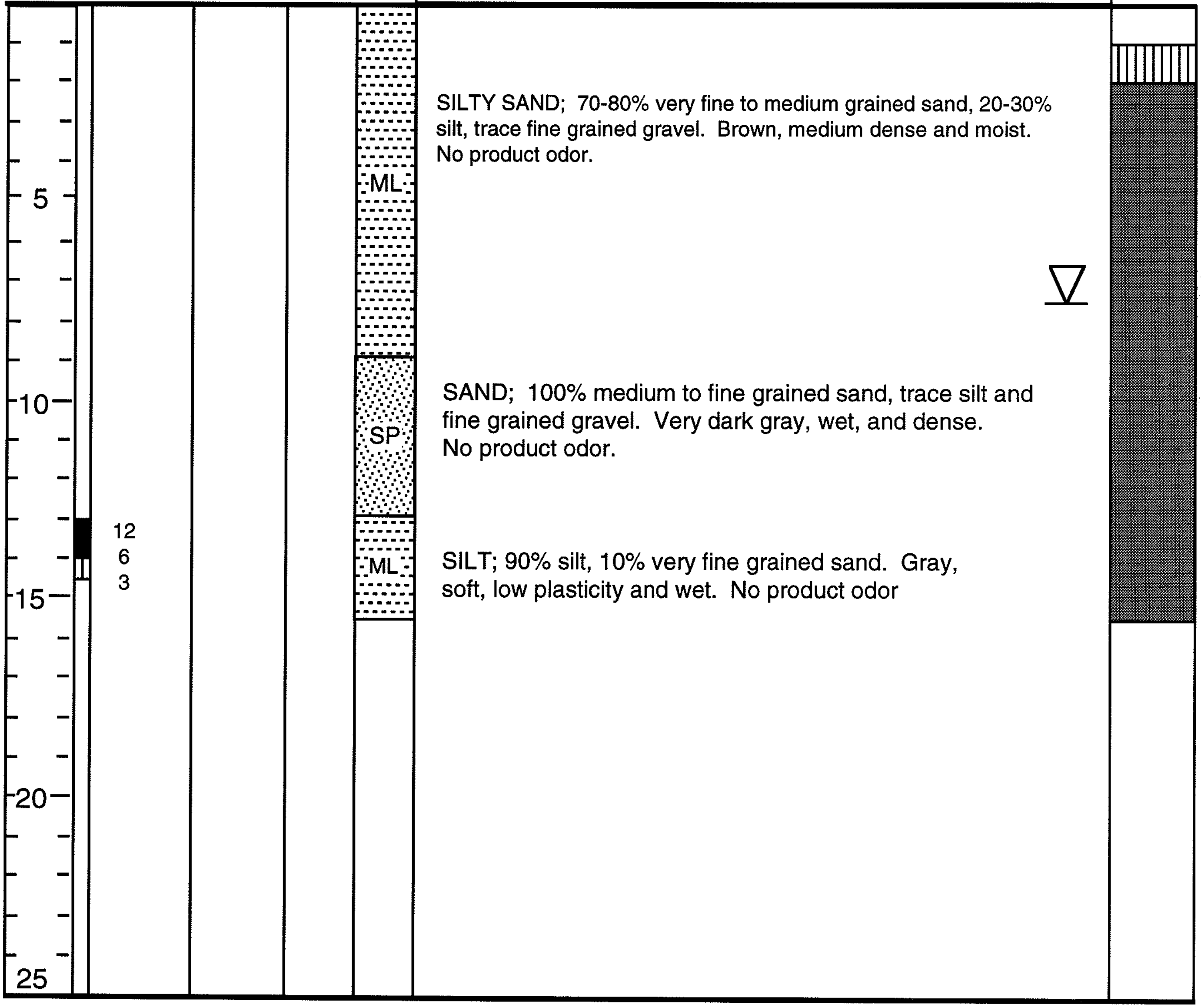
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 1/22/99
Boring/Well Number: TB-3
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, WA
Drilling Contractor: Cascade
Log by: Jim Orr
Drill Rig: CME-75
Auger Size/Type: 6" Hollow stem
Sample Method: Split Spoon
Total Depth: 15.5
Depth to Groundwater: 7.5' ATOB
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A
Filter Material/Size: N/A
Well A: Casing/Screen Diameter: N/A
Slot Size: N/A
Seal: N/A
Screened Interval: N/A

Depth (feet)	Sample	Blows	**PID** (ppm) headspace	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Completion Details
0–9					ML	SILTY SAND; 70-80% very fine to medium grained sand, 20-30% silt, trace fine grained gravel. Brown, medium dense and moist. No product odor.	
9–13					SP	SAND; 100% medium to fine grained sand, trace silt and fine grained gravel. Very dark gray, wet, and dense. No product odor.	
13–15.5		12 6 3			ML	SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor	



General Remarks:

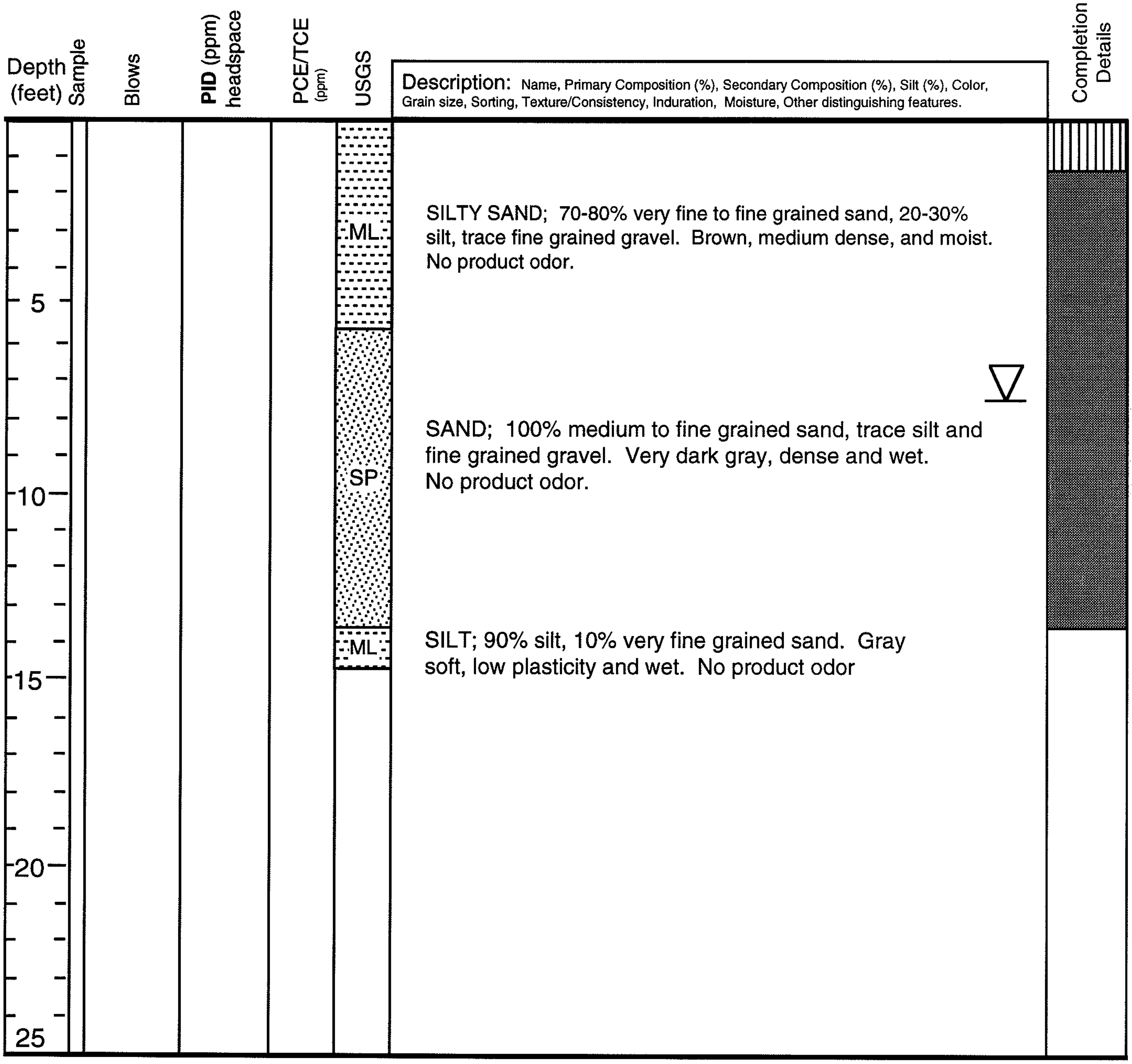
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Page 1 of 1

TERRA VAC

Date Drilled: 1/22/99 **Boring/Well Number:** TB-4
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, WA
Drilling Contractor: Cascade Log by: Jim Orr
Drill Rig: CME-75 Auger Size/Type: 6" Hollow stem Sample Method: Split Spoon
Total Depth: 13.5 Depth to Groundwater: 7.5' ATOB Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A
Well A: Casing/Screen Diameter: N/A Slot Size: N/A Seal: N/A Screened Interval: N/A



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY SAND; 70-80% very fine to fine grained sand, 20-30% silt, trace fine grained gravel. Brown, medium dense, and moist. No product odor.

SAND; 100% medium to fine grained sand, trace silt and fine grained gravel. Very dark gray, dense and wet. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray soft, low plasticity and wet. No product odor

General Remarks:

- Blow counts are recorded for ___ inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

ERM
915 118th Avenue S.E.
Suite 130
Bellevue, Washington 98005
(425) 462-8591

TEST PIT LOG

Fox Avenue Test Pit

Project Number: 5303.12

Project Name: Fox Avenue

Location: CCDC, Seattle, Washington

Date(s): 8/27/03

Test Pit Equipment: Back–Hoe

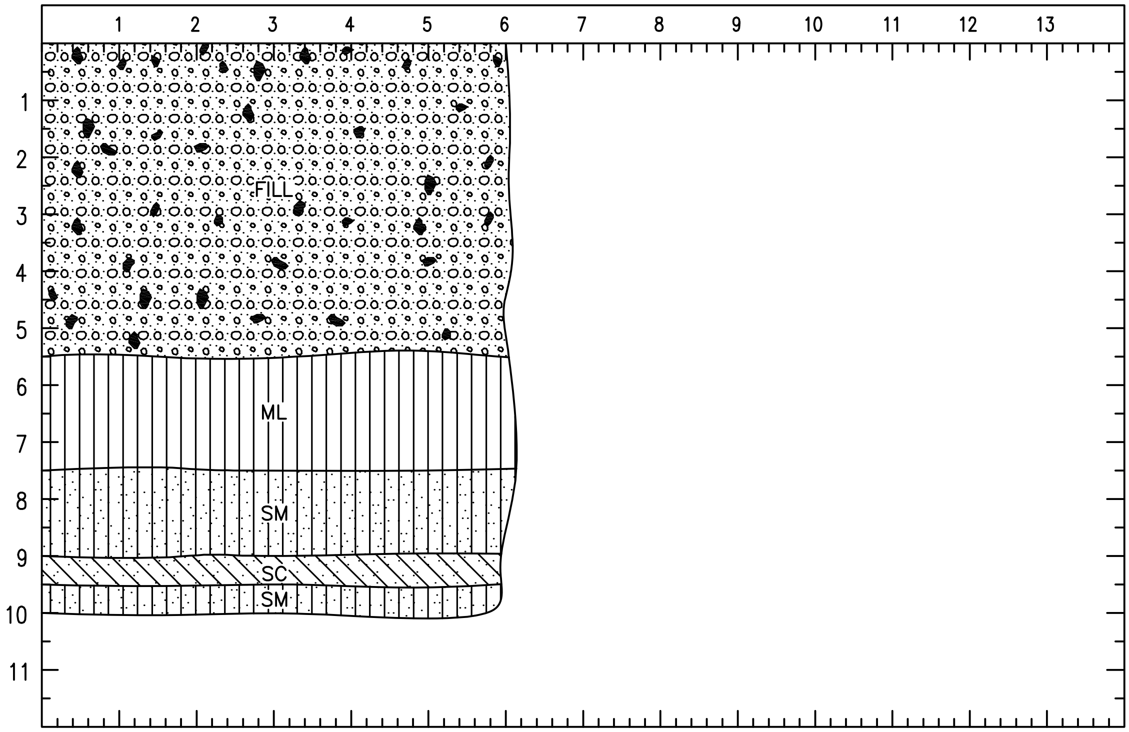
Logged By: Z. Clements

Total Depth: 10.00 Feet

Ground Water Depth: 10.00'

DEPTH (feet)	USCS LOG	SAMPLE	FID/PID (ppm)	SOIL DESCRIPTION AND OBSERVATIONS
				Gravel/broken concrete debris in sand/silt fill.
1				Silty sand with fill debris
			16	
			20	Sandy, peaty material, black organic, slight solvent odor.
2				Sandy silt, with black "slag" fill.
	FILL			
3			10	
4			15–25	Silty, sandy, gravelly slag fill, black to gray, solvent–like odor.
5				
				SANDY SILT (ML): black, soft, slight odor, slightly moist.
6				SILT (ML): tan, soft, cohesive, slight odor, moist.
	ML			SILT (ML): tan, with some fine grained sand, cohesive, slight odor, moist
7				SILT (ML): as above, with stringers of less cohesive sand.
8			35+	SILTY SAND (SM): tan, slightly cohesive, moist.
	SM			SILTY SAND (SM): tan to gray, fine to medium grained, slightly cohesive, strong odor, moist.
9				
	SC			CLAYEY SAND (SC): tan to gray, fine to medium grained, cohesive, strong odor, moist.
	SM		20–60	SILTY SAND (SM): gray, fine to medium grained, slightly cohesive, strong odor.
10				SILTY SAND/CLAYEY SILT (SM/ML): gray, mixed sand, silty, clayey, moist to wet.
11				

TEST PIT WALL: BEARING: ??? SCALE: 1:1.35



C=CONTACT B=BEDDING J=JOINT S=SHEAR

This summary applies only at the location and time of the excavation. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

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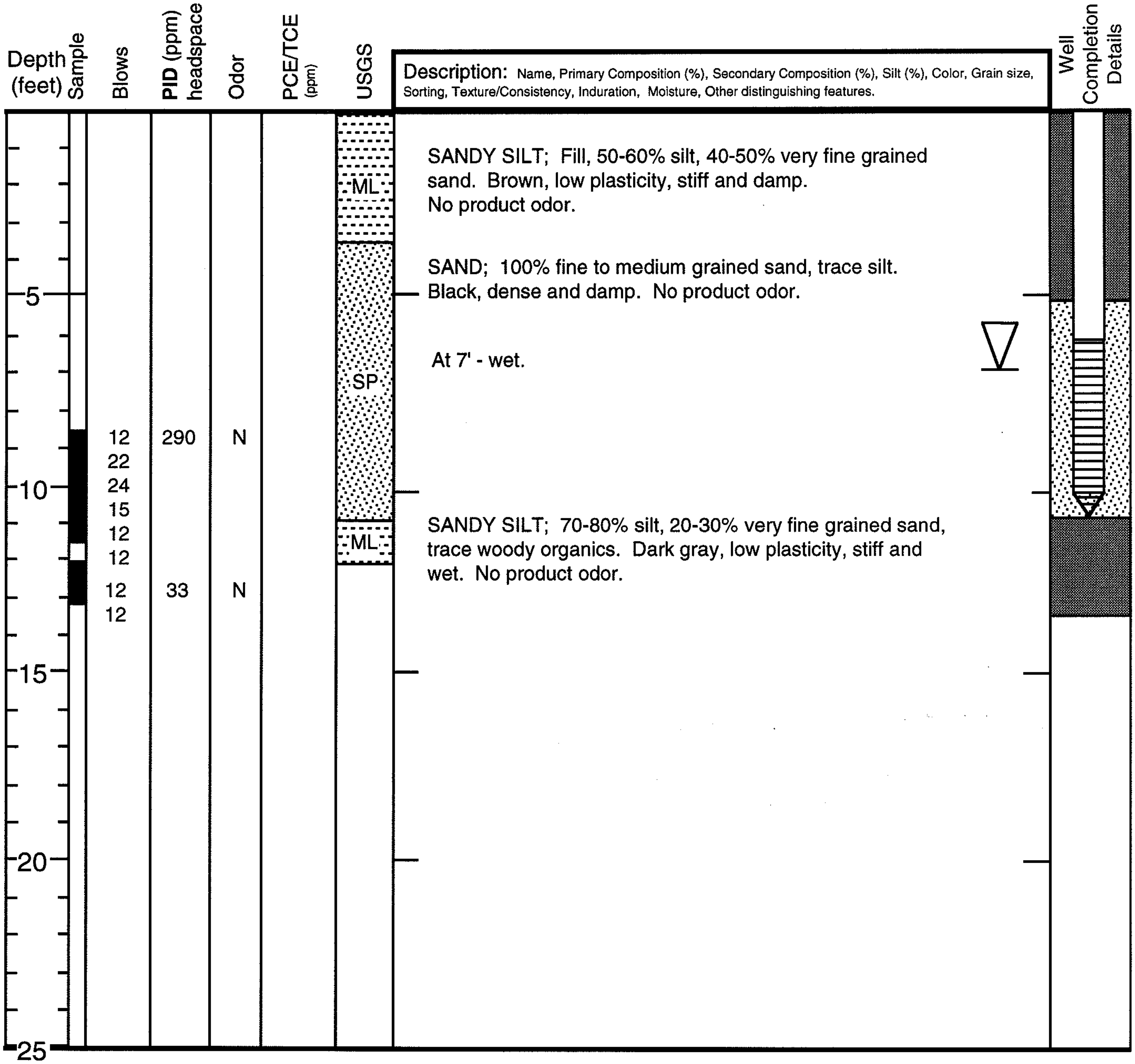
TERRA VAC

Limited Access

Date Drilled: 7/6/99 **Boring/Well Number:** TW-1 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Dames & Moore
Total Depth: 13 feet Depth to Groundwater: Approx. 7 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-5 feet Screened Interval: 6-11 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SANDY SILT; Fill, 50-60% silt, 40-50% very fine grained sand. Brown, low plasticity, stiff and damp. No product odor.

SAND; 100% fine to medium grained sand, trace silt. Black, dense and damp. No product odor.

At 7' - wet.

SANDY SILT; 70-80% silt, 20-30% very fine grained sand, trace woody organics. Dark gray, low plasticity, stiff and wet. No product odor.

Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)
12	290	N	
22			
24			
15			
12			
12			
12	33	N	
12			

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

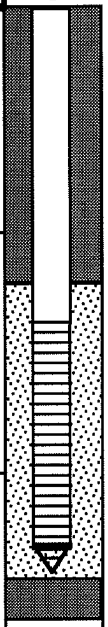
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/6/99 **Boring/Well Number: TW-2** Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Dames & Moore
Total Depth: 13.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						SP	SAND; Fill, 100% very fine to fine grained sand, trace fiine to medium grained subrounded gravel. Yellow-brown, very loose and damp. No product odor.
5							
		2	170	N			▽
		1					
		2					
10		5	46	N		SP	SAND; 100% fine to medium grained sand, trace roots and organics. Black, medium dense and wet No product odor. At 12.5' - trace of subrounded medium grained gravel.
		10					
		10					
		15	3.4	N		ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Dark gray, low plasticity, hard and moist. Gradational contact to 70-80% silt. No product odor.
		15					
15							
20							
25							

Well Completion Details

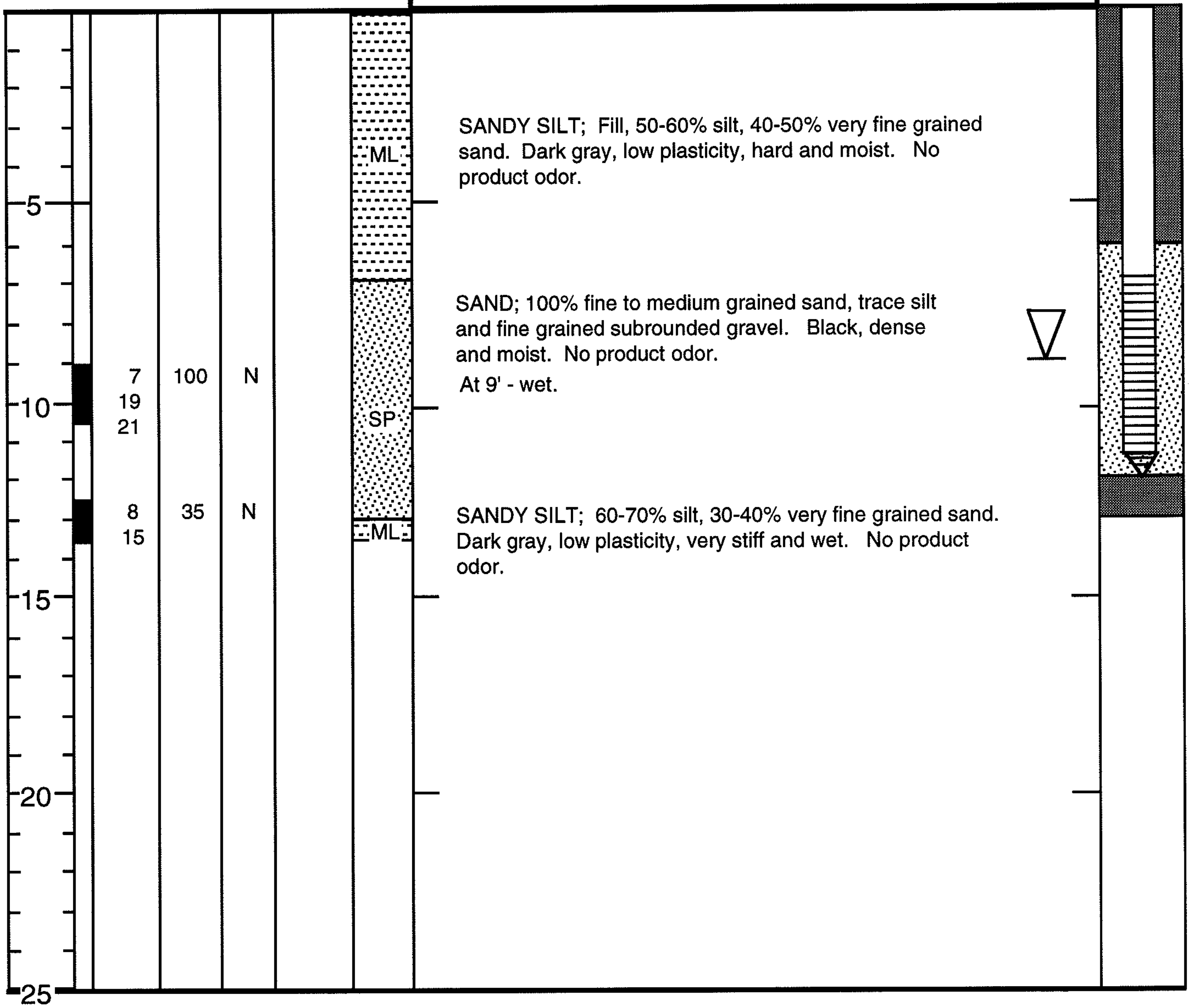


General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

TERRA VAC

Date Drilled: 7/6/99 **Boring/Well Number:** TW-3 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Dames & Moore
Total Depth: 13.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet



Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						ML	SANDY SILT; Fill, 50-60% silt, 40-50% very fine grained sand. Dark gray, low plasticity, hard and moist. No product odor.
	■	7 19 21	100	N		SP	SAND; 100% fine to medium grained sand, trace silt and fine grained subrounded gravel. Black, dense and moist. No product odor. At 9' - wet.
	■	8 15	35	N		ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

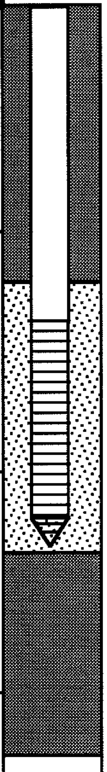
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/7/99 **Boring/Well Number:** TW-5 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Mod. Cal.
Total Depth: 16.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 7-12 feet

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
							ASPHALT; 2" thick.
						GP	SANDY GRAVEL; Fill, 80-90% fine to coarse grained gravel, 10-20% sand, trace silt. Brown, dense and damp. No product odor.
5				N		ML	SANDY SILT; Fill, 60-70% silt, 30-40% very fine grained sand, trace clay. Brown, low plasticity, very stiff and moist. Dendritic iron oxide veinlets. No product odor.
10	■	8 12 15	12	N		SP	SAND; 100% fine to medium grained sand, trace silt, trace fine grained subrounded gravel. Black, medium dense and moist to wet. No product odor. ▽
	■	8 13 20	33	N		SP	SAND; 100% very fine to fine grained sand, trace silt. Very dark gray, hard and wet. Sandy silt to sandy clay 1-1.5" thick stringers, no observable horizontal bedding - dark gray color. No product odor.
15	■	19 25 30	168	N		SP	SAND; 100% fine to medium grained sand, trace silt, trace fwood fragments (0.5" thich tree limb). Black, very dense and wet. 0.5" to 1" thick dark gray to brown sandy silt to sandy clay stringers. No product odor.
20							
25							

Well Completion Details



General Remarks:

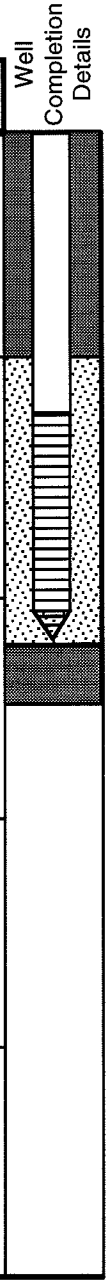
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/8/99 **Boring/Well Number:** TW-6 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-55 Auger Size/Type: HSA Sample Method: Mod. Cal/Std. Pen.
Total Depth: 13.5 feet Depth to Groundwater: Approx. 9 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-5 feet Screened Interval: 6-11 feet

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GP	ASPHALT; 3" thick. SANDY GRAVEL; Fill, 80-90% fine to coarse grained subrounded gravel, 10-20% fine grained sand, trace silt and clay. Brown, dense and damp. No product odor.
						ML	SILTY SAND; Fill, 50-60% very fine grained sand, 40-50% silt, trace clay. Brown, low plasticity, medium dense and damp. No product odor.
5	X	Grab	6			SP	SAND; 100% fine to medium grained sand, trace silt. Black, medium dense and moist. 0.5" thick very fine grained silty interbedded stringers, trace fine subrounded gravel. No product odor.
10		7 9 11 16	0	N			
		* 12 21 23	43	N		ML	SANDY SILT; 6" thick, 60-70% silt, 30-40% very fine grained sand. Upper 2" - yellow-brown, lower 4" dark gray, low plasticity, stiff and wet. No product odor.
						SP	SAND; 100% fine to medium grained sand, trace silt. Black, medium dense and moist. 0.5" thick very fine grained silty interbedded stringers, trace fine subrounded gravel. No product odor.
15							
20							
25							



General Remarks:

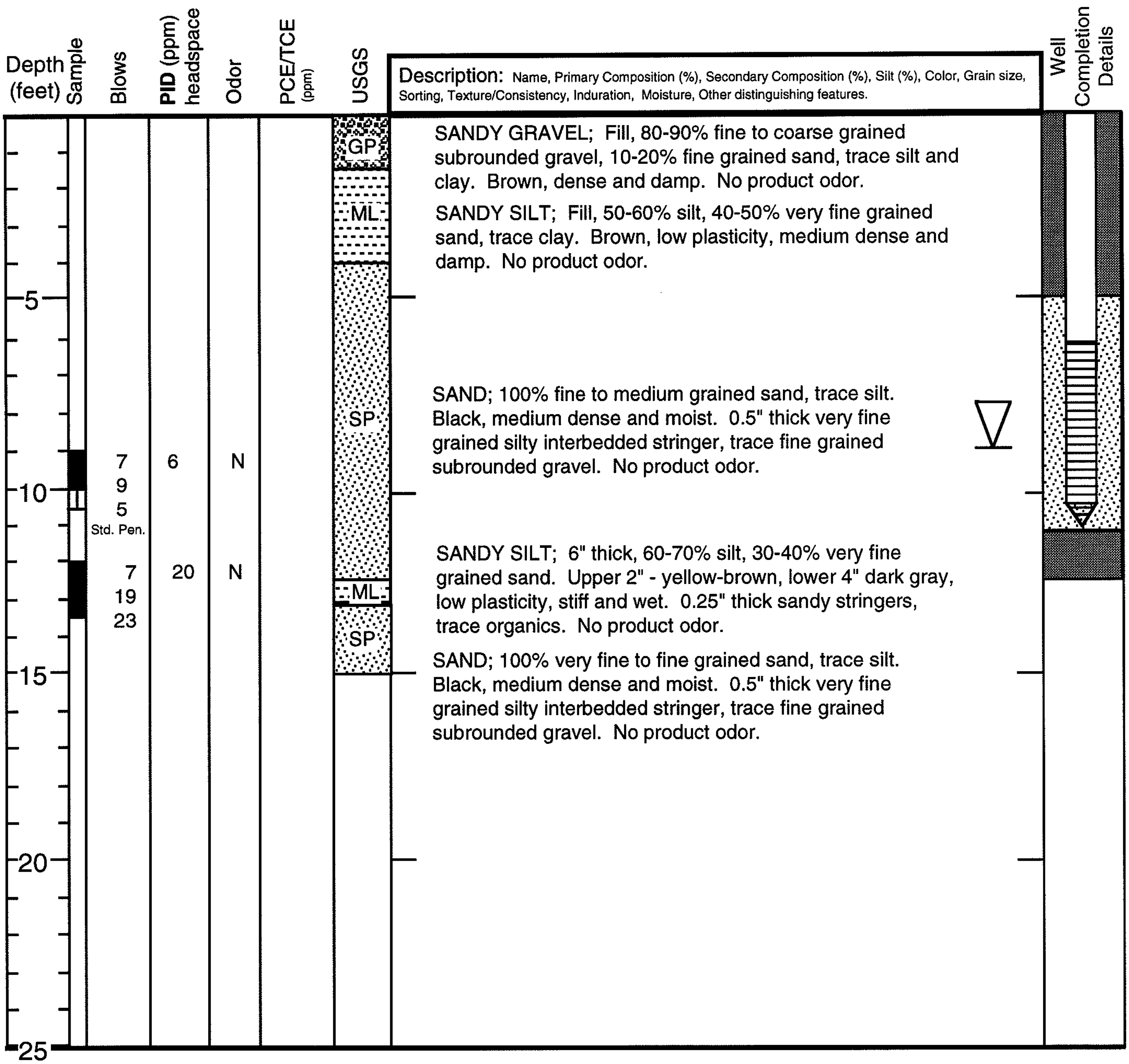
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

* Note - 9' sample with Standar Penetration - not Dames & Moore.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 7/8/99
Boring/Well Number: TW-7
Page 1 of 1
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington 98188
Drilling Contractor: Cascade Drilling, Inc.
Log by: J. Orr
Drill Rig: CME-55
Auger Size/Type: HSA
Sample Method: Mod. Cal./Std. Pen.
Total Depth: 13.5 feet
Depth to Groundwater: Approx. 9 feet
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Lonestar Sand: 2/12
Well A: Casing/Screen Diameter: 2 in.
Slot Size: 0.01"
Seal: 0-5 feet
Screened Interval: 6-11 feet



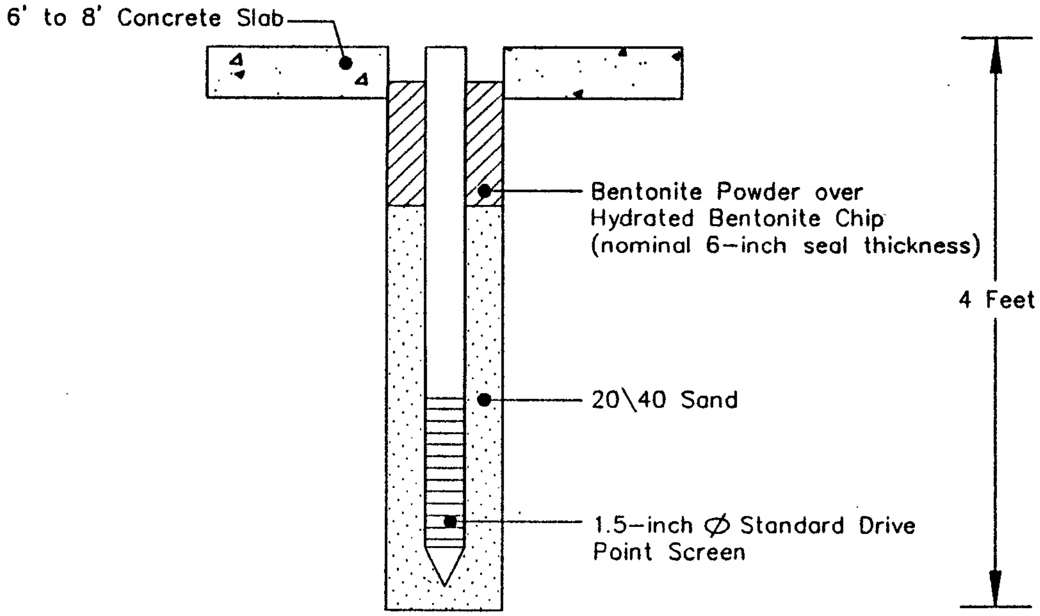
Depth (feet)	Sample	Blows	**PID (ppm)** headspace	Odor	PCE/TCE (ppm)	USGS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GP	SANDY GRAVEL; Fill, 80-90% fine to coarse grained subrounded gravel, 10-20% fine grained sand, trace silt and clay. Brown, dense and damp. No product odor.
						ML	SANDY SILT; Fill, 50-60% silt, 40-50% very fine grained sand, trace clay. Brown, low plasticity, medium dense and damp. No product odor.
		7 9 5 Std. Pen.	6	N		SP	SAND; 100% fine to medium grained sand, trace silt. Black, medium dense and moist. 0.5" thick very fine grained silty interbedded stringer, trace fine grained subrounded gravel. No product odor.
		7 19 23	20	N		ML	SANDY SILT; 6" thick, 60-70% silt, 30-40% very fine grained sand. Upper 2" - yellow-brown, lower 4" dark gray, low plasticity, stiff and wet. 0.25" thick sandy stringers, trace organics. No product odor.
						SP	SAND; 100% very fine to fine grained sand, trace silt. Black, medium dense and moist. 0.5" thick very fine grained silty interbedded stringer, trace fine grained subrounded gravel. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Typical Warehouse Interior Vapor Probe Construction Diagram



Vapor Probes SVP-1 and SVP-2 were installed by drilling to about a tenth foot below base of screen depth and installing screen riser with sand pack as auger was withdrawn. No soil samples were taken. Probes were abandoned after sampling, see text.

Probe No.	Top of Casing Elevation in Feet
SVP-1	10.95
SVP-2	11.85

248914\VP3 1/6/94

HARTCROWSER

J-2489-14 3/93

Figure A-56

ERM
ERM
915 118th Avenue SE
Suite 130
Bellevue, WA 98005
(425) 462-8591

BOREHOLE LOG

Site Id: VMP-1
Page 1 of 1

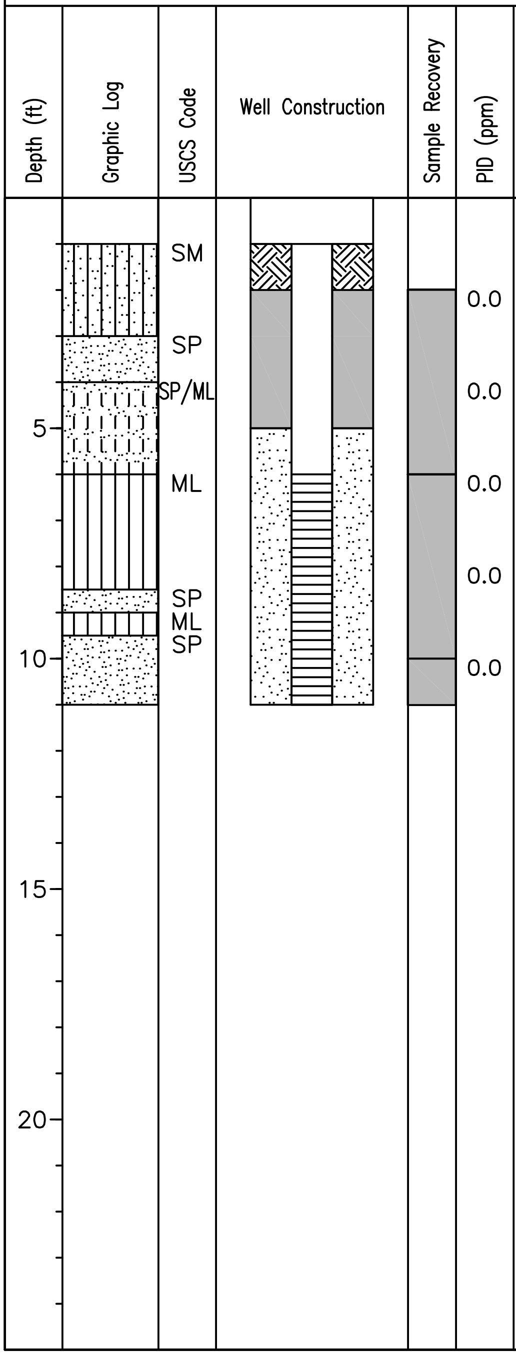
Project Number: 0021460.51
Project Name: Fox Avenue
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: GeoProbe
Logged By: A. Musselman
Date(s): 11/09/04
Initial Water Level: NA

Total Depth: 11.00'
Completed Depth: 11.00'
Borehole Dia.: 2.25in

Blank Casing:
type: PVC dia: 1.00in fm: 1.0' to: 6.00'

Screens:
type: Slotted size: 0.010in dia: 1.00in fm: 6.00' to: 11.00'

Annular Fill:
type: Backfill fm: 1.00' to: 2.00'
type: Bentonite Pellets fm: 2.00' to: 5.00'
type: Sand Filter Pack fm: 5.00' to: 11.00'



Description/Soil Classification

Vapor monitoring point located in utility box.

SILTY SAND (SM): brown, fine to medium, medium dense, subrounded gravel, moist.

SILTY SAND (SM): as above, gray.

SAND (SP): brown, fine to medium, trace silt, medium dense, dry.

SAND INTERBEDDED WITH SILT (SP/ML): brown, fine to medium, layers of black sandy silt, brick fragments, moist.

SILT (ML): brown, medium stiff to stiff, some fine sand, rust mottling, moist.

SAND (SP): brown, fine, trace silt, medium dense, dry.
SILT (ML): brown/gray, scattered glass (fill).
SAND (SP): brown, fine to medium, layers of fine sand (Duwamish Sand), trace silt, medium dense, dry.

Total Depth – 11.0' bgs

ERM
915 118th Avenue SE
Suite 130
Bellevue, WA 98005
(425) 462-8591

BOREHOLE LOG

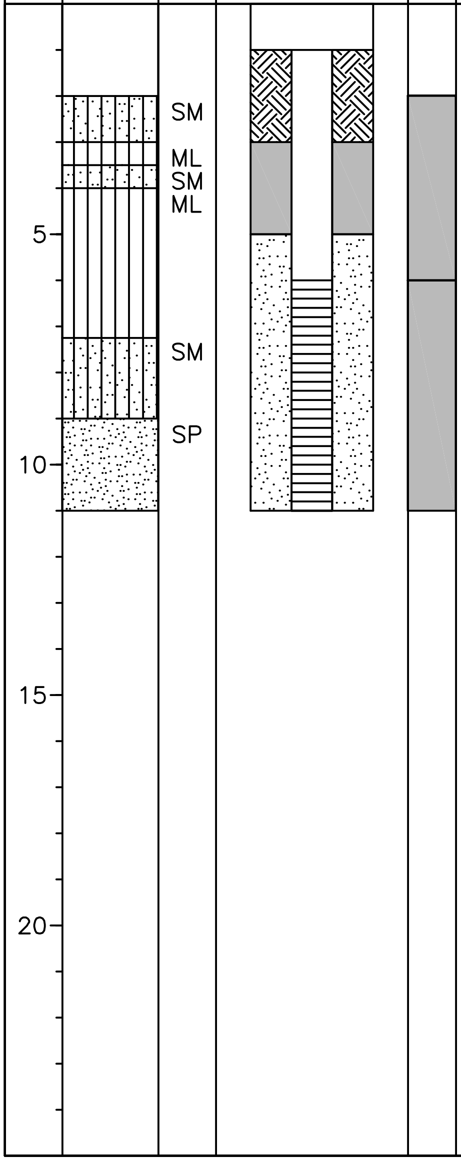
Site Id: VMP-2
Page 1 of 1

Project Number: 0021460.51
Project Name: Fox Avenue
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: GeoProbe
Logged By: A. Musselman
Date(s): 11/09/04
Initial Water Level: NA

Total Depth: 11.00'
Completed Depth: 11.00'
Borehole Dia.: 2.25in

Blank Casing:					
type: PVC		dia: 1.00in	fm: 1.0'	to: 6.00'
Screens:					
type: Slotted	size: 0.010in	dia: 1.00in	fm: 6.00'	to: 11.00'
Annular Fill:					
type: Backfill			fm: 1.00'	to: 3.00'
type: Bentonite Pellets			fm: 3.00'	to: 5.00'
type: Sand Filter Pack			fm: 5.00'	to: 11.00'

Depth (ft) | Graphic Log | USCS Code | Well Construction | Sample Recovery | PID (ppm) | Description/Soil Classification



USCS Code	PID (ppm)	Description/Soil Classification
		Vapor monitoring point located in utility box.
SM	0.0	SILTY SAND (SM): brown, slightly silty, medium dense, some gravel, moist.
ML		SILT (ML): dark brown, stiff, sandy, moist.
SM		SILTY SAND (SM): olive green, medium dense, gravelly.
ML	0.0	SILT (ML): dark brown, stiff.
	0.0	SILT (ML): light brown, medium stiff, moist.
SM	0.0	SILTY SAND (SM): light brown, fine, medium stiff, moist.
	0.0	
SP	0.0	SAND (SP): dark brown, fine to medium, (Duwamish Sand), trace silt, medium dense, dry.
		Total Depth — 11.0' bgs

ERM
ERM
915 118th Avenue SE
Suite 130
Bellevue, WA 98005
(425) 462-8591

BOREHOLE LOG

Site Id: VMP-3
Page 1 of 1

Project Number: 0021460.51

Project Name: Fox Avenue

Location: CCDC, Seattle, Washington

Contractor: Cascade Drilling

Drilling Method: GeoProbe

Logged By: A. Musselman

Date(s): 11/09/04

Initial Water Level: NA

Total Depth: 11.00'

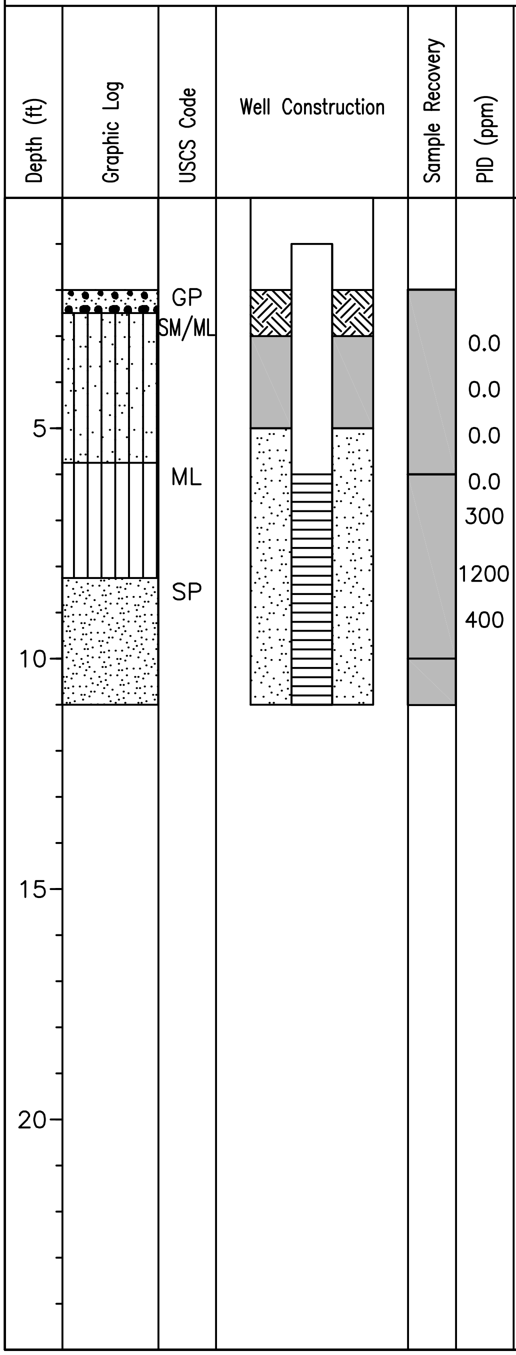
Completed Depth: 11.00'

Borehole Dia.: 2.25in

Blank Casing:
type: PVC dia: 1.00in fm: 1.0' to: 6.00'

Screens:
type: Slotted size: 0.010in dia: 1.00in fm: 6.00' to: 11.00'

Annular Fill:
type: Backfill fm: 2.00' to: 3.00'
type: Bentonite Pellets fm: 3.00' to: 5.00'
type: Sand Filter Pack fm: 5.00' to: 11.00'



Description/Soil Classification

Vapor monitoring point located in utility box.

PEA GRAVEL (GP)
SILTY SAND (SM)/SANDY SILT (ML): dark brown, soft, intermixed, scattered gravel, (unusual clast with metallic luster).

SILT (ML): gray, soft, moist to wet.

SAND (SP): dark gray, fine to medium, trace silt, dry (duwamish sand).

Total Depth – 11.0' bgs

ERM
915 118th Avenue SE
Suite 130
Bellevue, WA 98005
(425) 462-8591

BOREHOLE LOG

Site Id: VMP-4
Page 1 of 1

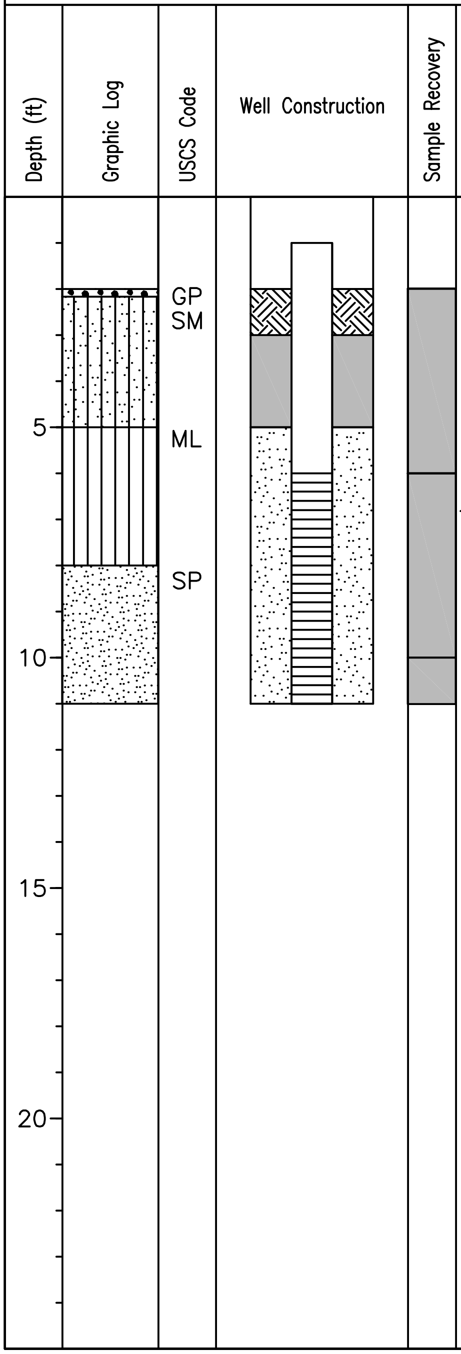
Project Number: 0021460.51
Project Name: Fox Avenue
Location: CCDC, Seattle, Washington
Contractor: Cascade Drilling
Drilling Method: GeoProbe
Logged By: A. Musselman
Date(s): 11/09/04
Initial Water Level: NA

Total Depth: 11.00'
Completed Depth: 11.00'
Borehole Dia.: 2.25in

Blank Casing:
type: PVC dia: 1.00in fm: 1.0' to: 6.00'

Screens:
type: Slotted size: 0.010in dia: 1.00in fm: 6.00' to: 11.00'

Annular Fill:
type: Backfill fm: 2.00' to: 3.00'
type: Bentonite Pellets fm: 3.00' to: 5.00'
type: Sand Filter Pack fm: 5.00' to: 11.00'



PID (ppm)	Description/Soil Classification
	Vapor monitoring point located in utility box.
0.0	PEA GRAVEL (GP): 1.0–2.0".
0.0	SILTY SAND (SM): dark brown, medium dense, some gravel (clast with metallic luster), layers and pockets of silt, scattered wood debris (burnt).
0.0	
0.0	SILT (ML): dark brown, medium stiff.
	SILT (ML): light brown, soft, some fine sand, moist to wet.
1200	
300	SAND (SP): dark gray, fine to medium, loose, trace silt, dry (Duwamish Sand).
400	
800	
400	Total Depth – 11.0' bgs

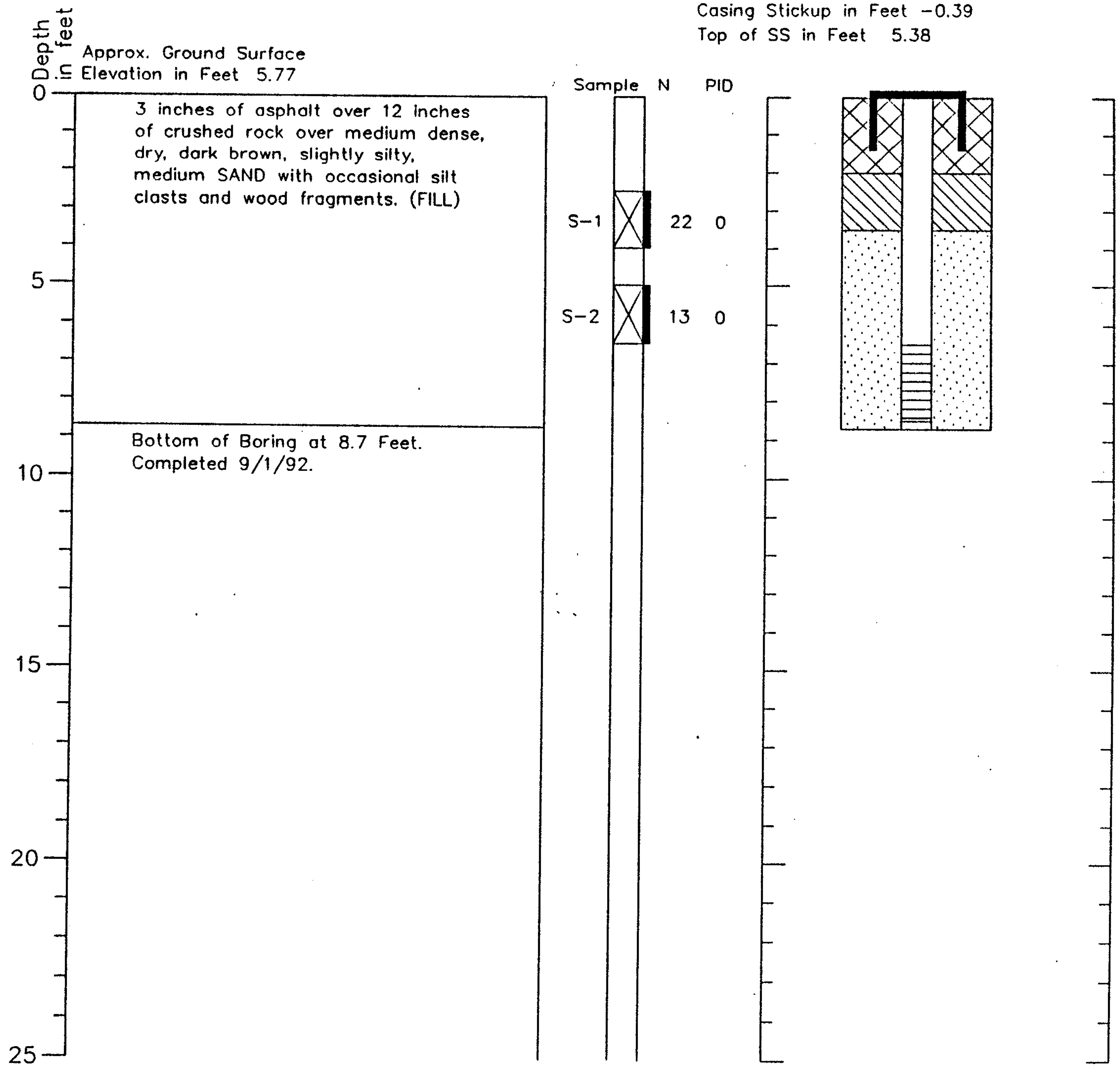
Boring Log and Construction Data for Monitoring Well VP-11

Geologic Log

Monitoring Well Design

Casing Stickup in Feet −0.39
Top of SS in Feet 5.38

Approx. Ground Surface Elevation in Feet 5.77



3 inches of asphalt over 12 inches of crushed rock over medium dense, dry, dark brown, slightly silty, medium SAND with occasional silt clasts and wood fragments. (FILL)

Bottom of Boring at 8.7 Feet.
Completed 9/1/92.

1. Refer to Figure A−1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

acad\jobs\248918\vp-11

HARTCROWSER
J-2489-13 **9/92**

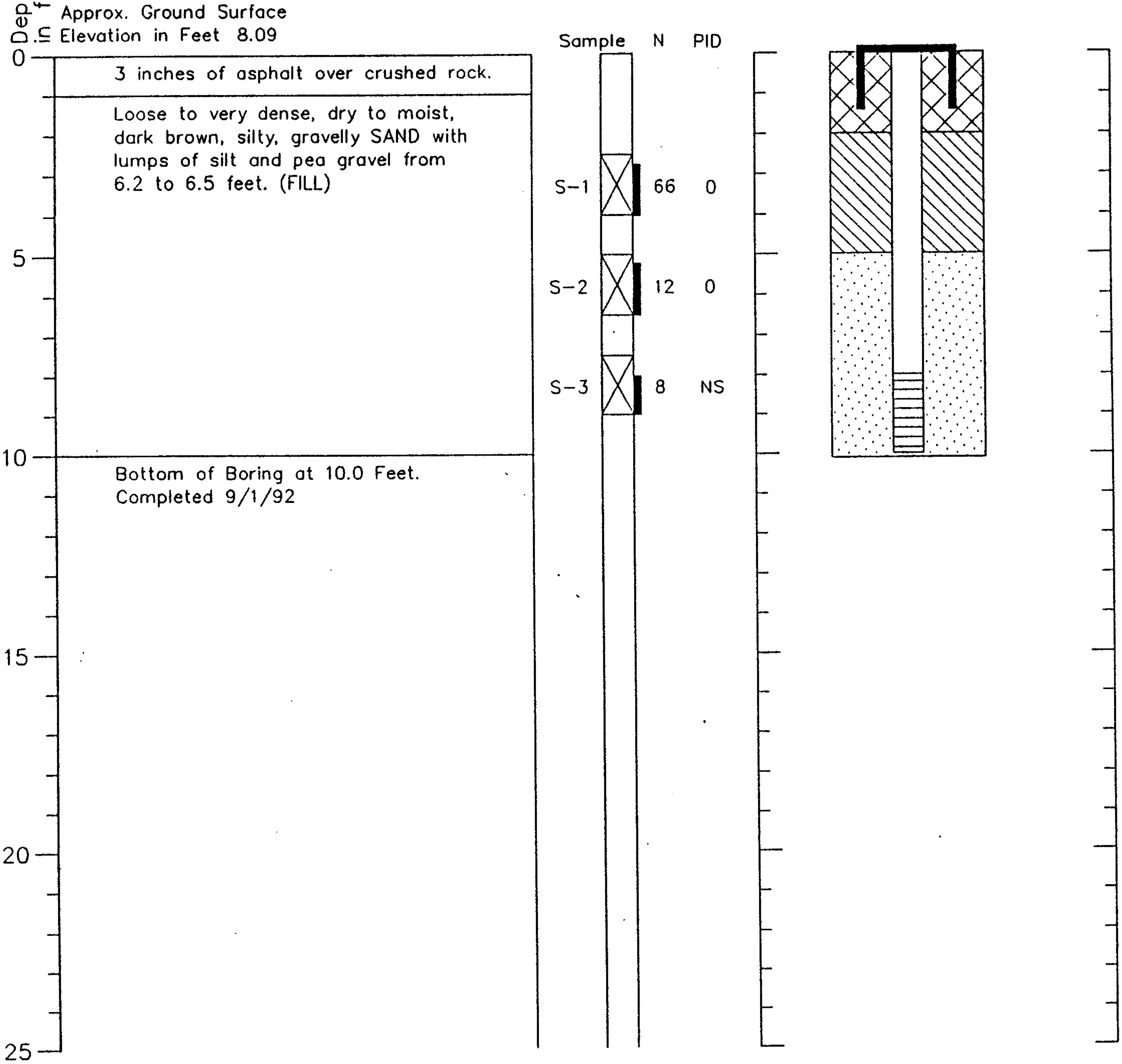
Figure A-61

Boring Log and Construction Data for Monitoring Well VP-2

Geologic Log

Monitoring Well Design

Casing Stickup in Feet −0.62
Top of SS in Feet 7.48



3 inches of asphalt over crushed rock.

Loose to very dense, dry to moist, dark brown, silty, gravelly SAND with lumps of silt and pea gravel from 6.2 to 6.5 feet. (FILL)

Bottom of Boring at 10.0 Feet.
Completed 9/1/92

1. Refer to Figure A−1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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HARTCROWSER
J-2489-13 **9/92**
Figure A-57

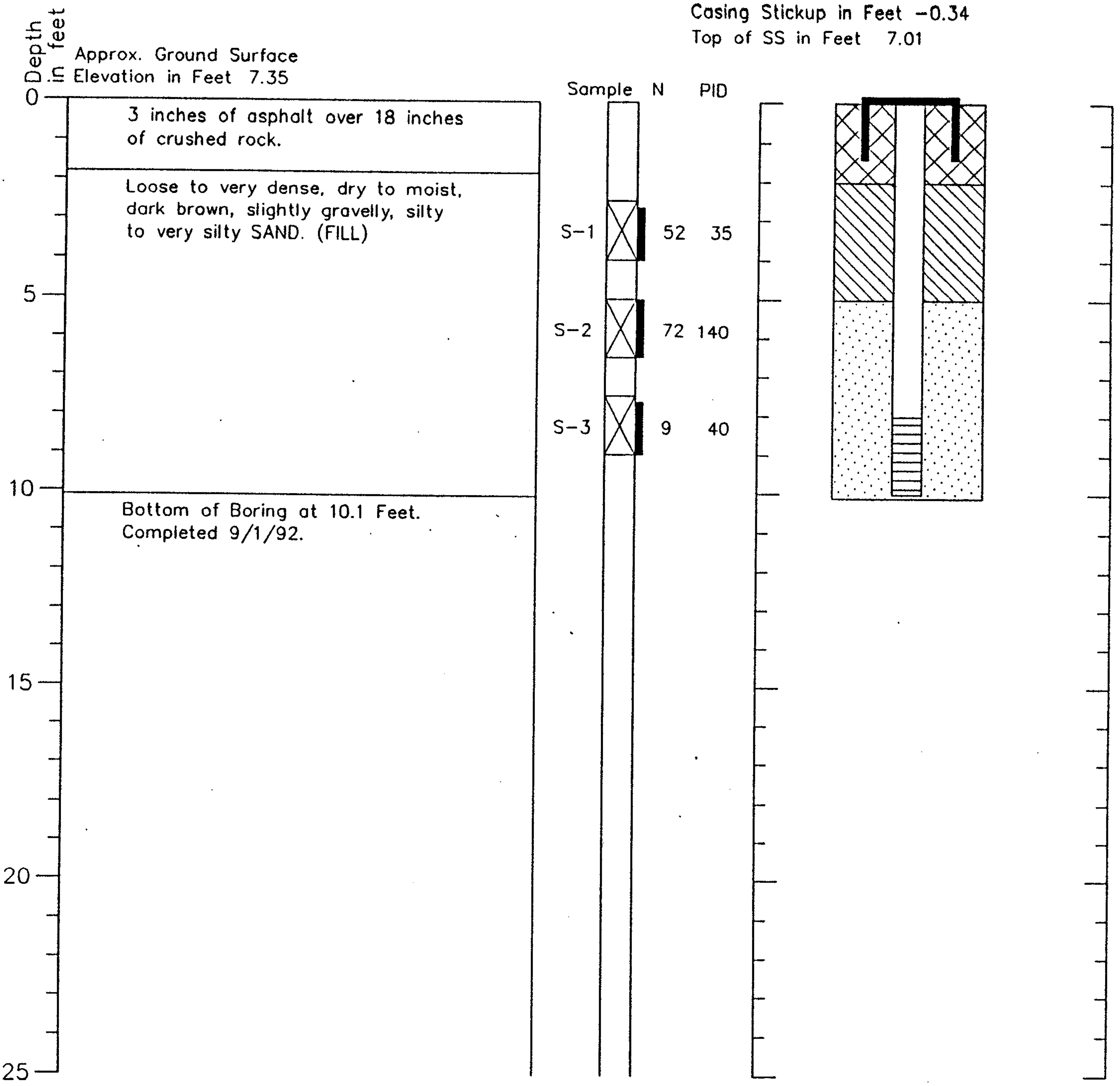
Boring Log and Construction Data for Monitoring Well VP-6

Geologic Log

Approx. Ground Surface
Elevation in Feet 7.35

Monitoring Well Design

Casing Stickup in Feet −0.34
Top of SS in Feet 7.01



3 inches of asphalt over 18 inches of crushed rock.

Loose to very dense, dry to moist, dark brown, slightly gravelly, silty to very silty SAND. (FILL)

Bottom of Boring at 10.1 Feet.
Completed 9/1/92.

Sample	N	PID
S-1	52	35
S-2	72	140
S-3	9	40

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
J-2489-13 **9/92**

Figure A-58

acad\jobs\248918\vp-6

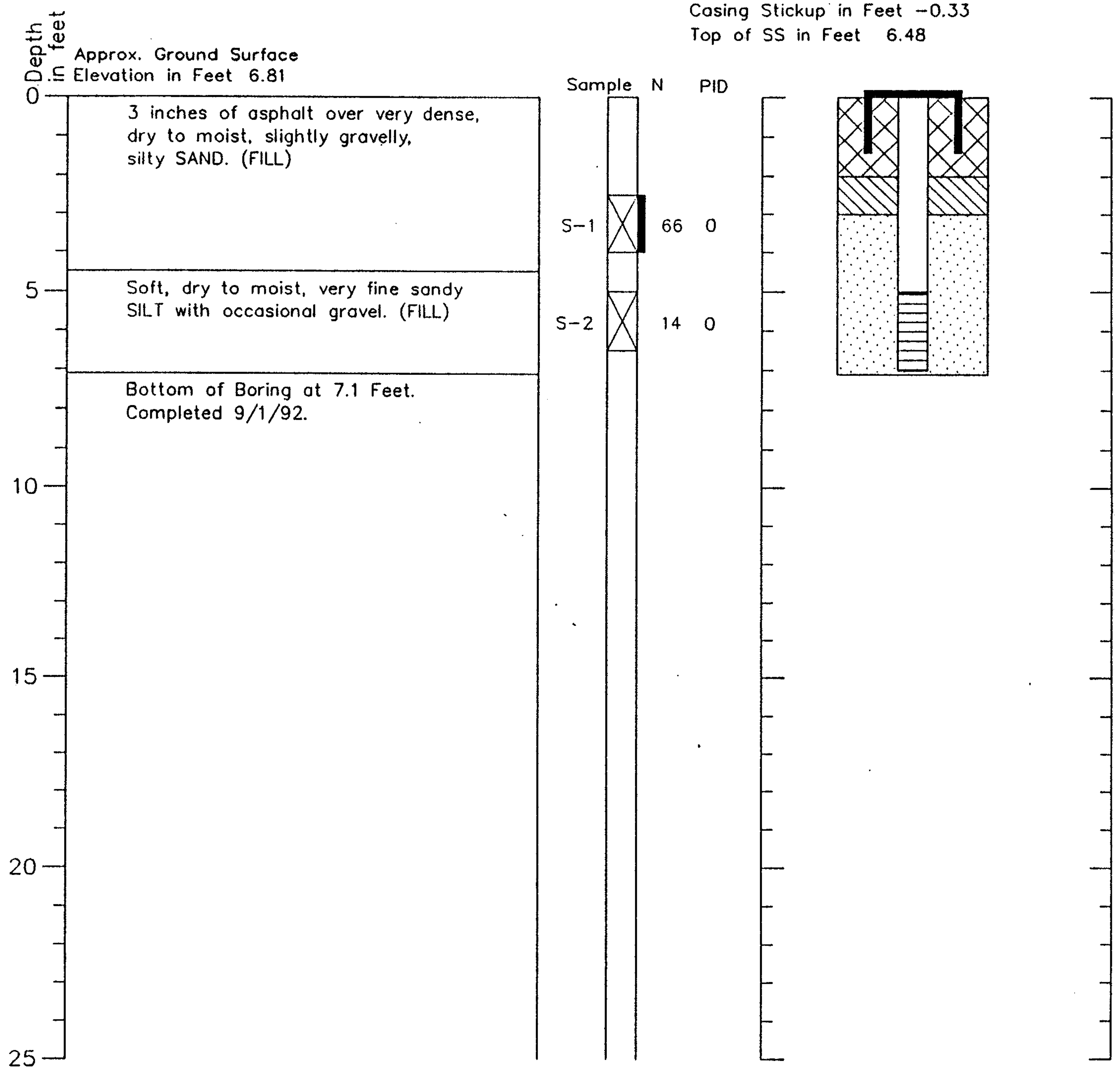
Boring Log and Construction Data for Monitoring Well VP-7

Geologic Log

Monitoring Well Design

Casing Stickup in Feet -0.33
Top of SS in Feet 6.48

Approx. Ground Surface
Elevation in Feet 6.81



3 inches of asphalt over very dense, dry to moist, slightly gravelly, silty SAND. (FILL)

Soft, dry to moist, very fine sandy SILT with occasional gravel. (FILL)

Bottom of Boring at 7.1 Feet.
Completed 9/1/92.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

acad\jobs\248918\vp-7

HARTCROWSER
J-2489-13 9/92
Figure A-59

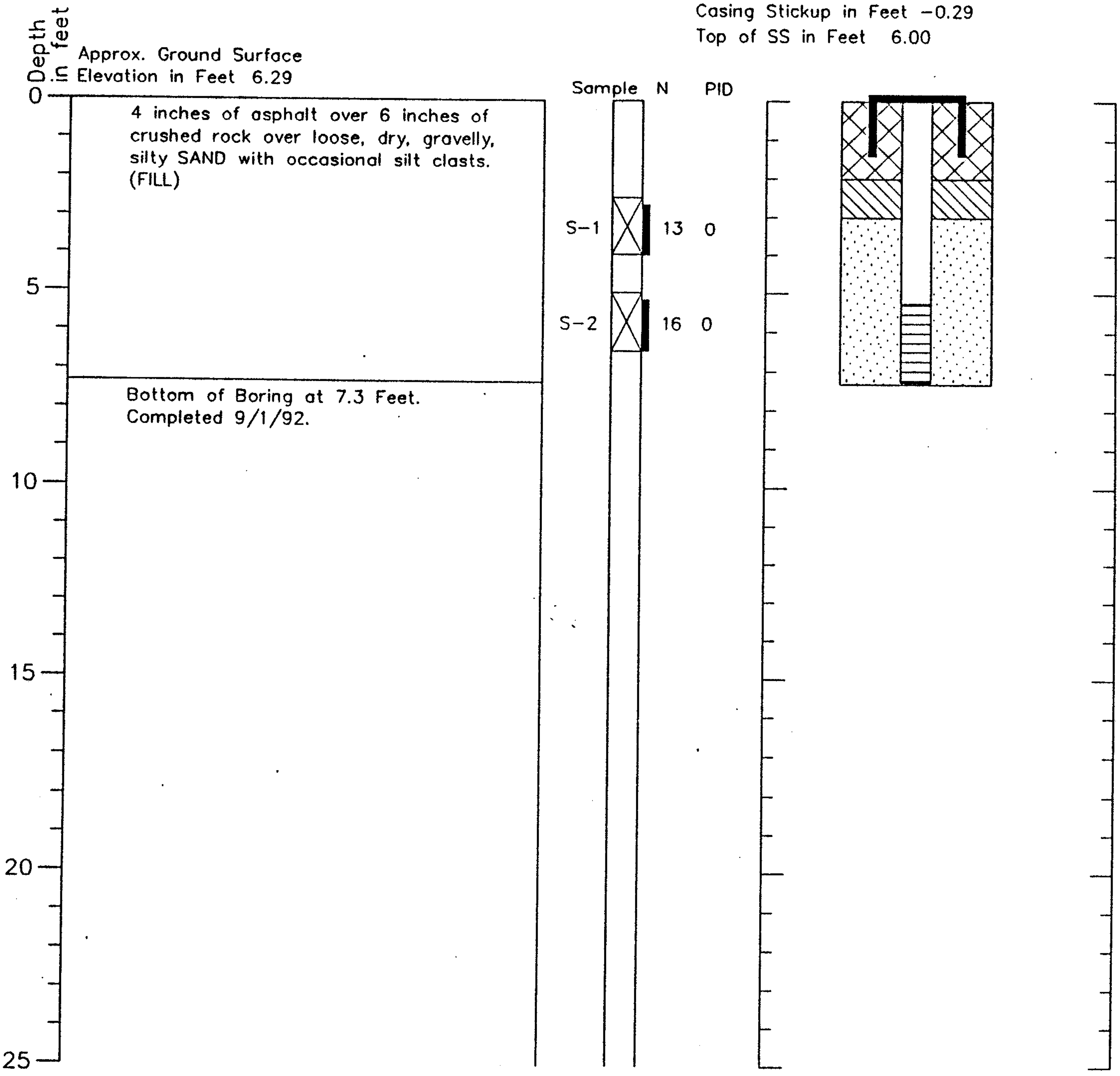
Boring Log and Construction Data for Monitoring Well VP-9

Geologic Log

Approx. Ground Surface
Elevation in Feet 6.29

Monitoring Well Design

Casing Stickup in Feet −0.29
Top of SS in Feet 6.00



4 inches of asphalt over 6 inches of crushed rock over loose, dry, gravelly, silty SAND with occasional silt clasts. (FILL)

Bottom of Boring at 7.3 Feet.
Completed 9/1/92.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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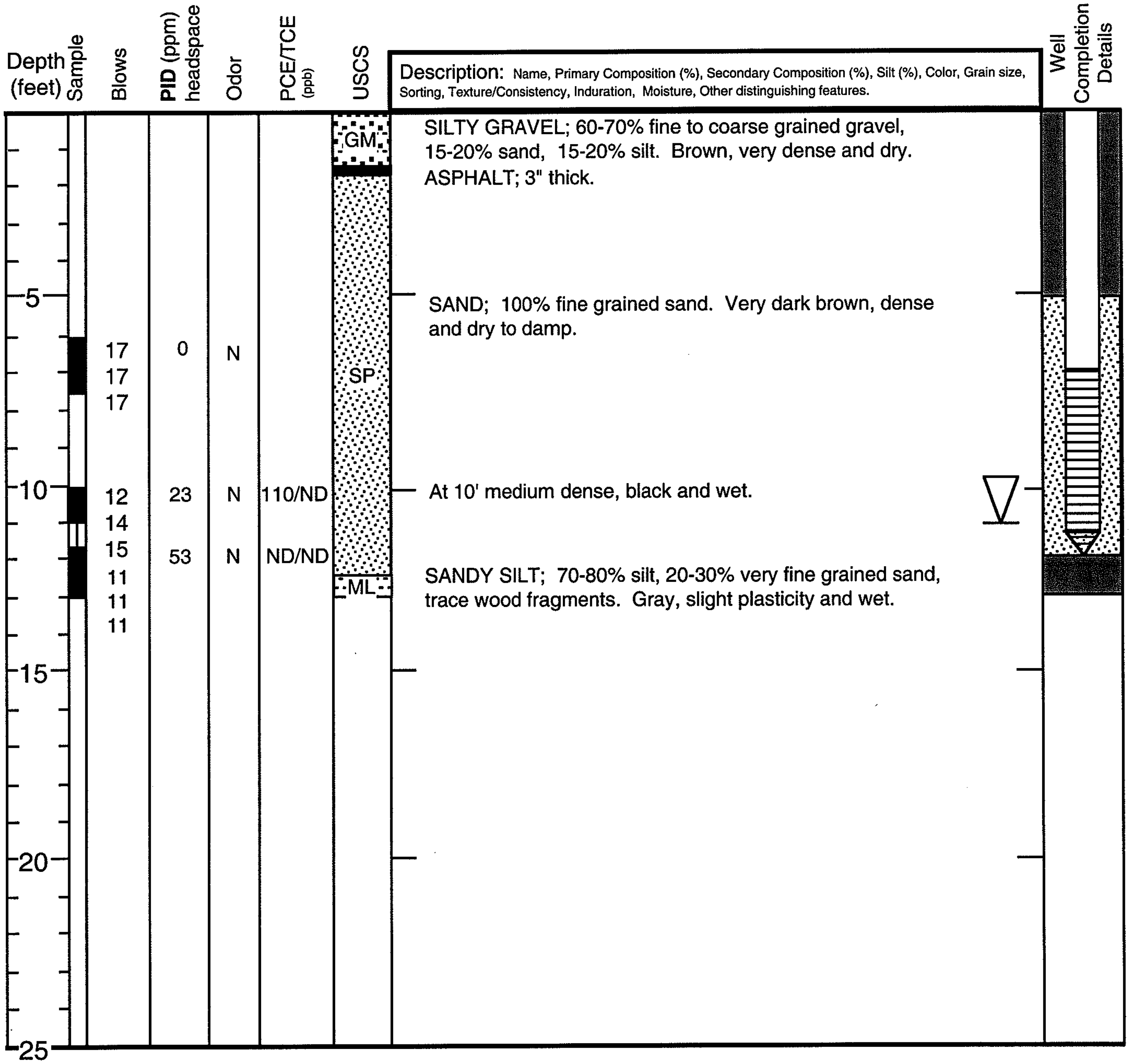
HARTCROWSER

J-2489-13 9/92

Figure A-60

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-1 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 13 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-5 feet Screened Interval: 7-12 feet



Depth (feet)	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
					GM	SILTY GRAVEL; 60-70% fine to coarse grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry. ASPHALT; 3" thick.
5	17 17 17	0	N		SP	SAND; 100% fine grained sand. Very dark brown, dense and dry to damp.
10	12 14 15	23	N	110/ND		At 10' medium dense, black and wet.
	11 11 11	53	N	ND/ND	ML	SANDY SILT; 70-80% silt, 20-30% very fine grained sand, trace wood fragments. Gray, slight plasticity and wet.
15						
20						
25						

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

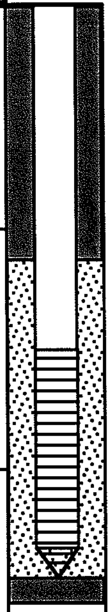
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-2 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 13 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-5.5 feet Screened Interval: 7.5-12.5 feet

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GM	SILTY GRAVEL; 60-70% fine to coarse grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry. ASPHALT; 3" thick.
5							SAND; 100% fine grained sand. Very dark brown, dense and dry to damp.
	■	11 21 20	2	N		SP	
10	■	15 20 21	10	N	4400 /450		At 10' Black and wet.
	■	14 16 15	39	N	110/ND	ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Gray, low plasticity, very stiff and wet. Trace woody organics, thin laminar bedding.
15							
20							
25							

Well Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-3 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

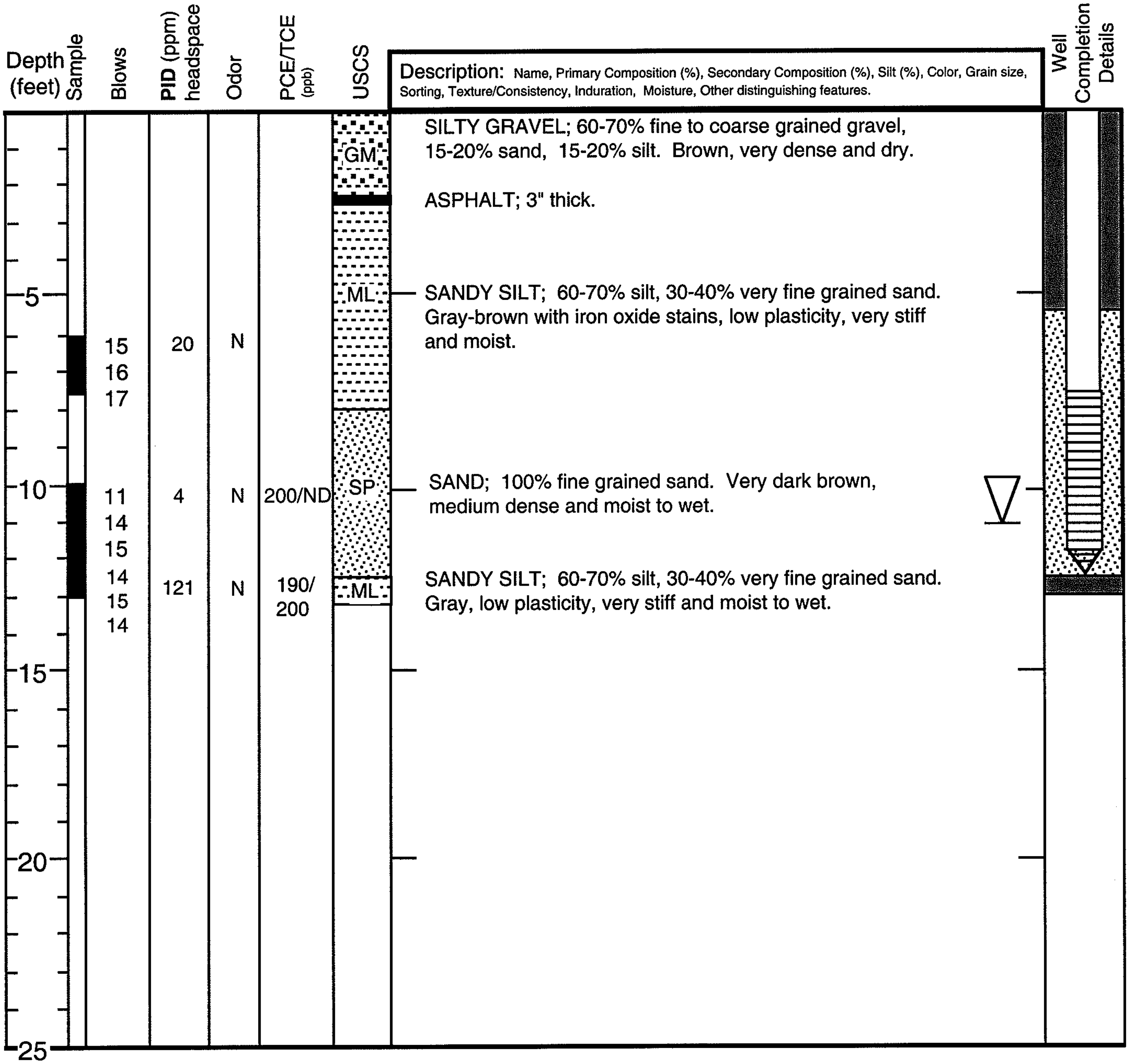
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.

Total Depth: 13 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-5.5 feet Screened Interval: 7.5-12.5 feet



Depth (feet)	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
					GM	SILTY GRAVEL; 60-70% fine to coarse grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry.
						ASPHALT; 3" thick.
5					ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Gray-brown with iron oxide stains, low plasticity, very stiff and moist.
	15 16 17	20	N			
10	11 14 15	4	N	200/ND	SP	SAND; 100% fine grained sand. Very dark brown, medium dense and moist to wet.
	14 15 14	121	N	190/ 200	ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Gray, low plasticity, very stiff and moist to wet.
15						
20						
25						

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

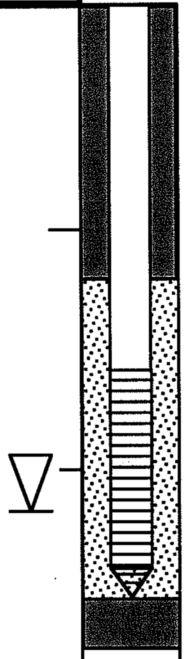
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-4 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 14 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-6 feet Screened Interval: 8-13 feet

Depth (feet)	Sample	Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GM	SILTY GRAVEL; 60-70% fine to coarse grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry. ASPHALT; 2" thick.
5						SP	SAND; 100% fine grained sand. Very dark brown, dense and damp.
	■	15 18 14	4	N			
10	■	15 22 23	10	N	81/ND		At 10' black and moist to wet.
	■	9 11 15	56	N			ML - 2" thick silt layer.
						SP	Same as above with a trace of coarse grained sand.
	■	9 11 15	101	N	110/570	ML	SANDY SILT; (8" thick) 60-70% silt, 30-40% very fine grained sand. Gray, low plasticity, very stiff and moist.
15							
20							
25							

Well Completion Details



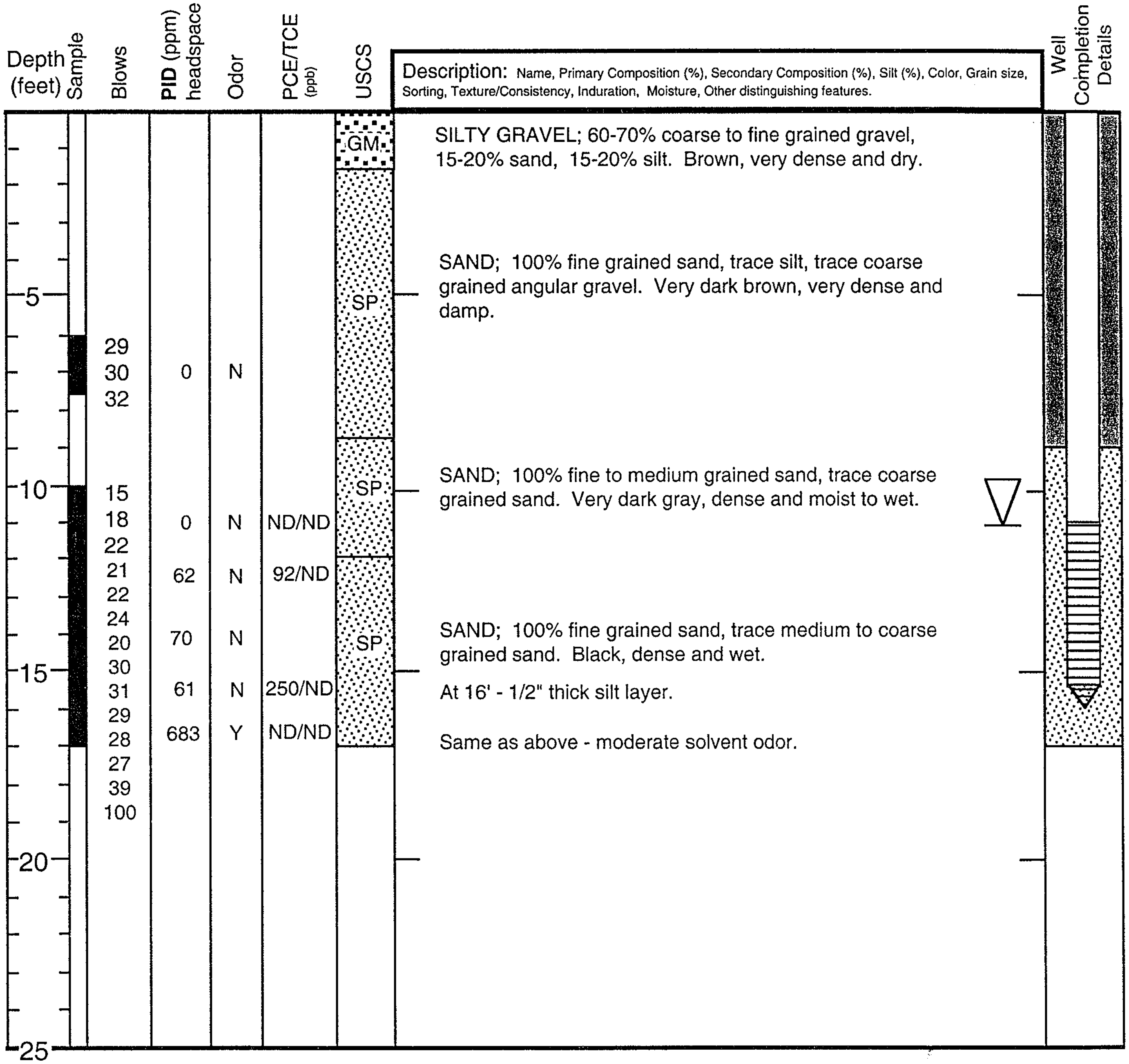
General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-5 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 17 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-9 feet Screened Interval: 11-16 feet



Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppb)
29			
30	0	N	
32			
15			
18	0	N	ND/ND
22			
21	62	N	92/ND
22			
24			
20	70	N	
30			
31	61	N	250/ND
29			
28	683	Y	ND/ND
27			
39			
100			

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; 60-70% coarse to fine grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry.

SAND; 100% fine grained sand, trace silt, trace coarse grained angular gravel. Very dark brown, very dense and damp.

SAND; 100% fine to medium grained sand, trace coarse grained sand. Very dark gray, dense and moist to wet.

SAND; 100% fine grained sand, trace medium to coarse grained sand. Black, dense and wet.

At 16' - 1/2" thick silt layer.

Same as above - moderate solvent odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-6 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

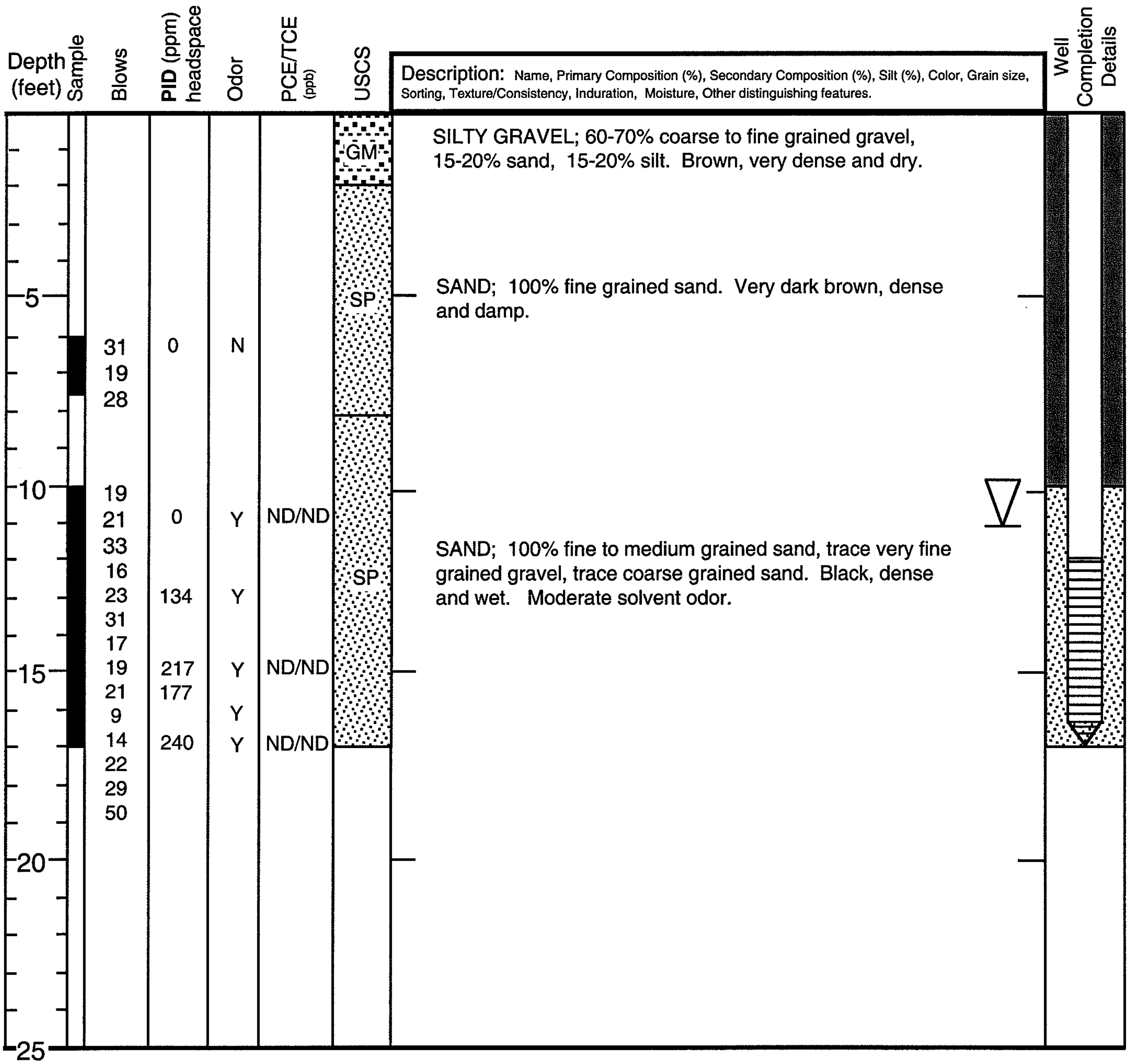
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.

Total Depth: 17 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-10 feet Screened Interval: 12-17 feet



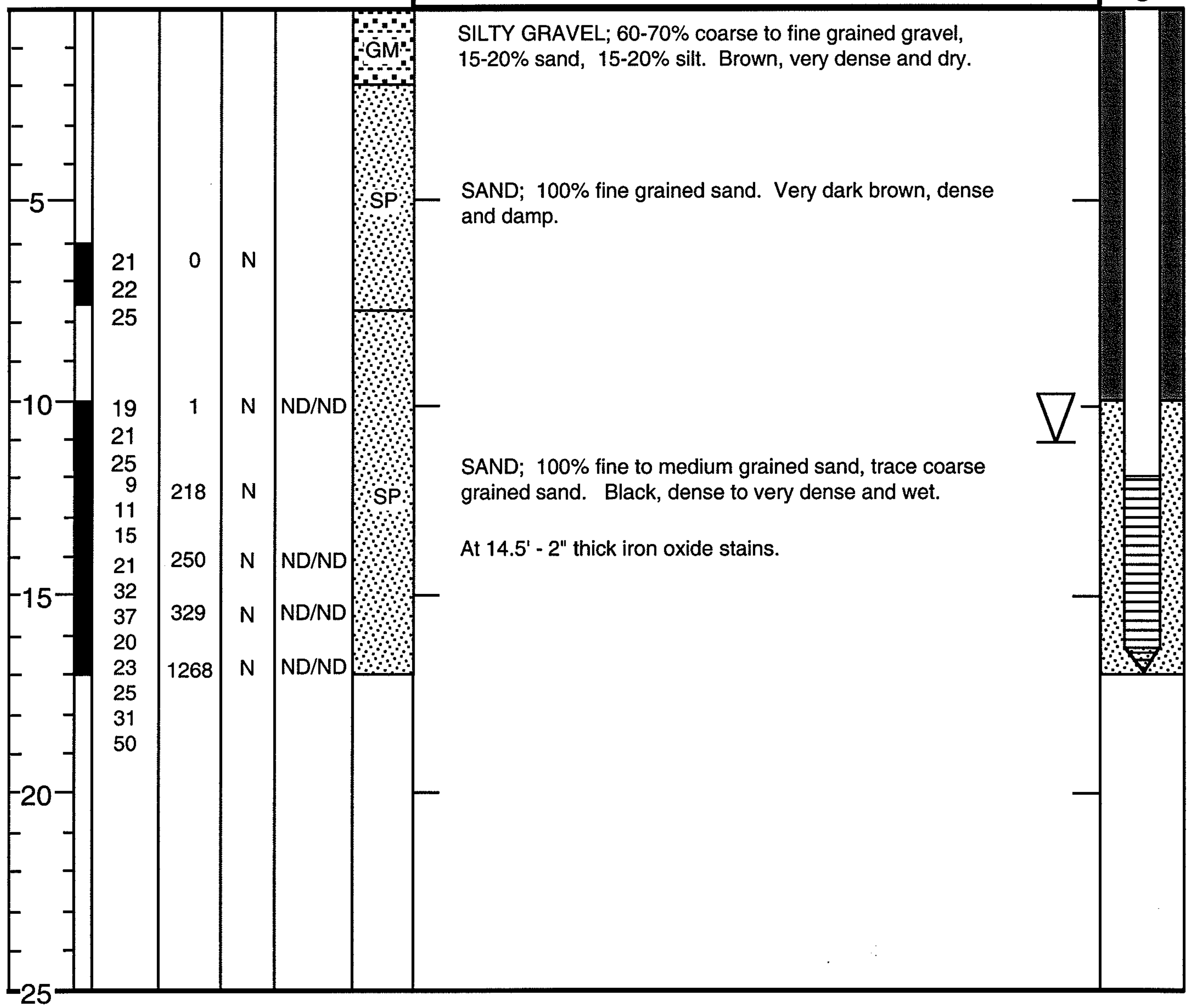
Depth (feet)	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
					GM	SILTY GRAVEL; 60-70% coarse to fine grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry.
5					SP	SAND; 100% fine grained sand. Very dark brown, dense and damp.
	31	0	N			
	19					
	28					
10	19					
	21	0	Y	ND/ND		
	33					
	16				SP	SAND; 100% fine to medium grained sand, trace very fine grained gravel, trace coarse grained sand. Black, dense and wet. Moderate solvent odor.
	23	134	Y			
	31					
	17					
15	19	217	Y	ND/ND		
	21	177				
	9		Y			
	14	240	Y	ND/ND		
	22					
	29					
	50					
20						
25						

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

TERRA VAC

Date Drilled: 8/9/00 **Boring/Well Number:** WH-7 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 17 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-10 feet Screened Interval: 12-17 feet



Depth (feet)	Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
					GM	SILTY GRAVEL; 60-70% coarse to fine grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry.
5					SP	SAND; 100% fine grained sand. Very dark brown, dense and damp.
	21	0	N			
	22					
	25					
10	19	1	N	ND/ND		
	21					
	25					SAND; 100% fine to medium grained sand, trace coarse grained sand. Black, dense to very dense and wet.
	9	218	N		SP	
	11					
	15					At 14.5' - 2" thick iron oxide stains.
	21	250	N	ND/ND		
15	32					
	37	329	N	ND/ND		
	20					
	23	1268	N	ND/ND		
	25					
	31					
	50					
20						
25						

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

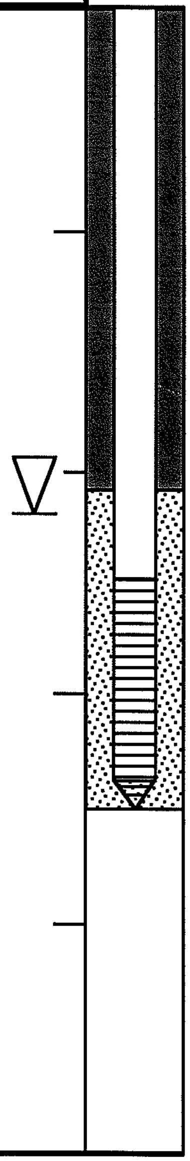
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/10/00 **Boring/Well Number:** WH-8 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 17.5 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-10.5 feet Screened Interval: 12.5-17.5 feet

Depth (feet)	Sample	Blows	**PID** (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
						GM	SILTY GRAVEL; 60-70% coarse to fine grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry.
5						SP	SAND; 100% fine grained sand. Very dark brown, very dense and dry to damp.
		18	5	N			
		22					
		28					
10		10	18	N	140/ND		
		10					At 11' 3" thick silty sand bed.
		10					At 11.5' TO 13' - 0.25" to 1" thick liminar sandy silt interbeds.
		8	44	N	ND/ND		
		9					
		15					SAND; 100% very fine to fine grained sand. Black, very dense and wet.
		16	345	N		SP	
15		21					
		24	119	N			
		28					
		50	181	N	ND/ND		
		50					
		27					
		50					
20							
25							

Well Completion Details



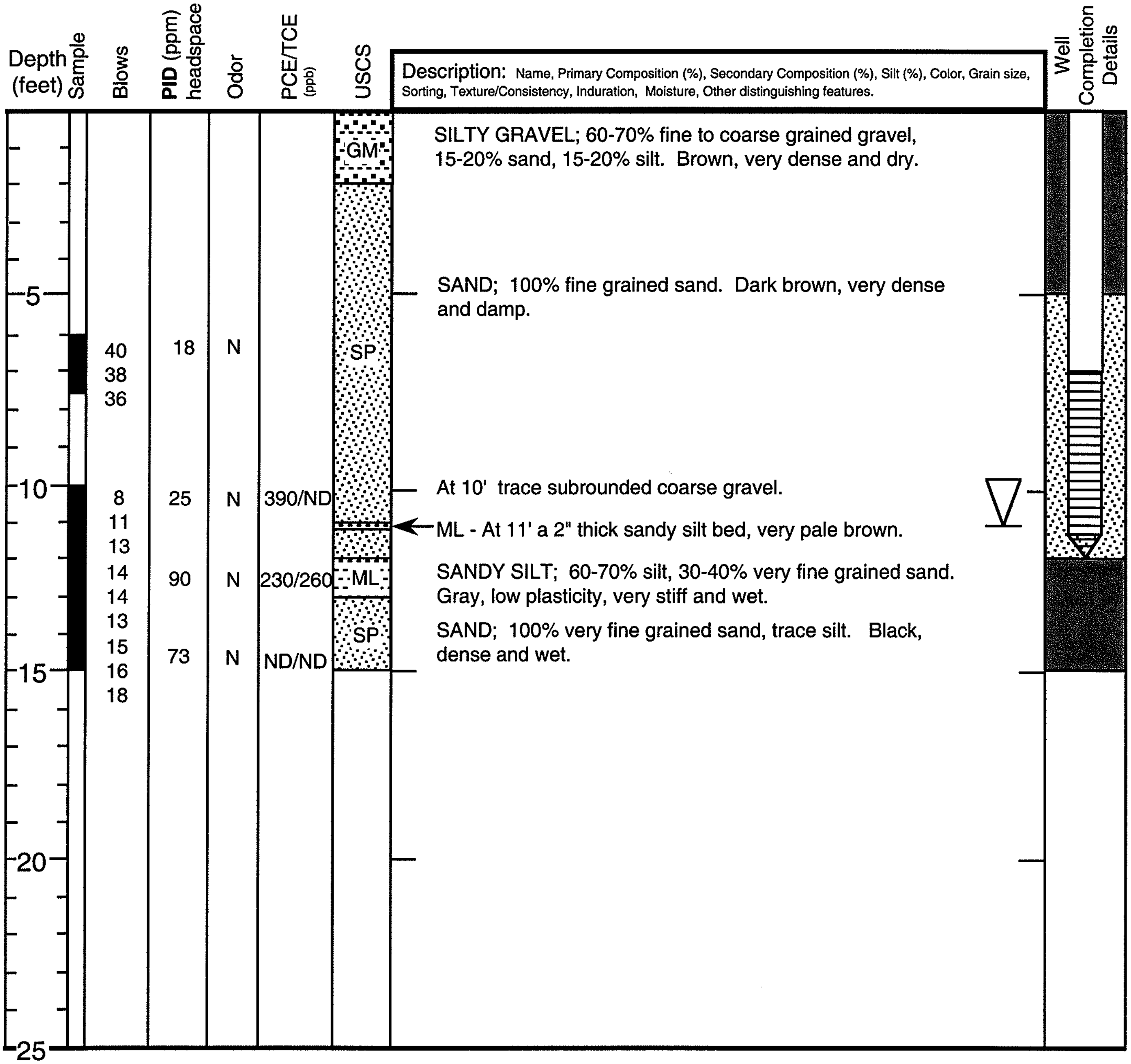
General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/10/00
Boring/Well Number: WH-9
Page 1 of 1
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc.
Log by: J. Orr
Drill Rig: CME-75
Auger Size/Type: 8" HSA
Sample Method: Mod. Cal.
Total Depth: 15 feet
Depth to Groundwater: 11 feet
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in.
Slot Size: 0.01"
Seal: 0-5 feet
Screened Interval: 7-12 feet



Depth (feet)	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
0-2					GM	SILTY GRAVEL; 60-70% fine to coarse grained gravel, 15-20% sand, 15-20% silt. Brown, very dense and dry.
2-11	40 38 36	18	N		SP	SAND; 100% fine grained sand. Dark brown, very dense and damp.
10	8 11 13	25	N	390/ND		At 10' trace subrounded coarse gravel.
11						ML - At 11' a 2" thick sandy silt bed, very pale brown.
12-13	14 14 13	90	N	230/260	ML	SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Gray, low plasticity, very stiff and wet.
13-15	15 16 18	73	N	ND/ND	SP	SAND; 100% very fine grained sand, trace silt. Black, dense and wet.

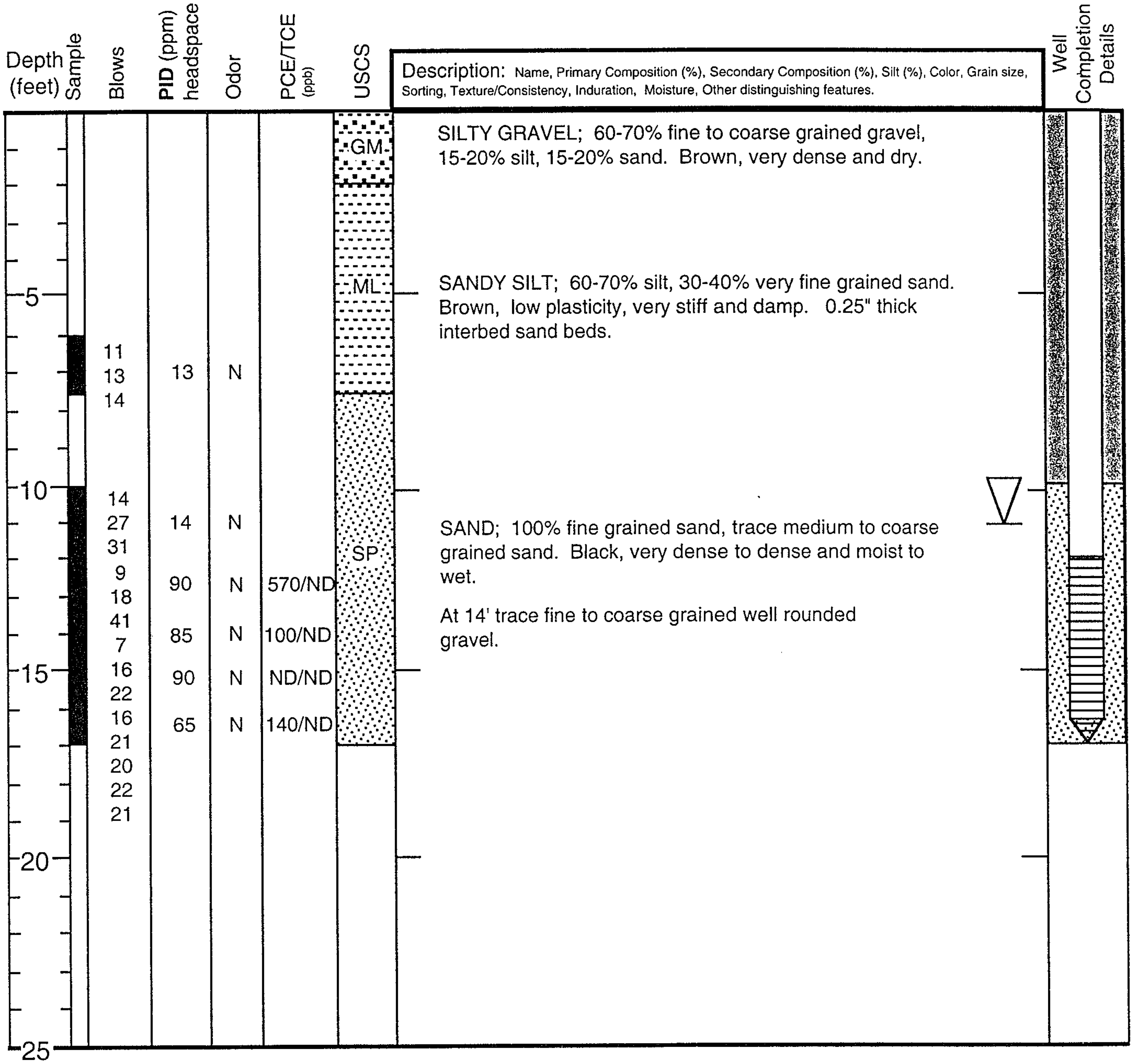
General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/10/00 **Boring/Well Number:** WH-10 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 17 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-10 feet Screened Interval: 12-17 feet



Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)
11			
13	13	N	
14			
14			
27	14	N	
31			
9	90	N	570/ND
18			
41			
7	85	N	100/ND
16	90	N	ND/ND
22			
16	65	N	140/ND
21			
20			
22			
21			

Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; 60-70% fine to coarse grained gravel, 15-20% silt, 15-20% sand. Brown, very dense and dry.

SANDY SILT; 60-70% silt, 30-40% very fine grained sand. Brown, low plasticity, very stiff and damp. 0.25" thick interbed sand beds.

SAND; 100% fine grained sand, trace medium to coarse grained sand. Black, very dense to dense and moist to wet.

At 14' trace fine to coarse grained well rounded gravel.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

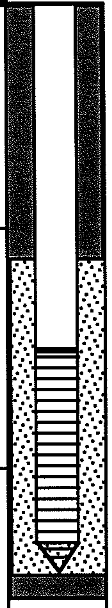
Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 8/10/00 **Boring/Well Number:** WH-11 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr
Drill Rig: CME-75 Auger Size/Type: 8" HSA Sample Method: Mod. Cal.
Total Depth: 13 feet Depth to Groundwater: 11 feet Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Pacific Materials: 2/12
Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-5.5 feet Screened Interval: 7.5-12.5 feet

Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppb)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
0							CONCRETE; 4" thick.
5							SAND; 100% fine grained sand. Very dark brown, very dense and damp.
	■	21 24 31	3	N		SP	
10	■	20 17 20	10	N	590/ND		At 10' -11.5" trace coarse grained sand. Black and moist to wet. ▽
	■	3 5 7	22	N	220/ND	ML	SANDY SILT; 60-70% silt, 30-40% fine grained sand. Gray, slight plasticity, stiff and wet.
15							
20							
25							

Well Completion Details



General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Fox Avenue Site
Seattle, Washington

Remedial Investigation/ Feasibility Study

Appendix C
2000 Supplemental Remedial Investigation and Select Appendices

FINAL

Table of Contents

Supplemental Remedial Investigation and Feasibility Study

PREPARED FOR:

GW International

PREPARED BY:

TERRA VAC
23106 100th Ave West
Edmonds, WA 98020-5018

and

FLOYD & SNIDER INC.
83 S. King Street Suite 614
Seattle, WA 98104

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

SRI Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

Acronym	**Definition**
AOC	Area of concern
AST	Aboveground storage tank
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, xylenes
COCs	Chemicals of concern
CSD	City of Seattle Datum
DNAPL	Dense non-aqueous phase liquids
DPP	Duwamish Pathways Project
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
1st SH	First Silt Horizon

List of Acronyms

Acronym	Definition
1st WBZ	First Water Bearing Zone
GWI	Great Western International
HPAHs	High molecular weight polycyclic aromatic hydrocarbons
IRM	Interim Remedial Measure
LGZ	Lower Groundwater Zone
LPAHs	Low molecular weight polycyclic aromatic hydrocarbons
MTCA	Model Toxics Control Act
OM	Organic Matter
PAHs	Polycyclic aromatic hydrocarbons
PCP	Pentachlorophenol
PCE	Perchloroethylene
PCOCs	Preliminary chemicals of concern
RI	Remedial Investigation
RI/PRA	Remedial Investigation and Preliminary Risk Assessment
Seattle Chain	Seattle Chain & Manufacturing Company
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SRI & FS	Supplemental Remedial Investigation and Feasibility Study
2nd SH	Second Silt Horizon
2nd WBZ	Second Water-bearing Zone
TCA	Trichloroethane
TCE	Trichloroethene
TPHs	Total Petroleum Hydrocarbons
UGZ	Upper Groundwater Zone
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
WAC	Washington Administrative Code

1.0 Introduction

Pursuant to the authority of the Washington Model Toxics Control Act WAC 173-340 (MTCA), Great Western Chemical Company dba Great Western International (GWI) entered into Agreed Order No. DE-TC91-N203 with the Washington State Department of Ecology (Ecology) effective September 30, 1991. Under the Agreed Order, GWI agreed to conduct a Remedial Investigation and Feasibility Study (RI/FS) regarding contamination of its property located at 6900 Fox Avenue S. in Seattle, Washington. A Remedial Investigation and Preliminary Risk Assessment (RI/PRA) report was produced in December 1993. In July 1994, the Agreed Order was amended to include an Interim Remedial Measure (IRM). The intent of the amended Agreed Order was to allow some limited remediation to proceed on the site while cleanup plans were evaluated for remaining contaminants and areas. In 1997, the IRM system was determined to be ineffective, and GWI began to re-evaluate alternative remedies for the site.

Since 1997, GWI has performed significant new investigative work at the site to define the nature and extent of contamination. GWI also has performed an extensive Pilot Study to evaluate source control options to replace or modify the existing IRM, and has completed the evaluation of cleanup action alternatives. The purpose of this Supplemental Remedial Investigation and Feasibility Study (SRI & FS) report is to present the results of this work and to document the following:

- The new information gathered since the original RI/PRA.
- The nature and extent of contamination at the site based on both the historical and new information.
- The cleanup standards for all affected media.
- The evaluation of alternative remedies and selection of a cleanup action under WAC 173-340-360.

2.0 Site Setting

The GWI Facility property is approximately two and a half acres in size, and is located in the Duwamish River Valley at 6900 Fox Avenue S. in Seattle. The property is essentially flat, and is almost entirely paved and/or covered by structures. It is zoned for industrial use, as are adjoining and nearby surrounding properties. A zoning map for a portion of Duwamish Corridor including the GWI Facility is presented in Figure 2.1 The GWI Facility property is approximately 400 feet from the S. Myrtle Street Embayment of the Duwamish River. The GWI "site" includes the facility and those properties located between the facility and the Duwamish River. Figure 2.2 shows the location of the facility and major landmarks in its vicinity.

2.1 OWNERSHIP, HISTORY AND CURRENT OPERATIONS

Much of the historical information presented below was derived from Hart Crowser's work in support of the Remedial Investigation and Preliminary Risk Assessment for Great Western Chemical Company (Hart Crowser 1993).

2.1.1 GWI FACILITY HISTORY

2.1.1.1 Land Use and Ownership

GWI's business is and historically has been the packaging of liquid chemicals for wholesale distribution and the warehousing of liquid and dry vendor chemical products. GWI's activities occur on the three westernmost lots of a four-lot block bounded to the north by South Willow Street and a parallel rail spur, to the east by East Marginal Way, to the south by Frontenac Street, and to the west by Fox Avenue S. and a parallel railroad spur. The easternmost lot of this block (Lot 11) is used for storage by parties other than GWI. An area map identifying the GWI Facility and adjoining and adjacent properties is presented as Figure 2.3. A map showing the current configuration of GWI's operations is presented as Figure 2.4.

The four-lot block between Fox Avenue S. and East Marginal Way was first developed for industrial use in 1918 by the Seattle Chain & Manufacturing Company (Seattle Chain). This company leased the property from King County between 1918 and 1937, when it purchased the entire block outright. Seattle Chain and its successor companies operated coke-fired and oil-fired furnaces and warehouses. Ownership of Seattle Chain was transferred in the late 1940s and the company was renamed the Round-Seattle Chain Co. Round-Seattle Chain and the property (i.e., the four lot block) were purchased in 1954 by Republic Steel. Republic sold all four lots to Marian Enterprises in 1956, though it continued operations in a warehouse on the northern part of the facility via a lease-back agreement.

GWI began leasing property from Marian Enterprises in 1956. Initial GWI operations took place at a drumming dock located parallel to a rail spur along Frontenac Street, which had originally served Seattle Chain, and in portions of the former Seattle Chain main building. GWI constructed a new warehouse and office building on the west end of the property in 1959. A sump was located in the drumming area and connected to a subsurface tle drainpipe that ran to the south edge of the dock.

Other lessees of the property during the 1950s and 1960s included Campbell Chain Company, which leased and used a warehouse in the northern part of the facility abutting S. Willow Street, and Tyee Lumber Company, which leased parts of Lot 11 and the Seattle Chain building for storage and product assembly.

GWI completed major facilities modifications in the 1960s and 1970s, including replacement of and upgrades to existing structures; installation of a concrete, aboveground storage tank pad east of the warehouse/office; and replacement of the sump and drain system in the drumming area. In 1976, both the tank and the drumming facilities were expanded considerably, including the construction in the dock area of two concrete and metal sheds fordrum storage. The dock area itself was also enlarged at that time, to the configuration that exists today.

Tyee Lumber's operations in former Seattle Chain Facility buildings on Lot 11 terminated in 1969 with the demolition of these structures. The property that was cleared when the buildings were demolished was leased in the 1970s and early 1980s by Western Salvage Co., a truck and heavy equipment recycler. This parcel was subsequently leased to Nelson Trucking as a parking area, and is currently used for container storage.

2.1.1.2 Underground and Aboveground Storage Tanks

GWI historically has used a variety of underground storage tanks (USTs) and aboveground storage tanks (ASTs) at the facility. Figure 2.5 identifies the sizes and locations of all known USTs, and the dates of their installation, decommissioning and removal (where known). Most USTs and ASTs were used for a variety of products, depending on the variability of demand.

The six original USTs at the facility, installed in 1956, were 10,000-gallon, single-compartment tanks, located beneath the drum shed along Frontenac Street. These tanks, referred to as the "old" tank farm, were decommissioned in 1989. They remain in place beneath a concretepad under the drum shed in the southeast corner of the facility (Refer to Section 3.4 for details). In 1976, 10 double-compartment USTs, each UST with a 12,000-gallon capacity, were installed in the central part of the facility. These tanks, which form the "main" tank farm, remained in use until they were decommissioned in 1989 and removed in the fall of 1990 (refer to Section 3.4 for details). A 1000-gallon UST located near the Fox Avenue S. loading dock area historically was used for storage of diesel fuel. It was decommissioned in place in 1989. A 500-gallon heating oil UST, installed in the northwest portion of the property during the early years of GWI's operations, remains in use.

In 1959, GWI installed an AST in the southwest corner of the loading dock area to store sulfuric acid. Two smaller, 1000-gallon, aboveground "wing tanks" were also used historically on the loading dock: one contained perchloroethylene (PCE) and the other tank stored methanol. Portable, vertical ASTs called "tote bins" used for product storage were stored on pallets in the vicinity of the old tank farm. In 1976, GWI constructed a bermed AST acid storage area, with sumps, adjacent to the warehouse/office. Five ASTs were installed in this area by 1980. In the 1970s and 1980s, GWI used three blending and/or storage ASTs that were located near the main tank farm.

2.1.1.3 GWI Products

The GWI Facility has been used since 1956 for the storage, repackaging and distribution of chemical and petroleum products. Until the late 1980's, GWI supplied chemicals and supplies to the laundry and dry cleaning industry. This aspect of GWI's business, as well as most of its petroleum product handling, was phased out by 1990.

Materials at GWI have been received, handled and shipped in drums, in bulk for storage tank transfer and as packaged dry chemical products. Both rail and truck transport has been used at the facility.

GWI has handled the following chemical classes and product types at the property:

Class	Product Type
Ketones	Methyl ethyl ketone (MEK), methyl *iso*-butyl ketone (MIBK), and acetone
Monocyclic Aromatic Solvents	Toluene and xylenes
Alcohols and glycols	Isopropyl alcohol, ethyl alcohol, methyl alcohol, ethylene glycol, and propylene glycol
Mineral Spirits/Petroleum Solvents	Chevron solvents 325, 350-B, 410 and 450, and kerosene.
Chlorinated Compounds	Methylene chloride, PCE, PCP, TCE, 1,1,1-TCE
Acids	Nitric, sulfuric and muriatic (hydrochloric) acids
Dry Products	Phosphates, soda ash, titanium dioxide, borax, boric acid
Miscellaneous	Ferric and ammonium chloride etchants, phenols, hydrogen peroxide, and linseed oil

GWI transferred and drummed products principally in the vicinity of the drum shed. Pump lines from USTs and ASTs to the drumming area ran aboveground and underground.

GWI began handling pentachlorophenol (penta) on the property sometime in 1966. Product was stored in one of the 12,000-gallon tank compartments and, for a period of 1 to 2 years only, penta was blended with Stoddard solvents or mineral spirits in a small AST north and west of the drum shed. From 1969 until the late 1970s or early 1980s, GWI purchased mixed penta in drums from outside vendors. Product was delivered to customers in vendor-packaged drums or transferred to a tanker truck and delivered in bulk.

2.1.1.4 Current Product Use

The GWI Seattle Facility warehouses liquid and dry products, including vendor pre-packaged containers and GWI-packaged containers. Inventory includes hazardous and non-hazardous products, including food products. Products are stored according to hazard class, type of product and chemical compatibility.

The facility packages liquid chemical product into containers (drums or totes) from tanker trucks. Products transferred in this manner include the following:

- Sodium chlorate
- Sulfuric acid
- Hydrochloric acid
- MIBC
- Ferric chloride
- Potassium carbonate
- Caustic soda

The facility transfers hydrogen peroxide from drums to tote by a filling process. The facility also transfers liquid chemical product by rail car, including the transfer of methanol to common carrier tanker trucks. The facility transfers dry product, such as calcium chloride and calcium sulfate, from rail car to the warehouse for storage and delivery to customers by truck or customer Will Call pick-up.

2.1.2 ADJACENT AND NEARBY PROPERTIES

The GWI Facility is located in an industrial section of the Georgetown neighborhood of South Seattle. This area has been the site of manufacturing, maintenance, and warehousing operations since the early 20th century. Much of this activity has been associated with metal fabrication and finishing operations. An environmental assessment of the nearby Othello Street Warehouse property (now Seattle Iron and Metal, 660 Othello Street) by Hart Crowser in 1996 identified 20 sites within a 5/8 mile radius that are on the Washington State Register of Toxic Sites, and 35 sites within the same radius with confirmed UST releases (Hart Crowser 1996). The following discussion is limited to those properties that have been identified as having the most potential to impact, or to be impacted by, environmental conditions at theGWI Facility.

2.1.2.1 Tyee Lumber Block

This block starts immediately south of the GWI Facility (south of Frontenac Street), was the site of lumber resawing and finishing operations from the 1920s to the early 1990s. The basic facility layout for these operations was established in the late 1930s. The original operations were conducted by Williams Fir Finish Co. on land leased from King County. In 1930, the Williams lease was assigned to Tyee Lumber and Manufacturing Company. Tyee purchased the property in 1953. The property was purchased in 1982 by CECO Corporation. In 1986, the property was purchased by the Whitehead Co./Reliable Transfer & Storage Co. Lumber operations were curtailed on the property in the early 1990s. The property is currently used for materials storage.

The resawing and finishing facility included planing mills, steam-dry kilns, a boiler plant, a glue shop and a wood refuse burner. As discussed above, a portion of the Marian Enterprises property was leased by Tyee from about 1959 to 1969 for product assembly.

At the plant, lumber was treated with preservatives, including penta, in a top-loading dip tank. The dip tank shed was situated adjacent to S. Myrtle Street, in the approximate location depicted on the aerial photograph presented as Figure 2.6. The dip tank was approximately 10 to 15 feet long, 5 feet wide and 5 to 6 feet deep. Three to four feet of the tank depth was below grade (personal communication with J. Riverman June 2000). Dipped lumber was processed and kiln-dried or, in some cases, air-dried and stored outside (Identified as the "post dip tank" lay down area in Figure 2.6) or in wooden sheds near the drying kilns. Penta dipping operations continued until 1982. A 300-gallon penta UST, located adjacent to the dip tank shed, was removed by Northwest Enviroservices in 1986.

2.1.2.2 Emerson/Schultz Distributing Block

The block immediately north of the GWI Facility is currently leased by Schultz Distributing Co., from D.M. Emerson, Jr. This property was developed in the 1920s for the Gypsum Products Corporation. From the late 1930s until the 1960s, Federal Pipe manufactured wood pipes and tanks on the property. Its operations included a dip tank, drying kilns and warehouse space. In 1964, a group of individuals, including members of the Emerson family, purchased the property. Emerson GM Diesel leased the property in the 1960s, and performed maintenance and repair of diesel motors and trucks on the property. Pacific Detroit Diesel occupied the property between 1989 and 1997. In 1996, the property was leased to Schultz Distributing, Inc. Schultz has used the property as a distribution center for petroleum products. A number of ASTs were installed on the site as part of the Schultz operation.

In the central part of the yard, solvents used in the shop area were contained in a dry sink and drained into a 20 gallon drum. Full drums were moved to an area behind the shop (Geraghty & Miller 1989). In the west part of the yard, a 2,000 to 6,000 gallon UST collected paint material and solvents from a former paint room/carpenter shop (Geraghty & Miller 1989).

Recently, potential sources of chlorinated solvents have been investigated near the Emerson/Schultz Distributing. GWIThe results of these recent investigations are discussed in Appendix A. Additional investigation of potential contamination is ongoing in this area.

2.1.2.3 Bunge Foods

This property to the west/northwest of the GWI Facility has been occupied since 1978 by a large warehouse used for the storage and shipment of food products. The building was originally occupied by Richardson & Holland and the Sam Wilde Flour Company. It is currently operated by Bunge Foods. Prior to building construction in 1978, this block was occupied by a number of small manufacturing operations.

2.1.2.4 National Steel/Seattle Boiler Works Block

The commercial block immediately west of the GWI Facility was historically occupied by the National Steel Construction Company, which used the property for construction and storage from approximately 1908 until 1966. National Steel reportedly conducted shipbuilding activities both on this block and on property immediately to the south (south of S. Myrtle Street). The property contained, at various times during National Steel's tenancy, an iron foundry, woodworking and blacksmith shops, a marine railway, galvanizing and aluminum dipping facilities, a boiler works, and waste metal and slag piles. In 1966, the property waspurchased by Seattle Boiler Works, which manufactures boilers, refuse burners, and incinerators.

2.1.2.5 Seattle Iron and Metals Property

Seattle Iron and Metals conducts operations on a large parcel located to the southwest of the GWI Facility, immediately south of Seattle Boiler Works. Beginning in 1917, this site was used for metalworking, foundry work, painting activities, steel can manufacturing equipment construction, and fuel storage. Both USTs and ASTs were installed at, and removed from, various locations on the property. The site was used primarily for warehousing and terminal operations during the 1980s and 1990s.

This parcel has been the subject of several environmental assessments and investigations during the 1980s and 1990s. In 1998, Othello Warehouse Street Corporation, owner of this property at the time, submitted a "Voluntary Cleanup Action Report" (Hart Crowser 1998) to Ecology. Othello intended to sell the property and was seeking an "Interim No Further Action" letter from Ecology to facilitate the sale. The report, which includes a summary of investigative data and remedial actions performed at the site, documents the presence of total petroleum hydrocarbons (TPHs), metals, volatile organic compounds (VOCs), and penta contamination at the site, and attributes the contamination to both on-site and off-site sources. Biannual groundwater monitoring is ongoing at this location.

2.2 REGIONAL GEOLOGY

The GWI site is located in the Duwamish River Valley within the southern part of the Puget Sound Basin. The lowlands of the Puget Sound Basin lie between the Cascade Range on the east and the Olympic Mountains on the west. The regional topography and geology have been influenced by the glacial incursions that occurred during the Pleistocene epoch. Bedrock in the area is composed of Tertiary period marine and continental sedimentary rocks and isolated igneous intrusions (Duwamish Pathways Project (DPP 1998a). The Duwamish River Valley is dominated by alluvial deposits laid down after the last glaciers retreated from the Puget Sound some 10,000 years ago.

Hydrogeology in the area is controlled by alluvial deposits within the Duwamish River Valley and by Pleistocene glacial deposits in the surrounding uplands. Industrial development over the last 100 years has resulted in locally shallow groundwater within fill deposits.

2.2.1 GEOLOGICAL HISTORY

Figure 2.7 presents the Regional Geological Map for the primary geological units in the site area. This map was compiled as part of the Duwamish Basin Groundwater Pathways Study (DPP 1998a). Table 2.1 presents a stratigraphic sequence for the southern Puget Sound Basin. Sediment in the vicinity of the GWI site is unconsolidated.

Tertiary bedrock exposed in the uplands, and collectively known as the Puget Group, was deposited in the late to middle Eocene and Oligocene. Eocene deposits are represented by the Tukwila (Tpt), Renton (Tpr), and Blakely (Tb) Formations. Locally, irregular masses of mafic igneous rocks (Ti) intrude into the Puget Group. In the area of the GWI site, the Oligocene Blakely Formation is believed to form the bedrock beneath the alluvial valley deposits and the uplands to the east. The Blakely Formation is composed of marine sandstones, some conglomerates and a minor amount of siltstone. These beds were deposited in a shallow marine coastal environment and have a distinctive collection of marine fossils (DPP 1998a; Galster and Laprade 1991).

During the Pleistocene Epoch, about 2 million years ago, continental glaciers slowly advanced south from the Coastal Range of British Columbia to cover the Puget Lowlands. The Puget Lobe of the glaciers retreated and advanced more than six times during this period. Sedimentary deposits from this middle Pleistocene period have both glacial and non-glacial origins (e.g., Olympia Beds: Qob). In the uplands west of theGWI site (Figure 2.8), these pre-Vashon deposits are several hundred feet thick; they are composed of fine- and coarse-grained sediments and are overlain with glacial deposits laid down during the advance and retreat of the Vashon Ice. The depositional sequence of the western upland deposits is inferred from the Beverly Park test well (06-02), located nearly one mile southeast of the site, and from regional geology compilations (DPP 1998a; Woodard et al. 1995).

The Duwamish Valley is a relic arm of the Puget Sound Basin, which was carved by overriding ice sheets of the Vashon Stade that last advanced into the area about 15,000 years ago. Vashon glacial deposits now mantle the older upland Pleistocene and Tertiary deposits (DPP 1998a; Woodard et al. 1995). West of the GWI site, the tops of the uplands are dominated by Vashon till (Qvt), while recessional outwash deposits are prevalent along the flanks (Figure 2.7). The till was deposited by melt-out of debris at the base of the glacier as ice covered the region. Underlying the till are advance outwash deposits (Qva) that mark the beginning of the subsequent Vashon Stade, when coarser outwash was deposited by streams originating from the advancing ice sheet. Recessional outwash deposits (Qvr) flank the hills to the west and mark the channel deposits of long-vanished rivers that issued from the snout of the retreating Vashon ice sheet as it withdrew. The uplands east of the site are mantled by a veneer of till overlying Tertiary bedrock. In general, till is composed predominately of a gravelly silty to very silty sand, but locally it is sub-stratified, and contains lenses of silt, sand, and gravel. Recessional deposits are chiefly fine to medium sand, but include some pebbles, gravel, and laminated silts. Advance outwash deposits are dominated by sands and gravels.

After the retreat of the Vashon ice sheet, the Duwamish arm of the Puget Sound reached Auburn, about 20 miles upstream of the present mouth of the Duwamish Waterway at Elliot Bay. Approximately 5,700 years ago, a tremendous mudflow, the Osceola Mudflow, descended from the flanks of Mount Rainer along the valley of the White River, building a voluminous fan of sediment into the marine waters at Auburn and progressing down-valley as a submarine flow as far north as Kent (Dragovich et al. 1994). Over subsequent centuries, the deposits of the Osceola were eroded and redeposited downstream, filling in the Duwamish arm of the Puget Sound. This redeposition, coupled with isostatic rebound, resulted in a complex deposition pattern of deltaic and estuarine deposits within the Duwamish Valley (DPP 1998a). Even more recently (with the last 100 years), the delta/estuary was modified by hydraulic fill and by-products of industrial development in the area.

Immediately to the east of the GWC site, the uplands are dominated by Pleistocene Vashon Till (Qvt) and the Tertiary Blakely Formation (Tb). To the west, the uplands are dominated by till (Qvt) and recessional (Qvr) deposits of the Vashon Stade. Figure 2.8, Cross Section A-A', shows the distribution of the stratigraphy in theGWI area. Figures 2.9 and 2.10, Cross Sections B-B' and C-C', show the distribution of the recent alluvium in theGWI site area.

These Duwamish Valley deposits consist of 50 to 100 feet of older alluvium (Qoal), representing sand and silt estuarine deposits. Locally, these older sediments contain discontinuous gravel lenses, shells, and some wood (DPP 1998a). The younger alluvial (Qyal) deposits have a relatively constant thickness and depth, with a base that almost everywhere is within five to 10 feet of the modern sea level. These deposits, which consist of silt, sand, and sandy silt with abundant wood and organics (DPP 1998a), represent channel and floodplain deposits laid down by the modern Duwamish River. Overlying the younger alluvium are varying amounts of fill that range in thickness from three to 10 feet. The fill material is composed of a mixture of sand, gravel, silt, and miscellaneous construction debris. It is these layers of fill and alluvial deposits that form the stratigraphic components of the GWI site and control the fate and transport of contaminants.

Old river meanders north, south, and west of the GWI Facility were filled between 1914 and 1918 (Hart Crowser 1993). Aquifers occur in both the older and younger alluvial deposits. Shallow aquifers are found locally within fill material. The hydrostratigraphy of alluvium and upland deposits and their relationship to aquifers and groundwater hydrology in the area of the GWI site are discussed below.

2.2.2 HYDROSTRATIGRAPHY

Within the uplands of the Duwamish Valley, glacial outwash (e.g., Qva and Qvr) deposits typically host aquifers; whereas glacial till (e.g., Qvt), glacio-lacustrine deposits and interglacial deposits typically serve as aquitards (e.g., Qtb). In general, the valley alluvium is believed to comprise a single, large aquifer system (DPP 1998a). Locally, where this aquifer is thickest, upper and lower groundwater zones are often differentiated on a site-specific basis, based on the occurrence of locally-continuous silt aquitards, upward gradients at depth, and/or saline groundwater pockets (DPP 1998a). Although some of the saline pockets are a reflection of the current intrusion of marine waters, most reflect connate or "trapped" seawater from previous depositional events.

2.2.2.1 Upland Aquifers and Aquitards

The available data indicate that there is no drinking water supply well in the GWI site area. The nearest water supply wells are located approximately four miles southwest of the site and are owned and operated by the City of Seattle. The subsurface stratigraphy within the well field is well understood and serves as a model for the uplands west of the GWI site (DPP 1998a and 1998b). Figure 2.11, Cross Section D-D', illustrates the stratigraphic relationships between the various deposits underlying the well field. Figure 2.8, Cross Section A-A', illustrates the predicted distribution of the upland deposits west of the site.

City of Seattle water supply wells are screened within what is known as the Highline Intermediate and Deep Aquifers. These wells tap pre-Vashon glacial units {Q(A)c and Q(B)c}. Within the well field, the Intermediate Aquifers range in elevation from 200 feet above mean sea level to 150 feet below mean sea level (DPP 1998a). The uppermost aquifer in the well field is the Vashon Advanced Outwash (Qva), which occurs at an elevation of approximately 250 to 400 feet above mean sea level. Locally, the Olympia interglacial aquifer (Qob) lies between the pre-Vashon and Vashon aquifers.

The aquitard {Q(B)f} separating the Intermediate and Deeper Aquifers in the Highline well field is described as a fine-grained deposit that is believed to correlate with Possession Drift/Whidbey Formations, implying an age of at least 100,000 years. Underlying the Vashon Advanced Outwash deposit (Qva) is the Lawton Clay Aquitard (Qtb), composed of lacustrine silt and clay (DPP 1998a).

As can be seen in Figure 2.8, Cross Section A-A', the uplands west of the GWI site area are interpreted to display a vertical sequence of alternating coarse- and fined-grained layers down to several hundred feet below mean sea level. Based on boring logs from the Beverly Park test well (06-02), a thick layer of Vashon Advance Outwash (Qva) overlies approximately 200 feet of Lawton Clay (Qtb). Underlying these sediments, a sequence of pre-Vashon deposits is predicted to extend from zero to -400 feet below sea level.

Unlike uplands north and south of the GWI site area, the western slope of the Duwamish Valley wall is mantled in Vashon Recessional Outwash (Qvr) and Lawton Clay (Qtb). The Recessional Outwash deposit is roughly similar in permeability to the Vashon Advanced Outwash (Qva), but is very much more permeable than the adjacent Lawton Clay. In areas where the Lawton Clay is absent, recessional outwash deposit can provide a subsurface pathway for water to move into the valley alluvial sediments without first emerging as hillside seeps above the Lawton Clay (DPP 1998a).

Upland stratigraphy allows water from the uplands to discharge into the alluvial valley both along subsurface pathways and through visible seeps along valley walls. The stratigraphy does not allow contamination from the Duwamish Valley in the vicinity of GWI site to be transported toward the Highline well field.

2.2.2.2 GWI Site Area Aquifers and Aquitards

As noted above, the Duwamish Valley alluvium generally comprises a single large aquifer system. However, the aquifer characteristics are modified locally because of tidal effects, discontinuous low permeability interbeds, compositional variations, thickness, and/or the proximity of upland discharge areas. In the GWI site area, shallow and deep groundwater-bearing zones have been defined by numerous studies, particularly associated with projects at the Boeing aircraft facility just east of the river, with the Renton Effluent Transfer System (RETS) project along the west edge of the valley, and with detailed subsurface investigations conducted at the GWI site. Figures 2.9 and 2.10, Cross Sections B-B' and C-C', illustrate the predicted distribution of the valley deposits in the GWI site area. The alluvium is divided into younger (Qyal) and older (Qoal) alluvial deposits. Where alluvial aquifers are thickest, as in the area of the GWI site, the Upper and Lower Groundwater Zones are differentiated based on locally continuous silt aquitards that separate the zones and the occurrence of upward gradients and/or the occurrence of saline groundwater pockets in the Lower Groundwater Zone (DPP 1998a).

Upper Groundwater Zone

The Upper Groundwater Zone (UGZ) is hosted by both younger and older alluvial deposits (i.e., Qyal and Qoal, respectively) and typical occurs down to depths of 60 to 80 feet below ground surface (bgs) (DPP 1998a). Groundwater flow in the UGZ occurs primarily under water table conditions, but locally, the aquifer is confined by silt aquitards. The UGZ appears to be recharged primarily by water-bearing glacial sediment deposits comprising the east and west uplands; however, locally some surface recharge does occur. This unit contains moderately well sorted silty, sand, and sandy silt, locally containing abundant wood and organics (Figures 2.9 and 2.10). The net groundwater flow within the UGZ is generally toward the Duwamish Waterway; however, locally, tidal effects have been shown to cause apparent groundwater flow reversal. In general, temporal groundwater flow reversal occurs within 500 feet of the waterway (DPP 1998a). In some areas of the valley, tidal response has been measured as far as 1,000 feet from the river. Downward gradients have been observed in the UGZ at depths of 30 to 50 feet (DPP 1998a). The magnitude of the downward gradients reflects the degree of infiltration (much of the area is paved), the degree of silt and sand interbedding, and the proximity to the river.

Upward gradients are common between the UGZ and Lower Groundwater Zone (LGZ). On the east side of the Duwamish Waterway, gradients are reported to be an order of magnitude lower than on the west side. This difference is likely due to the more limited inflow from bedrock-dominated deposits (i.e., Tertiary deposits) on the east side of the waterway as compared to inflow from glacial deposits on the west. Upward gradients in the alluvium on the west side of the river have been reported to range from 0.02 to 0.3, while on the east side of the river they range from 0.002 to 0.07 (DPP 1998a). The higher gradients on the west could be attributed to discharge from glacial sands and gravel deposited in the uplands (DPP 1998a).

Lower Groundwater Zone

The LGZ is hosted in estuarine/deltaic deposits (i.e., Qoal). The LGZ is typically differentiated from the UGZ by a higher percentage of fines, an abundance of shell fragments, and brackish groundwater conditions caused by contact with seawater. In the central part of the Duwamish Valley, where the GWI site is located, the LGZ is estimated to occur at depths of greater than 60 to 80 feet bgs (DPP 1998a). On the edges of the valley the LGZ occurs at shallower depths. In general, the upper two-thirds of the LGZ is typically described as sand to silty sand; and the lower third is commonly described as sandy silt. Vertical gradients in the LGZ are generally upward (DPP 1998a).

Undifferentiated Low Permeability Zones

Locally, low permeability deposits are present within the UGZ and LGZ. These deposits play an important role in groundwater flow direction and contaminant transport. At the GWI site, low permeability fine-grained deposits have been observed in the regional UGZ at depths ranging from 10 to 50 feet bgs.

At the GWI site, a low permeability zone divides the regional UGZ into what are designated for site-specific purposes as the First Water-Bearing Zone (1st WBZ) and Second Water-Bearing Zone (2nd WBZ). A second low permeability zone defines the bottom of the 2nd WBZ. These low permeability zones are described in Section 2.3.3.4.

2.2.3 BRACKISH WATER QUALITY

The salinity of valley groundwater is a natural by-product of the estuarine environment in which the valley deposits occur. The natural groundwater quality is a function of the current tidal mixing of water from the Duwamish River system as well as the original depositional environment of the alluvium (DPP 1998a), especially prior to the Oceola Mudflow when the valley was still an arm of the Puget Sound. Saltwater intrusions have been documented in the Duwamish River as far south as the historic Black River (approximately 7 miles south east of GWI site) . Near the river, in the area of the GWI site, electrical conductivity data ranging from 1,600 to 24,000 µmhos/cm have been measured in wells screened in the LGZ. Further away from the river, electrical conductivity data have been reported to range from 500 to 1,500 µmhos/cm (DPP 1998a and DPP 1998b).

2.2.4 SHALLOW GROUNDWATER (UGZ) USE DESIGNATION

In May, 2000, the Department of Ecology accepted three documents prepared by the Duwamish Coalition for the Duwamish Industrial Area Hydrogeologic Pathways Project as suitable for use by site managers and others making site-specific cleanup decisions under the Model Toxics Control Act (MTCA) for sites within the Duwamish Industrial area. The documents: *Duwamish Basin Groundwater Pathways Conceptual Model Report (DPP 1998a); Duwamish Industrial Area Technical Memorandum – Shallow Groundwater Use Designation (DPP 1998c)*; and *Numerical Groundwater Flow Model for the Duwamish River Basin (UW 1998)*, provide a detailed characterization of the hydrogeologic conditions of a large portion of the Duwamish River basin and fill a long-standing need for a comprehensive understanding of groundwater in the area.

The Duwamish Coalition documents referenced above provide the documentation necessary to help establish the highest beneficial use designation of shallow groundwater within the Duwamish valley as protection of beneficial uses of adjacent surface waters. The materials document that:

- The ground water does not serve as a current source of drinking water.
- The groundwater is not a potential future source of drinking water (due to insufficient quantity, poor natural quality, or inaccessibility).
- It is unlikely that hazardous substances will be transported from the contaminated ground water to ground water that is a current or potential future source of drinking water.
- The surface water is not classified as a suitable domestic water supply source.

This highest beneficial use designation is applicable to the GWI site. Site specific data confirm that hydrogeologic characteristics of the site are consistent with the regional valley context. In the GWI site area, the alluvial aquifer system extends to a depth of 100 feet, with the upper 60 to 80 feet comprising the UGZ. Deposits below this depth (LGZ) are differentiated from the shallow aquifer zone by their high saline content, silt interbeds, vertical gradients, and higher fines content.

2.3 SITE GEOLOGY

The GWI site geology has been interpreted from soil boring and monitoring well logs completed during the investigations conducted at the site by Hart Crowser, Inc. and Terra Vac. The subsurface geology of the GWI site consists of natural geological and manmade stratigraphic features. Description and testing of geologic units beneath the surface of the site allows for the evaluation of the units' areal extent and their potential to allow for or act as barriers to contaminant flow.

Field geological data for soil boring and monitoring well samples collected during the site investigations are compiled in Appendix B.

2.3.1 INTRODUCTION

The Duwamish Waterway flows northwesterly and is located west of the GWI Facility. The main channel is about 600 feet from the GWI Facility, but a small embayment (the S. Myrtle Street Embayment) brings the river to within about 400 feet of the property. Prior to backfilling, the Duwamish River meandered across the area to the north, south, and west of the facility; none of these meanders were located on the GWI site. Between 1914 and 1918, these meanders were filled. Tidal flats have been observed at the S. Myrtle Street Embayment. These are shown on a chart maintained by the National Oceanic and Atmospheric Administration (NOAA 1978). Near the GWI site, the tidal flats vary in width from about 15 feet to greater than 100 feet and extend intermittently along the river bank in bands several hundred feet long (Hart Crowser 1993).

The GWI site is located on a floodplain of the Duwamish River. The site and vicinity are relatively flat. The site elevation ranges from 14 to 21 feet City of Seattle Datum (CSD). The GWI Facility extends over an area of about two and a half acres. Fill covers much of the site in depths ranging from five to 10 feet bgs. Near-surface fill appears to be of local origin, including some debris and dredge spoils from river channel improvements, but the fill consists primarily of local soil disturbed by construction.

Underlying the fill material are alluvial deposits representing younger alluvial channel and floodplain deposits laid down by the modern Duwamish River. Underlying the younger deposits (Qyal) are older sedimentary deposits (Qoal) representing deltaic and estuarine depositional environments (Figures 2.9 and 2.10). These alluvial deposits contain what have been designated as the UGZ and LGZ (DPP 1998a and 1998b). The UGZ is in contained in both the younger and older alluvium deposits, while the LGZ is found only in the older alluvium. Locally, these groundwater-bearing zones consist of low permeability deposits that play an important role in groundwater flow direction and contaminant transport. At the GWI site, these low permeability fine-grained deposits have been observed at various depths between 10 to 50 feet bgs. The contact between older alluvium and Tertiary bedrock in the area of the GWI site is interpreted to range from 40 to 50 feet below sea level on the margins of the valley to greater than 100 feet below sea level in the center of the valley. None of the wells at the GWI site are deep enough to penetrate the alluvial deposits and reach bedrock.

The uplands west of the GWI site display a vertical sequence of alternating coarse- and fine-grained layers down to several hundred feet below mean sea level. The flanks of the west uplands are mantled by Vashon Recessional Outwash (Qvr) and Lawton Clay (Qtb). Underlying these deposits are pre-Vashon middle Pleistocene deposits of both glacial and non-glacial origins (Figures 2.7 and 2.8). In the upland area east of the GWI site, the rocks are mapped as Oligocene Blakely Formation (Qtb) and Vashon Till (Qvt) (Figures 2.7 and 2.8). The Blakely Formation is composed of marine sandstones, some conglomerates, and a minor amount of siltstone, while the Vashon Till is primarily composed of gravelly silty to very silty sand but, locally, is sub-stratified and contains lenses of silt, sand, and gravel.

2.3.2 GEOLOGIC CROSS SECTIONS

Figure 2.12 illustrates the location of six geologic cross sections on the GWI site. The section locations have been chosen as a representative schematic of the geologic units throughout the site and include borings logs that intercept representative lithologies and depths. The geologic cross sections include:

- Section A-A': Figure 2.13 trends east to west approximately 500 feet across the northern border of the facility.
- Section B-B': Figure 2.14 trends east to west approximately 630 feet across the center of the facility.
- Section C-C': Figure 2.15 trends east to west approximately 385 feet across the southern border of the facility.
- Section D-D': Figure 2.16 trends southwest to northeast approximately 630 feet from the S. Myrtle Street Embayment to the center of the facility.
- Section E-E': Figure 2.17 trends southwest to northeast approximately 590 feet from S. Myrtle Street to the center of the facility.

2.3.3 SITE STRATIGRAPHY

The geologic and manmade materials on the surface and at depth below the GWI site are deposited in chronological order, the youngest material existing on the surface and geologic units increasing in age with depth. The unit descriptions presented below are characteristic of separate units found beneath the GWI site. Correlation with geological and hydrological units is discussed in Section 2.4.

2.3.3.1 Fill Material

Near-surface soil at the GWI site predominately consists of fill material, although native material is also present. Fill ranges in depth from five to 10 feet bgs. Typically, the fill is thickest near the center of site and thins toward the edges. Some of the thickest fill deposits occur beneath the GWI loading platform near the center of the facility.

Fill material is predominately composed of poorly graded silty fine sand to gravelly sand or sandy silt to gravelly sandy silt. Locally, fill includes some organic matter, wood, and debris, including pieces of masonry, cinders, and slag. A deposit of slag was intercepted in Boring B-29 beneath a GWI-loading platform. Slag was observed at a depth of approximately two to eight feet bgs and has a limited lateral extent. Slag was not intercepted in Borings B-1, B-17, and B-30 which are located, 40 feet north, 70 feet southeast and 80 feet northwest of Boring B-29, respectively.

2.3.3.2 Younger Alluvial Deposits

The fluvial deposits identified at the GWI site occur just below the fill and are interpreted to represent younger alluvial deposits (Qyal) of the Duwamish Valley. These deposits range in composition from fine to medium sand to slightly silty to very silty fine to medium sand. Locally, within these deposits, fine sandy silt lenses are intercepted. Where fill is lacking, these deposits range in depth from near-surface to approximately 10 to 20 feet bgs. In general, these sediments show a fining upward sequence that typifies meandering fluvial environments. In the Duwamish Valley, these deposits have been interpreted to represent channel and floodplain deposits laid down by the modern Duwamish River (DPP 1998a). At the GWI site, these younger alluvial deposits host the 1st WBZ within the regionally designated UGZ.

2.3.3.3 Older Alluvial Deposits

Estuarine/deltaic sediments (Qoal) are interpreted to be deposited beneath Duwamish River alluvium (Qyal). At the GWI site, these deposits are typically composed of fine to medium silty sands with interbeds, stringers, and lenses of dense to very dense very silty fine sand to soft to medium stiff sandy silt. In the GWI site area, estuarine/deltaic sediments are interpreted to extend to depths of more than 100 feet bgs. In general, these deposits become finer-grained with depth, but often show repeated sequences of silt to silty sand to sand. These deposits are typical of a cycle generated by gradual progradation of a delta into a shallow marine environment. At the GWI site, these older alluvial deposits host the 2nd WBZ within the regionally designated UGZ.

2.3.3.4 Silt Horizons

Two primary low permeability deposits have been identified at the GWI site. These units are named the First and Second Silt Horizons and are interpreted to represent flood plain deposits and/or estuarine/deltaic fine sand/silt deposits. Where present, the First Silt Horizon (1stSH), separates the 1st WBZ and 2nd WBZ. The Second Silt Horizon (2nd SH), where present, is located at depths of 30 to 40 feet beneath the 1stSH. The 2nd SH separates the 2nd WBZ from deeper estuarine/deltaic deposits. Where persistent, the 1st SH and 2nd SH can serve as shallow aquitards, impeding contaminant transport to lower units. The absence of either the 1st SH or the 2nd SH does not imply that contaminants have a pathway for reaching the underlying aquifers. However, it does suggest that the absence of either silt horizon in some locations illustrates the heterogeneity of local subsurface deposits, and reflects fluvial and estuarine/deltaic depositional environments of the valley.

First Silt Horizon

The 1st SH is primarily composed of very silty fine sand to very fine sandy silt. Figures 2.13 through 2.17, Cross Sections A-A' through E-E', illustrate the location of the 1st SH beneath the site. Figure 2.18 shows the elevation of the 1st SH.

First Silt Horizon – GWI Facility

The 1st SH is present beneath a majority of the GWI Facility, with the exception of a small area northwest of the former main UST farm.). The absence of the 1st SH at this location is seen in Soil Boring Log B-1 and is shown in Figure 2.18. At the GWC Facility, the thickness of 1st SH ranges from approximately less 0.5 to 2.5 feet. The 1st SH is thickest in the area of Soil Borings B-16 and B-17. These borings were drilled at the former main UST farm located near the center of the Facility.

On the east side of the GWI Facility, at the location of Soil Borings B-14 and B-32, a topographic high is present in the surface of the 1st SH. In this area, the elevation of the 1st SH is greater than 6 feet (CSD). North, south, and west of this location, the 1st SH descends to an elevation of less the 3 feet (CDS). To the east, the 1st SH descends to an estimated elevation of 5 feet (CDS). A depression in the 1st SH is located near the southwest corner of the GWI Facility, on the south side of the loading dock. Boring B10A is located at the center of the depression.

First Silt Horizon – Outside GWI Facility

Based on available field data, the 1st SH appears to be absent or discontinuous south and east of the GWI Facility; however, detailed subsurface information is lacking or limited in these areas. In past reports, the absence of the 1st SH south of the GWI Facility has been defined as a hole in the unit which allows the movement of groundwater and contaminants between the 1stWBZ and 2nd WBZ (Hart Crowser 1993). Southwest of the hole, the 1st SH is intercepted in Soil Borings B-35/B-36 and B-64/B-65 at elevations of less than 6 and 3 feet (CSD), respectively. Boring B-34, located southwest of Borings B-64/B-65, indicates that the 1st SH terminates at the S. Myrtle Street Embayment. West of Boring B-34, the 1st SH is absent because the unit was excavated during the installation of underground utilities.

Data presented in the tidal study (Section 2.4.4 and Appendix C), suggest that the 1st SH is present west of Fox Avenue. This conclusion is based on the fact that lag times and tidal efficiency data for the 2nd WBZ suggest that the aquifer is largely confined between the river and Fox Avenue, implying that the 1st SH is present west of Fox Avenue and acting as a confining layer.

Second Silt Horizon

The 2nd SH has been intercepted in deeper borings drilled at the site (i.e., 50 feet bgs). The 2nd SH, where present, forms the base of the 2nd WBZ. In general, the 2nd SH is located at depths of 30 to 40 feet beneath the 1st SH. The 2ndSH is discontinuous and is primarily intercepted east of Fox Avenue., although it was also intercepted in Soil Boring B-33A, located just east of the S. Myrtle Street Embayment. Because of a limited number of borings, it is not known if the 2nd SH west of Fox Avenue is truly absent; however, tidal efficiency and lag times do suggests the 2nd SH may be locally present (See Section 2.4.4.3). Where present, the 2nd SH ranges in thickness from approximately 1 foot to 5 feet and is primarily composed of soft to very stiff, clayey to very sandy silt or very silty sand. The location of 2nd SH is illustrated in Figures 2.13, 2.14, 2.15 and 2.16, Cross Sections A-A', B-B', D-D, and E-E'.

Although the 2nd SH and underlying deposits have not been completely differentiated in the area of the GWI site, the regional hydrostratigraphy would suggest that it is unlikely that contaminants will reach deeper sections of the regional UGZ and LGZ. This conclusion is based on the fact that deposits below with the LGZ are differentiated from the UGZ by their high saline content, silt interbeds, upward vertical gradients, and higher fines content. These differences support the conclusion that the UGZ is not hydrologically connected to the LGZ or to potential drinking water supply aquifers (DPP 1998b).

Undifferentiated Low Permeability Horizons

Within the 2nd WBZ, above the elevation of the 2nd SH, several borings have intercepted silt to very silty sand horizons ranging in thickness from 0.5 feet to 10 feet. These horizons appear to be relatively discontinuous in comparison to the extent of the 1st SH and 2nd SH. The most extensive of the horizons was intercepted in Borings B-17, B-27, and B-25 at depths of 30 to 35 feet bgs. Based on its nature and extent, this horizon could function as an intermediate aquitard within the 2nd WBZ and limit the transport of contaminants to deeper groundwater in the zone. Low permeability horizontal beds are particularly important in areas where the flow is primarily horizontal (little or no vertical gradients). In these areas silt and organic-rich beds act to significantly reduce the vertical dispersion of contaminants. Undifferentiated, low permeability horizons are illustrated in Figures 2.13 through 2.17 Cross Sections A-A' through E-E'.

2.4 GROUNDWATER HYDROLOGY

The previous section on site geology provides a foundation for analyzing and understanding the groundwater hydrology at the GWI site. This section emphasizes the groundwater flow system through the subsurface geological materials and their relationship to the subsurface environment.

2.4.1 INTRODUCTION

The groundwater hydrology of the GWI site is affected by the characteristics of subsurface materials, the interaction between shallow and deeper water-bearing zones, local recharge, vertical gradients, and the impact of tidal fluctuations. Locally, subsurface utilities may act as preferential pathways for shallow groundwater flow, although no evidence to date has been collected to confirm this assumption. The data supporting the followinggroundwater hydrologic characterization are presented in Appendix B and Appendix C.

The groundwater hydrologic analysis for the GWI site is best characterized using a simplified hydrostratigraphic model modified from the regional hydrostratigraphy presented in Section 2.2. Figures 2.13 through 2.14, Cross Sections A-A' through E-E' of Section 2.3, illustrate the hydrostratigraphic relationships beneath the GWI site. The specifications for each on-site and off-site well are presented in Table 2.2.

2.4.2 AQUIFERS

At the GWI site, two groundwater-bearing zones (i.e., 1st WBZ and 2nd WBZ) within the UGZ, have been identified based on water chemistry, tidal effects, and the presence of a low permeability deposit (the 1st SH) separating the zones.

2.4.2.1 Vadose Zone

The vadose zone at the GWI site is composed of fill and native material. Fill covers much of the GWI site at depths ranging from five to 10 feet bgs. Near-surface fill appears to be of local origin, including some debris and dredge spoils from river channel improvements, but the fill consists primarily of local soil disturbed by construction. Fill is predominately composed of poorly graded, silty fine sand to gravelly sand or sandy silt to gravelly sandy silt. Locally, fill includes some organic matter, wood, and debris, including pieces of masonry, cinders, and slag.

Where present, fill deposits overlie the 1st WBZ at the GWI site. These deposits are typically unsaturated but locally perched water may occur as result of surface water infiltration. In the past, perched water has been observed near the center of the GWI Facility at the end of the rainy season (Hart Crowser 1993). The impact of surface infiltration on groundwater level is discussed later in this section.

2.4.2.2 First Water-Bearing Zone

The 1st WBZ is the uppermost groundwater bearing unit beneath the GWI site and is most vulnerable to impacts from surface activities. This zone is primarily composed of native alluvial deposits of fine to medium sand to slightly silty to very silty, fine to medium sand. These sands are interpreted to represent channel and floodplain deposits laid down by the modern Duwamish River (DPP 1998a). Locally, within these deposits, fine sandy silt lenses are present. The 1st WBZ is unconfined, with depth to the water table ranging from approximately 7 to 13 feet bgs. The 1st SH serves as the base for the 1st WBZ throughout most of the site (Figures 2.13 through 2.17, Cross Sections A-A' through E-E'). A hole in the 1st SH south of the GWI Facility allows the movement of groundwater between the 1st WBZ and the 2nd WBZ. The impact of tidal cycle groundwater elevations at the hole and near the S. Myrtle Street Embayment are presented in Figures 2.20 through 2.23.

Groundwater Elevations and Flow Direction

At both low and high tides, 1st WBZ Potentiometric Maps (Figures 2.20 and 2.21) show the general direction of groundwater flow at the GWI site to be to the southwest, similar to the regional groundwater flow direction on the east side of the Duwamish Valley. At both high and low tides, a depression occurs in the potentiometric surface in the vicinity of Wells B-8, B-42, B-44, and B-49. This depression is located in close proximity to the hole in the 1st SH and illustrates the hydraulic connection between the 1st WBZ and the 2nd WBZ. A second depression in the potentiometric surface, which is only present at high tide, is located in the vicinity of Wells B-36 and B-64. This depression does not reflect a hole in the 1st SH, but rather the impact of a tidal groundwater pressure wave on the 1st WBZ. The depression is not present at low tide because the impact of the pressure wave on the 1st WBZ is diminished at low tide. At low tide, west of Fox Avenue S., groundwater flows toward the S. Myrtle Street Embayment; however, at high tide, groundwater flows northeast toward the GWI site. This reversal in groundwater flow direction during the tidal cycle is typical of aquifers in contact with marine surface water bodies (Robinson et al. 1998). The magnitude and direction of hydraulic gradients are a function of distance from the shoreline (Robinson et al. 1998; Serfes 1991). The impact of the tidal cycle on groundwater elevations at the GWI site is discussed in more detail later in this section.

Horizontal Hydraulic Conductivity

The hydraulic conductivity of the 1st WBZ varies across the GWI site. Hydraulic conductivity was measured using slug tests in Wells B10 (abandoned), B10-A, B-28, and B-31 in 1990 and 1992 (Hart Crowser 1993). The hydraulic conductivity of the 1st WBZ is estimated to range from 3×10^{-3} to 2×10^{-2} centimeters per second (cm/s). The geometric mean of the hydraulic conductivity of the 1st WBZ is 7.5×10^{-3} cm/s.

Horizontal Gradients

Horizontal gradients in the GWI site area are affected by tides, variations in hydraulic conductivity, and the presence or absence of the 1st SH. In general, gradients become steeper moving from east to west. In the vicinity of Wells B-14, B-25, and B-32, (installed on the east side and upgradient of the GWI Facility) gradients measured from low and high tide potentiometric contours are both 0.001 feet/foot (ft/ft) (Figures 2.19 and 2.20). In the vicinity of Wells B-31, B-42, and B-47, screened near the hole in the 1st SH, low and high tide gradients are calculated as approximately 0.006 and 0.009 ft/ft, respectively. The similar magnitude of horizontal gradients on the east and central parts of the GWI Facility suggests that the hydrologic properties of the 1st WBZ are comparable in these two areas. West of Fox Avenue S., near the S. Myrtle Street Embayment, low and high tide horizontal gradients in the vicinity of Wells B-34 and B-64 are calculated as approximately 0.015 and 0.011 ft/ft, respectively. In this area of the 1st WBZ, groundwater flows east during high tide and west during low tide. The reversal of the groundwater flow direction results from the eastward advance of the tidal pressure wave during the flood tide. The gradients in this area are approximately an order of magnitude higher than gradients measured east of Fox Avenue S. These higher gradients reflect the strong impact of the tidal cycle on the 1st WBZ west of Fox Avenue S., as compared to the east side of Fox Avenue S.

Groundwater Flow Velocity

Like hydraulic conductivity and gradient, groundwater flow velocity in the area of the GWI site varies from east to west. Using an average hydraulic conductivity of 21.3 ft/day (7.5×10^{-3} cm/s) and an assumed conservative effective porosity of 0.25 (Freeze and Cherry 1979), 1st WBZ groundwater velocities were calculated using Darcy's equation: $V = KI/n$, where V = Groundwater Velocity, K = Hydraulic Conductivity, I = Hydraulic Gradient, and n = Effective Porosity. On the east side of the GWI site, in the vicinity of Wells B-14, B-25, and B-32 the average groundwater velocity (average of high and low tide) for the 1st WBZ is approximately 0.10 ft/day (36 ft/year). The average groundwater velocity was used for the east portion of the GWI property because the impact of the tidal cycle on gradient and hydraulic heads is considered to be minimal. In the vicinity of Wells B-31, B-42, and B-49,(screened near the hole in the 1st SH) the low tide groundwater velocity is 0.47 ft/day (172 ft/year), while the high tide velocity is 0.80 ft/day (291 ft/year). West of Fox Avenue S., near the S. Myrtle Street Embayment, in the vicinity of Wells B-34 and B-64, the velocity at low tide is 1.25 ft/day (456 ft/year) toward the Duwamish River, while velocity at high tide is 0.93 ft/day (339 ft/year) in the opposite direction. The reciprocative movement of groundwater in tidal influence regions can increase the dispersion of contaminants and results in earlier arrival of contamination at the aquifer-surface water interface (Robinson et al. 1998) than would be expected based on the average gradient across the tidal cycle.

Due to variability in aquifer properties and difficulty in determining gradients at a complex and tidally influenced site, these gradients and related velocities should be considered estimates of the actual conditions.

Infiltration and Recharge

Most of the GWI Facility is paved or roofed. Infiltration occurs primarily on the north and east sides of the facility in limited unpaved areas that are not used for chemical storage. Infiltration also occurs in the area near the center of the facility and west of the drum shed, and in limited areas of deteriorated pavement and railroad tracks along the southern side of the facility. Railroad tracks are also present on the north side of the facility.

The volume of surface water infiltrating to the 1st WBZ from the GWI site and the surrounding area is unknown; however, based on an analysis of stormwater runoff conducted at theGWI site in 1992 (Hart Crowser 1992), this volume is believed to be minimal relative to the volume of surface water captured by municipal storm sewers and on-site catch basins. The principal stormwater discharge from the GWI Facility is primarily to the west, and at least part of this discharge enters the City of Seattle storm sewer on Fox Avenue S. Groundwater levels typically are above or slightly below the invert elevation of buried storm and sanitary sewers in all blocks around the GWI Facility.

In early 1990, groundwater data from the GWI site were evaluated GWIto assess whether buried utilities or surface water infiltration impacted groundwater levels. Results from this qualitative analysis did not find measurable water level changes that could be clearly related to the proximity of buried utilities or other sources (Hart Crowser 1992).

2.4.2.3 Second Water-Bearing Zone

Nineteen borings drilled in the vicinity of the GWI site intercepted the 2nd WBZ. Of these 19 borings, 17 are active wells and two are wells that have been abandoned. The specifications for each well are presented in Table 2.2. The 2nd WBZ is contained within a semi-confined (i.e., locally unconfined) estuarine/deltaic aquifer and consists of fine to medium, silty sands with interbeds, stringers, and lenses of dense to very dense, very silty, fine sand to soft to medium stiff, sandy silt. In general, estuarine/deltaic deposits become fine-grained with depth, but often show repeated sequences of silt to silty sand to sand Within this aquifer, the 2nd WBZ ranges in depth from approximately 15 to 45 feet bgs. Where present, the 2nd SH serves as the base for the 2nd WBZ. Geological cross sections (Figures 2.13 through 2.17, Cross Sections A-A' through E-E') illustrate the contact between the 2nd WBZ and the 2nd SH.

Groundwater Elevations and Flow Direction

At both low and high tide, the 2nd WBZ Potentiometric Maps (Figures 2.21 and 2.21) show the general direction of groundwater flow at the GWI site to be to the southwest. At high tide, a depression occurs in the potentiometric surface in the vicinity of Wells B-45, B-59, and B-61. This depression is similar to the depression observed in the potentiometric surface of the 1st WBZ, but shifted to the southwest. At low tide, the depression is not present. This suggests that the phenomenon is a condition of the tidal cycle and possibly represents a local heterogeneity in or beneath the 2nd WBZ. However, due to the complex interaction between groundwater flow tidal reversals, it is not possible to determine whether this depression is a reflection of tidal flux, downward vertical gradients, or lag time, or whether it is an artifact of the measurement process.

At low tide, west of Fox Avenue S. in the vicinity of Wells B-33A and B-65, groundwater in the 2nd WBZ flows toward the S. Myrtle Street Embayment; however, at high tide, groundwater flows northeast toward the GWI Facility area. This reversal was also observed in the 1st WBZ. The impact of the tidal cycle on groundwater elevations at the GWI site is discussed in more detail later in this section.

Horizontal Hydraulic Conductivity

The hydraulic conductivity of the 2nd WBZ varies across the GWI site. Hydraulic conductivity was measured, using slug tests, in Wells B-5 (abandoned), B-8, B-9, B-25, and B-27 in 1990 and 1992 (Hart Crowser 1993). The hydraulic conductivity of the 2nd WBZ is estimated to range from 3 x 10^{-3} to 1 x 10^{-2} cm/s. The average hydraulic conductivity of the 2nd WBZ is 5.3 x 10^{-3} cm/s.

Horizontal Hydraulic Gradient and Flow Velocity

As measured from low and high tide potentiometric contours, horizontal gradients at the GWI site, with the exception of the gradient in the vicinity of Wells B-45, B-58, and B-61, are of similar magnitude. From the east side of the GWI Facility to the S. Myrtle Street Embayment, low and high tide horizontal gradients range from 0.001 to 0.005 ft/ft, respectively. At Wells B-45, B-58, and B-61, a depression occurs in the potentiometric contours plotted at high tide. Based on those contours, the horizontal gradient at this location is calculated at approximately 0.013 ft/ft.

The groundwater flow velocity in the 2nd WBZ is estimated based on contours presented in Figure 2.22 and 2.23 is similar in magnitude at low and high tides, with the exception of the velocity at the high tide depression in the potentiometric surface. Using an average hydraulic conductivity of 15.0 ft/day (5.3 x 10^{-3} cm/s) and an assumed effective porosity of 0.25, 2ndWBZ groundwater velocities were calculated using Darcy's equation: $V = KI/n$, where V = Groundwater Velocity, K = Hydraulic Conductivity, I = Hydraulic Gradient, and n = Effective Porosity. On the south and east side of the GWI Facility, in the vicinity of Wells B-8, B-17, and B-25, the average groundwater velocity (average of high and low tides) for the 2nd WBZ is approximately 0.17 ft/day (62 ft/year). In the vicinity of Wells B-45, B-59, and B-61, at the depression in the potentiometric surface at Fox Avenue, the groundwater velocity is calculated at 0.75 ft/day (275 ft/year). West of Fox Avenue S., near the S. Myrtle Street Embayment, in the vicinity of Wells B-33A and B-65, the low and high tide velocities are 0.32 ft/day (117 ft/year) and 0.25 ft/day (91 ft/year), respectively.

Infiltration and Recharge

In the area of the GWI site, some recharge to the 2nd WBZ occurs from the 1st WBZ, particularly where the 1st SH is absent. Where the 1st SH is present, the estuarine/deltaic aquifer is primarily recharged by water-bearing glacial sediment deposits comprising the east uplands. Upward gradients in the alluvium on the east side of the river range from 0.0002 to 0.07 (DPP 1998a).

2.4.3 GROUNDWATER SEEPS

Groundwater flow in both the 1st WBZ and 2nd WBZ discharges to the Duwamish River. Groundwater from both zones has been observed to discharge from a series of seeps located in the intertidal zone of the Duwamish River and S. Myrtle Street Embayment. Recently (as May of 2000), a new seep, known as Seep S-16, has been discovered in the intertidal zone.

Due to the impact of tidal cycles on groundwater flow direction near the Duwamish River, groundwater flow from the seeps to the surface water is transient. Section 2.4.4 and Appendix C provide detailed discussions of tidal impacts on groundwater hydrology at the GWI site.

Because contaminants attributed to the GWI Facility have been detected in S. Myrtle Street Embayment Seeps S-1, S-2, and S-13, and not in other known seeps, the discussion of groundwater hydrology and its impact on seep discharge focuses on these particular seeps. The location of the seeps is presented in Figure 2.12.

2.4.3.1 First Water-Bearing Zone Seeps

Near the S. Myrtle Street Embayment, groundwater in the 1st WBZ flows through an area of higher-permeability fill material. Flow paths within the fill material channel groundwater to distinct seeps at the S. Myrtle Street Embayment. At seeps S-1 and S-2 (-1.58 and-2.71 feet CSD, respectively), the volume and velocity of discharge observed at low-river stage illustrates that these seeps are discharging from soil with relatively high conductivity and steep horizontal hydraulic gradient. This conclusion is confirmed by the hydrostratigraphy and hydraulic gradients observed in this area of the GWI site.

2.4.3.2 Second Water-Bearing Zone Seeps

Groundwater from the 2nd WBZ attempts to discharge through native sands and silts. The relative denseness of native sediment limits the rate at which discharge can occur. At the top of this zone, the native sediment is overlain by the more permeable fill material that is present in the 1st WBZ. Consequently, the highest discharge rate from the 2nd WBZ occurs along a seep face at the top of the zone into this more permeable fill material. This seep face is approximately 120 feet in length and exists at approximately –3 feet CSD; for sampling purposes it is characterized by Seep S-13 at –3.02 feet CSD.

No other discharge point for the 2nd WBZ has been observed, although an extensive search was made for other seep faces during the S. Myrtle Street Embayment Study (Appendix D). This study relied on subsurface probes on an approximately 50 foot grid and tested for chlorinated organics present in groundwater and in seep S-13. This study was able to accurately locate the existing seeps, but found no other deeper seeps discharging from the 2nd WBZ.

2.4.3.3 Groundwater Quality Data and Seep Discharge

Water quality data from the seep S-1, S-2, and S-13 and Wells B-33A and B-34 also provides evidence that groundwater from Seeps S-1 and S-2 are discharging form the 1st WBZ, while Seep S-13 is discharging from the 2nd WBZ. This conclusion is based on the observed concentrations of chlorinated ethenes and ethanes in Seeps S-1 and S-13 compared to the concentrations at Wells B34 and B33A, screened in the 1st WBZ and 2nd WBZ, respectively. Based on seep chemistry, Seep S-2 is also believed to discharge to the 1st WBZ; however, Seep S-2 is believed to be primarily impacted by contaminants which have traveled downgradient from the northwest corner area of the GWI site within the 1st WBZ. This conclusion is based on the higher concentrations of parent compounds present at this seep compared to those present at Seep S-1. A detailed discussion of seep chemistry is presented in Section 5.0.

2.4.4 TIDAL IMPACTS

Five pressure transducers were installed at the GWI site to record the relative fluctuations in groundwater elevations and surface level changes in the Duwamish River resulting from the tidal cycle. The objectives the tidal study were to monitor the impact of the tidal cycle on groundwater water levels in the 1st and 2nd WBZ near the S. Myrtle Street Embayment and compare those impacts to water levels in the hole in the 1st SH (Figure 2.18). The results of the tidal study were subsequently used to aid in interpreting the fate and transport of contaminates of concern at the hole and near the S. Myrtle Street Embayment. A detailed discussion of Fate and Transport is presented in Section 5.0.

The tidal study was conducted over a five and one-half-day period. The transducers were installed in wells screened in both the 1stWBZ (B-34 and B-20) and 2ndWBZ (B-21, B-33A, and B-45). A detailed discussion of the tidal study is presented in Appendix C. A summary of the transducer responses for the wells is shown in Figure 2.19. Potentiometric surfaces at high and low tides are depicted in Figures 2.20 through 2.23.

2.4.4.1 First Water-Bearing Zone

In Well B-34, installed near the S. Myrtle Street Embayment, water levels were observed to fluctuate approximately 3 feet as a result of tidal influence, compared to surface water flux of 14 feet at the Duwamish River. The lag time between changes in the surface water and groundwater elevations was approximately 3.7 hours. The tidal efficiency at Well B-34 was calculated to be 14 percent. For Well B-20, installed on the east side of Fox AvenueS., the tidal influence on groundwater levels is considerably less than at B-34 (± 0.5 feet). The lag time and the tidal efficiency at this well were calculated to be 2.9 hours and one percent, respectively. The dramatic decrease in tidal efficiency between Wells B-34 and B-20 indicates that tidal impact east of Fox Avenue S. is minimal. The increased lag and decreased tidal efficiency is consistent with water table conditions which allows for the physical movement ofthe water table surface.

2.4.4.2 Second Water-Bearing Zone

In Well B-33A, installed near the S. Myrtle Street Embayment, water levels were observed to fluctuate approximately 3.5 feet because of tidal influence, compared to surface water flux of 14 feet in the Duwamish River. The lag time between changes in the surface water and groundwater elevations was approximately 0.58 hours. The tidal efficiency at Well B-33A was calculated to be 27 percent (almost twice the efficiency observed in the 1st WBZ and a significantly shorter lag time compared to the 1st WBZ). For Well B-21, installed on the east side of Fox Avenue S., and Well B-45, installed near the southwest corner of the GWI Facility, the tidal influence is considerably less than at B-33A (± 0.25 feet). The lagtime at these wells was calculated to be 1.3 and 1.5 hours, respectively. The tidal efficiency of both wells was two percent.

2.4.4.3 Aquifer Characteristics

Tidal efficiency and lag time can be used to interpret whether an aquifer is confined or unconfined because velocity, amplitude, wave length and attenuation of the pressure wave are partly a function of the aquifer's storativity and transmissivity. In unconfined aquifers the pressure wave is mostly generated by dewatering and resaturation of the pores; whereas, in a confined aquifer it is mostly due to changes in fluid pressure (Serfes 1991).

Near the S. Myrtle Street Embayment, the tidal efficiency factor for the 1st WBZ (14 percent) is less than that of the 2nd WBZ (27 percent), suggesting that the two aquifers have different hydraulic properties in this area. The difference in the hydrologic characteristics of the two water-bearing zones also is confirmed by the difference in lag times (i.e., 0.53 hours vs. 3.7 hours for Wells B-33A and B-34, respectively). The differences in tidal efficiency and lag time indicate that the 2nd WBZ is partially confined in the area of Wells B-33A and B-34 by the overlying 1st SH. For tidal monitoring wells B-21 and B-45, located east of Fox Avenue S., the lag times are nearly identical (1.3 and 1.5 hours, respectively). The similar magnitude of the lag times for wells B-33A, B-21, and B-45 indicates that the 2nd WBZ is confined to semi-confined by the 1st SH west of Fox Avenue S. The lag time at B-20 (2.9 hours) is considered to be a composite of both 1st and 2nd WBZ aquifer characteristics, due to fact that the well was screened across both zones. Therefore, the lag time and tidal efficiency at the wells are a composite of aquifer characteristics at the hole in the 1st SH.

2.4.4.4 Vertical Gradients

Results from the tidal study were used to calculate vertical gradients at well pairs B20A/B21 and B33A/B34; the well pairs are screened at the hole on the east side of Fox Avenue and just east of the Duwamish River, respectively (Figure 2.12). Data used to calculate vertical gradients was taken from Figures 5 and 6 of the tidal study (Appendix C).

At well pairs B20A/B21, downward vertical gradients are persistent at both low and high tides, although low tide gradients are greater than high tide gradients. Vertical gradients at high and low tide range from -0.016 to -0.018 and -0.019 to -0.024, respectively. The average vertical gradient is -0.019.

At well pairs B33A/B34, vertical gradients at low tide are downward, while at high tide the gradients are upward. Low tide gradients are greater than high tide gradients. Vertical gradients at high and low tide range from +0.024 and +0.048 and -0.014 to -0.092, respectively. The average vertical gradient at well pair 33A/34 is downward with a value of -0.006.

Compared to horizontal gradients, vertical gradients at well B-20A/B21 are approximately an order of magnitude greater than horizontal gradients. At well pair B33A/B34, vertical and horizontal gradients have similar orders of magnitude; however, vertical gradients are larger. Larger vertical gradients compared to horizontal gradients at the hole imply that groundwater flow in this area of GWI site has a strong downward component. This downward flow draws contaminants from the 1st WBZ to the 2nd WBZ, but also increases the residence time of contaminants in the 2nd WBZ, compared to a case where horizontal gradients exceed vertical gradients. Longer residence time allows for more contaminant mass to degrade before reaching the Duwamish River. The similarity of horizontal and vertical gradients at well pair B33A/B34 indicates that groundwater flow is essentially horizontal at this location at both low and high tide. At this location the reversal in the groundwater flow direction from high to low tide has a greater impact on contaminant migration than do vertical gradients.

2.4.4.5 Groundwater Discharge Cycle

Discharge from the seeps S-1, S-2, and S-13 is influenced by the tidal cycle of the Duwamish River (see Section 2.4.4 for discussion of tidal impacts). As can be seen in Figure 5 of the tidal study (Appendix C), during part of the 24 hour tidal cycle the elevation of the Duwamish River drops below the elevation of groundwater (as measured in adjacent wells B-33A and B-34). When this occurs, groundwater discharges from the seeps to the Duwamish River. When Duwamish River levels are below the elevation of the seeps, the seeps are clearly visible. When the level of the river rises above the adjacent groundwater, potentiometric surface water begins to move from the river into the formation. Based upon data collected during the tidal study, and the known elevation of the seeps, groundwater from the 1st WBZ discharged to the river approximately 58 percent to time during the tidal study, while the 2nd WBZ discharged to the river 67 percent of time during tidal cycle.

2.4.5 STRATIGRAPHY AND HYDRAULICS - IMPACT ON CONTAMINANT MIGRATION

The fate of contaminants in the 1st and 2nd WBZ is influenced by stratigraphy and hydraulic characteristics of the aquifers. These characteristics work to influence the migration of contaminants at the GWI site in the follows ways:

- The low hydraulic conductivity of the 1st SH inhibits the vertical migration of dissolved contaminants to the 2nd WBZ, except at the hole in the 1st SH. Vertical hydraulic conductivities for the 1st SH range from 3×10^{6} to 7×10^{-6} cm/s (Hart Crowser 1993). Under these conditions, the migration of dissolved contaminants through the 1st SH is probably dominated by diffusion rather than advective transport. The rate of contaminant movement via diffusion is considerably less than that by advection, thus increasing contaminant residence time and contaminant degradation within the 1st SH. A similar impact is apparent in the 2nd SH where vertical hydraulic conductivities are estimated be on the order of 10^{-4} to 10^{-5} cm/sec (Hart Crower 1993).
- The 1st SH inhibits the vertical migration of dense non-aqueous phase liquids (DNAPL) because the head pressure of the DNAPL is typically insufficient to overcome the capillary forces retaining the soil porewater in fine grained deposits. In addition, any DNAPL that enters the 1st SH would be retained by the same strong capillary forces that retain the porewater.
- Native organic matter in the 2nd WBZ acts to attenuate the movement of contaminats via the process of sorption. The organic matter deposits in the 2nd WBZ are characteristic of an estuarine/deltaic depositional environment.
- The 2nd WBZ contains numerous discontinuous narrow layers of low permeability silt and clay deposits. Like the 1st and 2nd SHs, these deposits aid in attenuating the vertical migration of dissolved contaminants and DNAPL.

- Downward hydraulic gradients at the hole in 1st SH allow groundwater and contaminats to move from the 1st WBZ to the 2nd WBZ. As noted earlier, downward gradients are common between the 1st WBZ and 2nd WBZ, particularly in the area of the hole in the 1st SH. At the hole, vertical gradients are an order of magnitude greater than horizontal gradients. This relationship results in an increase the groundwater flow path and the residence time of contaminants in the 2nd WBZ.
- Below the 2nd WBZ, regional hydraulic data indicates that upward vertical gradients are prevalent. These upward gradients in combination with the 2nd SH would inhibit contaminated groundwater from traveling much below the 2nd WBZ into the regional LGZ.
- Tides impact the flow of groundwater at the GWI site and the migration of contaminats. Near the S. Myrtle Street Embayment the reversal in groundwater flow from west to east prevents contaminants from discharging into theEmbayment for a portion of the tidal cycle. In addition, the reversal in the tidal cycle probablyresults in a period of groundwater flow reduction. This reduction influences the net migration of contaminants toward the river, resulting in a longer residence time in the groundwater system than would be predicted by low tide velocities.

Detailed discussions of the nature and extent of contamination and fate and transport are presented in Sections 4.0 and 5.0, respectively.

2.5 DUWAMISH RIVER

The Duwamish Waterway forms the western boundary of the GWI site. The Duwamish Waterway originates as the Green River in the Cascade Mountains of western Washington. Where the Green River joins the Black River, near Renton, Washington, it is called the Duwamish River. The Duwamish River flows north through Tukwila and becomes the Duwamish Waterway at the head of navigation, sometimes referred to as the turning basin. The Duwamish Waterway extends from the head of navigation to the West and East Waterways, a distance of five miles. The East and West Waterways discharge into Elliott Bay. The GWI Facility is located approximately 4.5 miles from the mouth of the waterway (Figure 2.2). The Duwamish River/Green River system drains an area of 483 square miles.

The flow of water in the Duwamish Waterway is primarily controlled by releases at the Howard Hanson Dam and diversions from the Green River. Since 1961, flows have been regulated for flood control and during summer months to augment natural river flow by the Howard Hanson Dam. The average annual freshwater flow in the waterway is about 1,500 cubic feet per second (cfs) measured at a U.S. Geological Survey (USGS) gauging station near Tukwila, located 12.4 miles from the mouth of the waterway. Flow rates vary from a record high 12,000 cfs to a low of 195 cfs. Peak discharges generally occur from December throughout February as a result of seasonal precipitation and secondary peaks occur during spring snowmelt. The lowest flow rates occur during August.

The water elevation in the Duwamish Waterway is primarily controlled by tidal effects. Tides occurring in the Puget Sound basin, including the Duwamish Waterway, are classified as "mixed tides." Mixed tides, a combination of diural and semidiural tides, fluctuate in cycles consisting of two unequal high and low tides within a 24.8-hour period. The mean higher high water tides are -1.06 feet (CSD) and mean lower water tides are -12.36 feet (CSD). The highest annual tides occur in December or January , and the lowest annual tides occur in June or July. Tidal effects in the Duwamish River have been observed in Renton, 13 miles upstream from the river mouth (Harper-Owes, 1981).

The Duwamish Waterway is part of the Duwamish River salt-wedge estuary, a stratified aquatic system in which a bottom layer of saline water intrudes some distance upriver (forming a "saltwater wedge"). The saline water moves inland up to 10 miles from the mouth of the waterway at Elliott Bay during periods of low river flow and high tide (Stoner, 1967). The toe of the saltwater wedge consists of undiluted seawater and brackish water with a salinity between normal seawater and freshwater. The saltwater wedge has been consistently found at least as far up channel as the 16th Avenue South Bridge and extends past the East Marginal Way Bridge during low river discharges in the summer. Generally, the saltwater wedge appears to be present in the vicinity of the GWI site throughout the year.

Circulation of water within the Duwamish Waterway consists of net upstream movement in the saltwater wedge and net downstream movement in the freshwater overlying the wedge. The freshwater remains mostly in the upper 5 to 15 feet of the waterway and is underlain by a wedge-shaped body of saline water. Stratification is more evident in an upstream direction and more distinct during high rates of stream flow. Where stratification is present, the thickness of the freshwater layer varies directly with the rate of freshwater inflow.

There is virtually no mixing of freshwater downward into the saltwater layer. Most of the mixing of fresh and saline water in the waterway takes place at the interface, where saline water is entrained upward into the overriding freshwater, The entrainment of saline water is balanced by a net upstream movement of the water into the saline water wedge (Stoner, 1972).

The distribution of salinity varies with the rate of freshwater flow and with tide stage. For a given freshwater flow, the saltwater wedge migrates upstream and downstream with the tide stage; for a similar tide condition, the wedge advances farthest upstream during low rates of freshwater flow and retreats downstream during greater freshwater flow. A freshwater flow greater than 1,000 cfs limits the upstream travel of the saltwater wedge to the East Marginal Way Bridge at approximately river mile 7.1.

2.6 ECOLOGICAL SETTING

2.6.1 TERRESTRIAL ENVIRONMENT

The GWI site is located in an industrial area and offers little or no undisturbed natural habitat for terrestrial wildlife. A majority of the GWI Facility is paved and contains roofed structures, with the exception of approximately 0.2 acres located east of the old warehouse and drum storage area and 0.1 acres located at the former underground storage tank farm. The majority of the facility is surrounded by an eight-foot high chain-link fence.

The highly industrial nature of the GWI site and the isolation of the GWI Facility from the surrounding lands make it unlikely that large mobile species such as mammalian grazers or predators will encounter contaminated soil at the facility. However, it is possible that rodents that use the area as their primary habitat could act as limited sources of contaminant exposure to their predators. (A detailed discussion of the nature and extent of contaminated vadose zone soil at the GWI site is presented in Section 4.0.) Terrestrial mammals in the area of theGWI site may include the Norway rat, raccoon, snowshoe hare, and Townsend vole (Tanner 1991). According to the Washington State Department of Natural Resources' Natural Heritage Program, there is currently no rare plant or high quality ecosystem in the vicinity of theGWI site (DNR 1999).

2.6.2 AQUATIC ENVIRONMENT

The GWI Facility is located approximately 600 feet east of the Duwamish River; but the S. Myrtle Street Embayment brings the river to within about 400 feet of the facility. The river is maintained for vessel traffic in the vicinity of the GWI site. At the S. Myrtle Street Embayment, the shoreline is distantly separated by a steep erosional cut-bank joining a sloping intertidal mud shoreline. A dock and pilings and miscellaneous debris are found in both the intertidal and subtidal zones.

The Duwamish River is an estuarine waterway that flows into Elliot Bay. In general, the estuary provides nursery habit for numerous marine fish species and juvenile salmonids. Studies conducted in the lower Duwamish River have identified 20 marine and anadromous fish species (King County 1996). The lower 6 to 8 miles of the estuary is an important transition zone for juvenile salmon to acclimate to saltwater (Parametrix 1980). The Green River (located upstream of the Duwamish) and the lower reaches of its tributaries provide important spawning habitat (King County 1996).

Aquatic mammals observed in the Duwamish River estuary include harbor seal, killer whale, Stellar sea lion, muskrat, and river otter (Tanner 1991). Eighty-four bird species have been observed in the Duwamish River estuary (Tanner 1991). Some avian species observed in the estuary include American goldfinch, California quail, Canada goose, gadwall, northern oriole, red-winged blackbird, song sparrow, and spotted sandpiper (Canning et al. 1979).

3.0 Site Characterization Activities and Interim Remedial Actions

In 1990, the main tank farm area USTs were removed, in 1989 the ASTs were reconditioned, and other GWI Facilities were improved. Soil contamination was discovered in the main tank farm area when the USTs were removed. Subsequent soil and groundwater borings encountered contamination in the vicinity of the loading dock UST and the USTs under the drum shed, as well as at other locations around the Facility (Hart Crowser 1990). Additional investigations were undertaken by Hart Crowser to determine the extent of contamination at the Facility, including any migration of contamination beyond the property boundaries. Adjacent and nearby properties have also been investigated independently by other property owners. Hart Crowser installed a soil vapor and groundwater extraction system as an IRM to begin source control at the Facility.

Investigations at and around the GWI Facility, and interim remedial measures, are described in the following sections:

- Investigations by Hart Crowser (Section 3.1)
- Investigations by Terra Vac (Section 3.2)
- Investigations at Adjoining properties (Section 3.3)
- Tank Closures and Interim Remedial Measures (Section 3.4)

3.1 SUMMARY OF INVESTIGATIONS BY HART CROWSER

Following the initial UST removal, Hart Crowser conducted a number of investigations at the GWI facility and surrounding properties in order to establish the nature and extent of contamination potentially related to GWI's operations. A brief description of the scope and purpose of each of these investigations is provided in Table 3.1. Locations of soil, soil vapor, groundwater, surface water, and mussel tissue sampling are shown on Figures 4.1 and 4.2. The results of these investigations are incorporated into the discussion of the nature and extent of contamination in Section 4.0 of this document, and are reported in full in Appendix E. Summaries of the individual components of Hart Crowser's activities are provided below.

3.1.1 INITIAL SITE ASSESSMENT (1989-1990)

In 1989, GWI began renovations to the GWI Facility. These renovations included decommissioning and closure of all USTs, reconditioning of ASTs, a partial demolition of the north warehouse, and a subsequent repaving of the north warehouse area for use as a truck loading and unloading area.

Before the renovations began, an exploratory boring (B-1) was performed west of the central UST area to obtain soil data and groundwater elevations. Samples from this boring were screened for VOCs by EPA Methods 8010 and 8020. The results indicated the presence of benzene, toluene, PCE, and TCE (Hart Crowser 1993). This boring was subsequently completed as a groundwater monitoring well.

In May 1990, three additional borings (B-2, B-3 and B-4) were completed in the area of the Fox Avenue S. loading dock. Sampling of these borings confirmed the presence of soil impacted by VOCs (Hart Crowser 1990). This information was conveyed to Ecology in June 1990.

In August 1990, GWI began removing USTs in the central part of the GWI Facility. The area was backfilled with clean fill in October 1990. A more detailed description of this removal is contained in Section 3.4. Following the UST removal, Hart Crowser sampled six test pits (TP-1 through TP-6), nine additional monitoring wells (B-5, B-6, B-8, B-9, B-10, B-11, B-12, B-13, B-14) and 10 additional soil borings (B-7, SB-1 through SB-9). Four of the nine additional monitoring wells (B-5, B-6, B8, and B-9) were installed into the 2nd WBZ, while the remainder (B-10, B-11, B-12, B-13, and B-14) were installed into the 1st WBZ.

3.1.1.1 Agreed Order (1991)

GWI entered into an Agreed Order (No. DE-TC91-N203) with Ecology in September 1991. The Agreed Order required that GWI perform a Remedial Investigation (RI) to address the nature and extent of contamination discovered during the UST removal, an environmental and health risk assessment (RA) and a Feasibility Study (FS) to study and evaluate remedial options at the site. The scope and purpose of the proposed investigation were set forth in an RI/FS Work Plan, submitted to Ecology in December 1991 (Hart Crowser, 1991). Results of the RI were presented in a Remedial Investigation/Preliminary Risk Assessment (RI/PRA), which was submitted to Ecology in December 1993.

3.1.2 REMEDIAL INVESTIGATION/PRELIMINARY RISK ASSESSMENT

Hart Crowser prepared a series of Technical Memoranda (Nos. 1 through 7) that documented the various individual sampling activities to be included in the RI. Brief descriptions of these Technical Memoranda are included in Table 3.1. Work conducted in the RI/PRA included well installation and soil sampling, groundwater and surface water sampling, and soil vapor sampling, as described below.

3.1.2.1 Well Installation and Soil Sampling (1992)

Technical Memorandum No. 5 discusses soil borings and monitoring wells installed along S. Frontenac Street and in the interior portion of the GWI Facility (Hart Crowser 1993). This work included:

- Drilling and sampling three soil borings (SB-10, SB-11, and SB-12) and a monitoring well (B-15) in the vicinity of S. Frontenac Street and the drum shed.
- Surface soil samples and two shallow hand auger borings in a proposed truck unloading area along S. Willow Street.
- Tests on soil excavated from the pipe trench area, in Stockpile No. 3. This work was done after SVOCs (PCP in particular) were identified as potential contaminants.
- Installation of two observation well borings (B-16 in the 1st WBZ and B-17 in the 2nd WBZ) to assess chemical contaminant concentrations in the main tank farm.

Based on the results of these and previous investigations, Hart Crowser determined that additional data were required to assess soil and groundwater quality and to evaluate groundwater gradients near the GWI Facility. Wells were installed in March and April 1992 to assess upgradient water quality (B-24 through B-27), to assess downgradient water quality (B-18 through B-23), and to further assess groundwater quality and gradients in the center of the Facility (B-28 through B-31). Eleven additional monitoring wells were installed in September and October 1992. Three monitoring well clusters (1st WBZ Wells B-34, B-36 and B-38; 2nd WBZ Wells B-33A, B-35 and B-37) were installed outside the GWI Facility boundary, while five additional 1st WBZ Wells (B-38 through B-42) were installed at the Facility.

3.1.2.2 Groundwater and Surface Water Sampling (1992)

Throughout 1992, groundwater samples were collected to provide data on seasonal variations in groundwater quality. In addition to groundwater sampling, stormwater samples were collected prior to discharge to the Duwamish River for chemical and salinity analysis.

3.1.2.3 Soil Vapor Sampling (1992)

In addition to the soil results from shallow observation wells, Hart Crowser obtained information on soil vapor in the vadose zone from various locations at or near the GWI Facility. The purpose and location of these probes was as follows:

- Two vapor probes (SVP-1 and SVP-2) were installed in the GWI warehouse to assess the potential for a vadose zone pathway beneath structures.
- Three vapor probes (P-1, P-2, and P-3) were completed near Monitoring Well B-30 for use in an air injection test.
- Five vapor probes (VP-2, VP-6, VP-7, VP-9 and VP-11) were completed in sewer backfill to test for potential preferential off-site migration of VOCs through sewer trench backfill. VP-2 and VP-6 were installed in the sanitary sewer backfill in Fox Avenue S.; VP-7, VP-9 and VP-11 were installed in the storm sewer backfill in Fox Avenue S.

3.1.3 POST RI/PRA INVESTIGATIONS (1993-1996)

Following the submittal of the RI/PRA to Ecology in 1993, Hart Crowser performed investigations to obtain the following additional information:

- Extent of contamination in the vicinity of Monitoring Well B-12, where DNAPL was observed in the 1st SH.
- Impacts on surface water and mussel tissue in the Duwamish River.
- Annual soil vapor and groundwater contaminant concentrations in wells on and off the GWI Facility.

3.1.3.1 Extent of Contamination Near Monitoring Well B-12

Hart Crowser installed 10 two-inch monitoring wells (B-43 through B-52) in the immediate vicinity of Monitoring Well B-12. These wells were intended to define both site stratigraphy and the extent of DNAPL at this location. Nine of the 10 new monitoring wells (all except Monitoring Well B-45) were installed in the 1st WBZ. None of the new wells encountered DNAPL.

3.1.3.2 Surface Water and Mussel Tissue Sampling (1994)

Hart Crowser resumed collecting samples of Duwamish River surface water seeps and mussel tissue in 1994. Sample collection was conducted both in the Duwamish River and at the S. Myrtle Street Embayment located directly downgradient of the GWI Facility. Mussel tissue, surface water, and seep sampling continued at these locations on an annual basis through 1999.

3.1.3.3 Annual Soil Vapor and Groundwater Sampling (1993-1996)

Following the installation of Monitoring Wells B-43 through B-52, Hart Crowser began an annual soil vapor and groundwater sampling program in selected wells both on and off the GWI Facility. Results from the 1995 and 1996 annual sampling are included in Hart Crowser Technical Memoranda No. 11 and No. 13, respectively, as well as in Appendix E.

3.2 SUMMARY OF INVESTIGATIONS COMPLETED BY TERRA VAC

GWI retained Terra Vac in 1997 to perform work on the interim remedial measurements (see Section 3.4), to evaluate remedial alternatives and to assist GWI in selecting a preferred alternative for site cleanup. Terra Vac continued the annual groundwater, surface water, and mussel tissue monitoring program initiated by Hart Crowser, and also initiated a number of additional, discreet investigations to collect additional data needed to fill critical data gaps concerning the nature and extent of contamination and evaluate remedial alternatives. These investigations are described below, and the data derived from them is reported in Section 4 and in Appendices A, C, D, E and F. GWI retained Terra Vac and Floyd and Snider in 1998 to assist Terra Vac in preparing reports regarding the additional site investigations and this SRI & FS.

3.2.1 PILOT STUDY

In the spring of 1998, Terra Vac conducted a successful dual vacuum extraction (DVE)/OxyVac pilot test at the GWI Facility. The purpose of the pilot test was to evaluate the effectiveness of DVE and OxyVac in remediating soil and groundwater impacted by VOCs and SVOCs. Terra Vac also tested the efficacy of injecting hydrogen peroxide to reduce VOC and SVOC concentrations in groundwater at the Facility. Hydrogen peroxide was injected into three GWI monitoring wells (B-12, B-31 and B-39) and analytical samples were taken one day and one week after the peroxide injection. Groundwater analytical results indicated a dramatic decrease in both VOC and SVOC concentrations. The results and conclusions from the pilot study and the hydrogen peroxide injection test are discussed in Appendix F.

3.2.2 S. MYRTLE STREET EMBAYMENT STUDY

GWI conducted an investigation to determine whether groundwater is discharging to the S. Myrtle Street Embayment through a finite number of seeps, such as those already identified in the RI, or through broad areas of groundwater upwelling through the S. Myrtle Street

Embayment sediments. The goal was to gather information that would both distinguish between the two types of discharge (seeps and generalized upwelling) and identify the areas where significant discharge is occurring, so that the discharge points could be sampled during other SRI activities using conventional sampling protocols.

Terra Vac performed three separate sampling events between October and December 1998 to measure and map the distribution of chlorinated ethenes in sediment porewater:

1. Sampling of sediments in the S. Myrtle Street Embayment using a series of passive screening devices (GORE-SORBERS®).
2. Sampling of seep-face sediment in the S. Myrtle Street Embayment and along the Duwamish River main channel using several GORE-SORBERS®.
3. Sampling of seep-water discharging to the S. Myrtle Street Embayment and to the Duwamish River main channel as part of the annual sampling.

3.2.3 NORTHWEST CORNER INVESTIGATION

During the annual groundwater monitoring in 1998 and subsequent re-sampling in early 1999, elevated concentrations of PCE, as well as moderate concentrations of TCE and DCE, were detected at Monitoring Wells B-13 and B-22. These monitoring wells are cross-gradient of the GWI original source area. Further analysis of the data revealed that the plume signature at Monitoring Wells B-13 and B-22 is not consistent with the ratios of chlorinated VOCs seen in the GWI original source area. Terra Vac performed an investigation in early 1999 to evaluate the source of the elevated PCE concentrations in Monitoring Wells B-13 and B-22. The purpose of the investigation was to assess existing soil and groundwater quality upgradient of wells in the Northwest corner of the GWI Facility.

The following tasks were performed as part of the Northwest corner investigation:

- Four soil borings were advanced and completed as temporary monitoring wells on January 22, 1999. Results from samples collected during this investigation indicated that shallow groundwater is impacted by chlorinated solvents.
- Five additional borings were advanced and completed as permanent groundwater Monitoring Wells B-53 through B-57. These wells were sampled 48 hours following installation and again in April 1999. Groundwater samples confirmed the presence of chlorinated solvents in shallow groundwater to the south of Shultz Distributing and across the northwest corner of GWI's property.
- The 12-inch sewer line running parallel to S. Willow Street between Shultz Distributing and GWI was visually inspected and determined not to be leaking.

Further discussion of this investigation is contained in Appendix A.

3.2.4 TIDAL INFLUENCE STUDY

GWI contracted with Terra Vac to perform a Tidal Influence Study of the area adjacent to the GWI Facility. The purpose of this study was to assess and document the impact of Duwamish River tidal fluctuations on groundwater flow direction and hydraulic gradients at the S. Myrtle Street Embayment and the hole in 1st SH, and to provide information relevant to contaminant transport in both the upper and lower subsurface water-bearing zones identified in previous investigations.

The following tasks were completed as part of this supplemental investigation:

- Collection of site survey data to measure relative elevations of five existing monitoring wells.
- Survey of seep locations and elevations where groundwater enters the S. Myrtle Street Embayment.
- Installation of six pressure transducers, five in existing groundwater monitoring wells and one in a temporary Embayment stilling well, to record relative fluctuations in groundwater elevations and Duwamish River surface level changes.
- Transducer data collection and analysis.

A detailed evaluation of the data obtained during the tidal study is included in Appendix C.

3.2.5 FOX/MYRTLE STREET INVESTIGATION

Previous investigations, conducted off-property and downgradient of the GWI Facility, identified the presence of a hole in the 1st SH separating the 1st WBZ and 2nd WBZ. These two water-bearing zones become connected near the intersection of Fox Avenue S. and Fronentac Street, in the vicinity of Monitoring Well B-20 and B-45. The goal of the Fox/Myrtle Street Investigation was to determine the extent of the connection between the 1stWBZ and the 2nd WBZ and the size of the hole.

The following tasks were completed during this supplemental investigation:

- Installation of eight monitoring wells and six temporary monitoring wells along the right-of-ways for Fox Avenue S. and S. Myrtle Street.
- Collection of soil and groundwater samples for VOC analysis and for the purpose of lithologic characterization.

This investigation and its results are discussed in detail in Appendix G.

3.2.6 1999 ANNUAL GROUNDWATER MONITORING

Terra Vac sampled all monitoring wells, seeps/surface water and mussel tissue during the annual groundwater monitoring in October and November 1999. This sampling was performed in order to provide a site-wide synoptic view of groundwater contaminant concentrations. The results of this analysis are included in the discussion of the nature and extent of contamination in Section 4.0.

3.3 TANK CLOSURES AND INTERIM REMEDIAL MEASURES

Interim remedial actions are remedial activities that partially address the cleanup of a site (WAC 173-340-430). At the GWI Facility, interim actions since 1988 have included the following activities:

- Decommissioning of the old tank farm along S. Frontenac Street and conversion of these USTs, located beneath the drum shed, to soil vapor extraction wells.
- Decommissioning of the main tank farm in the central part of the GWI Facility, including removal of the USTs and contaminated soil from the tank excavation.
- Removal of product piping west of the drum shed.
- Decommissioning of a 1,000-gallon UST at the Fox Avenue S. loading dock.
- Construction of a source control system for remediation of VOCs in the subsurface beneath the GWI Facility.

The following sections summarize these interim actions.

3.3.1 DECOMMISSIONING OF THE OLD TANK FARM (1995)

The tanks that previously comprised the old tank farm are located beneath the drum shed on the southeastern portion of the GWI property. They consist of six single-compartment USTs with a nominal capacity of 10,000 gallons each. These tanks were identified by numbering each tank sequentially starting with number 21 (i.e., UST 21 through UST 26). The location of the old tank farm is shown in Figure 3.1. These tanks were installed in 1956, taken out of service in 1989, and formally decommissioned in 1989, and closed inplace in 1995 (Hart Crowser 1996).

Hart Crowser determined that removal of these tanks and adjacent soil would not be prudent because of structural considerations; that is, significant engineering in the form of structural underpinning would be required to remove the tanks from beneath the existing drum shed. Additionally, substantial over-excavation of contaminated soil to remove contaminant source material would not likely have been possible (Hart Crowser 1990). Therefore, the USTs comprising the old tank farm were closed inplace.

Approximately 2,500 gallons of residual liquids were removed from the old tank farm USTs and stored in two Baker tanks prior to disposal. The tanks were cleaned and all residuals, including liquids, rinse water, and sludges, were disposed of off-site.

Permanent closure of the USTs in the old tank farm was performed as part of the source control IRM. The USTs were perforated and piping and controls were installed so that the tank shells would function as part of the soil vapor extraction system. Additional discussion of the IRM is presented in Section 3.4.5.

3.3.2 DECOMMISSIONING OF THE MAIN TANK FARM (1990)

The main tank farm was located in the central part of the GWI property. It consisted of 10 double-compartment product USTs with a nominal capacity of 12,000 gallons per tank (6,000-gallon capacity in each compartment). These tanks were identified by the numbering of each compartment (i.e., UST 1/2, UST 3/4, etc.) and were designated USTs 1/2 through 19/20 (Figure 3.1). These tanks were installed in 1976, taken out of service in the late 1980s, and formally decommissioned in September 1990 (Hart Crowser 1990). Decommissioning included the following activities:

- Removal and salvage of USTs with associated piping and concrete.
- Soil excavation, sampling, analysis, and disposal.
- Excavation closure.

The individual components of decommissioning of the main tank farm are summarized below.

3.3.2.1 UST and Associated Piping and Concrete Removal and Salvage

Approximately 9,000 gallons of residual liquids were removed from the main tank farm USTs and stored in two Baker tanks prior to disposal. The tanks were cleaned and all residuals, including liquids, rinse water, and sludges, were disposed of off-site.

The 10 double-compartment USTs and associated vent and product piping were removed following the tank cleaning activities. The USTs and piping were comprised of steel and were transported off-site to Seattle Iron and Metals Corporation's Harbor Island facility for scrap salvage.

Concrete pavement and the concrete UST hold-down devices that were removed during decommissioning were demolished on-site with a hydraulic breaker. The majority of the concrete debris was hauled off-site for salvage at Stoneway Rock and Recycling in Renton. About 25 cubic yards of concrete was stained or contained VOC contamination, based on photoionization detection readings. This debris was stockpiled on-site in a visqueen-lined and covered stockpile prior to disposal at Arlington, Oregon (Hart Crowser 1990).

3.3.2.2 Soil Excavation, Sampling, Analysis, and Disposal

Soil excavated during removal of the USTs was placed in two separate bermed, lined, and covered stockpiles (designated Stockpile 1 and Stockpile 2). Soils were distinguished based on field observations of visual staining and soil vapor screening levels measured using a hand-held photoionization detector. Stockpile 1 contained approximately 75 cubic yards of soil; Stockpile 2 contained approximately 200 cubic yards of soil. Additional over excavation of soil was not attempted during removal of the USTs because of structural considerations (i.e., the presence of existing structures in close proximity to the excavation and ongoing facility operations) as well as the apparent need for additional remediation outside of the main tank farm area. The soil from Stockpiles 1 and 2 was disposed of off-site at Arlington, Oregon (Hart Crowser 1990).

Sampling and analysis was performed on soil remaining in the main tank farm excavation to characterize contaminant concentrations upon completion of tank removal activities. The results of this analysis are presented Appendix E and incorporated in the discussion of the nature and extent of site contamination in Section 4.0.

3.3.2.3 Excavation Closure

Soil vapor extraction was identified as a reasonable means of remediating unsaturated zone soil contamination at the time the main tank farm excavation was being closed. Therefore, components of a soil vapor extraction system were installed in the main tank farm excavation for future remedial use.

A series of perforated soil vapor extraction pipes with non-perforated riser pipes were installed at the base of the main tank farm excavation. The perforated pipes were placed horizontally on approximately 10-foot centers, running north-south, with a single riser (fourinch diameter schedule 80 PVC) for each pair of horizontal vapor extraction pipes. The soil vapor extraction piping was covered with clean gravelly sand and a layer of visqueen was placed across the excavation to restrict the downward inflow of air. The main tank farm excavation was then backfilled with clean compacted soil imported by barge from the Sea Shealt Pit near Vancouver, British Columbia.

3.3.3 REMOVAL OF PRODUCT PIPING WEST OF THE DRUM SHED

During decommissioning of the main tank farm in September 1990, three additional pipelines were removed from the west side of the drum shed (Figure 3.1). Soil removed during the excavation of these lines was stained and/or had a solvent-like odor.

The excavated soil and concrete pavement that was removed to provide access to the piping were placed in bermed, visqueen-lined and covered stockpiles. Approximately six to eight cubic yards of soil was removed during the pipe trench excavations and placed in a stockpile, designated Stockpile 3. No attempt was made to excavate all the contaminated soil in the pipe trench area west of the drum shed, because additional investigation was being performed to evaluate the extent of contamination at the site. Following removal of the piping, the trench excavations west of the drum shed were lined with visqueen and backfilled with imported soil. The soil excavated from west of the drum shed was disposed of off-site.

Sampling and analysis were performed on soil remaining in the pipe trench excavations to characterize contaminant concentrations upon completion of pipe removal activities (Hart Crowser 1990). The results of this analysis are presented in Appendix E and incorporated into the discussion of the nature and extent of site contamination in Section 4.0.

3.3.4 DECOMMISSIONING OF A 1,000-GALLON UST AT THE FOX AVENUE S. LOADING DOCK (1998)

A 1,000-gallon gasoline UST and pump dispenser located adjacent to the Main Warehouse along Fox Avenue S. were operated from the 1970s until they were decommissioned in November 1998 (WGR Southwest, Inc.,1999). The UST and dispenser were situated immediately adjacent to the main warehouse loading dock structural footings. Substantial underpinning would have been required to remove the UST and associated piping. Therefore, the UST and associated piping were permanently closed in-place.

Initially, an excavation was performed to uncover the top of the tank. Approximately 500-gallons of residual fuel and water were pumped from the tank and into 55-gallons drums. The top of the tank was cut off and the tank was cleaned. Approximately 20-gallons of residual sludge was removed during cleaning.

Once the tank was cleaned, the tank and associated piping were filled with concrete. Concrete was also used to backfill the excavation from the top of the tank to the ground surface. The soil and asphalt that was removed to expose the top of the tank, in addition to the recovered liquids and sludge, were disposed of at Remedco, Inc. in Seattle.

Soil sampling and analysis was performed prior to tank decommissioning. The results of this analysis are presented in Appendix E and incorporated in the discussion of the nature and extent of site contamination in Section 4.0.

3.3.5 SOURCE CONTROL IRM (1995-1996)

A soil vapor and groundwater extraction and treatment system was installed on the GWI Facility as an interim source control measure while final cleanup plans were being evaluated for the remainder of the site. The system consisted of components installed during decommissioning of the main tank farm (Section 3.4.2), modifications to the old tank farm USTs (Section 3.4.1), and additional extraction and treatment equipment.

Two horizontal groundwater extraction wells and three horizontal soil vapor extraction wells were installed where DNAPL was present beneath the southwest portion of the GWI Facility. Additionally, a monitoring well (B-12) installed during the site investigation was modified for use in the soil vapor and groundwater extraction system. These components of the system were designed to lower the groundwater elevation near Monitoring Well B-12 and expose the DNAPL present in the first silt layer to make it responsive to treatment by vapor extraction. IRM system components are shown in Figure 3.1

The soil vapor extraction system was designed to use a regenerative blower to extract contaminated soil vapor from the following system components and areas:

- Five horizontal vents (HC-1 and HC-2) installed in the former main tank farm area.
- Six perforated USTs under the drum shed.
- Two horizontal vents under Frontenac Street in the vicinity of Monitoring Well B-12 as well as through Monitoring Well B-12 itself.
- One horizontal "trench" vent in the Monitoring Well B-31 "catch basin" area

Groundwater was to be extracted using dual diaphragm pumps from the following components:

- Two horizontal extraction wells (HC-3 and HC-4) under S. Frontenac Street in the vicinity of Monitoring Well B-12.
- The converted Monitoring Well B-12.

Soil vapor from the extraction points was to be piped to a treatment facility where a vapor/liquid separator, or knockout pot, would remove entrained water droplets. After leaving the knockout pot, vapor would be mixed with vapor from a groundwater air stripping tower and enter a catalytic oxidizer for treatment. Combustion of chlorinated compounds by the oxidizer would produce hydrochloric acid, carbon dioxide, and water. Hydrochloric acid would be removed from the vapor stream by a conventional scrubber before the treated vapor was discharged to the atmosphere. The water effluent from the scrubber, containing sodium chloride, would be discharged to the sanitary sewer under permit from METRO.

The water that accumulated in the knockout pot would be pumped to a DNAPL separator tank, then routed to an air-stripping tower. Water from the stripping tower would then be routed to a series of bio-treatment tanks designed to remove ketones and penta not removed by air stripping. Upon exiting the bio-treatment tanks, water would be sent through a set of activated carbon filters for polishing. Treated water was to be discharged to the sanitary sewer under permit from METRO.

Following the initial start-up of the system in the spring of 1996, a number of problems developed related to vapor destruction efficiency. The soil vapor extraction and groundwater treatment system was unable to meet long-term air quality discharge standards. Consequently, the system was unable to operate on a routine basis. Efforts to correct the problems ended in April 1997.

4.0 Nature and Extent of Contamination

4.1 INTRODUCTION

GWI has collected a large volume of environmental data at the site over the last decade, as part of GWI's RI and SRI activities described in Section 3. These data include geological and hydrogeological data used to define the site conditions in Section 2, and chemical and physical data used to evaluate the nature and extent of contamination at the site. This section summarizes the nature and extent of contamination, identifies the potential chemicals of concern (PCOCs) for the site, and evaluates the relationships between the source areas and the extent of contamination. Section 5 refines this information to evaluate the fate and transport of chemicals at the site and to develop a site conceptual model. Section 6 synthesizes the information in the previous sections and establishes cleanup levels and points of compliance for the chemicals of concern (COCs) in each media.

The following media have been sampled and analyzed as part of the RI and SRI:

- Soil including Soil Vapor
- Groundwater
- Seeps and Surface Water
- Sediment
- Mussel Tissue
- Ambient and Indoor Air

The chemicals found in each media are summarized briefly in Sections 4.2. Section 4.3 discusses the source and distribution of specific chemicals across the site in all media. This data has been augmented by sediment data collected as part of EPA's evaluation of the Duwamish River, and by available data from adjacent facilities.

The discussion of chemical results has been focused on those compounds that exceed toxicological screening criteria; some compounds may have been detected, but are not discussed further if their concentrations are less than these criteria. Exceedance of a toxicological screening criterion warrants further discussion of the chemical, but does not imply that it has exceeded the cleanup level for the site. The following toxicological screening criteria were used:

- **Soil and Groundwater:** Residential (Method B) cleanup levels from Ecology's CLARC II database.
- **Surface Water and Seeps:** National Toxics Rule ambient water quality criteria for both the protection of marine organisms and the protection of human health through the consumption of aquatic organisms.
- **Duwamish River Sediment:** Washington State Sediment Management Standards (SMS) Sediment Quality Standards (SQS).

- **Ambient Air:** Residential (Method B) cleanup levels for ambient air per the Washington State Model Toxics Control Act

Chemicals detected in soil vapor and mussels are discussed, but are not screened against toxicological criteria because established criteria do not exist.

Because these standards and criteria are used in this section to "screen" results for toxicological concerns, rather than for compliance, they will be referred to as "screening levels" throughout this section. Conservative criteria, such as residential criteria, are used in this screening, in order to be conservative in the identification of PCOCs. In Section 6, points of compliance and cleanup levels for chemicals of concern in each media will be established based on an evaluation of ARARs.

4.2 ANALYTICAL SCHEDULE AND IDENTIFICATION OF POTENTIAL CHEMICALS OF CONCERN

This section presents the analytical schedule for each media, and presents a preliminary screening evaluation to identify PCOCs for further evaluation and discussion. PCOCs are identified through a stepwise process that evaluates and organizes the RI data to identify chemicals that may pose risks to human health and the environment, or which exceed regulatory requirements. The presence of a chemical on the PCOC list does not imply that the chemical must be remediated in that media. Instead, it means that preliminary screening indicates that it is necessary to evaluate the specific chemical further to determine whether it is present at concentrations that require cleanup action.

The initial screening follows EPA guidance for identification of PCOCs. Chemicals are evaluated against the following criteria:

- **Background concentration comparisons for metals and inorganics.** This is a critical step to eliminate metals with concentrations at or below background concentrations from further regulatory concern.
- **Frequency of detection evaluation.** Chemicals that were not detected with standard EPA methods in a specific media are eliminated. Chemicals detected at a frequency of five percent or less are retained only if they are PCOCs for another media detected at a frequency greater than five percent.
- **Risk-based screening.** Maximum concentrations in soil, soil vapor, groundwater, surface water, seeps, sediment, and mussel tissue are screened against appropriate conservative risk-based criteria as discussed in Section 4.1.

Chemicals that exceed these criteria are retained as PCOCs and evaluated further in the SRI. Final COCs are identified in Section 6.0 based on a comparison to site-specific cleanup levels established under MTCA.

4.2.1 SOIL

Over 200 soil samples have been collected from 99 sample stations at the GWI Facility and on adjacent properties during the GWI site investigation. The majority of the soil samples were collected on the GWI Facility in the original and secondary source areas. The sample locations are shown in Figure 4.1. Soil samples have been analyzed for EPA's target analyte list of compounds including VOCs and SVOCs, metals, and petroleum hydrocarbons. A small number of soil samples in the areas of highest contamination have also been analyzed for glycols, alcohols, and chlorinated dioxins/furans. Table 4.1 presents the analytical schedule for soil samples collected during the GWI site investigation. Appendix E contains a listing of all soil results arranged alphabetically by location.

Table 4.2 presents the frequency of detection summary for chemical parameters in soil. The following chemicals or classes of chemicals were detected in soil samples:

- Chlorinated solvents perchloroethylene (PCE) and trichloroethane (TCE), and their degradation products
- Volatile aromatic hydrocarbons (the BTEX family)
- Other volatile solvents, such as methylene chloride
- Chlorinated benzenes and phenols, including pentachlorophenol (penta)
- Dioxins and furans
- Petroleum fuels and solvents and their constituents
- Polycyclic aromatic hydrocarbons
- Other semi-volatile organic compounds, including phthalates and glycols
- Metals

Table 4.3 presents the chemical parameters that were not detected in soil during the investigation of the GWI site.

4.2.1.1 Chlorinated Ethenes and Ethanes

This family of chemicals consists of the several chlorinated solvents commonly used as degreasers and dry cleaning fluids, and their degradation products. Table 4.4 lists the chemicals included in this family, including their common names and abbreviations. Figure 4.2 presents the common degradation sequence for these chemicals under environmental conditions.

The chlorinated ethenes detected most frequently in soil are PCE and TCE (Table 4.2). PCE was detected in 59 percent of soil samples; TCE was detected in 26 percent of soil samples. Other chlorinated ethenes and ethanes were detected less frequently and at lower concentrations. PCE and TCE were the only chlorinated ethenes or ethanes present in more than five percent of soil samples with maximum concentrations greater than the MTCA Method B screening standards. The maximum concentration of both compounds was detected at Station SB-10 (Figure 4.1).

The 1,2-Dichloroethnes and 1,1,1-trichloroethane (1,1,1-TCA) were the only other chlorinated ethenes or ethanes detected at a frequency of greater than five percent in soil. The maximum detected concentrations of these compounds were less than the MTCA Method B screening standards.

PCE and TCE have been retained as PCOCs in soil. The source and distribution of these chemicals will be discussed further in Section 4.3.

4.2.1.2 Volatile Aromatic Compounds (The BETX Family)

Volatile aromatic compounds are a group of chemicals that contain simple carbon chains attached to a benzene ring. Some of these compounds, such as toluene and xylenes, are solvents. All of them are present in a variety of petroleum fuels and products including gasoline, petroleum solvents (i.e., Stoddard solvents, kerosene, mineral spirits, etc.), heating oil, and diesel no. 2. The primary aromatics in this family are benzene, toluene, ethyl benzene, and xylene, commonly known as the BTEX group or family.

Petroleum-contaminated soil was removed from the site during the IRMs described in Section 3. Benzene and styrene were not detected at a frequency of greater than five percent. Toluene, ethyl benzene, and xylenes were detected in 20 to 35 percent of soil samples that remained after the interim actions. However, the maximum detected concentrations of these BTEX compounds in soils were one to three orders of magnitude below the Method B screening standards (Table 4.2).

4.2.1.3 Other Volatile Organic Compounds

The only other VOCs detected in soil at the GWI Facility at a frequency greater than five percent were the solvents acetone and methylene chloride. Acetone was detected in soil samples at a frequency of less than 25 percent (Table 4.2). The maximum detected concentration of acetone was less than the MTCA Method B screening standard by more than two orders of magnitude. Methylene chloride was detected in 19 percent of soil samples. The maximum detected concentration of methylene chloride exceeded the MTCA Method B screening standard, and was detected at Station SB-3 prior to the installation and operation of the source control interim action at the site.

Methylene chloride has been tentatively retained as a PCOC in soil based on old data that precedes the IRMs. The retention of methylene chloride as a PCOC is evaluated further, in combination with the evaluation of groundwater data, in Section 4.2.2.3.

4.2.1.4 Chlorinated Benzenes

Chlorinated benzenes detected in soil include 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and chlorobenzene. These chlorinated benzenes were detected in soil at a frequency of less than four percent (i.e., one to five out of approximately 130 samples). The detected concentrations of these chlorinated benzenes did not exceed the MTCA Method B screening standards.

No chlorinated benzene was retained as a PCOC in soil.

4.2.1.5 Chlorinated Phenols and By-products

The chlorinated phenols are a group of chemicals that include the product penta, and the lesser chlorinated analogs. Chlorinated dioxins and furans are by-products in the manufacturing of penta and were included in the analysis of samples in the penta original source area.

Penta, tetrachlorophenol, and 2,4-dichlorophenol were detected in greater than five percent of soil samples. Penta was detected in approximately 40 percent of soil samples, while all other chlorinated phenols were detected in less than or equal to 17 percent of samples (Table 4.2).

Penta was the only chlorinated phenol that was detected at a concentration greater than the MTCA Method B screening standard. The detected concentrations of all other chlorinated phenols were between two and five orders of magnitude less than the Method B standards.

Dioxin and furan analyses were performed on three soil samples collected from the area with the highest penta concentrations. Hexa, hepta, and octa dioxin and furan congeners are known by-products of the manufacture of penta. 2,3,7,8-TCDD, the most toxic of the dioxin congeners, was not detected in the samples; however, the related furan was detected in one sample and the more heavily chlorinated (but less toxic) dioxins and furans were detected in all three samples. The calculated 2,3,7,8-TCDD equivalence concentrations for each sample were compared to the MTCA Method B screening standard for 2,3,7,8-TCDD. The 2,3,7,8-TCDD equivalence concentrations exceeded the Method B standard, although they were considerably less than the Method C cleanup level (Section 4.3).

Penta, dioxins and furans have been retained as PCOCs in soil.

4.2.1.6 Petroleum Hydrocarbons

Analyses for various petroleum products have been performed on soil samples collected during the investigation of the GWI site. These analyses have included Stoddard's solvent, mineral spirits, thinner, light hydrocarbons, gasoline, diesel, and motor-oil, as well as others. Due to weathering processes, it is difficult to identify the original product type detected by these various analyses. However, the predominant petroleum products detected via the various petroleum methods at the GWI site were light-end mineral spirits, petroleum spirits, and gasoline. Bunker C, Diesel #2 and kerosene/Jet A were not detected at the site. The MTCA cleanup level of 200 mg/kg for non-gasoline petroleum hydrocarbons was used to screen detected compounds for further consideration.

Petroleum hydrocarbons have been retained as PCOCs in soil.

4.2.1.7 Low Molecular Weight Polycyclic Aromatic Hydrocarbons and High Molecular Weight Polycyclic Aromatic Hydrocarbons

Low molecular weight polycyclic aromatic hydrocarbons (LPAHs). The only LPAHs detected in soil at a frequency greater than five percent were naphthalene, phenanthrene, and 2-methlynaphthalene, which were detected in eight to 12 percent of the samples (Table 4.2). The maximum detected concentration of naphthalene was three orders of magnitude less than the MTCA Method B screening standard. The maximum detected concentrations of phenanthrene and 2-methlynaphthalene were less than or equal to the maximum concentration of naphthalene. MTCA Method B screening standards are not currently available for these compounds. The nature and extent of these LPAHs is consistent with their source being petroleum products (Section 4.2.1.6).

High molecular weight polycyclic aromatic hydrocarbons (HPAHs). The HPAHs benzo(a)anthracene, chrysene, fluoranthene, and pyrene were detected at a frequency greater than five percent. Benzo(a)anthracene and chrysene were detected at concentrations exceeding the MTCA Method B screening standards. Chrysene and pyrene were not detected at concentrations exceeding Method B standards.

Out of approximately 100 soil samples, benzo(a)anthracene was detected in six samples and chrysene was detected in seven samples. Benzo(a)anthracene and chrysene were detected in surface or near-surface soil at stations around the perimeter of the GWI Facility in areas subject to vehicle and train traffic, but were not detected within the interior of the facility or in areas with contamination from the petroleum products discussed in Section 4.2.1.6. Therefore, the area in which these compounds are detected would be consistent with their presence due to motor oil and transportation vehicles and not operations specific to GWI (Vershueren, 1996).

The maximum detected concentrations of benzo(a)anthracene and chrysene were less than or equal to 1.0 mg/kg and were detected in one near-surface (1.5 to 3 feet bgs) soil sample collected from Station B-22, adjacent to Fox Avenue S. (Figure 4.1 shows sample locations). A sample in which only chrysene was detected consisted of surface soil (0 to 0.5 feet bgs) collected from Station B-28, located within the S. Willow Street right-of-way. Two of the remaining four samples with detected concentrations of benzo(a)anthracene and chrysene were collected from two stations (B-49 and B-50) located adjacent to railroad tracks in the Frontenac Street right-of-way. The remaining two samples (Comp A and Comp F) consisted of surface soil (0 to 1 feet bgs) collected from a truck loading and unloading area on the northern boundary of the GWI Facility.

The average detected concentrations of benzo(a)anthracene 0.16 mg/kg and chrysene 0.17 mg/kg were only slightly greater than the Method B screening standard for these compounds 0.137 mg/kg. All detected concentrations were considerably less than the Method C cleanup standard for these compounds of 18 mg/kg.

Benzo(a)anthracene and chrysene were tentatively retained as PCOCs in soil, pending discussion of groundwater quality

4.2.1.8 Other Semi-volatile Organic Compounds, Including Phthalates and Glycols

Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were the only phthalates detected at a frequency greater than five percent; however, only bis(2-ethylhexyl)phthalate exceeded the MTCA Method B screening standard, and the detected concentrations of bis(2-ethylhexyl)phthalate were considerably less than the Method C cleanup level (Table 4.2).

Analyses for glycols were performed on six soil samples collected from the area of the GWI Facility where glycols were stored. Propylene glycol and ethylene glycol were each detected in one sample and di-ethylene glycol was detected in two samples. The detected concentrations of glycols did not exceed Method B screening standards.

Bis(2-ethylhexl)phthalate was retained as a PCOC in soil, pending evaluation of groundwater data.

4.2.1.9 Metals

Metals detected at a frequency greater than five percent in soil sampes include aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, and zinc (Table 4.2). Of these metals, only arsenic and lead concentrations exceeded the MTCA Method A residential soil cleanup levels. Method B cleanup levels are not available for these metals. The other metals did not exceed the Method B screening standard. The Method A cleanup level for arsenic (20 mg/kg) is based on a state-wide background concentration developed by Ecology. The Method A value for lead (250 mg/kg) is based on the bio-kinetic model for lead toxicity as used by Ecology and the EPA.

Only one of approximately 75 soil samples collected during the investigation contained both arsenic and lead at levels greater than the MTCA Method A residential soil cleanup level. The sample consisted of surface soil (0 to 0.5 feet bgs) collected from Station B-28, located in the S. Willow Street right-of-way outside of the northern GWI Facility boundary (Figure 4.1). The sample station was established during the RI to evaluate conditions upgradient of the site.

The detected concentrations of arsenic (43 mg/kg) and lead (500 mg/kg) in the soil sample were approximately twice the Method A cleanup levels. The detected concentrations were considerably less than the Method A industrial soil cleanup level for these metals (200 mg/kg for arsenic and 1,000 mg/kg for lead).

Because metals, including arsenic and lead, were not detected at the GWI Facility at concentrations exceeding residential soil cleanup levels, no metal has been retained as a PCOC in soil.

4.2.1.10 Potential Chemicals of Concern for Soil

The following chemicals were identified as PCOCs in soil at the GWI site:

- Chlorinated ethenes and ethanes
- Pentachlorophenol
- Total petroleum hydrocarbons (solvent-range)

In addition to these chemicals, methylene chloride, bis(2-ethylhexyl)phthalate and two HPAHs were retained pending evaluation of groundwater; chlorinated dioxins and furans were retained pending further discussion in Section 4.3. The methylene chloride data is old and may not represent current site conditions, and the bis(2-ethylhexyl)phthalate and HPAH concentrations are considerably less than industrial soil cleanup levels (MTCA Method C).

4.2.1.11 Soil Vapor

On April 17, 2000, soil vapor samples were collected within five feet of the five existing on-site groundwater monitoring wells in areas with the highest groundwater/soil concentrations of volatiles. The samples were collected using direct push sample collection equipment (Strataprobe®). The soil vapor probe was attached to the lead section of the Strataprobe® rod.

The probe was connected to polyethylene tubing that existed the top of rod at ground surface. Soil vapor samples were collected in three liter Summa Canisters and analyzed at an off-site lab for volatile organic compounds using EPA Method TO-14. A detail description of the soil vapor sampling analysis plan is presented in Appendix H. Soil vapor sample locations and their sampling depths were as follows:

Location	Adjacent Well	Depth 1 (in feet)	Depth -2 (in feet)	Depth 3 (in feet)	Depth 4 (in feet)	Depth 5 (in feet)
VP10A	B-10A	0.25	2.0	4.5	6.5	Not Sampled
VP11	B-11	0.25	2.0	4.5	6.5	Not Sampled
VP44	B-44	1.0	3.0	6.0	8.0	Not Sampled
VP52	B-52	0.25	2.0	4.0	6.0	Not Sampled
VP58	B-58	0.25	2.0	5.0	7.0	9.0

The above sample locations were selected for the following reasons:

- Results from a recent groundwater sampling event (November 1999) indicated high concentrations of vinyl chloride in the 1st WBZ groundwater near the locations selected.
- The EPA's Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings (EPA 1999) predicted that groundwater concentrations were not protective of indoor air quality.

One or more chlorinated ethenes and ethanes were detected in all soil vapor samples. VC was detected at three of the five locations but did not exceed MTCA Method C (see Section 6.4) ambient air criteria (i.e., stations VP11, VP52, and VP58). BTEX compounds (primarily toluene) were also present in some vapor samples. Because of the presence of these in the soil vapor above MTCA screening levels, the following chemicals have been added to the PCOC list for soil pending review of further data: cis-1,2-DCE and benzene (1 sample only). TCE and PCE also were detected in the soil vapor, but are already PCOCs for soil.

4.2.2 GROUNDWATER

A total of 57 groundwater monitoring wells have been installed at the GWI site over the last decade. Locations of the monitoring wells are shown in Figure 4.1. Table 4.5 lists the wells by general location and water-bearing zones. These wells have been sampled at various times throughout the RI and SRI field activities. Contaminant concentrations tend to vary following completion of the IRMs (such as UST decommissioning and cleanup) and due to seasonal differences, normal variations between sampling rounds, and long-term trends. Data from the last 2 years will be emphasized in the following discussion, with special emphasis on the 1999 annual monitoring results, as they represent the first complete and synoptic measurement of all wells and seeps.

Table 4.6 is the analytical schedule for groundwater sampling. Because the various groundwater events sampled different wells, the table lists how many groundwater samples were analyzed per year by analyte group. The sampling has been extensive and has included analyses for EPA's target analyte list chemicals including metals, VOCs, and SVOCs. Additionally, several rounds of sampling have included total petroleum hydrocarbons. Appendix E presents all groundwater results for all rounds arranged by event and location.

Table 4.7 lists those analytes that have not been detected in groundwater during the last 2 years, along with their detection limits. Tables 4.8 and 4.9 are frequency of detection summaries for analytes detected at less than, or equal to, five percent frequency, and those detected at greater than or equal to a five percent frequency, respectively.

The following chemicals or classes of chemicals were detected in groundwater in more than five percent of samples:

- Chlorinated ethenes and ethanes and their degradation products
- Volatile aromatics (BTEX family) and petroleum hydrocarbons
- Chlorinated benzenes
- Pentachlorophenol
- Semi-volatile organic compounds, specifically PAHs associated with the petroleum products, phthalates (common plasticizers), and phenols
- Metals

All other chemical parameters were either not detected or were detected in five percent or less of groundwater samples.

4.2.2.1 Chlorinated Ethenes and Ethanes

The primary chlorinated solvents detected in groundwater are PCE and its degradation products. As shown in Table 4.9, eight of these chemicals are present in greater than five percent of the samples with seven having maximum concentrations greater than the MTCA Method B groundwater cleanup level used for screening. The other one has a maximum concentration less than the Method B screening standard.

The maximum concentrations detected for most compounds were highest prior to 1993 and were found within the GWI Facility boundary. Since the late 1980s and early 1990s when the various IRMs were conducted, groundwater concentrations for these volatiles have generally decreased, and maximum concentrations for several of the degradation products are now located downgradient from the facility.

The seven chlorinated ethenes and ethanes that still exceed MTCA Method B screening values have been retained as PCOCs in groundwater at the site. Their sources and distribution are discussed further in Section 4.3 and Section 5.0.

4.2.2.2 Petroleum Products, the BTEX family, and LPAHs

Various petroleum products and individual petroleum constituents have been detected as dissolved compounds in groundwater. Because of weathering processes, it is not always possible to identify the original product type, but the results are consistent with the presence of gasoline, mineral spirits, petroleum spirits, and, perhaps, diesel-range products.

Monocyclic aromatic hydrocarbons, including the BTEX family, have been detected with a frequency of about 15 to 40 percent. All except the xylenes have maximum concentrations above the MTCA Method B screening levels (Table 4.9). This is consistent with its presence on the site as a solvent, as well as its presence in various petroleum products. The distribution of the BTEX family is discussed in Section 4.3. Benzene, toluene and ethyl benzene have been retained as PCOCs in groundwater for the GWI site.

Several LPAHs were detected in groundwater at a frequency greater than five percent, but all had maximum concentrations that were considerably less than the Method B screening levels. No LPAH has been retained as a PCOC in groundwater.

The presence of BTEX and LPAHs is consistent with the presence of both light-end petroleum fuels and solvents, such as toluene, at the GWI Facility. These aromatics are the most soluble components in the petroleum products, and would be expected to be detected in groundwater if petroleum contamination is present.

No free or floating petroleum product has been found in the wells within the site; however, floating product has been found off-site adjacent to the abandoned Tyee dip tank near S. Myrtle Street. (Discussion in Section 4.3.)

4.2.2.3 Other Volatile Organic Compounds

One other VOC, methylene chloride, has been detected in the groundwater at the GWI Facility in more than five percent of the samples at a maximum concentration greater than the MTCA Method B groundwater screening levels. (Table 4.9). Methylene chloride has been retained as a PCOC in groundwater. Because it was retained in groundwater, it has been retained in soil.

4.2.2.4 Chlorinated Benzenes

The three dichlorinated benzene isomers have been detected in groundwater frequently over the last 2 years. The maximum concentrations for the 1,4-dichlorobenzene isomers exceed MTCA Method B screening standard (Table 4.9). 1,4-Dichlorobenzene has been retained as a PCOC in groundwater.

4.2.2.5 Chlorinated Phenols

Penta has been detected in over 35 percent of the groundwater samples (Table 4.9), and in a LNAPL sample from the off-site well adjacent to the former location of a dip tank at the historical Tyee Lumber Facility. The maximum concentration of penta at the GWI Facility was 1,900 μg/L in Monitoring Well B-11. The other chlorinated phenols have not been detected during the last 2 years. Penta has been retained as a PCOC in groundwater, and its sources and distribution will be discussed further in Section 4.3.

4.2.2.6 HPAHs and Other SVOCs

HPAHs were not detected in groundwater at the site (Table 4.7). This is consistent with the limited detection of HPAH in soil near surface only and the low solubilities of HPAHs. No HPAH has been retained as a PCOC for groundwater; therefore, benzo(a)anthracene and chrysene, which were tentatively retained as PCOCs in soil, will not be retained as PCOCs for soil.

Phthalates and phenols were the only other SVOCs detected in groundwater. All concentrations were considerably less than the MTCA Method B screening standard, except for a single detection of bis(2-ethylhexyl)phthalate in Monitoring Well B-11 in 1999. The detection of 6.9 μg/L was very close to the MTCA Method B screening level of 6.25μg/L. Because of the laboratory's chronic blank contamination problem with bis(2-ethylhexyl)phthalate (Appendix E), and because of a very marginal exceedance of the screening level in a single well, it has not been retained as a PCOC, nor has it been retained as a PCOC in soil.

4.2.2.7 Potential Chemicals of Concern for Groundwater

The following chemicals were identified as PCOCs for groundwater at the GWI site:

- Chlorinated ethenes and ethanes
- Benzene, toluene, and ethyl benzene
- Methylene chloride
- 1,4-Dichlorobenzene
- Pentachlorophenol
- Total petroleum hydrocarbons (solvent-range)

4.2.3 SEEPS/SURFACE WATER

Groundwater from the 1st WBZ and 2nd WBZ discharges to the Duwamish River. A number of seeps have been identified during the RI and SRI activities along the waterfronts of Bunge Foods, Seattle Boiler Works, the S. Myrtle Street Embayment, and the former Othello Warehouse property. During the RI, two of the seeps, S-1 and S-2 in the S. Myrtle Street Embayment, were found to be contaminated with chlorinated ethenes and ethanes. These seeps and the "clean" seeps located to the north (downriver) and south (upriver) have been sampled approximately every year since 1995 (Table 4.10). Surface water and mussel samples from the Embayment also have been collected as part of this effort. Sample locations are shown in Figure 4.3.

In 1998, an extensive search was made in the Embayment for additional seeps and seep faces, and generalized analysis of Embayment discharges of volatile organic compounds was completed using porewater analysis. This work is presented in Appendix D. This investigation identified one additional seep face, identified as S-13. It discharges from the 2nd WBZ, while all other seeps were found to discharge from the 1st WBZ.

4.2.3.1 Chlorinated Ethenes and Ethanes

The chlorinated ethenes and ethanes were detected in seep samples and occasionally in surface water samples from the Embayment. The parent chlorinated ethenes and ethanes, PCE and TCE, have been measured at maximum concentrations of 320 µg/L and 270 µg/L, respectively. These concentrations are greater than the National Toxics Rule ambient water quality criteria by more than two orders of magnitude. The primary degradation products detected in seeps and surface water samples are *cis*-1,2-DCE and VC. In the 1st WBZ, the maximum concentrations of *cis*-1,2-DCE and VC are is 100 µg/L and 1,000 µg/L, respectively at Seep S-2. The analytes were detected during the 1999 annual monitoring event. In the 2nd WBZ, the maximum concentration of *cis*-1,2-DCE is 3300 µg/L at Seep S-13 detected during the 1998 annual monitoring event and the maximum concentration of VC is 3500µg/L at Seep S-13 detected during the 1999 annual monitoring event. VC exceeds the National Toxics Rule ambient water quality criteria. There is no National Toxics Rule ambient water quality criterion for *cis*-1,2-DCE; however, the maximum concentration of *cis*-1,2-DCE in the 2nd WBZ is less than the National Toxics Rule ambient water quality criterion for *trans*-1,2-DCE by two orders of magnitude. Since the maximum concentration for *trans*-1,2-DCE is generally less than the concentration of *cis*-1,2-DCE, it can be assumed that the maximum concentration of *cis*-1,2-DCE in the 2nd WBZ is at an acceptable level.

1,1-Dichloroethene was detected in 1st WBZ and 2nd WBZ seep samples at maximum concentrations greater than the National Toxics Rule ambient water quality criterion.

The dichloroethanes have been detected in the seep samples collected during the last 2 years. The maximum concentration of 1,1-dichloroethane is 88 µg/L in the 1st WBZ and 58 µg/L in the 2nd WBZ. There is no National Toxics Rule ambient water quality criterion for 1,1-dichloroethane. 1,2-Dichloroethane was detected; however, its maximum concentration is an order of magnitude less than the National Toxics Rule ambient water quality criterion. The trichloroethanes were not detected in the seep samples.

PCE, TCE, 1,1-dichloroethane, and VC have been retained as PCOCs in seeps and will be discussed further in Section 4.3.

4.2.3.2 The BTEX Family

The BTEX family has been detected in seeps and surface water. Precautionary measures were taken during sampling to avoid contaminating the samples with boat exhaust. Concentrations in surface water that exceed adjacent groundwater concentrations most likely result from other sources of petroleum fuels to the Duwamish River.

Benzene was detected in the seep samples; however, the maximum detected concentration is only about one-half that of the National Toxics Rule ambient water quality criterion for benzene. Toluene was detected in the seep samples; however, the maximum concentration of toluene was less than the National Toxics Rule ambient water quality criterion by more than four orders of magnitude. o-Xylene was detected in the seep samples at a concentration similar in magnitude to that of toluene.

No member of the BTEX family has been retained as a PCOC for seeps or surface water.

4.2.3.3 Other Volatile Organic Compounds

During a 1998 sampling event, seeps were sampled using the GORE-SORBER® screen modules. The screening module is a passive soil, sediment, and groundwater sampling device used to detect VOCs and SVOCs. Analytical results from screen modules are qualitative (i.e., mass) and can not be used to derive the concentration of a contaminant in the affected media. A detailed discussion of properties of GORE-SORBER® and the sampling effort are presented in Appendix D.

Ten screening modules were installed in the eastern S. Myrtle Street Embayment seep-face., and nine contained detectable quantities of PCE or one of its degradation products. 1,1,2-TCA (not degradation product of PCE) was detected at one sample location, north of the S. Myrtle Street Embayment. Methylene chloride was detected at one sample location. Acetone was also detected in two sample locations. A detailed discussion the sampling effort and results are presented in Appendix D.

Based upon the sampling, no other VOC has been retained as a PCOC for seeps or surface water.

4.2.3.4 Chlorinated Phenols and Chlorinated Benzenes

None of the chlorinated phenols have been detected in the seeps or surface water near theGWI site. In 1999, seeps samples were analyzed using method EPA Method 8270 by Selective Ion Monitoring to decrease the detection limit to 0.5 μg/L (from the 5.0 μg/L detection limit with the standard EPA Method 8270C). Even with the lower detection limit, penta was not detected in the seeps or surface water.

1,2-Dichlorobenzene was detected in Seep S-13 using EPA Method 8240 at 1.3 μg/L in 1998. In 1999, the seep was analyzed for the dichlorobenzenes using both EPA Methods 8260B and 8270C and none were detected at detection limits of 0.5 μg/L. The other chlorinated benzenes have not been detected in seeps or surface water by either method.

The National Toxics Rule ambient water quality criterion for 1,2-dichlorobenzenes is 17,000 μg/L. I,3-Dichlorobenzene and 1,4-dichlorobenzene both have criterion of 2,600 μg/L.

Chlorobenzene was detected in the seeps from the 1st WBZ with a maximum concentration of 8.9 μg/L at least three orders of magnitude less than the National Toxics Rule ambient water quality criterion of 21,000 μg/L for chlorobenzene.

No chlorinated phenol or chlorinated benzene has been retained as a PCOC for seeps or surface water.

4.2.3.5 Other Semi-volatile Compounds

No other SVOC was detected in seeps or surface water during the last 2 years.

4.2.3.6 Potential Chemicals of Concern for Seeps and Surface Water

Chlorinated ethenes and ethanes were identified as PCOCs for seeps and surface water at the GWI site.

4.2.4 SEDIMENT

Sediment samples were collected in the Duwamish River as part of a EPA Site Investigation (EPA SI) performed under Superfund. The intent of the EPA SI was to collect sufficient data to evaluate whether the Duwamish River should be included on the National Priorities List and to establish priorities for additional action, if warranted. The EPA SI was designed to provide an evaluation of sediment quality for a nine-kilometer section of the Duwamish River (Weston 1999).

Four intertidal surface sediment samples were collected in or adjacent to the S. Myrtle Street Embayment. Station DR116 was within the Embayment; Station DR117 was just outside of the Embayment along an intertidal shelf; Station DR118 was upgradient of the Embayment and the dock at the former Othello Warehouse property; and Station DR115 was downgradient of the Embayment and adjacent to Seattle Boiler Works. These stations are shown in Figure 4.3.

Sediment samples were analyzed for a combination of VOCs, SVOCs, polychlorinated biphenyls (PCBs), pesticides, metals, organotins, dioxins and furans, and conventional parameters (Table 4.10). The analytical schedule for these sediment samples included a wide range of chemical constituents because the investigation was performed by EPA to evaluate the range of contaminants that are known to be present in the Duwamish Basin as a result of historical industrial activities. The analytical schedule included numerous chemicals for which GWI is not a potential source. Previous investigations at other facilities have identified a number of COCs for the Duwamish River and identified existing sources for these chemicals, which include PCBs, PAHs, metals, dioxins and furans, phthalates, and chlorinated benzenes.

Table 4.11 presents the detection frequency summary for the four sediment samples of interest. Chemicals that were detected in one or more samples include multiple LPAHs, HPAHs, phthalates, chlorinated benzenes, PCBs, metals, organotins, and dioxins and furans. No groundwater PCOC for the GWI site was detected in the EPA SI sediment samples.

No PCOCs have been identified for sediments at the GWI site.

4.2.5 SEDIMENT POREWATER

During a 1998 sampling event, sediment porewater in the S. Myrtle Street Embayment was screened for VOCs using the GORE-SORBER ® screen modules. Analytical results from screen modules are qualitative (i.e., mass) and can not be used to derive the concentration of a contaminant in the affected media. A detailed discussion of GORE-SORBER ® properties and the sampling effort are presented in Appendix D.

The screening module is a passive soil, sediment, and groundwater sampling device used to detect VOCs and SVOCs. Forty-three screening modules were installed in the Embayment. The modules were installed along eight transects running from the mouth of the Embayment toward the shoreline closest to S. Myrtle Street.

Of the 43 modules installed and retrieved, only two contained detectable quantities of PCE breakdown products. One module contained *cis*-1,2-DCE, while the second contained *cis*-1,2-

DCE, *trans*-1,2-DCE, VC and 1,1-dichloroethane. Both of these modules were located adjacent to seeps (i.e., S-2 and S-1) that have been identified during the RI as discharge points for groundwater impacted by GWI site VOCs. A detailed discussion of the sampling effort and results are presented in Appendix D.

Based upon the sampling, no other VOC has been retained as a PCOC for sediments.

4.2.6 AMBIENT AIR

On June 9 and July 12, 2000 screening-level ambient air samples were collected at the GWI Facility using evacuated stainless-steel canisters supplied by the laboratory. A total of 11 samples were collected between the two sampling events: five outdoor and six indoor ambient air samples. Samples were analyzed for VOCs using EPA Test Method TO-14. Sample locations were as follows:

Sample No.	Sample Location
1	Upwind of the GWI Facility on Fox Avenue near the railroad tacks, near well B-20A
2	Upwind of the GWI Facility on Fox Avenue near the railroad tracks, near well B-63
3	At well B-58, six to 12 inches above the ground (note: sample No. 4 is a duplicate of sample No. 3)
5	Inside the GWI Facility warehouse office, six to 12 inched above the floor
6	Inside the GWI Facility warehouse changing room, six to 12 inched above the floor
7	Downwind, north end of the Emerson/Schultz property near railroad tracks
8	Inside the GWI Facility warehouse office, six to 12 inched above the floor
9	Inside the GWI Facility warehouse office, breathing zone (5 feet above the floor)
10	Inside the GWI Facility warehouse changing room, breathing zone (5 feet above the floor)
11	Inside the GWI Facility warehouse changing room, six to 12 inched above the floor

The purpose of the screening-level ambient air sampling events was to determine if VOCs were present in the ambient air at the site, and if so, to determine their nature and extent. One or more chlorinated ethenes and ethanes were detected in all ambient air samples. VC was not detected in the samples. BTEX compounds also were present in ambient air samples. A detailed discussion of ambient sampling events and results are presented in Appendix I.

4.2.6.1 Potential Chemicals of Concern for Ambient Air

The following chemicals were identified as PCOCs for ambient air at the GWI site:

- PCE and TCE
- Methylene chloride
- Benzene

4.2.7 SUMMARY OF POTENTIAL CHEMICALS OF CONCERN

The following chemicals have been identified as potential chemicals of concern for the various media and will be discussed further in the next sections.

PCOC	Soil	Groundwater	Seeps	Sediment	Air
Chlorinated ethenes and ethanes	Yes[1]	Yes[2]	Yes[3]	No	Yes[4]
Pentachlorophenol	Yes	Yes	No	No	No
Chlorinated dioxins and furans	Yes	No[5]	No[5]	No	No
Total petroleum hydrocarbons solvent-range	Yes	Yes	No	No	No
BTEX Family	Yes[6]	Yes[7]	No	No	Yes[8]
Methylene chloride	Yes	Yes	No	No	Yes
1,4-Dichlorobenzene	No	Yes[9]	No	No	No

Notes:

1 Specific PCOCs for soil: PCE and TCE (soil samples) and VC and cis-1,2-DCE (soil vapor samples).
2 Specific PCOCs for groundwater: PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, VC, 1,1,1-TCA, and 1,2-DCA.
3 Specific PCOCs for seeps and surface water: PCE, TCE, 1,1-DCE and VC.
4 Specific PCOC for outdoor and indoor air: PCE and TCE.
5 See discussion in Section 4.3 for future details.
6 Specific PCOC for soils: benzene and toluene (soil vapor samples).
7 Specific PCOCs for groundwater: benzene, toluene, and ethyl benzene.
8 Specific PCOCs for ambient air: benzene.
9 1,4-DCB exceedances in groundwater are in central area wells only.

4.3 NATURE AND EXTENT OF POTENTIAL CHEMICALS OF CONCERN

The majority of contaminants at the GWI site are co-located in a few source areas and in plumes that extend away from the source areas. Volatile and mobile contaminants, such as the chlorinated ethenes, have migrated in groundwater to the S. Myrtle Street Embayment. Non-mobile contaminants, such as penta, remain localized near their source areas. The following sections describe the extent of PCOCs at the site. Section 5 expands this discussion to consider the chemical and site properties that control the migration of PCOCs and influence their fate in the environment.

The nature and extent of the chlorinated ethenes and ethanes is discussed first because they are expected to control many of the cleanup decisions at the site.

4.3.1 CHLORINATED ETHENES AND ETHANES

4.3.1.1 Original Source Area

The GWI Facility Source Area. The original source area for the chlorinated ethenes and ethanes at the GWI Facility corresponds generally to the former main UST area and the location of the drum shed, old tank farm and associated underground piping near Frontenac Street. Operational releases, including UST and line leaks, appear to have contributed significant contamination to the surrounding soil and groundwater in these areas. As discussed in Section 3.4, these areas have undergone significant IRMs, including decommissioning of USTs and piping, removal of portions of the contaminated soil, and operation of a partially successful interim action to remove VOCs from the original source area. Although residual contamination exists in the vadose zone and the underlying saturated soil, there is no ongoing operational source of these compounds, as all of the USTs in the former main tank farm have been decommissioned, and the handling of chemical products for the dry cleaning business (the principal PCE source) was discontinued in 1992.

The Secondary Source Area in the 1st SH. Historical releases at the facility appear to have contributed to a secondary source area beneath the facility in the vicinity of Monitoring Well B-12. This source area is shown with gray shading on Figure 4.4. (This map will be discussed further in Section 5 with respect to the conceptual site model.) Solvent leaks from the original source area on the property appear to have resulted in "streamers" of residual DNAPL sinking through the 1st WBZ and encountering the 1st SH. The product slowly saturated parts of the silt horizon, especially in the topographic depression in the silt horizon near B-12. (This depression is best seen by reviewing Figure 2.17, which shows the topographic surface of the 1st SH.)

Recoverable DNAPL has been encountered only in Monitoring Well B-12, and not in the adjacent wells; however, it is likely that the silt in this area is partially saturated with solvent and acts as an ongoing source. This source is referred to throughout the rest of this document as the "secondary source area," to distinguish it from the original source area at the facility. As can be seen in Figure 4.4, this secondary source area extends from the southern part of the GWI Facility beneath the railroad tracks on Frontenac Street and under a small northern section of the former Tyee Lumber Facility. The secondary source area represents the principal ongoing source of chlorinated ethenes and ethanes to groundwater at the GWI site.

Methylene chloride is found associated with the chlorinated ethanes and ethenes. This association is probably due to similar historical handling and storage practices on-site, and due to its similar chemical properties and behavior in the environment. It is not a parent or degradation product in the natural PCE degradation process; however, it is co-located with the plume of PCE and its degradation products.

The NW Corner Source Area. In recent years, a second plume of chlorinated ethenes and ethanes has been identified in the 1st WBZ. This plume was identified in the northwest corner of the GWI Facility, and is referred to as the NW Corner Plume. Based on existing data, the plume appears to be currently in the 1st WBZ only. Its source area appears to be near or upgradient of Monitoring Well B-54. The source of this plume is currently unknown. However, as discussed in Section 5, it appears to be unrelated to the plume originating in the area around Monitoring Well B-12. Appendix A presents a complete discussion of the Northwest Corner investigation and findings.

4.3.1.2 Soil

The majority of the soil data was collected during the RI and IRMs from 1988 to 1993, and may overstate the current concentrations of chemicals remaining in soil due to the following reasons:

- Site releases stopped in the late 1980s.
- The IRM has been operating.
- Natural degradation has been occurring.

Both the historical and recent soil data are shown in Figure 4.5 and tabulated in Table 4.12. The data in the table are represented in Figure 4.5 by a bar divided into four sections. The bar sections represent results from zero to five feet bgs, 5 to 10 feet bgs, 10 to 15 feet bgs, and 15 to 20 feet bgs, respectively. White boxes indicate that no sample was collected, green boxes indicate that all PCE and TCE concentrations are less than MTCA Method B screening levels, yellow boxes indicate an exceedance of the screening level for the specified compound, and red boxes indicated an exceedance of the MTCA Method C cleanup level for industrial sites for the specified compound.

The highest concentrations of PCE and TCE were detected in the GWI Facility original source area. The maximum concentrations of PCE (18,000 mg/kg) and TCE (1,100 mg/kg) were detected in samples collected from Station SB-10 at the former location of the pump sheds. The concentrations of both PCE and TCE that exceeded MTCA Method B screening standards encompass an area around the old tank farm beneath the drum shed and the former location of the pump sheds. Only PCE concentrations exceeded the Method B screening standard outside the original source area.

PCE and TCE concentrations exceeding the Method B screening standard, and PCE concentrations exceeding the Method C cleanup standard, were detected in the GWI Facility original source area in soil from the surface down to the 1st SH. Outside this original source area, concentrations of PCE exceeding the Method B screening standard were generally detected at a depth corresponding to the 1st SH. The pattern of PCE and TCE concentrations indicates that these compounds were released at or near the surface, flowed vertically downward to the silt, then moved along the silt horizon to a topographic low near Monitoring Well B-12 (the secondary source area).

PCE was detected at Stations B-2 and B-3 outside of the GWI Facility original source area adjacent to the southwest corner of the Main Warehouse at a concentration exceeding Methods B and C cleanup levels. The sample was collected from between 10 and 11.5 feet bgs. The soil with PCE concentrations exceeding soil cleanup levels appears to be present in a thin layer on top of the 1st SH. Samples collected from adjacent Stations B-9 and B-10A at depths above and below 10 to 11.5 feet bgs had PCE concentrations less than the Method B cleanup level. The area around these two stations is the topographic low point for the 1st SH (as shown in Figure 2.17) and is "downhill" from the main tank farm and transfer piping.

Methylene chloride was detected in nearly 20 percent of the soil samples; however, as stated previously in Section 4.2.1.3, this is historical data. In the early 1990s, the maximum concentration was 780 mg/kg, which exceeded the MTCA Method B screening level, but was less than the MTCA Method C cleanup standard of 17,500 mg/kg. Since that time, significant IRMs have occurred that would decrease soil concentrations.

4.3.1.3 Soil Vapor

Soil vapor samples have been collected from numerous stations at the GWI site. Soil vapor samples were collected from various stations during separate events to evaluate chemical concentrations in soil vapor. Soil vapor sampling stations are listed below.

After initial soil vapor characterization activities were performed for the GWI property, 10 stations were sampled for soil vapor during consecutive events to provide ongoing annual monitoring. Additionally, two separate investigations were performed to evaluate chemical concentrations in soil vapor on the adjacent Seattle Boiler Works (SBW) property and to aid in determining the relationship between PCOCs in the groundwater and their presence in the vadose zone. This section presents the analytical results from three sampling events. The most recent annual soil vapor monitoring events were performed in 1995 and 1996. During these events, soil vapor samples were collected from the following stations (Figure 4.1):

Station(s)	Location
B-28	Upgradient / GWI Northern Property Boundary
B10A and B-13	GWI Western Property Boundary
B-16, B-31, and B-39	GWI Original and Secondary Source Areas
B-32	GWI Southeast Property Boundary
VP-6	Downgradient / GWI Southwestern Property Boundary
B-34 and B-36	Downgradient / SBW Southern Property Boundary

All of these stations, except VP-6, are groundwater monitoring wells that are screened across the water table of the 1st WBZ. Therefore, samples from the groundwater monitoring wells are representative of vadose zone soil vapor present immediately above the water table (approximately six to 10 feet bgs). Station VP-6 is a vapor monitoring probe with a screened interval in the vadose zone. Samples collected during the annual monitoring events were analyzed for specific chlorinated ethenes and ethanes including PCE, TCE, 1,1-dichloroethene, and vinyl chloride.

During the investigation of the SBW property, soil vapor samples were collected from the following stations (Figure 4.1):

Stations	Locations
P-2 and P-5	Eastern portion of the SBW property
P-1 and P-6	Western Portion of the SBW property
P-7 and P-8	Adjacent to the S. Myrtle Street Embayment

The soil vapor samples from these stations were collected from vadose zone soil approximately three to five feet bgs. GeoProbe® sampling devices were used to collected the soil vapor samples. Samples collected during the investigation of the SBW property were analyzed for VOCs including chlorinated ethenes and ethanes, other solvents, chlorinated and non-chlorinated aromatics, and other miscellaneous volatile compounds.

The soil vapor results, as shown in Figure 4.6, appear to coincide with the identified source areas discussed above. The highest concentrations are near the GWI Facility original source area associated with the main tank farm and transfer piping, and at the secondary source area in the 1st SH. The soil vapor sample from B-13 appears to coincide with the NW Corner Plume, although the PCE concentration was only slightly elevated. The correlations between soil vapor sampling locations and soil and groundwater contamination identified in these areas is generally as follows:

Soil Vapor Location	Relationship to Soil in the Area
B-39, B-31	Sample stations at the original source area and secondary source areas. These are areas with highest soil and groundwater concentrations.
V-6	Sample station directly downgradient of secondary source area. The 1st SH exists in this area, and concentrations in groundwater and in the silt remain elevated.
B-32	Sample station near main tank farm area where PCE releases occurred. This area contains elevated vadose zone concentrations in soil.
B-13	Soil vapor correlate with PCE in groundwater. PCE soil concentrations are low.
B-10A	Soil vapor correlate with chlorinated ethenes in groundwater and PCE in 1st SH. Distribution of chlorinated ethenes at B-10A is very different that B-13, indicating two different plumes.
P-1 through P-8 and B-34	Soil vapor concentrations roughly follow the PCE plume in the 1st WBZ. Concentrations are 2 to 3 orders of magnitude lower than in original source area.
B-16 and B-28	Soil Vapor concentrations drop sharply relative to source areas, consistent with absence of soil and groundwater contamination in these areas.

During a May 2,000 investigation of the GWI property, new temporary vapor probes were installed adjacent to key 1st WBZ monitoring wells on site that contained high concentrations of vinyl chloride. The goal of this investigation was to better understand the relationship between volatile organics (especially the most volatile – vinyl chloride) in the vadose zone and in groundwater in the 1st WBZ. This information was essential in understanding cross-media interactions between soil, groundwater, and soil vapor, and helpful in predicting areas where ambient air evaluations would prudent.

The soil vapor samples were collected from the following stations (Figure 4.1):

Stations	Locations
VP10A	This Sample Station is Located at the GWI Western Property Boundary Near Main Warehouse Near Monitoring Well B-10A. Location is primarily downgradient from the plume location.
VP11	This Sample Station is Located at the GWI Southern Property Boundary South of the Former Drum Shed/Tank Farm Near Monitoring Well B-11. This location is representative of the original source area and contains both vadose zone soil and groundwater contamination.
VP44	This Sample Station is Located South of GWI Property Boundary, east of Fox Street Near Monitoring Well B-44. This well is representative of the secondary source area in the 1st SH.
VP52	This Sample Station is Located at the GWI Southern Property Boundary south of the Main Warehouse Near Monitoring Well B-52. This well is also representative of the secondary source area in the 1st SH.
VP58	This Sample Station is Located at the Southwest of GWI Property Boundary, west side of Fox Avenue near Monitoring Well B-58. This is the nearest downgradient area well to the source area.

In addition to soil vapor samples, groundwater samples were collected at the adjacent wells: B-10A, B-11, B-44, B-52, and B-58.

PCE, TCE, and/or *cis*-1,2-DCE were detected at all stations and at all sample depths. The highest concentration of total chlorinated ethenes were typical detected in soil vapor samples collected at depths ranging from 4.5 to 8 feet bgs (i.e., those samples that were closer to the water surface). VC was detected in soil vapor samples at three out of five stations at depths of 0.25 to 2 feet bgs (i.e., VP11, VP52, and VP58). The highest concentration of VC was detected at station VP11 at 2 feet bgs.

Of these five probes, the one with the highest total concentration of chlorinated ethenes is VP11. This is consistent with both the high groundwater concentrations in this location and with the historical presence of significant vadose-zone soil contamination from the tank farm and drum shed releases. The next highest is at VP44, which is located over the secondary source area but very near the original source area. The lowest are at VP52 and VP10A. In general, these results are consistent with the following conceptual model: soil vapor concentrations will be influenced by residual contamination in the vadose soil, by "off-gassing" from the 1st WBZ into the vadose, and by degradation (both biotic in the capillary fringe and abiotic) within the vadose zone. Therefore, the highest concentrations in soil vapor should be in areas with both vadose zone soil contamination and/or the highest groundwater contamination. This would predict that VP11 and VP44 would be more contaminated than VP10A, consistent with the results. VP52 would be expected to be intermediate between the two areas, but is actually fairly similar to VP10A.

VOCs detected in the vadose zone at soil vapor station VP11 can be attributed to both contaminated soil and groundwater associated with the original release of solvents at the GWI Facility. Anaerobic conditions near the capillary fringe degrade PCE and TCE to product daughter products; whereas, more aerobic conditions in the vadose zone serve to reduce the concentrations of daughter products in the vadose zone. Because of the continued source of PCE and TCE in the original and secondary source areas at the GWI Facility, the concentration of VC in the vadose zone near the source areas is consistently higher than in vadose soils downgradient of the GWI site.

Correlations between soil vapor and groundwater concentrations for individual ethenes is poor, indicating that groundwater concentrations are a poor predictor of soil vapor concentrations, and that soil vapor concentrations at this site are primarily controlled by vadose zone processes (off-gassing from soils, diffusion through the soil column, and degradation within the vadose zone.)

Concentrations in the soil probe locations nearest the surface are the best indicator of a potential to affect ambient air. PCE and TCE concentrations are consistently the highest concentrations. VC concentrations are consistently the lowest; in fact, VC is only detected in 3 of the 5 locations and is below the MTCA Method C criterion for VC in ambient air at these locations.

These data would seem to indicate that PCE and TCE need to remain COCs for soil, while VC does not need to be added to the COC list (there are currently no soil exceedances for VC). Further, this implies that vadose zone soils are affecting vapors in the vadose zone and that this pathway will need to be addressed as part of the remedy.

4.3.1.4 Groundwater, Seeps and Surface Water

The presence of PCE and its degradation products at the GWI site is most apparent in groundwater.

The PCE Plume. Figures 4.4 and 4.7 show the migration of PCE in groundwater at the site in the 1st and 2nd WBZs. Several effects are noticeable, specifically:

- The GWI Facility original source area near Monitoring Well B-15 beneath the drum shed continues to act as a significant source of groundwater contamination. Review of soil data in this area (Figure 4.5), indicates that the source has reached the 1st SH in this area.

- DNAPL is also in present at Well B-12, and suspected in the area of Well B-31. DNAPL at or near these wells functions as a secondary source for dissolved PCE. Section 5.3.1 presents a complete discussion of the original and secondary source of DNAPL at the GWI Facility.
- Groundwater monitoring data indicate some DNAPL may have been present in the 2nd WBZ. Although no longer present, some residual soil contamination remains. This soil is a source of contamination for the 2nd WBZ. Section 5.3.1 presents a complete discussion of the original and secondary source of DNAPL at the GWI Facility.
- As groundwater from the area near B-15 moves downgradient, it contacts the secondary source in the 1st SH near B-12, and concentrations rise.
- As this groundwater continues to move toward the Duwamish River, it divides at the hole in the 1st SH at Fox Avenue S. Groundwater at B-58 moves toward the river in an area where the 1st SH is still present and contamination remains in the 1st WBZ. Groundwater at Monitoring Wells B-60 and B-62 enters the hole and encounters a significant vertically downward flow component into the 2nd WBZ. Roughly ¼ of the plume continues to move toward the river in the 1st WBZ along a narrow corridor centered around B-58 (this is easiest to see in the soil probe data in Figure 4.5). Roughly the other ¾ of the plume moves into the 2nd WBZ.
- Contamination in the 2nd WBZ begins beneath the GWI Facility and secondary source areas, and then flows along a narrow corridor towards the S. Myrtle Street Embayment and the seep face at S-13.
- Concentrations of PCE in the 2nd WBZ drop significantly along this flow path from 85,000 µg/L near B-12 to 100 to 300 µg/L in groundwater and seeps at the S. Myrtle Street Embayment.
- The NW Corner Plume is visible as a distinct plume coming across the northwest corner of the site. This plume is distinct based on both its location and on the relationship between the concentrations of PCE and its degradation products (this distinction will be discussed further in Section 5).

PCE Degradation. Tables 4.13, 4.14, and 4.15 summarize the concentrations of chlorinated ethenes and ethanes in groundwater, seeps and surface water. The tables are broken into three groups:

1. The first group includes monitoring wells in the 1st WBZ and 2nd WBZ that are either on the facility, near the secondary source in the 1st SH, or located on the east side of Fox Avenue S.
2. The second group includes monitoring wells west of Fox Avenue S. that are downgradient of the source areas and located between the GWI Facility and the Duwamish River.
3. The third group contains results for seeps and surface water.

For the chlorinated ethenes, two additional columns are present in the tables: the first lists the dominant chlorinated ethene that is present in the well, and the second is a ratio of the

PCE + TCE (the parents) to DCE (all isomers) + VC (the degradation products). Ratios of greater than one indicate that PCE or TCE dominate; ratios of less than one indicate that the degradation products dominate. Section 5 discusses the chemical and biological processes that control the degradation of PCE in the environment, but first it is necessary to understand the distribution of ethenes at the GWI site.

As PCE moves toward the river, degradation is occurring. As shown in Table 4.13, the dominant chlorinated ethene in the source areas and in the top of the hole at Fox Avenue S. is the parent compound PCE. This reflects the dissolution of the parent from the silts in the source areas. Except for the area around B-10A, little degradation is occurring in the 1st WBZ until groundwater reaches the river. The major factors controlling the amount of PCE that reaches the river are how much is leached from the source areas and how much is lost to the 2nd WBZ at the hole in the 1st SH.

The pattern in the 2nd WBZ is very different. This is most easily seen in the ratios of parent to degradation products in Table 4.14, the monitoring wells west of Fox Avenue S. in the 2nd WBZ. In these wells, DCE and vinyl chloride are dominant, and PCE and TCE are rarely detected.

Seeps discharging from the 1st WBZ in the S. Myrtle Street Embayment (e.g., S-1 and S-2). containi mostly parent compounds with concentrations in the 100s µg/L range, while seeps (e.g. S-13) discharging from the 2nd WBZ (the zone in which the dominant flow path moves) are dominated by degradation products at higher concentrations. This dominance of daughter products in the 2nd WBZ can be attributed to longer residence time of the parent compounds in 2nd WBZ and the more anaerobic state of 2nd WBZ compared to the 1st WBZ. The greater residence time can be attributed to a longer the flow path in the 2nd WBZ resulting from vertical gradients exceeding horizontal gradients and presence of more organic matter in the 2nd WBZ to retard the migration of the parent compounds.

Methylene chloride also is found in the groundwater at the GWI Facility. The most recent groundwater sampling events have detected methylene chloride at a frequency of only 9 percent with a maximum near the hole at Well B-20A having a concentration near 100µg/L. This concentration drops rapidly to only 20 µg/L along S. Myrtle Street in Well B-36; and the decreasing trend continues until concentrations are less than detectable limits along the Embayment (Wells B-33A and B-34). Methylene chloride was not detected in the seeps.

4.3.1.5 Sediment and Mussels

The chlorinated ethenes and ethanes are not detected in sediment or mussel samples. As discussed in Section 5, this is consistent with the very short lifetime of ethenes and ethanes in surface water environments, and the fact that they do not appear to bioaccumulate in tissue.

Methylene chloride was not detected in the intertidal sediment that was analyzed for VOCs. Methylene chloride has not been detected in the mussel samples

4.3.1.6 Sediment Porewater

Of the 43 GORE-SORBER® screening modules installed to monitor porewater at the S. Myrtle Street Embayment, only two contained detectable quantities of PCE breakdown products. One module contained *cis*-1,2-DCE, while the second contained *cis*-1,2-DCE, *trans*-1,2-DCE, VC and 1,1-dichloroethane. Both of these modules were located adjacent to seeps (i.e., S-2 and S-1) that have been identified during the RI as discharge points for groundwater impacted by GWI site VOCs. A detailed discussion of the sampling effort and results are presented in Appendix D.

4.3.1.7 Ambient Air

<u>Indoor Air</u>

At the GWI Facility change room and office, concentrations of chlorinated ethenes and ethanes detected in indoor ambient air samples, collected at 1 foot and 5 feet above the floor, are similar. For example, the concentrations of methylene chloride near office floor and in the breathing zone were 14 ug/m^3 (July 12 sampling event). Similarly, the concentration of PCE in the change room near the floor was 55 ug/m^3, while the concentration near the breathing zone was 60 ug/m^3. Analytical results are presented in Appendix I.

At present it has not been determined whether the presence of chlorinated ethenes and ethanes detected in indoor air sample results from the release of these compound from the underlying vadose zone or groundwater, or results from the presence of the compounds in the building, given that solvents are stored on the premises. The GWI Facility's ventilation system is currently under review to evaluate how air is drawn into the building and how it moves within the building.

Although concentrations of methylene chloride and several chlorinated ethenes are above the conservative screening criteria used to designate PCOCs in this section, their concentrations are several orders of magnitude below NIOSH/OSHA criterion for industrial facilities handling these chemicals.

<u>Outdoor Air</u>

PCE was the only chlorinated ethenes detected in outdoor ambient air samples; its downgradient concentration is higher than its upgradient concentration. Chlorinated ethanes were not detected. Methylene chloride was detected in all outdoor locations; concentrations were between 2.6 and 8.5 ug/m3, and between 7.9 and 8.4 in source area and downgradient locations.

4.3.2 PETROLEUM HYDROCARBONS AND THEIR CONSTITUENTS

4.3.2.1 Original Source Area

The original source area for petroleum hydrocarbons and their constituents at the GWI site has been identified as the old tank farm area. Gasoline, diesel, and a variety of petroleum solvents were stored in the USTs in this area at various times prior to their decommissioning. Additionally, a small, leaking, heating oil tank was located near B-10A. All of the USTs in the former tank farm areas have been removed or decommissioned. Based on product usage, the most likely petroleum products released would have been heating oil (a light-end petroleum product similar to kerosene) and various petroleum solvents. In addition to the petroleum products, toluene and xylenes were also handled at the GWI Facility and stored in various USTs. Consequently, they may be present in soil and/or groundwater either because they were stored and handled as products themselves, or because of their presence in light-end petroleum products.

The 1999 groundwater monitoring discovered a petroleum LNAPL in Monitoring Well B-38, located to the south of the GWI Facility along S. Myrtle Street, just south of where Tyee Lumber operated the PCP dip tank discussed in Section 2. The LNAPL was analyzed via HCID to determine the identity of its petroleum products. Although the LNAPL was weathered, it appeared that it was a mixture of mineral spirits and diesel no. 2. This would be consistent with the mixture that Tyee reportedly used in the dip tank. This source area is more than 200 feet south of the GWI Facility.

4.3.2.2 Soil and Soil Vapor

Analyses for various petroleum products have been performed on 79 soil samples collected during the investigation of the GWI site. Analyses for petroleum-range products have included Stoddard's solvent, mineral spirits, thinner, light hydrocarbons, gasoline, diesel, and motor-oil, as well as others. For the purposes of this report, results reported as light hydrocarbons include all petroleum based fuels and solvents lighter than diesel fuel No.2. This category petroleum hydrocarbons was developed to capture historical results for petroleum hydrocarbon fuels and solvents that could not be positively identified because of productweathering.

Six samples were collected during decommissioning of tanks in the old and main tank farm areas and analyzed for Stoddard's solvent and mineral spirits. One sample (21-C on Figure 4.1) collected from beneath Tank 21 had Stoddard's solvent and mineral spirits concentrations of 2,200 and 1,800 mg/kg, respectively (Table 4.16). These compounds were detected at concentrations less than 15 mg/kg in the other five samples.

Additional samples were collected from soil borings and trench excavations during the decommissioning of the UST tank farms and removal of piping west of the drum shed. Sample stations were established in the former location of the pump equipment storage area (Stations SB-1 through SB-9 and PT-1 through PT-5) and around the perimeter of this area (Stations B-7 and B-10 through B-14) (Figure 4.1). The samples from these stations were analyzed for Bunker C, oil, diesel no. 2, kerosene/Jet A, and light hydrocarbons; however, only light hydrocarbons were detected. Light hydrocarbons also were detected in samples collected from the pipe trench excavations (PT-2 through PT-5) and soil borings in or adjacent to where pipes were removed (SB-1 and SB-3 through SB-5) (Table 4.17). Samples from these same stations also had PCE, TCE, and methylene chloride concentrations (quantified using a method specific to chlorinated compounds) that exceeded the Method B soil screening standards. The GC method used to analyze for petroleum hydrocarbons is not specific for the petroleum hydrocarbons; rather it will quantify all carbon-containing compounds with a similar boiling point range. Therefore, the light hydrocarbon "concentration" includes both TPH and other volatile organics including the PCE, TCE, and methylene chloride.

Additional investigation was performed to characterize the nature and extent of contamination upon completion of UST decommissioning activities. Petroleum hydrocarbons were detected in samples collected from soil borings at the GWI Facility and on adjacent properties and right-of-ways during this investigation.

Petroleum hydrocarbons were detected in soil at two upgradient sample stations. At Station B-24, petroleum hydrocarbons in the diesel and motor oil range were detected at a depth of between 7.5 and 12 feet bgs (Table 4.18). These hydrocarbons were detected at concentrations between approximately 200 to 12,500 mg/kg. This station is directly across E. Marginal Way from two known leaking UST sites with petroleum releases (Section 3.3). At Station B-28, along S. Willow Street across from the railroad tracks, gasoline, diesel, and motor oil-range hydrocarbons were detected in surface soil at concentrations up to approximately 1,000 mg/kg.

Analyses of soil from Stations B-29, B-30, and B-31 indicate that petroleum products are present at the former location of the pump equipment storage area on the GWI Facility. At Stations B-30 and B-31, petroleum hydrocarbons ranging from thinner to motor oil were detected. The light hydrocarbons were detected at concentrations up to approximately 3,500 mg/kg. The detection of light hydrocarbons is consistent with the presence of solvents in soil in this area. Motor oil-range hydrocarbons were detected at concentrations up to approximately 4,000 mg/kg. The detection of motor oil and diesel in samples from this area contradicts the results of analyses conducted during decommissioning of the tank farms. Much of the later data were qualified (N qualifier), indicating that the product was only tentatively identified.

Petroleum hydrocarbons in the gasoline to motor oil-range were also detected at Stations B-2 and B-3. (Monitoring Well B-10A was completed in this area.) Gasoline-range hydrocarbons (probably the light-end of the heating oil range) were detected at concentrations up to 6,500 mg/kg in soil on top of the 1st SH.

The BTEX family of compounds was either not detected, detected infrequently (in five percent or less of soil samples), or were detected at concentrations less than the Method B residential soil screening standard in soil samples (Section 4.2.1). No LPAH was detected at levels greater than Method B cleanup standards in soil samples.

Soil Vapor

For the April 17, 2000 soil vapor sampling event, toluene and/or benzene were the only petroleum hydrocarbons detected in soil vapor. Benzene and toluene were typicaly detected at depths of less than 1.5 feet bgs. Benzene was detected at station VP11 only. Toluene was detected at stations VP11, VP52, VP44, and VP58 (Figure 4.6).

Benzene and toluene soil vapor results do not coincide with groundwater sample results. Only one groundwater sample collected at well B-44 contained toluene. Toluene was detected in soil vapor probe VP44 at depth of 1 foot bgs; however, toluene was not detected in soil vapor collected nearest the water table (i.e., 8 feet bgs). Benzene was not detected in groundwater samples, but was detected in soil vapor probe VP11 at depth of 0.25 feet bgs. Ethyl benzene and xylenes were detected in the groundwater sample collected from well B-10A, but were not present in soil vapor samples collected from soil vapor probe VP10A.

The lack of agreement between soil vapor and groundwater results cannot readily be explained. The fact that benzene and toluene were detected only in near surface soil vapor samples could possibly be attributed to near surface petroleum contaminated soil or a poor surface seal around the soil vapor probe which allowed ambient air containing benzene and tolueneto be drawn into the soil column.

4.3.2.3 Ambient Air

Indoor Air

BTEX concentrations, detected in one indoor ambient air sample collected in GWI Facility change room and office, were similar at 1 foot and 5 feet above the floor (July 12, 2000 sampling event). For example, the concentrations of benzene near the office floor and in the breathing zone were both 4.7 ug/m^3. The benzene concentration in the change room for the June 9, 2000 sampling event was 9.8 ug/m^3 near the floor. Analytical results are presented in Appendix I.

At present it has not been determined whether the presence of BTEX detected in indoor air sample results from the release of these compound from the underlying vadose zone or groundwater or from an area background concentration for the GWI Facility. At present the GWI Facility's ventilation system is under review to determine what role it might play in the nature and extent of BTEX detected in the office and the change room.

Outdoor Air

BTEX was detected in outdoor ambient air samples collected at both upwind and downwind stations and at well B-58. The concentrations of BTEX in upwind and downwind ambient air sample were similar. For example the upwind ambient sample collected near well 20A had a benzene concentration of 3 ug/m^3, while the downwind sample had benzene concentration of 2.0 ug/m^3. The highest concentration of benzene was reported at ambient air sample No. 3 collected near well B-58 (4.0 ug/m^3).

Applicability of MTCA Method C CULs

With the exception of benzene, concentrations of toluene and ethyl benzene in indoor and outdoor ambient air samples were less than applicable MTCA Method C ambient air CULs (Table 6.2); and, all the concentrations, including benzene, are well below NIOSH and OSHA levels of concern.

4.3.2.4 Groundwater and Seeps

Petroleum contamination of groundwater at the GWI Facility follows a pattern (with some exceptions) similar to that seen for chlorinated ethenes and ethanes:

- There is no source area for petroleum hydrocarbons at B-15 beneath the tank shed, so groundwater contamination is first noticeable near the secondary source area between the west shed (and its piping) and Monitoring Well B-12.
- A source appears to exist in the area of B-10A, close to where the heating oil UST was located.
- Dissolved components of petroleum hydrocarbons follow the same path as the chlorinated ethenes; that is, BTEX/TPH dissolved components in the 1st WBZ between B-58 and B-10A remain in the 1st WBZ and travel toward the river. In general, concentrations of BTEX and TPH are not detectable by the time this water reaches the river (occasional detection of toluene at concentrations considerably less than applicable criteria are seen in B-34).

- Dissolved components of petroleum hydrocarbons in the 1st WBZ south of B-58 drop into the hole at Fox Avenue S. and continue toward the river in the 2nd WBZ. The only measurable component reaching the river is benzene in the seep.
- Toluene concentrations are especially high in the hole in the 1st SH at Fox Avenue S., but decrease rapidly between the hole and the river.
- BTEX was not detected in wells installed north of the GWI Facility along S. Willow Street (i.e., B-53 through B-57, B-6, and B26 through B-28). Groundwater samples from these wells were not analyzed for TPHs. However, since indicators of dissolved petroleum hydrocarbon components were not detected in volatile and semi-volatile analyses of the groundwater samples, there is no indication that petroleum hydrocarbons are present in the groundwater along S. Willow Street.

4.3.2.5 Sediment

Sediment samples were not analyzed using methods for quantifying petroleum products; however, they were analyzed for volatile and semi-volatile aromatic constituents of petroleum products. Sediment collected from Station DR116 was analyzed for VOCs, including the BTEX family of compounds. No VOC was detected in this sediment sample (Section 4.2.1).

All four sediment samples were analyzed for SVOCs, including the PAHs found in petroleum products.

The only PAH detected in groundwater at the GWI site was naphthalene; naphthalene was not detected in any sediment sample. Several other LPAHs were detected in the sediment samples collected in and adjacent to the S. Myrtle Street Embayment and adjacent to the SBW and Othello properties. The detected concentrations of LPAHs in the sediment samples were less than the SMS SQS.

Multiple HPAHs were detected in the sediment samples collected in or adjacent to the S. Myrtle Street Embayment. The detected HPAHs in these sediment samples also were detected throughout the Duwamish River (Weston, 1999). The HPAHs detected are not associated with the lighter petroleum solvents and fuels used at the GWI Facility, and HPAHs have not been detected in groundwater at the site. The detected concentrations of HPAHs in the sediment samples collected in and adjacent to the S. Myrtle Street Embayment were less than regulatory criteria (SMS and SQS).

4.3.2.6 Sediment Porewater

The 43 GORE-SORBER® screening modules installed in sediment at S. Myrtle Street Embayment were not analyzed for BTEX and other related fuel related petroleum hydrocarbons.

4.3.2.7 Mussel Tissue

Mussels tissues collected over the last 2 years have been analyzed for BTEX. No BTEX has been detected in these samples.

4.3.3 CHLORINATED PHENOLS

Penta is the chlorinated phenol detected most frequently at the GWI site. It is detected in both soil and groundwater. Several other chlorinated phenols are also detected, but at much lower concentrations and frequencies. They are co-located with the penta, which is consistent with their presence in technical grade penta and their formation as degradation products of penta. The occurrence of penta at the site is consistent with its mixing and sale on the GWI Facility, and its use for wood treatment at the adjacent historical Tyee Lumber Facility.

4.3.3.1 Original Source Areas

Two original source areas were identified for penta. The first penta source area is located on the south central portion of the GWI Facility adjacent to the Frontenac Street right-of-way, and is shown in Figure 4.8. The source include the penta storage and handling areas at GWI and the adjacent swale along Frontenac Street; specifically, the following original source areas are included:

- Penta bulk storage in UST No. 22 located beneath the west-end of the drum shed.
- Penta mixing with petroleum spirits in the area west of the drum shed.
- Penta/petroleum spirit mixture storage in the AST located west of the drum shed.
- The swale along the Frontenac street right-of-way and the parallel railroad spur, where storm water runoff from both the former penta drumming area and large sections of the Tyee property collected and infiltrated.

Penta handling at the GWI Facility began in approximately 1966 and ended in the early 1980s. No penta has been stored or handled at the GWI Facility since about 1985. The second source area is outside of the GWI site and was inadvertently identified during the installation of the groundwater well pair B-38 and B-39. These wells were installed to represent background, upgradient groundwater conditions, but have since been determined to be cross-gradient to the site, and contaminated with dissolved penta and petroleum spirits and with a free floating product consisting of approximately five percent penta in petroleum spirits. This second penta source area is located near the dip tank at the former Tyee Lumber Facility adjacent to S. Myrtle Street (Figures 2.5 and 4.8). This source area includes the previous location of a wood-treating dip-tank in which lumber was "dipped" into the penta/petroleum spirits treating solution to preserve the wood. Additionally, the area included a UST for stored penta which was removed from the former Tyee Lumber Facility in 1986 (Section 2.1.2.1).

4.3.3.2 Soil

Analyses for chlorinated phenols (penta, 2,4-dichlorophenol, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, and tetrachlorophenol) were performed on 60 soil samples. Another 50 soil samples were analyzed for penta only. These 110 soil samples were collected at various depths from 0.5 to 49.5 feet bgs from 49 stations on and surrounding the GWI Facility. They included samples from the vadose zone, the 1st WBZ and the 2nd WBZ.

Soil samples were analyzed for chlorinated phenols using two methods: semi-volatile analysis using EPA Method 8270 and chlorinated phenols analysis using EPA Method 8040. EPA Method 8270 is the more accurate method for samples with multiple contaminants and moderate to high concentrations because it uses a mass spectral detector to confirm identification of the detected compound. EPA Method 8040 is the more sensitive method with a significantly lower detection limit, but is prone to false positives and high bias in the presence of other chlorinated organics.

Analyses for dioxins and furans were performed on three soil samples collected from Station B-30 and B-31. Dioxins and furans are by-products of the manufacture of penta. The samples analyzed for dioxins and furans were collected from stations in the penta original source area at the GWI Facility.

Pentachlorophenol. Penta was detected in approximately 40 percent of soil samples analyzed for penta. Penta concentrations detected in soil samples ranged from 0.0022 to 29 mg/kg. Results are summarized in Table 4.19.

The highest penta concentrations detected in soil samples were used to define the source areas further. Penta concentrations detected in soil samples collected from stations in the original source area on the GWI property (B-15, B-30, B-31, SB-10, and SB-11) ranged from 0.0047 to 29 mg/kg (Table 4.19 and Figure 4.8). The highest penta concentration was detected in near-surface soil (from 2.5 to 4.0 feet bgs) collected from Station SB-10. Station SB-10 is located west of the drum shed where penta drumming operations had previously occurred. The only samples with exceedances of the MTCA Method B screening level were in Borings SB-10, SB-11, and B-30. The exceedances in SB-11 and B-30 were at the water table at greater than 10 feet bgs.

Two samples collected from stations adjacent to the source area on the former Tyee Lumber Facility (B-37 and B-38) had penta concentrations of 2.7 mg/kg. The deeper of these two samples was analyzed using both methods for penta. EPA Method 8040 yielded a result of 71 mg/kg for penta near the water table. While it is possible that this result is a false positive, it is consistent with subsequent groundwater results. The Method 8040 result exceeds the MTCA Method B screening level. Samples collected from the closest adjacent stations (B-18 and B-19) had penta concentrations considerably less than 1.0 mg/kg.

All penta concentrations detected in soil were considerably less than the MTCA Method C Industrial soil cleanup level of 1,090 mg/kg.

Other Chlorinated Phenols. Chlorinated phenols other than penta include 2,4-dichlorophenol, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, and tetrachlorophenol. The compound 2,4-dichlorophenol was detected in 16 of 110 soil samples. The other chlorinated phenols were only detected in three to five soil samples (Table 4.19). Chlorinated phenols other than penta were only detected using EPA Method 8040. The reported concentrations were lower than the detection limit provided by analysis using EPA Method 8270. All detected concentrations of other chlorinated phenols were between two and five orders of magnitude less than the MTCA Method B screening standards.

Dioxins and Furans. Dioxin and furan analyses were performed on two samples collected from Station B-30 and one sample from Station B-31. Results are summarized in Table 4.20. The samples from Station B-30 were from the surface (0 to 0.5 feet bgs) and from the 1st SH

(14.5 to 16 feet bgs). The sample collected from Station B-31 was collected from soil comprising the 1st SH and soil just above the silt (10.5 to 12 feet bgs).

In general, the dioxin and furan concentrations for the surface soil sample collected from Station B-30 were greater than concentrations detected in the sample collected from the 1st SH. The concentrations in the 1st SH sample are generally 85 percent or less of the concentrations in the surface sample. Conversely, the penta concentration in the sample collected from the 1st SH was four times the concentration of the penta concentration detected in the sample collected at the surface. These results are consistent with a portion of the dioxins and furans that were present in penta that was released at the surface being adsorbed to surface soil.

Fewer dioxin and furan congeners were detected and the detected concentrations were substantially lower in the sample collected from Station B-31.

The 2,3,7,8-TCDD equivalence was calculated for each sample using the Total Equivalence Factors established by EPA (EPA 1994 and 2000). The 2,3,7,8-TCDD equivalence concentrations were then compared to MTCA Method B residential and Method C industrial cleanup levels for 2,3,7,8-TCDD for screening purposes. The 2,3,7,8-TCDD equivalence concentrations at Station B-30 exceeded the Method B cleanup level of 6.67 pg/g for 2,3,7,8-TCDD, but were an order of magnitude less than the Method C cleanup level of 875 pg/g (Ecology 1996). The 2,3,7,8-TCDD equivalence concentrations at Station B-31 was less than the Method B cleanup level.

The 2,3,7,8-TCDF equivalence was calculated for each sample using the Total Equivalence Factors established by EPA (EPA 1994 and 2000). The 2,3,7,8-TCDF equivalence concentrations were then compared to MTCA Method B residential and Method C industrial cleanup levels for furans for screening purposes. The 2,3,7,8-TCDF equivalence concentrations at Station B-30 and B-31 were less than the Methods B and C cleanup levels of 80 mg/kg and 3,500 mg/kg (Ecology 1996

4.3.3.3 Groundwater and Seeps

Groundwater samples were analyzed for chlorinated phenols using EPA 8270C. Selected samples also were analyzed for penta using EPA Method 8270C with selective ion monitoring in order to achieve lower detection limits. Results are summarized in Tables 4.21 and 4.22 and plotted for the 1st WBZ in Figure 4.9. The locations of two source areas are evident in the figure. The first source area exists along the Frontenac Street right-of-way from B-11 by the drum shed to the edge of the 1st SH at Monitoring Well B-45. Multiple sources existed in this area and contributed to the elongated shape along the right-of-way. Subsequent movement of the penta in groundwater has followed the direction of groundwater flow (toward the river, with downward flow components in the area of the hole in the 1st SH).

The second source area by the former Tyee dip tank also is evident in both groundwater concentrations and in the presence of LNAPL containing approximately five percent penta. Contamination from the two source areas is separated by an area of unimpacted groundwater defined by B-19, B-62, B-63, B-20A, and B-21.

Penta releases to the subsurface are believed to have occurred in the 1970's and early 1980's (approximately 20 years ago), giving them sufficient time to have reached steady state conditions. Concentrations decrease up to three orders of magnitude 300 feet from the source; for example, concentrations near B-12 are between 300 and 500 µg/L, while concentrations at B-58, approximately 100 feet downgradient, are between five and 10 µg/L. Likewise, concentrations in B-38 are at 5,500 µg/L with a source of five percent penta floating on the water table, yet concentrations drop to between 0.37 and 6.5 µg/L within 300 feet as groundwater flows toward the river.

Groundwater wells nearest the river (B-33A, B-34, B-64, and B-65) contain no detectable penta, even at the lower detection limit of 0.5 µg/L. These wells are downgradient from both sources.

Seeps samples have been collected and analyzed annually for penta and other chlorinated phenols since 1990. No penta or any other chlorinated phenol has ever been detected in the seeps. In the 1999 annual groundwater monitoring event, the seeps samples were analyzed with EPA Method 8270 with selective ion monitoring to lower the detection limit to 0.5µg/L (an order of magnitude less than the MTCA surface water standard). No penta was detected even with this lower detection limit.

4.3.3.4 Sediment and Mussels

Sediment. Chlorinated phenols were not detected in the four sediment samples collected from stations located in or adjacent to the S. Myrtle Street Embayment. Dioxins and furans were detected in one sample analyzed for these compounds (Appendix E).

Dioxin and furan analysis indicated the presence of specific dioxins and furan congeners including 1,2,3,4,6,7,8-HpCDF, 1,2,3,6,7,8-HxCDD, and 1,2,3,4,6,7,8-HpCDD as well as the presence of other dioxin and furan congeners as indicated by detected total concentrations of dioxin and furan congener groups. The 2,3,7,8-TCDD equivalence concentration for this sample (4.8 pg/g) was less than the screening standard used by the EPA for evaluation of sediment in the Duwamish River (10 pg/g) (Weston 1999).

For the EPA investigation of Duwamish River sediment, 30 sediment samples were collected from stations between Harbor Island and the Upper Turning Basin of the Duwamish River. Furans and/or dioxins were detected in all 30 sediment samples analyzed for these compounds. In general, the EPA investigation indicates that dioxins and furans are present in Duwamish sediment throughout the industrialized portion of the river. Additionally, the investigation indicates that the concentrations of dioxins and furans increase the farther down stream the sediment sample was collected.

Mussels. Mussels have been collected annually from the S. Myrtle Street Embayment since 1994 as part of the ongoing annual monitoring at GWI. The only detection of penta in mussels occurred in sample M-1 in 1999. The concentration was 76 µg/kg. Given the absence of penta in groundwater near the S. Myrtle Street Embayment, in seeps, in sediment, and in previous tissue samples, this anomalous detection suggests that the wood pilings on which the mussels are growing have been treated with some product containing penta.

4.3.3.5 Sediment Porewater

The 43 GORE-SORBER® screening modules installed in sediment at S. Myrtle Street Embayment were not analyzed for chlorinated phenols.

4.3.3.6 Soil Vapor

Soil vapor samples were not analyzed for chlorinated phenols.

4.3.3.7 Ambient Air

Ambient air samples were not analyzed for chlorinated phenols.

4.3.4 DICHLOROBENZENES

4.3.4.1 Original Source Area

The source area for the dichlorobenzenes at the GWI Facility is unknown, but likely was historically associated with the location of the drum shed and associated underground piping near S. Frontenac Street. As discussed in Section 4.3.1.1, these areas have undergone significant IRMs, including decommissioning of USTs and piping, and removal of portions of the contaminated soil. Although residual contamination exists in the vadose zone and the underlying saturated soil, there is no ongoing operational source of these compounds, as all of the USTs in the former main tank farm have been decommissioned. None of the residual contamination exceeds Method B screening levels.

One of the DCBs, 1,4-dichlorobenzene, exceeds the MTCA Method B screening level in groundwater. Its maximum concentration is in Monitoring Well B-42, in the central section of the secondary source area in the 1st SH. It is assumed that the area near B-42 represents a residual source to groundwater for 1,4-DCB.

4.3.4.2 Groundwater and Seeps

Groundwater samples were analyzed for the dichlorobenzenes using both EPA 8260B and EPA 8270C. EPA 8270C generally had detection limits of 0.5 μg/L. Results are summarized in Table 4.21 for the central area wells, and in Table 4.22 for the wells west of Fox Avenue S.

Monitoring Well B-42 has the highest concentrations of 1,4-DCB (120 μg/L vs. a Method B screening level of 1.82 μg/L). However, concentrations rapidly decrease downgradient of this location. As groundwater moves toward the Duwamish River the concentrations drop to less than 5 μg/L at B-21 at the hole and less than 2 μg/L at B-58. This trend continues until 1,4-DCB concentrations are less than the detection limit of 0.5 μg/L along S. Myrtle Street (Monitoring Wells B-35, B-36, B-65 and B-64) and beside the S. Myrtle Street Embayment (Monitoring Wells B-33A and B-34.) No 1,4-dichlorobenzene was detected in any of the seeps.

4.4 CHEMICAL INDICATORS OF NATURAL ATTENUATION AT THE GWI SITE

Concentrations of PCE and its degradation products indicate that a substantial portion of the PCE plume at the GWI site is degrading between the original source area and the Duwamish River. The degradation of PCE in groundwater is a well-documented process involving several microbial and chemical steps. In order to make appropriate remedial decisions, it is critical to evaluate the degradation processes at the site. This evaluation was accomplished by collecting physical and chemical information to develop a conceptual model of the site conditions and the influence that those conditions have on PCE degradation.

In 1998 and 1999, Terra Vac conducted two annual groundwater sampling events at the GWI site to evaluate the degradation of PCOCs in groundwater. The objectives of these sampling events were to identify whether the 1st and 2nd WBZs are capable of degrading PCOCs over time and whether natural attenuation should be considered an active part of any remediation alternative selected for the GWI site.

This section of the SRI describes the findings from the two sampling eventsand discusses the evidence showing that natural attenuation is occurring at the GWI site. Table 4.23 lists the information that was gathered for this study and its intended purpose. Table 4.24 lists the analyses performed to evaluate natural attenuation during the 1999 annual groundwater monitoring event. Appendix J discusses the results ofthe natural attenuation analyses. Section 5.3.2 of the SRI discusses this data with respect to the impact naturalattenuation has on the fate and transport of the PCOCs in the 1stand 2nd WBZs.

4.4.1 1998 INVESTIGATION

Terra Vac performed an initial natural attenuation assessment at the GWI site in 1998 to determine if natural attenuation was occurring in the groundwater. In addition, the results from this sampling were used to develop a more comprehensive plan for access natural attenuation at the GWI site.

As part of the 1998 assessment, groundwater samples were collected from the following wells:

Well	Location
B-24	Upgradient
B-25	Upgradient
B-8	Secondary Source Area
B-44	Secondary Source Area
B-20	Fox Avenue S.
B-21	Fox Avenue S.
B-19	Fox Avenue S.
B-35	S. Myrtle Street
B-36	S. Myrtle Street
B-33A	S. Myrtle Street
B-34	S. Myrtle Street

The samples collected from each of these wells were tested for the analytes listed in the table below.

Analytes	**Test Method**
Volatile Organic	EPA Method 8260b
Semi-Volatile Organics	EPA Method 8270c
Total Organic Carbon	EPA Method 415.1
Metabolic Gases	EPA Method 8015 Modified
Ferrous Iron	Hach Method # 8146
Total Iron	Hach Method # 8008
Ammonia	Hach Method # 8038
Nitrate	Hach Method # 8171
Nitrite	Hach Method # 8507
Sulfate	Hach Method # 8051
Sulfide	Hach Method # 8131
Phosphorus, reactive	Hach Method # 8048
Chloride	Hach Method # 8113
Dissolved Oxygen	Hach Method # 8166
Temperature	Field Probe
pH	Field Probe
Specific Conductance	Field Probe
Oxidation-Reduction Potential	Field Probe

Results for the volatile and semi-volatile analyses and metabolic gases are included in Appendix E.

4.4.2 1999 INVESTIGATION

Terra Vac expanded the natural attenuation study to further understand the nature and extent of degradation occurring within the 1st and 2nd WBZs. During the 1999 annual groundwater sampling event, natural attenuation assessment samples were collected from wells listed in the table below.

Well Numbers	**Location**
B-24, B-25, B-26, B-27, B-28 and B-6	Upgradient
B-1, B-14, B-15, B-16 and B-17	Original Source Area

Well Numbers	Location
B-8, B-9, B-10A, B-11, B-12, B-31, B-39, B-42, B-44, B-45, B-46, B-47, B-49, B-50 and B-52	Secondary Source Area
B-13, B-22, B-23, B-53, B-54, B-55, B-56 and B-57	Northwest Corner
B-20A, B-21, B-37, B-38, B-58, B-59, B-60, B-61, B-62 and B-63	Downgradient along Fox Avenue S.
B-33A, B-34, B-35, B-36, B-64 and B-65	Downgradient along S. Myrtle Street

Groundwater samples were analyzed for the same parameters collected during the 1998 event. The samples collected in 1999 were submitted to a contract laboratory for analysis of all inorganic constituents except ferrous iron and sulfide, which were analyzed in the field immediately following sample retrieval.

Results for volatile and semi-volatile analytes and metabolic gases are included in Appendix E. Results for ferrous iron, sulfide, and field parameters (e.g., pH, DO, etc.) are also included in Appendix J.

4.4.3 DISSOLVED OXYGEN AND REDOX POTENTIAL

Concentrations of dissolved oxygen (DO) and oxidation-reduction potentials (Redox) in groundwater can be used as indicators to determine whether the dissolved chlorinated ethenes will degrade under the biologically mediated process known as reductive dechlorination. The Redox potential in shallow aquifers, like the 1st WBZ, is influenced by microbial activity which is affected by availability of nutrients (e.g., nitrogen and phosphorous), dissolved oxygen and carbon sources (e.g., petroleum hydrocarbons and native carbon). Bacteria use carbon as energy sources, causing the release of enzymes that transform the chlorinated compounds. This activity influences redox conditions and the availability of electron acceptors (e.g., oxygen, nitrate, sulfate, ferric iron, and carbon dioxide) and donors (e.g., carbon) present in the groundwater, and also greatly influences the transformation of chlorinated ethenes. For this reason, the nature and extent of dissolved oxygen and Redox at the GWI site were evaluated during the 1999 annual groundwater sampling event.

4.4.3.1 Dissolved Oxygen

Dissolved Oxygen in the1st WBZ

The 1st WBZ at the GWI site receives a substantial infiltration of rainfall during the winter months resulting in increases in groundwater elevations and in DO concentrations. Areas both north and east of the GWI facility are unpaved and receive infiltration from stormwater run-off from roadways and roofs. This results in local recharge and oxygen inputs to the 1st WBZ. However, there are several sources of DO demand present within the subsurface soils and 1st WBZ groundwater which deplete oxygen, including the following:

- Known releases of petroleum hydrocarbons from both the GWI facility and other adjacent facilities. These releases have resulted in elevated concentrations of BTEX compounds, ketones, and fuel hydrocarbons, all of which contribute to the depletion of DO levels in the 1st WBZ, both in and downgradient of the GWI secondary source area. During the biodegradation of these hydrocarbons, dissolved oxygen is reduced to water and dissolved oxygen concentrations decrease.

- The presence of reduced chemical species (e.g., Fe^{+2}, NH_4^+ and Mn^{+2}) is expected to create an oxygen demand in the groundwater at the site. These anions react with oxygen to form more oxidized species {e.g., Fe $(OH)^{+2}$ and NO_3^-}.
- Naturally occurring organic matter (OM) is present in the alluvial deposits comprising the 1st WBZ. This OM is mostly composed of partially decayed solid plant matter and peat deposits. In addition, some of the naturally occurring OM is dissolved in the groundwater. In the presence of dissolved oxygen, these materials undergo further decay, which consumes oxygen.

DO concentrations in the 1st WBZ, as measured during the 1999 annual sampling event, are summarized below. This data is also depicted in Figure J.07 of Appendix J.

Well	Location	DO Conc. Range (mg/L)	Mean DO Conc. (mg/L)
B-24 and B-26	Upgradient	0.1 – 0.18	0.14
B-16	Original Source Area	0.33	0.33
B-10A, B-42, B-44, B-46, B-47, B-49 and B-52	Secondary Source Area	0.13 – 0.92	0.46
B-13, B-22, B-28, B-53, B-54, B-55, B-56 and B-57	Northwest Corner	0.14 – 2.31	0.95
B-18, B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	0.01 – 1.6	0.68
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	5.63 – 10.41	8.51

From the data presented in the table above, the nature and extent of DO in the 1st WBZ is as follows:

- The concentration of DO upgradient of the GWI source area in the vicinity of wells B-24 and B-26 was low, indicating anoxic groundwater conditions. This conclusion is further supported by elevated levels of methane present in these wells (see section 4.4.2.2). The low DO in this area of the site probably results from high levels of OM in soil that supports microbial activity and therefore the consumption of DO.
- Concentrations of DO in the secondary source area increase slightly relative to background concentrations. This increase may have resulted from oxygen in the head-space above the water column entering the sample because some wells contained less than one foot of water when sampled. However, the data could indicate a source of dissolved oxygen exists for the secondary source.

- Downgradient of the secondary source area, in the vicinity of Fox Avenue S., DO concentrations in the 1st WBZ wells at B-20A, B-58, B-60, and B-62 are higher than those in the secondary source area. This increase in DO levels, relative to the secondary source area, may result of from an influx of groundwater with higher DO. The groundwater probably flows into this location in response to the steep downward vertical groundwater gradients in this area (e.g., the hole in the 1st SH). However, similar conditions would result if there was a lower degree of biological activity due to fewer carbon sources in the groundwater.
- Near the S. Myrtle Street Embayment of the Duwamish River, DO concentrations in the 1st WBZ increased sharply in wells B-64 and B-34 to 10.41 and 9.48 mg/L, respectively. These increases presumably result from the tidally influenced groundwater flow reversals and introduction of oxygenated surface water from the Duwamish River.
- The concentrations of DO in the northwest corner wells B-13, B-22, B-28, and B-53 through B-57 was variable. DO concentrations in these wells probably represent area background for the northwest corner of the GWI site.

Dissolved Oxygen in the 2nd WBZ

DO concentrations within the 2nd WBZ are influenced to a lesser degree by local groundwater recharge or surface water infiltration (except in the vicinity of the hole in the 1st SH at Fox Avenue S.) and therefore are less variable beneath the GWI site. The 2nd WBZ contains DO levels which are consistently lower than those in the 1st WBZ (see Figures J.07 and J.08 of Appendix J).

DO concentrations in the 2nd WBZ, as measured during the 1999 annual sampling event, are summarized below. This data is depicted in Figure J.08 in Appendix J.

Well	Location	DO Conc. Range (mg/L)	Mean DO Conc. (mg/L)
B-6, B-25 and B-27	Upgradient	0.1 – 0.29	0.20
B-17	Original Source Area	0.33	0.33
B-9 and B-45	Secondary Source Area	0.08 – 0.27	0.18
B-19, B-21, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	0.1 – 0.53	0.34
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	0.38 – 5.77	3.79

From the data presented in the table above, the nature and extent of DO in 2nd WBZ is as follows:

- DO in groundwater at upgradient wells B-25 and B-27 is depleted, which suggests that anoxic conditions are present. DO levels at these wells probably represent upgradient background concentrations for the 2nd WBZ.

- Within the original source area, the DO concentration in well B-17 was slightly higher compared to background concentrations. This slight increase may be attributed to local variability in the background DO concentration.
- DO concentrations within the secondary source area are slightly lower than background concentrations, but begin to increase downgradient of the secondary source area, along Fox Avenue S. This increase is presumed to result from oxygenated water from the1st WBZ entering the 2nd WBZ at the hole in the 1st SH.
- Near the S. Myrtle Street Embayment of the Duwamish River, DO concentrations in the 2nd WBZ increased in wells B-35 and B-65 when compared to the GWI source areas. However, at well B-33A (nearest the Embayment), DO concentrations are similar to source area and background concentrations. The increase in DO concentrations at B-35 and B-65 can be attributed to the infiltration of surface water from the Duwamish River. The decrease in DO concentration at well B-33A is likely due to the influx of dissolved OM carried into the 2nd WBZ during tidally induced groundwater flow reversals.

No information is available for DO conditions for the 2nd WBZ groundwater in the northwest corner of the GWI site since no monitoring wells screened in the 2nd WBZ are located in this area of the site.

4.4.3.2 Redox Potentials

Redox Potentials in the 1st WBZ

Redox potentials in the 1st WBZ as measured during the 1999 annual sampling event are summarized below. This data is also depicted in Figure J.09 of Appendix J.

Well	Location	Redox Potential Range (mV)	Mean Redox Potential (mV)
B-24 and B-26	Upgradient	81 to -76	2.5
B-16	Original Source Area	6	6
B-10A, B-42, B-44, B-46, B-47, B-49 and B-52	Secondary Source Area	4 to –56	0
B-13, B-22, B-28, B-53, B-54, B-55, B-56 and B-57	Northwest Corner	65 to 230	152
B-18, B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	192 to -42	75
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	211 to -32	100

From the data presented in the table above, the nature and extent of redox conditions in the 1st WBZ is as follows:

- The Redox potentials measured in the 1st WBZ groundwater were typically lower where petroleum hydrocarbon impacts are present (e.g., at wells B-10A, B-36, B-38, B-47, and B-58). Bacteria are using the petroleum hydrocarbons as energy sources, which in turn, results in reducing conditions and low Redox potentials. These bacteria aid in the transformation of chlorinated ethenes.

- Groundwater at upgradient well B-26 contained a negative Redox potential. This well is located upgradient of the GWI source area along S. Willow Street in an area that contains high levels of organic carbon.
- Redox potentials declined in wells B-10A, B-42, B-44, B-46, B-47, B-49, and B-52 when compared to upgradient Redox potentials. These declines again result from the presence of petroleum hydrocarbons and other labile carbon sources (e.g., ketones and alcohols) supporting aerobic bacterial consumption of DO.
- Along Fox Avenue S. and downgradient of the original and secondary source areas, Redox potentials in the 1st WBZ increase compared to those in the source areas. This increase in Redox potential results from mixing with 2nd WBZ groundwater at the hole in the 1st SH. This mixing, and the resulting dilution, lowers the dissolved hydrocarbon load and allows Redox potentials to increase.
- Redox potentials in 1st WBZ increase closer to the Embayment. This increase is presumably influenced by the presence of brackish surface water intrusions from the Duwamish River. The intrusion of brackish water leads to increases in both DO concentration and Redox potential. The Redox potential in well B-36 was an exception to this general trend in that it contained groundwater with a –32 mV potential. Since well B-36 is located downgradient from an area that is believed to be impacted by petroleum hydrocarbon (mineral spirits releases from the former Tyee Lumber Facility and detectable concentrations of BTEX in samples collected at well B-26 during the 1998 sampling event), low Redox potentials in the 1st WBZ at this location would be expected.
- Redox potentials measured in monitoring wells B-13, B-22, B-28, and wells B-53 through B-57 in the northwest corner of the GWI site contained consistently higher Redox potentials (mean Redox potential = 152 mV) with wells B-53, B-54, and B-55 containing the highest Redox potentials. These high Redox potentials reflect both the absence of petroleum hydrocarbons within the 1st WBZ in this area of the site and the infiltration of precipitation through the uncovered ground surfaces also present in this area.

Redox Potential in the 2nd WBZ

Redox potentials in the 2nd WBZ as measured during the 1999 annual sampling event are summarized below. This data is also contained in Table J.03 and is depicted in Figure J.01 of Appendix J.

Well	Location	Redox Potential Range (mV)	Mean Redox Potential (mV)
B-6, B-25 and B-27	Upgradient	142 to -126	-89
B-17	Original Source Area	-127	-127

Well	Location	Redox Potential Range (mV)	Mean Redox Potential (mV)
B-9 and B-45	Secondary Source Area	-63 to -80	-72
B-19, B-21, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	-22 to -61	-45
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	-60 to -91	-74

Redox potentials at the 2nd WBZ exhibited the following general trends:

- Redox potentials in the 2nd WBZ were consistently negative and ranged from -12 mV to -127 mV. These negative Redox potentials mimic the low DO concentrations present within the 2nd WBZ and further support the assessment that the lower confined aquifer (2nd WBZ) is less influenced by local groundwater recharge or surface water infiltration (except in the vicinity of the hole in the 1st SH) than the 1st WBZ. These low Redox conditions are the result of local conditions prevalent throughout this lower aquifer.
- Redox potentials upgradient of the GWI site in wells B-6, B-25, and B-27 were very low, indicating anoxic groundwater conditions presumably resulting from microbial DO consumption of the OM and wood debris present in this area of the site (see well logs in Appendix B). The negative Redox potentials at these wells could also result from the depletion of dissolved DO in groundwater originating upgradient from the GWI site. The loss of DO could be caused by the decay of OM or from the degradation of petroleum hydrocarbons at a potential upgradient source (e.g., 'Hat n' Boots' filling station).
- Within the original GWI source area, the Redox potential in well B-17 was -127 mV. The groundwater Redox potential at this well is believed to be influenced by microbial DO consumption of naturally occurring OM (see boring logs in Appendix B) and/or a lack of anthropogentic carbon sources in this area of the site.
- Downgradient of well B-17, in the secondary source area, Redox potentials decline due to an increase in petroleum hydrocarbon concentrations and resulting consumption of DO.
- Downgradient of the secondary source area along Fox Avenue S., Redox potentials in the 2nd WBZ increase slightly relative to those observed in the secondary source area, presumably due to mixing with groundwater from the 1st WBZ which is relatively enriched with dissolved oxygen.
- Near the S. Myrtle Street Embayment, Redox potentials declined slightly (from -50 to -71 mV). This decline may be in response to the accumulation of ferrous iron, which indicates anaerobic conditions, and may be amplified by stagnant groundwater conditions resulting from tidal flux in the area ofthe GWI site.

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in the 2nd WBZ.

4.4.4 OTHER REDOX COUPLES

Redox potential in most subsurface systems is governed by microbial activity and the chemical substances present which microorganisms utilize as carbon and energy sources. To degrade, various carbon source microorganisms obtain energy for cell production and maintenance by facilitating transfer of electrons from electron donors (e.g., carbon source) to electron acceptors (e.g., oxygen, ferric iron, sulfate, nitrate, and carbon dioxide) in the groundwater. The process of transferring electrons from the donor, and subsequent reduction in valence state of the acceptor (e.g., Fe^{+3} to Fe^{+2}), is known as a redox reaction.

The relative presence and/or absence of these electron acceptors can provide an indication of the types of microbial populations present and the chemical environment to which they are accustomed. For example, in the absence of oxygen, microorganisms known as facultative anaerobes will utilize nitrate or other electron acceptors (e.g., sulfate or carbon dioxide) to produce energy with which aids in the biotransformation of various contaminants like chlorinated ethenes. These microbial processes and the resulting chemical transformations produced by them are discussed further in Section 5.2.

The primary inorganic redox couples driving the natural attenuation of the petroleum hydrocarbons and chlorinated solvents at the GWI site are sulfate and sulfide, and ferrous and ferric iron. Because these are the primary redox reactions occurring in groundwater, analysis of these reduced electron acceptors is useful for assessing changes in redox conditions across the site and for providing evidence that natural attenuation of chlorinated ethenes is occurring in the groundwater at the GWI site (Section 5.2.4.1).

4.4.4.1 Ferrous Iron and Sulfide Concentrations in the 1st WBZ

Ferrous Iron Concentrations in the 1st WBZ

Ferrous iron concentrations in the 1st WBZ, as measured during the 1999 annual sampling event, are summarized below. This data is also depicted in Figure J.04 of Appendix J.

Well	Location	Ferrous Iron Conc. Range (mg/L)	Mean Ferrous Iron Conc. (mg/L)
B-24	Upgradient	1.68	1.68
B-16	Original Source Area	2.13	2.13
B-42, B-44, B-46, B-47 and B-49	Secondary Source Area	15.0 – 81.8	33.0
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner	0.005 - .02	0.01
B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	0.01 – 2.33	0.59
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	0.05 – 7.9	2.69

At the GWI site, ferrous iron concentrations along the primary groundwater flow path exhibit the following general trends:

- At upgradient well B-24, the ferrous iron (Fe^{+2}) groundwater concentration was 1.68 mg/L. This concentration can be considered the background concentration for the site. Any increase in ferrous iron concentration in the 1st WBZ downgradient of well B-24, would indicate reduced conditions and microbial activity, both of which will contribute to the degradation of chlorinated ethenes.
- In the original source area, the ferrous iron concentration increased in well B-16, and was highest in the secondary source area (mean concentration 33.0). This area of the site contains the greatest hydrocarbon impacts and the most reducing conditions. The increase in the ferrous iron concentration in this area is consistent with the presence of reducing conditions capable of supporting reductive dechlorination of chlorinated ethenes.
- Downgradient of the secondary source area along Fox Avenue S. at the hole in the 1st SH, ferrous iron concentrations declined, presumably due to groundwater mixing between the 1st WBZ and 2nd WBZ. The decline in ferrous iron concentrations probably results from the influx of DO from the 1st WBZ and from the preference that some bacteria have for using oxygen (when available) as an electron acceptor relative to ferric iron.
- Ferrous iron concentrations display a slight increase in wells B-34, B-36, and B-64 near the S. Myrtle Street Embayment. This increase may be related to the influx of dissolved OM into the 2nd WBZ during a flood tide or from OM in the aquifer material.
- In the northwest corner of the site, ferrous iron concentrations measured in monitoring wells B-13, B-22, and B-53 through B-55, contained the lowest ferrous concentrations observed at the site (ranging from 0.005 to 0.02 mg/L). These wells intercept upgradient groundwater from areas that are partially unpaved, resulting in relatively higher levels of DO in the groundwater. These oxygen levels reflect the preference that some bacteria have for using oxygen as an electron acceptor relative to ferric iron.

Sulfide Concentrations in the 1st WBZ

Sulfide concentrations in the 1st WBZ as measured during the 1999 annual groundwater sampling event are summarized below. This data is also contained in Table J.06 and is depicted in Figure J.05 of Appendix J.

Well	Location	Sulfide Conc. Range (mg/L)	Mean Sulfide Conc. (mg/L)
B-24	Upgradient	0.001	0.001
B-16	Original Source Area	0.019	0.019
B-42, B-44, B-46, B-47 and B-49	Secondary Source Area	0.0025 – 0.031	0.018

Well	Location	Sulfide Conc. Range (mg/L)	Mean Sulfide Conc. (mg/L)
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner	0.001 – 0.004	0.002
B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	0.001 – 0.01	0.004
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	0.001 – 0.029	0.013

At the GWI site, sulfide concentrations along the primary groundwater flow direction exhibit the following general trends:

- Sulfide concentrations across the site were consistently low (ranging from 0.0025 to 0.031 mg/L) and did not vary substantialy from background concentrations. These findings suggest that groundwater redox conditions at the site are not generally conducive to the reduction of sulfate, and that bacteria are primarily utilizing oxygen, nitrate and ferric iron as electron acceptors.
- The highest sulfide concentrations were measured at wells in the secondary source area and are indicative of more reducing conditions present in this portion of the site.
- Increases in sulfide concentrations, when compared to background concentrations, were also observed in the vicinity of the S. Myrtle Street Embayment. These increases are likely due to the intrusion of sulfate-bearing surface water from the Duwamish River into the 1st WBZ, and from increased concentrations of dissolved OM.

4.4.4.2 Ferrous Iron and Sulfide Concentrations in the 2nd WBZ

Ferrous Iron Concentrations in the 2nd WBZ

Ferrous iron concentrations in the 2nd WBZ, as measured during the 1999 annual sampling event, are summarized below. This data is also depicted in Figure J.04 of Appendix J.

Well	Location	Ferrous Iron Conc. Range (mg/L)	Mean Ferrous Iron Conc. (mg/L)
B-6 and B-25	Upgradient	0.64 – 2.53	1.59
B-17	Original Source Area	2.49	2.49
B-45	Secondary Source Area	12.05	12.0
B-21, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	4.8 – 16.3	11.3
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	3.7 – 18.7	11.4

At the GWI site, ferrous iron concentrations in the 2nd WBZ along the primary groundwater flow direction exhibit the following general trends:

- Within the 2nd WBZ, ferrous iron concentrations were much higher than those observed in the 1st WBZ. This condition may result from a higher concentration of native iron in the 2nd WBZ relative to 1st WBZ or from redox conditions in the 2nd WBZ that are more conducive to the reduction of ferric iron.
- Ferrous iron concentrations upgradient of the GWI source area near wells B-25 and B-6 were 0.64 and 2.53 mg/L, respectively. The concentration of ferrous iron at the upgradient well B-25 most likely represents the background concentration for the 2nd WBZ.
- Within the original source area, the ferrous iron concentration in well B-17 was 2.49 mg/L, while at the secondary source area, the ferrous iron concentration in well B-45 was 12.05 mg/L. The substantial increase in the ferrous iron concentration in the secondary source area suggests that an abundant carbon source is present. Aromatic hydrocarbons detected in the groundwater at well B-45 and OM identified in the 2nd WBZ near the bottom of boring B-45 are likely acting as the carbon source.
- Downgradient of the source area along Fox Avenue S., ferrous iron concentrations in the 2nd WBZ at wells B-21, B-59, B-61, and B-63 ranged from 4.8 to 16.3 mg/L. Similar concentrations were observed in wells installed nearer to the S. Myrtle Street Embayment. These results suggest that redox conditions in the 2nd WBZ are some what uniform as are sources of labile native carbon.

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in this WBZ.

Sulfide Concentrations in the 2nd WBZ

Sulfide concentrations in the 2nd WBZ, as measured during the 1999 annual sampling event, are summarized below. This data is also depicted in Figure J.05 of Appendix J.

Well	Location	Sulfide Conc. Range (mg/L)	Mean Sulfide Conc. (mg/L)
B-6 and B-25	Upgradient	0.001 – 0.019	0.01
B-17	Original Source Area	0.034	0.034
B-45	Secondary Source Area	0.005	0.005
B-21, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	0.005 – 0.039	0.018
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	0.007 – 0.54	0.188

Sulfide concentrations along the primary groundwater flow path at the site exhibited the following general trends:

- Within the 2nd WBZ, sulfide concentrations were much higher than those observed in the 1st WBZ. This suggests that the 2nd WBZ is more anaerobic when compared to the 1st WBZ, and therefore more conducive to the degradation of chlorinated ethenes.
- Sulfide concentrations upgradient of the source areas, near wells B-6 and B-25, were 0.001 and 0.019 mg/L, respectively. Sulfide concentrations in these wells most likely represent background concentrations for this site.
- Sulfide concentrations in both the original and secondary source areas (well B-17 contained 0.034 mg/L sulfide and well B-45 contained 0.005 mg/L sulfide) and along Fox Avenue S. (sulfide concentrations in wells B-21, B-59, B-61, and B-63 ranged from 0.005 to 0.039 mg/L) were similar. These results support the conclusion that generally, redox conditions in the 2nd WBZ are not conducive to sulfate reduction.
- Closer to the S. Myrtle Street Embayment, sulfide concentrations in the 2nd WBZ in wells B-33A, B-35, and B-65 were 0.007, 0.54 and 0.016 mg/L, respectively, which are similar to upgradient and source area concentrations. The fact that sulfide concentrations do not increase near the Embayment indicates that even with a substantial increase in sulfate as a result of the influx of brackish water, redox conditions in the 2nd WBZ are not conducive to sulfate reduction.

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in this WBZ.

4.4.5 THE OCCURRENCE OF METABOLIC GASES AND OTHER PRODUCTS OF THE NATURAL ATTENUATION OF CHLORINATED SOLVENTS

A metabolic gas is a product of microbial reactions that occur in the vadose zone and groundwater. The three common metabolic gasses often associated with the biodegradation of chlorinated hydrocarbons are ethene, ethane, and methane. These gasses can occur naturally beneath the water table under reducing conditions, or as a result of the natural attenuation of anthropogenic organic compounds. When formed as a result of the biodegradation of chlorinated solvents, these three gases, and ethene in particular, may be present at concentrations greater than those found under native conditions.

There are many natural and anthropogenic carbon sources from which these gases can be formed. Ethene, for instance, can be formed through the fermentation of OM, and where present, through the reductive dechlorination of DCE and VC. Ethane and methane can be derived from soil organic carbon feed methanogenesis, and from the reductive dechlorination of DCE, VC, DCA, and chloromethane under very reducing conditions.

When reducing conditions are maintained along the groundwater flow path of a chlorinated solvent plume, ethene, ethane, and methane can accumulate to levels where their presence can be used as an indicator of natural attenuation. For example, ethene is formed when the last remaining chloride atom on the VC molecule is substituted for by hydrogen (a reaction usually mediated by methanogenic bacteria). Ethane and methane are formed by the continued reduction of ethene under strongly reducing conditions. Regardless of the source of the methane carbon, the presence of methane in groundwater systems is indicative of strongly reducing conditions.

The analyses of metabolic gases were designed to evaluate the degradation of chlorinated ethenes occurring within the 1st and 2nd WBZ's at the GWI site. Methane, ethane, and ethene samples were collected using the methods, materials and equipment described in Appendix J.

4.4.5.1 Sampling Locations

During the 1999 annual groundwater sampling event, Terra Vac collected groundwater samples from the following locations for analyses of the dissolved metabolic gases: ethene, ethane, and methane.

Well Numbers	Location
B-24, B-25, B-26, B-27 and B-6	Upgradient
B-16 and B-17	Original Source Area
B-42, B-44, B-45, B-46, B-47 and B-49	Secondary Source Area
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner
B-20A, B-21, B-23, B-58, B-59, B-60, B-61, B-62 and B-63	Downgradient along Fox Avenue S.
B-33A, B-34, B-35, B-36, B-64 and B-65	Downgradient along S. Myrtle Street

Immediately following sample retrieval, each sample container was placed in a sampling cooler with ice and shipped under chain of custody to a Washington State certified contract laboratory (On-Site Environmental Inc. in Redmond, Washington) for analysis of methane, ethane, and ethene by EPA Method 8015 (modified). Results of these analyses are included in Appendix E and J. The nature and extent of ethene, ethane, and methane at the GWI site is discussed below.

4.4.5.2 Ethene

Ethene in the 1st WBZ

Ethene concentrations in the 1st WBZ along the groundwater flow line as measured during the 1999 annual sampling are summarized below. This data is also depicted in Figure J.06.

Well	Location	Ethene Conc. Range (µg/L)	Mean Ethene Conc. (µg/L)
B-24 and B-26	Upgradient	ND	ND
B-16	Original Source Area	ND	ND
B-42, B-44, B-46, B-47 and B-49	Secondary Source Area	9.9 - 266	177

Well	Location	Ethene Conc. Range (µg/L)	Mean Ethene Conc. (µg/L)
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner	ND	ND
B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	ND – 23.6	6.25
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	ND – 1.3	0.71

From the data presented in the table above, the nature and extent of dissolved ethene inthe 1st WBZ is as follows:

- Within the 1st WBZ, ethene was not detected at or above 0.5 µg/L (the minimum detection limit) in the groundwater upgradient of the GWI source area (wells B-24 or B-26), or in the original GWI source area in well B-16.
- Within the secondary source area, ethene concentrations in wells B-42, B-44, B-46, B-47 and B-49 ranged from 9.9 to 266 µg/L. This increase above background concentrations can be attributed to the ongoing reductive dechlorination of the VC present in this area and the presence of redox conditions which inhibit the oxidative respiration of ethene. The continued reduction of ethene to ethane at this location is too energy intensive to be a viable metabolic pathway.
- Downgradient of the secondary source area along Fox Avenue S., ethene concentrations in wells B-58 and B-62 in the 1st WBZ were 23.4 and 2.66, respectively. These concentrations, when compared to the secondary source area, suggest that ethene production is related to the presence of chlorinated ethene daughter products and is therefore greater in well B-58 where the 1st SH is present. At well B-62 within the area of the hole, ethene concentrations decline, reflecting the dilution produced by mixing groundwater from the 1st and 2nd WBZs and from the decline in ethene production concurrent with declines in electron donor concentrations.
- Ethene was not detected (<0.5 µg/L) in wells B-20A and B-60. These wells are located at the hole in the 1st SH. At this location, down-ward vertical groundwater gradients may be responsible for transporting ethene into the 2nd WBZ, resulting in the reduction in ethene concentrations at wells B-20A and B-60.
- Near the S. Myrtle Street Embayment, ethene concentrations in the 1st WBZ range from <0.5 to 1.3 µg/L in wells B-34, B-36, and B-64. The relatively low levels of ethene at these wells suggests that the reducing conditions prominent within the secondary source area, which were responsible for ethene production, are no longer actively fostering ethene production. Declines in both cis-DCE and VC at these wells reflects both dilution by surface water intrusions and direct oxidation of these daughter products under aerobic conditions.
- The concentration of ethene measured in monitoring wells B-53 through B-55 and wells B-13, B-22 and B-28 in the northwest corner of the GWI site were all non-

detect (<0.5 µg/L). These concentrations, when compared to those detected downgradient, demonstrate that both dechlorination and ethene production will not occur when oxidizing conditions are present, such as at the northwest corner.

Ethene in the 2nd WBZ

Ethene concentrations in the 2nd WBZ along the groundwater flow line as measured during the 1999 annual sampling event are summarized below. This data is also contained in Table J.10 and is depicted in Figure J.07 of Appendix J.

Well	Location	Ethene Conc. Range (µg/L)	Mean Ethene Conc. (µg/L)
B-6, B-25 and B-27	Upgradient	ND - 6	2
B-17	Original Source Area	ND	ND
B-45	Secondary Source Area	2.1	2.1
B-21, B-23, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	ND - 160	54.8
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	1.8 - 83	53.9

From the data presented in the table above, the nature and extent of ethene concentration in the 2nd WBZ is as follows:

- Within the 2nd WBZ at the GWI site, upgradient of the GWI source areas, ethene was not detected (<0.5 µg/L) in wells B-25 and B-28; however, the ethene concentration detected at well B-27 was 6 µg/L. The concentration of ethene at this well probably is the result of the historic presence of chlorinated ethenes (see Hart Crowser 1993). Because of the presence of OM at this well, anaerobic conditions have formed leading to the production of ethane (see bore log in Appendix B).
- Within the original GWI source area, ethene was not detected (<0.5 µg/L) in groundwater at well B-17, while in the secondary source area at well B-45, the concentration of ethene was 2.1 µg/L. The increase in ethene at the secondary source area when compared to the original source area results from the dechlorination of cis-DCE and VC. The reducing conditions present in the secondary source area result from the presence of petroleum hydrocarbon donor compounds which were released concurrent with the chlorinated ethenes.
- Downgradient of the source area along Fox Avenue S., ethene concentrations in wells B-21, B-59, B-61, and B-63 ranged between 5.0 to 106 µg/L. The highest ethene concentrations were detected in wells B-61 and B-63. These relatively elevated concentrations of ethene represent the active dechlorination occurring within the 2nd WBZ at the hole in the 1st SH, and demonstrate the complete biological destruction of PCE.

- Downgradient near the S. Myrtle Street Embayment of the Duwamish River, ethene concentrations in wells B-33A, B-35, and B-65 were 83, 77 and 1.8 µg/L, respectively. These relatively elevated concentrations of ethene reflect the continuing dechlorination of cis-DCE and VC within the 2nd WBZ.

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in this WBZ.

4.4.5.3 Ethane

Ethane in the 1st WBZ

Ethane concentrations in the 1st WBZ along the groundwater flow line as measured during the 1999 annual sampling event are summarized below. This data is also contained in Table J.11 and is depicted in Figure J.06 of Appendix J.

Well	Location	Ethane Conc. Range (µg/L)	Mean Ethane Conc. (µg/L)
B-24 and B-26	Upgradient	ND - 93	46.5
B-16	Original Source Area	ND	ND
B-42, B-44, B-46, B-47 and B-49	Secondary Source Area	ND - <2.5	1.5
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner	ND	ND
B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	ND	ND
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	ND	ND

From the data presented in the table above, the nature and extent of ethane in the1st WBZ is as follows:

- The concentration of ethene in the 1st WBZ upgradient of the GWI source area in well B-26 was 93 µg/L. This was the only well sampled during the 1999 annual sampling event which contained ethane at a concentration exceeding the detection limit of 0.5 µg/L.
- The concentration of ethane in well B-26 is presumably the result of microbially mediated organic carbon supported methanogenesis. The elevated concentrations of dissolved OM known to be present in this area serve as a carbon source for metabolic gas production.
- The general lack of ethane within the 1st WBZ at the GWI site suggests ethane production is hampered by the oxidizing conditions prevalent in the 1st WBZ. Under such conditions, ethane under-goes rapid oxidative transformation to methane or carbon dioxide.

Ethane in the 2nd WBZ

Ethane concentrations in the 2nd WBZ along the groundwater flow line as measured during the 1999 annual sampling are summarized below. This data is also contained in Table J.12 and is depicted in Figure J.07 of Appendix J.

Well	Location	Ethane Conc. Range (µg/L)	Mean Ethane Conc. (µg/L)
B-6, B-25 and B-27	Upgradient	ND - <2.5	ND
B-17	Original Source Area	ND	ND
B-45	Secondary Source Area	2.1	2.1
B-21, B-23, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	ND - <2.5	0.5
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	ND - 26	8.7

From the data presented in the table above, the nature and extent of ethane inthe 2nd WBZ are as follows:

- Ethane was only detected in wells B-35 and B-45. Well B-45 is located near the secondary source area, while B-35 is located along S. Myrtle Street. Both wells are downgradient of the GWI source areas.
- Well B-45 contained 2.1 µg/L of ethane. Elevated concentrations of ethene are also present at this location. Well B-35 contained 26 µg/L of ethane, potentially resulting from biological decay of wood and partially decomposed organic materials encountered at this location during well installation (see boring logs in Appendix B).

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in this WBZ.

4.4.5.4 Methane

Methane in the 1st WBZ

Methane concentrations in the 1st WBZ measured during the 1999 annual sampling are summarized below. This data is also contained in Table J.13 and is depicted in Figure J.06 of Appendix J.

Well	Location	Methane Conc. Range (µg/L)	Mean Methane Conc. (µg/L)
B-24 and B-26	Upgradient	1.8 - 460	231
B-16	Original Source Area	1.4	1.4
B-42, B-44, B-46, B-47 and B-49	Secondary Source Area	12 - 307	156

Well	Location	Methane Conc. Range (µg/L)	Mean Methane Conc. (µg/L)
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner	ND – 3.9	1.14
B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	0.51 - 120	32.5
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	ND – 2.2	1.0

From the data presented in the table above, the nature and extent of methane in 2nd WBZ is as follows:

- Methane concentrations in the 1st WBZ, upgradient of the GWI source area at wells B-24 and B-28, were 1.8 and <0.5 µg/L, respectively, while the methane concentration in upgradient well B-26 was 460 µg/L. The methane concentrations at wells B-24 and B-28 can be considered background concentrations for the site. The very high concentration of methane at well B-26 can probably be attributed toa high concentration of OM in the 1st WBZ and its fermentation by indigenous anaerobic bacteria. The low DO concentration and negative ORP value at this location along with the absence of petroleum hydrocarbons in groundwater from this well further supports this presumption.
- Within the original and secondary source areas, methane concentrations in wells B-16, B-42, B-44, B-46, B-47 and B-49 ranged from 1.4 to 307 µg/L. These elevated methane concentrations, relative to background concentrations, can be attributed to the complete mineralization of the chlorinated ethenes. The strong reducing conditions in this area produced by the aerobic consumption of petroleum hydrocarbons facilitate the production of methane.
- Downgradient of the source areas, along Fox Avenue S., methane concentrations in wells B-20A, B-58, B-60 and B-62 ranged from 0.5 to 120 µg/L, with the highest concentration (120 µg/L) at well B-58. The concentration of methane in these wells is highly correlated to the concentrations of TCE, DCE and VC in these same wells (correlation coefficients of 0.994, 0.999 and 0.940, respectively). The high correlation suggests that the occurrence of methane results from the dechlorination of chlorinated ethene daughter compounds which are known to be present at these well locations.
- The relatively high methane concentration at well B-58 can be attributed to the very high concentrations of daughter products present at this location. The occurrence of these daughter products at elevated concentrations is further supported by low DO concentrations and negative ORP values in groundwater at this location.
- Near the S. Myrtle Street Embayment, methane concentrations in the 1st WBZ wells B-34, B-36 and B-64 were <0.5, 2.2 and 0.8 µg/L, respectively. These concentrations are similar to background methane concentrations, with the exception of well B-36 which had a concentration of 2.2 µg/L. The presence of both wood

fragments and OM at this location (see bore logs in Appendix B) suggests methanogenic production from native carbon substrates. Furthermore, the elevated levels of DCE and VC compared to concentrations at wells B-34 and B-64 suggests that the methane in well B-36 may also be attributed to dechlorination of chlorinated ethene daughter products.

- The concentration of methane measured in monitoring wells B-53 through B-57 and well B-13 in the northwest corner of the GWI site ranged from <0.5 to 3.9 µg/L. These concentrations are similar to the methane concentration detected in wells B-24 and B-28 and likely reflect background concentrations.

Methane in the 2nd WBZ

Ethane concentrations in the 2nd WBZ along the groundwater flow line as measured during the 1999 annual sampling are summarized below. This data is also contained in Table J.14 and is depicted in Figure J.07 of Appendix J.

Well	Location	Methane Conc. Range (µg/L)	Mean Methane Conc. (µg/L)
B-6, B-25 and B-27	Upgradient	13 - 625	239
B-17	Original Source Area	78	78
B-45	Secondary Source Area	9.8	9.8
B-21, B-23, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	4.2 - 360	112
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	34 - 58	44.0

From the data presented in the table above, the nature and extent of methane in the 2nd WBZ is as follows:

- Within the 2nd WBZ, the concentration of methane in groundwater in wells B-6 and B-25 was 13 and 80 µg/L, respectively. The concentrations of methane in the groundwater at these wells represent background concentrations.
- The concentration of methane in the upgradient well B-27 was 625 µg/L, the highest concentration measured during the 1999 annual sampling. This anomalous concentration is probably the result of native carbon supported methanogenesis (see bore log in Appendix B).
- Within the original GWI source area, the concentration of methane in well B-17 was 78 µg/L. This concentration reflects the continued presence of native carbon derived methane upgradient of the secondary source area
- Within the secondary source area in well B-45, 9.8 µg/L of methane was detected. This concentration, when compared to background, may reflect dilution of methane in the groundwater as a result of mixing between the 1st and 2nd WBZ's at the hole in the 1st SH.

- Downgradient of the secondary source area along Fox Avenue S., methane concentrations in wells B-21, B-59, B-61 and B-63 ranged from 15.1 to 360 µg/L. These downgradient concentrations, when compared to source area concentrations, suggest that increased methane production related to increased concentrations of chlorinated ethene daughter products is occurring in the 2nd WBZ at the hole in the 1st SH.
- Near the S. Myrtle Street Embayment, methane concentrations in wells B-33A, B-35 and B-65 were 58, 34 and 40 µg/L, respectively. These concentrations probably reflect both continuing dechlorination of DCE and VC and methanogenic production from native carbon sources.

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in this WBZ.

4.4.5.5 The Occurrence of Chloride

The sequential dechlorination of chlorinated solvents produces not only the metabolic gases but also results in the formation of chloride ions. Because chloride ions typically do not undergo oxidation-reduction reactions, form salts of low solubility, or complex with other solutes, nor are they significantly adsorbed to soil or mineral surfaces, the nature and extent of chloride ions in natural groundwater systems are principally controlled by physical processes (i.e., advection and dispersion).

The non-reactive nature of chloride ion commonly results in elevated chloride concentrations in groundwater when compared to background concentrations. Therefore, chloride ions can be used as an indicator of reductive dechlorination.

Chloride in the 1st WBZ

Chloride concentrations in the 1st WBZ as measured during the 1999 annual sampling are summarized below. This data is also contained in Table J.15 and is depicted in Figure J.08 of Appendix J.

Well	Location	Chloride Conc. Range (mg/L)	Mean Chloride Conc. (mg/L)
B-24 and B-26	Upgradient	3.9 – 4.6	4.3
B-16	Original Source Area	4.1	4.1
B-31, B-42, B-44, B-46, B-47 and B-49	Secondary Source Area	74 - 130	114.4
B-13, B-22, B-28, B-53, B-54 and B-55	Northwest Corner	3.0 – 9.3	6.4
B-20A, B-58, B-60 and B-62	Downgradient along Fox Avenue S.	9.3 - 26	14.6
B-34, B-36 and B-64	Downgradient along S. Myrtle Street	2.2 – 11000*	3.4

*Note: Concentration represents surface water salinity and was not used to compute mean.

From the data presented in the table above, the nature and extent of chloride in the 1st WBZ is as follows:

- The concentration of chloride in wells B-24, B-26 and B-28, located upgradient of the GWI source area, ranged between 3.9 to 9.3 mg/L. These concentrations reflect background concentrations for the 1st WBZ.
- The chloride concentration in the original source area at well B-16 was 4.1 mg/L and is similar to background concentrations.
- Within the secondary source area, chloride concentrations increased in wells B-11, B-12, B-15, B-42, B-44, B-46, B-47 and B-49 when compared to concentrations in the original source area and at background wells. Chloride concentrations in the secondary source area range from 43 to 130 mg/l. Wells B-42, B-44, B-47 and B-49 each contained 130 mg/L or more of chloride (one order of magnitude greater than upgradient background concentrations). This increase in the chloride concentration reflects active dechlorination and complete mineralization of PCE.
- Downgradient of the source area along Fox Avenue S., chloride concentrations in the 1st WBZ in wells B-20A, B-58, B-60 and B-62 (ranging in concentration from 11 to 26 mg/L) decreased when compared to those in the source area. This decline in chloride concentration as compared to the concentrations present in the secondary source area most likely reflects the dilution of chloride as a result of groundwater mixing between the 1st and 2nd WBZ's at the hole in the 1st SH.
- Along S. Myrtle Street the chloride concentrations in the 1st WBZ wells B-36 and B-64 were 4.5 and 2.2 mg/L, respectively. The decrease in chloride concentrations at these wells, when compared to secondary source area and Fox Avenue S. wells, further reflects a decline in the degradation chlorinated ethenes in this area of the site.
- Nearest the S. Myrtle Street Embayment in well B-34, the chloride concentration increased to 11,000 mg/L. The chloride concentration in well B-34 is presumably a result of brackish surface water intrusion from the Duwamish River.
- The concentration of chloride measured in monitoring wells B-53 through B-57 and well B-13 in the northwest corner of the GWI site ranged from 0.08 to 2.3 mg/L. These values are consistent with those observed in the upgradient wells Northeast of the GWI property and reflect background concentrations.

Chloride in the 2nd WBZ

Chloride concentrations in the 2nd WBZ as measured during the 1999 annual sampling are summarized below. This data is also contained in Table J.16 and is depicted in Figure J.08 of Appendix J.

Well	Location	Chloride Conc. Range (mg/L)	Mean Chloride Conc. (mg/L)
B-6, B-25 and B-27	Upgradient	54 - 110	85
B-17	Original Source Area	110	110

Well	Location	Chloride Conc. Range (mg/L)	Mean Chloride Conc. (mg/L)
B-45	Secondary Source Area	28	28
B-21, B-23, B-59, B-61 and B-63	Downgradient along Fox Avenue S.	17 - 47	34
B-33A, B-35 and B-65	Downgradient along S. Myrtle Street	36 – 730*	62

*Note: Concentration represents surface water salinity and was not used to compute mean.

From the data presented in the table above, the nature and extent of chloride inthe 2nd WBZ is as follows:

- Within the 2nd WBZ at the GWI site, chloride concentrations in groundwater upgradient of the GWI source area in wells B-6, B-25 and B-27 ranged from 54 to 110 mg/L. These concentration reflect background concentrations for the site
- Within the original GWI source area, the concentration of chloride in well B-17 was 110 mg/L, which is the same concentration observed at well B-27 and is similar to background concentrations for this site in the 2nd WBZ.
- The concentration of chloride in the 2nd WBZ at well B-45 decreased to 28 mg/L. This decease most likely reflects dilution of chloride as a result of groundwater mixing between the 1st and 2nd WBZ's at the hole in the 1st SH.
- Downgradient of the source area along Fox Avenue S., chloride concentrations in the 2nd WBZ in wells B-21, B-59, B-61 and B-63 ranged from 17 to 47 mg/L. These concentrations, when compared to source area and background wells, potentially indicate both the decline in chloride production resulting from reductive dechlorination and the continued dilution of the chloride in the 2nd WBZ.
- At the S. Myrtle Street Embayment of the Duwamish River, chloride concentrations in the 2nd WBZ in wells B-33A, B-35 and B-65 were 730, 36 and 88 mg/L, respectively. As with the 1st WBZ, these concentrations presumably are a result of brackish surface water intrusion from the Duwamish River.

No information is available for 2nd WBZ groundwater in the northwest corner of the GWI site since existing monitoring wells are not screened in this WBZ.

4.4.5 SUMMARY AND CONCLUSION

The data indicate that natural attenuation in the 1st WBZ is dominated by the following general conditions:

- DO in the 1st WBZ is variable and principally influenced by the presence of petroleum hydrocarbon compounds, which act to increase biological oxygen demand and result in DO depletion on a very local scale. DO concentrations within the 1st WBZ range between 0.1 and 10.41 mg/L. DO concentrations within the 2nd WBZ are consistently lower than those in the 1st WBZ, averaging approximately 0.3 mg/L.

DO concentrations within the 2nd WBZ experience localized variations both at Fox Avenue S., due to mixing with the 1st WBZ, and at the S. Myrtle Street Embayment, where the influx of surface water from the Duwamish River causes concentrations to increase. The difference in DO concentrations between the two WBZs has a significant influence on the distribution of chlorinated ethenes, especially the daughter products of reductive dechlorination, which are known to undergo direct aerobic biodegradation.

- Redox potentials in the 1st WBZ (like DO concentrations) are variable, and range between 152 and 0 mV, while in the 2nd WBZ, redox potentials are consistently negative, ranging between –127 and –12mV. Localized patterns in redox potential are also observed in the 1st WBZ, both upgradient of the source area and within the NW corner of the GWI property. In these two areas, redox potentials are positive and reflect the general absence of biologically oxidizable hydrocarbons. Redox potentials in the 1st WBZ decline in the secondary source area and vary widely at Fox Avenue and S. Myrtle Street. At S. Myrtle Street, redox potentials increase with the influx of surface water from the Duwamish River.
- Ferrous iron, chloride and ammonia concentrations are all elevated within the secondary source area in comparison to upgradient (background) concentrations. These elevated concentrations indicate that groundwater in the secondary source area is anoxic and predominated by both nitrate and iron reducing conditions, and the elevated chloride concentrations result from dechlorination of chlorinated ethenes in this part of the site.
- Ethene and methane concentrations are elevated within the secondary source area in comparison to upgradient (background) concentrations. The elevated concentration of ethene has resulted from reductive dechlorination of chlorinated ethenes, while the methane present is presumably a result of the anaerobic biodegradation of the petroleum hydrocarbons, which are also present in the secondary source area.

Within the 2nd WBZ, natural attenuation is influenced by conditions different from those observed in the 1st WBZ. These conditions can generally be defined as follows:

- DO in the 2nd WBZ ranges between 0.1 and 0.3 mg/L within the secondary source area and then increases slightly at Fox Avenue, due to mixing with 1st WBZ groundwater in the area of the hole in the 1st SH. DO increases at the S. Myrtle Street Embayment with an influx of DO resulting from the intrusion of DO rich surface water from the Duwamish River.
- Redox potentials in the 2nd WBZ are negative across the entire site, ranging between -127 and -12 mV. Even with the influx of surface water from the Duwamish River at S. Myrtle Street, redox potentials remain negative in the 2nd WBZ. Within the 2nd WBZ, negative redox potentials reflect areas where active dechlorination is prevalent and native OM is present
- Ferrous iron concentrations in the 2nd WBZ are generally lower in the secondary source area, but increased at the hole in the 1st SH. Ferrous iron concentrations between Fox Avenue and the S. Myrtle Street Embayment are higher than those in the 1st WBZ, averaging 11.3 mg/L. These elevated concentrations indicate that

groundwater in the 2nd WBZ downgradient of the secondary source area is anoxic, supporting both iron reducing and methanogenic conditions.

- Chloride concentrations throughout the 2nd WBZ are higher than those in the 1st WBZ, but decline slightly in the area of the hole in the 1st SH, presumably due to dilution from 1st WBZ groundwater entering the 2nd WBZ. Chloride concentrations in the 2nd WBZ groundwater at S. Myrtle Street, like those in the 1st WBZ, increase rapidly due to an influx of chloride-rich brackish surface water from the Duwamish River.
- Ethene and methane concentrations increase in the area of the hole in the 1st SH in comparison to concentrations detected upgradient in the secondary source area. Unlike the trend seen in the 1st WBZ where both ethene and methane concentrations increase, in the 2nd WBZ methane concentrations are seven times greater than the ethene concentrations downgradient of the hole in the 1st SH. This increase in methane concentrations is an indication of the methanogenic conditions present. These conditions also help to explain the rapid production and accumulation of the chlorinated ethene daughter products DCE and VC, both of which are products of PCE and TCE dechlorination.

Section 5 describes the fate and transport of the COCs under these conditions.

5.0 Fate and Transport

The fate and transport of chemical contaminants at the GWI site is controlled by a complex web of processes. Section 5.1 discusses chemical-specific properties that influence the mobility of chemicals and how these chemicals are transported through the site. Section 5.2 discusses the natural degradation of PCOCs at the GWI site. These degradation processes decrease the concentrations of certain PCOCs, which results in the formation of other PCOCs. An understanding of the degradation process is necessary to understand the formation and fate of the PCOCs. Finally, in Section 5.3, chemical transport and fate are combined with a description of site conditions and human and ecosystem receptors to develop a conceptual site model.

5.1 CHEMICAL MOBILITY

The mobility of a chemical in the environment is a function of the inherent nature of the chemical, or chemical-specific properties, and the environment through which it moves.

5.1.1 PHYSICAL PROCESSES

The following processes are used to describe how materials move through the environment.

- **Convection and Advection:** Convection and advection both relate to the movement of mass. Because engineers and hydrogeologists refer to these terms slightly differently, there is often overlap in the terms. Convection refers to the movement of a bulk material. Groundwater, residual DNAPL, and soil gases can all move by convection if (1) there is sufficient material present for a bulk phase to exist and (2) there is a pressure gradient to drive the movement. The convective movement of groundwater at the site is well understood, and was discussed in Section 2.

  The convective movement of soil gas requires the production of soil gas at a sufficient rate to cause a pressure gradient, such as those formed at landfills during years of active refuse degradation, or as a results of significant changes in water table levels or atmospheric pressure. GWIConvective movement would occur during the operation of a vapor extraction system because the system applies a pressure gradient (vacuum).

  Residual DNAPL can move by convection if it moves as a bulk fluid. At the GWI Facility, PCE appears to have moved historically as residual DNAPL from the original source area to the "secondary source area" in the 1st SH. The "pressure gradient" in this case is more accurately a density gradient where the heavier material (the PCE) sinks through the less dense liquid (water) because of the force of gravity. There is not sufficient residual DNAPL remaining at the site for this convective process to be continuing today, although it did occur historically.

  Advection refers to the transport of molecules in a bulk fluid. Advection is the preferred term by hydrogeologists, who tend to reserve convection for movement driven by heat-derived pressure gradients. Hydrogeologists will use advection to describe both the movement of molecules of the bulk fluid (i.e., the advective movement of the water molecules that make up bulk groundwater movement) and the movement of solute molecules dissolved in the bulk fluid (i.e., the advective movement of PCE molecules in groundwater caused by the bulk movement of the groundwater). The movement of groundwater at the GWI site was described in Section 2. The advective movement of contaminants along the groundwater flow path will be described later in this section.

- **Dispersion:** If convection/advection occurred in a frictionless pipe, all of the molecules would stay together; however, as the molecules move through the soil, they follow torturous paths among the soil grains. This causes the path of individual molecules to spread along and away from the expected groundwater flow path. This process is called dispersion and results from the movement of groundwater in individual pores and channels. Dispersion will effect both the molecules of the bulk fluid and the solute molecules dissolved in the bulk fluid. The relatively narrow plumes seen in Figures 4.4 and 4.7 indicate that only limited dispersion is occurring at the GWI site.
- **Diffusion:** Diffusion is another dispersive process that results from the movement of molecules along a concentration gradient. Molecules move from areas of high concentration to low concentration. Diffusion tends to be applied to only the solute molecules, since the process is driven by concentration gradients. At GWI, diffusion is most important for the soil gas pathway, where it is the only process causing contaminats in the vadose zone to move away from the source area.
- **Dilution:** The combined processes of advection, dispersion, and diffusion result in a net dilution of the molecules in the groundwater, resulting in a net decrease in concentration at any one point. This is not a loss in total mass, but a natural spreading of the mass over a larger volume, resulting in a decrease in the source area concentration.
- **Sorption/Desorption:** Molecules can adsorb onto and, in some cases, be absorbed by geologic materials. Over time, these molecules will desorb from the geologic materials in response to concentration gradients. While a molecule is sorbed, it is not available to move with the bulk liquid (groundwater). Sorption affects the advective rate of molecules dissolved in groundwater by keeping them out of solution for a period of time. This decreases groundwater concentrations and retards the rate at which chemicals move relative to groundwater. The stronger the sorption, the lower the groundwater concentration and the slower the movement. (Because the retardation of movement relative to groundwater results in a "spreading" of the chemical along the direction of groundwater movement, sorption/desorption can also be thought of as a dispersive process.) Sorption/desorption processes are very dependent on chemical and physical parameters and will be discussed further beginning with Section 5.1.2.
- **Stabilization:** Stabilization is a process whereby chemical molecules become chemically bound or transformed by a stabilizing agent (e.g., clay, humic materials), reducing the mobility of the molecule in the groundwater. As the sorption/desorption reaction becomes more irreversible, either due to the molecules partitioning into deep pores and crevices in the soil, or due to a strong chemical-specific preference for solid phase, the chemical is said to be "bound" or "stabilized." Stabilization is most important for metals and strongly absorptive organics.

- **Volatilization:** The transfer of a molecule into the vapor phase is termed volatilization. Chlorinated solvents are volatile organic compounds (VOCs) that partition from soil (adsorbed phase), from residual DNAPL, or from aqueous phases into the gas phase. Volatilization will decrease the concentrations in soil and groundwater in and near the vadose zone by allowing part of the mass to partition into the vadose zone. This "soil gas" or "soil vapor" may, in turn, vent from the ground into the surrounding air.

The processes of convection/advection, dispersion, dilution, diffusion, sorption/desorption, volatilization and stabilization are physical processes that are included in the EPA's definition of natural attenuation. All of these processes are occurring at the GWI site.

5.1.2 CHEMICAL-SPECIFIC PROPERTIES

There are various factors that influence a chemical's mobility through the environment. Vapor pressure, boiling point, and melting point indicate at what temperatures and pressures a pure chemical will exist as a gas, liquid, or solid. This information also serves as a surrogate measure of other properties such as volatility and mobility. For example, chemicals with high vapor pressures and low boiling points will be "volatile," meaning that the chemical will tend to partition into overlying air. Volatile compounds, in turn, will tend to move along specific pathways in the environment, and to move faster and further than their non-volatile kin.

In general, the chemicals grouped as semi-volatile organic compounds are solids at room temperature, have low vapor pressures, and will not move great distances as pure chemicals. VOCs are usually liquids at room temperature, and a few such as vinyl chloride, are gases. They are able to move through the environment in pure form as either liquids or gases. Because VOCs can move through the environment as liquids and/or gases, other properties, such as molecular diffusivities and liquid viscosity, can become important to predict how far and how fast they will move. For semi-volatile organic compounds and metals, which rarely move as pure chemicals, properties that govern how they might move under various physical and chemical conditions are irrelevant.

Henry's Law constant, aqueous solubilities, and partitioning constants are used to indicate to what extent a chemical will associate with a specific matrix versus another matrix. Henry's Law predicts the partitioning of a chemical between aqueous solution and overlying air. Aqueous solubilities predict the dissolution of the pure phase into aqueous solution, and give a maximum concentration for aqueous solutions. Partitioning coefficients predict the partitioning of a chemical between matrices, with the most common matrices being aqueous solution and either a pure organic solvent (octanol) or powdered organic carbon (carbon). Only a very few chemicals have measured partitioning coefficients between aqueous solutions and soil, and for these the "soil" is almost always pure clay.

In general terms, VOCs are more soluble than semi-volatile organic compounds, while semi-volatile organic compounds are more likely to prefer both soil and organic matter to water than are volatile organic compounds. The combination of these two preferences is that semi-volatile organic compounds are less likely to dissolve in water (e.g., groundwater, infiltrating rainwater, etc.) in the first place, and will take the first opportunity to partition onto a soil particle, especially one with organic matter associated with it. For these reasons, semi-volatile organic compounds are less likely to move in groundwater than VOCs.

Table 5.1 lists the vapor pressures, boiling points, melting points, Henry's Law constants, aqueous solubilities, and partitioning coefficients for the PCOCs identified in Section 4. Based on these properties, the following trends can be identified:

- Vinyl chloride, the DCE isomers, and methylene chloride are the most volatile organic compounds and will be the most likely to volatilize from soil and residual DNAPL in the vadose zone into soil gas and travel along soil gas and air pathways. Travel along these pathways will be driven by concentration gradients and soil permeabilities, and, the directions of movement will generally be radial, away from source areas, with the greatest movement through permeable zones.
- Vinyl chloride, the DCE isomers, and methylene chloride are also the most soluble in water and the least likely to partition onto soil (though they all still prefer organic carbon to water). Although they will spend the majority of the time partitioned onto soil, they will spend sufficient time in the aqueous phase to travel further in groundwater than other PCOCs. As they move with groundwater, they will be spreading along the groundwater flow path due to dispersion, diffusion, and sorption/desorption.
- Vinyl chloride, TCE, and PCE have the largest Henry's Law constants, so although they all prefer to dissolve in water rather than enter the vapor phase within the vadose zone, they will partition into the vadose zone more than the other chemicals. They may be detected in soil gas in areas where they "arrived" by groundwater transport.
- The BTEX family is moderate in solubility and volatility, with benzene being the most mobile in both air and water, and xylenes being the least. Benzene is the only member that is more mobile than PCE, which is the least mobile of the ethenes; consequently, BTEX will be less mobile than most chlorinated ethenes and ethanes.
- Pentachlorophenol is a non-volatile solid that has a fairly low solubility and a strong preference for adsorption onto organic carbon. Its movement in the environment will be along the groundwater pathway only, and it will be slow and for short distances. The fraction of organic carbon in the soil will significantly effect its limited mobility.
- The dioxins, which are also non-volatile solids, are even less volatile and mobile than penta. The partitioning factor between organic matter and water is so high that with even 0.01 percent organic matter in the soil, dioxin will be immobile or stabilized on the soil matrix.

5.1.3 SITE-SPECIFIC PARAMETERS

Several of the PCOCs for the GWI site are potentially mobile in groundwater and soil vapor. To understand how mobile they are and where they will tend to accumulate, additional information about the site is needed.

The following information will be useful for predicting the mobility of PCOCs:

- The nature and extent of unsaturated strata through which soil gas migrates.
- The nature and extent of saturated strata through which groundwater migrates.
- The fraction of organic matter present in the soil (both the sands and the silts).
- Other hydrological and hydrogeological parameters that influence how soil gas and groundwater move through the site.

Unsaturated Strata or the Vadose Zone. At the GWI site, the only unsaturated zone encountered was the vadose zone between ground surface and the water table. This zone varies seasonally and with surface topography, but is generally about eight feet thick. As discussed in Section 2, this strata is composed of general fill and hydraulic fill (sands and silts dredged from the Duwamish River), underlain by native alluvial silts and sands. The alluvial deposits (both native and fill) are dominated by sands and silts, and are rich in organic matter.

Saturated Strata and Groundwater Flow. Beneath the thin vadose zone is the alluvial aquifer, which is a complex alluvial system of interbedded silts and sands that becomes increasingly silty with depth. At the site, the first two distinct water-bearing zones in the alluvial aquifer- the 1st WBZ and the 2nd WBZ - have been well studied. These zones are separated by a discontinuous layer of low permeability silts, the 1st SH. Although discontinuous and thin, the 1st SH is sufficient to exert significant control over tidal responses, groundwater flow, and contaminant transport. The following findings describe the groundwater conditions:

- The 1st and 2nd WBZs are primarily composed of fine to medium sand, with abundant silt stringers; however, the soil in the 1st WBZ is somewhat coarser than the soil in the 2nd WBZ and contains less fines (Sections 2.2 and 2.3). The soil in both zones is organic-rich, especially the silts.
- Groundwater movement in both zones is from the GWI Facility toward the S. Myrtle Street Embayment of the Duwamish River. This same flow pattern is seen on the Schultz/Emerson facility to the north of the GWI Facility. In general, groundwater velocities range from 20 to 300 ft/yr (Section 2.4.2).
- Groundwater flow near the river is tidally influenced. At high tide, the groundwater flow direction in the 1st and 2nd WBZ reverses near the river, allowing groundwater to flow back towards Fox Avenue S. The permeable seeps even allow river water to flow into the groundwater system for some limited distance (Section 2.4.3). Primarily, the tidal reversal acts to (1) reduce the net migration of contaminants toward the river so that they have a longer residence time in the groundwater system than would be predicted by average velocities and (2) disperse contaminants along the groundwater flow path.
- The 1st SH acts to retard tidal effects in the 1st WBZ. Specifically, the tidal study found that the 1st WBZ acted as a water table aquifer where tidal effects damp out quickly, while the 2nd WBZ acted as a semi-confined system where the tidal effects propagate much further inland. By Fox Avenue S., tidal effects in the 1st WBZ are not measurable and are significantly attenuated in the 2nd WBZ (Section 2.4.4).

- Where the 1st SH is absent, such as in the Fox Avenue hole, the 1st and 2nd WBZs are strongly connected and vertical mixing occurs. During most of the tidal cycle, gradients are vertically downward. This can be seen in both water levels in the tidal study and in the path that chemicals take as they move with groundwater. During a small part of each tidal cycle, however, gradients in the hole may be upward. Depending on the strength of this gradient (which is tidally and seasonally variable), groundwater and contaminants may actually flow from the lower zone into the upper zone, or, more commonly, downward groundwater flow is temporary halted and the flow in the 1st WBZ acts as if the 1st SH were continuous, allowing chemicals toflow across the top of the hole (Section 2.4.4).
- Contaminant plumes, primarily PCE and its degradation products, have moved from the GWI Facility to the river. Concentration ratios of PCE to its degradation products and have been used to help define the movement of groundwater especially between the zones (Section 4.3).
- Movement of chemical contaminants from the 1st WBZ to the 2nd WBZ is believed to be minimal, except in the Fox Avenue hole where significant vertical mixing and downward migration of contamination is occurring.

5.2 BIODEGRADATION

5.2.1 INTRODUCTION

Simple models of chemical transport are often poor predictors of the behavior of chlorinated ethenes and ethanes in the environment, because the models ignore the powerful natural biodegradation that often occurs in the subsurface environment. PCE and 1,1,1-TCA were the primary materials released to the subsurface, with minor amounts of TCE released as well. Dichlorinated ethenes and ethanes, chloroethane, and vinyl chloride were not used, produced, stored, or released at the GWI Facility. Yet today, concentrations of vinyl chloride and the dichlorinated ethenes are almost as high as the PCE and 1,1,1-TCA. Intrinsic biodegradation, a well documented processes in the subsurface environment, has caused degradation of PCE and 1,1,1 TCA. The natural processes that degrade PCE and TCA to form the other chlorinated ethenes and ethanes, and other natural processes that effect their fate in the environment are the topic of this section.

The biodegradation reactions affecting PCE concentrations at GWI also are producing other PCOCs. Yet, these same processes also are degrading other volatile organic compounds at the facility, especially the volatile components of petroleum products (BTEX and the volatile fraction of TPH). Compared to PCE, these non-chlorinated compounds more readily degrade under aerobic to slightly anaerobic conditions. Since non-chlorinated compounds have been shown to impact the degradation of PCE through a process called co-metabolism, the degradation of volatile petroleum hydrocarbons will be discussed first.

5.2.2 GENERAL PRINCIPALS OF BIODEGRADATION

Many organic contaminants are biodegraded by microorganisms indigenous to the subsurface environment. Since the microorganisms require moisture to live, much of this activity occurs in the groundwater system and the capillary fringe just above the water table. In order for the chemicals to be degraded by the organisms, the chemical must first get to the organism; therefore, the dissolved component is by far the most bioavailable form. Consequently, the potential for biodegradation to occur is generally limited to areas that are saturated (or near saturated) with water and to chemicals that are dissolved in the groundwater.

During biodegradation, dissolved contaminants are ultimately transformed into innocuous by-products such as carbon dioxide, chloride, methane, and water. In some cases, intermediate products of these transformations may be more hazardous than the original compound; however, they may also be more easily degraded. Biodegradation of organic compounds dissolved in groundwater results in both a reduction in contaminant concentrations and a reduction in total contaminant mass.

Chemotrophic organisms (e.g., the most common soil microorganisms) obtain energy for growth and activity from harvesting the chemical energy that is available in food or nutrients. This harvesting is normally performed as a series of coupled redox reactions that use both food and an electron acceptor chemicals to release a net amount of energy for growth. Some of the food and electron receptors are also converted into cell mass.

Under aerobic conditions (in the presence of molecular oxygen) many bacteria couple the oxidation of organic compounds (food) to the reduction of oxygen (from the air or groundwater). However in the absence of oxygen (anaerobic conditions), microorganisms can use other pathways to release energy from nutrients. Anaerobic microorganisms can obtain energy from a variety of carbon-containing foods (electron donors in the redox couple), such as natural organic carbon and many dissolved organic chemicals. The electron acceptor half of the couple (the role normally played by oxygen) is replaced by chemicals such as nitrate, iron (III), sulfate, carbon dioxide, and a variety of the chlorinated solvents.

As electron acceptors and nutrients are depleted by microbial activity during biodegradation of contaminants, their concentrations in the groundwater system decreases, and the organisms must turn to other sources of both nutrients and electron acceptors. When the change is minor, say changing from methanol to ethanol as a carbon or nutrient source, the change may simply result in decreased growth rates (and therefore, decreased degradation rates as the "easy to consume" foods are used first). However, as the shifts to alternate foods and electron receptors become more extreme (for example, shifting from using oxygen to using nitrate), different microorganisms will become dominant. This results in a succession of species of microorganism types adapted to specific energy needs based on the electron acceptors available.

Most organic compounds are degraded by groups of interacting microorganisms, referred to as a consortium. In these consortia, individual types of organisms carry out different specialized reactions which, when combined, can lead to the complete biodegradation of a particular compound. In the presence of electron acceptors such as oxygen, subsurface microbial communities contain the metabolic diversity required to utilize a wide-variety of organic contaminants for growth.

Several of the chemicals released at GWI, such as methanol, alcohols, and ketones, are excellent food sources for microbial growth and were detected in the early 1990's during the RI; however, their concentrations are orders of magnitude lower today and they are no longer PCOCs for the facility. This significant decrease in concentrations is due both to the interim remedial measures taken at the GWI Facility to control the sources and to the effective degradation of these chemicals in the groundwater.

Two major groups of food sources remain at the GWI site:, petroleum hydrocarbons (primarily the volatile components including BTEX); and natural organic materials in the alluvial soil.

5.2.3 BIODEGRADATION OF PETROLEUM HYDROCARBONS

The BTEX family of VOCs are common petroleum constituents that are known to break down predictably, do not form more toxic daughter products, and tend not to migrate great distances. A wealth of information has been accumulated over the past 15 years by both industrial and academic researchers regarding the principle mechanisms influencing petroleum hydrocarbon biodegradation (Appendix J). Various biological processes have been identified which control the rate and extent by which petroleum hydrocarbons degrade under natural conditions. The following sections describe the primary metabolic routes for petroleum hydrocarbon bioremediation.

5.2.3.1 Aerobic Biodegradation of Petroleum Hydrocarbons

Fuel hydrocarbons are most rapidly biodegraded when they are utilized as the primary electron donor for microbial metabolism under aerobic conditions. Biodegradation of fuel hydrocarbons occurs naturally when sufficient oxygen and nutrients are available in soil and groundwater systems. The rate of hydrocarbon biodegradation is generally limited by a lack of oxygen rather than a lack of nutrients such as nitrogen or phosphorus. Therefore, the rate of natural aerobic biodegradation in soil and groundwater systems is largely dependent upon the rate at which oxygen enters the contaminated media.

Biodegradation causes measurable changes in groundwater chemistry. During aerobic respiration, dissolved oxygen concentrations decrease. Concentrations of contaminants also decrease. Concentrations of the degradation products may increase, at least until they in turn are degraded. The aerobic degradation of petroleum hydrocarbons generally produces small, partially oxidized organic chemical intermediates, such as the volatile fatty acids, which are then readily converted to carbon dioxide and cellular bio-mass by a host of microorganisms.

5.2.3.2 Anaerobic Biodegradation of Petroleum Hydrocarbons

The depletion of dissolved oxygen, caused by aerobic biodegradation in soil and groundwater systems with high organic carbon concentrations, results in the establishment of anaerobic conditions. When oxygen is depleted and nitrate is present, some microorganisms will utilize nitrate (NO_3^{-1}) instead of oxygen as a terminal electron acceptor. Because nitrate has a lower electron potential than oxygen, this reaction, although still providing energy to the microorganisms involved, does not provide the same amount of energy and is therefore a less preferred metabolic route.

Once oxygen and nitrate have been depleted, either manganese(IV) and/or ferric iron(III) may be used as a terminal electron acceptor. This degradation route results in elevated concentrations of manganese(III) and dissolved ferrous iron(II). This condition is routinely observed in western Washington sites with petroleum contamination because local soil and groundwater are rich in iron and manganese. This results in high dissolved manganese(III) and iron(II) concentrations in the groundwater. Since these forms of manganese and iron are much more soluble than the oxidized forms, the total concentrations for these metals in groundwater will be significantly increased.

Finally, when ferric iron has been depleted, sulfate, and then carbon dioxide can serve as terminal electron acceptors during oxidation of organic contaminants. Each successive step in this order of electron acceptor preference yields less energy to the microorganisms involved. For this reason, oxygen is the most preferred electron acceptor because microorganisms gain the most energy for aerobic reactions. Sulfate and carbon dioxide are the least preferred because microorganisms gain the least energy from these reactions.

Biodegradation causes measurable changes in groundwater chemistry. In anaerobic systems where nitrate is the electron acceptor, the nitrate is reduced to NO_2^- (nitrite), N_2O, NO, NH_4^+ (ammonia), or N_2. Where iron(III) is the electron acceptor, it is reduced to iron(II), and iron(II) concentrations increase. Where sulfate is the electron acceptor, it is reduced to H_2S (sulfide), and sulfate concentrations decrease. In anaerobic systems where CO_2 is used as an electron acceptor, it is reduced by methanogenic bacteria during methanogenesis, and CH_4 (methane) is produced.

In each of these systems the BTEX constituents are transformed to simple fatty acids and carbon dioxide, which are less mobile, less toxic non-aromatic compounds. Under aerobic conditions, carbon dioxide and water are produced. Under methanogenic conditions, this process eventually produces methane (and some ethane) from both the aromatic and non-aromatic petroleum hydrocarbons. Together these processes decrease the toxicity, concentration, and mass of the contaminant.

5.2.4 GENERAL PATHWAYS OF CHLORINATED SOLVENT BIODEGRADATION

PCE and TCA are common solvents used for degreasing machine parts, commercial dry cleaning, and a host of other commercial and industrial applications. The solvents contain PCE and TCA (i.e., parent compounds) along with manufacturing impurities and degradation products of the parent compounds (i.e., daughter products). Once released into the environment, the parent and daughter compounds undergo further degradation. The primary parent and daughter compounds, along with their name and abbreviation, are shown in Figure 4.2. This group of compounds falls into two groups: chlorinated ethenes and ethanes. Other common chlorinated solvents that undergo similar biological degradation include tetrachloromethane (carbon tetrachloride) and chlorinated benzenes.

Chlorinated solvents are degraded by soil microorganisms using one of three common biological degradation pathways. These processes have been well studied; key references are listed in Table 5.2. The first two biodegradation mechanisms (reductive dechlorination and aerobic biodegradation) are essentially equivalent to the anaerobic and aerobic pathways described above for petroleum hydrocarbons; the two pathways use the chlorinated solvents as either the food source or as an electron acceptor in redox reactions. Food sources (the electron donors) include natural organic material, petroleum hydrocarbons, alcohols, ketones, and the less oxidized chlorinated ethenes and ethanes, such as vinyl chloride, chloroethane, and the DCE isomers. The most common naturally occurring electron acceptors in groundwater include dissolved oxygen, nitrate, manganese (IV), iron (III), sulfate, and carbon dioxide. In addition, the more oxidized chlorinated solvents such as PCE, TCE and TCA, and polychlorinated benzenes can act as electron acceptors under favorable conditions. Under aerobic conditions, dissolved oxygen is used as the terminal electron acceptor during aerobic respiration. Under anaerobic conditions, the electron acceptors will go through the same progression as for anaerobic degradation of petroleum hydrocarbons.

The third biodegradation mechanism for chlorinated solvents is co-metabolism. During co-metabolism, the compound being degraded does not benefit the organism. Instead, degradation is brought about by a fortuitous reaction wherein an enzyme produced during an unrelated reaction degrades the organic compound.

5.2.4.1 Reductive Dechlorination of Chlorinated Ethenes

The most important process for the natural biodegradation of the more highly chlorinated solvents is reductive dechlorination. At GWI, this process is degrading more than 95 percent of the PCE and 100 percent of the TCA that reaches groundwater. During this process, the chlorinated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a chlorine atom is removed and replaced with a hydrogen atom. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to VC to ethene. Depending upon environmental conditions, this sequence may be interrupted, with other processes acting upon the products. Note that since the chlorinated ethene is being used as the electron acceptor rather than oxygen, this process only occurs in the absence of oxygen and is, therefore, an anaerobic process.

Actual mechanisms of reductive dehalogenation are still unclear, and in some cases may be a form of co-metabolism (Gantzer and Wackett 1991; Adriaens and Vogel 1995; Wackett 1995). In addition, other factors that will influence the process include the type of electron donor and the presence of competing electron acceptors (Adriaens and Vogel 1995; Suflita and Townsend 1995), temperature, and substrate availability.

During reductive dechlorination, all three isomers of DCE can theoretically be produced. However, under the influence of biodegradation, *cis*-1,2-DCE is a more common intermediate than *trans*-1,2-DCE, while 1,1-DCE is the least prevalent of the three DCE isomers formed. This relative distribution of DCE isomers is found at the site. Reductive dechlorination of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in the concentration of chloride ions. Reductive dechlorination affects each of the chlorinated ethenes differently. Of these compounds, PCE is the most susceptible to reductive dechlorination because it is the most oxidized. Conversely, VC is the least susceptible to reductive dechlorination because it is the least oxidized of these compounds.

Consequently, the rate of reductive dechlorination decreases as the degree of chlorination decreases. This decrease in degradation rates may explain the accumulation of VC in PCE and TCE plumes that are undergoing reductive dechlorination. Reductive dechlorination has been demonstrated under nitrate- and iron-reducing conditions, but the most rapid biodegradation rates, affecting the widest range of chlorinated aliphatic hydrocarbons, occur under sulfate-reducing and methanogenic conditions (Bouwer 1994). Measurements of sulfide and methane at the GWI site indicate these conditions are present.

Because chlorinated solvents are used as electron acceptors rather than electron donors during reductive dechlorination, an appropriate source of carbon for microbial growth is required in order for this process to occur. Some of the carbon sources documented as supporting reductive dechlorination include low molecular weight organic compounds (lactate, acetate, methanol, glucose, etc.), fuel hydrocarbons (BTEX), by-products of fuel degradation (e.g., volatile fatty acids and methane), or naturally occurring organic matter.

Thus, highly chlorinated compounds such as PCE, TCE, TCA, or hexachlorobenzene (HCB) are more likely to undergo reductive reactions than oxidative reactions. During these reductive reactions, electrons are transferred to the chlorinated compound, and a chlorine atom is replaced with a hydrogen atom. As an example, consider the reductive dechlorination of PCE to TCE and then TCE to DCE, and finally DCE to VC. Because of the relatively low oxidation state of VC, this compound more commonly undergoes aerobic biodegradation as a primary substrate than reductive dechlorination.

Reductive dechlorination processes result in the formation of intermediates that are more reduced than the parent compound. These intermediates are often more susceptible to oxidative bacterial metabolism than to further reductive anaerobic processes.

5.2.4.2 Aerobic Biodegradation of Chlorinated Ethenes

Biodegradation of organic compounds is often an aerobic process that occurs when indigenous populations of microorganisms are supplied with the oxygen and nutrients necessary to utilize organic carbon as an energy source. The biodegradation of fuel hydrocarbons occurs rapidly under aerobic conditions and is discussed in Wiedemeier et al. (1995a). Some pollutants, especially the highly oxidized chlorinated hydrocarbons (i.e., those containing more chlorine), are biologically recalcitrant under aerobic conditions. However, some of the less chlorinated ethenes and ethanes such as DCE, VC, and 1,2-DCA, and many of the chlorinated benzenes can be utilized as a carbon source (food) and oxidized under aerobic conditions. During aerobic biodegradation (oxidation) of chlorinated solvents, the facilitating microorganism obtains energy and organic carbon from the degraded solvent.

Of the chlorinated ethenes, vinyl chloride is the most susceptible to aerobic biodegradation, and PCE is the least susceptible. Of the chlorinated ethanes, 1,2-DCA is the most susceptible to aerobic biodegradation, while TCA, tetrachloroethane, and hexachloroethane are less susceptible. Chlorinated benzenes with up to four chlorine atoms (i.e., chlorobenzene, dichlorobenzene, trichlorobenzene, and tetrachlorobenzene) also have been shown to be readily biodegradable under aerobic conditions (Spain 1996).

Using microcosms from two different sites with no prior history of exposure to DCE, Klier*et* al. (1998) showed that all three isomers of DCE (i.e., 1,1-DCE, *cis*-1,2-DCE, and *trans*-1,2-DCE) can be biodegraded in aerobic systems. In these experiments, it was observed that *cis*-1,2-DCE degraded more rapidly than the other isomers. Hartmans et al. (1985) and Hartmans and de Bont (1992) showed that VC can be used as a primary substrate under aerobic conditions, with VC apparently being directly mineralized to chloride, carbon dioxide and water. This has been reported by Davis and Carpenter (1990) too. Aerobic biodegradation is rapid relative to other mechanisms of VC degradation, especially reductive dehalogenation.

5.2.4.3 Co-metabolic Biodegradation of Chlorinated Ethenes

When a chlorinated solvent is biodegraded through co-metabolism, it serves as neither an electron acceptor nor as food in a biologically mediated redox reaction. Instead, the degradation of the compound is catalyzed by an oxygenase enzyme that is fortuitously produced by organisms for another purposes. Oxygenase enzymes catalyze the initial step required for degradation of other food sources (BTEX or other organic compounds); that is, their job is to partially oxidize the carbon-to-carbon backbone of the organic food source. These oxygenases are typically nonspecific and, therefore, fortuitously promote oxidation of a variety of compounds, including many of the chlorinated solvents (McCarty and Semprini 1994). Consequently, the microorganism involved receives no known benefit from the degradation of the chlorinated solvent, and in some cases may be harmed by the process (McCarty and Semprini 1994).

Chlorinated solvents are usually only partially transformed during co-metabolic processes, with additional biotic or abiotic degradation generally required to complete the transformation (McCarty and Semprini 1994). Co-metabolism is best documented for chloroethenes in aerobic environments. Strong evidence for the co-metabolism of chlorinated benzenes and for anaerobic co-metabolic processes is still being sought. Currently most researchers believe that in an aerobic environment, many chlorinated organic compounds can only be degraded via co-metabolism, and that the rate of co-metabolism increases as the degree of dechlorination decreases.

5.2.4.4 Summary

The more chlorinated ethenes (PCE and TCE) degrade best by reductive dechlorination under anaerobic conditions to form DCE and VC. Under these conditions, DCE and VC will continue to degrade to harmless metabolites, but at a slower rate than for PCE and TCE. This results in the following:

- A net loss of chlorinated ethenes which degrade past VC.
- A temporary accumulation of DCE and VC.

DCE and VC degrade rapidly under aerobic conditions, where PCE and TCE are slow to degrade. Therefore, the best bioreactor (natural or man-made) consists of an anaerobic cell to convert PCE and TCE to DCE and VC, followed by an aerobic cell to convert DCE and VC to carbon dioxide.

5.2.5 BEHAVIOR OF CHLORINATED SOLVENT PLUMES

The behaviors described above can be broken into three principle behavior types (Type I, Type II, and Type III) depending on the carbon source (electron donor) available for microbial consumption and the type, concentration, and distribution of electron acceptors. A single plume may exhibit one or all of these behavior types at different locations throughout the plume.

5.2.5.1 Type I Behavior

Type I behavior occurs where the primary substrate is anthropogenic carbon (e.g., petroleum hydrocarbon or landfill leachate), and microbial degradation of this anthropogenic carbon drives reductive dechlorination. Type I behavior results in the rapid and extensive degradation of the more highly chlorinated solvents such as PCE, TCE, and DCE, and is characterized by low dissolved oxygen (DO) concentrations, low (less than -50) Oxidation Reduction Potentials (ORP), and by high levels of labile carbon (i.e., easy to eat carbon sources).

5.2.5.2 Type II Behavior

Type II behavior dominates in areas that are characterized by relatively high concentrations of biologically available <u>native</u> organic carbon. Microbial utilization of this natural carbon source drives reductive dechlorination (i.e., it is the primary substrate for microorganism growth). Type II behavior generally results in slower biodegradation of the highly chlorinated solvents than Type I behavior, but under the right conditions (e.g., areas with high natural organic carbon contents), this type of behavior also can result in degradation rates comparableto those of Type I behavior.

5.2.5.3 Type III Behavior

Type III behavior dominates in areas that are characterized by inadequate concentrations of native and/or anthropogenic carbon and concentrations of dissolved oxygen that are greater than 1.0 mg/L. Under these aerobic conditions, reductive dechlorination will not occur. The most significant natural attenuation mechanisms for PCE, TCE, and DCE will be advection, dispersion, sorption, and possibly co-metabolism. However, DCE, VC, ethene and ethane can be rapidly oxidized under these conditions.

5.2.5.4 Mixed Behavior

As mentioned above, a single chlorinated solvent plume can exhibit all three types of behavior in different portions of the plume. This can be beneficial for natural biodegradation of chlorinated solvent. For example, Wiedemeier *et* al. (1996a) describes a plume at Plattsburgh AFB, New York, that exhibited Type I behavior in the source area and Type III behavior downgradient from the source. The most fortuitous scenario involves a plume in which PCE and TCE undergo reductive dechlorination with accumulation of DCE and VC near the source area (Type I or Type II behavior), then both DCE and VC are oxidized aerobically (Type III behavior) further downgradient. DCE and VC are readily oxidized to carbon dioxide in this type of plume and do not tend to accumulate.

A less desirable scenario, but one in which all contaminants may be entirely biodegraded, involves a plume in which all chlorinated solvents are reductively dechlorinated via Type I or Type II behavior. DCE and VC degrade more slowly under anaerobic conditions and therefore tend to accumulate. This results in increased residence times and longer plume lengths. If the plume is not impacting a receptor or presenting a risk to human health, this scenario may be acceptable. When these conditions present a risk to human health or an environmental receptor, modification of conditions to increase degradation may provide an acceptable solution.

5.3 FATE AND TRANSPORT OF CHEMICALS AT THE GWI SITE

5.3.1 RESIDUAL DNAPL MIGRATION

The pure chlorinated solvents, such as PCE and TCE, are denser (heavier) than water. Consequently, when they are present as residual product in the environment they form dense non-aqueous phase liquids (DNAPL). The movement of DNAPL in the subsurface is well understood. The primary characteristics of DNAPL movement relevant to the GWI Facility are as follows:

- DNAPL, present at concentrations greater than residual saturation, will flow vertically downward due to gravitational forces. This flow continues downward through both unsaturated and saturated soil and is not significantly inhibited by the presence of groundwater. The downward flow path in most soil looks likes fingers (or threads) of contamination moving downward through the soil.
- Silty sands, silts, and clay layers tend to stop or slow the downward migration of DNAPL. The smaller pores of the fine-grained units are more difficult for the solvent to penetrate, so it tends to accumulate on the surface and flow down the surface of the fine-grained unit to the lowest point (along the sloping upper surface of the silt layer) where it will "pool" if sufficient volume is present.
- DNAPL can exist as isolated droplets in the subsurface where the concentrations are insufficient to form a free flowing product. These droplets of DNAPL, especially when they are located along the upper surface of a silt layer, can act as a significant 'secondary' source of on-going groundwater contamination due to their relative high surface area and contact with the overlying groundwater.

During their 1993 site investigation, Hart Crowser identified likely sources of DNAPL at the GWI Facility (Hart Crowser 1993): The sources were as follows:

- The pipe trench area formerly located between the West Shed and the Drum Shed.
- The Drum Shed and the portion of the former S. Frontenac Street located south and east of Drum Shed.
- The Fox Avenue S. loading dock, located on the southwest side of the Main Warehouse.

There were four possible destinations for DNAPL released at these locations: evaporation into the atmosphere; cleanup and off-site disposal; runoff, capture and off-site transport by the storm water or sanitary sewer system; and, infiltration into the ground. Presumably, almost all DNAPL released from leaking underground pipes and tanks would have infiltrated into the ground.

Therefore, none or only a portion of the surface releases and most of the subsurface releases would have infiltrated into the subsurface.

Subsurface releases would mainly have occurred from underground tanks and piping. These were located in the west and north of the drum shed. Consequently, the largest volume of DNAPL probably entered the ground in this area.

DNAPL migrating though the unsaturated zone would have flowed both downward and laterally, depending on the fill composition and the geometry of the upper surfaces of the shallow silty sands and silt (Figures 2.15 and 2.16). The DNAPL would have had to flow through at least 10 to 13 feet of unsaturated fill and silty soil and at least 3 to 4 feet of saturated sand and silty sand to reach the 1st Silt Horizon (1st SH). Depending on the total amount of lateral displacements, the overall flow path(s) could have been longer than 13 to 17 feet.

Only a portion of the DNAPL that infiltrated the ground would have reached the 1st SH. A portion would have been retained in the soil as "residual saturation", some could have "perched" and remained on a low permeability soil or fill layer; some would have evaporated into the soil vapor, and some would have dissolved into the groundwater. However, portions of large releases would have reached the 1st SH.

DNAPL that did reach the 1st SH could have flowed through it or along the top of it because of its variable thickness, surface geometry and composition. The 1st SH varies in thickness up to approximately 2.5 feet. The west shed and drum shed are located near topographic highs on the 1st SH (Figure 2.17).

Beneath the former South Frontenac Street, the top of the 1st SH dips to the south and descends to an elevation of less than 3 feet (CSD). There is a depression in the 1st SH beneath the loading dock. At locations where the silt thins, has convergent surface topography, or has higher sand content, DNAPL could have seeped into the 2nd WBZ. At locations where the silt is thicker, has a more steeply dipping surface, or has a higher silt and clay content, the DNAPL is more likely to have flowed laterally down the silt surface toward a depression or the edge.

DNAPL has reached the 1st SH in sufficient quantity to have formed a residual DNAPL layer near Well B-12. This well is located in the western part of the secondary source area (Figure 5.1). It is not clear why the DNAPL accumulated at this location. The structure contour map for the top of the 1st SH (Figure 2.17) indicates the top of the silt dips to the southwest at this location. However, small topographic features that could trap up to a few tenths of a foot of DNAPL cannot be resolved with this type of data.

The DNAPL appears to be trapped in and on the 1st SH. This unit has a relatively low hydraulic conductivity. Consequently, DNAPL is likely to remain in place unless it can build up a pressure head causing it to displace water in the pores of the silt layer and sink. However, because the DNAPL source was stopped over 10 years ago, it is unlikely to acquire additional head. Therefore, the DNAPL within the 1st SH is essentially contained. It is also resistant to remediation technologies that depend on groundwater to move the dissolved DNAPL to the remedy.

Groundwater monitoring data from Well B-45 suggests DNAPL was not present in the lower portion of the 2nd WBZ. In contrast, DNAPL is present in Well B-12, whose screen is located above Well B-45's screen and above the 1st SH. This information suggests that a large enough volume of DNAPL, to reach the lower portion of the 2nd WBZ did not flow past the location of Well B-12.

Groundwater monitoring data suggests that a relatively small volume of DNAPL was present in the 2nd WBZ in the vicinity of well B-8 when the well was constructed in 1990. Although it is possible the DNAPL was carried down during drilling, it is also possible the DNAPL was present in the formation. Recent monitoring data from well B-8, and wells B-45 and B-61, which are downgradient from B-8, suggest DNAPL currently is not present as measurable ganglia or pools in the lower portion of the 2nd WBZ. In summary, the available data suggests groundwater contamination currently detected in the 2nd WBZ is there due to the combination of the following processes: (1) downward migration of dissolved contaminants from the 1st WBZ through the hole in the 1st SH; (2) historical migration of DNAPL from the 1st WBZ into the 2nd WBZ through the 1st SH (no measurable DNAPL has been detected in the 2nd WBZ, but residual droplets are possible); and (3) desorption from residual soil contamination in the 2nd WBZ.

5.3.2 MIGRATION AND DEGRADATION OF DISSOLVED COMPONENTS

The chlorinated solvents are soluble, volatile, and partition into both groundwater and soil vapor. The residual PCE product in the "secondary source area" will dissolve into groundwater of the 1st WBZ and be transported downgradient from the source area. Eventually the dissolved fractions will discharge into the S. Myrtle Street Embayment (Table 5.1). Additionally, active degradation of these solvents is occurring at the site.

The following subsections will trace the biodegradation of a finite mass of PCE as it travels through the secondary source area at GWI and toward the S. Myrtle Street Embayment of the Duwamish River. During this discussion, the factors influencing PCE transformation to its breakdown products (ethene and chloride) will be discussed.

5.3.2.1 Secondary Source Area

Within the secondary source area at GWI, both PCE and petroleum hydrocarbons have impacted the vadose zone soil and the 1st WBZ groundwater (Section 4.3). Both dissolved PCE and TCE have (by advective groundwater flow) traveled southwest towards Fox Avenue S. The shape and location of the PCE and TCE plumes are shown in Figures 5.1 through 5.4.

Within the source area, dissolved oxygen in groundwater has been depleted as a result of aerobic degradation of the labile hydrocarbons present (methanol, ketones, toluene and other volatile petroleum hydrocarbons). This has resulted in the sequential utilization of secondary electron acceptors for anaerobic biodegradation of these hydrocarbons and increased concentrations of ammonia, ferrous iron, sulfide, and methane (Section 4.4). With the depletion of these secondary electron acceptors, a reducing environment has been established which is conducive to the rapid reductive dechlorination of PCE and TCE and the formation of DCE (greater than 90 percent as the cis isomer), vinyl chloride, ethene, and chloride within the 1st WBZ groundwater. The formation of cis-1,2-DCE, VC, ethene, and chloride is further evidence of reductive dechlorination of PCE and TCE within this region.

PCE is present within the 2nd WBZ beneath the source area, but at a concentration that is four orders of magnitude less than the concentration of PCE in the 1st WBZ (Figure 5.2). The reduced concentration is due to an absence of DNAPL present within a topographic low in the 1st SH within the vicinity of Well B-12. The presence of the 1st SH within the source area has prevented the downward migration of DNAPL and greatly reduced PCE impact within the 2nd WBZ beneath the GWI Site. The presence of low level dissolved concentrations of PCE and TCE in the 2nd WBZ below the source area results from groundwater mixing between the 1st and 2nd WBZ downgradient of the source area, and groundwater reversals produced by high tidal stage in the Duwamish River (Section 2).

The 1st WBZ within the GWI source area displays classic Type I plume behavior (Section 5.2.5.1), as evidenced by the absence of dissolved oxygen, the production of dechlorination daughter and end products, the accumulation of reduced electron acceptor species and the presence of strong reducing conditions along with high concentrations of hydrocarbon donor compounds known to support reductive dechlorination (i.e., methanol, MEK, and toluene).

The 2nd WBZ beneath the GWI property displays Type II plume behavior, in that many of the same indicators found in the 1st WBZ are present, yet there is too little anthropogenic carbon present to support dechlorination.

5.3.2.2 Soil Vapor

In the 1st WBZ, dissolved chlorinated ethenes and ethanes are partitioning into the vapor phase and migrating through advective and diffusive transport in overlying vadose zone soils. At the GWI site, and particularly in the secondary source area, this phenomenon has been confirmed by numerous soil vapor sampling events (Section 4.3.1.2). These sampling events have demonstrated that chlorinated ethenes and ethanes present in the groundwater generally coincide with those present in the vadose zone.

Once reaching the vadose zone volatile compounds can migrate to the surface, dissolve in soil moisture, or travel laterally within the vadose through the processes of advection and diffusion. Within the vadose zone, little or no degradation of chlorinated ethenes and ethanes is suspected to occur given the aerobic conditions that probably exist, with the exception of degradation VC. For VC, aerobic biodegradation is rapid relative to other mechanisms of degradation, especially reductive dehalogenation. Once reaching the ambient atmosphere, compounds like PCE and VC can be expected to exist mainly in the vapor phase. These compounds are expected to degrade rapidly in air by reaction with photochemically produced hydroxyl radical.

The release of soil vapor to the ambient air produces potential human health exposure pathways for outdoor and indoor air at the GWI site. Methylene chloride and chlorinated ethenes and ethanes were detected in indoor air samples collected during the June 9 and July 12, 2000 sampling events. VC was not detected in either indoor or outdoor air samples collected during either sampling event. To date, it has not been determined whether the presence of indoor air contaminants results from a release of contaminated soil vapor or represents area background conditions at the facility.

5.3.2.3 Fox Avenue S. and the Hole

Immediately south of the secondary source area, near Wells B-45, B-60/61 and B-62/63 the 1st SH disappears, producing an area referred to as the Fox Avenue hole. This hole in the 1st SH allows groundwater from the 1st and 2nd WBZ to mix as a result of fluctuations in hydraulic gradient due to changes in tidal stage at the Duwamish River (Section 2.4). The presence of this hole and the mixing which occurs as a result have a profound effect on the biodegradation of PCE and TCE at this site.

The 1st WBZ groundwater with high concentrations of both chlorinated solvent parent and daughter products, along with hydrocarbon donors, travels downgradient from the source area. The groundwater is then drawn into the Fox Avenue hole where the highly reducing conditions present within the source area along with the anoxic nature of this deeper groundwater system combine and produce ideal conditions for the continued reductive dechlorination of PCE and TCE within the 2nd WBZ (Section 5.2.4.1). Figures 5.1 through 5.4 depictPCE and TCE loaded groundwater as it enters the hole and how the concentrations of these two compounds in the 2nd WBZ rapidly decrease. As this mixing occurs, the rate of DCE and VC production increases. The accumulation of DCE and VC within the 2nd WBZ at and downgradient of the Fox Avenue hole is the result of two factors:

1) The conditions present are not reducing enough for rapid conversion to ethene, and yet are too reducing to cause aerobic degradation of DCE and VC to carbon dioxide and chloride.

2) The hydrocarbon electron donors which were supporting reductive dechlorination closer to the source area have been depleted.

Figures 5.5 through 5.8 illustrate the rapid rate of DCE and VC accumulation within the 2nd WBZ. The concentrations of ethene and methane also decline with downgradient distance within the 2nd WBZ; however, the concentration of chloride continues to increase. These observations are indicative of continuing reductive dechlorination at rates sufficient to produce elevated chloride concentrations (greater than background) but are not rapid enough to prevent DCE and VC accumulation.

The complex 3-dimensional shape of this system, including the contours of PCE, TCE, DCE, and VC have been produced on cross sections A-A', and are shown as Figures 5.9 through 5.12. In cross section view, the of PCE can be seen "dropping" into the hole, followed by its degradation to TCE. The TCE continues to degrade in the 2nd WBZ to produce DCE and VC (Figures 5.11 and 5.12), which move by advective flow to the Duwamish River.

Finally, Figure 5.13 combines this information by overlaying concentration graphs (see right hand axis) with distance along the length of the cross section. Note that the original source material in the 1st WBZ (PCE and TCE) converts to DCE and VC beginning in the hole and continuing as the plume moves toward the Duwamish River.

As groundwater from the 1st WBZ migrates downgradient past the area of the Fox Avenuehole, the concentration of PCE and TCE within it begins a slow steady decline. This decline is caused, in part, from dilution (i.e., mixing with downgradient groundwater in both the 1st and 2nd WBZs) and in part from a decline in reductive dechlorination. This decrease in reductive dechlorination results from the depletion of the electron donor and from the infiltration of oxic precipitation into the 1st WBZ from unpaved areas immediately south of the source area. The concentrations of DCE and VC within the 1st WBZ downgradient of the Fox Avenue hole rapidly decline with distance from the source area because of direct aerobic biodegradation of these two compounds. The concentration of both ethene and methane display this same trend within the 1st WBZ at and downgradient of the Fox Avenue hole .

The Fox Avenue hole and the area between it and Wells B-64/65 demonstrate both Type I and Type II plume characteristics within the 2nd WBZ. The 1st WBZ within this same portion of the plume tract demonstrates Type III behavior, with oxidizing conditions, the absence of anthropogenic hydrocarbon donors and the rapid oxidative degradation of chlorinated solvent daughter products.

5.3.2.4 Northern End of Fox Avenue

As the contaminated groundwater plume leaves the secondary source area, it approaches the Fox Avenue hole and breaks into two discrete flow paths as it travels toward the S. Myrtle Street Embayment. The principle flow path is toward the Fox Avenue hole; however, a second flow path takes contaminated groundwater north of the hole toward monitoring well cluster B-58/59 (installed in the 1st and 2nd WBZs, respectively). For discussion purposes, this area north of the hole is know as the northern end of Fox Avenue.

The factors influencing the composition of dissolved COCs in wells B-58 and B-59 include the high BOD in the secondary source area, the presence of a surface cap (i.e., pavement), the 1st SH, and advection and dispersion at the Fox Avenue hole. The impact of these factors on the composition of COCs at well cluster B-58/59 is as follows:

- The high BOD at the secondary source area contributes to the reducing conditions at well B-58, because groundwater flowing from the secondary source area is depleted of electron acceptors and donors. This condition leads to a lower parent-daughter ratio at well B-58, compared to the secondary source area.
- The surface pavement overlying N. Fox Avenue inhibits the infiltration of aerobic surface water to the 1st WBZ, further contributing to the reducing conditions seen at well B-58. These reducing conditions are exemplified by elevated methane concentrations at well B-58.
- The 1st SH prevents groundwater from the 1st WBZ (which is relatively aerobic compared to the 2nd WBZ) from entering the 2nd WBZ. This further contributes to the anaerobic conditions and the production of daughter products.
- Strong downward flow gradients and relatively high groundwater velocities suggest advection is dominate at the Fox Avenue hole, thus limiting the lateral extent of the plume. Limited transverse dispersion of COCs originating in the secondary source area is demonstrated by the low concentrations of COCs at well B-59, and by a lack of chloride, which is abundant in the groundwater in the secondary source area.

5.3.2.5 S. Myrtle Street and Seeps

Further downgradient from the Fox Avenue hole near Wells B-64/65 and B-33A/34 on S. Myrtle Street, the 1st SH is again present. This area is highly influenced by tidal changes in the

Duwamish River and by the resulting groundwater reversals. These groundwater reversals produce three unique conditions:

1) They increase the residence time of DCE and VC within the 2nd WBZ between Fox Avenue S. and S. Myrtle Street.

2) They increase groundwater dissolved oxygen (DO) concentrations in the 1st WBZ by introducing oxygenated surface water during high tidal stages.

3) They mix surface water with groundwater, further reducing the concentration of DCE and VC by dilution with surface water.

As 1st WBZ groundwater containing PCE and TCE reaches S. Myrtle Street, it mixes with surface water from the Duwamish River and eventually (during low tidal stage) discharges to the S. Myrtle Street Embayment through Seeps S-1 and S-2. Due to the parent to daughter chemical ratio present at these seeps, it has been inferred that 1st WBZ groundwater discharging at Seep S-2 is primarily impacted by contaminants which have traveled downgradient from N. Fox Avenue within the 1st WBZ. This inference is based on the higher concentrations of parent compounds (PCE and TCE) present at this seep compared to those present at Seep S-1. The oxic conditions affecting the 1st WBZ groundwater within this plume path and the lack of petroleum hydrocarbon (BTEX) donor available to drive/support DO reduction and reductive dechlorination has resulted in parent product enrichment (Type III plume behavior).

Groundwater discharging from Seep S-1 contains very low concentrations of both parent compounds (PCE and TCE) and daughter compounds (DCE and VC). The difference in chlorinated solvent concentrations observed at Seep S-1 compared to those at Seep S-2 are consistent with the following observations:

- Groundwater discharging from Seep S-1 has emanated from the GWI source areas; consequently, it contains both PCE and TCE along with petroleum hydrocarbon donor compounds. These donors have, as previously stated, supported/driven reductive dechlorination and conversion of PCE and TCE to DCE and VC.
- As the 1st WBZ groundwater within this plume travels downgradient, it experiences additional Type II dechlorination, further transforming TCE and DCE to VC and ethene.
- When the groundwater comprising the S-1 discharge volume reaches S. Myrtle Street, infiltrating surface water from the Duwamish River drastically increases both DO and oxidation reduction potential (ORP). The DCE, VC, and ethene contained in this water are aerobically biodegraded to ethane and carbon dioxide (classic Type III plume behavior).

Groundwater discharging to the S. Myrtle Street Embayment from Seep S-13 originates from the 2nd WBZ and contains high levels of the daughter products DCE and VC and of ferric iron, which deposits as a band on the surface of the marine sediment comprising the north face of the Embayment around Seep S-13. The concentration of DCE and VC in 2nd WBZ groundwater collected from Well B-33A at S. Myrtle Street contains the same ratio of DCE to VC (1:1) as the groundwater discharging from Seep S-13. The presence of high concentrations of DCE and VC at Seep S-13 is a result of the anaerobic conditions present in the 2nd WBZ between Fox Avenue and S. Myrtle Street, and the inability of the 2nd WBZ to support aerobic biodegradation of DCE and VC. The aerobic degradation of DCE, VC, and ethene in this 2nd WBZ groundwater does not occur until the groundwater encounters the more oxidized conditions in the sediment of the Embayment, and beneath S. Myrtle Street. In addition to the chlorinated solvent daughter products present, increases in petroleum hydrocarbons (BTEX), ethene, methane, and chloride are all observed in samples collected from Well B-33A and Seep S-13.

The plume conditions within the 1st WBZ beneath S. Myrtle Street and at the Embayment seeps indicate that Type III conditions are prevalent at these locations, whereas within the 2nd WBZ Type II plume conditions continue to dominate the biodegradation process.

5.3.3 NATURAL ATTENUATION OF DISSOLVED CONTAMINANTS OF CONCERN AT GWI

The conceptual site model for the GWI site, as presented in Section 5.3.2, describes the migration and degradation of PCE and its daughter products, from the secondary source area to the seeps of the S. Myrtle Street Embayment of the Duwamish River. The COCs present in the secondary source area (PCE, TCE, DCE, and VC) go through various biologically mediated transformations as they migrate downgradient to the S. Myrtle Street Embayment. The biological transformation of PCE, TCE, DCE, VC, and ethene has been well explored along the groundwater flow path and abundant evidence demonstrating the processes contributing to bio-transformations has been collected. Factors controlling this biological transformation include the reducing or oxidizing (redox) conditions present in the 1st and 2nd WBZs and the availability of various geochemical constituents (e.g., dissolved oxygen, ferrous iron, methane, and carbon sources). Section 4.4 discusses the redox conditions in the 1st and 2nd WBZs and the nature and extent of geochemical constituents and metabolic gases present under various redox conditions at the GWI site. The hydrogeology of the GWI site also influences the conceptual site model for the degradation and migration of chlorinated ethenes. Section 2.2 discusses the hydrogeology of the GWI site.

This section of the SRI presents the evidence supporting the conclusion that reductive dechlorination of PCE and TCE is occurring at the GWI site and that natural attenuation is an effective treatment method for these COCs. A planar view of the various elements of the conceptual site model (e.g., Fox Avenue hole) developed in Section 5.3.2 is shown in Figure 5.14. Figure 5.15 presents a summary of the evidence that is available to support the conclusion that natural attenuation of PCE and TCE is occurring in the manner predicted by the site conceptual model. This summary uses a cross sectional view of the GWI site to illustrate the progression of the natural attenuation process as PCE and TCE travel from the secondary source area to the S. Myrtle Street Embayment. Appendix J discusses the evidence supporting the site conceptual model that is summarized in this Section. It provides supporting information on the principle factors responsible for the degradation of PCE and TCE.

This section, including Figures 5.14 and 5.15, supports the lines-of-evidence approach developed by the EPA. Appendix J presents the evidence that natural attenuation of dissolved chlorinated ethenes is occurring at the site. Additionally, Appendix J discusses monitored natural attenuation as it relates to the site-wide remedy. It provides supporting information on the principle factors responsible for these bio-transformations and uses qualitative data to demonstrate that bio-transformations are occurring. Based on this evidence, it is clear that biodegradation has a major impact on the fate and transport of COCs as groundwater in both the 1st and 2nd WBZs travels from the secondary source area to the S. Myrtle StreetEmbayment of the Duwamish River.

To facilitate the discussion of reductive dechlorination, and lines-of-evidence that support it within the conceptual site model, the concentrations of COCs in this Section are discussed in units of micro moles per litter (µmols/L). A molar concentration more accurately reflects the principal of the conservation of mass (compared to the concentration units µg/L) as PCE degrades to its daughter products (e.g., TCE and DCE). A more detailed discuss on the rationale for the use of molar concentrations is presented in Appendix J.

5.3.3.1 Original Source Area

The original source area is located in the northeast corner of the GWI site. This portion of the site historically contained USTs and connecting piping. The USTs and connecting piping held and distributed both PCE and petroleum hydrocarbons within the GWI facility. Releases of these compounds have impacted the vadose zone soils and groundwater of the 1st WBZ (see Figures 4.5 and 5.1). These compounds (PCE dominated DNAPL and dissolved and co-solvent petroleum hydrocarbons) have traveled southwest to Frontenac St. At this location, DNAPL has reached the 1st SH and collected in a topographic depression (see Figure 2.18 and well B-12). For purposes of the conceptual site model, this area of GWI site has been identified as the secondary source area. The impact of the contaminant composition and redox conditions in the secondary source area on the nature and extent of PCE and daughter product at the GWI site is presented below.

5.3.3.2 Secondary Source Area

The secondary source area is located at the southern edge of the GWI property. The area is characterized by a localized depression in the 1st SH in the vicinity of monitoring well B-12 (see Figures 2.18 and 4.4). The DNAPL present within this depression is principally composed of PCE and is co-mingled with biodegradation products, pentachlorophenol and petroleum hydrocarbons. Well B-12, and surrounding wells, B-39, B-46, B-47, B-12, B-44, B-42 and B-49, define the secondary source area (see Section 4.3 and Figure 5.14).

The predominant COC within the 1st WBZ in the secondary source area is PCE. Also present are the daughter products of PCE reductive dechlorination, which include TCE, cis-DCE, VC, and ethene (see Section 5.2). Based on the µmols/L of PCE and daughter compounds that were measured in secondary source area wells (screened in the 1st WBZ), 64 percent of the COCs present in the secondary source area are parent compounds, while the remaining 36 percent of the COCs are the daughter compounds (DCE and VC). In addition to these COCs, dissolved ethane, methane, and chloride are present at concentrations far greater than local background concentrations.

Reductive dechlorination of PCE and its daughter compounds results in the formation of ethene, which under highly reducing conditions (as in the secondary source area) can result in the formation of methane. As PCE is transformed to ethene, chloride is released during each sequential dechlorination step from parent compound to daughter products. The release of chloride, the production of methane, and the presence of PCE degradation daughter products are evidence that support the conclusion that reductive dechlorination is occurring in the secondary source area.

Additional evidence to support the redox conditions observed in the secondary source area is the presence of anthropogentic carbon sources, which provide energy for microbial growth via oxidation reduction reactions. These carbon sources (found in the secondary source area) include toluene, ethylbenzene, xylenes, 1,2,4-trimethylbenzene, naphthalene, paint thinner, and Stoddard solvent. Historically, other compounds may also have acted as electron donors, including methanol, methyl ethyl ketone, isopropanol and methyl isobutyl ketone.

5.3.3.3 Fox Avenue Hole

Groundwater and COCs leaving the secondary source area travel in a southwesterly direction toward Fox Avenue S. The groundwater in the 1st WBZ separates into two groundwater flow paths at this location before it discharges at the S. Myrtle Street Embayment (see Figure 5.14). The two flow paths are influenced by groundwater elevations, tidal fluctuations, and by the proximity of the hole in the 1st SH to the secondary source area (Section 5.3.2.3). The dominant flow pathway is through the hole to the 2nd WBZ, while the other flow path is north of the hole through the 1st WBZ. North of the hole, the 1st SH separates the 1st and 2nd WBZs (see Section 5.3.2.4).

The Fox Avenue hole is defined by an area were the 1st SH is absent and strong downward vertical groundwater gradients are present (see Section 2.4.4.4). This results in groundwater from the 1st WBZ flowing into the 2nd WBZ. The total molar concentration of COCs at the Fox Avenue hole (as measured at wells within the hole – see Figure 5.14) in the 2nd WBZ is 422 µmols/L. This represents a 24 percent decline in the total concentration of COCs compared to their total concentration in the secondary source area (556 µmol/L). The decline can be attributed to both the dispersion of the COCs entering the hole and to reductive dechlorination. Evidence of mechanical dispersion can been seen by the decline in the concentration of chloride at the hole, when compared to the concentration at the secondary source area (see Appendix J). Chloride is a conservative tracer; therefore, its decline cannot be attributed to natural attenuation. The indicator for reductive dechlorination within the hole is the low ratio of parent to daughter products at the hole (92 percent daughter products vs. 8 percent parent), which is less than the parent to daughter ratio in the secondary source area, where parent compounds dominant (see Appendix J). Additionally, there is a source of electron donors in the 2nd WBZ (i.e., toluene and ethylbenzene) which support the reducing conditions that were found in the 2nd WBZ at the hole. These conditions provided for the production of DCE, VC, ethene, and methane.

PCE is the predominant COC within the 1st WBZ above the hole in the 1st SH. Also present above the hole, in significant amounts, are the degradation daughter products, TCE, DCE, VC, and ethene. The predominance of PCE in the 1st WBZ can be explained by the relatively slow rate of degradation of this compound at this location. The oxidation-reduction potential in the 1st WBZ indicates that this zone exhibits more aerobic conditions than the 2nd WBZ (see Section 4.4), which would inhibit the degradation of PCE. Furthermore, the groundwater in the 1st WBZ upgradient of the hole, contains very low levels of petroleum hydrocarbons, which might act as electron donors and deplete oxygen and therefore support further reductive dechlorination.

5.3.3.4 North End of Fox Avenue

As discussed in Section 5.3.2.4, COC impacted groundwater in the 1st WBZ leaving the secondary source area flows along two separate paths towards the S. Myrtle Street Embayment. The principle route is downward through the Fox Avenue hole; however, a second potential flow path exists were groundwater in the 1st WBZ flows around the hole to the north toward the S. Myrtle Street Embayment. The site conceptual model discussed in Section 5.3.2 called the area to the north of the hole the north end of Fox Avenue S. This flow path is represented by wells B-58 and B-59 (1st and 2nd WBZ wells, respectively). In this area, the 1st SH is present and no mixing with groundwater from the 2nd WBZ occurs.

The evidence for the secondary flow path is the composition of COCs found at wells B-58 and B-59, compared to the composition of COCs measured at the Fox Avenue hole and further downgradient at seeps S-1 and S-2. The evidence for this secondary flow path is based on the following observations:

- The mass of COCs leaving the secondary source area appears roughly divided between N. Fox Avenue and the Fox Avenue hole. The total concentration of dissolved COCs at wells B-58 and B-59 is 369 µmols/L, while the concentration of COCs at the hole is 391 µmols/L. Given the close proximity of the Fox Avenue hole and the northern end of Fox Avenue to the secondary source area and the groundwater flow directions in this area of GWI site, it is reasonable to assume that the combined mass of COCs in the two areas originated at the secondary source area.
- Seep S-2 drains and discharges water from the 1st WBZ (refer to Section 2.4), which is judged to originate in the vicinity of B-58. This conclusion is based on the fact that the COC composition in the groundwater discharging at seep S-2 is consistent with the COC composition (although not the parent to daughter ratio) at well B-58, but unlike the COC composition at the Fox Avenue hole (refer to Figure 5.14).
- Samples collected from the 1st WBZ in monitoring wells B-64 and B-34, located downgradient of the Fox Avenue hole, have COC compositions similar to the composition found in wells installed at the Fox Avenue hole. In addition, the COC composition at these wells is similar to that at seep S-1.
- The COC composition at well B-58 and seep S-2 is similar, as is the COC composition at well B-64 and seep S-1. These findings support the conclusion that two separate groundwater flow paths are responsible for the COCs present in seeps S-1 and S-2 (i.e., the N. Fox Avenue vs. Fox Avenue hole flow path).

The average total COC concentration present in groundwater at the north end of Fox Avenue is 369 µmols/L (well B-58 and B-59). This is essentially the same as the average total concentration in the wells at the Fox Avenue hole. Over 98 percent of the mass of COCs in groundwater at the north end of Fox Avenue is present in the 1st WBZ. Seventy seven percent of the mass is PCE daughter products. A small amount of COCs (6 µmol/L of daughter products only) is present in the 2nd WBZ in this area. The dominance of PCE in the 1st WBZ at the north end of Fox Avenue, as at the Fox Avenue hole, can be attributed to a relatively slow rate of PCE degradation within the 1st WBZ. Evidence for this rate of decay is based on relatively elevated oxidation-reduction potentials in the 1st WBZ, the relative absence of petroleum hydrocarbons (electron donors), the increased residence time of the groundwater in this area caused by tidal variations in the Duwamish River, and the groundwater flow reversals resulting from these tidal influences.

5.3.3.5 S. Myrtle Street and the Seeps

The dissolved COCs in the groundwater reaching the S. Myrtle Street area have originated predominately from the Fox Avenue hole (see Figure 5.14) where the 1st and 2nd WBZs co-mingle. For purposes of this discussion, S. Myrtle Street is defined by monitoring wells B-64 and B-65 on the upgradient side and by monitoring wells B-33A and B-34 on the downgradient side (the Embayment wells).

The conceptual site model at S. Myrtle Street predicts that parent to daughter ratios and the concentration of COCs at S. Myrtle Street are predominately influenced by redox conditions, which are in turn affected by tidal flux in this area of the GWI site. The evidence to support this conclusion is based in part on the following observations:

- In the 1st WBZ at well B-64, the total concentration of COCs is 0.55 µmols/L, PCE is the dominant COC (55 percent), with lesser amounts of DCE (13 percent), and no VC is present (parent to daughter ratio of 81 percent to 19 percent, respectively). Downgradient at well B-34, the total COC concentration (0.22 µmols/L) is similar to the concentration upgradient; however, at well B-34, DCE and VC comprise a greater percent of total COCs (36 percent and 16 percent, respectively; parent to daughter ratio of 48 percent to 52 percent, respectively).
- In the 2nd WBZ at well B-65, the total concentration of COC is 652 µmols/L. No PCE is present in the groundwater at well B-65; however, DCE and VC comprise 62 percent and 37 percent of the total COCs present. Down gradient, at well B-33A, the total concentration of COCs (588 µmols/L) is similar to the upgradient concentration; however, VC is the dominant COC (63 percent) at well B-33A.

The nature and extent of COCs in the 1st WBZ can be attributed to relative oxidizing conditions that exist in the groundwater at S. Myrtle Street (see Figure 5.13). This condition leads to the predominance of PCE and a lack of VC at well B-64. Under relatively oxidizing conditions, PCE and DCE will degrade to VC at a relatively slow rate (compared to more anaerobic conditions); however, any VC present will degrade under these condition to ethene. Ethene has been detected at well B-34 (6 percent of total COCs). The oxidizing conditions in the area of well B-64 are further supported by the lack of anthropogenic carbon sources and low levels of dissolved OM which would deplete oxygen from the groundwater and lead to conditions that degrade PCE and lead to the production of VC. Such is the case at well B-34, where VC comprises 16 percent of COCs present. At this location, surface water entering the 1st WBZ during a flood tide supplies dissolved OM and electronic acceptors that support biologically mediated redox reactions and the development of reducing conditions appropriate for the degradation of PCE to VC, but not to degradation of VC.

Groundwater flowing from the 1st and 2nd WBZs at S. Myrtle Street discharges at S-1 and S-13. As shown in the conceptual site model (Section 5.3.2), seep S-1 discharges from the 1st WBZ, while seep S-13 discharges from the 2nd WBZ. The percentage of parent and daughter products in groundwater discharging at seeps S-1 and S-13 are similar to those observed in the 1st and 2nd WBZs at the downgradient end of S. Myrtle Street (e.g., 63 percent VC at B-33A and S-13). However, the total concentration of COCs decreases from 0.55 to 0.10 µmols/L at well B-64 to seep S-1 (1st WBZ), respectively, and from 652 to 89 µmols/L at well B-65 to seep S-13 (2nd WBZ), respectively. The conceptual site model predicts that tidal flux (as seen by reversal in groundwater gradients) in the 1st and 2nd WBZs would result in the dilution of the total COC concentration between S. Myrtle Street and the seeps. Therefore, the decrease in concentrations can probably not be attributed to degradation, but rather to dilution asa result of the dispersion of COCs. This conclusion is further supported by the fact that high groundwater velocities, which are the result of steep gradients during high and low tide (see Figures 2.20 to 2.23 and Section 2.4) probably would not allow for sufficient residence time for further decay of COCs between S. Myrtle Street and the Embayment.

Supplemental Remedial Investigation and Feasibility Study

Tables

AGENCY REVIEW DRAFT

Table 2.1
Stratigraphic Sequence in Southern Puget Lowland: Uplands and Duwamish Valley

Formations	Symbols	Descriptions	Climatic Episode and Age
Alluvial Deposits	fill	Fill and modified land – Sand, gravel, silt, and miscellaneous construction debris. Deposited as fill that obscures or substantially alters the original geologic deposit.	Recent Nonglacial (0-1,000 Years. BP)
	Qyal	Younger Alluvium – Moderately sorted deposits of silt, sand, and sandy silt; soft and containing abundant wood and organics. Typically found within a few feet above or below modern sea level. Represents channel and overbank (floodplain) sediments, deposited by modern Duwamish River while flowing at an elevation substantially equivalent to that seen today.	
	Qoal	Older Alluvium – Sands and silt deposits in an estuarine and deltaic environment; contains discontinuous gravel lenses and locally abundant shells and some wood. Moderately dense to dense. Represents the northward advance wedges of sediment transported by the Duwamish River into the marine embayment of the Duwamish Valley, while the valley floor still lay beneath tens of hundreds of feet of water. Deposited within the last 5,000 years.	
Vashon Deposits	Qvr	Vashon Recessional Outwash – Predominately sand and gravel deposited by the retreat of Vashon ice sheet. Commonly occurs on hillsides along the valley. Glacially overridden sediments – Sediments coincident with or predating the last advance of the ice sheet, about 15,000 years ago. Discriminating from younger sediments by significantly greater density, absence of organics, and depth.	Fraser Glaciation (10,000-20,000 Years B.P.)
	Qvt	Lodgment till deposited during Vashon glacial advance	
	Qva	Well bedded sand and gravel deposited by streams and rivers issuing from the front of the advancing ice sheet. Generally unoxidized; almost devoid of silt or clay, except near the base of the unit and as discontinuous beds.	
	Qtb	Transitional beds: lacustrine silt and clay, spanning a time from non-glacial slackwater depositional environments to glacially impounded lakes during the early Vashon advance	
Pre-Vashon Deposits	Qob	Olympia beds: non-glacial silt, sand, and gravel deposited by lowlands rivers during the interval preceding the Vashon glaciation. Discriminated only where radiocarbon dates and/or stratigraphic relationships indicate an age between 18,000 and 100,000.	Olympic Interglaciation (20,000-60,000 Years B.P.)
	Q(A)c	Coarse grained deposits, presumably immediately underlying Olympia-age sediments.	Pre-Olympic Glacial and Interglacial (80,000 to 250,000 Year B.P.)

Table 2.1
Stratigraphic Sequence in Southern Puget Lowland: Uplands and Duwamish Valley

Formations	Symbols	Descriptions	Climatic Episode and Age
Pre-Vashon Deposits (con't)	Q(B)f	Fine grained deposits, immediately underlying the Q(A)c unit; speculative correlation would imply age of at least 100,000 years old.	Pre-Olympic Glacial and Interglacial (80,000 to 250,000 Year B.P.)
	Q(B)c	Coarse-grained deposits, immediately underlying unit Q(B)f.	
	Q(C)f	Older undifferentiated, unconsolidated fine-grained deposits.	
	Qto	Older (pre-Vashon) glacial till, undifferentiated.	
Tertiary Bedrock	Tb	Sandstone and conglomerate of the Blakely Formation	Marine and Continental Sedimentary Rocks, and isolated igneous intrusions (10,000,000 to 40,000,000 years B.P.)
	Tpr	Fine to coarse grained sandstone assigned to the Renton Formation of the Puget Group	
	Tpt	Volcanic breccia conglomerate, sandstone, and flows assigned to the Tukwila Formation of the Puget Group	

Table 2.2
Well Status Table

Well Number	Completion Date	Drilling Method	Boring Depth (ft)	Well Depth (ft)	Screen Interval (ft)	Casing Type	Well Casing	Well Dia. (in)	Well Status	Water Bearing Zone	Comments
B-1	30-May-89	HSA	24.50	16.50	6.5-16.5	pvc	Flush	2	Active	First	
B-2	11-May-90	HSA	11.50	**Wells Not Installed**					Abandoned	First	
B-3	11-May-90	HSA	11.50						Abandoned	First	
B-4	11-May-90	HSA	11.50						Abandoned	First	
B-5	28-Sep-90	HSA	46.50	45.00	40-45	pvc	Flush	2	Abandoned	Second	
B-6	27-Sep-90	HSA	51.75	45.15	40.5-45.5	pvc	Flush	2	Active	Second	
B-7	10-Apr-90	HSA	19.00	**Well Not Installed**					Abandoned	Second	
B-8	29-Sep-90	HSA	46.50	43.06	39.5-44.5	pvc	Flush	2	Active	Second	
B-9	30-Sep-90	HSA	49.00	41.55	38.5-43..5	pvc	Flush	2	Active	Second	
B-10A	9-Oct-90	HSA	17.50	13.60	9.5-14.5	pvc	Flush	2	Active	First	
B-11	5-Oct-90	HSA	14.50	12.32	11-13	pvc	Flush	2	Active	First	Well pumps dry
B-12	8-Oct-90	HSA	13.00	11.43	10.5-13	pvc	Flush	2	Active	First	
B-13	9-Oct-90	HSA	13.00	11.80	7.5-12.5	pvc	Flush	2	Active	First	
B-14	10-Oct-90	HSA	14.50	14.10	8.5-13.5	pvc	Flush	2	Active	First	Well pumps dry
B-15	23-Jan-91	HSA	18.00	16.10	12-17	pvc	Flush	2	Active	First	Well pumps dry
B-16	16-Aug-91	HSA	16.50	17.92	11-16	pvc	Stickup	2	Active	First	
B-17	19-Aug-91	HSA	52.00	51.80	40-50	pvc	Stickup	4	Active	Second	
B-18	29-Mar-92	HSA	16.50	15.50	6-16	pvc	Flush	2	Active	First	
B-19	7-Apr-92	HSA	50.50	46.60	37.5-47.5	pvc	Flush	2	Active	Second	
B-20	28-Mar-99	HSA	21.00	22.00	11-22	pvc	Flush	2	Abandoned	First/Second	
B-20A	28-Mar-92	HSA	21.00	12.10	6-16	pvc	Flush	2	Active	First	
B-21	8-Apr-92	HSA	51.00	40.10	38-43	pvc	Flush	2	Active	Second	
B-22	27-Mar-92	HSA	12.00	10.32	6-11	pvc	Flush	2	Active	First	
B-23	3-Apr-92	HSA	50.50	28.77	20.5-30.5	pvc	Flush	2	Active	Second	
B-24	30-Mar-92	HSA	18.00	16.30	6-16	pvc	Flush	2	Active	First	
B-25	31-Mar-92	HSA	47.50	37.05	27-37	pvc	Flush	2	Active	Second	
B-26	29-Mar-92	HSA	13.50	12.70	8.5-13.25	pvc	Flush	2	Active	First	
B-27	6-Apr-92	HSA	50.50	46.31	42.5-47.5	pvc	Flush	2	Active	Second	
B-28	30-Mar-92	HSA	15.00	13.29	9-14	pvc	Flush	2	Active	First	
B-29	8-Apr-92	HSA	15.00	13.45	9-14	pvc	Flush	2	Active	First	Dry
B-30	2-Apr-92	HSA	16.00	14.45	8-15	pvc	Flush	4	Active	First	Well pumps dry
B-31	2-Apr-92	HSA	13.50	10.66	6.5-11.5	pvc	Flush	4	Active	First	Well pumps dry
B-32	28-Aug-92	HSA	13.00	11.00	6.5-11.5	pvc	Flush	2	Active	First	Dry
B-33A	17-Sep-92	HSA	38.00	34.10	28-38	pvc	Flush	2	Active	Second	
B-34	25-Aug-92	HSA	14.50	11.55	7.5-12.5	pvc	Flush	2	Active	First	
B-35	26-Aug-92	HSA	50.00	27.95	19.5-29.5	pvc	Flush	2	Active	Second	
B-36	26-Aug-92	HSA	13.00	10.60	6-11	pvc	Flush	2	Active	First	
B-37	27-Aug-92	HSA	32.00	27.80	23-28	pvc	Flush	2	Active	Second	
B-38	27-Aug-92	HSA	19.00	15.69	6-16	pvc	Flush	2	Active	First	
B-39	11-Nov-92	HSA	12.00	11.82	5.5-11.82	pvc	Flush	2	Active	First	Well pumps dry
B-40	28-Dec-99	HSA	14.00	12.50	6.5-12.5	pvc	Flush	2	Abandoned	First	
B-41	11-Nov-92	HSA	12.00	11.00	5.0-11.00	pvc	Flush	2	Abandoned	First	
B-42	12-Nov-92	HSA	12.00	10.74	5.75-11.75	pvc	Flush	2	Active	First	

Table 2.2
Well Status Table

Well Number	Completion Date	Drilling Method	Boring Depth (ft)	Well Depth (ft)	Screen Interval (ft)	Casing Type	Well Casing	Well Dia. (in)	Well Status	Water Bearing Zone	Comments
B-43	24-Jun-93	HSA	16.00	15.00	7.0-15.0	SS	Flush	2	Abandoned	First	
B-44	25-Jun-93	HSA	16.00	14.97	9.5-15.5	pvc	Flush	2	Active	First	
B-45	25-Jun-93	HSA	48.00	46.32	37-47	pvc	Flush	2	Active	Second	
B-46	25-Jun-93	HSA	14.00	12.72	7.3-13.3	pvc	Flush	2	Active	First	
B-47	7-Jul-93	HSA	14.00	12.45	6.8-12.8	pvc	Flush	2	Active	First	
B-48	6-Jul-93	HSA	16.00	14.50	6.5-14.5	pvc	Flush	2	Abandoned	First	
B-49	6-Jul-93	HSA	16.00	14.52	9.5-15.5	pvc	Flush	2	Active	First	
B-50	7-Jul-93	HSA	12.00	10.20	5-11	pvc	Flush	2	Active	First	Dry
B-51	29-Jul-93	HSA	14.00	13.50	7.5-13.5	SS	Flush	2	Abandoned	First	
B-52	29-Jul-93	HSA	14.00	12.73	6.75-12.75	pvc	Flush	2	Active	First	
B-53	3-Feb-99	HSA	15.00	14.20	10-15	pvc	Flush	2	Active	First	
B-54	3-Feb-99	HSA	14.50	13.42	9-14	pvc	Flush	2	Active	First	
B-55	3-Feb-99	HSA	15.00	13.75	9-14	pvc	Flush	2	Active	First	
B-56	3-Feb-99	HSA	15.00	13.60	9-14	pvc	Flush	2	Active	First	
B-57	3-Feb-99	HSA	15.00	13.82	10.15	pvc	Flush	2	Active	First	
B-58	7-Jul-99	HSA	14.00	11.50	7-12	pvc	Flush	2	Active	First	
B-59	9-Jul-99	HSA	35.00	29.60	25-30	pvc	Flush	2	Active	Second	
B-60	7-Jul-99	HSA	16.50	11.77	7-12	pvc	Flush	2	Active	First	
B-61	9-Jul-99	HSA	45.00	44.30	39-44	pvc	Flush	2	Active	Second	
B-62	7-Jul-99	HSA	16.50	12.90	8-13	pvc	Flush	2	Active	First	Temporary Well TW-4
B-63	8-Jul-99	HSA	45.00	43.20	39-44	pvc	Flush	2	Active	Second	
B-64	6-Jul-99	HSA	13.00	11.42	7-12	pvc	Flush	2	Active	First	
B-65	6-Jul-99	HSA	35.50	33.78	30-35	pvc	Flush	2	Active	Second	
TW-1	6-Jul-99	HSA	13.00	11.00	6-11	pvc	Flush	2	Abandoned	First	Temporary well
TW-2	6-Jul-99	HSA	13.50	12.00	7-12	pvc	Flush	2	Abandoned	First	Temporary well
TW-3	6-Jul-99	HSA	13.50	12.00	7-12	pvc	Flush	2	Abandoned	First	Temporary well
TW-4	7-Jul-99	HSA	16.50	13.00	8-13	pvc	Flush	2	Abandoned	First	Temporary well
TW-5	7-Jul-99	HSA	16.50	12.00	7-12	pvc	Flush	2	Abandoned	First	Temporary well
TW-6	8-Jul-99	HSA	13.50	11.00	6-11	pvc	Flush	2	Abandoned	First	Temporary well
TW-7	8-Jul-99	HSA	13.50	11.00	6-11	pvc	Flush	2	Abandoned	First	Temporary well
VP-6	1-Sep-92	HSA	10.10	10.00	8-10	pvc	Flush	2	Active	First	

Table 3.1
Summary of Previous Hart Crowser Investigations
Great Western Chemical Company
Seattle, Washington

Report Date	Investigation Report Title	Purpose of Report/Investigation	Scope
December-90	Underground Storage Tank Removal and Initial Site Assessment - Volume I and Volume II	To document the work accomplished to date during underground storage tank (UST) closure, provide results from preliminary assessment of soil and groundwater.	The scope of this report includes: documentation of UST removal work to date; description of excavated materials disposed off-site; description of subsurface conditions at the site and in the immediate vicinity; description of field and laboratory work; documentation of chemical analysis of soil and groundwater samples; description of preliminary soil and groundwater remediation concepts.
December-91	Remedial Investigation/Feasibility Study Work Plan	To provide additional information on the nature and extent of contamination at and in the vicinity of the Great Western Chemical Company (GWCC) facility and to provide information necessary to evaluate remedial options.	This work plan is designed to: identify the nature and extent of contamination at the site; to identify and quantify human health and ecological risks associated with this contamination, and to provide information necessary to evaluate potential remedial options at the site.
December-93	Remedial Investigation and Preliminary Risk Assessment	This report includes sections on: Site Characterization, Contaminant Fate and Transport, Baseline Risk Assessment, Preliminary Development of Remedial Action Objectives, Feasibility Study, and Proposed Interim Remedial Measures.	This report includes the following: drilling and sampling of 14 borings completed as groundwater observation wells; chemical and physical properties tests on soil samples; monthly groundwater elevation monitoring and two rounds of groundwater sampling and analytical testing; collection and analyses of soil vapor samples from two probes, from nine wells, and from five flux chamber locations; tidal monitoring, observation of stormwater runoff, sewer dye testing, and sampling in Duwamish River to assess groundwater – surface water interaction.
January-92	Technical Memorandum No. 1 - Remedial Investigation/Feasibility Study	Provide background information on site and groundwater use in investigation area.	This report addresses the following issues: Industrial Site Use, Groundwater Use, Groundwater Flowpaths, and Groundwater Discharge Points. Total of 102 water samples collected and tested for salinity.

Table 3.1
Summary of Previous Hart Crowser Investigations
Great Western Chemical Company
Seattle, Washington

Report Date	Investigation Report Title	Purpose of Report/Investigation	Scope
August-92	Technical Memorandum No. 2 - Contaminant Transport and Point of Exposure Modeling	Discusses the proposed rational and approach to evaluating contaminant transport and estimating point of exposure concentrations for the site.	This report addresses the following issues: identifying Reasonable Maximum Exposure (RME) locations; estimating inhalation exposure concentrations; estimating exposure concentrations due to groundwater discharge to Duwamish River.
January-92	Technical Memorandum No. 3 - Site History and Summary of Site Operations Including Nearby Historical Land Use	Discusses the results of historical background review for the site.	This historical review effort included: reviewing aerial photographs, fire insurance maps, and city directories; reviewing published environmental agency lists to identify known areas of environmental concern in the vicinity; reviewing files from USEPA and Ecology offices on six nearby properties; reviewing King County Assessor property files and DCLU records; interviewing current and former employees of Great Western.
July-92	Technical Memorandum No. 4 - Preliminary Development of the Baseline Risk Assessment	Discusses several issues related to development of the baseline risk assessment for the site.	This report includes: summaries of soil, groundwater, and air quality data; review of available toxicologic data; review of available references for bioconcentration factors
January-93	Technical Memorandum No. 5 - Facility Remedial Investigation Previously Unreported Data	Presents data collected on three occasions in 1991	This report includes: data from three soil borings and one monitoring well in the vicinity of S. Frontenac Street; data from surficial soil samples and two shallow hand auger borings in the proposed truck unloading area; data from tests on soil excavated from the pipe trench area.

Table 3.1
Summary of Previous Hart Crowser Investigations
Great Western Chemical Company
Seattle, Washington

Report Date	Investigation Report Title	Purpose of Report/Investigation	Scope
March-93	Technical Memorandum No. 6 - Facility Renovations	Compilation of separate submittals to address planned upgrades to facility operations	This report documents: renovation work done since the start of the RI: partial construction of a new aboveground storage tank containment area; grading and paving a new truck loading and unloading area; installation of storm drains to the sanitary sewer from these areas
June-92	Technical Memorandum No. 7 - Stormwater Management	Documents existing surface water runoff conditions at the site to provide a benchmark for ongoing facilities planning and input to the RI/FS.	The report discusses: existing surface water runoff conditions and plans and implementation schedule for future stormwater management systems
December-93	Technical Memorandum No. 8 - IRM Progress Report and Proposed Pilot Test Design	Presents the results of work accomplished, and discusses pending work as part of proposed Interim Remedial Measures (IRM).	This report includes: installing and sampling 10 groundwater monitoring wells; completing 36-hour water level monitoring studies in two well clusters; calibrating a groundwater flow model; completing baseline groundwater quality monitoring in selected wells; completing baseline soil vapor quality monitoring in selected wells; conducting a Proof-of-Concept pumping test; conducting numerical modeling studies to assess groundwater and soil vapor extraction alternatives; developing a Pilot Test design for the IRM.
August-94	Technical Memorandum No. 9 - Duwamish Waterway Seep and Shellfish Sampling	Summarizes and describes the sampling and analysis of seep discharges and shellfish tissue within the Duwamish Waterway, hydraulically downgradient of the site, as performed in April, 1994.	This report documents: samples that were taken from six seep locations and samples of edible mussels were obtained from three locations in the vicinity of the seep sample sites.

Table 3.1
Summary of Previous Hart Crowser Investigations
Great Western Chemical Company
Seattle, Washington

Report Date	Investigation Report Title	Purpose of Report/Investigation	Scope
September-94	Technical Memorandum No. 10 - Second Quarter Duwamish Waterway Seep and Shellfish Sampling	Summarizes and describes the independent sampling and analysis of seep discharge and shellfish tissue within the Duwamish Waterway, hydraulically downgradient of the site, as performed on July 22, 1994.	This report documents: samples that were taken from three seep locations and mussels were obtained from three locations in the vicinity of the seep sample sites. In addition a background sample was taken from the Duwamish River and hourly samples were taken from Seep S-2.
June-96	Technical Memorandum No. 11 - Off-site GeoProbe™ Study and Baseline Sampling and Analysis Results	Presents the results of the off-site GeoProbe™ study and the trends in environmental quality baseline data in the different media (groundwater, soil vapor, groundwater seeps in the Duwamish, and tissue samples collected from mussels living in the Duwamish).	This report includes: installation of nine GeoProbes™ on Seattle Iron and Metal and Seattle Boiler Works, 1995 Annual Groundwater Monitoring of on-site and off-site monitoring wells, surface water and mussel samples from the S. Myrtle Street Embayment.
December-96	Technical Memorandum No. 12 - Expanded Soil Vapor Extraction and Pentachlorophenol Remediation, Interim Remedial Measures	Discusses the proposed action to reduce concentrations of SVOCs at the site, and to improve effectiveness of remediation for VOCs.	This report documents the main components of the proposed action: expanding/improving the existing soil vapor extraction (SVE) remediation system and improving stormwater management.
March-97	Technical Memorandum No. 13 - RI/FS Annual Monitoring (December 1996)	Annual groundwater monitoring of GWCC and off-property monitoring wells, Duwamish seeps and mussels.	This report includes: water level measurement from 29 wells. Groundwater sampling from 18 wells. Vapor sampling from 11 wells. Seep sampling from six locations and mussel sampling from three locations.

Table 4.1

Analytical Schedule for Soil Samples

	RI Event 1	RI Event 2	RI - Ecology Splits	RI Event 2 Supplemental	Fox/Myrtle Supplemental Investigation	Northwest Corner Supplemental Investigation	Well B-20A Installation	UST Assess & Pre-RI	Tank Closure/ Abandonment
Major Metals	42	11	0	0	0	0	0	0	0
Trace Metals	42	11	0	0	0	0	0	19	1
Chlorinated Phenols	42	11	12	0	0	2	1	30	0
Other Semivolatile Organics	42	11	12	0	24	12	1	30	0
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LPAHs)	42	11	12	0	20	2	1	30	0
High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAHs)	42	11	12	0	0	2	0	30	0
Chlorinated Benzenes	42	11	12	0	24	12	1	68	0
Chlorinated Ethenes & Ethanes	42	11	12	20	24	12	1	68	0
Phthalates and Gylcols	42	11	12	0	0	2	0	36	0
Other Volatile Organics	42	11	12	0	24	12	1	68	0
Total Petroleum Hydrocarbons	41	11	0	0	0	0	0	28	3
Substituted Benzenes	36	11	0	0	20	0	1	68	3
Other Solvents	36	11	0	0	24	10	1	68	0
Chlorinated Dioxins and Furans - Individual Congeners	3	0	0	0	0	0	0	0	0
Chlorinated Dioxins and Furans - Groups	3	0	0	0	0	0	0	0	0

Table 4.2

Detection Frequency Summary for Soil

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1] (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Reporting Limit (mg/kg)	Minimum Reporting Limit (mg/kg)	Soil Screening Level[2] (mg/kg)
Chlorinated Ethenes and Ethanes	Tetrachloroethene	150	88	59	567	18,000	0.003	0.07	0.001	19.6
	Trichloroethene	150	39	26	36	1,100	0.003	24	0.001	90.9
	1,1-Dichloroethene	150	1	1	0.41	8.9	8.9	47	0.001	1.67
	1,2-Dichloroethene (cis)	53	12	23	1.1	24	0.01	47	0.002	800
	1,2-Dichloroethene (Total)	88	22	25	1.5	57	0.017	17	0.002	1,600
	Vinyl Chloride	150	7	5	0.46	0.2	0.11	70	0.002	0.526
	1,1,1-Trichloroethane	150	10	7	4.02	160	0.035	24	0.001	72,000
	1,1-Dichloroethane	150	8	5	0.44	14	0.01	24	0.001	8,000
	1,2-Dichloroethane	150	1	1	0.29	0.097	0.097	24	0.002	11
Aromatics (The BTEX Family)	Benzene	139	7	5	0.43	12	0.068	24	0.001	34.5
	Toluene	139	33	24	45	1,800	0.011	24	0.001	16,000
	Ethylbenzene	138	27	20	9.5	470	0.002	24	0.001	800
	Xylene (Total)	115	40	35	56	1,200	0.006	0.35	0.001	160,000
	Styrene	116	6	5	3.4	200	0.007	24	0.002	33.3
Chlorinated Aromatics	1,2-Dichlorobenzene	132	5	4	0.27	18	0.035	3.8	0.036	7,200
	1,3-Dichlorobenzene	132	1	1	0.13	1.1	1.1	3.8	0.036	NA
	1,4-Dichlorobenzene	132	2	2	0.17	5.9	0.71	3.8	0.036	41.7
	Chlorobenzene	150	1	1	0.61	0.031	0.031	50	0.001	1,600
Other Solvents	Acetone	116	22	19	3.30	47	0.012	84	0.025	8,000
	Methyl Ethyl Ketone	116	6	5	2.5	21	0.021	180	0.005	48,000
	Methyl iso-butyl ketone	116	3	3	1.3	8.6	1.3	50	0.005	6,400
	Methylene Chloride	150	29	19	8.1	780	0.002	16	0.001	133
Miscellaneous VOCs	1,2-Dichloropropane	150	2	1	0.28	0.017	0.011	24	0.001	14.7
Chlorinated Phenols	Pentachlorophenol	95	45	47	2.3	71	0.0022	1.7	0.002	8.33
	Tetrachlorophenols(Total)	52	4	8	0.78	38	0.02	0.7	0.006	2,400
	2,4,5-Trichlorophenol	95	5	5	0.23	0.089	0.013	5.4	0.01	8,000
	2,4,6-Trichlorophenol	95	3	3	0.074	0.082	0.0099	1.1	0.006	90.9
	2,4-Dichlorophenol	95	16	17	0.13	2.1	0.028	2.1	0.03	240

Table 4.2

Detection Frequency Summary for Soil

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1] (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Reporting Limit (mg/kg)	Minimum Reporting Limit (mg/kg)	Soil Screening Level[2] (mg/kg)
Low Molecular Weight PAHs	2-Methylnaphthalene	97	10	10	0.22	2.8	0.087	3.8	0.036	NA
	Acenaphthene	97	2	2	0.16	0.21	0.14	3.8	0.036	4,800
	Acenaphthylene	97	1	1	0.16	0.43	0.43	3.8	0.036	NA
	Anthracene	97	5	5	0.16	0.58	0.054	3.8	0.036	24,000
	Dibenzofuran	97	4	4	0.16	0.19	0.05	3.8	0.036	NA
	Fluorene	97	4	4	0.16	0.24	0.079	3.8	0.036	3,200
	Naphthalene	118	14	12	0.30	5.9	0.041	3.8	0.036	3,200
	Phenanthrene	97	8	8	0.22	2.4	0.22	3.8	0.036	NA
High Molecular Weight PAHs	Benzo(a)Anthracene	97	6	6	0.16	0.79	0.12	3.8	0.036	0.137
	Benzo(a)Pyrene	97	4	4	0.17	1	0.063	3.8	0.036	0.137
	Benzo(b)Fluoranthene	97	3	3	0.17	0.73	0.13	3.8	0.036	0.137
	Benzo(g,h,i)Perylene	97	1	1	0.16	0.58	0.58	3.8	0.036	NA
	Benzo(k)Fluoranthene	97	1	1	0.16	0.47	0.47	3.8	0.036	0.137
	Chrysene	97	7	7	0.17	1	0.11	3.8	0.036	0.137
	Fluoranthene	97	9	9	0.21	2.4	0.079	3.8	0.036	3,200
	Indeno(1,2,3-cd)Pyrene	97	1	1	0.16	0.47	0.47	3.8	0.036	0.137
	Pyrene	97	9	9	0.21	3.1	0.11	3.8	0.036	2,400
Chlorinated Benzenes, Phthalates, and Glycols	bis(2-Ethylhexyl)phthalate	97	30	31	4.1	140	0.052	1.1	0.042	71.4
	Butylbenzylphthalate	97	5	5	0.28	6.9	0.05	3.8	0.036	16,000
	Di-n-butylphthalate	96	15	16	4.2	200	0.042	40	0.038	8,000
	Di-n-octylphthalate	97	1	1	0.16	0.032	0.032	3.8	0.036	1,600
	Ethylene Glycol	6	2	33	2.8	12	0.01	10	0.005	160,000
	Diethylene Glycol	6	4	67	3.5	11	0.01	0.005	0.005	160,000
	Propylene Glycol	6	1	17	1.7	0.012	0.012	10	0.005	1,600,000
Miscellaneous SVOCs	4-Methylphenol	67	2	3	0.19	0.45	0.11	3.8	0.18	400
	Benzoic acid	83	1	1	0.80	3.2	3.2	19	0.61	320,000
	Carbazole	14	1	7	0.19	0.08	0.08	0.78	0.04	50

Table 4.2
Detection Frequency Summary for Soil

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1] (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Reporting Limit (mg/kg)	Minimum Reporting Limit (mg/kg)	Soil Screening Level[2] (mg/kg)
Chlorinated Dioxins and Furans	1,2,3,7,8-PeCDD	3	2	67	5.65E-06	1.13E-05	5.50E-06	3.00E-07	3.00E-07	NA
	1,2,3,4,7,8-HxCDD	3	3	100	2.15E-05	3.89E-05	1.40E-06	--	--	NA
	1,2,3,6,7,8-HxCDD	3	3	100	1.30E-04	2.03E-04	9.60E-06	--	--	NA
	1,2,3,7,8,9-HxCDD	3	3	100	6.04E-05	1.03E-04	3.80E-06	--	--	NA
	1,2,3,4,6,7,8-HpCDD	3	3	100	5.14E-03	8.17E-03	2.69E-04	--	--	NA
	2,3,7,8-TCDF	3	2	67	4.78E-06	1.25E-05	1.70E-06	3.00E-07	3.00E-07	NA
	2,3,4,7,8-PeCDF	3	2	67	3.83E-06	7.30E-06	4.00E-06	4.00E-07	4.00E-07	NA
	1,2,3,7,8-PeCDF	3	2	67	3.73E-06	7.10E-06	3.90E-06	4.00E-07	4.00E-07	NA
	1,2,3,4,7,8-HxCDF	3	3	100	2.95E-05	4.84E-05	1.80E-06	--	--	NA
	1,2,3,6,7,8-HxCDF	3	3	100	2.50E-05	4.22E-05	1.00E-06	--	--	NA
	1,2,3,7,8,9-HxCDF	3	1	33	1.00E-05	2.16E-05	2.16E-05	1.63E-05	7.00E-07	NA
	2,3,4,6,7,8-HxCDF	3	3	100	4.55E-05	7.35E-05	2.10E-06	--	--	NA
	1,2,3,4,6,7,8-HpCDF	3	3	100	7.35E-04	1.19E-03	3.33E-05	--	--	NA
	1,2,3,4,7,8,9-HpCDF	3	3	100	6.04E-05	9.87E-05	4.00E-06	--	--	NA
Chlorinated Dioxin and Furan Groups	TOTAL-TCDD	3	1	33	1.78E-06	1.70E-06	1.70E-06	7.00E-06	3.00E-07	NA
	TOTAL PeCDD	3	2	67	1.17E-05	2.34E-05	1.13E-05	5.00E-07	5.00E-07	NA
	TOTAL-HxCDD	3	3	100	6.15E-04	1.05E-03	3.73E-05	--	--	NA
	TOTAL HpCDD	3	3	100	8.55E-03	1.38E-02	4.73E-04	--	--	NA
	TOTAL OCDD	3	3	100	4.61E-02	8.37E-02	3.05E-03	--	--	NA
	TOTAL-TCDF	3	3	100	4.16E-05	9.42E-05	5.80E-07	--	--	NA
	TOTAL PeCDF	3	3	100	3.18E-05	7.34E-05	4.40E-06	--	--	NA
	TOTAL HxCDF	3	3	100	6.69E-04	1.09E-03	3.73E-05	--	--	NA
	TOTAL HpCDF	3	3	100	2.84E-03	4.49E-03	1.48E-04	--	--	NA
	TOTAL OCDF	3	3	100	2.81E-03	4.75E-03	1.77E-04	--	--	NA
Metals	Aluminum	53	53	100	5,847	16,000	1,400	--	--	NA
	Arsenic	72	70	97	3.6	43	0.46	0.31	0.05	1.67
	Barium	53	53	100	57	1,700	7.4	--	--	5,600
	Cadmium	72	69	96	0.52	4.3	0.013	0.013	0.01	80
	Chromium	72	72	100	9.7	42	3.3	--	--	80,000
	Copper	72	72	100	19	210	2.5	--	--	2,960
	Lead	73	60	82	13	500	0.26	10	1.1	NA
	Mercury	72	12	17	0.202	8.8	0.1	0.25	0.074	24
	Nickel	72	72	100	8.1	30	3	--	--	1,600
	Zinc	72	72	100	55	880	8.2	--	--	24,000

Table 4.2
Detection Frequency Summary for Soil

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1] (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Reporting Limit (mg/kg)	Minimum Reporting Limit (mg/kg)	Soil Screening Level[2] (mg/kg)
Total Petroleum Hydrocarbons	Stoddard's solvent	6	6	100	372	2,200	2.9	--	--	100
	Mineral Spirits	6	6	100	304	1,800	1.8	--	--	100
	Thinner	39	6	15	225	2,452	45	144	26	100
	Light Hydrocarbons	19	10	53	2,821	20,000	14	25	0.025	100
	Gasoline	58	18	31	338	6,500	6	29	5	100
	Diesel	72	10	14	92	2,758	142	287	0.025	200
	Motor Oil	31	11	35	877	12,644	458	107	0.025	200
	Total Petroleum Hydrocarbons	2	2	100	1700	1,900	1,500	--	--	200

Notes:
1 Average was calculated using the following equation: Sum of the Detected Concentrations + .5 (Reporting Limit for Non-Detects)/Number of Samples.
2 The MTCA Method B residential cleanup level was used as the soil screening level.
NA A MTCA soil cleanup standard does not currently exist for this parameter.
-- Results were all positive; no non-detects.

Table 4.3
Parameters Not Detected in Soil

Parameter Group	Parameter	Number of Samples Analyzed	Maximum Reporting Limit (mg/kg)	Minimum Reporting Limit (mg/kg)
Chlorinated Ethenes and Ethanes	1,2-Dichloroethene (trans)	71	47	0.001
	Hexachloroethane	97	3.8	0.036
	1,1,1,2-Tetrachloroethane	35	0.78	0.04
	1,1,2,2-Tetrachloroethane	150	24	0.001
	1,1,2-Trichloroethane	150	24	0.001
	Chloroethane	130	50	0.001
Aromatics (The BTEX Family)	Xylene (ortho)	24	47	0.002
	Xylene (meta & para)	24	47	0.002
	1,2,4-Trimethyl benzene	21	0.78	0.04
	1,3,5-Trimethyl benzene	21	0.78	0.04
	iso-Propyl benzene	21	0.78	0.04
	n-Propyl benzene	21	0.78	0.04
	n-Butyl benzene	21	0.78	0.04
	sec-Butyl benzene	21	0.78	0.04
	tert-Butyl benzene	21	0.78	0.04
	iso-Propyl toluene	21	0.78	0.04
Chlorinated Aromatics	2-Chloro toluene	35	0.78	0.04
	4-Chloro toluene	35	0.78	0.04
	Bromo benzene	35	0.78	0.04
Other Solvents	2-Hexanone	95	17	0.002
	Carbon Tetrachloride	150	24	0.001
	Chloroform	150	24	0.001
	iso-Propanol	4	0.005	0.005
	Ethanol	4	0.005	0.005
	Methanol	4	0.005	0.005
Miscellaneous VOCs	1,1-Dichloropropene	35	0.78	0.04
	1,2,3-Trichloropropane	35	0.78	0.04
	1,2-Dibromo-3-Chloropropane	35	0.78	0.04
	1,2-Dibromoethane (EDB)	35	0.78	0.04
	1,3-Dichloropropane	35	0.78	0.04
	1,3-Dichloropropene (cis)	130	17	0.002
	1,3-Dichloropropene (total)	21	0.2	0.005
	1,3-Dichloropropene (trans)	130	17	0.002
	1-Propanol	4	0.005	0.005
	2,2-Dichloropropane	35	47	0.002
	2,2-Oxybis(1-Chloropropane)	12	0.78	0.39
	2,4-Dinitrotoluene	97	3.8	0.036
	2,6-Dinitrotoluene	97	1.1	0.042
	2-Chloroethyl vinyl ether	27	47	0.002
	2-Nitroaniline	97	3.8	0.036
	3,3'-Dichlorobenzidine	97	3.8	0.036
	3-Nitroaniline	97	3.8	0.036
	4-Bromophenyl-phenylether	97	3.8	0.036
	4-Chloroaniline	97	3.8	0.036
	4-Chlorophenyl phenyl ether	97	3.8	0.036
	4-Nitroaniline	97	3.8	0.036
	Bis(2-chloroethoxy)methane	97	3.8	0.036

Table 4.3
Parameters Not Detected in Soil

Parameter Group	Parameter	Number of Samples Analyzed	Maximum Reporting Limit (mg/kg)	Minimum Reporting Limit (mg/kg)
Miscellaneous VOCs (con't)	Bis(2-chloroethyl)ether	97	3.8	0.036
	Bis(2-chloroisopropyl)ether	85	3.8	0.036
	Bromodichloromethane	150	24	0.001
	Bromoform	150	24	0.001
	Bromomethane	130	47	0.001
	Carbon Disulfide	116	17	0.002
	Chloromethane	130	50	0.001
	Dibromochloromethane	150	24	0.001
	Dibromomethane	35	0.78	0.04
	Dichlorodifluoromethane	35	0.78	0.04
	Nitrobenzene	97	3.8	0.036
	Trichlorofluoromethane	58	0.78	0.04
	Vinyl Acetate	116	17	0.002
Chlorinated Phenols	2-Chlorophenol	95	3.8	0.036
LPAHs	1-Methylnaphthalene	53	3.8	0.036
HPAHs	Dibenzo(a,h)Anthracene	97	3.8	0.036
Chlorinated Benzenes, Phthalates, and Glycols	1,2,3-Trichlorobenzene	35	0.78	0.04
	1,2,4-Trichlorobenzene	132	3.8	0.036
	Hexachlorobenzene	97	3.8	0.036
	Diethylphthalate	97	3.8	0.036
	Dimethylphthalate	97	3.8	0.036
Miscellaneous SVOCs	2,4-Dimethylphenol	95	1.1	0.042
	2,4-Dinitrophenol	95	19	0.36
	2-Chloronaphthalene	97	3.8	0.036
	2-Methylphenol	95	1.1	0.042
	2-Nitrophenol	95	3.8	0.036
	4,6-Dinitro-2-methylphenol	96	3.8	0.036
	4-Chloro-3-methylphenol	95	3.8	0.036
	4-Nitrophenol	67	3.8	0.036
	Aniline	85	3.8	0.18
	Benzidine	85	3.8	0.036
	Benzyl alcohol	85	19	0.61
	Hexachlorobutadiene	132	3.8	0.036
	Hexachlorocyclopentadiene	97	3.8	0.036
	Isophorone	97	3.8	0.036
	N-Nitrosodimethylamine	71	3.8	0.036
	N-Nitroso-di-n-propylamine	97	3.8	0.036
	N-Nitrosodiphenylamine	97	3.8	0.036
	Phenol	95	1.1	0.042
Dioxins and Furans	2,3,7,8-TCDD	3	4.00E-07	4.00E-07
Total Petroleum Hydrocarbons	Kerosene/Jet A	19	0.005	0.005
	Bunker C	19	0.005	0.005

Notes:

LPAHs	Low Molecular Weight PAHs.
HPAHs	High Molecular Weight PAHs.

Table 4.4
The Chlorinated Ethenes and Ethanes

Chemical Name	Abbreviation	Common Name	Solvent or Degradation Product
Tetrachloroethene	PCE	Perchloroethylene or Perc	Solvent
Trichloroethene	TCE	Trichloroethylene	Solvent
1,1-Dichoroethene	1,1-DCE	Vinylidiene chloride and 1,1-Dichloroethylene	Degradation product
cis-1,2-Dichloroethene	*cis*-1,2-DCE	Acetylene dichloride and *cis*-1,2-Dichloroethylene	Degradation Product
trans-1,2-Dichloroethene	*trans*-1,2-DCE	Acetylene dichloride and *trans*-1,2-Dichloroethylene	Degradation Product
Vinyl Chloride	VC	Chloroethylene, Chloroethene, Monochloroethylene and Ethylene monochloride	Degradation Product
1,1,1-Trichloroethane	1,1,1-TCA	Methylchloroform	Solvent
1,1,2-Trichloroethane	1,1,2-TCA	Vinyl trichloride and Ethane trichloride	Solvent / by-product
1,1-Dichloroethane	1,1-DCA	Ethylidene dichloride	Degradation Product
1,2-Dichloroethane	1,2-DCA	Ethylene dichloride and Ethane chloride and Glycol dichloride	Degradation Product
Chloroethane	CA	Chloroethane	Degradation Product

Table 4.5
Groundwater Monitoring Wells[1]

Well ID	Water-Bearing Unit Sampled	Property or ROW	Downgradient of GWI and Frontenac Street?	Original Source Area?	Secondary Source Area?
B-1	1st WBZ	GWI	No	No	No
B-6	2nd WBZ	Willow Street	No	No	No
B-8	2nd WBZ	Frontenac Street	No	No	Yes
B-9	2nd WBZ	GWI	No	No	No
B-10A	1st WBZ	GWI	No	No	No
B-11	1st WBZ	Frontenac Street	No	No	No
B-12	1st WBZ	Frontenac Street	No	No	Yes
B-13	1st WBZ	GWI	No	No	No
B-14	1st WBZ	GWI	No	No	No
B-15	1st WBZ	GWI	No	Yes	No
B-16	1st WBZ	GWI	No	Yes	No
B-17	2nd WBZ	GWI	No	Yes	No
B-18	1st WBZ	Fox Avenue	Yes	No	No
B-19	2nd WBZ	Fox Avenue	Yes	No	No
B-20A	1st WBZ	Fox Avenue	Yes	No	No
B-21	2nd WBZ	Fox Avenue	Yes	No	No
B-22	1st WBZ	Fox Avenue	Yes	No	No
B-23	2nd WBZ	Fox Avenue	Yes	No	No
B-24	1st WBZ	Lot 11	No	No	No
B-25	2nd WBZ	Lot 11	No	No	No
B-26	1st WBZ	Willow Street	No	No	No
B-27	2nd WBZ	Willow Street	No	No	No
B-28	1st WBZ	Willow Street	No	No	No
B-29	1st WBZ	GWI	No	No	No
B-30	1st WBZ	GWI	No	No	Yes
B-31	1st WBZ	Frontenac Street	No	No	Yes
B-32	1st WBZ	Frontenac Street	No	No	No
B-33A	2nd WBZ	Myrtle Street	Yes	No	No
B-34	1st WBZ	Myrtle Street	Yes	No	No

Table 4.5
Groundwater Monitoring Wells[1]

Well ID	Water-Bearing Unit Sampled	Property or ROW	Downgradient of GWI and Frontenac Street?	Original Source Area?	Secondary Source Area?
B-35	2nd WBZ	Myrtle Street	Yes	No	No
B-36	1st WBZ	Myrtle Street	Yes	No	No
B-37	2nd WBZ	Myrtle Street	No	No	No
B-38	1st WBZ	Myrtle Street	No	No	No
B-39	1st WBZ	Frontenac Street	No	No	Yes
B-42	1st WBZ	Frontenac Street	No	No	Yes
B-44	1st WBZ	Tyee	Yes	No	Yes
B-45	2nd WBZ	Tyee	Yes	No	No
B-46	1st WBZ	Frontenac Street	No	No	Yes
B-47	1st WBZ	Frontenac Street	No	No	Yes
B-49	1st WBZ	Tyee	Yes	No	Yes
B-50	1st WBZ	Frontenac Street	No	No	Yes
B-52	1st WBZ	Frontenac Street	No	No	No
B-53	1st WBZ	Willow Street	No	No	No
B-54	1st WBZ	Willow Street	No	No	No
B-55	1st WBZ	Willow Street	No	No	No
B-56	1st WBZ	Willow Street	No	No	No
B-57	1st WBZ	Willow Street	No	No	No
B-58	1st WBZ	Fox Avenue	Yes	No	No
B-59	2nd WBZ	Fox Avenue	Yes	No	No
B-60	1st WBZ	Fox Avenue	Yes	No	No
B-61	2nd WBZ	Fox Avenue	Yes	No	No
B-62	1st WBZ	Fox Avenue	Yes	No	No
B-63	2nd WBZ	Fox Avenue	Yes	No	No
B-64	1st WBZ	Myrtle Street	Yes	No	No
B-65	2nd WBZ	Myrtle Street	Yes	No	No

Note:
1 Does not include decommissioned wells.

Table 4.6

Analytical Schedule for Groundwater Samples

	1999 Annual Monitoring	RI Event 1	RI Event 2	RI Event 3	1995 Annual Monitoring	RI - Ecology Splits	RI Event 2 Supplemental	1996 Annual Monitoring	IRM Start-Up	1998 Annual Monitoring
Other Semivolatile Organics	51	26	32	8	7	10	0	5	1	24
Other Volatile Organics	51	27	32	18	21	10	15	18	1	24
Chlorinated Phenols	51	26	32	9	9	10	0	9	1	24
Chlorinated Benzenes	51	26	32	18	21	10	15	18	1	24
Chlorinated Ethenes & Ethanes	51	26	32	18	21	10	15	18	23	24
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LPAHs)	51	26	32	7	7	10	0	5	1	24
High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAHs)	51	25	29	7	7	10	0	5	1	24
Phthalates and Gylcols	51	27	32	7	7	10	0	5	1	24
Substituted Benzenes	50	26	32	17	20	0	0	18	1	24
Other Solvents	50	27	75	17	20	0	15	18	1	24
Major Metals	39	27	32	0	0	0	0	0	0	0
Nutrients	39	0	0	0	0	0	0	0	0	0
NA Parameters - Fixed Gases	37	0	0	0	0	0	0	0	0	1
Trace Metals	0	27	32	0	0	0	0	0	0	0
Total Petroleum Hydrocarbons	0	27	32	0	0	0	0	0	0	0
Other Parameters	0	0	0	0	0	0	0	0	0	0

Table 4.6

Analytical Schedule for Groundwater Samples

	Fox/Myrtle Supplemental Investigation	Northwest Corner Supplemental I	Post Oxy-Vac Pilot Study	Pre Oxy-Vac Pilot Study	UST Assess & Pre-RI	Othello Warehouse VCP Report	1997 Annual Monitoring
Other Semivolatile Organics	15	17	7	7	2	6	7
Other Volatile Organics	15	17	7	7	21	6	19
Chlorinated Phenols	5	6	7	7	2	4	11
Chlorinated Benzenes	15	17	7	7	21	6	19
Chlorinated Ethenes & Ethanes	15	17	7	7	21	6	19
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LPAHs)	15	11	7	7	2	6	7
High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAHs)	5	6	7	7	2	0	7
Phthalates and Gylcols	5	6	7	7	2	0	7
Substituted Benzenes	15	11	7	7	21	6	19
Other Solvents	15	17	7	7	21	6	19
Major Metals	0	0	0	0	0	0	0
Nutrients	0	0	0	0	0	0	0
NA Parameters - Fixed Gases	0	0	0	0	0	0	10
Trace Metals	0	0	0	0	0	6	0
Total Petroleum Hydrocarbons	0	0	0	0	9	6	0
Other Parameters	0	0	0	0	0	6	0

Table 4.7

Chemicals Not Detected in Groundwater

Analyte	Number of Samples Analyzed	Minimum Reporting Limit
Chlorinated Ethenes and Ethanes (ug/L)		
Hexachloroethane	75	0.5
1,1,1,2-Tetrachloroethane	74	1
1,1,2,2-Tetrachloroethane	74	1
1,1,2-Trichloroethane	74	1
Chloroethane	74	1
BTEX Family of Volatile Aromatics (ug/L)		
tert-Butyl benzene	74	1
Other Volatile Organics (ug/L)		
2-Chloro toluene	74	1
4-Chloro toluene	74	1
Bromo benzene	74	1
Acetone	50	50
Carbon Tetrachloride	74	1
Methyl Ethyl Ketone	50	50
Methyl iso-butyl ketone	50	20
1,1-Dichloropropene	74	1
1,2,3-Trichloropropane	74	5
1,2-Dibromo-3-Chloropropane	74	5
1,2-Dibromoethane (EDB)	74	1
1,3-Dichloropropane	74	1
1,3-Dichloropropene (cis)	74	1
1,3-Dichloropropene (trans)	74	1
2,2-Dichloropropane	74	1
2,4-Dinitrotoluene	75	0.5
2,6-Dinitrotoluene	75	2
2-Chloroethyl vinyl ether	50	20
2-Nitroaniline	75	0.5
3,3'-Dichlorobenzidine	75	0.5
3-Nitroaniline	75	0.5
4-Bromophenyl-phenylether	75	0.5
4-Chloroaniline	75	0.5
4-chlorophenyl phenyl ether	75	0.5
4-Nitroaniline	75	0.5
Bis(2-chloroethoxy)methane	75	0.5
Bis(2-chloroethyl)ether	75	0.5
Bis(2-chloroisopropyl)ether	75	0.5
Bromodichloromethane	74	1
Bromoform	74	1
Bromomethane	74	1
Carbon Disulfide	50	1
Dibromochloromethane	74	1
Dibromomethane	74	1
Dichlorodifluoromethane	74	1
Nitrobenzene	75	0.5
Trichlorofluoromethane	74	1
Vinyl Acetate	50	20

Table 4.7
Chemicals Not Detected in Groundwater

Analyte	Number of Samples Analyzed	Minimum Reporting Limit
Chlorinated Phenols (ug/L)		
2,4,6-Trichlorophenol	75	5
2,4-Dichlorophenol	75	5
2-Chlorophenol	75	0.5
LPAHs (ug/L)		
Acenaphthylene	75	0.5
Anthracene	75	0.5
HPAHs (ug/L)		
Benzo(a)Anthracene	75	0.5
Benzo(a)Pyrene	75	0.5
Benzo(b)Fluoranthene	75	0.5
Benzo(g,h,i)Perylene	75	0.5
Benzo(k)Fluoranthene	75	0.5
Chrysene	75	0.5
Dibenzo(a,h)Anthracene	75	0.5
Fluoranthene	75	0.5
Indeno(1,2,3-cd)Pyrene	75	0.5
Chlorinated Benzenes (ug/L)		
1,2,3-Trichlorobenzene	74	1
1,2,4-Trichlorobenzene	75	0.5
Hexachlorobenzene	75	0.5
Phthalates & Other SVOCs (ug/L)		
Butylbenzylphthalate	75	0.5
Di-n-octylphthalate	75	0.5
Dimethylphthalate	75	0.5
2,4-Dinitrophenol	75	5
2-Nitrophenol	75	5
4-Nitrophenol	75	5
Aniline	75	0.5
Benzidine	75	1
Benzoic acid	75	13
Carbazole	75	0.5
Hexachlorobutadiene	75	0.5
Hexachlorocyclopentadiene	75	1
N-Nitrosodiphenylamine	75	0.5

Table 4.8

Chemicals Detected in Groundwater: Frequency of Detection Less Than or Equal to 5 Percent

Analyte	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Minimum Detected Concentration	Maximum Detected Concentration	Minimum Reporting Limit	MTCA Method B
Chlorinated Ethenes and Ethanes (ug/L)							
1,2-Dichloroethane	74	4	5	1.4	50	1	0.481
BTEX Family of Volatile Aromatics (ug/L)							
iso-Propyl benzene	74	3	4	5.3	34	1	NA
Styrene	74	3	4	460	1,800	1	400
n-Butyl benzene	74	1	1	7	7	1	NA
iso-Propyl toluene	74	3	4	8.5	7,300	1	NA
n-Propyl benzene	74	4	5	9.8	2,200	1	NA
sec-Butyl benzene	74	4	5	4.7	2,300	1	NA
Other Volatile Organics (ug/L)							
Chloro benzene	74	1	1	2.7	2.7	1	160
Chloroform	74	1	1	2.1	2.1	1	7.17
1,2-Dichloropropane	74	1	1	11	11	1	0.64
Chloromethane	74	1	1	81	81	1	3.36
Chlorinated Benzenes (ug/L)							
1,3 Dichlorobenzene	75	1	1	20	20	0.5	NA
1,4 Dichlorobenzene	75	4	5	1.4	290	0.5	1.82
Chlorinated Phenols (ug/L)							
2,4,5-Trichlorophenol	75	1	1	5.1	5.1	5	1,600
LPAHs (ug/L)							
Dibenzofuran	75	2	3	2.2	2.5	0.5	NA
Naphthalene	75	1	1	120	120	0.5	320
HPAHS (ug/L)							
Pyrene	75	2	3	0.55	0.59	0.5	480
Phthalates & Other SVOCs (ug/L)							
bis (2-ethylhexyl)phthalate	75	1	1	1	1	0.5	6.25
2-Chloronaphthalene	75	1	1	2.1	2.1	0.5	1,280
4,6-Dinitro-2-methylphenol	75	2	3	6.5	15	5	NA
4-Chloro-3-methylphenol	75	1	1	3.8	3.8	0.5	NA
Benzyl alcohol	75	1	1	17	17	0.5	4,800
Isophorone	75	1	1	2.5	2.5	0.5	92.1
N-Nitroso-di-n-propylamine	75	1	1	9.7	9.7	0.5	0.0125
Phenol	75	1	1	2.5	2.5	0.5	9,600

Note:
NA Not available.

Table 4.9

Chemicals Detected in Groundwater: Frequency of Detection Greater Than 5 Percent

Analyte	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Minimum Detected Concentration	Maximum Detected Concentration	Minimum Reporting Limit	Maximum Reporting Limit	Average Detected Concentration[1]	MTCA Method B	Location of Maximum Concentration
Chlorinated Ethenes and Ethanes (ug/L)										
Tetrachloroethene	74	53	72	2.4	85,000	1	250	9,072	0.858	B-49
Trichloroethene	74	58	78	2.6	22,000	1	250	3,160	3.98	B-49
1,1-Dichloroethene	74	8	11	1.6	260	1	1,000	74.9	0.0729	B-65
1,2-Dichloroethene (cis)	74	67	91	1.2	40,000	1	100	7,191	80	B-65
1,2-Dichloroethene (trans)	74	23	31	1	680	1	1,000	127	160	B-58
Vinyl Chloride	74	47	64	1.5	23,000	1	1,000	1,994	0.023	B-33A
1,1,1-Trichloroethane	74	9	12	36	10,000	1	5,000	436	7200	B-49
1,1-Dichloroethane	74	16	22	1	490	1	1,000	91.76	800	B-21
BTEX Family of Volatile Aromatics (ug/L)										
Benzene	74	12	16	1.2	440	1	1,000	80.9	1.51	B-49
Toluene	74	29	39	1.3	27,000	1	1,000	1,466	1,600	B-49
Ethyl benzene	74	20	27	2.8	2,200	1	1,000	239	800	B-49
Xylene (ortho)	74	17	23	1	2,500	1	1,000	190	16,000	B-49
Xylene (meta & para)	74	17	23	2.6	4,900	2	2,000	362	16,000	B-49
1,2,4-Trimethyl benzene	74	19	26	1.2	11,000	1	1,000	403	NA	B-49
1,3,5-Trimethyl benzene	74	11	15	18	9,600	1	1,000	224	NA	B-49
Other Volatile Organics (ug/L)										
Methylene Chloride	74	6	8	5.3	120	5	5,000	340	5.83	B-20A
Chlorinated Benzenes (ug/L)										
1,2-Dichloro benzene	75	10	13	1.1	1,000	0.5	1,000	99	720	B-39
Chlorinated Phenols (ug/L)										
Pentachlorophenol	75	31	41	0.01	5,500	0.5	15	180	0.729	B-38
LPAHs (ug/L)										
2-Methylnaphthalene	75	11	15	1.1	26	0.5	25	1.56	NA	B-38
Acenaphthene	75	7	9	0.68	6.4	0.5	25	0.87	960	B-49
Fluorene	75	5	7	0.51	3.2	0.5	25	0.80	640	B-49
Phenanthrene	75	7	9	1.2	4.5	0.5	25	0.88	NA	B-46

Table 4.9

Chemicals Detected in Groundwater: Frequency of Detection Greater Than 5 Percent

Analyte	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Minimum Detected Concentration	Maximum Detected Concentration	Minimum Reporting Limit	Maximum Reporting Limit	Average Detected Concentration[1]	MTCA Method B	Location of Maximum Concentration
Phthalates & Other SVOCs (ug/L)										
Di-n-butylphthalate	75	7	9	2.7	150	0.5	250	9.97	1,600	B-42
Diethylphthalate	75	5	7	0.77	7.4	0.5	25	0.87	12,800	B-52
2,4-Dimethylphenol	75	14	19	0.66	310	0.5	25	8.47	NA	B-31
2-Methylphenol	75	16	21	7.5	67	0.5	5	6.61	800	B-49
4-Methylphenol	75	16	21	0.88	76	0.5	1	5.88	80	B-20
Natural Attenuation Parameters (ug/L)										
Iron	39	34	87	110	92,000	56	56	16,880.26	NA	B-47
Ethane	38	4	11	1.1	93	0.5	2.5	3.57	NA	B-26
Ethene	38	18	47	0.75	266	0.5	0.5	30.11	NA	B-46
Methane	38	36	95	0.47	670	0.5	0.5	95.13	NA	B-19
Ammonia, total as nitrogen	39	31	79	48	25,000	40	40	2,915.85	NA	B-47
Chloride	39	39	100	2,200	11,000,000			344,889.74	NA	B-34
Nitrate	39	30	77	8	16,000	30	300	1,747.69	25,600	B-16
Nitrite	39	13	33	16	11,000	30	300	374.87	1,600	B-34
Sulfate	39	39	100	150	1,600,000			158,460.26	272,000	B-34
Total Phosphorus	39	39	100	85	2,600			551.64	0.32	B-58
Total Organic Carbon (TOC)	11	10	91	3,100	33,000	5,000	5,000	10,590.91	NA	B-44

Notes:

1 Average was calculated using the following equation: Sum of the Detected Concentrations + .5 (Reporting Limit for Non-Detects)/Number of Samples.

NA Not available.

Table 4.10
Analytical Schedule for Sediment Samples

Analysis	SD-DR115	SD-DR116	SD-DR117	SD-DR118
VOCs	--	X	--	--
BNA	X	X	X	X
PCBs	X	X	X	X
Pesticides	--	X	--	--
Metals	X	X	X	X
Organotins	X	X	--	--
Dioxins and Furans	X	--	--	--
TOC	X	X	X	X
Grain Size	X	X	X	X

Notes:

VOCs	Volatile Organic Compounds.
BNA	Base/Neutral Acids.
PCBs	Polychlorinated Biphenyls.
TOC	Total Organic Carbon.
--	Sample not analyzed by the specified method.

Table 4.11

Detection Frequency Summary for Intertidal Sediment

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1]	Maximum Detected Concentration	Minimum Detected Concentration	Maximum Reporting Limit	Minimum Reporting Limit	Sediment Screening Level[2]
Chlorinated Aromatics (ug/kg)	1,2-Dichlorobenzene	4	1	25	2.6	2.6	2.6	20	20	NA
Chlorinated Benzenes, Phthalates, and Glycols (ug/kg)	Bis(2-ethylhexyl) Phthalate	4	3	75	293	390	310	240	240	NA
	Butyl Benzyl Phthalate	4	3	75	25	30	30	20	20	NA
	Dimethyl Phthalate	4	1	25	20	50	50	20	20	NA
Miscellaneous SVOCs (ug/kg)	Carbazole	4	4	100	43	80	30	--	--	NA
Chlorinated Dioxins and Furans (pg/g)	1,2,3,6,7,8-HxCDD	1	1	100	8.6	8.6	8.6	--	--	NA
	1,2,3,7,8,9-HxCDD	1	1	100	6.9	6.9	6.9	--	--	NA
	1,2,3,4,6,7,8-HpCDD	1	1	100	260	260	260	--	--	NA
	2,3,7,8-TCDF	1	1	100	.99	0.99	0.99	--	--	NA
	1,2,3,4,6,7,8-HpCDF	1	1	100	25	25	25	--	--	NA
PAHs (ug/kg)	Acenaphthene	4	4	100	53	100	20	--	--	NA
	Fluorene	4	4	100	63	110	30	--	--	NA
	Phenanthrene	4	4	100	373	640	240	--	--	NA
	Anthracene	4	4	100	150	290	100	--	--	NA
	Total LPAH	4	4	100	638	1,140	400	--	--	NA
	Fluoranthene	4	4	100	1,025	1,400	740	--	--	NA
	Pyrene	4	4	100	843	1,100	700	--	--	NA
	Benz(a)anthracene	4	4	100	365	400	330	--	--	NA
	Chrysene	4	4	100	503	610	460	--	--	NA
	Benzo(b)fluoranthene	4	4	100	343	410	290	--	--	NA
	Benzo(K)fluoranthene	4	4	100	308	380	270	--	--	NA
	Benzofluoranthene (Total)	4	4	100	650	790	560	--	--	NA
	Benzo(a)pyrene	4	4	100	285	360	250	--	--	NA
	Indeno(1,2,3-cd)pyrene	4	4	100	170	210	140	--	--	NA
	Dibenz(a,h)anthracene	4	4	100	40	50	30	--	--	NA
	Benzo(g,h,i)perylene	4	4	100	140	170	120	--	--	NA
	Total HPAH	4	4	100	4,020	4,460	3,510	--	--	NA
	Dibenzofuran	4	4	100	43	70	20	--	--	NA

Table 4.11
Detection Frequency Summary for Intertidal Sediment

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1]	Maximum Detected Concentration	Minimum Detected Concentration	Maximum Reporting Limit	Minimum Reporting Limit	Sediment Screening Level[2]
Total Organic Carbon Normalized (ug/kg)	Acenaphthene	4	4	100	2,273	3,850	791	--	--	16
	Fluorene	4	4	100	2,655	4,230	1,580	--	--	23
	Phenanthrene	4	4	100	16,448	24,600	9,490	--	--	100
	Anthracene	4	4	100	6,693	11,200	3,930	--	--	220
	Total LPAH	4	4	100	28,050	43,800	15,800	--	--	370
	Total HPAH	4	4	100	194,750	333,000	135,000	--	--	960
	Fluoranthene	4	4	100	48,550	76,900	29,200	--	--	160
	Pyrene	4	4	100	39,350	58,500	27,700	--	--	1000
	Benzo(a)anthracene	4	4	100	17,525	29,200	12,500	--	--	110
	Chrysene	4	4	100	25,000	46,900	16,800	--	--	110
	Benzofluoranthene (Total)	4	4	100	32,350	60,800	21,400	--	--	230
	Benzo(a)pyrene	4	4	100	14,328	27,700	9,290	--	--	99
	Indeno(1,2,3-cd)pyrene	4	4	100	8,503	16,200	5,380	--	--	34
	Dibenz(a,h)anthracene	4	4	100	2,003	3,850	1,150	--	--	12
	Benzo(g,h,i)perylene	4	4	100	6,973	13,100	4,620	--	--	31
	1,2-Dichlorobenzene	4	1	25	1,615	103	103	1,540	714	2
	Dimethylphthalate	4	1	25	873	1,980	1,980	1,540	714	53
	Butylbenzylphthalate	4	3	75	1,239	2,310	1,070	769	769	5
	bis(2-Ethylhexyl)phthalate	4	3	75	12,263	15,400	11,900	18,500	18,500	47
	Dibenzofuran	4	4	100	1,803	2,690	1,190	--	--	15
	Total PCB	4	4	100	6,218	10,900	1,890	--	--	12
Chlorinated Dioxin and Furan Groups (pg/g)	Total TCDD	1	1	100	1.6	1.6	1.6	--	--	NA
	Total HxCDD	1	1	100	97	97	97	--	--	NA
	Total HpCDD	1	1	100	900	900	900	--	--	NA
	OCDD	1	1	100	2,600	2,600	2,600	--	--	NA
	Total TCDF	1	1	100	13	13	13	--	--	NA
	Total PeCDF	1	1	100	23	23	23	--	--	NA
	Total HxCDF	1	1	100	28	28	28	--	--	NA
	Total HpCDF	1	1	100	110	110	110	--	--	NA
	OCDF	1	1	100	95	95	95	--	--	NA
	2,3,7,8-TCDD Equivalence	1	1	100	4.8	4.8	4.8	--	--	NA
PCBs (ug/kg)	Aroclor 1254	4	4	100	85	108	21	--	--	NA
	Aroclor 1260	4	4	100	57	96	32	--	--	NA
	Total PCB	4	4	100	139	204	53	--	--	NA

Table 4.11
Detection Frequency Summary for Intertidal Sediment

Parameter Group	Parameter	Number of Samples Analyzed	Number of Detections	Detections (% of Total Samples)	Average Detected Concentration[1]	Maximum Detected Concentration	Minimum Detected Concentration	Maximum Reporting Limit	Minimum Reporting Limit	Sediment Screening Level[2]
Metals (mg/kg)	Aluminum	4	4	100	19,675	20,700	18,100	--	--	NA
	Antimony	4	1	25	5	5	5	10	10	NA
	Arsenic	4	4	100	11	12.5	8.2	--	--	57
	Barium	4	4	100	76	79	72	--	--	NA
	Beryllium	4	4	100	0.49	0.5	0.33	--	--	NA
	Cadmium	4	4	100	0.33	0.41	0.2	--	--	5.1
	Calcium	4	4	100	5,763	5,950	5,550	--	--	NA
	Chromium	4	4	100	28	29	27	--	--	260
	Cobalt	4	4	100	9.5	10	8	--	--	NA
	Copper	4	4	100	64	83	55	--	--	390
	Iron	4	4	100	28,500	30,600	28,500	--	--	NA
	Lead	4	4	100	26	29.8	25.1	--	--	450
	Magnesium	4	4	100	7,613	8,100	6,510	--	--	NA
	Manganese	4	4	100	298	331	276	--	--	NA
	Mercury	4	4	100	0.21	0.31	0.1	--	--	0.41
	Nickel	4	4	100	20	20.9	19.4	--	--	NA
	Potassium	4	4	100	2,450	2,700	1,800	--	--	NA
	Selenium	4	3	75	4.6	6	6	1	1	NA
	Silver	4	4	100	0.28	0.34	0.19	--	--	6.1
	Sodium	4	4	100	11,928	14,000	7,110	--	--	NA
	Thallium	4	4	100	0.09	0.09	0.08	--	--	NA
	Tin	4	3	75	2.9	3	3	5	5	NA
	Vanadium	4	4	100	59	61	56	--	--	NA
	Zinc	4	4	100	115	126	107	--	--	410
Organotins (ug/kg)	Di-n-butyltin (as Organotin)	2	2	100	16	22	9	--	--	NA
	Tri-n-butyltin (as Organotin)	2	2	100	1,900	48	31	--	--	NA
Conventionals (%)	Total Organic Carbon	4	4	100	2.3	2.8	1.3	--	--	NA

Notes:
1 Average was calculated using the following equation: Sum of the Detected Concentrations + .5 (Reporting Limit for Non-Detects)/Number of Samples.
2 The Sediment Management Standards Sediment Quality Standard was used as the sediment screening level.
NA A Sediment Quality Standard does not currently exist for this parameter.
-- No detections to report.

Table 4.12

Summary of PCE, TCE, and Methylene Chloride Results for Soil

Station	Sample ID	Depth (feet bgs)	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	Methylene Chloride (mg/kg)
SB1	SB1/S3	12.5 - 14	19.2	0.05 U	0.05 U
SB3	SB3/S2	7.5 - 9	0.05 U	0.05 U	**780**
SB4	SB4/S1	~~1.5 - 3~~	**900**	**220**	0.05 U
SB5	SB5/S3	12.5 - 14	**44**	0.05 U	**270**
SB-6	S-2SB-6	7.5 - 9	0.19	0.13 U	0.12 J
SB7	SB7/S3	12.5 - 14	**220**	4.8	0.05 U
SB8	SB8/S3	12.5 - 14	0.5	0.05 U	0.05 U
SB9	SB9/S2	7.5 - 9	0.05 U	0.05 U	0.05 U
SB-10	SB-10/S1	~~2.5 - 4~~	***18,000***	**940**	34
	SB-10/S3	12.5 - 14	**900**	16 U	16 U
	SB-10/S6	17 - 18.5	***15,000***	**1,100**	22
SB-11	SB-11/S1	~~2.5 - 4~~	5	0.92	0.35
	SB-11/S2	7.5 - 9	1.7	0.13 U	0.13 U
	SB-11/S5	13 - 14.5	7.7	0.37	0.96
SB-12	SB-12/S1	2.5 - 4	0.05	0.47	0.055
	SB-12/S2	7.5 - 9	0.003	0.002 U	0.002
	SB-12/S5	13 - 14.5	0.098	0.015	0.013
B-2	B2/S3	10 - 11.5	**1,900**	7.7	0.19 B
B-3	B3/S3	10 - 11.5	***2600***	24 U	38 B
B-5	B5-S2	5 - 6.5	0.004	0.002 U	0.002 U
	B5-S17	42.5 - 44	0.002 U	0.002 U	0.002
B-6	B6-S11	27.5 - 29	0.092	0.008	0.002
B-7	B7/S3	7.5 - 9	**1,500**	**980**	0.05 U
	B-7/S7B	16.5 - 17.5	**110**	0.05 U	0.05 U
B-8	B8-S7	17.5 - 19	0.058	0.014	0.11
B-9	B9-S6	15 - 16.5	8.4	0.3	0.002
	B9-S10	25 - 26.5	0.002 U	0.002 U	0.002
	B9-S17	42.5 - 44	0.002 U	0.002 U	0.002
B-10	B10A/S1	7.5 - 9	1.4	0.05 U	0.05 U
B-11	B-11/S2	5 - 6.5	0.001 U	0.001 U	0.001 U
	B11/S4	10 - 11.5	**50**	3.4	0.05 U
B-12	B12/S1	~~2.5 - 4~~	**160**	0.05 U	0.05 U
B-13	B13/S2	5 - 6.5	1	0.05 U	0.05 U
	S-4B-13	10 - 11.5	0.008	0.002 U	0.003
B-14	B14/S3	11.5 - 13	0.64	0.05 U	0.05 U
B-15	B-15/S1	~~2.5 -~~ 4	**300**	3.2 U	4.2
	B-15/S3	12.5 - 14	0.016	0.002 U	0.005
	B-15/S5	17 - 18	0.026	0.003	0.005
B-16	B-16/S2	9 - 10.5	4.5	0.05 U	1.4 U
	B-16/S6	15 - 16	0.05 U	0.05 U	2.3 U
	B-16/S7	15 - 16.5	0.73	0.05 U	2.2 U

Table 4.12

Summary of PCE, TCE, and Methylene Chloride Results for Soil

Station	Sample ID	Depth (feet bgs)	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	Methylene Chloride (mg/kg)
B-17	B-17/S1	17.5 - 19	0.05 U	0.05 U	1.2 U
	B-17/S2	22.5 - 24	0.05 U	0.05 U	0.89 U
	B-17/S6	37.5 - 39	0.05 U	0.05 U	0.91 U
	B-17/S12	46 - 47.5	0.05 U	0.05 U	1.4 U
B-18	B-18/S3	3 - 4.5	0.061 U	0.061 U	0.17 U
	B-18/S6	7.5 - 9	0.053 U	0.053 U	0.38 U
	B-18/S11	15 - 16.5	0.063 U	0.063 U	0.46 U
B-19	B-19/S8	26.5 - 28	0.061 U	0.061 U	0.3 U
	B-19/S20	44.5 - 46	0.06 U	0.06 U	0.3 U
B-20	B-20/S3	3 - 4.5	0.058 U	0.058 U	0.19 U
	B-20/S7	7.5 - 9	0.057 U	0.057 U	0.38 U
	B-20/S10	12 - 13.5	0.067 U	0.067 U	0.45 U
B-20A	B20A-12.5	12.5	0.38	0.062 U	0.65 UB
B-21	B-21/S2	22.5 - 24	0.063 U	0.22	0.31 U
	B-21/S15	42 - 43.5	0.066 U	0.066 U	0.33 U
	B-21/S19	48 - 49.5	0.12	1.2	0.27 U
B-22	B-22/S2	1.5 - 3	0.057 U	0.057 U	0.43 U
	B-22/S5	6 - 7.5	0.054 U	0.054 U	0.49 U
	B-22/S8	10.5 - 12	1.9	0.39	0.42 U
B-23	B-23/S11	26.5 - 28	0.062 U	0.062 U	0.31 U
	B-23/S25	47.5 - 49	0.073	0.06 U	0.3 U
B-24	B-24/S3	3 - 4.5	0.054 U	0.054 U	0.61 U
	B-24/S6	7.5 - 9	0.057 U	0.057 U	0.71 U
	B-24/S8	10.5 - 12	0.065 U	0.065 U	0.96 U
B-25	B-25/S9	28 - 29.5	0.19	0.06 U	0.28 U
B-26	B-26/S3	3 - 4.5	0.061 U	0.061 U	0.49 U
	B-26/S5	6 - 7.5	0.053 U	0.053 U	0.37 U
	B-26/S11	12 - 13.5	0.11	0.07	0.47 U
B-27	B-27/S23	44.5 - 46	0.072	0.066 U	0.33 U
	B-27/S25	47.5 - 49	0.07 U	0.07 U	0.35 U
B-28	B-28/S3	4.5 - 6	0.054 U	0.054 U	0.66 U
	B-28/S6	7.5 - 9	0.055 U	0.055 U	0.82 U
	B-28/S10	13.5 - 15	0.096	0.061 U	0.93 U
B-29	B-29/S6	9 - 10.5	0.057 U	0.057 U	0.26 U
	B-29/S9	13.5 - 15	0.27	0.065 U	0.29 U
B-30	B-30/S2	4 - 5.5	**21**	0.87	2.3 U
	B-30/S6	10 - 11.5	***3,000***	38	2.4 U
	B-30/S9	14.5 - 16	***13,000***	**820**	11
B-31	B-31/S2	1.5 - 3	0.94	0.064 U	0.31 U
	B-31/S6	7.5 - 9	0.44	0.053 U	0.24 U
	B-31/S8	10.5 - 12	**71**	11	2.3 U
B-32	B-32/S-1	0 - 3	16	0.66	0.27 U
	B-32/S-4	7 - 9	1.7	0.06 U	0.3 U

Table 4.12

Summary of PCE, TCE, and Methylene Chloride Results for Soil

Station	Sample ID	Depth (feet bgs)	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	Methylene Chloride (mg/kg)
B-33	B-33/S-22	29.5 - 31	0.066 U	0.066 U	0.33 U
	B-33/S-28	38.5 - 40	0.07 U	0.07 U	0.35 U
B-34	B-34/S-3	12.5 - 14.5	0.065 U	0.065 U	0.32 U
B-35	B-35/S-4	8 - 10	0.06 U	0.06 U	0.3 U
	B-35/S-13	28 - 30	0.062 U	0.062 U	0.31 U
B-36	B-36/S-1	9 - 11	0.062 U	0.062 U	0.31 U
B-37	B-37/S-1	1.5 - 3.5	0.06 U	0.06 U	0.3 U
	B-37/S-11	21.5 - 23.5	0.063 U	0.063 U	0.33 U
B-38	B-38/S-1	9 - 11	0.065 U	0.065 U	0.32 U
B-53	B-53-8.5	8.5	0.97	0.06 U	0.3 U
B-54	B-54-9	9	3	0.066	0.27 U
	B-54-14	14	1	0.13	0.32 U
B-55	B-55-10	10	1.3	0.063 U	0.31 U
B-56	B-56-6	6	5.2	0.057 U	0.29 U
	B-56-8.5	8.5	18	0.06 U	0.3 U
	B-56-11	11	0.58	0.066 U	0.33 U
	B-56-14	14	1.4	0.062 U	0.31 U
B-57	B-57-8.5	8.5	0.46	0.062 U	0.31 U
	B-57-14.5	14.5	0.067	0.065 U	0.32 U
B-58	B58-10	10	0.17	0.063 U	0.31 U
	B58-12.5	12.5	0.067 U	0.067 U	0.33 U
B-59	B59-30	30	0.064 UJ	0.064 UJ	0.32 UJ
B-60	B60-10	10	0.19	0.058 U	0.29 U
	B60-16	16	0.057 U	0.057 U	0.29 U
B-61	B61-13.5	13.5	0.072	0.063 U	0.32 U
	B61-24.5	24.5	0.13	0.063 U	0.31 U
	B61-43.5	43.5	0.071	0.26	0.3 U
B-62	B62-9	9	0.057 U	0.057 U	0.29 U
	B62-16	16	0.076	0.06 U	0.3 U
B-64	B64-10	10	0.59	0.14	0.3 U
	B64-12.5	12.5	0.54	0.066 U	0.33 U
TW-1	TW-1-9	9	0.062 U	0.062 U	0.31 U
	TW-1-11	11	0.068 U	0.12	0.34 U
TW-2	TW-2-8	8	0.066 U	0.066 U	0.33 U
	TW-2-13	13	0.063 U	0.063 U	0.32 U
TW-3	TW-3-10	10	0.063 U	0.063 U	0.32 U
	TW-3-13	13	1.3	0.69	0.3 U
TW5	TW5-10	10	0.06 U	0.06 U	0.3 U
	TW5-16	16	0.06 U	0.06 U	0.3 U
TW6	TW6-9	9	0.81	0.06 U	0.3 U
	TW6-12	12	8.4	0.79	0.34 U
TW-7	TW-7-9	9	0.13	0.057 U	0.29 U
	TW-7-12	12	0.2	0.06 U	0.3 U

Table 4.12

Summary of PCE, TCE, and Methylene Chloride Results for Soil

Station	Sample ID	Depth (feet bgs)	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	Methylene Chloride (mg/kg)
BOR G	BOR G-1	2.5	0.05 U	0.05 U	0.66 U
	BOR G-2	5	0.05 U	0.05 U	0.71 U
	BOR G-3	7.5	0.073	0.05 U	0.81 U
BOR H	BOR H-1	2.5	0.4	0.05 U	0.8 U
	BOR H-2	5	0.05 U	0.05 U	0.55 U
	BOR H-3	7.5	0.05 U	0.05 U	0.39 U
15/16N	15/16N	10 - 12	0.005 U	0.005 U	0.014
21-C	21-C	10 - 12	**170**	4.9	0.27 U
25-S	25-S	10 - 12	***11,000***	**180**	13 U
5/6N	5/6N	10 - 12	0.005 U	0.005 U	0.007
7/8S	7/8S	10 - 12	0.005 U	0.005 U	0.011
SW-19E	SW-19E	5 - 10	0.01	0.005 U	0.008
PT-1	PT-1	0.5 - 1	**2,500**	**150**	0.05 U
PT-2	PT-2	~~0.5 - 1~~	***4,400***	**230**	0.05 U
PT-3	PT-3	~~0.5 - 1~~	***5,900***	**550**	5.6
PT-4	PT-4	~~0.5 - 1~~	**2,300**	59	1.2 U
PT-5	PT-5	~~0.5 - 1~~	**930**	78	0.96
COMP A	COMP A	0 - 1	0.32	0.094	1 U
COMP B	COMP B	0 - 1	0.34	0.05 U	1.1 U
COMP C	COMP C	0 - 1	0.36	0.05 U	1 U
COMP D	COMP D	0 - 1	0.42	0.05 U	1.1 U
COMP E	COMP E	0 - 1	0.05 U	0.05 U	1.7 U
COMP F	COMP F	0 - 1	0.05 U	0.05 U	1.3 U

Notes:
Bold text indicates exceedance of MTCA Method B Soil Cleanup Levels.
Bold and italicized text indicates exceedance of MTCA Method C Soil Cleanup Levels.
bgs Below ground surface.
U The parameter was not detected at a concentration greater than the specified reporting limit.
B The Analyte was detected in the associated laboratory method blank.
J The Analyte was positively identified; the reported value is the approximate concentration of the Analyte in the sampl

Table 4.13
Volatile Organic Chemicals
Central Area Wells
Chlorinated Ethenes and Chlorinated Ethanes (ug/L)

		Chlorinated Ethenes								Chlorinated Ethanes						
Event Name	Sample ID	Tetrachloroethene	Trichloroethene	1,1-Dichloroethene	1,2-Dichloroethene (cis)	1,2-Dichloroethene (trans)	Vinyl Chloride	Dominant Form	Ratio^1 (PCE+TCE)/(DCE+VC)	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,2-Dichloroethane	Chloroethane
1st WBZ Wells	**MTCA B**	**0.86**	**4.0**	**72**	**80**	**160**	**0.023**			**1.68**	**7,200**	**0.219**	**0.768**	**800**	**0.4**	**NA**
1998 Annual	B-10A	100 U	260	100 U	6400	100 U	440	DCE	0.04	100 U	100 U	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-10A	100 U	950	100 U	13000	100 U	1000	DCE	0.07	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1999 Annual	B-11	3000	2800	100 U	14000	140	1900	DCE	0.36	100 U	140	100 U	100 U	100 U	100 U	100 U
1998 Annual	B-12	47000	10000	100 U	16000	420	5500	PCE	2.6	100 U	890	100 U	100 U	170	100 U	100 U
1999 Annual	B-12	19000	3300	500 U	4500	500 U	750	PCE	4.1	500 U	500 U	500 U	500 U	500 U	500 U	500 U
1998 Annual	B-13	4000	194	100 U	100 U	100 U	100 U	PCE	28	500 U	100 U	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-13	4700	200	1 U	76	1.7 J	1 U	PCE	63	1 U	5 U	5 U	1 U	1	1 U	1 U
1999 Annual	B-14	170	13	1 U	3.8	1 U	1 U	PCE	38	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1999 Annual	B-15	20000	5600	200 U	2100	200 U	200 U	PCE	11	200 U	1000 U	1000 U	200 U	200 U	200 U	200 U
1999 Annual	B-16	470	300	1.6	460	8.4	340	equal	0.95	1 U	5 U	5 U	1 U	6.1	1 U	1 U
1998 Annual	B-18	2.8	41	6	360	12	430	DCE	0.05	1 U	1 U	1 U	1 U	4.6	1.4	1 U
1999 Annual	B-18	130	120	140	6000	120	6100	DCE, VC	0.02	50 U	250 U	250 U	50 U	69	50 U	50 U
1999 Annual	B-20A	920	240	10 U	72	10 U	10 U	PCE	14	10 U	50 U	50 U	10 U	10 U	10 U	10 U
1999 Annual	B-22	2100	160	100 U	190	100 U	100 U	PCE	7.8	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1998 Annual	B-24	1 U	1 U	1 U	1 U	1 U	1 U	NA	0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-24	1 U	1 U	1 U	1 U	1 U	1 U	NA	0.67	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-26	6.1	15	1 U	57	1	1 U	NA	0.36	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-26	4.2	9.8	1 U	41	1 U	1 U	NA	0.33	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1999 Annual	B-28	15	2.6	1 U	6.5	1 U	1 U	NA	2.35	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1999 Annual	B-31	7300	1200	200 U	450	200 U	200 U	PCE	13	200 U	210	200 U	200 U	200 U	200 U	200 U
1999 Annual	B-38	5 U	5.2	5 U	21	5 U	5 U	NA	0.30	5 U	25 U	25 U	5 U	5 U	5 U	5 U
1998 Annual	B-39	40000	10000	1000 U	12000	1000 U	1400	PCE	3.6	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
1999 Annual	B-39	40000 J	7500 J	000 UJ	11000 J	000 UJ	1900 J	PCE	3.5	000 UJ	5000 UJ	5000 UJ	000 UJ	1000 UJ	000 UJ	000 UJ
1998 Annual	B-42	36000	13000	100 U	14000	130	690	PCE	3.3	100 U	880	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-42	36000	9000	1000 U	28000	1000 U	1000 U	PCE,DCE	1.6	1000 U	5000 U	5000 U	1000 U	1000 U	1000 U	1000 U
1998 Annual	B-44	14000	20000	100 U	15000	440	3000	PCE,DCE	1.8	100 U	760	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-44	57000 J	7800	100 U	10000	100 U	490	PCE	6.1	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1998 Annual	B-46	47000	9100	100 U	21000	490	1600	PCE	2.4	100 U	200	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-46	31000	18000	1000 U	13000	1000 U	1400	PCE	3.3	1000 U	5000 U	5000 U	1000 U	1000 U	1000 U	1000 U
1999 Annual	B-47	54000	21000	1000 U	33000	1000 U	1000 U	PCE,DCE	2.2	1000 U	5000 U	5000 U	1000 U	1000 U	1000 U	1000 U
1998 Annual	B-49	85000	22000	140 J	14000	270	1200	PCE	6.9	100 U	10000	100 U	100 U	260	100 U	100 U
1999 Annual	B-49	69000	19000	1000 U	25000	1000 U	1000 U	PCE	3.4	1000 U	5000 U	5000 U	1000 U	1000 U	1000 U	1000 U
1998 Annual	B-52	12000	5300	15	8300	120	2800	PCE,DCE	1.5	1 U	36	1 U	1 U	36	3.6	1 U
1999 Annual	B-52	3300	830	50 U	13000 J	140	3100	DCE	0.25	50 U	250 U	250 U	50 U	50 U	50 U	50 U

Table 4.13
Volatile Organic Chemicals
Central Area Wells
Chlorinated Ethenes and Chlorinated Ethanes (ug/L)

		Chlorinated Ethenes								Chlorinated Ethanes						
Event Name	Sample ID	Tetrachloroethene	Trichloroethene	1,1-Dichloroethene	1,2-Dichloroethene (cis)	1,2-Dichloroethene (trans)	Vinyl Chloride	Dominant Form	Ratio[1] (PCE+TCE)/(DCE+VC)	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,2-Dichloroethane	Chloroethane
1st WBZ Wells	**MTCA B**	**0.86**	**4.0**	**72**	**80**	**160**	**0.023**			**1.68**	**7,200**	**0.219**	**0.768**	**800**	**0.4**	**NA**
1999 Annual	B-53	620	42	10 U	41	10 U	10 U	PCE	13	10 U	50 U	50 U	10 U	10 U	10 U	10 U
1999 Annual	B-54	9800	420	100 U	150	100 U	100 U	PCE	41	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1999 Annual	B-55	230 J	16	1 U	14 J	1 U	3.2	PCE	14	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1999 Annual	B-56	460 J	16	2 U	12	2 U	2 U	PCE	34	2 U	10 U	10 U	2 U	6.8	2 U	2 U
1999 Annual	B-57	490 J	23	2 U	25	2 U	2 U	PCE	19	2 U	10 U	10 U	2 U	13	2 U	2 U
2nd WBZ																
1999 Annual	B-6	1 U	1 U	1 U	2.8	1 U	2.3	NA	0.18	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1999 Annual	B-17	1 U	1 U	1 U	4.6	1 U	3.3	DCE/VC	0.12	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-19	350	160	1 U	37	1 U	5	PCE	12	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-19	64	62	1 U	25	1 U	2.8	PCE	4.5	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-21	100 U	100 U	100 U	23000	530	11000	DCE/VC	0.003	100 U	100 U	100 U	100 U	490	100 U	100 U
1999 Annual	B-21	250 U	250 U	250 U	28000	250 U	18000	DCE/VC	0.01	250 U	1300 U	1300 U	250 U	250 U	250 U	250 U
1999 Annual	B-23	17	13	1 U	4	1 U	1 U	PCE	6.0	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-25	1 U	1 U	1 U	1 U	1 U	1 U	NA	0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-25	1 U	1 U	1 U	1 U	1 U	1 U	NA	0.67	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-27	1 U	1 U	1 U	1 U	1 U	3	NA	0.25	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-27	1 U	1 U	1 U	1.2	1 U	4.3	NA	0.17	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1999 Annual	B-37	1 U	1 U	1 U	1 U	1 U	1 U	NA	0.67	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-45	1300	13000	100 U	14000	270	290	DCE,TCE	0.98	100 U	100 U	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-45	1400	10000	100 U	21000	140	270	DCE,TCE	0.53	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1998 Annual	B-45 BAL	2300	12000	100 U	14000	220	340	DCE,TCE	0.98	100 U	100 U	100 U	100 U	100 U	100 U	100 U
1999 Annual	B-45 DUP	1000	9600	100 U	20000	170	230	DCE	0.52	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1998 Annual	B-8	3100	7300	2.4 J	1500	5.8	1.5	PCE	6.9	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-8	410	3100	50 U	660	50 U	50 U	PCE	4.9	50 U	250 U	250 U	50 U	50 U	50 U	50 U
1998 Annual	B-9	4.6	12	1 U	45	1 U	11	DCE	0.29	1 U	1 U	1 U	1 U	1 U	45	1 U
1999 Annual	B-9	2.4	15	1 U	35	1 U	14	DCE	0.35	1 U	5 U	5 U	1 U	1 U	50	1 U

Notes:

1 Ratio less than 10 indicates groundwater near well source has been subject to significant anaerobic biodegradation.

J The Analyte was positively identified; the reported value is the approximate concentration of the Analyte in the sample.

U The parameter was not detected at a concentration greater than the specified reporting limit.

MTCA B Model Toxic Control Act Method B Groundwater Cleanup Levels.

NA Not available.

Table 4.14
Volatile Organic Chemicals
Wells West of Fox Avenue S. (Downgradient)
Chlorinated Ethenes and Chlorinated Ethanes (ug/L)

		Chlorinated Ethenes								Chlorinated Ethanes						
EventName	SampleID	Tetrachloroethene	Trichloroethene	1,1-Dichloroethene	1,2-Dichloroethene (cis)	1,2-Dichloroethene (trans)	Vinyl Chloride	Dominant Form	Ratio (PCE+TCE)/(DCE+VC)	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,2-Dichloroethane	Chloroethane
1st WBZ Wells	**NTR**	**0.86**	**4.0**	**72**	**80**	**160**	**0.023**									
1998 Annual	B-34	13	6.8	1 U	61	1 U	3.7	DCE	0.30	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-34	11	5.7	1 U	7.6	1 U	2.2	PCE/DCE	1.62	1 U	5 U	5 U	1 U	1 U	1 U	1 U
1998 Annual	B-36	35	18	1 U	49	1 U	37	ALL	0.61	1 U	1 U	1 U	1 U	2.5	1 U	1 U
1999 Annual	B-36	180	150	2 U	290	3.2	210	ALL	0.66	2 U	10 U	10 U	2 U	9.5	2 U	2 U
1999 Annual	B-58	6200	6200	100 U	22000	680	3100	DCE	0.48	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1999 Annual	B-60	9400	1100	100 U	960	100 U	100 U	PCE	9.91	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1999 Annual	B-62	3000	1000	100 U	930	100 U	1000	PCE	2.02	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1999 Annual	B-64	50	19	1 U	6.8	1 U	1 U	PCE	8.85	1 U	5 U	5 U	1 U	1 U	1 U	1 U
2nd WBZ Wells																
1998 Annual	B-33A	100 U	100 U	170 J	26000	300	7300	DCE	0.003	100 U	100 U	100 U	100 U	100 U	100 U	100 U
1998 Annual	B-33A	130	100 U	100 U	21000	100	23000	DCE/VC	0.004	100 U	500 U	500 U	100 U	170	100 U	100 U
1998 Annual	B-35	42 U	19	10 U	33	10 U	3300	VC	0.012	10 U	10 U	10 U	10 U	210	10 U	10 U
1999 Annual	B-35	100 U	100 U	100 U	450	100 U	2300	VC	0.036	100 U	500 U	500 U	100 U	220	100 U	100 U
1999 Annual	B-59	5 U	5 U	5 U	280	5 U	180	DCE/VC	0.011	5 U	25 U	25 U	5 U	5 U	5 U	5 U
1999 Annual	B-61	200 U	1700	200 U	22000	200 U	2700	DCE	0.073	200 U	1000 U	1000 U	200 U	200 U	200 U	200 U
1999 Annual	B-63	100 U	760	100 U	5400	100 U	5800	DCE/VC	0.072	100 U	500 U	500 U	100 U	100 U	100 U	100 U
1999 Annual	B-65	100 UJ	100 UJ	260 J	40000 J	360 J	J	DCE	0.002	100 UJ	500 UJ	500 U	100 UJ	100 UJ	100 UJ	100 UJ

Notes:
NTR National Toxic Rule.
NA Not available.
J The Analyte was positively identified; the reported value is the approximate concentration of the Analyte in the sample.
U The parameter was not detected at a concentration greater than the specified reporting limit.

Table 4.15
Volatile Organic Chemicals
Seeps and Surface Water
Chlorinated Ethenes and Chlorinated Ethanes (ug/L)

		Chlorinated Ethenes								Chlorinated Ethanes						
EventName	SampleID	Tetrachloroethene	Trichloroethene	1,1-Dichloroethene	1,2-Dichloroethene (cis)	1,2-Dichloroethene (trans)	Vinyl Chloride	Dominant Form	Ratio (PCE+TCE)/(DCE+VC)	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,2-Dichloroethane	Chloroethane
1st WBZ Seeps	**NTR**	**8.85**	**81**	**3.2**	**NA**	**140,000**	**525**			**NA**	**NA**	**11**	**42**	**NA**	**99**	
1998 Annual	S-1	7.3	4	1 U	41	1 U	1		0.27	1 U	1 U	1 U	1 U	4.1	1 U	1 U
1999 Annual	S-1	3.7	1.8	1 U	6	1 U	1 U		0.79	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-11	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-12	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-2	250	180	1 U	65	3.6	1 U		6.22	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	S-2	190	270	2 U	100	12	2 U		4.07	2 U	2 U	2 U	2 U	2 U	2 U	2 U
1998 Annual	S-3	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	S-3	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-4	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-5	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-6	1.3	1 U	1 U	1 U	1 U	1 U		1.20	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	S-6	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2nd WBZ Seeps																
1998 Annual	S-13	3.8	6.2	18	3300	46	760		0.00	1 U	1 U	1 U	1 U	53	8.5	1 U
1999 Annual	S-13	20 U	20 U	20 U	3200	27	3500		0.00	20 U	20 U	20 U	20 U	58	20 U	20 U
Surface Water from Duwamish River																
1998 Annual	S-7	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	S-7	1 U	1 U	1 U	3.7	1 U	2		0.16	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	S-9	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1998 Annual	S-10	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	S-10	1 U	1 U	1 U	1 U	1 U	1 U		0.67	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Notes:
NTR National Toxic Rule.
NA Not available.
U The parameter was not detected at a concentration greater than the specified reporting limit.

Table 4.16

Detected Concentrations of Mineral Spirits and Stoddard's Solvent in Soil

Location	Depth (feet bgs)	Mineral Spirits (mg/kg)	Stoddard's solvent (mg/kg)
15/16N	10 - 12	1.8	2.9
21-C	10 - 12	1,800	2,200
25-S	10 - 12	12	14
5/6N	10 - 12	2	3.3
7/8S	10 - 12	4.7	7.6
SW-19E	5 - 10	4	6.9

Note:
bgs Below ground surface.

Table 4.17

Detected Concentrations of Light Hydrocarbons in Soil

Location	Depth (feet bgs)	Light Hydrocarbons (mg/kg)
B-7	16.5 - 17.5	310
B-7	7.5 - 9	14
PT-2	0.5 - 1	4,200
PT-3	0.5 - 1	20,000
PT-4	0.5 - 1	6,400
PT-5	0.5 - 1	13,000
SB1	12.5 - 14	400
SB3	7.5 - 9	6,400
SB4	1.5 - 3	2,100
SB5	12.5 - 14	700

Note:
bgs Below ground surface.

Table 4.18

Detected Concentrations of Petroleum Hydrocarbons in Soil

Location	Depth (feet bgs)	Thinner (mg/kg)	Gasoline (mg/kg)	Diesel (mg/kg)	Motor Oil (mg/kg)
B-2	10 - 11.5	NA	6,500	NA	NA
B-3	10 - 11.5	NA	2,600	NA	NA
B-5	0 - 0.5	NA	13	408 N	1,408
B-21	22.5 - 24	33 U	11	33 U	NA
B-22	1.5 - 3	29 U	6 U	29 U	712 J
B-24	7.5 - 9	144 U	29 U	2,758 N	12,644
	10.5 - 12	32 U	6 U	167 N	570
B-28	0 - 0.5	NA	6 J	264 J	1,126 J
B-29	0 - 0.5	NA	37	395 N	1,023
	9 - 10.5	28 U	9 N	28 U	NA
B-30	0 - 0.5	2,414	2,988 N	287 U	3,908
	4 - 5.5	NA	67	36 U	NA
	10 - 11.5	2,452	3,411 N	373	107 U
	14.5 - 16	1,358	1,728 N	210 N	741
B-31	0 - 0.5	659	557	142 N	1,477
	10.5 - 12	30 U	30 N	30 U	458 N
B-32	0 - 3	NA	13	772 N	2,894
B-34	12.5 - 14.5	NA	8	32 U	NA
B-35	28 - 30	NA	13	32 U	NA
B-37	1.5 - 3.5	1,310	1,429 N	143	NA
B-38	9 - 11	45	48 N	31 U	NA

Notes:

N	Evidence exists for the presence of the analyte, however, identification is tentative.
U	The parameter was not detected at a concentration greater than the specified reporting limit.
J	The analyte was positively identified; the reported value is the approximate concentration of the analyte in the sample.
NA	Not applicable.

Table 4.19

Summary of Chlorinated Phenol Results for Soil[1]

			Pentachlorophenol Results		2,4-Dichlorophenol Results		2,4,5-Trichlorophenol Results		2,4,6-Trichlorophenol Results		Tetrachlorophenol Results	
Station	Sample ID	Sample Depth (feet bgs)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)
B-5	B-5/Surface Total	0 - 0.5	2.3 U	0.0020 U	0.47 U	0.03 U	2.3 U	0.01 U	0.47 U	0.006 U	NA	0.006 U
B-15	B-15/S1	2.5 - 4	6.3	NA	0.078 U	NA	0.078 U	NA	0.078 U	NA	NA	NA
	B-15/S3	12.5 - 14	0.38 U	NA	0.076 U	NA	0.076 U	NA	0.076 U	NA	NA	NA
	B-15/S5	17 - 18	7.5	NA	0.099 U	NA	0.099 U	NA	0.099 U	NA	NA	NA
B-16	B-16/S2	9 - 10.5	0.97	0.49	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	B-16/S7	15 - 16.5	0.85 U	0.0027	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
B-17	B-17/S1	17.5 - 19	0.85 U	0.0022	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	B-17/S2	22.5 - 24	0.85 U	0.0020 U	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	B-17/S6	37.5 - 39	0.85 U	0.0020 U	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	B-17/S12	46 - 47.5	0.85 U	0.0020 U	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
B-18	B-18/S3	3 - 4.5	1.0 U	0.0020 U	0.2 U	0.043	1.0 U	0.01 U	0.2 U	0.006 U	NA	0.006 U
	B-18/S6	7.5 - 9	0.91 U	0.0020 U	0.18 U	0.03 U	0.91 U	0.01 U	0.18 U	0.006 U	NA	0.006 U
	B-18/S11	15 - 16.5	1.0 U	0.0037	0.21 U	0.03 U	1.0 U	0.01 U	0.21 U	0.006 U	NA	0.006 U
B-19	B-19/S8	26.5 - 28	1.1 U	0.055	0.22 U	0.3 U	1.1 U	0.1 U	0.22 U	0.06 U	NA	0.06 U
	B-19/S20	44.5 - 46	1.1 U	0.0020 U	0.21 U	0.03 U	1.1 U	0.01 U	0.21 U	0.006 U	NA	0.006 U
B-20	B-20/S3	3 - 4.5	1.0 U	0.0020 U	0.21 U	NA	1.0 U	0.01 U	0.21 U	0.006 U	NA	0.006 U
	B-20/S7	7.5 - 9	0.94 U	0.0020 U	0.19 U	0.03 U	0.94 U	0.01 U	0.19 U	0.0099	NA	0.006 U
	B-20/S10	12 - 13.5	1.1 U	0.0020 U	0.22 U	0.03 U	1.1 U	0.01 U	0.22 U	0.006 U	NA	0.006 U
B-20A	B20A-13	12 - 13.5	0.42 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
B-21	B-21/S2	22.5 - 24	1.0 U	0.022	0.21 U	0.03 U	1.0 U	0.01 U	0.21 U	0.006 U	NA	0.006 U
	B-21/S15	42 - 43.5	1.0 U	0.0062	0.21 U	2.1	1.0 U	0.074	0.21 U	0.017	NA	0.02
	B-21/S19	48 - 49.5	1.1 U	0.0020 U	0.22 U	0.38	1.1 U	0.013	0.22 U	0.006 U	NA	0.006 U
B-22	B-22/S2	1.5 - 3	2.0 U	0.0023	0.4 U	0.052	2.0 U	0.01 U	0.4 U	0.006 U	NA	0.006 U
	B-22/S5	6 - 7.5	0.94 U	0.0020 U	0.19 U	0.084	0.94 U	0.01 U	0.19 U	0.006 U	NA	0.006 U
	B-22/S8	10.5 - 12	1.1 U	0.0020 U	0.22 U	0.03 U	1.1 U	0.01 U	0.22 U	0.006 U	NA	0.006 U
B-23	B-23/S11	26.5 - 28	1.0 U	0.0024	0.21 U	0.037 U	1.0 U	0.012 U	0.21 U	0.0073 U	NA	0.0073 U
	B-23/S25	47.5 - 49	1.1 U	0.0025 U	0.22 U	0.038 U	1.1 U	0.013 U	0.22 U	0.0076 U	NA	0.0076 U
B-24	B-24/S3	3 - 4.5	0.92 U	0.0020 U	0.18 U	0.03 U	0.92 U	0.01 U	0.18 U	0.006 U	NA	0.006 U
	B-24/S6	7.5 - 9	19 U	0.0020 U	3.8 U	0.057	19 U	0.01 U	3.8 U	0.006 U	NA	0.006 U
	B-24/S8	10.5 - 12	1.1 U	0.0020 U	0.22 U	0.072	1.1 U	0.01 U	0.22 U	0.006 U	NA	0.006 U
B-25	B-25/S9	28 - 29.5	1.1 U	0.0025 U	0.21 U	0.037 U	1.1 U	0.012 U	0.21 U	0.0075 U	NA	0.0075 U
B-26	B-26/S3	3 - 4.5	0.97 U	0.0020 U	0.19 U	0.03 U	0.97 U	0.01 U	0.19 U	0.006 U	NA	0.006 U
	B-26/S5	6 - 7.5	0.90 U	0.0020 U	0.18 U	0.049	0.9 U	0.01 U	0.18 U	0.006 U	NA	0.006 U
	B-26/S11	12 - 13.5	1.1 U	0.0050	0.21 U	0.03 U	1.1 U	0.01 U	0.21 U	0.006 U	NA	0.006 U
B-27	B-27/S23	44.5 - 46	1.1 U	0.0026 U	0.22 U	0.5	1.1 U	0.014	0.22 U	0.0079 U	NA	0.0079 U
	B-27/S25	47.5 - 49	1.2 U	0.0027 U	0.23 U	0.22	1.2 U	0.014 U	0.23 U	0.0082 U	NA	0.0082 U
B-28	B-28/Surface Total	0 - 0.5	2.5 U	0.0029	0.49 U	0.035	2.5 U	0.015 U	0.49 U	0.0087 U	NA	0.0087 U
	B-28/S3	3 - 4.5	0.92 U	0.0020 U	0.18 U	0.037	0.92 U	0.01 U	0.18 U	0.006 U	NA	0.006 U
	B-28/S6	7.5 - 9	0.94 U	0.0020 U	0.19 U	0.03 U	0.94 U	0.01 U	0.19 U	0.006 U	NA	0.006 U
	B-28/S10	13.5 - 15	1.0 U	0.0020 U	0.21 U	0.028	1.0 U	0.01 U	0.21 U	0.006 U	NA	0.006 U
B-29	B-29/Surface Total	0 - 0.5	2.0 U	0.0023	0.39 U	0.03 U	2.0 U	0.01 U	0.39 U	0.006 U	NA	0.006 U
	B-29/S4	6 - 7.5	1.0 U	NA	0.21 U	NA	1.0 U	NA	0.21 U	NA	NA	NA
	B-29/S6	9 - 10.5	0.94 U	0.0020 U	0.19 U	0.03 U	0.94 U	0.01 U	0.19 U	0.006 U	NA	0.006 U
	B-29/S9	13.5 - 15	1.1 U	0.0026	0.22 U	0.03 U	1.1 U	0.01 U	0.22 U	0.006 U	NA	0.006 U
B-30	B-30/Suraface Total	0 - 0.5	3.4	4.2	0.39 U	3.5 U	2.0 U	1.2 U	0.39 U	0.7 U	NA	0.7 U
	B-30/S2	4 - 5.5	1.2 U	0.22	0.25 U	0.44 U	1.2 U	0.15 U	0.25 U	0.087 U	NA	0.087 U
	B-30/S6	10 - 11.5	11	4.7	0.9 U	3.0 U	4.5 U	1.0 U	0.9 U	0.6 U	NA	0.9
	B-30/S9	14.5 - 16	13	5.0	2.1 U	3.0 U	10 U	1.0 U	2.1 U	0.6 U	NA	0.73
B-31	B-31/Surface Total	0 - 0.5	0.96 U	0.25	0.19 U	0.34 U	0.96 U	0.11 U	0.19 U	0.068 U	NA	0.068 U
	B-31/S2	1.5 - 3	5.0 U	0.0047	1.0 U	0.03 U	5.0 U	0.01 U	1.0 U	0.006 U	NA	0.006 U
	B-31/S6	7.5 - 9	0.91 U	0.027	0.18 U	0.03 U	0.91 U	0.01 U	0.18 U	0.006 U	NA	0.006 U
	B-31/S8	10.5 - 12	4.4	2.0	0.21 U	3.0 U	1.0 U	NA	0.21 U	0.6 U	NA	0.6 U
B-32	B-32/S-1	0 - 3	0.91 U	0.0043 J	0.18 U	0.15 J	0.91 U	0.021 U	0.18 U	0.013 U	NA	0.013 U
	B-32/S-4	7 - 9	1.1 U	0.0025 U	0.22 U	0.076	1.1 U	0.013 U	0.22 U	0.0076 U	NA	0.0076 U

Table 4.19

Summary of Chlorinated Phenol Results for Soil[1]

Station	Sample ID	Sample Depth (feet bgs)	Pentachlorophenol Results		2,4-Dichlorophenol Results		2,4,5-Trichlorophenol Results		2,4,6-Trichlorophenol Results		Tetrachlorophenol Results	
			Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)	Semi-Volatile Organics (mg/kg)	Chlorinated Phenols (mg/kg)
B-33	B-33/S-22	29.5 - 31	1.1 U	0.0026 U	0.22 U	0.038 U	1.1 U	0.013 U	0.22 U	0.0077 U	NA	0.0077 U
	B-33/S-28	38.5 - 40	1.1 U	0.0027 U	0.23 U	0.041 U	1.1 U	0.076 J	0.23 U	0.082 J	NA	0.0081 U
B-34	B-34/S-3	12.5 - 14.5	1.1 U	0.0026 U	0.22 U	0.039 U	1.1 U	0.013 U	0.22 U	0.0077 U	NA	0.0077 U
B-35	B-35/S-4	8 - 10	1.1 U	0.0038	0.21 U	0.038 U	1.1 U	0.013 U	0.21 U	0.0075 U	NA	0.0075 U
	B-35/S-13	28 - 30	1.0 U	0.075	0.21 U	0.36 U	1.0 U	0.089	0.21 U	0.072 U	NA	0.072 U
B-36	B-36/S-1	9 - 11	1.0 U	0.0027	0.21 U	0.056 J	1.0 U	0.012 U	0.21 U	0.0073 U	NA	0.0073 U
B-37	B-37/S-1	1.5 - 3.5	2.7	0.34	0.21 U	1.8 U	1.0 U	0.62 U	0.21 U	0.37 U	NA	0.37 U
	B-37/S-11	21.5 - 23.5	1.1 U	0.011	0.21 U	0.037 U	1.1 U	0.012 U	0.21 U	0.0074 U	NA	0.0074 U
B-38	B-38/S-1	9 - 11	2.7	**71**	1.1 U	19 U	5.4 U	6.4 U	1.1 U	3.8 U	NA	**38**
B-43	B-43-12	? -	0.89	NA	0.39 U	NA	0.96 U	NA	0.39 U	NA	NA	NA
B-44	B-44-14	? -	0.46 J	NA	0.4 U	NA	0.96 U	NA	0.4 U	NA	NA	NA
B-45	B-45-12	28 - 30	0.68	NA	0.42 U	NA	1.0 U	NA	0.42 U	NA	NA	NA
	B-45-46	? -	0.13 J	NA	0.43 U	NA	1.0 U	NA	0.43 U	NA	NA	NA
B-46	B-46-12	? -	0.45	NA	0.4 U	NA	0.96 U	NA	0.4 U	NA	NA	NA
B-47	B-47-12	? -	**11 R**	NA	0.57 U	NA	1.4 U	NA	0.57 U	NA	NA	NA
B-48	B-48-12	? -	0.42	NA	0.39 U	NA	0.96 U	NA	0.39 U	NA	NA	NA
B-49	B-49-15	? -	2.9	NA	0.43 U	NA	1.0 U	NA	0.43 U	NA	NA	NA
B-50	B-50-06	? -	**29 R**	NA	0.78 U	NA	1.9 U	NA	0.78 U	NA	NA	NA
	B-50-10	? -	**9.9 R**	NA	0.41 U	NA	1.0 U	NA	0.41 U	NA	NA	NA
B-51	B-51	? -	0.13 J	NA	0.41 U	NA	0.99 U	NA	0.41 U	NA	NA	NA
B-52	B-52	? -	1.0 U	NA	0.41 U	NA	1.0 U	NA	0.41 U	NA	NA	NA
B-53	B-53-14.0	12.5 - 14	0.41 U	NA	0.04 U	NA	0.2 U	NA	0.2 U	NA	NA	NA
B-55	B-55-14.5	13.5 - 15	0.42 U	NA	0.04 U	NA	0.21 U	NA	0.21 U	NA	NA	NA
SB-10	SB-10/S1	2.5 - 4	**29 J**	NA	1.7 R	NA	1.7 R	NA	1.7 R	NA	NA	NA
	SB-10/S3	12.5 - 14	**10**	NA	0.079 U	NA	0.079 U	NA	0.079 U	NA	NA	NA
	SB-10/S6	17 - 18.5	**22 J**	NA	1.6 R	NA	1.6 R	NA	1.6 R	NA	NA	NA
SB-11	SB-11/S1	2.5 - 4	0.41 U	NA	0.082 U	NA	0.082 U	NA	0.082 U	NA	NA	NA
	SB-11/S2	7.5 - 9	**1.5**	NA	0.071 U	NA	0.071 U	NA	0.071 U	NA	NA	NA
	SB-11/S5	13 - 14.5	**22**	NA	0.087 U	NA	0.087 U	NA	0.087 U	NA	NA	NA
SB-12	SB-12/S1	2.5 - 4	0.41 U	NA	0.083 U	NA	0.083 U	NA	0.083 U	NA	NA	NA
	SB-12/S2	7.5 - 9	0.14 J	NA	0.071 U	NA	0.071 U	NA	0.071 U	NA	NA	NA
	SB-12/S5	13 - 14.5	0.44 U	NA	0.088 U	NA	0.088 U	NA	0.088 U	NA	NA	NA
BOR G	BOR G-1	2.5	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	BOR G-2	5	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
BOR G	BOR G-3	7.5	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
BOR H	BOR H-1	2.5	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	BOR H-2	5	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
	BOR H-3	7.5	0.85 U	0.0020 U	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
COMP A	COMP A[2]	0 - 1	0.89 J	NA	0.33 U	NA	1.7 U	NA	0.33 U	NA	NA	NA
COMP B	COMP B[2]	0 - 1	1.7 U	NA	0.33 U	NA	1.7 U	NA	0.33 U	NA	NA	NA
COMP C	COMP C[2]	0 - 1	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
COMP D	COMP D[2]	0 - 1	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
COMP E	COMP E[2]	0 - 1	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA
COMP F	COMP F[2]	0 - 1	0.85 U	NA	0.17 U	NA	0.85 U	NA	0.17 U	NA	NA	NA

Notes:

Bold text indicates detected concentration exceeds MTCA Method B residential soil cleanup level of 8.33 mg/kg for Pentachlorophenol.

1 Some samples were analyzed for both semi-volatile organic compounds (SVOCs) using EPA Method 8270 and chlorinated phenols using EPA Method 8040 producing two results for pentachlorophenol. The chlorinated phenol analyses were performed at a "low level" providing detection limits for pentachlorophenol that are approximately three orders of magnitude lower than the SVOC analyses.

2 This sample consisted of a composite of 4 grab samples collected from a transect established in the truck loading area located in the north central portion of the Great Western International property.

U The parameter was not detected at a concentration greater than the specified reporting limit.

J The Analyte was positively identified; the reported value is the approximate concentration of the Analyte in the sample.

R The sample results are rejected due to deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

bgs Below ground surface.

NA The sample was not analyzed for the specified parameter using the specified method.

Table 4.20
Dioxins and Furans Detected in Soil Samples (pg/kg)

Parameter	Sample Location		
	B-30	B-30	B-31
	B-30/Surface Total	B-30/S9	B-31/S8
	0-0.5 feet bgs	14.5-16 feet bgs	10.5-12 feet bgs
2,3,7,8-TCDF	12.5	1.7	0.3 U
Total TCDF	94.2	29.9	0.58
1,2,3,7,8-PeCDF	7.1	3.9	0.4 U
2,3,4,7,8 PeCDF	7.3	4	0.4 U
Total PeCDF	17.5	73.4	4.4
1,2,3,4,7,8-HxCDF	48.4	38.4	1.8
1,2,3,6,7,8-HxCDF	42.2	31.7	1
1,2,3,7,8,9-HxCDF	16.3 U	21.6	0.7 U
2,3,4,6,7,8-HxCDF	73.5	61	2.1
Total HxCDF	881	1,090	37.3
1,2,3,4,6,7,8-HpCDF	1,190	981	33.3
1,2,3,4,7,8,9-HpCDF	98.7	78.6	4
Total HpCDF	4,490	3,880	148
OCDF	4,750	3,490	177
Furan Equivalence	**19.8**	**12.6**	**0.33**
2,3,7,8-TCDD	7 U	0.6 U	0.3 U
Total TCDD	7 U	1.7	0.3 U
1,2,3,7,8-PeCDD	11.3	5.5	0.3 U
Total PeCDD	11.3	23.4	0.5 U
1,2,3,4,7,8-HxCDD	38.9	24.1	1.4
1,2,3,6,7,8-HxCDD	203	176	9.6
1,2,3,7,8,9-HxCDD	103	74.4	3.8
Total HxCDD	1,050	758	37.3

Table 4.20
Dioxins and Furans Detected in Soil Samples (pg/kg)

Parameter	Sample Location		
	B-30	B-30	B-31
	B-30/Surface Total	B-30/S9	B-31/S8
	0-0.5 feet bgs	14.5-16 feet bgs	10.5-12 feet bgs
1,2,3,4,6,7,8-HpCDD	8,170	6,980	269
Total HpCDD	13,800	11,390	473
OCDD	83,720	51,540	3,050
2,3,7,8-TCDD Equivalence	**88.3**	**52.4**	**3.22**

Notes:

pg/kg	Picogram/kilogram	bgs	Below ground surface.	HpCDD	Heptachlorodibenzo-p-dioxin
HxCDD	Hexachlorodibenzo-p-dioxin	OCDD	Octachlorodibenzo-p-dioxin	PeCDD	Pentachlorodibenzo-p-dioxin
TCDD	Tetrachlorodibenzo-p-dioxin	HpCDF	Heptachlorodibenzo-p-furan	HxCDF	Hexachlorodibenzo-p-furan
OCDF	Octachlorodibenzo-p-furan	PeCDF	Pentachlorodibenzo-p-furan	TCDF	Tetrachlorodibenzo-p-furan

U The parameter was not detected at a concentration greater than the specified reporting limit.

Table 4.21
Semi-Volatile Organic Chemicals
Central Area Wells in Groundwater in the 1st WBZ (ug/L)

		Dichlorobenzenes			Phenols			Penta	Phthalates		LPAHs			
EventName	SampleID	1,2-Dichloro benzene	1,3-Dichloro benzene	1,4-Dichloro benzene	2,4-Dimethylphenol	2-Methylphenol	4-Methylphenol	Pentachlorophenol	bis(2-Ethylhexyl)phthalate	Di-n-butylphthalate	2-Methylnaphthalene	Acenaphthene	Naphthalene	Phenanthrene
1st WBZ	**MTCA B**	**720**	**NA**	**1.82**	**NA**	**800**	**80**	**0.8**	**6.25**	**1,600**	**NA**	**101**	**320**	**NA**
1998 Annual	B-10A	4	1 U	1 U	5 U	5 U	1 U	15 U	1 U	1 U	10	1 U	43	1 U
1999 Annual	B-10A	4.1	0.6	0.71	1.1	0.5 U	0.5 U	5 U	1.1 UB	0.5 UB	9.2	0.5 U	40 UB	0.5 U
1999 Annual	B-11	0.5 U	0.5 U	0.5 U	1	0.5 U	4.9	**1900**	6.9 UB	1.5 UB	0.5 U	0.5 U	1.2 UB	0.5 U
1998 Annual	B-12	170	13	**63**	5 U	7.5	16	**450 J**	1 U	43	3.9	1.7	16	2.8
1999 Annual	B-12	110	6.8	**36**	30	19	14	**430**	5.7 UB	33 UB	1.6	0.68	9.5 UB	1.3
1998 Annual	B-13	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.51 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.51 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-15	0.5 U	0.5 U	0.5 U	0.66	0.5 U	0.5 U	**26**	1.4 UB	0.5 UB	0.5 U	0.5 U	0.52 UB	0.5 U
1999 Annual	B-16	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**6.3**	20 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-18	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-18	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**13**	0.51 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-20A	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	1.3 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-22	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-24	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-24	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-26	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-26	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	2.7 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-28	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-31	5 U	5 U	5 U	310	60	6.2	**330**	5 UB	5 UB	5 U	5 U	26 UB	5 U
1999 Annual	B-38	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.88	**5500**	2.4 UB	0.61 UB	26	0.5 U	58 UB	0.5 U
1998 Annual	B-39	130	39	1 U	39	31	1 U	**440**	1 U	47	1.7	1 U	11	1 U
1999 Annual	B-39	81 J	5 UJ	**22 J**	7.2 J	11 J	10 J	**380 J**	5 UB	25 UJ	5 UJ	5 UJ	5 UB	5 UJ

Table 4.21
Semi-Volatile Organic Chemicals
Central Area Wells in Groundwater in the 1st WBZ (ug/L)

		Dichlorobenzenes			Phenols			Penta	Phthalates		LPAHs			
EventName	SampleID	1,2-Dichloro benzene	1,3-Dichloro benzene	1,4-Dichloro benzene	2,4-Dimethylphenol	2-Methylphenol	4-Methylphenol	Pentachlorophenol	bis(2-Ethylhexyl)phthalate	Di-n-butylphthalate	2-Methylnaphthalene	Acenaphthene	Naphthalene	Phenanthrene
1st WBZ	**MTCA B**	**720**	**NA**	**1.82**	**NA**	**800**	**80**	**0.8**	**6.25**	**1,600**	**NA**	**101**	**320**	**NA**
1998 Annual	B-42	230 J	22	**110**	66	29	52	**260 J**	1	150	2.3	1 U	13	1 U
1999 Annual	B-42	340	20	**120**	5 U	28	54	**370**	5 UB	250 UB	5 U	5 U	13 UB	5 U
1998 Annual	B-44	80	21	1 U	13	20	1 U	**570**	1 U	28	1.9	1.5	10	1.3
1999 Annual	B-44	88	5 U	**23**	12	18	15	**360**	5 UB	16 UB	5 U	5 U	5 UB	5 U
1998 Annual	B-46	150	11	**54**	5 U	14	16	**360**	1 U	60	3.2	2.8	12	4.5
1999 Annual	B-46	100	6.2	**33**	16	9.1	7.4	**200**	5 UB	81 UB	5 U	5 U	7.1 UB	5 U
1999 Annual	B-47	350	13	**100**	10 U	39	51	**490**	10 UB	240 UB	10 U	10 U	15 UB	10 U
1998 Annual	B-49	120	5.3	**36**	13	52	34	**480 J**	1 U	51	7.5	6.4	23	2.3
1999 Annual	B-49	110	25 U	**28**	25 U	67	49	**520**	25 UB	41 UB	25 U	25 U	25 UB	25 U
1998 Annual	B-52	120	12	**39**	5 U	5 U	1 U	**120**	1 U	2.7	1.1	1.2	4.4	2.4
1999 Annual	B-52	55	5.7	**20**	27	11	15	**37**	0.7 UB	1.7 UB	0.5 U	0.5 U	1.8 UB	1.2
1999 Annual	B-53	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.61 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-54	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.74 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-54[1]	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	2.5 UB	0.5 UB	0.5 U	0.5 U	0.5 U	0.5 U
1999 Annual	B-55	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.69 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-56	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.53 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-57	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	2.5 UB	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U

Notes:

1 Resampled on 12/17/99 to verify original results.

NA Not available.

J The Analyte was positively identified; the reported value is the approximate concentration of the Analyte in the sample.

U The parameter was not detected at a concentration greater than the specified reporting limit.

UB The material was analyzed for, but was not detected above the associated value. The associated value was elevated above the customary level due to blank contamination at the laboratory.

MTCA B Model Toxic Control Act Method B Groundwater Cleanup Levels.

Bold values indicate concentration greater than cleanup level.

Table 4.22
Semi-Volatile Organic Chemicals
Central Area Wells in Groundwater in the 2nd WBZ

		Dichlorobenzenes			Phenols			Penta	Phthalates		LPAHs			
EventName	**SampleID**	**1,2-Dichloro benzene**	**1,3-Dichloro benzene**	**1,4-Dichloro benzene**	**2,4-Dimethylphenol**	**2-Methylphenol**	**4-Methylphenol**	**Pentachlorophenol**	**Bis(2-chloroethoxy)metha**	**Di-n-butylphthalate**	**2-Methylnaphthalene**	**Acenaphthene**	**Naphthalene**	**Phenanthrene**
2^{nd} WBZ	**MTCA B**	**720**	**NA**	**1.82**	**NA**	**800**	**80**	**0.8**	**6.25**	**1,600**	**NA**	**101**	**320**	**NA**
1999 Annual	B-6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-8	2.5	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-8	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-9	1 U	1 U	1 U	5 U	5 U	1 U	15 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-17	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-19	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-19	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-21	16 J	1 UJ	1 UJ	5 U	5 U	1 U	10 U	1 UJ	1 UJ	1 UJ	1 UJ	6.7 J	1 UJ
1999 Annual	B-21	19	0.75	**4.4**	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	5.2 UB	0.5 U
1999 Annual	B-23	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 B	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-25	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-25	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-27	1 U	1 U	1 U	5 U	5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1999 Annual	B-27	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1999 Annual	B-37	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U
1998 Annual	B-45	3.5	1 U	1 U	5 U	5 U	1 U	15 U	1 U	1 U	1 U	1 U	2.6	1 U
1999 Annual	B-45	2.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**22**	0.5 U	0.5 UB	0.5 U	0.5 U	0.5 UB	0.5 U

Notes:

NA	Not available.
U	The parameter was not detected at a concentration greater than the specified reporting limit.
UB	The material was analyzed for, but was not detected above the associated value. The associated value was elevated above the customary level due to blank contamination at the laboratory.
MTCA B	Model Toxic Control Act Method B Groundwater Cleanup Levels.

Bold values indicate concentration greater than cleanup level.

Table 4.23
Analytical Parameters Used to Assess Natural Degradation and Attenuation Processes

Alkalinity	Provides an indication of the buffering capacity of the water and the amount of carbon dioxide dissolved in the water. Increases due to biodegradation of organic compounds.
pH	Microbial activity tends to be reduced outside of a pH range of 5 to 9, and many anaerobic bacteria are particularly sensitive to pH extremes.
Temperature	Affects rates of microbial metabolism. Slower biodegradation occurs at lower temperatures.
Dissolved oxygen	Highest energy-yielding electron acceptor for biodegradation of organic constituents.
Redox potential	A measure of the oxidation-reduction potential of the environment. Ranges from +500 mV for aerobic conditions to -300 mV for methanogenic conditions.
Sulfate	Used as an electron acceptor in biodegradation of organic constituents. Reduced to form sulfide.
Sulfide	Microbially reduced form of sulfate. Indicates reduced conditions.
Methane	Indicator of anaerobic conditions and of methanogenic bacteria. Produced by the microbial reduction of carbon dioxide. Solubility limit 25 to 40 ppm.
Ethane/ethene	Metabolic end product of reductive dehalogenation of halogenated ethenes and ethanes.
Total organic carbon (TOC)	A measure of the total concentration of organic material in water that may be available for biological degradation.
Chloride	May be useful as an indicator of biological dechlorination and as a conservative tracer.
VOC/daughter products	Provides a measure of the type and quantity of parent and biogenic daughter products.
Iron (total, dissolved)	A measure of bacterial iron reduction. Only the reduced form (ferrous) is soluble. The oxidized form (ferric) is used as an electron acceptor.
Nitrogen	An essential nutrient of microbial growth and biodegradation.
Nitrate	Used as an electron acceptor. Consumed next after oxygen.
Nitrite	Product of nitrate reduction. Produced only under anaerobic conditions. Rarely observed.
Phosphorus	Essential nutrient for microbial growth and biodegradation.

Source: Natural Attenuation of Chlorinted Solvents in Groundwater, Training Course Workbook
July, 1998. Prepared by the Industrial Members of the RTDF Bioremediation Consortium

Table 4.24

Analytical Schedule for Natural Attenuation Parameters for 1999 Annual Monitoring Event

Parameter	Method	1st WBZ Wells																																			
		B-1	B-10A	B-11	B-12	B-13	B-14	B-15	B-16	B-18	B-20A	B-22	B-24	B-26	B-28	B-29	B-30	B-31	B-32	B-34	B-36	B-38	B-39	B-42	B-44	B-46	B-47	B-49	B-50	B-52	B-53	B-54	B-55	B-56	B-57	B-58	B-60	B-62	B-64
Field-Measured																																							
Temperature	Field Probe	--	X	--	--	X	X	X	X	--	X	X	X	X	X	--	X	--	--	X	X	X	X	X	X	X	X	X	--	X	X	X	X	X	X	X	X	X	X
pH	Field Probe	--	X	--	--	X	X	X	X	--	X	X	X	X	X	--	X	--	--	X	X	X	X	X	X	X	X	X	--	X	X	X	X	X	X	X	X	X	X
Specific Conductance	Field Probe	--	X	--	--	X	X	X	X	--	X	X	X	X	X	--	X	--	--	X	X	X	X	X	X	X	X	X	--	X	X	X	X	X	X	X	X	X	X
Dissolved Oxygen	Field Probe	--	X	--	--	X	X	X	X	--	X	X	X	X	X	--	X	--	--	X	X	X	X	X	X	X	X	X	--	X	X	X	X	X	X	X	X	X	X
Oxidation-reduction Potential	Field Probe	--	X	--	--	X	X	X	X	--	X	X	X	X	X	--	X	--	--	X	X	X	X	X	X	X	X	X	--	X	X	X	X	X	X	X	X	X	X
Ferrous Iron	Hach Method 8146	--	--	--	--	X	--	--	X	--	X	X	X	X	X	--	X	--	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Sulfide	Hach Method 8131	--	--	X	--	X	--	--	X	--	X	X	X	--	X	--	X	--	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Lab-Measured																																							
Nitrate	EPA Method 300A	--	--	X	X	X	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Nitrite	EPA Method 300A	--	--	X	X	X	--	--	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Ammonia	EPA Method 350.1	--	--	X	X	X	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Sulfate	EPA Method 300A	--	--	X	X	--	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Phosphate, Total	EPA Method 365.1	--	--	X	X	X	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Chloride	EPA Method 300A	--	--	X	X	X	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Iron, Total	EPA Method 6010B	--	--	X	X	--	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	X	X	X	--	--	X	X	X	X
Gases (Methane, Ethane, Ethene)		--	--	X	--	X	--	X	X	--	X	X	X	X	X	--	X	X	--	X	X	--	--	X	X	X	X	X	--	--	--	X	X	--	--	X	X	X	X

Parameter	Method	2nd WBZ Wells																	
		B-5	B-6	B-8	B-9	B-17	B-19	B-21	B-23	B-25	B-27	B-33A	B-35	B-37	B-45	B-59	B-61	B-63	B-65
Field-Measured																			
Temperature	Field Probe	--	X	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	Field Probe	--	X	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Specific Conductance	Field Probe	--	X	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dissolved Oxygen	Field Probe	--	X	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oxidation-reduction Potential	Field Probe	--	X	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ferrous Iron	Hach Method 8146	--	X	--	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Sulfide	Hach Method 8131	--	--	--	--	X	--	X	X	X	--	X	X	--	X	X	X	X	X
Lab-Measured																			
Nitrate	EPA Method 300A	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Nitrite	EPA Method 300A	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Ammonia	EPA Method 350.1	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Sulfate	EPA Method 300A	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Phosphate, Total	EPA Method 365.1	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Chloride	EPA Method 300A	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Iron, Total	EPA Method 6010B	--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X
Gases (Methane, Ethane, Ethene)		--	X	X	--	X	--	X	X	X	X	X	X	--	X	X	X	X	X

Note:
-- Sample not analyzed by the specified method.

Table 4.25

Natural Attenuation/Degradation Parameters in Key Wells

1999 Annual Groundwater Monitoring Event

MW#	DO mg/L	ORP mV	Ammonia mg/L	Nitrate mg/L	Nitrite mg/L	Ferrous Iron mg/L	Total Iron ug/L
1st WBZ							
B-10A	0.27	-55.0	NA	NA	NA	NA	NA
B-11	NA	NA	3.6	0.02	0.11	NA	18000
B-12	NA	NA	9.2	0.33	0.15	NA	37000
B-13	1.10	62.0	ND	4.6	0.016	0.0	ND
B-14	1.40	3.5	NA	NA	NA	NA	NA
B-15	1.78	175.0	2.9	3.1	ND	NA	5200
B-16	0.30	5.6	1.3	16	0.67	2.13	2200
B-20A	1.65	148.0	0.087	8.1	ND	0.01	290
B-22	0.14	230.0	ND	3.5	ND	0.02	ND
B-24	0.10	81.0	0.07	0.39	0.026	1.67	1900
B-26	0.19	-76.0	0.11	0.008	ND	NA	45000
B-28	0.70	106.0	ND	0.97	0.02	0.02	110
B-31	NA	NA	14	4.6	0.19	NA	46000
B-34	9.48	121.0	0.096	0.55	11	0.12	590
B-36	5.81	-32.0	0.13	0.25	ND	7.9	13000
B-38	0.31	-122.0	NA	NA	NA	NA	NA
B-39	1.04	29.0	NA	NA	NA	NA	NA
B-42	0.14	13.0	22	0.2	0.19	81.8	79000
B-44	0.60	54.0	9.1	1.7	ND	10.55	26000
B-46	0.49	24.0	6.4	0.14	0.16	17.3	34000
B-47	0.66	-24.0	25	0.69	0.23	40.75	92000
B-49	0.93	4.6	11	1.6	0.22	15.0	31000
B-52	0.20	13.0	NA	NA	NA	NA	NA
B-53	0.08	170.0	ND	0.54	ND	0.005	ND
B-54	2.35	217.0	ND	1.4	ND	0.005	ND
B-55	1.27	149.0	ND	2.5	ND	0.02	ND
B-56	0.90	137.0	NA	NA	NA	NA	NA
B-57	0.30	133.0	NA	NA	NA	NA	NA
B-58	0.47	-40.0	1.9	0.51	ND	2.33	14000
B-60	0.58	89.0	0.048	5.3	ND	0.006	270
B-62	0.77	191.0	ND	8.4	ND	0.03	340
B-64	10.41	195.0	ND	2	ND	0.05	390

Table 4.25

Natural Attenuation/Degradation Parameters in Key Wells

1999 Annual Groundwater Monitoring Event

MW#	DO mg/L	ORP mV	Ammonia mg/L	Nitrate mg/L	Nitrite mg/L	Ferrous Iron mg/L	Total Iron ug/L
2nd WBZ							
B-6	0.01	-39.0	0.27	0.024	0.048	2.54	5800
B-8	NA	NA	0.32	52	ND	NA	20000
B-9	0.27	-62.0	NA	NA	NA	NA	NA
B-17	0.35	-127.0	0.68	ND	ND	2.49	2800
B-19	0.10	-22.0	NA	NA	NA	NA	NA
B-21	0.38	-31.0	0.064	ND	ND	16.3	27000
B-23	0.15	-9.7	0.073	0.06	ND	2.66	11000
B-25	0.20	99.0	1.6	ND	ND	0.64	800
B-27	0.32	-126.0	0.69	0.024	ND	NA	1900
B-33A	0.40	-90.0	0.6	ND	ND	11.72	42000
B-35	5.27	-59.0	0.28	ND	ND	18.66	37000
B-37	0.16	-84.0	NA	NA	NA	NA	NA
B-45	0.09	-80.0	0.29	ND	ND	12.05	21000
B-59	0.39	-53.0	0.53	ND	ND	4.8	6700
B-61	0.35	55.0	0.26	ND	ND	12.7	15000
B-63	0.58	-58.0	0.35	ND	ND	11.25	16000
B-65	5.95	-71.0	0.61	0.014	ND	3.75	4900

Table 4.25

Natural Attenuation/Degradation Parameters in Key Wells

1999 Annual Groundwater Monitoring Event

MW#	Sulfate mg/L	Sulfide mg/L	Phosphorous mg/L	Chloride mg/L	Ethene ug/L	Ethane ug/L	Methane ug/L
1st WBZ							
B-10A	NA	NA	NA	NA	NA	NA	NA
B-11	56	NA	1.4	43	NA	NA	NA
B-12	350	NA	0.51	97	NA	NA	NA
B-13	97	0.001	0.15	8.9	ND	ND	0.47
B-14	NA	NA	NA	NA	NA	NA	NA
B-15	110	NA	0.2	82	ND	1.1	1.4
B-16	140	0.019	0.1	4.1	ND	ND	1.4
B-20A	19	0.001	0.085	11	ND	ND	0.51
B-22	30	0.003	0.14	3	ND	ND	0.86
B-24	22	0.001	0.17	3.9	ND	ND	1.8
B-26	130	NA	1.1	4.6	ND	93	460
B-28	150	0.002	0.15	9.3	ND	ND	ND
B-31	250	NA	1.6	110	ND	ND	1.0
B-34	1600	0.001	0.1	11000	ND	ND	ND
B-36	19	0.008	0.37	4.5	1.3	ND	2.2
B-38	NA	NA	NA	NA	NA	NA	NA
B-39	NA	NA	NA	NA	NA	NA	NA
B-42	550	0.013	1.1	130	131	ND	197
B-44	400	0.0025	0.31	130	9.9	ND	12
B-46	300	0.024	0.64	74	266	ND	106
B-47	520	0.031	1.2	130	246	ND	307
B-49	300	0.021	1.1	130	230	ND	158
B-52	NA	NA	NA	NA	NA	NA	NA
B-53	270	0.0	0.15	6.4	ND	ND	3.9
B-54	170	0.004	0.01	5.3	ND	ND	0.98
B-55	94	0	0.17	5.5	ND	ND	0.65
B-56	NA	NA	NA	NA	NA	NA	NA
B-57	NA	NA	NA	NA	NA	NA	NA
B-58	75	0.01	2.6	26	6.6	ND	120
B-60	46	0.002	0.11	9.3	ND	ND	7.4
B-62	27	0.002	0.089	12	0.75	ND	1.96
B-64	15	0.029	0.2	2.2	0.83	ND	0.82

Table 4.25

Natural Attenuation/Degradation Parameters in Key Wells
1999 Annual Groundwater Monitoring Event

MW#	Sulfate mg/L	Sulfide mg/L	Phosphorous mg/L	Chloride mg/L	Ethene ug/L	Ethane ug/L	Methane ug/L
2nd WBZ							
B-6	13	NA	0.38	54	ND	ND	13
B-8	52	NA	0.32	7.7	ND	ND	61
B-9	NA	NA	NA	NA	NA	NA	NA
B-17	1.9	0.035	1.2	110	ND	ND	78
B-19	NA	NA	NA	NA	NA	NA	NA
B-21	6.9	0.019	0.23	39	4.0	ND	15.1
B-23	91	0.019	0.31	18	ND	ND	4.2
B-25	0.15	0.19	1.5	92	ND	ND	80
B-27	0.3	NA	1.2	110	6.0	ND	625
B-33A	86	0.007	0.4	730	83	ND	58
B-35	5.2	0.54	0.68	36	77	26	34
B-37	NA	NA	NA	NA	NA	NA	NA
B-45	34	0.005	0.25	28	2.1	2.1	9.8
B-59	81	0.039	0.3	32	1.4	ND	156
B-61	15	0.005	0.34	47	45	ND	360
B-63	44	0.008	0.28	17	26.6	ND	24.9
B-65	9.5	0.016	0.44	88	1.8	ND	40

Notes:
NA Not analyzed.
ND Not detected.

Table 5.1
Chemical-Specific Properties for the PCOCs

Analyte	CAS Number	Boiling Point (°C)	Melting Point (°C)	Specific Gravity	Form at 20°C	Vapor Pressure (atm)	Volatile	Solubility at 20°C (mg/L)	Henry's Law Constant (atm-m3/mol)	Partitioning Coeffiecient Organic Carbon to Water (Koc) (cm3/g)	Mobility in Water
Chlorinated Ethenes and Ethanes											
Tetrachloroethene	127184	121 [1]	-19 [1]	1.623 [6]	liquid	0.02 [2]	moderate	200 [4]	1.84E-02 [4]	3.64E+02 [5]	moderate
Trichloroethene	79016	87 [1]	-73 [1]	1.462 [6]	liquid	0.08 [2]	moderate	1,100 [4]	1.03E-02 [4]	1.26E+02 [5]	high
1,2-Dichloroethene (cis)	156592	60 [1]	-80 [1]	1.284 [6]	liquid	0.26 [3]	high	3,500 [4]	4.07E-03 [4]	49 [5]	high
1,2-Dichloroethene (trans)	156605	48 [1]	-50 [1]	1.257 [6]	liquid	0.43 [3]	high	6,300 [4]	9.39E-03 [4]	59 [5]	high
1,1-Dichloroethene	75354	32 [1]	-122.5 [1]	1.213 [6]	liquid	0.78 [3]	high	2,250 [4]	2.61E-02 [4]	5.89E+01 [4]	high
Vinyl chloride	75014	-14 [1]	-153.2 [1]	NA	gas	3.3 [2]	very high	2,760 [4]	2.71E-02 [4]	1.86E+01 [4]	very high
BTEX Family of Volatile Aromatics											
Benzene	71432	80 [1]	5.5 [1]	0.8786 [6]	liquid	0.1 [2]	moderate	1,750 [4]	5.56E-03 [4]	5.89E+01 [4]	high
Toluene	108883	111 [1]	-95 [1]	0.867 [6]	liquid	0.03 [2]	moderate	526 [4]	6.63E-03 [4]	1.82E+02 [4]	high
Ethyl benzene	100414	136 [1]	-94 [1]	0.867 [6]	liquid	0.009 [2]	low	169 [4]	7.88E-03 [4]	3.63E+02 [4]	moderate
Styrene	100425	145 [1]	-33 [1]	0.9045 [6]	liquid	0.007 [2]	low	310 [4]	2.76E-03 [4]	7.76E+02 [4]	moderate
Other Volatile Organics											
Methylene Chloride	75092	40 [1]	-97 [1]	1.3225 [6]	liquid	0.046 [2]	moderate	13,000 [4]	2.19E-03 [4]	1.17E+01 [4]	high
Chlorinated Phenols											
Pentachlorophenol	87865	309 [1]	174 [1]	1.979 [6]	solid	1.30E-07 [2]	no	14 [4]	2.44E-08 [4]	2.00E+03 [7]	low
Dioxins and Furans											
2,3,7,8-TCDD	1746016	NA	305 [3]	NA	solid	9.70E-13 [3]	no	1.93E-05 [3]	2.10E-03 [3]	4.00E+06 [7]	non-mobile
1,2,3,7,8-PeCDD	40321764	NA	241 [3]	NA	solid	<9.7E-13	no	<2 E-05	NA	NA	non-mobile
1,2,3,4,7,8-HxCDD	39227286	NA	273 [3]	NA	solid	<9.7E-13	no	<2 E-05	NA	NA	non-mobile
OCDD	3268879	NA	332 [3]	NA	solid	<9.7E-13	no	<2 E-05	NA	NA	non-mobile
2,3,7,8-TCDF	51207319	NA	228 [3]	NA	solid	<9.7E-13	no	<2 E-05	NA	NA	non-mobile
Chlorinated Benzenes											
1,4-Dichlorobenzene	106467	174 [1]	53 [1]	1.2417 [6]	solid	0.002 [2]	very low	79 [3]	2.72E-03 [3]	6.17E+02 [4]	moderate

Notes:
1 From CRC Handbook of Chemistry and Physics published by Cleveland Chemical and Ruber Company.
2 From NIOSH pocket guide to Chemical Hazards, distributed and published by Center for Diseases Control and Prevention, DHHS (NIOSH) Publication No. 97-140.
3 From USEPA Treatability Study Data Base Version 6.0.
4 From Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings.
5 From A Review of Immiscible Fluids in the Subsurface, Journal of Contaminant Hydrology, Mercer and Cohen, 1990.
6 From htpp://www.chemfinder.com.
7 Estimate based on regression calculations in the Handbook of Chemical Property Estimation Methods, Lymann et al., 1990, published by the American Chemical Society, and solubilities.
NA Not available.

Table 5.2
Natural Attenuation Case Studies with References

Site #	Location, Facility Type, and Date	Geology	Predominant Redox	Parent/Daughter Chemicals	Electron Donors	Microbial Process	Studies to Date	Papers/Reports
1	Toronto, Ontario Chemical Transfer Facility 1989-Present	Low K Silt Till Shallow, <30 ft bgs	Anaerobic	PCE → ethene	Methanol, Acetate	Methanogenesis Acetogenesis Sulphate-reduction	NA Investigation Laboratory Study 8 In Situ Microcosms NA Remedy	Major et al. 1991 Major & Cox, 1992 Major & Cox., 1993 Major & Cox, 1994
2	Sacramento, CA Industrial Facility 1994-Present	Unconsolidated Alluvium Silty Sand, Gravel Deep, 70 ft bgs	Generally Aerobic Anaerobic Source	TCE → ethene VC → CO2 TCA → ethane CF, DCM	Septage	Methanogenesis Aerobic Oxidation Cometabolic oxidation?	NA Investigation (Groundwater) Laboratory Study NA Investigation (Unsaturated Zone) Site-Wide Intrinsic Review (>50 sites)	Cox et al., 1995 Edwards & Cox, 1997 BEAK Report, 1996b BEAK Report, 1996a
3	Auburn, NY	Overburden Fractured Bedrock	Anaerobic	TCE → ethene	Acetone, methanol	Methanogenesis Acetogenesis Sulphate-reduction Iron-reduction	Intrinsic Biodegradation Investigation Conceptual Design	Major et al., 1994 Major et al., 1995
4	Portland, OR Chemical Transfer Facility 1995-Present	Sand and Fill Shallow, < 30 ft bgs Clay Confining Layer	Anaerobic	PCE/TCE → ethene DCM, Toluene, xylene	DCM (acetate), alcohols, TEX	Methanogenesis Acetogenesis Iron-reduction Sulphate-reduction	NA Investigation (Groundwater) Lab Study of NA and enhanced (proposed)	Lehmicke et al., 1996
5	Kitchener, Ontario Industrial Facility 1995-Present	Silty Sand Shallow, < 30 ft bgs Clay Confining Layer	Aerobic Anaerobic Source	TCE → ethene	Acetone, DCM, TX	Methanogenesis Acetogenesis Sulphate-reduction Iron-reduction	NA Investigation (Groundwater) Lab Study of NA and enhanced Pilot Test (ongoing)	Edwards & Cox, 1997 Edwards & Cox, 1997

Table 5.2
Natural Attenuation Case Studies with References

Site #	Location, Facility Type, and Date	Geology	Predominant Redox	Parent/Daughter Chemicals	Electron Donors	Microbial Process	Studies to Date	Papers/Reports
6	Farmington, NH Landfill 1995-Present	Landfill, Rubber Silty Sand to 65 ft bgs Bedrock	Aerobic Anaerobic Source	TCE, DCE, VC trace ethene DCM, TEX, ketones	TX, DCM, ketones	Acetogenesis Methanogenesis Cometabolic oxidation	NA Investigation (Groundwater) Laboratory Study	Cox et al., 1996 Cox et al., 1997 Edwards and Cox, 1997
7	St. Joseph, MI Industrial Facility 1991-Present	Fine and medium sand to 65-95 ft bgs	Background aerobic Anaerobic plume	TCE → VC, ethene	Unidentified TOC	Methanogenesis Sulphate-reduction	NA Investigation (Groundwater) Laboratory tests of enhanced (cometabolic)	McCarty et al., 1991 McCarty & Wilson, 1992 Kitanidis et al., 1993 Wilson et al., 1994 Weaver et al., 1996 McCarty et al., 1991 Dolan & McCarty, 1994
8	Plattsburgh, NY Air Force Base 1995-Present	Fine and medium sand 0-90 ft bgs	Background aerobic? Anaerobic plume	TCE → VC, ethene	BTEX, jet fuel	Methanogenesis Sulphate-reduction Iron-reduction	NA Investigation (Groundwater)	Wiedemeyer et al., 1996b
9	New Jersey Picatinny Arsenal 199?-199?	Fine to course sand, discontinuous silt/clay to 50 - 70 ft bgs	Background aerobic? Anaerobic plume	TCE → VC, ethene	Unidentified TOC	Methanogenesis Sulphate-reduction Iron-reduction	NA Investigation (Groundwater)	Imbrigiotta, et al., 1996

Table 5.2
Natural Attenuation Case Studies with References

Site #	Location, Facility Type, and Date	Geology	Predominant Redox	Parent/Daughter Chemicals	Electron Donors	Microbial Process	Studies to Date	Papers/Reports
10	Dover, DE Dover Air Force Base 1995 - Present	Fine to coarse sand, some silt to 30 - 60 ft bgs	Background aerobic Anaerobic source	TCE → VC, ethene	BTEX, jet fuel Unidentified TOC	Methanogenesis Cometabolic oxidation? Aerobic oxidation	NA Investigation (Groundwater) Lab Study of Enhanced Anaerobic Lab Study of Cometabolic Bioventing Cometabolic Bioventing pilot test Enhanced Anaerobic pilot test	Ellis et al., 1996 Klecka et al., 1997 Harkness et al., 1997 Moser et al., 1997 Sayles, et al., 1997 Buchanan et al., 1997
11	Alaska Eielson Air Force Base 1992-Present	Coarse sand and gravel to 180 - 300 ft bgs	Background aerobic Anaerobic plume	TCE → VC, ethene	BTEX, jet fuel	Methanogenesis Sulphate-reduction Iron-reduction	NA Investigation (Groundwater)	Dupont et al., 1996
12	Oscoda, MI Wurtsmith Air Force Base 1994 - present	Medium to fine sand, coarse sand and gravel to 60 - 90 ft bgs	Background aerobic Anaerobic plume	PCE/TCE → DCE, trace VC	BTEX, jet fuel	Methanogenesis Sulphate-reduction Iron-reduction	NA Investigation (Groundwater)	Barcelona et al., 1996
13	Richmond, CA Chemical Plant 1996-present	Estuarial deposits of clays, silts and sands to 130 ft bgs	Background aerobic Anaerobic plume	PCE/TCE → VC, and ethene	Unidentified TOC	Some unidentified Sulphate-reduction	NA Investigation (Groundwater)	Buscheck et al., 1997

Table 5.2
Natural Attenuation Case Studies with References

Site #	Location, Facility Type, and Date	Geology	Predominant Redox	Parent/Daughter Chemicals	Electron Donors	Microbial Process	Studies to Date	Papers/Reports
14	Niagra Falls, NY Landfill 1994	Overburden fractured bedrock	Background aerobic Anaerobic plume	PCE/TCE → VC, TCA, DCA, CA CT, CF, DCM, CM ethene and ethane	Landfill leachate other chemicals	Methanogenesis Sulphate-reduction	NA Investigation (Groundwater)	Lee et al., 1995
15	Niagra Falls, NY Chemical Plant 1994	Overburden fractured bedrock	Background aerobic Anaerobic plume	PCE/TCE → VC, TCA, DCA, DCM	DCM, others?	Methanogenesis Sulphate-reduction	NA Investigation (Groundwater)	Buchanan et al., 1995
16	Hawkesbury, Ontario Carpet Manufacturing 1992	Till, reworked sand and silts over un-weathered sandy silt and fractured bedrock	Background aerobic? Anaerobic plume?	PCE/TCE → VC, TCA → DCA and CA ethene and ethane DCM	DCM, methanol naphtha	Methanogenesis Sulphate-reduction Iron-reduction Acetogenesis	NA Investigation (Groundwater)	Fiorenza et al., 1994
17	Gulf Coast Chemical Plant 1995	Peat, clay and silt layers	Aerobic and anaerobic	1,2-DCA 2-chloroethanol ethanol, ethene, ethane	1,2-DCA Unidentified TOC	Methanogenesis? Sulphate-reduction Iron-reduction	NA Investigation (Groundwater) Laboratory study	Lee et al., 1996
18	Netherlands VC Production Plant 1995	4 m of sand fill over natural material	Aerobic and anaerobic	1,2-DCA VC, ethene and ethane	1,2-DCA Unidentified TOC	Methanogenesis? Sulphate-reduction	NA Investigation (Groundwater)	Bosma et al., 1997

Table 5.2
Natural Attenuation Case Studies with References

Site #	Location, Facility Type, and Date	Geology	Predominant Redox	Parent/Daughter Chemicals	Electron Donors	Microbial Process	Studies to Date	Papers/Reports
19	Louisiana VC Production Plant 1995	Very fine sand to 20 ft clay aquitard	Background aerobic? Anaerobic plume	VC release ethene	VC Unidentified TOC	Methanogenesis Sulphate-reduction Iron-reduction Aerobic oxidation	NA Investigation (Groundwater)	Leetham & Larson, 1997
20	Cecil County, MD Landfill 1995-1996	Sand and fill over fractured saprolitic bedrock	Background aerobic? Anaerobic plume	VC release	VC	Aerobic oxidation Anaerobic oxidation?	NA Investigation (Groundwater)	Personal communications from John Wilson, 1997
21	Pinellas, FL. DOE Facility 1995-present	Marine deposits Fine sand, some silt, clay <30 ft bgs	Anaerobic	TCE → VC (suspect ethene) DCM → CM	BTEX, Ketones DCM	Unidentified	Pilot Test of enhanced	Acree et al., 1997
22	Canoga Park, CA Industrial Facility 1996-present	Shallow overburden over fractured bedrock	Generally aerobic anaerobic source	TCE → VC, TCA → DCA CT, CF, DCM 1,2-DCA	Benzene, DCM	Methanogenesis Nitrate-reduction Aerobic degradation	NA Investigation (Groundwater)	BEAK Report, 1997b (To be published)
23	Sacramento, CA Industrial Facility 1996-present	Unconsolidated Alluvium Silty sand, gravel Deep, 70 ft bgs	Generally aerobic anaerobic source	TCE → VC and ethene CF, DCM, 1,2-DCA → ethene 1,2-DCA → CO2	Alcohols, acids, ketones, BTEX	Methanogenesis Nitrate-reduction Sulphate-reduction Aerobic degradation	NA Investigation (Groundwater)	BEAK Report, 1997c (To be published)

Table 5.2
Natural Attenuation Case Studies with References

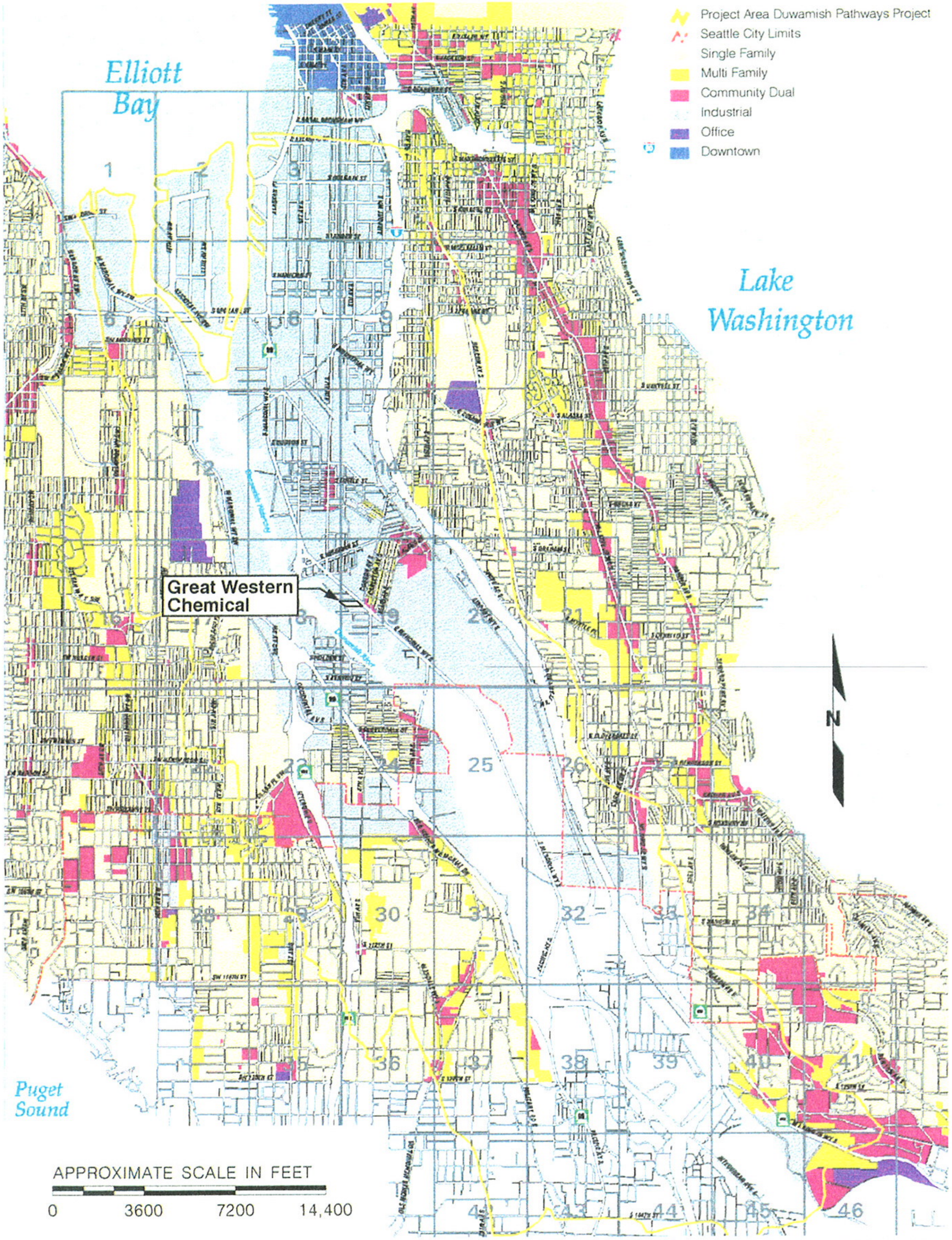
Site #	Location, Facility Type, and Date	Geology	Predominant Redox	Parent/Daughter Chemicals	Electron Donors	Microbial Process	Studies to Date	Papers/Reports
24	Ogden, UT Hill Air Force Base 1995-present	Interbedded clay, silt, sand, gravel 15 - 110 ft bgs	Generally aerobic	PCE/TCE ->DCE	none	Unidentified (Abiotic processes and possibly natural phytoremediation)	NA Investigation (Groundwater and vadose)	Graves et al., 1997

Source: Natural Attenuation of Chlorinated Solvents in Groundwater: Principles and Practices Version 3.0 August 1997.

Supplemental Remedial Investigation and Feasibility Study

Figures

AGENCY REVIEW DRAFT



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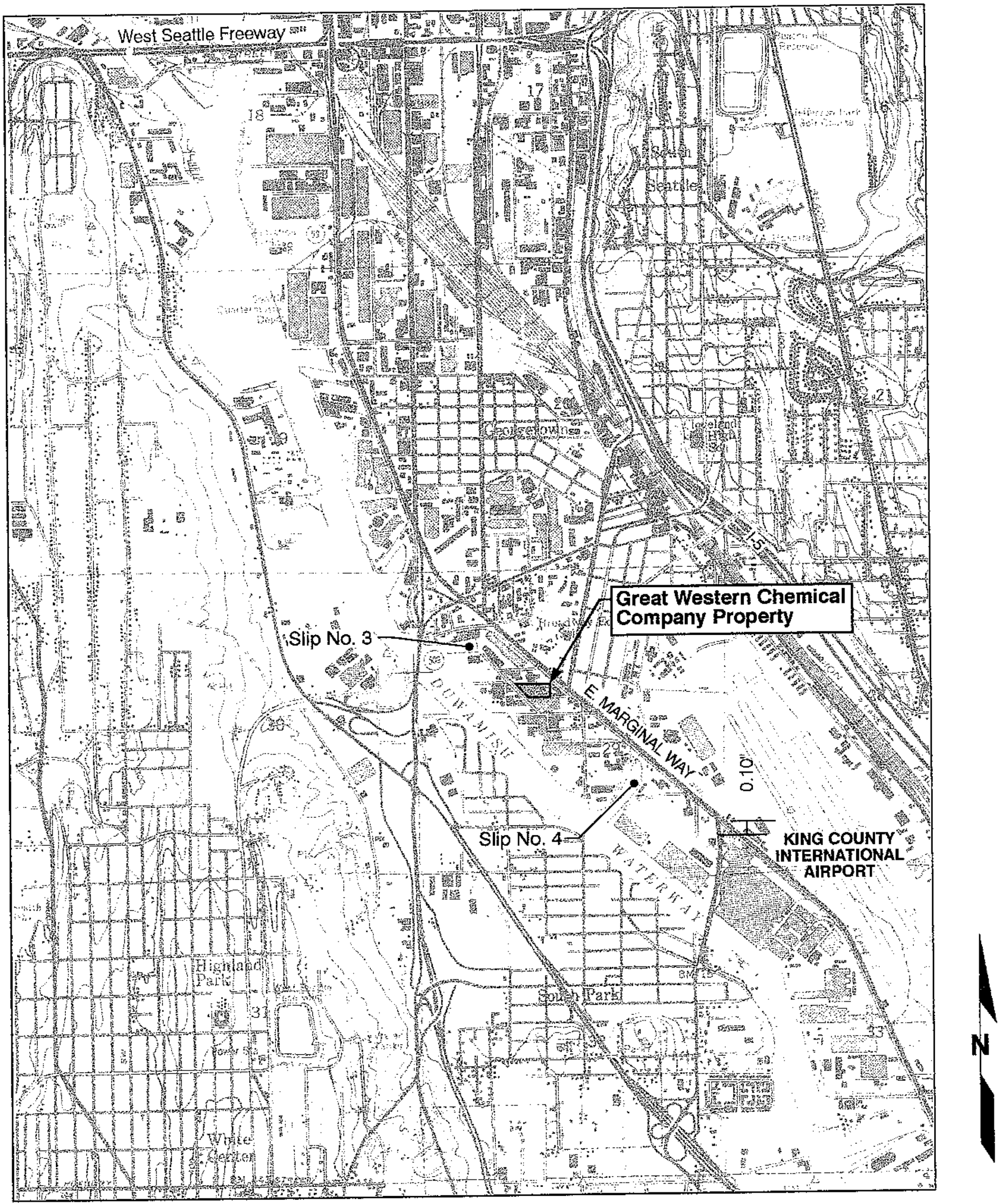
TERRA VAC

Great Western Chemical Company Seattle, Washington

Figure 2.1 Regional Zoning Map

02/23/00 ZoningMap.cdr



Note: Base map prepared from USGS 7.5 minute quadrangle map
of Seattle South, Washington, dated 1973.

APPROXIMATE SCALE IN MILES
0 ½ 1

05/26/00 VMAP.cdr

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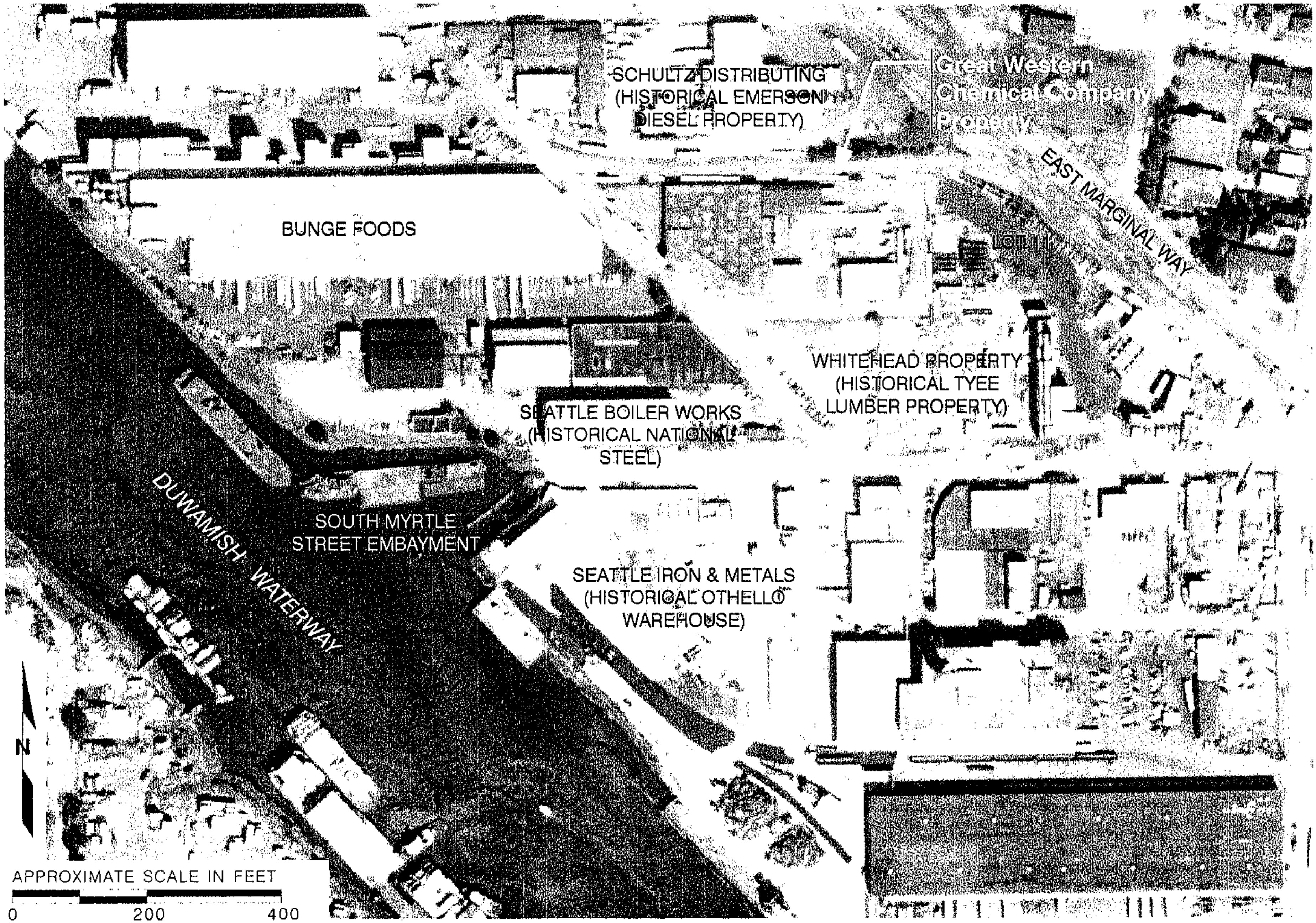
TERRA VAC

Great Western Chemical Company
Seattle, Washington

Figure 2.2
Vicinity Map



ORIGINAL IN COLOR

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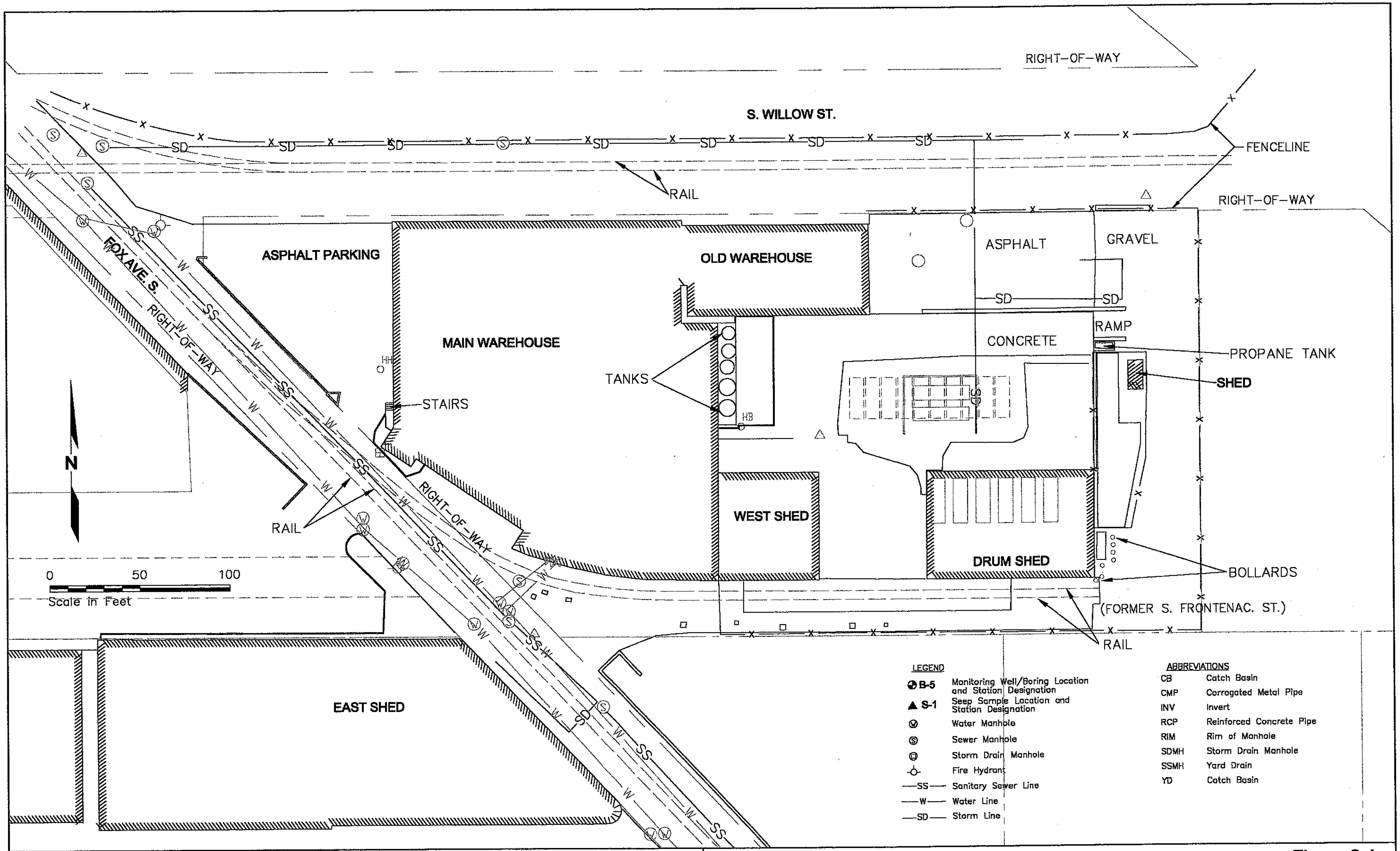
Chemical Company
Seattle, Washington**

Figure 2.3
Area Map

[illegible]



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Seattle, Washington

Figure 2.4
Current Facility Configuration

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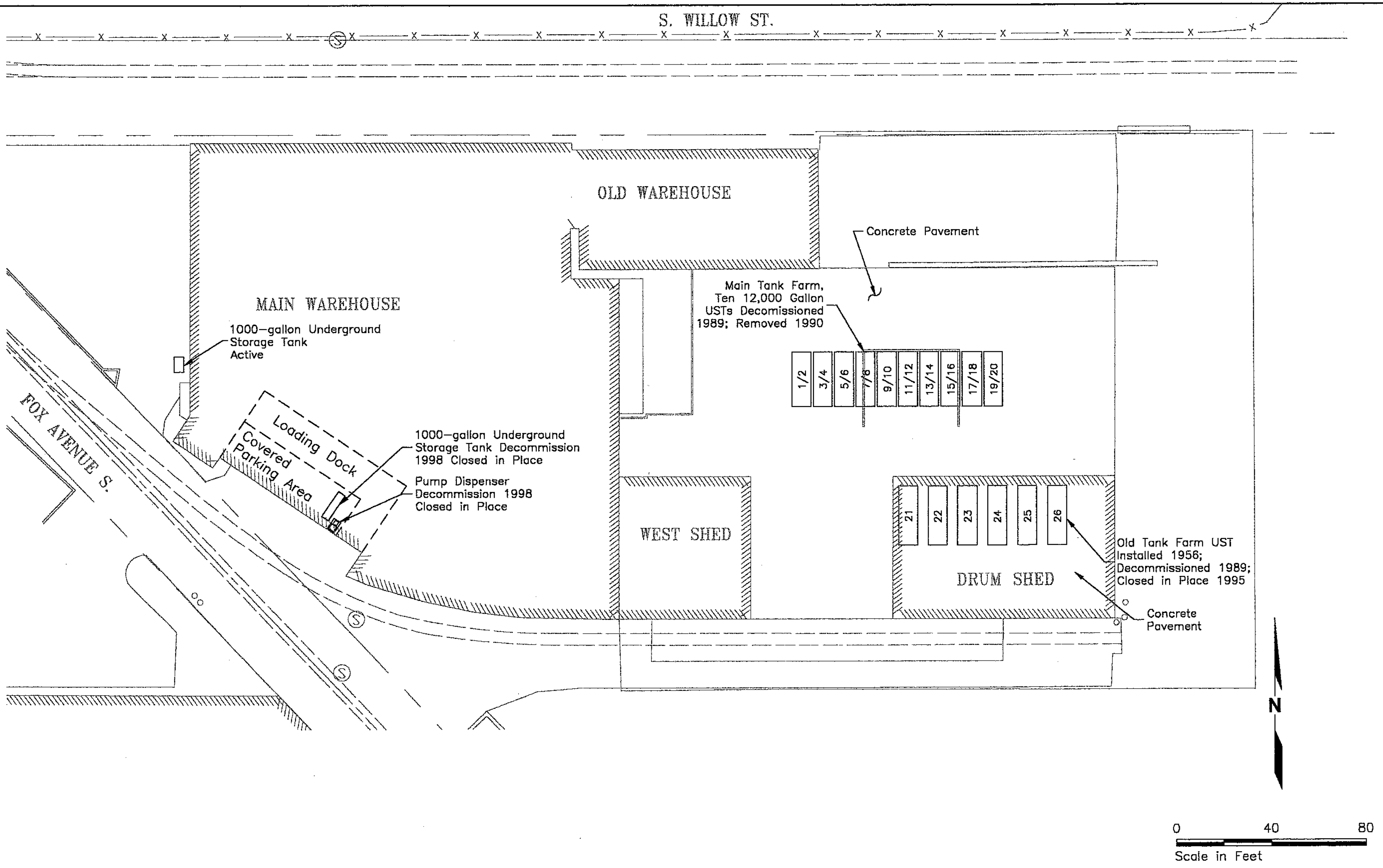

Floyd & Snider Inc.

TERRA VAC

Great Western Chemical Company
Seattle, Washington

Figure 2.5
Location Map of USTs

DATE: 10/20/00 10:10am
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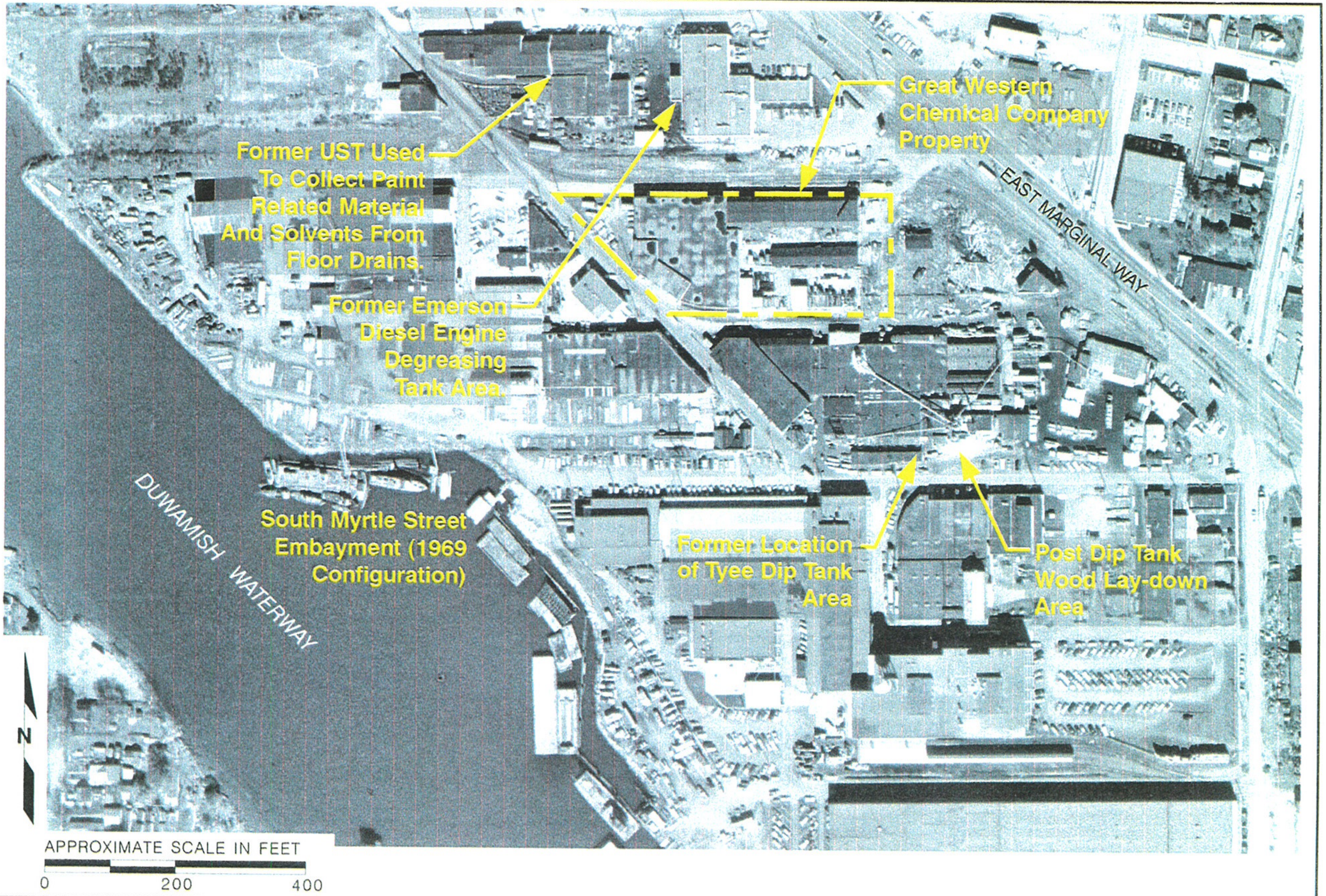

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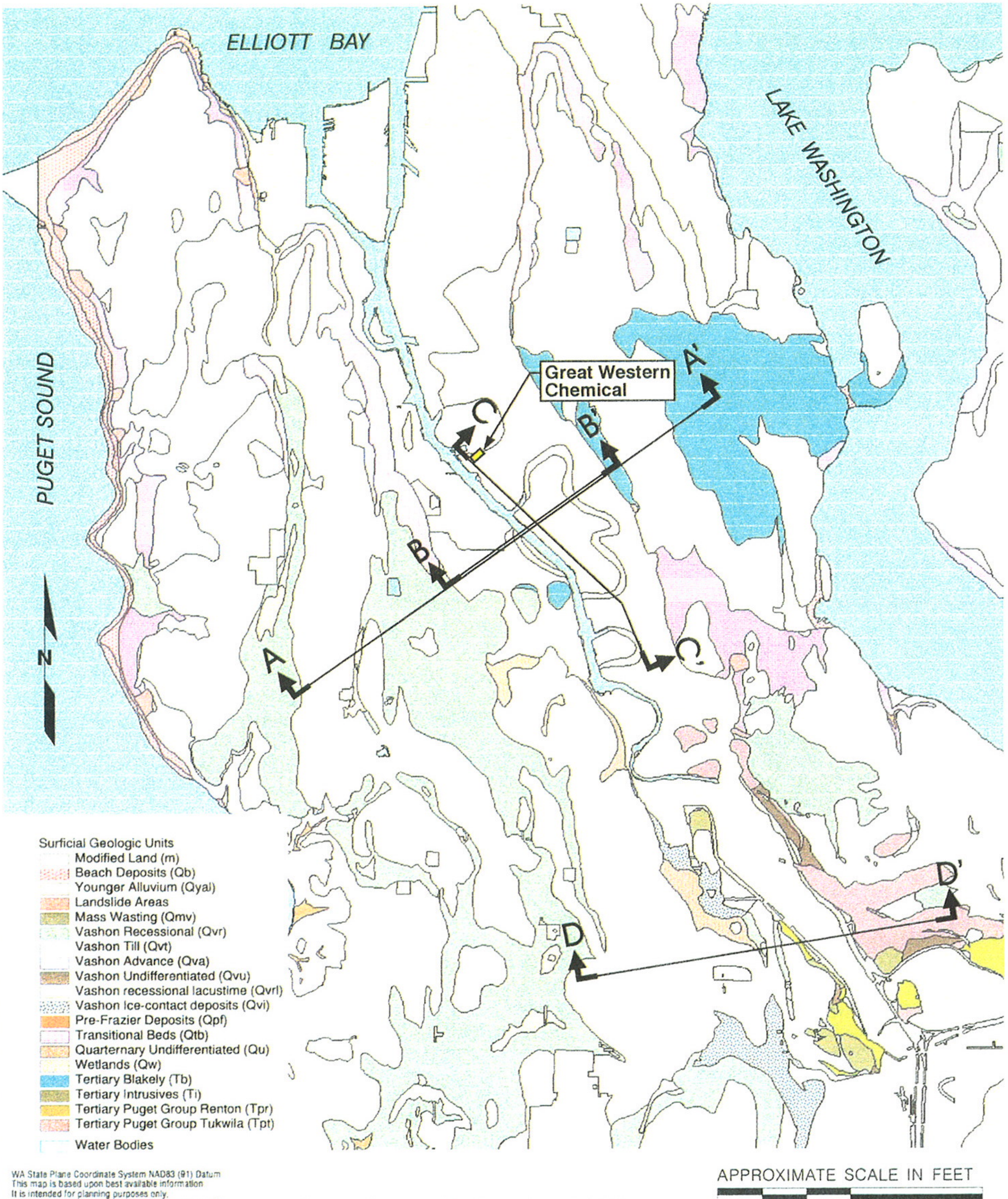
Seattle, Washington

Figure 2.6

Locations of Tyee and Emerson/Schultz Dip Tanks and Laydown Area. March 1969 Aerial Photograph.

09/05/00 VicinMapTankLocations.cdr



WA State Plane Coordinate System NAD83 (91) Datum
This map is based upon best available information
It is intended for planning purposes only,
and is not guaranteed to show accurate measurements.

Source: Duwamish Pathway Project, 1998.

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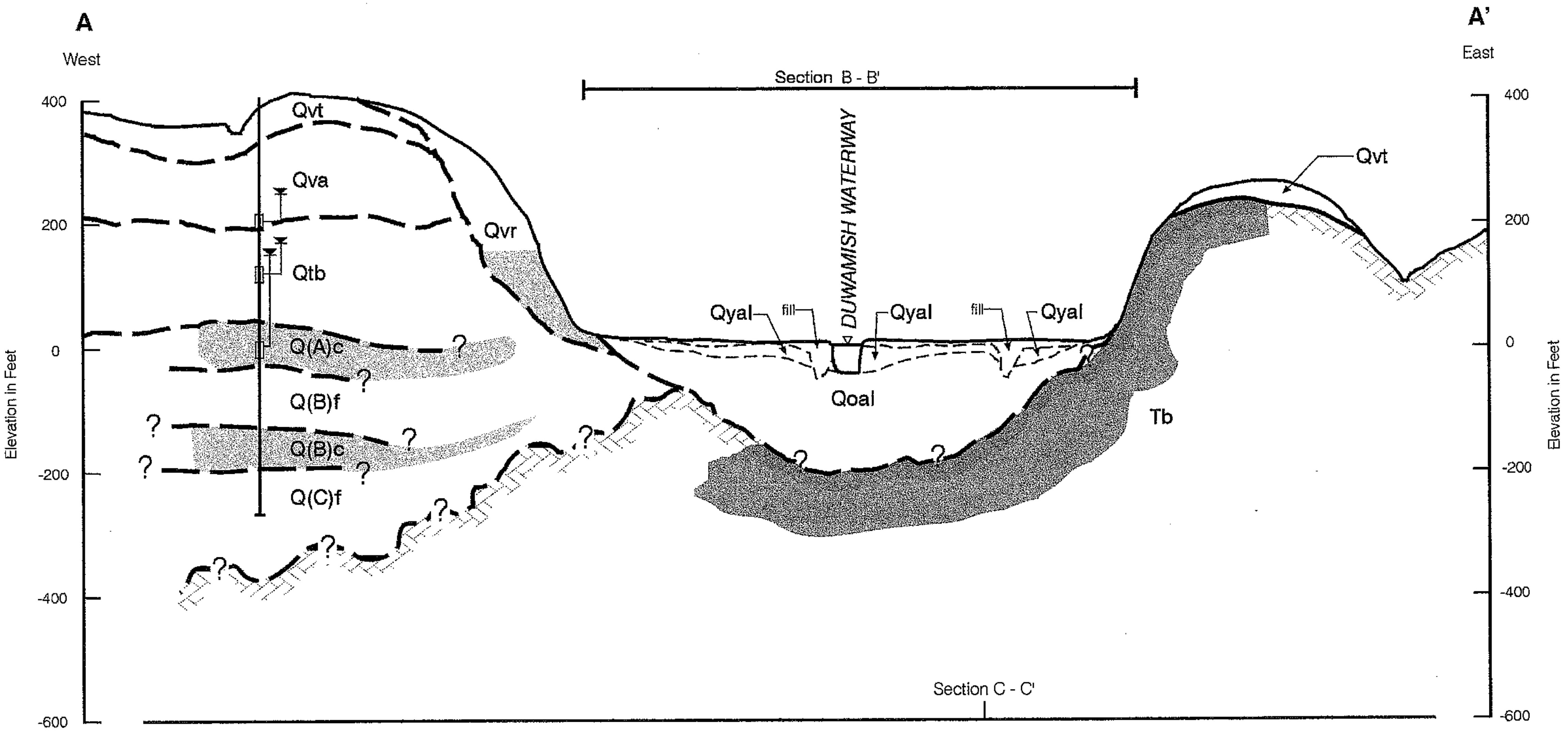
Figure 2.7
Regional Geology Map

02/23/00 GeologicMap.cdr



Well Location

- Water level from original log
- Screened interval

↑ 0.07 Direction and magnitude (where available) of vertical gradient indicated at nested well pairs.

▇ Limited upland groundwater discharge to valley.

▒ Potential zone of groundwater discharge to valley.

Notes: 1. Contacts between geologic units are based upon interpolation between wells and surface exposures where available. They represent the interpretation of subsurface conditions based upon currently available data.

2. Section from Duwamish Industrial Area Hydrogeologic Pathways Project, January 1998. Developed by Lori Herman and Derek Booth.

Horizontal Scale in Feet

0 2000 4000 8000

Vertical Exaggeration: 10X

Note: First and second water zones occur with the regional upper water bearing zone.

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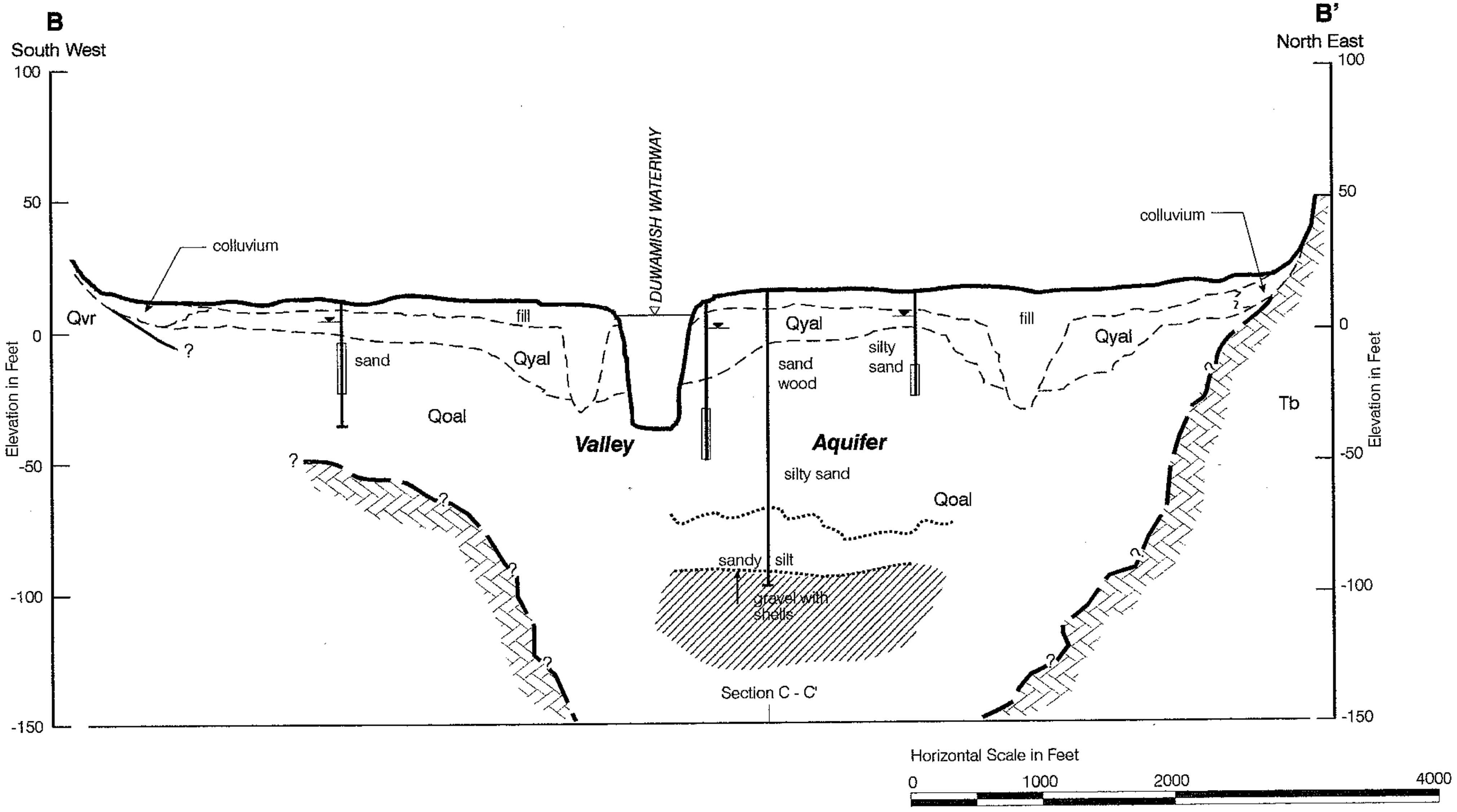
Figure 2.8
Cross Section A-A'
Duwamish Valley
Source: Duwamish Pathway Project, 1998.

02/23/00 AA'DV.cdr



Well Location

- Water level from original log
- Screened interval
- 0.07 Direction and magnitude (where available) of vertical gradient indicated at nested well pairs.

Notes: 1. Contacts between geologic units are based upon interpolation between wells and surface exposures where available. They represent the interpretation of subsurface conditions based upon currently available data.

2. Section from Duwamish Industrial Area Hydrogeologic Pathways Project, January 1998. Developed by Lori Herman and Derek Booth.

Vertical Exaggeration: 20X

Note: First and second water zones occur with the regional upper water bearing zone.

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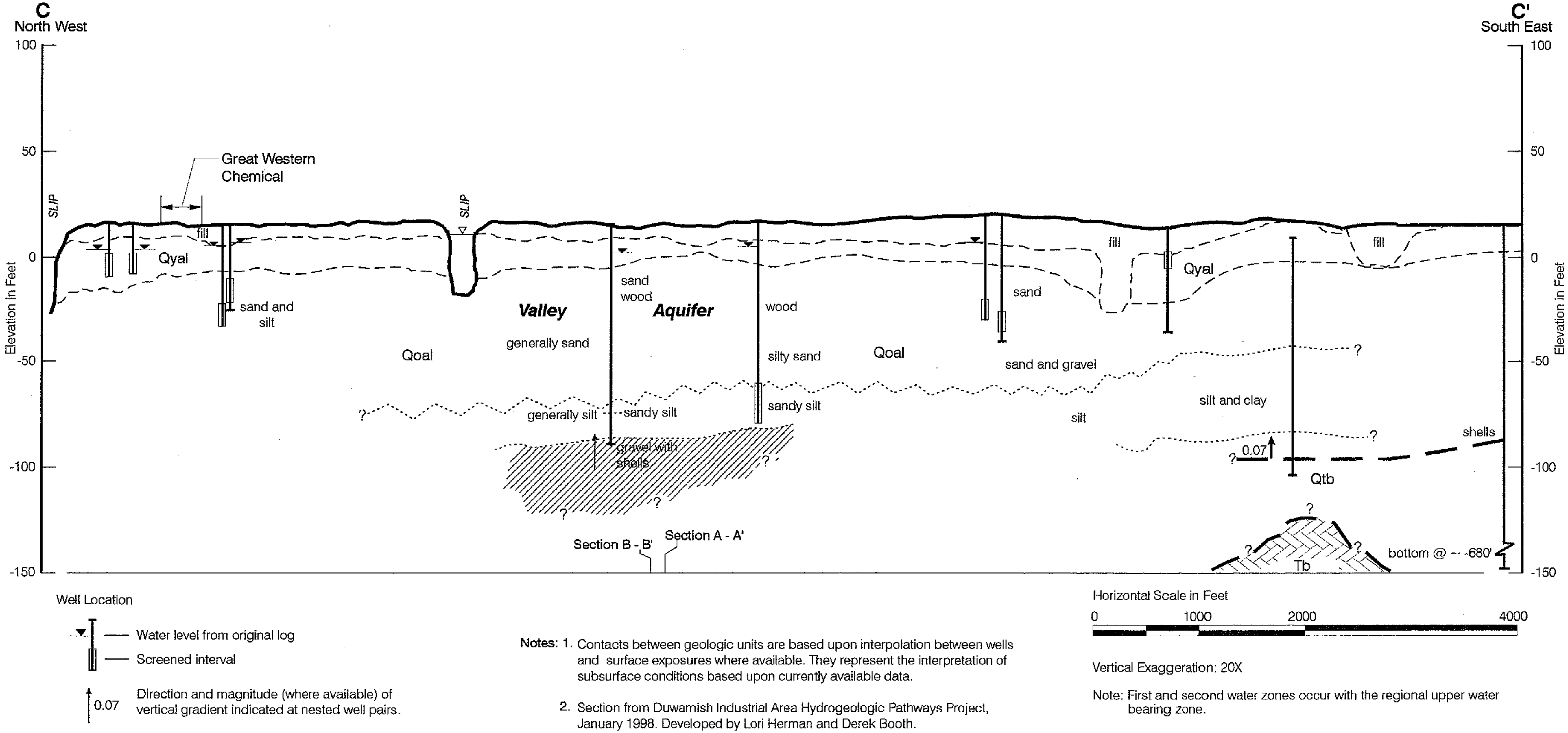
Figure 2.9
Cross Section B-B'
Duwamish Valley
Source: Duwamish Pathways Project, 1998.

02/23/00 BB'DV.cdr



Notes: 1. Contacts between geologic units are based upon interpolation between wells and surface exposures where available. They represent the interpretation of subsurface conditions based upon currently available data.

2. Section from Duwamish Industrial Area Hydrogeologic Pathways Project, January 1998. Developed by Lori Herman and Derek Booth.

Vertical Exaggeration: 20X

Note: First and second water zones occur with the regional upper water bearing zone.

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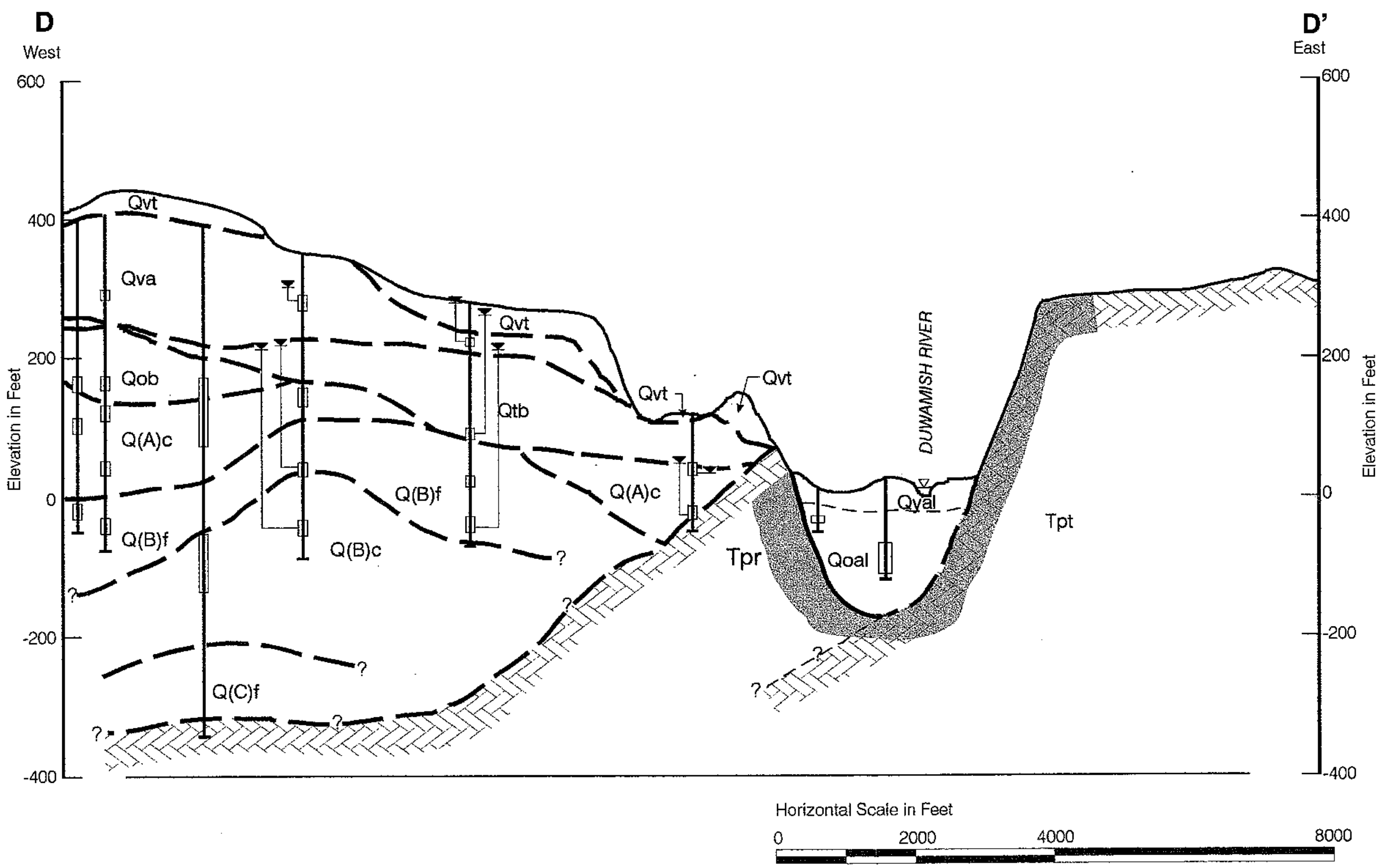
Figure 2.10
Cross Section C-C'
DuwamishValley
Source: Duwamish Pathways Project, 1998.

02/23/00 CCDV.cdr



Vertical Exaggeration: 10X

Note: First and second water zones occur with the regional upper water bearing zone.

Notes: 1. Contacts between geologic units are based upon interpolation between wells and surface exposures where available. They represent the interpretation of subsurface conditions based upon currently available data.

2. Section from Duwamish Industrial Area Hydrogeologic Pathways Project, January 1998. Developed by Lori Herman and Derek Booth.

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Figure 2.11
Cross Section D-D'
DuwamishValley
Source: Duwamish Pathways Project, 1998.

02/23/00 DD'DV.cdr

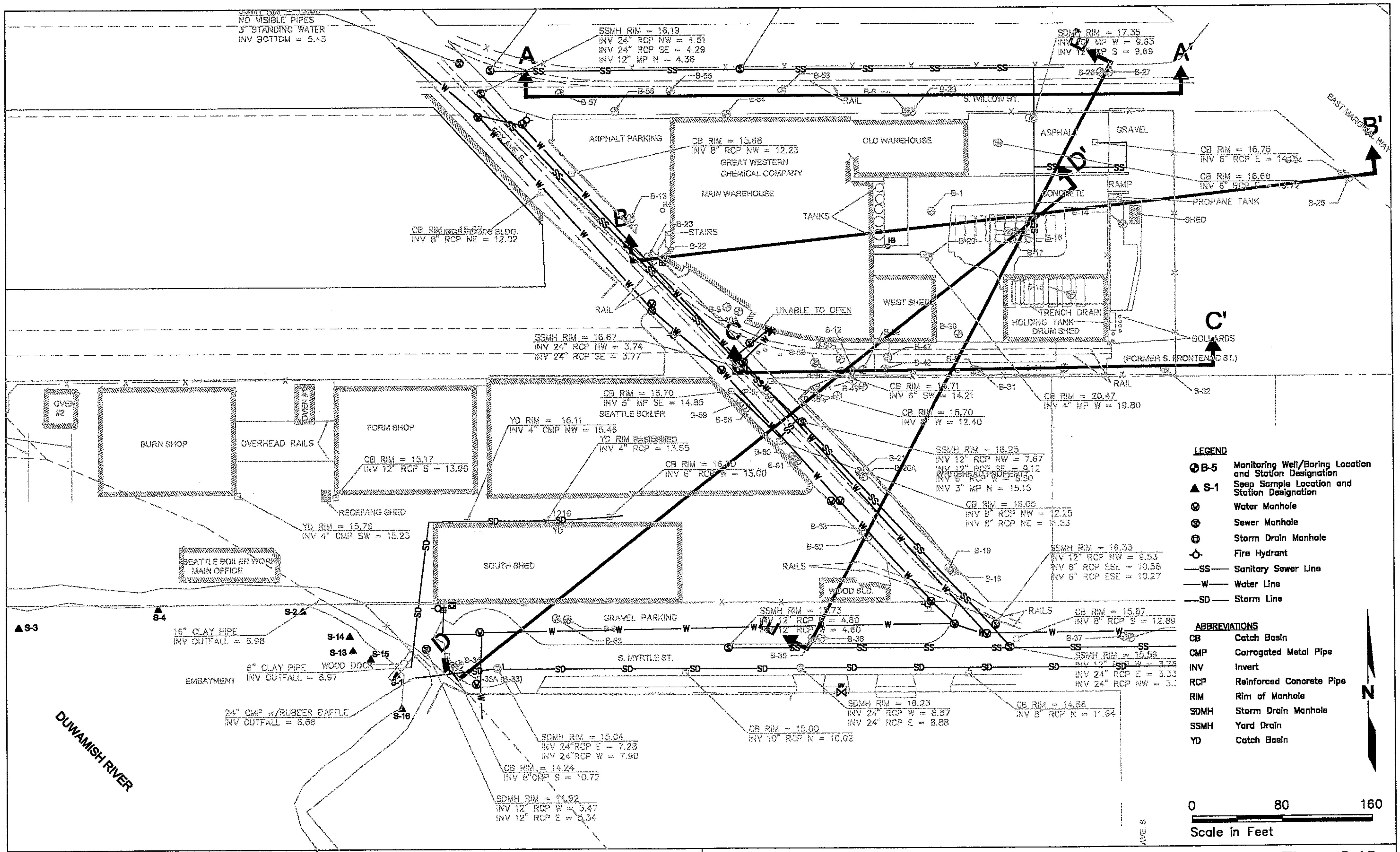

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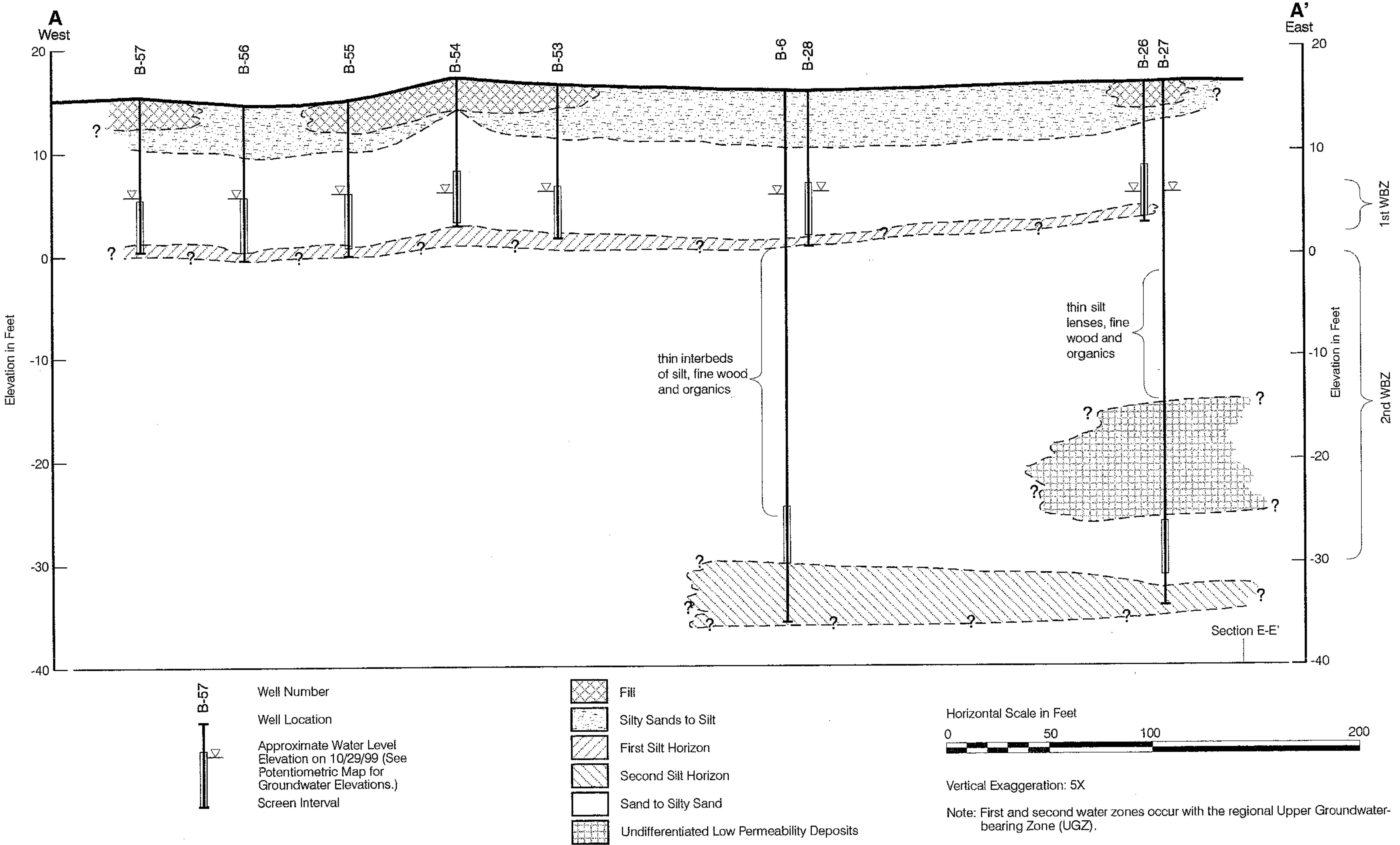
Figure 2.12
Cross Section Locations
Great Western Chemical

DATE: 10/18/00 4:29pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0028a.dwg



Vertical Exaggeration: 5X

Note: First and second water zones occur with the regional Upper Groundwater-bearing Zone (UGZ).

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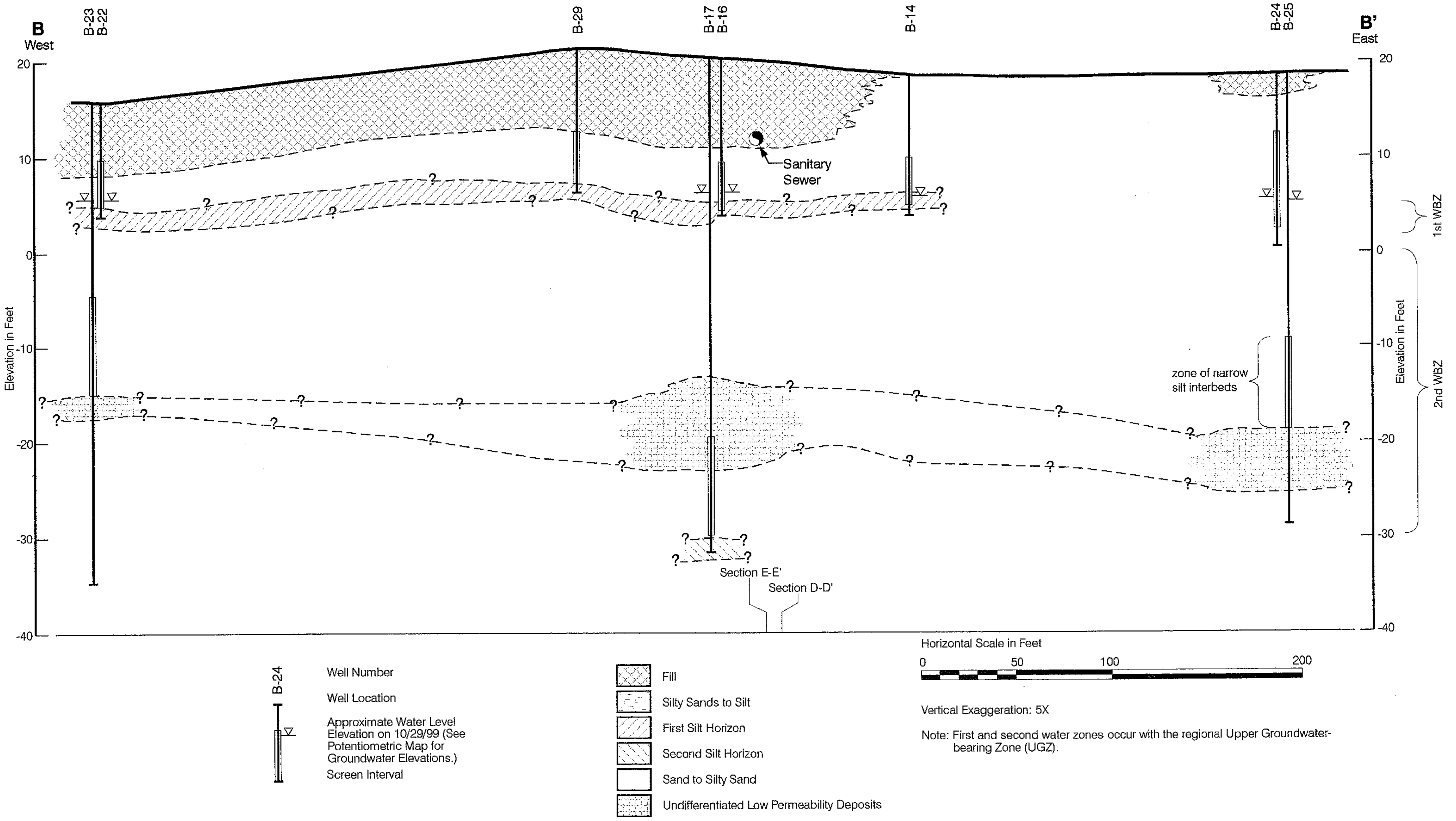
Figure 2.13
Cross Section A-A'
Great Western Chemical

06/09/00 SectionAA'.cdr



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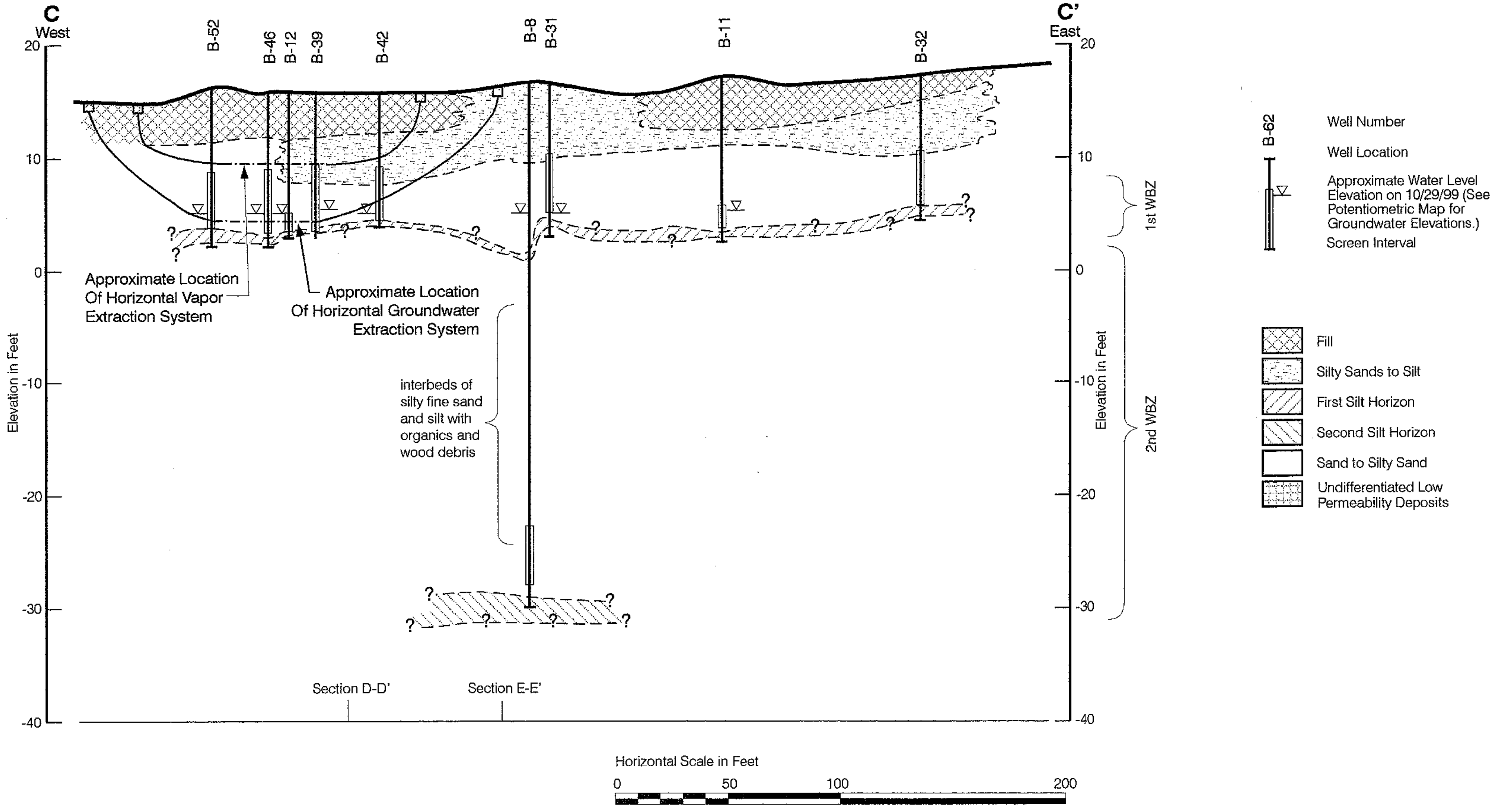
TERRA VAC

Great Western Chemical Company Seattle, Washington

Figure 2.14
Cross Section B-B'
Great Western Chemical

05/24/00 SectionBB'.cdr



Vertical Exaggeration: 5X

Note: First and second water zones occur with the regional Upper Groundwater-bearing Zone (UGZ).

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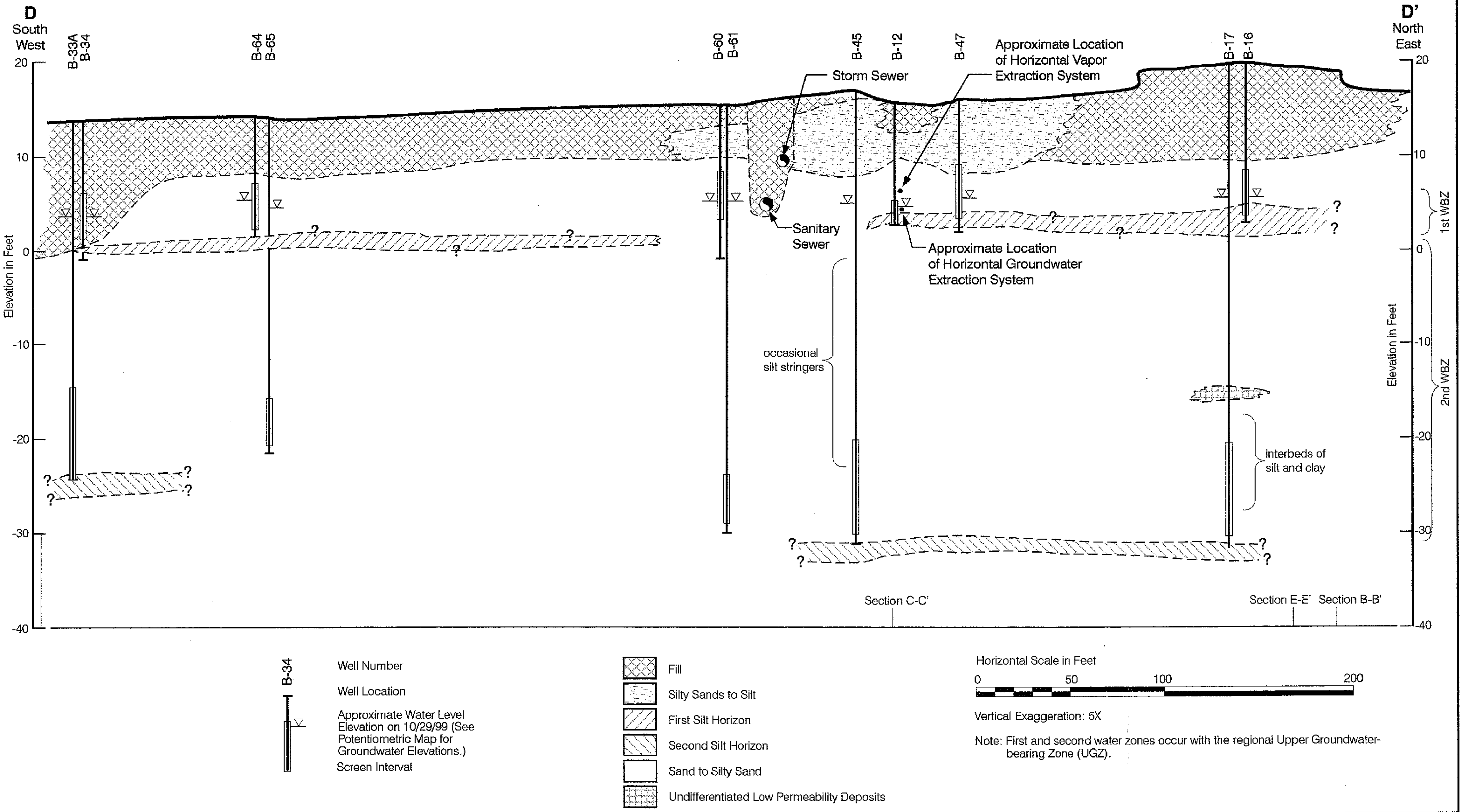
Seattle, Washington

Figure 2.15
Cross Section C-C'
Great Western Chemical

05/24/00 SectionCC.cdr



Vertical Exaggeration: 5X

Note: First and second water zones occur with the regional Upper Groundwater-bearing Zone (UGZ).

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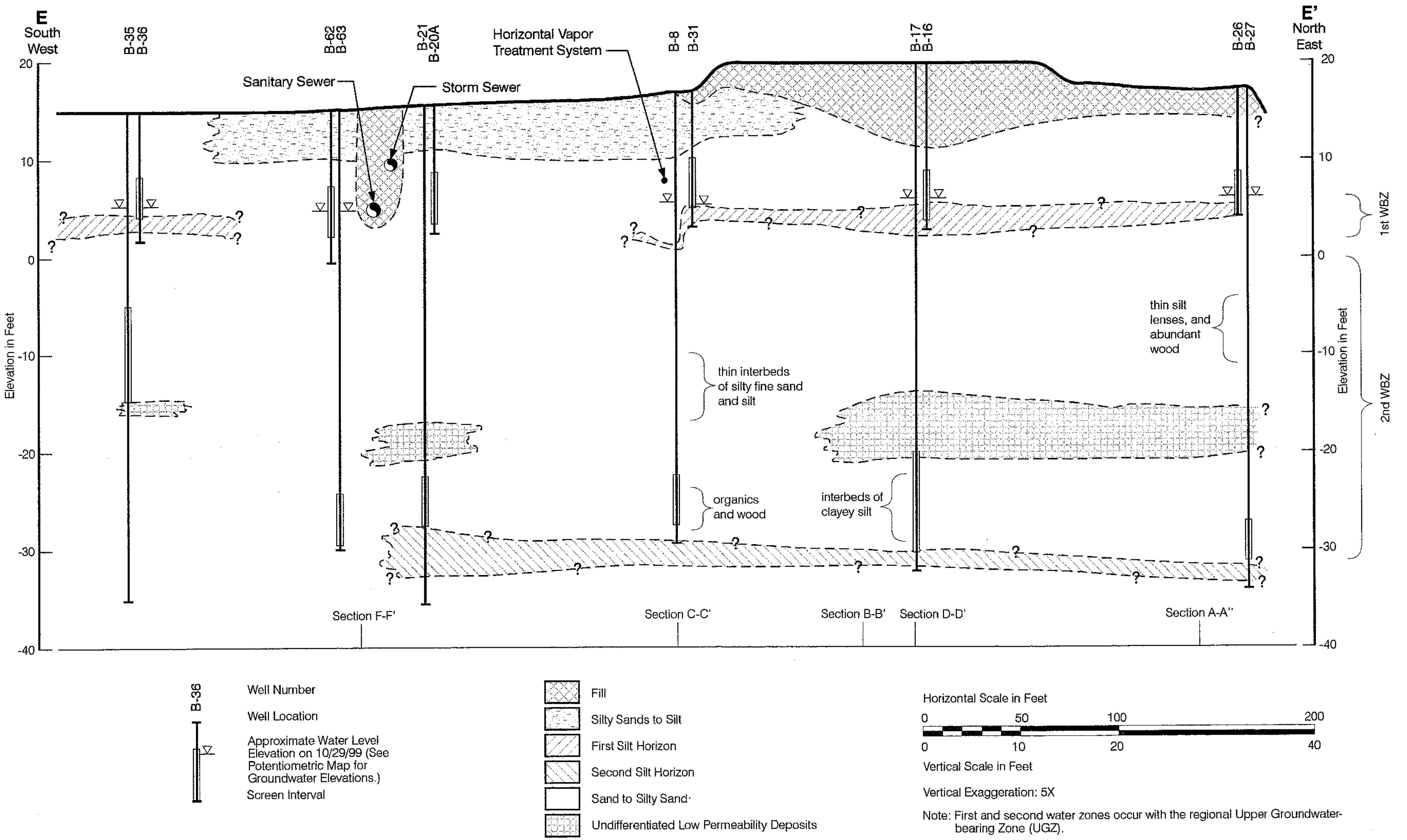
Figure 2.16
Cross Section D-D'
Great Western Chemical



Note: First and second water zones occur with the regional Upper Groundwater-bearing Zone (UGZ).

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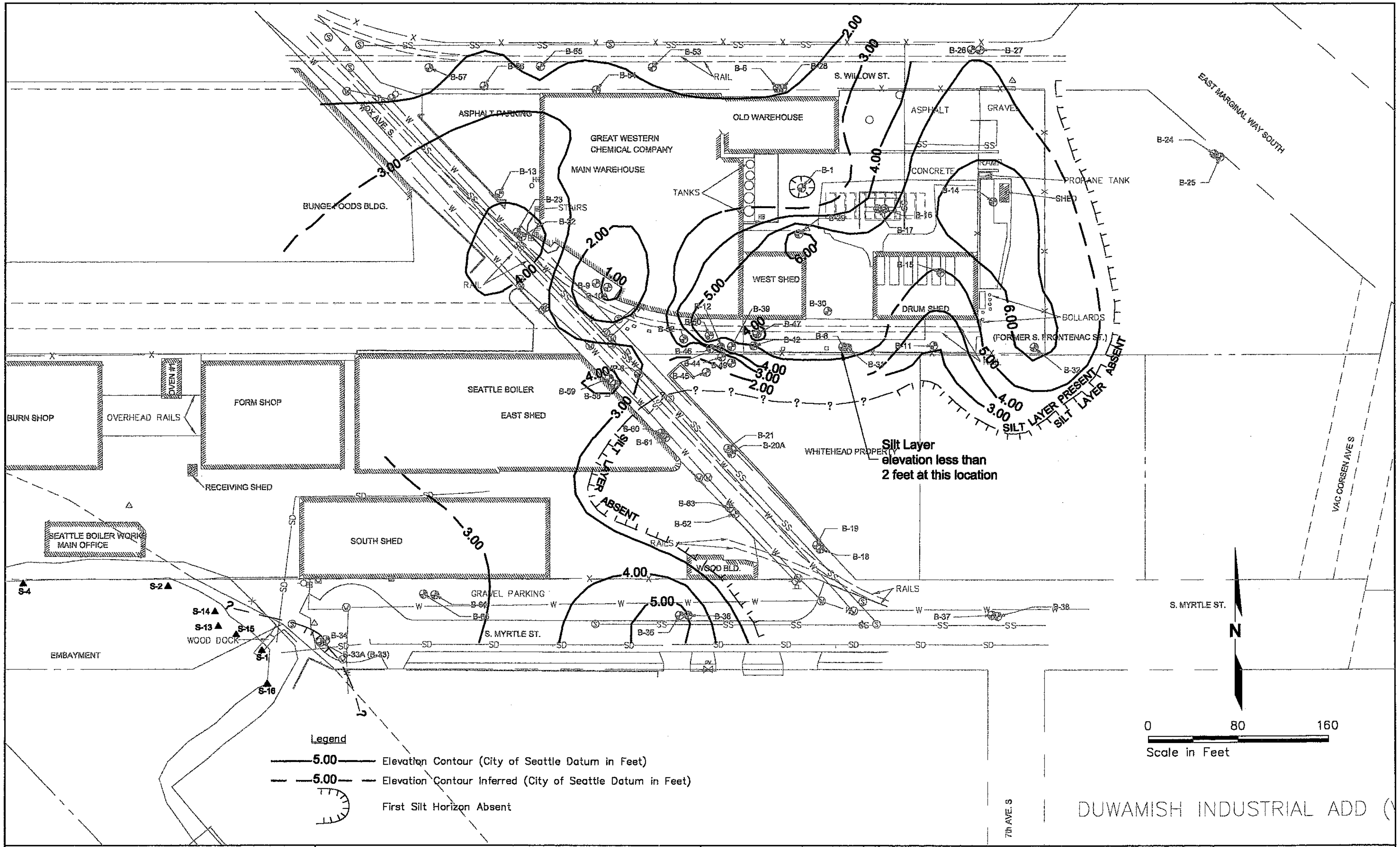
Figure 2.17
Cross Section E-E'
Great Western Chemical

06/09/00 SectionEE'.cdr



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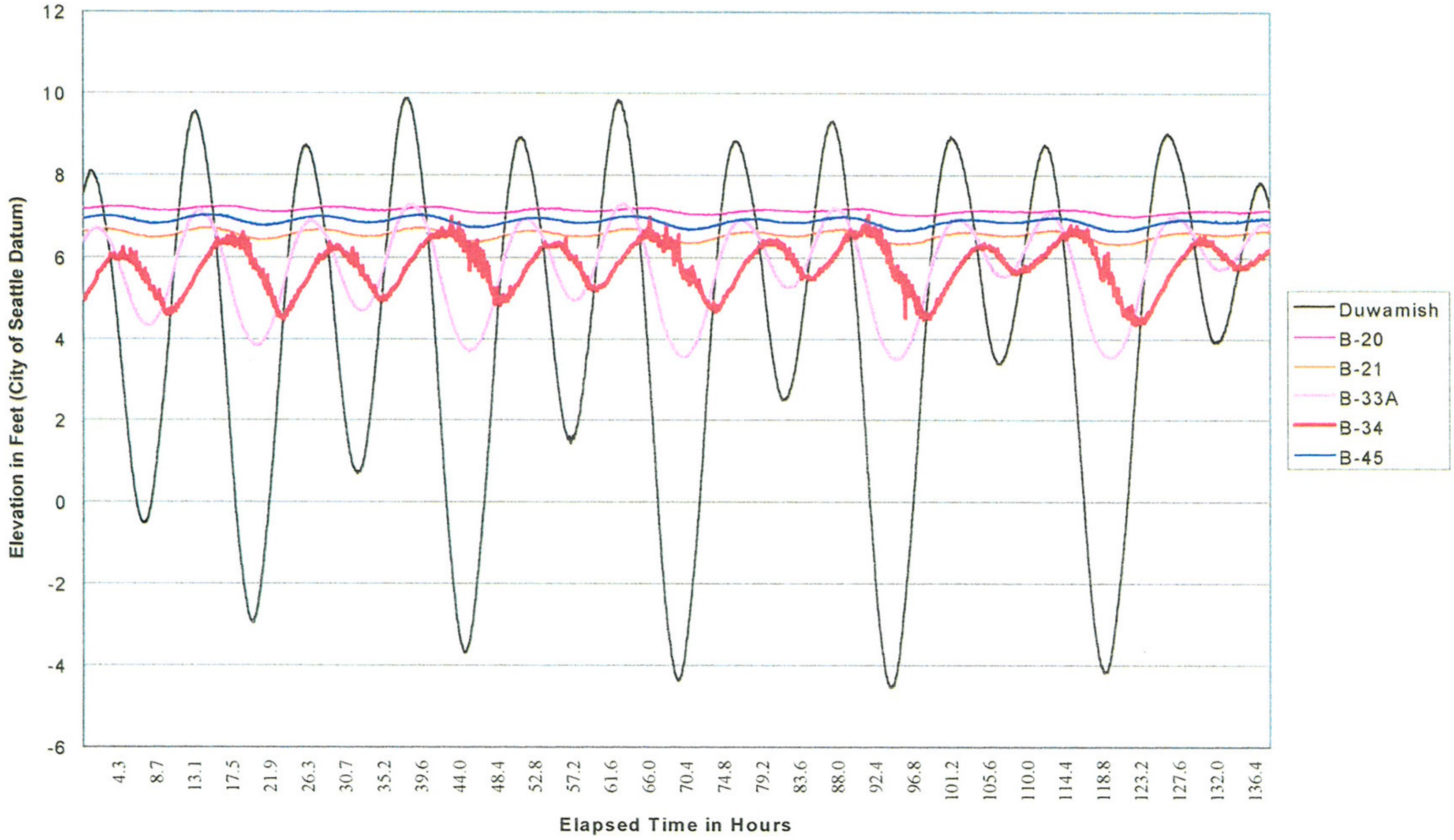
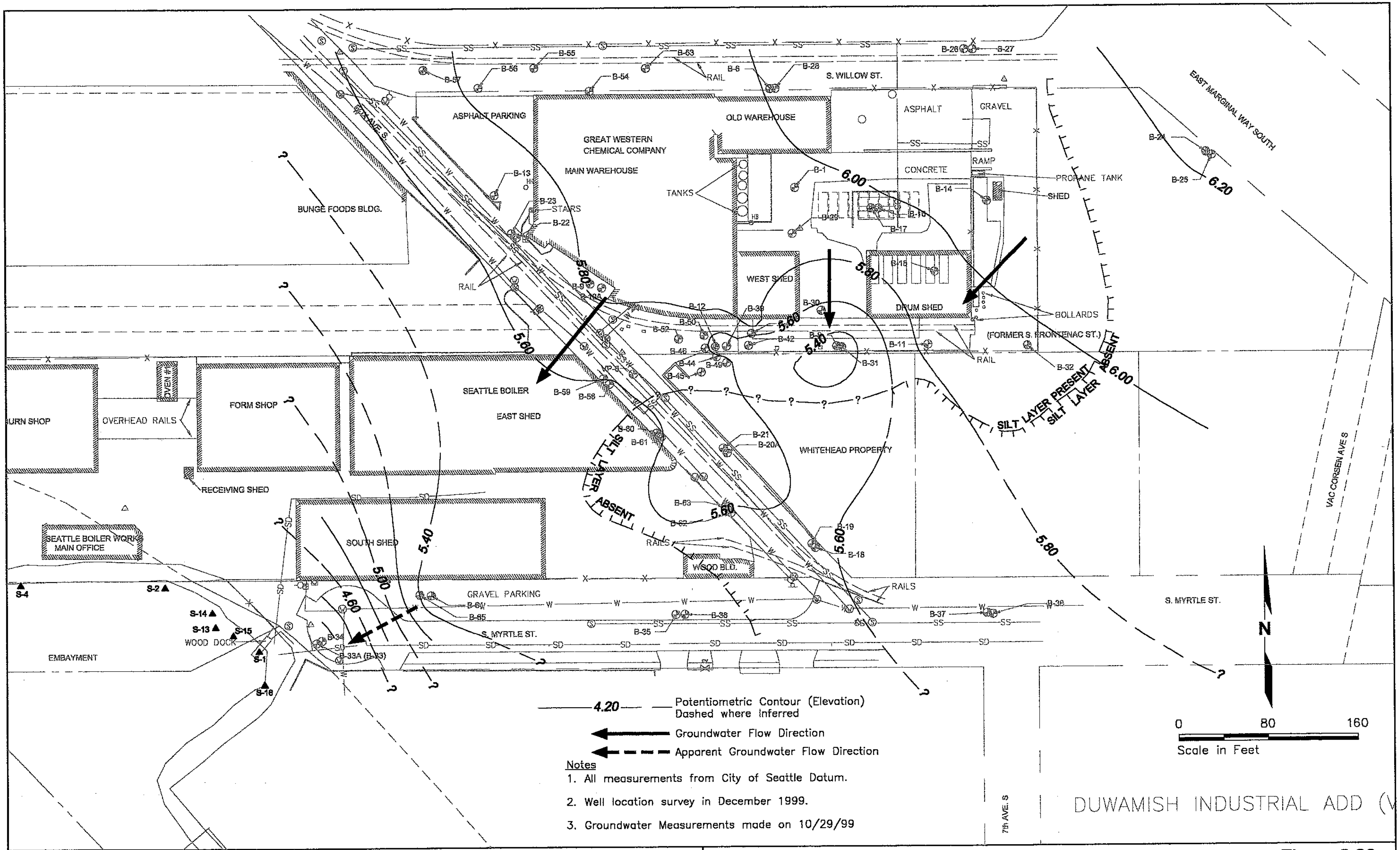
Seattle, Washington

Figure 2.18
Elevation Map
First Silt Horizon

DATE: 06/10/00 4:05pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0029.dwg

Figure 2.19
Transducer Responses for Monitoring Wells B-20, B-21, B-33A, B-34, and B-45





4.20 Potentiometric Contour (Elevation) Dashed where Inferred

Groundwater Flow Direction

Apparent Groundwater Flow Direction

Notes

1. All measurements from City of Seattle Datum.
2. Well location survey in December 1999.
3. Groundwater Measurements made on 10/29/99

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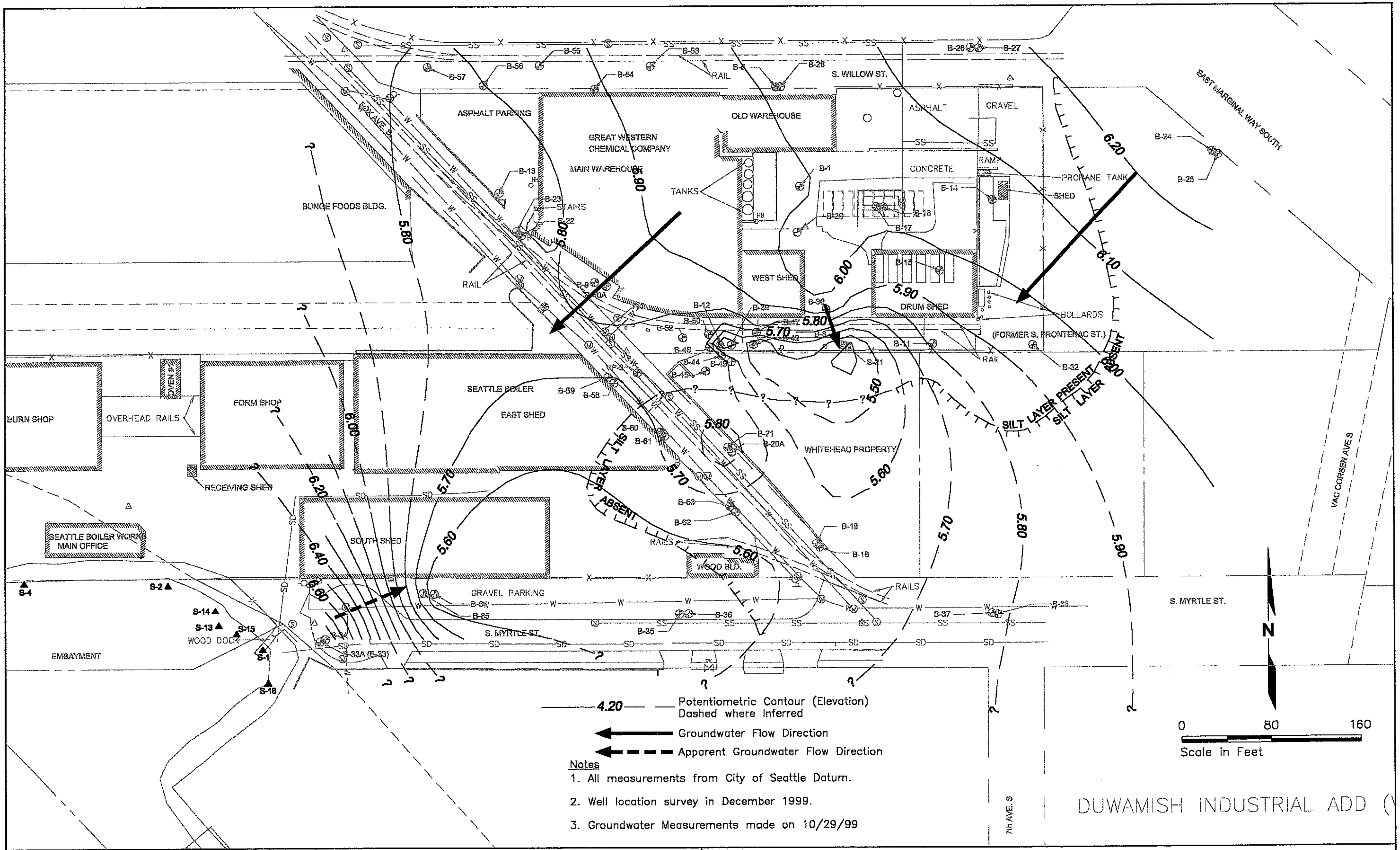
Figure 2.20
Potentiometric Map
Low Tide First Water Bearing Zone

DATE: 08/10/00 4:07pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0030.dwg



——4.20—— — Potentiometric Contour (Elevation) Dashed where Inferred

Groundwater Flow Direction

Apparent Groundwater Flow Direction

Notes
1. All measurements from City of Seattle Datum.
2. Well location survey in December 1999.
3. Groundwater Measurements made on 10/29/99

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TERRA VAC

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Figure 2.21
Potentiometric Map
High Tide First Water Bearing Zone

DATE: 08/10/00 4:08pm
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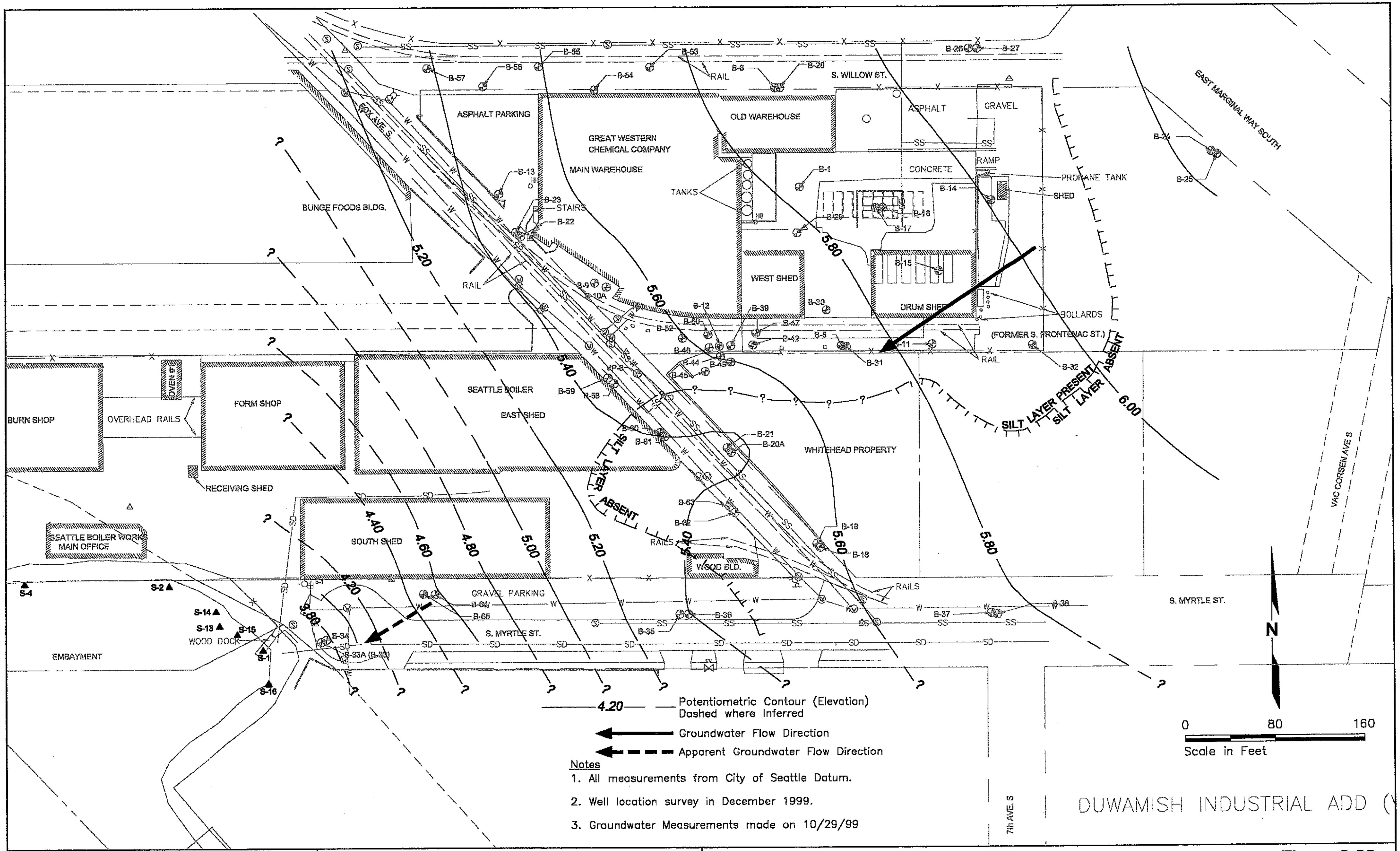

Notes
1. All measurements from City of Seattle Datum.
2. Well location survey in December 1999.
3. Groundwater Measurements made on 10/29/99

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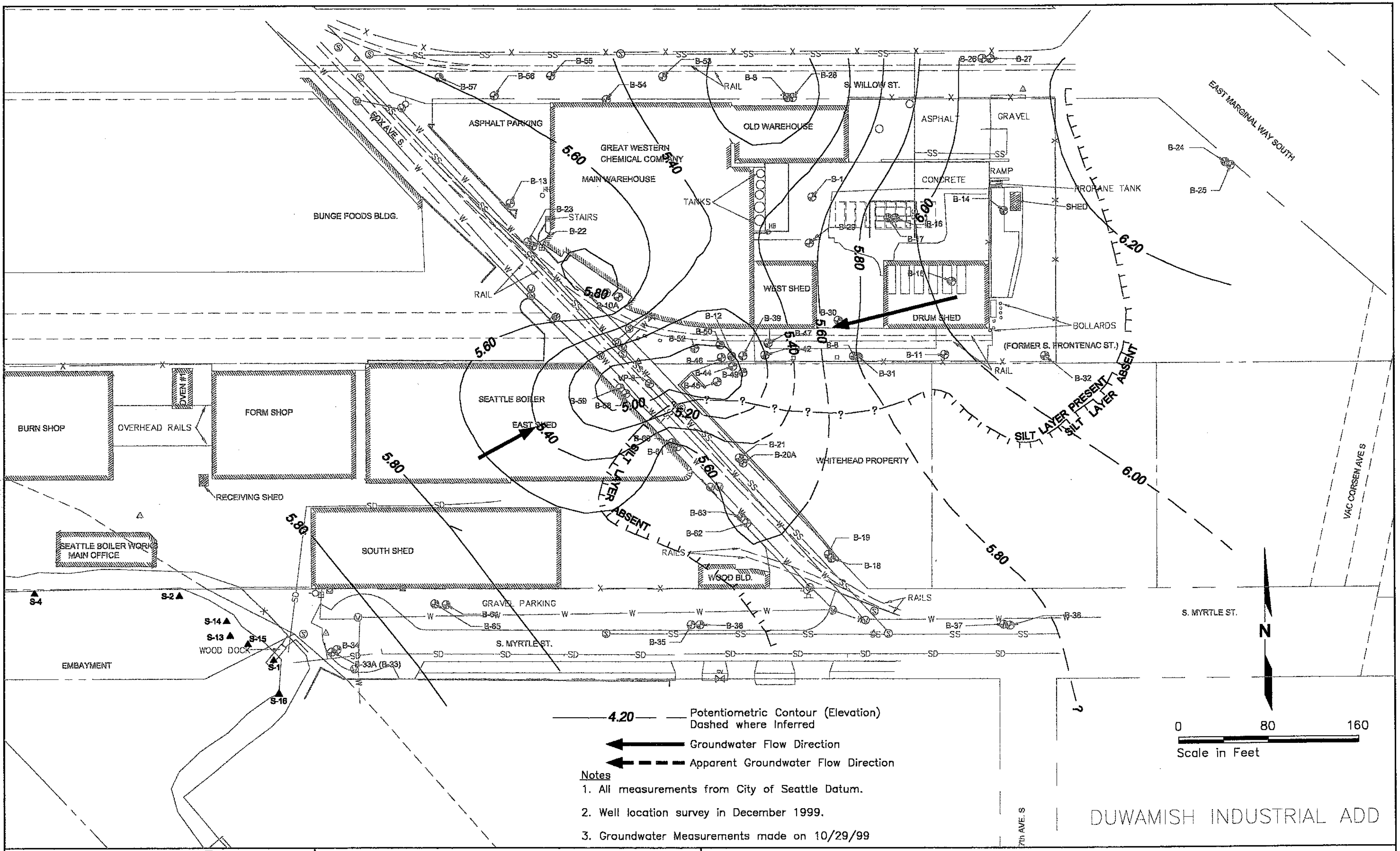
Figure 2.22
Potentiometric Map
Low Tide Second Water Bearing Zone

DATE: 08/10/00 4:10pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0032.dwg



———4.20——— Potentiometric Contour (Elevation) Dashed where Inferred

Groundwater Flow Direction

Apparent Groundwater Flow Direction

Notes

1. All measurements from City of Seattle Datum.
2. Well location survey in December 1999.
3. Groundwater Measurements made on 10/29/99

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Figure 2.23
Potentiometric Map
High Tide Second Water Bearing Zone

DATE: 08/10/00 4:11pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0033.dwg

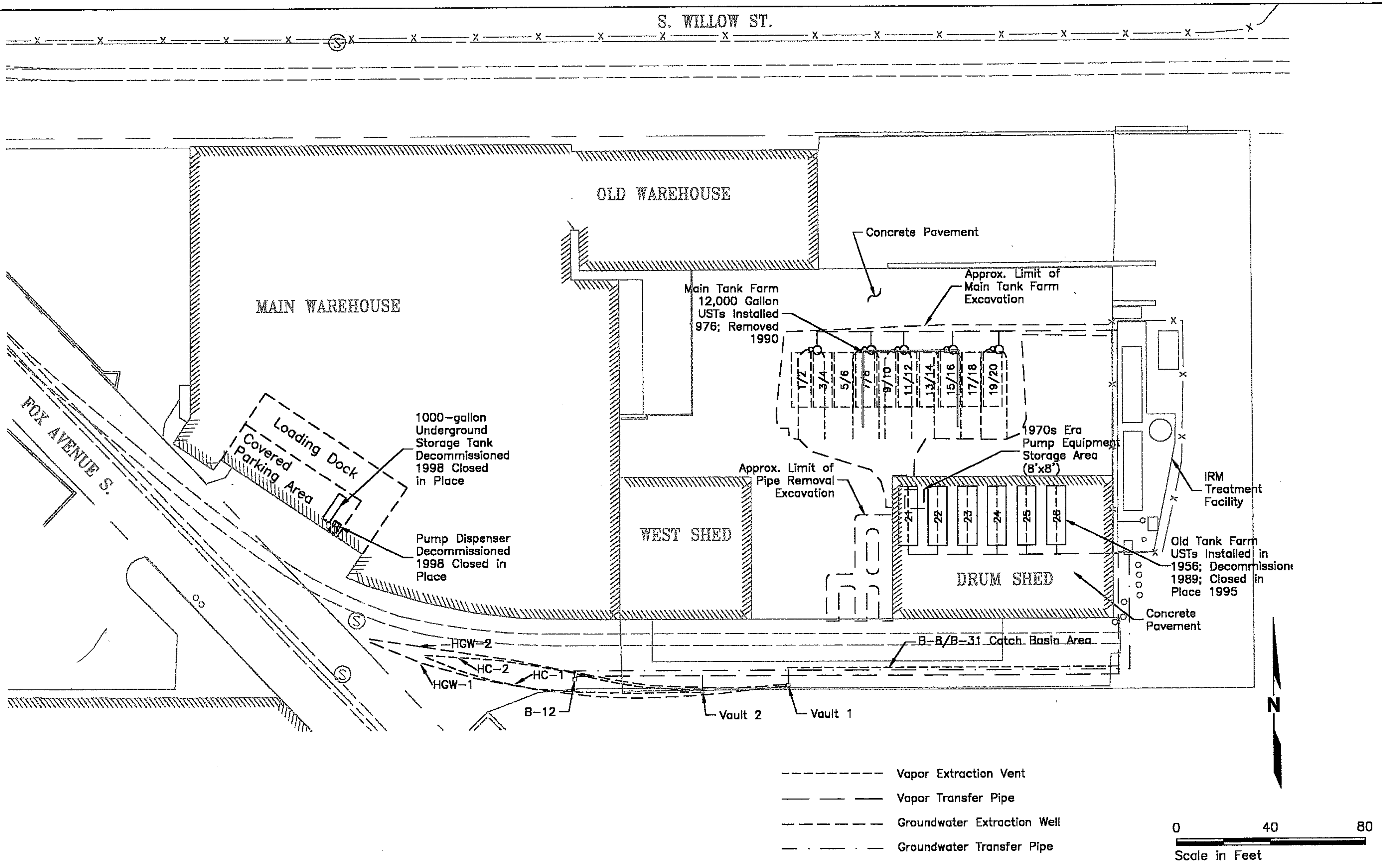

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Figure 3.1
Interim Remedial Activities

DATE: 10/15/00 4:22pm
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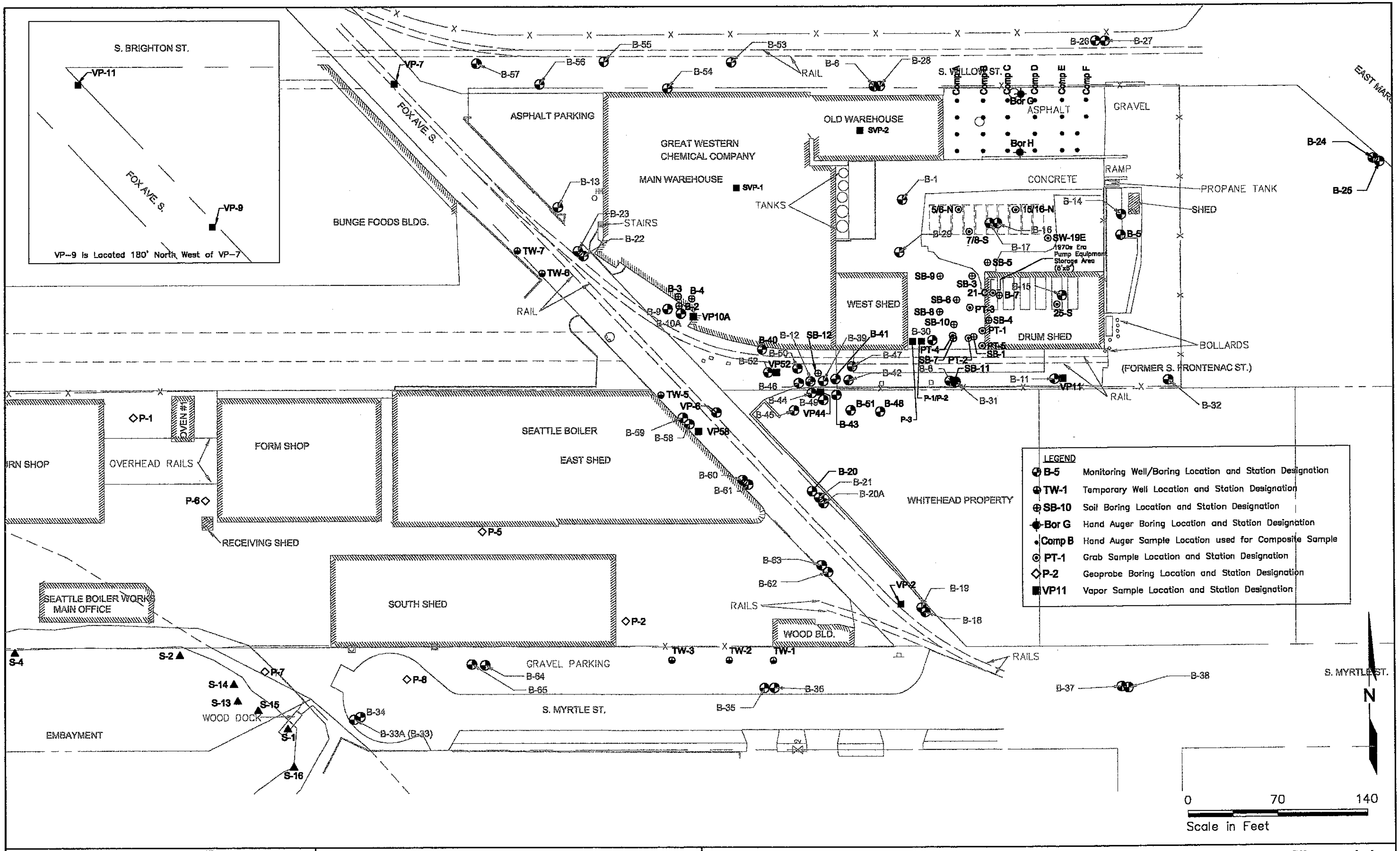

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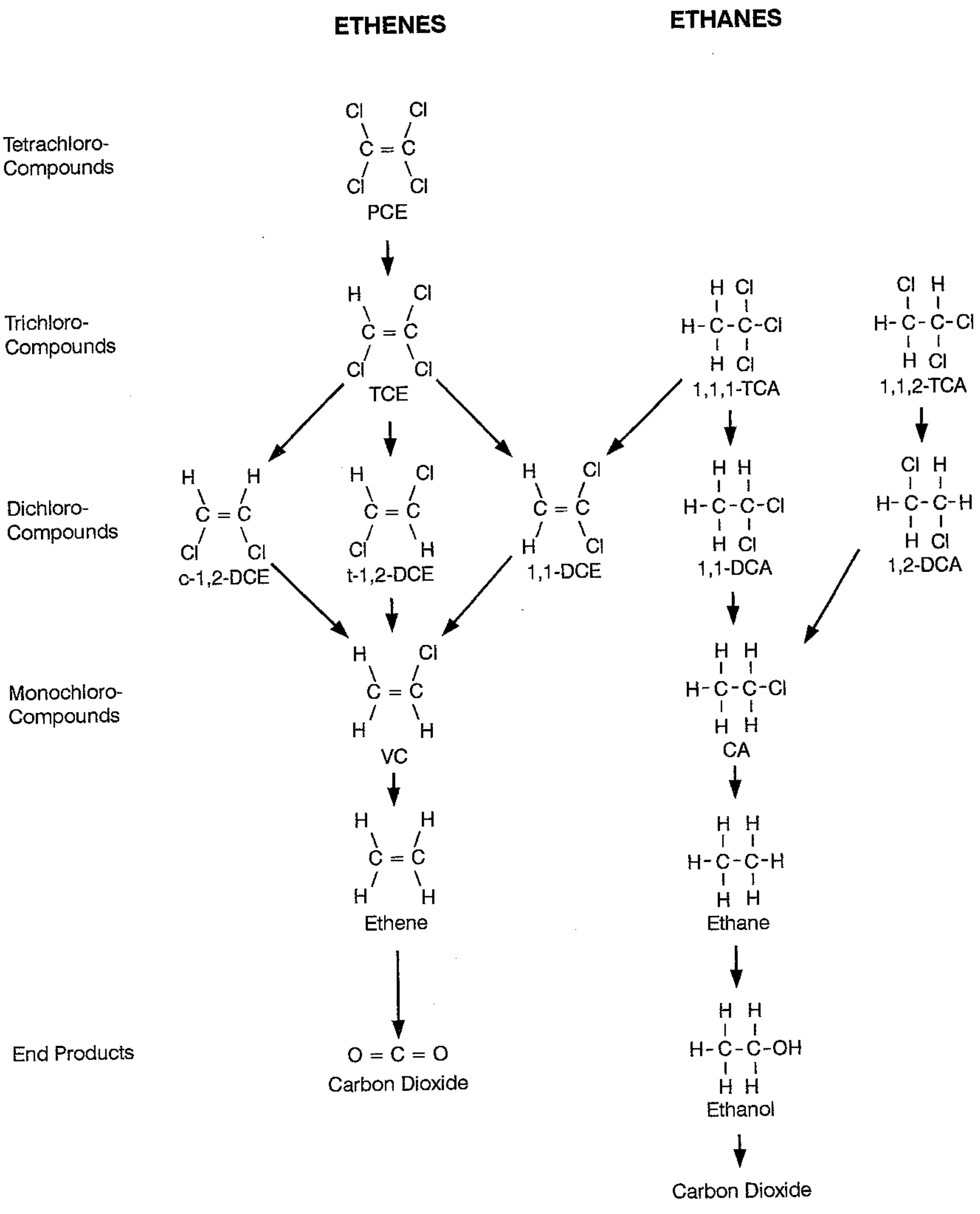
Great Western Chemical Company Seattle, Washington

Figure 4.1 Soil, Groundwater, and Soil Vapor Sample Stations

DATE: 10/20/00 10:15am
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0057.dwg



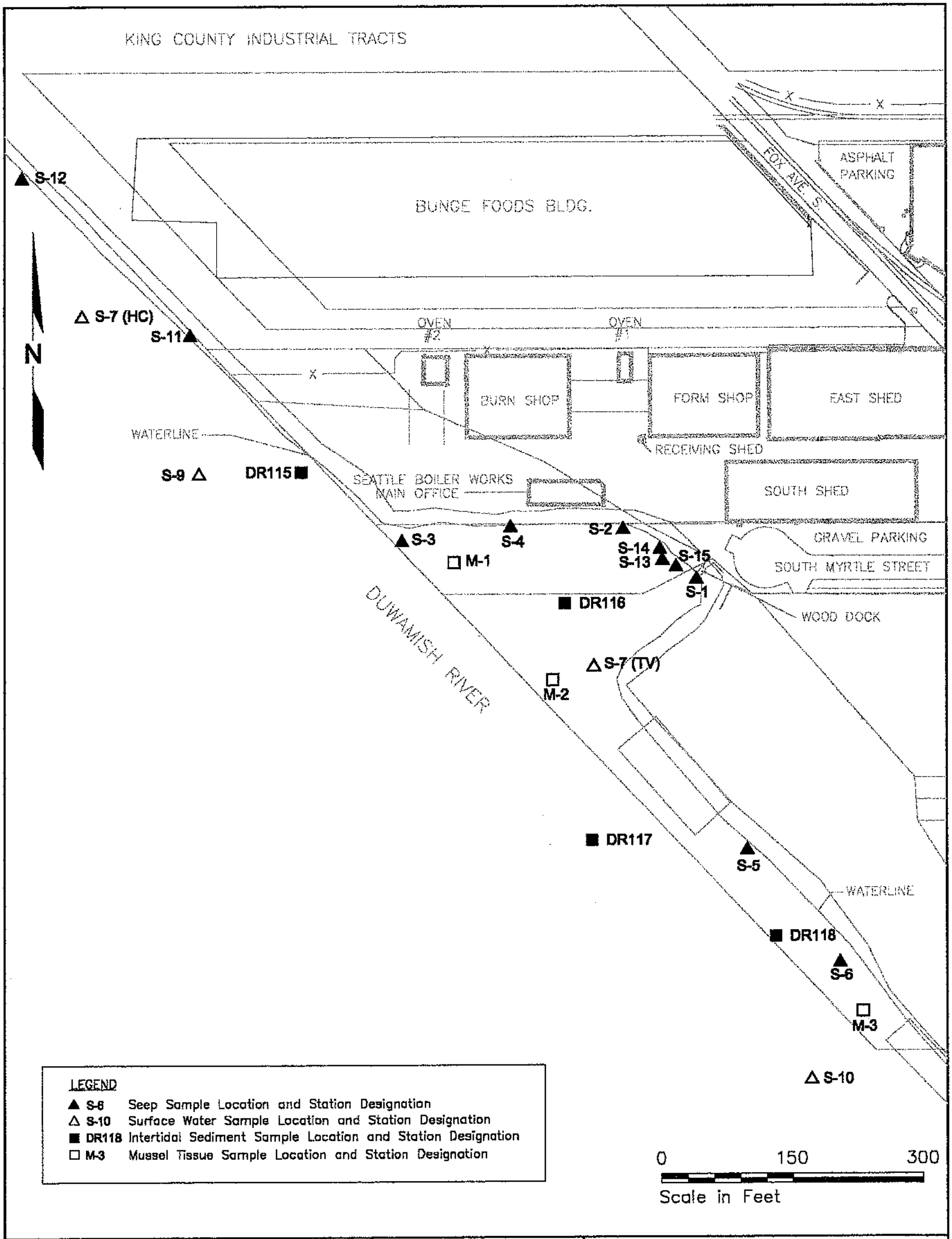
Floyd & Snider Inc.

TERRA VAC

Great Western Chemical Company Seattle, Washington

Figure 4.2 Degradation Sequence for Chlorinated Ethenes and Ethanes

10/17/00 ReductiveDehalogenation.cdr



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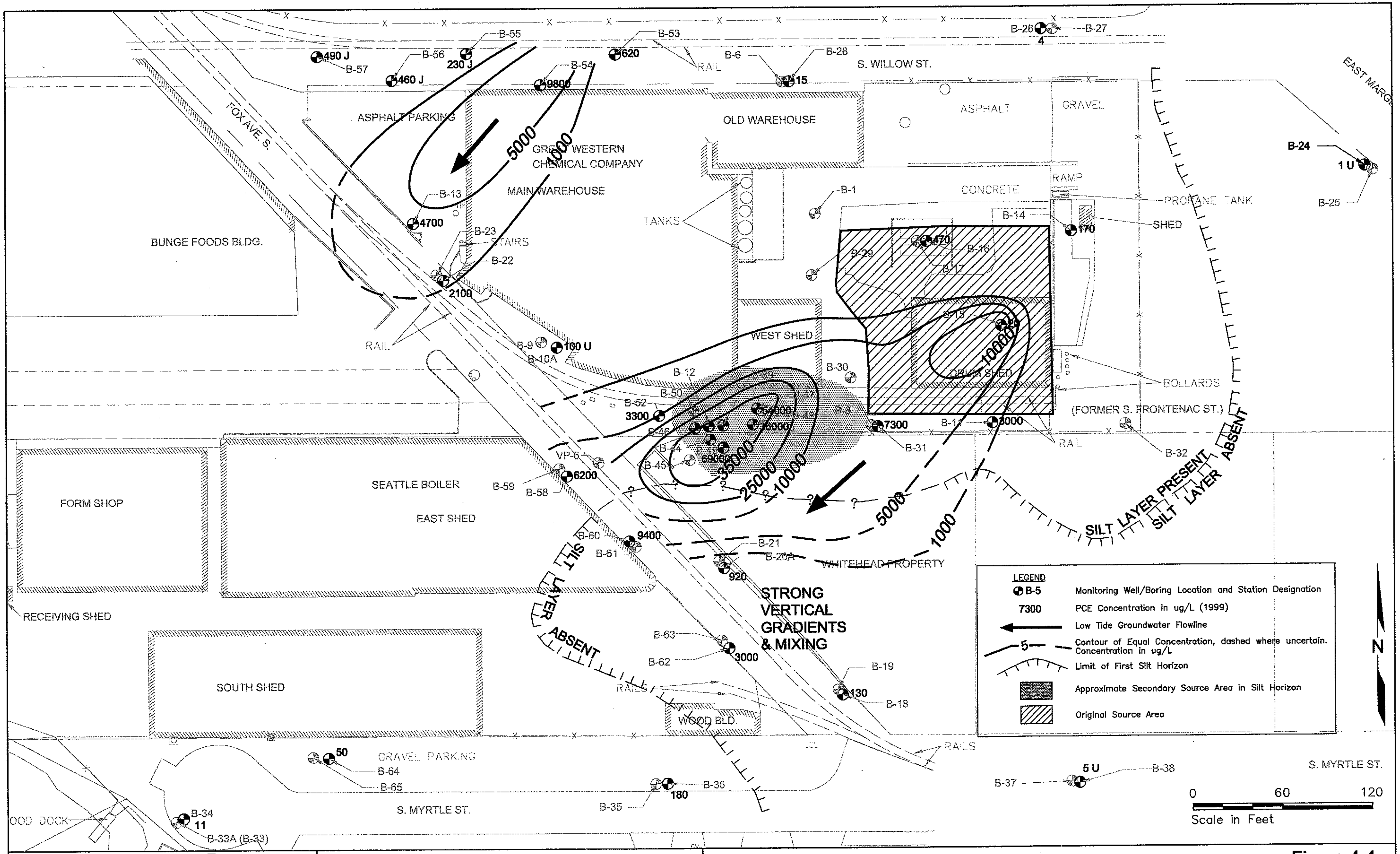
Chemical Company
Seattle, Washington

Figure 4.3

Surface Water, Sediment, and Mussel Sample Stations

DATE: 08/10/00 1:33pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0004.dwg



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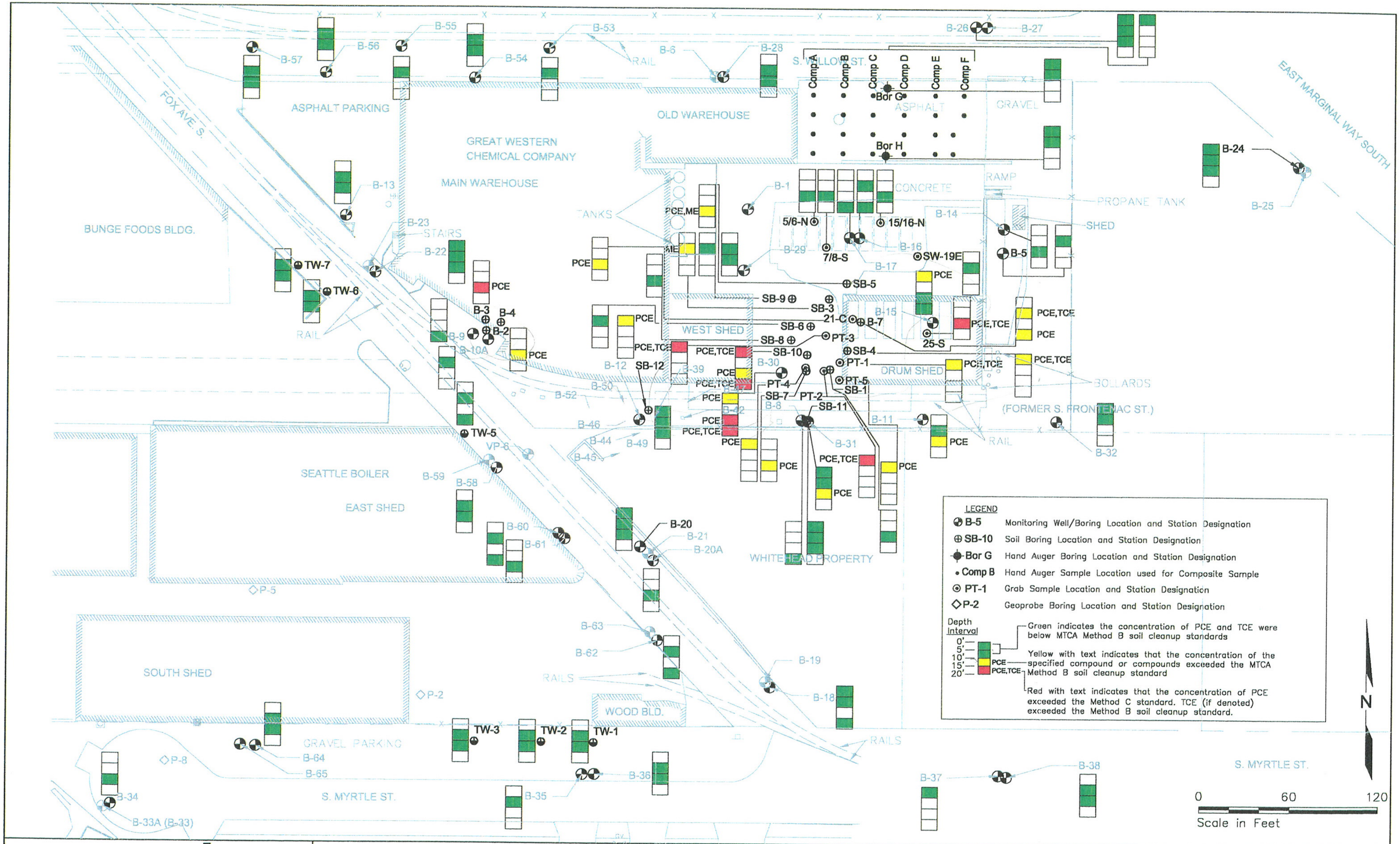
Seattle, Washington

Figure 4.4
Tetrachloroethene in 1st Water Bearing Zone
1999 Sampling Event

DATE: 10/16/00 4:09pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0005.dwg



LEGEND

B-5	Monitoring Well/Boring Location and Station Designation
⊕ SB-10	Soil Boring Location and Station Designation
Bor G	Hand Auger Boring Location and Station Designation
• Comp B	Hand Auger Sample Location used for Composite Sample
⊙ PT-1	Grab Sample Location and Station Designation
◇ P-2	Geoprobe Boring Location and Station Designation

Depth Interval
0'
5'
10'
15'
20'

🟩 Green indicates the concentration of PCE and TCE were below MTCA Method B soil cleanup standards

🟨 PCE — Yellow with text indicates that the concentration of the specified compound or compounds exceeded the MTCA Method B soil cleanup standard

🟥 PCE,TCE — Red with text indicates that the concentration of PCE exceeded the Method C standard. TCE (if denoted) exceeded the Method B soil cleanup standard.

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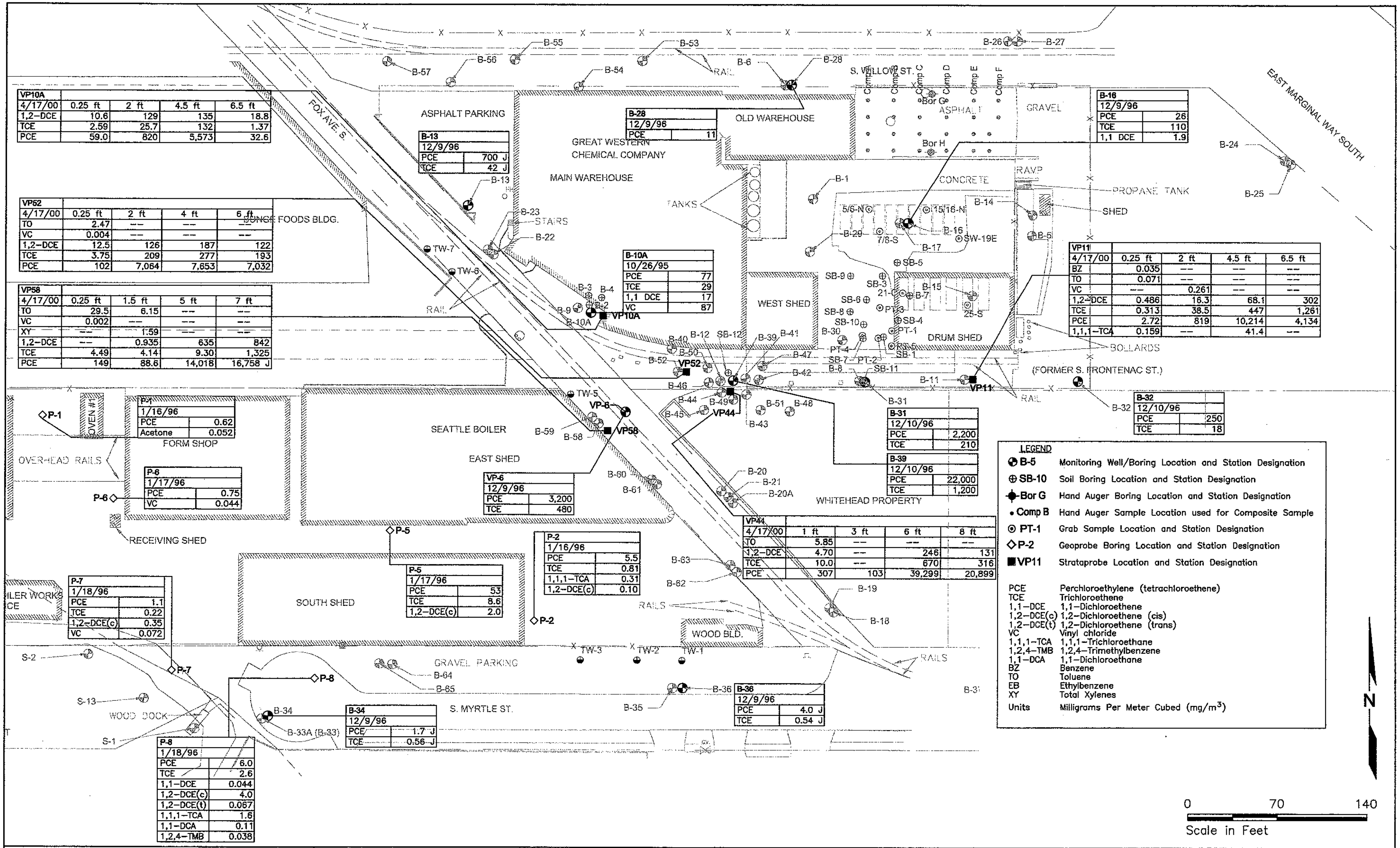
Seattle, Washington

Figure 4.5
PCE, TCE, and Methylene Chloride Results for Soil

DATE: 08/10/00 1:20pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0003.dwg



VP10A				
4/17/00	0.25 ft	2 ft	4.5 ft	6.5 ft
1,2–DCE	10.6	129	135	18.8
TCE	2.59	25.7	132	1.37
PCE	59.0	820	5,573	32.6

VP52				
4/17/00	0.25 ft	2 ft	4 ft	6 ft
TO	2.47	––	––	––
VC	0.004	––	––	––
1,2–DCE	12.5	126	187	122
TCE	3.75	209	277	193
PCE	102	7,064	7,653	7,032

VP58				
4/17/00	0.25 ft	1.5 ft	5 ft	7 ft
TO	29.5	6.15	––	––
VC	0.002	––	––	––
XY	––	1.59	––	––
1,2–DCE	––	0.935	635	842
TCE	4.49	4.14	9.30	1,325
PCE	149	88.6	14,018	16,758 J

B-13	
12/9/96	
PCE	700 J
TCE	42 J

B-28	
12/9/96	
PCE	11

B-10A	
10/26/95	
PCE	77
TCE	29
1,1 DCE	17
VC	87

B-16	
12/9/96	
PCE	26
TCE	110
1,1 DCE	1.9

VP11				
4/17/00	0.25 ft	2 ft	4.5 ft	6.5 ft
BZ	0.035	––	––	––
TO	0.071	––	––	––
VC	––	0.261	––	––
1,2–DCE	0.486	16.3	68.1	302
TCE	0.313	38.5	447	1,261
PCE	2.72	819	10,214	4,134
1,1,1–TCA	0.159	––	41.4	––

P-1	
1/16/96	
PCE	0.62
Acetone	0.052

P-6	
1/17/96	
PCE	0.75
VC	0.044

VP-6	
12/9/96	
PCE	3,200
TCE	480

B-31	
12/10/96	
PCE	2,200
TCE	210

B-32	
12/10/96	
PCE	250
TCE	18

B-39	
12/10/96	
PCE	22,000
TCE	1,200

VP44				
4/17/00	1 ft	3 ft	6 ft	8 ft
TO	5.85	––	––	––
1,2–DCE	4.70	––	246	131
TCE	10.0	––	670	316
PCE	307	103	39,299	20,899

P-2	
1/16/96	
PCE	5.5
TCE	0.81
1,1,1–TCA	0.31
1,2–DCE(c)	0.10

P-5	
1/17/96	
PCE	53
TCE	8.6
1,2–DCE(c)	2.0

P-7	
1/18/96	
PCE	1.1
TCE	0.22
1,2–DCE(c)	0.35
VC	0.072

P-8	
1/18/96	
PCE	6.0
TCE	2.6
1,1–DCE	0.044
1,2–DCE(c)	4.0
1,2–DCE(t)	0.067
1,1,1–TCA	1.6
1,1–DCA	0.11
1,2,4–TMB	0.038

B-34	
12/9/96	
PCE	1.7 J
TCE	0.56 J

B-36	
12/9/96	
PCE	4.0 J
TCE	0.54 J

LEGEND

◕ B-5	Monitoring Well/Boring Location and Station Designation
⊕ SB-10	Soil Boring Location and Station Designation
✦ Bor G	Hand Auger Boring Location and Station Designation
• Comp B	Hand Auger Sample Location used for Composite Sample
⊙ PT-1	Grab Sample Location and Station Designation
◇ P-2	Geoprobe Boring Location and Station Designation
■ VP11	Strataprobe Location and Station Designation

PCE	Perchloroethylene (tetrachloroethene)
TCE	Trichloroethene
1,1–DCE	1,1–Dichloroethene
1,2–DCE(c)	1,2–Dichloroethene (cis)
1,2–DCE(t)	1,2–Dichloroethene (trans)
VC	Vinyl chloride
1,1,1–TCA	1,1,1–Trichloroethane
1,2,4–TMB	1,2,4–Trimethylbenzene
1,1–DCA	1,1–Dichloroethane
BZ	Benzene
TO	Toluene
EB	Ethylbenzene
XY	Total Xylenes
Units	Milligrams Per Meter Cubed (mg/m^3)

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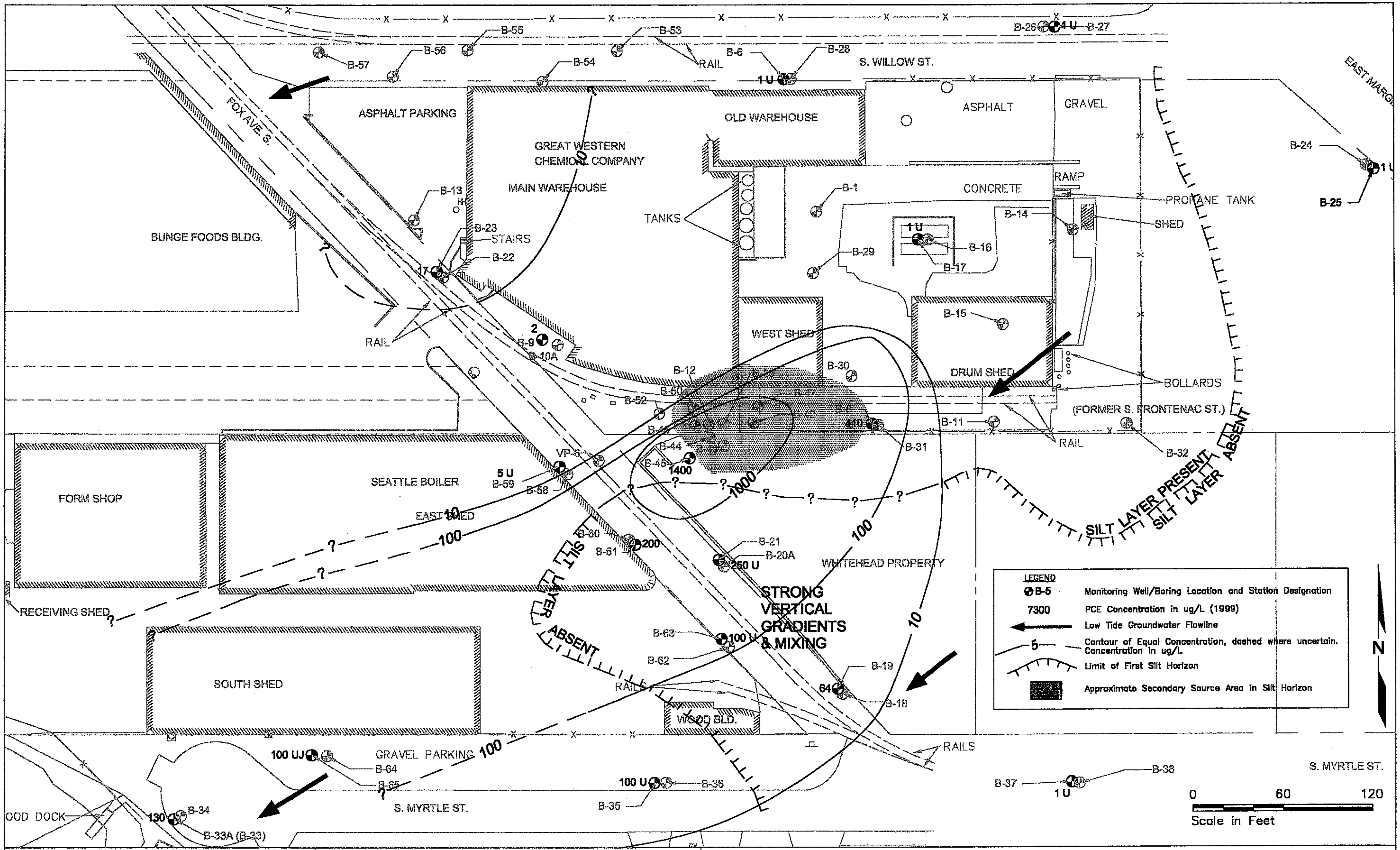
Seattle, Washington

Figure 4.6
Soil Vapor Results

DATE: 10/16/00 4:05pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0002.dwg



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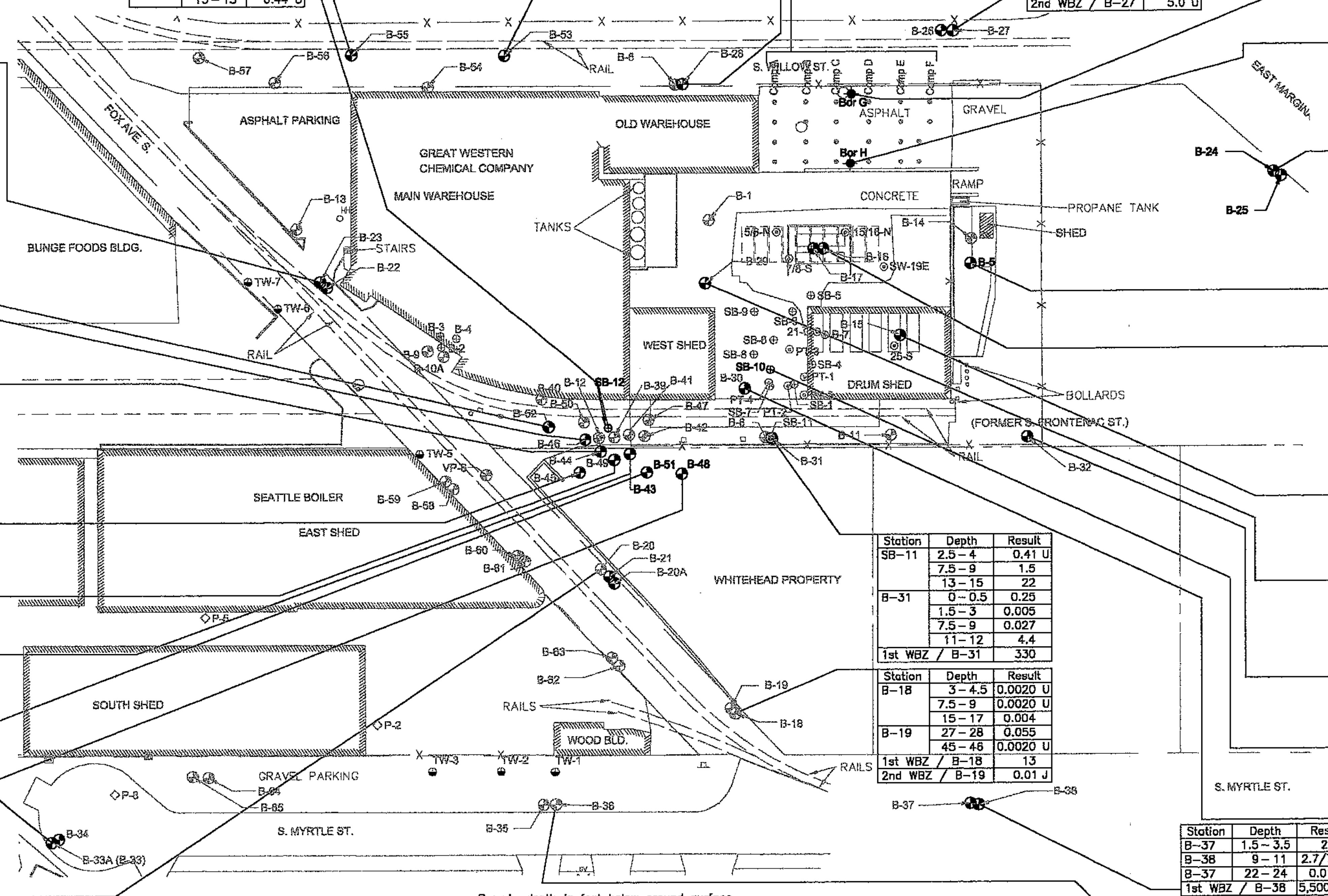
Seattle, Washington

Figure 4.7
Tetrachloroethene Contours in the 2nd Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 2:28pm
DWG NAME: G:\project\Clients\Floyd and Snider\gwco\final\gwc0008.dwg



Station	Depth	Result
SB-12	2.5 – 4	0.41 U
	7.5 – 9	0.14 J
	13 – 15	0.44 U

Station	Depth	Result
B-53	13 – 14	0.41 U
1st WBZ / B-53		5.0 U

Station	Depth	Result
B-55	14 – 15	0.42 U
1st WBZ / B-55		5.0 U

Station	Depth	Result
B-28	0 – 0.5	0.003
	3 – 4.5	0.0020 U
	7.5 – 9	0.0020 U
	14 – 15	0.0020 U
1st WBZ / B-28		5.0 U

Station	Depth	Result
COMP A	0 – 1	0.89 J
COMP B	0 – 1	1.7 U
COMP C	0 – 1	0.85 U
COMP D	0 – 1	0.85 U
COMP E	0 – 1	0.85 U
COMP F	0 – 1	0.85 U

Station	Depth	Result
B-26	3 – 4.5	0.0020 U
	6 – 7.5	0.0020 U
	12 – 14	0.0050
B-27	45 – 46	0.003 U
	48 – 49	0.003 U
1st WBZ / B-26		5.0 U
2nd WBZ / B-27		5.0 U

Station	Depth	Result
BOR G	2.5	0.85 U
	5	0.85 U
	7.5	0.85 U

Station	Depth	Result
BOR H	2.5	0.85 U
	5	0.85 U
	7.5	0.0020 U

Station	Depth	Result
B-22	1.5 – 3	0.002
	6 – 7.5	0.0020 U
	11 – 12	0.0020 U
B-23	27 – 28	0.002
	48 – 49	0.003 U
1st WBZ / B-22		5.0 U
2nd WBZ / B-23		0.5 U

Station	Depth	Result
B-24	3 – 4.5	0.0020 U
	7.5 – 9	0.0020 U
	11 – 12	0.0020 U
B-25	28 – 30	0.0025 U
1st WBZ / B-24		5.0 U
2nd WBZ / B-25		5.0 U

Station	Depth	Result
B-52	? –	1.0 U
1st WBZ / B-52		37

Station	Depth	Result
B-5	0 – 0.5	0.0020 U
1st WBZ / B-5		ABDN

Station	Depth	Result
B-46	? –	0.45
1st WBZ / B-46		200

Station	Depth	Result
B-16	9 – 11	0.49
	15 – 17	0.0027
B-17	18 – 19	0.0022
	23 – 24	0.0020 U
	38 – 39	0.0020 U
	46 – 48	0.0020 U
1st WBZ / B-16		6.3
2nd WBZ / B-17		0.5 U

Station	Depth	Result
B-44	? –	0.46 J
1st WBZ / B-44		360

Station	Depth	Result
B-45	28 – 30	0.68
	? –	0.13 J
2nd WBZ / B-45		24

Station	Depth	Result
B-15	2.5 – 4	6.3
	13 – 14	0.38 U
	17 – 18	7.5
1st WBZ / B-15		26

Station	Depth	Result
SB-11	2.5 – 4	0.41 U
	7.5 – 9	1.5
	13 – 15	22
B-31	0 – 0.5	0.25
	1.5 – 3	0.005
	7.5 – 9	0.027
	11 – 12	4.4
1st WBZ / B-31		330

Station	Depth	Result
B-49	? –	2.9
1st WBZ / B-49		520

Station	Depth	Result
B-29	0 – 0.5	0.002
	6 – 7.5	1.0 U
	9 – 11	0.0020 U
	14 – 15	0.003
1st WBZ / B-29		DRY

Station	Depth	Result
B-43	? –	0.89
1st WBZ / B-43		ABDN

Station	Depth	Result
B-18	3 – 4.5	0.0020 U
	7.5 – 9	0.0020 U
	15 – 17	0.004
B-19	27 – 28	0.055
	45 – 46	0.0020 U
1st WBZ / B-18		13
2nd WBZ / B-19		0.01 J

Station	Depth	Result
B-32	0 – 3	0.004 J
	7 – 9	0.003 U
1st WBZ / B-32		DRY

Station	Depth	Result
B-51	? –	0.13 J
1st WBZ / B-51		ABDN

Station	Depth	Result
SB-10	2.5 – 4	29 J
	13 – 14	10
	17 – 19	22 J

Station	Depth	Result
B-48	? –	0.42
1st WBZ / B-48		ABDN

Station	Depth	Result
B-34	13 – 15	0.003 U
B-33	30 – 31	0.003 U
	39 – 40	0.003 U
1st WBZ / B-34		5.0 U
2nd WBZ / B-33A		0.5 U

Station	Depth	Result
B-37	1.5 – 3.5	2.7
B-38	9 – 11	2.7/71
B-37	22 – 24	0.011
1st WBZ / B-38		5,500
2nd WBZ / B-37		5.0 U

Station	Depth	Result
B-30	0 – 0.5	3.4
	4 – 5.5	0.22
	10 – 12	11
	15 – 16	13
1st WBZ / B-30		NC

Station	Depth	Result
B-20	3 – 4.5	0.0020 U
	7.5 – 9	0.0020 U
	12 – 14	0.0020 U
B-21	23 – 24	0.022
	42 – 44	0.006
	48 – 50	0.0020 U
1st WBZ / B-20A		0.5 U
2nd WBZ / B-21		0.5 U

Station	Depth	Result
B-35	8 – 10	0.004
B-36	9 – 11	0.003
B-35	28 – 30	0.075
1st WBZ / B-36		0.37 J
2nd WBZ / B-35		0.07 J

<u>LEGEND</u>

- ● B-5 Monitoring Well/Boring Location and Station Designation
- ⊕ SB-10 Soil Boring Location and Station Designation
- ● Bor G Hand Auger Boring Location and Station Designation
- • Comp B Hand Auger Sample Location used for Composite Sample

Sample depth in feet below ground surface
Soil boring/well designation
First/Second water bearing zone

Station	Depth	Result
B-18	3 – 4.5	0.0020 U
	7.5 – 9	0.0020 U
	15 – 17	0.004
B-19	27 – 28	0.055
	45 – 46	0.0020 U
1st WBZ / B-18		Dry/ABDN/NC
2nd WBZ / B-19		0.01 J

Penta concentration in soil (mg/kg)
Dry=Inadequate volume of water to sample
ABDN=Well was abandoned
NC=Not collected
Penta concentration in groundwater (ug/L)

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Seattle, Washington

Figure 4.8
Pentachlorophenol Results for Soil

DATE: 08/10/00 1:47pm
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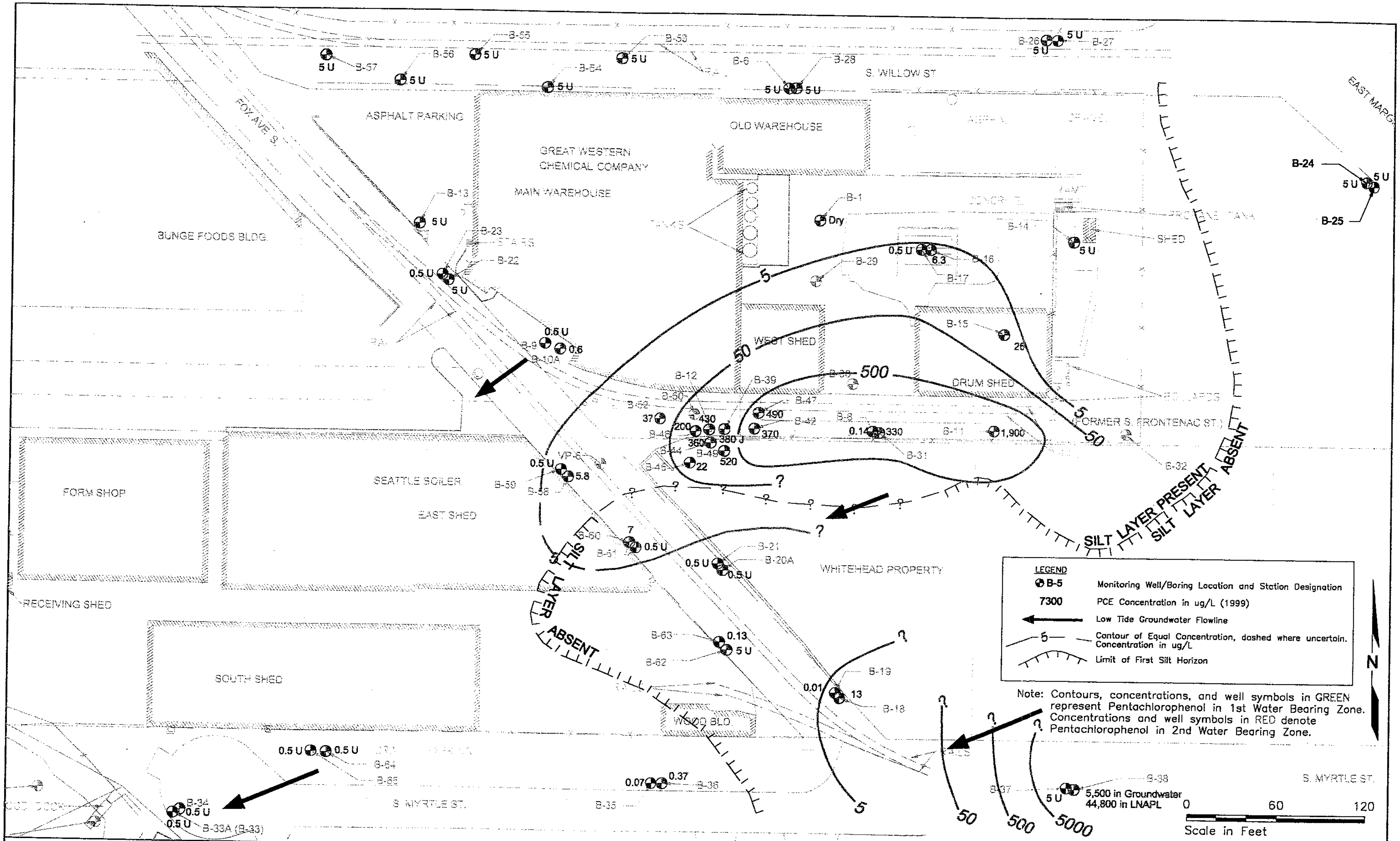

LEGEND

● B-5	Monitoring Well/Boring Location and Station Designation
7300	PCE Concentration in ug/L (1999)
←	Low Tide Groundwater Flowline
—5—	Contour of Equal Concentration, dashed where uncertain. Concentration in ug/L
⌒	Limit of First Silt Horizon

Note: Contours, concentrations, and well symbols in GREEN represent Pentachlorophenol in 1st Water Bearing Zone. Concentrations and well symbols in RED denote Pentachlorophenol in 2nd Water Bearing Zone.

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Chemical Company
Seattle, Washington

Figure 4.9
Pentachlorophenol in 1st and 2nd Water Bearing Zones
1999 Sampling Event

DATE: 10/17/00 09:08am
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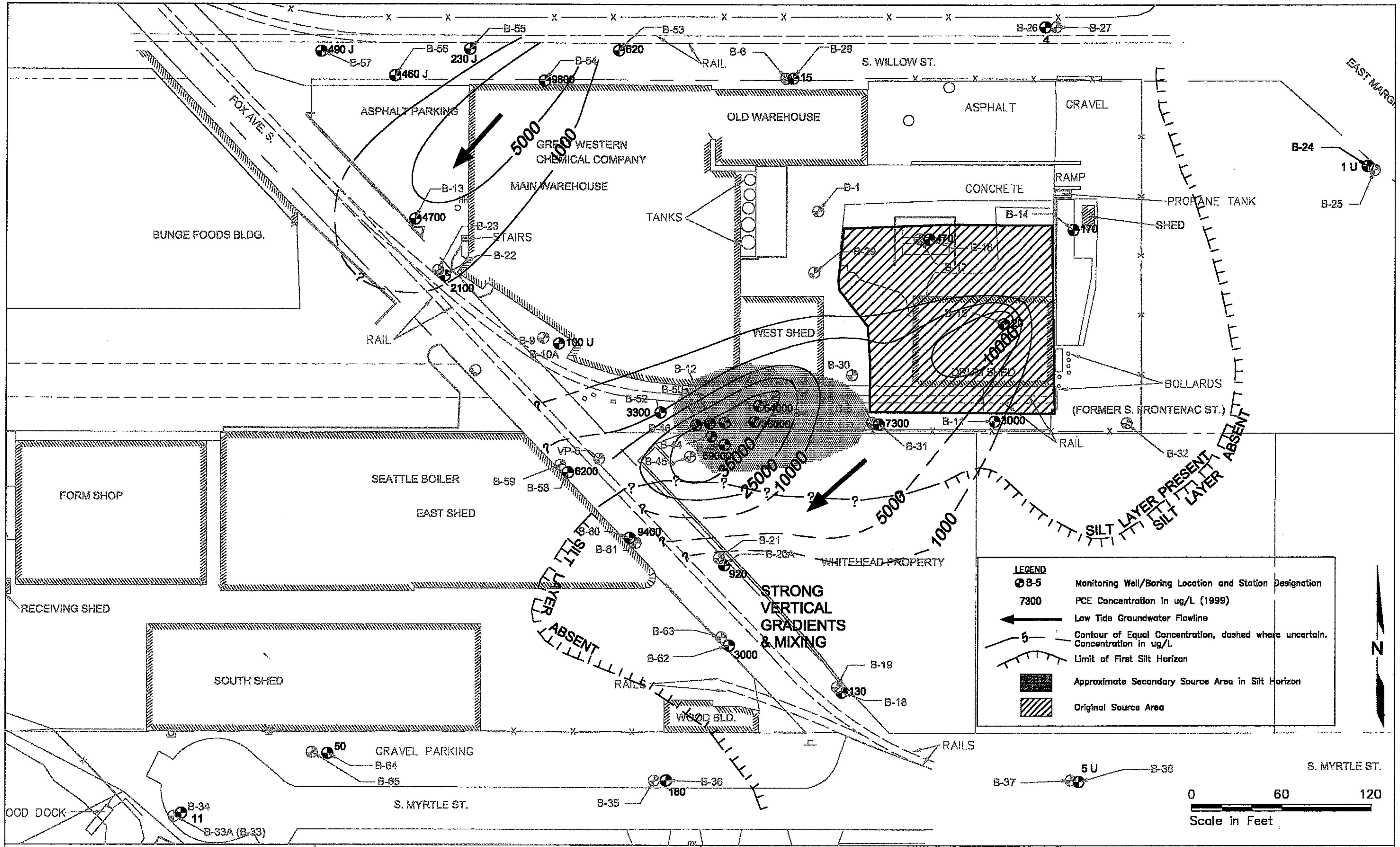

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Figure 5.1
Tetrachloroethene Contours in 1st Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 10:13am
DWG NAME: C:\project\Clients\Floyd and Snider\gwcc\final\gwc0008.dwg

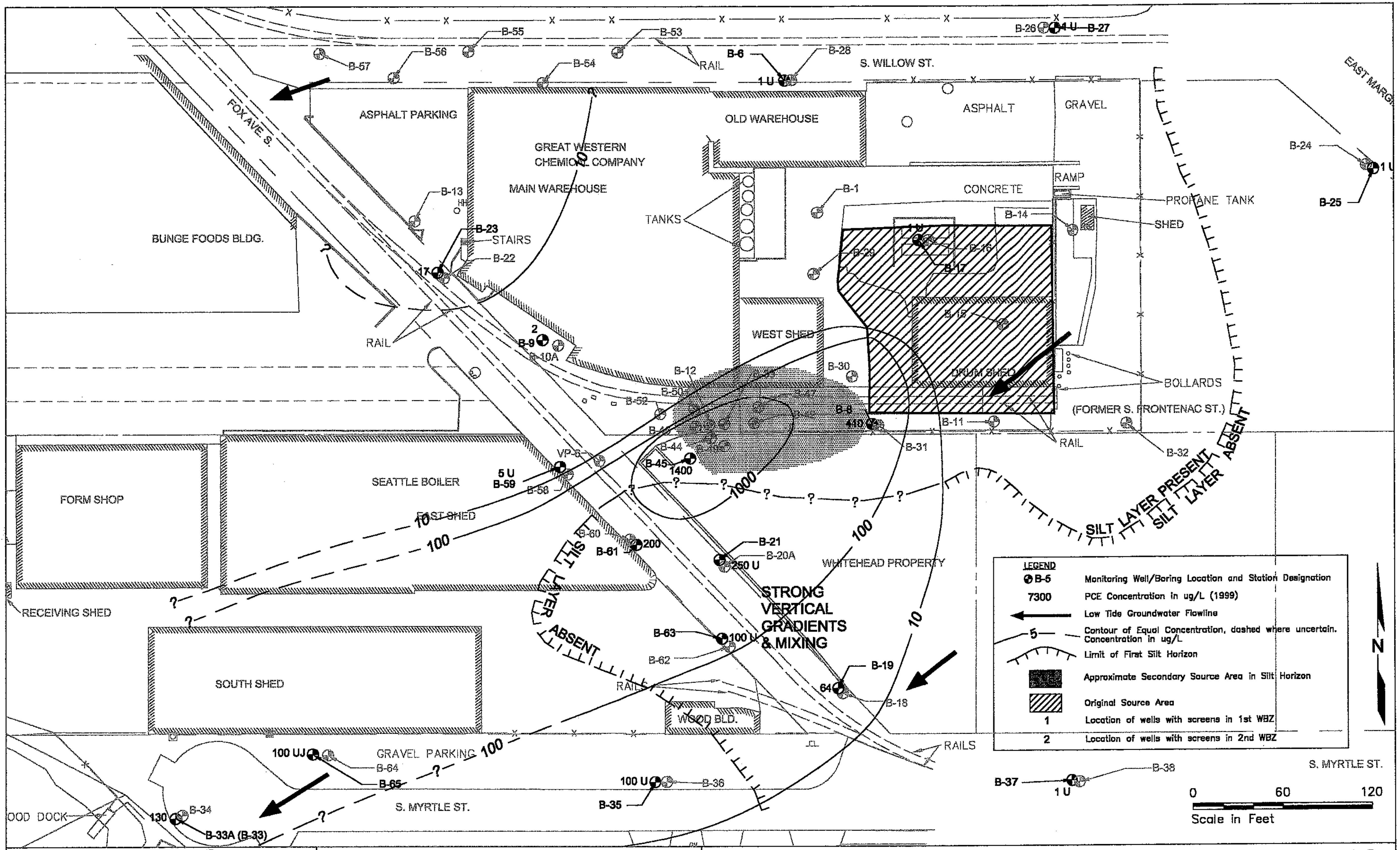

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Figure 5.2
Tetrachloroethene Contours in the 2nd Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 10:15am
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0010.dwg

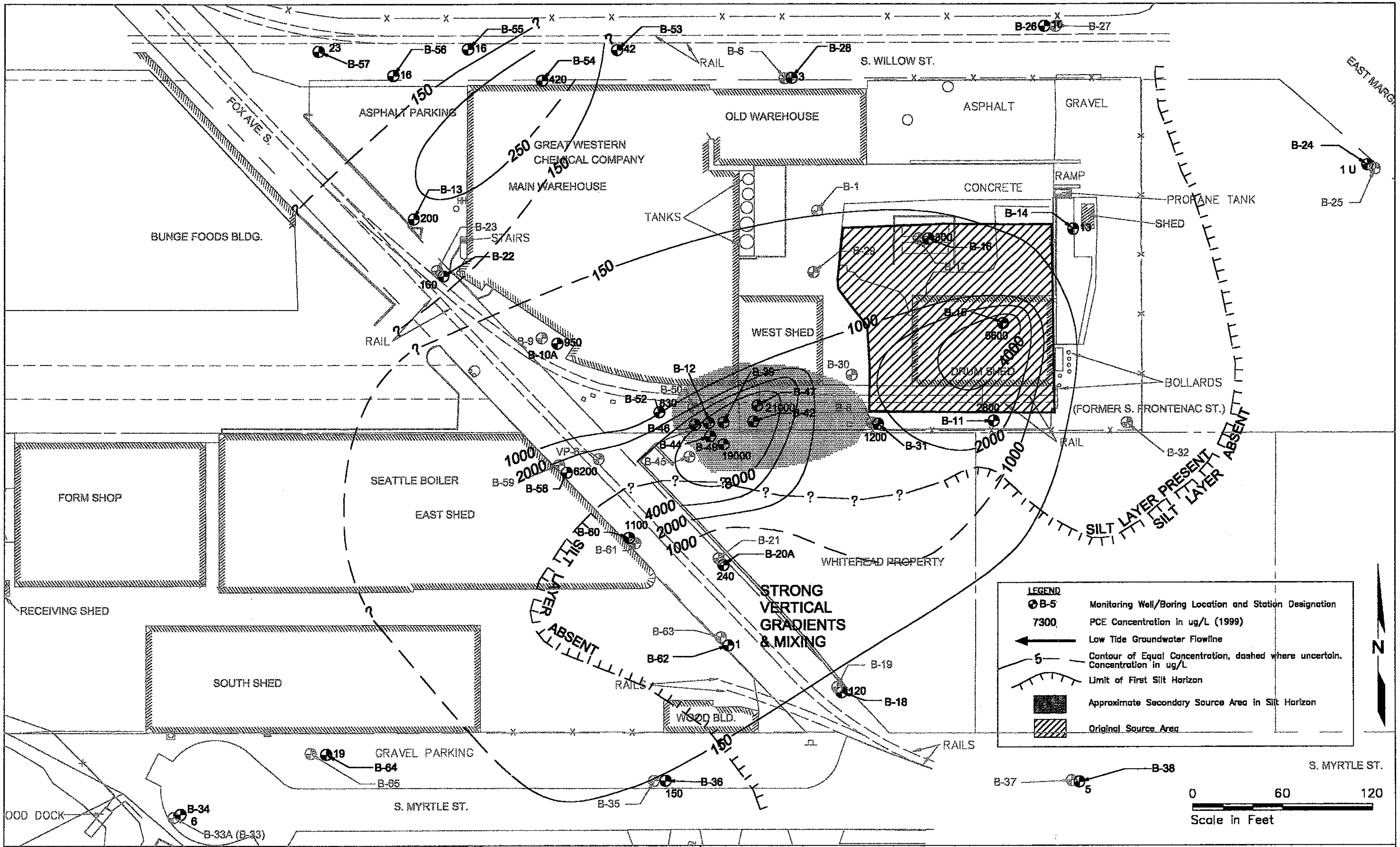

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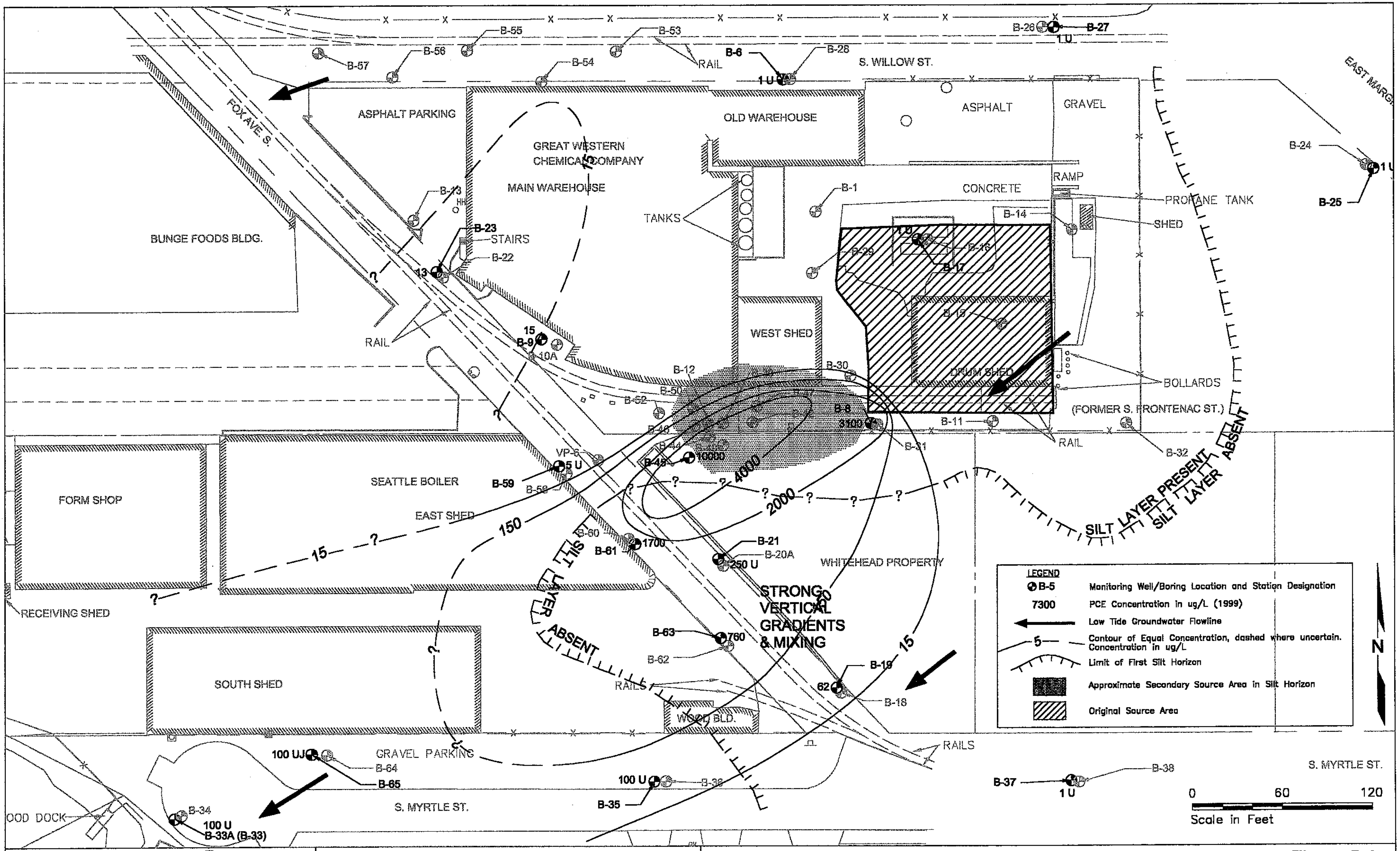
Figure 5.3
Trichloroethene Contours in the 1st Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 10:17am
DWG NAME: c:\project\Clients\Floyd and Snider\gwco\final\gwc0011.dwg



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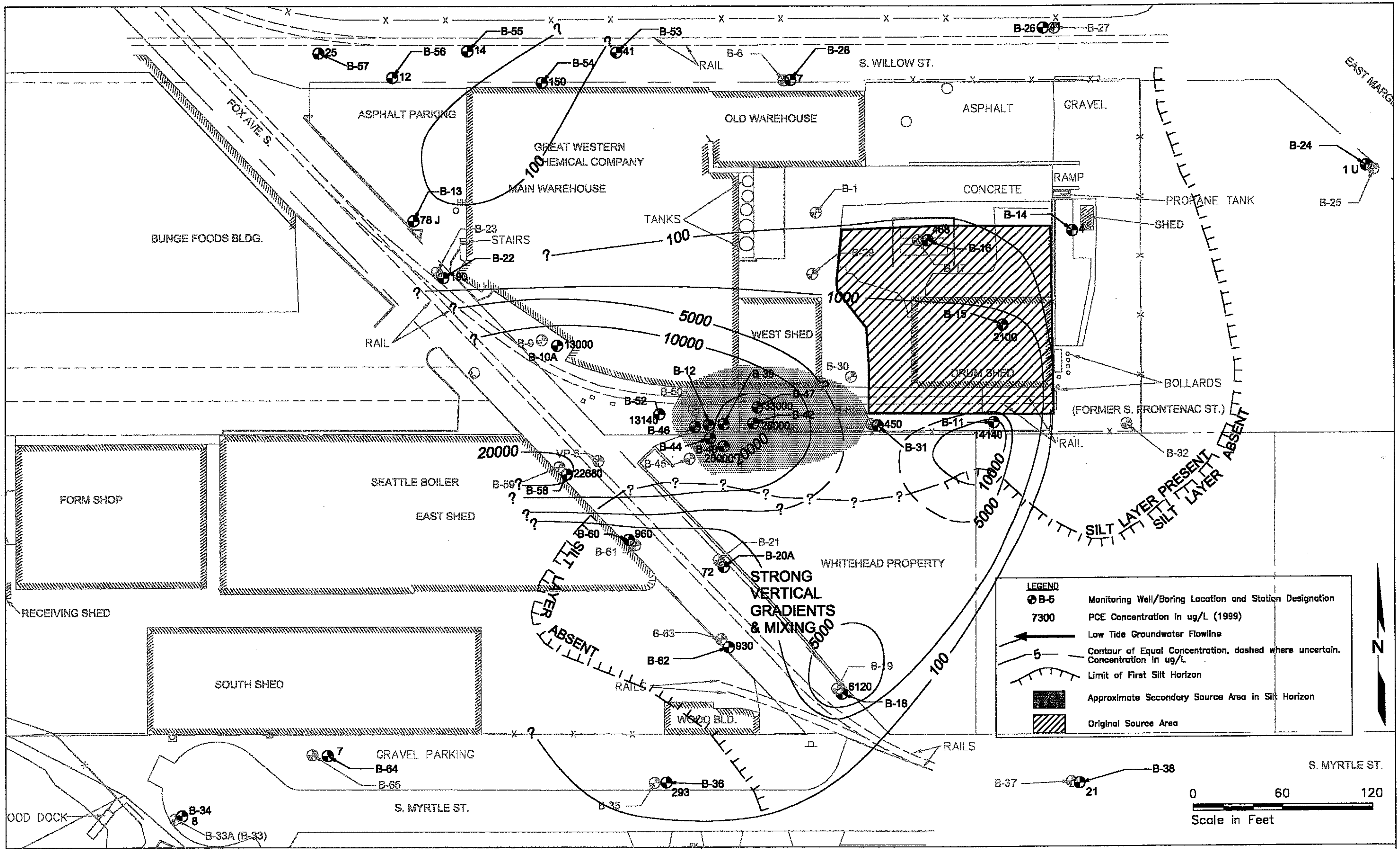
Seattle, Washington

Figure 5.4
Trichloroethene Contours in the 2nd Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 10:15am
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0012.dwg



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TERRA VAC

Great Western
Chemical Company
Seattle, Washington

Figure 5.5

1,2-Dichloroethene (total) Contours in the 1st Water Bearing Zone
1999 Sampling Event

DATE: 08/10/00 2:37pm
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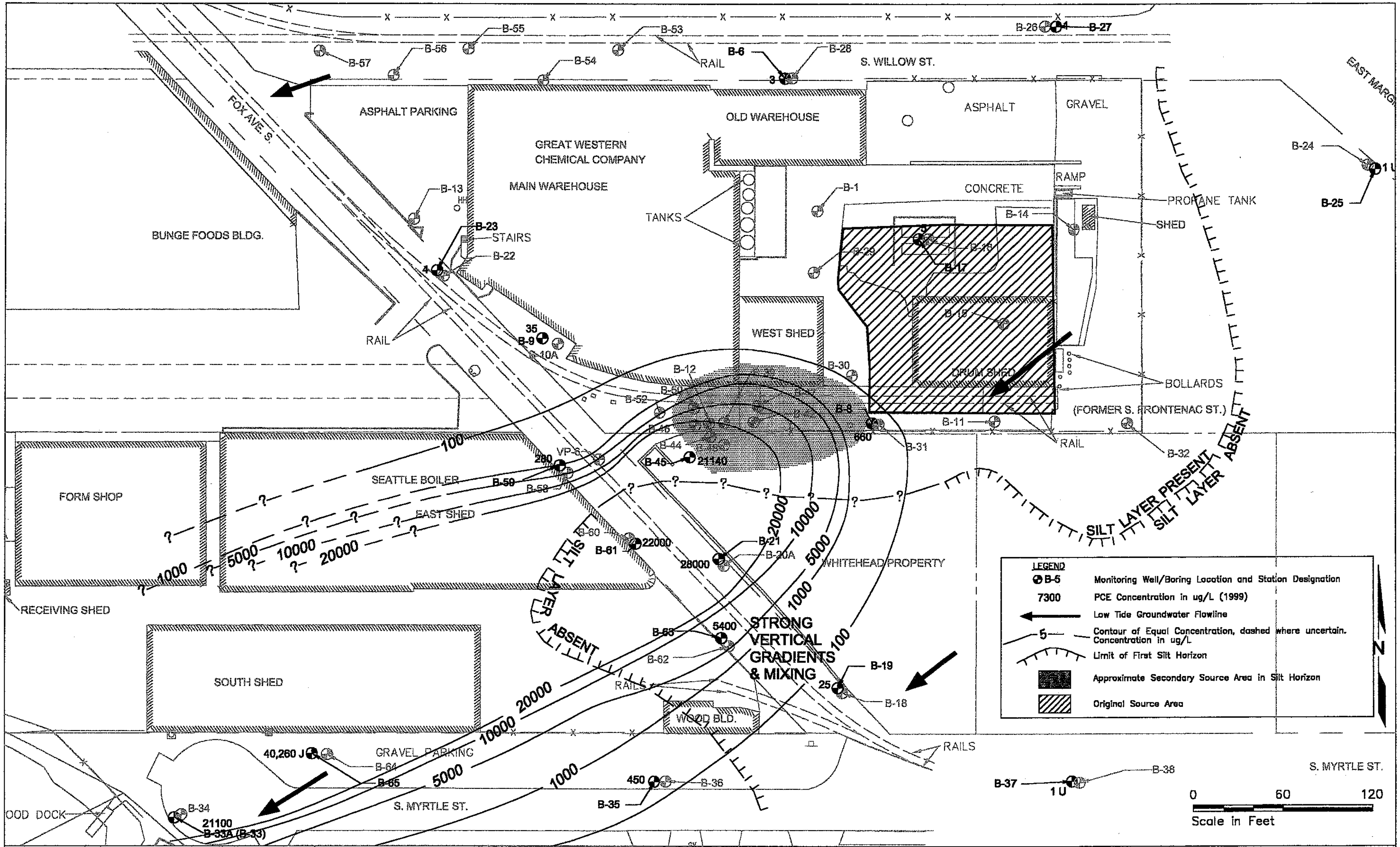

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Figure 5.6
1,2-Dichloroethene (total) Contours in the 2nd Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 10:48am
DWG NAME: D:\project\Clients\Floyd and Snider\gwcc\final\gwc0014.dwg

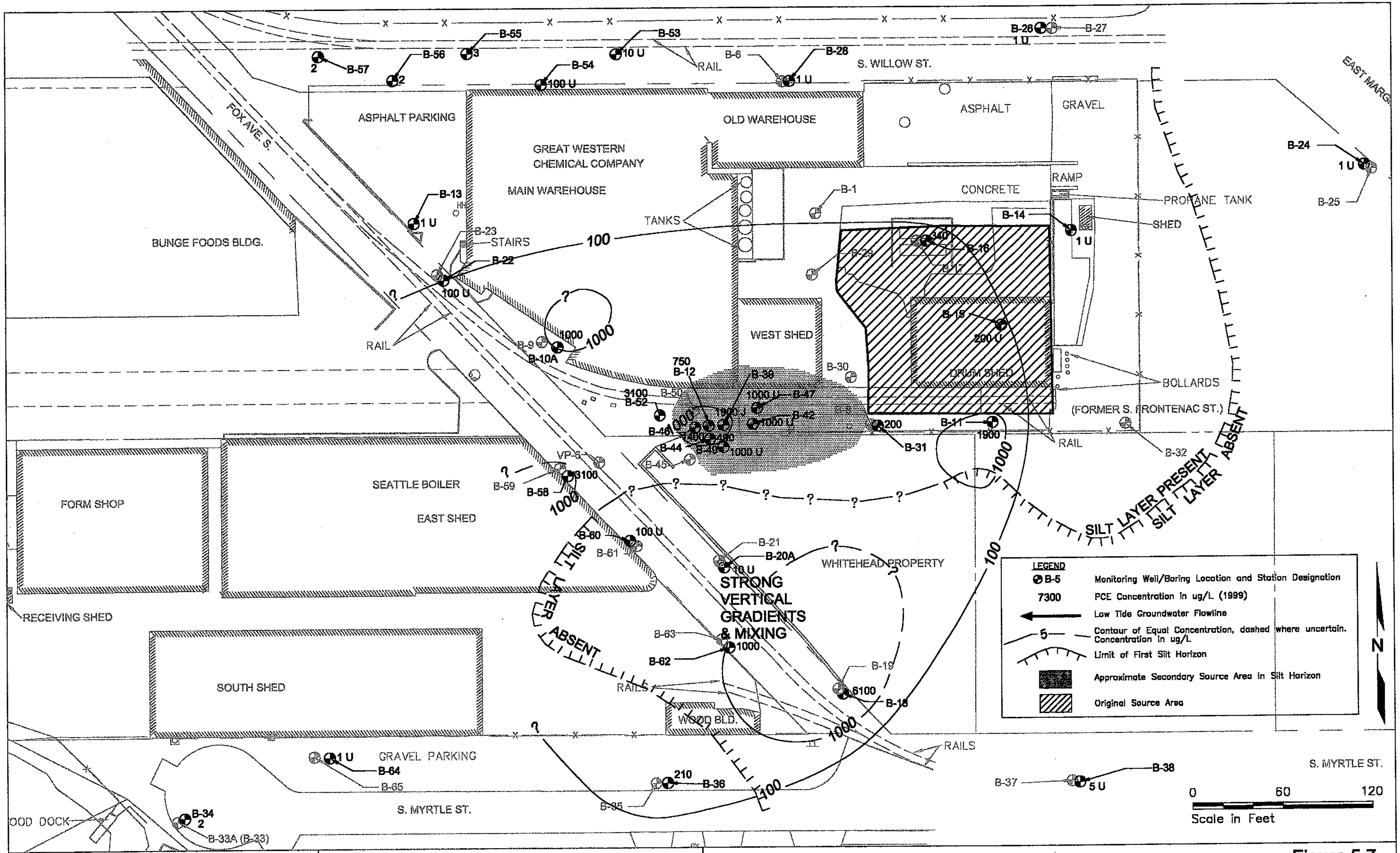

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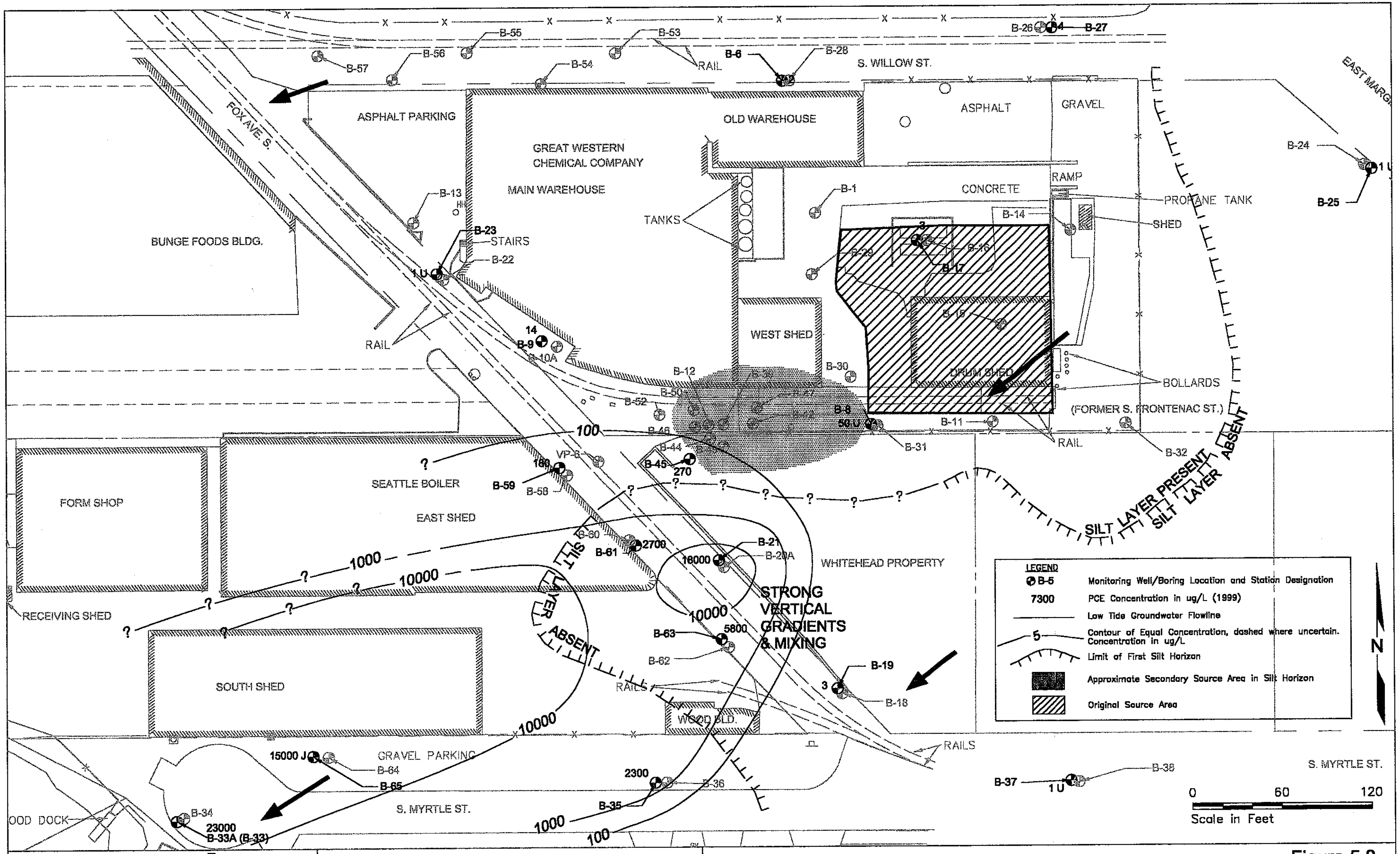
Figure 5.7
Vinyl Chloride Contours in the 1st Water Bearing Zone
1999 Sampling Event

DATE: 10/17/00 10:50am
DWG NAME: G:\project\Clients\Floyd and Snider\gwcc\final\gwc0018.dwg



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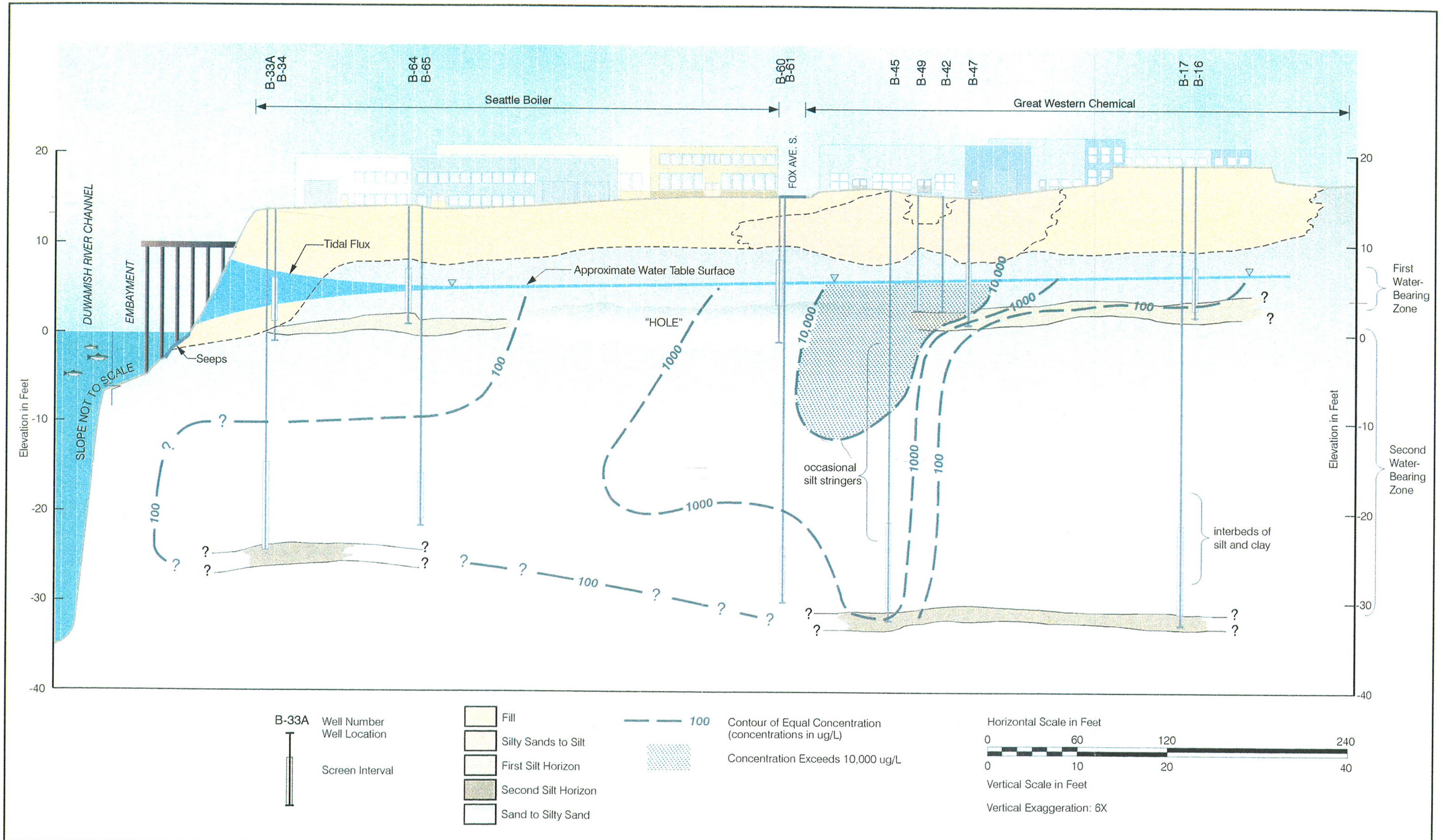
Great Western Chemical Company Seattle, Washington

Figure 5.8

Vinyl Chloride Contours in the 2nd Water Bearing Zone 1999 Sampling Event

DATE: 10/17/00 11:23am
DWG NAME: G:\project\Clients\Floyd and Snider\gwco\final\gwc0015.dwg



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Great Western Chemical Company Seattle, Washington

Figure 5.9
Schematic Cross Section Showing Tetrachloroethene Concentrations 1999 Sampling Event

02/23/00 ConceptualTetra.cdr

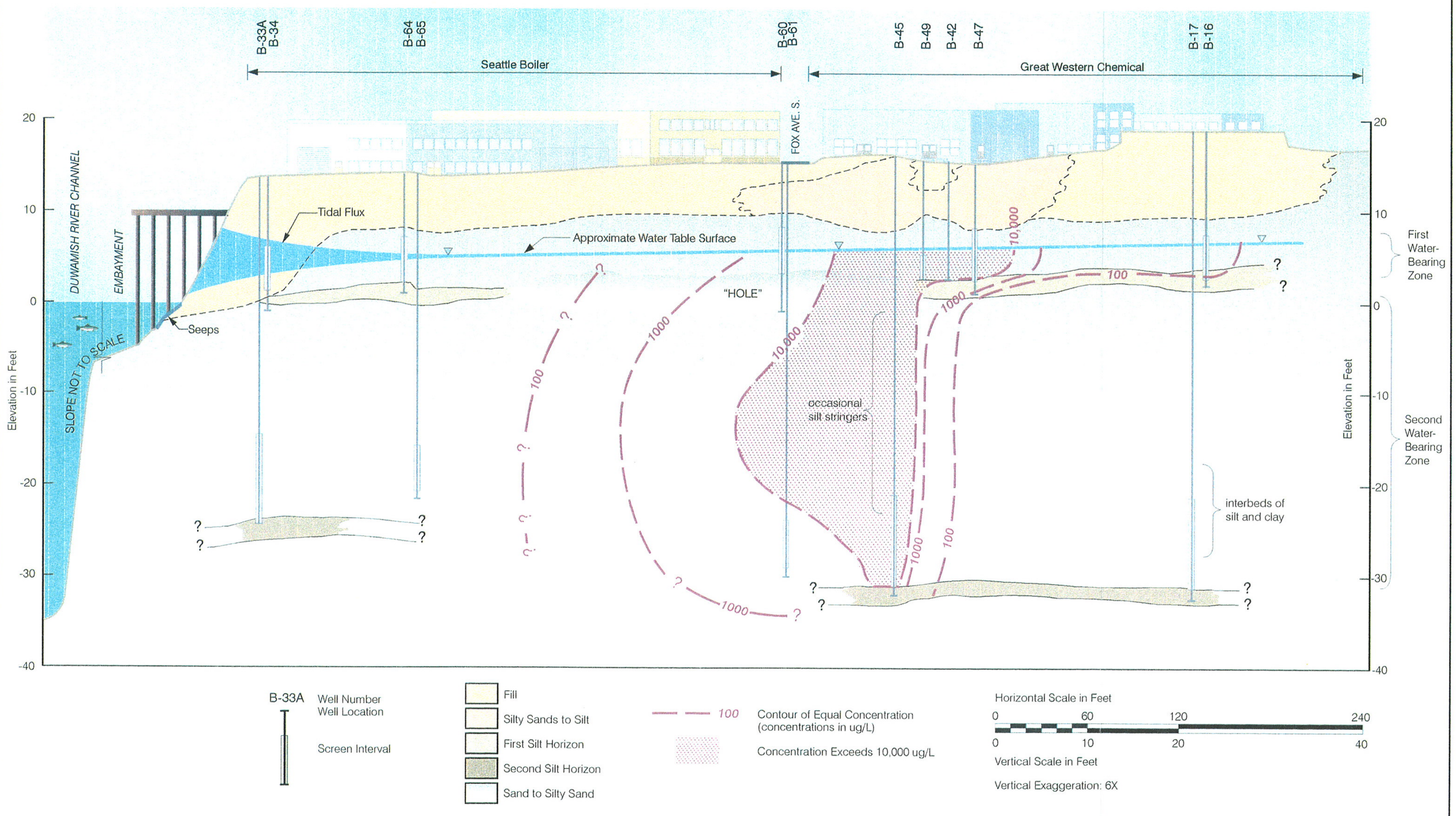

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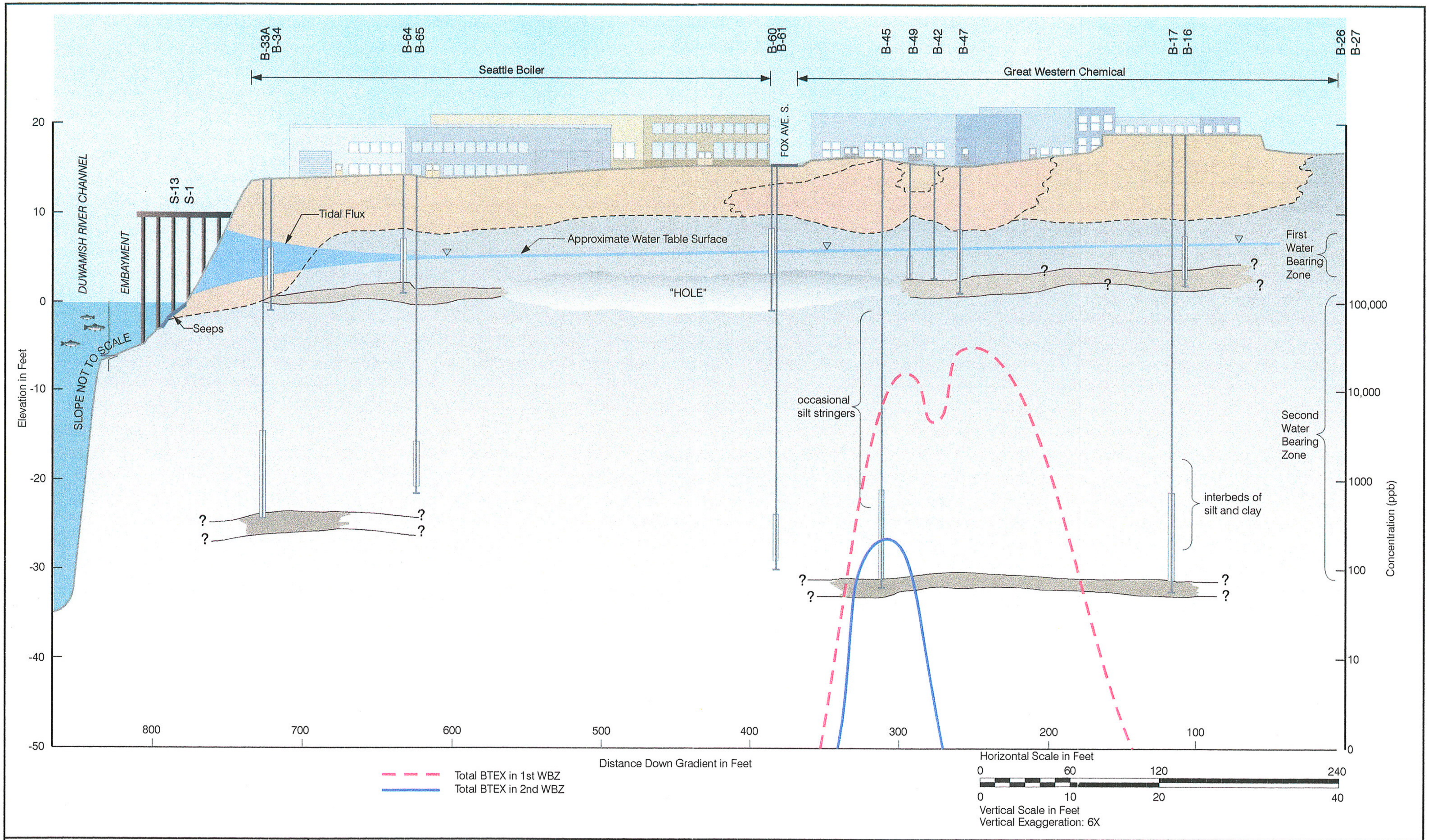
Figure 5.10
Schematic Cross Section Showing Trichloroethene Concentrations 1999 Sampling Event

02/23/00 ConceptualTrichlor.cdr



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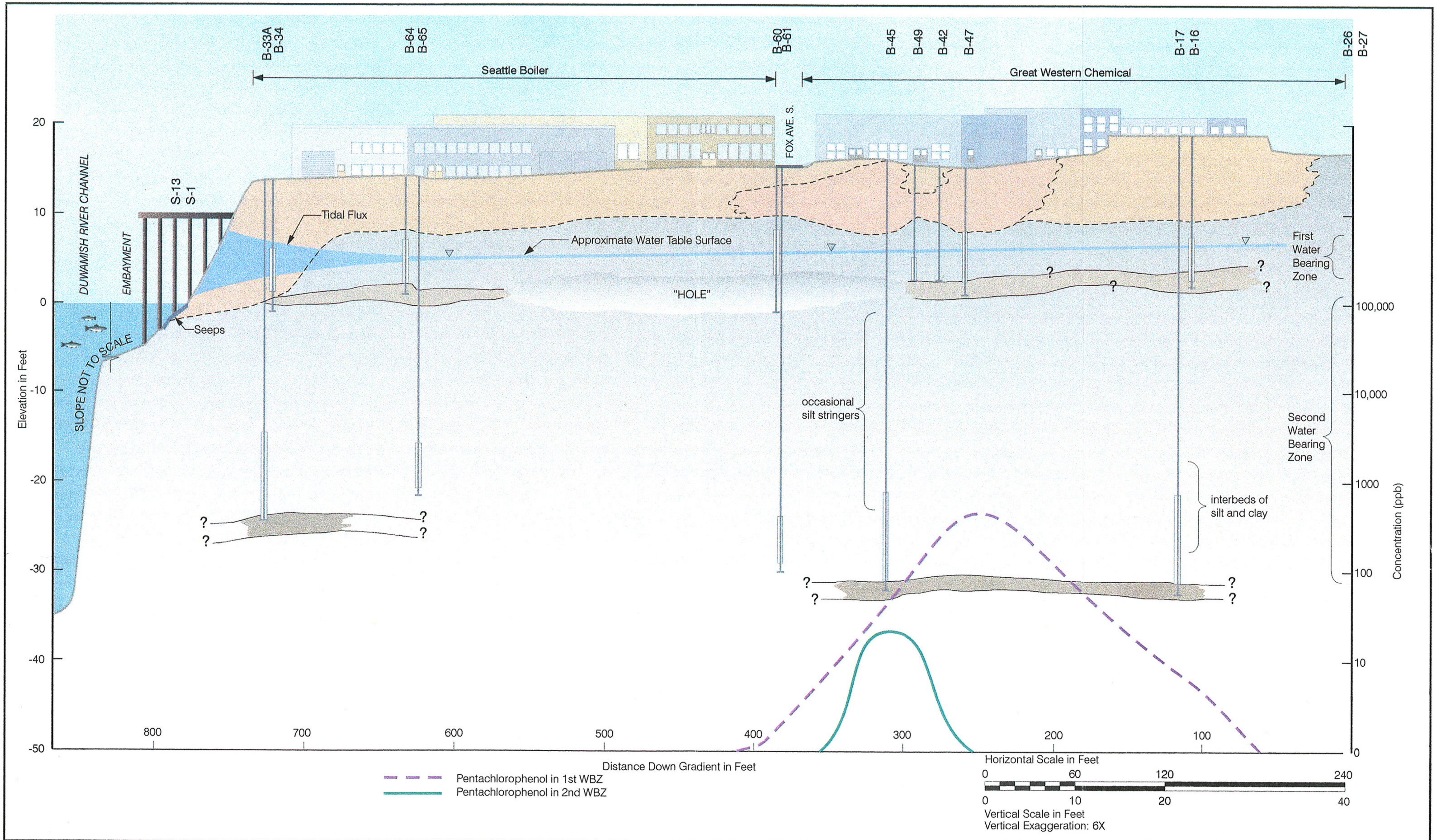
GW International
Seattle, Washington

Schematic Cross Section Showing Total BTEX

10/31/00 total_btex.cdr



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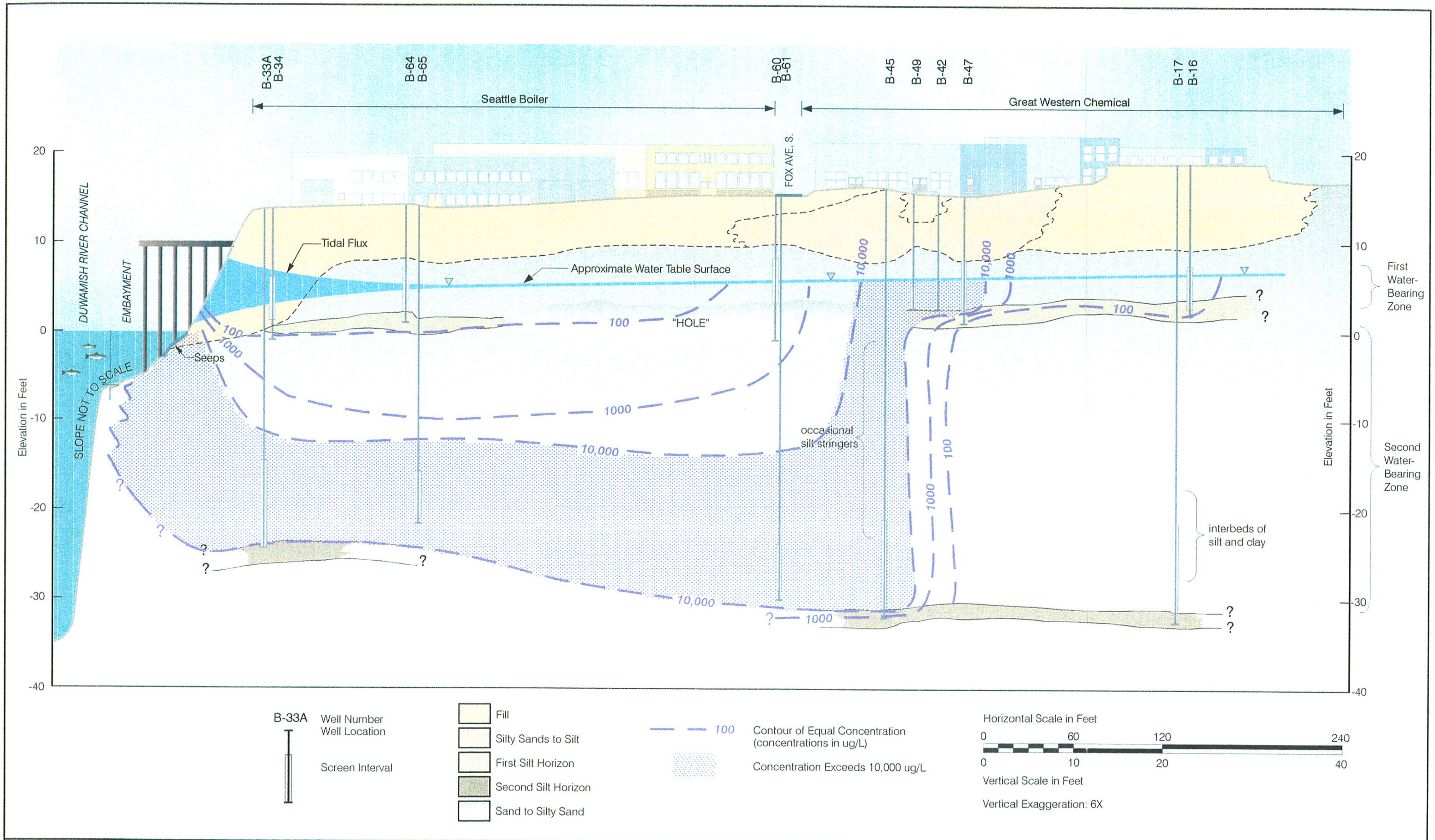
GW International
Seattle, Washington

Schematic Cross Section Showing Pentachlorophenol

10/31/00 pentachlorophenol.cdr



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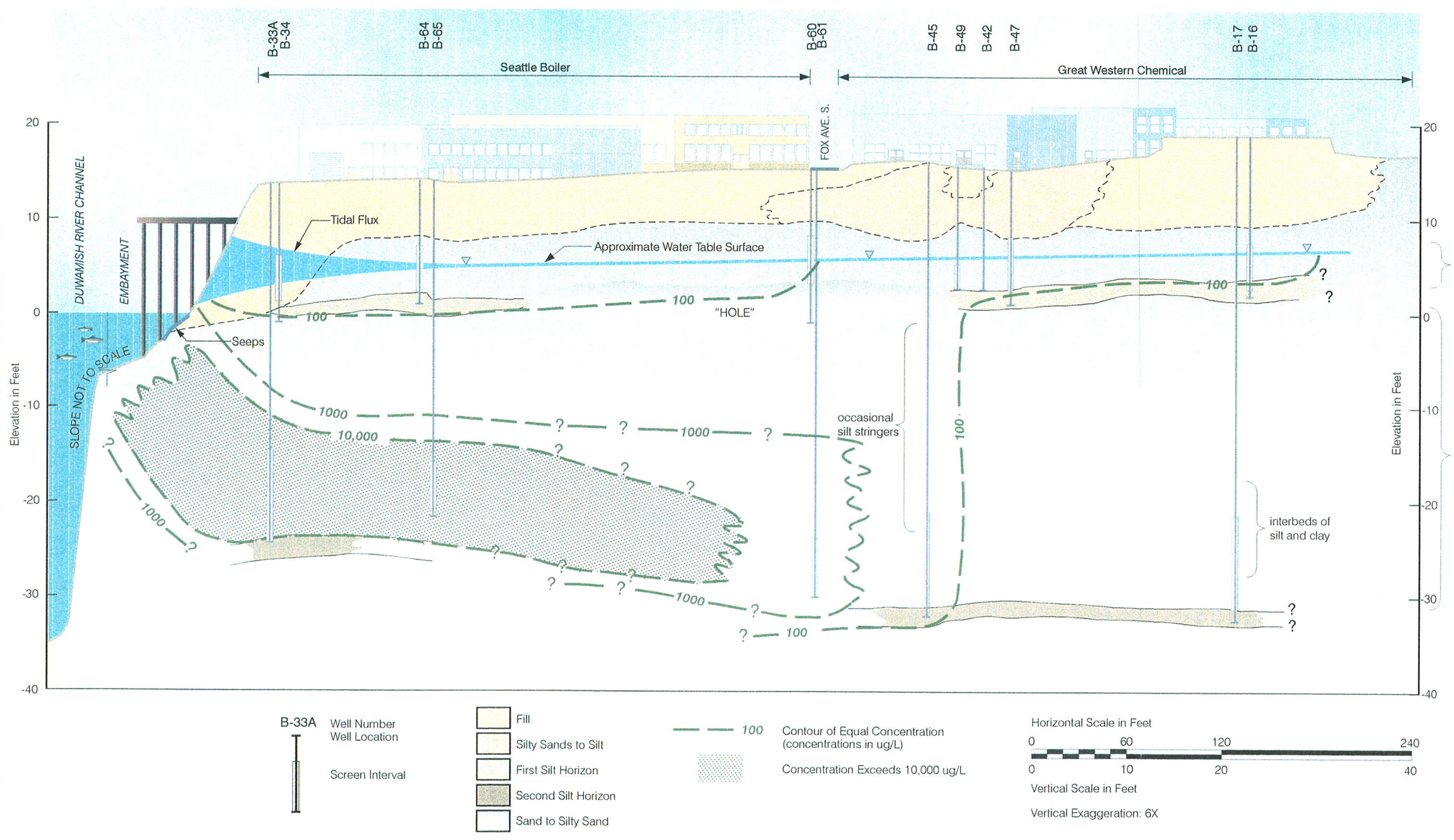
Great Western Chemical Company Seattle, Washington

Figure 5.11 Schematic Cross Section Showing Dichloroethene Concentrations 1999 Sampling Event

02/23/00 ConceptualDichloroethene1.cdr



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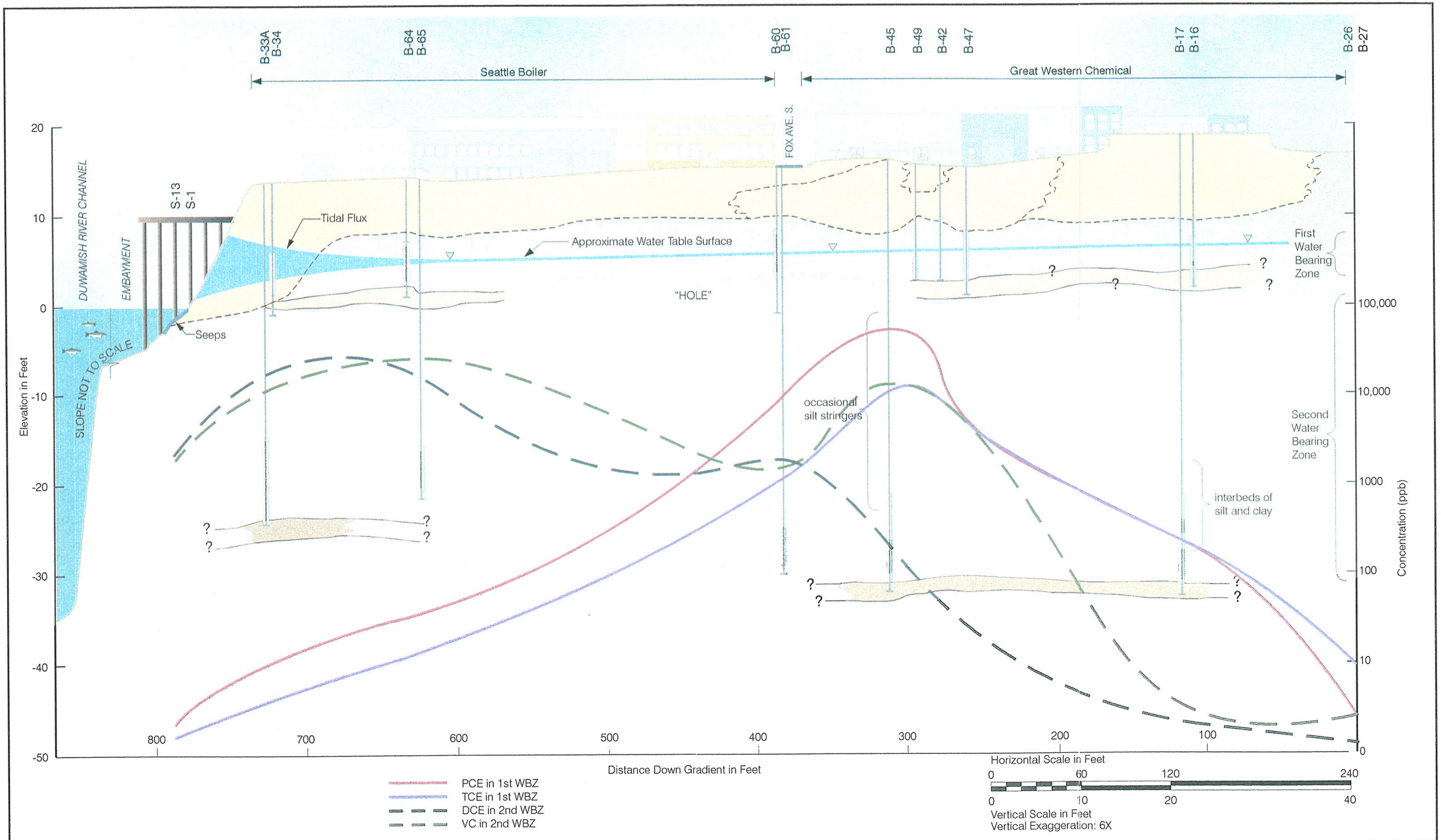
Great Western Chemical Company Seattle, Washington

Figure 5.12
Schematic Cross Section Showing Vinyl Chloride Concentrations 1999 Sampling Event

02/23/00 ConceptualVinyl.cdr



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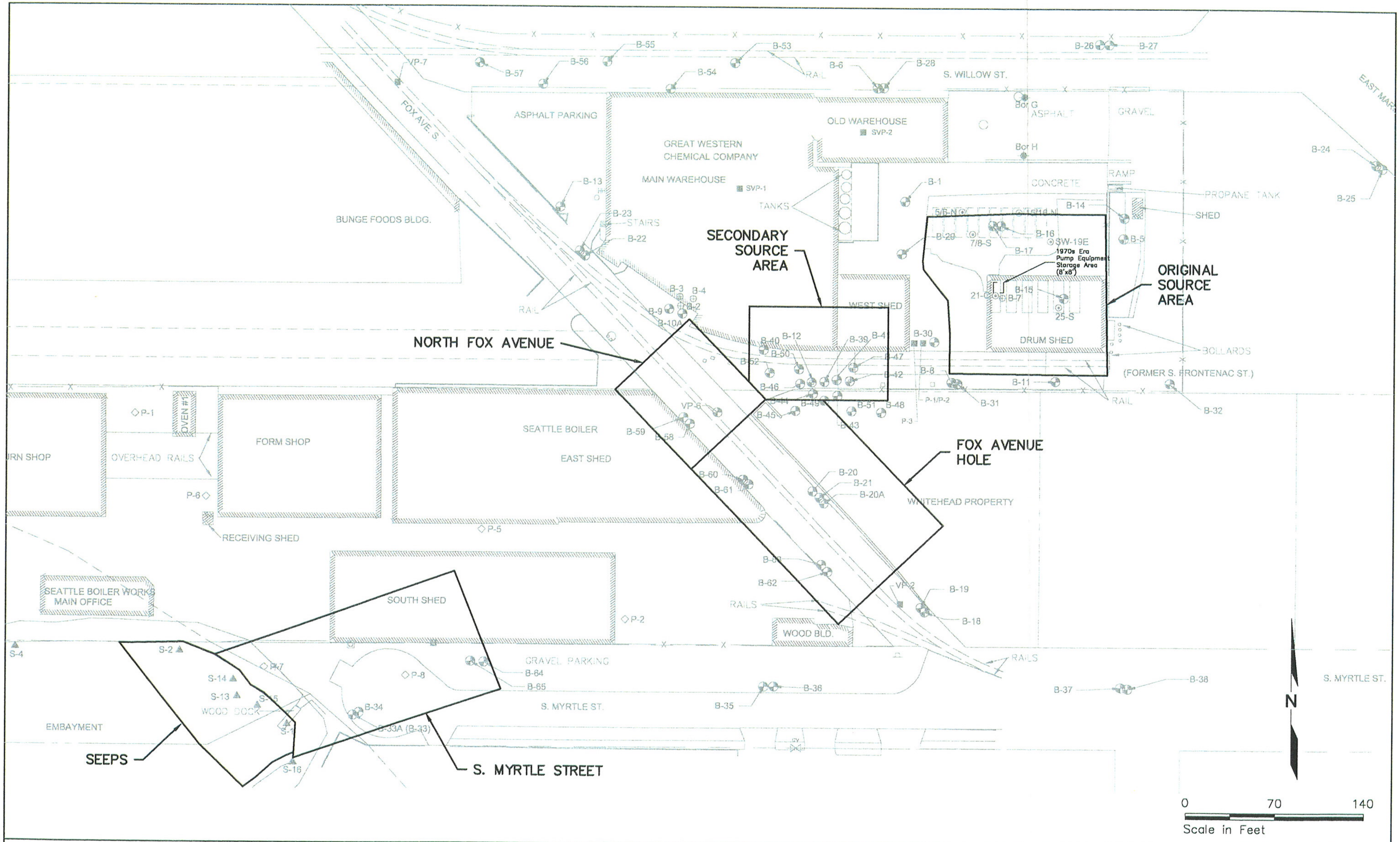
GW International
Seattle, Washington

Figure 5.13
Schematic Cross Section
Showing Chlorinated Ethenes

10/25/00 PCE1TCE1DCE2VC2.cdr



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Seattle, Washington

Figure 5.14
Locations Associated With
Natural Attenuation Discussion

DATE: 10/20/00 11:35am
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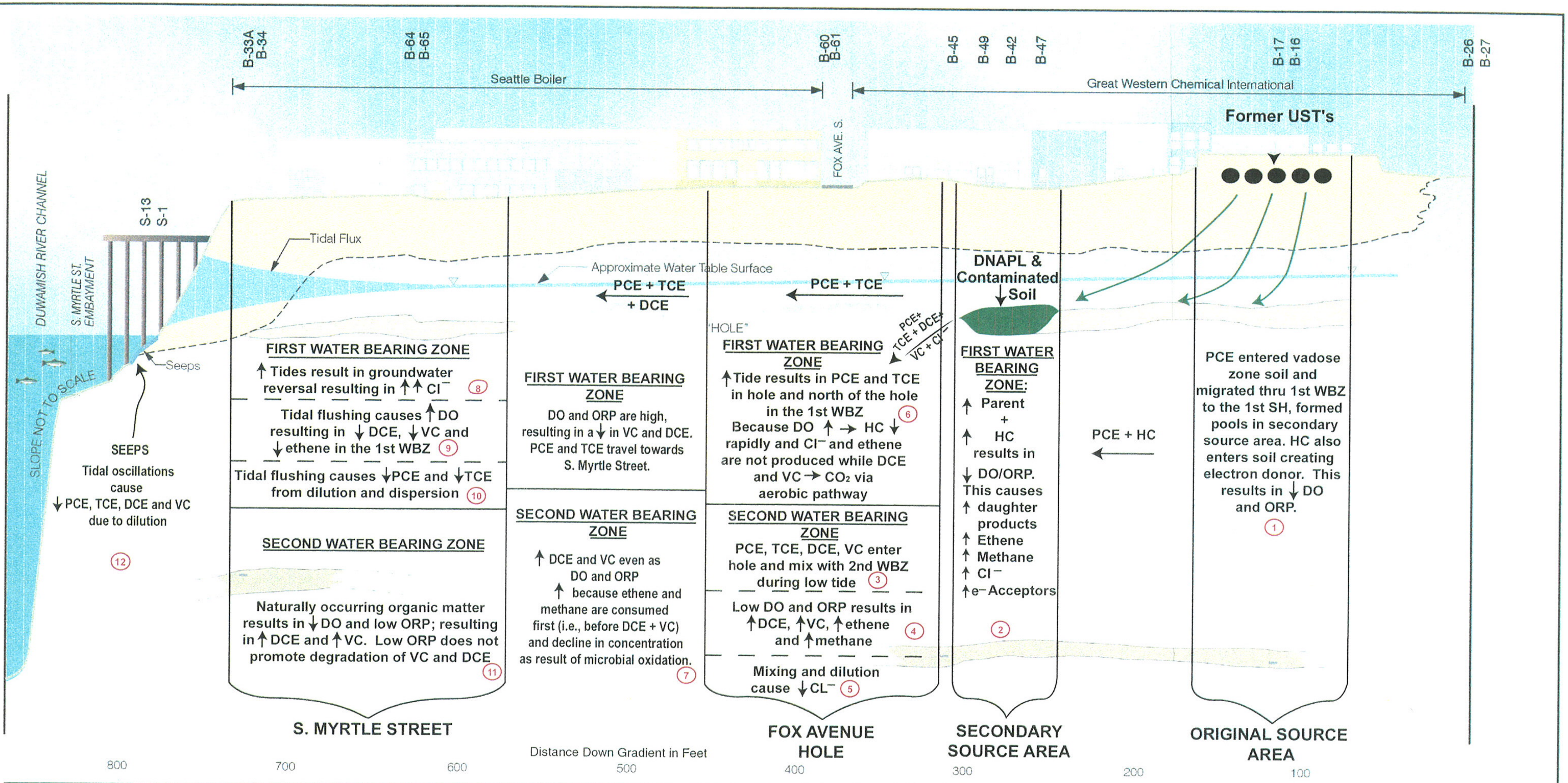

① See Sections 2.3.3.4, 4.3.1.1, 5.1.2 and 5.3.1

② See Sections 2.3.3.4, 4.2.1, 4.3.2, 4.4, 5.2.3, 5.2.4.1 and 5.3.2.1

③ See Sections 2.3.3.4, 2.4.2.2, 2.4.2.3, 2.4.4.4 and Appendix C

④ See Sections 4.4.1, 5.2.4, 5.2.5.2 and Appendix G

⑤ See Sections 2.4.2.3, 2.4.4.4, 4.4.2.1 and Appendix C

⑥ See Sections 2.4.2.2, 2.4.4, 4.4, 5.2.4 and Appendices C and G

⑦ See Sections 4.4., 5.2.3, 5.2.5, and Appendices G and J

⑧ See Sections 2.4.4, 2.4.5, 4.4.2.1, and Appendix C

⑨ See Sections 2.4.4, 4.4.1.1, 5.2.3, 5.2.4 and Appendix J

⑩ See Sections 2.4.4, 4.2.2, 4.2.3, 4.3.1.4 and Appendix D

⑪ See Sections 2.3.3, 2.4.3, 2.5, 4.4.1, 5.2.4 and Appendices C and D

⑫ See Sections 2.4.4, 4.2.3, 4.3.1.4, 5.1.1 and Appendices B, D and G

LEGEND

→ Means not increasing or decreasing

↑ Means increase or increasing

↓ Means decrease or decreasing

e⁻ acceptor = electron acceptor

ORP = oxidation/reduction potential

HC = Hydrocarbon

Horizontal Scale in Feet

0 60 120

0 10 20

Vertical Scale in Feet

Vertical Exaggeration: 6X

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Great Western Chemical Company
Seattle, Washington

Figure 5.15
Site Conceptual Model for
the Degradation of Chlorinated Ethenes

pce1a.ai 10/18/2000

Supplemental Remedial Investigation and Feasibility Study

Appendix A

Northwest Corner Investigation

AGENCY REVIEW DRAFT

NORTHWEST CORNER INVESTIGATION

GW International

808 S.W. 15th Avenue
Portland, OR 97205

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

TERRA VAC

Floyd & Snider Inc.

Northwest Corner Investigation

PREPARED FOR:

GW International

PREPARED BY:

TERRA VAC
23106 100th Ave West
Edmonds, WA 98020-5018

and

FLOYD & SNIDER INC.
83 S. King Street Suite 614
Seattle, WA 98104

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

Table of Contents

List of Tables

List of Figures

List of Attachments

1.0 Introduction

On behalf of Great Western Chemical Company dba Great Western International (GWI), Terra Vac performed the Northwest Corner Investigation in response to elevated PCE concentrations in perimeter monitoring wells. Elevated concentrations of chlorinated solvent were detected at monitoring wells B-13 and B-22 (Figure 1) during the annual site-wide groundwater sampling performed in November 1998 and were verified by subsequent re-sampling performed in early 1999. The purpose of this investigation was to assess and document existing soil and groundwater quality upgradient of onsite wells in the Northwest Corner ofGWI's Seattle facility.

The following tasks were performed as part of this investigation.

- Visual inspection of the site and the surrounding area.
- Review of Washington State Department of Ecology (Ecology) information on the site.
- Collection of groundwater from existing monitoring wells B-13 and B-22.
- Lithologic screening of soil collected during the installation of five temporary monitoring wells.
- Analysis of groundwater collected from five temporary monitoring wells and three existing monitoring wells (B-13, B-22, and B-28).
- Construction of five new 2-inch groundwater monitoring wells.
- Analysis of soil collected during the installation of five new monitoring wells.
- Development of the monitoring wells and groundwater sampling.
- Analysis of soil and groundwater samples for Volatile Organic Hydrocarbons (VOCs) by U.S. EPA Method 8260B and Semi-Volatile Organic Hydrocarbons (SVOCs) by U.S. EPA Method 8270C.
- Cleaning and visual inspection of the sanitary sewer line running parallel to S. Willow Street.

2.0 Background Information

2.1 GWI SITE DESCRIPTION

The GWI Seattle Facility is located in King County at 6900 Fox Avenue S. in Seattle, Washington. A site location map is provided as Figure 1. Land use in the surrounding area is primarily industrial.

The site currently occupies an area of about two and a half acres and is enclosed by a chain link fence on the western end. GWI has used the facility for commercial storage, repackaging, and distribution of chemical products, including petroleum, since the late 1950s. Topography in the vicinity of the site is relatively flat.

2.2 GWI SITE HISTORY

In May 1989, GWI performed an exploratory boring west of its central UST area (Figure 1) to gather data for use in renovations planned for the site. Samples from this boring were screened for volatiles by EPA methods 8010 and 8020 and the results indicated the presence of benzene, toluene, PCE and TCE. In May 1990, additional borings were performed in the area of the Fox Avenue loading dock that confirmed the presence of more VOC impacted soils. This information was conveyed to Washington State Department of Ecology (Ecology) in June 1990.

In August 1990, GWI began removing the USTs in the central part of the site. The area was back-filled with clean fill in October 1990. A more detailed description of the removal and findings from the investigation is contained in Underground Storage Tank Removal and Initial Site Assessment, prepared for Great Western Chemical Company (Hart Crowser, 1990a and 1990b). These reports also detail findings from nine additional monitoring well installations and ten soil borings.

In September 1991, GWI and Ecology entered into an Agreed Order for further site investigation and characterization. In 1991 and 1992, GWI performed additional borings and installed additional monitoring wells along Frontenac Street and the interior portion of the site. This additional investigation was in support of an RI/FS work plan accepted by Ecology in March 1992 (Hart Crowser, 1991b).

Between 1992 and 1999, Hart Crowser and Terra Vac (who was retained by GWI in 1997) performed additional site investigation, including installation of additional monitoring wells and soil borings and collection of soil vapor samples. Hart Crowser also instituted an Ecology-approved annual program of monitoring well and surface water (S. Myrtle Street Embayment) sampling in support of remedial actions and risk assessment.

Based on the work conducted to date, Terra Vac has concluded that the majority of the impacted area (source area) is onsite and is bounded to the east by the former UST area, to the south by B-11, and to the west by B-46 and B-52. VOC impact is documented in both the soil and groundwater in this area. This impact is caused by a mixture of VOCs. The GWI plume signature is approximately 50% tetrachloroethene (PCE), 14% trichloroethene (TCE), 18% dichloroethene (DCE), 11% BTEX (benzene, toluene, ethylbenzene and xylene) components, and 7% other VOCs (such as vinyl chloride and other chlorinated hydrocarbons).

Offsite impact is mainly confined to the groundwater. As the VOC groundwater plume travels offsite, natural attenuation of the PCE and TCE occurs to such a significant extent that the offsite VOC impact in the area of B-20 and B-34 consists of breakdown products of PCE and TCE. These breakdown products are cis-1,2 DCE and vinyl chloride.

2.3 NORTHWEST CORNER SITE HISTORY

During the annual groundwater monitoring in November 1998, elevated concentrations of PCE, as well as moderate concentrations of TCE and DCE, were detected at monitoring wells B-13 and B-22 (Figure 1), which are upgradient of the onsite source area. Further analysis of the groundwater monitoring data revealed that the plume signature at B-13 and B-22 was not consistent with the ratios seen in the GWI source area. This was a significant finding, since it indicates the existence of a secondary source in the Northwest Corner. After notifying Ecology and receiving its approval, an investigation was performed in early 1999 to evaluate the source of the elevated PCE concentrations in B-13 and B-22.

3.0 Geology and Hydrogeology

The site is located within the floodplain of the Duwamish River. Soils in the area are primarily alluvial sands and silts with discontinuous areas of recent fill. The fill soils generally appear to be of local origin, including some debris and dredge spoils from river channel improvements. Old river meander channels have been filled in areas north, south and west of the site, primarily during the period between 1914 and 1918. Below the fill are alluvial soils comprised of sand and silty sand with occasional silt interbeds.

Near-surface soils at the site are predominantly fill material, with local areas of sandy silt, sand, and gravel. Beneath the fill soils is a sequence of alluvial soils typically comprised of loose to medium dense, non-silty to slightly silty, fine to medium sand, and silty sand with thin interbeds of soft to stiff, fine sandy silt to silt.

4.0 Northwest Corner Assessment

On behalf of GWI, and with approval from the Washington State Department of Ecology, Terra Vac performed the Northwest Corner Investigation in response to elevated PCE concentrations in perimeter site investigation monitoring wells. Elevated concentrations of chlorinated solvents with different plume signatures were detected at monitoring wells B-13 and B-22 (Figure 1) during the annual site-wide groundwater sampling performed in November 1998 and were verified by subsequent re-sampling in early 1999. After verbal communications with Ecology on the scope of the Northwest Corner Investigation, the following actions were undertaken.

- Ecology files were reviewed to determine if there was any history of chemical releases or Ecology inspections of the property to the northwest of GWI.
- Four soil borings were advanced and completed as temporary monitoring wells on January 22, 1999. Samples collected during this investigation indicated the presence of chlorinated solvent impact to shallow groundwater.
- Five additional borings were advanced on February 3, 1999, and were completed as permanent groundwater monitoring wells B-53 through B-57. These wells were sampled 48 hours following installation.
- Monitoring wells B-53 through B-57 were re-sampled on April 8, 1999. Groundwater samples confirmed the presence of chlorinated solvents in shallow groundwater to the south of Shultz Distributing and across the northwest corner of GWIs property.
- The 12" sewer line running parallel to S. Willow Street between Shultz Distributing and GWI was cleaned and visually inspected on April 9, 1999.

4.1 ECOLOGY FILE REVIEW

In early 1999, Terra Vac visited the Bellevue office of the Washington State Department of Ecology to determine if there was any history of chemical releases or Ecology site visits to properties upgradient of the northwest corner of the GWI site The following items were discovered.

- Ecology performed a site visit to 6851 E. Marginal Way South on July 10, 1986. At this time, the property was occupied by Emerson Diesel. During this site visit, Ecology took a series of site photos (included as Attachment A) and noted some drums with unknown contents along the south border (Northwest border of GWI) of the property.
- Two METRO Enforcement Action were given to Emerson Diesel for discharge of Fats, Oils and Grease (FOG) in exceedance of the 100 microgram per liter permitted allowance from the discharge of the onsite oil/water separator.

4.2 DRILLING AND SOIL SAMPLING - TEMPORARY MONITORING WELLS

On January 22, 1999, four temporary monitoring wells (TB-1 to TB-4) were installed along the northern property boundary of GWI and within the S. Willow Street right-of-way. These wells were completed by Cascade Drilling, Inc. using a CME-75 drill rig and 6-inch O.D. hollow stem auger. Augers were steam-cleaned prior to arrival on site, between each boring, and at the conclusion of drilling activities. A Terra Vac field geologist was present to provide oversight during drilling activities and to record subsurface lithology and collect both soil and groundwater samples.

Each of the four temporary wells was constructed to allow for preliminary subsurface lithologic characterization, measurement of groundwater elevations, and groundwater sampling. Temporary well locations are presented in Figure 2.

Each of the four temporary wells was installed to 14.0 feet bgs. Soil samples for subsurface lithologic characterization were collected from boring TB-2 from the interval between 12 to 15.5 feet bgs and from boring TB-3 at 13 feet bgs to confirm the presence and depth of the silt layer. Samples were collected using 1-3/8-inch I.D. by 18-inch split spoon samplers. Samplers were decontaminated between sampling events to minimize cross contamination. Each soil sample was visually inspected, logged for soil type, and preserved for laboratory analysis. Groundwater was encountered in each of the borings at between 6.5 and 7.5 feet bgs.

Drill cuttings, decontamination water, and monitoring well development water were containerized in 55-gallon DOT approved drums and stored on-site pending the results of laboratory analyses.

4.3 GROUNDWATER MONITORING WELL CONSTRUCTION - TEMPORARY MONITORING WELLS

Each of the temporary groundwater monitoring wells was constructed of 2-inch PVC well casing and of 0.01-inch slot screen. The screened interval was surrounded by a 2/12 sand filter pack which extended approximately 1 foot above and below the screen interval while the remainder of the annular space around each well casing was sealed with bentonite chips. Following well development and sample collection, each temporary casing was withdrawn, and the borehole was back-filled with bentonite chips to within 1 foot of grade elevation. Four to six inches of concrete was then added to cap the boring, and the hole was then leveled to grade with native fill material. Well construction details, including construction dates, well diameters, total depths, and screened intervals are pictured on the drilling logs contained in Attachment B.

4.4 GROUNDWATER SAMPLING - TEMPORARY MONITORING WELLS

Upon completion, each temporary monitoring well was developed by pumping until groundwater turbidity had declined or was no longer produced. Groundwater samples were then collected from the discharge stream of the down-well pump used for development. Once collected, samples were immediately sealed, properly labeled, and placed into a pre-cooled ice chest. At the conclusion of groundwater sampling, samples were delivered under proper temperature and chain-of-custody control to On-Site Environmental Inc.

The down-well pump was cleaned and decontaminated between each development and groundwater sampling event and new sample tubing was used at each temporary well to prevent cross contamination.

4.5 DRILLING AND SOIL SAMPLING - PERMANENT MONITORING WELLS

On February 3, 1999, five permanent monitoring wells were installed along the northern property boundary of GWI and within the S. Willow Street right-of-way. These wells were completed by Cascade Drilling, Inc. using a CME-75 limited access drill rig and 6-inch O.D. hollow stem auger. Augers were steam-cleaned prior to arrival on site, between each boring, and at the conclusion of drilling activities. A Terra Vac field geologist was present to provide oversight during drilling activities and to record subsurface lithology and collect both soil and groundwater samples. Permanent well locations are presented in Figure 3.

Soil lithology beneath the northwest corner of the GWI site (extending north into S. Willow Street) consists of silty gravel fill extending to three feet below ground surface (bgs). Below the fill layer, dark gray to gray-brown silty sands were encountered to an average of five feet bgs. Below this silty sand, fine to medium grained clean sands are present to approximately thirteen to fifteen feet bgs, where a layer of very fine grained, dark gray stiff, wet silt is encountered. This silt layer appears to be continuous across the northern portion of the site. Figures 4 and 5 are a cross section of the soil lithology in the northwest corner of the GWIsite.

Each of the five permanent wells was installed between 13.5 and 15.0 feet bgs. Soil samples were collected at the groundwater interface (between 8 and 10 feet bgs) and from the upper 6-12 inches of the silt layer encountered at approximately 15 feet bgs. Samples were collected from each boring using 1-3/8-inch I.D. by 18-inch split spoon samplers. Samplers were decontaminated between sampling events to minimize cross contamination. Each soil sample was visually inspected, logged for soil type, and preserved for laboratory analyses.

Two or more soil samples from each boring were collected for laboratory analyses. Analytical samples were chosen to provide a representation of chlorinated solvent concentrations at the vadose zone/groundwater interface and from the upper surface of the silt layer. Additional samples were collected based on the observations of the field geologist and the presence of staining or odor.

An analytical sample was prepared from each soil sample by completely filling pre-cleaned glass sampling jars, which were immediately sealed, properly labeled, and placed into a pre-cooled ice chest. At the conclusion of all drilling activities, selected soil samples were delivered, under proper temperature and chain-of-custody control, to On-Site Environmental Inc.

Drill cuttings, decontamination water, and monitoring well development water were containerized in 55-gallon DOT approved drums and stored on-site pending the results of laboratory analyses.

4.6 GROUNDWATER MONITORING WELL CONSTRUCTION - PERMANENT MONITORING WELLS

Each of the permanent groundwater monitoring wells was constructed of 2-inch PVC well casing and of 0.01-inch slot screen. The screened interval was surrounded by a 2/12 sand filter pack which extended approximately 1 foot above and below the screen interval while the remainder of the annular space around each well casing was sealed with bentonite chips. Well construction details, including construction dates, diameters, total depths, and screened intervals are provided in Table 1 and pictured on the drilling logs contained in Attachment C.

4.7 GROUNDWATER SAMPLING - PERMANENT MONITORING WELLS

Upon completion, each permanent monitoring well was developed using a surge block followed by over-pumping using a hand lift pump until turbid water was no longer produced. Each well was allowed to equilibrate for 48 hours prior to sampling on February 5, 1999.

Prior to sampling, each well was sounded for depth to groundwater using an electronic interface probe. Once sounded, a minimum of three well volumes were withdrawn from each wellusing a low-flow peristaltic pump prior to sample collection. Water quality, as measured by temperature, pH, and conductivity, was recorded for each well volume recovered.

The elevation at the top of each newly installed Northwest Corner monitoring well casing was surveyed to the top of the well casings of existing wells B-13, B-22, B-23 and B-28. Depth to groundwater was measured in the above listed existing wells and the newly installed Northwest Corner monitoring wells on February 5, 1999, and groundwater elevation data is presented in Table 2. The average depth to water in the Northwest Corner is similar to the depth across the site, approximately 10 feet bgs. Based upon groundwater elevation data collected on February 5, 1999 and again on April 8, 1999, the inferred direction of groundwater flow at the site is south-southwest.

Analytical samples were collected by filling sample vials from the discharge stream of the low-flow pump. Once collected, samples were immediately sealed, properly labeled, and placed into a pre-cooled ice chest. At the conclusion of groundwater sampling, samples were delivered under proper temperature and chain-of-custody control to On-Site Environmental Inc. A duplicate sample was collected from well B-56 on February 5, 1999 as a quality assurance measure.

On April 8, 1999, Terra Vac re-sampled wells B-13, B-53, B-54, B-55, B-56 and B-57 to confirm the concentrations detected in samples collected on February 5th. Well purging and sample collection was performed in a manner identical to that previously described.

5.0 Analytical Results

5.1 LABORATORY ANALYSES

Soil and groundwater samples from each monitoring well were analyzed for Volatile Organic Compounds (VOCs) per U.S. EPA Method 8260B. In addition, groundwater samples collected on February 5th from the five permanent monitoring wells were analyzed for Semi-Volatile Organic Compounds per U.S. EPA Method 8270C.

5.2 ANALYTICAL RESULTS - SOIL

Analytical results for soil samples are presented in Table 3. A complete analytical laboratory report, including chain-of-custody documents and QA/QC results, is contained in Attachment D.

A summary of the soil analytical results follows.

- Tetrachloroethene (PCE) was detected in all ten samples collected and ranged from 0.066 mg/kg to 18.0 mg/kg.
- Trichloroethene (TCE) was detected in both of the samples collected from well B-54, and ranged from 0.13 mg/kg to 3.0 mg/kg.

Field observations and field instrumentation used during the installation of all the Northwest Corner wells did not note any soil impact in surface soils (from ground surface to less than 6 feet bgs). All soil impacts were confined to depths of greater than 6 feet bgs. If a release in the parking lot or along the railroad tracks was the cause of the secondary source, the surface and near surface (less than 6 feet bgs) soil samples would have the highest VOC concentrations. The highest concentrations of COCs were detected in the soil/groundwater interface at a depth of 8 to 9 feet bgs in well B-56.

5.3 ANALYTICAL RESULTS - GROUNDWATER

Analytical results for groundwater are presented in Table 4 and Table 5. A complete analytical laboratory report, including chain-of-custody documents and QA/QC results, is presented in Attachment E.

The following is a summary of the groundwater analytical results from the temporary wells:

- PCE was detected in groundwater samples from each of the temporary wells (TB-1, to TB-4) at concentrations ranging from 2100 to 4300 µg/l.
- TCE was detected in groundwater samples from each of the temporary wells (TB-1, to TB-4) at concentrations ranging from 36 to 130 µg/l.
- The cis isomer of 1,2 dichloroethene (cis 1,2-DCE) was detected in groundwater samples collected from each of the temporary wells TB-1 to TB-4 at concentrations ranging from 28 to 60 µg/l.

- 1,1,1 trichloroethane (1,1,1-TCA) was detected in groundwater collected from temporary wells TB-3 and TB-4 at concentrations of 13 and 16 µg/l respectively.
- No other volatile compounds (including BTEX) were detected in groundwater from the temporary wells sampled.

The following is a summary of the groundwater analytical results from the permanent wells:

- PCE was detected in groundwater samples collected from wells B-13, B-22, B-28 and wells B-53 through B-57 at concentrations ranging from 63 to 4300 µg/l.
- TCE was detected in groundwater samples collected from wells B-13, B-22, B-28 and wells B-53 through B-57 at concentrations ranging from 1.0 to 250 µg/l.
- Cis 1,2-DCE was detected in groundwater samples collected from wells B-13, B-22, B-53, B-55, B-56 and B-57 at concentrations ranging from <1.0 to 320 µg/l.
- 1,1 dichloroethane (1,1-DCA) was detected in groundwater samples collected from wells B-56 and B-57 at concentrations of 10.0 and 5.8 µg/l respectively.
- 1,1,1 TCA was detected in groundwater collected from well B-57 at a concentration of 8.4 µg/l.
- No other volatile compounds (including BTEX) were detected in groundwater from the permanent wells sampled.

5.4 GROUNDWATER MONITORING WELLS – VOC SIGNATURE

Groundwater collected from the recently installed temporary and permanent monitoring wells, as well as groundwater collected from previously installed monitoring wells B-13 and B-22, displays a signature of VOCs that is approximately 95% PCE and 5% total TCE and DCE. In theGWI source area, the signature of the VOCs is as follows: 50% PCE, 14% TCE, 18% DCE, 11% BTEX and 7% other VOCs. These plume signatures are different based on the fact that the Northwest Corner groundwater contains no BTEX or other VOCs and has a greater percentage of PCE than the GWI source area groundwater. In addition, with the small percentage of TCE and the absence of other PCE breakdown products (DCE and VC) in the Northwest Corner groundwater, this plume appears to be the result of a more recent release than the GWI source area release. This strongly indicates that the PCE, TCE and DCE seen in the Northwest Corner emanate from a different source than the VOCs in the GWI source area.

6.0 Sewer Inspection

On April 9, 1999, Terra Vac supervised the cleaning and video inspection of the 12" sanitary side sewer running east-west along S. Willow Street parallel to the southern fence line of Shultz Distributing. This action was conducted at the request of the Department of Ecology after the results of the temporary and permanent wells were communicated. With this investigation, Terra Vac was to determine the condition of this side sewer, and to determine whether the side sewer might be transporting chlorinated solvents from the elevated drum storage pad at GWI to a discharge point in the vicinity of the Northwest Corner.

6.1 SEWER INSPECTION PROCEDURE

Prior to inspection by video camera, the line section between GWI and Shultz Distributing was flushed with high pressure water and vacuumed to remove any debris which might interfere with visual inspection. Following cleaning, a video camera was pulled through the clean section of sewer pipe from a manhole at the intersection of S. Willow Street and Fox Avenue S. to allow Terra Vac to determine the condition of the pipe and inspect for leaks or cracks.

6.2 SEWER INSPECTION FINDINGS

The inspection revealed that the sewer line was recently installed (less then five years ago). It is comprised of eight-foot sections of concrete and is in excellent condition. Invert elevations indicate that this line drains to the west where it joins the line running along Fox Avenue S. At the time of inspection, groundwater elevation was greater than 1.5 feet above the invert elevation of this line. If a break or crack in the line had been present, material would not be expected to escape from the line due to the greater hydrostatic pressure in the surrounding backfill.

7.0 Conclusions

As a result of the Northwest Corner investigation, Terra Vac has concluded that the PCE detected in the Northwest Corner is due to a secondary source.

Groundwater samples of wells B-13 and B-22, as well as groundwater samples from the recently installed temporary and permanent wells in the Northwest Corner, indicate that PCE is the predominant chemical constituent (95%) impacting the Northwest Corner. This constituent, together with a small percentage of TCE and DCE, forms a plume signature that is much different than the GWI source area signature which contains 50% PCE, 14% TCE, 18% DCE, 11% BTEX and 7% other VOCs. The distinct signature in the Northwest Corner is indicative of a secondary release which occurred after the GWI source area release.

Surface or sewer line releases from the GWI property are not the cause of the secondary source. Since the highest VOC concentration was found in soil samples that are deeper than the near surface soil samples, it is evident that the source is not a surface release. Finally, as the sewer line was determined to be in excellent condition and free of leaks, the source of the Northwest Corner VOC impact appears to be from an upgradient source.

Based upon groundwater elevation data collected on February 5, 1999 and again on April 8, 1999, the inferred direction of groundwater flow at the Northwest Corner, and the site as a whole, is south-southwest. This groundwater flow direction, as well as the lack of appreciable soil impact, indicates a possible source area located to the north of the investigation area; however, further investigation is required to substantiate this theory.

8.0 Limitations

Field activities were performed in a manner consistent with the level of skill and care standard for local environmental professionals. Findings and conclusions presented in this report have been prepared based upon the specific site conditions at the time of field activities and no warranty, expressed or implied, is made.

9.0 References

Hart Crowser. 1990a. *Underground Storage Tank Removal and Initial Site Assessment Volume I*. Prepared for Great Western Chemical Company. December 10.

Hart Crowser. 1990b. *Underground Storage Tank Removal and Initial Site Assessment Volume II*. Prepared for Great Western Chemical Company. November 7.

Hart Crowser. 1991. *RI/FS Work Plan*. Prepared for Great Western Chemical Company. December 1.

Northwest Corner Investigation

Tables

AGENCY REVIEW DRAFT

Table 1

Groundwater Monitoring Well Construction Data

Well Identification	Date Installed	Total Depth (Feet bgs)	Screen Interval Top (Feet bgs)	Screen Interval Bottom (Feet bgs)	Well Diameter (inches)
B-13	10/9/90	13	8	13	2
B-22	3/27/92	11	6	11	2
B-28	3/30/92	14	9	14	2
B-53	2/3/99	15	10	15	2
B-54	2/3/99	14.5	9.5	14.5	2
B-55	2/3/99	14.5	9.5	14.5	2
B-56	2/3/99	14.5	9.5	14.5	2
B-57	2/3/99	15	10	15	2

Note:

bgs Below ground surface.

Table 2

Groundwater Elevation Data

Well I.D.	Top of Casing Elevation (feet-MSL)	Date Sounded	Depth to Water (feet-bgs)	Water Level Elevation (feet-MSL)	Difference from Previous Measurement (feet)
B-13	6.76	2/5/99	8.54	-1.78	**
		4/8/99	8.98	-2.22	-0.44
B-22	6.18	2/5/99	8.06	-1.88	**
B-28	7.04	2/5/99	8.32	-1.28	**
B-53	6.67	2/5/99	8.30	-1.63	**
		4/8/99	8.50	-1.83	-0.20
B-54	7.64	2/5/99	9.35	-1.71	**
		4/8/99	9.62	-1.98	-0.27
B-55	6.10	2/5/99	7.86	-1.76	**
		4/8/99	8.12	-2.02	-0.26
B-56	7.02	2/5/99	8.87	-1.85	**
		4/8/99	9.13	-2.11	-0.26
B-57	6.27	2/5/99	8.17	-1.90	**
		4/8/99	8.46	-2.19	-0.29

Notes:
Depth to water measurements made from top of casing.
Elevations based on a April 1999 Terra Vac Survey using a benchmark of 6.76 feet MSL elevation taken at B-13.

**	Not calculated; previous measurements not available.
--	Not Applicable; no separate phase product detected in well.
bgs	Below ground surface.
MSL	Mean Sea Level.

Table 3

Subsurface Soil Analytical Results

Sample ID	Sample Depth (Feet bgs)	Date Sampled	Parameters (mg/Kg)							
			PCE	TCE	cis 1,2-DCE	VC	Naphthalene	Phenanthrene	Pyrene	Pentachlorophenol
B-53	8.5	2/3/99	0.97	ND	ND	ND	ND	ND	ND	ND
B-54	9.0	2/3/99	0.07	3.00	ND	ND	ND	ND	ND	ND
B-54	14.0	2/3/99	1.00	0.13	ND	ND	ND	ND	ND	ND
B-55	10.0	2/3/99	1.30	ND	ND	ND	ND	ND	ND	ND
B-56	6.0	2/3/99	5.20	ND	ND	ND	ND	ND	ND	ND
B-56	8.5	2/3/99	18.00	ND	ND	ND	ND	ND	ND	ND
B-56	11.0	2/3/99	0.58	ND	ND	ND	ND	ND	ND	ND
B-56	14.0	2/3/99	1.40	ND	ND	ND	ND	ND	ND	ND
B-57	8.5	2/3/99	0.46	ND	ND	ND	ND	ND	ND	ND
B-57	14.5	2/3/99	0.07	ND	ND	ND	ND	ND	ND	ND
Reporting Limits			0.1	0.1	0.07	0.07	0.04	0.04	0.04	0.41
MTCA Method A Cleanup Level			0.5	0.5	NA	NA	NA	NA	NA	NA

Notes:

MTCA Washington State Model Toxics Control Act Method A cleanup criteria for industrial soil (mg/Kg).

Reporting Limits are the lowest analytical detection level (mg/Kg).

Total Xylenes are the total of meta, ortho and para Xylene.

cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
mg/Kg	Milligrams per kilogram.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.

Table 4

Temporary Groundwater Monitoring Well Analytical Results

Well	Sampling Date	Parameters, ug/L												
		PCE	TCE	1,1,1-TCA	cis 1,2-DCE	VC	Benzene	Toluene	Ethylbenzene	Total Xylenes	Naphthalene	Phenanthrene	Pyrene	Pentachlorophenol
TB-1	1/22/99	4300	130	ND	54	ND	NA	NA	NA	NA	NA	NA	NA	NA
TB-2	1/22/99	2700	74	ND	60	ND	NA	NA	NA	NA	NA	NA	NA	NA
TB-3	1/22/99	2100	52	13	41	ND	NA	NA	NA	NA	NA	NA	NA	NA
TB-4	1/22/99	2400	36	16	28	ND	NA	NA	NA	NA	NA	NA	NA	NA
Method Detection Limit		**10.0**	**1.0**	**1.0**	**1**	**1.0**	**1.000**	**1.000**	**1.00**	**2.00**	**1.00**	**1.00**	**1.00**	**10.00**
MTCA Method A Cleanup		**5.0**	**5.0**	**200.0**	**NA**	**0.2**	**5.0**	**40.0**	**30.0**	**20.0**	**NA**	**NA**	**NA**	**NA**

Notes:

MTCA Washington State Model Toxics Control Act Method A cleanup criteria for industrial soil (mg/Kg).

Reporting Limits are the lowest analytical detection level (mg/Kg).

Total Xylenes are the total of meta, ortho and para Xylene.

1,1,1-TCA	1,1,1 - Triochloroethane
cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
mg/Kg	Milligrams per kilogram.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.

Table 5

Permanent Groundwater Monitoring Well Analytical Results

Well	Sampling Date	Parameters, ug/L												
		PCE	TCE	1,1,1-TCA	cis 1,2-DCE	VC	Benzene	Toluene	Ethylbenzene	Total Xylenes	Naphthalene	Phenanthrene	Pyrene	Pentachlorophenol
B-13	12/17/98	3,660	214	3.37	72.6	ND	ND	ND	ND	ND	ND	NA	NA	NA
	2/5/99	4,300	180	ND	74	ND	ND	ND	ND	ND	ND	NA	NA	NA
	4/8/99	4,600	220	ND	100	ND	NA	NA	NA	NA	NA	NA	NA	NA
B-22	12/17/98	1,850	226	1.55	403	17.4	ND	ND	ND	ND	ND	NA	NA	NA
	2/5/99	1,900	250	ND	320	44.0	ND	ND	ND	ND	ND	NA	NA	NA
B-28	2/5/99	63	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
B-53	2/5/99	1200	36	ND	20	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4/8/99	930	37	ND	19	ND	NA	NA	NA	NA	NA	NA	NA	NA
B-54	2/5/99	3400	93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4/8/99	4100	170	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
B-55	2/5/99	1100	35	ND	18	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4/8/99	780	32	ND	22	ND	NA	NA	NA	NA	NA	NA	NA	NA
B-56	2/5/99	1,700	30	ND	23	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4/8/99	1,600	49	ND	226	ND	NA	NA	NA	NA	NA	NA	NA	NA
B-57	2/5/99	350	10	8.4	12	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4/8/99	400	19	ND	20	ND	NA	NA	NA	NA	NA	NA	NA	NA
Method Detection Limit		10.0	1.0	1.0	1	1.0	1.000	1.000	1.00	2.00	1.00	1.00	1.00	10.00
MTCA Method A Cleanup Level		5.0	5.0	200.0	NA	0.2	5.0	40.0	30.0	20.0	NA	NA	NA	NA

Notes:

MTCA Washington State Model Toxics Control Act Method A cleanup criteria for industrial soil (mg/Kg).

Reporting Limits are the lowest analytical detection level (mg/Kg).

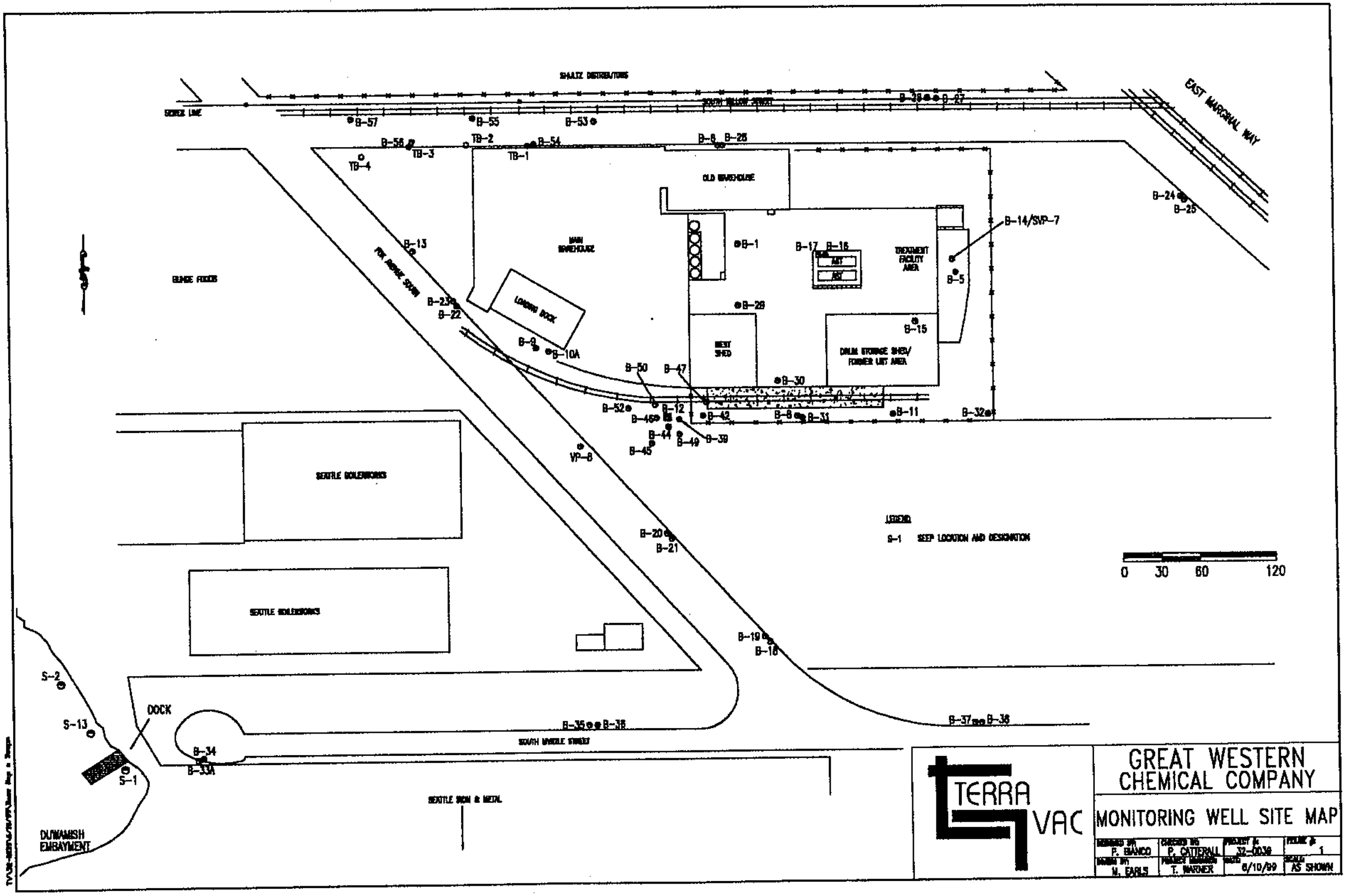
Total Xylenes are the total of meta, ortho and para Xylene.

1,1,1-TCA	1,1,1 - Triochloroethane
cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
mg/Kg	Milligrams per kilogram.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.

Northwest Corner Investigation

Figures

AGENCY REVIEW DRAFT

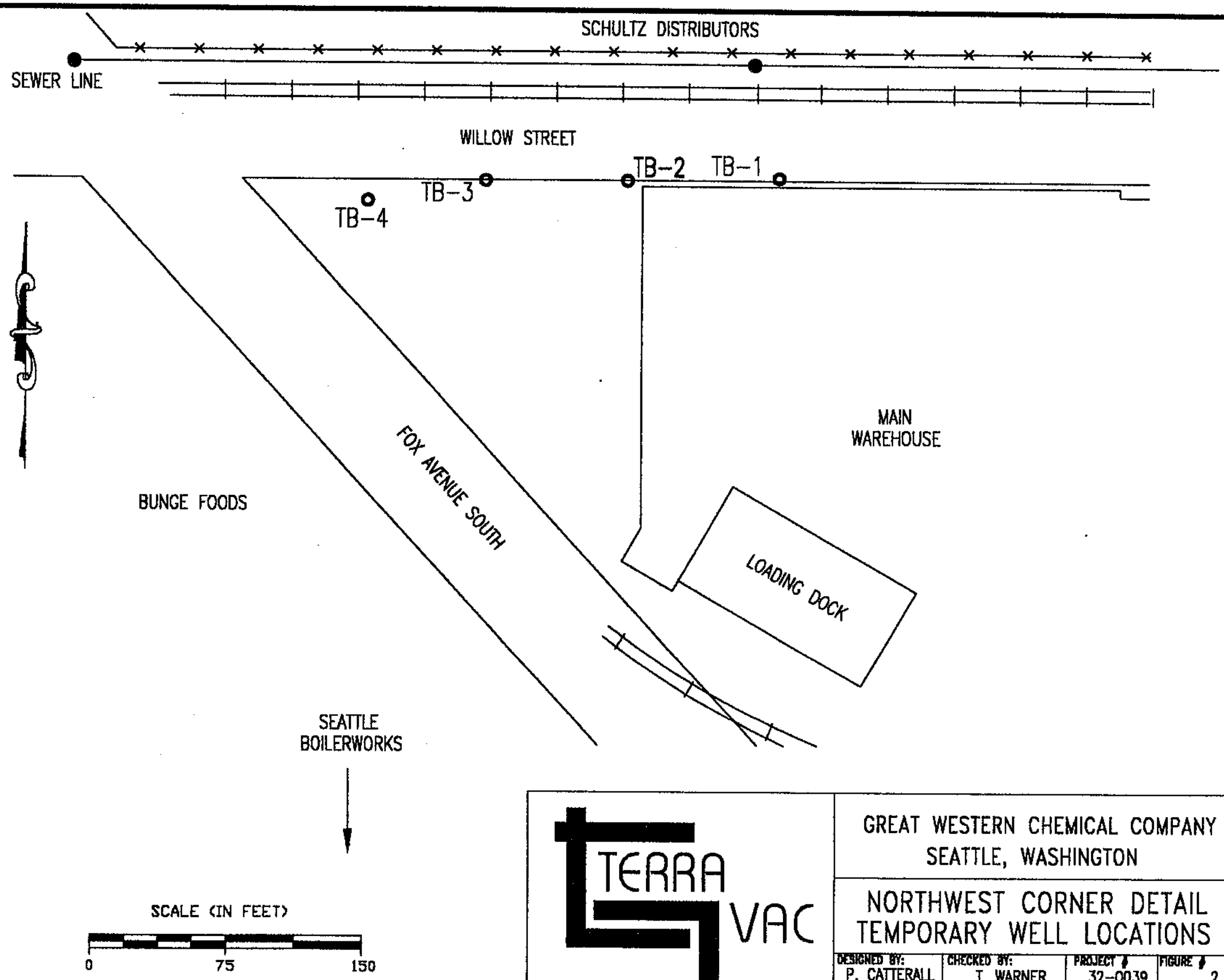


TERRA VAC

GREAT WESTERN
CHEMICAL COMPANY

MONITORING WELL SITE MAP

DESIGNED BY	CHECKED BY	PROJECT #	FIGURE #
P. BIANCO	P. CATTERALL	32-0039	1
DRAWN BY	PROJECT MANAGER	DATE	SCALE
M. EARLS	T. WARNER	6/10/99	AS SHOWN



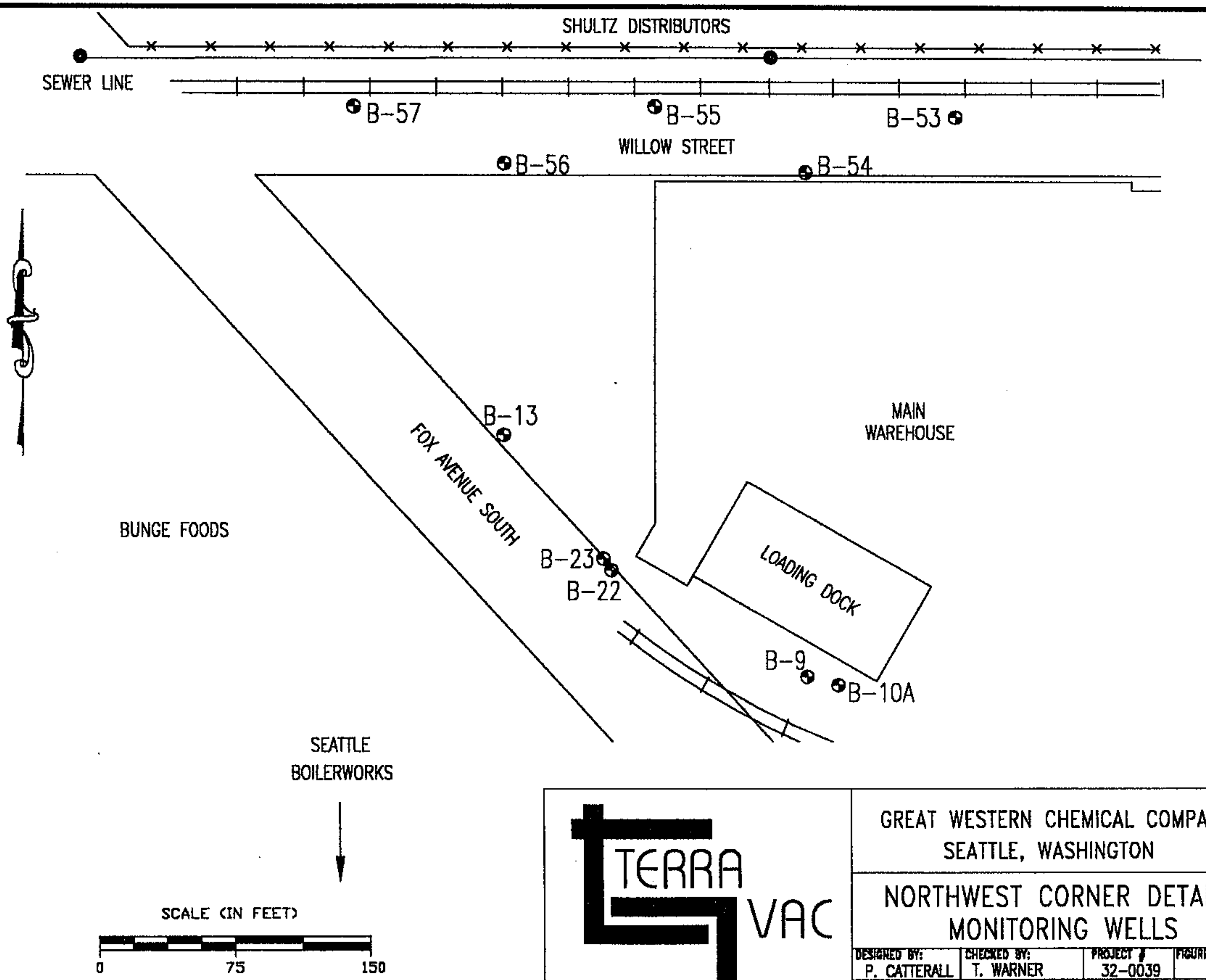
TERRA VAC

GREAT WESTERN CHEMICAL COMPANY
SEATTLE, WASHINGTON

NORTHWEST CORNER DETAIL TEMPORARY WELL LOCATIONS

DESIGNED BY: P. CATTERALL	CHECKED BY: T. WARNER	PROJECT #: 32-0039	FIGURE #: 2
DRAWN BY: M. EARLS	PROJECT MANAGER: T. WARNER	DATE: 4/27/99	SCALE: AS SHOWN

TV-SEA\PROJECT #\FILE NAME.DWG



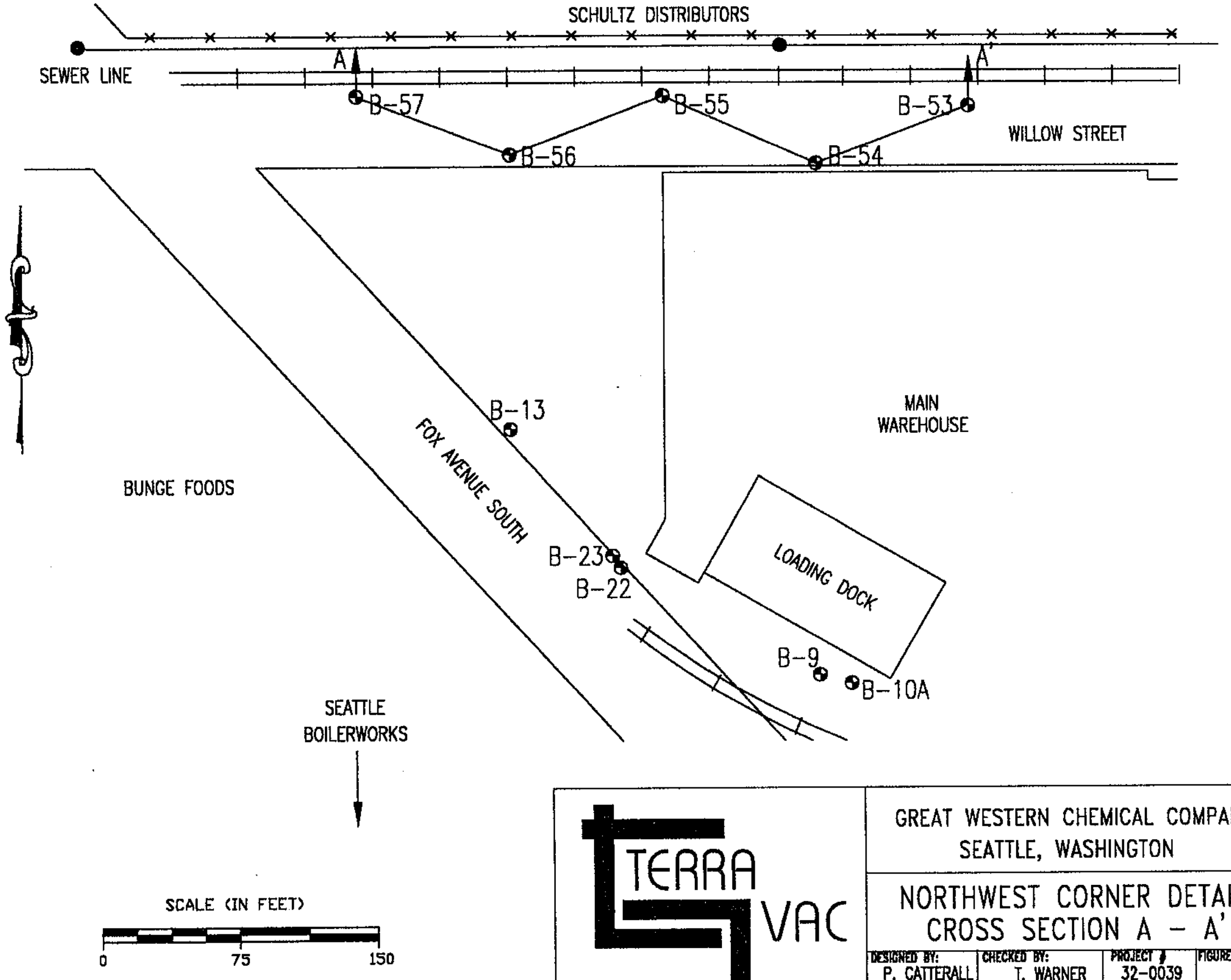
TERRA VAC

GREAT WESTERN CHEMICAL COMPANY
SEATTLE, WASHINGTON

NORTHWEST CORNER DETAIL
MONITORING WELLS

DESIGNED BY: P. CATTERALL	CHECKED BY: T. WARNER	PROJECT # 32-0039	FIGURE # 3
DRAWN BY: M. EARLS	PROJECT MANAGER: T. WARNER	DATE: 4/27/99	SCALE: AS SHOWN

TV-SEA\PROJECT #\FILE NAME.DWG



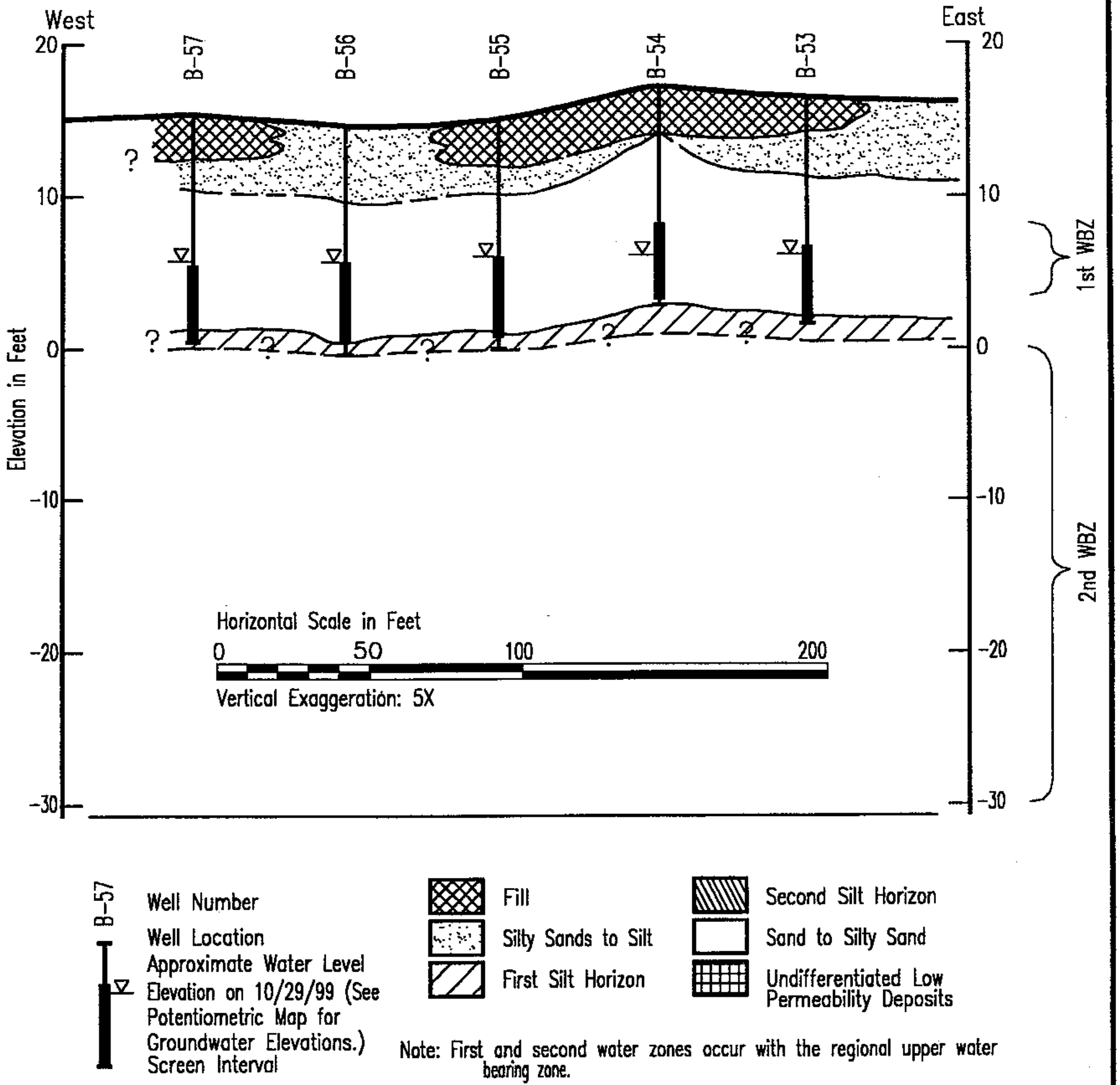
TERRA VAC

GREAT WESTERN CHEMICAL COMPANY
SEATTLE, WASHINGTON

NORTHWEST CORNER DETAIL
CROSS SECTION A - A'

DESIGNED BY: P. CATTERALL	CHECKED BY: T. WARNER	PROJECT # 32-0039	FIGURE # 4
DRAWN BY: M. EARLS	PROJECT MANAGER: T. WARNER	DATE: 4/27/99	SCALE: AS SHOWN

TV-SEA\PROJECT #\FILE NAME.DWG



Note: First and second water zones occur with the regional upper water bearing zone.

TERRA VAC

GREAT WESTERN CHEMICAL COMPANY
SEATTLE, WASHINGTON

NORTHWEST CORNER DETAIL SUBSURFACE CROSS SECTION

DESIGNED BY: J. MALOT	CHECKED BY: J. MALOT	PROJECT #: 32-0039	FIGURE #: FIGURE 5
DRAWN BY: M. EARLS	PROJECT MANAGER: J. MALOT	DATE: 8/3/00	SCALE: AS SHOWN

TV\32-0039\8/3/00\NWSUBCROSS

Northwest Corner Investigation

Attachment A

Ecology Site Photos

AGENCY REVIEW DRAFT

DEPARTMENT OF ECOLOGY
INSPECTION REPORT

TO:Files, Dan Cargill
DATE OF VISIT: 7/10/86
NEW INDUSTRY:

INSPECTOR: R. Koch & L. Dorigan
PERMIT NO: WA-000000-0
PERMIT EXPIRES:

TYPE OF INSPECTION

PERMIT APPLICATION	___	COMPLAINT	___
PERMIT RENEWAL	___	ENFORCEMENT	___
PERMIT COMPLIANCE	___	DROP IN	xxx

FACILITY: Emerson GM Diesel, Inc.
ADDRESS: 6851 E. Marginal Way S.
CITY: Seattle ZIP 98108 COUNTY: King Ph. NO. 764-3883

PERSON CONTACTED: Gary Beard shop foreman, Leigh Burdick General Service manager and Paul Berg controller
TYPE OF FACILITY: Truck maintenance and parts warehouse
RECEIVING WATER: METRO sewer
TYPE OF TREATMENT SYSTEM: none

OPERATION Satis____Fair_xx_ Unsatis___

Does comply with permit conditions: NA

DESCRIPTION: The facility performs diesel engine maintence, warehousing of parts and has a training center for mechanics.

The first building, east to west, houses offices and the main repair facility at the west end of the building. Collection troughs are located inside the doors and drain to the oil/water seperator (picture taken) outside the east doors to the shop. There is also a catch basin outside the east shop doors.

Shop floors are cleaned with Zep soap. The residue is then washed into METRO drains.

Outside the west shop doors is a catch basin for the parking area. The south area slopes to the catch basins. North of the catch basin the area is relatively flat.

Along the west outside wall of the shop are underground tanks (picture taken) for recycling water for the dynameter and for diesel fuel (picture taken). The water tanks are not used.

Waste oil is stored along the south edge of the paved area and next to a concrete block wall. There is no berm nor a roof. There is evidence of spillage (picture taken) to the gravel bordering the pavement.

The second building (L shaped) is for the training center and parts warehouseing.

The area south of the second building borders an unused railroad siding. This area is a catch all for equipment and 15 to 18 barrels (picture taken) of unknown contents. The barrels are in two groups. One at the east end and the second about 100 feet from the west fence.

The final building is for electrical work on generators and similar equipment. There is a short railroad siding between this final building and the L shaped building which is below the level of the pavement and has a sump. The sump has a flanged pumped out connection. The loading dock from the electrical work area to the rail siding is stained by oil. It appears to be an old stain.

Manifest for waste oil disposal was provided.

FOLLOW UP:
1. Inspect in Aug. for barrels & containment
2.

Richard A. Koch

Richard A. Koch
District Engineer
Environmental Quality

PHOTO No. ________

DATE: 7-10-86

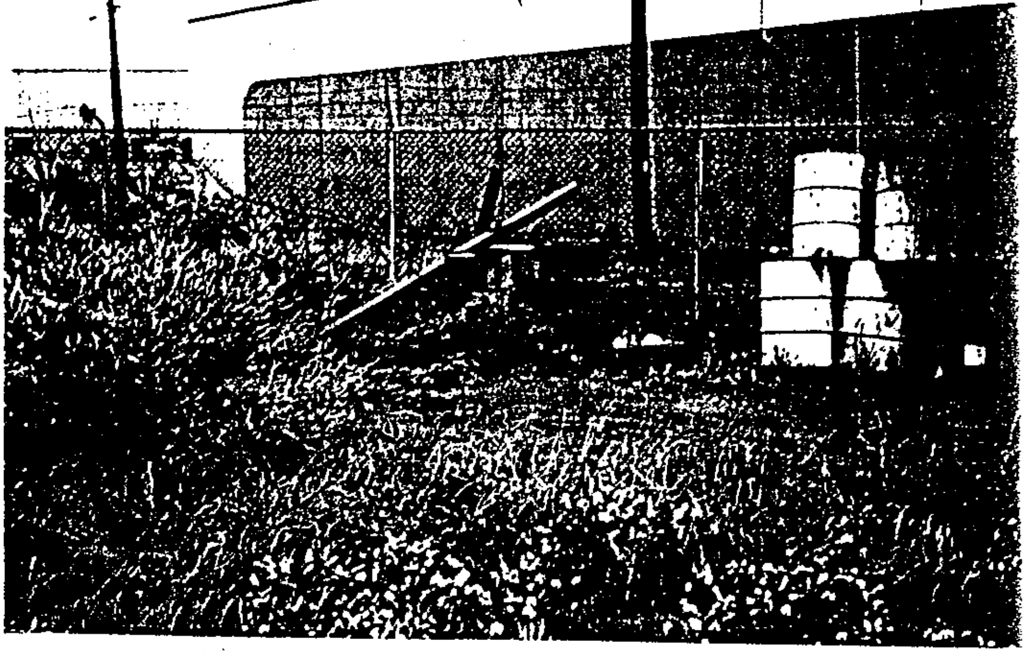
TIME: A.M.

TAKEN BY:
RICHARD KOCH

WITNESS:
LEE DORICAU

FILM: KODAK
CM 400 5079

CAMERA:
CANON SURESHOT



DESCRIPTION:

Barrells are
at Westend
of Emerson Diesel property along south ⅊

COMMENTS:
Barrel contents are unknown

PHOTO No. ________

DATE: 7-10-86

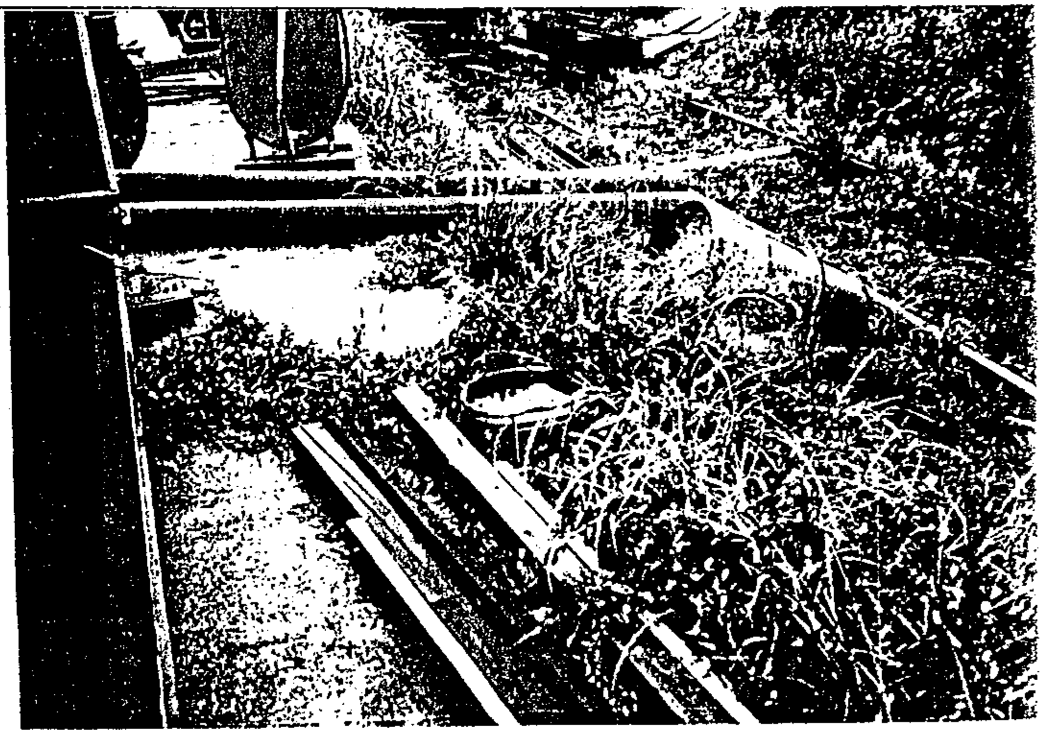
TIME: A M

TAKEN BY:
RICHARD KOCH

WITNESS:
LEE DORICAU

FILM: KODAK
CM 400 5079

CAMERA:
CANON SURESHOT



DESCRIPTION:

Emerson Diesel
RR. along south
prop. line. ~100 to 150' from west end

COMMENTS: Barrel contents unknown.

Emerson Diesel

PHOTO No.

DATE: 7-10-86

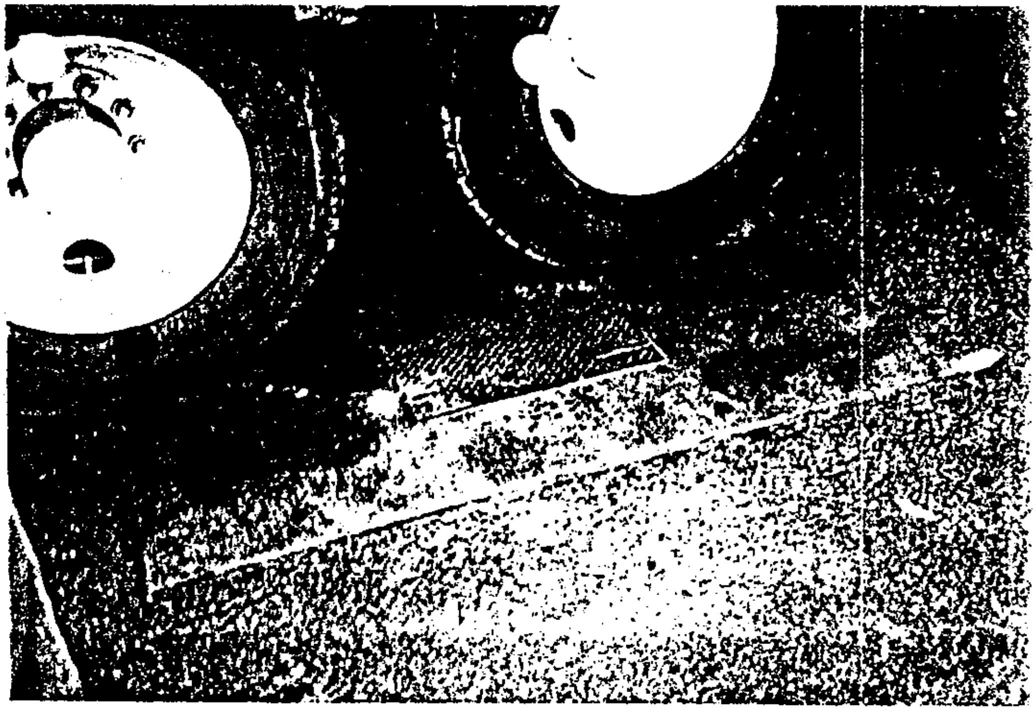
TIME: A.M.

TAKEN BY:
Richard Koch

WITNESS:
Lee Dorical

FILM: Kodak
CM 400 5079

CAMERA:
Canon Sureshot



DESCRIPTION:
Oil water
Seperator
connects to METRO. Located at east entrance to
COMMENTS: Truck shop.

PHOTO No.

DATE: 7-10-86

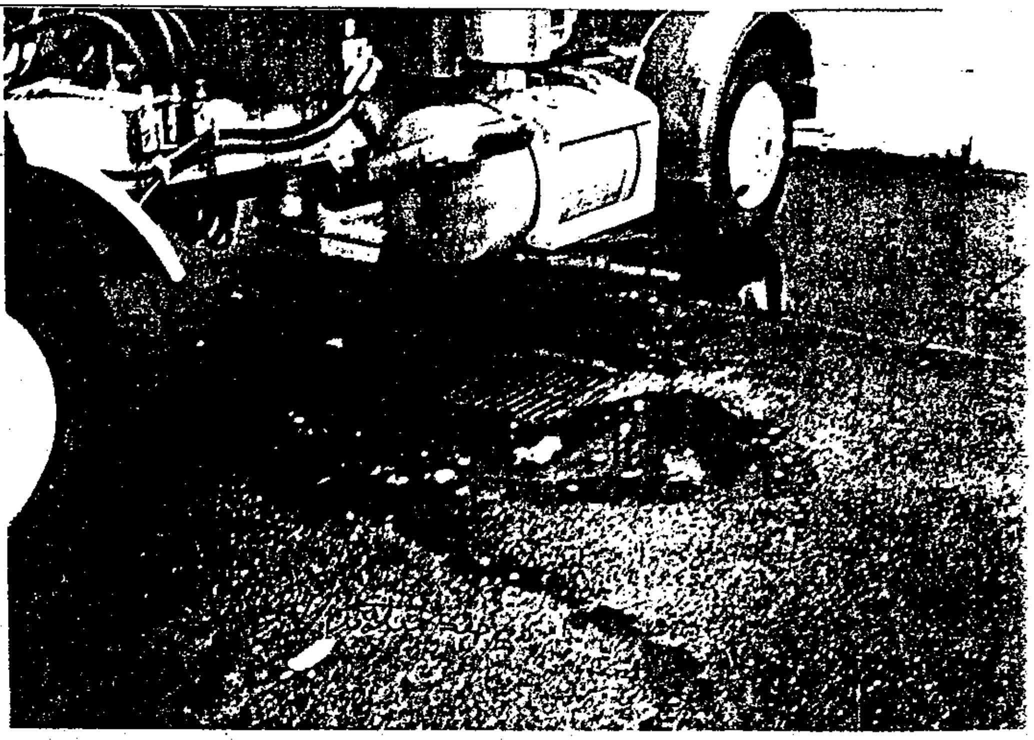
TIME: A.M.

TAKEN BY:
Richard Koch

WITNESS:
Lee Dorical

FILM: Kodak
CM 400 5079

CAMERA:
Canon Sureshot



DESCRIPTION:
Catch basin
outside east door of
truck maint shop. connects to oil water separator
COMMENTS: Catchments through inside doors connect to
Oil/water Separator

Emerson
Diesel

PHOTO No. ________

DATE: 7-10-86

TIME: A.M.

TAKEN BY:
Richard Koch

WITNESS:
Lee Dorigan

FILM: Kodak
CM 400 5079

CAMERA:
Canon Sureshot

DESCRIPTION:

Parking area
between truck
shop and training center

COMMENTS: catch basin connects to oil water Separator

PHOTO No. ________

DATE: 7-10-86

TIME: A M

TAKEN BY:
Richard Koch

WITNESS:
Lee Dorigan

FILM: Kodak
CM 400 5079

CAMERA:
Canon Sureshot

DESCRIPTION:

Parking area
between truck
shop and training center

COMMENTS: good drainage from South / north of drain relatively flat

Emerson Diesel

PHOTO No. ________

DATE: 7-10-86

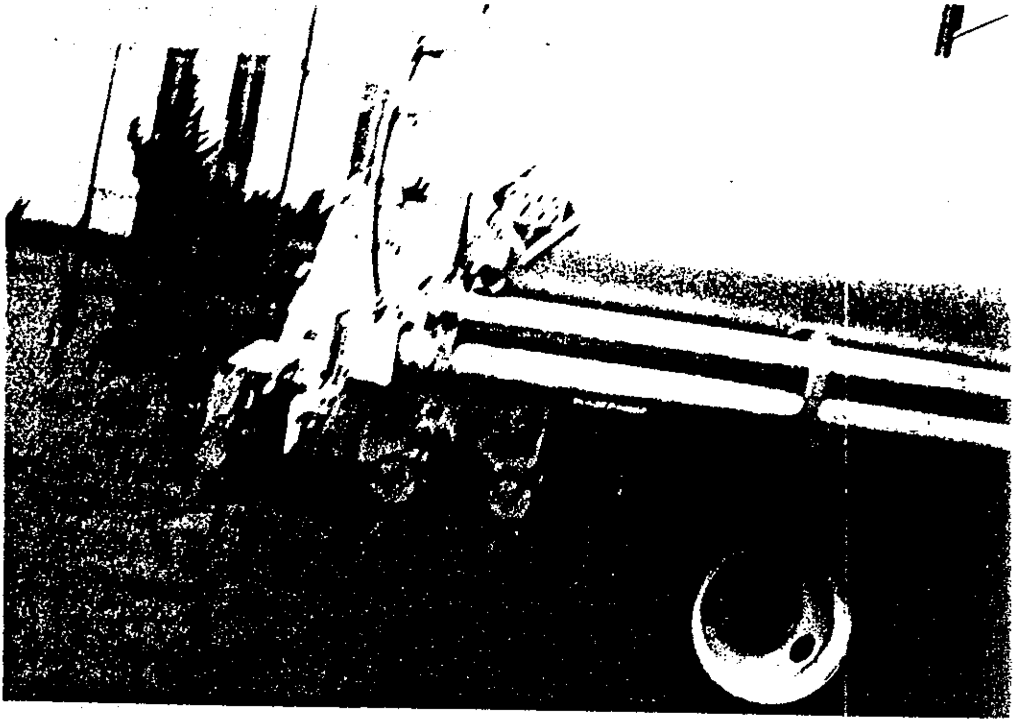
TIME: A.M.

TAKEN BY:
RICHARD KOCH

WITNESS:
LEE DORIGAN

FILM: KODAK
CM 400 5079

CAMERA:
CANON SURESHOT



DESCRIPTION:
Parking area between truck maint. shop and training center/warehouse.

COMMENTS:

Emerson Diesel

PHOTO No. ________

DATE: 7-10-86

TIME: A.M.

TAKEN BY:
RICHARD KOCH

WITNESS:
LEE DORIGAN

FILM: KODAK
CM 400 5079

CAMERA:
CANON SURESHOT

DESCRIPTION:
Storage area S.W. Corner of Truck Maint Shop.

COMMENTS: Waste Oil Storage / used to have wood roof

erson
Dread

PHOTO No. ________

DATE: 7-10-86

TIME: A.M.

TAKEN BY:
Richard Koch

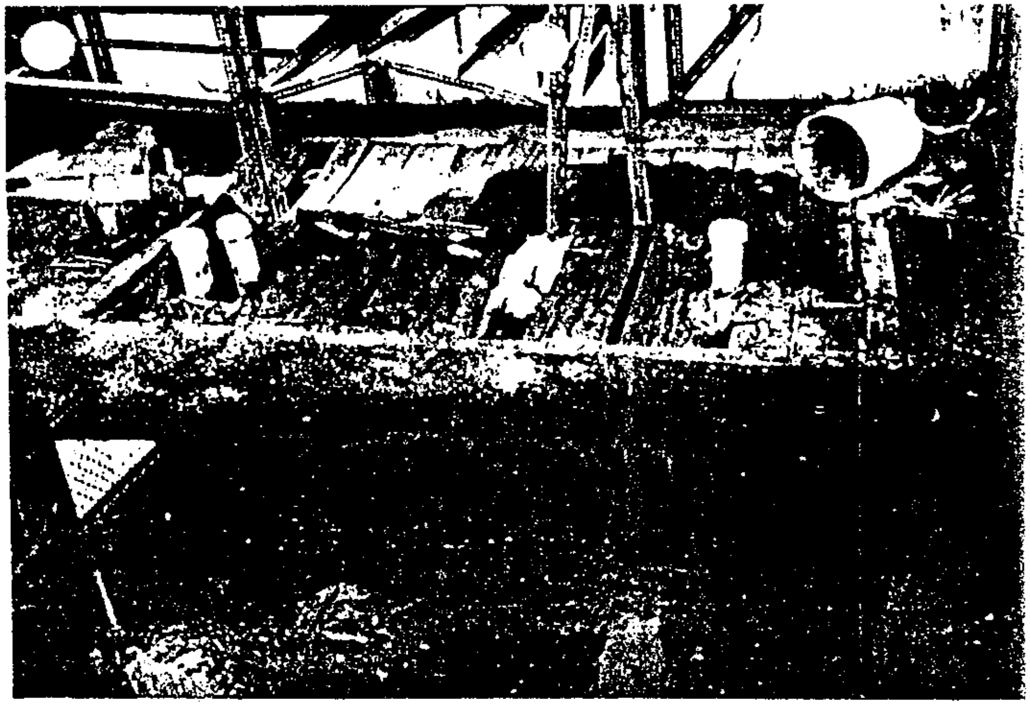
WITNESS:
Lee Doriceau

FILM: Kodak
CM 400 5079

CAMERA:
Canon Sureshot

DESCRIPTION:

South Side of
Truck Maintenance
Shop



COMMENTS: Unused water recycling tanks for ~~hydra~~dynameter test equipment

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PHOTO No. ________

DATE: 7-10-86

TIME: A.M.

TAKEN BY:
Richard Koch

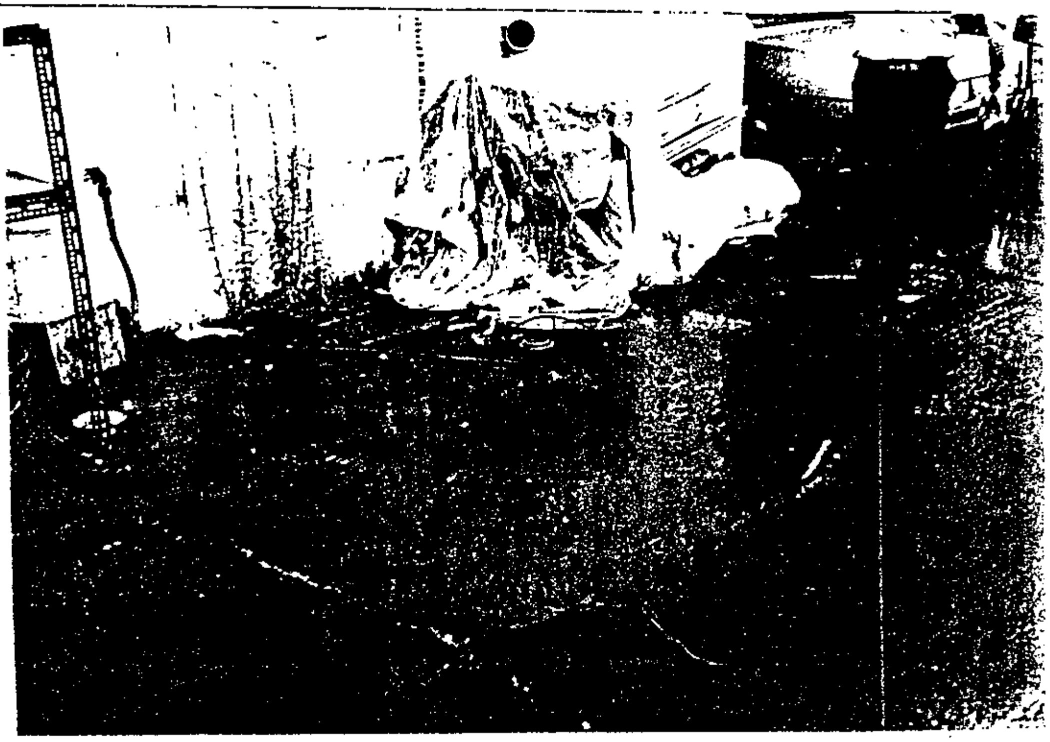
WITNESS:
Lee Doriceau

FILM: Kodak
CM 400 5079

CAMERA:
Canon Sureshot

DESCRIPTION:

South Side of
Truck maint.
Shop



COMMENTS: Underground Tank for diesel fuel.

Northwest Corner Investigation

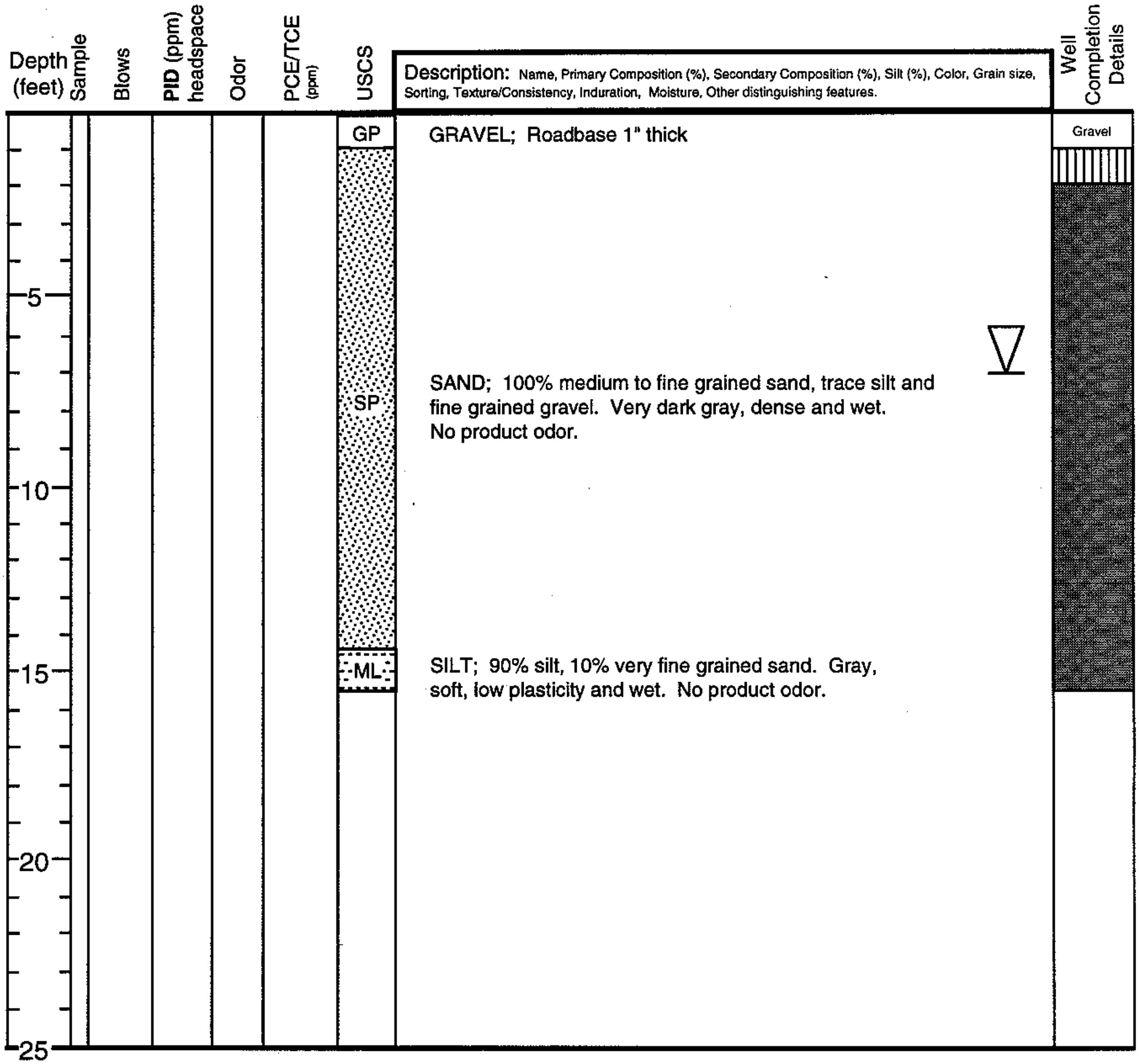
Attachment B

Wells Logs and Construction Details - Temporary Monitoring Wells

AGENCY REVIEW DRAFT

TERRA VAC

Date Drilled: 1/22/99 **Boring/Well Number:** TB-1 Page 1 of 1
Project: Great Western Chemical Company Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, WA
Drilling Contractor: Cascade Log by: Jim Orr
Drill Rig: CME-75 Auger Size/Type: 6" Hollow Stem Sample Method: Grab
Total Depth: 15.5 Depth to Groundwater: 7' ATOB Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A Filter Material/Size: N/A
Well A: Casing/Screen Diameter: NA. Slot Size: NA Seal: N/A Screened Interval: NA



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

GRAVEL; Roadbase 1" thick

SAND; 100% medium to fine grained sand, trace silt and fine grained gravel. Very dark gray, dense and wet. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor.

General Remarks:

- Blow counts are recorded for NA inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 1/22/99 **Boring/Well Number:** TB-2 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, WA

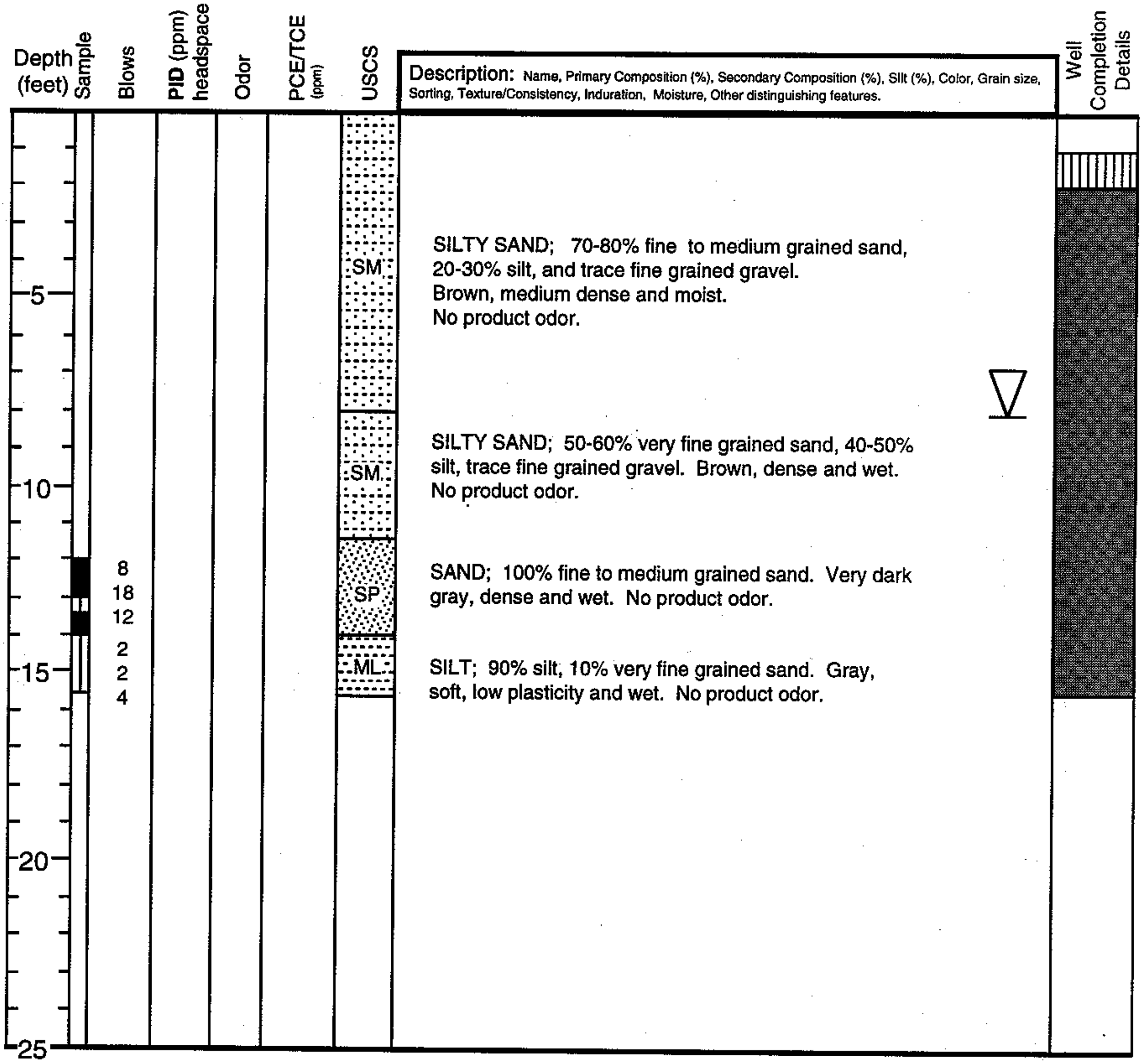
Drilling Contractor: Cascade Log by: Jim Orr

Drill Rig: CME-75 Auger Size/Type: 6" Hollow Stem Sample Method: Split Spoon

Total Depth: 15.5 Depth to Groundwater: 8' ATOB Backfill or Grout Material: Bentonite

Well Casing/Screen Material: N/A Filter Material/Size: N/A

Well A: Casing/Screen Diameter: NA. Slot Size: NA Seal: N/A Screened Interval: NA



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY SAND; 70-80% fine to medium grained sand, 20-30% silt, and trace fine grained gravel. Brown, medium dense and moist. No product odor.

SILTY SAND; 50-60% very fine grained sand, 40-50% silt, trace fine grained gravel. Brown, dense and wet. No product odor.

SAND; 100% fine to medium grained sand. Very dark gray, dense and wet. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor.

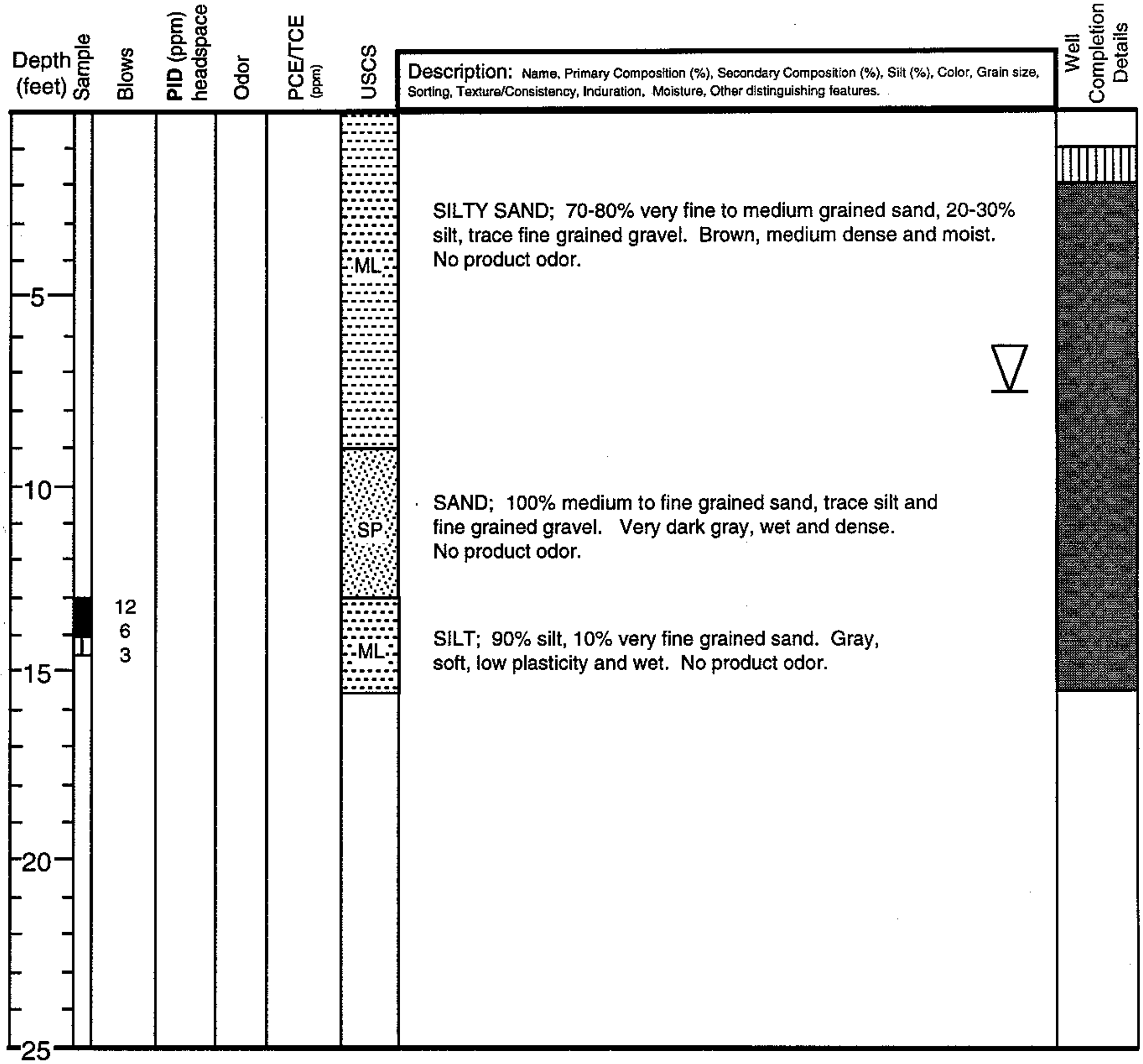
General Remarks:

- Blow counts are recorded for NA inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 1/22/99
Boring/Well Number: TB-3
Page 1 of 1
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, WA
Drilling Contractor: Cascade
Log by: Jim Orr
Drill Rig: CME-75
Auger Size/Type: 6" Hollow Stem
Sample Method: Split Spoon
Total Depth: 15.5
Depth to Groundwater: 7.5' ATOB
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: N/A
Filter Material/Size: N/A
Well A: Casing/Screen Diameter: NA.
Slot Size: NA
Seal: N/A
Screened Interval: NA



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY SAND; 70-80% very fine to medium grained sand, 20-30% silt, trace fine grained gravel. Brown, medium dense and moist. No product odor.

SAND; 100% medium to fine grained sand, trace silt and fine grained gravel. Very dark gray, wet and dense. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor.

General Remarks:

- Blow counts are recorded for NA inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 1/22/99 **Boring/Well Number:** TB-4 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, WA

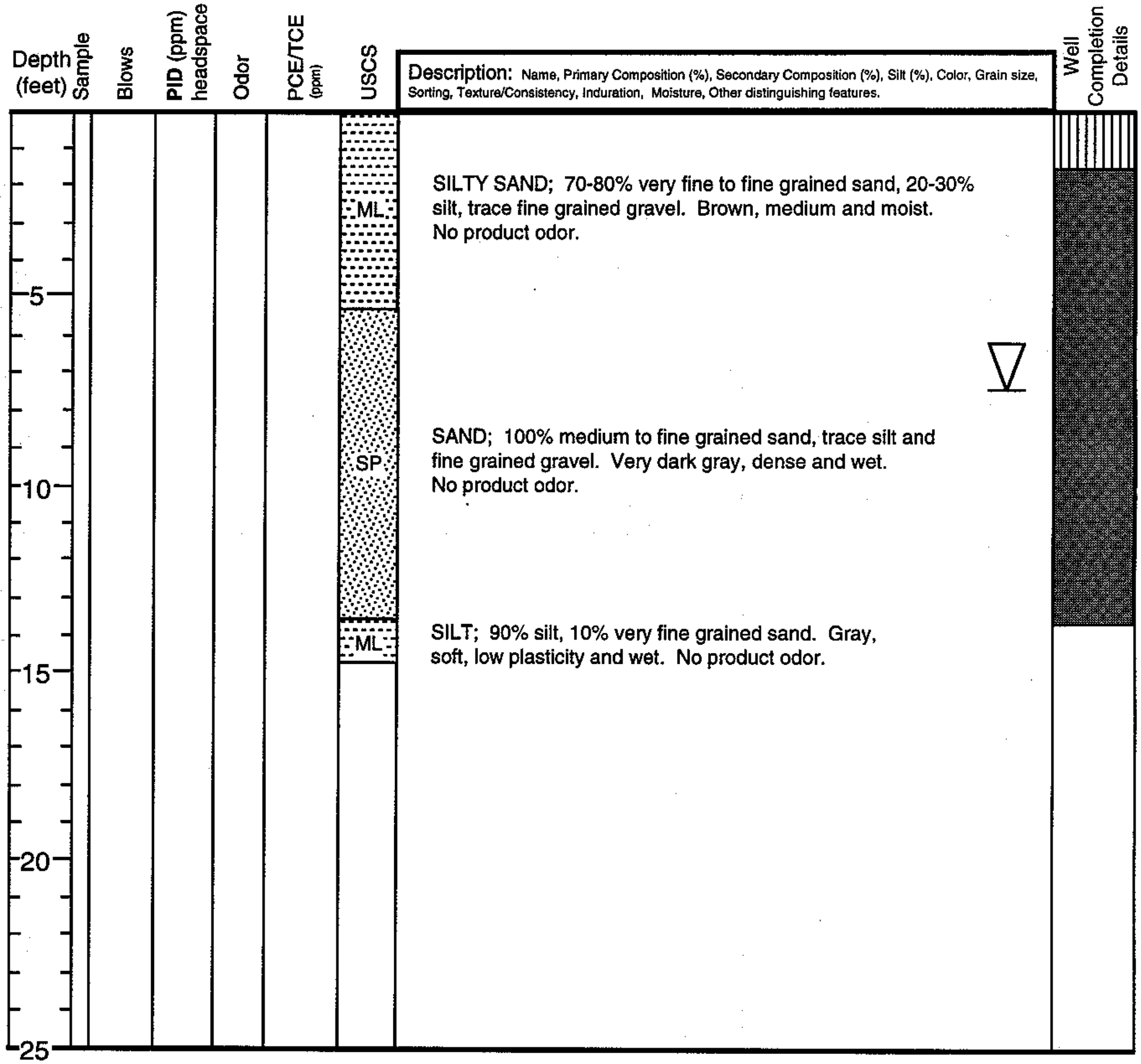
Drilling Contractor: Cascade Log by: Jim Orr

Drill Rig: CME-75 Auger Size/Type: 6" Hollow Stem Sample Method: Split Spoon

Total Depth: 13.5 Depth to Groundwater: 7.5' ATOB Backfill or Grout Material: Bentonite

Well Casing/Screen Material: N/A Filter Material/Size: N/A

Well A: Casing/Screen Diameter: NA Slot Size: NA Seal: N/A Screened Interval: NA



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY SAND; 70-80% very fine to fine grained sand, 20-30% silt, trace fine grained gravel. Brown, medium and moist. No product odor.

▽

SAND; 100% medium to fine grained sand, trace silt and fine grained gravel. Very dark gray, dense and wet. No product odor.

SILT; 90% silt, 10% very fine grained sand. Gray, soft, low plasticity and wet. No product odor.

General Remarks:

- Blow counts are recorded for NA inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits.
- NA = Not Analyzed.

This summary applies only at the location of this boring, and at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Northwest Corner Investigation

Attachment C

Well Logs and Construction Details - Permanent Monitoring Wells

AGENCY REVIEW DRAFT

TERRA VAC

Date Drilled: 2/3/99 **Boring/Well Number:** B-53 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

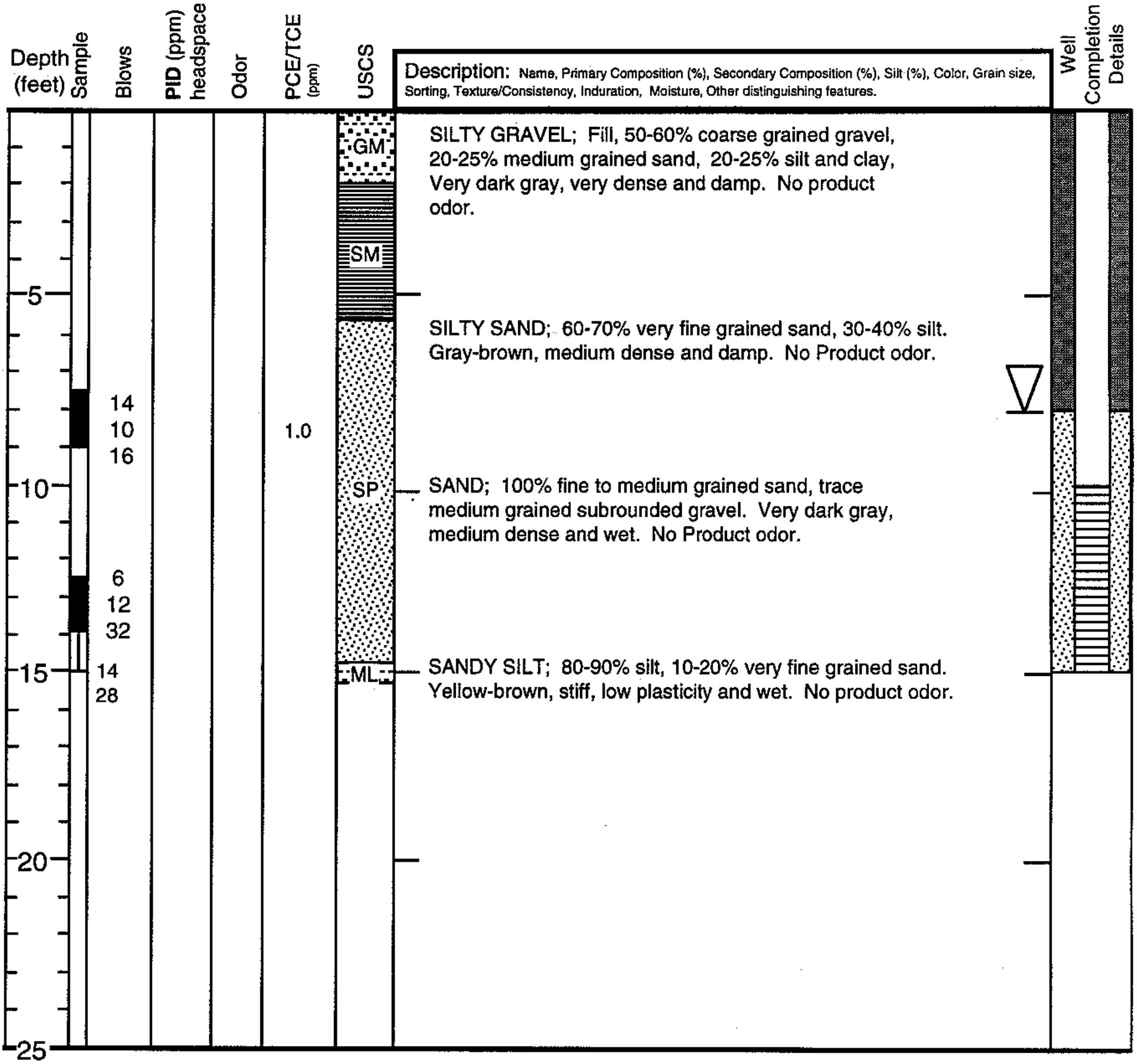
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon

Total Depth: 15 feet Depth to Groundwater: 8 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-8 feet Screened Interval: 5-15 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 50-60% coarse grained gravel, 20-25% medium grained sand, 20-25% silt and clay, Very dark gray, very dense and damp. No product odor.

SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Gray-brown, medium dense and damp. No Product odor.

SAND; 100% fine to medium grained sand, trace medium grained subrounded gravel. Very dark gray, medium dense and wet. No Product odor.

SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Yellow-brown, stiff, low plasticity and wet. No product odor.

General Remarks:

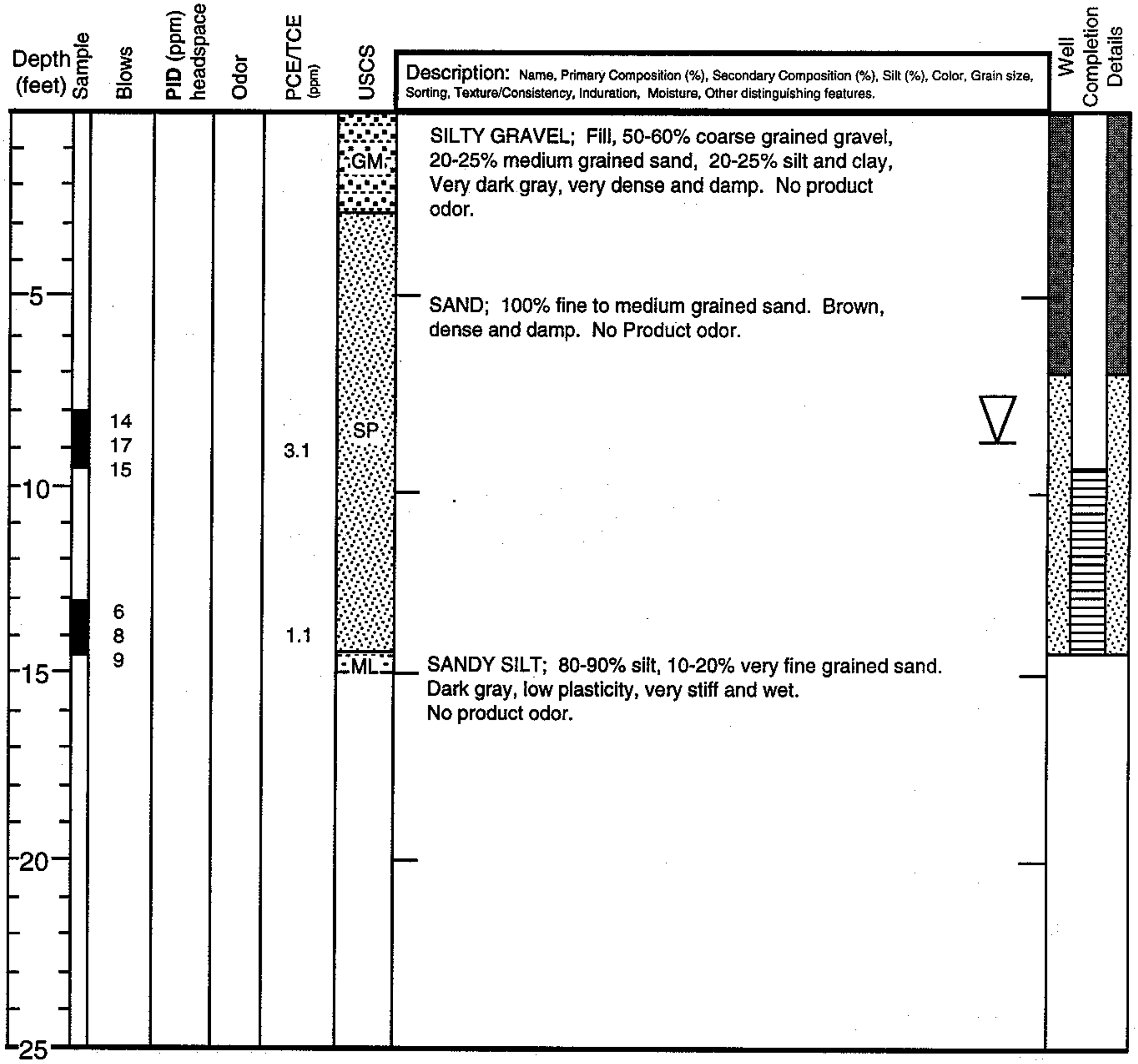
- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Limited Access

Date Drilled: 2/3/99
Boring/Well Number: B-54
Page 1 of 1
Project: Great Western Chemical Company
Project Number: 32-0039
Address: 6900 Fox Avenue South, Seattle, Washington
Drilling Contractor: Cascade Drilling, Inc.
Log by: J. Orr
Drill Rig: CME-75
Auger Size/Type: 6" HSA
Sample Method: Split Spoon
Total Depth: 14.5 feet
Depth to Groundwater: 9 feet
Backfill or Grout Material: Bentonite
Well Casing/Screen Material: Sch. 40 PVC
Filter Material/Size: Lonestar Sand: 10/12
Well A: Casing/Screen Diameter: 2 in.
Slot Size: 0.01"
Seal: 0-7 feet
Screened Interval: 9-14 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SILTY GRAVEL; Fill, 50-60% coarse grained gravel, 20-25% medium grained sand, 20-25% silt and clay, Very dark gray, very dense and damp. No product odor.

SAND; 100% fine to medium grained sand. Brown, dense and damp. No Product odor.

SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Limited Access

Date Drilled: 2/3/99 **Boring/Well Number:** B-55 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

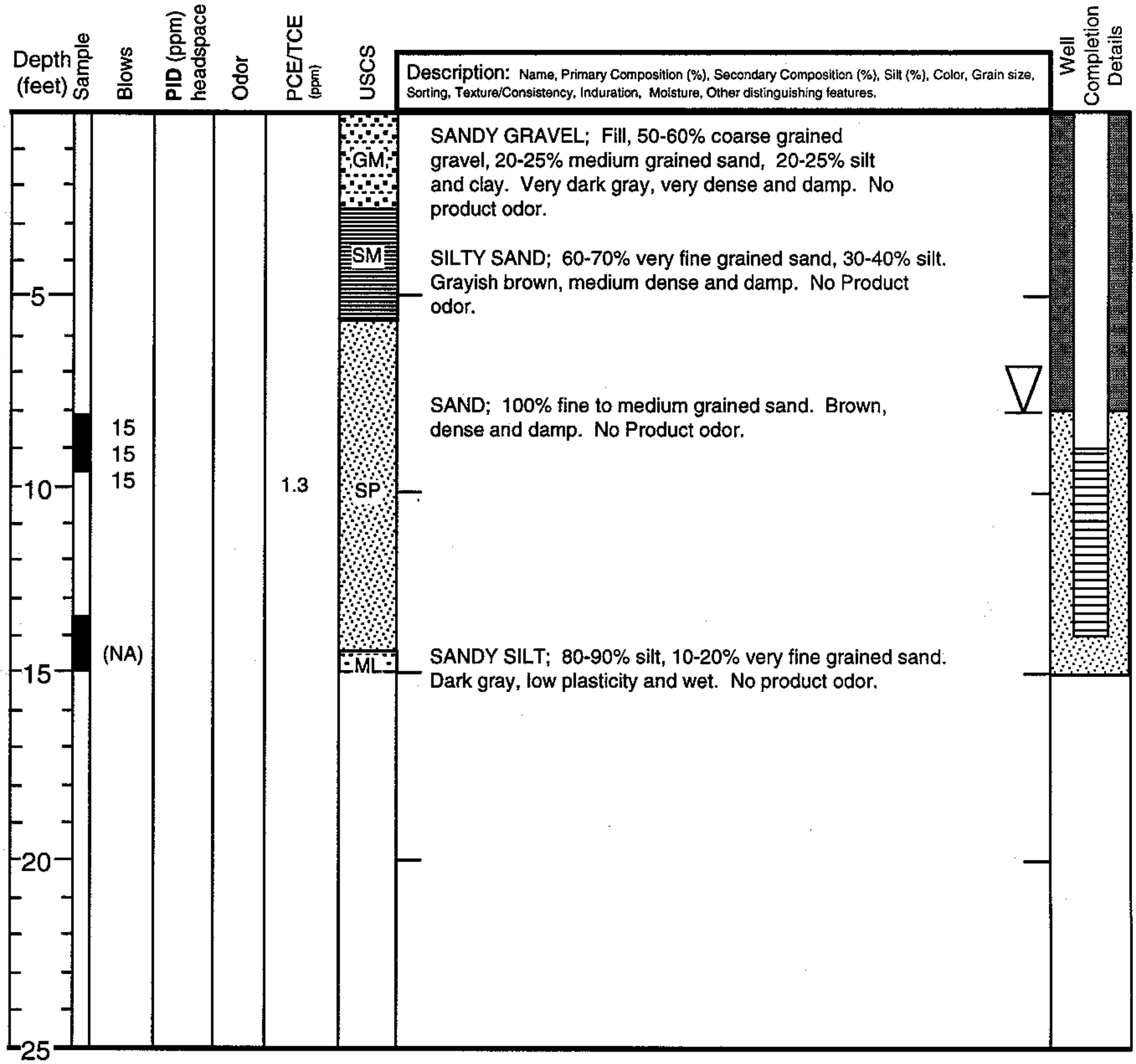
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon

Total Depth: 15 feet Depth to Groundwater: 8 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-7 feet Screened Interval: 9-14 feet



Depth (feet)	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.
					GM	SANDY GRAVEL; Fill, 50-60% coarse grained gravel, 20-25% medium grained sand, 20-25% silt and clay. Very dark gray, very dense and damp. No product odor.
5					SM	SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Grayish brown, medium dense and damp. No Product odor.
10	15 15 15			1.3	SP	SAND; 100% fine to medium grained sand. Brown, dense and damp. No Product odor.
15	(NA)				ML	SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

TERRA VAC

Limited Access

Date Drilled: 2/3/99 **Boring/Well Number:** B-56 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

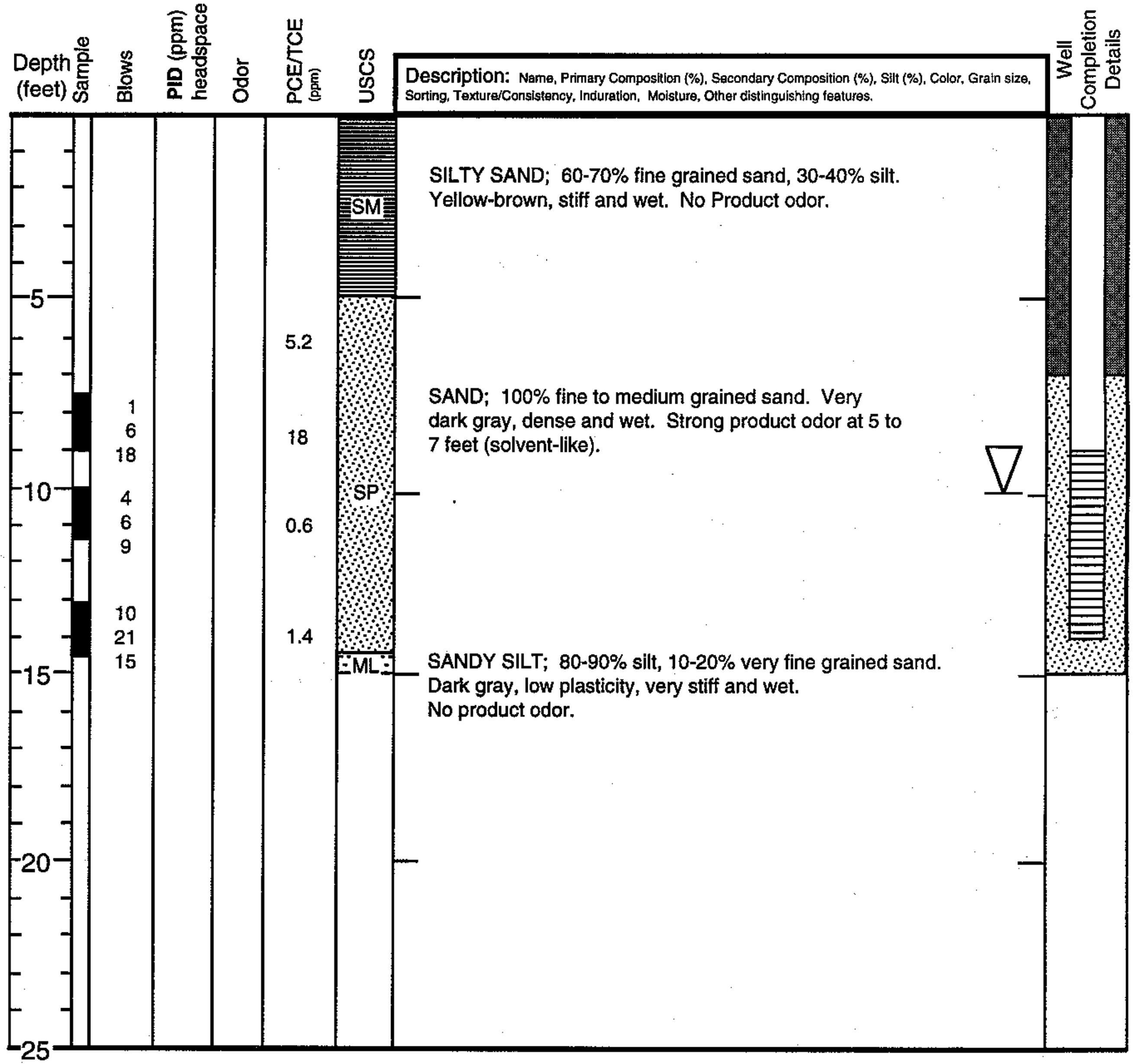
Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon

Total Depth: 15 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-7 feet Screened Interval: 9-14 feet



Depth (feet)	Sample	Blows	PID (ppm) headspace	Odor	PCE/TCE (ppm)	USCS	Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.	Well Completion Details
0-5						SM	SILTY SAND; 60-70% fine grained sand, 30-40% silt. Yellow-brown, stiff and wet. No Product odor.	
5-14.5					5.2	SP	SAND; 100% fine to medium grained sand. Very dark gray, dense and wet. Strong product odor at 5 to 7 feet (solvent-like).	
	■	1 6 18			18			
10	■	4 6 9			0.6			
	■	10 21 15			1.4			
14.5-15						ML	SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.	

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

TERRA VAC

Date Drilled: 2/3/99 **Boring/Well Number:** B-57 Page 1 of 1

Project: Great Western Chemical Company Project Number: 32-0039

Address: 6900 Fox Avenue South, Seattle, Washington

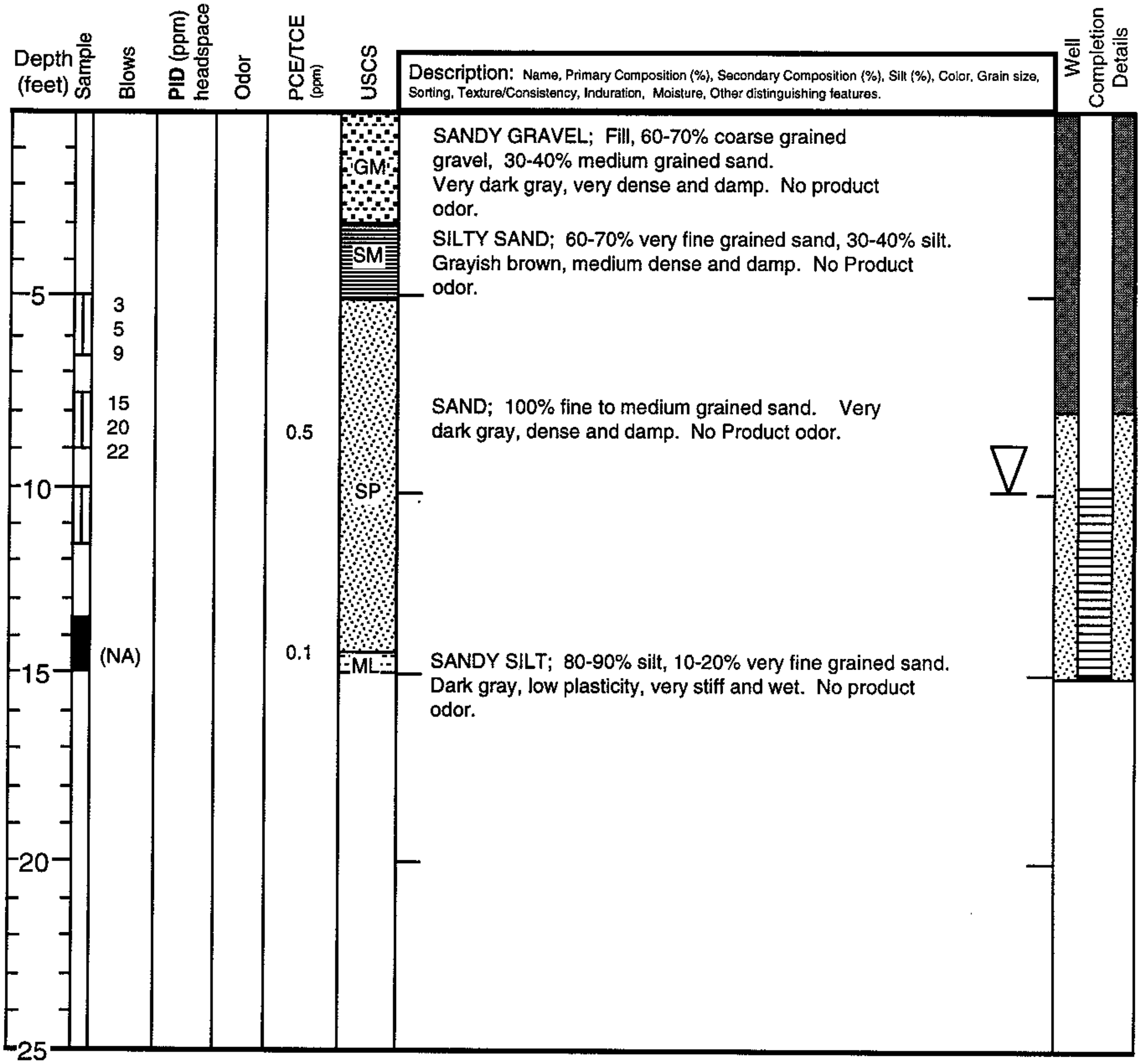
Limited Access Drilling Contractor: Cascade Drilling, Inc. Log by: J. Orr

Drill Rig: CME-75 Auger Size/Type: 6" HSA Sample Method: Split Spoon

Total Depth: 15 feet Depth to Groundwater: 10 feet Backfill or Grout Material: Bentonite

Well Casing/Screen Material: Sch. 40 PVC Filter Material/Size: Lonestar Sand: 10/12

Well A: Casing/Screen Diameter: 2 in. Slot Size: 0.01" Seal: 0-8 feet Screened Interval: 10-15 feet



Description: Name, Primary Composition (%), Secondary Composition (%), Silt (%), Color, Grain size, Sorting, Texture/Consistency, Induration, Moisture, Other distinguishing features.

SANDY GRAVEL; Fill, 60-70% coarse grained gravel, 30-40% medium grained sand. Very dark gray, very dense and damp. No product odor.

SILTY SAND; 60-70% very fine grained sand, 30-40% silt. Grayish brown, medium dense and damp. No Product odor.

SAND; 100% fine to medium grained sand. Very dark gray, dense and damp. No Product odor.

SANDY SILT; 80-90% silt, 10-20% very fine grained sand. Dark gray, low plasticity, very stiff and wet. No product odor.

General Remarks:

- Blow counts are recorded for 6 inches of sampler penetration using a 140 lb hammer unless otherwise specified.
- PCE/TCE = Concentrations Analyzed using Method 8260b for Halogented Volatiles.
- ND = Not detected, or levels were below analytical detection limits. NA = Not Analyzed.

Summary applies only at the boring location at the time of drilling. Subsurface conditions may differ at other locations, and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Northwest Corner Investigation

Attachment D

Laboratory Analytical Results - Soil and Groundwater

AGENCY REVIEW DRAFT

OnSite
Environmental Inc.
Analytical Testing and Mobile Laboratory Services

February 11, 1999

Tim Warner
Terra Vac
10740 Meridian Ave. North, Suite 202
Seattle, WA 98133-9010

Re: Analytical Data for Project 32-0039
Laboratory Reference No. 9802-030

Dear Tim:

Enclosed are the analytical results and associated quality control data for samples submitted on February 4, 1999.

The standard policy of OnSite Environmental Inc., is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Chemist

Enclosures

14924 NE 31st Circle • Redmond, WA 98052 • (425) 883-3881 • Fax (425) 885-4603

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-01
Client ID:	**B-53-8.5**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.060
Chloromethane	ND		0.060
Vinyl Chloride	ND		0.060
Bromomethane	ND		0.060
Chloroethane	ND		0.060
Trichlorofluoromethane	ND		0.060
1,1-Dichloroethene	ND		0.060
Methylene Chloride	ND		0.30
(trans) 1,2-Dichloroethene	ND		0.060
1,1-Dichloroethane	ND		0.060
2,2-Dichloropropane	ND		0.060
(cis) 1,2-Dichloroethene	ND		0.060
Chloroform	ND		0.060
1,1,1-Trichloroethane	ND		0.060
Carbon Tetrachloride	ND		0.30
1,1-Dichloropropene	ND		0.060
1,2-Dichloroethane	ND		0.060
Trichloroethene	ND		0.060
1,2-Dichloropropane	ND		0.060
Dibromomethane	ND		0.060
Bromodichloromethane	ND		0.060
(cis) 1,3-Dichloropropene	ND		0.060
(trans) 1,3-Dichloropropene	ND		0.060
1,1,2-Trichloroethane	ND		0.060
Tetrachloroethene	0.97		0.060
1,3-Dichloropropane	ND		0.060
Dibromochloromethane	ND		0.060

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID: 02-030-01
Client ID: **B-53-8.5**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.060
Chlorobenzene	ND		0.060
1,1,1,2-Tetrachloroethane	ND		0.060
Bromoform	ND		0.060
Bromobenzene	ND		0.060
1,1,2,2-Tetrachloroethane	ND		0.060
1,2,3-Trichloropropane	ND		0.30
2-Chlorotoluene	ND		0.060
4-Chlorotoluene	ND		0.060
1,3-Dichlorobenzene	ND		0.060
1,4-Dichlorobenzene	ND		0.060
1,2-Dichlorobenzene	ND		0.060
1,2-Dibromo-3-chloropropane	ND		0.30
1,2,4-Trichlorobenzene	ND		0.060
Hexachlorobutadiene	ND		0.060
1,2,3-Trichlorobenzene	ND		0.060

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	75	63-94
Toluene-d8	71	56-104
4-Bromofluorobenzene	73	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-03
Client ID:	**B-54-9**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.054
Chloromethane	ND		0.054
Vinyl Chloride	ND		0.054
Bromomethane	ND		0.054
Chloroethane	ND		0.054
Trichlorofluoromethane	ND		0.054
1,1-Dichloroethene	ND		0.054
Methylene Chloride	ND		0.27
(trans) 1,2-Dichloroethene	ND		0.054
1,1-Dichloroethane	ND		0.054
2,2-Dichloropropane	ND		0.054
(cis) 1,2-Dichloroethene	ND		0.054
Chloroform	ND		0.054
1,1,1-Trichloroethane	ND		0.054
Carbon Tetrachloride	ND		0.27
1,1-Dichloropropene	ND		0.054
1,2-Dichloroethane	ND		0.054
Trichloroethene	0.066		0.054
1,2-Dichloropropane	ND		0.054
Dibromomethane	ND		0.054
Bromodichloromethane	ND		0.054
(cis) 1,3-Dichloropropene	ND		0.054
(trans) 1,3-Dichloropropene	ND		0.054
1,1,2-Trichloroethane	ND		0.054
Tetrachloroethene	3.0		0.054
1,3-Dichloropropane	ND		0.054
Dibromochloromethane	ND		0.054

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID: 02-030-03
Client ID: **B-54-9**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.054
Chlorobenzene	ND		0.054
1,1,1,2-Tetrachloroethane	ND		0.054
Bromoform	ND		0.054
Bromobenzene	ND		0.054
1,1,2,2-Tetrachloroethane	ND		0.054
1,2,3-Trichloropropane	ND		0.27
2-Chlorotoluene	ND		0.054
4-Chlorotoluene	ND		0.054
1,3-Dichlorobenzene	ND		0.054
1,4-Dichlorobenzene	ND		0.054
1,2-Dichlorobenzene	ND		0.054
1,2-Dibromo-3-chloropropane	ND		0.27
1,2,4-Trichlorobenzene	ND		0.054
Hexachlorobutadiene	ND		0.054
1,2,3-Trichlorobenzene	ND		0.054

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	78	63-94
Toluene-d8	79	56-104
4-Bromofluorobenzene	58	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-04
Client ID:	**B-54-14**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.065
Chloromethane	ND		0.065
Vinyl Chloride	ND		0.065
Bromomethane	ND		0.065
Chloroethane	ND		0.065
Trichlorofluoromethane	ND		0.065
1,1-Dichloroethene	ND		0.065
Methylene Chloride	ND		0.32
(trans) 1,2-Dichloroethene	ND		0.065
1,1-Dichloroethane	ND		0.065
2,2-Dichloropropane	ND		0.065
(cis) 1,2-Dichloroethene	ND		0.065
Chloroform	ND		0.065
1,1,1-Trichloroethane	ND		0.065
Carbon Tetrachloride	ND		0.32
1,1-Dichloropropene	ND		0.065
1,2-Dichloroethane	ND		0.065
Trichloroethene	0.13		0.065
1,2-Dichloropropane	ND		0.065
Dibromomethane	ND		0.065
Bromodichloromethane	ND		0.065
(cis) 1,3-Dichloropropene	ND		0.065
(trans) 1,3-Dichloropropene	ND		0.065
1,1,2-Trichloroethane	ND		0.065
Tetrachloroethene	1.0		0.065
1,3-Dichloropropane	ND		0.065
Dibromochloromethane	ND		0.065

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID: 02-030-04
Client ID: **B-54-14**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.065
Chlorobenzene	ND		0.065
1,1,1,2-Tetrachloroethane	ND		0.065
Bromoform	ND		0.065
Bromobenzene	ND		0.065
1,1,2,2-Tetrachloroethane	ND		0.065
1,2,3-Trichloropropane	ND		0.32
2-Chlorotoluene	ND		0.065
4-Chlorotoluene	ND		0.065
1,3-Dichlorobenzene	ND		0.065
1,4-Dichlorobenzene	ND		0.065
1,2-Dichlorobenzene	ND		0.065
1,2-Dibromo-3-chloropropane	ND		0.32
1,2,4-Trichlorobenzene	ND		0.065
Hexachlorobutadiene	ND		0.065
1,2,3-Trichlorobenzene	ND		0.065

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	68	63-94
Toluene-d8	66	56-104
4-Bromofluorobenzene	55	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-05
Client ID:	**B-55-10**

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		0.063
Chloromethane	ND		0.063
Vinyl Chloride	ND		0.063
Bromomethane	ND		0.063
Chloroethane	ND		0.063
Trichlorofluoromethane	ND		0.063
1,1-Dichloroethene	ND		0.063
Methylene Chloride	ND		0.31
(trans) 1,2-Dichloroethene	ND		0.063
1,1-Dichloroethane	ND		0.063
2,2-Dichloropropane	ND		0.063
(cis) 1,2-Dichloroethene	ND		0.063
Chloroform	ND		0.063
1,1,1-Trichloroethane	ND		0.063
Carbon Tetrachloride	ND		0.31
1,1-Dichloropropene	ND		0.063
1,2-Dichloroethane	ND		0.063
Trichloroethene	ND		0.063
1,2-Dichloropropane	ND		0.063
Dibromomethane	ND		0.063
Bromodichloromethane	ND		0.063
(cis) 1,3-Dichloropropene	ND		0.063
(trans) 1,3-Dichloropropene	ND		0.063
1,1,2-Trichloroethane	ND		0.063
Tetrachloroethene	1.3		0.063
1,3-Dichloropropane	ND		0.063
Dibromochloromethane	ND		0.063

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-030-05
Client ID:	**B-55-10**

Compound	Results	Flags	PQL
1,2-Dibromoethane	ND		0.063
Chlorobenzene	ND		0.063
1,1,1,2-Tetrachloroethane	ND		0.063
Bromoform	ND		0.063
Bromobenzene	ND		0.063
1,1,2,2-Tetrachloroethane	ND		0.063
1,2,3-Trichloropropane	ND		0.31
2-Chlorotoluene	ND		0.063
4-Chlorotoluene	ND		0.063
1,3-Dichlorobenzene	ND		0.063
1,4-Dichlorobenzene	ND		0.063
1,2-Dichlorobenzene	ND		0.063
1,2-Dibromo-3-chloropropane	ND		0.31
1,2,4-Trichlorobenzene	ND		0.063
Hexachlorobutadiene	ND		0.063
1,2,3-Trichlorobenzene	ND		0.063

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	70	63-94
Toluene-d8	69	56-104
4-Bromofluorobenzene	60	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-07
Client ID:	**B-56-6**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.057
Chloromethane	ND		0.057
Vinyl Chloride	ND		0.057
Bromomethane	ND		0.057
Chloroethane	ND		0.057
Trichlorofluoromethane	ND		0.057
1,1-Dichloroethene	ND		0.057
Methylene Chloride	ND		0.29
(trans) 1,2-Dichloroethene	ND		0.057
1,1-Dichloroethane	ND		0.057
2,2-Dichloropropane	ND		0.057
(cis) 1,2-Dichloroethene	ND		0.057
Chloroform	ND		0.057
1,1,1-Trichloroethane	ND		0.057
Carbon Tetrachloride	ND		0.29
1,1-Dichloropropene	ND		0.057
1,2-Dichloroethane	ND		0.057
Trichloroethene	ND		0.057
1,2-Dichloropropane	ND		0.057
Dibromomethane	ND		0.057
Bromodichloromethane	ND		0.057
(cis) 1,3-Dichloropropene	ND		0.057
(trans) 1,3-Dichloropropene	ND		0.057
1,1,2-Trichloroethane	ND		0.057
Tetrachloroethene	5.2		0.057
1,3-Dichloropropane	ND		0.057
Dibromochloromethane	ND		0.057

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-030-07
Client ID:	**B-56-6**

Compound	Results	Flags	PQL
1,2-Dibromoethane	ND		0.057
Chlorobenzene	ND		0.057
1,1,1,2-Tetrachloroethane	ND		0.057
Bromoform	ND		0.057
Bromobenzene	ND		0.057
1,1,2,2-Tetrachloroethane	ND		0.057
1,2,3-Trichloropropane	ND		0.29
2-Chlorotoluene	ND		0.057
4-Chlorotoluene	ND		0.057
1,3-Dichlorobenzene	ND		0.057
1,4-Dichlorobenzene	ND		0.057
1,2-Dichlorobenzene	ND		0.057
1,2-Dibromo-3-chloropropane	ND		0.29
1,2,4-Trichlorobenzene	ND		0.057
Hexachlorobutadiene	ND		0.057
1,2,3-Trichlorobenzene	ND		0.057

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	75	63-94
Toluene-d8	73	56-104
4-Bromofluorobenzene	64	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-08
Client ID:	**B-56-8.5**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.060
Chloromethane	ND		0.060
Vinyl Chloride	ND		0.060
Bromomethane	ND		0.060
Chloroethane	ND		0.060
Trichlorofluoromethane	ND		0.060
1,1-Dichloroethene	ND		0.060
Methylene Chloride	ND		0.30
(trans) 1,2-Dichloroethene	ND		0.060
1,1-Dichloroethane	ND		0.060
2,2-Dichloropropane	ND		0.060
(cis) 1,2-Dichloroethene	ND		0.060
Chloroform	ND		0.060
1,1,1-Trichloroethane	ND		0.060
Carbon Tetrachloride	ND		0.30
1,1-Dichloropropene	ND		0.060
1,2-Dichloroethane	ND		0.060
Trichloroethene	ND		0.060
1,2-Dichloropropane	ND		0.060
Dibromomethane	ND		0.060
Bromodichloromethane	ND		0.060
(cis) 1,3-Dichloropropene	ND		0.060
(trans) 1,3-Dichloropropene	ND		0.060
1,1,2-Trichloroethane	ND		0.060
Tetrachloroethene	18		0.12
1,3-Dichloropropane	ND		0.060
Dibromochloromethane	ND		0.060

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-030-08
Client ID:	**B-56-8.5**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.060
Chlorobenzene	ND		0.060
1,1,1,2-Tetrachloroethane	ND		0.060
Bromoform	ND		0.060
Bromobenzene	ND		0.060
1,1,2,2-Tetrachloroethane	ND		0.060
1,2,3-Trichloropropane	ND		0.30
2-Chlorotoluene	ND		0.060
4-Chlorotoluene	ND		0.060
1,3-Dichlorobenzene	ND		0.060
1,4-Dichlorobenzene	ND		0.060
1,2-Dichlorobenzene	ND		0.060
1,2-Dibromo-3-chloropropane	ND		0.30
1,2,4-Trichlorobenzene	ND		0.060
Hexachlorobutadiene	ND		0.060
1,2,3-Trichlorobenzene	ND		0.060

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	69	63-94
Toluene-d8	67	56-104
4-Bromofluorobenzene	53	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-09
Client ID:	**B-56-11**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.066
Chloromethane	ND		0.066
Vinyl Chloride	ND		0.066
Bromomethane	ND		0.066
Chloroethane	ND		0.066
Trichlorofluoromethane	ND		0.066
1,1-Dichloroethene	ND		0.066
Methylene Chloride	ND		0.33
(trans) 1,2-Dichloroethene	ND		0.066
1,1-Dichloroethane	ND		0.066
2,2-Dichloropropane	ND		0.066
(cis) 1,2-Dichloroethene	ND		0.066
Chloroform	ND		0.066
1,1,1-Trichloroethane	ND		0.066
Carbon Tetrachloride	ND		0.33
1,1-Dichloropropene	ND		0.066
1,2-Dichloroethane	ND		0.066
Trichloroethene	ND		0.066
1,2-Dichloropropane	ND		0.066
Dibromomethane	ND		0.066
Bromodichloromethane	ND		0.066
(cis) 1,3-Dichloropropene	ND		0.066
(trans) 1,3-Dichloropropene	ND		0.066
1,1,2-Trichloroethane	ND		0.066
Tetrachloroethene	0.58		0.066
1,3-Dichloropropane	ND		0.066
Dibromochloromethane	ND		0.066

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-030-09
Client ID:	**B-56-11**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.066
Chlorobenzene	ND		0.066
1,1,1,2-Tetrachloroethane	ND		0.066
Bromoform	ND		0.066
Bromobenzene	ND		0.066
1,1,2,2-Tetrachloroethane	ND		0.066
1,2,3-Trichloropropane	ND		0.33
2-Chlorotoluene	ND		0.066
4-Chlorotoluene	ND		0.066
1,3-Dichlorobenzene	ND		0.066
1,4-Dichlorobenzene	ND		0.066
1,2-Dichlorobenzene	ND		0.066
1,2-Dibromo-3-chloropropane	ND		0.33
1,2,4-Trichlorobenzene	ND		0.066
Hexachlorobutadiene	ND		0.066
1,2,3-Trichlorobenzene	ND		0.066

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	67	63-94
Toluene-d8	67	56-104
4-Bromofluorobenzene	56	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-10
Client ID:	**B-56-14**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.062
Chloromethane	ND		0.062
Vinyl Chloride	ND		0.062
Bromomethane	ND		0.062
Chloroethane	ND		0.062
Trichlorofluoromethane	ND		0.062
1,1-Dichloroethene	ND		0.062
Methylene Chloride	ND		0.31
(trans) 1,2-Dichloroethene	ND		0.062
1,1-Dichloroethane	ND		0.062
2,2-Dichloropropane	ND		0.062
(cis) 1,2-Dichloroethene	ND		0.062
Chloroform	ND		0.062
1,1,1-Trichloroethane	ND		0.062
Carbon Tetrachloride	ND		0.31
1,1-Dichloropropene	ND		0.062
1,2-Dichloroethane	ND		0.062
Trichloroethene	ND		0.062
1,2-Dichloropropane	ND		0.062
Dibromomethane	ND		0.062
Bromodichloromethane	ND		0.062
(cis) 1,3-Dichloropropene	ND		0.062
(trans) 1,3-Dichloropropene	ND		0.062
1,1,2-Trichloroethane	ND		0.062
Tetrachloroethene	1.4		0.062
1,3-Dichloropropane	ND		0.062
Dibromochloromethane	ND		0.062

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-030-10
Client ID:	**B-56-14**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.062
Chlorobenzene	ND		0.062
1,1,1,2-Tetrachloroethane	ND		0.062
Bromoform	ND		0.062
Bromobenzene	ND		0.062
1,1,2,2-Tetrachloroethane	ND		0.062
1,2,3-Trichloropropane	ND		0.31
2-Chlorotoluene	ND		0.062
4-Chlorotoluene	ND		0.062
1,3-Dichlorobenzene	ND		0.062
1,4-Dichlorobenzene	ND		0.062
1,2-Dichlorobenzene	ND		0.062
1,2-Dibromo-3-chloropropane	ND		0.31
1,2,4-Trichlorobenzene	ND		0.062
Hexachlorobutadiene	ND		0.062
1,2,3-Trichlorobenzene	ND		0.062

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	68	63-94
Toluene-d8	67	56-104
4-Bromofluorobenzene	58	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-11
Client ID:	**B-57-8.5**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.062
Chloromethane	ND		0.062
Vinyl Chloride	ND		0.062
Bromomethane	ND		0.062
Chloroethane	ND		0.062
Trichlorofluoromethane	ND		0.062
1,1-Dichloroethene	ND		0.062
Methylene Chloride	ND		0.31
(trans) 1,2-Dichloroethene	ND		0.062
1,1-Dichloroethane	ND		0.062
2,2-Dichloropropane	ND		0.062
(cis) 1,2-Dichloroethene	ND		0.062
Chloroform	ND		0.062
1,1,1-Trichloroethane	ND		0.062
Carbon Tetrachloride	ND		0.31
1,1-Dichloropropene	ND		0.062
1,2-Dichloroethane	ND		0.062
Trichloroethene	ND		0.062
1,2-Dichloropropane	ND		0.062
Dibromomethane	ND		0.062
Bromodichloromethane	ND		0.062
(cis) 1,3-Dichloropropene	ND		0.062
(trans) 1,3-Dichloropropene	ND		0.062
1,1,2-Trichloroethane	ND		0.062
Tetrachloroethene	0.46		0.062
1,3-Dichloropropane	ND		0.062
Dibromochloromethane	ND		0.062

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 2 of 2

Lab ID: 02-030-11
Client ID: **B-57-8.5**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.062
Chlorobenzene	ND		0.062
1,1,1,2-Tetrachloroethane	ND		0.062
Bromoform	ND		0.062
Bromobenzene	ND		0.062
1,1,2,2-Tetrachloroethane	ND		0.062
1,2,3-Trichloropropane	ND		0.31
2-Chlorotoluene	ND		0.062
4-Chlorotoluene	ND		0.062
1,3-Dichlorobenzene	ND		0.062
1,4-Dichlorobenzene	ND		0.062
1,2-Dichlorobenzene	ND		0.062
1,2-Dibromo-3-chloropropane	ND		0.31
1,2,4-Trichlorobenzene	ND		0.062
Hexachlorobutadiene	ND		0.062
1,2,3-Trichlorobenzene	ND		0.062

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	67	63-94
Toluene-d8	65	56-104
4-Bromofluorobenzene	51	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-12
Client ID:	**B-57-14.5**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		0.065
Chloromethane	ND		0.065
Vinyl Chloride	ND		0.065
Bromomethane	ND		0.065
Chloroethane	ND		0.065
Trichlorofluoromethane	ND		0.065
1,1-Dichloroethene	ND		0.065
Methylene Chloride	ND		0.32
(trans) 1,2-Dichloroethene	ND		0.065
1,1-Dichloroethane	ND		0.065
2,2-Dichloropropane	ND		0.065
(cis) 1,2-Dichloroethene	ND		0.065
Chloroform	ND		0.065
1,1,1-Trichloroethane	ND		0.065
Carbon Tetrachloride	ND		0.32
1,1-Dichloropropene	ND		0.065
1,2-Dichloroethane	ND		0.065
Trichloroethene	ND		0.065
1,2-Dichloropropane	ND		0.065
Dibromomethane	ND		0.065
Bromodichloromethane	ND		0.065
(cis) 1,3-Dichloropropene	ND		0.065
(trans) 1,3-Dichloropropene	ND		0.065
1,1,2-Trichloroethane	ND		0.065
Tetrachloroethene	0.067		0.065
1,3-Dichloropropane	ND		0.065
Dibromochloromethane	ND		0.065

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-030-12
Client ID:	**B-57-14.5**

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.065
Chlorobenzene	ND		0.065
1,1,1,2-Tetrachloroethane	ND		0.065
Bromoform	ND		0.065
Bromobenzene	ND		0.065
1,1,2,2-Tetrachloroethane	ND		0.065
1,2,3-Trichloropropane	ND		0.32
2-Chlorotoluene	ND		0.065
4-Chlorotoluene	ND		0.065
1,3-Dichlorobenzene	ND		0.065
1,4-Dichlorobenzene	ND		0.065
1,2-Dichlorobenzene	ND		0.065
1,2-Dibromo-3-chloropropane	ND		0.32
1,2,4-Trichlorobenzene	ND		0.065
Hexachlorobutadiene	ND		0.065
1,2,3-Trichlorobenzene	ND		0.065

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	69	63-94
Toluene-d8	66	56-104
4-Bromofluorobenzene	50	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 1 of 2

Date Extracted:	2-5-99
Date Analyzed:	2-8-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	MB0205S1

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		0.050
Chloromethane	ND		0.050
Vinyl Chloride	ND		0.050
Bromomethane	ND		0.050
Chloroethane	ND		0.050
Trichlorofluoromethane	ND		0.050
1,1-Dichloroethene	ND		0.050
Methylene Chloride	ND		0.25
(trans) 1,2-Dichloroethene	ND		0.050
1,1-Dichloroethane	ND		0.050
2,2-Dichloropropane	ND		0.050
(cis) 1,2-Dichloroethene	ND		0.050
Chloroform	ND		0.050
1,1,1-Trichloroethane	ND		0.050
Carbon Tetrachloride	ND		0.25
1,1-Dichloropropene	ND		0.050
1,2-Dichloroethane	ND		0.050
Trichloroethene	ND		0.050
1,2-Dichloropropane	ND		0.050
Dibromomethane	ND		0.050
Bromodichloromethane	ND		0.050
(cis) 1,3-Dichloropropene	ND		0.050
(trans) 1,3-Dichloropropene	ND		0.050
1,1,2-Trichloroethane	ND		0.050
Tetrachloroethene	ND		0.050
1,3-Dichloropropane	ND		0.050
Dibromochloromethane	ND		0.050

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 2 of 2

Lab ID: MB0205S1

Compound	**Results**	**Flags**	**PQL**
1,2-Dibromoethane	ND		0.050
Chlorobenzene	ND		0.050
1,1,1,2-Tetrachloroethane	ND		0.050
Bromoform	ND		0.050
Bromobenzene	ND		0.050
1,1,2,2-Tetrachloroethane	ND		0.050
1,2,3-Trichloropropane	ND		0.25
2-Chlorotoluene	ND		0.050
4-Chlorotoluene	ND		0.050
1,3-Dichlorobenzene	ND		0.050
1,4-Dichlorobenzene	ND		0.050
1,2-Dichlorobenzene	ND		0.050
1,2-Dibromo-3-chloropropane	ND		0.25
1,2,4-Trichlorobenzene	ND		0.050
Hexachlorobutadiene	ND		0.050
1,2,3-Trichlorobenzene	ND		0.050

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	93	63-94
Toluene-d8	88	56-104
4-Bromofluorobenzene	80	47-133

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
MS/MSD QUALITY CONTROL

Date Extracted:	1-27-99
Date Analyzed:	1-27-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	01-125-01

Compound	**Spike Amount**	**MS**	**Percent Recovery**	**MSD**	**Percent Recovery**	**RPD**	
1,1-Dichloroethene	2.50	1.90	76	1.73	69	9.1	
Benzene	2.50	2.37	95	2.34	94	1.3	
Trichloroethene	2.50	2.35	94	2.36	94	0.49	
Toluene	2.50	1.79	72	2.10	84	16	*
Chlorobenzene	2.50	2.13	85	2.14	86	0.62	

* RPD outside control limits.

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
page 1 of 3

Date Extracted:	02-05-99
Date Analyzed:	02-08-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-02
Client ID :	B-53-14.0

Compound:	Results	Flags	PQL
Aniline	ND		0.04
bis(2-Chloroethyl)ether	ND		0.04
Phenol	ND		0.20
2-Chlorophenol	ND		0.20
1,3-Dichlorobenzene	ND		0.04
1,4-Dichlorobenzene	ND		0.04
1,2-Dichlorobenzene	ND		0.04
Benzyl alcohol	ND		0.04
bis(2-chloroisopropyl)ether	ND		0.04
2-Methylphenol	ND		0.20
Hexachloroethane	ND		0.04
N-Nitroso-di-n-propylamine	ND		0.04
4-Methylphenol	ND		0.20
Nitrobenzene	ND		0.04
Isophorone	ND		0.04
2-Nitrophenol	ND		0.20
2,4-Dimethylphenol	ND		0.20
bis(2-Chloroethoxy)methane	ND		0.04
2,4-Dichlorophenol	ND		0.04
Benzoic acid	ND		0.61
1,2,4-Trichlorobenzene	ND		0.04
Naphthalene	ND		0.04
4-Chloroaniline	ND		0.04
Hexachlorobutadiene	ND		0.04
4-Chloro-3-methylphenol	ND		0.20
2-Methylnaphthalene	ND		0.04

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID:	02-030-02
Client ID :	B-53-14.0

Compound:	Results	Flags	PQL
Hexachlorocyclopentadiene	ND		0.04
2,4,6-Trichlorophenol	ND		0.20
2,4,5-Trichlorophenol	ND		0.20
2-Chloronaphthalene	ND		0.04
2-Nitroaniline	ND		0.04
Acenaphthylene	ND		0.04
Dimethylphthalate	ND		0.04
2,6-Dinitrotoluene	ND		0.41
Acenaphthene	ND		0.04
3-Nitroaniline	ND		0.04
2,4-Dinitrophenol	ND		0.41
Dibenzofuran	ND		0.04
2,4-Dinitrotoluene	ND		0.04
4-Nitrophenol	ND		0.20
Fluorene	ND		0.04
4-Chlorophenyl-phenylether	ND		0.04
Diethylphthalate	ND		0.04
4-Nitroaniline	ND		0.04
4,6-Dinitro-2-methylphenol	ND		0.41
n-Nitrosodiphenylamine	ND		0.04
4-Bromophenyl-phenylether	ND		0.04
Hexachlorobenzene	ND		0.04
Pentachlorophenol	ND		0.41
Phenanthrene	ND		0.04
Anthracene	ND		0.04
Carbazole	ND		0.04
Di-n-butylphthalate	ND		0.04
Fluoranthene	ND		0.04
Benzidine	ND		0.04
Pyrene	ND		0.04

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-030-02
Client ID :	B-53-14.0

Compound:	**Results**	**Flags**	**PQL**
Butylbenzylphthalate	ND		0.04
3,3'-Dichlorobenzidine	ND		0.04
Benzo[a]anthracene	ND		0.04
Chrysene	ND		0.04
bis(2-Ethylhexyl)phthalate	0.067		0.04
Di-n-octylphthalate	ND		0.04
Benzo[b]fluoranthene	ND		0.04
Benzo[k]fluoranthene	ND		0.04
Benzo[a]pyrene	ND		0.04
Indeno[1,2,3-cd]pyrene	ND		0.04
Dibenz[a,h]anthracene	ND		0.04
Benzo[g,h,i]perylene	ND		0.04

Surrogate :	**Percent Recovery**	**Control Limits**
2-Fluorophenol	43	25 - 121
Phenol-d6	48	24 - 113
Nitrobenzene-d5	42	23 - 120
2-Fluorobiphenyl	59	30 - 115
2,4,6-Tribromophenol	38	19 - 122
Terphenyl-d14	80	18 - 137

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C

page 1 of 3

Date Extracted:	02-05-99
Date Analyzed:	02-08-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-030-06
Client ID :	B-55-14.5

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		0.04
bis(2-Chloroethyl)ether	ND		0.04
Phenol	ND		0.21
2-Chlorophenol	ND		0.21
1,3-Dichlorobenzene	ND		0.04
1,4-Dichlorobenzene	ND		0.04
1,2-Dichlorobenzene	ND		0.04
Benzyl alcohol	ND		0.04
bis(2-chloroisopropyl)ether	ND		0.04
2-Methylphenol	ND		0.21
Hexachloroethane	ND		0.04
N-Nitroso-di-n-propylamine	ND		0.04
4-Methylphenol	ND		0.21
Nitrobenzene	ND		0.04
Isophorone	ND		0.04
2-Nitrophenol	ND		0.21
2,4-Dimethylphenol	ND		0.21
bis(2-Chloroethoxy)methane	ND		0.04
2,4-Dichlorophenol	ND		0.04
Benzoic acid	ND		0.63
1,2,4-Trichlorobenzene	ND		0.04
Naphthalene	ND		0.04
4-Chloroaniline	ND		0.04
Hexachlorobutadiene	ND		0.04
4-Chloro-3-methylphenol	ND		0.21
2-Methylnaphthalene	ND		0.04

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID: 02-030-06
Client ID : B-55-14.5

Compound:	**Results**	**Flags**	**PQL**
Hexachlorocyclopentadiene	ND		0.04
2,4,6-Trichlorophenol	ND		0.21
2,4,5-Trichlorophenol	ND		0.21
2-Chloronaphthalene	ND		0.04
2-Nitroaniline	ND		0.04
Acenaphthylene	ND		0.04
Dimethylphthalate	ND		0.04
2,6-Dinitrotoluene	ND		0.42
Acenaphthene	ND		0.04
3-Nitroaniline	ND		0.04
2,4-Dinitrophenol	ND		0.42
Dibenzofuran	ND		0.04
2,4-Dinitrotoluene	ND		0.04
4-Nitrophenol	ND		0.21
Fluorene	ND		0.04
4-Chlorophenyl-phenylether	ND		0.04
Diethylphthalate	ND		0.04
4-Nitroaniline	ND		0.04
4,6-Dinitro-2-methylphenol	ND		0.42
n-Nitrosodiphenylamine	ND		0.04
4-Bromophenyl-phenylether	ND		0.04
Hexachlorobenzene	ND		0.04
Pentachlorophenol	ND		0.42
Phenanthrene	ND		0.04
Anthracene	ND		0.04
Carbazole	ND		0.04
Di-n-butylphthalate	ND		0.04
Fluoranthene	ND		0.04
Benzidine	ND		0.04
Pyrene	ND		0.04

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C

page 3 of 3

Lab ID:	02-030-06
Client ID :	B-55-14.5

Compound:	**Results**	**Flags**	**PQL**
Butylbenzylphthalate	ND		0.04
3,3'-Dichlorobenzidine	ND		0.04
Benzo[a]anthracene	ND		0.04
Chrysene	ND		0.04
bis(2-Ethylhexyl)phthalate	0.052		0.04
Di-n-octylphthalate	ND		0.04
Benzo[b]fluoranthene	ND		0.04
Benzo[k]fluoranthene	ND		0.04
Benzo[a]pyrene	ND		0.04
Indeno[1,2,3-cd]pyrene	ND		0.04
Dibenz[a,h]anthracene	ND		0.04
Benzo[g,h,i]perylene	ND		0.04

Surrogate :	**Percent Recovery**	**Control Limits**
2-Fluorophenol	34	25 - 121
Phenol-d6	45	24 - 113
Nitrobenzene-d5	41	23 - 120
2-Fluorobiphenyl	64	30 - 115
2,4,6-Tribromophenol	41	19 - 122
Terphenyl-d14	85	18 - 137

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
METHOD BLANK QUALITY CONTROL
page 1 of 3

Date Extracted:	02-05-99
Date Analyzed:	02-08-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	MB0205S1

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		0.03
bis(2-Chloroethyl)ether	ND		0.03
Phenol	ND		0.17
2-Chlorophenol	ND		0.17
1,3-Dichlorobenzene	ND		0.03
1,4-Dichlorobenzene	ND		0.03
1,2-Dichlorobenzene	ND		0.03
Benzyl alcohol	ND		0.03
bis(2-chloroisopropyl)ether	ND		0.03
2-Methylphenol	ND		0.17
Hexachloroethane	ND		0.03
N-Nitroso-di-n-propylamine	ND		0.03
4-Methylphenol	ND		0.17
Nitrobenzene	ND		0.03
Isophorone	ND		0.03
2-Nitrophenol	ND		0.17
2,4-Dimethylphenol	ND		0.17
bis(2-Chloroethoxy)methane	ND		0.03
2,4-Dichlorophenol	ND		0.03
Benzoic acid	ND		0.50
1,2,4-Trichlorobenzene	ND		0.03
Naphthalene	ND		0.03
4-Chloroaniline	ND		0.03
Hexachlorobutadiene	ND		0.03
4-Chloro-3-methylphenol	ND		0.17
2-Methylnaphthalene	ND		0.03

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
METHOD BLANK QUALITY CONTROL
page 2 of 3

Lab ID: MB0205S1

Compound:	Results	Flags	PQL
Hexachlorocyclopentadiene	ND		0.03
2,4,6-Trichlorophenol	ND		0.17
2,4,5-Trichlorophenol	ND		0.17
2-Chloronaphthalene	ND		0.03
2-Nitroaniline	ND		0.03
Acenaphthylene	ND		0.03
Dimethylphthalate	ND		0.03
2,6-Dinitrotoluene	ND		0.33
Acenaphthene	ND		0.03
3-Nitroaniline	ND		0.03
2,4-Dinitrophenol	ND		0.33
Dibenzofuran	ND		0.03
2,4-Dinitrotoluene	ND		0.03
4-Nitrophenol	ND		0.17
Fluorene	ND		0.03
4-Chlorophenyl-phenylether	ND		0.03
Diethylphthalate	ND		0.03
4-Nitroaniline	ND		0.03
4,6-Dinitro-2-methylphenol	ND		0.33
n-Nitrosodiphenylamine	ND		0.03
4-Bromophenyl-phenylether	ND		0.03
Hexachlorobenzene	ND		0.03
Pentachlorophenol	ND		0.33
Phenanthrene	ND		0.03
Anthracene	ND		0.03
Carbazole	ND		0.03
Di-n-butylphthalate	ND		0.03
Fluoranthene	ND		0.03
Benzidine	ND		0.03
Pyrene	ND		0.03

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
METHOD BLANK QUALITY CONTROL
page 3 of 3

Lab ID: MB0205S1

Compound:	**Results**	**Flags**	**PQL**
Butylbenzylphthalate	ND		0.03
3,3'-Dichlorobenzidine	ND		0.03
Benzo[a]anthracene	ND		0.03
Chrysene	ND		0.03
bis(2-Ethylhexyl)phthalate	ND		0.03
Di-n-octylphthalate	ND		0.03
Benzo[b]fluoranthene	ND		0.03
Benzo[k]fluoranthene	ND		0.03
Benzo[a]pyrene	ND		0.03
Indeno[1,2,3-cd]pyrene	ND		0.03
Dibenz[a,h]anthracene	ND		0.03
Benzo[g,h,i]perylene	ND		0.03

Surrogate :	**Percent Recovery**	**Control Limits**
2-Fluorophenol	57	25 - 121
Phenol-d6	61	24 - 113
Nitrobenzene-d5	57	23 - 120
2-Fluorobiphenyl	75	30 - 115
2,4,6-Tribromophenol	44	19 - 122
Terphenyl-d14	95	18 - 137

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

SEMIVOLATILES by EPA 8270C
MS/MSD QUALITY CONTROL

Date Extracted:	02-05-99
Date Analyzed:	02-10-99
Matrix:	Soil
Units:	mg/Kg (ppm)
Lab ID:	02-019-01MS

Compound:	**Spike Amount**	**MS**	**Percent Recovery**	**MSD**	**Percent Recovery**	**RPD**
Phenol	3.30	1.83	55	1.85	56	1.1
2-Chlorophenol	3.30	2.14	65	2.26	69	5.7
1,4-Dichlorobenzene	1.65	1.04	63	0.99	60	5.5
N-Nitroso-di-n-propylamine	1.65	0.96	58	1.10	66	13
1,2,4-Trichlorobenzene	1.65	1.11	67	1.18	72	6.3
4-Chloro-3-methylphenol	3.30	2.03	61	2.70	82	28
Acenaphthene	1.65	1.46	88	1.57	95	7.2
2,4-Dinitrotoluene	1.65	1.04	63	1.33	80	25
4-Nitrophenol	3.30	1.76	53	1.71	52	2.5
Pentachlorophenol	3.30	1.65	50	2.23	68	30
Pyrene	1.65	3.14	97	3.15	98	0.69

Date of Report: February 11, 1999
Samples Submitted: February 4, 1999
Lab Traveler: 02-030
Project: 32-0039

Date Analyzed: 2-4-99

% MOISTURE

Client ID	Lab ID	% Moisture
B-53-8.5	02-030-01	19
B-53-14.0	02-030-02	22
B-54-9	02-030-03	17
B-54-14	02-030-04	8.0
B-55-10	02-030-05	23
B-55-14.5	02-030-06	20
B-56-6	02-030-07	13
B-56-8.5	02-030-08	16
B-56-11	02-030-09	24
B-56-14	02-030-10	19
B-57-8.5	02-030-11	19
B-57-14.5	02-030-12	23

OnSite
Environmental Inc.

DATA QUALIFIERS AND ABBREVIATIONS

A - Due to high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

D - Data from 1:____ dilution.

E - The value reported exceeds the quantitation range, and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

G - Insufficient sample quantity for duplicate analysis.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeniety. The sample was re-extracted and re-analyzed with similar results.

M - Predominantly ______________ range hydrocarbons present in the sample.

N - Hydrocarbons in the gasoline range (C7-toluene) are present in the sample.

O - Hydrocarbons in the heavy oil range (>C24) are present in the sample.

P - Hydrocarbons in the diesel range (C12-C24) are present in the sample which are elevating the oil result.

Q - The RPD of the results between the two columns is greater than 25.

R - Hydrocarbons outside the defined gasoline range are present in the sample; NWTPH-Dx recommended.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ______________.

U - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

X - Sample underwent silica gel cleanup procedures.

Y - Sample underwent acid cleanup procedures.

Z - Interferences were present which prevented the quantitation of the analyte below the detection limit reported.

ND - Not Detected
MRL - Method Reporting Limit
PQL - Practical Quantitation

OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Chain of Custody

Page 1 of 1

Company: TEERA VAC
Project No.: 32-0039
Project Name: GLCC - NW CORNER
Project Manager: T WARNER

Turn Around Requested
(Check One)
☐ Same Day
☐ 24 Hours*
☐ 48 Hours
☒ Standard
☐ ______ (other)

Project Chemist: DB

Laboratory No.

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH								% Moisture
1	B-53-8.5	2/3/99	845	S	1					X															X
2	B-53-14.0		0920		2						X														X
3	B-54-9		1023		1					X															X
4	B-54-14		1035		1					X															X
5	B-55-10		1114		1					X															X
6	B-55-14.5		1124		1						X														X
* 7	B-56-6		1321		1					X															X
8	B-56-8.5		1247		1					X															X
9	B-56-11		1300		1					X															X
10	B-56-14		1308		1					X															X
11	B-57-8.5		1401		1					X															X
2	B-57-14.5		1415		1					X															X

RELINQUISHED BY Peter CATTERALL	DATE 2/4/99	RECEIVED BY	DATE 2/4/99
FIRM TERRA VAC	TIME 8:55	FIRM OnSite Env	TIME 8:55
RELINQUISHED BY	DATE	RECEIVED BY	DATE
FIRM	TIME	FIRM	TIME
REVIEWED BY		DATE REVIEWED	

COMMENTS:
B-56 SAMPLES MAY BE High IN chlorinATED SOLVENT CONC. (*)

NORTH CREEK ANALYTICAL
Environmental Laboratory Services

BOTHELL ▪ (425) 420-9200 ▪ FAX 420-9210
SPOKANE ▪ (509) 924-9200 ▪ FAX 924-9290
PORTLAND ▪ (503) 906-9200 ▪ FAX 906-9210

Terra Vac
10740 Meridian Ave N Suite 202
eattle, WA 98133

Project: GWCC
Project Number: 32-0039
Project Manager: Timothy Warner

Sampled: 12/17/98
Received: 12/18/98
Reported: 12/30/98 15:17

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
B 13	B812397-01	Water	12/17/98
B 22	B812397-02	Water	12/17/98
B 23	B812397-03	Water	12/17/98

North Creek Analytical - Bothell

Steve Davis, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document
This analytical report must be reproduced in its entirety

Terra Vac	Project:	GWCC	Sampled:	12/17/98
10740 Meridian Ave N Suite 202	Project Number:	32-0039	Received:	12/18/98
Seattle, WA 98133	Project Manager:	Timothy Warner	Reported:	12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
B 13			**B812397-01**				**Water**	
Acetone	1280743	12/28/98	12/29/98		10.0	ND	ug/l	
Benzene	"	"	"		1.00	ND	"	
Bromobenzene	"	"	"		1.00	ND	"	
Bromochloromethane	"	"	"		1.00	ND	"	
Bromodichloromethane	"	"	"		1.00	ND	"	
Bromoform	"	"	"		1.00	ND	"	
Bromomethane	"	"	"		1.00	ND	"	
2-Butanone	"	"	"		10.0	ND	"	
n-Butylbenzene	"	"	"		1.00	ND	"	
sec-Butylbenzene	"	"	"		1.00	ND	"	
tert-Butylbenzene	"	"	"		1.00	ND	"	
Carbon disulfide	"	"	"		1.00	ND	"	
Carbon tetrachloride	"	"	"		1.00	ND	"	
Chlorobenzene	"	"	"		1.00	ND	"	
Chloroethane	"	"	"		1.00	ND	"	
Chloroform	"	"	"		1.00	**1.19**	"	
Chloromethane	"	"	"		5.00	ND	"	
2-Chlorotoluene	"	"	"		1.00	ND	"	
4-Chlorotoluene	"	"	"		1.00	ND	"	
Dibromochloromethane	"	"	"		1.00	ND	"	
1,2-Dibromo-3-chloropropane	"	"	"		5.00	ND	"	
1,2-Dibromoethane	"	"	"		1.00	ND	"	
Dibromomethane	"	"	"		1.00	ND	"	
1,2-Dichlorobenzene	"	"	"		1.00	ND	"	
1,3-Dichlorobenzene	"	"	"		1.00	ND	"	
1,4-Dichlorobenzene	"	"	"		1.00	ND	"	
Dichlorodifluoromethane	"	"	"		1.00	ND	"	
1,1-Dichloroethane	"	"	"		1.00	**1.31**	"	
1,2-Dichloroethane	"	"	"		1.00	ND	"	
1,1-Dichloroethene	"	"	"		1.00	ND	"	
cis-1,2-Dichloroethene	"	"	"		1.00	**72.6**	"	
trans-1,2-Dichloroethene	"	"	"		1.00	ND	"	
1,2-Dichloropropane	"	"	"		1.00	ND	"	
1,3-Dichloropropane	"	"	"		1.00	ND	"	
2,2-Dichloropropane	"	"	"		1.00	ND	"	
1,1-Dichloropropene	"	"	"		1.00	ND	"	
cis-1,3-Dichloropropene	"	"	"		1.00	ND	"	
trans-1,3-Dichloropropene	"	"	"		1.00	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Steve Davis, Project Manager

Terra Vac 10740 Meridian Ave N Suite 202 Seattle, WA 98133	Project: GWCC Project Number: 32-0039 Project Manager: Timothy Warner	Sampled: 12/17/98 Received: 12/18/98 Reported: 12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
B 13 (continued)			**B812397-01**				**Water**	
Ethylbenzene	1280743	12/28/98	12/29/98		1.00	ND	ug/l	
Hexachlorobutadiene	"	"	"		1.00	ND	"	
2-Hexanone	"	"	"		10.0	ND	"	
Isopropylbenzene	"	"	"		1.00	ND	"	
p-Isopropyltoluene	"	"	"		1.00	ND	"	
Methylene chloride	"	"	"		5.00	ND	"	
4-Methyl-2-pentanone	"	"	"		10.0	ND	"	
Naphthalene	"	"	"		1.00	ND	"	
n-Propylbenzene	"	"	"		1.00	ND	"	
Styrene	"	"	"		1.00	ND	"	
1,1,1,2-Tetrachloroethane	"	"	"		1.00	**1.59**	"	
1,1,2,2-Tetrachloroethane	"	"	"		1.00	ND	"	
Tetrachloroethene	"	"	"		100	**3660**	"	
Toluene	"	"	"		1.00	ND	"	
1,2,3-Trichlorobenzene	"	"	"		1.00	ND	"	
1,2,4-Trichlorobenzene	"	"	"		1.00	ND	"	
1,1,1-Trichloroethane	"	"	"		1.00	**3.37**	"	
1,1,2-Trichloroethane	"	"	"		1.00	ND	"	
Trichloroethene	"	"	"		20.0	**214**	"	
Trichlorofluoromethane	"	"	"		1.00	ND	"	
1,2,3-Trichloropropane	"	"	"		1.00	ND	"	
1,2,4-Trimethylbenzene	"	"	"		1.00	ND	"	
1,3,5-Trimethylbenzene	"	"	"		1.00	ND	"	
Vinyl chloride	"	"	"		1.00	ND	"	
m,p-Xylene	"	"	"		2.00	ND	"	
o-Xylene	"	"	"		1.00	ND	"	
Surrogate: 2-Bromopropene	"	"	"	*80.0-120*		*101*	%	
Surrogate: 1,2-DCA-d4	"	"	"	*80.0-120*		*109*	"	
Surrogate: Toluene-d8	"	"	"	*80.0-120*		*106*	"	
Surrogate: 4-BFB	"	"	"	*80.0-120*		*95.5*	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Steve Davis, Project Manager

Terra Vac	Project: GWCC	Sampled:	12/17/98
10740 Meridian Ave N Suite 202	Project Number: 32-0039	Received:	12/18/98
Seattle, WA 98133	Project Manager: Timothy Warner	Reported:	12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
B 22			**B812397-02**				**Water**	
Acetone	1280743	12/28/98	12/29/98		10.0	ND	ug/l	
Benzene	"	"	"		1.00	ND	"	
Bromobenzene	"	"	"		1.00	ND	"	
Bromochloromethane	"	"	"		1.00	ND	"	
Bromodichloromethane	"	"	"		1.00	ND	"	
Bromoform	"	"	"		1.00	ND	"	
Bromomethane	"	"	"		1.00	ND	"	
2-Butanone	"	"	"		10.0	ND	"	
n-Butylbenzene	"	"	"		1.00	ND	"	
sec-Butylbenzene	"	"	"		1.00	ND	"	
tert-Butylbenzene	"	"	"		1.00	ND	"	
Carbon disulfide	"	"	"		1.00	ND	"	
Carbon tetrachloride	"	"	"		1.00	ND	"	
Chlorobenzene	"	"	"		1.00	ND	"	
Chloroethane	"	"	"		1.00	ND	"	
Chloroform	"	"	"		1.00	ND	"	
Chloromethane	"	"	"		5.00	ND	"	
2-Chlorotoluene	"	"	"		1.00	ND	"	
4-Chlorotoluene	"	"	"		1.00	ND	"	
Dibromochloromethane	"	"	"		1.00	ND	"	
1,2-Dibromo-3-chloropropane	"	"	"		5.00	ND	"	
1,2-Dibromoethane	"	"	"		1.00	ND	"	
Dibromomethane	"	"	"		1.00	ND	"	
1,2-Dichlorobenzene	"	"	"		1.00	ND	"	
1,3-Dichlorobenzene	"	"	"		1.00	ND	"	
1,4-Dichlorobenzene	"	"	"		1.00	ND	"	
Dichlorodifluoromethane	"	"	"		1.00	ND	"	
1,1-Dichloroethane	"	"	"		1.00	**1.97**	"	
1,2-Dichloroethane	"	"	"		1.00	ND	"	
1,1-Dichloroethene	"	"	"		1.00	**1.01**	"	
cis-1,2-Dichloroethene	"	"	"		20.0	**403**	"	
trans-1,2-Dichloroethene	"	"	"		1.00	**3.35**	"	
1,2-Dichloropropane	"	"	"		1.00	ND	"	
1,3-Dichloropropane	"	"	"		1.00	ND	"	
2,2-Dichloropropane	"	"	"		1.00	ND	"	
1,1-Dichloropropene	"	"	"		1.00	ND	"	
cis-1,3-Dichloropropene	"	"	"		1.00	ND	"	
trans-1,3-Dichloropropene	"	"	"		1.00	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Steve Davis, Project Manager

Terra Vac 10710 Meridian Ave N Suite 202 Seattle, WA 98133	Project: GWCC Project Number: 32-0039 Project Manager: Timothy Warner	Sampled: 12/17/98 Received: 12/18/98 Reported: 12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
B 22 (continued)			**B812397-02**				**Water**	
Ethylbenzene	1280743	12/28/98	12/29/98		1.00	ND	ug/l	
Hexachlorobutadiene	"	"	"		1.00	ND	"	
2-Hexanone	"	"	"		10.0	ND	"	
Isopropylbenzene	"	"	"		1.00	ND	"	
p-Isopropyltoluene	"	"	"		1.00	ND	"	
Methylene chloride	"	"	"		5.00	ND	"	
4-Methyl-2-pentanone	"	"	"		10.0	ND	"	
Naphthalene	"	"	"		1.00	ND	"	
n-Propylbenzene	"	"	"		1.00	ND	"	
Styrene	"	"	"		1.00	ND	"	
1,1,1,2-Tetrachloroethane	"	"	"		1.00	ND	"	
1,1,2,2-Tetrachloroethane	"	"	"		1.00	ND	"	
Tetrachloroethene	"	"	"		20.0	**1850**	"	
Toluene	"	"	"		1.00	ND	"	
1,2,3-Trichlorobenzene	"	"	"		1.00	ND	"	
1,2,4-Trichlorobenzene	"	"	"		1.00	ND	"	
1,1,1-Trichloroethane	"	"	"		1.00	**1.55**	"	
1,1,2-Trichloroethane	"	"	"		1.00	ND	"	
Trichloroethene	"	"	"		20.0	**226**	"	
Trichlorofluoromethane	"	"	"		1.00	ND	"	
1,2,3-Trichloropropane	"	"	"		1.00	ND	"	
1,2,4-Trimethylbenzene	"	"	"		1.00	ND	"	
1,3,5-Trimethylbenzene	"	"	"		1.00	ND	"	
Vinyl chloride	"	"	"		1.00	**17.4**	"	
m,p-Xylene	"	"	"		2.00	ND	"	
o-Xylene	"	"	"		1.00	ND	"	
Surrogate: 2-Bromopropene	"	"	"	*80.0-120*		*100*	%	
Surrogate: 1,2-DCA-d4	"	"	"	*80.0-120*		*106*	"	
Surrogate: Toluene-d8	"	"	"	*80.0-120*		*103*	"	
Surrogate: 4-BFB	"	"	"	*80.0-120*		*95.0*	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Steve Davis, Project Manager

Terra Vac	Project: GWCC	Sampled: 12/17/98
10740 Meridian Ave N Suite 202	Project Number: 32-0039	Received: 12/18/98
Seattle, WA 98133	Project Manager: Timothy Warner	Reported: 12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
B 23			**B812397-03**				**Water**	
Acetone	1280743	12/28/98	12/29/98		10.0	ND	ug/l	
Benzene	"	"	"		1.00	ND	"	
Bromobenzene	"	"	"		1.00	ND	"	
Bromochloromethane	"	"	"		1.00	ND	"	
Bromodichloromethane	"	"	"		1.00	ND	"	
Bromoform	"	"	"		1.00	ND	"	
Bromomethane	"	"	"		1.00	ND	"	
2-Butanone	"	"	"		10.0	ND	"	
n-Butylbenzene	"	"	"		1.00	ND	"	
sec-Butylbenzene	"	"	"		1.00	ND	"	
tert-Butylbenzene	"	"	"		1.00	ND	"	
Carbon disulfide	"	"	"		1.00	ND	"	
Carbon tetrachloride	"	"	"		1.00	ND	"	
Chlorobenzene	"	"	"		1.00	ND	"	
Chloroethane	"	"	"		1.00	ND	"	
Chloroform	"	"	"		1.00	ND	"	
Chloromethane	"	"	"		5.00	ND	"	
2-Chlorotoluene	"	"	"		1.00	ND	"	
4-Chlorotoluene	"	"	"		1.00	ND	"	
Dibromochloromethane	"	"	"		1.00	ND	"	
1,2-Dibromo-3-chloropropane	"	"	"		5.00	ND	"	
1,2-Dibromoethane	"	"	"		1.00	ND	"	
Dibromomethane	"	"	"		1.00	ND	"	
1,2-Dichlorobenzene	"	"	"		1.00	ND	"	
1,3-Dichlorobenzene	"	"	"		1.00	ND	"	
1,4-Dichlorobenzene	"	"	"		1.00	ND	"	
Dichlorodifluoromethane	"	"	"		1.00	ND	"	
1,1-Dichloroethane	"	"	"		1.00	ND	"	
1,2-Dichloroethane	"	"	"		1.00	ND	"	
1,1-Dichloroethene	"	"	"		1.00	ND	"	
cis-1,2-Dichloroethene	"	"	"		1.00	**3.49**	"	
trans-1,2-Dichloroethene	"	"	"		1.00	ND	"	
1,2-Dichloropropane	"	"	"		1.00	ND	"	
1,3-Dichloropropane	"	"	"		1.00	ND	"	
2,2-Dichloropropane	"	"	"		1.00	ND	"	
1,1-Dichloropropene	"	"	"		1.00	ND	"	
cis-1,3-Dichloropropene	"	"	"		1.00	ND	"	
trans-1,3-Dichloropropene	"	"	"		1.00	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Steve Davis, Project Manager

Terra Vac	Project: GWCC	Sampled: 12/17/98
10740 Meridian Ave N Suite 202	Project Number: 32-0039	Received: 12/18/98
Seattle, WA 98133	Project Manager: Timothy Warner	Reported: 12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
B 23 (continued)			**B812397-03**				**Water**	
Ethylbenzene	1280743	12/28/98	12/29/98		1.00	ND	ug/l	
Hexachlorobutadiene	"	"	"		1.00	ND	"	
2-Hexanone	"	"	"		10.0	ND	"	
Isopropylbenzene	"	"	"		1.00	ND	"	
p-Isopropyltoluene	"	"	"		1.00	ND	"	
Methylene chloride	"	"	"		5.00	ND	"	
4-Methyl-2-pentanone	"	"	"		10.0	ND	"	
Naphthalene	"	"	"		1.00	ND	"	
n-Propylbenzene	"	"	"		1.00	ND	"	
Styrene	"	"	"		1.00	ND	"	
1,1,1,2-Tetrachloroethane	"	"	"		1.00	ND	"	
1,1,2,2-Tetrachloroethane	"	"	"		1.00	ND	"	
Tetrachloroethene	"	"	"		1.00	**7.20**	"	
Toluene	"	"	"		1.00	ND	"	
1,2,3-Trichlorobenzene	"	"	"		1.00	ND	"	
1,2,4-Trichlorobenzene	"	"	"		1.00	ND	"	
1,1,1-Trichloroethane	"	"	"		1.00	ND	"	
1,1,2-Trichloroethane	"	"	"		1.00	ND	"	
Trichloroethene	"	"	"		1.00	**7.96**	"	
Trichlorofluoromethane	"	"	"		1.00	ND	"	
1,2,3-Trichloropropane	"	"	"		1.00	ND	"	
1,2,4-Trimethylbenzene	"	"	"		1.00	ND	"	
1,3,5-Trimethylbenzene	"	"	"		1.00	ND	"	
Vinyl chloride	"	"	"		1.00	ND	"	
m,p-Xylene	"	"	"		2.00	ND	"	
o-Xylene	"	"	"		1.00	ND	"	
Surrogate: 2-Bromopropene	"	"	"	*80.0-120*		*97.0*	%	
Surrogate: 1,2-DCA-d4	"	"	"	*80.0-120*		*109*	"	
Surrogate: Toluene-d8	"	"	"	*80.0-120*		*99.5*	"	
Surrogate: 4-BFB	"	"	"	*80.0-120*		*97.0*	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions*

Steve Davis, Project Manager

Terra Vac	Project: GWCC	Sampled: 12/17/98
10740 Meridian Ave N Suite 202	Project Number: 32-0039	Received: 12/18/98
Seattle, WA 98133	Project Manager: Timothy Warner	Reported: 12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1280743	**Date Prepared: 12/28/98**				**Extraction Method: EPA 5030B [P/T]**					
Blank	**1280743-BLK1**									
Acrolein	12/28/98			ND	ug/l	5.00				
Iodomethane	"			ND	"	5.00				
t-1,4-Dichloro-2-butene	"			ND	"	5.00				
Vinyl acetate	"			ND	"	5.00				
Acetone	"			ND	"	10.0				
Benzene	"			ND	"	1.00				
Bromobenzene	"			ND	"	1.00				
Bromochloromethane	"			ND	"	1.00				
Bromodichloromethane	"			ND	"	1.00				
Bromoform	"			ND	"	1.00				
Bromomethane	"			ND	"	1.00				
2-Butanone	"			ND	"	10.0				
n-Butylbenzene	"			ND	"	1.00				
sec-Butylbenzene	"			ND	"	1.00				
tert-Butylbenzene	"			ND	"	1.00				
Carbon disulfide	"			ND	"	1.00				
Carbon tetrachloride	"			ND	"	1.00				
Chlorobenzene	"			ND	"	1.00				
Chloroethane	"			ND	"	1.00				
Chloroform	"			ND	"	1.00				
Chloromethane	"			ND	"	5.00				
2-Chlorotoluene	"			ND	"	1.00				
4-Chlorotoluene	"			ND	"	1.00				
Dibromochloromethane	"			ND	"	1.00				
1,2-Dibromo-3-chloropropane	"			ND	"	5.00				
1,2-Dibromoethane	"			ND	"	1.00				
Dibromomethane	"			ND	"	1.00				
1,2-Dichlorobenzene	"			ND	"	1.00				
1,3-Dichlorobenzene	"			ND	"	1.00				
1,4-Dichlorobenzene	"			ND	"	1.00				
Dichlorodifluoromethane	"			ND	"	1.00				
1,1-Dichloroethane	"			ND	"	1.00				
1,2-Dichloroethane	"			ND	"	1.00				
1,1-Dichloroethene	"			ND	"	1.00				
cis-1,2-Dichloroethene	"			ND	"	1.00				
trans-1,2-Dichloroethene	"			ND	"	1.00				
1,2-Dichloropropane	"			ND	"	1.00				

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions*

Steve Davis, Project Manager

Terra Vac	Project: GWCC	Sampled: 12/17/98
10740 Meridian Ave N Suite 202	Project Number: 32-0039	Received: 12/18/98
Seattle, WA 98133	Project Manager: Timothy Warner	Reported: 12/30/98 15:17

Volatile Organic Compounds by EPA Method 8260B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes
Blank (continued)	**1280743-BLK1**									
1,3-Dichloropropane	12/28/98			ND	ug/l	1.00				
2,2-Dichloropropane	"			ND	"	1.00				
1,1-Dichloropropene	"			ND	"	1.00				
cis-1,3-Dichloropropene	"			ND	"	1.00				
trans-1,3-Dichloropropene	"			ND	"	1.00				
Ethylbenzene	"			ND	"	1.00				
Hexachlorobutadiene	"			ND	"	1.00				
2-Hexanone	"			ND	"	10.0				
Isopropylbenzene	"			ND	"	1.00				
p-Isopropyltoluene	"			ND	"	1.00				
Methylene chloride	"			ND	"	5.00				
4-Methyl-2-pentanone	"			ND	"	10.0				
Naphthalene	"			ND	"	1.00				
n-Propylbenzene	"			ND	"	1.00				
Styrene	"			ND	"	1.00				
1,1,1,2-Tetrachloroethane	"			ND	"	1.00				
1,1,2,2-Tetrachloroethane	"			ND	"	1.00				
Tetrachloroethene	"			ND	"	1.00				
Toluene	"			ND	"	1.00				
1,2,3-Trichlorobenzene	"			ND	"	1.00				
1,2,4-Trichlorobenzene	"			ND	"	1.00				
1,1,1-Trichloroethane	"			ND	"	1.00				
1,1,2-Trichloroethane	"			ND	"	1.00				
Trichloroethene	"			ND	"	1.00				
Trichlorofluoromethane	"			ND	"	1.00				
1,2,3-Trichloropropane	"			ND	"	1.00				
1,2,4-Trimethylbenzene	"			ND	"	1.00				
1,3,5-Trimethylbenzene	"			ND	"	1.00				
Vinyl chloride	"			ND	"	1.00				
m,p-Xylene	"			ND	"	2.00				
o-Xylene	"			ND	"	1.00				
Surrogate: 2-Bromopropene	"	*20.0*		*19.4*	"	*80.0-120*	*97.0*			
Surrogate: 1,2-DCA-d4	"	*20.0*		*20.1*	"	*80.0-120*	*101*			
Surrogate: Toluene-d8	"	*20.0*		*19.8*	"	*80.0-120*	*99.0*			
Surrogate: 4-BFB	"	*20.0*		*19.4*	"	*80.0-120*	*97.0*			
LCS	**1280743-BS1**									
Benzene	12/28/98	10.0		10.4	ug/l	80.0-120	104			

Volatile Organic Compounds by EPA Method 8260B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	**Reporting Limit** Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
LCS (continued)	**1280743-BS1**									
Chlorobenzene	12/28/98	10.0		10.1	ug/l	80.0-120	101			
1,1-Dichloroethene	"	10.0		9.60	"	80.0-120	96.0			
Toluene	"	10.0		9.66	"	80.0-120	96.6			
Trichloroethene	"	10.0		10.1	"	80.0-120	101			
Surrogate: 2-Bromopropene	"	*20.0*		*19.2*	"	*80.0-120*	*96.0*			
Surrogate: 1,2-DCA-d4	"	*20.0*		*21.3*	"	*80.0-120*	*106*			
Surrogate: Toluene-d8	"	*20.0*		*19.8*	"	*80.0-120*	*99.0*			
Surrogate: 4-BFB	"	*20.0*		*19.4*	"	*80.0-120*	*97.0*			
Matrix Spike	**1280743-MS1**		**B812325-01**							
Benzene	12/28/98	10.0	ND	11.0	ug/l	80.0-120	**110**			
Chlorobenzene	"	10.0	ND	10.4	"	80.0-120	**104**			
1,1-Dichloroethene	"	10.0	ND	10.3	"	80.0-120	**103**			
Toluene	"	10.0	ND	10.0	"	80.0-120	**100**			
Trichloroethene	"	10.0	ND	10.8	"	80.0-120	**108**			
Surrogate: 2-Bromopropene	"	*20.0*		*19.2*	"	*80.0-120*	*96.0*			
Surrogate: 1,2-DCA-d4	"	*20.0*		*22.2*	"	*80.0-120*	*111*			
Surrogate: Toluene-d8	"	*20.0*		*19.6*	"	*80.0-120*	*98.0*			
Surrogate: 4-BFB	"	*20.0*		*19.2*	"	*80.0-120*	*96.0*			
Matrix Spike Dup	**1280743-MSD1**		**B812325-01**							
Benzene	12/28/98	10.0	ND	10.9	ug/l	80.0-120	**109**	15.0	**0.913**	
Chlorobenzene	"	10.0	ND	10.4	"	80.0-120	**104**	15.0	**0**	
1,1-Dichloroethene	"	10.0	ND	10.2	"	80.0-120	**102**	15.0	**0.976**	
Toluene	"	10.0	ND	9.94	"	80.0-120	**99.4**	15.0	**0.602**	
Trichloroethene	"	10.0	ND	10.7	"	80.0-120	**107**	15.0	**0.930**	
Surrogate: 2-Bromopropene	"	*20.0*		*19.4*	"	*80.0-120*	*97.0*			
Surrogate: 1,2-DCA-d4	"	*20.0*		*22.0*	"	*80.0-120*	*110*			
Surrogate: Toluene-d8	"	*20.0*		*19.7*	"	*80.0-120*	*98.5*			
Surrogate: 4-BFB	"	*20.0*		*19.4*	"	*80.0-120*	*97.0*			

Terra Vac	Project:	GWCC		Sampled:	12/17/98
10740 Meridian Ave N Suite 202	Project Number:	32-0039		Received:	12/18/98
Seattle, WA 98133	Project Manager:	Timothy Warner		Reported:	12/30/98 15:17

Notes and Definitions

#	Note
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

North Creek Analytical - Bothell

Steve Davis, Project Manager

Chain of Custody

L812511

Page 1 of 1

OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Company: TERRA VAC CORP
Project No.: 32-0039
Project Name: GWCC
Project Manager: T WARNER

Turn Around Requested
(Check One)
☐ Same Day
☐ 24 Hours
☐ 48 Hours
☒ Standard
☐ ______ (other)

Project Chemist: DB

Laboratory No.

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH								% Moisture
	B13	12/17/98	VARIOUS	W	3				X															B812397-01	
	B22	↓		W	3				X															02	
	B23	12/17/98		W	3				X															03	

RELINQUISHED BY: K CATTERALL
FIRM: TERRA VAC
DATE: 12/18/98
TIME: 10/40 am
RECEIVED BY: S. Widec...
FIRM: NCA
DATE: 12/18/98
TIME: 1040

RELINQUISHED BY: S. Widec...
FIRM: NCA
DATE: 12/18/98
TIME: 1330
RECEIVED BY: Cathy Hick...
FIRM:
DATE: 12/18/98
TIME: 13:30

REVIEWED BY:
DATE REVIEWED:

COMMENTS:
W/O
1.0

OnSite Environmental Inc.
Analytical Testing and Mobile Laboratory Services

January 28, 1999

Tim Warner
Terra Vac
10740 Meridian Ave. North, Suite 202
Seattle, WA 98133-9010

Re: Analytical Data for Project 32-0039
Laboratory Reference No. 9901-116

Dear Tim:

Enclosed are the analytical results and associated quality control data for samples submitted on January 25, 1999.

The standard policy of OnSite Environmental Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Chemist

Enclosures

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	1-26-99
Date Analyzed:	1-26-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-116-01
Client ID:	**TB-1**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	54		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	130		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	4300		100
1,3-Dichloropropane	ND		10
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	01-116-01
Client ID:	**TB-1**

Compound	**Results**	**Flags**	**PQL**
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Bromoform	ND		50
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3-Dichlorobenzene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	100	71-133
Toluene-d8	93	80-151
4-Bromofluorobenzene	97	75-139

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	1-26-99
Date Analyzed:	1-26-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-116-02
Client ID:	**TB-2**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	10		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	60		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	74		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	2700		100
1,3-Dichloropropane	ND		10
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 2 of 2

Lab ID:	01-116-02
Client ID:	**TB-2**

Compound	**Results**	**Flags**	**PQL**
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Bromoform	ND		50
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3-Dichlorobenzene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	100	71-133
Toluene-d8	102	80-151
4-Bromofluorobenzene	94	75-139

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	1-26-99
Date Analyzed:	1-26-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-116-03
Client ID:	**TB-3**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	18		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	41		10
Chloroform	ND		10
1,1,1-Trichloroethane	13		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	52		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	2100		100
1,3-Dichloropropane	ND		10
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	01-116-03
Client ID:	**TB-3**

Compound	**Results**	**Flags**	**PQL**
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Bromoform	ND		50
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3-Dichlorobenzene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	98	71-133
Toluene-d8	100	80-151
4-Bromofluorobenzene	105	75-139

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	1-26-99
Date Analyzed:	1-26-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-116-04
Client ID:	**TB-4**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	15		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	28		10
Chloroform	ND		10
1,1,1-Trichloroethane	16		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	36		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	2400		100
1,3-Dichloropropane	ND		10
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	01-116-04
Client ID:	**TB-4**

Compound	**Results**	**Flags**	**PQL**
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Bromoform	ND		50
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3-Dichlorobenzene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	99	71-133
Toluene-d8	93	80-151
4-Bromofluorobenzene	102	75-139

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 1 of 2

Date Extracted: 1-26-99
Date Analyzed: 1-26-99

Matrix: Water
Units: ug/L (ppb)

Lab ID: MB0126W1

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 2 of 2

Lab ID: MB0126W1

Compound	Results	Flags	PQL
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Bromoform	ND		5.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	98	71-133
Toluene-d8	105	80-151
4-Bromofluorobenzene	96	75-139

Date of Report: January 28, 1999
Samples Submitted: January 25, 1999
Lab Traveler: 01-116
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
SB/SBD QUALITY CONTROL

Date Extracted:	1-25-99
Date Analyzed:	1-25-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	SB0125W1

Compound	**Spike Amount**	**SB**	**Percent Recovery**	**SBD**	**Percent Recovery**	**RPD**
1,1-Dichloroethene	50.0	45.1	90	46.7	93	3.4
Benzene	50.0	54.3	109	53.2	106	2.0
Trichloroethene	50.0	52.9	106	51.7	103	2.2
Toluene	50.0	39.1	78	40.5	81	3.5
Chlorobenzene	50.0	47.7	95	47.6	95	0.19

OnSite
Environmental Inc.

DATA QUALIFIERS AND ABBREVIATIONS

A - Due to high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

D - Data from 1:____ dilution.

E - The value reported exceeds the quantitation range, and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

G - Insufficient sample quantity for duplicate analysis.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeniety. The sample was re-extracted and re-analyzed with similar results.

M - Predominantly ____________ range hydrocarbons present in the sample.

N - Hydrocarbons in the gasoline range (C7-toluene) are present in the sample.

O - Hydrocarbons in the heavy oil range (>C24) are present in the sample.

P - Hydrocarbons in the diesel range (C12-C24) are present in the sample which are elevating the oil result.

Q - The RPD of the results between the two columns is greater than 25.

R - Hydrocarbons outside the defined gasoline range are present in the sample; NWTPH-Dx recommended.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

X - Sample underwent silica gel cleanup procedures.

Y - Sample underwent acid cleanup procedures.

Z - Interferences were present which prevented the quantitation of the analyte below the detection limit reported.

ND - Not Detected
MRL - Method Reporting Limit
PQL - Practical Quantitation

OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Chain of Custody

Page 1 of 1

Company: TERRA VAC
Project No.: 32-0039
Project Name: GWCC
Project Manager: T WARNER

Turn Around Requested (Check One)
☐ Same Day
☐ 24 Hours
☐ 48 Hours
☒ Standard
☐ ________ (other)

Project Chemist: DB
Laboratory No. 01-116

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH								% Moisture
1	TB-1	1/22/99	VARIOUS	W	2					X															
2	TB-2	↓	↓	↓	↓					X															
3	TB-3	↓	↓	↓	↓					X															
4	TB-4	↓	↓	↓	↓					X															

RELINQUISHED BY Peter Catterall	DATE 1/25/99	RECEIVED BY	DATE 1/25/99
FIRM TERRA VAC	TIME	~~FIRM~~ OSE	TIME 9:00 AM
RELINQUISHED BY	DATE	RECEIVED BY	DATE
FIRM	TIME	FIRM	TIME
REVIEWED BY		DATE REVIEWED	

COMMENTS:

DISTRIBUTION LEGEND: White - OnSite Copy Yellow - Report Copy Pink - Client Copy

OnSite Environmental Inc.
Analytical Testing and Mobile Laboratory Services

February 17, 1999

Tim Warner
Terra Vac
10740 Meridian Ave. North, Suite 202
Seattle, WA 98133-9010

Re: Analytical Data for Project 32-0039 NW
Laboratory Reference No. 9902-044

Dear Tim:

Enclosed are the analytical results and associated quality control data for samples submitted on February 8, 1999.

The standard policy of OnSite Environmental Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Chemist

Enclosures

14924 NE 31st Circle • Redmond, WA 98052 • (425) 883-3881 • Fax (425) 885-4603

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-11-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-01
Client ID:	**B-13**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	74		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	180		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	4300		100
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-01
Client ID:	**B-13**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	95	71-133
Toluene-d8	88	80-151
4-Bromofluorobenzene	109	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-02
Client ID:	**B-22**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	44		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	320		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	250		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	1900		10
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-02
Client ID:	**B-22**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	95	71-133
Toluene-d8	95	80-151
4-Bromofluorobenzene	124	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-03
Client ID:	**B-53**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	20		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	36		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	1200		10
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-03
Client ID:	**B-53**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	92	71-133
Toluene-d8	92	80-151
4-Bromofluorobenzene	130	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-04
Client ID:	**B-54**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	ND		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	93		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	3400		100
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-04
Client ID:	**B-54**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	94	71-133
Toluene-d8	86	80-151
4-Bromofluorobenzene	104	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-05
Client ID:	**B-55**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	18		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	35		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	1100		10
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-05
Client ID:	**B-55**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	92	71-133
Toluene-d8	94	80-151
4-Bromofluorobenzene	133	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-06
Client ID:	**B-56**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	10		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	23		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	30		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	1700		10
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-06
Client ID:	**B-56**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	92	71-133
Toluene-d8	94	80-151
4-Bromofluorobenzene	125	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-11-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-07
Client ID:	**B-57**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	5.8		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	12		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	8.4		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	10		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	350		10
1,3-Dichloropropane	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-07
Client ID:	**B-57**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	93	71-133
Toluene-d8	91	80-151
4-Bromofluorobenzene	122	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-08
Client ID:	**DUP**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	11		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	23		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	26		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	1500		10
1,3-Dichloropropane	ND		10

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B

page 2 of 2

Lab ID:	02-044-08
Client ID:	**DUP**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	96	71-133
Toluene-d8	93	80-151
4-Bromofluorobenzene	82	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-11-99
Date Analyzed:	2-11-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-09
Client ID:	**BLANK**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	1.2		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-09
Client ID:	**BLANK**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	92	71-133
Toluene-d8	94	80-151
4-Bromofluorobenzene	137	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-10
Client ID:	**B-28**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	1.0		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	63		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	02-044-10
Client ID:	**B-28**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	92	71-133
Toluene-d8	93	80-151
4-Bromofluorobenzene	117	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 1 of 2

Date Extracted:	2-10-99
Date Analyzed:	2-10-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	MB0210W1

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 2 of 2

Lab ID: MB0210W1

Compound	Results	Flags	PQL
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	94	71-133
Toluene-d8	92	80-151
4-Bromofluorobenzene	118	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 1 of 2

Date Extracted:	2-11-99
Date Analyzed:	2-11-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	MB0211W1

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 2 of 2

Lab ID: MB0211W1

Compound	Results	Flags	PQL
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	91	71-133
Toluene-d8	87	80-151
4-Bromofluorobenzene	121	75-139

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

VOLATILES by EPA 8260B
SB/SBD QUALITY CONTROL

Date Extracted:	2-10-99
Date Analyzed:	2-11-99
Matrix:	Water
Units:	ug/L (ppb)

Lab ID: SB0210W1

Compound	Spike Amount	SB	Percent Recovery	SBD	Percent Recovery	RPD
1,1-Dichloroethene	50.0	46.2	93	46.8	94	1.2
Benzene	50.0	48.4	97	46.4	93	4.3
Trichloroethene	50.0	51.5	103	51.1	102	0.77
Toluene	50.0	36.6	73	41.9	84	13
Chlorobenzene	50.0	47.1	94	49.0	98	3.9

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C

page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-03
Client ID:	**B-53**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C

page 2 of 3

Lab ID:	02-044-03
Client ID:	**B-53**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-03
Client ID:	**B-53**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	2.1		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	47	21 - 100
Phenol-d5	35	10 - 94
Nitrobenzene-d5	50	35 - 114
2-Fluorobiphenyl	66	43 - 116
2,4,6-Tribromophenol	42	10 - 123
Terphenyl-d14	49	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C

page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-04
Client ID:	**B-54**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C

page 2 of 3

Lab ID:	02-044-04
Client ID:	**B-54**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-04
Client ID:	**B-54**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	ND		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	57	21 - 100
Phenol-d5	43	10 - 94
Nitrobenzene-d5	60	35 - 114
2-Fluorobiphenyl	77	43 - 116
2,4,6-Tribromophenol	44	10 - 123
Terphenyl-d14	48	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-05
Client ID:	**B-55**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID: 02-044-05
Client ID: **B-55**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-05
Client ID:	**B-55**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	ND		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	45	21 - 100
Phenol-d5	35	10 - 94
Nitrobenzene-d5	51	35 - 114
2-Fluorobiphenyl	66	43 - 116
2,4,6-Tribromophenol	45	10 - 123
Terphenyl-d14	46	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C

page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-06
Client ID:	**B-56**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID:	02-044-06
Client ID:	**B-56**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-06
Client ID:	**B-56**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	1.0		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	46	21 - 100
Phenol-d5	37	10 - 94
Nitrobenzene-d5	55	35 - 114
2-Fluorobiphenyl	69	43 - 116
2,4,6-Tribromophenol	44	10 - 123
Terphenyl-d14	45	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C

page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-07
Client ID:	**B-57**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID: 02-044-07
Client ID: **B-57**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-07
Client ID:	**B-57**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	1.6		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	44	21 - 100
Phenol-d5	34	10 - 94
Nitrobenzene-d5	51	35 - 114
2-Fluorobiphenyl	67	43 - 116
2,4,6-Tribromophenol	44	10 - 123
Terphenyl-d14	45	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-08
Client ID:	**DUP**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID:	02-044-08
Client ID:	**DUP**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-08
Client ID:	**DUP**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	1.5		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	44	21 - 100
Phenol-d5	35	10 - 94
Nitrobenzene-d5	51	35 - 114
2-Fluorobiphenyl	67	43 - 116
2,4,6-Tribromophenol	43	10 - 123
Terphenyl-d14	45	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	02-044-10
Client ID:	**B-28**

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 2 of 3

Lab ID:	02-044-10
Client ID:	**B-28**

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
page 3 of 3

Lab ID:	02-044-10
Client ID:	**B-28**

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	1.1		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	51	21 - 100
Phenol-d5	40	10 - 94
Nitrobenzene-d5	58	35 - 114
2-Fluorobiphenyl	73	43 - 116
2,4,6-Tribromophenol	42	10 - 123
Terphenyl-d14	49	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
METHOD BLANK QUALITY CONTROL

page 1 of 3

Date Extracted:	2-8-99
Date Analyzed:	2-12-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	MB0208W1

Compound:	**Results**	**Flags**	**PQL**
Aniline	ND		1.0
bis(2-Chloroethyl)ether	ND		1.0
Phenol	ND		5.0
2-Chlorophenol	ND		5.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
Benzyl alcohol	ND		1.0
bis(2-chloroisopropyl)ether	ND		1.0
2-Methylphenol	ND		5.0
Hexachloroethane	ND		1.0
N-Nitroso-di-n-propylamine	ND		1.0
4-Methylphenol	ND		1.0
Nitrobenzene	ND		1.0
Isophorone	ND		1.0
2-Nitrophenol	ND		10
2,4-Dimethylphenol	ND		5.0
bis(2-Chloroethoxy)methane	ND		1.0
2,4-Dichlorophenol	ND		5.0
Benzoic acid	ND		15
1,2,4-Trichlorobenzene	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
METHOD BLANK QUALITY CONTROL
page 2 of 3

Lab ID: MB0208W1

Compound:	Results	**Flags**	PQL
Naphthalene	ND		1.0
4-Chloroaniline	ND		1.0
Hexachlorobutadiene	ND		1.0
4-Chloro-3-methylphenol	ND		5.0
2-Methylnaphthalene	ND		1.0
Hexachlorocyclopentadiene	ND		1.0
2,4,6-Trichlorophenol	ND		5.0
2,4,5-Trichlorophenol	ND		5.0
2-Chloronaphthalene	ND		1.0
2-Nitroaniline	ND		1.0
Acenaphthylene	ND		1.0
Dimethylphthalate	ND		1.0
2,6-Dinitrotoluene	ND		2.0
Acenaphthene	ND		1.0
3-Nitroaniline	ND		1.0
2,4-Dinitrophenol	ND		10
Dibenzofuran	ND		1.0
2,4-Dinitrotoluene	ND		1.0
4-Nitrophenol	ND		10
Fluorene	ND		1.0
4-Chlorophenyl-phenylether	ND		1.0
Diethylphthalate	ND		1.0
4-Nitroaniline	ND		2.0
4,6-Dinitro-2-methylphenol	ND		10
n-Nitrosodiphenylamine	ND		1.0
4-Bromophenyl-phenylether	ND		1.0
Hexachlorobenzene	ND		1.0
Pentachlorophenol	ND		10
Phenanthrene	ND		1.0
Anthracene	ND		1.0
Carbazole	ND		1.0

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
METHOD BLANK QUALITY CONTROL
page 3 of 3

Lab ID: MB0208W1

Compound:	Results	**Flags**	PQL
Di-n-butylphthalate	ND		1.0
Fluoranthene	ND		1.0
Benzidine	ND		1.0
Pyrene	ND		1.0
Butylbenzylphthalate	ND		1.0
3,3'-Dichlorobenzidine	ND		1.0
Benzo[a]anthracene	ND		1.0
Chrysene	ND		1.0
bis(2-Ethylhexyl)phthalate	ND		1.0
Di-n-octylphthalate	ND		1.0
Benzo[b]fluoranthene	ND		1.0
Benzo[k]fluoranthene	ND		1.0
Benzo[a]pyrene	ND		1.0
Indeno[1,2,3-cd]pyrene	ND		1.0
Dibenz[a,h]anthracene	ND		1.0
Benzo[g,h,i]perylene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
2-Fluorophenol	53	21 - 100
Phenol-d5	42	10 - 94
Nitrobenzene-d5	56	35 - 114
2-Fluorobiphenyl	71	43 - 116
2,4,6-Tribromophenol	45	10 - 123
Terphenyl-d14	69	33 - 144

Date of Report: February 17, 1999
Samples Submitted: February 8, 1999
Lab Traveler: 02-044
Project: 32-0039 NW

SEMIVOLATILES by EPA 8270C
SB/SBD QUALITY CONTROL

Date Extracted:	1-26-99
Date Analyzed:	1-27-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	SB0126W1

Compound:	Spike Amount	SB	Percent Recovery	SBD	Percent Recovery	RPD
Phenol	100	38.2	38	43.6	44	13
2-Chlorophenol	100	69.1	69	70.9	71	2.6
1,4-Dichlorobenzene	50.0	34.5	69	33.9	68	1.8
N-Nitroso-di-n-propylamine	50.0	33.7	67	33.1	66	1.8
1,2,4-Trichlorobenzene	50.0	36.6	73	34.4	69	6.2
4-Chloro-3-methylphenol	100	92.9	93	79.6	80	15
Acenaphthene	50.0	42.1	84	41.3	83	1.9
2,4-Dinitrotoluene	50.0	41.4	83	40.7	81	1.7
4-Nitrophenol	100	40.6	41	42.1	42	3.6
Pentachlorophenol	100	39.6	40	31.1	31	24
Pyrene	50.0	45.7	91	43.2	86	5.6

DATA QUALIFIERS AND ABBREVIATIONS

A - Due to high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

D - Data from 1:____ dilution.

E - The value reported exceeds the quantitation range, and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

G - Insufficient sample quantity for duplicate analysis.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeniety. The sample was re-extracted and re-analyzed with similar results.

M - Predominantly ______________ range hydrocarbons present in the sample.

N - Hydrocarbons in the gasoline range (C7-toluene) are present in the sample.

O - Hydrocarbons in the heavy oil range (>C24) are present in the sample.

P - Hydrocarbons in the diesel range (C12-C24) are present in the sample which are elevating the oil result.

Q - The RPD of the results between the two columns is greater than 25.

R - Hydrocarbons outside the defined gasoline range are present in the sample; NWTPH-Dx recommended.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ______________.

U - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

X - Sample underwent silica gel cleanup procedures.

Y - Sample underwent acid cleanup procedures.

Z - Interferences were present which prevented the quantitation of the analyte below the detection limit reported.

ND - Not Detected
MRL - Method Reporting Limit
PQL - Practical Quantitation

Chain of Custody

Page 1 of 1

OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Company: TERRA VAC
Project No.: 32-0039 NW
Project Name: GWCC
Project Manager: T WARNER

Turn Around Requested (Check One)
☐ Same Day
☐ 24 Hours
☐ 48 Hours
☒ Standard
☐ ________ (other)

Project Chemist: DB

Laboratory No. 02-044

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH	% Moisture
1	B-13	2/5/99		W	2				X									
2	B-22			W	2				X									
3	B-53			W	3				X		X							
4	B-54		VARIOUS	W	3				X		X							
5	B-55			W	3				X		X							
6	B-56			W	3				X		X							
7	B-57			W	3				X		X							
8	DUP.			W	3				X		X							
9	BLANK			W	2				X									
10	B-28 added 2/8	2/6/99		W	3				X		X							

RELINQUISHED BY: PETER CATTERALL
DATE: 2/8/99
FIRM: TERRA VAC
TIME: 11:58

RECEIVED BY: Speedy 47
DATE:
FIRM:
TIME:

RELINQUISHED BY:
DATE:
FIRM:
TIME:

RECEIVED BY: Rachel Anderson
DATE: 2/8/99
FIRM: OnSite
TIME: 11:15am

REVIEWED BY:
DATE REVIEWED:

COMMENTS:

OnSite Environmental Inc.
Analytical Testing and Mobile Laboratory Services

April 14, 1999

Tim Warner
Terra Vac
10740 Meridian Ave. North, Suite 202
Seattle, WA 98133-9010

Re: Analytical Data for Project 32-0039
Laboratory Reference No. 9904-063

Dear Tim:

Enclosed are the analytical results and associated quality control data for samples submitted on April 9, 1999.

The standard policy of OnSite Environmental Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Chemist

Enclosures

14924 NE 31st Circle • Redmond, WA 98052 • (425) 883-3881 • Fax (425) 885-4603

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	04-063-01
Client ID:	**B-53**

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		5
Chloromethane	ND		5
Vinyl Chloride	ND		5
Bromomethane	ND		5
Chloroethane	ND		5
Trichlorofluoromethane	ND		5
1,1-Dichloroethene	ND		5
Methylene Chloride	ND		25
(trans) 1,2-Dichloroethene	ND		5
1,1-Dichloroethane	ND		5
2,2-Dichloropropane	ND		5
(cis) 1,2-Dichloroethene	19		5
Chloroform	ND		5
1,1,1-Trichloroethane	ND		25
Carbon Tetrachloride	ND		5
1,1-Dichloropropene	ND		5
1,2-Dichloroethane	ND		5
Trichloroethene	37		5
1,2-Dichloropropane	ND		5
Dibromomethane	ND		5
Bromodichloromethane	ND		25
2-Chloroethyl Vinyl Ether	ND		100
(cis) 1,3-Dichloropropene	ND		5
(trans) 1,3-Dichloropropene	ND		5
1,1,2-Trichloroethane	ND		5
Tetrachloroethene	930		5
1,3-Dichloropropane	ND		5

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID: 04-063-01
Client ID: **B-53**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		5
1,2-Dibromoethane	ND		5
Chlorobenzene	ND		5
1,1,1,2-Tetrachloroethane	ND		5
Bromoform	ND		5
Bromobenzene	ND		5
1,1,2,2-Tetrachloroethane	ND		25
1,2,3-Trichloropropane	ND		25
2-Chlorotoluene	ND		5
4-Chlorotoluene	ND		5
1,3-Dichlorobenzene	ND		5
1,4-Dichlorobenzene	ND		5
1,2-Dichlorobenzene	ND		5
1,2-Dibromo-3-chloropropane	ND		25
1,2,4-Trichlorobenzene	ND		25
Hexachlorobutadiene	ND		5
1,2,3-Trichlorobenzene	ND		25

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	123	71-133
Toluene-d8	120	80-151
4-Bromofluorobenzene	99	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	04-063-02
Client ID:	**B-54**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		20
Chloromethane	ND		20
Vinyl Chloride	ND		20
Bromomethane	ND		20
Chloroethane	ND		20
Trichlorofluoromethane	ND		20
1,1-Dichloroethene	ND		20
Methylene Chloride	ND		100
(trans) 1,2-Dichloroethene	ND		20
1,1-Dichloroethane	ND		20
2,2-Dichloropropane	ND		20
(cis) 1,2-Dichloroethene	ND		20
Chloroform	ND		20
1,1,1-Trichloroethane	ND		100
Carbon Tetrachloride	ND		20
1,1-Dichloropropene	ND		20
1,2-Dichloroethane	ND		20
Trichloroethene	170		20
1,2-Dichloropropane	ND		20
Dibromomethane	ND		20
Bromodichloromethane	ND		100
2-Chloroethyl Vinyl Ether	ND		400
(cis) 1,3-Dichloropropene	ND		20
(trans) 1,3-Dichloropropene	ND		20
1,1,2-Trichloroethane	ND		20
Tetrachloroethene	4100		20
1,3-Dichloropropane	ND		20

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 2 of 2

Lab ID: 04-063-02
Client ID: B-54

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		20
1,2-Dibromoethane	ND		20
Chlorobenzene	ND		20
1,1,1,2-Tetrachloroethane	ND		20
Bromoform	ND		20
Bromobenzene	ND		20
1,1,2,2-Tetrachloroethane	ND		100
1,2,3-Trichloropropane	ND		100
2-Chlorotoluene	ND		20
4-Chlorotoluene	ND		20
1,3-Dichlorobenzene	ND		20
1,4-Dichlorobenzene	ND		20
1,2-Dichlorobenzene	ND		20
1,2-Dibromo-3-chloropropane	ND		100
1,2,4-Trichlorobenzene	ND		100
Hexachlorobutadiene	ND		20
1,2,3-Trichlorobenzene	ND		100

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	120	71-133
Toluene-d8	123	80-151
4-Bromofluorobenzene	100	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	04-063-03
Client ID:	**B-55**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		5.0
Chloromethane	ND		5.0
Vinyl Chloride	ND		5.0
Bromomethane	ND		5.0
Chloroethane	ND		5.0
Trichlorofluoromethane	ND		5.0
1,1-Dichloroethene	ND		5.0
Methylene Chloride	ND		25
(trans) 1,2-Dichloroethene	ND		5.0
1,1-Dichloroethane	ND		5.0
2,2-Dichloropropane	ND		5.0
(cis) 1,2-Dichloroethene	22		5.0
Chloroform	ND		5.0
1,1,1-Trichloroethane	ND		25
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		5.0
1,2-Dichloroethane	ND		5.0
Trichloroethene	32		5.0
1,2-Dichloropropane	ND		5.0
Dibromomethane	ND		5.0
Bromodichloromethane	ND		25
2-Chloroethyl Vinyl Ether	ND		100
(cis) 1,3-Dichloropropene	ND		5.0
(trans) 1,3-Dichloropropene	ND		5.0
1,1,2-Trichloroethane	ND		5.0
Tetrachloroethene	780		5.0
1,3-Dichloropropane	ND		5.0

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 2 of 2

Lab ID:	04-063-03
Client ID:	**B-55**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		5.0
1,2-Dibromoethane	ND		5.0
Chlorobenzene	ND		5.0
1,1,1,2-Tetrachloroethane	ND		5.0
Bromoform	ND		5.0
Bromobenzene	ND		5.0
1,1,2,2-Tetrachloroethane	ND		25
1,2,3-Trichloropropane	ND		25
2-Chlorotoluene	ND		5.0
4-Chlorotoluene	ND		5.0
1,3-Dichlorobenzene	ND		5.0
1,4-Dichlorobenzene	ND		5.0
1,2-Dichlorobenzene	ND		5.0
1,2-Dibromo-3-chloropropane	ND		25
1,2,4-Trichlorobenzene	ND		25
Hexachlorobutadiene	ND		5.0
1,2,3-Trichlorobenzene	ND		25

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	120	71-133
Toluene-d8	121	80-151
4-Bromofluorobenzene	95	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	04-063-04
Client ID:	**B-56**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	ND		10
1,1-Dichloroethane	20		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	26		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		50
Carbon Tetrachloride	ND		10
1,1-Dichloropropene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	49		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		50
2-Chloroethyl Vinyl Ether	ND		200
(cis) 1,3-Dichloropropene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	1600		10
1,3-Dichloropropane	ND		10

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 2 of 2

Lab ID: 04-063-04
Client ID: B-56

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Bromoform	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		50
1,2,3-Trichloropropane	ND		50
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3-Dichlorobenzene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		50
Hexachlorobutadiene	ND		10
1,2,3-Trichlorobenzene	ND		50

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	119	71-133
Toluene-d8	119	80-151
4-Bromofluorobenzene	103	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	04-063-05
Client ID:	**B-57**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		5.0
Chloromethane	ND		5.0
Vinyl Chloride	ND		5.0
Bromomethane	ND		5.0
Chloroethane	ND		5.0
Trichlorofluoromethane	ND		5.0
1,1-Dichloroethene	ND		5.0
Methylene Chloride	ND		25
(trans) 1,2-Dichloroethene	ND		5.0
1,1-Dichloroethane	12		5.0
2,2-Dichloropropane	ND		5.0
(cis) 1,2-Dichloroethene	20		5.0
Chloroform	ND		5.0
1,1,1-Trichloroethane	ND		25
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		5.0
1,2-Dichloroethane	ND		5.0
Trichloroethene	19		5.0
1,2-Dichloropropane	ND		5.0
Dibromomethane	ND		5.0
Bromodichloromethane	ND		25
2-Chloroethyl Vinyl Ether	ND		100
(cis) 1,3-Dichloropropene	ND		5.0
(trans) 1,3-Dichloropropene	ND		5.0
1,1,2-Trichloroethane	ND		5.0
Tetrachloroethene	400		5.0
1,3-Dichloropropane	ND		5.0

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	04-063-05
Client ID:	**B-57**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		5.0
1,2-Dibromoethane	ND		5.0
Chlorobenzene	ND		5.0
1,1,1,2-Tetrachloroethane	ND		5.0
Bromoform	ND		5.0
Bromobenzene	ND		5.0
1,1,2,2-Tetrachloroethane	ND		25
1,2,3-Trichloropropane	ND		25
2-Chlorotoluene	ND		5.0
4-Chlorotoluene	ND		5.0
1,3-Dichlorobenzene	ND		5.0
1,4-Dichlorobenzene	ND		5.0
1,2-Dichlorobenzene	ND		5.0
1,2-Dibromo-3-chloropropane	ND		25
1,2,4-Trichlorobenzene	ND		25
Hexachlorobutadiene	ND		5.0
1,2,3-Trichlorobenzene	ND		25

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	117	71-133
Toluene-d8	120	80-151
4-Bromofluorobenzene	98	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	04-063-06
Client ID:	**B-13**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		50
Chloromethane	ND		50
Vinyl Chloride	ND		50
Bromomethane	ND		50
Chloroethane	ND		50
Trichlorofluoromethane	ND		50
1,1-Dichloroethene	ND		50
Methylene Chloride	ND		250
(trans) 1,2-Dichloroethene	ND		50
1,1-Dichloroethane	ND		50
2,2-Dichloropropane	ND		50
(cis) 1,2-Dichloroethene	100		50
Chloroform	ND		50
1,1,1-Trichloroethane	ND		250
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		50
1,2-Dichloroethane	ND		50
Trichloroethene	220		50
1,2-Dichloropropane	ND		50
Dibromomethane	ND		50
Bromodichloromethane	ND		250
2-Chloroethyl Vinyl Ether	ND		1000
(cis) 1,3-Dichloropropene	ND		50
(trans) 1,3-Dichloropropene	ND		50
1,1,2-Trichloroethane	ND		50
Tetrachloroethene	4600		50
1,3-Dichloropropane	ND		50

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B

page 2 of 2

Lab ID:	04-063-06
Client ID:	**B-13**

Compound	Results	Flags	PQL
Dibromochloromethane	ND		50
1,2-Dibromoethane	ND		50
Chlorobenzene	ND		50
1,1,1,2-Tetrachloroethane	ND		50
Bromoform	ND		50
Bromobenzene	ND		50
1,1,2,2-Tetrachloroethane	ND		250
1,2,3-Trichloropropane	ND		250
2-Chlorotoluene	ND		50
4-Chlorotoluene	ND		50
1,3-Dichlorobenzene	ND		50
1,4-Dichlorobenzene	ND		50
1,2-Dichlorobenzene	ND		50
1,2-Dibromo-3-chloropropane	ND		250
1,2,4-Trichlorobenzene	ND		250
Hexachlorobutadiene	ND		50
1,2,3-Trichlorobenzene	ND		250

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	125	71-133
Toluene-d8	120	80-151
4-Bromofluorobenzene	98	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL

page 1 of 2

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	MB0413W1

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		5.0
Carbon Tetrachloride	ND		1.0
1,1-Dichloropropene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		5.0
2-Chloroethyl Vinyl Ether	ND		20
(cis) 1,3-Dichloropropene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
METHOD BLANK QUALITY CONTROL
page 2 of 2

Lab ID: MB0413W1

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Bromoform	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,2,3-Trichloropropane	ND		5.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		5.0
Hexachlorobutadiene	ND		1.0
1,2,3-Trichlorobenzene	ND		5.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	123	71-133
Toluene-d8	128	80-151
4-Bromofluorobenzene	100	75-139

Date of Report: April 14, 1999
Samples Submitted: April 9, 1999
Lab Traveler: 04-063
Project: 32-0039

HALOGENATED VOLATILES by EPA 8260B
SB/SBD QUALITY CONTROL

Date Extracted:	4-13-99
Date Analyzed:	4-13-99
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	SB0413W1

Compound	Spike Amount	SB	Percent Recovery	SBD	Percent Recovery	RPD
1,1-Dichloroethene	50.0	41.6	83	40.9	82	1.8
Benzene	50.0	42.4	85	43.7	87	2.9
Trichloroethene	50.0	48.2	96	47.8	96	0.77
Toluene	50.0	47.6	95	46.5	93	2.5
Chlorobenzene	50.0	48.1	96	50.4	101	4.6

DATA QUALIFIERS AND ABBREVIATIONS

A - Due to high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

D - Data from 1:____ dilution.

E - The value reported exceeds the quantitation range, and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

G - Insufficient sample quantity for duplicate analysis.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeniety. The sample was re-extracted and re-analyzed with similar results.

M - Predominantly ____________ range hydrocarbons present in the sample.

N - Hydrocarbons in the gasoline range (C7-toluene) are present in the sample.

O - Hydrocarbons in the heavy oil range (>C24) are present in the sample.

P - Hydrocarbons in the diesel range (C12-C24) are present in the sample which are elevating the oil result.

Q - The RPD of the results between the two columns is greater than 25.

R - Hydrocarbons outside the defined gasoline range are present in the sample; NWTPH-Dx recommended.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

X - Sample underwent silica gel cleanup procedures.

Y - Sample underwent acid cleanup procedures.

Z - Interferences were present which prevented the quantitation of the analyte below the detection limit reported.

ND - Not Detected
MRL - Method Reporting Limit
PQL - Practical Quantitation

Chain of Custody

Page 1 of 1

OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Company: Terra Vac
Project No.: 32-0039
Project Name: GWCC
Project Manager: Mr. Tim Warner

Turn Around Requested
(Check One)
☐ Same Day
☐ 24 Hours
☐ 48 Hours
☒ Standard
☒ 3 day (other)

Project Chemist: DB

Laboratory No. 04-063

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH	FOC - Astm 2974-87	Grain Size Dist						% Moisture
1	B-53	4899	1130	W	2					X															
2	B-54		1215							X															
3	B-55		1235							X															
4	B-56		1320							X															
5	B-57		1417							X															
6	B-13		1455							X															
7	B-53		1600	S	Bag														X						X
8	B-53				Jar													X							X
9	B-54				Bag														X						X
10	B-54				Jar													X							X
11	B-57				Bag														X						X
12	B-57				Jar													X							X

RELINQUISHED BY	DATE 4-8-99	RECEIVED BY Peter Catterall	DATE 4/8/99
FIRM Terra Vac	TIME 1700	FIRM Terra Vac	TIME 510 pm
RELINQUISHED BY Kent [illegible]	DATE 4/9/99	RECEIVED BY	DATE 4/9/99
FIRM [illegible]	TIME 8:50am	FIRM OnSite Env	TIME 8:50
REVIEWED BY		DATE REVIEWED	

COMMENTS:

Northwest Corner Investigation

Attachment E

PARCC Analysis

AGENCY REVIEW DRAFT

Northwest Corner Investigation
PARCC Analysis

OnSite Environmental Inc. of Redmond, WA was the primary analytical subcontractor for the Northwest Corner Investigation conducted in early 1999. Groundwater samples taken in 1998 were analyzed by North Creek Analytical of Bothell, Washington.

Groundwater samples in 1998 were analyzed for Volatile Organic Compounds by EPA Method 8260B. Soil and groundwater samples collected in 1999 were analyzed for Halogenated Volatiles by EPA Method 8260B and for Semi-Volatiles by EPA 8270C.

INTERNAL DATA REVIEW

A Terra Vac chemist conducted the internal data review. All of the analytical chemistry data was validated by Saylor Data Solutions, a subcontractor to Floyd & Snider. The Saylor Data Solutions data validation report is attached to this PARCC Analysis. Elements covered in the internal data review include precision, accuracy, representativeness, completeness and comparability (PARCC parameters). Analytical holding times, method blanks, laboratory control spikes and laboratory spike duplicates as well as matrix spike and matrix spike duplicates were reviewed. The following is a summary of the data along with any abnormalities and a conclusion as to the usability of the data.

PARCC PARAMETERS

Precision

Relative percent differences (RPD) in the laboratory control spike and laboratory control spike duplicates were within the laboratory control limits for all sample with the exception of toluene for the 8260 soils on January 27, 1999. The RPD was 16, slightly above the acceptable limit of 15. As this is only slightly above the acceptable laboratory RPD and all the internal standards and surrogates were within the control limits, it is not expected that reported results would have been effected by toluene having a high RPD in the laboratory control spike samples.

Accuracy

Matrix Spike, matrix spike duplicates, laboratory control spike duplicates, internal standard and surrogate recoveries were within the laboratory control limits for each method. Several of the soil and groundwater samples were diluted due to high concentrations of target analytes resulting in higher practical quantitation limits (PQLs). All of the diluted samples were within acceptable PQLs based on the concentrations of the target analytes. Therefore, the raised PQLs are not considered an out-of-control condition.

Representativeness

Representativness is addressed in the workplan for the site and the design of the sampling location. Samples were generally collected in the designated sampling locations. Duplicate groundwater samples were analyzed during both the 1998 and 1999 samplings.

Completeness

Completeness is defined in the CERCLA program as the percentage of measurements made which are judged to be valid measurements (EPA, 1987). The potential data gaps were assessed as well as matching the chain of custodies to the samples received and analyzed by the laboratory. During this investigation, no samples were lost during shipment. All samples received by the laboratory were analyzed according to the corresponding chain of custody. No data qualifier flags were necessary for any of the data. All samples were within both internal laboratory QC/QC parameters and EPA parameters.

Appropriate trip blanks and duplicates were collected where necessary with the exception of the January 22, 1999 groundwater samples collected from the four temporary borings. All the samples analyzed had PQLs of 10 parts per billion (ppb) or greater due to concentrations of tetrachloroethene at 2,100 ppb or greater. Therefore any slight VOC contamination from the transport of the samples would have most likely been diluted and would not be seen in the final data.

No samples were analyzed out of hold time. Therefore, completeness is qualified at 98+ percent for the collected samples.

Comparability

Laboratory spike and matrix spike duplicate samples were generally within laboratory control limits. Field duplicates were within acceptable limits. The duplicate sample for B56 groundwater for semivolatiles had a 50% difference but as the only target compound detected was bis(2-Ethylhexl)phthalate and the concentration detected was 1.0 (ppb) in the sample and 1.5 ppb in the duplicate this result is acceptable.

Duplicate EPA 8260B volatile analysis for B56 had differences no greater than 12% in the target compounds detected.

ADDITIONAL PARAMETERS

Holding Times

Samples were extracted and analyzed within the specified EPA analytical holding times.

Blanks

Blank samples, both field and laboratory had no contamination above the PQLs.

CONCLUSION

The results of the internal data review of the data packages determined that the data was generally of high quality. Appropriate data flags have been applied by the laboratory in those instances where data are required to be qualified according to method protocols or laboratory implementing SOPs. No data had any out-of-control instances that rendered the data unusable. The data, unless otherwise noted, are judged to be valid and usable for their intended purpose.

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Sayler Data Solutions

DATA VALIDATION REPORT

Great Western Terra Vac Data

Prepared for:
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1.0 Introduction

Data validation was performed on the following data:

Sample Date(s)	Lab Batch Number	Report Date	Sample Event
Analytical Resources, Inc. (ARI)			
11/04/98-11/05/98	Z139	11/20/98	1998 Annual Monitoring
Multichem Analytical Services (MAS)			
10/24/97	710072	12/03/97	1997 Annual Monitoring
11/04/97	711008	11/19/97	1997 Annual Monitoring
12/19/97	712048	01/12/98	1997 Annual Monitoring
North Creek Analytical (NCA)			
12/17/98	B812397	12/30/98	GW VOCs NW Corner
OnSite Environmental (OSE)			
04/28/98	04-169	05/05/98	Pre Oxy-Vac Pilot Study
05/28/98	05-177	05/05/98	Gore Sorber Initial
06/22/98	06-159	07/06/98	Pre Oxy-Vac Pilot Study
06/29/98	06-192	07/14/98	Post Oxy-Vac Pilot Study
10/20/98	10-158	10/28/98	1998 Annual Monitoring
10/21/98	10-167	10/29/98	1998 Annual Monitoring
~10/98	10-183	11/03/98	1998 Annual Monitoring
11/03/98	11-021	11/11/98	1998 Annual Monitoring
11/05/98	11-036	11/18/98	1998 Annual Monitoring
~11/98	11-048	11/18/98	Embayment/Seep Sampling
~12/98	12-063	12/11/98	Embayment
01/22/99	01-116	01/28/99	NW Corner-GW
02/03/99	02-030	02/11/99	NW Corner Soil/GW Volatiles
02/05/99	02-044	02/17/99	NW Corner-GW
04/08/99	04-063	04/14/99	NW Corner-GW
07/06/99	07-037	07/21/99	Fox/Myrtle Soil GW Volatiles
07/07/99 – 07/08/99	07-038	07/23/99	Fox/Myrtle Soil GW Volatiles

Sample Date(s)	Lab Batch Number	Report Date	Sample Event
07/08/99	07-047	07/21/99	Fox/Myrtle Soil GW by 8260B
07/09/99	07-073	07/27/99	Fox/Myrtle Soil GW by 8260B
07/15/99	07-122	07/22/99 (VOA), 07/26/99 (SV)	Fox/Myrtle Soil GW by 8260B
09/10/99	09-115	09/27/99	Fox/Myrtle Soil GW by 8260B
Performance Analytical, Inc. (PAI)			
10/20/98-10/21/98	P9801872	11/05/98	1997 Annual Monitoring
10/22/98	P9801885	11/17/98	1997 Annual Monitoring or Pre Oxy-Vac Pilot Study
Sound Analytical Services (SAS)			
11/04/97	68617	11/14/97	1997 Annual Monitoring
04/28/98	72414	05/05/98	1997 Annual Monitoring or Pre Oxy-Vac Pilot Study
05/28/98	73152	06/05/98	Pre Oxy-Vac Pilot Study
06/29/98	74075	07/17/98	Post Oxy-Vac Pilot Study
~10/98	76287	10/19/98	
10/20/98	76508	10/19/98	1997 or 1998 Annual Monitoring
10/21/98	76509	10/30/98	1998 Annual Monitoring
10/20 – 10/22/98	76548	10/30/98	1998 Annual Monitoring
11/06/98	76959	11/16/98	Embayment/Seep
~12/98	77601	12/11/98	Embayment Study

A summary evaluation was performed on the analytical results. Evaluation was performed by Cari Sayler. Numeric quality control criteria for the requirements listed below are presented in the quality control sections of the laboratory reports or are based on professional judgement. Data qualifiers are assigned based only on the criteria reviewed and do not include calibration or instrument performance issues unless noted in the laboratory report. Data qualifiers are summarized in section 14.0 of this report.

In the following report, a checked box (☑) indicates that the data requirement was met; and an empty box (☐) indicates that a discussion of the data requirement follows. The data may or may not be qualified.

2.0 Volatile Organic Analyses - ARI

Analyses were performed by purge and trap GC/MS. The following data requirements were evaluated:

☑ Quality control analysis frequencies
☑ Analysis holding times
☐ Laboratory blank contamination
☑ Surrogate recoveries
☐ Matrix spike (MS) and laboratory control sample (LCS) recoveries
☑ Matrix spike duplicate (MSD) relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed. Each analysis was completed within the required holding times.

The method blank contained methylene chloride at 2.5 ug/kg. Methylene chloride was also detected in sample M-3. This result should be considered not detected at the reported concentration and is qualified "U". No other blank contamination was detected. However, low levels of acetone were detected in both samples (M-1 and M-3). Because acetone is a common laboratory contaminant, these results are qualified "B" for possible laboratory contamination.

All surrogate recoveries were within acceptable recovery limits.

Vinyl Acetate was not recovered in the MS or the MSD, and Acrolein was not recovered in the MS, the MSD or the LCS. Results for these two compounds in the associated samples are rejected, and are not usable for any purpose.

All other LCS recoveries were within the acceptable range. No laboratory MS/MSD control limits were provided by the laboratory. Compounds outside the range of 50% to 150% in the MS and/or MSD are qualified as estimated in the associated samples. The MSD relative percent differences (RPDs) were within expected ranges.

ARI volatile data qualifiers are summarized in section 14.0of this report.

3.0 Volatile Organic Analyses - MAS

Analyses were performed by EPA Method 8240A. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☐ Analysis holding times
☑ Laboratory blank contamination
☑ Surrogate recoveries
☑ Matrix spike (MS) and laboratory control sample (LCS) recoveries
☑ Matrix spike duplicate (MSD) relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch.

The analysis of sample B-34 and the dilution analyses of selected compounds in several other samples were performed at 15 days, slightly outside of the 14 day holding time. No qualifiers are assigned.

No blank contamination was detected. All surrogate recoveries were within acceptable recovery limits. All LCS recoveries were within the acceptable range. All MS/MSD recoveries were within control limits. The MSD relative percent differences (RPDs) were within applicable limits.

The continuing calibration verification result for chloroform was high, exceeding the control limit of 20%. Chloroform was not detected in the associated samples and no qualifiers are assigned.

MAS volatile data are acceptable as reported and no qualifiers are assigned.

4.0 Volatile Organic Analyses - NCA

Analyses were performed by EPA Method 8260B. The following data requirements were evaluated:

- ☑ Quality control analysis frequencies
- ☑ Analysis holding times
- ☑ Laboratory blank contamination
- ☑ Surrogate recoveries
- ☑ Matrix spike (MS) and laboratory control sample (LCS) recoveries
- ☑ Matrix spike duplicate (MSD) relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed. Each analysis was completed within the required holding times. No blank contamination was detected. All surrogate recoveries were within acceptable recovery limits. All LCS recoveries were within the acceptable range. All MS/MSD recoveries were within control limits. The MSD relative percent differences (RPDs) were within applicable limits.

NCA volatile data are acceptable as reported and no qualifiers are assigned.

5.0 Volatile Organic Analyses - OSE

Analyses were performed by EPA Method 8260B. The following data requirements were evaluated:

- ☑ Quality control analysis frequencies
- ☐ Analysis holding times
- ☐ Laboratory blank contamination
- ☐ Surrogate recoveries
- ☐ Matrix spike (MS) and blank spike (BS) recoveries
- ☑ Matrix spike duplicate (MSD) and blank spike duplicate (BSD) relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch.

No chain of custody was provided in batches 10-183, 11-048, or 12-063 and holding times could not be evaluated. No qualifiers are assigned. Samples in batches 07-037 (16 days), 07-038 (15 days), and 07-047 (15 days) were analyzed outside the 14 day holding time. These exceedances were slight, and no qualifiers were assigned. Sample B59-30 in batch 07-073 was analyzed at 18 days, 4 days outside of holding time. All results in this sample are qualified as estimated. All other analyses were completed within the required holding times.

The field blank from batch 02-044 contained tetrachloroethene at 1.2 ug/L. The tetrachloroethene concentrations in the associated samples were greater than 10 times this level, and no qualifiers are assigned. The method blank from batch 04-169 contained acetone at 41 ug/L. The method blanks from batches 04-169, 05-177, 06-

159, and 06-115 and the trip blank from batch 11-036 contained methylene chloride at concentrations ranging from 1.5 ug/L to 17 ug/L, and at 0.56 ug/Kg. Sample results with concentrations below 10 times the associated blank concentration should be considered not detected at the reported concentration and are qualified "U". No other blank contamination was detected.

The following surrogate recoveries were outside of the laboratory control limit:

Batch	Sample ID	Surrogate	Recovery	Limit
04-169	S-2	4-Bromofluorobenzene	77	86-115
04-169	S-6	4-Bromofluorobenzene	85	86-115
04-169	S-5	4-Bromofluorobenzene	85	86-115
07-037	TW-3-10	Toluene-d8	75	77-116
07-037/ 07-038	Blank	Toluene-d8	119	77-116
07-047	TW6	Dibromofluoromethane	70	71-133
07-047	Blank	Toluene-d8	74	77-116
07-073	Blank	Toluene-d8	122	77-116
10-158/10-167	Blank	Dibromofluoromethane	145	71-133
10-167	B-36	Dibromofluoromethane	134	71-133
10-167	B-100	Dibromofluoromethane	139	71-133
10-167	Field Blank	Dibromofluoromethane	154	71-133
11-021	Blank	Dibromofluoromethane	140	71-133
11-021	B-45	Dibromofluoromethane	151	71-133
11-021	B-49	Dibromofluoromethane	142	71-133

In each sample, two out of three surrogate recoveries were within limits and no qualifiers are necessary. The usability of the blank results are not affected by these slight outliers. All other surrogate recoveries were within limits.

The following BS and BSD recoveries were flagged by the laboratory as out of limits:

Batch	Sample ID	Analyte	Recovery
07-037/07-047	BS (water)	1,1-Dichloroethene	52
07-037/07-047	BSD (water)	1,1-Dichloroethene	51
07-037/07-038/07-047	BS (soil)	1,1-Dichloroethene	51
07-037/07-038/07-047	BSD (soil)	1,1-Dichloroethene	43
07-122	BS	1,1-Dichloroethene	65
07-122	BSD	1,1-Dichloroethene	67
10-158/10-167/10-183/11-021	BS	1,1-Dichloroethene	121
10-158/10-167/10-183/11-021	BSD	1,1-Dichloroethene	132
11-036	BSD	1,1-Dichloroethene	124
11-036	BSD	Benzene	124

Positive and non-detect results with low recoveries (67% and below) in the associated BS or BSD are qualified as estimated. Positive results with high recoveries (121% and higher) in the associated BS or BSD are qualified as estimated. All other BS recoveries were within an acceptable range.

The following MS and MSD recoveries were flagged by the laboratory as out of limits:

Batch	Sample ID	Analyte	Recovery
04-169	MSD	Ethyl Benzene	116
05-177	MSD	Chlorobenzene	115
07-073	MS	1,1-Dichloroethene	51
07-073	MSD	1,1-Dichloroethene	43
09-115	MS	1,1-Dichloroethene	65
09-115	MSD	1,1-Dichloroethene	67

No positive results were associated with the high MSD recoveries in batch 04-169 or 05-177, and no qualifiers are necessary.

Because soil recoveries are affected by complex matrices, MS qualification is often limited to the specific sample that was spiked. However, in the absence of associated blank spike results and in view of the number of 1,1-dichloroethene recoveries out of limits in the blank spikes from other batches, positive and non-detect 1,1-dichloroethene results in all samples from batches 07-073 and 09-115 are qualified as estimated. All other MS/MSD recoveries were within control limits.

All BS/BSD and MS/MSD relative percent differences (RPDs) were below 25%.

Concentrations of various analytes in seven samples in batches 06-159 and 07-122 were flagged E by the laboratory to indicate that the concentration exceeded the calibration range. These concentrations should be considered estimated and are qualified "J".

OSE volatile data qualifiers are summarized in section 14.0 of this report.

6.0 Volatile Organic Analyses - SAS

Analyses were performed by EPA Method 8260B. The following data requirements were evaluated:

☑ Quality control analysis frequencies
☑ Analysis holding times
☐ Laboratory blank contamination
☐ Surrogate recoveries
☑ Laboratory control sample (LCS) recoveries
☑ Matrix spike (MS) and matrix spike duplicate (MSD) recoveries
☑ MS/MSD relative percent differences (RPDs)
☑ Field duplicate variability

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times.

The method blank in batch 68617 contained methylene chloride at 2.1 ug/kg. Methylene chloride was detected in the associated samples (M-1 and M-3) at concentrations within 10 times the blank level. These results should be considered not detected at the reported concentration and are qualified "U". One of the method blanks in batch 74075 contained tetrachloroethene at 14 ug/L. The tetrachloroethene concentration in the associated sample was greater than 10times this concentration, and no qualifier is assigned. No other blank contamination was detected.

Surrogate recoveries of toluene d-8 in seven of the samples exceeded the control limit of 88-112%, indicative of matrix interference, and no qualifiers are assigned. The surrogate recovery of bromofluorobenzene in sample B-31 (55%) was below the control limit of 63-152. All analytes in this sample are qualified as estimated. All other surrogate recoveries were within acceptable recovery limits.

All LCS recoveries were within the acceptable range. All MS/MSD recoveries were within control limits. The MSD relative percent differences (RPDs) were within applicable limits.

Concentrations of various analytes in seven samples in batch 74075 were flagged E by the laboratory to indicate that the concentration exceeded the calibration range. These concentrations should be considered estimated and are qualified "J".

SAS volatile data qualifiers are summarized in section 14.0 of this report.

7.0 Semivolatile Organic Analyses - ARI

Analyses were performed by GC/MS. The following data requirements were evaluated:

☑ Quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination
☑ Surrogate recoveries
☑ Matrix spike (MS) and laboratory control sample (LCS) recoveries
☑ Matrix spike duplicate (MSD) relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed. Each analysis was completed within the required holding times. No blank contamination was detected. All surrogate recoveries were within acceptable recovery limits. All LCS recoveries were within expected ranges. All MS/MSD recoveries were within expected ranges. The MSD relative percent differences (RPDs) were within expected ranges.

ARI semivolatile data are acceptable as reported and no qualifiers are assigned.

8.0 Semivolatile Organic Analyses - MAS

Analyses were performed by EPA Method 8270. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies

- ☑ Preparation and analysis holding times
- ☐ Laboratory blank contamination
- ☑ Surrogate recoveries
- ☐ LCS and laboratory control sample duplicate (LCSD) recoveries
- ☑ LCSD RPDs

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times.

Bis(2-ethylhexyl)phthalate was detected in the method blanks at levels below the reporting limit. Samples containing concentrations within 10 times the blank concentration should be considered not detected at the reported concentration and are qualified "U".

All surrogate recoveries were within acceptable recovery limits.

4-Nitrophenol recoveries in the LCS and LCSD (164 and 173%) were above the control limit of 55-138%. 4-Nitrophenol was not detected in the associated samples, and no qualifiers are assigned. All other LCS/LCSD recoveries were within the acceptable range. The LCSD relative percent differences (RPDs) were within applicable limits.

The continuing calibration verification result for hexachlorobutadiene was high, exceeding the control limit of 30%. Hexachlorobutadiene was not detected in the associated samples and no qualifiers are assigned.

MAS semivolatile organic data qualifiers are summarized in section 14.0 of this report.

9.0 Semivolatile Organic Analyses - OSE

Analyses were performed by EPA Method 8270C. The following data requirements were evaluated:

- ☑ Quality control analysis frequencies
- ☐ Analysis holding times
- ☐ Laboratory blank contamination
- ☐ Surrogate recoveries
- ☐ Matrix spike (MS) and blank spike (BS) recoveries
- ☑ Matrix spike duplicate (MSD) and blank spike duplicate (BSD) relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch.

No chain of custody was provided in batches 10-183, or 11-048 and holding times could not be evaluated. No qualifiers are assigned. All other analyses were completed within the required holding times.

The method blank from batch 11-036 contained Bis(2-ethylhexyl)phthalate at 1.1 ug/L. Bis(2-ethylhexyl)phthalate was not detected in any associated samples, and no qualifiers are necessary.

The following surrogate recoveries were outside of the laboratory control limit:

Batch	Sample ID	Surrogate	Recovery	Limit
06-159	B-31	Nitrobenzene-D5	29	35-114
06-159	B-31	2-Fluorobiphenyl	33	43-116
06-159	B-8	2-Fluorophenol	17	21-100
06-159	B-8	Nitrobenzene-D5	33	35-114
06-159	B-42	2-Fluorophenol	15	21-100
06-159	B-42	Nitrobenzene-D5	29	35-114
06-159	B-42	2-Fluorobiphenyl	36	43-116
06-159	B-47	2-Fluorophenol	19	21-100
06-159	B-47	Nitrobenzene-D5	31	35-114
06-159	B-47	2-Fluorobiphenyl	38	43-116
06-159	B-39	Nitrobenzene-D5	30	35-114
06-159	B-39	2-Fluorobiphenyl	37	43-116
06-159	B-12	2-Fluorophenol	19	21-100
06-159	Blank	2-Fluorobiphenyl	42	43-116
06-192	B-31	2-Fluorobiphenyl	40	43-116
06-192	B-12	Nitrobenzene-D5	34	35-114
06-192	Blank	Nitrobenzene-D5	34	35-114
06-192	Blank	2-Fluorobiphenyl	40	43-116
07-122	B-63	2-Fluorophenol	19	21-100
10-167	B-21	2-Fluorophenol	15	21-100
10-167	B-21	Nitrobenzene-D5	28	35-114
10-167	B-21	2-Fluorobiphenyl	41	43-116
10-167	B-35	2-Fluorophenol	20	21-100
10-167	B-35	Nitrobenzene-D5	28	35-114
10-167	B-35	2-Fluorobiphenyl	40	43-116
10-167	Field Blank	2-Fluorophenol	17	21-100
10-167	Field Blank	Nitrobenzene-D5	31	35-114
10-167	Field Blank	2-Fluorobiphenyl	41	43-116
10-183	B-19	2-Fluorophenol	19	21-100
11-021	B-42	2-Fluorophenol	20	21-100

All other surrogate recoveries were within limits. In samples where two out of three acid surrogates and two out of three base/neutral surrogates are within limits, no qualifiers are necessary. Positive and non-detect results for base/neutral compounds are qualified as estimated in four samples from batch 06-159 and two samples and the field blank from batch 10-167. The usability of the blank results in batches 06-159 and 06-192 are not affected by these slight outliers.

The following BS and BSD recoveries were flagged by the laboratory as out of limits:

Batch	Sample ID	Analyte	Recovery
06-159	BS	1,4-Dichlorobenzene	35
06-192	BS	1,4-Dichlorobenzene	32

Batch	Sample ID	Analyte	Recovery
06-192	BS	1,2,4-Trichlorobenzene	39
07-172	BS	Phenol	21
07-172	BSD	Phenol	33
07-172	BS	4-Nitrophenol	33
07-172	BSD	4-Nitrophenol	45

Positive and non-detect results in the associated samples are qualified as estimated. All other BS and BSD recoveries were within an acceptable range.

The 1,4-Dichlorobenzene BS/BSD RPD (35%) and the 1,2,4-Trichlorobenzene BS/BSD RPD (29%) in batch 06-159 and the Phenol BS/BSD RPD (42%) from batch 07-122 were flagged by the laboratory as out of limits. All associated positive results are qualified as estimated. All other BS/BSD RPDs were within an acceptable range.

The MS/MSD recoveries and MS/MSD RPDs were within acceptable limits.

Concentrations of various analytes in samples from batches 06-159, 16-192, and 11-021 were flagged E by the laboratory to indicate that the concentration exceeded the calibration range. These concentrations should be considered estimated and are qualified "J".

OSE semivolatile data qualifiers are summarized in section 14.0 of this report.

10.0 Phenol Analyses - MAS

Analyses were performed by EPA Method 8040 modified. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☐ Extraction and analysis holding times
☑ Laboratory blank contamination
☐ Surrogate recoveries
☑ LCS and laboratory control sample duplicate (LCSD) recoveries
☑ LCSD RPDs

Adequate laboratory quality control samples were analyzed.

The extraction of all samples was performed at 19 days, outside of the 14-day holding time, due to pentachlorophenol contamination in the original method blank. All results are qualified as estimated.

No blank contamination was detected in the re-extraction method blank. High surrogate recoveries were noted in samples B-39 and B-100, at 155 and 132%, respectively. Positive results in these two samples are already qualified as estimated, and no further action is required. All other surrogate recoveries were within acceptable recovery limits.

All LCS recoveries were within the acceptable range. All MS/MSD recoveries were within control limits. The MSD relative percent differences (RPDs) were within applicable limits.

The continuing calibration verification result for chloroform was high, exceeding the control limit of 20%. Chloroform was not detected in the associated samples and no qualifiers are assigned.

MAS phenol data qualifiers are summarized in section 14.0 of this report.

11.0 Dissolved Gas analysis - PAI

Analyses were performed by RSK Method 175. The following data requirements were evaluated:

- ☑ Analysis holding times
- ☑ Laboratory and field blank contamination

Each analysis was completed within the required holding times. No blank contamination was detected.

PAI dissolved gas data are acceptable as reported and no qualifiers are assigned.

12.0 Salinity Analyses - SAS

Analyses were performed by Method SM 2520B. The following data requirements were evaluated:

- ☐ Quality control analysis frequencies
- ☑ Analysis holding times
- ☑ Laboratory blank contamination
- ☑ Laboratory duplicate variability

Due to photocopying errors, quality control data with batch 77601 was not readable; blank contamination and duplicate variability could not be evaluated. No chain of custody was provided with batch 77601 and holding times could not be evaluated. No problems were noted in the other batches, and no qualifiers are assigned.

Adequate laboratory quality control samples were analyzed with all other laboratory batches. All other analyses were completed within the required holding times. No blank contamination was detected. Lab duplicate variability was within the expected range.

SAS salinity data are acceptable as reported and no qualifiers are assigned.

13.0 TOC Analyses - SAS

Analyses were performed by EPA method 415.1. The following data requirements were evaluated:

☑ Quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination
☑ Matrix spike (MS) and Matrix spike duplicate (MSD) recoveries
☑ MS/MSD relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch. No chain of custody was provided in batch 76287 and holding times could not be evaluated. All other analyses were completed within the required holding times, and no qualifiers are assigned.

No blank contamination was detected. All MS and MSD recoveries were within the acceptable range. MS/MSD RPDs were within acceptable limits.

SAS TOC data are acceptable as reported and no qualifiers are assigned.

14.0 Qualifier Summary Table

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
Volatile Organics - ARI				
Z139	M-3	Methylene chloride	U	Blank Contamination
Z139	M-1	Acetone	B	Common Contaminant
Z139	M-3	Acetone	B	Common Contaminant
Z139	M-1	Vinyl Acetate	R	Spike Rec.
Z139	M-3	Vinyl Acetate	R	Spike Rec.
Z139	M-1	Acrolein	R	Spike & LCS Rec.
Z139	M-3	Acrolein	R	Spike & LCS Rec.
Z139	M-1	2-Chloroethylvinylether	UJ	Spike Rec.
Z139	M-1	Bromoform	UJ	Spike Rec.
Z139	M-1	Styrene	UJ	Spike Rec.
Z139	M-1	1,2-Dichlorobenzene	UJ	Spike Rec.
Z139	M-1	1,3-Dichlorobenzene	UJ	Spike Rec.
Z139	M-1	1,4-Dichlorobenzene	UJ	Spike Rec.
Z139	M-1	Trans-1,4-Dichloro-2-butene	UJ	Spike Rec.
Z139	M-1	1,3,5-Trimethylbenzene	UJ	Spike Rec.
Z139	M-1	1,2,4-Trimethylbenzene	UJ	Spike Rec.
Z139	M-1	Hexachlorobutadiene	UJ	Spike Rec.
Z139	M-1	n-Propylbenzene	UJ	Spike Rec.
Z139	M-1	2-Chlorotoluene	UJ	Spike Rec.
Z139	M-1	4-Chlorotoluene	UJ	Spike Rec.
Z139	M-1	tert-Butylbenzene	UJ	Spike Rec.
Z139	M-1	Sec-Butylbenzene	UJ	Spike Rec.
Z139	M-1	4-Isopropyltoluene	UJ	Spike Rec.
Z139	M-1	n-Butylbenzene	UJ	Spike Rec.
Z139	M-1	1,2,4-Trichlorobenzene	UJ	Spike Rec.
Z139	M-1	Naphthalene	UJ	Spike Rec.
Z139	M-1	1,2,3-Trichlorobenzene	UJ	Spike Rec.
Z139	M-3	2-Chloroethylvinylether	UJ	Spike Rec.
Z139	M-3	Bromoform	UJ	Spike Rec.
Z139	M-3	Styrene	UJ	Spike Rec.
Z139	M-3	1,2-Dichlorobenzene	UJ	Spike Rec.
Z139	M-3	1,3-Dichlorobenzene	UJ	Spike Rec.

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
Z139	M-3	1,4-Dichlorobenzene	UJ	Spike Rec.
Z139	M-3	Trans-1,4-Dichloro-2-butene	UJ	Spike Rec.
Z139	M-3	1,3,5-Trimethylbenzene	UJ	Spike Rec.
Z139	M-3	1,2,4-Trimethylbenzene	UJ	Spike Rec.
Z139	M-3	Hexachlorobutadiene	UJ	Spike Rec.
Z139	M-3	n-Propylbenzene	UJ	Spike Rec.
Z139	M-3	2-Chlorotoluene	UJ	Spike Rec.
Z139	M-3	4-Chlorotoluene	UJ	Spike Rec.
Z139	M-3	tert-Butylbenzene	UJ	Spike Rec.
Z139	M-3	Sec-Butylbenzene	UJ	Spike Rec.
Z139	M-3	4-Isopropyltoluene	UJ	Spike Rec.
Z139	M-3	n-Butylbenzene	UJ	Spike Rec.
Z139	M-3	1,2,4-Trichlorobenzene	UJ	Spike Rec.
Z139	M-3	Naphthalene	UJ	Spike Rec.
Z139	M-3	1,2,3-Trichlorobenzene	UJ	Spike Rec.
Volatile Organics - OSE				
04-169	River	Acetone	U	Blank Contamination
04-169	S-2	Acetone	U	Blank Contamination
04-169	S-8	Acetone	U	Blank Contamination
04-169	S-4	Acetone	U	Blank Contamination
04-169	S-6	Acetone	U	Blank Contamination
04-169	S-5	Acetone	U	Blank Contamination
04-169	S-12	Acetone	U	Blank Contamination
05-177	S-8	Methylene Chloride	U	Blank Contamination
06-159	B-31	Methylene Chloride	U	Blank Contamination
06-159	B-42	Methylene Chloride	U	Blank Contamination
06-159	B-47	Methylene Chloride	U	Blank Contamination
06-159	B-39	Methylene Chloride	U	Blank Contamination
06-159	B-12	Methylene Chloride	U	Blank Contamination
06-159	B-44	Methylene Chloride	U	Blank Contamination
09-115	B20A-12.5	Methylene Chloride	U	Blank Contamination
07-037	TW-1-9	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-1-11	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-2-8	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-2-13	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-3-10	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-3-13	1,1-Dichloroethene	UJ	BS Recovery
07-037	B64-10	1,1-Dichloroethene	UJ	BS Recovery
07-037	B64-12.5	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-1	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-2	1,1-Dichloroethene	J	BS Recovery
07-037	TW-3	1,1-Dichloroethene	UJ	BS Recovery
07-037	TW-3 DUP	1,1-Dichloroethene	UJ	BS Recovery
07-038	TW6-9	1,1-Dichloroethene	UJ	BS Recovery
07-038	TW6-12	1,1-Dichloroethene	UJ	BS Recovery
07-038	B62-9	1,1-Dichloroethene	UJ	BS Recovery
07-038	B62-16	1,1-Dichloroethene	UJ	BS Recovery
07-038	B58-10	1,1-Dichloroethene	UJ	BS Recovery
07-038	B58-12.5	1,1-Dichloroethene	UJ	BS Recovery
07-038	TW5-10	1,1-Dichloroethene	UJ	BS Recovery
07-038	TW5-16	1,1-Dichloroethene	UJ	BS Recovery
07-038	B60-10	1,1-Dichloroethene	UJ	BS Recovery
07-038	B60-16	1,1-Dichloroethene	UJ	BS Recovery
07-047	B-62	1,1-Dichloroethene	UJ	BS Recovery

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
07-047	B-62 DUP	1,1-Dichloroethene	UJ	BS Recovery
07-047	TW-7	1,1-Dichloroethene	UJ	BS Recovery
07-047	TW-6	1,1-Dichloroethene	UJ	BS Recovery
07-047	TW-5	1,1-Dichloroethene	UJ	BS Recovery
07-047	TW-7-9	1,1-Dichloroethene	UJ	BS Recovery
07-047	TW-7-12	1,1-Dichloroethene	UJ	BS Recovery
07-122	B-13	1,1-Dichloroethene	UJ	BS Recovery
07-122	B-59	1,1-Dichloroethene	UJ	BS Recovery
07-122	B-58	1,1-Dichloroethene	J	BS Recovery
07-122	B-61	1,1-Dichloroethene	J	BS Recovery
07-122	B-60	1,1-Dichloroethene	UJ	BS Recovery
07-122	B-63	1,1-Dichloroethene	J	BS Recovery
07-122	B-64	1,1-Dichloroethene	UJ	BS Recovery
07-122	B-65	1,1-Dichloroethene	J	BS Recovery
07-122	B-63 DUP	1,1-Dichloroethene	J	BS Recovery
07-122	B-71	1,1-Dichloroethene	UJ	BS Recovery
10-158	B-8	1,1-Dichloroethene	J	BS Recovery
10-183	B-33A	1,1-Dichloroethene	J	BS Recovery
11-021	B-49	1,1-Dichloroethene	J	BS Recovery
06-159	B-31	Tetrachloroethene	J	Calibration Range
06-159	B-31	Trichloroethene	J	Calibration Range
06-159	B-42	Tetrachloroethene	J	Calibration Range
06-159	B-47	1,2-Dichloroethene (cis)	J	Calibration Range
06-159	B-47	Tetrachloroethene	J	Calibration Range
06-159	B-47	Toluene	J	Calibration Range
06-159	B-47	Trichloroethene	J	Calibration Range
06-159	B-39	1,2-Dichloroethene (cis)	J	Calibration Range
06-159	B-39	Tetrachloroethene	J	Calibration Range
06-159	B-39	Toluene	J	Calibration Range
06-159	B-39	Trichloroethene	J	Calibration Range
06-159	B-12	1,2-Dichloroethene (cis)	J	Calibration Range
06-159	B-12	Tetrachloroethene	J	Calibration Range
06-159	B-12	Trichloroethene	J	Calibration Range
06-159	B-44	1,2-Dichloroethene (cis)	J	Calibration Range
06-159	B-44	Tetrachloroethene	J	Calibration Range
06-159	B-44	Toluene	J	Calibration Range
06-159	B-44	Trichloroethene	J	Calibration Range
07-122	B-61	1,2-Dichloroethene (cis)	J	Calibration Range
07-073	B59-30	1,1,1,2-Tetrachloroethane	UJ	Holding Time
07-073	B59-30	1,1,1-Trichloroethane	UJ	Holding Time
07-073	B59-30	1,1,2,2-Tetrachloroethane	UJ	Holding Time
07-073	B59-30	1,1,2-Trichloroethane	UJ	Holding Time
07-073	B59-30	1,1-Dichloroethane	UJ	Holding Time
07-073	B59-30	1,1-Dichloroethene	UJ	Holding Time, MS Recovery
07-073	B59-30	1,1-Dichloropropene	UJ	Holding Time
07-073	B59-30	1,2,3-Trichlorobenzene	UJ	Holding Time
07-073	B59-30	1,2,3-Trichloropropane	UJ	Holding Time
07-073	B59-30	1,2,4-Trichlorobenzene	UJ	Holding Time
07-073	B59-30	1,2-Dibromo-3-Chloropropane	UJ	Holding Time
07-073	B59-30	1,2-Dibromoethane (EDB)	UJ	Holding Time
07-073	B59-30	1,2-Dichloro benzene	UJ	Holding Time
07-073	B59-30	1,2-Dichloroethane	UJ	Holding Time
07-073	B59-30	1,2-Dichloroethene (cis)	J	Holding Time

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
07-073	B59-30	1,2-Dichloroethene (trans)	UJ	Holding Time
07-073	B59-30	1,2-Dichloropropane	UJ	Holding Time
07-073	B59-30	1,3-Dichloro benzene	UJ	Holding Time
07-073	B59-30	1,3-Dichloropropane	UJ	Holding Time
07-073	B59-30	1,3-Dichloropropene (cis)	UJ	Holding Time
07-073	B59-30	1,3-Dichloropropene (trans)	UJ	Holding Time
07-073	B59-30	1,4-Dichloro benzene	UJ	Holding Time
07-073	B59-30	2,2-Dichloropropane	UJ	Holding Time
07-073	B59-30	2-Chloro toluene	UJ	Holding Time
07-073	B59-30	2-Chloroethyl vinyl ether	UJ	Holding Time
07-073	B59-30	4-Chloro toluene	UJ	Holding Time
07-073	B59-30	Bromo benzene	UJ	Holding Time
07-073	B59-30	Bromodichloromethane	UJ	Holding Time
07-073	B59-30	Bromoform	UJ	Holding Time
07-073	B59-30	Bromomethane	UJ	Holding Time
07-073	B59-30	Carbon Tetrachloride	UJ	Holding Time
07-073	B59-30	Chloro benzene	UJ	Holding Time
07-073	B59-30	Chloroethane	UJ	Holding Time
07-073	B59-30	Chloroform	UJ	Holding Time
07-073	B59-30	Chloromethane	UJ	Holding Time
07-073	B59-30	Dibromochloromethane	UJ	Holding Time
07-073	B59-30	Dibromomethane	UJ	Holding Time
07-073	B59-30	Dichlorodifluoromethane	UJ	Holding Time
07-073	B59-30	Hexachlorobutadiene	UJ	Holding Time
07-073	B59-30	Methylene Chloride	UJ	Holding Time
07-073	B59-30	Tetrachloroethene	UJ	Holding Time
07-073	B59-30	Trichloroethene	UJ	Holding Time
07-073	B59-30	Trichlorofluoromethane	UJ	Holding Time
07-073	B59-30	Vinyl Chloride	UJ	Holding Time
07-073	B61-13.5	1,1-Dichloroethene	UJ	MS Recovery
07-073	B61-24.5	1,1-Dichloroethene	UJ	MS Recovery
07-073	B61-43.5	1,1-Dichloroethene	UJ	MS Recovery
09-115	B20A-12.5	1,1-Dichloroethene	UJ	MS Recovery
Volatile Organics – SAS				
68617	M-1	Methylene chloride	U	Blank Contamination
68617	M-3	Methylene chloride	U	Blank Contamination
74075	B-8	cis-1,2-Dichloroethene	J	Calibration Range
74075	B-42	Vinyl Chloride	J	Calibration Range
74075	B-42	1,1,1-Trichloroethane	J	Calibration Range
74075	B-42	Tetrachloroethene	J	Calibration Range
74075	B-42	1,2-Dichlorobenzene	J	Calibration Range
74075	B-47	Vinyl Chloride	J	Calibration Range
74075	B-47	Tetrachloroethene	J	Calibration Range
74075	B-47	1,2-Dichlorobenzene	J	Calibration Range
74075	B-39	Vinyl Chloride	J	Calibration Range
74075	B-39	Tetrachloroethene	J	Calibration Range
74075	B-39	Ethylbenzene	J	Calibration Range
74075	B-39	m,p-Xylene	J	Calibration Range
74075	B-39	o-Xylene	J	Calibration Range
74075	B-12	Vinyl Chloride	J	Calibration Range
74075	B-12	1,1,1-Trichloroethane	J	Calibration Range
74075	B-12	Tetrachloroethene	J	Calibration Range

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
74075	B-12	Ethylbenzene	J	Calibration Range
74075	B-12	m,p-Xylene	J	Calibration Range
74075	B-12	o-Xylene	J	Calibration Range
74075	B-44	Vinyl Chloride	J	Calibration Range
74075	B-44	Methylene Chloride	J	Calibration Range
74075	B-44	trans-1,2-Dichloroethene	J	Calibration Range
74075	B-44	Tetrachloroethene	J	Calibration Range
74075	B-44	Ethylbenzene	J	Calibration Range
74075	B-44	m,p-Xylene	J	Calibration Range
74075	B-31	Chloromethane	UJ	Surrogate
74075	B-31	Bromomethane	UJ	Surrogate
74075	B-31	Vinyl Chloride	J	Surrogate
74075	B-31	Chloroethane	UJ	Surrogate
74075	B-31	Trichlorofluoromethane	J	Surrogate
74075	B-31	1,1-Dichloroethene	J	Surrogate
74075	B-31	Acetone	J	Surrogate
74075	B-31	Methylene Chloride	J	Surrogate
74075	B-31	trans-1,2-Dichloroethene	J	Surrogate
74075	B-31	1,1-Dichloroethane	J	Surrogate, Calibration Range
74075	B-31	cis-1,2-Dichloroethene	J	Surrogate
74075	B-31	2-Butanone	UJ	Surrogate
74075	B-31	Chloroform	J	Surrogate
74075	B-31	1,1,1-Trichloroethane	J	Surrogate
74075	B-31	Carbon Tetrachloride	UJ	Surrogate
74075	B-31	Benzene	J	Surrogate
74075	B-31	1,2-Dichloroethane	J	Surrogate
74075	B-31	Trichloroethene	J	Surrogate
74075	B-31	1,2-Dichloropropane	UJ	Surrogate
74075	B-31	Bromodichloromethane	UJ	Surrogate
74075	B-31	2-Chloroethyl Vinyl Ether	UJ	Surrogate
74075	B-31	(cis)1,3-Dichloropropene	UJ	Surrogate
74075	B-31	Toluene	J	Surrogate
74075	B-31	4-Methyl-2-Pentanone	UJ	Surrogate
74075	B-31	(trans)1,3-Dichloropropene	UJ	Surrogate
74075	B-31	1,1,2-Trichloroethane	UJ	Surrogate
74075	B-31	Tetrachloroethene	J	Surrogate, Calibration Range
74075	B-31	Dibromochloromethane	UJ	Surrogate
74075	B-31	2-Hexanone	UJ	Surrogate
74075	B-31	Chlorobenzene	UJ	Surrogate
74075	B-31	Ethylbenzene	J	Surrogate, Calibration Range
74075	B-31	m,p-Xylene	J	Surrogate
74075	B-31	o-Xylene	J	Surrogate
74075	B-31	Bromoform	UJ	Surrogate
74075	B-31	1,1,2,2-Tetrachloroethane	UJ	Surrogate
74075	B-31	1,3-Dichlorobenzene	UJ	Surrogate
74075	B-31	1,4-Dichlorobenzene	UJ	Surrogate
74075	B-31	1,2-Dichlorobenzene	J	Surrogate
Semivolatile Organics – MAS				
710072	B-24	Bis(2-ethylhexyl)phthalate	U	Blank Contamination

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
710072	B-25	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
710072	B-8	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
710072	B-101	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
710072	B-31	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
710072	Trip Blank	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
712048	B-12	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
712048	B-31	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
712048	B-39	Bis(2-ethylhexyl)phthalate	U	Blank Contamination
Semivolatile Organics – OSE				
06-159	B-31	1,4-Dichloro benzene	UJ	Surrogate, BS Recovery
06-159	B-8	1,4-Dichloro benzene	UJ	Blank Spike Recovery
06-159	B-42	1,4-Dichloro benzene	J	Surr., BS Recovery/ RPD
06-159	B-47	1,4-Dichloro benzene	J	Surr., BS Recovery/ RPD
06-159	B-39	1,4-Dichloro benzene	J	Surr., BS Recovery/ RPD
06-159	B-12	1,4-Dichloro benzene	UJ	Blank Spike Recovery
06-159	B-44	1,4-Dichloro benzene	J	Blank Spike Recovery/RPD
06-192	B-31	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-31	1,4-Dichloro benzene	UJ	Blank Spike Recovery
06-192	B-8	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-8	1,4-Dichloro benzene	UJ	Blank Spike Recovery
06-192	B-42	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-42	1,4-Dichloro benzene	UJ	Blank Spike Recovery
06-192	B-47	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-47	1,4-Dichloro benzene	J	Blank Spike Recovery
06-192	B-39	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-39	1,4-Dichloro benzene	J	Blank Spike Recovery
06-192	B-12	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-12	1,4-Dichloro benzene	UJ	Blank Spike Recovery
06-192	B-44	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-44	1,4-Dichloro benzene	J	Blank Spike Recovery
06-192	B-100	1,2,4-Trichlorobenzene	UJ	Blank Spike Recovery
06-192	B-100	1,4-Dichloro benzene	UJ	Blank Spike Recovery
07-122	B-59	4-Nitrophenol	UJ	Blank Spike Recovery
07-122	B-59	Phenol	UJ	Blank Spike Recovery
07-122	B-58	4-Nitrophenol	UJ	Blank Spike Recovery
07-122	B-58	Phenol	UJ	Blank Spike Recovery
07-122	B-61	4-Nitrophenol	UJ	Blank Spike Recovery
07-122	B-61	Phenol	UJ	Blank Spike Recovery
07-122	B-60	4-Nitrophenol	UJ	Blank Spike Recovery
07-122	B-60	Phenol	UJ	Blank Spike Recovery
07-122	B-63	4-Nitrophenol	UJ	Blank Spike Recovery
07-122	B-63	Phenol	UJ	Blank Spike Recovery
06-159	B-31	Pentachlorophenol	J	Calibration Range
06-159	B-42	Pentachlorophenol	J	Calibration Range
06-159	B-47	Pentachlorophenol	J	Calibration Range
06-159	B-39	Pentachlorophenol	J	Calibration Range
06-159	B-12	Pentachlorophenol	J	Calibration Range
06-159	B-44	Pentachlorophenol	J	Calibration Range
06-192	B-12	Di-n-butylphthalate	J	Calibration Range
06-192	B-12	Pentachlorophenol	J	Calibration Range
11-021	B-42	1,2-Dichloro benzene	J	Calibration Range
11-021	B-42	Pentachlorophenol	J	Calibration Range
11-021	B-12	Pentachlorophenol	J	Calibration Range
11-021	B-49	Pentachlorophenol	J	Calibration Range

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
06-159	B-31	1,2,4-Trichlorobenzene	UJ	Surrogate
06-159	B-31	1,2-Dichloro benzene	J	Surrogate
06-159	B-31	1,3-Dichloro benzene	UJ	Surrogate
06-159	B-31	2,4-Dinitrotoluene	UJ	Surrogate
06-159	B-31	2,6-Dinitrotoluene	UJ	Surrogate
06-159	B-31	2-Chloronaphthalene	UJ	Surrogate
06-159	B-31	2-Methylnaphthalene	J	Surrogate
06-159	B-31	2-Nitroaniline	UJ	Surrogate
06-159	B-31	3,3'-Dichlorobenzidine	UJ	Surrogate
06-159	B-31	3-Nitroaniline	UJ	Surrogate
06-159	B-31	4-Bromophenyl-phenylether	UJ	Surrogate
06-159	B-31	4-Chloroaniline	UJ	Surrogate
06-159	B-31	4-chlorophenyl phenyl ether	UJ	Surrogate
06-159	B-31	4-Nitroaniline	UJ	Surrogate
06-159	B-31	Acenaphthene	UJ	Surrogate
06-159	B-31	Acenaphthylene	UJ	Surrogate
06-159	B-31	Aniline	UJ	Surrogate
06-159	B-31	Anthracene	UJ	Surrogate
06-159	B-31	Benzidine	UJ	Surrogate
06-159	B-31	Benzo(a)Anthracene	UJ	Surrogate
06-159	B-31	Benzo(a)Pyrene	UJ	Surrogate
06-159	B-31	Benzo(b)Fluoranthene	UJ	Surrogate
06-159	B-31	Benzo(g,h,i)Perylene	UJ	Surrogate
06-159	B-31	Benzo(k)Fluoranthene	UJ	Surrogate
06-159	B-31	Bis(2-chloroethoxy)methane	UJ	Surrogate
06-159	B-31	Bis(2-chloroethyl)ether	UJ	Surrogate
06-159	B-31	Bis(2-chloroisopropyl)ether	UJ	Surrogate
06-159	B-31	bis(2-Ethylhexyl)phthalate	J	Surrogate
06-159	B-31	Butylbenzylphthalate	UJ	Surrogate
06-159	B-31	Carbazole	UJ	Surrogate
06-159	B-31	Chrysene	UJ	Surrogate
06-159	B-31	Di-n-butylphthalate	J	Surrogate
06-159	B-31	Di-n-octylphthalate	J	Surrogate
06-159	B-31	Dibenzo(a,h)Anthracene	UJ	Surrogate
06-159	B-31	Dibenzofuran	UJ	Surrogate
06-159	B-31	Diethylphthalate	UJ	Surrogate
06-159	B-31	Dimethylphthalate	UJ	Surrogate
06-159	B-31	Fluoranthene	UJ	Surrogate
06-159	B-31	Fluorene	UJ	Surrogate
06-159	B-31	Hexachlorobenzene	UJ	Surrogate
06-159	B-31	Hexachlorobutadiene	UJ	Surrogate
06-159	B-31	Hexachlorocyclopentadiene	UJ	Surrogate
06-159	B-31	Hexachloroethane	UJ	Surrogate
06-159	B-31	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
06-159	B-31	Isophorone	UJ	Surrogate
06-159	B-31	N-Nitroso-di-n-propylamine	UJ	Surrogate
06-159	B-31	N-Nitrosodiphenylamine	UJ	Surrogate
06-159	B-31	Naphthalene	J	Surrogate
06-159	B-31	Nitrobenzene	UJ	Surrogate
06-159	B-31	Phenanthrene	J	Surrogate
06-159	B-31	Pyrene	UJ	Surrogate
06-159	B-42	1,2,4-Trichlorobenzene	UJ	Surrogate
06-159	B-42	1,2-Dichloro benzene	J	Surrogate
06-159	B-42	1,3-Dichloro benzene	J	Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
06-159	B-42	2,4-Dinitrotoluene	UJ	Surrogate
06-159	B-42	2,6-Dinitrotoluene	UJ	Surrogate
06-159	B-42	2-Chloronaphthalene	UJ	Surrogate
06-159	B-42	2-Methylnaphthalene	J	Surrogate
06-159	B-42	2-Nitroaniline	UJ	Surrogate
06-159	B-42	3,3'-Dichlorobenzidine	UJ	Surrogate
06-159	B-42	3-Nitroaniline	UJ	Surrogate
06-159	B-42	4-Bromophenyl-phenylether	UJ	Surrogate
06-159	B-42	4-Chloroaniline	UJ	Surrogate
06-159	B-42	4-chlorophenyl phenyl ether	UJ	Surrogate
06-159	B-42	4-Nitroaniline	UJ	Surrogate
06-159	B-42	Acenaphthene	UJ	Surrogate
06-159	B-42	Acenaphthylene	UJ	Surrogate
06-159	B-42	Aniline	UJ	Surrogate
06-159	B-42	Anthracene	UJ	Surrogate
06-159	B-42	Benzidine	UJ	Surrogate
06-159	B-42	Benzo(a)Anthracene	UJ	Surrogate
06-159	B-42	Benzo(a)Pyrene	UJ	Surrogate
06-159	B-42	Benzo(b)Fluoranthene	UJ	Surrogate
06-159	B-42	Benzo(g,h,i)Perylene	UJ	Surrogate
06-159	B-42	Benzo(k)Fluoranthene	UJ	Surrogate
06-159	B-42	Bis(2-chloroethoxy)methane	J	Surrogate
06-159	B-42	Bis(2-chloroethyl)ether	UJ	Surrogate
06-159	B-42	Bis(2-chloroisopropyl)ether	UJ	Surrogate
06-159	B-42	bis(2-Ethylhexyl)phthalate	J	Surrogate
06-159	B-42	Butylbenzylphthalate	UJ	Surrogate
06-159	B-42	Carbazole	UJ	Surrogate
06-159	B-42	Chrysene	UJ	Surrogate
06-159	B-42	Di-n-butylphthalate	J	Surrogate
06-159	B-42	Di-n-octylphthalate	UJ	Surrogate
06-159	B-42	Dibenzo(a,h)Anthracene	UJ	Surrogate
06-159	B-42	Dibenzofuran	UJ	Surrogate
06-159	B-42	Diethylphthalate	UJ	Surrogate
06-159	B-42	Dimethylphthalate	UJ	Surrogate
06-159	B-42	Fluoranthene	UJ	Surrogate
06-159	B-42	Fluorene	UJ	Surrogate
06-159	B-42	Hexachlorobenzene	UJ	Surrogate
06-159	B-42	Hexachlorobutadiene	UJ	Surrogate
06-159	B-42	Hexachlorocyclopentadiene	UJ	Surrogate
06-159	B-42	Hexachloroethane	UJ	Surrogate
06-159	B-42	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
06-159	B-42	Isophorone	UJ	Surrogate
06-159	B-42	N-Nitroso-di-n-propylamine	UJ	Surrogate
06-159	B-42	N-Nitrosodiphenylamine	UJ	Surrogate
06-159	B-42	Naphthalene	J	Surrogate
06-159	B-42	Nitrobenzene	UJ	Surrogate
06-159	B-42	Phenanthrene	J	Surrogate
06-159	B-42	Pyrene	UJ	Surrogate
06-159	B-47	1,2,4-Trichlorobenzene	UJ	Surrogate
06-159	B-47	1,2-Dichloro benzene	J	Surrogate
06-159	B-47	1,3-Dichloro benzene	UJ	Surrogate
06-159	B-47	2,4-Dinitrotoluene	UJ	Surrogate
06-159	B-47	2,6-Dinitrotoluene	UJ	Surrogate
06-159	B-47	2-Chloronaphthalene	UJ	Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
06-159	B-47	2-Methylnaphthalene	J	Surrogate
06-159	B-47	2-Nitroaniline	UJ	Surrogate
06-159	B-47	3,3'-Dichlorobenzidine	UJ	Surrogate
06-159	B-47	3-Nitroaniline	UJ	Surrogate
06-159	B-47	4-Bromophenyl-phenylether	UJ	Surrogate
06-159	B-47	4-Chloroaniline	J	Surrogate
06-159	B-47	4-chlorophenyl phenyl ether	UJ	Surrogate
06-159	B-47	4-Nitroaniline	UJ	Surrogate
06-159	B-47	Acenaphthene	UJ	Surrogate
06-159	B-47	Acenaphthylene	UJ	Surrogate
06-159	B-47	Aniline	UJ	Surrogate
06-159	B-47	Anthracene	UJ	Surrogate
06-159	B-47	Benzidine	UJ	Surrogate
06-159	B-47	Benzo(a)Anthracene	UJ	Surrogate
06-159	B-47	Benzo(a)Pyrene	UJ	Surrogate
06-159	B-47	Benzo(b)Fluoranthene	UJ	Surrogate
06-159	B-47	Benzo(g,h,i)Perylene	UJ	Surrogate
06-159	B-47	Benzo(k)Fluoranthene	UJ	Surrogate
06-159	B-47	Bis(2-chloroethoxy)methane	UJ	Surrogate
06-159	B-47	Bis(2-chloroethyl)ether	UJ	Surrogate
06-159	B-47	Bis(2-chloroisopropyl)ether	UJ	Surrogate
06-159	B-47	bis(2-Ethylhexyl)phthalate	J	Surrogate
06-159	B-47	Butylbenzylphthalate	J	Surrogate
06-159	B-47	Carbazole	UJ	Surrogate
06-159	B-47	Chrysene	UJ	Surrogate
06-159	B-47	Di-n-butylphthalate	J	Surrogate
06-159	B-47	Di-n-octylphthalate	UJ	Surrogate
06-159	B-47	Dibenzo(a,h)Anthracene	UJ	Surrogate
06-159	B-47	Dibenzofuran	UJ	Surrogate
06-159	B-47	Diethylphthalate	J	Surrogate
06-159	B-47	Dimethylphthalate	UJ	Surrogate
06-159	B-47	Fluoranthene	UJ	Surrogate
06-159	B-47	Fluorene	UJ	Surrogate
06-159	B-47	Hexachlorobenzene	UJ	Surrogate
06-159	B-47	Hexachlorobutadiene	UJ	Surrogate
06-159	B-47	Hexachlorocyclopentadiene	UJ	Surrogate
06-159	B-47	Hexachloroethane	UJ	Surrogate
06-159	B-47	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
06-159	B-47	Isophorone	UJ	Surrogate
06-159	B-47	N-Nitroso-di-n-propylamine	UJ	Surrogate
06-159	B-47	N-Nitrosodiphenylamine	UJ	Surrogate
06-159	B-47	Naphthalene	J	Surrogate
06-159	B-47	Nitrobenzene	UJ	Surrogate
06-159	B-47	Phenanthrene	J	Surrogate
06-159	B-47	Pyrene	UJ	Surrogate
06-159	B-39	1,2,4-Trichlorobenzene	UJ	Surrogate
06-159	B-39	1,2-Dichloro benzene	J	Surrogate
06-159	B-39	1,3-Dichloro benzene	UJ	Surrogate
06-159	B-39	2,4-Dinitrotoluene	UJ	Surrogate
06-159	B-39	2,6-Dinitrotoluene	UJ	Surrogate
06-159	B-39	2-Chloronaphthalene	UJ	Surrogate
06-159	B-39	2-Methylnaphthalene	J	Surrogate
06-159	B-39	2-Nitroaniline	UJ	Surrogate
06-159	B-39	3,3'-Dichlorobenzidine	UJ	Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
06-159	B-39	3-Nitroaniline	UJ	Surrogate
06-159	B-39	4-Bromophenyl-phenylether	UJ	Surrogate
06-159	B-39	4-Chloroaniline	UJ	Surrogate
06-159	B-39	4-chlorophenyl phenyl ether	UJ	Surrogate
06-159	B-39	4-Nitroaniline	UJ	Surrogate
06-159	B-39	Acenaphthene	UJ	Surrogate
06-159	B-39	Acenaphthylene	UJ	Surrogate
06-159	B-39	Aniline	UJ	Surrogate
06-159	B-39	Anthracene	UJ	Surrogate
06-159	B-39	Benzidine	UJ	Surrogate
06-159	B-39	Benzo(a)Anthracene	UJ	Surrogate
06-159	B-39	Benzo(a)Pyrene	UJ	Surrogate
06-159	B-39	Benzo(b)Fluoranthene	UJ	Surrogate
06-159	B-39	Benzo(g,h,i)Perylene	UJ	Surrogate
06-159	B-39	Benzo(k)Fluoranthene	UJ	Surrogate
06-159	B-39	Bis(2-chloroethoxy)methane	UJ	Surrogate
06-159	B-39	Bis(2-chloroethyl)ether	UJ	Surrogate
06-159	B-39	Bis(2-chloroisopropyl)ether	UJ	Surrogate
06-159	B-39	bis(2-Ethylhexyl)phthalate	J	Surrogate
06-159	B-39	Butylbenzylphthalate	UJ	Surrogate
06-159	B-39	Carbazole	UJ	Surrogate
06-159	B-39	Chrysene	UJ	Surrogate
06-159	B-39	Di-n-butylphthalate	J	Surrogate
06-159	B-39	Di-n-octylphthalate	UJ	Surrogate
06-159	B-39	Dibenzo(a,h)Anthracene	UJ	Surrogate
06-159	B-39	Dibenzofuran	UJ	Surrogate
06-159	B-39	Diethylphthalate	J	Surrogate
06-159	B-39	Dimethylphthalate	UJ	Surrogate
06-159	B-39	Fluoranthene	UJ	Surrogate
06-159	B-39	Fluorene	UJ	Surrogate
06-159	B-39	Hexachlorobenzene	UJ	Surrogate
06-159	B-39	Hexachlorobutadiene	UJ	Surrogate
06-159	B-39	Hexachlorocyclopentadiene	UJ	Surrogate
06-159	B-39	Hexachloroethane	UJ	Surrogate
06-159	B-39	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
06-159	B-39	Isophorone	UJ	Surrogate
06-159	B-39	N-Nitroso-di-n-propylamine	UJ	Surrogate
06-159	B-39	N-Nitrosodiphenylamine	UJ	Surrogate
06-159	B-39	Naphthalene	J	Surrogate
06-159	B-39	Nitrobenzene	UJ	Surrogate
06-159	B-39	Phenanthrene	UJ	Surrogate
06-159	B-39	Pyrene	UJ	Surrogate
10-167	B-21	1,2,4-Trichlorobenzene	UJ	Surrogate
10-167	B-21	1,2-Dichloro benzene	J	Surrogate
10-167	B-21	1,3-Dichloro benzene	UJ	Surrogate
10-167	B-21	1,4-Dichloro benzene	UJ	Surrogate
10-167	B-21	2,4-Dinitrotoluene	UJ	Surrogate
10-167	B-21	2,6-Dinitrotoluene	UJ	Surrogate
10-167	B-21	2-Chloronaphthalene	UJ	Surrogate
10-167	B-21	2-Methylnaphthalene	UJ	Surrogate
10-167	B-21	2-Nitroaniline	UJ	Surrogate
10-167	B-21	3,3'-Dichlorobenzidine	UJ	Surrogate
10-167	B-21	3-Nitroaniline	UJ	Surrogate
10-167	B-21	4-Bromophenyl-phenylether	UJ	Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
10-167	B-21	4-Chloroaniline	UJ	Surrogate
10-167	B-21	4-chlorophenyl phenyl ether	UJ	Surrogate
10-167	B-21	4-Nitroaniline	UJ	Surrogate
10-167	B-21	Acenaphthene	UJ	Surrogate
10-167	B-21	Acenaphthylene	UJ	Surrogate
10-167	B-21	Aniline	UJ	Surrogate
10-167	B-21	Anthracene	UJ	Surrogate
10-167	B-21	Benzidine	UJ	Surrogate
10-167	B-21	Benzo(a)Anthracene	UJ	Surrogate
10-167	B-21	Benzo(a)Pyrene	UJ	Surrogate
10-167	B-21	Benzo(b)Fluoranthene	UJ	Surrogate
10-167	B-21	Benzo(g,h,i)Perylene	UJ	Surrogate
10-167	B-21	Benzo(k)Fluoranthene	UJ	Surrogate
10-167	B-21	Bis(2-chloroethoxy)methane	UJ	Surrogate
10-167	B-21	Bis(2-chloroethyl)ether	UJ	Surrogate
10-167	B-21	Bis(2-chloroisopropyl)ether	UJ	Surrogate
10-167	B-21	bis(2-Ethylhexyl)phthalate	UJ	Surrogate
10-167	B-21	Butylbenzylphthalate	UJ	Surrogate
10-167	B-21	Carbazole	UJ	Surrogate
10-167	B-21	Chrysene	UJ	Surrogate
10-167	B-21	Di-n-butylphthalate	UJ	Surrogate
10-167	B-21	Di-n-octylphthalate	UJ	Surrogate
10-167	B-21	Dibenzo(a,h)Anthracene	UJ	Surrogate
10-167	B-21	Dibenzofuran	UJ	Surrogate
10-167	B-21	Diethylphthalate	UJ	Surrogate
10-167	B-21	Dimethylphthalate	UJ	Surrogate
10-167	B-21	Fluoranthene	UJ	Surrogate
10-167	B-21	Fluorene	UJ	Surrogate
10-167	B-21	Hexachlorobenzene	UJ	Surrogate
10-167	B-21	Hexachlorobutadiene	UJ	Surrogate
10-167	B-21	Hexachlorocyclopentadiene	UJ	Surrogate
10-167	B-21	Hexachloroethane	UJ	Surrogate
10-167	B-21	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
10-167	B-21	Isophorone	UJ	Surrogate
10-167	B-21	N-Nitroso-di-n-propylamine	UJ	Surrogate
10-167	B-21	N-Nitrosodiphenylamine	UJ	Surrogate
10-167	B-21	Naphthalene	J	Surrogate
10-167	B-21	Nitrobenzene	UJ	Surrogate
10-167	B-21	Phenanthrene	UJ	Surrogate
10-167	B-21	Pyrene	UJ	Surrogate
10-167	B-35	1,2,4-Trichlorobenzene	UJ	Surrogate
10-167	B-35	1,2-Dichloro benzene	J	Surrogate
10-167	B-35	1,3-Dichloro benzene	UJ	Surrogate
10-167	B-35	1,4-Dichloro benzene	UJ	Surrogate
10-167	B-35	2,4-Dinitrotoluene	UJ	Surrogate
10-167	B-35	2,6-Dinitrotoluene	UJ	Surrogate
10-167	B-35	2-Chloronaphthalene	UJ	Surrogate
10-167	B-35	2-Methylnaphthalene	UJ	Surrogate
10-167	B-35	2-Nitroaniline	UJ	Surrogate
10-167	B-35	3,3'-Dichlorobenzidine	UJ	Surrogate
10-167	B-35	3-Nitroaniline	UJ	Surrogate
10-167	B-35	4-Bromophenyl-phenylether	UJ	Surrogate
10-167	B-35	4-Chloroaniline	UJ	Surrogate
10-167	B-35	4-chlorophenyl phenyl ether	UJ	Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
10-167	B-35	4-Nitroaniline	UJ	Surrogate
10-167	B-35	Acenaphthene	UJ	Surrogate
10-167	B-35	Acenaphthylene	UJ	Surrogate
10-167	B-35	Aniline	UJ	Surrogate
10-167	B-35	Anthracene	UJ	Surrogate
10-167	B-35	Benzidine	UJ	Surrogate
10-167	B-35	Benzo(a)Anthracene	UJ	Surrogate
10-167	B-35	Benzo(a)Pyrene	UJ	Surrogate
10-167	B-35	Benzo(b)Fluoranthene	UJ	Surrogate
10-167	B-35	Benzo(g,h,i)Perylene	UJ	Surrogate
10-167	B-35	Benzo(k)Fluoranthene	UJ	Surrogate
10-167	B-35	Bis(2-chloroethoxy)methane	UJ	Surrogate
10-167	B-35	Bis(2-chloroethyl)ether	UJ	Surrogate
10-167	B-35	Bis(2-chloroisopropyl)ether	UJ	Surrogate
10-167	B-35	bis(2-Ethylhexyl)phthalate	UJ	Surrogate
10-167	B-35	Butylbenzylphthalate	UJ	Surrogate
10-167	B-35	Carbazole	UJ	Surrogate
10-167	B-35	Chrysene	UJ	Surrogate
10-167	B-35	Di-n-butylphthalate	UJ	Surrogate
10-167	B-35	Di-n-octylphthalate	UJ	Surrogate
10-167	B-35	Dibenzo(a,h)Anthracene	UJ	Surrogate
10-167	B-35	Dibenzofuran	UJ	Surrogate
10-167	B-35	Diethylphthalate	UJ	Surrogate
10-167	B-35	Dimethylphthalate	UJ	Surrogate
10-167	B-35	Fluoranthene	UJ	Surrogate
10-167	B-35	Fluorene	UJ	Surrogate
10-167	B-35	Hexachlorobenzene	UJ	Surrogate
10-167	B-35	Hexachlorobutadiene	UJ	Surrogate
10-167	B-35	Hexachlorocyclopentadiene	UJ	Surrogate
10-167	B-35	Hexachloroethane	UJ	Surrogate
10-167	B-35	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
10-167	B-35	Isophorone	UJ	Surrogate
10-167	B-35	N-Nitroso-di-n-propylamine	UJ	Surrogate
10-167	B-35	N-Nitrosodiphenylamine	UJ	Surrogate
10-167	B-35	Naphthalene	J	Surrogate
10-167	B-35	Nitrobenzene	UJ	Surrogate
10-167	B-35	Phenanthrene	UJ	Surrogate
10-167	B-35	Pyrene	UJ	Surrogate
10-167	Field Blank	1,2,4-Trichlorobenzene	UJ	Surrogate
10-167	Field Blank	1,2-Dichloro benzene	UJ	Surrogate
10-167	Field Blank	1,3-Dichloro benzene	UJ	Surrogate
10-167	Field Blank	1,4-Dichloro benzene	UJ	Surrogate
10-167	Field Blank	2,4-Dinitrotoluene	UJ	Surrogate
10-167	Field Blank	2,6-Dinitrotoluene	UJ	Surrogate
10-167	Field Blank	2-Chloronaphthalene	UJ	Surrogate
10-167	Field Blank	2-Methylnaphthalene	UJ	Surrogate
10-167	Field Blank	2-Nitroaniline	UJ	Surrogate
10-167	Field Blank	3,3'-Dichlorobenzidine	UJ	Surrogate
10-167	Field Blank	3-Nitroaniline	UJ	Surrogate
10-167	Field Blank	4-Bromophenyl-phenylether	UJ	Surrogate
10-167	Field Blank	4-Chloroaniline	UJ	Surrogate
10-167	Field Blank	4-chlorophenyl phenyl ether	UJ	Surrogate
10-167	Field Blank	4-Nitroaniline	UJ	Surrogate
10-167	Field Blank	Acenaphthene	UJ	Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
10-167	Field Blank	Acenaphthylene	UJ	Surrogate
10-167	Field Blank	Aniline	UJ	Surrogate
10-167	Field Blank	Anthracene	UJ	Surrogate
10-167	Field Blank	Benzidine	UJ	Surrogate
10-167	Field Blank	Benzo(a)Anthracene	UJ	Surrogate
10-167	Field Blank	Benzo(a)Pyrene	UJ	Surrogate
10-167	Field Blank	Benzo(b)Fluoranthene	UJ	Surrogate
10-167	Field Blank	Benzo(g,h,i)Perylene	UJ	Surrogate
10-167	Field Blank	Benzo(k)Fluoranthene	UJ	Surrogate
10-167	Field Blank	Bis(2-chloroethoxy)methane	UJ	Surrogate
10-167	Field Blank	Bis(2-chloroethyl)ether	UJ	Surrogate
10-167	Field Blank	Bis(2-chloroisopropyl)ether	UJ	Surrogate
10-167	Field Blank	bis(2-Ethylhexyl)phthalate	J	Surrogate
10-167	Field Blank	Butylbenzylphthalate	J	Surrogate
10-167	Field Blank	Carbazole	UJ	Surrogate
10-167	Field Blank	Chrysene	UJ	Surrogate
10-167	Field Blank	Di-n-butylphthalate	UJ	Surrogate
10-167	Field Blank	Di-n-octylphthalate	UJ	Surrogate
10-167	Field Blank	Dibenzo(a,h)Anthracene	UJ	Surrogate
10-167	Field Blank	Dibenzofuran	UJ	Surrogate
10-167	Field Blank	Diethylphthalate	UJ	Surrogate
10-167	Field Blank	Dimethylphthalate	UJ	Surrogate
10-167	Field Blank	Fluoranthene	UJ	Surrogate
10-167	Field Blank	Fluorene	UJ	Surrogate
10-167	Field Blank	Hexachlorobenzene	UJ	Surrogate
10-167	Field Blank	Hexachlorobutadiene	UJ	Surrogate
10-167	Field Blank	Hexachlorocyclopentadiene	UJ	Surrogate
10-167	Field Blank	Hexachloroethane	UJ	Surrogate
10-167	Field Blank	Indeno(1,2,3-cd)Pyrene	UJ	Surrogate
10-167	Field Blank	Isophorone	UJ	Surrogate
10-167	Field Blank	N-Nitroso-di-n-propylamine	UJ	Surrogate
10-167	Field Blank	N-Nitrosodiphenylamine	UJ	Surrogate
10-167	Field Blank	Naphthalene	UJ	Surrogate
10-167	Field Blank	Nitrobenzene	UJ	Surrogate
10-167	Field Blank	Phenanthrene	UJ	Surrogate
10-167	Field Blank	Pyrene	UJ	Surrogate
Phenols – MAS				
710072	B-24	2,4-Dichlorophenol	UJ	Holding Time
710072	B-24	Pentachlorophenol	J	Holding Time
710072	B-24	Tetrachlorophenol (total)	UJ	Holding Time
710072	B-24	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-24	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-25	2,4-Dichlorophenol	UJ	Holding Time
710072	B-25	Pentachlorophenol	J	Holding Time
710072	B-25	Tetrachlorophenol (total)	UJ	Holding Time
710072	B-25	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-25	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-10A	2,4-Dichlorophenol	UJ	Holding Time
710072	B-10A	Pentachlorophenol	J	Holding Time
710072	B-10A	Tetrachlorophenol (total)	UJ	Holding Time
710072	B-10A	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-10A	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-39	2,4-Dichlorophenol	UJ	Holding Time
710072	B-39	Pentachlorophenol	J	Holding Time, Surrogate

Lab Batch	Sample ID	Analyte	DV Qualifier	Reason
710072	B-39	Tetrachlorophenol (total)	J	Holding Time, Surrogate
710072	B-39	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-39	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-31	2,4-Dichlorophenol	UJ	Holding Time
710072	B-31	Pentachlorophenol	J	Holding Time
710072	B-31	Tetrachlorophenol (total)	J	Holding Time
710072	B-31	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-31	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-20	2,4-Dichlorophenol	UJ	Holding Time
710072	B-20	Pentachlorophenol	J	Holding Time
710072	B-20	Tetrachlorophenol (total)	UJ	Holding Time
710072	B-20	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-20	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-21	2,4-Dichlorophenol	J	Holding Time
710072	B-21	Pentachlorophenol	J	Holding Time
710072	B-21	Tetrachlorophenol (total)	UJ	Holding Time
710072	B-21	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-21	2,4,6-Trichlorophenol	UJ	Holding Time
710072	Trip Blank	2,4-Dichlorophenol	UJ	Holding Time
710072	Trip Blank	Pentachlorophenol	UJ	Holding Time
710072	Trip Blank	Tetrachlorophenol (total)	UJ	Holding Time
710072	Trip Blank	2,4,5-Trichlorophenol	UJ	Holding Time
710072	Trip Blank	2,4,6-Trichlorophenol	UJ	Holding Time
710072	B-100	2,4-Dichlorophenol	J	Holding Time, Surrogates
710072	B-100	Pentachlorophenol	J	Holding Time, Surrogates
710072	B-100	Tetrachlorophenol (total)	UJ	Holding Time
710072	B-100	2,4,5-Trichlorophenol	UJ	Holding Time
710072	B-100	2,4,6-Trichlorophenol	UJ	Holding Time

15.0 Abbreviations and Definitions

DV Qualifer	Definition
B	Suspected laboratory contamination.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample reporting limit or the amount of contaminant detected in the sample.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.

Abbreviation	Definition
ARI	Analytical Resources, Inc.

Abbreviation	Definition
MAS	Multichem Analytical Services
NCA	North Creek Analytical, Inc.
OSE	OnSite Environmental, Inc.
PAI	Performance Analytical, Inc.
SAS	Sound Analytical Services, Inc.
DV	Data Validation
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MS	Matrix spike
MSD	Matrix spike duplicate
RPD	Relative percent difference

16.0 References

USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, February 1994, EPA540/R-94/012.

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, February 1994, EPA540/R-94/013.

Supplemental Remedial Investigation and Feasibility Study

Appendix C

Duwamish Waterway Tidal Influence Study

AGENCY REVIEW DRAFT

DUWAMISH WATERWAY TIDAL INFLUENCE STUDY

GW International

808 S.W. 15th Avenue
Portland, OR 97205

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

TERRA VAC

Floyd & Snider Inc.

Duwamish Waterway Tidal Influence Study

PREPARED FOR:

GW International

PREPARED BY:

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Seattle, WA 98104

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

Table of Contents

List of Figures

1.0 Introduction

Great Western Chemical Company dba Great Western International (GWI) contracted with Terra Vac to perform a Tidal Influence Study of the area adjacent to its Seattle Facility. The purpose of this study was to assess and document the impact of Duwamish River tidal fluctuations on groundwater flow direction and hydraulic gradients, and to provide information relevant to contaminant transport in both the upper and lower subsurface water-bearing zones identified in previous investigations.

The following tasks were completed as part of this supplemental investigation:

- Collection of site survey data to measure relative elevations of five existing monitoring wells.
- Survey of seep locations and elevations where groundwater enters the S. Myrtle Street Embayment.
- Installation of six pressure transducers in five existing groundwater monitoring wells and one in a temporary embayment stilling well, to record relative fluctuations in groundwater elevations and Duwamish River surface level changes.
- Collection and analysis of transducer data.

2.0 Site Description

The GWI facility property is approximately two and a half acres in size, and is located in the Duwamish River Valley at 6900 Fox Avenue S. in Seattle. The property is essentially flat, and is almost entirely paved and/or covered by structures. It is zoned for industrial use, as are adjoining and nearby surrounding properties. The GWI facility property is approximately 400 feet from the S. Myrtle Street Embayment (Embayment) of the DuwamishRiver. The GWI "site" includes the facility and certain downgradient properties between the facility and the Embayment that are impacted by the migration of source contaminants. The area map is provided as Figure 1.

3.0 Geology and Hydrogeology

The GWI site is located within the floodplain of the Duwamish River. Soils in the area are primarily alluvial sands and silts with discontinuous areas of recent fill. The fill soils generally appear to be of local origin, including some debris and dredge spoils from river channel improvements. Old river meander channels have been filled in areas north, south and west of the site, primarily during the period between 1914 and 1918. No old channels have been identified onsite.

Water levels in the Duwamish River are influenced by three factors: 1) Tidal fluctuations, which average approximately 10 feet (this is the primary effect); 2) river stage controlled by water release from the Howard-Hansen Dam on the Green River; and 3) river stage controlled by rainfall runoff. The net effect is that water levels in the Embayment routinely change by as much as five to 15 feet on a twice daily cycle.

Previous investigations have identified two distinct water-bearing zones at the site. The first water-bearing zone (1st WBZ) occurs between depths of approximately six to 14 feet below ground surface (bgs). It is comprised of a fine to medium silty sand. The saturated portion of the 1st WBZ is between one and three feet in thickness.

The 1st WBZ overlays a low permeability silt layer called the 1st Silt Horizon (1st SH). The thickness of the 1st SH ranges from between a few inches to 2.5 feet. The second water-bearing zone (2nd WBZ) is located beneath the 1st SH, and is comprised of slightly silty sand that extends to a depth of approximately 45 feet bgs. A second silt layer lies beneath the 2nd WBZ.

During previous investigations, limited tidal influence monitoring was completed. However, this monitoring was restricted to the GWI facility. Data from these prior tidal investigations suggested little tidal influence within the 1st WBZ zone. The results of this investigation were presented in Volume 2 of the *Remedial Investigation and Risk Assessment Report* (Hart Crowser, 1993). To fully evaluate site remedies involving end-of-plume treatment near the Duwamish River at the Embayment, tidal fluctuation data are needed between the facility and the river.

4.0 Tidal Influence Study Activities

4.1 PRESSURE TRANSDUCER INSTALLATION

During this tidal study, fluctuations in groundwater elevations were monitored at several locations downgradient of the GWI facility, and compared to the surface water elevations in the Embayment. Information was collected using down-well pressure transducers connected to two Aquistar DL-4 data loggers. This equipment recorded groundwater levels at specified time intervals, and these data were then downloaded into a spreadsheet for data reduction and analysis.

Monitoring locations were selected to provide information representative of the tidal influence on both the 1st WBZ and 2nd WBZ along the prevailing groundwater flow path. Pressure transducers were installed in Monitoring Wells B-34 (near the Embayment) and B-20 (along Fox Avenue S.) in order to record changes within the 1st WBZ. Monitoring Wells B-21 (near the Embayment) and B-33A and B-45 (along Fox Avenue S.) were used to monitor the 2nd WBZ. A temporary stilling well installed within the Embayment was used to measure tidal fluctuations of surface water in the Duwamish River. Monitoring well locations are shown in Figure 2.

4.2 DATA COLLECTION PROCESS

A site survey, which measured the relative elevations of the tops of each of the selected monitoring well casings, was conducted in order to tie all elevation data to the City of Seattle Datum (CSD). This common survey allowed for the comparison of data from multiple collection points.

In order to capture representative data, the tidal study was conducted over a 6-day period between March 15, 1999 and March 21, 1999. The pressure transducers were suspended above the bottom of each of the selected wells. The transducers measured groundwater head pressure above the transducer placement depth, which was converted to groundwater column height (to the nearest 1/100th of a foot). Groundwater and river elevation data were measured continuously, and recorded by a data logger at 4-minute intervals. Physical measurement of the depth to groundwater was made several times throughout the tidal study to provide comparison data for converting the data-logger inputs.

Upon completion of the monitoring phase of the tidal study, the information collected by the data-logger was downloaded into an Excel spreadsheet. Analysis and review of the data was conducted in order to determine the influence of flood and ebb tides at each of the monitoring well locations. Graphs depicting these cyclical fluctuations were prepared to evaluate "lag time;" that is, the time between changes in groundwater elevation compared to fluctuations in the Duwamish River surface water levels. Groundwater and surface water fluctuation measurements were also used to calculate "tidal efficiency". Tidal efficiency is a measure of the relative influence of the tidal fluctuations in the Duwamish Waterway on groundwater levels at GWC Site monitoring wells). Tidal efficiency was determined using the ratio of the standard deviation of the groundwater and surface water elevation data. This method allowed all collected data to be used rather than just the peak readings, therefore reducing the effect of individual reading errors (Erskine 1991).

4.3 SEEP ELEVATION SURVEY

Groundwater enters the Duwamish River through several identified seeps along the Embayment bank and through saturated fill materials at the northern edge of the Embayment. The relative elevation of these seeps was measured during the site survey. Groundwater seep locations are shown in Figure 2.

5.0 Tidal Influence Results and Discussion

5.1 DUWAMISH WATERWAY

Surface water elevation measurements collected from the stilling well placed in the Embayment recorded tidal induced water level fluctuations between –4.5 feet (CSD) and +10.0 feet (CSD). Using the procedure described by Serfes (Serfes 1991), the mean surface water elevation of the Embayment and the mean groundwater elevations in Monitoring Wells B-20, B-21, B-33A, B-34 and B-45 were determined. During the 5.5-day monitoring period, the mean elevation of the Embayment was +4.2 feet (CSD).

5.2 FIRST WATER-BEARING ZONE

Tidal fluctuation effects were recorded for the 1st WBZ at Monitoring Wells B-34 (near the Embayment) and B-20 (along Fox Avenue S.). The elevations observed at these wells and in the Duwamish River during the monitoring period are shown in Figures 3, 5, and 6. A variation in groundwater elevation of approximately 2.5 feet was observed at Well B-34, compared to fluctuations of approximately 14 feet for surface levels of the Duwamish River. This variation is shown in Figures 3 and 5. The lag time between the changes in surface level and groundwater elevation at this location was approximately 3.7 hours. The tidal efficiency at Well B-34 was 14 percent. The mean groundwater elevation at Well B-34 during the monitoring period was determined to be +5.8 feet (CSD).

Monitoring Well B-20 was used to determine the tidal influence further inland. The elevations observed at B-20 and in the Duwamish River during the monitoring period are shown in Figures 3 and 6. Tidal influence was observed at this well, but the range of fluctuation (± 0.5 feet) was less than that observed closer to the Embayment. The lag time was approximately 2.9 hours. Tidal efficiency at Well B-20 was 1 percent, and the mean groundwater elevation at Well B-20 during the monitoring period was +7.2 feet (CSD).

The relatively low tidal efficiencies are consistent with the unconfined conditions (water-table conditions) of the 1st WBZ.

5.3 SECOND WATER-BEARING ZONE

Tidal fluctuation effects were recorded for the 2nd WBZ at Monitoring Wells B-33A (near the Embayment) and at B-21and B-45 (along Fox Avenue S.). The elevations observed at these wells and in the Duwamish River during the monitoring period are shown in Figures 4, 5, and 6. A variation of approximately 1 foot was observed for the groundwater elevations at Well B-33A, compared to surface level fluctuations of approximately 8 feet. This variation is shown in Figures 4 and 5. The lag time between the changes in surface level and groundwater elevation at this location was approximately 0.53 of an hour. Tidal efficiency at Well B-33A was 27 percent, and the mean groundwater elevation at Well B-33A during the monitoring period was +5.7 feet (CSD).

Monitoring Wells B-21 and B-45 were used to determine the tidal influence further inland. The elevations observed at these wells and in the Duwamish River during the monitoring period are shown in Figures 4 and 6. The range of fluctuation (± 0.25 feet) was less than that observed closer to the Embayment. In addition, the lag time between the changes in surface level and groundwater elevation was approximately 1.3 hours at B-21 and 1.5 hours at B-45. The tidal efficiencies of both Well B-21 and Well B-45 were 2 percent. The mean groundwater elevations at Wells B-21 and B-45 during the monitoring period were +6.6 and +6.9 feet (CSD), respectively.

The higher efficiencies and shorter lag times of the 2nd WBZ in relation to the 1st WBZ indicate that the 1st SH, although thin and discontinuous, is still sufficient to produce semi-confined conditions within the aquifer.

5.4 DUWAMISH WATERWAY EMBAYMENT SEEPS

The elevations of Groundwater Seeps S-1, S-2, and S-13 were compared to the tidal fluctuations of the Duwamish River and the induced changes in groundwater elevations nearest the Embayment, at Wells B-33A and B-34. These comparisons are shown in Figure 5. As the surface level of the Duwamish River cycled with the tidal influence, groundwater flowed from the seeps above the water surface only at low tide. During a 24-hour cycle of the tidal study, groundwater flowed through the seeps into the Embayment approximately 58 percent of the time from the 1st WBZ and 67 percent from the 2nd WBZ. During the remaining portions of each cycle, a reversal in flow gradient resulted as the river level rose above groundwater elevations, and there was no groundwater discharge into the river.

6.0 Conclusions

The following conclusions are based on the data generated during this tidal study and the information available from previous site investigations:

1. Tidal fluctuations of the Duwamish River affect the groundwater elevations observed in both the 1st WBZ and 2nd WBZ, indicating that both of these water-bearing layers are in direct communication with the Duwamish River. This influence appears to extend inland to Fox Avenue S., although the decrease in tidal efficiencies between the Embayment wells and those along Fox Avenue S. indicate that tidal impacts east of Fox Avenue S., if any, are minimal.
2. The lag time between Duwamish River peak surface water levels and the observed groundwater elevation influences varied, based on both the water-bearing zone monitored and the distance inland from the Embayment. The lag time for tidal influence varied from 3.7 hours near the Embayment to 2.9 hours in the vicinity of Fox Avenue S. for the 1st WBZ, and from 0.53 to 1.3 hours over the same distance within the 2nd WBZ. The differences in lag time between the 1st WBZ and the 2nd WBZ indicate that the 1st SH, where present, acts as a hydrologic division between the two water-bearing zones.
3. Gradient reversal likely occurs near the Embayment, with water flowing from the Embayment into the groundwater system during approximately 1/3 of the tide cycle. (More during high water stages; less during low water stages.) This effect likely is manifested in the groundwater system to approximately midway between the Embayment and Fox Avenue S., beyond which the estimated tidal fluctuations are too small, relative to the groundwater gradients, to have any significant impact on groundwater flow direction.

7.0 References

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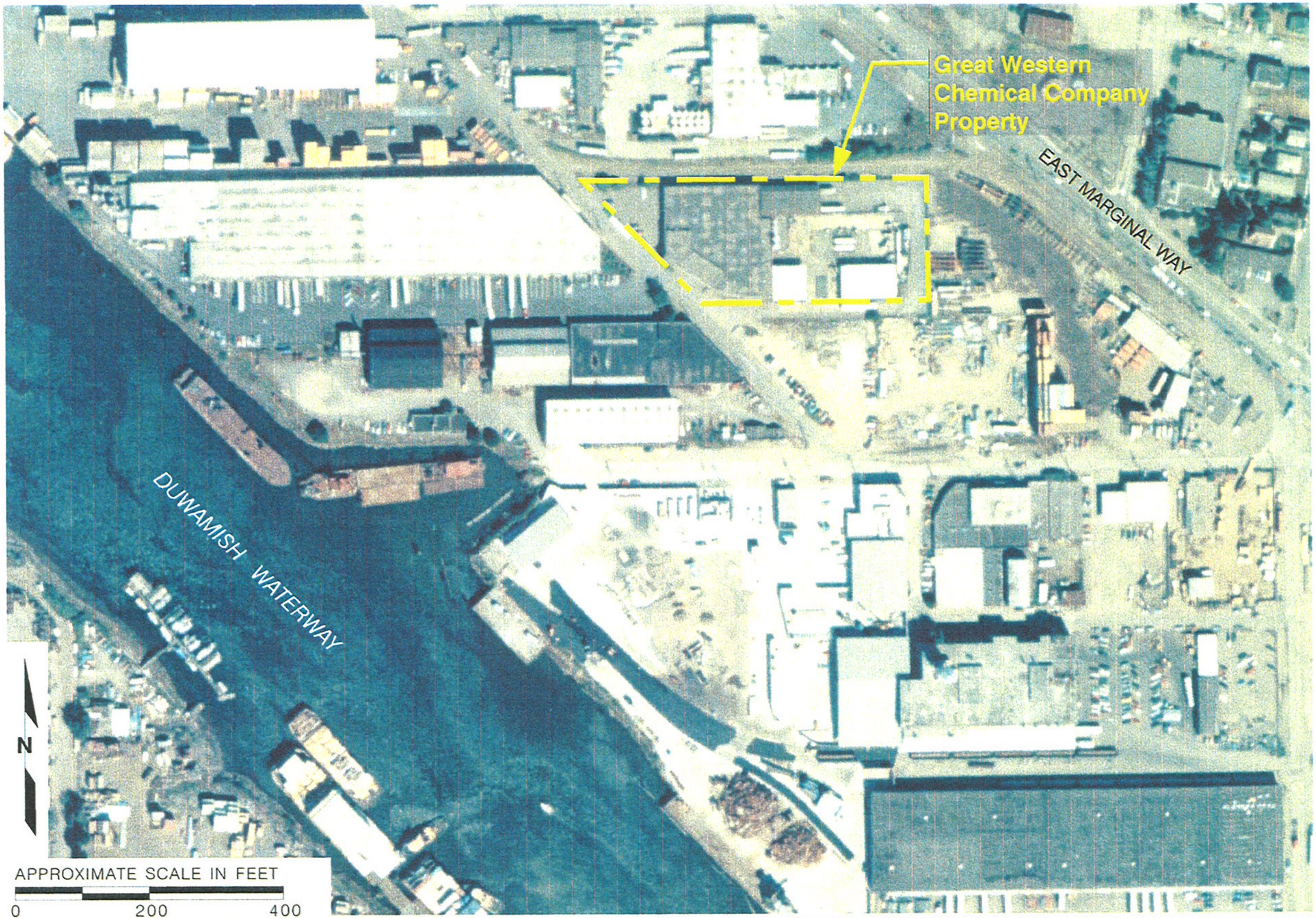
Serfes, M.E. 1991. "Determining Mean Hydraulic Gradient of Ground Water Affected by Tidal Fluctuations." *Ground Water*. v. 29, no. 4, pp. 549-555.

Todd, D.K. 1980. *Ground Water Hydrology.* Second edition. John Wiley and Sons Inc., New York. p. 535.

Duwamish Waterway Tidal Influence Study

Figures

AGENCY REVIEW DRAFT



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Great Western Chemical Company
Seattle, Washington

Figure 1
Area Map

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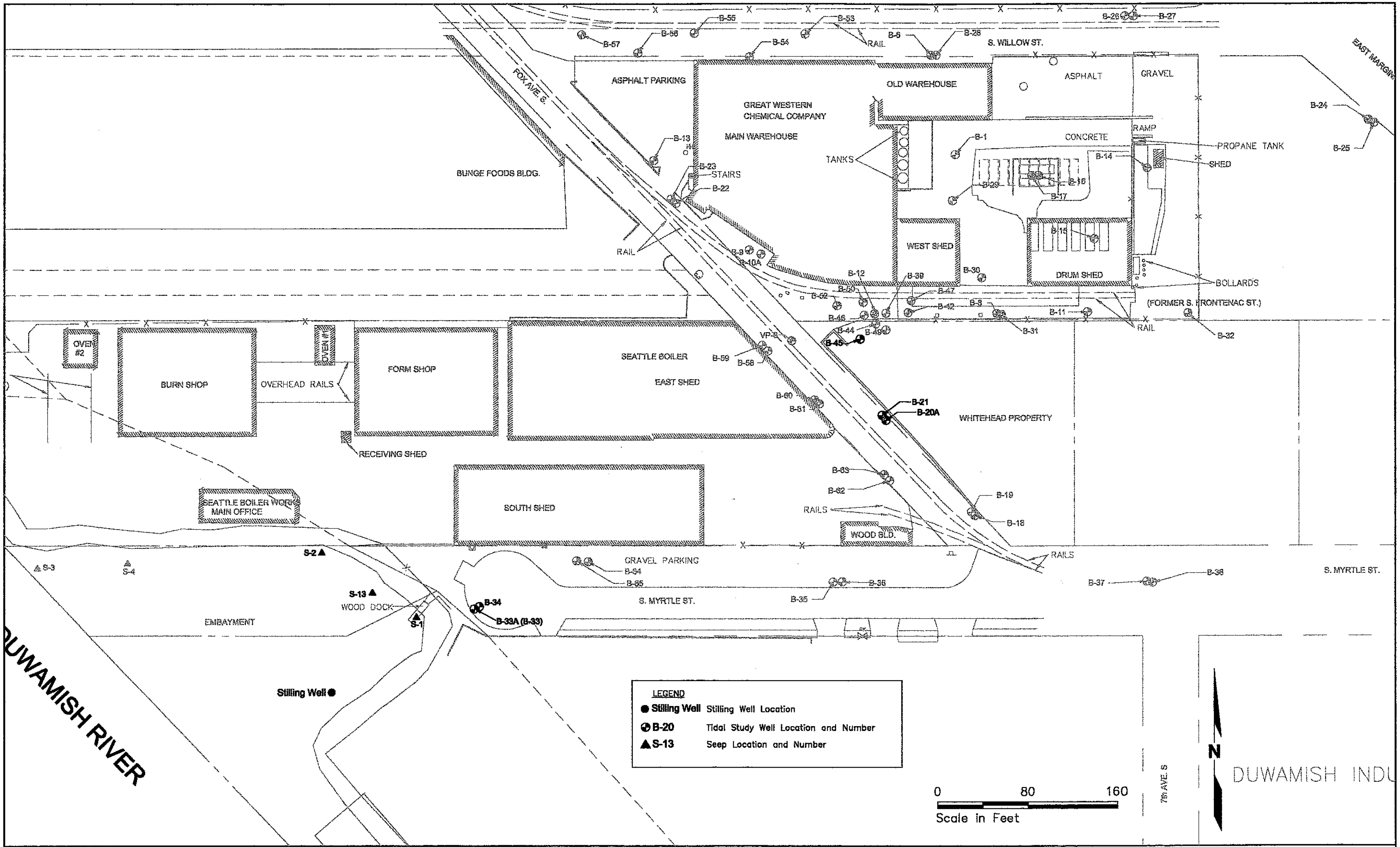

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TERRA VAC

Great Western Chemical Company
Seattle, Washington

Figure 2
Monitoring Well and Seep Stations

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Figure 3
Tidal Influence in Monitoring Wells B-20 and B-34, First Water-Bearing Zone

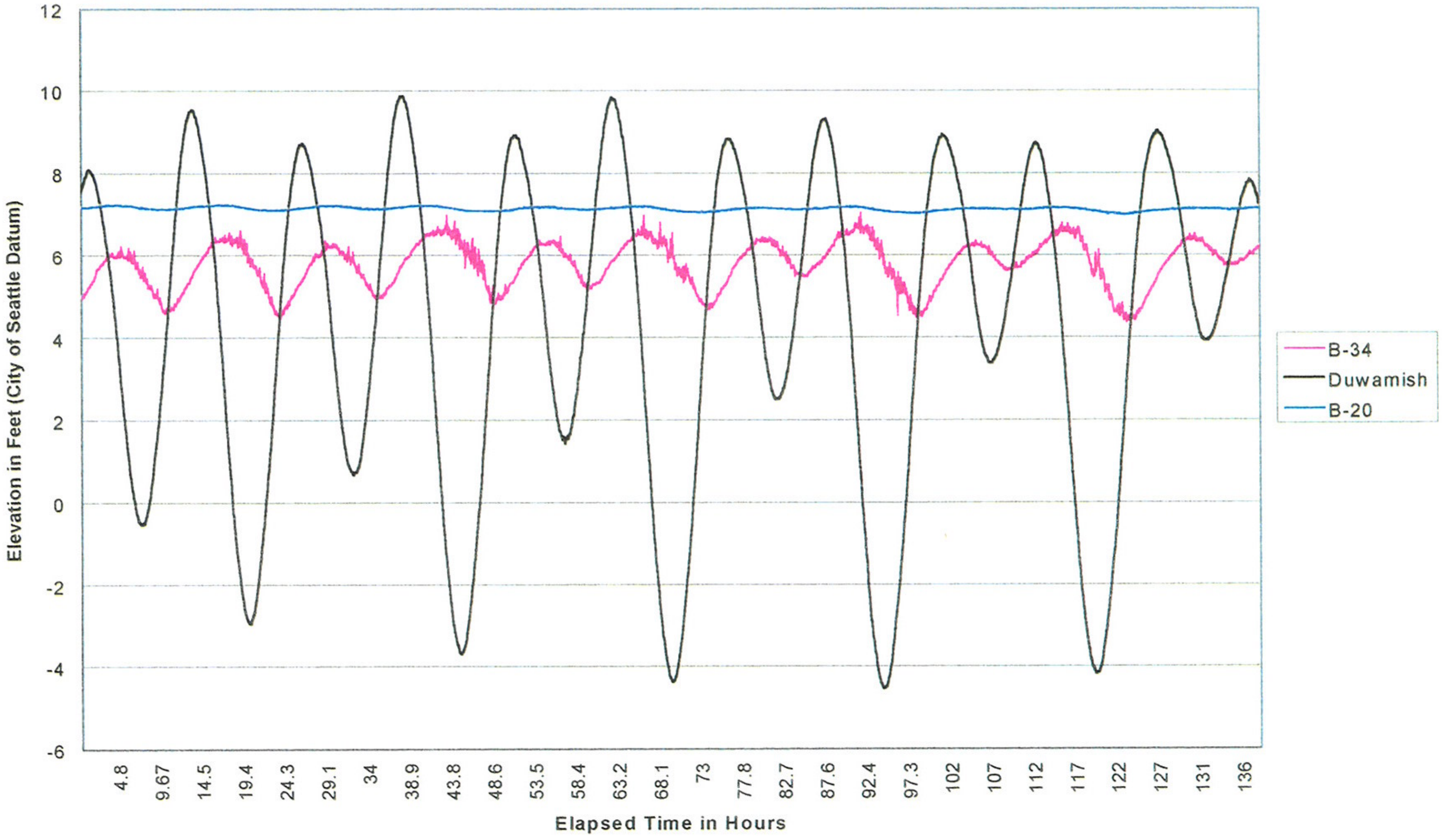


Figure 4
Tidal Influence in Monitoring Wells B-21, B-33A and B-45, Second Water-Bearing Zone

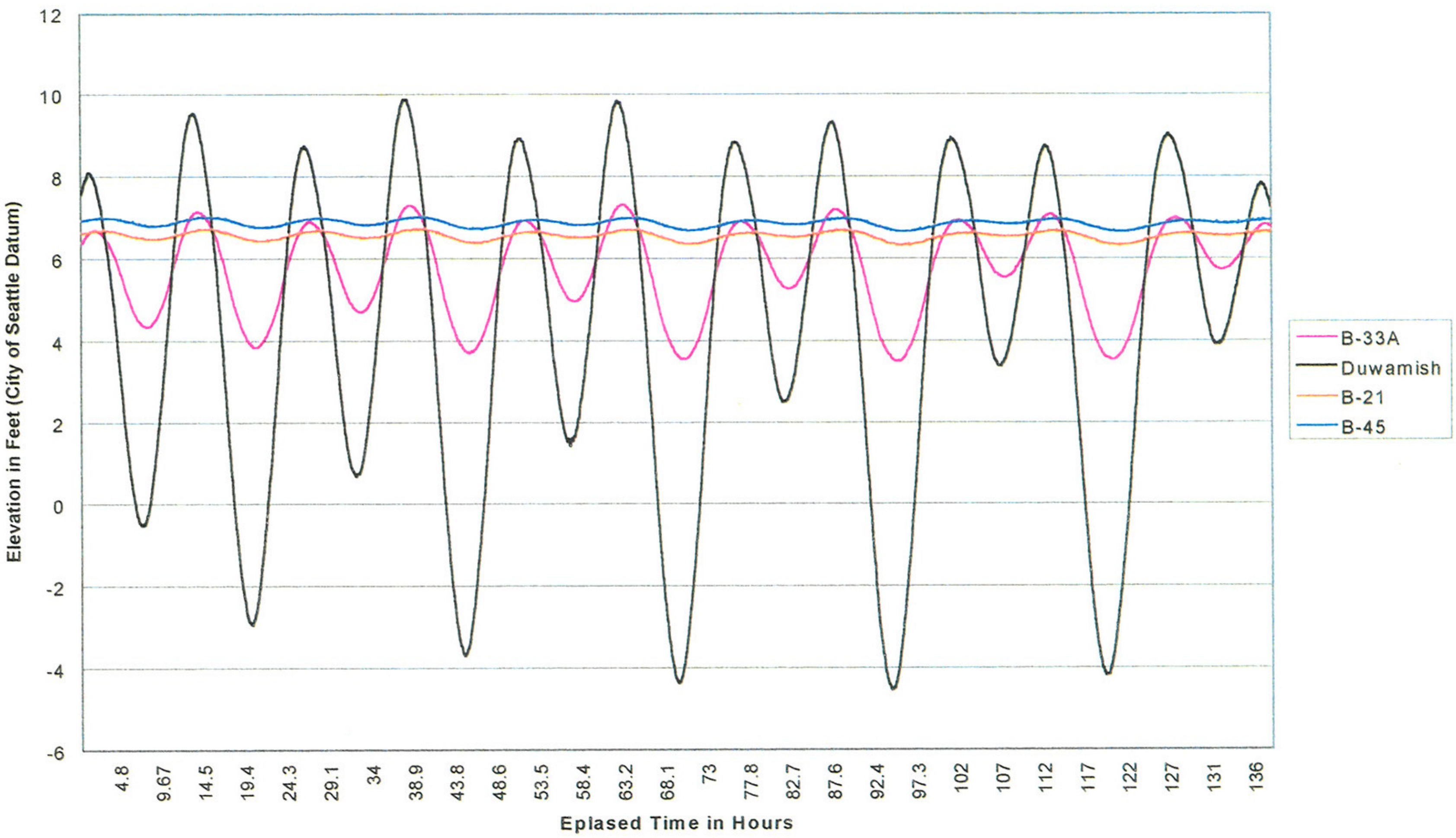


Figure 5
Tidal Influence in Monitoring Wells B-33A and B-34 at S. Myrtle Street vs. Surface Water Elevation at the Duwamish River

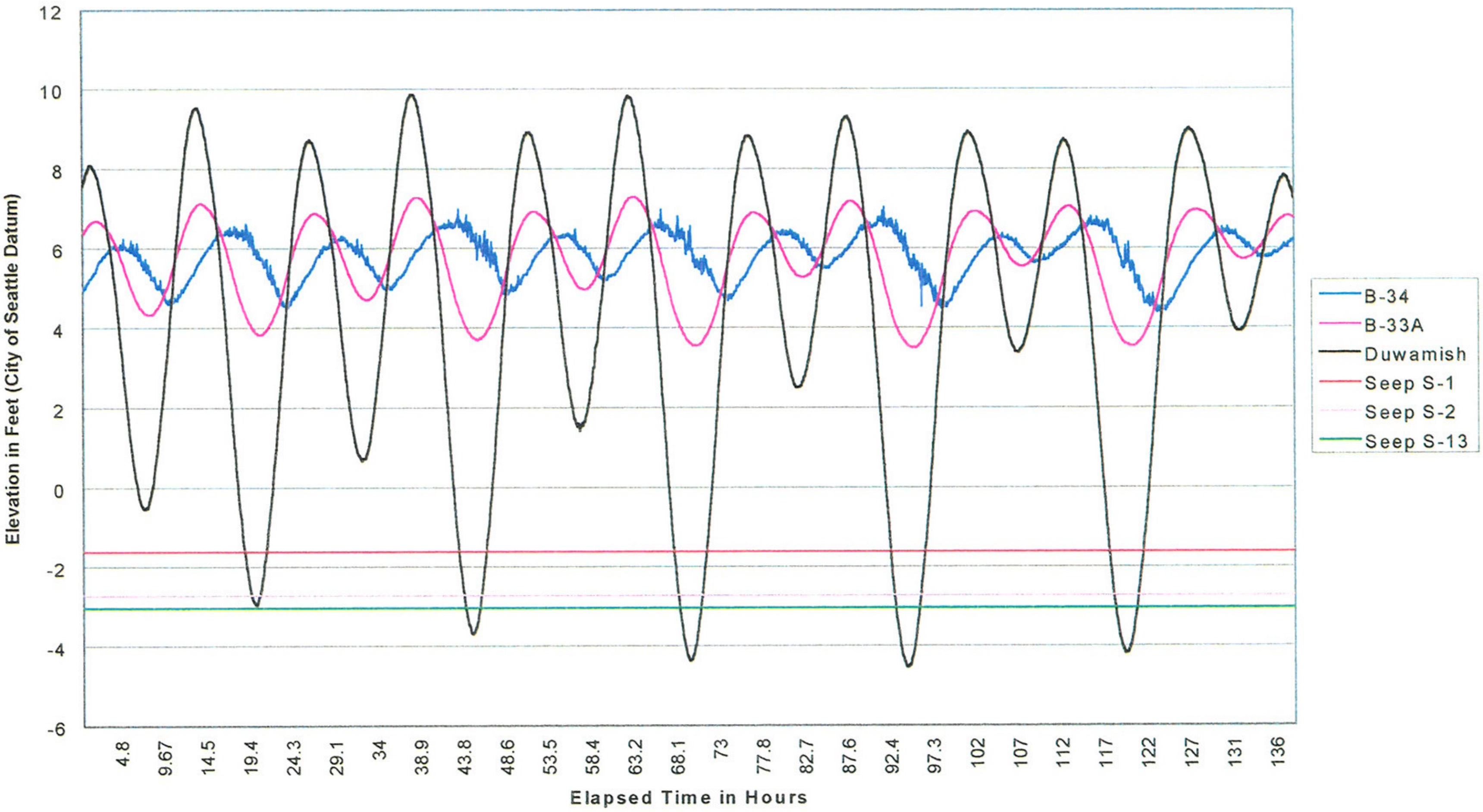
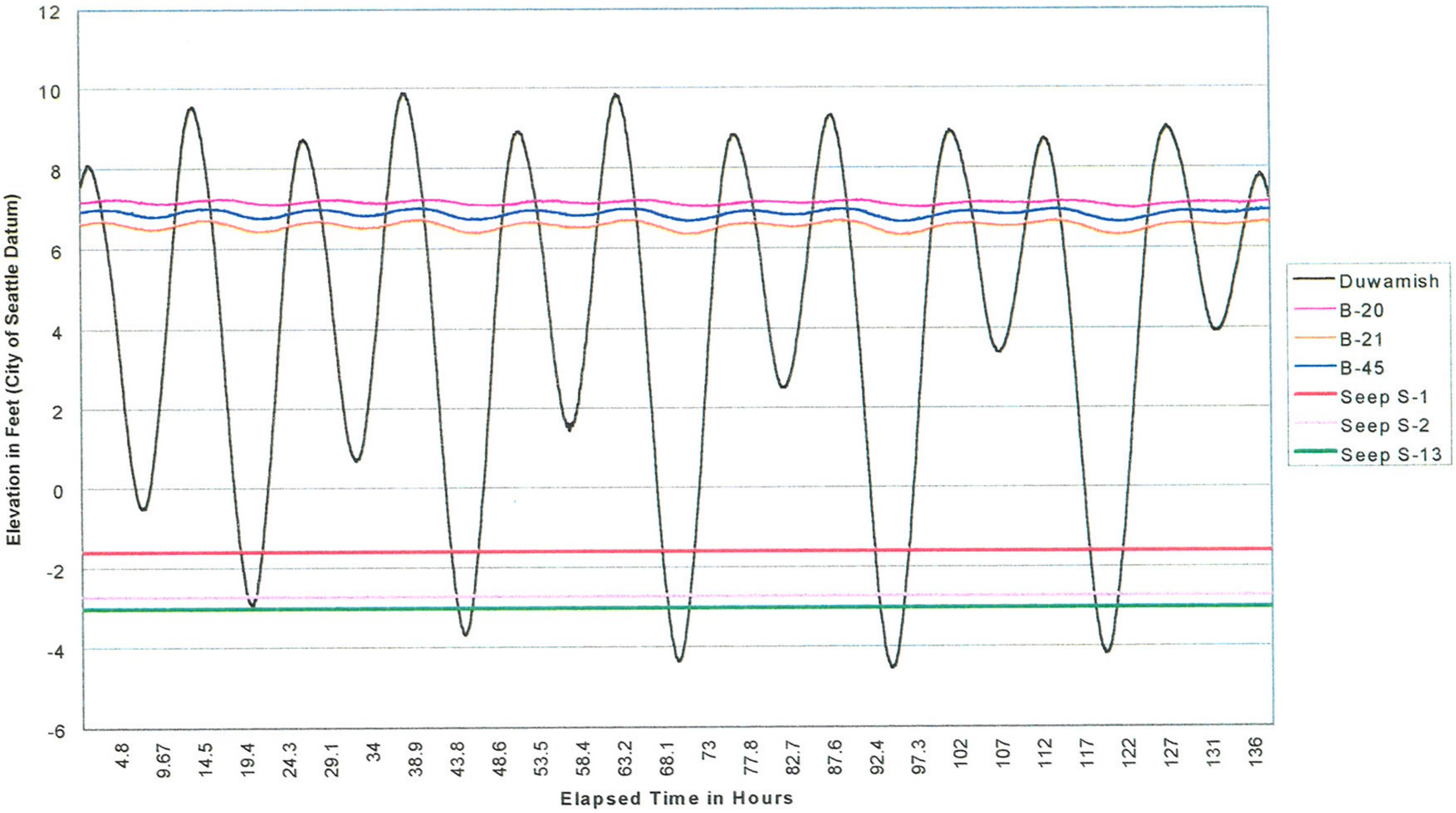


Figure 6
Tidal Influence in Monitoring Wells B-20, B-21, and B-45 at Fox Avenue S. vs. Surface Water Elevation at the Duwamish River



Supplemental Remedial Investigation and Feasibility Study

Appendix D

S. Myrtle Street Embayment Study

AGENCY REVIEW DRAFT

S. MYRTLE STREET EMBAYMENT STUDY

GW International

6900 Fox Avenue S.
Seattle, Washington

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

TERRA VAC

Floyd & Snider Inc.

S. Myrtle Street Embayment Study

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AGENCY REVIEW DRAFT

Table of Contents

List of Tables

List of Figures

List of Attachments

1.0 Introduction

This report presents the results of Great Western Chemical Company dba Great Western International's (GWI) 1999 investigation of groundwater discharge to the Duwamish River at the S. Myrtle Street Embayment (Embayment) near the GWI Seattle facility. This study was performed by Terra Vac Corporation on behalf of GWI. The area map is presented in Figure 1.

The purpose of the investigation was to determine whether groundwater was discharging to the Embayment through a finite number of seeps, such as those already identified in the Remedial Investigation (RI), or through broad areas of groundwater upwelling through the Embayment sediments. The goal was to gather information that would both distinguish between the two types of discharge (seeps and generalized upwelling) and identify the areas where significant discharge occurs. The discharge points could then be sampled during other Supplemental Remedial Investigation activities using conventional sampling protocols.

The traditional technique for identifying freshwater (groundwater) seeps into a marine-influenced river, such as the Duwamish, is to measure and map sediment porewater salinity. This technique is limited in its ability to detect small discharge rates (the salinity difference is not enough) and it is not specific to the source of fresh water. At theGWI site, the groundwater of interest contains high concentrations of tetrachloroethene (commonly called perchloroethylene or PCE) and its breakdown products. These concentrations remain elevated in identified seeps and in adjacent groundwater wells. Excellent analytical methods exist for monitoring these chemicals in sediments at concentrations that are orders-of-magnitude less than the concentrations in the groundwater and seeps. The method selected for identifying groundwater discharge of these chemicals was analyses for their presence in sediment porewater.

Terra Vac performed three separate sampling events between October and December 1998 to measure and map the distribution of chlorinated ethenes in sediment porewater:

1. Sampling of sediments in the Embayment using a series of passive screening devices known as GORE-SORBERS®.
2. Sampling of seep-face sediment in the Embayment and along the Duwamish River main channel using several GORE-SORBERS®.
3. Sampling of seep-water discharging to the Embayment and to the Duwamish River main channel as part of the annual sampling.

Event 3 was part of the annual groundwater monitoring in 1998 and its results are included in the Supplemental RI. A brief summary of these results for seeps is included in this report for comparison to the results from the GORE-SORBER® sampling.

2.0 Background

A Remedial Investigation (RI) was performed at the GWI site in 1993. The RI identified volatile organic compounds (VOCs) in groundwater at the site. These VOCs include PCE and its degradation products: trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-DCE, 1,1-dichloroethene, 1,1-dichloroethane, and vinyl chloride (VC).

Annual groundwater monitoring has occurred at the site since 1993. The annual groundwater event includes sampling of groundwater wells surrounding the facility and between the facility and the Duwamish River, sampling of groundwater seeps discharging at the Embayment, and sampling of mussels collected from within the Embayment and from upstream locations. Typical concentrations (from the 1999 Annual Groundwater Monitoring) of PCE, TCE, total-DCE, and VC in the seeps and nearby groundwater wells [1st and 2nd Water Bearing Zones (WBZ)] are shown below:

Chemical of Concern (μg/L)	1st WBZ Groundwater (B-34)	2nd WBZ Groundwater (B-33A)	Seeps
PCE	11	130	4-200
TCE	5.7	<100	2-270
Total-DCE	7.6	21,200	5-3,200
VC	2.2	23,000	<1-3,500

3.0 Methods, Materials, and Results

3.1 DESCRIPTON OF THE GORE-SORBER® SCREENING

The GORE-SORBER® screening module is a passive soil and sediment sampling device used to detect a variety of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Each module consists of a one meter long by 3mm-diameter piece of expanded polytetraflouroethylene GORE-TEX® tubing in which 40 milligrams of sorbant material appropriate for the compounds of interest have been inserted. The GORE-TEX® tubing prevents water from entering the sorbant material while still allowing VOCs and SVOCs to be captured. The screening modules are installed horizontally into the soil or sediments, and allowed to absorb any compounds present. Following a period of time appropriate for the level of detection desired, the modules are retrieved, returned to the laboratory and analyzed for VOCs and SVOCs by thermal desorption and gas chromatography. GORE-SORBERS® have been demonstrated as effective screening tools to determine the presence or absence of VOCs and SVOCs in soil and sediments. GORE-SORBERS® are not effective in quantifying the concentrations of compounds with greater than order-of-magnitude precision, or in distinguishing the sources of identified compounds. A description of the GORE-SORBER® screenings and the analytical steps used are presented in reports from W. L. Gore and Associates (Attachments A and B).

3.2 EMBAYMENT SEDIMENT SCREENING

3.2.1 METHODS

Between September 28, and October 2, 1998, Terra Vac and Pentec Environmental installed 43 GORE-SORBERS® in the sediments of the S. Myrtle Street Embayment and the Duwamish River. This task was undertaken to determine if groundwater potentially impacted byGWI site VOCs was entering sediments through upwelling of groundwater from beneath the Embayment.

Prior to installation of the modules, eight transects were established, running from the mouth of the Embayment towards the shoreline of the Embayment closest to S. Myrtle Street (Figure 2). Each of these transects was marked by lead lines pulled across the Embayment which contained marked locations at 50 foot intervals. A sorber module was installed at each of these interval marks. Each transect was given a letter designation (A through H) and each installation point was numbered starting from the point closest to S. Myrtle Street. Eight modules were installed in the main channel of the Duwamish River as extensions of Transects B, E and H (Figure 2). The specific location of each module was determined by a Differential Global Positioning System (DGPS) survey, which was later used to produce a map of the module installation locations relative to other surface features.

Pentec Environmental personnel, using surface supplied diving equipment, installed 43 GORE-SORBER® modules on September 30, 1998. The modules remained in the sediments for 48 hours, in order to allow sufficient time for the modules' absorbent material to approach equilibrium with the sediments. After 48 hours, the divers retrieved all 43 modules. Once retrieved, each module was placed in the sampling jar in which it had arrived. The modules (including field blanks used to identify any potential contamination during handling and transport) were returned to W. L. Gore and Associates in Elkton, Maryland for analysis.

Following retrieval of the modules, all of the buoys and lead lines used to mark the installation locations were removed from the S. Myrtle Street Embayment and from the river channel.

3.2.2 RESULTS OF THE S. MYRTLE STREET EMBAYMENT SEDIMENT SCREENING

Of the 43 modules installed and retrieved, only two contained detectable quantities of PCE breakdown products. Module #170597, installed at Transect E Location #1, detected cis-1,2-DCE. Module #170609, installed at Transect G Location #1, detected cis-1,2-DCE, trans-1,2-DCE, VC, 1,1-dichloroethene, and 1,1-dichloroethane. Both of these modules were located adjacent to seeps that have been identified during the RI as discharge points for groundwater impacted by GWI site VOCs.

The specific mass of each compound detected during the S. Myrtle Street Embayment sediment screening is presented in Table 1. The complete analytical results from this activity are presented in the report from W.L. Gore contained in Attachment A.

None of the other 41 modules installed in the S. Myrtle Street Embayment during this study detected any of the PCE breakdown products or any other evidence of VOCs in the sediments.

The eight modules deployed in the Duwamish River main channel were compromised by the transmission of water across the selective membrane as a result of hydrostatic pressure. The hydrostatic pressure was greater in the main channel because it is much deeper than the S. Myrtle Street Embayment as a result of dredging for ship traffic.

Two chlorinated benzenes, 1,2-dichlorobenzene and 1,4-dichlorobenzene, were also detected in Module #170609. These chlorinated benzenes are prevalent in sediments throughout the river, and have been associated with outfall discharges to the Duwamish River from other sites. Since they have not been detected in groundwater adjacent to the Duwamish River nor in the seeps, they are not considered chemical "markers" for groundwater that has been potentally impacted by the GWI site.

3.3 SEEP-FACE SCREENING

3.3.1 METHODS

During low tide (-2.3 feet below Mean Sea Level (MSL)) on November 5, 1998, Terra Vac installed 10 additional GORE-SORBER® modules horizontally in the sediments along the eastern face of the S. Myrtle Street Embayment (Figure 3). These modules were installed to confirm the presence and relative extent of VOCs in sediments along the seep-face in this area, in the immediate vicinity of Seeps S-1 and S-13, which have been identified asdischarge points for PCE degradation products in groundwater. Modules installed southwest of S-1 were used to define the limit of porewater impact from S-1, since the nearest seep to the southwest (S-6) is clean. In addition, five GORE-SORBER® modules were installed in sediments at previously identified seep locations both within the S. Myrtle Street Embayment and along the main Duwamish River bank. These modules were installed to confirm the absence ofGWI site VOCs in sediments at locations where previous seep sampling had not detected such compounds. All 15 modules were retrieved 48 hours after installation and returned to W. L. Gore and Associates in Elkton, Maryland for analysis.

3.3.2 RESULTS OF THE SEEP FACE SCREENING

Of the 10 modules installed in the eastern S. Myrtle Street Embayment seep-face, nine contained detectable quantities of PCE or one of its degradation products. PCE and 1,1,2-trichloroethane (a related solvent, that is not a degradation product of PCE) were detected in the module installed at S-11, north of the S. Myrtle Street Embayment. This location is outside the groundwater flow-path associated with the GWI site.

The specific mass of each compound detected during the seep-face screening is presented in Table 2. The complete analytical results from this activity are presented in the report from W. L. Gore contained in Attachment B.

3.4 SEEP SAMPLING

3.4.1 METHODS

During low tide (-2.3 feet MSL) on November 5, 1998, Terra Vac collected samples from several locations along the east bank of the Duwamish River and the S. Myrtle Street Embayment as part of the annual site-wide sampling event. The goal of this event was to compare the results of the GORE-SORBER® sampling to the more precise and accurate results from the annual seep sampling event.

Seep samples were collected from 12 locations (Figure 4), three of which were along the eastern edge of the S. Myrtle Street Embayment in an area characterized as a seepface. A second set of seep samples were collected concurrent with the seep-face screening during low tide (-2.8 feet MSL) on December 4, 1998 from Seep Locations S-1, S-2 and S-13 (Figure 4). Seep samples were collected using wide mouth jars, which were then used to fill sample containers specific to the analysis being performed. Once collected, samples were placed in a cooler with ice prior to being transported to the contract laboratory for analysis. Seep-water samples were analyzed for VOCs in accordance with EPA Method 8260b and for salinity by Standard Method SM2520B.

3.4.2 RESULTS OF THE SEEP SAMPLING

Five of the 12 seep-water samples collected on November 5, 1998 contained detectable quantities of PCE or its breakdown products. Seep-water discharged from S-1 contained PCE, TCE, cis-1,2-DCE and VC. Seep-water discharged from S-2/S-8 contained PCE, TCE, cis-1,2-DCE and trans-1,2-DCE. Seep-water discharged from S-13 contained PCE, TCE, cis-1,2-DCE and VC. Seep-water discharged from S-6 contained PCE. S-6, located south of the S. Myrtle Street Embayment, is outside the groundwater flow-path associated with the GWI site.

The specific concentration of each marker compound detected during the annual seep sampling in November 1998 is presented in Table 3. The complete analytical results from this activity as reported by the laboratory are presented in Attachment C.

3.4.3 RESULTS OF THE SECOND SEEP SAMPLING

All three seep-water samples collected on December 4, 1998 contained detectable quantities of PCE or its breakdown products. Seep-water discharged from S-1 contained PCE, TCE, cis-1,2-DCE and VC. Seep-water discharged from S-2/S-8 contained PCE, TCE and cis-1,2-DCE. Seep-water discharged from S-13 contained TCE, cis-1,2-DCE and VC.

The specific concentration of each marker compound detected during the second seep sampling in December 1998 is presented in Table 3. The complete analytical results from this activity as reported by the laboratory are presented in Attachment D.

4.0 Conclusions

The conclusions from this study are as follows:

1. Groundwater discharge to the Duwamish River at the S. Myrtle Street Embayment was found to occur as seep discharges. No generalized groundwater upwelling was measurable using chemical markers.
2. The seeps identified during the RI were also identified during this investigation as discrete seeps. Sediment porewater in the immediate vicinity of the seeps contained measurable concentrations of PCE and its degradation products. However, the effect was found to be very localized.
3. PCE and/or its degradation products also were detected in seep-face sediments along the eastern edge of the S. Myrtle Street Embayment. This seep face was further delineated in a second sampling event, and found to have a moderately long horizontal extent (as shown in Figure 3), but a very limited vertical extent.
4. The extent of groundwater discharge containing the chemical markers was delineated both vertically and horizontally using both sediment porewater screening and collection of seep grab samples. The extent was bounded to the north by Seep S-2 and to the south by S-1. The seeps also were bounded in elevation (vertical extent) and found to occur between approximately –1 and –3 feet (City of Seattle Datum).

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S. Myrtle Street
Embayment Study

Tables

AGENCY REVIEW DRAFT

Table 1

GORE-SORBER® Embayment Screening Results

Module #	Array Location	Compounds Detected (ug)							
		1,2-DCE (total)	1,2-DCE (cis)	1,2-DCE (trans)	1,1-DCE	VC	1,1-DCA	1,2-DCB	1,4-DCB
170597	E1	0.12	0.12	ND	ND	ND	ND	ND	ND
170609	G1	27.67	27.46	0.21	0.33	42.05	0.58	0.26	0.09
All Other Modules	All Other Locations	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

DCA	Dichloroethane
DCB	Dichlorobenzene
DCE	Dichloroethene
VC	Vinyl Chloride
ND	Not Detected.

Phase 2

Table 2
GORE-SORBER® Seep-Face Screening Results

Module #	Installed Location	Chlorinated Ethenes						
		PCE	TCE	1,2-DCE (total)	1,2-DCE (cis)	1,2-DCE (trans)	1,1-DCE	VC
171902	22' S of S-1	ND	ND	0.05	0.05	ND	ND	ND
171903	11' S of S-1	ND	ND	1.12	1.06	0.06	ND	7.71
171904	16.5' S of S-1	ND	ND	0.1	0.1	ND	ND	ND
171905	Seep (S-11)	0.26	ND	0.2	0.2	ND	ND	ND
171910	6' S of S-1	ND	0.11	43.58	42.75	0.83	0.41	103.94
171917	Seep (S-12)	ND	ND	ND	ND	ND	ND	ND
171924	2' N of S-13	0.92	1.76	349.05	341.94	7.11	1.5	38.57
171925	5.5' S of S-13	0.15	0.48	333.87	330.41	3.46	2.08	51.75
171926	15.5' S of S-13	0.17	0.46	145.58	143.41	2.17	1.24	44.96
171927	Seep (S-6)	ND	ND	ND	ND	ND	ND	ND
171928	2' S of S-13	0.45	1.55	312.11	305.3	6.81	4.15	27.9
171929	10.5' S of S-13	0.27	0.61	232.51	229.97	2.54	1.24	62.86
171930	20.5' S of S-13	0.22	0.58	125.82	123.31	2.51	0.94	47.58
171931	Seep (S-5)	ND	ND	ND	ND	ND	ND	ND
171932	Seep (S-3)	ND	ND	ND	ND	ND	ND	ND
171900	Blank	ND	ND	ND	ND	ND	ND	ND
171901	Blank	ND	ND	ND	ND	ND	ND	ND
171906	Blank	ND	ND	ND	ND	ND	ND	ND

Table 2

GORE-SORBER® Seep-Face Screening Results

Module #	Installed Location	Chlorinated Ethanes			
		1, 1, 1-TCA	1, 1, 2-TCA	1,1-DCA	1, 2-DCA
171902	22' S of S-1	ND	ND	1.91	ND
171903	11' S of S-1	ND	ND	5.61	ND
171904	16.5' S of S-1	ND	ND	2.78	ND
171905	Seep (S-11)	ND	0.26	ND	ND
171910	6' S of S-1	ND	ND	10.11	0.08
171917	Seep (S-12)	ND	ND	ND	ND
171924	2' N of S-13	ND	0.92	1.98	0.43
171925	5.5' S of S-13	ND	0.15	6.76	0.46
171926	15.5' S of S-13	ND	0.17	6.47	0.28
171927	Seep (S-6)	ND	ND	ND	ND
171928	2' S of S-13	ND	0.45	12.48	1.01
171929	10.5' S of S-13	ND	0.27	7.59	0.38
171930	20.5' S of S-13	ND	0.22	8.36	0.24
171931	Seep (S-5)	ND	ND	ND	ND
171932	Seep (S-3)	ND	ND	ND	ND
171900	Blank	ND	ND	ND	ND
171901	Blank	ND	ND	ND	ND
171906	Blank	ND	ND	ND	ND

Table 2
GORE-SORBER® Seep-Face Screening Results

Module #	Installed Location	Chlorinated Benzenes			
		1,2-DCB	1,3-DCB	1,4-DCB	CLBENZ
171902	22' S of S-1	0.09	ND	ND	0.06
171903	11' S of S-1	0.42	ND	0.07	0.29
171904	16.5' S of S-1	0.2	ND	ND	0.11
171905	Seep (S-11)	ND	ND	ND	ND
171910	6' S of S-1	0.85	0.03	0.23	0.59
171917	Seep (S-12)	ND	ND	ND	ND
171924	2' N of S-13	0.62	ND	0.03	0.19
171925	5.5' S of S-13	0.18	ND	0.04	0.91
171926	15.5' S of S-13	0.11	ND	0.04	0.6
171927	Seep (S-6)	ND	ND	ND	ND
171928	2' S of S-13	0.51	ND	0.14	2.79
171929	10.5' S of S-13	0.19	ND	0.08	0.82
171930	20.5' S of S-13	0.3	ND	0.1	1.02
171931	Seep (S-5)	ND	ND	ND	ND
171932	Seep (S-3)	ND	ND	ND	ND
171900	Blank	ND	ND	ND	ND
171901	Blank	ND	ND	ND	ND
171906	Blank	ND	ND	ND	ND

Table 2

GORE-SORBER® Seep-Face Screening Results

Module #	Installed Location	Other
		CCL4
171902	22' S of S-1	ND
171903	11' S of S-1	ND
171904	16.5' S of S-1	ND
171905	Seep (S-11)	ND
171910	6' S of S-1	ND
171917	Seep (S-12)	ND
171924	2' N of S-13	ND
171925	5.5' S of S-13	ND
171926	15.5' S of S-13	ND
171927	Seep (S-6)	ND
171928	2' S of S-13	ND
171929	10.5' S of S-13	ND
171930	20.5' S of S-13	ND
171931	Seep (S-5)	ND
171932	Seep (S-3)	ND
171900	Blank	ND
171901	Blank	ND
171906	Blank	ND

Notes:

ND	Not Detected.
PCE	Tetrachloroethene
TCE	Trichloroethene
DCE	Dichloroethene
ct 1,2-DCE	Sum total of cis aND trans DCE
VC	Vinyl chloride
TCA	Trichloroethane
CCL4	Methylene Chloride
CLBENZ	Chlorobenzene
DCA	Dichloroethane
DCB	Dichlorobenzene

Table 3
Seep Sampling Results

Parameter Group	Sample ID	S-1	S-1	S-1	S-1
	Sample Date	12/3/94	11/5/94	11/3/93	12/10/92
Salinity (S/cm)	Salinity (SM2520B)	7.2	22	5.4	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	7.5	7.3	19	13
	Trichloroethene	3.4	4	7	7
	cis 1,2-Dichloroethene	29	41	NA	NA
	total 1, 2-Dichloroethene	29	41	37	27
	Vinyl Chloride	1.5	1	ND	ND
	1, 1-Dichloroethene	ND	ND	ND	ND
	1, 2-Dichloroethane	ND	ND	ND	ND
	1, 1-Dichloroethane	2.3	4.1	1	ND
	1, 1, 1-Trichloroethane	ND	ND	ND	ND
	1, 2-Dichlorobenzene	ND	ND	NA	NA
	1, 4-Dichlorobenzene	ND	ND	NA	NA
	1, 3, 5-Trimethylbenzene	ND	ND	NA	NA
	1, 2, 4-Trimethylbenzene	4.1	ND	NA	NA
	Methylene Chloride	ND	ND	ND	ND
	Styrene	ND	ND	ND	ND
	Benzene	ND	ND	ND	ND
	Toluene	ND	ND	ND	ND
	Ethylbenzene	ND	ND	ND	ND
	m, p-Xylene	NA	NA	NA	NA
	total-Xylene	ND	ND	ND	ND

Table 3
Seep Sampling Results

Parameter Group	Sample ID	S-2	S-2	S-2	S-2
	Sample Date	12/3/94	11/5/94	11/3/93	12/10/92
Salinity (S/cm)	Salinity (SM2520B)	3.1	19	2.6	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	**520**	**250**	160	79
	Trichloroethene	**440**	**180**	200	58
	cis 1,2-Dichloroethene	190	65	NA	NA
	total 1, 2-Dichloroethene	202	68.6	470	8
	Vinyl Chloride	ND	ND	ND	3
	1, 1-Dichloroethene	ND	ND	ND	ND
	1, 2-Dichloroethane	ND	ND	ND	8
	1, 1-Dichloroethane	ND	ND	ND	1
	1, 1, 1-Trichloroethane	ND	ND	ND	ND
	1, 2-Dichlorobenzene	ND	ND	NA	NA
	1, 4-Dichlorobenzene	ND	ND	NA	NA
	1, 3, 5-Trimethylbenzene	ND	ND	NA	NA
	1, 2, 4-Trimethylbenzene	ND	ND	NA	NA
	Methylene Chloride	ND	ND	ND	ND
	Styrene	ND	ND	ND	ND
	Benzene	ND	ND	ND	ND
	Toluene	ND	ND	ND	ND
	Ethylbenzene	ND	ND	ND	ND
	m, p-Xylene	NA	NA	NA	NA
	total-Xylene	ND	ND	ND	ND

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-3 12/3/94	S-3 11/5/94	S-3 11/3/93	S-3 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	18	NS	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	NS	ND
	Trichloroethene	NS	ND	NS	ND
	cis 1,2-Dichloroethene	NS	ND	NS	ND
	total 1, 2-Dichloroethene	NS	ND	NS	NA
	Vinyl Chloride	NS	ND	NS	ND
	1, 1-Dichloroethene	NS	ND	NS	ND
	1, 2-Dichloroethane	NS	ND	NS	ND
	1, 1-Dichloroethane	NS	ND	NS	ND
	1, 1, 1-Trichloroethane	NS	ND	NS	ND
	1, 2-Dichlorobenzene	NS	ND	NS	NA
	1, 4-Dichlorobenzene	NS	ND	NS	NA
	1, 3, 5-Trimethylbenzene	NS	ND	NS	NA
	1, 2, 4-Trimethylbenzene	NS	ND	NS	NA
	Methylene Chloride	NS	ND	NS	ND
	Styrene	NS	ND	NS	ND
	Benzene	NS	ND	NS	ND
	Toluene	NS	ND	NS	ND
	Ethylbenzene	NS	ND	NS	ND
	m, p-Xylene	NS	NA	NS	NA
	total-Xylene	NS	ND	NS	ND

Table 3
Seep Sampling Results

Parameter Group	Sample ID	S-4	S-4	S-4	S-4
	Sample Date	**12/3/94**	**11/5/94**	**11/3/93**	**12/10/92**
Salinity (S/cm)	Salinity (SM2520B)	NS	16	NS	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	NS	ND
	Trichloroethene	NS	ND	NS	ND
	cis 1,2-Dichloroethene	NS	ND	NS	NA
	total 1, 2-Dichloroethene	NS	ND	NS	8
	Vinyl Chloride	NS	ND	NS	ND
	1, 1-Dichloroethene	NS	ND	NS	ND
	1, 2-Dichloroethane	NS	ND	NS	ND
	1, 1-Dichloroethane	NS	ND	NS	ND
	1, 1, 1-Trichloroethane	NS	ND	NS	ND
	1, 2-Dichlorobenzene	NS	ND	NS	NA
	1, 4-Dichlorobenzene	NS	ND	NS	NA
	1, 3, 5-Trimethylbenzene	NS	ND	NS	NA
	1, 2, 4-Trimethylbenzene	NS	ND	NS	NA
	Methylene Chloride	NS	ND	NS	ND
	Styrene	NS	ND	NS	ND
	Benzene	NS	ND	NS	ND
	Toluene	NS	ND	NS	2
	Ethylbenzene	NS	ND	NS	ND
	m, p-Xylene	NS	ND	NS	NA
	total-Xylene	NS	ND	NS	1

Table 3
Seep Sampling Results

Parameter Group	Sample ID	S-5	S-5	S-5	S-5
	Sample Date	**12/3/94**	**11/5/94**	**11/3/93**	**12/10/92**
Salinity (S/cm)	Salinity (SM2520B)	NS	19	NS	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	NS	ND
	Trichloroethene	NS	ND	NS	ND
	cis 1,2-Dichloroethene	NS	ND	NS	NA
	total 1, 2-Dichloroethene	NS	ND	NS	ND
	Vinyl Chloride	NS	ND	NS	ND
	1, 1-Dichloroethene	NS	ND	NS	ND
	1, 2-Dichloroethane	NS	ND	NS	ND
	1, 1-Dichloroethane	NS	ND	NS	ND
	1, 1, 1-Trichloroethane	NS	ND	NS	ND
	1, 2-Dichlorobenzene	NS	ND	NS	NA
	1, 4-Dichlorobenzene	NS	ND	NS	NA
	1, 3, 5-Trimethylbenzene	NS	ND	NS	NA
	1, 2, 4-Trimethylbenzene	NS	ND	NS	NA
	Methylene Chloride	NS	ND	NS	ND
	Styrene	NS	ND	NS	ND
	Benzene	NS	ND	NS	ND
	Toluene	NS	ND	NS	ND
	Ethylbenzene	NS	ND	NS	ND
	m, p-Xylene	NS	ND	NS	NA
	total-Xylene	NS	ND	NS	ND

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-6 12/3/94	S-6 11/5/94	S-6 11/3/93	S-6 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	19	NS	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	1.3	NS	NS
	Trichloroethene	NS	ND	NS	NS
	cis 1,2-Dichloroethene	NS	ND	NS	NS
	total 1, 2-Dichloroethene	NS	ND	NS	NS
	Vinyl Chloride	NS	ND	NS	NS
	1, 1-Dichloroethene	NS	ND	NS	NS
	1, 2-Dichloroethane	NS	ND	NS	NS
	1, 1-Dichloroethane	NS	ND	NS	NS
	1, 1, 1-Trichloroethane	NS	ND	NS	NS
	1, 2-Dichlorobenzene	NS	ND	NS	NS
	1, 4-Dichlorobenzene	NS	ND	NS	NS
	1, 3, 5-Trimethylbenzene	NS	ND	NS	NS
	1, 2, 4-Trimethylbenzene	NS	ND	NS	NS
	Methylene Chloride	NS	ND	NS	NS
	Styrene	NS	ND	NS	NS
	Benzene	NS	ND	NS	NS
	Toluene	NS	ND	NS	NS
	Ethylbenzene	NS	ND	NS	NS
	m, p-Xylene	NS	ND	NS	NS
	total-Xylene	NS	ND	NS	NS

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-7 12/3/94	S-7 11/5/94	S-7 11/3/93	S-7 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	5	NS	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	NS	NS
	Trichloroethene	NS	ND	NS	NS
	cis 1,2-Dichloroethene	NS	ND	NS	NS
	total 1, 2-Dichloroethene	NS	ND	NS	NS
	Vinyl Chloride	NS	ND	NS	NS
	1, 1-Dichloroethene	NS	ND	NS	NS
	1, 2-Dichloroethane	NS	ND	NS	NS
	1, 1-Dichloroethane	NS	ND	NS	NS
	1, 1, 1-Trichloroethane	NS	ND	NS	NS
	1, 2-Dichlorobenzene	NS	ND	NS	NS
	1, 4-Dichlorobenzene	NS	ND	NS	NS
	1, 3, 5-Trimethylbenzene	NS	ND	NS	NS
	1, 2, 4-Trimethylbenzene	NS	ND	NS	NS
	Methylene Chloride	NS	ND	NS	NS
	Styrene	NS	ND	NS	NS
	Benzene	NS	ND	NS	NS
	Toluene	NS	ND	NS	NS
	Ethylbenzene	NS	ND	NS	NS
	m, p-Xylene	NS	ND	NS	NS
	total-Xylene	NS	ND	NS	NS

Table 3
Seep Sampling Results

Parameter Group	**Sample ID**	**S-8**	**S-8**	**S-8**	**S-8**
	Sample Date	**12/3/94**	**11/5/94**	**11/3/93**	**12/10/92**
Salinity (S/cm)	Salinity (SM2520B)	NS	15	2.6	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	**320**	**140**	NS
	Trichloroethene	NS	**160**	**190**	NS
	cis 1,2-Dichloroethene	NS	59	NA	NS
	total 1, 2-Dichloroethene	NS	62.4	470	NS
	Vinyl Chloride	NS	ND	ND	NS
	1, 1-Dichloroethene	NS	ND	ND	NS
	1, 2-Dichloroethane	NS	ND	ND	NS
	1, 1-Dichloroethane	NS	ND	ND	NS
	1, 1, 1-Trichloroethane	NS	ND	ND	NS
	1, 2-Dichlorobenzene	NS	ND	NA	NS
	1, 4-Dichlorobenzene	NS	ND	NA	NS
	1, 3, 5-Trimethylbenzene	NS	ND	NA	NS
	1, 2, 4-Trimethylbenzene	NS	ND	NA	NS
	Methylene Chloride	NS	ND	ND	NS
	Styrene	NS	ND	ND	NS
	Benzene	NS	ND	ND	NS
	Toluene	NS	ND	ND	NS
	Ethylbenzene	NS	ND	ND	NS
	m, p-Xylene	NS	ND	NA	NS
	total-Xylene	NS	ND	ND	NS

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-9 12/3/94	S-9 11/5/94	S-9 11/3/93	S-9 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	NS	ND	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	NS	NS	NS
	Trichloroethene	NS	NS	NS	NS
	cis 1,2-Dichloroethene	NS	NS	NS	NS
	total 1, 2-Dichloroethene	NS	NS	NS	NS
	Vinyl Chloride	NS	NS	NS	NS
	1, 1-Dichloroethene	NS	NS	NS	NS
	1, 2-Dichloroethane	NS	NS	NS	NS
	1, 1-Dichloroethane	NS	NS	NS	NS
	1, 1, 1-Trichloroethane	NS	NS	NS	NS
	1, 2-Dichlorobenzene	NS	NS	NS	NS
	1, 4-Dichlorobenzene	NS	NS	NS	NS
	1, 3, 5-Trimethylbenzene	NS	NS	NS	NS
	1, 2, 4-Trimethylbenzene	NS	NS	NS	NS
	Methylene Chloride	NS	NS	NS	NS
	Styrene	NS	NS	NS	NS
	Benzene	NS	NS	NS	NS
	Toluene	NS	NS	NS	NS
	Ethylbenzene	NS	NS	NS	NS
	m, p-Xylene	NS	NS	NS	NS
	total-Xylene	NS	NS	NS	NS

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-10 12/3/94	S-10 11/5/94	S-10 11/3/93	S-10 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	4.8	1.1	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	ND	ND
	Trichloroethene	NS	ND	ND	ND
	cis 1,2-Dichloroethene	NS	ND	NA	NA
	total 1, 2-Dichloroethene	NS	ND	ND	ND
	Vinyl Chloride	NS	ND	ND	ND
	1, 1-Dichloroethene	NS	ND	ND	ND
	1, 2-Dichloroethane	NS	ND	ND	ND
	1, 1-Dichloroethane	NS	ND	ND	ND
	1, 1, 1-Trichloroethane	NS	ND	ND	ND
	1, 2-Dichlorobenzene	NS	ND	NA	NA
	1, 4-Dichlorobenzene	NS	ND	NA	NA
	1, 3, 5-Trimethylbenzene	NS	ND	NA	NA
	1, 2, 4-Trimethylbenzene	NS	ND	NA	NA
	Methylene Chloride	NS	ND	ND	ND
	Styrene	NS	ND	ND	ND
	Benzene	NS	ND	ND	ND
	Toluene	NS	ND	ND	ND
	Ethylbenzene	NS	ND	ND	ND
	m, p-Xylene	NS	ND	NA	NA
	total-Xylene	NS	ND	ND	ND

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-11 12/3/94	S-11 11/5/94	S-11 11/3/93	S-11 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	25	4.6	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	ND	NS
	Trichloroethene	NS	ND	ND	NS
	cis 1,2-Dichloroethene	NS	ND	NA	NS
	total 1, 2-Dichloroethene	NS	ND	ND	NS
	Vinyl Chloride	NS	ND	ND	NS
	1, 1-Dichloroethene	NS	ND	ND	NS
	1, 2-Dichloroethane	NS	ND	ND	NS
	1, 1-Dichloroethane	NS	ND	ND	NS
	1, 1, 1-Trichloroethane	NS	ND	ND	NS
	1, 2-Dichlorobenzene	NS	ND	NA	NS
	1, 4-Dichlorobenzene	NS	ND	NA	NS
	1, 3, 5-Trimethylbenzene	NS	ND	NA	NS
	1, 2, 4-Trimethylbenzene	NS	ND	NA	NS
	Methylene Chloride	NS	ND	ND	NS
	Styrene	NS	ND	ND	NS
	Benzene	NS	ND	ND	NS
	Toluene	NS	ND	ND	NS
	Ethylbenzene	NS	ND	ND	NS
	m, p-Xylene	NS	ND	NA	NS
	total-Xylene	NS	ND	ND	NS

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	S-12 12/3/94	S-12 11/5/94	S-12 11/3/93	S-12 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	19	14.5	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	ND	NS
	Trichloroethene	NS	ND	ND	NS
	cis 1,2-Dichloroethene	NS	ND	NA	NS
	total 1, 2-Dichloroethene	NS	ND	ND	NS
	Vinyl Chloride	NS	ND	ND	NS
	1, 1-Dichloroethene	NS	ND	ND	NS
	1, 2-Dichloroethane	NS	ND	ND	NS
	1, 1-Dichloroethane	NS	ND	ND	NS
	1, 1, 1-Trichloroethane	NS	ND	ND	NS
	1, 2-Dichlorobenzene	NS	ND	NA	NS
	1, 4-Dichlorobenzene	NS	ND	NA	NS
	1, 3, 5-Trimethylbenzene	NS	ND	NA	NS
	1, 2, 4-Trimethylbenzene	NS	ND	NA	NS
	Methylene Chloride	NS	ND	ND	NS
	Styrene	NS	ND	ND	NS
	Benzene	NS	ND	ND	NS
	Toluene	NS	ND	ND	NS
	Ethylbenzene	NS	ND	ND	NS
	m, p-Xylene	NS	ND	NA	NS
	total-Xylene	NS	ND	ND	NS

Table 3
Seep Sampling Results

Parameter Group	Sample ID	S-13	S-13	S-13	S-13
	Sample Date	12/3/94	11/5/94	11/3/93	12/10/92
Salinity (S/cm)	Salinity (SM2520B)	6.1	NS	NS	NS
Phenols (ug/L)	Pentachlorophenol (8270)	NS	NS	NS	NS
Volatiles (ug/L)	Tetrachloroethene	ND	3.8	NS	NS
	Trichloroethene	11	6.2	NS	NS
	cis 1,2-Dichloroethene	5400	3300	NS	NS
	total 1, 2-Dichloroethene	5472	3346	NS	NS
	Vinyl Chloride	**1600**	**760**	NS	NS
	1, 1-Dichloroethene	27	18	NS	NS
	1, 2-Dichloroethane	ND	8.5	NS	NS
	1, 1-Dichloroethane	62	53	NS	NS
	1, 1, 1-Trichloroethane	ND	ND	NS	NS
	1, 2-Dichlorobenzene	ND	1.3	NS	NS
	1, 4-Dichlorobenzene	ND	ND	NS	NS
	1, 3, 5-Trimethylbenzene	ND	ND	NS	NS
	1, 2, 4-Trimethylbenzene	ND	ND	NS	NS
	Methylene Chloride	ND	ND	NS	NS
	Styrene	ND	ND	NS	NS
	Benzene	36	28	NS	NS
	Toluene	ND	ND	NS	NS
	Ethylbenzene	ND	ND	NS	NS
	m, p-Xylene	ND	ND	NS	NS
	total-Xylene	ND	1.4	NS	NS

Table 3
Seep Sampling Results

Parameter Group	Sample ID	M-1	M-1	M-1	M-1
	Sample Date	12/3/94	11/3/94	11/3/93	12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	NA	NA	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	ND	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	ND	ND
	Trichloroethene	NS	ND	ND	ND
	cis 1,2-Dichloroethene	NS	ND	NA	NA
	total 1, 2-Dichloroethene	NS	ND	ND	ND
	Vinyl Chloride	NS	ND	ND	ND
	1, 1-Dichloroethene	NS	ND	ND	ND
	1, 2-Dichloroethane	NS	ND	ND	ND
	1, 1-Dichloroethane	NS	ND	ND	ND
	1, 1, 1-Trichloroethane	NS	ND	ND	ND
	1, 2-Dichlorobenzene	NS	NA	NA	NA
	1, 4-Dichlorobenzene	NS	ND	NA	NA
	1, 3, 5-Trimethylbenzene	NS	ND	NA	NA
	1, 2, 4-Trimethylbenzene	NS	ND	NA	NA
	Methylene Chloride	NS	ND	ND	ND
	Styrene	NS	ND	ND	ND
	Benzene	NS	ND	ND	ND
	Toluene	NS	ND	ND	ND
	Ethylbenzene	NS	ND	ND	ND
	m, p-Xylene	NS	ND	NA	NA
	total-Xylene	NS	ND	ND	ND

Table 3
Seep Sampling Results

Parameter Group	Sample ID Sample Date	M-3 12/3/94	M-3 11/3/94	M-3 11/3/93	M-3 12/10/92
Salinity (S/cm)	Salinity (SM2520B)	NS	NA	NA	NA
Phenols (ug/L)	Pentachlorophenol (8270)	NS	ND	NS	NS
Volatiles (ug/L)	Tetrachloroethene	NS	ND	ND	ND
	Trichloroethene	NS	ND	ND	ND
	cis 1,2-Dichloroethene	NS	ND	NA	NA
	total 1, 2-Dichloroethene	NS	ND	ND	ND
	Vinyl Chloride	NS	ND	ND	ND
	1, 1-Dichloroethene	NS	ND	ND	ND
	1, 2-Dichloroethane	NS	ND	ND	ND
	1, 1-Dichloroethane	NS	ND	ND	ND
	1, 1, 1-Trichloroethane	NS	ND	ND	ND
	1, 2-Dichlorobenzene	NS	NA	NA	NA
	1, 4-Dichlorobenzene	NS	ND	NA	NA
	1, 3, 5-Trimethylbenzene	NS	ND	NA	NA
	1, 2, 4-Trimethylbenzene	NS	ND	NA	NA
	Methylene Chloride	NS	ND	ND	ND
	Styrene	NS	ND	ND	ND
	Benzene	NS	ND	ND	ND
	Toluene	NS	ND	ND	ND
	Ethylbenzene	NS	ND	ND	ND
	m, p-Xylene	NS	ND	NA	NA
	total-Xylene	NS	ND	ND	ND

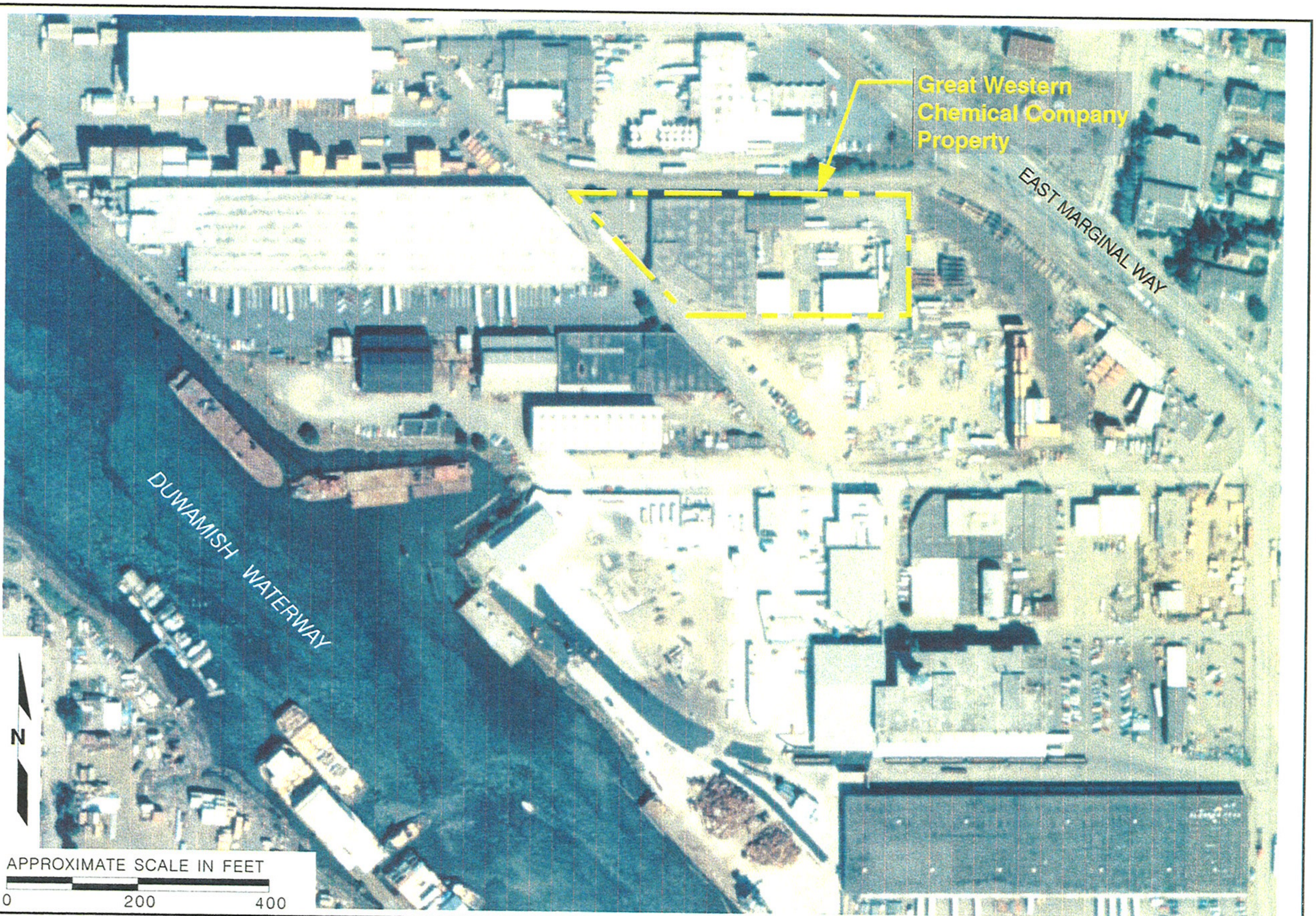
Notes:

NA	Not Available.
ND	Not Detected.
NS	No Sample.

S. Myrtle Street
Embayment Study

Figures

AGENCY REVIEW DRAFT



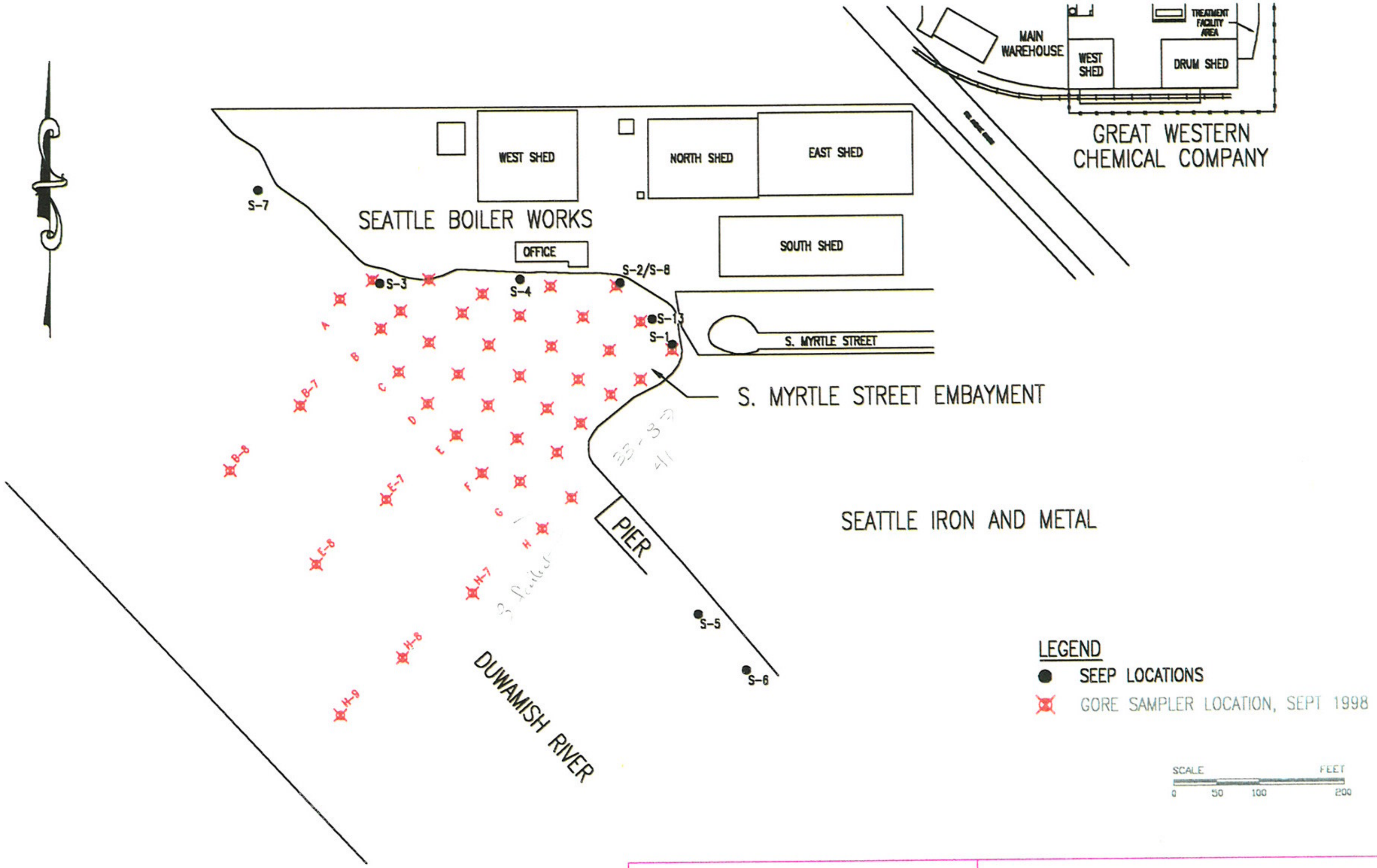
Floyd & Snider Inc.

TERRA VAC

Great Western
Chemical Company
Seattle, Washington

Figure 1
Area Map

02/23/00 VicinMapTidal.cdr



Washington State Plan North, NAD 83, feet

Exact location of land features has not been confirmed.

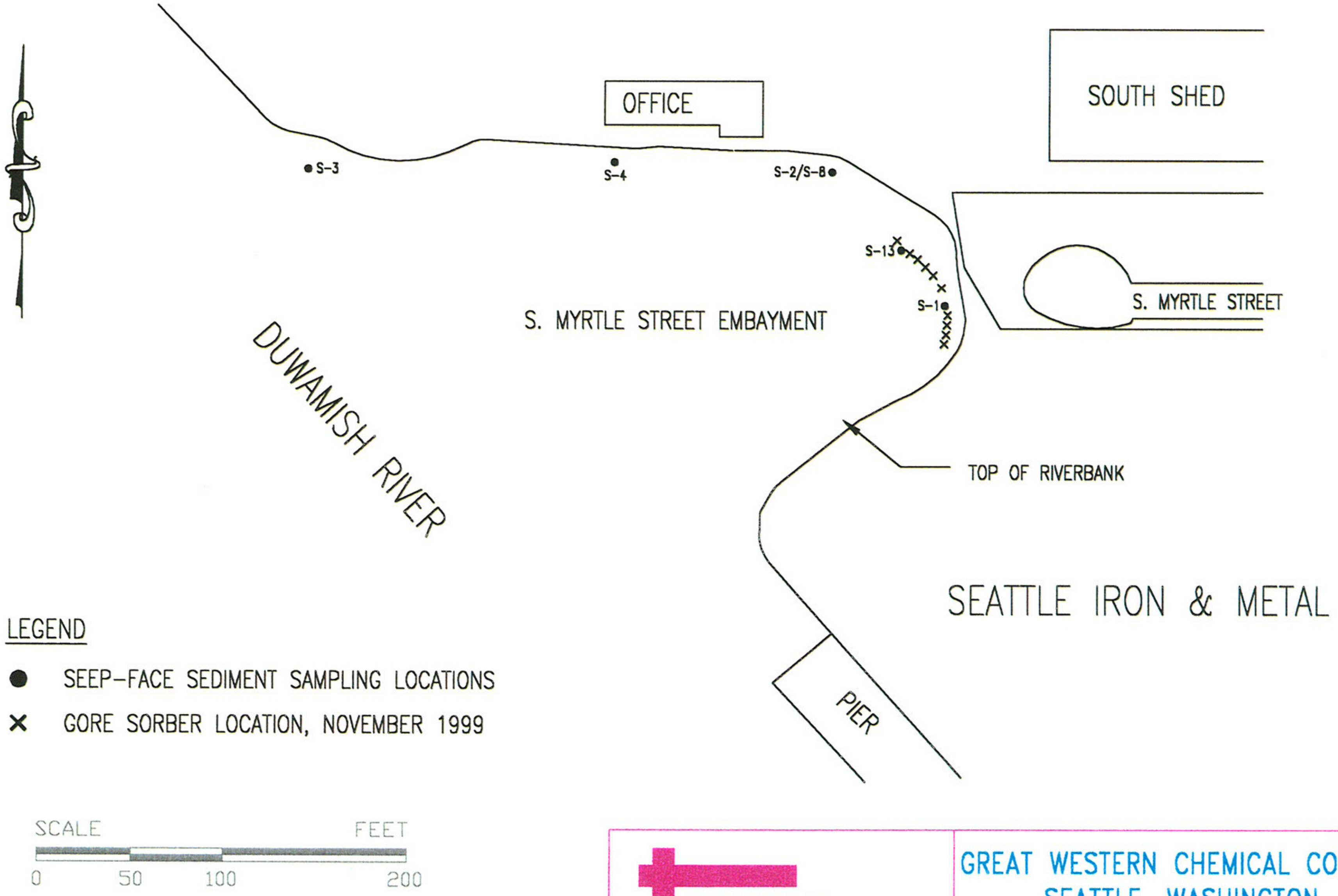
TERRA VAC

GREAT WESTERN CHEMICAL COMPANY
SEATTLE, WASHINGTON

EMBAYMENT SEDIMENT
SCREENING LOCATIONS

DESIGNED BY: P. CATTERALL	CHECKED BY: T. WARNER	PROJECT # 32-0039	FIGURE # 2
DRAWN BY: P. BIANCO	PROJECT MANAGER: T. WARNER	DATE: 12/14/98	SCALE: AS SHOWN

TV/32-0039/12/14/98/SIMSEW2



Washington State Plan North, NAD 83, feet

Exact location of land features has not been confirmed.

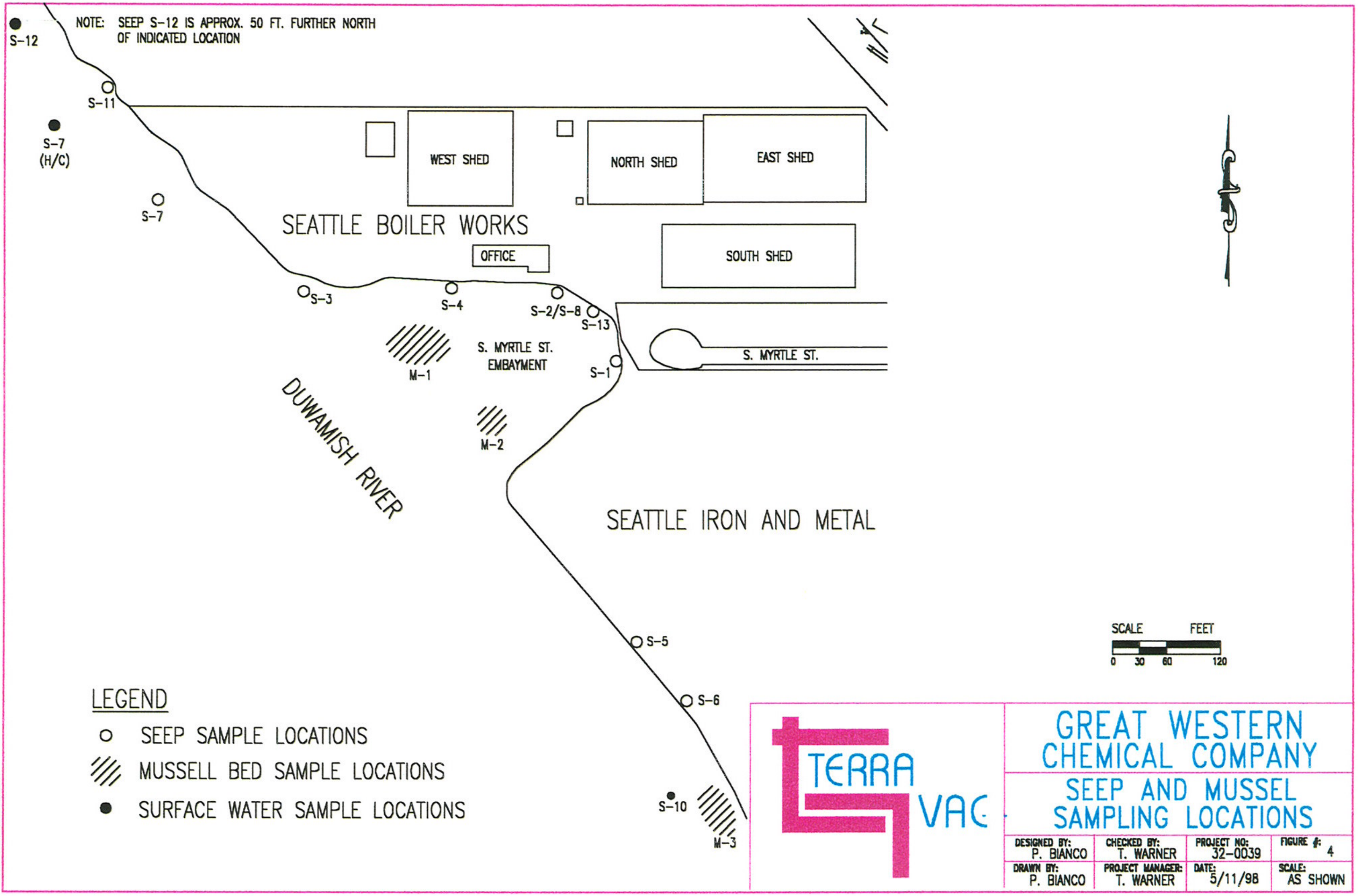
TERRA VAC

GREAT WESTERN CHEMICAL COMPANY
SEATTLE, WASHINGTON

SEEP FACE SEDIMENT
SCREENING LOCATIONS

DESIGNED BY: P. CATTERALL	CHECKED BY: T. WARNER	PROJECT #: 32-0039	FIGURE #: 3
DRAWN BY: P. BIANCO	PROJECT MANAGER: T. WARNER	DATE: 12/14/98	SCALE: AS SHOWN

TV\32-0039\12/14/98\SIMSBW3



GREAT WESTERN CHEMICAL COMPANY

SEEP AND MUSSEL SAMPLING LOCATIONS

DESIGNED BY: P. BIANCO	CHECKED BY: T. WARNER	PROJECT NO: 32-0039	FIGURE #: 4
DRAWN BY: P. BIANCO	PROJECT MANAGER: T. WARNER	DATE: 5/11/98	SCALE: AS SHOWN

TVA\32-0039\5/11/98\SEEPS4

S. Myrtle Street
Embayment Study

Attachment A

GORE-SORBER® Screening Survey Final Report
Duwamish River Embayment Sediment Survey

AGENCY REVIEW DRAFT

GORE
Creative Technologies
Worldwide

W. L. GORE & ASSOCIATES, INC.

100 CHESAPEAKE BLVD., P.O. BOX 10 • ELKTON, MARYLAND 21922-0010 • PHONE: 410/392-7600
FAX: 410/506-4780

GORE-SORBER® EXPLORATION SURVEY
GORE-SORBER® SCREENING SURVEY

1 of 6

GORE-SORBER® Screening Survey Final Report

Duamish River Embayment Sediment Study
Seattle, WA

October 19, 1998

Gore Production Order No. 095082

Prepared For:
Terra Vac Corporation
10740 Meridian Avenue North, Suite 202
Seattle, WA 98133

W.L. Gore & Associates, Inc.

Written/Submitted by:
Ray Fenstermacher, P.G., Project Manager

Reviewed/Approved by:
Mark J. Wrigley, P.G., Project Manager

Mark J. Wrigley

Analytical Data Reviewed by:
Wayne M. Wells, II, Chemist

I:\MAPPING\PROJECTS\095082\981019R.DOC

GORE-SORBER® Screening Survey
Final Report

REPORT DATE: October 19, 1998 **AUTHOR:** RFF

SITE INFORMATION

Site Reference: Duamish River Embayment Sediment Study, Seattle, WA
Customer Purchase Order Number: 320039SS-3-1374
Gore Production Order Number: 095082 **Gore Site Code:** ATB

FIELD PROCEDURES

 # Modules shipped: 80
Installation Date(s): 9/30/98 **# Modules Installed:** 43
Field work performed by: Terra Vac Corporation

Retrieval date(s): 10/2/98 **Exposure Time:** 3 **[days]**
 # Modules Retrieved: 43 **# Trip Blanks Returned:** 7 *
 # Unused Modules Returned: 30

Date/Time Received by Gore: 10/6/98 @ 10:00 AM **By:** TC
Recorded Cooler/Water Temperature Control Blank temperature: 15.2 [°C]
Chain of Custody Form attached: √
Chain of Custody discrepancies: None
Comments: * Of the 7 modules that were used as blanks, 5 were used as trip blanks and 2 were used as "tube" blanks. The modules were transported to the installation site in the glassware provided by Gore. They were then transferred into water filled tubes for the divers to carry to the bottom of the river. In order to document the possiblity of contamination from these tubes, clean modules were placed in similar tubes and called "tube" blanks. These samples are noted as such on the installation/retrieval document.

Modules 170629, '630 and '631 are listed twice on the chain of custody; once as being field-installed and a second time as being "tube" blanks. According to a phone conversation with Peter Catterall, these modules were actually installed in the field and were not used as blanks.

GORE-SORBER® Screening Survey
Final Report

ANALYTICAL PROCEDURES

W.L. Gore & Associates' Screening Module Laboratory operates under the guidelines of its Quality Assurance Manual, Operating Procedures and Methods. The quality assurance program is consistent with Good Laboratory Practices (GLP) and ISO Guide 25, "General Requirements for the Competence of Calibration and Testing Laboratories", third edition, 1990. The Laboratory is audited regularly by a quality system design, development and auditing company.
Instrumentation consists of state of the art gas chromatographs equipped with mass selective detectors, coupled with automated thermal desorption units. Sample preparation simply involves cutting the tip off the bottom of the sample module and transferring one or more exposed sorbent containers (sorbers, each containing 40mg of a suitable granular adsorbent) to a thermal desorption tube for analysis. Sorbers remain clean and protected from dirt, soil, and ground water by the insertion/retrieval cord, and require no further sample preparation. Samples remain frozen until analysis and unanalyzed sorbers are archived in the freezer for potential future analysis.

Analytical Method Quality Assurance:
The analytical method employed is a modified EPA method 8260A/8270B. Before each run sequence, two instrument blanks, a sorber containing 5µg BFB (Bromofluorobenzene), and a method blank are analyzed. The BFB mass spectra must meet the criteria set forth in the method before samples can be analyzed. A method blank and a sorber containing BFB is also analyzed after every 30 samples and/or trip blanks. Standards containing the selected target compounds at three calibration levels of 5, 20, and 50µg are analyzed at the beginning of each run. The criterion for each target compound is less than 35% RSD (relative standard deviation). If this criterion is not met for any target compound, the analyst has the option of generating second- or third-order standard curves, as appropriate. A second-source reference standard, at a level of 10µg per target compound, is analyzed after every ten samples and/or trip blanks, and at the end of the run sequence. Positive identification of target compounds is determined by 1) the presence of the target ion and at least two secondary ions; 2) retention time versus reference standard; and, 3) the analyst's judgment.

NOTE: All data have been archived. Any replicate sorbers not used in the initial analysis will be discarded fifteen (15) days from the date of analysis.

Laboratory analysis: thermal desorption, gas chromatography, mass selective detection
Quality Assurance Level: 2 (ANA-4/VCA1)
Instrument ID: # 2 **Chemist:** WW **Data Subdirectory:** 095082
Compounds/mixtures requested: Gore Chlorinated VOC Target Compounds (A10), plus vinyl chloride.
Deviations from Standard Method: None
Comments: Soil vapor analytes and abbreviations are tabulated in the Data Table Key (page 6). When these modules were being prepared for analysis, it was noticed that many of them had liquid water around the sorber, and the analysis revealed that a few modules were impacted by adsorption of liquid water which penetrated the sorber membrane under hydrostatic pressure.

GORE-SORBER® Screening Survey
Final Report

DATA TABULATION

 # CONTOUR MAPS ENCLOSED: No maps were generated from these data.

NOTE: All data values presented in Appendix A represent masses of compound(s) desorbed from the GORE-SORBER Screening Modules received and analyzed by W.L. Gore, as identified in the Chain of Custody (Appendix A). The measurement traceability and instrument performance are reproducible and accurate for the measurement process documented. Semi-quantitation of the compound mass is based on either a single-level (QA Level 1) or three-level (QA Level 2) standard calibration.

General Comments:

- This survey reports soil gas mass levels present in the vapor phase. Vapors are subject to a variety of attenuation factors during migration away from the source concentration to the module. Thus, mass levels reported from the module will often be less than concentrations reported in soil and groundwater matrix data. In most instances, the soil gas masses reported on the modules compare favorably with concentrations reported in the soil or groundwater (e.g., where soil gas levels are reported at greater levels relative to other sampled locations on the site, matrix data should reveal the same pattern, and vice versa). However, due to a variety of factors, a perfect comparison between matrix data and soil gas levels can rarely be achieved.
- Soil gas signals reported by this method cannot be identified to soil adsorbed, groundwater, and/or free-product contamination. The soil gas signal reported from each module can evolve from all of these sources. Differentiation between soil and groundwater contamination can only be achieved with prior knowledge of the site history (i.e., the site is known to have groundwater contamination only).
- QA/QC trip blank modules were provided to document contamination occurring that was not part of the soil gas signal of interest (i.e., impact during module shipment, installation and retrieval, and storage). The trip blanks are identically manufactured and packaged soil gas modules to those modules placed in the subsurface. However, the trip blanks remain unopened during all phases of the soil gas survey. Levels reported on the trip blanks may indicate potential impact to modules other than the contaminant source of interest.

GORE-SORBER® Screening Survey
Final Report

- Unresolved peak envelopes (UPEs) are represented as a series of compound peaks clustered together around a central GC elution time in the total ion chromatogram. Typically, UPEs are indicative of complex fluid mixtures that are present in the subsurface. UPEs observed early in the chromatogram are considered to indicate the presence of more volatile fluids, while UPEs observed later in the chromatogram may indicate the presence of less volatile fluids. Multiple UPEs may indicate the presence of multiple complex fluids.

Project Specific Comments:

- Stacked total ion chromatograms (TIC's) are included in Appendix A. The last four digits of each module number are incorporated into the TIC identification (e.g.: ATB0582TC.D represents module #170582).
- High levels of several target compounds were detected on module 170609, which was located in close proximity to a known seep. Additionally, module 170597 was also located near a known seep, and the analysis revealed a low level of cis-1,2-dichloroethene from this module. No other modules (trip blanks and tube blanks inclusive) revealed any target compounds above the method detection limit.
- The organic data for modules affected by adsorption of water cannot be compared with data for modules which were not, since the mechanism of transfer is different. Additionally, desorption of water from the sorber during analysis causes peak shape corruption and temporary detector shut down, making peak integration difficult. Therefore, while positive compound identification was achieved for all reported compounds, quantitation should be considered approximate for these modules.

GORE-SORBER® Screening Survey
Final Report

KEY TO DATA TABLE
Duamish River Embayment Sediment Study, Seattle, WA

UNITS

µg	micrograms (per sorber), reported for compounds
MDL	method detection limit
bdl	below detection limit
nd	non-detect

ANALYTES

ct12DCE	cis- & trans-1,2-dichloroethene
t12DCE	trans-1,2-dichloroethene
c12DCE	cis-1,2-dichloroethene
VC	vinyl chloride
11DCE	1,1-dichloroethene
11DCA	1,1-dichloroethane
$CHCl_3$	chloroform
111TCA	1,1,1-trichloroethane
12DCA	1,2-dichloroethane
CCl_4	carbon tetrachloride
TCE	trichloroethene
112TCA	1,1,2-trichloroethane
PCE	tetrachloroethene
ClBENZ	chlorobenzene
1112TetCA	1,1,1,2-tetrachloroethane
13DCB	1,3-dichlorobenzene
14DCB	1,4-dichlorobenzene
12DCB	1,2-dichlorobenzene

BLANKS

TBn	unexposed trip blanks, travels with the exposed modules
method blank	QA/QC module, documents analytical conditions during analysis

APPENDIX A:

1. CHAIN OF CUSTODY
2. DATA TABLE
3. STACKED TOTAL ION CHROMATOGRAMS

GORE-SORBER® Screening Survey Chain of Custody

For W.L. Gore & Associates use only
Production Order # 95082

GORE

W. L. Gore & Associates, Inc., Environmental Products Group
100 Chesapeake Boulevard • Elkton, Maryland 21921 • Tel: (410) 392-7600 • Fax (410) 506-4780

Instructions: Customer must complete ALL shaded cells

Customer Name: TeRRA VAC CORP
Address: 10740 MERIDIAN AVE. N.
Suite 202
Seattle, WA 98133
Phone: (206) 362-8294
FAX: (206) 362-9528

Site Name: DUAMISH Sediment
Site Address: Seattle, WA.

Project Manager: TIMOTHY WARNER
Customer Project No.: 32-0039
Customer P.O. #: D003955-3-BA Quote #: 12267

Serial # of Modules Shipped			
# 170582	through	#	170618
# 170625	through	#	170667
#	through	#	
#	through	#	
#	through	#	

\# of Modules for Installation 70 # of Trip Blanks 5 +5. Bh.
Total Modules Shipped: 80 Pieces
Total Modules Received: 80 Pieces
Total Modules Installed: 53 Pieces

Serial # of Trip Blanks (*Client Decides*)		
		# 170634 ✓
# 170635 ✓	# 170636 ✓	# 170637 ✓
# 170638 ✓	#	#
#	#	#

GORE ANALYTICAL OPTION:

[A/10+]

Installation Performed By:
Name (*please print*): GARY MAXWELL
Company/Affiliation: PENTEC ENVIROMENTAL

Installation Method(s) (*circle those that apply*):
Slide Hammer Hammer Drill Auger
Other: Sediment tube/HAND Insertion

Installation Start Date and Time: / / : AM PM
Installation Complete Date and Time: / / : AM PM

Retrieval Performed By:
Name (*please print*): SAME AS INSTALL
Company/Affiliation:

Total Modules Retrieved: Pieces
Total Modules Lost in Field: Pieces
Total Unused Modules Returned: Pieces

Retrieval Start Date and Time: / / : AM PM
Retrieval Complete Date and Time: / / : AM PM

Relinquished By T. Ch Affiliation: W.L. Gore & Associates, Inc.	Date 9/22/98	Time 12:00	Received By: PETER CATTERALL Affiliation: TERRA VAC CORP	Date 3 50pm	Time 9/24/98
Relinquished By PeterCatterall Affiliation: TERRA VAC	Date 10/5/98	Time 0930	Received By: Affiliation:	Date	Time
Relinquished By Affiliation	Date	Time	Received By: T. Ch Affiliation: W.L. Gore & Associates, Inc.	Date 11/6/98	Time 11:11

15.2 °C
97081805

GORE-SORBER® Screening Survey Installation and Retrieval Log

Page 1 of 2

SITE NAME & LOCATION
Duwamish River Embayment
Seattle, WA - GWCC
Fox Ave S.

LINE #	MODULE #	INSTALLATION DATE/TIME	RETRIEVAL DATE/TIME	EVIDENCE OF LIQUID HYDROCARBONS (LPH) or HYDROCARBON ODOR (Check as appropriate)			MODULE IN WATER (check one)		COMMENTS
				LPH	ODOR	NONE	YES	NO	
1.	170584	0918 / 9/30/98	0850 / 10/2/98			✓	✓		A5
2.	170583	0912	0910			✓	✓		A6
3.	170585	0938	0925			✓	✓		B4
4.	170586	0924	0920			✓	✓		B5
5.	170587	0921	0914			✓	✓		B6
6.	170588	1058	0925			✓	✓		C3
7.	170589	1006	0930			✓	✓		C4
8.	170590	0950	0932			✓	✓		C5
9.	170591	0948	0933			✓	✓		C6
10.	170592	1048	1049			✓	✓		D2
11.	170593	1037	1050			✓	✓		D3
12.	170594	1035	1056			✓	✓		D4
13.	170595	1033	1058			✓	✓		D5
14.	170596	1036	1059			✓	✓		D6
15.	170597	1147	1123			✓	✓		E1
16.	170598	1137	1120			✓	✓		E2
17.	170599	1134	1117			✓	✓		E3
18.	170600	1130	1115			✓	✓		E4
19.	170601	1127	1110			✓	✓		E5
20.	170602	1125	1107			✓	✓		E6
21.	170603	1353	1132			✓	✓		F1
22.	170604	1347	1135			✓	✓		F2
23.	170605	1343	1137			✓	✓		F3
24.	170606	1341	1138			✓	✓		F4
25.	170607	1337	1140			✓	✓		F5
26.	170608	1329	1141			✓	✓		F6
27.	170609	1447	1311			✓	✓		G1
28.	170610	1443	1309			✓	✓		G2
29.	170611	1439	1307			✓	✓		G3
30.	170612	1429	1304			✓	✓		G4
31.	170613	1425	1302			✓	✓		G5
32.	170614	1422	1300			✓	✓		~~G6~~ G6
33.	170615	1502	1326			✓	✓		H5
34.	170616	1500	1324			✓	✓		H6
35.	170617	1646	1416			✓	✓		H7
36.	170627	1742	1427			✓	✓		H8
37.	170628	1638	1437			✓	✓		H9
38.	170629	1710	1536			✓	✓		E7
39.	170630	1726	1521			✓	✓		E8
40.	170631	1726	1523			✓	✓		E8 DUP
41.	170618	1804 / 9/30/98	1607 / 10/2/98			✓	✓		B7

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FORM 8R.4
4/24/98

GORE-SORBER® Screening Survey Installation and Retrieval Log

Page ______ of ______

SITE NAME & LOCATION

LINE #	MODULE #	INSTALLATION DATE/TIME	RETRIEVAL DATE/TIME	EVIDENCE OF LIQUID HYDROCARBONS (LPH) or HYDROCARBON ODOR *(Check as appropriate)*			MODULE IN WATER *(check one)*		COMMENTS
				LPH	ODOR	NONE	YES	NO	
42.	✓170625	1814 9/30/98	1627 10/2/98			✓	✓		B8
43.	✓170626	1804	1608			✓	✓		B7 DUP
44.	✓170629	NA	NA			✓	✓		TUBE BLANK
45.	✓170630	NA				✓	✓		
46.	✓170631	NA				✓	✓		
47.	✓170632	NA				✓	✓		
48.	✓170633	NA				✓	✓		
49.	✓170634	NA				✓	✓		TUBE BLANK
50.	✓170635	NA				✓		✓	TRIP BLANK
51.	✓170636	NA				✓		✓	
52.	✓170637	NA				✓		✓	
53.	✓170638	NA	NA			✓		✓	TRIP BLANK
54.									
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GORE-SORBER ® Screening Survey is a registered service mark of W.L. Gore & Associates, Inc.

GORE SORBER SCREENING SURVEY ANALYTICAL RESULTS
TERRA VAC CORP., SEATTLE, WA
GORE TARGET CHLORINATED VOCs/SVOCs (A10)
DUWAMISH RIVER EMBAYMENT, SEATTLE, WA
SITE ATB - PRODUCTION ORDER #095082

DATE ANALYZED	SAMPLE NAME	ct12DCE, ug	t12DCE, ug	c12DCE, ug	VC, ug	11DCE, ug	11DCA, ug	CHCl3, ug	111TCA, ug	12DCA, ug
	MDL=	0.02	0.03	0.02	0.30	0.03	0.03	0.01	0.03	0.04
10/08/98	170582	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170583	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170584	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170585	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170586	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170587	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170588	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170589	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170590	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170591	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170592	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170593	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170594	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170595	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170596	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170597	0.12	nd	0.12	nd	nd	nd	nd	nd	nd
10/09/98	170598	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170599	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170600	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170601	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170602	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170603	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170604	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170605	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170606	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170607	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170608	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170609	27.67	0.21	27.46	42.05	0.33	0.58	nd	nd	nd
10/09/98	170610	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170611	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170612	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170613	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170614	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170615	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170616	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170617 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170618 *	nd	nd	nd	nd	nd	bdl	nd	nd	nd
10/09/98	170625 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170626 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170627 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170628 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	170629 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170630 *	nd	nd	nd	nd	nd	bdl	nd	nd	nd
10/09/98	170631 *	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170632	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	170633	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	TB1 - 170634	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	TB2 - 170635	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	TB3 - 170636	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	TB4 - 170637	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	TB5 - 170638	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/08/98	method blank	nd	nd	nd	nd	nd	nd	nd	nd	nd
10/09/98	method blank	nd	nd	nd	nd	nd	nd	nd	nd	nd
		ct12DCE, ug	t12DCE, ug	c12DCE, ug	VC, ug	11DCE, ug	11DCA, ug	CHCl3, ug	111TCA, ug	12DCA, ug
	Maximum	27.67	0.21	27.46	42.05	0.33	0.58	0.00	0.00	0.00
	Standard Dev.	4.08	0.03	4.05	6.20	0.05	0.09	0.00	0.00	0.00
	Mean	0.60	0.00	0.60	0.91	0.01	0.01	0.00	0.00	0.00

10/19/98

* These results are suspect due to the presence of liquid water on the sorbent material.

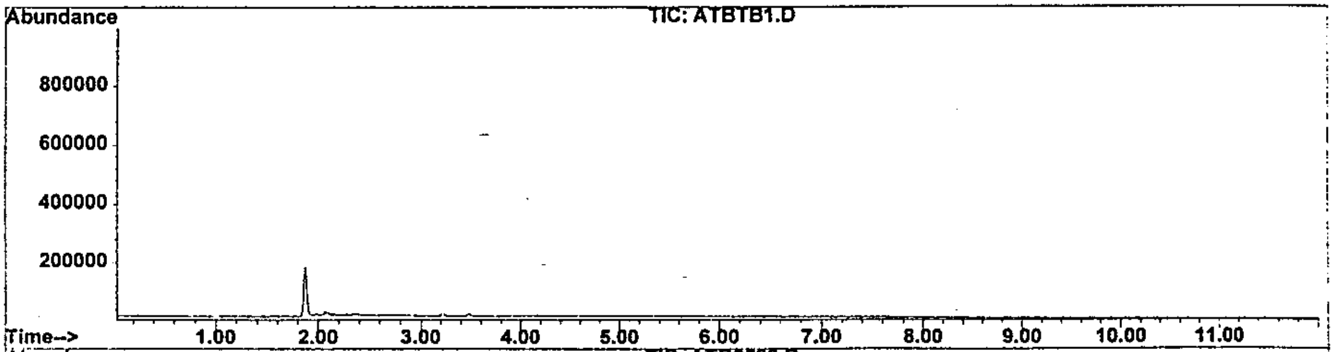
GORE SORBER SCREENING SURVEY ANALYTICAL RESULTS
TERRA VAC CORP., SEATTLE, WA
GORE TARGET CHLORINATED VOCs/SVOCs (A10)
DUWAMISH RIVER EMBAYMENT, SEATTLE, WA
SITE ATB - PRODUCTION ORDER #095082

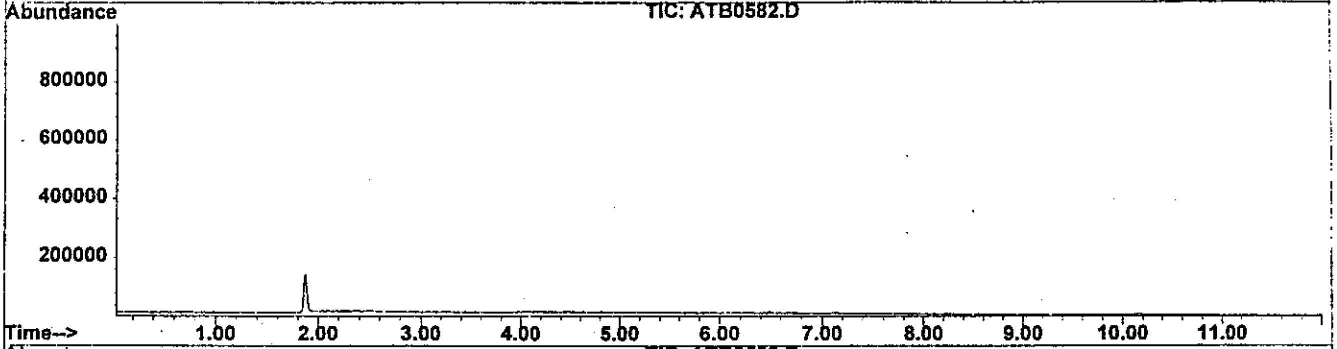
SAMPLE NAME	CCl4, ug	TCE, ug	112TCA, ug	PCE, ug	ClBENZ, ug	1112TetCA, ug	1122TetCA, ug	13DCB, ug	14DCB, ug	12DCB, ug
MDL=	0.02	0.03	0.03	0.03	0.04	0.03	0.02	0.01	0.02	0.02
170582	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170583	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170584	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170585	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170586	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170587	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170588	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170589	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170590	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170591	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170592	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170593	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170594	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170595	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170596	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170597	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170598	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170599	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170600	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170601	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170602	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170603	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170604	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170605	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170606	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170607	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170608	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170609	nd	nd	nd	nd	nd	nd	nd	nd	0.09	0.26
170610	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170611	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170612	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170613	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170614	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170615	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170616	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170617 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170618 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170625 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170626 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170627 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170628 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170629 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170630 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170631 *	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170632	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
170633	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TB1 - 170634	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TB2 - 170635	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TB3 - 170636	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TB4 - 170637	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TB5 - 170638	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
method blank	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
method blank	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	CCl4, ug	TCE, ug	112TCA, ug	PCE, ug	ClBENZ, ug	1112TetCA, ug	1122TetCA, ug	13DCB, ug	14DCB, ug	12DCB, ug
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.26
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

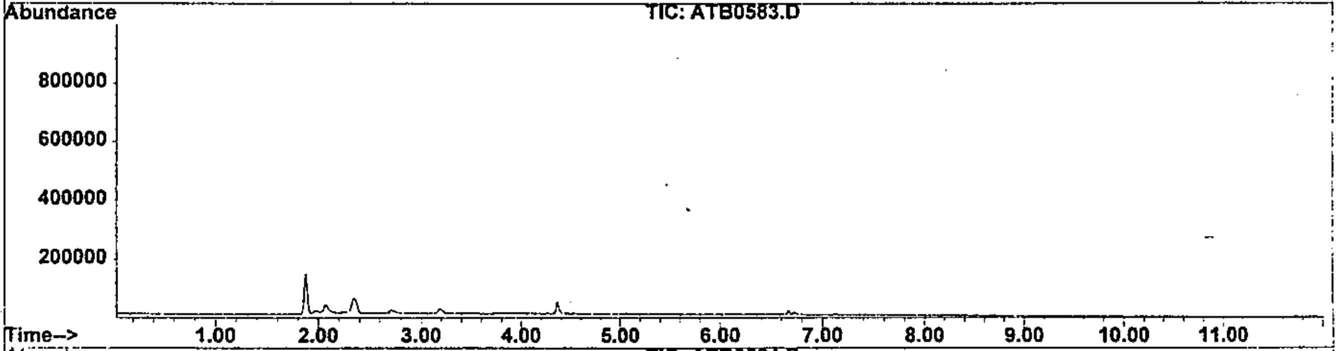
10/19/98

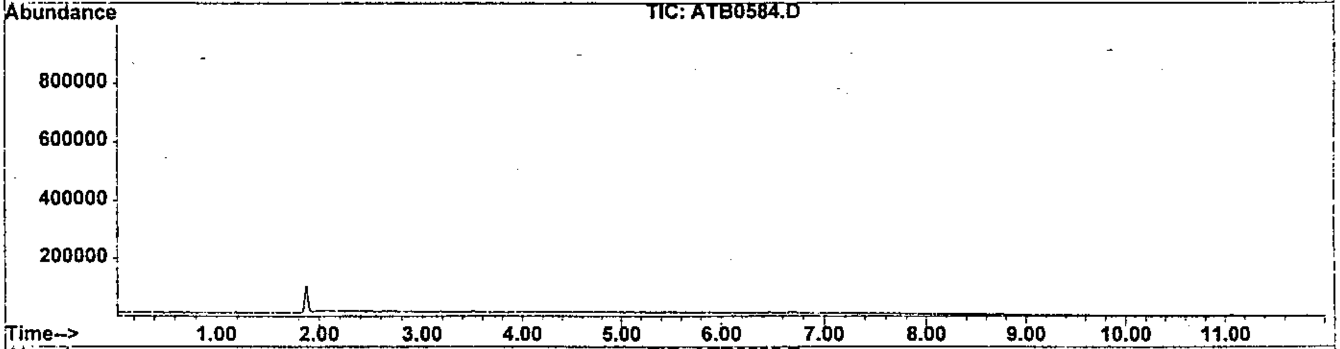
* These results are suspect due to the presence of liquid water on the sorbent material.

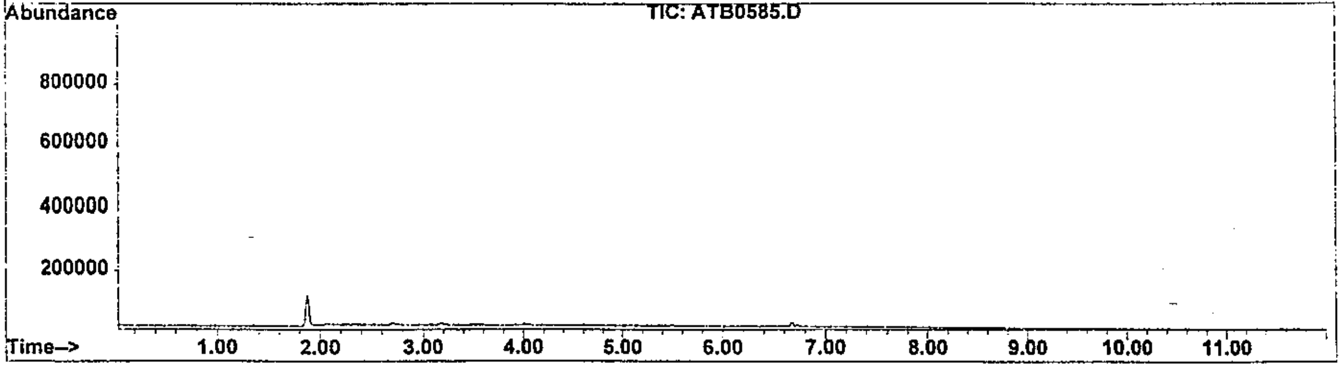
TIC - SITE ATB - PRODUCTION ORDER #095082
In sequence order











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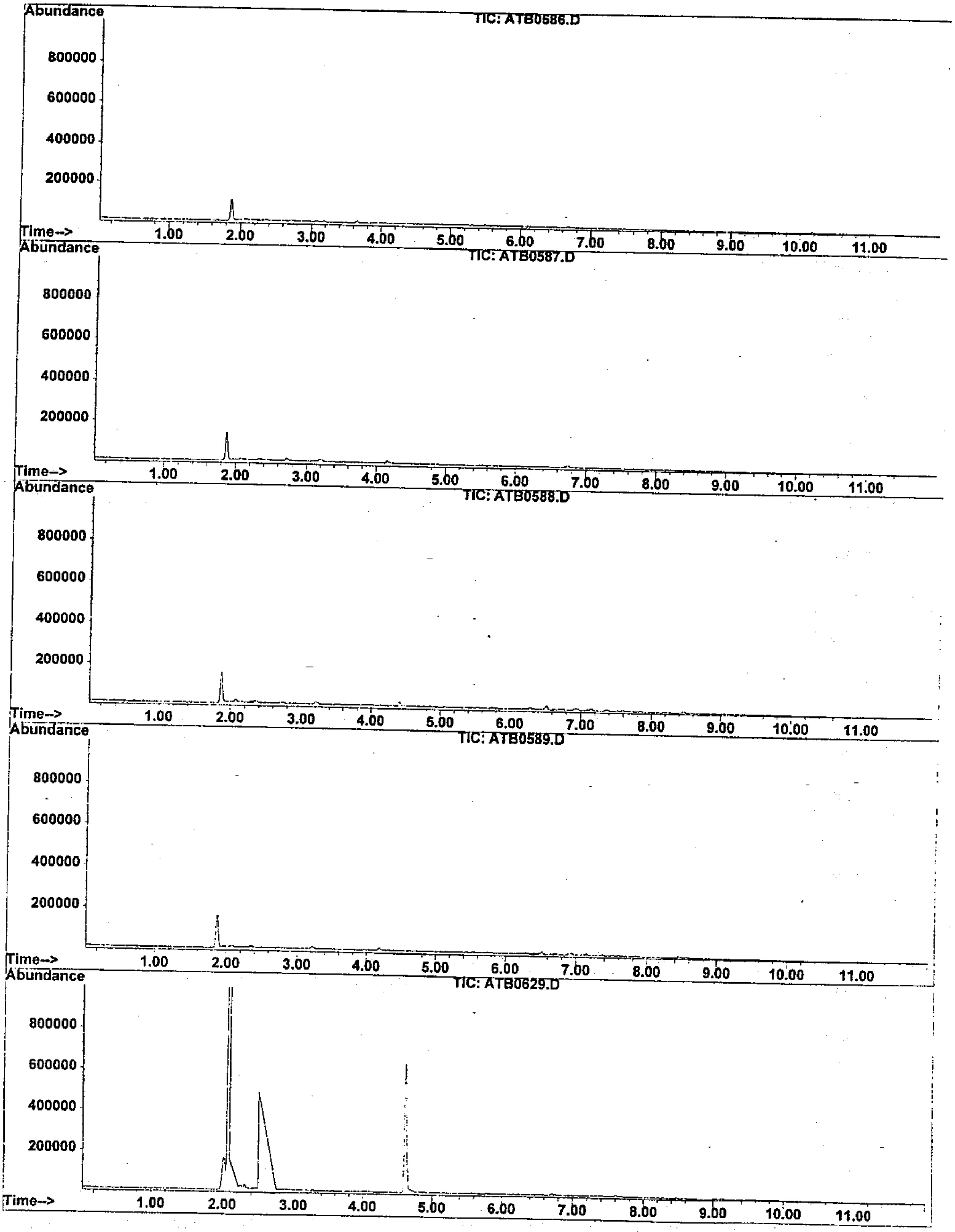
In sequence order



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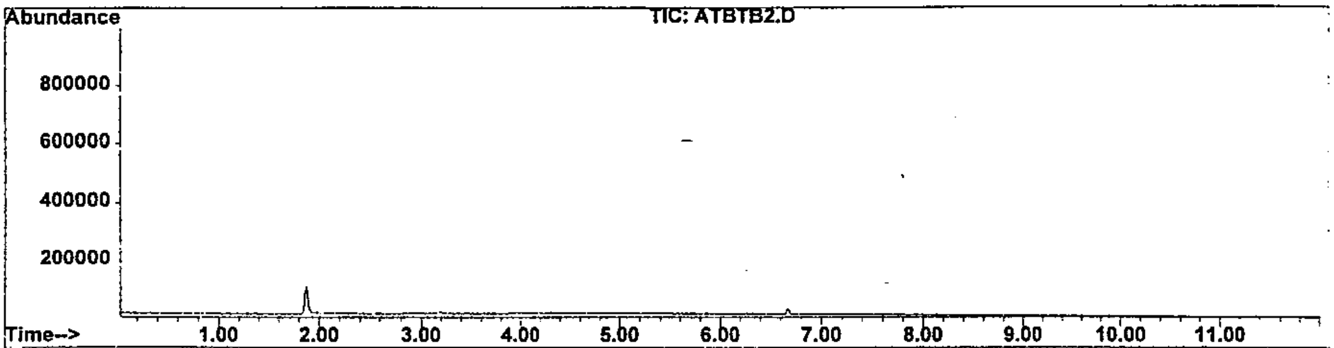
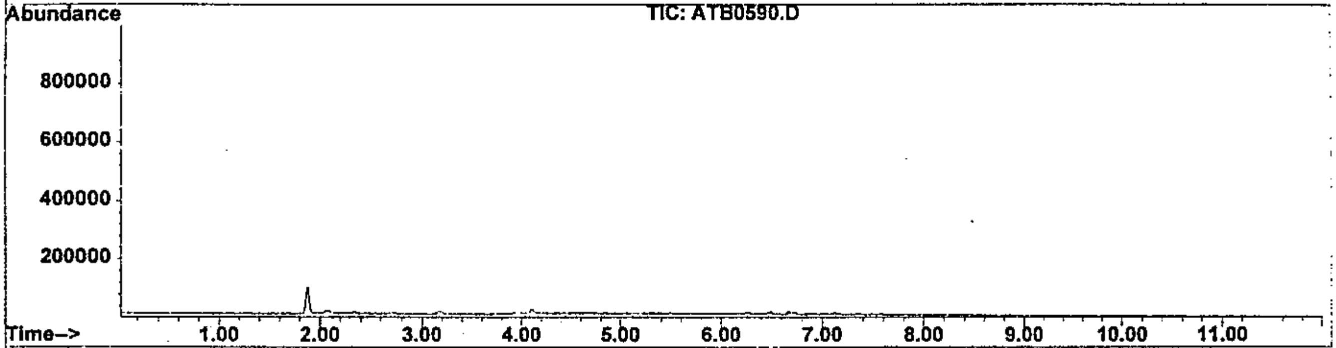
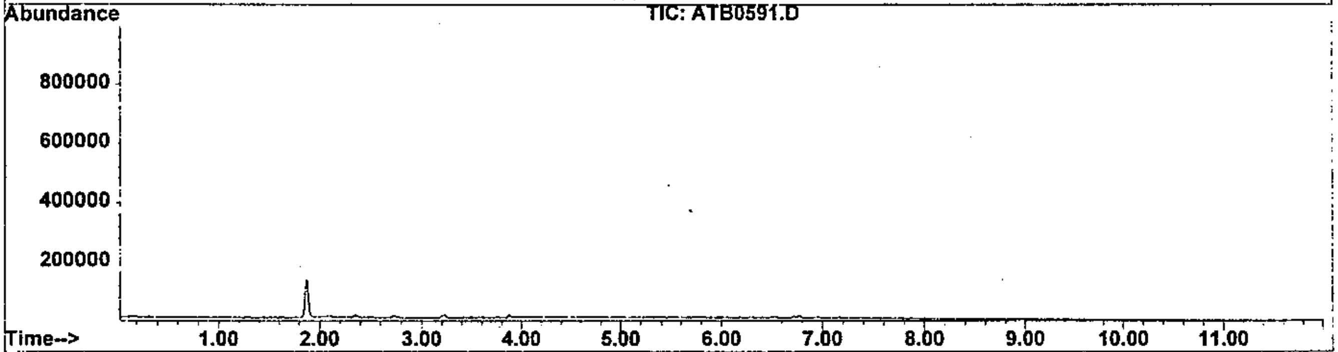
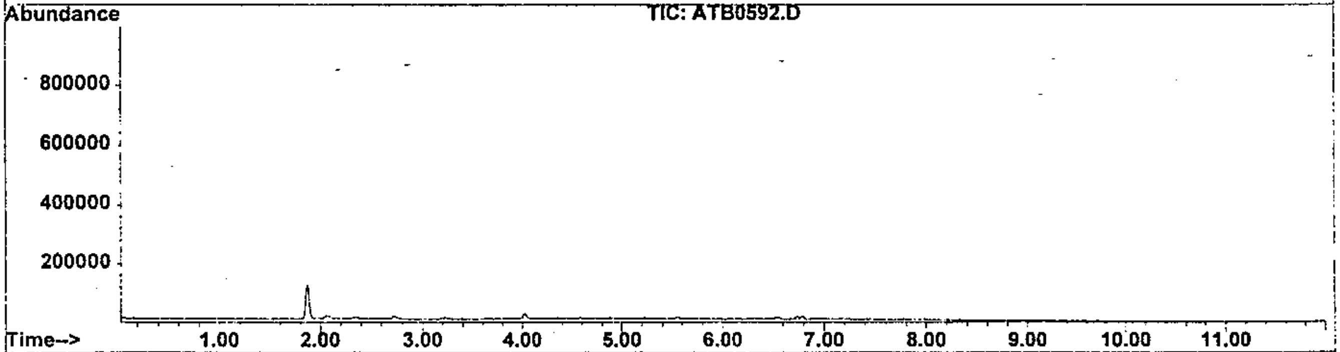
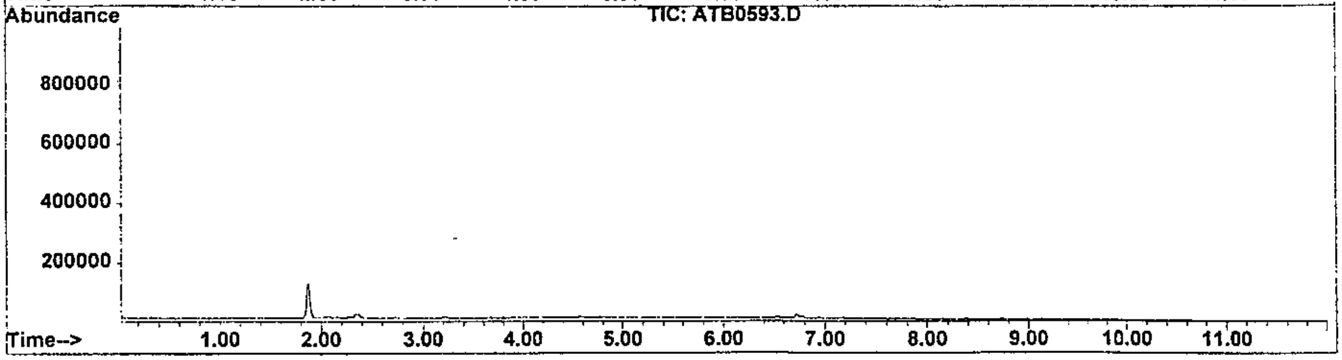
In sequence order











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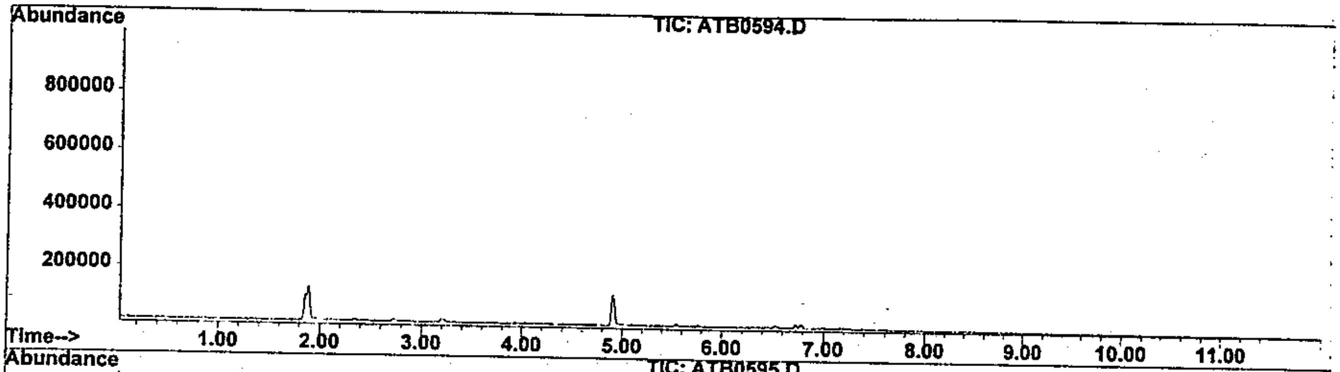
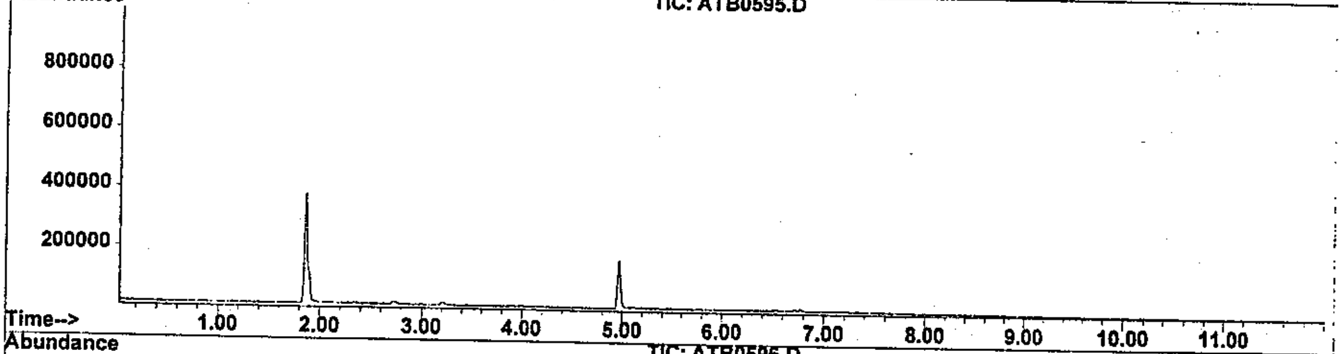
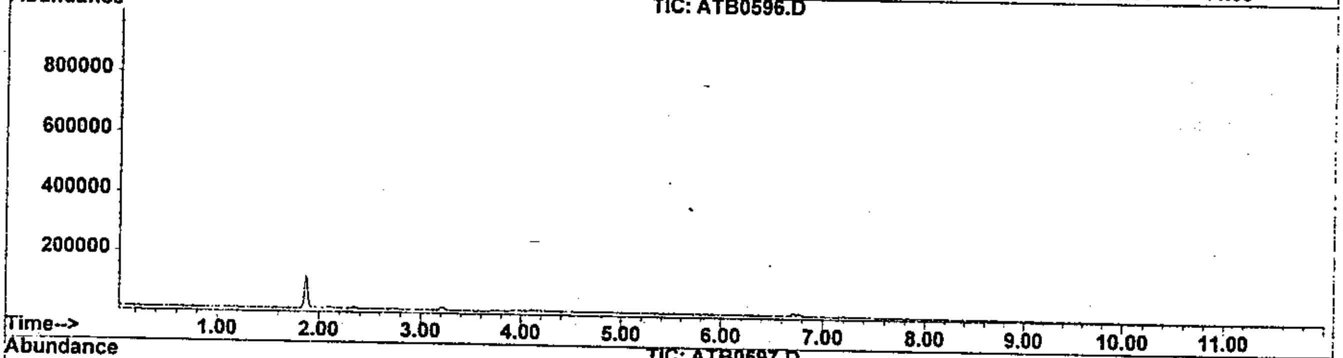
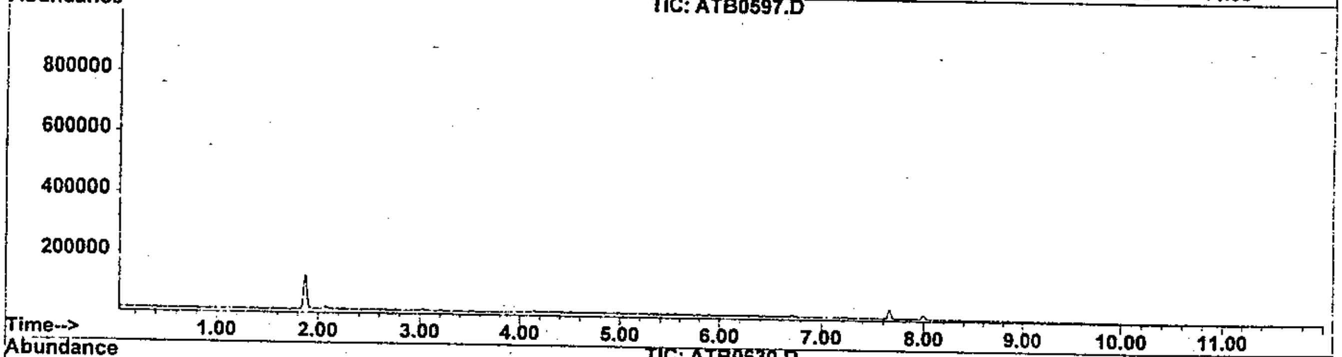
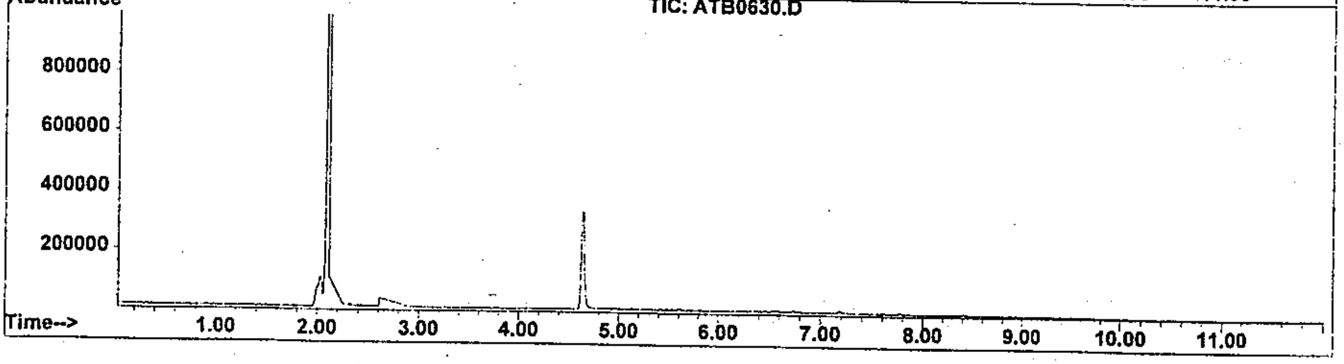
In sequence order



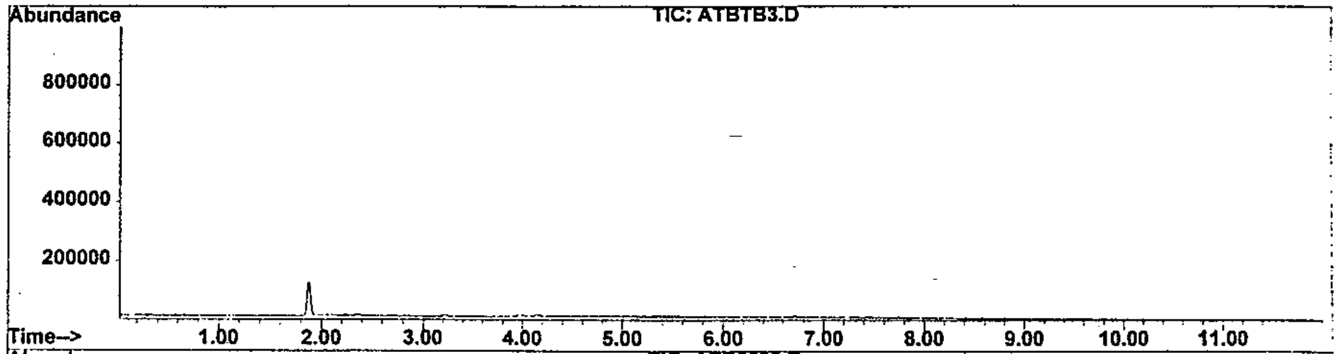


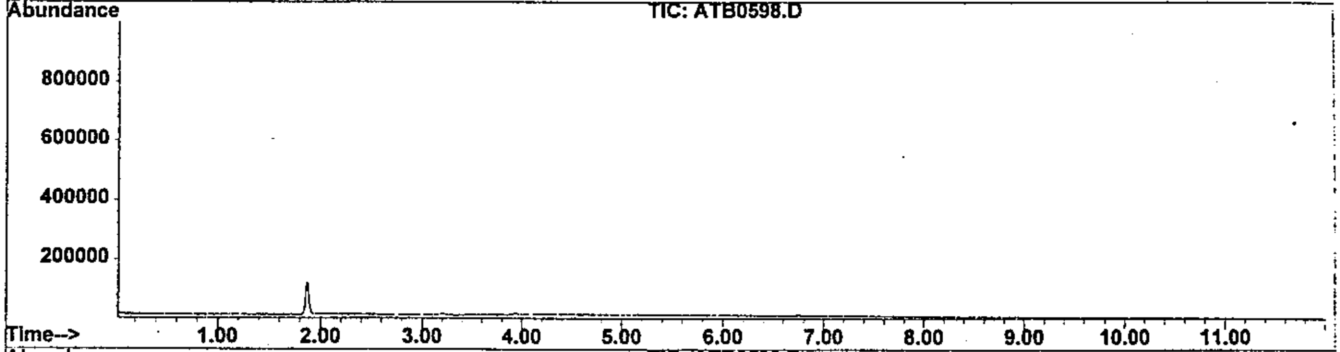


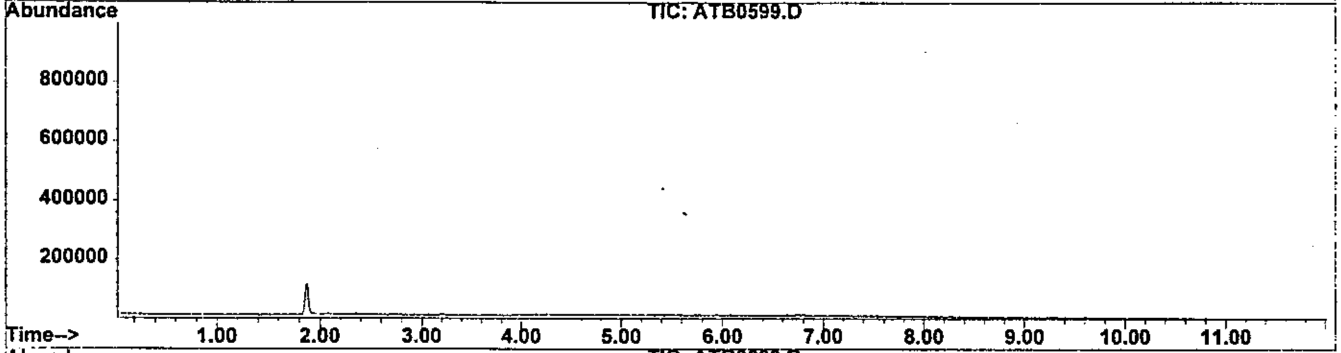


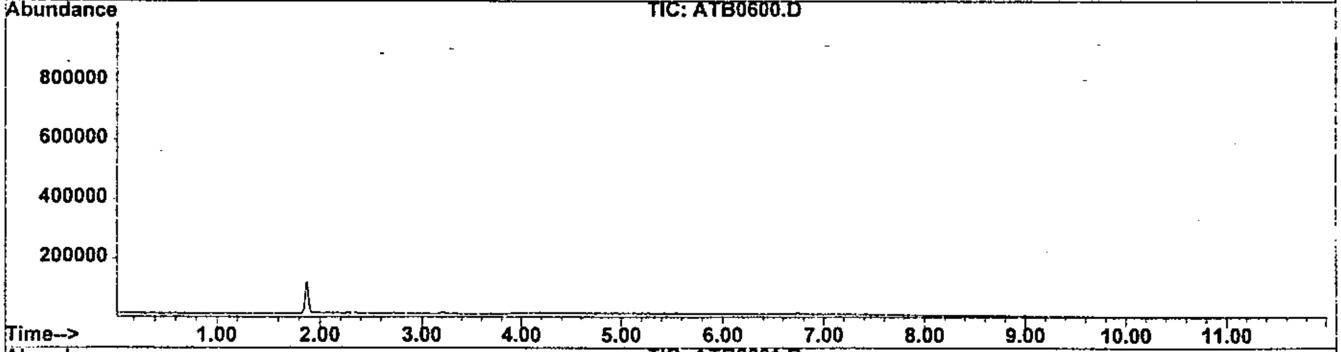


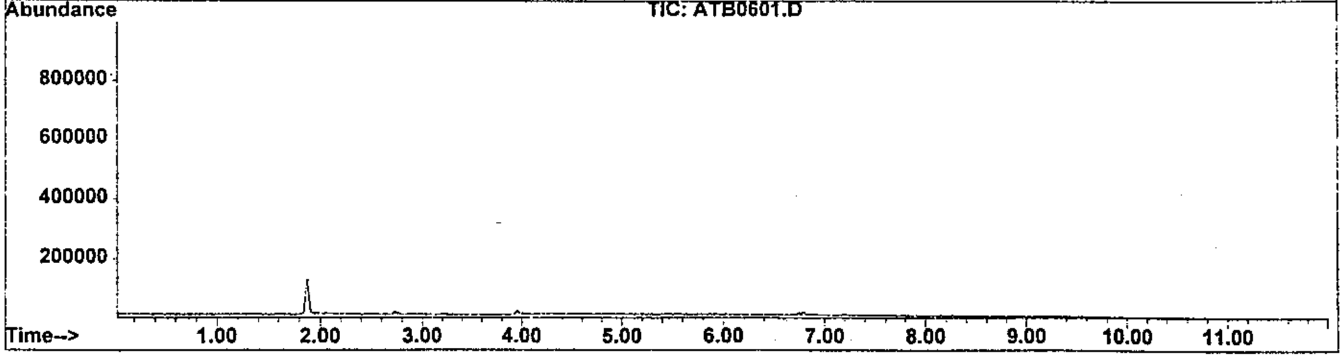
TIC - SITE ATB - PRODUCTION ORDER #095082
In sequence order





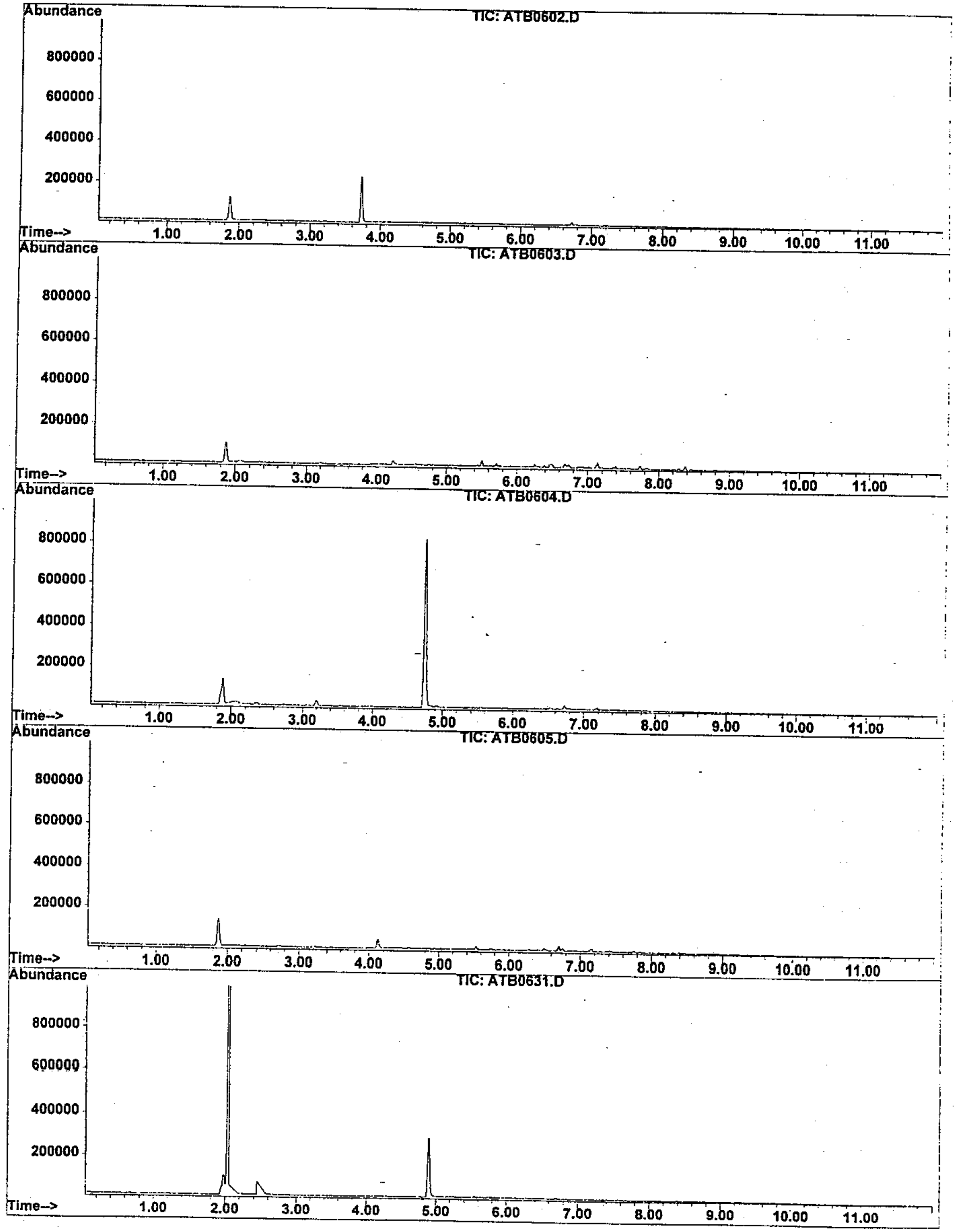






TIC - SITE ATB - PRODUCTION ORDER #095082

In sequence order



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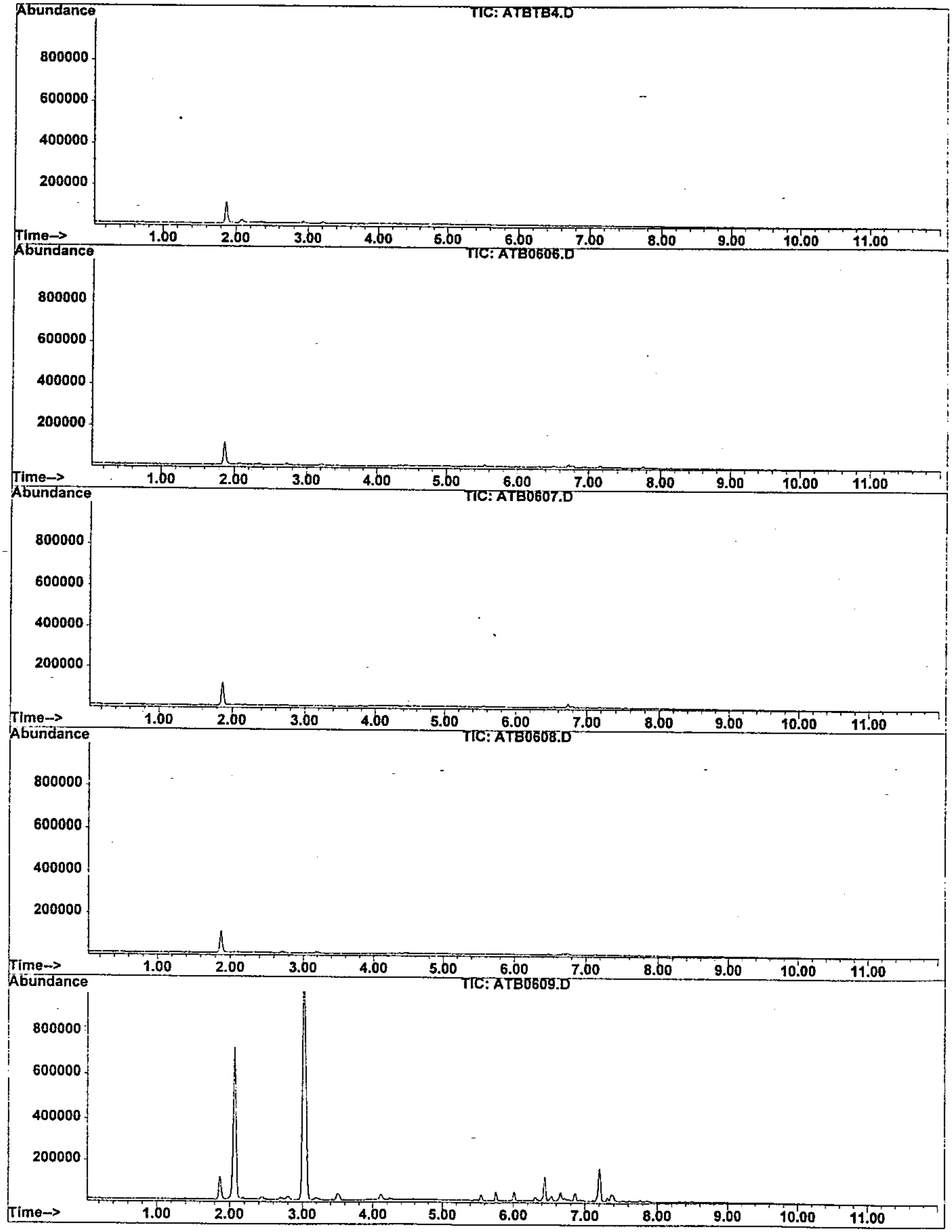

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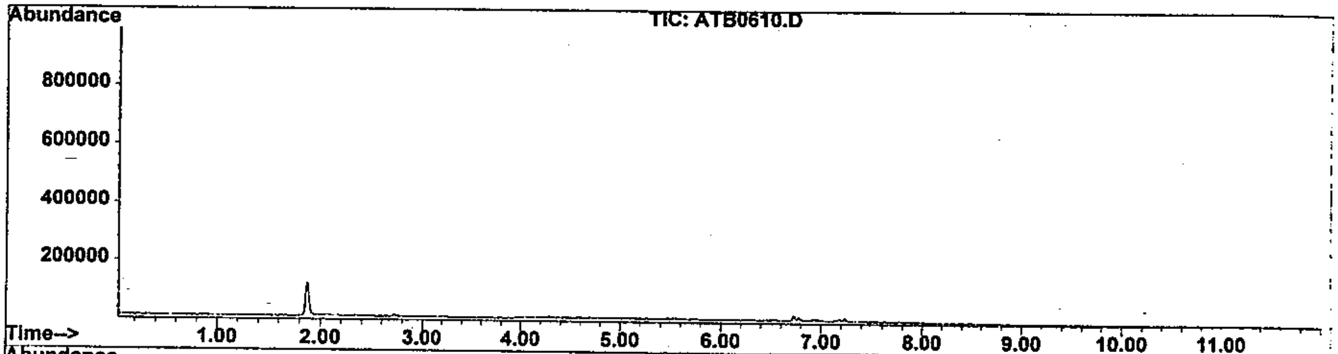
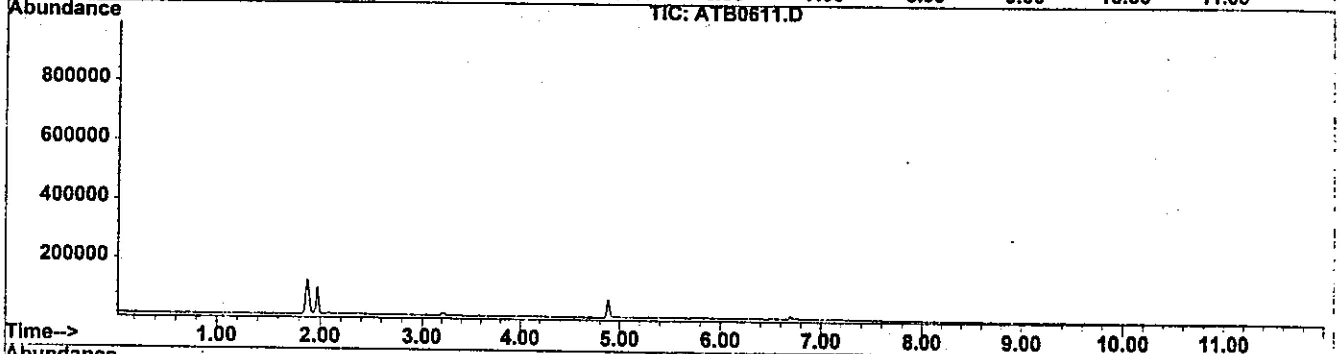
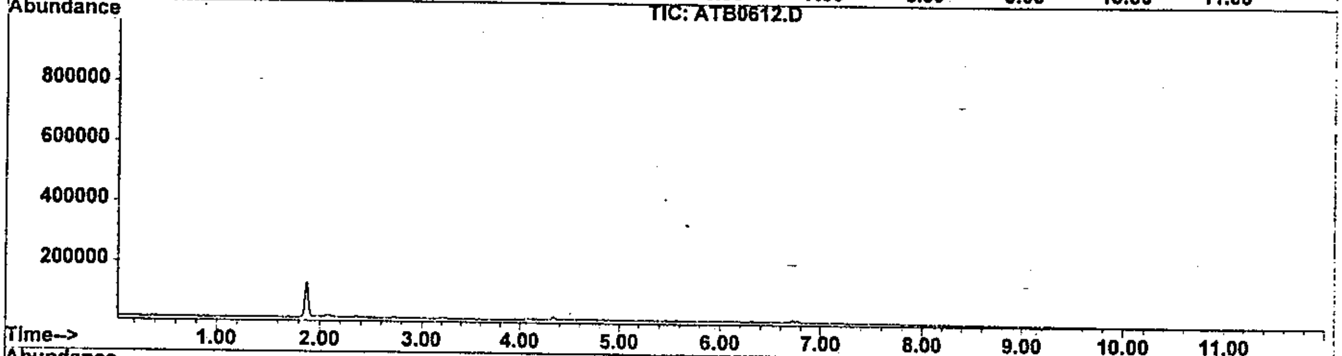
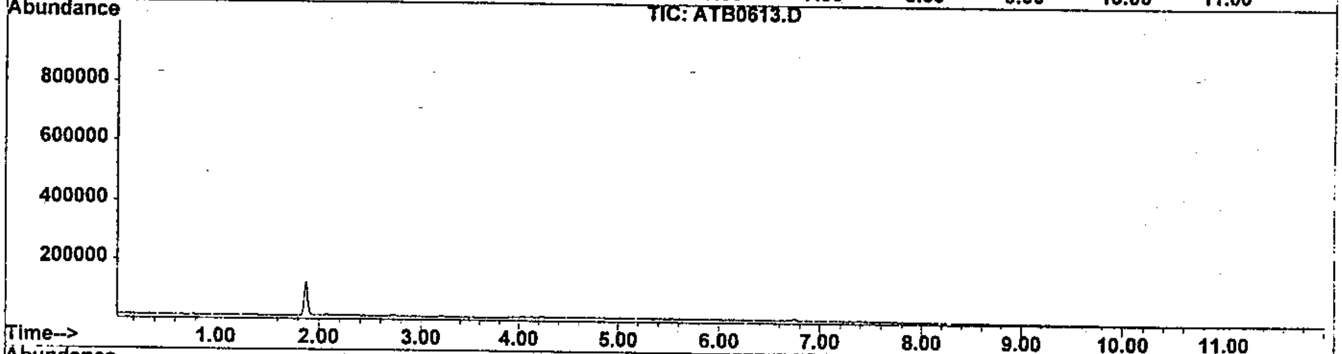
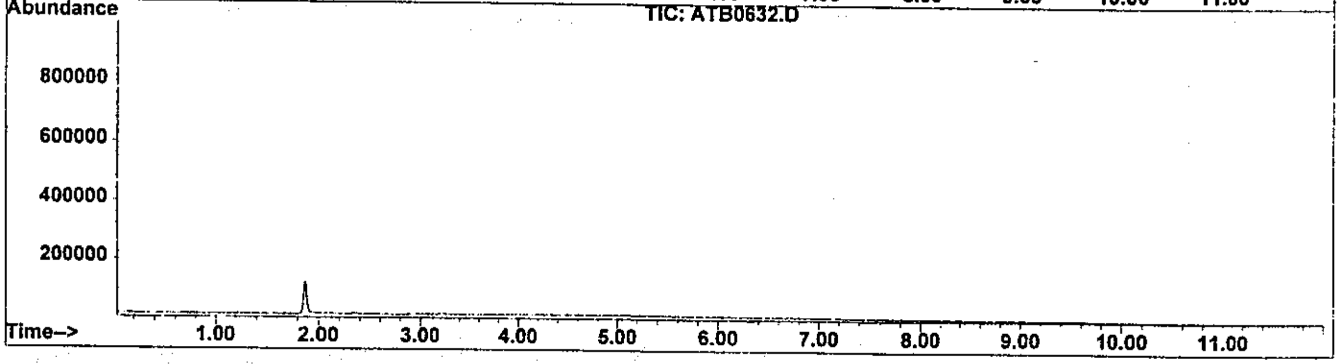
In sequence order











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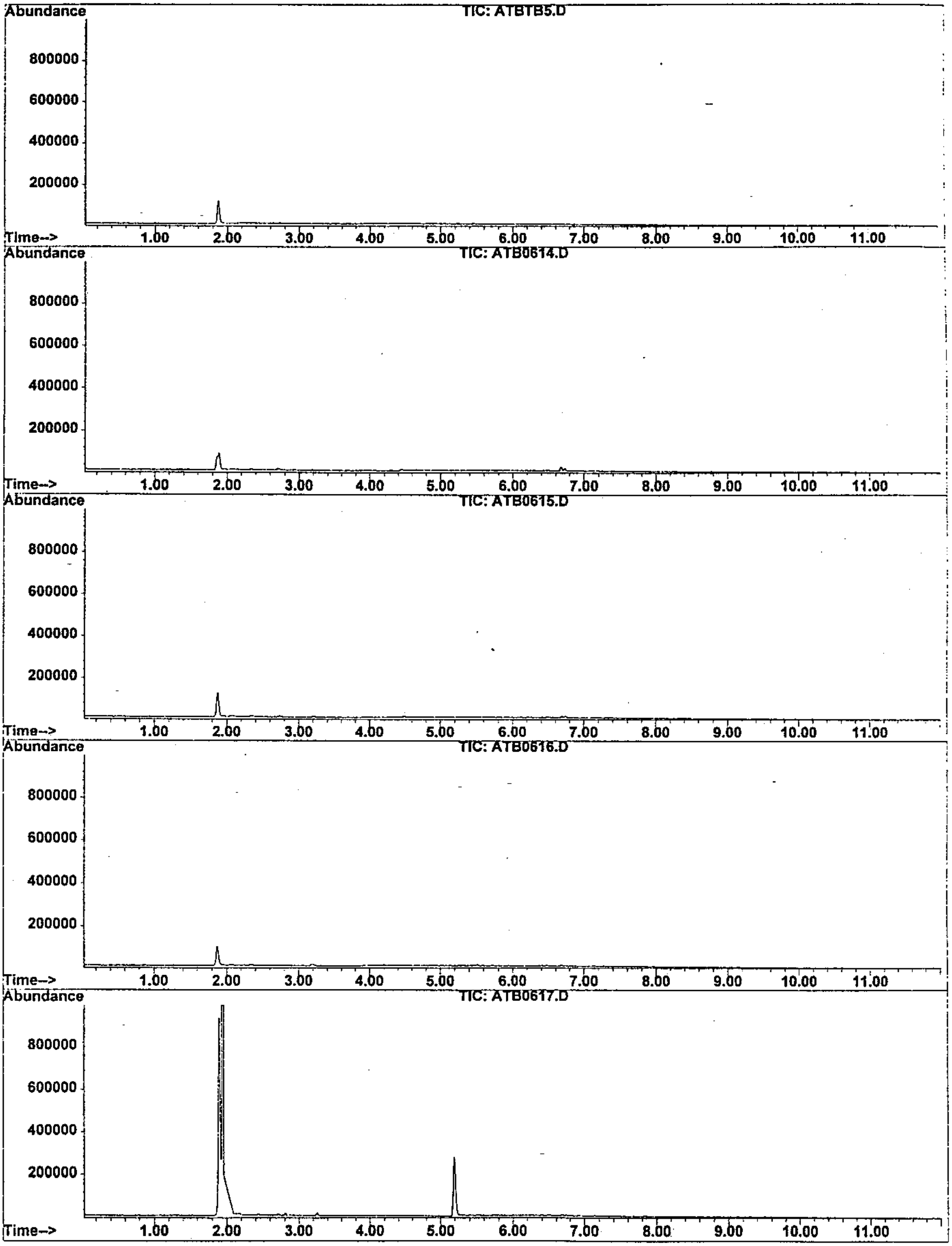

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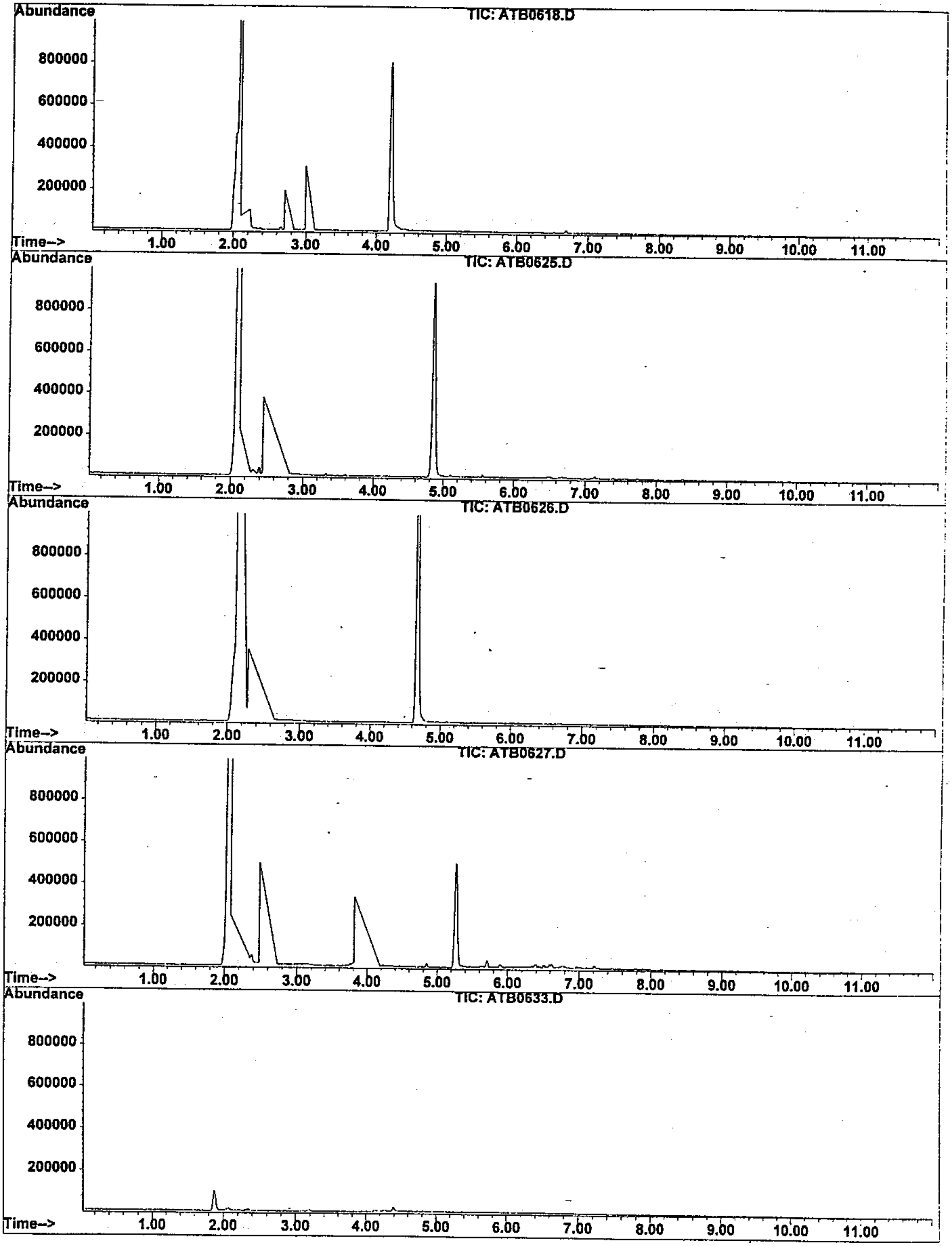

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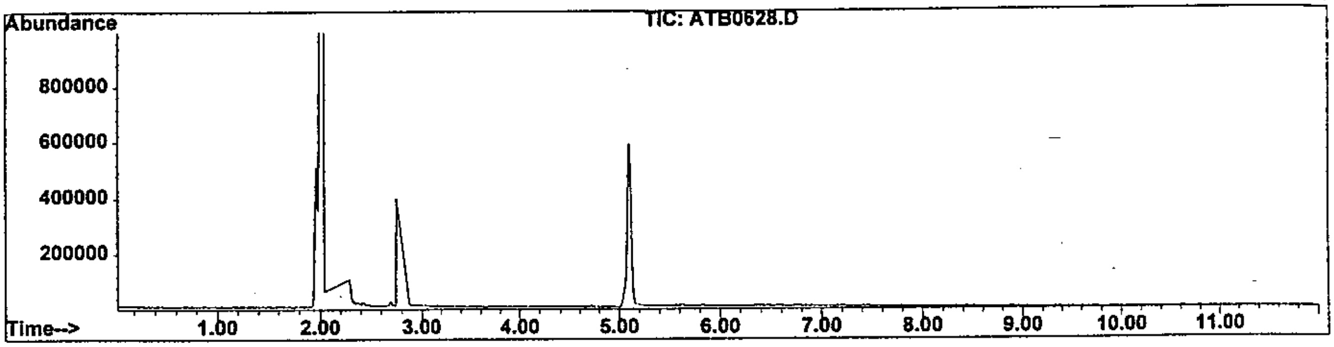

S. Myrtle Street
Embayment Study

Attachment B

GORE-SORBER® Screening Survey Final Report
Great Western International

AGENCY REVIEW DRAFT

GORE
Creative Technologies
Worldwide

W. L. GORE & ASSOCIATES, INC.

100 CHESAPEAKE BLVD., P.O. BOX 10 • ELKTON, MARYLAND 21922-0010 • PHONE: 410/392-7600
FAX: 410/506-4780

GORE-SORBER® EXPLORATION SURVEY
GORE-SORBER® SCREENING SURVEY

1 of 6

GORE-SORBER® Screening Survey
Final Report

Great Western Chemical Co.
Seattle, WA

December 2, 1998

Gore Production Order No. 098434

Prepared For:
Terra Vac Corporation
10740 Meridian Avenue North, Suite 202
Seattle, WA 98133

W.L. Gore & Associates, Inc.

Written/Submitted by:
Jay W. Hodny, Ph.D., Project Manager

Jay W. Hodny

Reviewed/Approved by:
Ray F. Fenstermacher, P.G., Project Manager

Analytical Data Reviewed by:
Kelly R. Scott, Chemist

Kelly R Scott

I:\MAPPING\PROJECTS\098434\981202R.DOC

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ASIA • AUSTRALIA • EUROPE • NORTH AMERICA

FORM 11 R.3
Rev 10/25/96

GORE-SORBER® Screening Survey
Final Report

REPORT DATE: December 2, 1998 **AUTHOR:** JWH

SITE INFORMATION

Site Reference: Great Western Chemical Co., Seattle, WA
Customer Purchase Order Number: 320039NA-3-1575
Gore Production Order Number: 098434 **Gore Site Code:** AUL

FIELD PROCEDURES

 # Modules shipped: 33
Installation Date(s): 11/4/98 **# Modules Installed:** 15
Field work performed by: Terra Vac Corporation

Retrieval date(s): 11/6/98 **Exposure Time:** 2 [days]
 # Modules Retrieved: 15 **# Trip Blanks Returned:** 3
 # Modules Lost in Field: 0 **# Unused Modules Returned:** 15

Date/Time Received by Gore: 11/10/98 @ 12:30 PM **By:** TS
Recorded Cooler/Water Temperature Control Blank temperature: 16.9 [°C]
Chain of Custody Form attached: √
Chain of Custody discrepancies: None
Comments: None

GORE-SORBER® Screening Survey
Final Report

ANALYTICAL PROCEDURES

W.L. Gore & Associates' Screening Module Laboratory operates under the guidelines of its Quality Assurance Manual, Operating Procedures and Methods. The quality assurance program is consistent with Good Laboratory Practices (GLP) and ISO Guide 25, "General Requirements for the Competence of Calibration and Testing Laboratories", third edition, 1990. The Laboratory is audited regularly by a quality system design, development and auditing company.

Instrumentation consists of state of the art gas chromatographs equipped with mass selective detectors, coupled with automated thermal desorption units. Sample preparation simply involves cutting the tip off the bottom of the sample module and transferring one or more exposed sorbent containers (sorbers, each containing 40mg of a suitable granular adsorbent) to a thermal desorption tube for analysis. Sorbers remain clean and protected from dirt, soil, and ground water by the insertion/retrieval cord, and require no further sample preparation. Samples remain frozen until analysis and unanalyzed sorbers are archived in the freezer for potential future analysis.

Analytical Method Quality Assurance:
The analytical method employed is a modified EPA method 8260A/8270B. Before each run sequence, two instrument blanks, a sorber containing 5µg BFB (Bromofluorobenzene), and a method blank are analyzed. The BFB mass spectra must meet the criteria set forth in the method before samples can be analyzed. A method blank and a sorber containing BFB is also analyzed after every 30 samples and/or trip blanks. Standards containing the selected target compounds at three calibration levels of 5, 20, and 50µg are analyzed at the beginning of each run. The criterion for each target compound is less than 35% RSD (relative standard deviation). If this criterion is not met for any target compound, the analyst has the option of generating second- or third-order standard curves, as appropriate. A second-source reference standard, at a level of 10µg per target compound, is analyzed after every ten samples and/or trip blanks, and at the end of the run sequence. Positive identification of target compounds is determined by 1) the presence of the target ion and at least two secondary ions; 2) retention time versus reference standard; and, 3) the analyst's judgment.

NOTE: All data have been archived. Any replicate sorbers not used in the initial analysis will be discarded fifteen (15) days from the date of analysis.

Laboratory analysis: thermal desorption, gas chromatography, mass selective detection
Quality Assurance Level: 2 (ANA-4/VCA1)
Instrument ID: # 2 **Chemist:** KS **Data Subdirectory:** 098434
Compounds/mixtures requested: Gore Chlorinated VOC Target Compounds (A10), plus vinyl chloride.
Deviations from Standard Method: None
Comments: Soil vapor analytes and abbreviations are tabulated in the Data Table Key (page 6). The cis-1,2-DCE levels overloaded the mass selective detector during the analysis of module #171928. Therefore, the value reported is represented with a ">" sign in the data table. This indicates that the microgram levels were at least this high. Quantification of these compounds is integrated up to a point of confidence in the chromatograms.

GORE-SORBER® Screening Survey
Final Report

DATA TABULATION

 # CONTOUR MAPS ENCLOSED: No maps were prepared.

NOTE: All data values presented in Appendix A represent masses of compound(s) desorbed from the GORE-SORBER Screening Modules received and analyzed by W.L. Gore, as identified in the Chain of Custody (Appendix A). The measurement traceability and instrument performance are reproducible and accurate for the measurement process documented. Semi-quantitation of the compound mass is based on either a single-level (QA Level 1) or three-level (QA Level 2) standard calibration.

General Comments:

- This survey reports soil gas mass levels present in the vapor phase. Vapors are subject to a variety of attenuation factors during migration away from the source concentration to the module. Thus, mass levels reported from the module will often be less than concentrations reported in soil and groundwater matrix data. In most instances, the soil gas masses reported on the modules compare favorably with concentrations reported in the soil or groundwater (e.g., where soil gas levels are reported at greater levels relative to other sampled locations on the site, matrix data should reveal the same pattern, and vice versa). However, due to a variety of factors, a perfect comparison between matrix data and soil gas levels can rarely be achieved.
- Soil gas signals reported by this method cannot be identified to soil adsorbed, groundwater, and/or free-product contamination. The soil gas signal reported from each module can evolve from all of these sources. Differentiation between soil and groundwater contamination can only be achieved with prior knowledge of the site history (i.e., the site is known to have groundwater contamination only).
- Currently, soil gas surveys are not designed to replace soil or groundwater matrix sampling. Following a soil gas survey, matrix sampling is recommended in select areas to establish the nature of the contamination (i.e., soil, groundwater, or both), and the relationship to the soil gas levels.

- QA/QC trip blank modules were provided to document contamination occurring that was not part of the soil gas signal of interest (i.e., impact during module shipment, installation and retrieval, and storage). The trip blanks are identically manufactured and packaged soil gas modules to those modules placed in the subsurface. However, the trip blanks remain unopened during all phases of the soil gas survey. Levels reported on the trip blanks may indicate potential impact to modules other than the contaminant source of interest.
- Unresolved peak envelopes (UPEs) are represented as a series of compound peaks clustered together around a central GC elution time in the total ion chromatogram. Typically, UPEs are indicative of complex fluid mixtures that are present in the subsurface. UPEs observed early in the chromatogram are considered to indicate the presence of more volatile fluids, while UPEs observed later in the chromatogram may indicate the presence of less volatile fluids. Multiple UPEs may indicate the presence of multiple complex fluids. Attenuation of the VOC/SVOC soil gas components may suggest the presence of a less volatile fluid, when in fact, a more volatile fluid existed but the volatile components have weathered away.

Project Specific Comments:

- Stacked total ion chromatograms (TICs) are included in Appendix A. The last four digits of each module number are incorporated into the TIC identification (e.g.: AUL1905TC.D represents module #171905).
- Nominal trip blank levels were reported for some target analytes. No detectable levels of target analytes were reported in the method blanks. In our experience, TPH present in the blanks at levels <10.00 µg can be considered "background." Thus, target analyte levels, reported for the field-installed modules, that exceed trip and method blank levels, have a high probability of originating from on-site sources.
- Moderate to high mass levels were reported for several chlorinated compounds including vinyl chloride.

GORE-SORBER® Screening Survey
Final Report

KEY TO DATA TABLE
Great Western Chemical Co., Seattle, WA

UNITS	
µg	micrograms (per sorber), reported for compounds
MDL	method detection limit
bdl	below detection limit
nd	non-detect
ANALYTES	
VC	vinyl chloride
ct12DCE	cis- & trans-1,2-dichloroethene
t12DCE	trans-1,2-dichloroethene
c12DCE	cis-1,2-dichloroethene
11DCE	1,1-dichloroethene
11DCA	1,1-dichloroethane
$CHCl_3$	chloroform
111TCA	1,1,1-trichloroethane
12DCA	1,2-dichloroethane
CCl_4	carbon tetrachloride
TCE	trichloroethene
112TCA	1,1,2-trichloroethane
PCE	tetrachloroethene
ClBENZ	chlorobenzene
1112TetCA	1,1,1,2-tetrachloroethane
1122TetCA	1,1,2,2-tetrachloroethane
13DCB	1,3-dichlorobenzene
14DCB	1,4-dichlorobenzene
12DCB	1,2-dichlorobenzene
BLANKS	
TBn	unexposed trip blanks, travels with the exposed modules
method blank	QA/QC module, documents analytical conditions during analysis

APPENDIX A:

1. CHAIN OF CUSTODY
2. DATA TABLE
3. STACKED TOTAL ION CHROMATOGRAMS

GORE-SORBER® Screening Survey Chain of Custody

For W.L. Gore & Associates use only
Production Order = 98434

GORE

W. L. Gore & Associates, Inc., Environmental Products Group
100 Chesapeake Boulevard • Elkton, Maryland 21921 • Tel: (410) 392-7600 • Fax (410) 506-4780

Instructions: Customer must complete ALL shaded cells

Customer Name: TERRA VAC Corp
Address: 10746 MERIDIAN AVENUE N
Suite 202
SEAttle WA. 98133
Phone: (206) 362-8128
FAX: (206) 362-9528

Site Name: DUAMISH Sediment Site III
Site Address: SEAttle, WA
Project Manager: TIMOTHY WARNER
Customer Project No.: 32-0039
Customer P.O. #: 320039WA-3-1575 Quote #: 24980

Serial # of Modules Shipped			# of Modules for Installation 30 # of Trip Blanks 3
# 171900	through	# 171932	Total Modules Shipped: 33 Pieces
#	through	#	Total Modules Received: 33 Pieces
#	through	#	Total Modules Installed: 15 Pieces
#	through	#	Serial # of Trip Blanks (Client Decides) #
#	through	#	# 171900 X # 171906 #

GORE ANALYTICAL OPTION: [A 11]

# 171901	#	#
# [illegible]	#	#

Installation Performed By:
Name (please print): PETER CATTERALL
Company/Affiliation: TERRA VAC/SLAFF ENG

Installation Method(s) (circle those that apply):
Slide Hammer Hammer Drill Auger
Other: Insertion tool (soft sediments)

Installation Start Date and Time: 11/4/98 / 11 ~~15~~ :00 AM [✓ PM]
Installation Complete Date and Time: 11/4/98 / 12 :45 [✓ AM] PM

Retrieval Performed By:
Name (please print): PETER CATTERALL
Company/Affiliation: TERRA VAC/SLAFF ENG

Total Modules Retrieved: 15 Pieces
Total Modules Lost in Field: 0 Pieces
Total Unused Modules Returned: 15 Pieces

Retrieval Start Date and Time: 11/6/98 11:30 AM [✓ PM]
Retrieval Complete Date and Time: 11/7/98 1:30 [✓ AM] PM

Relinquished By T. Or Affiliation: W.L. Gore & Associates, Inc.	Date 10/30/98	Time 12 n	Received By: PETER CATTERALL Affiliation: TERRA VAC	Date 11/2/98	Time 10 AM
Relinquished By PETER CATTERALL Affiliation: TERRA VAC	Date 11/9/98	Time 12 pm	Received By: Affiliation:	Date	Time
Relinquished By Affiliation	Date	Time	Received By: Affiliation: W.L. Gore & Associates, Inc.	Date 11/10/98	Time 12:30

GORE-SORBER ® Screening Survey is a registered service mark of W L. Gore & Associates, Inc.

FORM SR-1
4/24/98

GORE-SORBER® Exploration Survey Installation and Retrieval Log

Page ______of ______

Installer's Signature

SITE/PROSPECT NAME & LOCATION

Great Western Chemical Co.
Duwamish River Embayment
Seattle WA

LINE #	MODULE #	INSTALLATION DATE/TIME	RETRIEVAL DATE/TIME	MODEL SETS Check for Yes	 Location (e.g. well ID)	COMMENTS
1. ✓	171905	11/4/98	11/6/98		S-11	
2. ✓	171917				S-12	
3. ✓	171932				S-3	
4. ✓	171931				S-8	
5. ✓	171927				S-6	
6. ✓	171924				S-13 A	
7. ✓	171928				S-13 B	
8. ✓	171925				S-13 C	
9. ✓	171929				S-13 D	
10. ✓	171926				S-13 E	
11. ✓	171930				S-13 F	
12. ✓	171910				S-1 A	
13. ✓	171903				S-1 B	
14. ✓	171904				S-1 C	
15. ✓	171902	11/4/98	11/6/98		S-1 D	
16.						
17.						
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40.						

[illegible] Modules [illegible]

GORE SORBER SCREENING SURVEY ANALYTICAL RESULTS

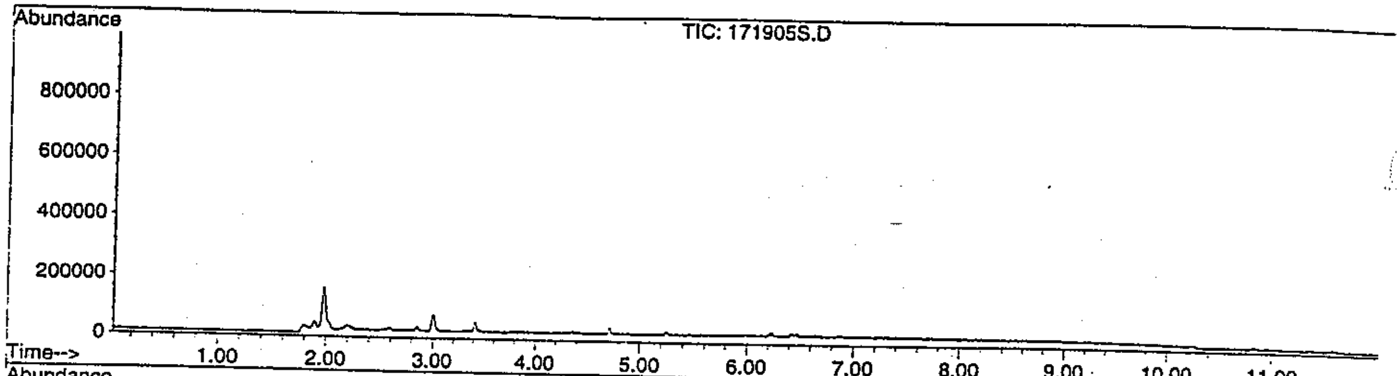
TERRA VAC CORPORATION,
SEATTLE, WASHINGTON
GORE CHLORINATED VOCS (A10)
DUAMISH SETTLEMENT SITE III, SEATTLE, WA
SITE AUL, PRODUCTION ORDER NO. 098434

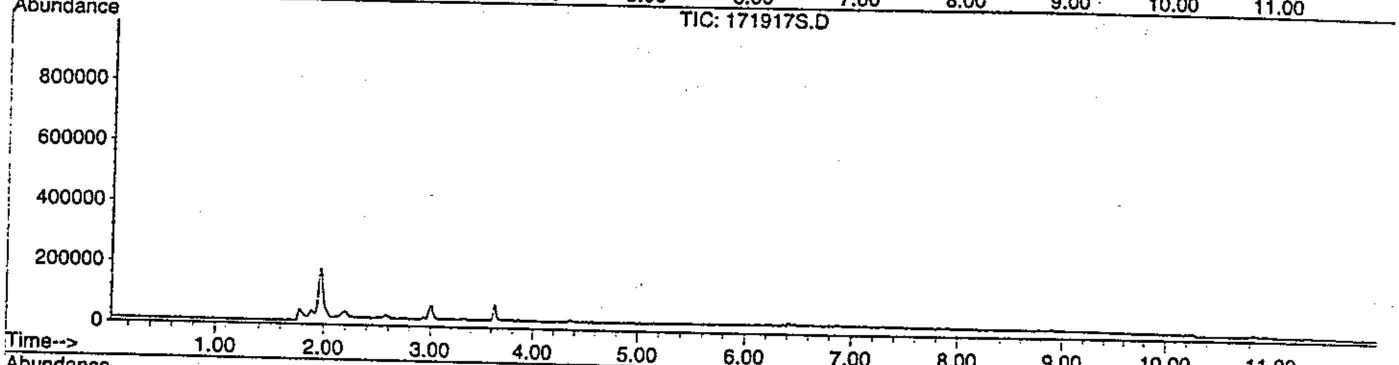
DATE ANALYZED	MODULE NUMBER	VC, ug	11DCE, ug	ct12DCE, ug	t12DCE, ug	11DCA, ug	c12DCE, ug	CHCl3, ug	111TCA, ug	12DCA, ug
	MDL=	0.30	0.03	0.02	0.03	0.03	0.02	0.01	0.03	0.04
11/14/98	171902	nd	nd	0.05	nd	1.91	0.05	nd	nd	nd
11/13/98	171903	7.71	nd	1.12	0.06	5.61	1.06	nd	nd	nd
11/14/98	171904	nd	nd	0.10	nd	2.78	0.10	nd	nd	nd
11/13/98	171905	nd	nd	0.20	nd	nd	0.20	nd	nd	nd
11/13/98	171910	103.94	0.41	43.58	0.83	10.11	42.75	nd	nd	0.08
11/13/98	171917	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/13/98	171924	38.57	1.50	349.05	7.11	1.98	341.94	nd	nd	0.43
11/13/98	171925	51.75	2.08	333.87	3.46	6.76	330.41	nd	nd	0.46
11/13/98	171926	44.96	1.24	145.58	2.17	6.47	143.41	nd	nd	0.28
11/13/98	171927	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/13/98	171928	27.90	4.15	>312.11	6.81	12.48	>305.3	nd	nd	1.01
11/13/98	171929	62.86	1.24	232.51	2.54	7.59	229.97	nd	nd	0.38
11/13/98	171930	47.58	0.94	125.82	2.51	8.36	123.31	nd	nd	0.24
11/13/98	171931	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/13/98	171932	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/13/98	171900	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/13/98	171901	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/14/98	171906	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/13/98	method blank	nd	nd	nd	nd	nd	nd	nd	nd	nd
	NUMBER	VC, ug	11DCE, ug	ct12DCE, ug	t12DCE, ug	11DCA, ug	c12DCE, ug	CHCl3, ug	111TCA, ug	12DCA, ug
	Maximum	103.94	4.15	349.05	7.11	12.48	341.94	0.00	0.00	1.01
	Standard Dev.	31.79	1.17	137.52	2.45	4.19	135.24	0.00	0.00	0.29
	Mean	25.68	0.77	102.93	1.70	4.27	101.23	0.00	0.00	0.19

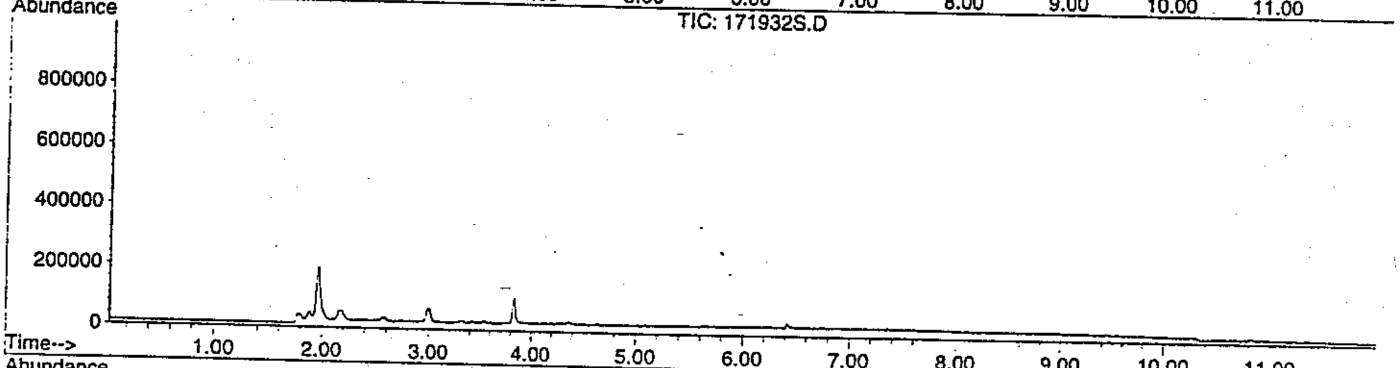
GORE SORBER SCREENING SURVEY ANALYTICAL RESULTS.
TERRA VAC CORPORATION,
SEATTLE, WASHINGTON
GORE CHLORINATED VOCS (A10)
DUAMISH SETTLEMENT SITE III, SEATTLE, WA
SITE AUL, PRODUCTION ORDER NO. 098434

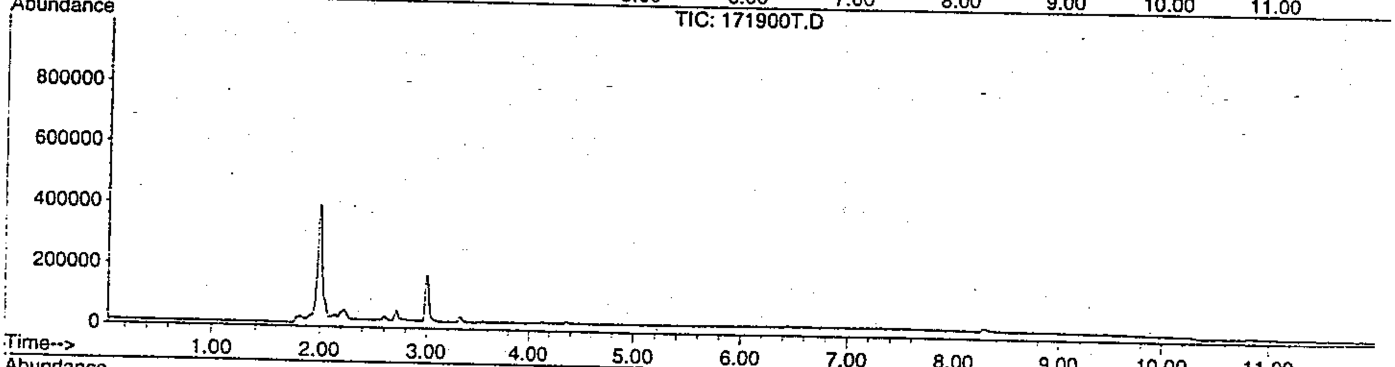
MODULE NUMBER	CCl4, ug	TCE, ug	112TCA, ug	PCE, ug	ClBENZ, ug	1112TetCA, ug	1122TetCA, ug	13DCB, ug	14DCB, ug	12DCB, ug
MDL=	0.02	0.03	0.03	0.03	0.04	0.03	0.02	0.01	0.02	0.02
171902	nd	nd	nd	nd	0.06	nd	nd	nd	nd	0.09
171903	nd	nd	nd	nd	0.29	nd	nd	nd	0.07	0.42
171904	nd	nd	nd	nd	0.11	nd	nd	nd	nd	0.20
171905	nd	nd	nd	0.26	nd	nd	nd	nd	nd	nd
171910	nd	0.11	nd	nd	0.59	nd	nd	0.03	0.23	0.85
171917	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
171924	nd	1.76	nd	0.92	0.19	nd	nd	nd	0.03	0.62
171925	nd	0.48	nd	0.15	0.91	nd	nd	nd	0.04	0.18
171926	nd	0.46	nd	0.17	0.60	nd	nd	nd	0.04	0.11
171927	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
171928	nd	1.55	nd	0.45	2.79	nd	nd	nd	0.14	0.51
171929	nd	0.61	nd	0.27	0.82	nd	nd	nd	0.08	0.19
171930	nd	0.58	nd	0.22	1.02	nd	nd	nd	0.10	0.30
171931	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
171932	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
171900	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
171901	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
171906	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
method blank	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NUMBER	CCl4, ug	TCE, ug	112TCA, ug	PCE, ug	ClBENZ, ug	1112TetCA, ug	1122TetCA, ug	13DCB, ug	14DCB, ug	12DCB, ug
Maximum	0.00	1.76	0.00	0.92	2.79	0.00	0.00	0.03	0.23	0.85
Standard Dev.	0.00	0.57	0.00	0.25	0.73	0.00	0.00	0.01	0.07	0.26
Mean	0.00	0.37	0.00	0.16	0.49	0.00	0.00	0.00	0.05	0.23

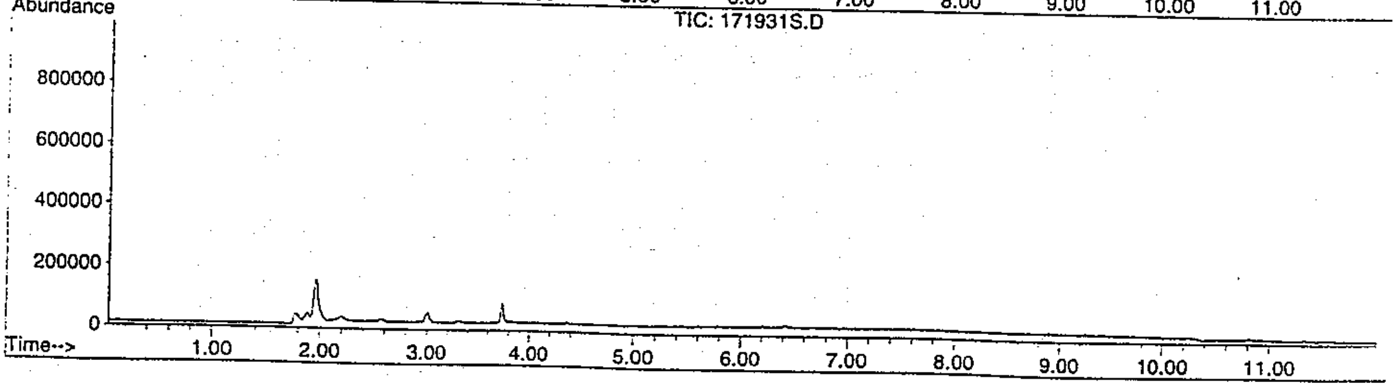
TICS- SITE AUL, PRODUCTION ORDER NO. 98434











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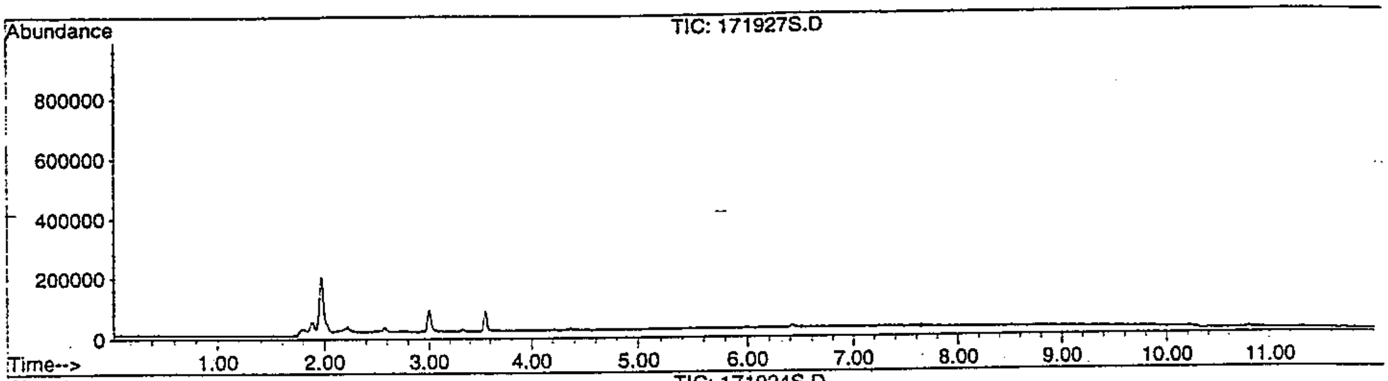

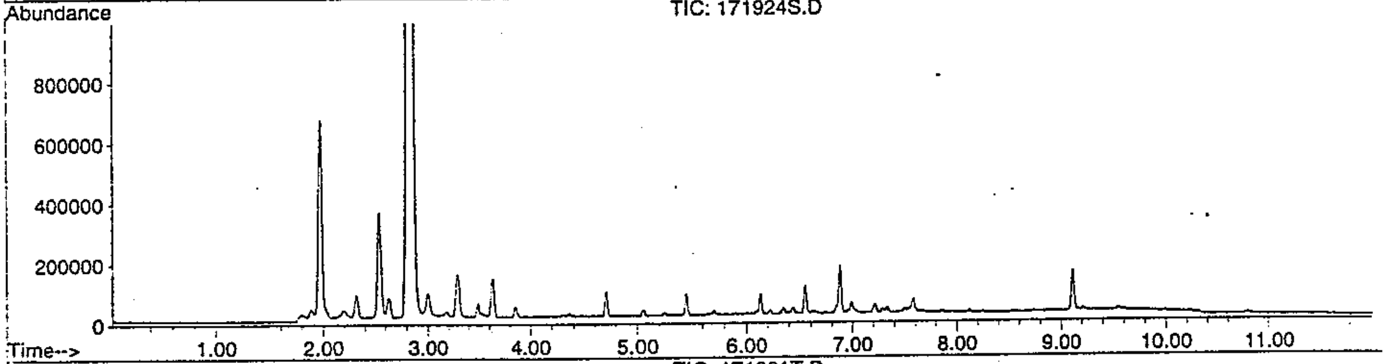

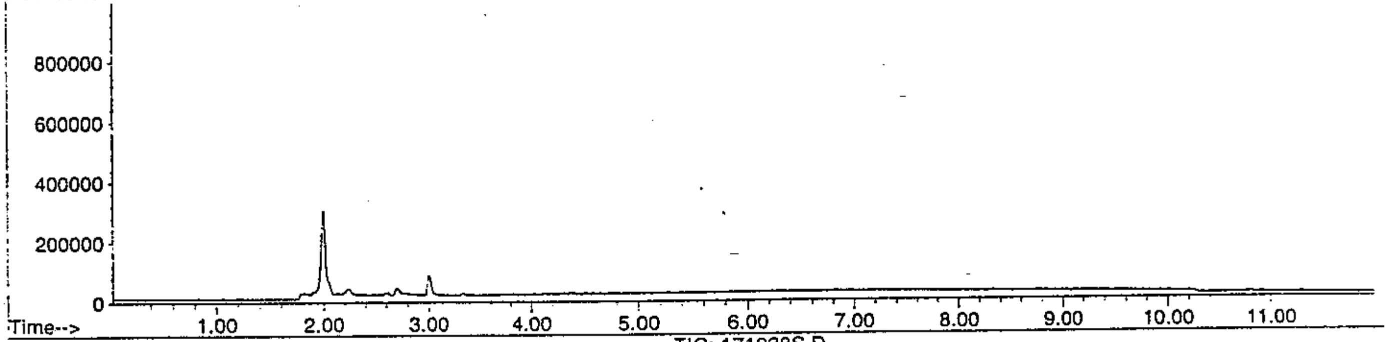

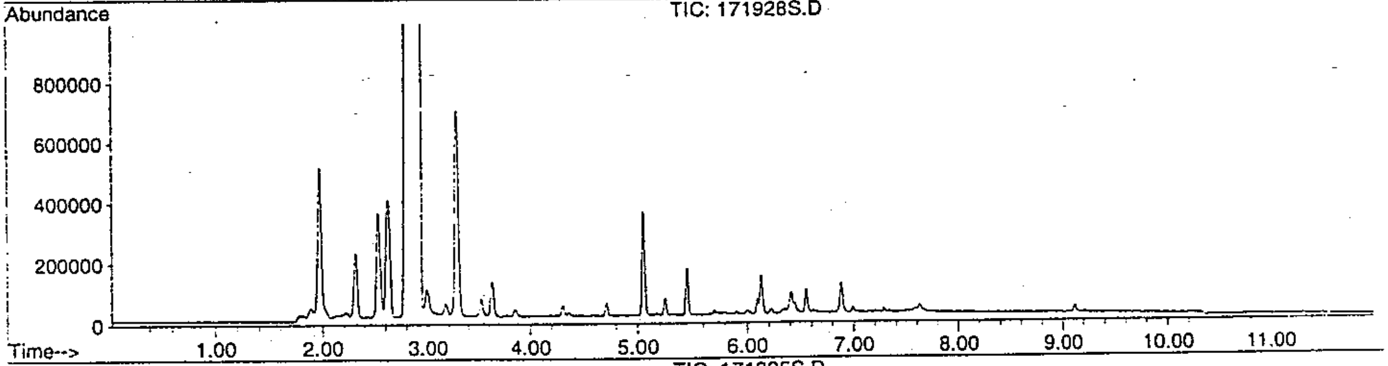

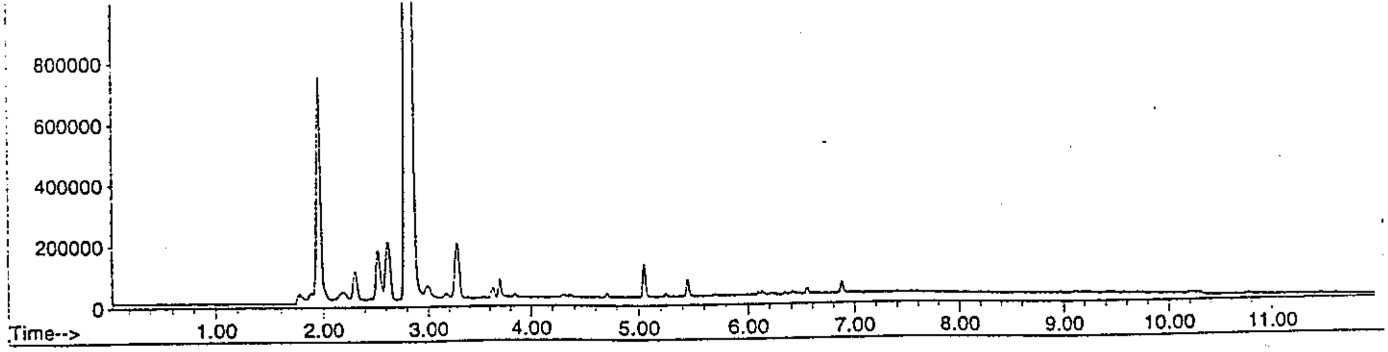

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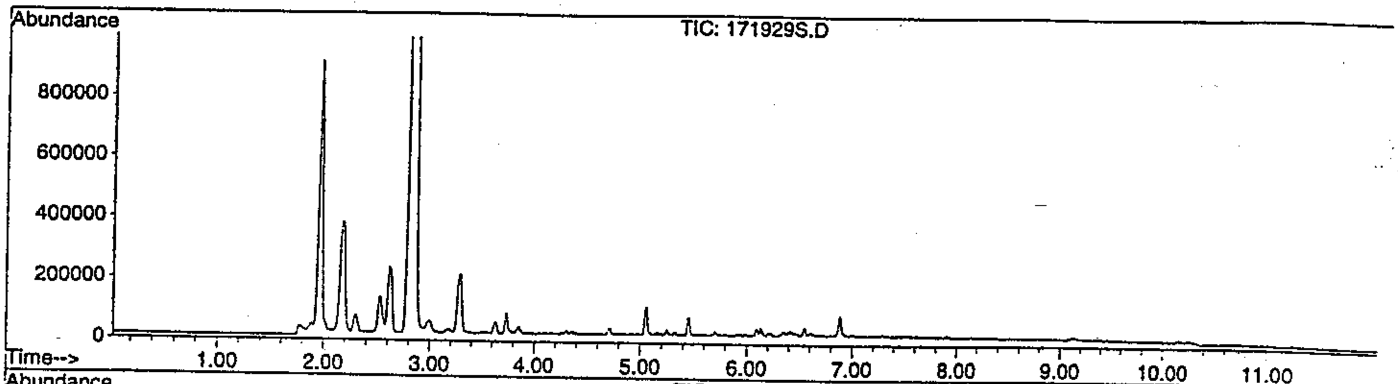

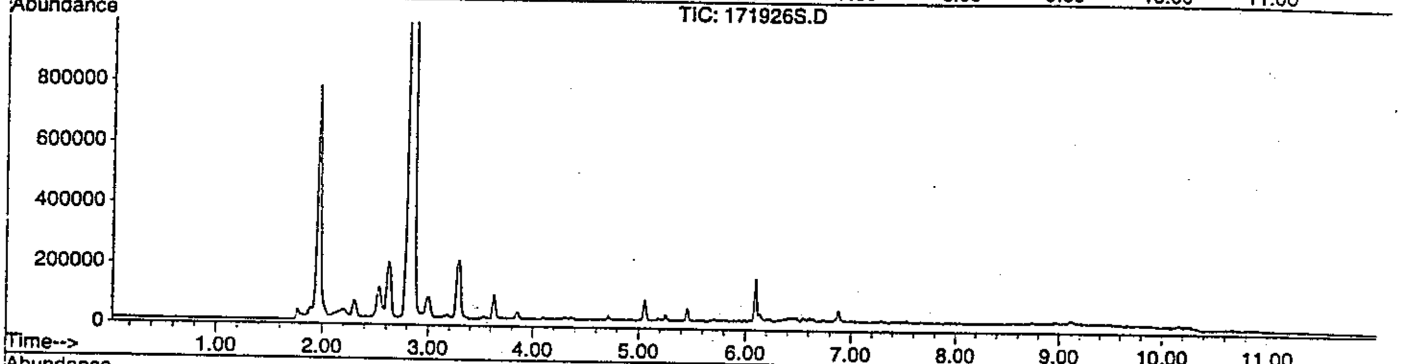

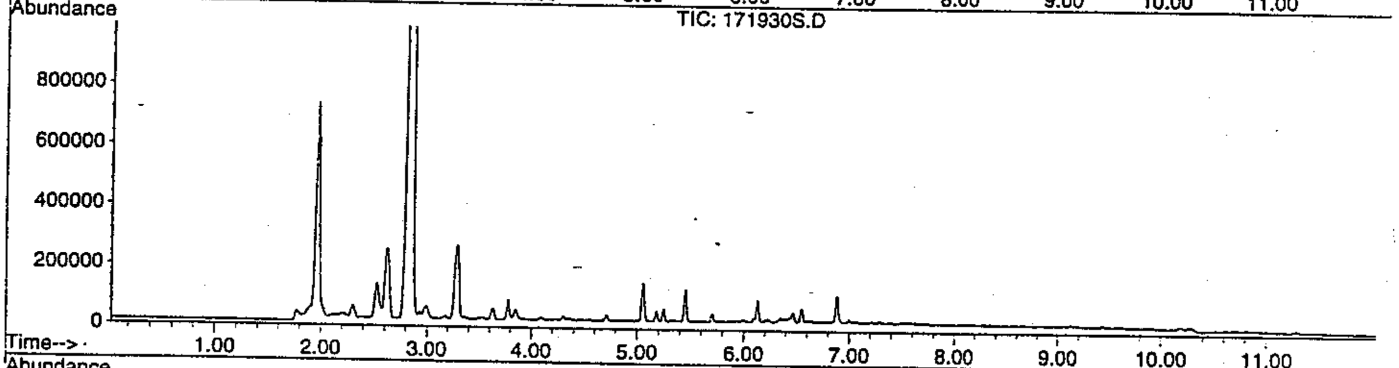

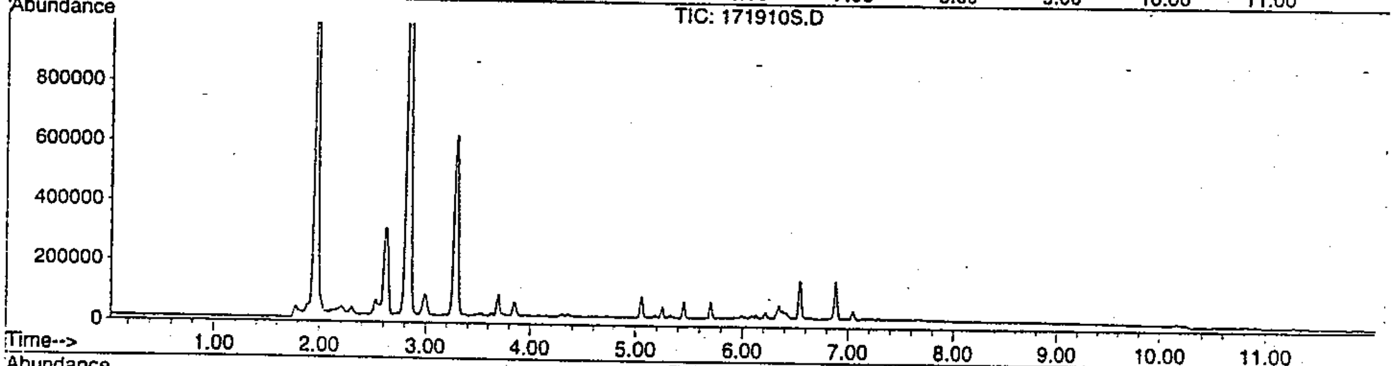

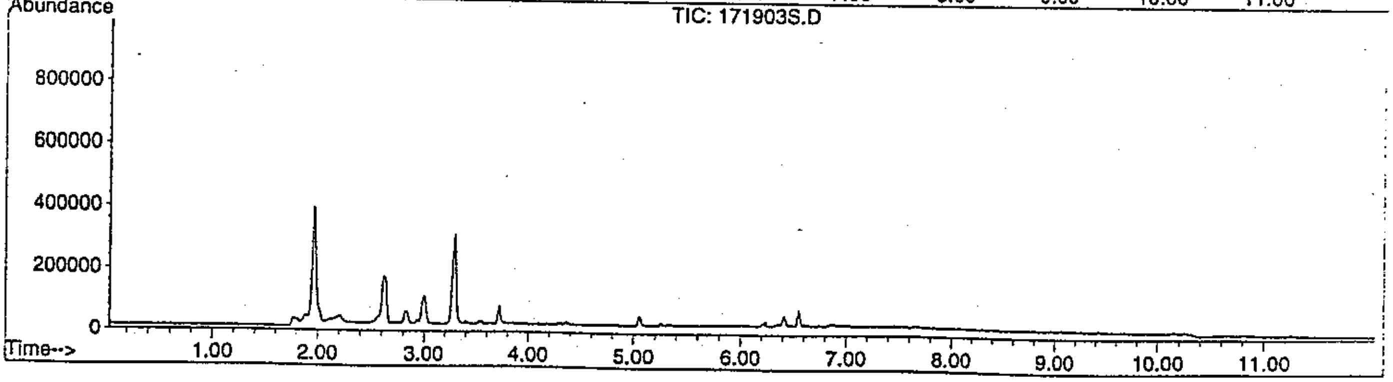

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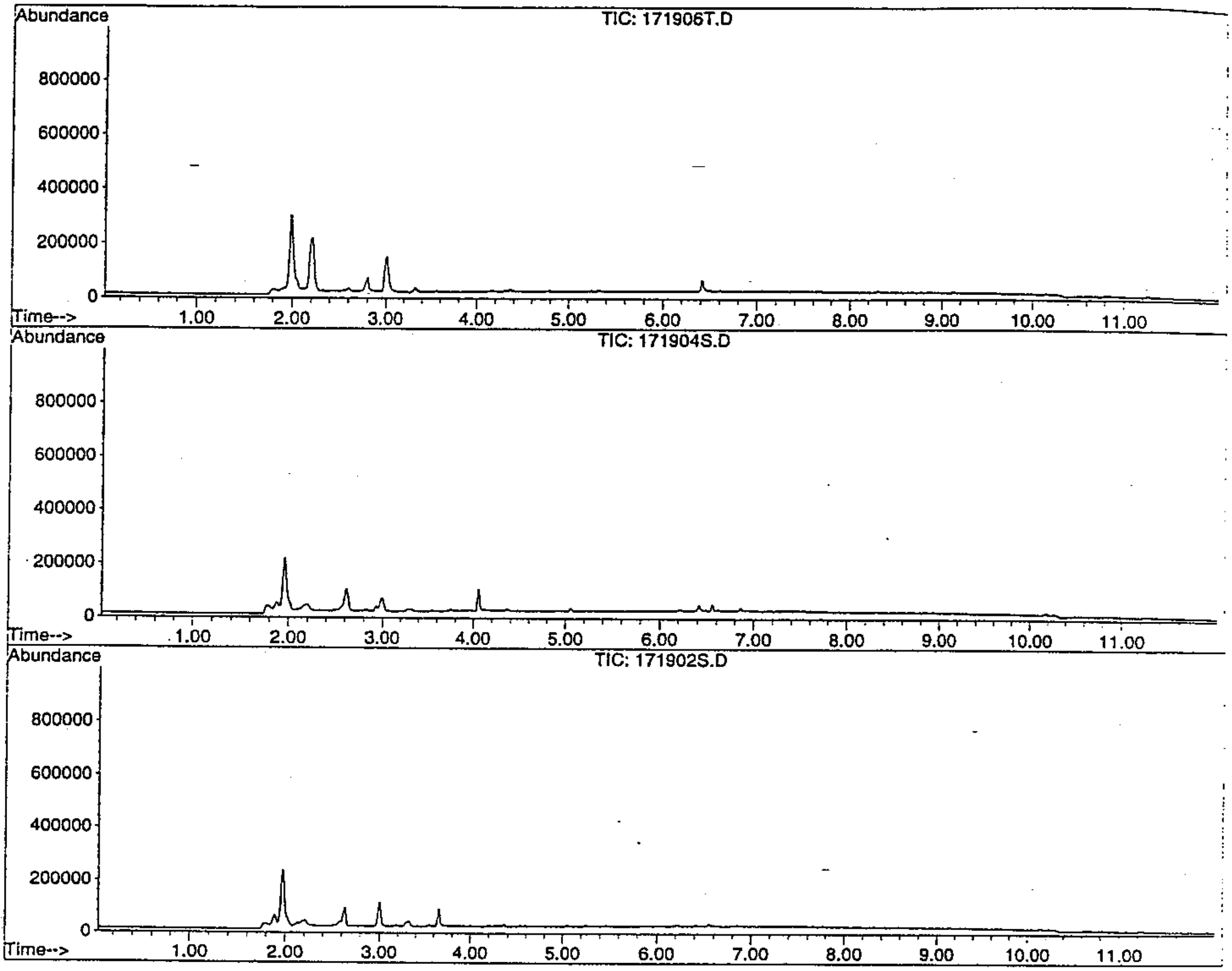

S. Myrtle Street
Embayment Study

Attachment C

Laboratory Results from Annual Seep Sampling

AGENCY REVIEW DRAFT

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-01
Client ID:	**S-1**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	1.0		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	4.1		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	41		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	4.0		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	7.3		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID: 11-048-01
Client ID: **S-1**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	119	71-133
Toluene-d8	122	80-151
4-Bromofluorobenzene	118	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-02
Client ID:	**S-2**

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	3.6		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	65		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	180		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	250		10
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-02
Client ID:	**S-2**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	118	71-133
Toluene-d8	122	80-151
4-Bromofluorobenzene	118	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-03
Client ID:	**S-3**

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-03
Client ID:	**S-3**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	106	71-133
Toluene-d8	117	80-151
4-Bromofluorobenzene	127	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-04
Client ID:	**S-4**

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-04
Client ID:	**S-4**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	106	71-133
Toluene-d8	121	80-151
4-Bromofluorobenzene	127	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B

page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-13-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-08
Client ID:	**S-5**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-08
Client ID:	**S-5**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		1.0
n-Propylbenzene	ND		5.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		1.0
1,2,4-Trichlorobenzene	ND		5.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		1.0
1,2,3-Trichlorobenzene	ND		5.0
	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	114	71-133
Toluene-d8	131	80-151
4-Bromofluorobenzene	121	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-06
Client ID:	**S-6**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	1.3		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-06
Client ID:	**S-6**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	103	71-133
Toluene-d8	120	80-151
4-Bromofluorobenzene	117	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-07
Client ID:	**S-7**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-07
Client ID:	**S-7**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	113	71-133
Toluene-d8	117	80-151
4-Bromofluorobenzene	121	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-12-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-05
Client ID:	**S-8**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	3.4		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	59		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	160		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	320		10
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID: 11-048-05
Client ID: **S-8**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	107	71-133
Toluene-d8	123	80-151
4-Bromofluorobenzene	120	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-13-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-09
Client ID:	**S-10**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-09
Client ID:	**S-10**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		1.0
o-Xylene	ND		2.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		1.0
n-Propylbenzene	ND		5.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		1.0
1,2,4-Trichlorobenzene	ND		5.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		1.0
1,2,3-Trichlorobenzene	ND		5.0
	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	115	71-133
Toluene-d8	125	80-151
4-Bromofluorobenzene	118	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-13-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-10
Client ID:	**S-11**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-10
Client ID:	**S-11**

Compound	Results	Flags	PQL
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		1.0
o-Xylene	ND		2.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		1.0
n-Propylbenzene	ND		5.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		1.0
1,2,4-Trichlorobenzene	ND		5.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		1.0
1,2,3-Trichlorobenzene	ND		5.0
	ND		1.0

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	104	71-133
Toluene-d8	117	80-151
4-Bromofluorobenzene	112	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-13-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-11
Client ID:	**S-12**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	ND		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	ND		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	ND		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	ND		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	ND		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-11
Client ID:	**S-12**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	105	71-133
Toluene-d8	122	80-151
4-Bromofluorobenzene	124	75-139

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	11-12-98
Date Analyzed:	11-13-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	11-048-12
Client ID:	**S-13**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	760		100
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	18		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	46		1.0
1,1-Dichloroethane	53		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	3300		100
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	28		1.0
1,2-Dichloroethane	8.5		1.0
Trichloroethene	6.2		1.0
1,2-Dichloropropane	2.7		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	3.8		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: November 18, 1998
Samples Submitted: November 9, 1998
Lab Traveler: 11-048
Project: 320039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	11-048-12
Client ID:	**S-13**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	4.1		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	1.4		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	ND		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	1.3		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	120	71-133
Toluene-d8	118	80-151
4-Bromofluorobenzene	119	75-139

Sound Analytical Services, Inc.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 Pacific Hwy East • Tacoma, WA 98424
(253) 922-2310 • FAX (253) 922-5047
e-mail: SoundL@aol.com

TRANSMITTAL MEMORANDUM

DATE: November 16, 1998

TO: David Baumeister
OnSite Environmental, Inc.
14924 N.E. 31st Circle
Redmond, WA 98052

PROJECT: 320039 GWCC

REPORT NUMBER: 76959

Enclosed are the test results for eleven samples received at Sound Analytical Services on November 10, 1998.

The report consists of this transmittal memo, analytical results, quality control reports, a copy of the chain-of-custody, a list of data qualifiers and analytical narrative when applicable, and a copy of any requested raw data.

Should there be any questions regarding this report, please contact me at (253) 922-2310.

Sincerely,

Stan Palmquist
Project Manager

SOUND ANALYTICAL SERVICES, INC.

ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (253)922-2310 - FAX (253)922-5047

Report To: OnSite Environmental, Inc. Date: November 16, 1998

Report On: Analysis of Liquid Report No.: 76959

IDENTIFICATION:
Samples received on 11-10-98
Project: 320039 GWCC

ANALYSIS:

Salinity per SM 2520B
Date Analyzed: 11-13-98
Units: S/cm

Lab Sample No. 76959-1 Client ID: S-1

Parameter	Result	PQL
Salinity	22	0.1

Lab Sample No. 76959-2 Client ID: S-2

Parameter	Result	PQL
Salinity	19	0.1

Lab Sample No. 76959-3 Client ID: S-3

Parameter	Result	PQL
Salinity	18	0.1

ND - Not Detected
PQL - Practical Quantitation Limit

OnSite Environmental, Inc.
Project: 320039 GWCC
Report No. 76959
November 16, 1998

Salinity per SM 2520B
Date Analyzed: 11-13-98
Units: S/cm

Lab Sample No. 76959-4 Client ID: S-4

Parameter	Result	PQL
Salinity	16	0.1

Lab Sample No. 76959-5 Client ID: S-5

Parameter	Result	PQL
Salinity	19	0.1

Lab Sample No. 76959-6 Client ID: S-6

Parameter	Result	PQL
Salinity	19	0.1

Lab Sample No. 76959-7 Client ID: S-7

Parameter	Result	PQL
Salinity	5	0.1

ND - Not Detected
PQL - Practical Quantitation Limit

SOUND ANALYTICAL SERVICES, INC.

OnSite Environmental, Inc.
Project: 320039 GWCC
Report No. 76959
November 16, 1998

Salinity per SM 2520B
Date Analyzed: 11-13-98
Units: S/cm

Lab Sample No. 76959-8 Client ID: S-8

Parameter	Result	PQL
Salinity	15	0.1

Lab Sample No. 76959-9 Client ID: S-10

Parameter	Result	PQL
Salinity	4.8	0.1

Lab Sample No. 76959-10 Client ID: S-11

Parameter	Result	PQL
Salinity	25	0.1

Lab Sample No. 76959-11 Client ID: S-12

Parameter	Result	PQL
Salinity	19	0.1

ND - Not Detected
PQL - Practical Quantitation Limit

QUALITY CONTROL REPORT

General Chemistry

Client: OnSite Environmental, Inc.
Lab No: 76959q1
Units: S/cm

QC Batch No. 30
Sample No. 76959-1
Date Analyzed: 11-13-98

METHOD BLANK

Parameter	Result	PQL
Salinity	ND	0.1

ND = Not Detected
PQL = Practical Quantitation Limit

DUPLICATE

Parameter	Sample Result	Duplicate Result	RPD	Flag
Salinity	22.1	22.0	0.5	

RPD = Relative Percent Difference

7/2

76959

OnSite Environmental Inc.

14924 NE 31st CIRCLE, REDMOND, WA 98052
PHONE (206) 883-3881 FAX (206) 885-4603

CHAIN OF CUSTODY RECORD

OSE TRAVELER #: 11-048

Project Manager: DAVID Baumeister

Project #: 320039

Project Name: GWCC

dash	Sample Number	Date Sampled	Type	# Jars	Analysis Required	Comments
1	S-1	11-6-98	W	1	Salinity	
2	S-2					
3	S-3					
4	S-4					
5	S-5					
6	S-6					
7	S-7					
8	S-8					
9	S-10					
10	S-11					
11	S-12	11-6-98	W	1	SAlinity	

Submitted:		date: 11/10/98	Received by: Joe Palm[illegible]	date:	11/10/98
Firm: OnSite Environ		time: 11:5 AM	Firm: SAS	time:	11:50 AM
Submitted: Joe Palm[illegible]		date: 11/10/98	Received by: S Giang	date:	11-10-98
Firm: SAS		time: 1:16 PM	Firm: SAS	time:	1:35pm

Chain of Custody

Page 1 of 2

OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Company: TERRA VAC
Project No.: 320039
Project Name: GWCC
Project Manager: P. CATTERALL

Turn Around Requested (Check One)
☐ Same Day
☐ 24 Hours
☐ 48 Hours
☒ Standard
☐ ________ (other)

Project Chemist: DB
Laboratory No. 11-048

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH	SALINITY							% Moisture
1	S-1	11/6/98							X									X							
2	S-2								X									X							
3	S-3								X									X							
4	S-4								X									X							
5	S-5								X									X							
6	S-6								X									X							
7	S-7								X									X							
8	S-8								X									X							
9	-S-10								X									X							
10	S-11								X									X							
11	S-12								X									X							
12	S-13								X																

RELINQUISHED BY Peter Catterall	DATE 11/9/98	RECEIVED BY	DATE 11/9/98
FIRM TERRA VAC	TIME 855	FIRM OSE	TIME 8:55 AM
RELINQUISHED BY	DATE	RECEIVED BY	DATE
FIRM	TIME	FIRM	TIME
REVIEWED BY		DATE REVIEWED	

COMMENTS:

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OnSite Environmental Inc.
14924 NE 31st Circle • Redmond, WA 98052
Fax: (425) 885-4603 • Phone: (425) 883-3881

Chain of Custody

Page 2 of 2

Company: TERRA VAC
Project No.: 320039
Project Name: GWCC
Project Manager: P. CATTERALL

Turn Around Requested
(Check One)
☐ Same Day
☐ 24 Hours
☐ 48 Hours
☒ Standard
☐ ________ (other)

Project Chemist: DB
Laboratory No. 11-048

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8240/624/8260	Halogenated Volatiles by 8260	Semivolatiles by 8270/625	PAHs by 8270/625	PCB's by 8081/608	Total RCRA Metals (8)	TCLP Metals	VPH	EPH								% Moisture
13	B-52								X		X														
14	B-46								X		X														
15	B-46 BAL								X		~~X~~														
16	B-18								X		X														
17	B-101								X		X														

RELINQUISHED BY PETER CATTERALL	DATE 11/9/88	RECEIVED BY	DATE 11/9/98
FIRM TERRA VAC	TIME 855	FIRM OSE	TIME 855
RELINQUISHED BY	DATE	RECEIVED BY	DATE
FIRM	TIME	FIRM	TIME
REVIEWED BY		DATE REVIEWED	

COMMENTS:
no 1Pr analysis removed per Peter Catterall
AW

DISTRIBUTION LEGEND: White - OnSite Copy Yellow - Report Copy Pink - Client Copy

S. Myrtle Street
Embayment Study

Attachment D

Laboratory Results from Second Seep Sampling

AGENCY REVIEW DRAFT

Date of Report: December 11, 1998
Samples Submitted: December 7, 1998
Lab Traveler: 12-063
Project: 32-0039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	12-8-98
Date Analyzed:	12-8-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	12-063-01
Client ID:	**S-1**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		1.0
Chloromethane	ND		1.0
Vinyl Chloride	1.5		1.0
Bromomethane	ND		1.0
Chloroethane	ND		1.0
Trichlorofluoromethane	ND		1.0
1,1-Dichloroethene	ND		1.0
Methylene Chloride	ND		5.0
(trans) 1,2-Dichloroethene	ND		1.0
1,1-Dichloroethane	2.3		1.0
2,2-Dichloropropane	ND		1.0
(cis) 1,2-Dichloroethene	29		1.0
Chloroform	ND		1.0
1,1,1-Trichloroethane	ND		1.0
Carbon Tetrachloride	ND		5.0
1,1-Dichloropropene	ND		1.0
Benzene	ND		1.0
1,2-Dichloroethane	ND		1.0
Trichloroethene	3.4		1.0
1,2-Dichloropropane	ND		1.0
Dibromomethane	ND		1.0
Bromodichloromethane	ND		1.0
(cis) 1,3-Dichloropropene	ND		1.0
Toluene	ND		1.0
(trans) 1,3-Dichloropropene	ND		1.0
1,1,2-Trichloroethane	ND		1.0
Tetrachloroethene	7.5		1.0
1,3-Dichloropropane	ND		1.0

Date of Report: December 11, 1998
Samples Submitted: December 7, 1998
Lab Traveler: 12-063
Project: 32-0039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	12-063-01
Client ID:	**S-1**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		1.0
1,2-Dibromoethane	ND		1.0
Chlorobenzene	ND		1.0
1,1,1,2-Tetrachloroethane	ND		1.0
Ethylbenzene	ND		1.0
m,p-Xylene	ND		2.0
o-Xylene	ND		1.0
Styrene	ND		1.0
Bromoform	ND		1.0
Isopropylbenzene	ND		1.0
Bromobenzene	ND		1.0
1,1,2,2-Tetrachloroethane	ND		1.0
1,2,3-Trichloropropane	ND		5.0
n-Propylbenzene	ND		1.0
2-Chlorotoluene	ND		1.0
4-Chlorotoluene	ND		1.0
1,3,5-Trimethylbenzene	ND		1.0
tert-Butylbenzene	ND		1.0
1,2,4-Trimethylbenzene	4.1		1.0
sec-Butylbenzene	ND		1.0
1,3-Dichlorobenzene	ND		1.0
p-Isopropyltoluene	ND		1.0
1,4-Dichlorobenzene	ND		1.0
1,2-Dichlorobenzene	ND		1.0
n-Butylbenzene	ND		1.0
1,2-Dibromo-3-chloropropane	ND		5.0
1,2,4-Trichlorobenzene	ND		1.0
Hexachlorobutadiene	ND		1.0
Naphthalene	ND		5.0
1,2,3-Trichlorobenzene	ND		1.0

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	107	71-133
Toluene-d8	113	80-151
4-Bromofluorobenzene	104	75-139

Date of Report: December 11, 1998
Samples Submitted: December 7, 1998
Lab Traveler: 12-063
Project: 32-0039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	12-8-98
Date Analyzed:	12-9-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	12-063-02
Client ID:	**S-2**

Compound	Results	Flags	PQL
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	ND		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	ND		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	12		10
1,1-Dichloroethane	ND		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	190		10
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	ND		10
1,2-Dichloroethane	ND		10
Trichloroethene	440		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	520		10
1,3-Dichloropropane	ND		10

Date of Report: December 11, 1998
Samples Submitted: December 7, 1998
Lab Traveler: 12-063
Project: 32-0039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	12-063-02
Client ID:	**S-2**

Compound	Results	Flags	PQL
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	Percent Recovery	Control Limits
Dibromofluoromethane	99	71-133
Toluene-d8	111	80-151
4-Bromofluorobenzene	86	75-139

Date of Report: December 11, 1998
Samples Submitted: December 7, 1998
Lab Traveler: 12-063
Project: 32-0039

VOLATILES by EPA 8260B
page 1 of 2

Date Extracted:	12-8-98
Date Analyzed:	12-9-98
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	12-063-03
Client ID:	**S-13**

Compound	**Results**	**Flags**	**PQL**
Dichlorodifluoromethane	ND		10
Chloromethane	ND		10
Vinyl Chloride	1600		10
Bromomethane	ND		10
Chloroethane	ND		10
Trichlorofluoromethane	ND		10
1,1-Dichloroethene	27		10
Methylene Chloride	ND		50
(trans) 1,2-Dichloroethene	72		10
1,1-Dichloroethane	62		10
2,2-Dichloropropane	ND		10
(cis) 1,2-Dichloroethene	5400		100
Chloroform	ND		10
1,1,1-Trichloroethane	ND		10
Carbon Tetrachloride	ND		50
1,1-Dichloropropene	ND		10
Benzene	36		10
1,2-Dichloroethane	ND		10
Trichloroethene	11		10
1,2-Dichloropropane	ND		10
Dibromomethane	ND		10
Bromodichloromethane	ND		10
(cis) 1,3-Dichloropropene	ND		10
Toluene	ND		10
(trans) 1,3-Dichloropropene	ND		10
1,1,2-Trichloroethane	ND		10
Tetrachloroethene	ND		10
1,3-Dichloropropane	ND		10

Date of Report: December 11, 1998
Samples Submitted: December 7, 1998
Lab Traveler: 12-063
Project: 32-0039

VOLATILES by EPA 8260B
page 2 of 2

Lab ID:	12-063-03
Client ID:	**S-13**

Compound	**Results**	**Flags**	**PQL**
Dibromochloromethane	ND		10
1,2-Dibromoethane	ND		10
Chlorobenzene	ND		10
1,1,1,2-Tetrachloroethane	ND		10
Ethylbenzene	ND		10
m,p-Xylene	ND		20
o-Xylene	ND		10
Styrene	ND		10
Bromoform	ND		10
Isopropylbenzene	ND		10
Bromobenzene	ND		10
1,1,2,2-Tetrachloroethane	ND		10
1,2,3-Trichloropropane	ND		50
n-Propylbenzene	ND		10
2-Chlorotoluene	ND		10
4-Chlorotoluene	ND		10
1,3,5-Trimethylbenzene	ND		10
tert-Butylbenzene	ND		10
1,2,4-Trimethylbenzene	ND		10
sec-Butylbenzene	ND		10
1,3-Dichlorobenzene	ND		10
p-Isopropyltoluene	ND		10
1,4-Dichlorobenzene	ND		10
1,2-Dichlorobenzene	ND		10
n-Butylbenzene	ND		10
1,2-Dibromo-3-chloropropane	ND		50
1,2,4-Trichlorobenzene	ND		10
Hexachlorobutadiene	ND		10
Naphthalene	ND		50
1,2,3-Trichlorobenzene	ND		10

Surrogate	**Percent Recovery**	**Control Limits**
Dibromofluoromethane	106	71-133
Toluene-d8	113	80-151
4-Bromofluorobenzene	86	75-139

Sound Analytical Services, Inc.
ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 Pacific Hwy East • Tacoma, WA 98424
(253) 922-2310 • FAX (253) 922-5047
e-mail: SoundL@aol.com

TRANSMITTAL MEMORANDUM

DATE: December 11, 1998

TO: David Baumeister
OnSite Environmental, Inc.
14924 N.E. 31st Circle
Redmond, WA 98052

PROJECT: 32-0039 GWCC

REPORT NUMBER: 77601

Enclosed are the test results for five samples received at Sound Analytical Services on December 8, 1998.

The report consists of this transmittal memo, analytical results, quality control reports, a copy of the chain-of-custody, a list of data qualifiers and analytical narrative when applicable, and a copy of any requested raw data.

Should there be any questions regarding this report, please contact me at (253) 922-2310.

Sincerely,

Stan Palmquist
Project Manager

SOUND ANALYTICAL SERVICES, INC.

ANALYTICAL & ENVIRONMENTAL CHEMISTS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (253)922-2310 - FAX (253)922-5047

Report To: OnSite Environmental, Inc. Date: December 10, 1998

Report On: Analysis of Liquid Report No.: 77601

IDENTIFICATION:
Samples received on 12-08-98
Project: 32-0039 GWCC

ANALYSIS:

Lab Sample No. 77601-1 Client ID: S-1

Salinity per SM 2520B
Date Analyzed: 12-09-98
Units: s/cm

Parameter	Result	PQL
Salinity	7.2	0.1

Lab Sample No. 77601-2 Client ID: S-2

Salinity per SM 2520B
Date Analyzed: 12-09-98
Units: s/cm

Parameter	Result	PQL
Salinity	3.1	0.1

Lab Sample No. 77601-3 Client ID: S-13

Salinity per SM 2520B
Date Analyzed: 12-09-98
Units: s/cm

Parameter	Result	PQL
Salinity	6.1	0.1

ND - Not Detected
PQL - Practical Quantitation Limit

QUALITY CONTROL REPORT

General Chemistry

Client: OnSite Environmental, Inc.
Lab No: 77601q
Units: s/cm

QC Batch No. 31
Sample No. 77601-1
Date Analyzed: 12-09-98

METHOD BLANK

Parameter	Result	PQL
Salinity	ND	0.1

ND = Not Detected
PQL = Practical Quantitation Limit

DUPLICATE

Parameter	Sample Result	Duplicate Result	RPD	Flag
Salinity	7.2	7.2	0.0	

RPD = Relative Percent Difference
NC = Not Calculated

S. Myrtle Street Embayment Study

Attachment E

PARCC Analysis

AGENCY REVIEW DRAFT

South Myrtle Street Embayment Study
PARCC Analysis

W.L. Gore & Associates, Inc. of Elkon, Maryland and OnSite Analytical, Inc. of Redmond, Washington were the primary analytical subcontractors for the South Myrtle Street Embayment Study.

Groundwater samples analyzed for Volatile Organic Compounds by EPA Method 8260B, Salinity per SM 2520B and Pentachlorophenol by EPA 8270b. Soil gas vapors were collected using GORE-SORBER® screening modules. The modules were then analyzed by W.L. Gore & Associates, Inc using a modified EPA method 8260A/8270B.

INTERNAL DATA REVIEW

A Terra Vac chemist conducted the internal data review. All of the analytical chemistry data was validated by Saylor Data Solutions, a subcontractor to Floyd & Snider. The Saylor Data Solutions data validation report is included in the Northwest Corner PARCC Analysis, presented as Attachment E of Appendix A, Northwest Corner Investigation. Elements covered in the internal data review include precision, accuracy, representativeness, completeness and comparability (PARCC parameters). Analytical holding times, method blanks, laboratory control spikes and laboratory spike duplicates as well as matrix spike and matrix spike duplicates were reviewed. The following is a summary of the data along with any abnormalities and a conclusion as to the usability of the data.

PARCC PARAMETERS

Precision

GORE-SORBER®

The GORE-SORBERS® installed on 9/30/98 and retrieved on 10/2/98 had acceptable results for the matrix duplicate samples. Both samples had no detectable concentrations. Due to the nature of the media, it is not possible analyze matrix spikes and matrix spike duplicates (MS/MSD). No duplicate samples were collected during the 11/98 sampling. Laboratory control spikes and duplicates (LCS/LCD) were not requested and are not typically analyzed during this type of analysis.

Water Samples - VOC

Relative percent differences (RPD) in the laboratory control spike and laboratory control spike duplicates were within the laboratory control limits for all samples.

Water Samples - SVOC

Relative percent differences (RPD) in the laboratory control spike and laboratory control spike duplicates were within the laboratory control limits for all samples.

Water Samples – Salinity

Duplicate samples were within laboratory control limits. The method does not require MS/MSD or LCS/LCSD samples.

Accuracy

GORE-SORBER®

Several of the adsorbers contained trace amounts of water that interfered with the analyses. They include samples H7, B7, B7 dup, B8, H8, H9, E7, E8, and E8 dup. All of the samples had no detectable hits with the exception of E8, which had 1,1,-DCA below the detection limit. As water typically increases the concentrations of the analytes, the results can be accepted.

Water Samples - VOC

Several of the water samples were diluted due to high concentrations of target analytes resulting in higher practical quantitation limits (PQLs). All of the diluted samples were within acceptable PQLs based on the concentrations of the target analytes. Therefore, the raised PQLs are not considered an out-of-control condition.

Water Samples – SVOC

No samples were diluted. The PQLs were the lowest possible for the extraction method utilized.

Water Samples - Salinity

No samples were diluted. The PQLs were the lowest possible for the method utilized.

Representativeness

Representativeness is addressed in the workplan for the site and the design of the sampling location. Samples were collected in the designated sampling locations. Duplicate GORE-SORBER® samples were analyzed.

Completeness

Completeness is defined in the CERCLA program as the percentage of measurements made which are judged to be valid measurements (EPA, 1987). The potential data gaps were assessed as well as matching the chain of custodies to the samples received and analyzed by the laboratory. During this investigation, no samples were lost during shipment. All samples received by the laboratory were analyzed according to the corresponding chain of custody.

GORE-SORBER®

Data qualifier flags were necessary for water contamination. Several of the adsorbers contained trace amounts of water that interfered with the analyses. They include samples H7, B7, B7 dup, B8, H8, H9, E7, E8, and E8 dup. All of the samples had no detectable hits with the exception of E8, which had 1,1,-DCA below the detection limit. As water typically increases the concentrations of the analytes, the results can be accepted.

Water Samples - VOC

Trip blanks were not collected during the November or December seep water sampling. All the samples analyzed had high concentrations of volatiles. Therefore any slight VOC contamination from the transport of the samples would not have a significant effect on the final data and the sample results were accepted.

Water Samples – SVOC

No data qualifier flags were necessary.

Water Samples - Salinity

No data qualifier flags were necessary.

Comparability

Matrix duplicates were within acceptable limits. Laboratory spike and matrix spike duplicate samples were within laboratory control limits.

ADDITIONAL PARAMETERS

Hold Times

No samples, including all parameters tested, were analyzed out of hold time.

Blanks

Laboratory blank samples had no contamination. Several of the GORE-SORBER® trip blanks had contamination below the detection limits. As the samples either had no analytes detected or a high concentration of analytes, the trip blank contamination did not effect the results significantly.

CONCLUSION

The data is generally acceptable for precision, accuracy, representativeness and completeness with only a few exceptions as noted above. All samples were collected and analyzed according to the workplan. As there were no significant data flags, completeness is qualified at 99+ percent for the collected samples. Appropriate data flags have been applied by the laboratory in those instances where data are required to be qualified according to method protocols or laboratory implementing SOPs. No data had any out-of-control instances that rendered the data unusable. The data, unless otherwise noted, are judged to be valid and usable for their intended purpose.

Supplemental Remedial Investigation and Feasibility Study

Appendix G

Supplemental Investigation
Fox Avenue and South Myrtle Street

AGENCY REVIEW DRAFT

SUPPLEMENTAL INVESTIGATION
FOX AVENUE AND S. MYRTLE STREET

GW International

808 S.W. 15th Avenue
Portland, OR 97205

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

TERRA VAC

Floyd & Snider Inc.

Supplemental Investigation
Fox Avenue and S. Myrtle Street

PREPARED FOR:

GW International

PREPARED BY:

TERRA VAC
23106 100th Ave West
Edmonds, WA 98020-5018

and

FLOYD & SNIDER INC.
83 S. King Street Suite 614
Seattle, WA 98104

OCTOBER 24, 2000

AGENCY REVIEW DRAFT

Table of Contents

List of Tables

List of Figures

List of Attachments

1.0 Introduction

Great Western Chemical Company dba Great Western International (GWI) engaged Terra Vac to perform a supplemental site investigation of the area adjacent to its Seattle facility. Previous investigations conducted by Terra Vac and others at the Seattle facility had determined that volatile organic compound (VOC) contamination had impacted soil and groundwater both on and off-property. The primary purpose of the supplemental investigation was to further assess and document existing soil and groundwater quality downgradient of the site. Secondary goals of the investigation were: (1) to evaluate the extent and effect of a gap in the silt layer between the two water-bearing zones off-property and (2) to further document the effect which natural attenuation has in degrading VOC contamination in groundwater.

The following tasks were completed by Terra Vac as part of this supplemental investigation.

- Visual inspection of the site and surrounding area
- Completion of permitting required by City of Seattle
- Installation of eight permanent monitoring wells and six temporary monitoring wells along the Fox Avenue S. and S. Myrtle Street right-of-ways
- Collection of soil and groundwater samples to characterize lithology and delineate VOC contamination

These tasks were completed in the summer of 1999, starting July 6 and ending July 9. This report presents the findings and conclusions of the supplemental investigation. Section 2 provides the context of the investigation by explaining the regulatory and investigative background of the site, and the geologic and hydrogeologic setting. Section 3 describes the specific activities undertaken during the supplemental investigation. Section 4 sets forth the analytical results of the investigation. Section 5 states the conclusions that can be drawn from the analytical results.

2.0 Background Information

The following sections provide a description of the site, a short history of previous activities, and a description of the geologic and hydrogeologic conditions.

2.1 SITE DESCRIPTION

The GWI Seattle Facility is located in King County at 6900 Fox Avenue S. in Seattle, Washington. GWI has used the facility for commercial storage, repackaging, and distribution of petroleum and other chemical products since the late 1950s. The facility occupies approximately two and a half acres within a primarily industrial area, adjacent to the Duwamish River. A site location map is provided as Figure 1.

2.2 SITE HISTORY

In conjunction with renovations of the site, GWI completed an exploratory soil boring in May 1989. The boring was located to the west of the central underground storage tank (UST) area (Figure 1). Laboratory analyses of the collected soil samples indicated the presence of benzene, toluene, tetrachloroethene (PCE), and trichloroethene (TCE). Additional investigations, conducted in the area of the Fox Avenue loading docks in May 1990, revealed the presence of VOC contaminated soil. GWI reported this finding to Ecology in June 1990.

GWI initiated removal of the USTs in the central part of the site in August 1990. Removal operations were completed in October 1990, when the area was backfilled with clean fill material. A detailed description of UST removal activities is contained in Underground Storage Tank Removal and Initial Site Assessment, prepared for Great Western Chemical Company (Hart Crowser, 1990a and 1990b). Initial assessment activities of on-site contamination included installation of nine monitoring wells and completion of ten soil borings.

GWI and the Washington Department of Ecology (Ecology) entered into an Agreed Order for further site investigation and characterization in September 1991. Activities included completion of additional soil borings and installation of monitoring wells along Frontenac Street and the interior portion of the site. The additional investigative work was completed to support an RI/FS work plan, which was accepted by Ecology in March 1992 (Hart Crowser, 1991). Investigation activities have continued to delineate the extent of subsurface contamination. An Ecology-approved program was implemented by Hart Crowser in 1992 for monitoring well and surface water (S. Myrtle Street Embayment) sampling, to support remedial actions and to prepare a risk assessment.

The first phase of assessment activities by Hart Crowser as part of this investigation involved a complete review of the existing Ecology database for the area downgradient of the initial on-site source area. The preliminary assessment activities focused on the property occupied by Seattle Boiler Works and included an off-site GeoProbe™ study and baseline environmental sampling conducted on the Seattle Boiler Works property. The results of this preliminary assessment were submitted to Ecology as Technical Memorandum No. 11, dated April 18, 1996, prepared by Hart Crowser. The results of the preliminary assessment indicated the possibility of off-site contamination and recommended additional characterization. GWI retained Terra Vac in 1997 to perform additional work at the site.

2.3 SITE GEOLOGY AND HYDROGEOLOGY

The site is located within the floodplain of the Duwamish River. Soils in the area are primarily alluvial sands and silts with discontinuous areas of recent fill. The fill soils generally appear to be of local origin, including sands and debris dredged during river channel improvements. Old river meander channels have been filled in areas north, south and west of the site, primarily between 1914 and 1918.

Previous investigations have identified two distinct water-bearing zones at the site. The first water-bearing zone occurs between depths of approximately 6.6 to 17.5 feet below ground surface (bgs), and is composed of a fine to medium, silty sand which overlays a low permeability, sandy silt layer. This low permeability silt horizon ranges between a few inches to 2.5 feet in thickness. The saturated portion of this first water-bearing zone is between one and three feet in thickness.

The second water-bearing zone is located beneath the separating silt horizon, and is composed of a slightly silty sand that extends to a depth of approximately 45 feet bgs before giving way to a second silt layer. Confined conditions occur for the groundwater within this second saturated zone beneath the site, but areas within 100 feet of the Duwamish River may experience unconfined conditions because of tidal fluctuations of the waterway.

Investigations conducted by Hart Crowser identified the presence of a gap in the silt horizon separating the two water-bearing zones. The two zones are connected immediately south of the source area, in the vicinity of well B-20. One of the goals of this supplemental investigation was to further define the location and magnitude of this connection between the two water-bearing zones.

3.0 Monitoring Well Installation and Sampling Activities

Six temporary and eight permanent monitoring wells were installed using a CME-55 drill rig, equipped with 6-inch, outside diameter hollow stem augers. Well installation was subcontracted by Terra Vac to Cascade Drilling, Inc. Terra Vac's on-site geologist was responsible for supervising all drilling activities, documenting subsurface lithology, and collecting both soil and groundwater samples for off-site laboratory analysis.

3.1 TEMPORARY MONITORING WELLS

A total of six temporary monitoring wells were installed during supplemental investigation activities. Three wells (TW-1, TW-2, and TW-3) were installed on July 6, 1999 within the S. Myrtle Street right-of-way, along the southeast corner of the Seattle Boiler Works property. The other three temporary wells (TW-5, TW-6, and TW-7) were installed within the Fox Avenue S. right-of-way on July 7 and July 8, 1999. Well TW-5 was located at the northeast corner of the Seattle Boiler Works property. Wells TW-6 and TW-7 were completed in front of the Bunge Foods facility, across the street from monitoring wells B-22 and B-23. Well locations are shown on Figure 2.

The depth of completion for each temporary monitoring well varied, depending on the point at which the separating silt horizon was encountered. Drilling at TW-1 was completed at 13 feet bgs. The total depth for the TW-2, TW-3, TW-6, and TW-7 borings was 13.5 feet bgs. The separating silt horizon was not observed at the TW-5 location, and drilling activities were completed at a depth of 16.5 feet bgs.

The temporary monitoring wells were constructed using 2-inch, Schedule 40 PVC well casing and a 5-foot section of 0.01-inch slotted well screen. The screen interval for wells TW-1, TW-6, and TW-7 was between 6 and 11 feet bgs. Wells TW-2, TW-3, and TW-5 were completed with a screen interval between 7 and 12 feet bgs. The lower portion of each bore hole was filled with bentonite chips to approximately 1 foot below the screen interval. The annular space was then filled with a 2/12 sand filter pack, extending to approximately 1 foot above the screen interval. The remaining portion of the bore hole was sealed, to ground surface, using bentonite chips. Construction data for the temporary monitoring wells is provided in Table 1. Well logs, detailing final construction and subsurface lithology, are provided in Attachment A.

Following completion of well development and groundwater sample collection, each temporary well casing was removed. The bore hole was then backfilled to within 1 foot of ground surface using bentonite chips and completed using concrete, leveled to grade. Drill cuttings, decontamination water, and monitoring well development water were placed in 55-gallon, DOT-approved drums and stored on site to await characterization and disposal.

3.2 PERMANENT MONITORING WELLS

A total of eight permanent monitoring wells were installed during supplemental investigation activities. Six wells (B-58 through B- 63) were installed within the Fox Avenue S. right-of-way, along the eastern boundary of the Seattle Boiler Works property. The other two wells (B-64 and B-65) were installed within the S. Myrtle Street right-of-way, west of TW-3 and adjacent to the South Shed, located on the Seattle Boiler Works property. Well locations are shown on Figure 2.

The depth of completion for each permanent monitoring well varied, depending on the point at which the separating silt horizon was encountered. Four well borings (B-58, B-60, B-62, and B-64) were installed in the first water-bearing zone at depths of 12 to 13 feet bgs. These wells are referred to as the "shallow wells." The remaining four borings (B-59, B-61, B-63, and B-65) were installed within the second water-bearing zone at depths of 30 to 44 feet bgs. These wells are referred to as the "deep wells".

The permanent monitoring wells were constructed using 2-inch, Schedule 40 PVC well casing and a 5-foot section of 0.01-inch slotted well screen. The screen interval for shallow wells B-58, B-60, and B-64 was between 7 and 12 feet bgs; for shallow well B-62 it was 8 to 13 feet bgs. Depths of completion for the deep monitoring wells depended on the location of the second silt horizon. Deep wells B-61 and B-63 were screened from 39 to 44 feet bgs; deep well B-65 was screened from 30 and 35 feet bgs; and deep well B-59 was screened from 25 to 30 feet bgs. Where the silt horizon was present, the deep wells were installed using a 10-inch diameter conductor casing placed into the first silt horizon to prevent possible contaminant migration from the first to the second water bearing zone. Wells B-59 and B-65 were installed using conductor casing.

The annular space of each bore hole was filled with a 2/12 sand filter pack, extending from approximately 1 foot below to 1 foot above the screen interval. The remaining portion was sealed, using bentonite chips. The wells were completed with flush-mounted well boxes and concrete caps. Drill cuttings, decontamination water, and monitoring well development water were placed in 55-gallon, DOT-approved drums and stored on site to await characterization and disposal. Construction data for the permanent monitoring wells is provided in Table 1. Well logs, detailing final construction and subsurface lithology, are provided in Attachment A.

3.3 DECOMMISSIONING OF MONITORING WELL B-20

Following initial review of the supplemental investigation data, it was determined that monitoring well B-20, installed in March, 1992, was screened over both the first and second water-bearing zones. The well had been installed to a depth of approximately 16 feet bgs and completed using a screen interval of ten feet, from 6 to 16 feet bgs. Consequently, this well could serve as a conduit for contamination to migrate from the upper water bearing zone to the lower water bearing zone.

On September 10, 1999, monitoring well B-20 was decommissioned. The 2-inch diameter, stainless steel well was removed by over-boring the well casing and filling the borehole with bentonite. Decommissioning was completed using a 2-foot cap of concrete to seal the bore hole. Monitoring well B-20A was then installed to replace well B-20. The new well was constructed of schedule 40 PVC and screened from 7.5 to 12.5 feet bgs. This construction provides sampling data that better represents conditions in the upper water-bearing zone. Well logs, detailing final construction and subsurface lithology, are provided in Attachment A.

3.4 SOIL SAMPLE COLLECTION

Terra Vac's on-site geologist supervised all drilling activities, collected all soil samples, and characterized subsurface lithologic during drilling. Samples were collected using 1-3/8-inch diameter by 18-inch split spoon samplers. Samplers were decontaminated between sampling intervals to minimize cross contamination.

Each sample was visually inspected and logged for soil type. Two or more soil samples were collected from each boring for off-site laboratory analyses. Sample locations were selected to represent VOC concentrations within saturated soils of both the first and second water-bearing zones. Additional samples were collected based on observations of the Terra Vac geologist.

Sample intervals selected for chemical analysis were sampled by completely filling laboratory-supplied, pre-cleaned glass jars with soil from the selected interval. The jars were then immediately sealed, labeled, and placed into a pre-cooled ice chest. Soil samples were delivered, under proper temperature and chain-of-custody control, to On-Site Environmental Inc. at the end of each day's drilling activities.

3.5 SUBSURFACE LITHOLOGY

The subsurface of the supplemental investigation area consists of a 1-foot interval of asphalt and gravel fill material that is underlain by a sandy silt, which gives way to a fine to medium grained sand with depth. The confining silt layer, identified during previous investigations, is not continuous within the investigation area, but when encountered, it consists of approximately one foot of sandy silt. Typically, this silt layer is located 12 feet bgs. Beneath the separating silt layer is a fine sand that extends to the second silt horizon, encountered between 30 and 45 feet bgs. Within the investigation area, depth to groundwater is approximately 9 feet.

Because the silt layer was not observed in borings B-60, B-61, B-62, or B-63, it appears that the "hole" in the first silt layer, previously identified by Hart Crowser in the vicinity of B-20, occurs southeast of B-58 and follows along Fox Avenue S. towards S. Myrtle Street. While definitely present in B-58, B-59, and TW-6, the interval was not very pronounced in boring TW-5. This may indicate that connection between the two distinct water-bearing zones extends further northwest, along Fox Avenue S. Detailed characterizations of the subsurface conditions encountered at each boring location are provided in the well logs attached as Attachment A.

3.6 GROUNDWATER SAMPLE COLLECTION

Each monitoring well was developed using a surge block followed by over-pumping until groundwater turbidity reached a stable number. The wells were then allowed to equilibrate to facilitate groundwater sample collection. Sampling was completed using a low-flow, peristaltic pump. New sample tubing was used for each monitoring well to minimize cross contamination.

Once collected, samples were immediately sealed, labeled, and placed into a pre-cooled ice chest. The samples were delivered, under proper temperature and chain-of-custody control, to On-Site Environmental, Inc. at the end of each day of sampling. Groundwater elevation, temperature, pH, and conductivity were also measured by Terra Vac's field geologist immediately prior to sample collection.

4.0 Analytical Results

The following sections present the results of chemical analysis of soil and groundwater samples.

4.1 LABORATORY METHODS

Soil and groundwater samples were delivered to On-Site Environmental, Inc. for laboratory analysis of VOC contamination using Environmental Protection Agency (EPA) Method 8260B. Table 2 lists the analytes and reporting limits. In addition, groundwater samples collected from permanent monitoring wells B-58, B-59, B-60, B-61, and B-63 were analyzed for semi-volatile organic compound (SVOC) contamination using EPA Method 8270C. Table 3 lists the analytes and reporting limits. The following sections describe the results of these analyses.

4.2 ANALYTICAL RESULTS - SOIL

Twenty-three soil samples were collected for laboratory analysis and tested for sixty-four volatile organics using EPA Method 8260B. The only chemicals detected were: vinyl chloride, cis-1,2-dichloroethene (cis 1,2-DCE), TCE, PCE, benzene, toluene and ethylbenzene.

- PCE was detected in twelve samples. TCE was detected in six samples.
- Concentrations of PCE ranged from less than the method detection limit (0.063 milligrams per kilogram [mg/kg]) to 8.40 mg/kg. The highest concentration was recorded for the TW-6 sample collected at approximately 12 feet bgs.
- Concentrations of TCE ranged from less than the method detection limit (0.063 mg/kg) to 0.79 mg/kg. The highest concentration was recorded for the TW-6 sample collected at approximately 12 feet bgs.
- Vinyl chloride and/or cis-1,2-DCE were detected in five of the samples. These compounds are products of incomplete anaerobic biodegradation of PCE and TCE. Each of the five soil samples with vinyl chloride and/or cis-1,2-DCE were collected from within the second water-bearing zone.
- Benzene, toluene and ethylbenzene were detected in samples collected from well TW-1 at an approximate depth of 11 feet bgs at concentrations of 0.14, 0.12 and 0.09 mg/kg respectively. None of the other soil samples collected during this investigation contained reportable levels of these three compounds.

Analytical results for the chemicals detected in soil samples from both the temporary and permanent monitoring wells are provided in Tables 4 and 5, respectively. Copies of the On-Site Environmental, Inc. reports, including chain-of-custody documents and QA/QC results, are contained in Attachment B.

4.3 ANALYTICAL RESULTS – GROUNDWATER

A total of fourteen groundwater samples were collected for laboratory analysis. These samples were tested for sixty-four VOCs using EPA Method 8260B. Samples from five of the eight permanent wells were also tested for SVOCs using EPA method 8270C. The VOCs that were detected include: vinyl chloride, cis 1,2-DCE, TCE, PCE, benzene, toluene, ethylbenzene, and xylene. The SVOCs that were detected include: phthalates; benzoic acid; the 1,2, 1,3, and 1,4 isomers of dichlorobenzene; naphthalene; 2-chloronaphthalene; n- nitroso-di-n-propylamine; and pentachlorophenol.

- PCE was detected in all fourteen samples. TCE was detected in every sample but those collected from TW-7.
- Concentrations of PCE ranged from less than the method detection limit (1 microgram per liter [µg/l]) to 18,000 µg/l. The highest concentration was recorded for the sample collected from B-58.
- Concentrations of TCE ranged from less than the method detection limit (1 µg/l) to 11,000 µg/l. The highest concentration was recorded for the sample collected from B-58.
- Vinyl chloride and/or cis-1,2-DCE were detected in five of the samples. These compounds are generated by the incomplete anaerobic biodegradation of both PCE and TCE. Each of the five samples was collected from within the second water-bearing zone.
- Benzene was detected in samples collected from the following wells: TW-2, B-61, B-63 and B-65. With the exception of the sample collected from well TW-2, benzene appears to be confined to the second water-bearing zone. In all cases, it was reported at concentrations indicating that it is present in its dissolved form only.
- Toluene was detected in the samples collected from the following wells: B-63 and B-65. Toluene appears to be confined to the second water-bearing zone. In all cases, toluene was reported at concentrations indicating that it is present in its dissolved form only.
- Ethylbenzene was detected in the samples collected from wells B-58, B-63 and B-65 at concentrations ranging from 11 to 84 µg/l.
- Xylene was detected in the samples collected from wells B-58 and B-63 at concentrations of 9 and 11 µg/l respectively.

Semi-volatile organics analysis was performed on samples from wells B-58, B-59, B-60, B-61 and B-63. Well B-58 contained phthalates, benzoic acid and the 1,2, 1,3, and 1,4 isomers of dichlorobenzene. Well B-59 contained phthalates only. Well B-60 contained 1,2-dichlorobenzene. Well B-61 contained 1,2-dichlorobenzene, naphthalene, 2-chloronaphthalene, n-nitroso-di-n-propylamine and phthalates. No SVOCs were detected in the sample collected from well B-63.

- Pentachlorophenol was detected in the sample collected from well B-58 at a concentration of 10 µg/l. Samples from wells B-58, B-59, B-60, B-61 and B-63 did not contain pentachlorophenol at concentrations above the method detection limit of 10 μg/l.

Analytical results for the groundwater samples collected from the temporary and permanent monitoring wells are provided in Tables 6 and 7, respectively. Copies of the On-Site Environmental, Inc. reports, including chain-of-custody documents and QA/QC results, are contained in Attachment B.

5.0 Conclusions

The following conclusions were made based on the data generated during this, and previous, site investigations and sampling events.

5.1 OFF-SITE CONTAMINATION

The VOC contaminant plume originating at the GWI site has migrated off site in a southwesterly direction towards the Duwamish River. The majority of VOC contamination has been identified within the soil in the area bounded to the east by the former UST area, to the south by B-11, and to the west by B-46 and B-52 (see Figure 2) of this area. Soil and groundwater samples collected from down-gradient well locations contained both TCE and PCE. Except at TW-6, soil and groundwater concentrations downgradient of the source area are consistent with the contamination existing in the dissolved phase only.

5.2 GAP IN THE FIRST SILT HORIZON

The silt horizon separating the two water-bearing zones was not observed in borings B-60, B-61, B-62, and B-63. This gap in the first silt horizon, previously identified by Hart Crowser in the vicinity of well B-20, was encountered southeast of B-58 and follows Fox Avenue S. towards S. Myrtle Street. While the first silt horizon is distinctly present in B-58, B-59, and TW-6, the silt horizon was only slightly present in boring TW-5. Migration of the contaminant plume towards the Duwamish River appears to occur within both the first and second water-bearing zones, downgradient of the interconnection between the upper and lower saturated zone at Fox Avenue S.

5.3 NATURAL ATTENUATION

Groundwater samples collected from monitoring wells B-61, B-63, and B-65 show increased percentages of the breakdown products cis-1,2-DCE and vinyl chloride, compared to the source area. The presence of these VOCs in higher concentrations than those observed in the source area, coupled with a decrease in the concentrations of PCE and TCE at these sampling locations, strongly suggests that the lower groundwater bearing zone is supporting natural anaerobic biodegradation of these compounds.

6.0 References

Hart Crowser. 1990a. *Underground Storage Tank Removal and Initial Site Assessment Volume I.* Prepared for Great Western Chemical Company. December 10.

Hart Crowser. 1990b. *Underground Storage Tank Removal and Initial Site Assessment Volume II.* Prepared for Great Western Chemical Company. November 7.

Hart Crowser. 1991. *RI/FS Work Plan.* Prepared for Great Western Chemical Company. December 1.

Hart Crowser. 1996. *Technical Memorandum No. 11.* Prepared for Great Western Chemical Company. April 18.

Supplemental Investigation
Fox Avenue and S. Myrtle Street

Tables

AGENCY REVIEW DRAFT

Table 1
Groundwater Monitoring Well Construction Data

Well Identification	Date Installed	Total Depth (Feet bgs)	Screen Interval Top (Feet bgs)	Screen Interval Bottom (Feet bgs)	Well Diameter (inches)
TW-1	7/6/99	13.0	6.0	11.0	2.0
TW-2	7/6/99	13.5	7.0	12.0	2.0
TW-3	7/6/99	13.5	7.0	12.0	2.0
TW-5	7/7/99	16.5	7.0	12.0	2.0
TW-6	7/8/99	13.5	6.0	11.0	2.0
TW-7	7/8/99	13.5	6.0	11.0	2.0
B-58	7/7/99	14.0	7.0	12.0	2.0
B-59	7/9/99	35.0	25.0	30.0	2.0
B-60	7/7/99	16.5	7.0	12.0	2.0
B-61	7/9/99	45.0	39.0	44.0	2.0
B-62	7/7/99	16.5	8.0	13.0	2.0
B-63	7/8/99	45.0	39.0	44.0	2.0
B-64	7/6/99	13.0	7.0	12.0	2.0
B-65	7/6/99	35.5	30.0	35.0	2.0

Note:
bgs Below ground surface.

Table 2

Subsurface Soil Analyte List and Reporting Limits

Analyte	Units	PQL
Volatile Organics		
Tetrachloroethene	mg/Kg (ppm)	0.050
Trichloroethene	mg/Kg (ppm)	0.050
1,1-Dichloroethene	mg/Kg (ppm)	0.050
Vinyl Chloride	mg/Kg (ppm)	0.050
1,1,1-Trichloroethane	mg/Kg (ppm)	0.250
1,1,2-Trichloroethane	mg/Kg (ppm)	0.050
1,1-Dichloroethane	mg/Kg (ppm)	0.050
1,2-Dichloroethane	mg/Kg (ppm)	0.050
Chloroethane	mg/Kg (ppm)	0.050
1,1,1,2-Tetrachloroethane	mg/Kg (ppm)	0.050
1,1,2,2-Tetrachloroethane	mg/Kg (ppm)	0.250
1,1-Dichloropropene	mg/Kg (ppm)	0.050
2,2-Dichloropropane	mg/Kg (ppm)	0.050
2-Chloroethyl vinyl ether	mg/Kg (ppm)	1.000
Carbon Tetrachloride	mg/Kg (ppm)	0.050
Chloroform	mg/Kg (ppm)	0.050
Chloromethane	mg/Kg (ppm)	0.050
Hexachlorobutadiene	mg/Kg (ppm)	0.500
Methylene Chloride	mg/Kg (ppm)	0.250
Benzene	mg/Kg (ppm)	0.050
Toluene	mg/Kg (ppm)	0.050
Ethylbenzene	mg/Kg (ppm)	0.050
o-Xylene	mg/Kg (ppm)	0.050
m,p-Xylene	mg/Kg (ppm)	0.100
Styrene	mg/Kg (ppm)	0.050
1,2,3-Trichlorobenzene	mg/Kg (ppm)	0.050
1,2,3-Trichloropropane	mg/Kg (ppm)	0.250
1,2,4-Trichlorobenzene	mg/Kg (ppm)	0.050
1,2,4-Trimethylbenzene	mg/Kg (ppm)	0.050
1,2-Dibromo-3-Chloropropane	mg/Kg (ppm)	0.500
1,2-Dibromoethane (EDB)	mg/Kg (ppm)	0.050
1,2-Dichlorobenzene	mg/Kg (ppm)	0.050
1,2-Dichloroethene(cis)	mg/Kg (ppm)	0.050
1,2-Dichloroethene(trans)	mg/Kg (ppm)	0.050
1,2-Dichloropropane	mg/Kg (ppm)	0.050
1,3,5-Trimethylbenzene	mg/Kg (ppm)	0.050
1,3-Dichlorobenzene	mg/Kg (ppm)	0.050
1,3-Dichloropropane	mg/Kg (ppm)	0.050
1,3-Dichloropropene(cis)	mg/Kg (ppm)	0.050
1,3-Dichloropropene(trans)	mg/Kg (ppm)	0.050
1,4-Dichlorobenzene	mg/Kg (ppm)	0.050
2-Butanone	mg/Kg (ppm)	5.000
Volatile Organics		
2-Chlorotoluene	mg/Kg (ppm)	0.050
4-Chlorotoluene	mg/Kg (ppm)	0.050
Acetone	mg/Kg (ppm)	2.500
Bromobenzene	mg/Kg (ppm)	0.050

Table 2

Subsurface Soil Analyte List and Reporting Limits

Analyte	Units	PQL
Bromodichloromethane	mg/Kg (ppm)	0.250
Bromoform	mg/Kg (ppm)	0.050
Bromomethane	mg/Kg (ppm)	0.050
Carbon Disulfide	mg/Kg (ppm)	0.050
Chlorobenzene	mg/Kg (ppm)	0.050
Dibromochloromethane	mg/Kg (ppm)	0.050
Dibromomethane	mg/Kg (ppm)	0.500
Dichlorodifluoromethane	mg/Kg (ppm)	0.050
Isopropylbenzene	mg/Kg (ppm)	0.050
Methyl Isobutyl Ketone	mg/Kg (ppm)	1.000
n-Butylbenzene	mg/Kg (ppm)	0.050
n-Propylbenzene	mg/Kg (ppm)	0.050
Naphthalene	mg/Kg (ppm)	0.500
p-Isopropyltoluene	mg/Kg (ppm)	0.050
sec-Butylbenzene	mg/Kg (ppm)	0.050
tert-Butylbenzene	mg/Kg (ppm)	0.050
Trichlorofluoromethane	mg/Kg (ppm)	0.050
Vinyl Acetate	mg/Kg (ppm)	1.000
Semi-Volatile Organics (Except PAH)		
Pentachlorophenol	mg/Kg (ppm)	0.42

Table 3
Groundwater Analyte List and Reporting Limits

Analyte	Units	PQL
Volatile Organics		
Tetrachloroethene	ug/L	1.0
Trichloroethene	ug/L	1.0
1,1-Dichloroethene	ug/L	1.0
Vinyl Chloride	ug/L	1.0
1,1,1-Trichloroethane	ug/L	5.0
1,1,2-Trichloroethane	ug/L	1.0
1,1-Dichloroethane	ug/L	1.0
1,2-Dichloroethane	ug/L	1.0
Chloroethane	ug/L	1.0
1,1,1,2-Tetrachloroethane	ug/L	1.0
1,1,2,2-Tetrachloroethane	ug/L	5.0
1,1-Dichloropropene	ug/L	1.0
2,2-Dichloropropane	ug/L	1.0
2-Chloroethyl vinyl ether	ug/L	20.0
Carbon Tetrachloride	ug/L	1.0
Chloroform	ug/L	1.0
Chloromethane	ug/L	1.0
Hexachlorobutadiene	ug/L	10.0
Methylene Chloride	ug/L	5.0
Benzene	ug/L	1.0
Toluene	ug/L	1.0
Ethylbenzene	ug/L	1.0
o-Xylene	ug/L	1.0
m,p-Xylene	ug/L	2.0
Styrene	ug/L	1.0
1,2,3-Trichlorobenzene	ug/L	1.0
1,2,3-Trichloropropane	ug/L	5.0
1,2,4-Trichlorobenzene	ug/L	1.0
1,2,4-Trimethylbenzene	ug/L	1.0
1,2-Dibromo-3-Chloropropane	ug/L	10.0
1,2-Dibromoethane (EDB)	ug/L	1.0
1,2-Dichlorobenzene	ug/L	1.0
1,2-Dichloroethene(cis)	ug/L	1.0
1,2-Dichloroethene(trans)	ug/L	1.0
1,2-Dichloropropane	ug/L	1.0
1,3,5-Trimethylbenzene	ug/L	1.0
1,3-Dichlorobenzene	ug/L	1.0
1,3-Dichloropropane	ug/L	1.0
1,3-Dichloropropene(cis)	ug/L	1.0
1,3-Dichloropropene(trans)	ug/L	1.0
1,4-Dichlorobenzene	ug/L	1.0
2-Butanone	ug/L	100.0
2-Chlorotoluene	ug/L	1.0

Table 3
Groundwater Analyte List and Reporting Limits

Analyte	Units	PQL
Volatile Organics		
4-Chlorotoluene	ug/L	1.0
Acetone	ug/L	50.0
Bromobenzene	ug/L	1.0
Bromodichloromethane	ug/L	1.0
Bromoform	ug/L	1.0
Bromomethane	ug/L	10.0
Carbon Disulfide	ug/L	1.0
Chlorobenzene	ug/L	1.0
Dibromochloromethane	ug/L	1.0
Dibromomethane	ug/L	10.0
Dichlorodifluoromethane	ug/L	1.0
Isopropylbenzene	ug/L	1.0
Methyl Isobutyl Ketone	ug/L	20.0
n-Butylbenzene	ug/L	1.0
n-Propylbenzene	ug/L	1.0
Naphthalene	ug/L	10.0
p-Isopropyltoluene	ug/L	1.0
sec-Butylbenzene	ug/L	1.0
tert-Butylbenzene	ug/L	1.0
Trichlorofluoromethane	ug/L	1.0
Vinyl Acetate	ug/L	20.0
Semi-Volatile Organics (Except PAH)		
Pentachlorophenol	ug/L	10.0
2,4,5-Trichlorophenol	ug/L	1.0
2,4,6-Trichlorophenol	ug/L	1.0
2,4-Dichlorophenol	ug/L	1.0
2-Chlorophenol	ug/L	1.0
4-Chloro-3-methylphenol	ug/L	1.0
1,2,4-Trichlorobenzene	ug/L	1.0
1,2-Dibromo-3-Chloropropane	ug/L	1.0
1,2-Dichlorobenzene	ug/L	1.0
1,3-Dichlorobenzene	ug/L	1.0
1,4-Dichlorobenzene	ug/L	1.0
2,4-Dimethylphenol	ug/L	1.0
2,4-Dinitrophenol	ug/L	10.0
2,4-Dinitrotoluene	ug/L	1.0
2,6-Dinitrotoluene	ug/L	1.0
2-Chloronaphthalene	ug/L	1.0
2-Methylnaphthalene	ug/L	1.0
2-Methylphenol	ug/L	1.0
2-Nitroaniline	ug/L	1.0
2-Nitrophenol	ug/L	10.0
3,3'-Dichlorobenzidine	ug/L	1.0
3-Nitroaniline	ug/L	1.0
4,6-Dinitro-2-methylphenol	ug/L	10.0
4-Chloroaniline	ug/L	1.0

Table 3
Groundwater Analyte List and Reporting Limits

Analyte	Units	PQL
4-Methylphenol	ug/L	1.0
4-Nitroaniline	ug/L	1.0
4-Nitrophenol	ug/L	10.0
Acenaphthene	ug/L	1.0
Acenaphthylene	ug/L	1.0
Aniline	ug/L	1.0
Anthracene	ug/L	1.0
Benzidine	ug/L	1.0
Benzo(a)Anthracene	ug/L	1.0
Benzo(a)Pyrene	ug/L	1.0
Benzo(b)Fluoranthene	ug/L	1.0
Benzo(g,h,i)Perylene	ug/L	1.0
Benzo(k)Fluoranthene	ug/L	1.0
Benzoic acid	ug/L	10.0
Benzyl alcohol	ug/L	1.0
Bis(2-chloroethoxy)methane	ug/L	1.0
Bis(2-chloroethyl)ether	ug/L	10.0
Bis(2-chloroisopropyl)ether	ug/L	1.0
bis(2-Ethylhexyl)phthalate	ug/L	1.0
Semi-Volatile Organics (Except PAH)		
Butylbenzylphthalate	ug/L	1.0
Chrysene	ug/L	1.0
Di-n-butylphthalate	ug/L	1.0
Di-n-octylphthalate	ug/L	10.0
Dibenzo(a,h)Anthracene	ug/L	1.0
Dibenzofuran	ug/L	1.0
Diethylphthalate	ug/L	1.0
Dimethylphthalate	ug/L	1.0
Fluoranthene	ug/L	1.0
Fluorene	ug/L	1.0
Hexachlorobenzene	ug/L	1.0
Hexachlorobutadiene	ug/L	1.0
Hexachlorocyclopentadiene	ug/L	1.0
Hexachloroethane	ug/L	1.0
Indeno(1,2,3-cd)Pyrene	ug/L	1.0
Isophorone	ug/L	1.0
N-Nitroso-di-n-propylamine	ug/L	1.0
N-Nitrosodiphenylamine	ug/L	10.0
Naphthalene	ug/L	1.0
Nitrobenzene	ug/L	1.0
Phenanthrene	ug/L	1.0
Phenol	ug/L	1.0
Pyrene	ug/L	1.0

Table 3
Groundwater Analyte List and Reporting Limits

Analyte	Units	PQL
Polycyclic Aromatic Hydrocarbons (PAH)		
Acenaphthene	ug/L	1.0
Acenaphthylene	ug/L	1.0
Anthracene	ug/L	1.0
Benzo(a)Anthracene	ug/L	1.0
Benzo(a)Pyrene	ug/L	1.0
Benzo(b)Fluoranthene	ug/L	1.0
Benzo(k)Fluoranthene	ug/L	1.0
Benzo(g,h,i)Perylene	ug/L	1.0
Chrysene	ug/L	1.0
Dibenzo(a,h)Anthracene	ug/L	1.0
Fluoranthene	ug/L	1.0
Fluorene	ug/L	1.0
Indeno(1,2,3-cd)Pyrene	ug/L	1.0
2-Methylnaphthalene	ug/L	1.0
Naphthalene	ug/L	1.0
Phenanthrene	ug/L	1.0

Table 4

Temporary Monitoring Well-Subsurface Soil Analytical Results

Well	Sample Depth (feet bgs)	Date Sampled	Parameters, mg/Kg							
			PCE	TCE	cis 1,2-DCE	VC	Benzene	Toluene	Ethylbenzene	Total Xylenes
TW-1	9.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
	11.0	7/8/99	ND	0.12	0.38	0.18	0.14	0.12	0.09	ND
TW-2	8.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
	13.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
TW-3	10.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
	13.0	7/8/99	1.30	0.69	0.45	ND	ND	ND	ND	ND
TW-5	10.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
	16.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
TW-6	9.0	7/8/99	0.81	ND	ND	ND	ND	ND	ND	ND
	12.0	7/8/99	8.40	0.79	ND	ND	ND	ND	ND	ND
TW-7	9.0	7/8/99	0.13	ND	ND	ND	ND	ND	ND	ND
	12.0	7/8/99	0.20	ND	ND	ND	ND	ND	ND	ND
Method Detection Limit			**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.10**

Notes:

Reporting Limits are the lowest analytical detection level (mg/Kg).

Total Xylenes are the total of meta, ortho and para Xylene.

cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
mg/Kg	Milligrams per kilogram.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.

Table 5

Permanent Monitoring Well-Subsurface Soil Analytical Results

Well	Sample Depth (feet bgs)	Date Sampled	Parameters, mg/Kg							
			PCE	TCE	cis 1,2-DCE	VC	Benzene	Toluene	Ethylbenzene	Total Xylenes
B-58	10.0	7/8/99	0.17	ND	ND	ND	ND	ND	ND	ND
	12.5	7/8/99	ND	ND	2.00	0.16	ND	ND	ND	ND
B-59	30.0	7/12/99	ND	ND	0.30	ND	ND	ND	ND	ND
B-60	10.0	7/8/99	0.19	ND	ND	ND	ND	ND	ND	ND
	16.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
B-61	13.5	7/12/99	0.07	ND	ND	ND	ND	ND	ND	ND
	24.5	7/12/99	0.13	ND	ND	ND	ND	ND	ND	ND
	43.5	7/12/99	0.07	0.26	0.09	ND	ND	ND	ND	ND
B-62	9.0	7/8/99	ND	ND	ND	ND	ND	ND	ND	ND
	16.0	7/8/99	0.08	ND	ND	ND	ND	ND	ND	ND
B-64	10.0	7/8/99	0.59	0.14	ND	ND	ND	ND	ND	ND
	12.5	7/8/99	0.54	ND	ND	ND	ND	ND	ND	ND
B-20A	12.5	9/10/99	0.38	ND	ND	ND	ND	ND	ND	ND
Method Detection Limit			**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.10**

Notes:

Reporting Limits are the lowest analytical detection level (mg/Kg).

Total Xylenes are the total of meta, ortho and para Xylene.

cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
mg/Kg	Milligrams per kilogram.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.

Table 6

Temporary Groundwater Monitoring Well Analytical Results

Well	Sampling Date	Parameters, ug/L								
		PCE	TCE	1,1,1-TCA	cis 1,2-DCE	VC	Benzene	Toluene	Ethylbenzene	Total Xylenes
TW-1	7/8/99	430	93	ND	95	31	ND	ND	ND	ND
TW-2	7/8/99	500	230	16	640	200	3	1	NA	ND
TW-3	7/8/99	130	140	9	780	12	ND	ND	ND	ND
TW-5	7/9/99	3900	790	ND	550	18	ND	ND	ND	ND
TW-6	7/9/99	3300	150	ND	86	3	ND	ND	ND	ND
TW-7	7/9/99	3	ND	ND	ND	ND	ND	ND	ND	ND
Method Detection Limit		**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**2.0**
MTCA Method A Cleanup Level		**5.0**	**5.0**	**200.0**	**NA**	**0.2**	**5.0**	**40.0**	**30.0**	**20.0**

Notes:

MTCA Washington State Model Toxics Control Act Method A cleanup criteria for industrial soil (mg/Kg).

Reporting Limits are the lowest analytical detection level (mg/Kg).

Total Xylenes are the total of meta, ortho and para Xylene.

1,1,1-TCA	1,1,1 - Trichloroethane
cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.
ug/L	Micrograms per liter.

Table 7
Permanent Groundwater Monitoring Well Analytical Results

Well	Sampling Date	Parameters, ug/L									
		PCE	TCE	1,1,1-TCA	cis 1,2-DCE	VC	Benzene	Toluene	Ethylbenzene	Total Xylenes	Pentachlorophenol
B-58	7/16/99	18,000	11,000	ND	21,000	220	ND	ND	11	9	12
B-59	7/16/99	39	8	ND	350	77	ND	ND	ND	ND	ND
B-60	7/16/99	5600	300	ND	220	ND	ND	ND	ND	ND	ND
B-61	7/16/99	78	3,700	ND	27,000	970	6	ND	ND	ND	ND
B-62	7/9/99	470	180	30	57	35	ND	ND	ND	ND	NS
B-63	7/16/99	40	920	ND	3,700	2,500	8	250	30	11	ND
B-64	7/16/99	61	14	ND	ND	ND	ND	ND	ND	ND	NS
B-65	7/16/99	15	57	ND	47,000	11,000	9	98	84	ND	NS
Method Detection Limit		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	10.0
MTCA Method A Cleanup Level		5.0	5.0	200.0	NA	0.2	5.0	40.0	30.0	20.0	NA

Notes:

MTCA	Washington State Model Toxics Control Act Method A cleanup criteria for industrial soil (mg/Kg).
Reporting Limits	Lowest analytical detection level (mg/Kg).
Total Xylenes	Total of meta, ortho and para Xylene.
1,1,1-TCA	1,1,1 - Trichloroethane
cis 1,2-DCE	Dichloroethylene (cis isomer)
PCE	Tetrachloroethylene (Perchloroethylene)
TCE	Trichloroethylene
VC	Vinyl Chloride
bgs	Below ground surface.
ND	Not present or detected at a concentration above the reporting limit.
NA	Not available.
ug/L	Micrograms per liter.

Supplemental Investigation
Fox Avenue and S. Myrtle Street

Figures

AGENCY REVIEW DRAFT