Landfill Monitoring Criteria - CAM-1 Jenny Lind Island

Soil and groundwater sampling to establish general site **Background** chemical conditions (not impacted by site activities) for inorganic elements and PCBs was conducted *in 1990* by the Environmental Science Group (ESG). **Baseline** conditions refer to existing soil chemistry at the landfill area prior to and during remediation. Baseline data for soil and groundwater are collected around landfill facilities during assessment and remediation of the sites, generally over a period of one or two years. These values are used to determine the existing conditions at each facility and create a baseline average that can be used for comparison to data collected over time following remediation. Baseline samples are collected in areas upgradient and downgradient of each landfill. **Upgradient** soil samples are taken at surface and shallow depth in areas near the landfill but not influenced by migration of contaminants through the landfill. **Downgradient** soil samples are collected at surface and shallow depth areas from areas at the toe of each landfill and from areas of preferential drainage. If a monitoring well is present, the soil samples are collected between 2 and 4m from the well. If only soil monitoring is conducted, samples are collected within a few metres of a specified location, downgradient locations are approximately 8-12m from the landfill toe. These soil samples are analyzed for inorganic elements, Total PCBs and TPH to determine whether there has been migration of contaminants, historically or recent, from the landfill area. Although contaminants are primarily transported in water (surface and groundwater), they have a tendency to sorb to soil particles the water is migrating through. The soil retains information regarding the historical input of contaminants.

During the investigation of CAM-1, it was determined that arsenic in the form of arsenate is naturally elevated at the site up to concentrations of 40 mg/kg (I. Koch et al, 2005). Therefore, during the remediation of the site, arsenic was only remediated if it was present with other elements above criteria or if the level exceeded 40 mg/kg.

During the CAM-1 assessment and remediation program, hydrocarbons were typically analyzed in the laboratory as total petroleum hydrocarbons (TPH) using hexane extraction. The analysis of hydrocarbons performed for the baseline monitoring sampling and for the long-term monitoring program is conducted according to the Canadian Council of Ministers of Environment (CCME 2008) Tier I Method –Rev. 5 Analysis of Petroleum Hydrocarbons (PHC) in Soil for F1 to F4 PHC fractions. In the following tables, results are presented for the F1 to F4 fractions. It should be noted that the action level for hydrocarbon remediation was typically 2500 mg/kg. Therefore, hydrocarbon concentrations below that level are not uncommon in the vicinity of landfills.

Analytical results of soil samples collected downgradient of landfills are compared to contaminant concentrations of samples collected upgradient of landfills. Upgradient and downgradient samples are also compared to overall site background and baseline contaminant levels. (1) Monitoring data can be considered within baseline conditions when it is within three standard deviations (SD) of the baseline mean. When this value is exceeded, the sample results will be further examined to determine whether any follow up action is required. In cases where more than 50% of baseline or background results were below detection, the baseline mean is set to the baseline detection limit and the baseline standard deviation is set to zero. If monitoring results indicate a need for further investigation, the baseline standard deviation may be reviewed to aid in decision making. For PCBs and PHC fractions in cases where the baseline mean has been set to the detection limit, the detection limit used is the 2019 monitoring reporting limit to reflect the current value achievable by commercial laboratories.

For the DEW Line Monitoring Data Review Tables, the background and baseline sample results were summarized by calculating the average, standard deviation, maximum concentration and minimum concentration along with the 95% confidence value of the mean. Concentrations which were below detection were included in the calculations as half of the detection limit. Analytical duplicates were averaged before being included in the data tables. Field duplicates are presented as separate values in baseline, background, and monitoring results.

Monitoring Data is compared to Baseline means as well Baseline mean plus 3 x standard deviation in the tables by highlighting those values which exceed the Baseline Mean and the Baseline Mean + 3xSD.

CAM-1 Tier II Disposal Facility - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2* C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**2.1**	**1.0**	**20.0**	**5.0**	**4.8**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**21.9**	**17.4**
Baseline Data - Standard Deviation	1.0	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.00	0.0	0.0	22.5	17.0
Baseline Data Mean + 3x Standard Deviation	**5.1**	**1.0**	**20.0**	**5.0**	**25.4**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**89.4**	**68.4**

CAM-1 Tier II Disposal Facility - Summary of Groundwater Monitoring Criteria

Criteria	Cd* (mg/L)	Cr (mg/L)	Co* (mg/L)	Cu (mg/L)	Pb (mg/L)	Ni (mg/L)	Zn (mg/L)	F1* C_6-C_{10} (mg/L)	F2* C_{10}-C_{16} (mg/L)	F3* C_{16}-C_{34} (mg/L)	F4* C_{34}-C_{50} (mg/L)
Baseline Data - Arithmetic Mean	0.0005	0.0297	0.0015	0.0117	0.0063	0.0200	0.0052	0.025	0.25	0.5	0.5
Baseline Data - Arithmetic Mean Corrected for Detect	**0.0010**	**0.0297**	**0.0030**	**0.0117**	**0.0063**	**0.0200**	**0.0052**	**0.05**	**0.5**	**1.0**	**1.0**
Baseline Data - Standard Deviation	0.0000	0.0140	0.0000	0.0055	0.0068	0.0085	0.0028	0.00	0.0	0.0	0.0
Baseline Data - Corrected Arithmetic Mean + 3x Stand	**0.0010**	**0.0718**	**0.0030**	**0.0282**	**0.0268**	**0.0456**	**0.0134**	**0.05**	**0.5**	**1.0**	**1.0**

CAM-1 Non-Hazardous Waste Landfill - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2* C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**6.9**	**1.0**	**20.0**	**5.0**	**5.9**	**20.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**34.1**	**17.4**
Baseline Data - Standard Deviation	7.6	0.0	0.0	0.0	3.4	18.4	0.0	0.0	0.00	0.0	0.0	30.7	12.6
Baseline Data Mean + 3x Standard Deviation	**29.6**	**1.0**	**20.0**	**5.0**	**16.1**	**75.1**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**126.3**	**55.3**

CAM-1 Non-Hazardous Waste Landfill - Summary of Groundwater Monitoring Criteria

Criteria	Cd* (mg/L)	Cr (mg/L)	Co* (mg/L)	Cu (mg/L)	Pb* (mg/L)	Ni (mg/L)	Zn (mg/L)	F1* C_6-C_{10} (mg/L)	F2* C_{10}-C_{16} (mg/L)	F3* C_{16}-C_{34} (mg/L)	F4* C_{34}-C_{50} (mg/L)
Baseline Data - Arithmetic Mean	0.0005	0.0894	0.0022	0.0092	0.0028	0.0360	0.0092	0.025	0.25	0.5	0.5
Baseline Data - Arithmetic Mean Corrected for Detect	**0.0010**	**0.0894**	**0.0030**	**0.0092**	**0.0100**	**0.0360**	**0.0092**	**0.05**	**0.5**	**1.0**	**1.0**
Baseline Data - Standard Deviation	0.0000	0.0828	0.0000	0.0060	0.0000	0.0281	0.0101	0.00	0.0	0.0	0.0
Baseline Data - Corrected Arithmetic Mean + 3x Stand	**0.0010**	**0.3378**	**0.0030**	**0.0273**	**0.0100**	**0.1203**	**0.0395**	**0.05**	**0.5**	**1.0**	**1.0**

CAM-1 Borrow Area North Landfill - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2 C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**2.5**	**1.0**	**20.0**	**5.0**	**5.8**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**37.5**	**59.9**	**52.4**
Baseline Data - Standard Deviation	3.5	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.00	0.0	36.8	61.2	49.8
Baseline Data Mean + 3x Standard Deviation	**12.9**	**1.0**	**20.0**	**5.0**	**21.2**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**148.0**	**243.6**	**201.9**

CAM-1 Northeast Landfill - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2 C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**3.3**	**1.0**	**20.0**	**5.0**	**5.0**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**31.4**	**107.6**	**108.1**
Baseline Data - Standard Deviation	2.3	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.00	0.0	41.5	133.5	132.6
Baseline Data Mean + 3x Standard Deviation	**10.1**	**1.0**	**20.0**	**5.0**	**15.2**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**156.0**	**508.1**	**505.9**

CAM-1 USAF Landfill - Summary of Soil Monitoring Criteria

Criteria	As* (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2 C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**1.0**	**1.0**	**20.0**	**5.0**	**3.9**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**28.4**	**55.3**	**23.8**
Baseline Data - Standard Deviation	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.00	0.0	23.9	50.9	17.2
Baseline Data Mean + 3x Standard Deviation	**1.0**	**1.0**	**20.0**	**5.0**	**8.5**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**100.1**	**208.1**	**75.2**

CAM-1 Station East and Main Landfills - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2* C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**5.4**	**1.0**	**20.0**	**5.0**	**5.6**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**54.8**	**45.0**
Baseline Data - Standard Deviation	5.5	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.00	0.0	0.0	34.1	30.0
Baseline Data Mean + 3x Standard Deviation	**22.0**	**1.0**	**20.0**	**5.0**	**20.9**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**157.2**	**135.0**

CAM-1 Station West Landfill - Summary of Soil Monitoring Criteria

Criteria	As* (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2 C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**1.0**	**1.0**	**20.0**	**5.0**	**5.0**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**7.6**	**50.9**	**46.1**
Baseline Data - Standard Deviation	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.00	0.0	4.0	38.2	43.1
Baseline Data Mean + 3x Standard Deviation	**1.0**	**1.0**	**20.0**	**5.0**	**17.0**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**19.7**	**165.4**	**175.5**

CAM-1 Southeast Landfill - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb* (mg/kg)	Ni* (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2* C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**1.9**	**1.0**	**20.0**	**5.0**	**3.2**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**18.9**	**13.8**
Baseline Data - Standard Deviation	2.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.00	0.0	0.0	12.6	7.1
Baseline Data Mean + 3x Standard Deviation	**7.9**	**1.0**	**20.0**	**5.0**	**10.0**	**10.0**	**5.0**	**15.0**	**0.10**	**10.0**	**10.0**	**56.6**	**35.0**

CAM-1 East Landing Landfill - Summary of Soil Monitoring Criteria

Criteria	As (mg/kg)	Cd* (mg/kg)	Cr* (mg/kg)	Co* (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Ni (mg/kg)	Zn* (mg/kg)	Total PCB* (mg/kg)	F1* C_6-C_{10} (mg/kg)	F2 C_{10}-C_{16} (mg/kg)	F3 C_{16}-C_{34} (mg/kg)	F4 C_{34}-C_{50} (mg/kg)
Background Data - Arithmetic Mean	3.3	1.0	20.0	5.0	11.3	10.0	5.0	15.0	0.10	N/A	N/A	N/A	N/A
Baseline Data - Arithmetic Mean	**5.8**	**1.0**	**20.0**	**5.0**	**7.6**	**13.8**	**7.3**	**15.0**	**0.10**	**10.0**	**4.9**	**48.4**	**30.4**
Baseline Data - Standard Deviation	5.1	0.0	0.0	0.0	3.7	9.8	3.9	0.0	0.00	0.0	2.8	34.8	23.1
Baseline Data Mean + 3x Standard Deviation	**21.2**	**1.0**	**20.0**	**5.0**	**18.6**	**43.2**	**19.1**	**15.0**	**0.10**	**10.0**	**13.2**	**152.8**	**99.8**

**** If baseline or background arithmetic mean was below the detection limit, the mean has been modified to match the detection limit value.***

N/A = not analyzed