Bottom Ash Data

2018 Week 28

The following analytical reports were sent to the Ministry of Environment and Climate Change Strategy:

- Weekly Composite Results were submitted on July 25, 2018
- Daily Composite Results were submitted on August 20, 2018
- Stockpile Sampling Results were submitted on October 26, 2018

This data represents bottom ash results for week 28 of 2018 (July 8, 2018 to July 14, 2018).

The bottom ash stockpile results from July 12, 2018 do not meet the requirements of Metro Vancouver's Bottom Ash Management Plan; per the Plan the bottom ash will be removed for disposal at an approved facility.

The bottom ash from July 9 to 11, 2018 and July 13 to 14, 2018 meets the requirements of Metro Vancouver's Bottom Ash Management Plan and is suitable for beneficial use during Coquitlam Landfill closure works.

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 17-JUL-18
Report Date: 25-JUL-18 14:42 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2130643

Project P.O. #: VANCO-0000047506
Job Reference:
C of C Numbers:
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2130643-1	L2130643-2	L2130643-3	L2130643-4	L2130643-5
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18
Sampled Time	09:00	09:00	09:00	09:00	09:00
Client ID	BA1828-A-1	BA1828-A-2	BA1828-A-3	BA1828-A-4	BA1828-A-5
Grouping / **Analyte**					
SOIL					
Physical Tests Moisture (%)	17.1	18.8	16.2	20.5	17.0
pH (1:2 soil:water) (pH)	11.34	11.02	11.18	10.99	11.03
Metals Aluminum (Al) (mg/kg)	27500	28800	27300	33100	34500
Antimony (Sb) (mg/kg)	82.3	94.1	162	100	108
Arsenic (As) (mg/kg)	45.9	45.8	39.1	39.7	47.3
Barium (Ba) (mg/kg)	549	466	420	493	569
Beryllium (Be) (mg/kg)	0.37	0.37	0.35	0.35	0.40
Bismuth (Bi) (mg/kg)	3.44	4.99	17.5	4.83	13.5
Boron (B) (mg/kg)	202	255	235	346	260
Cadmium (Cd) (mg/kg)	7.89	9.79	9.99	11.1	103
Calcium (Ca) (mg/kg)	110000	120000	111000	127000	115000
Chromium (Cr) (mg/kg)	141	155	250	132	127
Cobalt (Co) (mg/kg)	58.3	576	36.1	26.2	27.3
Copper (Cu) (mg/kg)	2280	8620	3010	1510	2200
Iron (Fe) (mg/kg)	50100	57700	58700	48100	57700
Lead (Pb) (mg/kg)	365	850	483	556	365
Lithium (Li) (mg/kg)	35.6	17.5	16.5	16.4	17.8
Magnesium (Mg) (mg/kg)	8580	9480	9030	10900	10600
Manganese (Mn) (mg/kg)	636	691	660	611	777
Mercury (Hg) (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum (Mo) (mg/kg)	54.9	50.4	55.9	127	53.7
Nickel (Ni) (mg/kg)	94.7	124	289	114	186
Phosphorus (P) (mg/kg)	10900	8740	8410	10500	10000
Potassium (K) (mg/kg)	5250	4690	4520	4750	4400
Selenium (Se) (mg/kg)	0.26	0.29	0.25	0.34	0.25
Silver (Ag) (mg/kg)	2.46	4.35	3.16	5.83	2.81
Sodium (Na) (mg/kg)	15000	13600	13200	14600	13200
Strontium (Sr) (mg/kg)	248	308	263	289	249
Sulfur (S) (mg/kg)	10200	13000	11900	12700	10500
Thallium (Tl) (mg/kg)	0.051	0.062	0.058	0.057	0.057
Tin (Sn) (mg/kg)	67.0	112	127	96.1	95.8
Titanium (Ti) (mg/kg)	1000	1110	627	821	1030
Tungsten (W) (mg/kg)	3.28	18.1	3.25	3.57	4.50
Uranium (U) (mg/kg)	4.05	4.76	4.64	4.88	5.60
Vanadium (V) (mg/kg)	39.8	47.5	42.6	44.4	47.1
Zinc (Zn) (mg/kg)	2390	4000	6690	2750	4200
Zirconium (Zr) (mg/kg)	1.5	1.4	1.2	1.4	1.4

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2130643-6	L2130643-7	L2130643-8	L2130643-9	L2130643-10
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18
Sampled Time	09:00	09:00	09:00	09:00	09:00
Client ID	BA1828-A-6	BA1828-A-7	BA1828-A-8	BA1828-A-9	BA1828-A-10
Grouping / **Analyte**					
SOIL					
Physical Tests Moisture (%)	20.1	21.4	20.2	18.1	19.8
pH (1:2 soil:water) (pH)	11.01	11.12	11.13	11.18	11.17
Metals Aluminum (Al) (mg/kg)	27000	34800	34100	29300	28400
Antimony (Sb) (mg/kg)	119	136	102	103	103
Arsenic (As) (mg/kg)	43.2	70.9	45.5	46.9	77.8
Barium (Ba) (mg/kg)	498	576	527	539	487
Beryllium (Be) (mg/kg)	0.35	0.43	0.36	0.40	0.34
Bismuth (Bi) (mg/kg)	6.29	6.85	6.35	4.98	4.97
Boron (B) (mg/kg)	288	363	344	222	214
Cadmium (Cd) (mg/kg)	15.4	11.3	14.5	11.0	11.1
Calcium (Ca) (mg/kg)	124000	122000	126000	125000	118000
Chromium (Cr) (mg/kg)	171	166	175	136	185
Cobalt (Co) (mg/kg)	24.7	24.3	33.8	22.9	18.9
Copper (Cu) (mg/kg)	3060	1490	2730	3550	4530
Iron (Fe) (mg/kg)	49900	46000	58700	63400	60300
Lead (Pb) (mg/kg)	390	1890	1020	737	358
Lithium (Li) (mg/kg)	16.7	17.6	19.1	21.0	18.0
Magnesium (Mg) (mg/kg)	11300	9420	10600	9900	9540
Manganese (Mn) (mg/kg)	750	718	752	1270	814
Mercury (Hg) (mg/kg)	<0.050	0.500	<0.050	<0.050	<0.050
Molybdenum (Mo) (mg/kg)	72.4	109	74.3	68.1	76.6
Nickel (Ni) (mg/kg)	123	230	100	114	98.6
Phosphorus (P) (mg/kg)	9610	10600	11300	8870	10300
Potassium (K) (mg/kg)	5480	4960	5350	5000	4910
Selenium (Se) (mg/kg)	0.36	0.36	0.37	0.32	0.35
Silver (Ag) (mg/kg)	3.36	6.50	5.53	5.34	3.83
Sodium (Na) (mg/kg)	14100	15100	14700	14300	13900
Strontium (Sr) (mg/kg)	288	354	292	290	279
Sulfur (S) (mg/kg)	12300	12400	13500	13000	12600
Thallium (Tl) (mg/kg)	0.060	0.064	0.069	0.061	0.065
Tin (Sn) (mg/kg)	146	196	163	141	105
Titanium (Ti) (mg/kg)	858	911	951	1070	931
Tungsten (W) (mg/kg)	3.28	3.40	3.90	7.11	3.76
Uranium (U) (mg/kg)	4.99	4.87	5.37	5.12	4.95
Vanadium (V) (mg/kg)	44.8	47.7	49.7	45.4	45.1
Zinc (Zn) (mg/kg)	3810	2940	4870	3300	4360
Zirconium (Zr) (mg/kg)	<1.0	1.3	1.5	1.3	1.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2130643-11	L2130643-12			
	Description	SOIL	SOIL			
	Sampled Date	11-JUL-18	04-JUL-18			
	Sampled Time	09:00	09:00			
	Client ID	BA1828-A-11	BA1828-A-12			
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	16.9	21.4			
	pH (1:2 soil:water) (pH)	11.26	11.07			
Metals	Aluminum (Al) (mg/kg)	27200	33200			
	Antimony (Sb) (mg/kg)	91.4	104			
	Arsenic (As) (mg/kg)	37.7	44.0			
	Barium (Ba) (mg/kg)	402	427			
	Beryllium (Be) (mg/kg)	0.46	0.35			
	Bismuth (Bi) (mg/kg)	4.72	6.38			
	Boron (B) (mg/kg)	218	263			
	Cadmium (Cd) (mg/kg)	15.0	13.3			
	Calcium (Ca) (mg/kg)	117000	120000			
	Chromium (Cr) (mg/kg)	120	201			
	Cobalt (Co) (mg/kg)	25.3	24.0			
	Copper (Cu) (mg/kg)	2890	2700			
	Iron (Fe) (mg/kg)	44100	61400			
	Lead (Pb) (mg/kg)	422	652			
	Lithium (Li) (mg/kg)	19.5	17.5			
	Magnesium (Mg) (mg/kg)	9270	9600			
	Manganese (Mn) (mg/kg)	561	653			
	Mercury (Hg) (mg/kg)	<0.050	<0.050			
	Molybdenum (Mo) (mg/kg)	118	53.5			
	Nickel (Ni) (mg/kg)	85.8	117			
	Phosphorus (P) (mg/kg)	9250	9830			
	Potassium (K) (mg/kg)	4470	4760			
	Selenium (Se) (mg/kg)	0.34	0.32			
	Silver (Ag) (mg/kg)	3.07	3.38			
	Sodium (Na) (mg/kg)	13200	13500			
	Strontium (Sr) (mg/kg)	273	292			
	Sulfur (S) (mg/kg)	12200	13400			
	Thallium (Tl) (mg/kg)	0.060	0.062			
	Tin (Sn) (mg/kg)	127	137			
	Titanium (Ti) (mg/kg)	609	735			
	Tungsten (W) (mg/kg)	2.91	4.22			
	Uranium (U) (mg/kg)	4.60	5.18			
	Vanadium (V) (mg/kg)	42.6	45.6			
	Zinc (Zn) (mg/kg)	3010	4250			
	Zirconium (Zr) (mg/kg)	1.3	1.5			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2130643-1	L2130643-2	L2130643-3	L2130643-4	L2130643-5
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18
Sampled Time	09:00	09:00	09:00	09:00	09:00
Client ID	BA1828-A-1	BA1828-A-2	BA1828-A-3	BA1828-A-4	BA1828-A-5
Grouping **Analyte**					
SOIL					
TCLP Metals 1st Preliminary pH (pH)	11.40	11.23	11.37	11.45	11.43
2nd Preliminary pH (pH)	8.85	8.79	8.83	9.00	9.24
Final pH (pH)	5.64	5.61	5.19	5.92	5.59
Extraction Solution Initial pH (pH)	2.90	2.90	2.90	2.90	2.90
Antimony (Sb)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (As)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
Barium (Ba)-Leachable (mg/L)	<2.5	<2.5	<2.5	<2.5	<2.5
Beryllium (Be)-Leachable (mg/L)	<0.025	<0.025	<0.025	<0.025	<0.025
Boron (B)-Leachable (mg/L)	3.21	2.59	2.29	2.98	3.47
Cadmium (Cd)-Leachable (mg/L)	0.253	0.305	8.86	0.197	0.497
Calcium (Ca)-Leachable (mg/L)	1710	1760	1520	1860	1760
Chromium (Cr)-Leachable (mg/L)	<0.25	<0.25	<0.25	<0.25	<0.25
Cobalt (Co)-Leachable (mg/L)	1.23	0.377	0.510	0.522	0.339
Copper (Cu)-Leachable (mg/L)	2.23	2.74	2.06	0.878	6.34
Iron (Fe)-Leachable (mg/L)	<5.0	<5.0	15.8	<5.0	5.8
Lead (Pb)-Leachable (mg/L)	<0.25	0.33	1.42	<0.25	0.41
Magnesium (Mg)-Leachable (mg/L)	108	111	92.7	117	117
Mercury (Hg)-Leachable (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel (Ni)-Leachable (mg/L)	0.83	0.83	4.31	1.04	0.51
Selenium (Se)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
Silver (Ag)-Leachable (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
Thallium (Tl)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium (V)-Leachable (mg/L)	<0.15	<0.15	<0.15	<0.15	<0.15
Zinc (Zn)-Leachable (mg/L)	49.4	43.1	67.9	110	66.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2130643-6 SOIL 11-JUL-18 09:00 BA1828-A-6	L2130643-7 SOIL 11-JUL-18 09:00 BA1828-A-7	L2130643-8 SOIL 11-JUL-18 09:00 BA1828-A-8	L2130643-9 SOIL 11-JUL-18 09:00 BA1828-A-9	L2130643-10 SOIL 11-JUL-18 09:00 BA1828-A-10
Sample ID						
Description						
Sampled Date						
Sampled Time						
Client ID						
SOIL						
TCLP Metals	1st Preliminary pH (pH)	11.45	11.53	11.56	11.50	11.57
	2nd Preliminary pH (pH)	9.09	9.10	9.13	9.03	9.23
	Final pH (pH)	5.78	6.14	5.69	5.84	5.86
	Extraction Solution Initial pH (pH)	2.90	2.90	2.90	2.90	2.90
	Antimony (Sb)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Arsenic (As)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Barium (Ba)-Leachable (mg/L)	<2.5	<2.5	<2.5	<2.5	<2.5
	Beryllium (Be)-Leachable (mg/L)	<0.025	<0.025	<0.025	<0.025	<0.025
	Boron (B)-Leachable (mg/L)	3.15	2.90	3.31	3.10	2.76
	Cadmium (Cd)-Leachable (mg/L)	0.898	0.207	0.501	0.178	0.479
	Calcium (Ca)-Leachable (mg/L)	1880	1950	1800	1900	1890
	Chromium (Cr)-Leachable (mg/L)	<0.25	<0.25	<0.25	<0.25	<0.25
	Cobalt (Co)-Leachable (mg/L)	0.516	1.79	0.596	0.548	0.606
	Copper (Cu)-Leachable (mg/L)	2.07	1.50	0.951	2.62	1.79
	Iron (Fe)-Leachable (mg/L)	<5.0	<5.0	<5.0	<5.0	<5.0
	Lead (Pb)-Leachable (mg/L)	<0.25	<0.25	0.25	0.36	0.31
	Magnesium (Mg)-Leachable (mg/L)	118	125	114	121	119
	Mercury (Hg)-Leachable (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Leachable (mg/L)	1.91	0.45	0.60	0.57	0.63
	Selenium (Se)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Silver (Ag)-Leachable (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Thallium (Tl)-Leachable (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Vanadium (V)-Leachable (mg/L)	<0.15	<0.15	<0.15	<0.15	<0.15
	Zinc (Zn)-Leachable (mg/L)	43.2	38.4	71.5	54.0	51.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2130643-11	L2130643-12			
	Description	SOIL	SOIL			
	Sampled Date	11-JUL-18	04-JUL-18			
	Sampled Time	09:00	09:00			
	Client ID	BA1828-A-11	BA1828-A-12			
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	11.61	11.53			
	2nd Preliminary pH (pH)	9.34	9.13			
	Final pH (pH)	5.63	5.75			
	Extraction Solution Initial pH (pH)	2.90	2.90			
	Antimony (Sb)-Leachable (mg/L)	<1.0	<1.0			
	Arsenic (As)-Leachable (mg/L)	<1.0	<1.0			
	Barium (Ba)-Leachable (mg/L)	<2.5	<2.5			
	Beryllium (Be)-Leachable (mg/L)	<0.025	<0.025			
	Boron (B)-Leachable (mg/L)	2.69	3.45			
	Cadmium (Cd)-Leachable (mg/L)	0.419	0.203			
	Calcium (Ca)-Leachable (mg/L)	1770	1850			
	Chromium (Cr)-Leachable (mg/L)	<0.25	<0.25			
	Cobalt (Co)-Leachable (mg/L)	1.09	0.400			
	Copper (Cu)-Leachable (mg/L)	1.98	1.83			
	Iron (Fe)-Leachable (mg/L)	<5.0	<5.0			
	Lead (Pb)-Leachable (mg/L)	0.51	0.27			
	Magnesium (Mg)-Leachable (mg/L)	106	120			
	Mercury (Hg)-Leachable (mg/L)	<0.0010	<0.0010			
	Nickel (Ni)-Leachable (mg/L)	0.48	0.58			
	Selenium (Se)-Leachable (mg/L)	<1.0	<1.0			
	Silver (Ag)-Leachable (mg/L)	<0.050	<0.050			
	Thallium (Tl)-Leachable (mg/L)	<1.0	<1.0			
	Vanadium (V)-Leachable (mg/L)	<0.15	<0.15			
	Zinc (Zn)-Leachable (mg/L)	48.4	45.9			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Antimony (Sb)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Bismuth (Bi)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Cobalt (Co)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Copper (Cu)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Lead (Pb)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Lithium (Li)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Manganese (Mn)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Nickel (Ni)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Silver (Ag)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Tin (Sn)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Tungsten (W)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Duplicate	Zinc (Zn)	DUP-H	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Cobalt (Co)-Leachable	MS-B	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Zinc (Zn)-Leachable	MS-B	L2130643-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.

HG-TCLP-CVAFS-VA	Soil	Mercury by CVAAS (TCLP)	EPA 1311/245.7

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using atomic absorption spectrophotometry (EPA 245.7).

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MOISTURE-VA	Soil	Moisture content	CWS for PHC in Soil - Tier 1

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Reference Information

VA ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

L2130643-COFC

COC # ____

Page ____ of ____

Report To	
Company:	Covanta Energy
Contact:	Steve Mckinney / Dan Skrypnyk
Address:	5150 Riverbend Drive
	Burnaby BC
Phone:	604-521-1025 Fax:
	☐ Yes ☐ No

Report	
☐Standard	
☑PDF ☐Excel ☐Digital ☐Fax	
Email 1:	smckinney@covanta.com
Email 2:	rjohnson4@covanta.com
Email 3:	dskrypnyk@covanta.com
	brent.kirkpatrick@metrovancouver.org
	Sarah.Wellman@metrovancouver.org

Service Requested (Rush for routine analysis subject to availability)
- (Standard Turnaround Times - Business Days)
- Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Invoice To	Same as Report ?
Hardcopy of Invoice with Report?	☐ Yes ☐ No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Client / Project Information	
Job #:	
PO / AFE:	PO# 46693 Weekly Bottom Ash - Suite
LSD:	(includes 2:1 pH)
Quote #:	
ALS Contact:	Sampler:

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	MET-TCLP-VA (all metals, Hg)	MOISTURE		Chrome 6		MET-CSR+FULL-VA (all metals							Number of Containers
	BA1828-A-1	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-2	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-3	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-4	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-5	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-6	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-7	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-8	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-9	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-10	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-11	11-Jul-18	9:00	Soil	X	X				X							1
	BA1828-A-12	04-Jul-18	9:00	Soil	X	X				X							1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: [signature]	Date (dd-mmm-yy) 17-Jul-18	Time (hh-mm) 08:00	Received by: HA	Date: 7/17	Time: 12:40P	Temperature: 24 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 30-JUL-18
Report Date: 13-AUG-18 11:39 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2138126

Project P.O. #: VANCO-0000047506
Job Reference: WEEKLY BOTTOM ASH-SUITE (INCLUDES 2:1 PH)

C of C Numbers:
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138126-1	L2138126-2	L2138126-3	L2138126-4	L2138126-5
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	09-JUL-18	09-JUL-18	09-JUL-18	09-JUL-18	09-JUL-18
	Sampled Time	09:00	09:00	09:00	09:00	09:00
	Client ID	DBA1828-A-01-01	DBA1828-A-01-02	DBA1828-A-01-03	DBA1828-A-01-04	DBA1828-A-01-05
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.88	10.76	10.71	10.99	10.51
TCLP Metals	1st Preliminary pH (pH)	11.29	11.29	11.23	11.30	11.23
	2nd Preliminary pH (pH)	9.59	9.39	9.29	9.60	9.33
	Final pH (pH)	5.85	5.96	5.92	5.80	5.57
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.234	0.265	0.252	0.368	0.335

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138126-6	L2138126-7	L2138126-8	L2138126-9	L2138126-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	09-JUL-18	09-JUL-18	09-JUL-18	09-JUL-18	09-JUL-18
	Sampled Time	09:00	09:00	09:00	09:00	09:00
	Client ID	DBA1828-A-01-06	DBA1828-A-01-07	DBA1828-A-01-08	DBA1828-A-01-09	DBA1828-A-01-10
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.61	11.11	10.67	10.63	11.15
TCLP Metals	1st Preliminary pH (pH)	11.22	11.54	11.28	11.20	11.61
	2nd Preliminary pH (pH)	8.97	9.71	9.15	9.43	9.83
	Final pH (pH)	5.72	5.95	5.55	6.00	6.16
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.306	0.284	0.248	0.231	0.223

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138126-11	L2138126-12			
	Description	Soil	Soil			
	Sampled Date	09-JUL-18	09-JUL-18			
	Sampled Time	09:00	09:00			
	Client ID	DBA1828-A-01-11	DBA1828-A-01-12			
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.70	10.78			
TCLP Metals	1st Preliminary pH (pH)	11.26	11.36			
	2nd Preliminary pH (pH)	9.18	9.22			
	Final pH (pH)	6.01	5.82			
	Extraction Solution Initial pH (pH)	2.88	2.88			
	Cadmium (Cd)-Leachable (mg/L)	0.207	0.319			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Cadmium (Cd)-Leachable	MS-B	L2138126-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody

L2138126-COFC

COC #

Page ___ of ___

Report To				Report For				Turnaround Time Requested (Rush for routine analysis subject to availability)
Company:	Covanta Energy			☐ Standard				◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Mckinney / Dan Skrypnyk			☑ PDF	☐ Excel	☐ Digital	☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	5150 Riverbend Drive			Email 1:	smckinney@covanta.com			○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Burnaby BC			Email 2:	dskrypnyk@covanta.com			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-521-1025	Fax:		Email 3:	sarah.wellman@metrovancouver.org			Analysis Request
		☐ Yes	☐ No		brent.kirkpatrick@metrovancouver.org			
					rjohnson4@covanta.com			
Invoice To	Same as Report ?			**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☐ No	Job #:				
Company:				PO / AFE:	Weekly Bottom Ash - Suite			
Contact:				LSD:	(includes 2:1 pH)			
Address:								
Phone:		Fax:		Quote #:				
Lab Work Order # (lab use only)				ALS Contact:		Sampler:		

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	CD-TCLP-VA(Cd and pH steps)	Number of Containers
	DBA1828-A-01-01	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-02	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-03	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-04	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-05	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-06	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-07	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-08	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-09	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-10	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-11	July 9 2018	9:00	Soil	X	1
	DBA1828-A-01-12	July 9 2018	9:00	Soil	X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Jul-18	15:30	HA	7/30	12:09P	24 °C				

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 30-JUL-18
Report Date: 08-AUG-18 15:47 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2138123

Project P.O. #: VANCO-0000047506
Job Reference: WEEKLY BOTTOM ASH-SUITE (INCLUDES 2:1 PH)

C of C Numbers:
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138123-1	L2138123-2	L2138123-3	L2138123-4	L2138123-5
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	10-JUL-18	10-JUL-18	10-JUL-18	10-JUL-18	10-JUL-18
Sampled Time					
Client ID	DBA1828-A-02-01	DBA1828-A-02-02	DBA1828-A-02-03	DBA1828-A-02-04	DBA1828-A-02-05
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	10.08	10.10	10.16	10.28	10.16
TCLP Metals 1st Preliminary pH (pH)	11.22	11.24	11.23	11.23	11.22
2nd Preliminary pH (pH)	8.94	8.80	8.90	9.01	8.76
Final pH (pH)	5.79	5.78	6.38	6.25	6.26
Extraction Solution Initial pH (pH)	2.90	2.90	2.90	2.90	2.90
Cadmium (Cd)-Leachable (mg/L)	0.113	0.145	0.121	0.126	0.093

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138123-6	L2138123-7	L2138123-8	L2138123-9	L2138123-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	10-JUL-18	10-JUL-18	10-JUL-18	10-JUL-18	10-JUL-18
	Sampled Time					
	Client ID	DBA1828-A-02-06	DBA1828-A-02-07	DBA1828-A-02-08	DBA1828-A-02-09	DBA1828-A-02-10
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.12	10.12	10.01	10.07	10.01
TCLP Metals	1st Preliminary pH (pH)	11.14	11.12	11.11	11.22	11.05
	2nd Preliminary pH (pH)	8.33	8.28	8.98	8.89	8.88
	Final pH (pH)	5.96	6.05	6.17	6.13	5.97
	Extraction Solution Initial pH (pH)	2.90	2.90	2.90	2.90	2.90
	Cadmium (Cd)-Leachable (mg/L)	0.796	0.267	0.153	0.114	0.109

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138123-11	L2138123-12			
	Description	Soil	Soil			
	Sampled Date	10-JUL-18	10-JUL-18			
	Sampled Time					
	Client ID	DBA1828-A-02-11	DBA1828-A-02-12			
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.16	10.19			
TCLP Metals	1st Preliminary pH (pH)	11.23	11.24			
	2nd Preliminary pH (pH)	9.04	9.44			
	Final pH (pH)	5.96	6.18			
	Extraction Solution Initial pH (pH)	2.90	2.90			
	Cadmium (Cd)-Leachable (mg/L)	0.105	0.112			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Cadmium (Cd)-Leachable	MS-B	L2138123-1, -10, -11, -12, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

L2138123-COFC

COC # _____ Page ____ of ____

Report To				Report		Service Requested (Rush for routine analysis subject to availability)
Company:	Covanta Energy			☐ Stan...		◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Mckinney / Dan Skrypnyk			☑ PDF ☐ Excel ☐ Digital ☐ Fax		○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	5150 Riverbend Drive			Email 1:	smckinney@covantaenergy.com	○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Burnaby BC			Email 2:	dskrypnyk@covanta.com	○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-521-1025	Fax:		Email 3:	sarah.wellman@metrovancouver.org	**Analysis Request**
		☐ Yes	☐ No		brent.kirkpatrick@metrovancouver.org	
					rjohnson4@covanta.com	
Invoice To	Same as Report ?			**Client / Project Information**		Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☐ No	Job #:		
Company:				PO / AFE:	Weekly Bottom Ash - Suite	
Contact:				LSD:	(includes 2:1 pH)	
Address:						
Phone:		Fax:		Quote #:		
Lab Work Order # (lab use only)				**ALS Contact:**	**Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	CD-TCLP-VA(Cd and pH steps)	Number of Containers
	DBA1828-A-02-01	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-02	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-03	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-04	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-05	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-06	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-07	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-08	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-09	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-10	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-11	July 10 2018	9:00	Soil	X	1
	DBA1828-A-02-12	July 10 2018	9:00	Soil	X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
[signature]	27-Jul-18	15:30	HA	7/30	1210P	24 °C				

GENF 20.00 Front

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 30-JUL-18
Report Date: 07-AUG-18 12:07 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2138127

Project P.O. #: VANCO-0000047506
Job Reference: WEEKLY BOTTOM ASH-SUITE (INCLUDES 2:1 PH)

C of C Numbers:
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138127-1	L2138127-2	L2138127-3	L2138127-4	L2138127-5
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18
Sampled Time					
Client ID	DBA1828-A-03-01	DBA1828-A-03-02	DBA1828-A-03-03	DBA1828-A-03-04	DBA1828-A-03-05
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	10.18	10.13	10.12	10.13	10.23
TCLP Metals 1st Preliminary pH (pH)	11.19	11.20	11.23	11.26	11.26
2nd Preliminary pH (pH)	8.39	8.19	7.66	7.33	7.73
Final pH (pH)	6.05	5.85	5.96	6.29	6.13
Extraction Solution Initial pH (pH)	2.91	2.91	2.91	2.91	2.91
Cadmium (Cd)-Leachable (mg/L)	0.190	0.262	0.208	0.171	0.193

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138127-6	L2138127-7	L2138127-8	L2138127-9	L2138127-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18	11-JUL-18
	Sampled Time					
	Client ID	DBA1828-A-03-06	DBA1828-A-03-07	DBA1828-A-03-08	DBA1828-A-03-09	DBA1828-A-03-10
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.24	10.21	10.19	10.15	10.12
TCLP Metals	1st Preliminary pH (pH)	11.20	11.27	11.28	11.27	11.25
	2nd Preliminary pH (pH)	7.98	8.31	8.24	8.44	7.73
	Final pH (pH)	6.13	6.24	6.12	6.20	6.10
	Extraction Solution Initial pH (pH)	2.91	2.91	2.91	2.91	2.91
	Cadmium (Cd)-Leachable (mg/L)	0.193	0.210	0.173	0.413	0.212

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138127-11	L2138127-12			
	Description	Soil	Soil			
	Sampled Date	11-JUL-18	11-JUL-18			
	Sampled Time					
	Client ID	DBA1828-A-03-11	DBA1828-A-03-12			
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.20	10.13			
TCLP Metals	1st Preliminary pH (pH)	11.19	11.24			
	2nd Preliminary pH (pH)	8.06	8.14			
	Final pH (pH)	5.82	5.80			
	Extraction Solution Initial pH (pH)	2.91	2.91			
	Cadmium (Cd)-Leachable (mg/L)	0.138	0.136			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

L2138127-COFC

COC #

Page ___ of ___

Report To				Report		Service Requested (Rush for routine analysis subject to availability)
Company:	Covanta Energy			☐ Stan		☐ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Mckinney / Dan Skrypnyk			☑ PDF ☐ Excel ☐ Digital ☐ Fax		☐ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	5150 Riverbend Drive			Email 1:	smckinney@covantaenergy.com	☐ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Burnaby BC			Email 2:	dskrypnyk@covanta.com	☐ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-521-1025	Fax:		Email 3:	sarah.wellman@metrovancouver.org	**Analysis Request**
		☐ Yes	☐ No		brent.kirkpatrick@metrovancouver.org	
					rjohnson4@covanta.com	
Invoice To	Same as Report ?			**Client / Project Information**		Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☐ No	Job #:		
Company:				PO / AFE:	Weekly Bottom Ash - Suite	
Contact:				LSD:	(includes 2:1 pH)	
Address:						
Phone:		Fax:		Quote #:		
Lab Work Order # (lab use only)				**ALS Contact:**	**Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	CD-TCLP-VA(Cd and pH steps)	Number of Containers
	DBA1828-A-03-01	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-02	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-03	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-04	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-05	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-06	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-07	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-08	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-09	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-10	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-11	July 11 2018	9:00	Soil	X	1
	DBA1828-A-03-12	July 11 2018	9:00	Soil	X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Jul-18	15:30	HA	7/30	12:09P	24 °C				

GENF 20.00 Front

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 30-JUL-18
Report Date: 13-AUG-18 15:16 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2138121

Project P.O. #: VANCO-0000047506
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: As per client request, certain samples were re-prepped from scratch and analyzed for TCLP Metals (TCLP Cd) in varying replicate amounts. Results are reported as samples #13-30, and have "REP" in the Client Sample ID field. Fluid determination was not performed for samples #13-30, as per client instructions. The prep data was taken from the original samples but is reported with the re-prepped samples for informational purposes.

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L2138121-1 Description: Soil Sampled Date: 12-JUL-18 Sampled Time: Client ID: DBA1828-A-04-01	L2138121-2 Soil 12-JUL-18 DBA1828-A-04-02	L2138121-3 Soil 12-JUL-18 DBA1828-A-04-03	L2138121-4 Soil 12-JUL-18 DBA1828-A-04-04	L2138121-5 Soil 12-JUL-18 DBA1828-A-04-05
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.23	10.16	10.18	10.22	10.24
TCLP Metals	1st Preliminary pH (pH)	11.13	11.18	11.27	11.19	11.23
	2nd Preliminary pH (pH)	7.68	7.73	7.97	8.11	8.19
	Final pH (pH)	6.16	6.23	6.28	6.36	6.41
	Extraction Solution Initial pH (pH)	2.90	2.90	2.90	2.90	2.90
	Cadmium (Cd)-Leachable (mg/L)	0.295	0.276	0.442	0.409	0.487

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2138121-6 Soil 12-JUL-18 DBA1828-A-04-06	L2138121-7 Soil 12-JUL-18 DBA1828-A-04-07	L2138121-8 Soil 12-JUL-18 DBA1828-A-04-08	L2138121-9 Soil 12-JUL-18 DBA1828-A-04-09	L2138121-10 Soil 12-JUL-18 DBA1828-A-04-10
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.23	10.24	10.25	10.27	10.31
TCLP Metals	1st Preliminary pH (pH)	11.16	11.12	11.22	11.17	11.20
	2nd Preliminary pH (pH)	7.75	8.14	8.44	8.15	8.97
	Final pH (pH)	6.38	6.30	6.32	6.39	6.37
	Extraction Solution Initial pH (pH)	2.90	2.90	2.90	2.90	2.90
	Cadmium (Cd)-Leachable (mg/L)	0.365	0.601	0.388	0.381	0.486

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138121-11	L2138121-12	L2138121-13	L2138121-14	L2138121-15
Description	Soil	Soil			
Sampled Date	12-JUL-18	12-JUL-18			
Sampled Time					
Client ID	DBA1828-A-04-11	DBA1828-A-04-12	DBA 1828-A-04-07 REP 1	DBA 1828-A-04-07 REP 2	DBA 1828-A-04-07 REP 3
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	10.23	10.14			
TCLP Metals 1st Preliminary pH (pH)	11.19	11.19	11.12	11.12	11.12
2nd Preliminary pH (pH)	9.03	8.48	8.14	8.14	8.14
Final pH (pH)	6.12	6.16	6.39	6.52	6.39
Extraction Solution Initial pH (pH)	2.90	2.90	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	2.09	1.46	0.370	1.18	0.450

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138121-16	L2138121-17	L2138121-18	L2138121-19	L2138121-20
Description					
Sampled Date					
Sampled Time					
Client ID	DBA 1828-A-04-07 REP 4	DBA 1828-A-04-07 REP 5	DBA 1828-A-04-07 REP 6	DBA 1828-A-04-11 REP 1	DBA 1828-A-04-11 REP 2
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)					
TCLP Metals 1st Preliminary pH (pH)	11.12	11.12	11.12	11.19	11.19
2nd Preliminary pH (pH)	8.14	8.14	8.14	9.03	9.03
Final pH (pH)	6.34	6.24	6.53	6.20	6.33
Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	0.361	0.424	0.399	0.464	0.545

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138121-21	L2138121-22	L2138121-23	L2138121-24	L2138121-25
Description	DBA 1828-A-04-11 REP 3	DBA 1828-A-04-11 REP 4	DBA 1828-A-04-11 REP 5	DBA 1828-A-04-11 REP 6	DBA 1828-A-04-12 REP 1
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)					
TCLP Metals 1st Preliminary pH (pH)	11.19	11.19	11.19	11.19	11.19
2nd Preliminary pH (pH)	9.03	9.03	9.03	9.03	8.48
Final pH (pH)	6.37	6.27	6.10	6.28	6.30
Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	0.513	0.909	0.459	0.436	0.459

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138121-26	L2138121-27	L2138121-28	L2138121-29	L2138121-30
Description					
Sampled Date					
Sampled Time					
Client ID	DBA 1828-A-04-12 REP 2	DBA 1828-A-04-12 REP 3	DBA 1828-A-04-12 REP 4	DBA 1828-A-04-12 REP 5	DBA 1828-A-04-12 REP 6
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)					
TCLP Metals 1st Preliminary pH (pH)	11.19	11.19	11.19	11.19	11.19
2nd Preliminary pH (pH)	8.48	8.48	8.48	8.48	8.48
Final pH (pH)	6.43	6.46	6.42	6.35	6.25
Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	0.412	0.475	0.389	0.551	0.530

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

(ALS) Environmental

Ch[illegible] L2138121-COFC

COC #

Page ___ of ___

Report To		Report [illegible]				[Servi]ce Requested (Rush for routine analysis subject to availability)
Company:	Covanta Energy	☐ Standa[rd]				◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Mckinney / Dan Skrypnyk	☑ PDF	☐ Excel	☐ Digital	☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	5150 Riverbend Drive	Email 1:	smckinney@covantaenergy.com			○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Burnaby BC	Email 2:	dskrypnyk@covanta.com			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-521-1025 Fax:	Email 3:	sarah.wellman@metrovancouver.org			**Analysis Request**
	☐ Yes ☐ No		brent.kirkpatrick@metrovancouver.org			
			rjohnson4@covanta.com			
Invoice To	Same as Report ?	**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?	☐ Yes ☐ No	Job #:				
Company:		PO / AFE:	Weekly Bottom Ash - Suite			
Contact:		LSD:	(includes 2:1 pH)			
Address:						
Phone:	Fax:	Quote #:				
Lab Work Order # (lab use only)		ALS Contact:		Sampler:		

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	CD-TCLP-VA(Cd and pH steps)	Number of Containers
	DBA1828-A-04-01	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-02	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-03	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-04	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-05	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-06	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-07	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-08	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-09	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-10	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-11	July 12 2018	9:00	Soil	X	1
	DBA1828-A-04-12	July 12 2018	9:00	Soil	X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
[signature]	27-Jul-18	15:30	[illegible]	7/30	1209P	24 °C				

GENF 20.00 Front

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 30-JUL-18
Report Date: 09-AUG-18 17:33 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2138122

Project P.O. #: VANCO-0000047506
Job Reference: WEEKLY BOTTOM ASH-SUITE (INCLUDES 2:1 PH)

C of C Numbers:
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138122-1	L2138122-2	L2138122-3	L2138122-4	L2138122-5
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	13-JUL-18	13-JUL-18	13-JUL-18	13-JUL-18	13-JUL-18
	Sampled Time	09:00	09:00	09:00	09:00	09:00
	Client ID	DBA1828-A-05-01	DBA1828-A-05-02	DBA1828-A-05-03	DBA1828-A-05-04	DBA1828-A-05-05
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	11.25	11.16	11.09	10.92	11.06
TCLP Metals	1st Preliminary pH (pH)	11.51	11.36	11.41	11.34	11.37
	2nd Preliminary pH (pH)	9.06	8.81	8.29	8.19	8.71
	Final pH (pH)	5.61	5.88	5.37	5.44	5.36
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.216	0.178	0.151	0.225	0.200

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138122-6	L2138122-7	L2138122-8	L2138122-9	L2138122-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	13-JUL-18	13-JUL-18	13-JUL-18	13-JUL-18	13-JUL-18
	Sampled Time	09:00	09:00	09:00	09:00	09:00
	Client ID	DBA1828-A-05-06	DBA1828-A-05-07	DBA1828-A-05-08	DBA1828-A-05-09	DBA1828-A-05-10
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	11.14	11.13	10.77	10.94	11.44
TCLP Metals	1st Preliminary pH (pH)	11.35	11.44	11.41	11.55	11.51
	2nd Preliminary pH (pH)	8.54	8.92	8.86	9.32	9.16
	Final pH (pH)	5.84	5.59	5.85	5.86	5.76
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.177	0.157	0.214	0.266	0.297

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138122-11	L2138122-12			
	Description	Soil	Soil			
	Sampled Date	13-JUL-18	13-JUL-18			
	Sampled Time	09:00	09:00			
	Client ID	DBA1828-A-05-11	DBA1828-A-05-12			
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	11.13	11.04			
TCLP Metals	1st Preliminary pH (pH)	11.41	11.47			
	2nd Preliminary pH (pH)	9.04	9.05			
	Final pH (pH)	5.89	5.98			
	Extraction Solution Initial pH (pH)	2.88	2.88			
	Cadmium (Cd)-Leachable (mg/L)	0.215	0.198			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

L2138122-COFC

COC # _____ Page ___ of ___

Report To				Report Format / Distribution				Service Requested (Rush for routine analysis subject to availability)
Company:	Covanta Energy			☐ Standard ☐ Other				◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Mckinney / Dan Skrypnyk			☑ PDF ☐ Excel ☐ Digital ☐ Fax				○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	5150 Riverbend Drive			Email 1:	smckinney@covantaenergy.com			○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Burnaby BC			Email 2:	dskrypnyk@covanta.com			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-521-1025	Fax:		Email 3:	sarah.wellman@metrovancouver.org			Analysis Request
		☐ Yes	☐ No		brent.kirkpatrick@metrovancouver.org			
					rjohnson4@covanta.com			
Invoice To	Same as Report ?			**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☐ No	Job #:				
Company:				PO / AFE:	Weekly Bottom Ash - Suite			
Contact:				LSD:	(includes 2:1 pH)			
Address:								
Phone:		Fax:		Quote #:				
Lab Work Order # (lab use only)				**ALS Contact:**		**Sampler:**		

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	CD-TCLP-VA(Cd and pH steps)										Number of Containers
	DBA1828-A-05-01	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-02	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-03	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-04	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-05	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-06	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-07	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-08	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-09	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-10	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-11	July 13 2018	9:00	Soil	X										1
	DBA1828-A-05-12	July 13 2018	9:00	Soil	X										1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Jul-18	15:30	HA	7/30	12:05PM	24 °C				

GENF 20.00 Front

Covanta Burnaby R.E., ULC
ATTN: Steve McKinney
5150 Riverbend Drive
Burnaby BC V3N 4V3

Date Received: 30-JUL-18
Report Date: 16-AUG-18 10:53 (MT)
Version: FINAL

Client Phone: 604-521-1025

Certificate of Analysis

Lab Work Order #: L2138124

Project P.O. #: VANCO-0000047506
Job Reference: WEEKLY BOTTOM ASH-SUITE (INCLUDES 2:1 PH)
C of C Numbers:
Legal Site Desc:

Comments: As per client request, certain samples were re-prepped from scratch and analyzed for TCLP Metals (TCLP Cd) in varying replicate amounts. Results are reported as samples #13-16, and have "REP" in the Client Sample ID field. Fluid determination was not performed for samples #13-16, as per client instructions. The prep data was taken from the original samples but is reported with the re-prepped samples for informational purposes.

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138124-1	L2138124-2	L2138124-3	L2138124-4	L2138124-5
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	14-JUL-18	14-JUL-18	14-JUL-18	14-JUL-18	14-JUL-18
Sampled Time					
Client ID	DBA1828-A-06-01	DBA1828-A-06-02	DBA1828-A-06-03	DBA1828-A-06-04	DBA1828-A-06-05
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	11.12	10.86	10.90	10.76	10.86
TCLP Metals 1st Preliminary pH (pH)	11.50	11.43	11.57	11.39	11.51
2nd Preliminary pH (pH)	9.50	7.57	8.83	8.50	8.74
Final pH (pH)	5.21	5.42	5.37	5.53	5.44
Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
Cadmium (Cd)-Leachable (mg/L)	0.146	0.143	0.151	0.172	0.169

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138124-6	L2138124-7	L2138124-8	L2138124-9	L2138124-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	14-JUL-18	14-JUL-18	14-JUL-18	14-JUL-18	14-JUL-18
	Sampled Time					
	Client ID	DBA1828-A-06-06	DBA1828-A-06-07	DBA1828-A-06-08	DBA1828-A-06-09	DBA1828-A-06-10
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	10.85	10.56	11.16	11.00	11.23
TCLP Metals	1st Preliminary pH (pH)	11.56	11.57	11.38	11.55	11.53
	2nd Preliminary pH (pH)	8.62	8.45	8.19	8.99	8.46
	Final pH (pH)	5.34	5.38	5.45	5.51	5.28
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.186	1.18	0.181	0.215	0.254

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2138124-11	L2138124-12	L2138124-13	L2138124-14	L2138124-15
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	14-JUL-18	14-JUL-18	14-JUL-18	14-JUL-18	14-JUL-18
Sampled Time					
Client ID	DBA1828-A-06-11	DBA1828-A-06-12	DBA1828-A-06-07 REP 1	DBA1828-A-06-07 REP 2	DBA1828-A-06-07 REP 3
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	11.12	10.79			
TCLP Metals 1st Preliminary pH (pH)	11.56	11.41	11.57	11.57	11.57
2nd Preliminary pH (pH)	8.81	8.88	8.45	8.45	8.45
Final pH (pH)	5.36	5.40	5.35	5.67	5.27
Extraction Solution Initial pH (pH)	2.88	2.88	2.91	2.91	2.91
Cadmium (Cd)-Leachable (mg/L)	0.250	0.202	0.149	0.188	0.160

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2138124-16				
	Description	Soil				
	Sampled Date	14-JUL-18				
	Sampled Time					
	Client ID	DBA1828-A-06-07 REP 4				
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)					
TCLP Metals	1st Preliminary pH (pH)	11.57				
	2nd Preliminary pH (pH)	8.45				
	Final pH (pH)	5.33				
	Extraction Solution Initial pH (pH)	2.91				
	Cadmium (Cd)-Leachable (mg/L)	0.266				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

L2138124-COFC

COC #

Page ___ of ___

Report To				Report				Service Requested (Rush for routine analysis subject to availability)
Company:	Covanta Energy			☐ Standard	☐ Other			☐ Regular (Standard Turnaround Times - Business Days)
Contact:	Steve Mckinney / Dan Skrypnyk			☑ PDF	☐ Excel	☐ Digital	☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	5150 Riverbend Drive			Email 1:	smckinney@covanta.com			○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Burnaby BC			Email 2:	dskrypnyk@covanta.com			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-521-1025	Fax:		Email 3:	sarah.wellman@metrovancouver.org			Analysis Request
		☐ Yes	☐ No		brent.kirkpatrick@metrovancouver.org			
					rjohnson4@covanta.com			
Invoice To	Same as Report ?			Client / Project Information				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☐ No	Job #:				
Company:				PO / AFE:	Weekly Bottom Ash - Suite			
Contact:				LSD:	(includes 2:1 pH)			
Address:								
Phone:		Fax:		Quote #:				
Lab Work Order # (lab use only)				ALS Contact:		Sampler:		

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	CD-TCLP-VA(Cd and pH steps)	Number of Containers
	DBA1828-A-06-01	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-02	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-03	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-04	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-05	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-06	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-07	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-08	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-09	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-10	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-11	July 14 2018	9:00	Soil	X	1
	DBA1828-A-06-12	July 14 2018	9:00	Soil	X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Jul-18	15:30	HA	7/30	12:09p	2.4 °C				

GENF 20.00 Front

October 25, 2018 Reference No. 18108461-003-L-Rev0

Brent Kirkpatrick, Lead Senior Engineer - Solid Waste Services
Metro Vancouver
4730 Kingsway
Burnaby, BC V5H 0C6

BOTTOM ASH STOCKPILE SAMPLING – COQUITLAM LANDFILL

Dear Mr. Kirkpatrick:

Metro Vancouver (MV) retained Golder Associates Ltd. (Golder) to carry out bottom ash stockpile sampling at Coquitlam Landfill (the Site), located at 995 United Boulevard, Coquitlam.

1.0 BACKGROUND

Metro Vancouver's Waste-to-Energy Facility is a mass-burn facility in which energy is produced by incinerating the garbage. Bottom ash is a by-product of the Waste-to-Energy Facility and is routinely sampled by Metro Vancouver. The purpose of the sampling is to assess bottom ash quality. If bottom ash meets the applicable regulations, it is set aside for disposal, or beneficial re-use in line with Metro Vancouver's Bottom Ash Management Plan (BAMP) as approved by the BC Ministry of Environment and Climate Change Strategy (BC ENV). If bottom ash does not meet applicable regulations, it is disposed as hazardous waste at a licensed disposal facility.

Golder understands that results from Metro Vancouver's routine sampling of bottom ash from July 12, 2018 indicated a high leachable cadmium content, which prompted further investigation of the bottom ash, specifically re-sampling in line with Metro Vancouver's BAMP, to assess the leachability of cadmium in the bottom ash.

2.0 SCOPE OF WORK

The scope of work generally included the following:

- Preparation of a site-specific health and safety plan (Golder deliverable reference 18108461-001-HASEP-Rev0).
- Collection of 27 composite samples (including three duplicate samples) from 12 bottom ash stockpiles.
- Laboratory analysis for leachable cadmium via the Toxicity Characteristic Leachate Procedure (TCLP) method.
- Data analysis and statistical evaluation of analytical results.
- Preparation of this technical memorandum.

Golder Associates Ltd.
Suite 200 - 2920 Virtual Way, Vancouver, British Columbia, V5M 0C4, Canada T: +1 604 296 4200 F: +1 604 298 5253

3.0 APPLICABLE REGULATIONS AND COMPARISON OF RESULTS

Metro Vancouver's BAMP identifies the *BC ENV Hazardous Waste Regulations* (HWR; including amendments up to BC Reg. 243/2016, 1 November 2017) as the applicable regulatory document for comparison against bottom ash sampling results. This regulation provides Leachate Quality Standards (LQSs) to determine whether soils and liquids are classified as Hazardous Waste.

The 90th percentile and 95% upper confidence limit on the mean of the leachable cadmium results from the bottom ash sampling were compared against the HWR LQS of 0.5 mg/L (see Section 5.0).

4.0 METHODOLOGY

The scope of work was carried out in accordance with Metro Vancouver's Bottom Ash Management Plan (see Attachment 1). The sampling methodology is briefly summarized below.

4.1 Field

The following steps were carried out in the field on September 4, 2018:

- One composite sample was collected from each half of the stockpile:
  - Three equally sized aliquots were obtained from each half of the stockpile by excavating at least 0.2 m into the stockpile at three different locations.
  - Each aliquot was placed in a laboratory sample bag to create a composite sample.
- Sample bags were labelled and placed in a cooler with freezer packs for preservation prior to being transported under chain-of-custody procedures to ALS Environmental in Burnaby, BC.

4.2 Laboratory

The following steps were carried out in the laboratory by ALS Environmental:

- Each sample was mixed thoroughly, then passed over a 3/8" screen.
- Material that did not pass over the 3/8" screen was crushed with a 4-pound hammer and re-passed over the 3/8" screen. Any material that still did not pass through the screen was weighed, then discarded.
- Material passing through the 3/8" screen was mixed thoroughly for 3 minutes and then sub-sampled for TCLP cadmium analysis.

4.3 Quality Control and Quality Assurance

A quality assurance/quality control (QA/QC) program was followed to produce interpretable, meaningful, and reproducible sampling and analytical data. In addition to procedures outlined in the BAMP, standard industry field procedures were used during the field investigation to help achieve reproducibility and minimize risk of cross-contamination. This involved using QA/QC measures in both the collection (field program) and analysis (laboratory) of samples. Specifically, the following was carried out:

- Clean disposable Nitrile™ gloves were used at each sampling location to prevent cross-contamination. Samples were subsequently transported to the laboratory using Golder chain-of-custody procedures; for example, within method- or laboratory-specified temperatures.
- Submission of three field duplicate samples (i.e., paired sample analyses). A field duplicate sample is a second sample from the same location that is submitted to the analytical laboratory under a separate label such that the laboratory has no prior knowledge that it is a duplicate. The relative percent difference (RPD) between paired sample results was used to assess field duplicate sample data. The RPD is a measure of the variability between two outcomes from the same procedure or process and is calculated by:

$$RPD(\%) = absolute\left(\frac{(x_1 - x_2)}{average(x_1, x_2)}\right) \times 100$$

- Samples were analyzed within method-specified hold times.
- ALS Laboratory's standard QA/QC program was followed, including analysis of lab duplicates and matrix spike recoveries.

4.4 Data Analysis

The BAMP specifies the process for statistical evaluation of the analytical data, which included the following for this sampling exercise:

- The option to analyse replicates. For this sampling event, the following samples were selected in consultation with MV for replication of analysis[1]:
  - BA-VLF-2A-0 – four replicates
  - BA-VLF-2B-0 – two replicates
  - BA-VLF-4A-1FD – five replicates
- Calculation of the 90th percentile and the 95% upper confidence limit of the mean, and subsequent comparison to the HWR LQS of 0.5 mg/L for cadmium.
- Where replicates or field duplicates were analyzed, the average of the primary and replicate(s) or field duplicate results was used for statistical evaluation.

[1] Additional replicates of these samples were requested, but sample volume limitations restricted the possible number of replicates for each sample.

5.0 RESULTS

Analytical results and statistics are presented on Table A after the text, and the laboratory certificate of analysis is presented in Attachment 2. Initial laboratory analytical results indicated concentrations of leachable cadmium ranging from 0.088 mg/L to 5.85 mg/L. Table 1 summarizes the statistical evaluation compared to the LQS; indicating that the 90th percentile (0.504 mg/L) does not meet the HWR LQS.

Table 1: Summary of Statistical Evaluation (mg/L)

Parameter	HWR LQS	90th Percentile	95% UCLM
Leachable Cadmium	**0.5**	**0.504**	0.367

Notes: UCLM = upper confidence limit on the mean

5.1 Quality Assurance / Quality Control

Field duplicate results are also presented on Table A. RPDs ranged from 3% to 191%, indicating a high degree of bottom ash heterogeneity, which is expected for this type of material. Table 2 presents the RPDs for each primary-field duplicate pair.

Table 2: Field Duplicate Results

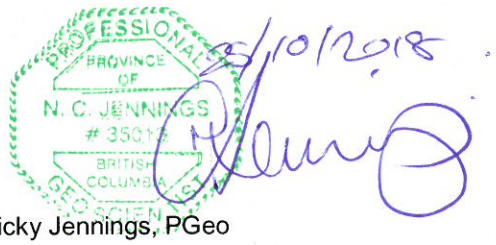
Sample Location	Sample Type	Leachable Cadmium (mg/L)	RPD (%)
BA-VLF-3A-1	Primary	0.376	65
	Field Duplicate	0.192	
BA-VLF-4A-1	Primary	0.140	191
	Field Duplicate	5.85	
BA-VLF-5A-0	Primary	0.225	3
	Field Duplicate	0.219	

6.0 CLOSING

We trust that the information presented in this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 604-296-4200.

Yours very truly,

Golder Associates Ltd.



Kathleen Edwards, EIT
Environmental Engineer

Nicky Jennings, PGeo
Associate

KE/NJ/lih

CC: Sarah Wellman, Metro Vancouver

Attachments: Table A – Bottom Ash Analytical Results
Attachment 1 – Bottom Ash Management Procedure
Attachment 2 – Laboratory Certificate of Analysis

https://golderassociates.sharepoint.com/sites/32478g/Deliverables/Issued to Client_For WP/18108461-003-L-Rev0/18108461-003-L-Rev0-Bottom Ash Results 25OCT_18.docx

Location	Sample ID	Sample Type	TCLP Leachable Cadmium (mg/L)	Average Concentration (Used for Statistics)
BA-VLF-1A-1	BA-VLF-1A-1	Primary	0.289	0.289
BA-VLF-1A-0	BA-VLF-1A-0	Primary	0.274	0.274
BA-VLF-1B-1	BA-VLF-1B-1	Primary	0.240	0.240
BA-VLF-1B-0	BA-VLF-1B-0	Primary	0.397	0.397
BA-VLF-2A-1	BA-VLF-2A-1	Primary	0.285	0.285
BA-VLF-2A-0	BA-VLF-2A-0	Primary	0.507	0.528
	BA-VLF-2A-0-REP1	Replicate 1	0.292	
	BA-VLF-2A-0-REP2	Replicate 2	0.334	
	BA-VLF-2A-0-REP3	Replicate 3	1.14	
	BA-VLF-2A-0-REP4	Replicate 4	0.369	
BA-VLF-2B-1	BA-VLF-2B-1	Primary	0.396	0.396
BA-VLF-2B-0	BA-VLF-2B-0	Primary	0.968	0.563
	BA-VLF-2B-0-REP1	Replicate 1	0.345	
	BA-VLF-2B-0-REP2	Replicate 2	0.376	
BA-VLF-3A-1	BA-VLF-3A-1	Primary	0.376	0.284
	BA-VLF-3A-1FD	FD	0.192	
BA-VLF-3A-0	BA-VLF-3A-0	Primary	0.321	0.321
BA-VLF-3B-1	BA-VLF-3B-1	Primary	0.187	0.187
BA-VLF-3B-0	BA-VLF-3B-0	Primary	0.140	0.140
BA-VLF-4A-1	BA-VLF-4A-1	Primary	0.140	0.89**
	BA-VLF-4A-1FD	FD	5.85	
	BA-VLF-4A-1FD-REP1	FD Replicate 1	0.719	
	BA-VLF-4A-1FD-REP2	FD Replicate 2	0.474	
	BA-VLF-4A-1FD-REP3	FD Replicate 3	0.724	
	BA-VLF-4A-1FD-REP4	FD Replicate 4	0.368	
	BA-VLF-4A-1FD-REP5	FD Replicate 5	1.71	
BA-VLF-4A-0	BA-VLF-4A-0	Primary	0.449	0.449
BA-VLF-4B-1	BA-VLF-4B-1	Primary	0.205	0.205
BA-VLF-4B-0	BA-VLF-4B-0	Primary	0.207	0.207
BA-VLF-5A-1	BA-VLF-5A-1	Primary	0.245	0.245
BA-VLF-5A-0	BA-VLF-5A-0	Primary	0.225	0.222
	BA-VLF-5A-0FD	FD	0.219	
BA-VLF-5B-1	BA-VLF-5B-1	Primary	0.223	0.223
BA-VLF-5B-0	BA-VLF-5B-0	Primary	0.143	0.143
BA-VLF-6A-1	BA-VLF-6A-1	Primary	0.136	0.136
BA-VLF-6A-0	BA-VLF-6A-0	Primary	0.150	0.150
BA-VLF-6B-1	BA-VLF-6B-1	Primary	0.088	0.088
BA-VLF-6B-0	BA-VLF-6B-0	Primary	0.113	0.113
			90th Percentile	**0.504**
			95% UCLM*	**0.367**

Notes: FD = Field duplicate

*Note: 95% BCA Bootstrap used based on >20 data points and no non-detects. Calculated with ProUCL 5.1 with bootstrapping set to 10000

** Average calculated by undertaking the following steps: 1) calculate average of FD and its replicates; 2) calculate average of primary sample results and average of FD and replicates.

ATTACHMENT 1

Bottom Ash Management Procedure

BRITISH COLUMBIA

January 30, 2014

File: 76780-35/MV/W2E
MR-01611

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8
Fax: 604 451-6180

Attention: **Paul Henderson**
General Manager, Solid Waste Services

Dear Mr. Henderson,

Re: Interim Bottom Ash Management Plan, Burnaby Waste-to-Energy Facility

Thank you for your January 24, 2014 email requesting the elimination of the first condition specified in the Ministry's November 7, 2012 letter approving the Bottom Ash Management Plan (BAMP) dated August 30, 2013. The first condition stated "No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the HWR".

The Ministry received the following supporting and summary documents:

- December 2013 – Final Report, Assessment of Sampling of Bottom Ash from Metro Vancouver Waste-to-Energy Facility, prepared by Hemmera;
- December 31, 2013 - Characterization of Bottom Ash Stockpiles at Vancouver Landfill from Weeks 24 and 25, prepared by Franz Environmental Inc; and
- January 22, 2014 – Sampling, Analysis and Evaluation of Bottom Ash at VLF, Bottom Ash Management Plan, prepared by Franz Environmental Inc.

Following review of the above documents and discussion with both City of Vancouver and Corporation of Delta staff, the Ministry agrees to change the first condition to the following:

1. A minimum of four replicates must be submitted for analysis for any result that exceeded two times the Leachate Quality Standards in schedule 4 of the HWR. The average of the original result and replicates must be included in the statistical analysis ensuring both the upper 90th percentile of the sample concentrations and upper 95 % confidence limit of the average concentrations are below the limit specified in the HWR; and

2. Should a replicate of the weekly sample also exceed the two times criteria, the daily samples for that week, must be analyzed in accordance with the BAMP.

.../2

Ministry of Environment South Coast Region
Environmental Protection Division
Mailing Address:
2nd Floor
10470 152nd Street
Surrey BC V3R 0Y3
Telephone: 604 582-5200
Facsimile: 604 584-9751
Website: www.gov.bc.ca/env

The Ministry considers the BAMP an interim plan and must be finalized as part of the conditions in the operational certificate for the Burnaby Waste-to-Energy facility currently being considered by the Director.

Therefore all bottom ash, either currently stored at the Vancouver Landfill (VLF) or generated in advance of a final plan being approved by the Ministry, that meets the requirements of the BAMP and conditions stated in the Ministry's November 7, 2013 letter, as further amended above, can be disposed of at the VLF as municipal solid waste.

This letter shall not be construed as a waiver of any lawful requirement pertaining to any unauthorized discharge of waste to the environment, and is without prejudice to any further legal action that the Ministry may take under the *Environmental Management Act.*

A copy of the *Environmental Management Act* can be downloaded from the internet at the following web link: http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm

If you have any questions, please contact the undersigned at (604) 582-5272.

Sincerely,

Avtar S. Sundher
Head, Government and Compliance Section
South Coast Region

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Albert Shamess, Director, Waste Management & Resource Recovery, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head Clean Technologies, Victoria

metrovancouver
4330 Kingsway, Burnaby, BC, Canada V5H 4G8 604-432-6200 www.metrovancouver.org

Solid Waste Services
Tel. 604-432-6442 Fax 604- 451-6180

August 30, 2013

File: SW-02-02-WTEF-10-04

Mr. Avtar Sundher, Head
Government and Compliance Section
South Coast Region
Environmental Protection Division
Ministry of Environment
2nd Floor, 10470-152nd Street
Surrey, BC V3R OY3

Dear Mr. Sundher:

Re: Bottom Ash Management Plan

I refer to your letter dated July 4, 2013 approving Metro Vancouver's Interim Bottom Ash Management Plan.

As requested, this letter details a proposed Bottom Ash Management Plan for the ash generated at Metro Vancouver's Waste-to-Energy Facility. The letter also addresses the ten conditions specified in your letter. We have attached your letter for reference.

The City of Vancouver and Corporation of Delta have not reviewed the proposed Bottom Ash Management Plan. We propose to meet jointly with the Ministry of Environment, City of Vancouver, the Corporation of Delta, Covanta Burnaby Renewable Energy (the operator of the Waste-to-Energy Facility), and our consultants to go through the details of the Plan and solicit input from Vancouver and Delta.

Call me if you have any questions.

Yours truly,

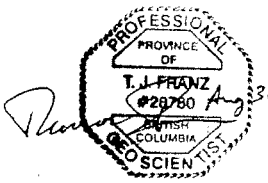
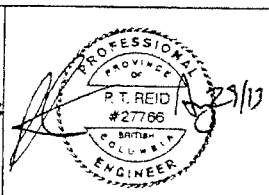
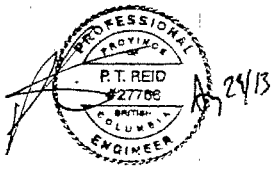
Paul Henderson, P.Eng.
General Manager, Solid Waste Services

PH/BK/jmb

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Lynn Belanger, Manager, Transfer and Landfill Operations, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head, Clean Technologies, Victoria
Shelley Metcalfe, Head, Business and Standards Section, Ministry of Environment, Surrey

Attachments: Index of Documents and Responsible Authors
Attachment 1: Bottom Ash Management Plan
Attachment 2: EMS Operational Procedure No. BA2
Attachment 3: Week 16 pH Assessment
Attachment 4: Contingency Disposal Plan
Attachment 5: Source Control Measures and WTEF Improvements
Attachment 6: Beneficial Reuse of Bottom Ash Reinstatement
Letter dated July 4, 2013 from Ministry of Environment to Metro Vancouver

INDEX

Attachment #		Responsible Author(s)		MoE Conditions[1] Addressed
1.	Bottom Ash Management Plan	 Thomas Franz, M.Sc., P.Geo Franz Environmental Inc.	 Peter T. Reid, M.Eng., P.Eng Hemmera Envirochem Inc.	1, 2, 4, 5, 7
2.	EMS Operational Procedure No. BA2	 Peter T. Reid, M.Eng., P.Eng Hemmera Envirochem Inc.	M. Neild Aug 29, 2013 Matthew Neild, Facility Manager, Covanta Burnaby	6
3.	Week 16 pH Assessment	 Peter T. Reid, M.Eng., P.Eng Hemmera Envirochem Inc.		3
4.	Contingency Disposal Plan	Not Applicable		8
5.	Source Control Measures and WTEF Improvements	Not Applicable		9
6.	Beneficial Reuse of Bottom Ash Reinstatement	Not applicable		10

[1] MoE Conditions as detailed in the July 4, 2013 letter to Metro Vancouver.

This page left blank intentionally

ATTACHMENT 1

Bottom Ash Management Plan

The Bottom Ash Management Plan addresses MoE conditions 1, 2, 4, 5, 7 which are included below for reference.

Condition 1:

The upper 90th percentile of the sample concentrations is less than the limits specified in the HWR.

Condition 2:

No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the Hazardous Waste Regulation (HWR).

Condition 4:

Bottom ash must be stored in daily segregated waste piles at the Vancouver Landfill until the waste is fully characterized.

Condition 5:

In addition to the weekly composite samples that are submitted for laboratory analysis, daily composite samples must be collected and stored. In the event there are exceedances in the weekly composite sample results that do not meet the Interim Bottom Ash Management Plan as conditionally approved, the daily composite samples must analyzed for further characterization of the bottom ash.

Condition 7:

Weekly laboratory results are to be submitted to the Ministry as soon as they become available and no later than within 3 weeks of sample collection, containing all applicable parameters related to the authorization of the Burnaby Waste-to-Energy facility.

This page left blank intentionally

Bottom Ash Management Plan

The Bottom Ash Management Plan (Plan) presented herein provides a comprehensive set of procedures for sampling and data analysis and evaluation of bottom ash generated at the Metro Vancouver Waste-to-Energy Facility (WTEF). The Plan provides detailed methodology to undertake the following steps:

1. bottom ash sample collection at the WTEF
2. weekly composite sample laboratory analysis
3. statistical evaluation of analytical data
4. daily sample laboratory analysis
5. bottom ash sample collection at the Vancouver Landfill (VLF)

The attached Bottom Ash Management Plan Flowchart (flowchart) provides a step-by-step guide for implementation of the Plan. The following sections detail each step of the Plan outlined above.

1.0 Bottom Ash Sample Collection at the WTEF

Bottom ash generated at the WTEF is transported on a regular basis to VLF (i.e. up to 4 or 5 loads per day), where it is offloaded in an approved designated bottom ash stockpile area. The ash is deposited into segregated stockpiles, which are staked and labeled to identify the week number and day the load was received at the landfill.

Prior to transport, weekly and daily bottom ash samples are collected by WTEF staff from bottom ash destined for the VLF. The methodology for sample collection and handling at the WTEF is described in Covanta's Operational Procedure ("EMS Operational Procedure No. BA2 - Bottom Ash Sampling").

2.0 Weekly Composite Sample Laboratory Analysis

Weekly composite bottom ash samples collected using the methods described in Section 1.0 are sent to ALS Environmental (ALS) or equivalent for the following chemical analysis:

- Leachate analysis by Toxicity Characteristic Leaching Procedure (TCLP) Method 1311;
- pH analysis in accordance with "pH, Electrometric, Soil and Sediment – Prescriptive", as prescribed in the British Columbia Ministry of Environment (BC MoE) 2009 British Columbia Environmental Laboratory Manual.

Refer to the flowchart for information on the protocol for the number of samples analyzed. Analytical data received from the laboratory is evaluated using the methodology detailed in the flowchart and in Section 3.0 below.

Laboratory results for weekly bottom ash will be submitted to the Ministry within three (3) weeks of sample collection. The WTE facility will hold all daily and weekly bottom ash sample material for a minimum of four (4) weeks after the decision is made to landfill the material at VLF.

3.0 Statistical Evaluation of Analytical Data

Bottom ash analytical data are statistically evaluated to assess the nature of the bulk material. The evaluation methodology has been developed utilizing the following guidance documents:

- BC MoE, Technical Guidance 1: Site Characterization and Confirmation Testing
- BC MoE, Technical Guidance 2: Statistical Criteria for Characterizing a Volume of Contaminated Material
- EPA530-R-95-036, Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic, Office of Waste, U.S. Environmental Protection Agency

From these documents, the following criteria are utilized to determine parameter concentrations of the bulk bottom ash material and to evaluate the material relative to the BC MoE Hazardous Waste Regulation, including Schedule 4 Leachate Quality Standards:

- The data is examined to determine if all data points belong to the same population and if outliers exist. Based on an evaluation of the statistics of the data to date, samples with concentrations greater than twice the standard were in all cases identified as statistical outliers, and therefore, individual samples with concentrations greater than twice the standard do not preclude the statistical evaluation of the bulk material. Instead, an additional evaluation is conducted when outliers with concentrations greater than twice the standard are present (see Section 3.1 below).
- The 90th percentile of the data set is below the applicable standard for the parameter (see Section 3.2 below).
- The 95% upper confidence limit (UCL) of the mean is below the applicable standard for the parameter (see Section 3.3 below).

Based on an evaluation of the weekly composite sample analytical data against the above three criteria, one of the two following scenarios will apply:

1. Weekly bottom ash stockpiled at the VLF that meets the evaluation criteria above will be moved for disposal or beneficial use (upon reinstatement of beneficial use designation at the VLF by BC MoE).
2. Weekly bottom ash stockpiled at the VLF that does not meet the evaluation criteria above will be subjected to further sampling and analysis utilizing the daily bottom ash samples retained at the WTEF. Stockpiled bottom ash from the corresponding week will remain segregated and intact at VLF while further characterization work is performed.

The following sections describe the rationale for applying the outlier test (twice-the-standard evaluation criteria), 90th percentile and 95% UCL of the mean evaluation criteria.

3.1 Outlier Analysis (Twice the Standard)

If any sample result or laboratory duplicate sample[1] is identified as an outlier with a concentration greater than twice the standard, then two replicate samples[2] will be analyzed for the identified parameter(s) (i.e. the parameter(s) that exhibited concentrations greater than twice the standard) from the original sample bottle from which the original laboratory aliquot was obtained. This procedure is supported by BC MoE Technical Guidance 12-8 "Outliers" and EPA530-R-95-036. Outliers will be determined by a statistically appropriate outlier test; based on data available to-date, all concentrations above twice the standard were identified as statistical outliers with high statistical confidence.

A data point can be an outlier for two reasons: 1) either there was an error in the sampling/analysis program and the data point is a false positive; or 2) the data point is from a separate population with higher concentrations (contamination). The two replicate samples from the original sample bottle will determine the case:

- If all three sample concentrations are above twice the standard they will be averaged.
- If two sample concentrations are above twice the standard and one is below the standard then the two sample concentrations above the standard will be averaged and used, while the value below the standard will be discarded.
- If only one sample concentration is above twice the standard and the remaining two are below then the one sample above twice the standard will be discarded and the other two will be averaged.

[1] a lab duplicate sample is a sample completed at random by the lab to verify the laboratory process is operating within the tolerances for the method

[2] a replicate sample is a targeted duplicate sample where there is an unexpected laboratory result and two additional samples are obtained to verify the original result

In addition to obtaining two replicate samples from the original sample bottle a more in-depth analysis will be conducted into the daily samples used to create the composite sample as explained below.

3.2 90th Percentile of the Data Set

The 90th percentile will be incorporated into the statistical analysis procedure, it is understood that the referenced statistic originates in BC MoE Technical Guidance 2: Statistical Criteria for Characterizing a Volume of Contaminated Material and the U.S. Environmental Protection Agency (USEPA) EPA530-R-95-036, Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic from the Office of Waste.

Prior to calculating the 90th percentile, the data need to undergo a quality assurance process for outliers, as discussed above. The 90th percentile will be calculated utilizing the percentile function in Microsoft Excel, which is the requested method by the BC MoE for background groundwater submissions and is analogous to the method specified in EPA530-R-95-036. Non-detects will be considered at the detection limit in performing this calculation.

3.3 95% Upper Confidence Limit of the Mean of the Data Set

The upper 95% confidence limit of the mean (95% UCL) will be incorporated into the statistical analysis procedure. It is understood that the referenced statistic originates in BC MoE Technical Guidance 2: Statistical Criteria for Characterizing a Volume of Contaminated Material and the U.S. Environmental Protection Agency (USEPA) EPA530-R-95-036, Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic from the Office of Waste.

Prior to calculating the 95% UCL, the data need to undergo a quality assurance process for outliers, as discussed above. The 95% UCL will be calculated utilizing the UCL function in Microsoft Excel, which is the requested method by the BC MoE for background groundwater submissions and is analogous to the method specified in EPA530-R-95-036. Non-detects will be considered at the detection limit in performing this calculation.

4.0 Daily Sample Laboratory Analysis

Under the circumstances described below, in order to create a sufficiently reliable database for evaluating bottom ash, additional laboratory analyses and evaluations will be completed on daily ash samples that will be archived at the WTEF. These additional analyses and evaluation steps are subject to future review and revision.

In the event that the 90th percentile or the 95% UCL of the weekly data is greater than the standard, or when at least one discrete sample is an outlier (which will typically include

samples with concentrations greater than twice the standard), the following procedure will be conducted in concert with the previous actions.

The following procedure is based on the composite sampling procedure in BC MoE Technical Guidance 1 - Site Characterization and Confirmation Testing (Technical Guidance 1). As the weekly composite samples are a composite of daily samples, it is possible that there is one day that is causing the elevated results, an offending nugget in the aliquot selected by the lab, or an issue with the municipal solid waste delivered to the WTEF. Therefore, the following test procedures are recommended to further examine the material characterized for the week by the original composite sample:

1. Each of the daily composite sample buckets for the week will be processed at the WTEF in accordance with Covanta EMS Operational Procedure No. BA2 to obtain twelve sub-samples (for each day).
2. Each day's sub-samples will be forwarded to ALS or equivalent for testing for the identified parameter(s).
3. Each day's sub-samples will be evaluated as follows:
    - For TCLP metals:
        - Outliers will be identified and processed as described in Section 3.1.
        - If the 90th percentile and the 95% UCL for the entire week are less than the standard, then the original weekly results will be discarded as an error, no further action will be taken, and the weekly ash will be classified as non-hazardous (subject to confirmation of non-hazardous pH).
        - If the 90th percentile or the 95% UCL for the entire week is greater than the standard or if at least one sub-sample is greater than twice the standard then the 90th percentile and 95% UCL will be calculated for each day. If the 90th percentile or 95% UCL for a specific day(s) is greater than the standard or if at least one sub-sample is greater than twice the standard, additional investigation limited to the day(s) in question will occur at VLF, as described in Section 5.0 below.
    - For pH:
        - If any individual pH result is greater than 12.5 then a statistical analysis will be completed. The 95% UCL and the 90th percentile of the distribution pH will be calculated using a log transform of the data as pH is a logarithmic scale.
        - If the 90th percentile and the 95% UCL are less than the standard the result will be discarded as an error.
        - If the 90th percentile or the 95th UCL is greater than the standard additional investigation limited to the day(s) in question will occur at VLF, as detailed in Section 5.0 below.

5.0 Bottom Ash Sample Collection at the VLF and Data Evaluation

Until the material is fully characterized, bottom ash generated by the WTEF will be delivered and stored in designated areas within the leachate collection system at VLF. Each individual load will be staked with the day of delivery by the hauler. Metro Vancouver will work with the City of Vancouver to develop an area on the VLF where a minimum of three weeks of bottom ash can be stockpiled.

In the event that evaluation of the daily samples identifies additional stockpile sampling requirements as described above, the bottom ash stockpiles corresponding to the day(s) requiring further assessment will be sampled in accordance with the following procedure. These additional laboratory analyses and evaluations will be completed on ash stockpiles at the VLF in order to create a sufficiently reliable database for evaluating bottom ash. These additional analyses and evaluation steps are subject to future review and revision.

5.1 Sampling Methodology and Laboratory Analysis

The sampling methodology is described on the attached flowchart which has been derived according to BC MoE Technical Guidance 1: Site Characterization and Confirmation Testing. This methodology was devised for conducting samples at a contaminated site rather than sampling an industrial waste stream. Under Technical Guidance 1, in-situ sampling is preferred and with material designated as suspect hazardous waste, the guidance indicates that one sample should represent 5 cubic metres (m^3) of in-situ material. In the case of the bottom ash, the ash material is held in one specific area where the individual dump loads can be identified, however, a stockpile has not been formed. Therefore, Technical Guidance 1, Part II. Batch Testing of Suspect Material in Stockpile (Ex Situ) is followed for sample collection at an in-situ sampling density.

In the following, each truckload or trailerload of ash material dumped at the VLF is referred to as a “load”; each load has a volume of approximately 8 to 10 m^3. Two samples will be obtained from each load, representing a “half-load” with a volume of 4 to 5 m^3. The combined loads from one day are referred to as a “stockpile” (even if they are not physically combined into one pile).

The sampling procedures for the characterization of ash are described in Section 5.1.1. However, for the special situation of very small ash volumes (i.e. less than 5 truck or trailer loads), refer to Section 5.1.2.

5.1.1 Stockpile Sampling Procedure

For the characterization of stockpiled bottom ash, the following site procedure will be utilized (for small stockpiles, please refer to Section 5.1.2):

1. If daily loads can be identified, then each day's ash will be considered to be a stockpile and will be assessed separately.
    i. If it is not possible to identify which loads originated on a specific day of the week (as is the case for weeks 13-24 and 13-25), then adjacent loads will be combined into a stockpile in order to obtain at least 10 samples and no more than 32 samples (plus duplicates) from each stockpile that will be prepared by the procedures described below. If possible, stockpiles should be arranged such that 20 samples are obtained from each stockpile (two samples are obtained from each load).
2. The individual truck or trailer loads will be visually surveyed and two labeled stakes will be placed in each individual pile; each stake will represent the respective half of the load.
    i. The stakes will be labeled A and B.
3. A sample will be obtained from each half-load by the following:
    i. Obtain a minimum of three equally sized aliquots from three different areas of the A side by excavating at least 20 cm into the face of the pile. Each aliquot should be a minimum of approximately 250 mL in volume.
    ii. Place all the aliquots into a clean 2.5 gallon bucket.
    iii. Seal the bucket and label as "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day of the week (1 to 7), A=A or B identifying the A or B side of the half-load, X= sequential numbering from 1 to n (where n is the number of loads included in the stockpile).
    iv. At a suitable location, process the material to create a composite sample for the half-load, as follows:
        a. Place material from the bucket onto a sheet of plywood or into a suitably sized stainless steel bowl and mix thoroughly for 1 minute.
        b. Pass the material over a 3/8" (9.5 mm) screen.
        c. Material that does not pass through the screen is to be subjected to a particle size reduction step. Make sure to weigh the amount of >3/8" material prior to size reduction and record on the worksheet.
            - In the particle size reduction step, materials are reduced in size by mechanical crushing with a 4 pound hammer and then passed over the 3/8" screen again. Do not work the material excessively (i.e. do not over crush and create a lot of fines).
            - Material (including metal) that does not pass through the 3/8" screen and cannot be reduced in size is discarded. Ensure the weight of this material is noted on the worksheet.
        d. Mix all the material that has passed through the 3/8" screen thoroughly on a piece of plywood or into a suitably sized stainless steel bowl. Ensure large and small material is mixed thoroughly for at least three minutes.

e. Cone and divide the composited material into 4 equal portions (quarters).
f. Place this ash into one (1) 500ml sample container by scooping material from each quarter. Put small scoops in the container until it is full. Ensure the sample container is filled to the top. Discard the remaining material back to the stockpile at VLF from which the material was collected.
g. Label the sample containers with "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A or B identifying the A or B side of the half-load, X=sequential numbering from 1 to n (where n is the number of loads for that day).

v. For one in ten samples (or portion of 10), a duplicate sample will be prepared and analyzed as a blind duplicate and will be prepared as follows:
   a. When a duplicate sample is to be prepared, then step 3.iv.f is amended as follows: fill the original and duplicate containers by putting small scoops into the containers until they are full by alternating between the two containers (i.e. do not fill them sequentially; alternating between containers will ensure the sampling procedures are maintained as uniform as possible and result in as near-replicated samples as possible).
   b. Label the duplicate sample container with "BA-VLF-YY-WW-DD-A-100+X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A or B, 100+X=the number identifying the load (same number as the original sample) plus 100. For example, the duplicate for BA-VLF-13-37-A-3 will be BA-VLF-13-37-A-103.
vi. Decontaminate all sampling equipment according to standard SOPs.
vii. Repeat on the B side.
viii. Repeat for all individual loads.

4. Based on this procedure, for analysis of bottom ash from one day, a minimum of six aliquots per load will be obtained for two laboratory samples (a minimum of three aliquots will be composited from each of the A and B side). Therefore, for example, for a day with ten piles (5 trucks and trailers), a minimum of 60 aliquots will be obtained and composited into 20 samples for the stockpile.
5. All samples will be submitted to ALS or equivalent for analysis of TCLP metals and/or pH (2:1) for the identified parameter(s).

5.1.2 Special Considerations for Small Stockpiles

If only a small amount of bottom ash (i.e. fewer than 5 loads, i.e. fewer than 3 haul trips of a truck and trailer combination) was delivered to VLF for a given day, the procedure under 5.1.1 is modified as follows:

1. All the day's ash will be considered to be a single stockpile and will be assessed separately.
2. The individual truck or trailer loads will be visually surveyed and a sufficient number of labeled stakes will be placed in each individual load to obtain a minimum of 10 samples. For example, if there is 1 load, then 10 stakes will be placed into that load. If there are 2 loads, each load will be subdivided into 5 equal parts and staked. If there are 3 loads, each load will be subdivided into 4 equal parts and staked. If there are 4 loads, each load will be subdivided into 3 equal parts and staked.
    i. The stakes will be labeled A, B, C… as required.
3. A sample will be obtained from each staked portion by the following:
    i. Obtain a minimum of three equally sized aliquots by excavating at least 20 cm into the face of the pile. Each aliquot should be a minimum of approximately 250 mL in volume.
    ii. Place all the aliquots into a clean 2.5 gallon bucket.
    iii. Seal the bucket and label as "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day of the week (1 to 7), A=A, B, C… identifying the portion of the ash, X= sequential numbering from 1 to n (where n is the number of loads included in the stockpile).
    iv. At a suitable location, process the material to create a composite sample, as under Section 5.1.1. Label the sample containers with "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A, B, C… identifying the staked portion of the ash, X=sequential numbering from 1 to n (where n is the number of loads for that day).
    v. For one in ten samples (or portion of 10), a duplicate sample will be prepared and analyzed as a blind duplicate and will be prepared as described in Section 5.1.1. Label the duplicate sample container with "BA-VLF-YY-WW-DD-A-100+X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A, B, C… identifying the staked portion of the ash, 100+X=the number identifying the load (same number as the original sample) plus 100. For example, the duplicate for BA-VLF-13-37-A-3 will be BA-VLF-13-37-A-103.
    vi. Decontaminate all sampling equipment according to standard SOPs.
    vii. Repeat for all remaining staked portions (i.e. B, C… etc.).
    viii. Repeat for all individual loads.
4. All samples will be submitted to ALS or equivalent for analysis of TCLP metals and/or pH (2:1) for the identified parameter(s).

5.2 Data Assessment Methodology

The results from each stockpile will be assessed as follows:

- The data is examined to determine if it all belongs to the same population and if outliers exist. Outliers will be removed from the data set; the remaining analysis is performed

on the data set representing the ash from one entire day (i.e. typically 10 to 30 samples).
- The 90th percentile of the data set is below the standard for the parameter.
- The 95% UCL is below the applicable standard for the parameter.

6.0 Stockpile Management

Bottom ash stockpiled at VLF that meets the evaluation criteria will be moved for disposal or beneficial use (upon reinstatement of beneficial use designation at VLF by BC MoE).

Upon determination that a portion of stockpiled bottom ash does not meet the evaluation criteria, to minimize the infiltration of water, the offending portion of the bottom ash will be covered by the hauling contractor with a tarp using weights to secure and regularly checked by the hauling contractor until such time that the material is removed from VLF and disposed at an approved facility.

7.0 Classification of Stockpiles at VLF for Weeks 13-24 and 13-25

The bottom ash data collected from week 13-24 and week 13-25 had individual sample concentrations that were twice the applicable standard; however this data was not able to be replicated in the laboratory. Daily ash samples were not routinely archived in the past, and therefore, daily samples are not available for those two weeks for conducting a daily sample laboratory analysis and evaluation. Therefore, the bottom ash material was segregated at the landfill and additional sampling and evaluation will occur from these piles as described in Section 5 and will be managed in accordance with Section 6.

Bottom Ash Management Plan Flowchart

Weekly Composite Samples

Lab Analysis
TCLP + pH 2:1

Data Evaluation of Weekly Composite Samples by Individual Parameter

Parameter(s) Meet Requirements

No Further Work

For weekly and daily sample collection/preparation refer to Covanta EMS Operational Procedure No. BA2

Parameter(s) Do Not Meet Requirements

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

Lab Analysis of Daily Composite Samples by Day for Identified Parameter(s)

Data Evaluation of Daily Composite Samples by Day for Identified Parameter(s)

Parameter(s) Do Not Meet Requirements

Parameter(s) Meet Requirements

No Further Work

Sample Daily Stockpiles at the Landfill for each Day Identified

Refer to the Bottom Ash Management Plan. Each stockpile is marked with a stake identifying the date it was received at the landfill.

Lab Analysis for Identified Parameter(s)

Data Evaluation of Stockpiled Composite Samples for Identified Parameter(s)

Parameter(s) meet Requirements

No Further Work

Parameter(s) Do Not Meet Requirements

Material Removed from VLF and Disposed at an Approved Facility

Orbit: 7733025 (Visio)
7734097 (PDF)

This page left blank intentionally

ATTACHMENT 2

EMS Operational Procedure No. BA2

The EMS Operational Procedure No. BA2 addresses MoE condition 6 which is included below for reference.

Condition 6:

Develop a detailed sampling protocol describing how samples of bottom ash are collected (both daily and weekly composites) prior to submission to the laboratory. A qualified professional must be consulted to ensure that analytical data derived from these samples can be statistically evaluated with supporting arguments.

This page left blank intentionally

EMS OPERATIONAL PROCEDURE No. BA2

Matt Neild Digitally signed by Matt Neild DN: cn=Matt Neild, o=Covanta Burnaby Renewable Energy, ou, email=mneild@covanta energy.com, c=CA Date: 2013.08.28 18:23:21 -07'00'

Bottom Ash Sampling

I PURPOSE

The purpose of this procedure is to:

1. Define the steps necessary to create and process a representative bottom ash weekly composite suitable for laboratory TCLP testing.
2. Define the steps to be taken to create a representative bottom ash daily composite sample
3. Minimize employee exposure to the bottom ash and to the dust generated by the bottom ash during sampling.

II REFERENCES

1. Bottom Ash and Treated Bottom Ash Safety Data Sheet
2. Directive D0001 – Routine Duties to be Performed Each Shift
3. Directive D0002 – Routine Duties to be Performed Each Week
4. Directive D0005 – Plant Housekeeping Duties
5. EMS Book 2 - Training Module #5 - Sewer & Storm Water Discharges.
6. US EPA Method 1311
7. All related JSA's

III GENERAL & DEFINITIONS

As per the BC Hazardous Waste Regulation, the toxicity characteristic of bottom ash is determined using an extraction procedure described in US EPA Method 1311. If this test produces an extract with a contaminant concentration is equal to or greater than those prescribed in Table 1 of Schedule 4 of the Regulations, the waste is considered to be hazardous. US EPA Method 1311 is commonly called the Toxicity Characteristic Leaching Procedure (TCLP).

There are 92 potential contaminates listed in Table 1 of Schedule 4. However, contaminants that are not present in the waste, or are present in such low concentrations that the regulatory limits could not be exceeded, need not be included in the TCLP test. An example of this is volatile organics; these are not expected to be found in the bottom ash since furnace temperatures exceed the boiling points of the compounds. 12 metals are regulated by Schedule 4 and are TCLP tested. Historically, in this facility and similar facilities worldwide, the bottom ash contaminants of most concern are lead and cadmium.

The TCLP test uses a minimum of 100 grams of sample; therefore, the sampling plan is a critical component in accurately determining the toxicity characteristic of the bottom ash. The objective of the sampling plan is to obtain a representative sample of the ash which exhibits the average properties of the ash as a whole. Composite sampling is used as it provides a good characterization of the variability in the bottom ash.

In this procedure, composite sampling is defined as the collection of a defined number of daily samples at a specified frequency. These samples are mixed together to form a single weekly composite. This single sample is then analyzed at the lab using the TCLP. Sampling procedures are used to describe the specific details of the different types of composite samples that may be collected. In all cases, the objective is to ensure enough samples are collected over a suitable period of time to represent the variability in the bottom ash. A suitable sampling plan will allow measurements that are both accurate and precise (repeatable).

IV PROCEDURES

This procedure defines the methods used to collect both a weekly (defined as 12:00am Sunday to 12:00 midnight the following Saturday) and daily composite bottom ash sample:

WEEKLY COMPOSITE SAMPLE

i. At the beginning of each day shift, obtain a sample from the ash crane bucket with ash from #1 Boiler pit. The sample must weigh approximately 1 kg and is to be obtained by filling the ash crane clamshell bucket with ash from the pit and then using a shovel to take a representative sample from the accessible points of the bucket. A representative sample is defined as collecting material in approximately the same proportion as the fine and larger material observed in the bucket. The sampled material is to be stored in a clean 2.5 gallon bucket. Ensure the container is clean prior to use.

ii. Repeat the above step for bottom ash from #2 and #3 storage pits.

iii. At the end of each day shift, repeat steps (i) and (ii). A total sample of approximately 6 kg per day must be collected for the weekly composite.

iv. Take the bucket with each day's portion of the weekly bottom ash sample and deposit into the wagon located in the Turbine Hall basement.

v. At the end of 7 days of sampling, the wagon will contain approximately 42 kg of material, ready for processing.

vi. After the weekly wagon storage pile is complete (7 days of samples), place the entire sample on a sheet of plywood and mix thoroughly. Do not discard any ash.

vii. Take a sub-sample of the weekly storage pile and, using the Sample Processing Procedure (see Section V below), process enough bottom ash to fill twelve (12) 500 mL sample bottles. The remaining processed ash is then to be placed into a 2.5 gallon pail with a lid attached and labeled as "Bottom Ash Weekly Composite Sample" and the date range for the week. Archive this sample in the blue shipping container on the apron.

DAILY COMPOSITE SAMPLE

i. Daily samples are to only be created from material loaded to the ash trucks. They are meant to be a one to one correspondence to material that is deposited in the landfill. No daily composite sample to be taken if no bottom ash is loaded and transported to the landfill on a particular day. While rare, there are days where no bottom ash is transported to the landfill.

ii. Take a 1 kg grapple bucket sample from each pit (a total of 3 kg) when the first truck is loaded in the day and repeat with the last truck loaded in the day. Collect at least 6kg in total for the day. Place the sample in a clean 2.5 gallon container.

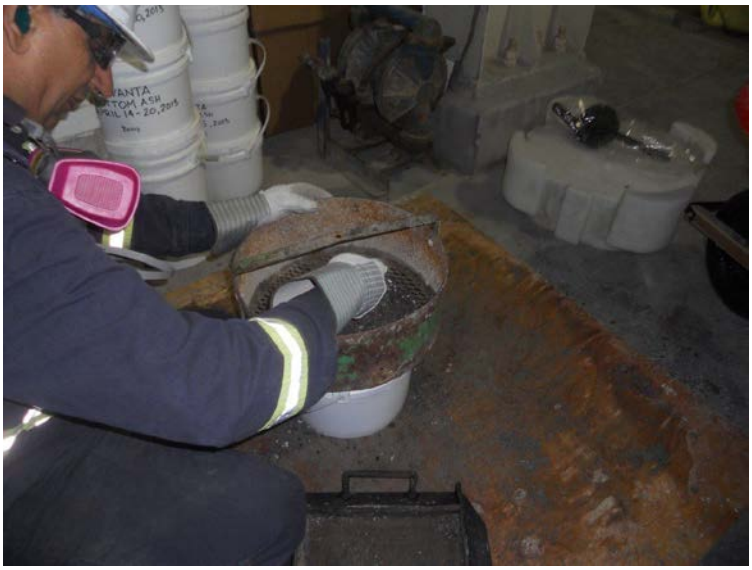
iii. Put a lid on the daily sample, label as “Bottom Ash Daily Sample” and the date the sample was created. The labeled daily sample buckets are to be temporarily stored at the ash station in the Turbine Hall basement. At the end of the week, the daily samples are to be archived in the blue shipping container located on the apron.

V SAMPLE PROCESSING PROCEDURE

Refer to the attached “Bottom Ash Sampling Worksheet” to record weights

i. All the ash from the week should be in one wagon and shall be weighed prior to mixing.

ii. All ash should first be passed over a 3/8” (9.5 mm) screen.



iii. Material that does not pass through the screen is to be subjected to a particle size reduction step. Make sure to weigh the amount of >3/8” material prior to size reduction and record on the worksheet.

   a. In particle size reduction, materials are reduced in size by mechanical crushing and then passed over the 3/8” screen again by using the 4 pound hammer. Do not work the material excessively (i.e. do not over crush and create a lot of fines)

iv. Material (including metal) that does not pass through the 3/8" screen and cannot be reduced in size is discarded. Ensure the weight of this material is noted on the worksheet.

v. Mix all the material that has passed through the 3/8" screen thoroughly on a piece of plywood. Ensure large and small material on the plywood is mixed thoroughly for at least three minutes.

vi. Cone and divide the pile into 4 equal portions (quarters).

vii. Place this ash into twelve (12) 500ml sample containers by scooping material from each quarter. Put small scoops in each container and alternate all containers until they are full (to ensure the sampling procedures are maintained as uniform as possible and result in as near-replicated samples as possible). Label the sample containers with “Bottom Ash” and the date when the when sample collected (ie; Bottom Ash from June 9-15 2013). Ensure the sample containers are filled to the top. Put the remaining material into a 2.5 gallon bucket and seal with a lid. Note the contents of the bucket and the date when sample collected. (ie; Bottom ash from June 9-15 2013)

viii. Bring the sample containers and Bottom Ash Worksheet to the Front Desk for further labeling and shipment to the laboratory for TCLP testing.

ix. Clean the sampling equipment and wagon. Ensure the ash testing area is tidied up.

Bottom Ash Worksheet

Date sample composited (DD/MM/YYYY)	
Person doing the sampling	
Total Sample Weight before processing, kg	
Weight of Material >3/8", kg	
Weight of Material that cannot be processed to <3/8" (metal, wood, etc), kg	
Final Total weight of Processed Bottom Ash, kg	

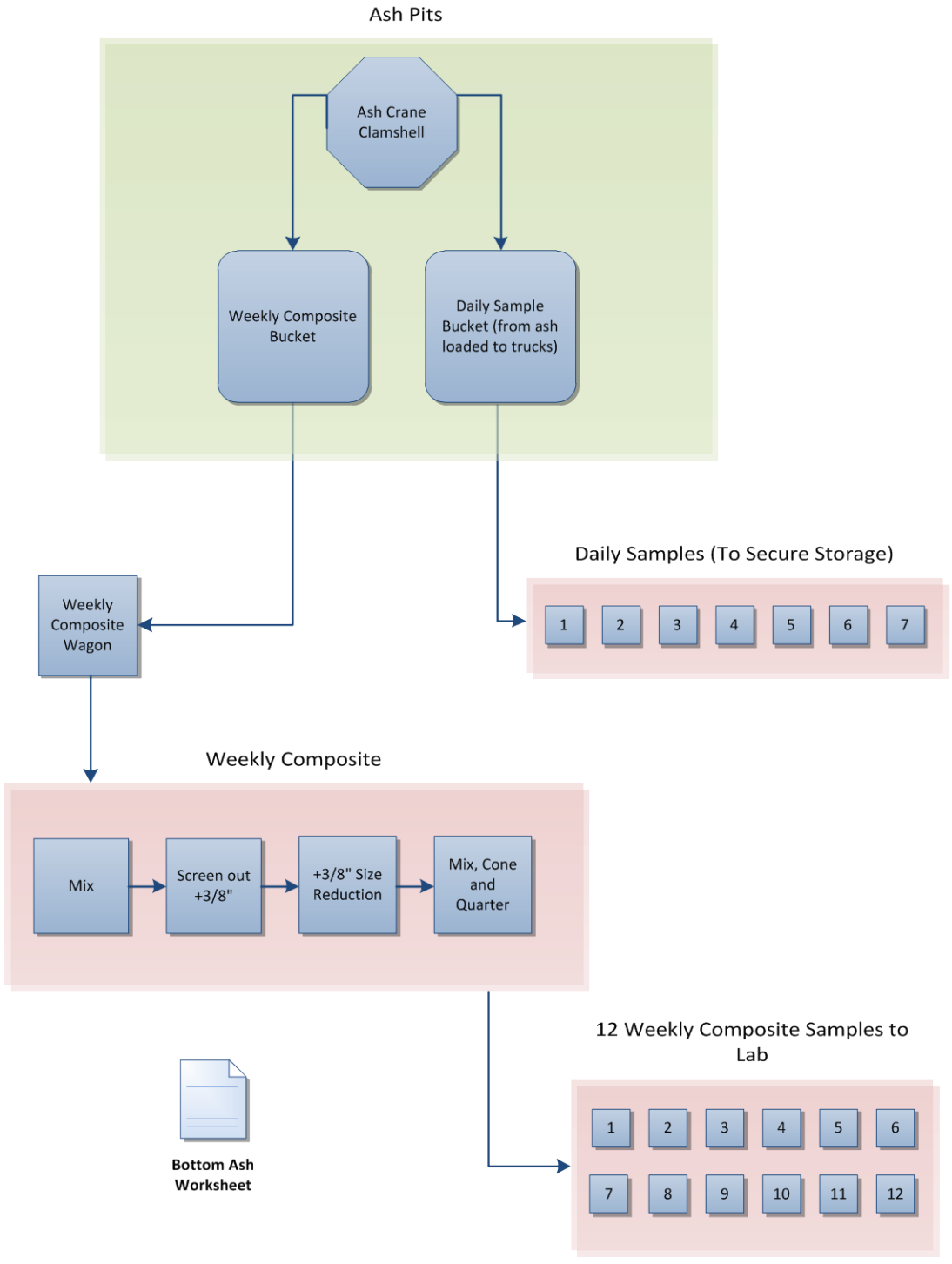
Return this form with the filled Weekly Bottom Ash Composite Sample containers

Completely fill twelve (12) 500ml sample containers and label each with "Bottom Ash" and the week the ash composite is from, i.e. "June 9-15, 2019"

Bottom Ash Sampling

Version – July 25, 2013

Bottom Ash Sampling Procedure Flowchart



Revisions and Edits Log:

1. **Aug 15, 2013** – V.iii.a Removed reference to using a hammer drill and special bit for size reduction and associated photo. Added "Do not work the material excessively (i.e. do not over crush and create a lot of fines)".
2. **Aug 16, 2013** – IV section i, ii, iii and iv: Clarified daily sampling methodology. Daily samples are to be created from material loaded to the ash trucks. They are meant to be a one to one correspondence to material that is deposited in the landfill. No daily composite sample to be taken if no bottom ash is loaded and transported to the landfill on a particular day. Sampling procedures separated into "Weekly Composite" and "Daily Composite" for clarity.
3. **Aug 27, 2013** – IV section i: changed sampling material from the ash crane bucket in equal proportions of fine and larger material to take samples approximately in proportion of fine and larger material (i.e. not "equal"). Added reference to storage in a 2.5 gal container, cleaned prior to use. V section iiii: added requirement to record +3/8 material prior to size reduction. V section vi: added to ensure large and small material on the plywood is mixed thoroughly for at least three minutes. Daily Composite Sample section iii: added place sample into a clean 2.5 gallon container. Daily Composite Sample, section i: added "while rare, there are days where no bottom ash is transported to the landfill". Removed for clarity - Daily Composite Sample, section ii: "The daily sample bucket is to be filled with bottom ash sampled from the grapple that is being loaded onto a truck"; added clarification to take a 1kg sample from each pit, total of 3 kg. V section vii: Added labeling instruction for sample bottles. Added "Put small scoops in each container and alternate all containers until they are full (to ensure the sampling procedures are maintained as uniform as possible and result in as near-replicated samples as possible)". Added "dust" to Purpose, Section 3, minimizing employee exposure.
4. **Aug 28, 2013** – Purpose, section 3: Deleted reference to fumes and vapours. IV Procedures: clarified sampling period for the weekly bottom ash composite. Weekly Composite, (i): Clarified representative sample to mean collecting material from the ash bucket in the same proportion as observed in the bucket (i.e. proportion of fines to larger particles).

ATTACHMENT 3

Week 16 pH Assessment

The Week 16 pH assessment addresses MoE condition 3 which is included below for reference.

Condition 3:

Retain a qualified professional to re-assess week 16 results as the May 10, 2013 Hemmera report did not include a discussion on the one elevated pH result.

Metro Vancouver response:

The Element One laboratory pH results for BA1316-E was 12.70 where the BA1316-E Dup result was 12.72. These results appear to be above 12.5 specified by the HWR; however, the results were not completed according to the correct method specified in British Columbia. The pH determined by Maxxam was 11.6 and the three ALS samples were 11.76, 11.64, and 11.67, these were all completed in accordance to the method specified in British Columbia.

In British Columbia, the measurement of pH in soil is a prescriptive method contained in Section B of the Water and Air Monitoring and Reporting Sampling, Methods and Quality Assurance British Columbia Environmental Laboratory Manual: 2009. ALS and Maxxam in British Columbia conduct pH analysis in accordance with this procedure.

Element One does not conduct pH measurement in accordance with this procedure but rather in accordance with US EPA Soil and Waste pH 9045C, 2:1 soluble pH. The table below highlights the differences in the method used.

Method	BC MOE pH, Electrometric, Soil and Sediment - Prescriptive	US EPA Soil and Waste pH 9045C
Soil Sample	20 g (2 mm sieve 60 °C)	20 g (no dry or sieve)
Water	2 mL /gram (40 mL) (deionized)	20 mL (reagent)
Mix time	30 minutes	5 minutes
Stand time	1 hour	1 hour

As the BC MoE method is a prescriptive method, it is not performance based and all elements of the method must be followed. As such, only the results of pH from ALS and Maxxam are considered accurate. Therefore, the one result from Element One that was above 12.5 has been discarded and pH is no longer tested at Element One.

This page left blank intentionally

ATTACHMENT 4

Contingency Disposal Plan

The Contingency Disposal Plan addressees MoE condition 8 which is included below for reference.

Condition 8:

Develop a contingency plan that identifies alternative disposal sites and/or further assessment if the bottom ash does not meet the standards of the Interim Bottom Ash Management Plan, conditions specified in this letter or the HWR. The plan shall include timelines for out-of-spec material to move off-site.

Metro Vancouver response:

Metro Vancouver proposes the following contingency plan to be implemented in the event that bottom ash does not meet the standards for acceptance at the Vancouver Landfill. Metro Vancouver has initiated inquiries with three landfills that could potentially accept bottom ash for disposal. Metro Vancouver will work through a waste acceptance protocol, specific to each landfill, to determine if the bottom ash can be accepted in any of the three landfills. Metro Vancouver will then inquire with two or three transportation firms to determine their ability to transport the waste to one, or more, of the landfills. Metro Vancouver will then review the information provided and issue purchase orders to the preferred landfill and hauler. Metro Vancouver will ensure that, in the event that bottom ash is does not meet the standards identified above, the bottom ash will be managed in compliance with all applicable regulatory requirements, including BC MoE HWR and Federal Transportation of Dangerous Goods Regulations.

The anticipated timing to complete the implementation of this contingency plan is as follows:

- identify disposal sites that can accept the bottom ash by October 1, 2013;
- identify potential haulers by November 1, 2013; and,
- issue purchase orders for bottom ash which does not meet Municipal Solid Waste standards by December 1, 2013.

This page left blank intentionally

ATTACHMENT 5

Source Control Measures and WTEF Improvements

The Source control measures and WTEF improvements addresses MoE Conditions 9 which is included below for reference.

Condition 9:

Assess works at the Burnaby WTE facility to ensure measures are implemented to further control the quality of bottom ash generated. Provide rationale on any further source control measures including any outreach programs currently implemented or proposed by Metro Vancouver.

Metro Vancouver response:

Cadmium in the Waste Stream / Source Control
The primary source of cadmium in the waste stream is household batteries, specifically rechargeable batteries including rechargeable household electronics. The other primary potential source of cadmium in the waste stream is plastics, but the amount of cadmium from plastics represents only a fraction of the cadmium resulting from rechargeable batteries[1]. According to the International Cadmium Association, 85% of annual production of cadmium in 2010 was for nickel cadmium (NiCd) batteries.

Metro Vancouver's waste composition studies over the last 20 years do not show an increase in household battery proportions, but given the relatively small portion batteries make up of the waste stream (estimated at no more than 0.1%) and the various types of batteries and the sources of those batteries, increases in rechargeable batteries may not be detected through waste composition analysis.

Actions to be taken by Metro Vancouver to better understand the sources of cadmium and to remove or redirect the cadmium sources from the waste received include:

a) Metro Vancouver will work with product stewards for household batteries and electrical and electronic products to explore options to continue to enhance these relatively new product stewardship programs as well as examine options at our facilities to specifically divert targeted materials that may contain cadmium.
b) Metro Vancouver will continue to enhance material ban inspection targeting sources of rechargeable batteries such as electronic devices. Inspection surcharges for electronic devices already make up 31% of all the surcharges issued.
c) Complete waste composition study in the fall of 2013, to identify the key sources of cadmium in the waste stream.

[1]Aucott, Michael , A. Namboodiripad, A. Caldarelli, K. Frank and H. Gross, 2009. "Estimated Quantities and Trends of Cadmium, Lead, and Mercury in US Municipal Solid Waste Based on Analysis of Incinerator Ash", pp. 1-4, NJDEP.

WTEF Process Improvements

Metro Vancouver will ask Covanta to review processes in place at the WTEF to ensure mechanical and chemical processes minimize leachable cadmium in the bottom ash.

Metro Vancouver will provide a copy of the review to MoE by October 15, 2013.

Some process improvements have already been identified. Since 2008, phosphoric acid has been added to each of the three bottom ash quench tanks to control the leachability of lead and cadmium. The phosphoric acid is injected into the quench tanks with a pump. By the middle of 2014, automated flow meters will be added to more accurately measure the amount of phosphoric acid injected and allow a tie-in to the plant's electronic control system.

Metro Vancouver is also investigating non-ferrous metal recovery which will allow the recycling of metals such as aluminum and copper from the waste stream, and may also enhance heavy metal recovery from the bottom ash.

ATTACHMENT 6

Beneficial Reuse of Bottom Ash Reinstatement

The Beneficial reuse of bottom ash reinstatement addresses MoE Conditions 10 which is included below for reference.

Condition 10:

The immediate suspension of the beneficial reuse of bottom ash at the Vancouver Landfill until further notice. Therefore, all bottom ash disposed at the Vancouver Landfill must count against the landfill's annual limit set forth in the operational certificate (MR-01611). The Ministry will consider an assessment, by a qualified professional, for reinstating the beneficial use of bottom ash at the landfill.

Metro Vancouver response:

The City of Vancouver and Metro Vancouver are both undertaking occupational health and safety studies by qualified consultants to ensure that the results from past studies showing no effects to human health or the environment remain applicable. It is anticipated that the Metro Vancouver study can be completed in September 2013.

This page left blank intentionally

BRITISH COLUMBIA

July 4, 2013

File: 76780-35/MV/W2E
MR-01611

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8
Fax: 604 451-6180

Attention: **Paul Henderson**
General Manager, Solid Waste Services

Re: Proposed Interim Bottom Ash Management Plan, Burnaby Waste-to-Energy Facility

Thank you for your letter and supporting documentation, dated May 21, 2013 seeking approval of a proposed Interim Bottom Ash Management Plan for the ash generated at the Burnaby Waste-to-Energy (WTE) facility.

The Ministry was first notified the week of April 15, 2013 of a potential issue concerning the disposal of bottom ash at the Vancouver Landfill. Metro Vancouver (MV) and the City of Vancouver advised that the landfill accepted bottom ash that may be classified as a hazardous waste. The Ministry subsequently requested further information and a plan regarding the monitoring and management of the bottom ash generated from the Burnaby WTE facility. The Ministry notes that the Vancouver Landfill has stored the bottom ash on a rock pad onsite since April 22, 2013 pending further sampling and classification of the waste.

The Ministry understands that the bottom ash samples are collected daily and composited into a weekly sample and subsequently submitted for analysis to 3 separate laboratories, ALS Environmental, Maxxam Analytics and Element One Inc. Ministry staff have reviewed lab results for approximately 260 samples for the period commencing December 2012. There have been a number of sample results that exceeded the leachable cadmium limit of 0.5 mg/L as specified in the Hazardous Waste Regulation (HWR). In addition there was one pH result and three leachable lead tests exceeding the HWR requirements. Hemmera Envirochem Inc. was retained by Covanta Renewable Energy to review the bottom ash test results and to propose statistical guidance for characterizing the waste and provide input in the development of bottom ash management plan.

.../2

Ministry of Environment South Coast Region
Environmental Protection Division
Mailing Address:
2nd Floor
10470 152nd Street
Surrey BC V3R 0Y3
Telephone: 604 582-5200
Facsimile: 604 584-9751
Website: www.gov.bc.ca/env

Based on the data reviewed to date, the proposed Interim Bottom Ash Management Plan dated May 21, 2013 is acceptable subject to the following additional conditions:

1. The upper 90th percentile of the sample concentrations is less than the limits specified in the HWR;

2. No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the HWR;

3. Retain a qualified professional to re-assess week 16 results as the May 10, 2013 Hemmera report did not include a discussion on the one elevated pH result;

4. Bottom ash must be stored in daily segregated waste piles at the Vancouver Landfill until the waste is fully characterized;

5. In addition to the weekly composite samples that are submitted for laboratory analysis, daily composite sample must be collected and stored. In the event there are exceedances in the weekly composite sample results that do not meet the Interim Bottom Ash Management Plan as conditionally approved, the daily composite samples must be analyzed for further characterization of the bottom ash;

6. Develop a detailed sampling protocol describing how samples of bottom ash are collected (both daily and weekly composites) prior to submission to the laboratory. A qualified professional must be consulted to ensure that analytical data derived from these samples can be statistically evaluated with supporting arguments;

7. Weekly laboratory results are to be submitted to the Ministry as soon as they become available and no later than within 3 weeks of sample collection, containing all applicable parameters related to the authorization of the Burnaby Waste-to-Energy facility;

8. Develop a contingency plan that identifies an alternative disposal sites and/or further assessment if the bottom ash does not meet the standards of the Interim Bottom Ash Management Plan, conditions specified in this letter or the HWR. The plan shall include timelines for out-of-spec material to move off-site;

9. Assess works at the Burnaby WTE facility to ensure measures are implemented to further control the quality of bottom ash generated. Provide rationale on any further source control measures including any outreach programs currently implemented or proposed by MV; and

...3

10. The immediate suspension of the beneficial reuse of bottom ash at the Vancouver Landfill until further notice. Therefore, all bottom ash disposed at the Vancouver Landfill must count against the landfill's annual limit set forth in the operational certificate (MR-01611). The Ministry will consider an assessment, by a qualified professional, for reinstating the beneficial use of bottom ash at the landfill.

Submit to the Ministry a report by July 31, 2013 to address the conditions above. The Ministry will reassess the plan within 4 months to determine if additional conditions are required.

Therefore, all bottom ash either stockpiled at the Vancouver Landfill or generated at the WTE during this 4 month period that meets the Interim Management Plan subject to the above conditions can be landfilled.

This letter shall not be construed as a waiver of any lawful requirement pertaining to any unauthorized discharge of waste to the environment, and is without prejudice to any further legal action that the Ministry may take under the *Environmental Management Act.*

A copy of the *Environmental Management Act* can be downloaded from the internet at the following web link: http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm

If you have any questions, please contact the undersigned or Ashley Smith at (604) 582-5200.

Sincerely,

Avtar S. Sundher
Head, Government and Compliance Section
South Coast Region

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Lynn Belanger, Manager, Transfer and Landfill Operations, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head Clean Technologies, Victoria
Shelley Metcalfe, Head, Business and Standards Section, Surrey

BRITISH COLUMBIA

November 7, 2013

File: 76780-35/MV/W2E
MR-01611

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8
Fax: 604 451-6180

Attention: **Paul Henderson**
General Manager, Solid Waste Services

Dear Mr. Henderson,

Re: Proposed Bottom Ash Management Plan, Burnaby Waste-to-Energy Facility

Thank you for your letters and supporting documentation, dated October 21 and August 30, 2013 addressing 10 conditions stipulated in a Ministry letter of July 4, 2013 regarding the management of bottom ash generated at the Burnaby Waste-to-Energy (WTE) facility and storage/disposal at the Vancouver landfill.

There are a number of factors, currently being reviewed by the Ministry, that need to be considered prior to making an ultimate decision on the proposed management of the bottom ash. The Ministry is willing to accept the plan, submitted on August 30, 2013, as a temporary management plan until the Ministry has more information as noted below. Therefore the proposed Bottom Ash Management Plan dated August 30, 2013 is acceptable subject to the following additional conditions:

1. No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the HWR;

2. Laboratory results are to be submitted to the Ministry as soon as they become available and no later than within 3 weeks of sample collection and/or submitted to approved lab, containing all applicable parameters related to the authorization of the Burnaby Waste-to-Energy facility. A summary report should be prepared and submitted to the Ministry by November 29, 2013, for the laboratory data collected for the past 6 months and a second report to be submitted by February 28, 2014 to include November, December and January 2014 data:

3. Outliers must be used in the calculation of the mean and/or the upper confidence limit;

.../2

Ministry of Environment South Coast Region
Environmental Protection Division
Mailing Address:
2nd Floor
10470 152nd Street
Surrey BC V3R 0Y3
Telephone: 604 582-5200
Facsimile: 604 584-9751
Website: www.gov.bc.ca/env

4. Prepare a report that compares the proposed sampling protocol and the use of statistical analysis with the USEPAs sampling protocol and the use of statistics in the assessment of bottom ash. The report must be submitted to the Ministry by December 31, 2013;

5. The Ministry does not support the reinstatement of the beneficial reuse of bottom ash at the Vancouver Landfill at this time. All bottom ash disposed at the Vancouver Landfill must count against the landfill's annual limit set forth in the operational certificate (MR-01611). The Ministry will consider an assessment, by a qualified professional, for reinstating the beneficial use of bottom ash at the landfill.

6. The Ministry will reassess and/or make a decision regarding the proposed bottom ash management plan within 4 months of the date of this letter.

Therefore, all bottom ash either stockpiled at the Vancouver Landfill or generated at the WTE during this 4 month period that meets the Proposed Management Plan subject to the above conditions can be landfilled.

This letter shall not be construed as a waiver of any lawful requirement pertaining to any unauthorized discharge of waste to the environment, and is without prejudice to any further legal action that the Ministry may take under the *Environmental Management Act.*

A copy of the *Environmental Management Act* can be downloaded from the internet at the following web link: http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm

If you have any questions, please contact the undersigned or Ashley Smith at (604) 582-5200.

Sincerely,

Avtar S. Sundher
Head, Government and Compliance Section
South Coast Region

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Lynn Belanger, Manager, Transfer and Landfill Operations, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head Clean Technologies, Victoria

ATTACHMENT 2

Laboratory Certificate of Analysis

GOLDER ASSOCIATES LTD.
ATTN: Kathleen Edwards
200-2920 Virtual Way
Vancouver BC V5M 0C4

Date Received: 05-SEP-18
Report Date: 01-OCT-18 11:49 (MT)
Version: FINAL REV. 2

Client Phone: 604-298-6623

Certificate of Analysis

Lab Work Order #: L2158553

Project P.O. #: NOT SUBMITTED
Job Reference: 18108461
C of C Numbers: 14-508319, 17-668278, 17-668279
Legal Site Desc:

Comments:

Samples in this report underwent specialized preparation, based on information supplied by Golder. A brief summary is as follows:

1. Samples are sieved to <9.5mm.
2. Weights recorded for both size fractions.
3. >9.5mm material crushed with a hammer, and re-sieved.
4. >9.5mm material remaining after crushing discarded.
4. All material <9.5mm is combined for TCLP analysis.

Additional procedural details are available on request.

1-OCT-2018 Additional TCLP Replicate data is included.

Amber Springer, B.Sc
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-1	L2158553-2	L2158553-3	L2158553-4	L2158553-5
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
Sampled Time					
Client ID	BA-VLF-1A-1	BA-VLF-1A-0	BA-VLF-1B-1	BA-VLF-1B-0	BA-VLF-2A-1
Grouping / **Analyte**					
SOIL					
TCLP Metals					
1st Preliminary pH (pH)	10.83	10.63	10.68	10.66	10.95
2nd Preliminary pH (pH)	7.60	6.76	6.62	6.59	6.29
Final pH (pH)	5.53	5.64	5.84	5.65	5.70
Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	0.289	0.274	0.240	0.397	0.285

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-6	L2158553-7	L2158553-8	L2158553-9	L2158553-10
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-2A-0	BA-VLF-2B-1	BA-VLF-2B-0	BA-VLF-3A-1	BA-VLF-3A-1FD
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	9.55	10.88	10.39	10.83	9.98
	2nd Preliminary pH (pH)	6.54	8.10	7.82	6.61	6.65
	Final pH (pH)	5.14	5.57	5.85	5.67	5.20
	Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
	Cadmium (Cd)-Leachable (mg/L)	0.507	0.396	0.968	0.376	0.192

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-11	L2158553-12	L2158553-13	L2158553-14	L2158553-15
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-3A-0	BA-VLF-3B-1	BA-VLF-3B-0	BA-VLF-4A-1	BA-VLF-4A-1FD
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.41	9.99	9.89	10.12	10.24
	2nd Preliminary pH (pH)	7.33	6.55	6.41	6.42	6.86
	Final pH (pH)	5.27	5.30	5.11	5.20	5.21
	Extraction Solution Initial pH (pH)	2.89	2.89	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.321	0.187	0.140	0.140	5.85

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-16	L2158553-17	L2158553-18	L2158553-19	L2158553-20
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-4A-0	BA-VLF-4B-1	BA-VLF-4B-0	BA-VLF-5A-1	BA-VLF-5A-0
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.72	10.30	9.96	10.75	10.41
	2nd Preliminary pH (pH)	8.14	7.34	7.14	8.18	7.38
	Final pH (pH)	5.29	5.51	5.55	5.31	5.51
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.449	0.205	0.207	0.245	0.225

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-21	L2158553-22	L2158553-23	L2158553-24	L2158553-25
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-5A-0FD	BA-VLF-5B-1	BA-VLF-5B-0	BA-VLF-6A-1	BA-VLF-6A-0
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.42	10.12	10.34	10.67	10.25
	2nd Preliminary pH (pH)	6.99	6.83	6.53	6.53	6.26
	Final pH (pH)	5.65	5.22	5.25	5.56	5.24
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.219	0.223	0.143	0.136	0.150

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-26	L2158553-27	L2158553-28	L2158553-29	L2158553-30
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date	04-SEP-18	04-SEP-18			
Sampled Time					
Client ID	BA-VLF-6B-1	BA-VLF-6B-0	BA-VLF-2A-0-REP1	BA-VLF-2A-0-REP2	BA-VLF-2A-0-REP3
Grouping **Analyte**					
SOIL					
TCLP Metals 1st Preliminary pH (pH)	9.67	10.70	9.55	9.55	9.55
2nd Preliminary pH (pH)	6.28	6.57	6.54	6.54	6.54
Final pH (pH)	4.94	5.01	5.04	5.22	5.64
Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
Cadmium (Cd)-Leachable (mg/L)	0.088	0.113	0.292	0.334	1.14

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-31	L2158553-32	L2158553-33	L2158553-34	L2158553-35
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date					
Sampled Time					
Client ID	BA-VLF-2A-0-REP4	BA-VLF-2B-0-REP1	BA-VLF-2B-0-REP2	BA-VLF-4A-1FD-REP1	BA-VLF-4A-1FD-REP2
Grouping / **Analyte**					
SOIL					
TCLP Metals 1st Preliminary pH (pH)	9.55	10.39	10.39	10.24	10.24
2nd Preliminary pH (pH)	6.54	7.82	7.82	6.86	6.86
Final pH (pH)	5.66	5.92	5.95	5.34	5.52
Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
Cadmium (Cd)-Leachable (mg/L)	0.369	0.345	0.376	0.719	0.474

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-36	L2158553-37	L2158553-38		
	Description	Ash	Ash	Ash		
	Sampled Date					
	Sampled Time					
	Client ID	BA-VLF-4A-1FD-REP3	BA-VLF-4A-1FD-REP4	BA-VLF-4A-1FD-REP5		
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.24	10.24	10.24		
	2nd Preliminary pH (pH)	6.86	6.86	6.86		
	Final pH (pH)	5.29	5.67	5.53		
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88		
	Cadmium (Cd)-Leachable (mg/L)	0.724	0.368	1.71		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Cadmium (Cd)-Leachable	MS-B	L2158553-32, -33, -34, -35
Matrix Spike	Cadmium (Cd)-Leachable	MS-B	L2158553-28, -29, -30, -31, -36, -37, -38

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

14-508319 17-668278 17-668279

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: GOLDER ASSOCIATES LTD.
200-2920 Virtual Way
Vancouver BC V5M 0C4
Contact: Kathleen Edwards

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TCLP-ICP-VA	**Soil**							
Batch R4222649								
WG2878936-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	18-SEP-18
WG2878936-2 MS		**L2158553-12**						
Cadmium (Cd)-Leachable			87.0		%		50-140	18-SEP-18
Batch R4227069								
WG2880107-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	19-SEP-18
WG2880107-2 MS		**L2158553-27**						
Cadmium (Cd)-Leachable			89.5		%		50-140	19-SEP-18
Batch R4247260								
WG2889870-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	26-SEP-18
WG2889870-2 MS		**L2158553-32**						
Cadmium (Cd)-Leachable			N/A	MS-B	%		-	26-SEP-18
Batch R4252530								
WG2890302-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	30-SEP-18
WG2890302-2 MS		**L2158553-38**						
Cadmium (Cd)-Leachable			N/A	MS-B	%		-	30-SEP-18

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Sample ID	Initial <9.5 mm sample (g)	Initial >9.5 mm sample (g)	>9.5 mm sample after particle size reduction (g)
L2158553-1	1164.42	716.47	381.15
L2158553-2	1119.12	732.87	409.41
L2158553-3	1499.16	586.14	291.82
L2158553-4	1327.61	717.4	334.67
L2158553-5	1045.87	653.09	335.98
L2158553-6	804.6	1011.25	559.94
L2158553-7	1239.33	527.31	257.85
L2158553-8	1105.75	802.35	607.49
L2158553-9	1103.66	710.01	516
L2158553-10	642.56	1307	1021.32
L2158553-11	1023.33	834.36	533.04
L2158553-12	1228.54	854.14	589.79
L2158553-13	613.72	1565.99	1219.89
L2158553-14	706.57	1134	714.08
L2158553-15	1018.47	701.77	401.12
L2158553-16	1266	950.87	504.9
L2158553-17	985.54	926.06	564.45
L2158553-18	899.09	1279	896.23
L2158553-19	1438	730.3	467.3
L2158553-20	904.16	914.37	646.54
L2158553-21	893.83	764.92	491.27
L2158553-22	1192.27	1174.16	850.21
L2158553-23	1309	839.42	630
L2158553-24	1255	812.09	604.45
L2158553-25	746.82	732.18	259.3
L2158553-26	809.95	1352	455.87
L2158553-27	922.12	1115.74	413.24

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2158553-COFC

COC Number: 14 - 508319

Page 1 of 3

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	Golder Associates	Select Report Format:	☐ PDF ☒ EXCEL ☐ EDD (DIGITAL)	R ☒ Regular (Standard TAT if received by 3pm)
Contact:	Kathleen Edwards	Quality Control (QC) Report with Report	☒ Yes ☐ No	P ☐ Priority (2-4 business days if received by 3pm)
Address:	Kathleen_edwards@golder.com	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
		Select Distribution:	☒ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
Phone:	604-356-4815	Email 1 or Fax	Kathleen_edwards@golder.com	Specify Date Required for E2, E or P:
		Email 2	Benjamin_Lucas@golder.com	

Invoice To		Invoice Distribution	
	Same as Report To ☒ Yes ☐ No	Select Invoice Distribution:	☒ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☒ Yes ☐ No	Email 1 or Fax	Kathleen_edwards@golder.com
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	369881	Approver ID:	Cost Center:
Job #:	18108461	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler: BL

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HOLD	Number of Containers
	BA-VLF-1A-1	04/Sept/18		ASH	X	1
	BA-VLF-1A-0	"		"	X	1
	BA-VLF-1B-1	"		"	X	1
	BA-VLF-1B-0	"		"	X	1
	BA-VLF-2A-1	"		"	X	1
	BA-VLF-2A-0	"		"	X	1
	BA-VLF-2B-1	"		"	X	1
	BA-VLF-2B-0	"		"	X	1
	BA-VLF-3A-1	"		"	X	1
	BA-VLF-3A-1FD	"		"	X	1
	BA-VLF-3A-0	"		"	X	1
	BA-VLF-3B-1	"		"	X	1

Drinking Water (DW) Samples (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No Are samples for human drinking water use? ☐ Yes ☐ No	Bottom ash - may contain large quantities of metals

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☑	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C	
			18	20

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
BL	05/Sept/18	10:49				JC		11 am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2158553-COFC

COC Number: 17 - 668278

Report To	Contact and company name below will appear on the final report
Company:	Golder Associates
Contact:	Kathleen Edwards
Phone:	604 - 396 - 4815
	Company address below will appear on the final report
Street:	700 - 2920 Virtual Way
City/Province:	Vancouver BC
Postal Code:	V5M 0C4

Report Format / Distribution	
Select Report Format:	PDF [X] EXCEL [ ] EDD (DIGITAL)
Quality Control (QC) Report with Report	[X] YES [ ] NO
[ ] Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	Benjamin-Lucas@golder.com
Email 3	

Invoice To		
	Same as Report To	[X] YES [ ] NO
	Copy of Invoice with Report	[X] YES [ ] NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	

Project Information	
ALS Account # / Quote #:	Q69881
Job #:	1810 8461
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)		
AFE/Cost Center:		PO#
Major/Minor Code:		Routing Code:
Requisitioner:		
Location:		

ALS Lab Work Order # (lab use only):

ALS Contact:

Sampler: BL

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] [ ] | 3 day [P3-25%] [ ] | 2 day [P2-50%] [ ]

EMERGENCY: 1 Business day [E-100%] [ ] | Same Day, Weekend or Statutory holiday [E2-200%] (Laboratory opening fees may apply)] [ ]

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HOLD	SAMPLES ON HOLD	Sample is hazardous (please provide further details	NUMBER OF CONTAINERS
	BA - VLF - 3B - 0	04-Sept-18		Ash	X			1
	BA - VLF - 4A - 1				X			1
	BA - VLF - 4A - 1FD				X			1
	BA - VLF - 4A - 0				X			1
	BA - VLF - 4B - 1				X			1
	BA - VLF - 4B - 0				X			1
	BA - VLF - 5A - 1				X			1
	BA - VLF - 5A - 0				X			1
	BA - VLF - 5A - 0FD				X			1
	BA - VLF - 5B - 1				X			1
	BA - VLF - 5B - 0				X			1
	BA - VLF - 6A - 1				X			1

Drinking Water (DW) Samples (client use)

Are samples taken from a Regulated DW System? [ ] YES [ ] NO

Are samples for human consumption/ use? [ ] YES [ ] NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Bottom ash (landfill) - may contain large quantities of metals

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ] | SIF Observations Yes [ ] No [ ]

Ice Packs [X] Ice Cubes [ ] | Custody seal intact Yes [ ] No [ ]

Cooling Initiated [ ]

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				18	20		

SHIPMENT RELEASE (client use)		
Released by: BL	Date: 05-Sept-18	Time: 1045

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (lab use only)		
Received by: JC	Date:	Time: 11 am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2158553-COFC

COC Number: 17 - 668279

Report To	Contact and company name below will appear on the final report
Company:	Golder Associates
Contact:	Kathleen Edwards
Phone:	604 - 356 - 4816
	Company address below will appear on the final report
Street:	700 - 2920 Virtual Way
City/Province:	Vancouver BC
Postal Code:	V5M0C4

Report Format / Distribution	
Select Report Format:	PDF [X] EXCEL [ ] EDD (DIGITAL)
Quality Control (QC) Report with Report	[X] YES [ ] NO
[ ] Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	Benjamin_Lucas@golder.com
Email 3	

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] [ ] | 3 day [P3-25%] [ ] | 2 day [P2-50%] [ ]

EMERGENCY: 1 Business day [E-100%] [ ] | Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] [ ]

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Invoice To		
	Same as Report To	[X] YES [ ] NO
	Copy of Invoice with Report	[X] YES [ ] NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	

Project Information	
ALS Account # / Quote #:	Q69881
Job #:	18108461
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)		
AFE/Cost Center:		PO#
Major/Minor Code:		Routing Code:
Requisitioner:		
Location:		

ALS Lab Work Order # (lab use only):

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HOLD	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
	BA-VLF-6A-0	04-Sept-18		Ash	X			1
	BA-VLF-6B-1	"		"	X			1
	BA-VLF-6B-0	"		"	X			1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
[ ] YES [ ] NO

Are samples for human consumption/ use?
[ ] YES [ ] NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Bottom Ash (landfill) - may contain large quantities of metals

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ] | SIF Observations Yes [ ] No [ ]

Ice Packs [X] | Ice Cubes [ ] | Custody seal intact Yes [ ] No [ ]

Cooling Initiated [ ]

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				18	20		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: BL	Date: 05-Sept-18	Time: 1049	Received by:	Date:	Time:	Received by: JC	Date:	Time: 11 am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Location	Sample ID	Sample Type	TCLP Leachable Cadmium (mg/L)	Average Concentration (Used for Statistics)
BA-VLF-1A-1	BA-VLF-1A-1	Primary	0.289	0.289
BA-VLF-1A-0	BA-VLF-1A-0	Primary	0.274	0.274
BA-VLF-1B-1	BA-VLF-1B-1	Primary	0.240	0.240
BA-VLF-1B-0	BA-VLF-1B-0	Primary	0.397	0.397
BA-VLF-2A-1	BA-VLF-2A-1	Primary	0.285	0.285
BA-VLF-2A-0	BA-VLF-2A-0	Primary	0.507	0.528
	BA-VLF-2A-0-REP1	Replicate 1	0.292	
	BA-VLF-2A-0-REP2	Replicate 2	0.334	
	BA-VLF-2A-0-REP3	Replicate 3	1.14	
	BA-VLF-2A-0-REP4	Replicate 4	0.369	
BA-VLF-2B-1	BA-VLF-2B-1	Primary	0.396	0.396
BA-VLF-2B-0	BA-VLF-2B-0	Primary	0.968	0.563
	BA-VLF-2B-0-REP1	Replicate 1	0.345	
	BA-VLF-2B-0-REP2	Replicate 2	0.376	
BA-VLF-3A-1	BA-VLF-3A-1	Primary	0.376	0.284
	BA-VLF-3A-1FD	FD	0.192	
BA-VLF-3A-0	BA-VLF-3A-0	Primary	0.321	0.321
BA-VLF-3B-1	BA-VLF-3B-1	Primary	0.187	0.187
BA-VLF-3B-0	BA-VLF-3B-0	Primary	0.140	0.140
BA-VLF-4A-1	BA-VLF-4A-1	Primary	0.140	0.89**
	BA-VLF-4A-1FD	FD	5.85	
	BA-VLF-4A-1FD-REP1	FD Replicate 1	0.719	
	BA-VLF-4A-1FD-REP2	FD Replicate 2	0.474	
	BA-VLF-4A-1FD-REP3	FD Replicate 3	0.724	
	BA-VLF-4A-1FD-REP4	FD Replicate 4	0.368	
	BA-VLF-4A-1FD-REP5	FD Replicate 5	1.71	
BA-VLF-4A-0	BA-VLF-4A-0	Primary	0.449	0.449
BA-VLF-4B-1	BA-VLF-4B-1	Primary	0.205	0.205
BA-VLF-4B-0	BA-VLF-4B-0	Primary	0.207	0.207
BA-VLF-5A-1	BA-VLF-5A-1	Primary	0.245	0.245
BA-VLF-5A-0	BA-VLF-5A-0	Primary	0.225	0.222
	BA-VLF-5A-0FD	FD	0.219	
BA-VLF-5B-1	BA-VLF-5B-1	Primary	0.223	0.223
BA-VLF-5B-0	BA-VLF-5B-0	Primary	0.143	0.143
BA-VLF-6A-1	BA-VLF-6A-1	Primary	0.136	0.136
BA-VLF-6A-0	BA-VLF-6A-0	Primary	0.150	0.150
BA-VLF-6B-1	BA-VLF-6B-1	Primary	0.088	0.088
BA-VLF-6B-0	BA-VLF-6B-0	Primary	0.113	0.113
			90th Percentile	**0.504**
			95% UCLM*	**0.367**

Notes: FD = Field duplicate

*Note: 95% BCA Bootstrap used based on >20 data points and no non-detects. Calculated with ProUCL 5.1 with bootstrapping set to 10000

** Average calculated by undertaking the following steps: 1) calculate average of FD and its replicates; 2) calculate average of primary sample results and average of FD and replicates.

ATTACHMENT 1

Bottom Ash Management Procedure

BRITISH COLUMBIA

January 30, 2014

File: 76780-35/MV/W2E
MR-01611

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8
Fax: 604 451-6180

Attention: **Paul Henderson**
General Manager, Solid Waste Services

Dear Mr. Henderson,

Re: Interim Bottom Ash Management Plan, Burnaby Waste-to-Energy Facility

Thank you for your January 24, 2014 email requesting the elimination of the first condition specified in the Ministry's November 7, 2012 letter approving the Bottom Ash Management Plan (BAMP) dated August 30, 2013. The first condition stated "No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the HWR".

The Ministry received the following supporting and summary documents:

- December 2013 – Final Report, Assessment of Sampling of Bottom Ash from Metro Vancouver Waste-to-Energy Facility, prepared by Hemmera;
- December 31, 2013 - Characterization of Bottom Ash Stockpiles at Vancouver Landfill from Weeks 24 and 25, prepared by Franz Environmental Inc; and
- January 22, 2014 – Sampling, Analysis and Evaluation of Bottom Ash at VLF, Bottom Ash Management Plan, prepared by Franz Environmental Inc.

Following review of the above documents and discussion with both City of Vancouver and Corporation of Delta staff, the Ministry agrees to change the first condition to the following:

1. A minimum of four replicates must be submitted for analysis for any result that exceeded two times the Leachate Quality Standards in schedule 4 of the HWR. The average of the original result and replicates must be included in the statistical analysis ensuring both the upper 90th percentile of the sample concentrations and upper 95 % confidence limit of the average concentrations are below the limit specified in the HWR; and

2. Should a replicate of the weekly sample also exceed the two times criteria, the daily samples for that week, must be analyzed in accordance with the BAMP.

.../2

Ministry of Environment South Coast Region
Environmental Protection Division
Mailing Address:
2nd Floor
10470 152nd Street
Surrey BC V3R 0Y3
Telephone: 604 582-5200
Facsimile: 604 584-9751
Website: www.gov.bc.ca/env

The Ministry considers the BAMP an interim plan and must be finalized as part of the conditions in the operational certificate for the Burnaby Waste-to-Energy facility currently being considered by the Director.

Therefore all bottom ash, either currently stored at the Vancouver Landfill (VLF) or generated in advance of a final plan being approved by the Ministry, that meets the requirements of the BAMP and conditions stated in the Ministry's November 7, 2013 letter, as further amended above, can be disposed of at the VLF as municipal solid waste.

This letter shall not be construed as a waiver of any lawful requirement pertaining to any unauthorized discharge of waste to the environment, and is without prejudice to any further legal action that the Ministry may take under the *Environmental Management Act.*

A copy of the *Environmental Management Act* can be downloaded from the internet at the following web link: http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm

If you have any questions, please contact the undersigned at (604) 582-5272.

Sincerely,

Avtar S. Sundher
Head, Government and Compliance Section
South Coast Region

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Albert Shamess, Director, Waste Management & Resource Recovery, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head Clean Technologies, Victoria

metrovancouver
4330 Kingsway, Burnaby, BC, Canada V5H 4G8 604-432-6200 www.metrovancouver.org

Solid Waste Services
Tel. 604-432-6442 Fax 604- 451-6180

August 30, 2013

File: SW-02-02-WTEF-10-04

Mr. Avtar Sundher, Head
Government and Compliance Section
South Coast Region
Environmental Protection Division
Ministry of Environment
2nd Floor, 10470-152nd Street
Surrey, BC V3R OY3

Dear Mr. Sundher:

Re: Bottom Ash Management Plan

I refer to your letter dated July 4, 2013 approving Metro Vancouver's Interim Bottom Ash Management Plan.

As requested, this letter details a proposed Bottom Ash Management Plan for the ash generated at Metro Vancouver's Waste-to-Energy Facility. The letter also addresses the ten conditions specified in your letter. We have attached your letter for reference.

The City of Vancouver and Corporation of Delta have not reviewed the proposed Bottom Ash Management Plan. We propose to meet jointly with the Ministry of Environment, City of Vancouver, the Corporation of Delta, Covanta Burnaby Renewable Energy (the operator of the Waste-to-Energy Facility), and our consultants to go through the details of the Plan and solicit input from Vancouver and Delta.

Call me if you have any questions.

Yours truly,

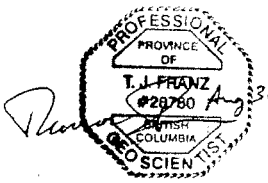
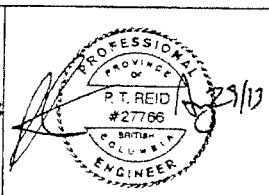
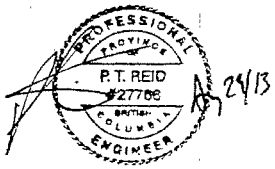
Paul Henderson, P.Eng.
General Manager, Solid Waste Services

PH/BK/jmb

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Lynn Belanger, Manager, Transfer and Landfill Operations, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head, Clean Technologies, Victoria
Shelley Metcalfe, Head, Business and Standards Section, Ministry of Environment, Surrey

Attachments: Index of Documents and Responsible Authors
Attachment 1: Bottom Ash Management Plan
Attachment 2: EMS Operational Procedure No. BA2
Attachment 3: Week 16 pH Assessment
Attachment 4: Contingency Disposal Plan
Attachment 5: Source Control Measures and WTEF Improvements
Attachment 6: Beneficial Reuse of Bottom Ash Reinstatement
Letter dated July 4, 2013 from Ministry of Environment to Metro Vancouver

INDEX

Attachment #		Responsible Author(s)		MoE Conditions[1] Addressed
1.	Bottom Ash Management Plan	 Thomas Franz, M.Sc., P.Geo Franz Environmental Inc.	 Peter T. Reid, M.Eng., P.Eng Hemmera Envirochem Inc.	1, 2, 4, 5, 7
2.	EMS Operational Procedure No. BA2	 Peter T. Reid, M.Eng., P.Eng Hemmera Envirochem Inc.	M. Neild Aug 29, 2013 Matthew Neild, Facility Manager, Covanta Burnaby	6
3.	Week 16 pH Assessment	 Peter T. Reid, M.Eng., P.Eng Hemmera Envirochem Inc.		3
4.	Contingency Disposal Plan	Not Applicable		8
5.	Source Control Measures and WTEF Improvements	Not Applicable		9
6.	Beneficial Reuse of Bottom Ash Reinstatement	Not applicable		10

[1] MoE Conditions as detailed in the July 4, 2013 letter to Metro Vancouver.

This page left blank intentionally

ATTACHMENT 1

Bottom Ash Management Plan

The Bottom Ash Management Plan addresses MoE conditions 1, 2, 4, 5, 7 which are included below for reference.

Condition 1:

The upper 90th percentile of the sample concentrations is less than the limits specified in the HWR.

Condition 2:

No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the Hazardous Waste Regulation (HWR).

Condition 4:

Bottom ash must be stored in daily segregated waste piles at the Vancouver Landfill until the waste is fully characterized.

Condition 5:

In addition to the weekly composite samples that are submitted for laboratory analysis, daily composite samples must be collected and stored. In the event there are exceedances in the weekly composite sample results that do not meet the Interim Bottom Ash Management Plan as conditionally approved, the daily composite samples must analyzed for further characterization of the bottom ash.

Condition 7:

Weekly laboratory results are to be submitted to the Ministry as soon as they become available and no later than within 3 weeks of sample collection, containing all applicable parameters related to the authorization of the Burnaby Waste-to-Energy facility.

This page left blank intentionally

Bottom Ash Management Plan

The Bottom Ash Management Plan (Plan) presented herein provides a comprehensive set of procedures for sampling and data analysis and evaluation of bottom ash generated at the Metro Vancouver Waste-to-Energy Facility (WTEF). The Plan provides detailed methodology to undertake the following steps:

1. bottom ash sample collection at the WTEF
2. weekly composite sample laboratory analysis
3. statistical evaluation of analytical data
4. daily sample laboratory analysis
5. bottom ash sample collection at the Vancouver Landfill (VLF)

The attached Bottom Ash Management Plan Flowchart (flowchart) provides a step-by-step guide for implementation of the Plan. The following sections detail each step of the Plan outlined above.

1.0 Bottom Ash Sample Collection at the WTEF

Bottom ash generated at the WTEF is transported on a regular basis to VLF (i.e. up to 4 or 5 loads per day), where it is offloaded in an approved designated bottom ash stockpile area. The ash is deposited into segregated stockpiles, which are staked and labeled to identify the week number and day the load was received at the landfill.

Prior to transport, weekly and daily bottom ash samples are collected by WTEF staff from bottom ash destined for the VLF. The methodology for sample collection and handling at the WTEF is described in Covanta's Operational Procedure ("EMS Operational Procedure No. BA2 - Bottom Ash Sampling").

2.0 Weekly Composite Sample Laboratory Analysis

Weekly composite bottom ash samples collected using the methods described in Section 1.0 are sent to ALS Environmental (ALS) or equivalent for the following chemical analysis:

- Leachate analysis by Toxicity Characteristic Leaching Procedure (TCLP) Method 1311;
- pH analysis in accordance with "pH, Electrometric, Soil and Sediment – Prescriptive", as prescribed in the British Columbia Ministry of Environment (BC MoE) 2009 British Columbia Environmental Laboratory Manual.

Refer to the flowchart for information on the protocol for the number of samples analyzed. Analytical data received from the laboratory is evaluated using the methodology detailed in the flowchart and in Section 3.0 below.

Laboratory results for weekly bottom ash will be submitted to the Ministry within three (3) weeks of sample collection. The WTE facility will hold all daily and weekly bottom ash sample material for a minimum of four (4) weeks after the decision is made to landfill the material at VLF.

3.0 Statistical Evaluation of Analytical Data

Bottom ash analytical data are statistically evaluated to assess the nature of the bulk material. The evaluation methodology has been developed utilizing the following guidance documents:

- BC MoE, Technical Guidance 1: Site Characterization and Confirmation Testing
- BC MoE, Technical Guidance 2: Statistical Criteria for Characterizing a Volume of Contaminated Material
- EPA530-R-95-036, Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic, Office of Waste, U.S. Environmental Protection Agency

From these documents, the following criteria are utilized to determine parameter concentrations of the bulk bottom ash material and to evaluate the material relative to the BC MoE Hazardous Waste Regulation, including Schedule 4 Leachate Quality Standards:

- The data is examined to determine if all data points belong to the same population and if outliers exist. Based on an evaluation of the statistics of the data to date, samples with concentrations greater than twice the standard were in all cases identified as statistical outliers, and therefore, individual samples with concentrations greater than twice the standard do not preclude the statistical evaluation of the bulk material. Instead, an additional evaluation is conducted when outliers with concentrations greater than twice the standard are present (see Section 3.1 below).
- The 90th percentile of the data set is below the applicable standard for the parameter (see Section 3.2 below).
- The 95% upper confidence limit (UCL) of the mean is below the applicable standard for the parameter (see Section 3.3 below).

Based on an evaluation of the weekly composite sample analytical data against the above three criteria, one of the two following scenarios will apply:

1. Weekly bottom ash stockpiled at the VLF that meets the evaluation criteria above will be moved for disposal or beneficial use (upon reinstatement of beneficial use designation at the VLF by BC MoE).
2. Weekly bottom ash stockpiled at the VLF that does not meet the evaluation criteria above will be subjected to further sampling and analysis utilizing the daily bottom ash samples retained at the WTEF. Stockpiled bottom ash from the corresponding week will remain segregated and intact at VLF while further characterization work is performed.

The following sections describe the rationale for applying the outlier test (twice-the-standard evaluation criteria), 90th percentile and 95% UCL of the mean evaluation criteria.

3.1 Outlier Analysis (Twice the Standard)

If any sample result or laboratory duplicate sample[1] is identified as an outlier with a concentration greater than twice the standard, then two replicate samples[2] will be analyzed for the identified parameter(s) (i.e. the parameter(s) that exhibited concentrations greater than twice the standard) from the original sample bottle from which the original laboratory aliquot was obtained. This procedure is supported by BC MoE Technical Guidance 12-8 "Outliers" and EPA530-R-95-036. Outliers will be determined by a statistically appropriate outlier test; based on data available to-date, all concentrations above twice the standard were identified as statistical outliers with high statistical confidence.

A data point can be an outlier for two reasons: 1) either there was an error in the sampling/analysis program and the data point is a false positive; or 2) the data point is from a separate population with higher concentrations (contamination). The two replicate samples from the original sample bottle will determine the case:

- If all three sample concentrations are above twice the standard they will be averaged.
- If two sample concentrations are above twice the standard and one is below the standard then the two sample concentrations above the standard will be averaged and used, while the value below the standard will be discarded.
- If only one sample concentration is above twice the standard and the remaining two are below then the one sample above twice the standard will be discarded and the other two will be averaged.

[1] a lab duplicate sample is a sample completed at random by the lab to verify the laboratory process is operating within the tolerances for the method

[2] a replicate sample is a targeted duplicate sample where there is an unexpected laboratory result and two additional samples are obtained to verify the original result

In addition to obtaining two replicate samples from the original sample bottle a more in-depth analysis will be conducted into the daily samples used to create the composite sample as explained below.

3.2 90th Percentile of the Data Set

The 90th percentile will be incorporated into the statistical analysis procedure, it is understood that the referenced statistic originates in BC MoE Technical Guidance 2: Statistical Criteria for Characterizing a Volume of Contaminated Material and the U.S. Environmental Protection Agency (USEPA) EPA530-R-95-036, Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic from the Office of Waste.

Prior to calculating the 90th percentile, the data need to undergo a quality assurance process for outliers, as discussed above. The 90th percentile will be calculated utilizing the percentile function in Microsoft Excel, which is the requested method by the BC MoE for background groundwater submissions and is analogous to the method specified in EPA530-R-95-036. Non-detects will be considered at the detection limit in performing this calculation.

3.3 95% Upper Confidence Limit of the Mean of the Data Set

The upper 95% confidence limit of the mean (95% UCL) will be incorporated into the statistical analysis procedure. It is understood that the referenced statistic originates in BC MoE Technical Guidance 2: Statistical Criteria for Characterizing a Volume of Contaminated Material and the U.S. Environmental Protection Agency (USEPA) EPA530-R-95-036, Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic from the Office of Waste.

Prior to calculating the 95% UCL, the data need to undergo a quality assurance process for outliers, as discussed above. The 95% UCL will be calculated utilizing the UCL function in Microsoft Excel, which is the requested method by the BC MoE for background groundwater submissions and is analogous to the method specified in EPA530-R-95-036. Non-detects will be considered at the detection limit in performing this calculation.

4.0 Daily Sample Laboratory Analysis

Under the circumstances described below, in order to create a sufficiently reliable database for evaluating bottom ash, additional laboratory analyses and evaluations will be completed on daily ash samples that will be archived at the WTEF. These additional analyses and evaluation steps are subject to future review and revision.

In the event that the 90th percentile or the 95% UCL of the weekly data is greater than the standard, or when at least one discrete sample is an outlier (which will typically include

samples with concentrations greater than twice the standard), the following procedure will be conducted in concert with the previous actions.

The following procedure is based on the composite sampling procedure in BC MoE Technical Guidance 1 - Site Characterization and Confirmation Testing (Technical Guidance 1). As the weekly composite samples are a composite of daily samples, it is possible that there is one day that is causing the elevated results, an offending nugget in the aliquot selected by the lab, or an issue with the municipal solid waste delivered to the WTEF. Therefore, the following test procedures are recommended to further examine the material characterized for the week by the original composite sample:

1. Each of the daily composite sample buckets for the week will be processed at the WTEF in accordance with Covanta EMS Operational Procedure No. BA2 to obtain twelve sub-samples (for each day).
2. Each day's sub-samples will be forwarded to ALS or equivalent for testing for the identified parameter(s).
3. Each day's sub-samples will be evaluated as follows:
    - For TCLP metals:
        - Outliers will be identified and processed as described in Section 3.1.
        - If the 90th percentile and the 95% UCL for the entire week are less than the standard, then the original weekly results will be discarded as an error, no further action will be taken, and the weekly ash will be classified as non-hazardous (subject to confirmation of non-hazardous pH).
        - If the 90th percentile or the 95% UCL for the entire week is greater than the standard or if at least one sub-sample is greater than twice the standard then the 90th percentile and 95% UCL will be calculated for each day. If the 90th percentile or 95% UCL for a specific day(s) is greater than the standard or if at least one sub-sample is greater than twice the standard, additional investigation limited to the day(s) in question will occur at VLF, as described in Section 5.0 below.
    - For pH:
        - If any individual pH result is greater than 12.5 then a statistical analysis will be completed. The 95% UCL and the 90th percentile of the distribution pH will be calculated using a log transform of the data as pH is a logarithmic scale.
        - If the 90th percentile and the 95% UCL are less than the standard the result will be discarded as an error.
        - If the 90th percentile or the 95th UCL is greater than the standard additional investigation limited to the day(s) in question will occur at VLF, as detailed in Section 5.0 below.

5.0 Bottom Ash Sample Collection at the VLF and Data Evaluation

Until the material is fully characterized, bottom ash generated by the WTEF will be delivered and stored in designated areas within the leachate collection system at VLF. Each individual load will be staked with the day of delivery by the hauler. Metro Vancouver will work with the City of Vancouver to develop an area on the VLF where a minimum of three weeks of bottom ash can be stockpiled.

In the event that evaluation of the daily samples identifies additional stockpile sampling requirements as described above, the bottom ash stockpiles corresponding to the day(s) requiring further assessment will be sampled in accordance with the following procedure. These additional laboratory analyses and evaluations will be completed on ash stockpiles at the VLF in order to create a sufficiently reliable database for evaluating bottom ash. These additional analyses and evaluation steps are subject to future review and revision.

5.1 Sampling Methodology and Laboratory Analysis

The sampling methodology is described on the attached flowchart which has been derived according to BC MoE Technical Guidance 1: Site Characterization and Confirmation Testing. This methodology was devised for conducting samples at a contaminated site rather than sampling an industrial waste stream. Under Technical Guidance 1, in-situ sampling is preferred and with material designated as suspect hazardous waste, the guidance indicates that one sample should represent 5 cubic metres (m^3) of in-situ material. In the case of the bottom ash, the ash material is held in one specific area where the individual dump loads can be identified, however, a stockpile has not been formed. Therefore, Technical Guidance 1, Part II. Batch Testing of Suspect Material in Stockpile (Ex Situ) is followed for sample collection at an in-situ sampling density.

In the following, each truckload or trailerload of ash material dumped at the VLF is referred to as a “load”; each load has a volume of approximately 8 to 10 m^3. Two samples will be obtained from each load, representing a “half-load” with a volume of 4 to 5 m^3. The combined loads from one day are referred to as a “stockpile” (even if they are not physically combined into one pile).

The sampling procedures for the characterization of ash are described in Section 5.1.1. However, for the special situation of very small ash volumes (i.e. less than 5 truck or trailer loads), refer to Section 5.1.2.

5.1.1 Stockpile Sampling Procedure

For the characterization of stockpiled bottom ash, the following site procedure will be utilized (for small stockpiles, please refer to Section 5.1.2):

1. If daily loads can be identified, then each day's ash will be considered to be a stockpile and will be assessed separately.
    i. If it is not possible to identify which loads originated on a specific day of the week (as is the case for weeks 13-24 and 13-25), then adjacent loads will be combined into a stockpile in order to obtain at least 10 samples and no more than 32 samples (plus duplicates) from each stockpile that will be prepared by the procedures described below. If possible, stockpiles should be arranged such that 20 samples are obtained from each stockpile (two samples are obtained from each load).
2. The individual truck or trailer loads will be visually surveyed and two labeled stakes will be placed in each individual pile; each stake will represent the respective half of the load.
    i. The stakes will be labeled A and B.
3. A sample will be obtained from each half-load by the following:
    i. Obtain a minimum of three equally sized aliquots from three different areas of the A side by excavating at least 20 cm into the face of the pile. Each aliquot should be a minimum of approximately 250 mL in volume.
    ii. Place all the aliquots into a clean 2.5 gallon bucket.
    iii. Seal the bucket and label as "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day of the week (1 to 7), A=A or B identifying the A or B side of the half-load, X= sequential numbering from 1 to n (where n is the number of loads included in the stockpile).
    iv. At a suitable location, process the material to create a composite sample for the half-load, as follows:
        a. Place material from the bucket onto a sheet of plywood or into a suitably sized stainless steel bowl and mix thoroughly for 1 minute.
        b. Pass the material over a 3/8" (9.5 mm) screen.
        c. Material that does not pass through the screen is to be subjected to a particle size reduction step. Make sure to weigh the amount of >3/8" material prior to size reduction and record on the worksheet.
            - In the particle size reduction step, materials are reduced in size by mechanical crushing with a 4 pound hammer and then passed over the 3/8" screen again. Do not work the material excessively (i.e. do not over crush and create a lot of fines).
            - Material (including metal) that does not pass through the 3/8" screen and cannot be reduced in size is discarded. Ensure the weight of this material is noted on the worksheet.
        d. Mix all the material that has passed through the 3/8" screen thoroughly on a piece of plywood or into a suitably sized stainless steel bowl. Ensure large and small material is mixed thoroughly for at least three minutes.

e. Cone and divide the composited material into 4 equal portions (quarters).
f. Place this ash into one (1) 500ml sample container by scooping material from each quarter. Put small scoops in the container until it is full. Ensure the sample container is filled to the top. Discard the remaining material back to the stockpile at VLF from which the material was collected.
g. Label the sample containers with "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A or B identifying the A or B side of the half-load, X=sequential numbering from 1 to n (where n is the number of loads for that day).

v. For one in ten samples (or portion of 10), a duplicate sample will be prepared and analyzed as a blind duplicate and will be prepared as follows:
   a. When a duplicate sample is to be prepared, then step 3.iv.f is amended as follows: fill the original and duplicate containers by putting small scoops into the containers until they are full by alternating between the two containers (i.e. do not fill them sequentially; alternating between containers will ensure the sampling procedures are maintained as uniform as possible and result in as near-replicated samples as possible).
   b. Label the duplicate sample container with "BA-VLF-YY-WW-DD-A-100+X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A or B, 100+X=the number identifying the load (same number as the original sample) plus 100. For example, the duplicate for BA-VLF-13-37-A-3 will be BA-VLF-13-37-A-103.
vi. Decontaminate all sampling equipment according to standard SOPs.
vii. Repeat on the B side.
viii. Repeat for all individual loads.

4. Based on this procedure, for analysis of bottom ash from one day, a minimum of six aliquots per load will be obtained for two laboratory samples (a minimum of three aliquots will be composited from each of the A and B side). Therefore, for example, for a day with ten piles (5 trucks and trailers), a minimum of 60 aliquots will be obtained and composited into 20 samples for the stockpile.
5. All samples will be submitted to ALS or equivalent for analysis of TCLP metals and/or pH (2:1) for the identified parameter(s).

5.1.2 Special Considerations for Small Stockpiles

If only a small amount of bottom ash (i.e. fewer than 5 loads, i.e. fewer than 3 haul trips of a truck and trailer combination) was delivered to VLF for a given day, the procedure under 5.1.1 is modified as follows:

1. All the day's ash will be considered to be a single stockpile and will be assessed separately.
2. The individual truck or trailer loads will be visually surveyed and a sufficient number of labeled stakes will be placed in each individual load to obtain a minimum of 10 samples. For example, if there is 1 load, then 10 stakes will be placed into that load. If there are 2 loads, each load will be subdivided into 5 equal parts and staked. If there are 3 loads, each load will be subdivided into 4 equal parts and staked. If there are 4 loads, each load will be subdivided into 3 equal parts and staked.
    i. The stakes will be labeled A, B, C… as required.
3. A sample will be obtained from each staked portion by the following:
    i. Obtain a minimum of three equally sized aliquots by excavating at least 20 cm into the face of the pile. Each aliquot should be a minimum of approximately 250 mL in volume.
    ii. Place all the aliquots into a clean 2.5 gallon bucket.
    iii. Seal the bucket and label as "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day of the week (1 to 7), A=A, B, C… identifying the portion of the ash, X= sequential numbering from 1 to n (where n is the number of loads included in the stockpile).
    iv. At a suitable location, process the material to create a composite sample, as under Section 5.1.1. Label the sample containers with "BA-VLF-YY-WW-DD-A-X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A, B, C… identifying the staked portion of the ash, X=sequential numbering from 1 to n (where n is the number of loads for that day).
    v. For one in ten samples (or portion of 10), a duplicate sample will be prepared and analyzed as a blind duplicate and will be prepared as described in Section 5.1.1. Label the duplicate sample container with "BA-VLF-YY-WW-DD-A-100+X", where BA=bottom ash, VLF=Vancouver Landfill, YY=year, WW=week (1 to 52), DD=day (1 to 7), A=A, B, C… identifying the staked portion of the ash, 100+X=the number identifying the load (same number as the original sample) plus 100. For example, the duplicate for BA-VLF-13-37-A-3 will be BA-VLF-13-37-A-103.
    vi. Decontaminate all sampling equipment according to standard SOPs.
    vii. Repeat for all remaining staked portions (i.e. B, C… etc.).
    viii. Repeat for all individual loads.
4. All samples will be submitted to ALS or equivalent for analysis of TCLP metals and/or pH (2:1) for the identified parameter(s).

5.2 Data Assessment Methodology

The results from each stockpile will be assessed as follows:

- The data is examined to determine if it all belongs to the same population and if outliers exist. Outliers will be removed from the data set; the remaining analysis is performed

on the data set representing the ash from one entire day (i.e. typically 10 to 30 samples).
- The 90th percentile of the data set is below the standard for the parameter.
- The 95% UCL is below the applicable standard for the parameter.

6.0 Stockpile Management

Bottom ash stockpiled at VLF that meets the evaluation criteria will be moved for disposal or beneficial use (upon reinstatement of beneficial use designation at VLF by BC MoE).

Upon determination that a portion of stockpiled bottom ash does not meet the evaluation criteria, to minimize the infiltration of water, the offending portion of the bottom ash will be covered by the hauling contractor with a tarp using weights to secure and regularly checked by the hauling contractor until such time that the material is removed from VLF and disposed at an approved facility.

7.0 Classification of Stockpiles at VLF for Weeks 13-24 and 13-25

The bottom ash data collected from week 13-24 and week 13-25 had individual sample concentrations that were twice the applicable standard; however this data was not able to be replicated in the laboratory. Daily ash samples were not routinely archived in the past, and therefore, daily samples are not available for those two weeks for conducting a daily sample laboratory analysis and evaluation. Therefore, the bottom ash material was segregated at the landfill and additional sampling and evaluation will occur from these piles as described in Section 5 and will be managed in accordance with Section 6.

Bottom Ash Management Plan Flowchart

Weekly Composite Samples

Lab Analysis
TCLP + pH 2:1

Data Evaluation of Weekly Composite Samples by Individual Parameter

Parameter(s) Meet Requirements

No Further Work

For weekly and daily sample collection/preparation refer to Covanta EMS Operational Procedure No. BA2

Parameter(s) Do Not Meet Requirements

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

Lab Analysis of Daily Composite Samples by Day for Identified Parameter(s)

Data Evaluation of Daily Composite Samples by Day for Identified Parameter(s)

Parameter(s) Do Not Meet Requirements

Parameter(s) Meet Requirements

No Further Work

Sample Daily Stockpiles at the Landfill for each Day Identified

Refer to the Bottom Ash Management Plan. Each stockpile is marked with a stake identifying the date it was received at the landfill.

Lab Analysis for Identified Parameter(s)

Data Evaluation of Stockpiled Composite Samples for Identified Parameter(s)

Parameter(s) meet Requirements

No Further Work

Parameter(s) Do Not Meet Requirements

Material Removed from VLF and Disposed at an Approved Facility

Orbit: 7733025 (Visio)
7734097 (PDF)

This page left blank intentionally

ATTACHMENT 2

EMS Operational Procedure No. BA2

The EMS Operational Procedure No. BA2 addresses MoE condition 6 which is included below for reference.

Condition 6:

Develop a detailed sampling protocol describing how samples of bottom ash are collected (both daily and weekly composites) prior to submission to the laboratory. A qualified professional must be consulted to ensure that analytical data derived from these samples can be statistically evaluated with supporting arguments.

This page left blank intentionally

EMS OPERATIONAL PROCEDURE No. BA2

Matt Neild Digitally signed by Matt Neild DN: cn=Matt Neild, o=Covanta Burnaby Renewable Energy, ou, email=mneild@covanta energy.com, c=CA Date: 2013.08.28 18:23:21 -07'00'

Bottom Ash Sampling

I PURPOSE

The purpose of this procedure is to:

1. Define the steps necessary to create and process a representative bottom ash weekly composite suitable for laboratory TCLP testing.
2. Define the steps to be taken to create a representative bottom ash daily composite sample
3. Minimize employee exposure to the bottom ash and to the dust generated by the bottom ash during sampling.

II REFERENCES

1. Bottom Ash and Treated Bottom Ash Safety Data Sheet
2. Directive D0001 – Routine Duties to be Performed Each Shift
3. Directive D0002 – Routine Duties to be Performed Each Week
4. Directive D0005 – Plant Housekeeping Duties
5. EMS Book 2 - Training Module #5 - Sewer & Storm Water Discharges.
6. US EPA Method 1311
7. All related JSA's

III GENERAL & DEFINITIONS

As per the BC Hazardous Waste Regulation, the toxicity characteristic of bottom ash is determined using an extraction procedure described in US EPA Method 1311. If this test produces an extract with a contaminant concentration is equal to or greater than those prescribed in Table 1 of Schedule 4 of the Regulations, the waste is considered to be hazardous. US EPA Method 1311 is commonly called the Toxicity Characteristic Leaching Procedure (TCLP).

There are 92 potential contaminates listed in Table 1 of Schedule 4. However, contaminants that are not present in the waste, or are present in such low concentrations that the regulatory limits could not be exceeded, need not be included in the TCLP test. An example of this is volatile organics; these are not expected to be found in the bottom ash since furnace temperatures exceed the boiling points of the compounds. 12 metals are regulated by Schedule 4 and are TCLP tested. Historically, in this facility and similar facilities worldwide, the bottom ash contaminants of most concern are lead and cadmium.

The TCLP test uses a minimum of 100 grams of sample; therefore, the sampling plan is a critical component in accurately determining the toxicity characteristic of the bottom ash. The objective of the sampling plan is to obtain a representative sample of the ash which exhibits the average properties of the ash as a whole. Composite sampling is used as it provides a good characterization of the variability in the bottom ash.

In this procedure, composite sampling is defined as the collection of a defined number of daily samples at a specified frequency. These samples are mixed together to form a single weekly composite. This single sample is then analyzed at the lab using the TCLP. Sampling procedures are used to describe the specific details of the different types of composite samples that may be collected. In all cases, the objective is to ensure enough samples are collected over a suitable period of time to represent the variability in the bottom ash. A suitable sampling plan will allow measurements that are both accurate and precise (repeatable).

IV PROCEDURES

This procedure defines the methods used to collect both a weekly (defined as 12:00am Sunday to 12:00 midnight the following Saturday) and daily composite bottom ash sample:

WEEKLY COMPOSITE SAMPLE

i. At the beginning of each day shift, obtain a sample from the ash crane bucket with ash from #1 Boiler pit. The sample must weigh approximately 1 kg and is to be obtained by filling the ash crane clamshell bucket with ash from the pit and then using a shovel to take a representative sample from the accessible points of the bucket. A representative sample is defined as collecting material in approximately the same proportion as the fine and larger material observed in the bucket. The sampled material is to be stored in a clean 2.5 gallon bucket. Ensure the container is clean prior to use.

ii. Repeat the above step for bottom ash from #2 and #3 storage pits.

iii. At the end of each day shift, repeat steps (i) and (ii). A total sample of approximately 6 kg per day must be collected for the weekly composite.

iv. Take the bucket with each day's portion of the weekly bottom ash sample and deposit into the wagon located in the Turbine Hall basement.

v. At the end of 7 days of sampling, the wagon will contain approximately 42 kg of material, ready for processing.

vi. After the weekly wagon storage pile is complete (7 days of samples), place the entire sample on a sheet of plywood and mix thoroughly. Do not discard any ash.

vii. Take a sub-sample of the weekly storage pile and, using the Sample Processing Procedure (see Section V below), process enough bottom ash to fill twelve (12) 500 mL sample bottles. The remaining processed ash is then to be placed into a 2.5 gallon pail with a lid attached and labeled as "Bottom Ash Weekly Composite Sample" and the date range for the week. Archive this sample in the blue shipping container on the apron.

DAILY COMPOSITE SAMPLE

i. Daily samples are to only be created from material loaded to the ash trucks. They are meant to be a one to one correspondence to material that is deposited in the landfill. No daily composite sample to be taken if no bottom ash is loaded and transported to the landfill on a particular day. While rare, there are days where no bottom ash is transported to the landfill.

ii. Take a 1 kg grapple bucket sample from each pit (a total of 3 kg) when the first truck is loaded in the day and repeat with the last truck loaded in the day. Collect at least 6kg in total for the day. Place the sample in a clean 2.5 gallon container.

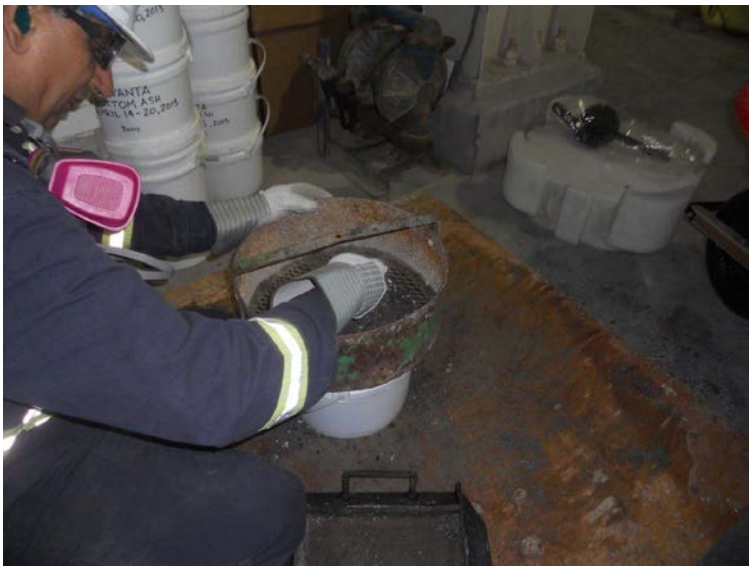
iii. Put a lid on the daily sample, label as “Bottom Ash Daily Sample” and the date the sample was created. The labeled daily sample buckets are to be temporarily stored at the ash station in the Turbine Hall basement. At the end of the week, the daily samples are to be archived in the blue shipping container located on the apron.

V SAMPLE PROCESSING PROCEDURE

Refer to the attached “Bottom Ash Sampling Worksheet” to record weights

i. All the ash from the week should be in one wagon and shall be weighed prior to mixing.

ii. All ash should first be passed over a 3/8” (9.5 mm) screen.



iii. Material that does not pass through the screen is to be subjected to a particle size reduction step. Make sure to weigh the amount of >3/8” material prior to size reduction and record on the worksheet.

   a. In particle size reduction, materials are reduced in size by mechanical crushing and then passed over the 3/8” screen again by using the 4 pound hammer. Do not work the material excessively (i.e. do not over crush and create a lot of fines)

iv. Material (including metal) that does not pass through the 3/8" screen and cannot be reduced in size is discarded. Ensure the weight of this material is noted on the worksheet.

v. Mix all the material that has passed through the 3/8" screen thoroughly on a piece of plywood. Ensure large and small material on the plywood is mixed thoroughly for at least three minutes.

vi. Cone and divide the pile into 4 equal portions (quarters).

vii. Place this ash into twelve (12) 500ml sample containers by scooping material from each quarter. Put small scoops in each container and alternate all containers until they are full (to ensure the sampling procedures are maintained as uniform as possible and result in as near-replicated samples as possible). Label the sample containers with “Bottom Ash” and the date when the when sample collected (ie; Bottom Ash from June 9-15 2013). Ensure the sample containers are filled to the top. Put the remaining material into a 2.5 gallon bucket and seal with a lid. Note the contents of the bucket and the date when sample collected. (ie; Bottom ash from June 9-15 2013)

viii. Bring the sample containers and Bottom Ash Worksheet to the Front Desk for further labeling and shipment to the laboratory for TCLP testing.

ix. Clean the sampling equipment and wagon. Ensure the ash testing area is tidied up.

Bottom Ash Worksheet

Date sample composited (DD/MM/YYYY)	
Person doing the sampling	
Total Sample Weight before processing, kg	
Weight of Material >3/8", kg	
Weight of Material that cannot be processed to <3/8" (metal, wood, etc), kg	
Final Total weight of Processed Bottom Ash, kg	

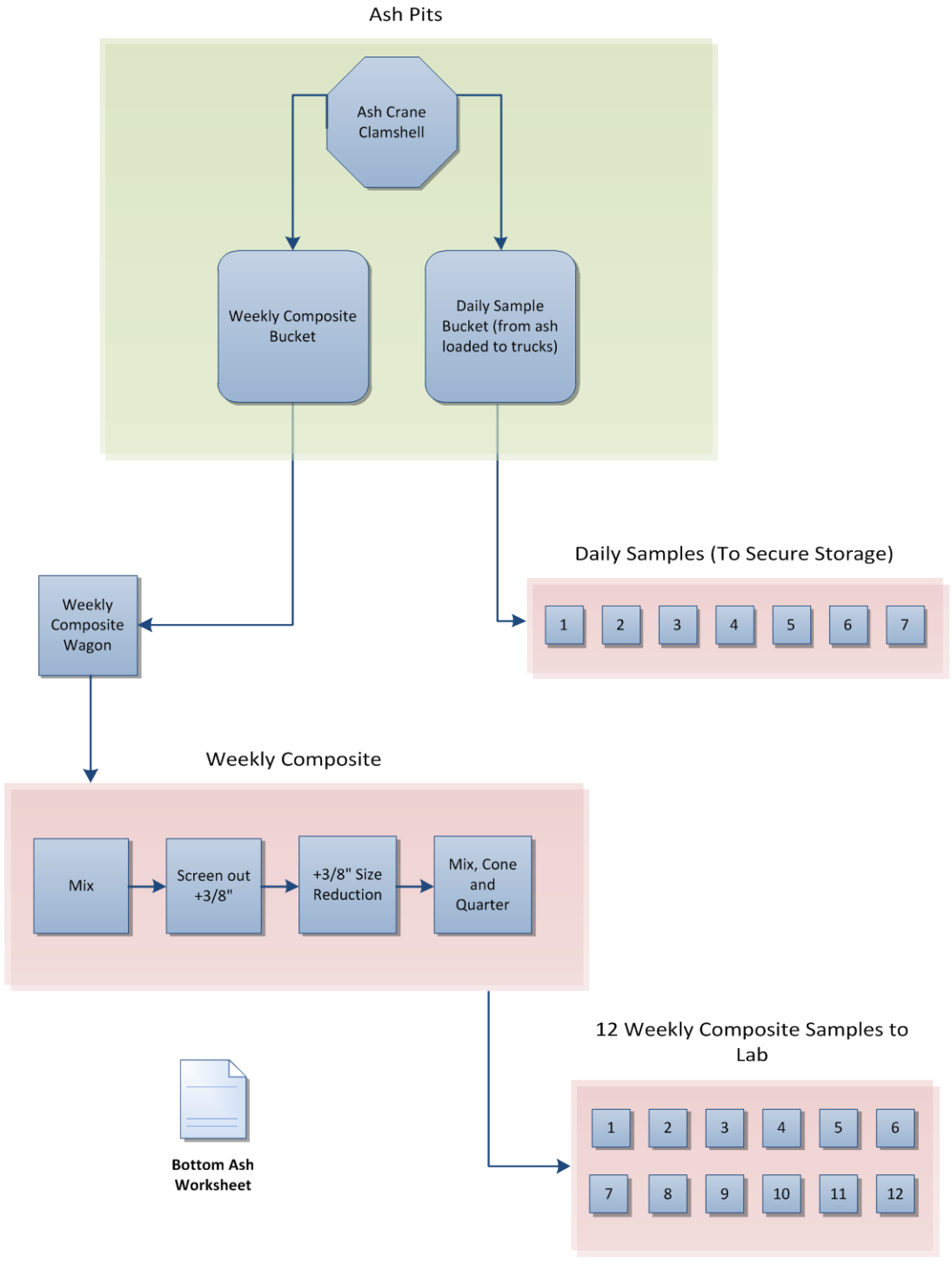
Return this form with the filled Weekly Bottom Ash Composite Sample containers

Completely fill twelve (12) 500ml sample containers and label each with "Bottom Ash" and the week the ash composite is from, i.e. "June 9-15, 2019"

Bottom Ash Sampling

Version – July 25, 2013

Bottom Ash Sampling Procedure Flowchart



Revisions and Edits Log:

1. **Aug 15, 2013** – V.iii.a Removed reference to using a hammer drill and special bit for size reduction and associated photo. Added "Do not work the material excessively (i.e. do not over crush and create a lot of fines)".
2. **Aug 16, 2013** – IV section i, ii, iii and iv: Clarified daily sampling methodology. Daily samples are to be created from material loaded to the ash trucks. They are meant to be a one to one correspondence to material that is deposited in the landfill. No daily composite sample to be taken if no bottom ash is loaded and transported to the landfill on a particular day. Sampling procedures separated into "Weekly Composite" and "Daily Composite" for clarity.
3. **Aug 27, 2013** – IV section i: changed sampling material from the ash crane bucket in equal proportions of fine and larger material to take samples approximately in proportion of fine and larger material (i.e. not "equal"). Added reference to storage in a 2.5 gal container, cleaned prior to use. V section iiii: added requirement to record +3/8 material prior to size reduction. V section vi: added to ensure large and small material on the plywood is mixed thoroughly for at least three minutes. Daily Composite Sample section iii: added place sample into a clean 2.5 gallon container. Daily Composite Sample, section i: added "while rare, there are days where no bottom ash is transported to the landfill". Removed for clarity - Daily Composite Sample, section ii: "The daily sample bucket is to be filled with bottom ash sampled from the grapple that is being loaded onto a truck"; added clarification to take a 1kg sample from each pit, total of 3 kg. V section vii: Added labeling instruction for sample bottles. Added "Put small scoops in each container and alternate all containers until they are full (to ensure the sampling procedures are maintained as uniform as possible and result in as near-replicated samples as possible)". Added "dust" to Purpose, Section 3, minimizing employee exposure.
4. **Aug 28, 2013** – Purpose, section 3: Deleted reference to fumes and vapours. IV Procedures: clarified sampling period for the weekly bottom ash composite. Weekly Composite, (i): Clarified representative sample to mean collecting material from the ash bucket in the same proportion as observed in the bucket (i.e. proportion of fines to larger particles).

ATTACHMENT 3

Week 16 pH Assessment

The Week 16 pH assessment addresses MoE condition 3 which is included below for reference.

Condition 3:

Retain a qualified professional to re-assess week 16 results as the May 10, 2013 Hemmera report did not include a discussion on the one elevated pH result.

Metro Vancouver response:

The Element One laboratory pH results for BA1316-E was 12.70 where the BA1316-E Dup result was 12.72. These results appear to be above 12.5 specified by the HWR; however, the results were not completed according to the correct method specified in British Columbia. The pH determined by Maxxam was 11.6 and the three ALS samples were 11.76, 11.64, and 11.67, these were all completed in accordance to the method specified in British Columbia.

In British Columbia, the measurement of pH in soil is a prescriptive method contained in Section B of the Water and Air Monitoring and Reporting Sampling, Methods and Quality Assurance British Columbia Environmental Laboratory Manual: 2009. ALS and Maxxam in British Columbia conduct pH analysis in accordance with this procedure.

Element One does not conduct pH measurement in accordance with this procedure but rather in accordance with US EPA Soil and Waste pH 9045C, 2:1 soluble pH. The table below highlights the differences in the method used.

Method	BC MOE pH, Electrometric, Soil and Sediment - Prescriptive	US EPA Soil and Waste pH 9045C
Soil Sample	20 g (2 mm sieve 60 °C)	20 g (no dry or sieve)
Water	2 mL /gram (40 mL) (deionized)	20 mL (reagent)
Mix time	30 minutes	5 minutes
Stand time	1 hour	1 hour

As the BC MoE method is a prescriptive method, it is not performance based and all elements of the method must be followed. As such, only the results of pH from ALS and Maxxam are considered accurate. Therefore, the one result from Element One that was above 12.5 has been discarded and pH is no longer tested at Element One.

This page left blank intentionally

ATTACHMENT 4

Contingency Disposal Plan

The Contingency Disposal Plan addressees MoE condition 8 which is included below for reference.

Condition 8:

Develop a contingency plan that identifies alternative disposal sites and/or further assessment if the bottom ash does not meet the standards of the Interim Bottom Ash Management Plan, conditions specified in this letter or the HWR. The plan shall include timelines for out-of-spec material to move off-site.

Metro Vancouver response:

Metro Vancouver proposes the following contingency plan to be implemented in the event that bottom ash does not meet the standards for acceptance at the Vancouver Landfill. Metro Vancouver has initiated inquiries with three landfills that could potentially accept bottom ash for disposal. Metro Vancouver will work through a waste acceptance protocol, specific to each landfill, to determine if the bottom ash can be accepted in any of the three landfills. Metro Vancouver will then inquire with two or three transportation firms to determine their ability to transport the waste to one, or more, of the landfills. Metro Vancouver will then review the information provided and issue purchase orders to the preferred landfill and hauler. Metro Vancouver will ensure that, in the event that bottom ash is does not meet the standards identified above, the bottom ash will be managed in compliance with all applicable regulatory requirements, including BC MoE HWR and Federal Transportation of Dangerous Goods Regulations.

The anticipated timing to complete the implementation of this contingency plan is as follows:

- identify disposal sites that can accept the bottom ash by October 1, 2013;
- identify potential haulers by November 1, 2013; and,
- issue purchase orders for bottom ash which does not meet Municipal Solid Waste standards by December 1, 2013.

This page left blank intentionally

ATTACHMENT 5

Source Control Measures and WTEF Improvements

The Source control measures and WTEF improvements addresses MoE Conditions 9 which is included below for reference.

Condition 9:

Assess works at the Burnaby WTE facility to ensure measures are implemented to further control the quality of bottom ash generated. Provide rationale on any further source control measures including any outreach programs currently implemented or proposed by Metro Vancouver.

Metro Vancouver response:

Cadmium in the Waste Stream / Source Control
The primary source of cadmium in the waste stream is household batteries, specifically rechargeable batteries including rechargeable household electronics. The other primary potential source of cadmium in the waste stream is plastics, but the amount of cadmium from plastics represents only a fraction of the cadmium resulting from rechargeable batteries[1]. According to the International Cadmium Association, 85% of annual production of cadmium in 2010 was for nickel cadmium (NiCd) batteries.

Metro Vancouver's waste composition studies over the last 20 years do not show an increase in household battery proportions, but given the relatively small portion batteries make up of the waste stream (estimated at no more than 0.1%) and the various types of batteries and the sources of those batteries, increases in rechargeable batteries may not be detected through waste composition analysis.

Actions to be taken by Metro Vancouver to better understand the sources of cadmium and to remove or redirect the cadmium sources from the waste received include:

a) Metro Vancouver will work with product stewards for household batteries and electrical and electronic products to explore options to continue to enhance these relatively new product stewardship programs as well as examine options at our facilities to specifically divert targeted materials that may contain cadmium.
b) Metro Vancouver will continue to enhance material ban inspection targeting sources of rechargeable batteries such as electronic devices. Inspection surcharges for electronic devices already make up 31% of all the surcharges issued.
c) Complete waste composition study in the fall of 2013, to identify the key sources of cadmium in the waste stream.

[1]Aucott, Michael , A. Namboodiripad, A. Caldarelli, K. Frank and H. Gross, 2009. "Estimated Quantities and Trends of Cadmium, Lead, and Mercury in US Municipal Solid Waste Based on Analysis of Incinerator Ash", pp. 1-4, NJDEP.

WTEF Process Improvements

Metro Vancouver will ask Covanta to review processes in place at the WTEF to ensure mechanical and chemical processes minimize leachable cadmium in the bottom ash.

Metro Vancouver will provide a copy of the review to MoE by October 15, 2013.

Some process improvements have already been identified. Since 2008, phosphoric acid has been added to each of the three bottom ash quench tanks to control the leachability of lead and cadmium. The phosphoric acid is injected into the quench tanks with a pump. By the middle of 2014, automated flow meters will be added to more accurately measure the amount of phosphoric acid injected and allow a tie-in to the plant's electronic control system.

Metro Vancouver is also investigating non-ferrous metal recovery which will allow the recycling of metals such as aluminum and copper from the waste stream, and may also enhance heavy metal recovery from the bottom ash.

ATTACHMENT 6

Beneficial Reuse of Bottom Ash Reinstatement

The Beneficial reuse of bottom ash reinstatement addresses MoE Conditions 10 which is included below for reference.

Condition 10:

The immediate suspension of the beneficial reuse of bottom ash at the Vancouver Landfill until further notice. Therefore, all bottom ash disposed at the Vancouver Landfill must count against the landfill's annual limit set forth in the operational certificate (MR-01611). The Ministry will consider an assessment, by a qualified professional, for reinstating the beneficial use of bottom ash at the landfill.

Metro Vancouver response:

The City of Vancouver and Metro Vancouver are both undertaking occupational health and safety studies by qualified consultants to ensure that the results from past studies showing no effects to human health or the environment remain applicable. It is anticipated that the Metro Vancouver study can be completed in September 2013.

This page left blank intentionally

BRITISH COLUMBIA

July 4, 2013

File: 76780-35/MV/W2E
MR-01611

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8
Fax: 604 451-6180

Attention: **Paul Henderson**
General Manager, Solid Waste Services

Re: Proposed Interim Bottom Ash Management Plan, Burnaby Waste-to-Energy Facility

Thank you for your letter and supporting documentation, dated May 21, 2013 seeking approval of a proposed Interim Bottom Ash Management Plan for the ash generated at the Burnaby Waste-to-Energy (WTE) facility.

The Ministry was first notified the week of April 15, 2013 of a potential issue concerning the disposal of bottom ash at the Vancouver Landfill. Metro Vancouver (MV) and the City of Vancouver advised that the landfill accepted bottom ash that may be classified as a hazardous waste. The Ministry subsequently requested further information and a plan regarding the monitoring and management of the bottom ash generated from the Burnaby WTE facility. The Ministry notes that the Vancouver Landfill has stored the bottom ash on a rock pad onsite since April 22, 2013 pending further sampling and classification of the waste.

The Ministry understands that the bottom ash samples are collected daily and composited into a weekly sample and subsequently submitted for analysis to 3 separate laboratories, ALS Environmental, Maxxam Analytics and Element One Inc. Ministry staff have reviewed lab results for approximately 260 samples for the period commencing December 2012. There have been a number of sample results that exceeded the leachable cadmium limit of 0.5 mg/L as specified in the Hazardous Waste Regulation (HWR). In addition there was one pH result and three leachable lead tests exceeding the HWR requirements. Hemmera Envirochem Inc. was retained by Covanta Renewable Energy to review the bottom ash test results and to propose statistical guidance for characterizing the waste and provide input in the development of bottom ash management plan.

.../2

Ministry of Environment South Coast Region
Environmental Protection Division
Mailing Address:
2nd Floor
10470 152nd Street
Surrey BC V3R 0Y3
Telephone: 604 582-5200
Facsimile: 604 584-9751
Website: www.gov.bc.ca/env

Based on the data reviewed to date, the proposed Interim Bottom Ash Management Plan dated May 21, 2013 is acceptable subject to the following additional conditions:

1. The upper 90th percentile of the sample concentrations is less than the limits specified in the HWR;

2. No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the HWR;

3. Retain a qualified professional to re-assess week 16 results as the May 10, 2013 Hemmera report did not include a discussion on the one elevated pH result;

4. Bottom ash must be stored in daily segregated waste piles at the Vancouver Landfill until the waste is fully characterized;

5. In addition to the weekly composite samples that are submitted for laboratory analysis, daily composite sample must be collected and stored. In the event there are exceedances in the weekly composite sample results that do not meet the Interim Bottom Ash Management Plan as conditionally approved, the daily composite samples must be analyzed for further characterization of the bottom ash;

6. Develop a detailed sampling protocol describing how samples of bottom ash are collected (both daily and weekly composites) prior to submission to the laboratory. A qualified professional must be consulted to ensure that analytical data derived from these samples can be statistically evaluated with supporting arguments;

7. Weekly laboratory results are to be submitted to the Ministry as soon as they become available and no later than within 3 weeks of sample collection, containing all applicable parameters related to the authorization of the Burnaby Waste-to-Energy facility;

8. Develop a contingency plan that identifies an alternative disposal sites and/or further assessment if the bottom ash does not meet the standards of the Interim Bottom Ash Management Plan, conditions specified in this letter or the HWR. The plan shall include timelines for out-of-spec material to move off-site;

9. Assess works at the Burnaby WTE facility to ensure measures are implemented to further control the quality of bottom ash generated. Provide rationale on any further source control measures including any outreach programs currently implemented or proposed by MV; and

...3

10. The immediate suspension of the beneficial reuse of bottom ash at the Vancouver Landfill until further notice. Therefore, all bottom ash disposed at the Vancouver Landfill must count against the landfill's annual limit set forth in the operational certificate (MR-01611). The Ministry will consider an assessment, by a qualified professional, for reinstating the beneficial use of bottom ash at the landfill.

Submit to the Ministry a report by July 31, 2013 to address the conditions above. The Ministry will reassess the plan within 4 months to determine if additional conditions are required.

Therefore, all bottom ash either stockpiled at the Vancouver Landfill or generated at the WTE during this 4 month period that meets the Interim Management Plan subject to the above conditions can be landfilled.

This letter shall not be construed as a waiver of any lawful requirement pertaining to any unauthorized discharge of waste to the environment, and is without prejudice to any further legal action that the Ministry may take under the *Environmental Management Act.*

A copy of the *Environmental Management Act* can be downloaded from the internet at the following web link: http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm

If you have any questions, please contact the undersigned or Ashley Smith at (604) 582-5200.

Sincerely,

Avtar S. Sundher
Head, Government and Compliance Section
South Coast Region

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Lynn Belanger, Manager, Transfer and Landfill Operations, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head Clean Technologies, Victoria
Shelley Metcalfe, Head, Business and Standards Section, Surrey

BRITISH COLUMBIA

November 7, 2013

File: 76780-35/MV/W2E
MR-01611

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8
Fax: 604 451-6180

Attention: **Paul Henderson**
General Manager, Solid Waste Services

Dear Mr. Henderson,

Re: Proposed Bottom Ash Management Plan, Burnaby Waste-to-Energy Facility

Thank you for your letters and supporting documentation, dated October 21 and August 30, 2013 addressing 10 conditions stipulated in a Ministry letter of July 4, 2013 regarding the management of bottom ash generated at the Burnaby Waste-to-Energy (WTE) facility and storage/disposal at the Vancouver landfill.

There are a number of factors, currently being reviewed by the Ministry, that need to be considered prior to making an ultimate decision on the proposed management of the bottom ash. The Ministry is willing to accept the plan, submitted on August 30, 2013, as a temporary management plan until the Ministry has more information as noted below. Therefore the proposed Bottom Ash Management Plan dated August 30, 2013 is acceptable subject to the following additional conditions:

1. No sample in the data set has a concentration exceeding two times the Leachate Quality Standards in Schedule 4 of the HWR;

2. Laboratory results are to be submitted to the Ministry as soon as they become available and no later than within 3 weeks of sample collection and/or submitted to approved lab, containing all applicable parameters related to the authorization of the Burnaby Waste-to-Energy facility. A summary report should be prepared and submitted to the Ministry by November 29, 2013, for the laboratory data collected for the past 6 months and a second report to be submitted by February 28, 2014 to include November, December and January 2014 data:

3. Outliers must be used in the calculation of the mean and/or the upper confidence limit;

.../2

Ministry of Environment South Coast Region
Environmental Protection Division
Mailing Address:
2nd Floor
10470 152nd Street
Surrey BC V3R 0Y3
Telephone: 604 582-5200
Facsimile: 604 584-9751
Website: www.gov.bc.ca/env

4. Prepare a report that compares the proposed sampling protocol and the use of statistical analysis with the USEPAs sampling protocol and the use of statistics in the assessment of bottom ash. The report must be submitted to the Ministry by December 31, 2013;

5. The Ministry does not support the reinstatement of the beneficial reuse of bottom ash at the Vancouver Landfill at this time. All bottom ash disposed at the Vancouver Landfill must count against the landfill's annual limit set forth in the operational certificate (MR-01611). The Ministry will consider an assessment, by a qualified professional, for reinstating the beneficial use of bottom ash at the landfill.

6. The Ministry will reassess and/or make a decision regarding the proposed bottom ash management plan within 4 months of the date of this letter.

Therefore, all bottom ash either stockpiled at the Vancouver Landfill or generated at the WTE during this 4 month period that meets the Proposed Management Plan subject to the above conditions can be landfilled.

This letter shall not be construed as a waiver of any lawful requirement pertaining to any unauthorized discharge of waste to the environment, and is without prejudice to any further legal action that the Ministry may take under the *Environmental Management Act.*

A copy of the *Environmental Management Act* can be downloaded from the internet at the following web link: http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm

If you have any questions, please contact the undersigned or Ashley Smith at (604) 582-5200.

Sincerely,

Avtar S. Sundher
Head, Government and Compliance Section
South Coast Region

cc: Jennifer McGuire, Executive Director, Ministry of Environment, Victoria
Jonn Braman, Regional Director, Ministry of Environment, Surrey
Lynn Belanger, Manager, Transfer and Landfill Operations, City of Vancouver
Mike Brotherston, Manager of Climate Action and Environment, Corporation of Delta
Rob Dalrymple, Unit Head Clean Technologies, Victoria

ATTACHMENT 2

Laboratory Certificate of Analysis

[redacted]

GOLDER ASSOCIATES LTD.
ATTN: Kathleen Edwards
200-2920 Virtual Way
Vancouver BC V5M 0C4

Date Received: 05-SEP-18
Report Date: 01-OCT-18 11:49 (MT)
Version: FINAL REV. 2

Client Phone: 604-298-6623

Certificate of Analysis

Lab Work Order #: L2158553

Project P.O. #: NOT SUBMITTED
Job Reference: 18108461
C of C Numbers: 14-508319, 17-668278, 17-668279
Legal Site Desc:

Comments:

Samples in this report underwent specialized preparation, based on information supplied by Golder. A brief summary is as follows:

1. Samples are sieved to <9.5mm.
2. Weights recorded for both size fractions.
3. >9.5mm material crushed with a hammer, and re-sieved.
4. >9.5mm material remaining after crushing discarded.
4. All material <9.5mm is combined for TCLP analysis.

Additional procedural details are available on request.

1-OCT-2018 Additional TCLP Replicate data is included.

[redacted]

[redacted]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-1	L2158553-2	L2158553-3	L2158553-4	L2158553-5
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
Sampled Time					
Client ID	BA-VLF-1A-1	BA-VLF-1A-0	BA-VLF-1B-1	BA-VLF-1B-0	BA-VLF-2A-1
Grouping / **Analyte**					
SOIL					
TCLP Metals					
1st Preliminary pH (pH)	10.83	10.63	10.68	10.66	10.95
2nd Preliminary pH (pH)	7.60	6.76	6.62	6.59	6.29
Final pH (pH)	5.53	5.64	5.84	5.65	5.70
Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	0.289	0.274	0.240	0.397	0.285

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-6	L2158553-7	L2158553-8	L2158553-9	L2158553-10
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
Sampled Time					
Client ID	BA-VLF-2A-0	BA-VLF-2B-1	BA-VLF-2B-0	BA-VLF-3A-1	BA-VLF-3A-1FD
Grouping / **Analyte**					
SOIL					
TCLP Metals					
1st Preliminary pH (pH)	9.55	10.88	10.39	10.83	9.98
2nd Preliminary pH (pH)	6.54	8.10	7.82	6.61	6.65
Final pH (pH)	5.14	5.57	5.85	5.67	5.20
Extraction Solution Initial pH (pH)	2.89	2.89	2.89	2.89	2.89
Cadmium (Cd)-Leachable (mg/L)	0.507	0.396	0.968	0.376	0.192

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-11	L2158553-12	L2158553-13	L2158553-14	L2158553-15
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-3A-0	BA-VLF-3B-1	BA-VLF-3B-0	BA-VLF-4A-1	BA-VLF-4A-1FD
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.41	9.99	9.89	10.12	10.24
	2nd Preliminary pH (pH)	7.33	6.55	6.41	6.42	6.86
	Final pH (pH)	5.27	5.30	5.11	5.20	5.21
	Extraction Solution Initial pH (pH)	2.89	2.89	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.321	0.187	0.140	0.140	5.85

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-16	L2158553-17	L2158553-18	L2158553-19	L2158553-20
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-4A-0	BA-VLF-4B-1	BA-VLF-4B-0	BA-VLF-5A-1	BA-VLF-5A-0
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.72	10.30	9.96	10.75	10.41
	2nd Preliminary pH (pH)	8.14	7.34	7.14	8.18	7.38
	Final pH (pH)	5.29	5.51	5.55	5.31	5.51
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.449	0.205	0.207	0.245	0.225

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-21	L2158553-22	L2158553-23	L2158553-24	L2158553-25
	Description	Ash	Ash	Ash	Ash	Ash
	Sampled Date	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18	04-SEP-18
	Sampled Time					
	Client ID	BA-VLF-5A-0FD	BA-VLF-5B-1	BA-VLF-5B-0	BA-VLF-6A-1	BA-VLF-6A-0
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.42	10.12	10.34	10.67	10.25
	2nd Preliminary pH (pH)	6.99	6.83	6.53	6.53	6.26
	Final pH (pH)	5.65	5.22	5.25	5.56	5.24
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
	Cadmium (Cd)-Leachable (mg/L)	0.219	0.223	0.143	0.136	0.150

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-26	L2158553-27	L2158553-28	L2158553-29	L2158553-30
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date	04-SEP-18	04-SEP-18			
Sampled Time					
Client ID	BA-VLF-6B-1	BA-VLF-6B-0	BA-VLF-2A-0-REP1	BA-VLF-2A-0-REP2	BA-VLF-2A-0-REP3
Grouping **Analyte**					
SOIL					
TCLP Metals 1st Preliminary pH (pH)	9.67	10.70	9.55	9.55	9.55
2nd Preliminary pH (pH)	6.28	6.57	6.54	6.54	6.54
Final pH (pH)	4.94	5.01	5.04	5.22	5.64
Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
Cadmium (Cd)-Leachable (mg/L)	0.088	0.113	0.292	0.334	1.14

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2158553-31	L2158553-32	L2158553-33	L2158553-34	L2158553-35
Description	Ash	Ash	Ash	Ash	Ash
Sampled Date					
Sampled Time					
Client ID	BA-VLF-2A-0-REP4	BA-VLF-2B-0-REP1	BA-VLF-2B-0-REP2	BA-VLF-4A-1FD-REP1	BA-VLF-4A-1FD-REP2
Grouping / **Analyte**					
SOIL					
TCLP Metals 1st Preliminary pH (pH)	9.55	10.39	10.39	10.24	10.24
2nd Preliminary pH (pH)	6.54	7.82	7.82	6.86	6.86
Final pH (pH)	5.66	5.92	5.95	5.34	5.52
Extraction Solution Initial pH (pH)	2.88	2.88	2.88	2.88	2.88
Cadmium (Cd)-Leachable (mg/L)	0.369	0.345	0.376	0.719	0.474

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2158553-36	L2158553-37	L2158553-38		
	Description	Ash	Ash	Ash		
	Sampled Date					
	Sampled Time					
	Client ID	BA-VLF-4A-1FD-REP3	BA-VLF-4A-1FD-REP4	BA-VLF-4A-1FD-REP5		
Grouping	**Analyte**					
SOIL						
TCLP Metals	1st Preliminary pH (pH)	10.24	10.24	10.24		
	2nd Preliminary pH (pH)	6.86	6.86	6.86		
	Final pH (pH)	5.29	5.67	5.53		
	Extraction Solution Initial pH (pH)	2.88	2.88	2.88		
	Cadmium (Cd)-Leachable (mg/L)	0.724	0.368	1.71		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Cadmium (Cd)-Leachable	MS-B	L2158553-32, -33, -34, -35
Matrix Spike	Cadmium (Cd)-Leachable	MS-B	L2158553-28, -29, -30, -31, -36, -37, -38

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TCLP-ICP-VA	Soil	Metals by ICPOES (TCLP)	EPA 1311/6010B

This analysis is carried out in accordance with the extraction procedure outlined in "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods Volume 1C" SW-846 EPA Method 1311, published by the United States Environmental Protection Agency (EPA). In summary, the sample is extracted at a 20:1 liquid to solids ratio for 16 to 20 hours using either extraction fluid #1 (glacial acetic acid, water and sodium hydroxide) or extraction fluid #2 (glacial acetic acid), depending on the pH of the original sample. The extract is then filtered through a 0.6 to 0.8 micron glass fibre filter and analysed using inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

14-508319 17-668278 17-668279

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: GOLDER ASSOCIATES LTD.
200-2920 Virtual Way
Vancouver BC V5M 0C4
Contact: Kathleen Edwards

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TCLP-ICP-VA	**Soil**							
Batch R4222649								
WG2878936-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	18-SEP-18
WG2878936-2 MS		**L2158553-12**						
Cadmium (Cd)-Leachable			87.0		%		50-140	18-SEP-18
Batch R4227069								
WG2880107-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	19-SEP-18
WG2880107-2 MS		**L2158553-27**						
Cadmium (Cd)-Leachable			89.5		%		50-140	19-SEP-18
Batch R4247260								
WG2889870-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	26-SEP-18
WG2889870-2 MS		**L2158553-32**						
Cadmium (Cd)-Leachable			N/A	MS-B	%		-	26-SEP-18
Batch R4252530								
WG2890302-1 MB								
Cadmium (Cd)-Leachable			<0.050		mg/L		0.05	30-SEP-18
WG2890302-2 MS		**L2158553-38**						
Cadmium (Cd)-Leachable			N/A	MS-B	%		-	30-SEP-18

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Sample ID	Initial <9.5 mm sample (g)	Initial >9.5 mm sample (g)	>9.5 mm sample after particle size reduction (g)
L2158553-1	1164.42	716.47	381.15
L2158553-2	1119.12	732.87	409.41
L2158553-3	1499.16	586.14	291.82
L2158553-4	1327.61	717.4	334.67
L2158553-5	1045.87	653.09	335.98
L2158553-6	804.6	1011.25	559.94
L2158553-7	1239.33	527.31	257.85
L2158553-8	1105.75	802.35	607.49
L2158553-9	1103.66	710.01	516
L2158553-10	642.56	1307	1021.32
L2158553-11	1023.33	834.36	533.04
L2158553-12	1228.54	854.14	589.79
L2158553-13	613.72	1565.99	1219.89
L2158553-14	706.57	1134	714.08
L2158553-15	1018.47	701.77	401.12
L2158553-16	1266	950.87	504.9
L2158553-17	985.54	926.06	564.45
L2158553-18	899.09	1279	896.23
L2158553-19	1438	730.3	467.3
L2158553-20	904.16	914.37	646.54
L2158553-21	893.83	764.92	491.27
L2158553-22	1192.27	1174.16	850.21
L2158553-23	1309	839.42	630
L2158553-24	1255	812.09	604.45
L2158553-25	746.82	732.18	259.3
L2158553-26	809.95	1352	455.87
L2158553-27	922.12	1115.74	413.24

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2158553-COFC

COC Number: 14 - 508319

Page 1 of 3

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	Golder Associates	Select Report Format:	☐ PDF ☒ EXCEL ☐ EDD (DIGITAL)	R ☒ Regular (Standard TAT if received by 3pm)
Contact:	Kathleen Edwards	Quality Control (QC) Report with Report	☒ Yes ☐ No	P ☐ Priority (2-4 business days if received by 3pm)
Address:	Kathleen_edwards@golder.com	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
		Select Distribution:	☒ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
Phone:	604-356-4815	Email 1 or Fax	Kathleen_edwards@golder.com	Specify Date Required for E2, E or P:
		Email 2	Benjamin_Lucas@golder.com	

Invoice To		Invoice Distribution	
	Same as Report To ☒ Yes ☐ No	Select Invoice Distribution:	☒ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☒ Yes ☐ No	Email 1 or Fax	Kathleen_edwards@golder.com
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	369881	Approver ID:	Cost Center:
Job #:	18108461	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler: BL

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HOLD	Number of Containers
	BA-VLF-1A-1	04/Sept/18		ASH	X	1
	BA-VLF-1A-0	"		"	X	1
	BA-VLF-1B-1	"		"	X	1
	BA-VLF-1B-0	"		"	X	1
	BA-VLF-2A-1	"		"	X	1
	BA-VLF-2A-0	"		"	X	1
	BA-VLF-2B-1	"		"	X	1
	BA-VLF-2B-0	"		"	X	1
	BA-VLF-3A-1	"		"	X	1
	BA-VLF-3A-1FD	"		"	X	1
	BA-VLF-3A-0	"		"	X	1
	BA-VLF-3B-1	"		"	X	1

Drinking Water (DW) Samples (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No Are samples for human drinking water use? ☐ Yes ☐ No	Bottom ash - may contain large quantities of metals

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☑	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C	
			18	20

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
BL	05/Sept/18	10:49				JC		11 am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2158553-COFC

COC Number: 17 - 668278

Report To	Contact and company name below will appear on the final report
Company:	Golder Associates
Contact:	Kathleen Edwards
Phone:	604 - 396 - 4815
	Company address below will appear on the final report
Street:	700 - 2920 Virtual Way
City/Province:	Vancouver BC
Postal Code:	V5M 0C4

Report Format / Distribution	
Select Report Format:	PDF [X] EXCEL [ ] EDD (DIGITAL)
Quality Control (QC) Report with Report	[X] YES [ ] NO
[ ] Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	Benjamin-Lucas@golder.com
Email 3	

Invoice To		
	Same as Report To	[X] YES [ ] NO
	Copy of Invoice with Report	[X] YES [ ] NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	

Project Information	
ALS Account # / Quote #:	Q69881
Job #:	1810 8461
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)		
AFE/Cost Center:		PO#
Major/Minor Code:		Routing Code:
Requisitioner:		
Location:		

ALS Lab Work Order # (lab use only):

ALS Contact:

Sampler: BL

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] [ ] | 3 day [P3-25%] [ ] | 2 day [P2-50%] [ ]

EMERGENCY: 1 Business day [E-100%] [ ] | Same Day, Weekend or Statutory holiday [E2-200%] (Laboratory opening fees may apply)] [ ]

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HOLD	SAMPLES ON HOLD	Sample is hazardous (please provide further details	NUMBER OF CONTAINERS
	BA - VLF - 3B - 0	04-Sept-18		Ash	X			1
	BA - VLF - 4A - 1				X			1
	BA - VLF - 4A - 1FD				X			1
	BA - VLF - 4A - 0				X			1
	BA - VLF - 4B - 1				X			1
	BA - VLF - 4B - 0				X			1
	BA - VLF - 5A - 1				X			1
	BA - VLF - 5A - 0				X			1
	BA - VLF - 5A - 0FD				X			1
	BA - VLF - 5B - 1				X			1
	BA - VLF - 5B - 0				X			1
	BA - VLF - 6A - 1				X			1

Drinking Water (DW) Samples (client use)

Are samples taken from a Regulated DW System? [ ] YES [ ] NO

Are samples for human consumption/ use? [ ] YES [ ] NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Bottom ash (landfill) - may contain large quantities of metals

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ] | SIF Observations Yes [ ] No [ ]

Ice Packs [X] Ice Cubes [ ] | Custody seal intact Yes [ ] No [ ]

Cooling Initiated [ ]

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				18	20		

SHIPMENT RELEASE (client use)		
Released by: BL	Date: 05-Sept-18	Time: 1045

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (lab use only)		
Received by: JC	Date:	Time: 11 am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2158553-COFC

COC Number: 17 - 668279

Report To	Contact and company name below will appear on the final report
Company:	Golder Associates
Contact:	Kathleen Edwards
Phone:	604 - 356 - 4816
	Company address below will appear on the final report
Street:	700 - 2920 Virtual Way
City/Province:	Vancouver BC
Postal Code:	V5M0C4

Report Format / Distribution	
Select Report Format:	PDF [X] EXCEL [ ] EDD (DIGITAL)
Quality Control (QC) Report with Report	[X] YES [ ] NO
[ ] Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	Benjamin_Lucas@golder.com
Email 3	

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] [X] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] [ ] | 3 day [P3-25%] [ ] | 2 day [P2-50%] [ ]

EMERGENCY: 1 Business day [E-100%] [ ] | Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] [ ]

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Invoice To		
	Same as Report To	[X] YES [ ] NO
	Copy of Invoice with Report	[X] YES [ ] NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kathleen_edwards@golder.com
Email 2	

Project Information	
ALS Account # / Quote #:	Q69881
Job #:	18108461
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)		
AFE/Cost Center:		PO#
Major/Minor Code:		Routing Code:
Requisitioner:		
Location:		

ALS Lab Work Order # (lab use only):

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HOLD	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
	BA-VLF-6A-0	04-Sept-18		Ash	X			1
	BA-VLF-6B-1	"		"	X			1
	BA-VLF-6B-0	"		"	X			1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
[ ] YES [ ] NO

Are samples for human consumption/ use?
[ ] YES [ ] NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Bottom Ash (landfill) - may contain large quantities of metals

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen [ ] | SIF Observations Yes [ ] No [ ]

Ice Packs [X] | Ice Cubes [ ] | Custody seal intact Yes [ ] No [ ]

Cooling Initiated [ ]

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				18	20		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: BL	Date: 05-Sept-18	Time: 1049	Received by:	Date:	Time:	Received by: JC	Date:	Time: 11 am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.