

Appendix 8-B

Baseline Soil and Vegetation
Chemistry Report

Baseline Soil and Vegetation Chemistry Report

NWP Crown Mountain Coking Coal Project



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1 Introduction

Keefer Ecological Services Ltd. (KES) was retained by NWP Coal Canada Ltd. (NWP) to assess baseline vegetation and soil chemistry at the Crown Mountain Coking Coal Project (the Project) prior to development. The baseline chemistry can then be used to assess the potential effects and provide a basis for mitigation, management, and monitoring requirements for the Project. Interpretation of metal and Polycyclic Aromatic Hydrocarbons (PAH) chemical concentrations as tested by a qualified third-party analytical laboratory are to be conducted by a qualified third-party risk assessor for the purposes of informing the human and terrestrial wildlife health risk assessment for the Project. This report outlines the basis for plant species selection, field methodology, and results of the metal and PAH chemical analysis. This report also includes a compilation of additional baseline data that was collected in the local study area (LSA) to support the human health and wildlife risk assessment, including soil samples analysed for metal concentrations collected for the baseline soil classification and mapping program.

2 Plant Species Selection

Plant species selected for chemical analysis include species that are consumed by humans and/or wildlife, have specific characteristics related to chemical uptake, are known to be sensitive or indicator species of change, and/or are potentially most affected by the Project. Plants selected for metal and PAH analyses are presented in Table 2-1. Important forage species for large mammals, such as elk, deer, moose, and bear, were selected for sampling as these mammals consume large volumes of food across a wide range of habitat types. Further, to provide information relating to human health, vegetation species were selected based on traditional and present-day use by humans, with focus on berry species. Specific tissue of important foods (e.g., foliage/branch tips, berries) for wildlife and humans available for consumption during the summer and winter is also presented in Table 2-1. Key rationale for the selection of vegetation species as bio accumulators or vegetation species demonstrating a potential pathway of concern for wildlife species and/or humans is outlined in Table 2-2. Species were not selected with input from First Nations, as consultation had not been initiated at the time of collection.

Table 2-1 Plant species selected for metal and polycyclic aromatic hydrocarbon (PAH) analysis based on wildlife use and traditional plant/human use.

Latin name	Common name	Component to Sample	Wildlife Use	Traditional Plant/Human Use	Summer Availability	Winter Availability
<i>Amelanchier alnifolia</i>	Saskatoon	foliage + branches	bighorn sheep, deer, elk, grizzly bear, moose		x	x
		berries		x	x	
<i>Carex utriculata</i>	beaked sedge	aerial plant	deer, elk, grizzly bear, moose	x	x	
<i>Equisetum arvense</i>	common horsetail	aerial plant	grizzly bear		x	
<i>Populus balsamifera</i> subsp. <i>trichocarpa</i>	black cottonwood	foliage + branches	deer, elk, moose	x	x	x
<i>Rosa</i> sp.	rose	foliage + branches	deer, elk, grizzly bear, moose		x	x
		berries		x	x	
<i>Rubus parviflorus</i>	thimbleberry	foliage + branches	deer, elk, moose		x	x
		berries		x	x	
<i>Sambucus racemosa</i> var. <i>melanocarpa</i>	black elderberry	foliage + branches	deer, elk, grizzly bear		x	x
		berries		x	x	
<i>Salix</i> sp.	willow	foliage + branches	bighorn sheep, deer, elk, grizzly bear, moose	x	x	x
<i>Shepherdia canadensis</i>	soopolallie	foliage + branches	bighorn sheep, deer, elk, grizzly bear		x	x
		berries		x	x	
<i>Vaccinium membranaceum</i>	black huckleberry	foliage + branches	deer, elk, grizzly bear	x	x	x
		berries		x	x	

Table 2-2 Rationale for species selection.

	Species	Common Name	Sample	Rationale
Wildlife	<i>Amelanchier alnifolia</i>	Saskatoon	twigs and leaves	Eaten by elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
	<i>Carex</i> sp.	sedge	whole plant	Eaten by grizzly bear (McLellan & Hovey, 1995), elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
	<i>Equisetum arvense</i>	horsetail	whole plant	Eaten by grizzly bear (McLellan & Hovey, 1995), elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
	<i>Populus balsamifera</i>	black cottonwood	twigs and leaves	Eaten by elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
	<i>Rubus parviflorus</i>	thimbleberry	twigs and leaves	Eaten by elk, deer, moose and bears (USDA, 2012)
	<i>Salix</i> sp.	willow	twigs and leaves	Eaten by elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
	<i>Sheperdia canadensis</i>	soopolallie	twigs, leaves and berries	Eaten by grizzly bear (McLellan & Hovey, 1995), elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
	<i>Vaccinium membranaceum</i>	huckleberry	twigs, leaves and berries	Eaten by grizzly bear (McLellan & Hovey, 1995), elk (USDA, 1999), moose (Wall, Belisle & Luke, 2011), and white-tailed deer (BC Government, 2000)
Humans	<i>Amelanchier alnifolia</i>	Saskatoon	berries	Kuhnlein & Turner (2009): Traditional Plant Foods of Canadian Indigenous Peoples
	<i>Rubus parviflorus</i>	thimbleberry	berries	Kuhnlein & Turner (2009): Traditional Plant Foods of Canadian Indigenous Peoples
	<i>Sheperdia canadensis</i>	soopolallie	berries	Kuhnlein & Turner (2009): Traditional Plant Foods of Canadian Indigenous Peoples
	<i>Salix</i> sp.	willow	whole plant	Traditional food source (First Nation Health Authority, n.d.)
	<i>Vaccinium membranaceum</i>	huckleberry	berries	Hobby & Keefer (2010): A black huckleberry case study in the Kootenay region of British Columbia
Accumulators	<i>Equisetum arvense</i>	horsetail	whole plant	Cannon, Shacklette & Bastron (1968): Metal absorption by <i>Equisetum</i> - <i>Equisetum</i> consistently accumulates zinc
	<i>Salix</i> sp.	willow	leaves, stems, roots	Han, Kim & Shin (2013): Bioaccumulation and physiological response of five willows to toxic levels of Cadmium and Zinc Gough <i>et al.</i> (2003): Cadmium mobility and bioaccumulation by willow

3 Methods

3.1 Field Sample Collection

3.1.1 Baseline Chemistry Vegetation and Soil Survey

The baseline sampling program was developed in general accordance with the British Columbia Field Sampling Manual (Ministry of Water, Land and Air Protection [BC MWLAP], 2013) and a Health Canada guidance document for including country foods in human health risk assessments (Health Canada, 2017). The guidance documents were used to develop study objectives, sample design and quality assurance/quality control (QA/QC) protocols for the sampling of soil and vegetation.

Vegetation samples were collected from 55 unique locations in August and September 2017 and in July 2019 to capture a range of seasonality and to target appropriate plant tissue collection. As such, the sample collection dates targeted the peak periods for new shoots, leaves, and/or berries of each plant species. Table 3-1 presents the number of sampling locations per species, which included Saskatoon (*Amelanchier alnifolia*), beaked sedge (*Carex utriculata*), common horsetail (*Equisetum arvense*), black cottonwood (*Populus balsamifera* subsp. *trichocarpa*), rose species (*Rosa* sp.), thimbleberry (*Rubus parviflorus*), black elderberry (*Sambucus racemosa* var. *melanocarpa*), willow species (*Salix* sp.), soopolallie (*Shepherdia canadensis*), and black huckleberry (*Vaccinium membranaceum*). The plant tissue collected per species at each sampling location is also presented in Table 3-1.

Sampling locations were selected based on the distribution of plant species throughout the Project area (Figure 3-1). For the sake of efficiency, soil and vegetation samples were paired with the terrestrial ecosystem mapping (TEM), soil and terrain baseline studies, where possible. The soil and terrain baseline study program aimed at collecting samples in proximity to and within the Project infrastructure footprint. Other samples were collected in sensitive areas (e.g., wetlands). Occasionally, two plant species were found in the same sampling location and thus a single GPS waypoint was taken to represent both species ([Appendix 1](#)).

Table 3-1 Number of sampling locations and plant tissue collected per vegetation species.

Latin Name	Common Name	Abbreviation	Number of Sampling Locations***	Plant Tissue/Soil Collected	Number of Samples Submitted for Metals Analysis	Number of Samples Submitted for PAH Analysis
<i>Amelanchier alnifolia</i>	Saskatoon	AMELALN	6	foliage/branch tips	6	1
				berries	3	1
				soil	5*	1
<i>Carex utriculata</i>	beaked sedge	CAREX	10	aerial plant	10	1
				soil	10*	1
<i>Equisetum arvense</i>	common horsetail	EQUIARV	6	aerial plant	6	1
				soil	6*	0
<i>Populus balsamifera</i> subsp. <i>trichocarpa</i>	black cottonwood	POPUBAL	6	foliage/branch tips	6	1
				soil	6*	1*
<i>Rosa</i> sp.	wood's rose	ROSA	6	foliage/branch tips	6	1
				rosehips	5	1
				soil	6*	1
<i>Rubus parviflorus</i>	thimbleberry	RUBUPAR	6	foliage/branch tips	6	1
				berries	5	1
				soil	6*	1
<i>Sambucus racemosa</i> var. <i>melanocarpa</i>	black elderberry	SAMBRAC****	6	foliage/branch tips	6	1
				berries	6	1
				soil	6*	1
<i>Salix</i> sp.	willow species.	SALIX	7	foliage/branch tips	7	1
				soil	7*	1*
<i>Shepherdia canadensis</i>	soopolallie	SHEPCAN	6	foliage/branch tips	6	1
				berries	6	1
				soil	6*	0
<i>Vaccinium membranaceum</i>	black huckleberry	VACCMEM	6	foliage/branch tips	6	1
				berries	2	--**
				soil	6*	1

* Soil sample associated with multiple vegetation samples.

** Sample was not submitted for PAH analysis as insufficient sample volume was available.

*** Sample locations are shown in Figure 3-1 which correspond to Appendix 1 and Tables 4-5 and 4-7.

**** SAMBRAC samples mislabeled as SAMBCAE in field (5 out of 6 samples).

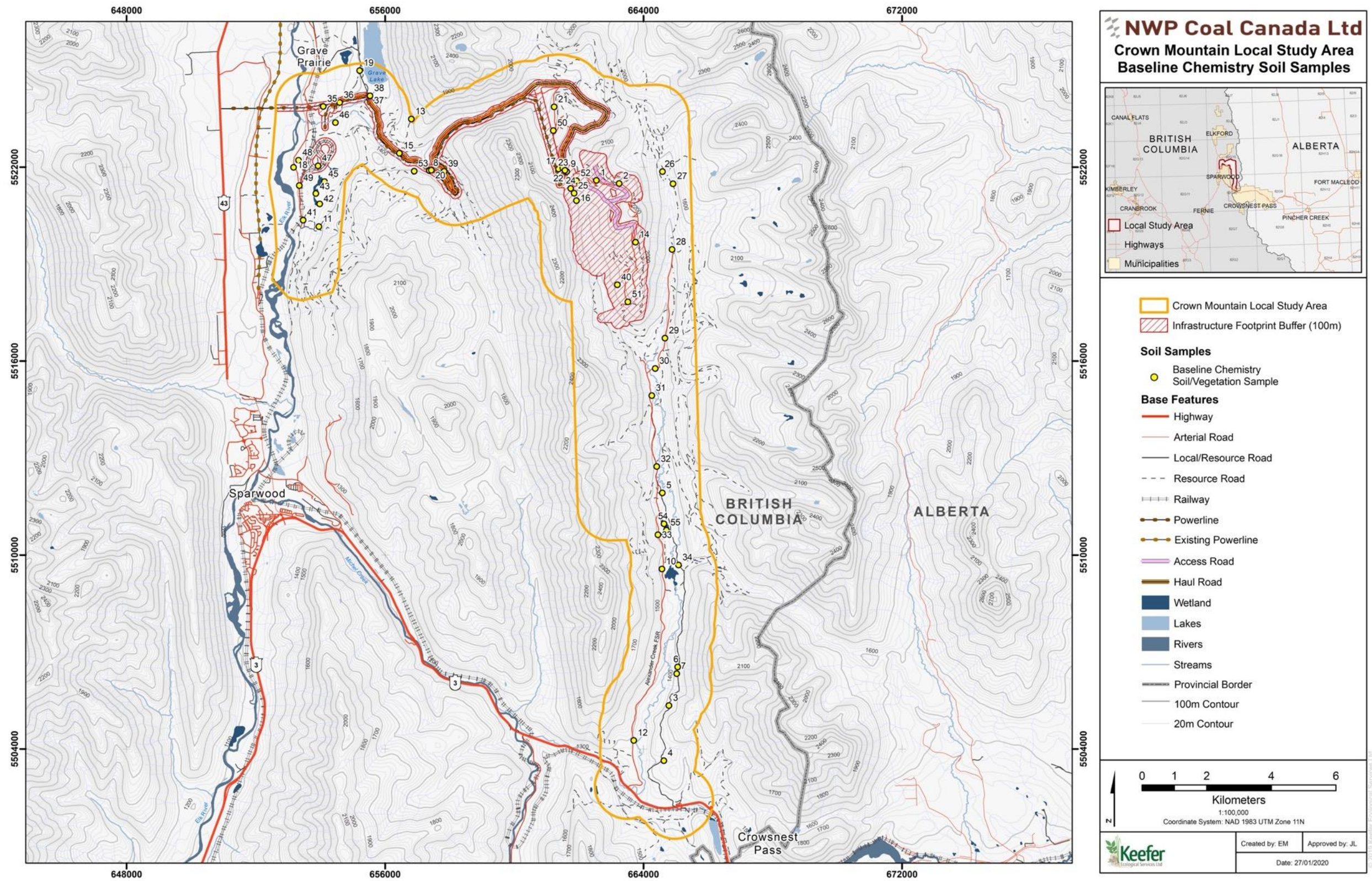
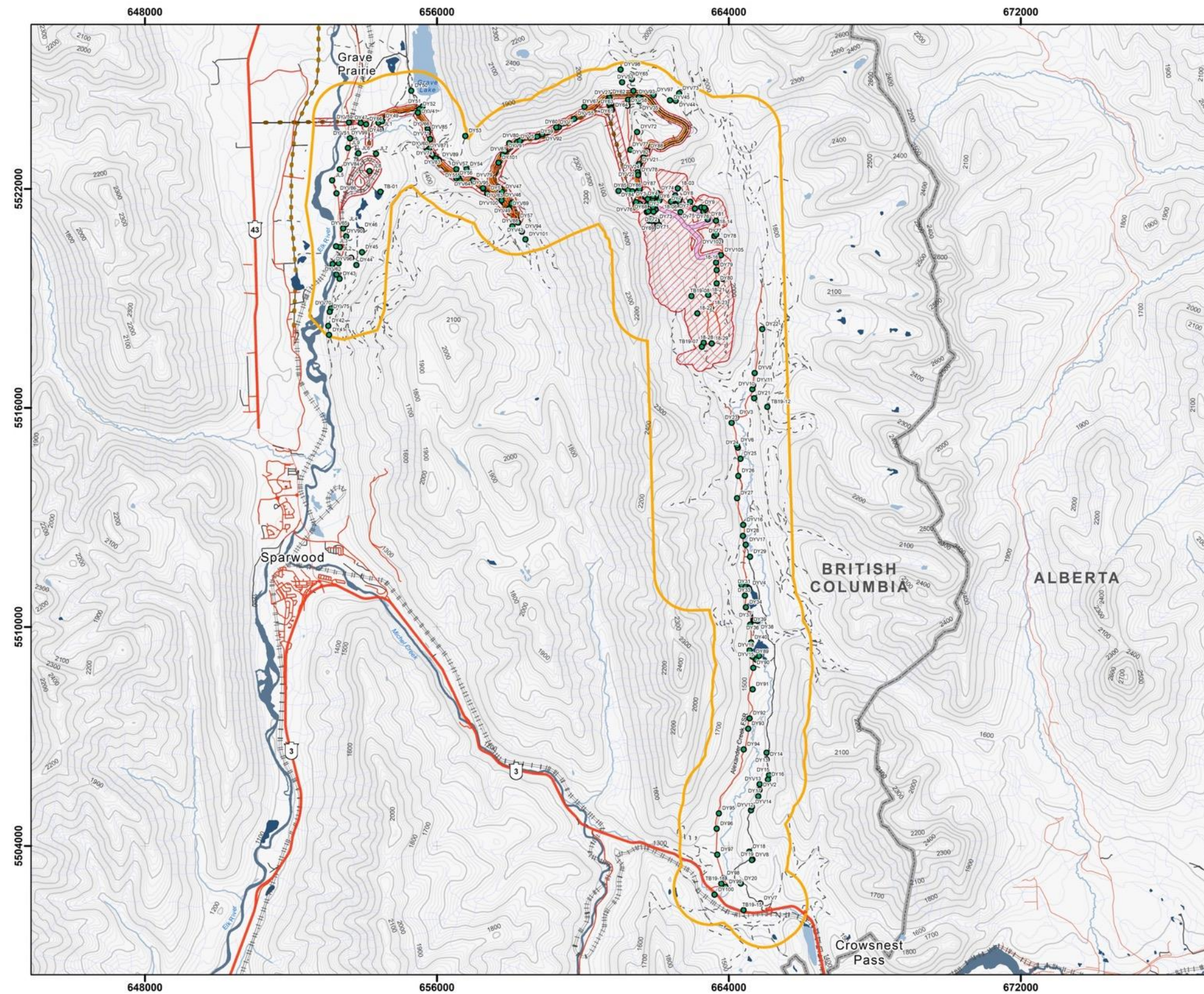


Figure 3-1. Vegetation and soil sample locations association with baseline chemistry surveys within the Project LSA.

Approximately 10 grams (g) of plant tissue sample was collected by hand and placed into a clean, labelled Ziploc® bag. A new pair of latex or nitrile gloves was worn at each of the sampling locations to reduce the risk of sample contamination. A ceramic knife was used to collect plant tissue when necessary and distilled water was used to clean the knife between samples. At each vegetation sampling location, soil samples were collected from within 2 meters (m) of the vegetation sample. Soil samples were collected between 0-30 centimeters (cm) in depth from the soil surface, as the top 30 cm of soil typically contains the greatest rooting density. If two plant species were in the same area, additional soil samples were not collected; rather, both plant species were associated with the same soil sample (Appendix 1). One, 125 millilitre (mL) composite soil sample was collected between 0-30 cm and soil texture, coarse fragment content, soil drainage, and the primary vegetation community were recorded at each sampling location (Appendix 2). A combination of A and B horizons for mineral soils (n = 60) and the upper 30 cm of organic soil horizons (n = 5) were sampled. A stainless-steel shovel was used to dig into the soil at a depth of approximately 50 cm. A plastic trowel was then used to scrape away soil exposed to the shovel to reduce the risk of contamination. An additional plastic trowel was used to collect soil for analysis and latex, or nitrile gloves were worn to reduce the risk of sample contamination. The shovel and plastic trowels were cleaned using distilled water between samples. Vegetation and soil samples were stored in coolers with ice packs and immediately shipped for analysis to ALS Global in Burnaby, BC, following sample collection. As an additional quality control measure, four random field duplicate tissue samples were collected at a subset of sampling locations throughout the LSA.

3.1.2 Baseline Soil Classification and Mapping

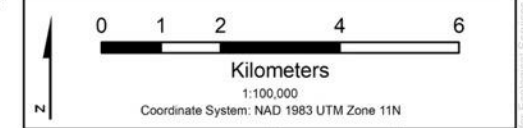
At representative soil pit locations, soil samples from different depths (e.g., leaf litter, 0-15 cm mineral, and rarely subsurface mineral) were collected using a small stainless-steel trowel and placed directly into labelled plastic bags or 125 mL soil sample jars. The soil samples were stored in coolers with ice packs prior to shipment to ALS Environmental. The results of this survey are included herein to ensure all available chemical data for soil samples throughout the LSA are considered in the human and terrestrial wildlife health risk assessment. Soil sample locations associated with these surveys are presented in Figure 3-2.



NWP Coal Canada Ltd
Crown Mountain Local Study Area
Soil Sample Plots



- Crown Mountain Local Study Area
- Infrastructure Footprint Buffer (100m)
- Soil Samples**
- Soil Sample
- Base Features**
- Highway
- Arterial Road
- Local/Resource Road
- Resource Road
- Railway
- Powerline
- Existing Powerline
- Access Road
- Haul Road
- Wetland
- Lakes
- Rivers
- Streams
- Provincial Border
- 100m Contour
- 20m Contour



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Date: 05/12/2019	

Figure 3-2. Soil sample locations association with baseline soil classification and mapping surveys within the Project LSA.

3.2 Laboratory Analysis

ALS Environmental conducted moisture content and metal analyses on all vegetation samples and moisture content, pH, and metal analyses on all soil samples. Test methods used are outlined in

as per the Certificates of Analysis (COA) L1970983, L1974841, L198616, L198617, L198619, L1984966, L2003527, L2318167 for the vegetation and soil sampling and L1981208, L2137302, L2318167 for the soil classification and mapping baseline sampling (Appendix 4).

Table 3-2 Laboratory testing methods for soil and tissue samples.

Test Description	Test Method	Method Reference
Mercury in Soil	CVAFS ¹	EPA 200.2/1631E (modified)
Mercury in Tissue	CVAFS (dry)	EPA 200.3, EPA 245.7
Metals in Soil	CRC ICPMS ²	EPA 200.2/6020A (modified)
Metals in Tissue	CRC ICPMS (dry)	EPA 200.3/6020A
% Moisture in Tissue	Gravimetrically	Puget Sound WQ Authority, Apr 1997
Moisture in Soil	Gravimetrically	CWS for PHC in Soil – Tier 1
PAH in Soil	GCMS ³	EPA 3570/8270
PAH in Tissue	GCMS	EPA 3540, 3630, 8270
pH in Soil	1:2 Soil:Water Extraction	BC WLAP Method: Electrometric, Soil

Metal concentrations in soil and plant tissue used EPA Method 6020 which is used to describe the multi-elemental determination of analytes by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) in environmental samples. The method measures ions produced by a radiofrequency inductively coupled plasma. Analyte species originating in liquid are nebulized and the resulting aerosol is transported by argon gas into the plasma torch. Ions produced in the plasma are sorted according to their mass-to-charge ratio (EPA, 1998). Modifying this method to include collision and reaction cells extends its capability by allowing the selective attenuation or removal of problematic interferences (McCurdy & Woods, 2004).

PAH analysis was only conducted on the first of each vegetation sample and the associated soil sample collected per plant species. This was done chronologically for each sample (e.g., AMELALN-01, CAREX-01). The rationale for this being that the much of the study area has not been previously disturbed and thus PAH levels were not expected to exceed acceptable levels as per the BC Contaminated Sites Regulation (CSR, BC Reg. 375/96, 2019) or Canadian Council for the Ministry of Environment guideline (CCME, 2010) for corresponding land use. Sampling proceeded under the understanding that if PAH level exceedances were identified; additional sampling would take place.

Lists of metals and PAH parameters analyzed by ALS Environmental for both soil and vegetation samples are presented in Appendix 3. Of the 21 PAH parameters analyzed for vegetation samples and 24 parameters analyzed for soil samples, four of the parameters (Acenaphthene d10, Chrysene d23, Naphthalene d8 and Phenanthrene d10) were used to spike samples, and refer to the percentage recovered from the extraction and analysis process. These parameters are compared to Acenaphthene, Chrysene, Naphthalene, and Phenanthrene in each sample as a method for quality control. Two additional parameters, Benzo(a)pyrene Total Potency Equivalent (B(a)P TPE) and the Index of Additive Cancer Risk (IACR), were calculated for soil samples in accordance with the CCME (2010) guidelines.

The B(a)P TPE represents the sum of estimated cancer potency relative to B(a)P for all potentially carcinogenic PAH parameters (i.e., Benz(a)anthracene, Benzo(a)pyrene, Benzo(b+j+k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene and Indeno{1,2,3-c,d}pyrene). B(a)P TPE for each

¹ Cold vapor atomic fluorescence spectrometry

² Collision/reaction cell inductively coupled plasma – mass spectrometry

³ Gas chromatography with mass spectrometric detection

soil sample is calculated by multiplying the concentration of each PAH in the sample by its corresponding B(a)P potency equivalence factor. The IACR assesses potential threats to potable groundwater water quality from leaching carcinogenic PAH mixtures from soil. The IACR is calculated by dividing the soil concentration of each carcinogenic PAH by its soil quality guideline of potable water component value, which are then added together (CCME, 2010).

On occasion, detection limits were increased on a per sample basis due to limited sample amount, high moisture content, dilutions due to high concentration of test analytes, dilution due to sample matrix effects (e.g., chemical interference, colour, turbidity), and analytical interferences⁴. This was particularly common in the analysis of PAH in vegetation samples. Occurrences of a detection limit being raised above the standard detection limit for some parameters are shown in the raw analytical data presented in Table 4-5, Table 4-7, Table 4-11 and Table 4-12. Listed detection limits used by ALS Environmental for both metal and PAH parameters for soil and vegetation samples are shown in Appendix 5.

3.3 Quality Assurance/Quality Control

For each COA, ALS Environmental included QC samples with qualifiers and comments describing their intra-laboratory quality control with respect to a random assortment of metal parameters (e.g., molybdenum, chromium, manganese). Further QA/QC was completed through the submission and analysis of duplicate vegetation samples. The results of the duplicate sample analysis are expressed as Relative Percent Difference (RPD); an indicator of laboratory precision and sample heterogeneity. The lower the RPD value, the more precise the laboratory analysis.

$$RPD = \frac{|sample - duplicate|}{mean} \times 100$$

In accordance with BC MWLAP (2013), duplicate samples with a larger variation than 20% for soil, or 30% for vegetation indicate high sample variability which may be attributed to laboratory analysis, sampling technique (applicable for soil samples only) or natural sample heterogeneity. ALS Environmental noted high levels of sample heterogeneity overall.

3.4 Data Analysis

Microsoft Excel was used to conduct data analysis on metal concentrations of vegetation samples per plant species. Average and standard deviation of metal concentrations was determined per species. A two-tailed t-test of unequal variances was conducted between the foliage/branch tips and berries of fruit-bearing shrubs to assess whether there was a statistically significant difference in metal concentrations. The two-tailed t-test assumed that the data were normally distributed, with unequal variances. The detection limit was used for vegetation samples which had metal levels below the detection limit in order to perform data analysis. Additionally, vegetation and soil samples were assessed individually to highlight which samples exhibited metal and/or PAH concentration exceedances relative to the provincial (BC Reg. 375/96, 2019) and federal (CCME, 2010) environmental thresholds for the land use.

4 Results

4.1 Metals

Provincially, soil metal concentrations are regulated under the *Environmental Management Act* Contaminated Sites Regulation (CSR, BC Reg. 375/96, 2014; Table 4-1,

⁴ See *Detection limit policies: Reducing the chance of false positives due to sample-specific issues*. Retrieved from <http://www.alsglobal.com>

Table 4-2). Federally, the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CCME, 2006) are used to evaluate the consequences of development associated with a variety of land uses (Table 4-3). As the Project falls within both provincial and federal jurisdiction, both thresholds were considered.

Table 4-1 Matrix numerical soil standards for wildlands natural (presented in $\mu\text{g/g} = \text{mg/kg}$).

Constituent	Human Health Protection (Intake of contaminated soil)	Environmental Protection (Toxicity to invertebrates and plants)
Anthracene	25,000	1.5
Arsenic (As)	40	15
Barium (Ba)	15,000	350
Benzo(a)pyrene	10	15
Beryllium (Be)	150	75
Cadmium (Cd)	40	15
Chromium (Cr)	250	100
Cobalt (Co)	25	25
Copper (Cu)	7,500	85
Cyanide (Cn)	50	2
Fluoranthene	3,500	30
Lead (Pb)	120	400
Manganese (Mn)	10,000	2,000
Mercury (Hg)	25	25
Molybdenum (Mo)	400	60
Naphthalene	1,500	0.4
Nickel (Ni)	900	100
Selenium (Se)	400	1.5
Uranium (U)	250	300
Vanadium (V)	400	100
Zinc (Zn)	25,000	300

Source: CSR, 2019

Table 4-2 Generic numerical soil standards for wildlands natural (presented in $\mu\text{g/g} = \text{mg/kg}$).

Constituent	Human Health Protection (Intake of contaminated soil)	Environmental Protection (Toxicity to invertebrates and plants)
Acenaphthene	2,000	NS ⁵
Aluminum (Al)	40,000	NS
Antimony (Sb)	500	15
Benz(a)anthracene	95	0.65
Benzo(b&j)fluoranthene	95	0.65
Benzo(k)fluoranthene	95	0.65
Boron (Bo)	15,000	NS
Chrysene	400	NS
Dibenz(a,h)anthracene	10	0.65
Fluorene	1,000	NS
Indeno(1,2,3-c,d)pyrene	95	0.65
Iron (Fe)	35,000	No data
Lithium (Li)	65	NS
2-Methylnaphthalene	100	NS
Phenanthrene	8,000	3
Pyrene	2,500	6.5
Silver (Ag)	400	15
Strontium (Sr)	20,000	NS
Sulfur (S)	No data	No data
Thallium (Tl)	No data	5.5
Tin (Sn)	50,000	30
Tungsten (W)	25	NS

Source: CSR, 2019

⁵ Insufficient acceptable scientific data to calculate a standard, or no appropriate standard, guideline or criterion exists to develop a soil quality standard

Table 4-3 CCME soil quality guidelines for metal concentrations (presented in mg/kg).

Metal	Concentrations				Date
	Agricultural	Residential/parkland	Commercial	Industrial	
Antimony (Sb)	20	20	40	40	1991
Arsenic (As)	12	12	12	12	1997
Barium (Ba)	750	500	2000	2000	2013
Beryllium (Be)	4	4	8	8	2015
Boron (B)	2	No data	No data	No data	1991
Cadmium (Cd)	1.4	10	22	22	1999
Chromium (Cr)	64	64	87	87	1997
Cobalt (Co)	40	50	300	300	1991
Copper (Cu)	63	63	91	91	1999
Lead (Pb)	70	140	260	600	1999
Mercury (Hg)	6.6	6.6	24	50	1999
Molybdenum (Mo)	5	10	40	40	1991
Nickel (Ni)	45	45	89	89	2015
Selenium (Se)	1	1	2.9	2.9	2009
Silver (Ag)	20	20	40	40	1991
Thallium (Tl)	1	1	1	1	1999
Tin (Sn)	5	50	300	300	1991
Uranium (U)	23	23	33	300	2007
Vanadium (V)	130	130	130	130	1997
Zinc (Zn)	250	250	410	410	2018

Source: CCME, 2018a

Note that there are no provincial or federal guidelines for the following analytes: Bi, Bo, Ca, Fe, Li, Mg, P, K, Na, Sr, S, Ti and Zr.

4.1.1 Soil Results: Baseline Chemical Surveys

The Certificates of Analysis provided by ALS Environmental (L1970983, L1974841, L198616, L198617, L198619, L1984966, L2003527, L2318167) for soil samples collected in association with vegetation sampling present results and document methods (Appendix 4). All baseline chemistry soil samples with guideline exceedances are presented in Figure 4-1.

Tin (Sn) and tungsten (W) metals occurred in concentrations below the detection limit for all samples collected during these surveys, 2.0 and 0.50 mg/kg, respectively. Sulphur (S, n=48) and bismuth (Bi, n=37) were also consistently found in concentrations below the detection limit (1,000 and 0.02 mg/kg, respectively; Table 4-5).

On a per sample basis, a soil sample (mineral material) associated with a rose vegetation sample (sample 38, ROSA-05) collected from the upland area surrounding a wetland located at the intersection of Harmer and Grave Lake Roads, of which 17 (Sb, Bi, B, Co, Cu, Fe, Mo, Ni, Se, Ag, Na, S, Sn, W, Zn and Zr) of the 34 metal parameters analyzed exhibited the lowest concentrations; followed by a soil sample (mesic organic material) associated with a beaked sedge vegetation sample (sample 45, CAREX-09), collected from a wetland in the western portion of the LSA (south of Grave Creek, west of the Elk River), exhibited the lowest metal concentration for 13 (Al, Ba, Be, Bi, Cr, Li, Mn, Ag, Tl, Sn, W, V and Zr) of the 34 metal parameters analyzed (Table 4-4). A soil sample (mineral material) associated with a rose vegetation sample (sample 48, ROSA-06), collected east of Valley Service Road, approximately 2 km south of the intersection with Harmer Road, exhibited the highest metal concentration for five (As, Be, Ni, K and V) of the 34 metal parameters analyzed; followed by a soil sample (mesic organic material) associated with a willow vegetation sample (sample 44, SALIX-06), of which four (B, Se, Na and Sr) of the 34 metal parameters analyzed exhibited the highest concentrations (Table 4-4).

The mesic organic soil sample associated with beaked sedge (sample 25, CAREX-02), collected from an open water wetland at the base of Gaff Peak, exhibited a barium concentration of 503 mg/kg, which exceeds the CCME guideline for residential/parkland (500 mg/kg; Table 4-3). Similarly, the mineral soil

sample associated with soopolallie (sample 11, SHEPCAN-02), collected immediately east and uphill of the reclaimed Teck land in the west of the LSA, was found to contain a barium concentration (601 mg/kg) that also exceeds the CCME guideline. A third mineral soil sample (sample 31, CAREX-03/EQUIARV-05), collected from a wetland south of the confluence of West Alexander and Alexander Creeks, was found to contain 401 mg/kg barium which exceeds the provincial wildlands natural guideline for the protection of ecological health (Table 4-1).

The mineral soil sample associated with a rose vegetation sample (sample 48, ROSA-06), collected from a forested site east of Valley Service Road approximately 2 km south of the intersection with Harmer Road, was found to contain concentrations of arsenic (12.7 mg/kg) and nickel (50.6 mg/kg) that exceeded the CCME residential/parkland guideline (Table 4-3).

The mesic organic soil sample associated with both willow and black cottonwood vegetation samples (sample 4, SALIX-01/POPUBAL-01) was found to contain a cobalt concentration (45 mg/kg) that exceeded the provincial wildlands natural guideline for the protection of ecological health (Table 4-1).

Thirteen soil samples collected throughout the LSA, representing 11% of soil samples analysed (n = 123), were found to contain concentrations of selenium that exceed either the CCME guidelines (1.0 mg/kg), the provincial guidelines (1.5 mg/kg), or both. These samples include 4 (SALIX-01/POPUBAL-01), 5 (POPUBAL-02), 8 (SALIX-03), 25 (CAREX-02), 31 (CAREX-03/EQUIARV-05), 34 (CAREX-04), 37 (CAREX-05), 42 (CAREX-07), 43 (CAREX-08), 44 (SALIX-06), 45 (CAREX-09), 54 (SALIX-07) and 55 (CAREX-10). Exceedances are detailed in Table 4-4 .

Table 4-4 Soil selenium concentration exceedances from baseline chemistry sampling.

Sample Number (Species)	Federal Exceedances (CCME, 2009)	Provincial Exceedances (CSR, 2019)
4 (willow and black cottonwood)	✓	✓
5 (black cottonwood)	✓	
8 (willow)	✓	✓
25 (beaked sedge)	✓	
31 (beaked sedge and horsetail)	✓	✓
34 (beaked sedge)	✓	
37 (beaked sedge)	✓	✓
42 (beaked sedge)	✓	✓
43 (beaked sedge)	✓	✓
44 (willow)	✓	✓
45 (beaked sedge)	✓	✓
54 (willow)	✓	✓
55 (beaked sedge)	✓	✓

Selenium is leached from coal waste rock into surface water features throughout the Elk Valley (CCME, 2009); it is therefore expected that samples collected from sites associated with surface water features (i.e., wetlands, ponds, creeks, rivers) may have increased selenium concentrations. Each of the 13 samples that exceeded the CCME regulatory guidelines for selenium, were near surface water features. Coal geology exists within the LSA and is a likely natural contributor to elevated selenium levels.

Table 4-5 Summary of soil samples collected in association with baseline chemical surveys. Samples with highest (■) and lowest (■) concentrations (mg/kg) are indicated, lowest values at the detection limit (■) are also indicated. Where thresholds for analytes exist: CCME (2018) guideline exceedances noted with red highlight; CSR (2019) exceedances noted with yellow highlight.

Sample Location #	Sample Name	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulfur (S)	Thallium (Tl)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Uranium (U)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
3	AMELALN-01	13300	0.36	3.98	168.0	0.73	0.22	6.2	0.167	2280	11.5	6.40	7.5	16000	12.4	16.9	3270	401	0.81	11.6	474	2710	<0.20	<0.10	<50	10.1	<1000	0.163	<2.0	72.3	<0.50	0.677	20.6	52.3	1.3
33	AMELALN-02	8290	0.13	2.72	291.0	0.36	<0.20	6.5	0.900	271000	9.24	2.42	7.11	6760	4.59	6.20	3850	333	0.29	7.01	629	670	0.78	<0.10	82	338	<1000	0.161	<2.0	139	<0.50	0.320	9.34	24.0	2.7
35	AMELALN-03	12900	0.61	5.93	196.0	0.71	0.21	7.9	1.56	3480	16.4	7.78	19.3	18100	11.7	12.3	2590	663	3.49	20.9	646	2830	0.62	0.12	111	15.1	<1000	0.330	<2.0	142	<0.50	0.417	38.8	156	1.7
39	AMELALN-05	5370	0.24	2.52	68.9	0.26	<0.20	<5.0	0.155	997	7.84	2.78	4.51	9970	6.64	4.80	1030	209	0.82	8.65	462	1010	<0.20	<0.10	<50	5.39	<1000	0.111	<2.0	99.3	<0.50	0.280	14.4	42.0	<1.0
47	AMELALN-06	14800	0.19	3.07	155	0.54	<0.20	5.5	0.149	1050	14.2	5.22	5.58	13800	8.94	13.0	2140	481	0.83	13.6	932	1910	<0.20	<0.10	128	10.4	<1000	0.177	<2.0	319	<0.50	0.391	27.3	92.1	2.5
24	CAREX-01/EQUIARV-02	22200	0.49	8.45	342.0	1.28	0.42	8.0	0.347	4510	18.3	9.33	14.5	27600	20.8	46.8	6080	1060	1.45	15.9	1170	2570	0.58	0.18	58	26.4	<1000	0.215	<2.0	19.4	<0.50	1.37	28.4	113	3.0
25	CAREX-02	24000	0.36	3.08	503.0	1.40	0.27	12.0	1.08	5920	22.7	3.35	16.0	12700	19.3	29.4	3810	64.9	0.36	15.6	2140	2990	1.39	0.51	71	27.2	1100	0.449	<2.0	16.2	<0.50	2.36	36.7	72.4	2.2
31	CAREX-03/EQUIARV-05	8730	0.97	5.35	401.0	1.11	0.24	8.5	2.31	14400	16.5	9.21	38.0	13100	18.2	11.6	3580	72.4	1.40	34.3	1020	1930	2.85	0.44	72	87.1	1300	0.186	<2.0	<24.0*	<0.50	1.53	36.8	129	2.9
34	CAREX-04	11100	0.47	4.46	128.0	0.81	<0.20	8.7	0.632	10700	16.4	6.45	16.2	14800	11.9	16.5	5840	76.6	0.89	20.2	1070	2090	1.28	0.17	67	23.2	<1000	0.246	<2.0	19.8	<0.50	1.01	27.5	91.0	1.7
37	CAREX-05	8010	0.23	4.89	258.0	0.53	<0.20	9.0	0.509	40000	13.4	2.89	8.36	16200	5.47	11.6	11800	156	1.34	12.1	1350	1140	2.10	0.13	88	66.7	3200	0.156	<2.0	<50.0*	<0.50	1.30	25.4	30.7	3.3
41	CAREX-06	9520	0.62	5.70	169	0.59	<0.20	12.1	0.886	65900	14.3	5.09	16.0	12400	8.55	14.7	12500	410	1.99	18.4	842	2000	0.45	0.15	151	104	1300	0.394	<2.0	40.9	<0.50	0.690	27.7	80.8	<1.0
42	CAREX-07	17600	0.39	5.64	193	0.91	0.21	32.6	2.79	18500	16.8	6.08	30.9	18400	9.25	21.3	4490	182	2.73	25.4	846	2750	3.05	0.23	199	135	3100	0.822	<2.0	33.4	<0.50	0.889	39.7	178	6.2
43	CAREX-08	1790	0.39	1.13	50.4	0.13	<0.20	58.9	0.260	28500	1.90	1.50	5.60	2450	4.15	2.6	2420	11.0	5.03	8.54	714	370	2.95	<0.10	148	243	12200	0.091	<2.0	25.6	<0.50	1.33	4.93	44.7	1.4
45	CAREX-09	856	0.16	0.94	43.5	0.10	<0.20	51.7	0.194	21500	0.94	1.56	6.44	2630	2.53	<2.0	1580	15.0	3.63	4.15	816	220	3.98	<0.10	254	186	7600	0.055	<2.0	19.1	<0.50	2.07	2.35	32.7	<1.0
55	CAREX-10	18800	0.34	4.63	312	0.93	0.25	16.1	2.19	9600	25.5	4.18	25.2	15700	12.6	21.6	4200	36.7	0.95	21.3	1000	3140	3.06	0.17	106	28.9	1300	0.406	<2.0	25.1	<0.50	2.67	39.8	101	4.6
53	EQUIARV-06	9640	0.49	7.28	130	0.71	<0.20	14.1	0.593	20000	18.6	6.21	13.5	17300	8.58	8.5	7740	1390	1.85	20.9	2650	2480	0.41	0.14	78	46.0	<1000	0.324	<2.0	54.0	<0.50	1.30	27.4	66.1	1.1
5	POPUBAL-02	13600	0.61	7.24	232.0	0.85	0.24	16.0	1.91	8720	21.0	8.80	30.1	21700	13.1	22.4	4730	343	2.40	28.1	1240	3570	1.17	0.15	58	24.1	<1000	0.363	<2.0	11.8	<0.50	0.510	33.4	159	1.8
15	POPUBAL-03	9710	0.57	7.72	249.0	0.75	0.21	9.5	1.07	12600	13.3	7.64	20.7	22200	12.1	16.0	5150	514	3.07	26.6	1410	1930	0.83	0.14	64	28.8	<1000	0.330	<2.0	<19.0*	<0.50	0.588	25.3	111	1.6
30	POPUBAL-04/EQUIARV-04	13800	0.40	6.28	85.4	0.70	<0.20	5.6	0.298	1460	16.7	4.21	12.0	19200	11.2	14.1	2180	92.6	2.14	11.9	1170	1470	0.41	<0.10	<50	7.42	<1000	0.277	<2.0	<22.0*	<0.50	0.429	36.0	96.1	1.3
32	POPUBAL-05	5250	0.53	4.06	138.0	0.64	<0.20	<5.0	0.359	2740	7.48	3.87	11.8	17200	11.2	2.40	654	78.4	0.57	13.7	1190	1570	0.38	0.13	<50	22.0	<1000	0.133	<2.0	15.5	<0.50	0.835	22.3	81.3	<1.0
49	POPUBAL-06	9450	0.57	6.84	178	0.61	<0.20	11.8	1.18	108000	16.3	4.72	15.6	15300	7.89	14.6	15000	362	2.03	20.9	1030	2360	0.38	0.11	95	125	<1000	0.370	<2.0	27.5	<0.50	0.685	27.9	80.9	1.0
13	ROSA-01	9170	0.27	2.40	140.0	0.57	<0.20	5.0	0.202	4490	15.7	4.26	5.74	14200	8.63	7.80	1860	621	1.12	14.2	402	1440	<0.20	<0.10	<50	12.3	<1000	0.170	<2.0	76.8	<0.50	0.346	19.1	43.9	3.1
18	ROSA-02	17600	0.46	5.68	164.0	0.96	<0.20	6.3	0.226	2180	22.5	10.8	13.6	21800	12.8	20.5	5180	748	1.21	23.6	2210	0.29	0.11	118	15.2	<1000	0.241	<2.0	205	<0.50	0.551	37.8	76.1	4.2	
19	ROSA-03	12300	0.35	2.90	200.0	0.64	<0.20	6.9	0.321	1310	14.9	5.30	10.7	14600	8.91	10.4	2350	579	1.19	14.4	435	2210	0.24	0.10	114	14.0	<1000	0.196	<2.0	194	<0.50	0.340	27.4	95.2	4.0
36	ROSA-04/AMELALN-04	13600	0.18	2.49	255.0	0.53	<0.20	6.5	0.375	2560	11.7	4.55	6.94	13100	8.42	11.0	2130	796	1.01	11.1	545	2310	<0.20	0.11	139	14.0	<1000	0.177	<2.0	337	<0.50	0.307	20.2	134	4.5
38	ROSA-05	4310	0.10	0.38	77.3	0.16	<0.20	<5.0	0.080	933	5.28	0.86	1.95	2250	3.40	4.90	640	29.8	0.12	2.04	381	610	<0.20	<0.10	<50	8.31	<1000	0.079	<2.0	31.8	<0.50	0.373	8.70	17.9	<1.0
48	ROSA-06	27900	1.14	12.7	236	1.53	0.23	20.1	1.03	7430	39.5	11.6	30.0	26400	14.4	27.2	6540	708	2.62	30.6	982	6030	0.54	0.27	94	28.5	<1000	0.657	<2.0	60.3	<0.50	0.747	73.2	139	4.3
6	RUBUPAR-01/SALIX-02	9580	0.21	2.37	96.8	0.44	<0.20	<5.0	0.119	1860	12.2	3.67	5.70	11900	7.79	7.60	1440	360	0.58	11.2	568	1190	<0.20	<0.10	56	8.39	<1000	0.147	<2.0	112	<0.50	0.437	18.0	33.1	<1.0
7	RUBUPAR-02	20500	0.14	2.08	296.0	0.80	<0.20	6.2	0.273	4210	27.5	3.52	4.84	13500	7.71	12.5	2290	611	0.38	15.2	2660	1440	<0.20	<0.10	149	12.7	<1000	0.143	<2.0	435	<0.50	0.840	17.3	81.4	7.4
20	RUBUPAR-03/EQUIARV-01	11500	0.68	7.80	168.0	0.83	<0.20	10.6	0.836	67100	19.3	7.24	20.1	18100	10.4	13.1	15100	523	2.24	26.8	1540	2790	0.57	0.23	110	69.8	<1000	0.370	<2.0	34.7	<0.50	0.890	33.0	93.5	1.6
21	RUBUPAR-04	26700	0.32	5.44	170.0	1.20	0.35	6.9	0.142	1470	19.6	6.79	10.5	27900	14.3	36.0	4600	180	0.99	24.1	1590	2500	<0.20	<0.10	55	8.55	<1000	0.155	<2.0	49.6	<0.50	0.405	31.5	81.1	2.2
28	RUBUPAR-05/SAMBACAE-04/SALIX-05	11900	0.30	4.58	57.9	0.52	<0.20	5.7	0.464	51700	23.6	2.85	3.32	10700	9.24	15.9	7630	196	0.81	14.1	747	850	0.26	0.10	61	43.1	<1000	0.163	<2.0	147	<0.50	0.611	21.7	45.0	1.7
50	RUBUPAR-06	25200	0.41	9.32	191	1.07	0.24	8.5	0.287	1050	25.7	9.83	16.6	26000	15.8	34.2	2200	430	1.11	24.5	1320	2600	0.53	0.16	69	10.5	<1000	0.300	<2.0	40.0	<0.50	0.725	45.4	102	1.6
16	SAMBACAE-01	12100	0.59	7.39	145.0	0.62	0.37	8.4	0.419	2370	15.0	6.22	19.6	23000	20.3	11.0	2620	1040	1.74	14.5	2420	3210	0.40	0.11	<50	8.48	<1000	0.200	<2.0	42.9	<0.50	0.612	26.5	124	<1.0
17	SAMBACAE-02	34400	0.26	4.56	59.9	0.44	0.25	<5.0	0.214	399	12.5	1.70	9.56	20400	11.9	10.2	894	218	0.86	4.30	688	670	0.30	0.48	156	4.84	<1000	0.128	<2.0	495	<0.50	0.726	32.7	25.3	7.2
23	SAMBACAE-03	12800	0.68	9.8																															

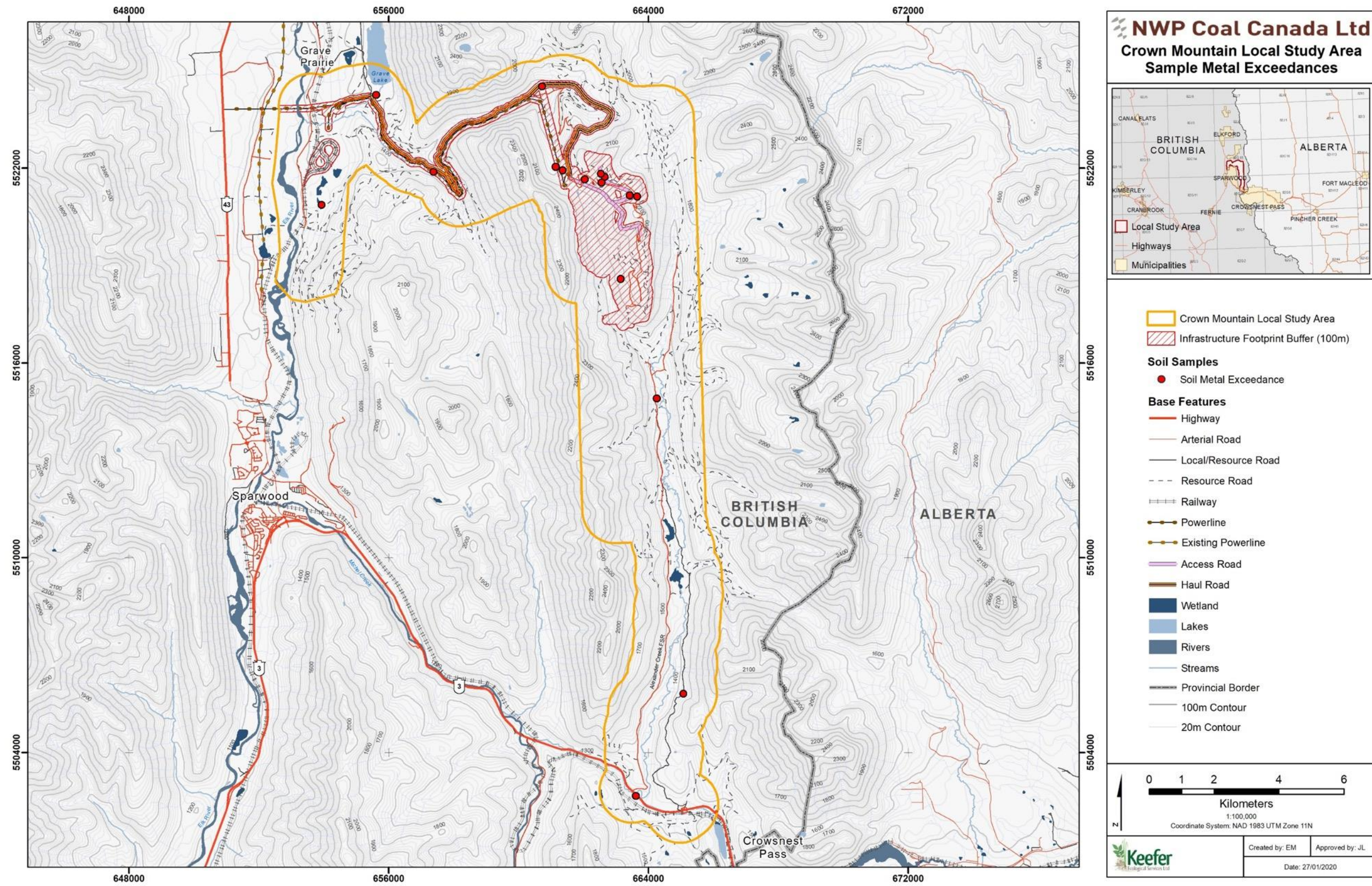


Figure 4-1. Soil sample locations association with baseline chemistry surveys found to contain metal concentrations above federal and/or provincial guidelines.

4.1.2 Soil Results: Baseline Soil Classification and Mapping

The Certificates of Analysis provided by ALS Environmental (L1981208 and L2137302) for soil samples collected in association with vegetation sampling present results and document methods (Appendix 4). All baseline chemistry soil samples with guideline exceedances are presented in Figure 4-2.

Tin (Sn) and tungsten (W) metals occurred in concentrations below the detection limit for all samples collected during these surveys, 2.0 and 0.50 mg/kg, respectively. Sulphur (S, n=55), boron (B, n=34), sodium (Na, n=33) and bismuth (Bi, n=32) were also consistently found in concentrations below the detection limit (1,000, 5.0, 50 and 0.02 mg/kg, respectively; Table 4-7).

On a per sample basis, a mineral soil sample associated with DY70 collected south and slightly uphill of an open water wetland at the base of Gaff Peak, of which 11 (Ba, Bi, B, Cu, Mo, K, Se, Na, S, Sn and W) of the 34 metal parameters analyzed exhibited the lowest concentrations; similarly, a mineral soil sample associated with DY80, collected from the Crown Mountain ridgeline, approximately 2 km straight-line distance south from the summit of Crown Mountain, exhibited the lowest metal concentration for 11 (Bi, B, Ca, Li, Se, Ag, Na, S, Sn, W, Zr) of the 34 metal parameters analyzed (Table 4-7). A mineral soil sample associated with 18-22-IIC, from a depth of approximately 3.5 m from the northwest wall of drill pad 18-22 (western face of the Crown Mountain ridge, south of the summit), exhibited the highest metal concentration for six (As, Cd, Co, Ni, V and Zn) of the 34 metal parameters analyzed; followed by a mineral soil sample associated with DY81 (0-15 cm), collected in a high elevation wetland below the summit of Crown Mountain, of which four (Ba, Be, P and Ag) of the 34 metal parameters analyzed exhibited the highest concentrations (Table 4-7).

The mineral soil sample at DY6 (0-15 cm), collected from a forested slope south of the Branch C Road (1970 m elevation), was found to contain concentrations of aluminum (40,010 mg/kg) that exceeded the provincial wildlands natural guideline for the protection of human health (40,000 mg/kg; a threshold for the protection of ecological health has not been defined) and barium (547 mg/kg) that exceeded the CCME guideline for residential/parkland (500 mg/kg). The mineral soil sample at DY83 (0-15 cm), collected from the cutblock along the Branch C road (below the road), was also found to contain concentrations of barium (40,000 mg/kg) that matched the threshold in the provincial guideline. Mineral soil samples from DY8 (0-8 cm) and DY81 (0-15 cm) had barium concentrations that exceeded the CCME guideline, 508 and 656 mg/kg, respectively. Additionally, mineral soil samples from DY16 (0-15 cm), DY45 and 18-22-IIC (350+ cm) were found to contain concentrations of barium that exceeded the provincial guideline (Table 4-6).

The mineral soil sample collected at DY88 (0-15 cm), a forested east-facing slope above the Branch C road, was found to contain concentrations of manganese (4,230 mg/kg) that exceeded the provincial wildlands natural guideline for ecological health (2,000 mg/kg). The mineral soil sample collected at DY46 (0-15 cm), an upland area adjacent to a wetland in the west of the LSA, was found to contain

concentrations of thallium (1.22 mg/kg) and zinc (257 mg/kg) that exceeded the CCME guideline, 1.0 and 250 mg/kg, respectively.

The subsoil sample (350+ cm depth) collected at drill pad 18-22 on the west-facing slope of the Crown Mountain ridge was found to contain additional exceedances including, barium (as above), arsenic (15.2 mg/kg), nickel (84.7 mg/kg) and zinc (320 mg/kg), all of which exceed the CCME guideline for residential/parkland.

As with the chemistry results presented in Section 4.1.1, selenium levels exceeded CCME residential/parkland and/or provincial wildlands natural guidelines at numerous locations (Table 4-6).

Table 4-6 Soil selenium concentration exceedances from baseline soil mapping.

Sample Number	Federal Exceedances (CCME, 2009)	Provincial Exceedances (CSR, 2019)
DY5	✓	✓
DY8	✓	✓
DY16	✓	✓
DY24	✓	✓
DY46	✓	✓
DY51	✓	✓
DY62	✓	✓
DY81	✓	✓
DY84	✓	
DY100	✓	
18-04	✓	
18-14	✓	
18-5	✓	

These samples correlate with many of the samples from Section 4.1.1 and with known coal geology surface features that are likely to produce selenium as they are weathered in place. For example, DY5 which corresponds to sample number 8 (willow species; Table 4-4) which also has elevated levels of selenium in the soil. DY8 corresponds to a coal seam that is exposed at the land surface and is likely producing selenium through weathering. Samples DY24 and 46 are also in similar locations to baseline chemistry samples that had selenium exceedances (Table 4-4). Samples DY51, DY81, DY84 and DY100 are in proximity to surface water features (i.e., wetlands, ponds, creeks, rivers) which may be contributing to the elevated selenium levels observed.

As with the soil sampled in conjunction with the baseline chemical (soil and vegetation) sampling, a large amount of variability is seen, with most parameters varying about ten-fold and calcium varying almost a thousand-fold.

Table 4-7 Summary of soil samples collected in association with baseline soil classification and mapping surveys. Samples with highest (■) and lowest (■) concentrations (mg/kg) are indicated, lowest values at the detection limit (■) are also indicated. Where thresholds for analytes exist: CCME (2018) guideline exceedances noted with red highlight; CSR (2019) exceedances noted with yellow highlight.

Sample Location #	Sample Name	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulfur (S)	Thallium (Tl)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Uranium (U)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
DY1	0-15CM	11300	0.47	4.18	73.2	0.29	<0.20	<5.0	0.227	884	10.8	3.48	9.21	15700	11.9	5.1	648	408	0.92	10.2	720	1000	0.26	1.26	<50	5.78	<1000	0.146	<2.0	58.5	<0.50	0.301	33.1	73.6	<1.0
DY2	LFH	3970	0.47	2.13	319	0.13	<0.20	<5.0	1.46	6040	4.69	1.57	9.56	4960	24.6	<2.0	1170	330	0.78	6.12	957	1160	0.43	1.09	<50	20.0	1300	0.106	<2.0	60.2	<0.50	0.257	14.1	88.2	1.1
DY2	0-15CM	3360	0.62	7.14	169	0.37	0.20	<5.0	0.225	583	10.7	2.39	10.9	20700	12.9	4.7	799	52.4	1.47	11.7	610	1200	0.28	0.21	<50	6.46	<1000	0.175	<2.0	<47*	<0.50	0.326	36.9	66.1	<1.0
DY2	40-46CM TO R	10690	0.63	7.67	175	0.89	<0.20	<5.0	0.411	2290	10.5	6.58	19.0	24600	14.6	8.4	1040	156	1.12	20.5	1300	1790	0.54	0.16	<50	15.1	<1000	0.131	<2.0	<19*	<0.50	0.761	30.6	132	<1.0
DY4	0-15CM	18020	0.82	6.67	266	0.77	<0.20	<5.0	0.546	2970	9.57	6.24	15.6	21100	13.8	5.2	775	293	1.28	20.9	1050	1260	0.53	0.45	<50	14.8	<1000	0.177	<2.0	16.8	<0.50	1.11	28.3	101	<1.0
DY5	0-15CM	25350	0.68	6.70	149	0.69	<0.20	8.0	1.29	23700	13.5	6.43	17.4	17200	10.6	10.7	9240	358	1.69	29.8	1180	1860	2.65	0.20	70	33.2	<1000	0.291	<2.0	19.3	<0.50	0.929	27.3	108	1.5
DY6	0-15CM	40010	0.67	8.07	547	1.16	0.26	<5.0	0.721	3410	18.7	8.72	15.9	23500	18.1	17.1	1700	1090	1.52	23.3	1440	1780	0.56	0.52	56	22.4	<1000	0.332	<2.0	31.1	<0.50	0.993	50.1	99.2	1.3
DY7	0-15CM	7860	0.79	2.43	293	1.02	0.25	<5.0	0.984	1470	11.6	1.30	26.4	8540	17.0	<2.0	343	19.2	1.52	7.69	375	1310	0.55	0.26	<50	28.5	<1000	0.185	<2.0	47.8	<0.50	1.27	37.4	42.1	2.3
DY8	0-8CM	10700	1.99	5.35	508	1.10	0.35	<5.0	1.02	1180	17.6	1.69	46.3	11900	23.4	2.0	430	88.1	2.91	9.18	639	1520	1.51	0.31	<50	93.4	<1000	0.276	<2.0	<61*	<0.50	2.00	67.6	58.9	5.5
DY9	0-15CM	20200	0.57	6.87	74.6	0.83	0.23	<5.0	0.222	575	13.3	9.44	20.2	27600	14.6	12.6	952	376	1.41	18.9	683	1650	0.55	0.20	56	8.47	<1000	0.174	<2.0	40.5	<0.50	0.676	38.5	116	4.0
DY9	LFH	3570	0.51	1.79	209	0.21	<0.20	<5.0	0.410	4900	4.45	3.14	11.9	4940	14.6	<2.0	734	1360	0.83	10.4	1070	1310	0.74	0.19	<50	20.2	<1000	0.114	<2.0	40.3	<0.50	0.289	13.0	73.6	<1.0
DY10	0-15CM	12700	0.69	7.10	126	0.88	0.24	6.2	0.221	552	15.4	6.14	20.5	26800	15.5	7.1	1110	226	1.44	18.5	867	2480	0.65	0.17	57	10.0	<1000	0.175	<2.0	20.4	<0.50	0.653	40.0	111	<1.0
DY10	LFH	7480	0.60	5.30	169	0.54	<0.20	5.8	0.326	2960	9.73	5.86	16.1	16500	15.6	4.0	958	1200	1.18	15.3	964	2260	0.59	0.13	<50	14.5	<1000	0.151	<2.0	22.4	<0.50	0.484	26.0	88.2	<1.0
DY11	LFH	2710	0.73	1.63	209	0.14	<0.20	5.1	0.680	6750	3.79	2.14	9.52	3550	34.7	<2.0	870	859	0.74	7.35	1310	1400	0.62	0.31	<50	19.8	1300	0.129	<2.0	80.5	<0.50	0.253	10.4	59.4	1.1
DY11	0-15CM	6720	0.39	3.26	50.8	0.20	<0.20	<5.0	0.143	413	9.32	2.21	4.61	12400	8.33	2.1	468	54.2	0.56	7.59	541	720	<0.20	<0.10	<50	4.47	<1000	0.106	<2.0	47.4	<0.50	0.205	28.0	44.8	<1.0
DY12	0-15CM	22900	0.34	6.60	145	1.14	0.30	<5.0	0.144	414	13.9	9.11	12.3	25600	16.8	30.6	4810	600	0.74	12.1	680	1610	<0.20	0.12	<50	4.25	<1000	0.170	<2.0	33.5	<0.50	0.742	28.5	72.0	2.6
DY15	0-15CM	11100	0.25	3.18	77.0	0.57	<0.20	5.7	0.238	6770	23.3	4.62	9.04	15000	7.74	8.5	4460	512	0.62	15.8	703	1400	0.21	<0.10	78	8.98	<1000	0.131	<2.0	160	<0.50	0.609	21.4	63.5	2.8
DY16	0-15CM	8460	0.20	1.36	401	0.51	<0.20	13.0	0.376	130000	13.0	2.77	7.30	8500	6.84	13.1	4680	279	0.57	7.23	633	1360	1.98	0.11	84	564	1400	0.115	<2.0	26.7	<0.50	0.649	11.9	22.8	2.9
DY16	LFH	4310	0.22	1.31	244	0.24	<0.20	21.3	0.667	24500	5.70	1.66	8.61	4930	11.1	6.5	2640	320	1.24	5.09	828	940	0.98	0.10	<50	244	2000	0.075	<2.0	25.8	<0.50	0.641	7.65	72.6	2.0
DY21	10-15CM	21900	0.15	4.93	62.2	0.69	<0.20	<5.0	0.327	2020	20.1	2.70	5.11	13300	7.34	20.7	1150	36.7	0.41	12.0	1410	510	0.25	<0.10	100	5.51	<1000	0.142	<2.0	538	<0.50	0.813	22.2	64.8	16.0
DY24		8170	0.81	4.95	342	0.86	0.21	6.7	1.82	12200	14.3	7.63	30.4	12700	16.1	11.2	3590	59.5	1.19	29.0	996	1730	2.80	0.32	73	63.5	<1000	0.171	<2.0	<21*	<0.50	1.80	30.1	121	2.7
DY40		27400	0.32	4.02	138	0.82	0.24	7.4	0.643	7990	29.6	5.06	6.41	16300	17.1	20.2	2270	297	1.05	20.5	1200	1280	0.25	<0.10	129	18.2	<1000	0.204	<2.0	401	<0.50	0.996	36.1	120	4.7
DY46	0-15CM	13300	0.97	9.33	251	0.87	0.30	22.9	3.37	31100	15.7	6.60	34.6	21000	14.9	19.7	6750	240	5.22	30.1	1270	2920	2.44	0.32	130	207	<1000	1.22	<2.0	32.0	<0.50	0.792	48.0	257	2.5
DY45		20600	0.50	7.74	477	1.32	0.39	14.1	0.165	29500	18.0	8.48	18.8	29400	15.9	25.9	6100	626	0.87	22.8	611	4440	0.23	0.14	68	65.8	<1000	0.264	<2.0	29.3	<0.50	0.324	28.7	77.0	2.8
DY48	0-15CM	9450	0.21	2.21	166	0.45	<0.20	<5.0	0.336	1570	10.3	4.91	6.05	11700	9.20	7.2	1770	619	1.09	9.63	399	1020	0.23	<0.10	85	9.48	<1000	0.147	<2.0	121	<0.50	0.346	19.7	82.1	1.8
DY49	0-15CM	8880	0.21	2.45	261	0.44	<0.20	<5.0	0.754	1420	11.0	4.09	4.75	11900	8.46	6.3	1470	1350	1.49	9.01	871	1110	<0.20	<0.10	58	10.4	<1000	0.154	<2.0	124	<0.50	0.255	19.0	111	<1.0
DY51	0-10CM	5570	0.27	8.29	272	0.37	<0.20	11.0	0.689	27900	9.01	4.07	11.3	21100	8.59	8.1	7080	225	1.24	11.2	1300	930	2.60	0.11	90	68.7	2800	0.122	<2.0	30.0	<0.50	1.33	18.0	50.2	2.7
DY53	0-15CM	7760	0.22	1.79	107	0.35	<0.20	<5.0	0.182	3990	11.8	2.59	4.08	9460	8.38	6.2	1470	421	0.82	8.39	365	1150	<0.20	<0.10	54	11.7	<1000	0.138	<2.0	124	<0.50	0.285	15.7	34.9	1.5
DY55	0-15CM	9710	0.57	7.72	249	0.75	0.21	9.5	1.07	12600	13.3	7.64	20.7	22200	12.1	16.0	5150	514	3.07	26.6	1410	1930	0.83	0.14	64	28.8	<1000	0.330	<2.0	<19*	<0.50	0.588	25.3	111	1.6
DY60	55-75CM	9560	0.62	8.17	253	0.76	0.22	7.0	0.905	11800	13.0	8.07	22.5	22400	13.1	18.2	5650	465	3.54	26.7	1490	1820	0.85	0.16	71	34.7	<1000	0.389	<2.0	<20*	<0.50	0.786	25.3	113	1.6
DY62	0-15CM	9820	0.52	6.71	288	0.69	0.25	9.3	1.10	8770	15.6	7.37	13.7	20500	17.0	16.4	2960	626	1.46	19.1	880	1740	0.87	0.10	51	21.8	<1000	0.226	<2.0	27.0	<0.50	0.673	22.5	109	1.8
DY62	LFH	8110	0.51	4.81	280	0.69	0.20	12.4	1.14	10900	14.1	6.83	17.0	15500	16.5	11.6	2500	776	1.96	19.7	1270	2330	2.19	0.15	51	26.9	1100	0.347	<2.0	25.4	<0.50	1.10	19.5	114	2.0
DY66	0-15CM	14200	0.52	5.57	174	0.79	<0.20	8.4	1.06	2530	20.0	8.32	20.1	19100	11.4	13.6	2910	687	2.12	24.0	663	2870	0.42	0.11	103	16.1	<1000	0.362	<2.0	159	<0.50	0.565	35.1	126	3.5
DY67	0-15CM	22300	0.61	7.01	84.5	0.65	0.22	<5.0	0.343	268	15.6	5.06	14.2	24200	13.2	14.3	1780	174	1.58	15.7	1070	1510	0.43	0.25	58	4.69	<1000	0.206	<2.0	70.3	<0.50	0.593	42.0	96.4	3.0
DY68	LFH	16100	0.46	5.73	316	0.91	0.28	14.3	0.739	8700	14.1	8.02	17.2	18700	17.3	27.8	4200	1070	1.32	13.8	1670	3950	0.72	0.18	61	48.9	1100	0.198	<2.0	24.0	<0.50	1.03	26.3	112	1.4
DY69	0-15CM	22700	0.47	5.55	240	1.18	0.41	12.5	0.194	2230	15.5	10.6	14.7	25000	19.4	32.1	5610	886	0.92	14.7															

Sample Location #	Sample Name	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulfur (S)	Thallium (Tl)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Uranium (U)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
18-14		8970	1.54	6.95	96.1	1.16	<0.20	<5.0	1.64	1720	17.0	6.55	29.9	27600	12.2	3.8	860	227	1.86	30.6	1650	1210	1.06	<0.10	<50	16.8	<1000	0.260	<2.0	22.6	<0.50	2.33	55.0	183	<1.0
18-21		8300	1.90	5.13	176	0.73	<0.20	<5.0	0.770	739	13.7	4.25	22.0	16900	11.1	3.6	637	104	2.29	33.5	811	1200	0.87	<0.10	<50	49.4	<1000	0.231	<2.0	27.3	<0.50	1.10	45.4	144	1.0
18-23		12300	0.70	9.30	159	0.84	<0.20	<5.0	0.777	582	14.9	8.63	19.5	17800	10.3	8.8	1690	234	1.36	20.3	810	1180	0.37	<0.10	<50	24.1	<1000	0.318	<2.0	89.0	<0.50	1.80	38.9	83.4	3.6
18-18		10000	1.21	4.41	150	0.93	0.22	<5.0	0.889	445	10.9	4.95	21.5	13400	12.2	3.7	571	72.1	1.29	20.4	312	1340	0.42	<0.10	<50	22.7	<1000	0.206	<2.0	34.8	<0.50	1.48	37.5	122	1.5
18-5		13000	1.62	7.49	316	0.96	0.29	<5.0	0.929	358	18.0	3.19	34.2	23200	17.3	4.8	424	82.6	3.10	20.7	737	1250	1.21	0.27	<50	65.5	<1000	0.194	<2.0	35.0	<0.50	1.96	65.4	97.0	4.9
18-6		5720	1.12	4.83	305	1.02	0.21	<5.0	1.61	2190	10.2	12.4	27.2	14100	14.9	<2.0	273	159	1.59	34.6	356	1260	0.79	0.18	<50	55.2	<1000	0.175	<2.0	18.6	<0.50	1.83	31.2	86.3	1.3
18-3		8150	1.22	8.31	140	1.02	<0.20	<5.0	1.84	234	16.1	9.03	28.5	17800	18.0	3.0	536	125	2.06	33.3	356	570	0.78	<0.10	<50	14.7	<1000	0.323	<2.0	51.2	<0.50	2.40	39.6	129	3.4
18-28		5470	1.19	5.06	236	0.86	<0.20	<5.0	1.64	754	9.51	5.59	25.2	16200	11.0	<2.0	306	131	1.61	29.4	534	1320	0.56	<0.10	<50	34.2	<1000	0.189	<2.0	31.0	<0.50	1.81	35.5	160	<1.0
18-29		4700	1.51	5.54	344	0.82	0.24	<5.0	0.688	918	8.78	9.75	29.6	12500	16.4	<2.0	244	487	1.82	25.2	278	1430	0.71	<0.10	<50	33.8	<1000	0.437	<2.0	<23*	<0.50	2.02	30.4	111	<1.0
18-22-IC		7620	0.76	3.28	246	0.99	<0.20	<5.0	0.927	2430	12.5	7.81	21.5	14700	11.3	<2.0	261	138	1.43	34.2	1400	1990	0.51	<0.10	<50	100	<1000	0.206	<2.0	<32	<0.50	1.41	32.6	133	<1.0
18-22-IIC		8890	1.93	15.2	455	0.96	<0.20	6.4	4.36	5640	23.2	17.5	27.6	29500	11.4	<2.0	357	491	3.57	84.7	2570	2840	0.94	<0.10	51	129	<1000	0.795	<2.0	43.6	<0.50	2.33	69.1	320	3.2

* Detection Limit adjusted from 1.0 mg/kg due to sample matrix effects (e.g., chemical interference, colour, turbidity).

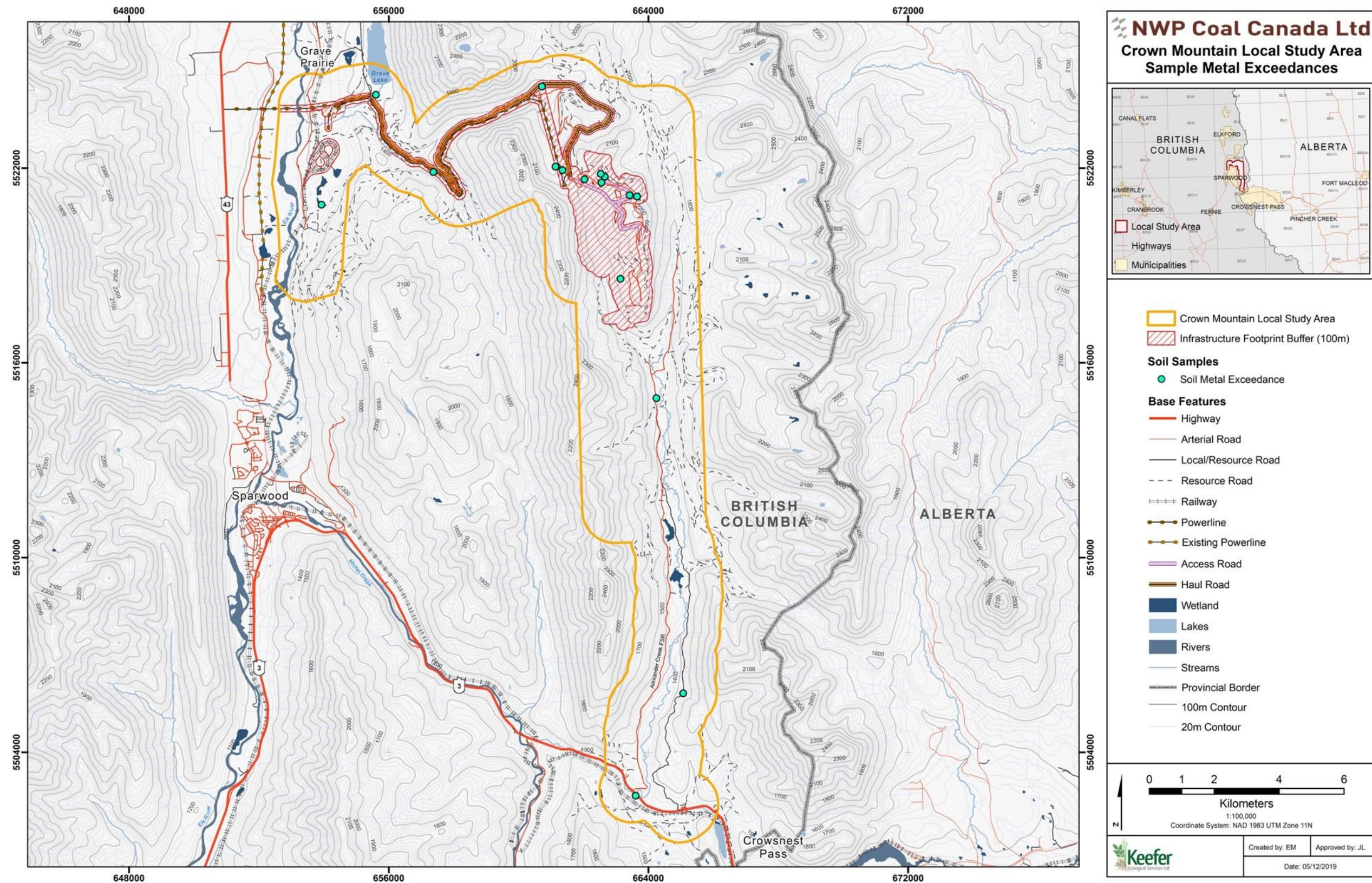


Figure 4-2. Soil sample locations association with baseline soil classification and mapping surveys found to contain metal concentrations above federal and/or provincial guidelines.

4.1.3 Vegetation Results

The Certificates of Analysis (L1970983, L1974841, L1978616, L1978617, L1978619, L1984966 and L2318167), provided by ALS Environmental, for plant tissue samples is presented in Appendix 4. No guidelines exist for levels of metals in vegetation with respect to environmental or human health, so interpretation of results is not definitive.

Bismuth (Bi) and tellurium (Te) metals occurred in concentrations below the detection limit for all samples collected during the baseline soil and vegetation chemistry surveys, 0.010 and 0.020 mg/kg, respectively. Beryllium (Be, n=88), lithium (Li, n=88), zirconium (Zr, n=87), tin (Sn, n=73) and antimony (Sb, n=67) were also consistently found in concentrations below the detection limit (0.010, 0.50, 0.20, 0.10 and 0.010 mg/kg, respectively; Table 4-8).

On a per tissue sample basis, a soopolallie berry sample (sample 10) collected from bedrock outcrop at the edge of an east-facing cutblock on the western side of the Alexander Main Forest Service Road (FSR), exhibited the lowest concentrations for 20 of the 33 metal parameters analyzed (Sb, As, Ba, Be, Bi, Cs, Cr, Co, Pb, Li, Mg, Mn, Na, Te, Ti, Sn, U, V, Zn and Zr). Samples of rosehips (sample 13, western edge of the Grave Creek canyon), thimbleberries (sample 7, eastern-facing toe slope of the continental divide range), elderberries (sample 16, avalanche chute below Gaff Peak) and huckleberries (sample 22, cutblock along Branch C) were also found to contain consistently low metal concentrations (Table 4-8). A composite sample of huckleberry foliage/branch tips (sample 51) collected from a west-facing bedrock and coal seam exposure near the southern extent of the Crown Mountain ridge, was found to contain the highest concentrations of six (Al, Be, Fe, Pb, U and V) of the 33 metal parameters analyzed (Table 4-8).

On average, horsetail vegetation (EQUIARV) was found to contain the highest concentrations of five (Ca, Cs, Pb, Rb, Se) of 33 metal parameters analyzed, followed by willow (SALIX) foliage/branch tips (4/33). Huckleberry (VACCMEM) berry samples were found to contain the highest concentrations of 12 of 33 metal parameters (Al, As, Cd, Cs, Cr, Co, Fe, Pb, Mn, Sn, U and V), followed by Saskatoon berries (AMELALN, 7/33). Conversely, Saskatoon foliage/branch tips were found to contain the lowest levels of six (As, Cr, Pb, Ni, Rb and V) of 33 metal parameters, on average. Soopolallie berry samples were found, on average, to have the lowest concentrations of eight (Ba, Ca, Cu, Mg, Mn, Sr, V and Zn) of the 33 metal parameters.

Table 4-8 Summary of metal analysis for vegetation samples. Samples with highest (■) and lowest (■) concentrations (mg/kg) are indicated, lowest values at the detection limit (■) are also indicated.

Sample Location #	Sample Location	Tissue Type	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Cesium (Cs)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Rubidium (Rb)	Selenium (Se)	Sodium (Na)	Strontium (Sr)	Tellurium (Te)	Thallium (Tl)	Tin (Sn)	Uranium (U)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
3	AMELALN-01	Plant	37.4	0.011	<0.020	238	<0.010	<0.010	16.5	0.0289	14300	<0.0050	<0.050	0.028	4.99	81.0	0.036	<0.50	2870	51.8	2.05	<0.20	5590	11900	1.11	<0.050	<20	28.6	<0.020	<0.0020	<0.10	<0.0020	<0.10	48.6	<0.20
3	AMELALN-01	Berries	18.1	<0.010	<0.020	114	<0.010	<0.010	23.6	0.0090	6830	<0.0050	<0.050	0.047	7.75	37.4	<0.020	<0.50	1870	14.3	2.14	0.40	3330	15500	2.52	<0.050	<20	12.6	<0.020	<0.0020	0.21	<0.0020	<0.10	31.6	<0.20
33	AMELALN-02	Plant	30.3	<0.010	0.023	297	<0.010	<0.010	22.9	0.0860	18800	0.0066	<0.050	0.024	5.64	72.3	0.070	<0.50	2640	48.2	0.221	<0.20	1410	10600	5.91	0.237	<20	36.1	<0.020	0.0023	<0.10	0.0023	0.10	26.4	<0.20
35	AMELALN-03	Plant	24.9	<0.010	<0.020	310	<0.010	<0.010	15.4	0.101	12400	<0.0050	0.063	0.030	4.33	86.6	0.030	<0.50	2650	63.4	2.56	0.68	3400	12500	0.967	0.150	<20	19.4	<0.020	0.0038	<0.10	0.0028	<0.10	37.3	<0.20
36	AMELALN-04	Plant	29.8	<0.010	0.024	226	<0.010	<0.010	18.2	0.123	14100	<0.0050	0.059	0.025	3.73	70.0	0.040	<0.50	3970	58.7	7.32	0.49	7030	11600	0.796	0.181	<20	27.9	<0.020	0.0029	<0.10	0.0033	0.12	44.1	<0.20
39	AMELALN-05	Plant	26.4	<0.010	0.022	131	<0.010	<0.010	16.6	0.197	10300	<0.0050	0.062	0.035	3.35	47.2	0.051	<0.50	3390	201	1.66	0.47	5350	10500	0.629	0.062	<20	15.4	<0.020	0.0022	<0.10	0.0037	0.17	62.6	<0.20
39	AMELALN-05	Berries	16.3	<0.010	0.020	56.4	<0.010	<0.010	26.2	0.0949	5470	<0.0050	<0.050	0.037	4.57	37.0	0.029	<0.50	2220	71.7	1.46	0.87	2500	14100	1.89	<0.050	<20	8.03	<0.020	<0.0020	<0.10	0.0030	0.12	25.5	<0.20
47	AMELALN-06	Plant	13.2	<0.010	<0.020	141	<0.010	<0.010	26.6	0.192	14100	<0.0050	0.097	0.029	4.48	63.9	0.025	<0.50	4290	128	2.12	0.78	4320	14000	1.83	0.159	<20	25.8	<0.020	<0.0020	<0.10	<0.0020	<0.10	60.6	<0.20
47	AMELALN-06	Berries	9.2	0.060	<0.020	108	<0.010	<0.010	27.9	0.177	8190	0.0057	0.154	0.040	6.00	39.4	<0.020	<0.50	3570	84.0	2.35	2.46	3430	17900	2.96	0.211	34	14.5	<0.020	<0.0020	0.40	<0.0020	<0.10	43.1	0.55
24	CAREX-01	Plant	59.9	<0.010	0.337	43.1	<0.010	<0.010	7.2	0.0102	2250	0.0406	0.106	0.092	2.20	120	0.077	<0.50	1380	252	2.11	2.15	2860	20600	23.0	<0.050	<20	8.50	<0.020	0.0026	<0.10	0.0050	0.21	35.1	<0.20
25	CAREX-02	Plant	27.5	<0.010	0.036	78.3	<0.010	<0.010	8.4	0.0898	5460	0.0091	0.077	0.034	3.40	62.0	0.060	<0.50	1250	68.2	0.468	0.65	1950	23200	4.57	0.074	<20	19.0	<0.020	0.0022	<0.10	0.0041	0.18	41.2	<0.20
31	CAREX-03	Plant	24.3	<0.010	0.038	46.7	<0.010	<0.010	13.5	0.0881	5250	0.0225	<0.050	0.050	5.95	54.8	0.043	<0.50	1880	59.4	0.355	0.74	1510	19800	8.21	0.360	<20	13.7	<0.020	0.0078	<0.10	0.0040	0.12	45.4	0.35
34	CAREX-04	Plant	20.6	<0.010	0.068	53.8	<0.010	<0.010	13.5	0.0166	4550	0.0438	<0.050	0.024	2.04	61.4	0.039	<0.50	1210	172	1.04	0.33	1930	17400	24.3	0.193	<20	8.10	<0.020	0.0031	<0.10	<0.0020	<0.10	29.4	<0.20
37	CAREX-05	Plant	20.8	<0.010	0.039	30.7	<0.010	<0.010	27.2	0.0079	6560	0.0119	0.059	0.020	0.86	49.9	0.037	<0.50	1970	141	0.452	<0.20	966	15300	3.81	<0.050	<20	38.9	<0.020	0.0021	<0.10	0.0030	0.10	12.9	<0.20
41	CAREX-06	Plant	101	0.014	0.185	46.7	<0.010	<0.010	16.4	0.0174	5040	0.0230	0.148	0.063	2.05	196	0.079	2.19	1430	331	0.797	0.33	2780	22000	8.64	0.120	146	42.9	<0.020	0.0031	<0.10	0.0084	0.30	38.1	<0.20
42	CAREX-07	Plant	8.6	<0.010	0.044	26.5	<0.010	<0.010	16.0	0.0141	4790	0.0591	0.055	0.033	3.53	31.8	<0.020	0.53	1230	286	0.802	<0.20	2000	16400	40.5	0.095	<20	41.7	<0.020	0.0028	<0.10	<0.0020	<0.10	35.4	<0.20
43	CAREX-08	Plant	12.8	<0.010	0.064	19.5	<0.010	<0.010	16.4	<0.0050	4770	0.0147	0.051	0.038	1.88	86.4	0.025	<0.50	1000	150	0.943	<0.20	1190	19900	3.71	<0.050	120	47.2	<0.020	0.0024	<0.10	0.0037	<0.10	44.8	<0.20
45	CAREX-09	Plant	6.4	<0.010	0.020	40.0	<0.010	<0.010	16.9	0.0054	4920	0.113	<0.050	0.138	4.46	113	<0.020	2.36	1360	261	1.63	<0.20	819	16200	6.01	0.810	73	61.7	<0.020	0.0063	<0.10	0.0026	<0.10	54.1	<0.20
55	CAREX-10	Plant	151	<0.010	0.130	48.7	<0.010	<0.010	14.5	0.0744	6640	0.105	0.244	0.142	6.89	281	0.093	<0.50	1350	238	1.72	0.86	2170	13700	21.7	0.601	<20	10.4	<0.020	0.0049	<0.10	0.0213	0.38	38.1	<0.20
20	EQUIARV-01	Plant	18.1	<0.010	0.023	35.8	<0.010	<0.010	37.1	0.546	20400	0.0326	<0.050	0.028	3.72	39.2	0.041	<0.50	4210	11.8	1.72	0.59	2290	29700	14.2	1.07	<20	20.4	<0.020	<0.0020	<0.10	0.0031	0.10	22.2	<0.20
24	EQUIARV-02	Plant	17.8	<0.010	<0.020	44.8	<0.010	<0.010	24.6	0.194	26800	0.0406	0.060	0.026	3.85	42.2	0.041	<0.50	7300	15.2	0.266	0.35	3050	27000	18.2	0.495	<20	30.2	<0.020	0.0055	<0.10	0.0026	0.10	19.2	<0.20
27	EQUIARV-03	Plant	45.8	<0.010	0.026	27.0	<0.010	<0.010	25.1	0.170	23600	0.0779	0.085	0.116	3.19	80.1	0.077	<0.50	7330	13.2	1.41	0.39	1520	27700	34.6	1.94	<20	18.8	<0.020	0.0056	<0.10	0.0049	0.17	22.8	<0.20
30	EQUIARV-04	Plant	22.3	0.011	0.029	98.2	<0.010	<0.010	23.2	0.154	20900	0.0593	0.055	0.055	3.75	56.8	0.058	<0.50	2420	21.8	2.12	0.54	2450	22500	25.7	1.43	<20	22.8	<0.020	0.0095	<0.10	0.0037	0.12	42.0	<0.20
31	EQUIARV-05	Plant	52.3	<0.010	0.058	71.1	<0.010	<0.010	33.8	0.179	28400	0.0253	0.107	0.646	2.38	71.1	0.071	<0.50	5180	24.5	0.197	0.62	3290	16400	8.61	1.35	65	93.8	<0.020	0.0066	<0.10	0.0075	0.30	34.2	<0.20
53	EQUIARV-06	Plant	91.7	<0.010	0.055	22.3	<0.010	<0.010	19.9	0.274	19000	0.0301	0.205	0.118	2.66	101	0.362	<0.50	4230	47.6	0.328	0.34	4140	20900	8.89	0.433	25	22.1	<0.020	0.0043	<0.10	0.0109	0.40	29.7	<0.20
4	POPUBAL-01	Plant	18.2	<0.010	0.035	26.2	<0.010	<0.010	46.8	1.17	15500	0.0103	<0.050	0.079	2.54	35.5	0.034	<0.50	2990	45.2	0.119	<0.20	1810	4420	2.24	<0.050	<20	43.4	<0.020	0.0025	<0.10	0.0020	<0.10	109	<0.20
5	POPUBAL-02	Plant	18.4	<0.010	0.022	89.5	<0.010	<0.010	28.1	2.50	18400	<0.0050	0.058	0.413	6.04	58.0	0.059	<0.50	2980	27.5	0.251	1.48	2030	16800	2.45	1.36	<20	35.5	<0.020	0.0020	<0.10	0.0029	0.10	157	<0.20
15	POPUBAL-03	Plant	43.8	<0.010	0.043	39.8	<0.010	<0.010	33.0	1.65	23700	0.0123	0.110	0.213	3.62	77.1	0.080	0.54	3450	13.5	0.191	1.68	1830	14100	4.35	0.364	<20	49.1	<0.020	0.0027	<0.10	0.0069	0.22	111	<0.20
30	POPUBAL-04	Plant	26.2	<0.010	<0.020	26.0	<0.010	<0.010	27.9	0.723	18900	0.0092	0.063	0.227	2.34	58.6	0.053	<0.50	3250	31.5	0.060	1.26	2010	10400	6.78	0.079	<20	30.7	<0.020	0.0060	<0.10	0.0035	0.14	93.2	<0.20
32	POPUBAL-05	Plant	13.5	<0.010	<0.020	149	<0.010	<0.010	27.0	2.02	22200	0.0124	<0.050	0.434	2.95	35.1	0.042	<0.50	1780	29.3	0.068	1.28	1760	11000	6.66	0.255	<20	40.7	<0.020	<0.0020	<0.10	<0.0020	<0.10	85.6	<0.20
49	POPUBAL-06	Plant	22.8	0.029	0.024	16.0	<0.010	<0.010	24.9	1.57	11200	0.0052	0.098	0.072	4.94	23.7	0.053	<0.50	2480	31.6	0.520	1.05	2620	14400	1.89	0.080	<20	13.7	<0.020	<0.0020	<0.10	<0.0020	<0.10	165	<0.20
13	ROSA-01	Plant	44.0	<0.010	0.049	12.5	<0.010	<0.010	28.6	0.0297	15200	0.0068	0.135	0.035	4.47	76.3	0.071	<0.50	4380	90.3	6.13	0.49	6140	12200	2.04	<0.050	<20	16.9	<0.020	<0.0020	<0.10	0.0267	0.23	15.7	<0.20
13	ROSA-01	Berries	9.4	<0.010	<0.020	3.89	<0.010	<0.010	18.1	0.0092	5660	<0.0050	<0.050	<0.020	4.65	27.3	<0.020	<0.50	2090	36.0	1.63	0.37	3250	12200	3.19	<0.050	<20	5.96	<0.020	<0.0020	<0.10	<0.0020	<0.10		

Sample Location #	Sample Location	Tissue Type	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Cesium (Cs)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Rubidium (Rb)	Selenium (Se)	Sodium (Na)	Strontium (Sr)	Tellurium (Te)	Thallium (Tl)	Tin (Sn)	Uranium (U)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
28	SAMBCAE-04	Plant	32.4	0.014	0.045	140	<0.010	<0.010	40.7	0.0229	26600	0.0083	0.131	0.063	2.85	97.4	0.101	<0.50	3150	59.0	1.16	0.65	2360	46100	6.24	<0.050	<20	21.4	<0.020	0.0039	<0.10	0.0102	0.23	36.2	<0.20
28	SAMBCAE-04	Berries	8.0	0.029	<0.020	17.0	<0.010	<0.010	19.3	<0.0050	3600	<0.0050	<0.050	<0.020	4.36	42.1	<0.020	<0.50	1560	16.3	0.682	0.35	4520	22900	5.31	<0.050	<20	2.65	<0.020	<0.0020	0.32	<0.0020	<0.10	14.6	<0.20
29	SAMBCAE-05	Plant	40.9	<0.010	0.109	105	<0.010	<0.010	43.1	0.0201	17000	0.0172	0.092	0.043	2.42	102	0.078	<0.50	3180	26.3	0.775	0.39	1990	42800	6.12	<0.050	<20	12.6	<0.020	0.0279	<0.10	0.0143	0.25	35.4	<0.20
29	SAMBCAE-05	Berries	10.0	<0.010	<0.020	22.8	<0.010	<0.010	23.7	0.0093	4870	0.0152	<0.050	0.034	2.03	38.9	<0.020	<0.50	2270	19.6	0.374	0.42	3460	20600	6.22	<0.050	<20	3.27	<0.020	<0.0020	0.23	<0.0020	<0.10	19.9	<0.20
52	SAMBRAC-06	Plant	25.4	<0.010	0.030	172	<0.010	<0.010	39.8	0.0157	11700	0.0161	0.080	0.036	6.45	108	0.043	<0.50	4040	88.5	1.33	0.92	5530	36600	16.5	<0.050	<20	24.6	<0.020	0.0064	<0.10	0.0037	0.13	35.9	<0.20
52	SAMBRAC-06	Berries	27.1	<0.010	0.020	136	<0.010	<0.010	23.1	0.0106	9580	0.0227	0.083	0.048	7.03	83.9	0.039	<0.50	4910	49.9	0.792	3.26	7460	28500	24.2	<0.050	<20	21.1	<0.020	<0.0020	<0.10	0.0032	0.16	44.2	<0.20
4	SALIX-01	Plant	26.2	<0.010	0.048	27.6	<0.010	<0.010	45.4	1.02	13400	0.0353	0.052	0.162	2.28	61.0	0.039	<0.50	3130	60.1	0.177	<0.20	1600	4930	5.52	<0.050	<20	57.7	<0.020	0.0249	<0.10	0.0031	<0.10	153	<0.20
6	SALIX-02	Plant	36.4	<0.010	0.032	26.8	<0.010	<0.010	18.6	1.32	20600	0.0051	0.071	0.108	4.31	70.3	0.061	<0.50	5160	59.1	0.204	3.21	3730	7520	1.23	0.250	<20	23.0	<0.020	<0.0020	<0.10	0.0028	0.13	51.6	<0.20
8	SALIX-03	Plant	60.5	<0.010	0.030	47.3	0.013	<0.010	6.5	1.06	5210	0.0112	0.095	0.655	2.65	68.4	0.059	<0.50	1840	115	0.049	3.69	3070	16500	12.9	<0.050	<20	24.1	<0.020	0.0021	<0.10	0.0048	0.25	79.7	<0.20
9	SALIX-04	Plant	57.7	0.022	0.074	16.9	<0.010	<0.010	31.3	2.95	13300	0.0215	0.157	0.236	7.09	133	0.121	<0.50	3860	121	0.360	6.02	2640	14500	5.88	2.15	<20	18.2	<0.020	0.0045	<0.10	0.0125	0.57	144	<0.20
28	SALIX-05	Plant	22.0	<0.010	0.021	43.3	<0.010	<0.010	24.5	4.57	18000	<0.0050	0.094	0.280	4.07	55.4	0.045	<0.50	1880	40.6	0.672	0.92	2900	11000	2.48	<0.050	<20	17.0	<0.020	0.0037	<0.10	0.0029	0.11	92.5	<0.20
44	SALIX-06	Plant	8.6	<0.010	<0.020	6.50	<0.010	<0.010	51.1	0.0156	11000	0.0125	<0.050	0.531	2.62	46.9	<0.020	<0.50	3860	76.2	0.102	<0.20	2960	11500	5.83	0.075	<20	263	<0.020	<0.0020	<0.10	<0.0020	<0.10	205	<0.20
54	SALIX-07	Plant	25.8	<0.010	0.026	18.8	<0.010	<0.010	20.9	2.55	8440	0.0083	0.104	0.333	4.19	68.2	0.043	<0.50	2770	42.4	0.684	1.03	2810	9220	6.27	2.07	<20	15.8	<0.020	0.0034	<0.10	0.0033	0.14	166	<0.20
10	SHEPCAN-01	Plant	60.2	<0.010	0.031	4.79	<0.010	<0.010	18.2	0.0397	6300	0.0098	0.300	0.068	2.21	107	0.095	<0.50	1440	23.3	0.702	0.90	1130	8220	7.23	0.123	<20	7.49	<0.020	0.0094	<0.10	0.0088	0.30	6.53	<0.20
10	SHEPCAN-01	Berries	7.7	<0.010	<0.020	0.674	<0.010	<0.010	13.6	0.0103	1160	<0.0050	<0.050	<0.020	2.75	23.7	<0.020	<0.50	440	9.03	1.05	1.34	1430	8560	8.42	0.105	<20	1.13	<0.020	<0.0020	<0.10	<0.0020	<0.10	6.24	<0.20
11	SHEPCAN-02	Plant	45.4	0.013	0.039	67.3	<0.010	<0.010	25.4	0.0164	7270	0.0077	0.124	0.057	2.04	101	0.106	<0.50	1370	28.6	0.685	1.26	1080	10300	1.40	0.124	<20	19.6	<0.020	0.0022	<0.10	0.0061	0.25	7.83	<0.20
11	SHEPCAN-02	Berries	13.8	0.013	<0.020	5.70	<0.010	<0.010	12.0	<0.0050	909	<0.0050	<0.050	0.021	2.03	35.8	<0.020	<0.50	446	11.3	1.08	2.02	1610	9440	0.929	0.206	<20	2.15	<0.020	<0.0020	0.26	<0.0020	<0.10	7.13	<0.20
12	SHEPCAN-03	Plant	77.2	0.012	0.064	12.3	<0.010	<0.010	16.1	0.0285	7660	0.0131	0.192	0.059	3.13	158	0.110	<0.50	2520	37.5	0.585	2.75	1620	13600	7.19	0.480	<20	8.53	<0.020	0.0033	<0.10	0.0081	0.33	10.2	<0.20
12	SHEPCAN-03	Berries	11.4	<0.010	<0.020	2.00	<0.010	<0.010	11.6	0.0210	934	<0.0050	<0.050	<0.020	3.94	35.9	<0.020	<0.50	534	12.2	1.94	3.01	1780	9920	4.56	0.352	<20	1.21	<0.020	<0.0020	0.58	<0.0020	<0.10	8.15	<0.20
26	SHEPCAN-04	Plant	36.1	0.011	0.034	11.3	<0.010	<0.010	13.3	0.0508	4210	0.0109	0.145	0.051	2.26	86.5	0.133	<0.50	1400	14.5	0.897	1.01	1640	8690	4.55	0.053	<20	4.33	<0.020	0.0117	<0.10	0.0076	0.26	11.8	<0.20
26	SHEPCAN-04	Berries	6.3	<0.010	<0.020	1.28	<0.010	<0.010	15.0	0.0184	807	0.0051	<0.050	<0.020	2.52	29.6	0.026	<0.50	614	13.1	2.44	2.28	2130	11200	7.65	0.067	<20	0.576	<0.020	<0.0020	0.31	<0.0020	<0.10	12.5	<0.20
27	SHEPCAN-05	Plant	45.6	<0.010	0.031	6.05	<0.010	<0.010	15.1	0.0386	6300	0.0112	0.260	0.045	2.44	86.7	0.122	<0.50	1740	16.7	2.38	0.47	1570	8740	11.7	0.306	<20	5.01	<0.020	0.0129	<0.10	0.0076	0.24	7.89	<0.20
27	SHEPCAN-05	Berries	31.2	0.010	<0.020	1.15	<0.010	<0.010	15.3	0.0229	1160	0.0059	0.117	0.029	3.30	48.3	0.036	<0.50	654	12.1	3.59	1.27	2240	10700	16.8	0.425	<20	0.817	<0.020	<0.0020	0.49	0.0023	<0.10	11.7	<0.20
46	SHEPCAN-06	Plant	31.8	0.017	0.031	23.8	<0.010	<0.010	24.2	0.0267	8230	0.0057	0.108	0.044	3.93	103	0.071	<0.50	1770	30.8	6.87	2.72	2080	17500	1.82	0.601	<20	10.8	<0.020	<0.0020	<0.10	0.0042	0.23	9.78	<0.20
46	SHEPCAN-06	Berries	5.0	0.017	<0.020	3.84	<0.010	<0.010	9.6	0.0165	1030	<0.0050	0.246	0.020	3.16	24.5	<0.020	<0.50	585	9.11	2.58	3.96	1990	11300	1.74	0.407	<20	1.49	<0.020	<0.0020	0.47	<0.0020	<0.10	8.70	0.23
1	VACCMEM-01	Plant	110	<0.010	0.047	160	<0.010	<0.010	18.8	0.0568	4080	0.0093	0.070	0.117	6.14	84.5	0.116	<0.50	1380	2210	0.089	1.39	1670	6240	4.71	<0.050	<20	2.97	<0.020	0.0088	<0.10	0.0067	0.27	35.8	<0.20
2	VACCMEM-02	Plant	182	0.012	0.055	81.5	<0.010	<0.010	16.5	0.0608	5220	0.0147	0.095	0.092	5.56	91.4	0.130	<0.50	2230	917	0.137	1.21	2020	8640	7.91	<0.050	<20	4.12	<0.020	0.0040	<0.10	0.0079	0.34	27.5	<0.20
14	VACCMEM-03	Plant	146	<0.010	0.043	58.5	<0.010	<0.010	16.6	0.0463	4600	0.0198	0.159	0.100	5.28	73.8	0.095	<0.50	2090	1240	0.054	1.19	1690	6310	10.6	<0.050	<20	4.68	<0.020	0.0044	<0.10	0.0066	0.26	30.5	<0.20
14	VACCMEM-03	Berries	30.2	<0.010	<0.020	11.0	<0.010	<0.010	7.4	0.0227	1480	0.0272	<0.050	<0.020	5.35	20.5	<0.020	<0.50	1030	273	0.118	0.67	1970	7720	21.8	<0.050	<20	1.40	<0.020	<0.0020	0.67	<0.0020	<0.10	10.3	<0.20
22	VACCMEM-04	Plant	197	<0.010	0.029	101	<0.010	<0.010	25.6	0.0943	5470	0.0080	0.064	0.063	5.41	58.2	0.059	<0.50	2340	1150	0.045	2.28	1750	7310	3.39	<0.050	<20	5.84	<0.020	<0.0020	<0.10	0.0032	0.13	21.2	<0.20
22	VACCMEM-04	Berries	26.2	<0.010	<0.020	19.1	<0.010	<0.010	9.3	0.0208	1330	<0.0050	<0.050	<0.020	4.31	13.8	<0.020	<0.50	895	120	0.213	0.46	1620	7430	5.57	<0.050	<20	1.17	<0.020	<0.0020	0.66	<0.0020	<0.10	7.55	<0.20
40	VACCMEM-05	Plant	138	0.016	0.051	80.1	<0.010	<0.010	19.3	0.145	4850	0.0115	0.224	0.088	4.26	73.4	0.113	<0.50	1430	1550	0.221	2.48	1650	6870	3.60	0.120	25	5.66	<0.020	0.0068	<0.10	0.0088	0.30	20.3	0.32
51	VACCMEM-06	Plant	456	0.04	0.164	92.3	0.032	<0.010	26.6	0.431	5040	0.0427	0.484	0.364	5.57	336	0.946	<0.50	1330	1570	0.175	3.97	1480	7330	4.65	0.165	20	8.01	<0.020	0.0108	<0.10	0.0364	1.28	36.1	0.35

Six foliage/branch tip samples were collected from all fruit-bearing shrub species between 2017 and 2019 sampling events. However, due to a lack of available berry tissue found throughout the LSA at the time of sampling, six berry samples were not collected from all fruit-bearing shrubs. Only five berry samples were collected from rose and thimbleberry; three berry samples from Saskatoon; and two berry samples from huckleberry. The differences in sample size are accounted for in the two-tailed, unequal variance t-test between fruit (e.g., berries) and foliage/branch tips (Table 4-9). Species that do not produce berries (beaked sedge, horsetail, black cottonwood, and willow species) cannot be analyzed in the same manner and as such, were compared using the mean and standard deviation of their metal concentrations (Table 4-10).

Among the fruit-bearing shrubs, the majority of metal concentrations found within the berries were equal to or less than metal concentrations in the foliage/branch tips (Table 4-9). However, tin concentrations in thimbleberry, elderberry, soopolallie, and black huckleberry berries were found to have higher concentrations than the foliage/branch tips. Additionally, the berries of Saskatoon were found to have higher concentrations of arsenic, boron, cobalt and potassium than the foliage/branch tips. Concentrations of all metal parameters between the rosehips and foliage/branch tips of the rose species collected were not found to differ significantly.

Table 4-9 Average \pm standard deviation of metal levels in plant tissue (mg/kg) collected from fruit-bearing shrubs throughout the LSA. Statistical significance between foliage/branch tips and berries of shrubs is presented. (\downarrow) and (\uparrow) indicates berries had metal levels significantly less or greater than the foliage/branch tips, (-) indicates no significant difference, (=) indicates that average concentrations were found to be equal.

Metals	Saskatoon (<i>Amelanchier alnifolia</i>)			Rose species (<i>Rosa</i> sp.)			Thimbleberry (<i>Rubus parviflorus</i>)			Elderberry (<i>Sambucus racemosa</i> var. <i>melanocarpa</i>)			Soopolallie (<i>Shepherdia canadensis</i>)			Black huckleberry (<i>Vaccinium membranaceum</i>)		
	Fruit	t-test	Foliage/ branch tips	Fruit	t-test	Foliage/ branch tips	Fruit	t-test	Foliage/ branch tips	Fruit	t-test	Foliage/ branch tips	Fruit	t-test	Foliage/ branch tips	Fruit	t-test	Foliage/ branch tips
Aluminum (Al)	14.5 \pm 4.7	\downarrow	27.0 \pm 8.0	52.6 \pm 65.4	-	43.7 \pm 22.8	15.1 \pm 10.2	\downarrow	57.5 \pm 40.5	12.1 \pm 7.5	\downarrow	41.6 \pm 12.6	12.6 \pm 9.7	\downarrow	49.4 \pm 16.8	28.2 \pm 2.8	\downarrow	204.8 \pm 127.0
Antimony (Sb)	0.03 \pm 0.01	-	0.01 \pm 0.00	0.02 \pm 0.01	-	0.01 \pm 0.01	0.01 \pm 0.00	-	0.01 \pm 0.00	0.01 \pm 0.01	-	0.01 \pm 0.00	0.01 \pm 0.00	-	0.01 \pm 0.00	0.01 \pm 0.00	-	0.02 \pm 0.01
Arsenic (As)	0.04 \pm 0.02	\uparrow	0.02 \pm 0.00	0.04 \pm 0.03	-	0.04 \pm 0.02	0.02 \pm 0.00	-	0.03 \pm 0.01	0.02 \pm 0.00	-	0.05 \pm 0.03	0.02 \pm 0.00	\downarrow	0.04 \pm 0.01	0.02 \pm 0.00	-	0.06 \pm 0.05
Barium (Ba)	16.8 \pm 11.3	-	223.8 \pm 75.4	22.2 \pm 20.9	-	16.8 \pm 11.3	8.1 \pm 5.2	\downarrow	36.5 \pm 18.7	89.2 \pm 64.9	-	217.0 \pm 146.3	2.4 \pm 1.9	\downarrow	20.9 \pm 23.7	15.1 \pm 5.7	\downarrow	95.6 \pm 34.6
Beryllium (Be)	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	-	0.01 \pm 0.01	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	-	0.01 \pm 0.01
Bismuth (Bi)	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00	0.01 \pm 0.00	=	0.01 \pm 0.00
Boron (B)	25.9 \pm 2.2	\uparrow	19.4 \pm 4.4	22.6 \pm 7.7	-	22.5 \pm 5.3	11.7 \pm 2.6	\downarrow	41.6 \pm 12.0	18.7 \pm 4.8	\downarrow	42.9 \pm 12.7	12.9 \pm 2.2	\downarrow	18.7 \pm 5.0	8.4 \pm 1.3	\downarrow	20.6 \pm 4.4
Cadmium (Cd)	0.0936 \pm 0.0840	-	0.1213 \pm 0.0647	0.0292 \pm 0.0315	-	0.0263 \pm 0.0217	0.0076 \pm 0.0043	-	0.0359 \pm 0.0502	0.0067 \pm 0.0026	\downarrow	0.0151 \pm 0.0059	0.0157 \pm 0.0068	\downarrow	0.0335 \pm 0.0121	0.0218 \pm 0.0013	-	0.1390 \pm 0.1475
Calcium (Ca)	6830 \pm 1360	\downarrow	14000 \pm 2807	10046 \pm 6039	-	10468 \pm 3630	5868 \pm 1293	\downarrow	16767 \pm 2757	5023 \pm 2353	\downarrow	15450 \pm 5858	1000 \pm 143	\downarrow	6662 \pm 1421	1405 \pm 106	\downarrow	4877 \pm 492
Cesium (Cs)	0.0052 \pm 0.0004	-	0.0053 \pm 0.0007	0.0098 \pm 0.0069	-	0.0087 \pm 0.0031	0.0059 \pm 0.0016	-	0.0117 \pm 0.0067	0.0112 \pm 0.0074	-	0.0129 \pm 0.0033	0.0052 \pm 0.0004	\downarrow	0.0097 \pm 0.0027	0.0161 \pm 0.0157	-	0.0177 \pm 0.0130
Chromium (Cr)	0.085 \pm 0.060	-	0.064 \pm 0.017	0.118 \pm 0.110	-	0.112 \pm 0.058	0.053 \pm 0.007	\downarrow	0.480 \pm 0.197	0.056 \pm 0.013	\downarrow	0.133 \pm 0.073	0.094 \pm 0.079	-	0.188 \pm 0.078	0.050 \pm 0.000	-	0.183 \pm 0.160
Cobalt (Co)	0.041 \pm 0.005	\uparrow	0.029 \pm 0.004	0.035 \pm 0.026	-	0.032 \pm 0.011	0.023 \pm 0.005	-	0.043 \pm 0.028	0.027 \pm 0.012	\downarrow	0.046 \pm 0.010	0.022 \pm 0.004	\downarrow	0.054 \pm 0.009	0.020 \pm 0.000	-	0.137 \pm 0.112
Copper (Cu)	6.11 \pm 1.59	-	4.42 \pm 0.83	4.49 \pm 1.23	-	4.30 \pm 1.12	5.71 \pm 1.14	-	4.79 \pm 1.05	3.42 \pm 2.08	-	3.40 \pm 1.63	2.95 \pm 0.67	-	2.67 \pm 0.73	4.83 \pm 0.74	-	5.37 \pm 0.62
Iron (Fe)	37.9 \pm 1.3	\downarrow	70.2 \pm 13.8	79.3 \pm 79.4	-	73.0 \pm 17.2	30.5 \pm 11.2	\downarrow	104.6 \pm 40.5	43.2 \pm 20.5	\downarrow	98.2 \pm 16.2	33.0 \pm 9.2	\downarrow	107.0 \pm 26.4	17.2 \pm 4.7	-	119.6 \pm 106.6
Lead (Pb)	0.023 \pm 0.005	\downarrow	0.042 \pm 0.016	0.063 \pm 0.068	-	0.059 \pm 0.034	0.021 \pm 0.002	\downarrow	0.079 \pm 0.025	0.026 \pm 0.009	\downarrow	0.070 \pm 0.021	0.024 \pm 0.007	\downarrow	0.106 \pm 0.022	0.020 \pm 0.000	-	0.243 \pm 0.345
Lithium (Li)	0.5 \pm 0.0	=	0.5 \pm 0.0	0.5 \pm 0.0	=	0.5 \pm 0.0	0.5 \pm 0.0	=	0.5 \pm 0.0	0.5 \pm 0.0	=	0.5 \pm 0.0	0.5 \pm 0.0	=	0.5 \pm 0.0	0.5 \pm 0.0	=	0.5 \pm 0.0
Magnesium (Mg)	2553 \pm 898	-	3302 \pm 704	3058 \pm 1052	-	3280 \pm 925	2626 \pm 498	\downarrow	6495 \pm 1232	2367 \pm 1282	-	3167 \pm 512	546 \pm 89	\downarrow	1707 \pm 435	963 \pm 95	\downarrow	1800 \pm 468
Manganese (Mn)	56.7 \pm 37.2	-	91.9 \pm 61.1	58.2 \pm 41.2	-	52.3 \pm 25.2	18.2 \pm 4.4	\downarrow	56.7 \pm 17.6	36.9 \pm 18.1	-	174.5 \pm 169.6	11.1 \pm 1.7	\downarrow	25.2 \pm 8.8	196.5 \pm 108.2	\downarrow	1439.5 \pm 451.6
Molybdenum (Mo)	1.983 \pm 0.465	-	2.655 \pm 2.422	1.433 \pm 0.648	-	3.230 \pm 4.227	0.681 \pm 0.336	-	2.010 \pm 2.656	0.394 \pm 0.283	-	0.706 \pm 0.458	2.113 \pm 0.973	-	2.020 \pm 2.469	0.166 \pm 0.067	-	0.120 \pm 0.070
Nickel (Ni)	1.24 \pm 1.08	-	0.47 \pm 0.24	0.50 \pm 0.19	-	2.48 \pm 4.62	0.29 \pm 0.06	-	0.74 \pm 0.77	1.61 \pm 1.37	-	2.00 \pm 2.71	2.31 \pm 1.03	-	1.52 \pm 0.98	0.57 \pm 0.15	\downarrow	2.09 \pm 1.08
Phosphorus (P)	3087 \pm 511	-	4517 \pm 1954	3242 \pm 1335	-	3687 \pm 1903	2900 \pm 544	\downarrow	5002 \pm 922	4373 \pm 1689	-	3037 \pm 1279	1863 \pm 312	-	1520 \pm 370	1795 \pm 247	-	1710 \pm 177
Potassium (K)	15833 \pm 1922	\uparrow	11850 \pm 1303	11240 \pm 650	-	11750 \pm 756	8134 \pm 1721	\downarrow	16783 \pm 4202	21433 \pm 4909	\downarrow	37600 \pm 6971	10187 \pm 1077	-	11175 \pm 3674	7575 \pm 205	-	7117 \pm 881
Rubidium (Rb)	2.46 \pm 0.54	-	1.87 \pm 2.02	2.81 \pm 1.57	-	2.60 \pm 1.52	4.85 \pm 3.63	-	5.59 \pm 3.64	11.78 \pm 8.00	-	10.58 \pm 4.83	6.68 \pm 5.80	-	5.65 \pm 3.88	13.69 \pm 11.48	-	5.81 \pm 2.85
Selenium (Se)	0.104 \pm 0.093	-	0.140 \pm 0.072	0.244 \pm 0.207	-	0.252 \pm 0.209	0.079 \pm 0.042	-	0.223 \pm 0.303	0.050 \pm 0.000	-	0.050 \pm 0.000	0.260 \pm 0.156	-	0.281 \pm 0.221	0.050 \pm 0.000	-	0.081 \pm 0.050
Sodium (Na)	25 \pm 8	-	20 \pm 0	20 \pm 0	-	20 \pm 0	20 \pm 0	-	21 \pm 3	20 \pm 0	=	20 \pm 0	20 \pm 0	=	20 \pm 0	20 \pm 0	-	21 \pm 2
Strontium (Sr)	11.7 \pm 3.3	-	25.5 \pm 7.3	18.2 \pm 14.3	-	15.3 \pm 5.4	5.7 \pm 3.0	-	25.8 \pm 20.9	9.0 \pm 6.7	\downarrow	24.1 \pm 10.0	1.2 \pm 0.6	\downarrow	9.3 \pm 5.6	1.3 \pm 0.2	\downarrow	5.2 \pm 1.7
Tellurium (Te)	0.02 \pm 0.00	=	0.02 \pm 0.00	0.02 \pm 0.00	=	0.02 \pm 0.00	0.02 \pm 0.00	=	0.02 \pm 0.00	0.02 \pm 0.00	=	0.02 \pm 0.00	0.02 \pm 0.00	=	0.02 \pm 0.00	0.02 \pm 0.00	=	0.02 \pm 0.00
Thallium (Tl)	0.0020 \pm 0.0000	-	0.0025 \pm 0.0007	0.0023 \pm 0.0007	-	0.0022 \pm 0.0005	0.0020 \pm 0.0000	-	0.0024 \pm 0.0007	0.0020 \pm 0.0000	-	0.0091 \pm 0.0093	0.0020 \pm 0.0000	-	0.0069 \pm 0.0050	0.0020 \pm 0.0000	\downarrow	0.0061 \pm 0.0033
Tin (Sn)	0.2 \pm 0.2	-	0.1 \pm 0.0	0.1 \pm 0.0	-	0.1 \pm 0.0	0.4 \pm 0.2	\uparrow	0.1 \pm 0.0	0.3 \pm 0.1	\uparrow	0.1 \pm 0.0	0.4 \pm 0.2	\uparrow	0.1 \pm 0.0	0.7 \pm 0.0	\uparrow	0.1 \pm 0.0
Uranium (U)	0.0023 \pm 0.0006	-	0.0027 \pm 0.0007	0.0040 \pm 0.0031	-	0.0085 \pm 0.0096	0.0021 \pm 0.0003	\downarrow	0.0051 \pm 0.0019	0.0022 \pm 0.0005	\downarrow	0.0070 \pm 0.0045	0.0021 \pm 0.0001	\downarrow	0.0071 \pm 0.0017	0.0020 \pm 0.0000	-	0.0116 \pm 0.0123
Vanadium (V)	0.11 \pm 0.01	-	0.12 \pm 0.03	0.20 \pm 0.16	-	0.20 \pm 0.12	0.11 \pm 0.02	-	0.21 \pm 0.11	0.11 \pm 0.02	-	0.19 \pm 0.08	0.10 \pm 0.00	\downarrow	0.27 \pm 0.04	0.10 \pm 0.00	-	0.43 \pm 0.42
Zinc (Zn)	33.4 \pm 8.9	-	46.6 \pm 13.8	12.6 \pm 4.5	-	13.0 \pm 2.0	14.3 \pm 4.0	\downarrow	16.7 \pm 5.9	20.9 \pm 11.7	\downarrow	37.7 \pm 6.1	9.1 \pm 2.5	-	9.0 \pm 1.9	8.9 \pm 1.9	\downarrow	28.6 \pm 6.9
Zirconium (Zr)	0.3 \pm 0.2	-	0.2 \pm 0.0	0.2 \pm 0.0	-	0.2 \pm 0.0	0.2 \pm 0.0	-	0.2 \pm 0.0	0.2 \pm 0.0	-	0.2 \pm 0.0	0.2 \pm 0.0	-	0.2 \pm 0.0	0.2 \pm 0.0	-	0.2 \pm 0.1

Table 4-10 Average \pm standard deviation of metal levels in plant tissue collected from non-fruit-bearing species throughout the LSA. Highest (■) and lowest (■) concentrations (mg/kg) are also indicated per species.

Metals	Beaked sedge (<i>Carex utriculata</i>)	Common horsetail (<i>Equisetum arvense</i>)	Black cottonwood (<i>Populus balsamifera</i> subsp. <i>trichocarpa</i>)	Willow species (<i>Salix</i> sp.)
Aluminum (Al)	43.3 \pm 47.5	41.3 \pm 28.8	23.8 \pm 10.7	33.9 \pm 19.1
Antimony (Sb)	0.01 \pm 0.00	0.010 \pm 0.000	0.013 \pm 0.008	0.012 \pm 0.005
Arsenic (As)	0.096 \pm 0.99	0.035 \pm 0.017	0.027 \pm 0.010	0.036 \pm 0.019
Barium (Ba)	43.4 \pm 16.3	49.9 \pm 29.3	57.8 \pm 51.8	26.7 \pm 14.5
Beryllium (Be)	0.01 \pm 0.00	0.01 \pm 0.00	0.01 \pm 0.00	0.01 \pm 0.00
Bismuth (Bi)	0.01 \pm 0.00	0.01 \pm 0.00	0.01 \pm 0.00	0.01 \pm 0.00
Boron (B)	15.0 \pm 5.4	27.3 \pm 6.7	31.3 \pm 8.1	28.3 \pm 15.6
Cadmium (Cd)	0.0329 \pm 0.0358	0.253 \pm 0.150	1.606 \pm 0.623	1.927 \pm 1.528
Calcium (Ca)	5023 \pm 1214	23183 \pm 3766	18317 \pm 4538	12850 \pm 5297
Cesium (Cs)	0.044 \pm 0.038	0.0443 \pm 0.0203	0.0091 \pm 0.0033	0.0141 \pm 0.0109
Chromium (Cr)	0.089 \pm 0.063	0.094 \pm 0.059	0.072 \pm 0.026	0.089 \pm 0.037
Cobalt (Co)	0.063 \pm 0.045	0.165 \pm 0.239	0.240 \pm 0.157	0.329 \pm 0.198
Copper (Cu)	3.33 \pm 1.93	3.26 \pm 0.62	3.74 \pm 1.47	3.89 \pm 1.65
Iron (Fe)	105.6 \pm 77.9	65.1 \pm 23.7	48.0 \pm 19.9	71.9 \pm 28.2
Lead (Pb)	0.049 \pm 0.026	0.108 \pm 0.125	0.054 \pm 0.016	0.055 \pm 0.032
Lithium (Li)	0.86 \pm 0.75	0.5 \pm 0.0	0.51 \pm 0.02	0.5 \pm 0.0
Magnesium (Mg)	1406 \pm 300	5112 \pm 1926	2822 \pm 606	3214 \pm 1190
Manganese (Mn)	195.9 \pm 92.0	22.4 \pm 13.3	29.8 \pm 10.1	73.5 \pm 32.7
Molybdenum (Mo)	1.032 \pm 0.598	1.007 \pm 0.846	0.202 \pm 0.172	0.321 \pm 0.262
Nickel (Ni)	0.59 \pm 0.60	0.47 \pm 0.13	1.16 \pm 0.52	2.18 \pm 2.19
Phosphorus (P)	1818 \pm 700	2790 \pm 908	2010 \pm 319	2816 \pm 637
Potassium (K)	18450 \pm 3101	24033 \pm 4996	11853 \pm 4337	10739 \pm 3966
Rubidium (Rb)	14.45 \pm 12.34	18.37 \pm 10.19	4.06 \pm 2.23	5.73 \pm 3.71
Selenium (Se)	0.240 \pm 0.267	1.120 \pm 0.581	0.365 \pm 0.503	0.67 \pm 0.99
Sodium (Na)	48 \pm 48	28 \pm 18	20 \pm 0	20 \pm 0
Strontium (Sr)	29.2 \pm 19.4	34.7 \pm 29.2	35.5 \pm 12.4	59.8 \pm 90.8
Tellurium (Te)	0.02 \pm 0.00	0.02 \pm 0.00	0.02 \pm 0.00	0.02 \pm 0.00
Thallium (Tl)	0.0037 \pm 0.0020	0.0056 \pm 0.0025	0.0029 \pm 0.0016	0.0061 \pm 0.0084
Tin (Sn)	0.1 \pm 0.0	0.1 \pm 0.0	0.1 \pm 0.0	0.1 \pm 0.0
Uranium (U)	0.00545 \pm 0.00319	0.0055 \pm 0.0032	0.0032 \pm 0.0019	0.0045 \pm 0.0036
Vanadium (V)	0.17 \pm 0.10	0.20 \pm 0.12	0.13 \pm 0.05	0.20 \pm 0.17
Zinc (Zn)	37.5 \pm 11.0	28.4 \pm 8.7	120.1 \pm 33.2	127.4 \pm 54.3
Zirconium (Zr)	0.22 \pm 0.05	0.20 \pm 0.00	0.20 \pm 0.00	0.20 \pm 0.00

4.2 PAH

4.2.1 Soil Samples

The COAs (L1970983, L19778617 and L1974841), provided by ALS Environmental, showing PAH concentrations in the collected soil samples are presented in Appendix 4. In total, seven soil samples were submitted for PAH analysis, following the first chronological sample submission procedure discussed in Section 3.2 (Figure 4-3). Soil from sample location 4 was associated with both willow and black cottonwood vegetation samples (SALIX-01 and POPUBAL-01), as both species were found growing on the soil that was sampled. A representative soil sample for common horsetail was not submitted in error as the first horsetail vegetation sample was associated with POPUBAL-03 (the third black cottonwood) soil sample. However, common horsetail grows alongside beaked sedge at soil sample location 24 (CAREX-01), at which PAH concentrations were analyzed. A representative soopolallie sample (SHEPCAN-01) was also not submitted in error.

Of the 18 PAH parameters analyzed, 14 of the parameters exhibited concentrations below the detection limits for all submissions (Table 4-11, Appendix 4). Additionally, both the B[a]P TPE and the IACR parameters were below the detection limit for all soil samples, demonstrating low carcinogenic risk to humans having direct contact with soil within the LSA (CCME, 2010).

All soil samples for the Benzo(b&j)fluoranthene parameter were found to contain concentrations below the detection limit (0.010 mg/kg; Table 4-11) with one exception. One mesic organic soil sample (sample 4) collected within an organic soil unit on the east side of Alexander Creek, north of Highway #3, was slightly above the detection limit with a concentration of 0.011 mg/kg. The residential/parkland guideline maximum is 1.0 mg/kg for the Benzo(b&j)fluoranthene parameter (CCME, 2010); this sample value is below the guideline level by a hundred-fold. Further the provincial guideline for wildlands natural threshold value is 0.65 mg/kg. This sample also exhibited the highest concentrations in the 2-methylaphthalene and Naphthalene parameters, at 0.040 mg/kg and 0.013 mg/kg, respectively. At present, CCME does not have soil quality guidelines for 2-methylaphthalene; the provincial guidelines also lack sufficient data to determine a threshold value for the protection of ecological health. The provincial threshold for the protection of human health is 100 mg/kg for 2-Methylnaphthalene (CSR, 2019).

One other sample submitted for PAH analysis yielded results above the detection limit; the soil sample collected near an exposed coal seam northwest of the summit of Crown Mountain (sample 1). The soil sample exhibited the highest concentration for the Phenanthrene parameter at 0.053 mg/kg. The environmental health guidelines (CCME, 2010) indicate that the maximum acceptable Phenanthrene concentration for residential/parkland is 0.046 mg/kg; however, this value represents the soil quality guideline for the protection of freshwater life. The value may be used for terrestrial soil quality where potential impacts to nearby surface water is a concern. Where is no potential risk to freshwater, the

threshold for Phenanthrene is 43.0 mg/kg⁶. The same applies to Naphthalene; where risk to freshwater exists, the threshold is 0.013 mg/kg, in the absence of risk to freshwater the threshold is 8.8 mg/kg. Provincially, only a guideline for Phenanthrene exists (3 mg/kg for the protection of ecological health; CSR, 2019).

Detection limits were raised for two samples (VACCMEM-01 and SALIX-01) due to co-eluting interference.

⁶ This guideline is considered provisional (CCME, 2010).

Table 4-11 Summary of PAH data analysis for soil samples. Samples with highest (■) concentrations (mg/kg) are indicated. Raised detection limits (□) are also indicated.

Sample Location #	Sample Name	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b&j)fluoranthene	Benzo(b+j+k)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	2-Methylnaphthalene	Naphthalene	Phenanthrene	Pyrene	B(a)p Total Potency Equivalent	IACR (CCME)	
3	AMELALN-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	<0.010	<0.015	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.15
24	CAREX-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	<0.010	<0.015	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	0.024	<0.010	0.025	<0.010	<0.020	<0.15	
13	ROSA-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	<0.010	<0.015	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	0.025	<0.010	0.020	<0.010	<0.020	<0.15	
6	RUBUPAR-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	<0.010	<0.015	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.15	
4	SALIX-01/POPUBAL-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	0.011	<0.015	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.050	<0.010	0.040	0.013	0.036	<0.010	<0.020	<0.15	
16	SAMBCAE-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	<0.010	<0.015	<0.010	<0.010	<0.010	<0.0050	<0.010	<0.010	<0.010	0.032	0.010	0.029	<0.010	<0.020	<0.15	
1	VACCMEM-01	<0.0050	<0.0050	<0.0040	<0.010	<0.010	<0.010	<0.015	<0.010	<0.010	<0.020	<0.0050	<0.010	<0.010	<0.010	<0.010	0.010	0.053	<0.010	<0.020	<0.15	

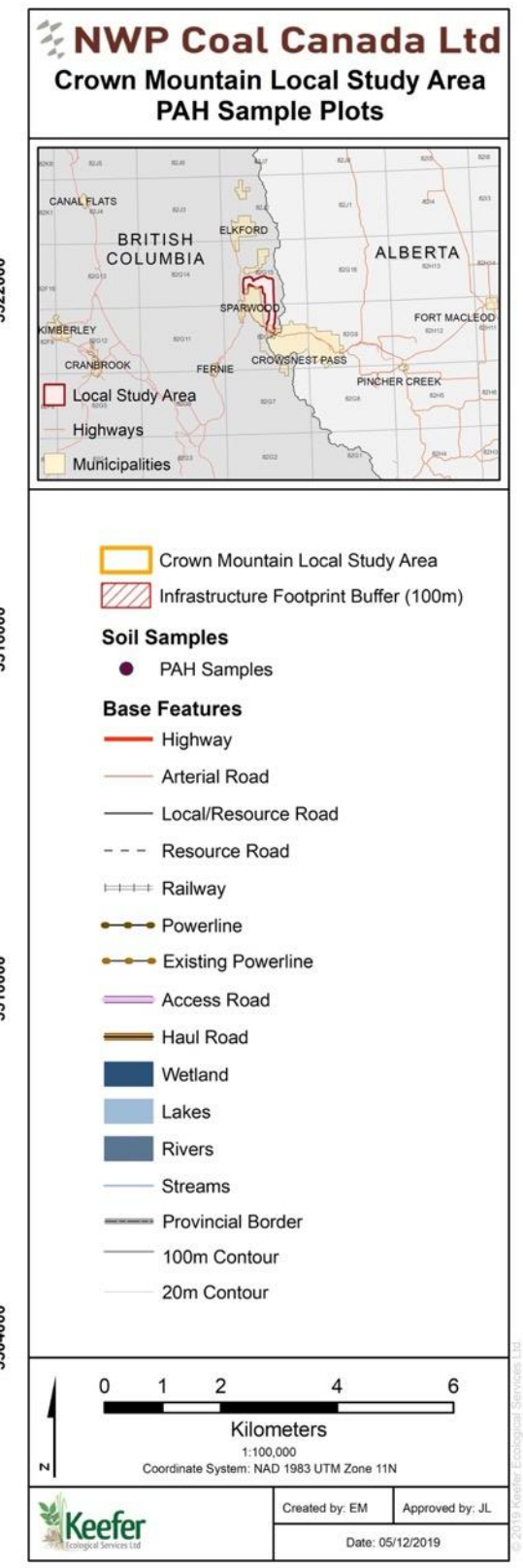
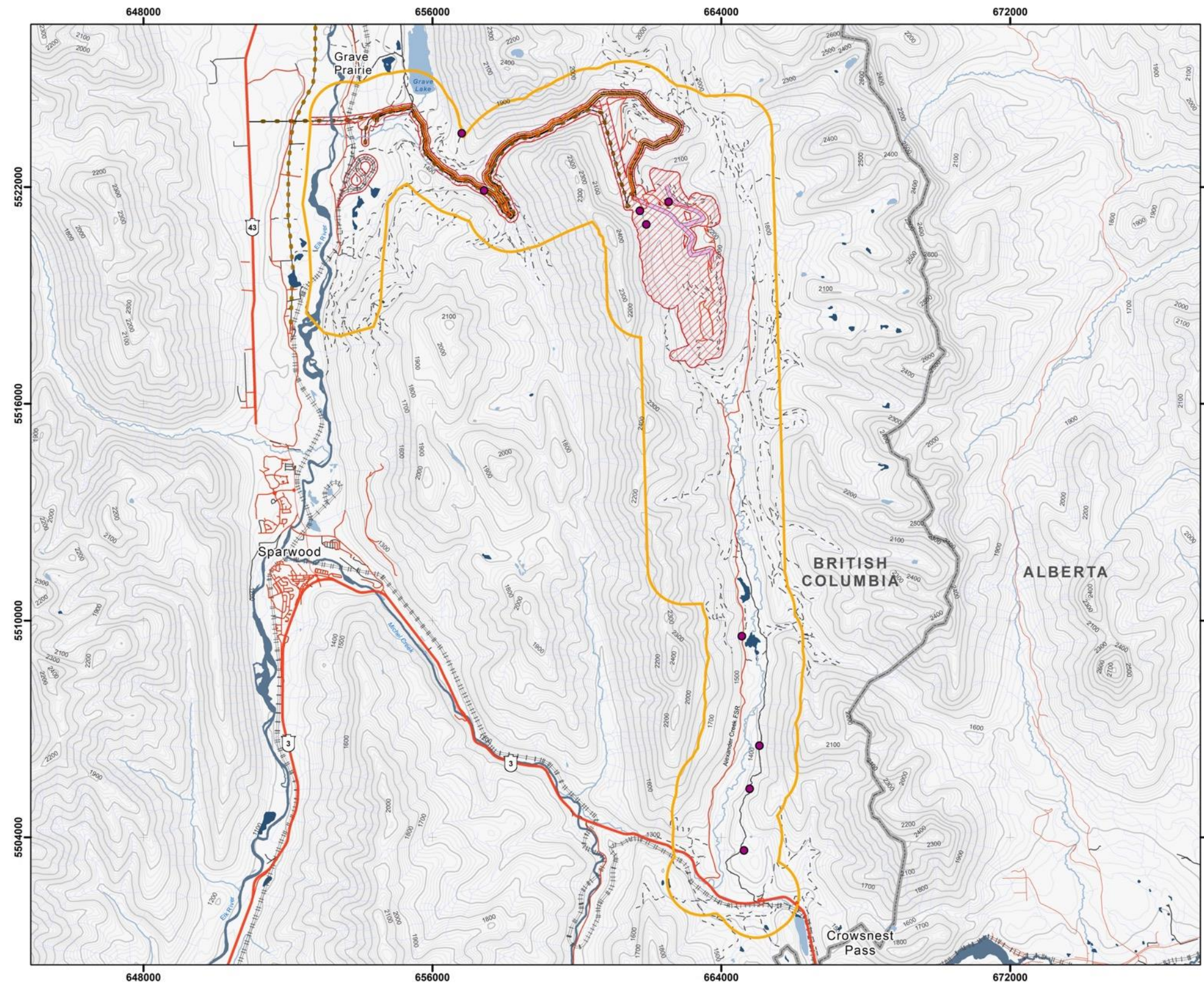


Figure 4-3. Sample locations for soil and vegetation samples submitted for PAH analysis.

4.2.2 Vegetation

The COAs (L1970983, L19778617 and L1974841), provided by ALS Environmental, showing PAH concentrations in vegetation samples collected is presented in Appendix 4. One plant tissue sample was submitted for PAH analysis for each species (Figure 4-3). In addition to the foliage/branch tip tissue samples submitted, berries were also submitted for PAH analysis for Saskatoon, rose, thimbleberry, elderberry and soopolallie. PAH analysis of the fruit of black huckleberry was not conducted as the poor berry crop prevented enough berries to be collected for analysis.

In total, 15 vegetation samples were submitted for PAH analysis (Table 4-12). 2-methylnaphthalene, Naphthalene, and Phenanthrene were the only parameters of the 17 analyzed that had resultant concentrations above the detection limit (Table 4-12). A black huckleberry tissue sample (sample 1) collected near an exposed coal seam northwest of the summit of Crown Mountain had the highest concentrations for 2-methylnaphthalene (0.156 mg/kg), Naphthalene (0.054 mg/kg), and Phenanthrene (0.095 mg/kg) parameters.

Statistical analysis was not completed for the PAH analytical results for vegetation samples as only a single sample was collected for each plant species and tissue type submitted. Alternatively, a direct comparison between the single samples of foliage/branch tips and berries of fruit-bearing shrub species was performed in place of statistical analysis (Table 4-13). The concentrations of all parameters, excluding 2-methylnaphthalene and Phenanthrene, did not differ between the foliage/branch tips and berries as all concentrations were below the corresponding detection limit. Concentration of 2-methylnaphthalene was greater in the foliage/branch tips than berries in the rose and black elderberry samples, as was Phenanthrene concentrations.

Detection limits were raised in cases where samples had insufficient volume, high moisture content, or high organic content, the detection limit was raised on a per-sample basis in the analytical laboratory⁷.

⁷ See *Detection limit policies: Reducing the chance of false positives due to sample-specific issues*. Retrieved from <http://www.alsglobal.com>

Table 4-12 Summary of PAH data analysis for vegetation samples (dry weight). Samples with highest concentrations (■) are indicated. Raised detection limits (■) are also indicated. (■) is used to indicate where the highest concentration is above a raised detection limit.

Sample Location #	Sample Name	Tissue Type	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b&j)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	2-Methylnaphthalene	Naphthalene	Phenanthrene	Pyrene
3	AMELALN-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.080	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
3	AMELALN-01	Berries	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
24	CAREX-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
20	EQUIARV-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	<0.050
4	POPUBAL-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
13	ROSA-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.092	<0.050	<0.050	<0.050
13	ROSA-01	Berries	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
6	RUBUPAR-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
6	RUBUPAR-01	Berries	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
4	SALIX-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
16	SAMBCAE-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.078	<0.050	0.052	<0.050
16	SAMBCAE-01	Berries	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.058	<0.050	<0.050	<0.050
10	SHEPCAN-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
10	SHEPCAN-01	Berries	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
1	VACCMEM-01	Plant	<0.050	<0.050	<0.050	<0.050	<0.050	<0.090	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.156	0.054	0.095	<0.050

Table 4-13 Comparison of PAH concentrations between foliage/branch tips and fruit (dry weight). Samples with highest (■) concentrations (mg/kg) are indicated. Raised detection limits (□) are also indicated.

PAH Parameter	Saskatoon (<i>Amelanchier alnifolia</i>)		Rose species (<i>Rosa</i> sp.)		Thimbleberry (<i>Rubus parviflorus</i>)		Elderberry (<i>Sambucus racemosa</i> var. <i>melanocarpa</i>)		Soopolallie (<i>Shepherdia canadensis</i>)	
	Foliage/ Branch Tips	Berries	Foliage/ Branch Tips	Berries	Foliage/ Branch Tips	Berries	Foliage/ Branch Tips	Berries	Foliage/ Branch Tips	Berries
Acenaphthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Acenaphthylene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Anthracene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(a)anthracene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(a)pyrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(b&j)fluoranthene	<0.080	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(g,h,i)perylene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(k)fluoranthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chrysene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Dibenz(a,h)anthracene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Fluoranthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Fluorene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Indeno(1,2,3-c,d)pyrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-Methylnaphthalene	<0.050	<0.050	0.092	<0.050	<0.050	<0.050	0.078	0.058	<0.050	<0.050
Naphthalene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phenanthrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	<0.050
Pyrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

4.3 Quality Assurance/Quality Control

In total, four field samples were submitted to ALS Environmental for QA/QC purposes for metal concentrations; beaked sedge foliage, rose foliage/branch tips and fruit, elderberry foliage/branch tips and fruit, soopolallie foliage/branch tips and fruit (Table 4-15). In addition, three field samples were submitted to ALS Environmental for QA/QC purposes for PAH; rose foliage/branch tips and fruit, elderberry foliage/branch tips and fruit, and soopolallie foliage/branch tips and fruit (Table 4-15). All QA/QC field samples are presented in Figure 4-4. ALS Environmental performs internal QA/QC, which is contained within each COA (Appendix 4).

Further analysis was conducted on these samples to satisfy the RPD requirement in the BC MWLAP sampling protocols (2013). The results of the RPD calculations are presented in Table 4-14.

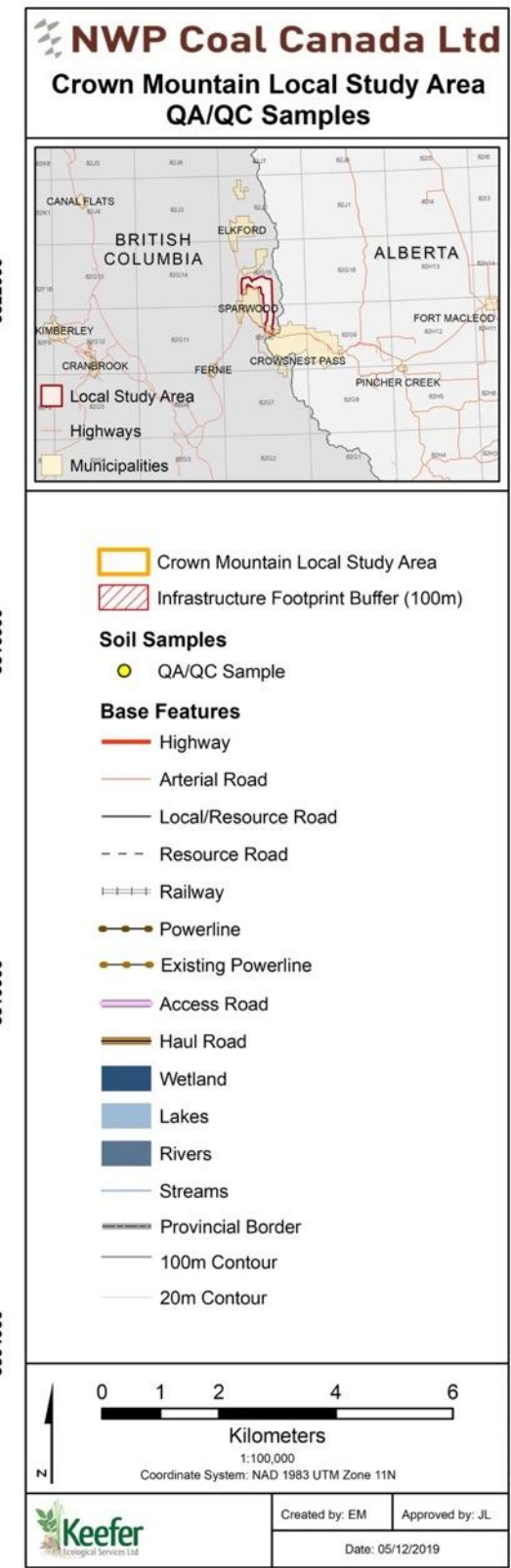
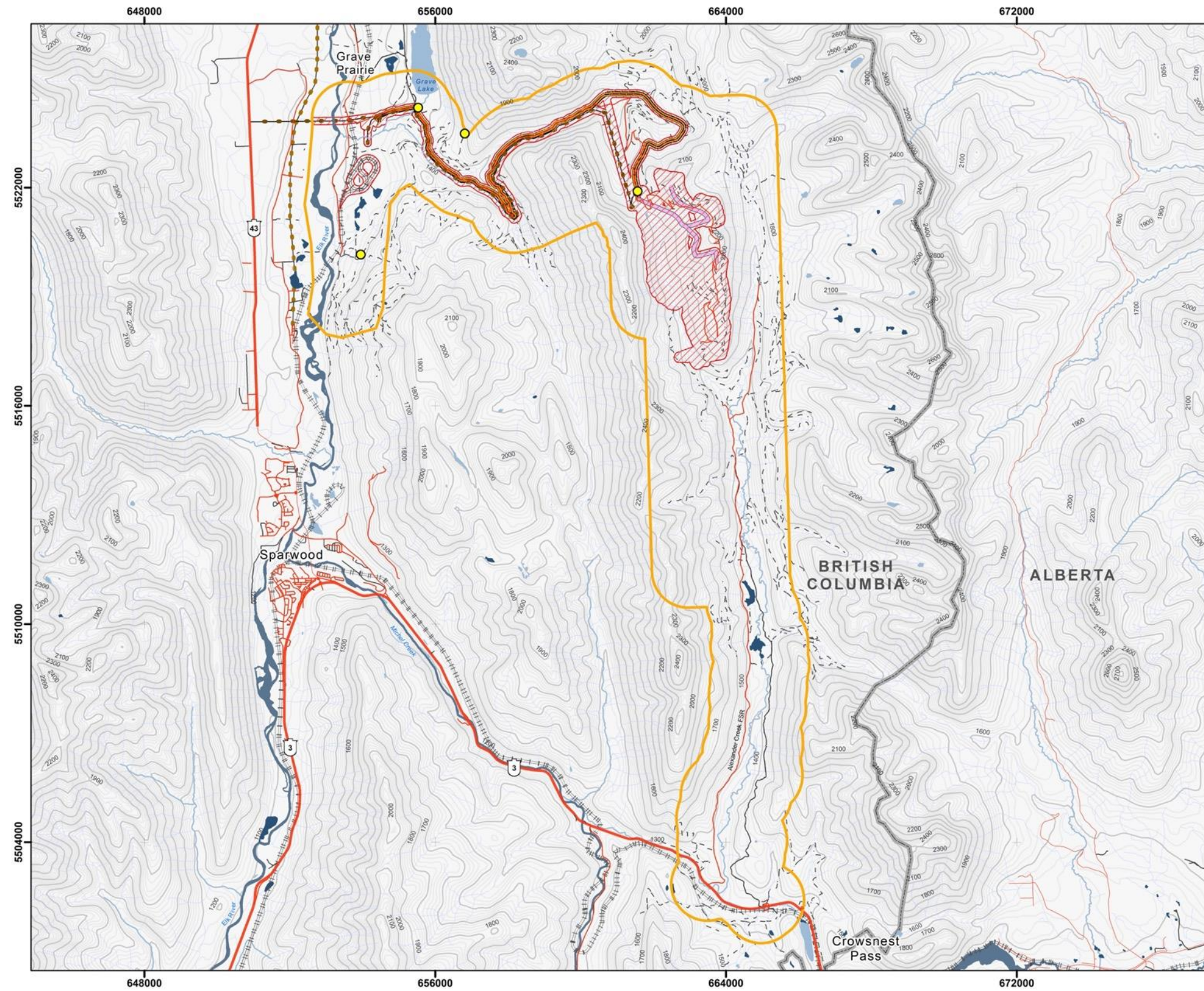


Figure 4-4. Sample locations for foliage/branch tip and fruit samples submitted for QA/QC purposes.

Table 4-14 Summary of metal concentrations (mg/kg) and RPD (%) calculations for QA/QC samples. Exceedances of 30% for vegetation are indicated (■).

	Shepcan-02		Shepcan-QA			Shepcan-02		Shepcan-QA			Rosa-01		Rosa-QA			Rosa-01		Rosa-QA			Carex-05		Carex-QA			Sambcae-03		Sambcae-QA			Sambcae-03		Sambcae-QA						
Metal Parameter	Foliage/ branch tips	Foliage/ branch tips	RPD	Fruit	Fruit	RPD	Foliage/ branch tips	Foliage/ branch tips	RPD	Fruit	Fruit	RPD	Foliage	Foliage	RPD	Foliage/ branch tips	Foliage/ branch tips	RPD	Fruit	Fruit	RPD	Foliage	Foliage	RPD	Foliage/ branch tips	Foliage/ branch tips	RPD	Fruit	Fruit	RPD									
Aluminum (Al)	45.4	85.6	61.4	13.8	11.7	16.5	44.0	33.3	27.7	9.4	7.3	25.1	20.8	28.1	29.9	43.6	49.9	13.5	9.5	9.1	4.3																		
Antimony (Sb)	0.013	0.01	26.1	0.013	0.01	26.1	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0																		
Arsenic (As)	0.039	0.057	37.5	0.02	0.02	0.0	0.049	0.031	45.0	0.02	0.02	0.0	0.039	0.063	47.1	0.02	0.033	49.1	0.02	0.02	0.0																		
Barium (Ba)	67.3	13.5	133.2	5.70	2.26	86.4	12.5	12.5	0.0	3.89	4.50	14.5	30.7	27.0	12.8	304	1920	145.3	176	66.7	90.1																		
Beryllium (Be)	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.016	0.015	6.5	0.01	0.01	0.0																		
Bismuth (Bi)	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0																		
Boron (B)	25.4	12.9	65.3	12.0	12.2	1.7	28.6	30.8	7.4	18.1	17.3	4.5	27.2	17.2	45.0	48.2	58.8	19.8	20.2	21.7	7.2																		
Cadmium (Cd)	0.0164	0.0326	66.1	0.005	0.0326	146.8	0.0297	0.0230	25.4	0.0092	0.0092	0.0	0.0079	0.0075	5.2	0.0102	0.0088	14.7	0.005	0.005	0.0																		
Calcium (Ca)	7270	7690	5.6	909	1100	19.0	15200	16300	7.0	5660	5970	5.3	6560	6470	1.4	13700	20700	40.7	3290	3260	0.9																		
Cesium (Cs)	0.0077	0.0137	56.1	0.005	0.005	0.0	0.0068	0.005	30.5	0.005	0.005	0.0	0.0119	0.0176	38.6	0.0132	0.0224	51.7	0.0140	0.0114	20.5																		
Chromium (Cr)	0.124	0.206	49.7	0.05	0.05	0.0	0.135	0.133	1.5	0.05	0.05	0.0	0.059	0.060	1.7	0.072	0.112	43.5	0.05	0.05	0.0																		
Cobalt (Co)	0.057	0.056	1.8	0.021	0.02	4.9	0.035	0.025	33.3	0.02	0.02	0.0	0.020	0.025	22.2	0.044	0.056	24.0	0.021	0.020	4.9																		
Copper (Cu)	2.04	3.28	46.6	2.03	4.52	76.0	4.47	3.26	31.3	4.65	4.94	6.0	0.86	0.68	23.4	3.08	1.59	63.8	2.78	2.85	2.5																		
Iron (Fe)	101	150	39.0	35.8	36.4	1.7	76.3	59.4	24.9	27.3	26.6	2.6	49.9	84.2	51.2	91.3	94.7	3.7	33.4	34.1	2.1																		
Lead (Pb)	0.106	0.128	18.8	0.02	0.02	0.0	0.071	0.052	30.9	0.02	0.02	0.0	0.037	0.050	29.9	0.050	0.077	42.5	0.02	0.02	0.0																		
Lithium (Li)	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0																		
Magnesium (Mg)	1370	2540	59.8	446	622	33.0	4380	4310	1.6	2090	2170	3.8	1970	1870	5.2	2460	2640	7.1	1730	1770	2.3																		
Manganese (Mn)	28.6	34.4	18.4	11.3	13.3	16.3	90.3	89.7	0.7	36.0	33.6	6.9	141	101	33.1	336	331	1.5	53.6	54.2	1.1																		
Molybdenum (Mo)	0.685	0.829	19.0	1.08	1.72	45.7	6.13	7.10	14.7	1.63	1.89	14.8	0.452	0.553	20.1	0.283	0.276	2.5	0.245	0.212	14.4																		
Nickel (Ni)	1.26	2.24	56.0	2.02	3.62	56.7	0.49	0.43	13.0	0.37	0.44	17.3	0.2	0.2	0.0	2.25	3.22	35.5	3.02	3.16	4.5																		
Phosphorus (P)	1080	1490	31.9	1610	2040	23.6	6140	7370	18.2	3250	3200	1.6	966	923	4.6	2950	2970	0.7	4690	4560	2.8																		
Potassium (K)	10300	12200	16.9	9440	10500	10.6	12200	13200	7.9	12200	13400	9.4	15300	14600	4.7	39200	47900	20.0	24400	22400	8.5																		
Rubidium (Rb)	1.40	5.94	123.7	0.929	5.69	143.9	2.04	2.27	10.7	3.19	3.41	6.7	3.81	5.15	29.9	15.1	23.4	43.1	18.1	13.8	27.0																		
Selenium (Se)	0.124	0.313	86.5	0.206	0.436	71.7	0.05	0.05	0.0	0.05	0.05	0.0	0.05	0.05	0.0	0.05	0.05	0.0	0.05	0.05	0.0																		
Sodium (Na)	20	20	0.0	20	20	0.0	20	20	0.0	20	20	0.0	20	20	0.0	20	20	0.0	20	20	0.0																		
Strontium (Sr)	19.6	9.10	73.2	2.15	1.44	39.6	16.9	17.5	3.5	5.96	6.44	7.7	38.9	37.6	3.4	31.1	61.1	65.1	9.05	7.76	15.3																		
Tellurium (Te)	0.02	0.02	0.0	0.02	0.02	0.0	0.02	0.02	0.0	0.02	0.02	0.0	0.02	0.02	0.0	0.02	0.02	0.0	0.02	0.02	0.0																		
Thallium (Tl)	0.0022	0.0040	58.1	0.002	0.002	0.0	0.002	0.002	0.0	0.002	0.002	0.0	0.0021	0.002	4.9	0.0052	0.0051	1.9	0.002	0.002	0.0																		
Tin (Sn)	0.1	0.1	0.0	0.26	0.80	101.9	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.28	0.14	66.7																		
Uranium (U)	0.0061	0.0069	12.3	0.002	0.002	0.0	0.0267	0.0040	147.9	0.002	0.002	0.0	0.0030	0.0042	33.3	0.0030	0.0051	51.9	0.002	0.002	0.0																		
Vanadium (V)	0.25	0.35	33.3	0.1	0.1	0.0	0.23	0.16	35.9	0.1	0.1	0.0	0.10	0.13	26.1	0.11	0.15	30.8	0.1	0.1	0.0																		
Zinc (Zn)	7.83	8.73	10.9	7.13	9.04	23.6	15.7	12.0	26.7	10.7	9.82	8.6	12.9	11.4	12.3	40.7	30.6	28.3	15.8	16.1	1.9																		
Zirconium (Zr)	0.2	0.2	0.0	0.2	0.2	0.0	0.2	0.2	0.0	0.2	0.2	0.0	0.2	0.2	0.0	0.2	0.2	0.0	0.2	0.2	0.0																		

Table 4-15 Summary of PAH concentrations for QA/QC samples (dry weight). Samples with highest (■) concentrations (mg/kg) are indicated. Raised detection limits (□) are also indicated.

PAH Parameter	Rosa QA-01		Sambcae QA-01		Shepcan QA-01	
	Foliage/ branch tips	Fruit	Foliage/ branch tips	Fruit	Foliage/ branch tips	Fruit
Acenaphthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Acenaphthylene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Anthracene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benz(a)anthracene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(a)pyrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(b&j)fluoranthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(g,h,i)perylene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(k)fluoranthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chrysene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Dibenz(a,h)anthracene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Fluoranthene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Fluorene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Indeno(1,2,3-c,d)pyrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-methylnaphthalene	<0.050	<0.050	<0.050	<0.050	0.109	<0.050
Naphthalene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phenanthrene	<0.050	<0.050	<0.050	<0.050	0.056	<0.050
Pyrene	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

5 Discussion

The CCME guidelines for soil quality provide science-based goals for the quality of the terrestrial ecosystem. These guidelines are derived using toxicological data to determine the threshold level of effects for key ecological receptors (e.g., human health, soil invertebrates, wildlife species). In some instances, where CCME has not developed thresholds the BC Contaminated Sites Regulation may fill in the gaps. The CSR, under authority of the Environmental Management Act, sets out the requirements for site remediation in BC; thus, the CSR thresholds can be used as a maximum acceptable concentration value where CCME guidelines do not exist.

In the terrestrial environment, there are native vegetation species that are capable of extracting contaminants of concern and storing them in their tissues (e.g., sedges, cattails, willow species). Throughout the baseline chemical and soil classification and mapping surveys, soil and plant associations were observed that support this general understanding. Across the LSA, willow and sedge species were often associated with soil samples exhibiting high concentrations of metals (e.g., selenium).

5.1 Metals

Several metal exceedances were found throughout the LSA, across a variety of landscape features and soil types (Table 4-5, Table 4-7). Through the baseline chemical surveys, soil metal concentration exceedances were found for arsenic, barium, cobalt, nickel and selenium. Further, through the baseline soil classification and mapping surveys, soil metal concentration exceedances were found for aluminum, manganese, thallium and zinc.

According to CCME guidelines (1997), arsenic, which closely resembles phosphorous chemically, is a metalloid that exhibits both metallic and nonmetallic properties. It rarely occurs in its elemental form but often occurs as complexes with iron, nickel, copper and cobalt. This relationship may explain why samples with As exceedances also exhibited Ni exceedances (e.g., ROSA-06, 18-22-IIC). Arsenic is naturally present in the terrestrial environment from the weathering and eroding of rock and soil (e.g., glacial till). Arsenic is rarely found in higher concentrations in plant tissue than in their substrate (CCME, 1997), as demonstrated in the ROSA-06 soil, foliage/branch tips and fruit samples (Table 4-5, Table 4-8). Arsenic concentrations greater than 10 mg/kg have been found to reduce yield in vegetable crops (Woolson, 1973 as cited in CCME, 1997).

Nickel exceedances were observed along with As exceedances in the LSA. Nickel is naturally present in soils as a result of chemical and mechanical weathering of bedrock (e.g., granite, sandstone and limestone; CCME, 2015). Nickel is essential for plant growth; however, concentrations greater than 80 mg/kg dry weight have been found to have toxic effects (CCME, 2015). Nickel concentrations that exceeded the CCME guideline in the LSA were 50.6 mg/kg (ROSA-06, fine-textured glaciolacustrine soil) and 84.7 mg/kg (18-22-IIC, deep clayey parent material soil).

Barium is an alkaline-earth metal that readily oxidizes in air and reacts with water (CCME, 2013). Barium is ubiquitous in soils, though concentrations vary with bedrock geology (limestone, feldspar and shale deposits) and anthropogenic inputs. The mean background soil concentration of barium in Canada is 140 mg/kg (Grunsky, 2010 as cited in CCME, 2013). The soils sampled throughout the LSA ranged from 38 to 656 mg/kg (Table 4-5, Table 4-7). Higher levels of barium can be found as a result of leaching and eroding from sedimentary rocks and coal (CCME, 2013). Barium is also easily precipitated as sulphates and carbonates in soil. Several samples with barium exceedances were found on till or fluvial parent materials in the LSA (SHEPCAN-02, DY16, DY45), which often contain carbonates, as confirmed by a visible effervescence field test. Barium exceedances were also found in organic soil horizons in wetland soils throughout the LSA (CAREX-02, CAREX-03/EQUIARV-05, DY81), as barium can be found in groundwater as a result of leaching and eroding from rocks and soil (CCME, 2013). Barium is found in most plants, though little barium is bioaccumulated by terrestrial plants (Schroeder, 1970; WHO, 1990 as cited in CCME, 2013).

Selenium is a non-metal that occurs naturally in coal (CCME, 2009). Both anthropogenic and natural sources of Se contribute to its ubiquitous presence in the environment; a major anthropogenic source locally is through the extraction of coal, while the major natural sources include the weathering of rocks, minerals and soils (e.g., shale parent materials). Selenium is taken up by terrestrial plants in its soluble forms and is influenced by a variety of soil physical and chemical properties, including the total level of selenium in soil and the capacity of the plant species to accumulate Se (CCME, 2009). Selenium is translocated to all parts of the plant; thus, selenium concentrations in animal tissue tend to reflect dietary selenium concentrations (CCME, 2009). Selenium levels throughout the LSA were found to exceed the CCME guideline for residential/parkland (1.0 mg/kg), and often also the provincial guideline for wildlands natural (1.5 mg/kg). Of the soil samples that exceed the guidelines, Se concentrations range from 1.00 to 22.5 mg/kg (Table 4-5, Table 4-7). The vegetation samples collected in association with the baseline chemistry samples that were found to contain Se concentrations above the guideline were most commonly beaked sedge (CAREX) and willow (SALIX), both of which are known to accumulate heavy metals in their tissues (Drahonovsky et al., 2016; Pulford & Watson, 2002; Szucs, 2014).

Thallium and zinc exceedances were found in a till soil sample (DY46) from a rich, moist site in the western portion of the LSA. Thallium is a widely distributed, naturally occurring element in the earth's crust and is readily absorbed by the roots of most plants, likely due to its similarity to phosphorous (CCME, 1999). Zinc was also found in concentrations above the CCME residential/parkland guideline at 18-22-IIC (Table 4-6). Zinc is highly reactive in soils, though its mobility is predominantly controlled by pH (CCME, 2018b).

The province of BC, within its Contaminated Sites Regulation (CSR, 2019), has identified maximum allowable concentrations for metals and other substances in soil based on the land use specified for a site. These thresholds fill in gaps for substances not found within the CCME guidelines for soil quality. For example, the regulation provides thresholds for aluminum, cobalt and manganese, each of which were found in exceedance of the wildlands natural category of land use in the LSA. These thresholds are intended to inform reclamation practices.

5.2 PAH

The results of the PAH analyses for soil and vegetation samples collected throughout the LSA indicated, as expected, that PAH contamination is not prevalent. Most samples reported levels of PAH parameters at or below the detection limit. The most common parameters which recorded values above the detection limit, but below any environmental thresholds were 2-methylnaphthalene, naphthalene and phenanthrene. 2-methylnaphthalene is a naphthalene related-related compound and, like naphthalene, is produced through incomplete combustion processes of wood and tobacco (ATSDR, 2005). Because 2-methylnaphthalene has similar chemical and physical properties, it is expected to act like naphthalene in air, water and soil. Naphthalene can dissolve in water and become weakly attached to soil; in air, it

degrades quickly. Phenanthrene is also created through the incomplete combustion of products like coal, oil, gas, and tobacco (US EPA, n.d.).

5.3 Quality Assurance/Quality Control

Quality Assurance/Quality Control was completed through the submission and analysis of duplicate vegetation samples. The results of the duplicate sample analysis are expressed as RPD; the lower the RPD value, the more precise the laboratory analysis. In accordance with BC MWLAP (2013), duplicate samples with a larger variation than 20% for soil, or 30% for vegetation indicate high sample variability which may be attributed to laboratory analysis, sampling technique (applicable for soil samples only) or natural sample heterogeneity. ALS Environmental noted high levels of sample heterogeneity overall.

For each QA/QC sample submitted to ALS Environment (soopolallie, rose, beaked sedge and elderberry), the RPD was calculated for each metal parameter (n=33) and, as ALS Environmental noted, high levels of sample heterogeneity was observed. The samples with the least amount of heterogeneity were rose foliage/branch tips and fruit (i.e., rosehips). The RPD for rose foliage/branch tip samples resulted in only six metal parameters exceeding the 30% threshold (As, Co, Cs, Cu, U and V); whereas, the RPD for rose fruits did not result in any exceedances (Table 4-14). In general, foliage/branch tips exhibited greater heterogeneity than fruit samples, as expected with sample composed of leafy and woody materials.

6 Conclusion

The baseline chemistry data collected and reported herein can be used to assess potential effects associated with the Project and provide a basis for mitigation, management, and monitoring requirements. Interpretation of metal and PAH chemical concentrations as tested by a qualified third-party analytical laboratory are to be conducted by a qualified third-party risk assessor for the purposes of informing the human and terrestrial wildlife health risk assessment for the Project.

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Appendix 1 Vegetation and soil samples collected per sample location within the Project LSA

Sample #	Plant/Berry Sample ID	Soil Sample ID	UTM Zone	UTM Easting	UTM Northing
1	VACCMEM-01	VACCMEM-01	11N	662545	5521593
2	VACCMEM-02	VACCMEM-02	11N	663247	5521493
3	AMELALN-01	AMELALN-01	11N	664789	5505346
4	SALIX-01	SALIX-01	11N	664629	
4	POPUBAL-01			5503637	
5	POPUBAL-02	POPUBAL-02	11N	664583	5511924
6	RUBUPAR-01	RUBUPAR-01	11N	665058	
6	SALIX-02			5506537	
7	RUBUPAR-02	RUBUPAR-02	11N	665028	5506330
8	SALIX-04	SALIX-04	11N	657369	5521892
9	SALIX-03	SALIX-03	11N	661624	5521864
10	SHEPCAN-01	SHEPCAN-01	11N	664573	5509567
11	SHEPCAN-02	SHEPCAN-02	11N	653955	5520161
12	SHEPCAN-03	SHEPCAN-03	11N	663699	5504264
13	ROSA-01	ROSA-01	11N	656816	5523489
14	VACCMEM-03	VACCMEM-03	11N	663755	5519680
15	POPUBAL-03	POPUBAL-03	11N	656448	5522432
16	SAMBCAE-01	SAMBCAE-01	11N	661926	5520965
17	SAMBCAE-02	SAMBCAE-02	11N	661369	5521944
18	ROSA-02	ROSA-02	11N	653169	5521996
19	ROSA-03	ROSA-03	11N	655215	5524987
20	RUBUPAR-03	RUBUPAR-03	11N	657433	
20	EQUIARV-01			5521906	
21	RUBUPAR-04	RUBUPAR-04	11N	661234	5523863
22	VACCMEM-04	VACCMEM-04	11N	661502	5521979
23	SAMBCAE-03	SAMBCAE-03	11N	661572	5521901
24	CAREX-01	CAREX-01	11N	661749	
24	EQUIARV-02			5521341	
25	CAREX-02	CAREX-02	11N	661854	5521192
26	SHEPCAN-04	SHEPCAN-04	11N	664590	5521861
27	SHEPCAN-05	SHEPCAN-05	11N	664916	
27	EQUIARV-03			5521488	
28	RUBUPAR-05	RUBUPAR-05	11N	664884	
28	SAMBCAE-04			5519456	
28	SALIX-05				
29	SAMBCAE-05	SAMBCAE-05	11N	664665	5516712

Sample #	Plant/Berry Sample ID	Soil Sample ID	UTM Zone	UTM Easting	UTM Northing
30	POPUBAL-04	POPUBAL-04	11N	664363	
30	EQUIARV-04			5515771	
31	CAREX-03	CAREX-03	11N	664259	
31	EQUIARV-05			5514932	
32	POPUBAL-05	POPUBAL-05	11N	664411	5512738
33	AMELALN-02	AMELALN-02	11N	664449	5510629
34	CAREX-04	CAREX-04	11N	665082	5509691
35	AMELALN-03	AMELALN-03	11N	654089	5523877
36	ROSA-04	ROSA-04	11N	654596	
36	AMELALN-04			5523999	
37	CAREX-05	CAREX-05	11N	655535	5524198
38	ROSA-05	ROSA-05	11N	655539	5524208
39	AMELALN-05	AMELALN-05	11N	657830	5521872
40	VACCMEM-05	VACCMEM-05	11N	663192	5518360
41	CAREX-06	CAREX-06	11N	653468	5520361
42	CAREX-07	CAREX-07	11N	653978	5520862
43	CAREX-08	CAREX-08	11N	653859	5521186
44	SALIX-06	SALIX-06	11N	654385	5521760
45	CAREX-09	CAREX-09	11N	654127	5521555
46	SHEPCAN-06	SHEPCAN-06	11N	654467	5523379
47	AMELALN-06	AMELALN-06	11N	653927	5522041
48	ROSA-06	ROSA-06	11N	653323	5522214
49	POPUBAL-06	POPUBAL-06	11N	653348	5521432
50	RUBUPAR-06	RUBUPAR-06	11N	661210	5523134
51	VACCMEM-06	VACCMEM-06	11N	663519	5517832
52	SAMBRAC-06	SAMBRAC-06	11N	661928	5521578
53	EQUIARV-06	EQUIARV-06	11N	656905	5521876
54	SALIX-07	SALIX-07	11N	664633	5510966
55	CAREX-10	CAREX-10	11N	664710	5510773

Appendix 2 Data sheets

~~DY19~~

Date:	AUGUST 2, 2017
Surveyors:	JL
UTM Zone:	11U
Easting:	06616 66 24
Northing:	55218 06 64
Slope:	- 19 9%.
Aspect	2 4 75

Veg label:	SALIX - 04
------------	------------

Soil label:	SALIX - 04
-------------	------------

Soil texture:	S S
Coarse fragment content:	3%.
Soil depth:	> 200 cm
Drainage:	WELL

Basic plant community description:

clearcut

Pl - Se - Vaccmem - Salix - Sambcae - Rhodalb -
Menzfer - Carex - Epilang - Anapmar

Additional comments:

SOIL PIT: DY1.

Date:	08-03-2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	657369
Northing:	5521892 1331
Slope:	0
Aspect	999

Veg label:	SALIX-03
------------	----------

Soil label:	SALIX-03
-------------	----------

Soil texture:	SiL
Coarse fragment content:	60
Soil depth:	50cm
Drainage:	Poor

Basic plant community description: SALIX CORNSTO CALAGAN URTI DIO GEUM MAC EQUI ARV ASTER
--

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Kefer Ecological Services Ltd.

Date:	08-03-2017	
Surveyors:	JL	
UTM Zone:	11U	
Easting:	662545	
Northing:	5521593	2090 m
Slope:		
Aspect	210	

Veg label:	VACCMEM-01
------------	------------

Soil label:	VACCMEM-01
-------------	------------

Soil texture:	SL
Coarse fragment content:	60%
Soil depth:	45
Drainage:	R

Basic plant community description: B1-se - P1 (dead) VACCMEM - VACCSCO - PEDIBRA - ARNILAT
--

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	08-03-2017
Surveyors:	JZ
UTM Zone:	11U
Easting:	66 3247
Northing:	5521493 2117m
Slope:	22
Aspect	162

Veg label:	VACCMEM-02
------------	------------

Soil label:	VACCMEM-02
-------------	------------

Soil texture:	SL
Coarse fragment content:	15%
Soil depth:	48 cm
Drainage:	R

Basic plant community description: B1 - Pa - Vaccmem - Vaccsco - Epilang

Additional comments:

**Jameson Vegetation and Soil Risk Assessment
Keefe Ecological Services Ltd.**

Date:	8.4.17
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	664789
Northing:	550346 <small>Correct Northing: 5505346</small> 1445m (DY17) (Waupoint 17)
Slope:	40%
Aspect	248°

missing #

Veg label:	AMELALN-01
------------	------------

Soil label:	AMELALN-01
-------------	------------

Soil texture:	SL
Coarse fragment content:	30%
Soil depth:	200 cm
Drainage:	R

Basic plant community description:	
Lupine	P1
Pennycress	Fd
Beak	Lw
Jumper	
EPILANG	
Pea sp	
SPIRBET	

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

DY19

Date:	08-04-2014		
Surveyors:	JL, DY		
UTM Zone:	11U		
Easting:	664629		
Northing:	5503637		1422m
Slope:	2%		
Aspect	296		

Veg label:	SALIX-01
------------	----------

Soil label:	SALIX-01
-------------	----------

Soil texture:	H (organic)
Coarse fragment content:	0%
Soil depth:	> 150cm
Drainage:	P

Basic plant community description: MARSH
SALIX SP.
CALACAN
GEUM MAC.

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	
Surveyors:	
UTM Zone:	11U
Easting:	SAME AS DY19 SALIX-01
Northing:	
Slope:	
Aspect	

Veg label:	POPUBAL-01
------------	------------

Soil label:	POPUBAL-01
-------------	------------

Soil texture:	
Coarse fragment content:	
Soil depth:	
Drainage:	

Basic plant community description:

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

0429

Date:	08.04.2017
Surveyors:	dz, DM
UTM Zone:	11U
Easting:	664583
Northing:	5511924
Slope:	0
Aspect	999

1465m

Veg label:	POPUBAL - 02
------------	--------------

Soil label:	POPUBAL - 02
-------------	--------------

Soil texture:	SiL
Coarse fragment content:	0
Soil depth:	> 200cm
Drainage:	m.

Basic plant community description:

Banberry
Stinging nettle
Equisil
Elymgl
Popubal

Additional comments:

Jameson Vegetation and Soil Risk Assessment
 Keefer Ecological Services Ltd.

DY/13

Date:	08-04-2017	
Surveyors:	JL	
UTM Zone:	11U	
Easting:	0665058	
Northing:	5506537	1425m
Slope:	281.	
Aspect	274°	

Veg label:	RUBUPAR - 01
------------	--------------

Soil label:	RUBUPAR - 01
-------------	--------------

Soil texture:	S
Coarse fragment content:	80%
Soil depth:	< 50 cm
Drainage:	R

Basic plant community description:	
SPIRBET	RUBUPAR
ACERGLA	AMELALN
PI	SHEPCA N
Fd	
Se	
Rosa sp.	
Salix sp.	
Populve	

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

DY14

Date:	08-04-17	
Surveyors:	JL	
UTM Zone:	11U	
Easting:	663028	
Northing:	5506330	1423 m
Slope:	45	
Aspect	264	

Veg label:	RUBUPAR - 02
------------	--------------

Soil label:	RUBUPAR - 02
-------------	--------------

Soil texture:	LS
Coarse fragment content:	65
Soil depth:	< 1 m
Drainage:	R

Basic plant community description: Alder RUBUPAR Sask. Soy. ACERGLA Paintbrush Poa sp.

Additional comments:

Date:	08-04-2017	
Surveyors:	JL, DY	
UTM Zone:	11U	
Easting:	665028	SAME AS RUBUPAR-02
Northing:	5506330	
Slope:		
Aspect		

Veg label:	SALIX-02
------------	----------

Soil label:	SALIX-02
-------------	----------

Soil texture:	
Coarse fragment content:	
Soil depth:	
Drainage:	

Basic plant community description:

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefe Ecological Services Ltd.

Date:	August 8, 2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	653955
Northing:	5520161
Slope:	53
Aspect:	300

Veg label:	SHEPCAN-02
------------	------------

Soil label:	SHEPCAN-02
-------------	------------

Soil texture:	SICL
Coarse fragment content:	∅
Soil depth:	100 +
Drainage:	W

Basic plant community description: Fd - Lx - At - Acer glabra - Rosa sp. - Aster

Additional comments: DY45

Date:	Aug 8 / 17	
Surveyors:	MJ, RM	
UTM Zone:	11U	
Easting:	663699	Elev: 1379m
Northing:	5504264	
Slope:	Level	
Aspect	Level	

Veg label:	SHEPCAN 03
------------	------------


Soil label:	SHEPCAN 03
-------------	------------

Soil texture:	Silt loam
Coarse fragment content:	15%
Soil depth:	Collected @ 10cm
Drainage:	well

Basic plant community description:	
PINUS (mature + maturing) POPULUS saplings PSEUDOTSUGA (mature + maturing, sapling)	
JUNIPER, SPIRAEA, MAHOAQUI, ROSA SP, ARCTICUM	
LUPINUS, CALARUB, EPILANG, FRAGARIA, THALLOPSIS	

Additional comments:
Just off road in forested area

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	August 9 2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	656816
Northing:	5523489
Slope:	7
Aspect	

Veg label:	ROSA SP.-01
------------	-------------

Soil label:	ROSA SP.-01
-------------	-------------

Soil texture:	LS
Coarse fragment content:	25
Soil depth:	400+
Drainage:	R

Basic plant community description:	Lf-Pl-Act-sprbet-rosa sp.- pinegrass
------------------------------------	--------------------------------------

Additional comments:	Sent ROSA SP. QA-01 - berries - twigs/leaves
	DY53

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	August 9 2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	656448
Northing:	5522432
Slope:	5%.
Aspect	112

Veg label:	POPUBAL-03
------------	------------

Soil label:	POPUBAL-03
-------------	------------

Soil texture:	SiL
Coarse fragment content:	∅
Soil depth:	100+
Drainage:	W→MW

Basic plant community description: Alnus - Cornsto

Additional comments: DY55

Jameson Vegetation and Soil Risk Assessment
Kefer Ecological Services Ltd.

Date:	August 10, 2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	663755
Northing:	5519680 2118m
Slope:	35%
Aspect	250°

Veg label:	VACCMEM-03
------------	------------

Soil label:	VACCMEM-03
-------------	------------

Soil texture:	LS
Coarse fragment content:	80%
Soil depth:	30 cm
Drainage:	R

Basic plant community description: VACCSCO - RHODALB - MENZFER B1 - Sx
--

Additional comments: DY79 ONLY VACCMEM w/ BERRIES

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	August 10, 2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	461926
Northing:	5520965
Slope:	40% 1886m
Aspect	60

Veg label:	SAMB CAE-01
------------	-------------

Soil label:	SAMB CAE-01
-------------	-------------

Soil texture:	L
Coarse fragment content:	75%
Soil depth:	200 +
Drainage:	I

Basic plant community description:
VERA VIR
THAL OCC
ANGE ARG
ALNUS SP.
ASTEL SP.
LADY FERN

Additional comments:
DY71

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	August 11, 2017
Surveyors:	JL, DY
UTM Zone:	11U
Easting:	661369
Northing:	5521944
Slope:	10% 1842m
Aspect	278°

Veg label:	SAMBCAE - 02
------------	--------------

Soil label:	SAMBCAE - 02
-------------	--------------

Soil texture:	L
Coarse fragment content:	15%
Soil depth:	35cm
Drainage:	R

Basic plant community description:
SAMBCAE MENZFER
EPILANG
ANAPMAR
RIBELAC
VACCMEM
Sx, P1
RHODALB

Additional comments:
DY83

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

①

Date:	8/17/17
Surveyors:	JL, KB
UTM Zone:	11U
Easting:	0653169
Northing:	5521996 1777 m
Slope:	5%
Aspect	270°

Veg label:	ROSA SP-02
------------	------------

Soil label:	ROSA SP-02
-------------	------------

Soil texture:	SIL
Coarse fragment content:	5%
Soil depth:	200 +
Drainage:	R

Basic plant community description:	<table border="0"> <tr> <td>trembling aspens</td> <td>pine grass</td> </tr> <tr> <td>lodge pole</td> <td>SASK berry</td> </tr> <tr> <td>lodge pole pine</td> <td>strawberry</td> </tr> <tr> <td>spruce</td> <td></td> </tr> <tr> <td>soopolallie</td> <td></td> </tr> <tr> <td>oregon grape</td> <td></td> </tr> </table>	trembling aspens	pine grass	lodge pole	SASK berry	lodge pole pine	strawberry	spruce		soopolallie		oregon grape	
trembling aspens	pine grass												
lodge pole	SASK berry												
lodge pole pine	strawberry												
spruce													
soopolallie													
oregon grape													

Additional comments:	Waypoint 92
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Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

2

Date:	Aug. 17, 2017
Surveyors:	JL KB
UTM Zone:	11U 0655215 5524987
Easting:	
Northing:	
Slope:	4
Aspect	76

Veg label:	Rosa sp-03
------------	------------

Soil label:	Rosa sp-03
-------------	------------

Soil texture:	L
Coarse fragment content:	5%
Soil depth:	100+
Drainage:	rapid

Basic plant community description:	
Rose	- vaccona
Spruce	- spir bet
Fur	
lodge pole pine	
pine grass	
trembling aspen	

Additional comments:
Waypoint 93

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

3

Date:	August 17, 2017	
Surveyors:	JL, KB	
UTM Zone:	11U	
Easting:	0657433	1341m
Northing:	5521906	
Slope:	35	
Aspect	244	

Veg label:	Rubus par-03 / Equiarv-01
------------	---------------------------

Soil label:	''	''
-------------	----	----

Soil texture:	L
Coarse fragment content:	30%
Soil depth:	200+
Drainage:	Moderate

Basic plant community description:	
Rubus par	Spruce
Equiarv	Cotton Wood
Rosa sp.	Lodge Pole Pine
Aster sp.	red osier dog wood
American Vetch	raspberry
Sask berry	

Additional comments:
Waypoint 95.

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

(4)

Date:	Aug 17/17		
Surveyors:			
UTM Zone:	11U	0061234	
Easting:	5523063		1637m
Northing:			
Slope:	30		
Aspect	250		

Veg label:	RUBUPAR - 04
------------	--------------

Soil label:	"
-------------	---

Soil texture:	SL
Coarse fragment content:	10%
Soil depth:	100+
Drainage:	rapid

Basic plant community description:	
<p>sub sub alpin fur sp sp. Aster sp. Alder Rubu Pearly Ever lasting</p>	<p>fire weed (epilang) Canada blue grass</p>

Additional comments:
WP 96

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

5

Date:	August 17, 2017
Surveyors:	JL, KB
UTM Zone:	11U
Easting:	0661502
Northing:	5521979
Slope:	40%
Aspect:	288°

Veg label:	VACCMEM-04
------------	------------

Soil label:	VACCMEM-04
-------------	------------

Soil texture:	SL
Coarse fragment content:	5%
Soil depth:	100+
Drainage:	R

Basic plant community description:	
EPI LANG	SUB. ACP. FIR
VACCMEM	PI-SX
MENZ FER	ANAPMAR? (PEARLY EV.)
VACCSCO	
RHODALB	

Additional comments:
waypoint 97
⊗ with berries

Jameson Vegetation and Soil Risk Assessment
 Keefer Ecological Services Ltd.

(8)

Date:	August 17, 2017
Surveyors:	JL, KB
UTM Zone:	11U
Easting:	0661572
Northing:	5521901 1900m
Slope:	35
Aspect	288

Veg label:	SAMBCAE-03
------------	------------

Soil label:	SAMBCAE-63
-------------	------------

Soil texture:	
Coarse fragment content:	
Soil depth:	
Drainage:	

Basic plant community description:	
Lodge pole pine pearly e. lasing epilang Ribelias Vacceman Spruce	veravir Salix sp. Sambcae rhodalb vacesco

Additional comments:
SAMBCAE . QA-01

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.



Date:	Aug 17/17	
Surveyors:	JL KB	
UTM Zone:	11U	
Easting:	0661749	
Northing:	5521341	1894m
Slope:	0 LVL	
Aspect	999	

Veg label:	CAREX-01 / EQUIARV-03
------------	-----------------------

Soil label:	* 11 EQUIARV-03
-------------	-----------------

Soil texture:	SicL
Coarse fragment content:	0
Soil depth:	100+
Drainage:	I

Basic plant community description: Senetri Frag vir Equiarv butter cup
--

Additional comments: Waypoint 100

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.



Date:	Aug 17/17
Surveyors:	KB/JL
UTM Zone:	11U 0661854
Easting:	5521190
Northing:	1881
Slope:	LVL
Aspect	999

Veg label:	CAREX-02
------------	----------

Soil label:	"
-------------	---

Soil texture:	Om
Coarse fragment content:	0
Soil depth:	100+
Drainage:	I

Basic plant community description:	
Aster sp.	Spruce
Valesit	sub alpin fir
Equi Arv	Rubra par
Fragir	Carex sp.
Veravir	Thalocce
	Vaccaseo
	senetri

Additional comments:
WP 99

Jameson Vegetation and Soil Risk Assessment
Kefer Ecological Services Ltd.

9

Date:	August 18, 2017
Surveyors:	JL, KB
UTM Zone:	11U
Easting:	664590
Northing:	5521861
Slope:	10%
Aspect	180°

Veg label: SHEPCAN-04

Soil label: SHEPCAN-04

Soil texture:	SL
Coarse fragment content:	30%
Soil depth:	100+
Drainage:	W

Basic plant community description:

ALNUS SP.	CONIINV
SALIX SP.	SX
ANGEARG	BI
EQUIARV	RIBELAC
THALOCC	
SENETRI	

Additional comments:
waypoint 101

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

10

Date:	August 18/17
Surveyors:	JL KB
UTM Zone:	11U 0664916
Easting:	5521488
Northing:	1754
Slope:	30
Aspect	264

Veg label:	SHEPCAN-05 / EQUICARV-03
------------	--------------------------

Soil label:	11
-------------	----

Soil texture:	L
Coarse fragment content:	40%
Soil depth:	100+
Drainage:	R

Basic plant community description:	
Thalocce	1 edge pole pine
Vacc sco	5x
Rhod alb	to Ribelae
Alnus sp.	
Lonicera	
menz fer	
Sub. alp fir	

Additional comments:
WP102

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

11

Date:	August 18, 2017
Surveyors:	JL / KB
UTM Zone:	11U
Easting:	664884
Northing:	5519456 1685 m
Slope:	40
Aspect	282

Veg label: RUBUPAR-05/SAMBCAE-04/SALIX-05

Soil label: RUBUPAR-05

Soil texture:	LS
Coarse fragment content:	20
Soil depth:	100 +
Drainage:	R

Basic plant community description:
EPILANG SX-B1(LX)
THALOC
RUBUPAR
SAMBCAE
LONIUTA
RIBELAC
ASTER SP.

Additional comments:
Waypoint 103

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

12

Date:	August 18, 2017
Surveyors:	JL/KB
UTM Zone:	11U
Easting:	66 4665
Northing:	5516712 1569 m
Slope:	35 %
Aspect	278 °

Veg label:	SAMBCAE - 05
------------	--------------

Soil label:	SAMBCAE - 05
-------------	--------------

Soil texture:	vf S
Coarse fragment content:	10
Soil depth:	100 +
Drainage:	R

Basic plant community description: SX - B1 RIBELAC RASPBERRY RUBUPAR VACCMEM ASTER SP. PEARLY EVERL.

Additional comments: Waypoint 104

Jameson Vegetation and Soil Risk Assessment
 Keefer Ecological Services Ltd.

13

Date:	Aug 18, 2017
Surveyors:	KB JL
UTM Zone:	11U 0664363
Easting:	5515771
Northing:	1519
Slope:	5%
Aspect:	SW 336

Veg label:	Popubal-04 / EquArv-04
------------	------------------------

Soil label:	POPUBAL-04
-------------	------------

Soil texture:	LS
Coarse fragment content:	∅
Soil depth:	200+
Drainage:	R

Basic plant community description:		
P.I.	EquiArv	Menz fer
Sx	VABESCO	
At	Frag vir	
Bl.	^ Corn can	
	Clinoni	

Additional comments:
WP 105

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

14

Date:	AUG 18/17
Surveyors:	JL KB
UTM Zone:	11U 0664059
Easting:	5514930
Northing:	1502
Slope:	0
Aspect	999

Veg label:	CAREX-03 / EQUIARV-05
------------	-----------------------

Soil label:	11 11
-------------	-------

Soil texture:	L
Coarse fragment content:	0
Soil depth:	100+
Drainage:	I

Basic plant community description:	Carex EQUIARV CIR ARV perimeter (Spruce)
------------------------------------	---

Additional comments:	- heavy use by cattle WP 100
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Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	Aug 18/17
Surveyors:	JL
UTM Zone:	11U
Easting:	664411
Northing:	5512738
Slope:	10% 1465m
Aspect	146°

Veg label: POPUBAL-05

Soil label: POPUBAL-05

Soil texture:	L
Coarse fragment content:	15
Soil depth:	200+
Drainage:	R

Basic plant community description:
 RASP.
 SHEPCAN
 PI
 Sx
 SPIRBET
 FRAGUIR
 LINNBOR
 ALNUS SP.

Additional comments:
 Waypoint 107

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	August 18, 2017	
Surveyors:	JC/RB	
UTM Zone:	11U	
Easting:	664449	
Northing:	5510629	1474m
Slope:	20%	
Aspect	118°	

Veg label:	AMELALN-02
------------	------------

Soil label:	AMELALN-02
-------------	------------

Soil texture:	LS
Coarse fragment content:	5
Soil depth:	100 +
Drainage:	R

Basic plant community description:	
LINNBOR	SX
ROSA SP	PI
SHEPCAN	POPUBAL
CORN CAN	
FRAG VIR	
RUBUPAR	

Additional comments:
Waypoint 108
No berries

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

17

Date:	Aug. 18 / 17
Surveyors:	JL / KB
UTM Zone:	11U
Easting:	665082
Northing:	5509691
Slope:	2% 1437m
Aspect	130°

Veg label:	CAREX-04
------------	----------

Soil label:	CAREX-04
-------------	----------

Soil texture:	S:L
Coarse fragment content:	5
Soil depth:	100 +
Drainage:	I

Basic plant community description:	
CAREX SP.	PI
ASTER SP.	SX
ALNUS SP.	
SALIX SP.	
CIRARU	

Additional comments:
Waypoint 109

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

08:50

Date:	08/30/17
Surveyors:	JL/MJ
UTM Zone:	11U
Easting:	0654089
Northing:	5523877
Slope:	7% 1250m
Aspect	282°

①

Veg label:	AMELALN-03
------------	------------

Soil label:	AMELALN-03
-------------	------------

Soil texture:	SIL
Coarse fragment content:	15
Soil depth:	100 +
Drainage:	R

Basic plant community description: AMELALN ROSA SP. AT ASTELON
--

Additional comments: NO berries Waypoint 441 - Myra GPS

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

09:30
~~10:00~~

(2)

Date:	08/30/2017	
Surveyors:	JLIMJ	
UTM Zone:	11U	
Easting:	0654596	
Northing:	5523999	1272 m
Slope:	7%	
Aspect	132°	

Veg label: ROSA SP - 04 + AMELALN - 04

Soil label: ROSA SP. - 04

Soil texture:	SiL
Coarse fragment content:	5%
Soil depth:	100+
Drainage:	R

Basic plant community description:
At(Pl-Sx-Fd) SHEPCAN
ASTECON
ROSA SP
AMELALN
SYMPALB

Additional comments:
NO AMELALN BERRIES

③

Date:	08/30/2017
Surveyors:	JL / MJ
UTM Zone:	11U
Easting:	0655535
Northing:	5524198
Slope:	2% 1281 m
Aspect	240°

Veg label:	CAREX-05
------------	----------

Soil label:	CAREX-05(01) + CAREX-05(02)
-------------	-----------------------------

Soil texture:	L
Coarse fragment content:	0%
Soil depth:	100
Drainage:	I

Basic plant community description:
CAREX
SALIX SP.
Sx

Additional comments:
CAREX-QA01

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

10:00

④

Date:	08/30/15
Surveyors:	MJ / JL
UTM Zone:	11U
Easting:	0655539
Northing:	5524208
Slope:	4% 1281m
Aspect	304°

Veg label:	ROSA SP-05
------------	------------

Soil label:	ROSA SP-05
-------------	------------

Soil texture:	SL
Coarse fragment content:	5%
Soil depth:	100+
Drainage:	R

Basic plant community description:	
ASTERCON	P1
CORNCAN	SX
ROSA SP	
EQUIARV	
SALIX SP	

Additional comments:

Date:	08/30/2017
Surveyors:	JL / MJ
UTM Zone:	11U
Easting:	0657830
Northing:	5521872
Slope:	30% 1426m
Aspect	234°

Veg label:	AMELALN-05
------------	------------

Soil label:	AMELALN-05
-------------	------------

Soil texture:	L
Coarse fragment content:	30%
Soil depth:	100+
Drainage:	R

Basic plant community description:	
PI	ASTECON
Fd	ROSA SP.
MAHOAQU	EPILANG
SPIRBET	
LUPIN	
Sx	

Additional comments:

Jameson Vegetation and Soil Risk Assessment
Keefer Ecological Services Ltd.

Date:	09-28-2017	
Surveyors:	JL	
UTM Zone:	11U	
Easting:	663192	1855m .
Northing:	5518360	
Slope:		
Aspect		

Veg label:	VACCMEM-05
------------	------------

Soil label:	VACCMEM-05
-------------	------------

Soil texture:	SL
Coarse fragment content:	10%.
Soil depth:	> 100 cm
Drainage:	R

Basic plant community description:
Vacmem
Spirbet
Vaccsco
PI
BI
Pa.

Appendix 3 Metals and PAH parameters analyzed by ALS Environmental

Metal Analytical Parameters

Plant

Aluminum (Al)-Total
Antimony (Sb)-Total
Arsenic (As)-Total
Barium (Ba)-Total
Beryllium (Be)-Total
Bismuth (Bi)-Total
Boron (B)-Total
Cadmium (Cd)-Total
Calcium (Ca)-Total
Cesium (Cs)-Total
Chromium (Cr)-Total
Cobalt (Co)-Total
Copper (Cu)-Total
Iron (Fe)-Total
Lead (Pb)-Total
Lithium (Li)-Total
Magnesium (Mg)-Total
Manganese (Mn)-Total
Molybdenum (Mo)-Total
Nickel (Ni)-Total
Phosphorus (P)-Total
Potassium (K)-Total
Rubidium (Rb)-Total
Selenium (Se)-Total
Sodium (Na)-Total
Strontium (Sr)-Total
Tellurium (Te)-Total
Thallium (Tl)-Total
Tin (Sn)-Total
Uranium (U)-Total
Vanadium (V)-Total
Zinc (Zn)-Total
Zirconium (Zr)-Total

Soil

Aluminum (Al)-Total
Antimony (Sb)-Total
Arsenic (As)-Total
Barium (Ba)-Total
Beryllium (Be)-Total
Bismuth (Bi)-Total
Boron (B)-Total
Cadmium (Cd)-Total
Calcium (Ca)-Total
Chromium (Cr)-Total
Cobalt (Co)-Total
Copper (Cu)-Total
Iron (Fe)-Total
Lead (Pb)-Total
Lithium (Li)-Total
Magnesium (Mg)-Total
Manganese (Mn)-Total
Molybdenum (Mo)-Total
Nickel (Ni)-Total
Phosphorus (P)-Total
Potassium (K)-Total
Selenium (Se)-Total
Silver (Ag)-Total
Sodium (Na)-Total
Strontium (Sr)-Total
Sulfur (S)-Total-Total
Thallium (Tl)-Total
Tin (Sn)-Total
Titanium (Ti)-Total
Tungsten (W)-Total
Uranium (U)-Total
Vanadium (V)-Total
Zinc (Zn)-Total
Zirconium (Zr)-Total

PAH Analytical Parameters

Plant

Acenaphthene
Acenaphthylene
Anthracene
Benz(a)anthracene
Benzo(a)pyrene
Benzo(b&j)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene
Acenaphthene d10
Chrysene d12
Naphthalene d8
Phenanthrene d10

Soil

Acenaphthene
Acenaphthylene
Anthracene
Benz(a)anthracene
Benzo(a)pyrene
Benzo(b&j)fluoranthene
Benzo(b+j+k)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene
Acenaphthene d10
Chrysene d12
Naphthalene d8
Phenanthrene d10
B(a)P TPE
IACR (CCME)

Appendix 4 ALS Environmental analytical laboratory results of metal and PAH concentrations in vegetation and soil samples collected within the Project LSA

Certificates of Analysis (COA): L1970983, L1974841, L198616, L198617, L198619, L1984966, L1981208 (soil classification and mapping), L2003527



Pre-Pay Clients - Vancouver
ATTN: Mr. Art Palm
Jameson Resources - NWP Coal
800 - 1199 West Hastings St.
Vancouver BC V6E 3T5

Date Received: 08-AUG-17
Report Date: 08-SEP-17 16:46 (MT)
Version: FINAL

Client Phone: 250-489-5297

Certificate of Analysis

Lab Work Order #: L1970983
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 15-609383, 15-609384
Legal Site Desc:

<Original signed by>


Tony Nguyen
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-2	L1970983-4	L1970983-6	L1970983-9	L1970983-11
		Description	SOIL	SOIL	SOIL	SOIL	SOIL
		Sampled Date	03-AUG-17	03-AUG-17	04-AUG-17	04-AUG-17	04-AUG-17
		Sampled Time	10:00	09:00	10:00	12:00	16:00
		Client ID	VACCMEM-01 (SOIL) 0663247,5521493	VACCMEM-02 (SOIL) 0662545,5521593	AMELALN-01 (SOIL) 0664789,550346	SALIX-01 (SOIL) 0664651,5503628	POPUBAL-02 (SOIL) 0664583,5511924
Grouping	Analyte						
SOIL							
Physical Tests	Moisture (%)		33.5		3.73		76.8
	pH (1:2 soil:water) (pH)		5.53	4.72	6.51	7.26	7.11
Metals	Aluminum (Al) (mg/kg)		14300	9160	13300	5210	13600
	Antimony (Sb) (mg/kg)		0.63	0.81	0.36	0.82	0.61
	Arsenic (As) (mg/kg)		7.60	2.67	3.98	2.55	7.24
	Barium (Ba) (mg/kg)		64.1	278	168	314	232
	Beryllium (Be) (mg/kg)		0.78	0.98	0.73	0.24	0.85
	Bismuth (Bi) (mg/kg)		0.20	0.24	0.22	<0.20	0.24
	Boron (B) (mg/kg)		<5.0	<5.0	6.2	22.5	16.0
	Cadmium (Cd) (mg/kg)		0.210	1.02	0.167	0.953	1.91
	Calcium (Ca) (mg/kg)		468	1230	2280	48300	8720
	Chromium (Cr) (mg/kg)		9.85	12.5	11.5	3.85	21.0
	Cobalt (Co) (mg/kg)		9.86	1.42	6.40	2.29	8.80
	Copper (Cu) (mg/kg)		19.1	24.0	7.56	11.3	30.1
	Iron (Fe) (mg/kg)		25900	10200	16000	8630	21700
	Lead (Pb) (mg/kg)		13.4	16.5	12.4	4.28	13.1
	Lithium (Li) (mg/kg)		7.2	3.5	16.9	8.0	22.4
	Magnesium (Mg) (mg/kg)		717	356	3270	2400	4730
	Manganese (Mn) (mg/kg)		263	37.2	401	1780	343
	Mercury (Hg) (mg/kg)		0.0406	0.0512	0.0132	0.0907	0.0434
	Molybdenum (Mo) (mg/kg)		1.23	1.70	0.81	2.07	2.40
	Nickel (Ni) (mg/kg)		17.2	7.93	11.6	6.86	28.1
	Phosphorus (P) (mg/kg)		519	482	474	1430	1240
	Potassium (K) (mg/kg)		1450	1260	2710	590	3570
	Selenium (Se) (mg/kg)		0.52	0.56	<0.20	5.66	1.17
	Silver (Ag) (mg/kg)		0.15	0.35	<0.10	0.12	0.15
	Sodium (Na) (mg/kg)		<50	<50	<50	128	58
	Strontium (Sr) (mg/kg)		7.02	31.9	10.1	198	24.1
	Sulfur (S) (mg/kg)		<1000	<1000	<1000	7600	<1000
Thallium (Tl) (mg/kg)		0.154	0.177	0.163	0.118	0.363	
Tin (Sn) (mg/kg)		<2.0	<2.0	<2.0	<2.0	<2.0	
Titanium (Ti) (mg/kg)		25.0	45.0	72.3	51.4	11.8	
Tungsten (W) (mg/kg)		<0.50	<0.50	<0.50	<0.50	<0.50	
Uranium (U) (mg/kg)		0.624	1.26	0.677	2.73	0.510	
Vanadium (V) (mg/kg)		29.7	41.5	20.6	9.98	33.4	
Zinc (Zn) (mg/kg)		112	45.8	52.3	44.8	159	
Zirconium (Zr) (mg/kg)		1.6	2.6	1.3	3.3	1.8	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-14	L1970983-16	L1970983-18	L1970983-20	L1970983-22
		Description	SOIL	SOIL	TISSUE	TISSUE	SOIL
		Sampled Date	04-AUG-17	04-AUG-17	03-AUG-17	03-AUG-17	05-AUG-17
		Sampled Time	09:00	09:30	12:00	12:00	09:00
		Client ID	RUBUPAR-01 (SOIL) 0665028,5506330	RUBUPAR-02 (SOIL) 0665058,5506537	SALIX-03 (SOIL) 0657369,5521892	SALIX-04 (SOIL) 0661624,5521864	SHEPCAN-01 (SOIL) 0664573,5509567
Grouping	Analyte						
SOIL							
Physical Tests	Moisture (%)		6.17				
	pH (1:2 soil:water) (pH)		6.04	6.32	7.84	4.88	6.56
Metals	Aluminum (Al) (mg/kg)		9580	20500	6960	8170	27200
	Antimony (Sb) (mg/kg)		0.21	0.14	0.68	0.41	0.33
	Arsenic (As) (mg/kg)		2.37	2.08	6.00	3.94	4.29
	Barium (Ba) (mg/kg)		96.8	296	158	89.4	145
	Beryllium (Be) (mg/kg)		0.44	0.80	0.69	0.20	0.89
	Bismuth (Bi) (mg/kg)		<0.20	<0.20	<0.20	<0.20	0.26
	Boron (B) (mg/kg)		<5.0	6.2	6.7	<5.0	7.7
	Cadmium (Cd) (mg/kg)		0.119	0.273	1.23	0.265	0.708
	Calcium (Ca) (mg/kg)		1860	4210	20900	1540	8660
	Chromium (Cr) (mg/kg)		12.2	27.5	11.5	7.70	31.0
	Cobalt (Co) (mg/kg)		3.67	3.52	5.96	2.23	5.10
	Copper (Cu) (mg/kg)		5.70	4.84	16.9	8.08	6.56
	Iron (Fe) (mg/kg)		11900	13500	15500	14200	17300
	Lead (Pb) (mg/kg)		7.79	7.71	10.3	13.3	18.0
	Lithium (Li) (mg/kg)		7.6	12.5	9.9	3.7	21.6
	Magnesium (Mg) (mg/kg)		1440	2290	7490	571	2270
	Manganese (Mn) (mg/kg)		360	611	330	573	284
	Mercury (Hg) (mg/kg)		0.0171	0.0152	0.0593	0.0752	0.0518
	Molybdenum (Mo) (mg/kg)		0.58	0.38	1.62	0.79	1.10
	Nickel (Ni) (mg/kg)		11.2	15.2	28.5	7.58	20.5
	Phosphorus (P) (mg/kg)		568	2660	1180	956	1290
	Potassium (K) (mg/kg)		1190	1440	1630	870	1340
	Selenium (Se) (mg/kg)		<0.20	<0.20	3.04	0.23	0.30
	Silver (Ag) (mg/kg)		<0.10	<0.10	0.18	1.69	<0.10
	Sodium (Na) (mg/kg)		56	149	72	53	123
	Strontium (Sr) (mg/kg)		8.39	12.7	38.9	7.18	19.3
Sulfur (S) (mg/kg)		<1000	<1000	<1000	<1000	<1000	
Thallium (Tl) (mg/kg)		0.147	0.143	0.281	0.119	0.225	
Tin (Sn) (mg/kg)		<2.0	<2.0	<2.0	<2.0	<2.0	
Titanium (Ti) (mg/kg)		112	435	<14 ^{DLM}	49.6	411	
Tungsten (W) (mg/kg)		<0.50	<0.50	<0.50	<0.50	<0.50	
Uranium (U) (mg/kg)		0.437	0.840	0.918	0.237	1.12	
Vanadium (V) (mg/kg)		18.0	17.3	23.9	28.5	38.3	
Zinc (Zn) (mg/kg)		33.1	81.4	104	56.2	122	
Zirconium (Zr) (mg/kg)		<1.0	7.4	1.3	<1.0	5.4	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-2	L1970983-4	L1970983-6	L1970983-9	L1970983-11
		Description	SOIL	SOIL	SOIL	SOIL	SOIL
		Sampled Date	03-AUG-17	03-AUG-17	04-AUG-17	04-AUG-17	04-AUG-17
		Sampled Time	10:00	09:00	10:00	12:00	16:00
		Client ID	VACCMEM-01 (SOIL) 0663247,5521493	VACCMEM-02 (SOIL) 0662545,5521593	AMELALN-01 (SOIL) 0664789,550346	SALIX-01 (SOIL) 0664651,5503628	POPBAL-02 (SOIL) 0664583,5511924
Grouping	Analyte						
SOIL							
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050		<0.0050	<0.0050		
	Acenaphthylene (mg/kg)	<0.0050		<0.0050	<0.0050		
	Anthracene (mg/kg)	<0.0040		<0.0040	<0.0040		
	Benz(a)anthracene (mg/kg)	<0.010		<0.010	<0.010		
	Benzo(a)pyrene (mg/kg)	<0.010		<0.010	<0.010		
	Benzo(b&j)fluoranthene (mg/kg)	<0.010		<0.010	0.011		
	Benzo(b+j+k)fluoranthene (mg/kg)	<0.015		<0.015	<0.015		
	Benzo(g,h,i)perylene (mg/kg)	<0.010		<0.010	<0.010		
	Benzo(k)fluoranthene (mg/kg)	<0.010		<0.010	<0.010		
	Chrysene (mg/kg)	<0.020 ^{DLCI}		<0.010	<0.010		
	Dibenz(a,h)anthracene (mg/kg)	<0.0050		<0.0050	<0.0050		
	Fluoranthene (mg/kg)	<0.010		<0.010	<0.010		
	Fluorene (mg/kg)	<0.010		<0.010	<0.050 ^{DLO}		
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010		<0.010	<0.010		
	2-Methylnaphthalene (mg/kg)	<0.010		<0.010	0.040		
	Naphthalene (mg/kg)	0.010		<0.010	0.013		
	Phenanthrene (mg/kg)	0.053		<0.010	0.036		
	Pyrene (mg/kg)	<0.010		<0.010	<0.010		
	Surrogate: Acenaphthene d10 (%)	75.1		82.7	78.8		
	Surrogate: Chrysene d12 (%)	103.8		116.6	104.0		
	Surrogate: Naphthalene d8 (%)	81.6		84.7	77.2		
Surrogate: Phenanthrene d10 (%)	86.5		101.5	91.4			
B(a)P Total Potency Equivalent (mg/kg)	<0.020		<0.020	<0.020			
IACR (CCME) (mg/kg)	<0.15		<0.15	<0.15			

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-14	L1970983-16	L1970983-18	L1970983-20	L1970983-22
		Description	SOIL	SOIL	TISSUE	TISSUE	SOIL
		Sampled Date	04-AUG-17	04-AUG-17	03-AUG-17	03-AUG-17	05-AUG-17
		Sampled Time	09:00	09:30	12:00	12:00	09:00
		Client ID	RUBUPAR-01 (SOIL) 0665028,5506330	RUBUPAR-02 (SOIL) 0665058,5506537	SALIX-03 (SOIL) 0657369,5521892	SALIX-04 (SOIL) 0661624,5521864	SHEPCAN-01 (SOIL) 0664573,5509567
Grouping	Analyte						
SOIL							
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050					
	Acenaphthylene (mg/kg)	<0.0050					
	Anthracene (mg/kg)	<0.0040					
	Benz(a)anthracene (mg/kg)	<0.010					
	Benzo(a)pyrene (mg/kg)	<0.010					
	Benzo(b&j)fluoranthene (mg/kg)	<0.010					
	Benzo(b+j+k)fluoranthene (mg/kg)	<0.015					
	Benzo(g,h,i)perylene (mg/kg)	<0.010					
	Benzo(k)fluoranthene (mg/kg)	<0.010					
	Chrysene (mg/kg)	<0.010					
	Dibenz(a,h)anthracene (mg/kg)	<0.0050					
	Fluoranthene (mg/kg)	<0.010					
	Fluorene (mg/kg)	<0.010					
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010					
	2-Methylnaphthalene (mg/kg)	<0.010					
	Naphthalene (mg/kg)	<0.010					
	Phenanthrene (mg/kg)	<0.010					
	Pyrene (mg/kg)	<0.010					
	Surrogate: Acenaphthene d10 (%)	76.6					
	Surrogate: Chrysene d12 (%)	101.3					
Surrogate: Naphthalene d8 (%)	76.5						
Surrogate: Phenanthrene d10 (%)	85.0						
B(a)P Total Potency Equivalent (mg/kg)	<0.020						
IACR (CCME) (mg/kg)	<0.15						

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID	L1970983-1 TISSUE 03-AUG-17 10:00 VACCMEM-01 (PLANT) 0663247,5521493	L1970983-3 TISSUE 03-AUG-17 09:00 VACCMEM-02 (PLANT) 0662545,5521593	L1970983-5 TISSUE 04-AUG-17 10:00 AMELALN-01 (PLANT) 0664789,550346	L1970983-7 TISSUE 04-AUG-17 12:00 SALIX-01 (PLANT) 0664651,5503628	L1970983-8 TISSUE 04-AUG-17 12:00 POPUBAL-01 (PLANT) 0664651,5503628	
Grouping	Analyte					
TISSUE						
Physical Tests	% Moisture (%)	66.7	66.8	56.6	61.0	59.2
Metals	Aluminum (Al)-Total (mg/kg)	110	182	37.4	26.2	18.2
	Antimony (Sb)-Total (mg/kg)	<0.010	0.012	0.011	<0.010	<0.010
	Arsenic (As)-Total (mg/kg)	0.047	0.055	<0.020	0.048	0.035
	Barium (Ba)-Total (mg/kg)	160	81.5	238	27.6	26.2
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Boron (B)-Total (mg/kg)	18.8	16.5	16.5	45.4	46.8
	Cadmium (Cd)-Total (mg/kg)	0.0568	0.0608	0.0289	1.02	1.17
	Calcium (Ca)-Total (mg/kg)	4080	5220	14300	13400	15500
	Cesium (Cs)-Total (mg/kg)	0.0093	0.0147	<0.0050	0.0353	0.0103
	Chromium (Cr)-Total (mg/kg)	0.070	0.095	<0.050	0.052	<0.050
	Cobalt (Co)-Total (mg/kg)	0.117	0.092	0.028	0.162	0.079
	Copper (Cu)-Total (mg/kg)	6.14	5.56	4.99	2.28	2.54
	Iron (Fe)-Total (mg/kg)	84.5	91.4	81.0	61.0	35.5
	Lead (Pb)-Total (mg/kg)	0.116	0.130	0.036	0.039	0.034
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	1380	2230	2870	3130	2990
	Manganese (Mn)-Total (mg/kg)	2210	917	51.8	60.1	45.2
	Mercury (Hg)-Total (mg/kg)	0.0086	0.0086	0.0070	0.0081	0.0059
	Molybdenum (Mo)-Total (mg/kg)	0.089	0.137	2.05	0.177	0.119
	Nickel (Ni)-Total (mg/kg)	1.39	1.21	<0.20	<0.20	<0.20
	Phosphorus (P)-Total (mg/kg)	1670	2020	5590	1600	1810
	Potassium (K)-Total (mg/kg)	6240	8640	11900	4930	4420
	Rubidium (Rb)-Total (mg/kg)	4.71	7.91	1.11	5.52	2.24
	Selenium (Se)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	2.97	4.12	28.6	57.7	43.4
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0088	0.0040	<0.0020	0.0249	0.0025
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0067	0.0079	<0.0020	0.0031	0.0020
	Vanadium (V)-Total (mg/kg)	0.27	0.34	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	35.8	27.5	48.6	153	109
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.050		<0.050	<0.050	<0.050

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-10	L1970983-12	L1970983-13	L1970983-15	L1970983-17
		Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
		Sampled Date	04-AUG-17	04-AUG-17	04-AUG-17	04-AUG-17	03-AUG-17
		Sampled Time	16:00	09:00	09:00	09:30	12:00
		Client ID	POPBAL-02 (PLANT) 0664583,5511924	RUBUPAR-01 (PLANT) 0665028,5506330	SALIX-02 (PLANT) 0665028,5506330	RUBUPAR-02 (PLANT) 0665058,5506537	SALIX-03 (PLANT) 0657369,5521892
Grouping	Analyte						
TISSUE							
Physical Tests	% Moisture (%)			70.8			
Metals	Aluminum (Al)-Total (mg/kg)	18.4	47.8	36.4	63.4	60.5	
	Antimony (Sb)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010	
	Arsenic (As)-Total (mg/kg)	0.022	0.025	0.032	0.030	0.030	
	Barium (Ba)-Total (mg/kg)	89.5	26.7	26.8	10.7	47.3	
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	0.013	
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010	
	Boron (B)-Total (mg/kg)	28.1	21.2	18.6	35.5	6.5	
	Cadmium (Cd)-Total (mg/kg)	2.50	0.0136	1.32	0.0139	1.06	
	Calcium (Ca)-Total (mg/kg)	18400	18700	20600	13100	5210	
	Cesium (Cs)-Total (mg/kg)	<0.0050	0.0069	0.0051	0.0083	0.0112	
	Chromium (Cr)-Total (mg/kg)	0.058	0.372	0.071	0.736	0.095	
	Cobalt (Co)-Total (mg/kg)	0.413	0.030	0.108	0.028	0.655	
	Copper (Cu)-Total (mg/kg)	6.04	4.73	4.31	4.14	2.65	
	Iron (Fe)-Total (mg/kg)	58.0	89.7	70.3	106	68.4	
	Lead (Pb)-Total (mg/kg)	0.059	0.069	0.061	0.072	0.059	
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50	
	Magnesium (Mg)-Total (mg/kg)	2980	6560	5160	6250	1840	
	Manganese (Mn)-Total (mg/kg)	27.5	72.4	59.1	42.7	115	
	Mercury (Hg)-Total (mg/kg)	0.0092	0.0068	0.0099	0.0086	0.0063	
	Molybdenum (Mo)-Total (mg/kg)	0.251	1.47	0.204	0.534	0.049	
	Nickel (Ni)-Total (mg/kg)	1.48	0.63	3.21	0.29	3.69	
	Phosphorus (P)-Total (mg/kg)	2030	5770	3730	3790	3070	
	Potassium (K)-Total (mg/kg)	16800	18700	7520	13800	16500	
	Rubidium (Rb)-Total (mg/kg)	2.45	4.22	1.23	2.97	12.9	
	Selenium (Se)-Total (mg/kg)	1.36	0.333	0.250	<0.050	<0.050	
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20	
	Strontium (Sr)-Total (mg/kg)	35.5	20.0	23.0	7.24	24.1	
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020	
	Thallium (Tl)-Total (mg/kg)	0.0020	<0.0020	<0.0020	<0.0020	0.0021	
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10	
	Uranium (U)-Total (mg/kg)	0.0029	0.0029	0.0028	0.0042	0.0048	
	Vanadium (V)-Total (mg/kg)	0.10	0.14	0.13	0.17	0.25	
	Zinc (Zn)-Total (mg/kg)	157	15.1	51.6	12.2	79.7	
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20	
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)		<0.050				

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID	L1970983-19 TISSUE 03-AUG-17 12:00 SALIX-04 (PLANT) 0661624,5521864	L1970983-21 TISSUE 05-AUG-17 09:00 SHEPCAN-01 (PLANT) 0664573,5509567	L1970983-23 TISSUE 04-AUG-17 10:00 AMELALN-01 (BERRIES) 0664789,550346	L1970983-24 TISSUE 04-AUG-17 09:00 RUBUPAR-01 (BERRIES) 0665028,5506330	L1970983-25 TISSUE 04-AUG-17 09:30 RUBUPAR-02 (BERRIES) 0665058,5506537	
Grouping	Analyte					
TISSUE						
Physical Tests	% Moisture (%)					
Metals	Aluminum (Al)-Total (mg/kg)	57.7	60.2	18.1	2.8	12.2
	Antimony (Sb)-Total (mg/kg)	0.022	<0.010	<0.010	<0.010	<0.010
	Arsenic (As)-Total (mg/kg)	0.074	0.031	<0.020	<0.020	<0.020
	Barium (Ba)-Total (mg/kg)	16.9	4.79	114	2.31	4.47
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Boron (B)-Total (mg/kg)	31.3	18.2	23.6	7.9	12.0
	Cadmium (Cd)-Total (mg/kg)	2.95	0.0397	0.0090	<0.0050	0.0062
	Calcium (Ca)-Total (mg/kg)	13300	6300	6830	3910	5970
	Cesium (Cs)-Total (mg/kg)	0.0215	0.0098	<0.0050	<0.0050	<0.0050
	Chromium (Cr)-Total (mg/kg)	0.157	0.300	<0.050	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.236	0.068	0.047	<0.020	<0.020
	Copper (Cu)-Total (mg/kg)	7.09	2.21	7.75	3.85	6.58
	Iron (Fe)-Total (mg/kg)	133	107	37.4	16.1	29.4
	Lead (Pb)-Total (mg/kg)	0.121	0.095	<0.020	<0.020	<0.020
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	3860	1440	1870	1870	3200
	Manganese (Mn)-Total (mg/kg)	121	23.3	14.3	14.2	25.3
	Mercury (Hg)-Total (mg/kg)	0.0092	0.0096	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	0.360	0.702	2.14	0.668	0.417
	Nickel (Ni)-Total (mg/kg)	6.02	0.90	0.40	0.32	<0.20
	Phosphorus (P)-Total (mg/kg)	2640	1130	3330	2370	3740
	Potassium (K)-Total (mg/kg)	14500	8220	15500	6710	10700
	Rubidium (Rb)-Total (mg/kg)	5.88	7.23	2.52	2.34	4.37
	Selenium (Se)-Total (mg/kg)	2.15	0.123	<0.050	0.105	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	18.2	7.49	12.6	3.70	3.28
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0045	0.0094	<0.0020	<0.0020	<0.0020
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	0.21	0.27	0.52
	Uranium (U)-Total (mg/kg)	0.0125	0.0088	<0.0020	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	0.57	0.30	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	144	6.53	31.6	7.58	14.3
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)		<0.050	<0.050	<0.050	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1970983-26 TISSUE 05-AUG-17 09:00 SHEPCAN-01 (BERRIES) 0664573.5509567			
Grouping	Analyte				
TISSUE					
Physical Tests	% Moisture (%)	65.1			
Metals	Aluminum (Al)-Total (mg/kg)	7.7			
	Antimony (Sb)-Total (mg/kg)	<0.010			
	Arsenic (As)-Total (mg/kg)	<0.020			
	Barium (Ba)-Total (mg/kg)	0.674			
	Beryllium (Be)-Total (mg/kg)	<0.010			
	Bismuth (Bi)-Total (mg/kg)	<0.010			
	Boron (B)-Total (mg/kg)	13.6			
	Cadmium (Cd)-Total (mg/kg)	0.0103			
	Calcium (Ca)-Total (mg/kg)	1160			
	Cesium (Cs)-Total (mg/kg)	<0.0050			
	Chromium (Cr)-Total (mg/kg)	<0.050			
	Cobalt (Co)-Total (mg/kg)	<0.020			
	Copper (Cu)-Total (mg/kg)	2.75			
	Iron (Fe)-Total (mg/kg)	23.7			
	Lead (Pb)-Total (mg/kg)	<0.020			
	Lithium (Li)-Total (mg/kg)	<0.50			
	Magnesium (Mg)-Total (mg/kg)	440			
	Manganese (Mn)-Total (mg/kg)	9.03			
	Mercury (Hg)-Total (mg/kg)	<0.0050			
	Molybdenum (Mo)-Total (mg/kg)	1.05			
	Nickel (Ni)-Total (mg/kg)	1.34			
	Phosphorus (P)-Total (mg/kg)	1430			
	Potassium (K)-Total (mg/kg)	8560			
	Rubidium (Rb)-Total (mg/kg)	8.42			
	Selenium (Se)-Total (mg/kg)	0.105			
	Sodium (Na)-Total (mg/kg)	<20			
	Strontium (Sr)-Total (mg/kg)	1.13			
	Tellurium (Te)-Total (mg/kg)	<0.020			
	Thallium (Tl)-Total (mg/kg)	<0.0020			
	Tin (Sn)-Total (mg/kg)	<0.10			
	Uranium (U)-Total (mg/kg)	<0.0020			
	Vanadium (V)-Total (mg/kg)	<0.10			
	Zinc (Zn)-Total (mg/kg)	6.24			
	Zirconium (Zr)-Total (mg/kg)	<0.20			
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.050			

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-1	L1970983-3	L1970983-5	L1970983-7	L1970983-8
		Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
		Sampled Date	03-AUG-17	03-AUG-17	04-AUG-17	04-AUG-17	04-AUG-17
		Sampled Time	10:00	09:00	10:00	12:00	12:00
		Client ID	VACCMEM-01 (PLANT) 0663247,5521493	VACCMEM-02 (PLANT) 0662545,5521593	AMELALN-01 (PLANT) 0664789,550346	SALIX-01 (PLANT) 0664651,5503628	POPBAL-01 (PLANT) 0664651,5503628
Grouping	Analyte						
TISSUE							
Polycyclic Aromatic Hydrocarbons	Acenaphthylene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Anthracene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Benz(a)anthracene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Benzo(a)pyrene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Benzo(b&j)fluoranthene (mg/kg)	<0.090 ^{DLQ}		<0.080 ^{DLQ}	<0.050	<0.050	<0.050
	Benzo(g,h,i)perylene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Benzo(k)fluoranthene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Chrysene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Dibenz(a,h)anthracene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Fluoranthene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Fluorene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	2-methylnaphthalene (mg/kg)	0.156		<0.050	<0.050	<0.050	<0.050
	Naphthalene (mg/kg)	0.054		<0.050	<0.050	<0.050	<0.050
	Phenanthrene (mg/kg)	0.095		<0.050	<0.050	<0.050	<0.050
	Pyrene (mg/kg)	<0.050		<0.050	<0.050	<0.050	<0.050
	Surrogate: Acenaphthene d10 (%)	111.0		109.1	106.9	103.1	
	Surrogate: Chrysene d12 (%)	108.9		110.6	103.9	105.3	
Surrogate: Naphthalene d8 (%)	113.2		99.3	100.1	Not Reptable ^{SMI}		
Surrogate: Phenanthrene d10 (%)	100.7		101.8	105.6	100.6		

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-10	L1970983-12	L1970983-13	L1970983-15	L1970983-17
		Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
		Sampled Date	04-AUG-17	04-AUG-17	04-AUG-17	04-AUG-17	03-AUG-17
		Sampled Time	16:00	09:00	09:00	09:30	12:00
		Client ID	POPUBAL-02 (PLANT) 0664583,5511924	RUBUPAR-01 (PLANT) 0665028,5506330	SALIX-02 (PLANT) 0665028,5506330	RUBUPAR-02 (PLANT) 0665058,5506537	SALIX-03 (PLANT) 0657369,5521892
Grouping	Analyte						
TISSUE							
Polycyclic Aromatic Hydrocarbons	Acenaphthylene (mg/kg)			<0.050			
	Anthracene (mg/kg)			<0.050			
	Benz(a)anthracene (mg/kg)			<0.050			
	Benzo(a)pyrene (mg/kg)			<0.050			
	Benzo(b&j)fluoranthene (mg/kg)			<0.050			
	Benzo(g,h,i)perylene (mg/kg)			<0.050			
	Benzo(k)fluoranthene (mg/kg)			<0.050			
	Chrysene (mg/kg)			<0.050			
	Dibenz(a,h)anthracene (mg/kg)			<0.050			
	Fluoranthene (mg/kg)			<0.050			
	Fluorene (mg/kg)			<0.050			
	Indeno(1,2,3-c,d)pyrene (mg/kg)			<0.050			
	2-methylnaphthalene (mg/kg)			<0.050			
	Naphthalene (mg/kg)			<0.050			
	Phenanthrene (mg/kg)			<0.050			
	Pyrene (mg/kg)			<0.050			
	Surrogate: Acenaphthene d10 (%)				108.0		
Surrogate: Chrysene d12 (%)				108.9			
Surrogate: Naphthalene d8 (%)				97.7			
Surrogate: Phenanthrene d10 (%)				107.0			

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1970983-19	L1970983-21	L1970983-23	L1970983-24	L1970983-25
		Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
		Sampled Date	03-AUG-17	05-AUG-17	04-AUG-17	04-AUG-17	04-AUG-17
		Sampled Time	12:00	09:00	10:00	09:00	09:30
		Client ID	SALIX-04 (PLANT) 0661624,5521864	SHEPCAN-01 (PLANT) 0664573,5509567	AMELALN-01 (BERRIES) 0664789,550346	RUBUPAR-01 (BERRIES) 0665028,5506330	RUBUPAR-02 (BERRIES) 0665058,5506537
Grouping	Analyte						
TISSUE							
Polycyclic Aromatic Hydrocarbons	Acenaphthylene (mg/kg)			<0.050	<0.050	<0.050	
	Anthracene (mg/kg)			<0.050	<0.050	<0.050	
	Benz(a)anthracene (mg/kg)			<0.050	<0.050	<0.050	
	Benzo(a)pyrene (mg/kg)			<0.050	<0.050	<0.050	
	Benzo(b&j)fluoranthene (mg/kg)			<0.050	<0.050	<0.050	
	Benzo(g,h,i)perylene (mg/kg)			<0.050	<0.050	<0.050	
	Benzo(k)fluoranthene (mg/kg)			<0.050	<0.050	<0.050	
	Chrysene (mg/kg)			<0.050	<0.050	<0.050	
	Dibenz(a,h)anthracene (mg/kg)			<0.050	<0.050	<0.050	
	Fluoranthene (mg/kg)			<0.050	<0.050	<0.050	
	Fluorene (mg/kg)			<0.050	<0.050	<0.050	
	Indeno(1,2,3-c,d)pyrene (mg/kg)			<0.050	<0.050	<0.050	
	2-methylnaphthalene (mg/kg)			<0.050	<0.050	<0.050	
	Naphthalene (mg/kg)			<0.050	<0.050	<0.050	
	Phenanthrene (mg/kg)			<0.050	<0.050	<0.050	
	Pyrene (mg/kg)			<0.050	<0.050	<0.050	
	Surrogate: Acenaphthene d10 (%)			115.5	105.5	105.0	
Surrogate: Chrysene d12 (%)			119.1	108.8	112.4		
Surrogate: Naphthalene d8 (%)			99.4	91.8	95.3		
Surrogate: Phenanthrene d10 (%)			108.7	101.2	101.3		

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1970983-26			
		TISSUE			
		05-AUG-17			
		09:00			
		SHEPCAN-01 (BERRIES) 0664573,5509567			
Grouping	Analyte				
TISSUE					
Polycyclic Aromatic Hydrocarbons	Acenaphthylene (mg/kg)	<0.050			
	Anthracene (mg/kg)	<0.050			
	Benz(a)anthracene (mg/kg)	<0.050			
	Benzo(a)pyrene (mg/kg)	<0.050			
	Benzo(b&j)fluoranthene (mg/kg)	<0.050			
	Benzo(g,h,i)perylene (mg/kg)	<0.050			
	Benzo(k)fluoranthene (mg/kg)	<0.050			
	Chrysene (mg/kg)	<0.050			
	Dibenz(a,h)anthracene (mg/kg)	<0.050			
	Fluoranthene (mg/kg)	<0.050			
	Fluorene (mg/kg)	<0.050			
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.050			
	2-methylnaphthalene (mg/kg)	<0.050			
	Naphthalene (mg/kg)	<0.050			
	Phenanthrene (mg/kg)	<0.050			
	Pyrene (mg/kg)	<0.050			
	Surrogate: Acenaphthene d10 (%)	110.4			
	Surrogate: Chrysene d12 (%)	108.7			
Surrogate: Naphthalene d8 (%)	96.6				
Surrogate: Phenanthrene d10 (%)	104.0				

* 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	L1970983-18, -20
Duplicate	Arsenic (As)	DUP-H	L1970983-18, -20
Duplicate	Barium (Ba)	DUP-H	L1970983-18, -20
Duplicate	Cadmium (Cd)	DUP-H	L1970983-18, -20
Duplicate	Manganese (Mn)	DUP-H	L1970983-11, -14, -16, -2, -22, -4, -6, -9
Duplicate	Selenium (Se)	DUP-H	L1970983-18, -20
Duplicate	Tin (Sn)	DUP-H	L1970983-18, -20
Duplicate	Zinc (Zn)	DUP-H	L1970983-18, -20
Duplicate	Zirconium (Zr)-Total	DUP-H	L1970983-1, -10, -13, -17, -19, -3, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DLQ	Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
SMI	Surrogate recovery could not be measured due to sample matrix interference.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/1631E (mod)
		Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.	
HG-DRY-CVAFS-N-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7
		This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 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 HNO ₃ 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-DRY-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (DRY)	EPA 200.3/6020A
		This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).	
		Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.	
MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	Puget Sound WQ Authority, Apr 1997
		This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.	
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.	
PAH-SURR-MS-VA	Tissue	PAH Surrogates for Tissues	SURROGATE
PAH-T-DRY-SOX-MS-VA	Tissue	PAHs in Tissue - dry weight basis	EPA METHODS 3540, 3630, 8270
		This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3540, 3630 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a Soxhlet system to extract with dichloromethane, a subsample of homogenized tissue which has been dried with anhydrous sodium sulphate. The extract then may undergo a silica gel cleanup to remove polar organic compounds. The final extract is analyzed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.	
PAH-TMB-H/A-MS-VA	Soil	PAH - Rotary Extraction (Hexane/Acetone)	EPA 3570/8270

Reference Information

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

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:

15-609383 15-609384

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.



DILLON CONSULTING LIMITED
ATTN: Richard Pope
510 - 3820 Cessna Drive
Richmond BC V7B 0A2

Date Received: 15-AUG-17
Report Date: 13-SEP-17 15:35 (MT)
Version: FINAL

Client Phone: 604-278-7847

Certificate of Analysis

Lab Work Order #: L1974841
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 15-609385, 15-609386
Legal Site Desc:

<Original signed by>

Brent Mack, B.Sc.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

13-SEP-17 15:35 (MT)

Version: FINAL

Sample ID Description Sampled Date Sampled Time Client ID	L1974841-3 Soil 08-AUG-17 13:00 SHEPCAN-02 (SOIL)	L1974841-6 Soil 08-AUG-17 14:00 SHEPCAN-03 (SOIL)	L1974841-9 Soil 09-AUG-17 07:00 ROSA SP-01 (SOIL)	L1974841-14 Soil 09-AUG-17 14:00 VACCMEM-03 (SOIL)	L1974841-21 Soil 10-AUG-17 11:00 SAMBCAE-01 (SOIL)
Grouping	Analyte				
SOIL					
Physical Tests	Moisture (%)			6.14	21.4
	pH (1:2 soil:water) (pH)	7.88	5.47	7.05	4.89
Metals	Aluminum (Al) (mg/kg)	16200	17600	9170	11600
	Antimony (Sb) (mg/kg)	0.43	0.42	0.27	0.24
	Arsenic (As) (mg/kg)	6.73	4.56	2.40	2.50
	Barium (Ba) (mg/kg)	601	245	140	46.6
	Beryllium (Be) (mg/kg)	1.15	0.78	0.57	0.19
	Bismuth (Bi) (mg/kg)	0.34	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	16.1	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.263	0.338	0.202	0.111
	Calcium (Ca) (mg/kg)	60900	2090	4490	185
	Chromium (Cr) (mg/kg)	15.2	15.7	15.7	7.59
	Cobalt (Co) (mg/kg)	8.13	5.14	4.26	1.66
	Copper (Cu) (mg/kg)	15.1	8.50	5.74	4.14
	Iron (Fe) (mg/kg)	24500	20400	14200	9180
	Lead (Pb) (mg/kg)	14.8	12.3	8.63	8.18
	Lithium (Li) (mg/kg)	26.8	16.0	7.8	8.6
	Magnesium (Mg) (mg/kg)	6660	2300	1860	595
	Manganese (Mn) (mg/kg)	719	316	621	25.8
	Mercury (Hg) (mg/kg)	0.0298	0.0144	0.0205	0.0360
	Molybdenum (Mo) (mg/kg)	0.89	1.30	1.12	0.44
	Nickel (Ni) (mg/kg)	18.3	17.4	14.2	5.59
	Phosphorus (P) (mg/kg)	717	670	402	815
	Potassium (K) (mg/kg)	4100	1480	1440	400
	Selenium (Se) (mg/kg)	0.20	0.25	0.20	<0.20
	Silver (Ag) (mg/kg)	0.12	<0.10	<0.10	0.13
	Sodium (Na) (mg/kg)	77	102	<50	<50
	Strontium (Sr) (mg/kg)	111	14.3	12.3	6.20
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.217	0.222	0.170	0.107
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	26.6	250	76.8	185
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.352	0.638	0.346	0.450
	Vanadium (V) (mg/kg)	25.6	31.4	19.1	24.8
	Zinc (Zn) (mg/kg)	65.0	117	43.9	40.9
	Zirconium (Zr) (mg/kg)	2.3	6.0	3.1	4.1

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1974841-24
Description	Soil
Sampled Date	11-AUG-17
Sampled Time	10:00
Client ID	SAMCAE-02 (SOIL)
Grouping	Analyte
SOIL	
Physical Tests	Moisture (%)
	pH (1:2 soil:water) (pH)
	5.05
Metals	Aluminum (Al) (mg/kg)
	34400
	Antimony (Sb) (mg/kg)
	0.26
	Arsenic (As) (mg/kg)
	4.56
	Barium (Ba) (mg/kg)
	59.9
	Beryllium (Be) (mg/kg)
	0.44
	Bismuth (Bi) (mg/kg)
	0.25
	Boron (B) (mg/kg)
	<5.0
	Cadmium (Cd) (mg/kg)
	0.214
	Calcium (Ca) (mg/kg)
	399
	Chromium (Cr) (mg/kg)
	12.5
	Cobalt (Co) (mg/kg)
	1.70
	Copper (Cu) (mg/kg)
	9.56
	Iron (Fe) (mg/kg)
	20400
	Lead (Pb) (mg/kg)
	11.9
	Lithium (Li) (mg/kg)
	10.2
	Magnesium (Mg) (mg/kg)
	894
	Manganese (Mn) (mg/kg)
	218
	Mercury (Hg) (mg/kg)
	0.0881
	Molybdenum (Mo) (mg/kg)
	0.86
	Nickel (Ni) (mg/kg)
	4.30
	Phosphorus (P) (mg/kg)
	688
	Potassium (K) (mg/kg)
	670
	Selenium (Se) (mg/kg)
	0.30
	Silver (Ag) (mg/kg)
	0.48
	Sodium (Na) (mg/kg)
	156
	Strontium (Sr) (mg/kg)
	4.84
	Sulfur (S) (mg/kg)
	<1000
	Thallium (Tl) (mg/kg)
	0.128
	Tin (Sn) (mg/kg)
	<2.0
	Titanium (Ti) (mg/kg)
	495
	Tungsten (W) (mg/kg)
	<0.50
	Uranium (U) (mg/kg)
	0.726
	Vanadium (V) (mg/kg)
	32.7
	Zinc (Zn) (mg/kg)
	25.3
	Zirconium (Zr) (mg/kg)
	7.2

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1974841-3	L1974841-6	L1974841-9	L1974841-14	L1974841-21
		Description	Soil	Soil	Soil	Soil	Soil
		Sampled Date	08-AUG-17	08-AUG-17	09-AUG-17	09-AUG-17	10-AUG-17
		Sampled Time	13:00	14:00	07:00	14:00	11:00
		Client ID	SHEPCAN-02 (SOIL)	SHEPCAN-03 (SOIL)	ROSA SP-01 (SOIL)	VACCMEM-03 (SOIL)	SAMBCAE-01 (SOIL)
Grouping	Analyte						
SOIL							
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)				<0.0050		<0.0050
	Acenaphthylene (mg/kg)				<0.0050		<0.0050
	Anthracene (mg/kg)				<0.0040		<0.0040
	Benz(a)anthracene (mg/kg)				<0.010		<0.010
	Benzo(a)pyrene (mg/kg)				<0.010		<0.010
	Benzo(b&j)fluoranthene (mg/kg)				<0.010		<0.010
	Benzo(b+j+k)fluoranthene (mg/kg)				<0.015		<0.015
	Benzo(g,h,i)perylene (mg/kg)				<0.010		<0.010
	Benzo(k)fluoranthene (mg/kg)				<0.010		<0.010
	Chrysene (mg/kg)				<0.010		<0.010
	Dibenz(a,h)anthracene (mg/kg)				<0.0050		<0.0050
	Fluoranthene (mg/kg)				<0.010		<0.010
	Fluorene (mg/kg)				<0.010		<0.010
	Indeno(1,2,3-c,d)pyrene (mg/kg)				<0.010		<0.010
	2-Methylnaphthalene (mg/kg)				0.025		0.032
	Naphthalene (mg/kg)				<0.010		0.010
	Phenanthrene (mg/kg)				0.020		0.029
	Pyrene (mg/kg)				<0.010		<0.010
	Surrogate: Acenaphthene d10 (%)				80.6		81.2
	Surrogate: Chrysene d12 (%)				86.2		82.2
Surrogate: Naphthalene d8 (%)				73.3		76.8	
Surrogate: Phenanthrene d10 (%)				87.6		85.0	
B(a)P Total Potency Equivalent (mg/kg)				<0.020		<0.020	
IACR (CCME) (mg/kg)				<0.15		<0.15	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1974841-24 Soil 11-AUG-17 10:00 SAMCAE-02 (SOIL)			
Grouping	Analyte				
SOIL					
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)				
	Acenaphthylene (mg/kg)				
	Anthracene (mg/kg)				
	Benz(a)anthracene (mg/kg)				
	Benzo(a)pyrene (mg/kg)				
	Benzo(b&j)fluoranthene (mg/kg)				
	Benzo(b+j+k)fluoranthene (mg/kg)				
	Benzo(g,h,i)perylene (mg/kg)				
	Benzo(k)fluoranthene (mg/kg)				
	Chrysene (mg/kg)				
	Dibenz(a,h)anthracene (mg/kg)				
	Fluoranthene (mg/kg)				
	Fluorene (mg/kg)				
	Indeno(1,2,3-c,d)pyrene (mg/kg)				
	2-Methylnaphthalene (mg/kg)				
	Naphthalene (mg/kg)				
	Phenanthrene (mg/kg)				
	Pyrene (mg/kg)				
	Surrogate: Acenaphthene d10 (%)				
	Surrogate: Chrysene d12 (%)				
	Surrogate: Naphthalene d8 (%)				
	Surrogate: Phenanthrene d10 (%)				
	B(a)P Total Potency Equivalent (mg/kg)				
	IACR (CCME) (mg/kg)				

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1974841-1	L1974841-2	L1974841-4	L1974841-5	L1974841-7
		Description	Tissue	Berry	Tissue	Berry	Tissue
		Sampled Date	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17	09-AUG-17
		Sampled Time	13:00	13:00	14:00	14:00	07:00
		Client ID	SHEPCAN-02 (PLANT) 653955,5520161 PLANT	SHEPCAN-02 (PLANT) 653955,5520161 BERRY	SHEPCAN-03 (PLANT) 663699,5504264	SHEPCAN-03 (PLANT)	ROSA SP-01 (PLANT) 656816,5523489 TISSUE
Grouping	Analyte						
TISSUE							
Physical Tests	% Moisture (%)	61.2	67.8	56.4	66.4	54.3	
Metals	Aluminum (Al)-Total (mg/kg)	45.4	13.8	77.2	11.4	44.0	
	Antimony (Sb)-Total (mg/kg)	0.013	0.013	0.012	<0.010	<0.010	
	Arsenic (As)-Total (mg/kg)	0.039	<0.020	0.064	<0.020	0.049	
	Barium (Ba)-Total (mg/kg)	67.3	5.70	12.3	2.00	12.5	
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010	
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010	
	Boron (B)-Total (mg/kg)	25.4	12.0	16.1	11.6	28.6	
	Cadmium (Cd)-Total (mg/kg)	0.0164	<0.0050	0.0285	0.0210	0.0297	
	Calcium (Ca)-Total (mg/kg)	7270	909	7660	934	15200	
	Cesium (Cs)-Total (mg/kg)	0.0077	<0.0050	0.0131	<0.0050	0.0068	
	Chromium (Cr)-Total (mg/kg)	0.124	<0.050	0.192	<0.050	0.135	
	Cobalt (Co)-Total (mg/kg)	0.057	0.021	0.059	<0.020	0.035	
	Copper (Cu)-Total (mg/kg)	2.04	2.03	3.13	3.94	4.47	
	Iron (Fe)-Total (mg/kg)	101	35.8	158	35.9	76.3	
	Lead (Pb)-Total (mg/kg)	0.106	<0.020	0.110	<0.020	0.071	
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50	
	Magnesium (Mg)-Total (mg/kg)	1370	446	2520	534	4380	
	Manganese (Mn)-Total (mg/kg)	28.6	11.3	37.5	12.2	90.3	
	Molybdenum (Mo)-Total (mg/kg)	0.685	1.08	0.585	1.94	6.13	
	Nickel (Ni)-Total (mg/kg)	1.26	2.02	2.75	3.01	0.49	
	Phosphorus (P)-Total (mg/kg)	1080	1610	1620	1780	6140	
	Potassium (K)-Total (mg/kg)	10300	9440	13600	9920	12200	
	Rubidium (Rb)-Total (mg/kg)	1.40	0.929	7.19	4.56	2.04	
	Selenium (Se)-Total (mg/kg)	0.124	0.206	0.480	0.352	<0.050	
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	20	
	Strontium (Sr)-Total (mg/kg)	19.6	2.15	8.53	1.21	16.9	
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020	
	Thallium (Tl)-Total (mg/kg)	0.0022	<0.0020	0.0033	<0.0020	<0.0020	
	Tin (Sn)-Total (mg/kg)	<0.10	0.26	<0.10	0.58	<0.10	
	Uranium (U)-Total (mg/kg)	0.0061	<0.0020	0.0081	<0.0020	0.0267	
	Vanadium (V)-Total (mg/kg)	0.25	<0.10	0.33	<0.10	0.23	
	Zinc (Zn)-Total (mg/kg)	7.83	7.13	10.2	8.15	15.7	
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20	
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)					<0.050	
	Acenaphthylene (mg/kg)					<0.050	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

13-SEP-17 15:35 (MT)

Version: FINAL

Sample ID	Description	Sampled Date	Sampled Time	Client ID	L1974841-8	L1974841-10	L1974841-12	L1974841-13	L1974841-15
					Berry	Tissue	Tissue	Berry	Tissue
					09-AUG-17	09-AUG-17	09-AUG-17	09-AUG-17	08-AUG-17
					07:00	12:00	14:00	14:00	12:00
					ROSA SP-01 (PLANT) 656816,5523489 BERRY	POPUBAL-03 (PLANT) 656448,5522432	VACCMEM-03 (PLANT) 663755,5519680 TISSUE	VACCMEM-03 (PLANT) 663755,5519680 BERRY	SHEPCAN-QA01 TISSUE
Grouping	Analyte								
TISSUE									
Physical Tests	% Moisture (%)	53.9	65.8	69.0	83.7	52.9			
Metals	Aluminum (Al)-Total (mg/kg)	9.4	43.8	146	30.2	85.6			
	Antimony (Sb)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010			
	Arsenic (As)-Total (mg/kg)	<0.020	0.043	0.043	<0.020	0.057			
	Barium (Ba)-Total (mg/kg)	3.89	39.8	58.5	11.0	13.5			
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010			
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010			
	Boron (B)-Total (mg/kg)	18.1	33.0	16.6	7.4	12.9			
	Cadmium (Cd)-Total (mg/kg)	0.0092	1.65	0.0463	0.0227	0.0326			
	Calcium (Ca)-Total (mg/kg)	5660	23700	4600	1480	7690			
	Cesium (Cs)-Total (mg/kg)	<0.0050	0.0123	0.0198	0.0272	0.0137			
	Chromium (Cr)-Total (mg/kg)	<0.050	0.110	0.159	<0.050	0.206			
	Cobalt (Co)-Total (mg/kg)	<0.020	0.213	0.100	<0.020	0.056			
	Copper (Cu)-Total (mg/kg)	4.65	3.62	5.28	5.35	3.28			
	Iron (Fe)-Total (mg/kg)	27.3	77.1	73.8	20.5	150			
	Lead (Pb)-Total (mg/kg)	<0.020	0.080	0.095	<0.020	0.128			
	Lithium (Li)-Total (mg/kg)	<0.50	0.54	<0.50	<0.50	<0.50			
	Magnesium (Mg)-Total (mg/kg)	2090	3450	2090	1030	2540			
	Manganese (Mn)-Total (mg/kg)	36.0	13.5	1240	273	34.4			
	Molybdenum (Mo)-Total (mg/kg)	1.63	0.191	0.054	0.118	0.829			
	Nickel (Ni)-Total (mg/kg)	0.37	1.68	1.19	0.67	2.24			
	Phosphorus (P)-Total (mg/kg)	3250	1830	1690	1970	1490			
	Potassium (K)-Total (mg/kg)	12200	14100	6310	7720	12200			
	Rubidium (Rb)-Total (mg/kg)	3.19	4.35	10.6	21.8	5.94			
	Selenium (Se)-Total (mg/kg)	<0.050	0.364	<0.050	<0.050	0.313			
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20			
	Strontium (Sr)-Total (mg/kg)	5.96	49.1	4.68	1.40	9.10			
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020			
	Thallium (Tl)-Total (mg/kg)	<0.0020	0.0027	0.0044	<0.0020	0.0040			
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	0.67	<0.10			
	Uranium (U)-Total (mg/kg)	<0.0020	0.0069	0.0066	<0.0020	0.0069			
	Vanadium (V)-Total (mg/kg)	<0.10	0.22	0.26	<0.10	0.35			
	Zinc (Zn)-Total (mg/kg)	10.7	111	30.5	10.3	8.73			
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20			
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.050				<0.050			
	Acenaphthylene (mg/kg)	<0.050				<0.050			

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

13-SEP-17 15:35 (MT)

Version: FINAL

		Sample ID	L1974841-16	L1974841-17	L1974841-18	L1974841-19	L1974841-20
		Description	Berry	Tissue	Berry	Tissue	Berry
		Sampled Date	08-AUG-17	09-AUG-17	09-AUG-17	10-AUG-17	10-AUG-17
		Sampled Time	12:00	12:00	12:00	11:00	11:00
		Client ID	SHEPCAN-QA01 BERRY	ROSA SP-QA01 TISSUE	ROSA SP-QA01 BERRY	SAMBCAE-01 (PLANT) 661926,5520965 TISSUE	SAMBCAE-01 (PLANT) 661926,5520965 BERRY
Grouping	Analyte						
TISSUE							
Physical Tests	% Moisture (%)		66.7	68.6	56.1	69.4	82.4
Metals	Aluminum (Al)-Total (mg/kg)		11.7	33.3	7.3	44.6	6.7
	Antimony (Sb)-Total (mg/kg)		<0.010	<0.010	<0.010	0.013	<0.010
	Arsenic (As)-Total (mg/kg)		<0.020	0.031	<0.020	0.046	<0.020
	Barium (Ba)-Total (mg/kg)		2.26	12.5	4.50	106	62.6
	Beryllium (Be)-Total (mg/kg)		<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)		<0.010	<0.010	<0.010	<0.010	<0.010
	Boron (B)-Total (mg/kg)		12.2	30.8	17.3	23.1	11.4
	Cadmium (Cd)-Total (mg/kg)		0.0326	0.0230	0.0092	0.0144	<0.0050
	Calcium (Ca)-Total (mg/kg)		1100	16300	5970	10900	5140
	Cesium (Cs)-Total (mg/kg)		<0.0050	<0.0050	<0.0050	0.0109	<0.0050
	Chromium (Cr)-Total (mg/kg)		<0.050	0.133	<0.050	0.265	<0.050
	Cobalt (Co)-Total (mg/kg)		<0.020	0.025	<0.020	0.051	<0.020
	Copper (Cu)-Total (mg/kg)		4.52	3.26	4.94	1.83	1.11
	Iron (Fe)-Total (mg/kg)		36.4	59.4	26.6	119	32.4
	Lead (Pb)-Total (mg/kg)		<0.020	0.052	<0.020	0.080	<0.020
	Lithium (Li)-Total (mg/kg)		<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)		622	4310	2170	2950	2170
	Manganese (Mn)-Total (mg/kg)		13.3	89.7	33.6	99.2	26.4
	Molybdenum (Mo)-Total (mg/kg)		1.72	7.10	1.89	0.272	0.177
	Nickel (Ni)-Total (mg/kg)		3.62	0.43	0.44	0.43	0.46
	Phosphorus (P)-Total (mg/kg)		2040	7370	3200	2400	2670
	Potassium (K)-Total (mg/kg)		10500	13200	13400	34800	15100
	Rubidium (Rb)-Total (mg/kg)		5.69	2.27	3.41	6.50	4.53
	Selenium (Se)-Total (mg/kg)		0.436	<0.050	<0.050	<0.050	<0.050
	Sodium (Na)-Total (mg/kg)		<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)		1.44	17.5	6.44	15.3	7.25
	Tellurium (Te)-Total (mg/kg)		<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)		<0.0020	<0.0020	<0.0020	0.0063	<0.0020
	Tin (Sn)-Total (mg/kg)		0.80	<0.10	<0.10	<0.10	0.48
	Uranium (U)-Total (mg/kg)		<0.0020	0.0040	<0.0020	0.0067	<0.0020
	Vanadium (V)-Total (mg/kg)		<0.10	0.16	<0.10	0.29	<0.10
	Zinc (Zn)-Total (mg/kg)		9.04	12.0	9.82	29.8	17.9
	Zirconium (Zr)-Total (mg/kg)		<0.20	<0.20	<0.20	<0.20	<0.20
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)		<0.050	<0.050	<0.050	<0.050	<0.050
	Acenaphthylene (mg/kg)		<0.050	<0.050	<0.050	<0.050	<0.050

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1974841-22 Tissue 11-AUG-17 10:00 SAMBCAE-02 (PLANT) 661369,5521944 TISSUE	L1974841-23 Berry 11-AUG-17 10:00 SAMBCAE-02 (PLANT) 661369,5521944 BERRY		
Grouping	Analyte				
TISSUE					
Physical Tests	% Moisture (%)	78.5	79.9		
Metals	Aluminum (Al)-Total (mg/kg)	62.4	11.2		
	Antimony (Sb)-Total (mg/kg)	<0.010	<0.010		
	Arsenic (As)-Total (mg/kg)	0.033	<0.020		
	Barium (Ba)-Total (mg/kg)	475	121		
	Beryllium (Be)-Total (mg/kg)	0.025	<0.010		
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010		
	Boron (B)-Total (mg/kg)	62.3	14.6		
	Cadmium (Cd)-Total (mg/kg)	0.0071	<0.0050		
	Calcium (Ca)-Total (mg/kg)	12800	3660		
	Cesium (Cs)-Total (mg/kg)	0.0119	<0.0050		
	Chromium (Cr)-Total (mg/kg)	0.159	<0.050		
	Cobalt (Co)-Total (mg/kg)	0.038	<0.020		
	Copper (Cu)-Total (mg/kg)	3.76	3.18		
	Iron (Fe)-Total (mg/kg)	71.5	28.6		
	Lead (Pb)-Total (mg/kg)	0.068	0.035		
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50		
	Magnesium (Mg)-Total (mg/kg)	3220	1560		
	Manganese (Mn)-Total (mg/kg)	438	55.6		
	Molybdenum (Mo)-Total (mg/kg)	0.417	0.093		
	Nickel (Ni)-Total (mg/kg)	7.35	2.14		
	Phosphorus (P)-Total (mg/kg)	2990	3440		
	Potassium (K)-Total (mg/kg)	26100	17100		
	Rubidium (Rb)-Total (mg/kg)	13.0	12.3		
	Selenium (Se)-Total (mg/kg)	<0.050	<0.050		
	Sodium (Na)-Total (mg/kg)	<20	<20		
	Strontium (Sr)-Total (mg/kg)	39.5	10.5		
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020		
	Thallium (Tl)-Total (mg/kg)	0.0048	<0.0020		
	Tin (Sn)-Total (mg/kg)	<0.10	0.36		
	Uranium (U)-Total (mg/kg)	0.0038	<0.0020		
	Vanadium (V)-Total (mg/kg)	0.12	<0.10		
	Zinc (Zn)-Total (mg/kg)	47.9	12.9		
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20		
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)				
	Acenaphthylene (mg/kg)				

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

13-SEP-17 15:35 (MT)

Version: FINAL

		Sample ID	L1974841-1	L1974841-2	L1974841-4	L1974841-5	L1974841-7
		Description	Tissue	Berry	Tissue	Berry	Tissue
		Sampled Date	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17	09-AUG-17
		Sampled Time	13:00	13:00	14:00	14:00	07:00
		Client ID	SHEPCAN-02 (PLANT) 653955,5520161 PLANT	SHEPCAN-02 (PLANT) 653955,5520161 BERRY	SHEPCAN-03 (PLANT) 663699,5504264	SHEPCAN-03 (PLANT)	ROSA SP-01 (PLANT) 656816,5523489 TISSUE
Grouping	Analyte						
TISSUE							
Polycyclic Aromatic Hydrocarbons	Anthracene (mg/kg)						<0.050
	Benz(a)anthracene (mg/kg)						<0.050
	Benzo(a)pyrene (mg/kg)						<0.050
	Benzo(b&j)fluoranthene (mg/kg)						<0.050
	Benzo(g,h,i)perylene (mg/kg)						<0.050
	Benzo(k)fluoranthene (mg/kg)						<0.050
	Chrysene (mg/kg)						<0.050
	Dibenz(a,h)anthracene (mg/kg)						<0.050
	Fluoranthene (mg/kg)						<0.050
	Fluorene (mg/kg)						<0.050
	Indeno(1,2,3-c,d)pyrene (mg/kg)						<0.050
	2-methylnaphthalene (mg/kg)						0.092
	Naphthalene (mg/kg)						<0.050
	Phenanthrene (mg/kg)						<0.050
	Pyrene (mg/kg)						<0.050
	Surrogate: Acenaphthene d10 (%)						105.5
	Surrogate: Chrysene d12 (%)						113.1
Surrogate: Naphthalene d8 (%)						107.8	
Surrogate: Phenanthrene d10 (%)						104.2	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1974841-8	L1974841-10	L1974841-12	L1974841-13	L1974841-15	
		Description	Berry	Tissue	Tissue	Berry	Tissue	
		Sampled Date	09-AUG-17	09-AUG-17	09-AUG-17	09-AUG-17	08-AUG-17	
		Sampled Time	07:00	12:00	14:00	14:00	12:00	
		Client ID	ROSA SP-01 (PLANT) 656816,5523489 BERRY	POPUBAL-03 (PLANT) 656448,5522432	VACCMEM-03 (PLANT) 663755,5519680 TISSUE	VACCMEM-03 (PLANT) 663755,5519680 BERRY	SHEPCAN-QA01 TISSUE	
Grouping	Analyte							
TISSUE								
Polycyclic Aromatic Hydrocarbons	Anthracene (mg/kg)	<0.050					<0.050	
	Benz(a)anthracene (mg/kg)	<0.050					<0.050	
	Benzo(a)pyrene (mg/kg)	<0.050					<0.050	
	Benzo(b&j)fluoranthene (mg/kg)	<0.050					<0.050	
	Benzo(g,h,i)perylene (mg/kg)	<0.050					<0.050	
	Benzo(k)fluoranthene (mg/kg)	<0.050					<0.050	
	Chrysene (mg/kg)	<0.050					<0.050	
	Dibenz(a,h)anthracene (mg/kg)	<0.050					<0.050	
	Fluoranthene (mg/kg)	<0.050					<0.050	
	Fluorene (mg/kg)	<0.050					<0.050	
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.050					<0.050	
	2-methylnaphthalene (mg/kg)	<0.050					<0.050	
	Naphthalene (mg/kg)	<0.050					<0.050	
	Phenanthrene (mg/kg)	<0.050					<0.050	
	Pyrene (mg/kg)	<0.050					<0.050	
	Surrogate: Acenaphthene d10 (%)		100.6					101.5
	Surrogate: Chrysene d12 (%)		113.6					115.0
Surrogate: Naphthalene d8 (%)		96.2					97.4	
Surrogate: Phenanthrene d10 (%)		103.4					100.5	

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L1974841-16	L1974841-17	L1974841-18	L1974841-19	L1974841-20
		Description	Berry	Tissue	Berry	Tissue	Berry
		Sampled Date	08-AUG-17	09-AUG-17	09-AUG-17	10-AUG-17	10-AUG-17
		Sampled Time	12:00	12:00	12:00	11:00	11:00
		Client ID	SHEPCAN-QA01 BERRY	ROSA SP-QA01 TISSUE	ROSA SP-QA01 BERRY	SAMBCAE-01 (PLANT) 661926,5520965 TISSUE	SAMBCAE-01 (PLANT) 661926,5520965 BERRY
Grouping	Analyte						
TISSUE							
Polycyclic Aromatic Hydrocarbons	Anthracene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Benz(a)anthracene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Benzo(a)pyrene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Benzo(b&j)fluoranthene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Benzo(g,h,i)perylene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Benzo(k)fluoranthene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Chrysene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Dibenz(a,h)anthracene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Fluoranthene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Fluorene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	2-methylnaphthalene (mg/kg)	<0.050	0.109	<0.050	0.078	0.058	
	Naphthalene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	
	Phenanthrene (mg/kg)	<0.050	0.056	<0.050	0.052	<0.050	
	Pyrene (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050	
	Surrogate: Acenaphthene d10 (%)	99.8	97.3	95.6	98.2	87.6	
	Surrogate: Chrysene d12 (%)	112.5	108.8	108.9	111.4	95.4	
Surrogate: Naphthalene d8 (%)	94.4	95.5	91.7	89.8	82.7		
Surrogate: Phenanthrene d10 (%)	101.2	99.9	99.0	99.8	86.2		

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1974841-22 Tissue 11-AUG-17 10:00 SAMBCAE-02 (PLANT) 661369,5521944 TISSUE	L1974841-23 Berry 11-AUG-17 10:00 SAMBCAE-02 (PLANT) 661369,5521944 BERRY		
Grouping	Analyte				
TISSUE					
Polycyclic Aromatic Hydrocarbons	Anthracene (mg/kg)				
	Benz(a)anthracene (mg/kg)				
	Benzo(a)pyrene (mg/kg)				
	Benzo(b&j)fluoranthene (mg/kg)				
	Benzo(g,h,i)perylene (mg/kg)				
	Benzo(k)fluoranthene (mg/kg)				
	Chrysene (mg/kg)				
	Dibenz(a,h)anthracene (mg/kg)				
	Fluoranthene (mg/kg)				
	Fluorene (mg/kg)				
	Indeno(1,2,3-c,d)pyrene (mg/kg)				
	2-methylnaphthalene (mg/kg)				
	Naphthalene (mg/kg)				
	Phenanthrene (mg/kg)				
	Pyrene (mg/kg)				
	Surrogate: Acenaphthene d10 (%)				
	Surrogate: Chrysene d12 (%)				
	Surrogate: Naphthalene d8 (%)				
	Surrogate: Phenanthrene d10 (%)				

* 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	Manganese (Mn)	DUP-H	L1974841-14, -24

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.	EPA 200.2/1631E (mod)
MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS This method uses a heated strong acid digestion with HNO ₃ 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.	EPA 200.2/6020A (mod)
MET-DRY-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (DRY) This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A). Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.	EPA 200.3/6020A
MOISTURE-TISS-VA	Tissue	% Moisture in Tissues This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.	Puget Sound WQ Authority, Apr 1997
MOISTURE-VA	Soil	Moisture content This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.	CWS for PHC in Soil - Tier 1
PAH-SURR-MS-VA	Tissue	PAH Surrogates for Tissues	SURROGATE
PAH-T-DRY-SOX-MS-VA	Tissue	PAHs in Tissue - dry weight basis This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3540, 3630 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a Soxhlet system to extract with dichloromethane, a subsample of homogenized tissue which has been dried with anhydrous sodium sulphate. The extract then may undergo a silica gel cleanup to remove polar organic compounds. The final extract is analyzed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.	EPA METHODS 3540, 3630, 8270
PAH-TMB-H/A-MS-VA	Soil	PAH - Rotary Extraction (Hexane/Acetone) This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.	EPA 3570/8270
PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction) 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.	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

** 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

Reference Information

Chain of Custody Numbers:

15-609385

15-609386

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.

Appendix 5 Detection limits used by ALS Global for metal and PAH analysis of soil and vegetation samples

Detection limits for metal analysis of soil samples:

Metals (Soil)	Lowest Detection Limit (mg/kg)
Aluminum (Al)-Total	50
Antimony (Sb)-Total	0.10
Arsenic (As)-Total	0.10
Barium (Ba)-Total	0.50
Beryllium (Be)-Total	0.10
Bismuth (Bi)-Total	0.20
Boron (B)-Total	5.0
Cadmium (Cd)-Total	0.020
Calcium (Ca)-Total	50
Chromium (Cr)-Total	0.50
Cobalt (Co)-Total	0.10
Copper (Cu)-Total	0.5
Iron (Fe)-Total	50
Lead (Pb)-Total	0.50
Lithium (Li)-Total	2.0
Magnesium (Mg)-Total	20
Manganese (Mn)-Total	1.0
Mercury (Hg)-Total	0.0050
Molybdenum (Mo)-Total	0.10
Nickel (Ni)-Total	0.50
Phosphorus (P)-Total	50
Potassium (K)-Total	100
Selenium (Se)-Total	0.20
Silver (Ag)-Total	0.10
Sodium (Na)-Total	50
Strontium (Sr)-Total	0.50
Sulfur (S)-Total	10000
Thallium (Tl)-Total	0.050
Tin (Sn)-Total	2.0
Titanium (Ti)-Total	1.0
Tungsten (W)-Total	0.50
Uranium (U)-Total	0.050
Vanadium (V)-Total	0.20
Zinc (Zn)-Total	2.0
Zirconium (Zr)-Total	1.0

Detection limits for metal analysis of vegetation samples:

Metals (Vegetation)	Lowest Detection Limit (mg/kg)
Aluminum (Al)-Total	2.0
Antimony (Sb)-Total	0.010
Arsenic (As)-Total	0.020
Barium (Ba)-Total	0.050
Beryllium (Be)-Total	0.010
Bismuth (Bi)-Total	0.010
Boron (B)-Total	1.0
Cadmium (Cd)-Total	0.0050
Calcium (Ca)-Total	20
Cesium (Cs)-Total	0.005
Chromium (Cr)-Total	0.050
Cobalt (Co)-Total	0.020
Copper (Cu)-Total	0.10
Iron (Fe)-Total	3.0
Lead (Pb)-Total	0.020
Lithium (Li)-Total	0.50
Magnesium (Mg)-Total	2.0
Manganese (Mn)-Total	0.050
Molybdenum (Mo)-Total	0.020
Nickel (Ni)-Total	0.20
Phosphorus (P)-Total	10
Potassium (K)-Total	20
Rubidium (Rb)-Total	0.050
Selenium (Se)-Total	0.050
Sodium (Na)-Total	20
Strontium (Sr)-Total	0.050
Tellurium (Te)-Total	0.020
Thallium (Tl)-Total	0.0020
Tin (Sn)-Total	0.10
Uranium (U)-Total	0.0020
Vanadium (V)-Total	0.10
Zinc (Zn)-Total	0.50
Zirconium (Zr)-Total	0.20

Detection limits for PAH analysis of soil samples:

PAH (Soil)	Lowest Detection Limit (mg/kg)
Acenaphthene	0.0050
Acenaphthylene	0.0050
Anthracene	0.0040
Benz(a)anthracene	0.010
Benzo(a)pyrene	0.010
Benzo(b&j)fluoranthene	0.010
Benzo(b+j+k)fluoranthene	0.0150
Benzo(g,h,i)perylene	0.010
Benzo(k)fluoranthene	0.010
Chrysene	0.010
Dibenz(a,h)anthracene	0.0050
Fluoranthene	0.010
Fluorene	0.010
Indeno(1,2,3-c,d)pyrene	0.050
2-Methylnaphthalene	0.010
Naphthalene	0.010
Phenanthrene	0.010
Pyrene	0.010
B(a)P Total Potency Equivalent	0.020
IACR (CCME)	0.150

Detection limits for PAH analysis of vegetation samples:

PAH (Vegetation)	Lowest Detection Limit (mg/kg)
Acenaphthene	0.050
Acenaphthylene	0.050
Anthracene	0.050
Benz(a)anthracene	0.050
Benzo(a)pyrene	0.050
Benzo(b&j)fluoranthene	0.050
Benzo(g,h,i)perylene	0.050
Benzo(k)fluoranthene	0.050
Chrysene	0.050
Dibenz(a,h)anthracene	0.050
Fluoranthene	0.050
Fluorene	0.050
Indeno(1,2,3-c,d)pyrene	0.050
2-methylnaphthalene	0.050
Naphthalene	0.050
Phenanthrene	0.050
Pyrene	0.050