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Public Services and Procurement Canada

2017 ENVIRONMENTAL MONITORING PROGRAM - CAMBRIDGE BAY AIRPORT APRON LTU

Cambridge Bay Airport, NU

February 22, 2018

2017 ENVIRONMENTAL MONITORING PROGRAM - APRON LTU

CAMBRIDGE BAY AIRPORT, NU

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ACRONYMS AND ABBREVIATIONS

Arcadis	Arcadis Canada Inc.
BTEX	Benzene, Toluene, Ethyl Benzene and Xylenes
CCME	Canadian Council of Ministers of the Environment
CCME FWAL	Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life
COC	Contaminant of Concern
DWSV	Drinking Water Screening Value
ESA	Environmental Site Assessment
FCSAP	Federal Contaminated Sites Action Plan
FIGQG	Federal Interim Groundwater Quality Guidelines
FTA	Fire Training Area
HC	Health Canada
km	kilometre(s)
kg	kilogram
l	litre(s)
LTU	Land Treatment Unit
m	metre(s)
m asl	metre(s) above sea level
m bgs	metre(s) below ground surface
NWB	Nunavut Water Board
OVM	Organic Vapour Measurement
PAH	Polycyclic Aromatic Hydrocarbon
PFAS	Poly-and-perfluoroalkyl Substances
PHC	Petroleum Hydrocarbon
ppm	parts per million
PSPC	Public Services and Procurement Canada
PWGSC	Public Works and Government Services Canada
RDL	Reportable Detection Limit
TC	Transport Canada
TOR	Terms of Reference

EXECUTIVE SUMMARY

Arcadis Canada Inc. (Arcadis) was retained by Public Services and Procurement Canada (PSPC) [formerly Public Works and Government Services Canada (PWGSC)] on behalf of Transport Canada (TC) to conduct an Environmental Monitoring Program at the Cambridge Bay Airport Apron Land Treatment Unit (LTU) and Excavation Area in Cambridge Bay, Nunavut. The 2017 field activities were completed from July 24 to August 10, 2017.

The Apron LTU was constructed in 2013 to treat petroleum hydrocarbon (PHC) impacted soil excavated from an area located near the Cambridge Bay Airport terminal, referred to as the Apron Excavation Area. The impacted soil occupies approximately 95% of the LTU. The remaining 5% of the LTU has been left empty to provide space for water storage around the sump located in the LTU's southwest corner.

The 2017 Environmental Monitoring Program included:

1. A groundwater and soil monitoring program that met the requirements of the Nunavut Water Board (NWB) License 1BR-FTA1217. This included modifying the soil sampling requirements to a single sampling event at the Apron LTU, as no active soil treatment is currently occurring at the site. Soil (7 samples), sump water (1 samples), and groundwater (4 samples) samples were collected and submitted for analysis;
2. The repair of damaged monitoring wells;
3. A Class A cost estimate for future proposed work (under separate cover); and,
4. The comparison of historical and current monitoring data from the various sampled media to assess for natural attenuation, and the integrity of the LTU.

Sump Water Monitoring Results

Analytical results for the 2017 sump water sample met the NWB Licence requirements for pH, oil-and-grease, dissolved lead, total zinc, benzene-toluene-ethylbenzene-and-xylenes (BTEX), and PHC fraction F1. Reported concentrations of oil-and-grease, dissolved lead, total zinc, BTEX, and PHC F1 were either below laboratory Reportable Detection Limits (RDLs) or were 2x below the applicable NWB Licence requirement. No exceedances of the NWB Licence requirements have ever been detected in the Apron LTU's sump water to date.

The 2017 sump water sample was also analyzed for poly-and-perfluoroalkyl substances (PFASs). Detectable levels of select PFAS were found in both the soil and sump water samples above Health Canada's Drinking Water Screening Values (DWSVs); however, no exceedances of existing federal guidelines for aquatic receptors were reported. Arcadis recommends that sump water should not be discharged to the ground surface outside the Apron LTU during future site activities until the risks associated with the PFAS impacts have been assessed.

Groundwater Monitoring Results

At the time of the 2017 field program, groundwater was observed to be frozen in four of the five monitoring wells surrounding the Apron LTU. In addition, monitoring well MW13-6, installed in the Apron Excavated Area, could not be located by Arcadis in 2017. This monitoring well has been buried under compacted granular material that resides in an active portion of the Airport's apron. As such, groundwater could only be collected from four of the nine monitoring wells (MW13-1, MW13-7, MW13-8 and MW13-9).

The 2017 groundwater analytical results were consistent with 2014, 2015 and 2016 analytical results. No increasing or decreasing trends in the groundwater parameters analyzed can be established. Concentrations of BTEX, PHCs and PAHs in all 2017 groundwater samples were below applicable Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME FWAL) and below laboratory RDLs. Exceedances of dissolved iron, dissolved chloride and phenols were detected in the groundwater sample collected from monitoring well MW13-1. In addition, exceedances of various metals/inorganics (including dissolved copper, dissolved iron, dissolved uranium, dissolved zinc, dissolved chloride and phenols) were detected in the groundwater samples collected from monitoring wells MW13-7, MW13-8 and MW13-9. The elevated dissolved metal concentrations are likely a result of naturally elevated background concentrations while the phenol exceedances are likely anthropogenic elevated concentrations. The 2017 dissolved chloride concentrations in the groundwater samples collected from monitoring wells MW13-7 and MW13-9 were between 9x and 68x the CCME FWAL. These are the highest dissolved chloride exceedance factors reported for the four monitoring wells located around the Apron excavation area since 2014. The dissolved chloride exceedances are likely due to road salt application practices used by the Cambridge Bay Airport.

Overall, the results from the 2017 Environmental Monitoring Program do not suggest that the integrity of the Apron LTU's liner and berms has been compromised.

Soil Petroleum Hydrocarbon Remediation Results

Arcadis collected seven soil samples (including one duplicate sample) from the Apron LTU during the 2017 field program. Samples were collected from the top 0.35 metres (m) of soil in the Apron LTU after the 2017 tilling activities (Refer to the 2017 Remedial Activities Program report (Arcadis, 2017) for more details regarding the 2017 tilling activities). Select soil samples were submitted for laboratory analysis of BTEX, PHCs and nutrient indicators. The soil analytical results were compared to the CCME FWAL guidelines and NWB License remediation requirements.

Exceedances of select BTEX and PHCs parameters were reported the soil samples above the CCME FWAL guidelines and NWB License remediation requirements. All 2017 soil samples reported BTEX concentrations below the NWB License remediation requirements; however, concentration of benzene and ethylbenzene in one soil sample were reported above applicable CCME FWAL guidelines. Concentrations of PHC fractions F1, F2 and F3 above both the CCME FWAL guidelines and NWB License remediation requirements were reported in 2017. Average hydrocarbon concentrations detected in the upper 0.35 m of soil in the Apron LTU in 2017 were comparable to 2016 PHC averages. The hydrocarbon concentrations in the Apron LTU's soil below 0.35 m depth have not been assessed to date.

The average nitrogen concentration in the upper 0.35 m of soil in the Apron LTU is above the estimated effective nitrogen range to for PHC biodegradation. Conversely, the average phosphorous concentration

is close to the lower limit of the estimated effective phosphorous range. Arcadis recommends no additional nutrients be added to the Apron LTU until average phosphorous concentrations drop below the lower limit of the estimated effective phosphorous range.

Monitoring Well Condition Assessment

Arcadis assessed the condition of the casing, riser and well cap of all monitoring wells around the Apron LTU and Excavation Area during the 2017 field program. Arcadis made repairs to two monitoring wells, MW13-7 and MW13-9. The well casing on monitoring well MW13-7 was reset to allow the well to be opened. The riser on MW13-9 was extended to prevent surface water from submerging the well during periods of wet conditions. All remaining monitoring wells were in good condition with the exception of monitoring well M13-8. The riser on monitoring well M13-8 was cracked; however, Arcadis did not have the materials necessary to repair the well during the 2017 field program.

Recommendations

Arcadis recommends that the following future work be completed at the Apron LTU:

1. To continue to be in compliance with the NWB License requirements and identified chemicals of concern, a groundwater monitoring program must be completed at the Apron LTU and Excavation Area to assess the parameters set out in the license. Attempts should be made to sample the monitoring wells during freshet conditions and during warmest weeks at Cambridge Bay, when liquid groundwater conditions are more probable and when groundwater levels are presumed to be at their highest to further evaluate groundwater trends. Based on temperature statistics obtained from ECCC, this sampling time period would occur in mid-July.

2. Once active treatment re-commences, Arcadis recommends that the number of soil samples submitted for laboratory analysis from the upper 0.35 m bgs of the soil in the Apron LTU be increased to 15 samples to better assess the effectiveness of PHC degradation. In addition, Arcadis recommends 15 additional soil samples be submitted for laboratory analysis from the soil located below 0.35 m bgs. Select soil samples should be analyzed for moisture, pH, bulk density, BTEX, and PHC Fractions F1 to F4.

3. Arcadis recommends that the riser on monitoring well MW13-8 be repaired. We recommend that a new J-plug style well cap be installed on monitoring well MW13-7 during the site's next scheduled monitoring program.

1 INTRODUCTION

Arcadis Canada Inc. (Arcadis) was retained by Public Services and Procurement Canada (PSPC) [formerly Public Works and Government Services Canada (PWGSC)] on behalf of Transport Canada (TC) to conduct an environmental monitoring program at the Cambridge Bay Airport Apron Land Treatment Unit (LTU) and excavation area in Cambridge Bay, Nunavut.

This report is submitted under Northern Standing Offer Contract Number EW699-141143/001/NCS and conducted in accordance with the Terms of Reference (TOR) Amendment entitled, "*Apron and Fire Training Area Site Remedial Activities Supervision and Environmental Monitoring Program, Cambridge Bay Airport, Victoria Island, Nunavut"* and the Arcadis proposal entitled, "*Fire Training Area (FTA) LTU, Site Remedial Activities Supervision and Environmental Monitoring Program, Cambridge Bay Airport, Victoria Island, Nunavut"* dated, July 13, 2017. Throughout this report the Apron LTU and Excavation Area will be referred to as "the site".

1.1 Project Objectives

The objectives of the 2017 Environmental Monitoring Program were to:

1. Complete an environmental monitoring program that meets the Nunavut Water Board (NWB) License 1BR-FTA1217 requirements. This included modifying the soil sampling requirements to a single sampling event at the LTU, as no active soil treatment is currently occurring at the site;
2. Complete a groundwater monitoring program at the Apron LTU (five monitoring wells) and Apron Excavated Area (four monitoring wells), in accordance with Part J, Item 7 of NWB license 1BR-FTA1217;
3. Repair damaged monitoring wells, if required and/or feasible;
4. Submit soil, sump water and groundwater samples for laboratory analysis and analyze data;
5. Provide a Class A cost estimate for future proposed work, if warranted; and,
6. Prepare draft and final reports of the above investigations.

2 BACKGROUND INFORMATION

As part of the airport operations transfer agreement between TC and the Government of Nunavut (GN), two areas of environmental concern (AECs) were identified for remediation at the Cambridge Bay Airport:

- AEC 1: an area on the apron near the airport terminal where airplanes refueled, hereafter referred to as the Apron Excavation Area, and
- AEC 2: a fire training area (FTA) located at the northwest end of the airport runway, hereafter referred to as the FTA Excavation Area.

The location of the Apron and FTA Excavation Areas are shown in **Figure 1** located at the end of this report. Previous investigation confirmed petroleum hydrocarbon (PHC) impacted soil and dissolved metal impacted groundwater in both AECs. To address these impacts, TC developed remedial action plans for both AECs that involved the excavation of impacted soil and its placement into two separate LTUs located near the northwest end of the airport's runway.

TC obtained an operating license for both LTUs (IBR-FTA1217/TC) through the Nunavut Water Board (NWB) in 2011.

2.1 Apron LTU and Excavation Area History

In 2013, a 55 metre (m) x 148 m LTU was constructed by GPEC International on airport land near the northwest end of the airport's runway, hereafter referred to as the Apron LTU (see **Figure 1**). The Apron LTU consists of berm walls and high-density polyethylene geomembrane liner. The berm walls were constructed to a height of approximately 0.5 m above the existing ground surface. The base of the Apron LTU was graded to direct captured water towards a single sump located in its southwest corner. A layer of granular material was spread and compacted over the geomembrane liner (excluding the portion of the geomembrane liner that extends over the berm walls). Five groundwater monitoring wells (MW13-1 to MW13-5) were installed around the Apron LTU. Monitoring well locations around the Apron LTU are shown in **Figure 2**.

Approximately 3,500 cubic metres (m^3) of impacted soil was transferred from the Apron Excavation Area to the Apron LTU following its construction. Additionally, a total of 165 m^3 of concrete debris (large pieces greater than 0.3 m in diameter) was removed from the Apron Excavation Area and placed adjacent and outside of the Apron LTU (see **Figure 2**). Four groundwater monitoring wells (MW13-6 to MW13-9) were installed around the Apron Excavated Area. Monitoring well locations around the Apron Excavated Area are shown in **Figure 3.**

In 2014, during construction of a second LTU to address the identified impacted soils in AEC 2, the remediation contractor discovered crushed drums and metal cylinders in the construction area. To minimize construction delays, 560 m^3 of impacted soil surrounding the drums and cylinders was placed in the Apron LTU. Based on observations in the field, the remedial oversight contractor assessed contaminants of concern as metals and PHCs. The soil was tested for metals, benzene, toluene, ethylbenzene, and xylenes (BTEX), and PHC fractions F1 through F4.

In 2014 and 2015, monitoring and sampling programs were conducted at the Apron LTU and excavation area by Dillon Consulting Limited (Dillon) to fulfill NWB Licence requirements. The programs included overseeing the discharge of water from the Apron LTU sump to an area of ground approximately 100 m to the west of the LTU after chemical analysis demonstrated that the sump water met licence discharge criteria. Dillion's activities in 2015 also included the supervision of a soil amendment program at the Apron LTU. The soil amendment program consisted of the addition of fertilizer to stimulates microbial growth in the LTU's soil and of soil aeration achieved through the tilling of the LTU's soil with a harrow.

In 2016, Arcadis supervised remedial activities and conducted an environmental monitoring program at the Apron LTU and Excavation Area. The remedial activities included recirculating water from around the Apron LTU's sump onto the soil in the LTU for water management purposes and to aide with PHC degradation. As part of the environmental monitoring program, soil and sump water samples were collected from the Apron LTU and analyzed for poly-and-perfluoroalkyl substances (PFASs). PFASs are a group of emerging contaminants and are found in fire treatment foams (HC, 2016). Detectable levels of PFASs were found in both the soil and sump water samples; however, no exceedances of existing federal guidelines were detected. The PFAS contamination in the Apron LTU soil and sump water is suspected to be caused by PFAS contaminated material associated with the drums and cylinders that were placed in the Apron LTU. As a result of the confirmed presence of PFAS contamination in the Apron LTU, TC has taken the position to suspend future active treatment of the soil in the Apron LTU until a national strategy has been determined.

3 ENVIRONMENTAL QUALITY GUIDELINES

Analytical results for the soil samples collected were evaluated against the Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, specifically the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CSQGs) and the Canada-Wide Standards for Petroleum Hydrocarbons in Soil (CWS-PHC) for commercial/industrial land use and fine grain size. Soils were also compared against the Nunavut Water Board Licence No. 1BR-FTA1217, Part J, Remediation Requirements.

As per the NWB Licence, groundwater analytical results, as well as analytical results for surface water samples collected from the two LTU sumps, were evaluated against the Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (freshwater and marine), hereafter referred to as CCME FWAL. Canadian water quality guidelines are intended to protect freshwater and marine life from anthropogenic stressors such as chemical inputs or changes to physical conditions. Surface water samples collected from the sumps were also evaluated against the NWB Licence, Part D, Effluent Quality Limits.

The following summarizes the site conditions in support of the guidelines selected:

- Grain size analysis of soils samples collected by Dillon in 2014 and 2015 indicate that the soil at the site is fine grained (based on the predominant soil texture);
- The FTA LTU and excavation area are on airport land that has been classified as commercial;
- Groundwater is not used as a source of potable water on-site or in the area. The Hamlet of Cambridge Bay obtains potable water from a surface water body located over four kilometres northeast of the site;
- Freshwater waterbodies are located north and northwest of the FTA LTU and excavation area (within 300 m). The marine waterbody of Cambridge Bay is located to the south of both the Apron LTU and excavation area (within 200 and 100 m respectively); and,
- Groundwater elevations measured in monitoring wells within around the FTA LTU suggest groundwater flows south towards the Cambridge Bay waterbody.

Perfluorooctane sulfonate (PFOS) and other PFASs are anthropogenic chemicals that have been introduced to the environment through their broad application including manufacturing products and consumer products. Based on risk assessment activities under the Canadian Environmental Protection Act, 1999, it was concluded that PFOS and its associated salts and precursors may be entering the environment in concentrations that may have an immediate or long-term harmful effect on the environment or biological diversity. Historically, PFOS and other PFASs were used in aqueous film forming foams which were typically used during fire fighting training activities.

There are currently no Canadian environmental quality guidelines for PFAS. The United States Environmental Protection Agency has developed health advisories for Perfloro-n-Octanoic Acid (PFOA) and PFOS, but these are not legally enforced standards and are subject to change as new information becomes available. In the absence of definitive guidelines, Health Canada (HC) and Environment Canada (EC) have taken steps to develop PFAS screening values, until such time that environmental quality guidelines are developed.

HC has derived drinking water screening values (DWSVs) for PFAS, as well as soil screening values (SSV) for PFOS and PFOA. Screening values are developed at the request of a federal department in the event of a spill, leak or other unforeseen event and are based on readily-available scientific studies. They have not been subjected to as thorough a review as actual guideline values. They are designed for the protection of human health through direct exposure through drinking water. It should be noted these drinking water screening values have not considered other exposure pathways such as the protection from consumption of fish or irrigation of food crops.

In 2013, EC developed draft ecological receptor Federal Environmental Quality Guidelines (FEQGs) for PFOS. They were revised in 2015 but have not been finalized. These FEQGs are summarized in Table 3-1. The values are based on laboratory toxicity studies. If concentrations are detected above these values in the environment, EC presumes that adverse effects may occur.

Table 3-1: Draft FEQG for PFOS in the Environment in Canada from ECCC (2013)

Water (µg/L)	Fish Tissue (ng/g wet weight)	Wildlife Diet (ng/g wet weight food)		Bird Egg (ng/g wet weight)
		Mammalian	Avian	
6	8,300	4.6	8.2	1,900

For the purposes of the PFAS assessments at LTUs on TC properties, the more applicable of either the Health Canada screening values or the FEQGs should be used for the human health evaluation (e.g. based on land use scenarios and lowest applicable screening values). In October 2015, the National Guidelines and Standards Office, Environment Canada, issued Version 1.3 of the Director General-approved Federal Soil Quality Guidelines (FSQGs) for PFOS available to the Federal Contaminated Sites Action Plan (FCSAP).

Analytical results for surface water samples collected by Arcadis in 2016 and 2017 were compared to the HC drinking water screening values and the draft FEQGs for PFOS.

4 PROGRAM METHODOLOGY

The following sections outline the scope of work and methodology implemented during 2017 Environmental Monitoring Program. The field activities were completed between July 24 and August 10, 2017.

4.1 Site Specific Health and Safety Plan

Arcadis prepared a site-specific health and safety plan (HASP) prior to the field activities. The HASP included the documentation of all foreseeable work hazards and mitigative actions. It also contained a listing of emergency contact numbers and provided protocols to follow in the event of an incident. Arcadis ensured that the HASP was communicated to all site personnel ensuring that they were aware of all contaminants of concern, associated precautions, and required personal protective equipment.

A health and safety kick-off meeting and daily tailgate meetings, including task specific job safety analyses, were conducted to inform on-site personnel of the potential risks and appropriate safety controls. The HASP has been retained on file by Arcadis.

4.2 Nunavut Water Board Licence Requirements

In accordance with the NWB Licence (1BR-FTA1217), the sampling plan developed by Arcadis and implemented during the 2017 site visit was reviewed by Maxxam Analytics Inc. (Maxxam). Maxxam is certified by the Canadian Association for Laboratory Accreditation Inc. (CALA). **Appendix A** contains the letter from Maxxam in response to their review of Arcadis's 2017 sampling plan.

4.2.1 Sump Water Sampling

Arcadis collected a grab sample (APRONSUMP) from the surface water around the Apron LTU sump on July 25, 2017. In accordance with the NWB Licence, Part D, Number 4, the sample was submitted for the following analyses: pH, oil and grease, dissolved lead, total zinc, dissolved lead, and benzene, toluene, ethylbenzene and xylene (BTEX), and petroleum hydrocarbon fraction F1 (PHC F1).

All sump water sample containers were placed in a cooler with ice immediately after they were collected and then stored in a refrigerator prior to their shipment. Sump water samples were shipped in coolers with ice packs to the Maxxam depot in Yellowknife, NT, on July 26, 2017. Analysis of the samples was completed by the Maxxam laboratory in Edmonton, AB. Copies of the Certificate of Analysis laboratory reports are attached in **Appendix B**.

4.2.2 Soil Sampling

Arcadis conducted Apron LTU soil sampling in accordance with the NWB Licence requirements. All soil samples were analyzed for BTEX and PHC Fractions F1 to F4. A total of six soil samples (APRON1701 to APRON1706) and one duplicate sample (APRONDUP01) were collected on August 5, 2017. Soil samples were collected after the 2017 tilling activities. Refer to the 2017 Remedial Activities Program report (Arcadis, 2017) for more details regarding the 2017 tilling activities.

Sample locations were chosen by dividing the Apron LTU into six sections of approximately equal areal extent (approximately 45 metre by 25 metre areas), as shown in **Figure 4**. Samples were collected in each area at a depth of approximately 0.35 metres below ground surface (m bgs).

All sampling equipment was decontaminated between each sample location with Alconox and distilled water. A new pair of nitrile gloves were worn prior to the collection of each sample. LTU field conditions and soil descriptions, including approximate grain size, colour, moisture content, and nature and extent of apparent contamination, were documented for each soil sampling location. The GPS coordinates of each soil sample were also collected using a Garmin eTrex 10, with an accuracy of 3 metres.

All soil sample containers were placed in a cooler with ice immediately after they were collected and then stored in a refrigerator prior to shipment. The samples were shipped in coolers with ice packs to the Maxxam depot in Yellowknife, NWT on August 8, 2017. Analysis of the soil samples was completed by the Maxxam laboratory in Edmonton, AB. Copies of the Certificate of Analysis laboratory reports are attached in **Appendix B**.

4.2.3 Groundwater Monitoring and Sampling at the Apron LTU and Excavation Area

Arcadis conducted groundwater monitoring and sampling during the 2017 field program at the Apron LTU and the Apron excavation area. Nine groundwater monitoring wells are located at the site: five wells (MW13-1 to MW13-5) located around the Apron LTU and four wells around the Apron Excavation Area (MW13-6 to MW13-9). Monitoring well locations for the Apron LTU and Excavation Area are shown on **Figure 2** and **Figure 3,** respectively.

Arcadis collected groundwater samples from all wells with a sufficient volume of water present. One blind duplicate sample was also collected. Before sample collection, a minimum of three well volumes were purged. Purge water was disposed of into the Apron LTU. Groundwater could only be collected from four of the nine monitoring wells (MW13-1, MW13-7, MW13-8 and MW13-9). The groundwater in monitoring wells MW13-2, MW13-3, MW13-4 and MW13-5 was frozen. Monitoring well MW13-6 could not be located by Arcadis as it was installed on the north side of the Apron Excavation area in an active portion of the airport's gravel apron and is suspected of being buried under the compacted granular material. Monitoring results are presented in **Table 1**.

Sampling and purging was conducted using low-flow sampling techniques via a peristaltic pump and dedicated tubing. Volatile organic compound levels inside each monitoring well were measured with a MiniRae 3000 immediately after removing the well cap. Physical chemistry parameters including pH, oxidation-reduction potential, conductivity, turbidity, dissolved oxygen, total dissolved solids and temperature were monitored using a calibrated Horiba U-52. Water level drawdown was monitored using a Heron oil/water interface probe. Where the recharge was not sufficient to conduct low flow sampling techniques, the well was purged dry three times before sampling. All sampling equipment was decontaminated between sample locations with Alconox and distilled water. A new pair of nitrile gloves were worn for each sample.

In accordance with the NWB Licence requirements, Part J, Number 7, the groundwater samples were submitted for BTEX, PHC F1-F4, polycyclic aromatic hydrocarbons (PAHs), total alkalinity, nitrate-nitrite,

ammonia nitrogen, oil and grease, total phenols, calcium, magnesium, sodium, potassium, chloride, sulphate, dissolved metals, total suspended solids and total dissolved solids analysis. Copies of the Certificate of Analysis laboratory reports are attached in **Appendix B.**

All groundwater sample bottles were placed in a cooler with ice packs immediately after they were collected. The groundwater samples were then stored in a refrigerator prior to their shipment. Groundwater samples were shipped in coolers with ice packs to the Maxxam depot in Yellowknife, NWT. Analysis of the groundwater samples was completed at the Maxxam laboratory in Edmonton, AB. The GPS coordinates of the location of each monitoring well were collected using a Garmin eTrex 10 (accurate to 3 metres).

4.3 Soil Amendment Sampling

Arcadis collected four soil samples (APRON1701, APRON1703, APRON1704 and APRON1706) on August 5, 2017 as part of soil amendment sampling program for the Apron LTU. These four soil samples, plus one duplicate sample (APRONDUP01), were submitted for total iron, total potassium, available phosphorus and total nitrogen analysis. These analytical parameters were required to gauge the requirement of subsequent soil amendment applications. Samples were collected following the procedure outlined Section 4.2.2.

4.4 Per- and Polyfluoroalkyl Substance (PFAS) Sampling

Arcadis collected one grab sample from the water within the Apron LTU sump (APRONSUMP) on July 25, 2017 for PFAS analysis.

The sampling procedure adhered to TC's February 2016 PFAS Field Sampling Guidance Document. Arcadis applied the following procedure to reduce the potential PFAS contamination during sampling:

- A pencil was used to label sample containers;
- Each sample container was transported in an individual-sealable plastic bag;
- All samples were kept in their own cooler separate from other sample containers;
- Field notes were taken on non-waterproof paper on an aluminum clip board with a pencil;
- A new pair of nitrile gloves were worn prior to obtaining each sample;
- 100% cotton clothes were worn during sampling (the items were put through a wash cycle without detergent, air dried, and stored in a cotton pillow case);
- A pillow case was used on the driver's seat of the truck used to transport samples; and,
- Steel-toed boots were worn but contact with any soil to be collected for PFAS sampling was prevented.

The PFAS analysis was completed by the Maxxam laboratory in Mississauga, ON.

5 QUALITY ASSURANCE AND QUALITY CONTROL

To assess the reliability of the laboratory analytical data, one duplicate sample was taken for approximately every ten samples collected. Arcadis generated the duplicate soil samples by alternately placing approximately 10% of the sample volume into the primary sample container and then placing the same amount into the duplicate container. Arcadis continued placing aliquots of approximately 10% of the container volume into each container until both containers were filled. Parent and duplicate samples collected for BTEX/F1 analysis were collected side by side by inserting a plunger into an undisturbed area of the soil column and placing the soil from the plunger in their respective methanol vials. A trip blank and field blank were collected during the groundwater sampling program. Duplicate groundwater samples were collected by filling the duplicate sample bottles immediately after the primary sample was collected.

Analytical data quality was assessed by submission of the following soil and groundwater samples:

- Soil sample APRON1704 (primary) and APRONDUP01 (duplicate) were analyzed for BTEX and PHC fractions F1-F4;
- Groundwater sample MW13-7 (primary) and APRONDUP01 (duplicate) were analyzed for PHC fractions F1-F4, BTEX, PAHs, total alkalinity, nitrate-nitrite, ammonia nitrogen, oil and grease, total phenols, calcium, magnesium, sodium, potassium, chloride, sulphate, dissolved metals, total suspended solids and total dissolved solids analysis; and,
- The groundwater Trip Blank and Field Blank were analyzed for BTEX and PHC fractions F1-F4.

For each set of duplicates, the relative percent difference (RPD) was calculated using the following formula:

$$RPD = \frac{|X_1 - X_2|}{X_{average}} \times 100$$

where, X_1 and X_2 are the duplicate concentrations and $X_{average}$ is the mean of these two values. Results for duplicate analyses of field duplicate samples were considered acceptable where RPD values were <50% for soil duplicate analyses and <50% for water duplicate analyses, consistent with common industry practices.

RPDs can be calculated only when the compound is detected in both the original and the duplicate sample at a concentration above the method detection limit. Alternative criteria are used to evaluate duplicate pairs where one or both of the results is less than five times the detection or quantitation limit, or where one or both of the results is less than the detection or quantitation limit (i.e., nd or ‘not-detected’).

6 ENVIRONMENTAL MONITORING PROGRAM RESULTS

The following sections summarizes the analytical results for all samples collected during the 2017 Environmental Monitoring Program.

6.1 Nunavut Water Board Licence Requirements Sampling Results

6.1.1 Sump Water Analytical Results

Arcadis collected a grab sample (APRONSUMP) from the standing water around the Apron LTU sump in 2017. Sump water sample APRONSUMP met all applicable NWB Licence requirements and CCME FWALs for oil and grease, dissolved lead, total zinc, BTEX and PHC F1. Notably, concentrations of oil and grease, total zinc, BTEX and PHC F1 in sump water sample APRONSUMP were below the laboratory's reportable detection limits (RDLs) and the concentration of Dissolved Lead was only 2 times above the RDL (and 2 times below the CCME FWAL).

The Sump Water analytical results are presented in **Table 6**. Laboratory certificate of analysis including lab QA/QC results are included in **Appendix B**.

6.1.2 Soil Analytical Results

A total of seven soil samples (including one duplicate sample) were collected from the Apron LTU and submitted for the laboratory analysis of BTEX and PHCs. The soil samples were identified as: APRON1701, APRON1702, APRON1703, APRON1704, APRON1705, APRON1706 and APRONDUP01. Soil samples results were compared to both CCME FWAL guidelines and NWB License remediation requirements.

BTEX and PHC F1 concentrations in all soil samples were below the laboratory RDLs with the exception of soil sample APRON1704 and its duplicate (APRONDUP01). Soil sample APRON1704 and its duplicate had concentrations of benzene and ethylbenzene above the applicable CCME guidelines. Exceedances of benzene and ethylbenzene in sample APRON1704 were 1.3 and 17.1 times above the applicable CCME guidelines, respectively. In addition, concentrations of PHC F1 in sample APRON1704 and its duplicate exceeded both the applicable NWB License requirements and CCME guidelines. The PHC F1 exceedance factor for sample APRON1704 was around 2.6 times for both criteria.

Concentrations of PHC F2 were well below applicable CCME guideline and NWB License requirements for all soil samples except soil sample APRON1704 and its duplicate. PHC F2 concentrations in sample APRON1704 and its duplicate were close to 2 times in exceedance factor for both criteria.

Exceedances of PHC F3 were reported in one of the seven soil samples. Soil sample APRON1705 had a concentration of PHC F3 1.1 times the applicable CCME guideline and NWB License requirements. Soil sample APRON1702 and APRON1703 had a concentration of PHC F3 close to exceeding both criteria. Remaining soil samples APRON1701, APRON1704 and APRON1706 had PHC F3 concentrations at least 3 times below both the applicable CCME guideline and NWB License requirements.

Concentrations of PHC F4 in all seven soil samples were below applicable CCME guideline and NWB License requirements. Soil samples APRON1701 and APRON1704 had PHC F4 concentrations below the laboratory RDL. The remaining soil samples had PHC F4 concentrations at least 1.2 times below both applicable criteria.

The soil analytical results for PHCs are presented in **Table 8**. Soil exceedances are shown on **Figure 4**. Laboratory certificate of analysis including lab QA/QC results are included in **Appendix B**.

6.1.3 Groundwater Analytical Results

Groundwater samples were collected from four monitoring wells (MW13-1, MW13-7, MW13-8 and MW13-9), one located adjacent to the Apron LTU (MW13-1) and three located in the excavation area (W13-7, MW13-8 and MW13-9). The analytical results for the groundwater samples were compared to the CCME FWAL guidelines.

The concentration of BTEX, PHCs and PAHs in all 2017 groundwater samples were below applicable CCME FWAL guidelines and laboratory RDLs. However, concentrations of select dissolved metal parameters, dissolved chloride and phenols above the CCME FWAL guidelines were reported for some of the analyzed groundwater samples.

The following exceedances were detected in monitoring well MW13-1 located immediately adjacent to the west side of the Apron LTU in 2017:

- Dissolved iron concentration was 19 times greater than the CCME guideline of 0.3 mg/L;
- Dissolved chloride concentration was 4 times greater than the CCME guideline of 120 mg/L; and
- Phenols concentration was 3 times greater than the CCME guideline of 0.004 mg/L.

The following exceedances were detected in the monitoring wells located around the Apron excavation area in 2017:

- Dissolved uranium concentrations reported in groundwater samples MW13-7, MW13-8 and MW13-9 range between 1.1 and 3 times the applicable CCME guideline of 0.015 mg/L;
- Dissolved iron concentrations in groundwater samples MW13-7 and MW13-9 range between 4 and 25 times the CCME guideline of 0.3 mg/L;
- Dissolved copper concentration in groundwater sample MW13-7 was 2.5 times the applicable CCME guideline of 0.004 mg/L;
- Dissolved zinc concentration in groundwater sample MW13-7 was 1.1 times the CCME guidelines of 0.03 mg/L;
- Dissolved chloride concentrations in groundwater samples MW13-7 and MW13-9 range between 9 and 68 times the CCME guideline of 120 mg/L; and,
- Phenols concentrations in groundwater samples MW13-1, MW13-7 and MW13-8 range between 2 and 9 times the CCME guideline of 0.004 mg/L.

The groundwater analytical results are presented in **Tables 2 to 5.** Groundwater **e**xceedances for the Apron LTU and excavation area are shown on **Figure 4** and **Figure 5** respectively. Laboratory certificate of analysis including lab QA/QC results are included in **Appendix B**.

6.2 Per- and Polyfluoroalkyl Substance (PFAS) Sampling Results

One grab sample (APRONSUMP) was collected from the water around the Apron LTU sump during the 2017 field program and submitted for the laboratory analysis of PFASs. The analytical results for APRONSUMP were compared to applicable HS DWSV and FEQGs. The following three PFAS exceedances were detected:

- Perfluoroheptanoic Acid (PFHpA) concentration in sump sample APRONSUMP was 1.2 the HS DWSV of 0.2 µg/L;
- Perfluorohexanoic Acid (PFHxA) concentration in sump sample APRONSUMP was 1.7 times the of HS DWSV of 0.2 µg/L; and
- Perfluoropentanoic Acid (PFPeA) concentration in sump sample APRONSUMP were 2.5 times the of HS DWSV of 0.2 µg/L;

No exceedances of FEQGs were reported.

The Sump Water PFAS analytical results are presented in **Table 7**. PFAS exceedances are shown on **Figure 3**. Laboratory certificate of analysis including lab QA/QC results are included in **Appendix B**.

7 QUALITY ASSURANCE AND QUALITY CONTROL

Arcadis quantitatively assessed the analytical quality of the data through calculating the relative percent difference (RPD) between each sample and its duplicate. A summary of the analytical results for the original and duplicate samples, along with the calculated RPDs, are included in the analytical results.

7.1 Soil and Groundwater Duplicates

The calculated RPDs for soil and groundwater duplicates sample APRON1704 (primary) and APRONDUP01 (duplicate) were at a maximum of 26% which meets the 50% alert level. In addition, internal laboratory quality control for analyses meets acceptability criteria; therefore, based on both laboratory and field QA/QC results, Arcadis deems the data as reliable for its intended use. Laboratory QA/QC results are included in the laboratory certificates of analyses provided in **Appendix B**.

7.2 Groundwater Duplicates

The calculated RPDs for groundwater sample MW13-7 (primary) and APRONDUP01 (duplicate) were all below 34% and deemed acceptable by Arcadis. In addition, internal laboratory quality control for analyses meets acceptability criteria; therefore, based on both laboratory and field QA/QC results, Arcadis deems the data as reliable for its intended use. Laboratory QA/QC results are included in the laboratory certificates of analyses provided in **Appendix B**.

7.3 Trip blank and Field blank

Both the trip blank and a field blank reported non-detect concentrations for BTEX and PHC F1. These results suggest no cross-contamination occurred between samples during their transportation. Furthermore, the field blank results suggest ambient conditions at the site have not impacted sample results. The trip blank and field blank analytical results are presented in **Table 2.**

8 DISCUSSION AND RECOMMENDATIONS

8.1 Monitoring Well Condition

Arcadis made repairs to monitoring wells MW13-7 and MW13-9 during the 2017 Environmental Monitoring Program. Monitoring well MW13-7 is located on the east side of the Apron excavation area along the edge of an access road associated with the Cambridge Bay airport. This access road is maintained year-round and routinely used by heavy equipment. The flush mount casing for monitoring well MW13-7 was reset to allow for the removal of the well cap (refer to Photos 1 and 2 in **Appendix C**). Monitoring well MW13-9 is situated south of the Apron excavation area in a low-lying area prone to drainage issues. Arcadis extended the well riser on monitoring well MW13-9 by 0.55 m to prevent the top of monitoring well MW13-9 from being routinely submerged (refer to Photos 3 in **Appendix C**).

Arcadis assessed the condition of the casing, riser and well cap on all monitoring wells around the Apron LTU and excavation area. Table 8-1 provides a summary of well conditions observed in 2017.

Table 8-1. FTA LTU and Excavation Area Monitoring Well Condition

Well ID	Well Condition	Comment
MW13-1	No repairs required	No lock on well casing
MW13-2	No repairs required	No lock on well casing. Well riser is loose.
MW13-3	No repairs required	No lock on well casing
MW13-4	No repairs required	No lock on well casing
MW13-5	No repairs required	No lock on well casing
MW13-6	Unknown	Well could not be located
MW13-7	No repairs required	Well requires a new J-plug style well cap
MW13-8	Well riser is cracked, refer to Photo 4 in **Appendix C**.	Well requires a new 2-inch diameter PVC coupling and riser extension.
MW13-9	No repairs required	Well has no monument casing or lock (refer to Photo 3 in **Appendix C**)

Arcadis recommends that the riser on monitoring well MW13-8 be repaired and that a new J-plug style well cap be installed on monitoring well MW13-7 during the site's next scheduled monitoring program.

8.2 Groundwater Conditions

The groundwater in four of the five wells surrounding the Apron LTU was frozen during the 2017 field program. As such, the shallow horizontal groundwater flow direction under the Apron LTU could not be accurately calculated. Historically, the interpreted shallow horizontal groundwater flow beneath the Apron LTU was to the southwest. Groundwater monitoring results for the monitoring wells associated with the Apron LTU are shown in **Figure 2**.

Groundwater elevations measured in the monitoring wells surrounding the Apron excavation area ranged between 16.54 to 18.75 metres above mean sea level (m amsl). The interpreted shallow horizontal groundwater flow direction is towards the southeast at the Apron excavation area. Groundwater monitoring results for the Apron excavation area are shown in **Figure 3**.

No measurable thickness of light non-aqueous phase liquid (LNAPL) was identified in any of the monitoring wells and no sheens were observed on purged groundwater or groundwater samples after collection.

8.3 Hydrocarbon Degradation Assessment

Average hydrocarbon concentrations detected in the upper 0.35 m of soil in the Apron LTU in 2017 were comparable to 2016 PHC averages. Since 2015, the average concentration of PHC F1 and F2 in the Apron LTU's soil has dropped by more than 50%. Average PHC F2 and F3 concentrations have remained relatively constant between 2015 and 2017. Table 8-2 shows the average concentrations of PHC fraction F1 to F4 in the Apron LTU soil between 2015 and 2017.

Table 8-2: Average Soil Hydrocarbon Concentrations for the Apron LTU

Petroleum Hydrocarbons	NWB License Requirements - Commercial (mg/kg)	2015 Average Concentration (mg/kg)	2016 Average Concentration (mg/kg)	2017 Average Concentration (mg/kg)
F1 (C6 to C10)	300	1,062	33	245
F1 (C6 to C10 minus BTEX)	300	1,062	33	242
F2 (C10 to C16)	300	1,223	109	161
F3 (C16 to C34)	1,700	860	866	773
F4 (C34 to C50)	1,700	389	528	512

Notes:
(1) One half the detection limit was used for calculations when results were below RDLs.
(2) The PHC averages for 2016 are based on analytical results from soil samples collected pre-and-post Apron LTU tilling activities.
(3) PHC averages represent soil concentration in the Apron LTU between 0.0 and 0.35 m bgs (PHC concentrations below 0.35 m bgs have not been assessed)

The PHC F1 averages in 2017 are elevated above 2016 PHC F1 averages due to the analytical results from soil sample APRON1704. Soil sample APRON1704 was collected from a pocket of soil showing signs of hydrocarbon impacts (refer to Photo 5 and 6 in **Appendix C**). This pocket of hydrocarbon impacted soil was identified approximately 0.6 m bgs during the soil excavation activities (conducted for

water management purposes) around the Apron Sump. For more details regarding the 2017 soil excavation activities in the Apron LTU refer to the 2017 Remedial Activities Program report (Arcadis, 2017). Arcadis observed multiple pockets of soil with hydrocarbon staining within the excavation area around the Apron LTU's sump. The location and extent of the excavation area is shown in **Figure 2**.

The moisture content detected in the upper 0.35 m of soil in the Apron LTU in 2017 ranged between 9.4% and 12%. These levels are below the lower limit of moisture content of 20% typically required to support healthy microbial populations (USEPA, 1994). The optimal moisture content for PHC biodegradation ranges between 40% and 80% (GC, 2006). Arcadis recommends the continued practice of sump water recirculation to elevate soil moisture levels and help promote microbial growth in the Apron LTU's soil.

Nitrogen and phosphorus are essential for promoting the microbial activities needed for hydrocarbon degradation; however, excessive concentrations of these nutrients have been found to decrease the biodegradation rate (USEPA ,1994). Federal guidelines for landfarming petroleum contaminated hydrocarbon soil recommends the carbon- to-nitrogen-to- phosphorus ratio remain between 100:10:1 and 100:1:0.5 to encourage effective biodegradation. Table 8-3 shows average nitrogen and phosphorus concentration in the Apron LTU's soil along with the estimated effective nutrient ranges.

Table 8-3: Average Nutrient Concentrations for the Apron LTU's soil

Petroleum Hydrocarbons	Effective Nutrient Range for Apron LTU	2016 Average Concentration	2017 Average Concentration
Nitrogen (mg/kg)	160 - 16	860	780
Phosphorus (mg/kg)	16 - 6	7.5	7.2

Note:
(1) Carbon content used to derive the effective nutrient ranges for the Apron LTU was based on the average total petroleum concentration in the Apron LTU in 2017.
(2) The effective nutrient range is based on the Federal Guidelines for Landfarming Petroleum Contaminated Hydrocarbon (GC, 2006) and does not consider site-specific climatic conditions.

The average nitrogen concentration in the upper 0.35 m of soil in the Apron LTU is above the estimated effective nitrogen range. Conversely, the average phosphorous concentration is close to the lower limit of the estimated effective phosphorous range. Arcadis recommends no additional nutrients be added to the Apron LTU until average phosphorous concentrations drop below the lower limit of the estimated effective phosphorous range. Nutrient concentration should continue to be monitored during future monitoring programs.

Due to the heterogenous nature of the hydrocarbon impacts in the Apron LTU, Arcadis recommends the number of soil samples submitted for laboratory analysis from the upper 0.35 m bgs of the soil in the Apron LTU be increased to 15 samples to better assess the effectiveness of hydrocarbon degradation. In addition, Arcadis recommends 15 additional soil samples from the soil located below 0.35 m bgs be submitted for laboratory analysis. Select soil samples should be analyzed for nutrients, moisture, pH, bulk density, BTEX, and PHC Fractions F1 to F4.

8.4 Groundwater Contaminant Assessment

The 2017 groundwater analytical results are comparable to the 2014, 2015 and 2016 analytical results. The same groundwater parameters (i.e., dissolved copper, dissolved iron, dissolved uranium, dissolved zinc, dissolved chloride and phenols) have consistently been reported above the CCME FWAL guidelines since 2014. BTEX, PHC F1 - F4 and PAHs groundwater concentrations have consistently been reported as non-detect or well below the CWS-PHCs standards and the CCME FWAL guidelines.

No increasing or decreasing trends in the groundwater parameters analyzed can be established. The magnitude of the reported dissolved metal and phenol exceedances have remained relatively consistent between 2014 and 2017. The dissolved metals are likely a result of naturally elevated background concentrations while phenol exceedances in groundwater at the site are likely a result of anthropogenic concentrations. The 2017 dissolved chloride exceedances in monitoring wells MW13-7 and MW13-9 range between 9 and 68 times the applicable CCME guideline. These are the highest dissolved chloride exceedance factors reported for the four wells located around the Apron excavation area since 2014. The dissolved chloride exceedances may be due to road salt application practices used by the Cambridge Bay Airport.

Overall, 2017 analytical results do not suggest that the integrity of the Apron LTU's liner and berms has been compromised. No increasing or decreasing trends in the groundwater parameters analyzed can be established.

8.5 Sump Water Assessment

Analytical results for surface water sample APRONSUMP confirmed that the surface water around the Apron LTU's sump met the NWB Licence requirements for pH, oil and grease, dissolved lead, total zinc and BTEX. PFAS analytical results for surface water sample APRONSUMP indicated concentrations of PFHxA, PFHpA and PFPeA above the HC DWSV; however, the concentration of PFOS detected in surface water sample APRONSUMP was below the FEQC for aquatic receptors. Arcadis recommends that sump water not be discharged to the ground surface outside the Apron LTU until the risk associated with the PFAS impacts are assessed.

8.6 Recommendations

Arcadis recommends the following future work at the Apron LTU and Apron Excavation Area:

1. To continue to be in compliance with the NWB License requirements and identified chemicals of concern, a groundwater monitoring program must be completed at the Apron LTU and Excavation Area to assess the parameters set out in the license. Attempts should be made to sample the monitoring wells during freshet conditions and during warmest weeks at Cambridge Bay, when liquid groundwater conditions are more probable and when groundwater levels are presumed to be at their highest to further evaluate groundwater trends. Based on temperature statistics obtained from ECCC, this sampling time period would occur in mid-July.

2. Due to the heterogenous nature of the PHC impacts in the Apron LTU soil, Arcadis recommends that the number of soil samples submitted for laboratory analysis from the upper 0.35 m bgs of the soil in the Apron LTU be increased to 15 samples to better assess the effectiveness of PHC degradation. In addition, Arcadis recommends 15 additional soil samples be submitted for laboratory analysis from the soil located below 0.35 m bgs. Select soil samples should be analyzed for moisture, pH, bulk density, BTEX, and PHC Fractions F1 to F4.

3. Arcadis recommends that the riser on monitoring well MW13-8 be repaired. We recommend that a new J-plug style well cap be installed on monitoring well MW13-7 during the site's next scheduled monitoring program.

9 LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by Arcadis Canada Inc. (Arcadis) for Public Services and Procurement Canada [(PSPC) formerly Public Works and Government Services Canada (PWGSC)] and Transport Canada (TC). It is intended for the sole and exclusive use of PSPC/TC. Any use, reliance on or decision made by any other person other than PSPC/TC based on this report is the sole responsibility of such other person. PSPC, TC and Arcadis make no representation or warranty to any other person with regard to this report and the work referred to in this report and they accept no duty of care to any other person or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other person as a result of the use of, reliance on, any decision made or any action taken based on this report or the work referred to in this report.

This report has been prepared in accordance with generally accepted engineering and environmental practices for the exclusive use of PSPC/TC. This report is based on the historical information provided and information obtained during this work program.

Third party information reviewed and used to compile the data and conclusions contained in this report is assumed to be complete and correct. Arcadis used this information in good faith and will not accept any responsibility for deficiencies, misinterpretation or incompleteness of the information contained in documents prepared by third parties.

The investigation undertaken by Arcadis with respect to this report and any conclusions or recommendations made in this report reflect Arcadis' judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for specific application to the site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken. Notwithstanding these limitations, this report is believed to provide a reasonable representation of activities completed and site conditions as of July and August 2017.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

Other than by PSPC/TC, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of Arcadis. Nothing in this report is intended to constitute or provide a legal opinion.

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TABLES

FIGURES

APPENDIX A

Laboratory Response to Sampling and Quality Control Protocols

APPENDIX B

Certificates of Analysis

APPENDIX C

Site Photographs

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