# Preliminary Quantitative Human Health and Ecological Risk Assessment: Resolute Bay Airport Land Treatment Unit, Cornwallis Island, Nunavut

Resolute Bay Airport Land Treatment Unit,
Cornwallis Island, Nunavut

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Prepared for:

Public Services and Procurement Canada
on behalf of Transport Canada

Prepared by:

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Stantec Project No. 110220180

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# Executive Summary

Public Services and Procurement Canada (PSPC), on behalf of Transport Canada, has retained Stantec Consulting Ltd. (Stantec) to conduct a Preliminary Quantitative Human Health and Ecological Risk Assessment (PQHHERA) at for the Land Treatment Units (LTU) located at the Resolute Bay Airport on Cornwallis Island, Nunavut (the Site).

The purpose of the PQHHERA is to review the information available from previous and current environmental investigations and complete a preliminary quantitative evaluation of the potential for human and ecological risks associated with chemicals of potential concern (COPCs) at the Site. Based on personal communications with PSPC, as guidelines for the assessment and risk management for PFAS compounds on federal airport properties continue to evolve, assessment of PFAS compounds was not included in this scope of work.

## Human Health Risk Assessment

The Human Health Risk Assessment (HHRA) problem formulation included identification of COPCs, receptor identification, as well as exposure pathway assessment. COPCs for human health were identified by screening the reported concentrations of PHCs, PAHs, and metals in soil, groundwater, and surface water against applicable human health screening levels. COPCs were not identified in soil from the LTUs at the Site. Three COPCs were identified for groundwater: cobalt, lead, and vanadium. Two COPCs were identified for surface water: petroleum hydrocarbon fraction F2, and lead. However, it is noted that the water analytical data was conservatively screened against the Guidelines for Canadian Drinking Water Quality or similar guidelines/standards for potable water even though the Site is subject to continuous permafrost, and groundwater is not used as potable water. Surface water may be found at or in proximity to the Site, but it is generally found in surface water accumulations subject to frozen conditions and transient in nature. As such, the screening of groundwater and surface water data and identification of lead as a COPC are not considered a concern and were not considered further in the HHRA. This was further confirmed through the exposure pathway assessment which did not identify exposure pathways requiring further assessment. Based on the results of problem formulation, potential unacceptable risks are not anticipated for human receptors at the Site.

## Ecological Risk Assessment

The Ecological Risk Assessment (ERA) problem formulation included identification of COPCs, receptor identification, as well as exposure pathway assessment. COPCs for ecological health were identified by screening the reported concentrations of PHCs, PAHs, and metals in soil, groundwater, and surface water against applicable ecological screening levels. For the purpose of this study, surface soil was stratified as shallow soil (<0.45 m), and deeper surface soil (≥0.45 m), as direct contact with soil at depths ≥0.45 m is considered very unlikely since the area is subject to continuous permafrost and liners are in place within the LTUs to limit potential exposures. Furthermore, two potential exposure pathways were considered for ecological receptors: direct contact/ingestion and the protection of groundwater for aquatic life. COPCs were not identified in shallow soil from the LTUs at the Site. In deeper soil, COPCs for the direct/contact ingestion pathway included xylenes, PHC fractions, and naphthalene. For the protection of groundwater for aquatic life, COPCs in deeper soil included benzene, toluene, xylenes, PHC fractions, fluorene, naphthalene, and phenanthrene. COPCs in groundwater were limited to metals. COPCs in surface water included petroleum hydrocarbon fraction F2, lead, nitrate, and phenols. The exposure pathway assessment demonstrated that potential exposure to impacted soil found within the LTUs was limited (provided that the liners and berms are still adequately protecting the LTUs). Furthermore, potential exposures to groundwater and surface water are also deemed to be limited since the area is subject to continuous permafrost, and the nearest continuous waterbodies are located more than 800 m away from the Site. Based on the results of problem formulation, potential unacceptable risks are not anticipated for ecological receptors at the Site.

The statements made in this Executive Summary are subject to the same limitations included in the Statement of Limitations Section 13.0 of this report and are to be read in conjunction with the remainder of this report.

# Abbreviations

| | |
|---|---|
| APV | Aquatic Protection Values |
| AST | Above-ground storage tank |
| BTEX | Benzene, Toluene, Ethylbenzene and Xylene |
| CCME | Canadian Council of Ministers of the Environment |
| COPC | Chemical of Potential Concern |
| CSM | Conceptual Site Model |
| CWS | Canada-Wide Standard |
| DQRACHEM | Detailed Quantitative Human Health Risk Assessment for Chemicals |
| EC | Environment Canada |
| ERA | Ecological Risk Assessment |
| ESA | Environmental Site Assessment |
| ESL | Ecological Screening Level |
| FCSAP | Federal Contaminated Sites Action Plan |
| FTA | Fire mock up Training Area |
| FWAL | Freshwater Aquatic Life |
| GCDWQ | Guidelines for Canadian Drinking Water Quality |
| HC | Health Canada |
| HHERA | Human Health and Ecological Risk Assessment |
| HHRA | Human Health Risk Assessment |
| HHSL | Human Health Screening Level |
| LTU | Land Treatment Unit |
| MAC | Maximum Acceptable Concentration |
| mbgs | metres below ground surface |
| MECP | (Ontario) Ministry of the Environment, Conservation, and Parks |
| MW | Monitoring Well |
| NU | Nunavut |
| NWB | Nunavut Water Board |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PFAS | per and polyfluorinated alkyl substances |
| PFOS | perfluorooctanesulfonic acid |
| PGWAL | Protection of Groundwater for Aquatic Life |
| PHC | Petroleum Hydrocarbon |
| PQHHERA | Preliminary Quantitative Human Health and Ecological Risk Assessment |
| PQRA | Preliminary Quantitative Risk Assessment |
| PSPC | Public Services and Procurement Canada |
| *SARA* | *Species at Risk Act* |
| SCS | Site Condition Standards |
| SQG | Soil Quality Guidelines |

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|---|---|
| TOR | Terms of Reference |
| TRV | toxicological reference values |
| USEPA | United States Environmental Protection Agency |
| WQG | Water Quality Guidelines |

# 1.0 INTRODUCTION

Public Services and Procurement Canada (PSPC), on behalf of Transport Canada, has retained Stantec Consulting Ltd. (Stantec) to conduct a preliminary Human Health and Ecological Risk Assessment (PQHHERA) for the Land Treatment Units (LTUs) located at the Resolute Bay Airport on Cornwallis Island, Nunavut (the Site).

The purpose of the PQHHERA is to review the information available from previous and current environmental investigations and to assess the potential risks to human and ecological receptors for the chemicals of potential concern (COPCs) at the Site.

The work was completed under the North Standing Offer EW699-170520/002/NCS Contract issued on April 1, 2017. The objectives for the scope for this work are set out in the "Terms of Reference (TOR) Amendment Request No. 3" prepared by PSPC, Western Region, received by Stantec on December 11, 2018 as well as the proposal for consulting services prepared by Stantec and submitted to PSPC on January 18, 2019.

# 2.0 SITE DESCRIPTION

The Site is located on the west side of Cornwallis Island, Nunavut, approximately 2 km north of the Resolute Bay Airport runway, and almost 7 km northeast of the town of Resolute Bay. A Site Location Plan is presented on Figure 1, in Appendix A. Photographs of the Site are presented in Appendix B. Two LTUs (LTU1 and LTU2) were constructed at the Site in 2002 to treat petroleum hydrocarbon (PHC) impacted soil from a former above ground storage tank (AST) farm that stored bulk fuel and a former fire mock up training area (FTA). Previous environmental reports state that nutrients were added to the soil within the LTUs in 2002 and 2003 to promote petroleum hydrocarbon remediation. In 2015, a soil sampling program confirmed that PHC concentrations exceeded applicable environmental guidelines in the LTU soils. Two smaller LTUs (LTU3 and LTU4) are also present on-site; however, Transport Canada is not the custodian of LTU3 and LTU4, and these LTUs are not included in the scope of work presented herein.

The Site is located at the intersection of two gravel roads surrounded by an area that is generally barren with little vegetative cover. Other than the four LTUs and random debris, the Site is vacant.

The Arcadis 2017 monitoring report (Arcadis, 2017) indicated that the surficial geology in the area of the Site consists of colluvial deposits that are residual materials deposited as veneers and blankets of debris through downslope movement and in-place disintegration of bedrock, including areas of rock outcrop. The colluvial rubble reportedly contains rubble and silt derived from carbonate and consolidated fine clastic sedimentary rock substrate.

The bedrock of the Site is of Paleozoic era, specifically the Arctic Platform and is composed of Silurian carbonate and siliciclastic rocks (Canada-Nunavut Geoscience Office, 2006a and 2006b).

Resolute Bay is subject to continuous permafrost, and groundwater is not used as potable water (Arcadis, 2017).

Regional surface drainage (anticipated shallow groundwater flow direction) appears to be to the west toward Allen Bay (permanent waterbody), located approximately 1.3 km west of the Site. Some potential surface drainage appears to be also possible to the north towards McMaster River (appears to be an ephemeral watercourse), located approximately 800 m north of the Site.

# 3.0 BACKGROUND

As part of the current study (as well as part of previous work), Stantec reviewed the background information included in the TOR and in historical reports provided by PSPC. Based on our review, Stantec understands that the history and background of the Site, including previous assessments, can be summarized as follows:

- The Resolute Bay Airport has been in operation since 1949. It was originally constructed by the Royal Canadian Air Force. Ownership was transferred to the Government of Canada in 1964 and it was operated by Transport Canada until July 1, 1995. Ownership was transferred to the Government of the Northwest Territories in 1999 and then to the Government of Nunavut.
- In 2002, two LTUs (LTU1 and LTU2) were constructed to treat PHC impacted soil from a former AST farm that stored bulk fuel and a former FTA. Approximately 500 cubic metres ($m^3$) of PHC impacted soil was excavated from the FTA and approximately 300 $m^3$ of PHC impacted soil was excavated from the AST farm for treatment in the LTUs.
- Two smaller LTUs (LTU3 and LTU4) are also present. There is no background information regarding the origin of these LTUs. As noted above, Transport Canada is not the custodian of LTU3 and LTU4, and as such these LTUs are not further discussed in this report.
- In 2015, a soil sampling program confirmed the presence of perfluorooctanesulfonic acid (PFOS), one of the per and polyfluorinated alkyl substances (PFAS), exceeding interim guidelines in the LTU soils, and PHC concentrations exceeding applicable environmental guidelines in the LTU soils.
- An operating licence for the historical LTUs (LTU1 and LTU2) was obtained by Transport Canada through the Nunavut Water Board (NWB) in 2015 (Licence No. IBR-RLF1520) and requires annual groundwater monitoring.
- In 2016-2017 the condition of six existing monitoring wells (MW) in the vicinity of the LTUs was inspected (MW1 through MW6), and the liner integrity in the LTUs was assessed. In 2017, only one groundwater sample could be collected. Surface water samples were also collected around the LTU perimeter to assess for potential impacts to compensate for the lack of groundwater samples. Monitoring wells MW4 and MW6 (located upgradient and downgradient of LTU2), had heaved and were not considered viable for future sampling.
- The preliminary results from the 2017-18 monitoring program, yielded limited sampling results, and follow up surface water and soil sampling has identified the LTU may be leaking. However, the potential risks to human or ecological receptors are not known.
- The 2018-2019 monitoring program included the collection of groundwater, surface water, and soil samples. Concentrations of PHC F2 in soil within LTU2 and in groundwater collected from the monitoring well located adjacent to LTU1 exceeded the applicable guidelines/standards. For the 2018-2019 monitoring program, concentrations of lead in surface water exceeded the applicable guidelines/standards at two locations, whereas concentrations of nitrate in surface water exceeded the applicable guidelines/standards at one location. Potential berm breaches were observed by Stantec personnel on LTU2. Berm breaches were not observed on LTU1.

# 4.0 SCOPE OF WORK

Based on the TOR Amendment Request No. 3 provided by PSPC dated December 11, 2018, the objectives of the project are to:

- Assess the potential risks to human and ecological receptors for the COPCs at the Site.

Based on our understanding of the project and review of the TOR, Stantec's proposed scope of work for Amendment No. 3 includes the completion of a PQHHERA using already available data collected through previous studies (e.g., monitoring). Based on personal communications with PSPC, as guidelines for the assessment and risk management for PFAS compounds on federal airport properties continue to evolve, assessment of PFAS compounds was not included in this scope of work.

Stantec understands that the long-term objective at the Site is to remediate the soil and decommission the LTUs at the Site to achieve site closure. The results of the PQHHERA will inform whether further remediation or risk management measures may be required to mitigate risks to human health or the environment for the ongoing management and/or closure of the Site. Stantec proposed the following scope of work for the Site in the proposal dated January 18, 2019:

- Plan and conduct a PQHHERA.
- Prior to completing the risk assessment, Stantec will prepare a problem formulation for the combined assessment including description of the conceptual model, identification of receptors/valued ecosystem components, assessment endpoints and measured endpoints.
- In addition to the preceding elements, the problem formulation will address:
  - Statistics to be used as point estimates of chemical concentrations in the various media;
  - The fate and transport models used to predict concentrations in exposure media not directly assessed;
  - Criteria to be used to screen contaminants of potential concern (COPCs);
  - Suitability of default soil ingestion and dermal soil loading rates;
  - How short term or intermittent receptor exposure will be amortized;
  - Hazard quotients/lifetime cancer risks with justification;
  - How background and off-site exposure effects the assessment;
  - Presence of rare or threatened species and their effect on the risk assessment approach;
  - The implications of habitat suitability and home/forage range in the exposure assessment for ecological receptors; and
  - Identification and justification of wildlife toxicity reference values including techniques for inter-species extrapolation.
- Based upon the findings of the PQHHERA, provide recommendations (and associated cost estimates) for follow-up work at the Site (as required).

Upon approval of the problem formulation by the Project Manager, the Consultant will complete the risk assessment in accordance with the methods, reporting standards and toxicological reference values outlined in:

- CCME, 1996a. A Framework for Ecological Risk Assessment – General Guidance;
- CCME, 1996b. Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada;
- CCME, 2008. Canada-Wide Standard (CWS) for Petroleum Hydrocarbons (PHC) in Soil;
- Environment Canada (EC), 2012. Federal Contaminated Sites Action Plan (FCSAP), Ecological Risk Assessment Guidance, including available modules.
- Health Canada (HC), 2012. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) (version 2.0);
- HC, 2010a. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors;
- HC, 2010b. Federal Contaminated Site Risk Assessment in Canada, Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada;
- HC, 2010c. Federal Contaminated Sites Guidance on Human Health Risk Assessment in Canada Part V: Guidance on Detailed Quantitative Human Health Risk Assessment for Chemicals (DQRACHEM);
- Including all updated documentation and recently published documentation from HC.

# 5.0 REGULATORY FRAMEWORK

For the purpose of the PQHHERA, screening levels were established to identify COPCs. Separate screening levels were established for the Human Health Risk Assessment (HHRA) and the Ecological Risk Assessment (ERA), which are referred to herein as the human health screening levels (HHSLs) and ecological screening levels (ESLs). HHSLs and ESLs were chosen from available guidelines and standards according to each media considered (i.e., soil, groundwater, and surface water) by considering potential routes of exposures specific to these receptors. As the Site is owned by the Crown and is subject to federal regulations and standards, federal guidelines were selected first (as available). Guidelines or standards from other jurisdictions such as Ontario and Alberta were also considered as required (and discussed further below).

For soil HHSLs, an industrial (or equivalent) land use scenario assuming coarse-grained soil and a non-potable water was considered to screen soil data. This approach is consistent with previous studies. As mentioned, other than the four LTUs and random debris, the Site is vacant without buildings or features of interest. As such, potential exposures from indoor vapour inhalation were not considered in the selection of the soil HHSLs. For soil ESLs, the more conservative agricultural land use scenario was considered. Although the area of the site is generally barren with little vegetative cover and is not used to grow crops or livestock, the agricultural land use scenario was selected since it considers both ecological soil contact and soil/food ingestion pathways which are considered protective of birds and mammals that may traverse the site (in contrast to the industrial land use scenario that only considers ecological soil contact). Furthermore, for the purpose of this study, surface soil was stratified as shallow soil (<0.45 m), and deeper surface soil (≥0.45 m), as direct contact with soil at depths ≥0.45 m is considered very unlikely since the area is subject to continuous permafrost and liners are in place within the LTUs to limit potential exposures.

For groundwater and surface water HHSLs, consideration was given to drinking water quality guidelines or similar standards/guidelines protective of potable water even though, as stated previously, the Site is considered non-potable. Although groundwater and surface water accumulations on Site are not expected to be used as a continuous source of drinking water, screening concentrations using drinking water guidelines was considered to be protective of potential incidental exposures to either shallow groundwater or surface water accumulations present on Site. Furthermore, as no buildings are present at (or in proximity of) the Site, potential exposures from indoor vapour inhalation were not considered in the selection of the soil HHSLs. For groundwater and surface water ESLs, guidelines protective of aquatic life were selected, including groundwater guidelines developed in consideration of potential migration to surface water bodies. This approach is considered conservative as both groundwater and surface water accumulations present on Site would not be considered aquatic habitat. Furthermore, although groundwater migration and discharge to the bay or river is possible, this is considered to represent low potential for contaminant migration as the area is subject to continuous permafrost and because the bay and river are located approximately 1.3 km and 800 m away from the site, respectively.

Further information and details on selection of HHSLs and ESLs are provided in Section 5.1 (Soil), Section 5.2 (Groundwater), and Section 5.3 (Surface Water).

## 5.1 SOIL

As mentioned, other than the four LTUs and random debris, the Site is vacant without buildings or features of interest. Groundwater is not used as a source of potable water at the Site, and the closest permanent surface water body to the Site is Allen Bay, located approximately 1.3 km west of the Site. Analytical soil results have historically been compared to industrial land use guidelines assuming coarse-grained soil and a non-potable water scenario, including the Canada Wide Standards for Petroleum Hydrocarbons (CWS; CCME, 2008) and, as per direction from the NWB, the Ontario Ministry of the Environment and Climate Change (now referred to as the Ontario Ministry of the Environment, Conservation, and Parks (MECP)), Table 3 Site Condition Standards (SCS) from the Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario (2011). As such, concentrations of PHC fractions 1 through 4 (PHC F1-F4) have historically been compared to the CWS industrial land use. Other parameters have been compared to the MECP Table 3 SCS for Industrial/Commercial/Community Land Use.

As the Site is owned by the Crown and is subject to federal regulations and standards, federal guidelines were selected first (as available) for the purpose of the PQHHERA. When federal guidelines were not available, standards or guidelines from other jurisdictions were considered to obtain screening levels for the highest number of parameters. Consistent with previous studies, an industrial (or equivalent) land use scenario assuming coarse-grained soil and a non-potable water was considered to screen soil data as part of the HHRA. As no buildings are present at (or in proximity of) the Site, the indoor vapour inhalation pathway was considered an inoperable pathway. For the ERA, the more conservative agricultural land use assuming coarse-grained soil was considered because agricultural land use guidelines also consider soil and food ingestion pathways, in addition to ecological soil contact. This approach is deemed conservative as the Site is generally vacant and without features that would be expected to attract wildlife. For the purposes of the PQHHERA, analytical results from soil samples collected at the Site during previous investigations have been screened using the following standards and guidelines, selected as HHSL or ESL:

- CCME. 2008. CWS for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Levels for coarse-grained surface soil with a non-potable Industrial (or Commercial in the event guidelines were not available for Industrial) Land Use without indoor air inhalation (human health) or Agricultural Land Use (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- CCME. 2018. Canadian Soil Quality Guidelines (SQG) for the Protection of Environmental and Human Health, coarse-grained soil with a non-potable Industrial Land Use without indoor air inhalation (human health) or Agricultural Land Use (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- MECP. 2011. Soil, Groundwater, and Sediment Standards for coarse-grained surface soil with a non-potable (Table 3 SCS) Industrial/Commercial Land Use without indoor air inhalation (human health) or Agricultural Land Use (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- Alberta Environment and Parks Alberta Tier 1 Soil and Groundwater Remediation Guidelines. 2019. Surface Soil Remediation Guideline Values for coarse-grained soil with a non-potable Industrial Land Use without indoor air inhalation (human health) or Agricultural Land Use (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- United States Environmental Protection Agency (USEPA). 2018. Regional Screening Levels, Composite Table – Industrial Soil (TR = 1E-6; THQ =1.0). Human health pathways.

Soil screening levels selected for this study are summarized according to each parameter in Table C.1a (shallow soil; <0.45 m) and Table C.1b (deeper surface soil; ≥0.45 m) in Appendix C.

## 5.2 GROUNDWATER

Monitoring wells were installed, monitoring and samples as part of previous investigations, with varying degree of groundwater collection success due to frozen conditions. The wells are installed to the maximum depth the permafrost would allow at the time of installation, and therefore susceptible to the freeze/thaw regime of the active permafrost layer. Groundwater is not used as a source of potable water at the Site. Analytical groundwater results (when available) have historically been compared to effluent guidelines (NWB Licence No. 1-BR-RLF-1530, Part D, Item 6) and, as per direction from the NWB, MECP SCS assuming a non-potable condition (not dependent on land use). The effluent guidelines provided in the licence apply only to a limited number of the parameters. Other parameters have been compared to the MECP Table 3 SCS for Non-Potable Groundwater (which are not dependent on land use).

As the Site is owned by the Crown and is subject to federal regulations and standards, federal guidelines were selected first (as available) for the purpose of the PQHHERA. When federal guidelines were not available, standards or guidelines from other jurisdictions were considered to obtain screening levels for the highest number of parameters. An industrial (or equivalent) land use scenario assuming a non-potable water was considered to screen available groundwater data as part of the PQHHERA. As no buildings are present at (or in proximity of) the Site, the indoor vapour inhalation pathway was considered an inoperable pathway. For human health screening, consideration was given to drinking water guidelines. Although this shallow groundwater may not be used as a continuous source of drinking water, the use of drinking water guidelines was considered a conservative approach for assessing incidental exposures. For ecological screening, guidelines protective of aquatic life were used for assessing exposures. Analytical results from groundwater samples collected at the Site during previous investigations have been screened using the following standards or guidelines, selected as HHSL or ESL:

- Health Canada. 2017. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. Health based Maximum Applicable Concentrations (MAC).
- Environment Canada. 2015. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites. Generic Guidelines for Agricultural Land Use. Pathway-specific information for each individual chemical was reviewed to confirm ecological screening levels.
- MECP. 2011. Soil, Groundwater, and Sediment Standards for potable water in coarse-grained soil without indoor air inhalation (human health) or for water within 30 m of a water body (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- Alberta Environment and Parks Alberta Tier 1 Soil and Groundwater Remediation Guidelines. 2019. Groundwater Remediation Guideline Values for Industrial Land Use in coarse-grained soil without indoor air inhalation (human health) or for aquatic life (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- United States Environmental Protection Agency (USEPA). 2018. Regional Screening Levels, Composite Table – Tap water (TR = 1E-6; THQ =1.0). Human health pathway.

Groundwater screening levels selected for this study are summarized according to each parameter in Table C.2 in Appendix C.

## 5.3 SURFACE WATER

Surface water samples have been collected as part of previous investigations, with varying degrees of success, from accumulated surface water located in proximity to the LTUs. Based on field observations reported in previous investigations, these surface water accumulations appear to be transient in nature, with changing location and appearance from year to year (when they have been observed). Analytical surface water results (when available) have historically been compared to effluent guidelines (NWB Licence No. 1-BR-RLF-1530, Part D, Item 6) as well as the CCME Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME FWAL). However, both the effluent guidelines and the CCME FWAL are not considered adequate for screening purposes because: 1) the accumulated surface water does not represent effluent; and 2) these surface water accumulations are transient in nature and do not sustain aquatic communities (e.g., fish or benthic invertebrates).

As such, other standards and guidelines were considered for screening surface water data for the purposes of the PQHHERA. As the Site is owned by the Crown and is subject to federal regulations and standards, federal guidelines were selected first, where available. When federal guidelines were not available, standards or guidelines from other jurisdictions were considered to obtain screening levels for the highest number of parameters. For human health screening, consideration was given to drinking water guidelines. Although surface water accumulations may not be used as a continuous source of drinking water, the use of drinking water guidelines was considered a conservative approach for assessing potential incidental exposures. For ecological screening, guidelines protective of aquatic life were used for assessing exposures. Analytical results from surface water samples collected at the Site during previous investigations have been screened using the following standards or guidelines, selected as HHSL or ESL:

- Health Canada. 2017. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table. Health based Maximum Applicable Concentrations (MAC). Human Health pathway.
- CCME. 2018. Canadian Water Quality Guidelines (WQG) for the Protection of Aquatic Life.
- MECP 2011 Soil, Groundwater, and Sediment Standards for potable water in coarse-grained soil without indoor air inhalation (human health) or for water within 30 m of a water body (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- Alberta Environment and Parks Alberta Tier 1 Soil and Groundwater Remediation Guidelines. 2019. Groundwater Remediation Guideline Values for Industrial Land Use in coarse-grained soil without indoor air inhalation (human health) or for aquatic life (ecological health). Pathway-specific information for each individual chemical was reviewed to confirm human health and ecological screening levels.
- United States Environmental Protection Agency (USEPA). 2018. Regional Screening Levels, Composite Table – Tap water (TR = 1E-6; THQ =1.0). Human health pathway.

Surface water screening levels selected for this study are summarized according to each parameter in Table C.3 in Appendix C.

# 6.0 ANALYTICAL SUMMARY

The following sections include a discussion of historical results for PHCs, polycyclic aromatic hydrocarbons (PAHs), and metals in soil, groundwater, and surface water from the 2015 Environmental Site Assessment (Arcadis, 2016), from the 2017 Environmental Monitoring Program (Arcadis, 2017), and from the Draft 2018 Environmental Monitoring Program (Stantec, 2019a). Analytical results from previous investigations are presented in Appendix C.

## 6.1 SOIL

Results were available for 22 soil samples collected from LTU1 and LTU2. Soil sample locations are shown on Figure 2, in Appendix A. Eleven soil samples, including two field duplicates, were collected at depth (≥0.45 m) as part of the 2015 ESA for PHC, PAH, and metal analysis (Arcadis, 2016). Another eleven soil samples were collected as part of the 2018 Environmental Monitoring Program (Stantec, 2019a), including nine below surface soil samples (i.e., 0.1 to 0.3 m) for PHC analysis, and two deeper samples (i.e., 0.4 to 0.6 m), including a field duplicate, for PHC fractionation analysis for potential PQHHERA calculations. PHC concentrations were found to be generally highest at depth (≥0.45 m) with generally non-detectable concentrations closer to surface (0.1 to 0.3 m). PAH concentrations were found to trend with PHC concentrations. Metal concentrations were found to exhibit little variability across both LTUs.

## 6.2 GROUNDWATER

As mentioned, although monitoring wells have been completed as part of previous investigations, groundwater collection has presented several challenges due to frozen conditions. Results were available for two groundwater samples collected from the same monitoring well (MW1) located along the eastern boundary of LTU1 as seen on Figure 2, in Appendix A. One groundwater sample was collected as part of the 2017 Environmental Monitoring Program (Arcadis, 2017) while the other was collected as part of the 2018 Environmental Monitoring Program (Stantec, 2019a) for PHC, PAH, and metal analysis. The groundwater sample collected in 2017 exhibited generally low concentrations of benzene, toluene, ethylbenzene and xylenes (BTEX), non-detectable concentrations of PHCs, generally non-detectable concentrations of PAHs (few detections slightly above the detection limits), and detectable concentrations of several metals with no clear distinguishable trends. The groundwater collected in 2018 exhibited generally non-detectable concentrations of BTEX, detection of PHC F2, generally non-detectable concentrations of PAHs (with the same exceptions as that encountered in the 2017 samples, and generally lower concentrations of metals than those encountered in the 2017 sample.

## 6.3 SURFACE WATER

Results were available for 11 surface water samples collected from surface water accumulations in proximity to LTU1 and LTU2. Surface water sample locations are shown on Figure 2, in Appendix A. Five surface water samples, including one field duplicate, were collected as part of the 2017 Environmental Monitoring Program (Arcadis, 2017). Six other surface water samples, including one field duplicate, were collected as part of the 2018 Environmental Monitoring Program (Stantec, 2019a). Although samples collected in 2017 and in 2018 sometimes bear the same sample identification name, these samples were not necessarily collected from the same locations due to the changing location of surface water accumulations. As such, for clarification, the sampling year was added to each surface water sample identification name. Surface water samples from both field programs were submitted for PHC, PAH, metal, and general chemistry analysis. PHC and PAH concentrations remained generally below detection limits, with few exceptions at concentrations only slightly above the detection limit (i.e., less than three times the detection limit). Several metals and general chemistry parameters remained below their respective detection limit. Ammonia, nitrite, and nitrate were detected in several samples. Sulphate and chloride were detected in all surface water samples submitted for analysis. No clear distinguishable trends were identified within the available surface water results.

# 7.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA process generally follows a widely-recognized framework that progresses from a qualitative initial Problem Formulation step, through Exposure and Toxicity Assessments. The process culminates in a quantitative Risk

Characterization step, followed by Conclusions and Recommendations. An Uncertainty Evaluation follows the Risk Characterization to discuss the uncertainties inherent in the HHRA process.

The primary guidance for conducting the HHRA is that of Health Canada:

- Federal Contaminated Site Risk Assessment in Canada Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (Health Canada, 2012)
- Federal Contaminated Site Risk Assessment in Canada Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0 (Health Canada, 2010a)
- Federal Contaminated Site Risk Assessment in Canada Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM; Health Canada, 2010b)

## 7.1 PROBLEM FORMULATION

The objective of the Problem Formulation is the development of a focused understanding of which substances constitute COPCs, what human receptors are likely to be present at the Site, and how COPCs migrate from the source(s) and ultimately reach, and are taken up by, the human receptors at the Site. This information is usually summarized in a human health conceptual site model (CSM), which provides a visual depiction of the relevant pathways linking COPCs in various environmental media to the human receptors of interest in the HHRA. However, as no pathways were identified as requiring further assessment, a CSM for human health exposure was not developed.

### 7.1.1 Identification of COPCs

COPCs for human health were identified by screening the reported chemical concentrations in soil, groundwater, and surface water against applicable human health-based guidelines. Human health screening levels were selected based on the approach outlined in Section 5.0 (Regulatory Framework). Pathway-specific information for each individual chemical was reviewed to confirm human health screening levels from the guidelines listed in Section 5.1 (Soil), Section 5.2 (Groundwater), and Section 5.3 (Surface Water).

Other than the four LTUs and random debris, the Site is vacant without buildings or features of interest. Groundwater is not used as a source of potable water at the Site, and the closest permanent surface water body to the Site is Allen Bay, located approximately 1.3 km west of the Site. Based on the location of the Site and site activities, an industrial (or equivalent) land use scenario assuming coarse-grained soil and a non-potable water was considered to screen soil and groundwater data as part of the HHRA. As no buildings are present at (or in proximity of) the Site, the indoor vapour inhalation pathway was not considered. For human health screening of surface water and groundwater, consideration was given to Guidelines for Canadian Drinking Water Quality (HC, 2017) or similar standards/guidelines protective of potable water even though groundwater and surface water accumulations on Site would not be used as a continuous source of drinking water. The use of Guidelines for Canadian Drinking Water Quality was considered a conservative approach for assessing the potential for incidental exposures.

Some metals that have a low inherent toxicity and/or that are associated with sea spray (e.g., aluminum, boron, bismuth, calcium, iron, lithium, magnesium, manganese, phosphorus, potassium, rubidium, sodium, and strontium) were excluded from evaluation and were not carried forward in the HHRA. Additionally, general chemistry parameters (e.g., hardness, conductivity), and parameters with limited toxicological information which were not detected (e.g., uncommon PAHs) were not carried forward in the HHRA. Some screening levels were also not identified for some COPC-pathway combination due to their limited interaction (e.g., soil screening level protection of water were limited for some parameters with low solubility (e.g., heavier petroleum hydrocarbons)).

A description of the screening process and corresponding results is provided in Section 7.1.1.1 for soil, in Section 7.1.1.2 for groundwater, and in Section 7.1.1.3 for surface water.

#### 7.1.1.1 COPCs in Soil

For the determination of human health COPCs in soil, concentrations of BTEX, PAH, and metal parameters were screened against the lowest applicable human health guideline from the CCME Canadian Soil Quality Guidelines for the Protection of Human Health (CCME, 2018). For PHCs, concentrations were screened against the lowest applicable human health guideline from the CWS for PHCs in Soil (CCME, 2008).

Based on current and intended land use, pathway-specific guidelines considered applicable at the Site include those protective of direct contact (i.e., soil ingestion, dermal contact, and soil inhalation). There are no buildings located on Site, liners are in place within the LTUs to limit potential exposures, and the Site is considered non-potable (due to the continuous permafrost condition). Therefore, potential human health exposures are limited to potential soil ingestion/dermal contact (further discussed in Section 7.1.3). As per CCME (2006) guidance, soil samples from grade to 1.5 m below ground surface are considered surface soil. However, as the area is subject to continuous permafrost and liners are in place within the LTUs to limit potential exposures, for the purpose of this study, surface soil was further stratified as shallow soil (<0.45 m), and deeper surface soil (≥0.45 m), as direct contact with soil at depths ≥0.45 m is considered very unlikely.

Concentrations exceeding the selected soil screening levels were not identified in shallow soil samples collected from LTUs at the Site for the human health direct exposure (soil ingestion/dermal contact) pathways considered. Soil analytical data considered in this HHRA are summarized and presented in Table 1. A summary of the human health screening results for identified COPCs in soil is presented in Table 1. As presented in Table 1, no COPCs were identified for the human health direct exposure to soil within the LTUs at the Site.

**Table 1 Hazards Identification in Soil – Human Health Screening**

| COPC | Maximum Measured Concentration in Soil (mg/kg) | Human Health Screening Level (mg/kg) | Exceedance Location(s) |
|---|---|---|---|
| ***Shallow Soils (<0.45 m)*** | | | |
| None Identified. | N/A | N/A | N/A |
| ***Deeper Soils (≥0.45 m)*** | | | |
| None Identified. | N/A | N/A | N/A |
| NOTES:<br>N/A – Not Applicable | | | |

#### 7.1.1.2 COPCs in Groundwater

As discussed, sampling of monitoring wells has been conducted, but with varying degrees of success due to frozen conditions. For the determination of human health COPCs in groundwater, concentrations of parameters were conservatively screened against the GCDWQ or similar standards/guidelines protective of potable water (even though the Site is considered non-potable) to address the potential for incidental exposures.

Concentrations of parameters in groundwater generally met the selected groundwater screening levels; however, the following exceedances were noted. Concentrations of cobalt in groundwater samples collected in July 2017 (0.013 mg/L) and August 2018 (0.005 mg/L) from monitoring well MW1 exceeded the HHSL (0.003 mg/L). Concentrations of lead in groundwater samples collected in July 2017 (0.144 mg/L) and August 2018 (0.039 mg/L) from monitoring well MW1 exceeded the HHSL (0.010 mg/L). The concentration of vanadium in the groundwater sample collected in August 2018 (0.013 mg/L) from monitoring well MW1 exceeded the HHSL (0.0062 mg/L). Groundwater analytical data considered in this HHRA are summarized and presented in Table 2. A summary of the human health screening results for identified COPCs in groundwater is presented in Table 2. As presented in Table 2, the concentration of lead in groundwater exceeded the applicable screening guidelines during two sampling events, both at monitoring well MW1 (the only monitoring well that could effectively be sampled).

**Table 2 Hazards Identification in Groundwater – Human Health Screening**

| COPC | Maximum Measured Concentration in Groundwater [1] (mg/L) | Human Health Screening Level [2] (mg/L) | Exceedance Location(s) |
|---|---|---|---|
| Cobalt | 0.0103 | 0.003 | Monitoring Well MW1: eastern boundary of LTU1. Samples collected during both the 2017 and 2018 Environmental Monitoring Programs. |
| Lead | 0.144 | 0.010 | |
| Vanadium | 0.013 | 0.0062 | Monitoring Well MW1: eastern boundary of LTU1. Sample collected during the 2018 Environmental Monitoring Program. |

NOTES:
1. Concentrations in groundwater are based on Arcadis (2017) and Stantec (2019a).
2. As discussed in Section 5.2.

Groundwater at the Site and in the surrounding area is not used for drinking water, nor is groundwater extracted for other uses. No buildings are present at the Site. Therefore, the only potential pathway for human exposure to chemicals in groundwater is through potential migration of the groundwater to the surface. However, due to predominantly frozen conditions in monitoring wells (area is subject to continuous permafrost), this potential is deemed to be low. Furthermore, groundwater analytical data were conservatively screened using the GCDWQ or similar standards/guidelines protective of potable water even though potential for exposure to groundwater is considered to be negligible.

#### 7.1.1.3 COPCs in Surface Water

Surface water samples have been collected as part of previous investigations from surface water accumulations located in proximity to the LTUs. These surface water accumulations appear to be transient in nature, with changing locations and appearances according to previous field investigations.

For the determination of human health COPCs in surface water, concentrations of parameters were conservatively screened against the GCDWQ or similar standards/guidelines protective of potable water to assess potential incidental exposures. Surface water accumulations would not be used as a source of drinking water.

Concentrations of parameters in surface water generally met the selected surface water screening levels, with the exception of PHC F2 and lead. Concentrations of PHC F2 in two surface water samples did not meet the selected HHSL (concentrations ranging from <0.10 to 0.37 mg/L compared to the MECP 0.30 mg/L), and concentrations of lead in various surface water samples did not meet the selected HHSL (concentrations ranging from <0.00020 mg/L to 0.034 mg/L compared to the GCDWQ of 0.010 mg/L). Surface water analytical data considered in this HHRA are summarized and presented in Table 3. A summary of the human health screening results for identified COPCs in surface water is presented in Table 3.

**Table 3 Hazards Identification in Surface Water – Human Health Screening**

| COPC | Maximum Measured Concentration in Surface Water [1] (mg/L) | Human Health Screening Level [2] (mg/L) | Exceedance Location(s) |
|---|---|---|---|
| PHC F2 | 0.37 | 0.3 | Surface water accumulations in proximity of the LTUs. Samples collected during the 2018 Environmental Monitoring Program. |
| Lead | 0.034 | 0.010 | Surface water accumulations in proximity of the LTUs. Samples collected during both the 2017 and 2018 Environmental Monitoring Programs. |

NOTES:
1. Concentrations in surface water are based on Arcadis (2017) and Stantec (2019a).
2. As discussed in Section 5.3.

Surface water analytical data were conservatively screened using the GCDWQ even though the surface water accumulations would not be used as a continuous source of drinking water. While incidental dermal exposure is possible, exposure is expected to be low and infrequent, and use of drinking water guideline/standards based on continuous drinking water supply is very conservative.

### 7.1.2 Receptor Identification

To determine the potentially unacceptable health risk from exposures at an impacted site, it is important to determine the characteristics of the human receptors that might be exposed to the hazards present on the Site. The human receptors considered in this HHRA for the Site are as follows:

- Site is generally vacant, with four LTUs and random debris, but without a building. The potential human receptors who may be most affected by the potential hazards present at the Site were identified to be an adult remediation worker conducting work near or at the LTUs. For the purposes of this evaluation, it was assumed that the adult remediation worker would be exposed to soil at the site for 10 hours a day, 5 days per week, 48 weeks per year consistent with the industrial land use scenario assumptions (HC, 2012).

### 7.1.3 Exposure Pathway Assessment

The exposure assessment evaluates the likelihood that the potential hazards can come into contact with the human receptors expected to be present at the Site. The likelihood of exposure is determined through consideration of the properties of individual hazards that control chemical mobility, and the various pathways through which the hazard could move to contact the receptor, or through which the receptor could move to contact the hazard. The exposure analysis also considers the possible mechanisms through which a hazard can be introduced to a human receptor (i.e., ingestion, dermal contact, inhalation).

Exposure pathways are used to describe how a substance could move from the impacted media (e.g., soil, water, etc.) to a point where it can come into contact with the human body. Only those pathways for which there is a reasonable potential for exposure were considered quantitatively in this risk assessment. The likelihood of exposure includes consideration of the duration and frequency of exposure to COPCs. The exposure scenarios that were considered for human receptors at the Site include:

- Ingestion/dermal contact with soil;
- Inhalation/ingestion/dermal contact with dust;
- Ingestion/dermal contact with surface water;
- Ingestion/dermal contact with groundwater;
- Ingestion of vegetation or garden produce grown in impacted soil or irrigated with impacted groundwater; and
- Inhalation of vapors (indoor and outdoor).

The relevant exposure pathways for the Site are summarized in Table 4. This includes the qualitative evaluation and whether the pathway requires further assessment. The evaluation of exposure considered the duration and frequency of exposure to each potential hazard and relative concentrations to which the receptor is likely to be exposed. Those hazard-exposure-receptor combinations considered to have the highest likelihood to contribute a health risk were carried forward for further quantitative analysis. However, based on qualitative evaluation, no exposure pathways were identified as requiring further assessment.

**Table 4 Potential Exposure Scenarios for Human Receptors at the Site**

| Exposure Pathway Description (On-site and Off-site) | Likelihood of Exposure | Carried Forward in HHRA? | Justification |
|---|---|---|---|
| Ingestion of soil<br>Dermal contact with soil<br>Ingestion of dust<br>Dermal contact with dust | Possible | No | Although the identified receptor may come into contact with surface soil, no COPCs were identified in LTU soil at the Site (i.e., maximum concentrations were less than HHSLs). As such, this exposure pathway is not considered further in the HHRA. |
| Ingestion of surface water | Unlikely | No | Although receptors at the Site may come into contact with surface water with concentrations of PHC F2 and lead above drinking water guidelines, surface water accumulations would not be used a |

**Table 4 Potential Exposure Scenarios for Human Receptors at the Site**

| Exposure Pathway Description (On-site and Off-site) | Likelihood of Exposure | Carried Forward in HHRA? | Justification |
|---|---|---|---|
| Dermal contact with surface water | | | continuous source of drinking water. Incidental ingestion and dermal contact may be possible, but this would be limited due to generally frozen conditions and the transient nature of the surface water accumulations. Therefore, exposures are considered negligible and this exposure pathway is not considered further in the HHRA. |
| Ingestion of groundwater | Very Unlikely | No | No groundwater on or near the Site is used for drinking, showering or irrigation. Therefore, this exposure pathway is not considered further in the HHRA. |
| Dermal contact with groundwater | | | |
| Ingestion of vegetation/garden produce grown in impacted soil | Very Unlikely | No | The site is located within airport property. It is also adjacent to a historical landfill and immediately adjacent to the municipal waste storage area. It is unlikely that edible produce would be grown at this Site. Therefore, this exposure pathway is not considered further in the HHRA. |
| Ingestion of vegetation/garden produce irrigated with impacted groundwater. | | | |
| Inhalation of vapours (outdoors) | Possible | No | Inhalation of vapours in outdoor air is not considered to be a concern due to the high potential for dilution. Therefore, this exposure pathway is not considered further in the HHRA. |
| Inhalation of vapours (indoors) | None | No | No buildings are present at the Site. Therefore, this exposure pathway is not considered further in the HHRA. |

## 7.2 CONCEPTUAL SITE MODEL

Based on the exposure pathway assessment, no exposure pathways were identified as requiring further assessment. As such, a CSM for human health exposure was not developed.

## 7.3 SUMMARY OF PROBLEM FORMULATION

Based on the comparison of measured soil, groundwater, and surface water concentrations to selected human health screening levels as well as the exposure pathway assessment, potential unacceptable risks are not anticipated for human receptors at the Site.

# 8.0 ECOLOGICAL RISK ASSESSMENT

The purpose of this ERA is to evaluate the potential that ecological receptors (i.e., mammals, birds, plants, soil invertebrates, fish and benthic invertebrates) may experience toxicologically induced changes in health because of exposure to chemicals found at the Site. The ERA process follows a widely recognized framework that progresses from a qualitative initial problem formulation step, through exposure and toxicity assessments. The process culminates in a quantitative (and qualitative) risk characterization, including an evaluation of the uncertainties that are inherent in the risk assessment process. The risk assessment methodology for this ERA follows guidance from the following documents:

- Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance (Environment Canada, 2012);
- Framework for Ecological Risk Assessment, General Guidance (CCME, 1996a); and
- Framework for Ecological Risk Assessment, Technical Appendices (CCME, 1997).

## 8.1 PROBLEM FORMULATION

The objective of the Problem Formulation is the development of a focused understanding of which substances constitute COPCs, what ecological receptors are likely to be present at the Site, and how COPCs migrate from the source(s) and ultimately reach, and are taken up by, the ecological receptors at the Site. This information is usually summarized in an ecological CSM, which provides a visual depiction of the relevant pathways linking COPCs in various environmental media to the ecological receptors of interest in the ERA. However, as no pathways were identified as requiring further assessment, a CSM for ecological exposure was not developed.

### 8.1.1 Identification of COPCs

COPCs for ecological health were identified by screening the reported chemical concentrations in soil, groundwater, and surface water against applicable ecological health-based guidelines. Ecological health screening levels were selected based on the approach outlined in Section 5.0 (Regulatory Framework). Pathway-specific information for each individual chemical was reviewed to confirm ecological health screening levels from the guidelines listed in Section 5.1 (Soil), Section 5.2 (Groundwater), and Section 5.3 (Surface Water).

Other than the four LTUs and random debris, the Site is vacant without buildings or features of interest. The closest permanent surface water body to the Site is Allen Bay, located approximately 1.3 km west of the Site. Based on the location of the Site and site activities, an agricultural (or equivalent) land use scenario assuming coarse-grained soil was considered to screen soil and groundwater data as part of the ERA because agricultural land use guidelines also consider soil and food ingestion pathways, in addition to ecological soil contact.

Some metals that have a low inherent toxicity and/or that are associated with sea spray (e.g., aluminum, boron, bismuth, calcium, iron, lithium, magnesium, manganese, phosphorus, potassium, rubidium, sodium, and strontium) were excluded from evaluation and were not carried forward in the ERA. Additionally, general chemistry parameters (e.g., hardness, conductivity), and parameters with limited toxicological information which were not detected (e.g., uncommon PAHs) were not carried forward in the ERA. Some COPC-pathway combinations were not available due to their limited interaction (e.g., soil screening level protection of water pathways were not available for parameters with low solubility, such as heavier petroleum hydrocarbons PHC F3 and F4).

A description of the screening process and corresponding results is provided in Section 7.1.1.1 for soil, in Section 7.1.1.2 for groundwater, and in Section 8.1.1.3 for surface water.

#### 8.1.1.1 COPCs in Soil

For the determination of ecological COPCs in soil, concentrations of BTEX, PAH, and metal parameters were screened against the lowest applicable ecological health guideline from the CCME Canadian Soil Quality Guidelines for the Protection of Ecological Health (CCME, 2018). For PHCs, concentrations were screened against the lowest applicable ecological guideline from the CWS for PHCs in Soil (CCME, 2008).

Ecological screening levels used for the Site include those protective of ecological direct contact/ingestion and the protection of groundwater for aquatic life (PGWAL). As per CCME (2006) guidance, soil samples from grade to 1.5 m below ground surface are considered surface soil. The same two soil stratigraphies as that of the HHRA approach were considered in the evaluation of potential exposure pathways and applicable screening levels selection: shallow soil (<0.45 m) and deeper soil (≥0.45 m).

Concentrations exceeding the selected soil screening levels were not identified in shallow soil samples collected from LTUs at the Site for the ecological health direct exposure (soil ingestion/contact) and protection of groundwater for aquatic life pathways considered.

Concentrations of parameters in deeper soils generally met the selected soil screening levels, with some exceptions. Exceedances in deeper soils (≥0.45 m) included:

- Benzene concentrations ranged from <0.0050 to 1.3 mg/kg and exceeded the ESL for PGWAL (1 mg/kg) in one sample;
- Toluene concentrations ranged from <0.020 to 25 mg/kg and exceeded the ESL for PGWAL (0.1 mg/kg) in five samples, including a field duplicate;
- Xylenes concentrations ranged from <0.04 to 150 mg/kg and exceeded the ESL for soil ingestion/contact (95 mg/kg) in one sample, and the ESL for PGWAL (37 mg/kg) in three samples;
- PHC F1 concentrations ranged from <10 to 4,100 mg/kg and exceeded the ESL for soil ingestion/contact (210 mg/kg) in eight samples, including one field duplicate, and the ESL for PGWAL (1,800 mg/kg) in two samples;
- PHC F2 concentrations ranged from 210 to 5,100 mg/kg and exceeded the ESL for soil ingestion/contact (150 mg/kg) in 13 samples, including three field duplicates, and the ESL for PGWAL (600 mg/kg) in nine samples, including two field duplicates;
- PHC F3 concentrations ranged from 120 to 1,000 mg/kg and exceeded the ESL for soil ingestion/contact (300 mg/kg) in eight samples, including two field duplicates;
- Fluorene concentrations ranged from 0.20 to 0.51 mg/kg and exceeded the ESL for PGWAL (0.25 mg/kg) in two samples;
- Naphthalene concentrations ranged from <0.5 to 16 mg/kg and exceeded the ESL for soil ingestion/contact (8.8 mg/kg) in one sample, and the ESL for PGWAL (0.013 mg/kg) in five samples, including one field duplicate; and
- Phenanthrene concentrations ranged from 0.044 to 0.58 mg/kg and exceeded the ESL for PGWAL (0.046 mg/kg) in five samples, including one field duplicate.

No exceedances of the ESLs were identified for metals. Soil analytical data considered in this ERA are summarized and presented in Table 5. A summary of the ecological risk screening results for identified COPCs in soil is presented in Table 5. These COPCs were carried forward for in the problem formulation.

### Table 5 Hazards Identification in Soil – Ecological Health Screening

| COPC | Maximum Measured Concentration in Soil [1] (mg/kg) | ESL for soil ingestion/contact (mg/kg) [2] | ESL for PGWAL [2] (mg/kg) | Exceedance Location(s) |
|---|---|---|---|---|
| ***Shallow Soils (<0.45 m)*** | | | | |
| None Identified. | N/A | N/A | N/A | N/A |
| ***Deeper Soils (≥0.45 m)*** | | | | |
| Benzene | **1.3** | 31 | **1** | Soil samples collected from both LTU1 and LTU2.<br><br>Highest concentrations and most frequent exceedances encountered in soil samples collected at depth (≥0.45 m) from both LTUs. |
| Toluene | **25** | 75 | **0.1** | |
| Xylenes | **150** | **95** | **37** | |
| PHC F1 | **4,100** | **210** | **600** | |
| PHC F2 | **5,100** | **150** | N/A | |
| PHC F3 | **1,000** | **300** | N/A | |
| Fluorene | **0.51** | 15.4 | **0.25** | |
| Naphthalene | **16** | **8.8** | **0.013** | |
| Phenanthrene | **0.58** | 43 | **0.046** | |

NOTES:
1. Concentrations in soil are based on Arcadis (2016) and Stantec (2019a).
2. As discussed in Section 5.1.
   N/A = Not Available
   **Bold** indicates exceedances of ESL.

#### 8.1.1.2 COPCs in Groundwater

Although monitoring wells have been completed as part of previous investigations, groundwater collection has presented several challenges due to frozen conditions. As such, results are only available for two samples collected from the same monitoring well (MW1): one collected as part of the 2017 Environmental Monitoring Program (Arcadis, 2017) and the other collected as part of the 2018 Environmental Monitoring Program (Stantec, 2019a).

For the determination of ecological COPCs in groundwater, concentrations of BTEX, PAH, and metal parameters were screened against the guidelines/standards protective of aquatic biota exposed to contaminants from migration of contaminated groundwater to surface water (as discussed in Section 5.2).

Concentrations of parameters in groundwater generally met the selected groundwater screening levels, with some exceptions. Exceedances identified included:

- Aluminum concentrations ranged from 5 to 8.1 mg/L and exceeded the ESL (0.1 mg/L) in both samples;
- Cadmium concentrations ranged from 0.00078 to 0.00237 mg/L and exceeded the ESL (0.000017 mg/L) in both samples;
- Chromium concentrations ranged from 0.010 to 0.016 mg/L and exceeded the ESL (0.0089 mg/L) in both samples;
- Copper concentrations ranged from 0.0085 to 0.00223 mg/L and exceeded the ESL (0.0039 mg/L) in both samples;

- Iron concentrations ranged from 7.40 to 9.99 mg/L and exceeded the ESL (0.3 mg/L) in both samples;
- Lead concentrations ranged from 0.039 to 0.144 mg/L and exceeded the ESL (0.0067 mg/L) in both samples;
- Silver concentrations ranged from <0.00010 to 0.00050 mg/L and exceeded the ESL (0.0001 mg/L) in the 2016 sample;
- Titanium concentrations ranged from 0.077 to 0.15 mg/L and exceeded the ESL (0.1 mg/L) in the 2018 sample; and
- Zinc concentrations ranged from 0.110 to 0.297 mg/L and exceeded the ESL (0.03 mg/L) in both samples.

No exceedances of the ecological screening levels were identified for PHCs and PAHs. Groundwater analytical data considered in this ERA are summarized and presented in Table 6. A summary of the ecological risk screening results for identified COPCs in groundwater is presented in Table 6. These COPCs were carried forward for in the problem formulation.

**Table 6 Hazards Identification in Groundwater – Ecological Health Screening**

| COPC | Maximum Measured Concentration in Groundwater [1] (mg/L) | Ecological Screening Level [2] (mg/L) | Exceedance Location(s) |
|---|---|---|---|
| Aluminum | 8.7 | 0.1 | Monitoring Well MW1: eastern boundary of LTU1<br>Exceedances for Al, Cd, Cr, Cu, Fe, Pb, and Zn in both 2016 and 2017 samples.<br>Exceedance for Ag only in the 2016 sample.<br>Exceedance for Ti only in the 2018 sample. |
| Cadmium | 0.00237 | 0.000017 | |
| Chromium | 0.016 | 0.0089 | |
| Copper | 0.0223 | 0.0039 | |
| Iron | 9.99 | 0.3 | |
| Lead | 0.144 | 0.0067 | |
| Silver | 0.00050 | 0.0001 | |
| Titanium | 0.15 | 0.1 | |
| Zinc | 0.297 | 0.03 | |

NOTES:
1. Concentrations in groundwater are based on Arcadis (2017) and Stantec (2019a).
2. As discussed in Section 5.2.

#### 8.1.1.3 COPCs in Surface Water

Surface water samples have been collected as part of previous investigations from surface water accumulations located in proximity to the LTUs. For the determination of ecological COPCs in surface water, concentrations of BTEX, PAH, and metal parameters were screened against guidelines/standards protective of aquatic biota exposed to contaminants from migration of contaminated groundwater to surface water (as discussed in Section 5.3).

Concentrations of parameters in surface water generally met the selected surface water screening levels, with some exceptions. Exceedances identified included:

- PHC F2 concentrations ranged from <0.10 to 0.37 mg/L and exceeded the ESL (0.17 mg/L) in three samples;
- Lead concentrations ranged from <0.00020 to 0.034 mg/L and exceeded the ESL (0.0067 mg/L) in several samples, including field duplicates;
- Nitrate (as N) concentrations ranged from <0.02 to 4.6 mg/L and exceeded the ESL (3 mg/L) in one sample; and

- Phenols concentrations ranged from <0.0010 to 0.023 mg/L and exceeded the ESL (0.004 mg/L) in several samples, including field duplicates.

No exceedances of the ecological screening levels were identified for PAHs. Surface water analytical data considered in this ERA are summarized and presented in Table 7. A summary of the ecological risk screening results for identified COPCs in surface water is presented in Table 7. These COPCs were carried forward for in the problem formulation.

**Table 7 Hazards Identification in Surface Water – Ecological Health Screening**

| COPC | Maximum Measured Concentration in Surface Water [1] (mg/L) | Ecological Screening Level [2] (mg/L) | Exceedance Location(s) |
|---|---|---|---|
| PHC F2 | 0.37 | 0.17 | Surface water accumulations in proximity of the LTUs.<br>Exceedances for PHC F2 and nitrate for 2018 samples.<br>Exceedances for Pb and phenols in 2017 and 2018 samples. |
| Lead | 0.034 | 0.002 | |
| Nitrate | 4.6 | 3 | |
| Phenols | 0.023 | 0.004 | |

NOTES:
1. Concentrations in surface water are based on Arcadis (2017) and Stantec (2019a).
2. As discussed in Section 5.3.

### 8.1.2 Receptor Identification

The following ecological receptors have the potential to be exposed to impacted media at the Site:

- Vegetation including lichens and mosses;
- Soil organisms and terrestrial wildlife (birds and mammals); and
- Aquatic receptors (benthic macroinvertebrates, fish, and plants) in nearby Allen Bay or McMaster River.

The Site is located on the west side of Cornwallis Island, Nunavut, approximately 2 km north of the Resolute Bay Airport runway, and approximately 7 km northeast of the town of Resolute Bay. Species at risk identified on Schedule 1 of the *Species at Risk Act* (*SARA*) and potentially present on Cornwallis Island include the wolverine (*Gulo gulo*), the Ross's gull (*Rhodostethia rosea*), the Red knot rufa and islandica subspecies (*Calidris canutus rufa* and *Calidris canutus islandica*), the polar bear (*Ursus maritimus*), the Peary caribou (*Rangifer tarandus pearyi*), and the Ivory gull (*Pagophila eburnea*).

Site surfaces are mainly barren with little vegetative cover found generally in localized surface depressions. With the exception of the four LTUs constructed on Site, the Site is generally vacant. Birds (e.g., ducks and geese) and mammals (e.g., polar bears, foxes, and ungulates) would not be expected to spend an extended amount of time in the area of potential soil impacts because the Site lacks features of interest for wildlife. Furthermore, the potential exposure of birds and mammals to impacted soil is deemed low since the LTUs are enclosed by liners and berms (including a portion of LTU2 capped with geosynthetic liner). Should the integrity of the liners and berms be compromised, additional exposure for terrestrial wildlife may be expected; however, potential exposures would still be considered relatively small owing to the small areal extent of the LTUs relative to the home ranges of most bird and mammal species that may be expected to frequent the area. Furthermore, as mentioned previously, the Site is generally vacant and without features that would be expected to attract wildlife. Potential exposures to water are also considered low since the site is located within an arctic desert, with low precipitation and high evaporation rates, resulting in transient surface water accumulations. These exposure pathways are further considered and discussed in Section 8.1.3.

The Site is located approximately 1.3 km east of Allen Bay (permanent waterbody) and approximately 800 m south of McMaster River (appears to be an ephemeral watercourse). However, the potential for groundwater migration and discharge to the bay or river is considered low because the area is subject to continuous permafrost and because of their respective distances from the Site.

### 8.1.3 Exposure Pathway Assessment

For COPCs to have deleterious effects, they need to have access to the organism or receptor. The route by which this occurs is referred to as an exposure pathway and is dependent on the nature of both the chemical and receptor. A complete exposure pathway is one that meets the following four criteria:

- Source of COPC must be present;
- Transport mechanisms and media must be available to move the chemicals from the source to the ecological receptors;
- Opportunity must exist for the ecological receptors to contact the affected media; and
- Means must exist by which the chemical is taken up by ecological receptors, such as direct contact, ingestion or inhalation.

The potential ecological exposure pathways applicable at the Site are summarized in Table 8 which includes the qualitative evaluation of each pathway and a justification for the likelihood of the assigned exposure.
Those hazard-exposure-receptor combinations considered to have the highest likelihood of contributing to an ecological health risk were considered further. However, based on qualitative evaluation, no exposure pathways were identified as requiring further assessment.

**Table 8 Potential Exposure Scenarios for Ecological Receptors at the Site**

| Exposure Pathway Description | Likelihood of Exposure | Carried Forward for Analysis? | Justification |
|---|---|---|---|
| Ingestion of soil | Unlikely | No | The areas investigated included four LTUs which are protected using liners and berms, thereby limiting potential exposure for ecological receptors. Although loss of integrity of the LTUs may provide some potential exposure, this would still be considered small and would be rectified by repairing the liners and berms. Therefore, this exposure pathway was not considered further in the ERA. |
| Dermal contact with soil | | | |

**Table 8 Potential Exposure Scenarios for Ecological Receptors at the Site**

| Exposure Pathway Description | Likelihood of Exposure | Carried Forward for Analysis? | Justification |
|---|---|---|---|
| Direct contact with shallow groundwater | Unlikely | No | While it is possible for vegetation and soil organisms to be exposed to shallow groundwater, this potential exposure pathway is deemed limited due to the continuous permafrost in the area. Therefore, this exposure pathway was not considered further in the ERA. |
| Groundwater migration and discharge to downgradient watercourses (Allen Bay and McMaster River) | Unlikely | No | There is potential for groundwater migration and discharge to Allen Bay and McMaster River. However, Allen Bay is located approximately 1.3 km west of the Site, while McMaster River is located approximately 800 m north of the Site. The potential for groundwater migration and discharge to the bay or river is considered low because the area is subject to continuous permafrost and because of their respective distances from the Site. Dispersion and biodegradation coupled with continuous permafrost encountered in the area of the Site limits this pathway. Therefore, this exposure pathway was not considered further in the ERA. |
| Ingestion of terrestrial invertebrates, vegetation, or small animal prey living at the Site and exposed to contaminated soil | Unlikely | No | Impacted soil are located in the LTUs which are protected with liners and berms. Therefore, food items are not expected to be exposed to impacted soil. This exposure pathway was not considered further in the ERA. |
| Ingestion of fresh water, sediments, plants, invertebrates or fish | Unlikely | No | There is potential for groundwater migration and discharge to Allen Bay and McMaster River. However, as mentioned, the potential for groundwater migration and discharge to the bay or river is considered low. Although surface water was located in closer proximity to the LTUs, this was limited to transient surface water accumulations which would not sustain aquatic communities. Therefore, this exposure pathway was not considered further in the ERA. |
| Dermal contact with fresh water or sediments | | | |

## 8.2 CONCEPTUAL SITE MODEL

Based on the exposure pathway assessment, no exposure pathways were identified as requiring further assessment. As such, a CSM for ecological exposure was not developed.

## 8.3 SUMMARY OF PROBLEM FORMULATION

Based on the comparison of measured soil, groundwater, and surface water concentrations to selected ecological health screening levels as well as the exposure pathway assessment, potential unacceptable risks are not anticipated for ecological receptors at the Site provided that the integrity of the liners and berms protecting the LTUs is maintained.

# 9.0 UNCERTAINTY ASSESSMENT

Sources of uncertainty associated with the Problem Formulation tend to focus on the following:

- Data limitations.
- Identification of relevant COPCs
- Identification of appropriate human and ecological receptors
- Identification of appropriate exposure pathways

The quality of a risk assessment calculation often hinges on the size, extent and quality of the data. The time available for collection of data precluded consideration of fluctuations in measured concentrations due to daily or seasonal influences. Because no exposure pathways were identified as complete or operable, sufficient site-specific data have been collected to complete the PQHHERA. However, should site conditions or land uses change (e.g., loss of integrity of the LTUs liners and berms, or construction of a building of at the Site), the results of the risk assessment may need to be revisited to assess/confirm that there are no additional or increased risks to potential receptors.

The primary concern regarding the selection of COPCs is that relevant chemicals will have been overlooked and thus omitted from consideration within the risk assessment. This concern was addressed through investigation of the Site that focused on the historical land-use and how these activities might have led to environmental contamination. Based on this information, sampling programs were designed to target areas expected to contain the highest levels of chemicals that might be in the soil associated with the Site. Based on the effort associated with the Site characterization, the data used to quantify the potential environmental contamination and identify COPCs was considered to be suitable for the Site.

The potential uncertainty associated with the identification of COPCs was further addressed using a conservative screening approach. For the COPC screening, the environmental concentrations were represented using the maximum reported concentrations from the available data and these were compared to environmental quality standards that were identified from established regulatory authorities and chosen to be protective, and sometimes overly conservative, of relevant endpoints for human and ecological receptors. As noted in Section 4.0, assessment of PFAS compounds was not included in this scope of work as guidelines for the assessment and risk management for PFAS compounds on federal airport properties continue to evolve.

Human and ecological receptors were selected based on the historical and current nature of the site. Review of previous investigations carried out at the site as well as review of available site and aerial photography were conducted to support the selection of appropriate receptors. Therefore, the potential uncertainty associated with the identification of appropriate human and ecological receptors is considered low as the receptors that were selected are known to be present or can reasonably be expected to be present on the site.

The uncertainty associated with the selection of human and ecological exposure pathways stems from the potential to omit a relevant pathway that would subsequently undermine the accuracy of the predicted exposure. To address this, a standard and accepted list of exposure pathways was evaluated and screened for their relevance to the receptors, chemicals, and environmental media. Therefore, the probability that a pathway was missed or omitted was not considered to be a concern.

# 10.0 MANAGEMENT LIMITS

PHC management limits are normally considered relevant at all sites. These management limits, which include consideration of factors such as free phase formation, fire and explosive hazards, effects on buried infrastructure, aesthetic concerns, and exposure of workers in excavations and trenches, cannot be adjusted or omitted at Tier 2 (CCME, 2008). Regardless of the results of any Tier 2 adjustment, the presence of free phase hydrocarbons, aesthetic concerns from PHC contamination, and any observed effects on buried utilities and other infrastructure must be addressed (CCME, 2008).

A summary of the Site maximum concentrations, management limits, and sample locations exceeding management limits is provided in Table 9.

**Table 9 Evaluation of PHC Management Limits**

| PHC Fraction | Maximum Concentration (mg/kg) | Management Limit (mg/kg) | Number of Samples Exceeding Management Limit |
|---|---|---|---|
| F1 | 4,100 | 700 | 4 |
| F2 | 5,100 | 1,000 | 6 |
| F3 | 1,000 | 3,500 | none |

The maximum concentrations of PHC F1 and PHC F2 detected in LTU soil at the Site exceed the applicable Management Limits.

The management limit is provided to include the effects of free phase formation, exposure of workers in trenches to petroleum hydrocarbon vapours, fire and explosive hazards, effects on buried infrastructure and aesthetic considerations. Each of these effects has been considered for this assessment, as follows:

**Formation of Free Phase**—Free product was not observed at any sample location. As a result, the potential for substantive free product is considered to be low.

**Exposure of Workers in Trenches to Petroleum Hydrocarbon Vapours**—Limits of 800 mg/kg, 1,000 mg/kg, and 3,500 mg/kg for F1, F2, and F3 fractions respectively, are deemed protective of adverse effects on workers in trenches. Stantec understand that there are no plans for development of the Site; therefore, the potential for trench construction is considered minimal. In the event that trench excavation is to occur at the Site in the future, an appropriate health and safety plan should be developed and implemented.

**Fire and Explosive Hazards**—Concentrations of PHC exceeding the Management Limit primarily represent fuel. Neither F2 nor F3 are considered explosive hazards. PHC F1 exceedances are located at depth (≥0.45 m). Therefore, fire and explosive hazards are not considered an issue at this Site.

**Effects on Buried Infrastructure**—Significant underground infrastructure is not known to be present in the vicinity of the Site (e.g., buried utilities), and Stantec understands that installation of buried infrastructure is not being considered for the foreseeable future; therefore, adverse effects on buried infrastructure are not considered an issue at this Site.

**Aesthetic Considerations**—The impacted soil is located within two visible LTUs. Impacts were not reported to present an odour concern.

**Technological Factors**—Bioremediation is presently the preferred technology for dealing with PHC contamination of soils; however, addressing F3 is the major challenge for bioremedial systems. As a result, the CCME established the management limit of 3,500 mg/kg for F3 in coarse-grained soil on residential sites. This management limit considers the toxic risks to plants and soil invertebrates, aesthetics, effects on infrastructure and bioremedial capabilities. No exceedances were identified for the F3 management limit; therefore, technological factors are not considered an issue at this Site.

Based on the above, effects associated with management limit exceedances in soils at the Site are considered minimal.

# 11.0 CONCLUSIONS

Stantec was retained by PSPC to conduct a PQHHERA for the LTUs located at the Resolute Bay Airport on Cornwallis Island, Nunavut. The purpose of the PQHHERA was to review the information available from previous and current environmental investigations perform a preliminary quantitative evaluation of the potential for human and ecological risks associated with COPCs at the Site. Based on the PQHHERA, Stantec provides the following conclusions:

- A soil sampling program completed in 2015 by Arcadis (2016) confirmed that PHC concentrations exceeded applicable environmental guidelines in the LTU soils.
- An operating licence for the historical LTUs (LTU1 and LTU2) was obtained by Transport Canada through the NWB in 2015 and requires annual groundwater monitoring.
- Monitoring wells have been installed, monitored and sampled as part of previous investigations, with varying degree of success due to frozen conditions. Of the six existing monitoring wells, groundwater sampling has only been completed at one (MW1) on two occasions: one groundwater sample was collected as part of the 2017 Environmental Monitoring Program, while the other sample was collected as part of the 2018 Environmental Monitoring Program. Surface water samples were also collected from nearby surface water accumulations during both monitoring programs in an attempt to supplement the water data and compensate for the limited number of groundwater samples for this Site.
- Additional soil samples were collected from the LTUs during the 2018 Environmental Monitoring Program to assess PHC concentrations closer to the surface, as well as to obtain PHC fractionation information should HHERA calculations be required.
- Assessment of PFAS compounds was not included in this scope of work.
- Based on the HHRA problem formulation, potential unacceptable risks are not anticipated for human receptors at the Site. COPCs were not identified in LTU soil. Although COPCs were identified in groundwater and surface water based on the use of drinking water guidelines as screening levels, potential exposures to groundwater and surface water are considered limited. Thus, substantive site-related health risks to human health were not identified. Hence risk management for human receptors is not required.
- Based on the ERA problem formulation, potential unacceptable risks are not anticipated for ecological receptors at the Site. As the area is subject to continuous permafrost and liners and berms are in place at the LTUs to limit

potential exposure. COPCs were not identified in shallow soil (<0.45m) in the LTUs at the Site. In deeper soil (≥0.45 m), COPCs for the direct/contact ingestion pathway included xylenes, PHC fractions, and naphthalene. For the protection of groundwater for aquatic life, COPCs in deeper soil included benzene, toluene, xylenes, PHC fractions, fluorene, naphthalene, and phenanthrene. COPCs in groundwater were limited to metals. COPCs in surface water included PHC F2, lead, nitrate, and phenols. However, potential exposures to soil, groundwater and surface water are considered limited. Thus, substantive site-related health risks to ecological receptors were not identified. Hence risk management for ecological receptors is not required.

# 12.0 RECOMMENDATIONS

Based on the PQHHERA conducted at Site, Stantec provides the following recommendations:

- Further risk assessment and/or risk management is not required for PHCs, PAHs, and metals found in LTU soil.
- However, should site conditions or land uses change (e.g., loss of integrity of the LTUs liners and berms, or construction of a building of at the Site), the results of the risk assessment may need to be revisited to assess/confirm that there are no additional or increased risks to potential receptors.
- Assessment PFAS compounds should be considered once additional guidance for their assessment and management are available.

# 13.0 LIMITATIONS

This report documents work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This report provides an evaluation of selected environmental conditions associated with the identified portion of the property that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Stantec at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Stantec to be correct. Stantec assumes no responsibility for any deficiency or inaccuracy in information received from others.

The opinions in this report can only be relied upon as they relate to the condition of the portion of the identified property that was assessed at the time the work was conducted. Activities at the property subsequent to Stantec's assessment may have significantly altered the property's condition. Stantec cannot comment on other areas of the property that were not assessed.

Conclusions made within this report consist of Stantec's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Stantec assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

March 31, 2019

This report is limited by the following:

- The human health and ecological risk assessment is limited to the subject Site. Assessment of off-site issues was not within the scope of work.

The locations of any utilities, buildings and structures, and property boundaries illustrated in or described within this report, if any, including pole lines, conduits, water mains, sewers and other surface or sub-surface utilities and structures are not guaranteed. Before starting work, the exact location of all such utilities and structures should be confirmed and Stantec assumes no liability for damage to them. This report was prepared by Annick St-Amand and reviewed by Tania Noble and Tanya Shanoff.

Regards,

**STANTEC CONSULTING LTD.**


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# 14.0 REFERENCES

Alberta Environment and Parks Alberta. 2019. Tier 1 Soil and Groundwater Remediation Guidelines.

Arcadis Canada Inc. March 23, 2016. Environmental Site Assessment, Resolute Bay Airport Land Treatment Units. File No. 100463-000.

Arcadis Canada Inc. December 9, 2016. 2016 Environmental Monitoring, Resolute Bay Airport Land Treatment Units. File No. 100463-001.

Arcadis Canada Inc. November 21, 2017. 2017 Environmental Monitoring Program, Resolute Bay Airport Land Treatment Units. File No. 100463-003.

Canada-Nunavut Geoscience Office and Geological Survey of Canada. 2006a. Geology of Nunavut Map.

Canada-Nunavut Geoscience Office and Geological Survey of Canada. 2006b. Surficial Materials of Nunavut Map.

CCME. 1996a. A Framework for Ecological Risk Assessment – General Guidance.

CCME. 1996b. Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada.

CCME. 1997. A Framework for Ecological Risk Assessment – Technical Appendices.

CCME. 2006. A Protocol for the Derivation of Environmental and Human Health Soil Guidelines

CCME. 2008. Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil.

CCME. 2018. Soil Quality Guidelines for the Protection of Environmental and Human Health.

CCME. 2018. Canadian Water Quality Guidelines for the Protection of Aquatic Life.

Eng-Tech Consulting Ltd. and Environmental Management Technologies Inc. November 2003. Limited Phase II Environmental Site Assessment, Resolute Bay, Nunavut, Canada. File No. 02-117-06.

Environment Canada. 2015. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites.

Environment Canada. 2012. Federal Contaminated Sites Action Plan (FCSAP), Ecological Risk Assessment Guidance, including available modules.

Franz Environmental Inc. February 1, 2010. Letter Report: Soil Sampling Program for the land treatment units (LTUs) at the Resolute Former Fire Fighting Training Area. File No. 1747-0901.

Government of Nunavut, Department of Environment. December 2014. Environmental Guideline for the Management of Contaminated Sites.

Health Canada. 2012. Federal Contaminated Site Risk Assessment in Canada Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0

Health Canada. 2010a. Federal Contaminated Site Risk Assessment in Canada Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0

Heath Canada. 2010b. Federal Contaminated Site Risk Assessment in Canada Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM)

Health Canada, 2010c. Federal Contaminated Site Risk Assessment in Canada, Part VII: Guidance for Soil Vapour Assessment at Contaminated Sites

Health Canada. 2017. Guidelines for Canadian Drinking Water Quality (GCDWQ) Summary Table.

Nunavut Water Board. August 19, 2015. NWB Water Licence No. 1BR-RLF1520.

Ontario Ministry of the Environment and Climate Change (now referred to as the Ontario MECP). 2011. Soil, Groundwater, and Sediment Standards for use under Part XV.1 of the Environmental Protection Act.

Ontario Ministry of the Environment and Climate Change (now referred to as the Ontario MECP). 2011. Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario.

Public Services and Procurement Canada. December 11, 2018. Terms of Reference (TOR) Amendment Request No. 3, Resolute Bay Airport LTU, Nunavut.

Stantec Consulting Ltd. 2019a. 2018 Environmental Monitoring Program, Resolute Bay Airport Land Treatment Unit, Cornwallis Island, Nunavut, DRAFT. File No. 110220180

Stantec Consulting Ltd. 2019b. Proposal for Amendment 3, Proposal for Consulting Services – Environmental Monitoring, Resolute Bay Airport Land Treatment Unit, Nunavut. Proposal No. 110220180

United States Environmental Protection Agency (USEPA). 2018. Regional Screening Levels, Composite Table.

# APPENDIX A
# FIGURES

# Appendix A FIGURES

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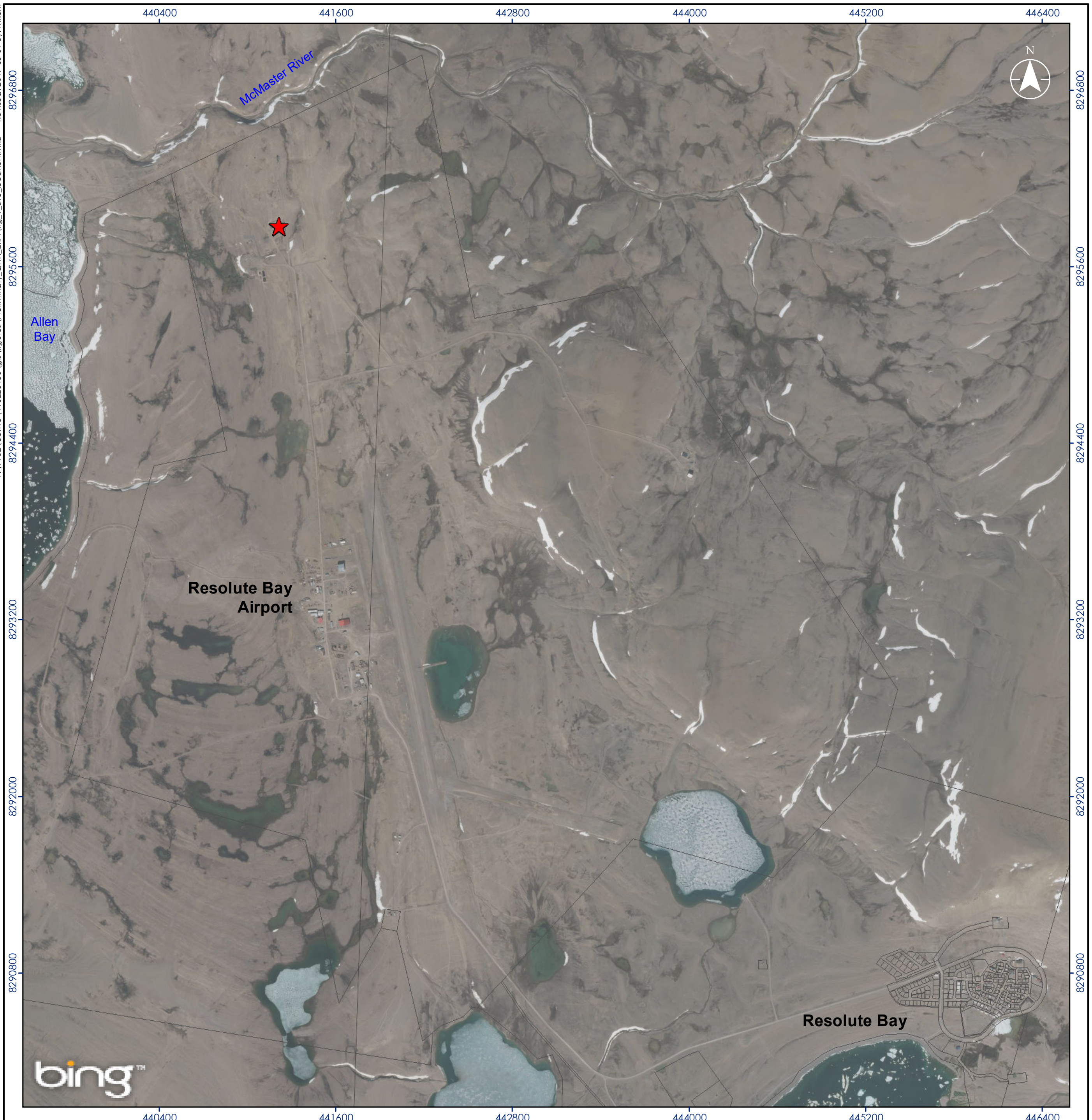


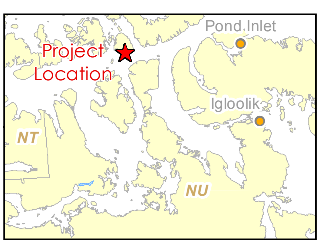


★ Site Location

☐ Land Parcel

PSPC: Public Services and Procurement Canada

0 600 1,200 metres

1:40,000 (at original document size of 8.5x11)

Stantec

Project Location
Cornwallis Island, Nunavut

110220180
Prepared by MK on 2019-03-01
Quality Review by DJ on 2019-03-31
Approved by LVN on 2019-03-31

Client/Project
PSPC for Transport Canada
Preliminary Quantitative Human Health and Ecological Risk Assessment
Resolute Bay Airport Land Treatment Unit

Figure No.
1

Title
## Site Location Plan

**Notes**
1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base features: Geogratis, ©Department of Natural Resources Canada, All rights reserved.
3. Imagery: Microsoft Bing product screen shot(s) reprinted with permission from Microsoft Corporation.
4. Parcels: Canada Lands Digital Cadastral Data,©Her Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

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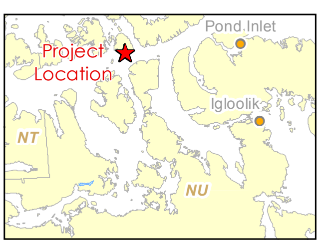


- Monitoring Well Location (Others)
- Soil Sampling Location (Stantec 2018)
- Soil Sampling Location (ARCADIS 2015)
- Surface Water Sample Location (Stantec 2018)
- Surface Water Sample Location (ARCADIS 2017)
- Potential Berm Breach (Observed August 2018)
- Land Treatment Unit (LTU)

0 15 30 metres

1:1,200 (at original document size of 8.5x11)

**Notes**

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base features: Geogratis, ©Department of Natural Resources Canada, All rights reserved.
3. Imagery: Microsoft Bing product screen shot(s) reprinted with permission from Microsoft Corporation.

^A CCME. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Freshwater.
^B Nunavut Water Board License No. 1BR-RLF1520 requirements for effluent discharged from a sump at the Landfarm Facility.
^C CCME 2008. Canada-Wide Standards for Petroleum Hydrocarbon (PHC) in Soil. Industrial Land Use. Coarse-grained soil. Excluding vapour inhalation (indoor), protection of potable groundwater, and protection of groundwater for aquatic life exposure pathways.
^D Ontario Ministry of the Enviornment and Climate Change (now referred to as the Ministry of Enviornment, Conservation, and Parks). Soil, Groundwater, and Sediment Standards for use under Part XV.1 of the Environmental Protection Act.

PSPC: Public Services and Procurement Canada

Stantec

Project Location: Cornwallis Island, Nunavut

110220180
Prepared by MK on 2019-03-01
Quality Review by DJ on 2019-03-31
Approved by LVN on 2019-03-31

Client/Project
PSPC for Transport Canada
Preliminary Quantitative Human Health and Ecological Risk Assessment
Resolute Bay Airport Land Treatment Unit

Figure No.
**2**

Title
**Historical Sampling Locations**



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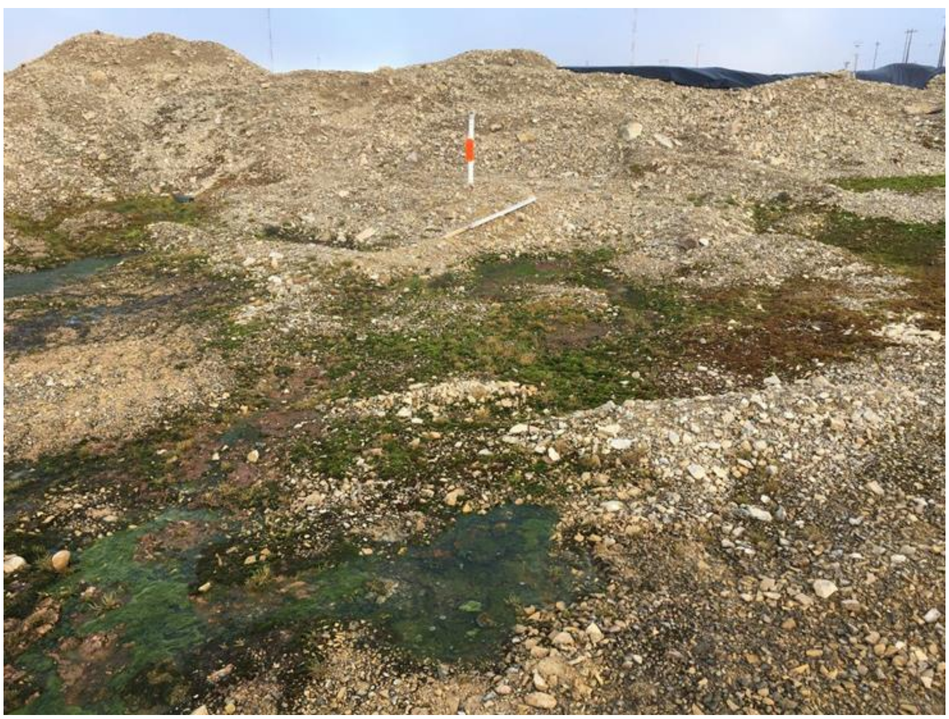
# APPENDIX B
# PHOTOGRAPHS

# Appendix B PHOTOGRAPHS

**Photograph 1: South view of potential berm breach in southwest corner of LTU 2, August 22, 2018.**

**Photograph 2: Potential berm breach along west berm of LTU 2, August 22, 2018.**

**Photograph 3: Northeast view of MW1, August 22, 2018.**



**Photograph 4: North view of SW1 (LTU 2 in background), August 25, 2018.**

**Photograph 5: North view of SW2, August 25, 2018.**

**Photograph 6: West view of SW3 (ocean in background), August 22, 2018.**

**Photograph 7: South view of SW4 (LTU 2 in background), August 25, 2018.**

**Photograph 8: North view of SW5, August 25, 2018.**

# APPENDIX C
# SCREENING AND ANALYTICAL SUMMARY TABLES

# Appendix C SCREENING AND ANALYTICAL SUMMARY TABLES

**Table C.1a - Soil Analytical Data for Resolute Bay Airport Land Treatment Unit (Shallow Soils; <0.45 m)**

| Parameter | HHSL [1] Contact/Ingestion | ESL [2] Contact/Ingestion | ESL [3] PGWAL | Concentration (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **SS2 @0.1-0.3** | **SS3 @0.1-0.3** | **SS4 @0.1-0.3** | **SS5 @0.1-0.3** | **SS6 @0.1-0.3** | **SS7 @0.1-0.3** | **SS8 @0.1-0.3** | **SS9 @0.1-0.3** | **SS10 @0.1-0.3** |
| Sampling Date | | | | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 | 22-Aug-18 |
| Depth (mbgs) | | | | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 | 0.1-0.3 |
| ***Petroleum Hydrocarbons (PHCs)*** | | | | | | | | | | | | |
| Benzene | 110 | 31 | 1 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 |
| Toluene | 82000 | 75 | 0.1 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| Ethylbenzene | 210000 | 55 | 50 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Xylenes (Total) | 560000 | 95 | 37 | <0.045 | <0.045 | <0.045 | <0.045 | <0.045 | <0.045 | <0.045 | <0.045 | <0.045 |
| F1 (C6-C10) | RES | 210 | 1800 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| F2 (C10-C16) | RES | 150 | 600 | <10 | <10 | <10 | <10 | 51 | <10 | <10 | 40 | <10 |
| F3 (C16-C34) | RES | 300 | na | <50 | <50 | <50 | <50 | 190 | <50 | <50 | <50 | <50 |
| F4 (C34-C50) | RES | 2800 | na | <50 | <50 | <50 | <50 | 110 | <50 | <50 | <50 | <50 |

Notes:

1. HHSL = Human Health Screening Level. As discussed in Section 5.1.
2. ESL = Ecological Screening Level. As discussed in Section 5.1.
3. ESL PGWAL = Ecological Screening Level for the Protection of Groundwater for Aquatic Life. As discussed in Section 5.1.

**Bold** indicates exceedances of HHSL.

Underlined indicates exceedances of ESL.

*Italics* indicates exceedances of the ESL PGWAL.

na = not applicable

RES = Residual PHC formation

**Table C.1b - Soil Analytical Data for Resolute Bay Airport Land Treatment Unit (Deeper Soils; ≥0.45 m)**

| Parameter | HHSL [1] Contact/Ingestion | ESL [2] Contact/Ingestion | ESL [3] PGWAL | Concentration (mg/kg) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LTU1-1 | LTU1-1 FD (LTU-DUP2) | LTU1-2 | LTU1-3 | LTU1-4 | LTU1-5 | LTU2-1 | LTU2-2 | LTU2-2 FD (LTU-DUP1) | LTU2-3 | LTU2-4 | SS1 @0.4-0.6 | SS1 @0.4-0.6 FD (Dup 18-01) |
| Sampling Date | | | | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Aug-18 | 22-Aug-18 |
| Depth (mbgs) | | | | 0.45 | 0.45 | 0.45 | 0.45 | 0.6 | 0.65 | 0.75 | 0.6 | 0.6 | 0.7 | 0.75 | 0.4-0.6 | 0.4-0.6 |
| ***Petroleum Hydrocarbons (PHCs)*** | | | | | | | | | | | | | | | | |
| Benzene | 110 | 31 | 1 | <0.005 | <0.01 | 0.24 | 0.25 | <0.05 | <0.03 | *1.3* | 0.2 | <0.05 | <0.005 | 0.009 | <0.0050 | <0.0050 |
| Toluene | 82000 | 75 | 0.1 | <0.02 | <0.04 | *0.2* | <0.1 | *1.8* | 0.1 | *25* | *0.5* | *0.4* | <0.02 | <0.02 | <0.020 | <0.020 |
| Ethylbenzene | 210000 | 55 | 50 | <0.01 | <0.02 | 0.09 | <0.05 | 0.4 | <0.05 | 3.6 | 0.11 | 0.2 | <0.01 | <0.01 | <0.010 | <0.010 |
| Xylenes (Total) | 560000 | 95 | 37 | <0.04 | <0.08 | 5.7 | 4.4 | *60* | 1.3 | *150* | *39* | 26 | <0.04 | 0.28 | <0.045 | <0.045 |
| F1 (C6-C10) | RES | 210 | 1800 | 170 | *230* | *530* | *830* | *2400* | *600* | *4100* | *1300* | *780* | 39 | 120 | <10 | <10 |
| F2 (C10-C16) | RES | 150 | 600 | *810* | *780* | *650* | *1800* | *5100* | *2600* | *4600* | *1600* | *2000* | 280 | 380 | 210 | 280 |
| F3 (C16-C34) | RES | 300 | na | 250 | 190 | 130 | 370 | 1000 | 660 | 830 | 330 | 330 | 120 | 250 | 570 | 650 |
| F4 (C34-C50) | RES | 2800 | na | 92 | 71 | <50 | 150 | 370 | 320 | 380 | 120 | 110 | <50 | 140 | 310 | 360 |
| ***Polycyclic Aromatic Hydrocarbons (PAHs)*** | | | | | | | | | | | | | | | | |
| B(a)P TPE | 5.3 | na | na | - | - | - | 0.0305 | - | 0.1052 | 0.0382 | 0.0074 | 0.0074 | - | - | - | - |
| Acenaphthene | 96 | 6600 | 560 | - | 0.077 | - | 0.25 | - | 0.21 | 0.28 | 0.15 | 0.14 | - | - | - | - |
| Acenaphthylene | 9.6 | ng | 0.15 | - | 0.019 | - | 0.066 | - | 0.067 | 0.084 | 0.041 | 0.04 | - | - | - | - |
| Anthracene | 42000 | 2.5 | 0.67 | - | <0.0050 | - | 0.023 | - | 0.054 | 0.052 | 0.011 | 0.011 | - | - | - | - |
| Benzo(a)anthracene | 0.96 | 6.2 | saturation | - | <0.0050 | - | 0.022 | - | 0.069 | 0.028 | 0.0066 | 0.006 | - | - | - | - |
| Benzo(b&j)fluoranthene | 0.96 | 6.2 | saturation | - | <0.0050 | - | 0.034 | - | 0.093 | 0.038 | 0.0083 | 0.0079 | - | - | - | - |
| Benzo(k)fluoranthene | 0.96 | 6.2 | saturation | - | <0.0050 | - | 0.011 | - | 0.03 | 0.012 | <0.0050 | <0.0050 | - | - | - | - |
| Benzo(g,h,i)perylene | 9.6 | 6.6 | saturation | - | <0.0050 | - | 0.026 | - | 0.069 | 0.045 | 0.012 | 0.01 | - | - | - | - |
| Benzo(a)pyrene | 0.096 | 20 | 8800 | - | <0.0050 | - | 0.021 | - | 0.072 | 0.027 | 0.0051 | 0.0053 | - | - | - | - |
| Benzo(e)pyrene | 0.096 | 20 | 8800 | - | <0.0050 | - | 0.019 | - | 0.047 | 0.025 | 0.0075 | 0.0067 | - | - | - | - |
| Chrysene | 9.6 | 6.2 | saturation | - | <0.0050 | - | 0.023 | - | 0.065 | 0.029 | 0.0075 | 0.0069 | - | - | - | - |
| Dibenz(a,h)anthracene | 0.096 | 0.1 | saturation | - | <0.0050 | - | <0.0050 | - | 0.0062 | <0.0050 | <0.0050 | <0.0050 | - | - | - | - |
| Fluoranthene | 9.6 | 50 | 40000 | - | 0.016 | - | 0.076 | - | 0.18 | 0.11 | 0.028 | 0.026 | - | - | - | - |
| Fluorene | 5600 | 15.4 | 0.25 | - | 0.073 | - | *0.28* | - | 0.22 | *0.51* | 0.21 | 0.2 | - | - | - | - |
| Indeno(1,2,3-cd)pyrene | 0.96 | 0.38 | saturation | - | <0.0050 | - | 0.023 | - | 0.065 | 0.027 | 0.0063 | 0.0051 | - | - | - | - |
| 1-Methylnaphthalene | 560 | ng | 76 | - | 0.76 | - | 5.4 | - | 0.31 | 19 | 6.9 | 6.1 | - | - | - | - |
| 2-Methylnaphthalene | 560 | ng | 76 | - | 0.22 | - | 4 | - | 0.16 | 28 | 10 | 8.7 | - | - | - | - |
| Naphthalene | 2800 | 8.8 | 0.013 | - | *0.22* | - | *1.8* | - | <0.50 | *16* | *5.7* | *4.6* | - | - | - | - |
| Phenanthrene | 5600 | 43 | 0.046 | - | 0.044 | - | *0.25* | - | *0.16* | *0.58* | *0.16* | *0.15* | - | - | - | - |
| Perylene | ng | ng | ng | - | <0.0050 | - | <0.0050 | - | 0.013 | 0.0059 | <0.0050 | <0.0050 | - | - | - | - |
| Pyrene | 96 | 7.7 | 2600 | - | 0.024 | - | 0.13 | - | 0.32 | 0.16 | 0.044 | 0.041 | - | - | - | - |
| Biphenyl | 6000 | --- | 190 | - | <0.010 | - | <0.050 | - | <0.050 | 1.5 | <0.50 | <0.10 | - | - | - | - |
| ***Metals*** | | | | | | | | | | | | | | | | |
| Antimony | 63 | 20 | na | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | - | - |
| Arsenic | 31 | 26 | na | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | - |
| Barium | 96000 | 390 | na | 11 | 12 | 14 | 24 | 16 | 26 | 12 | 11 | 11 | 12 | 11 | - | - |
| Beryllium | 1100 | 4 | na | <0.2 | <0.2 | <0.2 | <0.2 | 0.2 | <0.2 | <0.2 | <0.2 | <0.2 | 0.2 | <0.2 | - | - |
| Cadmium | 192 | 3.8 | na | <0.1 | <0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | <0.1 | 0.1 | - | - |
| Chromium | 2300 | 64 | na | 5 | 6 | 5 | 6 | 6 | 5 | 5 | 5 | 6 | 5 | 5 | - | - |
| Cobalt | 250 | 40 | na | 1.3 | 1.6 | 1.6 | 1.5 | 1.7 | 1.3 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | - | - |
| Copper | 16000 | 63 | na | 2.5 | 2.9 | 3.2 | 3.3 | 4.5 | 4.5 | 3.5 | 3.2 | 3 | 3 | 2.7 | - | - |
| Lead | 740 | 70 | na | 12 | 14 | 17 | 43 | 64 | 68 | 34 | 11 | 11 | 10 | 14 | - | - |
| Molybdenum | 1200 | 6.9 | na | 0.6 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 | 0.6 | 0.5 | 0.6 | 0.7 | - | - |
| Nickel | 2500 | 45 | na | 4.9 | 5.6 | 5.2 | 4.9 | 4.9 | 4.3 | 4.3 | 4.9 | 5.2 | 5.1 | 4.9 | - | - |
| Selenium | 1135 | 1 | na | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | 0.5 | <0.5 | 0.6 | <0.5 | <0.5 | - | - |
| Silver | 490 | 20 | na | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | - | - |
| Sulphur | na | na | na | 200 | 200 | 200 | 210 | 240 | 250 | 220 | 200 | 200 | 220 | 200 | - | - |
| Tin | 700000 | 5 | na | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | - | - |
| Uranium | 300 | 33 | na | 0.33 | 0.35 | 0.37 | 0.37 | 0.49 | 0.39 | 0.39 | 0.36 | 0.33 | 0.35 | 0.36 | - | - |

**Table C.1b - Soil Analytical Data for Resolute Bay Airport Land Treatment Unit (Deeper Soils; ≥0.45 m)**

| Parameter | HHSL [1] Contact/Ingestion | ESL [2] Contact/Ingestion | ESL [3] PGWAL | Concentration (mg/kg) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LTU1-1 | LTU1-1 FD (LTU-DUP2) | LTU1-2 | LTU1-3 | LTU1-4 | LTU1-5 | LTU2-1 | LTU2-2 | LTU2-2 FD (LTU-DUP1) | LTU2-3 | LTU2-4 | SS1 @0.4-0.6 | SS1 @0.4-0.6 FD (Dup 18-01) |
| Sampling Date | | | | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Sep-15 | 22-Aug-18 | 22-Aug-18 |
| Depth (mbgs) | | | | 0.45 | 0.45 | 0.45 | 0.45 | 0.6 | 0.65 | 0.75 | 0.6 | 0.6 | 0.7 | 0.75 | 0.4-0.6 | 0.4-0.6 |
| Vanadium | 160 | 130 | na | 7 | 8 | 7 | 7 | 8 | 6 | 7 | 7 | 8 | 6 | 6 | - | - |
| Zinc | 140000 | 250 | na | 20 | 23 | 22 | 28 | 41 | 82 | 25 | 19 | 19 | 18 | 23 | - | - |

Notes:
1. HHSL = Human Health Screening Level.  As discussed in Section 5.1.
2. ESL = Ecological Screening Level. As discussed in Section 5.1.
3. ESL PGWAL = Ecological Screening Level for the Protection of Groundwater for Aquatic Life. As discussed in Section 5.1.

**Bold** indicates exceedances of HHSL.
<u>Underlined</u> indicates exceedances of ESL.
*Italics* indicates exceedances of the ESL PGWAL.

na = not applicable
ng = no guidelines identified
RES = Residual PHC formation

**Table C.2 - Groundwater Analytical Data for Resolute Bay Airport Land Treatment Unit**

| Parameter | HHSL [1] | ESL [2] | Concentration (mg/L) | |
|---|---|---|---|---|
| | | | 2017_MW1 | 2018_MW1 |
| Sampling Date | | | 25-Jul-17 | 24-Aug-18 |
| ***Petroleum Hydrocarbons (PHCs)*** | | | | |
| Benzene | 0.005 | 0.2 | <0.00020 | <0.00040 |
| Toluene | 0.06 | 0.083 | 0.003 | <0.00040 |
| Ethylbenzene | 0.14 | 20 | 0.00036 | <0.00040 |
| Xylenes (Total) | 0.09 | 18 | 0.0033 | <0.00089 |
| F1 (C6-C10) | 0.82 | 7.1 | <0.025 | <0.10 |
| F2 (C10-C16) | 0.3 | 1.3 | <0.10 | 0.29 |
| F3 (C16-C34) | 1 | na | <0.20 | - |
| F4 (C34-C50) | 1.1 | na | <0.20 | - |
| ***Polycyclic Aromatic Hydrocarbons (PAHs)*** | | | | |
| B(a)P TPE | 0.00004 | na | - | <0.000010 |
| Acenaphthene | 0.0041 | 0.0058 | <0.000010 | <0.00010 |
| Acenaphthylene | 0.00045 | 0.046 | <0.000010 | <0.00010 |
| Acridine | ng | ng | - | <0.000050 |
| Anthracene | 0.89 | 0.000012 | <0.000010 | <0.000010 |
| Benzo(a)anthracene | 0.001 | 0.000018 | <0.000010 | <0.0000085 |
| Benzo(b&j)fluoranthene | 0.0001 | 0.00048 | <0.000010 | <0.0000085 |
| Benzo(k)fluoranthene | 0.0001 | 0.00048 | <0.000010 | <0.0000085 |
| Benzo(g,h,i)perylene | 0.001 | 0.00017 | <0.000010 | <0.0000085 |
| Benzo(c)phenanthrene | ng | ng | - | <0.000050 |
| Benzo(a)pyrene | 0.00004 | 0.000015 | <0.000010 | <0.0000075 |
| Benzo(e)pyrene | 0.00004 | 0.000015 | - | <0.000050 |
| Chrysene | 0.0001 | 0.0014 | <0.000010 | <0.0000085 |
| Dibenz(a,h)anthracene | 0.00001 | 0.00026 | <0.000010 | <0.0000075 |
| Fluoranthene | 0.00041 | 0.00004 | <0.000010 | <0.000010 |
| Fluorene | 0.12 | 0.003 | <0.000010 | <0.000050 |
| Indeno(1,2,3-cd)pyrene | 0.0001 | 0.00021 | <0.000010 | <0.0000085 |
| 1-Methylnaphthalene | 0.012 | 0.18 | 0.00005 | 0.0036 |
| 2-Methylnaphthalene | 0.012 | 0.18 | 0.00004 | 0.0038 |
| Naphthalene | 0.059 | 0.0011 | 0.00005 | <u>0.02</u> |
| Phenanthrene | 0.001 | 0.0004 | <0.000010 | <0.000050 |
| Perylene | ng | ng | - | <0.000050 |
| Pyrene | 0.0041 | 0.000025 | <0.000010 | <0.000020 |
| Quinoline | ng | ng | - | <0.00020 |
| ***Metals*** | | | | |
| Total Aluminum | 20 | 0.1 | <u>8.7</u> | <u>5</u> |
| Total Antimony | 0.006 | 2 | <0.00050 | <0.00060 |
| Total Arsenic | 0.01 | 0.005 | 0.0035 | 0.0033 |
| Total Barium | 1 | 2.9 | 0.164 | 0.061 |
| Total Beryllium | 0.004 | 0.0053 | 0.0018 | <0.0010 |
| Total Bismuth | na | na | <0.010 | - |
| Total Boron | 5 | 36 | <0.5 | 0.035 |
| Total Cadmium | 0.005 | 0.000017 | <u>0.00237</u> | <u>0.00078</u> |
| Total Calcium | na | na | 2430 | 620 |

**Table C.2 - Groundwater Analytical Data for Resolute Bay Airport Land Treatment Unit**

| Parameter | HHSL [1] | ESL [2] | Concentration (mg/L) | |
|---|---|---|---|---|
| | | | **2017_MW1** | **2018_MW1** |
| Sampling Date | | | 25-Jul-17 | 24-Aug-18 |
| Total Chromium | 0.05 | 0.0089 | <u>0.016</u> | <u>0.01</u> |
| Total Cobalt | 0.003 | 0.05 | **0.0103** | **0.005** |
| Total Copper | 1 | 0.00391 | <u>0.0223</u> | <u>0.0085</u> |
| Total Iron | 14 | 0.3 | <u>9.99</u> | <u>7.4</u> |
| Total Lead | 0.01 | 0.00672 | **<u>0.144</u>** | **<u>0.039</u>** |
| Total Lithium | 0.04 | na | <0.020 | <0.020 |
| Total Magnesium | na | na | 1070 | 290 |
| Total Manganese | na | na | 1.85 | 0.62 |
| Total Molybdenum | 0.07 | 0.073 | <0.010 | 0.0011 |
| Total Nickel | 0.1 | 0.1494 | 0.018 | 0.011 |
| Total Phosphorus | na | na | - | 0.27 |
| Total Potassium | na | na | 3.36 | 2.4 |
| Total Selenium | 0.05 | 0.001 | <0.0010 | 0.00027 |
| Total Silicon | na | na | 8.68 | 6.8 |
| Total Silver | 0.1 | 0.0001 | <u>0.0005</u> | <0.00010 |
| Total Sodium | 200 | 1800 | 7.42 | 3.8 |
| Total Strontium | 12 | na | 0.973 | 0.33 |
| Total Sulphur | na | na | <30 | 1.1 |
| Total Thallium | 0.002 | 0.0008 | 0.00026 | <0.00020 |
| Total Tin | 12 | na | <0.050 | 0.0011 |
| Total Titanium | na | 0.1 | 0.077 | <u>0.15</u> |
| Total Uranium | 0.02 | 0.015 | 0.0034 | 0.00078 |
| Total Vanadium | 0.0062 | 0.2 | <0.050 | **0.013** |
| Total Zinc | 5 | 0.03 | <u>0.297</u> | <u>0.11</u> |
| Total Zirconium | 0.0016 | na | <0.001 | - |
| ***Other Parameters*** | | | | |
| Dissolved Nitrate (as N) | 10 | 3 | 0.19 | <0.020 |
| Dissolved Nitrite (as N) | 1 | 0.06 | - | <0.010 |
| Chloride | 250 | 120 | 12 | 3.7 |
| Phenols | 0.89 | 9.6 | <0.0010 | 0.075 |

Notes:
1. HHSL = Human Health Screening Level. As discussed in Section 5.2.
2. ESL = Ecological Screening Level. As discussed in Section 5.2.
**Bold** indicates exceedances of HHSL.
<u>Underlined</u> indicates exceedances of ESL.
na = not applicable
ng = no guidelines identified

Table C.3 - Surface Water Analytical Data for Resolute Bay Airport Land Treatment Unit

| Parameter | Concentration (mg/L) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HHSL [1] | ESL [2] | 2017_SW1 | 2017_SW2 | 2017_SW3 | 2017_SW3 FD (DUP-1) | 2017_SWB | 2018_SW1 | 2018_SW1 FD (SW-DUP18-01) | 2018_SW2 | 2018_SW3 | 2018_SW4 | 2018_SW5 |
| Sampling Date | | | 25-Jul-17 | 25-Jul-17 | 25-Jul-17 | 25-Jul-17 | 25-Jul-17 | 24-Aug-18 | 24-Aug-18 | 24-Aug-18 | 24-Aug-18 | 24-Aug-18 | 24-Aug-18 |
| ***Petroleum Hydrocarbons (PHCs)*** | | | | | | | | | | | | | |
| Benzene | 0.005 | 0.37 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00040 | <0.00040 | <0.00040 | <0.00040 | <0.00040 | <0.00040 |
| Toluene | 0.06 | 0.002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00040 | <0.00040 | <0.00040 | <0.00040 | 0.00057 | <0.00040 |
| Ethylbenzene | 0.14 | 0.09 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00040 | <0.00040 | 0.00044 | 0.00057 | <0.00040 | <0.00040 |
| Xylenes (Total) | 0.09 | 3.3 | <0.00040 | 0.00071 | <0.00040 | <0.00040 | <0.00040 | <0.00089 | <0.00089 | <0.00089 | <0.00089 | 0.0024 | <0.00089 |
| F1 (C6-C10) | 0.82 | 0.42 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.10 | <0.10 | 0.15 | 0.15 | <0.10 | <0.10 |
| F2 (C10-C16) | 0.3 | 0.17 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | 0.15 | 0.16 | **0.37** | 0.27 | **0.31** | <0.10 |
| F3 (C16-C34) | 1 | na | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | - | - | - | - | - | - |
| F4 (C34-C50) | 1.1 | na | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | - | - | - | - | - | - |
| ***Polycyclic Aromatic Hydrocarbons (PAHs)*** | | | | | | | | | | | | | |
| B(a)P TPE | 0.00004 | na | - | - | - | - | - | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| Acenaphthene | 0.0041 | 0.0058 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Acenaphthylene | 0.00045 | 0.0014 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Acridine | ng | 0.0044 | - | - | - | - | - | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Anthracene | 0.89 | 0.000012 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| Benzo(a)anthracene | 0.001 | 0.000018 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 |
| Benzo(b&j)fluoranthene | 0.0001 | 0.0042 | - | - | - | - | - | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 |
| Benzo(k)fluoranthene | 0.0001 | 0.0014 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 |
| Benzo(g,h,i)perylene | 0.001 | 0.0002 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 |
| Benzo(c)phenanthrene | ng | ng | - | - | - | - | - | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Benzo(a)pyrene | 0.00004 | 0.000015 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000075 | <0.0000075 | <0.0000075 | <0.0000075 | <0.0000075 | <0.0000075 |
| Benzo(e)pyrene | 0.00004 | 0.000015 | - | - | - | - | - | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Chrysene | 0.0001 | 0.0007 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 |
| Dibenz(a,h)anthracene | 0.00001 | 0.0004 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000075 | <0.0000075 | <0.0000075 | <0.0000075 | <0.0000075 | <0.0000075 |
| Fluoranthene | 0.00041 | 0.00004 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| Fluorene | 0.12 | 0.003 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Indeno(1,2,3-cd)pyrene | 0.0001 | 0.0014 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 | <0.0000085 |
| 1-Methylnaphthalene | 0.012 | 1.5 | <0.000010 | 0.00006 | 0.000015 | 0.000025 | <0.000010 | <0.00010 | <0.00010 | 0.00024 | 0.00023 | 0.00023 | <0.00010 |
| 2-Methylnaphthalene | 0.012 | 1.5 | <0.000010 | 0.000045 | 0.000045 | 0.000025 | 0.000025 | <0.00010 | <0.00010 | 0.00016 | <0.00010 | 0.00027 | <0.00010 |
| Naphthalene | 0.059 | 0.0011 | <0.000010 | 0.000055 | 0.000025 | 0.000015 | <0.000010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Phenanthrene | 0.001 | 0.0004 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Perylene | ng | ng | - | - | - | - | - | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Pyrene | 0.0041 | 0.000025 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 |
| Quinoline | ng | 0.0034 | - | - | - | - | - | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| ***Metals*** | | | | | | | | | | | | | |
| Total Aluminum | 20 | 0.1 | 0.0062 | 0.0127 | 0.0037 | 0.0038 | 0.0087 | 0.095 | 0.065 | 0.017 | 0.019 | 0.027 | 0.018 |
| Total Antimony | 0.006 | 16 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00060 | <0.00060 | <0.00060 | <0.00060 | <0.00060 | <0.00060 |
| Total Arsenic | 0.01 | 0.005 | 0.00012 | 0.00027 | 0.00031 | 0.00028 | 0.00048 | 0.0019 | 0.0017 | 0.0013 | 0.0016 | 0.0002 | <0.00020 |
| Total Barium | 1 | 23 | 0.0051 | 0.0083 | 0.0149 | 0.0147 | 0.0137 | 0.025 | 0.023 | 0.028 | 0.018 | 0.011 | <0.010 |
| Total Beryllium | 0.004 | 0.053 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| Total Bismuth | na | na | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | - | - | - | - | - | - |
| Total Boron | 5 | 1.5 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | 0.032 | 0.029 | 0.028 | 0.033 | 0.023 | <0.020 |

**Table C.3 - Surface Water Analytical Data for Resolute Bay Airport Land Treatment Unit**

| Parameter | Concentration (mg/L) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HHSL [1] | ESL [2] | 2017_SW1 | 2017_SW2 | 2017_SW3 | 2017_SW3 FD (DUP-1) | 2017_SWB | 2018_SW1 | 2018_SW1 FD (SW-DUP18-01) | 2018_SW2 | 2018_SW3 | 2018_SW4 | 2018_SW5 |
| Total Cadmium | 0.005 | 0.00009 | 0.000013 | <0.000010 | 0.00001 | 0.000011 | 0.000013 | 0.000037 | 0.000022 | <0.000020 | <0.000020 | <0.000020 | <0.000020 |
| Total Calcium | na | na | 34.6 | 38.2 | 56.2 | 53.1 | 50.8 | 84 | 75 | 61 | 44 | 43 | 30 |
| Total Chromium | 0.05 | 0.0089 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | 0.0011 | 0.0011 | <0.0010 | 0.0011 | <0.0010 |
| Total Cobalt | 0.003 | 0.052 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | 0.00055 | 0.00051 | 0.00047 | 0.00041 | <0.00030 | <0.00030 |
| Total Copper | 1 | 0.0030 | <0.00050 | <0.00050 | 0.00077 | 0.00071 | 0.0009 | 0.0025 | 0.0025 | 0.0023 | 0.0025 | 0.0012 | 0.00045 |
| Total Iron | 14 | 0.3 | <0.010 | 0.028 | <0.010 | <0.010 | 0.019 | 0.21 | 0.14 | <0.060 | 0.081 | <0.060 | <0.060 |
| Total Lead | 0.01 | 0.0044 | <0.00020 | 0.00489 | **0.0118** | **0.0118** | **0.0152** | **0.032** | **0.03** | 0.0056 | **0.034** | 0.0049 | <0.00020 |
| Total Lithium | 0.04 | na | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| Total Magnesium | na | na | 12.7 | 11.6 | 12.5 | 12.2 | 12.9 | 22 | 20 | 15 | 39 | 13 | 13 |
| Total Manganese | na | na | <0.0010 | 0.0157 | 0.0042 | 0.0045 | 0.007 | 0.059 | 0.049 | 0.021 | 0.0043 | 0.021 | <0.0040 |
| Total Molybdenum | 0.07 | 0.073 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | 0.00087 | 0.00075 | 0.00053 | 0.0023 | 0.0015 | 0.00065 |
| Total Nickel | 0.1 | 0.12 | <0.0010 | <0.0010 | 0.0012 | 0.0011 | 0.0013 | 0.004 | 0.0042 | 0.0045 | 0.0038 | 0.00056 | <0.00050 |
| Total Phosphorus | na | na | - | - | - | - | - | 0.41 | 0.23 | <0.10 | <0.10 | <0.10 | <0.10 |
| Total Potassium | na | na | 0.467 | 1 | 1.54 | 1.51 | 2.58 | 7.1 | 7 | 7.2 | 5.1 | 1.4 | 0.49 |
| Total Selenium | 0.05 | 0.001 | <0.00010 | <0.00010 | 0.00012 | 0.00012 | 0.00011 | 0.00021 | <0.00020 | 0.00021 | 0.00033 | <0.00020 | <0.00020 |
| Total Silicon | na | na | 0.338 | 0.482 | 0.615 | 0.567 | 0.66 | 1.5 | 1.4 | 0.53 | 1.6 | 0.39 | 0.27 |
| Total Silver | 0.1 | 0.00025 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Total Sodium | 200 | 1800 | 6.41 | 6.12 | 6.22 | 5.92 | 6.3 | 4.7 | 4.6 | 2.6 | 4.6 | 8.1 | 3 |
| Total Strontium | 12 | na | 0.0603 | 0.0936 | 0.153 | 0.148 | 0.135 | 0.23 | 0.21 | 0.22 | 0.21 | 0.11 | 0.063 |
| Total Sulphur | na | na | <3 | <3 | <3 | <3 | <3 | 2.5 | 2.4 | 3.8 | 2.7 | 1.5 | 0.66 |
| Total Thallium | 0.002 | 0.0008 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | 0.00001 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Total Tin | 12 | na | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| Total Titanium | na | na | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | 0.0051 | 0.0036 | <0.0010 | 0.001 | 0.0013 | <0.0010 |
| Total Uranium | 0.02 | 0.015 | 0.0001 | 0.00031 | 0.00041 | 0.00041 | 0.00047 | 0.00096 | 0.00073 | 0.0008 | 0.00081 | 0.0002 | 0.00013 |
| Total Vanadium | 0.0062 | 0.2 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| Total Zinc | 5 | 0.007 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.0041 | 0.0042 | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Total Zirconium | 0.0016 | na | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | - | - | - | - | - | - |
| ***Other Parameters*** | | | | | | | | | | | | | |
| Dissolved Nitrate (as N) | 10 | 3 | 0.17 | 0.11 | 0.37 | 0.36 | 1.45 | 4.6 | 0.73 | 0.93 | 0.027 | <0.020 | 0.021 |
| Dissolved Nitrite (as N) | 1 | 0.06 | - | - | - | - | - | 0.035 | 0.057 | 0.035 | <0.010 | <0.010 | <0.010 |
| Chloride | 250 | 120 | 7.4 | 4.9 | 6.7 | 6.9 | 7.3 | 6 | 5.9 | 2.5 | 3.6 | 10 | 2.1 |
| Phenols | 0.89 | 0.004 | <0.0010 | 0.0026 | <0.010 | <0.010 | 0.0056 | 0.014 | 0.0087 | 0.023 | 0.021 | 0.0092 | <0.0020 |

Notes:

1. HHSL = Human Health Screening Level. As discussed in Section 5.3.
2. ESL = Ecological Screening Level. As discussed in Section 5.3.

**Bold** indicates exceedances of HHSL.

Underlined indicates exceedances of ESL.

na = not applicable

ng = no guidelines identified