COMPLETION REPORT

REMEDIATION of the CONTWOYTO LAKE FORMER WEATHER STATION, NUNAVUT

Prepared for:

Public Works and Government Services Canada

Prepared by:

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ARCADIS
Infrastructure · Water · Environment · Buildings

March 2016

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Prepared for:

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ARCADIS Project No.: 350600-508
PWGSC Project No.: R.057569

March 2016

EXECUTIVE SUMMARY

ES1 INTRODUCTION

SENES Consultants (now Arcadis Canada Inc. and referred to as Arcadis henceforth) was retained by Public Works and Government Services Canada (PWGSC) to provide contract administrative support including the provision of resident engineering services for the duration of the remedial work at the Contwoyto Lake former weather station site. The consultancy services were in accordance with the terms and conditions of the Supply Arrangement (PWGSC Contract EW699-121587/002/NCS) between Arcadis and PWGSC.

The remedial works at the former weather station were completed in the summer of 2014 with off-site transport of equipment, machinery, and waste materials occurring in March 2015.

ES2 REMEDIATION PROGRAM OVERVIEW

The remedial works at the former weather station site were based on the Remedial Action Plan (RAP) developed by Arcadis and included:

- Hazardous material abatement;
- Demolition of four structures;
- The excavation and on-site treatment of petroleum hydrocarbon (PHC)-impacted soils;
- The collection and consolidation of discarded drums and residual contents;
- Waste debris collection, consolidation, packaging, and off-site transport;
- The excavation, packaging, and off-site transport of metals-impacted soils ; and,
- The backfill and regrading of excavated areas to reinstate former grades across the site.

ES3 LOCATION

The Contwoyto Lake weather station was located on the northwestern shore of an unnamed island approximately one third of the way northbound on Contwoyto Lake in the Kitikmeot Region of Nunavut (see Figure 1, Appendix A). The 37.4 ha site is located on Crown land. The island is approximately 380 ha in size.

The site is approximately 330 km southeast of Kugluktuk, Nunavut; 400 km northeast of Yellowknife, Northwest Territories, and 50 km southeast of the Lupin mine site (see Figure 2, Appendix A).

ES4 TIMELINE

The Contwoyto Lake weather station was originally a small camp built by Pacific Western Airlines (PWA) during the Distant Early Warning (DEW) Line Site construction era c. 1956.

PWA operated the site until 1978, when Transport Canada (TC) acquired the site to establish a telecommunications and navigational aid station. A few years later, TC abandoned the site to establish a non-directional beacon (NDB) air navigation aid at the nearby Echo Bay Mines - Lupin Site. In 1984, the Kugluktuk (formerly Coppermine) Hunters and Trappers Organization (HTO) took over responsibility for the site buildings and established it as an outpost camp.

In the 1990s, the Department of Indian and Northern Development (DIAND) conducted inspections of the site. The DIAND reports stated that the site was in poor condition and cleanup was recommended. A combined Phase I and II Environmental Site Assessment (ESA) was conducted in the summer of 2010 by WESA Inc. (WESA). A Phase III ESA and Archaeological Impact Assessment (AIA) were completed in the summer of 2012 by SENES Consultants Ltd. (SENES) and Golder Associates (Golders), respectively. These documents, along with a community meeting held in Kugluktuk in January 2013, were the basis of the RAP and remedial specifications.

A remediation contractor, Delta Carter Joint Venture (DCJV), was selected by PWGSC in 2013. The remedial project began in April 2014 with mobilization via Hercules aircraft from Yellowknife to the Lupin mine site and the subsequent winter road construction from Lupin to the former weather station island. The remedial works occurred during the summer of 2014 with final demobilization of equipment and materials occurring March 2015. Table ES-1 summarizes the timeline of the remedial project.

Table ES-1: Remediation Timeline

Item	Date
Mobilization via Winter Road from Lupin Mine	**April 2 – 18, 2014**
Remedial Works	**July 4 – August 31, 2014**
Demobilization via Winter Road to Yellowknife	**March 25 – 29, 2015**

ES5 SITE INFRASTRUCTURE AND QUANTITIES OF MATERIALS

The site consisted of five buildings, a radio tower, two main debris areas, an airstrip, and four drum caches. The structures included a hunting cabin (Structure 01) located on the peninsula at the northwest corner of the site, the main building (Structure 02) located in the centre of the site, a generator building (Structure 03) located east of the main building and two small 'ham radio' shacks (Structures 04 and 05) located southeast of the main building. The radio tower was previously cut into sections which were located near the shoreline south of the main camp area. The locations of the buildings and site features including the 10 zones identified during the ESA phase which contained impacted soils are shown on Figure 3, Appendix A.

Structure 01, the hunting cabin, was not demolished and was not included as part of the remediation project at the request of the Kugluktuk HTO. Additionally, INAC requested that the unmaintained airstrip continue its viability as an emergency airstrip during and after remedial works. Thus, the hunting cabin on the peninsula and the airstrip on the esker remain.

In total, 2100 m^3 of PHC-impacted soils were excavated and treated; 84 m^3 of metals-impacted soils were excavated and transported off-site; 13.5 m^3 of hazardous materials were segregated, consolidated, and transported off-site; and, 123 m^3 of non-hazardous debris and demolition waste were gathered and transported off-site along with 367 drums. The material volumes and quantities are summarized in Table ES-2, ES-3, and ES-4 for soil, waste, and borrow material used, respectively.

Table ES-2: Soil Volumes

ZONE #	VOLUME OF METALS-IMPACTED SOILS EXCAVATED[1,2]	VOLUME OF PHC-IMPACTED SOILS EXCAVATED[3]
Impact Zone 01	**0 m^3**	**0.10 m^3**
Impact Zone 02	**0.25 m^3**	**0.25 m^3**
Impact Zone 03	**24 m^3**	**1636 m^3**
Impact Zone 04	**0 m^3**	**360 m^3**
Impact Zone 05	**0 m^3**	**4 m^3**
Impact Zone 06	**42 m^3**	**26 m^3**
Impact Zone 07	**5 m^3**	**5 m^3**
Impact Zone 08	**9 m^3**	**25 m^3**
Impact Zone 09	**4 m^3**	**0 m^3**
Impact Zone 10	**0 m^3**	**43 m^3**
TOTAL	**84 m^3**	**2100 m^3**

1. Metals-impacted soils were excavated and consolidated during the summer of 2014.
2. Metals-impacted soils were transported off-site in March 2015.
3. PHC-impacted soils were excavated and treated during the summer of 2014.

Table ES-3: Quantities of Waste

ITEM	QUANTITY
Drums[1]	**367**
Hazardous Material[2]	**13.5 m^3**
Non-Hazardous Debris and Demolition Waste[2]	**123 m^3**

1. 253 drums transported off-site in April 2014, remainder transported off-site in March 2015.
2. Consolidated during the summer of 2014, transported off-site in March 2015.

Table ES-4: Volume of Borrow Material Used

ITEM	QUANTITY
Borrow Material[1] Used for Backfill and Regrading	2831 m^3

1. Borrow source located on the esker, east of the former camp, and west of the unmaintained airstrip (See Figure 2, Appendix A).

ES6 PROJECT TEAM

Table ES-5: The Project Team

ELEMENT	COMPANY/GROUP	RESPONSIBLE PERSONS
Site Custodian	Indigenous and Northern Affairs Canada (INAC), Nunavut Region Iqaluit, NU	Erika Solski, Dele Morakinyo
Owner's Representative	Public Works and Government Services Canada (PWGSC) Yellowknife, NT	Janice Lee, Michael Bernardin
Remediation Contractor	Delta Carter Joint Venture (DCJV) Yellowknife, NT and Hay River, NT	Robert Johnson, Shawn Carter
Site Quality Assurance	Arcadis Canada Inc. Yellowknife, NT and Richmond Hill, ON	Charles Gravelle, Jason Mauchan

ES7 REGULATORY CONSIDERATIONS

Water License #1BR-CLR1419, Type B was issued by the Nunavut Water Board (NWB) to Aboriginal Affairs and Northern Development Canada (AANDC)[1] on May 16, 2014. The license permits the use of fresh water from Contwoyto Lake at 15 m^3 per day until expiry on May 15, 2019. The licence stipulates various requirements such as recording the volumes of fresh water collected, adhering to the monitoring program, and filing an annual report. Two separate documents, one for each year of the remedial works, are attached within Appendix B. The first, dated March 2015, was entitled "*Contwoyto Lake former Weather Station 2014 Annual Report for the Nunavut Water Board*". The second, entitled "*Contwoyto Lake former Weather Station 2015 Annual Report for the Nunavut Water Board*" is dated November 2015.

For a summary of the annual reports and further details pertaining to the water license, see Section 4.1.

Land-Use Permit (LUP) #N2013U0028 was issued by Nunavut Land Administration to INAC effective April 1, 2014. The permit allowed for remedial works to occur on the lands of the Contwoyto Lake former weather station site such as collecting waste debris material, using borrow material for regrading purposes, burning untreated wood, and having a temporary camp. For further details of the LUP, see Section 4.2.

Inuit Owned Land (IOL) exemption certificate #KTX114X004 was issued by the Kitikmeot Inuit Association (KitIA) to INAC on April 3, 2014. The exemption certificate allowed for remedial works such as debris collection to be carried out on the extents of the island beyond the original weather station site boundaries. Two separate documents, one for each year of the remedial works, are attached within Appendix B. The first, dated March 2015, was entitled "*Contwoyto Lake former Weather Station 2014 Annual Report for the Kitikmeot Inuit Association*". The second, entitled "*Contwoyto Lake former Weather Station 2015 Annual Report for the Kitikmeot Inuit Association"* was dated November 2015.

For a summary of the annual reports and further details pertaining to the IOL exemption certificate, see Section 4.3.

The Water License, LUP, and IOL exemption certificate documents are included within this report as Appendix B.

[1] At the end of the 2015 calendar year AANDC officially changed their name to Indigenous and Northern Affairs Canada (INAC) and will be referred to as INAC henceforth in this report.

ES8 COMMUNITY MEETINGS

A community meeting was held in Kugluktuk on January 15, 2013. The meeting was held after the environmental site assessment findings and during the planning stages of the RAP.

A second community meeting was held after the remedial works and demobilization occurred. The meeting was held in Kugluktuk on October 21, 2015.

ES9 BASELINE SAMPLING

Prior to remedial works involving excavation, baseline samples were collected in April and early July 2014. Soil samples were collected from the treatment cell area, fuel cache area, and the contractor's camp location. These locations are shown on Figure 3, Appendix A. At the end of the summer construction season once remedial works were completed, soil samples were collected from similar locations. Analytical summary tables are included in Appendix C. Full laboratory certificates are provided in Appendix D.

ES10 CONFIRMATORY SAMPLING

The ESA work identified 10 zones of impacted soil at the former weather station site. The impact zones contained elevated concentrations of metals and/or PHCs. These areas, referred to as Soil Impact Zone 01 through Soil Impact Zone 10, were excavated during the 2014 summer construction season.

Confirmatory soil samples were collected from base and side walls of excavations to confirm the removal of the impacted soil. In total, 189 samples were collected as confirmatory samples. Samples were analyzed both on and off-site. On-site, samples were analyzed for Total Petroleum Hydrocarbons (TPH) using PetroFlag^{TM} test kits. Off-site, samples were shipped to Maxxam Analytics Ltd (Maxxam) for metals and petroleum hydrocarbons (PHC) testing. Maxxam is an accredited laboratory with the Canadian Association for Laboratory Accreditation Ltd. (CALA).

Analytical results were compared to AMSRP and CCME Table 1 values for an agricultural land use. Confirmatory data are summarized in Tables within Appendix C. Laboratory certificates are attached as Appendix D.

ES11 THE WAY FORWARD

It is recommended that long-term monitoring to be carried out in order to provide INAC ongoing assurance that the remediation works are performing as designed. It is recommended that in order to determine the long-term monitoring plan requirements, the following occur in 2016.

- Surface water samples collected for total and dissolved metals at four monitoring locations; and
- Inspection of the regraded lands which were part of the excavation works and treatment works on the esker (to coincide with surface water sampling event).

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1.0 INTRODUCTION

1.1 BACKGROUND

The former weather station site at Contwoyto Lake was remediated during the summer of 2014. Mobilization of equipment and materials occurred the preceding winter and demobilization was completed in March 2015. The site is situated within Nunavut in the Kitikmeot Region. The site operated as a weather station from c. 1956 to c. 1982.

1.1.1 Location

The Contwoyto Lake former weather station site is located at easting 528831 and northing 7262678 in UTM zone 12W. The site is approximately 330 km southeast of Kugluktuk. And 400 km northeast of Yellowknife (see Figure 1, Appendix A). The Lupin mine site is 50 km northwest (see Figures 2, Appendix A).

The site is situated on an unnamed island and covers an area of approximately 37.5 ha, extending from the peninsula on the west end of the island to the eastern end of the unmaintained airstrip on the esker (see Figure 3, Appendix A).

1.1.2 Operational History

The Contwoyto Lake weather station was originally built c. 1956 by PWA during the DEW-Line era. PWA operated the weather station until 1978, when TC acquired the site to establish a telecommunications and navigational aid station. A few years later, TC abandoned the site, for the more economical option of establishing an alternative air navigation aid at the nearby Lupin mine site. In 1984, the Coppermine HTO took over responsibility for the site buildings and established it as an outpost camp.

1.2 SITE ACCESS

The mobilization of heavy equipment occurred through a combination of aircraft and winter road construction. Hercules aircraft transported heavy equipment to Lupin mine in April 2014. Subsequently, a winter road approximately 50 km in length was constructed to mobilize the heavy equipment and machinery brought to Lupin.

Throughout the summer construction season, the site was typically accessed by twin otter aircraft on floats originating from Yellowknife. Twin otter airplanes delivered supplies and personnel on generally a weekly basis throughout the summer.

1.3 SUMMARY OF REMEDIATION ACTIVITIES

The remedial work at the Contwoyto Lake former weather station involved:

- Collection, containerization, and off-site transport of the formerly used radio tower;
- Abatement of hazardous building materials such as wood with PCB and lead-amended paints;
- Collection, segregation, containerization, and off-site transport of hazardous waste including batteries, compressed gas cylinders, and paint cans;
- Demolition of the existing structures apart from the HTO cabin (Structure 01);
- Collection, containerization, and off-site transport of non-hazardous demolition debris and non-hazardous waste debris;
- Excavation and on-site remediation of soil impacted with petroleum hydrocarbons;
- Excavation, packaging, and off-site transport of soil impacted with metals;
- Collection and off-site disposal of drum contents;
- Washing empty drums;
- Collection, segregation, and burning of untreated wood waste; and,
- Backfill, grading, and compaction of excavated areas to reinstate former grades across the site.

For details on the program, refer to the Specifications for Site Remediation (PWGSC, 2013) and the RAP (SENES, 2013a). A full reference list is provided below as Section 7.0. Photographs showing the remediation activities are attached as Appendix E.

1.4 THE PROJECT TEAM

Table 1-1 presents the project team for the remediation program.

Table 1-1: Project Team

Element	Company/Group	Responsible Persons
Site Custodian	Aboriginal Affairs and Northern Development Canada, Nunavut Region (Iqaluit, NU)	Erika Solski, Dele Morakinyo
Owner's Representative	Public Works and Government Services Canada (Yellowknife, NT)	Janice Lee, Michael Bernardin
Remediation Contractor	Delta Carter (Yellowknife, NT and Hay River, NT)	Robert Johnson, Shawn Carter
Site Quality Assurance	Arcadis (Yellowknife, NT and Richmond Hill, ON)	Charles Gravelle, Jason Mauchan

1.5 COMPARISON CRITERIA

Comparison criteria were utilized during both assessment and remedial phases. The following documents and classifications were used during the remedial phase.

PHCs in soil

- Soil quality with respect to PHCs Fraction 1 to Fraction 4 (F1-F4) was compared to *Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil* (CCME, 2008) – Tier 1 agricultural land use, coarse-grained soil;
- Soil quality with respect to BTEX was compared to Canadian Council of Ministers of the Environment (CCME) *Canadian Soil Quality Guidelines (CSQG) for the Protection of Environmental and Human Health* – agricultural land use, coarse-grained soil, 2004; and
- The *Abandoned Military Site Remediation Protocol* (AMSRP) Remedial Objectives

Metals in soil

- Soil quality with respect to metals was compared to *CSQG for the Protection of Environmental and Human Health* (CSQG; CCME, 2007) for agricultural land use; and
- The AMSRP which lists the DEW-Line Clean-up Criteria (DCC), Tier I and II

During the ESA phase, sediment and surface water quality were analyzed and compared to the Canadian Freshwater Interim Sediment Quality Guidelines (ISedQG) for the Protection of Aquatic Life and CCME Canadian Water Quality Guidelines (CWQG), respectively. The Phase III ESA determined that sediment and surface water were not adversely impacted by historic activities (SENES, 2013b). As a result, sediment and surface water were not sampled during the remedial works.

A summary of the comparison criteria documents for respective media is presented below as Table 1-2.

Table 1-2: Comparison Criteria References

Medium	Comparison
Soil	CCME CSQGs Agricultural (metals, BTEX) CCME CWS Tier 1 coarse grained (PHCs) AMSRP Remedial Objectives (PHCs) AMSRP (DCC[1] metals)
Surface Water	CCME CWQG
Sediment	CCME ISedQG
Vegetation	Background
Drum Contents	AMSRP
Building Materials	Government of Nunavut (Asbestos) Health Canada (PCBs, Pb)
Grey Water[2]	Water License Part D, Item 12

1. DCC metals criteria as per the AMSRP are the same criteria as per Table 1 in the water license.
2. Grey water produced during remedial construction works was containerized for off-site transport to Yellowknife. Grey water was not released to the environment during remedial works.

2.0 WORK SITE HEALTH AND SAFETY

2.1 SITE SPECIFIC HEALTH AND SAFETY PLAN

Health and Safety of the workers employed for the program was of paramount concern to the project management team. As such, a site specific health and safety plan (SSHASP) was developed prior to mobilization (DCJV, 2014a). The plan detailed expected job hazards, recommended safety measures, safe work practices, emergency procedures and personal protective equipment requirements.

All new workers arriving at Contwoyto Lake completed an orientation seminar on-site. The seminar (DCJV, 2014b) was conducted repeatedly at the site and covered topics including:

- an overview of the Contwoyto Lake site;
- the history of the Contwoyto Lake weather station;
- project communication, organization and administration;
- remediation activities and scope of work;
- work specific task requirements;
- site specific health and safety
- personal protective equipment (PPE);
- radio communication protocols;
- Workplace Hazardous Material Information System (WHMIS); and
- environmental protection.

Within the first 24 hours of being on-site, all workers completed the orientation seminar.

The worker orientation seminar handout, along with other contractor submittals such as the SSHASP, is presented within Appendix F.

2.2 DAILY TAILGATE MEETINGS

Each work day began with a safety meeting (tailgate meeting) led by the site supervisor. During the safety meeting the activities for the day were outlined and safety topics were discussed. DCJV incorporated daily record keeping of the tailgate meeting in their health and safety binder. The safety topics varied according to the remediation activities scheduled. The tailgate meetings included safety topics such as potential safety hazards regarding the day's work, bear fence operation, PPE, general hygiene, and input from the site workers. The development of procedures and protocols to mitigate hazards also included worker feedback.

The items discussed in the daily tailgate meeting were recorded within the daily reports, attached as Appendix H.

2.3 WEEKLY CONSTRUCTION MEETING

During the course of the site work, a weekly construction meeting, incorporating health and safety, was conducted. The site supervisor, foreman, field technician, and departmental representative attended the weekly meeting. During these meetings, the work completed was documented, any incidents were reviewed, and selected health and safety topics were discussed.

Weekly construction meeting minutes are presented within Appendix H.

2.4 PERSONAL PROTECTIVE EQUIPMENT (PPE)

All personnel were required to wear the appropriate PPE, which at a minimum consisted of a CSA approved safety hard hat, CSA certified footwear Grade 1 approved, safety glasses and reflective clothing. Workers were also required to wear other safety equipment including hearing protection, or dust masks depending on the nature of the work.

For work involving handling hazardous materials, workers were required to wear additional safety equipment including:

- Tyvek coveralls;
- Half face-piece respirator with NIOSH approved P100 filter; and
- Nitrile gloves;

A decontamination area was established outside of the building demolition area during the hazardous material removal. Eating, drinking, smoking and chewing tobacco were controlled by setting aside breaks for these activities. Tyvek coveralls were disposed of daily.

2.5 WILDLIFE SAFETY

A wildlife response plan was developed for the remediation work that addressed potential encounters, firearm protocols, basic safety principles, social responsibilities of a firearm user, preventing and responding to bear encounters and minimizing the impact on wildlife.

An electric bear fence was installed around the camp perimeter which was activated every evening and deactivated every morning prior to the safety meeting. To reduce the risk of attracting wildlife, food scraps were burned each day in the incinerator by the peninsula, and workers were required to return all food waste from the work site to camp disposal facilities.

No bears were seen during the course of the remediation project.

2.6 INCIDENTS

Two minor incidents occurred on-site during the remedial works. The first incident occurred on July 7, 2014 and involved a cut to the eyebrow/forehead of one of the labourers during demolition work. The second incident occurred on July 12, 2014 and involved a minor burn to the leg of one of the labourers while cutting metal. Both incidents were treated by the on-site medic and recorded. The incident reports are included within Appendix F.

2.7 ENVIRONMENT, HEALTH AND SAFETY AUDIT

An Environment, Health, and Safety Audit was conducted at the Contwoyto Lake former weather station by WESA during the remedial work. The inspection occurred on July 15, 2014. The compliance audit report outlined legal non-compliance (LCN) and non-conformance (NC) to regulations and standards as well as Areas for Improvement (AI) and positive findings. The report recommendations were acted upon in a timely manner and included action items such as improving the on-site signage, posting the permits and licenses, and thoroughly labelling the consolidated waste materials. The audit report is included as Appendix G.

3.0 REMEDIATION ACTIVITIES

3.1 TIMELINE

A community meeting was held in Kugluktuk on January 15, 2013. The meeting was held after the environmental site assessment findings and during the planning stages of the RAP. The community meeting presentation slides, which were prepared by INAC, are attached within Appendix I.

The on-site remedial program commenced in April 2014 with the mobilization of heavy equipment and supplies to site via Lupin Mine. The heavy equipment and supplies were mobilized by aircraft to Lupin from Yellowknife. A winter road was constructed from Lupin Mine to the former weather station island. Mobilization occurred April 2 to 18, 2014. The mobilization route is shown on Figure 2, Appendix A. The mobilization plan is attached within Appendix F, contractor submittals.

Site remedial works were completed from July 4 to August 31, 2014. Personnel and light equipment were mobilized to site via Twin Otter aircraft from Yellowknife on generally a weekly basis.

Demobilization occurred March 25 to March 29, 2015. Equipment, supplies, and consolidated waste materials were transported off-site to Yellowknife via a winter road. The demobilization plan is attached within Appendix F, contractor submittals.

A second community meeting was held after the remedial works and demobilization were completed. The meeting was held in Kugluktuk on October 21, 2015. Questions asked during the community meeting are included within Appendix I.

3.2 REMEDIATION ACTIVITIES BY QUANTITY

Part of the basis of payment schedule for remediation activities were on a unit cost. These items included collection of drums, excavation and off-site transport of metals-impacted soils, excavation and on-site treatment of PHC-impacted soils, and backfill. A summary of remedial activities and their respective quantities is presented in Table 3-1.

Table 3-1: Summary of Quantities

Activity	Quantity
Number of drums collected and transported off-site	367 drums
Volume of PHC-impacted soil excavated and remediated on-site	2100 m^3
Volume of metals-impacted soils excavated, packaged, and transported off-site	84 m^3
Volume of non-hazardous debris and demolition waste consolidated, packaged, and transported off-site	123 m^3
Volume of hazardous waste consolidated, segregated, and transported off-site	13.5 m^3
Volume of backfill used	2831 m^3

3.3 BASELINE SAMPLING

Baseline soil samples were collected prior to remedial works from the temporary fuel cache area (FC-1, FC-2), treatment cell area (LFB-1 through LFB-6), and remedial contractor's camp area (C-1, C-2). These samples were used to assess the hydrocarbon concentrations, if any, in soils prior to areas receiving fuel storage, PHC-impacted soils, and temporary structures for the fuel cache, treatment cell, and camp facilities respectively.

There were no elevated levels of hydrocarbons in baseline sample soils collected. Summaries of the baseline soil analyses conducted and data results are presented below in Table 3-2, and within the Appendix C data summary tables, respectively.

Table 3-2: Baseline Analytical Regime

Area	PHC (Testkit)	PHC (lab)	Metals (lab)	Total
Baseline	5	9	2	16

3.4 REMEDIATION OF SOIL IMPACT ZONES

Soil Impact Zones 01 through 10 were identified during the ESA phase (see Figure 3, Appendix A). Impact Zone 01 and 02 were located on the peninsula. The remainder were located in the general vicinity of the former camp. The demarcation lines of the impacted areas were based on the analytical data from soil samples collected during the 2010 and 2012 ESAs. The volume of impacted soils excavated from each impact zone is listed in Table 3-3.

Table 3-3: Volume of Impacted Soil

Impact Zone	Metals Impact	PHC Impact
	Volume	
01	0 m^3	0.1 m^3
02	0.25 m^3	0.25 m^3
03	24 m^3	1636 m^3
04	0 m^3	360 m^3
05	0 m^3	4 m^3
06	42 m^3	26 m^3
07	5 m^3	5 m^3
08	9 m^3	25 m^3
09	4 m^3	0 m^3
10	0 m^3	43 m^3
Total	**84 m^3**	**2100 m^3**

Metals-impacted soils were excavated for off-site transport. Metals analyses of soils for confirmation purposes were performed solely by Maxxam. In total, 84 m^3 of metals-impacted soils were removed.

PHC-impacted soils were excavated for on-site treatment. PHC analyses of soils were conducted using both on-site PetroFlag™ test kits and Maxxam. In total, 2100 m^3 of PHC-impacted soils were excavated and treated.

To confirm the extents of the impacted soil, 189 soil samples were collected for analyses during the excavation works. Samples were collected in order to confirm the lateral and vertical extents of the impacts. Table 3-4 is a summary of the samples collected from the individual impact zones.

Table 3-4: Soil Impact Zones Analytical Regime

Area	PHC (Testkit)	PHC (lab)	Metals (lab)	Total
Zone 01	0	0	0	0
Zone 02	0	1	1	2
Zone 03	56	49	1	106
Zone 04	16	17	0	32
Zone 05	0	4	0	4
Zone 06	0	7	1	8
Zone 07	0	5	1	6
Zone 08	2	7	1	10
Zone 09	0	3	1	4
Zone 10	9	7	0	16
Total	**83**	**100**	**6**	**189**

The data from the confirmatory samples are summarized within Appendix C Tables C-1, C-2, and C-3 for metals, PHCs, and test kits, respectively. The full laboratory reports are attached as Appendix D.

Soil sample concentrations were compared to Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for an agricultural land use and the AMSRP.

At the on-set of the remedial works it was considered unlikely that the metals impact on soils had varied significantly as compared to the ESA work in the previous years, whereas it was considered more likely that PHC impacts may have increased due to seasonal fluctuations in permafrost and the general mobile nature of fuel contaminants.

3.4.1 Impact Zone 01

Soil Impact Zone 01 was located on the peninsula on the north side of Structure 01 at Stain 01 (see Figure 3, Appendix A). The 0.1 m^3 of PHC-impacted soil was excavated by hand on July 9,

2014 and directed by visual observations and photo-ionization detector (PID) readings. No samples were collected.

3.4.2 Impact Zone 02

Soil Impact Zone 02 was located south of Structure 01 at Burn Pit 01 (see Figure 3, Appendix A). Impact Zone 02 was initially excavated by hand on July 9, 2014 to a depth of 0.2 m. The old burn pit contained ash and metals-impacted coarse-grained soils which were packaged for off-site transport. At the base of the initial excavation, sample BP-1 was collected. Sample BP-1 contained 2.2 ppm boron in soil which is greater than the CCME Table 1 agricultural land use value of 2.0 ppm. Note that the AMSRP does not list a value for boron. The old burn pit was further excavated to 0.5 m with excavated materials packaged for off-site transport.

As a conservative approach, and based on slightly elevated PID readings, soils were dug out around the burn pit excavation to a depth of 0.8 m and transported to the treatment cell. Soil sample 'Zone 2 BP-1' was collected from the excavation at a depth of 0.8 m and contained concentrations of hydrocarbons below method detection limits (MDLs).

In total, there was 0.5 m^3 of soil removed from Impact Zone 02.

3.4.3 Impact Zone 03

Soil Impact Zone 03 was centred beneath Structure 03, the Generator Building (see Figure 5, Appendix A). Excavation of Zone 03 began on July 17, 2014. The extent of the metals impact within Zone 03 was determined through sampling and analytical work at the ESA phase combined with a sample (Z3M) collected from the base of the excavation on July 18, 2014. The metals-impacted soils were packaged for off-site transport.

Moderate hydrocarbon odours and elevated PetroFlag™ readings were observed in the excavation at the initial extents of the Zone 03 PHC-impact. The excavation was therefore expanded laterally beyond the initial extents. The excavation was also expanded vertically due to the observation of oily bubbles coming up from the permafrost at 1.0 m below ground level (bgl). The permafrost layer was scraped down in the areas of visual observations of hydrocarbons and elevated PID readings. Lateral and vertical extents of the PHC impact were sampled for PetroFlag™ analyses and shipment off-site to Maxxam.

There were 40 soil samples collected at 1.1 m bgl within Impact Zone 03 for analysis by Maxxam. Sample locations S1, S3, S12, S17, S25, S34, S37, and S40 contained elevated concentrations of hydrocarbons (see Figure 5A, Appendix A).

A secondary excavation was completed in areas of soils containing elevated PHC concentrations. The secondary excavation was to a depth of 1.6 m bgl. Samples at the second level were given the same sample number with 'b' nomenclature. Beneath the building footprint at 1.6 mbgl, hydrocarbon concentrations were up to 14,000 ppm as per S-17b and therefore further excavation was required (see Figure 5B, Appendix A). Further excavation to a depth of 1.9 m bgl was completed if elevated concentrations of PHCs were reported or PID readings were elevated. The excavation continued down beneath the former building footprint due to elevated PetroFlag™ readings at 1.9 m bgl through 2.9 m bgl.

The Zone 03 soil samples collected beneath the former building footprint at 3.05 m bgl contained concentrations of hydrocarbons less than the applicable soil standards. The maximum depth of the excavation was 3.05 m bgl at soil sample level 'h' (see Figure 5C, Appendix A). In total, 106 samples were collected from Impact Zone 03 for test kit and Maxxam analyses. The analytical data is summarized in Appendix C tables.

The Impact Zone 03 excavation was larger than originally anticipated. It was surmised that historic spills from the operational era had been captured within the permafrost below Structure 03 as a result of heat in the buildings ceasing when the site was shut down c. 1982 and subsequent rise in the permafrost level. As the excavation deepened during remedial operations of 2014, hydrocarbons were released from the permafrost as was observed by oil bubbles coming to the surface on the base of the excavation. In total, 1636 m^3 of PHC-impacted soils were excavated from Zone 03 and transported to the treatment cell.

The Zone 03 excavation was the only Impact Zone to require dewatering at the base of the excavation. The majority of the water at the base was the result of melting permafrost and precipitation with a minimal amount contributed from groundwater infiltration. The ponded water at the base of the excavation was pumped into drums contained within Overpacks and used as mixing water for nutrients added to the treatment cell soil. The remedial contractor's hydrocarbon treatment plan involved adding monoammonium phosphate (MAP) mixed with water to the PHC-impacted soils within the treatment cell (DCJV, 2014c). Approximately 1,500 L were pumped and added to the treatment cell with the MAP as part of the nutrient amendment regime. The contractor's hydrocarbon treatment plan is included within Appendix F.

The excavation work and subsequent backfill and regrading of Impact Zone 03 were carried out between July 17 and August 11, 2014.

3.4.4 Impact Zone 04

Soil Impact Zone 04 was centred beneath Structure 02 (see Figure 3, Appendix A) and contained elevated concentrations of PHCs. There were no impacts due to metals in this area. The excavation of Soil Impact Zone 04 began on July 18, 2014. The excavation was deepened beyond 0.6 m bgl due to strong hydrocarbon odours and oil-laden soils observed from 0.5 to 1.0 m bgl. The excavation was also widened due to samples Z4 S-10 and Z4 S-11 collected from the south wall of the excavation containing elevated concentrations of PHCs. The excavation expanded south until PID readings were 0 ppm and soil samples collected contained concentrations of PHCs below applicable guidelines (see Figure 4, Appendix A).

In total, 360 m^3 of PHC-impacted soils were removed from Impact Zone 04 and subsequently treated.

3.4.5 Impact Zone 05

Soil Impact Zone 05 contained elevated concentrations of PHCs. There were no impacts due to metals in this area. Soil Impact Zone 05 was located west of Structure 02 in Debris Area 01. Zone 05 soil samples collected from the base and walls of the excavation contained PHC concentrations less than the detection limits. Excavation work was conducted on July 15, 2014. There were no visual or olfactory observations of PHCs made after the initial excavation occurred. Once confirmatory results from Maxxam were received (see Table C-2), backfill and regrading were completed.

3.4.6 Impact Zone 06

Soil Impact Zone 06 was located southwest of Structure 02 in Debris Area 02. Excavation work was conducted on July 13 with backfill and regrading completed on July 24, 2014 after laboratory results were received. The soil samples collected from Zone 06 (see Figure 4, Appendix A) contained concentrations of contaminants below method detection limits.

3.4.7 Impact Zone 07

Soil Impact Zone 07 was located south of Structure 02 in Debris Area 02. Excavation work was conducted on July 13, 2014. Soil samples collected from Zone 07 (see Figure 4, Appendix A) contained concentrations of contaminants below method detection limits. Backfill and regrading activities were completed on July 20, 2014.

3.4.8 Impact Zone 08

Soil Impact Zone 08 was located south of Structure 05. Initial excavation work was completed on July 14, 2014. Two soil samples collected from the base of the excavation, samples 'Zone 8A' and 'Zone 8B' contained elevated levels of PHC F2 and PHC F3 with concentrations of 260 ppm and 450 ppm, respectively. A subsequent excavation, to a depth of 1.5 m bgl, occurred on July 21, 2014 with soil samples, 'Z8 S-8ar' and 'Z8 S-8br' collected from beneath the 8A and 8B locations. The samples collected at 1.5 m bgl contained concentrations of PHCs below method detection limits.

3.4.9 Impact Zone 09

Soil Impact 09 was located within Drum Cache 04 (see Figure 3, Appendix A). The metals-impacted soil was excavated on July 13 and backfilled on July 24, 2014. There were no PHC concerns in this area. The concentrations of metals within soil sample 'Zone 9' collected from the base of the excavation were below the applicable standards.

3.4.10 Impact Zone 10

Soil Impact Zone 10 was located east of Structure 03 (see Figure 3, Appendix A). There were no metals impacts identified in this area. The initial excavation was completed on July 18, 2014. Soil samples collected from the base and walls of the excavation contained concentrations of PHCs below method detection limits (see Table C-2, Appendix C). After the initial excavation, there were no visual or olfactory observations of PHCs. Backfill and regrading were completed once Maxxam results were received.

3.5 DRUMS

The majority of the drums were located within the drum caches, namely Drum Cache 01 through Drum Cache 04 (see Figure 3, Appendix A) with the remainder spread sporadically across the site. The collection of drums began during the mobilization period of April 2014. At this time, the west end of the island had considerable snow drifts. However, 279 drums were located based on GPS co-ordinates and visual observations. These drums were transported to Lupin via the winter road mobilization route in Seacan containers. Once at Lupin, drums were emptied, washed, and crushed.

The remaining drums were located once the snow had melted during the summer construction season with additional drums unearthed during the excavation of Impact Zone 03 and 04. In total, 367 drums were transported off-site from the former weather station site.

3.6 HAZARDOUS WASTE

Hazardous waste was identified during the ESA phase of the remediation process. Hazardous waste on-site included building components such as materials with amended paint as well as scattered debris. The hazardous waste collected from the former weather station site included:

- Wood with PCB-Amended Paint (PAP);
- Wood with lead-amended paint;
- Painted metal (the former Radio Tower);
- Compressed gas cylinders;
- Old radiators;
- Decaying batteries;
- Paint cans;
- Jerry cans with residual contents; and,
- Freon from fridges and freezer.

The abatement of wood with PCB-amended paint (PAP) and wood with lead-amended paint occurred prior to the demolition of the structures. The hazardous building materials along with the collected hazardous wastes were segregated and appropriately packaged for off-site transport. Abatement work was completed July 8th, 2014 and the collection of scattered debris was completed on July 19, 2014. In total, there were 13.5 m^3 of hazardous materials collected, packaged, and transported to Yellowknife.

PCB-amended paint (PAP) was shipped to Swan Hills, AB via Yellowknife, NT in April 2014. Attached within Appendix F is a letter to KBL Environmental Ltd. (KBL) of Yellowknife from SENA Waste Services, operator of the Swan Hills Treatment Centre in Alberta, which confirms that the PAP will be accepted. Appendix F also includes: the bills of lading, which confirm the off-site transportation of the waste; and, the certificates of disposal, which correlate to the respective bills of lading.

3.7 BUILDING DEMOLITION

Building demolition occurred once abatement work was completed. Building materials, apart from burnable wood, were segregated, packaged, and transported off-site. Wood from Structures 02, 03, 04, and 05 which was unpainted and untreated was considered burnable. The burnable wood from Structure 03, 04, and 05 was burnt at the burn location established near Structure 03 (see Figure 3, Appendix A) on July 5, 2014. The burnable wood from Structure 02 was burnt on July 9, 2014.

In total, 12.1 m^3 of wood from the on-site structures was burnt on-site. The ash from the two burns was collected, packaged, and transported off-site. Note that Structure 01 was not demolished at the request of the Kugluktuk HTO.

3.8 NON-HAZARDOUS WASTE AND DEBRIS

Non-hazardous waste and debris was typically located around the main camp area and Debris Area 01 and 02 (see Figure 3, Appendix A). However, scattered debris was located on the peninsula and beyond the former camp area extents. In total, 125 m^3 of non-hazardous waste was collected, packaged, and transported off-site for disposal.

3.9 TREATMENT CELL

The treatment cell was located at the west end of the unmaintained airstrip (see Figure 3, Appendix A). Soils which were impacted with hydrocarbons, and not co-contaminated with metals, were transported to the treatment cell. The objective of the treatment cell was to treat PHC-impacted soils as per the Delta Carter Treatment Plan (DCJV, 2014c), attached within Appendix F.

Four monitoring wells were installed by Delta Carter on August 9th, 2014. The UTM co-ordinates of the four monitoring wells, which were installed adjacent to each of the respective four sides of the treatment cell are listed below in Table 3-5.

Table 3-5: Monitoring Well Co-ordinates

Monitoring Well	Easting	Northing
MW-1	529071	7262651
MW-2	529163	7262630
MW-3	529146	7262589
MW-4	529252	7262543

1. Contwoyto Lake is in UTM Zone 12W.

There were insufficient volumes of water within the monitoring wells to obtain samples. The monitoring wells were decommissioned during final demobilization in March 2015.

Soil within the treatment cell was aerated on an approximate daily basis. In total, 2100 m^3 of PHC-impacted soil was treated. To confirm the treatment of soils within the treatment cells a three-stepped approach was adopted. First, olfactory observations and a PID were used to gain a general sense as to the PHC levels. Second, samples were collected for on-site PetroFlag™ analyses to determine the range of PHC concentrations within soil from the various cells. Thirdly, soil samples were collected from individual cells and shipped to Maxxam for laboratory

analysis to confirm PHC concentrations. Samples sent to Maxxam from the treatment cells were composite samples. The Treatment Cell (TC) was comprised of TC-14 through TC-35 in Zones 1 through 11 as shown on Schematic 3-1 below.

Schematic 3-1: Treatment Cell

N ↑

TC-14	TC-16	TC-18	TC-20	TC-22	TC-24	TC-26	TC-28	TC-30	TC-32	TC-34
ROAD							Contractor's Camp →			
TC-15	TC-17	TC-19	TC-21	TC-23	TC-25	TC-27	TC-29	TC-31	TC-33	TC-35
Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11

Composite samples from TC-14 through TC-35 consisted of mixing 5 discrete samples collected from within each cell at approximately 0.15 m depth. Each treatment cell contained approximately 100 m^3 of soil. Treatment cell samples analyzed with PetroFlag™ test kits were used as an indicator of treatment progress. Composite samples collected and analyzed by Maxxam were used to confirm treatment to concentration below applicable guidelines.

Note that stockpiles (SP) SP-1 through SP-13 were constructed by Delta Carter within the treatment cell area to ascertain the treatment regime effectiveness. These stockpiles contained elevated levels of PHCs (see Table C-2) and were thus aerated further. The stockpiles were subsequently mixed and spread into TC-14 through TC-35. In total, 90 samples were collected in order to determine the effectiveness of the treatment cell soil as per Table 3-6 below.

Figure 6, within Appendix A, shows the treatment cell zones and the adjacent monitoring wells.

Table 3-6: Treatment Cell Analytical Regime

Area	PHC (Testkit)	PHC (lab)	Metals (lab)	Total
Treatment Cell	48	42	0	90

Once composite samples from TC-14 through TC-35 contained PHC concentrations below applicable guidelines the soils were regraded to match the natural contours of the surrounds. Note that both Arcadis and Delta Carter took TC samples for analysis.

3.10 BORROW MATERIAL

One borrow area was used by Delta Carer during the 2014 construction season for use as backfill material within the excavated soil impact zones; and, re-grading construction areas to conform to the natural contours of the land. The borrow area was rectangular in shape, located on the esker, east of the former buildings, and west of the airstrip (see Figure 3, Appendix A).

The GPS co-ordinates of the four corners of the borrow area were as follows.

Table 3-7: Borrow Source Co-ordinates

Borrow Source Corners	Easting	Northing
Northeast	529064	7262663
Southeast	529062	7262656
Southwest	528993	7262674
Northwest	528995	7262682

1. UTM Zone 12W

The volume of borrow source material used for backfill and regrading purposes was 2831 m^3.

3.11 POST-CONSTRUCTION SAMPLING

Soil samples were collected on September 18, 2014 from the temporary fuel cache area and the temporary camp area. Soil samples collected from the fuel cache and temporary camp areas (see Figure 3, Appendix A) contained total petroleum hydrocarbon (TPH) concentrations between 0 ppm and 84 ppm as per PetroFlag™ test kit analysis.

Post-construction soil samples were collected from the treatment cell on September 18, 2014 and March 27, 2015. Samples collected September 18, 2014 from the treatment cell were analyzed using Petroflag™ test kits and contained TPH concentrations below 400 ppm. Samples collected in March, 2015 contained PHC and BTEX concentrations below detection limits. A summary of the sample results for the Post-Construction soil sampling are included within Table C-2 and C-3 for laboratory and Petroflag™ test kit analyses, respectively.

Post-construction surface water samples were collected on August 13, 2015 from CL-1, CL-6, CL-8, and CL-9 (see Figure 8, Appendix A). The concentrations of metals were consistent with earlier findings. For example, the concentration of aluminum at CL-6 and CL-8 was above the CCME FWAL guidelines, however, was below the background concentration. The results of the metals analyses are included within Table C-5A within Appendix C. Note that samples collected from stations CL-6 and CL-9 contained concentrations of PHCs below laboratory detection limits. Laboratory certificates are included within Appendix D.

3.12 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

Duplicate soil samples were collected as part of the QA/QC program. The program included requesting analysis for 15 duplicate samples from 131 soil samples submitted to Maxxam. The duplicate soil samples and respective locations are listed in Table 3-8.

Table 3-8: Soil Duplicates

Sample #	Duplicate #
LFB-1	LFB DUP-1
Z6 N	DUP-2
Z3 S-3	Z3 DUP-1
Z3 S-37	Z3 DUP-2
Z3 S-24B	Z3 DUP-3
Z3 S-12B	DUP-4
Z3 S-1B	DUP-5
Z3 BWG	DUP-6
Z4 S-2	Z4 DUP-1
Z4 S-12	Z4 DUP-2
Z4 S-11B	Z4 DUP-3
Z8 S-8BR	Z8 DUP-1
Z10 S-5	Z10 DUP
TC-16	TC DUP
Base-2	Base-B

Table C-4, in Appendix C, lists relative per cent differences (RPD) values for the duplicate samples collected and analyzed by Maxxam. RPD values were acceptable in 11 of the 15 duplicate analyses. RPD values exceeded 40% in four of the samples collected, however, as a conservative approach, if either the original sample or duplicate sample contained soil concentrations above applicable guidelines, the area was considered impacted and further excavation, or in the case of the treatment cell, further aeration occurred.

Analytical duplicates were also performed on PetroFlag™ test kit samples at a rate of 10%. Generally, RPD values were below 30%. As a conservative approach, if PetroFlag™ test kit samples contained TPH concentrations greater than 400 ppm, further excavation or further aeration was recommended along with the collection of samples for laboratory analyses.

4.0 REGULATORY CONSIDERATIONS

4.1 WATER LICENCE

Water licence 1BR-CLR1419 was granted on May 16, 2014 by the Nunavut Water Board (NWB). The licence expires on May 15, 2019. The license allowed for the use of fresh water from Contwoyto Lake up to a maximum of 15 m^3 per day. The water license is attached within Appendix B.

During the remedial work time period, a total of 1,500 litres of fresh water was obtained from Contwoyto Lake. Water use was metered using 22 litre (5 gallon) containers.

Water was collected from approximately 50 m off-shore, north of the peninsula (see Figure 3, Appendix A). Lake water collected was used for camp activities and a mixing additive to the treatment soil amendment regime. Water use at camp included cleaning, washing, and showering. Drinking water was shipped to site via Yellowknife. Grey water was produced from showers, dishwashing, and cleaning. The shower water was left to evaporate within a bermed and tarped area whereas grey water was collected, containerized, and shipped off-site to Yellowknife. Grey water was not released to the environment.

In accordance with the Surveillance Network Program (SNP) stipulated in the water license, monitoring stations were established. A summary of the SNP presented in Table 4-1.

Table 4-1: Water Licence SNP Summary

Monitoring Station	Description	Status	Data
IN1	Fresh water intake volume.	Fresh water collected during remedial operation time period of July and August.	1.5 m^3 collected in 2014 0 m^3 collected in 2015
SW1	Retention cell run-off volume and water quality.	Grey water was containerized and transported to Yellowknife for disposal.	None
SW2	Effluent discharge volume and quality at the Treatment Cell.	No discharge of water.	None
MW1 **MW2** **MW3** **MW4**	Groundwater quality at monitoring stations N, W, S, and E side of treatment cell.	MW1-4 installed August 9, 2014. Insufficient volume for sample collection cue to minimal groundwater present on the esker. MW1-4 decommissioned March 27, 2015	None

Grey water was not discharged to the environment. The remedial contractor chose to containerize grey water for off-site shipment to Yellowknife. Thus, there is no data for SW1. Monitoring wells 1 through 4 contained insufficient volume and effluent was not discharged from the treatment cell. Thus, there is no data for SW2, MW1, MW2, MW3, or MW4.

Raw sewage was collected in honey buckets and transported off-site for disposal.

Two separate reports, one for each year of the remedial program, were prepared as part of the water license requirements. The two reports were entitled:

- *Annual Report 2014 Remediation of the Contwoyto Lake former Weather Station, Nunavut, Licence 1BR-CLR1419* dated March 2015 (SENES, 2015a)
- *Annual Report 2015 Remediation of the Contwoyto Lake former Weather Station, Nunavut, Licence 1BR-CLR1419* dated February 2016 (Arcadis, 2016a).

Table 4-2 below details a selection of water license conditions of note.

Table 4-2: Water Licence Conditions of Note

Section	Condition	Notes
B.1	File and annual report	Separate documents produced for 2014 and 2015 entitled *Annual Report Remediation of the Contwoyto Lake former Weather Station, Nunavut, Licence 1BR-CLR1419.*
C.1	Maximum quantity of water allowed is 15 cubic meters per day	Fresh water use was under the maximum allowable volume.
C.2	Implement suitable methods to quantify volume of fresh water attained	22-litre containers used.
D.1	Designate waste disposal areas at least 31 m from the ordinary high water mark of any water body.	The waste disposal area was approximately 50 m from the ordinary high water mark (see Figure 3, Appendix A)
D.3	Food waste, paper waste and untreated wood waste is acceptable to burn in an incinerator.	Food waste was burned daily and untreated wood was burnt within the former camp area (see Figure 3, Appendix A).
D.4	Burning plastic and treated wood is unacceptable.	Plastics, treated wood, and debris was consolidated and packaged for off-site transport and disposal to Yellowknife.
D.5	Authorization is required before disposing of waste in Nunavut communities.	The waste from the former weather station was not disposed of in Nunavut. The waste was transported off-site to Yellowknife in March 2015 for disposal or furtherance to a contractor-selected disposal site in Alberta.
D.6	Backhaul waste generated through the course of remedial activities such as waste oil.	All waste on-site was transported to Yellowknife, apart from burnable wood.
D.7	Maintain records of backhauled waste and provide confirmation of disposal certificates	Disposal certificates provided by KBL (see Appendix F).
D.8	Direct grey-water to the on-site treatment system.	Grey water was collected, consolidated, and transported off-site within 205 L drums.
D.9	Direct sewage to the on-site sewage treatment facilities.	Black water was collected in honey buckets, consolidated, and shipped off-site.

Section	Condition	Notes
D.12	Contact water	Contact water at the base of Zone 03 excavation was used as mixing water for the treatment cell. No contact water was produced within the borrow pit.
D.15	Provide borrow source analyses	Laboratory data from potential borrow sources was included within the RAP (SENES, 2013a) provided to the NWB during the application process.
D.17	Proper storage, transport, and disposal off-site at an approved facility all hazardous and non-hazardous waste.	Disposal certificates provided by KBL (see Appendix F).
D.18	Do not mix contaminated soils for dilution purposes to achieve AMSRP concentrations stipulated.	Impacted soils were identified during the Phase I+II ESA. The subsequent Phase III ESA quantified volumes. Metals-impacted soils were excavated and consolidated during the summer of 2014 for off-site transport in March 2015. PHC-impacted soils were excavated and transported to the treatment cell.
D.20	Dispose of PCB-amended paints off-site	Materials coated with PCB-amended paints were segregated, consolidated, packaged and stored in 2014 for off-site transport in 2015. The temporary storage of PCB-containing materials was the seacan located at the former camp location (see Figure 3, Appendix A).
E.1	GPS co-ordinates of borrow source	The borrow source was identified in the RAP. GPS co-ordinates provided in Section 3.10. See Figure 3, Appendix A.
F.1	Camp location	The temporary camp was located at the east end of the esker airstrip (Figure 3, Appendix A). It was in operation from July 4 until August 31, 2014.
G.1	Installing monitoring wells is authorized	Four monitoring wells were installed on the four respective sides of the treatment cell. There were insufficient water volumes to collect samples and monitoring wells were subsequently decommissioned.
G.2	Restore all disturbed areas to natural conditions immediately upon completion of the project.	Areas were regraded to match the natural contours of the surroundings.
J.5	Remove all temporary infrastructure such as fuel caches and equipment prior to the expiry of the license.	The temporary camp has been removed. All materials were removed off-site in March 2015.
K.1	Monitoring Program	See Table 4-1

4.2 LAND USE PERMIT

The Nunavut Impact Review Board (NIRB) issued Land Use Permit (LUP) N2013U0028 Class 'A' permit to INAC on March 12, 2014. The permit was valid from April 1, 2014 until March 31, 2016.

A selection of LUP conditions stipulated is outlined below in Table 4-3. The LUP is included within Appendix B.

Table 4-3: Land Use Permit Conditions of Note

Section	Condition	Notes
31.1.a.2	Remove all scrap metal, discarded machinery, and building material.	All waste debris and demolition material was segregated and consolidated during the summer of 2014. Off-site transport occurred March 2015.
31.1.a.4	Provide GPS coordinates of the camp location.	The location of the temporary camp utilized during the summer 2014 construction season is shown on Figure 3, Appendix A. The approximate co-ordinates of the temporary camp were 65°29'N, 110°22'.
31.1.c.11 and 12	Use a forced-air fuel-fired incinerator to burn all combustible garbage.	A forced-air fuel-fired incinerator was used on a daily basis to burn combustible garbage. Location shown on Figure 3, Appendix A.
31.1.c.16	Maintain fire-fighting equipment in the base camp.	Each temporary structure and temporary storage area contained a fire extinguisher. The two temporary fuel storage areas contained axes, shovels, spill kits, and extinguishers.
31.1.d.17	The equipment used for soil aeration is cleaned within the extents of the treatment cell.	The excavator was used to turn the soil and cleaned within the extents of the treatment cell.
31.1.d.18 and 22	Dust suppression measures shall be taken.	Water was added to the soil within the treatment cell during soil turning activities.
31.1.d.23	Camps shall not be erected on the surface ice of streams.	Camp location during winter road construction was at the Lupin Mine site, see Figure 2, Appendix A.
31.1.e.25	Camps are to be located on gravel, sand or other durable land.	The temporary camp was located on the esker at the east end of the emergency airstrip as shown on Figure 3, Appendix A.
31.1.e.29	The quarry boundaries shall be clearly marked.	The borrow material was taken from west of the emergency airstrip and east of the former PWA camp area as shown on Figure 3, Appendix A.
31.1.f.35	The winter road should maximize the use of frozen water bodies.	The winter road route is shown on Figure 2, Appendix A. The winter road route on Contwoyto Lake was entirely on frozen water apart from the beach landing at the Lupin Mine site and the landing at the former weather station island.
31.1.f.52	Restore the lands to a pre-disturbed state upon the completion of the field work.	Borrow material was used to backfill and regrade excavated areas. Excavated areas, including the borrow source, and the treatment cell were regraded to match the natural surrounding contours.
31.1.f.55	Store fuel in such a manner that they are inaccessible to wildlife.	Fuel was stored in double-walled steel tanks at the fuel cache (see Figure 3, Appendix A).
31.1.f.58	Burn garbage daily and remove ash from site	Garbage was burned daily and ash was packaged for off-site transport.
31.1.f.63	Use drip pans and have spill response equipment	Spill kits were placed at both fuel caches, see Figure 3, Appendix A.
31.1.f.67	Treat only hydrocarbon-contaminated soils on-site, other substances must be disposed of off-site	Hydrocarbon-contaminated soils were treated on-site. Soils with metals contamination were consolidated, packaged, and transported off-site in March 2015.
31.1.h.71	Cease activity that may interfere with migration of caribou and muskox	No caribou or muskox were seen on-site during the construction season.

Section	Condition	Notes
31.1.h.77	Bears may be encountered. Proper food handling practices are required.	A bear fence was in operation, food waste was burned daily. No bears were seen during the construction season.
31.1.k.87	Check fuel storage containers daily.	The fuel storage containers were inspected daily at both fuel storage locations (see Figure 3, Appendix A).
31.1.k.88	Refuelling greater than 31 m from high water mark.	Refuelling was done adjacent to the fuel cache as shown on Figure 3, Appendix A.
31.1.m.98	Avoid known archaeological sites	The three archaeological sites identified during the summer of 2012 were avoided. Locations are shown on Figure 3, Appendix A.

4.3 INUIT OWNED LAND EXEMPTION CERTIFICATE

The Kitikmeot Inuit Association (KitIA) Department of Lands, Environment and Resources (DLER) issued an Inuit Owned Land (IOL) exemption certificate to INAC for the remedial work project at the Contwoyto Lake former weather station site. The IOL exemption certificate is included within Appendix B.

The remedial work on the IOL included collecting waste and scattered debris such as the former radio tower, old drums, broken plywood, and tin cans. The majority of the drums were collected during April 2014 while there was snow cover which reduced ground disturbance.

The approximate quantities of waste material collected from IOL on the island included:

- 0.5 m^3 of scattered debris
- 10 old fuel drums
- 2 m^3 of metal from the former radio tower

There were no excavations on IOL. All equipment and waste materials stored in 2014 were located north of the IOL boundary line. The segregated, consolidated, and packaged wastes were located near the former site buildings on the esker (see Figure 3, Appendix A) and removed from the island in March 2015.

Two separate reports, one for each year of the remedial program, were prepared as part of the exemption certificate requirements. The two reports were entitled:

- *2014 Annual Report Remediation of the Contwoyto Lake former Weather Station, Nunavut, KTX114X004* dated March 2015 (SENES, 2015b); and,
- *2015 Annual Report Remediation of the Contwoyto Lake former Weather Station, Nunavut, KTX114X004* dated February 2016 (Arcadis, 2016b)

5.0 REMEDIAL SUMMARY

The remediation program at the former weather station at Contwoyto Lake was completed in accordance with the provisions of the RAP (SENES, 2013a) and remedial specifications (PWGSC, 2013). The project operated over the period of one summer field season and two mobilization/demobilization winter periods. In the summer of 2014, the former site buildings were demolished, the residual debris was consolidated, the metals-impacted soil was excavated and consolidated, and the PHC-impacted soil was excavated and successfully treated. Demobilization activities occurred in March 2015 and included the off-site transport of packaged debris, metals-impacted soil, equipment and materials.

The remedial activities were in accordance with the regulatory requirements as stipulated in the land use permit, water license and IOL certificate.

The remediation program at the Contwoyto Lake former weather station was successfully completed. The results of soil analyses on samples procured from the former areas of metals and/or petroleum hydrocarbon impacts reported that the soil at the final limits of the earthworks meet the clean-up criteria as outlined in the specifications and applicable CCME guidelines. All non-hazardous and hazardous debris was containerized and transported off site in its entirety in March 2015. No remediation work remains to be completed on site.

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6.0 THE WAY FORWARD

Based on the Federal Approach to Contaminated Sites, once the remediation of a site is complete, long-term monitoring suitable for the site conditions and remedial options shall occur (CSMWG, 2000). INAC has the designated responsibility for conducting any long-term monitoring necessary to confirm that the environment and human-health are being protected.

The remedial options implemented included the off-site transport of hazardous debris, demolition debris, and metal-impacted soil. Therefore, the scope of the long-term monitoring plan is expected to be minimized.

The Water License, Part K, Item 22 states the following with regard to long-term monitoring:

> "*If there is a need for long-term monitoring, the Licensee shall submit to the Board for approval, at least sixty (60) days prior to initiating any long-term monitoring activities, a Post-closure Monitoring Plan for the project sites. The plan shall include information pertaining to the long-term monitoring of the Waste Disposal Facilities, stability of the sites, and the need for thermal and groundwater monitoring."*

Thermal and groundwater monitoring are not deemed necessary. Thermal monitoring is not deemed necessary because an engineered landfill was not constructed, the remedial work included treating PHC-impacted soils, and regrading work included matching the natural surrounding contours. Groundwater wells installed during the summer of 2014 at the extents of the treatment cell, as part of the Surveillance Network Program, contained minimal volumes and were subsequently decommissioned. Therefore, it is not deemed necessary to install groundwater wells at the site.

The 2013 RAP stated the following with regard to sediment and surface water:

> *"Somewhat random metal concentrations have been detected in sediments slightly exceeding the low level ISQGs. Based on the types of site activities and distribution of metal concentrations, it is considered unlikely that elevated metal concentrations are attributable to activities at the site." (SENES, 2013a)*
>
> *"Once surface debris is collected, natural attenuation of any localized surface water impacts is expected." (SENES, 2013a)*

It is recommended that long-term monitoring to be carried out in order to provide INAC ongoing assurance that the remediation works are performing as designed. Therefore, it is recommended

that in order to determine the long-term monitoring plan requirements, the following first step be taken:

- Collect surface water samples in 2016 for total and dissolved metals at four monitoring locations; and,
- Inspection of the regraded lands which were part of the excavation works and treatment works on the esker (to coincide with surface water sampling event).

In advance of developing a long-term monitoring plan, water samples were collected on August 13, 2015 at four locations. Samples were collected at CL-1, CL-6, CL-8, and CL-9 as shown on Figure 8, attached within Appendix A. Note that the same nomenclature was used as the 2012 sampling program. Both CL-9 and CL-6 contained concentrations of PHC and BTEX below detection limits. Note that these locations also contained concentrations of PHC and BTEX below detection limits in 2012 and thus analyzing for PHC/BTEX is not foreseen as a requirement for the long-term monitoring plan.

Analytical results of total and dissolved metals for samples collected in August 2013 are summarized in Table C-5A and Table C-5B for total and dissolved metals, respectively. For comparison, the tables list results from both the 2013 and 2015 sampling events. The 2015 concentrations of metals in surface water are comparable to the 2013 concentrations.

It is recommended that after the collection of surface water data in 2016, a long-term monitoring plan be developed as appropriate to provide a framework for site closure and/or ongoing assurance that the remediation works continue to perform as intended.

7.0 LIMITATIONS

Arcadis Canada Inc. undertook the work referred to in this report for PWGSC on behalf of INAC. It is intended for the sole, and exclusive use of INAC, its affiliated departments, agencies, companies and partners and their respective insurers, agents, employees and advisors.

Any use, reliance on or decision made by any person other than INAC based on this report is the sole responsibility of such other person. INAC 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.

The work undertaken by Arcadis with respect to this report and any conclusions made in this report reflect Arcadis's judgment based on the site observations at the time and on information available at the time of the preparation of this report. This report relies in part upon data collected by others. INAC and Arcadis make no representation or warranty to anyone with regard to these data or information from others which are presented 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 these data referred to in this report. None of these data have been verified and they are subject to the limitations outlined in the reports by others.

Nothing in this report is intended to constitute or provide a legal opinion.

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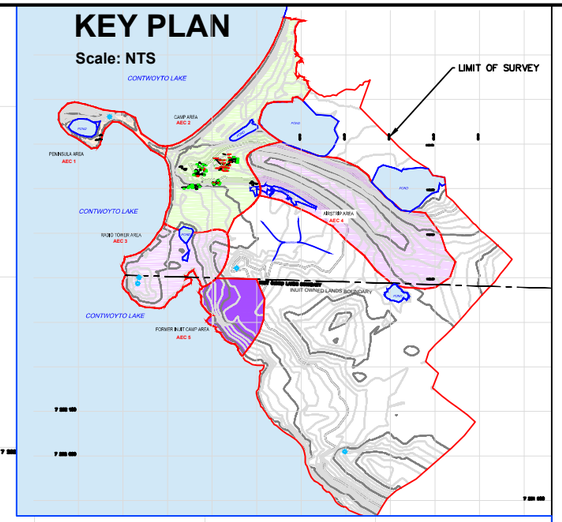
APPENDIX A

FIGURES

KEY PLAN

Scale: NTS



GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ALL COORDINATES ARE REFERENCED TO NAD83(CSRS). ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL, RELATIVE TO GEOID MODEL CANADIAN HT2_0.
3. CONTOUR INTERVAL IS 0.5 m.
4. ALL STRUCTURES REMOVED EXCEPT STRUCTURE 01

LEGEND:

- APPROXIMATE EXTENT OF BORROW AREA
- LIMIT OF SURVEY
- LIMIT OF AREA OF ENVIRONMENTAL CONCERN
- BOUNDARY OF INUIT OWNED LANDS
- FORMER EXTENT OF CONCENTRATED SITE DEBRIS AREAS
- MAJOR CONTOUR LINES
- MINOR CONTOUR LINES
- DRUM CACHE
- BODY OF WATER
- BURN PIT
- INDIVIDUAL DRUMS COLLECTED IN 2014
- SCATTERED DEBRIS LOCATION (HAZARDOUS/NON-HAZARDOUS WASTE)

- AEC 1 - AREA OF ENVIRONMENTAL CONCERN 1 PENINSULA AREA
- AEC 2 - AREA OF ENVIRONMENTAL CONCERN 2 CAMP AREA
- AEC 3 - AREA OF ENVIRONMENTAL CONCERN 3 RADIO TOWER AREA
- AEC 4 - AREA OF ENVIRONMENTAL CONCERN 4 AIRSTRIP AREA
- AEC 5 - AREA OF ENVIRONMENTAL CONCERN 5 FORMER INUIT CAMP AREA
- ARCHEOLOGICAL FEATURES PROTECTED DURING SITE WORK

ARCADIS

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CONTWOYTO LAKE REMEDIATION PROJECT

PREVIOUSLY IDENTIFIED AREAS OF ENVIRONMENTAL CONCERN

Drawn By: P.A.F.	Approved By: J.M.	Project No: 350600-508	
Date: NOV. 2015	Scale: 1:3500	Drawing No: FIGURE 3	