

## **APPENDIX D**

### **GROUNDWATER MONITORING**

Table D-1. Vibrating Wire Piezometer Readings

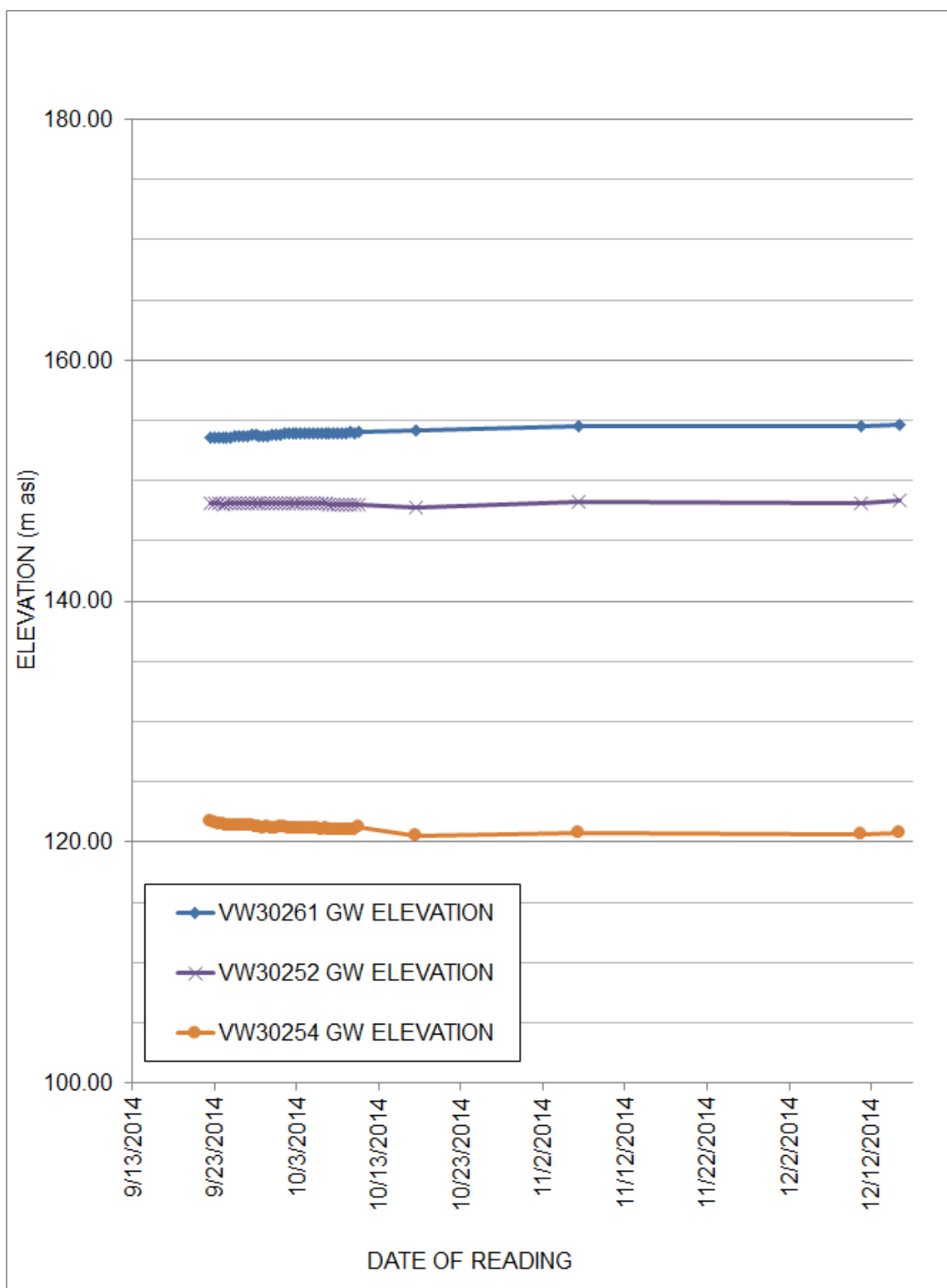
Hole ID	VWP Serial Number	VWP Tip Elevation (m asl)	Groundwater Elevation (m asl)		
			17-Oct-14	6-Nov-14	15-Dec-14
HMM-BH-02	VW21537	218.0	N/A <sup>1</sup>		
	VW31091	63.4			
HMM-BH-03	VW30261	140.0	154.17	154.48	154.49
	VW30252	119.0	147.78	148.19	148.34
	VW30254	89.0	120.57	120.79	120.78
HMM-BH-05	VW30253	15.0	27.78	28.91	N/A <sup>2</sup>
	VW30255	-5.0	15.08	15.88	15.75

1. No readings - site inaccessible due to continued protest activity

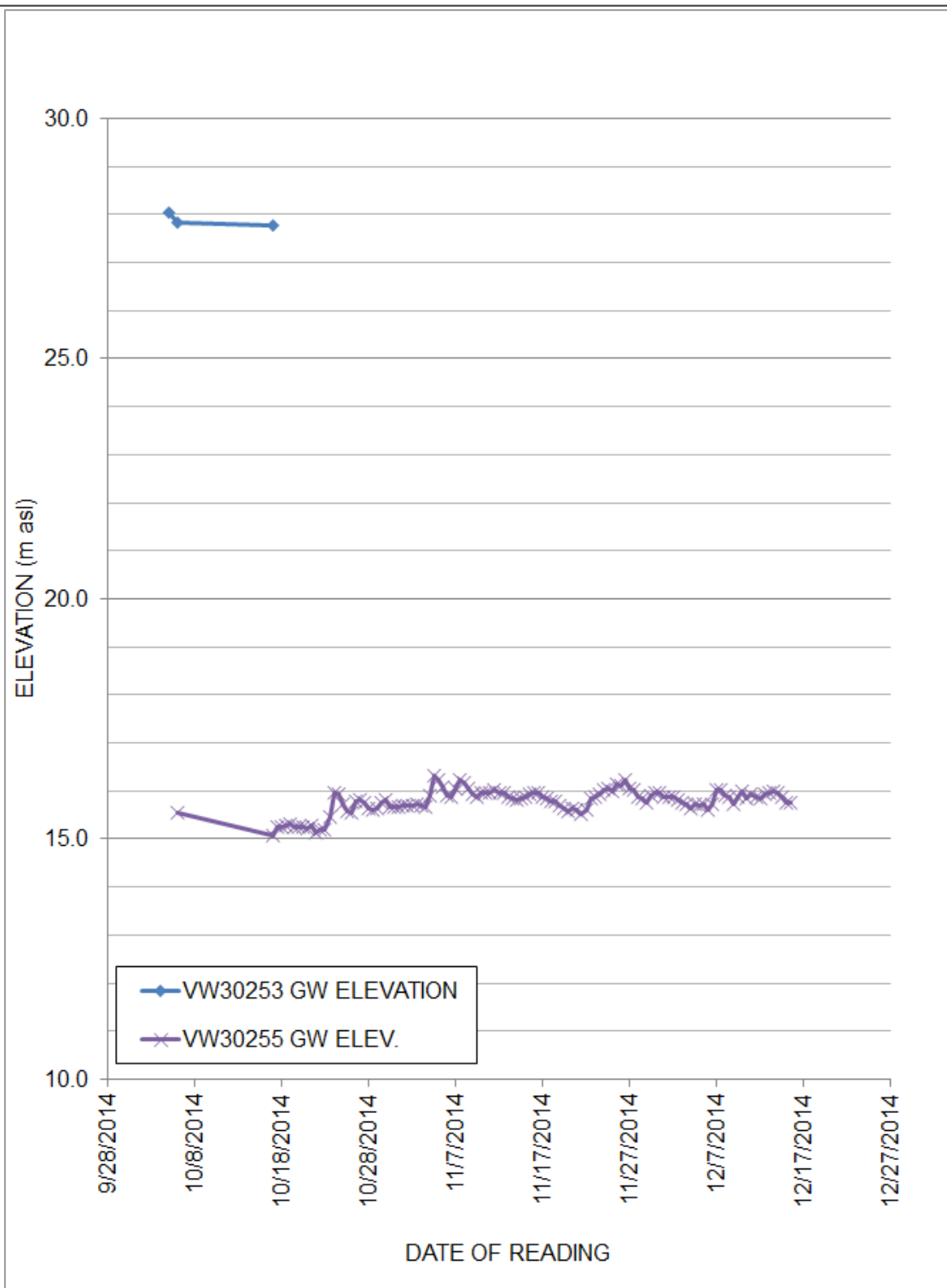
2. No readings - datalogger malfunction

Table D-2. Borehole Water Levels Measured During Drilling

Hole ID	Date	Borehole Depth (m bgs)	Measured Water Level (m bgs)	Water Elevation (m asl)
HMM-BH-01	11/24/2014	24.37	7.94	204.06
	11/27/2014	70.1	7.15	204.85
HMM-BH-02	11/22/2014	52.85	8.1	228.9
	11/23/2014	112.85	15.2	221.8
	11/24/2014	142.85	8.3	228.7
HMM-BH-03	9/13/2014	38.59	8.50	156.50
	9/14/2014	53.84	10.70	154.30
	9/14/2014	70.60	12.06	152.94
	9/15/2014	90.42	9.93	155.07
	9/16/2014	125.48	10.75	154.25
	9/17/2014	160.54	15.26	149.74
	9/18/2014	181.89	14.29	150.71
HMM-BH-05	10/4/2014	32.25	4.59	28.41



**Figure D1 GROUNDWATER ELEVATIONS – HMM-BH-03**



NOTES:

1. CONTINUING DATA WAS NOT RECORDED FOR VW30253 DUE TO DATALOGGER MALFUNCTION.

**Figure D2 GROUNDWATER ELEVATIONS – HMM-BH-05**

TMEP Westridge Tunnel Investigation

Borehole ID:	HMM-BH-03	A	-1.3090E-09
Location:	Tank Farm	B	-0.00027288
Collar Northing:		C	2.4993
Collar Easting:		Tk	-0.01119 (Kpa/degree C rise)
Collar Elevation (m asl):	165.00	CF	0.2914 (Kpa/B unit)
Borehole Plunge:	90	Bi	8795.6 B Unit
VW number:	VW30261		
VWP Elevation (m asl):	140.00		
VWP vertical depth (m bgs)*:	25.00		
VWP Rating (MPa):	1.00		

Conversion1 Kpa = 0.1019977

\* Already corrected for hole plunge

READINGS CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Groundwater Elevation (ft asl)	Notes
2014-09-19	8794.9	16.9	0.00	0.00			Before installation
2014-09-19	8552.3	13.9	70.73	7.21	147.21	482.99	Placed in hole
2014-09-20	8578.1	13.1	63.22	6.45	146.45	480.47	Before Grouting
2014-09-20 11:00	8199.0	16.6	173.65	17.71	157.71	517.43	After Grout
2014-09-22 12:00	8340.06	12.44	132.59	13.52	153.52	503.69	
2014-09-23 0:00	8340.13	12.27	132.57	13.52	153.52	503.68	
2014-09-23 12:00	8339.74	12.14	132.69	13.53	153.53	503.72	
2014-09-24 0:00	8340.3	12.03	132.52	13.52	153.52	503.67	
2014-09-24 12:00	8338.07	11.94	133.18	13.58	153.58	503.88	
2014-09-25 0:00	8337.15	11.86	133.44	13.61	153.61	503.97	
2014-09-25 12:00	8336.41	11.79	133.66	13.63	153.63	504.05	
2014-09-26 0:00	8336.1	11.73	133.75	13.64	153.64	504.08	
2014-09-26 12:00	8334.81	11.71	134.13	13.68	153.68	504.20	
2014-09-27 0:00	8332.95	11.51	134.67	13.74	153.74	504.38	
2014-09-27 12:00	8331.97	11.5	134.96	13.77	153.77	504.48	
2014-09-28 0:00	8332.21	11.47	134.89	13.76	153.76	504.46	
2014-09-28 12:00	8332.68	11.45	134.75	13.74	153.74	504.41	
2014-09-29 0:00	8333.58	11.44	134.49	13.72	153.72	504.32	
2014-09-29 12:00	8333.11	11.48	134.63	13.73	153.73	504.37	
2014-09-30 0:00	8332.3	11.33	134.86	13.76	153.76	504.45	
2014-09-30 12:00	8330.25	11.36	135.46	13.82	153.82	504.65	
2014-10-01 0:00	8328.88	11.36	135.86	13.86	153.86	504.78	
2014-10-01 12:00	8327.86	11.39	136.16	13.89	153.89	504.88	
2014-10-02 0:00	8327.32	11.38	136.31	13.90	153.90	504.93	
2014-10-02 12:00	8326.24	11.37	136.63	13.94	153.94	505.04	
2014-10-03 0:00	8325.86	11.37	136.74	13.95	153.95	505.08	
2014-10-03 12:00	8326.3	11.35	136.61	13.93	153.93	505.03	
2014-10-04 0:00	8326.27	11.35	136.62	13.94	153.94	505.04	
2014-10-04 12:00	8325.57	11.27	136.83	13.96	153.96	505.10	
2014-10-05 0:00	8325.51	11.28	136.84	13.96	153.96	505.11	
2014-10-05 12:00	8325.38	11.24	136.88	13.96	153.96	505.12	
2014-10-06 0:00	8325.8	11.2	136.76	13.95	153.95	505.08	
2014-10-06 12:00	8325.83	11.19	136.75	13.95	153.95	505.08	
2014-10-07 0:00	8326.14	11.19	136.66	13.94	153.94	505.05	
2014-10-07 12:00	8326.04	11.18	136.69	13.94	153.94	505.06	
2014-10-08 0:00	8326.01	11.17	136.70	13.94	153.94	505.06	
2014-10-08 12:00	8325.07	11.16	136.97	13.97	153.97	505.15	
2014-10-09 0:00	8324.78	11.16	137.06	13.98	153.98	505.18	
2014-10-09 12:00	8324.51	11.16	137.14	13.99	153.99	505.21	
2014-10-10 0:00	8324.99	11.16	137.00	13.97	153.97	505.16	
2014-10-10 12:00	8321.21	11.2	138.10	14.09	154.09	505.53	
2014-10-17 11:00	8318.6	5.1	138.93	14.17	154.17	505.81	
2014-11-06 10:00	8307.8	10.8	142.01	14.48	154.48	506.84	
2014-12-10 18:00	8308.3	12.1	141.85	14.47	154.47	506.79	
2014-12-15 13:00	8304.4	10.8	143.00	14.59	154.59	507.17	

TMEP Westridge Tunnel Investigation

Borehole ID:	HMM-BH-03	A	-1.0264E-09
Location:	Tank Farm	B	-0.00027092
Collar Northing:		C	2.452
Collar Easting:		Tk	0.1409 (Kpa/degree C rise)
Collar Elevation (m asl):	165.00	CF	0.28531 (Kpa/B unit)
Borehole Plunge:	90	Bi	8765.7 B Unit
VW number:	VW30252		
VWP Elevation (m asl):	119.00		
VWP vertical depth (m bgs)*:	46.00		
VWP Rating (MPa):	1.00		

Conversion1 Kpa = 0.10199773

\* Already corrected for hole plunge

READINGS CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Groundwater Elevation (ft asl)	Notes
2014-09-19	8764.7	17.2	0.0	0.0			Before installation
2014-09-19	7791.8	13.3	277.03	28.26	147.26	483.12	Placed in hole
2014-09-20	7825.4	12.7	267.36	27.27	146.27	479.89	Before Grouting
2014-09-20 11:00	7139.6	16.2	463.52	47.28	166.28	545.53	After Grout
2014-09-22 12:00	7762.51	11.74	285.17	29.09	148.09	485.85	
2014-09-23 0:00	7762.79	11.55	285.06	29.08	148.08	485.81	
2014-09-23 12:00	7763.05	11.41	284.96	29.07	148.07	485.78	
2014-09-24 0:00	7763.43	11.29	284.84	29.05	148.05	485.74	
2014-09-24 12:00	7761.67	11.19	285.33	29.10	148.10	485.90	
2014-09-25 0:00	7761.28	11.1	285.43	29.11	148.11	485.93	
2014-09-25 12:00	7761.15	11.03	285.45	29.12	148.12	485.94	
2014-09-26 0:00	7761.03	10.96	285.48	29.12	148.12	485.95	
2014-09-26 12:00	7760.35	10.92	285.67	29.14	148.14	486.01	
2014-09-27 0:00	7759.32	10.78	285.94	29.17	148.17	486.11	
2014-09-27 12:00	7759.11	10.76	286.00	29.17	148.17	486.13	
2014-09-28 0:00	7760.12	10.7	285.70	29.14	148.14	486.03	
2014-09-28 12:00	7761.02	10.66	285.44	29.11	148.11	485.94	
2014-09-29 0:00	7762.45	10.68	285.03	29.07	148.07	485.80	
2014-09-29 12:00	7762.5	10.72	285.02	29.07	148.07	485.80	
2014-09-30 0:00	7762.42	10.58	285.03	29.07	148.07	485.80	
2014-09-30 12:00	7761.44	10.61	285.31	29.10	148.10	485.90	
2014-10-01 0:00	7760.96	10.63	285.45	29.12	148.12	485.94	
2014-10-01 12:00	7760.42	10.65	285.61	29.13	148.13	486.00	
2014-10-02 0:00	7760.54	10.6	285.57	29.13	148.13	485.98	
2014-10-02 12:00	7759.68	10.58	285.81	29.15	148.15	486.06	
2014-10-03 0:00	7759.87	10.55	285.75	29.15	148.15	486.04	
2014-10-03 12:00	7760.61	10.51	285.53	29.12	148.12	485.97	
2014-10-04 0:00	7760.51	10.49	285.56	29.13	148.13	485.98	
2014-10-04 12:00	7760.96	10.44	285.42	29.11	148.11	485.93	
2014-10-05 0:00	7760.81	10.44	285.47	29.12	148.12	485.95	
2014-10-05 12:00	7761.42	10.4	285.29	29.10	148.10	485.89	
2014-10-06 0:00	7761.78	10.4	285.18	29.09	148.09	485.85	
2014-10-06 12:00	7762.34	10.38	285.02	29.07	148.07	485.80	
2014-10-07 0:00	7762.99	10.37	284.84	29.05	148.05	485.74	
2014-10-07 12:00	7763.51	10.36	284.69	29.04	148.04	485.69	
2014-10-08 0:00	7763.98	10.35	284.55	29.02	148.02	485.64	
2014-10-08 12:00	7763.41	10.34	284.71	29.04	148.04	485.70	
2014-10-09 0:00	7763.7	10.33	284.63	29.03	148.03	485.67	
2014-10-09 12:00	7763.46	10.32	284.69	29.04	148.04	485.69	
2014-10-10 0:00	7764.06	10.69	284.58	29.03	148.03	485.65	
2014-10-10 12:00	7763.99	10.82	284.61	29.03	148.03	485.66	
2014-10-17 11:00	7769.3	4.3	282.18	28.78	147.78	484.85	
2014-11-06 10:00	7758.2	10.0	286.15	29.19	148.19	486.18	
2014-12-10 18:00	7761.6	10.8	285.29	29.10	148.10	485.89	
2014-12-15 13:00	7753.0	9.9	287.62	29.34	148.34	486.67	

TMEP Westridge Tunnel Investigation

Borehole ID:	HMM-BH-03	A	-3.2458E-09
Location:	Tank Farm	B	-0.00083058
Collar Northing:		C	7.6172
Collar Easting:		Tk	0.427 (Kpa/degree C rise)
Collar Elevation (m asl):	165.00	CF	0.87702 (Kpa/B unit)
Borehole Plunge:	90	Bi	8869.7 B Unit
VW number:	VW30254		
VWP Elevation (m asl):	89.00		
VWP vertical depth (m bgs)*:	76.00		
VWP Rating (MPa):	3.00		

Conversion1 Kpa = 0.1019977

\* Already corrected for hole plunge

READINGS CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Groundwater Elevation (ft asl)	Notes
2014-09-19	8871.2	17.7	0.0	0.0			Before installation
2014-09-19	8228.6	12.9	561.52	57.27	146.27	479.90	Placed in hole
2014-09-20	8235.2	12.3	555.48	56.66	145.66	477.88	Before Grouting
2014-09-20 11:00	7959.9	18.9	799.74	81.57	170.57	559.62	After Grout
2014-09-22 12:00	8502.83	11.62	320.47	32.69	121.69	399.24	
2014-09-23 0:00	8503.85	11.37	319.47	32.59	121.59	398.90	
2014-09-23 12:00	8504.76	11.18	318.59	32.50	121.50	398.61	
2014-09-24 0:00	8505.53	11.02	317.85	32.42	121.42	398.36	
2014-09-24 12:00	8505.93	10.9	317.45	32.38	121.38	398.22	
2014-09-25 0:00	8505.99	10.79	317.35	32.37	121.37	398.19	
2014-09-25 12:00	8505.91	10.69	317.37	32.37	121.37	398.20	
2014-09-26 0:00	8506.24	10.61	317.05	32.34	121.34	398.09	
2014-09-26 12:00	8506.16	10.55	317.09	32.34	121.34	398.11	
2014-09-27 0:00	8506.28	10.42	316.93	32.33	121.33	398.05	
2014-09-27 12:00	8506.36	10.4	316.85	32.32	121.32	398.03	
2014-09-28 0:00	8506.71	10.34	316.52	32.28	121.28	397.92	
2014-09-28 12:00	8507.63	10.3	315.70	32.20	121.20	397.64	
2014-09-29 0:00	8508.04	10.3	315.34	32.16	121.16	397.52	
2014-09-29 12:00	8507.88	10.28	315.47	32.18	121.18	397.56	
2014-09-30 0:00	8507.96	10.13	315.34	32.16	121.16	397.52	
2014-09-30 12:00	8508.33	10.17	315.03	32.13	121.13	397.42	
2014-10-01 0:00	8507.86	10.15	315.43	32.17	121.17	397.55	
2014-10-01 12:00	8507.49	10.11	315.74	32.20	121.20	397.65	
2014-10-02 0:00	8507.86	10.06	315.39	32.17	121.17	397.54	
2014-10-02 12:00	8507.89	10.01	315.35	32.16	121.16	397.52	
2014-10-03 0:00	8508.08	10.03	315.19	32.15	121.15	397.47	
2014-10-03 12:00	8508.14	9.94	315.10	32.14	121.14	397.44	
2014-10-04 0:00	8508.24	9.97	315.02	32.13	121.13	397.41	
2014-10-04 12:00	8507.93	9.95	315.29	32.16	121.16	397.50	
2014-10-05 0:00	8508.48	9.93	314.79	32.11	121.11	397.34	
2014-10-05 12:00	8508.89	9.95	314.44	32.07	121.07	397.22	
2014-10-06 0:00	8509.16	9.93	314.20	32.05	121.05	397.14	
2014-10-06 12:00	8508.83	9.92	314.48	32.08	121.08	397.23	
2014-10-07 0:00	8509.39	9.94	314.00	32.03	121.03	397.07	
2014-10-07 12:00	8509.58	9.94	313.83	32.01	121.01	397.02	
2014-10-08 0:00	8509.71	9.93	313.72	32.00	121.00	396.98	
2014-10-08 12:00	8509.58	9.91	313.82	32.01	121.01	397.01	
2014-10-09 0:00	8509.76	9.9	313.66	31.99	120.99	396.96	
2014-10-09 12:00	8509.49	9.9	313.90	32.02	121.02	397.04	
2014-10-10 0:00	8509.81	10.6	313.91	32.02	121.02	397.04	
2014-10-10 12:00	8508.18	10.94	315.49	32.18	121.18	397.57	
2014-10-17 11:00	8511.6	3.9	309.48	31.57	120.57	395.56	
2014-11-06 10:00	8511.8	9.5	311.70	31.79	120.79	396.30	
2014-12-10 18:00	8513.9	11.0	310.50	31.67	120.67	395.90	
2014-12-15 13:00	8511.9	9.5	311.61	31.78	120.78	396.27	



TMEP Westridge Tunnel Investigation

Borehole ID:

HMM-BH-05

Location:

Kask Bros

Collar Northing:

Collar Easting:

Collar Elevation (m asl):

33.00

Borehole Plunge:

90

VW number:

VW30253

VWP Elevation (m asl):

15.00

VWP vertical depth (m bgs)\*:

18.00

VWP Rating (MPa):

3.00

A

-3.2977E-09

B

-0.00082999

C

7.6197

Tk

0.03084 (Kpa/degree C rise)

CF

0.8772 (Kpa/B unit)

Bi

8873.9 B Unit

Conversion1 Kpa = 0.1019977

\* Already corrected for hole plunge

READINGS

CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Groundwater Elevation (ft asl)	Notes
2014-10-05	8870.70	16.30	0.0	0.0			Before installation
2014-10-05	8724.90	14.40	127.8	13.0	28.0	92.0	Placed in hole
2014-10-06	8727.40	18.30	125.8	12.8	27.8	91.3	Grout is set
2014-10-17	8727.40	4.30	125.3	12.8	27.8	91.2	
2014-11-06	8715.00	10.00	136.4	13.9	28.9	94.9	

TMEP Westridge Tunnel Investigation

Borehole ID:	HMM-BH-05	A	-3.4157E-09
Location:	Kask Bros	B	0.00081637
Collar Northing:		C	7.63
Collar Easting:		Tk	0.2226 (Kpa/degree C rise)
Collar Elevation (m asl):	33.00	CF	0.86607 (Kpa/B unit)
Borehole Plunge:	90	Bi	9013.1 B Unit
VW number:	VW30255		
VWP Elevation (m asl):	-5.00		
VWP vertical depth (m bgs)*:	38.00		
VWP Rating (MPa):	3.00		

Conversion1 Kpa = 0.10199773

\* Already corrected for hole plunge

READINGS CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Groundwater Elevation (ft asl)	Notes
2014-10-05	9008.3	16.3	0.0	0.0			Before installation
2014-10-05	8637.3	12.2	320.4	32.7	27.68	90.8	Placed in hole
2014-10-06	8775.80	16.2	201.3	20.5	15.54	51.0	Grout is set
2014-10-17 0:00	8777.80	4.1	196.9	20.1	15.08	49.5	
2014-10-17 12:00	8777.59	10.05	198.4	20.2	15.24	50.0	
2014-10-18 0:00	8777.49	10.01	198.5	20.2	15.25	50.0	
2014-10-18 12:00	8777.22	9.97	198.7	20.3	15.27	50.1	
2014-10-19 0:00	8776.82	9.93	199.1	20.3	15.30	50.2	
2014-10-19 12:00	8777.28	9.89	198.7	20.3	15.26	50.1	
2014-10-20 0:00	8777.45	9.86	198.5	20.2	15.25	50.0	
2014-10-20 12:00	8777.26	9.83	198.7	20.3	15.26	50.1	
2014-10-21 0:00	8777.73	9.8	198.2	20.2	15.22	49.9	
2014-10-21 12:00	8777.00	9.77	198.9	20.3	15.28	50.1	
2014-10-22 0:00	8778.58	9.74	197.5	20.1	15.14	49.7	
2014-10-22 12:00	8777.88	9.71	198.1	20.2	15.21	49.9	
2014-10-23 0:00	8777.88	9.69	198.1	20.2	15.20	49.9	
2014-10-23 12:00	8774.95	9.66	200.6	20.5	15.46	50.7	
2014-10-24 0:00	8769.27	9.64	205.5	21.0	15.96	52.4	
2014-10-24 12:00	8769.77	9.62	205.1	20.9	15.92	52.2	
2014-10-25 0:00	8771.78	9.6	203.4	20.7	15.74	51.6	
2014-10-25 12:00	8773.68	9.58	201.7	20.6	15.57	51.1	
2014-10-26 0:00	8774.06	9.56	201.4	20.5	15.54	51.0	
2014-10-26 12:00	8771.36	9.54	203.7	20.8	15.78	51.8	
2014-10-27 0:00	8770.89	9.52	204.1	20.8	15.82	51.9	
2014-10-27 12:00	8771.59	9.51	203.5	20.8	15.76	51.7	
2014-10-28 0:00	8772.79	9.49	202.5	20.6	15.65	51.3	
2014-10-28 12:00	8773.37	9.47	201.9	20.6	15.60	51.2	
2014-10-29 0:00	8772.84	9.46	202.4	20.6	15.64	51.3	
2014-10-29 12:00	8771.55	9.44	203.5	20.8	15.76	51.7	
2014-10-30 0:00	8770.82	9.43	204.1	20.8	15.82	51.9	
2014-10-30 12:00	8772.46	9.42	202.7	20.7	15.68	51.4	
2014-10-31 0:00	8772.72	9.4	202.5	20.7	15.65	51.4	
2014-10-31 12:00	8772.62	9.39	202.6	20.7	15.66	51.4	
2014-11-01 0:00	8772.25	9.38	202.9	20.7	15.69	51.5	
2014-11-01 12:00	8772.32	9.36	202.8	20.7	15.69	51.5	
2014-11-02 0:00	8772.13	9.35	203.0	20.7	15.70	51.5	
2014-11-02 12:00	8772.04	9.34	203.1	20.7	15.71	51.6	
2014-11-03 0:00	8772.21	9.33	202.9	20.7	15.70	51.5	
2014-11-03 12:00	8772.58	9.32	202.6	20.7	15.66	51.4	
2014-11-04 0:00	8769.93	9.31	204.9	20.9	15.90	52.2	
2014-11-04 12:00	8765.29	9.3	208.9	21.3	16.31	53.5	
2014-11-05 0:00	8766.02	9.29	208.3	21.2	16.24	53.3	
2014-11-05 12:00	8767.68	9.28	206.8	21.1	16.10	52.8	
2014-11-06 0:00	8770.00	9.27	204.8	20.9	15.89	52.1	
2014-11-06 12:00	8770.17	9.26	204.7	20.9	15.88	52.1	
2014-11-07 0:00	8768.20	9.25	206.4	21.0	16.05	52.7	
2014-11-07 12:00	8766.15	9.24	208.1	21.2	16.23	53.2	
2014-11-08 0:00	8766.77	9.24	207.6	21.2	16.18	53.1	
2014-11-08 12:00	8768.17	9.23	206.4	21.1	16.05	52.7	
2014-11-09 0:00	8769.55	9.22	205.2	20.9	15.93	52.3	
2014-11-09 12:00	8770.19	9.21	204.6	20.9	15.87	52.1	
2014-11-10 0:00	8769.08	9.20	205.6	21.0	15.97	52.4	
2014-11-10 12:00	8769.01	9.20	205.7	21.0	15.98	52.4	
2014-11-11 0:00	8769.14	9.19	205.5	21.0	15.97	52.4	
2014-11-11 12:00	8768.52	9.18	206.1	21.0	16.02	52.6	
2014-11-12 0:00	8768.99	9.17	205.7	21.0	15.98	52.4	
2014-11-12 12:00	8769.23	9.17	205.5	21.0	15.96	52.4	
2014-11-13 0:00	8770.10	9.16	204.7	20.9	15.88	52.1	
2014-11-13 12:00	8770.36	9.15	204.5	20.9	15.86	52.0	
2014-11-14 0:00	8770.89	9.15	204.0	20.8	15.81	51.9	
2014-11-14 12:00	8770.35	9.14	204.5	20.9	15.86	52.0	
2014-11-15 0:00	8770.16	9.14	204.7	20.9	15.87	52.1	
2014-11-15 12:00	8769.58	9.13	205.2	20.9	15.93	52.2	
2014-11-16 0:00	8769.30	9.12	205.4	20.9	15.95	52.3	
2014-11-16 12:00	8769.23	9.12	205.5	21.0	15.96	52.3	
2014-11-17 0:00	8770.21	9.11	204.6	20.9	15.87	52.1	

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Groundwater Elevation (ft asl)	Notes
2014-11-17 12:00	8770.63	9.11	204.2	20.8	15.83	51.9	
2014-11-18 0:00	8771.01	9.10	203.9	20.8	15.80	51.8	
2014-11-18 12:00	8771.27	9.10	203.7	20.8	15.78	51.8	
2014-11-19 0:00	8772.21	9.10	202.9	20.7	15.69	51.5	
2014-11-19 12:00	8772.93	9.09	202.2	20.6	15.63	51.3	
2014-11-20 0:00	8773.37	9.09	201.9	20.6	15.59	51.1	
2014-11-20 12:00	8772.67	9.09	202.5	20.7	15.65	51.3	
2014-11-21 0:00	8773.26	9.09	202.0	20.6	15.60	51.2	
2014-11-21 12:00	8774.03	9.09	201.3	20.5	15.53	51.0	
2014-11-22 0:00	8773.10	9.09	202.1	20.6	15.61	51.2	
2014-11-22 12:00	8770.51	9.08	204.3	20.8	15.84	52.0	
2014-11-23 0:00	8770.26	9.08	204.6	20.9	15.86	52.0	
2014-11-23 12:00	8769.35	9.08	205.3	20.9	15.94	52.3	
2014-11-24 0:00	8768.57	9.07	206.0	21.0	16.01	52.5	
2014-11-24 12:00	8768.22	9.07	206.3	21.0	16.04	52.6	
2014-11-25 0:00	8768.95	9.06	205.7	21.0	15.98	52.4	
2014-11-25 12:00	8767.18	9.06	207.2	21.1	16.14	52.9	
2014-11-26 0:00	8767.54	9.06	206.9	21.1	16.10	52.8	
2014-11-26 12:00	8766.08	9.06	208.2	21.2	16.23	53.3	
2014-11-27 0:00	8768.06	9.06	206.5	21.1	16.06	52.7	
2014-11-27 12:00	8768.45	9.06	206.1	21.0	16.02	52.6	
2014-11-28 0:00	8770.10	9.06	204.7	20.9	15.88	52.1	
2014-11-28 12:00	8770.57	9.05	204.3	20.8	15.84	52.0	
2014-11-29 0:00	8771.45	9.04	203.5	20.8	15.76	51.7	
2014-11-29 12:00	8769.95	9.03	204.8	20.9	15.89	52.1	
2014-11-30 0:00	8769.18	9.03	205.5	21.0	15.96	52.4	
2014-11-30 12:00	8768.99	9.02	205.6	21.0	15.97	52.4	
2014-12-01 0:00	8770.02	9.02	204.7	20.9	15.88	52.1	
2014-12-01 12:00	8770.10	9.02	204.7	20.9	15.88	52.1	
2014-12-02 0:00	8770.05	9.01	204.7	20.9	15.88	52.1	
2014-12-02 12:00	8770.66	9.00	204.2	20.8	15.83	51.9	
2014-12-03 0:00	8771.60	9.00	203.4	20.7	15.74	51.7	
2014-12-03 12:00	8771.64	8.99	203.3	20.7	15.74	51.6	
2014-12-04 0:00	8772.95	8.99	202.2	20.6	15.62	51.3	
2014-12-04 12:00	8771.94	8.99	203.1	20.7	15.71	51.6	
2014-12-05 0:00	8772.25	8.99	202.8	20.7	15.69	51.5	
2014-12-05 12:00	8771.90	8.98	203.1	20.7	15.72	51.6	
2014-12-06 0:00	8772.98	8.98	202.2	20.6	15.62	51.3	
2014-12-06 12:00	8771.74	8.98	203.2	20.7	15.73	51.6	
2014-12-07 0:00	8768.55	8.98	206.0	21.0	16.01	52.5	
2014-12-07 12:00	8768.38	8.98	206.2	21.0	16.03	52.6	
2014-12-08 0:00	8769.91	8.98	204.8	20.9	15.89	52.1	
2014-12-08 12:00	8770.26	8.98	204.5	20.9	15.86	52.0	
2014-12-09 0:00	8771.71	8.98	203.3	20.7	15.73	51.6	
2014-12-09 12:00	8770.14	8.99	204.6	20.9	15.87	52.1	
2014-12-10 0:00	8768.76	8.99	205.8	21.0	15.99	52.5	
2014-12-10 12:00	8770.43	8.99	204.4	20.8	15.85	52.0	
2014-12-11 0:00	8769.41	9.00	205.3	20.9	15.94	52.3	
2014-12-11 12:00	8769.95	8.99	204.8	20.9	15.89	52.1	
2014-12-12 0:00	8770.49	8.99	204.3	20.8	15.84	52.0	
2014-12-12 12:00	8769.34	8.99	205.3	20.9	15.94	52.3	
2014-12-13 0:00	8769.20	8.99	205.5	21.0	15.96	52.3	
2014-12-13 12:00	8768.92	8.98	205.7	21.0	15.98	52.4	
2014-12-14 0:00	8769.06	8.98	205.6	21.0	15.97	52.4	
2014-12-14 12:00	8770.19	8.97	204.6	20.9	15.87	52.1	
2014-12-15 0:00	8771.43	8.96	203.5	20.8	15.76	51.7	
2014-12-15 12:00	8771.48	8.96	203.5	20.8	15.75	51.7	

TMEP Westridge Tunnel Investigation

Borehole ID:

Location:

Collar Northing:

Collar Easting:

Collar Elevation (m asl):

Borehole Plunge:

VW number:

VWP Elevation (m asl):

VWP vertical depth (m bgs)\*:

VWP Rating (MPa):

HMM-BH-02

Centenial Way

240.00

90

VW31091

63.40

176.60

3.00

A

B

C

Tk

CF

Bi

-3.7971E-09

-0.00082543

7.5895

0.7871 (Kpa/degree C rise)

0.87958 (Kpa/B unit)

8842.1 B Unit

Conversion1 Kpa = 0.10199773

\* Already corrected for hole plunge

READINGS

CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Notes
11/27/2014	8829.1	10.1	0.0	0.0		Before installation
11/27/2014	7136.9	10.0	1488.3	151.8	215.2	Placed in hole
11/27/2014 23:00	7541.3	13.8	1135.6	115.8	179.2	After Grout
11/27/2014 23:59	7582.6	13.1	1098.8	112.1	175.5	

TMEP Westridge Tunnel Investigation

Borehole ID:

Location:

Collar Northing:

Collar Easting:

Collar Elevation (m asl):

Borehole Plunge:

VW number:

VWP Elevation (m asl):

VWP vertical depth (m bgs)\*:

VWP Rating (MPa):

HMM-BH-02

Centenial Way

240.00

90

VW21537

218.00

22.00

1.00

A

B

C

Tk

CF

Bi

-1.1978E-09

-0.00027599

2.5981

0.0000051 (Kpa/degree C rise)

0.29361 (Kpa/B unit)

9063.8 B Unit

Conversion1 Kpa = 0.10199773

\* Already corrected for hole plunge

READINGS

CALCULATIONS (LINEAR)

Date	Pressure (B)	Temp (°C)	Pressure Head (kPa)	Pressure Head (m of water)	Groundwater Elevation (m asl)	Notes
11/27/2014	9064.1	9.3	-207.3	-21147.3		Before installation
11/27/2014	9064.8	10.3	-207.2	-21.1	42.3	Placed in hole
11/27/2014 23:00	8671.3	10.6	139.2	14.2	77.6	After Grout
11/27/2014 23:59	8687.6	12.8	126.6	12.9	76.3	After Grout

## **APPENDIX E**

### **PACKER TESTING RESULTS**

**CALCULATED USING WATER LEVELS DURING DRILLING**

## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigations  
**Project #:** 0095150-15  
**Personel:**

**Collar El.:** \_\_\_\_\_  
**Trend:** \_\_\_\_\_  
**Plunge:** \_\_\_\_\_ deg  
**Date:** \_\_\_\_\_

**Hole #** HMM-BH-02  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 1

### Packer Setup Type: Single

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			--
1			0.0000
2			0.0000
3			0.0000
4			0.0000
5			0.0000
6			0.0000
7			0.0000
8			0.0000
9			0.0000
10			0.0000

Stable Ave. #DIV/0! 0.0000

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			--
1			0.0000
2			0.0000
3			0.0000
4			0.0000
5			0.0000
6			0.0000
7			0.0000
8			0.0000
9			0.0000
10			0.0000

Stable Ave. #DIV/0! 0.0000

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			--
1			0.0000
2			0.0000
3			0.0000
4			0.0000
5			0.0000
6			0.0000
7			0.0000
8			0.0000
9			0.0000
10			0.0000

Stable Ave. #DIV/0! 0.0000

**Additional Comments:**

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			--
1			0.0000
2			0.0000
3			0.0000
4			0.0000
5			0.0000
6			0.0000
7			0.0000
8			0.0000
9			0.0000
10			0.0000

Stable Ave. #DIV/0! 0.0000

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			--
1			0.0000
2			0.0000
3			0.0000
4			0.0000
5			0.0000
6			0.0000
7			0.0000
8			0.0000
9			0.0000
10			0.0000

Stable Ave. #DIV/0! 0.0000

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 4.51 m  
 Top of Packer Interval: 33.90 m  
 Bottom of Packer Interval (or Bottom of Hole): 49.85 m  
 Packer Inflation Pressure: 350 psi  
 Rod Stickup Height: 1.28 m  
 Water Flushed (Vol./Time/Until Clean): \_\_\_\_\_  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.3 m

### Measurment Units

Volume: m3  
 Pressure: psi  
 Length: m

### Time

Start Flushing: 6:15 PM  
 End Flushing: 6:30 PM  
 Start Packer Testing: \_\_\_\_\_  
 End Packer Testing: \_\_\_\_\_

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0	0.260	-
1	0.360	0.1000
2	0.460	0.1000
4	0.660	0.1000
6	0.850	0.0950
8	1.030	0.0900
10	1.210	0.0900
15	1.640	0.0860
20	2.070	0.0860
25	2.480	0.0820
30	2.880	0.0800
40	3.630	0.0750
50	4.350	0.0720
60	5.020	0.0670
75	5.950	0.0620

Hole #: HMM-BH-02  
Test #: 1



### Calculation Input Parameters

Top of Packer Test Interval (mah): 33.9  
Bottom of Packer Test Interval (mah): 49.9  
L: Length of Test Interval (mah): 16.0  
Test Interval Midpoint (mah): 42  
Stickup Height (mah): 1.28  
Pressure Gauge Height (m above ground): 0.30  
Depth to Water Table (mah): 4.51  
Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
\* mah indicates "meters along hole"

$$K = \frac{\pi r^2 \times \ln(L / r)}{T_0 \times 2\pi L}$$

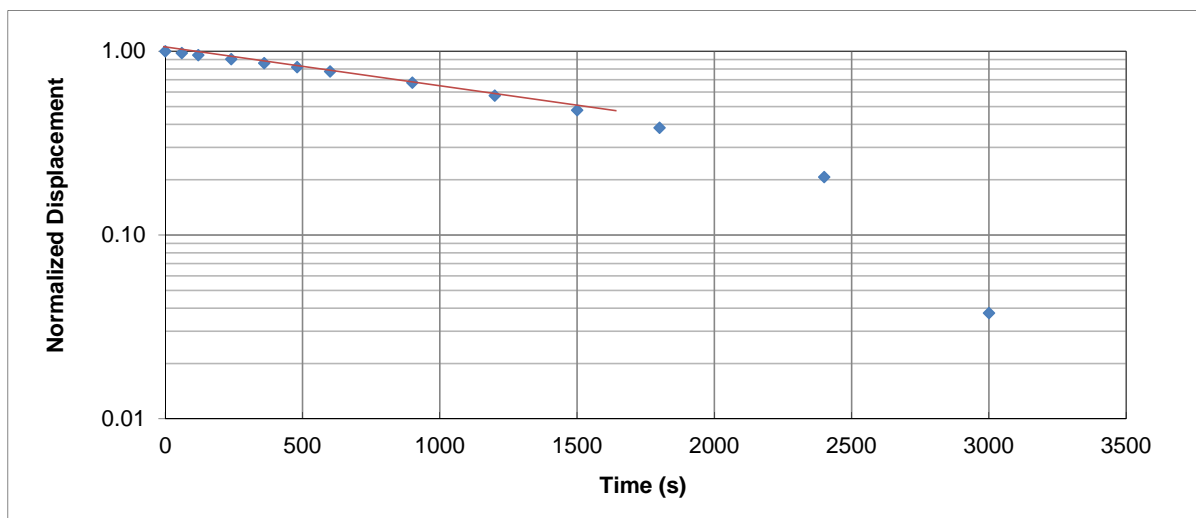
Time (s)	Depth to Water (mah)	Normalized Displacement
0	0.26	1.00
60	0.36	0.98
120	0.46	0.95
240	0.66	0.91
360	0.85	0.86
480	1.03	0.82
600	1.21	0.78
900	1.64	0.68
1200	2.07	0.57
1500	2.48	0.48
1800	2.88	0.38
2400	3.63	0.21
3000	4.35	0.04
3600	5.02	-0.12
4500	5.95	-0.34

From Hvorslev Solution

$$T_0 = -(480 \text{ s}) / \ln(0.82) = 2401.36$$

Hydraulic Conductivity (m/s)

$$K = 1.7\text{E-}07$$





## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN/TMEP  
**Project:** Westridge Tunnel SI  
**Project #:** 0095150-15  
**Personel:** SB

### Packer Setup Type: Single

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	50.0	284.0000	--
1	50.0	286.5000	2.5000
2	50.0	289.1000	2.6000
3	50.0	291.4000	2.3000
4	50.0	293.8000	2.4000
5	50.0	296.2000	2.4000
6	50.0	298.7000	2.5000
7	50.0	301.0000	2.3000
8	50.0	303.5000	2.5000
9	50.0	305.9000	2.4000
10	50.0	308.3000	2.4000

Stable Ave. 50.0 2.4200

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	76.0	316.0000	--
1	76.0	318.3000	2.3000
2	76.0	321.3000	3.0000
3	75.0	323.9000	2.6000
4	75.0	326.4000	2.5000
5	75.0	328.9000	2.5000
6	76.0	331.4000	2.5000
7	76.0	333.9000	2.5000
8	75.0	336.4000	2.5000
9	75.0	339.0000	2.6000
10	75.0	341.5000	2.5000

Stable Ave. 75.3 2.5200

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	100.0	367.0000	--
1	100.0	382.1000	15.1000
2	100.0	396.8000	14.7000
3	100.0	412.5000	15.7000
4	100.0	429.3000	16.8000
5	100.0	446.2000	16.9000
6	100.0	462.9000	16.7000
7	100.0	479.8000	16.9000
8	100.0	496.5000	16.7000
9	100.0	513.0000	16.5000
10	100.0	530.0000	17.0000

Stable Ave. 100.0 16.7600

**Additional Comments:** Bubbling from stuffing box during test

**Collar El.:** \_\_\_\_\_  
**Trend:** \_\_\_\_\_  
**Plunge:** 90 deg  
**Date:** Nov 23, 2014, dayshift

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	75.0	539.0000	--
1	75.0	541.4000	2.4000
2	75.0	543.8000	2.4000
3	75.0	546.3000	2.5000
4	75.0	548.7000	2.4000
5	75.0	551.0000	2.3000
6	75.0	553.5000	2.5000
7	75.0	555.8000	2.3000
8	75.0	558.2000	2.4000
9	75.0	560.5000	2.3000
10	75.0	562.9000	2.4000

Stable Ave. 75.0 2.3800

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	50.0	565.0000	--
1	50.0	566.9000	1.9000
2	50.0	568.9000	2.0000
3	50.0	570.8000	1.9000
4	50.0	572.7000	1.9000
5	50.0	574.6000	1.9000
6	50.0	576.5000	1.9000
7	50.0	578.4000	1.9000
8	50.0	580.3000	1.9000
9	50.0	582.1000	1.8000
10	50.0	584.0000	1.9000

Stable Ave. 50.0 1.8800

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

**Hole #** HMM-BH-02  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 2

### Measurements

Depth to Water from Top of Stickup: 11.92 m  
 Top of Packer Interval: 62.40 m  
 Bottom of Packer Interval (or Bottom of Hole): 79.85 m  
 Packer Inflation Pressure: 440 psi  
 Rod Stickup Height: 1.00 m  
 Water Flushed (Vol./Time/Until Clean): 20 minutes  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.00 m

### Measurment Units

Volume: L  
 Pressure: psi  
 Length: m

### Time

Start Flushing: 11:20 AM  
 End Flushing: 11:40 AM  
 Start Packer Testing: 12:45 PM  
 End Packer Testing: 1:50 PM

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

Hole #: HMM-BH-02  
 Test #: 2

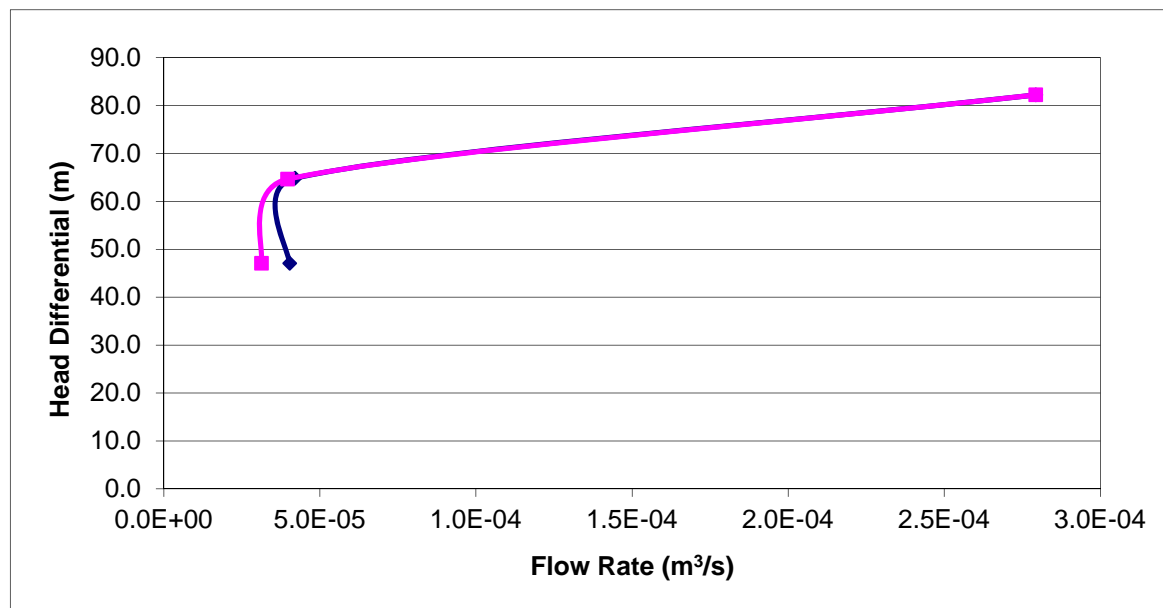


### Calculation Input Parameters

Top of Packer Test Interval (mah): 62.4  
 Bottom of Packer Test Interval (mah): 79.9  
L: Length of Test Interval (mah): 17.5  
 Test Interval Midpoint (mah): 71  
 Stickup Height (mah): 1.00  
 Pressure Gauge Height (m above ground): 0.00  
 Depth to Water Table (mah): 12.92  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	4.0E-05	35.2	47.1	4.6E-08
75.3	4.2E-05	52.9	64.9	3.5E-08
100.0	2.8E-04	70.3	82.2	1.8E-07
75.0	4.0E-05	52.7	64.7	3.3E-08
50.0	3.1E-05	35.2	47.1	3.6E-08
			Geo Mean	5.1E-08



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** TMEP  
**Project:** Westridge Tunnel SI  
**Project #:** 0095-150-15  
**Personel:** JVH

### Packer Setup Type: Single

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	100.0	775.0000	--
1	100.0	776.7000	1.7000
2	100.0	779.3000	2.6000
3	100.0	781.5000	2.2000
4	100.0	784.8000	3.3000
5	100.0	789.4000	4.6000
6	100.0	790.4000	1.0000
7	100.0	793.6000	3.2000
8	100.0	795.4000	1.8000
9	100.0	798.4000	3.0000
10	100.0	800.8000	2.4000

Stable Ave. 100.0 2.6000

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	50.0	801.4000	--
1	50.0	803.5000	2.1000
2	50.0	805.3000	1.8000
3	50.0	807.5000	2.2000
4	50.0	808.9000	1.4000
5	50.0	810.7000	1.8000
6	50.0	812.5000	1.8000
7	50.0	814.4000	1.9000
8	50.0	815.9000	1.5000
9	50.0	817.6000	1.7000
10	50.0	819.3000	1.7000

Stable Ave. 50.0 1.7200

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	75.0	821.2000	--
1	75.0	823.4000	2.2000
2	75.0	825.4000	2.0000
3	75.0	827.6000	2.2000
4	75.0	829.8000	2.2000
5	75.0	831.5000	1.7000
6	75.0	833.5000	2.0000
7	75.0	835.7000	2.2000
8	75.0	837.6000	1.9000
9	75.0	839.6000	2.0000
10	75.0	841.6000	2.0000

Stable Ave. 75.0 2.0200

#### Additional Comments:

**Collar El.:** \_\_\_\_\_  
**Trend:** -  
**Plunge:** 90 deg  
**Date:** \_\_\_\_\_

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	50.0	843.0000	--
1	50.0	844.7000	1.7000
2	50.0	846.3000	1.6000
3	50.0	848.7000	2.4000
4	50.0	849.7000	1.0000
5	50.0	851.4000	1.7000
6	50.0	853.0000	1.6000
7	50.0	854.8000	1.8000
8	50.0	856.5000	1.7000
9	50.0	858.0000	1.5000
10	50.0	859.7000	1.7000

Stable Ave. 50.0 1.6667

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	75.0	861.0000	--
1	75.0	863.0000	2.0000
2	75.0	865.0000	2.0000
3	75.0	867.0000	2.0000
4	75.0	868.9000	1.9000
5	75.0	870.8000	1.9000
6	75.0	872.9000	2.1000
7	75.0	874.8000	1.9000
8	75.0	876.7000	1.9000
9	75.0	878.6000	1.9000
10	75.0	880.5000	1.9000

Stable Ave. 75.0 1.9400

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

**Hole #** HMM-BH-02  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 3

#### Measurements

Depth to Water from Top of Stickup: 16.08 m  
 Top of Packer Interval: 88.85 m  
 Bottom of Packer Interval (or Bottom of Hole): 109.85 m  
 Packer Inflation Pressure: 500 psi  
 Rod Stickup Height: 1.05 m  
 Water Flushed (Vol./Time/Until Clean): 20 minutes  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.00 m

#### Measurment Units

Volume: L  
 Pressure: psi  
 Length: m

#### Time

Start Flushing: 2:40 AM  
 End Flushing: 3:00 AM  
 Start Packer Testing: 5:19 AM  
 End Packer Testing: 6:19 AM

#### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

Hole #: HMM-BH-02  
 Test #: 3

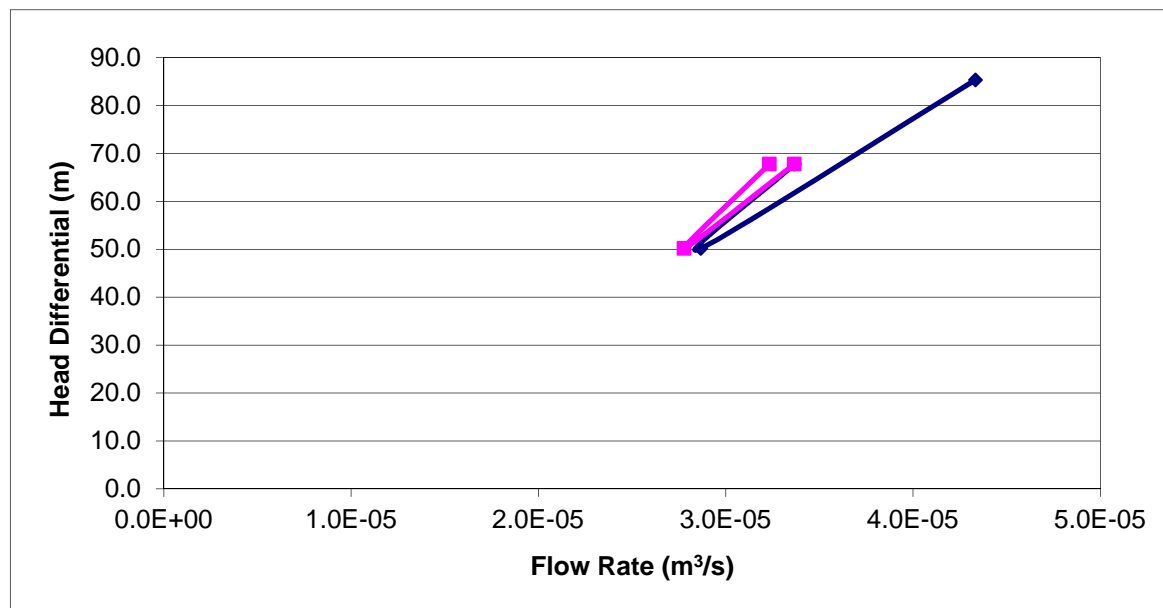


### Calculation Input Parameters

Top of Packer Test Interval (mah): 88.9  
 Bottom of Packer Test Interval (mah): 109.9  
L: Length of Test Interval (mah): 21.0  
 Test Interval Midpoint (mah): 99  
 Stickup Height (mah): 1.05  
 Pressure Gauge Height (m above ground): 0.00  
 Depth to Water Table (mah): 16.08  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
100.0	4.3E-05	70.3	85.3	2.3E-08
50.0	2.9E-05	35.2	50.2	2.6E-08
75.0	3.4E-05	52.7	67.8	2.3E-08
50.0	2.8E-05	35.2	50.2	2.6E-08
75.0	3.2E-05	52.7	67.8	2.2E-08
			Geo Mean	2.4.E-08



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** TMEP  
**Project:** Westridge  
**Project #:** 0095-150-15  
**Personel:**

**Collar El.:** \_\_\_\_\_  
**Trend:** \_\_\_\_\_  
**Plunge:** \_\_\_\_\_ 90 deg  
**Date:** 24-Nov-14

**Hole #** HMM-BH-02  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 4

### Packer Setup Type: Single

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	52.0	25.8000	--
1	52.0	28.7000	2.9000
2	52.0	31.2000	2.5000
3	52.0	33.5000	2.3000
4	52.0	35.8000	2.3000
5	52.0	38.1000	2.3000
6	52.0	40.4000	2.3000
7	52.0	42.7000	2.3000
8	52.0	45.0000	2.3000
9	52.0	47.3000	2.3000
10	52.0	49.6000	2.3000

Stable Ave. 52.0 2.3000

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	75.0	51.4000	--
1	75.0	54.1000	2.7000
2	75.0	56.7000	2.6000
3	75.0	59.1000	2.4000
4	75.0	61.7000	2.6000
5	75.0	64.3000	2.6000
6	75.0	66.8000	2.5000
7	75.0	69.2000	2.4000
8	75.0	71.6000	2.4000
9	75.0	74.0000	2.4000
10	75.0	76.2000	2.2000

Stable Ave. 75.0 2.3800

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	100.0	79.0000	--
1	100.0	81.8000	2.8000
2	100.0	84.4000	2.6000
3	100.0	87.0000	2.6000
4	100.0	89.5000	2.5000
5	100.0	92.0000	2.5000
6	100.0	94.5000	2.5000
7	100.0	97.1000	2.6000
8	100.0	99.6000	2.5000
9	100.0	102.1000	2.5000
10	100.0	104.6000	2.5000

Stable Ave. 100.0 2.5200

**Additional Comments:**

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	76.0	107.6000	--
1	76.0	109.7000	2.1000
2	76.0	111.8000	2.1000
3	76.0	113.8000	2.0000
4	76.0	115.9000	2.1000
5	76.0	117.9000	2.0000
6	76.0	119.9000	2.0000
7	76.0	121.9000	2.0000
8	76.0	123.9000	2.0000
9	76.0	126.0000	2.1000
10	76.0	128.0000	2.0000

Stable Ave. 76.0 2.0167

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0	49.0	129.3000	--
1	49.0	130.9000	1.6000
2	49.0	132.6000	1.7000
3	49.0	134.2000	1.6000
4	49.0	135.9000	1.7000
5	49.0	137.5000	1.6000
6	49.0	139.2000	1.7000
7	49.0	141.8000	2.6000
8	49.0	142.5000	0.7000
9	49.0	144.1000	1.6000
10	49.0	145.8000	1.7000

Stable Ave. 49.0 1.6600

#### Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 8.50 m  
 Top of Packer Interval: 116.40 m  
 Bottom of Packer Interval (or Bottom of Hole): 139.85 m  
 Packer Inflation Pressure: 500 psi  
 Rod Stickup Height: 1.20 m  
 Water Flushed (Vol./Time/Until Clean): 20 minutes  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.00 m

### Measurment Units

Volume: L  
 Pressure: psi  
 Length: m

### Time

Start Flushing: 6:00 AM  
 End Flushing: 6:20 AM  
 Start Packer Testing: \_\_\_\_\_  
 End Packer Testing: \_\_\_\_\_

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

Hole #: HMM-BH-02  
 Test #: 4

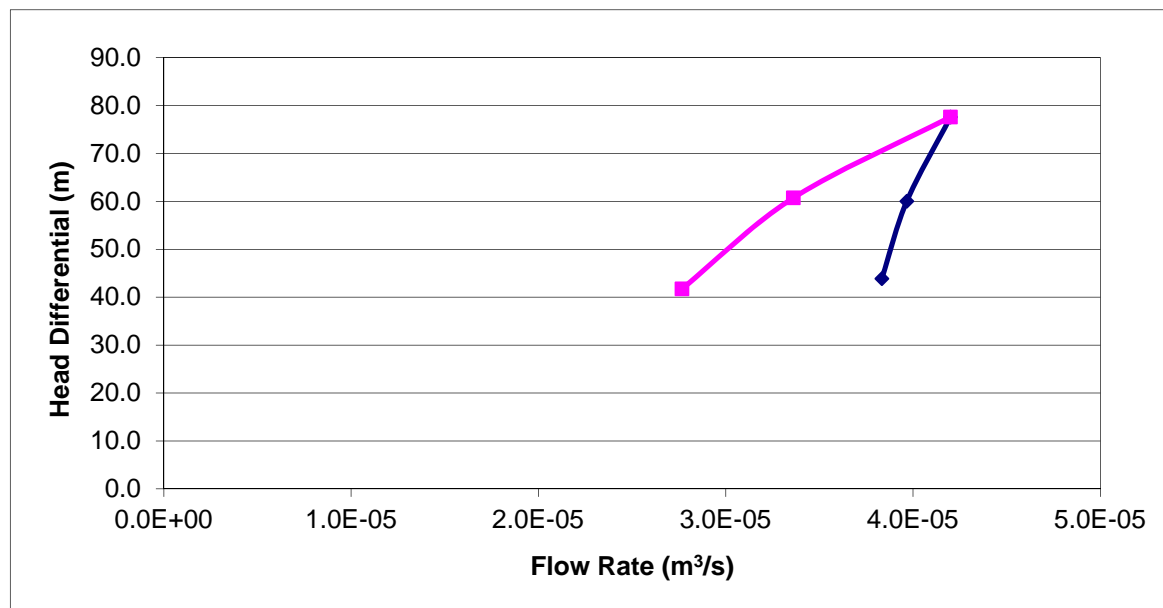


### Calculation Input Parameters

Top of Packer Test Interval (mah): 116.4  
 Bottom of Packer Test Interval (mah): 139.9  
L: Length of Test Interval (mah): 23.5  
 Test Interval Midpoint (mah): 128  
 Stickup Height (mah): 1.20  
 Pressure Gauge Height (m above ground): 0.00  
 Depth to Water Table (mah): 8.50  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
52.0	3.8E-05	36.6	43.9	3.7E-08
75.0	4.0E-05	52.7	60.0	2.8E-08
100.0	4.2E-05	70.3	77.6	2.3E-08
76.0	3.4E-05	53.4	60.7	2.3E-08
49.0	2.8E-05	34.5	41.8	2.8E-08
			Geo Mean	2.7E-08



# Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

Client: KINDER MORGAN  
 Project: Westridge Tunnel Geotechnical Investigation  
 Project #: 0095150-15  
 Personnel: PCL

Collar El.:  
 Trend: - deg  
 Plunge: 90 deg  
 Date: 25-Nov-14

Hole # HMM-BH-02  
 Design Test Interval:  
 Test #: 5

## Packer Setup Type: Single

Pressure Inte	psi	1	L
Minutes	Pressure	Volume	Δ Volume
0	50.0	301.0000	-
1	50.0	302.0000	1.0000
2	50.0	303.0000	1.0000
3	50.0	304.0000	1.0000
4	50.0	305.0000	1.0000
5	50.0	306.0000	1.0000
6	50.0	307.0000	1.0000
7	50.0	308.0000	1.0000
8	50.0	309.0000	1.0000
9	50.0	310.4000	1.4000
10	50.0	311.3000	0.9000

Stable Ave. 50.0 1.0300

Pressure Interval		2	
Minutes	Pressure	Volume	Δ Volume
0	75.0	312.8000	-
1	75.0	313.9000	1.1000
2	75.0	314.9000	1.0000
3	75.0	315.8000	0.9000
4	75.0	317.2000	1.4000
5	75.0	318.1000	0.9000
6	75.0	319.2000	1.1000
7	75.0	320.2000	1.0000
8	75.0	321.3000	1.1000
9	75.0	322.3000	1.0000
10	75.0	323.4000	1.1000

Stable Ave. 75.0 1.0600

Pressure Interval		3	
Minutes	Pressure	Volume	Δ Volume
0	100.0	325.0000	-
1	100.0	326.4000	1.4000
2	100.0	327.5000	1.1000
3	100.0	328.7000	1.2000
4	100.0	330.0000	1.3000
5	100.0	331.2000	1.2000
6	100.0	332.4000	1.2000
7	100.0	333.7000	1.3000
8	100.0	334.9000	1.2000
9	100.0	336.2200	1.3200
10	100.0	337.4000	1.1800

Stable Ave. 100.0 1.2400

Pressure Interval		4	
Minutes	Pressure	Volume	Δ Volume
0	75.0	338.4000	-
1	75.0	339.5000	1.1000
2	75.0	340.6000	1.1000
3	75.0	341.7000	1.1000
4	75.0	342.7000	1.0000
5	75.0	343.8000	1.1000
6	75.0	344.9000	1.1000
7	75.0	345.9000	1.0000
8	75.0	347.0000	1.1000
9	75.0	348.0000	1.0000
10	75.0	349.1000	1.1000

Stable Ave. 75.0 1.0700

Pressure Interval		5	
Minutes	Pressure	Volume	Δ Volume
0	50.0	348.7000	--
1	50.0	350.6000	1.9000
2	50.0	351.4000	0.8000
3	50.0	352.3000	0.9000
4	50.0	353.1000	0.8000
5	50.0	354.0000	0.9000
6	50.0	355.7000	1.7000
7	50.0	356.5000	0.8000
8	50.0	357.3000	0.8000
9	50.0	358.2000	0.9000
10	50.0	358.2610	0.0610

Stable Ave. 50.0 0.9561

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

## Measurements

Depth to Water from Top of Stickup: 21.30 m  
 Top of Packer Interval: 143.43 m  
 Bottom of Packer Interval (or Bottom of Hole): 166.85 m  
 Packer Inflation Pressure: 560 psi  
 Rod Stickup Height: 1.00 m  
 Water Flushed (Vol./Time/Until Clean): 30 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96  
 Vertical height of gauge above ground: 0.20 m

## Measurment Units

Volume: L  
 Pressure: psi  
 Length: m

## Time

Start Flushing: 2:40 AM  
 End Flushing: 3:00 AM  
 Start Packer Testing: 5:19 AM  
 End Packer Testing: 6:19 AM

## IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

Additional Comments: Driller bumped the nozzle during pressure interval 2, minute 2

Hole #: HMM-BH-02  
 Test #: 5

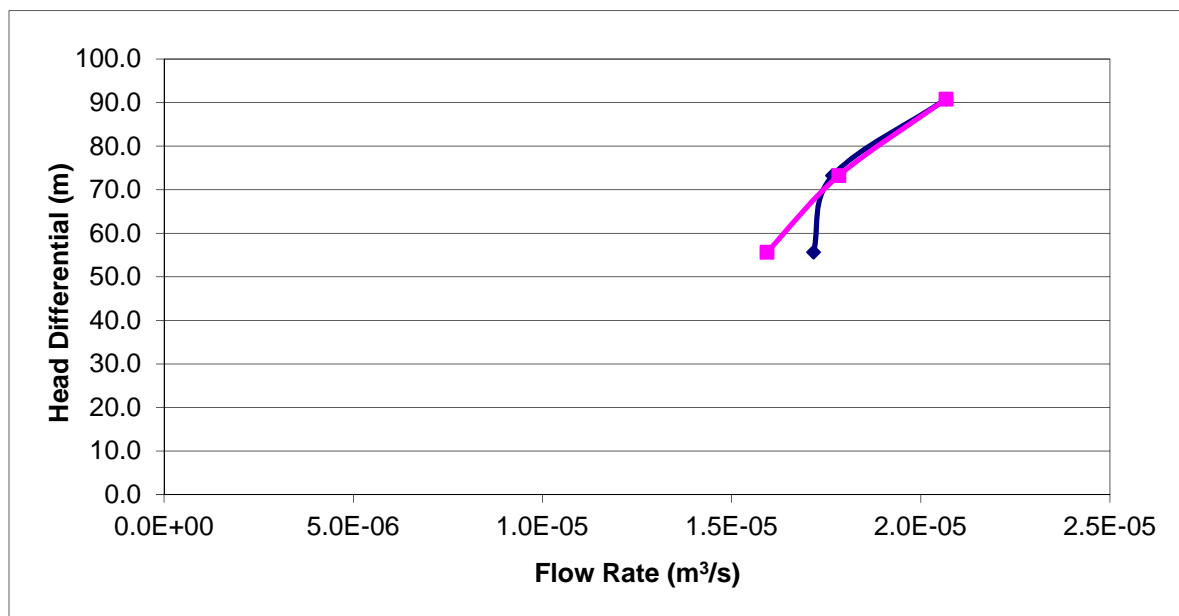


### Calculation Input Parameters

Top of Packer Test Interval (mah): 143.4  
 Bottom of Packer Test Interval (mah): 166.9  
 L: Length of Test Interval (mah): 23.4  
 Test Interval Midpoint (mah): 155  
 Stickup Height (mah): 1.00  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 21.30  
 Borehole Diameter (mm): 96.0  
 r: Borehole Radius (m): 0.048  
 A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	1.7E-05	35.2	55.7	1.3E-08
75.0	1.8E-05	52.7	73.2	1.0E-08
100.0	2.1E-05	70.3	90.8	9.6E-09
75.0	1.8E-05	52.7	73.2	1.0E-08
50.0	1.6E-05	35.2	55.7	1.2E-08
Geo Mean				1.1.E-08





## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** TMEP  
**Project:** Westridge Tunnel SI  
**Project #:** 0095-150-15  
**Personel:** JVH

**Collar El.:** \_\_\_\_\_  
**Trend:** \_\_\_\_\_  
**Plunge:** 90 deg  
**Date:** \_\_\_\_\_

**Hole #** HMM-BH-02  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 6

### Packer Setup Type: Single

Pressure Inte	psi	1	m3
Minutes	Pressure	Volume	Δ ζολυμε
0	50.0	464.4000	-
1	50.0	465.5000	1.1000
2	50.0	466.1000	0.6000
3	50.0	466.9000	0.8000
4	50.0	467.7000	0.8000
5	50.0	468.5000	0.8000
6	50.0	469.3000	0.8000
7	50.0	470.0000	0.7000
8	50.0	470.7000	0.7000
9	50.0	471.5000	0.8000
10	50.0	472.3000	0.8000

Stable Ave. 50.0 0.7900

Pressure Interval	2	
Minutes	Pressure	Volume
0	77.0	475.0000
1	77.0	476.0000
2	77.0	476.9000
3	77.0	477.8000
4	77.0	478.7000
5	77.0	479.3000
6	75.0	480.3000
7	75.0	481.2000
8	75.0	482.0000
9	75.0	482.9000
10	75.0	483.7000

Stable Ave. 76.0 0.8700

Pressure Interval	3	
Minutes	Pressure	Volume
0	100.0	485.7000
1	100.0	486.8000
2	100.0	487.8000
3	100.0	488.8000
4	100.0	489.8000
5	100.0	490.8000
6	100.0	491.8000
7	100.0	492.8000
8	100.0	493.8000
9	100.0	494.8000
10	100.0	495.7000

Stable Ave. 100.0 1.0000

Pressure Interval	4	
Minutes	Pressure	Volume
0	75.0	496.2000
1	75.0	497.1000
2	75.0	498.0000
3	75.0	498.8000
4	75.0	499.6000
5	78.0	500.5000
6	78.0	501.4000
7	78.0	502.2000
8	78.0	503.0000
9	78.0	503.9000
10	78.0	504.8000

Stable Ave. 76.8 0.8600

Pressure Interval	5	
Minutes	Pressure	Volume
0	49.0	505.1000
1	49.0	505.8000
2	49.0	506.4000
3	50.0	507.1000
4	50.0	507.8000
5	50.0	508.5000
6	50.0	509.2000
7	50.0	509.9000
8	50.0	510.6000
9	50.0	511.2000
10	50.0	511.9000

Stable Ave. 49.8 0.6800

Pressure Interval		
Minutes	Pressure	Volume
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

### Measurements

Depth to Water from Top of Stickup: 12.14 m  
 Top of Packer Interval: 162.35 m  
 Bottom of Packer Interval (or Bottom of Hole): 186.35 m  
 Packer Inflation Pressure: 570 psi  
 Rod Stickup Height: 1.23 m  
 Water Flushed (Vol./Time/Until Clean): 45 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96  
 Vertical height of gauge above ground: 0.20 m

### Measurment Units

Volume: L  
 Pressure: psi  
 Length: m

### Time

Start Flushing: 2:40 AM  
 End Flushing: 3:00 AM  
 Start Packer Testing: 5:19 AM  
 End Packer Testing: 6:19 AM

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

**Additional Comments:**

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Hole #: HMM-BH-02  
 Test #: 6

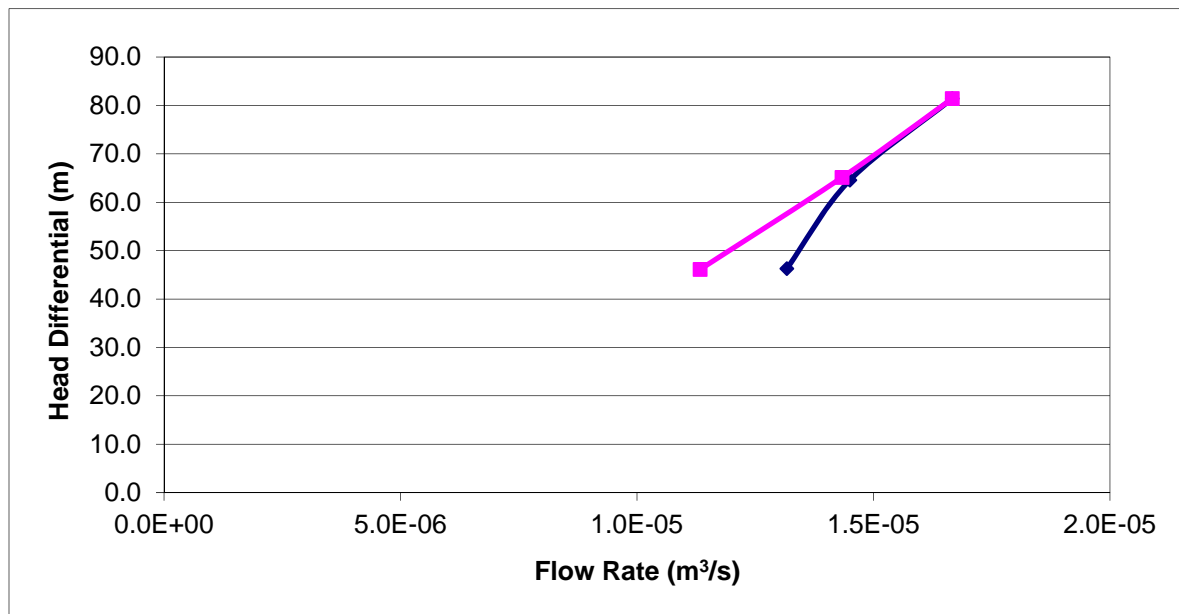


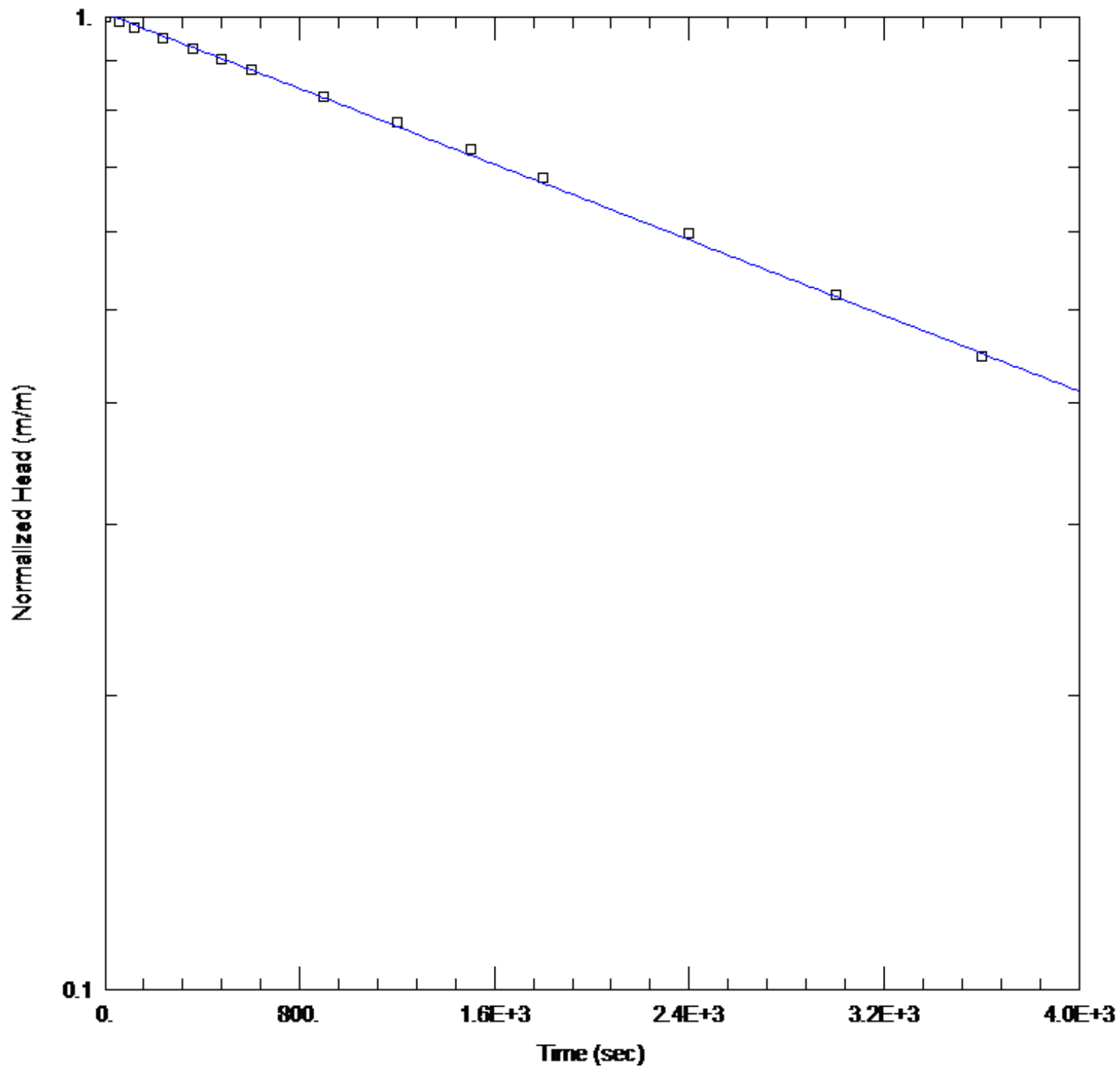
### Calculation Input Parameters

Top of Packer Test Interval (mah): 162.4  
 Bottom of Packer Test Interval (mah): 186.4  
 L: Length of Test Interval (mah): 24.0  
 Test Interval Midpoint (mah): 174  
 Stickup Height (mah): 1.23  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 12.14  
 Borehole Diameter (mm): 96.0  
 r: Borehole Radius (m): 0.048  
 A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	1.3E-05	35.2	46.3	1.2E-08
76.0	1.5E-05	53.4	64.5	9.3E-09
100.0	1.7E-05	70.3	81.4	8.4E-09
76.8	1.4E-05	54.0	65.1	9.1E-09
49.8	1.1E-05	35.0	46.1	1.0E-08
			Geo Mean	9.7.E-09





Obs. Wells

□ HMM-BH-03 Test 1

Aquifer Model

Confined

Solution

Hvorslev

Parameters

$K = 1.902E-7$  m/sec

$y_0 = 10.24$  m

Hole #: HMM-BH-03  
 Test #: 2

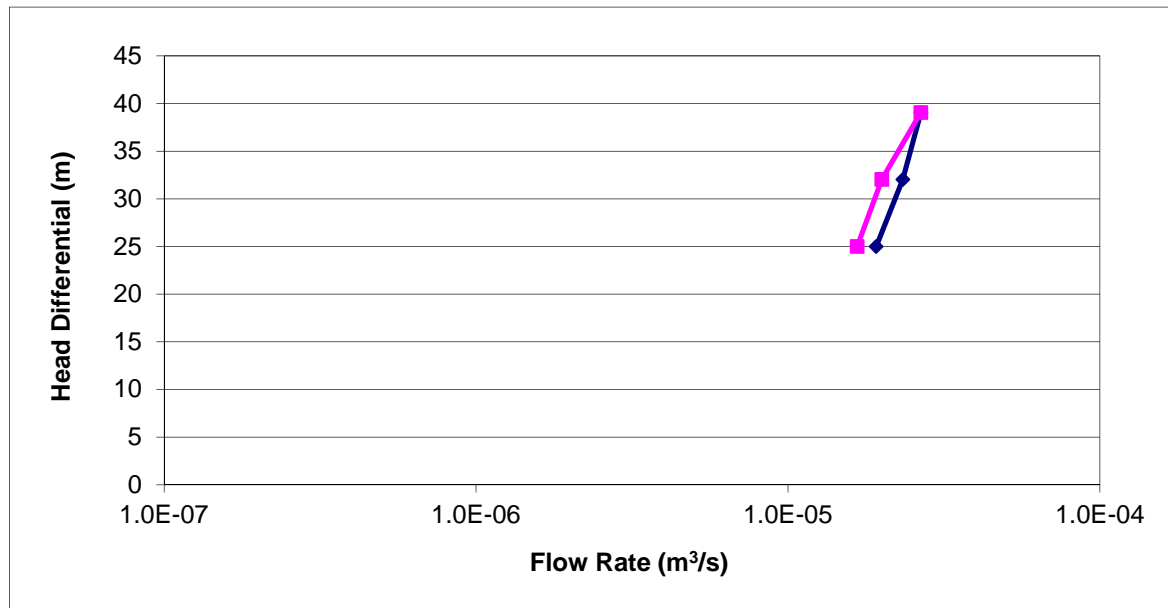


### Calculation Input Parameters

Top of Packer Test Interval (mah): 52.2  
 Bottom of Packer Test Interval (mah): 70.6  
L: Length of Test Interval (mah) 18.4  
 Test Interval Midpoint (mah): 61.4  
 Stickup Height (mah): 1.33  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 12.06  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
20.0	1.9E-05	14.1	25.0	3.9E-08
30.0	2.3E-05	21.1	32.0	3.7E-08
40.0	2.7E-05	28.1	39.1	3.5E-08
30.0	2.0E-05	21.1	32.0	3.2E-08
20.0	1.7E-05	14.1	25.0	3.4E-08
			Geo Mean	3.6E-08



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Scott Garrison / Anne Clayton

**Collar El.:** 165.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 15-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 2

### Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	20	6.6910	-
1	20	6.6930	0.0020
2	20	6.6940	0.0010
3	20	6.6940	0.0000
4	20	6.6950	0.0010
5	20	6.6970	0.0020
6	20	6.6980	0.0010
7	20	6.6990	0.0010
8	20	6.7000	0.0010
9	20	6.7015	0.0015
10	20	6.7025	0.0010

Stable Ave. 20 0.0011

Pressure Interval		2	
Minutes	Pressure	Volume	$\Delta$ Volume
0	30	6.7100	-
1	30	6.7110	0.0010
2	30	6.7125	0.0015
3	30	6.7140	0.0015
4	30	6.7155	0.0015
5	30	6.7170	0.0015
6	30	6.7185	0.0015
7	30	6.7200	0.0015
8	30	6.7215	0.0015
9	30	6.7230	0.0015
10	30	6.7240	0.0010

Stable Ave. 30 0.0014

Pressure Interval		3	
Minutes	Pressure	Volume	$\Delta$ Volume
0	40	6.7290	-
1	40	6.7310	0.0020
2	40	6.7330	0.0020
3	40	6.7340	0.0010
4	40	6.7355	0.0015
5	40	6.7370	0.0015
6	40	6.7385	0.0015
7	40	6.7400	0.0015
8	40	6.7420	0.0020
9	40	6.7430	0.0010
10	40	6.7450	0.0020

Stable Ave. 40 0.0016

Pressure Interval		4	
Minutes	Pressure	Volume	$\Delta$ Volume
0	30	6.7450	-
1	30	6.7455	0.0005
2	30	6.7465	0.0010
3	30	6.7470	0.0005
4	30	6.7490	0.0020
5	30	6.7505	0.0015
6	30	6.7520	0.0015
7	30	6.7530	0.0010
8	30	6.7545	0.0015
9	30	6.7555	0.0010
10	30	6.7570	0.0015

Stable Ave. 30.0 0.0012

Pressure Interval		5	
Minutes	Pressure	Volume	$\Delta$ Volume
0	20	6.7570	--
1	20	6.7575	0.0005
2	20	6.7585	0.0010
3	20	6.7595	0.0010
4	20	6.7605	0.0010
5	20	6.7615	0.0010
6	20	6.7625	0.0010
7	20	6.7640	0.0015
8	20	6.7650	0.0010
9	20	6.7660	0.0010
10	20	6.7670	0.0010

Stable Ave. 20.0 0.0010

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 12.06 m  
 Top of Packer Interval: 52.19 m  
 Bottom of Packer Interval (or Bottom of Hole): 70.6 m  
 Packer Inflation Pressure: 360 psi  
 Rod Stickup Height: 1.33 m  
 Water Flushed (Vol./Time/Until Clean): 25 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 4:20  
 End Flushing: 5:05  
 Start Packer Testing: 6:30  
 End Packer Testing: 7:30

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Hole #: HMM-BH-03  
 Test #: 3

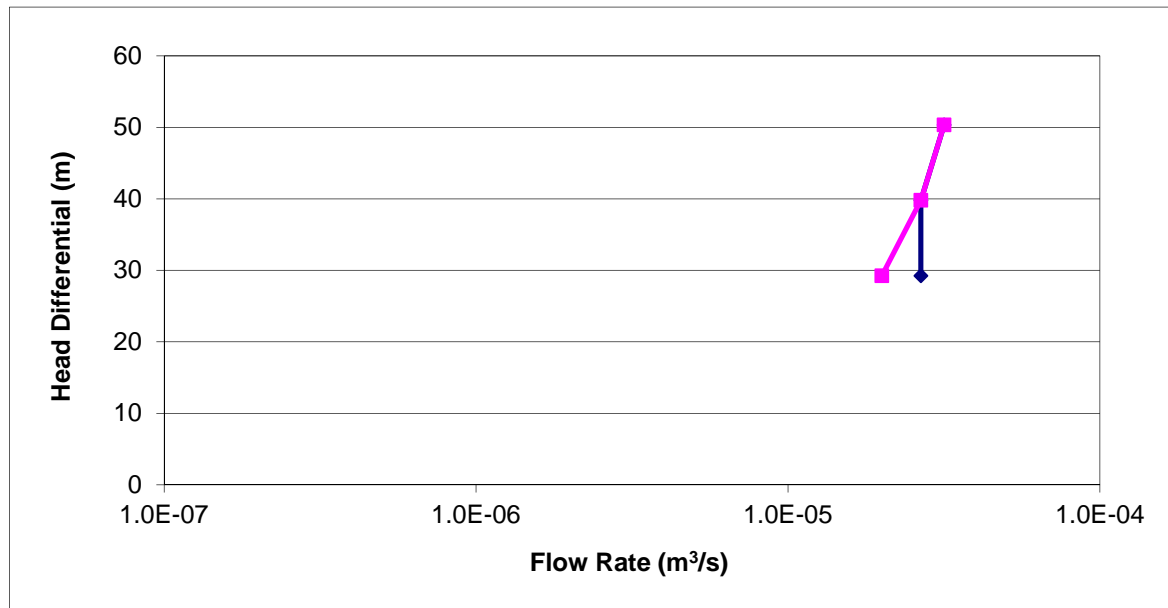


### Calculation Input Parameters

Top of Packer Test Interval (mah): 70.6  
 Bottom of Packer Test Interval (mah): 79.8  
L: Length of Test Interval (mah) 9.2  
 Test Interval Midpoint (mah): 75.2  
 Stickup Height (mah): 1.12  
 Pressure Gauge Height (m above ground): 0.84  
 Depth to Water Table (mah): 8.43  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
30.0	2.7E-05	21.1	29.2	8.3E-08
45.0	2.7E-05	31.6	39.8	6.1E-08
60.0	3.2E-05	42.2	50.3	5.7E-08
45.0	2.7E-05	31.6	39.8	6.1E-08
30.0	2.0E-05	21.1	29.2	6.2E-08
			Geo Mean	6.5E-08



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Cole Christiansen

**Collar El.:** 165.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 15-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 3

### Packer Setup Type: Single

Pressure Interval      psi      1      m3			
Minutes	Pressure	Volume	Δ Volume
0	30	6.8780	-
1	30	6.8800	0.0020
2	30	6.8810	0.0010
3	30	6.8830	0.0020
4	30	6.8850	0.0020
5	30	6.8860	0.0010
6	30	6.8880	0.0020
7	30	6.8890	0.0010
8	30	6.8900	0.0010
9	30	6.8920	0.0020
10	30	6.8940	0.0020

Stable Ave.      30      0.0016

Pressure Interval      2			
Minutes	Pressure	Volume	Δ Volume
0	45	6.8960	-
1	45	6.8980	0.0020
2	45	6.9000	0.0020
3	45	6.9020	0.0020
4	45	6.9030	0.0010
5	45	6.9050	0.0020
6	45	6.9060	0.0010
7	45	6.9080	0.0020
8	45	6.9090	0.0010
9	45	6.9110	0.0020
10	45	6.9120	0.0010

Stable Ave.      45      0.0016

Pressure Interval      3			
Minutes	Pressure	Volume	Δ Volume
0	60	6.9140	-
1	60	6.9160	0.0020
2	60	6.9180	0.0020
3	60	6.9200	0.0020
4	60	6.9220	0.0020
5	60	6.9240	0.0020
6	60	6.9260	0.0020
7	60	6.9270	0.0010
8	60	6.9290	0.0020
9	60	6.9310	0.0020
10	60	6.9330	0.0020

Stable Ave.      60      0.0019

Pressure Interval      4			
Minutes	Pressure	Volume	Δ Volume
0	45	6.9360	-
1	45	6.9380	0.0020
2	45	6.9390	0.0010
3	45	6.9410	0.0020
4	45	6.9420	0.0010
5	45	6.9440	0.0020
6	45	6.9450	0.0010
7	45	6.9470	0.0020
8	45	6.9490	0.0020
9	45	6.9500	0.0010
10	45	6.9520	0.0020

Stable Ave.      45.0      0.0016

Pressure Interval      5			
Minutes	Pressure	Volume	Δ Volume
0	30	6.9530	--
1	30	6.9540	0.0010
2	30	6.9550	0.0010
3	30	6.9570	0.0020
4	30	6.9580	0.0010
5	30	6.9590	0.0010
6	30	6.9600	0.0010
7	30	6.9610	0.0010
8	30	6.9630	0.0020
9	30	6.9640	0.0010
10	30	6.9650	0.0010

Stable Ave.      30.0      0.0012

Pressure Interval			
Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 8.43 m  
 Top of Packer Interval: 70.60 m  
 Bottom of Packer Interval (or Bottom of Hole): 79.75 m  
 Packer Inflation Pressure: 400 psi  
 Rod Stickup Height: 1.12 m  
 Water Flushed (Vol./Time/Until Clean): 30 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.84 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 12:45  
 End Flushing: 13:15  
 Start Packer Testing: 13:53  
 End Packer Testing: 15:51

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Hole #: HMM-BH-03  
 Test #: 4

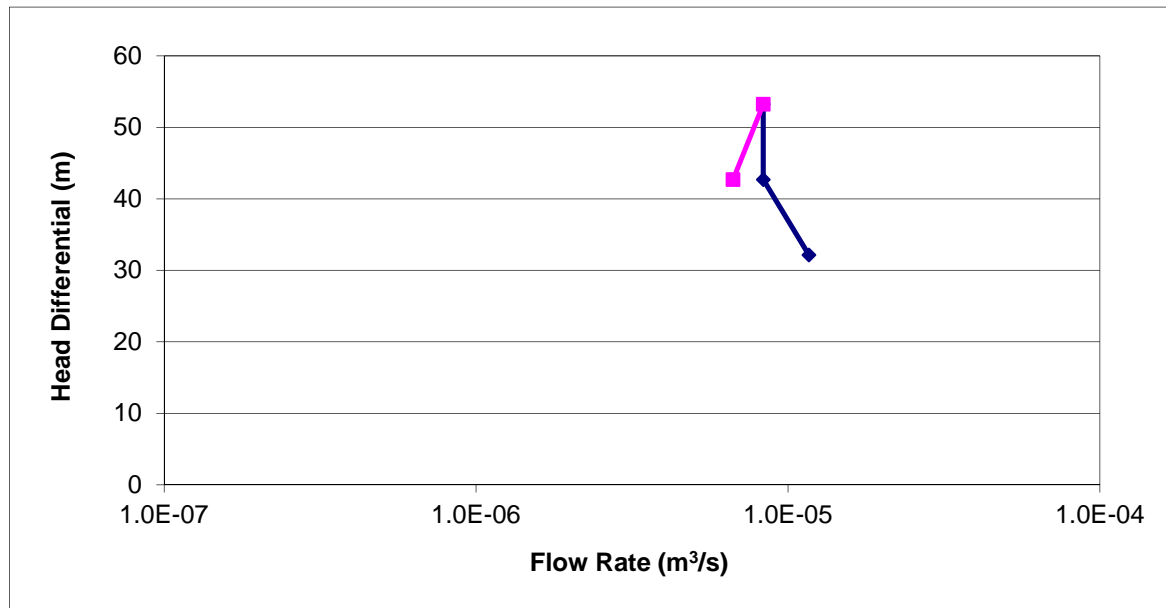


**Calculation Input Parameters**

Top of Packer Test Interval (mah): 108.7  
 Bottom of Packer Test Interval (mah): 122.4  
L: Length of Test Interval (mah) 13.7  
 Test Interval Midpoint (mah): 115.6  
 Stickup Height (mah): 1.37  
 Pressure Gauge Height (m above ground): 0.30  
 Depth to Water Table (mah): 12.12  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
30.0	1.2E-05	21.1	32.1	2.4E-08
45.0	8.3E-06	31.6	42.7	1.3E-08
60.0	8.3E-06	42.2	53.2	1.0E-08
45.0	6.7E-06	31.6	42.7	1.0E-08
			Geo Mean	1.3.E-08





## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Cole Christiansen

**Collar El.:** 65.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 16-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 4

### Packer Setup Type: Single

Pressure Interval      psi      1      m3			
Minutes	Pressure	Volume	Δ Volume
0	30	7.0810	-
1	30	7.0820	0.0010
2	30	7.0830	0.0010
3	30	7.0840	0.0010
4	30	7.0850	0.0010
5	30	7.0855	0.0005
6	30	7.0860	0.0005
7	30	7.0865	0.0005
8	30	7.0870	0.0005
9	30	7.0875	0.0005
10	30	7.0880	0.0005

Stable Ave.      30      0.0007

Pressure Interval      2			
Minutes	Pressure	Volume	Δ Volume
0	45	7.0900	-
1	45	7.0905	0.0005
2	45	7.0910	0.0005
3	45	7.0915	0.0005
4	45	7.0920	0.0005
5	45	7.0925	0.0005
6	45	7.0930	0.0005
7	45	7.0935	0.0005
8	45	7.0940	0.0005
9	45	7.0945	0.0005
10	45	7.0950	0.0005

Stable Ave.      45      0.0005

Pressure Interval      3			
Minutes	Pressure	Volume	Δ Volume
0	60	7.0960	-
1	60	7.0965	0.0005
2	60	7.0970	0.0005
3	60	7.0975	0.0005
4	60	7.0980	0.0005
5	60	7.0985	0.0005
6	60	7.0990	0.0005
7	60	7.0995	0.0005
8	60	7.1000	0.0005
9	60	7.1005	0.0005
10	60	7.1010	0.0005

Stable Ave.      60      0.0005

Pressure Interval      4			
Minutes	Pressure	Volume	Δ Volume
0	45	7.1020	-
1	45	7.1025	0.0005
2	45	7.1030	0.0005
3	45	7.1035	0.0005
4	45	7.1040	0.0005
5	45	7.1040	0.0000
6	45	7.1043	0.0003
7	45	7.1048	0.0005
8	45	7.1050	0.0003
9	45	7.1055	0.0005
10	45	7.1060	0.0005

Stable Ave.      45.0      0.0004

Pressure Interval      5			
Minutes	Pressure	Volume	Δ Volume
0	30	7.1070	--
1	30	7.1070	0.0000
2	30	7.1070	0.0000
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave.      30.0      0.0000

Pressure Interval			
Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 12.12 m  
 Top of Packer Interval: 108.71 m  
 Bottom of Packer Interval (or Bottom of Hole): 122.43 m  
 Packer Inflation Pressure: 440 psi  
 Rod Stickup Height: 1.37 m  
 Water Flushed (Vol./Time/Until Clean): 25 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.30 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 14:15  
 End Flushing: 14:40  
 Start Packer Testing: 15:15  
 End Packer Testing: 16:00

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Hole #: HMM-BH-03  
Test #: 5

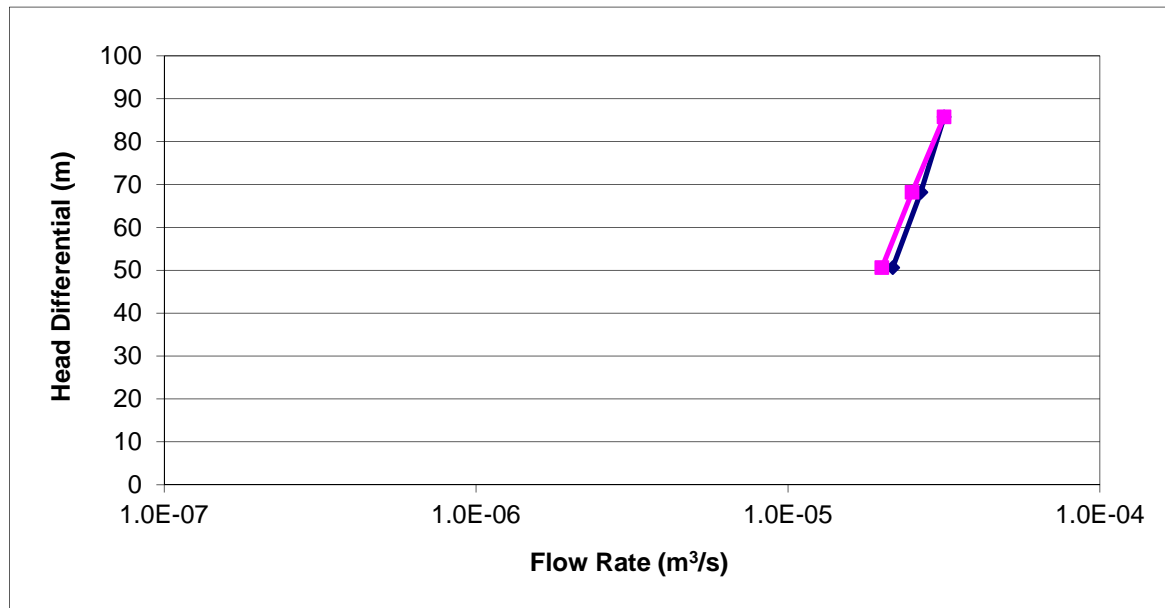


### Calculation Input Parameters

Top of Packer Test Interval (mah): 124.0  
Bottom of Packer Test Interval (mah): 152.9  
L: Length of Test Interval (mah) 29.0  
Test Interval Midpoint (mah): 138.4  
Stickup Height (mah): 1.33  
Pressure Gauge Height (m above ground): 0.20  
Depth to Water Table (mah): 16.59  
Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
\* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	2.2E-05	35.2	50.6	1.5E-08
75.0	2.7E-05	52.7	68.2	1.4E-08
100.0	3.2E-05	70.3	85.8	1.3E-08
75.0	2.5E-05	52.7	68.2	1.3E-08
50.0	2.0E-05	35.2	50.6	1.4E-08
			Geo Mean	1.4.E-08



# Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

Client: KINDER MORGAN  
 Project: Westridge Tunnel Geotechnical Investigation  
 Project #: 0095150-15  
 Personnel: Cole Christiansen

Collar El.: 165.00  
 Trend: - deg  
 Plunge: 90 deg  
 Date: 17-Sep-14

Hole # HMM-BH-03  
 Design Test Interval:  
 Test #: 5

## Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	50	7.2150	-
1	50	7.2160	0.0010
2	50	7.2180	0.0020
3	50	7.2190	0.0010
4	50	7.2200	0.0010
5	50	7.2220	0.0020
6	50	7.2230	0.0010
7	50	7.2240	0.0010
8	50	7.2255	0.0015
9	50	7.2270	0.0015
10	50	7.2280	0.0010

Stable Ave. 50 0.0013

Pressure Interval		2	
Minutes	Pressure	Volume	$\Delta$ Volume
0	75	7.2330	-
1	75	7.2350	0.0020
2	75	7.2360	0.0010
3	75	7.2380	0.0020
4	75	7.2395	0.0015
5	75	7.2410	0.0015
6	75	7.2430	0.0020
7	75	7.2445	0.0015
8	75	7.2460	0.0015
9	75	7.2475	0.0015
10	75	7.2490	0.0015

Stable Ave. 75 0.0016

Pressure Interval		3	
Minutes	Pressure	Volume	$\Delta$ Volume
0	100	7.2510	-
1	100	7.2530	0.0020
2	100	7.2550	0.0020
3	100	7.2570	0.0020
4	100	7.2590	0.0020
5	100	7.2605	0.0015
6	100	7.2620	0.0015
7	100	7.2640	0.0020
8	100	7.2660	0.0020
9	100	7.2680	0.0020
10	100	7.2700	0.0020

Stable Ave. 100 0.0019

Pressure Interval		4	
Minutes	Pressure	Volume	$\Delta$ Volume
0	75	7.2740	-
1	75	7.2755	0.0015
2	75	7.2770	0.0015
3	75	7.2785	0.0015
4	75	7.2800	0.0015
5	75	7.2815	0.0015
6	75	7.2830	0.0015
7	75	7.2845	0.0015
8	75	7.2860	0.0015
9	75	7.2875	0.0015
10	75	7.2890	0.0015

Stable Ave. 75.0 0.0015

Pressure Interval		5	
Minutes	Pressure	Volume	Δ Volume
0	50	7.2900	--
1	50	7.2915	0.0015
2	50	7.2925	0.0010
3	50	7.2940	0.0015
4	50	7.2950	0.0010
5	50	7.2960	0.0010
6	50	7.2970	0.0010
7	50	7.2985	0.0015
8	50	7.3000	0.0015
9	50	7.3010	0.0010
10	50	7.3020	0.0010

Stable Ave. 50.0 0.0012

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

## Measurements

Depth to Water from Top of Stickup: 16.59 m  
 Top of Packer Interval: 123.96 m  
 Bottom of Packer Interval (or Bottom of Hole): 152.93 m  
 Packer Inflation Pressure: 550 psi  
 Rod Stickup Height: 1.33 m

Water Flushed (Vol./Time/Until Clean):

Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

## Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

## Time

Start Flushing: 7:30  
 End Flushing: 9:45  
 Start Packer Testing: 10:37  
 End Packer Testing: 11:35

## IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

## Additional Comments:

Hole #: HMM-BH-03  
 Test #: 6

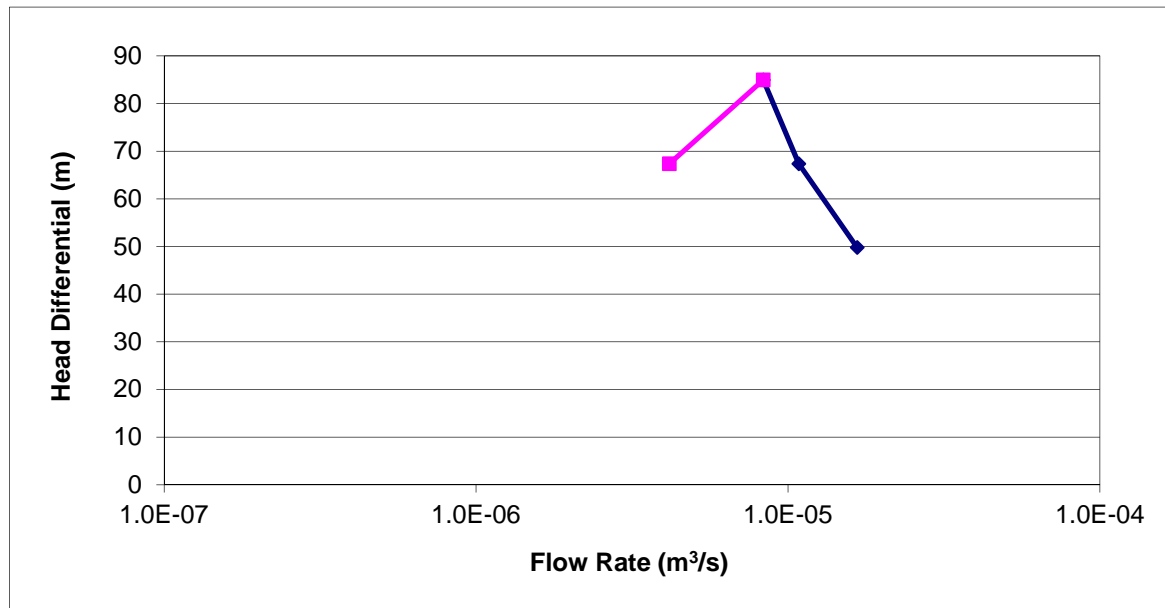


**Calculation Input Parameters**

Top of Packer Test Interval (mah): 149.9  
 Bottom of Packer Test Interval (mah): 181.9  
L: Length of Test Interval (mah): 32.0  
 Test Interval Midpoint (mah): 165.9  
 Stickup Height (mah): 1.41  
 Pressure Gauge Height (m above ground): 0.34  
 Depth to Water Table (mah): 15.70  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	1.7E-05	35.2	49.8	1.1E-08
75.0	1.1E-05	52.7	67.4	5.2E-09
100.0	8.3E-06	70.3	84.9	3.2E-09
75.0	4.2E-06	52.7	67.4	2.0E-09
			Geo Mean	4.3.E-09



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Cole Christiansen

**Collar El.:** 165.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 18-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:** \_\_\_\_\_  
**Test #:** 6

### Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	50	7.4050	-
1	50	7.4065	0.0015
2	50	7.4075	0.0010
3	50	7.4090	0.0015
4	50	7.4100	0.0010
5	50	7.4110	0.0010
6	50	7.4120	0.0010
7	50	7.4125	0.0005
8	50	7.4140	0.0015
9	50	7.4150	0.0010
10	50	7.4150	0.0000

Stable Ave. 50 0.0010

Pressure Interval		2	
Minutes	Pressure	Volume	$\Delta$ Volume
0	75	7.4180	-
1	75	7.4190	0.0010
2	75	7.4195	0.0005
3	75	7.4200	0.0005
4	75	7.4210	0.0010
5	75	7.4215	0.0005
6	75	7.4220	0.0005
7	75	7.4230	0.0010
8	75	7.4235	0.0005
9	75	7.4240	0.0005
10	75	7.4245	0.0005

Stable Ave. 75 0.0006

Pressure Interval		3	
Minutes	Pressure	Volume	$\Delta$ Volume
0	100	7.4270	-
1	100	7.4275	0.0005
2	100	7.4280	0.0005
3	100	7.4285	0.0005
4	100	7.4295	0.0010
5	100	7.4300	0.0005
6	100	7.4305	0.0005
7	100	7.4305	0.0000
8	100	7.4310	0.0005
9	100	7.4315	0.0005
10	100	7.4320	0.0005

Stable Ave. 100 0.0005

Pressure Interval		4	
Minutes	Pressure	Volume	$\Delta$ Volume
0	75	7.4325	-
1	75	7.4330	0.0005
2	75	7.4335	0.0005
3	75	7.4335	0.0000
4	75	7.4340	0.0005
5	75	7.4340	0.0000
6	75	7.4345	0.0005
7	75	7.4350	0.0005
8	75	7.4350	0.0000
9	75	7.4350	0.0000
10	75	7.4350	0.0000

Stable Ave. 75.0 0.0002

Pressure Interval		5	
Minutes	Pressure	Volume	$\Delta$ Volume
0	Flow stopped, so test was ended.		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave.

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 15.70 m  
 Top of Packer Interval: 149.87 m  
 Bottom of Packer Interval (or Bottom of Hole): 181.89 m  
 Packer Inflation Pressure: 600 psi  
 Rod Stickup Height: 1.41 m  
 Water Flushed (Vol./Time/Until Clean): 35 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.34 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

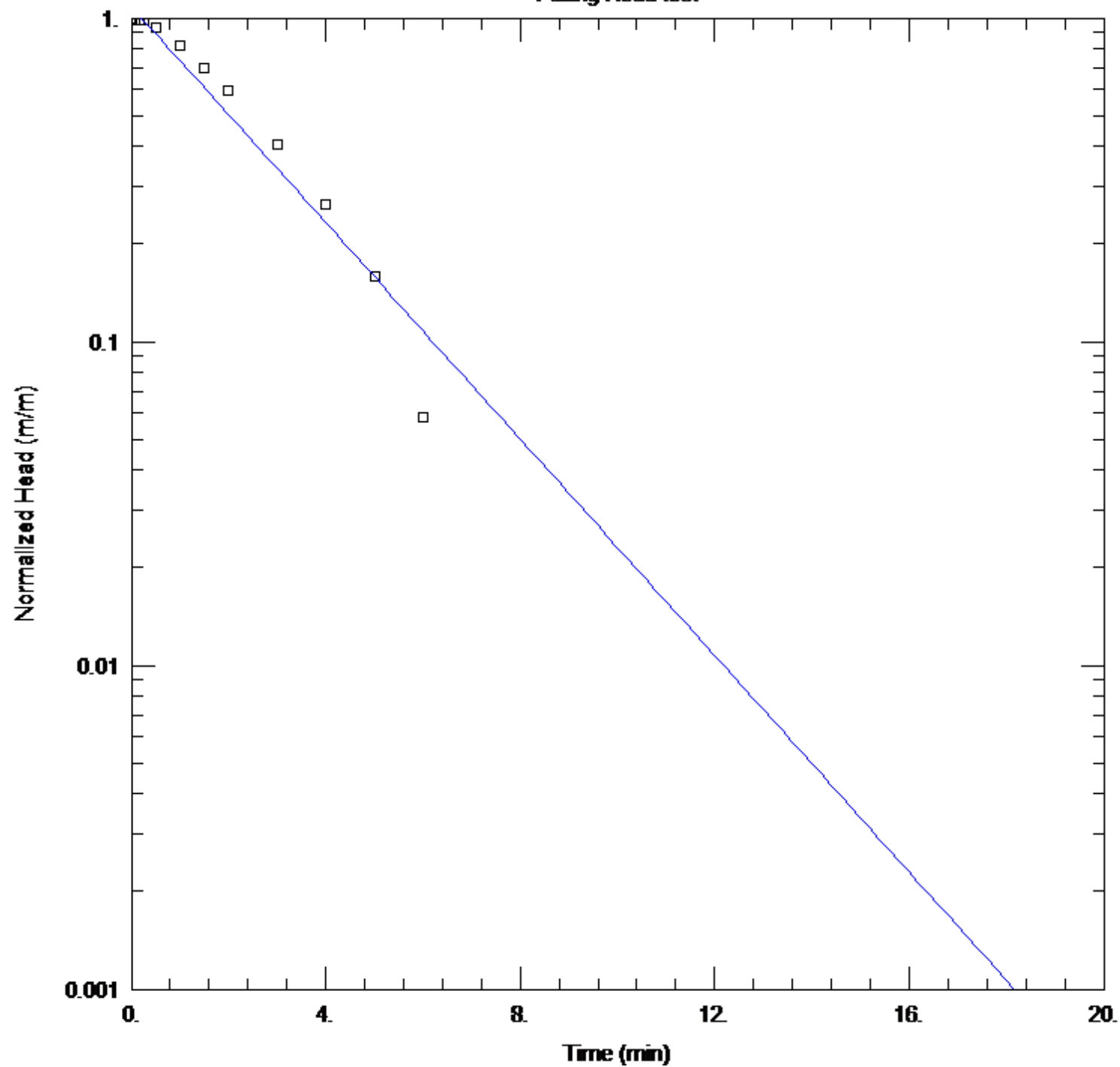
Start Flushing: 14:10  
 End Flushing: 14:45  
 Start Packer Testing: 15:45  
 End Packer Testing: 16:30

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

# Falling Head test



## Obs. Wells

□ HMM-BH-05

## Aquifer Model

Unconfined

## Solution

Hvorslev

## Parameters

$K = 1.139\text{E-}5 \text{ m/sec}$

$y_0 = 4.649 \text{ m}$

Hole #: HMM-BH-05  
Test #: 1

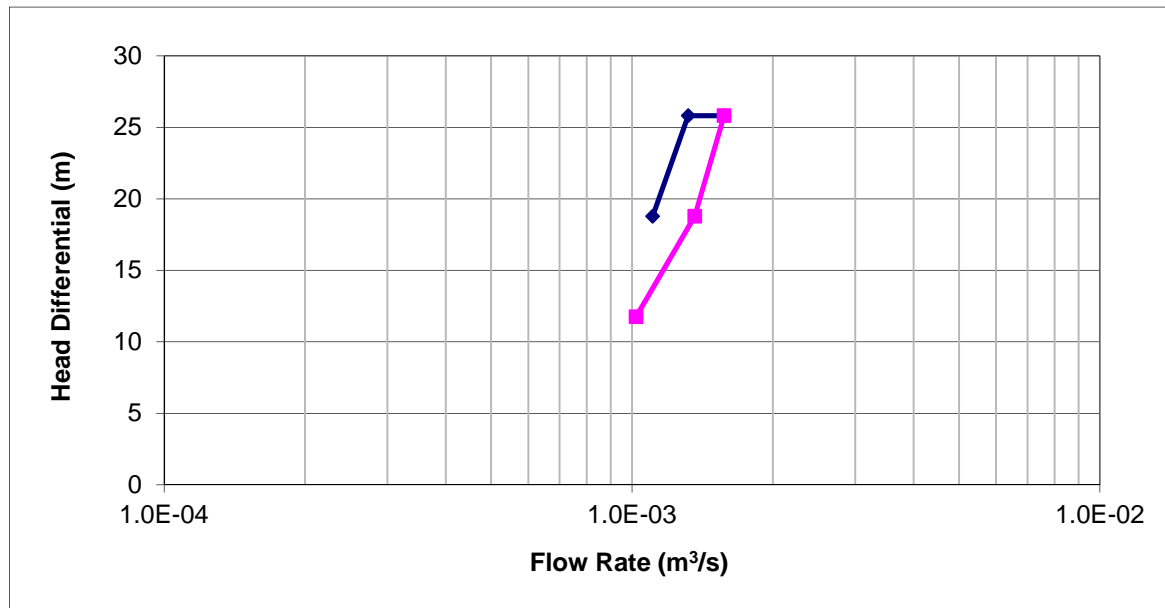


### Calculation Input Parameters

Top of Packer Test Interval (mah): 15.2  
Bottom of Packer Test Interval (mah): 32.3  
L: Length of Test Interval (mah): 17.0  
Test Interval Midpoint (mah): 23.7  
Stickup Height (mah): 0.38  
Pressure Gauge Height (m above ground): 0.20  
Depth to Water Table (mah): 4.90  
Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
\* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
20.0	1.1E-03	14.1	18.8	3.2E-06
30.0	1.3E-03	21.1	25.8	2.8E-06
30.0	1.6E-03	21.1	25.8	3.3E-06
20.0	1.4E-03	14.1	18.8	4.0E-06
10.0	1.0E-03	7.0	11.8	4.8E-06
			Geo Mean	3.6E-06



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Scott Garrison

**Collar El.:** \_\_\_\_\_  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 4-Oct-14

**Hole #** HMM-BH-05  
**Design Test Interval:** 17.01 m  
**Test #:** 1

### Packer Setup Type: Single

Pressure Interval 1

Minutes	Pressure	Volume	Δ Volume
0	20	7.525	-
1	20	7.592	0.067
2	20	7.657	0.065
3	20	7.724	0.067
4	20	7.790	0.066
5	20	7.852	0.062
6	20	7.923	0.071
7	20	7.990	0.067
8	20	8.056	0.066
9	20	8.123	0.067
10	20	8.189	0.066

Stable Ave. 20 0.0664

Pressure Interval 2

Minutes	Pressure	Volume	Δ Volume
0	30	8.572	-
1	30	8.650	0.078
2	30	8.724	0.074
3	30	8.799	0.075
4	30	8.875	0.076
5	30	8.950	0.075
6	30	9.028	0.078
7	30	9.110	0.082
8	30	9.193	0.083
9	30	9.278	0.085
10	30	9.363	0.085

Stable Ave. 30 0.0791

Pressure Interval 3

Minutes	Pressure	Volume	Δ Volume
0	30	9.800	-
1	30	9.894	0.094
2	30	9.988	0.094
3	30	10.084	0.096
4	30	10.178	0.094
5	30	10.272	0.094
6	30	10.367	0.095
7	30	10.462	0.095
8	30	10.556	0.094
9	30	10.650	0.094
10	30	10.744	0.094

Stable Ave. 30 0.0944

Pressure Interval 4

Minutes	Pressure	Volume	Δ Volume
0	20	10.825	-
1	20	10.907	0.082
2	20	10.989	0.082
3	20	11.069	0.080
4	20	11.152	0.083
5	20	11.233	0.081
6	20	11.315	0.082
7	20	11.396	0.081
8	20	11.478	0.082
9	20	11.559	0.081
10	20	11.642	0.083

Stable Ave. 20.0 0.0817

Pressure Interval 5

Minutes	Pressure	Volume	Δ Volume
0	10	11.715	--
1	10	11.777	0.062
2	10	11.838	0.061
3	10	11.899	0.061
4	10	11.960	0.061
5	10	12.021	0.061
6	10	12.082	0.061
7	10	12.144	0.062
8	10	12.205	0.061
9	10	12.266	0.061
10	10	12.327	0.061

Stable Ave. 10.0 0.0612

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 4.90 m  
 Top of Packer Interval: 15.24 m  
 Bottom of Packer Interval (or Bottom of Hole): 32.25 m  
 Packer Inflation Pressure: 320 psi  
 Rod Stickup Height: 0.38 m  
 Water Flushed (Vol./Time/Until Clean): 30 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3 Casing  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 18:30  
 End Flushing: 19:00  
 Start Packer Testing: 20:20  
 End Packer Testing: 21:30

### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Packer seated in HWT casing, borehole wall conditions were poor in highly weathered conglomerate. A packer would not have sealed in this material and the equipment would have been exposed to a high risk of damage if attempted. Bentonite mud was used for drilling prior to testing, borehole flushed as well as possible but it was not likely completely clean.



Hole #: HMM-BH-05  
 Test #: 2

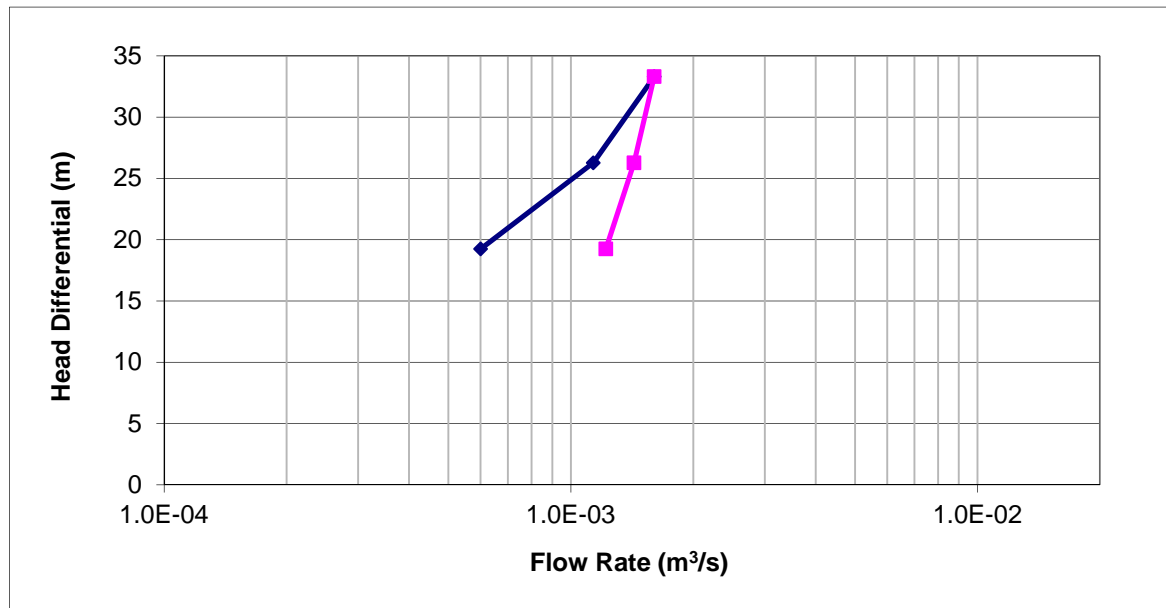


### Calculation Input Parameters

Top of Packer Test Interval (mah): 36.6  
 Bottom of Packer Test Interval (mah): 44.5  
L: Length of Test Interval (mah) 7.9  
 Test Interval Midpoint (mah): 40.5  
 Stickup Height (mah): 1.48  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 6.46  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
20.0	6.0E-04	14.1	19.2	3.2E-06
30.0	1.1E-03	21.1	26.3	4.5E-06
40.0	1.6E-03	28.1	33.3	5.0E-06
30.0	1.4E-03	21.1	26.3	5.6E-06
20.0	1.2E-03	14.1	19.2	6.5E-06
			Geo Mean	4.8.E-06



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Scott Garrison

**Collar El.:** \_\_\_\_\_  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 5-Oct-14

**Hole #** HMM-BH-05  
**Design Test Interval:** EOH  
**Test #:** 2

### Packer Setup Type: Single

Pressure Interval 1

Minutes	Pressure	Volume	Δ Volume
0	20	12.417	-
1	20	12.448	0.031
2	20	12.484	0.036
3	20	12.520	0.036
4	20	12.556	0.036
5	20	12.592	0.036
6	20	12.629	0.037
7	20	12.666	0.037
8	20	12.703	0.037
9	20	12.740	0.037
10	20	12.777	0.037

Stable Ave. 20 0.0360

Pressure Interval 2

Minutes	Pressure	Volume	Δ Volume
0	30	12.845	-
1	30	12.907	0.062
2	30	12.969	0.062
3	30	13.032	0.063
4	30	13.096	0.064
5	30	13.161	0.065
6	30	13.236	0.075
7	30	13.304	0.068
8	30	13.381	0.077
9	30	13.454	0.073
10	30	13.526	0.072

Stable Ave. 30 0.0681

Pressure Interval 3

Minutes	Pressure	Volume	Δ Volume
0	40	13.705	-
1	40	13.800	0.095
2	40	13.895	0.095
3	40	13.990	0.095
4	40	14.086	0.096
5	40	14.183	0.097
6	40	14.279	0.096
7	40	14.376	0.097
8	40	14.474	0.098
9	40	14.570	0.096
10	40	14.667	0.097

Stable Ave. 40 0.0962

Pressure Interval 4

Minutes	Pressure	Volume	Δ Volume
0	30	14.715	-
1	30	14.800	0.085
2	30	14.886	0.086
3	30	14.972	0.086
4	30	15.058	0.086
5	30	15.144	0.086
6	30	15.230	0.086
7			
8			
9			
10			

Stable Ave. 30.0 0.0858

Pressure Interval 5

Minutes	Pressure	Volume	Δ Volume
0	20	15.285	--
1	20	15.359	0.074
2	20	15.432	0.073
3	20	15.505	0.073
4	20	15.578	0.073
5	20	15.651	0.073
6	20	15.724	0.073
7			
8			
9			
10			

Stable Ave. 20.0 0.0732

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 6.46 m  
 Top of Packer Interval: 36.60 m  
 Bottom of Packer Interval (or Bottom of Hole): 44.46 m  
 Packer Inflation Pressure: 390 psi  
 Rod Stickup Height: 1.48 m  
 Water Flushed (Vol./Time/Until Clean): 45 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3 Casing  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 5:00  
 End Flushing: 5:45  
 Start Packer Testing: 6:30  
 End Packer Testing: 7:45

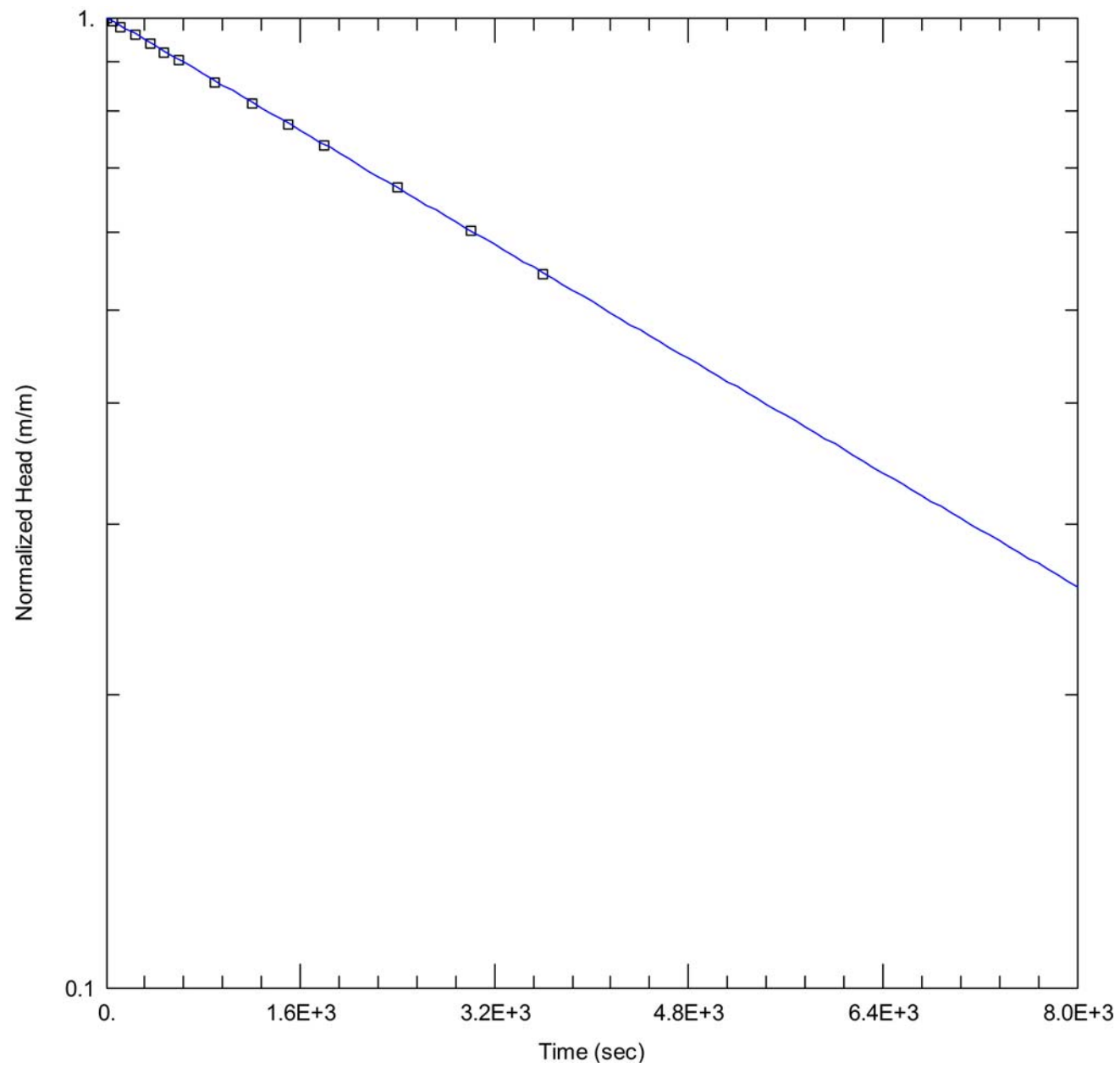
### IF NO MEASUREABLE FLOW IN CH TEST ----> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Bentonite mud was used for drilling prior to testing, borehole flushed as well as possible but it was not likely completely clean.

CORRECTED FOR STATIC WATER LEVEL



Obs. Wells

□ HMM-BH-03 Test 1

Aquifer Model

Confined

Solution

Hvorslev

Parameters

$K = 1.439\text{E-}7$  m/sec

$y_0 = 12.35$  m

# Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

Client: KINDER MORGAN  
Project: Westridge Tunnel Geotechnical Investigation  
Project #: 0095150-15  
Personnel: Scott Garrison / Anne Clayton

Collar El.: 165.00  
Trend: - deg  
Plunge: 90 deg  
Date: 15-Sep-14

Hole # HMM-BH-03  
Design Test Interval:  
Test #: 2

## Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	20	6.6910	-
1	20	6.6930	0.0020
2	20	6.6940	0.0010
3	20	6.6940	0.0000
4	20	6.6950	0.0010
5	20	6.6970	0.0020
6	20	6.6980	0.0010
7	20	6.6990	0.0010
8	20	6.7000	0.0010
9	20	6.7015	0.0015
10	20	6.7025	0.0010
Stable Ave.	20		0.0011

Pressure Interval		2	
Minutes	Pressure	Volume	Δ Volume
0	30	6.7100	-
1	30	6.7110	0.0010
2	30	6.7125	0.0015
3	30	6.7140	0.0015
4	30	6.7155	0.0015
5	30	6.7170	0.0015
6	30	6.7185	0.0015
7	30	6.7200	0.0015
8	30	6.7215	0.0015
9	30	6.7230	0.0015
10	30	6.7240	0.0010
Stable Ave.	30		0.0014

Pressure Interval		3	
Minutes	Pressure	Volume	Δ Volume
0	40	6.7290	-
1	40	6.7310	0.0020
2	40	6.7330	0.0020
3	40	6.7340	0.0010
4	40	6.7355	0.0015
5	40	6.7370	0.0015
6	40	6.7385	0.0015
7	40	6.7400	0.0015
8	40	6.7420	0.0020
9	40	6.7430	0.0010
10	40	6.7450	0.0020
Stable Ave.	40		0.0016

Pressure Interval		4	
Minutes	Pressure	Volume	Δ Volume
0	30	6.7450	-
1	30	6.7455	0.0005
2	30	6.7465	0.0010
3	30	6.7470	0.0005
4	30	6.7490	0.0020
5	30	6.7505	0.0015
6	30	6.7520	0.0015
7	30	6.7530	0.0010
8	30	6.7545	0.0015
9	30	6.7555	0.0010
10	30	6.7570	0.0015
Stable Ave.	30.0		0.0012

Pressure Interval		5	
Minutes	Pressure	Volume	Δ Volume
0	20	6.7570	--
1	20	6.7575	0.0005
2	20	6.7585	0.0010
3	20	6.7595	0.0010
4	20	6.7605	0.0010
5	20	6.7615	0.0010
6	20	6.7625	0.0010
7	20	6.7640	0.0015
8	20	6.7650	0.0010
9	20	6.7660	0.0010
10	20	6.7670	0.0010
Stable Ave.	20.0		0.0010

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

## Measurements

Depth to Water from Top of Stickup: 30.50 m  
Top of Packer Interval: 52.19 m  
Bottom of Packer Interval (or Bottom of Hole): 70.6 m  
Packer Inflation Pressure: 360 psi  
Rod Stickup Height: 1.33 m  
Water Flushed (Vol./Time/Until Clean): 25 min  
Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
Borehole Outside Diameter: 96 mm  
Vertical height of gauge above ground: 0.20 m

## Measurement Units

Volume: m<sup>3</sup>  
Pressure: psi  
Length: m/ft

## Time

Start Flushing: 4:20  
End Flushing: 5:05  
Start Packer Testing: 6:30  
End Packer Testing: 7:30

## IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

## Additional Comments:

Hole #: HMM-BH-03  
 Test #: 2

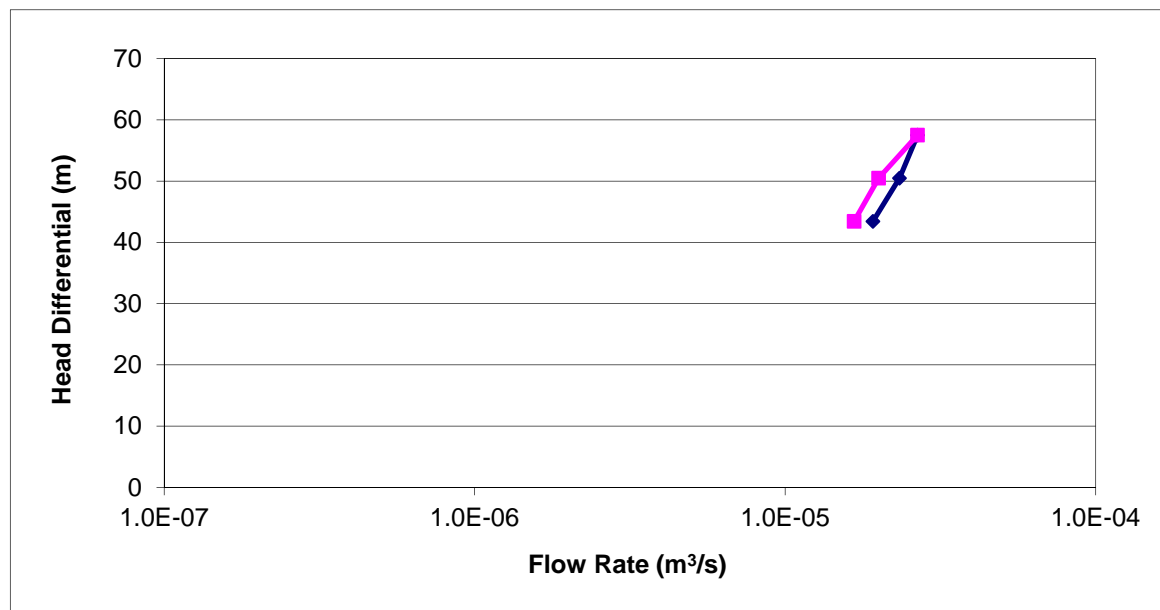


### Calculation Input Parameters

Top of Packer Test Interval (mah): 52.2  
 Bottom of Packer Test Interval (mah): 70.6  
 L: Length of Test Interval (mah): 18.4  
 Test Interval Midpoint (mah): 61.4  
 Stickup Height (mah): 1.33  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 30.50  
 Borehole Diameter (mm): 96.0  
 r: Borehole Radius (m): 0.048  
 A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
20.0	1.9E-05	14.1	43.4	2.3E-08
30.0	2.3E-05	21.1	50.5	2.4E-08
40.0	2.7E-05	28.1	57.5	2.4E-08
30.0	2.0E-05	21.1	50.5	2.0E-08
20.0	1.7E-05	14.1	43.4	2.0E-08
			Geo Mean	2.2E-08



# Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

Client: KINDER MORGAN  
 Project: Westridge Tunnel Geotechnical Investigation  
 Project #: 0095150-15  
 Personnel: Cole Christiansen

Collar El.: 165.00  
 Trend: - deg  
 Plunge: 90 deg  
 Date: 15-Sep-14

Hole # HMM-BH-03  
 Design Test Interval:  
 Test #: 3

## Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	30	6.8780	-
1	30	6.8800	0.0020
2	30	6.8810	0.0010
3	30	6.8830	0.0020
4	30	6.8850	0.0020
5	30	6.8860	0.0010
6	30	6.8880	0.0020
7	30	6.8890	0.0010
8	30	6.8900	0.0010
9	30	6.8920	0.0020
10	30	6.8940	0.0020
Stable Ave.	30		0.0016

Pressure Interval		2	
Minutes	Pressure	Volume	Δ Volume
0	45	6.8960	-
1	45	6.8980	0.0020
2	45	6.9000	0.0020
3	45	6.9020	0.0020
4	45	6.9030	0.0010
5	45	6.9050	0.0020
6	45	6.9060	0.0010
7	45	6.9080	0.0020
8	45	6.9090	0.0010
9	45	6.9110	0.0020
10	45	6.9120	0.0010
Stable Ave.	45		0.0016

Pressure Interval		3	
Minutes	Pressure	Volume	Δ Volume
0	60	6.9140	-
1	60	6.9160	0.0020
2	60	6.9180	0.0020
3	60	6.9200	0.0020
4	60	6.9220	0.0020
5	60	6.9240	0.0020
6	60	6.9260	0.0020
7	60	6.9270	0.0010
8	60	6.9290	0.0020
9	60	6.9310	0.0020
10	60	6.9330	0.0020
Stable Ave.	60		0.0019

Pressure Interval		4	
Minutes	Pressure	Volume	Δ Volume
0	45	6.9360	-
1	45	6.9380	0.0020
2	45	6.9390	0.0010
3	45	6.9410	0.0020
4	45	6.9420	0.0010
5	45	6.9440	0.0020
6	45	6.9450	0.0010
7	45	6.9470	0.0020
8	45	6.9490	0.0020
9	45	6.9500	0.0010
10	45	6.9520	0.0020
Stable Ave.	45.0		0.0016

Pressure Interval		5	
Minutes	Pressure	Volume	Δ Volume
0	30	6.9530	--
1	30	6.9540	0.0010
2	30	6.9550	0.0010
3	30	6.9570	0.0020
4	30	6.9580	0.0010
5	30	6.9590	0.0010
6	30	6.9600	0.0010
7	30	6.9610	0.0010
8	30	6.9630	0.0020
9	30	6.9640	0.0010
10	30	6.9650	0.0010
Stable Ave.	30.0		0.0012

Minutes	Pressure	Volume	Δ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

## Measurements

Depth to Water from Top of Stickup: 44.00 m  
 Top of Packer Interval: 70.60 m  
 Bottom of Packer Interval (or Bottom of Hole): 79.75 m  
 Packer Inflation Pressure: 400 psi  
 Rod Stickup Height: 1.12 m  
 Water Flushed (Vol./Time/Until Clean): 30 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.84 m

## Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

## Time

Start Flushing: 12:45  
 End Flushing: 13:15  
 Start Packer Testing: 13:53  
 End Packer Testing: 15:51

## IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

## Additional Comments:

Hole #: HMM-BH-03  
 Test #: 3



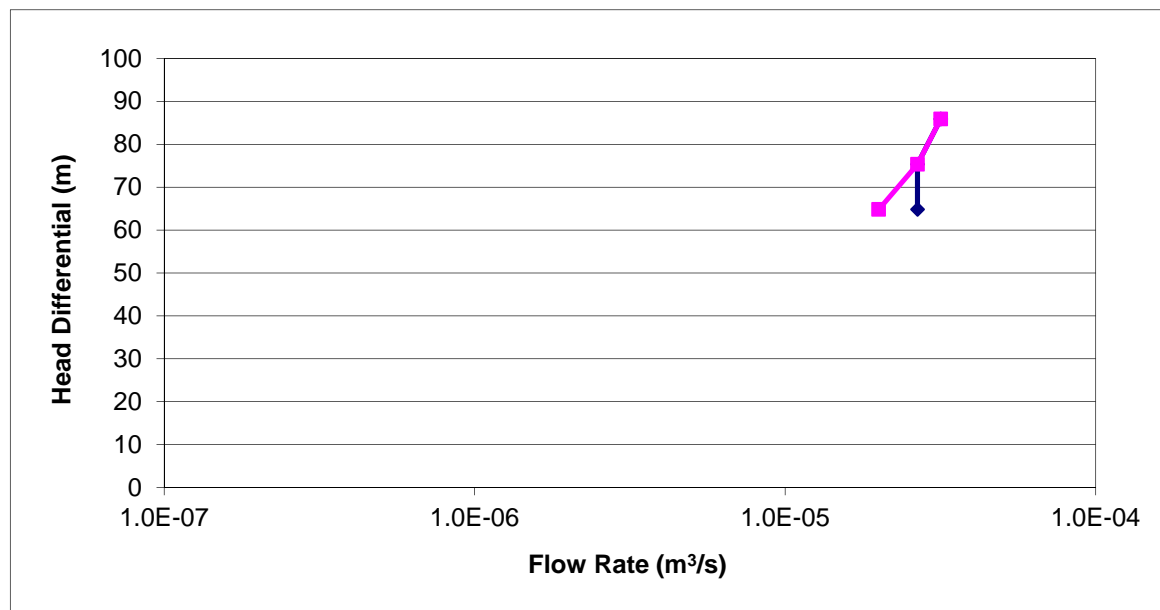
### Calculation Input Parameters

Top of Packer Test Interval (mah): 70.6  
 Bottom of Packer Test Interval (mah): 79.8  
L: Length of Test Interval (mah) 9.2  
 Test Interval Midpoint (mah): 75.2  
 Stickup Height (mah): 1.12  
 Pressure Gauge Height (m above ground): 0.84  
 Depth to Water Table (mah): 44.00  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90

\* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
30.0	2.7E-05	21.1	64.8	3.8E-08
45.0	2.7E-05	31.6	75.4	3.2E-08
60.0	3.2E-05	42.2	85.9	3.4E-08
45.0	2.7E-05	31.6	75.4	3.2E-08
30.0	2.0E-05	21.1	64.8	2.8E-08
			<b>Geo Mean</b>	<b>3.3E-08</b>





## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Cole Christiansen

**Collar El.:** 65.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 16-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:**  
**Test #:** 4

### Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	30	7.0810	-
1	30	7.0820	0.0010
2	30	7.0830	0.0010
3	30	7.0840	0.0010
4	30	7.0850	0.0010
5	30	7.0855	0.0005
6	30	7.0860	0.0005
7	30	7.0865	0.0005
8	30	7.0870	0.0005
9	30	7.0875	0.0005
10	30	7.0880	0.0005
Stable Ave.	30		0.0007

Pressure Interval		2	
Minutes	Pressure	Volume	Δ Volume
0	45	7.0900	-
1	45	7.0905	0.0005
2	45	7.0910	0.0005
3	45	7.0915	0.0005
4	45	7.0920	0.0005
5	45	7.0925	0.0005
6	45	7.0930	0.0005
7	45	7.0935	0.0005
8	45	7.0940	0.0005
9	45	7.0945	0.0005
10	45	7.0950	0.0005
Stable Ave.	45		0.0005

Pressure Interval		3	
Minutes	Pressure	Volume	Δ Volume
0	60	7.0960	-
1	60	7.0965	0.0005
2	60	7.0970	0.0005
3	60	7.0975	0.0005
4	60	7.0980	0.0005
5	60	7.0985	0.0005
6	60	7.0990	0.0005
7	60	7.0995	0.0005
8	60	7.1000	0.0005
9	60	7.1005	0.0005
10	60	7.1010	0.0005
Stable Ave.	60		0.0005

Pressure Interval		4	
Minutes	Pressure	Volume	Δ Volume
0	45	7.1020	-
1	45	7.1025	0.0005
2	45	7.1030	0.0005
3	45	7.1035	0.0005
4	45	7.1040	0.0005
5	45	7.1040	0.0000
6	45	7.1043	0.0003
7	45	7.1048	0.0005
8	45	7.1050	0.0003
9	45	7.1055	0.0005
10	45	7.1060	0.0005
Stable Ave.	45.0		0.0004

Pressure Interval		5	
Minutes	Pressure	Volume	Δ Volume
0	30	7.1070	--
1	30	7.1070	0.0000
2	30	7.1070	0.0000
3			
4			
5			
6			
7			
8			
9			
10			
Stable Ave.	30.0		0.0000

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			-
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 55.30 m  
 Top of Packer Interval: 108.71 m  
 Bottom of Packer Interval (or Bottom of Hole): 122.43 m  
 Packer Inflation Pressure: 440 psi  
 Rod Stickup Height: 1.37 m  
 Water Flushed (Vol./Time/Until Clean): 25 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.30 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 14:15  
 End Flushing: 14:40  
 Start Packer Testing: 15:15  
 End Packer Testing: 16:00

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Hole #: HMM-BH-03  
 Test #: 4

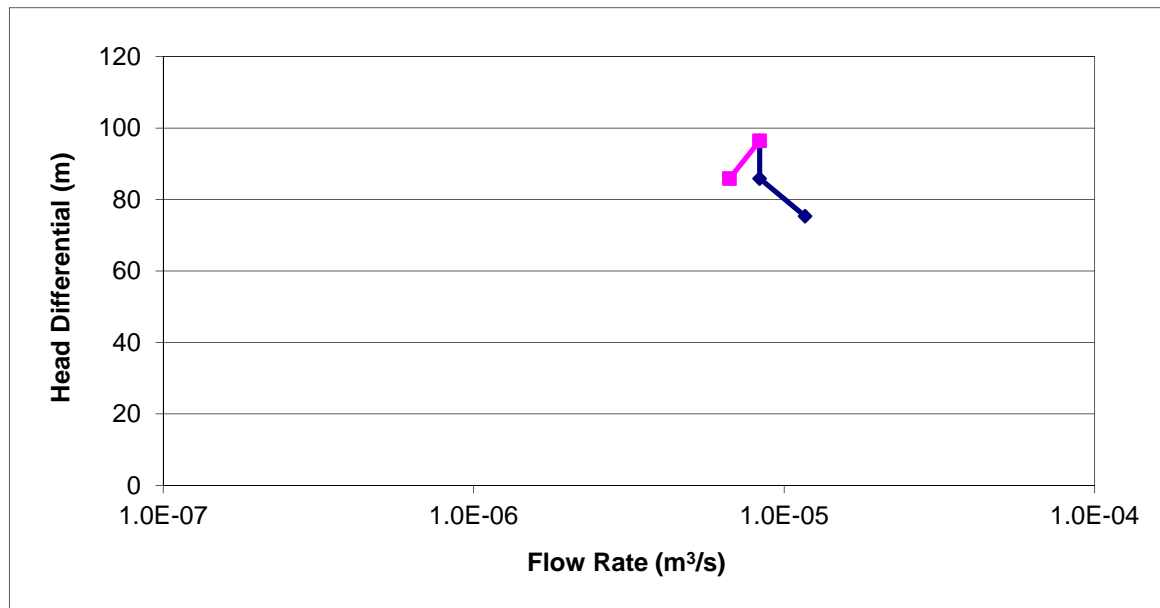


### Calculation Input Parameters

Top of Packer Test Interval (mah): 108.7  
 Bottom of Packer Test Interval (mah): 122.4  
 L: Length of Test Interval (mah): 13.7  
 Test Interval Midpoint (mah): 115.6  
 Stickup Height (mah): 1.37  
 Pressure Gauge Height (m above ground): 0.30  
 Depth to Water Table (mah): 55.30  
 Borehole Diameter (mm): 96.0  
 r: Borehole Radius (m): 0.048  
 A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
30.0	1.2E-05	21.1	75.3	1.0E-08
45.0	8.3E-06	31.6	85.9	6.4E-09
60.0	8.3E-06	42.2	96.4	5.7E-09
45.0	6.7E-06	31.6	85.9	5.1E-09
			Geo Mean	6.6E-09



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Cole Christiansen

**Collar El.:** 165.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 17-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:**  
**Test #:** 5

### Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	50	7.2150	-
1	50	7.2160	0.0010
2	50	7.2180	0.0020
3	50	7.2190	0.0010
4	50	7.2200	0.0010
5	50	7.2220	0.0020
6	50	7.2230	0.0010
7	50	7.2240	0.0010
8	50	7.2255	0.0015
9	50	7.2270	0.0015
10	50	7.2280	0.0010
Stable Ave.	50		0.0013

Pressure Interval		2	
Minutes	Pressure	Volume	Δ Volume
0	75	7.2330	-
1	75	7.2350	0.0020
2	75	7.2360	0.0010
3	75	7.2380	0.0020
4	75	7.2395	0.0015
5	75	7.2410	0.0015
6	75	7.2430	0.0020
7	75	7.2445	0.0015
8	75	7.2460	0.0015
9	75	7.2475	0.0015
10	75	7.2490	0.0015
Stable Ave.	75		0.0016

Pressure Interval		3	
Minutes	Pressure	Volume	Δ Volume
0	100	7.2510	-
1	100	7.2530	0.0020
2	100	7.2550	0.0020
3	100	7.2570	0.0020
4	100	7.2590	0.0020
5	100	7.2605	0.0015
6	100	7.2620	0.0015
7	100	7.2640	0.0020
8	100	7.2660	0.0020
9	100	7.2680	0.0020
10	100	7.2700	0.0020
Stable Ave.	100		0.0019

Pressure Interval		4	
Minutes	Pressure	Volume	Δ Volume
0	75	7.2740	-
1	75	7.2755	0.0015
2	75	7.2770	0.0015
3	75	7.2785	0.0015
4	75	7.2800	0.0015
5	75	7.2815	0.0015
6	75	7.2830	0.0015
7	75	7.2845	0.0015
8	75	7.2860	0.0015
9	75	7.2875	0.0015
10	75	7.2890	0.0015
Stable Ave.	75.0		0.0015

Pressure Interval		5	
Minutes	Pressure	Volume	$\Delta$ Volume
0	50	7.2900	--
1	50	7.2915	0.0015
2	50	7.2925	0.0010
3	50	7.2940	0.0015
4	50	7.2950	0.0010
5	50	7.2960	0.0010
6	50	7.2970	0.0010
7	50	7.2985	0.0015
8	50	7.3000	0.0015
9	50	7.3010	0.0010
10	50	7.3020	0.0010
Stable Ave.	50.0		0.0012

Minutes	Pressure	Volume	Δ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 55.30 m  
 Top of Packer Interval: 123.96 m  
 Bottom of Packer Interval (or Bottom of Hole): 152.93 m  
 Packer Inflation Pressure: 550 psi  
 Rod Stickup Height: 1.33 m  
 Water Flushed (Vol./Time/Until Clean):  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 7:30  
 End Flushing: 9:45  
 Start Packer Testing: 10:37  
 End Packer Testing: 11:35

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Hole #: HMM-BH-03  
 Test #: 5

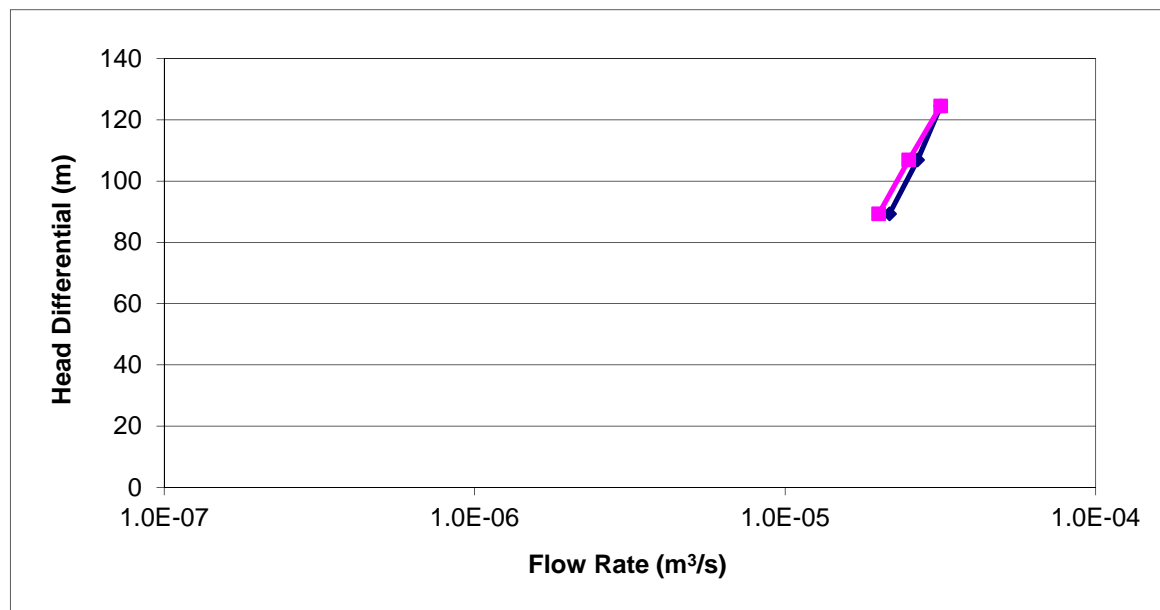


### Calculation Input Parameters

Top of Packer Test Interval (mah): 124.0  
 Bottom of Packer Test Interval (mah): 152.9  
L: Length of Test Interval (mah) 29.0  
 Test Interval Midpoint (mah): 138.4  
 Stickup Height (mah): 1.33  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 55.30  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	2.2E-05	35.2	89.3	8.5E-09
75.0	2.7E-05	52.7	106.9	8.8E-09
100.0	3.2E-05	70.3	124.5	8.9E-09
75.0	2.5E-05	52.7	106.9	8.2E-09
50.0	2.0E-05	35.2	89.3	7.9E-09
			Geo Mean	8.5E-09



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Cole Christiansen

**Collar El.:** 165.00  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 18-Sep-14

**Hole #** HMM-BH-03  
**Design Test Interval:**  
**Test #:** 6

### Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0	50	7.4050	-
1	50	7.4065	0.0015
2	50	7.4075	0.0010
3	50	7.4090	0.0015
4	50	7.4100	0.0010
5	50	7.4110	0.0010
6	50	7.4120	0.0010
7	50	7.4125	0.0005
8	50	7.4140	0.0015
9	50	7.4150	0.0010
10	50	7.4150	0.0000
Stable Ave.	50		0.0010

Pressure Interval	2		
Minutes	Pressure	Volume	Δ Volume
0	75	7.4180	-
1	75	7.4190	0.0010
2	75	7.4195	0.0005
3	75	7.4200	0.0005
4	75	7.4210	0.0010
5	75	7.4215	0.0005
6	75	7.4220	0.0005
7	75	7.4230	0.0010
8	75	7.4235	0.0005
9	75	7.4240	0.0005
10	75	7.4245	0.0005
Stable Ave.	75		0.0006

Pressure Interval	3		
Minutes	Pressure	Volume	Δ Volume
0	100	7.4270	-
1	100	7.4275	0.0005
2	100	7.4280	0.0005
3	100	7.4285	0.0005
4	100	7.4295	0.0010
5	100	7.4300	0.0005
6	100	7.4305	0.0005
7	100	7.4305	0.0000
8	100	7.4310	0.0005
9	100	7.4315	0.0005
10	100	7.4320	0.0005
Stable Ave.	100		0.0005

Pressure Interval	4		
Minutes	Pressure	Volume	Δ Volume
0	75	7.4325	-
1	75	7.4330	0.0005
2	75	7.4335	0.0005
3	75	7.4335	0.0000
4	75	7.4340	0.0005
5	75	7.4340	0.0000
6	75	7.4345	0.0005
7	75	7.4350	0.0005
8	75	7.4350	0.0000
9	75	7.4350	0.0000
10	75	7.4350	0.0000
Stable Ave.	75.0		0.0002

Pressure Interval	5		
Minutes	Pressure	Volume	Δ Volume
0	Flow stopped, so test was ended.		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Stable Ave.			

Pressure Interval			
Minutes	Pressure	Volume	Δ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 55.30 m  
 Top of Packer Interval: 149.87 m  
 Bottom of Packer Interval (or Bottom of Hole): 181.89 m  
 Packer Inflation Pressure: 600 psi  
 Rod Stickup Height: 1.41 m  
 Water Flushed (Vol./Time/Until Clean): 35 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.34 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 14:10  
 End Flushing: 14:45  
 Start Packer Testing: 15:45  
 End Packer Testing: 16:30

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Hole #: HMM-BH-03  
 Test #: 6

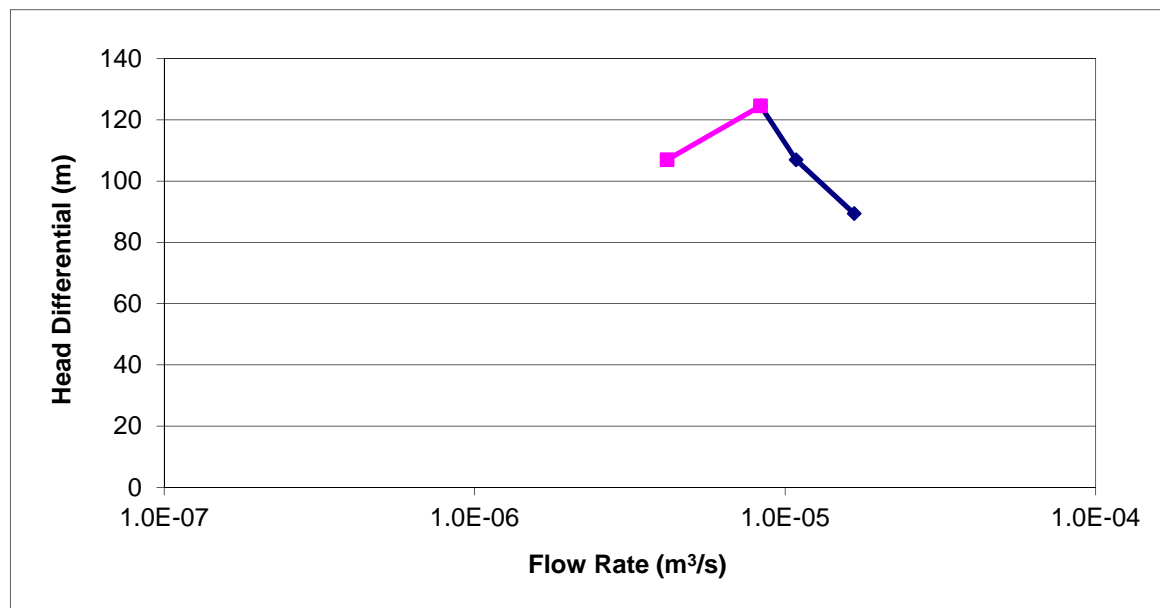


### Calculation Input Parameters

Top of Packer Test Interval (mah): 149.9  
 Bottom of Packer Test Interval (mah): 181.9  
L: Length of Test Interval (mah) 32.0  
 Test Interval Midpoint (mah): 165.9  
 Stickup Height (mah): 1.41  
 Pressure Gauge Height (m above ground): 0.34  
 Depth to Water Table (mah): 55.30  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
50.0	1.7E-05	35.2	89.4	6.0E-09
75.0	1.1E-05	52.7	107.0	3.3E-09
100.0	8.3E-06	70.3	124.5	2.2E-09
75.0	4.2E-06	52.7	107.0	1.3E-09
			Geo Mean	2.7.E-09



## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Scott Garrison

**Collar El.:**  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 4-Oct-14

**Hole #** HMM-BH-05  
**Design Test Interval:** 17.01 m  
**Test #:** 1

### Packer Setup Type: Single

Pressure Interval 1

Minutes	Pressure	Volume	Δ Volume
0	20	7.525	-
1	20	7.592	0.067
2	20	7.657	0.065
3	20	7.724	0.067
4	20	7.790	0.066
5	20	7.852	0.062
6	20	7.923	0.071
7	20	7.990	0.067
8	20	8.056	0.066
9	20	8.123	0.067
10	20	8.189	0.066

Stable Ave. 20 0.0664

Pressure Interval 2

Minutes	Pressure	Volume	Δ Volume
0	30	8.572	-
1	30	8.650	0.078
2	30	8.724	0.074
3	30	8.799	0.075
4	30	8.875	0.076
5	30	8.950	0.075
6	30	9.028	0.078
7	30	9.110	0.082
8	30	9.193	0.083
9	30	9.278	0.085
10	30	9.363	0.085

Stable Ave. 30 0.0791

Pressure Interval 3

Minutes	Pressure	Volume	Δ Volume
0	30	9.800	-
1	30	9.894	0.094
2	30	9.988	0.094
3	30	10.084	0.096
4	30	10.178	0.094
5	30	10.272	0.094
6	30	10.367	0.095
7	30	10.462	0.095
8	30	10.556	0.094
9	30	10.650	0.094
10	30	10.744	0.094

Stable Ave. 30 0.0944

Pressure Interval 4

Minutes	Pressure	Volume	Δ Volume
0	20	10.825	-
1	20	10.907	0.082
2	20	10.989	0.082
3	20	11.069	0.080
4	20	11.152	0.083
5	20	11.233	0.081
6	20	11.315	0.082
7	20	11.396	0.081
8	20	11.478	0.082
9	20	11.559	0.081
10	20	11.642	0.083

Stable Ave. 20.0 0.0817

Pressure Interval 5

Minutes	Pressure	Volume	Δ Volume
0	10	11.715	--
1	10	11.777	0.062
2	10	11.838	0.061
3	10	11.899	0.061
4	10	11.960	0.061
5	10	12.021	0.061
6	10	12.082	0.061
7	10	12.144	0.062
8	10	12.205	0.061
9	10	12.266	0.061
10	10	12.327	0.061

Stable Ave. 10.0 0.0612

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 17.63 m 17.75 m bgs  
 Top of Packer Interval: 15.24 m  
 Bottom of Packer Interval (or Bottom of Hole): 32.25 m  
 Packer Inflation Pressure: 320 psi  
 Rod Stickup Height: 0.38 m  
 Water Flushed (Vol./Time/Until Clean): 30 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3 Casing  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 18:30  
 End Flushing: 19:00  
 Start Packer Testing: 20:20  
 End Packer Testing: 21:30

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Packer seated in HWT casing, borehole wall conditions were poor in highly weathered conglomerate. A packer would not have sealed in this material and the equipment would have been exposed to a high risk of damage if attempted. Bentonite mud was used for drilling prior to testing, borehole flushed as well as possible but it was not likely completely clean.

Hole #: HMM-BH-05  
 Test #: 1

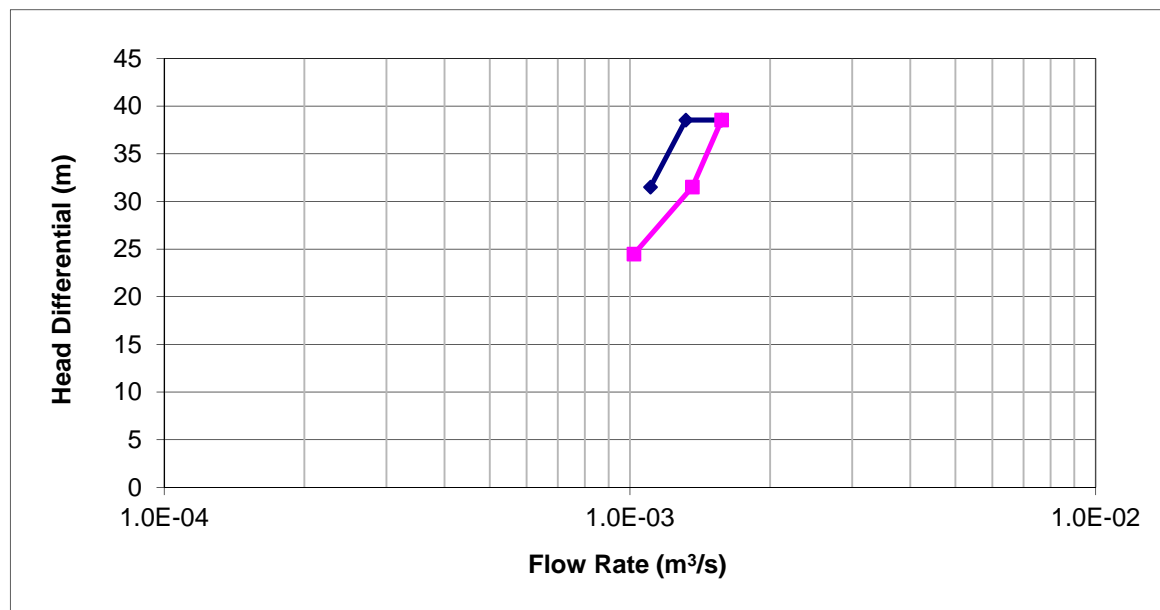


### Calculation Input Parameters

Top of Packer Test Interval (mah): 15.2  
 Bottom of Packer Test Interval (mah): 32.3  
L: Length of Test Interval (mah): 17.0  
 Test Interval Midpoint (mah): 23.7  
 Stickup Height (mah): 0.38  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 17.63  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
20.0	1.1E-03	14.1	31.5	1.9E-06
30.0	1.3E-03	21.1	38.5	1.9E-06
30.0	1.6E-03	21.1	38.5	2.2E-06
20.0	1.4E-03	14.1	31.5	2.4E-06
10.0	1.0E-03	7.0	24.5	2.3E-06
			Geo Mean	2.1E-06





## Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

**Client:** KINDER MORGAN  
**Project:** Westridge Tunnel Geotechnical Investigation  
**Project #:** 0095150-15  
**Personnel:** Scott Garrison

**Collar El.:**  
**Trend:** - deg  
**Plunge:** 90 deg  
**Date:** 5-Oct-14

**Hole #** HMM-BH-05  
**Design Test Interval:** EOH  
**Test #:** 2

### Packer Setup Type: Single

Pressure Interval 1

Minutes	Pressure	Volume	Δ Volume
0	20	12.417	-
1	20	12.448	0.031
2	20	12.484	0.036
3	20	12.520	0.036
4	20	12.556	0.036
5	20	12.592	0.036
6	20	12.629	0.037
7	20	12.666	0.037
8	20	12.703	0.037
9	20	12.740	0.037
10	20	12.777	0.037

Stable Ave. 20 0.0360

Pressure Interval 2

Minutes	Pressure	Volume	Δ Volume
0	30	12.845	-
1	30	12.907	0.062
2	30	12.969	0.062
3	30	13.032	0.063
4	30	13.096	0.064
5	30	13.161	0.065
6	30	13.236	0.075
7	30	13.304	0.068
8	30	13.381	0.077
9	30	13.454	0.073
10	30	13.526	0.072

Stable Ave. 30 0.0681

Pressure Interval 3

Minutes	Pressure	Volume	Δ Volume
0	40	13.705	-
1	40	13.800	0.095
2	40	13.895	0.095
3	40	13.990	0.095
4	40	14.086	0.096
5	40	14.183	0.097
6	40	14.279	0.096
7	40	14.376	0.097
8	40	14.474	0.098
9	40	14.570	0.096
10	40	14.667	0.097

Stable Ave. 40 0.0962

Pressure Interval 4

Minutes	Pressure	Volume	Δ Volume
0	30	14.715	-
1	30	14.800	0.085
2	30	14.886	0.086
3	30	14.972	0.086
4	30	15.058	0.086
5	30	15.144	0.086
6	30	15.230	0.086
7			
8			
9			
10			

Stable Ave. 30.0 0.0858

Pressure Interval 5

Minutes	Pressure	Volume	Δ Volume
0	20	15.285	--
1	20	15.359	0.074
2	20	15.432	0.073
3	20	15.505	0.073
4	20	15.578	0.073
5	20	15.651	0.073
6	20	15.724	0.073
7			
8			
9			
10			

Stable Ave. 20.0 0.0732

Pressure Interval

Minutes	Pressure	Volume	Δ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Measurements

Depth to Water from Top of Stickup: 18.73 m 17.25 m bgs  
 Top of Packer Interval: 36.60 m  
 Bottom of Packer Interval (or Bottom of Hole): 44.46 m  
 Packer Inflation Pressure: 390 psi  
 Rod Stickup Height: 1.48 m  
 Water Flushed (Vol./Time/Until Clean): 45 min  
 Packer Pipe ID/ or Drill Rod ID (circle one): HQ3 Casing  
 Borehole Outside Diameter: 96 mm  
 Vertical height of gauge above ground: 0.20 m

### Measurement Units

Volume: m<sup>3</sup>  
 Pressure: psi  
 Length: m/ft

### Time

Start Flushing: 5:00  
 End Flushing: 5:45  
 Start Packer Testing: 6:30  
 End Packer Testing: 7:45

### IF NO MEASUREABLE FLOW IN CH TEST ---> FALLING HEAD TEST or RISING HEAD TEST

Time (Min)	Depth to H2O	Δ Depth/Min
0		-
1		
2		
4		
6		
8		
10		
15		
20		
25		
30		
40		
50		
60		

### Additional Comments:

Bentonite mud was used for drilling prior to testing, borehole flushed as well as possible but it was not likely completely clean.

Hole #: HMM-BH-05  
 Test #: 2

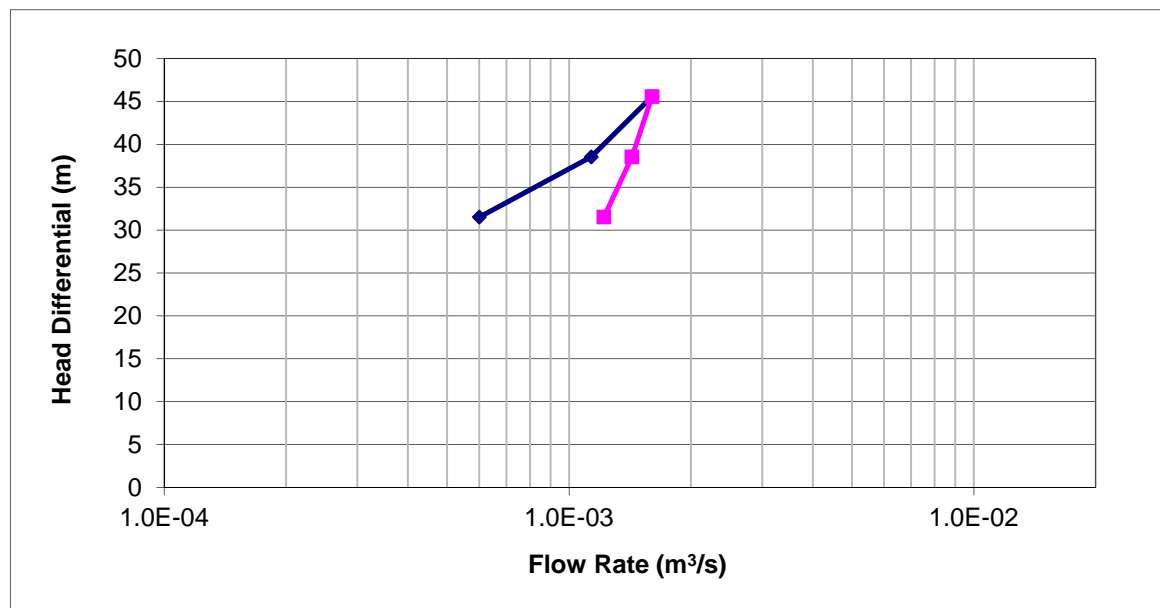


### Calculation Input Parameters

Top of Packer Test Interval (mah): 36.6  
 Bottom of Packer Test Interval (mah): 44.5  
L: Length of Test Interval (mah) 7.9  
 Test Interval Midpoint (mah): 40.5  
 Stickup Height (mah): 1.48  
 Pressure Gauge Height (m above ground): 0.20  
 Depth to Water Table (mah): 18.73  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m³/s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
20.0	6.0E-04	14.1	31.5	2.0E-06
30.0	1.1E-03	21.1	38.5	3.0E-06
40.0	1.6E-03	28.1	45.6	3.6E-06
30.0	1.4E-03	21.1	38.5	3.8E-06
20.0	1.2E-03	14.1	31.5	4.0E-06
			Geo Mean	3.2.E-06



# Constant Head (CH) and Falling/Rising Head (F/RH) Packer Test - Field Form

Client: KINDER MORGAN  
Project: Westridge Tunnel Geotechnical Investigation  
Project #: 0095150-15

Personnel: Jack Stratton

## Packer Setup Type: Single

Pressure Interval	psi	1	m3
Minutes	Pressure	Volume	Δ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave. #DIV/0! #DIV/0!

Pressure Interval		2	
Minutes	Pressure	Volume	$\Delta$ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave. #DIV/0! #DIV/0!

Pressure Interval		3	
Minutes	Pressure	Volume	$\Delta$ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave. #DIV/0! #DIV/0!

Collar El.:  
Trend: - deg  
Plunge: 90 deg

Date: 4-Oct-14

Pressure Interval		4	
Minutes	Pressure	Volume	$\Delta$ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave. #DIV/0! #DIV/0!

Pressure Interval		5	
Minutes	Pressure	Volume	$\Delta$ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Stable Ave. #DIV/0! #DIV/0!

Pressure Interval			
Minutes	Pressure	Volume	$\Delta$ Volume
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Hole # HMM-BH-05  
Design Test Interval:  
Test #: 3

## Measurements

Depth to Water from Top of Stickup: 17.88 m 17.25 m  
Top of Packer Interval: 30.72 m bgs + SU  
Bottom of Packer Interval (or Bottom of Hole): 30.72 m  
Packer Inflation Pressure: psi  
Rod Stickup Height: 0.63 m  
Water Flushed (Vol./Time/Until Clean): 30  
Packer Pipe ID/ or Drill Rod ID (circle one):  
Borehole Outside Diameter: 96 mm  
Vertical height of gauge above ground: m

## Measurement Units

Volume: m<sup>3</sup>  
Pressure: psi  
Length: m/ft

## Time

Start Flushing:  
End Flushing:  
Start Packer Testing:  
End Packer Testing:

Time (Min)	Depth to H2O from stickup	Depth below ground surface	Δ Depth/Min
0	0	-0.63	-
0.083	0.05	-0.58	0.60
0.167	0.05	-0.58	0
0.25	0.05	-0.58	0
0.5	0.27	-0.36	0.88
1	0.78	0.15	1.02
1.5	1.27	0.64	0.98
2	1.73	1.10	0.92
3	2.55	1.92	0.82
4	3.14	2.51	0.59
5	3.6	2.97	0.46
6	4.03	3.40	0.43
7	4.37	3.74	0.34
8	4.64	4.01	0.27
9	4.8	4.17	0.16
10	4.94	4.31	0.14
11	5.09	4.46	0.15
12	5.22	4.59	0.13
13	5.29	4.66	0.07
14	5.33	4.70	0.04
15	5.36	4.73	0.03

Additional Comments:

Hole #: HMM-BH-05  
 Test #: 3

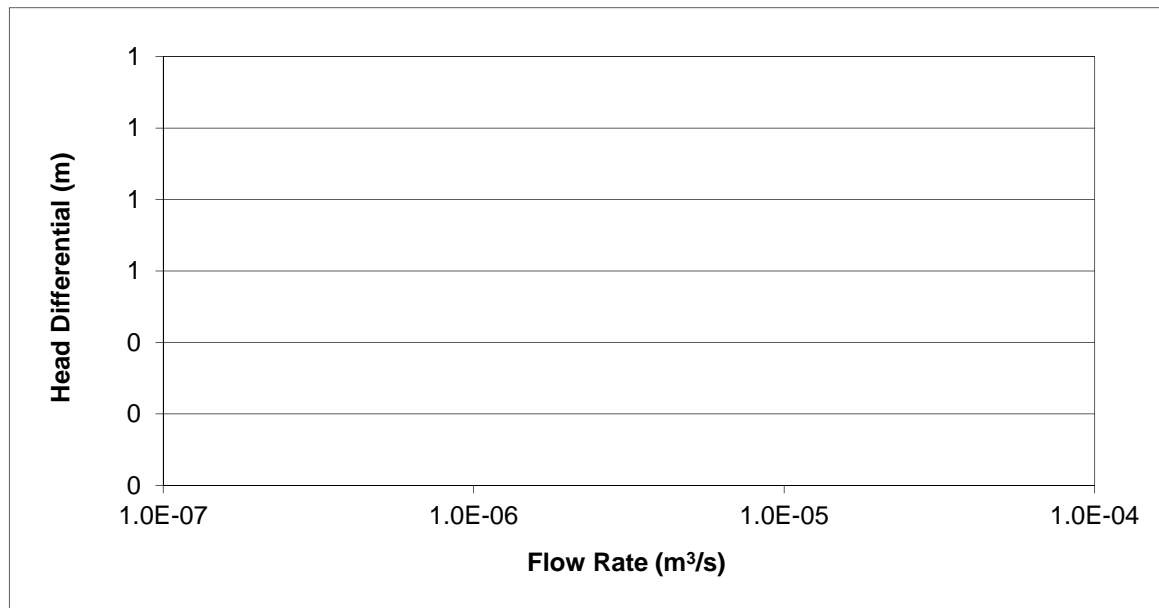


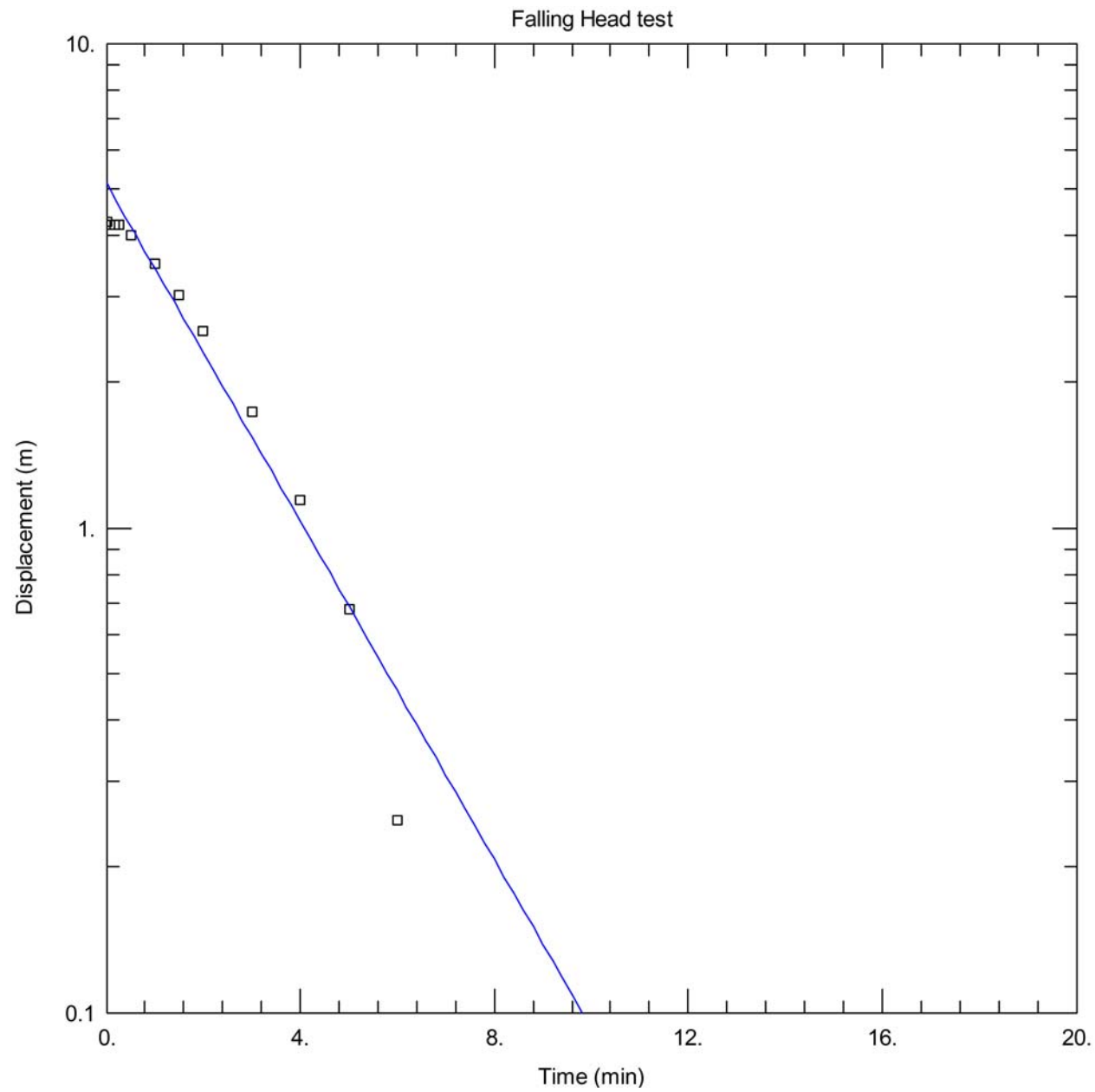
### Calculation Input Parameters

Top of Packer Test Interval (mah): 30.7  
 Bottom of Packer Test Interval (mah): 30.7  
L: Length of Test Interval (mah) 0.0  
 Test Interval Midpoint (mah): 30.7  
 Stickup Height (mah): 0.63  
 Pressure Gauge Height (m above ground): 0.00  
 Depth to Water Table (mah): 17.88  
 Borehole Diameter (mm): 96.0  
r: Borehole Radius (m): 0.048  
A: Angle From Horizontal (deg): 90  
 \* mah indicates "meters along hole"

$$K = \frac{Q \times \ln\left(\frac{L \sin(A)}{r}\right)}{2 \times \pi \times L \sin(A) \times dH}$$

Pressure (psi)	Q: Flowrate (m <sup>3</sup> /s):	Pressure (m of water)	dH: Head Differential (m)	K: Hydraulic Conductivity (m/s)
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			Geo Mean	#DIV/0!





Obs. Wells

□ HMM-BH-05

Aquifer Model

Unconfined

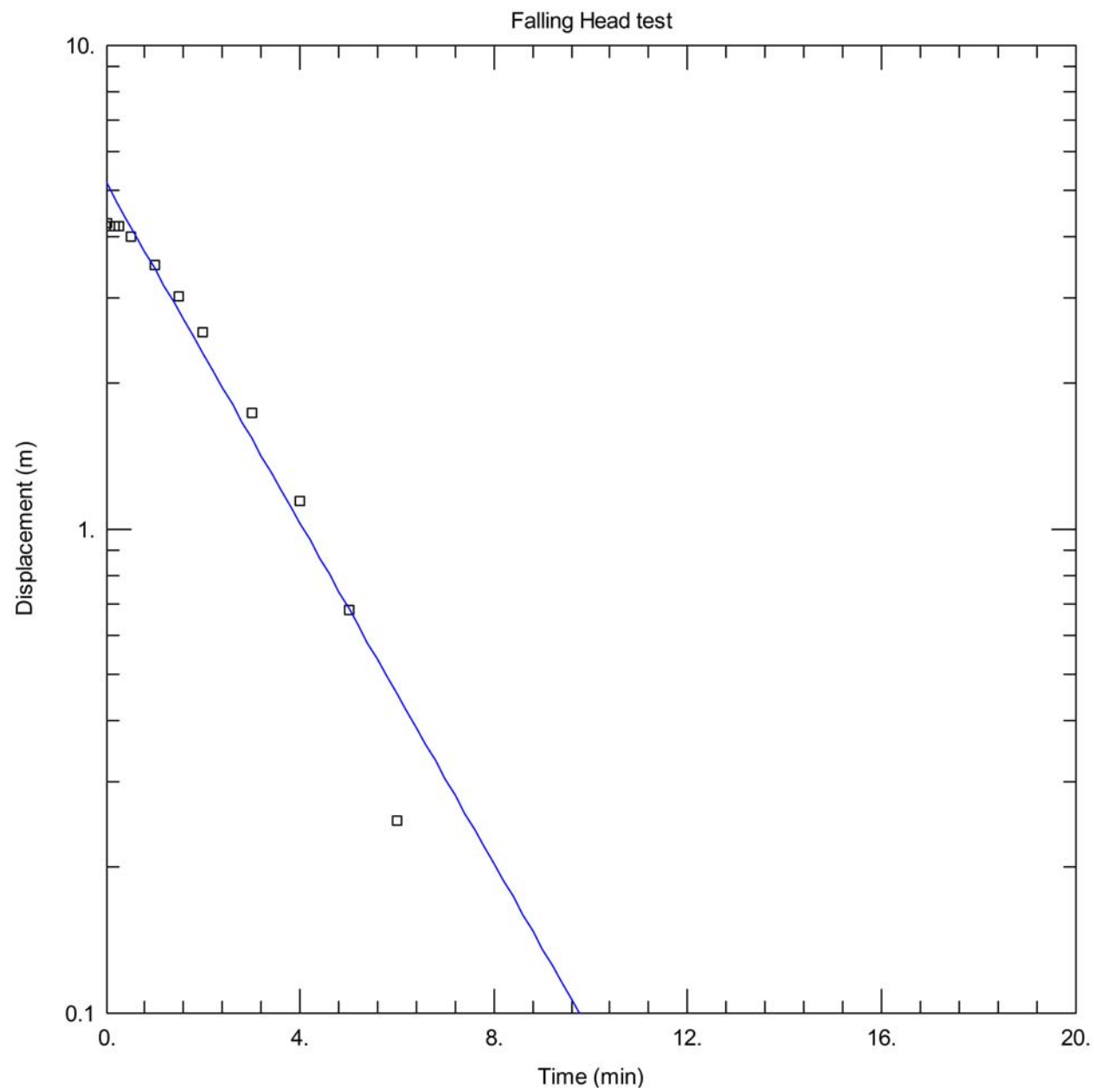
Solution

Hvorslev

Parameters

$K = 2.875E-5$  m/sec

$y_0 = 5.131$  m



Obs. Wells

□ HMM-BH-05

Aquifer Model

Unconfined

Solution

Hvorslev

Parameters

$K = 3.355\text{E-}6 \text{ m/sec}$

$y_0 = 5.165 \text{ m}$

## **APPENDIX F**

### **WATER QUALITY LABORATORY RESULTS**

**CLIENT NAME: BGC ENGINEERING INC.  
#500-1045 HOWE STREET  
VANCOUVER, BC V6Z2A9  
(604) 684-5900**

**ATTENTION TO: Cathy Schmid**

**PROJECT: 0090 150 15**

**AGAT WORK ORDER: 14V888816**

**TRACE ORGANICS REVIEWED BY: Andrew Garrard, B.Sc., General Manager**

**WATER ANALYSIS REVIEWED BY: Angela Bond, Technical Reviewer**

**DATE REPORTED: Sep 23, 2014**

**PAGES (INCLUDING COVER): 18**

**VERSION\*: 3**

Should you require any information regarding this analysis please contact your client services representative at (778) 452-4000

**\*NOTES**

VERSION 3: Sample receipt temperature: 9°C

Version 3 of this report contains additional results and supersedes Version 2 which was a partial report. Total Phenol is now included. New report issued on September 24, 2014.

**All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.**





**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### BTEX / VPH / EPH in Water

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

Parameter	Unit	SAMPLE DESCRIPTION:		HWM-BH-03-	HWM-BH-03-	HWM-BH-03-	HWM-BH-03-
		SAMPLE TYPE:		WS1	WS2	WS3	WS4
		DATE SAMPLED:		Water	Water	Water	Water
		G / S	RDL	9/12/2014	9/12/2014	9/15/2014	9/15/2014
				5807550	5807551	5807552	5807554
Methyl tert-butyl ether (MTBE)	µg/L		1	<1	<1	<1	<1
Benzene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5
Toluene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylene	µg/L		0.5	<0.5	<0.5	<0.5	0.5
o-Xylene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5
Styrene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5
VPH	µg/L		100	<100	<100	<100	<100
VH	µg/L		100	<100	<100	<100	<100
EPH C10-C19	µg/L		100	<100	170	<100	170
EPH C19-C32	µg/L		100	140	2380	<100	1490
Total Xylenes	ug/L		1	<1	<1	<1	<1

**Comments:** RDL - Reported Detection Limit; G / S - Guideline / Standard  
**5807550-5807554** VPH results have been corrected for BTEX contributions.  
LEPH & HEPH results have been corrected for PAH contributions.

Certified By:



**AGAT** Laboratories

# Certificate of Analysis

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

## British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

Parameter	Unit	SAMPLE DESCRIPTION:		HWM-BH-03-WS1	HWM-BH-03-WS2	HWM-BH-03-WS3	HWM-BH-03-WS4
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		9/12/2014	9/12/2014	9/15/2014	9/15/2014
		G / S	RDL	5807550	5807551	5807552	5807554
Aluminum Dissolved	µg/L		2	28	179	260	301
Antimony Dissolved	µg/L		0.2	<0.2	1.9	3.3	3.4
Arsenic Dissolved	µg/L		0.1	0.7	2.3	7.7	6.2
Barium Dissolved	µg/L		0.2	2.7	6.5	5.6	11.7
Beryllium Dissolved	µg/L		0.01	<0.01	<0.01	<0.01	0.01
Boron Dissolved	µg/L		2	3	57	99	217
Cadmium Dissolved	µg/L		0.01	<0.01	0.01	0.01	0.02
Calcium Dissolved	µg/L		50	1040	8350	8060	7980
Chromium Dissolved	µg/L		0.5	<0.5	<0.5	<0.5	0.6
Cobalt Dissolved	µg/L		0.05	<0.05	<0.05	0.09	0.11
Copper Dissolved	µg/L		0.2	1.4	1.9	3.0	7.3
Iron Dissolved	µg/L		10	61	22	45	99
Lead Dissolved	µg/L		0.05	0.23	0.16	0.36	1.27
Lithium Dissolved	µg/L		0.5	<0.5	3.2	2.5	2.5
Magnesium Dissolved	µg/L		50	118	2050	1090	557
Manganese Dissolved	µg/L		1	4	13	5	6
Mercury Dissolved	µg/L		0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum Dissolved	µg/L		0.05	0.17	21.7	45.3	78.1
Nickel Dissolved	µg/L		0.2	0.3	0.6	0.4	0.3
Selenium Dissolved	µg/L		0.5	<0.5	<0.5	<0.5	0.8
Silver Dissolved	µg/L		0.02	<0.02	<0.02	<0.02	<0.02
Sodium Dissolved	µg/L		50	5360	10100	15300	16300
Thallium Dissolved	µg/L		0.01	<0.01	<0.01	<0.01	<0.01
Titanium Dissolved	µg/L		0.5	0.7	41.5	68.7	366
Uranium Dissolved	µg/L		0.01	0.03	0.20	0.16	0.28
Vanadium Dissolved	µg/L		0.5	<0.5	12.6	112	29.4
Zinc Dissolved	µg/L		2	3	<2	3	3
Hardness (calc)	ug CaCO3/L		100	3080	29300	24600	22200

Certified By:

*Angela Bond*



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

**British Columbia CSR- Schedule 6 Dissolved Metals**

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5807550-5807554 Sample not filtered at time of collection as per analysis requirements.

Certified By:



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

Parameter	Unit	HWM-BH-03-WS1				HWM-BH-03-WS2				HWM-BH-03-WS3				HWM-BH-03-WS4			
		SAMPLE DESCRIPTION: Water				SAMPLE DESCRIPTION: Water				SAMPLE DESCRIPTION: Water				SAMPLE DESCRIPTION: Water			
		DATE SAMPLED: 9/12/2014				DATE SAMPLED: 9/12/2014				DATE SAMPLED: 9/15/2014				DATE SAMPLED: 9/15/2014			
		G / S	RDL	5807550	RDL	5807551	RDL	5807552	RDL	5807552	RDL	5807554	RDL	5807554	RDL	5807554	RDL
Aluminum Total	µg/L		5	106	5000	218000	5000	928000	5000	1490000							
Antimony Total	µg/L		0.5	<0.5	0.5	0.7	5	<5	5	<5							
Arsenic Total	µg/L		0.1	0.8	0.1	33.1	1	58	1	103							
Barium Total	µg/L		0.5	3.0	0.5	1480	5	6130	5	8450							
Beryllium Total	µg/L		0.05	<0.05	0.05	3.85	0.5	18.3	0.5	30.0							
Boron Total	µg/L		5	<5	5	185	50	432	50	1580							
Cadmium Total	µg/L		0.01	<0.01	0.01	1.30	0.1	5.5	0.1	7.6							
Calcium Total	µg/L		50	1060	50	94800	500	256000	500	473000							
Chromium Total	µg/L		0.5	<0.5	0.5	231	5	1050	5	2150							
Cobalt Total	µg/L		0.05	0.09	0.05	120	0.5	542	0.5	921							
Copper Total	µg/L		0.5	2.4	5	1670	5	2990	5	4190							
Iron Total	µg/L		10	224	100	277000	1000	1380000	1000	2460000							
Lead Total	µg/L		0.05	0.29	0.05	87.0	0.5	273	0.5	568							
Lithium Total	µg/L		0.5	<0.5	5	171	5	634	50	1140							
Magnesium Total	µg/L		50	130	500	106000	500	566000	500	865000							
Manganese Total	µg/L		1	8	1	4690	10	22900	10	35600							
Mercury Total	µg/L		0.01	<0.01	0.01	<0.01	0.01	0.05	0.01	<0.01							
Molybdenum Total	µg/L		0.1	0.2	0.1	32.5	1	57	1	107							
Nickel Total	µg/L		0.5	<0.5	0.5	381	5	1060	5	1270							
Selenium Total	µg/L		0.5	<0.5	0.5	6.0	5	26	5	56							
Silver Total	µg/L		0.02	<0.02	0.02	1.63	0.2	3.0	0.2	6.8							
Sodium Total	µg/L		100	5390	100	21800	1000	72600	1000	85700							
Thallium Total	µg/L		0.02	<0.02	0.02	0.70	0.2	4.1	0.2	7.4							
Titanium Total	µg/L		1	2	10	2530	100	26500	10	10800							
Uranium Total	µg/L		0.01	0.06	0.01	5.23	0.1	21.5	0.1	45.5							
Vanadium Total	µg/L		1	<1	1	519	10	3590	10	4150							
Zinc Total	µg/L		5	<5	5	1720	50	4290	50	6990							
Total Hardness (calc)	ug CaCO3/L		100	3180	100	673000	100	2970000	100	4740000							

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5807551 Some total metal results are less than the dissolved metal results; results are within the precision of the method.  
5807552 Sample improperly preserved as per analysis requirements for Total Mercury.  
Total Mercury sample container inappropriate as per analysis requirements.

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CLIENT NAME: BGC ENGINEERING INC.

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SAMPLING SITE:

SAMPLED BY:

### Routine Chemistry Water Analysis

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

		SAMPLE DESCRIPTION:		HWM-BH-03-WS1	HWM-BH-03-WS2	HWM-BH-03-WS3	HWM-BH-03-WS4
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		9/12/2014	9/12/2014	9/15/2014	9/15/2014
Parameter	Unit	G / S	RDL	5807550	5807551	5807552	5807554
pH	pH units		0.01	7.34	7.72	8.06	8.17
p-Alkalinity	mg CaCO3/L		1	<1	<1	<1	<1
Alkalinity (pH 4.5)	mg CaCO3/L		1	14	53	72	70
Alkalinity, Bicarbonate	mg CaCO3/L		1	14	53	72	70
Alkalinity, Carbonate	mg CaCO3/L		1	<1	<1	<1	<1
Alkalinity, Hydroxide	mg CaCO3/L		1	<1	<1	<1	<1
Electrical Conductivity	uS/cm		1	35	106	118	122
Chloride	mg/L		0.05	2.01	3.52	3.15	5.93
Fluoride	mg/L		0.02	<0.02	0.11	0.24	0.27
Nitrate-N	mg/L		0.005	0.070	0.038	0.046	0.046
Nitrite-N	mg/L		0.005	<0.005	<0.005	0.018	<0.005
Sulphate	mg/L		0.5	0.6	3.5	1.9	3.2
Calcium Dissolved	mg/L		0.05	1.04	8.35	8.06	7.98
Magnesium Dissolved	mg/L		0.05	0.12	2.05	1.09	0.56
Sodium Dissolved	mg/L		0.05	5.36	10.1	15.3	16.3
Potassium Dissolved	mg/L		0.05	0.13	2.45	4.03	3.74
Iron Dissolved	mg/L		0.01	0.06	0.02	0.05	0.10
Manganese Dissolved	mg/L		0.001	0.004	0.013	0.005	0.006
Calculated TDS	mg/L		1	18	62	77	80
Hardness (calc)	mg CaCO3/L		0.5	3.1	29.3	24.6	22.2
Nitrate + Nitrite-N	mg/L		0.01	0.07	0.04	0.06	0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5807550-5807554 Literature holding time exceeded for pH analysis.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Total Phenols - 4AAP

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

				HWM-BH-03-	HWM-BH-03-	HWM-BH-03-	HWM-BH-03-
SAMPLE DESCRIPTION:				WS1	WS2	WS3	WS4
SAMPLE TYPE:				Water	Water	Water	Water
DATE SAMPLED:				9/12/2014	9/12/2014	9/15/2014	9/15/2014
Parameter	Unit	G / S	RDL	5807550	5807551	5807552	5807554
Phenol, Total	mg/L		0.002	<0.002	0.003	<0.002	0.003

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

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SAMPLED BY:

### Total Phosphorus and Total Dissolved Phosphorus

DATE RECEIVED: 2014-09-15

DATE REPORTED: 2014-09-23

		HWM-BH-03-		HWM-BH-03-		HWM-BH-03-		HWM-BH-03-	
SAMPLE DESCRIPTION:		WS1		WS2		WS3		WS4	
SAMPLE TYPE:		Water		Water		Water		Water	
DATE SAMPLED:		9/12/2014		9/12/2014		9/15/2014		9/15/2014	
Parameter	Unit	G / S	RDL	5807550	RDL	5807551	5807552	5807554	
Phosphorus Dissolved	mg/L		0.005	0.005	0.005	0.040	0.027	0.027	
Phosphorus Total	mg/L		0.005	0.006	0.02	0.246	0.840	0.933	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:





**AGAT** Laboratories

## Certificate of Analysis

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PROJECT: 0090 150 15

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

Turbidity									
DATE RECEIVED: 2014-09-15					DATE REPORTED: 2014-09-23				
		SAMPLE DESCRIPTION:		HWM-BH-03-WS1	HWM-BH-03-WS2		HWM-BH-03-WS3	HWM-BH-03-WS4	
		SAMPLE TYPE:		Water	Water		Water	Water	
		DATE SAMPLED:		9/12/2014	9/12/2014		9/15/2014	9/15/2014	
Parameter	Unit	G / S	RDL	5807550	5807551	RDL	5807552	5807554	
Turbidity	NTU		0.5	2.5	8.6	5	543	921	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0090 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V888816

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Trace Organics Analysis

RPT Date: Sep 23, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
BTEX / VPH / EPH in Water															
Methyl tert-butyl ether (MTBE)	63134	5807554	<1	<1	0.0%	< 1	100%	80%	120%				98%	70%	130%
Benzene	63134	5807554	<0.5	<0.5	0.0%	< 0.5	100%	80%	120%				102%	70%	130%
Toluene	63134	5807554	<0.5	<0.5	0.0%	< 0.5	98%	80%	120%				101%	70%	130%
Ethylbenzene	63134	5807554	<0.5	<0.5	0.0%	< 0.5	96%	80%	120%				100%	70%	130%
m&p-Xylene	63134	5807554	0.5	0.5	0.0%	< 0.5	97%	80%	120%				101%	70%	130%
o-Xylene	63134	5807554	<0.5	<0.5	0.0%	< 0.5	97%	80%	120%				102%	70%	130%
Styrene	63134	5807554	<0.5	<0.5	0.0%	< 0.5	96%	80%	120%				100%	70%	130%
VPH	63134	5807554	<100	<100	0.0%	< 100									
VH	63134	5807554	<100	<100	0.0%	< 100									
EPH C10-C19	63126	MS	1900	1840	3.0%	< 100	104%	70%	130%				86%	65%	120%
EPH C19-C32	63126	MS	2400	2270	5.6%	< 100	105%	70%	130%				98%	80%	120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0090 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V888816

ATTENTION TO: Cathy Schmid

SAMPLED BY:

Water Analysis															
RPT Date: Sep 23, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

### Routine Chemistry Water Analysis

pH	5738183		11.0	11.1	0.5%	< 0.01	99%	95%	105%						
p-Alkalinity	5738183		133	141	6.3%	< 1									
Alkalinity (pH 4.5)	5738183		187	190	1.5%	< 1	93%	90%	110%						
Alkalinity, Bicarbonate	5738183		<1	<1	0.0%	< 1									
Alkalinity, Carbonate	5738183		109	98	11.0%	< 1									
Alkalinity, Hydroxide	5738183		78	92	16.8%	< 1									
Electrical Conductivity	5738183		1160	1190	2.6%	< 1	99%	90%	110%						
Chloride	5812422		0.86	0.88	1.9%	< 0.05	103%	85%	115%	104%	90%	110%			
Fluoride	5812422		<0.02	<0.02	0.0%	< 0.02	99%	85%	115%	102%	90%	110%			
Nitrate-N	5812422		0.300	0.299	0.3%	< 0.005	98%	85%	115%	99%	90%	110%			
Nitrite-N	5812422		<0.005	<0.005	0.0%	< 0.005				98%	90%	110%			
Sulphate	5812422		4.5	4.5	0.3%	< 0.5	97%	85%	115%	98%	90%	110%			
Calcium Dissolved	5811607		73.1	74.4	1.8%	< 0.05	98%	90%	110%	96%	90%	110%			
Magnesium Dissolved	5811607		9.75	9.86	1.1%	< 0.05	103%	90%	110%	99%	90%	110%			
Sodium Dissolved	5811607		2.48	2.52	1.2%	< 0.05	105%	90%	110%	106%	90%	110%			
Potassium Dissolved	5811607		0.20	0.23	0.0%	< 0.05	100%	90%	110%	99%	90%	110%			
Iron Dissolved	5811607		23.7	24.2	2.0%	< 0.01	98%	90%	110%	100%	90%	110%			
Manganese Dissolved	5811607		0.196	0.199	1.5%	< 0.001	104%	90%	110%	101%	90%	110%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### Total Phosphorus and Total Dissolved Phosphorus

Phosphorus Dissolved	5807550		0.005	0.003	NA	< 0.005	87%	85%	115%	106%	90%	110%	101%	80%	120%
Phosphorus Total	5844604		0.013	0.015	14.3%	< 0.005	104%	85%	115%	101%	90%	110%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### British Columbia CSR- Schedule 6 Total Metals

Aluminum Total	5818001		25	25	0.0%	< 5	105%	85%	115%	100%	85%	115%			
Antimony Total	5818001		2.8	2.8	0.2%	< 0.5	110%	85%	115%	105%	90%	110%			
Arsenic Total	5818001		3.1	3.3	4.8%	< 0.1	92%	85%	115%	106%	90%	110%			
Barium Total	5818001		64.4	65.5	1.7%	< 0.5	113%	85%	115%	101%	90%	110%			
Beryllium Total	5818001		<0.05	<0.05	0.0%	< 0.05	102%	85%	115%	100%	90%	110%			
Boron Total	5818001		44	45	2.0%	< 5	104%	85%	115%	104%	80%	120%			
Cadmium Total	5818001		0.05	0.06	6.0%	< 0.01	102%	85%	115%	102%	90%	110%			
Calcium Total	5818001		49800	50700	1.8%	< 50	100%	85%	115%	97%	90%	110%			
Chromium Total	5818001		<0.5	<0.5	0.0%	< 0.5	105%	85%	115%	100%	90%	110%			
Cobalt Total	5818001		0.70	0.69	2.0%	< 0.05	111%	85%	115%	97%	90%	110%			
Copper Total	5818001		<0.5	<0.5	0.0%	< 0.5	102%	85%	115%	102%	90%	110%			
Iron Total	5818001		497	500	0.6%	< 10	102%	85%	115%	104%	90%	110%			
Lead Total	5818001		0.09	0.07	NA	< 0.05	90%	85%	115%	109%	90%	110%			
Lithium Total	5818001		6.3	6.2	2.2%	< 0.5				106%	90%	110%			

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Sep 23, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Magnesium Total	5818001		18100	18500	2.1%	< 50	103%	85%	115%	102%	90%	110%			
Manganese Total	5818001		107	109	2.1%	< 1	105%	85%	115%	102%	90%	110%			
Mercury Total	5807550		< 0.01	< 0.01	0.0%	< 0.01	108%	85%	115%	100%	90%	110%			
Molybdenum Total	5818001		1.5	1.5	0.2%	< 0.1	106%	85%	115%	104%	90%	110%			
Nickel Total	5818001		3.0	3.0	3.0%	< 0.5	107%	85%	115%	96%	90%	110%			
Selenium Total	5818001		2.7	2.9	4.2%	< 0.5	91%	85%	115%	99%	85%	115%			
Silver Total	5818001		<0.02	<0.02	0.0%	< 0.02				98%	90%	110%			
Sodium Total	5818001		19500	19700	0.8%	< 100	105%	85%	115%	106%	90%	110%			
Thallium Total	5818001		0.10	0.05	NA	< 0.02	113%	85%	115%	101%	90%	110%			
Titanium Total	5818001		2	2	0.0%	< 1				99%	90%	110%			
Uranium Total	5818001		0.89	0.91	1.7%	< 0.01	99%	85%	115%	109%	90%	110%			
Vanadium Total	5818001		<1	<1	0.0%	< 1	99%	85%	115%	100%	90%	110%			
Zinc Total	5818001		<5	<5	0.0%	< 5	93%	85%	115%	100%	80%	120%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### British Columbia CSR- Schedule 6 Dissolved Metals

Aluminum Dissolved	5812345		9	10	0.0%	< 2	95%	90%	110%	102%	85%	115%			
Antimony Dissolved	5812345		0.5	0.5	0.0%	< 0.2	100%	90%	110%	100%	85%	110%			
Arsenic Dissolved	5812345		0.1	0.1	0.0%	< 0.1	101%	90%	110%	103%	90%	110%			
Barium Dissolved	5812345		272	270	0.8%	< 0.2	103%	90%	110%	98%	90%	110%			
Beryllium Dissolved	5812345		<0.01	<0.01	0.0%	< 0.01	102%	90%	110%	103%	90%	110%			
Boron Dissolved	5812345		16	16	2.4%	< 2	102%	90%	110%	108%	80%	120%			
Cadmium Dissolved	5812345		0.02	0.02	0.0%	< 0.01	105%	90%	110%	99%	90%	110%			
Calcium Dissolved	5811607		73100	74400	1.8%	< 50	98%	90%	110%	96%	90%	110%			
Chromium Dissolved	5812345		<0.5	<0.5	0.0%	< 0.5	108%	90%	110%	108%	90%	110%			
Cobalt Dissolved	5812345		0.08	0.05	0.0%	< 0.05	99%	90%	110%	97%	90%	110%			
Copper Dissolved	5812345		1.1	0.8	0.0%	< 0.2	102%	90%	110%	99%	90%	110%			
Iron Dissolved	5811607		23700	24200	2.0%	< 10	98%	90%	110%	100%	90%	110%			
Lead Dissolved	5812345		0.11	0.10	0.0%	< 0.05	100%	90%	110%	99%	90%	110%			
Lithium Dissolved	5812345		15.6	15.7	0.6%	< 0.5				103%	90%	110%			
Magnesium Dissolved	5811607		9750	9860	1.1%	< 50	103%	90%	110%	99%	90%	110%			
Manganese Dissolved	5811607		196	199	1.5%	< 1	104%	90%	110%	101%	90%	110%			
Mercury Dissolved	5807550		< 0.01	< 0.01	0.0%	< 0.01	108%	90%	110%	100%	90%	110%			
Molybdenum Dissolved	5812345		2.69	2.69	0.1%	< 0.05	101%	90%	110%	100%	90%	110%			
Nickel Dissolved	5812345		2.4	2.4	1.8%	< 0.2	98%	90%	110%	98%	90%	110%			
Silver Dissolved	5812345		<0.02	<0.02	0.0%	< 0.02				98%	90%	110%			
Sodium Dissolved	5811607		2480	2520	1.2%	< 50	105%	90%	110%	106%	90%	110%			
Titanium Dissolved	5812345		<0.5	0.5	0.0%	< 0.5				95%	90%	110%			
Uranium Dissolved	5812345		1.32	1.34	1.1%	< 0.01	99%	90%	110%	103%	90%	110%			
Vanadium Dissolved	5812345		<0.5	<0.5	0.0%	< 0.5	101%	90%	110%	101%	90%	110%			



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Sep 23, 2014

DUPLICATE

REFERENCE MATERIAL

METHOD BLANK SPIKE

MATRIX SPIKE

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
							Lower	Upper		Lower	Upper		Lower	Upper

Zinc Dissolved	5812345		<2	<2	0.0%	< 2	96%	90%	110%	98%	85%	115%			
----------------	---------	--	----	----	------	-----	-----	-----	------	-----	-----	------	--	--	--

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Turbidity

Turbidity	5815941		0.9	0.9	0.0%	< 0.5	102%	85%	115%	102%	90%	110%			
-----------	---------	--	-----	-----	------	-------	------	-----	------	------	-----	------	--	--	--

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Total Phenols - 4AAP

Phenol, Total	5807550		< 0.002	< 0.002	NA	< 0.002	99%	85%	115%	101%	90%	110%	99%	70%	130%
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Methyl tert-butyl ether (MTBE)	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
Benzene	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
Toluene	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
Ethylbenzene	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
m&p-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
o-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
Styrene	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
VPH	ORG-180-5130	Modified from BC MOE Lab Manual Sec D (BTEX, VPH)	GC/MS/FID
VH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
EPH C10-C19	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID
EPH C19-C32	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0090 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V888816

ATTENTION TO: Cathy Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Aluminum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Antimony Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Arsenic Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Barium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Beryllium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Boron Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cadmium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Chromium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cobalt Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Copper Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Lead Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Lithium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Mercury Dissolved	MET-181-6103, LAB-181-4015	Modified from EPA 245.7	CV/AA
Molybdenum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Nickel Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Selenium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Silver Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Thallium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Titanium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Uranium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Vanadium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Zinc Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0090 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V888816

ATTENTION TO: Cathy Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Aluminum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Antimony Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Arsenic Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Barium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Beryllium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Boron Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cadmium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Calcium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Chromium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cobalt Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Copper Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Iron Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Lead Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Lithium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Magnesium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Manganese Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Mercury Total	MET-181-6103	Modified from EPA 245.7	CV/AA
Molybdenum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Nickel Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Selenium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Silver Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Sodium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Thallium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Titanium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Uranium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Vanadium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Zinc Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
pH	INOR-181-6000	Modified from SM 4500-H+	PH METER
p-Alkalinity	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity (pH 4.5)	INOR-181-6000	Modified from SM 2320 B	PC TITRATE





## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V888816

PROJECT: 0090 150 15

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Alkalinity, Bicarbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Carbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Hydroxide	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Electrical Conductivity	INOR-181-6000	Modified from SM 2510B	PC TITRATE
Chloride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Fluoride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Potassium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Phenol, Total	INOR-181-6014	Modified from SM 5530 C and EPA 420.2	CONTINUOUS FLOW ANALYZER
Phosphorus Dissolved	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
Phosphorus Total	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
Turbidity	INOR-181-6008	SM 2130 B	PC TITRATE



# Laboratories

120 - 8600 Glenlyon Parkway  
Burnaby, BC  
V5J 0B6  
**webeath.agatlabs.com**

**Laboratory Use Only**

Arrival Temperature: \_\_\_\_\_

AGAT Job Number: \_\_\_\_\_

Notes:

**P: 778.452.4000 • F: 778.452.4074**

## Chain of Custody Record

## Report Information

Company: Real Engineering Inc.  
Contact: Cathy Schmid  
Address: Vancouver, BC  
Phone: (604) 250 3748 Fax: \_\_\_\_\_  
LSD: \_\_\_\_\_  
Client Project #: 0090 15015

## Report Information

1. Name: Cathy Schmid  
Email: cschmid@bcgenscience.org

2. Name: \_\_\_\_\_  
Email: \_\_\_\_\_

### Requirements (Please Check)

☐ BC CSR Soil

☐ AL

☐ IL

☐ PL

☐ CL

☐ RL

☐ BC CSR - Water

☐ DW

☐ AW

☐ IW

☐ LW

## Invoice To

Same as above Yes ☒ / No ☐

Company: \_\_\_\_\_

Contact: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

PO/AFF #: \_\_\_\_\_

LABORATORY  
USE (LAB ID #)

## SAMPLE IDENTIFICATION

SAMPLE	MATRIX
--------	--------

DATE/TIME SAMPLED

COMMENTS - SITE SAMPLE INFO.  
SAMPLE CONTAINMENT

580350	HWM-BH-03 - WS1
580351	WS2
580352	WS3
580353	WS4

Samples Relinquished By (Print Name and Sign):

Samples Relinquished By (Print Name and Sign): Anne Clayton

Samples Relinquished By (Print Name and Sign):

Samples Received By (Print Name and Sign):

Samples Received By (Print Name and Sign): Steven Audobert

**Samples Received By (Print Name and Sign):**

Date/Time

Sept	Date/Time
------	-----------

Date/Time	Location	Activity	Remarks
10/10/2023	10:00 AM	Arrived at the site	Weather: Clear, Temperature: 25°C
10/10/2023	10:15 AM	Started data collection	Initial readings: pH 7.2, DO 8.5 mg/L
10/10/2023	11:30 AM	Conducted water sampling	Sample collected for analysis
10/10/2023	12:00 PM	Lunch break	Rest and equipment check
10/10/2023	1:30 PM	Continued data collection	Readings: pH 7.1, DO 8.3 mg/L
10/10/2023	3:00 PM	Completed data collection	Final readings: pH 7.0, DO 8.1 mg/L
10/10/2023	4:30 PM	Departed the site	Equipment cleaned and stored

## Report Format

☒ Single Sample per page

☐ Multiple Samples per page

## L

☐ Excel Format Included

## Turnaround Time Required (TAT)

**Regular TAT** ☐ 5 to 7 working days

**Rush TAT**

☐ Day 2 - 100%

☐ Day 3 - 50%

☐ Day 4 - 25%

Date Required:

PLEASE CONTACT LABORATORY IF RUSH REQUIRED SAMPLE  
SUBMISSION CUT OFF FOR EFFECTIVE DATE BY 3 PM

Hold for: ☐ 60 DAYS

HAZARDOUS (Y/N)

NUMBER OF CONTAINERS

Page 1 of 1

Nº: 005594



# AGAT

## Laboratories

### SAMPLE INTEGRITY RECEIPT FORM - BURNABY

Work Order # 14V888816

#### RECEIVING BASICS:

Received From: Anne

Waybill #: \_\_\_\_\_

#### SAMPLE QUANTITIES:

Coolers: 1 Containers: 47

#### TIME SENSITIVE ISSUES:

Earliest Date Sampled: 12 Sept 14

ALREADY EXCEEDED? Yes ☐ No ☒

Nitrate / Nitrite samples expire 15 Sept 14 at the  
Soonest

#### NON-CONFORMANCES:

3 temperatures of samples\* and average of each cooler: (record differing temperatures on the CoC next to sample ID's) \*use jars when available

(1) 9 + 9 + 8 = 9 °C (2)     +     +     =     °C (3)     +     +     =     °C (4)     +     +     =     °C

Was ice or ice pack present: ☒ Yes ☐ No

#### Integrity issues:

- 1) NO bottles received for sample "HMM-BH-03-WS4"
- 2) Two sets of bottles labeled "HMM-BH-03 WS3" received (except,
- 3) for the 1L plastic bottle, only 1 received)

Account Project Manager: \_\_\_\_\_ Have they been notified of the above issues: Yes ☐ No ☐

Whom spoken to: \_\_\_\_\_ Date and Time: \_\_\_\_\_

#### ADDITIONAL NOTES:

Only 10ml of sample received for "HMM-BH-03 WS2" for TDP analysis.  
Dissolved metal bottle for "HMM-BH-03-WS2" is empty upon receipt.  
The received dissolved metal samples require filtration, which  
will be done so in the lab.

CLIENT NAME: BGC ENGINEERING INC.  
#500-1045 HOWE STREET  
VANCOUVER, BC V6Z2A9  
(604) 684-5900

ATTENTION TO: Catherine Schmid

PROJECT:

AGAT WORK ORDER: 14V890933

TRACE ORGANICS REVIEWED BY: Angela Bond, Technical Reviewer

WATER ANALYSIS REVIEWED BY: Angela Bond, Technical Reviewer

DATE REPORTED: Sep 25, 2014

PAGES (INCLUDING COVER): 18

VERSION\*: 1

Should you require any information regarding this analysis please contact your client services representative at (778) 452-4000

**\*NOTES**

VERSION 1: Sample receipt temperature: 10°C

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

PROJECT:

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### BTEX / VPH / EPH Water

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

		SAMPLE DESCRIPTION:		HMM-BH-03	HMM-BH-03	
		SAMPLE TYPE:		WS-05	WS-06	HMM-BH-03 WS
		DATE SAMPLED:		9/15/2014	9/17/2014	9/18/2014
Parameter	Unit	G / S	RDL	5826761	5826767	5826769
Methyl tert-butyl ether (MTBE)	µg/L		1	<1	<1	<1
Benzene	µg/L		0.5	<0.5	<0.5	<0.5
Toluene	µg/L		0.5	<0.5	<0.5	<0.5
Ethylbenzene	µg/L		0.5	<0.5	<0.5	<0.5
m&p-Xylene	µg/L		0.5	<0.5	<0.5	<0.5
o-Xylene	µg/L		0.5	<0.5	<0.5	<0.5
Styrene	µg/L		0.5	<0.5	<0.5	<0.5
VPH	µg/L		100	<100	<100	<100
VH	µg/L		100	<100	<100	<100
EPH C10-C19	µg/L		100	<100	<100	<100
EPH C19-C32	µg/L		100	120	1020	190
Total Xylenes	ug/L		1	<1	<1	<1
Surrogate	Unit	Acceptable Limits				
Bromofluorobenzene	%		70-130	82	82	80
Dibromofluoromethane	%		70-130	115	115	110
Toluene - d8	%		70-130	93	90	88

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5826761-5826769 VPH results have been corrected for BTEX contributions.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

PROJECT:

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

Parameter	Unit	SAMPLE DESCRIPTION:		HMM-BH-03	HMM-BH-03
		SAMPLE TYPE:		WS-05	WS-06
		DATE SAMPLED:		Water	Water
		G / S		9/15/2014	9/17/2014
		RDL		5826761	5826767
Aluminum Dissolved	µg/L	2		118	126
Antimony Dissolved	µg/L	0.2		4.1	<0.2
Arsenic Dissolved	µg/L	0.1		9.7	0.4
Barium Dissolved	µg/L	0.2		13.2	2.7
Beryllium Dissolved	µg/L	0.01		<0.01	<0.01
Boron Dissolved	µg/L	2		114	6
Cadmium Dissolved	µg/L	0.01		0.09	<0.01
Calcium Dissolved	µg/L	50		9720	4690
Chromium Dissolved	µg/L	0.5		<0.5	<0.5
Cobalt Dissolved	µg/L	0.05		0.07	<0.05
Copper Dissolved	µg/L	0.2		3.9	1.1
Iron Dissolved	µg/L	10		61	303
Lead Dissolved	µg/L	0.05		1.00	0.16
Lithium Dissolved	µg/L	0.5		1.0	0.8
Magnesium Dissolved	µg/L	50		539	230
Manganese Dissolved	µg/L	1		8	9
Mercury Dissolved	µg/L	0.01		0.02	<0.01
Molybdenum Dissolved	µg/L	0.05		91.4	3.57
Nickel Dissolved	µg/L	0.2		0.5	<0.2
Selenium Dissolved	µg/L	0.5		<0.5	<0.5
Silver Dissolved	µg/L	0.02		0.03	<0.02
Sodium Dissolved	µg/L	50		11300	5230
Thallium Dissolved	µg/L	0.01		<0.01	<0.01
Titanium Dissolved	µg/L	0.5		504	7.2
Uranium Dissolved	µg/L	0.01		0.27	0.02
Vanadium Dissolved	µg/L	0.5		5.3	0.6
Zinc Dissolved	µg/L	2		<2	<2
Hardness (calc)	ug CaCO3/L	100		26500	12700

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

PROJECT:

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5826761 Sample not filtered at time of collection as per analysis requirements.  
Sample container inappropriate as per analysis requirements for Dissolved Mercury.  
Dissolved Mercury sample improperly preserved as per analysis requirements.  
Some dissolved metal results are greater than the total metal results; results have been verified.  
5826767 Sample not filtered at time of collection as per analysis requirements.  
Sample container inappropriate as per analysis requirements for Dissolved Mercury.  
Dissolved Mercury sample improperly preserved as per analysis requirements.

Certified By:



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

PROJECT:

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

		HMM-BH-03				HMM-BH-03	
		SAMPLE DESCRIPTION:		WS-05		WS-06	HMM-BH-03 WS
		SAMPLE TYPE:		Water		Water	Water
		DATE SAMPLED:		9/15/2014		9/17/2014	9/18/2014
Parameter	Unit	G / S	RDL	5826761	RDL	5826767	5826769
Aluminum Total	µg/L		5000	482000	50	5210	4250
Antimony Total	µg/L		0.5	<0.5	0.5	<0.5	<0.5
Arsenic Total	µg/L		0.1	109	0.1	1.2	0.9
Barium Total	µg/L		5	4410	0.5	57.1	35.7
Beryllium Total	µg/L		0.05	9.02	0.05	0.08	0.05
Boron Total	µg/L		5	167	5	8	6
Cadmium Total	µg/L		0.01	2.11	0.01	0.03	0.05
Calcium Total	µg/L		50	195000	50	6740	16100
Chromium Total	µg/L		0.5	397	0.5	13.5	16.7
Cobalt Total	µg/L		0.05	359	0.05	2.96	2.40
Copper Total	µg/L		5	1480	0.5	29.7	26.6
Iron Total	µg/L		1000	745000	10	9810	13800
Lead Total	µg/L		0.05	190	0.05	1.77	2.49
Lithium Total	µg/L		5	270	0.5	3.1	1.9
Magnesium Total	µg/L		500	241000	50	2230	1220
Manganese Total	µg/L		1	10300	1	144	226
Mercury Total	µg/L		1	2	0.01	<0.01	<0.01
Molybdenum Total	µg/L		0.1	19.3	0.1	5.7	6.7
Nickel Total	µg/L		0.5	423	0.5	7.8	4.1
Selenium Total	µg/L		0.5	28.8	0.5	<0.5	<0.5
Silver Total	µg/L		0.02	1.55	0.02	<0.02	<0.02
Sodium Total	µg/L		100	28800	100	6420	51800
Thallium Total	µg/L		0.02	2.60	0.02	<0.02	<0.02
Titanium Total	µg/L		1	707	1	218	158
Uranium Total	µg/L		0.01	9.65	0.01	0.13	0.12
Vanadium Total	µg/L		1	737	1	14	10
Zinc Total	µg/L		5	1800	5	44	21
Total Hardness (calc)	ug CaCO3/L		100	1480000	100	26000	45200

Certified By:

*Angela Bond*





**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

PROJECT:

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Low Level Dissolved Phosphorus

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

		HMM-BH-03		HMM-BH-03	
SAMPLE DESCRIPTION:		WS-05		WS-06	
SAMPLE TYPE:		Water		Water	
DATE SAMPLED:		9/15/2014		9/17/2014	
Parameter	Unit	G / S	RDL	5826761	5826767
Phosphorus Dissolved	mg/L	0.005	0.041	0.042	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5826761 Literature holding time exceeded for Total Dissolved Phosphorus analysis.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Phenols, Total - 4AAP

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

		HMM-BH-03		HMM-BH-03		HMM-BH-03 WS
SAMPLE DESCRIPTION:		WS-05		WS-06		Water
SAMPLE TYPE:		Water		Water		Water
DATE SAMPLED:		9/15/2014		9/17/2014		9/18/2014
Parameter	Unit	G / S	RDL	5826761	5826767	5826769
Phenol, Total	mg/L	0.002	0.003	< 0.002	< 0.002	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

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Burnaby, British Columbia  
CANADA V5J 0B6  
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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Phosphorus, Total

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

		HMM-BH-03		HMM-BH-03		HMM-BH-03 WS	
SAMPLE DESCRIPTION:		WS-05		WS-06		Water	
SAMPLE TYPE:		Water		Water		Water	
DATE SAMPLED:		9/15/2014		9/17/2014		9/18/2014	
Parameter	Unit	G / S	RDL	5826761	RDL	5826767	5826769
Phosphorus Total	mg/L	0.02	7.86	0.005	0.114	0.092	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V890933

PROJECT:

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Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### Routine Chemistry Water Analysis

DATE RECEIVED: 2014-09-19

DATE REPORTED: 2014-09-25

		HMM-BH-03			HMM-BH-03			HMM-BH-03 WS		
SAMPLE DESCRIPTION:		WS-05			WS-06			Water		
SAMPLE TYPE:		Water			Water			Water		
DATE SAMPLED:		9/15/2014			9/17/2014			9/18/2014		
Parameter	Unit	G / S	RDL	5826761	RDL	5826767	RDL	5826769		
pH	pH units		0.01	7.95	0.01	7.34	0.01	6.94		
p-Alkalinity	mg CaCO3/L		1	<1	1	<1	1	<1		
Alkalinity (pH 4.5)	mg CaCO3/L		1	58	1	23	1	13		
Alkalinity, Bicarbonate	mg CaCO3/L		1	58	1	23	1	13		
Alkalinity, Carbonate	mg CaCO3/L		1	<1	1	<1	1	<1		
Alkalinity, Hydroxide	mg CaCO3/L		1	<1	1	<1	1	<1		
Electrical Conductivity	uS/cm		1	124	1	53	1	37		
Chloride	mg/L		0.05	3.35	0.5	2.5	0.05	3.82		
Fluoride	mg/L		0.02	0.29	0.02	<0.02	0.02	<0.02		
Nitrate-N	mg/L		0.005	<0.005	0.005	0.053	0.005	0.058		
Nitrite-N	mg/L		0.005	0.020	0.005	<0.005	0.005	<0.005		
Sulphate	mg/L		0.5	15.5	0.5	0.8	0.5	0.8		
Calcium Dissolved	mg/L		0.05	9.72	0.05	4.69	0.05	2.19		
Magnesium Dissolved	mg/L		0.05	0.54	0.05	0.23	0.05	0.17		
Sodium Dissolved	mg/L		0.05	11.3	0.05	5.23	0.05	3.56		
Potassium Dissolved	mg/L		0.05	2.51	0.05	1.04	0.05	2.05		
Iron Dissolved	mg/L		0.01	0.06	0.01	0.30	0.01	0.01		
Manganese Dissolved	mg/L		0.001	0.008	0.001	0.009	0.001	0.029		
Calculated TDS	mg/L		1	78	1	28	1	20		
Hardness (calc)	mg CaCO3/L		0.5	26.5	0.5	12.7	0.5	6.2		
Nitrate + Nitrite-N	mg/L		0.01	0.02	0.01	0.05	0.01	0.06		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5826761 Literature holding time exceeded for Nitrate, Nitrite, and pH analyses.  
5826767-5826769 Literature holding time exceeded for pH analysis.

Certified By:

*Angela Bond*

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### Trace Organics Analysis

RPT Date: Sep 25, 2014

DUPLICATE

REFERENCE MATERIAL

METHOD BLANK SPIKE

MATRIX SPIKE

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value			Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
							Measured Value	Acceptable Limits		Lower	Upper		Lower	Upper			
								Lower	Upper								
BTEX / VPH / EPH Water																	
Methyl tert-butyl ether (MTBE)	63143	5827565	<1	<1	0.0%	< 1	98%	80%	120%						98%	70%	130%
Benzene	63143	5827565	<0.5	<0.5	0.0%	< 0.5	113%	80%	120%						102%	70%	130%
Toluene	63143	5827565	<0.5	<0.5	0.0%	< 0.5	100%	80%	120%						105%	70%	130%
Ethylbenzene	63143	5827565	<0.5	<0.5	0.0%	< 0.5	96%	80%	120%						104%	70%	130%
m&p-Xylene	63143	5827565	<0.5	<0.5	0.0%	< 0.5	99%	80%	120%						101%	70%	130%
o-Xylene	63143	5827565	<0.5	<0.5	0.0%	< 0.5	100%	80%	120%						101%	70%	130%
Styrene	63143	5827565	<0.5	<0.5	0.0%	< 0.5	95%	80%	120%						102%	70%	130%
VPH	63143	5827565	<100	<100	0.0%	< 100											
VH	63143	5827565	<100	<100	0.0%	< 100											
Bromofluorobenzene	63143	5827565	80	83	4.0%		96%	70%	130%						96%	70%	130%
Dibromofluoromethane	63143	5827565	103	119	14.0%		119%	70%	130%						94%	70%	130%
Toluene - d8	63143	5827565	88	86	2.0%		92%	70%	130%						97%	70%	130%
EPH C10-C19	63144	MS	1950	2080	6.0%	< 100	104%	70%	130%						87%	65%	120%
EPH C19-C32	63144	MS	2370	2690	13.0%	< 100	105%	70%	130%						100%	80%	120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

Water Analysis															
RPT Date: Sep 25, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

### Routine Chemistry Water Analysis

pH	5738244		9.74	9.77	0.3%	< 0.01	99%	95%	105%						
p-Alkalinity	5738244		38	39	3.1%	< 1									
Alkalinity (pH 4.5)	5738244		133	136	2.1%	< 1	94%	90%	110%						
Alkalinity, Bicarbonate	5738244		57	58	0.9%	< 1									
Alkalinity, Carbonate	5738244		75	78	3.1%	< 1									
Alkalinity, Hydroxide	5738244		<1	<1	NA	< 1									
Electrical Conductivity	5738244		494	499	1.0%	< 1	100%	90%	110%						
Chloride	5824540		102	102	0.4%	< 0.05	110%	85%	115%	106%	90%	110%			
Fluoride	5824540		2.61	2.91	10.8%	< 0.02	114%	85%	115%	108%	90%	110%			
Nitrate-N	5824540		1.56	1.58	1.1%	< 0.005	106%	85%	115%	107%	90%	110%			
Nitrite-N	5824540		1.32	1.38	4.5%	< 0.005				107%	90%	110%			
Sulphate	5824540		263	264	0.2%	< 0.5	107%	85%	115%	108%	90%	110%			
Calcium Dissolved	5831476		14.1	13.7	2.6%	< 0.05	97%	90%	110%	101%	90%	110%			
Magnesium Dissolved	5831476		1.96	1.93	1.2%	< 0.05	101%	90%	110%	100%	90%	110%			
Sodium Dissolved	5831476		13.6	13.6	0.5%	< 0.05	100%	90%	110%	101%	90%	110%			
Potassium Dissolved	5831476		3.55	3.49	1.9%	< 0.05	101%	90%	110%	99%	90%	110%			
Iron Dissolved	5831476		0.52	0.50	2.6%	< 0.01	98%	90%	110%	98%	90%	110%			
Manganese Dissolved	5831476		0.076	0.076	0.7%	< 0.001	103%	90%	110%	103%	90%	110%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### British Columbia CSR- Schedule 6 Total Metals

Aluminum Total	5829129		54	56	3.1%	< 5	108%	85%	115%	103%	85%	115%			
Antimony Total	5829129		<0.5	<0.5	NA	< 0.5	113%	85%	115%	103%	90%	110%			
Arsenic Total	5829129		0.2	0.3	NA	< 0.1	87%	85%	115%	106%	90%	110%			
Barium Total	5829129		222	224	0.7%	< 0.5	104%	85%	115%	100%	90%	110%			
Beryllium Total	5829129		<0.05	<0.05	NA	< 0.05	97%	85%	115%	95%	90%	110%			
Boron Total	5829129		12	12	NA	< 5	99%	85%	115%	104%	80%	120%			
Cadmium Total	5829129		<0.01	<0.01	NA	< 0.01	100%	85%	115%	104%	90%	110%			
Calcium Total	5829129		58300	58800	0.7%	< 50	99%	85%	115%	98%	90%	110%			
Chromium Total	5829129		<0.5	<0.5	NA	< 0.5	101%	85%	115%	99%	90%	110%			
Cobalt Total	5829129		0.09	0.09	NA	< 0.05	111%	85%	115%	107%	90%	110%			
Copper Total	5829129		1.0	1.1	NA	< 0.5	104%	85%	115%	98%	90%	110%			
Iron Total	5829129		95	95	0.6%	< 10	100%	85%	115%	102%	90%	110%			
Lead Total	5829129		0.07	0.07	NA	< 0.05	88%	85%	115%	107%	90%	110%			
Lithium Total	5829129		9.3	9.4	1.0%	< 0.5				100%	90%	110%			
Magnesium Total	5829129		17400	17500	0.7%	< 50	102%	85%	115%	103%	90%	110%			
Manganese Total	5829129		3	4	NA	< 1	105%	85%	115%	104%	90%	110%			
Mercury Total	5829377		0.02	0.03	NA	< 0.01	112%	85%	115%	110%	90%	110%			
Molybdenum Total	5829129		1.6	1.6	2.9%	< 0.1	103%	85%	115%	99%	90%	110%			

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Sep 25, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Nickel Total	5829129		1.4	1.6	NA	< 0.5	107%	85%	115%	102%	90%	110%			
Selenium Total	5829129		4.5	4.7	3.4%	< 0.5	97%	85%	115%	102%	85%	115%			
Silver Total	5829129		0.02	<0.02	NA	< 0.02				103%	90%	110%			
Sodium Total	5829129		9090	9170	0.9%	< 100	103%	85%	115%	107%	90%	110%			
Thallium Total	5829129		0.10	0.05	NA	< 0.02	105%	85%	115%	100%	90%	110%			
Titanium Total	5829129		1	1	NA	< 1				100%	90%	110%			
Uranium Total	5829129		0.87	0.86	2.0%	< 0.01	111%	85%	115%	108%	90%	110%			
Vanadium Total	5829129		<1	<1	NA	< 1	98%	85%	115%	94%	90%	110%			
Zinc Total	5829129		<5	<5	NA	< 5	97%	85%	115%	97%	80%	120%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### British Columbia CSR- Schedule 6 Dissolved Metals

Aluminum Dissolved	5831484		4	3	NA	< 2	96%	90%	110%	103%	85%	115%			
Antimony Dissolved	5831484		<0.2	<0.2	NA	< 0.2	95%	90%	110%	99%	85%	110%			
Arsenic Dissolved	5831484		27.2	27.1	0.3%	< 0.1	109%	90%	110%	108%	90%	110%			
Barium Dissolved	5831484		115	114	1.4%	< 0.2	102%	90%	110%	105%	90%	110%			
Beryllium Dissolved	5831484		<0.01	<0.01	NA	< 0.01	90%	90%	110%	90%	90%	110%			
Boron Dissolved	5831484		28	28	0.3%	< 2	92%	90%	110%	104%	80%	120%			
Cadmium Dissolved	5831484		0.02	0.02	NA	< 0.01	101%	90%	110%	100%	90%	110%			
Calcium Dissolved	5831476		14100	13700	2.6%	< 50	97%	90%	110%	101%	90%	110%			
Chromium Dissolved	5831484		<0.5	<0.5	NA	< 0.5	100%	90%	110%	98%	90%	110%			
Cobalt Dissolved	5831484		2.97	3.10	4.1%	< 0.05	109%	90%	110%	106%	90%	110%			
Copper Dissolved	5831484		0.5	<0.2	NA	< 0.2	107%	90%	110%	104%	90%	110%			
Iron Dissolved	5831476		517	504	2.6%	< 10	98%	90%	110%	98%	90%	110%			
Lead Dissolved	5831484		<0.05	<0.05	NA	< 0.05	97%	90%	110%	98%	90%	110%			
Lithium Dissolved	5831484		2.4	2.4	NA	< 0.5				98%	90%	110%			
Magnesium Dissolved	5831476		1960	1930	1.2%	< 50	101%	90%	110%	100%	90%	110%			
Manganese Dissolved	5831476		76	76	0.7%	< 1	103%	90%	110%	103%	90%	110%			
Mercury Dissolved	5826038		< 0.01	< 0.01	NA	< 0.01	105%	90%	110%	100%	90%	110%			
Molybdenum Dissolved	5831484		7.70	7.80	1.3%	< 0.05	97%	90%	110%	98%	90%	110%			
Nickel Dissolved	5831484		2.3	2.4	3.2%	< 0.2	105%	90%	110%	106%	90%	110%			
Selenium Dissolved	5831484		<0.5	<0.5	NA	< 0.5	107%	90%	110%	102%	85%	115%			
Silver Dissolved	5831484		<0.02	<0.02	NA	< 0.02				101%	90%	110%			
Sodium Dissolved	5831476		13600	13600	0.5%	< 50	100%	90%	110%	101%	90%	110%			
Thallium Dissolved	5831484		0.01	<0.01	NA	< 0.01	103%	90%	110%	97%	90%	110%			
Titanium Dissolved	5831484		0.9	1.1	NA	< 0.5				98%	90%	110%			
Uranium Dissolved	5831484		0.50	0.50	0.1%	< 0.01	107%	90%	110%	101%	90%	110%			
Vanadium Dissolved	5831484		1.6	1.7	NA	< 0.5	95%	90%	110%	96%	90%	110%			
Zinc Dissolved	5831484		3	<2	NA	< 2	106%	90%	110%	102%	85%	115%			





## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Sep 25, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Phosphorus, Total

Phosphorus Total	5820680	0.023	0.023	NA	< 0.005	100%	85%	115%	106%	90%	110%	102%	80%	120%
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Low Level Dissolved Phosphorus

Phosphorus Dissolved	5829129	0.015	0.016	NA	< 0.005	102%	85%	115%	107%	90%	110%	103%	80%	120%
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Phenols, Total - 4AAP

Phenol, Total	5878503	0.006	0.007	NA	< 0.002	97%	85%	115%	95%	90%	110%	93%	70%	130%
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Methyl tert-butyl ether (MTBE)	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Benzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Toluene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Ethylbenzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
m&p-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
o-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Styrene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VPH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Bromofluorobenzene	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Dibromofluoromethane	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Toluene - d8	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
EPH C10-C19	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID
EPH C19-C32	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Aluminum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Antimony Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Arsenic Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Barium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Beryllium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Boron Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cadmium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Chromium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cobalt Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Copper Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Lead Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Lithium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Mercury Dissolved	MET-181-6103, LAB-181-4015	Modified from EPA 245.7	CV/AA
Molybdenum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Nickel Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Selenium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Silver Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Thallium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Titanium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Uranium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Vanadium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Zinc Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Aluminum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Antimony Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Arsenic Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Barium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Beryllium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Boron Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cadmium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Calcium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Chromium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cobalt Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Copper Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Iron Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Lead Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Lithium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Magnesium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Manganese Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Mercury Total	MET-181-6103	Modified from EPA 245.7	CV/AA
Molybdenum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Nickel Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Selenium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Silver Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Sodium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Thallium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Titanium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Uranium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Vanadium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Zinc Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Phosphorus Dissolved	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
Phenol, Total	INOR-181-6014	Modified from SM 5530 C and EPA 420.2	CONTINUOUS FLOW ANALYZER



## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V890933

PROJECT:

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Phosphorus Total	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
pH	INOR-181-6000	Modified from SM 4500-H+	PH METER
p-Alkalinity	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity (pH 4.5)	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Bicarbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Carbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Hydroxide	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Electrical Conductivity	INOR-181-6000	Modified from SM 2510B	PC TITRATE
Chloride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Fluoride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Potassium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES



120 - 8600 Glenlyon Parkway  
Burnaby, BC  
V5J 0B6  
**webearth.agatlabs.com**

**P: 778.452.4000 • F: 778.452.4074**

Free-Form Deformation





## SAMPLE INTEGRITY RECEIPT FORM - BURNABY

Work Order # 14V890933

### RECEIVING BASICS:

Received From: Anne Waybill #: \_\_\_\_\_

### SAMPLE QUANTITIES:

Coolers: 1 Containers: 33

### TIME SENSITIVE ISSUES:

Earliest Date Sampled: 15 Sep 2014 ALREADY EXCEEDED? ☒ Yes ☐ No

Samples sampled on 15 Sep 2014 requiring Nitrate + Nitrite & ~~Ammonia~~ expired 18 Sep 2014.

### NON-CONFORMANCES:

3 temperatures of samples\* and average of each cooler: (record differing temperatures on the CoC next to sample ID's) \*use jars when available

(1) 10 + 9 + 10 = 10 °C (2) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C (3) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C (4) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C

Was ice or ice pack present: ☒ Yes ☐ No

Integrity issues:

- 1) Dissolved metals, mercury, phosphorus not filtered.
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_

Account Project Manager: \_\_\_\_\_ Have they been notified of the above issues: Yes ☐ No ☐

Whom spoken to: \_\_\_\_\_ Date and Time: \_\_\_\_\_

### ADDITIONAL NOTES:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

CLIENT NAME: BGC ENGINEERING INC.  
#500-1045 HOWE STREET  
VANCOUVER, BC V6Z2A9  
(604) 684-5900

ATTENTION TO: Catherine Schmid

PROJECT: 0095-150-15-01

AGAT WORK ORDER: 14V898377

TRACE ORGANICS REVIEWED BY: Andrew Garrard, B.Sc., General Manager

WATER ANALYSIS REVIEWED BY: Andrew Garrard, B.Sc., General Manager

DATE REPORTED: Oct 14, 2014

PAGES (INCLUDING COVER): 14

VERSION\*: 1

Should you require any information regarding this analysis please contact your client services representative at (778) 452-4000

**\*NOTES**

VERSION 1: Sample receipt temperature 5°C.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.





# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V898377

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### BTEX / VPH / EPH Water

DATE RECEIVED: 2014-10-06

DATE REPORTED: 2014-10-14

		HMM-BH05-WS		HMM-BH05-WS		HMM-BH05-WS		HMM-BH05-WS	
SAMPLE DESCRIPTION:		11		10		9		8	
SAMPLE TYPE:		Water		Water		Water		Water	
DATE SAMPLED:		10/4/2014		10/4/2014		10/4/2014		10/3/2014	
Parameter	Unit	G / S	RDL	5902959	5902961	RDL	5902962	5902963	
Methyl tert-butyl ether (MTBE)	µg/L		10	<10	<10	1	<1	<1	
Benzene	µg/L		5	<5	<5	0.5	<0.5	<0.5	
Toluene	µg/L		5	<5	<5	0.5	<0.5	<0.5	
Ethylbenzene	µg/L		5	<5	<5	0.5	<0.5	<0.5	
m&p-Xylene	µg/L		5	<5	<5	0.5	<0.5	<0.5	
o-Xylene	µg/L		5	<5	<5	0.5	<0.5	<0.5	
Styrene	µg/L		5	<5	<5	0.5	<0.5	<0.5	
VPH	µg/L		1000	<1000	<1000	100	<100	<100	
VH	µg/L		1000	<1000	<1000	100	<100	<100	
EPH C10-C19	µg/L		100	500	200	100	<100	<100	
EPH C19-C32	µg/L		100	2120	560	100	230	700	
Total Xylenes	ug/L		1	<1	<1	1	<1	<1	
Surrogate	Unit	Acceptable Limits							
Bromofluorobenzene	%	70-130		89		90		95	
Dibromofluoromethane	%	70-130		74		78		116	
Toluene - d8	%	70-130		85		102		88	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

5902959-5902961 VPH results have been corrected for BTEX contributions.

Reduction of BTEX/VPH analytical volume was necessary due to the nature of the sample. Detection limits increased.

5902962-5902963 VPH results have been corrected for BTEX contributions.

Certified By:



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V898377

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-10-06

DATE REPORTED: 2014-10-14

		HMM-BH05-WS			HMM-BH05-WS			HMM-BH05-WS			HMM-BH05-WS		
SAMPLE DESCRIPTION:		11			10			9			8		
SAMPLE TYPE:		Water			Water			Water			Water		
DATE SAMPLED:		10/4/2014			10/4/2014			10/4/2014			10/3/2014		
Parameter	Unit	G / S	RDL	5902959	RDL	5902961	RDL	5902962	RDL	5902963			
Aluminum Total	µg/L		500	95500	500	105000	500	19500	500	28500			
Antimony Total	µg/L		0.5	0.6	0.5	<0.5	0.5	2.3	0.5	0.6			
Arsenic Total	µg/L		0.1	40.1	0.1	26.7	0.1	4.5	0.1	2.6			
Barium Total	µg/L		5	2740	5	3820	0.5	333	0.5	484			
Beryllium Total	µg/L		0.05	25.5	0.05	22.2	0.05	0.68	0.05	0.69			
Boron Total	µg/L		5	74	5	97	5	23	5	71			
Cadmium Total	µg/L		0.01	3.56	0.01	2.93	0.01	0.39	0.01	0.69			
Calcium Total	µg/L		50	159000	50	108000	50	12000	50	28800			
Chromium Total	µg/L		0.5	384	0.5	4.3	0.5	81.3	0.5	171			
Cobalt Total	µg/L		0.05	63.2	0.05	30.8	0.05	22.6	0.05	39.3			
Copper Total	µg/L		0.5	823	0.5	30.8	0.5	121	0.5	517			
Iron Total	µg/L		100	212000	100	90200	10	42200	100	76700			
Lead Total	µg/L		0.05	243	0.05	311	0.05	13.5	0.05	18.7			
Lithium Total	µg/L		5	181	5	154	0.5	18.2	0.5	25.5			
Magnesium Total	µg/L		50	57300	50	38400	50	8910	50	13900			
Manganese Total	µg/L		1	4310	1	2850	1	731	1	1590			
Mercury Total	µg/L		0.01	0.02	0.01	0.03	0.01	0.05	0.01	0.07			
Molybdenum Total	µg/L		0.1	87.1	0.1	2.7	0.1	16.3	0.1	32.1			
Nickel Total	µg/L		0.5	287	0.5	36.4	0.5	49.2	0.5	131			
Selenium Total	µg/L		0.5	<0.5	0.5	2.3	0.5	<0.5	0.5	<0.5			
Silver Total	µg/L		0.02	0.64	0.02	1.06	0.02	0.02	0.02	0.06			
Sodium Total	µg/L		1000	385000	100	277000	100	7530	100	7720			
Thallium Total	µg/L		0.02	1.29	0.02	1.47	0.02	0.20	0.02	0.14			
Titanium Total	µg/L		1	155	1	144	1	125	1	135			
Uranium Total	µg/L		0.01	48.2	0.01	58.3	0.01	0.59	0.01	0.60			
Vanadium Total	µg/L		1	108	1	28	1	65	1	78			
Zinc Total	µg/L		5	1290	5	586	5	159	5	513			
Total Hardness (calc)	ug CaCO3/L		100	633000	100	428000	100	66700	100	129000			

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V898377

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-10-06

DATE REPORTED: 2014-10-14

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Phenols, Total - 4AAP

DATE RECEIVED: 2014-10-06

DATE REPORTED: 2014-10-14

				HMM-BH05-WS	HMM-BH05-WS	HMM-BH05-WS	HMM-BH05-WS
SAMPLE DESCRIPTION:				11	10	9	8
SAMPLE TYPE:				Water	Water	Water	Water
DATE SAMPLED:				10/4/2014	10/4/2014	10/4/2014	10/3/2014
Parameter	Unit	G / S	RDL	5902959	5902961	5902962	5902963
Phenol, Total	mg/L	0.002	0.006	0.005	0.007	0.006	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



**AGAT** Laboratories

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PROJECT: 0095-150-15-01

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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Phosphorus, Total

DATE RECEIVED: 2014-10-06

DATE REPORTED: 2014-10-14

		HMM-BH05-WS		HMM-BH05-WS		HMM-BH05-WS		HMM-BH05-WS	
SAMPLE DESCRIPTION:		11		10		9		8	
SAMPLE TYPE:		Water		Water		Water		Water	
DATE SAMPLED:		10/4/2014		10/4/2014		10/4/2014		10/3/2014	
Parameter	Unit	G / S	RDL	G / S	RDL	G / S	RDL	G / S	RDL
Phosphorus Total	mg/L	0.1	11.3	0.01	0.73	0.73	0.05	2.44	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



# AGAT Laboratories

## Certificate of Analysis

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PROJECT: 0095-150-15-01

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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### Routine Chemistry Water Analysis

DATE RECEIVED: 2014-10-06

DATE REPORTED: 2014-10-14

		HMM-BH05-WS			HMM-BH05-WS			HMM-BH05-WS			HMM-BH05-WS		
SAMPLE DESCRIPTION:		11			10			9			8		
SAMPLE TYPE:		Water			Water			Water			Water		
DATE SAMPLED:		10/4/2014			10/4/2014			10/4/2014			10/3/2014		
Parameter	Unit	G / S	RDL	5902959	RDL	5902961	5902962	5902962	5902962	5902963	5902963	5902963	5902963
pH	pH units		0.01	8.66	0.01	8.04	7.57	7.95					
p-Alkalinity	mg CaCO3/L		1	7	1	<1	<1	<1					
Alkalinity (pH 4.5)	mg CaCO3/L		1	139	1	51	29	41					
Alkalinity, Bicarbonate	mg CaCO3/L		1	124	1	51	29	41					
Alkalinity, Carbonate	mg CaCO3/L		1	14	1	<1	<1	<1					
Alkalinity, Hydroxide	mg CaCO3/L		1	<1	1	<1	<1	<1					
Electrical Conductivity	uS/cm		1	929	1	362	56	71					
Chloride	mg/L		0.05	24.5	0.05	19.4	2.92	2.29					
Fluoride	mg/L		0.02	0.26	0.02	0.08	0.10	0.10					
Nitrate-N	mg/L		0.005	0.587	0.005	0.310	0.098	0.100					
Nitrite-N	mg/L		0.005	0.014	0.005	<0.005	<0.005	<0.005					
Sulphate	mg/L		5	243	0.5	79.5	1.5	2.4					
Calcium Dissolved	mg/L		0.05	2.79	0.05	0.92	1.93	5.83					
Magnesium Dissolved	mg/L		0.05	0.45	0.05	0.09	0.76	1.29					
Sodium Dissolved	mg/L		0.05	169	0.05	68.9	7.49	7.01					
Potassium Dissolved	mg/L		0.05	5.02	0.05	5.41	2.29	1.50					
Iron Dissolved	mg/L		0.01	0.02	0.01	0.03	0.08	0.03					
Manganese Dissolved	mg/L		0.001	0.017	0.001	0.003	0.012	0.006					
Calculated TDS	mg/L		1	529	1	205	34	45					
Hardness (calc)	mg CaCO3/L		0.5	8.8	0.5	2.7	7.9	19.9					
Nitrate + Nitrite-N	mg/L		0.01	0.60	0.01	0.31	0.10	0.10					

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
5902959-5902963 Literature holding time exceeded for pH analysis.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V898377

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

Turbidity							
DATE RECEIVED: 2014-10-06				DATE REPORTED: 2014-10-14			
		HMM-BH05-WS		HMM-BH05-WS		HMM-BH05-WS	
SAMPLE DESCRIPTION:		11		10		9	
SAMPLE TYPE:		Water		Water		Water	
DATE SAMPLED:		10/4/2014		10/4/2014		10/4/2014	
		10/3/2014					
Parameter	Unit	G / S	RDL	5902959	5902961	5902962	5902963
Turbidity	NTU	1	7470	1230	2670	3040	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V898377

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Trace Organics Analysis

RPT Date: Oct 14, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
BTEX / VPH / EPH Water															
Methyl tert-butyl ether (MTBE)	63260	5911303	<1	<1	0.0%	< 1	107%	80%	120%				105%	70%	130%
Benzene	63260	5911303	<0.5	<0.5	0.0%	< 0.5	99%	80%	120%				102%	70%	130%
Toluene	63260	5911303	0.7	1.0	35.0%	< 0.5	105%	80%	120%				103%	70%	130%
Ethylbenzene	63260	5911303	<0.5	<0.5	0.0%	< 0.5	101%	80%	120%				99%	70%	130%
m&p-Xylene	63260	5911303	<0.5	<0.5	0.0%	< 0.5	91%	80%	120%				90%	70%	130%
o-Xylene	63260	5911303	<0.5	<0.5	0.0%	< 0.5	92%	80%	120%				95%	70%	130%
Styrene	63260	5911303	<0.5	<0.5	0.0%	< 0.5	101%	80%	120%				105%	70%	130%
VPH	63260	5911303	<100	<100	0.0%	< 100									
VH	63260	5911303	<100	<100	0.0%	< 100									
Bromofluorobenzene	63260	5911303	91	89	2.0%		103%	70%	130%				93%	70%	130%
Dibromofluoromethane	63260	5911303	109	110	1.0%		115%	70%	130%				117%	70%	130%
Toluene - d8	63260	5911303	89	96	8.0%		111%	70%	130%				102%	70%	130%
EPH C10-C19	63243	MS	1690	1770	5.0%	< 100	101%	70%	130%				88%	65%	120%
EPH C19-C32	63243	MS	2320	2420	4.0%	< 100	104%	70%	130%				97%	80%	120%

Certified By:





## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V898377

ATTENTION TO: Catherine Schmid

SAMPLED BY:

Water Analysis															
RPT Date: Oct 14, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

### Routine Chemistry Water Analysis

pH	5908096		6.80	6.82	0.3%	< 0.01	100%	95%	105%						
p-Alkalinity	5908096		<1	<1	NA	< 1									
Alkalinity (pH 4.5)	5908096		204	207	1.6%	< 1	96%	90%	110%						
Alkalinity, Bicarbonate	5908096		204	207	1.6%	< 1									
Alkalinity, Carbonate	5908096		<1	<1	NA	< 1									
Alkalinity, Hydroxide	5908096		<1	<1	NA	< 1									
Electrical Conductivity	5908096		367	368	0.3%	< 1	104%	90%	110%						
Chloride	5893571		4.50	4.50	0.0%	< 0.05	104%	85%	115%	99%	90%	110%			
Fluoride	5893571		0.19	0.19	0.2%	< 0.02	98%	85%	115%	94%	90%	110%			
Nitrate-N	5893571		26.8	26.8	0.0%	< 0.005	97%	85%	115%	102%	90%	110%			
Nitrite-N	5893571		0.410	0.404	1.3%	< 0.005				100%	90%	110%			
Sulphate	5893571		213	213	0.0%	< 0.5	102%	85%	115%	104%	90%	110%			
Calcium Dissolved	5907543		53.0	53.5	0.9%	< 0.05	99%	90%	110%	102%	90%	110%			
Magnesium Dissolved	5907543		6.46	6.51	0.8%	< 0.05	101%	90%	110%	103%	90%	110%			
Sodium Dissolved	5907543		27.5	27.0	1.7%	< 0.05	103%	90%	110%	108%	90%	110%			
Potassium Dissolved	5907543		0.53	0.55	4.1%	< 0.05	101%	90%	110%	102%	90%	110%			
Iron Dissolved	5907543		<0.01	<0.01	NA	< 0.01	100%	90%	110%	107%	90%	110%			
Manganese Dissolved	5907543		<0.001	<0.001	NA	< 0.001	103%	90%	110%	104%	90%	110%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### Turbidity

Turbidity	5893583		5.1	5.2	1.9%	< 0.1	93%	85%	115%	92%	85%	115%			
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### Phosphorus, Total

Phosphorus Total	5900354		< 0.005	< 0.005	NA	< 0.005	100%	85%	115%	96%	90%	110%	108%	80%	120%
------------------	---------	--	---------	---------	----	---------	------	-----	------	-----	-----	------	------	-----	------

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### British Columbia CSR- Schedule 6 Total Metals

Aluminum Total	5900428		8	8	NA	< 5	108%	85%	115%	106%	85%	115%			
Antimony Total	5900428		0.09	0.07	NA	< 0.5	111%	85%	115%	98%	90%	110%			
Arsenic Total	5900428		1.1	1.0	9.1%	< 0.1	104%	85%	115%	102%	90%	110%			
Barium Total	5900428		169	171	0.8%	< 0.5	105%	85%	115%	96%	90%	110%			
Beryllium Total	5900428		< 0.05	< 0.05	NA	< 0.05	97%	85%	115%	101%	90%	110%			
Boron Total	5900428		499	504	0.9%	< 5	102%	85%	115%	103%	80%	120%			
Cadmium Total	5900428		< 0.01	< 0.01	NA	< 0.01	97%	85%	115%	102%	90%	110%			
Calcium Total	5900428		65200	64700	0.7%	< 50	102%	85%	115%	98%	90%	110%			
Chromium Total	5900428		0.7	< 0.5	NA	< 0.5	107%	85%	115%	100%	90%	110%			
Cobalt Total	5900428		0.24	0.22	8.7%	< 0.05	112%	85%	115%	100%	90%	110%			



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V898377

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Oct 14, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Copper Total	5900428		0.9	0.5	NA	< 0.5	104%	85%	115%	101%	90%	110%			
Iron Total	5900428		<10	<10	NA	< 10	105%	85%	115%	105%	90%	110%			
Lead Total	5900428		< 0.05	< 0.05	NA	< 0.05	86%	85%	115%	98%	90%	110%			
Lithium Total	5900428		2.7	2.7	0.5%	< 0.5				102%	90%	110%			
Magnesium Total	5900428		20500	20400	0.4%	< 50	104%	85%	115%	101%	90%	110%			
Manganese Total	5900428		4	4	NA	< 1	108%	85%	115%	104%	90%	110%			
Mercury Total	5908378		< 0.01	< 0.01	NA	< 0.01	112%	85%	115%	102%	90%	110%			
Molybdenum Total	5900428		1.5	1.6	2.3%	< 0.1	113%	85%	115%	95%	90%	110%			
Nickel Total	5900428		0.7	0.5	NA	< 0.5	108%	85%	115%	103%	90%	110%			
Selenium Total	5900428		1.0	1.6	NA	< 0.5	95%	85%	115%	103%	85%	115%			
Silver Total	5900428		< 0.02	< 0.02	NA	< 0.02				99%	90%	110%			
Sodium Total	5900428		65700	65700	0.1%	< 100	109%	85%	115%	107%	90%	110%			
Thallium Total	5900428		0.06	0.02	NA	< 0.02	90%	85%	115%	97%	90%	110%			
Titanium Total	5900428		2	2	NA	< 1				101%	90%	110%			
Uranium Total	5900428		0.01	0.01	NA	< 0.01	85%	85%	115%	99%	90%	110%			
Vanadium Total	5900428		< 1	< 1	NA	< 1	101%	85%	115%	99%	90%	110%			
Zinc Total	5900428		< 5	< 5	NA	< 5	99%	85%	115%	98%	80%	120%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Phenols, Total - 4AAP

Phenol, Total	5917671	< 0.002	0.002	NA	< 0.002	101%	85%	115%	99%	90%	110%	101%	70%	130%
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V898377

ATTENTION TO: Catherine Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Methyl tert-butyl ether (MTBE)	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Benzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Toluene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Ethylbenzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
m&p-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
o-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Styrene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VPH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Bromofluorobenzene	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Dibromofluoromethane	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Toluene - d8	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
EPH C10-C19	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID
EPH C19-C32	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID



## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V898377

ATTENTION TO: Catherine Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Aluminum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Antimony Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Arsenic Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Barium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Beryllium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Boron Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cadmium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Calcium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Chromium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cobalt Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Copper Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Iron Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Lead Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Lithium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Magnesium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Manganese Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Mercury Total	MET-181-6103	Modified from EPA 245.7	CV/AA
Molybdenum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Nickel Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Selenium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Silver Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Sodium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Thallium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Titanium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Uranium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Vanadium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Zinc Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Phenol, Total	INOR-181-6014	Modified from SM 5530 C and EPA 420.2	CONTINUOUS FLOW ANALYZER



## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V898377

PROJECT: 0095-150-15-01

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Phosphorus Total	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
pH	INOR-181-6000	Modified from SM 4500-H+	PH METER
p-Alkalinity	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity (pH 4.5)	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Bicarbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Carbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Hydroxide	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Electrical Conductivity	INOR-181-6000	Modified from SM 2510B	PC TITRATE
Chloride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Fluoride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Potassium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Turbidity	INOR-181-6008	SM 2130 B	PC TITRATE



120 - 8600 Glenlyon Parkway  
Burnaby, BC  
V5J 0B6  
**webearth.agatlabs.com**

**P: 778.452.4000 • F: 778.452.4074**

## Report Format

### Requirements (Please Check)

**Invoice To** Same as above Yes ☒ / No ☐

Company: \_\_\_\_\_

Contact: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

PO/A/E#:

☐ IL ☐ PL ☐ CL ☐ RL ☐ LW ☐ IW ☐ LW

LABORATORY USE (LAB ID #)	SAMPLE IDENTIFICATION	SAMPLE MATRIX
------------------------------	-----------------------	------------------

DATE/TIME SAMPLED	COMMENTS - SITE SAMPLE INFO. SAMPLE CONTAINMENT

Notes:

Client Project #:

PLEASE CONTACT LABORATORY IF RUSH REQUIRED SAMPLE  
SUBMISSION CUT OFF FOR EFFECTIVE DATE BY 3 PM

PO/AFE#:

**Invoice To** Same as above Yes ☒ / No ☐

Company: \_\_\_\_\_

Contact: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

PO/A/E#:

☐ IL ☐ PL ☐ CL ☐ RL ☐ LW ☐ IW ☐ LW

DATE/TIME SAMPLED	COMMENTS - SITE SAMPLE INFO. SAMPLE CONTAINMENT

Routine Potable Water	Turbidity	BC CSR Total Metals	BC CSR Dissolved Metals	Total Phosphorus	Total Dissolved Phosphorus	Total Phenols (4AAP)	BTEX/VPH	EPH
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NUMBER OF CONTAINERS	PRESERVED (Y/N)	HAZARDOUS (Y/N)	Hold for: <input type="checkbox"/> 60 DAYS
----------------------	-----------------	-----------------	--

Hold for: ☐ 60 DAYS

**Samples Relinquished By (Print Name and Sign):**

Date/Time

Samples Received By (Print Name and Sign):

Page \_\_\_\_ of \_\_\_\_

V102110







## SAMPLE INTEGRITY RECEIPT FORM - BURNABY

Work Order # 14V898377

### RECEIVING BASICS:

Received From: Scott Waybill #: \_\_\_\_\_

### SAMPLE QUANTITIES:

Coolers: 1 Containers: 46

### TIME SENSITIVE ISSUES:

Earliest Date Sampled: Oct 3/4, 2014 ALREADY EXCEEDED? Yes ☐ No ☒

Nitrate/Nitrite, Turbidity samples expire Oct 6/7, 2014

### NON-CONFORMANCES:

3 temperatures of samples\* and average of each cooler: (record differing temperatures on the CoC next to sample ID's) \*use jars when available

(1) 5 + 5 + 5 = 5 °C (2) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C (3) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C (4) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C

Was ice or ice pack present: ☒ Yes ☐ No

### Integrity issues:

- 1) No analysis listed on the CoC. Samples assigned analyses according
- 2) to the bottle labels, ~~generic~~ vs and project-specific CoC
- 3) prepared for client

Account Project Manager: Jennifer Have they been notified of the above issues: ☒ Yes ☐ No

Whom spoken to: Jennifer Date and Time: Oct 6, 2014 16:20

### ADDITIONAL NOTES:

As per Catherine Schmid, we will not proceed with total dissolved phosphorus or dissolved metals analysis



CLIENT NAME: BGC ENGINEERING INC.  
#500-1045 HOWE STREET  
VANCOUVER, BC V6Z2A9  
(604) 684-5900

ATTENTION TO: Cathy Schmid

PROJECT: 0095 150 15

AGAT WORK ORDER: 14V922126

TRACE ORGANICS REVIEWED BY: Andrew Garrard, B.Sc., General Manager

WATER ANALYSIS REVIEWED BY: Andrew Garrard, B.Sc., General Manager

DATE REPORTED: Dec 02, 2014

PAGES (INCLUDING COVER): 19

VERSION\*: 1

Should you require any information regarding this analysis please contact your client services representative at (778) 452-4000

**\*NOTES**

VERSION 1: Sample receipt temperature 10°C.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### BTEX / VPH / EPH

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		SAMPLE DESCRIPTION:		HMM	HMM	HMM	HMM	HMM
		SAMPLE TYPE:		BH01-WS01	BH01-WS02	BH02-WS01	BH02-WS02	BH02-WS03
		DATE SAMPLED:		Water	Water	Water	Water	Water
				11/25/2014	11/26/2014	11/22/2014	11/23/2014	11/25/2014
Parameter	Unit	G / S	RDL	6129772	6129780	6129786	6129789	6129791
Methyl tert-butyl ether (MTBE)	µg/L		1	<1	<1	<1	<1	<1
Benzene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	µg/L		0.5	<0.5	<0.5	<0.5	16.7	2.5
Ethylbenzene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene	µg/L		0.5	<0.5	<0.5	<0.5	<0.5	<0.5
VPH	µg/L		100	<100	<100	<100	<100	<100
VH	µg/L		100	<100	<100	<100	<100	<100
EPH C10-C19	µg/L		100	140	180	<100	100	<100
EPH C19-C32	µg/L		100	3110	520	130	130	140
Total Xylenes	ug/L		1	<1	<1	<1	<1	<1
Surrogate	Unit	Acceptable Limits						
Bromofluorobenzene	%	70-130		94	100	94	94	96
Dibromofluoromethane	%	70-130		109	111	117	115	114
Toluene - d8	%	70-130		94	98	92	99	103

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
6129772-6129791 VPH results have been corrected for BTEX contributions.

Certified By:



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		SAMPLE DESCRIPTION:		HMM	HMM	HMM	HMM	HMM
		SAMPLE TYPE:		BH01-WS01	BH01-WS02	BH02-WS01	BH02-WS02	BH02-WS03
		DATE SAMPLED:		Water	Water	Water	Water	Water
Parameter	Unit	G / S	RDL	11/25/2014	11/26/2014	11/22/2014	11/23/2014	11/25/2014
				6129772	6129780	6129786	6129789	6129791
Aluminum Dissolved	µg/L	2	16		287	292	179	175
Antimony Dissolved	µg/L	0.5	<0.5		1.3	4.7	1.9	1.8
Arsenic Dissolved	µg/L	0.1	0.9		2.4	3.6	2.9	2.0
Barium Dissolved	µg/L	0.2	17.9		7.8	4.3	5.3	6.8
Beryllium Dissolved	µg/L	0.01	<0.01		0.02	0.02	0.03	0.05
Boron Dissolved	µg/L	2	3		19	43	72	77
Cadmium Dissolved	µg/L	0.01	0.09		0.03	0.10	0.04	0.06
Calcium Dissolved	µg/L	50	4560		8000	4150	8560	11000
Chromium Dissolved	µg/L	0.5	<0.5		<0.5	<0.5	<0.5	<0.5
Cobalt Dissolved	µg/L	0.05	0.06		<0.05	0.10	<0.05	<0.05
Copper Dissolved	µg/L	0.2	5.0		2.2	2.0	2.1	1.8
Iron Dissolved	µg/L	10	24		50	92	25	21
Lead Dissolved	µg/L	0.05	0.24		0.13	0.23	0.14	0.13
Lithium Dissolved	µg/L	0.5	<0.5		4.4	1.0	1.4	1.5
Magnesium Dissolved	µg/L	50	195		816	679	953	1000
Manganese Dissolved	µg/L	1	9		9	7	8	9
Mercury Dissolved	µg/L	0.01	<0.01		<0.01	0.01	0.01	<0.01
Molybdenum Dissolved	µg/L	0.05	0.35		20.0	71.2	21.5	42.8
Nickel Dissolved	µg/L	0.2	0.3		0.2	0.6	0.3	0.2
Selenium Dissolved	µg/L	0.5	<0.5		<0.5	<0.5	<0.5	<0.5
Silver Dissolved	µg/L	0.02	0.05		0.13	0.19	0.17	0.11
Sodium Dissolved	µg/L	50	1960		5990	13600	9780	9940
Thallium Dissolved	µg/L	0.01	0.04		0.04	0.03	0.03	0.04
Titanium Dissolved	µg/L	0.5	<0.5		46.4	55.6	33.9	29.1
Uranium Dissolved	µg/L	0.01	<0.01		0.07	0.06	0.14	0.13
Vanadium Dissolved	µg/L	0.5	<0.5		7.0	3.5	13.9	7.2
Zinc Dissolved	µg/L	2	20		<2	<2	<2	<2
Hardness (calc)	ug CaCO3/L	100	12200		23300	13200	25300	31600

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
6129772-6129791 Sample not filtered at time of collection as per analysis requirements.  
Sample improperly preserved as per analysis requirements.  
Sample container inappropriate as per analysis requirements for Dissolved Mercury.

Certified By:



# AGAT Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

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CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		HMM			HMM			HMM			HMM		
		SAMPLE DESCRIPTION: BH01-WS01			BH01-WS02			BH02-WS01			BH02-WS02		
		SAMPLE TYPE: Water			Water			Water			Water		
		DATE SAMPLED: 11/25/2014			11/26/2014			11/22/2014			11/23/2014		
Parameter	Unit	G / S	RDL										
			6129772	RDL		6129780	RDL		6129786	RDL		6129789	
Aluminum Total	µg/L		5	88	500	180000	500	139000	500	667000			
Antimony Total	µg/L		0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5			
Arsenic Total	µg/L		0.1	0.7	0.1	20.2	0.1	19.7	0.1	84.7			
Barium Total	µg/L		0.5	17.0	0.5	1190	0.5	590	5	7820			
Beryllium Total	µg/L		0.05	<0.05	0.05	2.90	0.05	1.92	0.05	10.5			
Boron Total	µg/L		5	<5	5	65	5	32	5	154			
Cadmium Total	µg/L		0.01	0.09	0.01	0.78	0.01	0.52	0.01	2.33			
Calcium Total	µg/L		50	4540	50	78100	50	53400	50	287000			
Chromium Total	µg/L		0.5	<0.5	0.5	259	0.5	394	0.5	960			
Cobalt Total	µg/L		0.05	0.11	0.05	96.9	0.05	114	0.05	460			
Copper Total	µg/L		0.5	12.4	0.5	808	5	1790	5	6430			
Iron Total	µg/L		10	162	100	280000	100	274000	1000	1190000			
Lead Total	µg/L		0.05	0.75	0.05	48.7	0.05	45.9	0.05	218			
Lithium Total	µg/L		0.5	<0.5	5	104	0.5	73.3	5	378			
Magnesium Total	µg/L		50	209	500	96500	50	86700	500	358000			
Manganese Total	µg/L		1	13	1	4440	1	3760	10	17500			
Mercury Total	µg/L		0.01	<0.01	0.01	0.06	0.01	0.05	0.01	0.03			
Molybdenum Total	µg/L		0.1	0.4	0.1	44.4	0.1	83.5	1	125			
Nickel Total	µg/L		0.5	0.5	0.5	110	0.5	325	5	1150			
Selenium Total	µg/L		0.5	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5			
Silver Total	µg/L		0.02	0.03	0.02	4.68	0.2	559	0.2	592			
Sodium Total	µg/L		100	1990	100	18700	100	14400	100	38600			
Thallium Total	µg/L		0.02	<0.02	0.02	0.76	0.02	0.51	0.02	3.58			
Titanium Total	µg/L		1	2	10	3390	10	3310	10	4430			
Uranium Total	µg/L		0.01	0.02	0.01	3.92	0.01	3.44	0.01	14.6			
Vanadium Total	µg/L		1	<1	1	444	1	357	10	1710			
Zinc Total	µg/L		5	24	5	752	5	619	5	1740			
Total Hardness (calc)	ug CaCO3/L		100	12200	100	592000	100	490000	100	2190000			

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		HMM		
		SAMPLE DESCRIPTION: BH02-WS03		
		SAMPLE TYPE: Water		
		DATE SAMPLED: 11/25/2014		
Parameter	Unit	G / S	RDL	
Aluminum Total	µg/L		500	614000
Antimony Total	µg/L		0.5	<0.5
Arsenic Total	µg/L		0.1	34.4
Barium Total	µg/L		5	4250
Beryllium Total	µg/L		0.05	9.80
Boron Total	µg/L		5	153
Cadmium Total	µg/L		0.01	1.75
Calcium Total	µg/L		500	294000
Chromium Total	µg/L		0.5	472
Cobalt Total	µg/L		0.05	339
Copper Total	µg/L		5	3360
Iron Total	µg/L		1000	1020000
Lead Total	µg/L		0.05	191
Lithium Total	µg/L		5	314
Magnesium Total	µg/L		500	291000
Manganese Total	µg/L		10	15400
Mercury Total	µg/L		0.01	<0.01
Molybdenum Total	µg/L		0.1	28.9
Nickel Total	µg/L		0.5	627
Selenium Total	µg/L		0.5	<0.5
Silver Total	µg/L		0.2	410
Sodium Total	µg/L		100	26600
Thallium Total	µg/L		0.02	2.24
Titanium Total	µg/L		10	3680
Uranium Total	µg/L		0.01	12.5
Vanadium Total	µg/L		10	1670
Zinc Total	µg/L		5	1330
Total Hardness (calc)	ug CaCO3/L		100	1930000

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## Certificate of Analysis

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CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

6129772-6129791 Some total metal results are less than the dissolved metal results; results are within the precision of the method.

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## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Phenols, Total - 4AAP

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		HMM		HMM		HMM		HMM	
SAMPLE DESCRIPTION:		BH01-WS01		BH01-WS02		BH02-WS01		BH02-WS02	
SAMPLE TYPE:		Water		Water		Water		Water	
DATE SAMPLED:		11/25/2014		11/26/2014		11/22/2014		11/23/2014	
Parameter	Unit	G / S	RDL	6129772	6129780	6129786	6129789	6129791	
Phenol, Total	mg/L	0.002	< 0.002	0.002	< 0.002	0.002	0.002	0.004	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:





**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Phosphorus

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		HMM		HMM		HMM		HMM		HMM	
SAMPLE DESCRIPTION:		BH01-WS01		BH01-WS02		BH02-WS01		BH02-WS02		BH02-WS03	
SAMPLE TYPE:		Water		Water		Water		Water		Water	
DATE SAMPLED:		11/25/2014		11/26/2014		11/22/2014		11/23/2014		11/25/2014	
Parameter	Unit	G / S	RDL	6129772		6129780		6129786		6129789	
Phosphorus Dissolved	mg/L		0.005	0.013		0.112		0.072		0.013	
Phosphorus Total	mg/L		0.005	0.013		3.42		2.59		8.69	
										0.05	
										13.7	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

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CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

### Routine Chemistry Water Analysis

DATE RECEIVED: 2014-11-27

DATE REPORTED: 2014-12-02

		HMM		HMM		HMM		HMM		HMM	
SAMPLE DESCRIPTION:		BH01-WS01		BH01-WS02		BH02-WS01		BH02-WS02		BH02-WS03	
SAMPLE TYPE:		Water		Water		Water		Water		Water	
DATE SAMPLED:		11/25/2014		11/26/2014		11/22/2014		11/23/2014		11/25/2014	
Parameter	Unit	G / S	RDL	6129772	6129780	6129786	6129789	6129789	6129791	6129791	6129791
pH	pH units		0.01	7.06	8.66	8.49	8.68	8.68	8.68	8.68	8.68
p-Alkalinity	mg CaCO <sub>3</sub> /L		1	<1	3	2	3	3	3	3	3
Alkalinity (pH 4.5)	mg CaCO <sub>3</sub> /L		1	12	71	65	119	119	115	115	115
Alkalinity, Bicarbonate	mg CaCO <sub>3</sub> /L		1	12	65	61	112	112	108	108	108
Alkalinity, Carbonate	mg CaCO <sub>3</sub> /L		1	<1	6	4	7	7	7	7	7
Alkalinity, Hydroxide	mg CaCO <sub>3</sub> /L		1	<1	<1	<1	<1	<1	<1	<1	<1
Electrical Conductivity	uS/cm		1	38	81	89	100	100	108	108	108
Chloride	mg/L		0.05	3.14	3.31	5.26	4.62	4.62	4.95	4.95	4.95
Fluoride	mg/L		0.02	0.04	0.09	0.20	0.17	0.17	0.18	0.18	0.18
Nitrate-N	mg/L		0.005	0.133	0.087	0.070	0.111	0.111	0.406	0.406	0.406
Nitrite-N	mg/L		0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.010	0.010	0.010
Sulphate	mg/L		0.5	1.7	1.9	3.3	2.0	2.0	3.3	3.3	3.3
Calcium Dissolved	mg/L		0.05	4.56	8.00	4.15	8.56	8.56	11.0	11.0	11.0
Magnesium Dissolved	mg/L		0.05	0.20	0.82	0.68	0.95	0.95	1.00	1.00	1.00
Sodium Dissolved	mg/L		0.05	1.96	5.99	13.6	9.78	9.78	9.94	9.94	9.94
Potassium Dissolved	mg/L		0.05	0.25	4.35	2.60	3.51	3.51	3.76	3.76	3.76
Iron Dissolved	mg/L		0.01	0.02	0.05	0.09	0.03	0.03	0.02	0.02	0.02
Manganese Dissolved	mg/L		0.001	0.009	0.009	0.007	0.008	0.008	0.009	0.009	0.009
Calculated TDS	mg/L		1	19	67	69	101	101	104	104	104
Hardness (calc)	mg CaCO <sub>3</sub> /L		0.5	12.2	23.4	13.2	25.3	25.3	31.6	31.6	31.6
Nitrate + Nitrite-N	mg/L		0.01	0.13	0.09	0.07	0.11	0.11	0.42	0.42	0.42

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
 6129772-6129780 Literature holding time exceeded for pH analysis.  
 6129786-6129789 Literature holding time exceeded for pH, Nitrate, Nitrite analysis.  
 6129791 Literature holding time exceeded for pH analysis.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
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TEL (778)452-4000  
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<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Cathy Schmid

SAMPLED BY:

Turbidity									
DATE RECEIVED: 2014-11-27					DATE REPORTED: 2014-12-02				
				HMM	HMM	HMM	HMM	HMM	
		SAMPLE DESCRIPTION:		BH01-WS01	BH01-WS02	BH02-WS01	BH02-WS02	BH02-WS03	
		SAMPLE TYPE:		Water	Water	Water	Water	Water	
		DATE SAMPLED:		11/25/2014	11/26/2014	11/22/2014	11/23/2014	11/25/2014	
Parameter	Unit	G / S	RDL	6129772	6129780	6129786	6129789	6129791	
Turbidity	NTU		0.5	2.2	9600	27000	21000	50000	

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Trace Organics Analysis

RPT Date: Dec 02, 2014

RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
BTEX / VPH / EPH															
Methyl tert-butyl ether (MTBE)	63450	6128010	<1	<1	0.0%	< 1	98%	80%	120%				101%	70%	130%
Benzene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	101%	80%	120%				101%	70%	130%
Toluene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	91%	80%	120%				115%	70%	130%
Ethylbenzene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	97%	80%	120%				105%	70%	130%
m&p-Xylene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	88%	80%	120%				99%	70%	130%
o-Xylene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	97%	80%	120%				101%	70%	130%
Styrene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	99%	80%	120%				101%	70%	130%
VPH	63450	6128010	<100	<100	0.0%	< 100									
VH	63450	6128010	<100	<100	0.0%	< 100									
Bromofluorobenzene	63450	6128010	96	93	3.0%		99%	70%	130%				102%	70%	130%
Dibromofluoromethane	63450	6128010	106	109	3.0%		106%	70%	130%				90%	70%	130%
Toluene - d8	63450	6128010	102	102	0.0%		85%	70%	130%				96%	70%	130%
EPH C10-C19	63455	MS	2080	2020	3.0%	< 100	101%	70%	130%				103%	65%	120%
EPH C19-C32	63455	MS	2480	2400	3.3%	< 100	102%	70%	130%				111%	80%	120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

Water Analysis															
RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

### Routine Chemistry Water Analysis

pH	6067409		4.32	4.21	2.6%	< 0.01	99%	95%	105%						
Alkalinity (pH 4.5)	6067409		<1	<1	NA	< 1	96%	90%	110%						
Electrical Conductivity	6067409		19	19	1.9%	< 1	101%	90%	110%						
Chloride	6129959		2.08	2.07	0.4%	< 0.05	100%	85%	115%	96%	90%	110%			
Fluoride	6129959		0.03	0.03	NA	< 0.02	101%	85%	115%	99%	90%	110%			
Nitrate-N	6129959		0.201	0.200	0.7%	< 0.005	94%	85%	115%	99%	90%	110%			
Nitrite-N	6129959		<0.005	<0.005	NA	< 0.005				102%	90%	110%			
Sulphate	6129959		4.0	4.1	1.3%	< 0.5	99%	85%	115%	100%	90%	110%			
Calcium Dissolved	6133080		207	249	18.4%	< 0.05	102%	90%	110%	100%	90%	110%			
Magnesium Dissolved	6133080		90.7	105	14.6%	< 0.05	100%	90%	110%	99%	90%	110%			
Sodium Dissolved	6133080		7.06	7.99	12.4%	< 0.05	104%	90%	110%	91%	90%	110%			
Potassium Dissolved	6133080		4.37	5.35	20.0%	< 0.05	101%	90%	110%	108%	90%	110%			
Iron Dissolved	6133080		0.02	0.02	NA	< 0.01	100%	90%	110%	100%	90%	110%			
Manganese Dissolved	6133080		0.544	0.616	12.3%	< 0.001	103%	90%	110%	94%	90%	110%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### British Columbia CSR- Schedule 6 Dissolved Metals

Aluminum Dissolved	6133080		10	10	5.9%	< 2	100%	90%	110%	107%	85%	115%			
Antimony Dissolved	6133080		2.4	2.2	8.3%	< 0.2	107%	90%	110%	104%	85%	110%			
Arsenic Dissolved	6133080		1.0	1.0	1.0%	< 0.1	99%	90%	110%	93%	90%	110%			
Barium Dissolved	6133080		194	227	15.8%	< 0.2	109%	90%	110%	104%	90%	110%			
Beryllium Dissolved	6133080		0.03	0.04	NA	< 0.01	100%	90%	110%	98%	90%	110%			
Boron Dissolved	6133080		21	22	5.6%	< 2	99%	90%	110%	101%	80%	120%			
Cadmium Dissolved	6133080		0.19	0.18	7.6%	< 0.01	103%	90%	110%	102%	90%	110%			
Calcium Dissolved	6133080		207000	249000	18.4%	< 50	102%	90%	110%	100%	90%	110%			
Chromium Dissolved	6133080		<0.5	<0.5	NA	< 0.5	106%	90%	110%	96%	90%	110%			
Cobalt Dissolved	6133080		9.02	10.4	14.6%	< 0.05	104%	90%	110%	101%	90%	110%			
Copper Dissolved	6133080		1.3	1.4	6.5%	< 0.2	103%	90%	110%	95%	90%	110%			
Iron Dissolved	6133080		17	19	NA	< 10	100%	90%	110%	100%	90%	110%			
Lead Dissolved	6133080		0.17	<0.05	NA	< 0.05	102%	90%	110%	102%	90%	110%			
Lithium Dissolved	6133080		25.5	29.6	15.0%	< 0.5				102%	90%	110%			
Magnesium Dissolved	6133080		90700	105000	14.6%	< 50	100%	90%	110%	99%	90%	110%			
Manganese Dissolved	6133080		544	616	12.3%	< 1	103%	90%	110%	94%	90%	110%			
Mercury Dissolved	6134576		< 0.01	< 0.01	NA	< 0.01	100%	90%	110%	109%	90%	110%			
Molybdenum Dissolved	6133080		26.6	26.8	0.6%	< 0.05	104%	90%	110%	107%	90%	110%			
Nickel Dissolved	6133080		66.0	79.9	19.0%	< 0.2	103%	90%	110%	95%	90%	110%			
Selenium Dissolved	6133080		91.3	76.0	18.2%	< 0.5	100%	90%	110%	115%	85%	115%			
Silver Dissolved	6133080		0.07	0.06	NA	< 0.02				97%	90%	110%			
Sodium Dissolved	6133080		7060	7990	12.4%	< 50	104%	90%	110%	91%	90%	110%			

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Titanium Dissolved	6133080		<0.5	0.5	NA	< 0.5				103%	90%	110%			
Uranium Dissolved	6133080		14.4	14.9	3.3%	< 0.01	107%	90%	110%	105%	90%	110%			
Vanadium Dissolved	6133080		<0.5	<0.5	NA	< 0.5	102%	90%	110%	95%	90%	110%			
Zinc Dissolved	6133080		8	7	NA	< 2	103%	90%	110%	94%	85%	115%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### British Columbia CSR- Schedule 6 Total Metals

Aluminum Total	6134675		621	588	5.5%	< 5	97%	85%	115%	99%	85%	115%			
Antimony Total	6134675		1.4	1.4	NA	< 0.5	114%	85%	115%	97%	90%	110%			
Arsenic Total	6134675		0.6	0.6	8.2%	< 0.1	107%	85%	115%	101%	90%	110%			
Barium Total	6134675		1.7	1.7	NA	< 0.5	103%	85%	115%	100%	90%	110%			
Beryllium Total	6134675		0.08	0.08	NA	< 0.05	104%	85%	115%	94%	90%	110%			
Boron Total	6134675		1110	1190	7.0%	< 5	94%	85%	115%	93%	80%	120%			
Cadmium Total	6134675		0.10	0.10	0.3%	< 0.01	100%	85%	115%	96%	90%	110%			
Calcium Total	6134675		24900	25100	1.0%	< 50	104%	85%	115%	99%	90%	110%			
Chromium Total	6134675		<0.5	<0.5	NA	< 0.5	101%	85%	115%	94%	90%	110%			
Cobalt Total	6134675		0.11	0.09	NA	< 0.05	110%	85%	115%	97%	90%	110%			
Copper Total	6134675		2.8	2.5	10.8%	< 0.5	101%	85%	115%	99%	90%	110%			
Iron Total	6134675		287	267	7.3%	< 10	102%	85%	115%	104%	90%	110%			
Lead Total	6134675		0.10	0.09	NA	< 0.05	98%	85%	115%	99%	90%	110%			
Lithium Total	6134675		776	858	10.0%	< 0.5				104%	90%	110%			
Magnesium Total	6134675		2770	2760	0.3%	< 50	102%	85%	115%	100%	90%	110%			
Manganese Total	6134675		203	202	0.6%	< 1	105%	85%	115%	101%	90%	110%			
Mercury Total	6134576		< 0.01	< 0.01	0.0%	< 0.01	101%	85%	115%	109%	90%	110%			
Molybdenum Total	6134675		24.6	23.3	5.3%	< 0.1	107%	85%	115%	97%	90%	110%			
Nickel Total	6134675		<0.5	<0.5	NA	< 0.5	106%	85%	115%	103%	90%	110%			
Selenium Total	6134675		1.2	0.8	NA	< 0.5	96%	85%	115%	98%	85%	115%			
Silver Total	6134675		0.04	0.02	NA	< 0.02				97%	90%	110%			
Sodium Total	6134675		199000	194000	2.4%	< 100	105%	85%	115%	106%	90%	110%			
Thallium Total	6134675		0.05	0.03	NA	< 0.02	110%	85%	115%	100%	90%	110%			
Titanium Total	6134675		6	6	10.0%	< 1				97%	90%	110%			
Uranium Total	6134675		0.25	0.24	4.3%	< 0.01	100%	85%	115%	96%	90%	110%			
Vanadium Total	6134675		<1	<1	NA	< 1	95%	85%	115%	99%	90%	110%			
Zinc Total	6134675		8	7	NA	< 5	92%	85%	115%	99%	80%	120%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### Phosphorus

Phosphorus Dissolved	6131116		< 0.005	< 0.005	0.0%	< 0.005	99%	85%	115%	95%	90%	110%	107%	80%	120%
Phosphorus Total	6131116		< 0.005	< 0.005	0.0%	< 0.005	87%	85%	115%	90%	90%	110%	115%	80%	120%



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Phenols, Total - 4AAP

Phenol, Total	6127914	< 0.002	< 0.002	NA	< 0.002	102%	85%	115%	97%	90%	110%	105%	70%	130%
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Turbidity

Turbidity	6131213	5.2	5.4	3.8%	< 0.5	101%	85%	115%	101%	90%	110%
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Methyl tert-butyl ether (MTBE)	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Benzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Toluene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Ethylbenzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
m&p-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
o-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Styrene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VPH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Bromofluorobenzene	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Dibromofluoromethane	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Toluene - d8	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
EPH C10-C19	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID
EPH C19-C32	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID



## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Aluminum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Antimony Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Arsenic Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Barium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Beryllium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Boron Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cadmium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Chromium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cobalt Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Copper Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Lead Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Lithium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Mercury Dissolved	MET-181-6103, LAB-181-4015	Modified from EPA 245.7	CV/AA
Molybdenum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Nickel Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Selenium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Silver Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Thallium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Titanium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Uranium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Vanadium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Zinc Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095 150 15

SAMPLING SITE:

AGAT WORK ORDER: 14V922126

ATTENTION TO: Cathy Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Aluminum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Antimony Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Arsenic Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Barium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Beryllium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Boron Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cadmium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Calcium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Chromium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cobalt Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Copper Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Iron Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Lead Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Lithium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Magnesium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Manganese Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Mercury Total	MET-181-6103	Modified from EPA 245.7	CV/AA
Molybdenum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Nickel Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Selenium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Silver Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Sodium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Thallium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Titanium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Uranium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Vanadium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Zinc Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Phenol, Total	INOR-181-6014	Modified from SM 5530 C and EPA 420.2	CONTINUOUS FLOW ANALYZER
Phosphorus Dissolved	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER



## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V922126

PROJECT: 0095 150 15

ATTENTION TO: Cathy Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Phosphorus Total	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
pH	INOR-181-6000	Modified from SM 4500-H+	PH METER
p-Alkalinity	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity (pH 4.5)	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Bicarbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Carbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Hydroxide	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Electrical Conductivity	INOR-181-6000	Modified from SM 2510B	PC TITRATE
Chloride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Fluoride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Potassium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Turbidity	INOR-181-6008	SM 2130 B	PC TITRATE



# Laboratories

120 - 8600 Glenlyon Parkway  
Burnaby, BC V5J 0B6  
778.452.4006  
**webearth.agatlabs.com**

## Laboratory Use Only

Arrival Temperature: 10°C

AGAT Job Number: 14 VGS2126

## Chain of Custody Record

## Report Information

Company: BGC Engineering  
Contact: Catny Schmid.  
Address: Kamloops BC  
Phone: 250 374 8100 Fax: 250 374 8100  
LSD: 0095 150 15  
Client Project #: 0095 150 15

**Invoice To**

Same as above Yes ☒ No ☐

Company: \_\_\_\_\_

Contact: \_\_\_\_\_

Address: \_\_\_\_\_

Phone: \_\_\_\_\_

Fax: \_\_\_\_\_

PO/A/E# : \_\_\_\_\_

## Report Information

1. Name: Cathy Schmid  
Email: cschmid@brycngreening.ca

2. Name: Anne Clayton  
Email: aclayton@brycngreening.ca

### Requirements (Please Check)

☐ BC CSR Soil

☐ AL

☐ IL

☐ PL

☐ CL

☐ RL

☐ BC CSR - Water

☐ DW

☐ AW

☐ IW

☐ LW

Schedule 11 (Please Specify)

CCME (Please Specify)

Other (Please Specify)

## Report Information

☐ Single Samples per page

☐ Multiple Samples per page

☐ Excel Format Included

## Turnaround Time Required (TAT)

**Regular TAT** ☐ 5 to 7 working days

**Rush TAT** ☐ Day 2 - 100%  
☐ Day 3 - 50%  
☐ Day 4 - 25%

Date Required:

PLEASE CONTACT LABORATORY IF RUSH REQUIRED SAMPLE  
SUBMISSION CUT OFF FOR EFFECTIVE DATE BY 3 PM

## Invoice To

Same as above Yes ☒ / No ☐

Company:



Contact:

Address:

Phone:

PO/AFE#:

LABORATORY USE (LAB ID #)	SAMPLE IDENTIFICATION	SAMPLE MATRIX	DATE/TIME SAMPLED	COMMENTS - SITE SAMPLE INFO. SAMPLE CONTAINMENT
6129772	HMMBH01 W501		Nov 25 5am	
80	" W502		Nov 26 1am	
86	HMMBH02 W51		Nov 22 8am	
89	" 2		Nov 25 12:00pm	Nov 23 3p
91	" 3		Nov 25 12:00pm	

Samples Acquired By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):
	Nov 27	
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):
		

Date/Time

Date/Time

Date/Time:

Page of

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010290

Document #: DIV-198-1501.002

Data Received: October 24, 2012





# AGAT Laboratories

## SAMPLE INTEGRITY RECEIPT FORM - BURNABY

Work Order # 14V 922126

### RECEIVING BASICS:

Received From: Ann

Waybill #: \_\_\_\_\_

### SAMPLE QUANTITIES:

Coolers: 12 Containers: 60 2 bags on side

### TIME SENSITIVE ISSUES:

Earliest Date Sampled: 22 Nov 14'

ALREADY EXCEEDED? ☒ Yes ☐ No

HMMRM02 WS1/WS2 nitrate/nitrite expired 25/26 Nov 14'

### NON-CONFORMANCES:

3 temperatures of samples\* and average of each cooler: (record differing temperatures on the CoC next to sample ID's) \*use jars when available

(1) 9 + 8 + 8 = 8°C (2) 10 + 11 + 11 = 11°C (3)    +   +   =   °C (4)    +   +   =   °C

Was ice or ice pack present: ☒ Yes ☒ No

### Integrity Issues:

Analyses cannot be ran from the dissolved  
metal/Hg bottles due to preservation before filtration,  
we will subsample from the 1L bottles and have  
samples filtered/preserved.

Account Project Manager: \_\_\_\_\_ have they been notified of the above issues: Yes ☒ No

Whom spoken to: \_\_\_\_\_ Date and Time: \_\_\_\_\_

### ADDITIONAL NOTES:

CLIENT NAME: BGC ENGINEERING INC.  
#500-1045 HOWE STREET  
VANCOUVER, BC V6Z2A9  
(604) 684-5900

ATTENTION TO: Catherine Schmid

PROJECT: 0095-150-15-01

AGAT WORK ORDER: 14V922453

TRACE ORGANICS REVIEWED BY: Andrew Garrard, B.Sc., General Manager

WATER ANALYSIS REVIEWED BY: Andrew Garrard, B.Sc., General Manager

DATE REPORTED: Dec 02, 2014

PAGES (INCLUDING COVER): 18

VERSION\*: 1

Should you require any information regarding this analysis please contact your client services representative at (778) 452-4000

**\*NOTES**

VERSION 1: Sample receipt temperature 6°C.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### BTEX / VPH / EPH Water

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS				
SAMPLE DESCRIPTION: 03				
SAMPLE TYPE: Water				
DATE SAMPLED: 11/27/2014				
Parameter	Unit	G / S	RDL	6133096
Methyl tert-butyl ether (MTBE)	µg/L		1	1
Benzene	µg/L		0.5	<0.5
Toluene	µg/L		0.5	3.5
Ethylbenzene	µg/L		0.5	<0.5
m&p-Xylene	µg/L		0.5	2.2
o-Xylene	µg/L		0.5	0.7
Styrene	µg/L		0.5	1.2
VPH	µg/L		100	<100
VH	µg/L		100	<100
EPH C10-C19	µg/L		100	1240
EPH C19-C32	µg/L		100	800
Total Xylenes	ug/L		1	3
Surrogate	Unit	Acceptable Limits		
Bromofluorobenzene	%	70-130		116
Dibromofluoromethane	%	70-130		107
Toluene - d8	%	70-130		102

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
6133096 VPH results have been corrected for BTEX contributions.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS				
SAMPLE DESCRIPTION: 03				
SAMPLE TYPE: Water				
DATE SAMPLED: 11/27/2014				
Parameter	Unit	G / S	RDL	6133096
Aluminum Dissolved	µg/L		2	335
Antimony Dissolved	µg/L		0.5	2.0
Arsenic Dissolved	µg/L		0.1	0.8
Barium Dissolved	µg/L		0.2	8.3
Beryllium Dissolved	µg/L		0.01	0.02
Boron Dissolved	µg/L		2	105
Cadmium Dissolved	µg/L		0.01	0.11
Calcium Dissolved	µg/L		50	8120
Chromium Dissolved	µg/L		0.5	0.5
Cobalt Dissolved	µg/L		0.05	<0.05
Copper Dissolved	µg/L		0.2	3.5
Iron Dissolved	µg/L		10	108
Lead Dissolved	µg/L		0.05	0.10
Lithium Dissolved	µg/L		0.5	3.3
Magnesium Dissolved	µg/L		50	1220
Manganese Dissolved	µg/L		1	24
Mercury Dissolved	µg/L		0.01	<0.01
Molybdenum Dissolved	µg/L		0.05	96.8
Nickel Dissolved	µg/L		0.2	0.6
Selenium Dissolved	µg/L		0.5	2.7
Silver Dissolved	µg/L		0.02	0.05
Sodium Dissolved	µg/L		50	18900
Thallium Dissolved	µg/L		0.01	0.04
Titanium Dissolved	µg/L		0.5	21.5
Uranium Dissolved	µg/L		0.01	0.05
Vanadium Dissolved	µg/L		0.5	1.4
Zinc Dissolved	µg/L		2	3
Hardness (calc)	ug CaCO3/L		100	25300

Certified By:





**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

Unit 120, 8600 Glenlyon Parkway  
Burnaby, British Columbia  
CANADA V5J 0B6  
TEL (778)452-4000  
FAX (778)452-4074  
<http://www.agatlabs.com>

CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

British Columbia CSR- Schedule 6 Dissolved Metals

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
6133096 Sample container inappropriate as per analysis requirements for Dissolved Mercury.  
Sample not filtered at time of collection as per analysis requirements.  
Sample improperly preserved as per analysis requirements.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

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CLIENT NAME: BGC ENGINEERING INC.

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

### British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS				
SAMPLE DESCRIPTION: 03				
SAMPLE TYPE: Water				
DATE SAMPLED: 11/27/2014				
Parameter	Unit	G / S	RDL	6133096
Aluminum Total	µg/L		500	38600
Antimony Total	µg/L		0.5	0.7
Arsenic Total	µg/L		0.1	2.8
Barium Total	µg/L		0.5	422
Beryllium Total	µg/L		0.05	0.84
Boron Total	µg/L		5	107
Cadmium Total	µg/L		0.01	0.10
Calcium Total	µg/L		50	23900
Chromium Total	µg/L		0.5	31.6
Cobalt Total	µg/L		0.05	9.50
Copper Total	µg/L		0.5	111
Iron Total	µg/L		10	41900
Lead Total	µg/L		0.05	9.36
Lithium Total	µg/L		0.5	15.8
Magnesium Total	µg/L		50	13300
Manganese Total	µg/L		1	724
Mercury Total	µg/L		0.01	<0.01
Molybdenum Total	µg/L		0.1	84.5
Nickel Total	µg/L		0.5	16.8
Selenium Total	µg/L		0.5	4.5
Silver Total	µg/L		0.02	1.76
Sodium Total	µg/L		100	25000
Thallium Total	µg/L		0.02	0.13
Titanium Total	µg/L		1	494
Uranium Total	µg/L		0.01	0.69
Vanadium Total	µg/L		1	88
Zinc Total	µg/L		5	94
Total Hardness (calc)	ug CaCO3/L		100	114000

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## Certificate of Analysis

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

British Columbia CSR- Schedule 6 Total Metals

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
6133096 Some total metal results are less than the dissolved metal results; results are within the precision of the method.

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**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Phenols, Total - 4AAP

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS

SAMPLE DESCRIPTION: 03

SAMPLE TYPE: Water

DATE SAMPLED: 11/27/2014

Parameter	Unit	G / S	RDL	6133096
Phenol, Total	mg/L	0.002	0.006	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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## Certificate of Analysis

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Phosphorus

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS

SAMPLE DESCRIPTION: 03

SAMPLE TYPE: Water

DATE SAMPLED: 11/27/2014

Parameter	Unit	G / S	RDL	6133096
Phosphorus Dissolved	mg/L		0.005	0.016
Phosphorus Total	mg/L		0.005	0.360

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Routine Chemistry Water Analysis

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS				
SAMPLE DESCRIPTION: 03				
SAMPLE TYPE: Water				
DATE SAMPLED: 11/27/2014				
Parameter	Unit	G / S	RDL	6133096
pH	pH units		0.01	7.45
p-Alkalinity	mg CaCO3/L		1	<1
Alkalinity (pH 4.5)	mg CaCO3/L		1	69
Alkalinity, Bicarbonate	mg CaCO3/L		1	69
Alkalinity, Carbonate	mg CaCO3/L		1	<1
Alkalinity, Hydroxide	mg CaCO3/L		1	<1
Electrical Conductivity	uS/cm		1	158
Chloride	mg/L		0.05	6.66
Fluoride	mg/L		0.02	0.18
Nitrate-N	mg/L		0.005	0.548
Nitrite-N	mg/L		0.005	0.006
Sulphate	mg/L		0.5	7.1
Calcium Dissolved	mg/L		0.05	8.12
Magnesium Dissolved	mg/L		0.05	1.22
Sodium Dissolved	mg/L		0.05	18.9
Potassium Dissolved	mg/L		0.05	6.43
Iron Dissolved	mg/L		0.01	0.11
Manganese Dissolved	mg/L		0.001	0.024
Calculated TDS	mg/L		1	91
Hardness (calc)	mg CaCO3/L		0.5	25.3
Nitrate + Nitrite-N	mg/L		0.01	0.55

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard  
6133096 Literature holding time exceeded for pH analysis.

Certified By:



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

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CLIENT NAME: BGC ENGINEERING INC.

SAMPLING SITE:

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Turbidity

DATE RECEIVED: 2014-11-28

DATE REPORTED: 2014-12-02

HMM-BH-01,WS

SAMPLE DESCRIPTION: 03

SAMPLE TYPE: Water

DATE SAMPLED: 11/27/2014

Parameter	Unit	G / S	RDL	6133096
Turbidity	NTU	0.5	960	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Trace Organics Analysis

RPT Date: Dec 02, 2014

RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
BTEX / VPH / EPH Water															
Methyl tert-butyl ether (MTBE)	63450	6128010	<1	<1	0.0%	< 1	98%	80%	120%				101%	70%	130%
Benzene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	101%	80%	120%				101%	70%	130%
Toluene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	91%	80%	120%				115%	70%	130%
Ethylbenzene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	97%	80%	120%				105%	70%	130%
m&p-Xylene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	88%	80%	120%				99%	70%	130%
o-Xylene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	97%	80%	120%				101%	70%	130%
Styrene	63450	6128010	<0.5	<0.5	0.0%	< 0.5	99%	80%	120%				101%	70%	130%
VPH	63450	6128010	<100	<100	0.0%	< 100									
VH	63450	6128010	<100	<100	0.0%	< 100									
Bromofluorobenzene	63450	6128010	96	93	3.0%		99%	70%	130%				102%	70%	130%
Dibromofluoromethane	63450	6128010	106	109	3.0%		106%	70%	130%				90%	70%	130%
Toluene - d8	63450	6128010	102	102	0.0%		85%	70%	130%				96%	70%	130%
EPH C10-C19	63455	MS	2080	2020	3.0%	< 100	101%	70%	130%				103%	65%	120%
EPH C19-C32	63455	MS	2480	2400	3.3%	< 100	102%	70%	130%				111%	80%	120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:





## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

Water Analysis															
RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

### Routine Chemistry Water Analysis

pH	6129959		4.79	5.30	10.1%	< 0.01	99%	95%	105%						
p-Alkalinity	6129959		<1	<1	NA	< 1									
Alkalinity (pH 4.5)	6129959		7.85	7.72	1.7%	< 1	93%	90%	110%						
Alkalinity, Bicarbonate	6129959		<1	2	NA	< 1									
Alkalinity, Carbonate	6129959		<1	<1	NA	< 1									
Alkalinity, Hydroxide	6129959		<1	<1	NA	< 1									
Electrical Conductivity	6129959		190	190	0.0%	< 1	102%	90%	110%						
Chloride	6129959		2.08	2.07	0.4%	< 0.05	100%	85%	115%	96%	90%	110%			
Fluoride	6129959		0.03	0.03	NA	< 0.02	101%	85%	115%	99%	90%	110%			
Nitrate-N	6129959		0.201	0.200	0.7%	< 0.005	94%	85%	115%	99%	90%	110%			
Nitrite-N	6129959		<0.005	<0.005	NA	< 0.005				102%	90%	110%			
Sulphate	6129959		4.0	4.1	1.3%	< 0.5	99%	85%	115%	100%	90%	110%			
Calcium Dissolved	6133080		207	249	18.4%	< 0.05	102%	90%	110%	100%	90%	110%			
Magnesium Dissolved	6133080		90.7	105	14.6%	< 0.05	100%	90%	110%	99%	90%	110%			
Sodium Dissolved	6133080		7.06	7.99	12.4%	< 0.05	104%	90%	110%	91%	90%	110%			
Potassium Dissolved	6133080		4.37	5.35	20.0%	< 0.05	101%	90%	110%	108%	90%	110%			
Iron Dissolved	6133080		0.02	0.02	NA	< 0.01	100%	90%	110%	100%	90%	110%			
Manganese Dissolved	6133080		0.544	0.616	12.3%	< 0.001	103%	90%	110%	94%	90%	110%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### Turbidity

Turbidity	6133301		730	730	0.0%	< 0.5	104%	85%	115%	102%	90%	110%			
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Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

### British Columbia CSR- Schedule 6 Total Metals

Aluminum Total	6134675		623	630	1.0%	< 5	95%	85%	115%	99%	85%	115%			
Antimony Total	6134675		1.4	1.4	NA	< 0.5	114%	85%	115%	97%	90%	110%			
Arsenic Total	6134675		0.6	0.6	8.2%	< 0.1	107%	85%	115%	101%	90%	110%			
Barium Total	6134675		1.7	1.7	NA	< 0.5	103%	85%	115%	100%	90%	110%			
Beryllium Total	6134675		0.08	0.08	NA	< 0.05	104%	85%	115%	94%	90%	110%			
Boron Total	6134675		1110	1190	7.0%	< 5	94%	85%	115%	93%	80%	120%			
Cadmium Total	6134675		0.10	0.10	0.3%	< 0.01	100%	85%	115%	96%	90%	110%			
Calcium Total	6131119		30900	31600	2.2%	< 50	102%	85%	115%	102%	90%	110%			
Chromium Total	6134675		<0.5	<0.5	NA	< 0.5	101%	85%	115%	94%	90%	110%			
Cobalt Total	6134675		0.11	0.09	NA	< 0.05	110%	85%	115%	97%	90%	110%			
Copper Total	6134675		2.8	2.5	10.8%	< 0.5	101%	85%	115%	99%	90%	110%			
Iron Total	6131119		25	26	NA	< 10	101%	85%	115%	101%	90%	110%			
Lead Total	6134675		0.10	0.09	NA	< 0.05	98%	85%	115%	99%	90%	110%			
Lithium Total	6134675		776	858	10.0%	< 0.5				104%	90%	110%			

## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Dec 02, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Magnesium Total	6131119		10800	11000	2.4%	< 50	100%	85%	115%	102%	90%	110%			
Manganese Total	6131119		5	5	6.2%	< 1	103%	85%	115%	96%	90%	110%			
Mercury Total	6134576		< 0.01	< 0.01	NA	< 0.01	101%	85%	115%	109%	90%	110%			
Molybdenum Total	6134675		24.6	23.3	5.3%	< 0.1	107%	85%	115%	97%	90%	110%			
Nickel Total	6134675		<0.5	<0.5	NA	< 0.5	106%	85%	115%	103%	90%	110%			
Selenium Total	6134675		1.2	0.8	NA	< 0.5	96%	85%	115%	98%	85%	115%			
Silver Total	6134675		0.04	0.02	NA	< 0.02				97%	90%	110%			
Sodium Total	6131119		4260	4360	2.5%	< 100	104%	85%	115%	92%	90%	110%			
Thallium Total	6134675		0.05	0.03	NA	< 0.02	110%	85%	115%	100%	90%	110%			
Titanium Total	6134675		6	6	10.0%	< 1				97%	90%	110%			
Uranium Total	6134675		0.25	0.24	4.3%	< 0.01	100%	85%	115%	96%	90%	110%			
Vanadium Total	6134675		<1	<1	NA	< 1	95%	85%	115%	99%	90%	110%			
Zinc Total	6134675		8	7	NA	< 5	92%	85%	115%	99%	80%	120%			

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### British Columbia CSR- Schedule 6 Dissolved Metals

Aluminum Dissolved	6133080		10	10	5.9%	< 2	100%	90%	110%	107%	85%	115%			
Antimony Dissolved	6133080		2.4	2.2	8.3%	< 0.2	107%	90%	110%	104%	85%	110%			
Arsenic Dissolved	6133080		1.0	1.0	1.0%	< 0.1	99%	90%	110%	93%	90%	110%			
Barium Dissolved	6133080		194	227	15.8%	< 0.2	109%	90%	110%	104%	90%	110%			
Beryllium Dissolved	6133080		0.03	0.04	NA	< 0.01	100%	90%	110%	98%	90%	110%			
Boron Dissolved	6133080		21	22	5.6%	< 2	99%	90%	110%	101%	80%	120%			
Cadmium Dissolved	6133080		0.19	0.18	7.6%	< 0.01	103%	90%	110%	102%	90%	110%			
Calcium Dissolved	6133080		207000	249000	18.4%	< 50	102%	90%	110%	100%	90%	110%			
Chromium Dissolved	6133080		<0.5	<0.5	NA	< 0.5	106%	90%	110%	96%	90%	110%			
Cobalt Dissolved	6133080		9.02	10.4	14.6%	< 0.05	104%	90%	110%	101%	90%	110%			
Copper Dissolved	6133080		1.3	1.4	6.5%	< 0.2	103%	90%	110%	95%	90%	110%			
Iron Dissolved	6133080		17	19	NA	< 10	100%	90%	110%	100%	90%	110%			
Lead Dissolved	6133080		0.17	<0.05	NA	< 0.05	102%	90%	110%	102%	90%	110%			
Lithium Dissolved	6133080		25.5	29.6	15.0%	< 0.5				102%	90%	110%			
Magnesium Dissolved	6133080		90700	105000	14.6%	< 50	100%	90%	110%	99%	90%	110%			
Manganese Dissolved	6133080		544	616	12.3%	< 1	103%	90%	110%	94%	90%	110%			
Mercury Dissolved	6134576		< 0.01	< 0.01	NA	< 0.01	100%	90%	110%	109%	90%	110%			
Molybdenum Dissolved	6133080		26.6	26.8	0.6%	< 0.05	104%	90%	110%	107%	90%	110%			
Nickel Dissolved	6133080		66.0	79.9	19.0%	< 0.2	103%	90%	110%	95%	90%	110%			
Selenium Dissolved	6133080		91.3	76.0	18.2%	< 0.5	100%	90%	110%	115%	85%	115%			
Silver Dissolved	6133080		0.07	0.06	NA	< 0.02				97%	90%	110%			
Sodium Dissolved	6133080		7060	7990	12.4%	< 50	104%	90%	110%	91%	90%	110%			
Titanium Dissolved	6133080		<0.5	0.5	NA	< 0.5				103%	90%	110%			
Uranium Dissolved	6133080		14.4	14.9	3.3%	< 0.01	107%	90%	110%	105%	90%	110%			



## Quality Assurance

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

### Water Analysis (Continued)

RPT Date: Dec 02, 2014			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Vanadium Dissolved 6133080 <0.5 <0.5 NA < 0.5 102% 90% 110% 95% 90% 110%

Zinc Dissolved 6133080 8 7 NA < 2 103% 90% 110% 94% 85% 115%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### Phosphorus

Phosphorus Dissolved 6131116 < 0.005 < 0.005 NA < 0.005 93% 85% 115% 90% 90% 110% 107% 80% 120%

Phosphorus Total 6131116 < 0.005 < 0.005 NA < 0.005 87% 85% 115% 90% 90% 110% 115% 80% 120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

#### Phenols, Total - 4AAP

Phenol, Total 6133096 0.006 0.008 NA < 0.002 104% 85% 115% 99% 90% 110% 101% 70% 130%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.

Certified By:

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Methyl tert-butyl ether (MTBE)	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Benzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Toluene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Ethylbenzene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
m&p-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
o-Xylene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Styrene	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VPH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
VH	ORG-180-5130	Modified from BC MOE Lab Manual Section D	GC/MS/FID
Bromofluorobenzene	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Dibromofluoromethane	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
Toluene - d8	ORG-180-5130	modified from BC MOE Lab Manual Section D	GC/MS
EPH C10-C19	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID
EPH C19-C32	ORG-180-5134	Modified from BC MOE Lab Manual Section D (EPH)	GC/FID

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Aluminum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Antimony Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Arsenic Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Barium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Beryllium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Boron Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cadmium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Chromium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Cobalt Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Copper Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Lead Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Lithium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Mercury Dissolved	MET-181-6103, LAB-181-4015	Modified from EPA 245.7	CV/AA
Molybdenum Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Nickel Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Selenium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Silver Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Thallium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Titanium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Uranium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Vanadium Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS
Zinc Dissolved	MET-181-6102, LAB-181-4015	Modified from SM 3125 B	ICP-MS

## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

PROJECT: 0095-150-15-01

SAMPLING SITE:

AGAT WORK ORDER: 14V922453

ATTENTION TO: Catherine Schmid

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Aluminum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Antimony Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Arsenic Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Barium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Beryllium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Boron Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cadmium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Calcium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Chromium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Cobalt Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Copper Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Iron Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Lead Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Lithium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Magnesium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Manganese Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Mercury Total	MET-181-6103	Modified from EPA 245.7	CV/AA
Molybdenum Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Nickel Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Selenium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Silver Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Sodium Total	MET-181-6101, LAB-181-4009	Modified from SM 3120 B	ICP/OES
Thallium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Titanium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Uranium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Vanadium Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Zinc Total	MET-181-6102, LAB-181-4009	Modified from SM 3125 B	ICP-MS
Phenol, Total	INOR-181-6014	Modified from SM 5530 C and EPA 420.2	CONTINUOUS FLOW ANALYZER
Phosphorus Dissolved	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER



## Method Summary

CLIENT NAME: BGC ENGINEERING INC.

AGAT WORK ORDER: 14V922453

PROJECT: 0095-150-15-01

ATTENTION TO: Catherine Schmid

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Phosphorus Total	INOR-181-6011	Modified from SM 4500-P B&E	SPECTROPHOTOMETER
pH	INOR-181-6000	Modified from SM 4500-H+	PH METER
p-Alkalinity	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity (pH 4.5)	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Bicarbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Carbonate	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Alkalinity, Hydroxide	INOR-181-6000	Modified from SM 2320 B	PC TITRATE
Electrical Conductivity	INOR-181-6000	Modified from SM 2510B	PC TITRATE
Chloride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Fluoride	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite-N	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-181-6002	Modified from SM 4110 B	ION CHROMATOGRAPH
Calcium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Magnesium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Sodium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Potassium Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Iron Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Manganese Dissolved	MET-181-6101, LAB-181-4015	Modified from SM 3120 B	ICP/OES
Turbidity	INOR-181-6008	SM 2130 B	PC TITRATE









# Laboratories

**P: 778.452.4000 • F: 778.452.4074**

## Report Information

1. Name: \_\_\_\_\_  
 Email: \_\_\_\_\_

2. Name: \_\_\_\_\_  
 Email: \_\_\_\_\_

**Requirements (Please Check)**

☐ BC CSR Soil                      ☐ BC CSR - Water

<input type="checkbox"/> IL	<input type="checkbox"/> AW
<input type="checkbox"/> PL	<input type="checkbox"/> IW
<input type="checkbox"/> CL	<input type="checkbox"/> LW
<input type="checkbox"/> RL	

**Schedule 11** *(Please Specify)*

---

**CCME** *(Please Specify)*

---

**Other** *(Please Specify)*

---

- ☐ Single Sample per page
- ☐ Multiple Samples per page
- ☐ Excel Format Included

**Regular TAT**  
☐ 5 to 7 working days  
☐ Day 2 - 100%  
☐ Day 3 - 50%  
☐ Day 4 - 25%

**Rush TAT**

Date Required: \_\_\_\_\_

PLEASE CONTACT LABORATORY IF RUSH REQUIRED SAMPLE  
SUBMISSION CUT OFF FOR EFFECTIVE DATE BY 3 PM

Notes:

2

14V 922453

Samples Relinquished By (Print Name and Sign): <i>Scott Garrison</i>	Date/Time <i>November 25, 14</i>	Samples Received By (Print Name and Sign):	Date/Time
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign): <i>Joeyson Baron</i>	Date/Time <i>Nov. 28/14</i>

Page 1 of 1  
 No: **010271**



# AGAT Laboratories

## SAMPLE INTEGRITY RECEIPT FORM - BURNABY

Work Order # 14V 922453

### RECEIVING BASICS:

Received From: Scott

Waybill #: \_\_\_\_\_

### SAMPLE QUANTITIES:

Coolers: 1 Containers: 12

### TIME SENSITIVE ISSUES:

Earliest Date Sampled: 27 Nov 2014

ALREADY EXCEEDED? Yes ☐ No ☒

### NON-CONFORMANCES:

3 temperatures of samples\* and average of each cooler: (record differing temperatures on the CoC next to sample ID's) \*use jars when available

(1) 6 + 6 + 5 = 6 °C (2) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C (3) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C (4) \_\_\_\_ + \_\_\_\_ + \_\_\_\_ = \_\_\_\_ °C

Was ice or ice pack present: ☒ Yes ☐ No

Integrity Issues:

Account Project Manager: \_\_\_\_\_ have they been notified of the above issues: Yes ☐ No ☐

Whom spoken to: \_\_\_\_\_ Date and Time: \_\_\_\_\_

### ADDITIONAL NOTES:

Dissolved metals, dissolved mercury, total dissolved phosphorus  
were all preserved, but not filtered. Will have to  
subsample from 1 L plastic

## **APPENDIX G**

### **WATERLINE TECHNICAL MEMORANDUM**



2301 McCullough Road, Unit D  
Nanaimo, British Columbia  
Canada V9S 4M9  
Tel: 250.585.0800  
Fax: 250.585.0802  
Toll Free: 1.888.641.6795  
[www.waterlineresources.com](http://www.waterlineresources.com)

November 18, 2014  
2137-14-004

Transmountain Pipeline ULC  
Suite 2700, 300 5<sup>th</sup> Avenue SW  
Calgary, AB, T2P 5J2

**Attention:** Bill Nooyen, P.Eng.

Dear Mr. Nooyen,

**RE: TMEP – Burnaby Terminal HMM-BH-03 Groundwater Sampling**

## **1.0 INTRODUCTION AND BACKGROUND**

Waterline Resources Inc. (Waterline) was retained by TERA Environmental Consultants (TERA) on behalf of Transmountain Pipeline ULC to conduct gas and groundwater sampling from a piezometer installed by BGC Engineering Inc. (BGC) in borehole HMM-BH-03 at the Burnaby Terminal Facility (Burnaby Terminal). This is part of an ongoing investigation into the environmental site conditions at Burnaby Mountain along the proposed Trans Mountain Expansion Project (TMEP) corridor.

From September 11 to 20, 2014, BGC advanced borehole HMM-BH-03 to 182 m below ground level (mbgl) to investigate rock and fluid properties at/near the proposed portal of the TMEP trenchless route from Burnaby Terminal to Westridge Marine Terminal. The location of the borehole within the Burnaby Terminal is presented on Figure 1. The borehole was completed with a 2.54 cm (1 inch) piezometer installed to a depth of 113 m (Appendix A). The borehole below the piezometer was backfilled with sand, providing hydraulic communication between the deeper borehole and the shallower screened interval. The borehole above the screened interval was sealed to surface with grout to hydraulically isolate the shallow zones. The screened interval was completed in a conglomerate (Appendix A).

During drilling of borehole HMM-BH-03, seven water quality samples were obtained by BGC from the water used for drilling. Analytical results are provided in Appendix B and a comparison table is provided in Table B1. Descriptions of the samples are as follows (BGC Engineering Inc., 2014):

- BGC WS-1 (September 12, 2014): Collected from the clean water as delivered to the site.
- BGC WS-2 to WS-6 (September 12 – 17, 2014): Collected from the recirculated drilling water. No additives or drilling mud was used during the drilling process

- BGC WS-7 (September 18, 2014): Collected from the recirculated drilling water after flushing of the borehole with clean water.

The present sampling program was conducted by Waterline to provide baseline groundwater quality information and to confirm the presence or absence of methane and hydrogen sulphide gas.

## **1.1 Waterline's Scope of Work**

Waterline's scope of work included:

- Collect a gas sample from HMM-BH-03 using two methods:
  1. Directly measure the headspace gas at the top of the well and immediately above the groundwater column in the well; and
  2. Collect a water sample and submit for analysis of dissolved methane and hydrogen sulphide gases;
- Collect a water sample for analysis of general chemistry, Benzene, Ethylbenzene, Toluene and Xylenes (BTEX), Volatile Petroleum Hydrocarbons (VPH), Extractable Hydrocarbons (EPH), total and dissolved metals, total and dissolved phosphorous, total phenols and turbidity; and
- Provide a technical memorandum summarizing the results of the field work, interpretation of analytical results, and an interpretation and comparison of analytical data from the water samples collected by BGC during drilling of HMM-BH-03.

## **2.0 SAMPLING METHODOLOGY**

### **2.1 Gas Sampling**

A portable RKI Eagle gas monitor was used to measure the headspace gas for methane and hydrogen sulphide in the piezometer on October 9, 2014. A copy of the calibration certificates are provided in Appendix C.

The piezometer cap was carefully lifted and the headspace gas at the top of the standpipe was collected into the gas monitor and measured for methane and hydrogen sulphide for approximately 5 minutes and the maximum concentration was recorded. The groundwater level was then measured and recorded at 55.27 metres below ground level (mbgl) (Table 1). A 6.35 mm (1/4 inch) diameter probe (HDPE tubing) was measured and cut to the appropriate length at ground surface and lowered into the piezometer to measure the head space gas immediately above the groundwater level. The head space was measured for approximately 5 minutes and the maximum concentration was recorded. The probe was removed and the cap was replaced on the piezometer for 30 minutes at which time the process was repeated.

**Table 1: Water Level and Well Measurements**

Well ID	Northing	Easting	UTM	Stick-up (m)	Water Level (mbgl)	Depth (mbgl)	Date and Time
HMM-BH-03	5457797	504629	10	-0.25	55.27	113.6	9-Oct-2014 15:45

**Notes:** mbgl denotes metres below ground level

Photos showing the site and gas sampling equipment are included in Appendix D.

## 2.2 Groundwater Sampling

To ensure a representative formation water sample was obtained and to remove the standing water in the piezometer, an attempt was made to purge the well of approximately 3 volumes of water and/or allow select water quality parameters (specifically electrical conductivity (EC), in addition to pH, total dissolved solids (TDS) and temperature) to stabilize. The non-pumping water level in HMM-BH-03 was recorded at 55.27 mbgl and the depth of the well was measured at 113.6 mbgl (Table 1), yielding a 58.3 m water column. In a 2.54 cm (1 inch) diameter well (0.5 L/m), one well volume equates approximately 30 L, resulting in an estimated purge volume of 90 L.

On October 9, 2014, an initial attempt was made to purge the groundwater manually using 15.9 mm (5/8 inch) diameter HDPE Waterra tubing attached with a one-way foot valve. However, because of the high sediment load in the water and depth of the well, the weight of the water was substantial and it was determined that a surface pump was necessary to complete the purging.

On October 10, 2014 a Waterra HydroLift II gas powered pump, which reportedly has water lifting capabilities from approximately 61 to 91 mbgl (200 to 300 feet), was sourced and used to pump the HDPE Waterra tubing from surface (refer to site photos in Appendix D). However, the water would not flow freely to the outlet of the tubing, possibly because of the high suspended sediment load that obstructed the operation of the foot valve, or friction effects in the small diameter casing that limited the valve action. Consequently, the tubing had to be pulled from the well, coiled and secured on a clean surface (polyethylene tarp) and then cleared of water using an air compressor. The purged water was contained in 20 L sealable pails. The tubing was then reinstalled into the well and the process was repeated.

Water quality parameters were measured in the field during groundwater purging (Table 2). After purging approximately 65 L, the water quality parameters had stabilized enough to sample (electrical conductivity measurements varied less than 5%); however because of time constraints and issues with the foot valve, sampling was postponed until the next day. The groundwater was sampled on October 11, 2014 by pulling the tubing out of the well and up a hill located directly east of BH-HMM-03. The foot valve was then removed and the groundwater was sampled from the outlet end of the tubing. The groundwater was field-filtered and preserved where applicable. Water samples were transported from the field to the laboratory in an insulated cooler and submitted for chemical analysis on October 11, 2014 under a chain of custody protocol to Maxxam Analytics.

**Table 2: Water Quality Parameters**

Well ID	Date	Time	Temperature (°C)	pH	Electrical Conductivity (µS/cm)	TDS (ppm)	Purge Volume (L)
HMM-BH-03	10-Oct-2014	12:00	13.0	7.47	622	301	30
	10-Oct-2014	16:00	13.9	7.82	581	291	50
	10-Oct-2014	16:15	13.9	8.26	606	301	65
	11-Oct-2014	8:15	12.7	8.02	546	274	75

Groundwater level recovery occurred relatively quickly during groundwater purging, with water levels remaining above 56 mbgl. At the end of sampling on October 11, 2014, the water level in BH-HMM-03 was measured at 55.94 mbgl.

### 3.0 RESULTS

#### 3.1 Gas Samples

Methane concentrations were measured between 85 and 150 ppm in the headspace gas located at the top of the piezometer (0.25 mbgl), and between 120 and 310 ppm at a depth of 55.2 mbgs during the first and second measurements, respectively. Hydrogen sulphide was not detected and odours were not present. Table 3 provides details of the gas sampling results.

**Table 3: Head Space Gas Sampling Results**

Well ID	Date	Depth of Groundwater (mbgl)	Time	Depth of Reading (mbgl)	Methane Concentration (ppm)	Hydrogen Sulphide Concentration (ppm)
HMM-BH-03	9-Oct-2014	55.27	15:45	0.25	85	0
			16:15	55.2	120	0
			16:46	0.25	150	0
			16:52	55.2	310	0

**Notes:** mbgl denotes metres below ground level.

#### 3.2 Water Samples

Table B1 (Appendix B) summarizes the water quality results during drilling of HMM-BH-03 collected between September 12 to 18, 2014 (sample IDs: BGC WS-1 to -7), and compares the results with the sample collected by Waterline on October 11, 2014 (sample ID: Waterline WSW-8). Although the water from HMM-BH-03 is not used for drinking water purposes, the results are compared for reference to the Canadian Drinking Water Quality Guidelines (CDWQG; Health Canada, 2014) Maximum Allowable Concentrations (MAC) and Aesthetic Objectives (AO), or, where applicable,



the BC Contaminated Sites Regulation for Drinking Water (BC CSR; BC MoE, 2014). Water quality results can be summarized as follows:

- Numerous total metal concentrations are elevated above the MAC or AO guidelines in all of the samples collected, with the exception of BGC WSW-1, which was obtained from clean water as delivered. This indicates the total metal concentrations are influenced by the high particulate concentration in the water. Total metal concentrations are highest in the samples collected from the drilling fluids between September 12 and 15, 2014 (BGC WS-2 to -5);
- TDS, EC and alkalinity are greater in the water sample collected post-drilling (Waterline WS-8);
- Dissolved aluminum exceeds the AO guideline of 0.1 mg/L in all of the samples except BGC WSW-1;
- Dissolved iron exceeds the AO guideline of 0.3 mg/L in BGC WS-6 and Waterline WS-8;
- Dissolved metals and major dissolved ions including calcium, sodium, sulphate, chloride and bicarbonate are higher in the groundwater sample collected post-drilling (Waterline WSW-8);
- Extractable Petroleum Hydrocarbons (EPH; C19-C32) were detected in all of the samples collected, including the sample collected from the clean water as delivered to the site (BGC WS-1);
- Nitrate was detected in the samples collected from BGC, but its concentration was less than the MAC guideline of 10 mg/L;
- Nitrite was detected in the sample collected post-drilling (Waterline WS-8), but its concentration was less than the MAC guideline of 1 mg/L;
- Toluene was detected in the sample collected post-drilling (Waterline WS-8), but its concentration was less than the AO and MAC guidelines of 24 and 60 µg/L, respectively;
- Chloroform was detected in the sample collected post-drilling (Waterline WS-8), but its concentration was less than the MAC guideline of 100 µg/L.

Water quality results have been plotted on a Piper diagram (Figure 2). The water chemistry data shows that the sample collected by Waterline on October 11, 2014 has a different geochemical signature than the water samples collected by BGC between September 12 and 18, 2104. The sample collected by Waterline has a sodium-sulphate type signature, whereas the samples collected from BGC primarily have a sodium- bicarbonate type signature.

The water samples obtained by Waterline on October 11, 2014 were also analyzed for methane and hydrogen sulphide gases. Results are shown on Table B1.

Hydrogen sulphide concentration was less than the reported detection limit of 0.0050 mg/L; however, methane gas was detected in the water sample. Methane concentrations were reported as 0.006 L/m<sup>3</sup> which corresponds to a calculated methane concentration of 0.004 mg/L.



Certificates of Analysis and copies of the chain of custody records are provided in Appendix B.

## 4.0 DISCUSSION

### 4.1 Presence of Methane

Gas and groundwater sampling at HMM-BH-03 indicate methane gas is present in the aquifer screen by the test well. Methane concentrations were greater in the head space immediately above the standing water in the well likely because the head space above the water was in equilibrium with the water. In addition, methane concentrations were greater during the second set of gas measurements because the head space and water column were disturbed during the first gas measurement, resulting in methane exsolving from the water into the air space above the water in the well.

The methane gas concentration in the air space of the well is compared to the dissolved methane concentration obtained from the lab using a form of Henry's Law (USEPA, 2004):

$$C_A = (n_w V) * (p_g / H) * MW$$

where:

$C_A$  = aqueous gas concentration in water after equilibrium

$n_w V$  = molar concentration of water = 55.5 mol/L

$p_g$  = partial pressure of the gas at atmospheric pressure

$H$  = Henry's Law constant

$MW$  = molecular weight of the analyte (g/mol)

The concentration of the gas immediately above the water surface in the well, which is considered the most likely to be in equilibrium with the water, ranged between 120 and 310 ppm. This translates to 0.000120 and 0.000310 atm at atmospheric pressure. Using a Henry's Law constant of 39,769 atm/mol fraction (Mitchell, 2014) and molecular weight of methane (16 g/mol), the maximum partial pressure of 310 ppm yields a gas concentration of:

$$C_A = (55.5 \text{ mol/L}) * (0.000310 \text{ atm} / 39,769 \text{ atm/mol\_fraction}) * (16 \text{ g/mol}) * 10^3 \text{ mg/g}$$
$$C_A = 0.0069 \text{ mg/L}$$

Alternatively, the minimum partial pressure of 120 ppm results in a dissolved gas concentration of 0.003 mg/L. This calculation assumes a sealed static system where the methane gas in the air is in equilibrium with that dissolved in the water and no losses from the system. This is not the case because the well is opened to allow sampling, thus it is possible that the methane gas concentration was actually greater than measured.

These values correspond to the laboratory derived dissolved gas concentration of 0.004 mg/L, especially considering the water sample submitted to the laboratory was subject to agitation of the

water during sampling. This would likely have resulted in the exsolution of some methane to the atmosphere.

#### **4.2 Baseline Groundwater Quality**

The groundwater sample collected by Waterline on October 11, 2014 indicates the samples collected by BGC during drilling were not representative of the groundwater at the site. The elevated TDS, EC, alkalinity and dissolved ions (particularly sulphate), indicates the groundwater has a different geochemical signature. The water samples collected by BGC are more representative of the fluids used during drilling, although mixing with the groundwater is likely to have occurred.

Although the BGC water samples cannot be used as a baseline data for the groundwater at the site, the samples are beneficial in that they indicate whether any cross contamination may have occurred during drilling. In this respect, low concentrations of EPH C19-C32 were detected in all of the samples collected, including the sample obtained from the clean water as delivered. The presence of coal noted during drilling by BGC at a number of depth intervals (BGC Engineering Inc., 2014), could account for the presence of EPH C19-C32; although not in the clean water sample. The groundwater sample collected by Waterline on October 11, 2014 also indicates low concentrations of toluene and chloroform were present, however, both are less than the BC CSR guidelines for drinking water.

Both the groundwater and drilling water samples were affected by the high level of particulates. As such, dissolved metals are a better indicator of water quality than total metals. The groundwater at the site was characterized by elevated dissolved aluminum and iron.

Low concentrations of nitrate were detected in the water samples collected by BGC. Low concentrations of nitrite were also detected in the groundwater sample collected by Waterline. Although nitrite concentrations were less than the MAC guideline of 1 mg/L, they were elevated above typical background concentrations of 0.01 mg/L (Health Canada, 2013a). Nitrite and nitrate can be formed as a result of nitrification of excess ammonia, which occurs naturally in groundwater from the decay of organic materials (Health Canada, 2013b). The presence of either nitrate or nitrite is dependent on the redox conditions of the environment. Borehole HMM-BH-03 is completed in a sedimentary environment that likely contains abundant organic materials, which would explain the presence of nitrate and nitrite. Reduction of organic matter is likely also the cause of methane gas within the groundwater.

#### **5.0 CONCLUSIONS**

The enclosed report provides a review and evaluation of the gas and groundwater samples collected from HMM-BH-03 at the Burnaby Terminal between September 12 and October 11, 2014. The results indicate that dissolved methane is present within the aquifer screened by the test well,

which is likely related to the presence of coal or the reduction of organic matter. Hydrogen Sulphide gas was not detected, either in the airspace of the well or in a dissolved phase in the water

Based on the conclusions of the groundwater assessment, methane gas concentrations should be monitored during construction and tunneling related activities. In addition, further sampling can be conducted to provide additional baseline water quality information and to monitor any changes during construction at Burnaby Mountain along the proposed Trans Mountain Expansion Project (TMEP) corridor.

## 6.0 CERTIFICATION

This document was prepared under the direction of a professional geoscientist registered in the Province of British Columbia.

Waterline Resources Inc. trusts that the information provided in this document is sufficient for your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

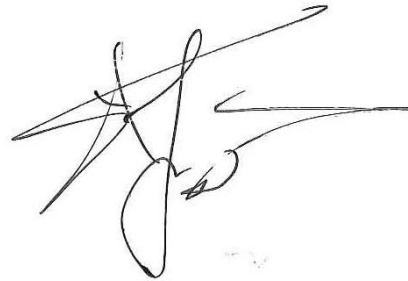
Respectfully submitted,

**Waterline Resources Inc.**

**Reviewed By:**



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## 7.0 REFERENCES

- BGC Engineering Inc., 2014. TMEP Westridge Tunnel Investigation: 2014 Site Investigation Data Report, November 2014.
- British Columbia Ministry of Environment (BC MoE, 2014). Contaminated Sites Regulation, BC Reg 375/96.
- Health Canada, 2103a. Guidelines for Canadian Drinking Water Quality, Guideline Technical Document, Nitrate and Nitrite.
- Health Canada, 2103b. Guidelines for Canadian Drinking Water Quality, Guideline Technical Document, Ammonia.
- Health Canada, 2014. Guidelines for Canadian Drinking Water Quality – Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. October, 2014.
- Mitchell, T., 2014. RE: Methane Gas Calculation. [November 6, 2014 email].
- U.S. Environmental Protection Agency (USEPA, 2004). Standard Operation Procedure: Sample Preparation and Calculations for Dissolved Gas Analysis in Water Samples Using a GC Headspace Equilibration Technique. Document RSKSOP-175, Revision No. 2.

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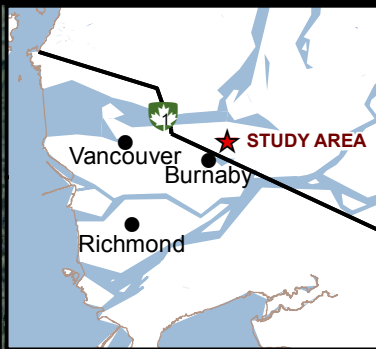
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## FIGURES

**Figure 1: Well Location Diagram**

**Figure 2: Piper Plot**






\* Borehole HHM-BH-03 Location

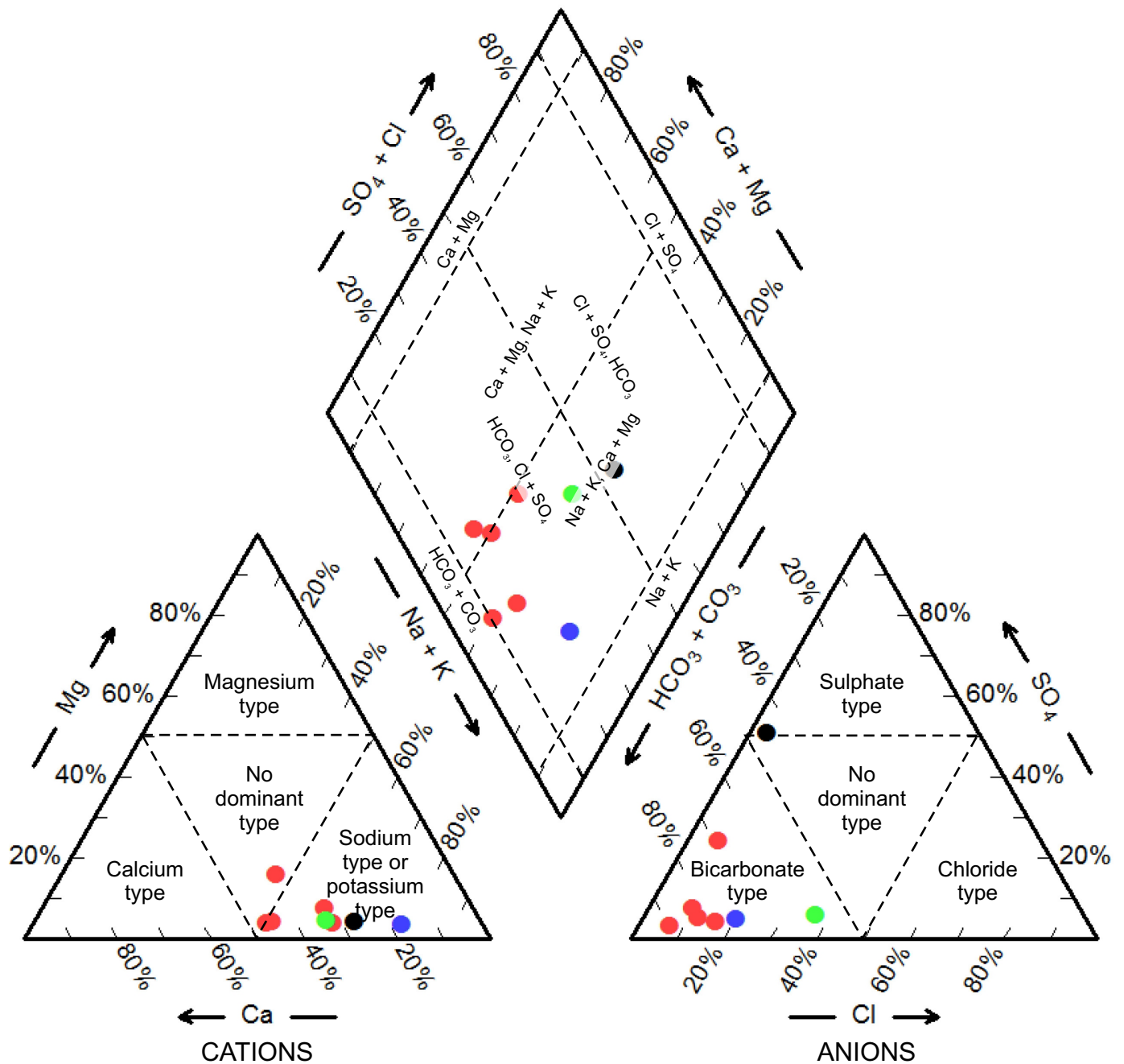
Scale: 1:9,000 0 50 100 200 300 Meters

Coordinate System: NAD 1983 UTM Zone 10N

Sources:  
Google Earth, 2014


PROJECT	<b>TMEP - Burnaby Mountain Groundwater Sampling Burnaby, BC Submitted to BGC Engineering Inc.</b>	
TITLE	<b>SITE LOCATION</b>	
	PREPARED BY: Waterline Resources Inc.	<b>Figure 1</b>
	PROJECT: 2137-14-004	
	COMPILED BY: mscott	
	DATE ISSUED: 18/11/2014	
DATE REVISED:		





#### LEGEND:

- BGC Sample: Clean Water As Delivered (September 12, 2014)
- BGC Sample: Recirculated Drilling Water - No Drilling Additives Used (September 12-17, 2014)
- BGC Sample: Recirculated Drilling Water - Taken After Flushing (September 18, 2014)
- Waterline Sample Collected Post-Drilling Activities (October 11, 2014)

PROJECT		TMEP - Burnaby Mountain Groundwater Sampling Burnaby Tank Farm	
TITLE		PIPER PLOT	
	PREPARED BY: Waterline Resources Inc.		FIGURE 2
	PROJECT: 2137-14-001		
	COMPILED BY: CGD		
	DATE ISSUED: November 2014		
	REVISED: --		