Preliminary Regional Risk Assessment

For Contamination Related to the 2021 Atmospheric River Flood Event

Princeton Study Area

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Executive Summary

In November 2021, "atmospheric river" events occurred across southwestern British Columbia (BC) causing widespread flooding and damage in some communities, including the Town of Princeton. Excessive rainfall, combined with warming temperatures, resulted in increased snowmelt and rain-on-snow runoff, which led to the rapid and dramatic rise in river stage levels. As a result, riverbanks and dikes overflowed and the Town of Princeton's sewer lift station was stressed. The Tulameen and Similkameen Rivers contributed to flooding in the Princeton Study Area, which is the subject of this Preliminary Regional Risk Assessment (PRRA).

The objectives of the PRRA are to:

Assess the potential for contamination which is both associated with the November 2021 flood event and present at a regional scale to adversely impact human health and the environment, and

Identify areas where additional action or communication by government agencies are required.

The PRRA is based on data that are representative of conditions across areas impacted by flooded waters. Evaluation of contamination from point sources and risks to private properties or water wells from point source contamination were not assessed. The PRRA relies on data collected from public lands that were impacted by the flood to assess general conditions across the Study Area, including conditions considered representative of typical flood-related impacts to both public and private lands.

Contaminants of potential concern (COPCs) with the potential to be associated with the flood were identified in soil, sediment and groundwater. No COPCs were identified for the evaluation of risks to ecological receptors of concern (ROCs) and, therefore, no unacceptable risks to the environment are predicted.

For evaluating risks to human health, the COPCs in each medium included indicators of potential microbiological contamination in soil and groundwater, as well as turbidity in groundwater, as follows:

› Soil: Total coliforms and fecal coliforms;

› Sediment: Total coliforms and fecal coliforms; and

› Groundwater: Turbidity, total coliforms and *Escherichia coli* (*E. coli)*.

The following conclusions and recommendations with respect to the potential for adverse impacts to human heath are as follows:

Soil and Sediment

Total and fecal coliforms were both measured in soil collected from the Study Area, with the soil data conservatively assumed to be representative of sediment that remains in the Study Area's watercourses. When present, these coliforms may indicate the potential for other microorganisms; however, coliforms are also ubiquitous in the environment (Health Canada, 2020). The BC Ministry of Agriculture and Food (2022) indicates that over time (120 days) the extra load of potential bacteria that may result from flooding would be reduced in healthy soils exposed to ultraviolet rays from the sun. Given the time that has elapsed since the flood event, it is unlikely that bacteria from the flood remain in surface soils in the Study Area.

As coliform bacteria may indicate the potential for other microorganisms, best practices for preventing illness are always recommended and include washing hands after contact with soil or sediment and to wash or cook produce. Further information on reducing risks from microorganisms in soil is available at:

› Food Safety: Preparing | HealthLink BC,Foodborne Illness and Safe Food Handling | HealthLink BC;

› Foodborne illness | HealthLink BC;

- E. Coli Infection from Food or Water | HealthLink BC;
- Hand Washing: Help Stop the Spread of Germs | HealthLink BC;
- Food Safety for Fresh Fruits and Vegetables | HealthLink BC; and
- Foodborne & Waterborne Diseases (bccdc.ca).

The above recommendations align with existing BC Ministry of Health and BC Centre for Disease Control guidance for good hand hygiene and food safety.

Groundwater and Surface Water

Following the flood event, turbidity, total coliforms and *E. coli* in excess of the Guidelines for Canadian Drinking Water Quality were measured in groundwater from the Town of Princeton's water supply wells. Turbidity is a measurement of how clear water is, and when it is high, it can interfere with the treatment of drinking water. The municipality is currently replacing their water supply wells, and in the interim, or until the water is deemed safe for consumption, Interior Health has issued a boil water notice for some areas of Princeton.

Based on the measurement of these parameters in the municipal water supply following the flood, there is the potential that private water wells, which can be more vulnerable to impacts than municipal supply wells, were also impacted. Further, there is the potential that impacted groundwater could overtime migrate to surface water.

Based on the above, users of private water wells and surface water points of diversion in the Study Area, if any, should continue to follow health authority guidance for testing and disinfecting their water source. This guidance and information on how to manage flood-related drinking water issues is available at:

- Drinking Water | Environmental & Seasonal Health | IH (interiorhealth.ca); and
- Floods & Landslides | Natural Disasters & Emergencies | IH (interiorhealth.ca).

The above recommendations align with existing health authority guidance for private water well and point of diversion users.

Summary of the Results of the PRRA

In summary, with respect to the potential for risks to human health and the environment, the results of the PRRA indicate the following:

- Bacteria were found in soil. However, they are naturally occurring in soil and unlikely to remain in surface soil with exposure to sunlight. Best practices for preventing illness, including good hand hygiene and food safety practices, are always recommended.
- Interior Health has issued a boil water notice for some areas of Princeton. As a boil water notice is in place under the direction of the health authority, no additional actions, or communications regarding the identified COPCs in groundwater from the Town of Princeton's water supply are required.
- Potential flood-related impacts to groundwater were identified. Users of private water wells and surface water points of diversion should continue to follow health authority guidance for testing and disinfecting their water source.
- No unacceptable risks are predicted for ecological receptors, including aquatic receptors in surface water bodies.

No additional actions or communications from government agencies are recommended for management of contamination in the Princeton Study Area from the November 2021 flood event.

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1 Introduction

In November 2021, "atmospheric river" events occurred across southwestern BC causing widespread flooding and damage in some communities. Excessive rainfall, combined with warming temperatures, resulted in increased snowmelt and rain-on-snow runoff, which led to the rapid and dramatic rise in river stage levels in the Princeton Study Area. Consequently, riverbanks and dikes overflowed, and Princeton's sewer lift station was stressed. The Tulameen and Similkameen Rivers contributed to flooding in the Princeton Study Area, which is the subject of this Preliminary Regional Risk Assessment (PRRA). The PRRA was conducted at the regional level, based on data representative of regional conditions in areas impacted by flood waters. The PRRA used data collected from public lands that were flooded to assess general conditions across the Study Area, including conditions considered representative of typical flood-related impacts to public and private lands. The PRRA did not include the evaluation of point source contamination or risks from point sources to private properties or water wells.

The assessment focused on the priority contaminants, environmental media, receptors and pathways, which are defined as those that have the potential to drive risk to human health and the environment. These parameters are identified in the SNC-Lavalin report *Preliminary Conceptual Site Models of Potential Contamination Related to the 2021 Atmospheric River Event in BC, Hope, Sumas Prairie, Princeton and Merritt*, dated March 30, 2022 (SNC-Lavalin, 2022a). The preliminary conceptual site model (CSM) for the Study Area from SNC-Lavalin (2022a) has been updated based on the findings of the PRRA.

The objectives of the PRRA are to assess the potential for contamination which is both associated with the November 2021 flood event and present on a regional scale, to adversely impact human health and the environment. Further, it is to identify areas where additional action or communication by government agencies is required. Based on information provided by the province, areas of concern could include, but are not limited to:

- Identifying public health hazards under the *Public Health Act* and drinking water health hazards under the *Drinking Water Protection Act* by the regional health authorities;
- Determining whether notifications or water advisories to water users across a specified geographic region are required;
- Identifying areas where contaminants of potential concern (COPCs) pose an immediate and ongoing risk and require immediate action to protect public health;
- Identifying areas where COPCs pose a long-term risk and require action to protect public health;
- Identifying areas which contain media that are considered contaminated under the *Environmental Management Act*[1] (EMA) and/or *Contaminated Sites Regulation*[2] (CSR);
- Identifying areas with ecological receptors potentially sensitive to COPCs;
- Identifying areas known or expected to include habitat of animals that the federal or provincial governments recognize as threatened, endangered, or of special concern; and
- Identifying areas with year-round ecological receptors or migratory birds.

[1] *Environmental Management Act* (EMA), B.C. Reg. 179/2021 / effective July 7, 2021.
[2] *Contaminated Sites Regulation* (CSR), B.C. Reg. 375/96, includes amendments up to B.C. Reg. 179/2021, July 7, 2021.

This PRRA comprises a human health and ecological risk assessment Problem Formulation only, because, based on the results of the Problem Formulation, a more detailed risk assessment is not required.

This report presents the findings of the PRRA and includes:

- **Section 2**: Human health and ecological risk assessment Problem Formulation, including the identification of contaminants of concern (COCs) that are potentially related to the flood event and have the potential to be present at a regional scale. The Problem Formulation also includes a secondary screening of the COCs to identify final COPCs. Based on the results of the secondary screening, final COPCs were limited to total coliforms and fecal coliforms in soil and sediment, and total coliforms, *Escherichia coli (E. coli)* and turbidity in groundwater. Coliform bacteria are used as indicators for the microbiological contaminants, were identified for the evaluation of risks to human health only and were evaluated qualitatively. The updated human health and ecological CSM is presented in **Section 2.8**.
- **Section 3**: Discussion and Conclusions.
- **Section 4**: Professional Statement.
- **Section 5**: Notice to Reader.
- **Section 6**: References.

Tables and Drawings follow **Section 6**, and SNC-Lavalin (2022b) Surface Soil Sampling Memo is included in **Appendix I**. **Appendix II** presents PRRA Supporting Information.

1.1 Preliminary Conceptual Site Model – Princeton

To help understand the potential risks from the contamination resulting from the flooding events in BC, SNC-Lavalin (2022a) developed Preliminary CSMs for each of the Study Areas impacted by the 2021 atmospheric rivers, including the Princeton Study Area, which is the focus of the PRRA. In addition, data gaps and uncertainties in understanding the impacts of the flood event were identified, and recommendations for addressing data gaps were provided.

The Preliminary CSM for the Princeton Study Area described the setting of the Study Area and defined the extent of the 2021 flood boundary; this information is included in **Sections 2.1, 2.2 and 2.3**. Priority sources and activities were also identified, as were related potential contaminants of concern (PCOCs), which are the contaminants identified as having the potential to be present, based on the potential sources of contamination identified in the Study Area. From the PCOCs identified, a list of *priority* PCOCs was created for the Study Area, which included microbiological parameters[3], metals, light non-aqueous phase liquid (LNAPL), nitrate and polycyclic aromatic hydrocarbons (PAHs) potentially related to coal mining in the area. These priority PCOCs and potential sources are described in further detail in **Section 2.4**.

Finally, the Preliminary CSM (SNC-Lavalin, 2022a) identified potential exposure pathways between these priority PCOCs and receptors in the Study Area that were considered to have the potential to drive risks. These included:

- Human consumption of groundwater or surface water as drinking water;
- Human incidental ingestion of shallow soils contaminated by receding floodwaters;
- Plant and soil invertebrate direct contact with shallow soils contaminated by receding floodwaters and/or irrigated with contaminated groundwater and/or surface water;

[3] Microbiological parameters related to human and animal waste; referred to as pathogens in SNC-Lavalin (2022a).

- Aquatic primary producer direct contact with nitrates in surface water (i.e., potential eutrophication); and
- Aquatic invertebrate direct contact with contaminated sediments and/or surface water.

In the PRRA, these priority PCOCs were identified as COCs when the measured concentrations exceeded applicable benchmarks or when non-regulated parameters were detected frequently. The COCs were then retained as preliminary COPCs and evaluated in a secondary screening process as final COPCs. The COPC screening is provided in **Section 2.7.**

Based on the results of the secondary screening, final COPCs were limited to total coliforms and fecal coliforms in soil and sediment, and total coliforms, *E. coli* and turbidity in groundwater. Coliform bacteria are used as indicators of potential microbiological contaminants and were identified for the evaluation of risks to human health only and were evaluated qualitatively, so the PRRA did not proceed past the Problem Formulation phase. No final COPCs were identified for the evaluation of risks to ecological receptors. The Preliminary CSM was updated based on the results of the PRRA, and this updated model is provided in **Section 2.8**.

1.2 Guidance and Approach

Lands under multiple jurisdictions were impacted by the flood event, including the Vermillion Forks No. 1 Indian Reserve. Therefore, both federal and provincial regulations were considered in the PRRA, as was risk assessment guidance from Health Canada, the Canadian Council of Ministers of the Environment (CCME) and the BC Ministry of Environment and Climate Change Strategy (BC ENV). The specific methods and guidance applied in this work included Health Canada (2021a,b), CCME (2020) and BC ENV (2021a and 2021b)[4]. The federal and provincial guidance is founded in the best available science and is consistent with risk assessment methods recommended by international regulatory agencies, including the United States Environmental Protection Agency (US EPA).

The PRRA used a phased approach:

- **Phase 1**: Compiling data, sampling and identifying major data gaps; and
- **Phase 2**: Problem Formulation, including updating the CSM from SNC-Lavalin (2022a).

As noted, based on the results of the Problem Formulation, a more detailed risk assessment is not required (i.e., the PRRA did not advance past Phase 2).

In Phase 1 existing data from the Princeton Study Area were compiled (including soil and groundwater data from other sources), and field investigations and sampling were conducted to characterize surface soil within the Study Area. The data representative of the Princeton Study Area is included in tables following the report text. Parameters that exceeded the benchmarks were identified as COCs. Microbiological parameters that were detected and/or exceeded applicable guidelines were also identified as COCs, as were unregulated parameters that were detected, considered to have the potential to be associated with the flood event and considered to be present at a regional scale.

[4] Assessment of microbiological parameters was conducted using methods and guidance from health agencies and best practice determined based on the scientific literature.

The Problem Formulation (Phase 2) of the PRRA included the following:

- **Identifying preliminary COPCs:** All COCs identified as having the potential to be associated with the flood event were identified as preliminary COPCs. These are Category A COCs and are described in **Section 2.6.3**.
- **Identifying final COPCs**: Final COPCs were identified by screening the maximum concentrations of preliminary COPCs against receptor-pathway specific benchmarks (protective of human and ecological receptors).
- **Updating the Preliminary CSM:** The Preliminary CSM from SNC-Lavalin (2022a) was updated based on results of the Problem Formulation.
- **Discussing results and drawing conclusions**: The results of the PRRA are presented.
- **Providing recommendations:** Based on the results of the PRRA, recommendations are provided.

It is noted that the following items were considered outside of the scope of the PRRA:

- Assessment of risks from point source contamination on private property, including impacts to individual properties, dwellings or private water wells; and
- Public communication of health messaging.

SNC-Lavalin understands that the requirement for public communication will be determined by the regulatory agencies, based on the results of the PRRA.

2 Problem Formulation

2.1 Site Setting

As a result of the atmospheric river event in November 2021, flooding occurred in the Tulameen and Similkameen Rivers, located in the Similkameen River watershed in the southwest interior of BC. Flooding was most extensive in the Town of Princeton (Princeton) where the population density is highest. As such, the SNC-Lavalin (2022a) Preliminary CSM study focused on Princeton. Lands within Princeton are under multiple jurisdictions and include the Vermillion Forks No. 1 Indian Reserve, located at the confluence of the two rivers, as shown in **Figure 2-1** below in **Section 2.3**.

Princeton is located approximately 280 km east of Vancouver, BC and has a population of approximately 3,000 people. It is located at the confluence of the Tulameen and Similkameen Rivers in the dry Okanagan Range just east of the Cascade Mountains. After the confluence, the Similkameen River flows to the east toward Keremeos, BC, and eventually crosses the international border.

The Study Area comprises the lands within Princeton that were flooded in November 2021. While land use in the Study Area is primarily residential and commercial, industrial and agricultural uses are also present. Within the Study Area, areas used for industrial purposes are located on the south side and east end of Princeton, and agricultural lands are located to the north of the confluence of the two rivers (the point bar agricultural area) within the extent of the flood boundary. Forestry, mining, pharmaceutical cannabis production, tourism, agriculture and ranching are mainstays of the local economy (Town of Princeton, 2022).

Princeton and the surrounding area are characterized as mountainous with an elevation of 631 m asl at the confluence of the two rivers. A bedrock high (680 m asl to 720 m asl) separates the rivers.

The valley bottoms are filled with mostly sands and gravels (over 30 m thick in places) deposited by fluvial and glaciofluvial processes. The main portion of these deposits extends from the west end of Princeton along the Tulameen River to the Similkameen River downgradient of the confluence of the two rivers. These deposits do not seem to be widespread in the upper portion of the Similkameen River valley south of Princeton. Fine-grained valley fill deposits are rarely documented in the Princeton area, except for a few boreholes that identified clay and till (rather than sand and gravel) in the Princeton area. Most of Princeton is underlain Eocene-aged sedimentary Allenby Formation (Princeton Group). The Allenby Formation is mainly shale, sandstone, conglomerate and coal. These folded deposits were the target of coal mining up to the 1960s. Just east of Princeton, the bedrock subcrops are igneous deposits of the Princeton and Nicola Groups. A normal fault runs north/south separating the sedimentary and igneous deposits on the east edge of Princeton.

The coarse-grained sands and gravels of the valley fill sediments are mapped as the Similkameen River Aquifer #259. Aquifer #259 is a shallow, unconfined, vulnerable and productive aquifer that is moderately used. This aquifer is well connected to surface water flows and follows the Similkameen River east and south to the international border. There are several groundwater wells in this aquifer near Princeton, including three main water source wells operated by the municipality. Directly underlying Aquifer #259 is the deeper sedimentary bedrock aquifer #1024. These bedrock units are targeted for water supply mainly where Aquifer #259 is not present (i.e., upland areas and upper Similkameen River valley area).

Princeton is influenced by both inland and coastal weather conditions. The closest Environment Canada Princeton weather station is located at 49º 28' 04.000" N, 120º 30' 45.000" W at an elevation of 701.65 m (Government of Canada, 2009). The average daily air temperature is 6.6ºC. The mean annual precipitation, recorded between the years of 1981 and 2010, is 346.9 mm. The monthly precipitation fluctuates from 16.5 mm in March to 44.5 mm in November. The majority of the snowfall precipitation occurs between November and January. It is acknowledged that these "normals" do not capture the last 12 years of temperature or precipitation data, and that weather events that would lead to moderate and severe riverine flooding (including extreme precipitation such as the 2021 atmospheric river), have and will continue to become more frequent in the years and decades ahead (BC ENV, 2019).

2.2 Ecological Setting

The Study Area is located within the Ponderosa Pine Very Dry-Hot (PPxh1) biogeoclimatic zone, which occurs at low elevations along the very dry valleys of the southern Interior Plateau of British Columbia (Meidinger and Pojar, 1991). The PPxh1 zone occurs from Lytton to north of Lillooet, and west along the Yalakom River and east along the Nicola River (Meidinger and Pojar, 1991). It also occurs as an elevational band between the interior Douglas fir and Bunchgrass zones along the Thompson River from Lytton to east and north of Kamloops and occurs in the Okanagan valley from south of Vernon to the U.S. border. Elevations range from 335 m to 900 m (Meidinger and Pojar, 1991).

The PPxh1 zone is the driest biogeoclimatic zone and, in the summer, given the pronounced rainshadow cast by the Coast Mountains, it is the warmest forested zone in BC. Mean annual temperature ranges from 4.8ºC to 10ºC for 5 – 6 months and is below 0ºC for 2 – 5 months. Summers are very warm, with a mean July temperature range of 17°C – 22°C. The hot, dry summers result in large moisture deficits during the growing season. Winters are cool with light snow cover.

The forests of the PPxh1 zone landscape are dominated by ponderosa pine. Stands are often very open and parklike with a ponderosa pine canopy and an understory dominated by *Agropyron spicatum* (bluebunch wheatgrass). The vegetation often consists of a mosaic of forest and grassland. Ponderosa pine is well adapted to fire, and fires have played an important role in the ecology of the zone. Douglas fir is most common on moist and very moist sites associated with gullies, draws and streams, but it also occurs as a minor component of drier sites in the northern part of the zone. Trembling aspen is a dominant component of the dense stands that occur on riparian or seepage sites throughout the zone. Water birch (*Betula occidentalis*) and paper birch are found locally in moisture-receiving sites. Black cottonwood occurs on floodplains and grasslands occur throughout. The grasslands are thought to have developed because of a combination of edaphic and topographic conditions, together with fire history. Dominant species in ecosystems in good range condition are *Agropyron spicatum* and *Artemisia tridentata* (big sagebrush), as well as Festuca spp. (fescues). Overgrazed sites in fair to poor range condition have less *Agropyron spicatum* and Festuca spp. and more *Artemisia tridentata* and *Poa sandbergii* (Sandberg's bluegrass), along with the invaders *Bromus tectorum* (cheatgrass) and Centaurea spp. (knapweeds). Many of the extensive grassland areas adjacent to the PPxh1 zone are included in the Bunchgrass zone.

The three factors that most influence the assemblage of wildlife species in this zone are short winters with low snowfall, a strategic location between the Great Basin to the south and the boreal forests to the north, and a great diversity of vegetation types. The short, largely snow-free winters attract many animals during the winter months. Mule deer, white-tailed deer, bighorn sheep and Rocky Mountain elk can migrate long distances (up to 80 km) to spend winter in this zone. Flocks of passerine birds that have descended from higher elevations are also found here during the winter months.

2.3 Extent of 2021 Flood Boundary

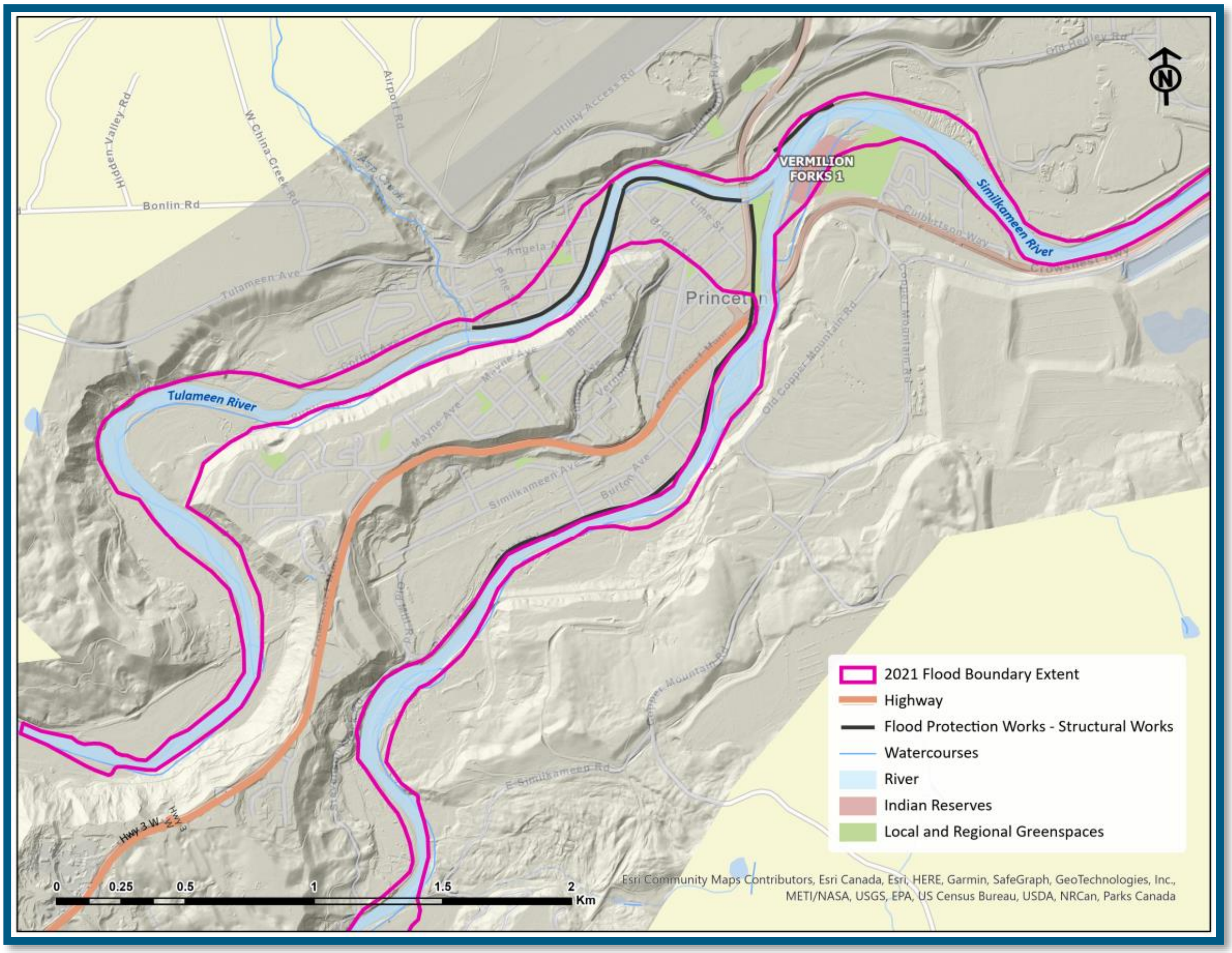
Within the Study Area, the flood event of November 14, 2021, was dominated by significant flow in the Tulameen River (920 m^3/sec) in comparison to the Similkameen River (520 m^3/sec). The river stage of the Tulameen River rose 4 m at Princeton in a matter of hours, resulting in a fast, high energy flood event. The estimated extent of the 2021 flood boundary is provided in **Figure 2-1**, below. There is some uncertainty about the exact extent of the flood. Nonetheless, it was interpreted based on several lines of evidence, including:

- Land parcels under flood order;
- Images of flooding;
- Reports of the sewer lift station backing up;
- Reports of damage to the Public Works building;
- Reports of flood water entering the pumphouses of water supply Wells #1 and #2;
- Breaching of flood protection structures along Allison Flats;
- Anecdotal evidence that Burton Flats and the mobile home park just east of Memorial Park did not flood; and
- Observations made during the SNC-Lavalin March 22, 2022, reconnaissance of the Study Area.

Unlike other areas impacted by the November 2021 atmospheric rivers, no remote sensing imagery was available for the Study Area. It should also be noted that five river watermain crossings were damaged during the flood. This not only raised concerns about water quality related to the backup of the sewer lift station but also contributed to the shutdown of part of the Town of Princeton's water distribution system.

River flow just east of the confluence with the Similkameen River is believed to mainly be constrained to the existing river channel. As such, flood water did not extensively enter the floodplain in this area, except for the low-lying area near Princeton water supply Well #1 and the pumphouses for Wells #1 and #2.

Figure 2-1: Estimated Extent of 2021 Flood Boundary – Princeton Study Area



2.3.1 Results of Site Reconnaissance

On March 22, 2022, SNC-Lavalin conducted a reconnaissance (i.e., via driving and walking) across most of the Study Area to ground truth the flood boundary that was established in SNC-Lavalin (2022a) and to identify sample locations where flood-related sediment was deposited. This reconnaissance was limited to areas with public access only (e.g., parks, trails, roadways and school grounds).

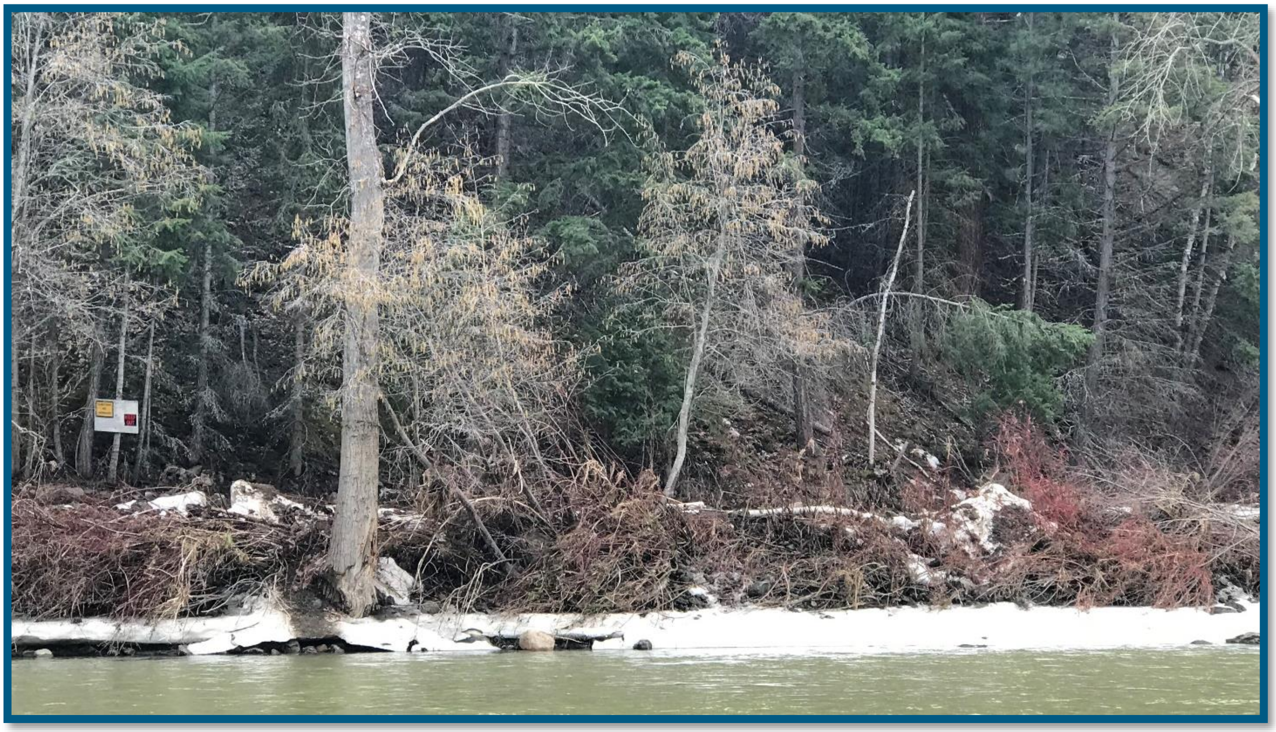
Observations and discussions with local residents indicated that the flood extent boundary established by SNC-Lavalin (2022a) was well defined. The flood waters reached residential properties and apartment buildings along the north side of the Tulameen River (i.e., Allison Flats area) and the low-lying area of downtown Princeton, mainly in the vicinity of Brown Bridge and east of Bridge Street. Sediment and other material deposited on land during the flood event had not been removed or was undergoing remediation, specifically at the Rotary Splash Park, the adjacent motel and surrounding residential properties, as well as in the residential area on the north side of the Tulameen River, upstream of the Brown Bridge. The roadways had been cleared and were accessible, except for the road to the Public Works building, which had been washed out along the south side of the Tulameen River. Photographs from the site reconnaissance are presented below, with additional photographs included in SNC-Lavalin (2022b) in **Appendix I**.

At the confluence and further downstream, the riverbanks were eroded. Log jams were present and gravel and boulders were deposited and/or exposed, which was indicative of scouring and aggressive flow conditions (Photograph 1 and Photograph 2, below). As such, soil samples were not collected downstream of the confluence.

Photograph 1: Two Rivers Park at the confluence. Looking downstream (eastward) and showing eroded banks resulting from the flood. The foreground area was completely submerged during the flood.

Photograph 2: Memorial Park, looking northwest. View of flood debris channel associated with the Similkameen River on the right. The pumphouses for Town of Princeton Wells #1 and #2 are located approximately 100 m to left of this photo location.

One data gap that was identified in the Preliminary CSM (SNC-Lavalin, 2022a) was confirming the suspected presence of a historical coal mine entrance just west of the Public Works building and the potential for flood waters to have entered the historical mine workings and impacted groundwater and/or redistributed coal related PCOCs (i.e., PAHs and metals). The road was inaccessible because it had been washed out during the flood. As a result, reconnaissance of the area could only be completed from across the river. Observations of the slope from across the river did not reveal the presence of any anthropogenic features at the estimated height of the floodwaters, except for “keep out” and “no trespassing” signs.



Photographs 3 and 4: View from the north to south side of the Tulameen River at the suspected location of the historical mine entrance. No entrance was observed at or just above road level.

Based on the results of the reconnaissance, five soil sample locations were identified. The results of SNC-Lavalin's soil sampling are documented separately (SNC-Lavalin, 2022b) and discussed further in **Section 2.6.1**.

2.4 Priority Media and Potential Contaminants of Concern

It is well documented that severe flooding events can result in contaminants being mobilized or remobilized and spatially transported and distributed. The 2021 flooding event in the Study Area was a rapid, high-energy event that scoured and transported natural and human-made materials a significant distance. Sediments transported by the Tulameen and Similkameen River were deposited across the Study Area and remained in some locations after the flood waters receded.

While the deposited sediments were subsequently removed from some areas, the sediments that remain in other areas are now, effectively, soil. In this report, sediments deposited on land during the flood event will be referred to and treated as surface soil. The potential impacts on the mobility and availability of contaminants in the sediments that have become soil, as well as the smaller soil particle size associated with sediments deposited on soil, were considered in the PRRA.

The potential also exists that prior to receding, flood waters infiltrated soils across the Study Area and mixed with shallow groundwater. While the potential for flood waters to have reached deeper aquifers is anticipated to be low, the potential exists that shallow groundwater potentially impacted by the flood event is being used for drinking water or agricultural purposes, or that it could have migrated to downgradient surface water bodies. Based on the results of the Preliminary CSM (SNC-Lavalin, 2022a), the Princeton water supply Wells #1 & #2 (and associated groundwater capture zone) at Memorial Park were identified to be a concern because it was reported that flood water entered Well #1 and #2 pumphouses and may have entered the well casing of Well #1. These wells are located downstream of the Fenchurch Sewer Lift Station that reportedly backed up during the flood. To avoid this situation in the future, Princeton is currently upgrading and adding a second sewer force main to increase the capacity at the Fenchurch Lift Station and relocating the water supply wells. These wells are completed at 32 m and 18 m depth, respectively, in the Similkameen River Aquifer #259 (a potential contaminant migration pathway), which interacts and discharges to the Similkameen River (a contaminant migration pathway).

No data from sediments (i.e., particulate material that remains in rivers, streams or ditches below the high-water mark) that are representative of post-flood conditions were available for water courses in the Study Area. Due to the lack of sediment data, the available soil data (i.e., collected from sediments deposited on land during the flood event) were conservatively assumed to be representative of sediment and were screened against the applicable sediment benchmarks to identify COCs.

Given the rapid, high-energy nature of the flood event, surface water quality was not characterized during or after the event. Like sediment, surface water has the potential to have been impacted by flooding through natural and human-made materials being transported across lands that are generally “dry” into the rivers in the Study Area. However, given that the rivers were high-flow and high-volume (flow rates of the Tulameen River [920 m^3/sec] and the Similkameen River [520 m^3/sec]), flood associated impacts, if any, would have been limited both temporally to a narrow window immediately following the flood event and spatially, given the magnitude of dilution within the rivers with flow downgradient. Based on this and on the available data representative of post-flood conditions in the Sumas Prairie Study Area indicating that concentrations of flood-related PCOCs in surface water returned to baseline levels in December 2021 (Gabelhouse et al., 2022), no flood-related impacts to surface water are anticipated. This is further discussed in the context of the results of the PRRA in **Section 3**.

Given the mechanisms by which the flood had the potential to impact the environment, the conclusions and recommendations of SNC-Lavalin (2022a) generally focused on the following media:

- Surface soil, including sediments that were deposited on land during the flood event. Surface soil was defined as ground surface to 0.2 m for land that has not been disturbed since the flood. The rationale is that this is the depth horizon where the highest concentrations of flood-related contaminants would be expected to be found (i.e., material deposited from the flood).
- Sediments, which are defined as sediments that remain in rivers, streams or ditches below the high-water mark.
- At-risk drinking water sources.

Available data representative of these priority media, including surface soil (which was also considered to be representative of sediments) and groundwater, are further discussed and evaluated in subsequent sections of the PRRA.

2.4.1 Priority Potential Contaminants of Concern

Based on a review of potential sources and activities in the general region and within the interpreted flood extent for the Study Area, the priority source of contamination was the sewer lift station located east of downtown Princeton that backed up during the flood. However, other sources were also considered. Priority PCOCs and the media these contaminants are most likely to be associated with are listed below:

- Microbiological parameters: The sewer lift system, which is located upgradient of two of the Town of Princeton's water supply wells and pumphouses, backed up during the flood event. In addition, other sources of microbiological parameters, such as animal manure, on-site septic systems and/or domestic wastewater have the potential to exist in the Princeton Study Area.
- Metals: Numerous anthropogenic (e.g., historical coal mining and a currently operating copper mine) and natural sources of various metals exist in the Princeton Study Area. In previous studies on potential contamination caused from flooding, metals were often COCs due to their persistence as pollutants (Ibragimow et al., 2013; Ciszewski and Grygar, 2016; Ponting et al., 2021). These studies indicated the potential for the mobility or availability of some metals to change through altered redox conditions resulting from flooding and/or post-flood changes to surface soil texture (e.g., due to particle size and density).
- Fuels: Due to potential fuel sources (e.g., vehicles, heating oil tanks, fuel storage tanks) in the Study Area, contaminants associated with fuels were retained as priority contaminants. If fuels (e.g., gasoline, diesel) were released in a flooded area, they have the potential to spread and contaminate shallow soil when the flood waters receded. There was no anecdotal evidence and there were no observations of such releases having occurred in the Princeton Study Area.
- Nitrates: Activities with sources of nitrates were identified in the Study Area (e.g., septic systems, wastewater plants).
- PAHs: Because PAHs were identified as potentially related to historic coal mining, SNC-Lavalin analyzed for PAHs in all soil samples collected and carried out a site reconnaissance. The site reconnaissance did not indicate the presence of a suspected historical mine entrance within the Study Area.

Other chemical types/families were not considered priorities in SNC-Lavalin (2022a) because it was concluded they would be less of a concern on a regional scale, due to the limited extent of their sources/volume/use, and/or their limited persistence in the environment. However, where data for other parameters were available they were considered in this PRRA.

As noted, microbiological parameters were identified as PCOCs based on potential sources in the Study Area. These parameters included salmonella and the three indicators of contamination: total coliforms, fecal coliforms and *E. coli* (Health Canada, 2020). These bacteria are routinely used as indicators of microbiological contamination.

The term total coliforms describes a group of bacteria that are widespread in nature and are generally not harmful. The total coliform test includes several species that are not of fecal origin (Health Canada, 2020). When total coliforms are detected without the presence of *E. coli* their source is most likely environmental, not human or animal. Total coliforms are generally not considered to be a reliable measure of fecal organisms that could lead to detrimental health effects (Health Canada, 2020).

Fecal coliforms (also known as thermotolerant coliforms) are a subset of total coliform bacteria that have a more fecal-specific origin (Health Canada, 2020). Fecal coliforms by themselves are not pathogenic but are used as indicator organisms, which, when present, may indicate the presence of other pathogenic bacteria. Testing for fecal coliforms also captures some species of non-fecal origin, including species of environmental origin (Health Canada, 2020).

E. coli is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. Most *E. coli* strains are harmless (CDC, 2022) and *E. coli* is ubiquitous in the environment. Like fecal coliforms, regulatory agencies use *E. coli* as an indicator of the potential for pathogenic bacteria; however, the presence of *E. coli* does not necessarily indicate that pathogens are present.

The priority PCOCs, as well as the additional parameters for which data were available for the Study Area, are further discussed and evaluated in subsequent sections of this PRRA.

2.5 Applicable Standards & Guidelines

The following is a summary of numerical standards and guidelines (i.e., benchmarks) that were used to identify COCs in each of the media types. Given that lands under multiple jurisdictions were impacted by the flood event, both the provincial and federal regulations apply to the Study Area. As a result, the PRRA applied provincial standards and BC ENV risk assessment guidance, as well as federal guidelines and federal risk assessment guidance from Health Canada and the Canadian Council of Ministers of the Environment (CCME). Accordingly, the analytical results for soil (also evaluated as sediment) and groundwater collected from the Study Area have been evaluated based on both the provincial BC CSR standards and federal guidelines (from various sources) listed below. Land uses within the Study Area are varied, so SNC-Lavalin applied standards and guidelines applicable to the most sensitive land uses, including Agricultural (AL) and Residential (RL) (BC CSR Low Density RL or RLLD). These “sensitive use” standards and guidelines protect other regulatory defined land uses within the Study Area, including parkland (PL), commercial (CL) and industrial (IL) land uses.

Provincial Standards:

› CSR Schedule 3.1 Part 1 (Matrix), Part 2 and 3 (Generic Numerical) AL and RLLD Land Use Standards for Soil;

› CSR Schedule 3.2 Generic Numerical Water Standards Freshwater Aquatic Life (AW), Irrigation (IW), Livestock (LW) and Drinking Water (DW); and

- CSR Schedule 3.4 Generic Numerical Sediment Standards, Freshwater Sediment Standard for Sensitive Use (FWSedSU).

The BC Sediment Quality Guidelines have not been included in the analytical chemistry tables presenting sediment data because they are largely based on the CCME Canadian Environmental Quality Guidelines (CEQG) for sediment, which have been applied (see below Federal Guidelines), with a few exceptions (e.g., nickel, selenium). Parameters that do not have a CCME CEQG are further considered in the PRRA.

Federal Guidelines:

- *Canada Wide Standards for Petroleum Hydrocarbons in Soil (CWS-PHC),* Canadian Council of Ministers of the Environment (CCME), Winnipeg, MB, January 1, 2008;
- *Canadian Environmental Quality Guidelines* (CEQG) for AL and RL Land Use in Soil, CCME, including updates to 2022;
- CEQG for sediment including the Interim Sediment Quality Guidelines (ISQG) and the Probable Effect Levels (PELs), CCME, including updates to 2022.
- *Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites* (FIGWQG), prepared for the Federal Contaminated Sites Action Plan (FSCAP) Secretariat of Environment Canada, Version 4, June 2016; and
- Guidelines for Canadian Drinking Water Quality (GCDWQ).

While these guidelines and standards were applied to identify COCs, parameters that do not have screening benchmarks were also detected in the various media. Those that were considered to have the potential to be associated with the flood event and be present on the regional scale were identified as COCs.

2.6 Data Evaluated in the PRRA

Available data representative of post-flood conditions in the Study Area were compiled and compared to the benchmarks summarized in **Section 2.5** to identify COCs with the potential to be related to the flood event.

The data considered in the PRRA were from limited sources, including soil data collected by SNC-Lavalin (see **Section 2.6.1**, below) and additional soil and groundwater data collected on behalf of the Town of Princeton to assess the impacts of the flood event. The available groundwater data are for Princeton's water supply wells, including Wells #1 and #2. The collection methods for the Town of Princeton data sources were reviewed and confirmed to align with recommended sampling protocols. Further, the sampling conducted for soil and groundwater in the Study Area focussed on the priority PCOCs identified in SNC-Lavalin (2022a). Therefore, all the available data are considered representative of flood-related impacts. On this basis, although the Town of Princeton data sources could not be referenced, all the data was considered when identifying COCs.

As noted, no sediment data (i.e., sediments that remain in rivers, streams or ditches below the high-water mark) representative of post-flood conditions were available for water courses in the Study Area. The soil data were conservatively assumed to be representative of sediment and were screened against the applicable sediment benchmarks to identify COCs.

The data considered in the PRRA is further discussed below.

2.6.1 SNC-Lavalin 2022 Soil Investigation (SNC-Lavalin, 2022b)

SNC-Lavalin conducted a soil sampling program in the Study Area on March 22, 2022. The sampling locations, methods and results are presented in SNC-Lavalin (2022b), which is included in **Appendix III**. The soil sample locations were selected based on public accessibility (i.e., publicly accessible vs private lands) and visible deposits on land that had not been disturbed since the flood. Parameters chosen for analysis at each location were based on the priority PCOCs identified in SNC-Lavalin (2022a) and on observations at the time of sampling. All samples were collected at depths of ground surface to 0.2 m to sample sediment deposited during the flood event.

A total of six samples (including one duplicate sample) were collected from five locations within the areas flooded by the Tulameen River and the Similkameen River. **Drawing 688421-002** shows the locations of where samples were collected.

The soil analytical results from the sampling program are provided in Tables 1 to 6 following the text. Parameters in soil samples with concentrations greater than the CSR standards and/or CCME guidelines were as follows:

- Nickel at sample location P-SS22-01 exceeded CCME AL/RL guidelines;
- Ethylbenzene at sample location P-SS22-03 exceeded CCME AL/RL guidelines. The method detection limit (MDL) for benzene and toluene was higher than the CCME AL/RL guideline at P-SS22-03 and P-SS22-05 (ethylbenzene as well); and
- Phenanthrene exceeded CSR AL and RLLD standards and CCME AL/RL guidelines at sample location P-SS22-03. The MDL was higher than the CCME AL/RL guideline for naphthalene in all samples.

There are no benchmarks for microbiological parameters in soil. Concentrations of these parameters are as follows:

- Total coliforms: concentrations were less than laboratory MDL in all samples except for sample location P-SS22-02 (46 most probable number per gram [MPN/g]) and sample location P-SS22-03 (13 MPN/g); and
- Concentrations of fecal coliforms, *Escherichia coli* (*E. coli)*, and Salmonella were all less than laboratory MDL in samples.

2.6.2 Data from Other Sources

In addition to the data from SNC-Lavalin (2022b) summarized above, additional soil and groundwater data were provided by the Town of Princeton and were compiled and considered when evaluating impacts from the flood event in the Princeton Study Area. As noted, all soil data was also assumed to be representative of sediment below the high-water mark in watercourses in the Study Area; the SNC-Lavalin (2022b) soil data has been compared to the sediment benchmarks in Tables 7 to 11 following the text.

The additional available data considered in the PRRA include the following:

- Soil samples: Eleven soil samples submitted for one or more of the following analyses: total and fecal coliforms, benzene, toluene, ethylbenzene, and xylenes (BTEX), volatile petroleum hydrocarbons in soil (VPHs), light and heavy extractable petroleum hydrocarbons in soil (LEPHs/HEPHs) (or extractable petroleum hydrocarbons [EPH_{10-19}/EPH_{19-32}]) and PAHs. A summary of the available results is presented in Table 12.

- Groundwater samples: A total of 198 groundwater samples submitted for analysis of total coliform and *E. coli*, 103 samples for turbidity, six samples for inorganics and general chemical parameters and five samples for total metals. As noted, the available groundwater data were for Princeton's water supply wells. A summary of the groundwater data is presented in Table 13.

COCs in soil, sediment and groundwater are identified in **Section 2.6.3**, below.

2.6.3 Evaluation of Data Sources and Identification of Contaminants of Concern

As described, COCs in soil/sediment and groundwater were identified by comparing the chemistry results for samples collected from the Study Area to the benchmarks summarized in **Section 2.5**. The available data is presented in the tables following the report text including:

- Tables 1 to 6 present the analytical results for surface soil collected by SNC-Lavalin;
- Tables 7 to 11 present the SNC-Lavalin results compared to the sediment benchmarks; and
- Tables 12 and 13 present a summary of the data soil and groundwater data from the Town of Princeton.

Based on the objectives of the PRRA, specifically to evaluate potential risks associated with flood-related contamination at the regional level, the data have been categorized based on the likelihood that they are representative of flood-related contamination and that the identified contamination has the potential to be present on a regional scale.

All available data (i.e., from SNC-Lavalin [2022a] and from the Town of Princeton sources) are for the priority PCOCs identified in SNC-Lavalin (2022a) and are considered representative of potential flood-related impacts. Therefore, all parameters detected frequently and/or exceeding benchmarks, except those representative of background conditions. The data were further evaluated to determine if they have the potential to be representative of impacts at the regional level. In this evaluation, the frequency at which a parameter exceeded a standard or guideline was considered, and for non-regulated parameters, the frequency of detection, was considered.

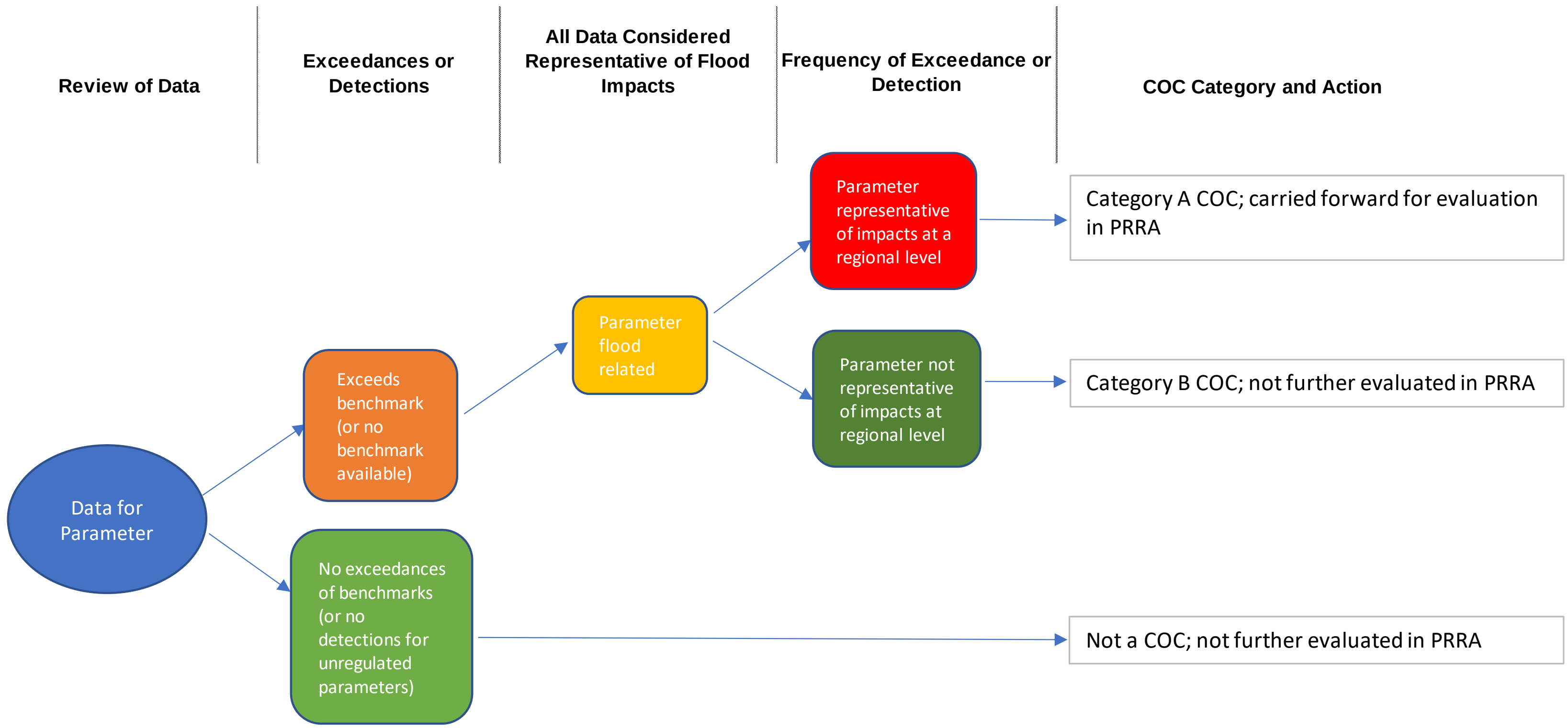
Based on the results of the evaluation, the data were categorized as follows:

- COCs potentially representative of regional, flood-related impacts (Category A COCs): Data for these parameters indicate the potential for the measured concentrations to be associated with the flood event and representative of impacts on a regional scale.
- COCs not representative of regional, flood-related impacts (Category B COCs): Data for these parameters indicate they are unlikely to be associated with or exacerbated by the flood event and/or are not representative of impacts on a regional scale.

Category B COCs will not be further evaluated in the PRRA.

Figure 2-2, below presents the COC categorization process.

Figure 2-2: COC Categorization Process



The following sections

- Describe the available data using the categories depicted in **Figure 2-2**; and
- Identify COCs in each medium.

2.6.3.1 Soil

Naturally occurring parameters, such as soil minerals that were consistently detected across samples (e.g., calcium, magnesium, potassium) were not retained as COCs. Further, while ammonia-N and soluble phosphate were detected across the samples submitted for analysis, they were not retained as COCs. They are unregulated but were within typical levels and representative of natural conditions in the Study Area. While background levels of ammonia in soil are typically between 1 µg/g and 5 µg/g, ATSDR (2004) indicates that additional ammonia is often present from natural or synthetic fertilizer application, human or animal waste, decaying organic matter or natural nitrogen fixation from the atmosphere. And Horneck et al. (2011) indicate that ammonia-N concentrations greater than 10 µg/g may occur in cold or wet soils. Within the Study Area, the average concentration of ammonia-N measured in soils is 10.2 µg/g, but this is likely associated with natural sources and/or elevated because the soils were cold and wet following the flood event. Further, the average concentration of soluble phosphate was 1.42 mg/L, which is within the range considered to be low for soil (Horneck et al., 2011).

Soil pH levels exceeded the CCME AL and RL guideline of pH 6.0 to 8.0 in select soil samples, ranging from 8.2 to 8.7. Nonetheless, the measured soil pH is considered representative of natural conditions in the region. The BC Ministry of Agriculture and Food (2015) indicates that in areas of low rainfall such as the area of the Study Area (i.e., the South-Central Interior), mineral compounds may become concentrated, leading to the development of alkaline soils and saline soils. On this basis, soil pH is not considered to be a COC.

The laboratory MDLs for select parameters/samples were greater than the CCME guidelines. This includes benzene and toluene from the SNC-Lavalin (2022b) data, and benzene, ethylbenzene, toluene, naphthalene and phenanthrene from the data provided by the Town of Princeton. Of these parameters, only phenanthrene and ethylbenzene, which are discussed below, were identified in any of the samples submitted for analysis. None of the other parameters were detected. Therefore, while there is some uncertainty whether the samples with elevated detection limits exceed the guidelines, it is unlikely that they do, because they were not detected in any samples and no visual or olfactory evidence of contamination was noted during the SNC-Lavalin March 22, 2022 site reconnaissance and sampling. On this basis, these parameters were not identified as COCs.

The concentration of phenanthrene (0.259 µg/g) in one soil sample exceeded both the CSR AL standard (0.1 µg/g) and the CCME AL/RL guideline protective of soil leaching to groundwater used by aquatic life (0.046 µg/g). In addition, 1-methylnaphthalene (0.163 µg/g) and 2-methylnapthalene (0.105 µg/g) were detected in the same soil sample. These concentrations were well below the CSR soil standards for human health, but there are no standards/guidelines for ecological receptors. These PAHs were not detected in any of the other eight soil samples (four from SNC-Lavalin [2022b] and four from the Town of Princeton source). The measured concentrations of them are localized (i.e., potentially related to a point source) and not considered representative of regional soil quality in the Study Area. On this basis, phenanthrene, 1-methylnaphthalene and 2-methylnapthalene were identified as Category B COCs.

Like the PAHs, ethylbenzene was detected in a single soil sample, and its concentration (0.156 µg/g) was greater than the CCME AL and RL guideline. It was not detected in any of the other twelve soil samples analyzed (one from SNC-Lavalin (2022b) and eleven from the Town of Princeton source of soil data). The measured concentration exceeds the CCME groundwater check guideline for drinking water only. Based on the infrequent detection, the ethylbenzene concentration is not considered to be representative of regional soil quality in the Study Area, and thus, was identified as a Category B COC.

In addition to the above parameters, nickel exceeded the CCME AL and RL guideline in one sample. Despite being measured in only one sample, nickel was carried forward as a Category A COC based on the limited number of soil samples analyzed for metals (including nickel) (n=5) and the resulting lower certainty regarding its potential to be present at a concentration exceeding the CCME guideline on a regional scale.

A summary of the COCs identified in soil is presented in **Table 2-1**, below.

Table 2-1: Soil COCs Identified in the Princeton Study Area

Parameter	> Standard / Guidelines	Potential to be Flood-Related?*	Potential to be representative of impacts at a regional level?**	Rationale	COC Category
Ethylbenzene	CCME AL/RL	Yes	No	> CCME AL/RL in 1 of 13 samples; < MDL in all other samples	B
Nickel	CCME AL/RL	Yes	Yes	> CCME AL/RL in 1 of 5 samples; conservatively carried forward	**A**
1-methylnaphthalene	NA	Yes	No	> MDL in 1 of 9 samples; < MDL in all other samples	B
2-methylnaphthalene	NA	Yes	No	> MDL in 1 of 9 samples; < MDL in all other samples	B
Phenanthrene	CSR AL; CCME AL/RL	Yes	No	> CSR and CCME in 1 of 9 samples; < MDL in all other samples	B
Microbiological indicator parameters (fecal coliforms, total coliforms)	NA	Yes	Yes	Fecal coliforms detected in 9 of 16 samples; total coliforms detected in 14 of 16 samples	**A**

Notes:

**	All data conservatively assumed to have the potential to be flood-related
CSR	BC Contaminated Sites Regulation
CCME	Canadian Council of Ministers of the Environment
AL	Agricultural
RL	Residential
Category A	Potentially flood-related and representative of regional impacts; carried forward for evaluation in PRRA
Category B	Not flood-related/not representative of regional impacts; not carried forward for further consideration in PRRA
NA	No standards/guidelines available

As presented in **Table 2-1**, Category A COCs identified in soil include the following:

- Nickel; and
- Microbiological indicator parameters (fecal coliforms and total coliforms).

It is noted that *E. coli* was not detected in the five soil samples submitted for analysis by SNC-Lavalin (2022b) and, therefore, it was not identified as a COC. An additional 11 soil samples from the Town of Princeton soil data were submitted for analysis of fecal coliforms and total coliforms, but not for *E. coli*.

2.6.3.2 Sediment

The soil data collected by SNC-Lavalin and on behalf of the Town of Princeton were conservatively assumed to be representative of sediment and were screened against the applicable sediment benchmarks to identify COCs.

Like for soil, naturally occurring sediment parameters such as minerals that were consistently detected across samples (e.g., calcium, magnesium, potassium) were not retained as COCs. Further, ammonia-N and soluble phosphate were not evaluated as COCs because they are highly soluble and would therefore not remain in sediments once submerged. On this basis, no further consideration was given to evaluating these nutrients in sediments.

Most of the PAHs analyzed for were not detected in eight of the nine samples submitted for analysis (five by SNC-Lavalin (2022b), four by the Town of Princeton); however, the MDLs for select PAHs exceeded the CCME ISQG. While there is uncertainty about whether the non-detect PAHs exceed sediment benchmarks, it is premature to identify them as COCs based on non-detect data. Further, as per CCME (1999), adverse biological effects rarely occur at concentrations below the ISQG, while they are expected to occur frequently above the PEL. All MDLs were less than the CCME PELs. Consequently, non-detect PAHs were not retained as COCs.

Using the same rationale discussed for soil, phenanthrene, 1-methylnaphthalene and 2-methynaphthalene, were not considered representative of regional sediment quality (each were detected in only a single sample [n=9], with phenanthrene and 2-methylnapthalene measured above the CCME ISQG). On this basis, the PAHs were identified as Category B COCs. It is noted that while phenanthrene and 2-methylnaphthalene exceeded the CCME ISQGs, the measured concentrations were below the CCME PELs, and thus are considered to represent a low risk to aquatic organisms.

While copper in a single soil sample exceeded the CCME ISQG, it was retained as a Category A COC based on the limited number of samples analyzed for metals (n=5) and the resulting lower certainty regarding its potential to be present on a regional scale.

A summary of the COCs identified in sediment is presented in **Table 2-2**.

Table 2-2: Sediment COCs Identified in the Princeton Study Area

Parameter	> Standards / Guidelines	Potential to be Flood-Related?*	Potential to be representative of impacts at a regional level?**	Rationale	COC Category
Ethylbenzene	NA	Yes	No	> MDL in 1 of 13 samples; < MDL in all other samples	B
HEPH/EPH$_{C19-32}$	NA	Yes	Yes	> MDL in 8 of 16 samples; < MDL in all other samples	**A**
Copper	CCME ISQG	Yes	Yes	> CCME ISQG in 1 of 5 samples; conservatively carried forward	**A**
Chromium	CCME ISQG	Yes	Yes	> CCME ISQG in 3 of 5 sample	**A**
1-methylnaphthalene	NA	Yes	No	> MDL in 1 of 9 samples; < MDL in all other samples	B
2-methylnaphthalene	CCME ISQG	Yes	No	> CCME ISQG in 1 of 9 samples; < MDL in all other samples	B
Phenanthrene	CCME ISQG	Yes	No	> CCME ISQG in 1 of 9 samples; < MDL in all other samples	B
Microbiological indicator parameters (fecal coliforms, total coliforms)	NA	Yes	Yes	Fecal coliforms detected in 9 of 16 samples; total coliforms detected in 13 of 16 samples	**A**

Notes:

**	All data conservatively assumed to have the potential to be flood-related
CSR FWSedSU	BC CSR Regulation Schedule 3.4 Freshwater Sediment Standards, Sensitive Use
CCME ISQG	CCME Interim Sediment Quality Guideline
CCME PEL	CCME Probable Effect Level
Category A	Potentially flood-related and representative of regional impacts; carried forward for evaluation in PRRA
Category B	Not flood-related/not representative of regional impacts; not carried forward for further consideration in PRRA
HEPH	Heavy extractable petroleum hydrocarbons
EPH$_{C19-32}$	Extractable petroleum hydrocarbons; covers same carbon range as HEPH, but includes select PAHs
NA	No standards/guidelines available

As presented in **Table 2-2**, Category A COCs identified in sediment include the following:

› HEPH/EPH$_{C19-C32}$;

› Chromium;

› Copper; and

› Microbiological indicator parameters (fecal coliforms and total coliforms).

As noted for soil, *E. coli* was not detected and therefore is not identified as a COC in sediment.

2.6.3.3 Groundwater

The available data for groundwater was reviewed to identify COCs. Groundwater data was, as noted, only available from the Town of Princeton source and was only for select parameters, including microbiological parameters (total coliform and *E. coli*), inorganics (including chloride, fluoride, nitrate-N, nitrite-N and sulfate), general chemistry (including alkalinity, total organic carbon, conductivity, pH, temperature and turbidity) and total metals. The available groundwater data are from the Princeton water supply wells.

Similar to soil and sediment, groundwater parameters without regulatory benchmarks that were detected frequently and considered to have the potential to be associated with the flood event were considered as potential COCs. Naturally occurring parameters, such as minerals that were consistently detected across samples (e.g., calcium, magnesium, potassium) were not retained as COCs. Additionally, molybdenum and strontium were detected across the groundwater samples but lack GCDWQ. Their detected concentrations were below the CSR DW standards, and they were, therefore, not further evaluated as COCs.

The COCs identified in groundwater in the Study Area are summarized in **Table 2-3** based on water use; all COCs identified were assumed to be related to the flood and given that the data are from the Princeton water supply wells, present on the regional scale in the Similkameen River Aquifer #259.

Table 2-3: Groundwater COCs identified in the Princeton Study Area

COCs Identified Based on Water Use			
Aquatic Life	**Irrigation Water**	**Livestock Water**	**Drinking Water**
Data Representative of Town of Princeton Water Supply System			
Regulated Parameters			
None	None	None	Turbidity[a], *E. coli*[a], Total Coliforms[a]
Unregulated Parameters[a]			
None	None	None	None

Notes:

Aquatic Life FIGWQG AW and CSR AW applied
Irrigation Water FIGWQG IW and CSR IW applied
Livestock Water FIGWQG LW and CSR LW applied
Drinking Water CDWQG and CSR DW applied
[a] Parameter measured in excess of the CDWQG

As presented in **Table 2-3**, no Category A COCs were identified in groundwater based on the AW, IW and LW water uses. Category A COCs were identified in groundwater from the Princeton water supply wells for DW use only and include the following:

› Turbidity; and

› Microbiological indicator parameters (*E. coli* and total coliforms).

Following the flood event turbidity, *E. coli* and total coliforms were measured at concentrations exceeding the CDWQG, in groundwater from Princeton's water supply wells. The available data for review spans the period from November 18, 2021, to March 17, 2022. A decrease in concentrations of these parameters was generally observed over the sampling period, and a review of the groundwater data indicates the following:

› Turbidity measurements as high as 1.45 NTU (Nephelometric Turbidity unit) were measured in November 2021 and 2.65 NTU in early December 2021, with consistent measurements above 0.1 NTU observed over this period and in the months following the flood event. Turbidity data was not available after January 31, 2022. Typical annual turbidity readings outside of the flood event were reported to range from 0.03 NTU to 0.7 NTU.

- *E. coli* was measured at 1 CFU/100 mL in three water samples collected during the period of November 19 to December 8, 2021, consistent with the timing of the elevated turbidity measurements. *E. coli* was not detected in the water samples throughout the remainder of period covered by the available data.
- Total coliforms were consistently detected in water samples collected in November and December 2021 with counts as high as 150 CFU/100 mL. Detected concentrations have generally decreased over time, with concentrations predominantly < 1 CFU/100 mL since the beginning of February 2022 through to the end of the period covered by the available data, with sporadic measurements of 1 CFU/100 mL to 2 CFU/100 mL recorded in February and March 2022.

It is SNC-Lavalin's understanding that the Town of Princeton is currently replacing their water supply wells, and that a boil water notice is in place for specific areas in Princeton until the wells can be replaced or until Interior Health deems the water safe for consumption.

2.7 COPC Screening

All Category A COCs were carried forward as preliminary COPCs. To identify final COPCs, analytical data were screened using receptor-pathway specific benchmarks to identify COPCs for evaluating risks to human and ecological receptors. The COPC screening process for each of the media types is described in the following sections.

2.7.1 Soil

Land use within the Study Area varies and includes agricultural, residential (including institutional), parkland, commercial and industrial lands. COPCs were identified for the most sensitive land uses (AL and RL), because the identification of COPCs for these land uses is also protective of the less sensitive regulatory defined land uses (PL, CL and IL).

The potential for COCs in soil to leach to groundwater and result in impacts at the regional scale is considered negligible. Deposited sediment was noted in shallow soils (≤0.2 m) and has largely been removed or is planned for removal. Further, groundwater data are available and have been considered in the PRRA. On this basis, soil benchmarks protective of groundwater were not applied when identifying final soil COPCs. Instead, only soil benchmarks protective of direct soil contact pathways for both human and ecological receptors were applied.

When evaluating soil analytical data to identify final COPCs, the following standards and guidelines were applied:

Provincial:

- CSR Schedule 3.1 – Part 1, Matrix Numerical Soil Standards, protective of Human Health (Intake of Contaminated Soil) and Environmental Protection (Toxicity to Soil Invertebrates and Plants; and for AL standards, Livestock Ingesting Soil and Fodder and Major Microbial Impairment); or
- CSR Schedule 3.2 – Part 2 and 3, Generic Numerical Soil Standards to Protect Human Health or Ecological Health, respectively.

Federal:

- CCME Canadian Soil Quality Guidelines protective of Human Health (Direct Contact; Produce, Meat and Milk check) and Environmental Health (Soil Contact Guideline, Soil and Food Ingestion Guideline, Nutrient and energy-cycling).

The soil analytical results are presented in Tables 1 to 6 and in Table 12, which can be found after the report text. The locations of the SNC-Lavalin soil samples are shown on **Drawing 688421-002**. Maximum measured concentrations of each preliminary soil COPCs were screened against the lowest available COPC screening benchmark for each receptor type, as presented in **Table 2-4**, below. The receptor-pathway specific screening benchmarks have been used to estimate maximum screening quotients (SQs) (i.e., maximum soil concentration/benchmark). An SQ less than one indicates that the maximum concentration is below the benchmark; an SQ greater than one indicates the concentration exceeds the benchmark and may require further consideration depending on the magnitude of the SQ and the number of samples exceeding the benchmark.

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Table 2-4: Secondary Soil COPC Screening for Princeton Study Area

Parameter	No. of Samples Analyzed	Max Conc.	HH Benchmark[a] / No. Samples >[b]	Max Screening Quotient HH[c]	Eco Benchmark[d]/ No. Samples >[b]	Max Screening Quotient Eco[e]	Retained as COPC for HH?	Retained as a COPC for Eco?
Metals								
Nickel (µg/g)	5	46.5	200[f] / 0	0.23	45[f] / 1	1.03	No, Max SQ < 1	No, Max SQ ~ = to 1; next highest nickel 43.7 µg/g (SQ = 0.97)
Microbiological Indicator Parameters								
Coliforms, fecal (MPN/g)	16	1,200	n.b. / 9	NA	n.b./9	NA	**Yes**; no HH benchmark and potentially flood-related	No[g]
Coliforms, total (MPN/g)	16	6,600	n.b. / 13	NA	n.b. / 13	NA	**Yes**; no HH benchmark and potentially flood-related	No[g]

Notes:

HH Human health
Eco Ecological receptors
n.b. No benchmark available
[a] The lowest of the applicable matrix factors (CSR) and/or check values (CCME) including human intake of contaminated soil (CSR) and soil ingestion (CCME)
[b] For parameters with no benchmark, number of detections indicated
[c] Screening quotient calculated by dividing the maximum reported soil concentration by the HH benchmark
[d] The lowest of the CSR FWSedSU and CCME PEL
[e] Screening quotient calculated by dividing the maximum reported soil concentration by the Eco benchmark
[f] from CCME
[g] Not identified to be a concern for ecological receptors
NA Not applicable

Microbiological indicator parameters (fecal coliforms and total coliforms only) were identified as final COPCs in soil for evaluating risks to human health. *E. coli* was not detected in the soil samples submitted for analysis. No additional final COPCs were identified for evaluating risks to human health. No final COPCs were identified in soil for evaluating risks to ecological receptors.

No pre-flood soil data was available for microbiological parameters and there are no regulatory benchmarks for these parameters. As noted, they are used by regulatory agencies as indicators of the potential for microbiological contamination; however, they are also ubiquitous in the environment at variable concentrations.

The BC Ministry of Agriculture and Food (2022) indicates that over time (120 days) the extra load of potential bacteria that may result from flooding would be reduced in healthy soils exposed to ultraviolet rays from the sun. Given the time that has elapsed since the flood event, it is unlikely that potential bacteria from the flood remain in surface soils in the Study Area.

Based on the above, the available soil data indicates that bacteria from the flood are unlikely to remain in soil in the Study Area. It is however noted the presence of coliforms can indicate the potential for other microorganisms, and therefore recommendations for preventing illness are provided in **Section 3**.

2.7.2 Sediment

To identify sediment COPCs for evaluating risks to human and ecological receptors, maximum concentrations of preliminary COPCs (i.e., the sediment Category A COCs) were compared to the lowest applicable benchmarks.

Concentrations of preliminary COPCs were compared to the lowest of the CSR Schedule 3.4 FWSedSU and CCME PELs to identify COPCs for evaluating risks to aquatic ecological receptors. As indicated, adverse biological effects are expected to occur rarely at concentrations below the ISQG, and they are expected to occur frequently at concentrations above the PEL (CCME, 1999). Parameters with maximum concentrations that exceed the CCME PEL were retained as final COPCs in sediment, requiring further evaluation for aquatic receptors.

As recommended by BC ENV Protocol 1 (2021a), the soil benchmarks for the protection of human health (lowest of AL and RL) were used to identify COPCs for evaluating risks to human health.

Where no CSR or CCME benchmarks were available, guidelines from other jurisdictions were used. Specifically, no sediment benchmarks were available for HEPH/EPH_{C19-32}, which was detected in soil and has been used as a proxy for sediment. However, sediment quality guidelines for petroleum hydrocarbons (Mroz et al., 2016) have been proposed by Environment Canada. A sediment quality guideline for HEPH/EPH_{C19-32} of 485 µg/g was therefore estimated using the lowest total organic carbon (TOC) measured in the soil samples collected from the Study Area and based on a diesel carbon range. The methods used to calculate the sediment quality guideline are included in **Appendix II**.

A summary of the soil analytical results, which were used as a proxy for sediment, are summarized in Tables 7 to 11 and in Table 12 (Town of Princeton source) following the text of the report. Maximum measured concentrations of each of the preliminary sediment COPCs were screened against the lowest applicable COPC screening benchmarks and, as with soil, SQs were estimated, as presented in **Table 2-5**, below.

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Table 2-5: Secondary Sediment COPC Screening for Princeton Study Area

Parameter	No. of Samples Analyzed	Max Conc.	HH Benchmark[a] / No. Samples >[b]	Max Screening Quotient HH[c]	Eco Benchmark[d]/ No. Samples >[b]	Max Screening Quotient Eco[e]	Retained as COPC for HH?	Retained as a COPC for Eco?
Hydrocarbons								
$HEPH/EPH_{C19-32}$	16	290	1000[f] / 0	0.29	485 / 0 (Mroz et al., 2016)	0.59	No, Max SQ < 1	No, Max SQ < 1
Metals								
Chromium (µg/g)	5	47.5	100[f] / 0	0.48	56[f] / 0	0.84	No, Max SQ < 1	No, Max SQ < 1
Copper (µg/g)	5	44.8	1100[g] / 0	0.04	120[f] / 0	0.37	No, Max SQ < 1	No, Max SQ < 1
Microbiological Indicator Parameters								
Coliforms, fecal (MPN/g)	16	1,200	n.b./9	NA	n.b./9	NA	**Yes**; no HH benchmark and potentially flood-related	No[h]
Coliforms, total (MPN/g)	16	6,600	n.b./13	NA	n.b./13	NA	**Yes**; no HH benchmark and potentially flood-related	No[h]

Notes:

HH Human health
Eco Ecological receptors
n.b. No benchmark available
[a] The lowest of the applicable matrix factors (CSR) and/or check values (CCME) including human intake of contaminated soil (CSR) and soil ingestion (CCME)
[b] For parameters with no benchmark, number of detections indicated
[c] Screening quotient calculated by dividing the maximum reported soil concentration by the HH benchmark
[d] The lowest of the CSR FWSedSU and CCME PEL
[e] Screening quotient calculated by dividing the maximum reported soil concentration by the Eco benchmark
[f] From CSR
[g] From CCME
[h] Not identified to be a concern for ecological receptors
NA Not applicable

As summarized in **Table 2-5**, the final COPCs for evaluating risks to human health identified in sediment in the Study Area were microbiological indicator parameters (fecal coliforms and total coliforms only).

No final COPCs were identified for evaluating risks to ecological receptors.

As with soil and based on the same rationale, the available soil data indicates that bacteria from the flood are unlikely to have persisted, but their presence may indicate the potential for other microorganisms. Therefore, recommendations for preventing illness are provided in **Section 3**.

2.7.3 Groundwater

Preliminary COPCs in groundwater were limited to microbiological indicator parameters (total coliforms and *E. coli*) and turbidity for evaluating risks to human health only. The available groundwater data are summarized in Table 13 following the text. As these preliminary COPCs were identified based on the receptor-pathway specific standard/guidelines (i.e., for drinking water), a secondary screening was not conducted, and they are carried forward as final COPCs.

As noted, following the flood event, turbidity, total coliforms and *E. coli* were measured in excess of the CDWQG in groundwater from Princeton's water supply wells. Based on these exceedances, Interior Health issued a boil water notice for some areas of Princeton. It is expected that the boil water notice will remain in place until the new water supply wells are installed or until Interior Health deems the water safe for consumption.

2.7.4 Summary of Contaminants of Potential Concern

A summary of the COPCs identified in each medium is presented in **Table 2-6**.

Table 2-6: Summary of Final COPCs Identified for the Princeton Study Area

Medium	Human Health	Ecological
Soil	Total coliforms and fecal coliforms	None
Sediment	Total coliforms and fecal coliforms	None
Groundwater	*E. coli*, total coliforms and turbidity	None

2.8 Conceptual Site Model

The CSM provided in SNC-Lavalin (2022a) has been updated based on the results of the PRRA, and it is summarized in **Figure 2-3**, below.

Total coliforms and fecal coliforms were identified as final COPCs in soil and sediment. These parameters are used as indicators of the potential for other microorganisms but are also ubiquitous in the environment (Health Canada, 2020). The BC Ministry of Agriculture and Food (2022) indicates that over time (120 days), the extra load of potential bacteria that may result from flooding would be reduced in healthy soils due to exposure to ultraviolet rays from the sun. Given the time that has elapsed since the flood event, it is unlikely that bacteria from the flood have persisted. Despite this, as their presence may indicate the potential for other microorganisms, recommendations to prevent exposures to microorganisms in soil and sediment are provided in **Section 3** and are included in **Figure 2-3**.

Following the flood event, turbidity, total coliforms and *E. coli* in excess of the CDWQG were measured in groundwater from Princeton's water supply wells. Interior Health has issued a boil water notice for some areas of Princeton and, therefore, no additional actions or communications regarding the identified COPCs in groundwater from the Town of Princeton's water supply are required. As total coliforms and *E. coli* were measured in groundwater following the flood, private water well and surface water point of diversion[5] users in the Study Area should continue to follow Interior Health and First Nations Health Authority guidance for testing and disinfection of their water source.

[5] A point of diversion is a water licence that authorizes works related to the diversion and use of water from a waterbody.

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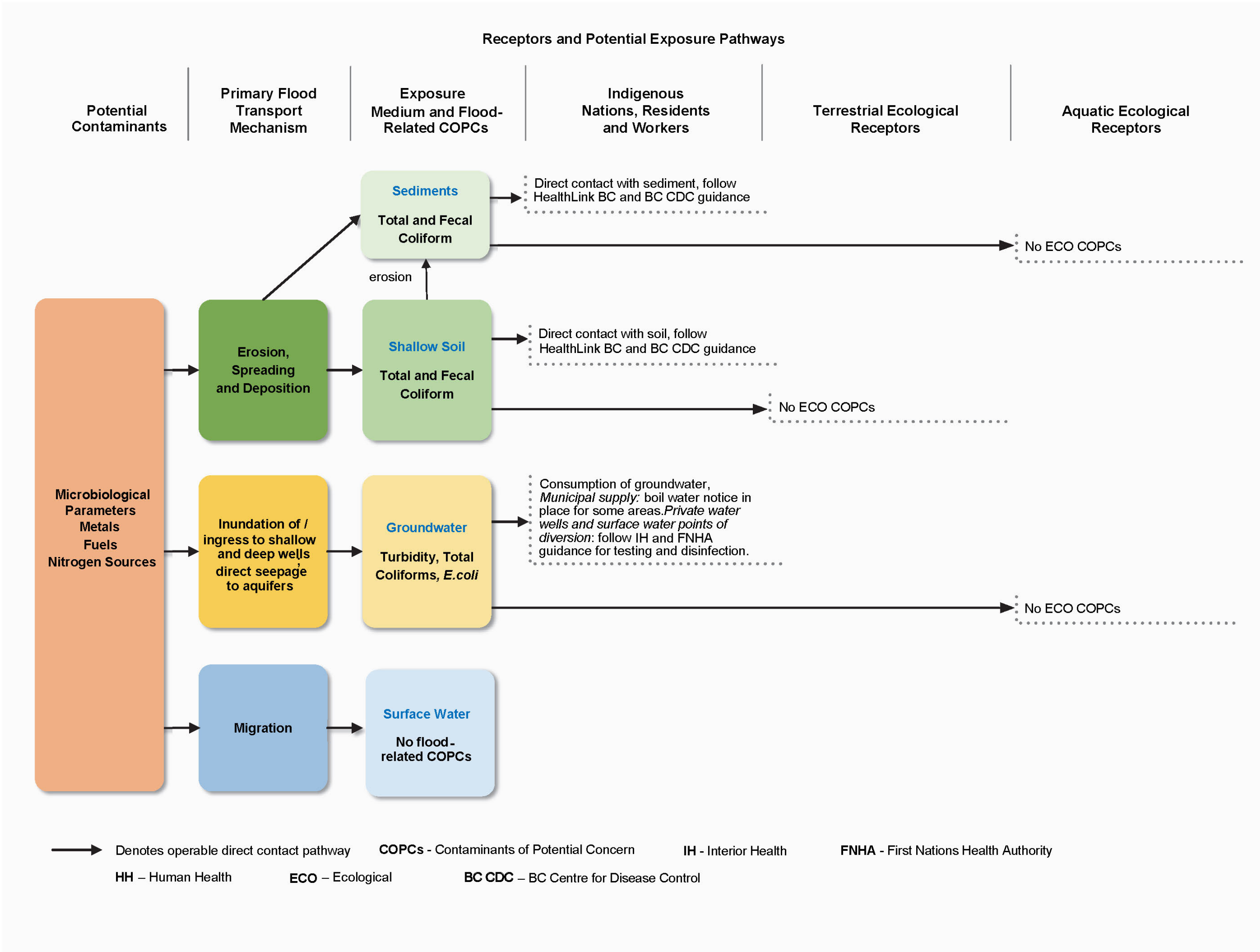
Figure 2-3: Updated Conceptual Site Model



2.9 Uncertainty Analysis

The primary area of uncertainty in the PRRA is measurement uncertainty associated with the data collected to characterize the impacts from the flood event.

Surface soil data collected by SNC-Lavalin and on behalf of the Town of Princeton targeted sediment deposited on ground surface from the flood event in areas considered to be representative of regional (i.e., non-point source) soil conditions within the Study Area. The sediments primarily originated from the Tulameen River, with some contribution from the Similkameen River (at the confluence). Based on the source and mechanism of deposition, they are considered likely to be homogenous. This is supported by the relatively consistent results between the data collected by SNC-Lavalin and the Town of Princeton data source. Further, no visual or olfactory observations that would suggest the presence of other contaminant types were noted during sampling, and SNC-Lavalin is not aware of any reports of significant contaminant releases (e.g., from tanks etc.) during or following the flood event. Despite the time elapsed between the flood event and the sampling, the data captured persistent COCs which were identified as priority PCOCs for protecting human health and the environment. The potential exists for point source related contamination within private properties within the Study Area; however, assessing those impacts is beyond the scope of the PRRA.

While measurement uncertainty in the soil data collected from the Study Area is generally considered to be low, the following areas of uncertainty and the associated potential to impact the PRRA results are noted:

› Laboratory MDLs for some parameters exceeded the regulatory benchmarks including:
  - Benzene and toluene in the SNC-Lavalin (2022b) data, and benzene, ethylbenzene, toluene, naphthalene and phenanthrene in data from the Town of Princeton soil data: Except for ethylbenzene and phenanthrene, which were addressed in the PRRA, these parameters were not detected in the samples analyzed. As these PCOCs were not detected in any samples and no visual or olfactory evidence of contamination was noted during SNC-Lavalin’s March 22, 2022, site reconnaissance and sampling, it was concluded that they are not COCs. There is low uncertainty in this conclusion.
  - Most of the PAHs analyzed were not detected in the eight of the nine samples submitted for analysis (five by SNC-Lavalin [2022b], four on behalf of the Town of Princeton); however, the MDLs for select PAHs exceeded the CCME ISQG. All MDLs were below the CCMEs PEL. Therefore, the PAHs were not retained as COCs, and it is concluded that they represent a low risk to aquatic receptors. There is low uncertainty in this conclusion.
  - Total coliform and fecal coliform were identified as COPCs in soil (and sediment) when evaluating risks to human health. *E. coli* was not detected in the five soil samples submitted by SNC-Lavalin (2022b) for analysis; however, no *E. coli* data were available for the Town of Princeton source (n=11). The data from the Town of Princeton source (n=11) are only for total and fecal coliforms.

Limited soil data (also used as a proxy for sediment) was available for *E. coli*. While there is limited data, given the time that has elapsed since the flood event, there is low uncertainty in the conclusion that coliform bacteria from the flood are unlikely to remain in soil. Further, coliform bacteria are ubiquitous in the environment at variable concentrations (Health Canada, 2020).

Limited data was available for *E. coli* , which is a species of fecal coliform bacteria that is specific to fecal material from humans and warm-blooded animals. Most *E. coli* strains are harmless, although some strains can cause illness. Regulatory agencies use *E. coli,* as well as total and fecal coliforms, as indicators of the potential for the presence of other pathogenic microorganisms; however, the presence of these coliform bacteria does not necessarily indicate that pathogens are present. Levels of coliform bacteria in soil and sediment prior to the flood are not available. This raises some uncertainty in terms of the potential for flood-related exposure to pathogenic microorganisms in soil and sediment. Regardless, coliform bacteria are ubiquitous in the environment and recommendations to mitigate risk of illness from exposure to microorganisms in soil and sediment post-flood are consistent to recommendations pre-flood. To mitigate concerns recommendations from local health authorities, HealthLinkBC and BC Centre for Disease Control (BC CDC) should be followed, as detailed in **Section 3**.

The assumption that the soil data evaluated in the PRRA are representative of sediments remaining in waterways in the Study Area is conservative, because the soil sampled has the potential to have been impacted by on-land sources during or following the flood. Based on the conservative approach, and because the soils originated from the rivers (i.e., from sediments), uncertainty in both this assumption and the conclusion of no unacceptable risks to aquatic ecological receptors is low.

Only groundwater data from the Town of Princeton’s water supply wells was available. Two of the supply wells (Wells #1 and 2) were identified as being vulnerable to impacts from the flood, because they are located downgradient from the impaired sewer lift station and force main. The data for the wells indicate that flood impacts have persisted, even following disinfection. While evaluating risks to private water wells was beyond the scope of the PRRA, the impacts to the Town of Princeton’s wells, which are likely to be less vulnerable to impacts than private wells, suggest the potential exists for private water wells to have been contaminated by the flood event. There is also the potential for impacted groundwater to migrate to downgradient surface water bodies and thus for surface water point of users to be impacted. Surface water quality was not characterized during or after the flood event. As discussed in **Section 2.4**, any impacts to the high volume, high flow rivers in the Study Area would have been limited spatially and temporally to a narrow window immediately following the flood event. This is supported by the assessment of water quality in the Sumas Prairie Study Area following flooding, which indicated that concentrations of flood-related PCOCs in lower flow, lower volume surface water bodies returned to baseline levels in December 2021, within approximately 1 to 1.5 months following the flood event (Gabelhouse et al., 2022). Further, based on a review of the available groundwater data, no COCs were identified in groundwater for evaluating risks to aquatic life, and there is therefore no potential for flood contaminated groundwater to have migrated to surface water post-flood. Based on the evidence, uncertainty in the conclusion that the flood did not result in long-term impacts to surface water quality is low.

3 Conclusions and Recommendations

The PRRA was conducted to assess the potential for contamination associated with the November 2021 flood event and which is present on a regional scale in the Study Area to adversely impact human health and the environment. Potential flood-related contaminants were identified in soil, sediment and groundwater, and a secondary screening was conducted to identify final COPCs for evaluating risks to human health and the environment. No final COPCs were identified for evaluating risks to ecological ROCs, and, therefore, no unacceptable risks to the environment are predicted. Final COPCs identified in each medium included indicators of microbiological contamination in soil and groundwater, as well as turbidity in groundwater, which are summarized as follows:

- Soil: Total coliforms and fecal coliforms;
- Sediment: Total coliforms and fecal coliforms; and
- Groundwater: Turbidity, total coliforms and *E. coli*.

With respect the potential for adverse impacts to human heath, the following conclusions and recommendations are provided.

3.1 Soil and Sediment

Total and fecal coliforms were both measured in soil collected from the Study Area, with the soil data conservatively assumed to be representative of sediment that remains in the Study Area's watercourses. When present, these coliforms may indicate the potential for other microorganisms; however, coliforms are also ubiquitous in the environment (Health Canada, 2020). The BC Ministry of Agriculture and Food (2022) indicates that over time (120 days) the extra load of potential bacteria that may result from flooding would be reduced in healthy soils exposed to ultraviolet rays from the sun. Given the time that has elapsed since the flood event, it is unlikely that potential bacteria from the flood remain in surface soils in the Study Area.

As coliform bacteria may indicate the potential for other microorganisms, best practices for preventing illness are always recommended and include washing hands after contact with soil or sediment and to wash or cook produce. Further information on reducing risks from microorganisms in soil is available at:

- Food Safety: Preparing | HealthLink BC,Foodborne Illness and Safe Food Handling | HealthLink BC;
- Foodborne illness | HealthLink BC;
- E. Coli Infection from Food or Water | HealthLink BC;
- Hand Washing: Help Stop the Spread of Germs | HealthLink BC;
- Food Safety for Fresh Fruits and Vegetables | HealthLink BC; and
- Foodborne & Waterborne Diseases (bccdc.ca).

The above recommendations align with existing BC Ministry of Health and BC Centre for Disease Control guidance for good hand hygiene and food safety. No additional actions or communications from government agencies are recommended for management of soil or sediment contamination in the Princeton Study Area from the November 2021 flood event.

3.2 Groundwater and Surface Water

Following the flood event turbidity, total coliforms and *E. coli* in excess of the Guidelines for Canadian Drinking Water Quality were measured in groundwater from the Town of Princeton's water supply wells. The municipality is currently replacing their water supply wells, and in the interim, or until the water is deemed safe for consumption, Interior Health has issued a boil water notice for some areas of Princeton.

Based on the measurement of these parameters in the municipal water supply following the flood, there is the potential that private water wells, which can be more vulnerable to impacts than municipal supply wells, were also impacted. Further, there is the potential that impacted groundwater could overtime migrate to surface water.

Based on the above, users of private water wells and surface water points of diversion in the Study Area, if any, should continue to follow health authority guidance for testing and disinfecting their water source. This guidance and information on how to manage flood-related drinking water issues is available at:

› Drinking Water | Environmental & Seasonal Health | IH (interiorhealth.ca); and

› Floods & Landslides | Natural Disasters & Emergencies | IH (interiorhealth.ca).

The above recommendations align with existing health authority guidance for private water well and point of diversion users.

Surface water quality was not characterized during or after the flood event. The potential exists for surface water to have been impacted by flooding, through natural and human-made materials being transported across lands that are generally "dry" into the rivers in the Study Area. Nonetheless, flood associated impacts, if any, would have been limited both temporally to a narrow window immediately following the flood event, and spatially, given the high flow and high-volume conditions of the Tulameen and Similkameen Rivers. This is supported by the assessment of water quality in the Sumas Prairie Study Area following flooding, which indicated that concentrations of flood-related PCOCs in lower flow, lower volume surface water bodies returned to baseline levels in December 2021, within approximately 1 to 1.5 months following the flood event (Gabelhouse et al., 2022).

The potential also exists for groundwater contaminated by the flood event to have migrated to downgradient surface water bodies through flood waters infiltrating soils and mixing with shallow groundwater. Because no COCs were identified in groundwater for evaluating risks to aquatic life, there are no risks to aquatic organisms.

No additional actions or communications from government agencies are recommended for management of groundwater contamination in the Princeton Study Area from the November 2021 flood event.

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4 Professional Statement

I declare that I am a qualified person and have the required knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

I confirm the:

1. Risk Assessment referred to above has been conducted in accordance with the Environmental Management Act, Contaminated Sites Regulation, director approved protocols, procedures, guidance and standard professional practice; and
2. Information used in the performance of the risk assessment and the conclusions of the risk assessment reported herein are true based on my knowledge as of the date completed.

Tara Siemens Kennedy, MET, PChem, CSAP
Senior Risk Assessor & Toxicologist

David Tarnocai, MSc, P.Geo.
Senior Risk Assessor & Toxicologist

5 Notice to Reader

This report has been prepared and the work referred to in this report have been undertaken by SNC-Lavalin Inc. (SNC-Lavalin) for the exclusive use of BC Ministry of the Environment and Climate Change Strategy (BC ENV), who has been party to the development of the scope of work and understands its limitations. The methodology, findings, conclusions and recommendations in this report are based solely upon the scope of work and subject to the time and budgetary considerations described in the proposal and/or contract pursuant to which this report was issued. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of such third party. SNC-Lavalin accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

The findings, conclusions and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our original contract and included in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered, site conditions change or standards are amended, modifications to this report may be necessary. The results of this assessment should in no way be construed as a warranty that the subject site is free from any and all environmental impact.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

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Tables

TABLE 1: Soil Sampling Log - Princeton

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Sample Type	Description	Depth (m)
P-SS22-01	P-SS22-01	2022 03 22	Surface Sample	SAND, fine grained, trace silt, brown, loose, trace rootlets, damp.	0.1
P-SS22-02	P-SS22-02	2022 03 22	Surface Sample	SAND, fine grained, trace silt, brown, loose, trace rootlets, damp.	0.05
P-SS22-03	P-SS22-03	2022 03 22	Surface Sample	SILT, some clay, dark brown, very soft, wet.	0.05
P-SS22-04	P-SS22-04	2022 03 22	Surface Sample	SAND, fine grained, trace medium grained sand, trace silt, brown, loose, trace organics, moist.	0.05
P-SS22-05	P-SS22-05	2022 03 22	Surface Sample	SAND, fine-medium grained, trace silt, light brown, loose, damp.	0.2
P-SS22-05	P-SS22-06	Duplicate	Surface Sample	Blind Field Duplicate of P-SS22-05	0.2

TABLE 2: Summary of Analytical Results for Soil - Total Metals.

Sample Location		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05			BC Standard		Federal Guideline	
Sample ID		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05	P-SS22-06	QA/QC RPD %	CSR Agricultural Land Use (AL)[a]	CSR Low Density Residential Land Use (RLLD)[b]	CCME CEQG Agricultural Surface (AL Surface)[c]	CCME CEQG Residential Surface (RL Surface)[d]
Sample Date (yyyy mm dd)		2022 03 22	2022 03 22	2022 03 22	2022 03 22	2022 03 22	Duplicate					
Depth Interval (m)		0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05	0.0 - 0.2	0.0 - 0.2					
Parameter	Units	Analytical Results										
Physical Parameters												
pH	pH	**8.50**	**8.28**	**8.70**	**8.41**	**8.55**	**8.61**	1	n/a	n/a	6.0 - 8.0	6.0 - 8.0
Total Organic Carbon	%	0.194	0.924	2.52	0.886	0.262	0.279	6	n/a	n/a	n/a	n/a
Total Organic Carbon	µg/g	1,940	9,240	25,200	8,860	2,620	2,790	6	n/a	n/a	n/a	n/a
Ammonia Nitrogen	µg/g	7.7	10.1	13.1	11.1	10.0	8.0	*	n/a	n/a	n/a	n/a
Water Soluble Nitrate Nitrogen	µg/g	1.10	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	*	25,000	25,000	n/a	n/a
Water Soluble Nitrite Nitrogen	µg/g	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	*	1,500	1,500	n/a	n/a
Water Soluble Phosphate	µg/g	0.265	0.330	4.78	0.305	< 0.250	< 0.250	*	n/a	n/a	n/a	n/a
Total Metals												
Aluminum	µg/g	9,310	12,500	15,100	9,770	7,770	8,510	9	40,000	40,000	n/a	n/a
Antimony	µg/g	0.22	0.34	0.34	0.29	0.16	0.24	*	20	20	20	20
Arsenic	µg/g	3.96	5.80	4.55	3.87	2.38	2.74	14	10	10	12	12
Barium	µg/g	78.8	121	223	88.1	55.3	43.1	25	350	700	750	500
Beryllium	µg/g	0.18	0.29	0.69	0.26	0.17	0.18	*	85 (pH >=8.0)	85 (pH >=8.0)	4	4
Boron	µg/g	< 2.0	< 2.0	9.1	3.2	2.3	< 2.0	*	8,500	8,500	n/a	n/a
Cadmium	µg/g	0.124	0.197	0.185	0.119	0.064	0.070	*	10 (pH >=8.0)	20 (pH >=8.0)	1.4	10
Chromium	µg/g	46.8	47.5	24.1	42.9	24.1	27.7	14	60[b]	60[f]	64[g]	64[g]
Chromium, hexavalent	µg/g	-	< 0.40	< 0.40	< 0.40	-	-	-	60	60	0.4	0.4
Chromium, trivalent	µg/g	-	47.5	24.1	42.9	-	-	-	60	100	64[g]	64[g]
Cobalt	µg/g	14.7	17.0	12.8	14.2	8.07	9.67	18	25	25	40	50
Copper	µg/g	29.0	44.8	27.4	30.4	18.9	20.5	8	150 (pH >=8.0)	150 (pH >=7.5)	63	63
Iron	µg/g	30,400	32,900	25,000	32,600	19,900	24,400	20	35,000	35,000	n/a	n/a
Lead	µg/g	4.46	7.29	15.6	6.95	4.26	3.76	12	120 (pH >=8.0)	120 (pH >=7.5)	70	140
Lithium	µg/g	6.17	7.76	8.16	6.66	5.83	6.26	7	30	30	n/a	n/a
Manganese	µg/g	448	630	1,120	495	324	369	13	2,000	2,000	n/a	n/a
Mercury	µg/g	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	*	0.6	10	6.6	6.6
Molybdenum	µg/g	0.54	0.96	1.15	0.78	0.37	0.55	*	3	80	5	10
Nickel	µg/g	**46.5**	43.7	19.6	36.7	16.7	21.5	25	150 (pH >=8.0)	150 (pH >=8.0)	45	45
Selenium	µg/g	< 0.20	0.29	< 0.20	< 0.20	< 0.20	< 0.20	*	1	1	1	1
Silver	µg/g	< 0.10	0.11	< 0.10	< 0.10	< 0.10	< 0.10	*	20	20	20	20
Strontium	µg/g	45.9	65.7	199	52.5	37.0	29.5	23	9,500	9,500	n/a	n/a
Thallium	µg/g	< 0.10	< 0.10	0.47	< 0.10	< 0.10	< 0.10	*	2	9	1	1
Tin	µg/g	< 0.20	0.28	1.20	0.26	0.21	0.21	*	5	50	5	50
Tungsten	µg/g	< 0.20	< 0.20	1.02	< 0.20	< 0.20	< 0.20	*	15	15	n/a	n/a
Uranium	µg/g	0.312	0.515	2.13	0.460	0.314	0.270	15	15	100	23	23
Vanadium	µg/g	71.3	73.1	47.9	77.6	43.1	54.1	23	100	150	130	130
Zinc	µg/g	44.3	61.4	75.8	51.0	38.8	40.9	5	200 (pH >=8.0)	450 (pH >=8.0)	250	250
Potassium	µg/g	750	1,030	1,420	724	493	556	12	n/a	n/a	n/a	n/a

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QA/QC RPD Denotes quality assurance/quality control relative percent difference
* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Agricultural Land Use (AL) Standard
SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
SHADOW	Concentration greater than CCME CEQG Agricultural Surface (AL Surface) Guideline
OUTLINE	Concentration greater than CCME CEQG Residential Surface (RL Surface) Guideline

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most

[b] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent). Samples with depths greater than 3.0 m are compared to Industrial Land Use (IL) standards.

[c] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy cycling, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Protection of Potable Groundwater, Historical Guideline, Soil General.

[d] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy-cycling check, Offsite Migration, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Historical Guideline, Soil General.

[e] Individual standards exist for Cr +3 and Cr +6. Reported value represents more stringent standard.

[f] Chromium guideline does not include nutrient and energy-cycling check.

TABLE 3: Summary of Analytical Results for Soil - Microbiological Parameters

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Depth Interval (m)	Microbiological Tests: Fecal Coliform MPN/g	E. Coli MPN/g	Total Coliforms MPN/g	Salmonella MPN/g
P-SS22-01	P-SS22-01	2022 03 22	0.0 - 0.1	< 3.0	< 3.0	< 3.0	< 0.2
P-SS22-02	P-SS22-02	2022 03 22	0.0 - 0.05	< 3.8	< 3.8	46	< 0.3
P-SS22-03	P-SS22-03	2022 03 22	0.0 - 0.05	< 4.3	< 4.3	13	< 0.3
P-SS22-04	P-SS22-04	2022 03 22	0.0 - 0.05	< 3.0	< 3.0	< 3.0	< 0.2
P-SS22-05	P-SS22-05	2022 03 22	0.0 - 0.2	< 3.0	< 3.0	< 3.0	< 0.2
	P-SS22-06	Duplicate	0.0 - 0.2	< 3.0	< 3.0	< 3.0	< 0.2
	QA/QC RPD%			*	*	*	*
BC Standard							
CSR Agricultural Land Use (AL)[a]				n/a	n/a	n/a	n/a
CSR Low Density Residential Land Use (RLLD)[a]				n/a	n/a	n/a	n/a
Federal Guideline							
CCME CEQG Agricultural Surface (AL Surface)				n/a	n/a	n/a	n/a
CCME CEQG Residential Surface (RL Surface)				n/a	n/a	n/a	n/a

Associated CARO file(s): 22C3076.
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n/a Denotes no applicable standard/guideline.
QA/QC RPD Denotes quality assurance/quality control relative percent difference
* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Agricultural Land Use (AL) Standard
SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
SHADOW	Concentration greater than CCME CEQG Agricultural Surface (AL Surface) Guideline
OUTLINE	Concentration greater than CCME CEQG Residential Surface (RL Surface) Guideline

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent). Samples with depths greater than 3.0 m are compared to Industrial Land Use (IL) standards.

[b] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy cycling, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Protection of Potable Groundwater, Historical Guideline, Soil General.

[c] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy-cycling check, Offsite Migration, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Historical Guideline, Soil General.

TABLE 4: Summary of Analytical Results for Soil - Hydrocarbons.

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Depth Interval (m)	Monocyclic Aromatic Hydrocarbons: Benzene µg/g	Ethylbenzen µg/g	Toluene µg/g	Xylenes µg/g	Styrene µg/g	Gross Parameters: VPHs µg/g	EPH (C10- µg/g	LEPHs[f] µg/g	EPH (C19- µg/g	HEPHs[f] µg/g	MTBE: Methyl Tert-butyl Ether µg/g
P-SS22-01	P-SS22-01	2022 03 22	0.0 - 0.1	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-02	P-SS22-02	2022 03 22	0.0 - 0.05	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-03	P-SS22-03	2022 03 22	0.0 - 0.05	< 0.020[a]	**0.156**	< 0.200[a]	0.124	< 0.050	< 20	< 50	< 50	99	99	< 0.280
P-SS22-04	P-SS22-04	2022 03 22	0.0 - 0.05	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-05	P-SS22-05	2022 03 22	0.0 - 0.2	< 0.020[a]	< 0.050[a]	< 0.200[a]	< 0.100	< 0.050	23	< 50	< 50	< 50	< 50	< 0.220
	P-SS22-06	Duplicate	0.0 - 0.2	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
	QA/QC RPD%			-	-	-	-	-	-	*	*	*	*	-
BC Standard														
CSR Agricultural Land Use (AL)[b]				0.035	15	0.5	6.5	0.1	200	1,000	1,000	1,000	1,000	4,000
CSR Low Density Residential Land Use (RLLD)[c]				2.5	200	0.5	20	5	200	1,000	1,000	1,000	1,000	4,000
Federal Guideline														
CCME CEQG Agricultural Surface (AL Surface)[d]				0.0068[g]	0.018	0.08	2.4	0.1	n/a	n/a	n/a	n/a	n/a	n/a
CCME CEQG Residential Surface (RL Surface)[e]				1	50	0.1	37	5	n/a	n/a	n/a	n/a	n/a	n/a

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QA/QC RPD Denotes quality assurance/quality control relative percent difference
* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

BOLD Concentration greater than CSR Agricultural Land Use (AL) standard
SHADED Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
SHADOW Concentration greater than CCME CEQG Agricultural Surface (AL Surface) Guideline
OUTLINE Concentration greater than CCME CEQG Residential Surface (RL Surface) Guideline

[a] Laboratory detection limit exceeds regulatory standard/guideline.
[b] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent). Samples with depths greater than 3.0 m are compared to Industrial Land Use (IL) standards.
[c] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, toxicity to soil invertebrates and plants, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent). Samples with depths greater than 3.0 m are compared to Industrial Land Use (IL) standards.
[d] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy cycling, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Protection of Potable Groundwater, Historical Guideline, Soil General.
[e] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy-cycling check, Offsite Migration, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Historical Guideline, Soil General.
[f] Where no LEPH and HEPH are available, EPH has been compared to LEPH and HEPH standards, which are conservative comparisons.
[g] Guidelines use 10-5 incremental risk.

TABLE 5: Summary of Analytical Results for Soil - Polycyclic Aromatic Hydrocarbons.

Sample Location		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05			BC Standard		Federal Guideline	
Sample ID		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05	P-SS22-06	QA/QC RPD %	CSR Agricultural Land Use (AL)[b]	CSR Low Density Residential Land Use (RLLD)[c]	CCME CEQG Agricultural Surface (AL Surface)[d]	CCME CEQG Residential Surface (RL Surface)[e]
Sample Date (yyyy mm dd)		2022 03 22	2022 03 22	2022 03 22	2022 03 22	2022 03 22	Duplicate					
Depth Interval (m)		0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05	0.0 - 0.2	0.0 - 0.2					
Parameter	Units	Analytical Results										
Polycyclic Aromatic Hydrocarbons												
Naphthalene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.6	0.6	0.013	0.013
Methylnaphthalene, 1-	µg/g	< 0.050	< 0.050	0.163	< 0.050	< 0.050	< 0.050	*	250	250	n/a	n/a
Methylnaphthalene, 2-	µg/g	< 0.050	< 0.050	0.105	< 0.050	< 0.050	< 0.050	*	60	60	n/a	n/a
Acenaphthylene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	320	320
Acenaphthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	950	950	0.28	0.28
Fluorene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	600	600	0.25	0.25
Phenanthrene	µg/g	< 0.050[a]	< 0.050[a]	***0.259***	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.1	5	0.046	0.046
Anthracene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	2.5	2.5	2.5	2.5
Fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	50	50	15.4	15.4
Pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	10	0.1	7.7
Benz(a)anthracene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	0.1	1
Chrysene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	200	200	6.2	6.2
Benzo(b)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	0.1	1
Benzo(b+j)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	0.1	1
Benzo(k)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	0.1	1
Benzo(a)pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	5	5	0.6	0.6
Indeno(1,2,3-cd)pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	0.1	1
Dibenz(a,h)anthracene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	0.1	1
Benzo(g,h,i)perylene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a	n/a
Quinoline	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	2.5	2.5	0.1	n/a
Chloronaphthalene, 2-	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	1,500	1,500	n/a	n/a

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[a] Laboratory detection limit exceeds regulatory standard/guideline.

[b] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent). Samples with depths greater than 3.0 m are compared to Industrial Land Use (IL) standards.

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[d] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy cycling, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Protection of Potable Groundwater, Historical Guideline, Soil General.

[e] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy-cycling check, Offsite Migration, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Historical Guideline, Soil General.

TABLE 6: Summary of Analytical Results for Soil - Polychlorinated Biphenyls

			BC Standard		Federal Guideline	
Sample Location		P-SS22-03				
Sample ID		P-SS22-03	CSR Agricultural Land Use (AL)[a]	CSR Low Density Residential Land Use (RLLD)[b]	CCME CEQG Agricultural Surface (AL Surface)[c]	CCME CEQG Residential Surface (RL Surface)[d]
Sample Date (yyyy mm dd)		2022 03 22				
Depth Interval (m)		0.0 - 0.05				
Parameter	Units	Analytical Results				
PCBs						
Aroclor 1016	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1221	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1232	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1242	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1248	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1254	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1260	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1262	µg/g	< 0.040	n/a	n/a	n/a	n/a
Aroclor 1268	µg/g	< 0.040	n/a	n/a	n/a	n/a
Polychlorinated Biphenyls, Total [PCBs	µg/g	< 0.040	1.5	1.5	0.5	1.3[e]

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* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Agricultural Land Use (AL) standard
SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
SHADOW	Concentration greater than CCME CEQG Agricultural Surface (AL Surface) Guideline
OUTLINE	Concentration greater than CCME CEQG Residential Surface (RL Surface) Guideline

[b] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent). Samples with depths greater than 3.0 m are compared to Industrial Land Use (IL) standards.

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[e] Pathways Included: Eco Soil Contact, Management Limit, Nutrient and energy-cycling check, Offsite Migration, Protection of Groundwater for Freshwater Aquatic Life, Soil and Food Ingestion, Direct Contact (particulate inhalation), Soil Dermal Contact, Soil Ingestion, Historical Guideline, Soil General.

[e] Guideline includes most stringent soil and food ingestion guideline (see factsheet for more details).

TABLE 7: Summary of Analytical Results for Sediment - Total Metals.

Sample Location		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05			BC Standard	Federal Guideline	
Sample ID		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05	P-SS22-06	QA/QC RPD %	CSR Freshwater Sediment (FW)[a]	CCME CEQG Interim Sediment Quality (ISQG)[b]	CCME CEQG Probable Effect Level (PEL)[b]
Sample Date (yyyy mm dd)		2022 03 22	2022 03 22	2022 03 22	2022 03 22	2022 03 22	Duplicate				
Depth Interval (m)		0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05	0.0 - 0.2	0.0 - 0.2				
Parameter	Units	Analytical Results									
Physical Parameters											
pH	pH	8.50	8.28	8.70	8.41	8.55	8.61	1	n/a	n/a	n/a
Total Organic Carbon	%	0.194	0.924	2.52	0.886	0.262	0.279	6	n/a	n/a	n/a
Total Organic Carbon	µg/g	1,940	9,240	25,200	8,860	2,620	2,790	6	n/a	n/a	n/a
Ammonia Nitrogen	µg/g	7.7	10.1	13.1	11.1	10.0	8.0	*	n/a	n/a	n/a
Water Soluble Nitrate Nitrogen	µg/g	1.10	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	*	n/a	n/a	n/a
Water Soluble Nitrite Nitrogen	µg/g	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	*	n/a	n/a	n/a
Phosphate Water Soluble	µg/g	0.265	0.330	4.78	0.305	< 0.250	< 0.250	*	n/a	n/a	n/a
Total Metals											
Antimony	µg/g	0.22	0.34	0.34	0.29	0.16	0.24	*	n/a	n/a	n/a
Arsenic	µg/g	3.96	5.80	4.55	3.87	2.38	2.74	14	11	5.9	17
Barium	µg/g	78.8	121	223	88.1	55.3	43.1	25	n/a	n/a	n/a
Beryllium	µg/g	0.18	0.29	0.69	0.26	0.17	0.18	*	n/a	n/a	n/a
Cadmium	µg/g	0.124	0.197	0.185	0.119	0.064	0.070	*	2.2	0.6	3.5
Chromium	µg/g	**46.8**	**47.5**	24.1	**42.9**	24.1	27.7	14	56	37.3	90
Chromium, hexavalent	µg/g	-	< 0.40	< 0.40	< 0.40	-	-	-	n/a	n/a	n/a
Chromium, trivalent	µg/g	-	47.5	24.1	42.9	-	-	-	n/a	n/a	n/a
Cobalt	µg/g	14.7	17.0	12.8	14.2	8.07	9.67	18	n/a	n/a	n/a
Copper	µg/g	29.0	**44.8**	27.4	30.4	18.9	20.5	8	120	35.7	197
Lead	µg/g	4.46	7.29	15.6	6.95	4.26	3.76	12	57	35	91.3
Lithium	µg/g	6.17	7.76	8.16	6.66	5.83	6.26	7	n/a	n/a	n/a
Manganese	µg/g	448	630	1,120	495	324	369	13	n/a	n/a	n/a
Mercury	µg/g	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	*	0.3	0.17	0.486
Molybdenum	µg/g	0.54	0.96	1.15	0.78	0.37	0.55	*	n/a	n/a	n/a
Nickel	µg/g	46.5	43.7	19.6	36.7	16.7	21.5	25	n/a	n/a	n/a
Selenium	µg/g	< 0.20	0.29	< 0.20	< 0.20	< 0.20	< 0.20	*	n/a	n/a	n/a
Silver	µg/g	< 0.10	0.11	< 0.10	< 0.10	< 0.10	< 0.10	*	n/a	n/a	n/a
Strontium	µg/g	45.9	65.7	199	52.5	37.0	29.5	23	n/a	n/a	n/a
Tin	µg/g	< 0.20	0.28	1.20	0.26	0.21	0.21	*	n/a	n/a	n/a
Uranium	µg/g	0.312	0.515	2.13	0.460	0.314	0.270	15	n/a	n/a	n/a
Vanadium	µg/g	71.3	73.1	47.9	77.6	43.1	54.1	23	n/a	n/a	n/a
Zinc	µg/g	44.3	61.4	75.8	51.0	38.8	40.9	5	200	123	315
Aluminum	µg/g	9,310	12,500	15,100	9,770	7,770	8,510	9	n/a	n/a	n/a
Boron	µg/g	< 2.0	< 2.0	9.1	3.2	2.3	< 2.0	*	n/a	n/a	n/a
Iron	µg/g	30,400	32,900	25,000	32,600	19,900	24,400	20	n/a	n/a	n/a
Potassium	µg/g	750	1,030	1,420	724	493	556	12	n/a	n/a	n/a
Thallium	µg/g	< 0.10	< 0.10	0.47	< 0.10	< 0.10	< 0.10	*	n/a	n/a	n/a
Tungsten	µg/g	< 0.20	< 0.20	1.02	< 0.20	< 0.20	< 0.20	*	n/a	n/a	n/a

Associated CARO file(s): 22C3076.

All terms defined within the body of SNC-Lavalin's report.

< Denotes concentration less than indicated detection limit.

- Denotes analysis not conducted.

n/a Denotes no applicable standard/guideline.

QA/QC RPD Denotes quality assurance/quality control relative percent difference

* RPDs are not calculated where one or more concentrations are less than five times RDL.

RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Freshwater Sediment (FW) standard
SHADED	Concentration greater than CCME CEQG Interim Sediment Quality (ISQG) Guideline
RED	Concentration greater than CCME CEQG Probable Effect Level (PEL) Guideline

[a] Pathways Included: Sensitive Site.

[b] Guideline to protect freshwater aquatic life.

TABLE 8 Summary of Analytical Results for Sediment - Microbiological Parameters

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Depth Interval (m)	Microbiological Tests: Fecal Coliform MPN/g	E. Coli MPN/g	Total Coliforms MPN/g	Salmonella MPN/g
P-SS22-01	P-SS22-01	2022 03 22	0.0 - 0.1	< 3.0	< 3.0	< 3.0	< 0.2
P-SS22-02	P-SS22-02	2022 03 22	0.0 - 0.05	< 3.8	< 3.8	46	< 0.3
P-SS22-03	P-SS22-03	2022 03 22	0.0 - 0.05	< 4.3	< 4.3	13	< 0.3
P-SS22-04	P-SS22-04	2022 03 22	0.0 - 0.05	< 3.0	< 3.0	< 3.0	< 0.2
P-SS22-05	P-SS22-05	2022 03 22	0.0 - 0.2	< 3.0	< 3.0	< 3.0	< 0.2
	P-SS22-06	Duplicate	0.0 - 0.2	< 3.0	< 3.0	< 3.0	< 0.2
	QA/QC RPD%			*	*	*	*
BC Standard							
CSR Freshwater Sediment (FW)				n/a	n/a	n/a	n/a
Federal Standard							
CCME CEQG Interim Sediment Quality (ISQG)				n/a	n/a	n/a	n/a
CCME CEQG Probable Effect Level (PEL)				n/a	n/a	n/a	n/a

Associated CARO file(s): 22C3076.
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QA/QC RPD Denotes quality assurance/quality control relative percent difference
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RDL Denotes reported detection limit.

BOLD Concentration greater than CSR Freshwater Sediment (FW) standard
SHADED Concentration greater than CCME CEQG Interim Sediment Quality (ISQG) Guideline
RED Concentration greater than CCME CEQG Probable Effect Level (PEL) Guideline

TABLE 9: Summary of Analytical Results for Sediment - Hydrocarbons.

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Depth Interval (m)	Monocyclic Aromatic Hydrocarbons					Gross Parameters					MTBE
				Benzene µg/g	Ethylbenzen µg/g	Toluene µg/g	Xylenes µg/g	Styrene µg/g	VPH (C6-C10) µg/g	EPH (C10- µg/g	LEPH (C10- µg/g	EPH (C19-C32) µg/g	HEPH (C19-C32) µg/g	Methyl Tert-butyl Ether [MTBE] µg/g
P-SS22-01	P-SS22-01	2022 03 22	0.0 - 0.1	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-02	P-SS22-02	2022 03 22	0.0 - 0.05	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-03	P-SS22-03	2022 03 22	0.0 - 0.05	< 0.020	0.156	< 0.200	0.124	< 0.050	< 20	< 50	< 50	99	99	< 0.280
P-SS22-04	P-SS22-04	2022 03 22	0.0 - 0.05	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-05	P-SS22-05	2022 03 22	0.0 - 0.2	< 0.020	< 0.050	< 0.200	< 0.100	< 0.050	23	< 50	< 50	< 50	< 50	< 0.220
	P-SS22-06	Duplicate	0.0 - 0.2	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
	QA/QC RPD%			-	-	-	-	-	-	*	*	*	*	-
BC Standard														
CSR Freshwater Sediment (FW)				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Federal Standard														
CCME CEQG Interim Sediment Quality (ISQG)				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CCME CEQG Probable Effect Level (PEL)				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Associated Caro file(s): 22C3076.
All terms defined within the body of SNC-Lavalin's report.
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RDL Denotes reported detection limit.

BOLD Concentration greater than CSR Freshwater Sediment (FW) standard
SHADED Concentration greater than CCME CEQG Interim Sediment Quality (ISQG) Guideline
RED Concentration greater than CCME CEQG Probable Effect Level (PEL) Guideline

TABLE 10: Summary of Analytical Results for Sediment - Polycyclic Aromatic Hydrocarbons.

Sample Location		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05			BC Standard	Federal Guideline	
Sample ID		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05	P-SS22-06	QA/QC RPD %	CSR Freshwater Sediment (FW)[b]	CCME CEQG Interim Sediment Quality (ISQG)[c]	CCME CEQG Probable Effect Level (PEL)[c]
Sample Date (yyyy mm dd)		2022 03 22	2022 03 22	2022 03 22	2022 03 22	2022 03 22	Duplicate				
Depth Interval (m)		0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05	0.0 - 0.2	0.0 - 0.2				
Parameter	**Units**	**Analytical Results**									
Polycyclic Aromatic Hydrocarbons											
Naphthalene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.24	0.0346	0.391
Methylnaphthalene, 1-	µg/g	< 0.050	< 0.050	0.163	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Methylnaphthalene, 2-	µg/g	< 0.050[a]	< 0.050[a]	**0.105**	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.12	0.0202	0.201
Acenaphthylene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.08	0.00587	0.128
Acenaphthene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.055	0.00671	0.0889
Fluorene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.089	0.0212	0.144
Phenanthrene	µg/g	< 0.050[a]	< 0.050[a]	**0.259**	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.32	0.0419	0.515
Anthracene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.15	0.0469	0.245
Fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	1.5	0.111	2.355
Pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.54	0.053	0.875
Benz(a)anthracene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.24	0.0317	0.385
Chrysene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.53	0.0571	0.862
Benzo(b)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Benzo(b+j)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Benzo(k)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Benzo(a)pyrene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.48	0.0319	0.782
Indeno(1,2,3-cd)pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Dibenz(a,h)anthracene	µg/g	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	< 0.050[a]	*	0.084	0.00622	0.135
Benzo(g,h,i)perylene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Quinoline	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Chloronaphthalene, 2-	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a

Associated Caro file(s): 22C3076.
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RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Freshwater Sediment (FW) standard
SHADED	Concentration greater than CCME CEQG Interim Sediment Quality (ISQG) Guideline
RED	Concentration greater than CCME CEQG Probable Effect Level (PEL) Guideline

[a] Laboratory detection limit exceeds regulatory standard/guideline.
[b] Pathways Included: Sensitive Site.
[c] Guideline to protect freshwater aquatic life.

TABLE 11: Summary of Analytical Results for Sediment - Polychlorinated Biphenyls

Sample Location		P-SS22-03	BC Standard	Federal Guideline	
Sample ID		P-SS22-03	CSR Freshwater Sediment (FW)[b]	CCME CEQG Interim Sediment Quality (ISQG)[c]	CCME CEQG Probable Effect Level (PEL)[c]
Sample Date (yyyy mm dd)		2022 03 22			
Depth Interval (m)		0.0 - 0.05			
Parameter	Units	Analytical Results			
PCBs					
Aroclor 1016	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1221	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1232	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1242	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1248	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1254	µg/g	< 0.040	n/a	0.06	0.34
Aroclor 1260	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1262	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1268	µg/g	< 0.040	n/a	n/a	n/a
Polychlorinated Biphenyls, Total [PCBs]	µg/g	< 0.040[a]	0.17	0.0341	0.277

Associated Caro file(s): 22C3076.

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QA/QC RPD Denotes quality assurance/quality control relative percent difference

* RPDs are not calculated where one or more concentrations are less than five times RDL.

RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Freshwater Sediment (FW) standard
SHADED	Concentration greater than CCME CEQG Interim Sediment Quality (ISQG) Guideline
RED	Concentration greater than CCME CEQG Probable Effect Level (PEL) Guideline

[a] Laboratory detection limit exceeds regulatory standard/guideline.

[b] Pathways Included: Sensitive Site.

[c] Guideline to protect freshwater aquatic life.

TABLE 12: Summary of Princeton Soil Data From Other Sources Compared to Soil and Sediment Standards and Guidelines

Source:	Town of Princeton				
Date(s) Sampled:	Nov 21 2021		Applicable Benchmarks:	Soil: CSR AL; CSR RLLD; CCME AL; CCME RL Sediment: CSR FWSedSU, CCME ISQG, CCME PEL	
# of Samples	**Parameter**	**Units**	**# of Exceedances/Detections**	**Max Conc.**	**Benchmarks exceeded**
11	Benzene	µg/g	11	<0.020	CCME AL/RL
11	Ethylbenzene	µg/g	11	<0.050	CCME AL/RL
11	Toluene	µg/g	11	<0.200	CCME AL/RL
4	Naphthalene	µg/g	4	<0.051	CCME AL/RL
4	Phenanthrene	µg/g	4	<0.051	CCME AL/RL
11	VPH/VH	µg/g	0	<20	none
11	EPHC10-C19/LEPH	µg/g	0	<51	none
11	EPHC19-C32/HEPH	µg/g	0	290	none
11	Fecal Coliform	MPN/g	9	1,200	n/a
11	Total Coliforms	MPN/g	11	6,600	n/a

bold shade parameter exceeds standard/guideline

Notes:

CSR AL - CSR Agricultural Land Use (AL) standard

CSR RL - CSR Low Density Residential Land Use (RLLD) standard

CCME AL - CCME CEQG Agricultural Surface (AL Surface) Guideline

CCME RL - CCME CEQG Residential Surface (RL Surface) Guideline

CSR $FWSed_{SU}$: CSR Freshwater Sediment (FW) standard for Sensitive Use (SU)

CCME ISQG: CCME CEQG Interim Sediment Quality (ISQG) Guideline

CCME PEL: CCME CEQG Probable Effect Level (PEL) Guideline

MPN = most probable number

n/a: no available benchmarks (i.e., standards or guidelines)

none: no benchmarks (i.e., standards or guidelines) exceeded; parameters are listed to indicate they were of interest and analyzed or detected

VPH = volatile petroleum hydrocarbons; VH = volatile hydrocarbons; HEPH = heavy extractable petroleum hydrocarbons; EPHC19-32 = extractable petroleum hydrocarbons carbon range 19 to 32

EPHC10-19 = extractable petroleum hydrocarbons carbon range 10 to 19; LEPH = light extractable petroleum hydrocarbons

TABLE 13: Summary of Princeton Groundwater Data From Other Sources

Source:	**Town of Princeton Water Supply Wells (three wells within flooded area)**					
Date(s) Sampled:	**Nov 18 2021 to Mar 17 2022**			**Applicable Benchmarks:**	**CSR DW / AW / IW / LW; CDWQG; FIGWQG AW / LW / IW**	
# of Samples	**Exceeding/Detected Parameter**	**Units**	**Benchmark Exceeded**	**# of Samples With Exceeding/Detected Parameter**	**Max Conc.**	**Date**
6	Dissolved Inorganics/General Parameters	-	None	0	N/A	two events tested; Nov 18 2021; Jan 17 2022
5	Total Metals	μg/L	None	0	N/A	two events tested; Nov 18 2021; Jan 17 2022
103	Turbidity	NTU	CDWQG	5	**2.65**	Dec 13 2021
198	*E. coli*	CFU/100 mL	CDWQG	3	**1**	Nov 19 2021; Nov 23 2021; Dec 8 2021
198	Total coliforms	CFU/100 mL	CDWQG	61	**150**	Dec 9 2021

bold shade parameter exceeds standard/guideline

Notes:

CSR DW / AW / LW / IW - CSR Drinking Water (DW) / Aquatic Life (AW) / Livestock (LW) / Irrigation (IW) standards

CDWQG - Canadian Drinking Water Quality Guidelines

FIGWQG - Federal Interim Groundwater Quality Guidelines

FIGWQG AW / LW / IW - FIGWQG Aquatic Life (AW) / Livestock (LW) / Irrigation (IW) guidelines

CFU = colony-forming units

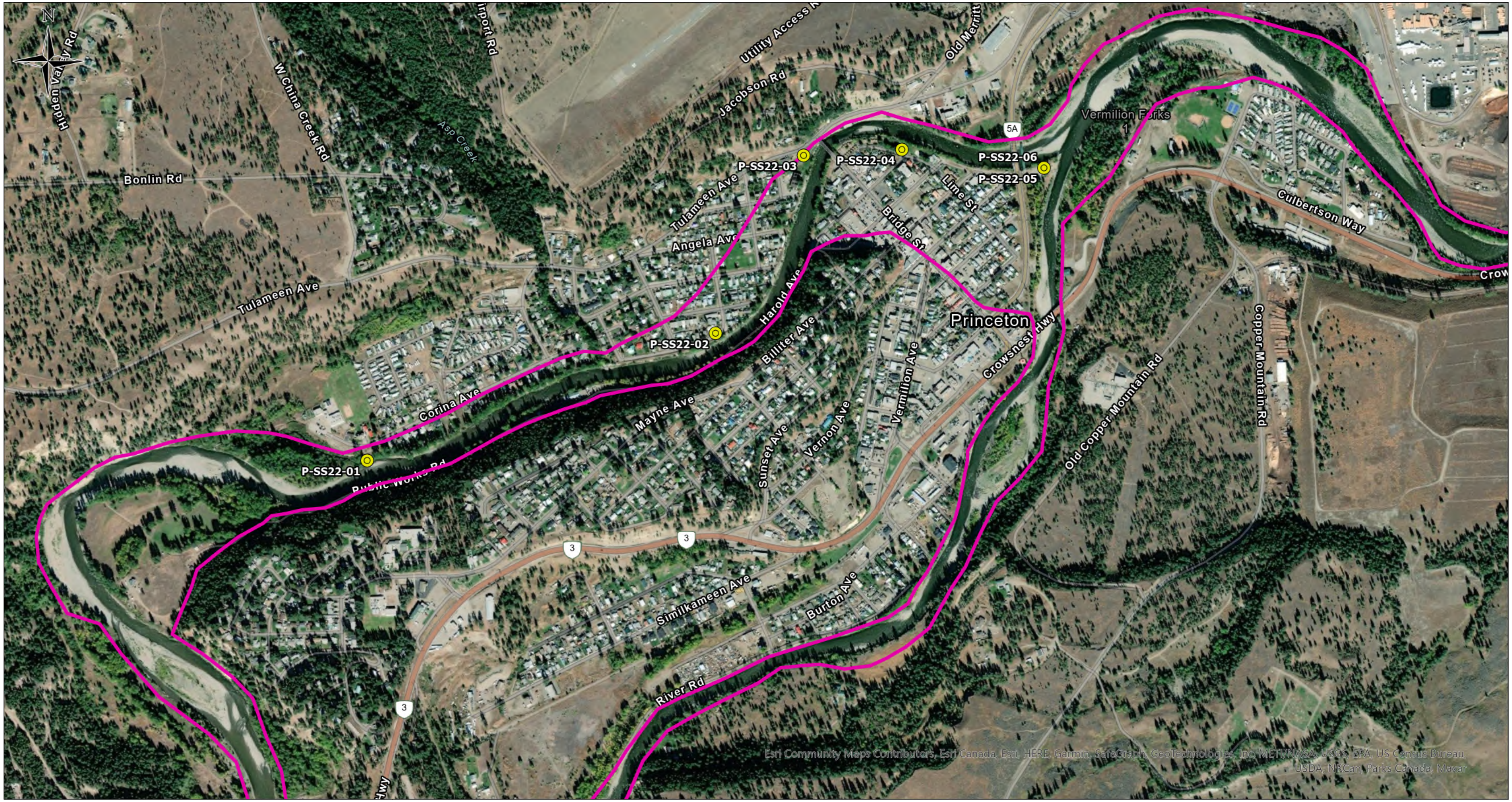
NTU = nephelometric turbidity unit

n/a: no available benchmarks (i.e., standards or guidelines)

none: no benchmarks (i.e., standards or guidelines) exceeded; parameters are listed to indicate they were of interest and analyzed or detected

Drawing

- 688241-002 – Soil Sample Location Plan



LEGEND

- Surface Soil Sample Location
- Monitoring Wells
- 2021 Flood Boundary Extent

0 70 140 280 420 560 Meters

REFERENCES

1. Data from SNC-Lavalin and DataBC,

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

SNC·LAVALIN

CLIENT NAME: Ministry of Environment and Climate Change Strategy	PROJECT LOCATION: Princeton, BC

Sample Location Plan - Princeton

BY: SS	SCALE: 1:10,000	DATE: 2022-05-31	REF No: REV: 01
CHK'D: TL	PROJ COORD SYS: NAD 1983 UTM Zone 10N		688421-002

MXD Path: \\Sli4395\projects\Current Projects\Ministry of Environment\688421\40_Execution\45_GIS_Dwgs\GIS\BCFlood_CSM_Pro\BCFlood_CSM_Pro.aprx

Project Path: \\sli4395\projects\Current Projects\Fisheries and Oceans Canada\687509

Appendix I

SNC-Lavalin Memorandum (2022b) – Results of Surficial Soil Sampling Investigation, Princeton

SNC·LAVALIN

Memorandum

To:	Ministry of Environment & Climate Change Strategy	Date:	June 14, 2022
Attention:	Cindy Meays, PhD, RPBio, P.Ag. Provincial Lead – Flood Water Quality Monitoring Task Force		
From:	Tania Lazorko, BSc, EP Patricia Carmichael, MSc, P.Geo., CSAP	Ref:	688421
Subject:	Results of Surficial Soil Sampling Investigation, Princeton		

SNC-Lavalin has conducted a surficial soil sampling investigation at multiple locations in Princeton, BC, which were identified to be impacted by flood events in November 2021. The work was completed to address data gaps identified during development of a Preliminary Conceptual Site Model (CSM) for the Study Area, dated March 30, 2022[1]. This memorandum provides results of work completed at the Princeton Study Area.

1 Background and Objectives

In November 2021, "atmospheric river" events occurred across southwestern BC causing widespread flooding and damage in some communities. A Preliminary CSM was developed for each of three identified Study Areas: Sumas Prairie, Merritt, and Princeton. The Preliminary CSMs focussed on priority contaminants, media, receptors, and pathways, defined as those with the potential to drive risks to human health and the environment. Through this process, data gaps were identified if there was uncertainty in any of these areas. A phased approach for collection of data was recommended to address these data gaps to support completion of a Preliminary Regional Risk Assessment (PRRA), planned for completion in June 2022.

The initial phase of field work comprised a site reconnaissance and sampling of surficial soil/sediment deposited from flood waters in the Study Area (workplan dated March 21, 2022[2]).

1.1 Princeton

Five data gaps were identified for the Princeton Study Area, as follows:

1. There was a sewer backup at the sewer lift station during the flood that resulted in contamination of the aquifer. The sewer lift station is located upgradient of the Town's water supply Wells #1 and #2. It is reported that flood water entered the pumphouses of these two wells and may have entered the well casing of Well #1.

[1] *Preliminary Conceptual Site Models of Potential Contamination Related to the 2021 Atmospheric River Event in BC, Hope, Sumas Prairie, Princeton and Merritt*, March 30, 2022, SNC-Lavalin Inc.

[2] *Workplan for Addressing Preliminary CSM Data Gaps*, March 21, 2022, SNC-Lavalin Inc.

2. Shallow groundwater quality in the Town Centre post-flood is unknown (concern is potential to contaminate drinking water supply).
3. Unknown quality of material deposited on land by flood waters.
4. Uncertain post-flood sediment quality related to potential upstream sources (e.g., mining operations, Coalmont / Tulameen area, composting facility in Eastgate, septic systems, landfill or disposal areas, etc.).
5. Uncertain whether flood water entered any old mine entrances and potentially impacted bedrock Aquifer #1024.

The scope of work for this report included investigating items 3, 4 and 5. For groundwater quality (items 1 and 2), post-flood analytical data was provided by the Town of Princeton for three water supply wells that were within the flood boundary. This groundwater data will be included in the PRRA. Priority potential contaminants of concern (PCOC) identified in soil include microbiological parameters (i.e., fecal coliform, *E. coli,* total coliforms, Salmonella), metals, nitrate, polycyclic aromatic hydrocarbons (PAHs) and light non-aqueous phase liquid (LNAPL: pure phase hydrocarbon fuels, such as gasoline, diesel, heating oil etc.). If hydrocarbon releases were reported or LNAPL was observed during site reconnaissance, the LNAPL and related hydrocarbon parameters would be further assessed. Other secondary potential contaminants and parameters were also assessed at the same time. The table below indicates the number of samples submitted for various test parameters.

Table A: Analytical Plan for Soil Testing

Priority Contaminants	No. Samples (including duplicates)
microbiological parameters (total coliform, fecal coliforms, Escherichia coli [*E. coli*], Salmonella)	6
metals	6
nitrate	6
PAHs	6
Other Parameters	
monocyclic aromatic hydrocarbons (MAHs, includes benzene, ethylbenzene, toluene, xylenes, volatile petroleum hydrocarbons (VPHs), methyl tert-butyl ether [MTBE])	2
light and heavy extractable petroleum hydrocarbons (LEPHs/HEPHs)	6
polychlorinated biphenyls (PCBs)	1
nitrite, ammonia, phosphate, potassium (i.e., inorganics)	6
speciated chromium	3
total organic carbon (TOC)	6

2 Regulatory Context

In BC, the *Environmental Management Act – Part 4*[3] (EMA) provides the legal requirements for managing contaminated sites. Under EMA, the Contaminated Sites Regulation[4] (CSR) contains the provision for the establishment of environmental quality standards to determine the acceptability of substances in soil, sediment, groundwater and vapour at sites. All the environmental quality standards listed in the CSR are based on, and are designed to be protective of, the toxicological effects of contaminating substances for a variety of land uses. Accordingly, soil analytical results are compared to the applicable BC CSR low density residential land use (RL_{LD}), CSR urban park land use (PL), and CSR agricultural land use (AL) soil standards, including matrix and generic standards (CSR Schedule 3.1).

Generic standards are based on land use, while matrix standards are based on a series of site-specific factors. The following site-specific factors are applicable to the locations sampled and the most stringent of each is applied to data analysis:

- Human intake of contaminated soil (mandatory for all sites);
- Toxicity to soil invertebrates and plants (mandatory for all sites);
- Groundwater flow to surface water used by freshwater aquatic life (AW);
- Groundwater used for drinking (DW);
- Major microbial functional impairment;
- Livestock ingesting soil and fodder;
- Groundwater used for irrigation (IW); and
- Groundwater used for Livestock (LW).

3 Methods

On March 22, 2022, a site reconnaissance (i.e., via driving and walking) was carried out across a majority of the Study Area to ground truth the flood boundary that was established in the Preliminary CSM and to identify sample locations where flood related sediment was deposited. This site reconnaissance was limited to areas with public access only (e.g., parks, trails, roadways and school grounds).

Soil sampling at identified locations in the Princeton Study Area was conducted on March 22, 2022. As indicated above, the sample locations were selected based on public accessibility and where there were visible deposits on land that had not been disturbed since the flood. Parameters chosen for analysis at each site were based on PCOC identified in SNC-Lavalin's March 30 report, as well as site observations at the time of sampling. All samples were collected in accordance with our written Preferred Operating Procedures which includes:

- Soil samples were logged in detail for soil type, colour, texture, moisture content and apparent hydrocarbon impacts;
- Samples were collected directly into laboratory-supplied containers immediately upon collection and transferred to an ice-chilled cooler;

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[3] *Environmental Management Act* (EMA), B.C. Reg. 179/2021 / effective July 7, 2021.

[4] *Contaminated Sites Regulation* (CSR), B.C. Reg. 375/96, includes amendments up to B.C. Reg. 179/2021, July 7, 2021.

- Collection of blind field duplicate samples at an approximate rate of 10% (i.e., one duplicate for every ten samples collected). Duplicate samples were collected from the same layer(s) and material within the sampling location and confirmed in the field to be consistent with regard to observable criteria (e.g., lithology, colour, grain size, moisture). However, as natural materials are not isotropic, some heterogeneity is anticipated; and
- All samples were stored in ice-chilled coolers and were transported to the project laboratory for analysis under chain-of-custody control.

A total of six samples (including one duplicate sample) were collected from five locations within the areas flooded by the Tulameen River, and the Similkameen River. The attached Drawing 688421-002 shows the locations of where samples were collected. Photographs of sample locations are provided in Attachment 1. Samples were submitted to CARO Analytical Services (CARO) for analysis of parameters as indicated in Table B, below.

Table B: Summary of Soil Sample Locations

Sample ID	Location	Depth (m)	Parameters Analyzed
P-SS22-01	North side along Tulameen River, before entrance to John Allison Elementary School	0.1	Priority Contaminants, LEPHs/HEPHs, inorganics, TOC
P-SS22-02	North side of Tulameen River, intersection of Poplar Street and Riverside Road	0.05	Priority Contaminants, speciated chromium, LEPHs/HEPHs, inorganics, TOC
P-SS22-03	North side of Tulameen River, Bridge View Park, near 160 Tulameen Avenue	0.05	Priority Contaminants, speciated chromium, MAHs, LEPHs/HEPHs, PCBs, inorganics, TOC
P-SS22-04	South side of Tulameen River, Rotary Splash Park playground area	0.05	Priority Contaminants, speciated chromium, LEPHs/HEPHs, inorganics, TOC
P-SS22-05/ P-SS22-06	2 Rivers Park at confluence of Tulameen and Similkameen Rivers	0.2	Priority Contaminants, MAHs, LEPHs/HEPHs, inorganics, TOC

Priority Contaminants include: microbiological parameters (i.e., fecal coliform, *E. coli,* total coliforms, Salmonella), metals, nitrate, and PAHs.

4 Results

4.1 Site Reconnaissance

As indicated above, SNC-Lavalin conducted a site reconnaissance of the Princeton flood area on March 22, 2022, and that the site reconnaissance was limited to areas with public access only. Observations and discussions with local residents indicated that the flood extent boundary established by SNC-Lavalin in the Preliminary CSM study was fairly well defined. The flood waters reached residential properties and apartment buildings along the north side of the Tulameen River (i.e., Allison Flats area) and the low-lying area of Downtown, mainly in the vicinity of Brown Bridge and east of Bridge Street. Sediment and other material deposited on land during the flood event, specifically at the Rotary Splash Park; the adjacent motel and surrounding residential properties; and residential properties on the north side of the Tulameen River upstream of the Brown Bridge, had not been removed or were in the process of remediation. The roadways had been cleared and were accessible with exception of the road to the Public Works building which had been washed out along the south side of the Tulameen River. No signs of hydrocarbon fuel releases were observed throughout the site visit. Photographs from the site reconnaissance are presented below.

At the confluence and further downstream, the riverbanks were eroded; log jams were present; and gravel and boulders were deposited and/or exposed indicating scouring and aggressive flow conditions (Photograph 1 and Photograph 2, below). As such, soil samples were not collected downstream of the confluence.

Photograph 1: Two Rivers Park, at the confluence, looking downstream (eastward) showing eroded banks resulting from the flood. The foreground area was completely submerged during the flood.

Photograph 2: Memorial Park, looking northwest showing a flood debris channel associated with the Similkameen River on the right. The pumphouses for Town Wells #1 and #2 are located approximately 100 m to left of this photo location.

One data gap that was identified in the Preliminary CSM (SNC-Lavalin, 2022a) was the suspected presence of a historical coal mine entrance just west of the Public Works building and the potential for flood waters to enter the historical mine workings and impact groundwater and/or redistribute coal related PCOCs (i.e., PAHs and metals) in sediment. The road was inaccessible as it had been washed out during the flood and as such, reconnaissance of the suspected area of the historical mine entrance could only be completed from across the river. Observations of the slope from across the river did not reveal the presence of any anthropogenic features, with exception of keep out and no trespassing signs, at the estimated height of the floodwaters.

Photographs 3 and 4: View from the north to south side of the Tulameen River at the suspected location of the historical mine entrance. No entrance was observed at or just above road level.

Based on the results of the site reconnaissance, five soil sample locations were identified, and it was determined to be unlikely that historical mine entrances were inundated with flood waters.

4.2 Analytical

A soil sample log is provided in attached Table 1. Detailed analytical results are presented on the attached Tables 2 to 6. Copies of the laboratory analytical reports are provided in Attachment 2.

4.2.1 Priority Contaminants

Metals and Inorganics

Analytical results for metals and inorganics parameters indicate the following:

- All metals and inorganics concentrations were less than the applicable CSR standards.
- Overall, the highest concentrations of metals and inorganics parameters were identified in sample location P-SS22-03, located at Bridgeview Park. This includes pH, which ranged from 8.28 at sample location P-SS22-02, to 8.70 at sample location P-SS22-03.
- Nitrate concentrations were below the laboratory MDL in all samples except P-SS22-01 (1.1 µg/g), located near John Allison Elementary school (most upstream location).

Microbiological Parameters

There are no standards under the CSR for the analyzed microbiological parameters in soil. Even though there are no standards or guidelines available for these parameters in soil, they will be carried forward and evaluated in the PRRA. Concentrations of these parameters are summarized as follows:

- Total coliforms: concentrations were less than laboratory MDL in all samples except for sample location P-SS22-02 (46 most probable number per gram [MPN/g]) and sample location P-SS22-03 (13 MPN/g).
- Concentrations of fecal coliforms, *E. coli*, and Salmonella are all less than laboratory MDL in samples.

Polycyclic Aromatic Hydrocarbons

Analytical results for PAH parameters indicate the following:

- Phenanthrene concentration exceeds CSR AL, RL_{LD}, and PL land use standards at sample location P-SS22-03. Concentrations of parameters 1-methylnaphthalene, and 2-methylnaphthalene in this sample were above the laboratory method detection limits (MDL), but less than the applicable CSR standards.
- Concentrations of PAH parameters were less than the applicable CSR standards, and less than the laboratory MDL, in all other samples.

4.2.2 Other Parameters

Soil samples were selectively analyzed for other parameters in addition to the priority contaminants, as identified in Table B, above. Concentrations of all other parameters analyzed were less than the applicable CSR standards, in all samples and typically less than the laboratory MDL. For those parameters that do not have CSR standards, results were less than the MDL.

4.2.3 Quality Assurance / Quality Control (QA/QC)

To assess the QA/QC for the blind duplicate sets, SNC-Lavalin calculates the practical quantitation limit (PQL) (defined as five times the laboratory MDL) and, if appropriate, the relative percent difference (RPD) (defined as the absolute value of the difference between a sample set divided by the average of the two results). If sample concentrations are less than the PQL, RPDs are not considered meaningful due to a relative increase in analytical variability at or near detection limits. Therefore, RPDs in such scenarios were not calculated.

All RPDs were less than SNC-Lavalin's acceptance criteria of 50%, where calculated. SNC-Lavalin considers the data to be representative and reliable.

5 Notice to Reader

This report has been prepared and the work referred to in this report have been undertaken by SNC-Lavalin Inc. (SNC-Lavalin) for the exclusive use of BC Ministry of the Environment and Climate Change Strategy (BC ENV), who has been party to the development of the scope of work and understands its limitations. The methodology, findings, conclusions and recommendations in this report are based solely upon the scope of work and subject to the time and budgetary considerations described in the proposal and/or contract pursuant to which this report was issued. Any use, reliance on, or decision made by a third party based on this report is the sole responsibility of such third party. SNC-Lavalin accepts no liability or responsibility for any damages that may be suffered or incurred by any third party as a result of the use of, reliance on, or any decision made based on this report.

The findings, conclusions and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our original contract and included in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered, site conditions change or standards are amended, modifications to this report may be necessary. The results of this assessment should in no way be construed as a warranty that the subject site is free from any and all environmental impact.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

SNC-Lavalin Inc.
Permit No. 1002642
2022-06-15

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Tables

TABLE 1: Soil Sampling Log - Princeton

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Sample Type	Description	Depth (m)
P-SS22-01	P-SS22-01	2022 03 22	Surface Sample	SAND, fine grained, trace silt, brown, loose, trace rootlets, damp.	0.1
P-SS22-02	P-SS22-02	2022 03 22	Surface Sample	SAND, fine grained, trace silt, brown, loose, trace rootlets, damp.	0.05
P-SS22-03	P-SS22-03	2022 03 22	Surface Sample	SILT, some clay, dark brown, very soft, wet.	0.05
P-SS22-04	P-SS22-04	2022 03 22	Surface Sample	SAND, fine grained, trace medium grained sand, trace silt, brown, loose, trace organics, moist.	0.05
P-SS22-05	P-SS22-05	2022 03 22	Surface Sample	SAND, fine-medium grained, trace silt, light brown, loose, damp.	0.2
P-SS22-05	P-SS22-06	Duplicate	Surface Sample	Blind Field Duplicate of P-SS22-05	0.2

TABLE 2: Summary of Analytical Results for Soil - Physical and Inorganic Parameters and Total Metals

Sample Location		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05			BC Standard		
Sample ID		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05	P-SS22-06	QA/QC RPD %	CSR Agricultural Land Use (AL)[a]	CSR Low Density Residential Land Use (RLLD)[a]	CSR Urban Park Land Use (PL)[a]
Sample Date (yyyy mm dd)		2022 03 22	2022 03 22	2022 03 22	2022 03 22	2022 03 22	Duplicate				
Depth Interval (m)		0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05	0.0 - 0.2	0.0 - 0.2				
Parameter	Units	Analytical Results									
Physical Parameters											
pH	pH	8.50	8.28	8.70	8.41	8.55	8.61	1	n/a	n/a	n/a
Total Organic Carbon	%	0.194	0.924	2.52	0.886	0.262	0.279	6	n/a	n/a	n/a
Total Organic Carbon	µg/g	1,940	9,240	25,200	8,860	2,620	2,790	6	n/a	n/a	n/a
Ammonia Nitrogen	µg/g	7.7	10.1	13.1	11.1	10.0	8.0	*	n/a	n/a	n/a
Water Soluble Nitrate Nitrogen	µg/g	1.10	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	*	25,000	25,000	50,000
Water Soluble Nitrite Nitrogen	µg/g	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	*	1,500	1,500	3,000
Water Soluble Phosphate	µg/g	0.265	0.330	4.78	0.305	< 0.250	< 0.250	*	n/a	n/a	n/a
Total Metals											
Aluminum	µg/g	9,310	12,500	15,100	9,770	7,770	8,510	9	40,000	40,000	40,000
Antimony	µg/g	0.22	0.34	0.34	0.29	0.16	0.24	*	20	20	20
Arsenic	µg/g	3.96	5.80	4.55	3.87	2.38	2.74	14	10	10	10
Barium	µg/g	78.8	121	223	88.1	55.3	43.1	25	350	350	350
Beryllium	µg/g	0.18	0.29	0.69	0.26	0.17	0.18	*	85 (pH >=8.0)	85 (pH >=8.0)	150 (pH >=8.0)
Boron	µg/g	< 2.0	< 2.0	9.1	3.2	2.3	< 2.0	*	8,500	8,500	15,000
Cadmium	µg/g	0.124	0.197	0.185	0.119	0.064	0.070	*	10 (pH >=8.0)	20 (pH >=8.0)	30 (pH >=8.0)
Chromium	µg/g	46.8	47.5	24.1	42.9	24.1	27.7	14	60[b]	60[b]	60[b]
Chromium, hexavalent	µg/g	-	< 0.40	< 0.40	< 0.40	-	-	-	60	60	60
Chromium, trivalent	µg/g	-	47.5	24.1	42.9	-	-	-	60	100	200
Cobalt	µg/g	14.7	17.0	12.8	14.2	8.07	9.67	18	25	25	25
Copper	µg/g	29.0	44.8	27.4	30.4	18.9	20.5	8	150 (pH >=8.0)	150 (pH >=8.0)	150 (pH >=8.0)
Iron	µg/g	30,400	32,900	25,000	32,600	19,900	24,400	20	35,000	35,000	35,000
Lead	µg/g	4.46	7.29	15.6	6.95	4.26	3.76	12	120 (pH >=8.0)	120 (pH >=8.0)	120 (pH >=8.0)
Lithium	µg/g	6.17	7.76	8.16	6.66	5.83	6.26	7	30	30	65
Manganese	µg/g	448	630	1,120	495	324	369	13	2,000	2,000	2,000
Mercury	µg/g	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	*	0.6	10	25
Molybdenum	µg/g	0.54	0.96	1.15	0.78	0.37	0.55	*	3	3	15
Nickel	µg/g	46.5	43.7	19.6	36.7	16.7	21.5	25	150 (pH >=8.0)	150 (pH >=8.0)	150 (pH >=8.0)
Selenium	µg/g	< 0.20	0.29	< 0.20	< 0.20	< 0.20	< 0.20	*	1	1	1
Silver	µg/g	< 0.10	0.11	< 0.10	< 0.10	< 0.10	< 0.10	*	20	20	20
Strontium	µg/g	45.9	65.7	199	52.5	37.0	29.5	23	9,500	9,500	20,000
Thallium	µg/g	< 0.10	< 0.10	0.47	< 0.10	< 0.10	< 0.10	*	2	9	9
Tin	µg/g	< 0.20	0.28	1.20	0.26	0.21	0.21	*	5	50	50
Tungsten	µg/g	< 0.20	< 0.20	1.02	< 0.20	< 0.20	< 0.20	*	15	15	25
Uranium	µg/g	0.312	0.515	2.13	0.460	0.314	0.270	15	15	15	30
Vanadium	µg/g	71.3	73.1	47.9	77.6	43.1	54.1	23	100	100	100
Zinc	µg/g	44.3	61.4	75.8	51.0	38.8	40.9	5	200 (pH >=8.0)	450 (pH >=8.0)	450 (pH >=8.0)
Potassium	µg/g	750	1,030	1,420	724	493	556	12	n/a	n/a	n/a

Associated Caro file(s): 22C3076.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit.
- Denotes analysis not conducted.
n/a Denotes no applicable standard/guideline.
QA/QC RPD Denotes quality assurance/quality control relative percent difference
* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Agricultural Land Use (AL) standard
SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
RED	Concentration greater than CSR Urban Park Land Use (PL) standard

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).
[b] Individual standards exist for Cr +3 and Cr +6. Reported value represents more stringent standard.

TABLE 3: Summary of Analytical Results for Soil - Microbiological Tests

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Depth Interval (m)	Microbiological Tests			
				Fecal MPN/g	E. Coli MPN/g	Total MPN/g	Salmonella MPN/g
P-SS22-01	P-SS22-01	2022 03 22	0.0 - 0.1	< 3.0	< 3.0	< 3.0	< 0.2
P-SS22-02	P-SS22-02	2022 03 22	0.0 - 0.05	< 3.8	< 3.8	46	< 0.3
P-SS22-03	P-SS22-03	2022 03 22	0.0 - 0.05	< 4.3	< 4.3	13	< 0.3
P-SS22-04	P-SS22-04	2022 03 22	0.0 - 0.05	< 3.0	< 3.0	< 3.0	< 0.2
P-SS22-05	P-SS22-05	2022 03 22	0.0 - 0.2	< 3.0	< 3.0	< 3.0	< 0.2
	P-SS22-06	Duplicate	0.0 - 0.2	< 3.0	< 3.0	< 3.0	< 0.2
	QA/QC RPD%			*	*	*	*
BC Standard							
CSR Agricultural Land Use (AL)[a]				n/a	n/a	n/a	n/a
CSR Low Density Residential Land Use (RLLD)[a]				n/a	n/a	n/a	n/a
CSR Urban Park Land Use (PL)[a]				n/a	n/a	n/a	n/a

Associated CARO file(s): 22C3076.
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RDL Denotes reported detection limit.

BOLD Concentration greater than CSR Agricultural Land Use (AL) standard
SHADED Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
RED Concentration greater than CSR Urban Park Land Use (PL) standard

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

TABLE 4: Summary of Analytical Results for Soil - Hydrocarbons

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Depth Interval (m)	Monocyclic Aromatic Hydrocarbons Benzene µg/g	Ethylbenzen µg/g	Toluene µg/g	Xylenes µg/g	Styrene µg/g	Gross Parameters VPHs µg/g	EPH (C10-C19)[b] µg/g	LEPHs µg/g	EPH (C19-C32)[b] µg/g	HEPHs µg/g	MTBE Methyl Tert-butyl Ether µg/g
P-SS22-01	P-SS22-01	2022 03 22	0.0 - 0.1	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-02	P-SS22-02	2022 03 22	0.0 - 0.05	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-03	P-SS22-03	2022 03 22	0.0 - 0.05	< 0.020	0.156	< 0.200	0.124	< 0.050	< 20	< 50	< 50	99	99	< 0.280
P-SS22-04	P-SS22-04	2022 03 22	0.0 - 0.05	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
P-SS22-05	P-SS22-05	2022 03 22	0.0 - 0.2	< 0.020	< 0.050	< 0.200	< 0.100	< 0.050	23	< 50	< 50	< 50	< 50	< 0.220
	P-SS22-06	Duplicate	0.0 - 0.2	-	-	-	-	-	-	< 50	< 50	< 50	< 50	-
	QA/QC RPD%			-	-	-	-	-	-	*	*	*	*	-
BC Standard														
CSR Agricultural Land Use (AL)[a]				0.035	15	0.5	6.5	0.1	200	1,000	1,000	1,000	1,000	4,000
CSR Low Density Residential Land Use (RLLD)[a]				0.035	15	0.5	6.5	5	200	1,000	1,000	1,000	1,000	4,000
CSR Urban Park Land Use (PL)[a]				0.035	15	0.5	6.5	5	200	1,000	1,000	1,000	1,000	8,000

Associated Caro file(s): 22C3076.
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SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
RED	Concentration greater than CSR Urban Park Land Use (PL) standard

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).
[b] Where no LEPH and HEPH are available, EPH has been compared to LEPH and HEPH standards, which are conservative comparisons.

TABLE 5: Summary of Analytical Results for Soil - Polycyclic Aromatic Hydrocarbons

Sample Location		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05			BC Standard		
Sample ID		P-SS22-01	P-SS22-02	P-SS22-03	P-SS22-04	P-SS22-05	P-SS22-06	QA/QC RPD %	CSR Agricultural Land Use (AL)[a]	CSR Low Density Residential Land Use (RLLD)[a]	CSR Urban Park Land Use (PL)[a]
Sample Date (yyyy mm dd)		2022 03 22	2022 03 22	2022 03 22	2022 03 22	2022 03 22	Duplicate				
Depth Interval (m)		0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05	0.0 - 0.2	0.0 - 0.2				
Parameter	Units	Analytical Results									
Polycyclic Aromatic Hydrocarbons											
Naphthalene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.6	0.6	0.6
Methylnaphthalene, 1-	µg/g	< 0.050	< 0.050	0.163	< 0.050	< 0.050	< 0.050	*	250	250	500
Methylnaphthalene, 2-	µg/g	< 0.050	< 0.050	0.105	< 0.050	< 0.050	< 0.050	*	60	60	100
Acenaphthylene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Acenaphthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	950	950	2,000
Fluorene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	600	600	1,000
Phenanthrene	µg/g	< 0.050	< 0.050	***<u>0.259</u>***	< 0.050	< 0.050	< 0.050	*	0.1	5	5
Anthracene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	2.5	2.5	2.5
Fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	50	50	50
Pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	10	10
Benz(a)anthracene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	1
Chrysene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	200	200	400
Benzo(b)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	1
Benzo(b+j)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	1
Benzo(k)fluoranthene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	1
Benzo(a)pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	5	5	10
Indeno(1,2,3-cd)pyrene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	1
Dibenz(a,h)anthracene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	0.1	1	1
Benzo(g,h,i)perylene	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	n/a	n/a	n/a
Quinoline	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	2.5	2.5	4.5
Chloronaphthalene, 2-	µg/g	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	*	1,500	1,500	2,500

Associated Caro file(s): 22C3076.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit.
- Denotes analysis not conducted.
n/a Denotes no applicable standard/guideline.
QA/QC RPD Denotes quality assurance/quality control relative percent difference
* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

<u>BOLD</u>	Concentration greater than CSR Agricultural Land Use (AL) standard
SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
RED	Concentration greater than CSR Urban Park Land Use (PL) standard

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

TABLE 6: Summary of Analytical Results for Soil - PCBs

Sample Location		P-SS22-03	BC Standard		
Sample ID		P-SS22-03	CSR Agricultural Land Use (AL)[a]	CSR Low Density Residential Land Use (RLLD)[a]	CSR Urban Park Land Use (PL)[a]
Sample Date (yyyy mm dd)		2022 03 22			
Depth Interval (m)		0.0 - 0.05			
Parameter	Units	Analytical Results			
PCBs					
Aroclor 1016	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1221	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1232	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1242	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1248	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1254	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1260	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1262	µg/g	< 0.040	n/a	n/a	n/a
Aroclor 1268	µg/g	< 0.040	n/a	n/a	n/a
Polychlorinated Biphenyls, Total [PCBs]	µg/g	< 0.040	1.5	1.5	1.5

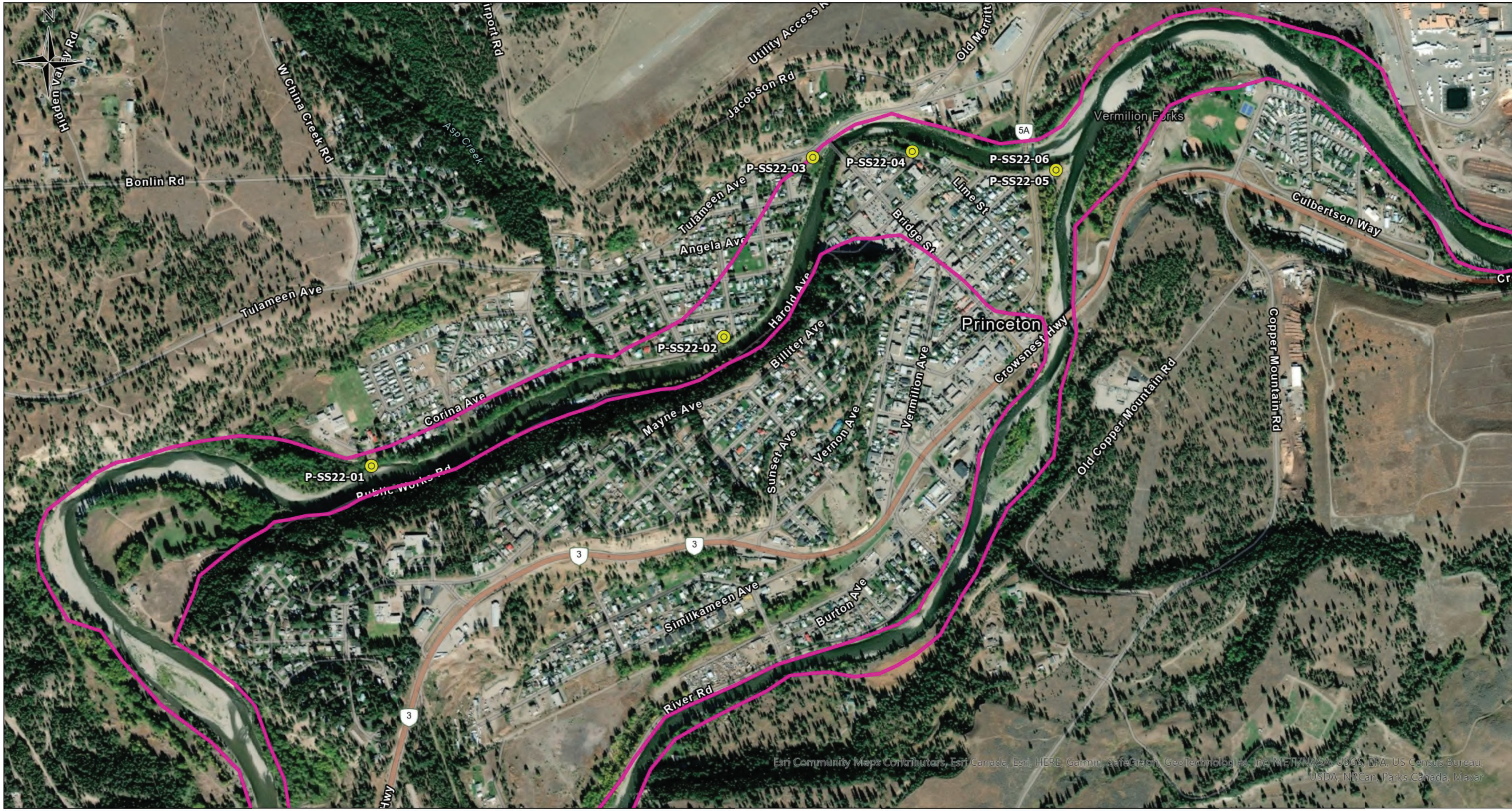
Associated Caro file(s): 22C3076.
All terms defined within the body of SNC-Lavalin's report.
< Denotes concentration less than indicated detection limit.
- Denotes analysis not conducted.
n/a Denotes no applicable standard/guideline.
QA/QC RPD Denotes quality assurance/quality control relative percent difference
* RPDs are not calculated where one or more concentrations are less than five times RDL.
RDL Denotes reported detection limit.

BOLD	Concentration greater than CSR Agricultural Land Use (AL) standard
SHADED	Concentration greater than CSR Low Density Residential Land Use (RLLD) standard
RED	Concentration greater than CSR Urban Park Land Use (PL) standard

[a] The site-specific factors used for determining the matrix standards for this site include: intake of contaminated soil, groundwater used for drinking water, groundwater used for irrigation, groundwater used for livestock watering, livestock ingesting soil and fodder,toxicity to soil invertebrates and plants, major microbial functional impairment, and groundwater flow to surface water used by freshwater aquatic life (whichever is most stringent).

Drawing

- 688421-002 – Soil Sample Location Plan



LEGEND

- Surface Soil Sample Location
- Monitoring Wells
- 2021 Flood Boundary Extent

0 70 140 280 420 560 Meters

REFERENCES

1. Data from SNC-Lavalin and DataBC,

NOTES

1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale, however scale bar will remain accurate.
3. Intended for illustration purposes, accuracy has not been verified for construction or navigation purposes.

SNC·LAVALIN

CLIENT NAME: Ministry of Environment and Climate Change Strategy	PROJECT LOCATION: Princeton, BC

Sample Location Plan - Princeton

BY: SS	SCALE: 1:10,000	DATE: 2022-05-31	REF No: REV: 01
CHK'D: TL	PROJ COORD SYS: NAD 1983 UTM Zone 10N		688421-002

MXD Path: \\Sli4395\projects\Current Projects\Ministry of Environment\688421\40_Execution\45_GIS_Dwgs\GIS\BCFlood_CSM_Pro\BCFlood_CSM_Pro.aprx

Project Path: \\sli4395\projects\Current Projects\Fisheries and Oceans Canada\687509

Attachment 1

Photographs

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Photograph 1: Location of P-SS22-01 on north side of Tulameen River (Allison Flats), looking upstream.

Photograph 2: P-SS22-01: SAND, fine-medium grained, trace silt, brown, loose, trace rootlets, damp.

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Photograph 3: Location of P-SS22-02, north side of Tulameen River at intersection of Poplar St. and Riverside Rd.

Photograph 4: P-SS22-02: SAND, fine grained, trace silt, brown, loose, trace rootlets, damp.

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Photograph 5: Location of P-SS22-03, north side of Tulameen River, at Bridge View Park looking west.

Photograph 6: Location of P-SS22-03, Bridge View Park, west of Brown Bridge looking east.

Photograph 7: P-SS22-03: SILT, some clay, light brown and dark grey, very soft, wet.

Photograph 8: P-SS22-04: SAND, fine grained, trace medium grained sand, trace silt, brown, loose, trace organics, moist.

Photograph 9: Looking downstream from 2 Rivers Park at confluence of the Tulameen and Similkameen Rivers. Location of P-SS22-05/6 is indicated with red star.

Photograph 10: P-SS22-05/06: SAND, fine-medium grained, trace silt, light brown, loose, damp.

Attachment 2

Laboratory Analytical Reports

CERTIFICATE OF ANALYSIS

REPORTED TO	SNC-Lavalin Inc. (Burnaby) 3777 Kingsway, Suite 1300 Burnaby, BC V5H3Z7		
ATTENTION	Alan Walker	**WORK ORDER**	22C3076
PO NUMBER		**RECEIVED / TEMP**	2022-03-22 17:10 / 3.9°C
PROJECT	688421	**REPORTED**	2022-05-06 08:20
PROJECT INFO		**COC NUMBER**	13347

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry

It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve

Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

Work Order Comments: Custody Seals Intact: YES

If you have any questions or concerns, please contact me at bwhitehead@caro.ca

Authorized By:

Brent Whitehead
Account Manager

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-01 (22C3076-01) | Matrix: Soil | Sampled: 2022-03-22 10:35					
BCMOE Aggregate Hydrocarbons					
EPHs10-19	< 50	50	mg/kg dry	2022-03-24	
EPHs19-32	< 50	50	mg/kg dry	2022-03-24	
LEPHs	< 50	50	mg/kg dry	N/A	
HEPHs	< 50	50	mg/kg dry	N/A	
Surrogate: 2-Methylnonane (EPH/F2-4)	*93*	*60-140*	%	*2022-03-24*	
Fertility / Nutrient Parameters					
Ammonia, Water-Soluble (as N)	**7.7**	2.0	mg/kg dry	2022-03-30	
General Parameters					
Carbon, Total Organic	**0.194**	0.050	% dry	2022-04-01	
Moisture	**16.3**	1.0	% wet	2022-03-24	
Nitrate, Water-Soluble (as N)	**1.10**	0.050	mg/kg dry	2022-03-25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
pH (1:2 H2O Solution)	**8.50**	0.10	pH units	2022-03-27	
Phosphate, Water-Soluble (as P)	**0.265**	0.025	mg/kg dry	2022-03-25	
Microbiological Parameters					
Salmonella	< 0.2	0.2	MPN/g dry	2022-03-23	
Coliforms, Total	< 3.0	3.0	MPN/g dry	2022-03-23	
Coliforms, Fecal	< 3.0	3.0	MPN/g dry	2022-03-23	
E. coli	< 3.0	3.0	MPN/g dry	2022-03-23	
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Acenaphthylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Chrysene	< 0.050	0.050	mg/kg dry	2022-03-24	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluorene	< 0.050	0.050	mg/kg dry	2022-03-24	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
1-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Naphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Phenanthrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-01 (22C3076-01) | Matrix: Soil | Sampled: 2022-03-22 10:35, Continued					
Polycyclic Aromatic Hydrocarbons (PAH), Continued					
Quinoline	< 0.050	0.050	mg/kg dry	2022-03-24	
Surrogate: Acenaphthene-d10	*98*	*50-140*	%	*2022-03-24*	
Surrogate: Chrysene-d12	*110*	*50-140*	%	*2022-03-24*	
Surrogate: Naphthalene-d8	*93*	*50-140*	%	*2022-03-24*	
Surrogate: Perylene-d12	*98*	*50-140*	%	*2022-03-24*	
Surrogate: Phenanthrene-d10	*99*	*55-140*	%	*2022-03-24*	
Strong Acid Leachable Metals					
Aluminum	**9310**	40	mg/kg dry	2022-03-28	
Antimony	**0.22**	0.10	mg/kg dry	2022-03-28	
Arsenic	**3.96**	0.30	mg/kg dry	2022-03-28	
Barium	**78.8**	1.0	mg/kg dry	2022-03-28	
Beryllium	**0.18**	0.10	mg/kg dry	2022-03-28	
Boron	< 2.0	2.0	mg/kg dry	2022-03-28	
Cadmium	**0.124**	0.040	mg/kg dry	2022-03-28	
Chromium	**46.8**	1.0	mg/kg dry	2022-03-28	
Cobalt	**14.7**	0.10	mg/kg dry	2022-03-28	
Copper	**29.0**	0.40	mg/kg dry	2022-03-28	
Iron	**30400**	20	mg/kg dry	2022-03-28	
Lead	**4.46**	0.20	mg/kg dry	2022-03-28	
Lithium	**6.17**	0.10	mg/kg dry	2022-03-28	
Manganese	**448**	0.40	mg/kg dry	2022-03-28	
Mercury	< 0.040	0.040	mg/kg dry	2022-03-28	
Molybdenum	**0.54**	0.10	mg/kg dry	2022-03-28	
Nickel	**46.5**	0.60	mg/kg dry	2022-03-28	
Potassium	**750**	40	mg/kg dry	2022-03-28	
Selenium	< 0.20	0.20	mg/kg dry	2022-03-28	
Silver	< 0.10	0.10	mg/kg dry	2022-03-28	
Strontium	**45.9**	0.20	mg/kg dry	2022-03-28	
Thallium	< 0.10	0.10	mg/kg dry	2022-03-28	
Tin	< 0.20	0.20	mg/kg dry	2022-03-28	
Tungsten	< 0.20	0.20	mg/kg dry	2022-03-28	
Uranium	**0.312**	0.050	mg/kg dry	2022-03-28	
Vanadium	**71.3**	2.5	mg/kg dry	2022-03-28	
Zinc	**44.3**	2.0	mg/kg dry	2022-03-28	
P-SS22-02 (22C3076-02) | Matrix: Soil | Sampled: 2022-03-22 11:10					
BCMOE Aggregate Hydrocarbons					
EPHs10-19	< 50	50	mg/kg dry	2022-03-24	
EPHs19-32	< 50	50	mg/kg dry	2022-03-24	
LEPHs	< 50	50	mg/kg dry	N/A	
HEPHs	< 50	50	mg/kg dry	N/A	

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-02 (22C3076-02) | Matrix: Soil | Sampled: 2022-03-22 11:10, Continued					
BCMOE Aggregate Hydrocarbons, Continued					
Surrogate: 2-Methylnonane (EPH/F2-4)	*89*	*60-140*	%	*2022-03-24*	
Calculated Parameters					
Chromium, Trivalent	**47.5**	1.00	mg/kg dry	N/A	
Fertility / Nutrient Parameters					
Ammonia, Water-Soluble (as N)	**10.1**	2.0	mg/kg dry	2022-03-30	
General Parameters					
Carbon, Total Organic	**0.924**	0.050	% dry	2022-04-01	
Chromium, Hexavalent	< 0.40	0.40	mg/kg	2022-03-29	
Moisture	**22.0**	1.0	% wet	2022-03-24	
Nitrate, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
pH (1:2 H2O Solution)	**8.28**	0.10	pH units	2022-03-27	
Phosphate, Water-Soluble (as P)	**0.330**	0.025	mg/kg dry	2022-03-25	
Microbiological Parameters					
Salmonella	< 0.3	0.2	MPN/g dry	2022-03-23	
Coliforms, Total	**46**	3.0	MPN/g dry	2022-03-23	
Coliforms, Fecal	< 3.8	3.0	MPN/g dry	2022-03-23	
E. coli	< 3.8	3.0	MPN/g dry	2022-03-23	
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Acenaphthylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Chrysene	< 0.050	0.050	mg/kg dry	2022-03-24	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluorene	< 0.050	0.050	mg/kg dry	2022-03-24	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
1-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Naphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Phenanthrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Quinoline	< 0.050	0.050	mg/kg dry	2022-03-24	

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-02 (22C3076-02) | Matrix: Soil | Sampled: 2022-03-22 11:10, Continued					
Polycyclic Aromatic Hydrocarbons (PAH), Continued					
Surrogate: Acenaphthene-d10	*98*	*50-140*	*%*	*2022-03-24*	
Surrogate: Chrysene-d12	*110*	*50-140*	*%*	*2022-03-24*	
Surrogate: Naphthalene-d8	*94*	*50-140*	*%*	*2022-03-24*	
Surrogate: Perylene-d12	*97*	*50-140*	*%*	*2022-03-24*	
Surrogate: Phenanthrene-d10	*100*	*55-140*	*%*	*2022-03-24*	
Strong Acid Leachable Metals					
Aluminum	**12500**	40	mg/kg dry	2022-03-28	
Antimony	**0.34**	0.10	mg/kg dry	2022-03-28	
Arsenic	**5.80**	0.30	mg/kg dry	2022-03-28	
Barium	**121**	1.0	mg/kg dry	2022-03-28	
Beryllium	**0.29**	0.10	mg/kg dry	2022-03-28	
Boron	< 2.0	2.0	mg/kg dry	2022-03-28	
Cadmium	**0.197**	0.040	mg/kg dry	2022-03-28	
Chromium	**47.5**	1.0	mg/kg dry	2022-03-28	
Cobalt	**17.0**	0.10	mg/kg dry	2022-03-28	
Copper	**44.8**	0.40	mg/kg dry	2022-03-28	
Iron	**32900**	20	mg/kg dry	2022-03-28	
Lead	**7.29**	0.20	mg/kg dry	2022-03-28	
Lithium	**7.76**	0.10	mg/kg dry	2022-03-28	
Manganese	**630**	0.40	mg/kg dry	2022-03-28	
Mercury	< 0.040	0.040	mg/kg dry	2022-03-28	
Molybdenum	**0.96**	0.10	mg/kg dry	2022-03-28	
Nickel	**43.7**	0.60	mg/kg dry	2022-03-28	
Potassium	**1030**	40	mg/kg dry	2022-03-28	
Selenium	**0.29**	0.20	mg/kg dry	2022-03-28	
Silver	**0.11**	0.10	mg/kg dry	2022-03-28	
Strontium	**65.7**	0.20	mg/kg dry	2022-03-28	
Thallium	< 0.10	0.10	mg/kg dry	2022-03-28	
Tin	**0.28**	0.20	mg/kg dry	2022-03-28	
Tungsten	< 0.20	0.20	mg/kg dry	2022-03-28	
Uranium	**0.515**	0.050	mg/kg dry	2022-03-28	
Vanadium	**73.1**	2.5	mg/kg dry	2022-03-28	
Zinc	**61.4**	2.0	mg/kg dry	2022-03-28	
P-SS22-03 (22C3076-03) | Matrix: Soil | Sampled: 2022-03-22 11:35					
BCMOE Aggregate Hydrocarbons					
VHs (6-10)	< 20	20	mg/kg dry	2022-03-25	
VPHs	< 20	20	mg/kg dry	N/A	
EPHs10-19	< 50	50	mg/kg dry	2022-03-24	
EPHs19-32	**99**	50	mg/kg dry	2022-03-24	
LEPHs	< 50	50	mg/kg dry	N/A	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-03 (22C3076-03) | Matrix: Soil | Sampled: 2022-03-22 11:35, Continued					
BCMOE Aggregate Hydrocarbons, Continued					
HEPHs	**99**	50	mg/kg dry	N/A	
Surrogate: 2-Methylnonane (EPH/F2-4)	*91*	*60-140*	*%*	*2022-03-24*	
Calculated Parameters					
Chromium, Trivalent	**24.1**	1.00	mg/kg dry	N/A	
Fertility / Nutrient Parameters					
Ammonia, Water-Soluble (as N)	**13.1**	2.0	mg/kg dry	2022-03-30	
General Parameters					
Carbon, Total Organic	**2.52**	0.050	% dry	2022-04-01	
Chromium, Hexavalent	< 0.40	0.40	mg/kg	2022-03-29	
Moisture	**30.8**	1.0	% wet	2022-03-24	
Nitrate, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
pH (1:2 H2O Solution)	**8.70**	0.10	pH units	2022-03-27	
Phosphate, Water-Soluble (as P)	**4.78**	0.025	mg/kg dry	2022-03-25	
Microbiological Parameters					
Salmonella	< 0.3	0.2	MPN/g dry	2022-03-23	
Coliforms, Total	**13**	3.0	MPN/g dry	2022-03-23	
Coliforms, Fecal	< 4.3	3.0	MPN/g dry	2022-03-23	
E. coli	< 4.3	3.0	MPN/g dry	2022-03-23	
Polychlorinated Biphenyl Aroclors					
PCB-1016	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1221	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1232	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1242	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1248	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1254	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1260	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1262	< 0.040	0.040	mg/kg dry	2022-03-30	
PCB-1268	< 0.040	0.040	mg/kg dry	2022-03-30	
Total PCBs	< 0.040	0.040	mg/kg dry	2022-03-30	
Surrogate: Decachlorobiphenyl	*107*	*50-140*	*%*	*2022-03-30*	
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Acenaphthylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-03 (22C3076-03) | Matrix: Soil | Sampled: 2022-03-22 11:35, Continued					
Polycyclic Aromatic Hydrocarbons (PAH), Continued					
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Chrysene	< 0.050	0.050	mg/kg dry	2022-03-24	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluorene	< 0.050	0.050	mg/kg dry	2022-03-24	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
1-Methylnaphthalene	**0.163**	0.050	mg/kg dry	2022-03-24	
2-Methylnaphthalene	**0.105**	0.050	mg/kg dry	2022-03-24	
Naphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Phenanthrene	**0.259**	0.050	mg/kg dry	2022-03-24	
Pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Quinoline	< 0.050	0.050	mg/kg dry	2022-03-24	
Surrogate: Acenaphthene-d10	*105*	*50-140*	*%*	*2022-03-24*	
Surrogate: Chrysene-d12	*111*	*50-140*	*%*	*2022-03-24*	
Surrogate: Naphthalene-d8	*101*	*50-140*	*%*	*2022-03-24*	
Surrogate: Perylene-d12	*97*	*50-140*	*%*	*2022-03-24*	
Surrogate: Phenanthrene-d10	*102*	*55-140*	*%*	*2022-03-24*	
Strong Acid Leachable Metals					
Aluminum	**15100**	40	mg/kg dry	2022-03-28	
Antimony	**0.34**	0.10	mg/kg dry	2022-03-28	
Arsenic	**4.55**	0.30	mg/kg dry	2022-03-28	
Barium	**223**	1.0	mg/kg dry	2022-03-28	
Beryllium	**0.69**	0.10	mg/kg dry	2022-03-28	
Boron	**9.1**	2.0	mg/kg dry	2022-03-28	
Cadmium	**0.185**	0.040	mg/kg dry	2022-03-28	
Chromium	**24.1**	1.0	mg/kg dry	2022-03-28	
Cobalt	**12.8**	0.10	mg/kg dry	2022-03-28	
Copper	**27.4**	0.40	mg/kg dry	2022-03-28	
Iron	**25000**	20	mg/kg dry	2022-03-28	
Lead	**15.6**	0.20	mg/kg dry	2022-03-28	
Lithium	**8.16**	0.10	mg/kg dry	2022-03-28	
Manganese	**1120**	0.40	mg/kg dry	2022-03-28	
Mercury	< 0.040	0.040	mg/kg dry	2022-03-28	
Molybdenum	**1.15**	0.10	mg/kg dry	2022-03-28	
Nickel	**19.6**	0.60	mg/kg dry	2022-03-28	
Potassium	**1420**	40	mg/kg dry	2022-03-28	
Selenium	< 0.20	0.20	mg/kg dry	2022-03-28	
Silver	< 0.10	0.10	mg/kg dry	2022-03-28	
Strontium	**199**	0.20	mg/kg dry	2022-03-28	
Thallium	**0.47**	0.10	mg/kg dry	2022-03-28	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-03 (22C3076-03) | Matrix: Soil | Sampled: 2022-03-22 11:35, Continued					
Strong Acid Leachable Metals, Continued					
Tin	**1.20**	0.20	mg/kg dry	2022-03-28	
Tungsten	**1.02**	0.20	mg/kg dry	2022-03-28	
Uranium	**2.13**	0.050	mg/kg dry	2022-03-28	
Vanadium	**47.9**	2.5	mg/kg dry	2022-03-28	
Zinc	**75.8**	2.0	mg/kg dry	2022-03-28	
Volatile Organic Compounds (VOC)					
Benzene	< 0.020	0.030	mg/kg dry	2022-03-31	
Ethylbenzene	**0.156**	0.050	mg/kg dry	2022-03-31	
Methyl tert-butyl ether	< 0.280	0.040	mg/kg dry	2022-03-31	RA3
Styrene	< 0.050	0.050	mg/kg dry	2022-03-31	
Toluene	< 0.200	0.200	mg/kg dry	2022-03-31	
Xylenes (total)	**0.124**	0.100	mg/kg dry	2022-03-31	
Surrogate: Toluene-d8	*113*	*60-140*	%	*2022-03-31*	
Surrogate: 4-Bromofluorobenzene	*103*	*60-140*	%	*2022-03-31*	
P-SS22-04 (22C3076-04) | Matrix: Soil | Sampled: 2022-03-22 12:00					
BCMOE Aggregate Hydrocarbons					
EPHs10-19	< 50	50	mg/kg dry	2022-03-24	
EPHs19-32	< 50	50	mg/kg dry	2022-03-24	
LEPHs	< 50	50	mg/kg dry	N/A	
HEPHs	< 50	50	mg/kg dry	N/A	
Surrogate: 2-Methylnonane (EPH/F2-4)	*94*	*60-140*	%	*2022-03-24*	
Calculated Parameters					
Chromium, Trivalent	**42.9**	1.00	mg/kg dry	N/A	
Fertility / Nutrient Parameters					
Ammonia, Water-Soluble (as N)	**11.1**	2.0	mg/kg dry	2022-03-30	
General Parameters					
Carbon, Total Organic	**0.886**	0.050	% dry	2022-04-01	
Chromium, Hexavalent	< 0.40	0.40	mg/kg	2022-03-29	
Moisture	**18.5**	1.0	% wet	2022-03-24	
Nitrate, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
pH (1:2 H2O Solution)	**8.41**	0.10	pH units	2022-03-27	
Phosphate, Water-Soluble (as P)	**0.305**	0.025	mg/kg dry	2022-03-25	
Microbiological Parameters					
Salmonella	< 0.2	0.2	MPN/g dry	2022-03-23	
Coliforms, Total	< 3.0	3.0	MPN/g dry	2022-03-23	
Coliforms, Fecal	< 3.0	3.0	MPN/g dry	2022-03-23	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-04 (22C3076-04) | Matrix: Soil | Sampled: 2022-03-22 12:00, Continued					
Microbiological Parameters, Continued					
E. coli	< 3.0	3.0	MPN/g dry	2022-03-23	
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Acenaphthylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Chrysene	< 0.050	0.050	mg/kg dry	2022-03-24	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluorene	< 0.050	0.050	mg/kg dry	2022-03-24	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
1-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Naphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Phenanthrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Quinoline	< 0.050	0.050	mg/kg dry	2022-03-24	
Surrogate: Acenaphthene-d10	*102*	*50-140*	%	*2022-03-24*	
Surrogate: Chrysene-d12	*119*	*50-140*	%	*2022-03-24*	
Surrogate: Naphthalene-d8	*100*	*50-140*	%	*2022-03-24*	
Surrogate: Perylene-d12	*104*	*50-140*	%	*2022-03-24*	
Surrogate: Phenanthrene-d10	*105*	*55-140*	%	*2022-03-24*	
Strong Acid Leachable Metals					
Aluminum	**9770**	40	mg/kg dry	2022-03-28	
Antimony	**0.29**	0.10	mg/kg dry	2022-03-28	
Arsenic	**3.87**	0.30	mg/kg dry	2022-03-28	
Barium	**88.1**	1.0	mg/kg dry	2022-03-28	
Beryllium	**0.26**	0.10	mg/kg dry	2022-03-28	
Boron	**3.2**	2.0	mg/kg dry	2022-03-28	
Cadmium	**0.119**	0.040	mg/kg dry	2022-03-28	
Chromium	**42.9**	1.0	mg/kg dry	2022-03-28	
Cobalt	**14.2**	0.10	mg/kg dry	2022-03-28	
Copper	**30.4**	0.40	mg/kg dry	2022-03-28	
Iron	**32600**	20	mg/kg dry	2022-03-28	
Lead	**6.95**	0.20	mg/kg dry	2022-03-28	
Lithium	**6.66**	0.10	mg/kg dry	2022-03-28	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-04 (22C3076-04) | Matrix: Soil | Sampled: 2022-03-22 12:00, Continued					
Strong Acid Leachable Metals, Continued					
Manganese	**495**	0.40	mg/kg dry	2022-03-28	
Mercury	< 0.040	0.040	mg/kg dry	2022-03-28	
Molybdenum	**0.78**	0.10	mg/kg dry	2022-03-28	
Nickel	**36.7**	0.60	mg/kg dry	2022-03-28	
Potassium	**724**	40	mg/kg dry	2022-03-28	
Selenium	< 0.20	0.20	mg/kg dry	2022-03-28	
Silver	< 0.10	0.10	mg/kg dry	2022-03-28	
Strontium	**52.5**	0.20	mg/kg dry	2022-03-28	
Thallium	< 0.10	0.10	mg/kg dry	2022-03-28	
Tin	**0.26**	0.20	mg/kg dry	2022-03-28	
Tungsten	< 0.20	0.20	mg/kg dry	2022-03-28	
Uranium	**0.460**	0.050	mg/kg dry	2022-03-28	
Vanadium	**77.6**	2.5	mg/kg dry	2022-03-28	
Zinc	**51.0**	2.0	mg/kg dry	2022-03-28	
P-SS22-05 (22C3076-05) | Matrix: Soil | Sampled: 2022-03-22 12:30					
BCMOE Aggregate Hydrocarbons					
VHs (6-10)	**23**	20	mg/kg dry	2022-03-25	
VPHs	**23**	20	mg/kg dry	N/A	
EPHs10-19	< 50	50	mg/kg dry	2022-03-24	
EPHs19-32	< 50	50	mg/kg dry	2022-03-24	
LEPHs	< 50	50	mg/kg dry	N/A	
HEPHs	< 50	50	mg/kg dry	N/A	
Surrogate: 2-Methylnonane (EPH/F2-4)	*88*	*60-140*	*%*	*2022-03-24*	
Fertility / Nutrient Parameters					
Ammonia, Water-Soluble (as N)	**10.0**	2.0	mg/kg dry	2022-03-30	
General Parameters					
Carbon, Total Organic	**0.262**	0.050	% dry	2022-04-01	
Moisture	**4.7**	1.0	% wet	2022-03-24	
Nitrate, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
pH (1:2 H2O Solution)	**8.55**	0.10	pH units	2022-03-27	
Phosphate, Water-Soluble (as P)	< 0.250	0.025	mg/kg dry	2022-03-25	
Microbiological Parameters					
Salmonella	< 0.2	0.2	MPN/g dry	2022-03-23	
Coliforms, Total	< 3.0	3.0	MPN/g dry	2022-03-23	
Coliforms, Fecal	< 3.0	3.0	MPN/g dry	2022-03-23	
E. coli	< 3.0	3.0	MPN/g dry	2022-03-23	
Polycyclic Aromatic Hydrocarbons (PAH)					

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-05 (22C3076-05) | Matrix: Soil | Sampled: 2022-03-22 12:30, Continued					
Polycyclic Aromatic Hydrocarbons (PAH), Continued					
Acenaphthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Acenaphthylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry	2022-03-24	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Chrysene	< 0.050	0.050	mg/kg dry	2022-03-24	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-24	
Fluorene	< 0.050	0.050	mg/kg dry	2022-03-24	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
1-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
2-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Naphthalene	< 0.050	0.050	mg/kg dry	2022-03-24	
Phenanthrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Pyrene	< 0.050	0.050	mg/kg dry	2022-03-24	
Quinoline	< 0.050	0.050	mg/kg dry	2022-03-24	
Surrogate: Acenaphthene-d10	*96*	*50-140*	*%*	*2022-03-24*	
Surrogate: Chrysene-d12	*112*	*50-140*	*%*	*2022-03-24*	
Surrogate: Naphthalene-d8	*95*	*50-140*	*%*	*2022-03-24*	
Surrogate: Perylene-d12	*98*	*50-140*	*%*	*2022-03-24*	
Surrogate: Phenanthrene-d10	*98*	*55-140*	*%*	*2022-03-24*	
Strong Acid Leachable Metals					
Aluminum	**7770**	40	mg/kg dry	2022-03-28	
Antimony	**0.16**	0.10	mg/kg dry	2022-03-28	
Arsenic	**2.38**	0.30	mg/kg dry	2022-03-28	
Barium	**55.3**	1.0	mg/kg dry	2022-03-28	
Beryllium	**0.17**	0.10	mg/kg dry	2022-03-28	
Boron	**2.3**	2.0	mg/kg dry	2022-03-28	
Cadmium	**0.064**	0.040	mg/kg dry	2022-03-28	
Chromium	**24.1**	1.0	mg/kg dry	2022-03-28	
Cobalt	**8.07**	0.10	mg/kg dry	2022-03-28	
Copper	**18.9**	0.40	mg/kg dry	2022-03-28	
Iron	**19900**	20	mg/kg dry	2022-03-28	
Lead	**4.26**	0.20	mg/kg dry	2022-03-28	
Lithium	**5.83**	0.10	mg/kg dry	2022-03-28	
Manganese	**324**	0.40	mg/kg dry	2022-03-28	
Mercury	< 0.040	0.040	mg/kg dry	2022-03-28	

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-05 (22C3076-05) | Matrix: Soil | Sampled: 2022-03-22 12:30, Continued					
Strong Acid Leachable Metals, Continued					
Molybdenum	**0.37**	0.10	mg/kg dry	2022-03-28	
Nickel	**16.7**	0.60	mg/kg dry	2022-03-28	
Potassium	**493**	40	mg/kg dry	2022-03-28	
Selenium	< 0.20	0.20	mg/kg dry	2022-03-28	
Silver	< 0.10	0.10	mg/kg dry	2022-03-28	
Strontium	**37.0**	0.20	mg/kg dry	2022-03-28	
Thallium	< 0.10	0.10	mg/kg dry	2022-03-28	
Tin	**0.21**	0.20	mg/kg dry	2022-03-28	
Tungsten	< 0.20	0.20	mg/kg dry	2022-03-28	
Uranium	**0.314**	0.050	mg/kg dry	2022-03-28	
Vanadium	**43.1**	2.5	mg/kg dry	2022-03-28	
Zinc	**38.8**	2.0	mg/kg dry	2022-03-28	
Volatile Organic Compounds (VOC)					
Benzene	< 0.020	0.030	mg/kg dry	2022-03-31	
Ethylbenzene	< 0.050	0.050	mg/kg dry	2022-03-31	
Methyl tert-butyl ether	< 0.220	0.040	mg/kg dry	2022-03-31	RA3
Styrene	< 0.050	0.050	mg/kg dry	2022-03-31	
Toluene	< 0.200	0.200	mg/kg dry	2022-03-31	
Xylenes (total)	< 0.100	0.100	mg/kg dry	2022-03-31	
Surrogate: Toluene-d8	*104*	*60-140*	%	*2022-03-31*	
Surrogate: 4-Bromofluorobenzene	*94*	*60-140*	%	*2022-03-31*	
P-SS22-06 (22C3076-06) | Matrix: Soil | Sampled: 2022-03-22 12:30					
BCMOE Aggregate Hydrocarbons					
EPHs10-19	< 50	50	mg/kg dry	2022-03-24	
EPHs19-32	< 50	50	mg/kg dry	2022-03-24	
LEPHs	< 50	50	mg/kg dry	N/A	
HEPHs	< 50	50	mg/kg dry	N/A	
Surrogate: 2-Methylnonane (EPH/F2-4)	*86*	*60-140*	%	*2022-03-24*	
Fertility / Nutrient Parameters					
Ammonia, Water-Soluble (as N)	**8.0**	2.0	mg/kg dry	2022-03-30	
General Parameters					
Carbon, Total Organic	**0.279**	0.050	% dry	2022-04-01	
Moisture	**4.5**	1.0	% wet	2022-03-24	
Nitrate, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry	2022-03-25	
pH (1:2 H2O Solution)	**8.61**	0.10	pH units	2022-03-27	
Phosphate, Water-Soluble (as P)	< 0.250	0.025	mg/kg dry	2022-03-25	
Microbiological Parameters					

TEST RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	WORK ORDER	22C3076
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Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-06 (22C3076-06) | Matrix: Soil | Sampled: 2022-03-22 12:30, Continued					
Microbiological Parameters, Continued					
Salmonella	< 0.2	0.2	MPN/g dry	2022-03-23	
Coliforms, Total	< 3.0	3.0	MPN/g dry	2022-03-23	
Coliforms, Fecal	< 3.0	3.0	MPN/g dry	2022-03-23	
E. coli	< 3.0	3.0	MPN/g dry	2022-03-23	
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	< 0.050	0.050	mg/kg dry	2022-03-25	
Acenaphthylene	< 0.050	0.050	mg/kg dry	2022-03-25	
Anthracene	< 0.050	0.050	mg/kg dry	2022-03-25	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry	2022-03-25	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry	2022-03-25	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-25	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-25	
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry	2022-03-25	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-25	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry	2022-03-25	
Chrysene	< 0.050	0.050	mg/kg dry	2022-03-25	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry	2022-03-25	
Fluoranthene	< 0.050	0.050	mg/kg dry	2022-03-25	
Fluorene	< 0.050	0.050	mg/kg dry	2022-03-25	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry	2022-03-25	
1-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-25	
2-Methylnaphthalene	< 0.050	0.050	mg/kg dry	2022-03-25	
Naphthalene	< 0.050	0.050	mg/kg dry	2022-03-25	
Phenanthrene	< 0.050	0.050	mg/kg dry	2022-03-25	
Pyrene	< 0.050	0.050	mg/kg dry	2022-03-25	
Quinoline	< 0.050	0.050	mg/kg dry	2022-03-25	
Surrogate: Acenaphthene-d10	*98*	*50-140*	*%*	*2022-03-25*	
Surrogate: Chrysene-d12	*112*	*50-140*	*%*	*2022-03-25*	
Surrogate: Naphthalene-d8	*96*	*50-140*	*%*	*2022-03-25*	
Surrogate: Perylene-d12	*95*	*50-140*	*%*	*2022-03-25*	
Surrogate: Phenanthrene-d10	*98*	*55-140*	*%*	*2022-03-25*	
Strong Acid Leachable Metals					
Aluminum	**8510**	40	mg/kg dry	2022-03-28	
Antimony	**0.24**	0.10	mg/kg dry	2022-03-28	
Arsenic	**2.74**	0.30	mg/kg dry	2022-03-28	
Barium	**43.1**	1.0	mg/kg dry	2022-03-28	
Beryllium	**0.18**	0.10	mg/kg dry	2022-03-28	
Boron	< 2.0	2.0	mg/kg dry	2022-03-28	
Cadmium	**0.070**	0.040	mg/kg dry	2022-03-28	
Chromium	**27.7**	1.0	mg/kg dry	2022-03-28	
Cobalt	**9.67**	0.10	mg/kg dry	2022-03-28	
Copper	**20.5**	0.40	mg/kg dry	2022-03-28	

Analyte	Result	RL	Units	Analyzed	Qualifier
P-SS22-06 (22C3076-06) | Matrix: Soil | Sampled: 2022-03-22 12:30, Continued					
Strong Acid Leachable Metals, Continued					
Iron	**24400**	20	mg/kg dry	2022-03-28	
Lead	**3.76**	0.20	mg/kg dry	2022-03-28	
Lithium	**6.26**	0.10	mg/kg dry	2022-03-28	
Manganese	**369**	0.40	mg/kg dry	2022-03-28	
Mercury	< 0.040	0.040	mg/kg dry	2022-03-28	
Molybdenum	**0.55**	0.10	mg/kg dry	2022-03-28	
Nickel	**21.5**	0.60	mg/kg dry	2022-03-28	
Potassium	**556**	40	mg/kg dry	2022-03-28	
Selenium	< 0.20	0.20	mg/kg dry	2022-03-28	
Silver	< 0.10	0.10	mg/kg dry	2022-03-28	
Strontium	**29.5**	0.20	mg/kg dry	2022-03-28	
Thallium	< 0.10	0.10	mg/kg dry	2022-03-28	
Tin	**0.21**	0.20	mg/kg dry	2022-03-28	
Tungsten	< 0.20	0.20	mg/kg dry	2022-03-28	
Uranium	**0.270**	0.050	mg/kg dry	2022-03-28	
Vanadium	**54.1**	2.5	mg/kg dry	2022-03-28	
Zinc	**40.9**	2.0	mg/kg dry	2022-03-28	

Sample Qualifiers:

RA3 The Reporting Limit has been raised due to comparable level detected in the blank(s).

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
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Analysis Description	Method Ref.	Technique	Accredited	Location
Ammonia, Water-Soluble in Soil	Carter 15.2.2 / SM 4500-NH3 G* (2017)	Fixed Ratio H2O Ext (1:5) / Automated Colorimetry (Phenate)		Kelowna
Anions in Soil	Carter 15.2.2 / SM 4110 B (2017)	Fixed Ratio H2O Ext (1:5) / Ion Chromatography		Kelowna
BTEX in Soil, MeOH in Soil	EPA 5035A/5030B / EPA 8260D	Methanol Extract, Purge&Trap / GC-MSD (SIM)	✓	Richmond
Carbon, Total Organic in Soil	Carter 21.2	Catalytic Combustion and Infrared Detection	✓	Kelowna
Chromium, Hexavalent in Soil	EPA 3060A / EPA 7196A	Alkaline Digestion / Colorimetry	✓	Richmond
Coliforms, Fecal in Soil	TMECC 07.01 B	Most Probable Number / Most Probable Number		Kelowna
Coliforms, Total in Soil	TMECC 07.01 A	Most Probable Number / Most Probable Number		Kelowna
E. coli in Soil	TMECC 07.01 C	Most Probable Number / Most Probable Number		Kelowna
EPH in Soil	EPA 3570* / BCMOE EPHs*	Shaker Extraction (Hexane-Acetone 1:1) / Gas Chromatography (GC-FID)	✓	Richmond
HEPHs in Soil	BCMOE LEPH/HEPH	Calculation		N/A
LEPHs in Soil	BCMOE LEPH/HEPH	Calculation		N/A
Moisture in Soil	ASTM D2974-87*	Gravimetry (Dried at 105C)		N/A
pH in Soil	Carter 16.2 / SM 4500-H+ B (2017)	1:2 Soil/Water Slurry / Electrometry	✓	Richmond
Polychlorinated Biphenyl Aroclors in Soil	EPA 3570* / EPA 8082A	Shaker Extraction (Hexane-Acetone 1:1) / Gas Chromatography (GC-ECD)	✓	Richmond
Polycyclic Aromatic Hydrocarbons in Soil	EPA 3570* / EPA 8270D	Shaker Extraction (Hexane-Acetone 1:1) / GC-MSD (SIM)	✓	Richmond
SALM in Soil	BCMOE SALM V.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
Salmonella in Soil	TMECC 07.02	Most Probable Number / Most Probable Number		Kelowna
VH in Soil	EPA 5035A/5030B / BCMOE VHs	Methanol Extract, Purge&Trap / Purge&Trap or Headspace, Gas Chromatography (GC-FID)	✓	Richmond
VPHs in Soil	BCMOE VPH	Calculation: VH - (Benzene + Toluene + Ethylbenzene + Xylenes + Styrene)		N/A

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Glossary of Terms:

RL	Reporting Limit (default)
% dry	Percent (dry weight basis)
% wet	Percent (as received basis)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
mg/kg	Milligrams per kilogram (dry weight basis)
mg/kg dry	Milligrams per kilogram (dry weight basis)
MPN/g dry	Most Probable Number per gram (dry weight basis)
pH units	pH < 7 = acidic, ph > 7 = basic
ASTM	ASTM International Test Methods
BCMOE	British Columbia Environmental Laboratory Manual, British Columbia Ministry of Environment
Carter	Soil Sampling and Methods of Analysis, 2nd Edition (2007), Carter/Gregorich
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association
TMECC	Test Method for the Examination of Composting and Compost, US Composting Council

CARO ANALYTICAL SERVICES

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
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General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued or once samples expire, whichever comes first. Longer hold is possible if agreed to in writing.

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS)**: A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS)**: A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
BCMOE Aggregate Hydrocarbons, Batch B2C2718										
Blank (B2C2718-BLK1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
VHs (6-10)	< 20	20	mg/kg wet							
LCS (B2C2718-BS2)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
VHs (6-10)	280	20	mg/kg wet	331		85	70-130			
BCMOE Aggregate Hydrocarbons, Batch B2C2720										
Blank (B2C2720-BLK1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
EPHs10-19	< 50	50	mg/kg wet							
EPHs19-32	< 50	50	mg/kg wet							
Surrogate: 2-Methylnonane (EPH/F2-4)	*70.6*		*mg/kg wet*	82.1		*86*	*60-140*			
LCS (B2C2720-BS2)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
EPHs10-19	2500	50	mg/kg wet	2870		86	70-130			
EPHs19-32	3900	50	mg/kg wet	4180		93	70-130			
Surrogate: 2-Methylnonane (EPH/F2-4)	*74.7*		*mg/kg wet*	83.6		*89*	*60-140*			
Duplicate (B2C2720-DUP1)	**Source: 22C3076-01**			Prepared: 2022-03-24, Analyzed: 2022-03-24						
EPHs10-19	< 50	50	mg/kg dry		< 50				40	
EPHs19-32	< 50	50	mg/kg dry		< 50				40	RPD1
Surrogate: 2-Methylnonane (EPH/F2-4)	*85.0*		*mg/kg dry*	88.6		*96*	*60-140*			
Reference (B2C2720-SRM1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
EPHs10-19	2700	75	mg/kg wet	3020		88	65-130			
EPHs19-32	4600	75	mg/kg wet	4330		107	65-130			
Surrogate: 2-Methylnonane (EPH/F2-4)	*114*		*mg/kg wet*	126		*90*	*60-140*			
Fertility / Nutrient Parameters, Batch B2C3255										
Blank (B2C3255-BLK1)				Prepared: 2022-03-30, Analyzed: 2022-03-30						
Ammonia, Water-Soluble (as N)	0.03	0.02	mg/kg wet							
Blank (B2C3255-BLK2)				Prepared: 2022-03-30, Analyzed: 2022-03-30						
Ammonia, Water-Soluble (as N)	0.03	0.02	mg/kg wet							

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Fertility / Nutrient Parameters, Batch B2C3255, Continued										
LCS (B2C3255-BS1)				Prepared: 2022-03-30, Analyzed: 2022-03-30						
Ammonia, Water-Soluble (as N)	1.0	0.02	mg/kg wet	1.00		102	85-115			
LCS (B2C3255-BS2)				Prepared: 2022-03-30, Analyzed: 2022-03-30						
Ammonia, Water-Soluble (as N)	1.0	0.02	mg/kg wet	1.00		101	85-115			
Duplicate (B2C3255-DUP1)	**Source: 22C3076-06**			Prepared: 2022-03-30, Analyzed: 2022-03-30						
Ammonia, Water-Soluble (as N)	9.1	2.0	mg/kg dry		8.0				25	
General Parameters, Batch B2C2624										
Blank (B2C2624-BLK1)				Prepared: 2022-03-23, Analyzed: 2022-03-25						
Nitrate, Water-Soluble (as N)	< 0.050	0.050	mg/kg dry							
Nitrite, Water-Soluble (as N)	< 0.050	0.050	mg/kg dry							
Phosphate, Water-Soluble (as P)	< 0.025	0.025	mg/kg dry							
LCS (B2C2624-BS1)				Prepared: 2022-03-23, Analyzed: 2022-03-25						
Nitrate, Water-Soluble (as N)	3.88	0.050	mg/kg dry	4.00		97	90-110			
Nitrite, Water-Soluble (as N)	2.02	0.050	mg/kg dry	2.00		101	85-115			
Phosphate, Water-Soluble (as P)	1.07	0.025	mg/kg dry	1.00		107	80-120			
Duplicate (B2C2624-DUP1)	**Source: 22C3076-01**			Prepared: 2022-03-23, Analyzed: 2022-03-25						
Nitrate, Water-Soluble (as N)	1.09	0.050	mg/kg dry		1.10				25	
Nitrite, Water-Soluble (as N)	< 0.500	0.050	mg/kg dry		< 0.500				15	
Phosphate, Water-Soluble (as P)	< 0.250	0.025	mg/kg dry		0.265				20	
General Parameters, Batch B2C2629										
Duplicate (B2C2629-DUP1)	**Source: 22C3076-01**			Prepared: 2022-03-24, Analyzed: 2022-03-24						
Moisture	99.0	1.0	% wet		16.3			143.5	40	
General Parameters, Batch B2C2814										
Blank (B2C2814-BLK1)				Prepared: 2022-03-25, Analyzed: 2022-03-29						
Chromium, Hexavalent	< 0.40	0.40	mg/kg							
LCS (B2C2814-BS1)				Prepared: 2022-03-25, Analyzed: 2022-03-29						
Chromium, Hexavalent	12.2	0.40	mg/kg	12.5		97	70-130			
Duplicate (B2C2814-DUP1)	**Source: 22C3076-02**			Prepared: 2022-03-25, Analyzed: 2022-03-29						
Chromium, Hexavalent	< 0.40	0.40	mg/kg		< 0.40				35	
Reference (B2C2814-SRM1)				Prepared: 2022-03-25, Analyzed: 2022-03-29						
Chromium, Hexavalent	168	0.40	mg/kg	203		83	40-160			
General Parameters, Batch B2C2892										
Blank (B2C2892-BLK1)				Prepared: 2022-04-01, Analyzed: 2022-04-01						
Carbon, Total Organic	< 0.050	0.050	% dry							
Blank (B2C2892-BLK2)				Prepared: 2022-04-01, Analyzed: 2022-04-01						
Carbon, Total Organic	< 0.050	0.050	% dry							
Reference (B2C2892-SRM1)				Prepared: 2022-04-01, Analyzed: 2022-04-01						
Carbon, Total Organic	0.587	0.050	% dry	0.645		91	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B2C2892, Continued										
Reference (B2C2892-SRM2)				Prepared: 2022-04-01, Analyzed: 2022-04-01						
Carbon, Total Organic	0.594	0.050	% dry	0.645		92	80-120			
General Parameters, Batch B2C2966										
Duplicate (B2C2966-DUP2)		**Source: 22C3076-05**		Prepared: 2022-03-27, Analyzed: 2022-03-27						
pH (1:2 H2O Solution)	8.68	0.10	pH units		8.55			2	4	
Microbiological Parameters, Batch B2C2537										
Blank (B2C2537-BLK1)				Prepared: 2022-03-23, Analyzed: 2022-03-23						
Coliforms, Total	< 3.0	3.0	MPN/g wet							
Coliforms, Fecal	< 3.0	3.0	MPN/g wet							
E. coli	< 3.0	3.0	MPN/g wet							
Blank (B2C2537-BLK2)				Prepared: 2022-03-23, Analyzed: 2022-03-23						
Coliforms, Total	< 3.0	3.0	MPN/g wet							
Coliforms, Fecal	< 3.0	3.0	MPN/g wet							
E. coli	< 3.0	3.0	MPN/g wet							
Duplicate (B2C2537-DUP2)		**Source: 22C3076-02**		Prepared: 2022-03-23, Analyzed: 2022-03-23						
Coliforms, Total	12	3.0	MPN/g dry		46			119	148	
Coliforms, Fecal	< 3.8	3.0	MPN/g dry		< 3.8				147	
E. coli	< 3.8	3.0	MPN/g dry		< 3.8				145	
Microbiological Parameters, Batch B2C2618										
Blank (B2C2618-BLK1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Salmonella	< 0.2	0.2	MPN/g wet							
Duplicate (B2C2618-DUP1)		**Source: 22C3076-01**		Prepared: 2022-03-24, Analyzed: 2022-03-24						
Salmonella	< 0.2	0.2	MPN/g dry		< 0.2				130	
Polychlorinated Biphenyl Aroclors, Batch B2C3124										
Blank (B2C3124-BLK1)				Prepared: 2022-03-29, Analyzed: 2022-03-30						
PCB-1016	< 0.040	0.040	mg/kg wet							
PCB-1221	< 0.040	0.040	mg/kg wet							
PCB-1232	< 0.040	0.040	mg/kg wet							
PCB-1242	< 0.040	0.040	mg/kg wet							
PCB-1248	< 0.040	0.040	mg/kg wet							
PCB-1254	< 0.040	0.040	mg/kg wet							
PCB-1260	< 0.040	0.040	mg/kg wet							
PCB-1262	< 0.040	0.040	mg/kg wet							
PCB-1268	< 0.040	0.040	mg/kg wet							
Total PCBs	< 0.040	0.040	mg/kg wet							
Surrogate: Decachlorobiphenyl	*0.354*		*mg/kg wet*	0.333		*106*	*50-140*			
LCS (B2C3124-BS1)				Prepared: 2022-03-29, Analyzed: 2022-03-30						
PCB-1016	1.68	0.040	mg/kg wet	1.65		102	60-130			
PCB-1260	1.47	0.040	mg/kg wet	1.64		90	60-130			
Surrogate: Decachlorobiphenyl	*0.343*		*mg/kg wet*	0.332		*103*	*50-140*			
LCS Dup (B2C3124-BSD1)				Prepared: 2022-03-29, Analyzed: 2022-03-30						
PCB-1016	1.67	0.040	mg/kg wet	1.60		104	60-130	< 1	50	
PCB-1260	1.36	0.040	mg/kg wet	1.59		85	60-130	7	50	

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Polychlorinated Biphenyl Aroclors, Batch B2C3124, Continued										
LCS Dup (B2C3124-BSD1), Continued				Prepared: 2022-03-29, Analyzed: 2022-03-30						
Surrogate: Decachlorobiphenyl	*0.333*		*mg/kg wet*	0.323		*103*	*50-140*			
Polycyclic Aromatic Hydrocarbons (PAH), Batch B2C2720										
Blank (B2C2720-BLK1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Acenaphthene	< 0.050	0.050	mg/kg wet							
Acenaphthylene	< 0.050	0.050	mg/kg wet							
Anthracene	< 0.050	0.050	mg/kg wet							
Benz(a)anthracene	< 0.050	0.050	mg/kg wet							
Benzo(a)pyrene	< 0.050	0.050	mg/kg wet							
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg wet							
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg wet							
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg wet							
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg wet							
2-Chloronaphthalene	< 0.050	0.050	mg/kg wet							
Chrysene	< 0.050	0.050	mg/kg wet							
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg wet							
Fluoranthene	< 0.050	0.050	mg/kg wet							
Fluorene	< 0.050	0.050	mg/kg wet							
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg wet							
1-Methylnaphthalene	< 0.050	0.050	mg/kg wet							
2-Methylnaphthalene	< 0.050	0.050	mg/kg wet							
Naphthalene	< 0.050	0.050	mg/kg wet							
Phenanthrene	< 0.050	0.050	mg/kg wet							
Pyrene	< 0.050	0.050	mg/kg wet							
Quinoline	< 0.050	0.050	mg/kg wet							
Surrogate: Acenaphthene-d10	*0.760*		*mg/kg wet*	0.813		*94*	*50-140*			
Surrogate: Chrysene-d12	*0.919*		*mg/kg wet*	0.813		*113*	*50-140*			
Surrogate: Naphthalene-d8	*0.733*		*mg/kg wet*	0.783		*94*	*50-140*			
Surrogate: Perylene-d12	*0.770*		*mg/kg wet*	0.813		*95*	*50-140*			
Surrogate: Phenanthrene-d10	*0.763*		*mg/kg wet*	0.813		*94*	*55-140*			
LCS (B2C2720-BS1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Acenaphthene	0.816	0.050	mg/kg wet	0.825		99	50-140			
Acenaphthylene	0.780	0.050	mg/kg wet	0.826		94	50-140			
Anthracene	0.831	0.050	mg/kg wet	0.826		101	50-140			
Benz(a)anthracene	0.876	0.050	mg/kg wet	0.825		106	50-140			
Benzo(a)pyrene	0.840	0.050	mg/kg wet	0.825		102	50-140			
Benzo(b)fluoranthene	0.783	0.050	mg/kg wet	0.825		95	50-140			
Benzo(b+j)fluoranthene	1.67	0.050	mg/kg wet	1.65		101	50-140			
Benzo(g,h,i)perylene	0.629	0.050	mg/kg wet	0.826		76	50-140			
Benzo(k)fluoranthene	0.860	0.050	mg/kg wet	0.826		104	50-140			
2-Chloronaphthalene	0.782	0.050	mg/kg wet	0.835		94	50-140			
Chrysene	0.961	0.050	mg/kg wet	0.826		116	50-140			
Dibenz(a,h)anthracene	0.600	0.050	mg/kg wet	0.825		73	50-140			
Fluoranthene	0.793	0.050	mg/kg wet	0.826		96	50-140			
Fluorene	0.786	0.050	mg/kg wet	0.825		95	50-140			
Indeno(1,2,3-cd)pyrene	0.614	0.050	mg/kg wet	0.826		74	50-140			
1-Methylnaphthalene	0.769	0.050	mg/kg wet	0.823		93	50-140			
2-Methylnaphthalene	0.793	0.050	mg/kg wet	0.826		96	50-140			
Naphthalene	0.794	0.050	mg/kg wet	0.826		96	50-140			
Phenanthrene	0.821	0.050	mg/kg wet	0.835		98	50-140			
Pyrene	0.807	0.050	mg/kg wet	0.826		98	50-140			
Quinoline	0.695	0.050	mg/kg wet	0.835		83	50-140			
Surrogate: Acenaphthene-d10	*0.779*		*mg/kg wet*	0.826		*94*	*50-140*			
Surrogate: Chrysene-d12	*0.895*		*mg/kg wet*	0.826		*108*	*50-140*			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Polycyclic Aromatic Hydrocarbons (PAH), Batch B2C2720, Continued

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
LCS (B2C2720-BS1), Continued				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Surrogate: Naphthalene-d8	*0.745*		*mg/kg wet*	0.796		*94*	*50-140*			
Surrogate: Perylene-d12	*0.765*		*mg/kg wet*	0.826		*93*	*50-140*			
Surrogate: Phenanthrene-d10	*0.770*		*mg/kg wet*	0.826		*93*	*55-140*			
Duplicate (B2C2720-DUP1)	**Source: 22C3076-01**			Prepared: 2022-03-24, Analyzed: 2022-03-24						
Acenaphthene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Acenaphthylene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Anthracene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Benz(a)anthracene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Benzo(a)pyrene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Benzo(b)fluoranthene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Benzo(b+j)fluoranthene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Benzo(g,h,i)perylene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Benzo(k)fluoranthene	< 0.050	0.050	mg/kg dry		< 0.050				50	
2-Chloronaphthalene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Chrysene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Dibenz(a,h)anthracene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Fluoranthene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Fluorene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Indeno(1,2,3-cd)pyrene	< 0.050	0.050	mg/kg dry		< 0.050				50	
1-Methylnaphthalene	< 0.050	0.050	mg/kg dry		< 0.050				50	
2-Methylnaphthalene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Naphthalene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Phenanthrene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Pyrene	< 0.050	0.050	mg/kg dry		< 0.050				50	
Quinoline	< 0.050	0.050	mg/kg dry		< 0.050				50	
Surrogate: Acenaphthene-d10	*0.904*		*mg/kg dry*	0.878		*103*	*50-140*			
Surrogate: Chrysene-d12	*1.08*		*mg/kg dry*	0.878		*123*	*50-140*			
Surrogate: Naphthalene-d8	*0.863*		*mg/kg dry*	0.845		*102*	*50-140*			
Surrogate: Perylene-d12	*0.924*		*mg/kg dry*	0.878		*105*	*50-140*			
Surrogate: Phenanthrene-d10	*0.896*		*mg/kg dry*	0.878		*102*	*55-140*			
Matrix Spike (B2C2720-MS1)	**Source: 22C3076-01**			Prepared: 2022-03-24, Analyzed: 2022-03-24						
Acenaphthene	0.940	0.050	mg/kg dry	0.912	< 0.050	103	50-140			
Acenaphthylene	0.908	0.050	mg/kg dry	0.914	< 0.050	99	50-140			
Anthracene	0.946	0.050	mg/kg dry	0.914	< 0.050	104	50-140			
Benz(a)anthracene	0.996	0.050	mg/kg dry	0.912	< 0.050	109	50-140			
Benzo(a)pyrene	0.954	0.050	mg/kg dry	0.912	< 0.050	105	50-140			
Benzo(b)fluoranthene	0.862	0.050	mg/kg dry	0.912	< 0.050	94	50-140			
Benzo(b+j)fluoranthene	1.92	0.050	mg/kg dry	1.83	< 0.050	105	50-140			
Benzo(g,h,i)perylene	0.726	0.050	mg/kg dry	0.914	< 0.050	79	50-140			
Benzo(k)fluoranthene	1.00	0.050	mg/kg dry	0.913	< 0.050	109	50-140			
2-Chloronaphthalene	0.745	0.050	mg/kg dry	0.923	< 0.050	81	50-140			
Chrysene	1.08	0.050	mg/kg dry	0.914	< 0.050	118	50-140			
Dibenz(a,h)anthracene	0.643	0.050	mg/kg dry	0.912	< 0.050	71	50-140			
Fluoranthene	0.891	0.050	mg/kg dry	0.914	< 0.050	98	50-140			
Fluorene	0.903	0.050	mg/kg dry	0.912	< 0.050	99	50-140			
Indeno(1,2,3-cd)pyrene	0.725	0.050	mg/kg dry	0.914	< 0.050	79	50-140			
1-Methylnaphthalene	0.891	0.050	mg/kg dry	0.910	< 0.050	98	50-140			
2-Methylnaphthalene	0.935	0.050	mg/kg dry	0.914	< 0.050	102	50-140			
Naphthalene	0.939	0.050	mg/kg dry	0.914	< 0.050	103	50-140			
Phenanthrene	0.963	0.050	mg/kg dry	0.923	< 0.050	104	50-140			
Pyrene	0.928	0.050	mg/kg dry	0.913	< 0.050	102	50-140			
Quinoline	0.748	0.050	mg/kg dry	0.923	< 0.050	81	50-140			
Surrogate: Acenaphthene-d10	*0.914*		*mg/kg dry*	0.914		*100*	*50-140*			
Surrogate: Chrysene-d12	*1.01*		*mg/kg dry*	0.914		*111*	*50-140*			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Polycyclic Aromatic Hydrocarbons (PAH), Batch B2C2720, Continued										
Matrix Spike (B2C2720-MS1), Continued	**Source: 22C3076-01**		Prepared: 2022-03-24, Analyzed: 2022-03-24							
Surrogate: Naphthalene-d8	*0.866*		*mg/kg dry*	0.880		*98*	*50-140*			
Surrogate: Perylene-d12	*0.859*		*mg/kg dry*	0.914		*94*	*50-140*			
Surrogate: Phenanthrene-d10	*0.880*		*mg/kg dry*	0.914		*96*	*55-140*			
Strong Acid Leachable Metals, Batch B2C2933										
Blank (B2C2933-BLK1)			Prepared: 2022-03-26, Analyzed: 2022-03-28							
Aluminum	< 40	40	mg/kg dry							
Antimony	< 0.10	0.10	mg/kg dry							
Arsenic	< 0.30	0.30	mg/kg dry							
Barium	< 1.0	1.0	mg/kg dry							
Beryllium	< 0.10	0.10	mg/kg dry							
Boron	< 2.0	2.0	mg/kg dry							
Cadmium	< 0.040	0.040	mg/kg dry							
Chromium	< 1.0	1.0	mg/kg dry							
Cobalt	< 0.10	0.10	mg/kg dry							
Copper	< 0.40	0.40	mg/kg dry							
Iron	< 20	20	mg/kg dry							
Lead	< 0.20	0.20	mg/kg dry							
Lithium	< 0.10	0.10	mg/kg dry							
Manganese	< 0.40	0.40	mg/kg dry							
Mercury	< 0.040	0.040	mg/kg dry							
Molybdenum	< 0.10	0.10	mg/kg dry							
Nickel	< 0.60	0.60	mg/kg dry							
Potassium	< 40	40	mg/kg dry							
Selenium	< 0.20	0.20	mg/kg dry							
Silver	< 0.10	0.10	mg/kg dry							
Strontium	< 0.20	0.20	mg/kg dry							
Thallium	< 0.10	0.10	mg/kg dry							
Tin	< 0.20	0.20	mg/kg dry							
Tungsten	< 0.20	0.20	mg/kg dry							
Uranium	< 0.050	0.050	mg/kg dry							
Vanadium	< 1.0	1.0	mg/kg dry							
Zinc	< 2.0	2.0	mg/kg dry							
LCS (B2C2933-BS1)			Prepared: 2022-03-26, Analyzed: 2022-03-28							
Antimony	1.95	0.10	mg/kg dry	2.00		98	80-120			
Arsenic	1.88	0.30	mg/kg dry	2.00		94	80-120			
Barium	2.3	1.0	mg/kg dry	2.00		113	80-120			
Beryllium	1.94	0.10	mg/kg dry	2.00		97	80-120			
Boron	2.2	2.0	mg/kg dry	2.00		108	80-120			
Cadmium	1.96	0.040	mg/kg dry	2.00		98	80-120			
Chromium	2.1	1.0	mg/kg dry	2.00		103	80-120			
Cobalt	2.08	0.10	mg/kg dry	2.00		104	80-120			
Copper	2.03	0.40	mg/kg dry	2.00		101	80-120			
Iron	216	20	mg/kg dry	200		108	80-120			
Lead	2.07	0.20	mg/kg dry	2.00		104	80-120			
Lithium	1.97	0.10	mg/kg dry	2.00		98	80-120			
Manganese	2.01	0.40	mg/kg dry	2.00		100	80-120			
Mercury	0.103	0.040	mg/kg dry	0.101		102	80-120			
Molybdenum	1.92	0.10	mg/kg dry	2.00		96	80-120			
Nickel	2.00	0.60	mg/kg dry	2.00		100	80-120			
Potassium	196	40	mg/kg dry	200		98	80-120			
Selenium	1.96	0.20	mg/kg dry	2.00		98	80-120			
Silver	2.02	0.10	mg/kg dry	2.00		101	80-120			
Strontium	1.92	0.20	mg/kg dry	2.00		96	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	**WORK ORDER**	22C3076
PROJECT	688421	**REPORTED**	2022-05-06 08:20

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Strong Acid Leachable Metals, Batch B2C2933, Continued										
LCS (B2C2933-BS1), Continued				Prepared: 2022-03-26, Analyzed: 2022-03-28						
Thallium	2.05	0.10	mg/kg dry	2.00		102	80-120			
Tin	2.07	0.20	mg/kg dry	2.00		103	80-120			
Tungsten	1.97	0.20	mg/kg dry	2.00		99	80-120			
Uranium	1.86	0.050	mg/kg dry	2.00		93	80-120			
Vanadium	2.0	1.0	mg/kg dry	2.00		102	80-120			
Zinc	2.2	2.0	mg/kg dry	2.00		111	80-120			
Reference (B2C2933-SRM1)				Prepared: 2022-03-26, Analyzed: 2022-03-28						
Aluminum	11400	40	mg/kg dry	11500		99	70-130			
Antimony	0.66	0.10	mg/kg dry	0.724		92	70-130			
Arsenic	82.4	0.30	mg/kg dry	82.1		100	70-130			
Barium	43.1	1.0	mg/kg dry	40.0		108	70-130			
Beryllium	0.36	0.10	mg/kg dry	0.369		96	70-130			
Chromium	67.6	1.0	mg/kg dry	63.1		107	70-130			
Cobalt	11.0	0.10	mg/kg dry	10.4		106	70-130			
Copper	20.8	0.40	mg/kg dry	19.8		105	70-130			
Iron	20700	20	mg/kg dry	20200		102	70-130			
Lead	16.6	0.20	mg/kg dry	17.3		96	70-130			
Manganese	312	0.40	mg/kg dry	315		99	70-130			
Mercury	0.111	0.040	mg/kg dry	0.110		101	70-130			
Molybdenum	0.64	0.10	mg/kg dry	0.619		103	70-130			
Nickel	32.8	0.60	mg/kg dry	31.7		103	70-130			
Silver	1.60	0.10	mg/kg dry	1.75		91	70-130			
Strontium	21.8	0.20	mg/kg dry	20.3		107	70-130			
Uranium	1.06	0.050	mg/kg dry	1.18		90	70-130			
Vanadium	32.9	1.0	mg/kg dry	33.5		98	70-130			
Zinc	38.1	2.0	mg/kg dry	40.2		95	70-130			
Volatile Organic Compounds (VOC), Batch B2C2718										
Blank (B2C2718-BLK1)				Prepared: 2022-03-24, Analyzed: 2022-03-25						
Benzene	< 0.020	0.020	mg/kg wet							
Ethylbenzene	< 0.050	0.050	mg/kg wet							
Methyl tert-butyl ether	< 0.040	0.040	mg/kg wet							
Styrene	< 0.050	0.050	mg/kg wet							
Toluene	< 0.200	0.200	mg/kg wet							
Xylenes (total)	< 0.100	0.100	mg/kg wet							
Surrogate: Toluene-d8	*5.32*		*mg/kg wet*	4.00		*133*	*60-140*			
Surrogate: 4-Bromofluorobenzene	*3.65*		*mg/kg wet*	3.99		*91*	*60-140*			
Blank (B2C2718-BLK2)				Prepared: 2022-03-24, Analyzed: 2022-03-29						
Benzene	< 0.020	0.020	mg/kg wet							
Ethylbenzene	< 0.050	0.050	mg/kg wet							
Methyl tert-butyl ether	< 0.040	0.040	mg/kg wet							
Styrene	< 0.050	0.050	mg/kg wet							
Toluene	< 0.200	0.200	mg/kg wet							
Xylenes (total)	< 0.100	0.100	mg/kg wet							
Surrogate: Toluene-d8	*3.77*		*mg/kg wet*	4.00		*94*	*60-140*			
Surrogate: 4-Bromofluorobenzene	*3.67*		*mg/kg wet*	3.99		*92*	*60-140*			
LCS (B2C2718-BS1)				Prepared: 2022-03-24, Analyzed: 2022-03-25						
Benzene	2.11	0.020	mg/kg wet	2.01		105	60-140			
Ethylbenzene	2.34	0.050	mg/kg wet	2.00		117	60-140			
Methyl tert-butyl ether	2.42	0.040	mg/kg wet	2.00		121	60-140			
Styrene	1.96	0.050	mg/kg wet	2.01		98	60-140			
Toluene	3.14	0.200	mg/kg wet	2.00		157	60-140			SPK

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	SNC-Lavalin Inc. (Burnaby)	WORK ORDER	22C3076
PROJECT	688421	REPORTED	2022-05-06 08:20

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Volatile Organic Compounds (VOC), Batch B2C2718, Continued										
LCS (B2C2718-BS1), Continued				Prepared: 2022-03-24, Analyzed: 2022-03-25						
Surrogate: Toluene-d8	*6.13*		*mg/kg wet*	4.00		*153*	*60-140*			*S02*
Surrogate: 4-Bromofluorobenzene	*4.47*		*mg/kg wet*	3.99		*112*	*60-140*			
LCS (B2C2718-BS3)				Prepared: 2022-03-24, Analyzed: 2022-03-29						
Benzene	1.92	0.020	mg/kg wet	2.01		96	60-140			
Ethylbenzene	1.92	0.050	mg/kg wet	2.00		96	60-140			
Methyl tert-butyl ether	2.42	0.040	mg/kg wet	2.00		121	60-140			
Styrene	2.02	0.050	mg/kg wet	2.01		100	60-140			
Toluene	1.95	0.200	mg/kg wet	2.00		97	60-140			
Xylenes (total)	5.93	0.100	mg/kg wet	6.01		99	60-140			
Surrogate: Toluene-d8	*4.17*		*mg/kg wet*	4.00		*104*	*60-140*			
Surrogate: 4-Bromofluorobenzene	*4.17*		*mg/kg wet*	3.99		*104*	*60-140*			

QC Qualifiers:

RPD1	Relative percent difference(s) (RPD) of one or more analytes on duplicate analysis are outside of control limits due to sample heterogeneity.
S02	Surrogate recovery outside of control limits. Data accepted based on acceptable recovery of other surrogates.
SPK	The recovery of this analyte was outside of established control limits.

* 2 2 C 3 0 7 6 *

SERVICES Obviously.

CARO.ca **1-888-311-8846**

#110-4011 Viking Way, Richmond, BC V6V 2K9
#102-3677 Highway 97N, Kelowna, BC V1X 5C3
17225 109 Avenue NW, Edmonton, AB T5S 1H7
#108-4475 Wayburne Dr, Burnaby, BC V5G 4X4

CARO AB COC, Rev 2020-01

CHAIN OF CUSTODY RECORD

COC# 13347 PAGE 1 OF 1

RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
P. Carmichael	2022-Mar-22	LD WI	03/22/22
	TIME:		TIME: 17:10

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
*Contact Lab To Confirm. Surcharge May Apply

REGULATORY APPLICATION:
Show on Report ☐
Canadian Drinking Water Quality ☐ AB WCR Class 9.3 ☐
AB T1 SOIL/GW: NA ☐ AG ☐ RES/PL ☐ CL ☐ IL ☐
AB SWQG: FWAL ☐ IW ☐ LW ☐
CCME: Other:

REPORT TO:
COMPANY: SNC-Lavalin Inc
ADDRESS: 1300-3777 Kingsway Burnaby BC V5H 3Z7
CONTACT: Alan Walker
TEL/FAX: 604-515-5151
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐ EQuIS ☒ AEP EMS ☐ OTHER* ☐
Copy of COC with report ☒
EMAIL 1: alan.walker@snclavalin.com
EMAIL 2: mia.salektoria@snclavalin.com

INVOICE TO: SAME AS REPORT TO ☒
COMPANY:
ADDRESS:
CONTACT:
TEL:
DELIVERY METHOD: EMAIL ☐ MAIL ☐ OTHER* ☐
EMAIL 1:
EMAIL 2:
Quote ID:
PO #: 688421

PROJECT NUMBER / INFO: 688421

A: Biohazard B: Cyanide C: PCBs D: Asbestos E: Heavy Metals F: Flammable G: Strong Odour H: High Contamination I: Other (please specify*)

** If you would like to sign up for ClientConnect, CARO's online service offerings, please check here: ☐

SAMPLED BY: MAH/PAC

CLIENT SAMPLE ID:	DRINKING WATER	OTHER WATER	SOIL	OTHER	CONTAINER QTY	DATE	TIME	CHLORINATED	FILTERED	PRESERVED	COMMENTS: (e.g. flow/volume, media ID, upload ID, notes)
P-SS22-01			X		3	2022/03/22	1035 (~~1115~~ MAH)				
P-SS-22-02			X		3	2022/03/22	1110				
P-SS-22-03			X		3	2022/03/22	1135				
P-SS22-04			X		3	2022/03/22	1200				
P-SS22-05			X		3	2022/03/22	1230				
P-SS22-06			X		3	2022/03/22	1230				

ANALYSES REQUESTED:

CLIENT SAMPLE ID	PHC F1 ☐ BTEX ☒ / VPH	PHC F2-F4 ☐ PAH ☒ / LEPH/HEPH	VOC ☐ THM ☐ HAA ☐	DISSOLVED METALS Hg ☐ Cr6 ☐	TOTAL METALS Hg ☐ Cr6 ☐	SOIL METALS SatP B ☐ Cr6 ☐ Hg ☐	SOIL SALINITY BASIC ☐ DETAILED ☐	PSA HYDROMETER ☐ 75 um SIEVE ☐	CLASS 2 LANDFILL	ROUTINE WATER Fe+Mn ☐	COD ☐ BOD ☐ TOC ☐ DOC ☐	TSS ☐ TDS ☐ VSS ☐	AMMONIA ☐ TKN ☐ TP ☐	TO&G ☐ PHENOLICS ☐	TCOL ☒ E. Coli ☒ FCOL ☒ HPC ☐	TOX TROUT MULTI CON. ☐ pH STAB ☐ P/F ☐	TOX DAPHNIA MULTI CON. ☐ P/F ☐	PCB Aroclors	nitrate/nitrite/ammonia	phosphorous/potassium	salmonella	Cr6 (speciated)		HOLD	POSSIBLE SAMPLE HAZARD CODE(S)
P-SS22-01		X			X										X				X	X	X				
P-SS-22-02		X			X										X				X	X	X	X			
P-SS-22-03	X	X			X										X			X	X	X	X	X			
P-SS22-04		X			X										X				X	X	X	X			
P-SS22-05	X	X			X										X				X	X	X				
P-SS22-06		X			X										X				X	X	X				

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:

SAMPLE RETENTION:
30 Days (default) ☐
60 Days ☐ 90 Days ☐
Other (surcharges may apply):

*** OTHER INSTRUCTIONS:**
Total Coliforms add via email Mar 23/22

If you would like to talk to a real live Scientist about your project requirements, please check here: ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 3.9 ICE: Y ☐ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT: NA ☐ Y ☐ N ☐

Appendix II

PRRA Supporting Information

HEPH/EPH$_{C19\text{-}C32}$ Sediment Guideline Derivation

The HEPH/EPH$_{C19\text{-}32}$ sediment guideline was derived based on Environment Canada methodology described by Mroz et al. (2016). Mroz et al. (2016) applied an equilibrium partitioning model, which assumed toxicity was based on the chemical concentration in the aqueous phase. For organic compounds, the partitioning behaviour is the function of the chemicals organic carbon-water partitioning coefficient (K_{oc}) and the sediments fraction of organic carbon (F_{oc}). The equation below described this relationship:

$$S_{ESL} = SW_{ESL} \cdot Koc \cdot Foc$$

Where:

S_{ESL} =Sediment Ecological Screening Level (µg/g)

SW_{ESL} =Surface Water Ecological Screening Level (mg/L)

K_{OC} =Organic carbon-water partitioning coefficient (chemical specific, L/kg)

F_{OC} =Sediment fraction organic carbon (Site-specific, g/g)

The above equation allows for site-specific adjustment based on F_{oc}. Mroz et al. (2016) provides sediment ecological screening levels for some petroleum-based substances based on an F_{OC} of 0.01 (see **Table II-1**, below), with a maximum of 500 µg/g for modified total petroleum hydrocarbons (TPH).

Table II-1: Sediment Ecological Screening Levels for the Protection of Aquatic Life (µg/g)

Sediment Type	Substance							
	Benzene	Toluene	Ethylbenzene	Xylenes	Modified TPH			
					Gas	Diesel/#2	#6 Oils/Lube	Max
Typical	1.2	1.4	1.2	1.3	15	25	43	500
Other	5.4	6.1	5.0	5.5	67	110	190	500

Notes:
Typical Sediment is used as a habitat for sensitive components of freshwater, marine or estuarine aquatic ecosystems
Other Sites were the sediment is not classified as typical, such as ditches, industrial-influence receiving areas or urban harbours, etc.

In the PRRA, no sediment benchmarks were available for heavy and extractable petroleum hydrocarbons that elute between C_{19} and C_{32} (HEPH/EPH$_{C19\text{-}32}$); these include most diesels, lubricating oils, greases, waxes and hydraulic oils. Based on the equation described by Mroz et al. (2016), a sediment guideline could be calculated. A site specific F_{oc} of 0.194 g/g for the Princeton Study Area was used and based on the Diesel/#2 sediment screening level of 25 for typical sediment types (F_{oc} =0.01), a site-specific sediment ecological screening level of 485 µg/g HEPH/EPH$_{c19\text{-}32}$ was derived for the Princeton Study Area for application in the PRRA.

Mroz et al. (2016) indicates that the screening levels indicated in Table II-1 and based on an F_{oc} of 0.01 change proportionally with the F_{oc} (sample provided indicated an Foc of 0.04 results in a 4-fold increase in the screening levels) to a maximum value of 500 µg/g. The Foc fo the Study Area of 0.194 therefore results in a 19.4-fold increase in the Table II-1 screening value for diesel/#2:

Princeton Study Area S_{ESL} HEPH/EPH$_{c19\text{-}32}$ = 25 µg/g x 19.4 = 485 µg/g

SNC·LAVALIN

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