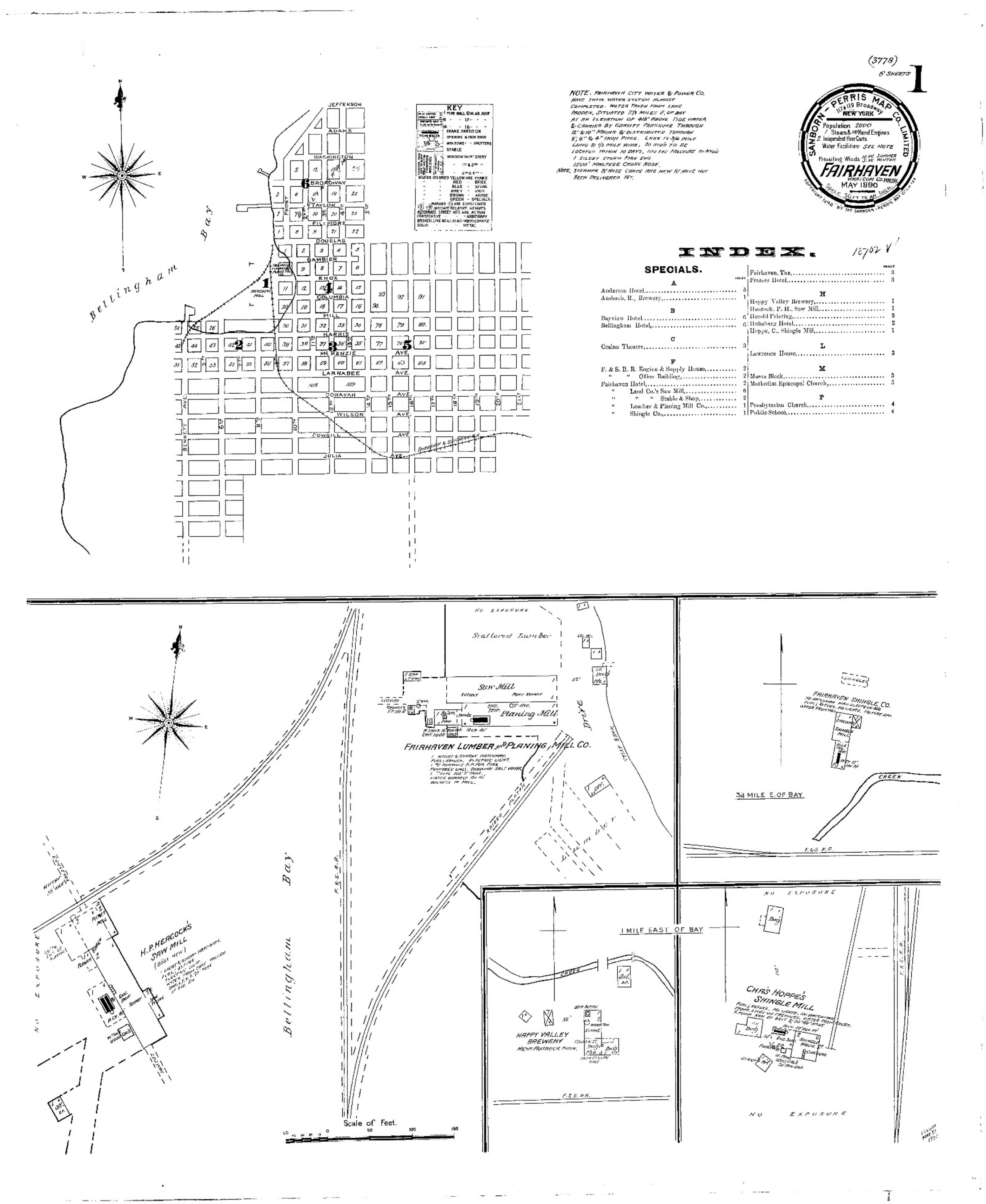
APPENDIX A

Historical Maps and Photographs

APPENDIX A-1

Historical Maps

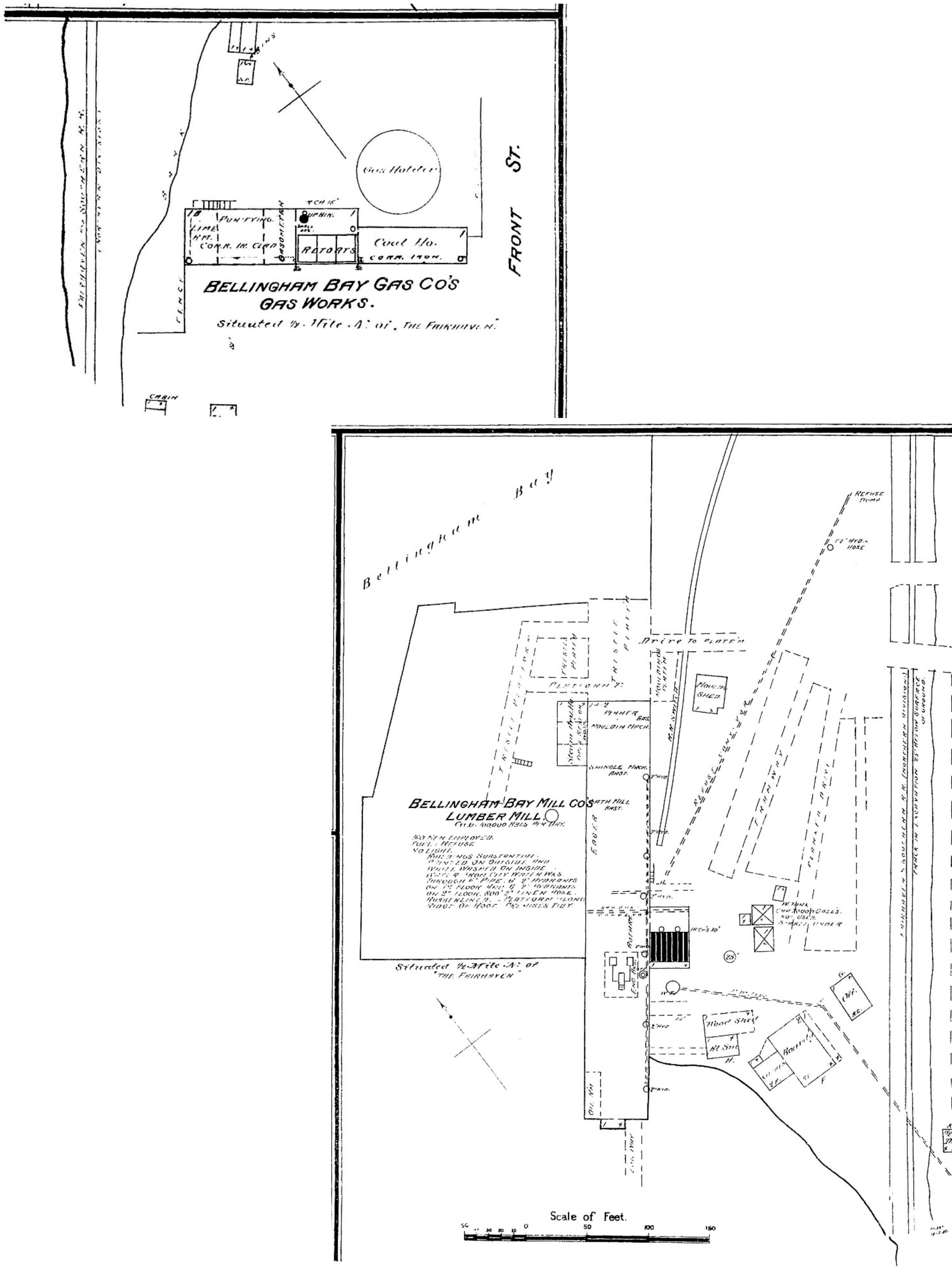


LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

1890 Sanborn Map
Fairhaven, Washington
(Sheet 1)

Figure
A-1

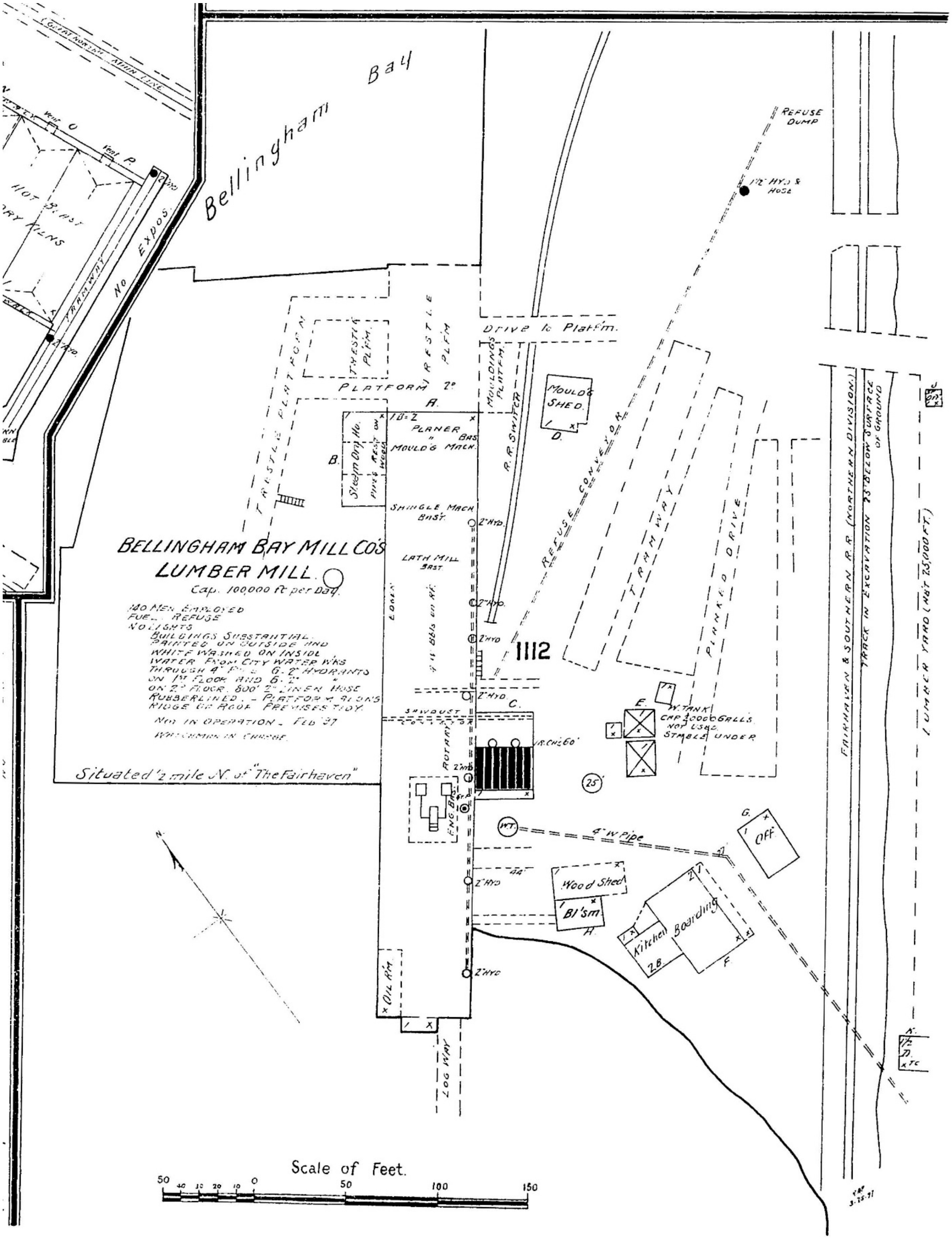


LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

1891 Sanborn Map
Fairhaven, Washington
(Sections of Sheet 1)

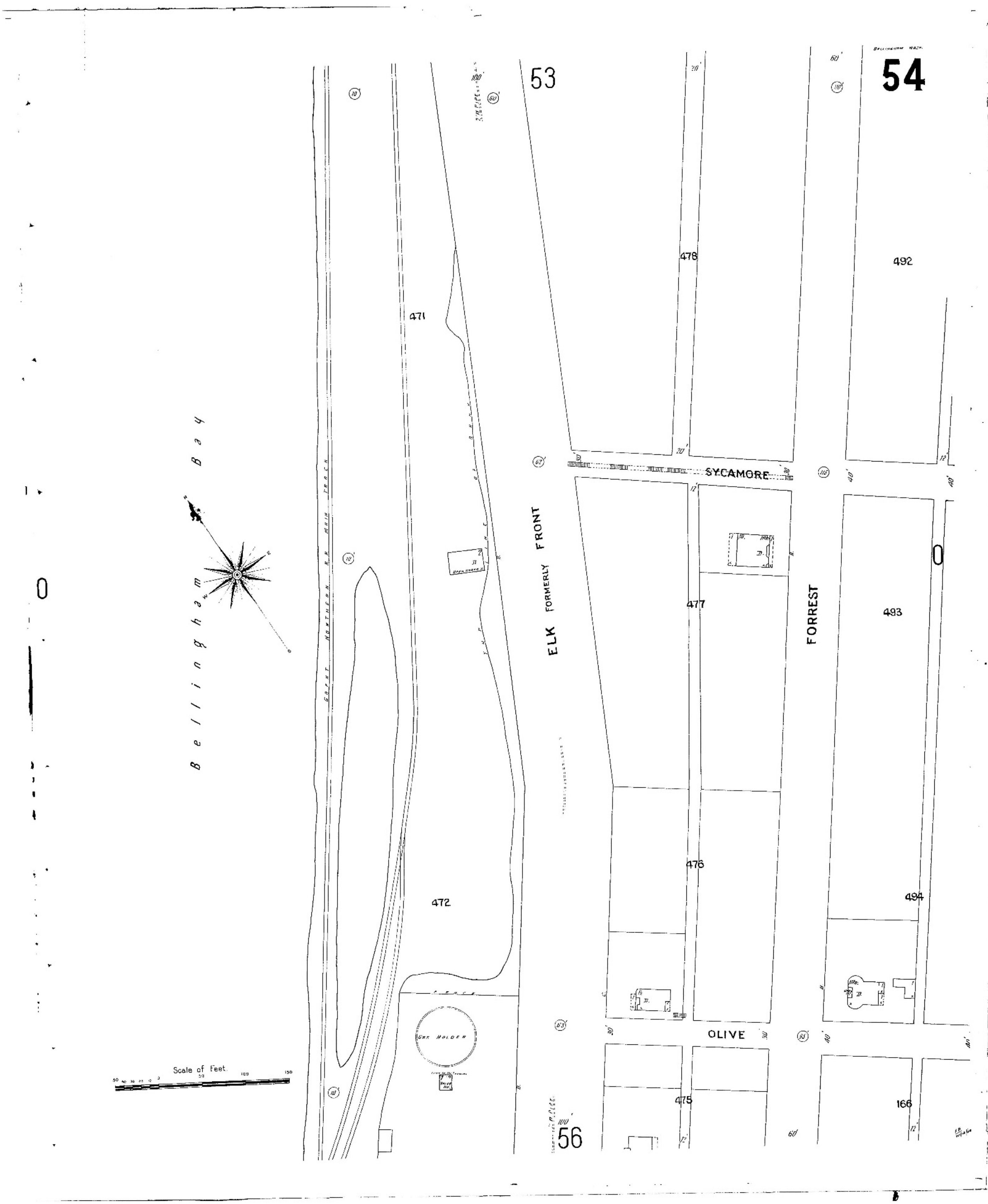
Figure
A-2



South State Street Manufactured Gas Plant Bellingham, Washington	**1897 Sanborn Map** **Fairhaven, Washington** **(Section of Sheet 1)**	Figure A-3

LANDAU ASSOCIATES

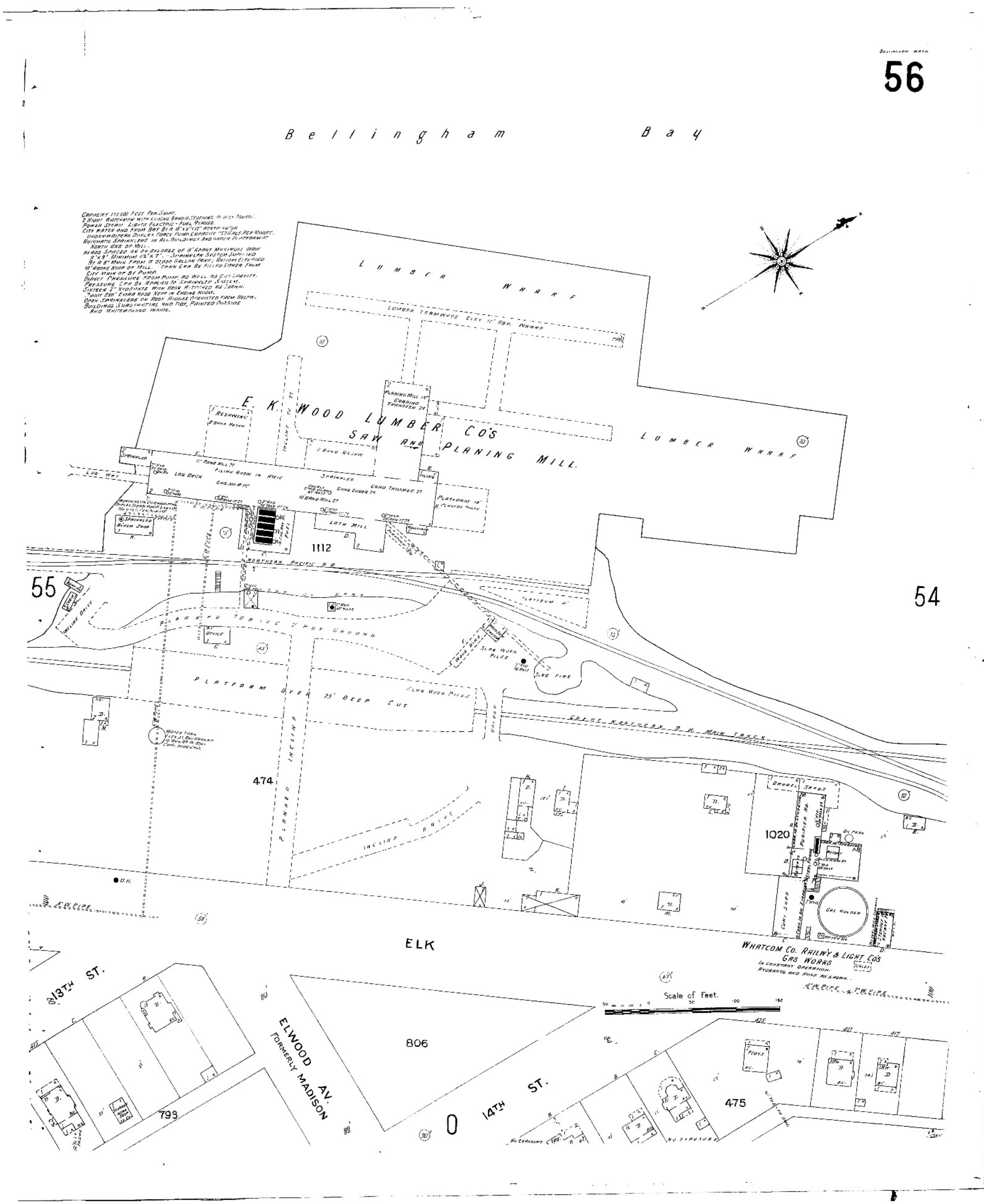
7/12/18 P:\015\015\050\FileRoom\R\2017 Draft RI Report\Appendices\Appendix A\App A_Fig A-3 1897.docx



7/12/18 P:\015\015\050\FileRoom\R\2017 Draft RI Report\Appendices\Appendix A\App A_Fig A-4 1904.docx

LANDAU ASSOCIATES

South State Street Manufactured Gas Plant Bellingham, Washington	**1904 Sanborn Map Bellingham, Washington (Sheet 54)**	Figure A-4



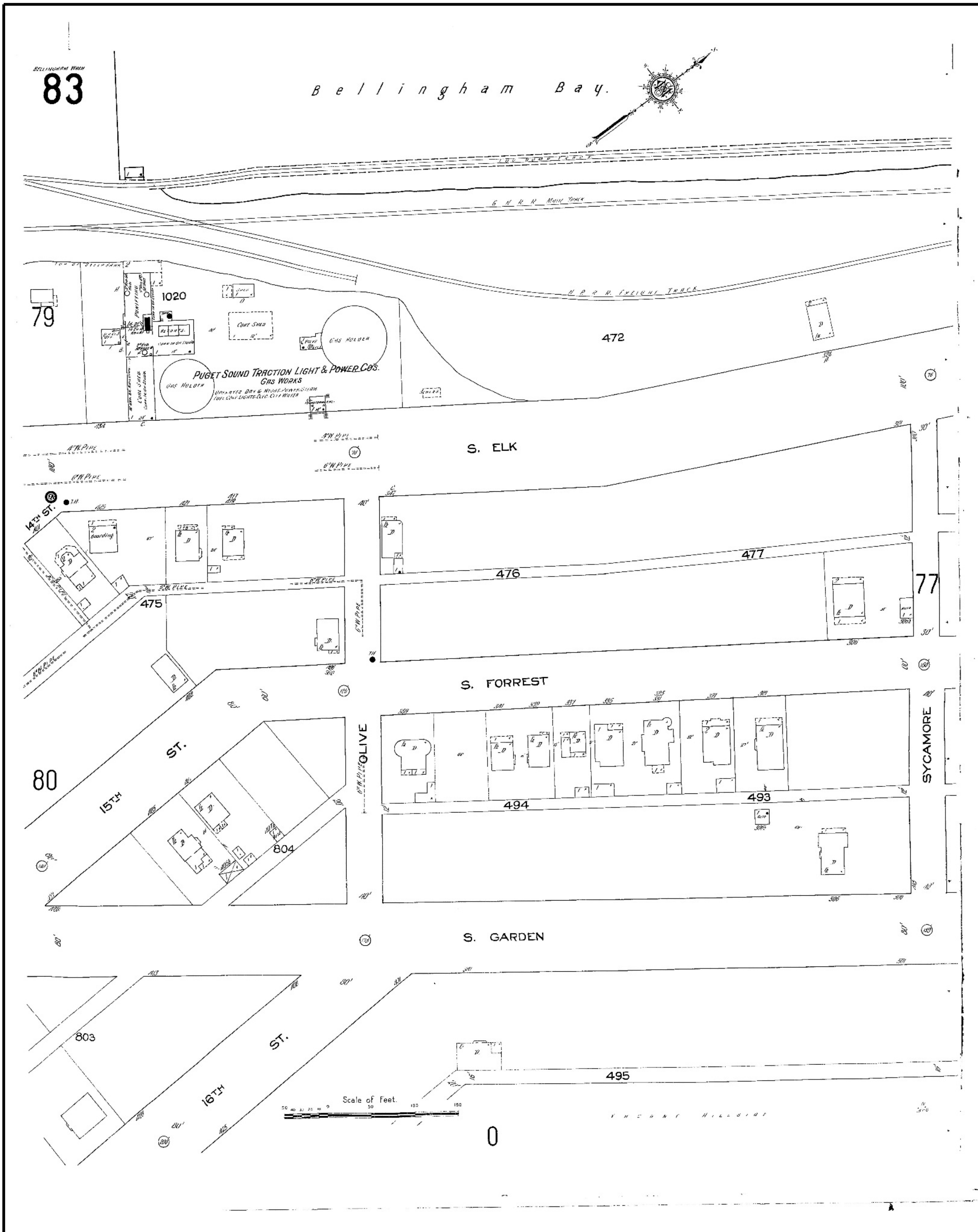
South State Street
Manufactured Gas Plant
Bellingham, Washington

1904 Sanborn Map
Bellingham, Washington
(Sheet 56)

Figure
A-5

Landau Associates

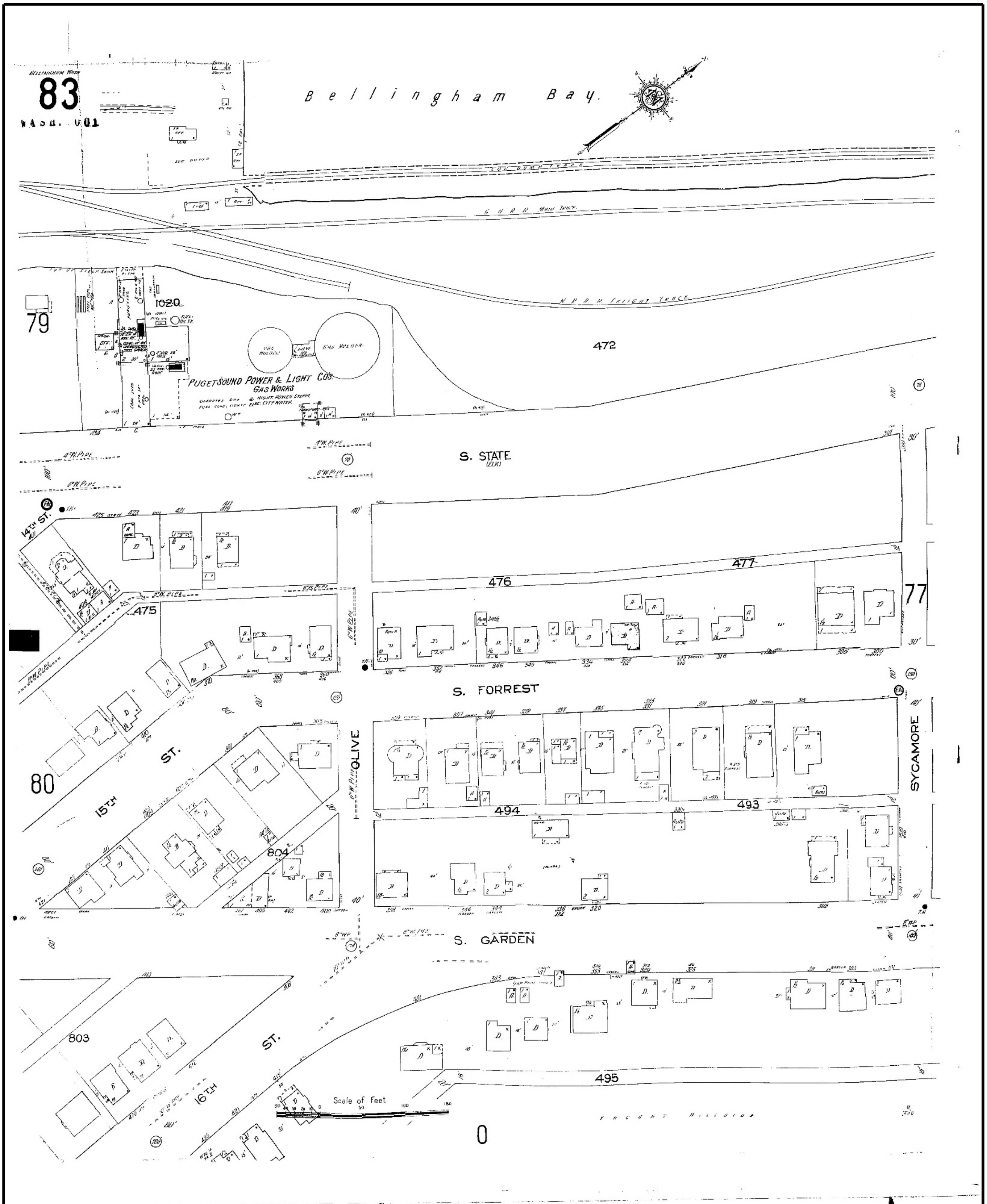
7/12/18 P:\015\015\050\FileRoom\R\2017 Draft RI Report\Appendices\Appendix A\App A_Fig A-5 1904.docx



South State Street Manufactured Gas Plant Bellingham, Washington	**1913 Sanborn Map** **Bellingham, Washington** **(Sheet 83)**	Figure A-6

LANDAU ASSOCIATES

7/12/18 P:\015\015\050\FileRoom\R\2017 Draft RI Report\Appendices\Appendix A\App A_Fig A-6 1913.docx

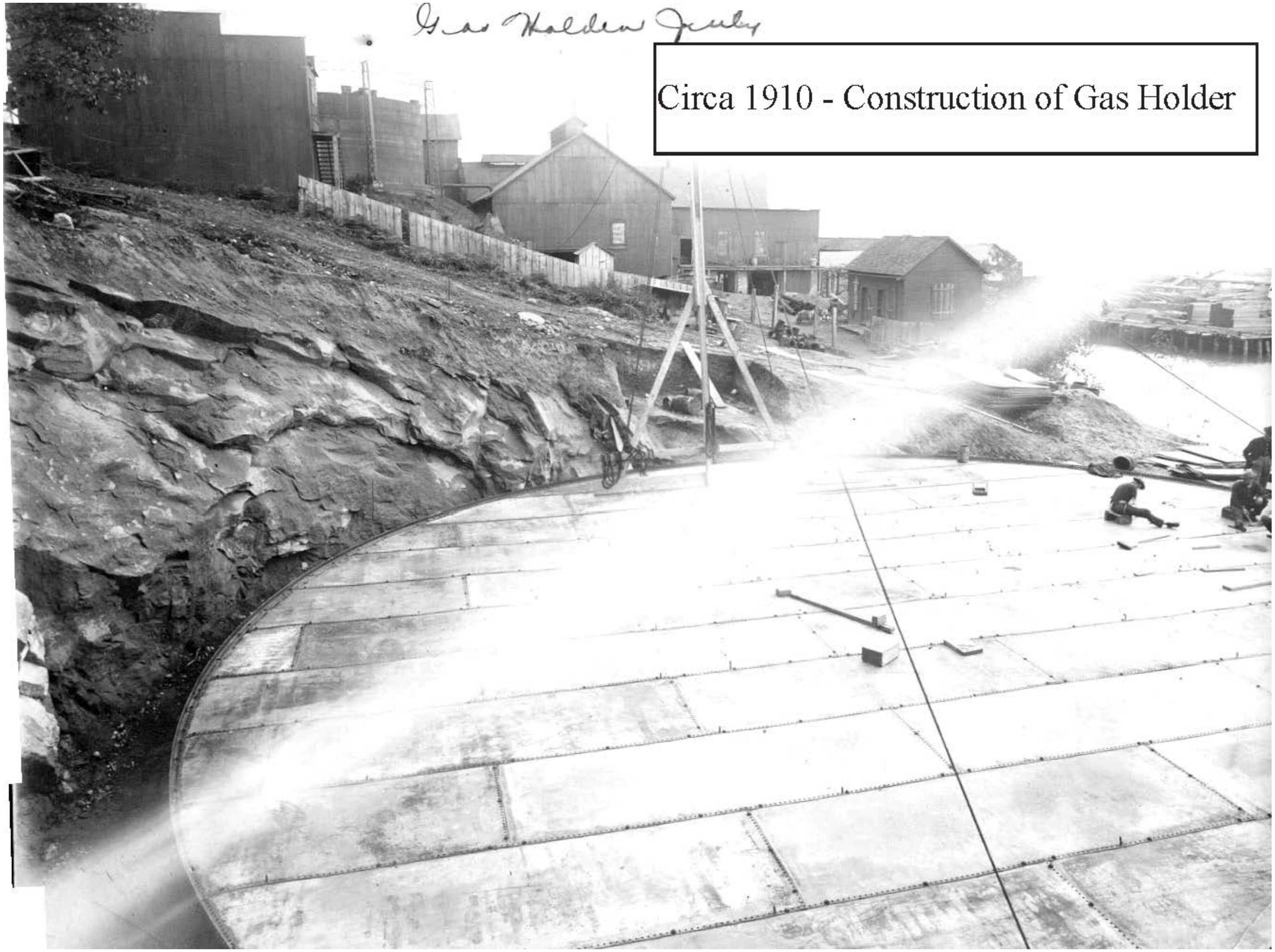


LANDAU ASSOCIATES

South State Street Manufactured Gas Plant Bellingham, Washington	**1950 Sanborn Map Bellingham, Washington (Sheet 83)**	Figure A-7

APPENDIX A-2

Historical and Aerial Photographs

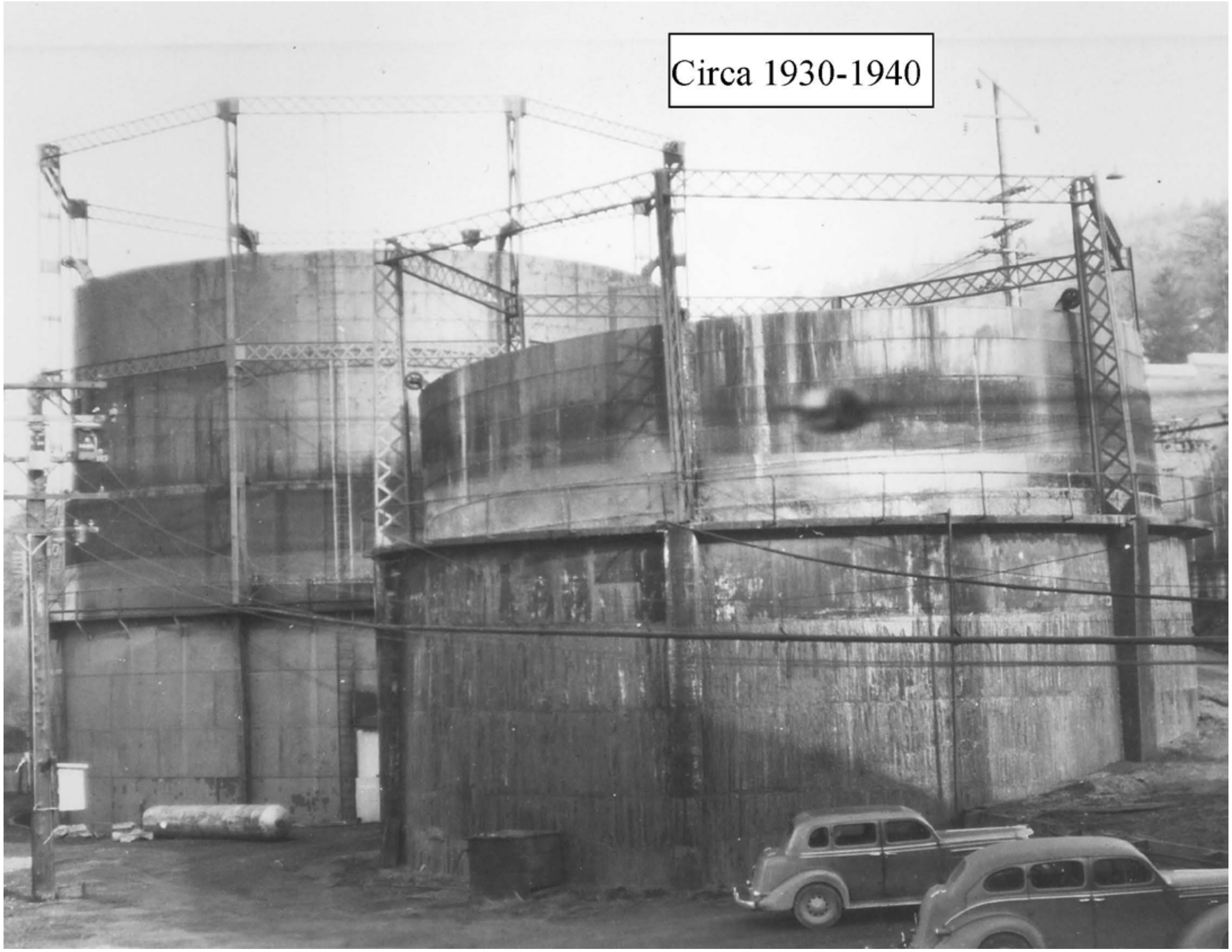


LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

Circa 1910 Gas Holder Construction Photograph

Figure
A-8

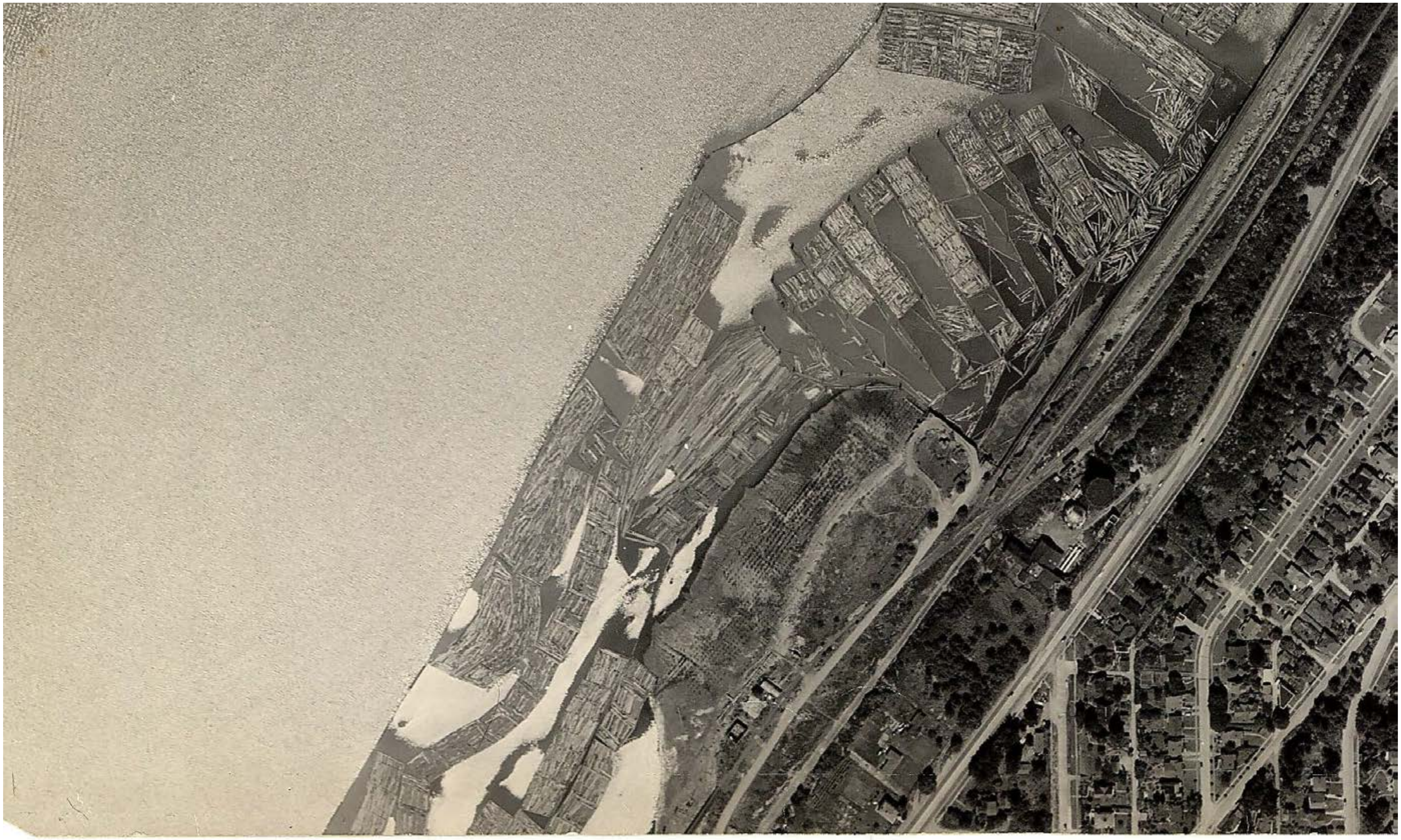


LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

1930–1940 Gas Holder Photograph

Figure
A-9



LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

1950 Aerial Photograph

Figure
A-10

Landau Associates

South State Street Manufactured Gas Plant Bellingham, Washington	**1955 Aerial Photograph**	Figure A-11

LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

1963 Aerial Photograph

Figure
A-12

APPENDIX B

Exploration Details

Table B-1
Soil Sample Analysis Summary
South State Street Manufactured Gas Plant Site
Bellingham, Washington

Exploration Name	Exploration Type[a]	Exploration Depth (feet)	Exploration Method	Exploration Date
GP-01	Soil Boring	7.5	Geoprobe	8/18/2010
GP-02	Soil Boring	8.0	Geoprobe	8/18/2010
GP-03	Soil Boring	6.5	Geoprobe	8/18/2010
GP-04	Soil Boring	4.5	Geoprobe	8/18/2010
GP-05	Soil Boring	8.1	Geoprobe	8/16/2010
GP-06A	Soil Boring	2.0	Geoprobe	8/18/2010
GP-06B	Soil Boring	5.0	Geoprobe	8/18/2010
GP-07	Soil Boring	14	Geoprobe	8/18/2010
GP-08	Soil Boring	15	Geoprobe	8/18/2010
GP-09	Soil Boring	15	Geoprobe	8/18/2010
GP-10	Soil Boring	16	Geoprobe	8/18/2010
GP-11	Soil Boring	7.5	Geoprobe	8/16/2010
GP-12	Soil Boring	7.0	Geoprobe	8/16/2010
GP-13	Soil Boring	6.5	Geoprobe	8/16/2010
GP-14	Soil Boring	6.5	Geoprobe	8/16/2010
GP-15	Soil Boring	17.0	Geoprobe	8/17/2010
GP-16	Soil Boring	26.0	Geoprobe	8/17/2010
GP-17	Soil Boring	8.1	Geoprobe	8/17/2010
GP-18	Soil Boring	16.0	Geoprobe	8/17/2010
GP-19	Soil Boring	22.0	Geoprobe	8/17/2010
GP-20	Soil Boring	6.5	Geoprobe	8/16/2010
GP-21	Soil Boring	5.6	Geoprobe	8/16/2010
GP-22	Soil Boring	17.0	Geoprobe	8/18/2010
GP-23A	Soil Boring	23.0	Geoprobe	8/17/2010
GP-23B	Soil Boring	15.0	Geoprobe	8/18/2010
GP-24	Soil Boring	16.0	Geoprobe	8/18/2010
GP-25	Soil Boring	17.0	Geoprobe	8/18/2010
GP-26	Soil Boring	4.5	Geoprobe	8/19/2010
GP-27	Soil Boring	7.0	Geoprobe	8/19/2010
GP-28	Soil Boring	15.0	Geoprobe	8/19/2010
GP-29	Soil Boring	15.1	Geoprobe	8/19/2010
GP-30	Soil Boring	12.0	Geoprobe	8/19/2010
GP-31	Soil Boring	12.0	Geoprobe	8/19/2010
GP-32	Soil Boring	13.0	Geoprobe	8/19/2010
GP-33	Soil Boring	12.1	Geoprobe	8/19/2010
GP-34	Soil Boring	15.0	Geoprobe	8/20/2010
GP-35	Soil Boring	19.0	Geoprobe	8/19/2010
GP-36	Soil Boring	22.0	Geoprobe	8/20/2010
GP-37	Soil Boring	25.0	Geoprobe	8/20/2010
GP-38	Soil Boring	27.0	Geoprobe	8/19/2010
GP-39	Soil Boring	31.0	Geoprobe	8/20/2010
GP-40	Soil Boring	20.0	Geoprobe	8/20/2010
GP-41	Soil Boring	29.0	Geoprobe	8/30/2010
GP-42	Soil Boring	36.0	Geoprobe	8/20/2010
GP-44	Soil Boring	14.0	Geoprobe	8/18/2010
GP-45	Soil Boring	15.0	Geoprobe	8/19/2010
GP-56	Soil Boring	16.0	Geoprobe	10/3/2012
GP-57	Soil Boring	22.0	Geoprobe	10/3/2012

Table B-1
Soil Sample Analysis Summary
South State Street Manufactured Gas Plant Site
Bellingham, Washington

Exploration Name	Exploration Type[a]	Exploration Depth (feet)	Exploration Method	Exploration Date
HA-01	Soil Boring	0.5	Hand Auger	8/26/2010
HA-02	Soil Boring	0.5	Hand Auger	8/26/2010
HA-03	Soil Boring	1.0	Hand Auger	8/26/2010
HA-04	Soil Boring	0.5	Hand Auger	8/26/2010
HA-05	Soil Boring	1.0	Hand Auger	8/26/2010
HA-06	Soil Boring	1.0	Hand Auger	8/26/2010
HA-07	Soil Boring	0.5	Hand Auger	8/26/2010
HA-08	Soil Boring	1.0	Hand Auger	8/26/2010
HA-09	Soil Boring	1.0	Hand Auger	8/26/2010
HA-10	Soil Boring	1.0	Hand Auger	8/26/2010
HA-11	Soil Boring	1.0	Hand Auger	8/26/2010
HA-12	Soil Boring	1.0	Hand Auger	8/26/2010
HA-13	Soil Boring	1.5	Hand Auger	9/20/2010
HA-14	Soil Boring	1.5	Hand Auger	9/20/2010
HS-26	Soil Boring	10.2	Hollow-stem Auger	8/23/2010
HS-43	Soil Boring	18.0	Hollow-stem Auger	8/26/2010
MW-07	Monitoring Well	13.5	Hollow-stem Auger	8/26/2010
MW-19	Monitoring Well	13.5	Hollow-stem Auger	8/26/2010
MW-24	Monitoring Well	15.0	Hollow-stem Auger	8/26/2010
MW-28	Monitoring Well	15.0	Hollow-stem Auger	8/23/2010
MW-29	Monitoring Well	15.0	Hollow-stem Auger	8/24/2010
MW-31	Monitoring Well	11.5	Hollow-stem Auger	8/23/2010
MW-34	Monitoring Well	15.2	Hollow-stem Auger	8/23/2010
MW-36	Monitoring Well	24	Hollow-stem Auger	8/24/2010
MW-38	Monitoring Well	27.0	Hollow-stem Auger	8/25/2010
MW-40	Monitoring Well	35.0	Hollow-stem Auger	8/25/2010
MW-42	Monitoring Well	36.0	Hollow-stem Auger	8/23/2010
MW-44	Monitoring Well	14.0	Hollow-stem Auger	8/26/2010
MW-45	Monitoring Well	13.0	Hollow-stem Auger	8/25/2010
MW-46	Monitoring Well	11.17	Hollow-Stem Auger	2/1/2012
MW-53	Monitoring Well	11.67	Hollow-Stem Auger	2/1/2012
MW-54	Monitoring Well	14.83	Hollow-Stem Auger	2/3/2012
MW-55	Monitoring Well	37.33	Hollow-Stem Auger	2/2/2012
MW-58	Monitoring Well	15.1	Hollow-Stem Auger	6/8/2016
SV-04	Temporary Soil Vapor Well	4.0	Geoprobe	8/30/2010
SV-12	Temporary Soil Vapor Well	5.0	Geoprobe	8/30/2010
SV-18	Temporary Soil Vapor Well	8.0	Geoprobe	8/30/2010
SV-25 (1)	Temporary Soil Vapor Well	8.0	Geoprobe	8/30/2010
SV-25 (2)	Temporary Soil Vapor Well	6.0	Geoprobe	7/25/2011
SV-32	Temporary Soil Vapor Well	6.0	Geoprobe	8/30/2010
SV-44	Temporary Soil Vapor Well	6.0	Geoprobe	8/30/2010
SV-49	Temporary Soil Vapor Well	8.0	Geoprobe	7/25/2011
SV-50	Temporary Soil Vapor Well	8.0	Geoprobe	7/25/2011
SV-51	Temporary Soil Vapor Well	11.0	Geoprobe	7/25/2011
SV-52	Temporary Soil Vapor Well	6.0	Geoprobe	7/25/2011
SB-01	Sediment Boring	11.0	Geoprobe	8/20/2010
SB-02	Sediment Boring	10.1	Geoprobe	8/20/2010
SB-03	Sediment Boring	5.0	Hollow-Stem Auger	9/8/2010

Table B-1
Soil Sample Analysis Summary
South State Street Manufactured Gas Plant Site
Bellingham, Washington

Exploration Name	Exploration Type[a]	Exploration Depth (feet)	Exploration Method	Exploration Date
SB-04	Sediment Boring	13.0	Geoprobe	8/20/2010
SB-05	Sediment Boring	6.0	Hollow-stem Auger	9/8/2010
SB-06	Sediment Boring	13.5	Hollow-stem Auger	9/7/2010
SB-07	Sediment Boring	18.5	Hollow-Stem Auger	9/9/2010
SB-08	Sediment Boring	24.5	Hollow-Stem Auger	9/8/2010
SB-09	Sediment Boring	39.5	Hollow-Stem Auger	9/7/2010
SB-10	Sediment Boring	31	Hollow-Stem Auger	9/9/2010
SB-11	Sediment Boring	50.0	Hollow-Stem Auger	9/8/2010
SB-12	Sediment Boring	51.5	Hollow-Stem Auger	9/9/2010
SB-14	Sediment Boring	14.0	Vibracore	9/24/2015
SB-15	Sediment Boring	11.9	Vibracore	9/25/2015
SB-16	Sediment Boring	7.1	Vibracore	9/24/2015
SB-17	Sediment Boring	6.0	Vibracore	9/24/2015
SB-18	Sediment Boring	5.5	Vibracore	9/24/2015
SB-19	Sediment Boring	14	Vibracore	9/24/2015
SB-21	Sediment Boring	14.0	Vibracore	9/25/2015
SB-22	Sediment Boring	14.0	Vibracore	9/23/2015
SB-23	Sediment Boring	10.75	Vibracore	9/23/2015
SB-25	Sediment Boring	14	Vibracore	9/24/2015
SB-31	Sediment Boring	6.0	Vibracore	9/25/2015
SS-02	Surface Sediment Grab	0.39	Hand Tools	9/2/2010
SS-04	Surface Sediment Grab	0.39	Hand Tools	9/2/2010
SS-06	Surface Sediment Grab	0.39	Van Veen Powergrab	9/2/2010
SS-07	Surface Sediment Grab	0.39	Van Veen Powergrab	9/2/2010
SS-08	Surface Sediment Grab	0.39	Van Veen Powergrab	9/2/2010
SS-13	Surface Sediment Grab	0.39	Hand Tools	9/24/2015
SS-14	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-15	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-16	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-17	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-18	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-19	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-20	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-21	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-22	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015
SS-23	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-24	Surface Sediment Grab	0.39	Hand Tools	9/24/2015
SS-25	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-26	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-27	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-28	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-29	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-30	Surface Sediment Grab	0.39	Van Veen Powergrab	9/23/2015
SS-31	Surface Sediment Grab	0.39	Van Veen Powergrab	9/22/2015

[a] Exploration logs for surface sediment grabs are not included.

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL(1)	TYPICAL DESCRIPTIONS (2)(3)
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50%	"GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50%	"very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30%	"gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15%	"with gravel," "with sand," "with silt," etc.
	≤ 5%	"with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

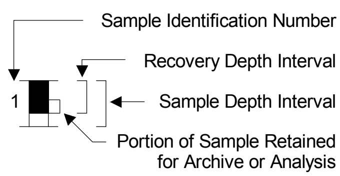
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)

▼ Approximate water level at time other than ATD

LANDAU ASSOCIATES

South State Street Manufactured Gas Plant
Bellingham, Washington

Soil Classification System and Key

Figure B-1

GP-01

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 54.28	
0			d3		0.0		SM	Light Brown, silty, fine SAND with gravel and trace pulverized brick; no odor, no sheen (loose, damp)	Groundwater not encountered.
							SP-SM	**Collected soil sample MGP-GP-01-0.5-1.0 at 0.5-1.0 ft. bgs** Light brown, fine to medium SAND with silt and gravel; no odor, no sheen (loose, damp)	
5	50		d3					**Collected soil sample MGP-GP-01-5.0-6.0 at 5.0-6.0 ft. bgs** **Collected soil sample MGP-GP-01-6.5-7.5 at 6.5-7.5 ft. bgs**	

Boring Completed 08/18/10
Total Depth of Boring = 7.5 ft.

Refusal on sandstone (?) at 7.5 ft. bgs

10

15

20

25

30

35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-01

Figure
B-2

GP-02

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 55.57

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Water Level
0	55		d3		1.2		SM	Light brown, silty, fine SAND with cobbles; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-02-0.5-1.0 at 0.5-1.0 ft. bgs**	
							ML	Brown, sandy, gravelly SILT; slight creosote-like odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-02-4.5-5.0 at 4.0-5.0 ft. bgs**	
5	50		d3		73.0		SM	Brown, silty, fine to medium SAND with some wood debris; petroleum-like odor, medium sheen (medium dense, wet) **Collected soil sample MGP-GP-02-7.0-8.0 at 7.0-8.0 ft. bgs**	ATD
10								Refusal on metal (?) at 8.0 ft. bgs	

Boring Completed 08/18/10
Total Depth of Boring = 8.0 ft.

15

20

25

30

35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-02

Figure B-3

GP-03

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 54.28	Water Level
0			d3				SM	Red/light brown, silty, fine SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-03-0.5-1.0 at 0.5-1.0 ft. bgs**	ATD
5	50		d3		23.2		SM	Dark brown, silty, fine to medium SAND with trace gravel; petroleum-like odor, medium sheen (loose, wet) **Collected soil sample MGP-GP-03-4.0-5.0 at 4.0-5.0 ft. bgs**	

Boring Completed 08/18/10
Total Depth of Boring = 6.5 ft.

Refusal on metal (?) at 6.5 ft. bgs

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Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-03

Figure
B-4

GP-04

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 53.96	Water Level
0			e3		3.2		SM	Light brown to grey, silty fine SAND with coarse gravel or cobbles; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-04-0.5-1.0 at 0.5-1.0 ft. bgs**	ATD
	50				455		ML	Dark brown to black, sandy SILT; strong petroleum-like odor, heavy sheen (soft, wet) **Collected soil sample MGP-GP-04-3.5-4.5 at 3.5-4.5 ft. bgs** Refusal at 4.5 ft. bgs on METAL	

Boring Completed 08/18/10
Total Depth of Boring = 4.5 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant Bellingham, Washington	Log of Soil Boring GP-04	Figure B-5

GP-05

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 72.60	
0					0.0		GM	Light brown, silty fine to medium GRAVEL with sand and roots; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-05-0.5-1.0 at 0.5-1.0 ft. bgs**	Groundwater not encountered.
	70		d3		5.2		SM	Dark brown to black SILT with sand and some black irregular shaped medium sand-sized grains; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-05-0.0-4.0 at 0.0-4.0 ft. bgs**	
							GM	Light brown, silty, fine to medium GRAVEL with sand; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-05-4.0-5.0 at 4.0-5.0 ft. bgs**	
5							SP-SM	Dark brown, fine to medium SAND with silt; slight petroleum-like odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-05-5.0-6.0 at 5.0-6.0 ft. bgs**	
			d3				ML	Light brown to red SILT with gravel and sand; no odor, no sheen (dense, dry) **Collected soil sample MGP-GP-05-6.0-7.0 at 6.0-7.0 ft. bgs** **Collected soil sample MGP-GP-05-7.0-8.0 at 7.0-8.0 ft. bgs**	
	65				0.0		RK	Light brown, fine to medium grained SANDSTONE Refusal at 8.1 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 8.1 ft.

Depth scale: 10, 15, 20, 25, 30, 35

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-05

Figure B-6

GP-06A

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): 54.80	
0			d3				GM	Light brown, silty, fine to coarse GRAVEL with sand; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-06-0.5-1.0 at 0.5-1.0 ft. bgs**	Groundwater not encountered.

Boring Completed 08/18/10
Total Depth of Boring = 2.0 ft.

Cobble/boulder-like refusal at 2 ft. bgs, moved location approximately 3 ft. west to GP-06b

5

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Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-06A

Figure
B-7

GP-06B

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Soil Profile	Groundwater
								Drilling Method: GeoprobeTM Ground Elevation (ft): 54.83	
0							GM	Light brown, silty, fine to coarse GRAVEL with sand; no odor, no sheen (loose, dry)	Groundwater not encountered.
			d3		2.1		SP	Light brown, gravelly, fine to coarse sand; no odor, no sheen (loose, dry)	
					1.8			**Collected soil sample MGP-GP-06-4.0-5.0 at 4.0-5.0 ft. bgs** - damp at 4.5 ft. bgs	
5	50							Refusal on sandstone (?) at 5 ft. bgs	

Boring Completed 08/18/10
Total Depth of Boring = 5.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-06B

Figure B-8

GP-07

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	

Drilling Method: GeoprobeTM

Ground Elevation (ft): 53.47

Depth (ft)	Elevation	Sampler Type	PID (ppm)	USCS Symbol	Description	Groundwater
0		d3	2.3	SM	Light brown, silty, fine SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-07-0.5-1.0 at 0.5-1.0 ft. bgs** - 0.5 ft. dark brown layer at 3.5 ft. bgs	Groundwater not encountered.
	50					
5		d3	3.2 2.7	SW-SM	Brown, dark brown, and light brown, silty, gravelly SAND; no odor, no sheen (medium dense to dense, damp) **Collected soil sample MGP-GP-07-4.0-5.0 at 4.0-5.0 ft. bgs** **Collected soil sample MGP-GP-07-5.0-6.0 at 5.0-6.0 ft. bgs** **Collected soil sample MGP-GP-07-6.0-7.0 at 6.0-7.0 ft. bgs** **Collected soil sample MGP-GP-07-9.0-10.0 at 9.0-10.0 ft. bgs**	
	45					
10		d3				
	40		320	GP	Brown, silty, medium to coarse GRAVEL with sand; strong petroleum-like odor, heavy sheen (dense, moist) **Collected soil sample MGP-GP-07-13.0-14.0 at 13.0-14.0 ft. bgs**	
15					Refusal on sandstone (?) at 14.0 ft. bgs	
20						
25						
30						
35						

Boring Completed 08/18/10
Total Depth of Boring = 14.0 ft.

Notes:
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2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-07

Figure
B-9

GP-08

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 75.77

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Water Level
0	75		d3		0.0		GW	Brown, 1/2 inch minus CRUSHED GRAVEL and medium to coarse SAND; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-08-0.5-1.0 at 0.5-1.0 ft. bgs** - saturated at 3 ft. bgs	ATD
5	70		d3		0.0			**Collected soil sample MGP-GP-08-5.0-6.0 at 5.0-6.0 ft. bgs**	
10	65		d3		0.0				
15									

Boring Completed 08/18/10
Total Depth of Boring = 15.0 ft.

20

25

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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-08

Figure
B-10

GP-09

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 75.71	Water Level
0	75		d3				GW	Brown, 1/2 inch minus CRUSHED GRAVEL and medium to coarse SAND; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-09-0.5-1.0 at 0.5-1.0 ft. bgs** - saturated at 3 ft. bgs	ATD
5	70		d3						
10	65		d3					- with thick black liquid from 10-15 ft. bgs; strong petroleum-like odor, heavy sheen (loose, saturated) **Collected soil sample MGP-GP-09-10.0-11.0 at 10.0-11.0 ft. bgs**	
15									

Boring Completed 08/18/10
Total Depth of Boring = 15.0 ft.

20

25

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Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-09

Figure
B-11

GP-10

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 57.02	
0							SM	Light brown and red, silty, fine SAND with gravel and cobbles; no odor, no sheen (loose, dry)	Groundwater not encountered.
	55		d3		1.6			**Collected soil sample MGP-GP-10-0.5-1.0 at 0.5-1.0 ft. bgs**	
5					3.7			**Collected soil sample MGP-GP-10-5.0-6.0 at 5.0-6.0 ft. bgs**	
	50		d3						
10								**Collected soil sample MGP-GP-10-11.0-12.0 at 11.0-12.0 ft. bgs**	
	45		d3		72.0		SM	Grey, silty, gravelly, fine to coarse SAND; strong petroleum-like odor, heavy sheen (dense, moist)	
15			d3		33.0			**Collected soil sample MGP-GP-10-12.0-13.0 at 12.0-13.0 ft. bgs**	
								Collected soil sample MGP-GP-10-15.0-16.0 at 15.0-16.0 ft. bgs	
								Refusal on sandstone (?) at 16.0 ft. bgs	

Boring Completed 08/18/10
Total Depth of Boring = 16.0 ft.

20

25

30

35

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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-10

Figure
B-12

GP-11

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 63.19	
0	60		d3		3.3		SP-SM	Brown fine SAND with silt; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-11-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-11-1.0-2.0 at 1.0-2.0 ft. bgs** **Collected soil sample MGP-GP-11-2.0-3.0 at 2.0-3.0 ft. bgs** **Collected soil sample MGP-GP-11-3.0-4.0 at 3.0-4.0 ft. bgs** **Collected soil sample MGP-GP-11-4.0-5.0 at 4.0-5.0 ft. bgs**	Groundwater not encountered.
5			d3		2.1		ML/WD	Brown SILT and black WOOD DEBRIS with some silt; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-11-5.0-6.0 at 5.0-6.0 ft. bgs**	
							RK	Grey, fine to medium grained SANDSTONE Refusal at 7.5 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 7.5 ft.

Depth scale (ft): 10, 15, 20, 25, 30, 35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-11

Figure
B-13

GP-12

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 62.68	Water Level
0	60		d3				ML	Light brown and light red, sandy SILT with gravel and occasional fine roots; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-12-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-12-1.0-2.0 at 1.0-2.0 ft. bgs** **Collected soil sample MGP-GP-12-2.0-3.0 at 2.0-3.0 ft. bgs** **Collected soil sample MGP-GP-12-3.0-4.0 at 3.0-4.0 ft. bgs** **Collected soil sample MGP-GP-12-4.0-5.0 at 4.0-5.0 ft. bgs**	
5			d3		2.0		WD	Black fine to medium WOOD DEBRIS; creosote-like odor, light sheen (loose, wet) **Collected soil sample MGP-GP-12-5.0-6.5 at 5.0-6.5 ft. bgs**	ATD
							RK	Grey with some black staining, fine to medium grained SANDSTONE Refusal at 7.0 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 7.0 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
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2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-12

Figure B-14

GP-13

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 61.53	Water Level
0	60		i3		0.7		ML	Light brown, SILT with sand and occasional 1/8 in. diameter silt nodules; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-13-0.5-1.0 at 0.5-1.0 ft. bgs**	
					1.5		SP-SM	**Collected soil sample MGP-GP-13-1.0-2.0 at 1.0-2.0 ft. bgs**	
5			i3		1.5			**Collected soil sample MGP-GP-13-2.0-3.0 at 2.0-3.0 ft. bgs**	ATD
								Grey fine SAND with silt; no odor, no sheen (medium dense, damp) **Collected soil sample MGP-GP-13-3.0-4.0 at 3.0-4.0 ft. bgs** - to brown and red at 4 ft. bgs **Collected soil sample MGP-GP-13-4.0-5.0 at 4.0-5.0 ft. bgs** **Collected soil sample MGP-GP-13-5.0-6.5 at 5.0-6.5 ft. bgs** - moist at 5.5 ft. bgs	
							RK	Grey, fine to medium grained SANDSTONE; no odor, no sheen Refusal at 6.5 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 6.5 ft.

10

15

20

25

30

35

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-13

Figure
B-15

GP-14

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 60.77	
0	60		d3		2.3		ML	Light brown and grey sandy SILT with occasional gravel; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-14-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-14-1.0-2.0 at 1.0-2.0 ft. bgs** **Collected soil sample MGP-GP-14-2.0-3.0 at 2.0-3.0 ft. bgs** **Collected soil sample MGP-GP-14-3.0-4.0 at 3.0-4.0 ft. bgs**	Groundwater not encountered.
							DB	Black, granular, medium to coarse sand-sized material; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-14-4.0-5.0 at 4.0-5.0 ft. bgs**	
5	55		d3		1.7		ML	Brown SILT with trace fine sand; no odor, no sheen (dense, damp) **Collected soil sample MGP-GP-14-5.0-6.5 at 5.0-6.5 ft. bgs** Refusal on sandstone (?) at 6.5 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 6.5 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant Bellingham, Washington	Log of Soil Boring GP-14	Figure B-16

GP-15

SAMPLE DATA	SOIL PROFILE	GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 58.82

Column headings: Depth (ft) | Elevation | Sample Number & Interval | Sampler Type | Blows/Foot | PID (ppm) | Graphic Symbol | USCS Symbol | Water Level

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Elevation scale: 55, 50, 45

Sampler Type	PID (ppm)
d3	0.2
d3	0.5
d3	0.5
d3	0.5
d3	

USCS Symbol	Description
SM	Light brown, silty fine SAND with some fine roots; no odor, no sheen (loose, dry)
	Collected soil sample MGP-GP-15-0.5-1.0 at 0.5-1.0 ft. bgs
SM	Dark brown and grey, silty SAND; no odor, no sheen (medium dense, moist)
	Collected soil sample MGP-GP-15-1.5-2.5 at 1.5-2.5 ft. bgs
DB	Grey, granular, medium sand-sized material with some black silt; slight creosote-like odor, no sheen (loose, dry)
	Collected soil sample MGP-GP-15-4.0-5.0 at 4.0-5.0 ft. bgs
DB	Black, granular, fine to medium sand-sized material, coal-like; creosote-like odor, medium sheen (medium dense, wet)
	Collected soil sample MGP-GP-15-8.0-9.0 at 8.0-9.0 ft. bgs
ML	Red and brown, sandy SILT with rounded gravel; no odor, no sheen (medium dense, moist)
	Collected soil sample MGP-GP-15-14.0-15.0 at 14.0-15.0 ft. bgs
SM	Red and brown, silty, fine SAND; no odor, no sheen (loose, wet)
	Collected soil sample MGP-GP-15-15.0-16.0 at 15.0-16.0 ft. bgs
ML	Red and brown with black mottling, sandy SILT; no odor, no sheen (medium dense, moist)
	Collected soil sample MGP-GP-15-16.0-17.0 at 16.0-17.0 ft. bgs
	Refusal on sandstone (?) at 17.0 ft. bgs

Water Level: ATD (at approx. 15 ft)

Boring Completed 08/17/10
Total Depth of Boring = 17.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-15

Figure B-17

GP-16

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 57.51	Water Level
0							SM	Brown, silty fine SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-16-0.5-1.0 at 0.5-1.0 ft. bgs** - cobble or boulder at 3-4 ft. bgs **Collected soil sample MGP-GP-16-4.0-5.0 at 4.0-5.0 ft. bgs**	
	55		d3						
5					2.2				
	50		d3				DB	Black, medium sand-sized granular material; slight creosote odor, no sheen (loose, dry) **Collected soil sample MGP-GP-16-7.0-8.0 at 7.0-8.0 ft. bgs** NO RECOVERY	
10					0.4				
	45		d3						
15					0.2		SM	Brown, silty SAND with gravel; slight creosote-like odor, no sheen (loose, moist) **Collected soil sample MGP-GP-16-14.0-15.0 at 14.0-15.0 ft. bgs**	
	40		d3		0.3		ML	Brown and light brown mottled sandy SILT; no odor, no sheen (stiff to very stiff, moist) - slight creosote odor and black staining at 16-17 ft. bgs **Collected soil sample MGP-GP-16-16.0-17.0 at 16.0-17.0 ft. bgs** **Collected soil sample MGP-GP-16-18.0-19.0 at 18.0-19.0 ft. bgs** **Collected soil sample MGP-GP-16-21.0-22.0 at 21.0-22.0 ft. bgs** **Collected soil sample MGP-GP-16-24.0-25.0 at 24.0-25.0 ft. bgs**	
20									ATD
	35		d3						
25			d3				SM	Grey, silty fine to coarse sand with trace gravel; no odor, slight sheen (medium dense, saturated) **Collected soil sample MGP-GP-16-25.0-26.0 at 25.0-26.0 ft. bgs** Refusal on sandstone (?) at 26 ft. bgs	
30									
35									

Boring Completed 08/17/10
Total Depth of Boring = 26.0 ft.

Notes:
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2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-16

Figure
B-18

GP-17

SAMPLE DATA	SOIL PROFILE	GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 60.36

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	USCS Symbol	Description	Water Level
0	60		d3		1.5	SM	Light and dark brown mottled, silty fine SAND; no odor, no sheen (medium dense, dry to damp) **Collected soil sample MGP-GP-17-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-17-3.0-4.0 at 3.0-4.0 ft. bgs**	
5	55		d3			DB	Grey, medium sand-sized granular material (DEBRIS) with brown silt; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-17-5.0-6.0 at 5.0-6.0 ft. bgs**	
					190	SP	Light brown-green with black mottling, medium SAND with trace silt; no odor, no sheen (medium dense, damp) **Collected soil sample MGP-GP-17-6.0-7.0 at 6.0-7.0 ft. bgs** **Collected soil sample MGP-GP-17-7.0-8.0 at 7.0-8.0 ft. bgs**	ATD
						GP/DB	Grey, fine to coarse GRAVEL and black coal-like granular debris; strong creosote-like odor, heavy sheen (medium dense, wet)	
						RK	Grey, fine to medium grained SANDSTONE	

Refusal at 8.1 ft. bgs

Boring Completed 08/17/10
Total Depth of Boring = 8.1 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-17

Figure
B-19

GP-18

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 59.46	Water Level
0			d3				SM	Mottled brown, silty fine SAND; no odor, no sheen (loose, dry to damp) **Collected soil sample MGP-GP-18-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-18-3.0-4.0 at 3.0-4.0 ft. bgs** **Collected soil sample MGP-GP-18-4.0-5.0 at 4.0-5.0 ft. bgs**	
5	55		d3					NO RECOVERY	ATD
10	50		d3		230		SP-SM	Black SAND with gravel and silt saturated in unidentified black liquid; strong creosote-like odor, heavy sheen (medium dense, wet with product) **Collected soil sample MGP-GP-18-9.0-10.0 at 9.0-10.0 ft. bgs**	
15	45		d3					**Collected soil sample MGP-GP-18-14.0-15.0 at 14.0-15.0 ft. bgs**	

Refusal on sandstone (?) at 16.0 ft. bgs

Boring Completed 08/17/10
Total Depth of Boring = 16.0 ft.

20

25

30

35

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

Log of Soil Boring GP-18

GP-19

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 58.39

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Water Level
0			d3				SM	Light brown, silty fine SAND; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-19-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-19-3.0-4.0 at 3.0-4.0 ft. bgs**	
5	55		d3				ML	Dark brown and grey SILT with sand and gravel and brown lightweight granular material; no odor, no sheen (medium dense, damp) **Collected soil sample MGP-GP-19-5.0-6.0 at 5.0-6.0 ft. bgs** **Collected soil sample MGP-GP-19-7.0-8.0 at 7.0-8.0 ft. bgs**	
10	50		d3		50		ML	Grey sandy SILT with some wood debris; gasoline-like odor, light sheen (medium dense, moist) **Collected soil sample MGP-GP-19-9.0-10.0 at 9.0-10.0 ft. bgs**	ATD
15	45		d3				CL	-solid 4 in. diameter piece of wood at 11 ft. bgs **Collected soil sample MGP-GP-19-12.0-13.0 at 12.0-13.0 ft. bgs** Grey silty CLAY; no odor, no sheen (very stiff, moist to wet) **Collected soil sample MGP-GP-19-14.0-15.0 at 14.0-15.0 ft. bgs**	
20	40		d3					- note: slough from 9-13 ft. bgs falling down hole, possibly contaminating samples collected from 13-22 ft. bgs	
25								Refusal on sandstone (?) at 22.0 ft. bgs	
30									
35									

Boring Completed 08/17/10
Total Depth of Boring = 22.0 ft.

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Log of Soil Boring GP-19

Figure
B-21

GP-20

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 70.64	
0	70				0.5		ML	Dark brown, sandy SILT with roots and wood chips; no odor, no sheen (loose, dry)	Groundwater not encountered.
			d3				SM/ML	Brown, sandy SILT to silty fine SAND with occasional medium sand and gravel; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-20-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-20-1.0-2.0 at 1.0-2.0 ft. bgs** **Collected soil sample MGP-GP-20-2.0-3.0 at 2.0-3.0 ft. bgs** **Collected soil sample MGP-GP-20-3.0-4.0 at 3.0-4.0 ft. bgs** **Collected soil sample MGP-GP-20-4.0-5.0 at 4.0-5.0 ft. bgs** **Collected soil sample MGP-GP-20-5.0-6.0 at 5.0-6.0 ft. bgs**	
					1.7				
5	65		d3				RK	Light brown, fine to medium grained SANDSTONE	
								Refusal at 6.5 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 6.5 ft.

10

15

20

25

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35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Log of Soil Boring GP-20

Figure
B-22

GP-21

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 61.41	
0	60		i3		2.6		ML	Brown SILT with fine roots; no odor, no sheen (loose, dry)	Groundwater not encountered.
							SM/ ML	Light to dark brown, sandy SILT to silty fine SAND; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-21-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-21-1.0-2.0 at 1.0-2.0 ft. bgs** **Collected soil sample MGP-GP-21-2.0-3.0 at 2.0-3.0 ft. bgs** **Collected soil sample MGP-GP-21-3.0-4.0 at 3.0-4.0 ft. bgs**	
5			i3		2.8		SM	Dark brown, silty SAND with gravel; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-21-4.0-5.0 at 4.0-5.0 ft. bgs**	
							RK	Grey, fine to medium grained SANDSTONE	
								Refusal at 5.6 ft. bgs	

Boring Completed 08/16/10
Total Depth of Boring = 5.6 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
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2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Log of Soil Boring GP-21

Figure
B-23

GP-22

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 61.52	Water Level
0	60		d3				SM	Brown, silty, fine to medium SAND with gravel; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-22-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	55		d3				SM	Dark brown, silty, gravelly, medium to coarse SAND; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-22-3.0-4.0 at 3.0-4.0 ft. bgs**	
							SM	Light brown, silty, fine SAND with trace gravel; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-22-4.0-5.0 at 4.0-5.0 ft. bgs**	
					2.8		DB	Red pulverized brick-like debris and black medium sand-sized granular material; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-22-7.0-8.0 at 7.0-8.0 ft. bgs**	
10	50		d3		3.4		ML	Light brown and green, sandy SILT with gravel; no odor, no sheen (dense, moist to wet) **Collected soil sample MGP-GP-22-10.0-11.0 at 10.0-11.0 ft. bgs**	ATD
15	45		d3		1.7				

Refusal on sandstone (?) at 17.0 ft. bgs

Boring Completed 08/18/10
Total Depth of Boring = 17.0 ft.

20

25

30

35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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GP-23A

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 59.67	Water Level
0			d3				SM	Light brown, silty, fine SAND; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-23-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-23-4.0-5.0 at 4.0-5.0 ft. bgs**	
5	55				0.0				
			d3				DB	DEBRIS, including red brick, grey cobble/boulder, brown silt, and black coal-like material; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-23-7.0-8.0 at 7.0-8.0 ft. bgs** - dry coal tar-like material at 9-10.5 ft. bgs **Collected soil sample MGP-GP-23-9.0-10.0 at 9.0-10.0 ft. bgs**	
10	50								
			d3		6.3				ATD
							SP-SM	Black, gravelly, fine to coarse SAND with silt; creosote-like odor, medium sheen (medium dense, wet) **Collected soil sample MGP-GP-23-14.0-15.0 at 14.0-15.0 ft. bgs**	
15	45		d3				CL	Brown to black mottled, silty CLAY; no odor, no sheen (stiff, moist) **Collected soil sample MGP-GP-23-17.0-18.0 at 17.0-18.0 ft. bgs**	
20	40		d3		1.4		SP-SM	Brown to grey, medium to coarse SAND with silt; creosote-like odor, medium sheen (medium dense, wet) **Collected soil sample MGP-GP-23-21.0-22.0 at 21.0-22.0 ft. bgs**	
							RK	Grey, fine to medium grained SANDSTONE Refusal at 23.0 ft. bgs	
25									
30									
35									

Boring Completed 08/17/10
Total Depth of Boring = 23.0 ft.

Notes:
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Log of Soil Boring GP-23A

Figure B-25

GP-23B

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 59.67	
0–14.0	59.67–45.67							See GP-23 for lithology; second boring advanced to collect additional soil at 14.0-15.0 ft. bgs depth	Groundwater not encountered.
10–15	50–45		d3						
14.0–15.0								**Collected soil sample MGP-GP-23-14.0-15.0 at 14.0-15.0 ft. bgs**	

Boring Completed 08/18/10
Total Depth of Boring = 15.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Log of Soil Boring GP-23B

Figure
B-26

GP-24

SAMPLE DATA / SOIL PROFILE / GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 55.28

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Groundwater
0	55		d3				SM	Light brown, silty, fine SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-24-0.5-1.0 at 0.5-1.0 ft. bgs**	Groundwater not encountered.
5	50		d3		2.1		WD	Black, splintered wood pieces with gravel saturated in a petroleum-like product; strong creosote-like odor, heavy sheen (loose, saturated) **Collected soil sample MGP-GP-24-5.0-6.0 at 5.0-6.0 ft. bgs**	
10	45		d3		0.7				
15	40		d3				SP-SM	Grey green mottled, fine SAND with silt and gravel and occasional black coal-like nodules; no odor, no sheen (dense, moist) **Collected soil sample MGP-GP-24-14.0-15.0 at 14.0-15.0 ft. bgs** - note: product from 5-14 ft. bgs may contaminate samples collected from 14-16 ft. bgs	

Boring Completed 08/18/10
Total Depth of Boring = 16.0 ft.

Refusal on sandstone (?) at 16.0 ft. bgs

20

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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-24

Figure
B-27

GP-25

Depth (ft)	Elevation	Sampler Type	PID (ppm)	USCS Symbol	Soil Profile	Water Level
0				WD	Wood chips	
		d3	1.3	SM	Brown, silty, fine to medium SAND with gravel; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-25-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-25-4.0-5.0 at 4.0-5.0 ft. bgs**	
5	50			DB	Red pulverized brick-like debris and black medium sand-sized granular material; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-25-5.0-6.0 at 5.0-6.0 ft. bgs**	
		d3		ML	Light brown, sandy SILT with gravel; no odor, no sheen (soft, moist) **Collected soil sample MGP-GP-25-6.0-7.0 at 6.0-7.0 ft. bgs**	
			48.0	SP-SM	Dark brown, fine to medium SAND with silt; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-25-8.0-9.0 at 8.0-9.0 ft. bgs**	
10	45			SM	Black, silty, fine SAND with gravel and wood pieces; strong petroleum-like odor, medium sheen (loose, moist) **Collected soil sample MGP-GP-25-9.0-10.0 at 9.0-10.0 ft. bgs**	ATD
15	40	d3 d3	2.7	SM	Brown to green with grey mottling, silty, fine SAND with gravel; no odor, no sheen (dense, moist) **Collected soil sample MGP-GP-25-14.0-15.0 at 14.0-15.0 ft. bgs**	
					Refusal on sandstone (?) at 17.0 ft. bgs	

Drilling Method: GeoprobeTM

Ground Elevation (ft): 54.52

Columns: SAMPLE DATA (Depth (ft), Elevation, Sample Number & Interval, Sampler Type, Blows/Foot, PID (ppm)); SOIL PROFILE (Graphic Symbol, USCS Symbol); GROUNDWATER (Water Level)

Boring Completed 08/18/10
Total Depth of Boring = 17.0 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
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Bellingham, Washington

Log of Soil Boring GP-25

Figure B-28

GP-26

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 20.68	
0	20		d3		0.0		SM	Light to dark brown, silty, fine SAND with trace gravel; no odor, no sheen (loose, dry)	Groundwater not encountered.
								Collected soil sample MGP-GP-26-0.5-1.0 at 0.5-1.0 ft. bgs	
							ML	Brown and black and orange, sandy SILT with gravel; no odor, no sheen (medium dense, damp)	
								Collected soil sample MGP-GP-26-2.5-3.5 at 2.5-3.5 ft. bgs	
								- thin horizon of black granular material at 3 ft. bgs	
							SP	Light grey, fine to medium SAND; no odor, no sheen (very dense, dry)	
5								Refusal on sandstone (?) at 4.5 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 4.5 ft.

Depth scale (ft): 0, 5, 10, 15, 20, 25, 30, 35

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Log of Soil Boring GP-26

Figure
B-29

GP-27

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 20.00	
0	20				0.9		GM	Light grey, silty, sandy, fine to coarse GRAVEL; no odor, no sheen (loose, dry)	Groundwater not encountered.
			d3		1.6		SM/ ML	Brown, silty, fine SAND to sandy SILT; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-27-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	15		d3		2.1		SP	Light brown, fine to medium SAND with trace silt; no odor, no sheen (dense, damp) **Collected soil sample MGP-GP-27-4.0-5.0 at 4.0-5.0 ft. bgs** - to grey at 5 ft. bgs **Collected soil sample MGP-GP-27-6.0-7.0 at 6.0-7.0 ft. bgs** Refusal on sandstone or very dense sand (?) at 7.0 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 7.0 ft.

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Log of Soil Boring GP-27

Figure
B-30

GP-28

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 19.55	
0							GM	Grey, silty, sandy, fine to coarse GRAVEL; no odor, no sheen (loose, dry)	Groundwater not encountered.
			d3		0.2		DB	Black medium sand to medium gravel sized granular, glassy, vesicular material with brown silt; slight coal-like odor, no sheen (loose, dry) **Collected soil sample MGP-GP-28-0.5-1.0 at 0.5-1.0 ft. bgs** **Collected soil sample MGP-GP-28-5.0-6.0 at 5.0-6.0 ft. bgs**	
5	15		d3				SP	Light brown, fine to medium SAND with trace silt; no odor, no sheen (loose, dry)	
10	10		d3		37.0 44.0		ML	Brown SILT with black gravel sized coal tar-like grains; slight petroleum-like odor, no sheen (loose, moist) **Collected soil sample MGP-GP-28-9.0-10.0 at 9.0-10.0 ft. bgs** **Collected soil sample MGP-GP-28-12.0-13.0 at 12.0-13.0 ft. bgs**	
15	5							Refusal on sandstone (?) at 15.0 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 15.0 ft.

20

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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Log of Soil Boring GP-28

Figure
B-31

GP-29

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 19.80	Water Level
0			d3				GM	Brown, silty, sandy, fine to coarse GRAVEL; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-29-0.5-1.0 at 0.5-1.0 ft. bgs**	
					0.4		SM	Brown and black, silty, fine to medium SAND with some gravel and gravel-sized shiny black grains; slight creosote-like odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-29-4.0-5.0 at 4.0-5.0 ft. bgs**	
5	15		d3						
							SP	Light brown with orange mottling, fine to medium SAND; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-29-9.0-10.0 at 9.0-10.0 ft. bgs** - grades to grey at 9.5 ft. bgs	
10	10		d3						ATD
							SP-SM	Light brown with orange mottling, fine SAND with silt and some clay nodules; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-29-14.0-15.0 at 14.0-15.0 ft. bgs**	
15	5						RK	Grey, fine to medium grained SANDSTONE Refusal at 15.1 ft. bgs	
20									
25									
30									
35									

Boring Completed 08/19/10
Total Depth of Boring = 15.1 ft.

Notes:
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2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-29

Figure B-32

GP-30

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 16.20	
0							WD	Brown wood chips and bark	Groundwater not encountered.
	15		d3				SM SM	Brown and black, silty, fine to medium SAND; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-30-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	10		d3		0.6			Brown and black, silty, fine to medium SAND with gravel; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-30-4.0-5.0 at 4.0-5.0 ft. bgs**	
					0.3		SP	Light brown and green, fine SAND with trace silt; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-30-9.0-10.0 at 9.0-10.0 ft. bgs**	
10	5		d3				SP-SM	Grey, fine to medium SAND with 1-inch think silt horizons; very slight creosote-like odor, no sheen (dense, moist) **Collected soil sample MGP-GP-30-10.0-11.0 at 10.0-11.0 ft. bgs**	
							RK	Grey fine to medium grained SANDSTONE Refusal at 12.0 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 12.0 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street Manufactured Gas Plant Bellingham, Washington	Log of Soil Boring GP-30	Figure B-33

GP-31

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 15.18	Water Level
0	15						WD	Wood chips	
			d3		1.0		SM	Brown, silty, fine SAND with gravel; no odor, no sheen (medium dense, dry) **Collected soil sample MGP-GP-31-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	10		d3					**Collected soil sample MGP-GP-31-5.0-6.0 at 5.0-6.0 ft. bgs** - wet at 6 ft. bgs	ATD
10	5		d3		6.9		SP	Grey, fine to medium SAND; strong petroleum-like odor, heavy sheen (dense, wet) **Collected soil sample MGP-GP-31-11.0-12.0 at 11.0-12.0 ft. bgs** Refusal on sandstone (?) at 12.0 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 12.0 ft.

15

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Notes:
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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-31

Figure
B-34

GP-32

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 12.20	Water Level
0							SM/ML	Light brown to grey, silty, fine SAND to sandy SILT; no odor, no sheen (loose/soft, moist) **Collected soil sample MGP-GP-32-0.5-1.0 at 0.5-1.0 ft. bgs**	
	10		d3						
							SP	**Collected soil sample MGP-GP-32-4.0-5.0 at 4.0-5.0 ft. bgs** Light brown, fine to medium SAND; no odor, no sheen (medium dense, wet)	ATD
5							WD	Black WOOD DEBRIS, typically pieces larger than the shoe with fresh wood surfaces cut when drilling; no odor, no sheen (wet, very loose) **Collected soil sample MGP-GP-32-7.0-8.0 at 7.0-8.0 ft. bgs**	
	5		d3						
10									
			d3						
	0				147			- strong petroleum-like odor and heavy sheen at 12-13 ft. bgs **Collected soil sample MGP-GP-32-12.0-13.0 at 12.0-13.0 ft. bgs** Refusal on sandstone (?) at 13.0 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 13.0 ft.

15

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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GP-33

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 11.77	Water Level
0			d3		0.3		GM	Brown to grey, silty, sandy, fine to coarse GRAVEL; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-33-0.5-1.0 at 0.5-1.0 ft. bgs**	ATD
	10						WD	Black decomposed WOOD DEBRIS; no odor, no sheen (very soft, wet) **Collected soil sample MGP-GP-33-5.0-6.0 at 5.0-6.0 ft. bgs**	
5	5		d3 d		0.5 0.9				
					0.3		SP	Brown, fine to coarse SAND with trace silt; no odor, no sheen (medium dense, wet)	
							WD	**Collected soil sample MGP-GP-33-8.0-9.0 at 8.0-9.0 ft. bgs** Black decomposed WOOD DEBRIS; no odor, no sheen (very soft, wet)	
10	0		d3				SP	Black, medium SAND; strong petroleum-like odor, heavy sheen (medium dense, wet) **Collected soil sample MGP-GP-33-11.0-12.0 at 11.0-12.0 ft. bgs**	
							RK	Grey, fine to medium grained SANDSTONE	
								Refusal at 12.1 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 12.1 ft.

15
20
25
30
35

Notes:
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-33

Figure
B-36

GP-34

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 10.49	Water Level
0	10		d3				GP/SP	Grey and brown medium to coarse SAND and fine to medium GRAVEL; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-34-0.5-1.0 at 0.5-1.0 ft. bgs**	
							GP	Grey, fine to medium GRAVEL and PEA GRAVEL; no odor, no sheen (loose, dry)	
5	5						DB	Red, pulverized bricks; no odor, no sheen (dry) **Collected soil sample MGP-GP-34-4.5-5.5 at 4.5-5.5 ft. bgs**	
			d3				WD	Black, 1/2 in. diameter WOOD DEBRIS; no odor, no sheen (loose, wet) **Collected soil sample MGP-GP-34-7.0-8.0 at 7.0-8.0 ft. bgs**	ATD
							SP	Dark grey, fine to coarse SAND; no odor, no sheen (loose, wet) **Collected soil sample MGP-GP-34-9.0-10.0 at 9.0-10.0 ft. bgs**	
10	0		d3				WD	Black, fine WOOD DEBRIS; no odor, no sheen (loose, wet) **Collected soil sample MGP-GP-34-12.0-13.0 at 12.0-13.0 ft. bgs** **Collected soil sample MGP-GP-34-13.0-14.0 at 13.0-14.0 ft. bgs**	
							SM/ML	Grey SILT and fine SAND with occasional white shell fragments; petroleum-like odor, light sheen (dense, wet) **Collected soil sample MGP-GP-34-14.0-15.0 at 14.0-15.0 ft. bgs** Refusal on sandstone (?) at 15.0 ft. bgs	
15									

Boring Completed 08/20/10
Total Depth of Boring = 15.0 ft.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-34

Figure
B-37

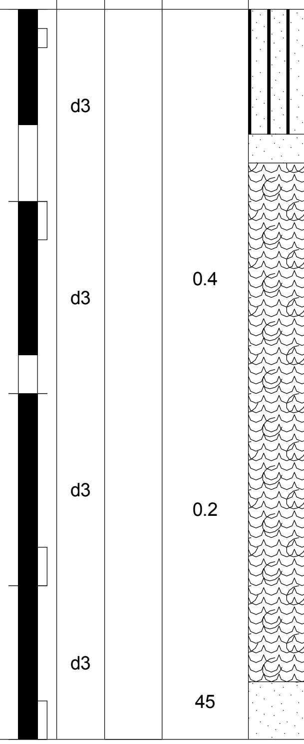
GP-35

SAMPLE DATA	SOIL PROFILE	GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 11.34

Depth (ft)	Elevation	Sampler Type	PID (ppm)	USCS Symbol	Description	Water Level
0	10	d3		SM	Brown, silty, fine to medium SAND; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-35-0.5-1.0 at 0.5-1.0 ft. bgs**	
				SP	Black and white, medium SAND; no odor, no sheen (loose, wet)	ATD
5	5	d3	0.4	WD	Brown to black, decomposed WOOD DEBRIS; no odor, no sheen (very soft, wet) **Collected soil sample MGP-GP-35-5.0-6.0 at 5.0-6.0 ft. bgs**	
10	0	d3	0.2		- less decomposed at 12-17.5 ft. bgs, solid 1/2 in. diameter pieces of wood - 6 in. thick layer of 50% wood debris and 50% brown silt at 12.5 ft. bgs - saturated at 13 ft. bgs	
15	-5	d3			**Collected soil sample MGP-GP-35-14.0-15.0 at 14.0-15.0 ft. bgs**	
			45	SP	Grey, fine to coarse SAND with fine gravel and 1/8 in. white shell fragments; strong petroleum-like odor, heavy sheen (medium dense, saturated) **Collected soil sample MGP-GP-35-18.0-19.0 at 18.0-19.0 ft. bgs**	



Boring Completed 08/19/10
Total Depth of Boring = 19.0 ft.

Refusal on sandstone (?) at 19.0 ft. bgs

20

25

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Bellingham, Washington

Log of Soil Boring GP-35

Figure B-38

GP-36

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	USCS Symbol	Soil Profile	Water Level
0						WD	Topsoil and beauty bark	
	10		d3			SM	Grey and brown, silty, fine SAND; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-36-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	5		d3		1.2	DB	DEBRIS, including red brick, grey silt, black wood debris; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-GP-36-4.0-5.0 at 4.0-5.0 ft. bgs**	ATD
10	0		d3			WD	Black, fine WOOD DEBRIS; organic odor, no sheen (loose, wet) **Collected soil sample MGP-GP-36-13.0-14.0 at 13.0-14.0 ft. bgs** **Collected soil sample MGP-GP-36-14.0-15.0 at 14.0-15.0 ft. bgs**	
15	-5		d3		0.9			
20	-10		d3		6.6	SP	Grey, medium to coarse SAND with occasional white shell fragments; no odor, no sheen (medium dense, wet) **Collected soil sample MGP-GP-36-21.0-22.0 at 21.0-22.0 ft. bgs** Refusal on sandstone (?) at 22.0 ft. bgs	

Drilling Method: GeoprobeTM

Ground Elevation (ft): 11.27

Boring Completed 08/20/10
Total Depth of Boring = 22.0 ft.

Notes:
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Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-36

Figure B-39

GP-37

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Soil Profile	Water Level
0							SM	Light brown, silty, fine SAND with gravel; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-37-0.5-1.0 at 0.5-1.0 ft. bgs**	
	10		d3		0.0				
5							WD	Brown to black, medium to coarse WOOD DEBRIS; no odor, no sheen (loose, wet) **Collected soil sample MGP-GP-37-5.0-6.0 at 5.0-6.0 ft. bgs** - saturated at 6 ft. bgs	ATD
	5		d3		0.0				
10	0		d3		0.0			**Collected soil sample MGP-GP-37-14.0-15.0 at 14.0-15.0 ft. bgs**	
15	-5		d3		147			**Collected soil sample MGP-GP-37-17.0-18.0 at 17.0-18.0 ft. bgs** - petroleum-like odor and medium sheen from 19-24 ft. bgs **Collected soil sample MGP-GP-37-19.0-20.0 at 19.0-20.0 ft. bgs**	
20	-10		d3		74.7		SP	Grey, fine to coarse SAND with white shell fragments; strong petroleum-like odor, medium sheen (loose, saturated)	
							RK	**Collected soil sample MGP-GP-37-22.0-23.0 at 22.0-23.0 ft. bgs** **Collected soil sample MGP-GP-37-23.0-24.0 at 23.0-24.0 ft. bgs** Grey, fine to medium grained SANDSTONE **Collected soil sample MGP-GP-37-24.0-25.0 at 24.0-25.0 ft. bgs** Refusal at 25.0 ft. bgs	
25									
30									
35									

Drilling Method: GeoprobeTM

Ground Elevation (ft): 11.81

Boring Completed 08/20/10
Total Depth of Boring = 25.0 ft.

Notes:
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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-37

Figure
B-40

GP-38

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 12.17	Water Level
0–4	10		d3		2.3		SM/ML	Brown, silty, fine SAND to sandy SILT with gravel; no odor, no sheen (loose, damp) **Collected soil sample MGP-GP-38-0.5-1.0 at 0.5-1.0 ft. bgs**	
4–8.5	5		d3				WD	Dark brown to black, fine to medium WOOD DEBRIS with approximately 20% medium sand; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-38-4.0-5.0 at 4.0-5.0 ft. bgs**	ATD
8.5–19	0, -5		d3, d3		18.7		WD	Black, coarse WOOD DEBRIS with some fresh surfaces exposed by drilling; organic odor, no sheen (loose, wet) **Collected soil sample MGP-GP-38-12.0-13.0 at 12.0-13.0 ft. bgs**	
19–27	-10		d3, d3		6.7		SP-SM	Grey and light brown, fine to medium SAND with silt and gravel and medium sand sized white shell fragments; organic odor, no sheen (loose, saturated) **Collected soil sample MGP-GP-38-22.0-23.0 at 22.0-23.0 ft. bgs** **Collected soil sample MGP-GP-38-26.0-27.0 at 26.0-27.0 ft. bgs**	

Boring Completed 08/19/10
Total Depth of Boring = 27.0 ft.

Refusal on sandstone (?) at 27.0 ft. bgs

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-38

Figure
B-41

GP-39

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 11.22

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Water Level
0	10		d3				SM	Brown and grey, silty, fine SAND with gravel; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-39-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	5		d3		0.0		WD	Brown, WOOD DEBRIS consisting of 3-12 in. alternating horizons of coarse and fine peat-like material; organic odor, no sheen (loose, wet) **Collected soil sample MGP-GP-39-4.0-5.0 at 4.0-5.0 ft. bgs**	ATD
					2.1			**Collected soil sample MGP-GP-39-8.0-9.0 at 8.0-9.0 ft. bgs**	
10	0		d3						
15	-5		d3		10.4			**Collected soil sample MGP-GP-39-14.0-15.0 at 14.0-15.0 ft. bgs**	
20	-10		d3						
25	-15		d3						
					257			- strong sulfide odor at 30 ft. bgs **Collected soil sample MGP-GP-39-29.0-30.0 at 29.0-30.0 ft. bgs**	
30			d3		2.1		SP-SM	Grey, fine SAND with silt, clay, and 1/4 in. lenses of medium to coarse sand and broken shell material; no odor, no sheen (dense, saturated) **Collected soil sample MGP-GP-39-30.0-31.0 at 30.0-31.0 ft. bgs**	
								Refusal at sandstone (?) at 31.0 ft. bgs	
35									
40									
45									

Boring Completed 08/20/10
Total Depth of Boring = 31.0 ft.

Notes:
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Bellingham, Washington

Log of Soil Boring GP-39

Figure
B-42

GP-40

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: GeoprobeTM

Ground Elevation (ft): 11.02

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Water Level
0	10		d3				SM/ ML	Brown to black, fine SAND with silt to SILT with sand; no odor, no sheen (moist, loose) **Collected soil sample MGP-GP-40-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	5		d3				SP	Brown, fine to medium SAND with occasional 1/2 in. wood debris layers; no odor, no sheen (medium dense, wet) **Collected soil sample MGP-GP-40-5.0-6.0 at 5.0-6.0 ft. bgs**	ATD
					0.0		WD	Brown to black, coarse WOOD DEBRIS; no odor, no sheen (loose, wet) - very fresh wood surfaces broken by drilling from 10-20 ft. bgs	
10	0		d3						
15	-5		d3		0.0			**Collected soil sample MGP-GP-40-14.0-15.0 at 14.0-15.0 ft. bgs**	
20								- drill rods difficult to remove (wood possibly swelling around rods), stopped drilling at 20 ft. bgs	

Boring Completed 08/20/10
Total Depth of Boring = 20.0 ft.

25

30

35

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-40

Figure
B-43

GP-41

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 10.47	Water Level
0	10		d3				SM	Brown, silty, fine SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-41-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	5		d3		0.0			**Collected soil sample MGP-GP-41-5.0-6.0 at 5.0-6.0 ft. bgs**	ATD
							WD	Black, 1/4 in. or less diameter WOOD DEBRIS; no odor, no sheen (loose, saturated)	
10	0		d3		0.0			- wood is charcoal-like from 10-27.5 ft. bgs	
15	-5		d3		0.0			**Collected soil sample MGP-GP-41-14.0-15.0 at 14.0-15.0 ft. bgs**	
20	-10		d3		0.0				
25	-15		d3						
					41.0		ML/ WD	Brown WOOD DEBRIS and grey SILT; strong sulfide and faint petroleum-like odor, no sheen (loose, wet) **Collected soil sample MGP-GP-41-28.0-29.0 at 28.0-29.0 ft. bgs** Refusal at sandstone (?) at 29.0 ft. bgs	
30									
35									

Boring Completed 08/30/10
Total Depth of Boring = 29.0 ft.

Notes:
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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-41

Figure B-44

GP-42

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 10.32	Water Level
0	10						SM	Grey to light brown, silty, fine SAND with gravel; no odor, no sheen (loose, dry)	
			d3				SM	**Collected soil sample MGP-GP-42-0.5-1.0 at 0.5-1.0 ft. bgs**	
5	5						WD	Brown, silty, fine to coarse SAND with gravel; no odor, no sheen (moist, medium dense)	
			d3		0.2			Dark brown to black, 1-1 1/2 in. pieces of WOOD DEBRIS; organic odor, no sheen (loose, wet)	ATD
10	0							**Collected soil sample MGP-GP-42-4.0-5.0 at 4.0-5.0 ft. bgs**	
			d3						
15	-5							**Collected soil sample MGP-GP-42-14.0-15.0 at 14.0-15.0 ft. bgs**	
			d3		0.0				
20	-10								
			d3						
25	-15							**Collected soil sample MGP-GP-42-24.0-25.0 at 24.0-25.0 ft. bgs**	
			d3						
30	-20								
			d3				SM	Grey, silty, fine to coarse SAND with gravel and shell fragments; sulfur-like odor, no sheen (medium dense, saturated	
35	-25		d3		0.0			**Collected soil sample MGP-GP-42-35.0-36.0 at 35.0-36.0 ft. bgs**	
40									
45									

Boring Completed 08/20/10
Total Depth of Boring = 36.0 ft.

Refusal at sandstone (?) at 36.0 ft. bgs

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-42

Figure B-45

GP-44

SAMPLE DATA

Depth (ft)	Elevation	Sampler Type	PID (ppm)
0			
	55		
		d3	
			31.5
			500
5			
	50		150
		d3	
			2.2
10			
	45		
		d3	3.0

Boring Completed 08/18/10
Total Depth of Boring = 14.0 ft.

SOIL PROFILE

Drilling Method: GeoprobeTM

Ground Elevation (ft): 55.97

USCS Symbol	Description
SM	Light brown, silty, fine SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-44-0.5-1.0 at 0.5-1.0 ft. bgs**
SP-SM	- 3 in. brown horizon at 1.5 ft. bgs Grey, medium to coarse SAND with silt and debris; strong petroleum-like odor, very shiny sheen (loose, dry) **Collected soil sample MGP-GP-44-2.5-3.5 at 2.5-3.5 ft. bgs**
DB	Black, medium to coarse sand sized granular material; strong petroleum-like odor, very shiny sheen (loose, dry)
ML	Grey SILT with black, shiny, coarse sand-sized nodules; strong light-petroleum-like odor, very shiny sheen (medium dense, moist) **Collected soil sample MGP-GP-44-5.0-6.0 at 5.0-6.0 ft. bgs**
ML	Grey SILT with sand and gravel; no odor, no sheen (dense, moist) - some orange mottling at 11 ft. bgs - wet at 13 ft. bgs **Collected soil sample MGP-GP-44-13.0-14.0 at 13.0-14.0 ft. bgs** Refusal at sandstone (?) at 14.0 ft. bgs

GROUNDWATER

Water Level: ATD

Depth (ft) scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

GP-45

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): 17.16	Water Level
0							GM	Grey and white, silty, sandy, fine to coarse GRAVEL; no odor, no sheen (loose, dry)	
							SM	Brown, silty, gravelly, fine to coarse SAND; no odor, no sheen (loose, dry) **Collected soil sample MGP-GP-45-0.5-1.0 at 0.5-1.0 ft. bgs**	
	15		d3		0.1		SM/ML	Brown and black SILT and medium to coarse SAND with gravel-sized metallic grains; no odor, no sheen (loose, moist) **Collected soil sample MGP-GP-45-5.0-6.0 at 5.0-6.0 ft. bgs**	
5	10		d3		0.2				
10	5		d3		0.0			- 6 in. think layer of dominantly black shiny grains at 11 ft. bgs	
							SP	Light brown to green, fine to medium SAND with 6 in. think saturated lenses; no odor, no sheen (dense, wet) **Collected soil sample MGP-GP-45-13.0-14.0 at 13.0-14.0 ft. bgs**	ATD
15							RK	Grey, fine to medium grained SANDSTONE **Collected soil sample MGP-GP-45-14.0-15.0 at 14.0-15.0 ft. bgs** Refusal at 15.0 ft. bgs	

Boring Completed 08/19/10
Total Depth of Boring = 15.0 ft.

20

25

30

35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
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3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

Landau Associates

South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-45

Figure B-47

GP-56

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): 14.09	Water Level
0							WD	Wood chips and topsoil	
							SP	Brown-red, fine SAND (no odor, no sheen) (medium dense, damp)	
			d3		0.0		ML	**Collected soil sample MGP-GP-56-1.0-2.0 at 1.0-2.0 ft. bgs**	
	10							Brown, sandy SILT with gravel (no odor, no sheen) (dense, moist)	
5								**Collected soil sample MGP-GP-56-3.0-4.0 at 3.0-4.0 ft. bgs**	
								- coarse white gravel at 5 ft bgs	
			d3		0.0		WD	Black, 1/4 to 1/2 inch diameter, weathered wood chips and charcoal with black fine organic silt (hydrogen sulfide-like odor, no sheen) (medium dense, moist to wet)	ATD
10	5							- 0.3 ft thick layer of brown sand with silt	
								- wet	
			d3		0.0			**Collected soil sample MGP-GP-56-10.0-11.0 at 10.0-11.0 ft. bgs**	
	0							- wood debris slightly weathered below 11 ft bgs	
15			d3		0.0		SP-SM	Grey, fine to medium SAND with silt (organic odor, no sheen) (dense, moist)	
								Collected soil sample MGP-GP-56-14.5-15.5 at 14.5-15.5 ft. bgs	
							RK	Grey SANDSTONE	
								Refusal at 16 ft bgs	

Boring Completed 10/03/12
Total Depth of Boring = 16.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-56

Figure B-48

GP-57

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): 16.59 MLLW	Water Level
0			d3		0.3		SM	Light brown, silty, fine to medium SAND with coarse sand and gravel (no odor, no sheen) (medium dense, dry) **Collected soil sample MGP-GP-57-1.0-2.0 at 1.0-2.0 ft. bgs**	
5			d3		0.7			**Collected soil sample MGP-GP-57-5.0-6.0 at 5.0-6.0 ft. bgs**	
							WD	Black, 1/4 to 1 inch diameter moderately weathered wood chips with black fine organic silt and some charcoal pieces (hydrogen sulfide-like odor, no sheen) (medium dense, wet)	ATD
10			d3		0.9			**Collected soil sample MGP-GP-57-11.0-12.0 at 11.0-12.0 ft. bgs** - with 1/8 to 1/4 inch diameter unweathered sawdust	
15			d3		0.5 0.5				
20							SP-SM	Grey, fine SAND with silt and some white shell fragments (hydrogen sulfide-like odor, no sheen) (dense, wet) **Collected soil sample MGP-GP-57-19.5-20.0 at 19.5-20.0 ft. bgs**	
							RK	Grey SANDSTONE	
								Refusal at 22 ft bgs	

Boring Completed 10/03/12
Total Depth of Boring = 22.0 ft.

25

30

35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring GP-57

Figure B-49

HA-01

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-01-0.0-0.5**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 0.5 ft.

2

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Hand Auger Boring HA-01

HA-02

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-02-0.0-0.5**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 0.5 ft.

2

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Manufactured Gas Plant
Bellingham, Washington

Log of Hand Auger Boring HA-02

Figure
B-51

HA-03

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-03-0.0-1.0**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

2

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

Log of Hand Auger Boring HA-03

Figure
B-52

HA-04

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-04-0.0-0.5**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 0.5 ft.

2

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

HA-05

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-05-0.0-1.0**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

2

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Bellingham, Washington

Log of Hand Auger Boring HA-05

Figure
B-54

HA-06

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-06-0.0-1.0**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

2

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

Log of Hand Auger Boring HA-06

Figure
B-55

HA-07

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-07-0.0-0.5**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 0.5 ft.

2

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

Log of Hand Auger Boring HA-07

Figure
B-56

HA-08

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-08-0.0-1.0**	Groundwater not encountered.
2									

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Manufactured Gas Plant
Bellingham, Washington

Log of Hand Auger Boring HA-08

Figure
B-57

HA-09

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-09-0.0-1.0**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

2

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Bellingham, Washington

Log of Hand Auger Boring HA-09

Figure
B-58

HA-10

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-10-0.0-1.0**	Groundwater not encountered.

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

2

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Bellingham, Washington

Log of Hand Auger Boring HA-10

HA-11

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-11-0.0-1.0**	Groundwater not encountered.
2									

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Bellingham, Washington

Log of Hand Auger Boring HA-11

Figure
B-60

HA-12

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					**Collected soil sample MGP-HA-12-0.0-1.0**	Groundwater not encountered.
2									

Boring Completed 08/26/10
Total Depth of Boring = 1.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

Log of Hand Auger Boring HA-12

Figure
B-61

HA-13

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					Collected soil sample MGP-HA-13-1.0-1.5 from below ivy roots, organic topsoil	Groundwater not encountered.
2									

Boring Completed 09/20/10
Total Depth of Boring = 1.5 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Bellingham, Washington

Log of Hand Auger Boring HA-13

Figure B-62

HA-14

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hand Auger Ground Elevation (ft): NA	
0			d5					Collected soil sample MGP-HA-14-1.0-1.5 from below ivy roots, organic topsoil	Groundwater not encountered.
2									

Boring Completed 09/20/10
Total Depth of Boring = 1.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

Log of Hand Auger Boring HA-14

Figure
B-63

HS-26

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft):	
0							SM	From cuttings: Brown, silty, fine to coarse SAND; no odor, no sheen; (dry)	Groundwater not encountered.
5			a2	50/ 2"			RK	Grey, fine to medium grained SANDSTONE	
10			a2	50/ 2"				- very slight petroleum-like odor at 10 ft. bgs **Collected soil sample MGP-HS-26-10.0-10.2 at 10.0-10.2 ft. bgs**	

Boring Completed 08/23/10
Total Depth of Boring = 10.2 ft.

15
20
25
30
35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Soil Boring HS-26

Figure
B-64

HS-43

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 56.56	
0	55							Drill cuttings: dry shredded wood, coarse gravel, glass bottle shard - choppy drilling at 3 ft. bgs	Groundwater not encountered.
5	50		a2	50/ 5"	0.2		RK	Red/orange, fine SAND with silt; no odor, no sheen (very dense, dry)(weathered sandstone) **Collected soil sample MGP-HS-43-5.0-5.5 at 5.0-5.5 ft. bgs**	
10	45		a2	50/ 4"				**Collected soil sample MGP-HS-43-10.0-10.5 at 10.0-10.5 ft. bgs**	
15	40		a2	50/ 2"	12.9			- slight creosote-like odor at 15 ft. bgs **Collected soil sample MGP-HS-43-15.0-15.5 at 15.0-15.5 ft. bgs**	

Boring Completed 08/26/10
Total Depth of Boring = 18.0 ft.

20

25

30

35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
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Bellingham, Washington

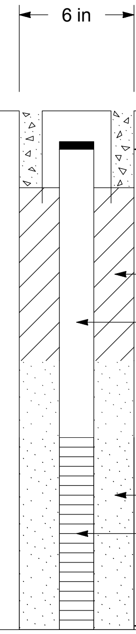
Log of Soil Boring HS-43

Figure
B-65

MW-07

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 53.80	Water Level
0								See GP-07 for lithology	Groundwater not encountered.
5	50								
10	45								
13.0–13.5		(sample interval)	a2	50/6"			ML	Grey and brown SILT with gravel and sand; slight petroleum-like odor, no sheen (very dense, moist) **Collected soil sample MGP-HS-07-13.0-13.5 at 13.0-13.5 ft. bgs** Refusal on bedrock at 13.5 ft. bgs	

Monitoring Well Detail



Boring Completed 08/26/10
Total Depth of Boring = 13.5 ft.

Monitoring Well Completed 08/26/10
Elevation at Top of Monitoring Well Casing = 53.42 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

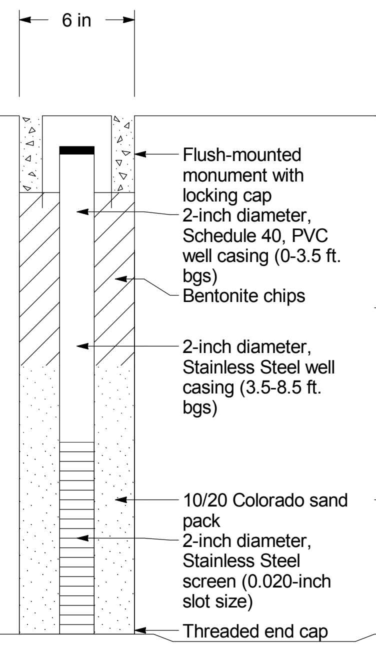
Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

MW-19

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 58.58	Water Level
0								See GP-19 for lithology	Groundwater not encountered.
12.0–12.5			a2	39	364		ML	Brown sandy SILT; gasoline-like odor, no sheen (medium dense, damp) **Collected soil sample MGP-HS-19-12.0-12.5 at 12.0-12.5 ft. bgs**	
13.0–13.5							CL	Grey silty CLAY; gasoline-like odor, no sheen (very stiff, moist) **Collected soil sample MGP-HS-19-13.0-13.5 at 13.0-13.5 ft. bgs**	

Depth scale (ft): 0, 5, 10, 15, 20, 25, 30, 35. Elevation scale: 55, 50.

Boring Completed 08/26/10
Total Depth of Boring = 13.5 ft.



Monitoring Well Completed 08/26/10
Elevation at Top of Monitoring Well Casing = 58.15 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

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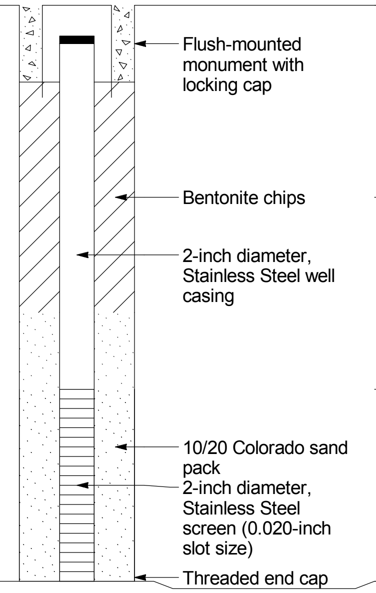
South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-19

Figure
B-67

MW-24

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 54.46	Water Level / Monitoring Well Detail (6 in)
0								See GP-24 for lithology	Groundwater not encountered.
14.5–15	40		a2	50/ 6"			ML	Grey to green with black mottling, sandy SILT with black granular nodules and gravel; medium petroleum-like odor, medium sheen (very dense, moist) **Collected soil sample MGP-HS-24-14.5-15.0 at 14.5-15.0 ft. bgs** Refusal on bedrock at 15.0 ft. bgs	



Boring Completed 08/26/10
Total Depth of Boring = 15.0 ft.

Monitoring Well Completed 08/26/10
Elevation at Top of Monitoring Well Casing = 53.83 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

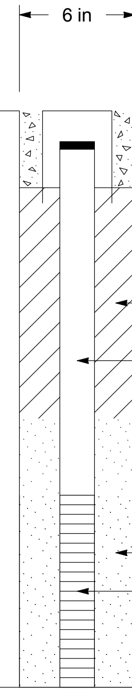
Log of Monitoring Well MW-24

Figure
B-68

MW-28

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 19.61	Water Level
0–10								See GP-28 for lithology	
10–15			a2	11			ML	Brown SILT with black gravel sized coal tar-like grains; slight petroleum-like odor, no sheen (loose, moist)	
			a2	50/ 3"	0.6			**Collected soil sample MGP-GP-28-10.0-11.5 at 10.5-11.5 ft. bgs** **Collected soil sample MGP-GP-28-12.5-14.0 at 12.5-14.0 ft. bgs** - moist to wet at 13 ft. bgs	ATD

Monitoring Well Detail



Boring Completed 08/23/10
Total Depth of Boring = 15.0 ft.

Refusal on bedrock at 15.0 ft. bgs

Monitoring Well Completed 08/23/10
Elevation at Top of Monitoring Well Casing = 19.27 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-28

Figure
B-69

MW-29

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 19.92	Water Level	Monitoring Well Detail (6 in)
0								See GP-29 for lithology	Groundwater not encountered.	Flush-mounted monument with locking cap
5	15									Bentonite chips
										2-inch diameter, Schedule 40, PVC well casing
10	10									10/20 Colorado sand pack
										2-inch diameter, Schedule 40, PVC screen (0.020-inch slot size)
			a2	60/ 7"	2.8		ML	Grey, sandy SILT with gravel; strong petroleum-like odor, medium sheen (medium dense, moist)		
15	5									Threaded end cap

Boring Completed 08/24/10
Total Depth of Boring = 15.0 ft.

Collected soil sample MGP-HS-29-13.5-14.0 at 13.5-14.0 ft. bgs

Collected soil sample MGP-HS-29-14.0-15.0 at 14.0-15.0 ft. bgs

Refusal on bedrock at 15.0 ft. bgs

Monitoring Well Completed 08/24/10
Elevation at Top of Monitoring Well Casing = 19.61 ft.

20

25

30

35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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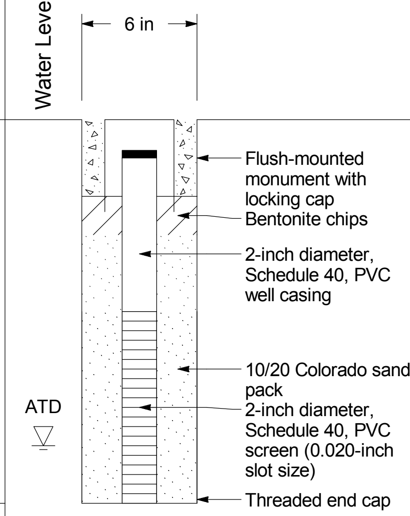
South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-29

Figure B-70

MW-31

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 15.21	Water Level / Monitoring Well Detail
0	15							See GP-31 for lithology	
5	10								
10	5		a2	50/ 6"	27.0		SP-SM	Grey, fine to medium SAND with silt; strong petroleum-like odor, medium sheen (very dense, wet)	ATD



Boring Completed 08/23/10
Total Depth of Boring = 11.5 ft.

Collected soil sample MGP-HS-31-10.0-11.0 at 10.0-11.0 ft. bgs

Refusal on bedrock at 12.0 ft. bgs

Monitoring Well Completed 08/23/10
Elevation at Top of Monitoring Well Casing = 14.88 ft.

Depth (ft): 15, 20, 25, 30, 35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

MW-34

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 10.66	Water Level	Monitoring Well Detail (6 in)
0	10							See GP-34 for lithology		Flush-mounted monument with locking cap Bentonite chips 2-inch diameter, Schedule 40, PVC well casing
5	5								ATD	
10	0		a2	73			SM	Grey, silty, fine to medium SAND with fine white shell fragments; no odor, light sheen (very dense, wet) **Collected soil sample MGP-HS-34-10.0-11.0 at 10.0-11.0 ft. bgs**		10/20 Colorado sand pack 2-inch diameter, Schedule 40, PVC screen (0.020-inch slot size)
			a2	50/ 6"				**Collected soil sample MGP-HS-34-10.0-13.0 at 10.0-13.0 ft. bgs**		
15			a2	50/ 2"						Threaded end cap

Boring Completed 08/23/10
Total Depth of Boring = 15.2 ft.

Refusal on bedrock at 15.2 ft. bgs

Monitoring Well Completed 08/23/10
Elevation at Top of Monitoring Well Casing = 10.37 ft.

Depth scale: 20, 25, 30, 35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-34

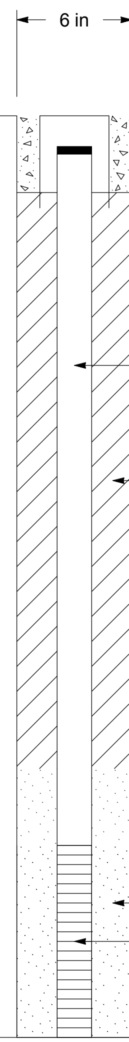
Figure
B-72

MW-36

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 11.56	Water Level
0								See GP-36 for lithology	
22.5–24.0			a2	97/ 11"			SM	Grey, silty, fine SAND with gravel; no odor, no sheen (dense, moist)	ATD

Depth scale (ft): 0, 5, 10, 15, 20, 25, 30, 35
Elevation scale: 10, 5, 0, -5, -10

Monitoring Well Detail



Collected soil sample MGP-HS-36-22.5-24.0 at 22.5-24.0 ft. bgs

Boring Completed 08/24/10
Total Depth of Boring = 24.0 ft.

Refusal on bedrock at 24.0 ft. bgs

Monitoring Well Completed 08/24/10
Elevation at Top of Monitoring Well Casing = 11.06 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-36

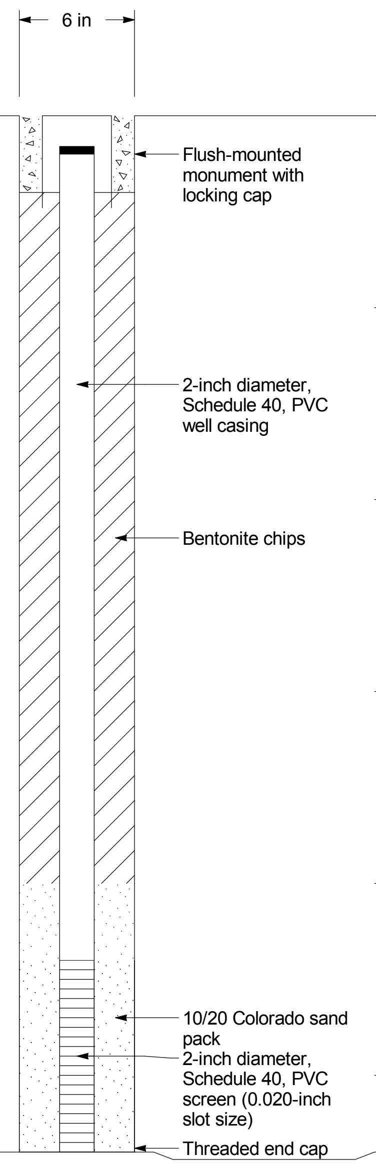
Figure B-73

MW-38

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 12.29	Water Level
0								See GP-38 for lithology	
25			a2	65			SP	Grey and brown, fine to coarse SAND with gravel and white shell fragments; no odor, no sheen (medium dense, wet)	

Water Level: ATD

Monitoring Well Detail



Depth scale (ft): 0, 5, 10, 15, 20, 25, 30, 35
Elevation scale: 10, 5, 0, -5, -10

Boring Completed 08/25/10
Total Depth of Boring = 27.0 ft.

Collected soil sample MGP-HS-38-25.0-26.0 at 25.0-26.0 ft. bgs

Collected soil sample MGP-HS-38-25.0-26.5 at 25.0-26.5 ft. bgs

Collected soil sample MGP-HS-38-26.0-26.5 at 26.0-26.5 ft. bgs

Refusal on bedrock at 27 ft. bgs

Monitoring Well Completed 08/25/10
Elevation at Top of Monitoring Well Casing = 11.79 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-38

Figure
B-74

MW-40

SAMPLE DATA / SOIL PROFILE / GROUNDWATER

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 11.16

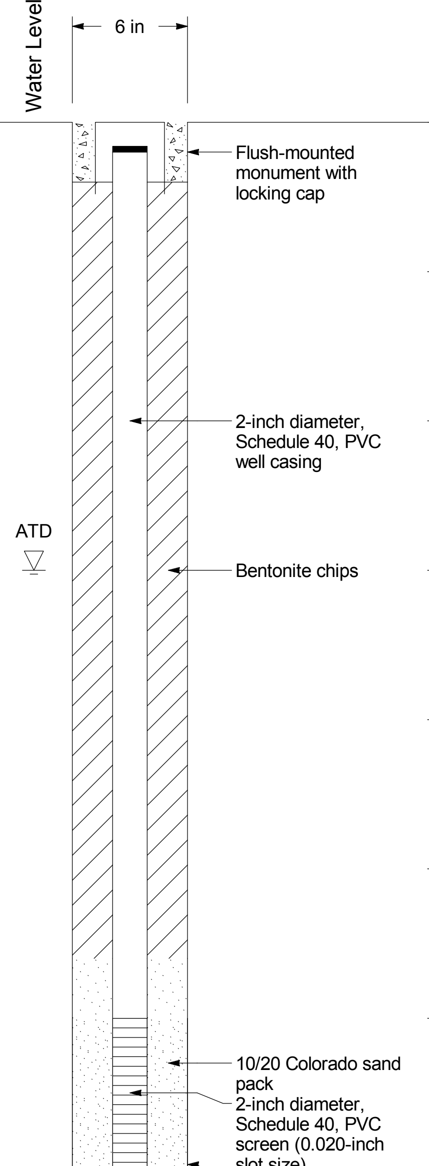
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description
0								See GP-40 for lithology
25			a2	50/ 6"			WD	Brown to black shredded WOOD DEBRIS; sulfide odor, no sheen (very dense, saturated) **Collected soil sample MGP-HS-40-25.0-25.5 at 25.0-25.5 ft. bgs**
30			a2	50/ 3"				
34			a2	50/ 5"				**Collected soil sample MGP-HS-40-34.0-34.5 at 34.0-34.5 ft. bgs**
34.5							RK	Grey, fine to medium grained SANDSTONE
35								Refusal on bedrock at 35.0 ft. bgs

Depth (ft) scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Elevation scale: 10, 5, 0, -5, -10, -15, -20

Water Level: ATD

Monitoring Well Detail



Boring Completed 08/25/10
Total Depth of Boring = 35.0 ft.

Monitoring Well Completed 08/25/10
Elevation at Top of Monitoring Well Casing = 10.75 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-40

Figure B-75

MW-42

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 10.30

Monitoring Well Detail (6 in)

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description	Water Level
0	10							Auger to 34.5 ft. bgs with wooden plug in bottom auger See GP-42 for lithology	
5	5								
10	0								ATD
15	-5								
20	-10								
25	-15								
30	-20								
35	-25		a2	44			SM	Grey, silty, gravelly, fine to coarse SAND with shell fragments; no odor, no sheen (medium dense, saturated)	

Well construction:
- Flush-mounted monument with locking cap
- 2-inch diameter, Schedule 40, PVC well casing
- Bentonite chips
- 10/20 Colorado sand pack
- 2-inch diameter, Schedule 40, PVC screen (0.020-inch slot size)
- Threaded end cap

Boring Completed 08/23/10
Total Depth of Boring = 36.0 ft.

Collected soil sample MGP-MW-42-34.5-36.0 at 34.5-36.0 ft. bgs

Refusal on bedrock at 36.0 ft. bgs

Monitoring Well Completed 08/23/10
Elevation at Top of Monitoring Well Casing = 9.86 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-42

MW-44

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Depth (ft) | Elevation | Sample Number & Interval | Sampler Type | Blows/Foot | PID (ppm) | Graphic Symbol | USCS Symbol | Water Level

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 54.98

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	USCS Symbol	Description
0							See GP-44 for lithology
5	50						- Drill cuttings: grey, moist to wet with a tar-like odor
10	45						
13			a2	50/ 1"	134	ML	Grey to green, SILT with sand and gravel and shiny coarse sand-sized nodules; strong tar-like odor, heavy sheen (medium dense, moist)

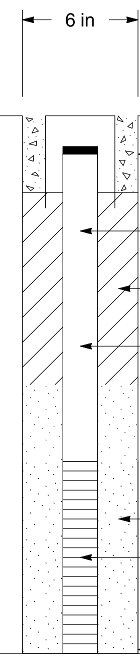
Collected soil sample MGP-HS-44-13.0-13.5 at 13.0-13.5 ft. bgs

Refusal on bedrock at 14.0 ft. bgs

Boring Completed 08/26/10
Total Depth of Boring = 14.0 ft.

Groundwater not encountered.

Monitoring Well Detail



Monitoring Well Completed 08/26/10
Elevation at Top of Monitoring Well Casing = 54.53 ft.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

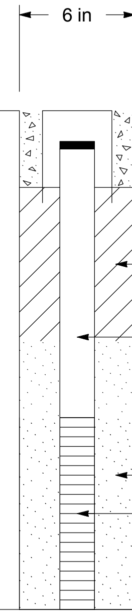
Log of Monitoring Well MW-44

Figure B-77

MW-45

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-stem Auger Ground Elevation (ft): 16.55	Water Level
0 – 12.0	15, 10, 5							See GP-45 for lithology	Groundwater not encountered.
12.0 – 13.0			a2	50/ 5"			SM/ WD	Brown, silty, WOOD DEBRIS with light brown to green, silty, fine to medium SAND; faint unidentifiable odor, no sheen (very dense, moist) **Collected soil sample MGP-HS-45-12.0-13.0 at 12.0-13.0 ft. bgs**	

Monitoring Well Detail



Boring Completed 08/25/10
Total Depth of Boring = 13.0 ft.

Refusal on bedrock at 13.0 ft. bgs

Monitoring Well Completed 08/25/10
Elevation at Top of Monitoring Well Casing = 16.00 ft.

Depth scale (ft): 0, 5, 10, 15, 20, 25, 30, 35

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-45

Figure
B-78

MW-46

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Hollow-Stem Auger Ground Elevation (ft): 9.74	Water Level
0							SP	Brown and grey, medium to coarse SAND with shell fragments; no odor, no sheen (loose, moist) **Collected soil sample MGP-HS-46-1.0-2.0 at 1.0-2.0 ft. bgs**	ATD
2	8		a2	12	0.0				
			a2	8	0.0		WD	Dark brown, weathered WOOD DEBRIS with sand and trace silt and occasional brick fragments; tar-like odor, no sheen (very loose, wet) **Collected soil sample MGP-HS-46-3.0-4.0 at 3.0-4.0 ft. bgs**	
4	6		a2	50/ 2"	0.0		ML	Dark brown SILT with wood, gravel, sand and shell fragments and occasional cobbles or rip rap; slight creosote-like or organic odor, no sheen (very stiff, wet) **Collected soil sample MGP-HS-46-4.0-4.5 at 4.0-4.5 ft. bgs**	
6	4		a2	84	0.0				
			a2	50/ 6"	0.0		SP-SM	Red brown, fine to medium SAND with silt; no odor, no sheen (medium dense, wet) **Collected soil sample MGP-HS-46-6.5-7.0 at 6.5-7.0 ft. bgs**	
8	2								
			a2	32	0.0				
10	0		a2	50/ 6"			SP-SM	Grey, fine to medium SAND with silt and a piece of moderately weathered wood with a tar-like odor; no sheen (dense, wet) **Collected soil sample MGP-HS-46-10.0-11.0 at 10.0-11.0 ft. bgs**	
			a2	100/ 2"			RK	Grey, fine to medium grained SANDSTONE	
12								Refusal at 11.17 ft. bgs	

Boring Completed 02/01/12
Total Depth of Boring = 11.2 ft.

14

16

18

20

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SOIL BORING LOG W/ ELEV

MW-53

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 16.09

Monitoring Well Detail (DOE#: BHM-114)

Depth (ft)	Elevation	Sampler Type	Blows/Foot	PID (ppm)	USCS Symbol	Description
0	16				WD	Wood chips and topsoil; no odor, no sheen (very loose, moist)
		a2	20	0.0	SM	**Collected soil sample MGP-HS-53-1.0-2.0 at 1.0-2.0 ft. bgs**
2	14					Grey-brown, silty, fine SAND with trace gravel; no odor, no sheen (loose, moist)
					ML	Brown SILT with sand; no odor, no sheen (stiff, moist)
		a2	18	0.0	SP	Tan, medium SAND; no odor, no sheen (loose, moist)
4	12	a2	11	0.0	ML	Brown SILT with trace sand and gravel; no odor, no sheen (medium stiff to stiff, moist) **Collected soil sample MGP-HS-53-4.0-5.0 at 4.0-5.0 ft. bgs** -Black SILT with small roots smaller than 1/8" at 4.5-5.0 ft bgs
6	10	a2	36	0.0	SM	Tan, medium SAND with silt and trace gravel; no odor, no sheen (medium dense, moist) **Collected soil sample MGP-HS-53-5.5-6.5 at 5.5-6.5 ft. bgs** **Collected soil sample MGP-HS-53-9.0-10.0 at 9.0-10.0 ft. bgs**
8	8	a2	22	0.0		
		a2	34	0.0	SP	Grey, fine to medium SAND with one very soft piece of weathered sandstone with a 1/4" wide vein of black, shiny, fine sand sized grains; no odor, no sheen (medium dense, damp)
10	6	a2	67	0.0	SP-SM	Grey, fine SAND with silt and trace gravel and white shell fragments; no odor, no sheen (medium dense, wet) **Collected soil sample MGP-HS-53-10.5-11.5 at 10.5-11.5 ft. bgs**
		a2	75/ 2"		RK	Grey, fine to medium sand sized SANDSTONE, moderately weathered; no odor, no sheen
12						Refusal at 11.67 ft. bgs

Water Level: ATD (approx. 8.7 ft)

Boring Completed 02/01/12
Total Depth of Boring = 11.7 ft.

Monitoring Well Completed 02/01/12
Elevation at Top of Monitoring Well Casing = 15.56 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-53

Figure B-80

MW-54

SAMPLE DATA

Sampler Type	Blows/Foot	PID (ppm)
a2	32	0.0
a2	14	
a2	3	0.0
a2	4	0.0
a2	3	0.0
a2	2	0.0
a2	2	0.0
a2	8	0.0
a2	54/ 10"	0.0
a2	80/ 4"	

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Elevation: 12, 10, 8, 6, 4, 2, 0

Boring Completed 02/03/12
Total Depth of Boring = 14.8 ft.

SOIL PROFILE

Drilling Method: Hollow-Stem Auger

Ground Elevation (ft): 13.19

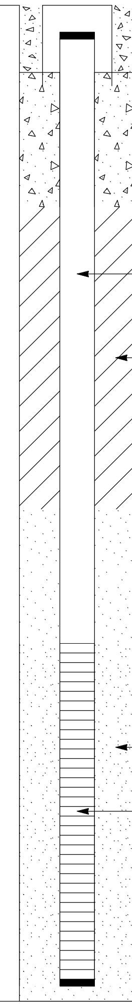
USCS Symbol	Description
SP	Brown, gravelly, fine to coarse SAND with trace silt; no odor, no sheen (loose to medium dense, moist) **Collected soil sample MGP-HS-54-1.0-1.5 at 1.0-1.5 ft. bgs** - grades to silty sand without gravel
SP	Brown and black, fine to medium SAND with fine to medium, severely decomposed organic material; no odor, no sheen (very loose, moist) **Collected soil sample MGP-HS-54-5.5-6.0 at 5.5-6.0 ft. bgs**
WD	Black, 1/4"-1/2" diameter irregular shaped, slightly to severely decomposed, WOOD DEBRIS with some charcoal pieces and silt; hydrogen sulfide odor, no sheen (very loose, wet) - larger, irregular pieces of wood up to 3" diameter mixed in with smaller wood debris **Collected soil sample MGP-HS-54-9.0-10.0 at 9.0-10.0 ft. bgs** **Collected soil sample MGP-HS-54-11.5-12.0 at 11.5-12.0 ft. bgs** - pieces of 3" diameter dimensional lumber and abundant charcoal and fine black organic material at 12 ft. bgs **Collected soil sample MGP-HS-54-13.0-14.0 at 13.0-14.0 ft. bgs**
SP	Grey, fine to medium SAND and trace silt with shell fragments; slight petroleum-like odor, very slight sheen (very dense, wet)
RK	Grey, fine to medium grained SANDSTONE

Refusal at 14.83 ft. bgs

GROUNDWATER

Water Level: ATD

Monitoring Well Detail
(DOE#: BHM-117)



Monitoring Well Completed 02/03/12
Elevation at Top of Monitoring Well Casing = 12.56 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-54

Figure B-81

MW-55

SAMPLE DATA

Elevation	Sampler Type	Blows/Foot	PID (ppm)
10	a2	38	0.0
8	a2	21	0.0
	a2	58	0.0
6	a2	29	0.0
4	a2	12	
2	a2	57/ 10"	
	a2	18	
0	a2	40	
-2	a2	14	
-4	a2	12	
	a2	22	H2S=169
-6	a2	15	
-8	a2	13	

Depth (ft): 0 – 20

SOIL PROFILE

Drilling Method: Hollow-Stem Auger

Ground Elevation (ft): 11.66

USCS Symbol	Description
ML	Grey SILT with sand and some gravel; no odor, no sheen (stiff to very stiff, moist) **Collected soil sample MGP-HS-55-1.0-2.0 at 1.0-2.0 ft. bgs** **Collected soil sample MGP-HS-55-2.5-3.5 at 2.5-3.5 ft. bgs** **Collected soil sample MGP-HS-55-5.5-6.0 at 5.5-6.0 ft. bgs**
SP	Grey fine to medium SAND with trace silt and white shell fragments; no odor, no sheen (loose, moist)
WD	**Collected soil sample MGP-HS-55-7.0-8.0 at 7.0-8.0 ft. bgs** Brown and black, fine to medium WOOD CHIPS up to 1/4"; organic odor, no sheen (loose, wet)
ML	Grey and black SILT with sand; no odor, no sheen (very stiff, wet)
ML / SP	**Collected soil sample MGP-HS-55-8.5-9.5 at 8.5-9.5 ft. bgs** Fine roots, decomposed pieces of WOOD, and tan CLAY; organic odor, no sheen (very stiff, wet) Black and grey, fine to medium SAND with fine to medium wood chips; organic odor, no sheen (loose, wet)
WD	Tan and brown, fresh to slightly decomposed, 1/4" to 1/2" WOOD CHIPS; strong hydrogen sulfide odor, no sheen (loose, wet) **Collected soil sample MGP-HS-55-11.5-12.25 at 11.5-12.25 ft. bgs** - slight isolated sheen at 17.5-22 ft. bgs **Collected soil sample MGP-HS-54-13.0-14.0 at 13.0-14.0 ft. bgs**

GROUNDWATER

Water Level: ATD

Monitoring Well Detail
(DOE#: BHM-116)

8 in

- Flush-mounted monument with locking cap
- Concrete Seal
- 2-inch diameter, Schedule 40, PVC well casing
- Bentonite chips

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-55

Figure B-82
(1 of 2)

MW-55

Drilling Method: Hollow-Stem Auger

Ground Elevation (ft): 11.66

Monitoring Well Detail (DOE#: BHM-116)

Depth (ft)	Elevation	Sampler Type	Blows/Foot	PID (ppm)	USCS Symbol	Soil Profile
20–28	-10 to -16	a2	25		WD	Tan and brown, fresh to slightly decomposed, 1/4" to 1/2" WOOD CHIPS; strong hydrogen sulfide odor, no sheen (loose, wet)
22		a2	18	ctd. high H2S		**Collected soil sample MGP-HS-55-22.0-23.0 at 22.0-23.0 ft. bgs**
24	-12	a2	15			
25–26	-14	a2	16			
27		a2	37			**Collected soil sample MGP-HS-55-27.0-27.5 at 27.0-27.5 ft. bgs**
28	-16	a2	16		SP	- large piece of wood and grey silt at 27.75 Grey, fine to medium SAND with trace silt and shell fragments and occasional slivers of wood; hydrogen sulfide odor, no sheen (loose, wet)
30	-18	a2	10			**Collected soil sample MGP-HS-55-28.5-29.5 at 28.5-29.5 ft. bgs**
31–32	-20	a2	13			
33	-22	a2	16			- with fine gravel
34–35		a2	10			**Collected soil sample MGP-HS-55-34.0-35.0 at 34.0-35.0 ft. bgs** - increased shell fragments
36	-24	a2	70/ 9"	0.0		**Collected soil sample MGP-HS-55-35.5-36.5 at 35.5-36.5 ft. bgs**
37		a2	75/ 4"	0.0	RK	Grey, fine grained SANDSTONE; no odor, no sheen

Groundwater / well detail labels: 20/40 Colorado sand pack; 2-inch diameter, Schedule 40, PVC screen (0.020-inch slot size); Threaded end cap

Boring Completed 02/02/12
Total Depth of Boring = 37.3 ft.

Refusal at 37.33 ft. bgs

Monitoring Well Completed 02/02/12
Elevation at Top of Monitoring Well Casing = 10.89 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

Log of Monitoring Well MW-55

Figure B-82 (2 of 2)

MW-58

SAMPLE DATA | SOIL PROFILE | GROUNDWATER

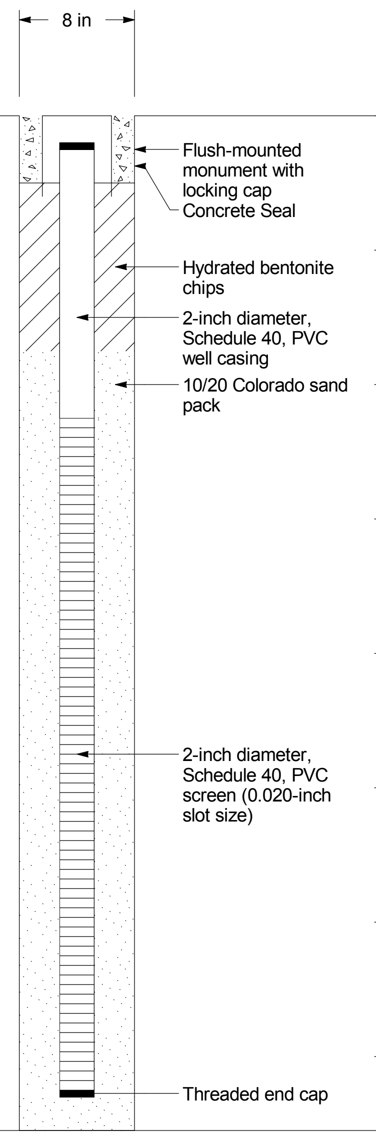
Drilling Method: Hollow-Stem Auger

Ground Elevation (ft):

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	USCS Symbol	Description
0						SM	Brown, silty, fine to medium SAND with gravel (medium dense, dry)(no odor, no sheen)
5			a2	50/ 2"		RK	Gray, fine to medium WEATHERED SANDSTONE (very dense, dry)(no odor, no sheen)
7.5			a2	100/ 1"			
10			a2	100/ 1"			
14.5							- harder at 14.5'
15			a2	100/ 1"			

Water Level: Groundwater not encountered.

Monitoring Well Detail



Boring Completed 06/08/16
Total Depth of Boring = 15.1 ft.

Monitoring Well Completed 06/08/16
Total Depth of Monitoring Well = 14.6 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street Manufactured Gas Plant
Bellingham, Washington

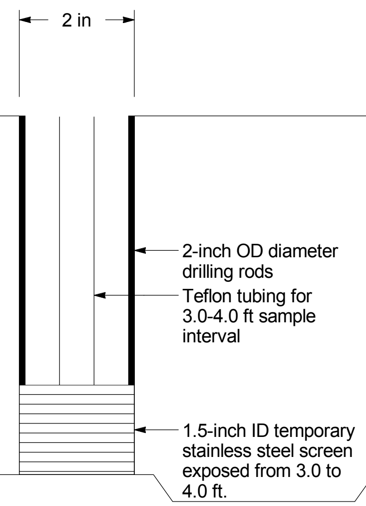
Log of Monitoring Well MW-58

Figure B-83

SV-04

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level
0–4								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. **Collected soil vapor sample MGP-SV-04-3.0-4.0**	Groundwater not encountered.

Temporary Soil Vapor Well Detail



Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14

Boring Completed 08/30/10
Total Depth of Boring = 4.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-04

Figure
B-84

SV-12

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail 2 in
0								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back two feet to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors.	Groundwater not encountered.	2-inch OD diameter drilling rods Teflon tubing for 3.0-5.0 ft sample interval
2										
4								**Collected soil vapor sample MGP-SV-12-3.0-5.0**		1.5-inch ID temporary stainless steel screen exposed from 3.0 to 5.0 ft.

Boring Completed 08/30/10
Total Depth of Boring = 5.0 ft.

6

8

10

12

14

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-12

Figure
B-85

SV-18

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail (2 in)
0–8								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back two feet to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. **Collected soil vapor sample MGP-SV-18-6.0-8.0**	Groundwater not encountered.	Teflon tubing for 6.0-8.0 ft sample interval 2-inch OD diameter drilling rods 1.5-inch ID temporary stainless steel screen exposed from 6.0 to 8.0 ft.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14

Boring Completed 08/30/10
Total Depth of Boring = 8.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-18

Figure B-86

SV-25 (1)

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail 2 in
0								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back two feet to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors.	Groundwater not encountered.	
2										Teflon tubing for 6.0-8.0 ft sample interval 2-inch OD diameter drilling rods
4										
6								**Collected soil vapor sample MGP-SV-25-6.0-8.0**		1.5-inch ID temporary stainless steel screen exposed from 6.0 to 8.0 ft.
8										

Boring Completed 08/30/10
Total Depth of Boring = 8.0 ft.

10

12

14

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-25 (1)

Figure B-87

SV-25 (2)

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: GeoprobeTM Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail (2 in)
0								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of first sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. After sample collection, rods are removed and process is repeated for deeper sample intervals.	Groundwater not encountered.	2-inch OD diameter drilling rods Teflon tubing for 3-4 ft sample interval
4								**Collected soil vapor sample MGP-SV-25-3.0-4.0**		1.5-inch ID temporary stainless steel screen exposed from 3 to 4 ft. Teflon tubing for 5-6 ft sample interval
6								**Collected soil vapor sample MGP-SV-25-5.0-6.0**		1.5-inch ID temporary stainless steel screen exposed from 5 to 6 ft.

Boring Completed 07/25/11
Total Depth of Boring = 6.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-25 (2)

Figure B-88

SV-32

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail (2 in)
0–6								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back two feet to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. **Collected soil vapor sample MGP-SV-32-4.0-6.0**	Groundwater not encountered.	2-inch OD diameter drilling rods Teflon tubing for 4.0-6.0 ft sample interval 1.5-inch ID temporary stainless steel screen exposed from 4.0 to 6.0 ft.

Depth scale (ft): 0, 2, 4, 6, 8, 10, 12, 14

Boring Completed 08/30/10
Total Depth of Boring = 6.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-32

Figure
B-89

SV-44

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail 2 in
0–6								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. **Collected soil vapor sample MGP-SV-44-4.0-5.0**	Groundwater not encountered.	2-inch OD diameter drilling rods Teflon tubing for 4.0-6.0 ft sample interval 1.5-inch ID temporary stainless steel screen exposed from 4.0 to 6.0 ft.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14

Boring Completed 08/30/10
Total Depth of Boring = 6.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

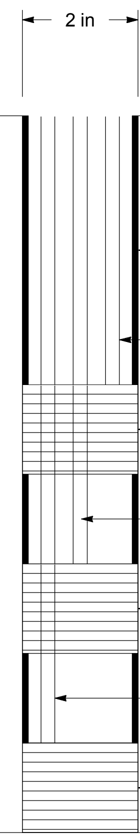
Log of Temporary Soil Vapor Well SV-44

Figure B-90

SV-49

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level
0								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of first sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. After sample collection, rods are removed and process is repeated for deeper sample intervals.	Groundwater not encountered.
4								**Collected soil vapor sample MGP-SV-49-3.0-4.0**	
6								**Collected soil vapor sample MGP-SV-49-5.0-6.0**	
8								**Collected soil vapor sample MGP-SV-49-7.0-8.0**	

Temporary Soil Vapor Well Detail



Boring Completed 07/25/11
Total Depth of Boring = 8.0 ft.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

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South State Street
Manufactured Gas Plant
Bellingham, Washington

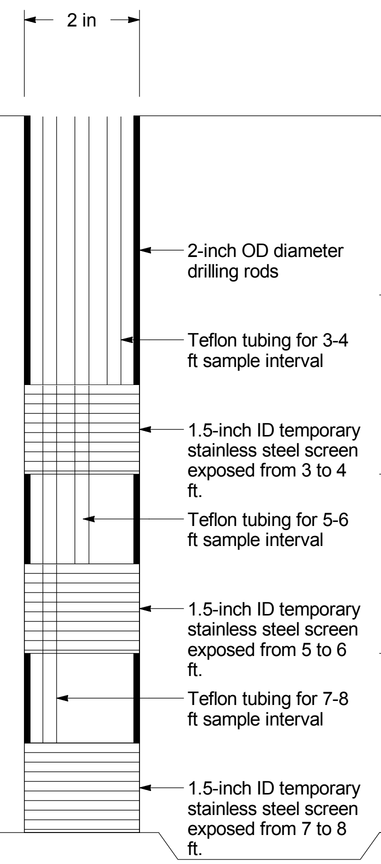
Log of Temporary Soil Vapor Well SV-49

Figure B-91

SV-50

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level
0								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of first sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. After sample collection, rods are removed and process is repeated for deeper sample intervals.	Groundwater not encountered.
4								**Collected soil vapor sample MGP-SV-50-3.0-4.0**	
6								**Collected soil vapor sample MGP-SV-50-5.0-6.0**	
8								**Collected soil vapor sample MGP-SV-50-7.0-8.0**	

Temporary Soil Vapor Well Detail



Boring Completed 07/25/11
Total Depth of Boring = 8.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-50

Figure
B-92

SV-51

SAMPLE DATA						SOIL PROFILE			GROUNDWATER	
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level	Temporary Soil Vapor Well Detail
0								Drilled with expendable drive point on rods, no soil samples collected. Sheathed sample screen driven to bottom of sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. First two sample attempts completed at 12.0-13.0 ft bgs and 11.0-12.0 ft bgs produced water during purging; final sample collected from boring 5 feet away from first two attempts.		2 in
2										
4										2-inch OD diameter drilling rods
6										
8										Teflon tubing for 9.5-11 ft sample interval
10								**Collected soil vapor sample MGP-SV-51-9.5-11.0**		1.5-inch ID temporary stainless steel screen exposed from 9.5 to 11 ft.
12									ATD	
14										

Boring Completed 07/25/11
Total Depth of Boring = 11.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-51

Figure B-93

SV-52

SAMPLE DATA						SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Drilling Method: Geoprobe™ Ground Elevation (ft): NA	Water Level

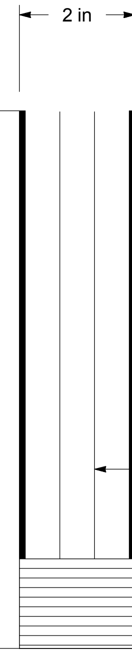
Drilled with expendable drive point on rods, no soil samples collected.

Sheathed sample screen driven to bottom of first sample interval, pulled back one foot to expose screen. Sample tubing attached to screen using post-run tubing (PRT) adaptors. After sample collection, rods are removed and process is repeated for deeper sample intervals.

Collected soil vapor sample MGP-SV-52-5.0-6.0

Groundwater not encountered.

Temporary Soil Vapor Well Detail



Depth scale (ft): 0, 2, 4, 6, 8, 10, 12, 14

Boring Completed 07/25/11
Total Depth of Boring = 6.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ WELL LOG W/ ELEVATION

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Temporary Soil Vapor Well SV-52

Figure
B-94

SB-01

SAMPLE DATA / SEDIMENT DESCRIPTION

Coring Method: Geoprobe™

Elevation (ft): 7.9

Depth (ft)	Elevation	In situ Sample Interval (ft)	Test Data	Graphic Symbol	USCS Symbol	Sediment Description
0					SP	Grey, fine to coarse SAND with white shell fragments; no odor, no sheen (loose, moist to wet) **Collected sediment sample MGP-SB-01-0.0-2.0 at 0.0-2.0 ft. bgs**
	5					
					PT	Black, fine organic material with medium sand; organic odor, no sheen (loose, wet)
5			7.6		SP	Grey, fine to medium SAND with trace silt; petroleum-like odor, medium sheen (loose, wet) **Collected sediment sample MGP-SB-01-4.0-6.0 at 4.0-6.0 ft. bgs**
					PT	Brown, fine to medium organic material; organic-like odor, no sheen (loose, wet)
	0				SP-SM	Grey, fine to medium SAND with silt and gravel; sulfur-like odor, no sheen (loose, wet) **Collected sediment sample MGP-SB-01-8.0-10.0 at 8.0-10.0 ft. bgs**
10						

Coring Completed 08/20/10
Total Penetration = 11.0 ft.

Refusal on sandstone (?) at 11 ft. bgs

15

20

25

30

35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Sediment Core SB-01

Figure
B-95

SB-02

SAMPLE DATA				SEDIMENT DESCRIPTION		
Depth (ft)	Elevation	In situ Sample Interval (ft)	Test Data	Graphic Symbol	USCS Symbol	Coring Method: Geoprobe™ Elevation (ft): 2.3
0					SP	Grey, medium to coarse SAND with white shell fragments; no odor, no sheen (loose, moist)
	0		3.0		WD	Brown medium to coarse WOOD DEBRIS; organic odor, no sheen (very soft, wet) **Collected sediment sample MGP-SB-02-0.0-2.0 at 0.0-2.0 ft. bgs**
5					SP	Grey, fine to medium SAND with trace silt and gravel and white shell fragments; no odor, no sheen (loose, wet) **Collected sediment sample MGP-SB-02-4.0-6.0 at 4.0-6.0 ft. bgs**
	-5				ML	Grey and green SILT with fine sand; no odor, no sheen (very stiff, moist) **Collected sediment sample MGP-SB-02-8.0-10.0 at 8.0-10.0 ft. bgs**
10					RK	Grey, fine to medium grained SANDSTONE Refusal at 10.1 ft. bgs

Coring Completed 08/20/10
Total Penetration = 10.1 ft.

15

20

25

30

35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SEDIMENT LOG

LANDAU ASSOCIATES

South State Street Manufactured Gas Plant Bellingham, Washington	Log of Sediment Core SB-02	Figure B-96

SB-04

SAMPLE DATA / SEDIMENT DESCRIPTION

Coring Method: Geoprobe™

Elevation (ft): 2.3

Depth (ft)	Elevation	Test Data	USCS Symbol	Sediment Description
0			SP	Grey, medium to coarse SAND with white shell fragments; no odor, no sheen (loose, moist)
			RK	**Collected sediment sample MGP-SB-04-0.0-2.0 at 0.0-2.0 ft. bgs**
	0	2.1		Grey, angular cobbles (RIP RAP) with silt; no odor, no sheen (loose, moist)
5				**Collected sediment sample MGP-SB-04-4.0-6.0 at 4.0-6.0 ft. bgs**
	-5	6.0		
			PT	Brown, fine organics; organic odor, slight sheen (very soft, moist)
10				**Collected sediment sample MGP-SB-04-8.0-10.0 at 8.0-10.0 ft. bgs**
			ML	Grey SILT; no odor, no sheen (very stiff, moist)
	-10		RK	Grey, fine grained SANDSTONE

Coring Completed 08/20/10
Total Penetration = 13.0 ft.

Refusal at 13 ft. bgs

Depth (ft): 0, 5, 10, 15, 20, 25, 30, 35

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

15015. 3/27/17 N:\PROJECTS\015015.010.GPJ SEDIMENT LOG

LANDAU ASSOCIATES

South State Street
Manufactured Gas Plant
Bellingham, Washington

Log of Sediment Core SB-04

Figure
B-97

SEDIMENT BORING LOG KEY

Major Divisions		Symbols	Typical Names
Coarse Grained Soils (More than 1/2 of soil >No. 200 sieve size)	**Gravels** (More than 50% coarse fraction > no. 4 sieve	GW	Well-graded gravels or gravel-sand mixtures, little to no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little to no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels or gravel-sand-clay mixtures
	Sands (Less than 50% coars fraction > no. 4 sieve)	SW	Well-graded sands or gravel-sand mixtures, little to no fines
		SP	poorly-graded sands or gravelly sands, little to no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine Grained Soils (More than 1/2 of soil <No. 200 sieve size)	**Silts & Clays** Liquid limit* less than 50%	ML	Inorganic silts and very fine sands, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy or silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts & Clays Liquid limit* greater than 50%	MH	Inorganic silts, micaceous or ditomaceous fine sand or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clay, organic silts
Highly Organic Soils		Pt	Peat or other highly organic soils

*Liquid limit represents the moisture contnet (in percent) of a soil at which point the soil no longer behaves like a plastic and starts to behave like a liquid.

Boring Log Symbols

Sample Interval
Groundwater, First Observed
Groundwater, Static

Sample Types

SS	Split Spoon
G	Grab
ST	Shelby Tube
GS	Geoprobe Sampler

Sheen Types

NS	No Sheen Observed
SS	Slight Sheen observed (Spotty coverage of sheen pan, no irridescence)
MS	Moderate Sheen (Full Coverage)
HS	Heavy Sheen (Full Coverage, Irredescent)

Sample Moisture

Dry	No Moisture, dry to touch
Moist	Damp but no visible moisture
Wet	Visible free water

Sample Plasticity (Fine-Grained Soils)

Non-Plastic - Cannot be rolled at any moisture content
Low - Barely rolled, lump cannot be formed when drier than plastic limit
Medium - Easily rolled, lump crumbles when drier than plastic limit
High - Easily rolled yet takes considerable time to reach the plastic limit, lump can be formed without crumbling when drier than the plastic limit

Partical Size Range (Course-Grained Soils)

Gravel - Fine, Course
Sand - Fine, Medium, Coarse

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mherrenkohl@msn.com

Based on Unified Soil Classification System and ASTM Standard D2487 and D2488

35-35.5* * Indicates sample was selected for analysis

HERRENKOHL CONSULTING LLC

321 Summerland Road
Bellingham, WA 98229

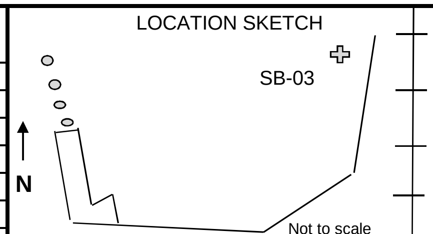
(360) 319-0721 FAX (360) 647-6980

BOREHOLE NUMBER	MGP-SB-03
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 1635

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
									Grey to black, silty F-M SAND overlying brown organic sandy SILT with
0-1.5*	1635	4/6/8	67	--	N	0-1.5		**SM/**	abundant wood debris (chips, fibers) and moderate sulfide odor
			(1.0 ft)				1--	**OH**	
							2--		
2.5-3.0	1640	10/23/50	80	3.5	N	2.5-4.0			
3.0-4.0*			(1.2 ft)				3--	**PT**	Creosote-treated wood fragment with moderate odor
									(3.0-4.0 ft sample collected for grain size analysis)
								SM	Grey, silty F SAND with moderate shell fragments and slight
									indiscernible odor (fine gravels above bedrock)
							4--		Base of Boring @ 4 ft. (weathered sandstone)
5.0-5.5	1645	50-4in	66	--	N	4.0-5.0			
			(0.3 ft)						Drilled into bedrock 1.0 ft (weathered sandstone)
							5--		
							6--		
							7--		
							8--		
							9--		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1238202.07
	N 636640.68
SURFACE ELEVATION	-1.8 ft
DATUM	MLLW

LOCATION SKETCH



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Bellingham, WA 98229

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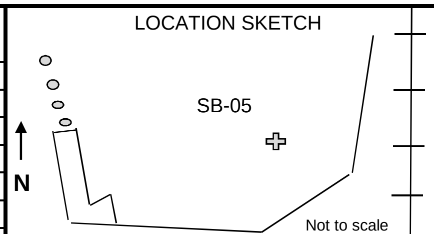
BOREHOLE NUMBER	MGP-SB-05
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 1535

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-1.5	1535	1-18in	33 (0.5 ft)	--	N	0-1.5		SM	Grey to black, silty F-M SAND with shell fragments and a few eel grass blades and slight sulfide odor
							1--		
							2--		
2.5-4.0*	1538	1-18in	87 (1.3 ft)	0.3	N	2.5-4.0	3--	OH	Brown, organic sandy SILT with abundant fine wood debris (chips, fibers) and slight to moderate sulfide odor
							4--		
							5--	OH	Brown, organic sandy SILT with abundant wood debris (chips, fibers), scattered shell fragments, and strong sulfide odor
5.0-6.0*	1542	35/40/41	67 (1.0 ft)	--	N	5.0-6.5			
6.0-6.5								SW	Sands and Gravels with shell hash overlying bedrock
							6--		Base of Boring @ 6.0 ft.
									(No odor in bedrock - grey Chuckanut sandstone)
							7--		
							8--		
							9--		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1238105.42
	N 636596.82
SURFACE ELEVATION	-2.4 ft
DATUM	MLLW

LOCATION SKETCH

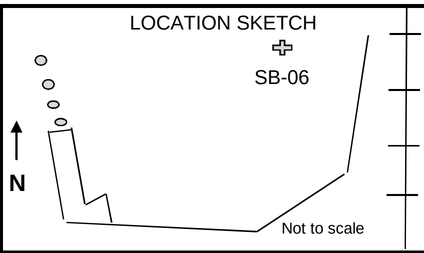


HERRENKOHL CONSULTING LLC	BOREHOLE NUMBER: MGP-SB-06
	PROJECT: SSSMGP RI/FS
	LOCATION: Boulevard Park, Bellingham, WA
321 Summerland Road	PROJECT NUMBER: HCL-017
Bellingham, WA 98229	LOGGED BY: Mark Herrenkohl, LEG
(360) 319-0721 FAX (360) 647-6980	DATE AND TIME: 9/7/2010 1535

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	%Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-2.0	1535	--	15	--	N	0-2.0		**OH**	Brown, organic sandy SILT with abundant wood chips and a few
			(0.3 ft)				1--		eelgrass blades and root fragments, slight to moderate sulfide odor
							2--		clay and silt increasing with depth
2.0-4.0*	1542	--	65	1.3	N	2.0-4.0		**OH**	Brown, organic clayey, sandy SILT with moderate to abundant wood
			(1.3 ft)				3--		chips and fibers, moderate sulfide odor
							4--		
4.0-6.0	1545	--	15	--	N	4.0-6.0		**OH**	Organic debris increasing, large piece of bark at bottom of sampler
			(0.3 ft)				5--		
							6--		More abundant wood fibers
									Shell hash layer
							7--		
6.0-8.0*	1554	--	90	--	N	6.0-8.0		**OH**	Same as above with moderate to strong sulfide odor
			(1.8 ft)						- field duplicate collected, SB-66 - 6.0-8.0 for analysis
							8--		
8.0-9.0	1600	--	20	--	N	8.0-9.0		**OH**	Same as above
			(0.2 ft)						
							9--		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238139.01
	N 636661.65
SURFACE ELEVATION	-6.1 ft
DATUM	MLLW

LOCATION SKETCH



HERRENKOHL CONSULTING LLC

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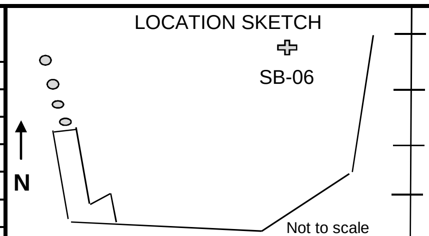
BOREHOLE NUMBER	MGP-SB-06
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/7/2010 1535

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	%Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
								OH/	Grey to olive organic clayey sandy SILT with wood debris (chips,
10-10.5	1610	--	100	1.1	N	10-11.5		MH	fibers)
			(0.5 ft)						
10.5-12*	1618	8/12/40	87	--	N	10.5-12			
			(1.3 ft)				11--		
									grading to olive to grey, silty F-C SAND with F gravels, abundant shell
									hash, and slight to moderate sulfide odor
							12--		
12-13.5*	1623	20/25/35	87	--	N	12-13.5		SM	Same as above
			(1.3 ft)						
									- large gravel in catcher
							13--		
									Base of Boring @ 13.5 ft - Grey Chuckanut Sandstone
							14--		
							15--		
							16--		
							17--		
							18--		
							19--		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238139.01
	N 636661.65
SURFACE ELEVATION	-6.1 ft
DATUM	MLLW

LOCATION SKETCH



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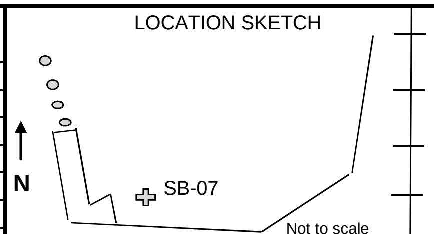
BOREHOLE NUMBER	MGP-SB-07
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/9/2010 1736

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-1.5	1736	5/6/7	20 (0.3 ft)	--	N	0-1.5		**SM**	Grey to black, silty F-C SAND with F gravel, brick fragment in bottom of sampler
							1		
							2		
2.5-4.0*	1741	4/3/3	73 (1.1 ft)	--	N	2.5-4.0		**SM**	Grey to black, silty F-C SAND with a chunk of wood at bottom of sampler, strong sulfide odor, brick fragments, and scattered fine gravels
							3		
							4		
							5		
5.0-6.5*	1744	4/4/4	47 (0.7 ft)	--	N	5.0-6.5		**SM**	Same as above with more fine gravels and brick fragments
							6		
							7		
7.5-9.0	1746	2/4/4	33	--	N	7.5-9.0		**SM**	Same as above but no brick fragments observed and wood piece lodged in bottom of sampler
							8		
							9		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1238009.18
	N 636591.30
SURFACE ELEVATION	-1.1 ft
DATUM	MLLW

LOCATION SKETCH



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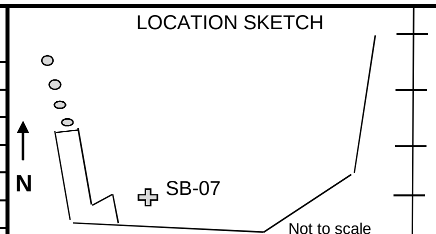
BOREHOLE NUMBER	MGP-SB-07
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/9/2010 1736

SAMPLE INFORMATION									
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
10-11.5	1748	1/1/2	67 (1.0 ft)	--	N	10-11.5		**SM/ OH**	Same as above but grading to organic sandy SILT
							11	**PT**	Wood chunk and debris (mostly fibers) in bottom of sampler
12.5-14	1751	1/2/2	60 (0.9 ft)	--	N	12.5-14	12	**OH**	Brown organic clayey, sandy (F) SILT with abundant wood debris (chips, fibers), and slight to moderate sulfide odor, scattered fine shell hash
							13		
							14		
15-16.5*	1754	2/2/3	60 (0.9 ft)	--	N	15-16.5	15	**OH**	Same as above but with brick fragments
							16		
17.5-19*	1756	15/20/50	73 (1.1 ft)	1.0	N	17.5-18.5	17	**OH**	Same as above but with more wood fibers and slight creosote-like odor
							18	**OH/ SM**	Blackened organics with slight creosote-like odor into surface of bedrock, and sand/gravels at bottom of sampler
									Base of Boring @ 18.5 ft - Grey Chuckanut Sandstone
							19		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1238009.18 N 636591.30
SURFACE ELEVATION	-1.1 ft
DATUM	MLLW

LOCATION SKETCH



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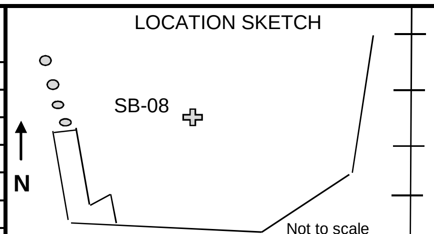
BOREHOLE NUMBER	MGP-SB-08
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 1320

Sample ID	Time	Blow Counts	%Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-2.0*	1320	--	55 (1.1 ft)	--	N	0-2.0	1	OH	Brown, organic sandy (F) SILT with abundant wood chips and fibers, and moderate sulfide odor
2.0-3.0	1324	--	90 (0.9 ft)	--	N	2.0-3.0	2	PT	Mostly wood debris and strong sulfide odor Large chunk of wood at 3 ft
3.0-5.0*	1332	--	30 (0.6 ft)	--	N	3.0-5.0	3, 4	OH	Brown, organic sandy (F) SILT with abundant wood debris (chips, and fibers), and strong sulfide odor
5.0-7.0	1336	--	70 (1.4 ft)	--	N	5.0-7.0	5, 6	OH/ PT	Chunks of wood from 5.0-5.5 ft Brown, organic, sandy (F) SILT with abundant wood debris (chips, and fibers), and strong sulfide odor grading to mostly wood debris in bottom of sampler
7.0-9.0	1342	--	85 (1.7 ft)	**41**	N	7.0-9.0	7, 8	OH	Brown, organic, sandy (F) SILT with abundant wood debris including large wood chips and bark, and strong sulfide odor
9.0-10*	1350	--	70 (0.7 ft)	**59**	N	9.0-10	9	PT	All wood debris with slight petroleum-like odor

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238059.96 N 636660.14
SURFACE ELEVATION	-5.3 ft
DATUM	MLLW

LOCATION SKETCH



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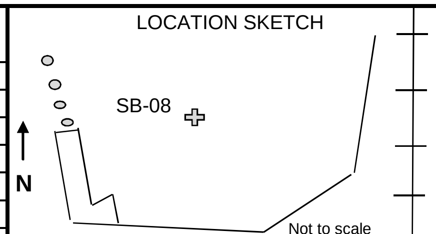
BOREHOLE NUMBER	MGP-SB-08
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 1320

Sample ID	Time	Blow Counts	%Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION (USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.)
									Mostly wood debris with sandy SILT and slight petroleum-like odor
10-11*	1356	--	30 (0.3 ft)	--	N	10-11	11	OH/PT	
11-12.5*	1402	1/2/2	100 (1.5 ft)	--	**Y**	11-12.5		PT	
							12	ML	Grey to olive, organic clayey SILT with F sand and slight petroleum-like odor with slight sheen in bottom of sampler
12.5-14	1405	1/1/2	87 (1.3 ft)	--	N	12.5-14	13	OH	Brown, organic sandy (F) SILT with abundant organics and wood debris, and moderate sulfide odor
14-15.5	1410	1/1/1	80 (1.2 ft)	--	N	14-15.5	14		Same as above
							15	SM	Shell hash layer in silty F-M SAND matrix
15.5-17	1412	1/2/2	100 (1.5 ft)	2.2	N	15.5-17	16	SM	Grey, silty F-C SAND with fine gravel and moderate shell fragments
17-18.5	1415	NR	0 (0 ft)	--	--	17-18.5	17		No recovery
18.5-20	1419	3/4/4	100 (1.5 ft)	--	N	18.5-20	18, 19	SM	Grey silty F gravelly F-C SAND with moderate shell fragments

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238059.96 N 636660.14
SURFACE ELEVATION	-5.3 ft
DATUM	MLLW

LOCATION SKETCH



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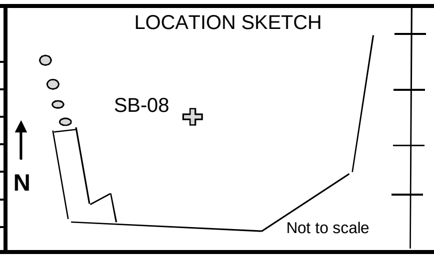
BOREHOLE NUMBER	MGP-SB-08
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 1320

Sample ID	Time	Blow Counts	%Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
20-21.5*	1421	4/4/4	47	--	N	20-21.5		**SM**	Grey, silty, fine gravelly F-C SAND with abundant shell fragments/hash,
			(0.7 ft)				21		and slight sulfide odor
									- grain size analysis
21.5-23*	1423	4/4/5	53	--	N	21.5-23	22	**SM**	Same as above
			(0.8 ft)						
							23		
23-24*	1428	10/15/40	80	--	N	23-24.5		**SM**	Same as above but silt increasing with depth and few coarse gravels,
24-24.5			(1.2 ft)						no obvious odor
							24		
									Base of Boring @ 24.5 ft - Grey Chuckanut Sandstone
							25		
							26		
							27		
							28		
							29		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238059.96
	N 636660.14
SURFACE ELEVATION	-5.3 ft
DATUM	MLLW

LOCATION SKETCH



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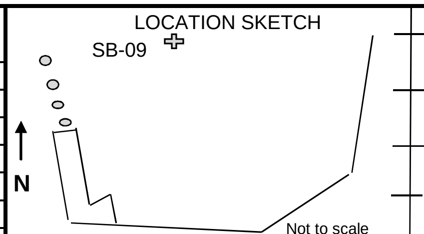
BOREHOLE NUMBER	MGP-SB-09
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/7/2010 1200

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-2.0*	1200	--	90 (1.8 ft)	--	N	0-2.0		**OH**	Brown, organic SILT with fine sand and bark fragments and moderate sulfide odor
							1		
							2		
2.0-4.0	1215	--	75 (1.5 ft)	--	N	2.0-4.0		**OH**	Same as above
							3		
							4		
4.0-6.0*	1220	--	70 (1.4 ft)	0.3	N	4.0-6.0		**OH**	Same as above
							5		
								SM	Grey, organic silty F-M SAND with fine shell fragments and scattered wood chips and moderate sulfide odor
							6		
6.0-8.0	1230	--	65 (1.3 ft)	0.6	N	6.0-8.0		**OH/ PT**	Brown, organic SILT with silty SAND lenses, slight to moderate sulfide odor, and bark fragments and wood chips
							7		
							8		
8.0-10	1240	--	91 (1 ft)	--	N	8.0-10		**PT**	Mostly wood chips and bark (only 1.1 ft penetration into the wood debris)
							9		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238088.20
	N 636719.69
SURFACE ELEVATION	-8.9 ft
DATUM	MLLW

LOCATION SKETCH



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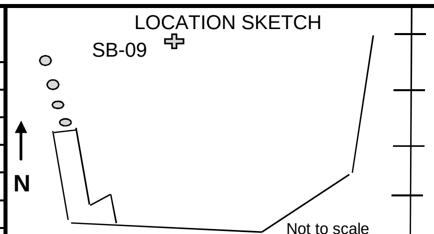
BOREHOLE NUMBER	MGP-SB-09
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/7/2010 1200

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
							11	PT/ OH	Brown, organic SILT with abundant wood chips, fibers, and bark fragments, strong sulfide odor
							12		
							13		
							14		
									Wood debris boundary at about 15 ft
							15		
15-17*	1250	--	95 (1.9 ft)	0.5	N	15-17		ML	0.3 ft shell hash lense near 15.5 ft Grey to olive, organic sandy SILT with slight to moderate sulfide odor
							16		
							17		Macoma shell half at 17 ft.
17-19*	1300	--	85 (1.7 ft)	--	N	17-19		SM	Grey to olive, silty F SAND with scattered Macoma shells - grain size analysis
							18		
							19		Concentrated shell fragments at 19 ft.

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238088.20 N 636719.69
SURFACE ELEVATION	-8.9 ft
DATUM	MLLW

LOCATION SKETCH



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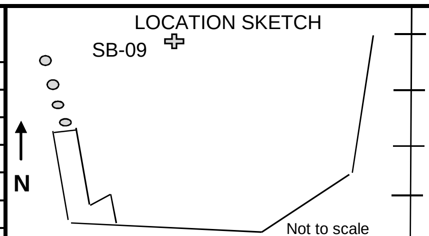
BOREHOLE NUMBER	MGP-SB-09
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/7/2010 1200

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
19-20.5	1310	3/4/4	33	--	N	19-20.5		**SM**	Same as above.
			(0.5 ft)						(attempted with Osterberg-Shelby but no recovery, then sampled with
									DM split spoon - blow counts are not representative)
							21		
20.5-22	1325	6/8/6	87	--	N	20.5-22		**SM**	Grey, silty F-M SAND with abundant shell hash
			(1.3 ft)						
							22		
							23		
23-24.5	1330	4/5/5	100	0.9	N	23-24.5			
			(1.5 ft)					**ML**	Grey, clayey SILT with fine sand, no obvious odor
							24		
							25		
25.5-27*	1331	4/5/5	100	--	N	25.5-27		**ML**	Same as above but sample is more saturated with water
			(1.5 ft)						- grain size analysis
							26		
							27		
							28		
28-29.5	1337	5/6/6	87	0.6	N	28-29.5		**ML/**	Clay increasing, not as wet
			(1.3 ft)					**CL**	Grey (slight mottling), silty CLAY to clayey SILT with fine sand, smooth
									texture
							29		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238088.20
	N 636719.69
SURFACE ELEVATION	-8.9 ft
DATUM	MLLW

LOCATION SKETCH

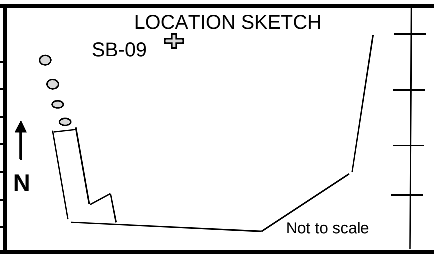


HERRENKOHL CONSULTING LLC	BOREHOLE NUMBER: MGP-SB-09
321 Summerland Road	PROJECT: SSSMGP RI/FS
Bellingham, WA 98229	LOCATION: Boulevard Park, Bellingham, WA
(360) 319-0721 FAX (360) 647-6980	PROJECT NUMBER: HCL-017
	LOGGED BY: Mark Herrenkohl, LEG
	DATE AND TIME: 9/7/2010 1200

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
30.5-32	1348	4/4/5	100 (1.5 ft)	--	N	30.5-32	31	**ML/ CL**	Same as above
							32		
							33		
33-34.5	1350	4/5/5	100 (1.5 ft)	1.2	N	33-34.5		**ML**	Grey, clayey SILT with fine sand and scattered fine gravels
							34		(sand increasing with depth)
							35		
35.5-37*	1355	5/5/6	100 (1.5 ft)	--	N	35.5-37		**ML**	Grey, sandy (F), clayey SILT with scattered fine gravels
							36		
							37		
							38		
38-39.5*	1357	10/25/28	100 (1.5 ft)	1.5	N	38-39.5		**SM**	Grey, silty, F-C SAND with clay and fine gravel (and 1 coarse gravel)
							39		
									Base of Boring @ 39.5 - Weathered Chuckanut Sandstone

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1238088.20
	N 636719.69
SURFACE ELEVATION	-8.9 ft
DATUM	MLLW

LOCATION SKETCH



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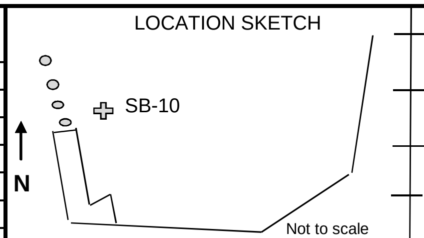
BOREHOLE NUMBER	MGP-SB-10
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/9/2010 1507

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-1.0	1507	--	40	--	N	0-1.0		**OH/**	Grey to black, organic silty F SAND with abundant fine wood debris and
			(0.4 ft)					**PT**	scattered shell fragments, moderate to strong sulfide odor, and
1.0-1.5	1510	--	100	--	N	1.0-1.5	1--		scattered eelgrass blades and roots
			(0.5 ft)						- samples from 0-1.0 and 1.0-1.5 ft were combined and archived.
									- larger wood chips
							2--		
2.0-4.0*	1521	--	55	--	N	2.0-4.0		**PT**	Brown, wood debris (primarily chips) with strong sulfide odor
			(1.1 ft)						
							3--		
							4--		
4.0-6.0	1525	--	45	--	N	4.0-6.0		**PT**	Brown, wood debris (primarily chips and fibers) with moderate sulfide
			(0.9 ft)						odor
							5--		
							6--		
7.0-8.0*	1530	--	85	**64.9**	N	6.0-8.0		**PT**	Same as above
			(1.7 ft)						
							7--		
									7.0-8.0 tested for PID - elevated reading from H_2S?
								OH	Grey, organic, sandy SILT with clay and abundant wood debris and
									strong sulfide odor
								PT	
							8--	**OH**	
								PT	- large wood chunks in thin layers observed at depth
8.0-10	1535	--	100	--	N	8.0-10		**OH**	
			(2.0 ft)					**PT**	
							9--	**OH**	- same as above but with wood debris layers (chips and fibers)
								PT	

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1237996.66
	N 636659.14
SURFACE ELEVATION	-4.7 ft
DATUM	MLLW

LOCATION SKETCH



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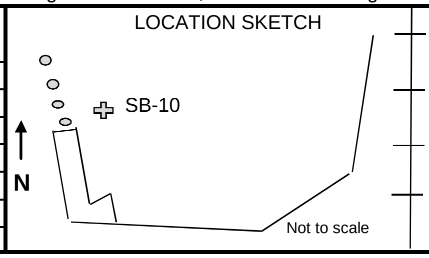
BOREHOLE NUMBER	MGP-SB-10
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/9/2010 1507

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
10-12	1543	--	0 (0 ft)	--	--	10-12			No Recovery
							11		
							12		
12-14	1551	--	45 (0.9 ft)	**171**	N	12-14		**PT**	Brown to grey, wood debris (chips, fibers, some bark fragments) with sandy SILT matrix and moderate to strong sulfide odor
							13		- PID reading due to strong sulfide odor?
									- switch to DM split spoon
							14		
14-15.5	1603	1/2/2	33 (0.5 ft)	--	N	14-15.5		**PT**	Same as above
							15		
							16		
15.5-17	1605	1/1 for12	67 (1.0 ft)	--	N	15.5-17		**OH**	Grey to brown, organic, sandy SILT to silty F SAND with abundant wood debris and moderate sulfide odor
							17		
							18		
17-18.5	1608	1 for 18	73 (1.1 ft)	9.0	N	17-18.5		**ML**	Grey to olive, clayey SILT with fine sand and strong sulfide odor and scattered wood fragments
							19		
19-19.5	1610	1/1/1	53	--	N	18.5-20			
19.5-21.5*			(0.8 ft)					**SM**	Grey, silty F-C SAND with F gravels at bottom, abundant shell frags

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1237996.66
	N 636659.14
SURFACE ELEVATION	-4.7 ft
DATUM	MLLW

LOCATION SKETCH



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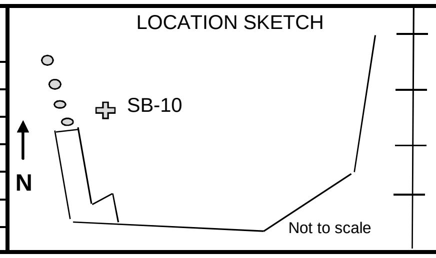
BOREHOLE NUMBER	MGP-SB-10
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/9/2010 1507

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
19.5-21.5*	1612	2/2 for12	67 (1.0 ft)	--	N	20-21.5	21	**GM**	Grey, silty, F-C sandy F GRAVEL with moderate shell fragments and hash, and moderate sulfide odor - 19.5-21.5 sample was composited for analysis.
21.5-23	1614	2/3/4	80 (1.2 ft)	--	N	21.5-23	22		Same as above grading to grey, silty, F gravelly F-C SAND with abundant shell fragments and slight sulfide odor
							23		
23-24.5	1619	2/2/3	87 (1.3 ft)	1.4	N	23-24.5	24	**SM**	Grey, silty, F gravelly F-C SAND with abundant shell fragments and slight sulfide odor
24.5-26	1622	2/3/3	87 (1.3 ft)	1.3	N	24.5-26	25		Same as above - Macoma clam shells observed
							26		
26-27.5	1628	3/3/4	87 (1.3 ft)	1.7	N	26-27.5	27	**ML**	Grey, clayey SILT with fine sand and smooth texture
27.5-29	1630	2/3/3	67 (1.0 ft)	--	N	27.5-29	28		Same as above
							29		
29-31*	1632	3/4/4	67 (1.0 ft)	--	N	29-30.5		**ML**	Grey, clayey SILT with F-C sand and F gravels at bottom of sample - Field duplicate collected for 29-31 ft (SB-20 - 29-31)

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1237996.66 N 636659.14
SURFACE ELEVATION	-4.7 ft
DATUM	MLLW

LOCATION SKETCH



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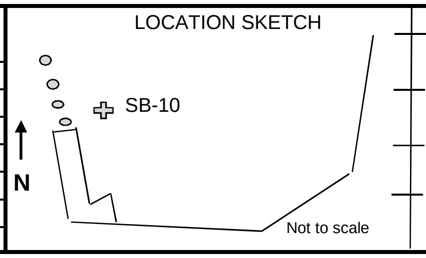
BOREHOLE NUMBER	MGP-SB-10
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/9/2010 1507

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
									- 29 - 31 ft samples were composited for analysis
29-31*	1635	50 for 6	100	--	N	30.5-31		ML	Grey, clayey, SILT with F-C sand and F gravels at bottom of sample
			(0.5 ft)				31--		
									Base of Boring @ 31 ft - Grey Chuckanut Sandstone
							32--		
							33--		
							34--		
							35--		
							36--		
							37--		
							38--		
							39--		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split Spoon
COORDINATES	E 1237996.66
	N 636659.14
SURFACE ELEVATION	-4.7 ft
DATUM	MLLW

LOCATION SKETCH



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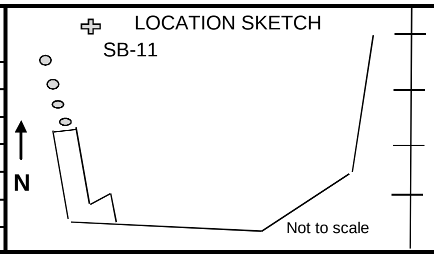
BOREHOLE NUMBER	MGP-SB-11
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 0839

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-2.0*	0839	--	50	--	N	0-2.0		OH	Brown to grey, organic sandy SILT with abundant wood debris (chips,
			(1.0 ft)						fibers) and scattered shell hash, with one fine gravel in upper sample,
							1--		moderate to strong sulfide odor
							2--		
2.0-4.0	0849	--	40	**30**	N	2.0-4.0			Same as above, fines increasing with depth
			(0.8 ft)						- PID reading may be from strong sulfides?
							3--		
							4--		
4.0-5.0*	0855	--	50	--	N	4.0-5.0		OH	Brown, organic, sandy SILT with clay and abundant wood debris
			(1.0 ft)						(fibers, chips, bark) and scattered shell hash with strong sulfide odor
							5--		- encountered large wood fragment at 5 ft (bark)
							6--		
6.0-8.0	0904	--	65	--	N	6.0-8.0		OH	Same as above with large stringy bark at bottom of sampler
			(1.3 ft)						- sand is decreasing
							7--		
							8--		
								PT	Concentrated wood fragments (chips, fibers)
8.0-10	0909	--	95	**68.9**	N	8.0-10			- PID reading from strong sulfide odor?
			(1.9 ft)						
							9--		
								OH/ ML	Grey, organic, clayey, SILT with fine sand, moderate wood debris and strong sulfide odor

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split-Spoon
COORDINATES	E 1238014.12
	N 636730.33
SURFACE ELEVATION	-14.0 ft
DATUM	MLLW

LOCATION SKETCH



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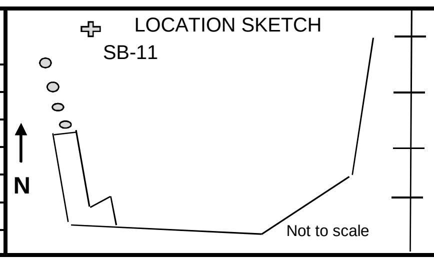
BOREHOLE NUMBER	MGP-SB-11
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 0839

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
							11		
							12		
12-14	0927	--	60 (1.2 ft)	--	N	12-14	13	**OH/ ML**	Grey, organic, clayey SILT with fine sand, moderate wood debris and moderate sulfide odor
							14		
							15		
							16		
							17		
16-18	0940	--	40 (0.8 ft)	--	N	16-18	18	**ML**	Olive, organic, sandy (F) SILT with clay, moderate wood debris in upper sample, sandy greater at depth, trace shell fragments, and moderate sulfide odor
							19		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split-Spoon
COORDINATES	E 1238014.12
	N 636730.33
SURFACE ELEVATION	-14.0 ft
DATUM	MLLW



HERRENKOHL CONSULTING LLC

321 Summerland Road
Bellingham, WA 98229

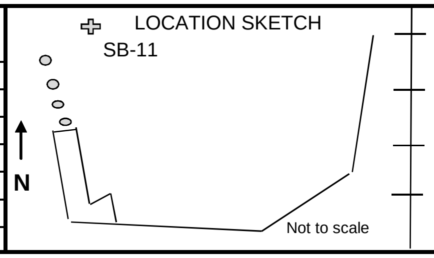
(360) 319-0721 FAX (360) 647-6980

BOREHOLE NUMBER	MGP-SB-11
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 0839

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
20-21	0947	--	0 (0 ft)	--	--	20-21		SM	No Recovery - switch to DM split spoon - from bottom of sampler - grey, silty F SAND with abundant shell hash and scattered wood debris (fibers)
							21		
							22		
22-23.5	1000	2/3/5	100 (1.5 ft)	1.6	N	22-23.5		ML	Grey to olive, clayey SILT with fine sand, smooth texture, and slight sulfide odor
							23		
							24		
24.5-26*	1005	2/6/6	87 (1.3 ft)	--	N	24.5-26		ML	Same as above - grain size analysis
							25		
							26		
							27	SM	Grey, silty F SAND layer
27-27.5 27.5-28.5	1012	5/5/6	80 (1.2 ft)	1.5	N	27-28.5		ML	Grey, clayey SILT with fine sand, slight sulfide odor, and scattered shell fragments - PID reading on sample collected from 27-27.5 ft
							28		
							29		
29.5-31	1021	5/5/6	67 (1.0 ft)	--	N	29.5-31			Same as above but clay increasing

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split-Spoon
COORDINATES	E 1238014.12 N 636730.33
SURFACE ELEVATION	-14.0 ft
DATUM	MLLW

LOCATION SKETCH

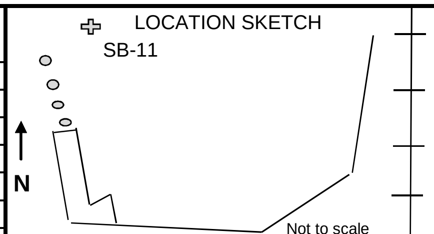


HERRENKOHL CONSULTING LLC	BOREHOLE NUMBER: MGP-SB-11
321 Summerland Road	PROJECT: SSSMGP RI/FS
Bellingham, WA 98229	LOCATION: Boulevard Park, Bellingham, WA
(360) 319-0721 FAX (360) 647-6980	PROJECT NUMBER: HCL-017
	LOGGED BY: Mark Herrenkohl, LEG
	DATE AND TIME: 9/8/2010 0839

SAMPLE INFORMATION									DESCRIPTION
Sample ID	**Time**	**Blow Counts**	**% Recovery**	**PID**	**Sheen**	**Sample Depth (ft)**	**Depth (ft)**	**STRATA**	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
							31		
							32		
32-33.5	1023	3/4/5	80	--	N	32-33.5		**ML**	Grey, clayey SILT with fine sand, no obvious odor
			(1.2 ft)						- thin sand lenses within sample
							33		
							34		
34.5-35.5*	1027	11/6/5	67	1.5	N	34.5-36		**ML**	Grey, clayey sandy (F) SILT
35.5-36			(1.0 ft)						- sand increasing
							35		- PID reading on sample from 34.5-35.5 ft
								SM	Grey, silty F-M SAND with slight sulfide odor
							36		
								ML	Grey, clayey, sandy SILT
							37		
37-37.5*	1030	18/30/50	47	--	N	37-38.5			
37.5-38.5			(0.7 ft)						
							38		
								SM	Grey, silty F-M SAND, with no obvious odor
							39		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split-Spoon
COORDINATES	E 1238014.12
	N 636730.33
SURFACE ELEVATION	-14.0 ft
DATUM	MLLW

LOCATION SKETCH



HERRENKOHL CONSULTING LLC

321 Summerland Road
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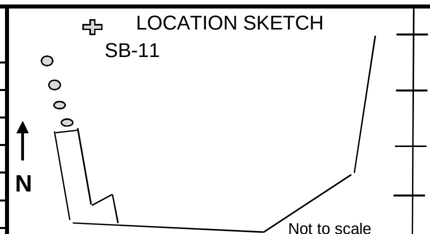
BOREHOLE NUMBER	MGP-SB-11
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9/8/2010 0839

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
39.5-41*	1042	16/25/40	80 (1.2 ft)	1.3	N	39.5-41		**SM**	Grey (some olive mottling), silty F-M SAND with no obvious odor
							41		
							42		
42-43.5*	1048	7/10/15	87 (1.3 ft)	--	N	42-43.5		**ML/ SM**	Grey, clayey, sandy SILT with sand lenses interlayed throughout sample
							43		
							44		
44.5-45.5 **45.5-48***	1054	8/16/30	67 (1.0 ft)	--	N	44.5-46		**ML/ SM**	44.5-45.5 ft ML with increasing F-M sand and F gravel
							45		
							46	**GM**	Grey, silty, F-C sand F-C GRAVEL with no obvious odor - coarse gravel in bottom of sample
									- 45.5-48 ft composited for analysis
							47		
45.5-48*	1100	33/50-6	53 (0.8 ft)	1.4	N	47-48		**SM/ SW**	Grey, silty, F-C gravelly F-C SAND with no obvious odor
							48		
							49		
49.5-50	1107	50- 2in	33 (0.2 ft)	--	N	49.5-50			Base of Boring @ 50.0 ft - Grey Chuckanut Sandstone

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	Osterberg-Shelby/DM Split-Spoon
COORDINATES	E 1238014.12 N 636730.33
SURFACE ELEVATION	-14.0 ft
DATUM	MLLW

LOCATION SKETCH



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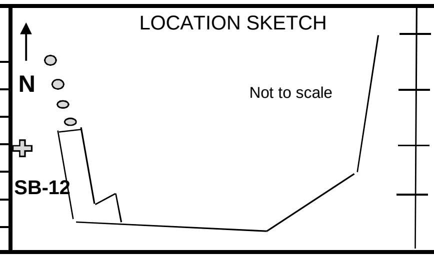
BOREHOLE NUMBER	MGP-SB-12
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9 Sept 10 1913

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
0-1.5	1913	4/4/4	33	--	N	0-1.5		**SM**	Grey to black, silty, F-M SAND with live littleneck clam, eelgrass blades
			(0.5 ft)				1--		roots, and moderate sulfide odor
							2--		
2.5-4.0	1916	2/3/3	0	--	--	2.5-4.0			No Recovery
			(0 ft)						- wood fragment in shoe of sampler
							3--		? ? ?
							4--		
							5--		
5.0-6.5*	1917	2/2/2	53	--	N	5.0-6.5		**PT**	Wood debris (chips, fibers) with moderate sulfide odor
			(0.8 ft)						
							6--		
							7--		
7.5-9.0	1919	1/1/2	20	--	N	7.5.9.0		**PT**	Same as above but with strong sulfide odor
			(0.3 ft)				8--		
							9--		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1237932.19
	N 636659.58
SURFACE ELEVATION	-3.2 ft
DATUM	MLLW

LOCATION SKETCH



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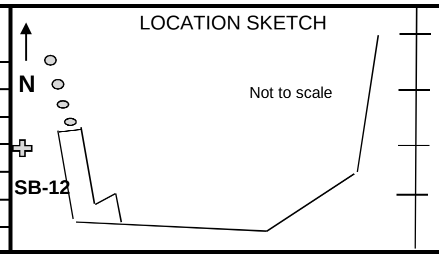
BOREHOLE NUMBER	MGP-SB-12
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9 Sept 10 1913

SAMPLE INFORMATION							Depth (ft)	STRATA	DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)			USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
10-11.5*	1920	2/2/1	40	--	N	10-11.5		**PT**	Same as above.
			(0.6 ft)						
							11		
									- Large chunk of wood in bottom of sampler
							12		
12.5-14	1922	1/1/2	<10	--	N	12.5-14		**PT**	Same as above (sample only in shoe)
			(0.1 ft)						- not much fines in sample
							13		
							14		
							15		
15-16.5	1925	1/1/2	47	--	N	15-16.5		**PT**	Same as above
			(0.7 ft)						
							16		
							17		
17.5-19	1928	1/1/2	40	--	N	17.5-19		**PT**	Same as above
			(0.6 ft)				18		
							19		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1237932.19
	N 636659.58
SURFACE ELEVATION	-3.2 ft
DATUM	MLLW

LOCATION SKETCH



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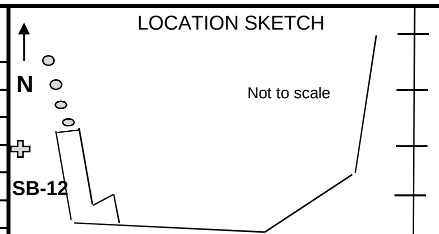
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9 Sept 10 1913

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
20-21.5	1930	1/1/1	53 (0.8 ft)	--	N	20-21.5	21	**PT**	Same as above
							22		
22.5-24	1932	0/1/1	67 (1.0 ft)	--	N	22.5-24	23	**OH/ ML**	Grey to olive, clayey SILT with fine sand, scattered to moderate organics, and moderate sulfide odor
							24		
25-26.5	1934	0/1/1	87 (1.3 ft)	**42.3**	N	25-26.5	25	**ML**	organics decreasing - PID reading due to sulfides?
							26	**SM**	Olive to grey, silty F-M SAND with moderate shell fragments and moderate sulfide odor - fines (clay) increasing with depth
							27		
27.5-29*	1936	1/1/2	73 (1.1 ft)	--	N	27.5-29	28	**SM**	Same as above - increasing shell fragments from 28.5 to 29 ft
							29		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1237932.19 N 636659.58
SURFACE ELEVATION	-3.2 ft
DATUM	MLLW

LOCATION SKETCH



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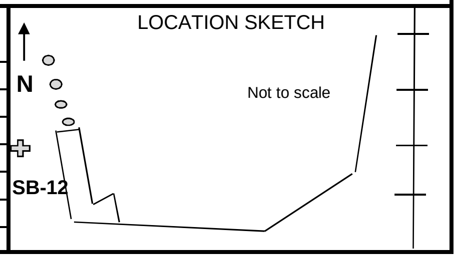
BOREHOLE NUMBER	MGP-SB-12
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9 Sept 10 1913

Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	DESCRIPTION: USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
30-31.5*	1939	2/2/2	67 (1.0 ft)	--	N	30-31.5		**SM**	Same as above with abundant shell fragments
							31		
							32		
32.5-34*	1941	4/4/5	53 (0.8 ft)	--	N	32.5-34	33	**SM**	Same as above
							34	**ML**	Olive, sandy SILT with abundant shell fragments, no obvious odor
							35		
35-36.5	1943	3/3/3	67 (1.0 ft)	--	N	35-36.5	36	**ML**	Grey to olive, sandy, clayey SILT with scattered to moderate shell fragments, and no obvious odor
							37		
37.5-39	1945	8/12/16	67 (1.0 ft)	--	N	37.5-39	38	**ML**	Grey to olive, clayey SILT with fine sand and smooth texture
							39		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1237932.19
	N 636659.58
SURFACE ELEVATION	-3.2 ft
DATUM	MLLW

LOCATION SKETCH



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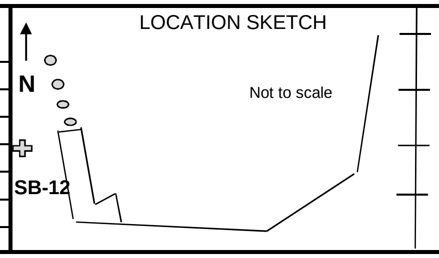
BOREHOLE NUMBER	MGP-SB-12
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9 Sept 10 1913

SAMPLE INFORMATION									DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)	Depth (ft)	STRATA	USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
40-41.5	1952	4/4/6	47	--	N	40-41.5		**ML**	Same as above
			(0.7 ft)						
							41		- F-M sand lense from 40.7 to 41 ft
								SM	Grey, silty F-M SAND with scattered shell fragments and fine gravels at bottom of sample
							42		
42.5-44	1956	5/5/5	80	--	N	42.5-44		**ML**	Grey to olive, F-M sandy SILT with fine gravels and scattered shell fragments
			(1.2 ft)				43		
							44		
							45		
45-46.5	1959	5/5/5	87	--	N	45-46.5		**ML**	Same as above
			(1.3 ft)				46		
							47		
47.5-49*	2001	5/5/5	93	1.5	N	47.5-49			
			(1.4 ft)				48		
								SM	Grey to olive, silty F-C SAND
							49	**ML**	Olive, sandy, clayey SILT

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1237932.19
	N 636659.58
SURFACE ELEVATION	-3.2 ft
DATUM	MLLW

LOCATION SKETCH



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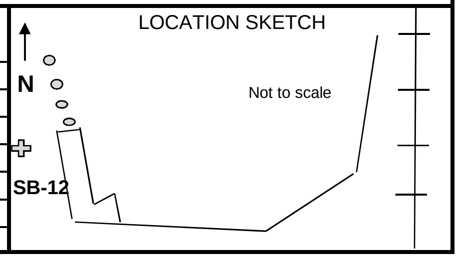
BOREHOLE NUMBER	MGP-SB-12
PROJECT	SSSMGP RI/FS
LOCATION	Boulevard Park, Bellingham, WA
PROJECT NUMBER	HCL-017
LOGGED BY	Mark Herrenkohl, LEG
DATE AND TIME	9 Sept 10 1913

SAMPLE INFORMATION							Depth (ft)	STRATA	DESCRIPTION
Sample ID	Time	Blow Counts	% Recovery	PID	Sheen	Sample Depth (ft)			USCS group name, moisture content and plasticity, color, minor and MAJOR constituents with grain size range, odor, sheen, texture, weathering, cementation, geologic interpretation, etc.
51-51.5	2005	30/42/50	33 (0.5 ft)	--	N	50-51.5		**ML/ GM**	Olive, sandy SILT with large gravel above bedrock
							51		
									Base of Boring @ 51.5 ft - Grey Chuckanut Sandstone
							52		
							53		
							54		
							55		
							56		
							57		
							58		
							59		

DRILLING CONTRACTOR	Cascade Drilling
DRILLING METHOD	Hollow Stem Auger/Barge
SAMPLING EQUIPMENT	DM Split Spoon
COORDINATES	E 1237932.19
	N 636659.58
SURFACE ELEVATION	-3.2 ft
DATUM	MLLW

LOCATION SKETCH



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PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-14
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/24/15, processed: 9/25/15

SAMPLE INFORMATION							**DESCRIPTION**
Sample ID	**Time**	**Sample Depth (ft)**	**Grain Size Range**	**Depth (ft)**	**Recovery (ft/ft)**	**STRATA**	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-14-0-2	845	0-2			100%	**PT**	Eelgrass over dark brown sawdust-sized WOOD with silt, occasional brick fragments, chunks of lumber, medium dense, medium sulfide odor, medium sheen
						PT	Unweathered SAWDUST, medium dense, medium sulfide odor, no sheen
				2--			- charcoal layers from approximately 1.0-1.25 and 2.25-2.5'
SB-14-2-4	855	2-4					
				4--			
SB-14-4-6	905	4-6					
				6--			
SB-14-6-8	915	6-8					
				8--			
SB-14-8-9	925	8-9					
					0%		No recovery from 9.0-14.0
				10--			
				12--			
				14--			14.0 ft of penetration

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 43.99829N
	122 30.10950W
WATER DEPTH	12.8'
WATER LEVEL (TIDE)	+8.6'
SEDIMENT ELEVATION (MLLW)	-4.2'
WEATHER	cloudy, breezy, 58^{o} F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-15
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/25/15, processed: 9/25/15

Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	DESCRIPTION USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-15-0-2	1115	0-2			100%	OH	Eelgrass over dark brown SILT with sawdust and some chunks of wood, soft, moderate sulfide odor, no sheen
						PT	Unweathered SAWDUST, occasional brown/slightly weathered layers, soft, moderate sulfide odor, no sheen
SB-15-2-4	1125	2-4		2--			
SB-15-4-6	1135	4-6		4--	69%		- sawdust settled in core duirng transport
SB-15-6-8	1145	6-8		6--			
SB-15-8-10	1155	8-10		8--			
				10--	0%		No recovery from 10.0-11.9
				12--			Refusal at 11.9 ft, 10.0 ft recovery
				14--			

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 43.97833N 122 30.14975W
WATER DEPTH	6.5'
WATER LEVEL (TIDE)	+1.4'
SEDIMENT ELEVATION (MLLW)	-5.1'
WEATHER	showers, 55^{o} F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-16
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/24/15, processed: 9/24/15

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-16-0-2	1120	0-2			100%	PT	Brown to red-brown, slightly weathered SAWDUST with occasional silt and slightly weathered wood chunks, soft, strong sulfide odor, medium sheen, PID reading of 0.7 ppm
SB-16-2-2.3	1125	2-2.3		2--			
				4--	0%		No recovery from 2.3 to 7.1 ft
				6--			
				8--			Refusal at 7.1 ft, 2.3 ft recovery, wood chunk in shoe
				10--			
				12--			
				14--			

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.010683N
	122 30.12828W
WATER DEPTH	17.0'
WATER LEVEL (TIDE)	+3.4'
SEDIMENT ELEVATION (MLLW)	-13.6'
WEATHER	cloudy, 55° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-17
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/24/15, processed: 9/24/15

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-17-0-2	1030	0-2			78%	OH	Dark brown/black organic SILT with trace sand, soft, slight sulfide odor, no sheen
SB-17-2-4	1040	2-4		2--		OH	Dark brown SILT with abundant fine to medium stringy chips of wood debris, very soft, slight sulfide odor, no sheen
SB-17-4-6	1050	4-6		4--		PT	Dark brown, stringy, unprocessed WOOD DEBRIS with silt, very soft, slight sulfide odor, no sheen
				6--			Stop core penetration at 6.0 ft, resistant wood layer observed below 6.0 ft in previous attempts
				8--			
				10--			
				12--			
				14--			

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.05131N
	122 30.07709W
WATER DEPTH	26.8'
WATER LEVEL (TIDE)	+1.0'
SEDIMENT ELEVATION (MLLW)	-25.8'
WEATHER	cloudy, 55^{o} F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-18
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/24/15, processed: 9/24/15

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-18-0-2	1630	0-2			76%	OH	Dark brown/black organic SILT with trace sand and wood chips and sawdust, very soft, medium sulfide odor, no sheen
				2--			
SB-18-2-4	1640	2-4					- wood content increasing with depth
				4--			
SB-18-4-5.5	1650	4-5.5					
				6--			Refusal at 5.5 ft, 4.2 ft of recovery Wood in catcher.
				8--			
				10--			
				12--			
				14--			

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.03792N 122 30.91615W
WATER DEPTH	27.0'
WATER LEVEL (TIDE)	+7.7'
SEDIMENT ELEVATION (MLLW)	-19.3'
WEATHER	partly cloudy, 60° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-19
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/24/15, processed: 9/24/15

SAMPLE INFORMATION				Depth (ft)	Recovery (ft/ft)	STRATA	DESCRIPTION
Sample ID	Time	Sample Depth (ft)	Grain Size Range				USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-19-0-2	1510	0-2				OH	Dark brown/black SILT with abundant wood chips, soft, slight to medium sulfide odor, no sheen
SB-DUP2-0-2	1800	0-2					
							- gravelly at 1.75 ft
SB-19-2-4	1520	2-4		2--		PT	Dark brown WOOD DEBRIS (chips and large fresh chunks) with silt and trace gravel, soft, medium sulfide odor, no sheen
SB-19-4-6	1530	4-6		4--			
						ML	Grey SILT with sand and gravel, soft, no odor, no sheen
SB-19-6-8	1540	6-8		6--		SP	Grey fine to medium SAND with white shell fragments, occasional coarse gravel, loose, ocean-like odor, no sheen
					89%		
SB-19-8-10	1550	8-10		8--			
							- Fresh piece of slightly weathered WOOD (log?) from 9.5-10.5 ft
SB-19-10-12	1600	10-12		10--			
				12--			
				14--			14 ft penetration, 12.5 ft recovery

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.02329N
	122 29.98085W
WATER DEPTH	12.8'
WATER LEVEL (TIDE)	+8.0'
SEDIMENT ELEVATION (MLLW)	-4.8'
WEATHER	partly sunny, breezy, 60° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-21
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/25/15, processed: 9/25/15

Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	DESCRIPTION: USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-21-0-2	1000	0-2			100%	OH	Dark brown/black organic SILT with trace sand, soft, medium sulfide odor, no sheen
						ML	Dark brown/grey SILT with trace sand, abundant chunks of processed lumber, soft, medium sulfide odor, no sheen
SB-21-2-4	1010	2-4		2--			
						ML	Grey SILT with occasional large shell fragments, medium stiff, no odor, no sheen
SB-21-4-6	1020	4-6		4--			
SB-21-6-7	1030	6-7		6--			
					0%		No recovery from 7.0-14.0 ft
				8--			
				10--			
				12--			
				14--			14 ft penetration, 7.0 ft recovery

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.08610N
	122 30.00370W
WATER DEPTH	24.1'
WATER LEVEL (TIDE)	+0.6'
SEDIMENT ELEVATION (MLLW)	-23.5'
WEATHER	cloudy, 55° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-22
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/23/15, processed: 9/23/15

SAMPLE INFORMATION							DESCRIPTION
Sample ID	**Time**	**Sample Depth (ft)**	**Grain Size Range**	**Depth (ft)**	**Recovery (ft/ft)**	**STRATA**	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-22-0-2	1745	0-2					Dark brown/black SILT with trace sand and abundant wood debris (large unprocessed wood, logs?), soft, no odor, no sheen
SB-22-2-4	1735	2-4		2--			
					62%	**OH**	- with abundant wood debris 3.0-6.5 ft
SB-22-4-6	1730	4-6		4--			
SB-22-6-8	1715	6-8		6--			
							Brown/dark grey SILT, stiff, no odor, no sheen
SB-22-8-10	1705	8-10		8--			- with large shells from 8.5-9.5
					100%	**ML**	
SB-22-10-12	1650	10-12		10--			
				12--			
				14--			14 ft penetration, 12.5 ft recovery

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.09669N
	122 30.09989W
WATER DEPTH	36.5'
WATER LEVEL (TIDE)	+8.3'
SEDIMENT ELEVATION (MLLW)	-28.2'
WEATHER	partly sunny, 65° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-23
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/23/15, processed: 9/24/15

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-23-0-2	900	0-2			100%	ML	Dark brown/black SILT with trace sand, soft, slight sulfide odor, no sheen
							- brown film/slime at 1.0 ft
SB-23-2-4	910	2-4		2--		PT	Brown WOOD DEBRIS (processed lumber), moderately weathered, no odor, no sheen
						SM	Brown and tan fine-medium SAND w/ silt and white shell frags, med dense, no odor or sheen
						SM	Grey fine to medium SAND with large shell fragments and silt, medium dense, no odor, no sheen
SB-23-4-5	925	4-5		4--			
				6--	9%		
				8--			
				10--		RK?	Squared WOOD/board over grey, highly weathered fine to medium grained SANDSTONE in shoe (Chuckanut Formation?)
							10.75 ft penetration, 4.9 ft recovery
				12--			
				14--			

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.08598N
	122 30.16649W
WATER DEPTH	37.5'
WATER LEVEL (TIDE)	+7.7'
SEDIMENT ELEVATION (MLLW)	-29.8
WEATHER	partly sunny, 65° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-25
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/24/15, processed: 9/24/15

SAMPLE INFORMATION: Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	DESCRIPTION: USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-25-0-2	1400	0-2			100%	ML	Dark brown/black SILT with trace sand and occasional wood chips, soft, medium sulfide odor, no sheen
				2--			
SB-25-2-4	1410	2-4					- black at 2.5-3.0 ft
						PT	Brown SAWDUST with silt, soft, medium sulfide odor, no sheen
				4--		ML	Brown SILT with sand, medium sfiff, medium sulfide odor, no sheen
SB-25-4-6	1420	4-6					
				6--			
SB-25-6-7.5	1430	6-7.5				SM	Brown, silty, fine to medium SAND with large shells, medium dense, medium sulfide odor, no sheen
				8--	0%	SM?	
				10--			
				12--			
							Sandy large SHELLS over loose fine to medium SAND with silt in shoe
				14--			14 ft penetration, 7.5 ft recovery

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 43.98009N
	122 30.24811W
WATER DEPTH	39.9'
WATER LEVEL (TIDE)	+6.9'
SEDIMENT ELEVATION (MLLW)	-33.0
WEATHER	cloudy, 60° F

LOCATION SKETCH

N

Not to scale

HERRENKOHL CONSULTING LLC

PO Box 1000
Lopez Island, WA 98261
(360) 319-0721

CORE NUMBER	MGP-SB-31
PROJECT	SSSMGP RI/FS
LOCATION	Bellingham Bay
PROJECT NUMBER	HCL040/015015.070
LOGGED BY	DHF
DATE	collected: 9/25/15, processed: 9/25/15

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Time	Sample Depth (ft)	Grain Size Range	Depth (ft)	Recovery (ft/ft)	STRATA	USCS group name, density, moisture, color, minor, MAJOR constituents, odor, sheen, organics, biology, weathering, cementation, geologic interpretation, etc.
SB-31-0-2	1200	0-2			100%	OH	Dark brown/black organic SILT, soft, medium sulfide odor, no sheen
SB-DUP3-0-2	1300	0-2					
SB-31-2-4	1210	2-4		2--		OH	Dark brown SILT with wood chips and processed wood chunks, soft, medium sulfide odor, no sheen
						ML	Grey SILT with sand and occasional shell fragments, soft, no odor, no sheen
SB-31-4-5	1220	4-5		4--			
					0%		No recovery
				6--			Refusal at 6.0 ft, 5.0 ft of recovery
							Wood debris below 6 ft, pile-drived previous coring attempts at this location.
				8--			
				10--			
				12--			
				14--			

SAMPLING CONTRACTOR	Marine Sampling Systems, Inc.
SAMPLING METHOD	Coring/Vessel
SAMPLING EQUIPMENT	Vibracorer
POSITIONING METHOD	GPS
COORDINATES	48 44.15721N
	122 30.00788W
WATER DEPTH	26.5'
WATER LEVEL (TIDE)	+0.8'
SEDIMENT ELEVATION (MLLW)	-25.7
WEATHER	showers, 55 degrees F

LOCATION SKETCH

N

Not to scale

APPENDIX C

Terrestrial Ecological Evaluation

APPENDIX C

TERRESTRIAL ECOLOGICAL EVALUATION

South State Street Manufactured Gas Plant RI/FS

Prepared for

City of Bellingham
Parks and Recreation Department
3424 Meridian Street
Bellingham, Washington 98225

Puget Sound Energy
Environmental Services
10885 NE 4th Street PSE-11N
Bellevue, Washington 98004

Prepared by
Landau Associates
130 2nd Avenue South
Edmonds, Washington, 98020

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ACRONYMS AND ABBREVIATIONS

BAFs	bioaccumulation factors
bgs	below ground surface
BNSF	Burlington Northern Santa Fe Railway
CEM	conceptual exposure model
City	City of Bellingham
COPCs	constituents of potential concern
EISC	ecological indicator soil concentration
EPA	Environmental Protection Agency
EPC	exposure point concentration
HI	hazard index
HPAHs	high molecular weight PAHs
HQ	hazard quotient
LOAEC	lowest observed adverse effect concentration
LPAHs	low molecular weight PAHs
MGP	manufactured gas plant
MTCA	Model Toxics Control Act
NOAEC	no observed adverse effect concentration
ORNL	Oak Ridge National Laboratory
PAHs	polycyclic aromatic hydrocarbons
POC	point of compliance
RGAF	gut absorption factor
RI/FS	Remedial Investigation/Feasibility Study
SSL	soil screening level
SSSMGP	South State Street Manufactured Gas Plant
SVOCs	semivolatile organic compounds
TEE	Terrestrial Ecological Evaluation
TRUs	toxicity reference values
UCL	upper confidence limit
VOCs	volatile organic compounds
WAC	Washington Administrative Code
WDNR	Washington State Department of Natural Resources

1 INTRODUCTION

This terrestrial ecological evaluation (TEE) was conducted as part of the remedial investigation and feasibility study (RI/FS) for the South State Street Manufactured Gas Plant cleanup site (Site) located in Bellingham, Washington (Figure C-1). The purpose of this TEE is to assess ecological hazards associated with the potential exposure of terrestrial ecological receptors to constituents present in Site soil. This TEE complies with Model Toxics Control Act (MTCA) requirements under Chapters 173-340-7490 through 7494 Washington Administrative Code (WAC).

1.1 SITE DESCRIPTION AND BACKGROUND

The Site is defined as the location where contamination is present due to releases or migration of those releases, and includes both an upland site and a marine site (Figure C-1). The uplands portion of the Site is situated on the northern portion of Boulevard Park, which is a City of Bellingham (City) managed park. This portion includes an upper park and lower park area, which is bisected by a steep slope (referred to as the slope area) and an active railroad tracks owned and managed by Burlington Northern Santa Fe Railway (BNSF; referred to as the BNSF area).The park is connected to the South Bay Trail which runs along the shoreline north and south of the park. The park is bounded by South State Street and single family and multi-family residential area to the southeast. The marine portion of the Site is situated in Bellingham Bay, adjacent to the park.

From approximately 1890 to the late 1940s, a coal gasification plant operated on the upper park area of the Site (Herrenkohl Consulting and Landau Associates 2010 and references therein). The facility manufactured gas from coal and supplied residents and local businesses of Bellingham with gas for heating, cooking, and lighting. The gas plant consisted of above-ground gas holder tanks, fuel oil tanks, a retort and purifying facility, a coal shed and a coke shed used for storage. Of the original gas plant structures, a concrete aboveground gas holder tank, a small brick utility building, remnants of concrete foundations and likely some underground piping remain in the upper park portion of the Site. The lower park area was originally developed as a lumber mill in 1884. The mill was located almost exclusively on a large wood dock/wharf supported by wood pilings that extended for approximately 1,200 ft along the shoreline and 400 ft out into Bellingham Bay. The mill was closed after a fire destroyed it on September 30, 1925. Over the next 50 years, most of the remaining pier and pilings were cut to the mudline or removed and the area was filled from local sources (e.g., demolition materials from the Fairhaven Hotel, wood debris from the mill) (Griffin 2007).

Residential developers purchased the property in the 1960s. In 1975, the City acquired ownership of the majority of the gas plant property from a private owner and Burlington Northern Railroad Company (Griffin 2007). Boulevard Park was dedicated by the City for public use in June 1980.

1.2 EVALUATION FRAMEWORK

The MTCA TEE framework for evaluating constituent concentrations in soil includes three tiers (Figure C-2). Tier 1 (Exclusions from Evaluation in the TEE) consists of a set of criteria that are used to determine if a site can be excluded from further consideration. If the site does not qualify for an exclusion, it may qualify for a simplified TEE, considered a Tier 2 evaluation. The simplified TEE evaluates potential ecological exposures and pathways, and compares constituent concentrations in site soil to default screening concentrations protective of plants and/or animals. If the site passes all Tier 2 criteria no further evaluation is required. If the site does not pass Tier 2 criteria for the simplified TEE, a site-specific TEE, or Tier 3 evaluation is conducted. MTCA provides a general framework for conducting a Tier 3 evaluation. The comments below summarize the evaluation framework for the Site; further explanation is presented in the sections below:

1. Does the Site qualify for an **exclusion?** → **No**
2. Does the Site qualify for a **simplified** TEE? → **No**
3. Conduct **site-specific** TEE:
4. Are Site conditions protective for terrestrial receptors? → **No**

Based on this evaluation, the Site must adopt screening levels in Table 749-3 or screening levels shall be developed based on site-specific evaluation

1.2.1 Tier One - Exclusions Evaluation

MTCA[1] provides four criteria for determining if a site is required to conduct a TEE. If any of the four criteria are met, no TEE is required because ecological exposure pathways are incomplete (*de minimus*) or constituent concentrations are below a level of concern. The four criteria are:

Criterion 1: *No further evaluation is required if contamination is below the POC and if institutional controls are in place (or will be in place) to prevent excavation of soil below 6 ft below ground surface (bgs).*

The Site does not qualify for exclusion based on this criterion, since contamination is present above the standard and conditional POC.

Criterion 2: *No further evaluation is required if exposure to contamination will be prevented by a physical barrier such as buildings or pavement.*

As shown on Figure C-3, many soil sample locations are not covered by a physical barrier, and it is not likely that a physical barrier will be installed covering the entirety of the affected area. As

[1] 173-340-7491 WAC

a result, the Site does not qualify for exclusion based on this criterion, since a physical barrier that would prevent contact with terrestrial wildlife is not presently in place or planned.

Criterion 3: *No further evaluation is required if a Site is so small that it is unlikely to pose an ecological hazard because of limited ecological exposure to constituents present in the soil.*

Figure C-1 shows that more than 1.5 acres of contiguous undeveloped land exists on or within 500 feet of the site[2]. The upland portion of the Site covers approximately 4.2 acres, of which approximately 75 percent is undeveloped. As a result, the Site dos not qualify for exclusion based on this criterion, since the size of the Site are large enough that a potential ecological hazard could exist.

Criterion 4**:** *No further evaluation is required if soil poses only a de minimus ecological hazard because concentrations are below natural background levels.*

Inorganic and some organic (polycyclic aromatic hydrocarbons – PAHs) constituents detected in soil at the Site are naturally occurring. The Agency of Toxic Substances and Disease Registry (ATSDR 2002) characterized the background concentrations of PAHs in rural, agricultural, and urban soils in the United States. Maximum detected concentrations of PAHs in soils at the Site exceed these background concentrations. As a result, the Site dos not qualify for exclusion based on this criterion, since concentrations of some parameters exceed the background levels.

Since none of the four exclusion criteria are met, it is concluded that the Site does not qualify for an exclusion from conducting a simplified or site-specific TEE.

1.2.2 Simplified TEE Qualification Evaluation

Since the Site does not qualify for an exclusion, the next step in the TEE process to determine whether the site qualifies for a simplified TEE evaluation in accordance with MTCA guidance. MTCA[3] provides four criteria for evaluating whether a site qualifies for a simplified TEE. If any of the four criteria is met, it is concluded that the site does not qualify for a simplified TEE and a site-specific TEE must be performed. The four criteria are:

[2] Although the railroad line bisecting the Site is considered a development that would effectively reduce the potential use of the site by wildlife (e.g., mammals will not readily move between the upper and lower portions of the site), sufficient contiguous undeveloped land is associated with the lower and upper areas to fail Criterion 3.
[3] 173-340-7491(2) WAC

Criterion 1: *The site is located on, or directly adjacent to, an area where management or land use plans will maintain or restore native or semi-native vegetation.*
The Site is connected to the South Bay Trail which runs along Bellingham Bay and is designated for public land use as an open space. The goals for these uses are to provide[4]:

- "…high quality, diversified open space system that preserves and enhances significant environmental resources and features to protect threatened species, preserve habitat, retain migration corridors, preserve agricultural lands or natural meadows, and protect water resources."

- "…an interconnected system of high quality, accessible multi-use trails and greenway corridors that offer diverse, healthy outdoor experiences within a rich variety of landscapes and natural habitats, accessing significant environmental features, public facilities and developed local neighborhoods and business districts."

Since the Site is located directly adjacent to an area where land use plans include the maintenance of native or semi-native vegetation (i.e., Bay View Trail), the Site does not qualify for a simplified TEE based on this criterion.

Criterion 2: *The site is used by threatened or endangered species, Washington State wildlife priority species or species of concern, or Washington State endangered, threatened, or sensitive plant species.*

This criterion assesses the potential for exposure of threatened, endangered, or otherwise listed sensitive species to become exposed to constituents present in soil. A formal request to federal and state agencies for information regarding listed or sensitive species use of the Site has not been made. However, the urban nature of the general area, the developed nature of the Site, and a review of information concerning the occurrence of threatened, endangered, and sensitive species occurring in and around Bellingham Bay[5], suggest it is unlikely that any threatened, endangered, or other sensitive species use the terrestrial portion of the Site. Therefore, the Site does not meet criterion 2.

Criterion 3: *The site is located on a property that contains at least ten acres of native vegetation within 500 feet of the site.*

This criterion assesses the potential for significant ecological resources to become exposed to constituents present in soil. The Site consists primarily of landscaped areas covered by non-native turfgrass, a parking lot, and shrub/tree plantings. The hillside sloping from the upper portion of the site to the railroad bed is a highly modified habitat supporting a mixture of invasive plants species (e.g., Himalayan blackberry and English ivy) and native plant species

---

[4] See the City of Bellingham Comprehensive Plan (accessed on 3/16/2013) at http://www.cob.org/documents/parks/development/pro-plan/5-goals.pdf
[5] The bald eagle, marbled murrelet, and peregrine falcon are species that use terrestrial habitats in the Bellingham Bay area, but are considered unlikely to become exposed to constituents present in Site soil.

(e.g., red alder, big leaf maple, vine maple, and sword fern). The Site does not contain any areas of native plant communities (Franklin and Dyrness 1988) and therefore does not meet criterion 3.

Criterion 4: *Ecology determines that the site may present a hazard to significant wildlife populations.*

Ecology has not made this determination, and therefore the site does not meet criterion 4.

Based upon Criterion 1, it is concluded that the Site requires a site-specific TEE (Tier 3) to assess ecological hazards.

To support the site-specific TEE, Sections 2 and 3 provide additional Site information regarding the ecological setting and land use, ecological goals, and points of compliance. The site-specific TEE is presented in Section 4, and the results are summarized in Section 5.

2 ECOLOGICAL SETTING

This section describes the terrestrial cover types present at the Site and biota observed and likely to occur at the Site. These descriptions are supported by an ecological field survey that was conducted on the Site on July 28 and August 8, 2011 (Attachment C-1). This survey included observations of plants, soil biota, and wildlife. In addition, earthworm populations and rooting depths were measured in turfgrass areas.

Discussion in the following sections is discussed relative to distinct areas within the upland portion of the Site. The upland portions of the Site occupies approximately 4.2 acres, and can be seen as consisting of four areas (Figure C-1):

- Upper Park Area – a relatively flat area of approximately 1.2 acres which was the location of the former MGP facility and now serves as a public use area of Boulevard Park;
- Slope Area – a steep area of approximately 0.2 acres which now serves as a non-public use area of Boulevard Park;
- Lower Park Area – a relatively flat area of approximately 2.8 acres which was the location of the former lumber mill facility and now serves as a public use area of Boulevard Park; and
- BNSF Railway Right of Way – this active railroad runs at the base of the Slope Area, along the east side of the lower area.

2.1 COVER TYPES

Five major cover types were identified at the Site: turfgrass, shrub/tree landscaping, covered areas, vegetated slope, and railroad bed (see Figure 1 in Attachment C-1).

The upper and lower portions of the Site are a blend of turfgrass, shrub/tree landscape plantings, and covered area (see Figure 2 in Attachment C-1). Extensive turfgrass plantings occur in the upper and lower areas. Perennial ryegrass forms a dense cover which contains a mixture of herbaceous weeds at a low density. Plant root depth in the turfgrass areas ranged from 8 to 12 inches in the upper area and 8 to 21 inches in the lower area (see Table 5 and Figure 3 in Attachment C-1). Earthworms are present throughout the turfgrass areas. Both deep-burrowing night-crawlers (*Lumbricus terrestris*) and shallower burrowing species are present (see Table 6 in Attachment C-1). All earthworms found at the Site are non-native species introduced from Europe. Several beetles were also observed during the Site survey. Turfgrass is mowed approximately twice weekly. While the upper area is not irrigated, the lower area is irrigated at least 4-times weekly during summer.

Tree and shrubs landscape plantings cover a significant part of the upper and lower portions of the Site (see Figure 2 in Attachment C-1). Both native (e.g., big leaf maple, red alder, salal, Oregon grape) and exotic (e.g., American elm, sycamore maple, red osier dogwood, rhododendron) species have been planted. The open ground under some of the trees and shrubs have been colonized by native and exotic species of forbs. Paved paths and structures prohibit ecological exposure to soil in portions of the upper and lower portions of the Site.

The upper park and lower park portions of the Site are heavily used for recreational purposes. Both humans and their pets frequent these areas. Given the high human use and high level of maintenance activities, wildlife use of these areas is expected to be limited to occasional foraging by urbanized species. Birds may occasionally nest in the trees and shrubs. No signs of burrowing mammals were noted on the Site during the field survey.

The slope area of the Site is very steep (see Figure 2 in Attachment C-1). During park development, it was planted with English ivy and Himalayan blackberry (both exotic species) to help stabilize the slope and discourage human use. Plants from the surrounding areas have partially recolonized the slope area since it was planted. Recolonizing plants include both native (e.g., Douglas fir, big leaf maple, stinging nettles, sword fern, fireweed) and exotic (e.g., American elm, old man's beard, common tansy) species, but Himalayan blackberry and English ivy still form a major component of the flora. The slope area provides cover and food for a relatively wide variety of local wildlife species.

In the BNSF Railway Right of Way, the BNSF railroad occupies a narrow strip of land along the east side of the lower area (see Figure 2 in Attachment C-1). It is covered by coarse gravel (ballast) that effectively limits use of the area by plants and animals. BNSF has an active program to control vegetation along the railroad rights-of-way for safety[6], maintenance purposes, and to comply with federal, state, and local regulations that govern weed control. Control is achieved using a combination of chemical and mechanical methods. Since no potential ecological exposures occur and no soil samples were collected from the BNSF area, this area is excluded from further evaluation in this TEE.

The Site is connected to the South Bay Trail which runs along the Bellingham Bay shoreline. The trail is vegetated with native plants and provides a corridor for wildlife movement.

2.2 WILDLIFE

Wildlife species common to urban areas were not observed during the ecological field survey, but are expected to utilize the upper park and lower park portions of the Site for foraging and possibly nesting/denning. Birds likely to use these areas include the American robin, northern flicker, Canada goose, European starling, house sparrow, and American crows. Mammals likely to use the upper park and lower park portions of the Site include Eastern grey squirrels and a variety of rodents (mice/voles/rats). A wider variety of wildlife species are likely to utilize the slope area including chickadees, nuthatches, sparrows, towhees, raccoon, mountain beaver and

[6] Available online at http://www.arema.org/files/library/2001_Conference_Proceedings/00008.pdf.

shrews/moles. Deer may occasionally be present at the park, though none have been observed while collecting data for the RI.

2.3 SENSITIVE SPECIES

Given the highly modified natures of the Site, sensitive species were not observed during the ecological field survey, and are not expected to occur there. Several sensitive species that utilize terrestrial habitats occur in the Bellingham Bay area including the bald eagle, marbled murrelet, and peregrine falcon. Based on foraging patterns and habitat requirements, these species are not expected to become exposed to contaminants present in Site soil.

3 LAND USE, ECOLOGICAL GOALS, AND POINTS OF COMPLIANCE

This section provides the land use, ecological goals, and points of compliance used to complete the site-specific TEE.

3.1 LAND USE AND ECOLOGICAL GOALS

MTCA uses land use to help determine the appropriate ecological goal for the TEE [WAC 173-340-7490(3)]. The 2011 Comprehensive Plan for the City indicates the land use designation for the Site is public (6)[7]. The use qualifier for areas zoned as public land is parks and open space/school. The City plans to continue managing the Site in its current form, as a park in the foreseeable future.

For industrial or commercial properties, the ecological goal is the protection of wildlife (i.e., birds and mammals). For all other land uses, the ecological goal is protection of plants, soil biota (i.e., invertebrates living in and on the soil), and wildlife. Since the upper park portion, slope area, and lower park portion of the Site do not qualify as a commercial/industrial property under MTCA (WAC 173-340-7490(2)(3)(c)), the goal of this TEE is for the protection of plants, soil biota, and wildlife. However, plants are omitted from this list as though some native species have also been planted or have encroached from nearby areas, vegetation on the Site predominantly consists of either non-native landscape plantings or invasive non-native plants (e.g., Himalayan blackberry, reed canary grass). Though a possible goal under the TEE process is the protection of native or semi-native vegetation, since all the vegetation on the Site was planted for ornamental and landscape purposes, MTCA provides for an exclusion for the protection of plants[8]. Therefore, the goal of the TEE for the Site is the protection of soil biota and wildlife.

Section 2.3 states that sensitive species will not become exposed to chemicals present in soil at the Site. Therefore, the overall goal of this TEE is the protection of populations of soil biota and wildlife from significant adverse effects that impair reproduction, growth, or survival (WAC 173-340-7490(3)).

3.2 POINTS OF COMPLIANCE

The standard POC for a TEE extends from the soil surface to a depth of 15 feet (WAC 173-340-7490(4)). MTCA also allows the use of a conditional POC which represents the bioactive soil layer extending from 0-6 ft below ground surface. The conditional POC represents a conservative estimate of the maximum depth of rooting and burrowing of soil biota and wildlife.

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[7] See description for the South Hill Neighborhood at http://www.cob.org/services/planning/neighborhoods/plans-and-zoning.aspx (accessed on 3/12/2013).
[8] See response to General Question (GQ) 14.3.5 in the Concise Explanatory Statement for the Amendments to MTCA (Ecology 2001).

However, site-specific conditions may limit the bioactive soil layer to less than the default bioactive layer of 0-6 ft. MTCA provides for the development of a site-specific POC for the TEE based upon analysis of the biological and physical conditions present at the site.

A conditional POC (0-6 ft) was selected for this TEE in the upper park and lower park portions of the Site. Bedrock and groundwater occur at a depth of greater than 6 ft across most of the upper area. In the lower area, bedrock occurs at a depth of greater than 6 ft, while groundwater levels, influenced by higher tides may reach levels of less than 6 ft in some locations during certain times of the year. Nevertheless, the conditional POC was also used for the lower area.

The slope area consists of a thin soil layer over bedrock. A review of the boring logs for 10 of the 12 soil samples collected from the slope area in 2011 shows the maximum depth to bedrock was two feet. Therefore, a site-specific POC of 0 to 2 ft was selected for this TEE in the slope area.

It should be noted that the standard POC (0-15 ft) is used in the RI report to assess compliance with screening levels developed for protection of human health and the environment, outside the scope of this evaluation for terrestrial biota and wildlife.

4 SITE-SPECIFIC TERRESTRIAL ECOLOGICAL EVALUATION

The site-specific TEE for the Site is organized into five sections:

- Problem Formulation (Section 4.1)
- Exposure Assessment (Section 4.2)
- Toxicity Assessment (Section 4.3)
- Hazard Characterization (Section 4.4)
- Uncertainty Analysis (Section 4.5)

4.1 PROBLEM FORMULATION

The problem formulation identifies constituents of potential ecological concern (COPECs), identifies complete exposure pathways, identifies receptors of concern, and describes potential toxic effects from COPECs.

4.1.1 Constituents of Potential Ecological Concern

The COPECs for this Site are defined by the following criteria:

1. The reasonable maximum exposure point concentration (EPC) is greater than the ecological indicator soil concentrations (EISC) provided in MTCA Table 749-3; and
2. For metals, the EPC also greater than the soil natural background concentration as determined for the Puget Sound region (Ecology 1994).
3. If fewer than 10 percent of the detected concentrations of a constituent were greater than the EISC in Table 749-3, AND, the detection frequency for that constituent was less than 5 percent (greater than 95 percent non-detect), AND, the maximum detected concentration was less than 2-times the EISC, then the constituent was not considered a COPEC[9].

A constituent would generally be evaluated by all three criteria to be identified as a candidate COPEC. However, constituents that were detected at a frequency of greater than 5 percent and had an EPC greater than the natural background concentration for the Puget Sound region were also identified as candidate COPECs.

[9] Although the 10 percent and 2-times rules are used for soil compliance monitoring under MTCA (WAC 173-340-740(7)), Ecology recommended these rules be used here to address the possible existence of hotspots (i.e., localized soil areas containing very high concentrations of constituents).

Soil EPCs were calculated using Site soil data collected from an upper interval depth of 6 ft or less (i.e., data within the conditional POC). The EPC was the lesser of the 95 percent upper confidence limit (UCL) and the maximum detected concentration of samples analyzed in this depth interval. The UCLs were calculated using the U.S. Environmental Protection Agency's (EPA) ProUCL statistical software[10]. ProUCL output files are provided in Attachment C-2 showing calculated UCLs. A summary statistics table including the UCLs and EPCs is provided at the front of Attachment C-2.

Results of this initial COPEC screening are shown in Table C-1[11]. These results show that 38 constituents are identified as candidate COPECs.

A supplemental evaluation of the 38 candidate COPECs was conducted to determine which constituents are applicable to the protection of only soil biota and wildlife, and not inclusive of plants, as determined in Section 3.1. This supplemental evaluation determined that lead and zinc are not applicable to soil biota and wildlife, and are not identified as COPECs in Table C-1. Results of the supplemental evaluation are presented in Attachment C-3.

Table C-1 lists the final COPECs and which receptor group EISC is exceeded.

4.1.2 Exposure Pathways Evaluation

An ecological conceptual site exposure model (CEM) for the Site is shown in Figure C-4. The CEM shows the potential sources of contamination, release/transport mechanisms, exposure media, receptors, and exposure routes.

The primary sources of contamination include the former MGP by-products, former lumber mill, railroad activities, and fill material. Coal tar and other process wastes from MGPs are potential sources of volatile organic compounds (VOCs), PAHs and other semivolatile organic compounds (SVOCs), heavy metals, and cyanide[12]. Fill material was placed on the upper and lower portions of the Site following cessation of industrial activities. The amount of mixing of fill material with the underlying industrial layer is unknown. In addition, the origin of the fill material is largely unknown and it may have contained contaminants including metals and PAHs.

Contamination in soil may be taken-up by plants and soil biota. Therefore, exposure media include soil, plants, and soil biota. Terrestrial ecological receptors include plants, soil biota, and wildlife. Plants are potentially exposed through direct contact with the soil. Soil biota are potentially exposed through direct dermal contact with soil, ingestion of soil, and ingestion of plant and soil biota. Wildlife are potential exposed through ingestion of plants and soil biota, and incidental ingestion of soil.

[10] ProUCL version 4.1.01 was used and is available online at http://www.epa.gov/osp/hstl/tsc/software.htm.
[11] Dioxins/furans and PCBs are not considered to be site-related (See Section 2 of the main body of the RI for more information) and were not included in the COPEC screening process.
[12] Wikipedia accessed on 3/23/2013 online at http://en.wikipedia.org/wiki/Coal_gasification.

4.1.3 Receptors of Concern

The ecological goal for this TEE, as described in Section 3.1, includes the protection of soil biota and wildlife.

Soil biota is a group that includes all macro-arthropods. Earthworms are a subgroup of arthropods that occur at the Site. Based on their presence at the Site and well-documented soil biota toxicity in literature, they are identified as appropriate receptors of concern for this site-specific TEE.

Wildlife are generally interpreted to include all terrestrial vertebrates. However, the MTCA TEE process focuses on mammalian and avian wildlife because there is considerable toxicity data available for these receptors. Three specific wildlife receptors are identified in MTCA for evaluating cleanup sites: the shrew, vole, and robin. The shrew and robin are insectivorous species that are highly exposed to soil-borne constituents. The vole is herbivorous and also highly exposed to soil-borne constituents. The shrew, robin, and vole are expected to occur on the Site and are identified as receptors of concern for this site-specific TEE.

4.1.4 Potential Toxic Effects

The following sources of comprehensive ecotoxicological information describe the effects of COPECs on soil biota and wildlife:

- Contaminant Hazard Review Reports by the U.S. Fish and Wildlife Service available at http://www.pwrc.usgs.gov/infobase/eisler/reviews.cfm
- Environmental Contaminants Encyclopedia by the National Park Service available at http://www.nature.nps.gov/hazardssafety/toxic/index.cfm
- Toxicity profiles in the Risk Assessment Information System by the U.S. Department of Energy available at http://rais.ornl.gov/tools/tox_profiles.html
- Toxicity profiles on the Ecological Toxicity Information website for U.S. EPA Region 5 available at http://www.epa.gov/R5Super/ecology/toxprofiles.htm
- Toxicity Literature Online (TOXLINE) by the U.S. National Library of Medicine includes ecotoxicology information and is available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TOXLINE
- Ecotoxicological Profiles for Selected Metals and Other Inorganic Chemicals by the U.S. Department of Energy Oak Ridge National Laboratory available at http://www.esd.ornl.gov/programs/ecorisk/guidance_docs.html

4.2 EXPOSURE ASSESSMENT

The exposure assessment identifies exposure areas, describes how reasonable maximum exposure point concentrations (EPCs) are calculated, identifies appropriate bioaccumulation factors (BAFs), and identifies appropriate wildlife exposure factors.

4.2.1 Exposure Areas

For the purposes of this TEE, the upland portion of the Site was divided into three (3) ecological exposure areas: upper, slope, and lower areas. These divisions were based upon cover type, human use level, land management practices, connectivity among exposure areas, and the analyte list for each area (Figure C-1 and Table C-2).

4.2.2 Soil Reasonable Maximum Exposure Point Concentrations

Reasonable maximum exposure point concentrations (EPCs) for soil were calculated for the upper, slope, and lower exposure areas. EPCs are the lesser of the 95 percent UCL and the maximum detected concentration. The UCLs were calculated using EPA's ProUCL statistical software[13]. ProUCL output files showing UCLs are provided in Attachment C-4. Attachment C-4 includes an upfront summary statistics table presenting the UCLs and EPCs for each exposure area.

4.2.3 Bioaccumulation Factors

EPA has developed ecological soil screening levels (EcoSSLs) for use in screening hazardous waste sites across the nation. The bioaccumulation factors (BAFs) provided were developed for PAHs (EPA 2007a) but not mercury or selenium.

For plants, EcoSSLs (EPA 2007a) are segregated the PAHs into low molecular weight PAHs (LPAHs) and high molecular weight PAHs (HPAHs). Experimental data using rinsed foliage was considered most appropriate as ingestion of soil particles or dust on leaves by wildlife is included in food chain models as incidental soil ingestion. In addition, use of rinsed foliage data showed the best fit (i.e., highest coefficient of determination). The log-log regressions[14] for estimating PAHs accumulation in plants are shown in Equations 1 and 2.

Equation 1: Bioaccumulation of LPAHs into plants

$$ln(Cp) = 0.4544 \; x \; ln(Cs) - 1.3205$$

Equation 2: Bioaccumulation of HPAHs into plants

[13] Version 4.1 of ProUCL was used to calculate UCLs and is available on-line at http://www.epa.gov/osp/hstl/tsc/software.htm
[14] EPA states that log-log regression models for estimating bioaccumulation require a coefficient of determination (r^2) of greater than 0.2 for acceptance; if r^2 is ≤ 0.2, the median BAF is used to estimate bioaccumulation.

$$\ln(Cp) = 0.9469 \, x \ln(Cs) - 1.7026$$

Where:

Cp = concentration in plant tissue (mg/kg dry weight)
Cs = concentration in soil (mg/kg dry weight)

Use of these log-log regression equations to derive bioaccumulation factors (BAFs)[15] indicates the BAF will vary with soil concentration in each ecological exposure area.

The best available science indicates that many contaminants become less bioavailable as the soil weathers and ages (Alexander 2000). This is because the more mobile fractions are either lost from the soil through leaching and/or volatilization or are degraded resulting in a residual fraction that is more strongly bound to particles of soil (e.g., clays) and organic matter. These residual concentrations are much less bioavailable than the newly released constituents. Many of the available literature-based BAFs were derived using studies where biota were exposed to constituents that were freshly applied to the test soil. Use of these literature-based BAFs at sites that have undergone significant weathering and aging can cause a significant over-estimation of bioaccumulation.

Unfortunately, no scientific data was identified that characterizes the uptake of weathered PAHs into plants. Although EPA's EcoSSL log-log regressions for plant uptake of PAHs are not considered representative of potential uptake at MGP site, they are considered the next best alternative estimate of PAH accumulation in plants. However, Kreitinger et al. (2007) provide useful information for characterizing the bioaccumulation of PAHs from soil into earthworms at MGP sites.

Soils collected in urban and industrial environments often contain anthropogenic sources of hard or black carbon (e.g., charcoal, coal, coal tar pitch, coke, and soot) that strongly sorb and reduce bioavailability of nonpolar organic compounds such as PAHs (Kreitinger et al. 2007). This is more apparent at MGP sites that used coal and produced coal tar pitch and soot as manufacturing byproducts. Kreitinger et al. (2007) evaluated the toxicity and bioaccumulation of PAHs into earthworms using soil samples collected from 16 different MGP sites. These 16 sites had been closed for approximately 50 years and had varying levels of PAHs and anthropogenic carbon in the soils. A similar condition exists at the Site. Therefore, this study was selected for development of BAFs for PAHs at the Site.

Kreitinger et al. (2007) derived biota soil accumulation factors (BSAFs) using both field and laboratory methods. The BSAFs are expressed as the PAH concentration in the lipid fraction of the earthworm divided by the PAH concentration in the soil organic carbon. Although not significantly different, accumulation of PAHs in earthworms in the laboratory tests was 37 to

[15] BAFs are calculated by dividing the tissue concentration estimated using the regression model by the soil concentration.

54 percent lower than in the field collected earthworms. Therefore, the field collected earthworm data was used to derive more conservative BAFs for PAHs for use at the Site.

In the field study, collocated earthworms and soil samples were collected from three MGP sites with a range of PAH and carbon contents (Kreitinger et al. 2007). BSAFs were derived for 16 PAHs and each of the three samples. Table C-3 shows how the BSAFs were converted to BAFs for use in food chain models (Section 4.4). Table C-3 shows that variation among the BAFs for the three soil samples were fairly consistent; typically a factor of 2 to 5 for each of the PAHs. The geometric mean BAF for each PAH was calculated using the three samples and was used to estimate the bioaccumulation of PAHs into earthworms at the Site.

The COPEC screening (Table C-1) shows that mercury exceeds the EISC for soil biota, but not for wildlife. Therefore, it is not necessary to evaluate hazards to wildlife from mercury, and BAFs do not need to be derived for the Site.

The COPEC screening (Table C-1) shows that selenium exceeds the EISC for wildlife, but not for soil biota. Therefore, it is necessary to evaluate hazards to wildlife from selenium and BAFs for plants and soil biota are needed to evaluate food-chain exposures. EPA (2007) provides log-log regression equations for estimating the bioaccumulation of selenium into plants (Equation 3) and earthworms (Equation 4), as described below:

Equation 3: Bioaccumulation of selenium into plants

$$ln(Cp) = 1.104 \, x \, ln(Cs) - 0.677$$

Equation 4: Bioaccumulation of selenium into earthworms

$$ln(Ce) = 0.733 \, x \, ln(Cs) - 0.075$$

Where:

Cp = concentration in plant tissue (mg/kg dry weight)
Ce = concentration in earthworm tissue (mg/kg dry weight)
Cs = concentration in soil (mg/kg dry weight)

Selenium was not detected in soil samples from the lower and slope areas of the Site, so exposure estimates and hazard calculations were not required in these areas. Table C-4 shows the selenium BAFs for plants and earthworms for the upper area.

4.2.4 Wildlife Exposure Parameters

EPA also developed wildlife exposure factors to support the development of the EcoSSLs (EPA 2007a). The wildlife exposure factors provided in the EcoSSLs are used in this TEE. As noted earlier, the MTCA TEE process uses the vole, shrew, and robin to assess hazards to wildlife. EPA used a wider variety of wildlife receptors which included the vole, shrew, and American woodcock. The robin and woodcock have similar feeding strategies; both consume earthworms and other invertebrates. The food and soil ingestion rates for the woodcock (EPA 2007a) are higher than those for the robin (MTCA Table 749-4). Therefore, the exposure factors for the woodcock were used herein as a conservative measure for assessing potential exposure to the robin. Incorporation of the EPA wildlife exposure factors into this TEE does not alter the wildlife receptors of concern identified in Section 4.1.3 (i.e., the shrew, vole, and robin).

Exposure factors for the shrew, vole, and robin for this Site are shown in Table C-5. Exposure factors from both the EcoSSLs and MTCA (Table 749-4) are presented, as EPA did not provide values for the proportion of contaminated food in diet (P) or the gut absorption factor (RGAF).

4.3 TOXICITY ASSESSMENT

The toxicity assessment identifies toxicity values to assess hazards from COPECs. The EPA's EcoSSLs were derived using more recent and comprehensive data then the MTCA EISCs. EPA (2007b) derived toxicity data for two major groups of PAHs; LPAHs and HPAHs. For soil biota, the EcoSSLs are 29 mg/kg for LPAHs and 18 mg/kg for HPAHs. These values are not significantly different from the MTCA soil biota EISC for fluorene (30 mg/kg). However, a shortcoming of these toxicity values is they are primarily based on exposing soil biota to soils freshly spiked with PAHs. As noted in Section 4.2.3, soils at the Site are well-aged and weathered making the residual PAHs much less bioavailable and thus less toxic to soil biota.

The study by Kreitinger et al. (2007) provides an assessment of the toxicity of PAHs to soil biota at MGP sites that is considerably more relevant to the Site than either the MTCA EISC or EPA EcoSSL. Kreitinger et al. (2007) conducted a 14-day study of earthworm bioassays on 16 soil samples from MGP sites with varying soil total PAH (tPAH) concentrations and carbon contents; the results are presented in Table C-6. There was a poor correlation between tPAH concentrations and earthworm survival ($r = 0.05$). Earthworm survival was 100 percent at MGP sites with soils having a tPAH concentration of up to 42,100 mg/kg. This is because much of the tPAH concentration found in soil at MGP sites is strongly bound to soil carbon so not bioavailable or toxic. In general, mortality occurred when the rapidly released fraction of PAHs was approximately 0.80 or greater. An exception to this generality is soil sample CG10 which had a rapidly released fraction of 0.25 and a 25 percent survival. This anomaly was not explained by Kreitinger et al. (2007). Some of the soil samples included in this study had exceptionally high carbon concentrations which were associated with visible soot (OG2 and OG10). Although not measured in Site soil, it would be unlikely to find organic matter contents this high at the Site. Normal organic matter contents for loam soils range from > 1 to 5 percent. The sample with the highest no-observed-adverse-effect-concentration (NOAEC) below the lowest-observed-adverse-effect-concentration (LOAEC) is sample CG2 with a tPAH concentration of 307 mg/kg. The sample with the lowest LOAEC is CG10 with a tPAH concentration of 521 mg/kg. Consistent with EPA's EcoSSL process, the soil screening level (SSL) for the protection of soil biota at the Site was calculated as the geometric mean of the NOAEC and LOAEC value and is 400 mg/kg.

The toxicological data used by EPA to derive the wildlife toxicity reference values (TRVs) for PAHs (EPA 2007a) is relatively current, comprehensive, and is state of the art. EPA conducted comprehensive literature surveys and identified ecotoxicity publications meeting specific scientific criteria for use in deriving TRVs for birds and mammals (EPA 2003). A preliminary review of each article was conducted to determine if the article contains data suitable for TRV derivation. For example, studies based on acute exposure, reporting results for dead animals, using mixtures of constituents, studies lacking experimental controls, studies not reporting a test duration, and studies reporting data from research not conducted by the author were deemed unsuitable. Each study was then reviewed in detail and scored using ten data quality criteria (EPA 2007c). Total scores range from 0 to 100 and a minimum score of 66 was required for acceptance of the study. Finally, NOAEL and LOAEL TRVs were derived for each study and expressed as a daily dose of constituent (mg/kg/d).

EPA (2007) determined there was insufficient toxicity data to develop a TRV for PAHs and birds. This is consistent with MTCA (Ecology 2000). Only mammal TRVs based on LOAEL toxicity data were used to derive the TRVs for this site-specific TEE. This approach is consistent with MTCA methodology (WAC 173-340-7493(4)(a). Toxicity data for growth, reproduction, and survival endpoints were used. A minimum of three acceptable toxicity values were needed to derive an alternative TRV consistent with EPA EcoSSL methodology (EPA 2003, 2007c). The tenth percentile value of the LOAELs was selected as the alternative TRV. The tenth percentile value is considered sufficiently protective and reduces uncertainties associated with toxicity values occurring at the extremes of the data distribution (i.e., data outliers)[16]. The mammalian TRVs derived from this process are 138 mg/kg/d for LPAHs and 15.72 mg/kg/d for HPAHs and the toxicity data used to derive those values are provided in Table C-7.

The MTCA Table 749-3 EISC for mercury to soil biota is 0.1 mg/kg. This value comes from Oak Ridge National Laboratory (ORNL) benchmark report (Efroymson et al. 1997) and was based on a 1983 study where the investigators applied mercury as mercuric chloride at several concentrations to the soil to which earthworms were exposed. Mercury in the form of mercuric chloride is very soluble and bioavailable and is not considered to be representative of mercury exposure at the Site. Efroymson et al. (1997) rated the confidence in this benchmark as low because it was based on a single study. A literature survey was conducted to identify more recent and appropriate toxicity data.

No appropriate published literature was found that assessed the chronic effects of mercury in weathered soil on soil biota. Zagury et al. (2006) evaluated the survival of earthworms exposed to three soil samples collected from a chlor-alkali plant. Survival was 100 percent in soils with 295 and 568 mg/kg mercury and 0 percent in the heavily contaminated soil sample

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[16] Published results of individual toxicity tests are subject to many vagaries associated with the test design and responses of the organisms. Examination of the mammalian and avian toxicity data presented in the EPA EcoSSL documents shows that the NOAEL and LOAEL datasets vary by several orders of magnitude, even when evaluating the same toxic endpoint and the same or similar species. There are typically some very low and very high toxicity values in the databases. So, instead of using the lowest NOAEL. Therefore, EPA selected the median NOAEL value to represent the TRV. Selection of the tenth percentile LOAEL as the TRV in this TEE is a more conservative approach than EPA's use of the median TRV.

(11,500 mg/kg). Lock and Janssen (2001) evaluated the effect of mercury, applied as mercuric chloride, on the reproduction of three soil biota: the earthworm *Eisenia fetida*, the potworm *Enchytracus albidus*, and the springtail *Folsomia candida*. The results of the chronic exposure tests showed the exposure concentrations at which there was a 50 percent reduction in reproduction (EC_{50}) were 9.16 mg/kg for the earthworm, 22 mg/kg for the potworm, and 3.26 mg/kg for the springtail. Liu et al. (2010) calculated a chronic reproduction EC_{50} for springtails of 9.29 mg/kg, which is similar to the findings of Lock and Janssen (2001). Gudbrandsen et al. (2007) evaluated the toxicity of mercury, applied as mercuric chloride, to two groups of earthworms (*Eisenia fetida*) – one group was pre-exposed to a non-lethal concentration of mercury in the soil (22 mg/kg) for one week and the other group was not pre-exposed. Glutathione is important in the cellular defense against mercury toxicity and pre-exposure to mercury can increase tolerance by increasing levels of glutathione. Gudbrandsen et al. (2007) found the lethal concentration at which 50 percent of earthworm died (LC_{50}) to rise from 170 mg/kg in non-pre-exposed earthworms to 545 mg/kg in pre-exposed earthworms. The reproduction (cocoon production at 28 days) EC_{50} values were 9.2 mg/kg in the non-pre-exposed earthworms and 16.5 mg/kg in the pre-exposed earthworms. The chronic earthworm reproduction EC_{50} value reported by Gudbrandsen et al. (2007) for non-pre-exposed earthworms is identical to the value reported by Lock and Janssen (2001). Based on this information, the selected SSL is 3.26 mg/kg for mercury. This level comes from the study by Lock and Janssen (2001) and is both the chronic reproduction EC_{50} and LOAEC for the most sensitive organisms, the springtail.

Wildlife TRVs for selenium were derived using the process described above for the mammalian TRVs for PAHs. The mammalian TRV for selenium derived from this process is 0.239 mg/kg/d and the avian TRV is 0.287 mg/kg/d. The toxicity data used to derive the selenium TRVs are provided in Table C-8.

4.4 HAZARD CHARACTERIZATION

The Hazard characterization describes how hazards are calculated and provides quantitative hazard estimates. Hazards are assessed by comparing the soil EPCs for the upper, slope, and lower exposure areas to EISCs for soil biota and wildlife. The SSLs for soil biota are presented in Section 4.3 and are 400 mg/kg for tPAHs and 3.26 mg/kg for mercury.

The wildlife SSLs for PAHs were derived using BAFs presented in Table C-3, exposure factors presented in Table C-5, and TRVs presented in Table C-7. The standard MTCA (Table 749-4) wildlife exposure models were used to derive the wildlife SSLs and the model details are presented in Attachment C-5.

Hazard quotients (HQs) are used to help interpret hazards. HQs are calculated by dividing the soil EPC by the SSL for each COPEC. An HQ greater than one (1) suggests a potential ecological hazard.

Hazards for soil biota are shown in Table C-9. The HQs for mercury are below 1 for all exposure areas indicating hazards from mercury are below a level of concern. The HQs are above 1 for tPAHs in the upper and lower exposure areas suggesting that PAHs in soil may pose a hazard to soil biota in these areas.

Earthworms are considered a fairly sensitive indicator of soil contamination and are a standard soil bioassay test organism. Results of earthworm sampling presented in the ecological survey of the Site (Attachment C-1) show that earthworms were present at all 6 sample locations in the upper and lower exposure areas. Both night crawlers (*Lumbricus terrestris*) and other species of earthworms were present suggesting a diverse assemblage. Night crawlers form vertical burrows up to three feet deep and forage at night on organic matter on the soil surface. Other earthworm species form horizontal burrows usually in the upper foot of soil and feed on organic matter mixed in the soil. The total number of earthworms present in the 30 cm x 30 cm sample area at each location ranged from 2 to 16. Although the purpose of the earthworm survey was not to provide a quantitative population analysis, the number and variety of earthworms found during the Site survey appear comparable to earthworm populations found in turfgrass at other locations in western Washington[17]. In addition, the sampling results do not show a significant difference in the number of earthworms per sample location between the lower and upper exposure areas despite a relatively large difference in tPAH concentrations (i.e., EPCs are 1,556 mg/kg in the lower area and 12,819 mg/kg in the upper area). As shown in the study by Kreitinger et al. (2007), anthropogenic carbon sources at MGP sites can effectively immobilize PAHs in soil making them non-toxic to soil biota at relatively high PAH concentrations (i.e., 100 percent earthworm survival at 42,100 mg/kg tPAHs). This information does not support the screening results that suggest PAHs pose a hazard to soil biota.

Hazards to wildlife from PAHs in soil are shown in Table C-10. HQs are equal to or below one for all individual PAHs in all exposure areas suggesting they do not pose a hazard to wildlife. The hazard index (HI) is the sum of HQs for the LPAHs and HPAHs and is equal to or below one for all exposure areas with the exception of the LPAHs in the upper exposure area for the shrew which had an HI=2. A review of Table C-10 shows that naphthalene is the driver for the HI in the upper exposure area. The EPC for naphthalene in the upper exposure area is significantly greater than the naphthalene EPCs in the lower and slope areas and also significantly higher than the EPCs for all other PAHs in the upper area. This information suggests that PAHs may pose a hazard to wildlife in the upper area.

Hazards to wildlife from selenium in the lower exposure area are shown in Table C-11. HQs are ≤ 1 for all wildlife receptors suggesting that selenium does not pose a hazard to wildlife in the lower exposure area.

[17] The author of this TEE (Dr. Dana Houkal) has conducted earthworm surveys at several locations in Washington State.

4.5 UNCERTAINTY ANALYSIS

Uncertainties are inherent in each step of the TEE process and affect the interpretation of results. The major uncertainties associated with the TEE for the Site are described below.

Several methods were used to identify COPECs in soil. Results of COPEC screening (Section 4.1.1) show that no constituents were eliminated as COPECs based upon the 5 percent frequency of detection criteria. Seventeen constituents were detected at a frequency of greater than 5 percent, but were not identified as COPECs based on supplemental information presented in Attachment C-3. In some instance, little or no toxicity information was available to evaluate the potential environmental effects of constituents detected in Site soils (e.g., little information was available to assess impacts of VOCs on plants and soil biota). Instead, factors such as chemical fate characteristics, bioaccumulation potential, conservative wildlife toxicity assessments, and field observations of the status of plants and soil biota communities on the Site were used to help identify COPECs. The use of these factors could result in an underestimation of potential adverse environmental effects, but the magnitude of uncertainty is considered low.

Evaluation of the toxicity of mercury and PAHs to soil biota is an important source of uncertainty. Although MTCA provides soil biota EISCs for mercury (0.1 for inorganic mercury) and one PAH (30 mg/kg for fluorene), alternative SSLs were developed for this site-specific TEE. The SSL for mercury is 3.62 mg/kg and is based on an up-to-date review of the scientific literature. The SSL for total PAHs is 400 mg/kg and is based on a comprehensive study of the toxicity of PAHs in soils to earthworms from 16 MGP sites. The SSL for mercury was based on 4 scientific studies that evaluated the effect of mercury on three different species of soil biota and included both reproductive and survival toxic endpoints. One of the studies used field collected soils in laboratory toxicity tests (i.e., aged and weathered soils more comparable to conditions present at the Site), while the other three studies applied mercury as mercuric chloride to test soils in the laboratory. The four studies showed comparable results and were deemed sufficient for development of an alternative SSL. As noted previously, the earthworm testing conducted to derive toxicity data exposed biota to a highly bioavailable form of mercury (mercuric chloride), so likely overestimates the actual hazards associated with exposure to the weathered/aged mercury present at the Site.

The soil biota SSL for tPAHs comes from a study of earthworm toxicity to PAHs present in soils at 16 MGP sites. This study is considered applicable to the Site because the test soils have comparable soil characteristics with respect to their weathered/aged nature and the presence of coal tar and soot. These characteristics cause the PAHs to become slightly bound to the soil reducing bioavailability and toxicity. Unfortunately, a dose-response curve could not be generated from this study because there were multiple factors that affected toxicity. Therefore, the SSL was calculated as the geometric mean of the highest NOAEC and lowest LOAEC. The direction and magnitude of uncertainty associated with this SSL derivation process is unknown. However, the soil biota SSL for tPAHs is based on results of a 14-day earthworm toxicity test having survival as the endpoint. Survival may not be the most sensitive endpoint and tests of longer duration may also show increased sensitivity. Therefore, the soil biota SSL for tPAHs may underestimate toxicity by an unknown magnitude.

Results of a site-specific ecological survey were used to help evaluate the effects of mercury and PAHs on soil biota. This survey was not intended to provide a quantitative assessment of the soil biota community present at the Site nor did it generate comparative reference area data. However, results of the survey show that a soil biota community (i.e., earthworms) is present within turfgrass located in the lower and upper exposure areas of the Site, which are comparable to communities found at other turfgrass areas in western Washington. There is a high degree of uncertainty associated with the survey results, although the direction of uncertainty is unknown.

There is some uncertainty in the BAFs for PAHs used in developing the wildlife SSLs. MTCA provides a default plant BAF for benzo(a)pyrene of 0.011 based upon a relationship between the log K_{ow} of non-ionic organic constituents and plant uptake. EPA in their EcoSSL program developed regression equations for estimating the plant uptake of LPAHs and HPAHs based upon published studies that measured PAH concentrations in collocated soil and plant samples. EPA's equations were selected for developing BAFs for the TEE because they are considered state-of-the-science. The resulting BAFs for the three exposure areas at the Site ranged from 0.002 to 0.019 for LPAHs and 0.125 to 0.133 for HPAHs. A thorough review of the studies EPA used to derive the plant BAF regression equations for PAHs was not conducted. However, it is unlikely that any of these studies included data from MGP sites where the bioavailability of PAHs should be lower than in non-MGP sites. Therefore, use of EPA's plant BAF regression equations may overestimate bioaccumulation of PAHs into plants.

MTCA provides a default earthworm BAF for benzo(a)pyrene of 0.43 which was calculated as the mean BAF from two published studies of bioaccumulation from sediment confined disposal facilities. Soil characteristics at confined disposal facilities are not expected to be comparable to soil characteristics found at MGP sites. Therefore, a recent published study characterizing earthworm bioaccumulation of PAHs from MGP sites was identified for deriving BAFs. The study provided bioaccumulation data for three soil samples with varying PAH concentrations and varying carbon contents. The BAFs derived using this data ranged from 0.013 to 0.099 for individual PAHs (the BAF was 0.082 for benzo(a)pyrene). There is some uncertainty associated with these BAFs because they were based on relatively few samples, but the direction and magnitude of uncertainties is unknown.

The plant and earthworm BAFs for selenium were obtained from the EPA's EcoSSL program. The EPA used log-log regression equations to characterize the bioaccumulation of selenium over a range of selenium concentrations in soil. The magnitude and direction of uncertainty associated with the use of the EPA EcoSSL BAFs for selenium is largely unknown.

Insufficient toxicological data are available to derive avian TRVs for PAHs. The direction and magnitude of this uncertainty is largely unknown. However, available avian toxicity data provided in EPA's EcoSSL document for PAHs (EPA 2007b) are higher than mammalian toxicity values used in this site-specific TEE suggesting that hazard estimates for mammalian receptors should be protective of avian receptors.

MTCA provides default mammalian wildlife TRVs for benzo(a)pyrene of 1.19 mg/kg/day for the shrew and 0.91 mg/kg/day for the vole. These values are based on a NOAEL value obtained from a 1981 study on reproductive impacts on mice reported in the ORNL wildlife screening benchmark study. The 1981 study did not report a NOAEL, but ORNL extrapolated a NOAEL from the reported LOAEL by dividing the LOAEL by a safety factor of 10. Normally, MTCA uses LOAEL TRVs to derive EISCs for wildlife, but because of uncertainties associated with the lack of data characterizing the toxicity of benzo(a)pyrene to birds, plants and soil biota, the mammalian NOAEL TRV was used. EPA (2007b) compiled a comprehensive number of LOAEL TRVs for PAHs for growth, reproduction and survival endpoints. Table C-7 shows there are 18 LOAELs for LPAHs and 15 LOAELs for HPAHs. The TRVs for the site-specific TEE at the Site were derived from this comprehensive dataset which represents the state of the science. The HPAH TRV of 15.72 mg/kg/d is not significantly different from the benzo(a)pyrene TRV of 10 mg/kg/day reported in the ORNL study. Uncertainties associated with the use of the LPAH and HPAH mammalian TRVs derived in this TEE are considered small.

As noted in Section 4.4, the shrew HI of 2 for LPAHs in the upper ecological exposure area is driven by a high naphthalene concentration, attributable to a single subsurface soil sample (MGP-GP-24-5.0-6.0) which has a naphthalene concentration of 63,000 mg/kg. The naphthalene concentration in surface soil at the same location (MGP-GP-24-0.5-1.0) is 22 mg/kg and the next highest naphthalene concentration in soil samples from the upper area is 2,200 mg/kg. An outlier test was performed on the naphthalene soils data from the upper area using ProUCL and results showed that the naphthalene concentration for sample MGP-GP-24-5.0-6.0 is a statistical outlier (Table C-12). Furthermore, when this statistical outlier is removed from the dataset, the EPC for naphthalene from the upper exposure area drops from 13,152 mg/kg to 805.6 mg/kg. The HQ for naphthalene and the HI for LPAHs drop to below one when using a naphthalene EPC of 805.6 mg/kg for the upper exposure area. The naphthalene concentration in subsurface soil at location MGP-GP-24 is not representative of naphthalene concentrations in soils within the conditional point of compliance across the upper area. Review of all the PAH data for sample location MGP-GP-24 does show that concentrations for all PAH are elevated in the subsurface soil sample compared to the surface soil sample indicating the presence of a possible hotspot[18]. However, since wildlife are assumed to have the same probability of exposure to soils across the upper area, significant exposure to the elevated subsurface soil naphthalene level at sample location MGP-GP-24 it is considered unlikely and hazards to wildlife are probably over-estimated.

There is limited uncertainty associated with other parameters used to estimate hazards to wildlife.

One final uncertainty relates to the overall goal of this TEE which is the protection of populations of soil biota and wildlife from adverse effects from constituents present in Site soil. Although the definition of a population varies greatly among scientists and resource managers, we can safely assume these populations occupy an area considerably larger than the Site. For example, the Site forms part of the South Bay Trail which provides a relatively continuous greenbelt along Bellingham Bay. If we conservatively assume that local populations of interest

[18] The elevated PAH concentrations in subsurface soil sample MGP-GP-24-5.0-6.0 will be evaluated further in the feasibility study.

occupy the South Bay Trail corridor, the area occupied by these populations can be estimated to be approximately 55 acres (i.e., the trail extends for 2.3 miles[19] and has an average width of 200 feet). The upland Site occupies approximately 4.2 acres or 6 percent of the area occupied by these local populations. It can be readily seen that these local populations will have limited exposure to soil contaminants at the Site. Therefore, results of the TEE for the likely overestimate hazards to local populations of soil biota and wildlife.

[19] Source http://www.cob.org/documents/parks/parks-trails/trail-guide/south_bay.pdf .

5 SUMMARY AND CONCLUSIONS

The Site did not qualify for exclusion from the TEE, or for a simplified version of the TEE, so a site-specific TEE was required. Receptors of concern for the Site included soil biota and wildlife. Plants were not identified as receptors of concern because vegetation at the Site (i.e., consisting of extensive turfgrass areas interplanted with exotic and native shrubs and trees) was planted for landscape and ornamental purposes. The TEE identified mercury, selenium, and 17 individual PAHs as COPECs, and these constituents were carried into the detailed evaluation of ecological hazards. Mercury presented a potential hazard only to soil biota, selenium presented a potential hazard only to wildlife, and PAHs presented potential hazards to soil biota and wildlife.

BAFs were developed for the evaluation to estimate the concentrations of COPECs that would accumulate in plants and soil biota from the soil, and in turn be consumed by wildlife. A soil biota SSL for mercury was derived using published literature values and for PAHs, was derived from a study of the toxicity to earthworms of soils collected from 16 MGPs sites. Wildlife TRVs were developed from toxicity data provided in EPA's recent EcoSSL document for PAHs and selenium. Wildlife SSLs for PAHs and selenium were developed using the BAFs and TRVs generated in the site-specific TEE.

Results of this evaluation indicate that mercury and selenium do not pose an unacceptable ecological hazard. Results of a comparison of tPAH soil concentrations in the lower and upper exposure areas to a threshold protective of soil biota (e.g., earthworms) suggested a potential hazard to soil biota. However, empirical evidence at the Site through the site-specific field survey show diverse communities of earthworms inhabit both areas and they appear comparable to communities found in turfgrass habitats elsewhere in western Washington. Therefore, it is concluded that tPAHs do not pose a hazard to soil biota. Wildlife hazards for individual PAHs were below a level of concern (i.e., HQ $\leq$ 1). Likewise, the cumulative effect of LPAHs and HPAHs in the lower and slope area and HPAHs in the upper area were below a level of concern (i.e., HI $\leq$ 1). However, the cumulative effect of LPAHs in the upper area was found to pose a potential hazard to one of the two wildlife receptors (i.e., shrew). Evaluation of the cumulative effect of LPAHs on the shrew in the upper exposure area presented in the uncertainty analysis shows the hazards were driven by a single soil sample result for naphthalene (i.e., MGP-GP-24-5.0-6.0) which was identified as a statistical outlier and not considered representative of Site conditions within the conditional POC. When the outlier sample was removed from the soil data set, the hazards from LPAHs dropped below a level of concern. Although sample MGP-GP-24-5.0-6.0 may represent a PAH hot spot, the limited potential exposure of the shrew to this location within the upper ecological exposure area suggests that wildlife hazards from LPAHs may be over-estimated beyond the immediate vicinity of the potential hot spot, which will be addressed in the FS.

A comprehensive list of potential uncertainties associated with this TEE is presented in the previous section. These types of uncertainties are typical and are not anticipated to result in underestimating the overall hazards to terrestrial ecology. As a result of this evaluation, protection of groundwater, surface water, sediment and marine ecology, and human health through direct contact and consumption of potentially affected marine organisms will be the primary factors for developing cleanup levels for the Site.

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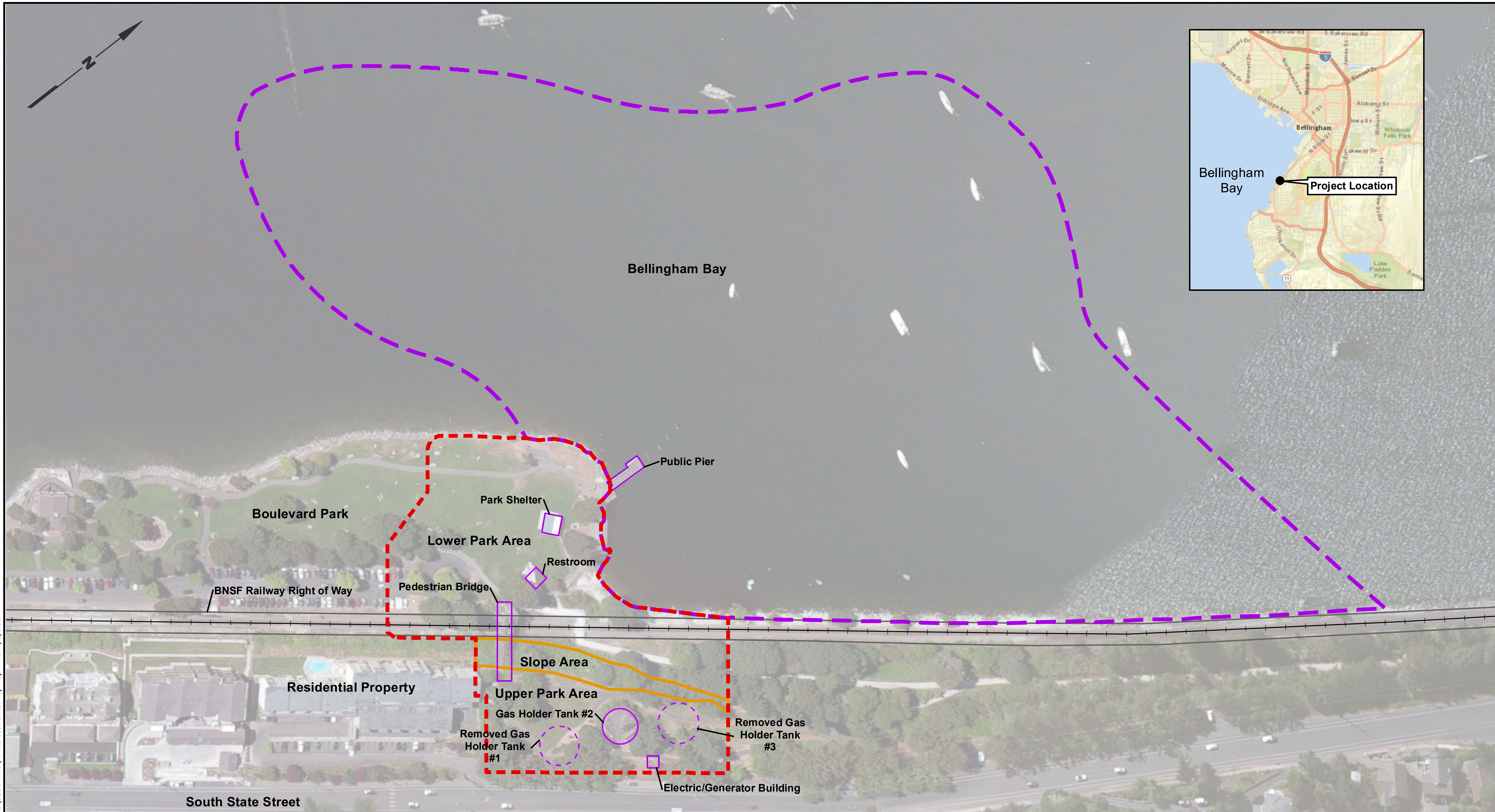

Legend

- Existing Site Structures
- Former Gas Holder Tanks
- Upland Site Boundary
- Marine Site Boundary

Notes

1. Horizontal Datum: NAD 83 (HARN), U.S. Survey Feet.
2. Vertical Datum: Mean Lower Low Water (MLLW), Feet.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 150 300

Scale in Feet

Data Sources: BergerABAM, 2010: Steele and Assoc, 2011; Esri World Imagery.

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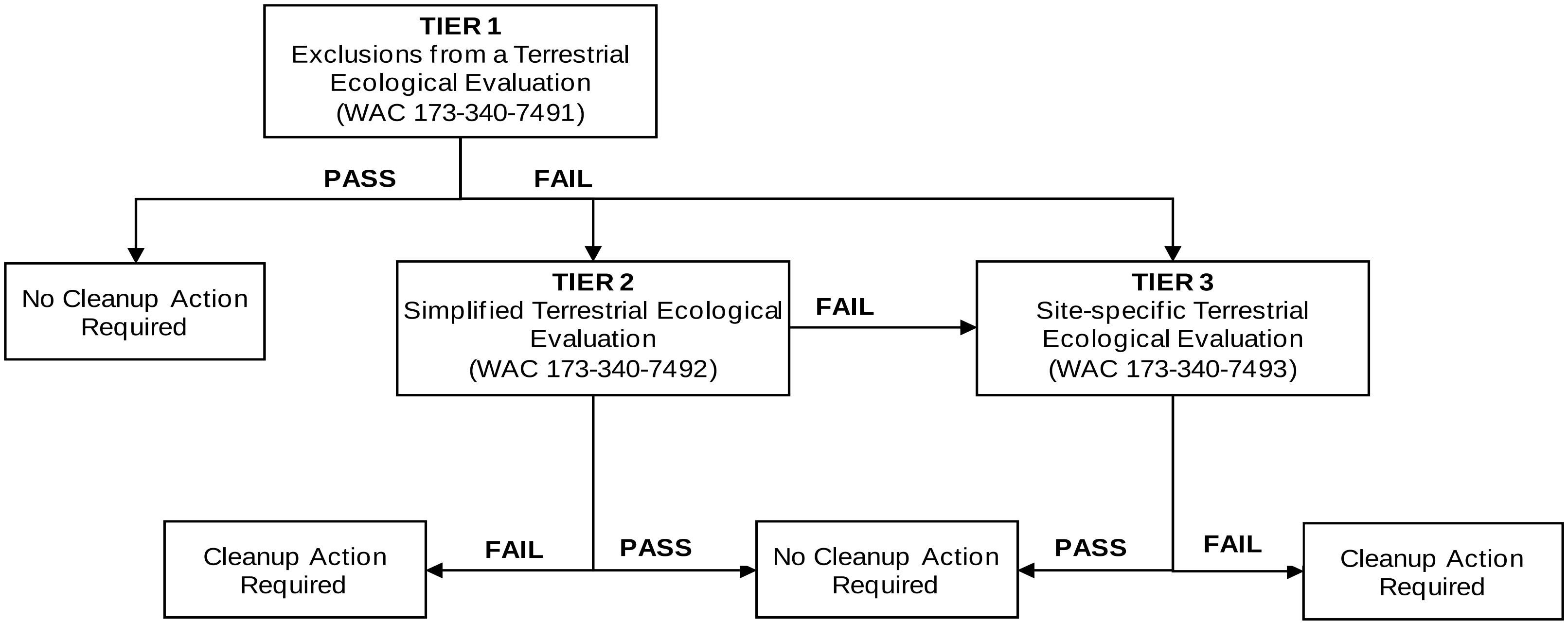
South State Street Manufactured Gas Plant RI/FS Bellingham, Washington	Site and Vicinity Map	Figure C-1



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South State Street Manufactured Gas Plant RI/FS Bellingham, Washington	**MTCA Terrestrial Ecological Evaluation Framework**	Figure C-2

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Legend

- MW-61; CA-02; CA-01; AA-01
- Bivalve Sample Locations
- Air Sample
- GeoProbe Soil Boring (and Soil Vapor if Indicated)
- Hollow-Stem Auger Soil Boring
- Hand Auger
- Monitoring Well
- Stormwater
- Well Point
- Existing Site Structures
- Former Gas Holder Tanks
- Upland Site Boundary

Notes

1. CA = Crawl Space Air AA= Ambient Air
   SV = Soil Vapor
2. Horizontal Datum: NAD 83 (HARN), U.S. Survey Feet.
3. Vertical Datum: Mean Lower Low Water (MLLW), Feet.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 75 150

Scale in Feet

Data Sources: BergerABAM, 2010: Steele and Assoc, 2011; Esri World Imagery.

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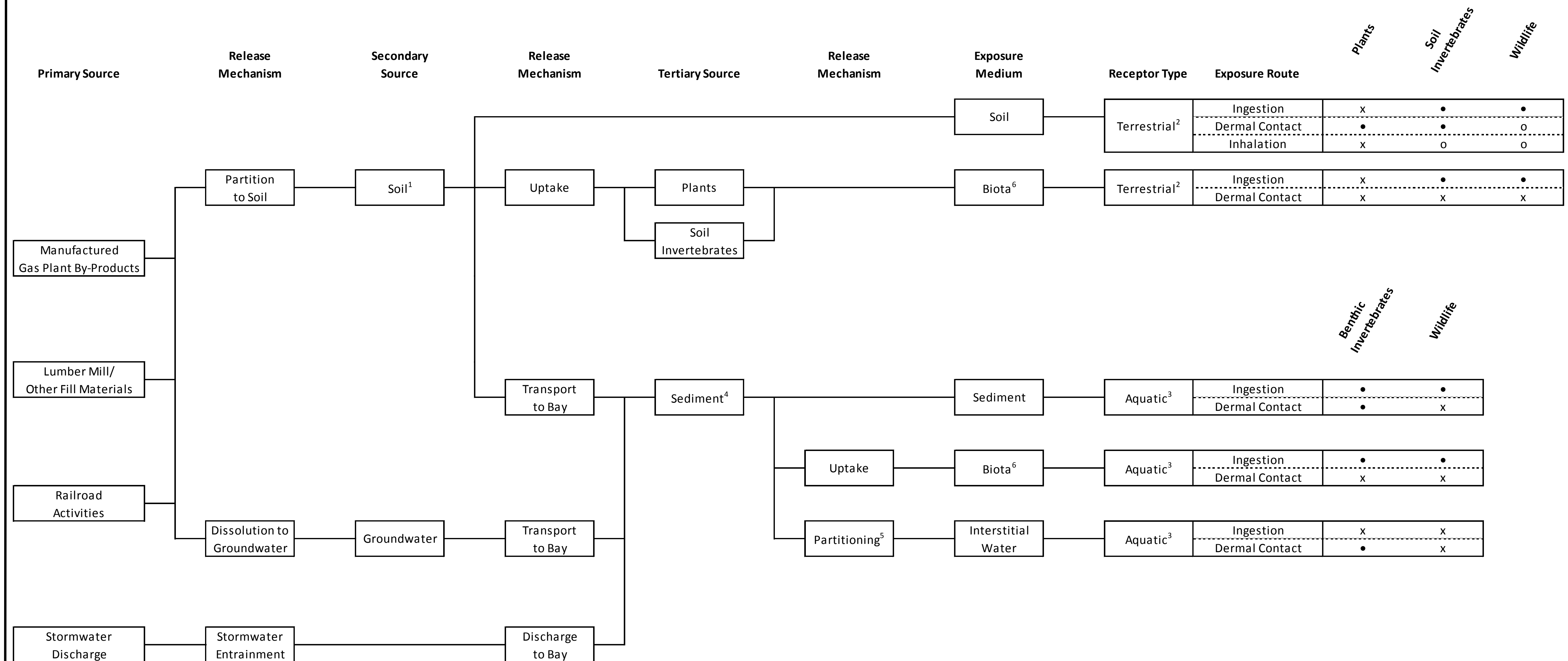
South State Street Manufactured Gas Plant RI/FS Bellingham, Washington	**Upland RI Sample Locations**	Figure C-3



Legend
• = Complete and potentially significant pathway
o = Complete but insignificant pathway
x = Incomplete or not applicable pathway

Notes

1. The terrestrial ecological evaluation (WAC 173-340-7490 through 7494) only considers exposure to soil and biota that may accumulate constituents from soil. For ecological exposure to soil, the evaluation will use the conditional point of compliance of 0-6 ft below ground surface.
2. Terrestrial receptor exposure may take place in both the upper and lower portions of the site.
3. Aquatic receptor exposure may take place in the lower portion of the site.
invertebrates which then become prey for wildlife. Benthic invertebrates (e.g., polychaetes, clams) are sessile organisms which live in intimate contact with site sediments and whose tissue constituent concentrations are more closely related to the site sediment constituent concentrations then pelagic organisms (e.g., fish, shrimp). This assessment and CEM do not address constituents present in over-lying sea water because these are transient in nature and may not be site-related. In addition, the primary site-related constituents are PAHs, which have limited water solubility. Pelagic organisms are mobile, can have large home ranges, are not closely associated with sediments, and typically accumulate constituents from the water column and from consumption of organisms that have accumulated constituents in their tissues. Since potential exposure of pelagic organisms to constituents present in site sediments is considered to be negligible, pelagic organisms are not the subject of this assessment.
5. Constituents partition between sediment and interstitial water based upon the physical and chemical properties of the sediment, interstitial water, and constituent. Partitioning is a dynamic two directional process which is rarely at equilibrium.
6. Biota in this case refers to benthic invertebrates. See note 4 for further discussion.

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South State Street Manufactured Gas Plant Bellingham, Washington	Ecological Conceptual Exposure Model	Figure C-4

Table C-1. Screening of Chemicals of Potential Ecological Concern in Soil

Constituent	Raw Statistics using Detected Observations[1]											EPC[1]	Ecological Indicator Soil Concentrations[2]			Nat. Soil Back-ground[3]	Candidate COPEC?	Final COPEC?	Rationale
	# Detects	# Non-detects	% Non-detects	Min. Conc.	Max. Conc.	Mean	Median	Stand. Dev.	MAD / 0.675	Skew-ness	CV		Plants	Soil Biota	Wild-life				
1,1,1,2-Tetrachloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1,1-Trichloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1,2,2-Tetrachloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1,2-Trichloro-1,2,2-trifluoroe	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1,2-Trichloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1-Dichloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1-Dichloroethene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,1-Dichloropropene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,2,3-Trichlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			20			No	No	Not detected
1,2,3-Trichloropropane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,2,4-Trichlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			20			No	No	Not detected
1,2,4-Trimethylbenzene	5	2	29%	0.012	120	45.93	37	51	53.91	0.734	1.11	70.14					Yes	No	See Attachment C-3
1,2-Dibromo-3-chloropropane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,2-Dichlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,2-Dichloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,2-Dichloropropane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			700			No	No	Not detected
1,3,5-Trimethylbenzene	3	4	57%	0.0035	52	17.41	0.24	29.95	0.351	1.732	1.72	52					Yes	No	See Attachment C-3
1,3-Dichlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,3-Dichloropropane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
1,4-Dichlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			20			No	No	Not detected
1-Methylnaphthalene	73	19	21%	0.0052	7500	122.9	0.07	885.1	0.093	8.284	7.205	611.9	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
2,2-Dichloropropane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2,2'-Oxybis(1-Chloropropane)	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2,4,5-Trichlorophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		4	9			No	No	Not detected
2,4,6-Trichlorophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			10			No	No	Not detected
2,4-Dichlorophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2,4-Dimethylphenol	1	6	86%	81	81	81	81	N/A	0	N/A	N/A	81					Yes	No	See Attachment C-3
2,4-Dinitrophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		20				No	No	Not detected
2,4-Dinitrotoluene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2,6-Dinitrotoluene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Butanone	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Chloroethylvinylether	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Chloronaphthalene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Chlorophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Chlorotoluene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Hexanone	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Methylnaphthalene	80	12	13%	0.0054	13000	190.1	0.0765	1462	0.0956	8.746	7.691	1054	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
2-Methylphenol	1	6	86%	86	86	86	86	N/A	0	N/A	N/A	86					Yes	No	See Attachment C-3
2-Nitroaniline	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
2-Nitrophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
3,3'-Dichlorobenzidine	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
3-Nitroaniline	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4,6-Dinitro-2-Methylphenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Bromophenyl-phenylether	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Chloro-3-methylphenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Chloroaniline	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Chlorophenyl-phenylether	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Chlorotoluene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Isopropyltoluene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Methyl-2-Pentanone (MIBK)	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Methylphenol	1	6	86%	210	210	210	210	N/A	0	N/A	N/A	210					Yes	No	See Attachment C-3
4-Nitroaniline	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
4-Nitrophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			7			No	No	Not detected
Acenaphthene	43	49	53%	0.0044	250	8.659	0.063	40.02	0.0845	5.664	4.622	22.09	20	30[b]	12[c]		Yes	Yes	EPC > plant and wildlife EISCs
Acenaphthylene	84	8	9%	0.0053	2600	43.73	0.135	291.7	0.173	8.419	6.67	221.6	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Acetone	2	5	71%	0.04	0.066	0.053	0.053	0.0184	0.0193	N/A	0.347	0.66					Yes	No	See Attachment C-3
Acrolein	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Acrylonitrile	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Anthracene	75	17	18%	0.0059	1000	22.34	0.29	123.3	0.415	7.285	5.52	90.92	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Antimony	4	87	96%	0.2	1.9	0.9	0.75	0.726	0.519	1.099	0.806	0.27	5			NA	No	No	EPC < all EISCs
Aroclor 1016	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Aroclor 1221	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Aroclor 1232	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Aroclor 1242	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Aroclor 1248	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Aroclor 1254	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Aroclor 1260	0	2	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40		0.65		No	No	Not detected
Arsenic	90	1	1%	2.1	33.6	5.764	4.35	4.574	1.26	3.632	0.793	6.573	10	60	132 (7)[e]	7	No	No	UCL < EISCs
Barium	98	0	0%	0.049	724	177.3	138.5	143.6	75.02	2.142	0.81	240.6	500		102	255	Yes	No	See Attachment C-3
Benzo(a)anthracene	99	5	5%	0.0075	650	20.87	0.44	90.2	0.632	6.077	4.321	73.83	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Benzo(a)pyrene	100	4	4%	0.0028	810	22.25	0.645	94.41	0.926	6.905	4.242	78.15	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Benzo(g,h,i)perylene	89	3	3%	0.007	360	10.06	0.48	40.18	0.692	7.789	3.996	35.49	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Benzoic Acid	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Benzyl Alcohol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
bis(2-Chloroethoxy) Methane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bis-(2-Chloroethyl) Ether	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
bis(2-Ethylhexyl)phthalate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bromobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bromochloromethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bromodichloromethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bromoethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bromoform	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Bromomethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Butylbenzylphthalate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Cadmium	53	45	46%	0.2	70	1.758	0.3	9.568	0.148	7.249	5.441	2.239	4	20	14	1	No	No	EPC < EISCs
Carbon Disulfide	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Carbon Tetrachloride	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Chlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			40			No	No	Not detected
Chloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Chloroform	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Chloromethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Chromium	90	1	1%	9	63	29.84	27	10.26	7.413	0.772	0.344	31.52	42	42	67	48	No	No	UCL < EISCs
Chrysene	101	3	3%	0.0033	670	20.62	0.44	87.7	0.629	6.211	4.253	72.99	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
cis-1,2-Dichloroethene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
cis-1,3-Dichloropropene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Copper	91	0	0%	1.4	143	36.78	28.9	23.92	9.489	2.14	0.65	47.72	100	50	217	36	No	No	UCL < EISCs
Cyanide	9	4	31%	0.125	76.4	13.17	1.46	24.91	1.979	2.53	1.891	20.15					Yes	No	See Attachment C-3
Dibenz(a,h)anthracene	84	20	19%	0.0029	83	2.707	0.19	9.703	0.264	7.146	3.585	7.567	20[a]	30[b]	12[c]		No	No	EPC < EISCs
Dibenzofuran	51	41	45%	0.0053	280	8.535	0.084	41.24	0.111	6.152	4.831	24.92	20[a]	30[b]	12[c]		Yes	Yes	EPC > plant and wildlife EISCs
Dibromochloromethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Dibromomethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Diesel Range Organics	7	0	0%	41	1200	473	510	422	578.2	0.741	0.892	783		200	6000 (2000)[d]		Yes	No	See Attachment C-3
Diethylphthalate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		100				No	No	Not detected
Dimethylphthalate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			200			No	No	Not detected
Di-n-Butylphthalate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		200				No	No	Not detected
Di-n-Octyl phthalate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Ethylbenzene	6	1	14%	0.0075	140	47.07	14	61.38	17.49	1.032	1.304	138.6					Yes	No	See Attachment C-3
Ethylene Dibromide	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Fluoranthene	90	2	2%	0.013	960	37.01	1	150.4	1.445	5.502	4.064	133.1	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Fluorene	63	29	32%	0.0049	1400	31.83	0.104	184.2	0.139	7.015	5.787	121.5	20[a]	30	12[c]		Yes	Yes	EPC > all EISCs
Gasoline Range Organics	6	1	14%	28	15000	6846	5450	6765	7948	0.445	0.988	10857		100	5000 (1000)[d]		Yes	No	See Attachment C-3
Hexachlorobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				17		No	No	Not detected
Hexachlorobutadiene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Hexachlorocyclopentadiene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		10				No	No	Not detected
Hexachloroethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Indeno(1,2,3-cd)pyrene	99	5	5%	0.0061	330	8.431	0.4	35.24	0.574	8.079	4.18	29.11	20[a]	30[b]	12[c]		Yes	Yes	EPC > plant and wildlife EISCs
Isophorone	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Isopropylbenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Lead	91	0	0%	3	747	72.34	35	118.1	29.65	3.563	1.632	91.23	50	500	118	24	No	No	Protection of plants not a goal of TEE
Lube Oil	7	0	0%	6	1300	481.3	280	474.1	266.9	1.114	0.985	829.5					Yes	No	See Attachment C-3
m, p-Xylene	6	1	14%	0.017	220	90.92	62	96.46	90.8	0.646	1.061	148.3					Yes	No	See Attachment C-3
Mercury	89	2	2%	0.03	1.37	0.162	0.09	0.225	0.0593	3.298	1.39	0.202	0.3	0.1	5.5 (0.4)[f]	0.07	Yes	Yes	EPC > soil biota EISC and background
Methyl Iodide	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Methyl tert-Butyl Ether	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Methylene Chloride	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Naphthalene	82	10	11%	0.0088	63000	846.6	0.185	6960	0.236	9.011	8.221	5036	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
n-Butylbenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Nitrobenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			40			No	No	Not detected
N-Nitroso-Di-N-Propylamine	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
N-Nitrosodiphenylamine	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			20			No	No	Not detected
n-Propylbenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
o-Xylene	6	1	14%	0.014	91	38.85	31.5	38.3	45.88	0.468	0.986	61.55					Yes	No	See Attachment C-3
Pentachlorophenol	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		3	6	4.5		No	No	Not detected
Phenanthrene	90	2	2%	0.01	2900	60.06	0.61	347.6	0.859	7.262	5.788	282.7	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
Phenol	1	6	86%	270	270	270	270	N/A	0	N/A	N/A	270	70	30			Yes	No	See Attachment C-3
Pyrene	90	2	2%	0.017	1400	54.42	1.3	224	1.858	5.449	4.117	197.6	20[a]	30[b]	12[c]		Yes	Yes	EPC > all EISCs
sec-Butylbenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected

Constituent	Raw Statistics using Detected Observations[1]											EPC[1]	Ecological Indicator Soil Concentrations[2]			Nat. Soil Back-ground[3]	Candidate COPEC?	Final COPEC?	Rationale
	# Detects	# Non-detects	% Non-detects	Min. Conc.	Max. Conc.	Mean	Median	Stand. Dev.	MAD / 0.675	Skew-ness	CV		Plants	Soil Biota	Wild-life				
Selenium	1	90	99%	2	2	2	2	N/A	0	N/A	N/A	2	1	70	0.3	NA	Yes	Yes	Although the FOD < 5%, the maximum detected concentration > 2-times wildlife EISC
Silver	4	87	96%	0.2	0.4	0.3	0.3	0.0816	0.0741	2.1E-15	0.272	0.21	2			NA	No	No	EPC < all EISCs
Styrene	1	6	86%	150	150	150	150	N/A	0	N/A	N/A	150	300				No	No	EPC < EISC
TEQ cPAH	102	2	2%	0.000313	1016	27.86	0.693	117	0.995	6.982	4.198	98.3	20[a]	30[b]	12[c]		No	No	cPAH not relevant for ecological receptors
tert-Butylbenzene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Tetrachloroethene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Toluene	7	0	0%	0.0047	220	58.19	39	78.71	57.41	1.746	1.353	220	200				Yes	No	See Attachment C-3
Total Benzofluoranthenes	101	3	3%	0.0028	930	22.86	0.97	99.51	1.4	7.985	4.354	82.3	**20[a]**	**30[b]**	**12[c]**		Yes	Yes	EPC > all EISCs
Total Xylenes	6	1	14%	0.031	311	129.8	93.5	134.6	136.7	0.597	1.037	209.8					Yes	No	See Attachment C-3
trans-1,2-Dichloroethene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
trans-1,3-Dichloropropene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
trans-1,4-Dichloro-2-butene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Trichloroethene	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Trichlorofluoromethane	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Vinyl Acetate	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Vinyl Chloride	0	7	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						No	No	Not detected
Weak Acid Dissoc. Cyanide	5	8	62%	0.14	7.6	2.258	0.59	3.182	0.667	1.671	1.409	2.084					Yes	No	See Attachment C-3
Zinc	90	1	1%	33	430	90.97	77.5	58.67	22.98	3.469	0.645	101.4	86	200	360	85	Yes	No	Protection of plants not a goal of TEE

[1] Summary statistics were calculated using ProUCL using detected values only. Reasonable maximum exposure point concentrations (EPCs) were the lesser of the maximum detect concentration or the 95% upper confidence limit (UCL). UCLs were calculated using ProUCL and

[2] Ecological indicator soil concentrations (EISCs) are from MTCA Table 749-3.

[3] Natural soil background concentrations for metals in the Puget Sound region are from Ecology (1994).

[a] The EISC for the protection of plants from PAHs is the EISC for acenaphthene.

[b] The EISC for the protection of soil biota from PAHs is the EISC for fluorene.

[c] The EISC for the protection of wildlife from PAHs is the EISC for benzo(a)pyrene.

[d] Value is EISC and value in parenthesis if soil saturation concentration.

[e] Value is for arsenic V, value in parenthesis is for arsenic III.

[f] Value is for inorganic mercury, value in parenthesis is for organic mercury.

All concentrations are expressed in mg/kg (ppm).

Highlighted constituents are COPECs.

Bolded EISCs are less than the EPC for COPECs.

Num Ds - number of samples with detected values

Num NDs - number of samples with nondetected values

% NDs - percent of samples with nondetected values

Minimum - minimum detected value (mg/kg)

Maximum - maximum detected value (mg/kg)

Mean - mean concentrations (mg/kg)

Median - median concentration (mg/kg)

SD - standard deviation (mg/kg)

MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)

Skewness - skewness statistic

CV - coefficient of variation (mg/kg)

UCL - 95 percent upper confidence limit (mg/kg); obtained from ProUCL UCL calculations shown below

EPC - reasonable maximum exposure point concentration (mg/kg); lesser of maximum detected value and UCL

Table C-2. Exposure Area Characteristics

Characteristic	Exposure Area		
	Upper	Slope	Lower
Cover Type	Landscaped plantings of turfgrass, shrubs, and trees with some covered areas; low quality habitat for wildlife	Ruderal vegetation consisting of a mixture of exotic and native species; moderate quality habitat for wildlife	Landscaped plantings of turfgrass, shrubs, and trees with some covered areas; low quality habitat for wildlife
Human Use	Heavily used by park visitors	Not used by park visitors	Heavily used by park visitors
Management Practices	Intensive -mowing	Limited	Intensive - mowing, irrigation
Connectivity	Directly connected to slope area	Directly connected to upper area	Separated from upper and slope areas by BNSF railroad
Analyte List	VOCs, non-PAH SVOCs, PAHs, Metals, Cyanide	PAHs, Metals	PAHs, Metals, Cyanide

Table C-3. Derivation of Earthworm Bioaccumulation Factors for Polycyclic Aromatic Hydrocarbons

Constituent	Soil Sample #	BSAF[1]	Conc. Worm[2] (ug/g lipid)	Conc. Soil[3] (ug/g OC)	Soil Total Carbon[1] (%)	Conc. Soil[4] (ug/g DW)	Conc. Worm[5] (ug/g DW)	BAF[6]	Geo-mean BAF
Acenaphthene	CG12	0.028	10	357.1	7.9	28.214	0.692	0.025	0.028
	CG15	0.063	3	47.6	24.1	11.476	0.208	0.018	
	CG17	0.09	3	33.3	12.5	4.167	0.208	0.050	
Anthracene	CG12	0.05	80	1600.0	7.9	126.400	5.538	0.044	0.099
	CG15	0.6	12	20.0	24.1	4.820	0.831	0.172	
	CG17	0.23	63	273.9	12.5	34.239	4.362	0.127	
Benzo(a)anthracene	CG12	0.059	220	3728.8	7.9	294.576	15.231	0.052	0.067
	CG15	0.16	57	356.3	24.1	85.856	3.946	0.046	
	CG17	0.23	86	373.9	12.5	46.739	5.954	0.127	
Benzo(a)pyrene	CG12	0.063	210	3333.3	7.9	263.333	14.538	0.055	0.082
	CG15	0.25	84	336.0	24.1	80.976	5.815	0.072	
	CG17	0.25	101	404.0	12.5	50.500	6.992	0.138	
Benzo(b&k)fluoranthene	CG12	0.061	480	7868.9	7.9	621.639	33.231	0.053	0.064
	CG15	0.16	139	868.8	24.1	209.369	9.623	0.046	
	CG17	0.19	139	731.6	12.5	91.447	9.623	0.105	
Benzo(e)pyrene	CG12	0.13	280	2153.8	7.9	170.154	19.385	0.114	0.154
	CG15	0.4	136	340.0	24.1	81.940	9.415	0.115	
	CG17	0.5	133	266.0	12.5	33.250	9.208	0.277	
Benzo(g,h,i)perylene	CG12	0.053	100	1886.8	7.9	149.057	6.923	0.046	0.081
	CG15	0.25	58	232.0	24.1	55.912	4.015	0.072	
	CG17	0.29	71	244.8	12.5	30.603	4.915	0.161	
Chrysene	CG12	0.06	220	3666.7	7.9	289.667	15.231	0.053	0.066
	CG15	0.18	90	500.0	24.1	120.500	6.231	0.052	
	CG17	0.19	89	468.4	12.5	58.553	6.162	0.105	
Dibenz(a,h)anthracene	CG12	0.04	30	750.0	7.9	59.250	2.077	0.035	0.051
	CG15	0.22	17	77.3	24.1	18.623	1.177	0.063	
	CG17	0.11	9	81.8	12.5	10.227	0.623	0.061	
Fluoranthene	CG12	0.06	460	7666.7	7.9	605.667	31.846	0.053	0.072
	CG15	0.21	100	476.2	24.1	114.762	6.923	0.060	
	CG17	0.21	112	533.3	12.5	66.667	7.754	0.116	
Fluorene	CG12	0.033	35	1060.6	7.9	83.788	2.423	0.029	0.041
	CG15	0.1	4	40.0	24.1	9.640	0.277	0.029	
	CG17	0.15	5	33.3	12.5	4.167	0.346	0.083	
Indeno(1,2,3-cd)perylene	CG12	0.01	20	2000.0	7.9	158.000	1.385	0.009	0.013
	CG15	0.036	8	222.2	24.1	53.556	0.554	0.010	
	CG17	0.039	12	307.7	12.5	38.462	0.831	0.022	
Naphthalene	CG12	0.034	10	294.1	7.9	23.235	0.692	0.030	0.058
	CG15	0.16	16	100.0	24.1	24.100	1.108	0.046	
	CG17	0.26	10	38.5	12.5	4.808	0.692	0.144	
Perylene	CG12	0.099	80	808.1	7.9	63.838	5.538	0.087	0.071
	CG15	0.16	17	106.3	24.1	25.606	1.177	0.046	
	CG17	0.16	18	112.5	12.5	14.063	1.246	0.089	
Phenanthrene	CG12	0.041	290	7073.2	7.9	558.780	20.077	0.036	0.052
	CG15	0.15	33	220.0	24.1	53.020	2.285	0.043	
	CG17	0.16	56	350.0	12.5	43.750	3.877	0.089	
Pyrene	CG12	0.056	310	5535.7	7.9	437.321	21.462	0.049	0.072
	CG15	0.23	141	613.0	24.1	147.743	9.762	0.066	
	CG17	0.21	139	661.9	12.5	82.738	9.623	0.116	

Notes:

BSAF - biota soil accumulation factor calculated as earthworm concentration (ug/g lipid)/soil concentrations (ug/g carbon)

OC - organic carbon

DW - dry weight

BAF - bioaccumulation factor calculated as earthworm concentration (ug/g DW)/soil concentration (ug/g DW)

[1] Source: Figure 1 in Kreitinger et al. (2007)

[2] Source: Figure 2 in Kreitinger et al. (2007)

[3] Calculated as (PAH Conc. Earthworm (ug/g lipid))/(BSAF)

[4] Calculated as [(PAH Conc. Soil (ug/g OC))*(Soil Total Carbon (%)/100)]

[5] Calculated as [(PAH Conc. Earthworm (ug/g lipid)/Earthworm lipid content (percent))/(100 - earthworm moisture content (percent)]. Earthworm lipid content is 0.018 percent (Kreitinger et al. 2007) and earthworm moisture content is 0.83 percent (EPA 1993).

[6] Calculated as (PAH Conc. Earthworm (ug/g DW))/(PAH Conc. Soil (ug/g DW))

Table C-4. Derivation of Plant and Earthworm Bioaccumulation Factors for Selenium for the Upper Area

Receptor	Bioaccumulation Regression Model	Cs	Ln(Cp or Ce)	Cp or Ce	BAF
Plants	Ln (Cp) = 1.104 * Ln (Cs) - 0.667	2	0.098	1.103	0.552
Earthworms	Ln (Ce) = 0.733 * Ln (Cs) - 0.075	2	0.433	1.542	0.771

Cp = concentration in plant tissue (mg/kg dry weight)

Ce = concentration in earthworm tissue (mg/kg dry weight)

Cs = exposure point concentration in soil (mg/kg dry weight) (Attachment C-4)

BAF = bioaccumulation factor calculated as Cp/Cs or Ce/Cs.

Table C-5. Wildlife Exposure Factors

Factor	Units	Shrew	Robin	Vole	Source
Food Ingestion Rate (FIR)	kg dry food/kg body weight/d	0.209	0.214	0.0875	EPA (2007)
Proportion of Contaminated Food in Diet (P)	unitless	0.5	0.52	1	MTCA Table 749-4
Soil Ingestion Rate (SIR) [1]	kg dry soil/kg body weight/d	0.00627	0.0351	0.0028	EPA (2007)
Gut Absorption Factor (RGAF) [2]	unitless	1	1	1	MTCA Table 749-5

[1] EPA (2007) expressed the soil ingestion as the 90th percentile of the percent soil in the diet (vole = 3.2%, shrew = 3.0%, woodcock = 16.4%). These were converted to a soil ingestion rate by multiplying the food ingestion rate by the percent soil in the diet.

[2] The gut absorption factor is a constituent-specific factor that estimates the absorption of a constituent from soil relative to its absorption from food. Although it is likely that a significant proportion of the COPECs will be tightly bound to soil and not absorbed by the gut, the assumption was made that 100% of the concentration present in the soil will be absorbed.

Table C-6. Earthworm Toxicity Test Results from Kreitinger et al. (2007).

Soil Sample	tPAH Concentration[a] (ug/g soil)	Total Carbon (%)	Molar C:H ratio[b]	tPAH Concentration (ug/g C)	SFE rapidly released fraction[c]	Worm Survival (%)
OG14	168	2.9	1.2	5,790	0.49	100
CG2	307	2.6	0.6	11,800	0.59	100
CG10	521	3.7	1.6	14,100	0.25	25
CG18	554	4.6	1.0	12,000	0.56	100
CG17	577	12.5	1.8	4,620	0.32	100[d]
CG15	1,020	24.1	3.5	4,200	0.25	100[d]
CG1	1,520	4.6	1.0	33,000	0.81	0
OG13	1,700	6.5	1.4	26,200	0.27	100
OG5	1,870	6.9	2.4	27,100	0.43	100
CG12	3,790	7.9	1.1	48,000	0.18	100[d]
CG3	4,100	7.5	0.9	54,700	0.87	0
OG2	6,760	59.4	6.3	11,400	0.22	100
CG11	15,600	29.3	2.3	53,200	0.07	100
OG17	17,200	47.3	5.7	36,400	0.32	100
OG18	17,300	25.5	2.5	67,900	0.80	0
OG10	42,100	86.6	5.0	48,600	0.37	100

[a] Sum of 16 compounds (naphthalene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[*a*]anthracene, chrysene, benzo[b+k]fluoranthene, benzo[e]pyrene, benzo[a]pyrene, perylene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, and benzo[ghi]perylene).

[b] Molar carbon to hydrogen ratio.

[c] Rapidly released fraction of total PAHs determined by mild supercritical CO_2 extraction (SFE).

[d] Earthworms (*Aporrectodea caliginosa* and *Lumbricus rubellus) were* observed in soil at the time of sample collection.

tPAH - total polycyclic aromatic hydrocarbon

Table C-7. Mammalian Toxicity Reference Values for PAHs

Mammalian TRVs (mg/kg/d) as LOAELs for Reproduction, Growth, and Survival	
LPAHs	HPAHs
50.0	3.07
110	12.4
150	20.7
267	24
300	26.4
300	26.4
300	26.4
300	27.3
300	40
328	45.9
450	50
500	50
630	63.4
630	98
630	118
700	15.72
1460	**15**
1470	
138	
18	

Highlighted values are the final TRVs represented as the 10th percentile of the individual TRVs.
Bolded values are the number of observations.
Data Source: EPA (2007b)
TRVs - toxicity reference values
LPAH - low molecular weight polycyclic aromatic hydrocarbons
HPAH - high molecular weight polycyclic aromatic hydrocarbons

Table C-8. Mammalian and Avian Toxicity Reference Values for Selenium

TRVs (mg/kg/d) as LOAELs for Reproduction, Growth, and Survival							
Mammals					Birds		
0.089	0.39	0.712	0.98	4.55	0.0911	0.826	5.75
0.0908	0.411	0.72	0.984	4.57	0.0912	0.855	6.08
0.0968	0.42	0.733	0.984	4.57	0.0988	0.859	6.14
0.13	0.425	0.747	0.988	5.01	0.12	0.859	6.99
0.145	0.434	0.749	1.02	5.01	0.127	0.896	7.98
0.156	0.435	0.754	1.11	5.96	0.127	0.898	8.32
0.157	0.435	0.763	1.11	6	0.13	1.08	11.5
0.163	0.435	0.763	1.19	6.03	0.18	1.13	11.7
0.166	0.44	0.763	1.21	6.36	0.275	1.14	11.9
0.168	0.441	0.763	1.21	6.39	0.306	1.19	12.3
0.205	0.454	0.767	1.23	6.39	0.355	1.2	29
0.209	0.47	0.768	1.28	6.39	0.368	1.23	
0.215	0.489	0.769	1.31	20	0.37	1.29	
0.215	0.49	0.769	1.51	20	0.371	1.38	
0.221	0.493	0.776	1.51	25.4	0.408	1.4	
0.232	0.498	0.776	1.54		0.412	1.44	
0.235	0.504	0.794	1.59		0.425	1.55	
0.254	0.51	0.794	1.59		0.426	1.72	
0.265	0.521	0.794	1.59		0.429	1.73	
0.267	0.521	0.794	1.59		0.438	1.78	
0.273	0.523	0.809	1.59		0.456	1.78	
0.273	0.54	0.809	1.62		0.5	2.27	
0.274	0.54	0.817	1.71		0.5	2.44	
0.275	0.543	0.817	1.79		0.5	2.76	
0.276	0.548	0.823	1.79		0.524	2.9	
0.282	0.55	0.823	1.81		0.546	3.44	
0.296	0.55	0.869	1.94		0.546	3.48	
0.303	0.564	0.869	1.94		0.579	3.64	
0.304	0.567	0.869	2.27		0.58	4.19	
0.307	0.57	0.869	2.28		0.614	4.26	
0.323	0.577	0.869	3.54		0.629	4.49	
0.33	0.58	0.88	3.54		0.675	4.53	
0.34	0.589	0.892	3.74		0.702	4.53	
0.345	0.632	0.903	3.74		0.721	4.75	
0.352	0.653	0.904	4.17		0.78	4.8	
0.378	0.667	0.968	4.18		0.788	4.94	
0.385	0.704	0.975	4.18		0.823	4.94	
				0.239			0.287
				163			**85**

Highlighted values are the final TRVs represented as the 10th percentile of the individual TRVs.
Bolded values are the number of observations.
Data Source: EPA (2007d)
TRVs - toxicity reference values

Table C-9. Hazards for Soil Biota

Constituent	Exposure Area	Soil EPC (mg/kg)	SSL (mg/kg)	HQ
tPAHs	Lower	1,556	400	4
	Slope	517.6	400	1
	Upper	12,819	400	32
Mercury	Lower	0.402	3.26	0
	Slope	0.54	3.26	0
	Upper	0.245	3.26	0

EPC - reasonable maximum exposure point concentration

SSL - soil screening level

HQ - hazard quotient

tPAHs - total polycyclic aromatic hydrocarbons

Table C-10. Hazards for Wildlife from PAHs

Constituent	Ecological Exposure Area														
	Lower Area					Slope Area					Upper Area				
	Soil EPC (mg/kg)	SSL_{shrew} (mg/kg)	SSL_{vole} (mg/kg)	HQ_{shrew}	HQ_{vole}	Soil EPC (mg/kg)	SSL_{shrew} (mg/kg)	SSL_{vole} (mg/kg)	HQ_{shrew}	HQ_{vole}	Soil EPC (mg/kg)	SSL_{shrew} (mg/kg)	SSL_{vole} (mg/kg)	HQ_{shrew}	HQ_{vole}
1-Methylnapthene	7.322	11,172	37,165	0	0	1.725	11,172	30,926	0	0	1590	11,172	38,865	0	0
2-Methynaphthene	12.09	11,172	37,165	0	0	3.531	11,172	30,926	0	0	2741	11,172	38,865	0	0
Acenaphthalene	2.265	14,993	37,165	0	0	0.722	14,993	30,926	0	0	57.28	14,993	38,865	0	0
Acenaphthene	37.92	14,993	37,165	0	0	19.59	14,993	30,926	0	0	567.1	14,993	38,865	0	0
Anthracene	28.89	8,320	37,165	0	0	9.107	8,320	30,926	0	0	229.4	8,320	38,865	0	0
Benz(a)anthracene	203.1	1,183	1,147	0	0	49.4	1,183	1,091	0	0	128.1	1,183	1,264	0	0
Benzo(a)pyrene	171.9	1,060	1,147	0	0	65.79	1,060	1,091	0	0	97.63	1,060	1,264	0	0
Benzo(g,h,i)perylene	152.6	1,065	1,147	0	0	27.87	1,065	1,091	0	0	22.75	1,065	1,264	0	0
Chrysene	210.6	1,195	1,147	0	0	49.64	1,195	1,091	0	0	118.4	1,195	1,264	0	0
Dibenzofuran	5.948	13,073	37,165	0	0	1.077	13,073	30,926	0	0	63.82	13,073	38,865	0	0
Fluoranthene	393.9	10,026	37,165	0	0	68.55	10,026	30,926	0	0	235.1	10,026	38,865	0	0
Fluorene	10.07	13,073	37,165	0	0	2.15	13,073	30,926	0	0	312.9	13,073	38,865	0	0
Indeno(1,2,3-cd)perylene	105.1	2,075	1,147	0	0	26.13	2,075	1,091	0	0	21.97	2,075	1,264	0	0
Naphthalene	16.99	11,172	37,165	0	0	4.462	11,172	30,926	0	0	13152	11,172	38,865	1	0
Phenanthrene	49.64	11,836	37,165	0	0	24.8	11,836	30,926	0	0	711	11,836	38,865	0	0
Pyrene	580.9	1,137	1,147	1	1	118.8	1,137	1,091	0	0	352.4	1,137	1,264	0	0
total Benzofluoranthenes	292.7	1,216	1,147	0	0	70.03	1,216	1,091	0	0	73.5	1,216	1,264	0	0
			HI LPAHs =	0	0			HI LPAHs =	0	0			HI LPAHs =	2	1
			HI HPAHs =	1	1			HI HPAHs =	0	0			HI HPAHs =	1	1

EPC - reasonable maximum exposure point concentration

SSL - soil screening level

HQ - hazard quotient and calculated as Soil EPC/SSL

HI = hazard index (i.e., sum of HQs)

Note: HQs and His were rounded to the nearest whole number and HQs > 1 suggest a potential hazard to wildlife

Table C-11. Hazards for Wildlife from Selenium in the Upper Area

Soil EPC (mg/kg)	SSL_{shrew} (mg/kg)	SSL_{vole} (mg/kg)	SSL_{robin} (mg/kg)	HQ_{shrew}	HQ_{vole}	HQ_{robin}
2	2.74	4.68	2.37	1	0	1

EPC - reasonable maximum exposure point concentration

SSL - soil screening level

HQ - hazard quotient and calculated as Soil EPC/SSL

Note: HQs and His were rounded to the nearest whole number and HQs > 1 suggest a potential hazard to wildlife

Table C-12. ProUCL Outlier Test for Naphthalene in Upper Area Soil Samples

Outlier Tests for Selected Variables

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers with Rosner test	1

Rosner's Outlier Test for Naphthalene - Upper Exposure Area

Mean	**1308**
Standard Deviation	**8651**
Number of data	**53**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1308	8569	63000	53	7.2	3.151	3.504

For 5% Significance Level, there is 1 Potential Outlier

Therefore, Observation 63000 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier

Therefore, Observation 63000 is a Potential Statistical Outlier

ATTACHMENT C-1

Ecological Survey of the Uplands Portion of the SSSMGP Site

Herrenkohl Consulting LLC

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MEMORANDUM

To:	Mark Herrenkohl, LEG
From:	Jeff Ninnemann, PWS, LG
Date:	August 31, 2011
Subject:	Terrestrial Ecological Field Survey of the SSSMGP Site
Project Name:	South State Street Manufactured Gas Plant Site, Bellingham, WA
Project No.:	HCL017

On behalf of Herrenkohl Consulting LLC, I visited the SSSMGP Site on July 28 and August 8, 2011 to gather field information in support of the terrestrial ecological evaluation (TEE) for the remedial investigation (RI). The purpose of the field survey is to help identify ecological receptors and exposure pathways by which receptors may be exposed to constituents present in soil at the Site. The following memorandum summarizes my findings.

Methods

Field methods followed those identified for the Site by Dana Houkal of Herrenkohl Consulting in a July 18 memorandum. The project site was divided into five major habitat types and included:

- <u>Turfgrass</u> – large turfgrass areas are present in the upper and lower portions of the Site.
- <u>Shrub/tree landscape</u> – landscaped areas consisting of planted shrubs and trees are present in the upper and lower portions of the Site.
- <u>Vegetated hillside</u> – a steep hillside vegetated with native and exotic plants parallel the east side of the BNSF railroad.
- <u>Railroad bed</u> – a railroad bed covered by ballast bisects the Site.
- <u>Covered areas</u> – asphalt paths and structures are present on the Site.

These habitats were delimited on an aerial photograph for use in the field survey (Figure 1).

Intrusive soil sampling complied with the Site Health and Safety Plan presented in the Sampling and Analysis Plan (Herrenkohl and Landau 2010).

Steve Nordeen, a City of Bellingham Parks and Recreation Department representative was contacted to obtain information concerning redevelopment activities during the creation of Boulevard Park. Mr. Nordeen also described the current maintenance practices (e.g., irrigation, mowing regime, fertilization, pest control) as well as routine observations by Park staff on use of the Site by wildlife and incidences of wildlife morbidity/mortality.

Methods for Plant Survey

The plant survey consisted of Site walks to identify the dominant plant species in each of the major habitats (from Houkal 2011). The relative abundance of each dominant species was noted along with its native status (i.e., native versus exotic species). Relative abundance was recorded as an estimate of the 100% cover each species occupied per habitat type. Photos of the general vegetative characteristics of each habitat were collected using a digital camera (attached).

It is assumed that the rooting depth of shrubs and trees across much of the Site extends through the biological active zone [i.e., 0 to 6 foot depth per WAC 173-340-7490(4)(a)]. However, the rooting depth of turfgrass is considerably less. Turfgrass root depth was measured in the field at three locations on the upper portion of the Site and three locations on the lower portion of the Site. A large plastic bag was placed on the ground near each sample location. A 30-centimeter by 30-centimeter square mat of turfgrass was carefully removed from the sample location and placed on the plastic bag root-side down. Soil was then excavated to a depth of approximately 30 centimeters and placed on the plastic bag. The turfgrass root depth was measured on a clean sidewall of the excavation (i.e., a knife with an 8 to 10-inch blade was used to expose a clean sidewall) using a ruler, to measure to the nearest centimeter. Rooting depth was documented using a digital camera and the presence of soil invertebrates was noted. The excavation was refilled with the loose soil, followed by the turfgrass mat which was compacted to the surrounding turfgrass height by foot. Approximate sample locations were noted using a GPS and recorded on an aerial photograph (Figure 1).

Methods for Soil Biota Survey

A liquid extraction sampling technique was used to survey for the presence of earthworms at the Site (from Houkal 2011). Earthworms are particularly important as food-chain vectors of soil constituents to wildlife. The MTCA TEE process uses two wildlife receptors that forage on earthworms (i.e., shrew and robin) to develop soil cleanup levels protective of wildlife (MTCA Table 749-4).

Liquid extraction sampling was conducted using a non-toxic fumigant (an aqueous solution of dry mustard powder) following the methods described by Gunn (1992) and the University of Minnesota[1]. Liquid extraction sampling does not require any intrusive soil activities. One-third of a cup of dry mustard powder was mixed into one gallon of tap water. To aid in visually locating emerging earthworms, turfgrass in the sample location was trimmed to a height of approximately 0.5 inch with a pair of hand shears. A 30-centimeter by 30-centimeter area was wetted with the mustard solution. One-half gallon of mustard solution was applied to each plot and allowed to slowly percolate into the soil. From each sample area, emerging earthworms were counted and identified as being either night crawler (*Lumbricus terrestris*) or non-night crawler species.

Specific liquid extraction sample locations were determined in the field. Three locations were sampled in both the upper and lower portions of the Site. Samples were located in turfgrass areas. Zones of low or high soil moisture were not sampled because earthworms avoid these conditions. One sample from the upper and lower portions of the Site was located proximal to shrub or tree landscape plantings, because balled and burlapped ornamental shrub and tree plantings are likely sources of introduced earthworms. Approximate liquid extraction sample locations were located by GPS and noted on an aerial photograph. The soil biota sample plots were located adjacent to the turfgrass rooting depth sample locations.

The presence of other soil-dwelling arthropods was noted at each of the liquid extraction and turfgrass root depth sample locations. Arthropods were identified down to the family level and their relative abundance noted.

Methods for Wildlife Survey

A wildlife survey of the Site was performed coincidently while conducting the plant and soil biota surveys (from Houkal 2011). The species observed were noted along with their relative abundance and native status (i.e., native versus exotic). Wildlife signs (e.g., footprints, scat, nests, rodent runs, and mole mounds) were also noted.

Results

Discussions with Steve Nordeen were conducted on August 15, 2011. Mr. Nordeen indicated that the upper site is not irrigated and the lower site is irrigated four days every week during most of the summer and daily during the dries months of the summer. Mowing is conducted twice weekly. Fertilizer (21-4-17 30% CRN) is applied in the spring and fall. A minimal amount of Rodeo (Round-up Pro) herbicide is used at the site. Mr. Nordeen indicated that mostly birds are observed at the site, but an occasional harbor seal will also be spotted along the shoreline.

[1] Available online at http://www.nrri.umn.edu/worms/research/methods_worms.html.

Plant Survey Results

The results for the habitat areas identified in Figure 1 are shown in the following tables (Tables 1 - 4). Pictures characteristic of the Turfgrass, Shrub/tree, Vegetated Hillside, and Railroad Bed habitats are shown in Figure 2. The Covered Area habitat had no vegetation, and is therefore not represented in a table. Root depth and soil characteristics and photos are shown in Table 5 and Figure 3.

Table 1. Turfgrass Habitat

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Silver Weed	*Argentina egedii*	Herb	Turfgrass	≤1	Native
Perennial ryegrass	*Lolium perenne*	Herb	Turfgrass	≤1	Intro
3-way Perennial ryegrass	*Lolium perenne*	Herb	Turfgrass	95	Intro
Pineapple weed	*Matricaria disoidea*	Herb	Turfgrass	≤1	Intro
English plantain	*Plantago laneolata*	Herb	Turfgrass	≤1	Intro
Common plantain	*Plantago major*	Herb	Turfgrass	≤1	Intro
Common dandelion	*Taraxacum officinate*	Herb	Turfgrass	≤1	Intro
White clover	*Trifolium repens*	Herb	Turfgrass	≤1	Intro
Red maple	*Acer rubrum*	Tree	Turfgrass	≤1	Intro

Table 2. Shrub/Tree Habitat

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Yarrow	*Achillea millefolium*	Herb	Shrub Tree	≤1	Native
Colonial bentgrass	*Agrostis capillaris*	Herb	Shrub Tree	≤1	Intro
Lady fern	*Athyrium filix-femina*	Herb	Shrub Tree	2	Native
Lamb's quarters	*Chenopodium album*	Herb	Shrub Tree	≤1	Intro
Orchard grass	*Dacttkus gkinerata*	Herb	Shrub Tree	≤1	Intro
Fireweed	*Epilobium angustifolium*	Herb	Shrub Tree	≤1	Native
Field horsetail	*Equisetum arvense*	Herb	Shrub Tree	≤1	Native
Giant horsetail	*Equisetum telmatiea*	Herb	Shrub Tree	≤1	Native
Cleavers	*Galium aparine*	Herb	Shrub Tree	≤1	Native
Dovefoot geranium	*Geranium molle*	Herb	Shrub Tree	≤1	Intro
Ocean spray	*Holodiscus discolor*	Herb	Shrub Tree	≤1	Native
Wall Barley	*Hordeum murinum*	Herb	Shrub Tree	≤1	Intro
Soft rush	*Juncus effusus*	Herb	Shrub Tree	≤1	Native
Wall lettuce	*Lactuca muralis*	Herb	Shrub Tree	≤1	Intro
Oxeye daisy	*Leucanthemum vulgare*	Herb	Shrub Tree	≤1	Intro
Perennial ryegrass	*Lolium perenne*	Herb	Shrub Tree	≤1	Intro
Pineapple weed	*Matricaria disoidea*	Herb	Shrub Tree	≤1	Intro
American vetch	*Vicia americana*	Herb	Shrub Tree	≤1	Native
Five stemened mitrewort	*Mitella pentandra*	Herb	Shrub Tree	≤1	Native
English plantain	*Plantago laneolata*	Herb	Shrub Tree	≤1	Intro

Table 2. Shrub/Tree Habitat (Continued)

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Common plantain	*Plantago major*	Herb	Shrub Tree	≤1	Intro
Creeping buttercup	*Ranunculus repens*	Herb	Shrub Tree	≤1	Intro
Sheep sorrel	*Rumex acetosella*	Herb	Shrub Tree	≤1	Intro
Common tansy	*Tanacetum vulgare*	Herb	Shrub Tree	2	Intro
Common dandelion	*Taraxacum officinate*	Herb	Shrub Tree	2	Intro
Fringecup	*Tellima grandiflora*	Herb	Shrub Tree	≤1	Native
Field pennycress	*Thlaspi arvense*	Herb	Shrub Tree	≤1	Intro
White clover	*Trifolium repens*	Herb	Shrub Tree	≤1	Intro
Redosier dogwood	*Cornus sericea*	Shrub	Shrub Tree	3	Native
Salal	*Gaultheria shallon*	Shrub	Shrub Tree	2	Native
Tall Oregon grape	*Mahonia aquifolium*	Shrub	Shrub Tree	2	Native
Dwarf Oregon grape	*Mahonia nervosa*	Shrub	Shrub Tree	2	Native
Indian plum	*Oemleria cerasiformis*	Shrub	Shrub Tree	2	Native
Sword fern	*Polystichum munitum*	Shrub	Shrub Tree	2	Native
Sumac	*Rhus*	Shrub	Shrub Tree	2	Intro
Nootka rose	*Rosa nutkana*	Shrub	Shrub Tree	2	Native
Himalayan blackberry	*Rubus armeniacus*	Shrub	Shrub Tree	≤1	Intro
Elderberry	*Sambucus racemosa*	Shrub	Shrub Tree	≤1	Native
Hardhack	*Spiraea douglasii*	Shrub	Shrub Tree	2	Native
Snowberry	*Symphoricarpos albus*	Shrub	Shrub Tree	2	Native
exotic rody	*rhododendron*	Shrub	Shrub Tree	≤1	Intro
Big leaf maple	*Acer macrophyllum*	Tree	Shrub Tree	15	Native
Sycamore Maple	*Acer pseudoplatanus*	Tree	Shrub Tree	5	Intro
Norway Maple	*Acer platanoides*	Tree	Shrub Tree	5	Intro
Red Alder	*Alnus Rubra*	Tree	Shrub Tree	5	Native
Paper birch	*Betula papyrifera*	Tree	Shrub Tree	5	Native
Gary Oak	*Quercus garryana*	Tree	Shrub Tree	≤1	Native
Scouler's willow	*Salix scouleriana*	Tree	Shrub Tree	2	Native
American elm	*Ulmus americana*	Tree	Shrub Tree	2	Intro
Crab Apple	*Pyrus fusca*	Tree	Shrub Tree	≤1	Native
Old man's beard	*Clematis vitalba*	Vine	Shrub Tree	15	Intro
English ivy	*Hedera helix*	Vine	Shrub Tree	2	Intro
Nightshade	*Solanum dulcamara*	Vine	Shrub Tree	≤1	Intro

Table 3. Vegetated Hillside Habitat

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Yarrow	*Achillea millefolium*	Herb	Vegetated Hillslope	5	Native
Lady fern	*Athyrium filix-femina*	Herb	Vegetated Hillslope	≤1	Native
Bull thistles	*Cirsium vulgare*	Herb	Vegetated Hillslope	≤1	Intro
Field Bindweed	*Convolvulus arvensis*	Herb	Vegetated Hillslope	≤1	Intro
Orchard grass	*Dacttkus gkinerata*	Herb	Vegetated Hillslope	≤1	Intro
Fox glove	*Digitalis purpurea*	Herb	Vegetated Hillslope	≤1	Native
Fireweed	*Epilobium angustifolium*	Herb	Vegetated Hillslope	≤1	Native
California Poppy	*Eschscholzia californica*	Herb	Vegetated Hillslope	≤1	Intro
Cleavers	*Galium aparine*	Herb	Vegetated Hillslope	≤1	Native
Bedstraw	*Galium triflorum*	Herb	Vegetated Hillslope	2	Native
Dovefoot geranium	*Geranium molle*	Herb	Vegetated Hillslope	≤1	Native
White/Purple Dame's Rocket	*Hesperis matronalis*	Herb	Vegetated Hillslope	≤1	Intro
Velvet grass	*Holcus lanatus*	Herb	Vegetated Hillslope	≤1	Intro
Wall Barley	*Hordeum murinum*	Herb	Vegetated Hillslope	≤1	Intro
Wall Lettuce	*Lactuca muralis*	Herb	Vegetated Hillslope	≤1	Intro
Oxeye daisy	*Leucanthemum vulgare*	Herb	Vegetated Hillslope	≤1	Intro
Perennial ryegrass	*Lolium perenne*	Herb	Vegetated Hillslope	≤1	Intro
Pineapple weed	*Matricaria disoidea*	Herb	Vegetated Hillslope	≤1	Intro
American vetch	*Micia americana*	Herb	Vegetated Hillslope	5	Native
Forget-me-nots	*Myosotis laxa*	Herb	Vegetated Hillslope	2	Intro
English plantain	*Plantago laneolata*	Herb	Vegetated Hillslope	2	Intro
Common plantain	*Plantago major*	Herb	Vegetated Hillslope	2	Intro
Sword fern	*Polystichum munitum*	Herb	Vegetated Hillslope	2	Native
Bracken fern	*Pteridium aquilinum*	Herb	Vegetated Hillslope	≤1	Native
Sheep sorrel	*Rumex acetosella*	Herb	Vegetated Hillslope	2	Intro
Curled dock	*Rumex crispus*	Herb	Vegetated Hillslope	≤1	Intro
Dock	*Rumex occidentalis*	Herb	Vegetated Hillslope	≤1	Native
Common Tansy	*Tanacetum vulgare*	Herb	Vegetated Hillslope	3	Intro
Common dandelion	*Taraxacum officinate*	Herb	Vegetated Hillslope	3	Intro
Field Pennycress	*Thlaspi arvense*	Herb	Vegetated Hillslope	3	Intro
White clover	*Trifolium repens*	Herb	Vegetated Hillslope	3	Intro
Stinging Nettles	*Urtica dioica*	Herb	Vegetated Hillslope	2	Native

Table 3. Vegetated Hillside Habitat (Continued)

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Scotch broom	*Cytisus scoparius*	Shrub	Vegetated Hillslope	≤1	Intro
Ocean spray	*Holodiscus discolor*	Shrub	Vegetated Hillslope	5	Native
Indian plum	*Oemleria cerasiformis*	Shrub	Vegetated Hillslope	≤1	Native
Sumac	*Rhus*	Shrub	Vegetated Hillslope	≤1	Intro
Himalayan blackberry	*Rubus armeniacus*	Shrub	Vegetated Hillslope	20	Intro
Thimbleberry	*Rubus parviflorus*	Shrub	Vegetated Hillslope	≤1	Native
Elderberry	*Sambucus racemosa*	Shrub	Vegetated Hillslope	≤1	Native
Snowberry	*Symphoricarpos albus*	Shrub	Vegetated Hillslope	3	Native
Big leaf maple	*Acer macrophyllum*	Tree	Vegetated Hillslope	20	Native
Red Alder	*Alnus Rubra*	Tree	Vegetated Hillslope	5	Native
Shore Pine	*Pinus controrta*	Tree	Vegetated Hillslope	10	Native
Douglas Fir	*Pseudotsuga menziesii*	Tree	Vegetated Hillslope	10	Native
American elm	*Ulmus americana*	Tree	Vegetated Hillslope	40	Intro
Old man’s beard	*Clematis vitalba*	Vine	Vegetated Hillslope	20	Intro
English ivy	*Hedera helix*	Vine	Vegetated Hillslope	20	Intro
Nightshade	*Solanum dulcamara*	Vine	Vegetated Hillslope	2	Intro

Table 4. Railroad Bed Habitat

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Yarrow	*Achillea millefolium*	Herb	Railroad Bed	2	Native
Colonial bentgrass	*Agrostis capillaris*	Herb	Railroad Bed	2	Intro
Pearly Everlasting	*Anaphalis margaritacea*	Herb	Railroad Bed	≤1	Native
Burdock	*Artium minus*	Herb	Railroad Bed	≤1	Native
Butterfly bush	*Buddleja davidii*	Herb	Railroad Bed	≤1	Native
Lamb's quarters	*Chenopodium album*	Herb	Railroad Bed	≤1	Intro
Bull thistles	*Cirsium vulgare*	Herb	Railroad Bed	2	Intro
Fireweed	*Epilobium angustifolium*	Herb	Railroad Bed	5	Native
Field horsetail	*Equisetum arvense*	Herb	Railroad Bed	2	Native
Giant horsetail	*Equisetum telmatiea*	Herb	Railroad Bed	2	Native
Dovefoot geranium	*Geranium molle*	Herb	Railroad Bed	2	Intro
Velvet grass	*Holcus lanatus*	Herb	Railroad Bed	5	Intro
Wall Barley	*Hordeum murinum*	Herb	Railroad Bed	≤1	Intro
Wall Lettuce	*Lactuca muralis*	Herb	Railroad Bed	≤1	Intro

Table 4. Railroad Bed Habitat (Continued)

Common Name	Latin Name	Layer	Location	Relative Abundance	Native Status
Oxeye daisy	*Leucanthemum vulgare*	Herb	Railroad Bed	≤1	Intro
Perennial ryegrass	*Lolium perenne*	Herb	Railroad Bed	3	Intro
Pineapple weed	*Matricaria disoidea*	Herb	Railroad Bed	≤1	Intro
American vetch	*Micia americana*	Herb	Railroad Bed	2	Native
Forget-me-nots	*Myosotis laxa*	Herb	Railroad Bed	≤1	Intro
English plantain	*Plantago laneolata*	Herb	Railroad Bed	≤1	Intro
Common plantain	*Plantago major*	Herb	Railroad Bed	≤1	Intro
Sheep sorrel	*Rumex acetosella*	Herb	Railroad Bed	≤1	Intro
Common Tansy	*Tanacetum vulgare*	Herb	Railroad Bed	3	Intro
Common dandelion	*Taraxacum officinate*	Herb	Railroad Bed	3	Intro
White clover	*Trifolium repens*	Herb	Railroad Bed	≤1	Intro
Stinging Nettles	*Urtica dioica*	Herb	Railroad Bed	2	Native
Mullein	*Verbascum thapsus*	Herb	Railroad Bed	≤1	Intro
European beach grass	*Ammophila arenaria*	Herb	Railroad Bed	≤1	Intro
Red Alder	*Alnus Rubra*	Shrub	Railroad Bed	2	Native
English Holly	*Ilex aquifolium*	Shrub	Railroad Bed	≤1	Intro
Himalayan blackberry	*Rubus armeniacus*	Shrub	Railroad Bed	3	Intro
Trailing Blackberry	*Rubus ursinus*	Shrub	Railroad Bed	≤1	Native
Old man's beard	*Clematis vitalba*	Vine	Railroad Bed	5	Intro
Nightshade	*Solanum dulcamara*	Vine	Railroad Bed	≤1	Intro

Table 5. Root Depth and Soil Characteristics

Soil Plot Id	Longitude (West)	Latitude (North)	Root Depth (cm)	Site Location	Soil Observation
1	122°30'3.221"	48°43'56.924"	15	Lower	Silty Loam with Gravel
2	122°30'3.455"	48°43'57.972"	8	Lower	Hard packed Sandy loam with Gravels
3	122°30'4.607"	48°43'58.038"	21	Lower	Silty Loam
4	122°29'59.559"	48°43'56.623"	12	Upper	Silty Loam with Gravel, very compact
5	122°29'57.857"	48°43'58.14"	9	Upper	top 6 cm Silty Loam, below 6 cm was gravel, refusal at 18 cm
6	122°30'0.693"	48°43'56.144"	8	Upper	Silty Loam with Gravel, very compact

Soil Biota Results

The results for the soil biota survey are shown in the following table.

Table 6. Soil Biota

Soil Plot Id	Longitude (West)	Latitude (North)	Site Location	Night crawlers	Other worms	Arthopods
1	122°30'3.221"	48°43'56.924"	Lower	6	0	1-beetle escaped 1-*Coleoptera Carobidae*
2	122°30'3.455"	48°43'57.972"	Lower	3	0	0
3	122°30'4.607"	48°43'58.038"	Lower	13	3	1-*Coleoptera Carobidae*
4	122°29'59.559"	48°43'56.623"	Upper	2	0	2-*Coleoptera Staphylinidae* 1-*Julia Parajulidae* 1-*Coleoptera Carobidae*
5	122°29'57.857"	48°43'58.14"	Upper	11	4	1-beetle escaped
6	122°30'0.693"	48°43'56.144"	Upper	2	0	3-*Coleoptera Staphylinidae*

Wildlife Survey Results

During my site visits several animals were observed using the Site including the following:

- Two Garter snakes (*Thamnophis sp.*) near the Railroad Bed area.
- Bees (Honey, Wasps, Yellow Jackets) throughout the Site.
- A mating pair of White-crested Sparrows (Zonotrichia leucophrys) perching near the walking bridge at the upper portion of Site.
- One American crow (*Corvus brachyrhynchos*) flying and perching in lower portion of Site.
- Multiple Glaucous Gulls (*Larus hyperboreus*) perched near pier, along shore, flying overhead, on water, etc.
- Four Canadian geese (*Branta Canadensis*) floating offshore.
- Dragon flies.
- Domestic dogs with owners.
- Possibly a river otter observed (*Lutra Canadensis*).
- Harbor seal sightings as reported by Park employees.
- A Black-capped Chickadee (*Poecile atricapillus*) was heard in the trees of the upper park giving an alert call.

References

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Houkal, Dana. 2011. Methodology for Conducting a Terrestrial Ecological Field Survey of the SSSMGP Site. Memorandum. July 18, 2011.

Knoke, Don 2004. "Vascular Plant List Whatcom County" Washington Native Plant Society, http://www.wnps.org/plant_lists/counties/whatcom/whatcom_county.html

Figure 1. Aerial Photo of Plant Survey Habitat Types

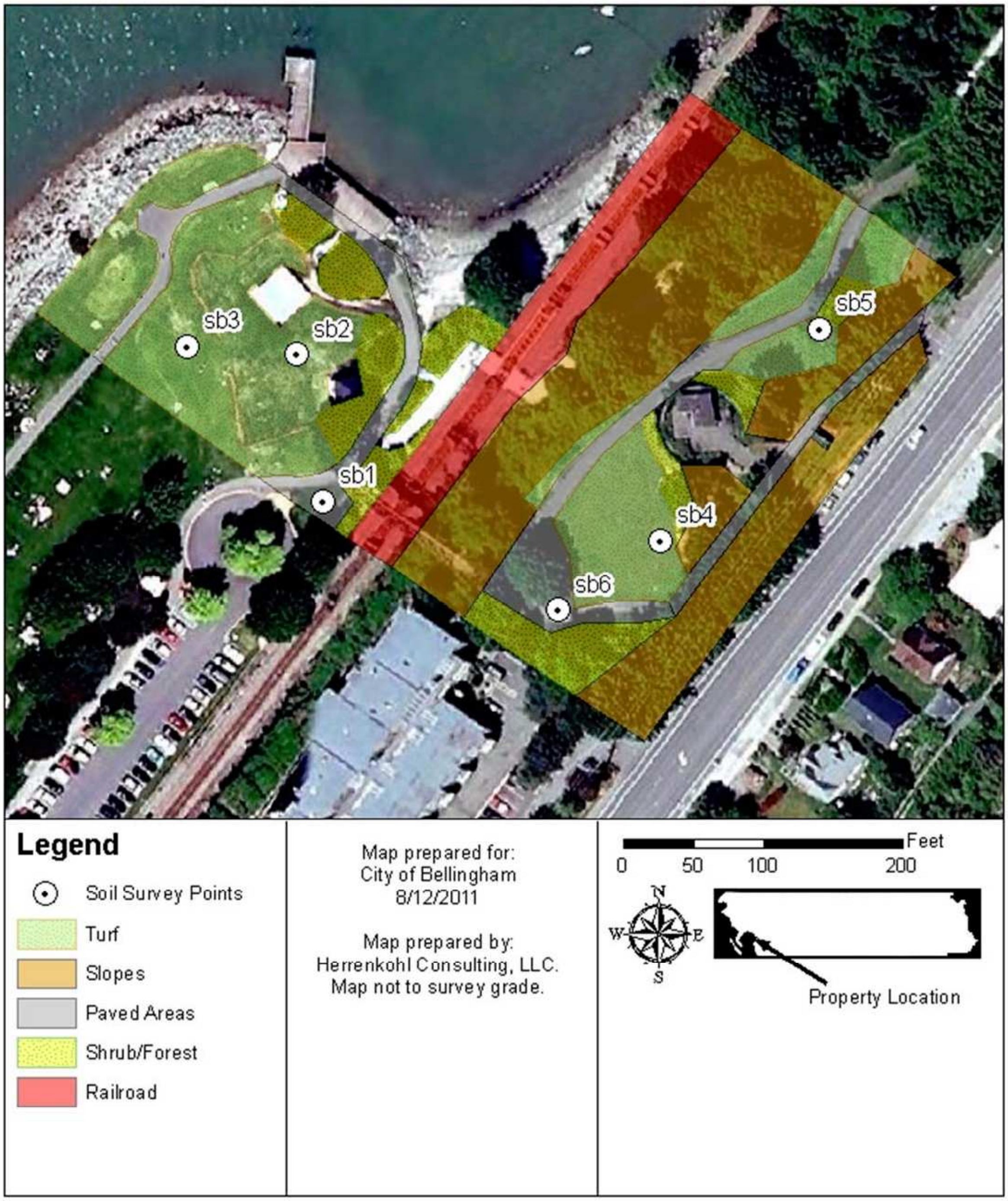


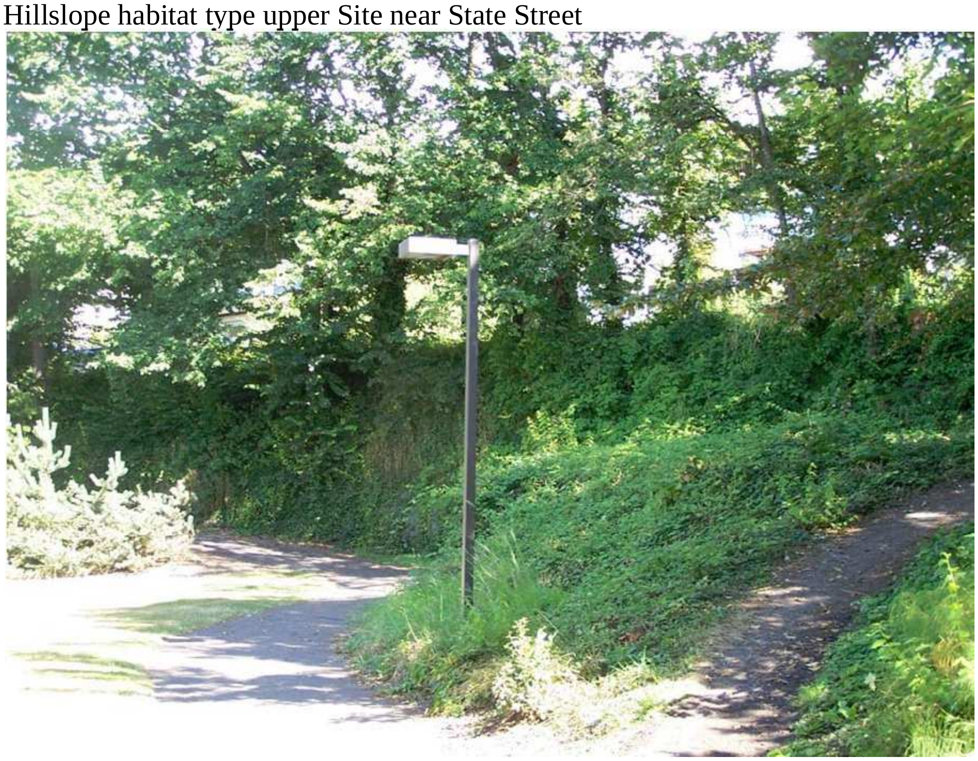
Figure 2. Photos for the Turfgrass, Shrub/tree, Vegetated Hillside, Railroad Bed habitat

Turfgrass habitat type lower Site

Turfgrass habitat type upper Site

Hillslope habitat type upper Site near State Street

Hillslope habitat type upper Site near State Street



Hillslope habitat type between upper and lower Site

Shrub/Tree habitat type lower Site

Shrub/Tree habitat type upper Site

Railroad bed looking west.

Railroad bed looking east.

Figure 3. Photos of Soil and Root Survey Profiles.

Soil Profile #1

Soil Profile #2

Soil Profile #3

Soil Profile #4

Soil Profile #5

Soil Profile #6

ATTACHMENT C-2

ProUCL Output Files – Site Soil UCLs

Attachment C-2. ProUCL Output Files - Site Soil UCLs

From File: C:\Users\admin\Desktop\SSSMGP soil data 1-100.wst

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

Constituent #	Constituent Name	Raw Statistics using Detected Observations												
		Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV	UCL	EPC
1	1,1,1,2-Tetrachloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	1,1,1-Trichloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	1,1,2,2-Tetrachloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	1,1,2-Trichloro-1,2,2-trifluoroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	1,1,2-Trichloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	1,1-Dichloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	1,1-Dichloroethene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	1,1-Dichloropropene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	1,2,3-Trichlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	1,2,3-Trichloropropane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	1,2,4-Trichlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	1,2,4-Trimethylbenzene	5	2	28.57%	0.012	120	45.93	37	51	53.91	0.734	1.11	70.14	70.14
13	1,2-Dibromo-3-chloropropane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	1,2-Dichlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	1,2-Dichloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	1,2-Dichloropropane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	1,3,5-Trimethylbenzene	3	4	57.14%	0.0035	52	17.41	0.24	29.95	0.351	1.732	1.72	123.6	52
18	1,3-Dichlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	1,3-Dichloropropane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	1,4-Dichlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21	1-Methylnaphthalene	73	19	20.65%	0.0052	7500	122.9	0.07	885.1	0.093	8.284	7.205	611.9	611.9
22	2,2-Dichloropropane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23	2,2'-Oxybis(1-Chloropropane)	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
24	2,4,5-Trichlorophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	2,4,6-Trichlorophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
26	2,4-Dichlorophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	2,4-Dimethylphenol	1	6	85.71%	81	81	81	81	N/A	0	N/A	N/A	N/A	81
28	2,4-Dinitrophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
29	2,4-Dinitrotoluene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	2,6-Dinitrotoluene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31	2-Butanone	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
32	2-Chloroethylvinylether	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
33	2-Chloronaphthalene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
34	2-Chlorophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
35	2-Chlorotoluene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
36	2-Hexanone	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
37	2-Methylnaphthalene	80	12	13.04%	0.0054	13000	190.1	0.0765	1462	0.0956	8.746	7.691	1054	1054
38	2-Methylphenol	1	6	85.71%	86	86	86	86	N/A	0	N/A	N/A	N/A	86
39	2-Nitroaniline	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
40	2-Nitrophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
41	3,3'-Dichlorobenzidine	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
42	3-Nitroaniline	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
43	4,6-Dinitro-2-Methylphenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
44	4-Bromophenyl-phenylether	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45	4-Chloro-3-methylphenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

46	4-Chloroaniline	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
47	4-Chlorophenyl-phenylether	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
48	4-Chlorotoluene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
49	4-Isopropyltoluene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50	4-Methyl-2-Pentanone (MIBK)	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
51	4-Methylphenol	1	6	85.71%	210	210	210	210	N/A	0	N/A	N/A	N/A	210
52	4-Nitroaniline	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
53	4-Nitrophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
54	Acenaphthene	43	49	53.26%	0.0044	250	8.659	0.063	40.02	0.0845	5.664	4.622	22.09	22.09
55	Acenaphthylene	84	8	8.70%	0.0053	2600	43.73	0.135	291.7	0.173	8.419	6.67	221.6	221.6
56	Acetone	2	5	71.43%	0.04	0.066	0.053	0.053	0.0184	0.0193	N/A	0.347	0.0783	0.066
57	Acrolein	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
58	Acrylonitrile	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	Anthracene	75	17	18.48%	0.0059	1000	22.34	0.29	123.3	0.415	7.285	5.52	90.92	90.92
60	Antimony	4	87	95.60%	0.2	1.9	0.9	0.75	0.726	0.519	1.099	0.806	0.27	0.27
61	Aroclor 1016	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	Aroclor 1221	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	Aroclor 1232	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
64	Aroclor 1242	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
65	Aroclor 1248	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
66	Aroclor 1254	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
67	Aroclor 1260	0	2	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68	Arsenic	90	1	1.10%	2.1	33.6	5.764	4.35	4.574	1.26	3.632	0.793	6.573	6.573
69	Barium	98	0	0.00%	0.049	724	177.3	138.5	143.6	75.02	2.142	0.81	240.6	240.6
70	Benzo(a)anthracene	99	5	4.81%	0.0075	650	20.87	0.44	90.2	0.632	6.077	4.321	73.83	73.83
71	Benzo(a)pyrene	100	4	3.85%	0.0028	810	22.25	0.645	94.41	0.926	6.905	4.242	78.15	78.15
72	Benzo(g,h,i)perylene	89	3	3.26%	0.007	360	10.06	0.48	40.18	0.692	7.789	3.996	35.49	35.49
73	Benzoic Acid	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74	Benzyl Alcohol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
75	bis(2-Chloroethoxy) Methane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
76	Bis-(2-Chloroethyl) Ether	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
77	bis(2-Ethylhexyl)phthalate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
78	Bromobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
79	Bromochloromethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
80	Bromodichloromethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
81	Bromoethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
82	Bromoform	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
83	Bromomethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
84	Butylbenzylphthalate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
85	Cadmium	53	45	45.92%	0.2	70	1.758	0.3	9.568	0.148	7.249	5.441	2.239	2.239
86	Carbon Disulfide	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
87	Carbon Tetrachloride	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
88	Chlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
89	Chloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
90	Chloroform	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
91	Chloromethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
92	Chromium	90	1	1.10%	9	63	29.84	27	10.26	7.413	0.772	0.344	31.52	31.52
93	Chrysene	101	3	2.88%	0.0033	670	20.62	0.44	87.7	0.629	6.211	4.253	72.99	72.99
94	cis-1,2-Dichloroethene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
95	cis-1,3-Dichloropropene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
96	Copper	91	0	0.00%	1.4	143	36.78	28.9	23.92	9.489	2.14	0.65	47.72	47.72

97	Cyanide	9	4	30.77%	0.125	76.4	13.17	1.46	24.91	1.979	2.53	1.891	20.15	20.15
98	Dibenz(a,h)anthracene	84	20	19.23%	0.0029	83	2.707	0.19	9.703	0.264	7.146	3.585	7.567	7.567
99	Dibenzofuran	51	41	44.57%	0.0053	280	8.535	0.084	41.24	0.111	6.152	4.831	24.92	24.92
100	Dibromochloromethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
101	Dibromomethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
102	Diesel Range Organics	7	0	0.00%	41	1200	473	510	422	578.2	0.741	0.892	783	783
103	Diethylphthalate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
104	Dimethylphthalate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
105	Di-n-Butylphthalate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
106	Di-n-Octyl phthalate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
107	Ethylbenzene	6	1	14.29%	0.0075	140	47.07	14	61.38	17.49	1.032	1.304	138.6	138.6
108	Ethylene Dibromide	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
109	Fluoranthene	90	2	2.17%	0.013	960	37.01	1	150.4	1.445	5.502	4.064	133.1	133.1
110	Fluorene	63	29	31.52%	0.0049	1400	31.83	0.104	184.2	0.139	7.015	5.787	121.5	121.5
111	Gasoline Range Organics	6	1	14.29%	28	15000	6846	5450	6765	7948	0.445	0.988	10857	10857
112	Hexachlorobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
113	Hexachlorobutadiene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
114	Hexachlorocyclopentadiene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
115	Hexachloroethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
116	Indeno(1,2,3-cd)pyrene	99	5	4.81%	0.0061	330	8.431	0.4	35.24	0.574	8.079	4.18	29.11	29.11
117	Isophorone	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
118	Isopropylbenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
119	Lead	91	0	0.00%	3	747	72.34	35	118.1	29.65	3.563	1.632	91.23	91.23
120	Lube Oil	7	0	0.00%	69	1300	481.3	280	474.1	266.9	1.114	0.985	829.5	829.5
121	m, p-Xylene	6	1	14.29%	0.017	220	90.92	62	96.46	90.8	0.646	1.061	148.3	148.3
122	Mercury	89	2	2.20%	0.03	1.37	0.162	0.09	0.225	0.0593	3.298	1.39	0.202	0.202
123	Methyl Iodide	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
124	Methyl tert-Butyl Ether	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
125	Methylene Chloride	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
126	Naphthalene	82	10	10.87%	0.0088	63000	846.6	0.185	6960	0.236	9.011	8.221	5036	5036
127	n-Butylbenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
128	Nitrobenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
129	N-Nitroso-Di-N-Propylamine	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130	N-Nitrosodiphenylamine	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
131	n-Propylbenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
132	o-Xylene	6	1	14.29%	0.014	91	38.85	31.5	38.3	45.88	0.468	0.986	61.55	61.55
133	Pentachlorophenol	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
134	Phenanthrene	90	2	2.17%	0.01	2900	60.06	0.61	347.6	0.859	7.262	5.788	282.7	282.7
135	Phenol	1	6	85.71%	270	270	270	270	N/A	0	N/A	N/A	N/A	N/A
136	Pyrene	90	2	2.17%	0.017	1400	54.42	1.3	224	1.858	5.449	4.117	197.6	197.6
137	sec-Butylbenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
138	Selenium	1	90	98.90%	2	2	2	2	N/A	0	N/A	N/A	N/A	2
139	Silver	4	87	95.60%	0.2	0.4	0.3	0.3	0.0816	0.0741	2.13E-15	0.272	0.21	0.21
140	Styrene	1	6	85.71%	150	150	150	150	N/A	0	N/A	N/A	N/A	150
141	TEQ cPAH	102	2	1.92%	0.000313	1016	27.86	0.693	117	0.995	6.982	4.198	98.3	98.3
142	tert-Butylbenzene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
143	Tetrachloroethene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
144	Toluene	7	0	0.00%	0.0047	220	58.19	39	78.71	57.41	1.746	1.353	795.1	220
145	Total Benzofluoranthenes	101	3	2.88%	0.0028	930	22.86	0.97	99.51	1.4	7.985	4.354	82.3	82.3
146	Total Xylenes	6	1	14.29%	0.031	311	129.8	93.5	134.6	136.7	0.597	1.037	209.8	209.8
147	trans-1,2-Dichloroethene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

148	trans-1,3-Dichloropropene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
149	trans-1,4-Dichloro-2-butene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
150	Trichloroethene	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
151	Trichlorofluoromethane	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
152	Vinyl Acetate	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
153	Vinyl Chloride	0	7	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
154	Weak Acid Dissoc. Cyanide	5	8	61.54%	0.14	7.6	2.258	0.59	3.182	0.667	1.671	1.409	2.084	2.084
155	Zinc	90	1	1.10%	33	430	90.97	77.5	58.67	22.98	3.469	0.645	101.4	101.4

Notes:
Num Ds - number of samples with detected values
Num NDs - number of samples with nondetected values
% NDs - percent of samples with nondetected values
Minimum - minimum detected value (mg/kg)
Maximum - maximum detected value (mg/kg)
Mean - mean concentrations (mg/kg)
Median - median concentration (mg/kg)
SD - standard deviation (mg/kg)
MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)
Skewness - skewness statistic
CV - coefficient of variation (mg/kg)
UCL - 95 percent upper confidence limit (mg/kg); obtained from ProUCL UCL calculations shown below
EPC - reasonable maximum exposure point concentration (mg/kg); lesser of maximum detected value and UCL

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	C:\Users\admin\Desktop\SSSMGP soil data 1-100.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

1

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 1 was not processed!

2

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 2 was not processed!

3

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 3 was not processed!

4

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 4 was not processed!

5

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 5 was not processed!

6

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 6 was not processed!

7

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 7 was not processed!

8

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 8 was not processed!

9

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 9 was not processed!

10

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 10 was not processed!

11

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 11 was not processed!

12

General Statistics

Number of Valid Data	7	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	2
		Percent Non-Detects	28.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.012	Minimum Detected	-4.423
Maximum Detected	120	Maximum Detected	4.787
Mean of Detected	45.93	Mean of Detected	1.561
SD of Detected	51	SD of Detected	3.931
Minimum Non-Detect	0.0018	Minimum Non-Detect	-6.32
Maximum Non-Detect	53	Maximum Non-Detect	3.97

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	5
Number treated as Detected	2
Single DL Non-Detect Percentage	71.43%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic	0.853
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	36.59	Mean	0.581
SD	45.24	SD	4.683
95% DL/2 (t) UCL	69.82	95% H-Stat (DL/2) UCL	6.24E+17
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.074
		SD in Log Scale	4.46
		Mean in Original Scale	32.83
		SD in Original Scale	47.27
		95% t UCL	67.55
		95% Percentile Bootstrap UCL	61.85
		95% BCA Bootstrap UCL	67.09
		95% H-UCL	7.75E+15

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.255	Data appear Normal at 5% Significance Level	
Theta Star	180.2		
nu star	2.548		
A-D Test Statistic	0.408	Nonparametric Statistics	
5% A-D Critical Value	0.739	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.739	Mean	34.15
5% K-S Critical Value	0.38	SD	43.31
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	18.52
		95% KM (t) UCL	70.14
Assuming Gamma Distribution		95% KM (z) UCL	64.62
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	69.17
Minimum	0.012	95% KM (bootstrap t) UCL	85.93
Maximum	120	95% KM (BCA) UCL	72.09
Mean	33.63	95% KM (Percentile Bootstrap) UCL	68.58
Median	4.397	95% KM (Chebyshev) UCL	114.9
SD	46.65	97.5% KM (Chebyshev) UCL	149.8
k star	0.277	99% KM (Chebyshev) UCL	218.4
Theta star	121.3		
Nu star	3.88	Potential UCLs to Use	
AppChi2	0.675	95% KM (t) UCL	70.14
95% Gamma Approximate UCL (Use when n >= 40)	193.4	95% KM (Percentile Bootstrap) UCL	68.58
95% Adjusted Gamma UCL (Use when n < 40)	353.2		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

13

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 13 was not processed!

14

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 14 was not processed!

15

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 15 was not processed!

16

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 16 was not processed!

17

General Statistics

Number of Valid Data	7	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	4
		Percent Non-Detects	57.14%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0035	Minimum Detected	-5.655
Maximum Detected	52	Maximum Detected	3.951
Mean of Detected	17.41	Mean of Detected	-1.044
SD of Detected	29.95	SD of Detected	4.815
Minimum Non-Detect	0.0018	Minimum Non-Detect	-6.32
Maximum Non-Detect	56	Maximum Non-Detect	4.025

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	7
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.753	Shapiro Wilk Test Statistic	0.995
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	16.46	Mean	-0.199
SD	19.85	SD	4.564
95% DL/2 (t) UCL	31.05	95% H-Stat (DL/2) UCL	3.79E+16
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.14
		SD in Log Scale	4.701
		Mean in Original Scale	7.468
		SD in Original Scale	19.64
		95% t UCL	21.89
		95% Percentile Bootstrap UCL	22.29
		95% BCA Bootstrap UCL	29.75
		95% H-UCL	7.63E+15

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Lognormal at 5% Significance Level	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	10.47
5% K-S Critical Value	N/A	SD	20.77
Data not Gamma Distributed at 5% Significance Level		SE of Mean	11.37
		95% KM (t) UCL	32.57
Assuming Gamma Distribution		95% KM (z) UCL	29.18
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	31.31
Minimum	N/A	95% KM (bootstrap t) UCL	2436
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	52
Median	N/A	95% KM (Chebyshev) UCL	60.05
SD	N/A	97.5% KM (Chebyshev) UCL	81.5
k star	N/A	99% KM (Chebyshev) UCL	123.6
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	99% KM (Chebyshev) UCL	123.6
95% Gamma Approximate UCL (Use when n >= 40)	N/A		
95% Adjusted Gamma UCL (Use when n < 40)	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

18

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 18 was not processed!

19

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 19 was not processed!

20

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 20 was not processed!

General Statistics

Number of Valid Data	92	Number of Detected Data	73
Number of Distinct Detected Data	66	Number of Non-Detect Data	19
		Percent Non-Detects	20.65%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0052	Minimum Detected	-5.259
Maximum Detected	7500	Maximum Detected	8.923
Mean of Detected	122.9	Mean of Detected	-1.877
SD of Detected	885.1	SD of Detected	2.799
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	76
Number treated as Detected	16
Single DL Non-Detect Percentage	82.61%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.493	Lilliefors Test Statistic	0.133
5% Lilliefors Critical Value	0.104	5% Lilliefors Critical Value	0.104
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	97.49	Mean	-2.46
SD	788.9	SD	2.798
95% DL/2 (t) UCL	234.2	95% H-Stat (DL/2) UCL	15.77
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.819
		SD in Log Scale	3.187
		Mean in Original Scale	97.49
		SD in Original Scale	788.9
		95% t UCL	234.2
		95% Percentile Bootstrap UCL	258.7
		95% BCA Bootstrap UCL	355.4
		95% H-UCL	50.62

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.123	Data do not follow a Discernable Distribution (0.05)	
Theta Star	999		
nu star	17.96		
A-D Test Statistic	16.39	**Nonparametric Statistics**	
5% A-D Critical Value	0.979	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.979	Mean	97.49
5% K-S Critical Value	0.119	SD	784.6
Data not Gamma Distributed at 5% Significance Level		SE of Mean	82.37
		95% KM (t) UCL	234.4
Assuming Gamma Distribution		95% KM (z) UCL	233
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	234.2

Minimum	0.000001	95% KM (bootstrap t) UCL	4279
Maximum	7500	95% KM (BCA) UCL	261
Mean	97.49	95% KM (Percentile Bootstrap) UCL	258.6
Median	0.0405	95% KM (Chebyshev) UCL	456.5
SD	788.9	97.5% KM (Chebyshev) UCL	611.9
k star	0.0962	99% KM (Chebyshev) UCL	917
Theta star	1013		
Nu star	17.7	**Potential UCLs to Use**	
AppChi2	9.177	97.5% KM (Chebyshev) UCL	611.9
95% Gamma Approximate UCL (Use when n >= 40)	188.1		
95% Adjusted Gamma UCL (Use when n < 40)	190.1		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

22

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 22 was not processed!

23

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 23 was not processed!

24

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 24 was not processed!

25

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 25 was not processed!

26

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 26 was not processed!

27

General Statistics

Number of Valid Data	7	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	6
		Percent Non-Detects	85.71%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 27 was not processed!

28

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 28 was not processed!

29

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 29 was not processed!

30

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 30 was not processed!

31

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 31 was not processed!

32

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 32 was not processed!

33

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 33 was not processed!

34

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 34 was not processed!

35

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 35 was not processed!

36

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 36 was not processed!

37

General Statistics

Number of Valid Data	92	Number of Detected Data	80
Number of Distinct Detected Data	68	Number of Non-Detect Data	12
		Percent Non-Detects	13.04%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0054	Minimum Detected	-5.221
Maximum Detected	13000	Maximum Detected	9.473
Mean of Detected	190.1	Mean of Detected	-1.749
SD of Detected	1462	SD of Detected	2.788
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	75
Number treated as Detected	17
Single DL Non-Detect Percentage	81.52%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.494	Lilliefors Test Statistic	0.154
5% Lilliefors Critical Value	0.0991	5% Lilliefors Critical Value	0.0991
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	165.3	Mean	-2.108
SD	1364	SD	2.824
95% DL/2 (t) UCL	401.5	95% H-Stat (DL/2) UCL	24.72
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.325
		SD in Log Scale	3.066
		Mean in Original Scale	165.3
		SD in Original Scale	1364
		95% t UCL	401.5
		95% Percentile Bootstrap UCL	442
		95% BCA Bootstrap UCL	744.7
		95% H-UCL	50.46

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.118	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1608		
nu star	18.91		
A-D Test Statistic	18.83	Nonparametric Statistics	
5% A-D Critical Value	0.989	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.989	Mean	165.3
5% K-S Critical Value	0.114	SD	1356
Data not Gamma Distributed at 5% Significance Level		SE of Mean	142.3
		95% KM (t) UCL	401.7

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001	95% KM (z) UCL	399.3
Maximum	13000	95% KM (jackknife) UCL	401.5
Mean	165.3	95% KM (bootstrap t) UCL	7675
Median	0.061	95% KM (BCA) UCL	450.7
SD	1364	95% KM (Percentile Bootstrap) UCL	432.6
k star	0.101	95% KM (Chebyshev) UCL	785.4
Theta star	1639	97.5% KM (Chebyshev) UCL	1054
Nu star	18.55	99% KM (Chebyshev) UCL	1581
AppChi2	9.791		
95% Gamma Approximate UCL (Use when n >= 40)	313.1		
95% Adjusted Gamma UCL (Use when n < 40)	316.4		

Potential UCLs to Use

97.5% KM (Chebyshev) UCL 1054

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

38

General Statistics

Number of Valid Data	7	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	6
		Percent Non-Detects	85.71%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 38 was not processed!

39

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 39 was not processed!

40

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 40 was not processed!

41

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 41 was not processed!

42

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 42 was not processed!

43

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 43 was not processed!

44

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 44 was not processed!

45

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 45 was not processed!

46

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 46 was not processed!

47

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 47 was not processed!

48

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 48 was not processed!

49

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 49 was not processed!

50

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 50 was not processed!

51

General Statistics

Number of Valid Data	7	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	6
		Percent Non-Detects	85.71%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 51 was not processed!

52

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 52 was not processed!

53

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 53 was not processed!

General Statistics

Number of Valid Data	92	Number of Detected Data	43
Number of Distinct Detected Data	40	Number of Non-Detect Data	49
		Percent Non-Detects	53.26%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0044	Minimum Detected	-5.426
Maximum Detected	250	Maximum Detected	5.521
Mean of Detected	8.659	Mean of Detected	-2.089
SD of Detected	40.02	SD of Detected	2.626
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	84
Number treated as Detected	8
Single DL Non-Detect Percentage	91.30%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.241	Shapiro Wilk Test Statistic	0.919
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.059	Mean	-3.595
SD	27.53	SD	2.458
95% DL/2 (t) UCL	8.829	95% H-Stat (DL/2) UCL	1.575
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.736
		SD in Log Scale	3.259
		Mean in Original Scale	4.048
		SD in Original Scale	27.53
		95% t UCL	8.818
		95% Percentile Bootstrap UCL	9.366
		95% BCA Bootstrap UCL	13.41
		95% H-UCL	10.1

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.18	Data do not follow a Discernable Distribution (0.05)	
Theta Star	48.16		
nu star	15.46		
A-D Test Statistic	6.243	**Nonparametric Statistics**	
5% A-D Critical Value	0.919	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.919	Mean	4.051
5% K-S Critical Value	0.15	SD	27.38
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2.888
		95% KM (t) UCL	8.851
Assuming Gamma Distribution		95% KM (z) UCL	8.802
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	8.821

Minimum	0.000001
Maximum	250
Mean	4.047
Median	0.000001
SD	27.53
k star	0.0896
Theta star	45.18
Nu star	16.48
AppChi2	8.302
95% Gamma Approximate UCL (Use when n >= 40)	8.033
95% Adjusted Gamma UCL (Use when n < 40)	8.124

Note: DL/2 is not a recommended method.

95% KM (bootstrap t) UCL	85.68
95% KM (BCA) UCL	9.315
95% KM (Percentile Bootstrap) UCL	9.589
95% KM (Chebyshev) UCL	16.64
97.5% KM (Chebyshev) UCL	22.09
99% KM (Chebyshev) UCL	32.79

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	22.09

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	92	Number of Detected Data	84
Number of Distinct Detected Data	67	Number of Non-Detect Data	8
		Percent Non-Detects	8.70%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0053	Minimum Detected	-5.24
Maximum Detected	2600	Maximum Detected	7.863
Mean of Detected	43.73	Mean of Detected	-1.389
SD of Detected	291.7	SD of Detected	2.748
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	25
Number treated as Detected	67
Single DL Non-Detect Percentage	27.17%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.457	Lilliefors Test Statistic	0.136
5% Lilliefors Critical Value	0.0967	5% Lilliefors Critical Value	0.0967
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	39.93	Mean	-1.73
SD	278.9	SD	2.859
95% DL/2 (t) UCL	88.25	95% H-Stat (DL/2) UCL	41.08
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.855
		SD in Log Scale	3.057
		Mean in Original Scale	39.93
		SD in Original Scale	278.9
		95% t UCL	88.24
		95% Percentile Bootstrap UCL	90.82
		95% BCA Bootstrap UCL	138.4
		95% H-UCL	78.17
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.152	Data do not follow a Discernable Distribution (0.05)	
Theta Star	288.6		
nu star	25.46		
A-D Test Statistic	14.08	**Nonparametric Statistics**	
5% A-D Critical Value	0.959	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.959	Mean	39.93
5% K-S Critical Value	0.11	SD	277.4
Data not Gamma Distributed at 5% Significance Level		SE of Mean	29.09
		95% KM (t) UCL	88.27
Assuming Gamma Distribution		95% KM (z) UCL	87.78
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	88.25

Minimum	0.000001	95% KM (bootstrap t) UCL	740.6
Maximum	2600	95% KM (BCA) UCL	98.18
Mean	39.93	95% KM (Percentile Bootstrap) UCL	94.93
Median	0.096	95% KM (Chebyshev) UCL	166.7
SD	278.9	97.5% KM (Chebyshev) UCL	221.6
k star	0.131	99% KM (Chebyshev) UCL	329.4
Theta star	305.3		
Nu star	24.07	**Potential UCLs to Use**	
AppChi2	13.9	97.5% KM (Chebyshev) UCL	221.6
95% Gamma Approximate UCL (Use when n >= 40)	69.14		
95% Adjusted Gamma UCL (Use when n < 40)	69.76		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	7	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	5
		Percent Non-Detects	71.43%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.04	Minimum Detected	-3.219
Maximum Detected	0.066	Maximum Detected	-2.718
Mean of Detected	0.053	Mean of Detected	-2.968
SD of Detected	0.0184	SD of Detected	0.354
Minimum Non-Detect	0.92	Minimum Non-Detect	-0.0834
Maximum Non-Detect	280	Maximum Non-Detect	5.635

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	7
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	62.51	Mean	1.666
SD	66.5	SD	3.749
95% DL/2 (t) UCL	111.4	95% H-Stat (DL/2) UCL	9.86E+11
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
		95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL (Use when n >= 40)	N/A
95% Adjusted Gamma UCL (Use when n < 40)	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.053
SD	0.013
SE of Mean	0.013
95% KM (t) UCL	0.0783
95% KM (z) UCL	0.0744
95% KM (jackknife) UCL	0.0861
95% KM (bootstrap t) UCL	0.0725
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	0.066
95% KM (Chebyshev) UCL	0.11
97.5% KM (Chebyshev) UCL	0.134
99% KM (Chebyshev) UCL	0.182

Potential UCLs to Use

95% KM (t) UCL	0.0783
95% KM (% Bootstrap) UCL	0.066

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

57

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 57 was not processed!

58

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 58 was not processed!

General Statistics

Number of Valid Data	92	Number of Detected Data	75
Number of Distinct Detected Data	66	Number of Non-Detect Data	17
		Percent Non-Detects	18.48%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0059	Minimum Detected	-5.133
Maximum Detected	1000	Maximum Detected	6.908
Mean of Detected	22.34	Mean of Detected	-1.038
SD of Detected	123.3	SD of Detected	2.676
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	28
Number treated as Detected	64
Single DL Non-Detect Percentage	30.43%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.447
5% Lilliefors Critical Value	0.102

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	18.21
SD	111.5
95% DL/2 (t) UCL	37.53
Maximum Likelihood Estimate(MLE) Method	N/A

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0859
5% Lilliefors Critical Value	0.102

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-1.863
SD	2.99
95% H-Stat (DL/2) UCL	59.4

Log ROS Method

Mean in Log Scale	-2.093
SD in Log Scale	3.313
Mean in Original Scale	18.21
SD in Original Scale	111.5
95% t UCL	37.53
95% Percentile Bootstrap UCL	39.36
95% BCA Bootstrap UCL	56.68
95% H-UCL	178.6

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.182
Theta Star	122.7
nu star	27.31
A-D Test Statistic	9.232
5% A-D Critical Value	0.927
K-S Test Statistic	0.927
5% K-S Critical Value	0.115

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	18.21
SD	110.9
SE of Mean	11.64
95% KM (t) UCL	37.56
95% KM (z) UCL	37.36
95% KM (jackknife) UCL	37.53

Minimum	0.000001	95% KM (bootstrap t) UCL	212.5
Maximum	1000	95% KM (BCA) UCL	40.23
Mean	18.21	95% KM (Percentile Bootstrap) UCL	39.21
Median	0.11	95% KM (Chebyshev) UCL	68.96
SD	111.5	97.5% KM (Chebyshev) UCL	90.92
k star	0.128	99% KM (Chebyshev) UCL	134.1
Theta star	141.9		
Nu star	23.61	**Potential UCLs to Use**	
AppChi2	13.55	97.5% KM (Chebyshev) UCL	90.92
95% Gamma Approximate UCL (Use when n >= 40)	31.72		
95% Adjusted Gamma UCL (Use when n < 40)	32.01		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	91	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	87
		Percent Non-Detects	95.60%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.2	Minimum Detected	-1.609
Maximum Detected	1.9	Maximum Detected	0.642
Mean of Detected	0.9	Mean of Detected	-0.396
SD of Detected	0.726	SD of Detected	0.939
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	1	Maximum Non-Detect	0

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	90
Number treated as Detected	1
Single DL Non-Detect Percentage	98.90%

Warning: There are only 4 Distinct Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Test Statistic	0.985
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.154	Mean	-2.117
SD	0.218	SD	0.514
95% DL/2 (t) UCL	0.192	95% H-Stat (DL/2) UCL	0.152
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-5.799
		SD in Log Scale	2.432
		Mean in Original Scale	0.0529
		SD in Original Scale	0.227
		95% t UCL	0.0926
		95% Percentile Bootstrap UCL	0.0955
		95% BCA Bootstrap UCL	0.121
		95% H-UCL	0.161
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.634	**Data appear Normal at 5% Significance Level**	
Theta Star	1.419		
nu star	5.074		
A-D Test Statistic	0.2	**Nonparametric Statistics**	

5% A-D Critical Value	0.661	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.661	Mean	0.231
5% K-S Critical Value	0.398	SD	0.195
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0236
		95% KM (t) UCL	0.27
Assuming Gamma Distribution		95% KM (z) UCL	0.27
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.485
Minimum	0.000001	95% KM (bootstrap t) UCL	0.275
Maximum	1.9	95% KM (BCA) UCL	N/A
Mean	0.0396	95% KM (Percentile Bootstrap) UCL	0.933
Median	0.000001	95% KM (Chebyshev) UCL	0.334
SD	0.228	97.5% KM (Chebyshev) UCL	0.379
k star	0.0877	99% KM (Chebyshev) UCL	0.466
Theta star	0.451		
Nu star	15.96	Potential UCLs to Use	
AppChi2	7.932	95% KM (t) UCL	0.27
95% Gamma Approximate UCL (Use when n >= 40)	0.0796	95% KM (Percentile Bootstrap) UCL	0.933
95% Adjusted Gamma UCL (Use when n < 40)	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics			
Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 61 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

62

General Statistics			
Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 62 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

63

General Statistics			
Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 63 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

64

General Statistics

Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 64 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

65

General Statistics

Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 65 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

66

General Statistics

Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 66 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

67

General Statistics

Number of Valid Data	2	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	2
		Percent Non-Detects	100.00%

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable 67 was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

General Statistics

Number of Valid Data	91	Number of Detected Data	90
Number of Distinct Detected Data	51	Number of Non-Detect Data	1
		Percent Non-Detects	1.10%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.1	Minimum Detected	0.742
Maximum Detected	33.6	Maximum Detected	3.515
Mean of Detected	5.764	Mean of Detected	1.588
SD of Detected	4.574	SD of Detected	0.508
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.292	Lilliefors Test Statistic	0.186
5% Lilliefors Critical Value	0.0934	5% Lilliefors Critical Value	0.0934
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	5.702	Mean	1.545
SD	4.587	SD	0.649
95% DL/2 (t) UCL	6.501	95% H-Stat (DL/2) UCL	6.62
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	5.679	Mean in Log Scale	1.574
SD	4.601	SD in Log Scale	0.523
95% MLE (t) UCL	6.48	Mean in Original Scale	5.716
95% MLE (Tiku) UCL	6.446	SD in Original Scale	4.572
		95% t UCL	6.512
		95% Percentile Bootstrap UCL	6.562
		95% BCA Bootstrap UCL	6.772
		95% H UCL	6.131

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.116	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1.85		
nu star	560.8		
A-D Test Statistic	6.182	**Nonparametric Statistics**	
5% A-D Critical Value	0.758	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.758	Mean	5.724
5% K-S Critical Value	0.0948	SD	4.539
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.479
		95% KM (t) UCL	6.519
Assuming Gamma Distribution		95% KM (z) UCL	6.511
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	6.519
Minimum	0.000001	95% KM (bootstrap t) UCL	6.86
Maximum	33.6	95% KM (BCA) UCL	6.573
Mean	5.701	95% KM (Percentile Bootstrap) UCL	6.496

Median	4.3	95% KM (Chebyshev) UCL	7.81
SD	4.588	97.5% KM (Chebyshev) UCL	8.713
k star	1.653	99% KM (Chebyshev) UCL	10.49
Theta star	3.449		
Nu star	300.9	Potential UCLs to Use	
AppChi2	261.7	95% KM (BCA) UCL	6.573
95% Gamma Approximate UCL (Use when n >= 40)	6.555		
95% Adjusted Gamma UCL (Use when n < 40)	6.569		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	98	Number of Distinct Observations	83

Raw Statistics		Log-transformed Statistics	
Minimum	0.049	Minimum of Log Data	-3.016
Maximum	724	Maximum of Log Data	6.585
Mean	177.3	Mean of log Data	4.791
Geometric Mean	120.5	SD of log Data	1.324
Median	138.5		
SD	143.6		
Std. Error of Mean	14.51		
Coefficient of Variation	0.81		
Skewness	2.142		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.215	Lilliefors Test Statistic	0.233
Lilliefors Critical Value	0.0895	Lilliefors Critical Value	0.0895
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	201.4	95% H-UCL	410.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	503.4
95% Adjusted-CLT UCL (Chen-1995)	204.6	97.5% Chebyshev (MVUE) UCL	598
95% Modified-t UCL (Johnson-1978)	202	99% Chebyshev (MVUE) UCL	783.9

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.399	Data do not follow a Discernable Distribution (0.05)	
Theta Star	126.7		
MLE of Mean	177.3		
MLE of Standard Deviation	149.9		
nu star	274.3		
Approximate Chi Square Value (.05)	236.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0476	95% CLT UCL	201.2
Adjusted Chi Square Value	236.4	95% Jackknife UCL	201.4
		95% Standard Bootstrap UCL	201.2
Anderson-Darling Test Statistic	3.066	95% Bootstrap-t UCL	204.6
Anderson-Darling 5% Critical Value	0.772	95% Hall's Bootstrap UCL	205.2
Kolmogorov-Smirnov Test Statistic	0.147	95% Percentile Bootstrap UCL	202.6
Kolmogorov-Smirnov 5% Critical Value	0.0922	95% BCA Bootstrap UCL	203.5
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	240.6
		97.5% Chebyshev(Mean, Sd) UCL	268
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	321.7
95% Approximate Gamma UCL (Use when n >= 40)	205.3		
95% Adjusted Gamma UCL (Use when n < 40)	205.8		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	240.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	104	Number of Detected Data	99
Number of Distinct Detected Data	85	Number of Non-Detect Data	5
		Percent Non-Detects	4.81%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0075	Minimum Detected	-4.893
Maximum Detected	650	Maximum Detected	6.477
Mean of Detected	20.87	Mean of Detected	-0.433
SD of Detected	90.2	SD of Detected	2.68
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	10
Number treated as Detected	94
Single DL Non-Detect Percentage	9.62%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.409	Lilliefors Test Statistic	0.098
5% Lilliefors Critical Value	0.089	5% Lilliefors Critical Value	0.089
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	19.87	Mean	-0.692
SD	88.09	SD	2.86
95% DL/2 (t) UCL	34.21	95% H-Stat (DL/2) UCL	103.2
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	13.18	Mean in Log Scale	-0.734
SD	93.01	SD in Log Scale	2.942
95% MLE (t) UCL	28.31	Mean in Original Scale	19.87
95% MLE (Tiku) UCL	27.03	SD in Original Scale	88.09
		95% t UCL	34.21
		95% Percentile Bootstrap UCL	35.44
		95% BCA Bootstrap UCL	42.06
		95% H UCL	134.3

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.211	Data do not follow a Discernable Distribution (0.05)
Theta Star	99.08	
nu star	41.71	

A-D Test Statistic	8.337
5% A-D Critical Value	0.908
K-S Test Statistic	0.908
5% K-S Critical Value	0.0994

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	650
Mean	19.87
Median	0.295
SD	88.09
k star	0.185
Theta star	107.7
Nu star	38.39
AppChi2	25.2
95% Gamma Approximate UCL (Use when n >= 40)	30.27
95% Adjusted Gamma UCL (Use when n < 40)	30.45

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	19.87
SD	87.67
SE of Mean	8.64
95% KM (t) UCL	34.21
95% KM (z) UCL	34.08
95% KM (jackknife) UCL	34.21
95% KM (bootstrap t) UCL	78.09
95% KM (BCA) UCL	38.57
95% KM (Percentile Bootstrap) UCL	35.16
95% KM (Chebyshev) UCL	57.53
97.5% KM (Chebyshev) UCL	73.83
99% KM (Chebyshev) UCL	105.8

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	73.83

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	104	Number of Detected Data	100
Number of Distinct Detected Data	83	Number of Non-Detect Data	4
		Percent Non-Detects	3.85%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0028	Minimum Detected	-5.878
Maximum Detected	810	Maximum Detected	6.697
Mean of Detected	22.25	Mean of Detected	-0.225
SD of Detected	94.41	SD of Detected	2.678
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	7
Number treated as Detected	97
Single DL Non-Detect Percentage	6.73%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.407	Lilliefors Test Statistic	0.0874
5% Lilliefors Critical Value	0.0886	5% Lilliefors Critical Value	0.0886
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.4	Mean	-0.438
SD	92.66	SD	2.837
95% DL/2 (t) UCL	36.48	95% H-Stat (DL/2) UCL	122.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	16.63	Mean in Log Scale	-0.458
SD	96.05	SD in Log Scale	2.876
95% MLE (t) UCL	32.26	Mean in Original Scale	21.4
95% MLE (Tiku) UCL	30.72	SD in Original Scale	92.66
		95% t UCL	36.48
		95% Percentile Bootstrap UCL	37.42
		95% BCA Bootstrap UCL	45.25
		95% H UCL	138.5

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.218	Data appear Lognormal at 5% Significance Level	
Theta Star	101.9		
nu star	43.66		

		Nonparametric Statistics	
A-D Test Statistic	7.606	Kaplan-Meier (KM) Method	
5% A-D Critical Value	0.904	Mean	21.4
K-S Test Statistic	0.904	SD	92.21
5% K-S Critical Value	0.0987	SE of Mean	9.088
Data not Gamma Distributed at 5% Significance Level		95% KM (t) UCL	36.48
Assuming Gamma Distribution		95% KM (z) UCL	36.35
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	36.48

Minimum	0.000001
Maximum	810
Mean	21.4
Median	0.48
SD	92.66
k star	0.195
Theta star	109.8
Nu star	40.53
AppChi2	26.94
95% Gamma Approximate UCL (Use when n >= 40)	32.19
95% Adjusted Gamma UCL (Use when n < 40)	32.38

Note: DL/2 is not a recommended method.

95% KM (bootstrap t) UCL	67.57
95% KM (BCA) UCL	40.6
95% KM (Percentile Bootstrap) UCL	37.46
95% KM (Chebyshev) UCL	61.01
97.5% KM (Chebyshev) UCL	78.15
99% KM (Chebyshev) UCL	111.8

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	78.15

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Data	92
Number of Distinct Detected Data	72
Number of Detected Data	89
Number of Non-Detect Data	3
Percent Non-Detects	3.26%

Raw Statistics

Minimum Detected	0.007
Maximum Detected	360
Mean of Detected	10.06
SD of Detected	40.18
Minimum Non-Detect	0.0046
Maximum Non-Detect	0.014

Log-transformed Statistics

Minimum Detected	-4.962
Maximum Detected	5.886
Mean of Detected	-0.608
SD of Detected	2.6
Minimum Non-Detect	-5.382
Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	11
Number treated as Detected	81
Single DL Non-Detect Percentage	11.96%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.401
5% Lilliefors Critical Value	0.0939

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	9.729
SD	39.56
95% DL/2 (t) UCL	16.58
Maximum Likelihood Estimate(MLE) Method	
Mean	5.929
SD	42.42
95% MLE (t) UCL	13.28
95% MLE (Tiku) UCL	12.74

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.244
Theta Star	41.27
nu star	43.37
A-D Test Statistic	5.081
5% A-D Critical Value	0.892
K-S Test Statistic	0.892
5% K-S Critical Value	0.104

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0944
5% Lilliefors Critical Value	0.0939

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.774
SD	2.714
95% H-Stat (DL/2) UCL	62.99
Log ROS Method	
Mean in Log Scale	-0.802
SD in Log Scale	2.773
Mean in Original Scale	9.729
SD in Original Scale	39.56
95% t UCL	16.58
95% Percentile Bootstrap UCL	17.15
95% BCA Bootstrap UCL	23.15
95% H UCL	75.66

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	9.729
SD	39.34
SE of Mean	4.125
95% KM (t) UCL	16.58
95% KM (z) UCL	16.51
95% KM (jackknife) UCL	16.58

Minimum	0.000001
Maximum	360
Mean	9.729
Median	0.475
SD	39.56
k star	0.219
Theta star	44.42
Nu star	40.3
AppChi2	26.75
95% Gamma Approximate UCL (Use when n >= 40)	14.65
95% Adjusted Gamma UCL (Use when n < 40)	14.75

Note: DL/2 is not a recommended method.

95% KM (bootstrap t) UCL	29.07
95% KM (BCA) UCL	17.13
95% KM (Percentile Bootstrap) UCL	17.51
95% KM (Chebyshev) UCL	27.71
97.5% KM (Chebyshev) UCL	35.49
99% KM (Chebyshev) UCL	50.77

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	35.49

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

73

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 73 was not processed!

74

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 74 was not processed!

75

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 75 was not processed!

76

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 76 was not processed!

77

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 77 was not processed!

78

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 78 was not processed!

79

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 79 was not processed!

80

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 80 was not processed!

81

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 81 was not processed!

82

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 82 was not processed!

83

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 83 was not processed!

84

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 84 was not processed!

85

General Statistics

Number of Valid Data	98	Number of Detected Data	53
Number of Distinct Detected Data	9	Number of Non-Detect Data	45
		Percent Non-Detects	45.92%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.2	Minimum Detected	-1.609
Maximum Detected	70	Maximum Detected	4.248
Mean of Detected	1.758	Mean of Detected	-0.903
SD of Detected	9.568	SD of Detected	0.879
Minimum Non-Detect	0.057	Minimum Non-Detect	-2.865
Maximum Non-Detect	26	Maximum Non-Detect	3.258

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	97
Number treated as Detected	1
Single DL Non-Detect Percentage	98.98%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.498	Lilliefors Test Statistic	0.242
5% Lilliefors Critical Value	0.122	5% Lilliefors Critical Value	0.122
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.174	Mean	-1.381
SD	7.156	SD	1.055
95% DL/2 (t) UCL	2.374	95% H-Stat (DL/2) UCL	0.561
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.611
		SD in Log Scale	1.086
		Mean in Original Scale	0.998
		SD in Original Scale	7.054
		95% t UCL	2.182
		95% Percentile Bootstrap UCL	2.418
		95% BCA Bootstrap UCL	3.22
		95% H-UCL	0.466

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.429	Data do not follow a Discernable Distribution (0.05)	
Theta Star	4.1		
nu star	45.46		
A-D Test Statistic	14.61	**Nonparametric Statistics**	
5% A-D Critical Value	0.829	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.829	Mean	1.051
5% K-S Critical Value	0.13	SD	7.012
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.715
		95% KM (t) UCL	2.239
Assuming Gamma Distribution		95% KM (z) UCL	2.227
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.233

Minimum	0.000001	95% KM (bootstrap t) UCL	37.18
Maximum	70	95% KM (BCA) UCL	2.494
Mean	0.953	95% KM (Percentile Bootstrap) UCL	2.464
Median	0.2	95% KM (Chebyshev) UCL	4.168
SD	7.06	97.5% KM (Chebyshev) UCL	5.517
k star	0.122	99% KM (Chebyshev) UCL	8.166
Theta star	7.79		
Nu star	23.98	**Potential UCLs to Use**	
AppChi2	13.83	95% KM (t) UCL	2.239
95% Gamma Approximate UCL (Use when n >= 40)	1.652	95% KM (% Bootstrap) UCL	2.464
95% Adjusted Gamma UCL (Use when n < 40)	1.666		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

86

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 86 was not processed!

87

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 87 was not processed!

88

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 88 was not processed!

89

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 89 was not processed!

90

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 90 was not processed!

91

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 91 was not processed!

General Statistics

Number of Valid Data	91	Number of Detected Data	90
Number of Distinct Detected Data	61	Number of Non-Detect Data	1
		Percent Non-Detects	1.10%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	9	Minimum Detected	2.197
Maximum Detected	63	Maximum Detected	4.143
Mean of Detected	29.84	Mean of Detected	3.337
SD of Detected	10.26	SD of Detected	0.355
Minimum Non-Detect	3	Minimum Non-Detect	1.099
Maximum Non-Detect	3	Maximum Non-Detect	1.099

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.12	Lilliefors Test Statistic	0.1
5% Lilliefors Critical Value	0.0934	5% Lilliefors Critical Value	0.0934
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	29.53	Mean	3.304
SD	10.63	SD	0.468
95% DL/2 (t) UCL	31.38	95% H-Stat (DL/2) UCL	33.25
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	29.51	Mean in Log Scale	3.326
SD	10.64	SD in Log Scale	0.367
95% MLE (t) UCL	31.36	Mean in Original Scale	29.63
95% MLE (Tiku) UCL	31.37	SD in Original Scale	10.4
		95% t UCL	31.45
		95% Percentile Bootstrap UCL	31.43
		95% BCA Bootstrap UCL	31.6
		95% H UCL	31.88

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	8.3	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	3.596		
nu star	1494		
A-D Test Statistic	0.697	Nonparametric Statistics	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	29.61
5% K-S Critical Value	0.0942	SD	10.38
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	1.094
		95% KM (t) UCL	31.43
Assuming Gamma Distribution		95% KM (z) UCL	31.41
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	31.42
Minimum	0.000001	95% KM (bootstrap t) UCL	31.57
Maximum	63	95% KM (BCA) UCL	31.52
Mean	29.52	95% KM (Percentile Bootstrap) UCL	31.39
Median	27	95% KM (Chebyshev) UCL	34.38
SD	10.68	97.5% KM (Chebyshev) UCL	36.45
k star	2.196	99% KM (Chebyshev) UCL	40.5
Theta star	13.44		
Nu star	399.7	Potential UCLs to Use	
AppChi2	354.4	95% KM (BCA) UCL	31.52
95% Gamma Approximate UCL (Use when n >= 40)	33.29		
95% Adjusted Gamma UCL (Use when n < 40)	33.36		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

93

General Statistics			
Number of Valid Data	104	Number of Detected Data	101
Number of Distinct Detected Data	83	Number of Non-Detect Data	3
		Percent Non-Detects	2.88%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0033	Minimum Detected	-5.714
Maximum Detected	670	Maximum Detected	6.507
Mean of Detected	20.62	Mean of Detected	-0.332
SD of Detected	87.7	SD of Detected	2.648
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	4
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	100
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	3.85%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.407	Lilliefors Test Statistic	0.0978
5% Lilliefors Critical Value	0.0882	5% Lilliefors Critical Value	0.0882
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	20.02	Mean	-0.496
SD	86.48	SD	2.78
95% DL/2 (t) UCL	34.1	95% H-Stat (DL/2) UCL	94
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	17.55	Mean in Log Scale	-0.51
SD	88.06	SD in Log Scale	2.81
95% MLE (t) UCL	31.88	Mean in Original Scale	20.02
95% MLE (Tiku) UCL	30.29	SD in Original Scale	86.48
		95% t UCL	34.1
		95% Percentile Bootstrap UCL	34.39
		95% BCA Bootstrap UCL	43.41
		95% H UCL	103.1
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.217	Data do not follow a Discernable Distribution (0.05)	
Theta Star	95.19		
nu star	43.76		
A-D Test Statistic	8.165	**Nonparametric Statistics**	
5% A-D Critical Value	0.905	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.905	Mean	20.02
5% K-S Critical Value	0.0985	SD	86.06
Data not Gamma Distributed at 5% Significance Level		SE of Mean	8.481
		95% KM (t) UCL	34.1
Assuming Gamma Distribution		95% KM (z) UCL	33.97
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	34.1

Minimum	0.000001
Maximum	670
Mean	20.02
Median	0.355
SD	86.48
k star	0.199
Theta star	100.7
Nu star	41.37
AppChi2	27.63
95% Gamma Approximate UCL (Use when n >= 40)	29.98
95% Adjusted Gamma UCL (Use when n < 40)	30.15

Note: DL/2 is not a recommended method.

95% KM (bootstrap t) UCL	60.25
95% KM (BCA) UCL	35.95
95% KM (Percentile Bootstrap) UCL	34.89
95% KM (Chebyshev) UCL	56.99
97.5% KM (Chebyshev) UCL	72.99
99% KM (Chebyshev) UCL	104.4

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	72.99

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

94

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 94 was not processed!

95

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 95 was not processed!

General Statistics

Number of Valid Observations	91	Number of Distinct Observations	76

Raw Statistics		Log-transformed Statistics	
Minimum	1.4	Minimum of Log Data	0.336
Maximum	143	Maximum of Log Data	4.963
Mean	36.78	Mean of log Data	3.442
Geometric Mean	31.25	SD of log Data	0.59
Median	28.9		
SD	23.92		
Std. Error of Mean	2.508		
Coefficient of Variation	0.65		
Skewness	2.14		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.257	Lilliefors Test Statistic	0.153
Lilliefors Critical Value	0.0929	Lilliefors Critical Value	0.0929
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	40.95	95% H-UCL	41.85
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	47.84
95% Adjusted-CLT UCL (Chen-1995)	41.51	97.5% Chebyshev (MVUE) UCL	52.49
95% Modified-t UCL (Johnson-1978)	41.05	99% Chebyshev (MVUE) UCL	61.62
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.122	Data do not follow a Discernable Distribution (0.05)	
Theta Star	11.78		
MLE of Mean	36.78		
MLE of Standard Deviation	20.82		
nu star	568.3		
Approximate Chi Square Value (.05)	514	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0474	95% CLT UCL	40.91
Adjusted Chi Square Value	513.2	95% Jackknife UCL	40.95
		95% Standard Bootstrap UCL	40.86
Anderson-Darling Test Statistic	4.05	95% Bootstrap-t UCL	41.62
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	41.53
Kolmogorov-Smirnov Test Statistic	0.191	95% Percentile Bootstrap UCL	41.08
Kolmogorov-Smirnov 5% Critical Value	0.0943	95% BCA Bootstrap UCL	41.63
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	47.72
		97.5% Chebyshev(Mean, Sd) UCL	52.45
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	61.74
95% Approximate Gamma UCL (Use when n >= 40)	40.67		
95% Adjusted Gamma UCL (Use when n < 40)	40.74		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	47.72

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	13	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	4
		Percent Non-Detects	30.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.125	Minimum Detected	-2.079
Maximum Detected	76.4	Maximum Detected	4.336
Mean of Detected	13.17	Mean of Detected	0.708
SD of Detected	24.91	SD of Detected	2.293
Minimum Non-Detect	0.106	Minimum Non-Detect	-2.244
Maximum Non-Detect	0.108	Maximum Non-Detect	-2.226

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	4
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	9
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	30.77%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.606	Shapiro Wilk Test Statistic	0.932
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	9.136	Mean	-0.412
SD	21.29	SD	2.561
95% DL/2 (t) UCL	19.66	95% H-Stat (DL/2) UCL	1485
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	3.051	Mean in Log Scale	-1.062
SD	26.15	SD in Log Scale	3.356
95% MLE (t) UCL	15.98	Mean in Original Scale	9.122
95% MLE (Tiku) UCL	16.56	SD in Original Scale	21.3
		95% t UCL	19.65
		95% Percentile Bootstrap UCL	19.82
		95% BCA Bootstrap UCL	26.69
		95% H UCL	171215

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.313
Theta Star	42.1
nu star	5.632
A-D Test Statistic	0.474
5% A-D Critical Value	0.797
K-S Test Statistic	0.797
5% K-S Critical Value	0.299
Data appear Gamma Distributed at 5% Significance Level	

Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	76.4
Mean	9.12
Median	0.376
SD	21.3
k star	0.152
Theta star	59.92
Nu star	3.957
AppChi2	0.705
95% Gamma Approximate UCL (Use when n >= 40)	51.2
95% Adjusted Gamma UCL (Use when n < 40)	67.13

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data appear Gamma Distributed at 5% Significance Level	

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	9.158
SD	20.45
SE of Mean	6.016
95% KM (t) UCL	19.88
95% KM (z) UCL	19.05
95% KM (jackknife) UCL	19.67
95% KM (bootstrap t) UCL	64.65
95% KM (BCA) UCL	20.15
95% KM (Percentile Bootstrap) UCL	19.62
95% KM (Chebyshev) UCL	35.38
97.5% KM (Chebyshev) UCL	46.73
99% KM (Chebyshev) UCL	69.01

Potential UCLs to Use	
95% KM (BCA) UCL	20.15

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Data	104	Number of Detected Data	84
Number of Distinct Detected Data	67	Number of Non-Detect Data	20
		Percent Non-Detects	19.23%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0029	Minimum Detected	-5.843
Maximum Detected	83	Maximum Detected	4.419
Mean of Detected	2.707	Mean of Detected	-1.516
SD of Detected	9.703	SD of Detected	2.307
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	36
Number treated as Detected	68
Single DL Non-Detect Percentage	34.62%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.39	Lilliefors Test Statistic	0.0882
5% Lilliefors Critical Value	0.0967	5% Lilliefors Critical Value	0.0967
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.187	Mean	-2.324
SD	8.776	SD	2.668
95% DL/2 (t) UCL	3.615	95% H-Stat (DL/2) UCL	10.24
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.447
		SD in Log Scale	2.848
		Mean in Original Scale	2.187
		SD in Original Scale	8.776
		95% t UCL	3.615
		95% Percentile Bootstrap UCL	3.804
		95% BCA Bootstrap UCL	4.717
		95% H-UCL	17.04

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.276	Data appear Lognormal at 5% Significance Level	
Theta Star	9.807		
nu star	46.36		
A-D Test Statistic	5.194	**Nonparametric Statistics**	
5% A-D Critical Value	0.876	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.876	Mean	2.187
5% K-S Critical Value	0.106	SD	8.733

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	83
Mean	2.186
Median	0.0815
SD	8.776
k star	0.165
Theta star	13.29
Nu star	34.22
AppChi2	21.84
95% Gamma Approximate UCL (Use when n >= 40)	3.425
95% Adjusted Gamma UCL (Use when n < 40)	3.447

Note: DL/2 is not a recommended method.

SE of Mean	0.862
95% KM (t) UCL	3.617
95% KM (z) UCL	3.604
95% KM (jackknife) UCL	3.614
95% KM (bootstrap t) UCL	5.84
95% KM (BCA) UCL	4.001
95% KM (Percentile Bootstrap) UCL	3.773
95% KM (Chebyshev) UCL	5.942
97.5% KM (Chebyshev) UCL	7.567
99% KM (Chebyshev) UCL	10.76

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	7.567

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

99

General Statistics

Number of Valid Data	92	Number of Detected Data	51
Number of Distinct Detected Data	46	Number of Non-Detect Data	41
		Percent Non-Detects	44.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0053	Minimum Detected	-5.24
Maximum Detected	280	Maximum Detected	5.635
Mean of Detected	8.535	Mean of Detected	-1.932
SD of Detected	41.24	SD of Detected	2.527
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	82
Number treated as Detected	10
Single DL Non-Detect Percentage	89.13%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.443	Lilliefors Test Statistic	0.119
5% Lilliefors Critical Value	0.124	5% Lilliefors Critical Value	0.124
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.745	Mean	-3.248
SD	30.86	SD	2.55
95% DL/2 (t) UCL	10.09	95% H-Stat (DL/2) UCL	3.015
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.312
		SD in Log Scale	3.414
		Mean in Original Scale	4.732
		SD in Original Scale	30.86
		95% t UCL	10.08
		95% Percentile Bootstrap UCL	10.87
		95% BCA Bootstrap UCL	15.86
		95% H-UCL	30.34

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.185	Data appear Lognormal at 5% Significance Level	
Theta Star	46.05		
nu star	18.91		
A-D Test Statistic	7.439	Nonparametric Statistics	
5% A-D Critical Value	0.919	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.919	Mean	4.736
5% K-S Critical Value	0.138	SD	30.69

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	280
Mean	4.732
Median	0.0079
SD	30.86
k star	0.0975
Theta star	48.54
Nu star	17.94
AppChi2	9.345
95% Gamma Approximate UCL (Use when n >= 40)	9.082
95% Adjusted Gamma UCL (Use when n < 40)	9.179

Note: DL/2 is not a recommended method.

SE of Mean	3.232
95% KM (t) UCL	10.11
95% KM (z) UCL	10.05
95% KM (jackknife) UCL	10.08
95% KM (bootstrap t) UCL	61.57
95% KM (BCA) UCL	10.64
95% KM (Percentile Bootstrap) UCL	10.7
95% KM (Chebyshev) UCL	18.82
97.5% KM (Chebyshev) UCL	24.92
99% KM (Chebyshev) UCL	36.89

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	24.92

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

100

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 100 was not processed!

101

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 101 was not processed!

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		**Log-transformed Statistics**	
Minimum	41	Minimum of Log Data	3.714
Maximum	1200	Maximum of Log Data	7.09
Mean	473	Mean of log Data	5.643
Geometric Mean	282.3	SD of log Data	1.242
Median	510		
SD	422		
Std. Error of Mean	159.5		
Coefficient of Variation	0.892		
Skewness	0.741		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.906	Shapiro Wilk Test Statistic	0.914
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	783	95% H-UCL	5701
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1585
95% Adjusted-CLT UCL (Chen-1995)	783.1	97.5% Chebyshev (MVUE) UCL	2044
95% Modified-t UCL (Johnson-1978)	790.4	99% Chebyshev (MVUE) UCL	2948

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	0.727	Data appear Normal at 5% Significance Level
Theta Star	650.7	
MLE of Mean	473	
MLE of Standard Deviation	554.8	
nu star	10.18	

Approximate Chi Square Value (.05)	4.053
Adjusted Level of Significance	0.0158
Adjusted Chi Square Value	2.973
Anderson-Darling Test Statistic	0.349
Anderson-Darling 5% Critical Value	0.726
Kolmogorov-Smirnov Test Statistic	0.227
Kolmogorov-Smirnov 5% Critical Value	0.319

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40)	1188
95% Adjusted Gamma UCL (Use when n < 40)	1619

Nonparametric Statistics

95% CLT UCL	735.4
95% Jackknife UCL	783
95% Standard Bootstrap UCL	710.8
95% Bootstrap-t UCL	852.4
95% Hall's Bootstrap UCL	830
95% Percentile Bootstrap UCL	724.3
95% BCA Bootstrap UCL	751.4
95% Chebyshev(Mean, Sd) UCL	1168
97.5% Chebyshev(Mean, Sd) UCL	1469
99% Chebyshev(Mean, Sd) UCL	2060

Potential UCL to Use — Use 95% Student's-t UCL 783

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

103

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 103 was not processed!

104

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 104 was not processed!

105

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 105 was not processed!

106

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 106 was not processed!

General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0075	Minimum Detected	-4.893
Maximum Detected	140	Maximum Detected	4.942
Mean of Detected	47.07	Mean of Detected	1.91
SD of Detected	61.38	SD of Detected	3.593
Minimum Non-Detect	0.0018	Minimum Non-Detect	-6.32
Maximum Non-Detect	0.0018	Maximum Non-Detect	-6.32

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.767	Shapiro Wilk Test Statistic	0.818
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	40.34	Mean	0.636
SD	58.79	SD	4.704
95% DL/2 (t) UCL	83.52	95% H-Stat (DL/2) UCL	9.56E+17
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	34.93	Mean in Log Scale	0.766
SD	60.91	SD in Log Scale	4.464
95% MLE (t) UCL	79.67	Mean in Original Scale	40.34
95% MLE (Tiku) UCL	78.28	SD in Original Scale	58.79
		95% t UCL	83.52
		95% Percentile Bootstrap UCL	76.06
		95% BCA Bootstrap UCL	79.72
		95% H UCL	1.91E+16

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.285	Data appear Gamma Distributed at 5% Significance Level
Theta Star	165.4	
nu star	3.415	

A-D Test Statistic	0.315
5% A-D Critical Value	0.759
K-S Test Statistic	0.759
5% K-S Critical Value	0.355

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	140
Mean	40.34
Median	11
SD	58.79
k star	0.201
Theta star	200.9
Nu star	2.811
AppChi2	0.319
95% Gamma Approximate UCL (Use when n >= 40)	355.8
95% Adjusted Gamma UCL (Use when n < 40)	690.9

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	40.35
SD	54.43
SE of Mean	22.53
95% KM (t) UCL	84.13
95% KM (z) UCL	77.41
95% KM (jackknife) UCL	83.28
95% KM (bootstrap t) UCL	329.4
95% KM (BCA) UCL	78.77
95% KM (Percentile Bootstrap) UCL	79.4
95% KM (Chebyshev) UCL	138.6
97.5% KM (Chebyshev) UCL	181.1
99% KM (Chebyshev) UCL	264.6

Potential UCLs to Use

95% KM (Chebyshev) UCL	138.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

108

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 108 was not processed!

109

General Statistics

Number of Valid Data	92	Number of Detected Data	90
Number of Distinct Detected Data	79	Number of Non-Detect Data	2
		Percent Non-Detects	2.17%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.013	Minimum Detected	-4.343
Maximum Detected	960	Maximum Detected	6.867
Mean of Detected	37.01	Mean of Detected	0.231
SD of Detected	150.4	SD of Detected	2.682
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	2
Number treated as Detected	90
Single DL Non-Detect Percentage	2.17%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.411	Lilliefors Test Statistic	0.105
5% Lilliefors Critical Value	0.0934	5% Lilliefors Critical Value	0.0934
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	36.2	Mean	0.0945
SD	148.8	SD	2.807
95% DL/2 (t) UCL	61.99	95% H-Stat (DL/2) UCL	210
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	33.85	Mean in Log Scale	0.0826
SD	150	SD in Log Scale	2.834
95% MLE (t) UCL	59.83	Mean in Original Scale	36.2
95% MLE (Tiku) UCL	56.77	SD in Original Scale	148.8
		95% t UCL	61.99
		95% Percentile Bootstrap UCL	65
		95% BCA Bootstrap UCL	75.85
		95% H UCL	229.5

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.215	Data do not follow a Discernable Distribution (0.05)
Theta Star	171.8	
nu star	38.78	

A-D Test Statistic	7.16
5% A-D Critical Value	0.905
K-S Test Statistic	0.905
5% K-S Critical Value	0.104
Data not Gamma Distributed at 5% Significance Level	

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	960
Mean	36.2
Median	0.96
SD	148.8
k star	0.201
Theta star	179.7
Nu star	37.07
AppChi2	24.13
95% Gamma Approximate UCL (Use when n >= 40)	55.61
95% Adjusted Gamma UCL (Use when n < 40)	56

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	36.2
SD	148
SE of Mean	15.52
95% KM (t) UCL	61.99
95% KM (z) UCL	61.73
95% KM (jackknife) UCL	61.99
95% KM (bootstrap t) UCL	101.3
95% KM (BCA) UCL	62.99
95% KM (Percentile Bootstrap) UCL	63.42
95% KM (Chebyshev) UCL	103.8
97.5% KM (Chebyshev) UCL	133.1
99% KM (Chebyshev) UCL	190.6

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	133.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Data	92	Number of Detected Data	63
Number of Distinct Detected Data	51	Number of Non-Detect Data	29
		Percent Non-Detects	31.52%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0049	Minimum Detected	-5.319
Maximum Detected	1400	Maximum Detected	7.244
Mean of Detected	31.83	Mean of Detected	-1.721
SD of Detected	184.2	SD of Detected	2.766
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	75
Number treated as Detected	17
Single DL Non-Detect Percentage	81.52%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.466	Lilliefors Test Statistic	0.134
5% Lilliefors Critical Value	0.112	5% Lilliefors Critical Value	0.112
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.8	Mean	-2.813
SD	152.8	SD	2.874
95% DL/2 (t) UCL	48.27	95% H-Stat (DL/2) UCL	14.71
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.487
		SD in Log Scale	3.566
		Mean in Original Scale	21.8
		SD in Original Scale	152.8
		95% t UCL	48.27
		95% Percentile Bootstrap UCL	51.62
		95% BCA Bootstrap UCL	72.56
		95% H-UCL	138.7

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.152	Data do not follow a Discernable Distribution (0.05)
Theta Star	209.3	
nu star	19.16	

A-D Test Statistic	10.73
5% A-D Critical Value	0.949
K-S Test Statistic	0.949
5% K-S Critical Value	0.126

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	1400
Mean	21.8
Median	0.025
SD	152.8
k star	0.099
Theta star	220.1
Nu star	18.22
AppChi2	9.552
95% Gamma Approximate UCL (Use when n >= 40)	41.59
95% Adjusted Gamma UCL (Use when n < 40)	42.03

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	21.8
SD	151.9
SE of Mean	15.97
95% KM (t) UCL	48.34
95% KM (z) UCL	48.07
95% KM (jackknife) UCL	48.27
95% KM (bootstrap t) UCL	512.2
95% KM (BCA) UCL	52.69
95% KM (Percentile Bootstrap) UCL	52.14
95% KM (Chebyshev) UCL	91.41
97.5% KM (Chebyshev) UCL	121.5
99% KM (Chebyshev) UCL	180.7

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	121.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	28	Minimum Detected	3.332
Maximum Detected	15000	Maximum Detected	9.616
Mean of Detected	6846	Mean of Detected	7.462
SD of Detected	6765	SD of Detected	2.644
Minimum Non-Detect	6.6	Minimum Non-Detect	1.887
Maximum Non-Detect	6.6	Maximum Non-Detect	1.887

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.843	Shapiro Wilk Test Statistic	0.819
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	5869	Mean	6.566
SD	6695	SD	3.382
95% DL/2 (t) UCL	10786	95% H-Stat (DL/2) UCL	1.09E+12
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	5294	Mean in Log Scale	6.592
SD	6982	SD in Log Scale	3.335
95% MLE (t) UCL	10422	Mean in Original Scale	5869
95% MLE (Tiku) UCL	10356	SD in Original Scale	6695
		95% t UCL	10786
		95% Percentile Bootstrap UCL	10129
		95% BCA Bootstrap UCL	10150
		95% H UCL	6.28E+11

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.345
Theta Star	19824
nu star	4.144
A-D Test Statistic	0.515
5% A-D Critical Value	0.741
K-S Test Statistic	0.741
5% K-S Critical Value	0.35
Data appear Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	28
Maximum	15000
Mean	5876
Median	4900
SD	6687
k star	0.317
Theta star	18554
Nu star	4.434
AppChi2	0.9
95% Gamma Approximate UCL (Use when n >= 40)	28942
95% Adjusted Gamma UCL (Use when n < 40)	50404

Data Distribution Test with Detected Values Only	
Data appear Normal at 5% Significance Level	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	5872
SD	6195
SE of Mean	2565
95% KM (t) UCL	10857
95% KM (z) UCL	10091
95% KM (jackknife) UCL	10783
95% KM (bootstrap t) UCL	14228
95% KM (BCA) UCL	9993
95% KM (Percentile Bootstrap) UCL	10150
95% KM (Chebyshev) UCL	17053
97.5% KM (Chebyshev) UCL	21891
99% KM (Chebyshev) UCL	31394
Potential UCLs to Use	
95% KM (t) UCL	10857
95% KM (Percentile Bootstrap) UCL	10150

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 112 was not processed!

113

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 113 was not processed!

114

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 114 was not processed!

115

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 115 was not processed!

General Statistics

Number of Valid Data	104	Number of Detected Data	99
Number of Distinct Detected Data	84	Number of Non-Detect Data	5
		Percent Non-Detects	4.81%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0061	Minimum Detected	-5.099
Maximum Detected	330	Maximum Detected	5.799
Mean of Detected	8.431	Mean of Detected	-0.877
SD of Detected	35.24	SD of Detected	2.595
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	16
Number treated as Detected	88
Single DL Non-Detect Percentage	15.38%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.406	Lilliefors Test Statistic	0.0982
5% Lilliefors Critical Value	0.089	5% Lilliefors Critical Value	0.089
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	8.026	Mean	-1.115
SD	34.42	SD	2.746
95% DL/2 (t) UCL	13.63	95% H-Stat (DL/2) UCL	44.92
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	3.581	Mean in Log Scale	-1.162
SD	37.8	SD in Log Scale	2.839
95% MLE (t) UCL	9.732	Mean in Original Scale	8.025
95% MLE (Tiku) UCL	9.397	SD in Original Scale	34.42
		95% t UCL	13.63
		95% Percentile Bootstrap UCL	14.28
		95% BCA Bootstrap UCL	18.71
		95% H UCL	59.81

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.237
Theta Star	35.51
nu star	47.01
A-D Test Statistic	6.262
5% A-D Critical Value	0.895
K-S Test Statistic	0.895
5% K-S Critical Value	0.0988
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	330
Mean	8.025
Median	0.28
SD	34.42
k star	0.205
Theta star	39.11
Nu star	42.68
AppChi2	28.7
95% Gamma Approximate UCL (Use when n >= 40)	11.93
95% Adjusted Gamma UCL (Use when n < 40)	12

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data do not follow a Discernable Distribution (0.05)	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	8.026
SD	34.25
SE of Mean	3.376
95% KM (t) UCL	13.63
95% KM (z) UCL	13.58
95% KM (jackknife) UCL	13.63
95% KM (bootstrap t) UCL	24.08
95% KM (BCA) UCL	14.19
95% KM (Percentile Bootstrap) UCL	13.98
95% KM (Chebyshev) UCL	22.74
97.5% KM (Chebyshev) UCL	29.11
99% KM (Chebyshev) UCL	41.61
Potential UCLs to Use	
97.5% KM (Chebyshev) UCL	29.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 117 was not processed!

118

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 118 was not processed!

119

General Statistics

Number of Valid Observations	91	Number of Distinct Observations	59

Raw Statistics		Log-transformed Statistics	
Minimum	3	Minimum of Log Data	1.099
Maximum	747	Maximum of Log Data	6.616
Mean	72.34	Mean of log Data	3.561
Geometric Mean	35.21	SD of log Data	1.15
Median	35		
SD	118.1		
Std. Error of Mean	12.38		
Coefficient of Variation	1.632		
Skewness	3.563		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.284	Lilliefors Test Statistic	0.0875
Lilliefors Critical Value	0.0929	Lilliefors Critical Value	0.0929
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	92.92	95% H-UCL	91.23
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	111.7
95% Adjusted-CLT UCL (Chen-1995)	97.64	97.5% Chebyshev (MVUE) UCL	130.9
95% Modified-t UCL (Johnson-1978)	93.69	99% Chebyshev (MVUE) UCL	168.5

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.802	Data appear Lognormal at 5% Significance Level	
Theta Star	90.23		
MLE of Mean	72.34		
MLE of Standard Deviation	80.79		
nu star	145.9		
Approximate Chi Square Value (.05)	119	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0474	95% CLT UCL	92.7
Adjusted Chi Square Value	118.6	95% Jackknife UCL	92.92
		95% Standard Bootstrap UCL	92.17
Anderson-Darling Test Statistic	3.373	95% Bootstrap-t UCL	101.8
Anderson-Darling 5% Critical Value	0.791	95% Hall's Bootstrap UCL	99.76
Kolmogorov-Smirnov Test Statistic	0.175	95% Percentile Bootstrap UCL	95.44
Kolmogorov-Smirnov 5% Critical Value	0.0972	95% BCA Bootstrap UCL	98.69
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	126.3
		97.5% Chebyshev(Mean, Sd) UCL	149.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	195.5
95% Approximate Gamma UCL (Use when n >= 40)	88.7		
95% Adjusted Gamma UCL (Use when n < 40)	88.99		

Potential UCL to Use	Use 95% H-UCL 91.23

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	69	Minimum of Log Data	4.234
Maximum	1300	Maximum of Log Data	7.17
Mean	481.3	Mean of log Data	5.706
Geometric Mean	300.6	SD of log Data	1.091
Median	280		
SD	474.1		
Std. Error of Mean	179.2		
Coefficient of Variation	0.985		
Skewness	1.114		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.844	Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	829.5	95% H-UCL	3177
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1362
95% Adjusted-CLT UCL (Chen-1995)	856.6	97.5% Chebyshev (MVUE) UCL	1741
95% Modified-t UCL (Johnson-1978)	842.1	99% Chebyshev (MVUE) UCL	2485

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.782	Data appear Normal at 5% Significance Level	
Theta Star	615.5		
MLE of Mean	481.3		
MLE of Standard Deviation	544.3		
nu star	10.95		
Approximate Chi Square Value (.05)	4.542	Nonparametric Statistics	
Adjusted Level of Significance	0.0158	95% CLT UCL	776
Adjusted Chi Square Value	3.382	95% Jackknife UCL	829.5
		95% Standard Bootstrap UCL	759.1
Anderson-Darling Test Statistic	0.268	95% Bootstrap-t UCL	1217
Anderson-Darling 5% Critical Value	0.725	95% Hall's Bootstrap UCL	2481
Kolmogorov-Smirnov Test Statistic	0.162	95% Percentile Bootstrap UCL	755.7
Kolmogorov-Smirnov 5% Critical Value	0.319	95% BCA Bootstrap UCL	817.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1262
		97.5% Chebyshev(Mean, Sd) UCL	1600
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2264
95% Approximate Gamma UCL (Use when n >= 40)	1160		
95% Adjusted Gamma UCL (Use when n < 40)	1558		
Potential UCL to Use		Use 95% Student's-t UCL	829.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.017	Minimum Detected	-4.075
Maximum Detected	220	Maximum Detected	5.394
Mean of Detected	90.92	Mean of Detected	2.545
SD of Detected	96.46	SD of Detected	3.717
Minimum Non-Detect	0.0018	Minimum Non-Detect	-6.32
Maximum Non-Detect	0.0018	Maximum Non-Detect	-6.32

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.842	Shapiro Wilk Test Statistic	0.808
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	77.93	Mean	1.18
SD	94.52	SD	4.957
95% DL/2 (t) UCL	147.4	95% H-Stat (DL/2) UCL	1.45E+20
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	69.65	Mean in Log Scale	1.355
SD	98.42	SD in Log Scale	4.629
95% MLE (t) UCL	141.9	Mean in Original Scale	77.93
95% MLE (Tiku) UCL	140.7	SD in Original Scale	94.52
		95% t UCL	147.4
		95% Percentile Bootstrap UCL	135.4
		95% BCA Bootstrap UCL	146
		95% H UCL	5.45E+17

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.283	Data appear Normal at 5% Significance Level	
Theta Star	321.5		
nu star	3.394		
A-D Test Statistic	0.481	**Nonparametric Statistics**	
5% A-D Critical Value	0.76	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.76	Mean	77.93
5% K-S Critical Value	0.355	SD	87.51
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	36.23
		95% KM (t) UCL	148.3
Assuming Gamma Distribution		95% KM (z) UCL	137.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	147.3
Minimum	0.017	95% KM (bootstrap t) UCL	227
Maximum	220	95% KM (BCA) UCL	142.6
Mean	78.73	95% KM (Percentile Bootstrap) UCL	141.7
Median	58	95% KM (Chebyshev) UCL	235.9
SD	93.78	97.5% KM (Chebyshev) UCL	304.2
k star	0.294	99% KM (Chebyshev) UCL	438.4
Theta star	268.1		
Nu star	4.111	Potential UCLs to Use	
AppChi2	0.766	95% KM (t) UCL	148.3
95% Gamma Approximate UCL (Use when n >= 40)	422.4	95% KM (Percentile Bootstrap) UCL	141.7
95% Adjusted Gamma UCL (Use when n < 40)	756.1		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Data	91	Number of Detected Data	89
Number of Distinct Detected Data	29	Number of Non-Detect Data	2
		Percent Non-Detects	2.20%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.03	Minimum Detected	-3.507
Maximum Detected	1.37	Maximum Detected	0.315
Mean of Detected	0.162	Mean of Detected	-2.287
SD of Detected	0.225	SD of Detected	0.839
Minimum Non-Detect	0.02	Minimum Non-Detect	-3.912
Maximum Non-Detect	0.05	Maximum Non-Detect	-2.996

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	14
Number treated as Detected	77
Single DL Non-Detect Percentage	15.38%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.323	Lilliefors Test Statistic	0.142
5% Lilliefors Critical Value	0.0939	5% Lilliefors Critical Value	0.0939
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.159	Mean	-2.328
SD	0.223	SD	0.877
95% DL/2 (t) UCL	0.197	95% H-Stat (DL/2) UCL	0.174
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.135	Mean in Log Scale	-2.324
SD	0.247	SD in Log Scale	0.871
95% MLE (t) UCL	0.178	Mean in Original Scale	0.159
95% MLE (Tiku) UCL	0.176	SD in Original Scale	0.223
		95% t UCL	0.197
		95% Percentile Bootstrap UCL	0.199
		95% BCA Bootstrap UCL	0.206
		95% H UCL	0.174

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	1.182
Theta Star	0.137
nu star	210.4
A-D Test Statistic	6.76
5% A-D Critical Value	0.778
K-S Test Statistic	0.778
5% K-S Critical Value	0.0971

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	1.37
Mean	0.158
Median	0.08
SD	0.223
k star	0.826
Theta star	0.191
Nu star	150.4
AppChi2	123
95% Gamma Approximate UCL (Use when n >= 40)	0.193
95% Adjusted Gamma UCL (Use when n < 40)	0.194

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.159
SD	0.222
SE of Mean	0.0234
95% KM (t) UCL	0.198
95% KM (z) UCL	0.197
95% KM (jackknife) UCL	0.198
95% KM (bootstrap t) UCL	0.209
95% KM (BCA) UCL	0.202
95% KM (Percentile Bootstrap) UCL	0.2
95% KM (Chebyshev) UCL	0.261
97.5% KM (Chebyshev) UCL	0.305
99% KM (Chebyshev) UCL	0.391

Potential UCLs to Use

95% KM (BCA) UCL	0.202

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

123

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 123 was not processed!

124

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 124 was not processed!

125

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 125 was not processed!

126

General Statistics

Number of Valid Data	92	Number of Detected Data	82
Number of Distinct Detected Data	72	Number of Non-Detect Data	10
		Percent Non-Detects	10.87%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0088	Minimum Detected	-4.733
Maximum Detected	63000	Maximum Detected	11.05
Mean of Detected	846.6	Mean of Detected	-1.059
SD of Detected	6960	SD of Detected	2.825
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.53	Maximum Non-Detect	-0.635

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	66
Number treated as Detected	26
Single DL Non-Detect Percentage	71.74%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.497	Lilliefors Test Statistic	0.161
5% Lilliefors Critical Value	0.0978	5% Lilliefors Critical Value	0.0978
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	754.6	Mean	-1.492
SD	6572	SD	2.976
95% DL/2 (t) UCL	1893	95% H-Stat (DL/2) UCL	81.63
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.645
		SD in Log Scale	3.183
		Mean in Original Scale	754.5
		SD in Original Scale	6572
		95% t UCL	1893
		95% Percentile Bootstrap UCL	2124
		95% BCA Bootstrap UCL	2898
		95% H-UCL	161.2

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.108
Theta Star	7840
nu star	17.71
A-D Test Statistic	21.09
5% A-D Critical Value	1
K-S Test Statistic	1
5% K-S Critical Value	0.113
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	63000
Mean	754.5
Median	0.135
SD	6572
k star	0.0949
Theta star	7950
Nu star	17.46
AppChi2	9.004
95% Gamma Approximate UCL (Use when n >= 40)	1463
95% Adjusted Gamma UCL (Use when n < 40)	1479

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data do not follow a Discernable Distribution (0.05)	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	754.5
SD	6536
SE of Mean	685.6
95% KM (t) UCL	1894
95% KM (z) UCL	1882
95% KM (jackknife) UCL	1893
95% KM (bootstrap t) UCL	22683
95% KM (BCA) UCL	2125
95% KM (Percentile Bootstrap) UCL	2124
95% KM (Chebyshev) UCL	3743
97.5% KM (Chebyshev) UCL	5036
99% KM (Chebyshev) UCL	7576
Potential UCLs to Use	
97.5% KM (Chebyshev) UCL	5036

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

127

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 127 was not processed!

128

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 128 was not processed!

129

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 129 was not processed!

130

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 130 was not processed!

131

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 131 was not processed!

General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.014	Minimum Detected	-4.269
Maximum Detected	91	Maximum Detected	4.511
Mean of Detected	38.85	Mean of Detected	1.929
SD of Detected	38.3	SD of Detected	3.433
Minimum Non-Detect	0.0018	Minimum Non-Detect	-6.32
Maximum Non-Detect	0.0018	Maximum Non-Detect	-6.32

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.892	Shapiro Wilk Test Statistic	0.8
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	33.3	Mean	0.651
SD	37.92	SD	4.609
95% DL/2 (t) UCL	61.15	95% H-Stat (DL/2) UCL	1.92E+17
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	30.04	Mean in Log Scale	0.839
SD	39.55	SD in Log Scale	4.26
95% MLE (t) UCL	59.1	Mean in Original Scale	33.3
95% MLE (Tiku) UCL	58.73	SD in Original Scale	37.92
		95% t UCL	61.15
		95% Percentile Bootstrap UCL	56.43
		95% BCA Bootstrap UCL	59.59
		95% H UCL	7.85E+14

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.303
Theta Star	128.4
nu star	3.631
A-D Test Statistic	0.491
5% A-D Critical Value	0.754
K-S Test Statistic	0.754
5% K-S Critical Value	0.353
Data appear Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.014
Maximum	91
Mean	33.72
Median	27
SD	37.51
k star	0.316
Theta star	106.7
Nu star	4.424
AppChi2	0.896
95% Gamma Approximate UCL (Use when n >= 40)	166.5
95% Adjusted Gamma UCL (Use when n < 40)	290.1

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data appear Normal at 5% Significance Level	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	33.3
SD	35.11
SE of Mean	14.54
95% KM (t) UCL	61.55
95% KM (z) UCL	57.21
95% KM (jackknife) UCL	61.12
95% KM (bootstrap t) UCL	80.39
95% KM (BCA) UCL	58.01
95% KM (Percentile Bootstrap) UCL	58.73
95% KM (Chebyshev) UCL	96.66
97.5% KM (Chebyshev) UCL	124.1
99% KM (Chebyshev) UCL	177.9
Potential UCLs to Use	
95% KM (t) UCL	61.55
95% KM (Percentile Bootstrap) UCL	58.73

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

133

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 133 was not processed!

General Statistics

Number of Valid Data	92	Number of Detected Data	90
Number of Distinct Detected Data	83	Number of Non-Detect Data	2
		Percent Non-Detects	2.17%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.01	Minimum Detected	-4.605
Maximum Detected	2900	Maximum Detected	7.972
Mean of Detected	60.06	Mean of Detected	-0.351
SD of Detected	347.6	SD of Detected	2.724
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	2
Number treated as Detected	90
Single DL Non-Detect Percentage	2.17%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.459	Lilliefors Test Statistic	0.0784
5% Lilliefors Critical Value	0.0934	5% Lilliefors Critical Value	0.0934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	58.75	Mean	-0.475
SD	343.9	SD	2.82
95% DL/2 (t) UCL	118.3	95% H-Stat (DL/2) UCL	124.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	53.15	Mean in Log Scale	-0.501
SD	346.3	SD in Log Scale	2.876
95% MLE (t) UCL	113.1	Mean in Original Scale	58.75
95% MLE (Tiku) UCL	105.9	SD in Original Scale	343.9
		95% t UCL	118.3
		95% Percentile Bootstrap UCL	123.8
		95% BCA Bootstrap UCL	154.2
		95% H UCL	149.6

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.171
Theta Star	350.2
nu star	30.87
A-D Test Statistic	12.01
5% A-D Critical Value	0.942
K-S Test Statistic	0.942
5% K-S Critical Value	0.106
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	2900
Mean	58.75
Median	0.575
SD	343.9
k star	0.163
Theta star	360
Nu star	30.03
AppChi2	18.52
95% Gamma Approximate UCL (Use when n >= 40)	95.28
95% Adjusted Gamma UCL (Use when n < 40)	96.03

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data appear Lognormal at 5% Significance Level	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	58.75
SD	342
SE of Mean	35.86
95% KM (t) UCL	118.3
95% KM (z) UCL	117.7
95% KM (jackknife) UCL	118.3
95% KM (bootstrap t) UCL	617.3
95% KM (BCA) UCL	122.6
95% KM (Percentile Bootstrap) UCL	123.5
95% KM (Chebyshev) UCL	215.1
97.5% KM (Chebyshev) UCL	282.7
99% KM (Chebyshev) UCL	415.5
Potential UCLs to Use	
97.5% KM (Chebyshev) UCL	282.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

135

General Statistics			
Number of Valid Data	7	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	6
		Percent Non-Detects	85.71%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 135 was not processed!

General Statistics

Number of Valid Data	92	Number of Detected Data	90
Number of Distinct Detected Data	78	Number of Non-Detect Data	2
		Percent Non-Detects	2.17%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.017	Minimum Detected	-4.075
Maximum Detected	1400	Maximum Detected	7.244
Mean of Detected	54.42	Mean of Detected	0.479
SD of Detected	224	SD of Detected	2.711
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	2
Number treated as Detected	90
Single DL Non-Detect Percentage	2.17%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.411	Lilliefors Test Statistic	0.0869
5% Lilliefors Critical Value	0.0934	5% Lilliefors Critical Value	0.0934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	53.24	Mean	0.337
SD	221.7	SD	2.846
95% DL/2 (t) UCL	91.65	95% H-Stat (DL/2) UCL	309.5
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	49.73	Mean in Log Scale	0.33
SD	223.4	SD in Log Scale	2.865
95% MLE (t) UCL	88.43	Mean in Original Scale	53.24
95% MLE (Tiku) UCL	83.87	SD in Original Scale	221.7
		95% t UCL	91.65
		95% Percentile Bootstrap UCL	95.26
		95% BCA Bootstrap UCL	115.8
		95% H UCL	329

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.208
Theta Star	261.1
nu star	37.52
A-D Test Statistic	7.678
5% A-D Critical Value	0.908
K-S Test Statistic	0.908
5% K-S Critical Value	0.104

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	1400
Mean	53.24
Median	1.09
SD	221.7
k star	0.195
Theta star	272.8
Nu star	35.91
AppChi2	23.19
95% Gamma Approximate UCL (Use when n >= 40)	82.42
95% Adjusted Gamma UCL (Use when n < 40)	83

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	53.24
SD	220.5
SE of Mean	23.12
95% KM (t) UCL	91.65
95% KM (z) UCL	91.26
95% KM (jackknife) UCL	91.65
95% KM (bootstrap t) UCL	140.9
95% KM (BCA) UCL	98.94
95% KM (Percentile Bootstrap) UCL	94.14
95% KM (Chebyshev) UCL	154
97.5% KM (Chebyshev) UCL	197.6
99% KM (Chebyshev) UCL	283.3

Potential UCLs to Use	
97.5% KM (Chebyshev) UCL	197.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

137

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 137 was not processed!

138

General Statistics

Number of Valid Data	91	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	90
		Percent Non-Detects	98.90%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 138 was not processed!

General Statistics

Number of Valid Data	91	Number of Detected Data	4
Number of Distinct Detected Data	3	Number of Non-Detect Data	87
		Percent Non-Detects	95.60%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.2	Minimum Detected	-1.609
Maximum Detected	0.4	Maximum Detected	-0.916
Mean of Detected	0.3	Mean of Detected	-1.233
SD of Detected	0.0816	SD of Detected	0.285
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	1	Maximum Non-Detect	0

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	91
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.944	Shapiro Wilk Test Statistic	0.931
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.132	Mean	-2.133
SD	0.0815	SD	0.402
95% DL/2 (t) UCL	0.146	95% H-Stat (DL/2) UCL	0.139
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.818
		SD in Log Scale	0.716
		Mean in Original Scale	0.0774
		SD in Original Scale	0.0645
		95% t UCL	0.0886
		95% Percentile Bootstrap UCL	0.0899
		95% BCA Bootstrap UCL	0.0911
		95% H-UCL	0.09

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	4.453
Theta Star	0.0674
nu star	35.62
A-D Test Statistic	0.341
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.394

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.4
Mean	0.0147
Median	0.000001
SD	0.0643
k star	0.0973
Theta star	0.151
Nu star	17.72
AppChi2	9.186
95% Gamma Approximate UCL (Use when n >= 40)	0.0284
95% Adjusted Gamma UCL (Use when n < 40)	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.205
SD	0.0264
SE of Mean	0.00334
95% KM (t) UCL	0.21
95% KM (z) UCL	0.21
95% KM (jackknife) UCL	0.268
95% KM (bootstrap t) UCL	0.209
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	0.304
95% KM (Chebyshev) UCL	0.219
97.5% KM (Chebyshev) UCL	0.226
99% KM (Chebyshev) UCL	0.238

Potential UCLs to Use

95% KM (t) UCL	0.21
95% KM (Percentile Bootstrap) UCL	0.304

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

140

General Statistics

Number of Valid Data	7	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	6
		Percent Non-Detects	85.71%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 140 was not processed!

141

General Statistics

Number of Valid Data	104	Number of Detected Data	102
Number of Distinct Detected Data	102	Number of Non-Detect Data	2
		Percent Non-Detects	1.92%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000313	Minimum Detected	-8.069
Maximum Detected	1016	Maximum Detected	6.924
Mean of Detected	27.86	Mean of Detected	-0.1
SD of Detected	117	SD of Detected	2.85
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	5
Number treated as Detected	99
Single DL Non-Detect Percentage	4.81%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.406	Lilliefors Test Statistic	0.0706
5% Lilliefors Critical Value	0.0877	5% Lilliefors Critical Value	0.0877
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	27.33	Mean	-0.214
SD	115.9	SD	2.939
95% DL/2 (t) UCL	46.19	95% H-Stat (DL/2) UCL	223.4
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	23.16	Mean in Log Scale	-0.217
SD	118.7	SD in Log Scale	2.945
95% MLE (t) UCL	42.48	Mean in Original Scale	27.33
95% MLE (Tiku) UCL	40.41	SD in Original Scale	115.9
		95% t UCL	46.19
		95% Percentile Bootstrap UCL	48.17
		95% BCA Bootstrap UCL	61.53
		95% H UCL	227.8

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.213
Theta Star	130.8
nu star	43.44
A-D Test Statistic	7.016
5% A-D Critical Value	0.907
K-S Test Statistic	0.907
5% K-S Critical Value	0.0983
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	1016
Mean	27.33
Median	0.597
SD	115.9
k star	0.201
Theta star	135.9
Nu star	41.81
AppChi2	27.99
95% Gamma Approximate UCL (Use when n >= 40)	40.82
95% Adjusted Gamma UCL (Use when n < 40)	41.05

Data Distribution Test with Detected Values Only	
Data appear Lognormal at 5% Significance Level	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	27.33
SD	115.3
SE of Mean	11.36
95% KM (t) UCL	46.19
95% KM (z) UCL	46.02
95% KM (jackknife) UCL	46.19
95% KM (bootstrap t) UCL	84.32
95% KM (BCA) UCL	50.89
95% KM (Percentile Bootstrap) UCL	47.99
95% KM (Chebyshev) UCL	76.86
97.5% KM (Chebyshev) UCL	98.3
99% KM (Chebyshev) UCL	140.4
Potential UCLs to Use	
97.5% KM (Chebyshev) UCL	98.3

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

142

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 142 was not processed!

143

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 143 was not processed!

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7

Raw Statistics		Log-transformed Statistics	
Minimum	0.0047	Minimum of Log Data	-5.36
Maximum	220	Maximum of Log Data	5.394
Mean	58.19	Mean of log Data	1.136
Geometric Mean	3.115	SD of log Data	4.289
Median	39		
SD	78.71		
Std. Error of Mean	29.75		
Coefficient of Variation	1.353		
Skewness	1.746		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.778	Shapiro Wilk Test Statistic	0.857
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	116	95% H-UCL	1.66E+15
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2404
95% Adjusted-CLT UCL (Chen-1995)	128.1	97.5% Chebyshev (MVUE) UCL	3244
95% Modified-t UCL (Johnson-1978)	119.3	99% Chebyshev (MVUE) UCL	4896

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.234	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	248.2		
MLE of Mean	58.19		
MLE of Standard Deviation	120.2		
nu star	3.282		
Approximate Chi Square Value (.05)	0.461	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0158	95% CLT UCL	107.1
Adjusted Chi Square Value	0.24	95% Jackknife UCL	116
		95% Standard Bootstrap UCL	103
Anderson-Darling Test Statistic	0.503	95% Bootstrap-t UCL	169.3
Anderson-Darling 5% Critical Value	0.805	95% Hall's Bootstrap UCL	291.3
Kolmogorov-Smirnov Test Statistic	0.258	95% Percentile Bootstrap UCL	110.3
Kolmogorov-Smirnov 5% Critical Value	0.339	95% BCA Bootstrap UCL	121
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	187.9
		97.5% Chebyshev(Mean, Sd) UCL	244
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	354.2
95% Approximate Gamma UCL (Use when n >= 40)	414.5		
95% Adjusted Gamma UCL (Use when n < 40)	795.1		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	795.1

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	104	Number of Detected Data	101
Number of Distinct Detected Data	84	Number of Non-Detect Data	3
		Percent Non-Detects	2.88%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0028	Minimum Detected	-5.878
Maximum Detected	930	Maximum Detected	6.835
Mean of Detected	22.86	Mean of Detected	0.00679
SD of Detected	99.51	SD of Detected	2.616
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	4
Number treated as Detected	100
Single DL Non-Detect Percentage	3.85%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.409	Lilliefors Test Statistic	0.0877
5% Lilliefors Critical Value	0.0882	5% Lilliefors Critical Value	0.0882
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	22.2	Mean	-0.167
SD	98.13	SD	2.771
95% DL/2 (t) UCL	38.17	95% H-Stat (DL/2) UCL	126.4
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	19.39	Mean in Log Scale	-0.17
SD	99.91	SD in Log Scale	2.776
95% MLE (t) UCL	35.65	Mean in Original Scale	22.2
95% MLE (Tiku) UCL	33.84	SD in Original Scale	98.13
		95% t UCL	38.17
		95% Percentile Bootstrap UCL	40.74
		95% BCA Bootstrap UCL	56.35
		95% H UCL	128.4

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.23
Theta Star	99.27
nu star	46.51
A-D Test Statistic	6.94
5% A-D Critical Value	0.899
K-S Test Statistic	0.899
5% K-S Critical Value	0.0982

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	930
Mean	22.2
Median	0.62
SD	98.13
k star	0.21
Theta star	105.9
Nu star	43.6
AppChi2	29.46
95% Gamma Approximate UCL (Use when n >= 40)	32.85
95% Adjusted Gamma UCL (Use when n < 40)	33.03

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	22.2
SD	97.66
SE of Mean	9.624
95% KM (t) UCL	38.17
95% KM (z) UCL	38.03
95% KM (jackknife) UCL	38.17
95% KM (bootstrap t) UCL	70.37
95% KM (BCA) UCL	40.33
95% KM (Percentile Bootstrap) UCL	39.77
95% KM (Chebyshev) UCL	64.14
97.5% KM (Chebyshev) UCL	82.3
99% KM (Chebyshev) UCL	117.9

Potential UCLs to Use

97.5% KM (Chebyshev) UCL	82.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General Statistics

Number of Valid Data	7	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	1
		Percent Non-Detects	14.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.031	Minimum Detected	-3.474
Maximum Detected	311	Maximum Detected	5.74
Mean of Detected	129.8	Mean of Detected	2.986
SD of Detected	134.6	SD of Detected	3.612
Minimum Non-Detect	0.0018	Minimum Non-Detect	-6.32
Maximum Non-Detect	0.0018	Maximum Non-Detect	-6.32

Warning: There are only 6 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.858	Shapiro Wilk Test Statistic	0.806
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	111.2	Mean	1.558
SD	132.3	SD	5.015
95% DL/2 (t) UCL	208.4	95% H-Stat (DL/2) UCL	6.21E+20
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	99.71	Mean in Log Scale	1.832
SD	137.8	SD in Log Scale	4.494
95% MLE (t) UCL	201	Mean in Original Scale	111.2
95% MLE (Tiku) UCL	199.3	SD in Original Scale	132.3
		95% t UCL	208.4
		95% Percentile Bootstrap UCL	190.3
		95% BCA Bootstrap UCL	199.7
		95% H UCL	9.02E+16

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.289
Theta Star	448.4
nu star	3.473
A-D Test Statistic	0.481
5% A-D Critical Value	0.758
K-S Test Statistic	0.758
5% K-S Critical Value	0.354
Data appear Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.031
Maximum	311
Mean	112.4
Median	85
SD	131.2
k star	0.301
Theta star	373.8
Nu star	4.209
AppChi2	0.806
95% Gamma Approximate UCL (Use when n >= 40)	586.9
95% Adjusted Gamma UCL (Use when n < 40)	1042

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data appear Normal at 5% Significance Level	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	111.2
SD	122.5
SE of Mean	50.72
95% KM (t) UCL	209.8
95% KM (z) UCL	194.7
95% KM (jackknife) UCL	208.3
95% KM (bootstrap t) UCL	290.4
95% KM (BCA) UCL	204.8
95% KM (Percentile Bootstrap) UCL	192.6
95% KM (Chebyshev) UCL	332.3
97.5% KM (Chebyshev) UCL	428
99% KM (Chebyshev) UCL	615.8
Potential UCLs to Use	
95% KM (t) UCL	209.8
95% KM (Percentile Bootstrap) UCL	192.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

147

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 147 was not processed!

148

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 148 was not processed!

149

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 149 was not processed!

150

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 150 was not processed!

151

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 151 was not processed!

152

General Statistics			
Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 152 was not processed!

153

General Statistics

Number of Valid Data	7	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	7
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 153 was not processed!

General Statistics

Number of Valid Data	13	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	8
		Percent Non-Detects	61.54%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.14	Minimum Detected	-1.966
Maximum Detected	7.6	Maximum Detected	2.028
Mean of Detected	2.258	Mean of Detected	-0.254
SD of Detected	3.182	SD of Detected	1.757
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.14	Maximum Non-Detect	-1.966

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	8
Number treated as Detected	5
Single DL Non-Detect Percentage	61.54%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.773	Shapiro Wilk Test Statistic	0.906
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.905	Mean	-1.838
SD	2.148	SD	1.654
95% DL/2 (t) UCL	1.967	95% H-Stat (DL/2) UCL	4.347
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.973
		SD in Log Scale	3.358
		Mean in Original Scale	0.87
		SD in Original Scale	2.163
		95% t UCL	1.94
		95% Percentile Bootstrap UCL	1.982
		95% BCA Bootstrap UCL	2.568
		95% H-UCL	9483

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	0.366
Theta Star	6.173
nu star	3.658
A-D Test Statistic	0.373
5% A-D Critical Value	0.707
K-S Test Statistic	0.707
5% K-S Critical Value	0.37

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	7.6
Mean	0.868
Median	0.000001
SD	2.164
k star	0.125
Theta star	6.922
Nu star	3.262
AppChi2	0.454
95% Gamma Approximate UCL (Use when n >= 40)	6.238
95% Adjusted Gamma UCL (Use when n < 40)	8.424

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.955
SD	2.044
SE of Mean	0.634
95% KM (t) UCL	2.084
95% KM (z) UCL	1.997
95% KM (jackknife) UCL	1.997
95% KM (bootstrap t) UCL	10.37
95% KM (BCA) UCL	2.482
95% KM (Percentile Bootstrap) UCL	2.308
95% KM (Chebyshev) UCL	3.717
97.5% KM (Chebyshev) UCL	4.912
99% KM (Chebyshev) UCL	7.26

Potential UCLs to Use

95% KM (t) UCL	2.084
95% KM (Percentile Bootstrap) UCL	2.308

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	91	Number of Detected Data	90
Number of Distinct Detected Data	56	Number of Non-Detect Data	1
		Percent Non-Detects	1.10%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	33	Minimum Detected	3.497
Maximum Detected	430	Maximum Detected	6.064
Mean of Detected	90.97	Mean of Detected	4.389
SD of Detected	58.67	SD of Detected	0.453
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	4	Maximum Non-Detect	1.386

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.242	Lilliefors Test Statistic	0.145
5% Lilliefors Critical Value	0.0934	5% Lilliefors Critical Value	0.0934
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	89.99	Mean	4.348
SD	59.09	SD	0.594
95% DL/2 (t) UCL	100.3	95% H-Stat (DL/2) UCL	104
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	89.72	Mean in Log Scale	4.376
SD	59.27	SD in Log Scale	0.468
95% MLE (t) UCL	100	Mean in Original Scale	90.23
95% MLE (Tiku) UCL	99.78	SD in Original Scale	58.76
		95% t UCL	100.5
		95% Percentile Bootstrap UCL	100.3
		95% BCA Bootstrap UCL	103.4
		95% H UCL	97.06

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	4.134
Theta Star	22.01
nu star	744.1
A-D Test Statistic	3.4
5% A-D Critical Value	0.755
K-S Test Statistic	0.755
5% K-S Critical Value	0.0945
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	430
Mean	89.97
Median	77
SD	59.12
k star	1.707
Theta star	52.7
Nu star	310.7
AppChi2	270.8
95% Gamma Approximate UCL (Use when n >= 40)	103.2
95% Adjusted Gamma UCL (Use when n < 40)	103.4

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only	
Data do not follow a Discernable Distribution (0.05)	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	90.33
SD	58.34
SE of Mean	6.15
95% KM (t) UCL	100.6
95% KM (z) UCL	100.4
95% KM (jackknife) UCL	100.5
95% KM (bootstrap t) UCL	105
95% KM (BCA) UCL	101.4
95% KM (Percentile Bootstrap) UCL	100.9
95% KM (Chebyshev) UCL	117.1
97.5% KM (Chebyshev) UCL	128.7
99% KM (Chebyshev) UCL	151.5
Potential UCLs to Use	
95% KM (BCA) UCL	101.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

ATTACHMENT C-3

Supplemental Screening for Identification of COPECs

Attachment C-3: Supplemental Screening for Identification of COPECs

1.0 Introduction

A preliminary screening to identify COPECs is presented in Section 4.1.1 of the TEE (Appendix C). A total of 38 constituents were identified as candidate COPECs. Additional information is presented in this supplemental screen to refine the COPEC list to those constituents of primary concern.

2.0 Metals

Four metals were identified as candidate COPECs in Section 4.1.1: barium, lead, mercury, and zinc. A more detailed comparison of Site concentrations to natural background was conducted for these four metals.

These metals are naturally occurring in soils and rock, but are also present in a number of manufactured products. Natural background data for lead, mercury and zinc was obtained from the dataset used to develop natural background soil metals concentrations for Washington State (Washington State Department of Ecology [Ecology] 1994). Natural background data from the Puget Sound region was deemed most suitable for comparison to Site data. Ecology (1994) did not provide natural background data for barium. So natural background data was obtained from the dataset generated by the U.S. Geological Survey for the United States (Shacklette and Boerngen 1984), but only data from Washington State was included in this evaluation. For barium, the evaluation uses the background value reported by Ecology for Washington State (Ecology 1994).

Background comparisons were made to test the hypothesis that the mean/median concentrations of metals were less than or equal to the mean/median concentrations in samples from natural background areas. The software and statistical methods recommended in EPA's ProUCL statistical software package were used to make the background comparisons[1]. Nonparametric hypothesis testing methods were used for making the background comparisons. Nonparametric methods were selected because:

- They can be used on data sets with normal and non-normal distributions.
- They have good performance for a wide variety of data distributions.
- They are not unduly affected by outlier observations.
- They can handle data sets with nondetect values.

Following EPA's ProUCL recommendations, the nonparametric Wilcoxon-Mann-Whitney (WMW) test was used when less than 40 percent of the samples from either the Site or background data sets contained non-detect values[2].

[1] ProUCL version 4.1.00 was used and is available online at http://www.epa.gov/osp/hstl/tsc/software.htm.

[2] Although ProUCL recommends the Quantile test be run in parallel with the Wilcoxon-Mann-Whitney test, the Quantile test is only used to detect a shift to the right in the right tails of the site and background data sets. Since the Quantile test has several statistical limitations that may apply to SSSMGP site data sets, it was not used in the background comparisons.

Results of the background comparisons along including summary statistics for the Site and background datasets is shown in Table 1. Results show that the Site data are equal to or below background for barium, but that the Site is above background for lead, mercury, and zinc. Therefore, barium is not identified as COPEC.

3.0 Cyanide

The gas produced at manufactured gas plants contained Prussic acid (HCN) which was removed by precipitation onto iron oxides (Trapp and Christiansen 2003). The resulting residue contained high concentrations of cyanide typically in the form of iron complexes, such as Prussian blue ($Fe_4[Fe(CN)_6]_3$). Free cyanide (HCN or CN-) was rarely present (Trapp and Christiansen 2003). These residues were potentially released to the soil around the former MGP facility at the Site.

Natural sources of cyanide include various species of bacteria, algae, fungi, and higher plants (Eisler 1991). Cyanide is produced in thousands of species of plants. A major threat to livestock and terrestrial mammals is through the ingestion of plants containing high levels of cyanogenic glycosides (Eisler 1991).

The fate of cyanide in soil is dependent upon concentration, pH, temperature, metal content, concentration of microbes, availability of nutrients, and acclimation of microbes (ATSDR 2006). Cyanide may occur in a variety of forms in soil including hydrogen cyanide, alkali metal salts, or as immobile metallocyanide complexes. Cyanide present at low concentrations will readily biodegrade under both aerobic and anaerobic soil conditions (ATSDR 2006). Cyanide has low biological availability in soils because it is either complexed by trace metals, metabolized by various microorganisms, or lost through volatilization (Eisler 1991). Soils at MGP sites contain probably some bioavailable cyanide, but most cyanide is complexed and far less toxic to plants and animals (Trapp and Christiansen 2003). Cyanide is highly reactive and readily metabolized in organisms demonstrating low bioaccumulation potential (Eisler 1991). Plants have evolved a number of strategies to detoxify cyanide (Trapp and Christiansen 2003). Trapp and Christiansen (2003) showed that trees can be successfully used to phytoremediate soils at an MGP site with total cyanide concentrations ranging from 41.8 to 452.4 mg/kg. Also, wildlife can detoxify sublethal doses of cyanide and excrete it as thiocyanate in urine (Eisler 1991).

Two types of cyanide analysis were performed on soil sample from the Site: total cyanide and weak acid dissociable (WAD) cyanide. The total cyanide or strong acid dissociable analysis used a strong acid and high heat extraction process that measures free cyanide, simple cyanides, and complex metal cyanides. The WAD analysis uses a weak acid extraction process that measures free cyanide, simple cyanides, and metallocyanides. Results of WAD cyanide analysis provide an estimate of the bioavailable fraction of cyanide. Trapp and Christiansen (2003) found that between 2.6 and 9.6 percent of the total cyanide present in soils at a MGP site was measures as WAD cyanide.

A total of 13 soil samples from within the conditional POC were analyzed for cyanide. Nine samples are located in the upper portion of the Site and four are located in the lower portion of the Site. Table 2 presents a summary of the cyanide results.

The fraction of total cyanide measured as WAD cyanide varied between 6.5 and 11.9 percent[3] which agrees well with the results from Trapp and Christiansen (2003).

Since plants naturally produce cyanogenic compounds and have evolved mechanisms of detoxification, it is unlikely that cyanide would present a hazard to plants at the Site. This is supported by the observation that apparently healthy vegetation is observed across the Site. No information was found to evaluate hazards of cyanide to soil biota. Sample et al. (1996) derived cyanide concentrations in food protective of a variety of mammalian wildlife species. These no-observed-adverse-effects-level (NOAEL) based concentrations ranged from 236.5 to 954.2 mg/kg. Since cyanide is not considered to be bioaccumulative, a comparison of the maximum detected soil concentration of total cyanide to the lowest protective concentration in mammalian food provides a conservative screen of hazards to mammals. This approach assumes that soil is the sole food source. Since the maximum detected soil concentration of total cyanide at the Site (76.4 mg/kg) is well below the minimum protective food concentration (236.5 mg/kg), it can be safely concluded that cyanide does not pose a hazard to mammalian wildlife. No toxicity data were available for avian wildlife.

Based on the preceding information, cyanide does not bioaccumulate and is unlikely to pose an ecological hazard. Additionally, the remedial investigation uses a very low screening level (1.01 mg/kg) to evaluate cyanide in the unsaturated zone, which is well below even the lowest screening level recommended by Ecology for this evaluation (5 mg/kg). Therefore, cyanide is not identified as a COPEC and the cleanup will mitigate cyanide to a lower level than would be achieved otherwise for protection of terrestrial species.

4.0 Volatile Organic Compounds

Six volatile organic compounds (VOCs) were identified as candidate COPECs in Section 4.1.1 including acetone, ethylbenzene, m,p-xylene, o-xylene, total xylenes, and toluene. All six VOCs were detected at a frequency of greater than 5 percent, but only toluene had an ecological indicator soil concentration (EISC). The EISC for toluene is 200 mg/kg which is based on the protection of plants and the soil EPC for toluene is 220 mg/kg.

VOC analysis was limited to seven soil samples collected from the 0 to 6-foot strata in the upper portion of the Site. The sample depth for these seven samples ranged from 2.5 to 6.5 feet. Table C-1 of Appendix C shows that acetone was detected in 2 of 7 samples, ethylbenzene and xylenes were detected in 6 of 7 samples, and toluene was detected in all 7 samples. Although the maximum detected concentration of acetone was relatively low (0.066 mg/kg), the maximum detected concentrations of the other six VOCs were relatively high ranging from 91 to 311 mg/kg.

Ethylbenzene, toluene, and xylenes are associated with coal tar[4], but are also found in gasoline and many solvents.

[3] This is based on samples with detections of both total and WAD cyanide and excludes one sample with detections at or slightly above the detection limit.
[4] See http://www.epa.gov/reg3hwmd/bf-lr/regional/industry/manufactured.htm.

Acetone, ethylbenzene, toluene, and xylenes are weakly to moderately bound to soil (ATSDR 1994, 2000, 2007, 2010). Significant transport mechanisms in soil include volatilization and leaching. In addition, biodegradation of these VOCs is significant in soil. The six VOCs have log K_{ow} values less than 3.5 (see Table 3) indicating that they have a low potential to bioaccumulate.

Very little information is available concerning the hazards of the VOCs to plants and soil biota probably because of the limited ability of these constituents to persist in soil and bioaccumulate. The single available MTCA EISC is for toluene is based on a plant value reported by Efroymson et al. (1997a). This study reported a reduced growth rate in corn and soybeans at a toluene soil concentration of 200 mg/kg. The authors rated confidence in the value as low because it was based on a limited published data. A second study cited by Efroymson et al. (1997a) reported an effects concentration that caused a 50 percent reduction in the growth of lettuce of greater than 1,000 mg/kg. Toluene is not actively taken up by plants and is known to be oxidatively detoxified by plants (Efroymson et. al. 1997a).

There were no overt signs of phytotoxicity or stress to soil biota observed during the Site ecological survey or during several Site visits. This could indicate the VOCs are not toxic to these receptors or possibly that plant roots and soil biota do not come into contact with the VOCs because they primarily occupy the upper 1 to 2 feet of the soil horizon where concentrations of VOCs are expected to be low due to volatilization and biodegradation.

Acetone and toluene are common laboratory contaminants (EPA 1991) which may lead to false positive results. Acetone concentrations in Site soils were relatively low and may be associated with laboratory contamination.

In addition, very little information is available concerning the hazards of the VOCs to terrestrial wildlife. VOCs present in soil are generally not considered to pose a potential hazard to mammalian and avian species because of their relatively low potential to bioaccumulate and persist in soil. Nonetheless, the wildlife exposure models described in Section 4.2 of Appendix C were used to estimate provisional wildlife soil screening levels (SSLs) for acetone, ethylbenzene, toluene, and xylenes. The models consist of exposure parameters for three indicator wildlife species (i.e., shrew, vole, and robin), chemical-specific bioaccumulation factors, and chemical- and species-specific toxicity reference values (TRVs). Wildlife exposure parameter values are described in Section 4.2.4 of Appendix C and bioaccumulation factors were estimated using methodologies described in MTCA (see MTCA Table 749-5). Since avian toxicity data for the 4 VOCs is very limited or non-existent, exposure models for the shrew and vole were used to evaluate potential impacts to wildlife.

Wildlife toxicity values are typically based on toxicological endpoints of ecological relevance that potentially manifest themselves by decreasing individual and/or population fitness. Acceptable toxicity endpoints for wildlife toxicity values include growth, reproduction, and survival. MTCA stipulates toxicity values be based on the lowest observed adverse effect level (LOAEL) from a toxicological study or group of studies [WAC 173-340-7493(4)(a)]. Toxicological studies evaluating relevant ecological endpoints on wildlife species are limited for the 4 VOCs of interest. Therefore, this evaluation utilizes toxicity data from U.S. EPA's Integrated Risk Information System (IRIS)[5] as a source of mammalian toxicity values.

IRIS provides protective oral reference doses (RfDs) for use in human health risk assessments that include summaries of the toxicological studies on which the RfD was based. These studies are typically conducted in the laboratory on rats and mice, but occasionally are based on epidemiological studies in occupational settings. Endpoints for the RfD toxicological studies do not typically include growth, reproduction, or survival, but usually include more sensitive endpoints such as increased organ weight, altered blood chemistry, and histopathological effects on specific organs. The ecological relevance for some of the RfD toxicity endpoints is unclear. For example, a rat's liver weight might increase in response to chemical exposure, but the impact of increased liver weight on growth, reproduction, or survival to animal in the wild is uncertain. In general, health protective RfD toxicity endpoints are considered protective of mammalian wildlife. The LOAEL from the primary RfD toxicological study was preferentially selected as the mammalian toxicity value for the 4 VOCs.

Table 3 presents the results of the quantitative evaluation of the potential ecological hazards posed by acetone, ethylbenzene, toluene, and xylene to wildlife. Provisional SSLs for the shrew (insectivorous mammal) and vole (herbivorous mammal) where calculated to evaluate the major routes of wildlife (mammalian) exposure to soil-borne chemicals. A comparison of the provisional SSLs to the soil EPCs at the Site shows the ISCs are 26 to 32,432 times greater. These results indicate that acetone, ethylbenzene, toluene, and xylenes do not pose a hazard to wildlife at the Site.

Additionally, the remedial investigation currently evaluates these VOCs using concentrations developed to be protective of the vapor intrusion pathway, which are lower and more-protective than the lowest values recommended by Ecology for this evaluation. For example, the remedial investigation uses 4.5 mg/kg for ethylbenzene (lower than Ecology's recommended value of 5.16 mg/kg for protection of the masked shrew) and 3.8 mg/kg for toluene (lower than Ecology's recommended value of 5.45 mg/kg). Based on the preceding evaluation and the lower, more restrictive values that will be used in order to protect indoor air from vapor intrusion, acetone, ethylbenzene, toluene, and xylenes were not identified as COPECs for this evaluation.

5.0 Semi-volatile Organic Compounds

Six non-PAH semi-volatile organic compounds (SVOCs) were detected in soil sample within the conditional point compliance (0-6 feet) at the Site. These SVOCs included 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and phenol. All seven of the samples analyzed for these constituents were collected from the upper portion of the Site from a depth ranging from 2.5-3.5 feet to 5.0-6.5 feet. The four phenolic compounds were detected in 1 of 7 samples at maximum concentrations ranging from 81 to 270 mg/kg (Table C-1 of Appendix C). However, 1,2,4-trimethybenzen was detected in 5 of 7 samples at a maximum concentration of 120 mg/kg and 1,3,5-trimethylbeneze was detected in 3 of 7 samples at a maximum concentration of 52 mg/kg.

[5] Available online at http://www.epa.gov/iris/search_keyword.htm.

1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and phenol are associated with coal tar and hence with MGP sites. However, the methylbenzenes are also associated with gasoline and the phenols are naturally occurring in plants and are breakdown products of wood degradation[6].

Both 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene have relatively low mobility in soil, can volatilize from soil, and are subject to biodegradation[7]. Since the log K_{ow} values of these two compounds are less than 4 (Table 4), they are not expected to bioaccumulate.

The four phenolic compounds have moderate to high mobility in soil, are able to volatilize from soil, and are readily biodegraded (ATSDR 2008a,b). Since the log K_{ow} values of these four compounds are less than 4 (Table 4), they are not expected to bioaccumulate.

No MTCA EISCs are available concerning the ecological hazards of 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2,4-dimethylphenol, 2-methylphenol, and 4-methylphenol to plants and soil biota probably because of the limited ability of these constituents to persist in soil and bioaccumulate. An internet search for toxicity information on these five SVOCs also failed to identify any suitable toxicity data. However, there were no overt signs of phytotoxicity or stress to soil biota observed during the site survey or during several site visits. This could indicate the SVOCs are not toxic to these receptors or possibly that plant roots and soil biota do not come into contact with the SVOCs because they primarily occupy the upper 1 to 2 feet of the soil horizon where concentrations of SVOCs are expected to be low due to volatilization and biodegradation.

The plant and soil biota EISCs for phenol were obtained from Efroymson et al. (1997a and 1997b). These reports rate confidence in both values as low because of a small number of published reports characterizing their potential toxicity. These types of plant and soil biota toxicity studies are typically conducted in the laboratory where soils are treated with the constituent and then the test subjects are exposed to the treated soil for a period time to evaluate their responses. Constituents present in soils at the Site have been there many years since park development and have been the subject of aging and degradation that have further altered their bioavailability and toxicity (Alexander 2000). Phenol is soluble in water and is expected to readily leach from soil (ATSDR 2008c). Phenol biodegrades rapidly in soil under both aerobic and anaerobic soil conditions with a half-life of generally less than 5 days. Since phenol is soluble in water, the potential for bioaccumulation is low (ATSDR 2008c). Although plants readily uptake phenol, they are capable of metabolizing phenol such that it does not accumulate in plant tissues. Given the fact that there were no overt signs of phytotoxicity or stress to soil biota observed during the site survey or during several site visits, it seems unlikely phenol present in the soil would pose a hazard to these receptors.

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[6] Information obtained from the Hazardous Substance Database available online at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB and http://www.epa.gov/reg3hwmd/bf-lr/regional/industry/manufactured.htm.
[7] Information obtained from the Hazardous Substance Database available online at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB.

In addition, very little information is available concerning the hazards of the six SVOCs to terrestrial wildlife. A conservative screening of potential hazards of these six SVOCs to wildlife was performed using the methodology described in Section 4.0 of Appendix C. Results of this evaluation are shown in Table 4. Mammalian toxicity reference values were not available for 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, or 4-methylphenol, so potential wildlife hazards could not be assessed. However, a comparison of the provisional SSLs to the soil EPCs at the Site for 2,4-dimethylphenol, 2-methylphenol, and phenol shows the ISCs are 1 to 19 times greater.

Additionally, for phenol, Ecology requested that this evaluation include a comparison of the Site data to a screening level developed for protection of the masked shrew (120 mg/kg). There was only one detection of phenol in Site soil, which was 0.25 mg/kg, well below the protective concentration.

Results of this evaluation suggest these SVOCs do not pose a hazard to wildlife, and 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and phenol were not identified as COPECs.

6.0 Petroleum Products

Three petroleum products were detected in Site soils: diesel range organics (DRO), gasoline range organics (GRO), and lube oil. The seven soil samples that were analyzed for petroleum products are all located in the upper portion of the Site and were collected from depths ranged from 2.5 - 3.5 feet to 5.0 – 6.5 feet. Table C-1 in Appendix C shows that GRO was detected in 6 of 7 samples, while DRO and lube oil were detected in 7 of 7 samples. Detected concentrations ranged from 41 to 1,200 mg/kg for DRO, 28 to 15,000 mg/kg for GRO, and 69 to 1,300 mg/kg for lube oil. Table C-1 also shows that the EPCs for DRO (783 mg/kg) and GRO (10,857 mg/kg) were above the EISCs for soil biota, and the EPC for GRO was also above the wildlife EISC. No EISCs are available for lube oil.

The risk-based EISCs for DRO and GRO are based on exposing biota to fresh product. The petroleum products detected in upper area soils are either associated with fill brought to the Site during Boulevard Park development around 1980 or are associated with historical MGP operations which ceased in the late 1940s. As petroleum products weather and age in soil, many of the more toxic components (e.g., benzene in GRO) are lost to evaporation and degradation processes, and the residual constituents become more strongly bound to the soil making them less bioavailable and toxic (Alexander 2000).

GRO, DRO, and lube oil are comprised of complex mixtures of petroleum hydrocarbons that can be grouped into two fractions: aliphatic hydrocarbons and aromatic hydrocarbons. The aliphatic fraction is comprised of straight-chained and branched alkanes, cycloalkanes, and alkenes. The aromatic fraction includes monocyclic aromatic hydrocarbons (e.g., benzene, ethylbenzene, toluene, and xylene) and polycyclic aromatic hydrocarbons (PAHs) (e.g., anthracene, benzo(a)pyrene, fluorene, and pyrene). The aromatic fraction is the more toxic fraction and the aromatic fraction is addressed as individual compounds in this TEE.

The aliphatic fraction of petroleum products in soil are subject to volatilization, leaching, and biodegradation (ATSDR 1999). In general, the lower the carbon number, the more volatile and soluble the compound. In addition, the organic carbon-water partition coefficient generally increases with carbon number such that the compound becomes more strongly bound to the organic carbon in the soil. For example, aliphatic compounds 5 and 6 carbons are readily removed from soil through volatilization and leaching, while aliphatic compounds with 16 to 35 carbon atoms are strongly bound to the organic carbon in the soil. Aliphatic compounds are subject to biodegradation by soil microbes (ATSDR 1999). In general, straight chain aliphatic compounds are degraded more rapidly than highly branched aliphatic compounds. Also, aliphatic compounds with lower carbon numbers (6 to 8) are readily degraded, while aliphatic compounds with more than 22 carbon atoms are not available to degrading microbes.

Since the more toxic components of DRO, GRO, and lube oil are addressed as individual compounds in this TEE and the residual aliphatic hydrocarbon fraction remaining in the soil likely has low toxicity and bioavailability, DRO, GRO, and lube oil are not identified as COPECs for this site-specific TEE. Additionally, Ecology requested that this evaluation compare Site data to screening levels developed for protection of soil biota. These screening levels are 260 mg/kg for DRO and 120 mg/kg for GRO. For GRO, the remedial investigation uses a screening level of 30 mg/kg, which is well below and therefore more protective than the value of 120 mg/kg. For DRO, the remedial investigation uses a larger value, 2,000 mg/kg. However, as discussed above, empirical demonstration of healthy soil biota confirms existing concentrations are protective. Additionally, the TPH detected at the Site is co-located with other indicator hazardous substance, and will be remediated as part of the cleanup action.

7.0 Conclusions

Based upon information presented in this attachment, barium, cyanide, acetone, ethylbenzene, toluene, xylenes, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2,4-dimethyphenol, 2-methylphenol, 4-methylphenol, DRO, GRO, and lube oil are note identified as COPECs for TEE of the SSSMGP Site. These conclusions are based on the evaluation of potential ecological hazards, environmental fate characteristics of the constituents, and observations of stress to plants and soil biota inhabiting the Site. In addition, the ecological hazards associated with DRO, GRO, and lube oil is assessed through the evaluation of the most toxic components of these complex petroleum hydrocarbon mixtures (i.e., PAHs, BTEX).

There are several sources of uncertainty associated with these conclusions. The most important uncertainty is the lack of toxicity information with which to assess hazards of many of these constituents to plants, soil biota, and birds. The main reason for this lack of toxicity information is that most of these constituents do not persist in the soil and do not bioaccumulate from soil into terrestrial plants and soil biota where they can enter terrestrial food chains. These characteristics suggest that these constituents are unlikely to pose ecological hazards at the relatively low concentrations present at the Site. In addition, no overt signs of stress to plants or soil biota (earthworms) were noted during the site survey and site visits. Although the toxicity of many constituents to birds could not be directly evaluated, toxicity to mammals was conservatively evaluated. Birds may be more or less sensitive to particular constituents than mammals, however, the relatively low hazards estimated for mammals is likely to be protective of birds.

8.0 References

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Table 1. Background Comparisons for Barium, Lead, Mercury, and Zinc.

Note: This table contains output files from EPA's ProUCL statistical package.

From File: WorkSheet.wst

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Barium - site	91	0	0.00%	32.2	724	187.9	144	143.1	78.72	2.205	0.762
Lead - site	91	0	0.00%	3	747	72.34	35	118.1	29.65	3.563	1.632
Mercury - site	89	2	2.20%	0.03	1.37	0.162	0.09	0.225	0.0593	3.298	1.39
Zinc - site	90	1	1.10%	33	430	90.97	77.5	58.67	22.98	3.469	0.645
Barium - background	-	-	-	-	-	255	-	-	-	-	-
Lead - background	26	15	36.59%	3.8	397	27.9	12	75.65	8.006	5.019	2.712
Mercury - background	41	0	0.00%	0.012	0.107	0.0508	0.052	0.0189	0.0148	0.392	0.372
Zinc - background	41	0	0.00%	12	135	55.84	54	25.93	23.72	1.051	0.464

Notes:
Num Ds - number of samples with detected values
Num NDs - number of samples with nondetected values
% NDs - percent of samples with nondetected values
Minimum - minimum detected value (mg/kg)
Maximum - maximum detected value (mg/kg)
Mean - mean concentrations (mg/kg)
Median - median concentration (mg/kg)
SD - standard deviation (mg/kg)
MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)
Skewness - skewness statistic
CV - coefficient of variation (mg/kg)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Barium
Background Data: Barium

Selected Null Hypothesis   Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)

Area of Concern Data: Lead
Background Data: Lead

Raw Statistics

	Site	Background
Number of Valid Data	91	41
Number of Non-Detect Data	0	15
Number of Detect Data	91	26
Minimum Non-Detect	N/A	4
Maximum Non-Detect	N/A	5
Percent Non detects	0.00%	36.59%
Minimum Detected	3	3.8
Maximum Detected	747	397
Mean of Detected Data	72.34	27.9
Median of Detected Data	35	12
SD of Detected Data	118.1	75.65

Wilcoxon-Mann-Whitney Site vs Background Test
All observations <= 5 (Max DL) are ranked the same
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	7376
WMW Test U-Stat	6.508
WMW Critical Value (0.050)	1.645

P-Value	3.8E-11

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Mercury
Background Data: Mercury

Raw Statistics

	Site	Background
Number of Valid Data	91	41
Number of Non-Detect Data	2	0
Number of Detect Data	89	41
Minimum Non-Detect	0.02	N/A
Maximum Non-Detect	0.05	N/A
Percent Non detects	2.20%	0.00%
Minimum Detected	0.03	0.012
Maximum Detected	1.37	0.107
Mean of Detected Data	0.162	0.0508
Median of Detected Data	0.09	0.052
SD of Detected Data	0.225	0.0189

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	6980
WMW Test U-Stat	4.561
WMW Critical Value (0.050)	1.645
P-Value	2.54E-06

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Zinc
Background Data: Zinc

Raw Statistics

	Site	Background
Number of Valid Data	91	41
Number of Non-Detect Data	1	0
Number of Detect Data	90	41
Minimum Non-Detect	4	N/A
Maximum Non-Detect	4	N/A
Percent Non detects	1.10%	0.00%
Minimum Detected	33	12
Maximum Detected	430	135
Mean of Detected Data	90.97	55.84
Median of Detected Data	77.5	54

SD of Detected Data	58.67	25.93

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	7024
WMW Test U-Stat	4.777
WMW Critical Value (0.050)	1.645
P-Value	8.88E-07

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Table 2. Summary of Cyanide Data for Site Soils

Parameter	Upper Exposure Area		Lower Exposure Area	
	Total Cyanide	WAD Cyanide	Total Cyanide	WAD Cyanide
Number of Samples	9	9	4	4
Number of Samples with Detected Concentrations	5	3	4	2
Minimum Detected Concentration (mg/kg)	0.125	0.14	0.376	0.59
Maximum Detected Concentration (mg/kg)	76.4	7.6	23.6	2.8

WAD - weak acid dissociable

Table 3. Provisional Wildlife Ecological Soil Screening Levels for Detected Volatile Organic Compounds

Constituent	Is Constituent Chlorinated?	Log K_{ow} [a]	Mammalian Toxicity Value (mg/kg/d) [b]	Toxicity Value Comment	Earthworm BAF [c]	Plant BAF [d]	Shrew SSL (mg/kg)	Vole SSL (mg/kg)	EPC (mg/kg) [e]	Ratio Shrew SSL to EPC	Ratio Vole SSL to EPC
Acetone	No	-0.24	1,700	LOAEL subchronic oral rat study based on increased kidney and liver weight	0.7	53.30	21,405	364	0.66	32,432	552
Ethyl benzene	No	3.15	291	LOAEL chronic rat oral study based on histopathological changes to liver and kidney	0.7	0.58	3,664	5,392	138.6	26	39
Toluene	No	2.73	446	LOAEL subchronic oral rat study based on increased kidney weight	0.7	1.02	5,616	4,832	220	26	22
Total Xylenes	No	3.12	500	LOAEL chronic oral rat study oral study based on decreased body weight and survival	0.7	0.61	6,296	8,920	209.8	30	43

Notes:

[a] Log octanol/water partition coefficient (Log Kow) values were obtained from the National Library of Medicine's Hazardous Substances Data Bank (HSDB) available at http://toxnet.nlm.nih.gov/.

[b] Mammalian toxicity values were obtained from U.S. EPA's Integrated Risk Information System (IRIS) available online at http://toxnet.nlm.nih.gov/.

[c] MTCA (Table 749-5) default bioaccumulation factors (BAFs) for organic chemicals in earthworms are:

Nonchlorinated organic chemicals:

Log Kow < 5 = 0.7

Log Kow > 5 = 0.9

Chlorinated organic chemicals:

Log Kow < 5 = 4.7

Log Kow > 5 = 11.8

[e] MTCA (Table 749-5) default BAFs for organic chemicals in plants are calculated as $10^{(1.588-(0.5781*LogKow))}$

[e] These values are the reasonable maximum exposure point concentrations (EPCs) from Table C-1 of Appendix C. For xylenes, the total xylene EPC was used which is the sum of m,p-xylene and o-xylene EPCs.

BAF - bioaccumulation factor

SSL - soil screening level

LOAEL - lowest observed adverse effect level

Table 4. Provisional Wildlife Soil Screening Levels for Detected Semi-volatile Organic Compounds

Constituent	Is Constituent Chlorinated?	Log K_{ow}[a]	Mammal Toxicity Value (mg/kg/d)[b]	Toxicity Value Comment	Earth-worm BAF[c]	Plant BAF[d]	Shrew SSL (mg/kg)	Vole SSL (mg/kg)	EPC (mg/kg)[e]	Ratio Shrew SSL to EPC	Ratio Vole SSL to EPC
1,2,4-Trimethylbenzene	No	3.78	NA		0.7	0.25	NA	NA	70.14	NA	NA
1,3,5-Trimethylbenzene	No	3.42	NA		0.7	0.41	NA	NA	52	NA	NA
2,4-Dimethylphenol	No	2.3	250	LOAEL subchronic oral mouse study based on clinical signs and hematological changes	0.7	1.81	3,148	1,549	81	39	19
2-Methylphenol	No	1.95	150	LOAEL subchronic oral rat study based on decreased body weight and neurotoxicity	0.7	2.89	1,889	587	86	22	7
4-Methylphenol	No	1.94	NA		0.7	2.93	NA	NA	210	NA	NA
Phenol	No	1.46	120	LOAEL for decreased maternal body weight gain in rats	0.7	5.55	1,511	246	270	6	1

Notes:

[a]Log octanol/water partition coefficient (Log Kow) values were obtained from the National Library of Medicine's Hazardous Substances Data Bank (HSDB) available at http://toxnet.nlm.nih.gov/.

[b]Mammalian toxicity values were obtained from U.S. EPA's Integrated Risk Information System (IRIS) available online at http://toxnet.nlm.nih.gov/.

[c] MTCA (Table 749-5) default bioaccumulation factors (BAFs) for organic chemicals in earthworms are:

Nonchlorinated organic chemicals:
Log Kow < 5 = 0.7
Log Kow > 5 = 0.9
Chlorinated organic chemicals:
Log Kow < 5 = 4.7
Log Kow > 5 = 11.8

[e] MTCA (Table 749-5) default BAFs for organic chemicals in plants are calculated as $10^{(1.588-(0.5781*LogKow))}$

[e] These values are the reasonable maximum exposure point concentrations (EPCs) from Table C-1 of Appendix C.

BAF - bioaccumulation factor
SSL - soil screening level
LOAEL - lowest observed adverse effect level
NA - not available

ATTTACHMENT C-4

ProUCL Output Files – Exposure Area Soil UCLs

Attachment C-4. ProUCL Output Files - Exposure Area Soil UCLs

From File: C:\Users\admin\Desktop\PAH data.wst

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

			Raw Statistics using Detected Observations												
Variable #	Exposure Area	Variable Name	Num Ds	Num NDs	% NDs	Min.	Max.	Mean	Median	SD	MAD/0.675	Skewness	CV	UCL	EPC
L21	Lower	1-Methylnaphthalene	18	9	33.33%	0.0097	16	1.431	0.0565	3.981	0.0549	3.365	2.782	7.322	7.322
S21	Slope	1-Methylnaphthalene	12	0	0.00%	0.021	3.4	0.794	0.395	1.088	0.415	1.839	1.371	1.725	1.725
U21	Upper	1-Methylnaphthalene	43	10	18.87%	0.0052	7500	207.8	0.048	1151	0.0614	6.354	5.541	1590	1590
L37	Lower	2-Methylnaphthalene	22	5	18.52%	0.013	28	1.828	0.0615	6.08	0.0541	4.195	3.326	12.09	12.09
S37	Slope	2-Methylnaphthalene	11	1	8.33%	0.036	6.3	1.284	0.46	1.911	0.543	2.189	1.489	3.531	3.531
U37	Upper	2-Methylnaphthalene	47	6	11.32%	0.0054	13000	322.3	0.068	1904	0.0875	6.701	5.908	2741	2741
L54	Lower	Acenaphthene	15	12	44.44%	0.0044	4.6	0.521	0.029	1.335	0.0354	2.707	2.561	2.265	2.265
S54	Slope	Acenaphthene	11	1	8.33%	0.012	1.1	0.283	0.099	0.374	0.129	1.591	1.32	0.722	0.722
U54	Upper	Acenaphthene	17	36	67.92%	0.0044	250	21.26	0.48	62.63	0.623	3.501	2.946	57.28	57.28
L55	Lower	Acenaphthylene	25	2	7.41%	0.0093	88	5.079	0.095	17.97	0.108	4.474	3.539	37.92	37.92
S55	Slope	Acenaphthylene	12	0	0.00%	0.041	34	5.886	1.25	10.65	1.601	2.21	1.809	19.59	19.59
U55	Upper	Acenaphthylene	47	6	11.32%	0.0053	2600	73.96	0.087	388.9	0.115	6.294	5.258	567.1	567.1
L59	Lower	Anthracene	24	3	11.11%	0.012	56	4.6	0.24	13.65	0.298	3.331	2.967	28.89	28.89
S59	Slope	Anthracene	12	0	0.00%	0.048	14	3.677	1.075	5.113	1.379	1.336	1.39	9.107	9.107
U59	Upper	Anthracene	39	14	26.42%	0.0059	1000	38.99	0.12	170	0.167	5.246	4.359	229.4	229.4
L70	Lower	Benzo(a)anthracene	35	1	2.78%	0.0075	650	23.63	0.44	110.1	0.638	5.747	4.657	203.1	203.1
S70	Slope	Benzo(a)anthracene	12	0	0.00%	0.34	76	20.18	7.35	27.8	9.451	1.302	1.378	49.4	49.4
U70	Upper	Benzo(a)anthracene	52	4	7.14%	0.012	570	19.18	0.195	85.92	0.26	5.814	4.481	128.1	128.1
L71	Lower	Benzo(a)pyrene	36	0	0.00%	0.0028	810	30.67	0.48	135.6	0.687	5.736	4.423	171.9	171.9
S71	Slope	Benzo(a)pyrene	12	0	0.00%	0.74	120	27.24	9.25	39.96	11.49	1.671	1.467	65.79	65.79
U71	Upper	Benzo(a)pyrene	52	4	7.14%	0.016	430	15.28	0.29	65	0.397	5.756	4.254	97.63	97.63
L72	Lower	Benzo(g,h,i)perylene	27	0	0.00%	0.007	360	19.33	0.53	69.58	0.638	4.866	3.599	152.6	152.6
S72	Slope	Benzo(g,h,i)perylene	12	0	0.00%	0.47	46	13.02	6.05	15.15	7.961	1.263	1.163	27.87	27.87
U72	Upper	Benzo(g,h,i)perylene	50	3	5.66%	0.0092	80	4.335	0.13	14.02	0.173	4.664	3.234	22.75	22.75
L93	Lower	Chrysene	35	1	2.78%	0.011	670	25.3	0.47	113.7	0.673	5.686	4.494	210.6	210.6
S93	Slope	Chrysene	12	0	0.00%	0.44	76	21.06	8.05	27.89	10.16	1.257	1.324	49.64	49.64
U93	Upper	Chrysene	54	2	3.57%	0.0033	520	17.48	0.25	77.66	0.338	5.825	4.442	118.4	118.4
L98	Lower	Dibenz(a,h)anthracene	33	3	8.33%	0.0029	83	3.679	0.11	14.54	0.139	5.396	3.953	26.53	26.53
S98	Slope	Dibenz(a,h)anthracene	12	0	0.00%	0.18	15	3.871	1.25	5.155	1.394	1.426	1.332	8.581	8.581
U98	Upper	Dibenz(a,h)anthracene	39	17	30.36%	0.0065	19	1.525	0.12	4.142	0.162	3.81	2.716	5.755	5.755
L99	Lower	Dibenzofuran	17	10	37.04%	0.0057	12	1.209	0.045	3.327	0.0531	2.876	2.753	5.948	5.948
S99	Slope	Dibenzofuran	11	1	8.33%	0.013	1.9	0.409	0.12	0.562	0.159	2.176	1.373	1.077	1.077
U99	Upper	Dibenzofuran	23	30	56.60%	0.0053	280	17.84	0.2	60.76	0.287	4.096	3.406	63.82	63.82
L109	Lower	Fluoranthene	27	0	0.00%	0.013	940	45.21	1.2	182.1	1.572	4.931	4.028	393.9	393.9
S109	Slope	Fluoranthene	12	0	0.00%	0.45	110	28.74	10	39.23	12.38	1.428	1.365	68.55	68.55
U109	Upper	Fluoranthene	51	2	3.77%	0.015	960	34.61	0.28	150.4	0.378	5.497	4.346	235.1	235.1
L110	Lower	Fluorene	18	9	33.33%	0.0066	18	1.959	0.0525	5.484	0.0578	2.725	2.8	10.07	10.07
S110	Slope	Fluorene	12	0	0.00%	0.012	4.1	0.893	0.268	1.252	0.357	1.814	1.402	2.15	2.15
U110	Upper	Fluorene	33	20	37.74%	0.0049	1400	59.38	0.12	253.2	0.167	5.05	4.263	312.9	312.9
L116	Lower	Indeno(1,2,3-cd)pyrene	35	1	2.78%	0.0061	330	13.55	0.29	56.17	0.417	5.577	4.145	105.1	105.1
S116	Slope	Indeno(1,2,3-cd)pyrene	12	0	0.00%	0.48	41	12.28	5.4	13.94	7.102	1.081	1.136	26.13	26.13
U116	Upper	Indeno(1,2,3-cd)pyrene	52	4	7.14%	0.0076	85	4.097	0.11	14.14	0.148	4.945	3.45	21.97	21.97
L126	Lower	Naphthalene	26	1	3.70%	0.022	39	2.267	0.13	7.866	0.143	4.477	3.47	16.99	16.99
S126	Slope	Naphthalene	11	1	8.33%	0.081	7.3	1.812	0.72	2.259	0.771	1.669	1.247	4.462	4.462
U126	Upper	Naphthalene	45	8	15.09%	0.0088	63000	1541	0.16	9385	0.2	6.675	6.091	13152	13152
L134	Lower	Phenanthrene	27	0	0.00%	0.01	150	9.765	0.54	33.18	0.623	3.77	3.398	49.64	49.64
S134	Slope	Phenanthrene	12	0	0.00%	0.21	52	10.93	4.6	15.24	5.671	2.082	1.394	24.8	24.8
U134	Upper	Phenanthrene	51	2	3.77%	0.011	2900	98.24	0.2	459.4	0.274	5.441	4.676	711	711
L136	Lower	Pyrene	27	0	0.00%	0.017	1400	64.76	1.2	269.5	1.542	5.042	4.162	580.9	580.9
S136	Slope	Pyrene	12	0	0.00%	0.61	170	40.87	12.5	58.59	15.49	1.467	1.434	118.8	118.8
U136	Upper	Pyrene	51	2	3.77%	0.021	1400	52.13	0.42	225.2	0.572	5.312	4.319	352.4	352.4
L145	Lower	Total Benzofluoranthenes	35	1	2.78%	0.019	930	35.89	0.73	157.6	1.048	5.694	4.391	292.7	292.7
S145	Slope	Total Benzofluoranthenes	12	0	0.00%	1.1	99	31.82	12.4	37.95	16.31	1.066	1.193	70.03	70.03
U145	Upper	Total Benzofluoranthenes	54	2	3.57%	0.0028	280	12.42	0.325	47.06	0.445	5.041	3.79	73.5	73.5
L156	Lower	Total HMW PAHs	35	0	0.00%	0.0775	5233	268.3	6.26	962.6	8.082	4.617	3.588	1284	1284
S156	Slope	Total HMW PAHs	12	0	0.00%	5.08	587	170.3	64.75	220.9	86.34	1.249	1.297	392.3	392.3
U156	Upper	Total HMW PAHs	56	0	0.00%	0.0184	3383	118	1.662	511.8	2.273	5.664	4.339	545.1	545.1
L157	Lower	Total LMW PAHs	27	0	0.00%	0.117	1290	70.85	2.414	257.8	2.912	4.499	3.638	380.7	380.7
S157	Slope	Total LMW PAHs	12	0	0.00%	0.924	198.3	54.46	21.19	71.45	25.9	1.325	1.312	127	127
U157	Upper	Total LMW PAHs	53	0	0.00%	0.023	92890	2036	0.879	12786	1.191	7.17	6.279	13004	13004
L158	Lower	Total PAHs	35	0	0.00%	0.213	6523	323	7.177	1168	9.345	4.837	3.618	1556	1556
S158	Slope	Total PAHs	12	0	0.00%	6.004	765	224.8	87.56	288.8	106.9	1.192	1.285	517.6	517.6
U158	Upper	Total PAHs	55	0	0.00%	0.0344	96273	1892	2.127	12976	2.926	7.392	6.859	12819	12819
L122	Lower	Mercury	25	1	3.85%	0.04	1.01	0.186	0.08	0.264	0.0445	2.309	1.42	0.402	0.402
S122	Slope	Mercury	12	0	0.00%	0.11	0.84	0.257	0.15	0.225	0.0519	1.93	0.877	0.54	0.54
U122	Upper	Mercury	52	1	1.89%	0.03	1.37	0.128	0.08	0.2	0.0445	5.111	1.557	0.245	0.245
--	Lower	Selenium[a]	1	25	4.00%	2	2	--	--	--	--	--	--	--	2
--	Slope	Selenium[a]	0	12	100.00%	--	--	--	--	--	--	--	--	--	--
--	Upper	Selenium[a]	0	53	100.00%	--	--	--	--	--	--	--	--	--	--

Notes:
Num Ds - number of samples with detected values
Num NDs - number of samples with nondetected values
% NDs - percent of samples with nondetected values
Minimum - minimum detected value (mg/kg)
Maximum - maximum detected value (mg/kg)
Mean - mean concentrations (mg/kg)
Median - median concentration (mg/kg)
SD - standard deviation (mg/kg)
MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)
Skewness - skewness statistic
CV - coefficient of variation (mg/kg)
UCL - 95 percent upper confidence limit (mg/kg)
EPC - reasonable maximum exposure point concentration (mg/kg)
[a] Running the selenium soils data through ProUCL was not required because selenium was only detected in 1 of 90 samples.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\PAH data.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

L21

General Statistics

Number of Valid Data	27	Number of Detected Data	18
Number of Distinct Detected Data	18	Number of Non-Detect Data	9
		Percent Non-Detects	33.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0097	Minimum Detected	-4.636
Maximum Detected	16	Maximum Detected	2.773
Mean of Detected	1.431	Mean of Detected	-2.27
SD of Detected	3.981	SD of Detected	2.057
Minimum Non-Detect	0.015	Minimum Non-Detect	-4.2
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	24
Number treated as Detected	3
Single DL Non-Detect Percentage	88.89%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.417	Shapiro Wilk Test Statistic	0.823
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.973	Mean	-2.833
SD	3.287	SD	1.964
95% DL/2 (t) UCL	2.052	95% H-Stat (DL/2) UCL	1.876
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.105
		SD in Log Scale	2.107
		Mean in Original Scale	0.958
		SD in Original Scale	3.291
		95% t UCL	2.038
		95% Percentile Bootstrap UCL	2.069
		95% BCA Bootstrap UCL	2.73
		95% H-UCL	2.353

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.26	Data do not follow a Discernable Distribution (0.05)	
Theta Star	5.509		
nu star	9.352		
A-D Test Statistic	2.867	**Nonparametric Statistics**	
5% A-D Critical Value	0.856	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.856	Mean	0.961
5% K-S Critical Value	0.222	SD	3.229
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.639
		95% KM (t) UCL	2.051
Assuming Gamma Distribution		95% KM (z) UCL	2.012
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.04
Minimum	1E-06	95% KM (bootstrap t) UCL	8.32
Maximum	16	95% KM (BCA) UCL	2.146
Mean	0.954	95% KM (Percentile Bootstrap) UCL	2.129
Median	0.03	95% KM (Chebyshev) UCL	3.748
SD	3.292	97.5% KM (Chebyshev) UCL	4.953
k star	0.14	99% KM (Chebyshev) UCL	7.322
Theta star	6.833		
Nu star	7.539	Potential UCLs to Use	
AppChi2	2.471	99% KM (Chebyshev) UCL	7.322
95% Gamma Approximate UCL (Use when n >= 40)	2.911		
95% Adjusted Gamma UCL (Use when n < 40)	3.142		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S21

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.021	Minimum of Log Data	-3.863
Maximum	3.4	Maximum of Log Data	1.224
Mean	0.794	Mean of log Data	-1.137
Geometric Mean	0.321	SD of log Data	1.526
Median	0.395		
SD	1.088		
Std. Error of Mean	0.314		
Coefficient of Variation	1.371		
Skewness	1.839		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.713	Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.358	95% H-UCL	6.332
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.689
95% Adjusted-CLT UCL (Chen-1995)	1.489	97.5% Chebyshev (MVUE) UCL	3.477
95% Modified-t UCL (Johnson-1978)	1.386	99% Chebyshev (MVUE) UCL	5.026

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.559	)ata appear Gamma Distributed at 5% Significance Leve	
Theta Star	1.42		
MLE of Mean	0.794		
MLE of Standard Deviation	1.062		
nu star	13.41		
Approximate Chi Square Value (.05)	6.169	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	1.31
Adjusted Chi Square Value	5.437	95% Jackknife UCL	1.358
		95% Standard Bootstrap UCL	1.285
Anderson-Darling Test Statistic	0.328	95% Bootstrap-t UCL	2.501
Anderson-Darling 5% Critical Value	0.772	95% Hall's Bootstrap UCL	3.903
Kolmogorov-Smirnov Test Statistic	0.162	95% Percentile Bootstrap UCL	1.373
Kolmogorov-Smirnov 5% Critical Value	0.256	95% BCA Bootstrap UCL	1.466
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2.163
		97.5% Chebyshev(Mean, Sd) UCL	2.756
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3.92
95% Approximate Gamma UCL (Use when n >= 40)	1.725		
95% Adjusted Gamma UCL (Use when n < 40)	1.957		

Potential UCL to Use		Use 95% Approximate Gamma UCL	1.725

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U21

General Statistics

Number of Valid Data	53	Number of Detected Data	43
Number of Distinct Detected Data	39	Number of Non-Detect Data	10
		Percent Non-Detects	18.87%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0052	Minimum Detected	-5.259
Maximum Detected	7500	Maximum Detected	8.923
Mean of Detected	207.8	Mean of Detected	-1.92
SD of Detected	1151	SD of Detected	3.3
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.048	Maximum Non-Detect	-3.037

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	31
Number treated as Detected	22
Single DL Non-Detect Percentage	58.49%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.194	Shapiro Wilk Test Statistic	0.821
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	168.6	Mean	-2.57
SD	1038	SD	3.284
95% DL/2 (t) UCL	407.3	95% H-Stat (DL/2) UCL	209
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.05
		SD in Log Scale	3.856
		Mean in Original Scale	168.6
		SD in Original Scale	1038
		95% t UCL	407.3
		95% Percentile Bootstrap UCL	448.8
		95% BCA Bootstrap UCL	734.8
		95% H-UCL	2441

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.118	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1756		
nu star	10.17		
A-D Test Statistic	9.155	**Nonparametric Statistics**	
5% A-D Critical Value	0.96	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.96	Mean	168.6
5% K-S Critical Value	0.153	SD	1028
Data not Gamma Distributed at 5% Significance Level		SE of Mean	142.9
		95% KM (t) UCL	407.8
Assuming Gamma Distribution		95% KM (z) UCL	403.6
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	407.3
Minimum	1E-06	95% KM (bootstrap t) UCL	7499
Maximum	7500	95% KM (BCA) UCL	427.5
Mean	168.6	95% KM (Percentile Bootstrap) UCL	448.1
Median	0.036	95% KM (Chebyshev) UCL	791.3
SD	1038	97.5% KM (Chebyshev) UCL	1061
k star	0.0963	99% KM (Chebyshev) UCL	1590
Theta star	1751		
Nu star	10.2	Potential UCLs to Use	
AppChi2	4.069	99% KM (Chebyshev) UCL	1590
95% Gamma Approximate UCL (Use when n >= 40)	422.6		
95% Adjusted Gamma UCL (Use when n < 40)	434.2		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L37

General Statistics

Number of Valid Data	27	Number of Detected Data	22
Number of Distinct Detected Data	20	Number of Non-Detect Data	5
		Percent Non-Detects	18.52%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.013	Minimum Detected	-4.343
Maximum Detected	28	Maximum Detected	3.332
Mean of Detected	1.828	Mean of Detected	-2.223
SD of Detected	6.08	SD of Detected	1.994
Minimum Non-Detect	0.015	Minimum Non-Detect	-4.2
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	24
Number treated as Detected	3
Single DL Non-Detect Percentage	88.89%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.336	Shapiro Wilk Test Statistic	0.799
5% Shapiro Wilk Critical Value	0.911	5% Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.506	Mean	-2.522
SD	5.508	SD	2.008
95% DL/2 (t) UCL	3.314	95% H-Stat (DL/2) UCL	2.973
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	16.92	Mean in Log Scale	-2.756
SD	10.81	SD in Log Scale	2.175
95% MLE (t) UCL	20.46	Mean in Original Scale	1.492
95% MLE (Tiku) UCL	27.25	SD in Original Scale	5.512
		95% t UCL	3.301
		95% Percentile Bootstrap UCL	3.407
		95% BCA Bootstrap UCL	4.987
		95% H UCL	4.278

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.247	Data do not follow a Discernable Distribution (0.05)	
Theta Star	7.395		
nu star	10.88		
A-D Test Statistic	3.902	**Nonparametric Statistics**	
5% A-D Critical Value	0.869	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.869	Mean	1.494
5% K-S Critical Value	0.203	SD	5.408
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.065
		95% KM (t) UCL	3.311
Assuming Gamma Distribution		95% KM (z) UCL	3.246
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3.303
Minimum	1E-06	95% KM (bootstrap t) UCL	13.1
Maximum	28	95% KM (BCA) UCL	3.295
Mean	1.49	95% KM (Percentile Bootstrap) UCL	3.451
Median	0.042	95% KM (Chebyshev) UCL	6.137
SD	5.512	97.5% KM (Chebyshev) UCL	8.147
k star	0.167	99% KM (Chebyshev) UCL	12.09
Theta star	8.938		
Nu star	8.999	Potential UCLs to Use	
AppChi2	3.327	99% KM (Chebyshev) UCL	12.09
95% Gamma Approximate UCL (Use when n >= 40)	4.03		
95% Adjusted Gamma UCL (Use when n < 40)	4.312		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S37

General Statistics

Number of Valid Data	12	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	1
		Percent Non-Detects	8.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.036	Minimum Detected	-3.324
Maximum Detected	6.3	Maximum Detected	1.841
Mean of Detected	1.284	Mean of Detected	-0.756
SD of Detected	1.911	SD of Detected	1.586
Minimum Non-Detect	0.53	Minimum Non-Detect	-0.635
Maximum Non-Detect	0.53	Maximum Non-Detect	-0.635

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.695	Shapiro Wilk Test Statistic	0.983
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.199	Mean	-0.803
SD	1.846	SD	1.521
95% DL/2 (t) UCL	2.156	95% H-Stat (DL/2) UCL	8.663
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.846
		SD in Log Scale	1.543
		Mean in Original Scale	1.19
		SD in Original Scale	1.851
		95% t UCL	2.149
		95% Percentile Bootstrap UCL	2.141
		95% BCA Bootstrap UCL	2.468
		95% H-UCL	9.031

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.506	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	2.536		
nu star	11.14		
A-D Test Statistic	0.32	**Nonparametric Statistics**	
5% A-D Critical Value	0.773	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.773	Mean	1.193
5% K-S Critical Value	0.267	SD	1.771
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.536
		95% KM (t) UCL	2.156
Assuming Gamma Distribution		95% KM (z) UCL	2.075
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.152
Minimum	1E-06	95% KM (bootstrap t) UCL	3.989
Maximum	6.3	95% KM (BCA) UCL	2.092
Mean	1.177	95% KM (Percentile Bootstrap) UCL	2.111
Median	0.35	95% KM (Chebyshev) UCL	3.531
SD	1.859	97.5% KM (Chebyshev) UCL	4.542
k star	0.308	99% KM (Chebyshev) UCL	6.529
Theta star	3.815		
Nu star	7.402	Potential UCLs to Use	
AppChi2	2.394	95% KM (Chebyshev) UCL	3.531
95% Gamma Approximate UCL (Use when n >= 40)	3.638		
95% Adjusted Gamma UCL (Use when n < 40)	4.393		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

U37

General Statistics

Number of Valid Data	53	Number of Detected Data	47
Number of Distinct Detected Data	44	Number of Non-Detect Data	6
		Percent Non-Detects	11.32%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0054	Minimum Detected	-5.221
Maximum Detected	13000	Maximum Detected	9.473
Mean of Detected	322.3	Mean of Detected	-1.76
SD of Detected	1904	SD of Detected	3.263
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	19
Number treated as Detected	34
Single DL Non-Detect Percentage	35.85%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.181	Shapiro Wilk Test Statistic	0.815
5% Shapiro Wilk Critical Value	0.946	5% Shapiro Wilk Critical Value	0.946
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	285.9	Mean	-2.193
SD	1794	SD	3.311
95% DL/2 (t) UCL	698.6	95% H-Stat (DL/2) UCL	345.8
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.459
		SD in Log Scale	3.676
		Mean in Original Scale	285.9
		SD in Original Scale	1794
		95% t UCL	698.5
		95% Percentile Bootstrap UCL	771.7
		95% BCA Bootstrap UCL	1267
		95% H-UCL	1656

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.114	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2822		
nu star	10.74		
A-D Test Statistic	10.52	**Nonparametric Statistics**	
5% A-D Critical Value	0.966	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.966	Mean	285.9
5% K-S Critical Value	0.147	SD	1777
Data not Gamma Distributed at 5% Significance Level		SE of Mean	246.7
		95% KM (t) UCL	699.1
Assuming Gamma Distribution		95% KM (z) UCL	691.7
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	698.6
Minimum	1E-06	95% KM (bootstrap t) UCL	13362
Maximum	13000	95% KM (BCA) UCL	771.6
Mean	285.9	95% KM (Percentile Bootstrap) UCL	776
Median	0.055	95% KM (Chebyshev) UCL	1361
SD	1794	97.5% KM (Chebyshev) UCL	1827
k star	0.101	99% KM (Chebyshev) UCL	2741
Theta star	2842		
Nu star	10.66	Potential UCLs to Use	
AppChi2	4.36	99% KM (Chebyshev) UCL	2741
95% Gamma Approximate UCL (Use when n >= 40)	699.1		
95% Adjusted Gamma UCL (Use when n < 40)	717.6		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L54

General Statistics

Number of Valid Data	27	Number of Detected Data	15
Number of Distinct Detected Data	15	Number of Non-Detect Data	12
		Percent Non-Detects	44.44%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0044	Minimum Detected	-5.426
Maximum Detected	4.6	Maximum Detected	1.526
Mean of Detected	0.521	Mean of Detected	-3.243
SD of Detected	1.335	SD of Detected	2.098
Minimum Non-Detect	0.015	Minimum Non-Detect	-4.2
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	25
Number treated as Detected	2
Single DL Non-Detect Percentage	92.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.447	Shapiro Wilk Test Statistic	0.843
5% Shapiro Wilk Critical Value	0.881	5% Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.315	Mean	-3.541
SD	1.01	SD	1.766
95% DL/2 (t) UCL	0.646	95% H-Stat (DL/2) UCL	0.489
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.923
		SD in Log Scale	1.779
		Mean in Original Scale	0.294
		SD in Original Scale	1.013
		95% t UCL	0.627
		95% Percentile Bootstrap UCL	0.636
		95% BCA Bootstrap UCL	0.806
		95% H-UCL	0.347

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.261	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1.998		
nu star	7.828		
A-D Test Statistic	2.293	Nonparametric Statistics	
5% A-D Critical Value	0.848	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.848	Mean	0.295
5% K-S Critical Value	0.242	SD	0.994
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.198
		95% KM (t) UCL	0.633
Assuming Gamma Distribution		95% KM (z) UCL	0.621
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.627
Minimum	1E-06	95% KM (bootstrap t) UCL	10.84
Maximum	4.6	95% KM (BCA) UCL	0.637
Mean	0.29	95% KM (Percentile Bootstrap) UCL	0.641
Median	0.0047	95% KM (Chebyshev) UCL	1.158
SD	1.015	97.5% KM (Chebyshev) UCL	1.532
k star	0.13	99% KM (Chebyshev) UCL	2.265
Theta star	2.227		
Nu star	7.022	Potential UCLs to Use	
AppChi2	2.183	99% KM (Chebyshev) UCL	2.265
95% Gamma Approximate UCL (Use when n >= 40)	0.932		
95% Adjusted Gamma UCL (Use when n < 40)	1.01		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S54

General Statistics			
Number of Valid Data	12	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	1
		Percent Non-Detects	8.33%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.012	Minimum Detected	-4.423
Maximum Detected	1.1	Maximum Detected	0.0953
Mean of Detected	0.283	Mean of Detected	-2.174
SD of Detected	0.374	SD of Detected	1.515
Minimum Non-Detect	0.014	Minimum Non-Detect	-4.269
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.743	Shapiro Wilk Test Statistic	0.953
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.26	Mean	-2.406
SD	0.366	SD	1.654
95% DL/2 (t) UCL	0.45	95% H-Stat (DL/2) UCL	2.897
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.219	Mean in Log Scale	-2.402
SD	0.399	SD in Log Scale	1.646
95% MLE (t) UCL	0.426	Mean in Original Scale	0.26
95% MLE (Tiku) UCL	0.421	SD in Original Scale	0.366
		95% t UCL	0.45
		95% Percentile Bootstrap UCL	0.439
		95% BCA Bootstrap UCL	0.488
		95% H UCL	2.826
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.545	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	0.52		
nu star	11.99		
A-D Test Statistic	0.403	**Nonparametric Statistics**	
5% A-D Critical Value	0.769	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.769	Mean	0.261
5% K-S Critical Value	0.266	SD	0.35
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.106
		95% KM (t) UCL	0.451
Assuming Gamma Distribution		95% KM (z) UCL	0.435
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.45
Minimum	1E-06	95% KM (bootstrap t) UCL	0.761
Maximum	1.1	95% KM (BCA) UCL	0.459
Mean	0.26	95% KM (Percentile Bootstrap) UCL	0.442
Median	0.076	95% KM (Chebyshev) UCL	0.722
SD	0.366	97.5% KM (Chebyshev) UCL	0.922
k star	0.334	99% KM (Chebyshev) UCL	1.315
Theta star	0.779		
Nu star	8.008	**Potential UCLs to Use**	
AppChi2	2.74	95% KM (Chebyshev) UCL	0.722
95% Gamma Approximate UCL (Use when n >= 40)	0.76		
95% Adjusted Gamma UCL (Use when n < 40)	0.908		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

U54

General Statistics			
Number of Valid Data	53	Number of Detected Data	17
Number of Distinct Detected Data	16	Number of Non-Detect Data	36
		Percent Non-Detects	67.92%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0044	Minimum Detected	-5.426
Maximum Detected	250	Maximum Detected	5.521
Mean of Detected	21.26	Mean of Detected	-1.015
SD of Detected	62.63	SD of Detected	3.215
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.24	Maximum Non-Detect	-1.427
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	44
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	9
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	83.02%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.397	Shapiro Wilk Test Statistic	0.939
5% Shapiro Wilk Critical Value	0.892	5% Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	6.827	Mean	-3.892
SD	36.16	SD	2.832
95% DL/2 (t) UCL	15.14	95% H-Stat (DL/2) UCL	7.609
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-5.996
		SD in Log Scale	4.274
		Mean in Original Scale	6.819
		SD in Original Scale	36.16
		95% t UCL	15.14
		95% Percentile Bootstrap UCL	16.06
		95% BCA Bootstrap UCL	24.36
		95% H-UCL	1469
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.19	**Data appear Lognormal at 5% Significance Level**	
Theta Star	111.8		
nu star	6.463		
A-D Test Statistic	1.66	**Nonparametric Statistics**	
5% A-D Critical Value	0.889	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.889	Mean	6.822
5% K-S Critical Value	0.232	SD	35.81
Data not Gamma Distributed at 5% Significance Level		SE of Mean	5.071
		95% KM (t) UCL	15.31
Assuming Gamma Distribution		95% KM (z) UCL	15.16
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	15.14
Minimum	1E-06	95% KM (bootstrap t) UCL	141
Maximum	250	95% KM (BCA) UCL	17.57
Mean	6.819	95% KM (Percentile Bootstrap) UCL	16.31
Median	1E-06	95% KM (Chebyshev) UCL	28.93
SD	36.16	97.5% KM (Chebyshev) UCL	38.49
k star	0.081	99% KM (Chebyshev) UCL	57.28
Theta star	84.19		
Nu star	8.585	**Potential UCLs to Use**	
AppChi2	3.078	99% KM (Chebyshev) UCL	57.28
95% Gamma Approximate UCL (Use when n >= 40)	19.02		
95% Adjusted Gamma UCL (Use when n < 40)	19.6		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L55

General Statistics

Number of Valid Data	27	Number of Detected Data	25
Number of Distinct Detected Data	24	Number of Non-Detect Data	2
		Percent Non-Detects	7.41%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0093	Minimum Detected	-4.678
Maximum Detected	88	Maximum Detected	4.477
Mean of Detected	5.079	Mean of Detected	-1.677
SD of Detected	17.97	SD of Detected	2.294
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	6
Number treated as Detected	21
Single DL Non-Detect Percentage	22.22%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.318	Shapiro Wilk Test Statistic	0.884
5% Shapiro Wilk Critical Value	0.918	5% Shapiro Wilk Critical Value	0.918
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.704	Mean	-1.943
SD	17.32	SD	2.415
95% DL/2 (t) UCL	10.39	95% H-Stat (DL/2) UCL	24.93
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.296	Mean in Log Scale	-2.009
SD	19.8	SD in Log Scale	2.522
95% MLE (t) UCL	7.795	Mean in Original Scale	4.703
95% MLE (Tiku) UCL	7.705	SD in Original Scale	17.32
		95% t UCL	10.39
		95% Percentile Bootstrap UCL	10.78
		95% BCA Bootstrap UCL	14.46
		95% H UCL	36.84

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.22	Data do not follow a Discernable Distribution (0.05)	
Theta Star	23.1		
nu star	11		
A-D Test Statistic	3.715	**Nonparametric Statistics**	
5% A-D Critical Value	0.887	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.887	Mean	4.704
5% K-S Critical Value	0.193	SD	17
Data not Gamma Distributed at 5% Significance Level		SE of Mean	3.339
		95% KM (t) UCL	10.4
Assuming Gamma Distribution		95% KM (z) UCL	10.2
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	10.39
Minimum	1E-06	95% KM (bootstrap t) UCL	39
Maximum	88	95% KM (BCA) UCL	11.6
Mean	4.703	95% KM (Percentile Bootstrap) UCL	10.8
Median	0.087	95% KM (Chebyshev) UCL	19.26
SD	17.32	97.5% KM (Chebyshev) UCL	25.55
k star	0.186	99% KM (Chebyshev) UCL	37.92
Theta star	25.32		
Nu star	10.03	Potential UCLs to Use	
AppChi2	3.96	99% KM (Chebyshev) UCL	37.92
95% Gamma Approximate UCL (Use when n >= 40)	11.91		
95% Adjusted Gamma UCL (Use when n < 40)	12.68		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S55

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.041	Minimum of Log Data	-3.194
Maximum	34	Maximum of Log Data	3.526
Mean	5.886	Mean of log Data	0.121
Geometric Mean	1.129	SD of log Data	2.069
Median	1.25		
SD	10.65		
Std. Error of Mean	3.074		
Coefficient of Variation	1.809		
Skewness	2.21		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.617	Shapiro Wilk Test Statistic	0.966
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11.41	95% H-UCL	233.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	24.46
95% Adjusted-CLT UCL (Chen-1995)	13.04	97.5% Chebyshev (MVUE) UCL	32.26
95% Modified-t UCL (Johnson-1978)	11.73	99% Chebyshev (MVUE) UCL	47.59

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.355	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	16.6		
MLE of Mean	5.886		
MLE of Standard Deviation	9.885		
nu star	8.509		
Approximate Chi Square Value (.05)	3.033	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	10.94
Adjusted Chi Square Value	2.556	95% Jackknife UCL	11.41
		95% Standard Bootstrap UCL	10.75
Anderson-Darling Test Statistic	0.577	95% Bootstrap-t UCL	29.97
Anderson-Darling 5% Critical Value	0.805	95% Hall's Bootstrap UCL	34.69
Kolmogorov-Smirnov Test Statistic	0.232	95% Percentile Bootstrap UCL	11.39
Kolmogorov-Smirnov 5% Critical Value	0.262	95% BCA Bootstrap UCL	12.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	19.28
		97.5% Chebyshev(Mean, Sd) UCL	25.08
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	36.47
95% Approximate Gamma UCL (Use when n >= 40)	16.51		
95% Adjusted Gamma UCL (Use when n < 40)	19.59		

Potential UCL to Use		Use 95% Adjusted Gamma UCL	19.59

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U55

General Statistics

Number of Valid Data	53	Number of Detected Data	47
Number of Distinct Detected Data	41	Number of Non-Detect Data	6
		Percent Non-Detects	11.32%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0053	Minimum Detected	-5.24
Maximum Detected	2600	Maximum Detected	7.863
Mean of Detected	73.96	Mean of Detected	-1.621
SD of Detected	388.9	SD of Detected	3.027
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	19
Number treated as Detected	34
Single DL Non-Detect Percentage	35.85%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.21	Shapiro Wilk Test Statistic	0.875
5% Shapiro Wilk Critical Value	0.946	5% Shapiro Wilk Critical Value	0.946
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	65.58	Mean	-2.04
SD	366.5	SD	3.093
95% DL/2 (t) UCL	149.9	95% H-Stat (DL/2) UCL	147.8
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.253
		SD in Log Scale	3.4
		Mean in Original Scale	65.58
		SD in Original Scale	366.5
		95% t UCL	149.9
		95% Percentile Bootstrap UCL	160.4
		95% BCA Bootstrap UCL	228.7
		95% H-UCL	499.7

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.138	Data do not follow a Discernable Distribution (0.05)	
Theta Star	536.5		
nu star	12.96		
A-D Test Statistic	8.64	**Nonparametric Statistics**	
5% A-D Critical Value	0.95	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.95	Mean	65.58
5% K-S Critical Value	0.146	SD	363
Data not Gamma Distributed at 5% Significance Level		SE of Mean	50.41
		95% KM (t) UCL	150
Assuming Gamma Distribution		95% KM (z) UCL	148.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	149.9
Minimum	1E-06	95% KM (bootstrap t) UCL	1753
Maximum	2600	95% KM (BCA) UCL	163.6
Mean	65.58	95% KM (Percentile Bootstrap) UCL	163.9
Median	0.059	95% KM (Chebyshev) UCL	285.3
SD	366.5	97.5% KM (Chebyshev) UCL	380.4
k star	0.118	99% KM (Chebyshev) UCL	567.1
Theta star	557.1		
Nu star	12.48	Potential UCLs to Use	
AppChi2	5.544	99% KM (Chebyshev) UCL	567.1
95% Gamma Approximate UCL (Use when n >= 40)	147.6		
95% Adjusted Gamma UCL (Use when n < 40)	151.1		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	27	Number of Detected Data	24
Number of Distinct Detected Data	23	Number of Non-Detect Data	3
		Percent Non-Detects	11.11%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.012	Minimum Detected	-4.423
Maximum Detected	56	Maximum Detected	4.025
Mean of Detected	4.6	Mean of Detected	-1.192
SD of Detected	13.65	SD of Detected	2.161
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	4
Number treated as Detected	23
Single DL Non-Detect Percentage	14.81%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.377	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.916	5% Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.089	Mean	-1.675
SD	12.92	SD	2.476
95% DL/2 (t) UCL	8.33	95% H-Stat (DL/2) UCL	42.2
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	2.567	Mean in Log Scale	-1.725
SD	14	SD in Log Scale	2.549
95% MLE (t) UCL	7.162	Mean in Original Scale	4.089
95% MLE (Tiku) UCL	6.904	SD in Original Scale	12.92
		95% t UCL	8.33
		95% Percentile Bootstrap UCL	8.688
		95% BCA Bootstrap UCL	10.53
		95% H UCL	54.84

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.255	Data appear Lognormal at 5% Significance Level	
Theta Star	18.04		
nu star	12.24		
A-D Test Statistic	2.992	Nonparametric Statistics	
5% A-D Critical Value	0.868	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.868	Mean	4.09
5% K-S Critical Value	0.195	SD	12.68
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2.492
		95% KM (t) UCL	8.341
Assuming Gamma Distribution		95% KM (z) UCL	8.19
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	8.33
Minimum	1E-06	95% KM (bootstrap t) UCL	39.25
Maximum	56	95% KM (BCA) UCL	8.704
Mean	4.089	95% KM (Percentile Bootstrap) UCL	8.456
Median	0.17	95% KM (Chebyshev) UCL	14.95
SD	12.92	97.5% KM (Chebyshev) UCL	19.65
k star	0.19	99% KM (Chebyshev) UCL	28.89
Theta star	21.52		
Nu star	10.26	Potential UCLs to Use	
AppChi2	4.103	99% KM (Chebyshev) UCL	28.89
95% Gamma Approximate UCL (Use when n >= 40)	10.22		
95% Adjusted Gamma UCL (Use when n < 40)	10.87		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S59

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.048	Minimum of Log Data	-3.037
Maximum	14	Maximum of Log Data	2.639
Mean	3.677	Mean of log Data	0.0468
Geometric Mean	1.048	SD of log Data	1.884
Median	1.075		
SD	5.113		
Std. Error of Mean	1.476		
Coefficient of Variation	1.39		
Skewness	1.336		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.721	Shapiro Wilk Test Statistic	0.951
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.328	95% H-UCL	89.57
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	16.26
95% Adjusted-CLT UCL (Chen-1995)	6.713	97.5% Chebyshev (MVUE) UCL	21.33
95% Modified-t UCL (Johnson-1978)	6.423	99% Chebyshev (MVUE) UCL	31.29
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.434	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	8.465		
MLE of Mean	3.677		
MLE of Standard Deviation	5.579		
nu star	10.43		
Approximate Chi Square Value (.05)	4.21	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	6.105
Adjusted Chi Square Value	3.627	95% Jackknife UCL	6.328
		95% Standard Bootstrap UCL	5.999
Anderson-Darling Test Statistic	0.448	95% Bootstrap-t UCL	7.878
Anderson-Darling 5% Critical Value	0.785	95% Hall's Bootstrap UCL	5.729
Kolmogorov-Smirnov Test Statistic	0.178	95% Percentile Bootstrap UCL	6.098
Kolmogorov-Smirnov 5% Critical Value	0.259	95% BCA Bootstrap UCL	6.566
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.11
		97.5% Chebyshev(Mean, Sd) UCL	12.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18.36
95% Approximate Gamma UCL (Use when n >= 40)	9.107		
95% Adjusted Gamma UCL (Use when n < 40)	10.57		
Potential UCL to Use		Use 95% Approximate Gamma UCL	9.107

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U59

General Statistics

Number of Valid Data	53	Number of Detected Data	39
Number of Distinct Detected Data	37	Number of Non-Detect Data	14
		Percent Non-Detects	26.42%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0059	Minimum Detected	-5.133
Maximum Detected	1000	Maximum Detected	6.908
Mean of Detected	38.99	Mean of Detected	-1.277
SD of Detected	170	SD of Detected	3.106
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	24
Number treated as Detected	29
Single DL Non-Detect Percentage	45.28%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.259	Shapiro Wilk Test Statistic	0.916
5% Shapiro Wilk Critical Value	0.939	5% Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	28.69	Mean	-2.391
SD	146.3	SD	3.269
95% DL/2 (t) UCL	62.36	95% H-Stat (DL/2) UCL	232
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.003
		SD in Log Scale	4.005
		Mean in Original Scale	28.69
		SD in Original Scale	146.3
		95% t UCL	62.36
		95% Percentile Bootstrap UCL	66.24
		95% BCA Bootstrap UCL	92.87
		95% H-UCL	5920

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.16	Data do not follow a Discernable Distribution (0.05)	
Theta Star	243.7		
nu star	12.48		
A-D Test Statistic	5.13	**Nonparametric Statistics**	
5% A-D Critical Value	0.929	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.929	Mean	28.69
5% K-S Critical Value	0.158	SD	145
Data not Gamma Distributed at 5% Significance Level		SE of Mean	20.17
		95% KM (t) UCL	62.47
Assuming Gamma Distribution		95% KM (z) UCL	61.87
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	62.36
Minimum	1E-06	95% KM (bootstrap t) UCL	486.8
Maximum	1000	95% KM (BCA) UCL	67.17
Mean	28.69	95% KM (Percentile Bootstrap) UCL	66.31
Median	0.039	95% KM (Chebyshev) UCL	116.6
SD	146.3	97.5% KM (Chebyshev) UCL	154.7
k star	0.109	99% KM (Chebyshev) UCL	229.4
Theta star	263.8		
Nu star	11.53	Potential UCLs to Use	
AppChi2	4.918	99% KM (Chebyshev) UCL	229.4
95% Gamma Approximate UCL (Use when n >= 40)	67.26		
95% Adjusted Gamma UCL (Use when n < 40)	68.95		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	36	Number of Detected Data	35
Number of Distinct Detected Data	31	Number of Non-Detect Data	1
		Percent Non-Detects	2.78%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0075	Minimum Detected	-4.893
Maximum Detected	650	Maximum Detected	6.477
Mean of Detected	23.63	Mean of Detected	-0.547
SD of Detected	110.1	SD of Detected	2.584
Minimum Non-Detect	0.0049	Minimum Non-Detect	-5.319
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.23	Shapiro Wilk Test Statistic	0.968
5% Shapiro Wilk Critical Value	0.934	5% Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	22.98	Mean	-0.698
SD	108.5	SD	2.704
95% DL/2 (t) UCL	53.54	95% H-Stat (DL/2) UCL	170.9
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	20.77	Mean in Log Scale	-0.729
SD	108.8	SD in Log Scale	2.771
95% MLE (t) UCL	51.4	Mean in Original Scale	22.98
95% MLE (Tiku) UCL	47.84	SD in Original Scale	108.5
		95% t UCL	53.54
		95% Percentile Bootstrap UCL	58.19
		95% BCA Bootstrap UCL	76.21
		95% H UCL	220.1
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.201	Data appear Lognormal at 5% Significance Level	
Theta Star	117.8		
nu star	14.04		
A-D Test Statistic	4.085	**Nonparametric Statistics**	
5% A-D Critical Value	0.9	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.9	Mean	22.98
5% K-S Critical Value	0.165	SD	107
Data not Gamma Distributed at 5% Significance Level		SE of Mean	18.1
		95% KM (t) UCL	53.56
Assuming Gamma Distribution		95% KM (z) UCL	52.75
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	53.54
Minimum	1E-06	95% KM (bootstrap t) UCL	357.8
Maximum	650	95% KM (BCA) UCL	59.39
Mean	22.98	95% KM (Percentile Bootstrap) UCL	57.94
Median	0.37	95% KM (Chebyshev) UCL	101.9
SD	108.5	97.5% KM (Chebyshev) UCL	136
k star	0.187	99% KM (Chebyshev) UCL	203.1
Theta star	122.7		
Nu star	13.48	Potential UCLs to Use	
AppChi2	6.218	99% KM (Chebyshev) UCL	203.1
95% Gamma Approximate UCL (Use when n >= 40)	49.82		
95% Adjusted Gamma UCL (Use when n < 40)	51.68		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S70

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.34	Minimum of Log Data	-1.079
Maximum	76	Maximum of Log Data	4.331
Mean	20.18	Mean of log Data	1.783
Geometric Mean	5.947	SD of log Data	1.829
Median	7.35		
SD	27.8		
Std. Error of Mean	8.026		
Coefficient of Variation	1.378		
Skewness	1.302		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.719	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	34.59	95% H-UCL	398.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	83.79
95% Adjusted-CLT UCL (Chen-1995)	36.6	97.5% Chebyshev (MVUE) UCL	109.7
95% Modified-t UCL (Johnson-1978)	35.09	99% Chebyshev (MVUE) UCL	160.7

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.443	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	45.5		
MLE of Mean	20.18		
MLE of Standard Deviation	30.3		
nu star	10.64		
Approximate Chi Square Value (.05)	4.347	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	33.38
Adjusted Chi Square Value	3.753	95% Jackknife UCL	34.59
		95% Standard Bootstrap UCL	32.71
Anderson-Darling Test Statistic	0.536	95% Bootstrap-t UCL	40.1
Anderson-Darling 5% Critical Value	0.784	95% Hall's Bootstrap UCL	30.8
Kolmogorov-Smirnov Test Statistic	0.191	95% Percentile Bootstrap UCL	33.86
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	35.55
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	55.16
		97.5% Chebyshev(Mean, Sd) UCL	70.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	100
95% Approximate Gamma UCL (Use when n >= 40)	49.4		
95% Adjusted Gamma UCL (Use when n < 40)	57.22		

Potential UCL to Use		Use 95% Approximate Gamma UCL	49.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U70

General Statistics

Number of Valid Data	56	Number of Detected Data	52
Number of Distinct Detected Data	49	Number of Non-Detect Data	4
		Percent Non-Detects	7.14%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.012	Minimum Detected	-4.423
Maximum Detected	570	Maximum Detected	6.346
Mean of Detected	19.18	Mean of Detected	-0.868
SD of Detected	85.92	SD of Detected	2.696
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	6
Number treated as Detected	50
Single DL Non-Detect Percentage	10.71%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.429	Lilliefors Test Statistic	0.151
5% Lilliefors Critical Value	0.123	5% Lilliefors Critical Value	0.123
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	17.81	Mean	-1.218
SD	82.89	SD	2.894
95% DL/2 (t) UCL	36.34	95% H-Stat (DL/2) UCL	148.9
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	10.71	Mean in Log Scale	-1.304
SD	87.74	SD in Log Scale	3.044
95% MLE (t) UCL	30.32	Mean in Original Scale	17.81
95% MLE (Tiku) UCL	28.77	SD in Original Scale	82.89
		95% t UCL	36.34
		95% Percentile Bootstrap UCL	37.99
		95% BCA Bootstrap UCL	51.85
		95% H UCL	258.6

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.195	Data do not follow a Discernable Distribution (0.05)	
Theta Star	98.23		
nu star	20.3		
A-D Test Statistic	5.698	Nonparametric Statistics	
5% A-D Critical Value	0.912	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.912	Mean	17.81
5% K-S Critical Value	0.137	SD	82.14
Data not Gamma Distributed at 5% Significance Level		SE of Mean	11.08
		95% KM (t) UCL	36.35
Assuming Gamma Distribution		95% KM (z) UCL	36.04
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	36.34
Minimum	1E-06	95% KM (bootstrap t) UCL	208.8
Maximum	570	95% KM (BCA) UCL	36.46
Mean	17.81	95% KM (Percentile Bootstrap) UCL	38.08
Median	0.165	95% KM (Chebyshev) UCL	66.12
SD	82.89	97.5% KM (Chebyshev) UCL	87.03
k star	0.166	99% KM (Chebyshev) UCL	128.1
Theta star	107.4		
Nu star	18.56	Potential UCLs to Use	
AppChi2	9.8	99% KM (Chebyshev) UCL	128.1
95% Gamma Approximate UCL (Use when n >= 40)	33.73		
95% Adjusted Gamma UCL (Use when n < 40)	34.32		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L71

General Statistics

Number of Valid Observations	36	Number of Distinct Observations	33

Raw Statistics		Log-transformed Statistics	
Minimum	0.0028	Minimum of Log Data	-5.878
Maximum	810	Maximum of Log Data	6.697
Mean	30.67	Mean of log Data	-0.369
Geometric Mean	0.691	SD of log Data	2.768
Median	0.48		
SD	135.6		
Std. Error of Mean	22.61		
Coefficient of Variation	4.423		
Skewness	5.736		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.245	Shapiro Wilk Test Statistic	0.981
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	68.86	95% H-UCL	312.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	82.84
95% Adjusted-CLT UCL (Chen-1995)	90.95	97.5% Chebyshev (MVUE) UCL	109.5
95% Modified-t UCL (Johnson-1978)	72.47	99% Chebyshev (MVUE) UCL	161.9

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.197	Data appear Lognormal at 5% Significance Level	
Theta Star	155.6		
MLE of Mean	30.67		
MLE of Standard Deviation	69.07		
nu star	14.19		
Approximate Chi Square Value (.05)	6.704	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0428	95% CLT UCL	67.85
Adjusted Chi Square Value	6.47	95% Jackknife UCL	68.86
		95% Standard Bootstrap UCL	67.17
Anderson-Darling Test Statistic	3.762	95% Bootstrap-t UCL	258.9
Anderson-Darling 5% Critical Value	0.903	95% Hall's Bootstrap UCL	229.4
Kolmogorov-Smirnov Test Statistic	0.268	95% Percentile Bootstrap UCL	74.04
Kolmogorov-Smirnov 5% Critical Value	0.163	95% BCA Bootstrap UCL	105.2
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	129.2
		97.5% Chebyshev(Mean, Sd) UCL	171.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	255.6
95% Approximate Gamma UCL (Use when n >= 40)	64.93		
95% Adjusted Gamma UCL (Use when n < 40)	67.27		

Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	171.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S71

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.74	Minimum of Log Data	-0.301
Maximum	120	Maximum of Log Data	4.787
Mean	27.24	Mean of log Data	2.121
Geometric Mean	8.34	SD of log Data	1.728
Median	9.25		
SD	39.96		
Std. Error of Mean	11.53		
Coefficient of Variation	1.467		
Skewness	1.671		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.71	Shapiro Wilk Test Statistic	0.939
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	47.95	95% H-UCL	363.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	98.61
95% Adjusted-CLT UCL (Chen-1995)	52.16	97.5% Chebyshev (MVUE) UCL	128.7
95% Modified-t UCL (Johnson-1978)	48.88	99% Chebyshev (MVUE) UCL	187.7

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.454	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	59.95		
MLE of Mean	27.24		
MLE of Standard Deviation	40.41		
nu star	10.9		
Approximate Chi Square Value (.05)	4.514	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	46.21
Adjusted Chi Square Value	3.906	95% Jackknife UCL	47.95
		95% Standard Bootstrap UCL	45.1
Anderson-Darling Test Statistic	0.534	95% Bootstrap-t UCL	68.32
Anderson-Darling 5% Critical Value	0.782	95% Hall's Bootstrap UCL	54.36
Kolmogorov-Smirnov Test Statistic	0.199	95% Percentile Bootstrap UCL	46.72
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	53.3
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	77.51
		97.5% Chebyshev(Mean, Sd) UCL	99.27
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	142
95% Approximate Gamma UCL (Use when n >= 40)	65.79		
95% Adjusted Gamma UCL (Use when n < 40)	76.03		
Potential UCL to Use		Use 95% Approximate Gamma UCL	65.79

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U71

General Statistics

Number of Valid Data	56	Number of Detected Data	52
Number of Distinct Detected Data	47	Number of Non-Detect Data	4
		Percent Non-Detects	7.14%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.016	Minimum Detected	-4.135
Maximum Detected	430	Maximum Detected	6.064
Mean of Detected	15.28	Mean of Detected	-0.666
SD of Detected	65	SD of Detected	2.552
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	4
Number treated as Detected	52
Single DL Non-Detect Percentage	7.14%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.407	Lilliefors Test Statistic	0.132
5% Lilliefors Critical Value	0.123	5% Lilliefors Critical Value	0.123
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	14.19	Mean	-1.03
SD	62.72	SD	2.795
95% DL/2 (t) UCL	28.21	95% H-Stat (DL/2) UCL	119.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	10.76	Mean in Log Scale	-1.085
SD	64.9	SD in Log Scale	2.894
95% MLE (t) UCL	25.27	Mean in Original Scale	14.19
95% MLE (Tiku) UCL	23.87	SD in Original Scale	62.72
		95% t UCL	28.21
		95% Percentile Bootstrap UCL	29.24
		95% BCA Bootstrap UCL	39.56
		95% H UCL	169.7

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.215	Data do not follow a Discernable Distribution (0.05)	
Theta Star	71.07		
nu star	22.36		
A-D Test Statistic	5.09	**Nonparametric Statistics**	
5% A-D Critical Value	0.901	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.901	Mean	14.19
5% K-S Critical Value	0.136	SD	62.15
Data not Gamma Distributed at 5% Significance Level		SE of Mean	8.387
		95% KM (t) UCL	28.22
Assuming Gamma Distribution		95% KM (z) UCL	27.98
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	28.21
Minimum	1E-06	95% KM (bootstrap t) UCL	133.2
Maximum	430	95% KM (BCA) UCL	32.49
Mean	14.19	95% KM (Percentile Bootstrap) UCL	29.34
Median	0.265	95% KM (Chebyshev) UCL	50.75
SD	62.72	97.5% KM (Chebyshev) UCL	66.56
k star	0.179	99% KM (Chebyshev) UCL	97.63
Theta star	79.39		
Nu star	20.02	Potential UCLs to Use	
AppChi2	10.86	99% KM (Chebyshev) UCL	97.63
95% Gamma Approximate UCL (Use when n >= 40)	26.14		
95% Adjusted Gamma UCL (Use when n < 40)	26.58		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L72

General Statistics

Number of Valid Observations	27	Number of Distinct Observations	24

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.007	Minimum of Log Data	-4.962
Maximum	360	Maximum of Log Data	5.886
Mean	19.33	Mean of log Data	-0.264
Geometric Mean	0.768	SD of log Data	2.572
Median	0.53		
SD	69.58		
Std. Error of Mean	13.39		
Coefficient of Variation	3.599		
Skewness	4.866		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.304	Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.923	Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	42.17	95% H-UCL	261.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	54.1
95% Adjusted-CLT UCL (Chen-1995)	54.76	97.5% Chebyshev (MVUE) UCL	71.49
95% Modified-t UCL (Johnson-1978)	44.26	99% Chebyshev (MVUE) UCL	105.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.224	Data appear Lognormal at 5% Significance Level	
Theta Star	86.36		
MLE of Mean	19.33		
MLE of Standard Deviation	40.86		
nu star	12.09		
Approximate Chi Square Value (.05)	5.286	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0401	95% CLT UCL	41.36
Adjusted Chi Square Value	5	95% Jackknife UCL	42.17
		95% Standard Bootstrap UCL	40.47
Anderson-Darling Test Statistic	2.69	95% Bootstrap-t UCL	135.8
Anderson-Darling 5% Critical Value	0.885	95% Hall's Bootstrap UCL	133.6
Kolmogorov-Smirnov Test Statistic	0.261	95% Percentile Bootstrap UCL	45.18
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	59.52
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	77.7
		97.5% Chebyshev(Mean, Sd) UCL	103
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	152.6
95% Approximate Gamma UCL (Use when n >= 40)	44.22		
95% Adjusted Gamma UCL (Use when n < 40)	46.75		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	152.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S72

General Statistics

Number of Valid Observations	12
Number of Distinct Observations	11

Raw Statistics

Minimum	0.47
Maximum	46
Mean	13.02
Geometric Mean	5.459
Median	6.05
SD	15.15
Std. Error of Mean	4.373
Coefficient of Variation	1.163
Skewness	1.263

Log-transformed Statistics

Minimum of Log Data	-0.755
Maximum of Log Data	3.829
Mean of log Data	1.697
SD of log Data	1.551

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.816
Shapiro Wilk Critical Value	0.859

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.942
Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	20.87

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	21.92
95% Modified-t UCL (Johnson-1978)	21.14

Assuming Lognormal Distribution

95% H-UCL	117.9
95% Chebyshev (MVUE) UCL	47.66
97.5% Chebyshev (MVUE) UCL	61.71
99% Chebyshev (MVUE) UCL	89.31

Gamma Distribution Test

k star (bias corrected)	0.577
Theta Star	22.55
MLE of Mean	13.02
MLE of Standard Deviation	17.14
nu star	13.86
Approximate Chi Square Value (.05)	6.473
Adjusted Level of Significance	0.029
Adjusted Chi Square Value	5.72
Anderson-Darling Test Statistic	0.337
Anderson-Darling 5% Critical Value	0.77
Kolmogorov-Smirnov Test Statistic	0.157
Kolmogorov-Smirnov 5% Critical Value	0.256

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40)	27.87
95% Adjusted Gamma UCL (Use when n < 40)	31.54

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	20.21
95% Jackknife UCL	20.87
95% Standard Bootstrap UCL	19.96
95% Bootstrap-t UCL	23.98
95% Hall's Bootstrap UCL	23.97
95% Percentile Bootstrap UCL	20.62
95% BCA Bootstrap UCL	21.82
95% Chebyshev(Mean, Sd) UCL	32.08
97.5% Chebyshev(Mean, Sd) UCL	40.33
99% Chebyshev(Mean, Sd) UCL	56.53

Potential UCL to Use

Use 95% Approximate Gamma UCL	27.87

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U72

General Statistics

Number of Valid Data	53	Number of Detected Data	50
Number of Distinct Detected Data	43	Number of Non-Detect Data	3
		Percent Non-Detects	5.66%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0092	Minimum Detected	-4.689
Maximum Detected	80	Maximum Detected	4.382
Mean of Detected	4.335	Mean of Detected	-1.348
SD of Detected	14.02	SD of Detected	2.483
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	9
Number treated as Detected	44
Single DL Non-Detect Percentage	16.98%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.343	Shapiro Wilk Test Statistic	0.921
5% Shapiro Wilk Critical Value	0.947	5% Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.09	Mean	-1.593
SD	13.65	SD	2.617
95% DL/2 (t) UCL	7.229	95% H-Stat (DL/2) UCL	32.56
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	2.165	Mean in Log Scale	-1.652
SD	15.15	SD in Log Scale	2.724
95% MLE (t) UCL	5.65	Mean in Original Scale	4.09
95% MLE (Tiku) UCL	5.494	SD in Original Scale	13.65
		95% t UCL	7.229
		95% Percentile Bootstrap UCL	7.573
		95% BCA Bootstrap UCL	9.128
		95% H UCL	46.55

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.25	Data do not follow a Discernable Distribution (0.05)	
Theta Star	17.32		
nu star	25.02		
A-D Test Statistic	3.591	**Nonparametric Statistics**	
5% A-D Critical Value	0.884	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.884	Mean	4.09
5% K-S Critical Value	0.137	SD	13.52
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.876
		95% KM (t) UCL	7.231
Assuming Gamma Distribution		95% KM (z) UCL	7.175
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	7.23
Minimum	1E-06	95% KM (bootstrap t) UCL	17.53
Maximum	80	95% KM (BCA) UCL	7.77
Mean	4.09	95% KM (Percentile Bootstrap) UCL	7.409
Median	0.11	95% KM (Chebyshev) UCL	12.27
SD	13.65	97.5% KM (Chebyshev) UCL	15.8
k star	0.211	99% KM (Chebyshev) UCL	22.75
Theta star	19.34		
Nu star	22.42	Potential UCLs to Use	
AppChi2	12.65	99% KM (Chebyshev) UCL	22.75
95% Gamma Approximate UCL (Use when n >= 40)	7.247		
95% Adjusted Gamma UCL (Use when n < 40)	7.367		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L93

General Statistics

Number of Valid Data	36	Number of Detected Data	35
Number of Distinct Detected Data	31	Number of Non-Detect Data	1
		Percent Non-Detects	2.78%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.011	Minimum Detected	-4.51
Maximum Detected	670	Maximum Detected	6.507
Mean of Detected	25.3	Mean of Detected	-0.312
SD of Detected	113.7	SD of Detected	2.493
Minimum Non-Detect	0.0049	Minimum Non-Detect	-5.319
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.24	Shapiro Wilk Test Statistic	0.961
5% Shapiro Wilk Critical Value	0.934	5% Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	24.6	Mean	-0.471
SD	112.1	SD	2.635
95% DL/2 (t) UCL	56.18	95% H-Stat (DL/2) UCL	160.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	22.32	Mean in Log Scale	-0.487
SD	112.4	SD in Log Scale	2.672
95% MLE (t) UCL	53.97	Mean in Original Scale	24.6
95% MLE (Tiku) UCL	50.3	SD in Original Scale	112.1
		95% t UCL	56.18
		95% Percentile Bootstrap UCL	60.78
		95% BCA Bootstrap UCL	81.63
		95% H UCL	184.4

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.208	Data appear Lognormal at 5% Significance Level	
Theta Star	121.7		
nu star	14.56		
A-D Test Statistic	4.191	**Nonparametric Statistics**	
5% A-D Critical Value	0.897	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.897	Mean	24.6
5% K-S Critical Value	0.164	SD	110.6
Data not Gamma Distributed at 5% Significance Level		SE of Mean	18.7
		95% KM (t) UCL	56.19
Assuming Gamma Distribution		95% KM (z) UCL	55.35
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	56.18
Minimum	1E-06	95% KM (bootstrap t) UCL	299.8
Maximum	670	95% KM (BCA) UCL	62.3
Mean	24.6	95% KM (Percentile Bootstrap) UCL	61.87
Median	0.395	95% KM (Chebyshev) UCL	106.1
SD	112.1	97.5% KM (Chebyshev) UCL	141.4
k star	0.193	99% KM (Chebyshev) UCL	210.6
Theta star	127.3		
Nu star	13.91	Potential UCLs to Use	
AppChi2	6.512	99% KM (Chebyshev) UCL	210.6
95% Gamma Approximate UCL (Use when n >= 40)	52.56		
95% Adjusted Gamma UCL (Use when n < 40)	54.48		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	12	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	0.44	Minimum of Log Data	-0.821
Maximum	76	Maximum of Log Data	4.331
Mean	21.06	Mean of log Data	1.932
Geometric Mean	6.906	SD of log Data	1.742
Median	8.05		
SD	27.89		
Std. Error of Mean	8.052		
Coefficient of Variation	1.324		
Skewness	1.257		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.73	Shapiro Wilk Test Statistic	0.94
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	35.52	95% H-UCL	318.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	83.58
95% Adjusted-CLT UCL (Chen-1995)	37.43	97.5% Chebyshev (MVUE) UCL	109.1
95% Modified-t UCL (Johnson-1978)	36.01	99% Chebyshev (MVUE) UCL	159.2

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.475	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	44.3		
MLE of Mean	21.06		
MLE of Standard Deviation	30.54		
nu star	11.41		
Approximate Chi Square Value (.05)	4.842	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	34.31
Adjusted Chi Square Value	4.208	95% Jackknife UCL	35.52
		95% Standard Bootstrap UCL	33.92
Anderson-Darling Test Statistic	0.498	95% Bootstrap-t UCL	41.3
Anderson-Darling 5% Critical Value	0.78	95% Hall's Bootstrap UCL	31.37
Kolmogorov-Smirnov Test Statistic	0.181	95% Percentile Bootstrap UCL	34.42
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	38.49
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	56.16
		97.5% Chebyshev(Mean, Sd) UCL	71.35
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	101.2
95% Approximate Gamma UCL (Use when n >= 40)	49.64		
95% Adjusted Gamma UCL (Use when n < 40)	57.12		

Potential UCL to Use		Use 95% Approximate Gamma UCL	49.64

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U93

General Statistics

Number of Valid Data	56	Number of Detected Data	54
Number of Distinct Detected Data	51	Number of Non-Detect Data	2
		Percent Non-Detects	3.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0033	Minimum Detected	-5.714
Maximum Detected	520	Maximum Detected	6.254
Mean of Detected	17.48	Mean of Detected	-0.848
SD of Detected	77.66	SD of Detected	2.68
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	3
Number treated as Detected	53
Single DL Non-Detect Percentage	5.36%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.432	Lilliefors Test Statistic	0.137
5% Lilliefors Critical Value	0.121	5% Lilliefors Critical Value	0.121
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	16.86	Mean	-1.034
SD	76.31	SD	2.805
95% DL/2 (t) UCL	33.92	95% H-Stat (DL/2) UCL	124.4
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	13.78	Mean in Log Scale	-1.058
SD	78.09	SD in Log Scale	2.853
95% MLE (t) UCL	31.23	Mean in Original Scale	16.86
95% MLE (Tiku) UCL	29.41	SD in Original Scale	76.31
		95% t UCL	33.92
		95% Percentile Bootstrap UCL	35.22
		95% BCA Bootstrap UCL	45.04
		95% H UCL	147.3

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.2	Data do not follow a Discernable Distribution (0.05)	
Theta Star	87.45		
nu star	21.59		
A-D Test Statistic	5.617	Nonparametric Statistics	
5% A-D Critical Value	0.909	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.909	Mean	16.86
5% K-S Critical Value	0.134	SD	75.62
Data not Gamma Distributed at 5% Significance Level		SE of Mean	10.2
		95% KM (t) UCL	33.93
Assuming Gamma Distribution		95% KM (z) UCL	33.64
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	33.92
Minimum	1E-06	95% KM (bootstrap t) UCL	183.2
Maximum	520	95% KM (BCA) UCL	39.39
Mean	16.86	95% KM (Percentile Bootstrap) UCL	34.88
Median	0.2	95% KM (Chebyshev) UCL	61.32
SD	76.31	97.5% KM (Chebyshev) UCL	80.56
k star	0.183	99% KM (Chebyshev) UCL	118.4
Theta star	92.15		
Nu star	20.49	Potential UCLs to Use	
AppChi2	11.21	99% KM (Chebyshev) UCL	118.4
95% Gamma Approximate UCL (Use when n >= 40)	30.81		
95% Adjusted Gamma UCL (Use when n < 40)	31.32		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	36	Number of Detected Data	33
Number of Distinct Detected Data	32	Number of Non-Detect Data	3
		Percent Non-Detects	8.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0029	Minimum Detected	-5.843
Maximum Detected	83	Maximum Detected	4.419
Mean of Detected	3.679	Mean of Detected	-1.783
SD of Detected	14.54	SD of Detected	2.338
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	4
Number treated as Detected	32
Single DL Non-Detect Percentage	11.11%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.275	Shapiro Wilk Test Statistic	0.943
5% Shapiro Wilk Critical Value	0.931	5% Shapiro Wilk Critical Value	0.931
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	3.373	Mean	-2.139
SD	13.94	SD	2.537
95% DL/2 (t) UCL	7.299	95% H-Stat (DL/2) UCL	20.45
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	2.149	Mean in Log Scale	-2.182
SD	14.74	SD in Log Scale	2.608
95% MLE (t) UCL	6.3	Mean in Original Scale	3.373
95% MLE (Tiku) UCL	5.981	SD in Original Scale	13.94
		95% t UCL	7.299
		95% Percentile Bootstrap UCL	7.978
		95% BCA Bootstrap UCL	10.73
		95% H UCL	26

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.232	Data appear Lognormal at 5% Significance Level	
Theta Star	15.87		
nu star	15.31		
A-D Test Statistic	3.659	**Nonparametric Statistics**	
5% A-D Critical Value	0.885	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.885	Mean	3.373
5% K-S Critical Value	0.169	SD	13.75
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2.327
		95% KM (t) UCL	7.305
Assuming Gamma Distribution		95% KM (z) UCL	7.2
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	7.299
Minimum	1E-06	95% KM (bootstrap t) UCL	22.56
Maximum	83	95% KM (BCA) UCL	8.074
Mean	3.373	95% KM (Percentile Bootstrap) UCL	7.806
Median	0.0815	95% KM (Chebyshev) UCL	13.52
SD	13.94	97.5% KM (Chebyshev) UCL	17.91
k star	0.189	99% KM (Chebyshev) UCL	26.53
Theta star	17.84		
Nu star	13.61	Potential UCLs to Use	
AppChi2	6.305	99% KM (Chebyshev) UCL	26.53
95% Gamma Approximate UCL (Use when n >= 40)	7.28		
95% Adjusted Gamma UCL (Use when n < 40)	7.55		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.18	Minimum of Log Data	-1.715
Maximum	15	Maximum of Log Data	2.708
Mean	3.871	Mean of log Data	0.399
Geometric Mean	1.49	SD of log Data	1.523
Median	1.25		
SD	5.155		
Std. Error of Mean	1.488		
Coefficient of Variation	1.332		
Skewness	1.426		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.739	Shapiro Wilk Test Statistic	0.942
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.543	95% H-UCL	29.01
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.41
95% Adjusted-CLT UCL (Chen-1995)	6.973	97.5% Chebyshev (MVUE) UCL	16.05
95% Modified-t UCL (Johnson-1978)	6.645	99% Chebyshev (MVUE) UCL	23.2

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.536	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	7.217		
MLE of Mean	3.871		
MLE of Standard Deviation	5.285		
nu star	12.87		
Approximate Chi Square Value (.05)	5.807	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	6.319
Adjusted Chi Square Value	5.1	95% Jackknife UCL	6.543
		95% Standard Bootstrap UCL	6.239
Anderson-Darling Test Statistic	0.531	95% Bootstrap-t UCL	8.249
Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL	6.458
Kolmogorov-Smirnov Test Statistic	0.171	95% Percentile Bootstrap UCL	6.223
Kolmogorov-Smirnov 5% Critical Value	0.256	95% BCA Bootstrap UCL	7.079
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.36
		97.5% Chebyshev(Mean, Sd) UCL	13.16
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18.68
95% Approximate Gamma UCL (Use when n >= 40)	8.581		
95% Adjusted Gamma UCL (Use when n < 40)	9.769		

Potential UCL to Use		Use 95% Approximate Gamma UCL	8.581

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U98

General Statistics

Number of Valid Data	56	Number of Detected Data	39
Number of Distinct Detected Data	33	Number of Non-Detect Data	17
		Percent Non-Detects	30.36%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0065	Minimum Detected	-5.036
Maximum Detected	19	Maximum Detected	2.944
Mean of Detected	1.525	Mean of Detected	-1.88
SD of Detected	4.142	SD of Detected	2.236
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.024	Maximum Non-Detect	-3.73

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	27
Number treated as Detected	29
Single DL Non-Detect Percentage	48.21%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.401	Shapiro Wilk Test Statistic	0.94
5% Shapiro Wilk Critical Value	0.939	5% Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.064	Mean	-3.026
SD	3.514	SD	2.575
95% DL/2 (t) UCL	1.849	95% H-Stat (DL/2) UCL	6.919
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.382
		SD in Log Scale	3.01
		Mean in Original Scale	1.063
		SD in Original Scale	3.515
		95% t UCL	1.849
		95% Percentile Bootstrap UCL	1.863
		95% BCA Bootstrap UCL	2.352
		95% H-UCL	27.85

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.294	Data appear Lognormal at 5% Significance Level	
Theta Star	5.195		
nu star	22.9		
A-D Test Statistic	2.433	**Nonparametric Statistics**	
5% A-D Critical Value	0.858	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.858	Mean	1.064
5% K-S Critical Value	0.153	SD	3.483
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.471
		95% KM (t) UCL	1.853
Assuming Gamma Distribution		95% KM (z) UCL	1.84
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.85
Minimum	1E-06	95% KM (bootstrap t) UCL	3.653
Maximum	19	95% KM (BCA) UCL	1.975
Mean	1.062	95% KM (Percentile Bootstrap) UCL	1.98
Median	0.0315	95% KM (Chebyshev) UCL	3.119
SD	3.515	97.5% KM (Chebyshev) UCL	4.009
k star	0.144	99% KM (Chebyshev) UCL	5.755
Theta star	7.376		
Nu star	16.13	Potential UCLs to Use	
AppChi2	8.053	99% KM (Chebyshev) UCL	5.755
95% Gamma Approximate UCL (Use when n >= 40)	2.127		
95% Adjusted Gamma UCL (Use when n < 40)	2.168		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L99

General Statistics

Number of Valid Data	27	Number of Detected Data	17
Number of Distinct Detected Data	17	Number of Non-Detect Data	10
		Percent Non-Detects	37.04%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0057	Minimum Detected	-5.167
Maximum Detected	12	Maximum Detected	2.485
Mean of Detected	1.209	Mean of Detected	-2.723
SD of Detected	3.327	SD of Detected	2.173
Minimum Non-Detect	0.0047	Minimum Non-Detect	-5.36
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	25
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	92.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.415	Shapiro Wilk Test Statistic	0.843
5% Shapiro Wilk Critical Value	0.892	5% Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.779	Mean	-3.282
SD	2.672	SD	2.01
95% DL/2 (t) UCL	1.657	95% H-Stat (DL/2) UCL	1.399
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.767
		SD in Log Scale	2.291
		Mean in Original Scale	0.763
		SD in Original Scale	2.676
		95% t UCL	1.642
		95% Percentile Bootstrap UCL	1.747
		95% BCA Bootstrap UCL	2.058
		95% H-UCL	2.437

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.241	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	5.02		
nu star	8.186		
A-D Test Statistic	2.796	**Nonparametric Statistics**	
5% A-D Critical Value	0.864	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.864	Mean	0.766
5% K-S Critical Value	0.229	SD	2.625
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.521
		95% KM (t) UCL	1.654
Assuming Gamma Distribution		95% KM (z) UCL	1.622
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.644
Minimum	1E-06	95% KM (bootstrap t) UCL	28.48
Maximum	12	95% KM (BCA) UCL	1.677
Mean	0.761	95% KM (Percentile Bootstrap) UCL	1.667
Median	0.01	95% KM (Chebyshev) UCL	3.036
SD	2.677	97.5% KM (Chebyshev) UCL	4.018
k star	0.132	99% KM (Chebyshev) UCL	5.948
Theta star	5.762		
Nu star	7.132	**Potential UCLs to Use**	
AppChi2	2.243	99% KM (Chebyshev) UCL	5.948
95% Gamma Approximate UCL (Use when n >= 40)	2.419		
95% Adjusted Gamma UCL (Use when n < 40)	2.619		

Note: DL/2 is not a recommended method.

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.**

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General Statistics

Number of Valid Data	12	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	1
		Percent Non-Detects	8.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.013	Minimum Detected	-4.343
Maximum Detected	1.9	Maximum Detected	0.642
Mean of Detected	0.409	Mean of Detected	-1.771
SD of Detected	0.562	SD of Detected	1.502
Minimum Non-Detect	0.53	Minimum Non-Detect	-0.635
Maximum Non-Detect	0.53	Maximum Non-Detect	-0.635

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.72	Shapiro Wilk Test Statistic	0.973
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.397	Mean	-1.734
SD	0.537	SD	1.438
95% DL/2 (t) UCL	0.676	95% H-Stat (DL/2) UCL	2.539
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.821
		SD in Log Scale	1.442
		Mean in Original Scale	0.383
		SD in Original Scale	0.543
		95% t UCL	0.665
		95% Percentile Bootstrap UCL	0.661
		95% BCA Bootstrap UCL	0.758
		95% H-UCL	2.367

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.563	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.728		
nu star	12.38		
A-D Test Statistic	0.325	**Nonparametric Statistics**	
5% A-D Critical Value	0.767	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.767	Mean	0.388
5% K-S Critical Value	0.266	SD	0.52
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.158
		95% KM (t) UCL	0.672
Assuming Gamma Distribution		95% KM (z) UCL	0.648
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.671
Minimum	0.013	95% KM (bootstrap t) UCL	1.025
Maximum	1.9	95% KM (BCA) UCL	0.653
Mean	0.384	95% KM (Percentile Bootstrap) UCL	0.673
Median	0.114	95% KM (Chebyshev) UCL	1.077
SD	0.543	97.5% KM (Chebyshev) UCL	1.375
k star	0.587	99% KM (Chebyshev) UCL	1.96
Theta star	0.655		
Nu star	14.08	Potential UCLs to Use	
AppChi2	6.625	95% KM (Chebyshev) UCL	1.077
95% Gamma Approximate UCL (Use when n >= 40)	0.816		
95% Adjusted Gamma UCL (Use when n < 40)	0.923		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

U99

General Statistics

Number of Valid Data	53	Number of Detected Data	23
Number of Distinct Detected Data	23	Number of Non-Detect Data	30
		Percent Non-Detects	56.60%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0053	Minimum Detected	-5.24
Maximum Detected	280	Maximum Detected	5.635
Mean of Detected	17.84	Mean of Detected	-1.424
SD of Detected	60.76	SD of Detected	3.049
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.48	Maximum Non-Detect	-0.734

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	45
Number treated as Detected	8
Single DL Non-Detect Percentage	84.91%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.334	Shapiro Wilk Test Statistic	0.928
5% Shapiro Wilk Critical Value	0.914	5% Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	7.749	Mean	-3.573
SD	40.51	SD	2.878
95% DL/2 (t) UCL	17.07	95% H-Stat (DL/2) UCL	12.67
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-5.824
		SD in Log Scale	4.62
		Mean in Original Scale	7.741
		SD in Original Scale	40.51
		95% t UCL	17.06
		95% Percentile Bootstrap UCL	18.19
		95% BCA Bootstrap UCL	25.1
		95% H-UCL	16008

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.181	Data appear Lognormal at 5% Significance Level	
Theta Star	98.67		
nu star	8.315		
A-D Test Statistic	2.665	Nonparametric Statistics	
5% A-D Critical Value	0.904	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.904	Mean	7.745
5% K-S Critical Value	0.202	SD	40.13
Data not Gamma Distributed at 5% Significance Level		SE of Mean	5.636
		95% KM (t) UCL	17.18
Assuming Gamma Distribution		95% KM (z) UCL	17.02
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	17.06
Minimum	1E-06	95% KM (bootstrap t) UCL	160.8
Maximum	280	95% KM (BCA) UCL	18.14
Mean	7.741	95% KM (Percentile Bootstrap) UCL	18.32
Median	1E-06	95% KM (Chebyshev) UCL	32.31
SD	40.51	97.5% KM (Chebyshev) UCL	42.94
k star	0.0877	99% KM (Chebyshev) UCL	63.82
Theta star	88.28		
Nu star	9.294	Potential UCLs to Use	
AppChi2	3.505	99% KM (Chebyshev) UCL	63.82
95% Gamma Approximate UCL (Use when n >= 40)	20.52		
95% Adjusted Gamma UCL (Use when n < 40)	21.12		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L109

General Statistics

Number of Valid Observations	27	Number of Distinct Observations	25

Raw Statistics		Log-transformed Statistics	
Minimum	0.013	Minimum of Log Data	-4.343
Maximum	940	Maximum of Log Data	6.846
Mean	45.21	Mean of log Data	0.427
Geometric Mean	1.533	SD of log Data	2.503
Median	1.2		
SD	182.1		
Std. Error of Mean	35.05		
Coefficient of Variation	4.028		
Skewness	4.931		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.269	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.923	Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	105	95% H-UCL	387.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	91.94
95% Adjusted-CLT UCL (Chen-1995)	138.4	97.5% Chebyshev (MVUE) UCL	121.3
95% Modified-t UCL (Johnson-1978)	110.5	99% Chebyshev (MVUE) UCL	178.9

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.216	Data appear Lognormal at 5% Significance Level	
Theta Star	209.5		
MLE of Mean	45.21		
MLE of Standard Deviation	97.32		
nu star	11.65		
Approximate Chi Square Value (.05)	4.999	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0401	95% CLT UCL	102.9
Adjusted Chi Square Value	4.723	95% Jackknife UCL	105
		95% Standard Bootstrap UCL	100.7
Anderson-Darling Test Statistic	3.194	95% Bootstrap-t UCL	1320
Anderson-Darling 5% Critical Value	0.889	95% Hall's Bootstrap UCL	825.9
Kolmogorov-Smirnov Test Statistic	0.273	95% Percentile Bootstrap UCL	112.7
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	157.7
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	198
		97.5% Chebyshev(Mean, Sd) UCL	264.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	393.9
95% Approximate Gamma UCL (Use when n >= 40)	105.4		
95% Adjusted Gamma UCL (Use when n < 40)	111.6		

Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	393.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S109

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.45	Minimum of Log Data	-0.799
Maximum	110	Maximum of Log Data	4.7
Mean	28.74	Mean of log Data	2.21
Geometric Mean	9.116	SD of log Data	1.778
Median	10		
SD	39.23		
Std. Error of Mean	11.32		
Coefficient of Variation	1.365		
Skewness	1.428		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.735	Shapiro Wilk Test Statistic	0.958
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	49.07	95% H-UCL	489.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	117.5
95% Adjusted-CLT UCL (Chen-1995)	52.35	97.5% Chebyshev (MVUE) UCL	153.6
95% Modified-t UCL (Johnson-1978)	49.85	99% Chebyshev (MVUE) UCL	224.5

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.465	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	61.81		
MLE of Mean	28.74		
MLE of Standard Deviation	42.15		
nu star	11.16		
Approximate Chi Square Value (.05)	4.678	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	47.36
Adjusted Chi Square Value	4.057	95% Jackknife UCL	49.07
		95% Standard Bootstrap UCL	46.37
Anderson-Darling Test Statistic	0.405	95% Bootstrap-t UCL	68.52
Anderson-Darling 5% Critical Value	0.781	95% Hall's Bootstrap UCL	54.5
Kolmogorov-Smirnov Test Statistic	0.182	95% Percentile Bootstrap UCL	47.25
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	50.33
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	78.1
		97.5% Chebyshev(Mean, Sd) UCL	99.46
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	141.4
95% Approximate Gamma UCL (Use when n >= 40)	68.55		
95% Adjusted Gamma UCL (Use when n < 40)	79.04		

Potential UCL to Use		Use 95% Approximate Gamma UCL	68.55

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U109

General Statistics

Number of Valid Data	53	Number of Detected Data	51
Number of Distinct Detected Data	46	Number of Non-Detect Data	2
		Percent Non-Detects	3.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.015	Minimum Detected	-4.2
Maximum Detected	960	Maximum Detected	6.867
Mean of Detected	34.61	Mean of Detected	-0.339
SD of Detected	150.4	SD of Detected	2.748
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	2
Number treated as Detected	51
Single DL Non-Detect Percentage	3.77%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.435	Lilliefors Test Statistic	0.155
5% Lilliefors Critical Value	0.124	5% Lilliefors Critical Value	0.124
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	33.3	Mean	-0.554
SD	147.6	SD	2.91
95% DL/2 (t) UCL	67.26	95% H-Stat (DL/2) UCL	296
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	29.18	Mean in Log Scale	-0.588
SD	149.5	SD in Log Scale	2.98
95% MLE (t) UCL	63.58	Mean in Original Scale	33.3
95% MLE (Tiku) UCL	59.74	SD in Original Scale	147.6
		95% t UCL	67.26
		95% Percentile Bootstrap UCL	69.26
		95% BCA Bootstrap UCL	88.5
		95% H UCL	385

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.193	Data do not follow a Discernable Distribution (0.05)	
Theta Star	179.5		
nu star	19.66		
A-D Test Statistic	5.531	Nonparametric Statistics	
5% A-D Critical Value	0.914	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.914	Mean	33.3
5% K-S Critical Value	0.138	SD	146.2
Data not Gamma Distributed at 5% Significance Level		SE of Mean	20.29
		95% KM (t) UCL	67.27
Assuming Gamma Distribution		95% KM (z) UCL	66.67
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	67.26
Minimum	1E-06	95% KM (bootstrap t) UCL	393.3
Maximum	960	95% KM (BCA) UCL	70.42
Mean	33.3	95% KM (Percentile Bootstrap) UCL	69.9
Median	0.28	95% KM (Chebyshev) UCL	121.7
SD	147.6	97.5% KM (Chebyshev) UCL	160
k star	0.176	99% KM (Chebyshev) UCL	235.1
Theta star	189.6		
Nu star	18.62	Potential UCLs to Use	
AppChi2	9.842	99% KM (Chebyshev) UCL	235.1
95% Gamma Approximate UCL (Use when n >= 40)	63.01		
95% Adjusted Gamma UCL (Use when n < 40)	64.18		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L110

General Statistics

Number of Valid Data	27	Number of Detected Data	18
Number of Distinct Detected Data	18	Number of Non-Detect Data	9
		Percent Non-Detects	33.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0066	Minimum Detected	-5.021
Maximum Detected	18	Maximum Detected	2.89
Mean of Detected	1.959	Mean of Detected	-2.468
SD of Detected	5.484	SD of Detected	2.206
Minimum Non-Detect	0.0044	Minimum Non-Detect	-5.426
Maximum Non-Detect	0.79	Maximum Non-Detect	-0.236

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	25
Number treated as Detected	2
Single DL Non-Detect Percentage	92.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.392	Shapiro Wilk Test Statistic	0.822
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.324	Mean	-3.093
SD	4.528	SD	2.166
95% DL/2 (t) UCL	2.81	95% H-Stat (DL/2) UCL	2.958
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.533
		SD in Log Scale	2.45
		Mean in Original Scale	1.308
		SD in Original Scale	4.532
		95% t UCL	2.796
		95% Percentile Bootstrap UCL	2.712
		95% BCA Bootstrap UCL	3.324
		95% H-UCL	5.872

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.228	Data do not follow a Discernable Distribution (0.05)	
Theta Star	8.585		
nu star	8.214		
A-D Test Statistic	3.263	**Nonparametric Statistics**	
5% A-D Critical Value	0.872	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.872	Mean	1.311
5% K-S Critical Value	0.224	SD	4.447
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.881
		95% KM (t) UCL	2.813
Assuming Gamma Distribution		95% KM (z) UCL	2.759
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.798
Minimum	1E-06	95% KM (bootstrap t) UCL	69.04
Maximum	18	95% KM (BCA) UCL	2.73
Mean	1.306	95% KM (Percentile Bootstrap) UCL	2.716
Median	0.022	95% KM (Chebyshev) UCL	5.149
SD	4.533	97.5% KM (Chebyshev) UCL	6.81
k star	0.133	99% KM (Chebyshev) UCL	10.07
Theta star	9.842		
Nu star	7.164	Potential UCLs to Use	
AppChi2	2.261	99% KM (Chebyshev) UCL	10.07
95% Gamma Approximate UCL (Use when n >= 40)	4.137		
95% Adjusted Gamma UCL (Use when n < 40)	4.478		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S110

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.012	Minimum of Log Data	-4.423
Maximum	4.1	Maximum of Log Data	1.411
Mean	0.893	Mean of log Data	-1.288
Geometric Mean	0.276	SD of log Data	1.827
Median	0.268		
SD	1.252		
Std. Error of Mean	0.361		
Coefficient of Variation	1.402		
Skewness	1.814		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.744	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	1.542	95% H-UCL	18.28
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.87
95% Adjusted-CLT UCL (Chen-1995)	1.69	97.5% Chebyshev (MVUE) UCL	5.067
95% Modified-t UCL (Johnson-1978)	1.573	99% Chebyshev (MVUE) UCL	7.419

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.457	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	1.955		
MLE of Mean	0.893		
MLE of Standard Deviation	1.321		
nu star	10.96		
Approximate Chi Square Value (.05)	4.553	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	1.487
Adjusted Chi Square Value	3.942	95% Jackknife UCL	1.542
		95% Standard Bootstrap UCL	1.477
Anderson-Darling Test Statistic	0.334	95% Bootstrap-t UCL	2.062
Anderson-Darling 5% Critical Value	0.782	95% Hall's Bootstrap UCL	1.879
Kolmogorov-Smirnov Test Statistic	0.178	95% Percentile Bootstrap UCL	1.46
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	1.594
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2.468
		97.5% Chebyshev(Mean, Sd) UCL	3.15
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	4.488
95% Approximate Gamma UCL (Use when n >= 40)	2.15		
95% Adjusted Gamma UCL (Use when n < 40)	2.484		

Potential UCL to Use		Use 95% Approximate Gamma UCL	2.15

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U110

General Statistics

Number of Valid Data	53	Number of Detected Data	33
Number of Distinct Detected Data	29	Number of Non-Detect Data	20
		Percent Non-Detects	37.74%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0049	Minimum Detected	-5.319
Maximum Detected	1400	Maximum Detected	7.244
Mean of Detected	59.38	Mean of Detected	-1.47
SD of Detected	253.2	SD of Detected	3.262
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.048	Maximum Non-Detect	-3.037

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	33
Number treated as Detected	20
Single DL Non-Detect Percentage	62.26%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.263	Shapiro Wilk Test Statistic	0.898
5% Shapiro Wilk Critical Value	0.931	5% Shapiro Wilk Critical Value	0.931
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	36.97	Mean	-3.015
SD	200.7	SD	3.284
95% DL/2 (t) UCL	83.14	95% H-Stat (DL/2) UCL	133.5
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.233
		SD in Log Scale	4.519
		Mean in Original Scale	36.97
		SD in Original Scale	200.7
		95% t UCL	83.14
		95% Percentile Bootstrap UCL	89.67
		95% BCA Bootstrap UCL	118.4
		95% H-UCL	40397

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.147	Data do not follow a Discernable Distribution (0.05)	
Theta Star	403.2		
nu star	9.72		
A-D Test Statistic	4.968	**Nonparametric Statistics**	
5% A-D Critical Value	0.931	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.931	Mean	36.97
5% K-S Critical Value	0.172	SD	198.8
Data not Gamma Distributed at 5% Significance Level		SE of Mean	27.73
		95% KM (t) UCL	83.41
Assuming Gamma Distribution		95% KM (z) UCL	82.59
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	83.14
Minimum	1E-06	95% KM (bootstrap t) UCL	951.1
Maximum	1400	95% KM (BCA) UCL	89.39
Mean	36.97	95% KM (Percentile Bootstrap) UCL	89.42
Median	0.013	95% KM (Chebyshev) UCL	157.9
SD	200.7	97.5% KM (Chebyshev) UCL	210.2
k star	0.0928	99% KM (Chebyshev) UCL	312.9
Theta star	398.3		
Nu star	9.838	Potential UCLs to Use	
AppChi2	3.841	99% KM (Chebyshev) UCL	312.9
95% Gamma Approximate UCL (Use when n >= 40)	94.7		
95% Adjusted Gamma UCL (Use when n < 40)	97.35		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L116

General Statistics			
Number of Valid Data	36	Number of Detected Data	35
Number of Distinct Detected Data	34	Number of Non-Detect Data	1
		Percent Non-Detects	2.78%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0061	Minimum Detected	-5.099
Maximum Detected	330	Maximum Detected	5.799
Mean of Detected	13.55	Mean of Detected	-0.816
SD of Detected	56.17	SD of Detected	2.547
Minimum Non-Detect	0.0049	Minimum Non-Detect	-5.319
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.263	Shapiro Wilk Test Statistic	0.96
5% Shapiro Wilk Critical Value	0.934	5% Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	13.17	Mean	-0.961
SD	55.41	SD	2.655
95% DL/2 (t) UCL	28.78	95% H-Stat (DL/2) UCL	107.1
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	12.06	Mean in Log Scale	-0.995
SD	55.55	SD in Log Scale	2.73
95% MLE (t) UCL	27.7	Mean in Original Scale	13.17
95% MLE (Tiku) UCL	25.89	SD in Original Scale	55.41
		95% t UCL	28.78
		95% Percentile Bootstrap UCL	31.1
		95% BCA Bootstrap UCL	42.36
		95% H UCL	141.8
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.214	Data appear Lognormal at 5% Significance Level	
Theta Star	63.41		
nu star	14.96		
A-D Test Statistic	3.766	**Nonparametric Statistics**	
5% A-D Critical Value	0.894	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.894	Mean	13.17
5% K-S Critical Value	0.164	SD	54.63
Data not Gamma Distributed at 5% Significance Level		SE of Mean	9.239
		95% KM (t) UCL	28.78
Assuming Gamma Distribution		95% KM (z) UCL	28.37
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	28.78
Minimum	1E-06	95% KM (bootstrap t) UCL	99.58
Maximum	330	95% KM (BCA) UCL	31.65
Mean	13.17	95% KM (Percentile Bootstrap) UCL	31.1
Median	0.265	95% KM (Chebyshev) UCL	53.44
SD	55.41	97.5% KM (Chebyshev) UCL	70.87
k star	0.199	99% KM (Chebyshev) UCL	105.1
Theta star	66.32		
Nu star	14.3	**Potential UCLs to Use**	
AppChi2	6.778	99% KM (Chebyshev) UCL	105.1
95% Gamma Approximate UCL (Use when n >= 40)	27.8		
95% Adjusted Gamma UCL (Use when n < 40)	28.79		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S116

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	11
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.48	Minimum of Log Data	-0.734
Maximum	41	Maximum of Log Data	3.714
Mean	12.28	Mean of log Data	1.651
Geometric Mean	5.214	SD of log Data	1.536
Median	5.4		
SD	13.94		
Std. Error of Mean	4.024		
Coefficient of Variation	1.136		
Skewness	1.081		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.825	Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	19.5	95% H-UCL	106.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	44.45
95% Adjusted-CLT UCL (Chen-1995)	20.24	97.5% Chebyshev (MVUE) UCL	57.52
95% Modified-t UCL (Johnson-1978)	19.71	99% Chebyshev (MVUE) UCL	83.18
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.584	ata appear Gamma Distributed at 5% Significance Leve	
Theta Star	21.01		
MLE of Mean	12.28		
MLE of Standard Deviation	16.06		
nu star	14.02		
Approximate Chi Square Value (.05)	6.588	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	18.9
Adjusted Chi Square Value	5.828	95% Jackknife UCL	19.5
		95% Standard Bootstrap UCL	18.73
Anderson-Darling Test Statistic	0.366	95% Bootstrap-t UCL	21.7
Anderson-Darling 5% Critical Value	0.769	95% Hall's Bootstrap UCL	19.44
Kolmogorov-Smirnov Test Statistic	0.173	95% Percentile Bootstrap UCL	18.82
Kolmogorov-Smirnov 5% Critical Value	0.256	95% BCA Bootstrap UCL	19.33
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	29.82
		97.5% Chebyshev(Mean, Sd) UCL	37.41
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	52.32
95% Approximate Gamma UCL (Use when n >= 40)	26.13		
95% Adjusted Gamma UCL (Use when n < 40)	29.55		
Potential UCL to Use		Use 95% Approximate Gamma UCL	26.13

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U116

General Statistics

Number of Valid Data	56	Number of Detected Data	52
Number of Distinct Detected Data	47	Number of Non-Detect Data	4
		Percent Non-Detects	7.14%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0076	Minimum Detected	-4.88
Maximum Detected	85	Maximum Detected	4.443
Mean of Detected	4.097	Mean of Detected	-1.502
SD of Detected	14.14	SD of Detected	2.49
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.014	Maximum Non-Detect	-4.269

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	44
Single DL Non-Detect Percentage	21.43%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.386	Lilliefors Test Statistic	0.132
5% Lilliefors Critical Value	0.123	5% Lilliefors Critical Value	0.123
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	3.805	Mean	-1.807
SD	13.65	SD	2.644
95% DL/2 (t) UCL	6.857	95% H-Stat (DL/2) UCL	30.43
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.219	Mean in Log Scale	-1.887
SD	15.67	SD in Log Scale	2.786
95% MLE (t) UCL	4.722	Mean in Original Scale	3.805
95% MLE (Tiku) UCL	4.656	SD in Original Scale	13.65
		95% t UCL	6.857
		95% Percentile Bootstrap UCL	7.142
		95% BCA Bootstrap UCL	8.671
		95% H UCL	49.15

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.243	Data do not follow a Discernable Distribution (0.05)	
Theta Star	16.83		
nu star	25.32		
A-D Test Statistic	3.943	**Nonparametric Statistics**	
5% A-D Critical Value	0.888	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.888	Mean	3.805
5% K-S Critical Value	0.135	SD	13.53
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.826
		95% KM (t) UCL	6.86
Assuming Gamma Distribution		95% KM (z) UCL	6.808
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	6.858
Minimum	1E-06	95% KM (bootstrap t) UCL	17.64
Maximum	85	95% KM (BCA) UCL	7.454
Mean	3.805	95% KM (Percentile Bootstrap) UCL	6.99
Median	0.1	95% KM (Chebyshev) UCL	11.76
SD	13.65	97.5% KM (Chebyshev) UCL	15.21
k star	0.2	99% KM (Chebyshev) UCL	21.97
Theta star	19.07		
Nu star	22.34	Potential UCLs to Use	
AppChi2	12.6	99% KM (Chebyshev) UCL	21.97
95% Gamma Approximate UCL (Use when n >= 40)	6.749		
95% Adjusted Gamma UCL (Use when n < 40)	6.854		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L126

General Statistics

Number of Valid Data	27	Number of Detected Data	26
Number of Distinct Detected Data	24	Number of Non-Detect Data	1
		Percent Non-Detects	3.70%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.022	Minimum Detected	-3.817
Maximum Detected	39	Maximum Detected	3.664
Mean of Detected	2.267	Mean of Detected	-1.676
SD of Detected	7.866	SD of Detected	1.868
Minimum Non-Detect	0.015	Minimum Non-Detect	-4.2
Maximum Non-Detect	0.015	Maximum Non-Detect	-4.2

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.318	Shapiro Wilk Test Statistic	0.875
5% Shapiro Wilk Critical Value	0.92	5% Shapiro Wilk Critical Value	0.92
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.183	Mean	-1.796
SD	7.725	SD	1.933
95% DL/2 (t) UCL	4.719	95% H-Stat (DL/2) UCL	4.768
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.979	Mean in Log Scale	-1.842
SD	7.755	SD in Log Scale	2.023
95% MLE (t) UCL	4.524	Mean in Original Scale	2.183
95% MLE (Tiku) UCL	4.245	SD in Original Scale	7.725
		95% t UCL	4.719
		95% Percentile Bootstrap UCL	4.944
		95% BCA Bootstrap UCL	6.543
		95% H UCL	6.176

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.273	Data do not follow a Discernable Distribution (0.05)	
Theta Star	8.304		
nu star	14.19		
A-D Test Statistic	3.874	**Nonparametric Statistics**	
5% A-D Critical Value	0.86	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.86	Mean	2.184
5% K-S Critical Value	0.187	SD	7.581
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.488
		95% KM (t) UCL	4.721
Assuming Gamma Distribution		95% KM (z) UCL	4.631
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	4.719
Minimum	1E-06	95% KM (bootstrap t) UCL	23.52
Maximum	39	95% KM (BCA) UCL	5.058
Mean	2.183	95% KM (Percentile Bootstrap) UCL	4.888
Median	0.12	95% KM (Chebyshev) UCL	8.669
SD	7.725	97.5% KM (Chebyshev) UCL	11.47
k star	0.243	99% KM (Chebyshev) UCL	16.99
Theta star	8.998		
Nu star	13.1	Potential UCLs to Use	
AppChi2	5.96	99% KM (Chebyshev) UCL	16.99
95% Gamma Approximate UCL (Use when n >= 40)	4.798		
95% Adjusted Gamma UCL (Use when n < 40)	5.058		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S126

General Statistics

Number of Valid Data	12	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	1
		Percent Non-Detects	8.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.081	Minimum Detected	-2.513
Maximum Detected	7.3	Maximum Detected	1.988
Mean of Detected	1.812	Mean of Detected	-0.209
SD of Detected	2.259	SD of Detected	1.424
Minimum Non-Detect	0.53	Minimum Non-Detect	-0.635
Maximum Non-Detect	0.53	Maximum Non-Detect	-0.635

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.773	Shapiro Wilk Test Statistic	0.962
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.683	Mean	-0.302
SD	2.2	SD	1.395
95% DL/2 (t) UCL	2.823	95% H-Stat (DL/2) UCL	9.201
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.86	Mean in Log Scale	-0.328
SD	3.014	SD in Log Scale	1.418
95% MLE (t) UCL	2.422	Mean in Original Scale	1.677
95% MLE (Tiku) UCL	2.639	SD in Original Scale	2.204
		95% t UCL	2.82
		95% Percentile Bootstrap UCL	2.745
		95% BCA Bootstrap UCL	3.075
		95% H UCL	9.699

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.603	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	3.006		
nu star	13.26		
A-D Test Statistic	0.379	**Nonparametric Statistics**	
5% A-D Critical Value	0.763	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.763	Mean	1.678
5% K-S Critical Value	0.265	SD	2.11
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.639
		95% KM (t) UCL	2.825
Assuming Gamma Distribution		95% KM (z) UCL	2.729
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.82
Minimum	1E-06	95% KM (bootstrap t) UCL	3.577
Maximum	7.3	95% KM (BCA) UCL	2.725
Mean	1.661	95% KM (Percentile Bootstrap) UCL	2.802
Median	0.65	95% KM (Chebyshev) UCL	4.462
SD	2.217	97.5% KM (Chebyshev) UCL	5.667
k star	0.327	99% KM (Chebyshev) UCL	8.034
Theta star	5.084		
Nu star	7.84	Potential UCLs to Use	
AppChi2	2.643	95% KM (Chebyshev) UCL	4.462
95% Gamma Approximate UCL (Use when n >= 40)	4.927		
95% Adjusted Gamma UCL (Use when n < 40)	5.905		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

U126

General Statistics

Number of Valid Data	53	Number of Detected Data	45
Number of Distinct Detected Data	44	Number of Non-Detect Data	8
		Percent Non-Detects	15.09%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0088	Minimum Detected	-4.733
Maximum Detected	63000	Maximum Detected	11.05
Mean of Detected	1541	Mean of Detected	-0.909
SD of Detected	9385	SD of Detected	3.439
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.016	Maximum Non-Detect	-4.135

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	9
Number treated as Detected	44
Single DL Non-Detect Percentage	16.98%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.171	Shapiro Wilk Test Statistic	0.779
5% Shapiro Wilk Critical Value	0.945	5% Shapiro Wilk Critical Value	0.945
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1308	Mean	-1.607
SD	8651	SD	3.583
95% DL/2 (t) UCL	3298	95% H-Stat (DL/2) UCL	2390
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	20.84	Mean in Log Scale	-1.967
SD	9512	SD in Log Scale	4.059
95% MLE (t) UCL	2209	Mean in Original Scale	1308
95% MLE (Tiku) UCL	2112	SD in Original Scale	8651
		95% t UCL	3298
		95% Percentile Bootstrap UCL	3683
		95% BCA Bootstrap UCL	5944
		95% H UCL	22857

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.107	Data do not follow a Discernable Distribution (0.05)	
Theta Star	14420		
nu star	9.617		
A-D Test Statistic	10.63	Nonparametric Statistics	
5% A-D Critical Value	0.984	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.984	Mean	1308
5% K-S Critical Value	0.15	SD	8569
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1190
		95% KM (t) UCL	3302
Assuming Gamma Distribution		95% KM (z) UCL	3266
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3298
Minimum	1E-06	95% KM (bootstrap t) UCL	37604
Maximum	63000	95% KM (BCA) UCL	3729
Mean	1308	95% KM (Percentile Bootstrap) UCL	3649
Median	0.1	95% KM (Chebyshev) UCL	6497
SD	8651	97.5% KM (Chebyshev) UCL	8742
k star	0.0907	99% KM (Chebyshev) UCL	13152
Theta star	14425		
Nu star	9.614	Potential UCLs to Use	
AppChi2	3.702	99% KM (Chebyshev) UCL	13152
95% Gamma Approximate UCL (Use when n >= 40)	3398		
95% Adjusted Gamma UCL (Use when n < 40)	3494		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

L134

General Statistics

Number of Valid Observations	27	Number of Distinct Observations	26

Raw Statistics		Log-transformed Statistics	
Minimum	0.01	Minimum of Log Data	-4.605
Maximum	150	Maximum of Log Data	5.011
Mean	9.765	Mean of log Data	-0.639
Geometric Mean	0.528	SD of log Data	2.133
Median	0.54		
SD	33.18		
Std. Error of Mean	6.386		
Coefficient of Variation	3.398		
Skewness	3.77		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.325	Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.923	Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	20.66	95% H-UCL	30.53
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.79
95% Adjusted-CLT UCL (Chen-1995)	25.22	97.5% Chebyshev (MVUE) UCL	17.99
95% Modified-t UCL (Johnson-1978)	21.43	99% Chebyshev (MVUE) UCL	26.24

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.242	Data appear Lognormal at 5% Significance Level	
Theta Star	40.37		
MLE of Mean	9.765		
MLE of Standard Deviation	19.86		
nu star	13.06		
Approximate Chi Square Value (.05)	5.934	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0401	95% CLT UCL	20.27
Adjusted Chi Square Value	5.628	95% Jackknife UCL	20.66
		95% Standard Bootstrap UCL	20.09
Anderson-Darling Test Statistic	3.951	95% Bootstrap-t UCL	286.8
Anderson-Darling 5% Critical Value	0.877	95% Hall's Bootstrap UCL	209.2
Kolmogorov-Smirnov Test Statistic	0.336	95% Percentile Bootstrap UCL	20.97
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	26.59
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	37.6
		97.5% Chebyshev(Mean, Sd) UCL	49.64
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	73.3
95% Approximate Gamma UCL (Use when n >= 40)	21.49		
95% Adjusted Gamma UCL (Use when n < 40)	22.66		

Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	49.64

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S134

General Statistics

Number of Valid Observations	12
Number of Distinct Observations	12

Raw Statistics

Minimum	0.21
Maximum	52
Mean	10.93
Geometric Mean	3.966
Median	4.6
SD	15.24
Std. Error of Mean	4.399
Coefficient of Variation	1.394
Skewness	2.082

Log-transformed Statistics

Minimum of Log Data	-1.561
Maximum of Log Data	3.951
Mean of log Data	1.378
SD of log Data	1.663

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.733
Shapiro Wilk Critical Value	0.859

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.98
Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	18.83

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	20.99
95% Modified-t UCL (Johnson-1978)	19.27

Assuming Lognormal Distribution

95% H-UCL	132.5
95% Chebyshev (MVUE) UCL	41.93
97.5% Chebyshev (MVUE) UCL	54.56
99% Chebyshev (MVUE) UCL	79.38

Gamma Distribution Test

k star (bias corrected)	0.512
Theta Star	21.36
MLE of Mean	10.93
MLE of Standard Deviation	15.28
nu star	12.28
Approximate Chi Square Value (.05)	5.414
Adjusted Level of Significance	0.029
Adjusted Chi Square Value	4.736
Anderson-Darling Test Statistic	0.225
Anderson-Darling 5% Critical Value	0.777
Kolmogorov-Smirnov Test Statistic	0.135
Kolmogorov-Smirnov 5% Critical Value	0.257

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

ata appear Gamma Distributed at 5% Significance Leve

Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40)	24.8
95% Adjusted Gamma UCL (Use when n < 40)	28.35

Nonparametric Statistics

95% CLT UCL	18.17
95% Jackknife UCL	18.83
95% Standard Bootstrap UCL	17.96
95% Bootstrap-t UCL	27.85
95% Hall's Bootstrap UCL	47.12
95% Percentile Bootstrap UCL	18.73
95% BCA Bootstrap UCL	21.27
95% Chebyshev(Mean, Sd) UCL	30.11
97.5% Chebyshev(Mean, Sd) UCL	38.4
99% Chebyshev(Mean, Sd) UCL	54.7

Potential UCL to Use

Use 95% Approximate Gamma UCL	24.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U134

General Statistics

Number of Valid Data	53	Number of Detected Data	51
Number of Distinct Detected Data	47	Number of Non-Detect Data	2
		Percent Non-Detects	3.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.011	Minimum Detected	-4.51
Maximum Detected	2900	Maximum Detected	7.972
Mean of Detected	98.24	Mean of Detected	-0.606
SD of Detected	459.4	SD of Detected	3.066
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	2
Number treated as Detected	51
Single DL Non-Detect Percentage	3.77%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.482	Lilliefors Test Statistic	0.138
5% Lilliefors Critical Value	0.124	5% Lilliefors Critical Value	0.124
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	94.53	Mean	-0.811
SD	450.9	SD	3.183
95% DL/2 (t) UCL	198.3	95% H-Stat (DL/2) UCL	757.5
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	81.85	Mean in Log Scale	-0.882
SD	456.6	SD in Log Scale	3.32
95% MLE (t) UCL	186.9	Mean in Original Scale	94.53
95% MLE (Tiku) UCL	175.1	SD in Original Scale	450.9
		95% t UCL	198.3
		95% Percentile Bootstrap UCL	204.9
		95% BCA Bootstrap UCL	264.7
		95% H UCL	1342

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.153	Data do not follow a Discernable Distribution (0.05)	
Theta Star	643.8		
nu star	15.57		
A-D Test Statistic	7.387	Nonparametric Statistics	
5% A-D Critical Value	0.942	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.942	Mean	94.53
5% K-S Critical Value	0.14	SD	446.6
Data not Gamma Distributed at 5% Significance Level		SE of Mean	61.96
		95% KM (t) UCL	198.3
Assuming Gamma Distribution		95% KM (z) UCL	196.4
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	198.3
Minimum	1E-06	95% KM (bootstrap t) UCL	1302
Maximum	2900	95% KM (BCA) UCL	229.2
Mean	94.53	95% KM (Percentile Bootstrap) UCL	207
Median	0.19	95% KM (Chebyshev) UCL	364.6
SD	450.9	97.5% KM (Chebyshev) UCL	481.5
k star	0.142	99% KM (Chebyshev) UCL	711
Theta star	663.7		
Nu star	15.1	Potential UCLs to Use	
AppChi2	7.33	99% KM (Chebyshev) UCL	711
95% Gamma Approximate UCL (Use when n >= 40)	194.7		
95% Adjusted Gamma UCL (Use when n < 40)	198.8		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	27	Number of Distinct Observations	26

Raw Statistics		Log-transformed Statistics	
Minimum	0.017	Minimum of Log Data	-4.075
Maximum	1400	Maximum of Log Data	7.244
Mean	64.76	Mean of log Data	0.593
Geometric Mean	1.809	SD of log Data	2.56
Median	1.2		
SD	269.5		
Std. Error of Mean	51.87		
Coefficient of Variation	4.162		
Skewness	5.042		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.259	Shapiro Wilk Test Statistic	0.963
Shapiro Wilk Critical Value	0.923	Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	153.2	95% H-UCL	586.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	124.1
95% Adjusted-CLT UCL (Chen-1995)	203.9	97.5% Chebyshev (MVUE) UCL	163.9
95% Modified-t UCL (Johnson-1978)	161.6	99% Chebyshev (MVUE) UCL	242.1
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.207	Data appear Lognormal at 5% Significance Level	
Theta Star	313.1		
MLE of Mean	64.76		
MLE of Standard Deviation	142.4		
nu star	11.17		
Approximate Chi Square Value (.05)	4.685	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0401	95% CLT UCL	150.1
Adjusted Chi Square Value	4.418	95% Jackknife UCL	153.2
		95% Standard Bootstrap UCL	147.1
Anderson-Darling Test Statistic	3.253	95% Bootstrap-t UCL	1243
Anderson-Darling 5% Critical Value	0.894	95% Hall's Bootstrap UCL	1038
Kolmogorov-Smirnov Test Statistic	0.281	95% Percentile Bootstrap UCL	166.5
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	226.5
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	290.9
		97.5% Chebyshev(Mean, Sd) UCL	388.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	580.9
95% Approximate Gamma UCL (Use when n >= 40)	154.4		
95% Adjusted Gamma UCL (Use when n < 40)	163.7		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	580.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.61	Minimum of Log Data	-0.494
Maximum	170	Maximum of Log Data	5.136
Mean	40.87	Mean of log Data	2.427
Geometric Mean	11.33	SD of log Data	1.858
Median	12.5		
SD	58.59		
Std. Error of Mean	16.91		
Coefficient of Variation	1.434		
Skewness	1.467		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.723	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	71.24	95% H-UCL	863.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	168
95% Adjusted-CLT UCL (Chen-1995)	76.34	97.5% Chebyshev (MVUE) UCL	220.2
95% Modified-t UCL (Johnson-1978)	72.43	99% Chebyshev (MVUE) UCL	322.7

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.427	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	95.64		
MLE of Mean	40.87		
MLE of Standard Deviation	62.52		
nu star	10.25		
Approximate Chi Square Value (.05)	4.102	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	68.69
Adjusted Chi Square Value	3.528	95% Jackknife UCL	71.24
		95% Standard Bootstrap UCL	67.01
Anderson-Darling Test Statistic	0.553	95% Bootstrap-t UCL	93.01
Anderson-Darling 5% Critical Value	0.786	95% Hall's Bootstrap UCL	68.91
Kolmogorov-Smirnov Test Statistic	0.201	95% Percentile Bootstrap UCL	68.6
Kolmogorov-Smirnov 5% Critical Value	0.259	95% BCA Bootstrap UCL	75.28
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	114.6
		97.5% Chebyshev(Mean, Sd) UCL	146.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	209.1
95% Approximate Gamma UCL (Use when n >= 40)	102.2		
95% Adjusted Gamma UCL (Use when n < 40)	118.8		

Potential UCL to Use		Use 95% Adjusted Gamma UCL	118.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U136

General Statistics

Number of Valid Data	53	Number of Detected Data	51
Number of Distinct Detected Data	43	Number of Non-Detect Data	2
		Percent Non-Detects	3.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.021	Minimum Detected	-3.863
Maximum Detected	1400	Maximum Detected	7.244
Mean of Detected	52.13	Mean of Detected	-0.0391
SD of Detected	225.2	SD of Detected	2.778
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	2
Number treated as Detected	51
Single DL Non-Detect Percentage	3.77%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.44	Lilliefors Test Statistic	0.142
5% Lilliefors Critical Value	0.124	5% Lilliefors Critical Value	0.124
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	50.17	Mean	-0.266
SD	221	SD	2.959
95% DL/2 (t) UCL	101	95% H-Stat (DL/2) UCL	485.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	43.99	Mean in Log Scale	-0.291
SD	223.9	SD in Log Scale	3.013
95% MLE (t) UCL	95.5	Mean in Original Scale	50.17
95% MLE (Tiku) UCL	89.76	SD in Original Scale	221
		95% t UCL	101
		95% Percentile Bootstrap UCL	103
		95% BCA Bootstrap UCL	136.5
		95% H UCL	595.2

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.188	Data do not follow a Discernable Distribution (0.05)	
Theta Star	276.6		
nu star	19.22		
A-D Test Statistic	5.698	**Nonparametric Statistics**	
5% A-D Critical Value	0.917	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.917	Mean	50.17
5% K-S Critical Value	0.138	SD	218.9
Data not Gamma Distributed at 5% Significance Level		SE of Mean	30.37
		95% KM (t) UCL	101
Assuming Gamma Distribution		95% KM (z) UCL	100.1
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	101
Minimum	1E-06	95% KM (bootstrap t) UCL	558.1
Maximum	1400	95% KM (BCA) UCL	113.1
Mean	50.17	95% KM (Percentile Bootstrap) UCL	105
Median	0.41	95% KM (Chebyshev) UCL	182.6
SD	221	97.5% KM (Chebyshev) UCL	239.9
k star	0.172	99% KM (Chebyshev) UCL	352.4
Theta star	292		
Nu star	18.21	Potential UCLs to Use	
AppChi2	9.546	99% KM (Chebyshev) UCL	352.4
95% Gamma Approximate UCL (Use when n >= 40)	95.72		
95% Adjusted Gamma UCL (Use when n < 40)	97.52		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Data	36	Number of Detected Data	35
Number of Distinct Detected Data	34	Number of Non-Detect Data	1
		Percent Non-Detects	2.78%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.019	Minimum Detected	-3.963
Maximum Detected	930	Maximum Detected	6.835
Mean of Detected	35.89	Mean of Detected	0.132
SD of Detected	157.6	SD of Detected	2.499
Minimum Non-Detect	0.0049	Minimum Non-Detect	-5.319
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.245	Shapiro Wilk Test Statistic	0.959
5% Shapiro Wilk Critical Value	0.934	5% Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	34.89	Mean	-0.0384
SD	155.4	SD	2.668
95% DL/2 (t) UCL	78.66	95% H-Stat (DL/2) UCL	283.7
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	31.74	Mean in Log Scale	-0.0433
SD	155.8	SD in Log Scale	2.679
95% MLE (t) UCL	75.61	Mean in Original Scale	34.89
95% MLE (Tiku) UCL	70.53	SD in Original Scale	155.4
		95% t UCL	78.66
		95% Percentile Bootstrap UCL	85.22
		95% BCA Bootstrap UCL	116.3
		95% H UCL	296

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.212	Data appear Lognormal at 5% Significance Level	
Theta Star	168.9		
nu star	14.87		
A-D Test Statistic	3.954	**Nonparametric Statistics**	
5% A-D Critical Value	0.895	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.895	Mean	34.89
5% K-S Critical Value	0.164	SD	153.3
Data not Gamma Distributed at 5% Significance Level		SE of Mean	25.92
		95% KM (t) UCL	78.67
Assuming Gamma Distribution		95% KM (z) UCL	77.52
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	78.66
Minimum	1E-06	95% KM (bootstrap t) UCL	328.8
Maximum	930	95% KM (BCA) UCL	88.13
Mean	34.89	95% KM (Percentile Bootstrap) UCL	83.81
Median	0.62	95% KM (Chebyshev) UCL	147.9
SD	155.4	97.5% KM (Chebyshev) UCL	196.7
k star	0.197	99% KM (Chebyshev) UCL	292.7
Theta star	177.5		
Nu star	14.15	Potential UCLs to Use	
AppChi2	6.674	99% KM (Chebyshev) UCL	292.7
95% Gamma Approximate UCL (Use when n >= 40)	73.97		
95% Adjusted Gamma UCL (Use when n < 40)	76.65		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

S145

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	1.1	Minimum of Log Data	0.0953
Maximum	99	Maximum of Log Data	4.595
Mean	31.82	Mean of log Data	2.523
Geometric Mean	12.46	SD of log Data	1.598
Median	12.4		
SD	37.95		
Std. Error of Mean	10.96		
Coefficient of Variation	1.193		
Skewness	1.066		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.771	Shapiro Wilk Test Statistic	0.931
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	51.49	95% H-UCL	322.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	117.9
95% Adjusted-CLT UCL (Chen-1995)	53.44	97.5% Chebyshev (MVUE) UCL	153.1
95% Modified-t UCL (Johnson-1978)	52.05	99% Chebyshev (MVUE) UCL	222

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.544	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	58.47		
MLE of Mean	31.82		
MLE of Standard Deviation	43.13		
nu star	13.06		
Approximate Chi Square Value (.05)	5.933	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	49.84
Adjusted Chi Square Value	5.218	95% Jackknife UCL	51.49
		95% Standard Bootstrap UCL	49.2
Anderson-Darling Test Statistic	0.443	95% Bootstrap-t UCL	57.23
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	46.86
Kolmogorov-Smirnov Test Statistic	0.161	95% Percentile Bootstrap UCL	50.33
Kolmogorov-Smirnov 5% Critical Value	0.256	95% BCA Bootstrap UCL	52.81
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	79.57
		97.5% Chebyshev(Mean, Sd) UCL	100.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	140.8
95% Approximate Gamma UCL (Use when n >= 40)	70.03		
95% Adjusted Gamma UCL (Use when n < 40)	79.64		

Potential UCL to Use		Use 95% Approximate Gamma UCL	70.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U145

General Statistics

Number of Valid Data	56	Number of Detected Data	54
Number of Distinct Detected Data	46	Number of Non-Detect Data	2
		Percent Non-Detects	3.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0028	Minimum Detected	-5.878
Maximum Detected	280	Maximum Detected	5.635
Mean of Detected	12.42	Mean of Detected	-0.634
SD of Detected	47.06	SD of Detected	2.552
Minimum Non-Detect	0.0046	Minimum Non-Detect	-5.382
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.319

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	3
Number treated as Detected	53
Single DL Non-Detect Percentage	5.36%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.396	Lilliefors Test Statistic	0.122
5% Lilliefors Critical Value	0.121	5% Lilliefors Critical Value	0.121
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	11.97	Mean	-0.827
SD	46.26	SD	2.703
95% DL/2 (t) UCL	22.32	95% H-Stat (DL/2) UCL	101.7
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	10.13	Mean in Log Scale	-0.835
SD	47.37	SD in Log Scale	2.719
95% MLE (t) UCL	20.72	Mean in Original Scale	11.97
95% MLE (Tiku) UCL	19.63	SD in Original Scale	46.26
		95% t UCL	22.32
		95% Percentile Bootstrap UCL	22.71
		95% BCA Bootstrap UCL	26.46
		95% H UCL	107.4

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.228	Data do not follow a Discernable Distribution (0.05)	
Theta Star	54.41		
nu star	24.65		
A-D Test Statistic	4.557	Nonparametric Statistics	
5% A-D Critical Value	0.895	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.895	Mean	11.97
5% K-S Critical Value	0.133	SD	45.84
Data not Gamma Distributed at 5% Significance Level		SE of Mean	6.183
		95% KM (t) UCL	22.32
Assuming Gamma Distribution		95% KM (z) UCL	22.14
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	22.32
Minimum	1E-06	95% KM (bootstrap t) UCL	76.61
Maximum	280	95% KM (BCA) UCL	24.43
Mean	11.97	95% KM (Percentile Bootstrap) UCL	23.35
Median	0.28	95% KM (Chebyshev) UCL	38.93
SD	46.26	97.5% KM (Chebyshev) UCL	50.59
k star	0.205	99% KM (Chebyshev) UCL	73.5
Theta star	58.3		
Nu star	23	Potential UCLs to Use	
AppChi2	13.09	99% KM (Chebyshev) UCL	73.5
95% Gamma Approximate UCL (Use when n >= 40)	21.04		
95% Adjusted Gamma UCL (Use when n < 40)	21.36		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

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General Statistics

Number of Valid Observations	35	Number of Distinct Observations	35

Raw Statistics		Log-transformed Statistics	
Minimum	0.0775	Minimum of Log Data	-2.558
Maximum	5233	Maximum of Log Data	8.563
Mean	268.3	Mean of log Data	2.139
Geometric Mean	8.494	SD of log Data	2.582
Median	6.26		
SD	962.6		
Std. Error of Mean	162.7		
Coefficient of Variation	3.588		
Skewness	4.617		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.32	Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical Value	0.934	Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	543.4	95% H-UCL	2015
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	634.9
95% Adjusted-CLT UCL (Chen-1995)	671.6	97.5% Chebyshev (MVUE) UCL	836
95% Modified-t UCL (Johnson-1978)	564.6	99% Chebyshev (MVUE) UCL	1231
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.212	Data appear Lognormal at 5% Significance Level	
Theta Star	1264		
MLE of Mean	268.3		
MLE of Standard Deviation	582.4		
nu star	14.86		
Approximate Chi Square Value (.05)	7.162	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0425	95% CLT UCL	535.9
Adjusted Chi Square Value	6.909	95% Jackknife UCL	543.4
		95% Standard Bootstrap UCL	530
Anderson-Darling Test Statistic	3.914	95% Bootstrap-t UCL	2008
Anderson-Darling 5% Critical Value	0.895	95% Hall's Bootstrap UCL	1774
Kolmogorov-Smirnov Test Statistic	0.301	95% Percentile Bootstrap UCL	561.5
Kolmogorov-Smirnov 5% Critical Value	0.164	95% BCA Bootstrap UCL	731.7
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	977.6
		97.5% Chebyshev(Mean, Sd) UCL	1284
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1887
95% Approximate Gamma UCL (Use when n >= 40)	556.6		
95% Adjusted Gamma UCL (Use when n < 40)	577		
Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	1284

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S156

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	5.08	Minimum of Log Data	1.625
Maximum	587	Maximum of Log Data	6.375
Mean	170.3	Mean of log Data	4.085
Geometric Mean	59.43	SD of log Data	1.677
Median	64.75		
SD	220.9		
Std. Error of Mean	63.76		
Coefficient of Variation	1.297		
Skewness	1.249		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.74	Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	284.8	95% H-UCL	2099
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	643.4
95% Adjusted-CLT UCL (Chen-1995)	299.8	97.5% Chebyshev (MVUE) UCL	837.7
95% Modified-t UCL (Johnson-1978)	288.7	99% Chebyshev (MVUE) UCL	1219

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.497	Data appear Gamma Distributed at 5% Significance Leve	
Theta Star	342.8		
MLE of Mean	170.3		
MLE of Standard Deviation	241.6		
nu star	11.93		
Approximate Chi Square Value (.05)	5.179	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	275.2
Adjusted Chi Square Value	4.519	95% Jackknife UCL	284.8
		95% Standard Bootstrap UCL	270.8
Anderson-Darling Test Statistic	0.483	95% Bootstrap-t UCL	333.3
Anderson-Darling 5% Critical Value	0.778	95% Hall's Bootstrap UCL	263.4
Kolmogorov-Smirnov Test Statistic	0.182	95% Percentile Bootstrap UCL	271.7
Kolmogorov-Smirnov 5% Critical Value	0.257	95% BCA Bootstrap UCL	292.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	448.2
		97.5% Chebyshev(Mean, Sd) UCL	568.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	804.7
95% Approximate Gamma UCL (Use when n >= 40)	392.3		
95% Adjusted Gamma UCL (Use when n < 40)	449.6		

Potential UCL to Use		Use 95% Approximate Gamma UCL	392.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U156

General Statistics

Number of Valid Observations	56	Number of Distinct Observations	56

Raw Statistics		Log-transformed Statistics	
Minimum	0.0184	Minimum of Log Data	-3.995
Maximum	3383	Maximum of Log Data	8.127
Mean	118	Mean of log Data	1.023
Geometric Mean	2.782	SD of log Data	2.82
Median	1.662		
SD	511.8		
Std. Error of Mean	68.4		
Coefficient of Variation	4.339		
Skewness	5.664		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.416	Lilliefors Test Statistic	0.108
Lilliefors Critical Value	0.118	Lilliefors Critical Value	0.118
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	232.4	95% H-UCL	1034
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	402.8
95% Adjusted-CLT UCL (Chen-1995)	285.8	97.5% Chebyshev (MVUE) UCL	529.6
95% Modified-t UCL (Johnson-1978)	241	99% Chebyshev (MVUE) UCL	778.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.198	Data appear Lognormal at 5% Significance Level	
Theta Star	595.1		
MLE of Mean	118		
MLE of Standard Deviation	265		
nu star	22.2		
Approximate Chi Square Value (.05)	12.49	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0457	95% CLT UCL	230.5
Adjusted Chi Square Value	12.3	95% Jackknife UCL	232.4
		95% Standard Bootstrap UCL	225.4
Anderson-Darling Test Statistic	5.106	95% Bootstrap-t UCL	1162
Anderson-Darling 5% Critical Value	0.911	95% Hall's Bootstrap UCL	797
Kolmogorov-Smirnov Test Statistic	0.228	95% Percentile Bootstrap UCL	243.2
Kolmogorov-Smirnov 5% Critical Value	0.132	95% BCA Bootstrap UCL	299.6
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	416.1
		97.5% Chebyshev(Mean, Sd) UCL	545.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	798.5
95% Approximate Gamma UCL (Use when n >= 40)	209.7		
95% Adjusted Gamma UCL (Use when n < 40)	213		
Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	545.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

L157

General Statistics

Number of Valid Observations	27	Number of Distinct Observations	27

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.117	Minimum of Log Data	-2.144
Maximum	1290	Maximum of Log Data	7.163
Mean	70.85	Mean of log Data	1.239
Geometric Mean	3.451	SD of log Data	2.155
Median	2.414		
SD	257.8		
Std. Error of Mean	49.61		
Coefficient of Variation	3.638		
Skewness	4.499		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.307	Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Critical Value	0.923	Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	155.5	95% H-UCL	216.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	94.59
95% Adjusted-CLT UCL (Chen-1995)	198.3	97.5% Chebyshev (MVUE) UCL	123.5
95% Modified-t UCL (Johnson-1978)	162.6	99% Chebyshev (MVUE) UCL	180.3

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.235	Data do not follow a Discernable Distribution (0.05)	
Theta Star	300.9		
MLE of Mean	70.85		
MLE of Standard Deviation	146		
nu star	12.71		
Approximate Chi Square Value (.05)	5.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0401	95% CLT UCL	152.5
Adjusted Chi Square Value	5.401	95% Jackknife UCL	155.5
		95% Standard Bootstrap UCL	151.7
Anderson-Darling Test Statistic	3.828	95% Bootstrap-t UCL	1291
Anderson-Darling 5% Critical Value	0.88	95% Hall's Bootstrap UCL	1133
Kolmogorov-Smirnov Test Statistic	0.322	95% Percentile Bootstrap UCL	155.1
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	226.6
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	287.1
		97.5% Chebyshev(Mean, Sd) UCL	380.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	564.5
95% Approximate Gamma UCL (Use when n >= 40)	158		
95% Adjusted Gamma UCL (Use when n < 40)	166.8		

Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	380.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S157

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.924	Minimum of Log Data	-0.079
Maximum	198.3	Maximum of Log Data	5.29
Mean	54.46	Mean of log Data	2.911
Geometric Mean	18.37	SD of log Data	1.737
Median	21.19		
SD	71.45		
Std. Error of Mean	20.63		
Coefficient of Variation	1.312		
Skewness	1.325		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.751	Shapiro Wilk Test Statistic	0.955
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	91.5	95% H-UCL	828.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	220.4
95% Adjusted-CLT UCL (Chen-1995)	96.81	97.5% Chebyshev (MVUE) UCL	287.6
95% Modified-t UCL (Johnson-1978)	92.81	99% Chebyshev (MVUE) UCL	419.7

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.485	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	112.3		
MLE of Mean	54.46		
MLE of Standard Deviation	78.19		
nu star	11.64		
Approximate Chi Square Value (.05)	4.991	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	88.38
Adjusted Chi Square Value	4.346	95% Jackknife UCL	91.5
		95% Standard Bootstrap UCL	86.62
Anderson-Darling Test Statistic	0.398	95% Bootstrap-t UCL	113.9
Anderson-Darling 5% Critical Value	0.779	95% Hall's Bootstrap UCL	90.98
Kolmogorov-Smirnov Test Statistic	0.178	95% Percentile Bootstrap UCL	89.2
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	96.34
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	144.4
		97.5% Chebyshev(Mean, Sd) UCL	183.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	259.7
95% Approximate Gamma UCL (Use when n >= 40)	127		
95% Adjusted Gamma UCL (Use when n < 40)	145.9		

Potential UCL to Use		Use 95% Approximate Gamma UCL	127

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U157

General Statistics

Number of Valid Observations	53	Number of Distinct Observations	53

Raw Statistics		Log-transformed Statistics	
Minimum	0.023	Minimum of Log Data	-3.772
Maximum	92890	Maximum of Log Data	11.44
Mean	2036	Mean of log Data	0.864
Geometric Mean	2.373	SD of log Data	3.207
Median	0.879		
SD	12786		
Std. Error of Mean	1756		
Coefficient of Variation	6.279		
Skewness	7.17		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.485	Lilliefors Test Statistic	0.167
Lilliefors Critical Value	0.122	Lilliefors Critical Value	0.122
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	4978	95% H-UCL	4509
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1026
95% Adjusted-CLT UCL (Chen-1995)	6773	97.5% Chebyshev (MVUE) UCL	1362
95% Modified-t UCL (Johnson-1978)	5266	99% Chebyshev (MVUE) UCL	2022

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.124	Data do not follow a Discernable Distribution (0.05)	
Theta Star	16473		
MLE of Mean	2036		
MLE of Standard Deviation	5792		
nu star	13.1		
Approximate Chi Square Value (.05)	5.963	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0455	95% CLT UCL	4925
Adjusted Chi Square Value	5.828	95% Jackknife UCL	4978
		95% Standard Bootstrap UCL	4911
Anderson-Darling Test Statistic	10.28	95% Bootstrap-t UCL	48549
Anderson-Darling 5% Critical Value	0.965	95% Hall's Bootstrap UCL	37884
Kolmogorov-Smirnov Test Statistic	0.356	95% Percentile Bootstrap UCL	5497
Kolmogorov-Smirnov 5% Critical Value	0.138	95% BCA Bootstrap UCL	8886
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9692
		97.5% Chebyshev(Mean, Sd) UCL	13004
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	19511
95% Approximate Gamma UCL (Use when n >= 40)	4475		
95% Adjusted Gamma UCL (Use when n < 40)	4579		

Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	13004

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

L158

General Statistics

Number of Valid Observations	35	Number of Distinct Observations	35

Raw Statistics		Log-transformed Statistics	
Minimum	0.213	Minimum of Log Data	-1.547
Maximum	6523	Maximum of Log Data	8.783
Mean	323	Mean of log Data	2.443
Geometric Mean	11.5	SD of log Data	2.451
Median	7.177		
SD	1168		
Std. Error of Mean	197.5		
Coefficient of Variation	3.618		
Skewness	4.837		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.317	Shapiro Wilk Test Statistic	0.944
Shapiro Wilk Critical Value	0.934	Shapiro Wilk Critical Value	0.934
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	656.9	95% H-UCL	1612
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	625.4
95% Adjusted-CLT UCL (Chen-1995)	820.3	97.5% Chebyshev (MVUE) UCL	820.4
95% Modified-t UCL (Johnson-1978)	683.8	99% Chebyshev (MVUE) UCL	1204

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.218	Data appear Lognormal at 5% Significance Level	
Theta Star	1481		
MLE of Mean	323		
MLE of Standard Deviation	691.5		
nu star	15.27		
Approximate Chi Square Value (.05)	7.449	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0425	95% CLT UCL	647.8
Adjusted Chi Square Value	7.19	95% Jackknife UCL	656.9
		95% Standard Bootstrap UCL	640.2
Anderson-Darling Test Statistic	4.159	95% Bootstrap-t UCL	2067
Anderson-Darling 5% Critical Value	0.892	95% Hall's Bootstrap UCL	2133
Kolmogorov-Smirnov Test Statistic	0.303	95% Percentile Bootstrap UCL	678.7
Kolmogorov-Smirnov 5% Critical Value	0.164	95% BCA Bootstrap UCL	1009
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1184
		97.5% Chebyshev(Mean, Sd) UCL	1556
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2288
95% Approximate Gamma UCL (Use when n >= 40)	662		
95% Adjusted Gamma UCL (Use when n < 40)	685.9		

Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	1556

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

S158

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	6.004	Minimum of Log Data	1.792
Maximum	765	Maximum of Log Data	6.64
Mean	224.8	Mean of log Data	4.363
Geometric Mean	78.47	SD of log Data	1.684
Median	87.56		
SD	288.8		
Std. Error of Mean	83.38		
Coefficient of Variation	1.285		
Skewness	1.192		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.739	Shapiro Wilk Test Statistic	0.932
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	374.5	95% H-UCL	2851
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	859.7
95% Adjusted-CLT UCL (Chen-1995)	392.6	97.5% Chebyshev (MVUE) UCL	1120
95% Modified-t UCL (Johnson-1978)	379.3	99% Chebyshev (MVUE) UCL	1630

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.497	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	452.2		
MLE of Mean	224.8		
MLE of Standard Deviation	318.8		
nu star	11.93		
Approximate Chi Square Value (.05)	5.182	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	361.9
Adjusted Chi Square Value	4.521	95% Jackknife UCL	374.5
		95% Standard Bootstrap UCL	353.9
Anderson-Darling Test Statistic	0.509	95% Bootstrap-t UCL	419.4
Anderson-Darling 5% Critical Value	0.778	95% Hall's Bootstrap UCL	335.4
Kolmogorov-Smirnov Test Statistic	0.192	95% Percentile Bootstrap UCL	362
Kolmogorov-Smirnov 5% Critical Value	0.257	95% BCA Bootstrap UCL	384.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	588.2
		97.5% Chebyshev(Mean, Sd) UCL	745.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1054
95% Approximate Gamma UCL (Use when n >= 40)	517.6		
95% Adjusted Gamma UCL (Use when n < 40)	593.2		

Potential UCL to Use		Use 95% Approximate Gamma UCL	517.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U158

General Statistics

Number of Valid Observations	55
Number of Distinct Observations	55

Raw Statistics

Minimum	0.0344
Maximum	96273
Mean	1892
Geometric Mean	4.866
Median	2.127
SD	12976
Std. Error of Mean	1750
Coefficient of Variation	6.859
Skewness	7.392

Log-transformed Statistics

Minimum of Log Data	-3.371
Maximum of Log Data	11.47
Mean of log Data	1.582
SD of log Data	2.996

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic	0.498
Lilliefors Critical Value	0.119

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic	0.125
Lilliefors Critical Value	0.119

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	4820

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	6633
95% Modified-t UCL (Johnson-1978)	5111

Assuming Lognormal Distribution

95% H-UCL	3709
95% Chebyshev (MVUE) UCL	1152
97.5% Chebyshev (MVUE) UCL	1521
99% Chebyshev (MVUE) UCL	2247

Gamma Distribution Test

k star (bias corrected)	0.136
Theta Star	13879
MLE of Mean	1892
MLE of Standard Deviation	5124
nu star	14.99
Approximate Chi Square Value (.05)	7.257
Adjusted Level of Significance	0.0456
Adjusted Chi Square Value	7.112
Anderson-Darling Test Statistic	9.664
Anderson-Darling 5% Critical Value	0.957
Kolmogorov-Smirnov Test Statistic	0.347
Kolmogorov-Smirnov 5% Critical Value	0.136

Data not Gamma Distributed at 5% Significance Level

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	4770
95% Jackknife UCL	4820
95% Standard Bootstrap UCL	4714
95% Bootstrap-t UCL	62088
95% Hall's Bootstrap UCL	61979
95% Percentile Bootstrap UCL	5395
95% BCA Bootstrap UCL	7241
95% Chebyshev(Mean, Sd) UCL	9518
97.5% Chebyshev(Mean, Sd) UCL	12819
99% Chebyshev(Mean, Sd) UCL	19301

Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40)	3908
95% Adjusted Gamma UCL (Use when n < 40)	3988

Potential UCL to Use

Use 97.5% Chebyshev (Mean, Sd) UCL 12819

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

L122

General Statistics

Number of Valid Data	26	Number of Detected Data	25
Number of Distinct Detected Data	14	Number of Non-Detect Data	1
		Percent Non-Detects	3.85%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.04	Minimum Detected	-3.219
Maximum Detected	1.01	Maximum Detected	0.00995
Mean of Detected	0.186	Mean of Detected	-2.259
SD of Detected	0.264	SD of Detected	0.953
Minimum Non-Detect	0.05	Minimum Non-Detect	-2.996
Maximum Non-Detect	0.05	Maximum Non-Detect	-2.996

UCL Statistics

Normal Distribution Test with Detected Values Only		**.ognormal Distribution Test with Detected Values Onl**	
Shapiro Wilk Test Statistic	0.578	Shapiro Wilk Test Statistic	0.825
5% Shapiro Wilk Critical Value	0.918	5% Shapiro Wilk Critical Value	0.918
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.179	Mean	-2.314
SD	0.26	SD	0.975
95% DL/2 (t) UCL	0.267	95% H-Stat (DL/2) UCL	0.257
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.143	Mean in Log Scale	-2.309
SD	0.294	SD in Log Scale	0.967
95% MLE (t) UCL	0.241	Mean in Original Scale	0.18
95% MLE (Tiku) UCL	0.239	SD in Original Scale	0.26
		95% t UCL	0.267
		95% Percentile Bootstrap UCL	0.27
		95% BCA Bootstrap UCL	0.3
		95% H UCL	0.256

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.91	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.204		
nu star	45.48		
A-D Test Statistic	2.767	**Nonparametric Statistics**	
5% A-D Critical Value	0.773	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.773	Mean	0.18
5% K-S Critical Value	0.18	SD	0.255
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.051
		95% KM (t) UCL	0.267
Assuming Gamma Distribution		95% KM (z) UCL	0.264
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.267
Minimum	1E-06	95% KM (bootstrap t) UCL	0.348
Maximum	1.01	95% KM (BCA) UCL	0.275
Mean	0.178	95% KM (Percentile Bootstrap) UCL	0.262
Median	0.08	95% KM (Chebyshev) UCL	0.402
SD	0.261	97.5% KM (Chebyshev) UCL	0.499
k star	0.58	99% KM (Chebyshev) UCL	0.688
Theta star	0.308		
Nu star	30.15	**Potential UCLs to Use**	
AppChi2	18.61	95% KM (Chebyshev) UCL	0.402
95% Gamma Approximate UCL (Use when n >= 40)	0.289		
95% Adjusted Gamma UCL (Use when n < 40)	0.299		

Note: DL/2 is not a recommended method.

ote: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCI
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006)
For additional insight, the user may want to consult a statistician.

S122

General Statistics

Number of Valid Observations	12	Number of Distinct Observations	9

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.11	Minimum of Log Data	-2.207
Maximum	0.84	Maximum of Log Data	-0.174
Mean	0.257	Mean of log Data	-1.613
Geometric Mean	0.199	SD of log Data	0.683
Median	0.15		
SD	0.225		
Std. Error of Mean	0.065		
Coefficient of Variation	0.877		
Skewness	1.93		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.701	Shapiro Wilk Test Statistic	0.82
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.373	95% H-UCL	0.412
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.466
95% Adjusted-CLT UCL (Chen-1995)	0.402	97.5% Chebyshev (MVUE) UCL	0.561
95% Modified-t UCL (Johnson-1978)	0.379	99% Chebyshev (MVUE) UCL	0.748
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.649	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.156		
MLE of Mean	0.257		
MLE of Standard Deviation	0.2		
nu star	39.58		
Approximate Chi Square Value (.05)	26.17	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	0.364
Adjusted Chi Square Value	24.52	95% Jackknife UCL	0.373
		95% Standard Bootstrap UCL	0.358
Anderson-Darling Test Statistic	1.168	95% Bootstrap-t UCL	0.483
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	0.384
Kolmogorov-Smirnov Test Statistic	0.268	95% Percentile Bootstrap UCL	0.369
Kolmogorov-Smirnov 5% Critical Value	0.248	95% BCA Bootstrap UCL	0.395
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.54
		97.5% Chebyshev(Mean, Sd) UCL	0.663
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.904
95% Approximate Gamma UCL (Use when n >= 40)	0.388		
95% Adjusted Gamma UCL (Use when n < 40)	0.414		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	0.54

ote: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCI
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

U122

General Statistics

Number of Valid Data	53	Number of Detected Data	52
Number of Distinct Detected Data	19	Number of Non-Detect Data	1
		Percent Non-Detects	1.89%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.03	Minimum Detected	-3.507
Maximum Detected	1.37	Maximum Detected	0.315
Mean of Detected	0.128	Mean of Detected	-2.455
SD of Detected	0.2	SD of Detected	0.743
Minimum Non-Detect	0.02	Minimum Non-Detect	-3.912
Maximum Non-Detect	0.02	Maximum Non-Detect	-3.912

UCL Statistics

Normal Distribution Test with Detected Values Only		.ognormal Distribution Test with Detected Values Onl	
Lilliefors Test Statistic	0.323	Lilliefors Test Statistic	0.169
5% Lilliefors Critical Value	0.123	5% Lilliefors Critical Value	0.123
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.126	Mean	-2.496
SD	0.199	SD	0.793
95% DL/2 (t) UCL	0.172	95% H-Stat (DL/2) UCL	0.142
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.124	Mean in Log Scale	-2.49
SD	0.199	SD in Log Scale	0.777
95% MLE (t) UCL	0.17	Mean in Original Scale	0.126
95% MLE (Tiku) UCL	0.165	SD in Original Scale	0.198
		95% t UCL	0.172
		95% Percentile Bootstrap UCL	0.175
		95% BCA Bootstrap UCL	0.201
		95% H UCL	0.141

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.32	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0971		
nu star	137.3		
A-D Test Statistic	4.251	**Nonparametric Statistics**	
5% A-D Critical Value	0.77	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.77	Mean	0.126
5% K-S Critical Value	0.126	SD	0.196
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0272
		95% KM (t) UCL	0.172
Assuming Gamma Distribution		95% KM (z) UCL	0.171
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.172
Minimum	1E-06	95% KM (bootstrap t) UCL	0.232
Maximum	1.37	95% KM (BCA) UCL	0.18
Mean	0.126	95% KM (Percentile Bootstrap) UCL	0.178
Median	0.08	95% KM (Chebyshev) UCL	0.245
SD	0.199	97.5% KM (Chebyshev) UCL	0.297
k star	0.928	99% KM (Chebyshev) UCL	0.397
Theta star	0.136		
Nu star	98.36	Potential UCLs to Use	
AppChi2	76.48	95% KM (Chebyshev) UCL	0.245
95% Gamma Approximate UCL (Use when n >= 40)	0.162		
95% Adjusted Gamma UCL (Use when n < 40)	0.163		

Note: DL/2 is not a recommended method.

ote: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCI
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006)
For additional insight, the user may want to consult a statistician.

ATTACHMENT C-5

Wildlife Exposure Models and Soil Screening Levels

Attachment C-5 Wildlife Exposure Models and Soil Screening Levels

Wildlife Exposure Model:

SSL = TRV/[(FIR*P*BAF)+(SIR*RGAF)]

Where:

SSL = soil screening level (mg/kg)
TRV = wildlife toxicity reference value (mg/kg/d)
FIR = food ingestion rate (kg/kg/d)
P = proportion of contaminated food in diet (unitless)
BAF = bioaccumulation factor (unitless)
SIR = soil ingestion rate (kg/kg/d)
RGAF = gut absorption factor (unitless)

SHREW - ALL AREAS PAHs

PAH Group	LMW	LMW	LMW	HMW	HMW	HMW	HMW	HMW	LMW	LMW	LMW	HMW	LMW	LMW	HMW	LMW	LMW	
	Acenaphthene	Acenaphthalene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	total Benzofluoranthenes	Benzo(g,h,i)perylene	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)perylene	Naphthalene	Phenanthrene	Pyrene	1-Methylnapthene	2-Methynaphthene	Source
SSL_{shrew}	14,993	14,993	8,320	1,183	1,060	1,216	1,065	1,195	13,073	10,026	13,073	2,075	11,172	11,836	1,137	11,172	11,172	Calculated
TRV	138	138	138	15.72	15.72	15.72	15.72	15.72	138	138	138	15.72	138	138	15.72	138	138	See Table C-7
FIR	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	See Table C-5
P	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	See Table C-5
SIR	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	0.00627	See Table C-5
RGAF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
BAF_{worm}	0.028	0.028	0.099	0.067	0.082	0.064	0.081	0.066	0.041	0.072	0.041	0.013	0.058	0.052	0.072	0.058	0.058	See Table C-3

Worm BAFs derived from Kreitinger et al. (2007) were not available for all PAH Site COPECs. BAFs were assigned based on structural similarities. The BAF for naphthalene was used for 1-methylnaphthalene and 2-methylnaphthalene. The BAF for fluorene was used for dibenzofuran. The BAF for acenaphthene was used for acenaphthalene.

VOLE - LOWER AREA PAHs

PAH Group	LMW	LMW	LMW	HMW	HMW	HMW	HMW	HMW	LMW	LMW	LMW	HMW	LMW	LMW	HMW	LMW	LMW	
	Acenaphthene	Acenaphthalene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	total Benzofluoranthenes	Benzo(g,h,i)perylene	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)perylene	Naphthalene	Phenanthrene	Pyrene	1-Methylnapthene	2-Methynaphthene	Source
SSL_{vole}	37,165	37,165	37,165	1,147	1,147	1,147	1,147	1,147	37,165	37,165	37,165	1,147	37,165	37,165	1,147	37,165	37,165	Calculated
TRV	138	138	138	15.72	15.72	15.72	15.72	15.72	138	138	138	15.72	138	138	15.72	138	138	See Table C-5
FIR	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	See Table C-5
P	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
SIR	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	See Table C-5
RGAF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
BAF_{plant}	0.010	0.010	0.010	0.125	0.125	0.125	0.125	0.125	0.010	0.010	0.010	0.125	0.010	0.010	0.125	0.010	0.010	See Equations 1 and 2

Total LMW PAHs

BAF_{plant} = Cp/Cs =	0.010
Cp = Exp[ln(Ce)] =	3.973
Ln(Cp) = 0.4544 * Ln(Cs) - 1.3205 =	1.380
Cs (Lower Area) =	380.7

Total HMW PAHs

BAF_{plant} = Cp/Cs =	0.125
Ce = Exp[ln(Cp)] =	159.98
Ln(Cp) = 0.9469 * Ln(Cs) - 1.7026 =	5.075
Cs (Lower Area) =	1284

VOLE - SLOPE AREA PAHs

PAH Group	LMW	LMW	LMW	HMW	HMW	HMW	HMW	HMW	LMW	LMW	LMW	HMW	LMW	LMW	HMW	LMW	LMW	
	Acenaphthene	Acenaphthalene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	total Benzofluoranthenes	Benzo(g,h,i)perylene	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)perylene	Naphthalene	Phenanthrene	Pyrene	1-Methylnapthene	2-Methynaphthene	Source
SSL_{vole}	30,926	30,926	30,926	1,091	1,091	1,091	1,091	1,091	30,926	30,926	30,926	1,091	30,926	30,926	1,091	30,926	30,926	Calculated
TRV	138	138	138	15.72	15.72	15.72	15.72	15.72	138	138	138	15.72	138	138	15.72	138	138	See Table C-5
FIR	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	See Table C-5
P	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
SIR	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	See Table C-5
RGAF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
BAF_{plant}	0.019	0.019	0.019	0.133	0.133	0.133	0.133	0.133	0.019	0.019	0.019	0.133	0.019	0.019	0.133	0.019	0.019	See Equations 1 and 2

Total LMW PAHs		**Total HMW PAHs**	
BAF_{plant} = Cp/Cs =	0.019	BAF_{plant} = Cp/Cs =	0.133
Cp = Exp[ln(Ce)] =	2.413	Ce = Exp[ln(Cp)] =	52.056
Ln(Cp) = 0.4544 * Ln(Cs) - 1.3205 =	0.881	Ln(Cp) = 0.9469 * Ln(Cs) - 1.7026 =	3.952
Cs (Slope Area) =	127	Cs (Slope Area) =	392.3

VOLE - UPPER AREA PAHs

PAH Group	LMW	LMW	LMW	HMW	HMW	HMW	HMW	HMW	LMW	LMW	LMW	HMW	LMW	LMW	HMW	LMW	LMW	
	Acenaphthene	Acenaphthalene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	total Benzofluoranthenes	Benzo(g,h,i)perylene	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)perylene	Naphthalene	Phenanthrene	Pyrene	1-Methylnapthene	2-Methynaphthene	Source
SSL_{vole}	47,051	47,051	47,051	1,106	1,106	1,106	1,106	1,106	47,051	47,051	47,051	1,106	47,051	47,051	1,106	47,051	47,051	Calculated
TRV	138	138	138	15.72	15.72	15.72	15.72	15.72	138	138	138	15.72	138	138	15.72	138	138	See Table C-7
FIR	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	0.0875	See Table C-5
P	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
SIR	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	See Table C-5
RGAF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	See Table C-5
BAF_{plant}	0.002	0.002	0.002	0.130	0.130	0.130	0.130	0.130	0.002	0.002	0.002	0.130	0.002	0.002	0.130	0.002	0.002	See Equations 1 and 2

Total LMW PAHs

BAF_{plant} = Cp/Cs =	0.002
Cp = Exp[ln(Ce)] =	19.767
Ln(Cp) = 0.4544 * Ln(Cs) - 1.3205 =	2.984
Cs (Upper Area) =	13004

Total HMW PAHs

BAF_{plant} = Cp/Cs =	0.130
Ce = Exp[ln(Cp)] =	71
Ln(Cp) = 0.9469 * Ln(Cs) - 1.7026 =	4.264
Cs (Upper Area) =	545.1

Selenium Upper Area

	Shrew	Vole	Robin	Source
SSL	2.74	4.68	2.37	Calculated
TRV	0.239	0.239	0.287	See Table E-8
FIR	0.209	0.0875	0.214	See Table E-5
P	0.5	1	0.52	See Table E-5
SIR	0.0067	0.0028	0.0351	See Table E-5
RGAF	1	1	1	See Table E-5
BAF	0.771	0.552	0.771	See Table E-4

APPENDIX D

Data Validation Reports

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TECHNICAL MEMORANDUM

TO: Chip Halbert

FROM: Kristi Schultz KES and Anne Halvorsen AH

DATE: October 6, 2010

**RE: CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL VAPOR SAMPLING
LABORATORY DATA QUALITY EVALUATION**

This technical memorandum provides the results of a focused data validation associated with 6 soil vapor samples collected on August 30, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. Samples were analyzed by Air Toxics, Ltd. (Air Toxics), located in Folsom, California. This data quality evaluation covers Air Toxics data packages 1009022A and 1009022B. Samples submitted to Air Toxics were analyzed for volatile organic compounds (VOCs) [U.S. Environmental Protection Agency (EPA) Method Modified TO-15] and aliphatic/aromatic air phase petroleum hydrocarbons (EPA Method Modified TO-15).

Sample data were evaluated in accordance with applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999) and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl and Landau 2010). The following parameters were evaluated:

- Chain-of-custody (COC) records
- Holding times
- Blank results (laboratory method)
- Surrogate recoveries
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Quantitation limits
- Audit/corrective action records
- Completeness and overall data quality.

Data validation qualifiers are added to samples based on the evaluation of data quality. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below.

CHAIN-OF-CUSTODY RECORDS

A signed chain-of-custody record was attached to each data package. The laboratory received all samples in good condition and all analyses were performed as requested.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks. No qualification of the data is necessary.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOC analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data is necessary. Surrogates were not reported by the laboratory for the APH analysis.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD sample was analyzed with each batch of samples for the VOC analysis. Recoveries and RPD for the LCS/LCSD and associated duplicates were within the current laboratory-specified control limits with the following exception. The percent recovery value for the LCSD associated with the VOC analysis for naphthalene was above the laboratory-specified control limits. All associated sample results were not detected. No qualification of the data is necessary. An LCS and/or LCSD was not reported by the laboratory for the APH analysis.

Quantitation Limits

Project-specified quantitation limits were met for all samples.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. Based on this data quality evaluation, all of the data were determined to be acceptable without qualification. No data were rejected.

REFERENCES

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Chip Halbert

FROM: Kristi Schultz and Anne Halvorsen KES ASH

DATE: December 1, 2010

**RE: AUGUST AND SEPTEMBER 2010 SEDIMENT SAMPLES LABORATORY DATA QUALITY EVALUATION
CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

This technical memorandum provides the results of a focused data validation associated with 42 sediment samples collected on August 20, 2010 and September 8-9, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. Samples were analyzed by Analytical Resources, Inc. (ARI), located in Tukwila, Washington. This data quality evaluation covers ARI data packages RJ85, RM22/RM27, and RM42. Samples submitted to ARI were analyzed for semivolatile organic compounds (SVOCs) [U.S. Environmental Protection Agency (EPA) Method Puget Sound Dredged Disposal Analysis (PSDDA) SW8270D], polycyclic aromatic hydrocarbons (PAHs) (EPA Method SW8270D-SIM), total metals (EPA Methods 200.8 and 7471A), and conventionals, including total organic carbon (Plumb 1981).

Sample data were evaluated in accordance with applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 2004), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl and Landau Associates 2010). The following parameters were evaluated:

- Chain-of-custody (COC) records
- Holding times
- Blank results (laboratory method)
- Surrogate recoveries
- Matrix spike/matrix spike duplicate (MS/MSD) and laboratory duplicate results
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Blind field duplicate results
- Quantitation limits
- Audit/corrective action records
- Completeness and overall data quality.

Data validation qualifiers are added to samples based on the evaluation of data quality. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below.

CHAIN-OF-CUSTODY RECORDS

A signed chain-of-custody (COC) record was attached to each data package. The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample jar information was compared to the associated COC and the cooler temperatures were recorded. All coolers were received within the EPA-recommended limits of 4°C±2°C.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary. All samples were frozen to protect holding times.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks with the following exceptions:

- The method blank associated with the SVOC analysis in data package RJ85 contained bis(2-ethylhexyl)phthalate. Associated samples were not detected; therefore no qualification of the data is necessary.
- The method blanks associated with the SVOC analysis in data packages RM22/RM27 and RM42 contained phenol. Several samples contained a detection of phenol below the action level[1]; therefore, the associated sample results are qualified as not detected (U), as indicated in Table 1.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for the various analyses. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

[1] The action level is defined as 10 times the concentration in the blank for common volatile laboratory contaminants (methylene chloride, acetone, 2-butanone, and cyclohexane), or 5 times the concentration for other target compounds (EPA 1999).

- Recovery of the surrogate d5-nitrobenzene associated with the SVOC analysis for sample MGP-SB-01-4.0-6.0 in data package RJ85 exceeded the laboratory-specified control limits. SVOC sample surrogate qualification requires that two or more surrogates of the same fraction to be outside of laboratory-specified control limits; therefore, no qualification of the data is necessary.

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) AND LABORATORY REPLICATE RESULTS

A MS and/or laboratory duplicate sample was analyzed with the SVOCs, PAHs, total metals, and conventionals analyses in several data packages. The recovery values for each required spiking compound were within the laboratory- and project-specified control limits for all project samples with the following exceptions:

- The MS/MSD recovery for 4-chloroaniline associated with the SVOC analysis for sample MGP-SB-03-3.0-4.0 in data package RM22/RM27 was below the laboratory-specified control limits; the MS/MSD recovery for fluoranthene exceeded the laboratory-specified control limits. The associated sample results were qualified as estimated (UJ/J), as indicated in Table 1.
- The MS/MSD recoveries for 3,3'-dichlorobenzidine associated with the SVOC analysis for sample MGP-SB-03-3.0-4.0 in data package RM22/RM27 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.
- The MS recovery for silver associated with the total metals analysis for sample MGP-SB-12-5.0-6.5 in data package RM42 was below the laboratory-specified control limit; the associated sample result was qualified as estimated (UJ), as indicated in Table 1.
- The MS/MSD recoveries for several compounds associated with the PAH analysis for sample MGP-SB-07-5.0-6.5 in data package RM42 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the laboratory replicate results and a project-specified control limit of 35 percent was used to evaluate the RPDs between the MS/MSDs, except when the samples were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. The RPDs between the laboratory replicate results or MS/MSD were within the current laboratory- and project-specified control limits for all project samples with the following exceptions:

- The MS/MSD RPD for 2,4-dimethylphenol associated with the SVOC analysis for sample MGP-SB-04-8.0-10.0 in data package RJ85 exceeded the laboratory-specified control limits. The associated sample result was not detected; therefore no qualification of the data is necessary.
- The MS/MSD RPD for 4-chloroaniline associated with the SVOC analysis for sample MGP-SB-03-3.0-4.0 in data package RM22/RM27 exceeded the laboratory-specified control limits. The associated sample result was not detected; therefore no qualification of the data is necessary.

- The MS/MSD RPD for 3,3'-dichlorobenzidine associated with the SVOC analysis for sample MGP-SB-03-3.0-4.0 in data package RM22/RM27 was not calculable due to incalculable percent recoveries of the spiking solution. No qualification of the data is necessary.
- The MS/MSD RPDs for several compounds associated with the SVOC analysis for sample MGP-SB-07-5.0-6.5 in data package RM42 were not calculable due to incalculable percent recoveries of the spiking solution. No qualification of the data is necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPD for the LCS/LCSD were within the current laboratory-specified control limits with the following exceptions:

- The LCS/LCSD recoveries and the LCS/LCSD RPDs for benzyl alcohol associated with the SVOC analysis in data packages RM22/RM27 and RM42 were not calculated due to a negative recovery of the spiking solution; therefore, no qualification of the data is necessary.

Blind Field Duplicates

One pair of blind field duplicate sediment samples (MGP-SB-20-29.0-31.0/MGP-SB-10-29.0-31.0) was submitted for analysis with data packages RM42 and analyzed for SVOCs, total metals, and conventionals.

A project-specified control limit of 35 percent was used to evaluate the RPDs between the duplicate sediment samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits. No qualification of the data is necessary.

Quantitation Limits

Project-specified quantitation limits were met for all samples, except for the following:

- Instances where samples required dilutions based on high concentrations of target analytes may have elevated reporting limits.
- The 9/30/10 and 10/4/10 SVOC continuing calibration (CCAL) in data package RM22/RM27 were out of control (low) for benzyl alcohol; the associated sample results were qualified as estimated (UJ), as indicated in Table 1.
- The 9/23/10 PAH CCAL in data package RM22/RM27 was out of control (low) for benzo(g,h,i)perylene; the associated sample results were qualified as estimated (J), as indicated in Table 1.
- The 9/30/10 SVOC CCAL in data package RM42 was out of control (low) for benzidine. The compound was analyzed for by the lab, but was not requested to be reported; no qualification of the data is necessary.

- The internal standard area of chrysene-d12 associated with the PAHs analysis for sample MGP-SB-05-2.5-4.0 in data package RM22/RM27 was outside control limits (high). The sample was re-analyzed at a dilution with all internal standard areas within control limits; no qualification of the data is necessary. Report results from the re-analysis.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through field duplicates, laboratory replicates, matrix spike duplicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

EPA. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA-540/R-04-004. U.S. Environmental Protection Agency. Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, D.C. October.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
SEDIMENT SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RM22/RM27	Benzyl Alcohol	100 U	UJ	MGP-SB-08-11.0-12.5	Low continuing calibration recovery
RM22/RM27	Benzyl Alcohol	89 U	UJ	MGP-SB-08-23.0-24.0	Low continuing calibration recovery
RM22/RM27	Benzyl Alcohol	87 U	UJ	MGP-SB-05-5.0-6.0	Low continuing calibration recovery
RM22/RM27	Benzyl Alcohol	19 U	UJ	MGP-SB-03-3.0-4.0	Low continuing calibration recovery
RM22/RM27	4-Chloroaniline	97 U	UJ	MGP-SB-03-3.0-4.0	Low MS/MSD recovery
RM22/RM27	Fluoranthene	320	J	MGP-SB-03-3.0-4.0	High MS/MSD recovery
RM22/RM27	Phenol	150	U	MGP-SB-08-11.0-12.5	Method blank contamination
RM22/RM27	Phenol	49	U	MGP-SB-08-23.0-24.0	Method blank contamination
RM22/RM27	Phenol	96	U	MGP-SB-05-5.0-6.0	Method blank contamination
RM22/RM27	Phenol	35	U	MGP-SB-03-3.0-4.0	Method blank contamination
RM22/RM27	Benzo(g,h,i)perylene	980	J	MGP-SB-08-0.0-2.0	Low continuing calibration recovery
RM22/RM27	Benzo(g,h,i)perylene	1100	J	MGP-SB-08-3.0-5.0	Low continuing calibration recovery
RM22/RM27	Benzo(g,h,i)perylene	23,000	J DNR	MGP-SB-08-9.0-10.0	Low continuing calibration recovery DNR - use dilution
RM22/RM27	Benzo(g,h,i)perylene	27,000	J DNR	MGP-SB-08-10.0-11.0	Low continuing calibration recovery DNR - use dilution
RM22/RM27	Benzo(g,h,i)perylene	9.8	J	MGP-SB-08-21.5-23.0	Low continuing calibration recovery
RM22/RM27	Benzo(g,h,i)perylene	3900	J DNR	MGP-SB-05-2.5-4.0	Low continuing calibration recovery DNR - use dilution
RM22/RM27	Benzo(g,h,i)perylene	2200	J DNR	MGP-SB-03-0.0-1.5	Low continuing calibration recovery DNR - use dilution
RM22/RM27	Benzo(g,h,i)perylene	520	J DNR	MGP-SB-11-0.0-2.0	Low continuing calibration recovery DNR - use dilution
RM22/RM27	All PAHs	All	---	MGP-SB-05-2.5-4.0-DL	Report diluted results
RM22/RM27	All PAHs	All	---	MGP-SB-05-2.5-4.0	DNR initial results (internal standard out of control high on initial run)
RM42	Phenol	32	U	MGP-SB-12-47.5-49.0	Method blank contamination
RM42	Phenol	28	U	MGP-SB-10-29.0-31.0	Method blank contamination
RM42	Phenol	31	U	MGP-SB-20-29.0-31.0	Method blank contamination
RM42	Phenol	52	U	MGP-SB-07-17.5-19.0	Method blank contamination
RM42	Silver	0.8 U	UJ	MGP-SB-12-5.0-6.5	Low MS recovery

Notes

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

U = Indicates the compound was undetected at the reported concentration.

DNR = Do Not Report

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TECHNICAL MEMORANDUM

TO: Chip Halbert

KES ASH

FROM: Kristi Schultz and Anne Halvorsen

DATE: December 1, 2010

RE: AUGUST AND SEPTEMBER 2010 GROUNDWATER AND SURFACE WATER SAMPLES LABORATORY DATA QUALITY EVALUATION CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT REMEDIAL INVESTIGATION/FEASIBILITY STUDY

This technical memorandum provides the results of a focused data validation associated with 3 surface water samples, 9 groundwater samples, and 3 trip blanks collected on September 6, September 28, and September 29, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. Samples were analyzed by Analytical Resources, Inc. (ARI), located in Tukwila, Washington. This data quality evaluation covers ARI data packages RL89 and RP01/RP09. Samples submitted to ARI were analyzed for volatile organic compounds (VOCs) [U.S. Environmental Protection Agency (EPA) Method SW8260C], semivolatile organic compounds (SVOCs) (EPA Method SW8270D), diesel- and oil-range petroleum hydrocarbons [Washington State Department of Ecology (Ecology) Method NWTPH-Dx], gasoline-range petroleum hydrocarbons (Ecology Method NWTPH-Gx), total and dissolved metals (EPA Methods 200.8 and 6010B/7470A), and conventionals, including total suspended solids (TSS) (EPA Method 160.2), total dissolved solids (TDS) (EPA Method 160.1), salinity (SM 2520.B), total cyanide (EPA Method 335.4), weak acid dissociable (WAD) cyanide (SM4500CN-I), and total organic carbon (TOC) and dissolved organic carbon (DOC) (EPA Method 415.1).

Sample data were evaluated in accordance with applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 2004), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl and Landau Associates 2010). The following parameters were evaluated:

- Chain-of-custody (COC) records
- Holding times
- Blank results (laboratory method and field trip)
- Surrogate recoveries
- Matrix spike/matrix spike duplicate (MS/MSD) and laboratory duplicate results
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Blind field duplicate results

- Quantitation limits
- Audit/corrective action records
- Completeness and overall data quality.

Data validation qualifiers are added to samples based on the evaluation of data quality. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below.

CHAIN-OF-CUSTODY RECORDS

A signed chain-of-custody (COC) record was attached to each data package. The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample jar information was compared to the associated COC and the cooler temperatures were recorded. All coolers were received within the EPA-recommended limits of 4°C±2°C.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times with the following exceptions:

- In data package RL89 for the SVOCs analysis, samples were extracted on 9/10/10 and analyzed on 9/16/10 within the method recommended holding time. Due to surrogate recovery difficulties, samples MGP-SW-02 and MGP-SW-01 were re-extracted on 9/21/10 and re-analyzed on 9/23/10, outside of the method recommended holding time. The associated sample results were qualified as estimated (J/UJ), as indicated in Table 1. The re-analysis results should not be reported and the original analysis results should be used.
- In data package RP01/RP09 for the conventionals analysis, sample MGP-GW-MW-45 exceeded the 7 day method-recommended hold time by 6 days for TDS. The associated sample result was qualified as estimated (J), as indicated in Table 1.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks with the following exceptions:

- Dissolved solids were detected in both of the method blanks associated with the conventionals analysis in data package RP01/RP09. The associated sample results were all detected at levels greater than the action level[1]; therefore no qualification of the data is necessary.

Field Trip Blanks

Trip blanks were submitted for VOC analysis with data package RP01/RP09 and for gasoline-range petroleum hydrocarbon analysis with data package RL89. No contamination was detected in any of the trip blanks with the following exception:

- The trip blanks associated with the VOC analysis in data package RP01/RP09 contained methylene chloride. The associated samples were all not detected; therefore no qualification of the data is necessary.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for the various analyses. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Recovery of the several surrogates associated with the SVOCs analysis for samples MGP-SW-02 and MGP-SW-01 in data package RL89 were below the laboratory-specified control limits. The associated sample results were qualified as estimated (UJ), as indicated in Table 1.
- Recovery of the surrogate 2,4,6-tribromophenol associated with the SVOCs analysis for samples MGP-SW-02RE, MGP-SW-03, and the 9/21/10 LCSD in data package RL89 exceeded the laboratory-specified control limits. Recoveries of the surrogates 2-fluorophenol and d5-nitrobenzene associated with the SVOC analysis for sample MGP-GW-MW-19 in data package RP01/RP09 also exceeded the laboratory-specified control limits. SVOC sample surrogate qualification requires two or more surrogates of the same fraction to be outside laboratory-specified control limits; therefore no qualification of the data is necessary.
- Surrogate recoveries were diluted out of two samples associated with the SVOCs analysis in data package RP01/RP09; no qualification of the data is necessary.

[1] The action level is defined as 10 times the concentration in the blank for common volatile laboratory contaminants (methylene chloride, acetone, 2-butanone, and cyclohexane), or 5 times the concentration for other target compounds (EPA 1999).

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) and Laboratory Replicate Results

A MS and/or laboratory duplicate sample was analyzed with the total metals, dissolved metals, and conventionals analyses in several data packages. The recovery values for each required spiking compound were within the laboratory-specified control limits for all project samples. No qualification of the data is necessary.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the laboratory replicate results, except when the samples were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the laboratory replicate results were within the current laboratory-specified control limits for all project samples. No qualification of the data is necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPD for the LCS/LCSD and associated duplicates were within the current laboratory-specified control limits with the following exceptions:

- The 9/23/10 LCS/LCSD recoveries for carbazole associated with the SVOCs analysis in data package RL89 were below the laboratory-specified control limit. The associated sample results were qualified as estimated (UJ), as indicated in Table 1; however, these recoveries are associated with the re-analysis of MGP-SW-02 and MGP-SW-01 and these results should not be reported (see above).
- The 9/16/10 LCS and/or LCSD recoveries for benzyl alcohol, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol and the LCS/LCSD RPD for hexachlorocyclopentadiene associated with the SVOCs analysis in data package RL89 exceeded the laboratory-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.
- The 10/16/10 LCS/LCSD recovery for acrolein associated with the VOCs analysis in data package RP01/RP09 exceeded the laboratory-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.
- The LCSD recovery for hexachlorocyclopentadiene associated with the SVOC analysis in data package RP01/RP09 exceeded the laboratory-specified control limits. Because the LCS recovery is acceptable, and the LCSD is only slightly below the control limits, no qualification of the data is necessary.

Blind Field Duplicates

One pair of blind field duplicate sediment samples (MGP-GW-MW-34/MGP-GW-MW-64) was submitted for analysis with data packages RP01/RP09 and analyzed for SVOCs, total and dissolved metals, TPH-D, and TDS.

A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate water samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits. No qualification of the data is necessary.

QUANTITATION LIMITS

Project-specified quantitation limits were met for all samples, except for the following:

- The 9/16/10 SVOC continuing calibration (CCAL) in data package RL89 was out of control (high) for several compounds. The associated sample results were not detected; therefore no qualification of the data is necessary.
- The 9/16/10 SVOC CCAL in data package RL89 was also out of control (low) for 2,4-dinitrophenol; the associated sample results were qualified as estimated (UJ), as indicated in Table 1.
- The 9/23/10 SVOC CCAL in data package RL89 was out of control (low) for several compounds. The associated sample results were qualified as estimated (UJ), as indicated in Table 1; however, the 9/23/10 SVOC CCAL is associated with the re-analysis of MGP-SW-02 and MGP-SW-01 and these results should not be reported (see above).
- The 10/6/10 VOC CCAL in data package RP01/RP09 was out of control (low) for bromomethane and out of control high for acrolein. This CCAL is associated with the analysis of the trip blanks; therefore no qualification of the data is necessary.
- The 10/2/10 SVOC CCAL in data package RP01/RP09 is out of control (high) for several compounds. The 10/5/10 SVOC CCAL is out of control (high) for 2,4-dinitrophenol and 4-chlorophenyl-phenylether. All associated samples are not detected for these compounds; therefore no qualification of the data is necessary.
- The 10/5/10 SVOC CCAL at 14:48 in data package RP01/RP09 is out of control (high) for fluorene. Associated sample results are qualified as estimated (J), as indicated in Table 1.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through field duplicates, laboratory replicates, , and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

EPA. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA-540/R-04-004. U.S. Environmental Protection Agency. Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, D.C. October.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
GROUNDWATER AND SURFACE WATER SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RL89	ALL SVOCs	ALL	U, UJ DNR	MGP-SW-02-RE	Exceeded holding time by 1 day - DNR
RL89	ALL SVOCs	ALL	U, UJ DNR	MGP-SW-01-RE	Exceeded holding time by 1 day - DNR
RL89	ALL SVOCs	ALL	U, UJ	MGP-SW-02	Low surrogate recovery
RL89	ALL SVOCs	ALL	U, UJ	MGP-SW-01	Low surrogate recovery
RL89	2,4-Dinitrophenol	10 U	UJ	MGP-SW-02	Low continuing calibration recovery
RL89	2,4-Dinitrophenol	10 U	UJ	MGP-SW-03	Low continuing calibration recovery
RL89	2,4-Dinitrophenol	10 U	UJ	MGP-SW-01	Low continuing calibration recovery
RL89	2,2'-Oxybis(1-Chloropropane)	1.0 U	UJ DNR	MGP-SW-02 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	N-Nitroso-Di-N-Propylamine	1.0 U	UJ DNR	MGP-SW-02 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	2-Nitroaniline	5.0 U	UJ DNR	MGP-SW-02 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	2,4-Dinitrophenol	10 U	UJ DNR	MGP-SW-02 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	4,6-Dinitro-2-Methylphenol	10 U	UJ DNR	MGP-SW-02 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	Butylbenzylphthalate	1.0 U	UJ DNR	MGP-SW-02 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	2,2'-Oxybis(1-Chloropropane)	1.0 U	UJ DNR	MGP-SW-01 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	N-Nitroso-Di-N-Propylamine	1.0 U	UJ DNR	MGP-SW-01 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	2-Nitroaniline	5.0 U	UJ DNR	MGP-SW-01 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	2,4-Dinitrophenol	10 U	UJ DNR	MGP-SW-01 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	4,6-Dinitro-2-Methylphenol	10 U	UJ DNR	MGP-SW-01 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	Butylbenzylphthalate	1.0 U	UJ DNR	MGP-SW-01 RE	Low continuing calibration recovery, DNR - Use original analysis
RL89	Carbazole	1.0 U	UJ DNR	MGP-SW-02 RE	Low LCS/LCSD recovery, DNR - Use original analysis
RL89	Carbazole	1.0 U	UJ DNR	MGP-SW-01 RE	Low LCS/LCSD recovery, DNR - Use original analysis
RP01/RP09	Total Dissolved Solids	1210	J	MGP-GW-MW-45	Exceeded holding time by 6 days
RP01/RP09	Fluorene	47	J	MGP-GW-MW-24	High continuing calibration recovery
RP01/RP09	Fluorene	26	J DNR	MGP-GW-MW-28 DL	High continuing calibration recovery, DNR - use original analysis
RP01/RP09	Fluorene	38	J DNR	MGP-GW-MW-29 DL	High continuing calibration recovery, DNR - use original analysis

Notes

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

DNR = Do Not Report

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TECHNICAL MEMORANDUM

TO: Chip Halbert

FROM: Kristi Schultz KES and Anne Halvorsen ASH

DATE: December 1, 2010

**RE: AUGUST AND SEPTEMBER 2010 SOIL SAMPLES LABORATORY DATA QUALITY EVALUATION
CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

This technical memorandum provides the results of a focused data validation for the analysis of 157 soil samples and 8 trip blanks collected on August 16-30, 2010 and September 20, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. Samples were analyzed by Analytical Resources, Inc. (ARI), located in Tukwila, Washington. This data quality evaluation covers ARI data packages RJ02/RJ03, RJ24, RJ49, RJ50, RJ51, RJ78, RJ80, RJ81, RJ84, RJ85, RK34, RK79, RK94, RL26, RN85, and RP57. Samples submitted to ARI were analyzed for volatile organic compounds (VOCs) [U.S. Environmental Protection Agency (EPA) Method SW8260C], semivolatile organic compounds (SVOCs) (EPA Method SW8270D), polycyclic aromatic hydrocarbons (PAHs) (EPA Method SW8270D-SIM), polychlorinated biphenyls (PCBs) (EPA Method SW8082), total metals (EPA Methods 200.8 and 7471A), diesel- and oil-range petroleum hydrocarbons (TPH-D) [Washington State Department of Ecology (Ecology) Method NWTPH-Dx], gasoline-range petroleum hydrocarbons (TPH-G) (Ecology Method NWTPH-Gx), extractable petroleum hydrocarbons (EPH) (Method WA EPH), volatile petroleum hydrocarbons (VPH) (Method WA VPH), and conventionals, including total cyanide (EPA Method 335.4) and weak acid dissociable (WAD) cyanide (SM4500CN-I).

Sample data were evaluated in accordance with applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 2004), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl and Landau Associates 2010). The following parameters were evaluated:

- Chain-of-custody (COC) records
- Holding times
- Blank results (laboratory method and field trip)
- Surrogate recoveries
- Matrix spike/matrix spike duplicate (MS/MSD) and laboratory duplicate results
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results

- Blind field duplicate results
- Quantitation limits
- Audit/corrective action records
- Completeness and overall data quality.

Data validation qualifiers are added to samples based on the evaluation of data quality. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below.

CHAIN-OF-CUSTODY RECORDS

A signed chain-of-custody (COC) record was attached to each data package. The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample jar information was compared to the COC and the cooler temperatures were recorded. Several coolers were received below the EPA-recommended limits of 4°C±2°C. Data were not qualified based on the cooler temperature.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary. All samples, with the exception of samples for VOC and TPH-G analysis, were frozen at the laboratory upon receipt to protect holding times.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks with the following exceptions:

- Barium was detected in the method blank associated with the total metals analysis included in data package RN85. The samples associated with this method blank had concentrations of barium higher than the action level[1]. No qualification of the data is necessary.
- Naphthalene was detected in the method blank associated with the PAH analysis in data package RJ80. The samples associated with this method blank had concentrations of naphthalene higher than the action level. No qualification of the data is necessary.

[1] The action level is defined as 10 times the concentration in the blank for common volatile laboratory contaminants (methylene chloride, acetone, 2-butanone, and cyclohexane), or 5 times the concentration for other target compounds (EPA 1999).

- Methylene chloride was detected in the method blank associated with the VOC analysis in data package RK34. Methylene chloride was detected in sample MGP-HS-29-13.5-14.0 at a concentration below the action level; therefore, the result is qualified as not detected (U), as indicated in Table 1.
- Methylene chloride was detected in the method blanks associated with the VOC analysis in data package RJ81. Associated samples were either not detected or were detected above the action level, with the exception of sample MGP-GP-32-12.0-13.0, which had a detection of methylene chloride below the action level; therefore the associated sample result was qualified as not detected (U), as indicated in Table 1. The method blank associated with the trip blank analysis had an action level higher than the trip blank detection; therefore the trip blank detection was qualified as not detected (U).
- Diesel was detected in the method blank associated with the TPH-D analysis in data package RJ81. Associated samples were detected above the action level; no qualification of the data is necessary.
- Naphthalene was detected in the method blank associated with the PAH analysis in data package RJ02/RJ03. Associated samples were either not detected or were detected above the action level with the exception of MGP-GP-12-0.5-1.0, MGP-GP-13-0.5-1.0, and MGP-GP-14-0.5-1.0; these sample results were qualified as not detected (U), as indicated in Table 1.
- Methylene chloride was detected in the method blanks associated with the VOC analysis in data package RJ84. Associated samples were detected above the action level with the exception of the trip blank. The method blank associated with the trip blank analysis had an action level higher than the trip blank detection; therefore the trip blank detection was qualified as not detected (U). No qualification of the data is necessary.
- C8-C10 aromatics were detected in the method blank associated with the EPH analysis in data package RJ24. Associated samples were not detected; therefore no qualification of the data is necessary.

Field Trip Blanks and Field Equipment Blanks

Trip blanks were submitted for VOC and gasoline-range petroleum hydrocarbon analysis with data packages RJ02/RJ03, RJ24, RJ50, RJ81, RJ84, RK34, RK79, and RL26. No contamination was detected in any of the trip blanks with the following exceptions:

- Chloromethane and methylene chloride were detected in the trip blank associated with the VOC analysis in data package RK34. All associated sample results were either not detected or were detected above the action levels; therefore no qualification of the data is necessary.
- Methylene chloride was detected in the trip blank associated with the VOC analysis in data package RJ81. The method blank contamination mentioned in the Blank Results section above qualified the trip blank detection as not detected; therefore no qualification of the data is necessary.
- Methylene chloride was detected in the trip blank associated with the VOC analysis in data package RJ24. All associated sample results were either not detected or were detected above the action level; therefore no qualification of the data is necessary.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for the various analyses. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- The laboratory noted that surrogate recoveries for numerous samples for various analyses in several data packages were outside laboratory-specified control limits due to dilution; no qualification of the data is deemed necessary.
- The MS sample MGP-GP-13-0.5-1.0 associated with the PAH analysis in data package RJ02/RJ03 did not have surrogates added due to an analyst error. No qualification of the data is deemed necessary.
- Recovery of the surrogate d4-1,2-dichlorobenzene associated with the SVOC analysis for sample MGP-GP-44-5.0-6.0 in data package RJ50 was below the laboratory-specified control limits; recovery of the surrogate d5-nitrobenzene associated with the SVOC analysis for sample MGP-GP-09-10.0-11.0 in data package RJ50 exceeded the laboratory-specified control limits. SVOC sample surrogate qualification requires two or more surrogates of the same fraction to be outside laboratory-specified control limits; therefore no qualification of the data is necessary.
- Recovery of the surrogate bromofluorobenzene associated with the VOC analysis for sample MGP-HS-40-34.0-34.5 in data package RK79 exceeded the laboratory-specified control limits; the laboratory re-analyzed the sample with surrogate recoveries within control limits; because the re-analysis was diluted, report the original date results, and qualify all detects as estimated (J), as indicated in Table 1.
- Recovery of the surrogate o-Terphenyl associated with the TPH-D analysis for sample MGP-HS-40-34.0-34.5 in data package RK79 was below the laboratory-specified control limits. The laboratory re-extracted and re-analyzed the sample with surrogate recoveries within control limits; the re-analysis results for this sample should be reported.
- Recovery of the surrogate d10-2-methylnaphthalene associated with the PAH analysis for sample MGP-GP-41-14.0-15.0 in data package RL26 was slightly below the laboratory-specified control limits; other surrogate recoveries were within limits. No qualification of the data is deemed necessary.

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) AND LABORATORY REPLICATE RESULTS

A MS and/or laboratory duplicate sample was analyzed with the VOCs, SVOCs, PAHs, PCBs, TPH-D, TPH-G, EPH, total metals, and conventionals analyses in several data packages. The recovery values for each required spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

- **Data package RJ02/03:**
  - The MS/MSD recoveries for pyrene and chrysene associated with the PAH analysis for sample MGP-GP-13-0.5-1.0 were below the laboratory-specified control limits; the associated sample results were qualified as estimated (J), as indicated in Table 1.

– The MS recovery for benzo(a)pyrene associated with the PAH analysis for sample MGP-GP-13-0.5-1.0 was below the laboratory-specified control limits. The MSD recovery was within control limits; therefore no qualification of the data is deemed necessary.

– The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-05-5.0-6.0 was below the laboratory-specified control limits; the associated sample result was qualified as estimated (UJ), as indicated in Table 1.

– The MS recovery for barium associated with the total metals analysis for sample MGP-GP-05-5.0-6.0 exceeded the laboratory-specified control limits; the MS recovery is not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.

- **Data package RJ24:**

  – The MS/MSD recoveries for 2-methylnaphthalene associated with the SVOC analysis for sample MGP-GP-19-9.0-10.0 were below the laboratory-specified control limits; the associated sample result was qualified as estimated (J), as indicated in Table 1.

  – The MS recovery for naphthalene associated with the SVOC analysis for sample MGP-GP-19-9.0-10.0 was below the laboratory-specified control limits; the MSD recovery was not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.

  – The MS recoveries for fluoranthene and phenanthrene associated with the PAH analysis for sample MGP-GP-19-0.5-1.0 were below the laboratory-specified control limits. The MSD recoveries were within control limits; therefore no qualification of the data is necessary.

  – The MS/MSD recoveries for several compounds associated with the EPH analysis for sample MGP-GP-17-7.0-8.0 are not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.

  – The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-17-7.0-8.0 was below the laboratory-specified control limits; the MS recovery for barium exceeded the laboratory-specified control limits. The associated sample results were qualified as estimated (J/UJ), as indicated in Table 1.

- **Data package RJ49:**

  – The MSD recovery for several compounds associated with the PAH analysis for sample MGP-GP-02-0.5-1.0 exceeded the laboratory-specified control limits. The MS recoveries are all within control limits; therefore no qualification of the data is necessary.

  – The MS/MSD recoveries for diesel associated with the TPH-D analysis and the MS recovery for total cyanide associated with the conventionals analysis for sample MGP-GP-23-14.0-15.0 were not calculated due to a negative recovery of the spiking solution; no qualification of the data is necessary.

  – The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-06-0.5-1.0 was below the laboratory-specified control limits; the associated sample result was qualified as estimated (UJ), as indicated in Table 1.

  – The MS recovery for mercury associated with the total metals analysis for sample MGP-GP-06-0.5-1.0 exceeded the laboratory-specified control limits; the MS recovery is not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.

- **Data package RJ50:**
  - The MS/MSD recoveries for 2,4-dimethylphenol and benzo(g,h,i)perylene associated with the SVOC analysis for sample MGP-GP-03-4.0-5.0 were below the laboratory-specified control limits. The associated sample results were qualified as estimated (J/UJ), as indicated in Table 1.
  - The MS or MSD recoveries for several compounds associated with the SVOC analysis for sample MGP-GP-03-4.0-5.0 were outside the laboratory-specified control limits either low or high. The corresponding MSD or MS recoveries were within control limits; therefore no qualification of the data is necessary.
  - The MS/MSD recoveries for benzoic acid associated with the SVOC analysis for sample MGP-GP-03-4.0-5.0 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.
  - The MS recovery for antimony and silver associated with the total metals analysis for sample MGP-GP-24-5.0-6.0 were below the laboratory-specified control limits; the MS recoveries for copper and zinc exceeded the laboratory-specified control limits. The associated sample results were qualified as estimated (J/UJ), as indicated in Table 1.
  - The MS recovery for lead associated with the total metals analysis for sample MGP-GP-24-5.0-6.0 was below the laboratory-specified control limits; however, the MS recovery is not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.
- **Data package RJ51:**
  - The MS/MSD recoveries for fluoranthene associated with the PAH analysis for sample MGP-GP-10-0.5-1.0 were below the laboratory-specified control limits; the associated result was qualified as estimated (J), as indicated in Table 1.
  - The MS/MSD recoveries for phenanthrene and pyrene associated with the PAH analysis for sample MGP-GP-10-0.5-1.0 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.
  - The MSD recovery for chrysene associated with the PAH analysis for sample MGP-GP-10-0.5-1.0 was below the laboratory-specified control limits. The MS recovery was within control limits; therefore no qualification of the data is necessary.
  - The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-22-0.5-1.0 was below the laboratory-specified control limits; the associated result was qualified as estimated (UJ), as indicated in Table 1.
- **Data package RJ78:**
  - The MS recovery for antimony, silver, and zinc associated with the total metals analysis for sample MGP-GP-33-0.5-1.0 were below the laboratory-specified control limits; the MS recovery for copper exceeded the laboratory-specified control limits. The associated sample results were qualified as estimated (J/UJ), as indicated in Table 1.
  - The MS recovery for barium associated with the total metals analysis for sample MGP-GP-33-0.5-1.0 exceeded the laboratory-specified control limits; the MS recovery is not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.

- **Data package RJ80:**
  - The MS/MSD recoveries for 2-methylnaphthalene associated with the PAH analysis for sample MGP-GP-45-0.5-1.0 were below the laboratory-specified control limits; the associated result is qualified as estimated (J), as indicated in Table 1.
  - The MS/MSD recoveries for naphthalene associated with the PAH analysis for sample MGP-GP-45-0.5-1.0 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.
  - The MS recovery for antimony and silver associated with the total metals analysis for sample MGP-GP-30-0.5-1.0 were below the laboratory-specified control limits; the MS recovery for mercury exceeded the laboratory-specified control limits. The associated sample results are qualified as estimated (UJ/J), as indicated in Table 1.
  - The MS recovery for barium associated with the total metals analysis for sample MGP-GP-30-0.5-1.0 was below the laboratory-specified control limits; the percent recovery is not applicable due to the high concentration of barium in the original sample; no qualification of the data is necessary.
  - The MS recovery for total cyanide associated with the conventional analysis for sample MGP-GP-30-0.5-1.0 was below the laboratory-specified control limits; the associated result is qualified as estimated (J), as indicated in Table 1.
- **Data package RJ81:**
  - The MS/MSD recoveries for several compounds associated with the PAH analysis for sample MGP-GP-31-11.0-12.0 were not calculated due to the high concentration of the target analyte in the original sample; no qualification of the data is necessary.
  - The MS/MSD recoveries for diesel associated with the TPH-D analysis for sample MGP-GP-33-11.0-12.0 was not calculated due to the high concentration of the target analyte in the original sample; no qualification of the data is necessary.
  - The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-28-9.0-10.0 was below the laboratory-specified control limits; the associated sample result has been qualified as estimated (UJ), as indicated in Table 1.
- **Data package RJ84:**
  - The MS/MSD recoveries for 1,1-dichloroethene and acrylonitrile associated with the VOC analysis and for dibenz(a,h)anthracene associated with the SVOC analysis for sample MGP-GP-37-23.0-24.0 exceeded the laboratory-specified control limits. The associated sample results are not detected; therefore no qualification of the data is necessary.
  - The MS recovery for chrysene associated with the SVOC analysis for sample MGP-GP-37-23.0-24.0 was below the laboratory-specified control limits; the MSD recovery exceeded the laboratory-specified control limits; the associated sample result was qualified as estimated (J), as indicated in Table 1.
  - The MS/MSD recoveries for several compounds associated with the SVOC analysis for sample MGP-GP-37-23.0-24.0 were not calculated due to a negative recovery of the spiking solution; the MS/MSD recoveries for several other compounds were not applicable due to the high concentration of the target analyte in the original sample. No qualification of the data is necessary.

– The MS or MSD recoveries for several compounds associated with the SVOC analysis for sample MGP-GP-37-23.0-24.0 either exceeded or were below the laboratory-specified control limits. The associated MSD or MS recoveries were within control limits; therefore no qualification of the data is necessary.

– The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-37-23.0-24.0 was below the laboratory-specified control limits; the associated sample result was qualified as estimated (UJ), as indicated in Table 1.

- **Data package RJ85:**

  – MS recovery for several compounds associated with the PAH analysis for sample MGP-GP-34-4.5-5.5 exceeded the laboratory-specified control limits. The MSD recoveries were within laboratory-specified control limits; therefore no qualification of the data is necessary.

  – The MS recovery for antimony associated with the total metals analysis for sample MGP-GP-34-0.5-1.0 was below the laboratory-specified control limits; the MS recovery for barium exceeded the laboratory-specified control limits. The associated sample results were qualified as estimated (UJ/J), as indicated in Table 1.

- **Data package RK34:**

  – The MS recovery for diesel associated with the TPH-D analysis for sample MGP-HS-29-14.0-15.0 was below the laboratory-specified control limits; the MSD recovery exceeded the laboratory-specified control limits. The associated result is qualified as estimated (J), as indicated in Table 1.

- **Data package RK79:**

  – The MS recoveries for antimony and silver associated with the total metals analysis for sample MGP-HS-38-25.0-26.0 were below the laboratory-specified control limits; the associated results are qualified as estimated (UJ), as indicated in Table 1.

- **Data package RK94:**

  – The MS/MSD recoveries for fluoranthene, benzo(a)anthracene, and chrysene associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 exceeded the laboratory-specified control limits; the MS recovery for phenanthrene was below laboratory-specified control limits and the MSD recovery exceeded laboratory-specified control limits. The associated sample results were qualified as estimated (J), as indicated in Table 1.

  – The MSD recovery for naphthalene and dibenz(a,h)anthracene associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 exceeded the laboratory-specified control limits; the MS recoveries were within control limits. No qualification of the data is necessary.

  – The MS recovery for pyrene and benzo(a)pyrene associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 were not calculated due to a negative recovery of the spiking solution; the MSD recoveries are not applicable due to the high concentration of target analytes in the original samples. No qualification of the data is necessary.

  – The MS/MSD recoveries for indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.

- The MS recovery for total benzofluoranthenes associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 was not calculated due to a negative recovery of the spiking solution; the MSD recovery was within the laboratory-specified control limits. No qualification of the data is necessary.
- The MS recovery for antimony associated with the total metals analysis for sample MGP-HA-11-0.0-1.0 was below the laboratory-specified control limits; the associated sample result has been qualified as estimated (UJ), as indicated in Table 1.
- The MS recovery for barium associated with the total metals analysis for sample MGP-HA-11-0.0-1.0 was below the laboratory-specified control limits; the MSD recovery is not applicable due to the high concentration of target analyte in the original sample. No qualification of the data is necessary.

- **Data package RL26:**
  - The MS/MSD recoveries for numerous compounds associated with the VOC analysis for sample MGP-GP-41-0.5-1.0 were below the laboratory-specified control limits; the MS recovery for antimony associated with the total metals analysis was also below the laboratory-specified control limits. The associated sample results were qualified as estimated (J/UJ), as indicated in Table 1.
  - The MSD recoveries for 2-butanone, methyl iodide, and acrylonitrile associated with the VOC analysis for sample MGP-GP-41-28.0-29.0 were below the laboratory-specified control limits. The MS recoveries were within control limits; therefore no qualification of the data is necessary.
  - The MS/MSD recoveries for multiple compounds associated with the VOC analysis for sample MGP-GP-41-28.0-29.0 were not calculated due to a negative recovery of the spiking solution. No qualification of the data is necessary.
  - The MS/MSD recoveries for 2-methylnaphthalene associated with the SVOC analysis for sample MGP-GP-41-28.0-29.0 exceeded the laboratory-specified control limits; the associated result was qualified as estimated (J), as indicated in Table 1.
  - The MS/MSD recoveries for several compounds associated with the SVOC analysis for sample MGP-GP-41-28.0-29.0 exceeded the laboratory-specified control limits. The associated results were not detected; therefore no qualification of the data is necessary.
  - The MS/MSD recoveries for several compounds associated with the SVOC analysis for sample MGP-GP-41-28.0-29.0 and the MS recovery for barium associated with the total metals analysis for sample MGP-GP-41-0.5-1.0 were not calculated due to either a negative recovery of the spiking solution or a high concentration of the target analyte in the original sample. No qualification of the data is necessary.
  - The MS recovery for diesel associated with the TPH-D analysis for sample MGP-GP-41-28.0-29.0 was below the laboratory-specified control limits. The MSD recovery exceeded the control limits; the associated result was qualified as estimated (J), as indicated in Table 1.

- **Data package RN85:**
  - The MS/MSD recoveries for fluoranthene associated with the PAH analysis for sample MGP-HA-14-1.0-1.5 exceeded the laboratory-specified control limits; the associated result is qualified as estimated (J), as indicated in Table 1.
  - The MS recovery for several compounds associated with the PAH analysis for sample MGP-HA-14-1.0-1.5 exceeded the laboratory-specified control limits. The MSD recoveries were within control limits; therefore no qualification of the data is necessary.

– The MS recovery for antimony and lead associated with the total metals analysis for sample MGP-HA-13-1.0-1.5 were below the laboratory-specified control limits; the associated results are qualified as estimated (J/UJ), as indicated in Table 1.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the laboratory replicate results or a project-specified control limit of 35 percent was used to evaluate the RPDs between the MS/MSDs, except when the samples were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. The RPDs between the laboratory replicate results or MS/MSD were within the current laboratory- or project-specified control limits for all project samples with the following exceptions:

- **Data package RJ24:**
  - The laboratory replicate RPD for several compounds associated with the total metals analysis for sample MGP-GP-17-7.0-8.0 exceeded the laboratory-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 1.
- **Data package RJ49:**
  - The MS/MSD RPD for several compounds associated with the PAH analysis for sample MGP-GP-02-0.5-1.0 exceeded the laboratory-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 1.
  - The laboratory replicate RPD for total cyanide associated with the conventionals analysis for sample MGP-GP-23-14.0-15.0 exceeded the laboratory-specified control limit; the associated sample result was qualified as estimated (J), as indicated in Table 1.
- **Data package RJ50:**
  - The MS/MSD RPD for 2,4-dimethylphenol associated with the SVOC analysis for sample MGP-GP-03-4.0-5.0 exceeded the laboratory-specified control limits; the associated sample result was not detected; therefore no qualification of the data is necessary.
  - The MS/MSD RPD for benzoic acid associated with the SVOC analysis for sample MGP-GP-03-4.0-5.0 was not calculable due to incalculable percent recoveries of the spiking solution; no qualification of the data is necessary.
  - The laboratory replicate RPD for several compounds associated with the total metals analysis for sample MGP-GP-24-5.0-6.0 exceeded the laboratory-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 1.
- **Data package RJ51:**
  - The MS/MSD RPDs for phenanthrene and pyrene associated with the PAH analysis for sample MGP-GP-10-0.5-1.0 was not calculable due to incalculable percent recoveries of the spiking solution. No qualification of the data is necessary.
- **Data package RJ80:**
  - The MS/MSD RPD for naphthalene associated with the PAH analysis for sample MGP-GP-45-0.5-1.0 was not calculable due to incalculable percent recoveries of the spiking solution. No qualification of the data is necessary.

- The laboratory replicate RPD for barium associated with the total metals analysis for sample MGP-GP-30-0.5-1.0 exceeded the laboratory-specified control limit; the associated result is qualified as estimated (J), as indicated in Table 1.

- **Data package RJ81:**
  - The MS/MSD RPD for several compounds associated with the PAH analysis for sample MGP-GP-31-11.0-12.0 were not calculable due to incalculable percent recoveries of the spiking solution; no qualification of the data is necessary.

- **Data package RJ84:**
  - The MS/MSD RPDs for several compounds associated with the SVOC analysis for sample MGP-GP-37-23.0-24.0 were not calculable due to incalculable percent recoveries of the spiking solution; no qualification of the data is necessary.

- **Data package RJ85:**
  - The laboratory replicate RPD for mercury associated with the total metals analysis for sample MGP-GP-34-0.5-1.0 exceeded the laboratory-specified control limit. The associated result is qualified as estimated (J), as indicated in Table 1.

- **Data package RK94:**
  - The MS/MSD RPD for phenanthrene associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 exceeded the project-specified control limit; the associated sample result is qualified as estimated (J), as indicated in Table 1.
  - The MS/MSD RPDs for several compounds associated with the PAH analysis for sample MGP-HA-07-0.0-0.5 were not calculable due to incalculable percent recoveries of the spiking solution; no qualification of the data is necessary.
  - The laboratory replicate RPD for barium, lead, and zinc associated with the total metals analysis for sample MGP-HA-11-0.0-1.0 exceeded the laboratory-specified control limit; the associated sample results are qualified as estimated (J), as indicated in Table 1.

- **Data package RL26:**
  - The MS/MSD RPDs for numerous compounds associated with the SVOC analysis and for diesel associated with the TPH-D analysis for sample MGP-GP-41-28.0-29.0 exceeded the project-specified control limits; the associated results are qualified as estimated (J), as indicated in Table 1.
  - The MS/MSD RPDs for several compounds associated with the VOC and SVOC analyses for sample MGP-GP-41-28.0-29.0 were not calculable due to incalculable percent recoveries of the spiking solution. No qualification of the data is necessary.
  - The MS/MSD RPDs for bromoethane and acrylonitrile associated with the VOC analysis and for phenol and 4-methylphenol associated with the SVOC analysis for sample MGP-GP-41-28.0-29.0 exceeded the project-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.

- **Data package RN85:**
  - The MS/MSD RPDs for several compounds associated with the PAH analysis for sample MGP-HA-14-1.0-1.5 exceeded the project-specified control limit; the associated results are qualified as estimated (J), as indicated in Table 1.

LABORATORY CONTROL SAMPLE AND LABORATORY CONTROL SAMPLE DUPLICATE RESULTS

At least one LCS and/or LCSD or one standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD samples were within the current laboratory-specified control limits with the following exceptions:

- **Data package RJ02/03:**
  - The LCS and/or LCSD recoveries for several compounds associated with the VOC analysis and for benzyl alcohol associated with the SVOC analysis exceeded the laboratory-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.
- **Data package RJ24:**
  - The LCS/LCSD recoveries for benzyl alcohol associated with the SVOC analysis exceeded the laboratory-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.
- **Data package RJ81:**
  - The LCS/LCSD recoveries for several compounds associated with the VOC analysis exceeded the laboratory-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.
- **Data package RJ84:**
  - The LCS/LCSD recoveries for several compounds associated with the SVOC analysis exceeded the laboratory-specified control limits. The associated sample results were not detected; therefore no qualification of the data is necessary.
  - The LCSD recoveries and LCS/LCSD RPDs for several compounds associated with the PAH analysis exceeded the laboratory-specified control limits; the associated sample results were qualified as estimated (J), as indicated in Table 1.
- **Data package RK34:**
  - The LCS recovery for 1,1-dichloroethene and the LCSD recovery for acrylonitrile associated with the VOC analysis and the LCS recoveries for several compounds associated with the SVOC analysis exceeded the laboratory-specified control limits. The associated samples results were not detected; therefore no qualification of the data is necessary.
  - The LCS recovery for benzo(b)fluoranthene and benzo(k)fluoranthene associated with the SVOC analysis exceeded the laboratory-specified control limits; the associated sample results were qualified as estimated (J), as indicated in Table 1.
- **Data package RK79:**
  - The LCS/LCSD recoveries for several compounds associated with the SVOC analysis exceeded the laboratory-specified control limits. The associated samples results were not detected; therefore no qualification of the data is necessary.
- **Data package RL26:**
  - The LCS/LCSD recoveries for 2,4-dimethylphenol associated with the SVOC analysis were below the project-specified control limits; the associated sample result is qualified as estimated (UJ), as indicated in Table 1.

- The LCS/LCSD RPD for pentachlorophenol associated with the SVOC analysis exceeded the project-specified control limit. The associated sample result was not detected; therefore no qualification of the data is necessary.

- **Data package RN85:**
  - The LCS/LCSD recoveries for aroclor 1016 associated with the PCB analysis exceeded the laboratory-specified control limits. The associated samples results were not detected; therefore no qualification of the data is necessary.

BLIND FIELD DUPLICATES

Nine pairs of blind field duplicates soil samples (MGP-GP-61-13.0-14.0/MGP-GP-34-13.0-14.0, MGP-GP-62-14.0-15.0/MGP-GP-36-14.0-15.0, MGP-GP-60-11.0-12.0/MGP-GP-31-11.0-12.0, MGP-GP-59-9.0-10.0/MGP-GP-28-9.0-10.0, MGP-GP-57-14.0-15.0/MGP-GP-23-14.0-15.0, MGP-GP-58-7.0-8.0/MGP-GP-02-7.0-8.0, MGP-GP-14-4.0-5.0/MGP-GP-54-4.0-5.0, MGP-GP-56-7.0-8.0/MGP-GP-17-7.0-8.0, and MGP-HA-30-0.0-1.0/MGP-HA-08-0.0-1.0) were submitted for analysis with data packages RJ02/RJ03, RJ24, RJ25, RJ49, RJ50, RJ78, RJ81, RJ85, RK94, and RP57. These were analyzed for total metals, PAHs, VOCs, TPH-G, or cyanide.

A project-specified control limit of 35 percent was used to evaluate the RPDs between the duplicate soil samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. RPDs for the duplicate sample pairs submitted for analysis were within the project-specified control limits with the following exceptions:

- **Data package RJ02/03:**
  - The RPDs for several compounds associated with the PAH analysis for sample pair MGP-GP-14-4.0-5.0/MGP-GP-54-4.0-5.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.

- **Data package RJ24:**
  - The RPD for gasoline associated with the TPH-G analysis for sample pair MGP-GP-56-7.0-8.0/MGP-GP-17-7.0-8.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.

- **Data package RJ49:**
  - The RPDs for several compounds associated with the total metals analysis for sample pair MGP-GP-57-14.0-15.0/MGP-GP-23/14.0-15.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.

- **Data package RJ50:**
  - The RPDs for several compounds associated with the VOC, SVOC, PAH, TPH-D, and TPH-G analyses for sample pair MGP-GP-58-7.0-8.0/MGP-GP-02-7.0-8.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.

- **Data package RJ78/RJ81:**
  - The RPDs for several compounds associated with the PAH analysis and the RPD for total cyanide associated with the conventional analysis for sample pair MGP-GP-60-11.0-12.0/MGP-GP-31-11.0-12.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.
- **Data package RJ81:**
  - The RPDs for benzene, toluene, and naphthalene associated with the VOC analysis for sample pair MGP-GP-59-9.0-10.0/MGP-GP-28-9.0-10.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.
- **Data package RJ85:**
  - RPDs for several compounds associated with the PAH analysis and the RPDs for barium and mercury associated with the total metals analysis for sample pair MGP-GP-34-13.0-14.0/MGP-GP-61-13.0-14.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.
  - The RPD for anthracene associated with the PAH analysis and the RPDs for arsenic and lead associated with the total metals analysis for sample pair MGP-GP-36-14.0-15.0/MGP-GP-62-14.0-15.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.
- **Data package RK94:**
  - The RPD for dibenz(a,h)anthracene associated with the PAH analysis and the RPDs for antimony, lead, and mercury associated with the total metals analysis for sample pair MGP-HA-30-0.0-1.0/MGP-HA-08-0.0-1.0 exceeded the project-specified control limit. The results are qualified as estimated (J/UJ), as indicated in Table 1.
- **Data package RP57:**
  - The RPD for lead for the total metals re-analysis for sample pair MGP-GP-36-14.0-15.0/MGP-GP-62-14.0-15.0 exceeded the project-specified control limit. The results are qualified as estimated (J), as indicated in Table 1.

QUANTITATION LIMITS

Project-specified quantitation limits were met for all samples, except for the following:

- Instances where samples required dilutions based on high concentrations of target analytes may have elevated reporting limits.
- **Data package RJ02/03:**
  - The 8/17/10 VOC continuing calibration (CCAL) was out of control (low) for 1,1,1,2-tetrachloroethane; the associated sample results were qualified as estimated, do not report (UJ DNR), as indicated in Table 1.
  - The 8/21/10 VOC CCAL was out of control (low) for chloroethane and trichlorofluoromethane; the 8/30/10 SVOC CCAL was out of control low for 2,4-dinitrophenol. The associated sample results were qualified as estimated (UJ), as indicated in Table 1.
  - The 8/17/10 VOC CCAL was out of control (high) for trans-1,4-dichloro-2-butene, 4-isopropylbenzene, and n-butylbenzene and the 8/21/10 VOC CCAL was out of control

(high) for 4-methyl-2-pentanone. The associated sample results were not detected; therefore no qualification of the data is necessary.

- The internal standard d4-1,4-dichlorobenzene associated with the VOC analysis was out of control (low) on both project samples (not the trip blank) in the original analysis run on 8/17/10. A follow-up run was performed on 8/21/10 with all internal standards in control and both sets of results were provided for review; the re-analysis results should be reported.

- **Data package RJ24:**
  - The 8/26/10 VOC CCAL was out of control (low) for several compounds; the SVOC CCAL was out of control (low) for 2,4-dinitrophenol. The associated sample results were qualified as estimated (UJ), as indicated in Table 1.

- **Data package RJ49:**
  - The 9/8/10 SVOC CCAL was out of control (low) for 2,4-dinitrophenol. The associated samples were the LCS/LCSD; therefore no qualification of the data is necessary.

- **Data package RJ50:**
  - The 8/27/10 VOC CCAL was out of control (low) for chloromethane, acetone, and methyl tert-butyl ether; the SVOC CCAL was out of control low for 2,4-dinitrophenol. The associated sample results were qualified as estimated (UJ/J), as indicated in Table 1.

- **Data package RJ81:**
  - The 8/31/10 VOC CCAL was out of control (low) for chloromethane; the SVOC CCAL was out of control low for 2,4-dinitrophenol. The associated sample results were qualified as estimated (UJ), as indicated in Table 1.
  - The 8/30/10 VOC CCAL was out of control (high) for methyl iodide and sec-butylbenzene. The results from the associated samples were not detected; therefore no qualification of the data is necessary.

- **Data package RJ84:**
  - The 8/30/10 VOC CCAL was out of control (high) for methyl iodide and sec-butylbenzene. The associated sample results were not detected; therefore no qualification of the data is necessary.
  - The 9/9/10 SVOC CCAL was out of control (low) for 2,4-dinitrophenol and hexachlorocyclopentadiene. This CCAL is associated with the LCS/LCSD; therefore no qualification of the data is necessary.

- **Data package RK79:**
  - The 9/7/10 and 9/8/10 VOC CCALs were out of control (low) for acetone. The associated sample results are qualified as estimated (J), as indicated in Table 1.
  - The 9/7/10 VOC CCAL was also out of control (high) for isopropylbenzene, s-butylbenzene, 4-isopropyltoluene, and n-butylbenzene and the 9/8/10 VOC CCAL was out of control high for n-butylbenzene. The 4-isopropylbenzene results from the associated samples are qualified as estimated (J), as indicated in Table 1. The isopropylbenzene, s-butylbenzene, and n-butylbenzene results from the associated samples were not detected; therefore no qualification of the data is necessary.

- **Data package RL26:**
  - The VOC CCAL was out of control (low) for acetone and the SVOC CCAL was out of control (low) for hexachlorocyclopentadiene, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol. The results from the associated sample are qualified as estimated (J/UJ), as indicated in Table 1.
  - The VOC CCAL was out of control (high) for n-butylbenzene. The result from the associated sample is not detected; therefore no qualification of the data is necessary.
- **Data package RN85:**
  - The PAH CCAL was out of control (high) for 2-methylnaphthalene. The results from the associated samples are qualified as estimated (J), as indicated in Table 1.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through field duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

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TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ02/03	1,1,1,2-Tetrachloroethane	1.1U	UJ DNR	MGP-GP-05-5.0-6.0	Low continuing calibration recovery DNR - use re-analysis results
RJ02/03	1,1,1,2-Tetrachloroethane	2.6 U	UJ DNR	MGP-GP-12-5.0-6.5	Low continuing calibration recovery DNR - use re-analysis results
RJ02/03	Chloroethane	1.8 U	UJ	MGP-GP-05-5.0-6.0 RE	Low continuing calibration recovery
RJ02/03	Trichlorofluoromethane	1.8 U	UJ	MGP-GP-05-5.0-6.0 RE	Low continuing calibration recovery
RJ02/03	Chloroethane	2.2 U	UJ	MGP-GP-12-5.0-6.5 RE	Low continuing calibration recovery
RJ02/03	Trichlorofluoromethane	2.2 U	UJ	MGP-GP-12-5.0-6.5 RE	Low continuing calibration recovery
RJ02/03	ALL VOCs	ALL	DNR	MGP-GP-05-5.0-6.0	DNR - use re-analysis results, internal standards out of control low
RJ02/03	ALL VOCs	ALL	DNR	MGP-GP-12-5.0-6.5	DNR - use re-analysis results, internal standards out of control low
RJ02/03	2,4-Dinitrophenol	1900 U	UJ	MGP-GP-05-5.0-6.0	Low continuing calibration recovery
RJ02/03	2,4-Dinitrophenol	1900 U	UJ	MGP-GP-12-5.0-6.5	Low continuing calibration recovery
RJ02/03	Acenaphthylene	330	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Fluorene	160	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Phenanthrene	4800	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Anthracene	1500	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Fluoranthene	9600	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Pyrene	10,000	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Benzo(a)anthracene	4800	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Chrysene	5100	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Benzo(a)pyrene	7300	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Indeno(1,2,3-cd)pyrene	4200	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Dibenz(a,h)anthracene	740	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Benzo(g,h,i)perylene	5300	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Total Benzofluoranthenes	8600	J	MGP-GP-14-4.0-5.0	High field duplicate RPD
RJ02/03	Acenaphthylene	130	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Fluorene	48	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Phenanthrene	1000	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Anthracene	250	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Fluoranthene	1900	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Pyrene	2100	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Benzo(a)anthracene	1600	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Chrysene	1900	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Benzo(a)pyrene	3600	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Indeno(1,2,3-cd)pyrene	2500	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Dibenz(a,h)anthracene	510	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Benzo(g,h,i)perylene	3200	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Total Benzofluoranthenes	4100	J	MGP-GP-54-4.0-5.0	High field duplicate RPD
RJ02/03	Pyrene	150	J	MGP-GP-13-0.5-1.0	Low MS/MSD recovery
RJ02/03	Chrysene	100	J	MGP-GP-13-0.5-1.0	Low MS/MSD recovery
RJ02/03	Naphthalene	16	U	MGP-GP-12-0.5-1.0	Method blank contamination
RJ02/03	Naphthalene	9.5	U	MGP-GP-13-0.5-1.0	Method blank contamination
RJ02/03	Naphthalene	14	U	MGP-GP-14-0.5-1.0	Method blank contamination
RJ02/03	Antimony	0.2 U	UJ	MGP-GP-05-5.0-6.0	Low MS recovery
RJ24	Chloromethane	49,000 U	UJ	MGP-GP-17-7.0-8.0	Low continuing calibration recovery
RJ24	Acetone	240,000 U	UJ	MGP-GP-17-7.0-8.0	Low continuing calibration recovery
RJ24	1,1,1-Trichloroethane	49,000 U	UJ	MGP-GP-17-7.0-8.0	Low continuing calibration recovery
RJ24	Methyl tert-butyl ether	49,000 U	UJ	MGP-GP-17-7.0-8.0	Low continuing calibration recovery
RJ24	Chloromethane	120,000 U	UJ	MGP-GP-18-9.0-10.0	Low continuing calibration recovery
RJ24	Acetone	600,000 U	UJ	MGP-GP-18-9.0-10.0	Low continuing calibration recovery
RJ24	1,1,1-Trichloroethane	120,000 U	UJ	MGP-GP-18-9.0-10.0	Low continuing calibration recovery
RJ24	Methyl tert-butyl ether	120,000 U	UJ	MGP-GP-18-9.0-10.0	Low continuing calibration recovery
RJ24	Chloromethane	89,000 U	UJ	MGP-GP-18-14.0-15.0	Low continuing calibration recovery
RJ24	Acetone	440,000 U	UJ	MGP-GP-18-14.0-15.0	Low continuing calibration recovery
RJ24	1,1,1-Trichloroethane	89,000 U	UJ	MGP-GP-18-14.0-15.0	Low continuing calibration recovery
RJ24	Methyl tert-butyl ether	89,000 U	UJ	MGP-GP-18-14.0-15.0	Low continuing calibration recovery
RJ24	Chloromethane	38,000 U	UJ	MGP-GP-19-12.0-13.0	Low continuing calibration recovery

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Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ24	Acetone	190,000 U	UJ	MGP-GP-19-12.0-13.0	Low continuing calibration recovery
RJ24	1,1,1-Trichloroethane	38,000 U	UJ	MGP-GP-19-12.0-13.0	Low continuing calibration recovery
RJ24	Methyl tert-butyl ether	38,000 U	UJ	MGP-GP-19-12.0-13.0	Low continuing calibration recovery
RJ24	Chloromethane	51,000 U	UJ	MGP-GP-56-7.0-8.0	Low continuing calibration recovery
RJ24	Acetone	260,000 U	UJ	MGP-GP-56-7.0-8.0	Low continuing calibration recovery
RJ24	1,1,1-Trichloroethane	51,000 U	UJ	MGP-GP-56-7.0-8.0	Low continuing calibration recovery
RJ24	Methyl tert-butyl ether	51,000 U	UJ	MGP-GP-56-7.0-8.0	Low continuing calibration recovery
RJ24	2,4-Dinitrophenol	620 U	UJ	MGP-GP-17-7.0-8.0	Low continuing calibration recovery
RJ24	2,4-Dinitrophenol	62,000 U	UJ	MGP-GP-18-9.0-10.0	Low continuing calibration recovery
RJ24	2,4-Dinitrophenol	52,000 U	UJ	MGP-GP-18-14.0-15.0	Low continuing calibration recovery
RJ24	2,4-Dinitrophenol	630 U	UJ	MGP-GP-19-9.0-10.0	Low continuing calibration recovery
RJ24	2,4-Dinitrophenol	1800 U	UJ	MGP-GP-19-12.0-13.0	Low continuing calibration recovery
RJ24	2-Methylnaphthalene	510	J	MGP-GP-19-9.0-10.0	Low MS/MSD recovery
RJ24	Gasoline	4200	J	MGP-GP-17-7.0-8.0	High field duplicate RPD
RJ24	Gasoline	2000	J	MGP-GP-56-7.0-8.0	High field duplicate RPD
RJ24	Arsenic	1.8	J	MGP-GP-17-7.0-8.0	High laboratory replicate RPD
RJ24	Barium	52.2	J	MGP-GP-17-7.0-8.0	High laboratory replicate RPD
RJ24	Chromium	11.5	J	MGP-GP-17-7.0-8.0	High laboratory replicate RPD
RJ24	Lead	6	J	MGP-GP-17-7.0-8.0	High laboratory replicate RPD
RJ24	Zinc	40	J	MGP-GP-17-7.0-8.0	High laboratory replicate RPD
RJ24	Antimony	0.2 U	UJ	MGP-GP-17-7.0-8.0	Low MS recovery
RJ24	Barium	52.2	J	MGP-GP-17-7.0-8.0	High MS recovery
RJ49	Naphthalene	25	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	2-Methylnaphthalene	14	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Fluoranthene	72	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Pyrene	90	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Benzo(a)anthracene	43	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Chrysene	54	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Benzo(a)pyrene	51	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Total Benzofluoranthenes	74	J	MGP-GP-02-0.5-1.0	High MS/MSD RPD
RJ49	Antimony	0.2 U	UJ	MGP-GP-06-0.5-1.0	Low MS recovery
RJ49	Arsenic	4.8	J	MGP-GP-23-14.0-15.0	High field duplicate RPD
RJ49	Chromium	30.2	J	MGP-GP-23-14.0-15.0	High field duplicate RPD
RJ49	Lead	8	J	MGP-GP-23-14.0-15.0	High field duplicate RPD
RJ49	Mercury	0.37	J	MGP-GP-23-14.0-15.0	High field duplicate RPD
RJ49	Arsenic	2.3	J	MGP-GP-57-14.0-15.0	High field duplicate RPD
RJ49	Chromium	14.9	J	MGP-GP-57-14.0-15.0	High field duplicate RPD
RJ49	Lead	5	J	MGP-GP-57-14.0-15.0	High field duplicate RPD
RJ49	Mercury	0.04	J	MGP-GP-57-14.0-15.0	High field duplicate RPD
RJ49	Total Cyanide	68.3	J	MGP-GP-23-14.0-15.0	High laboratory replicate RPD
RJ50	Benzene	21,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Toluene	17,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Ethylbenzene	24,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	m,p-Xylene	16,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Naphthalene	110,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzene	14,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Toluene	4600	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Ethylbenzene	12,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	m,p-Xylene	8000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Naphthalene	54,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Chloromethane	17,000 U	UJ	MGP-GP-24-5.0-6.0	Low continuing calibration recovery
RJ50	Acetone	84,000 U	UJ	MGP-GP-24-5.0-6.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	17,000 U	UJ	MGP-GP-24-5.0-6.0	Low continuing calibration recovery
RJ50	Chloromethane	1400 U	UJ	MGP-GP-25-9.0-10.0	Low continuing calibration recovery
RJ50	Acetone	6800 U	UJ	MGP-GP-25-9.0-10.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	1400 U	UJ	MGP-GP-25-9.0-10.0	Low continuing calibration recovery
RJ50	Chloromethane	40,000 U	UJ	MGP-GP-10-12.0-13.0	Low continuing calibration recovery
RJ50	Acetone	200,000 U	UJ	MGP-GP-10-12.0-13.0	Low continuing calibration recovery

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Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ50	Methyl tert-butyl ether	40,000 U	UJ	MGP-GP-10-12.0-13.0	Low continuing calibration recovery
RJ50	Chloromethane	7000 U	UJ	MGP-GP-10-15.0-16.0	Low continuing calibration recovery
RJ50	Acetone	35,000 U	UJ	MGP-GP-10-15.0-16.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	7000 U	UJ	MGP-GP-10-15.0-16.0	Low continuing calibration recovery
RJ50	Chloromethane	50,000 U	UJ	MGP-GP-44-2.5-3.5	Low continuing calibration recovery
RJ50	Acetone	250,000 U	UJ	MGP-GP-44-2.5-3.5	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	50,000 U	UJ	MGP-GP-44-2.5-3.5	Low continuing calibration recovery
RJ50	Chloromethane	53,000 U	UJ	MGP-GP-44-5.0-6.0	Low continuing calibration recovery
RJ50	Acetone	260,000 U	UJ	MGP-GP-44-5.0-6.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	53,000 U	UJ	MGP-GP-44-5.0-6.0	Low continuing calibration recovery
RJ50	Chloromethane	890 U	UJ	MGP-GP-44-13.0-14.0	Low continuing calibration recovery
RJ50	Acetone	4400 U	UJ	MGP-GP-44-13.0-14.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	890 U	UJ	MGP-GP-44-13.0-14.0	Low continuing calibration recovery
RJ50	Chloromethane	81,000 U	UJ	MGP-GP-07-13.0-14.0	Low continuing calibration recovery
RJ50	Acetone	400,000 U	UJ	MGP-GP-07-13.0-14.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	81,000 U	UJ	MGP-GP-07-13.0-14.0	Low continuing calibration recovery
RJ50	Chloromethane	4200 U	UJ	MGP-GP-02-7.0-8.0	Low continuing calibration recovery
RJ50	Acetone	21,000 U	UJ	MGP-GP-02-7.0-8.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	4200 U	UJ	MGP-GP-02-7.0-8.0	Low continuing calibration recovery
RJ50	Chloromethane	940 U	UJ	MGP-GP-58-7.0-8.0	Low continuing calibration recovery
RJ50	Acetone	4700 U	UJ	MGP-GP-58-7.0-8.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	940 U	UJ	MGP-GP-58-7.0-8.0	Low continuing calibration recovery
RJ50	Chloromethane	180 U	UJ	MGP-GP-03-4.0-5.0	Low continuing calibration recovery
RJ50	Acetone	920 U	UJ	MGP-GP-03-4.0-5.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	180 U	UJ	MGP-GP-03-4.0-5.0	Low continuing calibration recovery
RJ50	Chloromethane	0.9 U	UJ	MGP-GP-01-6.5-7.5	Low continuing calibration recovery
RJ50	Acetone	90	J	MGP-GP-01-6.5-7.5	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	0.9 U	UJ	MGP-GP-01-6.5-7.5	Low continuing calibration recovery
RJ50	Chloromethane	33,000 U	UJ	MGP-GP-09-10.0-11.0	Low continuing calibration recovery
RJ50	Acetone	170,000 U	UJ	MGP-GP-09-10.0-11.0	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	33,000 U	UJ	MGP-GP-09-10.0-11.0	Low continuing calibration recovery
RJ50	Chloromethane	56,000 U	UJ	MGP-GP-04-3.5-4.5	Low continuing calibration recovery
RJ50	Acetone	280,000 U	UJ	MGP-GP-04-3.5-4.5	Low continuing calibration recovery
RJ50	Methyl tert-butyl ether	56,000 U	UJ	MGP-GP-04-3.5-4.5	Low continuing calibration recovery
RJ50	4-Methylphenol	840	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Naphthalene	95,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	2-Methylnaphthalene	49,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthylene	20,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthene	2000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Dibenzofuran	1800	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Fluorene	12,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Phenanthrene	31,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Carbazole	620	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Anthracene	9000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Fluoranthene	9200	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Pyrene	12,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)anthracene	4100	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Chrysene	3700	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(b)fluoranthene	2300	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(k)fluoranthene	2300	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)pyrene	3400	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Indeno(1,2,3-cd)pyrene	570	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(g,h,i)perylene	530	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	1-Methylnaphthalene	29,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	4-Methylphenol	530	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Naphthalene	46,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	2-Methylnaphthalene	21,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthylene	8300	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthene	1300	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Dibenzofuran	930	J	MGP-GP-58-7.0-8.0	High field duplicate RPD

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ50	Fluorene	4500	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Phenanthrene	14,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Carbazole	330	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Anthracene	3100	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Fluoranthene	3300	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Pyrene	4200	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)anthracene	2000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Chrysene	1900	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(b)fluoranthene	1100	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(k)fluoranthene	1100	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)pyrene	1700	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Indeno(1,2,3-cd)pyrene	270	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(g,h,i)perylene	250	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	1-Methylnaphthalene	13,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	2,4-Dinitrophenol	1100 U	UJ	MGP-GP-25-9.0-10.0	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	1900 U	UJ	MGP-GP-44-5.0-6.0	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	620 U	UJ	MGP-GP-44-13.0-14.0	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	1800 U	UJ	MGP-GP-07-13.0-14.0	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	610 U	UJ	MGP-GP-02-7.0-8.0	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	570 U	UJ	MGP-GP-03-4.0-5.0	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	600 U	UJ	MGP-GP-01-6.5-7.5	Low continuing calibration recovery
RJ50	2,4-Dinitrophenol	1900 U	UJ	MGP-GP-09-10.0-11.0	Low continuing calibration recovery
RJ50	2,4-Dimethylphenol	57 U	UJ	MGP-GP-03-4.0-5.0	Low MS/MSD recovery
RJ50	Benzo(g,h,i)perylene	100	J	MGP-GP-03-4.0-5.0	Low MS/MSD recovery
RJ50	Naphthalene	130,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	2-Methylnaphthalene	61,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	1-Methylnaphthalene	35,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthylene	22,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthene	3000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Fluorene	11,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Phenanthrene	33,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Anthracene	11,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Fluoranthene	10,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Pyrene	15,000	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)anthracene	5900	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Chrysene	5700	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)pyrene	5100	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Indeno(1,2,3-cd)pyrene	1400	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Benzo(g,h,i)perylene	1400	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Dibenzofuran	2300	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Total Benzofluoranthenes	4600	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Naphthalene	60,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	2-Methylnaphthalene	28,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	1-Methylnaphthalene	16,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthylene	9300	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Acenaphthene	1800	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Fluorene	5500	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Phenanthrene	16,000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Anthracene	4500	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Fluoranthene	4100	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Pyrene	7600	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)anthracene	2400	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Chrysene	2300	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(a)pyrene	2200	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Indeno(1,2,3-cd)pyrene	550	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Benzo(g,h,i)perylene	550	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Dibenzofuran	1100	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Total Benzofluoranthenes	2000	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Diesel	510	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Motor Oil	640	J	MGP-GP-02-7.0-8.0	High field duplicate RPD

TABLE 1
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SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ50	Diesel	260	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Motor Oil	350	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Gasoline	970	J	MGP-GP-02-7.0-8.0	High field duplicate RPD
RJ50	Gasoline	230	J	MGP-GP-58-7.0-8.0	High field duplicate RPD
RJ50	Arsenic	9.6	J	MGP-GP-24-5.0-6.0	High laboratory replicate RPD
RJ50	Cadmium	0.8	J	MGP-GP-24-5.0-6.0	High laboratory replicate RPD
RJ50	Copper	39.4	J	MGP-GP-24-5.0-6.0	High laboratory replicate RPD
RJ50	Lead	412	J	MGP-GP-24-5.0-6.0	High laboratory replicate RPD
RJ50	Zinc	350	J	MGP-GP-24-5.0-6.0	High laboratory replicate RPD
RJ50	Antimony	0.3 U	UJ	MGP-GP-24-5.0-6.0	Low MS recovery
RJ50	Copper	39.4	J	MGP-GP-24-5.0-6.0	High MS recovery
RJ50	Silver	0.3 U	UJ	MGP-GP-24-5.0-6.0	Low MS recovery
RJ50	Zinc	350	J	MGP-GP-24-5.0-6.0	High MS recovery
RJ51	Fluoranthene	280	J	MGP-GP-10-0.5-1.0	Low MS/MSD recovery
RJ51	Antimony	0.2 U	UJ	MGP-GP-22-0.5-1.0	Low MS recovery
RJ78/RJ81	Naphthalene	22,000	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	2-Methylnaphthalene	9200	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	1-Methylnaphthalene	11,000	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Acenaphthylene	940	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Acenaphthene	8000	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Fluorene	4100	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Phenanthrene	14,000	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Anthracene	3800	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Pyrene	6800	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Benzo(a)anthracene	2300	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Chrysene	2300	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Dibenz(a,h)anthracene	310	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Dibenzofuran	1400	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Total Benzofluoranthenes	2500	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Naphthalene	15,000	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	2-Methylnaphthalene	6300	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	1-Methylnaphthalene	6200	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Acenaphthylene	570	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Acenaphthene	5000	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Fluorene	2800	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Phenanthrene	9600	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Anthracene	2400	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Pyrene	4500	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Benzo(a)anthracene	1600	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Chrysene	1600	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Dibenz(a,h)anthracene	190	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Dibenzofuran	980	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Total Benzofluoranthenes	1700	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ78	Antimony	0.2 U	UJ	MGP-GP-33-0.5-1.0	Low MS recovery
RJ78	Copper	55.1	J	MGP-GP-33-0.5-1.0	High MS recovery
RJ78	Silver	0.2 U	UJ	MGP-GP-33-0.5-1.0	Low MS recovery
RJ78	Zinc	85	J	MGP-GP-33-0.5-1.0	Low MS recovery
RJ78/RJ81	Total Cyanide	1.47	J	MGP-GP-60-11.0-12.0	High field duplicate RPD
RJ78/RJ81	Total Cyanide	2.21	J	MGP-GP-31-11.0-12.0	High field duplicate RPD
RJ80	2-Methylnaphthalene	61	J	MGP-GP-45-0.5-1.0	Low MS/MSD recovery
RJ80	Barium	424	J	MGP-GP-30-0.5-1.0	High laboratory replicate RPD
RJ80	Antimony	0.2 U	UJ	MGP-GP-30-0.5-1.0	Low MS recovery
RJ80	Mercury	0.63	J	MGP-GP-30-0.5-1.0	High MS recovery
RJ80	Silver	0.2 U	UJ	MGP-GP-30-0.5-1.0	Low MS recovery
RJ80	Total Cyanide	23.6	J	MGP-GP-30-0.5-1.0	Low MS recovery

TABLE 1
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SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ81	Methylene Chloride	930	U	MGP-GP-32-12.0-13.0	Method blank contamination
RJ81	Chloromethane	1900 U	UJ	MGP-GP-31-11.0-12.0	Low continuing calibration recovery
RJ81	2,4-Dinitrophenol	650 U	UJ	MGP-GP-31-11.0-12.0	Low continuing calibration recovery
RJ81	Antimony	2.0 U	UJ	MGP-GP-28-9.0-10.0	Low MS recovery
RJ81	Benzene	63,000	J	MGP-GP-59-9.0-10.0	High field duplicate RPD
RJ81	Toluene	110,000	J	MGP-GP-59-9.0-10.0	High field duplicate RPD
RJ81	Naphthalene	810,000	J	MGP-GP-59-9.0-10.0	High field duplicate RPD
RJ81	Benzene	13,000	J	MGP-GP-28-9.0-10.0	High field duplicate RPD
RJ81	Toluene	31,000	J	MGP-GP-28-9.0-10.0	High field duplicate RPD
RJ81	Naphthalene	460,000	J	MGP-GP-28-9.0-10.0	High field duplicate RPD
RJ84	Chrysene	4600	J	MGP-GP-37-23.0-24.0	Low MS recovery, high MSD recovery
RJ84	Naphthalene	400	J	MGP-GP-42-0.5-1.0	High LCSD recovery
RJ84	2-Methylnaphthalene	160	J	MGP-GP-42-0.5-1.0	High LCSD recovery
RJ84	Phenanthrene	22	J	MGP-GP-42-0.5-1.0	High LCSD recovery
RJ84	Naphthalene	430	J	MGP-GP-42-4.0-5.0	High LCSD recovery
RJ84	2-Methylnaphthalene	220	J	MGP-GP-42-4.0-5.0	High LCSD recovery
RJ84	Phenanthrene	700	J	MGP-GP-42-4.0-5.0	High LCSD recovery
RJ84	Naphthalene	4000	J	MGP-GP-42-14.0-15.0	High LCSD recovery
RJ84	2-Methylnaphthalene	1000	J	MGP-GP-42-14.0-15.0	High LCSD recovery
RJ84	Phenanthrene	13,000	J	MGP-GP-42-14.0-15.0	High LCSD recovery
RJ84	Naphthalene	65	J	MGP-GP-42-35.0-36.0	High LCSD recovery
RJ84	2-Methylnaphthalene	26	J	MGP-GP-42-35.0-36.0	High LCSD recovery
RJ84	Phenanthrene	820	J	MGP-GP-42-35.0-36.0	High LCSD recovery
RJ84	Naphthalene	61	J	MGP-GP-40-0.5-1.0	High LCSD recovery
RJ84	2-Methylnaphthalene	37	J	MGP-GP-40-0.5-1.0	High LCSD recovery
RJ84	Phenanthrene	220	J	MGP-GP-40-0.5-1.0	High LCSD recovery
RJ84	Naphthalene	46	J	MGP-GP-40-5.0-6.0	High LCSD recovery
RJ84	2-Methylnaphthalene	29	J	MGP-GP-40-5.0-6.0	High LCSD recovery
RJ84	Phenanthrene	540	J	MGP-GP-40-5.0-6.0	High LCSD recovery
RJ84	Naphthalene	22	J	MGP-GP-39-0.5-1.0	High LCSD recovery
RJ84	2-Methylnaphthalene	13	J	MGP-GP-39-0.5-1.0	High LCSD recovery
RJ84	Phenanthrene	110	J	MGP-GP-39-0.5-1.0	High LCSD recovery
RJ84	Naphthalene	160	J	MGP-GP-39-4.0-5.0	High LCSD recovery
RJ84	2-Methylnaphthalene	67	J	MGP-GP-39-4.0-5.0	High LCSD recovery
RJ84	Phenanthrene	360	J	MGP-GP-39-4.0-5.0	High LCSD recovery
RJ84	Naphthalene	9.7	J	MGP-GP-39-30.0-31.0	High LCSD recovery
RJ84	Phenanthrene	5.3	J	MGP-GP-39-30.0-31.0	High LCSD recovery
RJ84	Naphthalene	64	J	MGP-GP-37-0.5-1.0	High LCSD recovery
RJ84	2-Methylnaphthalene	25	J	MGP-GP-37-0.5-1.0	High LCSD recovery
RJ84	Phenanthrene	47	J	MGP-GP-37-0.5-1.0	High LCSD recovery
RJ84	Naphthalene	210	J	MGP-GP-37-5.0-6.0	High LCSD recovery
RJ84	2-Methylnaphthalene	63	J	MGP-GP-37-5.0-6.0	High LCSD recovery
RJ84	Phenanthrene	720	J	MGP-GP-37-5.0-6.0	High LCSD recovery
RJ84	Naphthalene	2,600,000	J	MGP-GP-37-19.0-20.0	High LCSD recovery
RJ84	2-Methylnaphthalene	560,000	J	MGP-GP-37-19.0-20.0	High LCSD recovery
RJ84	Phenanthrene	3,100,000	J	MGP-GP-37-19.0-20.0	High LCSD recovery
RJ84	Naphthalene	7800	J	MGP-GP-37-22.0-23.0	High LCSD recovery
RJ84	2-Methylnaphthalene	1400	J	MGP-GP-37-22.0-23.0	High LCSD recovery
RJ84	Phenanthrene	4500	J	MGP-GP-37-22.0-23.0	High LCSD recovery
RJ84	Naphthalene	400	J	MGP-GP-42-0.5-1.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	160	J	MGP-GP-42-0.5-1.0	High LCS/LCSD RPD
RJ84	Phenanthrene	22	J	MGP-GP-42-0.5-1.0	High LCS/LCSD RPD
RJ84	Naphthalene	430	J	MGP-GP-42-4.0-5.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	220	J	MGP-GP-42-4.0-5.0	High LCS/LCSD RPD
RJ84	Phenanthrene	700	J	MGP-GP-42-4.0-5.0	High LCS/LCSD RPD
RJ84	Naphthalene	4000	J	MGP-GP-42-14.0-15.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	1000	J	MGP-GP-42-14.0-15.0	High LCS/LCSD RPD
RJ84	Phenanthrene	13,000	J	MGP-GP-42-14.0-15.0	High LCS/LCSD RPD

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SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RJ84	Naphthalene	65	J	MGP-GP-42-35.0-36.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	26	J	MGP-GP-42-35.0-36.0	High LCS/LCSD RPD
RJ84	Phenanthrene	820	J	MGP-GP-42-35.0-36.0	High LCS/LCSD RPD
RJ84	Naphthalene	61	J	MGP-GP-40-0.5-1.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	37	J	MGP-GP-40-0.5-1.0	High LCS/LCSD RPD
RJ84	Phenanthrene	220	J	MGP-GP-40-0.5-1.0	High LCS/LCSD RPD
RJ84	Naphthalene	46	J	MGP-GP-40-5.0-6.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	29	J	MGP-GP-40-5.0-6.0	High LCS/LCSD RPD
RJ84	Phenanthrene	540	J	MGP-GP-40-5.0-6.0	High LCS/LCSD RPD
RJ84	Naphthalene	22	J	MGP-GP-39-0.5-1.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	13	J	MGP-GP-39-0.5-1.0	High LCS/LCSD RPD
RJ84	Phenanthrene	110	J	MGP-GP-39-0.5-1.0	High LCS/LCSD RPD
RJ84	Naphthalene	160	J	MGP-GP-39-4.0-5.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	67	J	MGP-GP-39-4.0-5.0	High LCS/LCSD RPD
RJ84	Phenanthrene	360	J	MGP-GP-39-4.0-5.0	High LCS/LCSD RPD
RJ84	Naphthalene	9.7	J	MGP-GP-39-30.0-31.0	High LCS/LCSD RPD
RJ84	Phenanthrene	5.3	J	MGP-GP-39-30.0-31.0	High LCS/LCSD RPD
RJ84	Naphthalene	64	J	MGP-GP-37-0.5-1.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	25	J	MGP-GP-37-0.5-1.0	High LCS/LCSD RPD
RJ84	Phenanthrene	47	J	MGP-GP-37-0.5-1.0	High LCS/LCSD RPD
RJ84	Naphthalene	210	J	MGP-GP-37-5.0-6.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	63	J	MGP-GP-37-5.0-6.0	High LCS/LCSD RPD
RJ84	Phenanthrene	720	J	MGP-GP-37-5.0-6.0	High LCS/LCSD RPD
RJ84	Naphthalene	2,600,000	J	MGP-GP-37-19.0-20.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	560,000	J	MGP-GP-37-19.0-20.0	High LCS/LCSD RPD
RJ84	Phenanthrene	3,100,000	J	MGP-GP-37-19.0-20.0	High LCS/LCSD RPD
RJ84	Naphthalene	7800	J	MGP-GP-37-22.0-23.0	High LCS/LCSD RPD
RJ84	2-Methylnaphthalene	1400	J	MGP-GP-37-22.0-23.0	High LCS/LCSD RPD
RJ84	Phenanthrene	4500	J	MGP-GP-37-22.0-23.0	High LCS/LCSD RPD
RJ84	Antimony	0.2 U	UJ	MGP-GP-37-23.0-24.0	Low MS recovery
RJ85	Mercury	0.05	J	MGP-GP-34-0.5-1.0	High laboratory replicate RPD
RJ85	Antimony	0.2 U	UJ	MGP-GP-34-0.5-1.0	Low MS recovery
RJ85	Barium	77.4	J	MGP-GP-34-0.5-1.0	High MS recovery
RJ85	Barium	99.7	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Mercury	0.04	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Barium	69.8	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Mercury	0.44	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Arsenic	4.8	J	MGP-GP-36-14.0-15.0	High field duplicate RPD
RJ85	Lead	1480	J	MGP-GP-36-14.0-15.0	High field duplicate RPD
RJ85	Arsenic	2.7	J	MGP-GP-62-14.0-15.0	High field duplicate RPD
RJ85	Lead	31	J	MGP-GP-62-14.0-15.0	High field duplicate RPD
RJ85	Naphthalene	1800	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	2-Methylnaphthalene	760	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	1-Methylnaphthalene	660	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Acenaphthylene	540	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Acenaphthene	770	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Fluorene	600	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Phenanthrene	4300	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Dibenzofuran	370	J	MGP-GP-34-13.0-14.0	High field duplicate RPD
RJ85	Naphthalene	3600	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	2-Methylnaphthalene	1900	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	1-Methylnaphthalene	1500	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Acenaphthylene	810	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Acenaphthene	1100	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Fluorene	1100	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Phenanthrene	7100	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Dibenzofuran	680	J	MGP-GP-61-13.0-14.0	High field duplicate RPD
RJ85	Anthracene	990	J	MGP-GP-36-14.0-15.0	High field duplicate RPD
RJ85	Anthracene	470	J	MGP-GP-62-14.0-15.0	High field duplicate RPD

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RK34	Methylene Chloride	200	U	MGP-HS-29-13.5-14.0	Method blank contamination
RK34	Benzo(b)fluoranthene	220	J	MGP-HS-29-13.5-14.0	High LCS recovery
RK34	Benzo(k)fluoranthene	220	J	MGP-HS-29-13.5-14.0	High LCS recovery
RK34	Diesel	540	J	MGP-HS-29-14.0-15.0	Low MS recovery, high MSD recovery
RK79	Acetone	24	J	MGP-HS-38-26.0-26.5	Low continuing calibration recovery
RK79	4-Isopropyltoluene	4.6	J	MGP-HS-38-26.0-26.5	High continuing calibration recovery
RK79	Acetone	27	J	MGP-HS-38-25.0-26.0	Low continuing calibration recovery
RK79	4-Isopropyltoluene	16	J	MGP-HS-38-25.0-26.0	High continuing calibration recovery
RK79	Acetone	140	J	MGP-HS-40-34.0-35.0	Low continuing calibration recovery
RK79	4-Isopropyltoluene	370	J	MGP-HS-40-34.0-35.0	High continuing calibration recovery
RK79	ALL VOCs	ALL	DNR	MGP-HS-40-34.0-34.5 RE	DNR - use original results
RK79	Acetone	1000 U	UJ DNR	MGP-HS-40-34.0-34.5 RE	Low continuing calibration recovery - DNR Use original results
RK79	Carbon Disulfide	3.0	J	MGP-HS-40-34.0-34.5	High surrogate recovery
RK79	Acetone	140	J	MGP-HS-40-34.0-34.5	High surrogate recovery
RK79	4-Isopropyltoluene	370	J	MGP-HS-40-34.0-34.5	High surrogate recovery
RK79	Diesel	11	J DNR	MGP-HS-40-34.0-34.5	Low surrogate recovery DNR - use re-analysis results
RK79	Motor Oil	27	J DNR	MGP-HS-40-34.0-34.5	Low surrogate recovery DNR - use re-analysis results
RK79	Antimony	0.2 U	UJ	MGP-HS-38-25.0-26.0	Low MS recovery
RK79	Silver	0.2 U	UJ	MGP-HS-38-25.0-26.0	Low MS recovery
RK94	Dibenz(a,h)anthracene	5300	J	MGP-HA-30-0.0-1.0	High field duplicate RPD
RK94	Dibenz(a,h)anthracene	2500	J	MGP-HA-08-0.0-1.0	High field duplicate RPD
RK94	Phenanthrene	210	J	MGP-HA-07-0.0-0.5	Low MS recovery, high MSD recovery
RK94	Fluoranthene	450	J	MGP-HA-07-0.0-0.5	High MSD recovery (MS was not calculable)
RK94	Benzo(a)anthracene	340	J	MGP-HA-07-0.0-0.5	High MSD recovery (MS was not calculable)
RK94	Chrysene	440	J	MGP-HA-07-0.0-0.5	High MSD recovery (MS was not calculable)
RK94	Phenanthrene	210	J	MGP-HA-07-0.0-0.5	High MS/MSD RPD
RK94	Barium	601	J	MGP-HA-11-0.0-1.0	High laboratory replicate RPD
RK94	Lead	65	J	MGP-HA-11-0.0-1.0	High laboratory replicate RPD
RK94	Zinc	182	J	MGP-HA-11-0.0-1.0	High laboratory replicate RPD
RK94	Antimony	0.2 U	UJ	MGP-HA-11-0.0-1.0	Low MS recovery
RK94	Antimony	0.6	J	MGP-HA-30-0.0-1.0	High field duplicate RPD
RK94	Lead	124	J	MGP-HA-30-0.0-1.0	High field duplicate RPD
RK94	Mercury	1.06	J	MGP-HA-30-0.0-1.0	High field duplicate RPD
RK94	Antimony	0.2 U	UJ	MGP-HA-08-0.0-1.0	High field duplicate RPD
RK94	Lead	84	J	MGP-HA-08-0.0-1.0	High field duplicate RPD
RK94	Mercury	0.62	J	MGP-HA-08-0.0-1.0	High field duplicate RPD
RL26	1,1-Dichloroethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	trans-1,2-Dichloroethene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	cis-1,2-Dichloroethene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Chloroform	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,2-Dichloroethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,1,1-Trichloroethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Carbon Tetrachloride	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Vinyl Acetate	20 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Bromodichloromethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,2-Dichloropropane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	cis-1,3-Dichloropropene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Trichloroethene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Dibromochloromethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,1,2-Trichloroethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RL26	Benzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	trans-1,3-Dichloropropene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Bromoform	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	4-Methyl-2-Pentanone (MIBK)	20 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	2-Hexanone	20 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Tetrachloroethene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,1,2,2-Tetrachloroethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Toluene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Chlorobenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Ethylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	m,p-Xylene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	o-Xylene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,2-Dichlorobenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,3-Dichlorobenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,4-Dichlorobenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,1-Dichloropropene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Dibromomethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,1,1,2-Tetrachloroethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,2-Dibromo-3-chloropropane	20 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,2,3-Trichloropropane	7.8 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	trans-1,4-Dichloro-2-butene	20 U	UJ	MGP-GP-41-28.0-29.0	Low MS recovery (MSD not calculable)
RL26	1,3,5-Trimethylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,2,4-Trimethylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Hexachlorobutadiene	20 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Ethylene Dibromide	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Bromochloromethane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	2,2-Dichloropropane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	1,3-Dichloropropane	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Isopropylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	n-Propylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Bromobenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	2-Chlorotoluene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	4-Chlorotoluene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	tert-Butylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	sec-Butylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	4-Isopropyltoluene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	n-Butylbenzene	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Naphthalene	35	J	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Methyl tert-butyl ether	3.9 U	UJ	MGP-GP-41-28.0-29.0	Low MS/MSD recovery
RL26	Acetone	100	J	MGP-GP-41-28.0-29.0	Low continuing calibration recovery
RL26	Hexachlorocyclopentadiene	9600 U	UJ	MGP-GP-41-28.0-29.0	Low continuing calibration recovery
RL26	2,4-Dinitrophenol	19,000 U	UJ	MGP-GP-41-28.0-29.0	Low continuing calibration recovery
RL26	4,6-Dinitro-2-Methylphenol	19,000 U	UJ	MGP-GP-41-28.0-29.0	Low continuing calibration recovery
RL26	2,4-Dimethylphenol	1900 U	UJ	MGP-GP-41-28.0-29.0	Low LCS/LCSD recovery
RL26	2-Methylnaphthalene	6300	J	MGP-GP-41-28.0-29.0	High MS/MSD recovery
RL26	Naphthalene	21,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	2-Methylnaphthalene	6300	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Acenaphthylene	48,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Acenaphthene	190,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Dibenzofuran	170,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Fluorene	230,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Phenanthrene	700,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Carbazole	8700	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Anthracene	290,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
RL26	Fluoranthene	560,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Pyrene	420,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Benzo(a)anthracene	230,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Chrysene	240,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Benzo(b)fluoranthene	140,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Benzo(k)fluoranthene	140,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Benzo(a)pyrene	240,000	J DNR	MGP-GP-41-28.0-29.0	High MS/MSD RPD DNR - use dilution
RL26	Indeno(1,2,3-cd)pyrene	94,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Dibenz(a,h)anthracene	40,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Benzo(g,h,i)perylene	91,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	1-Methylnaphthalene	100,000	J	MGP-GP-41-28.0-29.0	High MS/MSD RPD
RL26	Diesel	1300	J	MGP-GP-41-28.0-29.0	Low MS recovery, high MSD recovery & High MS/MSD RPD
RL26	Antimony	0.2 U	UJ	MGP-GP-41-0.5-1.0	Low MS recovery
RN85	Fluoranthene	85	J	MGP-HA-14-1.0-1.5	High MS/MSD recovery
RN85	Acenaphthylene	9.3	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Phenanthrene	39	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Anthracene	8.3	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Fluoranthene	85	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Pyrene	96	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Benzo(a)anthracene	37	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Chrysene	48	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Benzo(a)pyrene	45	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Indeno(1,2,3-cd)pyrene	27	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Dibenz(a,h)anthracene	11	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Benzo(g,h,i)perylene	28	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	Total Benzofluoranthenes	61	J	MGP-HA-14-1.0-1.5	High MS/MSD RPD
RN85	2-Methylnaphthalene	36	J	MGP-HA-13-1.0-1.5	High continuing calibration recovery
RN85	2-Methylnaphthalene	5.4	J	MGP-HA-14-1.0-1.5	High continuing calibration recovery
RN85	Antimony	0.2 U	UJ	MGP-HA-13-1.0-1.5	Low MS recovery
RN85	Lead	51	J	MGP-HA-13-1.0-1.5	Low MS recovery
RP57	Lead	50	J	MGP-GP-36-14.0-15.0	High field duplicate RPD
RP57	Lead	154	J	MGP-GP-62-14.0-15.0	High field duplicate RPD

Notes

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

U = Indicates the compound was undetected at the reported concentration.

DNR = Do Not Report

Data Validation Report

South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study
Bellingham, Washington

2010 Groundwater Samples

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December 22, 2010

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
BFB	bromofluorobenzene
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
DFTPP	decafluorotriphenylphosphine
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometer
ICSA	ICP interference check sample solution A
ICV	initial calibration verification
IDL	instrument detection limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDL	method detection limit
µg/L	microgram per liter
mg/L	milligram per liter
MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics, EPA 2004 - Inorganics)

QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RF	response factor
RL	reporting limit
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SRM	standard reference material
SVOCs	semi-volatile organic compounds
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
VOCs	volatile organic compounds
WAD	weak acid dissociable

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for groundwater samples collected during September 2010 for the referenced project. The laboratory report validated herein was submitted by Analytical Resources, Inc. (ARI), assigned ARI Job ID Number: RO79.

A Stage IV data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Herrenkohl & Landau 2010) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Matrix	Analysis					
				TPH-G VOCs	SVOCs	Metals	TPH-Dx	CN	Inorganic
MGP-GW-MW-38	RO79A&F	9/28/2010	GW	X	X	X	X	X	X
MGP-GW-MW-42	RO79B&G	9/28/2010	GW	X	X	X	X	X	X
MGP-GW-MW-31	RO79C	9/28/2010	GW	X	X	X		X	Hardness
TRIP BLANKS	RO79D	9/28/2010	GW	VOCs					
MGP-GW-MW-40	RO79E&H	9/28/2010	GW	X	X	X	X	X	X

Notes:
X - The analysis was requested and performed on the sample.
TPH-G – Gasoline range total petroleum hydrocarbon (TPH)
VOCs – Volatile organic compounds
SVOCs – Semi-volatile organic compounds
Metals – Total and Dissolved arsenic, barium, cadmium, calcium, chromium, copper, lead, magnesium, mercury, selenium, silver, and zinc.
TPH-Dx – Diesel and motor oil range TPH
CN – Total and weak-acid-dissociable (WAD) cyanide
Inorganic – Conductivity, total dissolved solids (TDS), total organic carbon (TOC), dissolved organic carbon (DOC), hardness, and salinity.

Analytical methods in respect to analytical parameters validated herein and the laboratory performing the analyses are summarized below:

Parameter	**Analytical Method**	**Laboratory**
VOCs	SW846 Method 8260C	Analytical Resources, Inc. (ARI), Tukwila, Washington
SVOCs	SW846 Method 8270D	
Metals	SW846 Methods 6010B/7470A	
Antimony	EPA Method 200.8	
TPH-Gasoline Range	NWTPH-Gx	
TPH-Diesel and Oil Ranges	NWTPH-Dx	
Total Cyanide	EPA Method 335.4	
WAD Cyanide	SM 4500CN-I	
Hardness	SW846 Method 6010B	
Conductivity	EPA Method 120.1	
Total Dissolved Solids	EPA Method 160.1	
TOC and DOC	EPA Method 415.1	
Salinity	SM 2520B	

Notes:

1. SW846 Methods - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Method - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. NWTPH Methods - *Analytical Methods for Petroleum Hydrocarbons,* ECY 97-602, Washington State Department of Ecology, June 1997.
4. SM - *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.

DATA VALIDATION FINDINGS

1. VOCs by GC/MS (EPA Method SW8260C)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport, except that sample MGP-GW-MW-42 was received in the laboratory with pH value at 7, greater than the method recommended pH value of 2. The sample was analyzed three days past the recommend seven-day holding time for un-preserved samples. VOCs results for sample MGP-GW-MW-42 were qualified (UJ) for non-detects and (J) for detects as estimated.

Acid-preserved water samples should be analyzed within 14 days of collection. All samples were analyzed within the required holding time.

1.2 GC/MS Instrument Performance Check

Bromofluorobenzene (BFB) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤ 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The National Functional Guidelines (NFGs) require that the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The percent difference (%D) values should be within ±20% for target compounds.

The initial calibrations met all the criteria above.

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method

blank and samples, (2) the %D values be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The RFs for numerous analytes in the calibration verification analyses were less than 0.05. The individual RFs of these analytes in the initial calibrations and all continuing calibration verifications indicated stable responses for the analytes. No data qualifying action was taken on this basis.

The calibration verification %D values met the criteria for all target compounds in all analytical sequences, except for the following:

CCV ID	Analyte	%D	Bias	Affected Sample	Data Qualifier
Instrument: NT5 Date: 09/23/2010	Bromomethane	-25.1%	Low	MGP-GW-MW-38 MGP-GW-MW-42 TRIP BLANKS	**UJ**

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the method detection limits (MDLs).

Trip Blank: Methylene chloride was detected in the trip blank at 0.7 µg/L, but not detected in any of the field samples. Data qualifying action was not required.

1.6 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

1.8 Matrix Spike (MS) and MS Duplicate (MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in sample MGP-GW-MW-40 in cases where the %R values exceeded the upper control limits.

1.9 Internal Standard

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample met the criteria.

1.10 Reporting Limits and Target Compound Quantitation

Reporting limits (RLs) were supported with adequate initial calibration concentrations. Sample MGP-GW-MW-31 required dilution at 50 folds due to the elevated concentrations of numerous target compounds in the sample. The sample-specific MDLs and RLs were raised proportionally.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

1.11 Overall Assessment of VOCs Data Usability

VOCs data are of known quality and acceptable for use, as qualified.

2. SVOCs by GC/MS (EPA Method SW8270D)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be extracted within seven days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

Decafluorotriphenylphosphine (DFTPP) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The NFGs criteria require that the average RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The %D values should be within ±20% for target compounds.

All of the criteria above were met, except that %RSD values for a number of target compounds exceeded 15% in the NT4, 09/03/2010 ICAL. The %RSD exceedance had no effects on data quality for compounds not detected in samples. Compounds detected in samples associated with this ICAL were affected and qualified as follows:

ICAL ID	Analyte	%RSD (%)	Affected Sample	Data Qualifier
Instrument: NT4 Date: 09/03/2010	Naphthalene	18.2%	MGP-GW-MW-42 MGP-GW-MW-31	J
Instrument: NT4 Date: 09/03/2010	1-Methylnaphthalene 2-Methylnaphthalene Anthracene Carbazole Dibenzofuran Fluoranthene Fluorene Phenanthrene Pyrene	18.1% 17.1% 17.5% 19.4% 19.5% 19.4% 17.3% 18.7% 19.2%	MGP-GW-MW-31	J

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verifications either met all the criteria above, or the %D values were biased high where the compounds were not detected in associated samples.

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blank.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All %R values were within the laboratory control limits.

2.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

2.8 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in sample MGP-GW-MW-40 in cases where the %R values exceeded the upper control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and RLs were adjusted with sample amount extracted and the RLs were supported with adequate initial calibration concentrations.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

2.11 Overall Assessment of SVOCs Data Usability

SVOCs data are of known quality and acceptable for use, as qualified.

3. Total/Dissolved Metals and Hardness (EPA Methods SW6010B, SW6020 and SW7470A)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be analyzed within 180 days for ICP metals and 28 days for mercury. Samples were analyzed within the required holding times.

3.2 ICP/MS Tuning

Instrument tuning was performed at the required frequency. The stability check (%RSD <5%), mass calibration (mass difference <0.1 AMU), and resolution check (peak width <1.0 AMU at 5% peak height) met the NFG and method criteria.

3.3 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury, the method requires that (1) a blank and three calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995. The associated initial calibrations met the method requirements.

All initial calibrations for metals met the criteria above.

A RL check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The check results were either within the NFGs criteria of 70-130% criteria, or if outside the control limits, the associated sample results were greater than the 2x RLs.

3.4 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) were analyzed at the required frequency. The %R values met the control criteria (90 – 110% for ICP metals, 80 – 120% for mercury).

3.5 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at the method-required frequency. Target analytes were not detected in ICBs/CCBs at or above the instrument detection limits (IDLs).

Negative detections for mercury and manganese were found in ICB and selected CCBs at levels where their absolute values were between those of IDLs and RLs. These negative detections were determined to have no significant effects on samples results.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were not detected in the method blanks at or above the RLs.

3.6 ICP Interference Check Sample (ICS)

The method requires that (1) an interelement interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several non-interfernt analytes were detected at low levels (less than RLs) in the solution containing only the interferents (ICSA). Since the interferent concentrations in the associated samples were less than 50% of the concentrations in ICSA samples, no action was taken.

3.7 Laboratory Control Sample (LCS)

LCS analyses were performed on all target analytes as required by the methods. All %R values met the project control limits.

3.8 Matrix Spike (MS)

MS analyses were performed on sample MGP-GW-MW-40. The %R values for calcium and magnesium were not applicable because their native concentrations in sample MGP-GW-MW-40 were greater than four times the spiking levels. %R values for other target analytes were within the laboratory control limits.

3.9 Laboratory Duplicate Analysis

Duplicate analysis was performed on sample MGP-GW-MW-40. All RPD values were within the laboratory control limits.

3.10 Internal Standards

At least three internal standards were added to all field and QC samples for ICP/MS analyses. All percent relative intensity values were within the method criteria (30 - 120% of those for the associated calibration blank).

3.11 ICP Serial Dilution

Serial dilution analysis was performed on sample MGP-GW-MW-40. The %D values for positive results greater than 50xMDL were within 10%.

3.12 Reporting Limits and Target Analyte Quantitation

The project requirements for quantitation limits were achieved. A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

3.13 Overall Assessment of Metals and Hardness Data Usability

Metals and hardness data are of known quality and acceptable for use, as qualified.

4. TPH-Gasoline by GC/FID (Method NWTPH-Gx)

4.1 Holding Time

Water samples should be analyzed within 14 days of collection. All samples were extracted and analyzed within the required holding times.

4.2 Initial Calibration

The method requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curve was verified with %RSD of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable.

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value. All calibration verification analyses met the method requirements.

4.4 Method Blank

Method blanks were prepared and analyzed as required. TPH-Gasoline was not detected at or above the MDL in the method blank.

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

4.6 Laboratory Control Samples (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required. All %R and RPD values met the laboratory control limits.

4.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values met the laboratory control criteria.

4.8 Target Compound Identification

The laboratory reported TPH-Gasoline results as integrated response between toluene and the C_{12} marker, which complies with the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. The RL goals identified in the QAPP were met.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

4.10 Overall Assessment of TPH-Gasoline Data Usability

TPH-Gasoline data are of known quality and acceptable for use.

5. TPH-Diesel & Motor Oil by GC/FID (Method NWTPH-Dx)

5.1 Holding Time

Water samples should be extracted within seven days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

5.2 Initial Calibration

The method requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curve was verified with %RSD of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both TPH-Diesel and TPH-Motor Oil.

5.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value. All calibration verification analyses met the method requirements.

5.4 Method Blank

Method blanks were prepared and analyzed as required. TPH-Diesel or Motor Oil was not detected at or above the MDLs in the method blank.

5.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

5.6 Laboratory Control Samples (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required. All %R and RPD values met the laboratory control limits.

5.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values met the laboratory control criteria.

5.8 Target Compound Identification

The laboratory reported TPH-Diesel results as integrated response between the C_{12} and C_{24} markers and TPH-Motor Oil between the C_{24} and C_{38} markers, which complies with the method.

5.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations and achieved the quantitation limit goals identified in the QAPP.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

5.10 Overall Assessment of TPH-Diesel & Motor Oil Data Usability

TPH-Diesel and Motor Oil data are of known quality and acceptable for use.

6. Inorganic Parameters (TDS, TOD, DOC, Conductivity, Salinity, Total Cyanide, and WAD Cyanide)

6.1 Sample Management and Holding Time

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Samples should be analyzed within 7 days of collection for TDS, 14 days for total and WAD cyanide, and 28 days for TOC and DOC. All samples were analyzed within the required holding times.

6.2 Instrument Calibration

The initial calibrations were established for ammonia, total sulfide, and TOC using one blank and at least five levels of standards. The correlation coefficients (r) of the initial calibration curves were >0.995, and met the method criteria.

6.3 Calibration Verification

ICV and CCV analyses were performed for cyanide and sulfide as required by the methods. All ICV and CCV %R values were within the laboratory control limits (90 – 110%).

6.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed as required by the method. No target analytes were positively reported in ICBs and CCBs at or above the RLs.

Method Blanks: Method blanks were prepared and analyzed as required by the method. Target analytes were not detected at or above the RLs in the method blank.

6.5 Laboratory Duplicate

Laboratory duplicate analyses were formed on project samples as required. The RPD or concentration difference values were within the control criterion.

6.6 Matrix Spike (MS)

MS analyses were performed on project samples as required. The %R values were within the project control limits.

6.7 Laboratory Control Samples (LCS) and Standard Reference Material (SRM)

LCS and/or SRM analyses were performed as required by the methods. All %R values were within the laboratory control limits.

6.8 Reporting Limits and Target Analyte Quantitation

The RLs were supported with adequate initial calibration concentrations. Sample-specific RLs achieved the project requirements for quantitation limits.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

6.9 Overall Assessment of Inorganic Data Usability

Inorganic data are of known quality and acceptable for use, as qualified.

SUMMARY

I. Data qualification is summarized as follows:

Sample ID	Analyte	Data Qualifier	Reason	Report Section
MGP-GW-MW-42	All VOCs	**J/UJ**	The sample was analyzed past the recommend holding time for kun-preserved sample.	**1.1**
MGP-GW-MW-38 MGP-GW-MW-42 TRIP BLANKS	Bromomethane	**UJ**	The CCV %D value biased low.	**1.4**
MGP-GW-MW-42 MGP-GW-MW-31	Naphthalene	**J**	The initial calibration %RSD value exceeded 15%.	**2.3**
MGP-GW-MW-31	1-Methylnaphthalene 2-Methylnaphthalene Anthracene Carbazole Dibenzofuran Fluoranthene Fluorene Phenanthrene Pyrene	**J**	The initial calibration %RSD value exceeded 15%.	**2.3**

II. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
R	The result was rejected and could not be used.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: ______________________ Date: *12/22/2010*

Mingta Lin, Senior Project Chemist

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Data Validation Report

South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study
Bellingham, Washington

2010 Groundwater Samples

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December 22, 2010

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
BFB	bromofluorobenzene
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
DFTPP	decafluorotriphenylphosphine
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometer
ICSA	ICP interference check sample solution A
ICV	initial calibration verification
IDL	instrument detection limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDL	method detection limit
µg/L	microgram per liter
mg/L	milligram per liter
MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics, EPA 2004 - Inorganics)

QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RF	response factor
RL	reporting limit
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SRM	standard reference material
SVOCs	semi-volatile organic compounds
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
VOCs	volatile organic compounds
WAD	weak acid dissociable

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for groundwater samples collected during September 2010 for the referenced project. The laboratory report validated herein was submitted by Analytical Resources, Inc. (ARI), assigned ARI Job ID Number: RO79.

A Stage IV data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Herrenkohl & Landau 2010) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Matrix	Analysis					
				TPH-G VOCs	SVOCs	Metals	TPH-Dx	CN	Inorganic
MGP-GW-MW-38	RO79A&F	9/28/2010	GW	X	X	X	X	X	X
MGP-GW-MW-42	RO79B&G	9/28/2010	GW	X	X	X	X	X	X
MGP-GW-MW-31	RO79C	9/28/2010	GW	X	X	X		X	Hardness
TRIP BLANKS	RO79D	9/28/2010	GW	VOCs					
MGP-GW-MW-40	RO79E&H	9/28/2010	GW	X	X	X	X	X	X

Notes:
X - The analysis was requested and performed on the sample.
TPH-G – Gasoline range total petroleum hydrocarbon (TPH)
VOCs – Volatile organic compounds
SVOCs – Semi-volatile organic compounds
Metals – Total and Dissolved arsenic, barium, cadmium, calcium, chromium, copper, lead, magnesium, mercury, selenium, silver, and zinc.
TPH-Dx – Diesel and motor oil range TPH
CN – Total and weak-acid-dissociable (WAD) cyanide
Inorganic – Conductivity, total dissolved solids (TDS), total organic carbon (TOC), dissolved organic carbon (DOC), hardness, and salinity.

Analytical methods in respect to analytical parameters validated herein and the laboratory performing the analyses are summarized below:

Parameter	Analytical Method	Laboratory
VOCs	SW846 Method 8260C	Analytical Resources, Inc. (ARI), Tukwila, Washington
SVOCs	SW846 Method 8270D	
Metals	SW846 Methods 6010B/7470A	
Antimony	EPA Method 200.8	
TPH-Gasoline Range	NWTPH-Gx	
TPH-Diesel and Oil Ranges	NWTPH-Dx	
Total Cyanide	EPA Method 335.4	
WAD Cyanide	SM 4500CN-I	
Hardness	SW846 Method 6010B	
Conductivity	EPA Method 120.1	
Total Dissolved Solids	EPA Method 160.1	
TOC and DOC	EPA Method 415.1	
Salinity	SM 2520B	

Notes:

1. SW846 Methods - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Method - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. NWTPH Methods - *Analytical Methods for Petroleum Hydrocarbons,* ECY 97-602, Washington State Department of Ecology, June 1997.
4. SM - *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.

DATA VALIDATION FINDINGS

1. VOCs by GC/MS (EPA Method SW8260C)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport, except that sample MGP-GW-MW-42 was received in the laboratory with pH value at 7, greater than the method recommended pH value of 2. The sample was analyzed three days past the recommend seven-day holding time for un-preserved samples. VOCs results for sample MGP-GW-MW-42 were qualified (UJ) for non-detects and (J) for detects as estimated.

Acid-preserved water samples should be analyzed within 14 days of collection. All samples were analyzed within the required holding time.

1.2 GC/MS Instrument Performance Check

Bromofluorobenzene (BFB) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤ 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The National Functional Guidelines (NFGs) require that the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The percent difference (%D) values should be within ±20% for target compounds.

The initial calibrations met all the criteria above.

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method

blank and samples, (2) the %D values be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The RFs for numerous analytes in the calibration verification analyses were less than 0.05. The individual RFs of these analytes in the initial calibrations and all continuing calibration verifications indicated stable responses for the analytes. No data qualifying action was taken on this basis.

The calibration verification %D values met the criteria for all target compounds in all analytical sequences, except for the following:

CCV ID	Analyte	%D	Bias	Affected Sample	Data Qualifier
Instrument: NT5 Date: 09/23/2010	Bromomethane	-25.1%	Low	MGP-GW-MW-38 MGP-GW-MW-42 TRIP BLANKS	**UJ**

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the method detection limits (MDLs).

Trip Blank: Methylene chloride was detected in the trip blank at 0.7 µg/L, but not detected in any of the field samples. Data qualifying action was not required.

1.6 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

1.8 Matrix Spike (MS) and MS Duplicate (MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in sample MGP-GW-MW-40 in cases where the %R values exceeded the upper control limits.

1.9 Internal Standard

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample met the criteria.

1.10 Reporting Limits and Target Compound Quantitation

Reporting limits (RLs) were supported with adequate initial calibration concentrations. Sample MGP-GW-MW-31 required dilution at 50 folds due to the elevated concentrations of numerous target compounds in the sample. The sample-specific MDLs and RLs were raised proportionally.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

1.11 Overall Assessment of VOCs Data Usability

VOCs data are of known quality and acceptable for use, as qualified.

2. SVOCs by GC/MS (EPA Method SW8270D)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be extracted within seven days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

Decafluorotriphenylphosphine (DFTPP) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The NFGs criteria require that the average RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The %D values should be within ±20% for target compounds.

All of the criteria above were met, except that %RSD values for a number of target compounds exceeded 15% in the NT4, 09/03/2010 ICAL. The %RSD exceedance had no effects on data quality for compounds not detected in samples. Compounds detected in samples associated with this ICAL were affected and qualified as follows:

ICAL ID	Analyte	%RSD (%)	Affected Sample	Data Qualifier
Instrument: NT4 Date: 09/03/2010	Naphthalene	18.2%	MGP-GW-MW-42 MGP-GW-MW-31	**J**
Instrument: NT4 Date: 09/03/2010	1-Methylnaphthalene 2-Methylnaphthalene Anthracene Carbazole Dibenzofuran Fluoranthene Fluorene Phenanthrene Pyrene	18.1% 17.1% 17.5% 19.4% 19.5% 19.4% 17.3% 18.7% 19.2%	MGP-GW-MW-31	**J**

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verifications either met all the criteria above, or the %D values were biased high where the compounds were not detected in associated samples.

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blank.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All %R values were within the laboratory control limits.

2.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

2.8 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in sample MGP-GW-MW-40 in cases where the %R values exceeded the upper control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and RLs were adjusted with sample amount extracted and the RLs were supported with adequate initial calibration concentrations.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

2.11 Overall Assessment of SVOCs Data Usability

SVOCs data are of known quality and acceptable for use, as qualified.

3. Total/Dissolved Metals and Hardness (EPA Methods SW6010B, SW6020 and SW7470A)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be analyzed within 180 days for ICP metals and 28 days for mercury. Samples were analyzed within the required holding times.

3.2 ICP/MS Tuning

Instrument tuning was performed at the required frequency. The stability check (%RSD <5%), mass calibration (mass difference <0.1 AMU), and resolution check (peak width <1.0 AMU at 5% peak height) met the NFG and method criteria.

3.3 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury, the method requires that (1) a blank and three calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995. The associated initial calibrations met the method requirements.

All initial calibrations for metals met the criteria above.

A RL check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The check results were either within the NFGs criteria of 70-130% criteria, or if outside the control limits, the associated sample results were greater than the 2x RLs.

3.4 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) were analyzed at the required frequency. The %R values met the control criteria (90 – 110% for ICP metals, 80 – 120% for mercury).

3.5 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at the method-required frequency. Target analytes were not detected in ICBs/CCBs at or above the instrument detection limits (IDLs).

Negative detections for mercury and manganese were found in ICB and selected CCBs at levels where their absolute values were between those of IDLs and RLs. These negative detections were determined to have no significant effects on samples results.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were not detected in the method blanks at or above the RLs.

3.6 ICP Interference Check Sample (ICS)

The method requires that (1) an interelement interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several non-interfernt analytes were detected at low levels (less than RLs) in the solution containing only the interferents (ICSA). Since the interferent concentrations in the associated samples were less than 50% of the concentrations in ICSA samples, no action was taken.

3.7 Laboratory Control Sample (LCS)

LCS analyses were performed on all target analytes as required by the methods. All %R values met the project control limits.

3.8 Matrix Spike (MS)

MS analyses were performed on sample MGP-GW-MW-40. The %R values for calcium and magnesium were not applicable because their native concentrations in sample MGP-GW-MW-40 were greater than four times the spiking levels. %R values for other target analytes were within the laboratory control limits.

3.9 Laboratory Duplicate Analysis

Duplicate analysis was performed on sample MGP-GW-MW-40. All RPD values were within the laboratory control limits.

3.10 Internal Standards

At least three internal standards were added to all field and QC samples for ICP/MS analyses. All percent relative intensity values were within the method criteria (30 - 120% of those for the associated calibration blank).

3.11 ICP Serial Dilution

Serial dilution analysis was performed on sample MGP-GW-MW-40. The %D values for positive results greater than 50xMDL were within 10%.

3.12 Reporting Limits and Target Analyte Quantitation

The project requirements for quantitation limits were achieved. A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

3.13 Overall Assessment of Metals and Hardness Data Usability

Metals and hardness data are of known quality and acceptable for use, as qualified.

4. TPH-Gasoline by GC/FID (Method NWTPH-Gx)

4.1 Holding Time

Water samples should be analyzed within 14 days of collection. All samples were extracted and analyzed within the required holding times.

4.2 Initial Calibration

The method requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curve was verified with %RSD of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable.

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value. All calibration verification analyses met the method requirements.

4.4 Method Blank

Method blanks were prepared and analyzed as required. TPH-Gasoline was not detected at or above the MDL in the method blank.

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

4.6 Laboratory Control Samples (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required. All %R and RPD values met the laboratory control limits.

4.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values met the laboratory control criteria.

4.8 Target Compound Identification

The laboratory reported TPH-Gasoline results as integrated response between toluene and the C_{12} marker, which complies with the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. The RL goals identified in the QAPP were met.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

4.10 Overall Assessment of TPH-Gasoline Data Usability

TPH-Gasoline data are of known quality and acceptable for use.

5. TPH-Diesel & Motor Oil by GC/FID (Method NWTPH-Dx)

5.1 Holding Time

Water samples should be extracted within seven days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

5.2 Initial Calibration

The method requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curve was verified with %RSD of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both TPH-Diesel and TPH-Motor Oil.

5.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value. All calibration verification analyses met the method requirements.

5.4 Method Blank

Method blanks were prepared and analyzed as required. TPH-Diesel or Motor Oil was not detected at or above the MDLs in the method blank.

5.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

5.6 Laboratory Control Samples (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required. All %R and RPD values met the laboratory control limits.

5.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GW-MW-40. All %R and RPD values met the laboratory control criteria.

5.8 Target Compound Identification

The laboratory reported TPH-Diesel results as integrated response between the C_{12} and C_{24} markers and TPH-Motor Oil between the C_{24} and C_{38} markers, which complies with the method.

5.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations and achieved the quantitation limit goals identified in the QAPP.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

5.10 Overall Assessment of TPH-Diesel & Motor Oil Data Usability

TPH-Diesel and Motor Oil data are of known quality and acceptable for use.

6. Inorganic Parameters (TDS, TOD, DOC, Conductivity, Salinity, Total Cyanide, and WAD Cyanide)

6.1 Sample Management and Holding Time

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Samples should be analyzed within 7 days of collection for TDS, 14 days for total and WAD cyanide, and 28 days for TOC and DOC. All samples were analyzed within the required holding times.

6.2 Instrument Calibration

The initial calibrations were established for ammonia, total sulfide, and TOC using one blank and at least five levels of standards. The correlation coefficients (r) of the initial calibration curves were >0.995, and met the method criteria.

6.3 Calibration Verification

ICV and CCV analyses were performed for cyanide and sulfide as required by the methods. All ICV and CCV %R values were within the laboratory control limits (90 – 110%).

6.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed as required by the method. No target analytes were positively reported in ICBs and CCBs at or above the RLs.

Method Blanks: Method blanks were prepared and analyzed as required by the method. Target analytes were not detected at or above the RLs in the method blank.

6.5 Laboratory Duplicate

Laboratory duplicate analyses were formed on project samples as required. The RPD or concentration difference values were within the control criterion.

6.6 Matrix Spike (MS)

MS analyses were performed on project samples as required. The %R values were within the project control limits.

6.7 Laboratory Control Samples (LCS) and Standard Reference Material (SRM)

LCS and/or SRM analyses were performed as required by the methods. All %R values were within the laboratory control limits.

6.8 Reporting Limits and Target Analyte Quantitation

The RLs were supported with adequate initial calibration concentrations. Sample-specific RLs achieved the project requirements for quantitation limits.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

6.9 Overall Assessment of Inorganic Data Usability

Inorganic data are of known quality and acceptable for use, as qualified.

SUMMARY

I. Data qualification is summarized as follows:

Sample ID	Analyte	Data Qualifier	Reason	Report Section
MGP-GW-MW-42	All VOCs	**J/UJ**	The sample was analyzed past the recommend holding time for kun-preserved sample.	**1.1**
MGP-GW-MW-38 MGP-GW-MW-42 TRIP BLANKS	Bromomethane	**UJ**	The CCV %D value biased low.	**1.4**
MGP-GW-MW-42 MGP-GW-MW-31	Naphthalene	**J**	The initial calibration %RSD value exceeded 15%.	**2.3**
MGP-GW-MW-31	1-Methylnaphthalene 2-Methylnaphthalene Anthracene Carbazole Dibenzofuran Fluoranthene Fluorene Phenanthrene Pyrene	**J**	The initial calibration %RSD value exceeded 15%.	**2.3**

II. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
R	The result was rejected and could not be used.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: Mingta Lin Date: *12/22/2010*

Mingta Lin, Senior Project Chemist

REFERENCES

USEPA *Test Methods for Evaluating Solid Waste (SW-846).* 3rd ed. and Revised Update IIIA. Office of Solid Waste and Emergency Response, Washington, D.C. April 1998.

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PSEP *Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound,* Puget Sound Water Quality Authority, March 1986.

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Data Validation Report

South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study
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2010 Soil Samples

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ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
BFB	bromofluorobenzene
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
DFTPP	decafluorotriphenylphosphine
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometer
ICSA	ICP interference check sample solution A
ICV	initial calibration verification
IDL	instrument detection limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDL	method detection limit
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics, EPA 2004 - Inorganics)

PAHs	polycyclic aromatic hydrocarbons
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RF	response factor
RL	reporting limit
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SIM	selective ion monitoring
SRM	standard reference material
SVOCs	semi-volatile organic compounds
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
VOCs	volatile organic compounds
WAD	weak acid dissociable

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for soil samples collected during August 2010 for the referenced project. The laboratory reports validated herein were submitted by Analytical Resources, Inc. (ARI), assigned ARI Job ID Numbers: RJ25 and RK11.

A Stage IV data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Herrenkohl & Landau 2010) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

				Analysis					
Field Sample ID	**Lab ID**	**Sampling Date**	**Matrix**	**VOCs TPH-G**	**SVOCs**	**PAHs**	**Metals**	**TPH-Dx**	**CN**
MGP-GP-23-14.0-15.0	RJ25A	08/17/10	Soil	X					
MGP-GP-23-17.0-18.0	RJ25B	08/17/10	Soil	X	X	X	X	X	X
MGP-GP-23-21.0-22.0	RJ25C	08/17/10	Soil	X	X	X	X	X	X
TRIP BLANKS	RJ25D	08/17/10	Water	X					
MGP-GP-23-0.5-1.0	RJ25E	08/17/10	Soil			X	X		X
MGP-GP-23-4.0-5.0	RJ25F	08/17/10	Soil			X	X		X
MGP-GP-16-0.5-1.0	RJ25G	08/17/10	Soil			X	X		
MGP-GP-16-7.0-8.0	RJ25H	08/17/10	Soil			X	X		
MGP-GP-16-4.0-5.0	RJ25I	08/17/10	Soil			X	X		
MGP-GP-16-14.0-15.0	RJ25J	08/17/10	Soil			X	X		
MGP-GP-16-16.0-17.0	RJ25K	08/17/10	Soil			X	X		
MGP-GP-16-18.0-19.0	RJ25L	08/17/10	Soil			X	X		
MGP-GP-16-21.0-22.0	RJ25M	08/17/10	Soil			X	X		
MGP-GP-16-24.0-25.0	RJ25N	08/17/10	Soil			X	X		

Field Sample ID	Lab ID	Sampling Date	Matrix	Analysis					
				VOCs TPH-G	SVOCs	PAHs	Metals	TPH-Dx	CN
MGP-GP-15-0.5-1.0	RJ25O	08/17/10	Soil			X	X		
MGP-GP-15-4.0-5.0	RJ25P	08/17/10	Soil			X	X		
MGP-GP-15-8.0-9.0	RJ25Q	08/17/10	Soil			X	X		
MGP-GP-15-14.0-15.0	RJ25R	08/17/10	Soil			X	X		
MGP-GP-15-15.0-16.0	RJ25S	08/17/10	Soil			X	X		
MGP-GP-55-14.0-15.0	RJ25T	08/17/10	Soil			X	X		
MGP-HS-31-10.0-11.0	RK11C	08/23/10	Soil	X	X			X	
MGP-HS-34-10.0-11.5	RK11E	08/23/10	Soil	X	X			X	
Trip Blanks	RK11J	08/23/10	Water	X					

Notes:
X - The analysis was requested and performed on the sample.
TPH-G – Gasoline range total petroleum hydrocarbon (TPH)
VOCs – Volatile organic compounds
SVOCs – Semi-volatile organic compounds
PAHs – Polycyclic aromatic hydrocarbons
Metals – Arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc.
TPH-Dx – Diesel and motor oil range TPH
CN – Total and weak-acid-dissociable (WAD) cyanide

Analytical methods in respect to analytical parameters validated herein and the laboratory performing the analyses are summarized below:

Parameter	Analytical Method	Laboratory
VOCs	SW846 Method 8260C	Analytical Resources, Inc. (ARI), Tukwila, Washington
SVOCs	SW846 Method 8270D	
PAHs	SW846 Method 8270D-SIM	
Metals	EPA Method 200.8	
Mercury	SW846 Method 7471A	
TPH-Gasoline Range	NWTPH-Gx	
TPH-Diesel and Oil Ranges	NWTPH-Dx	
Total Cyanide	EPA Method 335.4	
WAD Cyanide	SM 4500CN-I	

Notes:

1. SW846 Methods - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Method - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. NWTPH Methods - *Analytical Methods for Petroleum Hydrocarbons,* ECY 97-602, Washington State Department of Ecology, June 1997.
4. SM - *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.

DATA VALIDATION FINDINGS

1. VOCs by GC/MS (EPA Method SW8260C)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

Soil samples should be extracted and analyzed within 14 days of collection. All samples were analyzed within the required holding time.

1.2 GC/MS Instrument Performance Check

Bromofluorobenzene (BFB) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤ 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The National Functional Guidelines (NFGs) require that the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The percent difference (%D) values should be within ±20% for target compounds.

The initial calibrations met the criteria above, except that %RSD values exceeded 15% (but less than 20%) for a number of target compounds. These compounds were not detected in associated samples; the %RSD exceedance had no adverse effects on data quality. No data qualifying action was taken on this basis.

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method

blank and samples, (2) the %D values be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The RFs for numerous analytes in the calibration verification analyses were less than 0.05. The individual RFs of these analytes in the initial calibrations and all continuing calibration verifications indicated stable responses for the analytes. No data qualifying action was taken on this basis.

The calibration verification %D values met the criteria for all target compounds in all analytical sequences, except for the following:

CCV ID	Analyte	%D	Bias	Affected Sample	Data Qualifier
Instrument: FINN5 Date: 08/26/2010	1,1,1-Trichloroethane Acetone Chloromethane Methyl- *tert*-Butyl Ether	-21.3% -23.2% -22.5% -23.1%	Low	MGP-GP-23-14.0-15.0 MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 TRIP BLANKS	**UJ**
Instrument: FINN5 Date: 08/31/2010	Chloromethane	-20.2%	Low	MGP-HS-34-10.0-11.5	**UJ**

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the method detection limits (MDLs), exceptr for the following:

Method Blank ID	Analyte	Detection in Blank	Affected Sample	Original Result	Adjusted Results	Unit
MB-083010	Methylene Chloride	340	Trip Blank (8/23/2010) MGP-HS-31-10.0-11.0	5.2 4200	**5.2 U** **4200 U**	µg/Kg

Trip Blank: One trip blank was submitted with each of the two sample delivery groups (SDGs) collected on 8/17/2010 and 8/23/2010. Methylene chloride was detected in the 8/17/2010 trip blank at 2.4 µg/kg, but not detected in any of the associated field samples. Methylene chloride was detected in the 8/23/2010 trip blank; the detection was qualified as a non-detect based on the method blank result. Data qualifying action was not required in either case.

1.6 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

1.8 Matrix Spike (MS) and MS Duplicate (MSD)

MS/MSD analyses were not performed on project samples in these two SDGs.

1.9 Internal Standard

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample met the criteria.

1.10 Reporting Limits and Target Compound Quantitation

Reporting limits (RLs) were supported with adequate initial calibration concentrations. Selected samples required significant dilutions due to the elevated concentrations of target and non-target compounds in these samples; sample-specific MDLs and RLs were therefore raised proportionally in these cases. The dilutions were determined as justified; the project goals for quantitation limits were attained.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

1.11 Overall Assessment of VOCs Data Usability

VOCs data are of known quality and acceptable for use, as qualified.

2. SVOCs by GC/MS (EPA Method SW8270D)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be extracted within 14 days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

Decafluorotriphenylphosphine (DFTPP) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The NFGs criteria require that the average RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The %D values should be within ±20% for target compounds.

The initial calibrations met the criteria above, except that %RSD values exceeded 15% (but ≤20%) for a number of target compounds. These compounds were not detected in associated samples; the %RSD exceedance had no adverse effects on data quality. No data qualifying action was taken on this basis.

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

The calibration verification %D values met the criteria above for all target compounds in all analytical sequences, except for the following:

CCV ID	Analyte	%D	Bias	Affected Sample	Data Qualifier
Instrument: NT6 Date: 08/30/2010	2,4-Dinitrophenol	-30.2%	Low	MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0	**UJ**

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blank.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All %R values were within the laboratory control limits.

2.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

2.8 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-HS-34-10.0-11.5. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in sample MGP-HS-34-10.0-11.5 in cases where the %R values exceeded the upper control limits, with the following exceptions:

Parent Sample ID	Analyte	% R		Control Limit	Affected Sample	Data Qualifier
		MS	MSD			
MGP-HS-34-10.0-11.5	Benzoic Acid 2,4-Dinitrophenol	0 0	0 0	21-123% 20-140%	MGP-HS-34-10.0-11.5	**R**

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Method Reporting Limits and Target Compound Quantitation

MRLs were supported with adequate initial calibration concentrations. Selected samples required significant dilutions due to the elevated concentrations of target and non-target compounds in the sample; sample-specific MDLs and MRLs were therefore raised proportionally in these cases. The dilutions were determined as justified; the project goals for quntitation limits were attained to.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

2.11 Overall Assessment of SVOCs Data Usability

SVOCs data are of known quality and acceptable for use, as qualified.

3. PAHs by GC/MS (EPA Method SW8270D-SIM)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be extracted within 14 days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

3.2 GC/MS Instrument Performance Check

Decafluorotriphenylphosphine (DFTPP) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

3.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The NFGs criteria require that the average RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The %D values should be within ±20% for target compounds.

The initial calibration met all the criteria above.

3.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verifications met all the criteria above.

3.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blank.

3.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All %R values were within the laboratory control limits.

3.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All %R and RPD values either met the laboratory control criteria, or the target compounds were not detected in the associated samples in cases where the %R values exceeded the upper control limits.

3.8 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-GP-23-0.5-1.0. All %R and RPD values met the laboratory control criteria, except for the following:

Parent Sample ID	Analyte	% R		Control Limit	Affected Sample	Data Qualifier
		MS	MSD			
MGP-GP-23-0.5-1.0	Naphthalene	13.2%	22.5%	37-100%	MGP-GP-23-0.5-1.0	J

3.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

3.10 Field Duplicates

Samples MGP-GP-55-14.0-15.0 and MGP-GP-15-14.0-15.0 were field duplicates. The RPD or concentration difference values and data qualification are summarized in **Appendix A**.

3.11 Reporting Limits and Target Compound Quantitation

RLs were supported with adequate initial calibration concentrations. Selected samples required significant dilutions due to the elevated concentrations of target and non-target compounds in these samples; sample-specific MDLs and RLs were therefore raised proportionally in these cases. The dilutions were determined as justified; the project goals for quantitation limits were attained.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

3.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

4. Total Metals (EPA Method 200.8 and SW7471A)

4.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be digested and analyzed within 180 days for ICP metals and 28 days for mercury. Samples were digested and analyzed within the required holding times.

4.2 ICP/MS Tuning

Instrument tuning was performed at the required frequency. The stability check (%RSD <5%), mass calibration (mass difference <0.1 AMU), and resolution check (peak width <1.0 AMU at 5% peak height) met the NFG and method criteria.

4.3 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury, the method requires that (1) a blank and three calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995. The associated initial calibrations met the method requirements.

A RL check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The check results were either within the NFGs criteria of 70-130% criteria, or if outside the control limits, the associated sample results were greater than the 2x RLs.

4.4 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) were analyzed at the required frequency. The %R values met the control criteria (90 – 110% for ICP metals, 80 – 120% for mercury).

4.5 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Target analytes were not detected in ICBs/CCBs at or above the instrument detection limits (IDLs).

Negative detections for mercury and manganese were found in ICB and selected CCBs at levels where their absolute values were between those of IDLs and RLs. These negative detections were determined to have no significant effects on samples results.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were not detected in the method blanks at or above the RLs.

4.6 ICP Interference Check Sample (ICS)

The method requires that (1) an interelement interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several non-interfernt analytes were detected at low levels (less than RLs) in the solution containing only the interferents (ICSA). Since the interferent concentrations in the associated samples were less than 50% of the concentrations in ICSA samples, no action was taken.

4.7 Laboratory Control Sample (LCS)

LCS analyses were performed on all target analytes as required by the methods. All %R values met the project control limits.

4.8 Matrix Spike (MS)

MS analyses were performed on sample MGP-GP-23-17.0-18.0. The %R values met the laboratory control limits, except for the following:

Parent Sample	Analyte	MS % R	Control Limit	Affected Sample	Data Qualifier
MGP-GP-23-17.0-18.0	Antimony Chromium	6.0% 74.2%	75-125%	MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 MGP-GP-23-0.5-1.0 MGP-GP-23-4.0-5.0 MGP-GP-16-0.5-1.0 MGP-GP-16-7.0-8.0 MGP-GP-16-4.0-5.0 MGP-GP-16-14.0-15.0 MGP-GP-16-16.0-17.0 MGP-GP-16-18.0-19.0 MGP-GP-16-21.0-22.0 MGP-GP-16-24.0-25.0 MGP-GP-15-0.5-1.0 MGP-GP-15-4.0-5.0 MGP-GP-15-8.0-9.0 MGP-GP-15-14.0-15.0 MGP-GP-15-15.0-16.0 MGP-GP-55-14.0-15.0	**UJ** **J**

4.9 Laboratory Duplicate Analysis

Duplicate analysis was performed on sample MGP-GP-23-17.0-18.0. All RPD values were within the laboratory control limits, except for the following:

Parent Sample	Analyte	RPD or Difference	Control Limit	Affected Sample	Data Qualifier
MGP-GP-23-17.0-18.0	Chromium Lead Mercury	20.5% 40.5% 0.05 mg/kg	20% 20% 0.02 mg/kg	MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 MGP-GP-23-0.5-1.0 MGP-GP-23-4.0-5.0 MGP-GP-16-0.5-1.0 MGP-GP-16-7.0-8.0 MGP-GP-16-4.0-5.0 MGP-GP-16-14.0-15.0 MGP-GP-16-16.0-17.0 MGP-GP-16-18.0-19.0 MGP-GP-16-21.0-22.0 MGP-GP-16-24.0-25.0 MGP-GP-15-0.5-1.0 MGP-GP-15-4.0-5.0 MGP-GP-15-8.0-9.0 MGP-GP-15-14.0-15.0 MGP-GP-15-15.0-16.0 MGP-GP-55-14.0-15.0	**J**

Note: Mercury was not detected in sample MGP-GP-15-15.0-16.0; the mercury result for this sample was not qualified.

4.10 Internal Standards

At least three internal standards were added to all field and QC samples for ICP/MS analyses. All percent relative intensity values were within the method criteria (30 - 120% of those for the associated calibration blank).

4.11 ICP Serial Dilution

Serial dilution analysis was performed on sample MGP-GP-23-17.0-18.0. The %D values for positive results greater than 50xMDL were within 10%.

4.12 Field Duplicates

Samples MGP-GP-55-14.0-15.0 and MGP-GP-15-14.0-15.0 were field duplicates. The RPD or concentration difference values and data qualification are summarized in **Appendix A**.

4.13 Reporting Limits and Target Analyte Quantitation

The project requirements for quantitation limits were achieved. A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

4.14 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

5. TPH-Gasoline by GC/FID (Method NWTPH-Gx)

5.1 Holding Time

Soil samples should be extracted and analyzed within 14 days of collection. All samples were extracted and analyzed within the required holding times.

5.2 Initial Calibration

The method requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curve was verified with %RSD of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable.

5.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value. All calibration verification analyses met the method requirements.

5.4 Blanks

Method Blank: Method blanks were prepared and analyzed as required. TPH-Gasoline was not detected at or above the MDL in the method blank.

Trip Blank: One trip blank was submitted with each of the two sample delivery groups (SDGs) collected on 8/17/2010 and 8/23/2010. TPH-Gasoline was not detected at or above the MDL in the trip blanks.

5.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

5.6 Laboratory Control Samples (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required. All %R and RPD values met the laboratory control limits.

5.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed on project samples in these SDGs.

5.8 Target Compound Identification

The laboratory reported TPH-Gasoline results as integrated response between toluene and the C_{12} marker, which complies with the method.

5.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. The RL goals identified in the QAPP were met.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

5.10 Overall Assessment of TPH-Gasoline Data Usability

TPH-Gasoline data are of known quality and acceptable for use.

6. TPH-Diesel & Motor Oil by GC/FID (Method NWTPH-Dx)

6.1 Holding Time

Soil samples should be extracted within 14 days of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

6.2 Initial Calibration

The method requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curve was verified with %RSD of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both TPH-Diesel and TPH-Motor Oil.

6.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value. All calibration verification analyses met the method requirements.

6.4 Method Blank

Method blanks were prepared and analyzed as required. TPH-Diesel or Motor Oil was not detected at or above the MDLs in the method blank.

6.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

6.6 Laboratory Control Samples (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required. All %R and RPD values met the laboratory control limits.

6.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-HS-34-10.0-11.5. All %R and RPD values met the laboratory control criteria.

6.8 Target Compound Identification

The laboratory reported TPH-Diesel results as integrated response between C_{12} and C_{24} markers, and TPH-Motor Oil between the C_{24} and C_{38} markers, which complies with the method.

6.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations and achieved the quantitation limit goals identified in the QAPP.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

6.10 Overall Assessment of TPH-Diesel & Motor Oil Data Usability

TPH-Diesel and Motor Oil data are of known quality and acceptable for use.

7. Total and WAD Cyanide (EPA Method 335.4 and SM Method 4500CN-I)

7.1 Sample Management and Holding Time

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be extracted and analyzed within 28 days of collection. All samples were extracted and analyzed within the required holding time.

7.2 Instrument Calibration

The initial calibrations were established using one blank and at least five levels of standards. The correlation coefficients (r) of the initial calibration curves were >0.995, and met the method criteria.

7.3 Calibration Verification

ICV and CCV analyses were performed as required by the methods. All ICV and CCV %R values were within the laboratory control limits (90 – 110%).

7.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed as required by the method. No target analytes were positively reported in ICBs and CCBs at or above the RLs.

Method Blanks: Method blanks were prepared and analyzed as required by the method. Target analytes were not detected at or above the RLs in the method blank.

7.5 Laboratory Duplicate

Laboratory duplicate analyses were formed on project samples as required. The RPD or concentration difference values were within the control criterion.

7.6 Matrix Spike (MS)

MS/MSD analyses were not performed on project samples in these SDGs.

7.7 Standard Reference Material (SRM)

SRM analyses were performed as required by the methods. The %R values were within the laboratory control limits.

7.8 Reporting Limits and Target Analyte Quantitation

The RLs were supported with adequate initial calibration concentrations. Sample-specific RLs achieved the project requirements for quantitation limits.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

7.9 Overall Assessment of Total and WAD Cyanide Data Usability

Total and WAD cyanide data are of known quality and acceptable for use, as qualified.

SUMMARY

I. Data qualification is summarized as follows:

Sample ID	Analyte	Data Qualifier	Reason	Report Section
MGP-GP-23-14.0-15.0 MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 TRIP BLANKS	1,1,1-Trichloroethane Acetone Chloromethane Methyl- *tert*-Butyl Ether	**UJ**	The calibration verification %D value biased low.	**1.4**
MGP-HS-34-10.0-11.5	Chloromethane	**UJ**	The calibration verification %D value biased low.	**1.4**
MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0	2,4-Dinitrophenol	**UJ**	The calibration verification %D value biased low.	**2.4**
MGP-HS-34-10.0-11.5	Benzoic Acid 2,4-Dinitrophenol	**R**	The matrix spike %R was <10%.	**2.8**
MGP-GP-23-0.5-1.0	Naphthalene	**J**	The matrix spike %R biased low.	**3.8**
MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 MGP-GP-23-0.5-1.0 MGP-GP-23-4.0-5.0 MGP-GP-16-0.5-1.0 MGP-GP-16-7.0-8.0 MGP-GP-16-4.0-5.0 MGP-GP-16-14.0-15.0 MGP-GP-16-16.0-17.0 MGP-GP-16-18.0-19.0 MGP-GP-16-21.0-22.0 MGP-GP-16-24.0-25.0 MGP-GP-15-0.5-1.0 MGP-GP-15-4.0-5.0 MGP-GP-15-8.0-9.0 MGP-GP-15-14.0-15.0 MGP-GP-15-15.0-16.0 MGP-GP-55-14.0-15.0	Antimony	**UJ**	The matrix spike %R biased low.	**4.8**

Sample ID	Analyte	Data Qualifier	Reason	Report Section
MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 MGP-GP-23-0.5-1.0 MGP-GP-23-4.0-5.0 MGP-GP-16-0.5-1.0 MGP-GP-16-7.0-8.0 MGP-GP-16-4.0-5.0 MGP-GP-16-14.0-15.0 MGP-GP-16-16.0-17.0 MGP-GP-16-18.0-19.0 MGP-GP-16-21.0-22.0 MGP-GP-16-24.0-25.0 MGP-GP-15-0.5-1.0 MGP-GP-15-4.0-5.0 MGP-GP-15-8.0-9.0 MGP-GP-15-14.0-15.0 MGP-GP-15-15.0-16.0 MGP-GP-55-14.0-15.0	Chromium	**J**	The MS %R value biased low and duplicate analyses RPD value exceeded 20%.	**4.8** **4.9**
MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 MGP-GP-23-0.5-1.0 MGP-GP-23-4.0-5.0 MGP-GP-16-0.5-1.0 MGP-GP-16-7.0-8.0 MGP-GP-16-4.0-5.0 MGP-GP-16-14.0-15.0 MGP-GP-16-16.0-17.0 MGP-GP-16-18.0-19.0 MGP-GP-16-21.0-22.0 MGP-GP-16-24.0-25.0 MGP-GP-15-0.5-1.0 MGP-GP-15-4.0-5.0 MGP-GP-15-8.0-9.0 MGP-GP-15-14.0-15.0 MGP-GP-15-15.0-16.0 MGP-GP-55-14.0-15.0	Lead	**J**	The duplicate analyses RPD value exceeded 20%.	**4.9**
MGP-GP-23-17.0-18.0 MGP-GP-23-21.0-22.0 MGP-GP-23-0.5-1.0 MGP-GP-23-4.0-5.0 MGP-GP-16-0.5-1.0 MGP-GP-16-7.0-8.0 MGP-GP-16-4.0-5.0 MGP-GP-16-14.0-15.0 MGP-GP-16-16.0-17.0 MGP-GP-16-18.0-19.0 MGP-GP-16-21.0-22.0 MGP-GP-16-24.0-25.0 MGP-GP-15-0.5-1.0 MGP-GP-15-4.0-5.0 MGP-GP-15-8.0-9.0 MGP-GP-15-14.0-15.0 MGP-GP-55-14.0-15.0	Mercury	**J**	The duplicate analyses concentration difference value exceeded the control limit.	**4.9**

II. Data affected by associated blanks are qualified and results adjusted as follows:

Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
Trip Blank (8/23/2010) MGP-HS-31-10.0-11.0	Methylene Chloride	5.2 4200	**5.2 U** **4200 U**	µg/kg	**1.5**

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
R	The result was rejected and could not be used.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: Mingta Lin (signature) Date: *12/22/2010*
Mingta Lin, Senior Project Chemist

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City of Bellingham & Puget Sound Energy, *Work Plan for South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study, Bellingham, Washington.* Herrenkohl Consulting LLC. & Landau Associates Inc., August 2010.

Appendix A

The precision criterion of 35% specified in the QAPP was applied to evaluating the RPD values of sediment field duplicate results ≥5xRL. For results that are <5xRL, an advisory criterion of ±2xRL was applied to evaluating the concentration differences. The RPD (or concentration difference as applicable) values and data qualification for detected compounds in field duplicates are presented as follows:

Analytes	Unit	MRL	Sample ID & Results		RPD	Concentration Difference	Data Qualification
			MGP-GP-55-14.0-15.0	MGP-GP-55-14.0-15.0			
Antimony	mg/kg	0.2	ND	ND	-	0	
Arsenic	mg/kg	0.2	3.7	4.1	10%	-	
Barium	mg/kg	0.6	109	113	4%	-	
Cadmium	mg/kg	0.2	ND	ND	-	0	
Chromium	mg/kg	3	54	48	12%	-	
Copper	mg/kg	0.6	33.8	32.2	5%	-	
Lead	mg/kg	1	4	4	-	0	
Mercury	mg/kg	0.03	0.03	0.04	-	0.01	
Selenium	mg/kg	0.6	ND	ND	-	0	
Silver	mg/kg	0.2	ND	ND	-	0	
Zinc	mg/kg	4	49	49	0%	-	
Naphthalene	µg/kg	4.8	ND	ND	-	0	
2-Methylnaphthalene	µg/kg	4.8	ND	ND	-	0	
1-Methylnaphthalene	µg/kg	4.8	ND	ND	-	0	
Acenaphthylene	µg/kg	4.8	ND	ND	-	0	
Acenaphthene	µg/kg	4.8	ND	ND	-	0	
Fluorene	µg/kg	4.8	ND	ND	-	0	
Phenanthrene	µg/kg	4.8	ND	5.4	-	5.4	
Anthracene	µg/kg	4.8	ND	ND	-	0	
Fluoranthene	µg/kg	4.8	5.8	ND	-	0	
Pyrene	µg/kg	4.8	6.3	ND	-	0	
Benzo(a)anthracene	µg/kg	4.8	ND	ND	-	0	
Chrysene	µg/kg	4.8	ND	ND	-	0	
Benzo(a)pyrene	µg/kg	4.8	ND	ND	-	0	
Indeno(1,2,3-cd)pyrene	µg/kg	4.8	ND	ND	-	0	
Dibenz(a,h)anthracene	µg/kg	4.8	ND	ND	-	0	
Benzo(g,h,i)perylene	µg/kg	4.8	ND	ND	-	0	
Dibenzofuran	µg/kg	4.8	ND	ND	-	0	
Total Benzofluoranthenes	µg/kg	4.8	4.8	ND	-	4.8	

Note: ND – Not detected at or above the MRL.

Data Validation Report

South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study
Bellingham, Washington

2010 Sediment Samples

Prepared for:

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Edmonds, WA 98020

Prepared by:

Pyron Environmental, Inc.
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December 23, 2010

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
DFTPP	decafluorotriphenylphosphine
EPA	U.S. Environmental Protection Agency
GC/MS	gas chromatograph/mass spectrometer
ICAL	initial calibration
ICB	initial calibration blank
ICP/MS	inductively coupled plasma/ mass spectrometer
ICSA	ICP interference check sample solution A
ICV	initial calibration verification
IDL	instrument detection limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDL	method detection limit
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics, EPA 2004 - Inorganics)
PAHs	polycyclic aromatic hydrocarbons
PSEP	Puget Sound Estuary Program
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control

RF	response factor
RL	reporting limit
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SIM	selective ion monitoring
SRM	standard reference material
SVOCs	semi-volatile organic compounds
TOC	total organic carbon

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for sediment samples collected during September 2010 for the referenced project. The laboratory reports validated herein were submitted by Analytical Resources, Inc. (ARI), assigned ARI Job ID Numbers: RL74 and RM01.

A Stage IV data validation was performed on this laboratory report. The validation followed the procedures specified in the *USEPA CLP Functional Guidelines* ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) and the *Data Validation Guidance Manual* (PTI, 1989) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Herrenkohl & Landau, 2010) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Matrix	Analysis				
				SVOCs	PAHs	Metals	TOC	Ammonia Sulfide
Samish Bay REF 2	RL74A	9/2/2010	Sediment				X	X
Samish Bay REF 3	RL74B	9/2/2010	Sediment				X	X
MGP-SS-07	RL74C	9/2/2010	Sediment		X	X	X	X
MGP-SS-08	RL74D	9/2/2010	Sediment		X	X	X	X
MGP-SS-06	RL74E	9/2/2010	Sediment		X	X	X	X
MGP-SS-02	RL74F	9/2/2010	Sediment	X			X	X
MGP-SS-04	RL74G	9/2/2010	Sediment	X			X	X
MGP-SB-09-0.0-2.0	RM01A	9/7/2010	Sediment		X	X	X	
MGP-SB-09-4.0-6.0	RM01B	9/7/2010	Sediment		X	X	X	
MGP-SB-09-15.0-17.0	RM01C	9/7/2010	Sediment		X	X	X	
MGP-SB-09-35.5-37.0	RM01D	9/7/2010	Sediment		X	X	X	
MGP-SB-09-38.0-39.5	RM01E	9/7/2010	Sediment	X		X	X	
MGP-SB-06-2.0-4.0	RM01F	9/7/2010	Sediment		X	X	X	
MGP-SB-06-6.0-8.0	RM01G	9/7/2010	Sediment		X	X	X	

Field Sample ID	Laboratory Sample ID	Sampling Date	Matrix	Analysis				
				SVOCs	PAHs	Metals	TOC	Ammonia Sulfide
MGP-SB-66-6.0-8.0	RM01H	9/7/2010	Sediment		X	X	X	
MGP-SB-06-10.5-12.0	RM01I	9/7/2010	Sediment		X	X	X	
MGP-SB-06-12.0-13.5	RM01J	9/7/2010	Sediment	X		X	X	

Notes:
X - The analysis was requested and performed on the sample
SVOCs – Semi-volatile organic compounds
PAHs – Polycyclic aromatic hydrocarbons
Metals – Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc.
TOC – Total organic carbon

Analytical methods in respect to analytical parameters validated herein and the laboratory performing the analyses are summarized below:

Parameter	Analytical Method	Laboratory
SVOCs	SW846 Method 8270D	Analytical Resources, Inc. (ARI), Tukwila, Washington
PAHs	SW846 Method 8270D - SIM	
Metals	SW846 Methods 6020B/7471A	
Total Sulfide	EPA Method 376.2	
Ammonia	EPA Method 350.1M	
TOC	Plumb 1981	
Total Solids	EPA Method 160.3	

Notes:
1. SW846 Methods - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Method - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. Plumb 1981 - *Procedures for Handling and Chemical Analysis of Sediment and Water Samples.* Technical Report, EPA/CE-B1-1. U.S. Army Corps of Engineers. Plumb, R.H. 1981.
4. SM - *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.

DATA VALIDATION FINDINGS

1. SVOCs by GC/MS (EPA Method SW8270D)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

Sediment samples should be extracted within 14 days (one year if frozen at -20°C) of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

1.2 GC/MS Instrument Performance Check

Decafluorotriphenylphosphine (DFTPP) tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤ 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The National Functional Guidelines (NFGs) require that the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was to be analyzed to verify the calibration curve. The percent difference (%D) values should be within ±20% for target compounds.

Initial calibrations met all the criteria above, except that %RSD values for a number of target compounds exceeded 15% in the NT6, 09/28/2010 ICAL. The %RSD exceedance had no effects on data quality for compounds not detected in samples. Compounds detected in samples associated with this ICAL were affected and qualified as follows:

ICAL ID	Analyte	%RSD	Affected Sample	Data Qualifier
Instrument: NT6 Date: 09/28/2010	Benzoic Acid	19.0%	MGP-SS-07	**J**
Instrument: NT4 Date: 09/03/2010	1-Methylnaphthalene 2-Methylnaphthalene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Carbazole Chrysene Dibenzofuran Fluoranthene Fluorene Naphthalene Phenanthrene Pyrene	18.1% 17.1% 17.5% 19.9% 17.4% 15.3% 16.9% 19.4% 19.7% 19.5% 19.4% 17.3% 18.2% 18.7% 19.2%	MGP-SS-02 MGP-SS-04 MGP-SB-06-12.0-13.5	**J (detects)**

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D values be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The RFs for numerous analytes in the calibration verification analyses were less than 0.05. The individual RFs of these analytes in the initial calibrations and all continuing calibration verifications indicated stable responses for the analytes. No data qualifying action was taken on this basis.

The calibration verification %D values met the criteria for all target compounds in all analytical sequences, except for the following:

CCV ID	Analyte	%D	Bias	Affected Sample	Data Qualifier
Instrument: NT4 Date: 09/27/2010	2,4-Dinitrophenol 4,6-Dinitro-2-Methylphenol Benzo(g,h,i)perylene Benzoic Acid	-49.3% -20.7% -25.4% -46.2%	Low	MGP-SS-02 MGP-SS-04 MGP-SB-09-38.0-39.5 MGP-SB-06-12.0-13.5	**J (detects) UJ (non-detects)**
Instrument: NT6 Date: 10/04/2010	Benzyl Alcohol	-34.7%	Low	MGP-SS-07	**UJ**
Instrument: NT6 Date: 10/05/2010	Benzyl Alcohol	-25.4%	Low	MGP-SS-06 MGP-SS-08	**UJ**
Instrument: NT6 Date: 10/05/2010	Pyrene	21.3%	High	MGP-SS-06 MGP-SS-08	**J**

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the method detection limits (MDLs), except noted below. Sample result less than five times (10 times for common laboratory contaminants) the detection in method blanks were qualified (U) as non-detects at the reporting limits (RLs), if detected below the RL, or the reported concentration (if > RL).

Note that the blanks and sample results were evaluated based on the on-column concentrations, which excluded factors such as sample amount, moisture content, and dilution.

Method Blank ID	Analyte	Detection in Blank	Affected Sample	Original Result	Adjusted Results	Unit
MB-100210 MB-100410	Phenol	67 570	MGP-SS-07 MGP-SS-08 MGP-SS-06 MGP-SS-02 MGP-SS-04	900 280 97 60 79	**900 U** **280 U** **97 U** **60 U[(A)]** **79 U[(A)]**	µg/Kg
MB-100410	Benzoic Acid	150 J	MGP-SS-08	110 J	**360 U**	µg/Kg

Note:
J – The value was at a level between the MDL and MRL, and considered as estimated.
[(A)] – Phenol was not detected in the associated method blank, but consistently present in method blanks associated with project samples in different preparation batches. The result was qualified herein as a conservative measure.

1.6 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values met the laboratory control criteria, except for the following:

LCS ID	Analyte	% R (%)		%R Control Limit (%)	Affected Sample	Data Qualification
		LCS	LCSD			
LCS-100210 LCS-100410	Benzyl Alcohol	0 0	0 0	10-100	MGP-SS-07 MGP-SS-08 MGP-SS-06	**R**

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits, except that the %R value (15.7%) for 2,4,6-tribromopehnol in sample MGP-SB-06-12.0-13.0 was less than the lower control limit (33-118%). The recovery of internal standards and other surrogate spikes were within control limits; no data qualifying action was necessary.

1.8 Matrix Spike (MS) and MS Duplicate (MSD)

MS/MSD analyses were performed on sample MGP-SB-09-38.0-39.0. All %R and RPD values were within the control limits, except that the %R value (18.2%) for 2,4-dimethylphenol was slightly less than the lower control limit (19-100%). The recovery of the MSD and LCS/LCSD was within the control limits; no data qualifying action was necessary.

1.9 Internal Standard

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

1.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and RLs were adjusted with sample amount extracted and RLs were supported with adequate initial calibration concentrations. The project requirements for quantitation limits were achieved.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

1.11 Field Duplicates

Field duplicates were not submitted for SVOCs analyses in this SDG.

1.12 Overall Assessment of SVOCs Data Usability

SVOCs data are of known quality and acceptable for use, as qualified.

2. PAHs by GC/MS (EPA Method SW8270D - SIM)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Sediment samples should be extracted within 14 days (one year if frozen at -20°C) of collection; extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

DFTPP tuning was performed at the beginning of each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be ≤15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be ≥0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be ≥0.99.

The NFGs criteria require that the average RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

An initial calibration verification standard (second source standard) was analyzed to verify the calibration curve. The %D values were within ±20% for target compounds.

Initial calibrations for all target compounds met the criteria above.

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds. Calibration verifications met all the criteria above.

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blank.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All %R values were within the laboratory control limits.

2.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required by the method. All %R and RPD values were within the project control limits.

2.8 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample MGP-SB-06-10.5-12.0. All %R and RPD values were within the control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and RLs were adjusted with sample amount extracted and the RLs were supported with adequate initial calibration concentrations.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

2.11 Field Duplicates

Samples MGP-SB-06-6.0-8.0 and MGP-SB-66-6.0-8.0 were field duplicates. RPD (or concentration difference) values and data qualification are summarized in **Appendix A**.

2.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

3. Total Metals (EPA Methods SW6020B and SW7471A)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Sediment and water samples should be analyzed within 180 days for metals and 28 days for mercury. Samples were analyzed within the required holding time.

3.2 ICP/MS Tuning

Instrument tuning was performed at the required frequency. The stability check (%RSD <5%), mass calibration (mass difference <0.1 AMU), and resolution check (peak width <1.0 AMU at 5% peak height) met the NFG and method criteria.

3.3 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury, the methods require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995. The associated initial calibrations met the method requirements.

A RL check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The check results were either within the NFGs criteria of 70-130% criteria, or if outside the control limits, the associated sample results were greater than the 2x RLs.

3.4 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) were analyzed at the required frequency. The %R values met the control criteria (90 – 110% for ICP metals, 80 – 120% for mercury).

3.5 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at the method-required frequency. Target analytes were not detected in ICBs/CCBs at or above the instrument detection limits (IDLs).

Negative detections for mercury and manganese were found in ICB and selected CCBs at levels where their absolute values were between those of IDLs and RLs. These negative detections were determined to have no significant effects on samples results.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were not detected in the method blanks at or above the RLs.

3.6 ICP Interference Check Sample (ICS)

The method requires that (1) an interelement interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several non-interfernt analytes were detected at low levels (less than RLs) in the solution containing only the interferents (ICSA). Since the interferent concentrations in the associated samples were less than 50% of the concentrations in ICSA samples, no action was taken.

3.7 Laboratory Control Sample (LCS)

LCS analyses were performed on all target analytes as required by the methods. All %R values met the project control limits.

3.8 Matrix Spike (MS)

MS analyses were performed on samples MGP-SS-07 and MGP-SB-09-0.0-2.0. The %R values met the laboratory control limits, except for the following:

Parent Sample	Analyte	MS % R	Control Limit	Affected Sample	Data Qualification
MGP-SS-07	Silver	66.1%	75-125%	MGP-SS-02 MGP-SS-04 MGP-SS-06 MGP-SS-07 MGP-SS-08	**UJ**
MGP-SB-09-0.0-2.0	Silver	49.1%	75-125%	MGP-SB-09-0.0-2.0 MGP-SB-09-4.0-6.0 MGP-SB-09-15.0-17.0 MGP-SB-09-35.5-37.0 MGP-SB-09-38.0-39.5 MGP-SB-06-2.0-4.0 MGP-SB-06-6.0-8.0 MGP-SB-66-6.0-8.0 MGP-SB-06-10.5-12.0 MGP-SB-06-12.0-13.5	**UJ**

3.9 Laboratory Duplicate Analysis

Duplicate analysis was performed on samples MGP-SS-07 and MGP-SB-09-0.0-2.0. All RPD values were within the laboratory control limits, except for the flowing:

Parent Sample	Analyte	RPD	Control Limit	Affected Sample	Data Qualification
MGP-SS-07	Lead	25%	20%	MGP-SS-02 MGP-SS-04 MGP-SS-06 MGP-SS-07 MGP-SS-08	**J**
MGP-SB-09-0.0-2.0	Zinc	52.6%	20%	MGP-SB-09-0.0-2.0 MGP-SB-09-4.0-6.0 MGP-SB-09-15.0-17.0 MGP-SB-09-35.5-37.0 MGP-SB-09-38.0-39.5 MGP-SB-06-2.0-4.0 MGP-SB-06-6.0-8.0 MGP-SB-66-6.0-8.0 MGP-SB-06-10.5-12.0 MGP-SB-06-12.0-13.5	**J**

3.10 Internal Standards

At least three internal standards were added to all field and QC samples for ICP/MS analyses. All percent relative intensity values were within the method criteria (30 - 120% of those for the associated calibration blank).

3.11 ICP Serial Dilution

Serial dilution analysis was performed on samples MGP-SS-07 and MGP-SB-09-0.0-2.0. The %D values for positive results greater than 50xMDL were within 10%.

3.12 Reporting Limits and Target Analyte Quantitation

The project requirements for quantitation limits were achieved. A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

3.13 Field Duplicates

Samples MGP-SB-06-6.0-8.0 and MGP-SB-66-6.0-8.0 were field duplicates. RPD (or concentration difference) values and data qualification are summarized in **Appendix A**.

3.14 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

4. Conventional Chemistry Parameters (Ammonia, Total Sulfide, TOC, and TS)

4.1 Sample Management and Holding Time

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Sediment samples should be analyzed within 7 days of collection for total sulfide and ammonia, and six months for TOC and TS. All samples were analyzed within the required holding times.

4.2 Instrument Calibration

The initial calibrations were established for ammonia, total sulfide, and TOC using one blank and at least five levels of standards. The correlation coefficients (r) of the initial calibration curves were >0.995, and met the method criteria.

4.3 Calibration Verification

ICV and CCV analyses were performed as required by the methods. All ICV and CCV %R values were within the laboratory control limits (90 – 110%).

4.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed as required by the method. No target analytes were positively reported in ICBs and CCBs at or above the MRLs.

Method Blanks: Method blanks were prepared and analyzed as required by the method. Target analytes were not detected at or above the MRLs in the method blanks.

4.5 Laboratory Replicate

Laboratory triplicate analyses were formed on project sample Samish Bay REF2 for TS, TOC, ammonia, and total sulfide. The %RSD values were within the control criterion (20%), except for the following:

Parent Sample	Analyte	%RSD	Control Limit	Affected Sample	Data Qualification
Samish Bay REF2	Ammonia	20.1%	20%	Samish Bay REF 2 Samish Bay REF 3 MGP-SS-07 MGP-SS-08 MGP-SS-06 MGP-SS-02 MGP-SS-04	**J**

4.6 Matrix Spike (MS)

MS/MSD analyses were performed on project samples as required. The %R and RPD values were within the laboratory control limits (75-125%).

4.7 Laboratory Control Samples (LCS) and Standard Reference Material (SRM)

LCS and/or SRM analyses were performed as required by the methods. All %R values were within the laboratory control limits (80-120%).

4.8 Field Duplicates

Samples MGP-SB-06-6.0-8.0 and MGP-SB-66-6.0-8.0 were field duplicates submitted for TOC analyses. The RPD value and data qualification are summarized in **Appendix A**.

4.9 Reporting Limits and Target Analyte Quantitation

The RLs were supported with adequate initial calibration concentrations. Sample-specific RLs achieved the project requirements for quantitation limits.

A verification calculation was performed on 10% of the reported calibrations, laboratory QC analysis, and sample results. No transcription and calculation anomalies were found.

4.10 Overall Assessment of TOC, TS, Ammonia, and Total Sulfide Data Usability

TOC, TS, ammonia, and total sulfide data are of known quality and acceptable for use, as qualified.

SUMMARY

I. Data qualification is summarized as follows:

Sample ID	Analyte	Data Qualifier	Reason	Report Section
MGP-SS-07	Benzoic Acid	**J**	The ICAL %RSD value exceeded 15%.	**1.3**
MGP-SS-02 MGP-SS-04 MGP-SB-06-12.0-13.5	1-Methylnaphthalene 2-Methylnaphthalene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Carbazole Chrysene Dibenzofuran Fluoranthene Fluorene Naphthalene Phenanthrene Pyrene	**J**	The ICAL %RSD value exceeded 15%.	**1.3**
MGP-SS-02 MGP-SS-04 MGP-SB-09-38.0-39.5 MGP-SB-06-12.0-13.5	2,4-Dinitrophenol 4,6-Dinitro-2-Methylphenol Benzo(g,h,i)perylene Benzoic Acid	**J/UJ**	The CCV %D value biased low.	**1.4**
MGP-SS-07	Benzyl Alcohol	**UJ**	The CCV %D value biased low.	**1.4**
MGP-SS-06 MGP-SS-08	Benzyl Alcohol	**UJ**	The CCV %D value biased low.	**1.4**
MGP-SS-06 MGP-SS-08	Pyrene	**J**	The CCV %D value biased high.	**1.4**
MGP-SS-07 MGP-SS-08 MGP-SS-06	Benzyl Alcohol	**R**	The LCS/LCSD %R value was <10%.	**1.6**
MGP-SS-02 MGP-SS-04 MGP-SS-06 MGP-SS-07 MGP-SS-08 MGP-SB-09-0.0-2.0 MGP-SB-09-4.0-6.0 MGP-SB-09-15.0-17.0 MGP-SB-09-35.5-37.0 MGP-SB-09-38.0-39.5 MGP-SB-06-2.0-4.0 MGP-SB-06-6.0-8.0 MGP-SB-66-6.0-8.0 MGP-SB-06-10.5-12.0 MGP-SB-06-12.0-13.5	Silver	**UJ**	The MS %R value biased low.	**3.8**

Sample ID	Analyte	Data Qualifier	Reason	Report Section
MGP-SS-02 MGP-SS-04 MGP-SS-06 MGP-SS-07 MGP-SS-08	Lead	**J**	The laboratory duplicate analysis RPD value exceeded 20%.	**3.9**
MGP-SB-09-0.0-2.0 MGP-SB-09-4.0-6.0 MGP-SB-09-15.0-17.0 MGP-SB-09-35.5-37.0 MGP-SB-09-38.0-39.5 MGP-SB-06-2.0-4.0 MGP-SB-06-6.0-8.0 MGP-SB-66-6.0-8.0 MGP-SB-06-10.5-12.0 MGP-SB-06-12.0-13.5	Zinc	**J**	The laboratory duplicate analysis RPD value exceeded 20%.	**3.9**
Samish Bay REF 2 Samish Bay REF 3 MGP-SS-07 MGP-SS-08 MGP-SS-06 MGP-SS-02 MGP-SS-04	Ammonia	**J**	The laboratory replicate analysis %RSD value exceeded 20%.	**4.5**
MGP-SB-06-6.0-8.0 MGP-SB-66-6.0-8.0	Zinc Phenanthrene Anthracene Fluoranthene Pyrene Benzo(a)anthracene Chrysene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene Dibenz(a,h)anthracene Benzo(g,h,i)perylene Total Benzofluoranthenes	**J**	The field duplicate RPD value exceeded 35%.	**Appendix A**

Note: J/UJ - Detects were qualified (J) and non-detects qualified (UJ).

II. Data affected by associated blanks are qualified and results adjusted as follows:

Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
MGP-SS-07 MGP-SS-08 MGP-SS-06 MGP-SS-02 MGP-SS-04	Phenol	900 280 97 60 79	**900 U** **280 U** **97 U** **60 U** **79 U**	µg/kg	**1.5**
MGP-SS-08	Benzoic Acid	110 J	**360 U**	µg/kg	**1.5**

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
R	The result was rejected and could not be used.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: Mingta Lin Date: *12/23/2010*

Mingta Lin, Senior Project Chemist

REFERENCES

USEPA *Test Methods for Evaluating Solid Waste (SW-846).* 3rd ed. and Revised Update IIIA. Office of Solid Waste and Emergency Response, Washington, D.C. April 1998.

USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,* Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, October 2004, USEPA 540/R-04/004.

USEPA *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review,* Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, June 2008, USEPA-540-R-08-01.

USEPA *Methods for Chemical Analysis of Water and Wastes* (*MCAWW)* USEPA/600/4-79-020, revised March 1983.

PSEP *Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound,* Puget Sound Water Quality Authority, March 1986.

PSEP *Recommended Guidelines for Measuring Organic Compounds in Puget Sound Water, Sediment and Tissue Samples,* Puget Sound Water Quality Authority, April 1997.

Washington State Department of Ecology, *Data Validation Guidance Manual for Selected Sediment Variables*, PTI, June 1989.

City of Bellingham & Puget Sound Energy, *Work Plan for South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study, Bellingham, Washington.* Herrenkohl Consulting LLC. & Landau Associates Inc., August 2010.

Appendix A

Field duplicate RPD is indicative of field and laboratory precision and sample homogeneity in combination. The precision criterion of 35% specified in the QAPP was applied to evaluating the RPD values of sediment field duplicate results ≥5xRL. For results that are <5xRL, an advisory criterion of ±2xRL was applied to evaluating the concentration differences. The RPD (or concentration difference as applicable) values and data qualification for detected compounds in field duplicates are presented as follows:

			Sample ID & Results				
Analytes	**Unit**	**RL**	**MGP-SB-06-6.0-8.0**	**MGP-SB-66-8.0-9.0**	**RPD**	**Concentration Difference**	**Data Qualification**
Total Solids	%	0.01	40.4	39.8	1%	0.6	
Total Organic Carbon	%	0.116	10	12.1	19%	-	
Arsenic	mg/kg	0.5	2.8	3.3	16%	-	
Cadmium	mg/kg	0.5	0.6	0.8	-	0.2	
Chromium	mg/kg	1	33	34	3%	-	
Copper	mg/kg	1	25	27	8%	-	
Lead	mg/kg	2	10	11	10%	-	
Mercury	mg/kg	0.05	0.12	0.14	-	0.02	
Silver	mg/kg	0.5	ND	ND	-	0	
Zinc	mg/kg	9	69	104	40%	-	**J/J**
Naphthalene	µg/kg	250	12000	16000	29%	-	
2-Methylnaphthalene	µg/kg	250	2400	2200	9%	-	
1-Methylnaphthalene	µg/kg	250	2600	2800	7%	-	
Acenaphthylene	µg/kg	250	300	360	-	60	
Acenaphthene	µg/kg	250	3900	5200	29%	-	
Fluorene	µg/kg	250	2000	2300	14%	-	
Phenanthrene	µg/kg	250	6100	8800	36%	-	**J/J**
Anthracene	µg/kg	250	3700	6000	47%	-	**J/J**
Fluoranthene	µg/kg	250	11000	17000	43%	-	**J/J**
Pyrene	µg/kg	250	11000	17000	43%	-	**J/J**
Benzo(a)anthracene	µg/kg	250	3600	6300	55%	-	**J/J**
Chrysene	µg/kg	250	3600	6500	57%	-	**J/J**
Benzo(a)pyrene	µg/kg	250	4400	7800	56%	-	**J/J**
Indeno(1,2,3-cd)pyrene	µg/kg	250	2000	3500	55%	-	**J/J**
Dibenz(a,h)anthracene	µg/kg	250	600	1100	59%	-	**J/J**
Benzo(g,h,i)perylene	µg/kg	250	2300	3900	52%	-	**J/J**
Dibenzofuran	µg/kg	250	1700	2100	21%	-	
Total Benzofluoranthenes	µg/kg	250	5100	8900	54%	-	**J/J**

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Chip Halbert

FROM: Kristi Schultz KES and Anne Halvorsen ASH

DATE: January 14, 2011

**RE: AUGUST AND SEPTEMBER 2010 SOIL SAMPLES LABORATORY DATA QUALITY EVALUATION OF BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES (BTEX) ANALYSIS
CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

This technical memorandum provides the results of a focused data validation for the analysis of 21 soil samples collected on August 17-24, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. Samples were analyzed by Analytical Resources, Inc. (ARI), located in Tukwila, Washington. This data quality evaluation covers ARI data packages SB16/SB17. Samples submitted to ARI were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) [U.S. Environmental Protection Agency (EPA) Method SW8021Mod].

Sample data were evaluated in accordance with applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999) and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl and Landau Associates 2010). The following parameters were evaluated:

- Chain-of-custody (COC) records
- Holding times
- Blank results (laboratory method)
- Surrogate recoveries
- Matrix spike/matrix spike duplicate (MS/MSD) and laboratory duplicate results
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Blind field duplicate results
- Quantitation limits
- Audit/corrective action records
- Completeness and overall data quality.

Data validation qualifiers are added to samples based on the evaluation of data quality. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below.

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CHAIN-OF-CUSTODY RECORDS

A signed COC record was attached to each data package. The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample jar information was compared to the COC and the cooler temperatures were recorded. Several coolers were received slightly below the EPA-recommended limits of 4°C±2°C. Data were not qualified based on the cooler temperature.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks. No qualification of the data is necessary.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for the various analyses. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data is necessary.

LABORATORY CONTROL SAMPLE AND LABORATORY CONTROL SAMPLE DUPLICATE RESULTS

At least one LCS and/or LCSD was analyzed with each batch of samples for each analysis. Recoveries and relative percent difference (RPD) for the LCS/LCSD samples were within the current laboratory-specified control limits with the following exceptions:

- The 8/26/10 LCSD recovery for benzene associated with the BTEX analysis in data package SB16/SB17 slightly exceeded the laboratory-specified control limits; the associated sample results were qualified as estimated (J), as indicated in Table 1.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) AND LABORATORY REPLICATE RESULTS

No matrix spike or laboratory duplicate samples were analyzed with this data package.

BLIND FIELD DUPLICATES

One pair of blind field duplicate soil samples (MGP-GP-56-7.0-8.0/MGP-GP-17-7.0-8.0) was submitted for BTEX analysis with data package SB16/SB17. A project-specified control limit of 35 percent was used to evaluate the RPDs between the duplicate soil samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exceptions:

- The RPDs for m,p-xylene and o-xylene associated with the BTEX analysis exceeded 35 percent. The results are qualified as estimated (J), as indicated in Table 1.

QUANTITATION LIMITS

Project-specified quantitation limits were met for all samples, except for instances where samples required dilutions based on high concentrations of target analytes and may have elevated reporting limits.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through field duplicates and laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

EPA. 2008. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review.* EPA-540/R-08-01. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. June.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

TABLE 1
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
BTEX SOIL SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
SB16/SB17	Benzene	3400	J	MGP-GP-34-14.0-15.0	High LCSD recovery
SB16/SB17	m,p-Xylene	20,000	J	MGP-GP-17-7.0-8.0	High field duplicate RPD
SB16/SB17	o-Xylene	11,000	J	MGP-GP-17-7.0-8.0	High field duplicate RPD
SB16/SB17	m,p-Xylene	6700	J	MGP-GP-56-7.0-8.0	High field duplicate RPD
SB16/SB17	o-Xylene	3900	J	MGP-GP-56-7.0-8.0	High field duplicate RPD

Notes

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TECHNICAL MEMORANDUM

TO: Chip Halbert

FROM: Kristi Schultz and Stacy Lane KES SL

DATE: September 7, 2011

**RE: ARCHIVED SEDIMENT SAMPLES LABORATORY DATA QUALITY EVALUATION
CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 22 sediment samples collected on August 20 and September 9, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for low level polycyclic aromatic hydrocarbons [PAHs; U.S. Environmental Protection Agency (EPA) Method SW8270D-SIM]; polychlorinated biphenyls [PCBs; Puget Sound Dredged Disposal Analysis (PSDDA) Method]; dioxins and furans (EPA Method 1613B); total metals (EPA Methods 6010B and 7470A); and total organic carbon (TOC; Method Plumb 1981). The analytical results are reported in the ARI laboratory data package identified as TD69. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA 2009), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 2004), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl Consulting and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation, including chain-of-custody records (COCs); identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria.
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that quality control samples were performed as specified in the Work Plan.
- Evaluation of sample holding times.

- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike and matrix spike duplicate results, laboratory duplicate and/or replicate results, laboratory control sample results, and blind field duplicate results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial calibration data are provided for all requested analytes and linked to the field samples reported, and that the appropriate number and concentration of initial calibration standards are present.
- Verification that continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification and continuing calibration blank standards as appropriate.
- Verification that method specific instrument performance checks are present as appropriate.
- Verification that frequency of instrument quality control samples is appropriate.
- Comparison of instrument-related quality control data to the document requirements and guidelines present in the USEPA functional guidelines for data review identified above.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage 2B verification and validation check. The results of the verification and validation check are summarized below.

LABORATORY DATA PACKAGE COMPLETENESS

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

SAMPLE CONDITIONS AND ANALYSIS

The laboratory received all samples in good condition; select samples were archived and frozen upon initial receipt. Upon client request, select samples were removed from archive and thawed for analysis; all analyses were performed as requested.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times with the following exceptions:

- Samples analyzed for mercury and TOC were analyzed in excess of 9 months outside the method-recommended hold time (28 days) due to the inability to freeze samples for these analyses to extend the hold time. The analyses were completed by the laboratory at the request of the client, knowing the hold time had been exceeded. Associated sample results have been flagged as estimated (J/UJ), as indicated in Table 2.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks with the following exception:

- Several compounds were detected above the reporting limit in the method blank associated with the dioxins/furans analysis. The samples associated with this method blank had concentrations of these compounds greater than the action level[1]. No qualification of the data is necessary.

Field Trip Blanks

No field trip blanks were submitted for analysis.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Recovery of surrogate d14-Dibenzo(a,h)anthracene associated with the PAH analysis for sample MGP-SB-12-12.5-14.0 exceeded the laboratory-specified upper control limit during the initial analysis. The results of the initial analysis also exceeded the instrument calibration range. The sample was reanalyzed at a dilution with all surrogate recoveries within control limits. The dilution results will be reported; therefore, no qualification of the data is necessary.
- Surrogate recoveries were diluted out of several samples. No qualification of the data is necessary.

[1] The action level is defined as 10 times the concentration in the blank for common volatile laboratory contaminants (methylene chloride, acetone, 2-butanone, and cyclohexane), or 5 times the concentration for other target compounds (EPA 1999).

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) AND LABORATORY REPLICATE RESULTS

A MS and a MSD or laboratory replicate sample was analyzed with the PAHs, PCBs, total metals, and TOC analyses. The recovery values for each spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

- The MS/MSD recoveries for fluoranthene and pyrene associated with the PAH analysis of sample MGP-SB-08-15.5-17.0 exceeded the laboratory-specified upper control limits; the associated sample results were qualified as estimates (J), as indicated in Table 2.
- The MS or MSD recovery for phenanthrene, anthracene, benzo(a)anthracene, chrysene, and benzo(a)pyrene associated with the PAH analysis of sample MGP-SB-08-15.5-17.0 exceeded the laboratory-specified upper control limits. However, the corresponding MSD or MS was within the laboratory-specified control limits; therefore, no qualification of the data is necessary.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the laboratory replicate results were within the current laboratory-specified control limits for all project samples with the following exceptions:

- The laboratory replicate RPD for chromium and zinc associated with the total metals analysis of sample MGP-SB-08-12.5-14.0 exceeded the laboratory-specified upper control limit. The associated sample results were qualified as estimates (J), as indicated in Table 2.

LABORATORY CONTROL SAMPLE AND LABORATORY CONTROL SAMPLE DUPLICATE RESULTS

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD and SRMs were within the current laboratory-specified control limits. No qualification of the data is necessary.

BLIND FIELD DUPLICATES

No field duplicates were submitted for analysis.

REPORTING LIMITS

The reporting limits for PAHs, total metals, and TOC in several samples were above the target reporting limits due to dilution. The reporting limit for OCDD in sample MGP-SB05-2.5-4.0 during the dioxins/furans analysis was also above the target reporting limit due to dilution. Dilution was required due to high concentrations of target analytes in the samples. A list of the samples with raised reporting limits is provided in Table 3.

INITIAL AND CONTINUING CALIBRATION

Initial and continuing calibration verifications and instrument performance and quality control checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. Laboratory-specified calibration limits for initial and continuing calibrations were met for all analyses. No qualification of the data is necessary.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through matrix spike duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

EPA. 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use.* OSWER No. 9200.1-85 EPA 540-R-08-005. U.S. Environmental Protection Agency. January.

EPA. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA-540/R-04-004. U.S. Environmental Protection Agency. Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, D.C. October.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

ATTACHMENTS

Table 1 – Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2 – Summary of Data Qualifiers
Table 3 – Target Reporting Limit Exceedances

TABLE 1
SAMPLE NAMES AND DATES OF SAMPLE COLLECTION, EXTRACTION, AND ANALYSIS
ARCHIVED SEDIMENT SAMPLING ANALYSIS
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-SB-06-8.0-9.0	TD69A	9/7/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/21-7/23/11 (PAHs)
MGP-SB-07-7.5-9.0	TD69B	9/9/10	7/14/11 (PAHs)	7/22/11 (PAHs); 7/26/11 (TOC)
MGP-SB-07-10.0-11.5	TD69C	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-07-12.5-14.0	TD69D	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-08-12.5-14.0	TD69E	9/8/10	7/13/11 (Total Metals); 7/14/11 (PAHs)	7/14-7/18 (Total Metals); 7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-08-14.0-15.5	TD69F	9/8/10	7/13/11 (Total Metals); 7/14/11 (PAHs)	7/14-7/18 (Total Metals); 7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-08-15.5-17.0	TD69G	9/8/10	7/13/11 (Total Metals); 7/14/11 (PAHs)	7/14-7/18 (Total Metals); 7/20/11 (TOC); 7/22/11 (PAHs)
MGP-SB-09-6.0-8.0	TD69H	9/7/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-09-8.0-10.0	TD69I	9/7/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-10-8.0-10.0	TD69J	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-10-12.0-14.0	TD69K	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/22-7/23/11 (PAHs)
MGP-SB-10-14.0-15.5	TD69L	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/23/11 (PAHs)
MGP-SB-11-6.0-8.0	TD69M	9/8/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/23/11 (PAHs)
MGP-SB-11-8.0-10.0	TD69N	9/8/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/23/11 (PAHs)
MGP-SB-11-12.0-14.0	TD69O	9/8/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/23/11 (PAHs)
MGP-SB-12-12.5-14.0	TD69P	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/23/11 (PAHs)
MGP-SB-12-15.0-16.5	TD69Q	9/9/10	7/14/11 (PAHs)	7/20/11 (TOC); 7/23/11 (PAHs)
MGP-SB-01-4.0-6.0	TD69R	8/20/10	7/14/11 (PCBs; Dioxins/Furans)	7/19/11 (Dioxins/Furans); 7/21/11 (PCBs)
MGP-SB-02-0-2.0	TD69S	8/20/10	7/14/11 (PCBs; Dioxins/Furans)	7/19/11 (Dioxins/Furans); 7/21/11 (PCBs)
MGP-SB-05-2.5-4.0	TD69T	9/8/10	7/14/11 (PCBs; Dioxins/Furans)	7/19/11 (Dioxins/Furans); 7/21/11 (PCBs)
MGP-SB-08-9.0-10.0	TD69U	9/8/10	7/14/11 (PCBs; Dioxins/Furans)	7/19/11 (Dioxins/Furans); 7/21/11 (PCBs)
MGP-SB-09-4.0-6.0	TD69V	9/7/10	7/14/11 (PCBs; Dioxins/Furans)	7/19/11 (Dioxins/Furans); 7/21/11 (PCBs)

TABLE 2
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
ARCHIVED SEDIMENT SAMPLING ANALYSIS

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
TD69	Fluoranthene	410	J	MGP-SB-08-15.5-17.0	High MS/MSD recovery
TD69	Pyrene	430	J	MGP-SB-08-15.5-17.0	High MS/MSD recovery
TD69	Mercury	0.21	J	MGP-SB-08-12.5-14.0	Analyzed outside method-recommended hold time
TD69	Mercury	0.06	J	MGP-SB-08-14.0-15.5	Analyzed outside method-recommended hold time
TD69	Mercury	0.02U	UJ	MGP-SB-08-15.5-17.0	Analyzed outside method-recommended hold time
TD69	Chromium	44	J	MGP-SB-08-12.5-14.0	High laboratory duplicate RPD
TD69	Zinc	66	J	MGP-SB-08-12.5-14.0	High laboratory duplicate RPD
TD69	TOC	21.1	J	MGP-SB-06-8.0-9.0	Analyzed outside method-recommended hold time
TD69	TOC	4.42	J	MGP-SB-07-7.5-9.0	Analyzed outside method-recommended hold time
TD69	TOC	13.0	J	MGP-SB-07-10.0-11.5	Analyzed outside method-recommended hold time
TD69	TOC	10.5	J	MGP-SB-07-12.5-14.0	Analyzed outside method-recommended hold time
TD69	TOC	12.6	J	MGP-SB-08-12.5-14.0	Analyzed outside method-recommended hold time
TD69	TOC	4.17	J	MGP-SB-08-14.0-15.5	Analyzed outside method-recommended hold time
TD69	TOC	0.836	J	MGP-SB-08-15.5-17.0	Analyzed outside method-recommended hold time
TD69	TOC	17.3	J	MGP-SB-09-6.0-8.0	Analyzed outside method-recommended hold time
TD69	TOC	27.2	J	MGP-SB-09-8.0-10.0	Analyzed outside method-recommended hold time
TD69	TOC	13.7	J	MGP-SB-10-8.0-10.0	Analyzed outside method-recommended hold time
TD69	TOC	47.9	J	MGP-SB-10-12.0.14.0	Analyzed outside method-recommended hold time
TD69	TOC	42.7	J	MGP-SB-10-14.0-15.5	Analyzed outside method-recommended hold time
TD69	TOC	15.2	J	MGP-SB-11-6.0-8.0	Analyzed outside method-recommended hold time
TD69	TOC	11.6	J	MGP-SB-11-8.0-10.0	Analyzed outside method-recommended hold time
TD69	TOC	11.2	J	MGP-SB-11-12.0-14.0	Analyzed outside method-recommended hold time
TD69	TOC	53.6	J	MGP-SB-12-12.5-14.0	Analyzed outside method-recommended hold time
TD69	TOC	71.5	J	MGP-SB-12-15.0-16.5	Analyzed outside method-recommended hold time

Notes
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

TABLE 3
TARGET REPORTING LIMIT EXCEEDANCES
ARCHIVED SEDIMENT SAMPLING ANALYSIS
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-SB-08-12.5-14.0	TD69E	Arsenic	0.2 mg/kg	13 mg/kg	13U mg/kg
MGP-SB-08-12.5-14.0	TD69E	Silver	0.2 mg/kg	0.8 mg/kg	0.8U mg/kg
MGP-SB-08-14.0-15.5	TD69F	Silver	0.2 mg/kg	0.5 mg/kg	0.5U mg/kg
MGP-SB-08-15.5-17.0	TD69G	Arsenic	0.2 mg/kg	6.3 mg/kg	6.3U mg/kg
MGP-SB-08-15.5-17.0	TD69G	Cadmium	0.2 mg/kg	0.3 mg/kg	0.3U mg/kg
MGP-SB-08-15.5-17.0	TD69G	Silver	0.2 mg/kg	0.4 mg/kg	0.4U mg/kg

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Chip Halbert

FROM: Kristi Schultz and Stacy Lane KES SJL

DATE: September 7, 2011

RE: ARCHIVED SOIL SAMPLES LABORATORY DATA QUALITY EVALUATION CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT REMEDIAL INVESTIGATION/FEASIBILITY STUDY

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 13 soil samples collected between August 16 and 20, 2010 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for low level carcinogenic polycyclic aromatic hydrocarbons [cPAHs; U.S. Environmental Protection Agency (EPA) Method SW8270D-SIM]. The analytical results are reported in the ARI laboratory data package identified as TD68. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA 2009), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl Consulting and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation, including chain-of-custody records (COCs); identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria.
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that quality control samples were performed as specified in the Work Plan.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike and matrix spike duplicate results, laboratory duplicate and/or replicate results, laboratory control sample results, and blind field duplicate results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.

- Verification that initial calibration data are provided for all requested analytes and linked to the field samples reported, and that the appropriate number and concentration of initial calibration standards are present.
- Verification that continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification and continuing calibration blank standards as appropriate.
- Verification that method specific instrument performance checks are present as appropriate.
- Verification that frequency of instrument quality control samples is appropriate.
- Comparison of instrument-related quality control data to the document requirements and guidelines present in the USEPA functional guidelines for data review identified above.

If appropriate, data validation qualifiers are added to the sample results; however, based on this Stage 2B verification and validation check, no qualification of the data was determined necessary. The results of the verification and validation check are summarized below.

LABORATORY DATA PACKAGE COMPLETENESS

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

SAMPLE CONDITIONS AND ANALYSIS

The laboratory received all samples in good condition; select samples were archived and frozen upon initial receipt. Upon client request, select samples were removed from archive and thawed for analysis; all analyses were performed as requested.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks. No qualification of the data was necessary.

Field Trip Blanks

No field trip blanks were submitted for analysis.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the exception of surrogate recoveries being diluted out of several samples. No qualification of the data is necessary.

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) and Laboratory Replicate Results

A MS and a MSD were analyzed with the cPAHs analysis. The recovery values for each spiking compound were within the laboratory-specified control limits. No qualification of the data is necessary.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the MS/MSD, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the MS/MSD results were within the current laboratory-specified control limits. No qualification of the data is necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

One LCS/LCSD sample was analyzed with the batch of samples. Recoveries and RPDs for the LCS/LCSD were within the current laboratory-specified control limits. No qualification of the data is necessary.

Blind Field Duplicates

No field duplicates were submitted for analysis.

Reporting Limits

Target reporting limits were achieved for all non-detected results.

Initial and Continuing Calibration

Initial and continuing calibration verifications and instrument performance and quality control checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. Laboratory-specified calibration limits for initial and continuing calibrations were met for all analyses. No qualification of the data is necessary.

Completeness and Overall Data Quality

Data precision was evaluated through matrix spike duplicates and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

References

EPA. 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use.* OSWER No. 9200.1-85 EPA 540-R-08-005. U.S. Environmental Protection Agency. January.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

Attachments

Table 1 – Sample Names and Dates of Sample Collection, Extraction, and Analysis

TABLE 1
SAMPLE NAMES AND DATES OF SAMPLE COLLECTION, EXTRACTION, AND ANALYSIS
ARCHIVED SOIL SAMPLING ANALYSIS
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-GP-11-3.0-4.0	TD68A	8/16/10 (thawed as of 7/8/11)	7/14/11	7/21/11
MGP-GP-17-3.0-4.0	TD68B	8/17/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-23-9.0-10.0	TD68C	8/17/10 (thawed as of 7/8/11)	7/14/11	7/21/11-7/22/11
MGP-GP-25-6.0-7.0	TD68D	8/18/10 (thawed as of 7/8/11)	7/14/11	7/21/11
MGP-GP-27-6.0-7.0	TD68E	8/19/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-29-9.0-10.0	TD68F	8/19/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-37-14.0-15.0	TD68G	8/20/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-38-12.0-13.0	TD68H	8/19/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-39-8.0-9.0	TD68I	8/20/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-39-14.0-15.0	TD68J	8/20/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-40-14.0-15.0	TD68K	8/20/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-34-7.0-8.0	TD68L	8/20/10 (thawed as of 7/8/11)	7/14/11	7/22/11
MGP-GP-34-9.0-10.0	TD68M	8/20/10 (thawed as of 7/8/11)/11	7/14/11	7/22/11

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Chip Halbert

KES SgL

FROM: Kristi Schultz and Stacy Lane

DATE: October 5, 2011

**RE: MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLES LABORATORY DATA QUALITY EVALUATION
CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 14 groundwater samples and 3 surface water samples collected on March 22, 23, and 30, 2011 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for volatile organic compounds (VOCs) [U.S. Environmental Protection Agency (EPA) Method SW8260C]; semivolatile organic compounds (SVOCs) (EPA Method SW8270D); low level carcinogenic polycyclic aromatic hydrocarbons (cPAHs; EPA Method SW8270D-SIM); diesel- and oil-range petroleum hydrocarbons [TPH-D and TPH-O; Washington State Department of Ecology (Ecology) Method NWTPH-Dx]; gasoline-range petroleum hydrocarbons (TPH-G; Ecology Method NWTPH-Gx); benzene, toluene, ethylbenzene, and xylenes (BTEX; Modified EPA Method SW8021B); total and dissolved metals (EPA Methods 200.8, 6010B, and 7470A); and conventionals, including total suspended solids (TSS) (EPA Method 160.2), total dissolved solids (TDS) (EPA Method 160.1), salinity (SM 2520B), conductivity (EPA Method 120.1), total cyanide (EPA Method 335.4), weak acid dissociable (WAD) cyanide (SM 4500CN-I), and total organic carbon (TOC) and dissolved organic carbon (DOC) (EPA Method 415.1). Hardness was also calculated using the analytical results for the total and dissolved metals. The analytical results are reported in ARI laboratory data packages identified as SO46, SO63/SO66, and SP77/SP80. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA 2009), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 2004), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl Consulting and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation, including chain-of-custody records (COCs); identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria.
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that quality control samples were performed as specified in the Work Plan.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike and matrix spike duplicate results, laboratory duplicate and/or replicate results, laboratory control sample results, and blind field duplicate results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial calibration data are provided for all requested analytes and linked to the field samples reported, and that the appropriate number and concentration of initial calibration standards are present.
- Verification that continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification and continuing calibration blank standards as appropriate.
- Verification that method specific instrument performance checks are present as appropriate.
- Verification that frequency of instrument quality control samples is appropriate.
- Comparison of instrument-related quality control data to the document requirements and guidelines present in the USEPA functional guidelines for data review identified above.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage 2B verification and validation check. The results of the verification and validation check are summarized below.

LABORATORY DATA PACKAGE COMPLETENESS

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

SAMPLE CONDITIONS AND ANALYSIS

The laboratory received all samples in good condition, and all analyses were performed as requested with the following exception:

- The laboratory noted in data package SO63/SO66, the COC requested analysis for cPAHs for sample MGP-GW-MW-44; however, no sample container was submitted for the analysis because of limited groundwater availability from this location. The sample was therefore not analyzed for cPAHs.

Upon receipt by ARI, the sample container information was compared to the associated COC and the cooler temperatures were recorded. Seven of the ten coolers containing samples were received at the laboratory with temperatures of slightly below the EPA-recommended limit of 4°C±2°C (1.1°C, 1.5°C, 1.6°C, 1.8°C, 1.8°C, 1.8°C, and 1.9°C). No qualification was determined necessary due to the slightly low cooler temperatures.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks. No qualification of the data was necessary.

Field Trip Blanks

Trip blanks were submitted for VOC analysis with data packages SO46 and SO63/SO66 and for gasoline-range petroleum hydrocarbon analysis with data packages SO46, SO63/SO66, and SP77/SP80. No contamination was detected in any of the trip blanks. No qualification of the data was necessary.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Recovery of the surrogate d10-2-methylnaphthalene associated with the cPAH analyses for sample MGP-GW-MW-07 reported in data package SO63 exceeded the laboratory-specified upper control limit. However, the data was not qualified because the USEPA functional guidelines for data quality require two or more surrogates of the same fraction to be out of control limits to qualify SVOC results.

- The recovery of the surrogate associated with the 4/1/11 TPH-G continuing calibration (CCAL) in data package SP77/SP80 exceeded the laboratory-specified upper control limit. All other quality control and sample surrogate recoveries were in control; therefore, no qualification of the data is necessary.

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) AND LABORATORY REPLICATE RESULTS

A MS and a MSD or laboratory duplicate sample was analyzed with the VOCs, SVOCs, cPAHs, TPH-G and BTEX, TPH-D and TPH-O, total metals, dissolved metals, and conventionals analyses in one or more data package. The recovery values for each spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

- The MS recovery for 4-nitroaniline associated with the SVOCs analysis of sample MGP-GW-MW-40 included in data package SO46 exceeded the laboratory-specified upper control limit. 4-Nitroaniline was not detected in the associated sample; therefore, no qualification of the data is necessary.
- The MS/MSD recoveries for chloromethane, bromomethane, cis-1,3-dichloropropene, styrene, and acrolein associated with the VOCs analysis of sample MGP-GW-MW-40 included in data package SO46 were below the laboratory-specified lower control limits; the associated sample results were qualified as estimates (UJ), as indicated in Table 2.
- The MS/MSD recoveries for carbon disulfide associated with the VOCs analysis of sample MGP-GW-MW-40 included in data package SO46 exceeded the laboratory-specified upper control limit; the associated sample result was qualified as an estimate (J), as indicated in Table 2.
- The MS/MSD recoveries for 2-chloroethylvinylether associated with the VOCs analysis of sample MGP-GW-MW-40 included in data package SO46 were not calculated because this compound was not detected in the MS/MSD samples; no qualification of the data was determined necessary.
- The MS/MSD recoveries for vinyl chloride, vinyl acetate, 4-methyl-2-pentanone, 2-hexanone, and 1,2-dibromo-3-chloropropane associated with the VOCs analysis of sample MGP-GW-MW-40 included in data package SO46 exceeded the laboratory-specified upper control limits; these compounds were not detected in the associated sample; therefore, no qualification of the data is necessary.
- The MS or MSD recovery for chloroethane, 1,1-dichloroethene, trans-1,3-dichloropropene, methyl iodide, and methyl tert-butyl ether associated with the VOCs analysis for sample MGP-GW-MW-40 in data package SO46 exceeded the laboratory-specified upper control limits. However, the corresponding MSD or MS was within the laboratory-specified control limits; therefore, no qualification of the data is necessary.
- The MS/MSD recoveries for benzene, toluene, and o-xylene associated with the BTEX analysis for sample MGP-GW-MW-40 included in data package SO46 exceeded the laboratory-specified upper control limits. These compounds were not detected in the associated sample; therefore, no qualification of the data is necessary.
- The MS recovery for selenium associated with the total metals analysis of sample MGP-GW-MW-40 included in data package SO46 was below the laboratory-specified lower

control limit; the associated sample result was qualified as estimated (J), as indicated in Table 2.

- The MS recovery for WAD cyanide associated with the conventionals analysis of sample MGP-GW-MW-40 included in data package SO46 was below the laboratory-specified lower control limit; the associated sample result was qualified as estimated (UJ), as indicated in Table 2.
- The MS recovery for antimony associated with the total metals analysis of sample MGP-SW-02 included in data package SP77/SP80 was below the laboratory-specified lower control limit; the associated sample result was qualified as estimated (J), as indicated in Table 2.
- The MS recovery for n-nitrosodiphenylamine associated with the SVOCs analysis for sample MGP-SW-02 included in data package SP77/SP80 was below the laboratory-specified lower control limit; the associated sample result was qualified as estimated (UJ), as indicated in Table 2.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the laboratory replicate results were within the current laboratory-specified control limits for all project samples with the following exceptions:

- The MS/MSD RPD for 3,3'-dichlorobenzidine associated with the SVOCs analysis of sample MGP-GW-MW-40 included in data package SO46 exceeded the laboratory-specified upper control limit. 3,3'-dichlorobenzidine was not detected in the associated sample; therefore, no qualification of the data is necessary.
- The MS/MSD RPD for bromomethane, cis-1,3-dichloropropane, trans-1,3-dichloropropene, styrene, methyl iodide, and 2,2-dichloropropane associated with the VOCs analysis of sample MGP-GW-MW-40 included in data package SO46 exceeded the laboratory-specified upper control limit. These compounds were not detected in the associated sample; therefore, no qualification of the data is necessary.
- The MS/MSD RPD for 2-chloroethylvinylether associated with the VOCs analysis of sample MGP-GW-MW-40 included in data package SO46 was not calculated because this compound was not detected in the MS/MSD samples. No qualification of the data is necessary.
- The MS/MSD RPD for acrolein associated with the VOCs analysis of sample MGP-GW-MW-40 in data package SO46 was not calculated because this compound was not detected in the MS sample. No qualification of the data is necessary.

LABORATORY CONTROL SAMPLE AND LABORATORY CONTROL SAMPLE DUPLICATE RESULTS

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD and SRMs were within the current laboratory-specified control limits with the following exceptions:

- The 3/24/11 LCS/LCSD recoveries for bromoform associated with the VOCs analyses reported in data package SO46 were below the laboratory-specified lower control limit. The associated sample results were qualified as estimated (UJ), as indicated in Table 2.
- The 3/25/11 and 3/28/11 LCS/LCSD recoveries for 2-chloroethylvinylether associated with the VOCs analyses reported in data package SO63/SO66 were below the laboratory-specified lower control limit. The associated sample results were qualified as estimated (UJ), as indicated in Table 2.
- The 3/25/11 LCS/LCSD recovery for 2,2-dichloropropane and the 3/28/11 LCS/LCSD recoveries for 2,2-dichloropropane and 2-hexanone associated with the VOCs analysis in data package SO63/SO66 exceeded the laboratory-specified upper control limits. These compounds were not detected in the associated samples; therefore, no qualification of the data is necessary.
- The LCS/LCSD RPD for 2,4-dinitrophenol associated with the SVOC analyses reported in data package SO63/SO66 exceeded the laboratory-specified upper control limit. 2,4-dinitrophenol was not detected in the associated sample result; therefore, no qualification of the data is necessary.

BLIND FIELD DUPLICATES

One pair of blind field duplicate groundwater samples (MGP-GW-MW-34/MGP-GW-MW-64) was submitted for analysis with data package SO63/SO66 and analyzed for SVOCs, cPAHs, TPH-D and TPH-O, total and dissolved metals, and TDS. One pair of blind field duplicate surface water samples (MGP-SW-01/MGP-SW-04) was submitted for analysis with data package SP77/SP80 and analyzed for SVOCs, cPAHs, TPH-D and TPH-O, BTEX, TPH-G, total metals, TSS, and TOC.

A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate water samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exception:

- The RPDs for benzo(a)pyrene and total benzofluoranthenes associated with the cPAHs analysis of the blind field duplicate pair MGP-GW-MW-34/MGP-GW-MW-64 exceeded the project-specified control limit. The results are qualified as estimates (J), as indicated in Table 2.
- The RPD for total benzofluoranthenes associated with the cPAHs analysis of the blind field duplicate pair MGP-SW-01/MGP-SW-04 exceeded the project-specified control limit. The results are qualified as estimates (J), as indicated in Table 2.

REPORTING LIMITS

The reporting limits for VOCs in several samples were above the target reporting limits due to dilution. Dilution was required due to high concentrations of benzene and naphthalene in the samples.

During revisions to the project Work Plan (Herrenkohl Consulting and Landau Associates 2010), it was agreed that VOCs would be analyzed using EPA Method 8260, not EPA Method 8260-SIM. The target quantitation limits in Table C-2 do not reflect that update for two chemicals: vinyl chloride and 1,1-dichloroethene. The laboratory reporting limits achieved for these analytes are consistent with target reporting limits for EPA Method 8260 and are not considered a deviation from the Work Plan.

A list of the samples with raised reporting limits is provided in Table 3.

INITIAL AND CONTINUING CALIBRATION

Initial and continuing calibration verifications and instrument performance and quality control checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. Laboratory-specified calibration limits for initial and continuing calibrations were met for all analyses, except for the following:

- The SVOC initial calibrations for analyses reported in data packages SO46, SO63/SO66, and SP77/SP80 were high for benzidine and the continuing calibrations (CCALs) for benzidine were low. Benzidine was not a requested compound for analysis; therefore no qualification of the data is necessary.
- The SVOC CCALs for analyses reported in data packages SO46, SO63/SO66, and SP77/SP80 were low for 2,4-dinitrophenol; the associated sample results were qualified as estimates (UJ), as indicated in Table 1.
- The TPH-D and TPH-O CCALs for analyses reported in data packages SO46, SO63/SO66, and SP77/SP80 were high for AK Motor Oil. AK Motor Oil was not a requested compound for analysis; therefore no qualification of the data is necessary.
- The 3/25/11 and 3/28/11 VOC CCALs for analyses reported in data package SO63/SO66 were high for 2,2-dichloropropane. This compound was not detected in the associated samples; therefore no qualification of the data is necessary.
- The 3/25/11 VOC CCAL for analyses reported in data package SO63/SO66 was low for 2-chloroethylvinylether and the 3/28/11 VOC CCAL was low for 2-chloroethylvinylether and acetone; the associated sample results were qualified as estimated (UJ), as indicated in Table 1.
- The 3/28/11 VOC CCAL for analyses reported in data package SO63/SO66 was high for dichlorofluoromethane. Dichlorofluoromethane was not a requested compound for analysis; therefore no qualification of the data is necessary.
- The BTEX CCALs in data packages SO46 and SO63/SO66 were low for methyl tert-butyl ether. Methyl tert-butyl ether was not a requested compound for analysis; therefore no qualification of the data is necessary.
- The VOC CCAL for analyses reported in data package SO46 was low for bromoform; the associated sample results were qualified as estimated (UJ), as indicated in Table 1.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through blind field duplicate samples, matrix spike duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

EPA. 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use.* OSWER No. 9200.1-85 EPA 540-R-08-005. U.S. Environmental Protection Agency. January.

EPA. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA-540/R-04-004. U.S. Environmental Protection Agency. Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, D.C. October.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

ATTACHMENTS

Table 1 – Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2 – Summary of Data Qualifiers
Table 3 – Target Reporting Limit Exceedances

TABLE 1
SAMPLE NAMES AND DATES OF SAMPLE COLLECTION, EXTRACTION, AND ANALYSIS
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-GW-MW-31	SO46A	3/22/11	3/24/11	3/24/11 (VOCs, TDS); 3/25/11 (SVOCs, cPAHs, TPH-D and TPH-O, TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide)
MGP-GW-MW-40	SO46B	3/22/11	3/24/11	3/24/11 (VOCs, TDS, TOC, DOC); 3/25/11 (SVOCs, cPAHs, TPH-D and TPH-O, TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide)
MGP-GW-MW-45	SO46C	3/22/11	3/24/11	3/24/11 (VOCs, TDS); 3/25/11 (SVOCs, cPAHs, TPH-D and TPH-O, TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide)
MGP-GW-MW-38	SO63A	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS, DOC), 3/25/11 (VOCs, TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide, TOC), 3/28/11 (SVOCs, cPAHs, TPH-D and TPH-O, total and dissolved metals)
MGP-GW-MW-24	SO63B	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS), 3/25/11 (VOCs, TPH-G, BTEX, total and dissolved metals, total and WAD cyanide), 3/28/11 (SVOCs, cPAHs, TPH-D and TPH-O, total and dissolved metals)
MGP-GW-MW-19	SO63C	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS), 3/25/11 (VOCs, TPH-G, BTEX, total and dissolved metals, total and WAD cyanide), 3/28/11 (SVOCs, TPH-D and TPH-O, total and dissolved metals), 3/29/11 (cPAHs)
MGP-GW-MW-34	SO63D	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS, TOC, DOC), 3/25/11 (TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide), 3/28/11 (SVOCs, VOCs, TPH-D and TPH-O, total and dissolved metals), 3/29/11 (cPAHs)
MGP-GW-MW-42	SO63E	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs). 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS, TOC, DOC), 3/25/11 (TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide), 3/28/11 (SVOCs, VOCs, TPH-D and TPH-O, total and dissolved metals), 3/29/11 (cPAHs)
MGP-GW-MW-36	SO63F	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS, TOC, DOC), 3/25/11 (VOCs, TPH-G, BTEX, total and dissolved metals, conductivity, salinity, total and WAD cyanide), 3/28/11 (SVOCs, TPH-D and TPH-O, total and dissolved metals), 3/29/11 (cPAHs)
MGP-GW-MW-64	SO63G	3/23/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS), 3/25/11 (total and dissolved metals), 3/28/11 (SVOCs, TPH-D and TPH-O, total and dissolved metals), 3/29/11 (cPAHs)
MGP-GW-MW-44	SO66A	3/24/11		3/25/11 (VOCs, TPH-G, BTEX)
MGP-GW-MW-07	SO66B	3/24/11	3/25/11 (cPAHs)	3/25/11 (TPH-G, BTEX), 3/28/11 (VOCs), 3/29/11 (cPAHs)

TABLE 1
SAMPLE NAMES AND DATES OF SAMPLE COLLECTION, EXTRACTION, AND ANALYSIS
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-GW-MW-29	SO66C	3/24/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS), 3/25/11 (VOCs, TPH-G, BTEX, total and dissolved metals, conductivity, salinity), 3/28/11 (SVOCs, TPH-D and TPH-O, total and dissolved metals, total and WAD cyanide), 3/29/11 (cPAHs)
MGP-GW-MW-28	SO66D	3/24/11	3/25/11 (cPAHs, total and dissolved metals), 3/26/11 (SVOCs), 3/28/11 (TPH-D and TPH-O)	3/24/11 (TDS), 3/25/11 (TPH-G, BTEX, total and dissolved metals, conductivity, salinity), 3/28/11 (SVOCs, VOCs, TPH-D and TPH-O, total and dissolved metals, total and WAD cyanide), 3/29/11 (cPAHs)
MGP-SW_02	SP77A	3/30/11	4/1/11 (TPH-D and TPH-O, total metals), 4/2/11 (SVOCs); 4/4/11 (cPAHs, total metals)	4/1/11 (TPH-G, BTEX, TSS, TOC), 4/4/11 (SVOCs, cPAHs, TPH-D and TPH-O, total metals), 4/5/11 (total metals)
MGP-SW-01	SP80A	3/31/11	4/1/11 (TPH-D and TPH-O, total metals), 4/2/11 (SVOCs); 4/4/11 (cPAHs, total metals)	4/1/11 (TPH-G, BTEX, TSS, TOC), 4/4/11 (SVOCs, cPAHs, TPH-D and TPH-O, total metals), 4/5/11 (total metals)
MGP-SW-04	SP80B	3/31/11	4/1/11 (TPH-D and TPH-O, total metals), 4/2/11 (SVOCs); 4/4/11 (cPAHs, total metals)	4/1/11 (TPH-G, BTEX, TSS, TOC), 4/4/11 (SVOCs, cPAHs, TPH-D and TPH-O, total metals), 4/5/11 (total metals)

TABLE 2
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
GROUNDWATER AND SURFACE WATER SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
SO46	Bromoform	0.2U	UJ	MGP-GP-MW-31	Low LCS/LCSD recovery; low continuing calibration recovery
SO46	Bromoform	0.2U	UJ	MGP-GP-MW-40	Low LCS/LCSD recovery; low continuing calibration recovery
SO46	Bromoform	0.2U	UJ	MGP-GP-MW-45	Low LCS/LCSD recovery; low continuing calibration recovery
SO46	Chloromethane	0.5U	UJ	MGP-GP-MW-40	Low MS/MSD recovery
SO46	Bromomethane	1.0U	UJ	MGP-GP-MW-40	Low MS/MSD recovery
SO46	Carbon Disulfide	1.3	J	MGP-GP-MW-40	High MS/MSD recovery
SO46	cis-1,3-Dichloropropene	0.2U	UJ	MGP-GP-MW-40	Low MS/MSD recovery
SO46	Styrene	0.2U	UJ	MGP-GP-MW-40	Low MS/MSD recovery
SO46	Acrolein	5.0U	UJ	MGP-GP-MW-40	Low MS/MSD recovery
SO46	2,4-Dinitrophenol	10U	UJ	MGP-GP-MW-31	Low continuing calibration recovery
SO46	2,4-Dinitrophenol	10U	UJ	MGP-GP-MW-40	Low continuing calibration recovery
SO46	2,4-Dinitrophenol	10U	UJ	MGP-GP-MW-45	Low continuing calibration recovery
SO46	Selenium	0.1	J	MGP-GP-MW-40	Low MS recovery
SO46	WAD Cyanide	0.005U	UJ	MGP-GP-MW-40	Low MS recovery
SO63/SO66	2-Chloroethylvinylether	1.0U	UJ	MGP-GW-MW-38	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	200U	UJ	MGP-GW-MW-24	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	1.0U	UJ	MGP-GW-MW-19	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	1.0U	UJ	MGP-GW-MW-34	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	1.0U	UJ	MGP-GW-MW-42	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	1.0U	UJ	MGP-GW-MW-36	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	200U	UJ	MGP-GW-MW-44	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	50U	UJ	MGP-GW-MW-07	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	1.0U	UJ	MGP-GW-MW-29	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	2-Chloroethylvinylether	100U	UJ	MGP-GW-MW-28	Low LCS/LCSD recovery; low continuing calibration recovery
SO63/SO66	Acetone	5.0U	UJ	MGP-GW-MW-34	Low continuing calibration recovery
SO63/SO66	Acetone	5.0U	UJ	MGP-GW-MW-42	Low continuing calibration recovery
SO63/SO66	Acetone	250U	UJ	MGP-GW-MW-07	Low continuing calibration recovery
SO63/SO66	Acetone	500U	UJ	MGP-GW-MW-28	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-38	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-24	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-19	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-34	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-42	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-36	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-64	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-29	Low continuing calibration recovery
SO63/SO66	2,4-Dinitrophenol	10U	UJ	MGP-GW-MW-28	Low continuing calibration recovery
SO63/SO66	Benzo(a)pyrene	0.015	J	MGP-GW-MW-34	High field duplicate RPD
SO63/SO66	Benzo(a)pyrene	0.030	J	MGP-GW-MW-64	High field duplicate RPD
SO63/SO66	Total Benzofluoranthenes	0.016	J	MGP-GW-MW-34	High field duplicate RPD
SO63/SO66	Total Benzofluoranthenes	0.030	J	MGP-GW-MW-64	High field duplicate RPD
SP77/SP80	2,4-Dinitrophenol	10U	UJ	MGP-SW-02	Low continuing calibration recovery
SP77/SP80	2,4-Dinitrophenol	10U	UJ	MGP-SW-01	Low continuing calibration recovery
SP77/SP80	2,4-Dinitrophenol	10U	UJ	MGP-SW-04	Low continuing calibration recovery
SP77/SP80	N-Nitrosodiphenylamine	1.0U	UJ	MGP-SW-02	Low MS recovery
SP77/SP80	Antimony	0.3	J	MGP-SW-02	Low MS recovery
SP77/SP80	Total Benzofluoranthenes	0.075	J	MGP-SW-01	High field duplicate RPD
SP77/SP80	Total Benzofluoranthenes	0.19	J	MGP-SW-04	High field duplicate RPD

Notes

J = Indicates the analyte was positively identified; the associated numerical value is the approximat concentration of the analyte in the sample

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate

TABLE 3
TARGET REPORTING LIMIT EXCEEDANCES
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-24	SO63B	Chloromethane	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-24	SO63B	Bromomethane	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-24	SO63B	Vinyl Chloride	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Chloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Methylene Chloride	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-24	SO63B	Acetone	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-24	SO63B	Carbon Disulfide	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,1-Dichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,1-Dichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	trans-1,2-Dichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	cis-1,2-Dichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Chloroform	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,2-Dichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	2-Butanone	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-24	SO63B	1,1,1-Trichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Carbon Tetrachloride	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Vinyl Acetate	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-24	SO63B	Bromodichloromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,2-Dichloropropane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	cis-1,3-Dichloropropene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Trichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Dibromochloromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,1,2-Trichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	trans-1,3-Dichloropropene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	2-Chloroethylvinylether	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-24	SO63B	Bromoform	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	4-Methyl-2-Pentanone (MIBK)	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-24	SO63B	2-Hexanone	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-24	SO63B	Tetrachloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,1,2,2-Tetrachloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Chlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Trichlorofluoromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,1,2-Trichloro-1,2,2-trifluoroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,2-Dichlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,3-Dichlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,4-Dichlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Acrolein	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-24	SO63B	Methyl Iodide	0.2 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-24	SO63B	Bromoethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Acrylonitrile	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-24	SO63B	1,1-Dichloropropene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Dibromomethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,1,1,2-Tetrachloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,2-Dibromo-3-chloropropane	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-24	SO63B	1,2,3-Trichloropropane	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-24	SO63B	trans-1,4-Dichloro-2-butene	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-24	SO63B	Ethylene Dibromide	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Bromochloromethane	0.2 µg/L	40 µg/L	40U µg/L

TABLE 3
TARGET REPORTING LIMIT EXCEEDANCES
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-24	SO63B	2,2-Dichloropropane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,3-Dichloropropane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Isopropylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	n-Propylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	Bromobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	2-Chlorotoluene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	4-Chlorotoluene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	tert-Butylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	sec-Butylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	4-Isopropyltoluene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	n-Butylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-24	SO63B	1,2,4-Trichlorobenzene	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-24	SO63B	1,2,3-Trichlorobenzene	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	Chloromethane	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	Bromomethane	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-44	SO66A	Vinyl Chloride	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Chloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Methylene Chloride	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	Acetone	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-44	SO66A	Carbon Disulfide	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,1-Dichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,1-Dichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	trans-1,2-Dichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	cis-1,2-Dichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Chloroform	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,2-Dichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	2-Butanone	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-44	SO66A	1,1,1-Trichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Carbon Tetrachloride	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Vinyl Acetate	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-44	SO66A	Bromodichloromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,2-Dichloropropane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	cis-1,3-Dichloropropene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Trichloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Dibromochloromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,1,2-Trichloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	trans-1,3-Dichloropropene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	2-Chloroethylvinylether	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-44	SO66A	Bromoform	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	4-Methyl-2-Pentanone (MIBK)	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-44	SO66A	2-Hexanone	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-44	SO66A	Tetrachloroethene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,1,2,2-Tetrachloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Chlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Styrene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Trichlorofluoromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,1,2-Trichloro-1,2,2-trifluoroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,2-Dichlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,3-Dichlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,4-Dichlorobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Acrolein	5.0 µg/L	1000 µg/L	1000U µg/L
MGP-GW-MW-44	SO66A	Methyl Iodide	0.2 µg/L	200 µg/L	200U µg/L

TABLE 3
TARGET REPORTING LIMIT EXCEEDANCES
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-44	SO66A	Bromoethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Acrylonitrile	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-44	SO66A	1,1-Dichloropropene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Dibromomethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,1,1,2-Tetrachloroethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,2-Dibromo-3-chloropropane	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	1,2,3-Trichloropropane	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	trans-1,4-Dichloro-2-butene	1.0 µg/L	200 µg/L	200U µg/L
MGP-GW-MW-44	SO66A	Hexachlorobutadiene	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	Ethylene Dibromide	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Bromochloromethane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	2,2-Dichloropropane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,3-Dichloropropane	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Isopropylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	n-Propylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	Bromobenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	2-Chlorotoluene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	4-Chlorotoluene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	tert-Butylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	sec-Butylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	4-Isopropyltoluene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	n-Butylbenzene	0.2 µg/L	40 µg/L	40U µg/L
MGP-GW-MW-44	SO66A	1,2,4-Trichlorobenzene	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-44	SO66A	1,2,3-Trichlorobenzene	0.5 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-07	SO66B	Chloromethane	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-07	SO66B	Bromomethane	1.0 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-07	SO66B	Vinyl Chloride	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Chloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Methylene Chloride	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-07	SO66B	Acetone	5.0 µg/L	250 µg/L	250U µg/L
MGP-GW-MW-07	SO66B	Carbon Disulfide	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,1-Dichloroethene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,1-Dichloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	trans-1,2-Dichloroethene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	cis-1,2-Dichloroethene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Chloroform	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,2-Dichloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	2-Butanone	5.0 µg/L	250 µg/L	250U µg/L
MGP-GW-MW-07	SO66B	1,1,1-Trichloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Carbon Tetrachloride	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Vinyl Acetate	1.0 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-07	SO66B	Bromodichloromethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,2-Dichloropropane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	cis-1,3-Dichloropropene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Trichloroethene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Dibromochloromethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,1,2-Trichloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	trans-1,3-Dichloropropene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	2-Chloroethylvinylether	1.0 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-07	SO66B	Bromoform	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	4-Methyl-2-Pentanone (MIBK)	5.0 µg/L	250 µg/L	250U µg/L

TABLE 3
TARGET REPORTING LIMIT EXCEEDANCES
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-07	SO66B	2-Hexanone	5.0 µg/L	250 µg/L	250U µg/L
MGP-GW-MW-07	SO66B	Tetrachloroethene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,1,2,2-Tetrachloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Chlorobenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Styrene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Trichlorofluoromethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,1,2-Trichloro-1,2,2-trifluoroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,2-Dichlorobenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,3-Dichlorobenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,4-Dichlorobenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Acrolein	5.0 µg/L	250 µg/L	250U µg/L
MGP-GW-MW-07	SO66B	Methyl Iodide	0.2 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-07	SO66B	Bromoethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Acrylonitrile	1.0 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-07	SO66B	1,1-Dichloropropene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Dibromomethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,1,1,2-Tetrachloroethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,2-Dibromo-3-chloropropane	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-07	SO66B	1,2,3-Trichloropropane	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-07	SO66B	trans-1,4-Dichloro-2-butene	1.0 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-07	SO66B	Hexachlorobutadiene	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-07	SO66B	Ethylene Dibromide	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Bromochloromethane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	2,2-Dichloropropane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,3-Dichloropropane	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	n-Propylbenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	Bromobenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	2-Chlorotoluene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	4-Chlorotoluene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	tert-Butylbenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	sec-Butylbenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	4-Isopropyltoluene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	n-Butylbenzene	0.2 µg/L	10 µg/L	10U µg/L
MGP-GW-MW-07	SO66B	1,2,4-Trichlorobenzene	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-07	SO66B	1,2,3-Trichlorobenzene	0.5 µg/L	25 µg/L	25U µg/L
MGP-GW-MW-28	SO66D	Chloromethane	0.5 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-28	SO66D	Bromomethane	1.0 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-28	SO66D	Vinyl Chloride	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Chloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Methylene Chloride	0.5 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-28	SO66D	Acetone	5.0 µg/L	500 µg/L	500U µg/L
MGP-GW-MW-28	SO66D	Carbon Disulfide	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,1-Dichloroethene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,1-Dichloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	trans-1,2-Dichloroethene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	cis-1,2-Dichloroethene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Chloroform	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,2-Dichloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	2-Butanone	5.0 µg/L	500 µg/L	500U µg/L
MGP-GW-MW-28	SO66D	1,1,1-Trichloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Carbon Tetrachloride	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Vinyl Acetate	1.0 µg/L	100 µg/L	100U µg/L

TABLE 3
TARGET REPORTING LIMIT EXCEEDANCES
MARCH 2011 GROUNDWATER AND SURFACE WATER SAMPLING
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-28	SO66D	Bromodichloromethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,2-Dichloropropane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	cis-1,3-Dichloropropene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Trichloroethene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Dibromochloromethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,1,2-Trichloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	trans-1,3-Dichloropropene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	2-Chloroethylvinylether	1.0 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-28	SO66D	Bromoform	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	4-Methyl-2-Pentanone (MIBK)	5.0 µg/L	500 µg/L	500U µg/L
MGP-GW-MW-28	SO66D	2-Hexanone	5.0 µg/L	500 µg/L	500U µg/L
MGP-GW-MW-28	SO66D	Tetrachloroethene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,1,2,2-Tetrachloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Chlorobenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Trichlorofluoromethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,1,2-Trichloro-1,2,2-trifluoroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,2-Dichlorobenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,3-Dichlorobenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,4-Dichlorobenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Acrolein	5.0 µg/L	500 µg/L	500U µg/L
MGP-GW-MW-28	SO66D	Methyl Iodide	0.2 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-28	SO66D	Bromoethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Acrylonitrile	1.0 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-28	SO66D	1,1-Dichloropropene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Dibromomethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,1,1,2-Tetrachloroethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,2-Dibromo-3-chloropropane	0.5 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-28	SO66D	1,2,3-Trichloropropane	0.5 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-28	SO66D	trans-1,4-Dichloro-2-butene	1.0 µg/L	100 µg/L	100U µg/L
MGP-GW-MW-28	SO66D	1,3,5-Trimethylbenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Hexachlorobutadiene	0.5 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-28	SO66D	Ethylene Dibromide	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Bromochloromethane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	2,2-Dichloropropane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,3-Dichloropropane	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Isopropylbenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	n-Propylbenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	Bromobenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	2-Chlorotoluene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	4-Chlorotoluene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	tert-Butylbenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	sec-Butylbenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	4-Isopropyltoluene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	n-Butylbenzene	0.2 µg/L	20 µg/L	20U µg/L
MGP-GW-MW-28	SO66D	1,2,4-Trichlorobenzene	0.5 µg/L	50 µg/L	50U µg/L
MGP-GW-MW-28	SO66D	1,2,3-Trichlorobenzene	0.5 µg/L	50 µg/L	50U µg/L

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TECHNICAL MEMORANDUM

TO: Chip Halbert

FROM: Kristi Schultz and Stacy Lane KES SL

DATE: January 14, 2013

RE: 2012 SOIL AND GROUNDWATER SAMPLES LABORATORY DATA QUALITY EVALUATION
CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT REMEDIAL INVESTIGATION/FEASIBILITY STUDY

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 8 soil samples and 3 groundwater sample collected on October 3, 2012 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Soil samples submitted to ARI for analysis were analyzed for low level polycyclic aromatic hydrocarbons [PAHs; U.S. Environmental Protection Agency (EPA) Method SW8270D-SIM]. Groundwater samples were analyzed for weak acid dissociable (WAD) cyanide (Method SM4500-CN-I). The analytical results are reported in ARI laboratory data packages VL92 and VU15. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA 2009), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999), applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 2004), and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Work Plan; Herrenkohl Consulting and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation, including chain-of-custody records (COCs); identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria.
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that quality control samples were performed as specified in the Work Plan.
- Evaluation of sample holding times.

- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike and matrix spike duplicate results, laboratory duplicate and/or replicate results, laboratory control sample results, and blind field duplicate results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial calibration data are provided for all requested analytes and linked to the field samples reported, and that the appropriate number and concentration of initial calibration standards are present.
- Verification that continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification and continuing calibration blank standards as appropriate.
- Verification that method specific instrument performance checks are present as appropriate.
- Verification that frequency of instrument quality control samples is appropriate.
- Comparison of instrument-related quality control data to the document requirements and guidelines present in the USEPA functional guidelines for data review identified above.

If appropriate, data validation qualifiers are added to the sample results. The results of the verification and validation check are summarized below.

LABORATORY DATA PACKAGE COMPLETENESS

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

SAMPLE CONDITIONS AND ANALYSIS

The laboratory received all samples in good condition; soil samples were frozen upon initial receipt to protect holding times. Water samples were preserved upon receipt and were centrifuged prior to analysis per client request; all analyses were performed as requested.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks. No qualification of the data was necessary.

Field Trip Blanks

No field trip blanks were submitted for analysis.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) AND LABORATORY DUPLICATE RESULTS

The Work Plan specifies a matrix spike (MS)/matrix spike duplicate (MSD) should be analyzed for all organic analyses; no MS/MSD was analyzed with the cPAH analysis.

A MS and a laboratory duplicate were analyzed with the cyanide analysis. The recovery values for each spiking compound were within the laboratory-specified control limits. No qualification of the data was necessary.

A laboratory-specified control limit of 20 percent was used to evaluate the relative percent differences (RPDs) between the original sample and the laboratory duplicate, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the duplicate results were within the current laboratory-specified control limits. No qualification of the data was necessary.

LABORATORY CONTROL SAMPLE AND LABORATORY CONTROL SAMPLE DUPLICATE RESULTS

One LCS/LCSD sample was analyzed with the batch of samples. Recoveries and RPDs for the LCS/LCSD were within the current laboratory-specified control limits. No qualification of the data was necessary.

BLIND FIELD DUPLICATES

One pair of blind field duplicate soil samples (MGP-GP-57-11.0-12.0/MGP-GP-72-11.0-12.0) was submitted for analysis of cPAHs.

A project-specified control limit of 35 percent was used to evaluate the RPDs between the duplicate soil samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exception:

- The RPDs for benzo(a)anthracene, chrysene, and total benzofluoranthenes exceeded the project-specified control limit. The results for the parent sample and the duplicate sample were qualified as estimated (J), as indicated in Table 2. The high RPD may be due to sample heterogeneity and, therefore, no other project sample results were qualified.

REPORTING LIMITS

Target reporting limits were achieved for all non-detected results.

INITIAL AND CONTINUING CALIBRATION

Initial and continuing calibration verifications and instrument performance and quality control checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. Laboratory-specified calibration limits for initial and continuing calibrations were met for all analyses. No qualification of the data was necessary.

COMPLETENESS AND OVERALL DATA QUALITY

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through a matrix spike, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

REFERENCES

EPA. 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use.* OSWER No. 9200.1-85 EPA 540-R-08-005. U.S. Environmental Protection Agency. January.

EPA. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA-540/R-04-004. U.S. Environmental Protection Agency. Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, D.C. October.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

ATTACHMENTS

Table 1 – Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2 – Summary of Data Qualifiers

TABLE 1
SAMPLE NAMES AND DATES OF SAMPLE COLLECTION, EXTRACTION, AND ANALYSIS
2012 SOIL AND GROUNDWATER SAMPLING ANALYSIS
SOUTH STATE STREET MANUFACTURED GAS PLANT
BELLINGHAM, WASHINGTON

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-GP-GW-MW-56	VL92A	10/03/12	NA	10/9/12 (WAD Cyanide)
MGP-GP-GW-MW-71	VL92B	10/03/12	NA	10/9/12 (WAD Cyanide)
MGP-GP-GW-MW-57	VL92C	10/03/12	NA	10/9/12 (WAD Cyanide)
MGP-GP-56-1.0-2.0	VL92D	10/03/12	10/11/12 (PAHs)	10/11/12 (PAHs)
MGP-GP-56-3.0-4.0	VL92E	10/03/12	10/11/12 (PAHs)	10/11/12 (PAHs)
MGP-GP-56-14.5-15.5	VL92F	10/03/12	10/11/12 (PAHs)	10/11/12 (PAHs)
MGP-GP-57-1.0-2.0	VL92H	10/03/12	10/11/12 (PAHs)	10/11/12 (PAHs)
MGP-GP-57-5.0-6.0	VL92I	10/03/12	10/11/12 (PAHs)	10/11/12 (PAHs)
MGP-GP-57-11.0-12.0	VL92J	10/03/12	10/11/12 (PAHs)	10/11/12 (PAHs)
MGP-GP-72-11.0-12.0	VL92L	10/03/12	10/13/12 (PAHs)	10/15/12 (PAHs)
MGP-GP-56-10.0-11.0	VU15A	10/03/12	11/29/12 (PAHs)	11/30/12 (PAHs)

TABLE 2
SUMMARY OF DATA QUALIFIERS
SOUTH STATE STREET MANUFACTURED GAS PLANT
2012 SOIL AND GROUNDWATER SAMPLING

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
VL92	Benzo(a)anthracene	4.5J	J	MGP-GP-57-11.0-12.0	High field duplicate RPD
VL92	Benzo(a)anthracene	15	J	MGP-GP-72-11.0-12.0	High field duplicate RPD
VL92	Chrysene	5.1	J	MGP-GP-57-11.0-12.0	High field duplicate RPD
VL92	Chrysene	15	J	MGP-GP-72-11.0-12.0	High field duplicate RPD
VL92	Total Benzofluoranthenes	9.4	J	MGP-GP-57-11.0-12.0	High field duplicate RPD
VL92	Total Benzofluoranthenes	27	J	MGP-GP-72-11.0-12.0	High field duplicate RPD

Notes

J = Indicates the analyte was positively identified; the associated numerical value is the approximat
concentration of the analyte in the sample

TECHNICAL MEMORANDUM

TO: Chip Halbert

FROM: Kristi Schultz and Anne Halvorsen

DATE: March 7, 2013

RE: CITY OF BELLINGHAM SOUTH STATE STREET MANUFACTURED GAS PLANT
SOIL VAPOR SAMPLING
LABORATORY DATA QUALITY EVALUATION

This technical memorandum provides the results of a focused data validation associated with 3 soil vapor samples collected on February 26, 2013 at the South State Street Manufactured Gas Plant in Bellingham, Washington. Samples were analyzed by Air Toxics, Ltd. (Air Toxics), located in Folsom, California. This data quality evaluation covers Air Toxics data package 1302520. Samples submitted to Air Toxics were analyzed for benzene [U.S. Environmental Protection Agency (EPA) Method Modified TO-15 SIM].

Sample data were evaluated in accordance with applicable portions of the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1999) and the *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan* (Herrenkohl and Landau 2010). The following parameters were evaluated:

- Chain-of-custody (COC) records
- Holding times
- Blank results (laboratory method)
- Surrogate recoveries
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Quantitation limits
- Completeness and overall data quality.

Data validation qualifiers are added to samples based on the evaluation of data quality. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below.

CHAIN-OF-CUSTODY RECORDS

A signed chain-of-custody record was attached to the data package. The laboratory received all samples in good condition and all analyses were performed as requested.

HOLDING TIMES

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data is necessary.

BLANK RESULTS

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks. No qualification of the data is necessary.

SURROGATE RECOVERIES

Appropriate compounds were used as surrogate spikes for the benzene analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data is necessary.

LABORATORY CONTROL SAMPLE AND LABORATORY CONTROL SAMPLE DUPLICATE RESULTS

At least one LCS and/or LCSD sample was analyzed with each batch of samples for the benzene analysis. Recoveries and RPD for the LCS/LCSD were within the current laboratory-specified control limits. No qualification of the data is necessary.

QUANTITATION LIMITS

Project-specified quantitation limits were met for all samples.

COMPLETENESS AND OVERALL DATA QUALITY

The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. Based on this data quality evaluation, all of the data were determined to be acceptable without qualification. No data were rejected.

REFERENCES

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Herrenkohl Consulting LLC and Landau Associates Inc. 2010. *South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan.* Prepared for City of Bellingham and Puget Sound Energy. August 6.

Technical Memorandum

TO: Chip Halbert

FROM: Kristi Schultz and Anne Halvorsen

DATE: December 1, 2015

RE: **2015 Sediment Samples Laboratory Data Quality Evaluation**
City of Bellingham South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 37 sediment samples collected on September 22-25, 2015 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for some or all of the following: semivolatile organic compounds (SVOCs; US Environmental Protection Agency [EPA] Method SW8270D); low level SVOCs (SIM SVOCs; EPA Method SW8270D-SIM); total metals (EPA Method 200.8/7471A); total organic carbon (TOC) (Plumb 1981); and total solids (SM 2540G). The analytical results are reported in ARI laboratory data packages identified as ANE3, ANI0, ANL9, and AOK5. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009), and with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 1999, 2008) and the National Functional Guidelines for Inorganic Data Review (EPA 2004, 2010), and the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan (Herrenkohl Consulting LLC and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related QC data, and QC acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that QC samples were performed as specified in the Quality Assurance Project Plan (QAPP).
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.

- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial and continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification (CCV) and continuing calibration blank (CCB) standards as appropriate.
- Method specific instrument performance checks are present as appropriate (e.g., DDT/Endrin breakdown checks for pesticides and aroclors)
- Frequency of instrument QC samples is checked for appropriateness (e.g., GC-MS tunes have been run every 12 hours)
- Sample results are evaluated by comparing instrument-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical methods, or contract.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage 2B verification and validation check; a summary of the data validation qualifiers is presented in Table 2. The results of the verification and validation check are summarized below.

Laboratory Data Package Completeness

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

Sample Conditions and Analysis

The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample container information was compared to the associated COC and the cooler temperatures were recorded. All coolers were received at the laboratory with temperatures less than the EPA-recommended limit of 6°C.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times, with the following exceptions:

- The mercury analysis associated with data package AOK5 was completed between 3 and 4 days outside the method-recommended hold time per the client's request. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.

- The TOC analysis associated with data package AOK5 was completed 25 days outside the method-recommended hold time per the client's request. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. No contamination was detected in any of the method blanks, with the following exceptions:

- Cadmium and lead were detected in the method blank associated with the total metals analysis in data package ANE3. The associated samples contained concentrations of the affected compounds in excess of the associated action levels[1]; therefore, no qualification of the data was necessary.
- Phenol was detected in the method blank associated with the SVOC analysis in data package ANI0. Associated sample concentrations of phenol that were less than the associated action level were qualified as not detected (U), as indicated in Table 2.
- Lead was detected in the method blanks associated with the total metals analyses in data packages ANI0 and ANL9. The associated samples contained concentrations of lead in excess of the associated action levels; therefore, no qualification of the data was necessary.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Surrogate spikes were diluted out during required SVOC dilution reanalyses in data package AOK5. No qualification of the data was necessary.
- Recovery of the surrogate d14-p-terphenyl exceeded the laboratory-specified control limits in the method blank and laboratory control sample duplicate associated with the SVOC analysis in data package ANE3. All project sample surrogate recoveries were within laboratory-specified control limits; therefore, no qualification of the data was determined necessary.

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) and Laboratory Replicate Results

A MS and a MSD or laboratory duplicate sample was analyzed with the SVOCs, SIM SVOCs, total metals, and TOC analyses in one or more data packages. The recovery values for each spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

[1] The action level is defined as 10 times the concentration in the method blank for common volatile laboratory contaminants (methylene chloride, acetone, 2-butanone, and cyclohexane), and 5 times the concentration for other target compounds (EPA 1999).

- The MS recoveries for lead and zinc associated with the total metals analysis of sample MGP-SS-15 in data package ANE3 were below the laboratory-specified control limit; the associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.
- The MS recovery for zinc associated with the total metals analysis of sample MGP-SB-19-0-2 in data package ANL9 exceeded the laboratory-specified control limit; the associated sample result was qualified as estimated (J), as indicated in Table 2.
- The MS/MSD recoveries for several compounds associated with the SVOC analysis of sample MGP-SB-15-0-2 in data package AOK5 were not available due to a negative calculated recovery or an undetected spike. No qualification of the data was determined necessary.
- The MS or MSD recovery for multiple compounds associated with the SVOC analysis of sample MGP-SB-15-0-2 in data package AOK5 were outside laboratory-specified control limits; the corresponding MS or MSD recovery was within laboratory-specified control limits. No qualification of the data was determined necessary.
- The MS recoveries for several compounds associated with the total metals analysis of sample MGP-SB-14-0-2 in data package AOK5 were either below or exceeded the laboratory-specified control limits. The associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.

A project-specified control limit of 35 percent (organic analyses) or 20 percent (inorganic analyses) was used to evaluate the relative percent differences (RPDs) between the MS/MSD or laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. The RPDs between the MS/MSDs or laboratory replicate results were within the current laboratory-specified control limits for all project samples with the following exceptions:

- The MS/MSD RPDs for 2,4-dimethylphenol associated with both the SVOC and SIM SVOC analysis of sample MGP-SS-14 in data package ANE3 exceeded the project-specified control limit. 2,4-Dimethylphenol was not detected in the associated sample; therefore, no qualification of the data was necessary.
- The laboratory duplicate RPDs for lead and zinc associated with the total metals analysis of sample MGP-SS-15 in data package ANE3 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.
- The laboratory duplicate RPD for arsenic associated with the total metals analysis of sample MGP-SS-13 in data package ANI0 exceeded the project-specified control limit. The associated sample result was qualified as estimated (J), as indicated in Table 2.
- The laboratory duplicate RPD for lead associated with the total metals analysis of sample MGP-SB-19-0-2 in data package ANL9 exceeded the project-specified control limit. The associated sample result was qualified as estimated (J), as indicated in Table 2.
- The laboratory duplicate RPD for TOC associated with the conventionals analysis of sample MGP-SB-19-0-2 in data package ANL9 exceeded the project-specified control limit. The associated sample result was qualified as estimated (J), as indicated in Table 2.

- The MS/MSD RPD for n-nitrosodiphenylamine associated with the SVOC analysis of sample MGP-SB-15-0-2 in data package AOK5 exceeded the project-specified control limit. n-Nitrosodiphenylamine was not detected in the associated sample; therefore, no qualification of the data was necessary.
- The laboratory duplicate RPDs for several compounds associated with the total metals analysis of sample MGP-SB-14-0-2 in data package AOK5 exceeded the project-specified control limit. The associate sample results were qualified as estimated (J), as indicated in Table 2.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD and SRMs were within the current laboratory- and project-specified control limits, with the following exceptions:

- The LCS/LCSD RPD for 2,4-dimethylphenol associated with the SVOCs analysis in data package ANE3 exceeded the project-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 2.
- The LCS/LCSD RPDs for 2,4-dimethylphenol and benzyl alcohol associated with the SIM SVOCs analysis in data package ANE3 exceeded the project-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 2.
- The LCS/LCSD RPD for benzyl alcohol associated with the SVOCs analysis in data package ANI0 exceeded the project-specified control limit. Benzyl alcohol was not detected in the associated samples; therefore, no qualification of the data was necessary.
- The LCS/LCSD RPD for benzo(a)pyrene associated with the SVOCs analysis in data package ANL9 exceeded the project-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 2.
- The LCSD percent recovery for benzyl alcohol associated with the SIM SVOCs analysis in data package ANL9 was below the laboratory-specified control limit; the associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.
- The LCS/LCSD RPD for benzyl alcohol associated with the SIM SVOCs analysis in data package ANL9 exceeded the project-specified control limit. Benzyl alcohol was not detected in the associated samples; therefore, no qualification of the data was necessary.

Blind Field Duplicates

Two pairs of blind field duplicate sediment samples (MGP-SB-DUP2-0-2 / MGP-SB-19-0-2 and MGP-SS-DUP1 / MGP-SS-20) were submitted for analysis with data package ANE3 and ANL9 and analyzed for SVOCs, SIM SVOCs, total metals, and conventionals. A project-specified control limit of 35 percent was used to evaluate the RPDs between the duplicate sediment samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus two times the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exceptions:

- The RPDs for several compounds associated with the SVOCs analyses of the blind field duplicate pair MGP-SS-DUP1 / MGP-SS-20 in data package ANE3 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.
- The RPDs for several compounds associated with the SVOCs analyses of the blind field duplicate pair MGP-SB-DUP2-0-2 / MGP-SB-19-0-2 in data package ANL9 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.
- The RPDs for chromium and zinc associated with the total metals analysis of the blind field duplicate pair MGP-SB-DUP2-0-2 / MGP-SB-19-0-2 in data package ANL9 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.

Reporting Limits

The reporting limits for SVOCs and SIM SVOCs in several samples were above the target reporting limits due to either percent moisture of the sample, or required dilution due to high concentrations of target analytes in the samples. A list of the samples with raised reporting limits that did not contain detectable concentrations is provided in Table 3.

Initial and Continuing Calibration

Initial and continuing calibration verifications and instrument performance and quality control checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. Laboratory-specified calibration limits for initial and continuing calibrations were met for all requested analyses, with the following exceptions:

- The SVOC continuing calibration verifications (CCVs) in data packages ANE3 and ANL9 were low for several compounds. The associated sample analyses were required dilution reanalyses and the results will not be reported; therefore, no qualification of the data was necessary.
- The SIM SVOC CCV in data package ANE3 was low for pentachlorophenol and the surrogate 2-fluorophenol; associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.
- The SIM SVOC CCVs in data package ANI0 and ANL9 were low for the surrogate 2-fluorophenol; as all project sample surrogate recoveries were within laboratory-specified control limits, no qualification of the data was determined necessary.
- The SVOC CCV in data package AOK5 was high for several compounds; the associated sample detections were qualified as estimated (J), as indicated in Table 2.
- The SIM SVOC CCV in data package AOK5 was low for benzyl alcohol; the associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.

Additional Corrective Actions

Several of the SIM SVOC results in data package AOK5 were “E” qualified as the concentrations exceeded the laboratory instrument calibration. Since the samples had also been analyzed with quantifiable detections at a standard level (SW8270D), no dilution reanalysis of the samples was performed. No qualification of the data was necessary.

Completeness and Overall Data Quality

Data precision was evaluated through matrix spike duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Use of this Report

This data validation summary report has been prepared for the exclusive use of the City of Bellingham and its designated representatives for specific application to the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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Attachments

Table 1 – Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2 – Summary of Data Qualifiers
Table 3 – Target Reporting Limit Exceedances

References

EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. edited by Office of Emergency and Remedial Response. Washington, D.C.: US Environmental Protection Agency.

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Table 1
Sample Names and Dates of Sample Collection, Extraction, and Analysis
2015 Sediment Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-SS-15	ANE3A	9/22/15	9/28/15 (Metals, SIM SVOCs); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SIM SVOCs); 10/3-10/7/15 (SVOCs); 10/6/15 (TOC)
MGP-SS-16	ANE3B	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-14	ANE3C	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-19	ANE3D	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SIM SVOCs); 10/3-10/7/15 (SVOCs); 10/6/15 (TOC)
MGP-SS-17	ANE3E	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-18	ANE3F	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-20	ANE3G	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SIM SVOCs); 10/6/15 (SVOCs); 10/6/15 (TOC)
MGP-SS-21	ANE3H	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-22	ANE3I	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-28	ANE3J	9/22/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-29	ANE3K	9/22/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-30	ANE3L	9/22/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-31	ANE3M	9/22/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-25	ANE3N	9/23/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-26	ANE3O	9/23/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-27	ANE3P	9/23/15	9/28/15 (Metals)	10/2/15 (Metals)
MGP-SS-23	ANE3Q	9/23/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SVOCs, SIM SVOCs); 10/6/15 (TOC)
MGP-SS-Dup1	ANE3R	9/22/15	9/28/15 (Metals, SIM SVOCS); 9/29/15 (SVOCs)	9/29/15 (Total Solids); 9/30-10/2/15 (Metals); 10/3/15 (SIM SVOCs); 10/6/15 (SVOCs); 10/6/15 (TOC)
MGP-SS-13	ANI0A	9/24/15	9/29/15 (Metals); 9/30/15 (SIM SVOCs, SVOCs)	9/29/15 (Total Solids); 10/1-10/2/15 (Metals); 10/5/15 (SIM SVOCs, SVOCs, TOC)
MGP-SB-17-0-2	ANI0B	9/24/15	9/29/15 (Metals); 9/30/15 (SIM SVOCs, SVOCs)	9/29/15 (Total Solids); 10/1-10/2/15 (Metals); 10/5/15 (SIM SVOCs, SVOCs, TOC)
MGP-SB-17-2-4	ANI0C	9/24/15	9/29/15 (Metals); 9/30/15 (SIM SVOCs, SVOCs)	9/29/15 (Total Solids); 10/1-10/2/15 (Metals); 10/5/15 (SIM SVOCs, SVOCs, TOC)
MGP-SS-24	ANI0D	9/24/15	9/29/15 (Metals)	10/2/15 (Metals)
MGP-SB-19-0-2	ANL9A	9/24/15	10/1/15 (Metals, SIM SVOCs, SVOCs)	10/1/15 (Total Solids); 10/2-10/6/15 (Metals); 10/8/15 (SIM SVOCs, SVOCs); 10/13/15 (TOC)
MGP-SB-19-2-4	ANL9B	9/24/15	10/1/15 (Metals, SIM SVOCs, SVOCs)	10/1/15 (Total Solids); 10/2-10/6/15 (Metals); 10/8/15 (SIM SVOCs); 10/8-10/10/15 (SVOCs); 10/13/15 (TOC)

Table 1
Sample Names and Dates of Sample Collection, Extraction, and Analysis
2015 Sediment Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-SB-19-6-8	ANL9C	9/24/15	10/1/15 (Metals, SIM SVOCs, SVOCs)	10/1/15 (Total Solids); 10/2-10/6/15 (Metals); 10/8/15 (SIM SVOCs, SVOCs); 10/13/15 (TOC)
MGP-SB-18-0-2	ANL9D	9/24/15	10/1/15 (Metals, SIM SVOCs, SVOCs)	10/1/15 (Total Solids); 10/2-10/6/15 (Metals); 10/9/15 (SIM SVOCs, SVOCs); 10/13/15 (TOC)
MGP-SB-18-2-4	ANL9E	9/24/15	10/1/15 (Metals, SIM SVOCs, SVOCs)	10/1/15 (Total Solids); 10/2-10/6/15 (Metals); 10/9/15 (SIM SVOCs, SVOCs); 10/13/15 (TOC)
MGP-SB-DUP2-0-2	ANL9F	9/24/15	10/1/15 (Metals, SIM SVOCs, SVOCs)	10/2-10/6/15 (Metals); 10/5/15 (Total Solids); 10/9/15 (SIM SVOCs, SVOCs); 10/13/15 (TOC)
MGP-SB-14-0-2	AOK5A	9/25/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/22/15 (SIM SVOCs); 10/22-10/27/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-14-2-4	AOK5B	9/25/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/22/15 (SIM SVOCs); 10/22-10/27/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-14-6-8	AOK5C	9/25/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/22/15 (SIM SVOCs); 10/22-10/27/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-15-0-2	AOK5D	9/25/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/22/15 (SIM SVOCs); 10/22-10/27/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-15-2-4	AOK5E	9/25/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/22/15 (SIM SVOCs); 10/22-10/27/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-15-6-8	AOK5F	9/25/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/22/15 (SIM SVOCs); 10/22-10/28/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-16-0-2	AOK5G	9/24/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/23/15 (SIM SVOCs, SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-17-4-6	AOK5H	9/24/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/23/15 (SIM SVOCs); 10/23-10/28/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)
MGP-SB-18-4-5.5	AOK5I	9/24/15	10/16/15 (SIM SVOCs, SVOCs); 10/22-10/26/15 (Metals)	10/16/15 (Total Solids); 10/23/15 (SIM SVOCs); 10/23-10/28/15 (SVOCs); 10/23-10/27/15 (Metals); 11/3/15 (TOC)

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
2015 Sediment Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
ANE3	SVOCs	Naphthalene	1400	J	MGP-SS-20	High field duplicate RPD
ANE3	SVOCs	2-Methylnaphthalene	540	J	MGP-SS-20	High field duplicate RPD
ANE3	SVOCs	Fluorene	290	J	MGP-SS-20	High field duplicate RPD
ANE3	SVOCs	Phenanthrene	1000	J	MGP-SS-20	High field duplicate RPD
ANE3	SVOCs	1-Methylnaphthalene	540	J	MGP-SS-20	High field duplicate RPD
ANE3	SVOCs	Naphthalene	740	J	MGP-SS-Dup1	High field duplicate RPD
ANE3	SVOCs	2-Methylnaphthalene	270	J	MGP-SS-Dup1	High field duplicate RPD
ANE3	SVOCs	Fluorene	80	J	MGP-SS-Dup1	High field duplicate RPD
ANE3	SVOCs	Phenanthrene	620	J	MGP-SS-Dup1	High field duplicate RPD
ANE3	SVOCs	1-Methylnaphthalene	200	J	MGP-SS-Dup1	High field duplicate RPD
ANE3	SVOCs	2,4-Dimethylphenol	280	J	MGP-SS-19	High LCS/LCSD RPD
ANE3	SIM SVOCs	2,4-Dimethylphenol	30	J	MGP-SS-15	High LCS/LCSD RPD
ANE3	SIM SVOCs	2,4-Dimethylphenol	30	J	MGP-SS-16	High LCS/LCSD RPD
ANE3	SIM SVOCs	2,4-Dimethylphenol	250	J	MGP-SS-19	High LCS/LCSD RPD
ANE3	SIM SVOCs	Benzyl Alcohol	94	J	MGP-SS-17	High LCS/LCSD RPD
ANE3	SIM SVOCs	2,4-Dimethylphenol	22 J	J	MGP-SS-18	High LCS/LCSD RPD
ANE3	SIM SVOCs	2,4-Dimethylphenol	24 J	J	MGP-SS-20	High LCS/LCSD RPD
ANE3	SIM SVOCs	Benzyl Alcohol	100	J	MGP-SS-21	High LCS/LCSD RPD
ANE3	SIM SVOCs	Benzyl Alcohol	59	J	MGP-SS-23	High LCS/LCSD RPD
ANE3	SIM SVOCs	2,4-Dimethylphenol	14 J	J	MGP-SS-Dup1	High LCS/LCSD RPD
ANE3	SIM SVOCs	Pentachlorophenol	120 Q	J	MGP-SS-15	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	30 Q	J	MGP-SS-16	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	19 U	UJ	MGP-SS-14	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	19 U	UJ	MGP-SS-19	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	19 U	UJ	MGP-SS-17	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	12 J	J	MGP-SS-18	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	12 J	J	MGP-SS-20	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	14 J	J	MGP-SS-21	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	23	J	MGP-SS-22	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	19 U	UJ	MGP-SS-23	Low continuing calibration recovery
ANE3	SIM SVOCs	Pentachlorophenol	12 J	J	MGP-SS-Dup1	Low continuing calibration recovery
ANE3	Metals	Lead	66.3	J	MGP-SS-15	High lab duplicate RPD + low MS recovery
ANE3	Metals	Zinc	170	J	MGP-SS-15	High lab duplicate RPD + low MS recovery
ANI0	SVOCs	Phenol	8.6 JB	U	MGP-SS-13	Method blank contamination
ANI0	SVOCs	Phenol	67 B	U	MGP-SB-17-0-2	Method blank contamination
ANI0	Metals	Arsenic	3.0	J	MGP-SS-13	High lab duplicate RPD
ANL9	SVOCs	Phenol	340	J	MGP-SB-19-0-2	High field duplicate RPD
ANL9	SVOCs	Naphthalene	5200	J	MGP-SB-19-0-2	High field duplicate RPD
ANL9	SVOCs	Dibenzofuran	59 U	UJ	MGP-SB-19-0-2	High field duplicate RPD
ANL9	SVOCs	1-Methylnaphthalene	1700	J	MGP-SB-19-0-2	High field duplicate RPD
ANL9	SVOCs	Phenol	170	J	MGP-SB-Dup2-0-2	High field duplicate RPD
ANL9	SVOCs	Naphthalene	3600	J	MGP-SB-Dup2-0-2	High field duplicate RPD
ANL9	SVOCs	Dibenzofuran	410	J	MGP-SB-Dup2-0-2	High field duplicate RPD
ANL9	SVOCs	1-Methylnaphthalene	1100	J	MGP-SB-Dup2-0-2	High field duplicate RPD
ANL9	SVOCs	Benzo(a)pyrene	1600	J	MGP-SB-19-0-2	High LCS/LCSD RPD
ANL9	SVOCs	Benzo(a)pyrene	1600	J	MGP-SB-19-2-4	High LCS/LCSD RPD
ANL9	SVOCs	Benzo(a)pyrene	18 J	J	MGP-SB-19-6-8	High LCS/LCSD RPD
ANL9	SVOCs	Benzo(a)pyrene	510	J	MGP-SB-18-0-2	High LCS/LCSD RPD
ANL9	SVOCs	Benzo(a)pyrene	290	J	MGP-SB-18-2-4	High LCS/LCSD RPD
ANL9	SVOCs	Benzo(a)pyrene	1700	J	MGP-SB-Dup2-0-2	High LCS/LCSD RPD
ANL9	SIM SVOCs	Benzyl Alcohol	59 U	UJ	MGP-SB-19-0-2	Low LSCD recovery
ANL9	SIM SVOCs	Benzyl Alcohol	60 U	UJ	MGP-SB-19-2-4	Low LSCD recovery
ANL9	SIM SVOCs	Benzyl Alcohol	19 U	UJ	MGP-SB-19-6-8	Low LSCD recovery
ANL9	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-18-0-2	Low LSCD recovery
ANL9	SIM SVOCs	Benzyl Alcohol	19 U	UJ	MGP-SB-18-2-4	Low LSCD recovery
ANL9	SIM SVOCs	Benzyl Alcohol	59 U	UJ	MGP-SB-Dup2-0-2	Low LSCD recovery
ANL9	Metals	Lead	8.8	J	MGP-SB-19-0-2	High lab duplicate RPD
ANL9	Metals	Zinc	45	J	MGP-SB-19-0-2	High MS recovery
ANL9	Metals	Chromium	29	J	MGP-SB-19-0-2	High field duplicate RPD
ANL9	Metals	Zinc	45	J	MGP-SB-19-0-2	High field duplicate RPD
ANL9	Metals	Chromium	41.4	J	MGP-SB-Dup2-0-2	High field duplicate RPD
ANL9	Metals	Zinc	77	J	MGP-SB-Dup2-0-2	High field duplicate RPD
ANL9	Conv.	Total Organic Carbon	15.5	J	MGP-SB-19-0-2	High lab duplicate RPD
AOK5	SVOCs	4-Methylphenol	5700 Q	J	MGP-SB-14-2-4 (DL)	High continuing calibration recovery
AOK5	SVOCs	4-Methylphenol	8200 Q	J	MGP-SB-14-6-8 (DL)	High continuing calibration recovery
AOK5	SVOCs	4-Methylphenol	4900 Q	J	MGP-SB-15-2-4 (DL)	High continuing calibration recovery
AOK5	SVOCs	4-Methylphenol	14,000 Q	J	MGP-SB-15-6-8 (DL)	High continuing calibration recovery

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
2015 Sediment Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
AOK5	SVOCs	4-Methylphenol	2400 Q	J	MGP-SB-17-4-6 (DL)	High continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	58 U	UJ	MGP-SB-14-0-2	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-14-2-4	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-14-6-8	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-15-0-2	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-15-2-4	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-15-6-8	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	59 U	UJ	MGP-SB-16-0-2	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	20 U	UJ	MGP-SB-17-4-6	Low continuing calibration recovery
AOK5	SIM SVOCs	Benzyl Alcohol	58 U	UJ	MGP-SB-18-4-5.5	Low continuing calibration recovery
AOK5	Metals	Cadmium	1.0	J	MGP-SB-14-0-2	High lab duplicate RPD
AOK5	Metals	Chromium	43	J	MGP-SB-14-0-2	High lab duplicate RPD
AOK5	Metals	Lead	100	J	MGP-SB-14-0-2	High lab duplicate RPD
AOK5	Metals	Mercury	0.06	J	MGP-SB-14-0-2	High lab duplicate RPD
AOK5	Metals	Chromium	43	J	MGP-SB-14-0-2	Low MS recovery
AOK5	Metals	Lead	100	J	MGP-SB-14-0-2	High MS recovery
AOK5	Metals	Silver	0.5 U	UJ	MGP-SB-14-0-2	Low MS recovery
AOK5	Metals	Mercury	0.06	J	MGP-SB-14-0-2	Analyzed outside hold time
AOK5	Metals	Mercury	0.07 U	UJ	MGP-SB-14-2-4	Analyzed outside hold time
AOK5	Metals	Mercury	0.1 U	UJ	MGP-SB-14-6-8	Analyzed outside hold time
AOK5	Metals	Mercury	0.14	J	MGP-SB-15-0-2	Analyzed outside hold time
AOK5	Metals	Mercury	0.09 U	UJ	MGP-SB-15-2-4	Analyzed outside hold time
AOK5	Metals	Mercury	0.08 U	UJ	MGP-SB-15-6-8	Analyzed outside hold time
AOK5	Metals	Mercury	0.20	J	MGP-SB-16-0-2	Analyzed outside hold time
AOK5	Metals	Mercury	0.30	J	MGP-SB-17-4-6	Analyzed outside hold time
AOK5	Metals	Mercury	0.35	J	MGP-SB-18-4-5.5	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	23.5	J	MGP-SB-14-0-2	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	35.3	J	MGP-SB-14-2-4	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	51.8	J	MGP-SB-14-6-8	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	20.1	J	MGP-SB-15-0-2	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	44.9	J	MGP-SB-15-2-4	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	22.2	J	MGP-SB-15-6-8	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	24.5	J	MGP-SB-16-0-2	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	8.71	J	MGP-SB-17-4-6	Analyzed outside hold time
AOK5	Conv.	Total Organic Carbon	8.19	J	MGP-SB-18-4-5.5	Analyzed outside hold time

Notes
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = Indicates the compound was undetected at the reported concentration.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Table 3
Target Reporting Limit Exceedances
2015 Sediment Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-SS-15	ANE3A	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SS-16	ANE3B	1,4-Dichlorobenzene	37 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	1,2-Dichlorobenzene	35 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	1,2,4-Trichlorobenzene	31 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	Hexachlorobutadiene	11 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	Dimethylphthalate	24 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	N-Nitrosodiphenylamine	28 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	Hexachlorobenzene	22 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-16	ANE3B	Butylbenzylphthalate	21 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-14	ANE3C	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SS-19	ANE3D	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SS-17	ANE3E	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SS-18	ANE3F	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SS-20	ANE3G	1,4-Dichlorobenzene	37 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	1,2-Dichlorobenzene	35 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	1,2,4-Trichlorobenzene	31 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	Hexachlorobutadiene	11 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	Dimethylphthalate	24 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	N-Nitrosodiphenylamine	28 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	Hexachlorobenzene	22 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-20	ANE3G	Butylbenzylphthalate	21 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-21	ANE3H	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SS-22	ANE3I	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SS-23	ANE3Q	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SS-Dup1	ANE3R	1,4-Dichlorobenzene	37 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	1,2-Dichlorobenzene	35 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	1,2,4-Trichlorobenzene	31 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	Hexachlorobutadiene	11 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	Dimethylphthalate	24 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	N-Nitrosodiphenylamine	28 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	Hexachlorobenzene	22 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-Dup1	ANE3R	Butylbenzylphthalate	21 ug/kg	39 ug/kg	39 U ug/kg
MGP-SS-13	ANI0A	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SB-17-0-2	ANI0B	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-17-2-4	ANI0C	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-19-0-2	ANL9A	1,3-Dichlorobenzene	57 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	1,4-Dichlorobenzene	37 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	1,2-Dichlorobenzene	35 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	Hexachloroethane	47 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	1,2,4-Trichlorobenzene	31 ug/kg	59 ug/kg	59 U ug/kg

Table 3
Target Reporting Limit Exceedances
2015 Sediment Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-SB-19-0-2	ANL9A	Hexachlorobutadiene	11 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	Dimethylphthalate	24 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	N-Nitrosodiphenylamine	28 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	Hexachlorobenzene	22 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	Butylbenzylphthalate	21 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-19-0-2	ANL9A	Hexachlorobutadiene	11 ug/kg	15 ug/kg	15 U ug/kg
MGP-SB-19-2-4	ANL9B	1,3-Dichlorobenzene	57 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	1,4-Dichlorobenzene	37 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	1,2-Dichlorobenzene	35 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	Hexachloroethane	47 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	1,2,4-Trichlorobenzene	31 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	Hexachlorobutadiene	11 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	Dimethylphthalate	24 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	N-Nitrosodiphenylamine	28 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	Hexachlorobenzene	22 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	Butylbenzylphthalate	21 ug/kg	60 ug/kg	60 U ug/kg
MGP-SB-19-2-4	ANL9B	Hexachlorobutadiene	11 ug/kg	15 ug/kg	15 U ug/kg
MGP-SB-19-6-8	ANL9C	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SB-18-0-2	ANL9D	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-18-2-4	ANL9E	Hexachlorobutadiene	11 ug/kg	19 ug/kg	19 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	1,3-Dichlorobenzene	57 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	1,4-Dichlorobenzene	37 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	1,2-Dichlorobenzene	35 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	Hexachloroethane	47 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	1,2,4-Trichlorobenzene	31 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	Hexachlorobutadiene	11 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	Dimethylphthalate	24 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	N-Nitrosodiphenylamine	28 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	Hexachlorobenzene	22 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	Butylbenzylphthalate	21 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-DUP2-0-2	ANL9F	Hexachlorobutadiene	11 ug/kg	15 ug/kg	15 U ug/kg
MGP-SB-14-0-2	AOK5A	1,3-Dichlorobenzene	57 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	1,4-Dichlorobenzene	37 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	1,2-Dichlorobenzene	35 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	Hexachloroethane	47 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	1,2,4-Trichlorobenzene	31 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	Hexachlorobutadiene	11 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	Dimethylphthalate	24 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	N-Nitrosodiphenylamine	28 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	Hexachlorobenzene	22 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	Butylbenzylphthalate	21 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-14-0-2	AOK5A	Hexachlorobutadiene	11 ug/kg	15 ug/kg	15 U ug/kg
MGP-SB-14-2-4	AOK5B	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-14-6-8	AOK5C	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-15-0-2	AOK5D	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg

Table 3
Target Reporting Limit Exceedances
2015 Sediment Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-SB-15-2-4	AOK5E	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-15-6-8	AOK5F	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-16-0-2	AOK5G	1,3-Dichlorobenzene	57 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	1,4-Dichlorobenzene	37 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	1,2-Dichlorobenzene	35 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	Hexachloroethane	47 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	1,2,4-Trichlorobenzene	31 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	Hexachlorobutadiene	11 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	Dimethylphthalate	24 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	N-Nitrosodiphenylamine	28 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	Hexachlorobenzene	22 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	Butylbenzylphthalate	21 ug/kg	59 ug/kg	59 U ug/kg
MGP-SB-16-0-2	AOK5G	Hexachlorobutadiene	11 ug/kg	15 ug/kg	15 U ug/kg
MGP-SB-17-4-6	AOK5H	Hexachlorobutadiene	11 ug/kg	20 ug/kg	20 U ug/kg
MGP-SB-18-4-5.5	AOK5I	1,3-Dichlorobenzene	57 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	1,4-Dichlorobenzene	37 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	1,2-Dichlorobenzene	35 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	Hexachloroethane	47 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	1,2,4-Trichlorobenzene	31 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	Hexachlorobutadiene	11 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	Dimethylphthalate	24 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	N-Nitrosodiphenylamine	28 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	Hexachlorobenzene	22 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	Butylbenzylphthalate	21 ug/kg	58 ug/kg	58 U ug/kg
MGP-SB-18-4-5.5	AOK5I	Hexachlorobutadiene	11 ug/kg	15 ug/kg	15 U ug/kg

Technical Memorandum

TO: Chip Halbert

FROM: Kristi Schultz and Danille Jorgensen

DATE: October 25, 2016

RE: **2016 Groundwater Samples Laboratory Data Quality Evaluation**
City of Bellingham South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 11 groundwater samples collected on June 21-22, 2016 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for some or all of the following: benzene, toluene, ethylbenzene, and xylenes (BTEX; US Environmental Protection Agency [EPA] Method SW8260C); low-level semivolatile organic compounds (SIM SVOCs; EPA Method SW8270D-SIM); total and dissolved metals (EPA Method 6010C/6020A), including hardness calculation; total cyanide (SM4500-CNE); and weak acid dissociable (WAD) cyanide (SM4500CN-I). The analytical results are reported in ARI laboratory data packages identified as BCI3 and BCI7. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009), and with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 1999, 2008) and the National Functional Guidelines for Inorganic Data Review (EPA 2004, 2010), and the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan (Herrenkohl Consulting LLC and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control (QC) data, and QC acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that QC samples were performed as specified in the Quality Assurance Project Plan (QAPP).
- Evaluation of sample holding times.

- Evaluation of QC data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial and continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification (CCV) and continuing calibration blank (CCB) standards as appropriate.
- Method-specific instrument performance checks are present as appropriate (e.g., DDT/Endrin breakdown checks for pesticides and aroclors).
- Frequency of instrument QC samples is checked for appropriateness (e.g., GC-MS tunes have been run every 12 hours)
- Sample results are evaluated by comparing instrument-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical methods, or contract.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage 2B verification and validation check; a summary of the data validation qualifiers is presented in Table 2. The results of the verification and validation check are summarized below.

Laboratory Data Package Completeness

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

Sample Conditions and Analysis

The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample container information was compared to the associated COC and the cooler temperatures were recorded. All coolers were received at the laboratory with temperatures less than the EPA-recommended limit of 6°C.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times, with the following exceptions:

- The total and WAD cyanide analyses associated with samples MGP-GW-MW-40, MGP-GW-MW-42, and MGP-GW-MW-55 in data package BCI3 were completed 1 day outside the method-recommended hold time. Associated sample results were qualified as estimated (J), as indicated in Table 2.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks

At least one field (trip) blank was analyzed with each batch of samples submitted to the laboratory. Target analytes were not detected at concentrations greater than the reporting limits in the associated field blanks. No qualification of the data was necessary.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Surrogate spikes were diluted out during required SIM SVOC dilution reanalyses in data package BCI7. No qualification of the data was necessary.

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) and Laboratory Replicate Results

A MS and a MSD or laboratory duplicate sample was analyzed with the BTEX, SIM SVOCs, total and dissolved metals, and total and WAD cyanide analyses in data package BCI3. The recovery values for each spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

- The MS/MSD recoveries for fluoranthene associated with the SIM SVOCs analysis of sample MGP-GW-MW-42 in data package BCI3 were below the laboratory-specified control limit; the associated sample result was qualified as estimated (J), as indicated in Table 2.

- The MS recoveries for calcium and magnesium associated with the total metals analysis of sample MGP-GW-MW-42 in data package BCI3 were below the laboratory-specified control limits. The original sample concentrations were equal to or greater than four times the spike concentrations; therefore, no qualification of the data was necessary.
- The MS recovery for calcium associated with the dissolved metals analysis of sample MGP-GW-MW-42 in data package BCI3 was below the laboratory-specified control limit. The original sample concentration was equal to or greater than four times the spike concentration; therefore, no qualification of the data was necessary.

A project-specified control limit of 35 percent (organic analyses) or 20 percent (inorganic analyses) was used to evaluate the relative percent differences (RPDs) between the MS/MSD or laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the MS/MSDs or laboratory replicate results were within the current laboratory-specified control limits for all project samples. No qualification of the data was necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD and SRMs were within the current laboratory- and project-specified control limits, with the following exceptions:

- The LCS/LCSD RPD for naphthalene, 2-methylnaphthalene, and 1-methylnaphthalene associated with the SIM SVOCs analysis in data package BCI7 exceeded the project-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 2.

Blind Field Duplicates

One pair of blind field duplicate groundwater samples (MGP-GW-DUP-1 / MGP-GW-MW-34) was submitted for analysis with data package BCI7 and analyzed for BTEX, SIM SVOCs, total and dissolved metals, and total and WAD cyanide. A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate groundwater samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exceptions:

- The RPDs for several compounds associated with the SIM SVOCs analyses of the blind field duplicate pair MGP-GW-DUP-1 / MGP-GW-MW-34 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.
- The RPDs for arsenic and lead associated with the total metals analysis of the blind field duplicate pair MGP-GW-DUP-1 / MGP-GW-MW-34 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.

Total and Dissolved Metals Concentrations

The analytical results for total and dissolved metals were compared for each project sample. A project-specified control limit of 20 percent was used to evaluate the RPDs between the total and dissolved metals results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the total and dissolved metals results were within the project-specified control limits for all project samples. No qualification of the data was necessary.

Reporting Limits

The reporting limits for BTEX, SIM SVOCs, and metals in several samples were above the target reporting limits due to either limited sample volume or required dilution due to high concentrations of target analytes in the samples. A list of the samples with raised reporting limits that did not contain detectable concentrations is provided in Table 3.

Initial and Continuing Calibration

Initial and continuing calibration verifications and instrument performance and QC checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. No qualification of the data was necessary.

Completeness and Overall Data Quality

Data precision was evaluated through matrix spike duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Use of this Report

This data validation summary report has been prepared for the exclusive use of the City of Bellingham and its designated representatives for specific application to the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates, Inc. (LAI). Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Kristi Schultz
Data Specialist

Danille Jorgensen
Environmental Data Manager

KES/DRJ/ljc
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Attachments: Table 1. Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2. Summary of Data Qualifiers
Table 3. Target Reporting Limit Exceedances

References

EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA-540/R-99-008. Office of Emergency and Remedial Response, US Environmental Protection Agency.

EPA. 2004. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA 540-R-04-004. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency.

EPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. USEPA-540-R-08-01. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency.

EPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. US Environmental Protection Agency.

EPA. 2010. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review. USEPA-540-R-10-011. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency.

Herrenkohl Consulting LLC and Landau Associates. 2010. Report: South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan. August 6.

Table 1
Sample Names and Dates of Sample Collection, Extraction, and Analysis
2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-GW-MW-46	BCI3A/ BCI3F	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX); 6/27-6/28/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-MW-36	BCI3B/ BCI3G	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/8/16 (Metals)
MGP-GW-MW-40	BCI3C/ BCI3H	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/8/16 (Metals)
MGP-GW-MW-42	BCI3D/ BCI3I	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-MW-55	BCI3E/ BCI3J	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-WP-01	BCI3K	6/21/16	6/24/16 (SIM SVOCs)	6/27/16 (BTEX, SIM SVOCs)
Trip Blanks	BCI3M	6/21/16	NA	6/27/16 (BTEX)
MGP-GW-MW-28	BCI7A/ BCI7D	6/22/16	6/28/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/28-6/29/16 (BTEX); 6/30-7/2/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-MW-34	BCI7B/ BCI7E	6/22/16	6/28/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/29/16 (BTEX); 7/2/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-Dup-1	BCI7C/ BCI7F	6/22/16	6/28/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/28/16 (BTEX); 7/2/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-WP-02	BCI7G	6/22/16	6/28/16 (SIM SVOCs)	6/28/16 (BTEX); 7/2/16 (SIM SVOCs)
MGP-GW-MW-58	BCI7H	6/22/16	NA	6/27/16 (BTEX)
Trip Blanks	BCI7I	6/22/16	NA	6/27/16 (BTEX)

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
2016 Groundwater Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
BCI3	Conv.	Total Cyanide	0.017	J	MGP-GW-MW-40	Analyzed outside hold time
BCI3	Conv.	Weak Acid Dissociable Cyanide	0.005	J	MGP-GW-MW-40	Analyzed outside hold time
BCI3	Conv.	Total Cyanide	0.012	J	MGP-GW-MW-42	Analyzed outside hold time
BCI3	Conv.	Weak Acid Dissociable Cyanide	0.006	J	MGP-GW-MW-42	Analyzed outside hold time
BCI3	Conv.	Total Cyanide	0.022	J	MGP-GW-MW-55	Analyzed outside hold time
BCI3	Conv.	Weak Acid Dissociable Cyanide	0.006	J	MGP-GW-MW-55	Analyzed outside hold time
BCI3	SIM SVOCs	Fluoranthene	0.071	J	MGP-GW-MW-42	Low MS/MSD recovery
BCI3	SIM SVOCs	Acenaphthene	1.0 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
BCI3	SIM SVOCs	Fluoranthene	1.5 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
BCI3	SIM SVOCs	Pyrene	1.6 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
BCI3	SIM SVOCs	Naphthalene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	2-Methylnaphthalene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	1-Methylnaphthalene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Acenaphthene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Fluorene	0.73	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Phenanthrene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Anthracene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Benzo(a)anthracene	0.12	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Chrysene	0.13	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Benzo(a)pyrene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Indeno(1,2,3-cd)pyrene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Dibenz(a,h)anthracene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Benzo(g,h,i)perylene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Dibenzofuran	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Total Benzofluoranthenes	0.20 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI7	Total Metals	Arsenic	8	J	MGP-GW-MW-34	High field duplicate RPD
BCI7	Total Metals	Lead	11	J	MGP-GW-MW-34	High field duplicate RPD
BCI7	Total Metals	Arsenic	22	J	MGP-GW-Dup-1	High field duplicate RPD
BCI7	Total Metals	Lead	57	J	MGP-GW-Dup-1	High field duplicate RPD
BCI7	BTEX	Benzene	3000 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	BTEX	Toluene	190	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	BTEX	Ethylbenzene	190	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	BTEX	m,p-Xylene	240	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	BTEX	o-Xylene	320	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Naphthalene	2,200	J	MGP-GW-MW-28	High MS/MSD RPD
BCI7	SIM SVOCs	2-Methylnaphthalene	200	J	MGP-GW-MW-28	High MS/MSD RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	330	J	MGP-GW-MW-28	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	Naphthalene	0.74	J	MGP-GW-MW-34	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	2-Methylnaphthalene	0.069	J	MGP-GW-MW-34	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	0.11	J	MGP-GW-MW-34	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	Acenaphthylene	0.14	J	MGP-GW-MW-34	High field duplicate RPD
BCI7	SIM SVOCs	Naphthalene	0.27	J	MGP-GW-Dup-1	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	2-Methylnaphthalene	0.022	J	MGP-GW-Dup-1	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	0.034	J	MGP-GW-Dup-1	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	Acenaphthylene	0.029	J	MGP-GW-Dup-1	High field duplicate RPD
BCI7	SIM SVOCs	Naphthalene	0.16	J	MGP-GW-WP-02	High MS/MSD RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	0.02	J	MGP-GW-WP-02	High MS/MSD RPD
BCI7	SIM SVOCs	Naphthalene	130 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	2-Methylnaphthalene	70 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	1-Methylnaphthalene	85 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	Fluorene	26 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	Phenanthrene	16 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	Naphthalene	500 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	2-Methylnaphthalene	180 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	1-Methylnaphthalene	260 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	Acenaphthylene	110 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	Acenaphthene	8.4	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Anthracene	3.4	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Fluoranthene	1.2	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Pyrene	1.3	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)anthracene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Chrysene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)pyrene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Indeno(1,2,3-cd)pyrene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenz(a,h)anthracene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
2016 Groundwater Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
BCI7	SIM SVOCs	Benzo(g,h,i)perylene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenzofuran	6.1	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Total Benzofluoranthenes	2.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Acenaphthene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Fluorene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Phenanthrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Anthracene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Fluoranthene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Pyrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)anthracene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Chrysene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)pyrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Indeno(1,2,3-cd)pyrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenz(a,h)anthracene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(g,h,i)perylene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenzofuran	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Total Benzofluoranthenes	80 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis

Notes
DNR = Do not report
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = Indicates the compound was undetected at the reported concentration.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Table 3
Target Reporting Limit Exceedances
2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-46	BCI3A	Fluoranthene	0.01 ug/L	0.10 ug/L	2.0 ug/L
MGP-GW-MW-46	BCI3A	Total Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-46	BCI3A	Total Calcium	50 ug/L	100 ug/L	264,000 ug/L
MGP-GW-MW-46	BCI3A	Total Magnesium	50 ug/L	100 ug/L	599,000 ug/L
MGP-GW-MW-46	BCI3A	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-46	BCI3A	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-46	BCI3F	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-46	BCI3F	Dissolved Calcium	50 ug/L	100 ug/L	274,000 ug/L
MGP-GW-MW-46	BCI3F	Dissolved Magnesium	50 ug/L	100 ug/L	610,000 ug/L
MGP-GW-MW-46	BCI3F	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-46	BCI3F	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-36	BCI3B	Total Arsenic	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-36	BCI3B	Total Calcium	50 ug/L	100 ug/L	281,000 ug/L
MGP-GW-MW-36	BCI3B	Total Magnesium	50 ug/L	100 ug/L	523,000 ug/L
MGP-GW-MW-36	BCI3B	Total Selenium	0.5 ug/L	5 ug/L	5 U ug/L
MGP-GW-MW-36	BCI3B	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-36	BCI3G	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-36	BCI3G	Dissolved Calcium	50 ug/L	100 ug/L	300,000 ug/L
MGP-GW-MW-36	BCI3G	Dissolved Magnesium	50 ug/L	100 ug/L	554,000 ug/L
MGP-GW-MW-36	BCI3G	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-36	BCI3G	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-40	BCI3C	Total Arsenic	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-40	BCI3C	Total Calcium	50 ug/L	100 ug/L	250,000 ug/L
MGP-GW-MW-40	BCI3C	Total Magnesium	50 ug/L	100 ug/L	694,000 ug/L
MGP-GW-MW-40	BCI3C	Total Selenium	0.5 ug/L	5 ug/L	5 U ug/L
MGP-GW-MW-40	BCI3C	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-40	BCI3H	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-40	BCI3H	Dissolved Calcium	50 ug/L	100 ug/L	248,000 ug/L
MGP-GW-MW-40	BCI3H	Dissolved Magnesium	50 ug/L	100 ug/L	687,000 ug/L
MGP-GW-MW-40	BCI3H	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-40	BCI3H	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-42	BCI3D	Total Arsenic	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-42	BCI3D	Total Calcium	50 ug/L	100 ug/L	293,000 ug/L
MGP-GW-MW-42	BCI3D	Total Magnesium	50 ug/L	100 ug/L	875,000 ug/L
MGP-GW-MW-42	BCI3D	Total Selenium	0.5 ug/L	5 ug/L	5 U ug/L
MGP-GW-MW-42	BCI3D	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-42	BCI3I	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-42	BCI3I	Dissolved Calcium	50 ug/L	100 ug/L	299,000 ug/L
MGP-GW-MW-42	BCI3I	Dissolved Magnesium	50 ug/L	100 ug/L	890,000 ug/L
MGP-GW-MW-42	BCI3I	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-42	BCI3I	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-55	BCI3E	Total Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-55	BCI3E	Total Calcium	50 ug/L	100 ug/L	200,000 ug/L
MGP-GW-MW-55	BCI3E	Total Magnesium	50 ug/L	100 ug/L	673,000 ug/L
MGP-GW-MW-55	BCI3E	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-55	BCI3E	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-55	BCI3J	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-55	BCI3J	Dissolved Calcium	50 ug/L	100 ug/L	198,000 ug/L
MGP-GW-MW-55	BCI3J	Dissolved Magnesium	50 ug/L	100 ug/L	672,000 ug/L
MGP-GW-MW-55	BCI3J	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L

Table 3
Target Reporting Limit Exceedances
2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-55	BCI3J	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-WP-01	BCI3K	Fluoranthene	0.01 ug/L	0.020 ug/L	0.16 ug/L
MGP-GW-MW-28	BCI7A	Benzene	0.2 ug/L	20 ug/L	3400 ug/L
MGP-GW-MW-28	BCI7A	Toluene	0.2 ug/L	4.0 ug/L	220 ug/L
MGP-GW-MW-28	BCI7A	Ethylbenzene	0.2 ug/L	4.0 ug/L	250 ug/L
MGP-GW-MW-28	BCI7A	m,p-Xylene	0.4 ug/L	8.0 ug/L	290 ug/L
MGP-GW-MW-28	BCI7A	o-Xylene	0.2 ug/L	4.0 ug/L	410 ug/L
MGP-GW-MW-28	BCI7A	Fluoranthene	0.01 ug/L	0.1 ug/L	1.2 ug/L
MGP-GW-MW-28	BCI7A	Naphthalene	0.1 ug/L	40 ug/L	2200 ug/L
MGP-GW-MW-28	BCI7A	2-Methylnaphthalene	0.1 ug/L	40 ug/L	200 ug/L
MGP-GW-MW-28	BCI7A	1-Methylnaphthalene	0.1 ug/L	40 ug/L	330 ug/L
MGP-GW-MW-28	BCI7A	Acenaphthylene	0.1 ug/L	40 ug/L	120 ug/L
MGP-GW-MW-28	BCI7A	Fluorene	0.1 ug/L	1.0 ug/L	29 ug/L
MGP-GW-MW-28	BCI7A	Phenanthrene	0.1 ug/L	1.0 ug/L	19 ug/L
MGP-GW-MW-28	BCI7A	Total Calcium	50 ug/L	100 ug/L	87,100 ug/L
MGP-GW-MW-28	BCI7A	Total Magnesium	50 ug/L	100 ug/L	32,700 ug/L
MGP-GW-MW-28	BCI7D	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-28	BCI7D	Dissolved Calcium	50 ug/L	100 ug/L	85,900 ug/L
MGP-GW-MW-28	BCI7D	Dissolved Lead	1.0 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-28	BCI7D	Dissolved Magnesium	50 ug/L	100 ug/L	32,700 ug/L
MGP-GW-MW-28	BCI7D	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-28	BCI7D	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-34	BCI7B	Total Arsenic	0.2 ug/L	4 ug/L	8 ug/L
MGP-GW-MW-34	BCI7B	Total Calcium	50 ug/L	100 ug/L	272,000 ug/L
MGP-GW-MW-34	BCI7B	Total Lead	1.0 ug/L	2 ug/L	11 ug/L
MGP-GW-MW-34	BCI7B	Total Magnesium	50 ug/L	100 ug/L	707,000 ug/L
MGP-GW-MW-34	BCI7B	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-34	BCI7B	Total Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Calcium	50 ug/L	100 ug/L	273,000 ug/L
MGP-GW-MW-34	BCI7E	Dissolved Lead	1.0 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Magnesium	50 ug/L	100 ug/L	715,000 ug/L
MGP-GW-MW-34	BCI7E	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-Dup-1	BCI7C	Total Arsenic	0.2 ug/L	4 ug/L	22 ug/L
MGP-GW-Dup-1	BCI7C	Total Calcium	50 ug/L	100 ug/L	268,000 ug/L
MGP-GW-Dup-1	BCI7C	Total Lead	1.0 ug/L	2 ug/L	57 ug/L
MGP-GW-Dup-1	BCI7C	Total Magnesium	50 ug/L	100 ug/L	690,000 ug/L
MGP-GW-Dup-1	BCI7C	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-Dup-1	BCI7C	Total Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Calcium	50 ug/L	250 ug/L	279,000 ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Lead	1.0 ug/L	2 ug/L	2 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Magnesium	50 ug/L	250 ug/L	756,000 ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-WP-02	BCI7G	Fluoranthene	0.01 ug/L	0.017 ug/L	0.022 ug/L

Technical Memorandum

TO: Chip Halbert

FROM: Kristi Schultz and Danille Jorgensen

DATE: October 25, 2016

RE: **2016 Groundwater Samples Laboratory Data Quality Evaluation**
City of Bellingham South State Street Manufactured Gas Plant
Remedial Investigation/Feasibility Study

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 11 groundwater samples collected on June 21-22, 2016 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for some or all of the following: benzene, toluene, ethylbenzene, and xylenes (BTEX; US Environmental Protection Agency [EPA] Method SW8260C); low-level semivolatile organic compounds (SIM SVOCs; EPA Method SW8270D-SIM); total and dissolved metals (EPA Method 6010C/6020A), including hardness calculation; total cyanide (SM4500-CNE); and weak acid dissociable (WAD) cyanide (SM4500CN-I). The analytical results are reported in ARI laboratory data packages identified as BCI3 and BCI7. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009), and with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 1999, 2008) and the National Functional Guidelines for Inorganic Data Review (EPA 2004, 2010), and the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan (Herrenkohl Consulting LLC and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control (QC) data, and QC acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that QC samples were performed as specified in the Quality Assurance Project Plan (QAPP).
- Evaluation of sample holding times.

- Evaluation of QC data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial and continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification (CCV) and continuing calibration blank (CCB) standards as appropriate.
- Method-specific instrument performance checks are present as appropriate (e.g., DDT/Endrin breakdown checks for pesticides and aroclors).
- Frequency of instrument QC samples is checked for appropriateness (e.g., GC-MS tunes have been run every 12 hours)
- Sample results are evaluated by comparing instrument-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical methods, or contract.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage 2B verification and validation check; a summary of the data validation qualifiers is presented in Table 2. The results of the verification and validation check are summarized below.

Laboratory Data Package Completeness

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

Sample Conditions and Analysis

The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample container information was compared to the associated COC and the cooler temperatures were recorded. All coolers were received at the laboratory with temperatures less than the EPA-recommended limit of 6°C.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times, with the following exceptions:

- The total and WAD cyanide analyses associated with samples MGP-GW-MW-40, MGP-GW-MW-42, and MGP-GW-MW-55 in data package BCI3 were completed 1 day outside the method-recommended hold time. Associated sample results were qualified as estimated (J), as indicated in Table 2.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks

At least one field (trip) blank was analyzed with each batch of samples submitted to the laboratory. Target analytes were not detected at concentrations greater than the reporting limits in the associated field blanks. No qualification of the data was necessary.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Surrogate spikes were diluted out during required SIM SVOC dilution reanalyses in data package BCI7. No qualification of the data was necessary.

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) and Laboratory Replicate Results

A MS and a MSD or laboratory duplicate sample was analyzed with the BTEX, SIM SVOCs, total and dissolved metals, and total and WAD cyanide analyses in data package BCI3. The recovery values for each spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

- The MS/MSD recoveries for fluoranthene associated with the SIM SVOCs analysis of sample MGP-GW-MW-42 in data package BCI3 were below the laboratory-specified control limit; the associated sample result was qualified as estimated (J), as indicated in Table 2.

- The MS recoveries for calcium and magnesium associated with the total metals analysis of sample MGP-GW-MW-42 in data package BCI3 were below the laboratory-specified control limits. The original sample concentrations were equal to or greater than four times the spike concentrations; therefore, no qualification of the data was necessary.
- The MS recovery for calcium associated with the dissolved metals analysis of sample MGP-GW-MW-42 in data package BCI3 was below the laboratory-specified control limit. The original sample concentration was equal to or greater than four times the spike concentration; therefore, no qualification of the data was necessary.

A project-specified control limit of 35 percent (organic analyses) or 20 percent (inorganic analyses) was used to evaluate the relative percent differences (RPDs) between the MS/MSD or laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the MS/MSDs or laboratory replicate results were within the current laboratory-specified control limits for all project samples. No qualification of the data was necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD and SRMs were within the current laboratory- and project-specified control limits, with the following exceptions:

- The LCS/LCSD RPD for naphthalene, 2-methylnaphthalene, and 1-methylnaphthalene associated with the SIM SVOCs analysis in data package BCI7 exceeded the project-specified control limit; the associated sample results were qualified as estimated (J), as indicated in Table 2.

Blind Field Duplicates

One pair of blind field duplicate groundwater samples (MGP-GW-DUP-1 / MGP-GW-MW-34) was submitted for analysis with data package BCI7 and analyzed for BTEX, SIM SVOCs, total and dissolved metals, and total and WAD cyanide. A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate groundwater samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exceptions:

- The RPDs for several compounds associated with the SIM SVOCs analyses of the blind field duplicate pair MGP-GW-DUP-1 / MGP-GW-MW-34 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.
- The RPDs for arsenic and lead associated with the total metals analysis of the blind field duplicate pair MGP-GW-DUP-1 / MGP-GW-MW-34 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.

Total and Dissolved Metals Concentrations

The analytical results for total and dissolved metals were compared for each project sample. A project-specified control limit of 20 percent was used to evaluate the RPDs between the total and dissolved metals results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the total and dissolved metals results were within the project-specified control limits for all project samples. No qualification of the data was necessary.

Reporting Limits

The reporting limits for BTEX, SIM SVOCs, and metals in several samples were above the target reporting limits due to either limited sample volume or required dilution due to high concentrations of target analytes in the samples. A list of the samples with raised reporting limits that did not contain detectable concentrations is provided in Table 3.

Initial and Continuing Calibration

Initial and continuing calibration verifications and instrument performance and QC checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. No qualification of the data was necessary.

Completeness and Overall Data Quality

Data precision was evaluated through matrix spike duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Use of this Report

This data validation summary report has been prepared for the exclusive use of the City of Bellingham and its designated representatives for specific application to the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates, Inc. (LAI). Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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Attachments: Table 1. Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2. Summary of Data Qualifiers
Table 3. Target Reporting Limit Exceedances

References

EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA-540/R-99-008. Office of Emergency and Remedial Response, US Environmental Protection Agency.

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Table 1
Sample Names and Dates of Sample Collection, Extraction, and Analysis
2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Sample Collection Date	Sample Extraction Date	Sample Analysis Date
MGP-GW-MW-46	BCI3A/ BCI3F	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX); 6/27-6/28/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-MW-36	BCI3B/ BCI3G	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/8/16 (Metals)
MGP-GW-MW-40	BCI3C/ BCI3H	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/8/16 (Metals)
MGP-GW-MW-42	BCI3D/ BCI3I	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-MW-55	BCI3E/ BCI3J	6/21/16	6/24/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/27/16 (BTEX, SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-WP-01	BCI3K	6/21/16	6/24/16 (SIM SVOCs)	6/27/16 (BTEX, SIM SVOCs)
Trip Blanks	BCI3M	6/21/16	NA	6/27/16 (BTEX)
MGP-GW-MW-28	BCI7A/ BCI7D	6/22/16	6/28/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/28-6/29/16 (BTEX); 6/30-7/2/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-MW-34	BCI7B/ BCI7E	6/22/16	6/28/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/29/16 (BTEX); 7/2/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-Dup-1	BCI7C/ BCI7F	6/22/16	6/28/16 (SIM SVOCs); 6/27-6/29/16 (Metals)	6/24/16 (Total and WAD Cyanide); 6/28/16 (BTEX); 7/2/16 (SIM SVOCs); 7/5-7/11/16 (Metals)
MGP-GW-WP-02	BCI7G	6/22/16	6/28/16 (SIM SVOCs)	6/28/16 (BTEX); 7/2/16 (SIM SVOCs)
MGP-GW-MW-58	BCI7H	6/22/16	NA	6/27/16 (BTEX)
Trip Blanks	BCI7I	6/22/16	NA	6/27/16 (BTEX)

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
2016 Groundwater Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
BCI3	Conv.	Total Cyanide	0.017	J	MGP-GW-MW-40	Analyzed outside hold time
BCI3	Conv.	Weak Acid Dissociable Cyanide	0.005	J	MGP-GW-MW-40	Analyzed outside hold time
BCI3	Conv.	Total Cyanide	0.012	J	MGP-GW-MW-42	Analyzed outside hold time
BCI3	Conv.	Weak Acid Dissociable Cyanide	0.006	J	MGP-GW-MW-42	Analyzed outside hold time
BCI3	Conv.	Total Cyanide	0.022	J	MGP-GW-MW-55	Analyzed outside hold time
BCI3	Conv.	Weak Acid Dissociable Cyanide	0.006	J	MGP-GW-MW-55	Analyzed outside hold time
BCI3	SIM SVOCs	Fluoranthene	0.071	J	MGP-GW-MW-42	Low MS/MSD recovery
BCI3	SIM SVOCs	Acenaphthene	1.0 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
BCI3	SIM SVOCs	Fluoranthene	1.5 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
BCI3	SIM SVOCs	Pyrene	1.6 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
BCI3	SIM SVOCs	Naphthalene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	2-Methylnaphthalene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	1-Methylnaphthalene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Acenaphthene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Fluorene	0.73	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Phenanthrene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Anthracene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Benzo(a)anthracene	0.12	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Chrysene	0.13	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Benzo(a)pyrene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Indeno(1,2,3-cd)pyrene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Dibenz(a,h)anthracene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Benzo(g,h,i)perylene	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Dibenzofuran	0.10 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI3	SIM SVOCs	Total Benzofluoranthenes	0.20 U	DNR	MGP-GW-MW-46-DL	Do not report; use original analysis
BCI7	Total Metals	Arsenic	8	J	MGP-GW-MW-34	High field duplicate RPD
BCI7	Total Metals	Lead	11	J	MGP-GW-MW-34	High field duplicate RPD
BCI7	Total Metals	Arsenic	22	J	MGP-GW-Dup-1	High field duplicate RPD
BCI7	Total Metals	Lead	57	J	MGP-GW-Dup-1	High field duplicate RPD
BCI7	BTEX	Benzene	3000 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	BTEX	Toluene	190	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	BTEX	Ethylbenzene	190	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	BTEX	m,p-Xylene	240	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	BTEX	o-Xylene	320	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Naphthalene	2,200	J	MGP-GW-MW-28	High MS/MSD RPD
BCI7	SIM SVOCs	2-Methylnaphthalene	200	J	MGP-GW-MW-28	High MS/MSD RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	330	J	MGP-GW-MW-28	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	Naphthalene	0.74	J	MGP-GW-MW-34	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	2-Methylnaphthalene	0.069	J	MGP-GW-MW-34	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	0.11	J	MGP-GW-MW-34	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	Acenaphthylene	0.14	J	MGP-GW-MW-34	High field duplicate RPD
BCI7	SIM SVOCs	Naphthalene	0.27	J	MGP-GW-Dup-1	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	2-Methylnaphthalene	0.022	J	MGP-GW-Dup-1	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	0.034	J	MGP-GW-Dup-1	High MS/MSD RPD, High field duplicate RPD
BCI7	SIM SVOCs	Acenaphthylene	0.029	J	MGP-GW-Dup-1	High field duplicate RPD
BCI7	SIM SVOCs	Naphthalene	0.16	J	MGP-GW-WP-02	High MS/MSD RPD
BCI7	SIM SVOCs	1-Methylnaphthalene	0.02	J	MGP-GW-WP-02	High MS/MSD RPD
BCI7	SIM SVOCs	Naphthalene	130 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	2-Methylnaphthalene	70 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	1-Methylnaphthalene	85 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	Fluorene	26 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	Phenanthrene	16 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
BCI7	SIM SVOCs	Naphthalene	500 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	2-Methylnaphthalene	180 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	1-Methylnaphthalene	260 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	Acenaphthylene	110 E	DNR	MGP-GW-MW-28-DL	Do not report; use dilution analysis
BCI7	SIM SVOCs	Acenaphthene	8.4	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Anthracene	3.4	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Fluoranthene	1.2	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Pyrene	1.3	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)anthracene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Chrysene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)pyrene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Indeno(1,2,3-cd)pyrene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenz(a,h)anthracene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
2016 Groundwater Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
BCI7	SIM SVOCs	Benzo(g,h,i)perylene	1.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenzofuran	6.1	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Total Benzofluoranthenes	2.0 U	DNR	MGP-GW-MW-28-DL	Do not report; use original analysis
BCI7	SIM SVOCs	Acenaphthene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Fluorene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Phenanthrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Anthracene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Fluoranthene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Pyrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)anthracene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Chrysene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(a)pyrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Indeno(1,2,3-cd)pyrene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenz(a,h)anthracene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Benzo(g,h,i)perylene	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Dibenzofuran	40 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis
BCI7	SIM SVOCs	Total Benzofluoranthenes	80 U	DNR	MGP-GW-MW-28-DL2	Do not report; use original analysis

Notes
DNR = Do not report
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = Indicates the compound was undetected at the reported concentration.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Table 3
Target Reporting Limit Exceedances
2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-46	BCI3A	Fluoranthene	0.01 ug/L	0.10 ug/L	2.0 ug/L
MGP-GW-MW-46	BCI3A	Total Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-46	BCI3A	Total Calcium	50 ug/L	100 ug/L	264,000 ug/L
MGP-GW-MW-46	BCI3A	Total Magnesium	50 ug/L	100 ug/L	599,000 ug/L
MGP-GW-MW-46	BCI3A	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-46	BCI3A	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-46	BCI3F	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-46	BCI3F	Dissolved Calcium	50 ug/L	100 ug/L	274,000 ug/L
MGP-GW-MW-46	BCI3F	Dissolved Magnesium	50 ug/L	100 ug/L	610,000 ug/L
MGP-GW-MW-46	BCI3F	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-46	BCI3F	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-36	BCI3B	Total Arsenic	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-36	BCI3B	Total Calcium	50 ug/L	100 ug/L	281,000 ug/L
MGP-GW-MW-36	BCI3B	Total Magnesium	50 ug/L	100 ug/L	523,000 ug/L
MGP-GW-MW-36	BCI3B	Total Selenium	0.5 ug/L	5 ug/L	5 U ug/L
MGP-GW-MW-36	BCI3B	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-36	BCI3G	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-36	BCI3G	Dissolved Calcium	50 ug/L	100 ug/L	300,000 ug/L
MGP-GW-MW-36	BCI3G	Dissolved Magnesium	50 ug/L	100 ug/L	554,000 ug/L
MGP-GW-MW-36	BCI3G	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-36	BCI3G	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-40	BCI3C	Total Arsenic	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-40	BCI3C	Total Calcium	50 ug/L	100 ug/L	250,000 ug/L
MGP-GW-MW-40	BCI3C	Total Magnesium	50 ug/L	100 ug/L	694,000 ug/L
MGP-GW-MW-40	BCI3C	Total Selenium	0.5 ug/L	5 ug/L	5 U ug/L
MGP-GW-MW-40	BCI3C	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-40	BCI3H	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-40	BCI3H	Dissolved Calcium	50 ug/L	100 ug/L	248,000 ug/L
MGP-GW-MW-40	BCI3H	Dissolved Magnesium	50 ug/L	100 ug/L	687,000 ug/L
MGP-GW-MW-40	BCI3H	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-40	BCI3H	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-42	BCI3D	Total Arsenic	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-42	BCI3D	Total Calcium	50 ug/L	100 ug/L	293,000 ug/L
MGP-GW-MW-42	BCI3D	Total Magnesium	50 ug/L	100 ug/L	875,000 ug/L
MGP-GW-MW-42	BCI3D	Total Selenium	0.5 ug/L	5 ug/L	5 U ug/L
MGP-GW-MW-42	BCI3D	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-42	BCI3I	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-42	BCI3I	Dissolved Calcium	50 ug/L	100 ug/L	299,000 ug/L
MGP-GW-MW-42	BCI3I	Dissolved Magnesium	50 ug/L	100 ug/L	890,000 ug/L
MGP-GW-MW-42	BCI3I	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-42	BCI3I	Dissolved Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-55	BCI3E	Total Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-55	BCI3E	Total Calcium	50 ug/L	100 ug/L	200,000 ug/L
MGP-GW-MW-55	BCI3E	Total Magnesium	50 ug/L	100 ug/L	673,000 ug/L
MGP-GW-MW-55	BCI3E	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-55	BCI3E	Total Silver	0.2 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-55	BCI3J	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-55	BCI3J	Dissolved Calcium	50 ug/L	100 ug/L	198,000 ug/L
MGP-GW-MW-55	BCI3J	Dissolved Magnesium	50 ug/L	100 ug/L	672,000 ug/L
MGP-GW-MW-55	BCI3J	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L

Table 3
Target Reporting Limit Exceedances
2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-55	BCI3J	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-WP-01	BCI3K	Fluoranthene	0.01 ug/L	0.020 ug/L	0.16 ug/L
MGP-GW-MW-28	BCI7A	Benzene	0.2 ug/L	20 ug/L	3400 ug/L
MGP-GW-MW-28	BCI7A	Toluene	0.2 ug/L	4.0 ug/L	220 ug/L
MGP-GW-MW-28	BCI7A	Ethylbenzene	0.2 ug/L	4.0 ug/L	250 ug/L
MGP-GW-MW-28	BCI7A	m,p-Xylene	0.4 ug/L	8.0 ug/L	290 ug/L
MGP-GW-MW-28	BCI7A	o-Xylene	0.2 ug/L	4.0 ug/L	410 ug/L
MGP-GW-MW-28	BCI7A	Fluoranthene	0.01 ug/L	0.1 ug/L	1.2 ug/L
MGP-GW-MW-28	BCI7A	Naphthalene	0.1 ug/L	40 ug/L	2200 ug/L
MGP-GW-MW-28	BCI7A	2-Methylnaphthalene	0.1 ug/L	40 ug/L	200 ug/L
MGP-GW-MW-28	BCI7A	1-Methylnaphthalene	0.1 ug/L	40 ug/L	330 ug/L
MGP-GW-MW-28	BCI7A	Acenaphthylene	0.1 ug/L	40 ug/L	120 ug/L
MGP-GW-MW-28	BCI7A	Fluorene	0.1 ug/L	1.0 ug/L	29 ug/L
MGP-GW-MW-28	BCI7A	Phenanthrene	0.1 ug/L	1.0 ug/L	19 ug/L
MGP-GW-MW-28	BCI7A	Total Calcium	50 ug/L	100 ug/L	87,100 ug/L
MGP-GW-MW-28	BCI7A	Total Magnesium	50 ug/L	100 ug/L	32,700 ug/L
MGP-GW-MW-28	BCI7D	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-28	BCI7D	Dissolved Calcium	50 ug/L	100 ug/L	85,900 ug/L
MGP-GW-MW-28	BCI7D	Dissolved Lead	1.0 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-28	BCI7D	Dissolved Magnesium	50 ug/L	100 ug/L	32,700 ug/L
MGP-GW-MW-28	BCI7D	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-28	BCI7D	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-34	BCI7B	Total Arsenic	0.2 ug/L	4 ug/L	8 ug/L
MGP-GW-MW-34	BCI7B	Total Calcium	50 ug/L	100 ug/L	272,000 ug/L
MGP-GW-MW-34	BCI7B	Total Lead	1.0 ug/L	2 ug/L	11 ug/L
MGP-GW-MW-34	BCI7B	Total Magnesium	50 ug/L	100 ug/L	707,000 ug/L
MGP-GW-MW-34	BCI7B	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-34	BCI7B	Total Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Calcium	50 ug/L	100 ug/L	273,000 ug/L
MGP-GW-MW-34	BCI7E	Dissolved Lead	1.0 ug/L	2 ug/L	2 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Magnesium	50 ug/L	100 ug/L	715,000 ug/L
MGP-GW-MW-34	BCI7E	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-MW-34	BCI7E	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-Dup-1	BCI7C	Total Arsenic	0.2 ug/L	4 ug/L	22 ug/L
MGP-GW-Dup-1	BCI7C	Total Calcium	50 ug/L	100 ug/L	268,000 ug/L
MGP-GW-Dup-1	BCI7C	Total Lead	1.0 ug/L	2 ug/L	57 ug/L
MGP-GW-Dup-1	BCI7C	Total Magnesium	50 ug/L	100 ug/L	690,000 ug/L
MGP-GW-Dup-1	BCI7C	Total Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-Dup-1	BCI7C	Total Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Arsenic	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Calcium	50 ug/L	250 ug/L	279,000 ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Lead	1.0 ug/L	2 ug/L	2 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Magnesium	50 ug/L	250 ug/L	756,000 ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Selenium	0.5 ug/L	10 ug/L	10 U ug/L
MGP-GW-Dup-1	BCI7F	Dissolved Silver	0.2 ug/L	4 ug/L	4 U ug/L
MGP-GW-WP-02	BCI7G	Fluoranthene	0.01 ug/L	0.017 ug/L	0.022 ug/L

Technical Memorandum

TO: Jeremy Davis

FROM: Kristi Schultz and Danille Jorgensen

DATE: November 18, 2016

RE: **September 2016 Groundwater Samples Laboratory Data Quality Evaluation City of Bellingham South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study**

This technical memorandum provides the results of a Stage 2B verification and validation check of analytical data for 10 groundwater samples collected on September 14-15, 2016 at the South State Street Manufactured Gas Plant in Bellingham, Washington. All sample analyses were conducted at Analytical Resources, Inc. (ARI) laboratory, located in Tukwila, Washington. Samples submitted to ARI were analyzed for some or all of the following: benzene, toluene, ethylbenzene, and xylenes (BTEX; US Environmental Protection Agency [EPA] Method SW8260C); low-level semivolatile organic compounds (SIM SVOCs; EPA Method SW8270D-SIM); total and dissolved metals (EPA Method 6010C/6020A) including hardness calculation; total cyanide (SM4500-CNE); and weak acid dissociable (WAD) cyanide (SM4500-CNI). The analytical results are reported in ARI laboratory data packages identified as 16I0216 and 16I0219. Sample identifications and sample collection, extraction, and analysis dates are provided in Table 1.

The Stage 2B verification and validation check was conducted in accordance with EPA's Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009), and with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 1999, 2008) and the National Functional Guidelines for Inorganic Data Review (EPA 2004, 2010), and the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan (Herrenkohl Consulting LLC and Landau Associates 2010). The Stage 2B verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control (QC) data, and QC acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Verification that QC samples were performed as specified in the Quality Assurance Project Plan (QAPP).
- Evaluation of sample holding times.

- Evaluation of QC data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of reporting limits compared to target reporting limits specified in the Work Plan.
- Verification that initial and continuing calibration data are provided for all requested analytes and are linked to the field samples reported, and that reported samples are bracketed by continuing calibration verification (CCV) and continuing calibration blank (CCB) standards as appropriate.
- Method-specific instrument performance checks are present as appropriate (e.g., DDT/Endrin breakdown checks for pesticides and aroclors).
- Frequency of instrument QC samples is checked for appropriateness (e.g., GC-MS tunes have been run every 12 hours)
- Sample results are evaluated by comparing instrument-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical methods, or contract.

Data validation qualifiers are added to the sample results, as appropriate, based on the Stage 2B verification and validation check; a summary of the data validation qualifiers is presented in Table 2. The results of the verification and validation check are summarized below.

Laboratory Data Package Completeness

Each laboratory data package contained a signed COC, a cooler receipt form documenting the condition of the samples upon receipt at the laboratory, a cooler temperature compliance form, sample analytical results, and quality control results (method blanks, surrogate recoveries, laboratory control sample results, replicate sample results, initial and continuing calibrations, and instrument performance checks and quality control samples). A case narrative identifying any complications was also provided with each laboratory data package. Definitions of laboratory qualifiers and quality control acceptance criteria were provided, as appropriate.

Sample Conditions and Analysis

The laboratory received all samples in good condition, and all analyses were performed as requested. Upon receipt by ARI, the sample container information was compared to the associated COC and the cooler temperatures were recorded. All coolers were received at the laboratory with temperatures less than the EPA-recommended limit of 6°C.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for each analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks

At least one field (trip) blank was analyzed with each batch of samples submitted to the laboratory. Target analytes were not detected at concentrations greater than the reporting limits in the associated field blanks. No qualification of the data was necessary.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for each organic analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits with the following exceptions:

- Recoveries of surrogate fluoranthene-d10 associated with the SIM SVOCs analysis of sample MGP-GW-MW-40 in data package 16I0219 was below the laboratory-specified control limits. EPA National Functional Guidelines require two or more surrogates of the same fraction to be outside laboratory-specified control limits for qualification of the data based on surrogate recoveries; therefore, no qualification of the data was necessary.
- Recoveries of surrogate 2-methylnaphthalene-d10 associated with the SIM SVOCs analysis of sample MGP-GW-MW-28 in data package 16I0219 was below the laboratory-specified control limits. EPA National Functional Guidelines require two or more surrogates of the same fraction to be outside laboratory-specified control limits for qualification of the data based on surrogate recoveries; therefore, no qualification of the data was necessary.
- Recovery of surrogate 4-bromofluorobenzene exceeded laboratory-specified control limits in one of the continuing calibrations associated with the BTEX analysis in data package 16I0219. The associated project sample surrogate recoveries were within laboratory-specified control limits; therefore, no qualification of the data was considered necessary.

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) and Laboratory Replicate Results

A MS and a MSD or laboratory duplicate sample was analyzed with the BTEX, SIM SVOCs, total and dissolved metals, and total and WAD cyanide analyses in data package 16I0219; and with the dissolved metals analysis in data package 16I0216. The recovery values for each spiking compound were within the laboratory-specified control limits for all project samples with the following exceptions:

- The MS recoveries for calcium and magnesium associated with the total metals analysis of sample MGP-GW-MW-42 in data package 16I0219 were below the laboratory-specified control limits. The original sample concentrations were equal to or greater than four times the spike concentrations; therefore, no qualification of the data was necessary.
- The MS recoveries for calcium and magnesium associated with the dissolved metals analysis of sample MGP-GW-MW-34 in data package 16I0216 and sample MGP-GW-MW-42 in data package 16I0219 were below the laboratory-specified control limits. The original sample concentrations were equal to or greater than four times the spike concentrations; therefore, no qualification of the data was necessary.

A project-specified control limit of 35 percent (organic analyses) or 20 percent (inorganic analyses) was used to evaluate the relative percent differences (RPDs) between the MS/MSD or laboratory replicate results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the MS/MSDs or laboratory replicate results were within the current laboratory-specified control limits for all project samples. No qualification of the data was necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate Results

At least one LCS and/or LCSD or standard reference material (SRM) sample was analyzed with each batch of samples for each analysis. Recoveries and RPDs for the LCS/LCSD and SRMs were within the current laboratory- and project-specified control limits. No qualification of the data was necessary.

Blind Field Duplicates

One pair of blind field duplicate groundwater samples (MGP-GW-DUP-1 / MGP-GW-MW-34) was submitted for analysis with data package 16I0216 and analyzed for BTEX, SIM SVOCs, total and dissolved metals, and total and WAD cyanide. A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate groundwater samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits with the following exceptions:

- The RPD for lead associated with the total metals analysis of the blind field duplicate pair MGP-GW-DUP-1 / MGP-GW-MW-34 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.
- The RPDs for acenaphthylene associated with the SIM SVOCs analyses of the blind field duplicate pair MGP-GW-DUP-1 / MGP-GW-MW-34 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 2.

Total and Dissolved Metals Concentrations

The analytical results for total and dissolved metals were compared for each project sample. A project-specified control limit of 20 percent was used to evaluate the RPDs between the total and dissolved metals results, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. The RPDs between the total and dissolved metals results were within the project-specified control limits for all project samples. No qualification of the data was necessary.

Reporting Limits

The reporting limits for BTEX, SIM SVOCs, and metals in several samples were above the target reporting limits due to either limited sample volume or required dilution due to high concentrations of target analytes in the samples. A list of the samples with raised reporting limits that did not contain detectable concentrations is provided in Table 3.

Initial and Continuing Calibration

Initial and continuing calibration verifications and instrument performance and QC checks were performed for all requested analyses and were appropriate in number and frequency based on laboratory requirements. Calibration verifications were within laboratory-specified control limits, with the following exceptions:

- The initial calibration verification was low for benzo(g,h,i)perylene associated with the SIM SVOC analyses in data packages 16I0216 and 16I0219. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 2.

Completeness and Overall Data Quality

Data precision was evaluated through matrix spike duplicates, laboratory replicates, and laboratory control sample duplicates. Data accuracy was evaluated through matrix spikes, laboratory control samples, and surrogate spikes. Based on this data quality evaluation, the data reported, as qualified, are considered to be usable for meeting project objectives. No data were rejected. The completeness for this data set is 100 percent, which meets the project-specified goal of 95 percent minimum.

Use of this Report

This data validation summary report has been prepared for the exclusive use of the City of Bellingham and its designated representatives for specific application to the South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates, Inc. (LAI). Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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KES/DRJ/ljc
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Attachments: Table 1. Sample Names and Dates of Sample Collection, Extraction, and Analysis
Table 2. Summary of Data Qualifiers
Table 3. Target Reporting Limit Exceedances

References

EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA-540/R-99-008. Office of Emergency and Remedial Response, US Environmental Protection Agency.

EPA. 2004. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA 540-R-04-004. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency.

EPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. USEPA-540-R-08-01. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency.

EPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. US Environmental Protection Agency.

EPA. 2010. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review. USEPA-540-R-10-011. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency.

Herrenkohl Consulting LLC and Landau Associates. 2010. Report: South State Street Manufactured Gas Plant Remedial Investigation/Feasibility Study Work Plan. August 6.

Table 1
Sample Names and Dates of Sample Collection, Extraction, and Analysis
September 2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Sample Collection Date	Sample Prep/Extraction Date	Sample Analysis Date
MGP-GW-MW-34	16I0216-01/ 16I0216-07	9/15/16	9/19-9/20/16 (Metals); 9/21/16 (Cyanide, SIM SVOCs); 9/28/16 (BTEX)	9/21-9/23/16 (Metals); 9/22/16 (Cyanide); 9/26/16 (SIM SVOCs); 9/28/16 (BTEX)
MGP-GW-MW-36	16I0216-02/ 16I0216-08	9/15/16	9/19-9/20/16 (Metals); 9/21/16 (Cyanide, SIM SVOCs); 9/24/16 (BTEX)	9/21-9/23/16 (Metals); 9/22/16 (Cyanide); 9/24/16 (BTEX); 9/26/16 (SIM SVOCs)
MGP-GW-DUP-1	16I0216-03/ 16I0216-09	9/15/16	9/19-9/20/16 (Metals); 9/21/16 (Cyanide, SIM SVOCs); 9/24/16 (BTEX)	9/21-9/23/16 (Metals); 9/22/16 (Cyanide); 9/24/16 (BTEX); 9/26/16 (SIM SVOCs)
MGP-GW-MW-46	16I0216-04/ 16I0216-10	9/15/16	9/19-9/20/16 (Metals); 9/21/16 (Cyanide, SIM SVOCs); 9/24/16 (BTEX)	9/21-9/23/16 (Metals); 9/22/16 (Cyanide); 9/24/16 (BTEX); 9/26-9/27/16 (SIM SVOCs)
MGP-GW-WP-02	16I0216-05	9/15/16	9/21/16 (SIM SVOCs); 9/24/16 (BTEX)	9/24/16 (BTEX); 9/26/16 (SIM SVOCs)
Trip Blanks	16I0216-06	9/15/16	9/22/16 (BTEX)	9/23/16 (BTEX)
MGP-GW-MW-42	16I0219-01/ 16I0219-07	9/14/16	9/15-9/16/16 (Metals); 9/20/16 (BTEX); 9/21/16 (Cyanide, SIM SVOCs)	9/15-9/21/16 (Metals); 9/20/16 (BTEX); 9/22/16 (Cyanide); 9/26/16 (SIM SVOCs)
MGP-GW-MW-55	16I0219-02/ 16I0219-08	9/14/16	9/15-9/16/16 (Metals); 9/20/16 (BTEX); 9/21/16 (Cyanide, SIM SVOCs)	9/15-9/21/16 (Metals); 9/20/16 (BTEX); 9/22/16 (Cyanide); 9/26/16 (SIM SVOCs)
MGP-GW-MW-40	16I0219-03/ 16I0219-09	9/14/16	9/15-9/16/16 (Metals); 9/20/16 (BTEX); 9/21/16 (Cyanide, SIM SVOCs)	9/15-9/21/16 (Metals); 9/20/16 (BTEX); 9/22/16 (Cyanide); 9/26/16 (SIM SVOCs)
MGP-GW-WP-01	16I0219-04	9/14/16	9/15/16 (Metals); 9/20/16 (BTEX); 9/21/16 (Cyanide, SIM SVOCs)	9/15-9/20/16 (Metals); 9/20/16 (BTEX); 9/22/16 (Cyanide); 9/26-9/27/16 (SIM SVOCs)
MGP-GW-MW-28	16I0219-05/ 16I0219-010	9/14/16	9/15-9/16/16 (Metals); 9/20/16 (BTEX); 9/21/16 (Cyanide, SIM SVOCs)	9/15-9/21/16 (Metals); 9/20-9/24/16 (BTEX); 9/22/16 (Cyanide); 9/26-9/27/16 (SIM SVOCs)
Trip Blanks	16I0219-06	9/14/16	9/20/16 (BTEX)	9/20/16 (BTEX)

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
September 2016 Groundwater Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
3	Total Metals	Lead	7.02	J	MGP-GW-DUP-1	High field duplicate RPD
16I0216	Total Metals	Lead	2.4	J	MGP-GW-MW-34	High field duplicate RPD
16I0216	SIM SVOCs	Acenaphthylene	0.049	J	MGP-GW-DUP-1	High field duplicate RPD
16I0216	SIM SVOCs	Acenaphthylene	0.035	J	MGP-GW-MW-34	High field duplicate RPD
16I0216	SIM SVOCs	Benzo(g,h,i)perylene	0.01 U	UJ	MGP-GW-DUP-1	Low continuing calibration recovery
16I0216	SIM SVOCs	Benzo(g,h,i)perylene	0.01 U	UJ	MGP-GW-MW-34	Low continuing calibration recovery
16I0216	SIM SVOCs	Benzo(g,h,i)perylene	0.01 U	UJ	MGP-GW-MW-36	Low continuing calibration recovery
16I0216	SIM SVOCs	Benzo(g,h,i)perylene	0.01 U	UJ	MGP-GW-MW-46	Low continuing calibration recovery
16I0216	SIM SVOCs	Benzo(g,h,i)perylene	0.021	J	MGP-GW-WP-02	Low continuing calibration recovery
16I0216	SIM SVOCs	Pyrene	1.48 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
16I0216	SIM SVOCs	Fluoranthene	1.41 E	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
16I0216	SIM SVOCs	Acenaphthylene	1.02	DNR	MGP-GW-MW-46	Do not report; use dilution analysis
16I0216	SIM SVOCs	Anthracene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Dibenzofuran	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Benzo(g,h,i)perylene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Indeno(1,2,3-cd)pyrene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Chrysene	0.121	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Benzo(a)pyrene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Dibenzo(a,h)anthracene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Benzo(a)anthracene	0.114	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Acenaphthene	0.115	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Phenanthrene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Fluorene	0.615	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	1-Methylnaphthalene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Naphthalene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	2-Methylnaphthalene	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0216	SIM SVOCs	Total Benzofluoranthenes	0.1 U	DNR	MGP-GW-MW-46	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	0.1 U	UJ	MGP-GW-MW-28	Low continuing calibration recovery
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	0.1 U	UJ	MGP-GW-MW-40	Low continuing calibration recovery
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	0.1 U	UJ	MGP-GW-MW-42	Low continuing calibration recovery
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	0.1 U	UJ	MGP-GW-MW-55	Low continuing calibration recovery
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	0.049	J	MGP-GW-WP-01	Low continuing calibration recovery
16I0219	SIM SVOCs	Anthracene	2.26 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Pyrene	1.44 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Dibenzofuran	2.88 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Fluoranthene	1.34 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Acenaphthylene	8.69 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Acenaphthene	4.14 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Phenanthrene	4.78 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Fluorene	7.35 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	1-Methylnaphthalene	8.2 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Naphthalene	12.1 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	2-Methylnaphthalene	5.29 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Indeno(1,2,3-cd)pyrene	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Acenaphthylene	139 E	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Chrysene	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(a)pyrene	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Dibenzo(a,h)anthracene	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(a)anthracene	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	1-Methylnaphthalene	299 E	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Naphthalene	597 E	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	2-Methylnaphthalene	136 E	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Total Benzofluoranthenes	1 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Anthracene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Pyrene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Dibenzofuran	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Indeno(1,2,3-cd)pyrene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Fluoranthene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Chrysene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(a)pyrene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Dibenzo(a,h)anthracene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(a)anthracene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Acenaphthene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Phenanthrene	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Fluorene	37.6	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Total Benzofluoranthenes	30 U	DNR	MGP-GW-MW-28	Do not report; use original analysis
16I0219	SIM SVOCs	Pyrene	1.09 E	DNR	MGP-GW-WP-01	Do not report; use dilution analysis

Table 2
Summary of Data Qualifiers
South State Street Manufactured Gas Plant
September 2016 Groundwater Sampling

Data Package	Analytical Group	Analyte	Result	Qualifier	Sample Number	Reason
16I0219	SIM SVOCs	Anthracene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Dibenzofuran	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(g,h,i)perylene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Indeno(1,2,3-cd)pyrene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Fluoranthene	0.329	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Acenaphthylene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Chrysene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(a)pyrene	0.12	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Dibenzo(a,h)anthracene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Benzo(a)anthracene	0.107	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Acenaphthene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Phenanthrene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Fluorene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	1-Methylnaphthalene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Naphthalene	0.233	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	2-Methylnaphthalene	0.1 U	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	SIM SVOCs	Total Benzofluoranthenes	0.16	DNR	MGP-GW-WP-01	Do not report; use original analysis
16I0219	BTEX	Benzene	213 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	Ethylbenzene	143 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	Toluene	98.7 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	m,p-Xylene	140 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	o-Xylene	158 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	Benzene	2930 E	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	Ethylbenzene	66.9	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	Toluene	84.7	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	m,p-Xylene	80 U	DNR	MGP-GW-MW-28	Do not report; use dilution analysis
16I0219	BTEX	o-Xylene	136	DNR	MGP-GW-MW-28	Do not report; use dilution analysis

Notes

DNR = Do not report
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = Indicates the compound was undetected at the reported concentration.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Table 3
Target Reporting Limit Exceedances
September 2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-34	16I0216-02	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-34	16I0216-07	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-34	16I0216-07	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-MW-34	16I0216-02	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-34	16I0216-02	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-34	16I0216-07	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-34	16I0216-07	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-36	16I0216-02	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-MW-36	16I0216-02	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-36	16I0216-08	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-36	16I0216-08	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-MW-36	16I0216-02	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-36	16I0216-02	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-36	16I0216-08	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-36	16I0216-08	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-DUP-1	16I0216-03	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-DUP-1	16I0216-09	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-DUP-1	16I0216-09	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-DUP-1	16I0216-03	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-DUP-1	16I0216-03	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-DUP-1	16I0216-09	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-DUP-1	16I0216-09	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-46	16I0216-04	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-MW-46	16I0216-04	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-46	16I0216-10	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-46	16I0216-10	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-MW-46	16I0216-04	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-46	16I0216-04	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-46	16I0216-10	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-46	16I0216-10	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-WP-02	16I0216-05	2-Methylnaphthalene	0.01 µg/L	0.011 µg/L	0.011 U µg/L
MGP-GW-WP-02	16I0216-05	Acenaphthene	0.01 µg/L	0.011 µg/L	0.011 U µg/L
MGP-GW-WP-02	16I0216-05	Dibenzofuran	0.01 µg/L	0.011 µg/L	0.011 U µg/L
MGP-GW-WP-02	16I0216-05	Fluorene	0.01 µg/L	0.011 µg/L	0.011 U µg/L
MGP-GW-WP-02	16I0216-05	Dibenz(a,h)anthracene	0.01 µg/L	0.011 µg/L	0.011 U µg/L
MGP-GW-WP-02	16I0216-05	1-Methylnaphthalene	0.01 µg/L	0.011 µg/L	0.011 U µg/L
MGP-GW-MW-42	16I0219-01	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-MW-42	16I0219-07	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-42	16I0219-01	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-42	16I0219-07	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-MW-42	16I0219-01	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-42	16I0219-07	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-42	16I0219-01	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-42	16I0219-07	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-55	16I0219-02	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-MW-55	16I0219-08	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-55	16I0219-02	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-55	16I0219-08	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L

Table 3
Target Reporting Limit Exceedances
September 2016 Groundwater Sampling
South State Street Manufactured Gas Plant
Bellingham, Washington

Sample Name	Lab Sample ID	Analyte	Target Quantitation Limit	Sample Reporting Limit	Sample Result
MGP-GW-MW-55	16I0219-02	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-55	16I0219-08	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-55	16I0219-02	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-55	16I0219-08	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-40	16I0219-03	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-MW-40	16I0219-09	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-40	16I0219-03	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-40	16I0219-09	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-MW-40	16I0219-03	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-40	16I0219-09	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-40	16I0219-03	Dissolved Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-40	16I0219-09	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-WP-01	16I0219-04	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-WP-01	16I0219-04	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-WP-01	16I0219-04	Total Arsenic	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-WP-01	16I0219-04	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-28	16I0219-05	Total Lead	1.0 µg/L	2.0 µg/L	2.0 U µg/L
MGP-GW-MW-28	16I0219-10	Total Silver	0.2 µg/L	4.0 µg/L	4.0 U µg/L
MGP-GW-MW-28	16I0219-05	Dissolved Lead	1.0 µg/L	1.0 µg/L	2.0 U µg/L
MGP-GW-MW-28	16I0219-10	Dissolved Silver	0.2 µg/L	0.2 µg/L	4.0 U µg/L
MGP-GW-MW-28	16I0219-10	Total Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L
MGP-GW-MW-28	16I0219-10	Dissolved Selenium	0.5 µg/L	10.0 µg/L	10.0 U µg/L