Public Services and Procurement Canada

REMEDIAL ACTION PLAN

PIONEER HIGH ARCTIC BUNDLE, NUNAVUT – SMALL SITE PACKAGE

On behalf of Northern Contaminated Sites Program, Nunavut Region, Crown-Indigenous Relations and Northern Affairs Canada

Playfair Point, Pioneer Island, Cape Isachsen and Kristoffer Bay

Final Report

March 2023 P2021-10 Task H

Executive Summary

Dillon Consulting Limited and Outcome Consultants in joint venture (Dillon-Outcome or DOJV) have complete two Remedial Action Plans (RAPs) for the Pioneer High Arctic Bundle Sites in Nunavut. This RAP includes only the four sites of smaller remedial scope, which are: Playfair Point, Pioneer Island, Cape Isachsen and Kristoffer Bay. A separate RAP for the three sites of larger remedial scope (Cape Ahnighito, Skybattle Bay and Stupart Island) is a companion document. Management options for the waste streams present at each site have been assessed. Sections 2.0 through 5.0 of this report contain the remedial options analysis for each of the sites, by waste stream and Section 6 provides an integrated work plan for these four sites.

The waste streams, quantities and recommended remedial action, by site are as follows:

Table ES-1 Playfair Point Remedial Actions

Waste Stream	Quantity	Recommended Remedial Action
Waste fuel	615 litres	Collection into sturdy new containers. Removal from site for disposal or recycling
Drums	3 drums un-crushed volume: 1 cubic metre empty weight of drums: 54 kilograms.	Removal from site for out of Territory disposal or recycling

Table ES-2 Pioneer Island Remedial Actions

Waste Stream	Quantity	Recommended Remedial Action
Non-hazardous waste (wood/metal waste, charred debris)	10 m^3 / 10 tonnes	Wood waste would be incinerated at the existing burn area to reduce volume/weight. Then all ash, remaining metal waste and charred debris would be packaged for transport off-site disposal.
Hazardous waste	4 lead-acid batteries (80 kg)	The smashed lead batteries would be packaged as hazardous waste for transport out of Territory disposal.

Table ES-3 Cape Isachsen Remedial Actions

Waste Stream	Quantity	Recommended Remedial Action
Non-hazardous debris	Wood and Metal 8 m^3 / 4 tonnes	Collection of non-hazardous debris and drums into 1 m^3 soil bags. Freeing and removing the steel cylinder near the camp sump from the sand in which it has partially sunk. Transporting all waste by helicopter to the Isachsen HAWS. Transferring waste to fixed-wing aircraft for transportation to Resolute Bay and out of Territory for disposal or recycling.
Drums	Six exposed crushed drums	

Table ES-4 Kristoffer Bay Remedial Actions

Waste Stream	Quantity	Recommended Remedial Action
Non-hazardous debris	Metal drilling debris 10 m^3 / 30 tonnes	Collection of non-hazardous debris and drums into 1 m^3 soil bags. Transporting all waste by helicopter to the Isachsen HAWS. Transferring waste to fixed-wing aircraft for transportation to Resolute Bay and out of Territory for disposal or recycling.
Drums	Two exposed crushed drums	

Cape Isachsen and Kristoffer Bay would be serviced from a staging location at the Isachsen HAWS and Playfair Point and Pioneer Island would be staged from Resolute Bay. It is expected that the Contractor's team can be accommodated at a temporary camp that will be shared by other federal projects in progress at Isachsen. All wastes would be brought to Resolute Bay. Drums may be crushed, and waste fuel may be used as heating oil there, if there is opportunity to do so. Wastes would then be transported out of Territory for disposal or recycling at licenced facilities in the South.

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1.0 Overall Introduction

1.1 Description of Project

Dillon Consulting Limited and Outcome Consultants Inc. in joint venture (Dillon-Outcome or DOJV) were retained by Public Services and Procurement Canada (PSPC) to develop Remedial Action Plans (RAPs) for the Pioneer High Arctic Bundle Sites in Nunavut. The work was generally completed as outlined in the Scope of Work as part of the Terms of Reference ("ToR") entitled "Terms of Reference for Consulting Services for Pioneer Sites Assessment Various Locations, Nunavut", dated June, 2021. The work was carried out for PSPC on behalf of Crown-Indigenous Relations and Northern Affairs Canada's (CIRNAC's) Northern Contaminated Sites Program as call-up order no. 700596804 under the Standing Offer Agreement #EW699-170520/003/NCS.

This RAP report is a component of the scope of work being carried out under two fiscal years (2021/22 and 2022/23) for the Pioneer Sites. Other components of the scope of work include a Phase III Environmental Site Assessment (ESA), Site-wide Hazard Assessment (SWHA), Human Health and Ecological Risk Assessment (HHERA), Archaeological Impact Assessment (AIA) and Cost Estimate and Environmental Impact Assessment (EIA).

The Pioneer High Arctic Bundle consists of seven sites on Arctic Islands to the north and west of Resolute Bay, Nunavut which include: Playfair Point, Pioneer Island, Stupart Island, Skybattle Bay, Cape Ahnighito, Cape Isachsen and Kristoffer Bay. They are relics of historic oil exploration drilling activity and scientific research stations, with remnants of debris, wastes and fuel drums used to support those activities. The site locations are provided in Figure 100. The hamlet of Resolute Bay on Cornwallis Island and the Isachsen High Arctic Weather Station (HAWS) were used as staging points for the field operations.

Types and quantities of the wastes to be removed from the seven sites are the outputs of the Phase III ESAs conducted at the sites over the 2021 and 2022 field seasons. Impacted soils have been screened by the HHERA. Means and methods for executing the RAP have been developed in consideration of the site access constraints of these extremely remote sites.

1.2 Structure of this Report

The Remedial Action Plans of the seven Pioneer Sites have been grouped in to two packages for procurement of contracting services. The four sites with smaller remedial scope are covered in this RAP while the three sites with larger remedial scope are covered in a separate RAP. This report details the RAPs for the Small Site Package (planned for implementation in 2023) which includes Playfair Point, Pioneer Island, Cape Isachsen, and Kristoffer Bay. Sections 2.0 through 5.0 can be considered as self-contained sections for each site within the covers of the overall report. Each section is complete with the waste streams and quantities present by Site, remediation objectives and evaluation method, remedial options analysis by waste stream, and integrated work plan. Figures for each site follow the

text for the site. Section 6.0 presents the integrated Remedial Work Plan for efficient execution of the four sites planned for the first remediation contract. The Work Breakdown Structure and Project Schedules for the Small Site Package (2023) contract are provided in Appendix A. Waste Fuel characteristics are contained in Appendix B.

The Sections are assigned as follows:

Table 1-1 Structure of Report

Site within the Pioneer Bundle	Section
Playfair Point	2.0
Pioneer Island	3.0
Cape Isachsen	4.0
Kristoffer Bay	5.0

130° 0' 0" W | 125° 0' 0" W | 120° 0' 0" W | 115° 0' 0" W | 110° 0' 0" W | 105° 0' 0" W | 100° 0' 0" W | 95° 0' 0" W | 90° 0' 0" W | 85° 0' 0" W | 80° 0' 0" W | 75° 0' 0" W | 70° 0' 0" W | 65° 0' 0" W

75° 0' 0" N

CAPE ISACHSEN

ISACHSEN WEATHER STATION

ELLEF RINGNES ISLAND

AMUND RINGNES ISLAND

KRISTOFFER BAY

CAPE AHNIGHITO

LOUGHEED ISLAND

SKYBATTLE BAY

PIONEER ISLAND

STUPART ISLAND

BATHURST ISLAND

DEVON ISLAND

MELVILLE ISLAND

CORNWALLIS ISLAND

PLAYFAIR POINT

RESOLUTE BAY

115° 0' 0" W | 110° 0' 0" W | 105° 0' 0" W | 100° 0' 0" W | 95° 0' 0" W | 90° 0' 0" W | 85° 0' 0" W | 80° 0' 0" W

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\21-2370 PIONEER SITES\PLAYFAIR POINT 2141\PLAYFAIR POINT.DWG
PLOT DATE: 2021-11-11 @ 4:48:41 PM PLOT SCALE: 1:51.25 OF STYLE: DILLON.CTB

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1	ISSUED FOR INTERNAL REVIEW	05/04/17	TPW

DESIGN	GS
REVIEWED BY	GS
DRAWN	TPW
CHECKED BY	GS
DATE	NOVEMBER 2021
SCALE	AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

PIONEER SITE LOCATIONS AND STAGING LOCATION

SHEET NO. 100

2.0 Playfair Point Remedial Action Plan

2.1 Executive Summary

The Playfair Point site is designated as NB012 in the Northwest Territories/Nunavut contaminated site database. Its federal contaminated site inventory (FCSI) number is 00000270. It is located on a point of land on the southwest coast of Bathurst Island, about 160 km southeast of Resolute Bay. Playfair Point was used under the land use permits N88J059, N91J613 and N94J157 by the Canadian Wildlife Service (CWS) from 1989 to 1995 to support caribou research at the CWS Walker River Camp on the east side of Bathurst Island. The site has no officially designated airstrip. The sand bar parallel to the beach and beside the drum cache has been used for landing fixed-wing aircraft.

A summary of wastes which require remediation at the Playfair Point Site is as follows:

Table 2-1 Summary of Waste Streams at Playfair Point Requiring Remediation

Waste Stream	Quantity
Waste fuel	615 litres
Drums	3 drums un-crushed volume: 1 cubic metre empty weight of drums: 54 kilograms.

Soil with contaminant concentrations in excess of the applicable CCME Guidelines was found in the 2007 Phase II sampling program (WESA, 2007b) but not in the 2021 Phase III sampling program (DOJV, 2022a). Based on the risk characterization results, there is a negligible potential for human health risk at Playfair Point. The Ecological Risk Assessment concluded that based on the conservative assumptions, the likelihood of potential risk to terrestrial vegetation and soil invertebrate communities and mammalian wildlife populations on the site is also considered to be negligible. The Risk Assessment results therefore do not indicate a human or ecological risk-driven rationale for any management of contaminated soil at the Playfair Point site, however, the three full drums remaining on the site could be a source of future contamination, thus for that reason they are addressed in the RAP.

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. Evaluation criteria were the same for the analysis of options for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Required; iv) Reduction of Environmental Liabilities; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as favourable, neutral or unfavourable, according to the degree to which the criterion was

satisfied. The objective is to develop and recommend a solution which is protective of the environment and does not require on-going monitoring or maintenance, i.e., a "walk-away" solution.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option consists of:

1. Transferring the waste fuel into sturdy containers and removing it off-site for final disposal. The waste fuel volume is 615 litres (L) (615 kilograms (kg), not including containers).

2. Removing the 3 waste drums once emptied from site, without crushing, and transporting them to Resolute Bay and then out of the Territory for disposal. The combined weight of empty waste drums is 54 kg.

In summary, a small amount of solid waste (54 kilograms), and 615 L (615 kg) of liquid waste will require removal from the site, and transportation to waste receiving sites outside of the Territory. With this set of actions for the waste streams, the solution will be "walk-away", with no on-going requirements. Aircraft is the most viable method of transporting waste streams to nearby Resolute Bay for onward transportation. The landing strip at Playfair Point is a sand bar adjacent to the drum cache, and its short length (650 m) may impose a payload limitation on the aircraft. Two or three flights would be required using a Twin Otter. If there are facilities for burning the waste fuel for heating oil locally in Resolute Bay that is an acceptable option, otherwise the waste fuel should be transported out of Territory along with the drums by sealift.

The duration of the remedial activities at Playfair Point is approximately 2 or 3 days and it would be most feasible to execute it in July or August so that it can be moved out of Territory by the sealift which usually occurs in September.

2.2 Introduction

2.2.1 Objectives of the Remedial Action Plan

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of: i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project.
- Recommend optimal scheduling of work such that this group of sites can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

2.3 Background of Playfair Point and Features

The Playfair Point site is designated as NB012 in the Northwest Territories/Nunavut contaminated site database. Its FCSI number is 00000270. It is located on a point of land on the southwest coast of Bathurst Island, about 160 km southeast of Resolute Bay. Playfair Point was used under the land use permits N88J059, N91J613 and N94J157 by the Canadian Wildlife Service (CWS) from 1989 to 1995 to support caribou research at the CWS Walker River Camp on the east side of Bathurst Island. The site has no officially designated airstrip. The sand bar parallel to the beach and beside the drum cache has been used for landing fixed-wing aircraft.

Its location is approximately 75º 21' N latitude and 100º 43' W longitude. See Figure 100 for the site location.

2.3.1 Physical Setting and Site Reconnaissance

The Site was found to consist of exactly three rusty drums resting on their sides in a line, on the upland side of a sand bar which was used as a landing strip for the Twin Otter. This number of drums differs from the Phase I ESA (WESA 2007a) which reported four full or partially full drums and one empty drum. An extensive walk-around over a distance of 100 m in each direction did not reveal any other drums. With the exception of one small machine cut piece of wood (0.05 x 0.05 x 2m) there was no debris of any kind. There was a pile of caribou antlers and a caribou skull located immediately beside the drums on the east side. The ground had a thin layer of cobbles at the surface in some places and in other places it was light brown sand.

There was a shallow lagoon on the upland side of the drums (north), and a sand bar extending several hundreds of metres to the east and west. The seashore was located approximately 120 m to the south of the drums.

The site reconnaissance confirmed that there was only one APEC at the site: the drum cache. No staining of the soil around any of the drums was observed.

There were no physical hazards identified at the site.

2.3.2 Site Access Conditions

A reconnaissance flight to Playfair Point was completed on July 9, 2021 by Kenn Borek Airways using a Twin Otter on tundra tires, to assess its landing conditions for fixed wing aircraft. The reconnaissance flight landed on the sand bar close to the drums and reported that the landing strip was 'fairly short' and that a minimum fuel load should be carried when hauling out the drums. It was noted that there were two landing strips possible: a spring one that is usable in wet conditions; and a summer one that is usable in dry conditions and is wider and smoother of the two.

The field team for the Phase III ESA reached Playfair Point from Resolute Bay by Twin Otter and landed on the sand bar nearest to the abandoned drums. The plane was capable of landing and taking off with the distance between two washouts on the sand bar, approximately 260 m.

2.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the Playfair Point site for the previously confirmed and suspected contaminants. The only APEC was soil potentially impacted by petroleum hydrocarbons from a small cache of three fuel drums on the sand bar. Five test pits were carried out around the three drums, and another four background test pits were carried out up-gradient and at distances judged to be outside of area of impact of drums. The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the SSHHERA. The results of both assessments are summarized below.

One drum was opened and sampled for the product contained within.

2.3.4 Impacted Soil Assessment

Overall, nine environmental test pits were carried out in the 2021 Phase III ESA. The test pits were advanced to between 0.4 and 0.5 metres below ground surface (BGS). The soil type was dry to moist sand with gravel. Chemical analysis revealed no detection of benzene, toluene, ethylbenzene, or xylenes (BTEX), petroleum hydrocarbons (PHC) or polycyclic aromatic hydrocarbon (PAH) in any of the delineation samples and metals concentrations in all samples were below the CCME Agricultural guidelines. The 2007 Phase II ESA (WESA, 2007b) had detected PHC impact above the same guideline at one location adjacent to the drums on the downgradient side. This location was resampled in the 2021

assessment however there was no remaining indication of the PHC detected in the previous investigation.

2.3.4.1 Risk Assessment of Soil

The Human Health Risk Assessment concentrated on the 2007 soil result which had a PHC-F2 concentration of 11,500 µg/g (at a depth of 0.15 metres below ground surface (mbgs)) at a location adjacent to the drums on the downgradient side. Site specific target levels (SSTL) were derived for petroleum hydrocarbons in the F2 range, for a toddler receptor at Playfair Point for hypothetical visits up to 4 weeks per year. The SSTL derived for PHC-F2 was 6,800 µg/g which was exceeded in the 2007 sample NB012 SS02 in APEC 1 Drum Cache (Area 100). A deeper sample at the same location did not exceed the guideline and given that all soil samples collected in 2021 Phase III ESA around that same location had no detectable concentrations, PHC-F2 was considered not to be of concern to human health and was not carried forward for further assessment in the HHRA. No soil staining was observed on the site.

The Ecological Risk Assessment concluded that based on the conservative assumptions, the likelihood of potential risk to terrestrial vegetation and soil invertebrate communities and mammalian wildlife populations on the site is considered to be negligible.

As such, there is no human or ecological risk-driven need for remediation or risk management on the subject site in relation to any of the parameters exceeding generic guidelines, as long as the future land use and time on-site assumptions (i.e., exposure frequency and duration) do not exceed that which was assumed in the HHERA for the assessed receptors and assuming that remaining sources (i.e., barrels) are removed.

2.3.5 Waste Fuel and Drums

An inventory of drums at the Playfair Point Camp was conducted. The count was:

Empty drums:	0
Partially full:	0
Full:	3
Total:	**3**

The drums were judged to be essentially full, and the estimated volume of waste fuel is approximately 615 litres (205 litres per drum).

The drums all had a similar colour code. Their sides were reddish-brown, with a yellow centre band. None had a legible label. Given that all the drums appeared to come from a similar source, one sample of product was collected from the western most drum, which was painted with an ID of: 2.

The results of the analysis of product taken from one drum showed that it had a spectrum similar to a gasoline mixture with 0% water. Flashpoint was 22°C. Specific gravity was 0.7708. There was no PCB, lead, cadmium or chromium detected. The fuel testing results are included in Appendix B.

2.3.6 Hazardous and Non-hazardous Building Materials

The only non-hazardous debris was a single wooden stake of dimensions 0.05 x 0.05 x 2 m. The total volume of wood is on the order of 0.005 m^3. No action is deemed necessary for this piece of wood.

2.3.7 Summary of Waste Streams

There was no contaminated soil identified at the Playfair Point site. Waste to be managed includes three full drums of fuel found at the site. Table 2.2 summarizes the types and quantities of wastes to be managed at Playfair Point.

Table 2-2 Summary of Waste Streams Requiring Management at Playfair Point

Waste Stream	Quantity
Waste fuel	615 litres
Drums	3 drums un-crushed volume: 1 cubic metre empty weight of drums: 54 kilograms.

2.4 Remedial Options Analysis by Waste Stream

2.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were evenly weighted in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given

a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given in order to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 185 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are "walk-away" with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation

component of this project has not yet taken place, and the stakeholders' opinions on the integrated option which is the output of the remedial options analysis have not been heard.

2.4.2 Waste Fuel Options

A quantity of approximately 615 L of waste fuel in three 205 L drums is present at Playfair Point.

Options for management include:

1. Leaving it as-is: Leaving the waste fuel at its current location.
2. Incineration on-site: An incinerator would be mobilized to Playfair Point and the waste fuel would be incinerated at a prepared incineration area on-site. The feasibility of using small incinerators on-site to burn the waste fuel was assessed. There are at least two small/low weight incinerators on the market that are transportable by aircraft and capable of burning aviation fuel. Both of the models considered (SmartAsh) with an optional drum transfer pump and Total Combustion Inc, model DCL) would be capable of incinerating the volume of waste fuel in a maximum of 4 days (150 L per 8 hours) and could be transported to the site in a single Twin Otter aircraft flight even considering the weight limitations with landing an aircraft on the sandbar. On-site incineration reduces the number of times the fuel would be handled compared to off-site transportation and disposal. It would need some preparation work on-site to level and prepare an incineration area of about 5 by 5 metres. There is no vegetation to clear. This option would require five site visits to complete the work and a crew of three to handle the fuel transfer and operation of the incinerator.
3. Removal off-site for disposal. Given that the structural integrity of the drums is unknown, and their presence on-site may date as far back as 1989, they may have corroded and weakened to the point of near perforation. For this reason, it is not envisaged to move any of the drums from their present location until they have been emptied. The contents would be pumped from the three drums into alternative sturdy containers, transported to the aircraft, and flown to Resolute Bay for transfer out of the Territory for disposal, or disposal at facilities in Resolute Bay. Removal of the waste fuel from the site for disposal has no technical uncertainty, its movement would be tracked via manifests, and proof of disposal would be documented. The 615 L of waste fuel could be contained in three sturdy new drums for transportation to Resolute Bay. The drums would be handled by heavy equipment such as a forklift upon arrival to Resolute Bay, and subsequently be either disposed of in Resolute Bay by incineration or shipped via sealift to an appropriate disposal facility in the South, once offloaded from the sealift at its final destination. The removal of fuel from the site could be done in two Twin Otter flights back to Resolute Bay and would take about two workdays for transfer of fuel and flying it out to Resolute Bay.

Waste drum management is analyzed separately from waste fuel management (see next section).

The three options for waste fuel have been evaluated and the results are tabulated below.

Table 2-3 Evaluation of Options for Waste Fuel

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Incineration on-site	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	**Favourable (+1)**
Removal off-site for disposal	Favourable	Neutral	Favourable	Favourable	Neutral	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the waste fuel on site significantly increases the environmental risk and liability at the site. The three drums have not yet leaked may eventually do so. This option scores unfavourably under the Reduction of Environmental Risk. Although there is no current contaminated site liability, this option scores unfavourably on Reduction of Environmental Liability because it incurs the risk of future liability from site contamination. Resources required are nil, therefore it scores favourably. It does not create any local socio-economic benefits. It is not a viable option, and its overall score is unfavourable (-1).

Incineration of the waste fuel on-site would completely extinguish the environmental risk and liability but is seen as requiring substantial resources given that operation of the incinerators may be complex, require training to operate, and add logistical challenges in sourcing the incinerator from locations as far as the United States and bringing it to site. The preparation of an incineration area and setting up of the incinerator would take a day for the clean-up crew and burning 615L would take about 4 days at a rate of 150 L per day, so a total of five days of on-site work would be required.

Given the small volume of waste fuel to be removed from site, incineration is not seen as an effective use of time, or adequate value to the Crown. The reduction of environmental risk aspect of on-site incineration is favourable because of a fewer number of times the fuel would be moved and less risk of mishap. The local benefits are favourable because there would be local labour involved in the operation. Its overall score is favourable (+1).

Removal of the waste fuel off-site for disposal either in Resolute Bay or out of the Territory scores favourably under Reduction of Environmental Risk and Reduction of Liability because it removes the risk and any possibility of future liability. It is less costly than on-site incineration because it would require only two days on on-site work compared to five and therefore it was assigned a neutral score under Value to Crown. The resources required are only new, sturdy containers and a transfer pump and the logistical effort of transportation to Resolute and then to the South via sealift, if it cannot be burned locally. Local Benefits are neutral. The removal for off-site disposal option scores favourably (+2) overall.

The recommended remedial option is to proceed with removal of waste fuels off-site for disposal, which could consist of use as heating oil if the facilities exist in Resolute Bay, or transportation out of the Territory for disposal at a licensed facility.

2.4.3 Waste Drums

A total of 3 fuel drums are present at Playfair Point. Drums containing fuel must be pumped out where they lie in order to prevent any leakage due to shifting them in their potentially weakened state. The dry weight per drum is 18 kg, and the total weight is 54 kg. The identified options for their management are:

1. Leaving as-is: The waste drums would be left in one consolidated location at Playfair Pont after they had all been emptied.
2. Burial on-site: The empty drums would first be opened at one end and washed inside using a pressure washer within a plastic catchment basin. Wash water would be collected and treated or containerized prior to disposal. The other end of the drums would opened and they would be flattened using human weight. A flattened volume of 0.5 m^3 can be anticipated. The flattened drums would be placed in an on-site encapsulation cell. An encapsulation cell would require some degree of long-term monitoring.
3. Removal off-site for disposal. The drums would be emptied, but not cleaned or crushed on-site and would be transported to Resolute Bay for transfer to the sealift and then disposed of outside of the Territory.

The three management options for waste drums have been evaluated and the results are tabulated below.

Table 2-4 Evaluation of Options for Waste Drums

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score
	Reduction of Environmental Risks	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Burial on-site	Neutral	Unfavourable	Unfavourable	Unfavourable	Favourable	**Unfavourable (-2)**
Removal off-site for disposal	Favourable	Neutral	Neutral	Favourable	Favourable	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the empty waste drums on-site at a consolidated location is low-cost and presents no technical challenges and therefore scores favourably on Value to Crown and Resources Required criteria. It does not remove the environmental risk; however small the risk of empty drums is. Nor does it remove the liability, as a drum cache would still be considered a waste site and require future monitoring. The local community would not benefit in this option (unfavourable). This option scores unfavourably.

Although the option of burying empty, clean drums on-site has negligible environmental contamination risk, the metal waste would remain on-site (Environmental Risk: neutral). It would require: using retention basin, cutting the drums open, washing with a pressure washer, flattening them and burial in an encapsulation cell and treating the oily wash water. It has greater resources required than the other two options (unfavourable) and would be more costly than removal. Burial of empty steel drums in an encapsulated waste cell would also require on-going monitoring and as a result the liability would not be completely extinguished. Thus, it scores unfavourably in terms of Value to Crown, Resources Required, and Liability Reduction. Local benefits are considered to be favourable given that the labour component of this option is the highest. Overall, this option scores unfavourably.

Off-site removal of drums has the greatest reduction of environmental risk (favourable). It scores favourably under Reduction of Liability because it is a "walk-away" solution and is expected to benefit the local community in terms of leaving a clean site and providing a local labour component in achieving it (favourable).

It scores neutrally on Value to Crown because it is expected to cost more than leaving the drums but less than on-site burial because there are no return visit monitoring requirements. Similarly, the resources required for removal to Resolute Bay and ultimately out of Territory are greater than leaving on site but less than on-site burial. The recommended option for waste drums is therefore removal off-site for disposal outside of the Territory. With off-site removal, crushing the drums on-site prior to their movement offers no apparent benefit. There is not expected to be any heavy equipment on site therefore no effective volume reduction methods. A drum crushing operation would require a spill containment area and drum washing. The sealift cost for drums is the same whether they are crushed or not.

2.4.4 Integrated Remedial Plan

The integrated remedial work plan is comprised of the highest-ranking options from the multi-variant criteria decision matrix analysis for each waste stream requiring remediation. It is comprised of:

1. Waste fuel would be transferred into sturdy containers and removed for off-site and out of Territory for final disposal. The waste fuel volume is 615 L (weight 615 kg, plus containers).
2. The three waste drums once emptied would be removed off-site by aircraft, then moved out of the territory for disposal. The combined weight of empty waste drums is 54 kilograms.

In summary, less than 1 tonne of waste will require removal from the site, and transportation to waste receiving sites outside of the Territory. With this integrated set of actions for the waste streams, the solution would be "walk-away", with no on-going requirements. Aircraft is the only means of bringing waste fuel and empty drums out to Playfair Pont. Both waste streams must be removed concurrently. Use of the waste fuel as heating oil would be an acceptable means of disposal, otherwise the waste fuel and drums would then transported from Resolute Bay by sealift for off-site disposal at a facility in the South.

2.4.5 Scheduling

The remediation work at Playfair Point should be scheduled so that the waste fuel and drums can be transported off-site and to the South the same year, therefore the anticipated departure time of the sealift must be integrated into the timing of remedial activities. There is usually one sealift stop in Resolute Bay per year. The 2021 sealift date of departure from Resolute Bay was September 7th. The on-site remediation work should be done in July or August.

2.5 Scope of Work for Proposed Remedial Solution

The scope of work required to implement the work arising from the preferred remedial option has been resolved into a Work Breakdown Structure (WBS) included in Appendix A and has been packaged with three other 'small' sites in the Pioneer High Arctic Bundle. The WBS describes in a graphical form the work that will be required of a contractor for this site within the overall contract. The WBS contains four deliverables for work supporting all of the sites in the contract, three of which are common for the other three sites in the contract: BOPC1: Balance of Project Costs, 1: Project Meetings, 2 Health, Safety and Environment, 3 Logistics, Transportation and Facilities, and 7 Playfair Point Remediation.

Task 7 breaks down the work required to implement the remedial option for Playfair Point as defined in the previous section into work packages which will be defined in a Scope of Work and verifiable by the on-site PSPC Construction Representative.

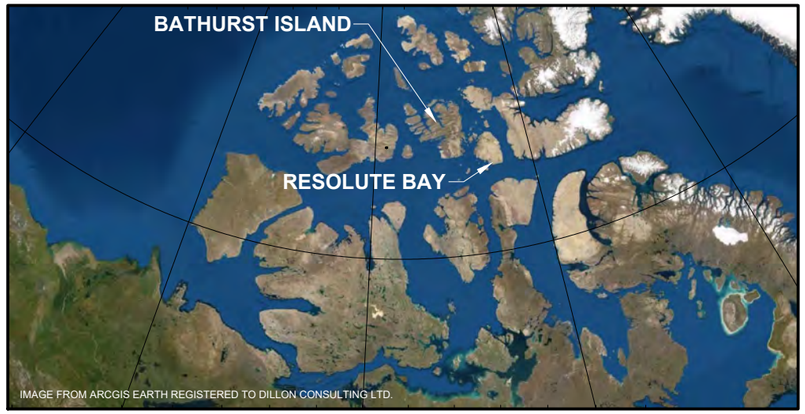
The work packages are as follows, with details being provided in the Tender Specification:

1 Drum Management

All drums containing fuel will be emptied as per the appropriate section in the Specifications and subsequently packaged for off-site disposal. Drums will be transported off-site to Resolute Bay by aircraft and out of Territory by sealift to a disposal facility in the South.

2 Waste Fuel Management

Waste fuel will be pumped out of any drum containing fuel into secure containers and transported off-site by means of aircraft to Resolute Bay and then out of Territory by sealift to a disposal facility in the South.



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FILENAME: C:\CAD\21270 PIONEER SITES\PLAYFAIR POINT 21-NN\PLAYFAIR POINT.DWG
PLOT DATE: 2021-11-08 @ 12:55:38 AM PLOT SCALE = 1:1 PLOT STYLE: DILLON.CTB

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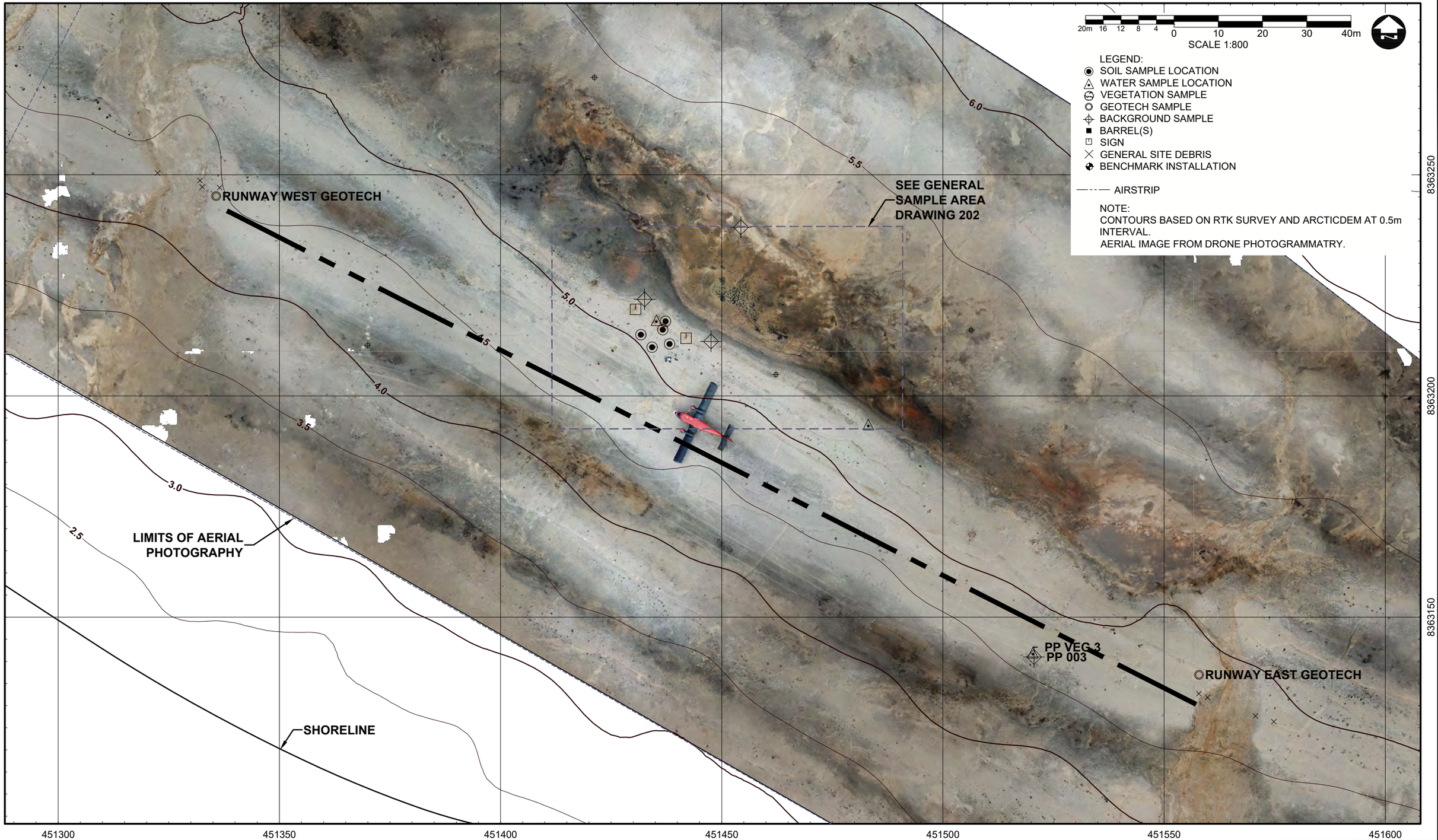
ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

PLAYFAIR POINT
SITE LOCATION PLAN

SHEET NO. **200**



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FILENAME: C:\CAD\21237D PIONEER SITES\PLAYFAIR POINT Z14N\PLAYFAIR POINT.DWG
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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

PLAYFAIR POINT SURVEYED LIMITS

SHEET NO. 201

451425 451430 451435 451440 451445 451450 451455

8363220

8363215

8363210

PP 001

SIGN

PP 101

PP 102

ANTLERS

PP 105

NO CONTAMINATION IDENTIFIED

SIGN

PP 002

PP 103

PP 104

5.2

5.1

5.0

4.9

4.8

Contents of three drums to be transferred to sturdy containers for transportation off-site.

Drums to be removed from site without crushing

All wastes to be transported to Resolute Bay and then out of Territory for final disposal.

2.0m 1.6 1.2 0.8 0.4 0 1.0 2.0 3.0 4.0m

SCALE 1:80

LEGEND:

- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES

NOTE:
CONTOURS BASED ON RTK SURVEY AND ARCTICDEM AT 0.1m INTERVAL.
AERIAL IMAGE FROM DRONE PHOTOGRAMMATRY.

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FILENAME: C:\CAD\21237\0 PIONEER SITES\PLAYFAIR POINT 21\4NPLAYFAIR POINT.DWG
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REVIEWED BY	DP
DRAWN	TPW
CHECKED BY	DP
DATE	NOVEMBER 2021
SCALE	AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PLAYFAIR POINT
SAMPLE AREA

PROJECT NO. 21-2370

SHEET NO. 203

3.0 Pioneer Island Remedial Action Plan

3.1 Executive Summary

Pioneer Island site is designated as EK007 – Devon Island (West) and EK011 – Pioneer Island/Devon Island in the Northwest Territories/Nunavut contaminated site database and its federal contaminated site inventory (FCSI) number is 00000258. It is located about 255 km north-northwest of Resolute Bay, off the northern end of Devon Island. Pioneer Island has a long smooth, but unmarked airstrip. No conclusive evidence has been found to link this site to its user or responsible party; however, it was reported in a Nunavut Mineral Database (NUMIN) database that Cominco Ltd. conducted detailed geological work in the Grinnell peninsula and adjacent areas which included Pioneer Island in 1973. The site is currently uninhabited by humans.

A Phase I and II ESA was conducted by Water and Earth Sciences Associated Inc., with field work in 2011 and reporting in 2012 (WESA, 2012a). WESA documented the Pioneer Island site as having an air strip, approximately 25 drums [five (5) full, four (4) partially full, six (6) empty, and approximately 10 in unknown condition or with unknown contents located throughout the site], metal and wood debris, and a burn pit. The Phase II ESA results indicated that there were soil exceedances above the applicable criteria for various substances including arsenic, barium, cadmium, molybdenum, nickel, selenium, thallium, vanadium, zinc, naphthalene, F2 PHCs.

The 2021 field work which formed the basis of the 2022 Phase III ESA (Dillon-Outcome, 2022a) conducted at Pioneer Island, assessed the 4 previously identified APECs (APEC 1 – Burn Pit; APEC 2 – (Former) Drum Cache; APEC 3 – (Former) Drum Cache and APEC 4 – Battery Area). The 2021 field work found that all of the drums previously identified at Pioneer Island have been removed but the non-hazardous waste (wood, metal and burned residue) and hazardous waste (batteries) still remains on the site.

A summary of wastes which require remediation at the Pioneer Island site is as follows:

Table 3-1 Summary of Waste Streams at Pioneer Island Requiring Remediation

Waste Stream	Quantity
Non-hazardous waste (wood/metal waste, charred debris)	10 m^3 / 10 tonnes
Hazardous waste	4 lead-acid batteries (80 kg)

Although soil with contaminant concentrations in excess of the applicable CCME Guidelines has been found at the Pioneer Island, the Human Health Risk Assessment results indicated there is negligible potential for human health risk from the contaminants. The Ecological Risk Assessment concluded that there is no need for corrective action or risk management on the site, in relation to communities or

populations of ecological receptors. The Risk Assessment results therefore do not indicate a compelling human or ecological risk-driven rationale for any management of contaminated soil at the Pioneer Island site.

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. Evaluation criteria were the same for the analysis of options for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Required; iv) Reduction of Environmental Liabilities; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as favourable, neutral or unfavourable, according to the degree to which the criterion was satisfied. The objective is to develop and recommend a solution which is protective of the environment and does not require on-going monitoring or maintenance, i.e., a "walk-away" solution.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option consists of:

1. Wood waste would be incinerated at the existing burn area to reduce volume/weight. Then all combined ash, remaining metal waste and charred debris would be packaged for transport via aircraft for off-site disposal.

2. The smashed lead batteries would be packaged for transport via aircraft for off-site disposal.

In summary, less than 10 tonnes of waste will require removal from the site, and transportation to waste receiving sites outside of the Territory. With this integrated set of actions for the waste streams, the solution would be "walk-away", with no on-going requirements. Aircraft is the most viable method of transporting the non-hazardous and hazardous waste out of Pioneer Island to Resolute Bay. From Resolute Bay all of the wastes would then be transported by sealift for final disposal at a facility in the South. There is usually one sealift stop in Resolute Bay per year. All waste steams should be transported to the South the same year remedial activities occur. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. It is recommended that the remediation activity take place in July or August so that it can be moved out of Territory by the sealift which usually occurs in September.

3.2 Introduction

3.2.1 Objectives of the Remedial Action Plan

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of : i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project.
- Recommend optimal scheduling of work such that the entire Pioneer Bundle can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

3.3 Background of Pioneer Island and Features

The Pioneer Island site is located approximately 255 km north-northwest of Resolute Bay, NU and immediately north of Devon Island, with a location of 79º 57' 59.47'' N latitude and 96º 58' 21.30'' W longitude. No conclusive evidence has been found to link this site to its user or responsible party; however, it was reported in a Nunavut Mineral Database (NUMIN) database that Cominco Ltd. conducted detailed geological work on the Grinnell peninsula and adjacent areas which included Pioneer Island in 1973 (Dillon-Outcome, 2022a).

A Phase I and II ESA was conducted by Water and Earth Sciences Associated Inc., with field work in 2011 and reporting in 2012 (WESA, 2012a). WESA documented the site as having an air strip, approximately 25 drums [five (5) full, four (4) partially full, six (6) empty, and approximately 10 in unknown condition or with unknown contents located throughout the site], metal and wood debris, and a burn pit. The Phase II ESA consisted of a site visit including the collection of six (6) soil samples (includes one (1) field duplicate and one (1) background sample) within the debris and burn pit area, around the drums, and near the discarded batteries. Results indicated that there were soil exceedances above the applicable criteria for various substances including arsenic, barium, cadmium, molybdenum, nickel, selenium, thallium, vanadium, zinc, naphthalene, PHC-F2. It was estimated that there was <1000 m^3 of impacted soil present at the site. WESA recommended additional lateral and vertical delineation of environmental containments of concern (COC) in soil to evaluate the extent of impacted soil and the collection of a background soil sample to determine if metal concentrations are naturally occurring at the site.

Dillon-Outcome's Phase III ESA of Pioneer Island, with fieldwork in 2021 and reporting in 2022 (Dillon-Outcome, 2022a) assessed the 4 previously identified APECs (APEC 1 – Burn Pit; APEC 2 – (Former) Drum

Cache; APEC 3 – (Former) Drum Cache and APEC 4 – Battery Area). The 2021 field work found that all of the drums previously identified at Pioneer Island have been removed but the non-hazardous waste (wood, metal and burned residue) and hazardous waste (batteries) still remains on the site. The Phase III ESA results are contained in the following sections.

3.3.1 Physical Setting and Site Reconnaissance

A site reconnaissance of the Pioneer Island site was the first task performed. The site is on a plateau on the north side of the island. The ground surface was flat and covered with gravel and coarse sand. The site is currently uninhabited by humans. Vegetation at the site is limited to sparse tufts of grass and arctic poppies. There were no drums present on the plateau however there were three drums that had rolled down the slope towards the water on the north side of the site. These drums were surveyed, but it is unknown if they contain any liquid. There was random weathered lumber with nails, a burn area with charred wood and tin cans, and chain-link fence lying on the ground (trip hazard). At the west end of the site there was four smashed 12-volt lead-acid batteries (chemical hazard) and cloth marking tape on the ground, and a survey benchmark.

The areas of potential environmental concern (APECs) targeted in the Phase III ESA were:

APEC 1: Burn Area

APEC 2: Former Drum Cache E

APEC 3: Former Drum Cache W

APEC 4: Battery Area

APECs 2 and 3 were named as *former* drum caches and could only be investigated based on the GPS coordinates in WESA (2012a). There was no stained soil in the vicinity of the GPS coordinates of either former drum cache.

3.3.2 Site Access Conditions

Although the site could potentially be reached by boat from Resolute Bay, the only practical means for accessing the site is by air, given the presence of sea ice.

A reconnaissance flight to Pioneer Island was completed on July 6, 2021 by Kenn Borek Airways using a Twin Otter on tundra tires, to assess its landing conditions for fixed wing aircraft. The reconnaissance flight landed on the airstrip and noted that there is 'plenty of length' for take-off with load. The elevation of the landing strip was 100 m above sea level; its length was over 1,200 m and its position was N 76.58'00.2" W 096.57'49.9". Potential for cross winds was noted. The pilot also noted that the drums had been removed by Polar Continental Shelf Program in June 2021.

In the field program for this Phase III ESA in August 2021, four attempts were required to make a successful landing on the airstrip at Pioneer Island. The position of the island, off the tip of Devon Island

and facing open water to the north and west, combined with the sloping sides of this high, flat-topped island, made for ideal conditions for cloud formation on top of the island with a northerly or westerly wind. Stable air was required for Pioneer Island to not be shrouded by cloud. The airstrip itself is long and smooth.

3.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the APECs at the Pioneer Island site via soil sampling and inventorying the other waste streams. The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the HHERA (DOJV 2021b). The results of both assessments are summarized below.

3.3.4 Impacted Soil Assessment

The Phase III ESA soil sampling was by test pits dug manually with a shovel. Test pits were dug to refusal on permafrost or as deep as possible if permafrost was not encountered. Bedrock was not encountered in any test pit at Pioneer Island.

The approach in planning the test pit locations was to target the previously identified APECs, plus any areas that Dillon-Outcome identified as data gaps based on the site reconnaissance, with a set of close and stepped-out test pits around the APEC. APECs were sampled on the up and down-gradient sides. The stepped-out test pits were 2 m out in order to have assurance of achieving lateral delineation. The stratigraphy observed in each test pit was logged in terms of soil type, evidence of contamination (staining or odour) presence of debris, moisture, water inflow, and colour. A total of 14 test pits were carried out including one background location, two geotechnical test pits and 11 test pits at the APECs.

The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the HHERA. The results of both assessments are summarized below.

3.3.4.1 Impacted Soil Quantities by Generic Guidelines

The generic guidelines used to screen for soil exceedances were:

- **Soil – BTEX, metals and PAH:** CCME Soil Quality Guidelines, Agricultural Land Use, coarse-grained soil, shallow depth (<1.5 metres);
- **Soil – Petroleum Hydrocarbons:** CCME Canada-Wide Standards for Petroleum Hydrocarbons, Tier 1, Agricultural land use, coarse grained soil, Eco soil contact, more than 10 m from aquatic habitat.

Agricultural land use was deemed appropriate given CCME agricultural/wildland use is defined as "land on which the primary activity is related to the productivity capability of the land and includes lands that provide habitat for wildlife and birds".

Background Soil Testing: There was one background test pit carried out (PI000) on the south side of the landing strip. It was analyzed for metals, PHC, BTEX and PAH. Chemical results indicated that several metals (arsenic, barium, cadmium, molybdenum, nickel, selenium and vanadium) parameters exceeded

the guidelines. The highest relative exceedance was barium with 2,400 mg/kg reported, compared to 750 mg/kg as a guideline level. A similar pattern was present in the background sample by WESA, with barium, molybdenum, nickel and selenium reported at concentrations over CCME guidelines.

APEC 1 Burn Area (Area 100): The Burn Area is evident by a slight above-grade mound of charred debris of dimensions approximately 2m by 2m.

The central sample (PI101), averaged with its duplicate sample (PI QA/QC 1) had guideline exceedances for benzene, toluene and ethylbenzene, and PHC F2, F3 and all of the metals in the background sample plus beryllium, copper, thallium and zinc and PAH. The perimeter test pits (PI102, PI103, PI104 and PI105) only had a hydrocarbon exceedance in PHC-F3, and a similar pattern of metals exceedances as the centre sample. The limit of the PHC-F3 impacted zone over the guideline value of 300 mg/kg is interpolated to be at a radius of no more than 8 m from the centre, for an area of 50 m^2. The depth extent was not confirmed through sampling. Given that the contaminant is petroleum hydrocarbons which were probably used as fire starter, the impact likely extends to permafrost which has a depth of 1 m. A volume of 50 m^3 of petroleum impacted soil is estimated at APEC 1.

APEC 2 Former Drum Cache E (Area 200): No zone of impact is interpreted to exist at this location.

APEC 3 Former Drum Cache W (Area 300): No zone of impact is interpreted to exist at this location.

APEC 4 Battery Area (Area 400): Four test pits were dug at the battery area: PI400 adjacent to a smashed battery, PI401 up-gradient to the battery area, PI402 and PI403 down-gradient of the battery area. All results showed exceedances of the metals molybdenum, nickel, selenium at similar concentrations as the background sample. No sample in the battery area had lead exceedance and the batteries were of lead-acid type. Thus, there is no evident contamination in this area caused by the batteries.

Table 3-2 Pioneer Island Impacted Soil Areas

Defined Area	Surface Area of Impact (m^2)	Depth (m) Assumed	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
APEC 1 - Burn Area	50	1	50	PHC	Medium
Totals	**50 m^2**		**50 m^3**	**PHC**	**Range: Low to High.**

3.3.4.2 Risk Assessment of Soil

The likelihood of potential risk to outdoor site visitors, terrestrial vegetation and soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible. The site is considered to be adequately characterized, as the portions that could be sampled provide good spatial coverage of the property. Although background soil sampling was limited, further sampling is considered unlikely to alter outcomes and conclusions of the Risk Assessment.

While metal concentrations reported in the burn area and charred debris may be influenced by natural background concentrations, it would be prudent to remove the charred debris in the burn pit to the extent possible, and dispose of hazardous wastes (smashed batteries) and other wastes, which would reduce potential exposures to wildlife species.

3.3.5 Waste Fuel and Drums

All of the drums that had been noted by WESA in 2011 on the plateau at Pioneer Island have been removed. There were three drums that had rolled down the slope towards the water on the north side of the site. These drums were surveyed, but it is unknown if they contain any liquid. The drums most likely originated at the Pioneer site and have been wind-blown and rolled over the edge. Drums which are susceptible to being blown by wind are likely essentially empty. Due to the steep slope, with no reasonable means of retrieving them, they are considered inaccessible and will not be included in the fuel and drum waste stream, thus the count was:

Empty drums:	0
Partially full:	0
Full:	0
Total:	**0**

3.3.6 Non-Hazardous Waste

An inventory of non-hazardous materials was conducted. There were several pieces of unpainted wood debris scattered across the site. It included plywood sheets, and pieces of timber. There was a metal chain-link fence on the ground. The charred debris at the burn area is also included in the non-hazardous waste inventory. There is approximately 2 m^3 of charred debris and 8 m^3 of wood and metal debris.

3.3.7 Hazardous Waste

An inventory of hazardous materials was conducted. There was no painted wood, asbestos containing material, or potential PCB containing equipment. Four smashed batteries were discovered and are considered hazardous waste due to their lead content. The total weight is estimated at about 80 kg.

3.3.8 Summary of Waste Streams

A summary of wastes which require remediation at the Pioneer Island site is as follows:

Table 3-3– Summary of Waste Streams Requiring Remediation

Waste Stream	Quantity
Non-hazardous waste (wood/metal debris and charred debris)	10 m^3 / 10 tonnes

Waste Stream	Quantity
Hazardous waste	4 lead-acid batteries (80 kg)

3.4 Remedial Options Analysis by Waste Stream

3.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were evenly weighted in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given in order to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are

scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 255 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are "walk-away" with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation component of this project has not yet taken place, and the stakeholders' opinions on the integrated option which is the output of the remedial options analysis have not been heard.

3.4.2 Non-hazardous waste (wood/metal debris and charred debris)

There is a total of 8 m^3 of wood debris (plywood sheets and pieces of timber) and metal debris (chain-link fence) scattered across the site and 2 m^3 of charred debris located at the burn area that is considered to be non-hazardous. The identified options for management are:

1. Leaving on-site: The wood/metal waste and charred debris would be concentrated in one consolidated location at Pioneer Island and left on-site.

2. Incineration of wood and removal of metal waste and charred debris: The wood would be burned on a constructed incineration pad in a monitored and controlled burn. The burn pad could be located at the previously used burn area and would not require any borrow material. There is no risk of the fire spreading as there is no vegetation to burn. The 8 m^3 of wood would be reduced in volume to 5-10% of the original volume, i.e., < 1 m^3 of ash with a weight of <0.5 T. The existing 2 m^3 of charred debris and any remaining metal debris (chain-link fence) with an expected average density of 2 T per cubic metre would weigh 4 T and would also be removed. The quantity to be removed from site for off-site disposal would be about 4.5T and 5 m^3.

3. Off-site disposal of wood/metal waste and charred debris: The wood waste would not be burned on-site. The wood, metal and charred debris in the burn pit would be moved off-site for disposal. The 8 m^3 of wood and 2 m^3 of metal and charred debris would be expected to weigh about 8 tonnes and 4 tonnes respectively for a total of 12T and 10m^3, and would require multiple aircraft flights to accomplish removal from the site.

The three options for the wood/metal waste and charred debris have been evaluated and the results are tabulated below.

Table 3-4- Evaluation of Options for Wood/Metal Waste and Charred Debris

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Leaving on-site (wood/metal waste and charred debris)	Unfavourable	Favourable	Favourable	Unfavorable	Unfavourable	Unfavourable (-1)
Incineration of wood waste and off-site disposal of ash and metal/charred debris	Favourable	Neutral	Favourable	Favourable	Favourable	Favourable (+3)
Off-site disposal of wood/metal waste and charred debris	Favourable	Unfavourable	Unfavorable	Favourable	Neutral	Neutral (0)

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

The environmental risk is not reduced (unfavourable) with leaving the charred debris on-site as this assumed to be a contributing factor for the PHC in APEC 1. The cost is lowest as are the resources required (both favourable) as this is the minimal intervention option. Leaving the wood/metal waste and charred debris on-site, does nothing to reduce the environmental liability since it would remain a waste site requiring return monitoring visits. There would be no local benefits (unfavourable). This option is unfavourable.

Incineration of the wood waste with off-site disposal of ash, metal and charred debris scores favourably on every criterion except Value to Crown where it scores neutral as the mid-priced option. The favourable score under local benefits was assigned because there would be a greater local labour content in the consolidation and incineration tasks of the waste than the other two options. Its overall score is favourable (+3).

The off-site disposal option without on-site burning of wood removes the environmental risk and has no on-going liability (both favourable), however it would be most costly option (unfavourable) and consume the more resources (time, fuel) in moving 12 tonnes of wood/metal waste and charred debris off site than the other options. The local benefits are neutral as this has a labour content lower than on-site incineration, however once the wood is off-site at Resolute Bay, some may be used as firewood. Overall, this option is neutral (0).

The optimum waste management solution for the non-hazardous waste is for the wood to be incinerated on-site in the existing burn area with off-site disposal of ash, metal and the charred debris. The environmental risk is nil, the cost is in the middle of the other two options, and there is no remaining liability for monitoring or maintenance.

3.4.3 Hazardous Waste

Four smashed batteries were discovered and are considered hazardous waste due to their lead content and exposed lead plates. The total weight is estimated at about 80 kg.

Given their moderate weight, and ease of collecting, the most viable management option for the hazardous waste (smashed batteries) is removal for off-site disposal. This option provides environmental protection, carries no on-going liability, is not expensive and does not require many resources. It offers local benefits in terms of improvement of the site.

3.4.4 Integrated Remedial Plan

The integrated remedial work plan is comprised of the highest-ranking options from the multi-variant criteria decision matrix analysis for each waste stream requiring remediation. It is comprised of:

1. Wood waste would be incinerated at the existing burn area to reduce volume/weight. Then all combined ash, remaining metal waste and charred debris would be packaged for transport via aircraft for off-site disposal. The quantity of non-hazardous waste to be removed from site for off-site disposal would be about 10T and 10 m^3.

2. The four smashed lead batteries would be removed off-site alongside the non-hazardous waste by then moved out of the territory for disposal. The combined weight of batteries is estimated to be 80 kilograms (0.08 tonnes).

In summary, approximately 10 tonnes of waste will require removal from the site, and transportation to waste receiving sites outside of the Territory. This work could be completed in approximately three

days of on-site work, and wastes would be flown out on each return trip to Resolute Bay. With this integrated set of actions for the waste streams, the solution would be "walk-away", with no on-going requirements. Once the wastes have been transported to Resolute Bay they would then be transported by sealift for off-site disposal at a facility in the South.

3.4.5 Scheduling

The on-site work should be completed in summer months and in order to reduce unnecessary environmental liability of keeping waste in storage in Resolute Bay over the winter, all of the waste should be transported to the South the same year remedial activities occur. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. There is usually one sealift stop in Resolute Bay per year. The 2021 sealift's departure from Resolute Bay was September 7th. The on-site remediation work should be done in July or August.

3.5 Scope of Work for Proposed Remedial Solution

The scope of work required to implement the work resulting from the selected remedial option at Pioneer Island has been resolved into a Work Breakdown Structure (WBS) included in Appendix A. The WBS conveys in a graphical form the work that will be required of a contractor who successfully meets the screening, selection and bidding process that is being developed for remediation of the Pioneer Bundle. The WBS contains four main tasks: 1 Balance of Project Costs and Project Meetings, 2 Health, Safety and Environment, 3 Transportation and Logistics, and 6 Pioneer Island Remediation.

Task 6 breaks down the work required to implement the remedial options defined in the previous section into work packages as defined in the Tender Specifications and verifiable by the on-site PSPC Construction Representative.

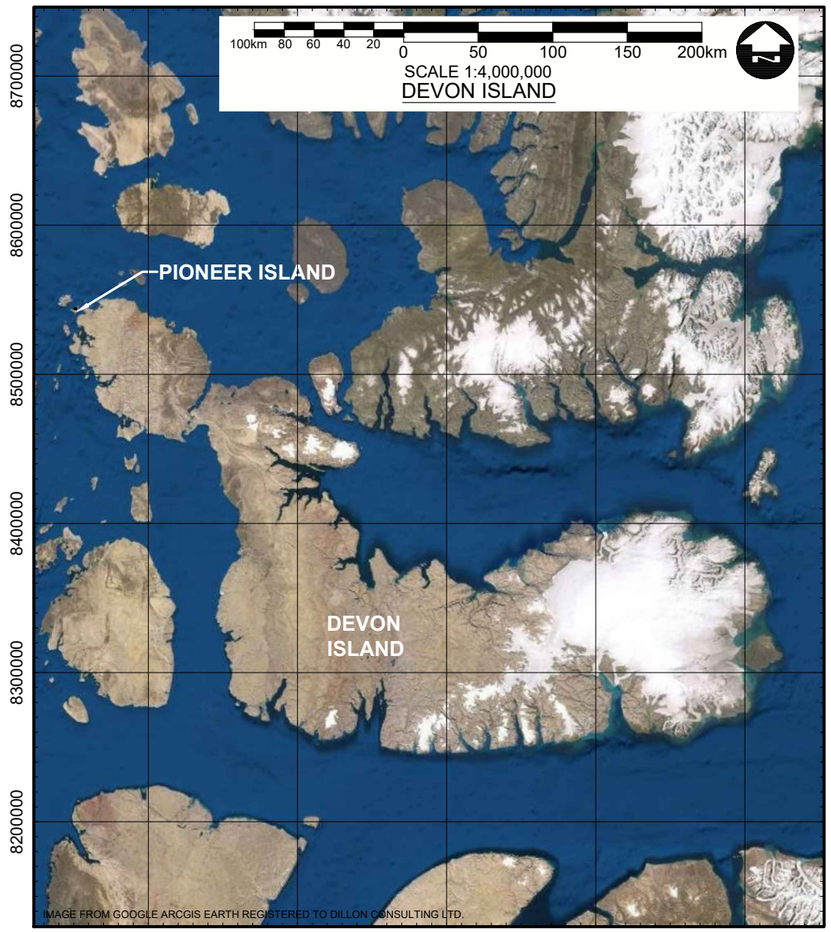
The work packages are as follows, with details being provided in the Tender Specification:

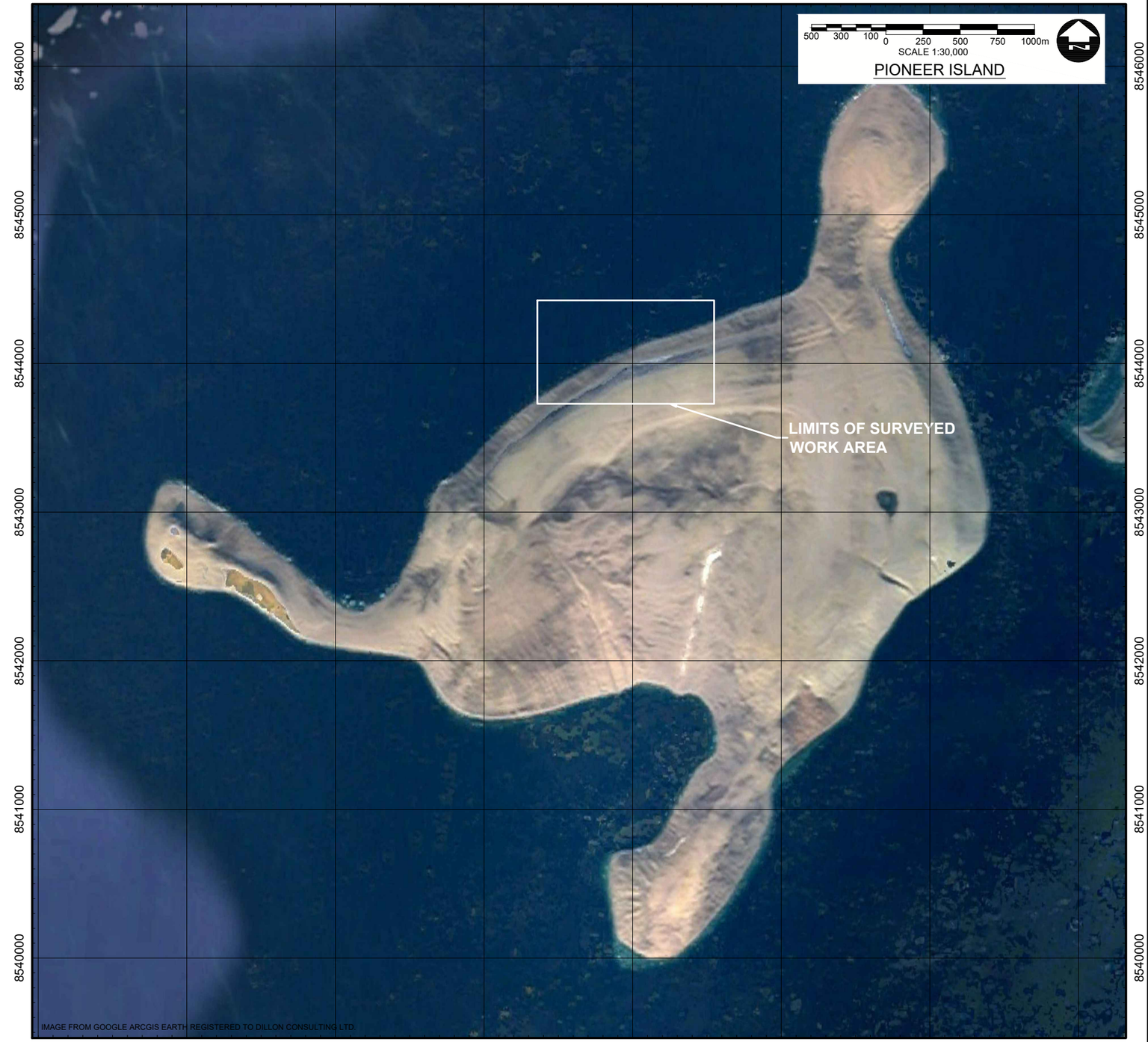
1 Non-Hazardous Waste Management

Wood waste will be incinerated at the existing burn area to reduce volume/weight. The combined ash, remaining metal waste and charred debris will be packaged and transported via aircraft for off-site disposal out of the Territory.

2 Hazardous Waste Management

All batteries will be collected from the site and put in leakproof containers and transported off-site by means of aircraft to Resolute Bay and then out of Territory by sealift to a disposal facility in the South.





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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT CIRNAC

PROJECT NO. 21-2370

PIONEER ISLAND SITE LOCATION PLAN

SHEET NO. 300

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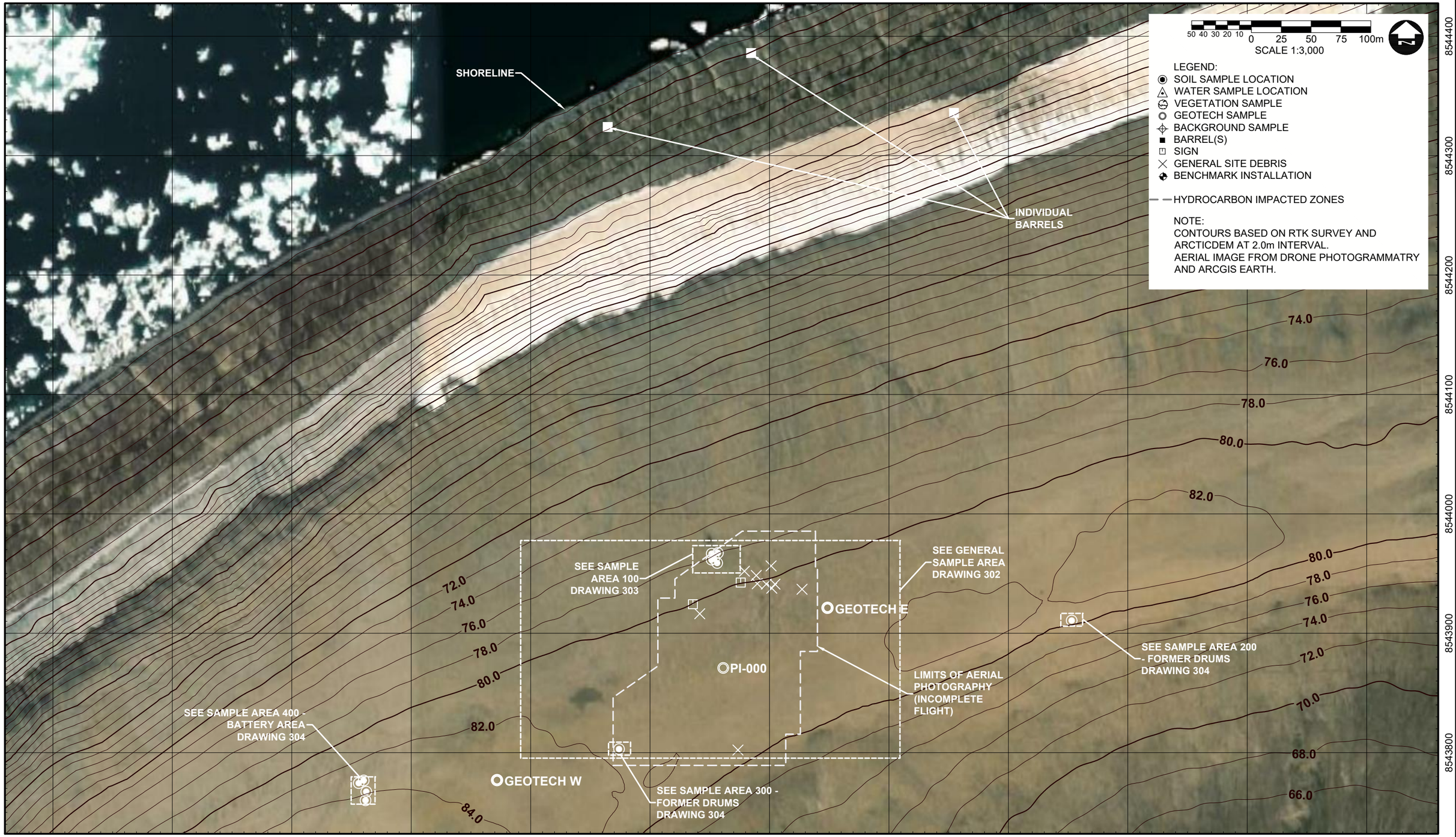

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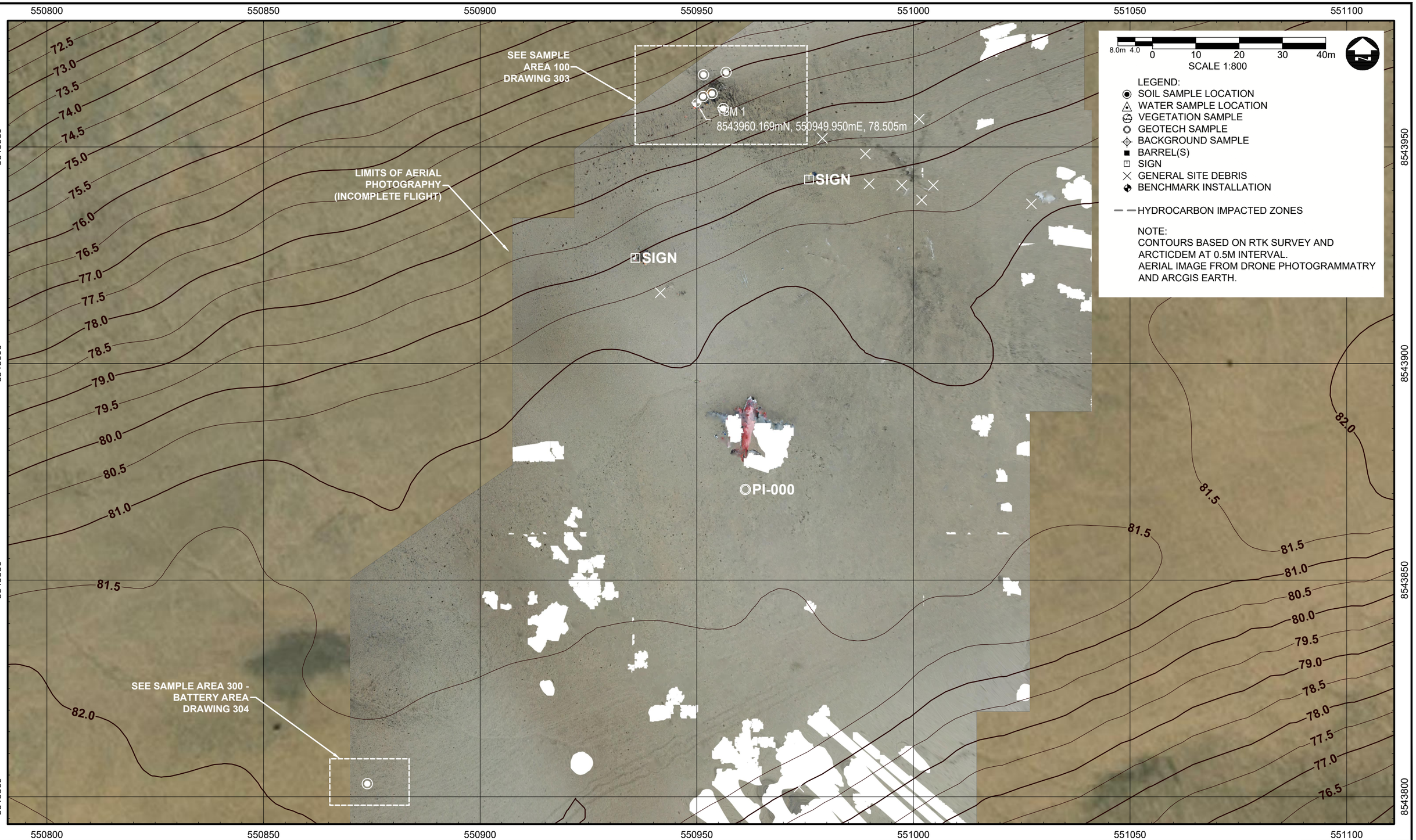
ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

PIONEER ISLAND SURVEYED LIMITS

SHEET NO. 301



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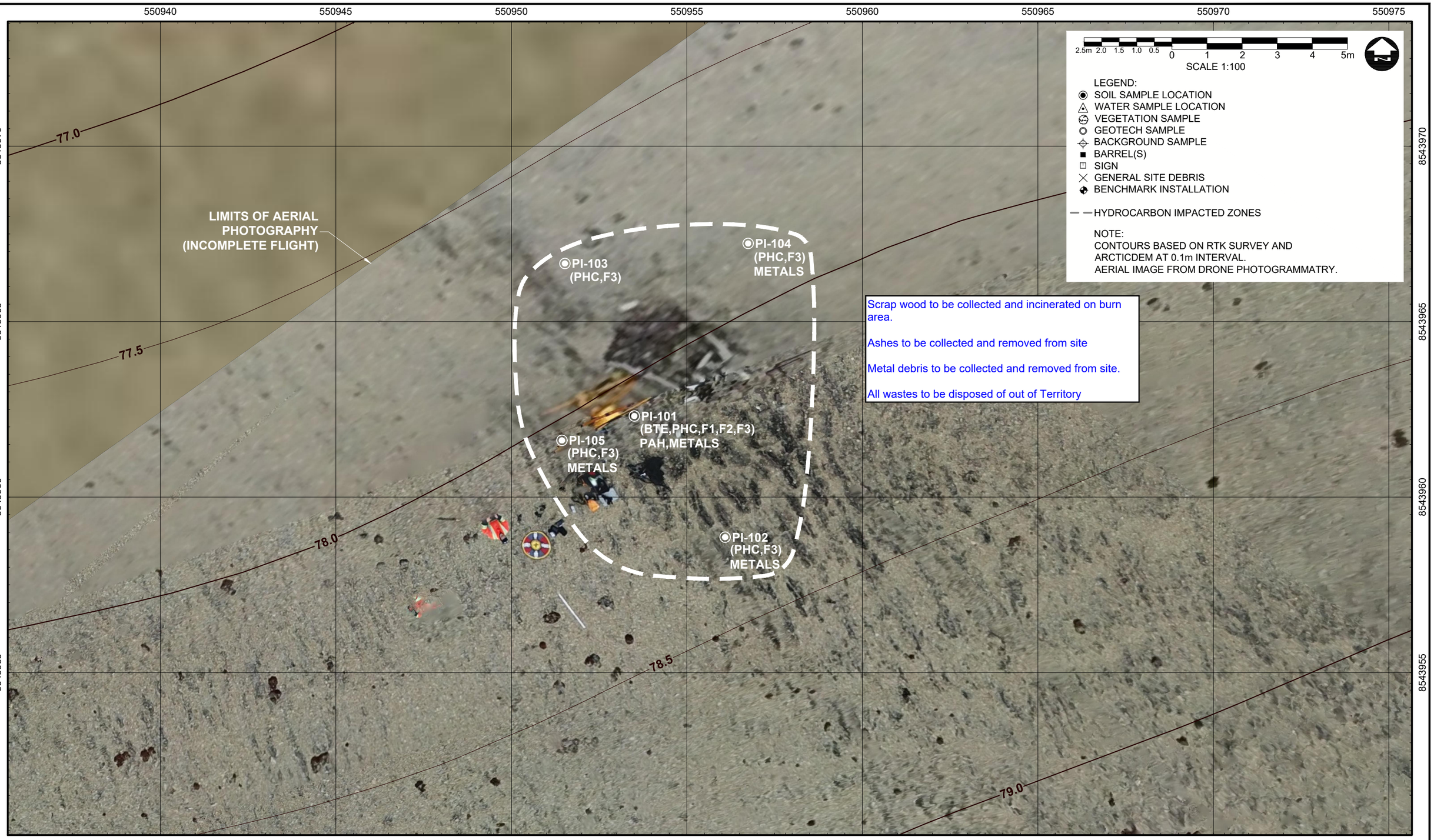
ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

PIONEER ISLAND
GENERAL SAMPLE AREA

SHEET NO. 302



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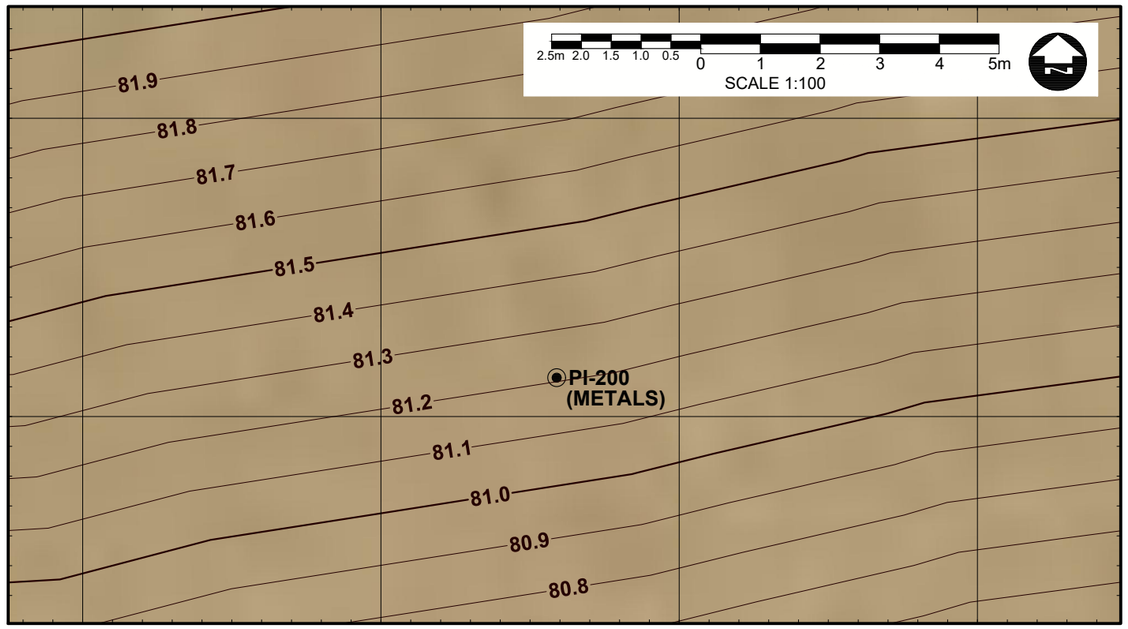
ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PIONEER ISLAND
SAMPLE AREA 100
BURN AREA

PROJECT NO. **21-2370**

SHEET NO. **303**



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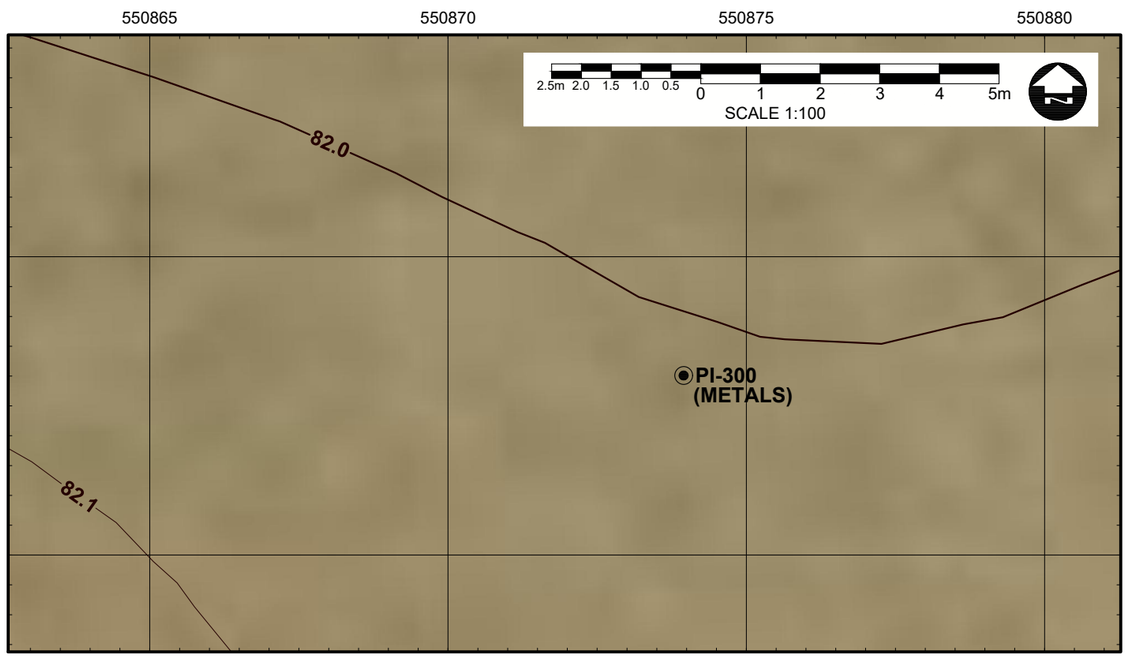

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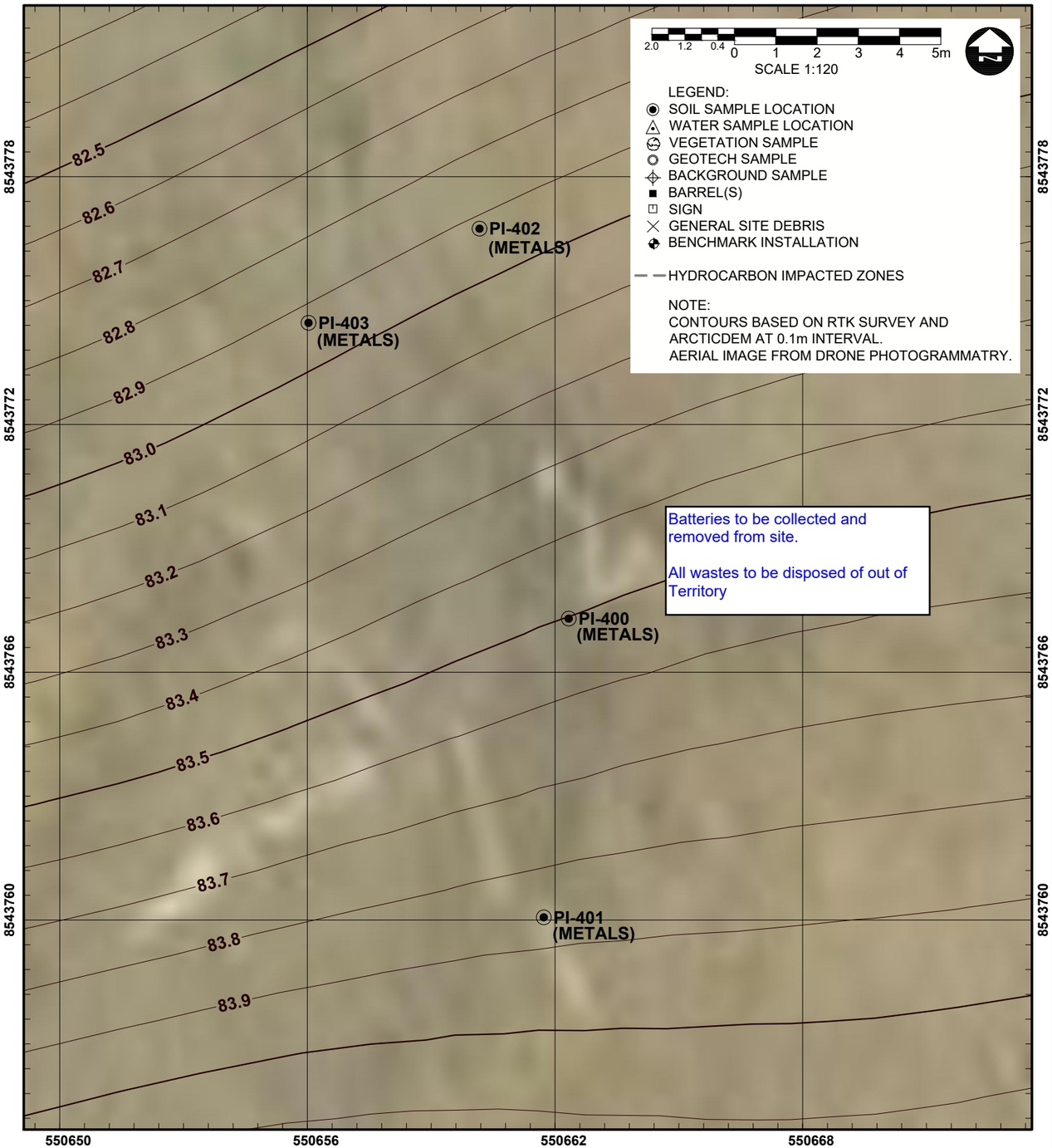

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SCALE 1:100

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PIONEER ISLAND
SAMPLE AREA 200 300 AND 400

PROJECT NO. 21-2370

SHEET NO. **304**

4.0 Cape Isachsen Remedial Action Plan

4.1 Executive Summary

Cape Isachsen is designated NB076 in the Northwest Territories/Nunavut contaminated site database and its federal contaminated site inventory (FCSI) number is 00000304. The site is located on the northwest tip of Ellef Ringnes Island, about 575 km northwest of Resolute Bay and 65 km northwest of the Isachsen High Arctic Weather Station (HAWS). Cape Isachsen is a former Panarctic Oils Ltd. drilling site where the J-37 exploration well was drilled, and a camp was established. There is no airstrip associated with Cape Isachsen.

The main features of the Cape Isachsen site are the J-37 Wellhead, a suspected drill sump and camp sump, a camp area, two disturbed areas and a widely scattered amount of partially buried metal and wood debris. Panarctic was active at Cape Isachsen in 1973. The Site covers an area of about 75 m on its north-south axis by 130 m on its east-west axis. The field work for the Phase III ESA (DOJV 2022a) at Cape Isachsen was carried out in the summer of 2022 with soil sampling and chemical analysis at four APECs:

- APEC 1 North Disturbed Area
- APEC 2 Old Footing
- APEC 3 Wellhead
- APEC 4 East Disturbed Area

The soil analytical results were first compared to generic CCME soil quality guidelines for agricultural land use. Hydrocarbon concentrations in soil exceeded the guideline at the Wellhead and Old Footing areas, with a portion of the hydrocarbon contaminated soil at the Wellhead also having metals impacts. The north and east Disturbed Areas both had boron (hot water soluble) concentrations over generic guidelines however boron has been found to be naturally occurring at other locations on Ellef Ringnes Island at comparable concentrations to those reported at this Site. The hydrocarbon concentrations do not exceed the component value for human dermal contact. The Human Health and Ecological Risk Assessment's conclusions were that the parameter concentrations found in soil are not a concern for human or ecological receptors, thus there is no risk-based requirement for remediation of soil at Cape Isachsen. The surface water sample collected from the well sump had no petroleum hydrocarbon detected and the metals detected locally at the Wellhead did not exceed the Guideline for Protection of Aquatic Life, thus the localized hydrocarbon and metals impacts in soil have not leached into the standing water or the sump.

There was no waste fuel or hazardous building material (lead paint, asbestos) found at the Site.

Non-hazardous debris is present in the form of wood and metal found at random, and six exposed crushed drums.

A summary of all waste streams at Cape Isachsen is given below.

Table 4-1– Summary of Waste Streams at Cape Isachsen Requiring Remediation

Waste Stream	Quantity
Contaminated Soil	None
Non-hazardous debris	Wood and Metal 8 m^3 / 4 tonnes
Waste fuel	None
Drums	Six exposed crushed drums, included in the non-hazardous debris

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. The evaluation criteria were consistent for the options analysis for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Available; iv) Reduction of Environmental Liabilities; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as either favourable, neutral or unfavourable, according to the degree to which the criterion was satisfied. The objective is to develop a solution which is protective of the environment and does not require on-going monitoring or maintenance, i.e., a "walk-away" solution.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option for Cape Isachsen consists of:

- Collection of non-hazardous debris into 1 m^3 soil bags. Freeing and removing the steel cylinder near the camp sump from the sand in which it has partially sunk. Transporting all waste by helicopter to the Isachsen HAWS where a waste transfer station would be established. It would require about 5 sling loads.
- Once the waste from Cape Isachsen has all been transferred to Isachsen HAWS it would be transferred to fixed-wing aircraft and flown to Resolute Bay for onward transportation by sealift.
- From Resolute Bay, the wastes would be transported by sealift for metal recycling or final disposal at licensed waste disposal facilities in the South.

Remediation at Cape Isachsen would be done in a single phase of work over about 4 days during the summer work season of 2023. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of

remedial activities. This solution will be “walk-away”, with no on-going monitoring requirements or liability.

4.2 Introduction

4.2.1 Objectives

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of: i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project.
- Recommend optimal scheduling of work such that the entire Pioneer Bundle can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

4.3 Background of Cape Isachsen Site and Features

The Cape Isachsen site is designated NB076 in the Northwest Territories/Nunavut contaminated site database and 00000304 in the FCSI. The site is located on the northwest tip of Ellef Ringnes Island, about 575 km northwest of Resolute Bay and 65 km northwest of the Isachsen High Arctic Weather Station. Cape Isachsen is a former Panarctic Oils Ltd. drilling site where the J-37 exploration well was drilled, and a camp was established. There is no airstrip associated with Cape Isachsen. Cape Isachsen site is located at approximately 79º 16' 40.44'' N latitude and 105º 16' 37.78'' W longitude. See Figure 700 for the site location.

The Phase I ESA for the Cape Isachsen site (WESA 2012e) revealed that the site was used by Panarctic Oils Ltd. as a drilling site to explore and prove oil and gas reserves in the Canadian arctic islands. Panarctic was active at Cape Isachsen in 1973. The site consists of the former J-37 exploration well, a suspected former camp area, two suspected sumps, at least two disturbed areas and a widely scattered amount of partially buried metal and wood debris. It covers an area of about 75 m on its north-south axis by 130 m on its east-west axis.

WESA's Phase II ESA field work was done concurrently to the Phase I site visit on July 6, 2011. Nine soil samples were collected, plus a duplicate and a background sample. A surface water sample was collected from the Drill Sump. The presence of petroleum hydrocarbon (PHC) impacted soil was confirmed at a location to the northwest of the Disturbed Area North, and at the Wellhead. At the Old Frame (former camp area) the soil impacts were in PHC, metals and polycyclic aromatic hydrocarbons (PAH). Delineation was not achieved at any of these locations.

The Phase III ESA (DOJV 2022a) at Cape Isachsen was carried out with field work in June and July 2022. The features and impacts previously identified were regrouped into four APECs and a detailed sampling program was completed with the aim of delineating the known impacted areas and collecting enough information to complete a HHERA. The areas targeted in the Phase III ESA were (Figure 701):

- APEC 1 North Disturbed Area
- APEC 2 Old Footing
- APEC 3 Wellhead
- APEC 4 East Disturbed Area

The water in the well sump was also sampled and analyzed. Field work for the Phase III ESA was carried out on June 27 and July 3, 2022. The results of the Phase III ESA for contaminated soil assessment and waste material classification are contained in the following sections.

4.3.1 Physical Setting and Site Reconnaissance

A ground-level site reconnaissance of the Cape Isachsen site was the first task performed. The Site was 80% snow-covered on the first visit of 2022, but was positively identified due to the presence of the Panarctic J-37 exploration wellhead steel marker panel. Once the wellhead was confirmed the two disturbed area were also identified. By the time of the second visit on July 3, 2022, the snow-cover was down to 50% and the snow that did remain was only a few centimetres deep and soft.

The Arctic Ocean is about 3 km to the northeast and 4 km to the west of the Cape Isachsen site. The Site covers an area of about 250 m on its north-south axis by 250 m on its east-west axis. It is characterized by two longitudinal mounds of sand on the north and east sides of the Site (named Disturbed Areas 1 and 3, by WESA). These mounds are topographic anomalies in the otherwise flat, featureless landscape and are inferred to be material removed by excavation or blasting to create a sump in which to accumulate water to lubricate the drill head. There was another disturbed area identified by WESA (Disturbed Area 3), however it was barely above the grade of the Site. During the second visit to the Site about 50% of the ground cover was visible and it was noted that there were scraps of plywood with nails distributed at a low density but wide spread across the Site.

Physical hazards were present with the wood waste (with nails) found at random and sharp metal in the form of shredded drums in the East Disturbed Area (APEC 4). There were no intact drums found.

4.3.2 Site Access Conditions

Reconnaissance flights over Cape Isachsen were completed by Kenn Borek Air in August 2021 and although it is flat, it was wet and soft. The reconnaissance flight identified no suitable landing areas for a Twin Otter aircraft on skis or tundra tires. It was thus determined that the best means of accessing Cape Isachsen was by helicopter. The flying time from the Isachsen weather station to Cape Isachsen in the AStar 350 B2 is about 22 minutes each way.

4.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the APECs at the Cape Isachsen via soil sampling and inventorying the other waste streams.

4.3.4 Impacted Soil Assessment

Soil sampling was carried out by manually dug test pits. Test pits were dug to refusal on permafrost or as deep as possible if permafrost was not encountered. Bedrock was not encountered in any test pit at Cape Isachsen.

The approach in planning the test pit locations was to target the previously identified contaminated soil locations, plus any areas that Dillon-Outcome felt were data gaps to be filled, with a set of inner and stepped-out test pits around the APEC. APECs were sampled on the up and down-gradient sides. The stratigraphy observed in each test pit was logged in terms of soil type, evidence of contamination (staining or odour) presence of debris, moisture, water inflow, and colour. A total of 18 environmental test pits, one geotechnical test pit and three background test pits were conducted at Cape Isachsen.

The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the Human Health and Ecological Risk Assessment (DOJV 2022b). The results of both assessments are summarized below.

4.3.4.1 Impacted Soil Quantities by Generic Guidelines

The generic guidelines used to screen for soil exceedances were:

- **Soil – BTEX, metals and PAH:** CCME Soil Quality Guidelines, Agricultural Land Use, fine-grained soil, shallow soil (<1.5 metres);
- **Soil – Petroleum Hydrocarbons:** CCME Canada-Wide Standards for Petroleum Hydrocarbons, Tier 1, Agricultural land use, fine grained soil, Eco soil contact, more than 10 m from aquatic habitat.

Agricultural land use was deemed appropriate given CCME agricultural/wildland use is defined as "Land on which the primary activity is related to the productivity capability of the land and includes lands that provide habitat for wildlife and birds".

Background Soil Testing: There were three background test pits dug and sampled (CI000, CI001 and CI002). CI000 was about 75 m to the southwest of Wellhead, CI001 was about 100 m to the south of the wellhead, and CI002 was 100 m due west of the Wellhead. Southwest is the upgradient direction of the Site. All three background samples were analyzed for BTEX, PHC, metals and PAH.

Chemical analysis of the background soil samples revealed no detection of any BTEX, PHC or PAH components. All metals were either non-detect or below Agricultural Guidelines across all background samples. Although sample CI002 had higher concentrations of most metals, the metals concentrations did not vary by more than a factor of two background samples and were below CCME Agricultural

guidelines. The background chemistry results show that the soil in this location is not highly mineralized and is not contaminated.

APEC 1 North Disturbed Area (Area 100): Four test pits (CI101 to CI104) were completed to investigate for contamination in the North Disturbed Area. The previous study found PHC impact to the northwest of this area. Test pit CI101 was located to replicate the previous sample result. There were no detections of PHC or BTEX in the current sample at that location. The three other soil samples from the North Disturbed Area also had no PHC or BTEX detected. The samples from test pits CI102 and CI013 both had boron exceedances of the CCME Agricultural Guidelines. CI102 had boron at 9.3 mg/kg and CI103 had 3.5 mg/kg compared to a CCME Agricultural Guideline of 2 mg/kg. The remaining sample, CI104 had no exceedances in any parameter. Although boron was below Guidelines in the background samples, boron detected in these two samples at APEC 1 is not necessarily inferred to be related to the drilling activities. These samples are not delineated by other samples that were below Guidelines in boron. The disturbed area is at most 1 m high and the mound around CI103 is about 10 m in radius and the mound around CI102 is about 5 m in radius (see Figure 702). Using the formula for the volume of a cone with those radii and a height of 1m, a volume of 130 m^3 is estimated for boron elevated soil. The soil encountered was silty sand with no organic layer; permafrost was not encountered.

APEC 2 Old Footing (Area 200): There were five test pits (CI200 to CI204) completed at an old footing to the west of the Drill Sump. The previous investigation found PHC-F1, F2 and F3 in exceedance of the CCME generic guidelines in the southwest of this area and PAH in exceedance in the southeast.

Although the footing was not visible in the 2022 investigation because of snow, the area was located based on WESA's site figure. Test pit CI200 was in the centre of the feature, CI201 was 10 m to the north of centre, CI202 was 10 m to the east, CI203 was 15 m to the south and CI204 was 8 m to the west. The centre sample (CI200 and its duplicate) exceeded CCME Agricultural Guideline for PHC F2 and F3, with average values of 4,000 mg/kg for PHC-F2 and 1,900 mg/kg for PHC-F3, compared to Guideline values of 150 mg/kg for PHC-F2 and 300 mg/kg for PHC-F3.

The southern sample (CI203) exceeded CCME Agricultural Guideline for PHC F2 and F3, with values of 1,300 mg/kg for PHC-F2 and 1,000 mg/kg for PHC-F3. There were no exceedances of any other parameters tested.

The current results indicate that there is a petroleum hydrocarbon impacted zone at the Old Footing area which includes CI200 and CI203 and is delineated by non-detect samples on the north, east and west. It has not been delineated on the south but has decreased by a factor of 2 from CI200 to CI203. The PHC impacted area is shown on Figure 703. Its extends 40 m in the north-south dimension and 20 m in the east-west dimension. This investigation met permafrost at 0.1 mbgs but the previous investigation met permafrost at 0.55 mbgs. An impacted depth of 0.5 m has been assumed giving this contaminated zone a volume of 400 m^3.

APEC 3 Wellhead (Area 300): The Wellhead, APEC 3 was also investigated with five test pits: CI300 was at the Wellhead itself, CI301 was 4 m to the north, CI302 was 4 m to the east, CI303 6 m to the south,

and CI304 4 m to the west. The previous investigation found a marginal exceedance of PHC-F2 at the Wellhead (173 mg/kg compared to a Guideline value of 150 mg/kg). No step-out samples were conducted.

In the current investigation, the centre (CI300), north (CI301), west (CI304) and south (CI303) had exceedances of PHC-F2 and/or F3. The central sample's duplicate had the highest level of PHC-F3 (1,400 mg/kg) while the northern sample CI301 had the highest level of PHC-F2 (1,300 mg/kg). The southern sample (CI303) also had CCME exceedance of metals (barium, lead), and the western sample location (CI304) had CCME exceedances of barium, chromium and lead.

The results at the Wellhead (Figure 704) indicate a petroleum hydrocarbon impacted zone extending to the north, west and south of the wellhead, with an inner area co-contaminated with metals (barium and lead). The PHC levels decrease with distance from the Wellhead, and there was no metals impact directly at the Wellhead. Approximate contaminated zones for PHC and metals concentric within that have been interpreted on Figure 704. The approximate PHC impacted area is 24m by 12 m and 0.5 m deep or 144 m^3, and the interior portion of (72m^3) is co-contaminated with metals.

APEC 4 East Disturbed Area (Area 400): Four test pits (CI400 to CI403) were completed to investigate for contamination in the East Disturbed Area. The previous investigation placed one test pit in the East Disturbed Area and one just to the east, outside of the disturbed area and found no CCME exceedances.

Three of the four test pit samples in the East Disturbed Area (CI400, CI401, CI403) had marginal exceedances for boron and no other parameter. The exceedance ratios were less than 2.0 with the highest boron concentration of 3.5 mg/kg compared to a CCME Agricultural Guideline of 2.0 mg/kg. Although CI402 did not have a boron exceedance, the spatial distribution of the other exceeding sample locations suggest that the entire East Disturbed Area has low-level boron impact. The approximate volume of the East Disturbed Area is 75 m x 40 m with an average height of 1m for 3,000 m^3 of boron elevated soil Figure 705 shows the East Disturbed Area with the elevated boron zone. The soil encountered was silty sand with no organic layer, permafrost was not encountered.

A summary of the contaminated soil volume estimates (comparing to CCME Agricultural Guidelines) for the APECs at Cape Isachsen and the degree of certainty in the delineation is provided below.

Table 4-2 Cape Isachsen Impacted Soil Areas

Defined Area	Surface Area of Impact (m^2)	Depth or height (m)	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
APEC 1 – North Disturbed Area	314+78	1	130*	Boron	Medium. Two of four samples had boron exceedances
APEC 2 – Old Footing	800	0.5	400	PHC	Fair, delineated by clean samples on three sites.
APEC 3 – Wellhead	288	0.5	144	PHC, half the volume is co-contaminated with metals	Low, four of five samples had exceedances.
APEC -4 East Disturbed Area	3,000	1	3,000	Boron	Medium. Three of four samples of the APEC had boron exceedances.
Totals	**4,480 m^2**		**3,674 m^3**	**3,130 m^3 Boron and 544 m^3 PHC (72 m^3 of the 544 m^3 PHC being co-contaminated with metals)**	**Range: Low to Fair.**

*conical volume calculated from radii and height

There is a total of approximately 3,674 m^3 of impacted soil, rounded up to 4,000 m^3.

4.3.4.2 Impacted Soil by Site Specific Human Health Risk Assessment

The petroleum hydrocarbon concentrations do not exceed human direct contact component values and are therefore not a concern.

4.3.4.3 Impacted Soil by Ecological Risk Assessment

Boron (hot water soluble) exceeded generic CCME Agricultural Guidelines by less than a factor of 5 at APEC 1 and less than a factor of 2 at APEC 4. Boron is an essential micronutrient for vegetation, however either insufficient or excess amounts can cause toxicity. The CCME guideline is only for the

agricultural land use scenario. Plant toxicity is not considered a concern in this unvegetated site thus the boron exceedances are not an ecological risk-related concern.

4.3.4.4 Conclusions of the HHERA

The likelihood of risk to outdoor site visitors, terrestrial vegetation and soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible. No soil remediation is proposed for Cape Isachsen.

4.3.5 Hazardous and Non-Hazardous Waste

An inventory of hazardous and non-hazardous building materials was conducted.

For hazardous wastes, the assessor was looking for painted materials, asbestos containing material and potential PCB containing equipment. No hazardous waste material was identified at the Site. Wood waste in the form of pieces of solid wood and plywood was observed distributed scattered at random across the Site, with still 50% snow cover at the last site visit. Metal waste was observed in the form of crushed and shredded drums in the East Disturbed Area and three more drums plus a steel cylinder at the former camp area. The descriptions and volumes are presented below.

Table 4-3 Debris Volumes and Descriptions by APEC at Cape Isachsen

Debris Area	Type of Debris	Estimated Volume (m^3)	Estimated Weight (T)
APEC 1 – North Disturbed Area	None observed	0	0
APEC 2 – Old Footing	Wood	2	2
APEC 3 – Wellhead	None observed	0	0
APEC -4 East Disturbed Area	3 Crushed drums and scrap metal	2	0.07
Outside of APECs	3 drums and metal cylinder	4	1.07
Totals		**8 m^3**	**3.14 T rounded to 4 T**

The total observed volume of non-hazardous waste is on the order of 8 m^3. A volumetric weight of 1 tonne per m^3 was used for wood and the weight of the drums is calculated as per below.

The average dry weight per drum is 22.5 kg, so the total weight of the three known drums in the East Disturbed Area 67.5 kg and the known drums near the camp sump are another 67.5 kg. The metal cylinder at the camp sump is 3m long and 1 m in diameter and a weight allowance of 1 tonne has been made. The total estimated weight of all the debris is under 4 tonnes.

4.3.6 Waste Fuel and Drums

There were no intact drums found at Cape Isachsen in the 2022 Phase III ESA nor in the previous study which was completed with no snow cover. Therefore, there is no waste fuel to manage at the Site. The crushed/shredded drums are included in the debris volumes.

4.3.7 Summary of Waste Streams

A summary of all waste streams at Cape Isachsen requiring remediation is given below.

Table 4-4 Summary of Waste Streams at Cape Isachsen Requiring Remediation

Waste Stream	Quantity
Contaminated Soil (PHC, PAH or metals)	None
Non-hazardous debris	8 m^3 / 4 tonnes
Waste fuel	None
Drums	Six exposed crushed drums, included in the non-hazardous debris

4.4 Remedial Options Analysis by Waste Stream

4.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were weighted evenly in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the

numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 580 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are “walk-away” with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation component of this project has not yet taken place, and the stakeholders’ opinions on the integrated option which is the output of the remedial options analysis have not been heard.

4.4.2 Non-Hazardous Waste Debris

There is a total of 8 m^3 of non-hazardous debris at Cape Isachsen comprised of 2 m^3 wood and 6 m^3 of metal with a total weight of 4 tonnes. The wood waste consists of solid wood and plywood, much of it was observed to be waterlogged with melt water in the 2022 site visit. The metal waste consists of three drums exposed in the East Disturbed area and three more drums plus a steel cylinder at the former camp area. The steel cylinder was partially buried in 2011 and not seen in 2022 due to snow cover. The assumptions regarding weight are outlined in Section 7.3.5.

Options for managing the non-hazardous debris are:

1) Consolidation on-site: All the non-hazardous waste would be consolidated at a single location at the Site and left on-site. The drums are already crushed but the cylinder is not, and it would not be possible to achieve any reduction of volume by crushing without heavy equipment. This material is not contaminated and therefore would not create impacted leachate. The wood and metal would decompose over time. A moderate degree of physical hazard would be present to wildlife, and it would constitute an unlicensed waste disposal area.

2) Incineration of the wood, and off-site disposal of other waste: The wood waste would be gathered up from across the Site and burned on top of one of the disturbed areas. The ash would be collected and removed along with the metal debris via soil bag by helicopter. A volume reduction of about 2 m^3 and a weight reduction of 2 T could potentially be achieved. The ashes and residue would be collected and put with the metal. The wood waste appeared to be waterlogged at the time of the 2022 site visit and incineration without an accelerant may be difficult. If the incineration of all wood was not completed in one workday it would have to be extinguished and restarted the next day. The crushed drums and other metal debris would be collected into soil bags for transportation to Isachsen HAWS. The soil bags have a volume of one cubic meter each but can only be filled to a weight within the sling capacity of the helicopter being used. As an example, an AStar 350 B2 has a sling capacity of about 800 kg, so the remaining debris after incineration (2 tonnes including the cylinder) would require about 3 sling load flights back to Isachsen HAWS. From Isachsen HAWS the material would be brought to Resolute Bay by fixed-wing aircraft, and then sent out of Territory for disposal at a licensed waste facility.

3) Off-site disposal of all non-hazardous debris: All wood and metal debris would all be removed from Cape Isachsen for eventual disposal of out of Territory. The wood waste, and crushed drums would be collected by hand and put in 1 m^3 soil bags. The steel cylinder at the camp sump would be dug free by hand and heli-transported to Isachsen by itself without a soil bag. The total debris volume is about 8 m^3 and total weight is 4 T. About 5 sling load trips back to Isachsen HAWS would be required.

The three options for management of non-hazardous debris have been evaluated and the results are tabulated below.

Table 4-5 Evaluation of Options for Non-Hazardous Debris at Cape Isachsen

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Consolidation on-site	Neutral	Favourable	Favourable	Unfavourable	Unfavourable	Neutral (0)
Incineration of wood and off-site disposal of other waste	Favourable	Neutral	Unfavourable	Favourable	Favourable	Favourable (+2)
Off-site disposal of all non-hazardous debris	Favourable	Neutral	Neutral	Favourable	Favourable	Favourable (+3)

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

In consolidating the non-hazardous debris on-site in one location the environmental risk is seen as a neutral because there is no contamination associated with this waste stream; it is non-leachable solid waste. It does not rate a favourable score because there is some physical risk to wildlife with leaving it on-site. The Value to the Crown with this option is favourable as it is the lowest cost option. Resources required are the least, thus it is favourable; the debris would be transported manually, to the Camp Sump and left near the steel cylinder that is partially buried there in work spanning 2 or 3 days. No air lift is involved, contrary to the other options. Reduction of liability however is unfavourable. Since debris would be left on-site it would constitute a waste disposal site and have some on-going monitoring requirements and may not receive Territorial approval. There is negligible local labour involved in this option, and it somewhat detracts from future site use so its rating under Local Benefits is unfavourable. The overall score is neutral (0).

Incineration of the wood waste fraction and off-site disposal of other waste scores favourably on Reduction of Environmental Risk because this waste stream would be eliminated from the site. The Value to the Crown (cost) is essentially equal to the third option (neutral) because with the short distance between the Site and Isachsen, the savings from one or two fewer helicopter trips with waste would not save a whole day and the helicopter incurs a daily minimum charge. The wood waste however appeared to be waterlogged, so the resources required to incinerate it and acquire any volume and weight reduction render it unfavourable for the Resources Required criterion. Time and effort spent trying to incinerate it as per the Nunavut environmental Guideline for the Burning and Incineration of Solid Waste would not have an adequate return in terms of cost saving from volume/weight reduction. Reduction of Liability scores favourably because it is a walk away solution; there would be no on-going monitoring commitments. The favourable score under Local Benefits arises because there is good local labour content in preparing the waste for off-site movement and incineration of the wood waste and the final condition is ideal. This option's overall score is favourable (+2).

The off-site disposal of all non-hazardous waste option (with no incineration) differs only in the criterion of Resource Required where it scores neutrally compared to the option with incineration of wood because it avoids the potential difficulty of incinerating waterlogged wood. There is no difference in it score in Value to the Crown, compared to the incineration option for the reason stated above. Overall, this option scores one point more favourable than Option 2 (+3).

The optimum waste management solution for the non-hazardous waste is to collect it in soil bags, except for the cylinder and transport it to Isachsen for transfer to Resolute Bay and out of the Territory.

4.4.3 Waste Drums

The remedial options for the crushed or shredded fuel drums have been accounted for under non-hazardous waste.

4.4.4 Integrated Remedial Plan

There is no other waste stream requiring management than non-hazardous debris.

The on-site work at Cape Isachsen would be completed in a single phase of work over about 3 or 4 days during the summer work season of 2023. On-Site activities will be the collection of non-hazardous debris into 1 m^3 soil bags, freeing and removing the steel cylinder. It would be transported to the Isachsen HAWS in about 5 sling loads by helicopter. Each round trip would have a cycle time of about 1 hour and 15 minutes. Refuelling would be needed every other round-trip.

Once the waste from Cape Isachsen has all been transferred to Isachsen HAWS it would be transferred to fixed-wing aircraft and flown to Resolute Bay for onward transportation by sealift.

From Resolute Bay, the wastes would be transported by sealift for metal recycling or final disposal at licensed waste disposal facilities in the South. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be “walk-away”, with no on-going monitoring requirements or liability.

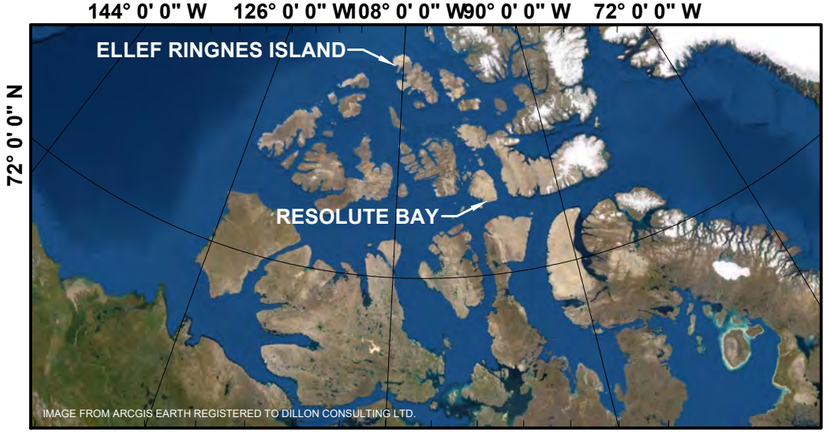
4.5 Scope of Work for Proposed Remedial Solution

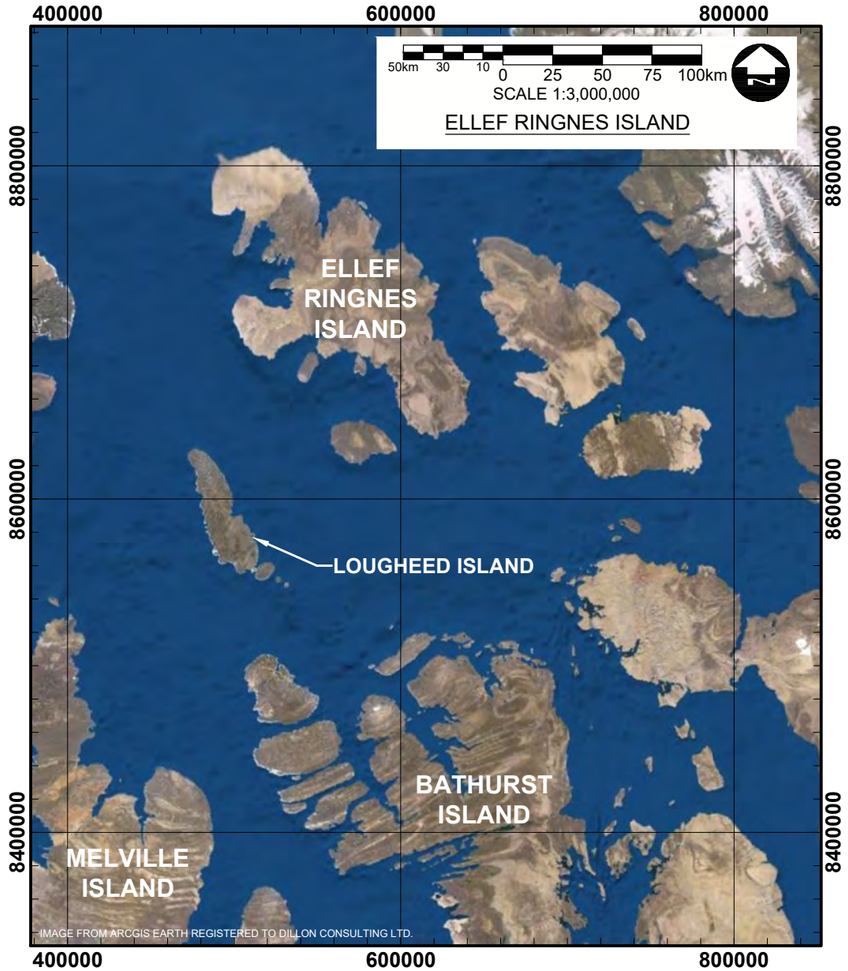
The scope of work required to implement the work resulting from the preferred remedial option has been resolved into a Work Breakdown Structure (WBS) included in Appendix A and has been packaged with three other ‘small’ sites in the Pioneer High Arctic Bundle. The WBS describes in a graphical form the work that will be required of a contractor for this site within the overall contract. The WBS contains four deliverables for work supporting all of the sites in the contract: 1: Balance of Project Costs, 2: Project Meetings, 3 Health, Safety and Environment, 4 Logistics, Transportation and Facilities, and 5 Cape Isachsen Remediation.

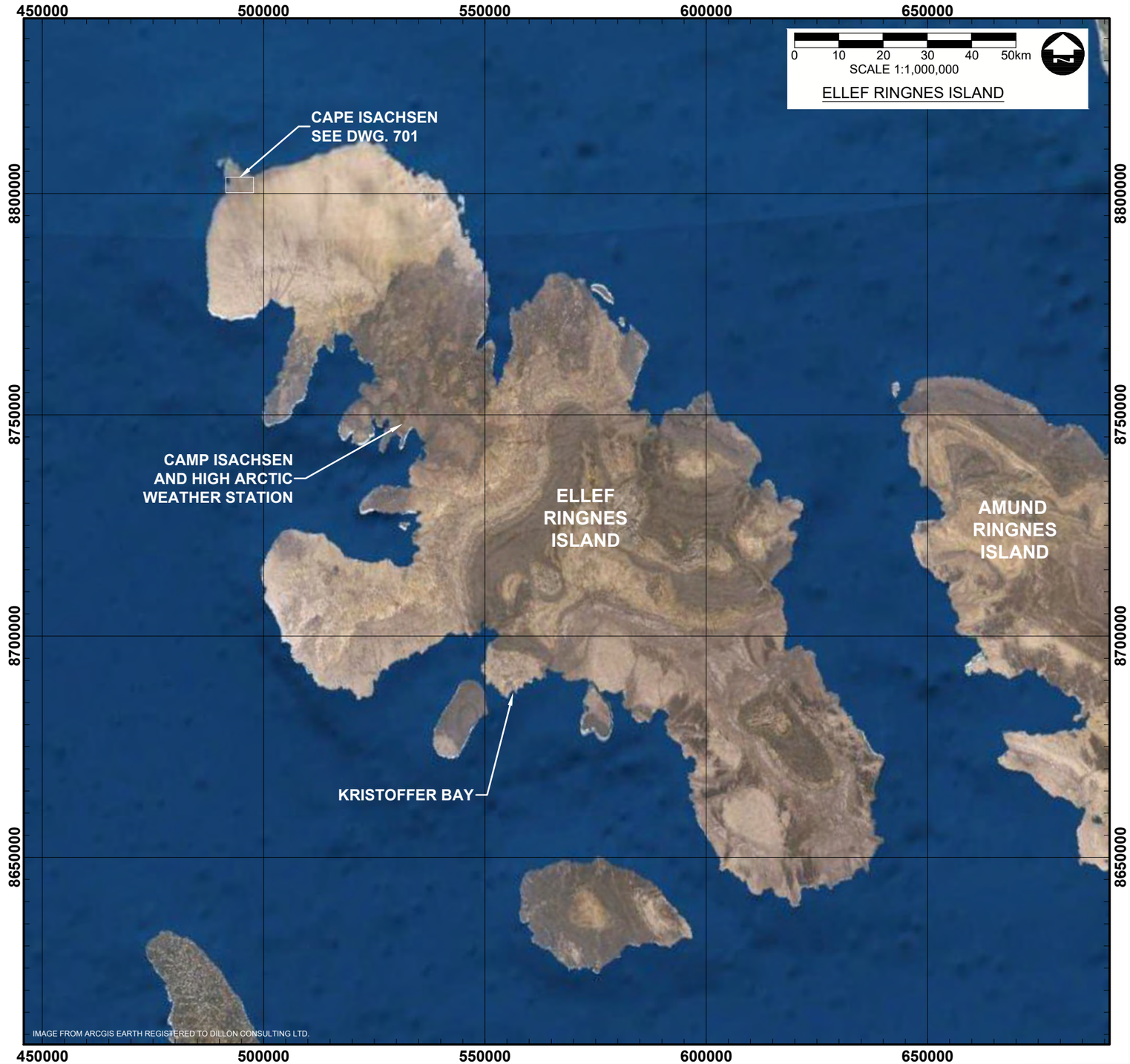
The Task at Cape Isachsen consist of non-hazardous waste management including collection of non-hazardous debris into 1 m^3 soil bags, freeing and removing the steel cylinder. All of the waste would be transported to the Isachsen HAWS by helicopter. Each round trip would have a cycle time of about 1 hour and 15 minutes. Refuelling would be needed every other round-trip. The on-site work at Cape Isachsen would be completed in a single phase of work over about 3 or 4 days during the summer work season of 2023.

Once the waste from Cape Isachsen has all been transferred to Isachsen HAWS it would be transferred to fixed-wing aircraft and flown to Resolute Bay.

From Resolute Bay, the wastes would be transported by sealift for metal recycling or final disposal at licensed waste disposal facilities in the South. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be "walk-away", with no on-going monitoring requirements or liability.







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DATE: OCTOBER 2022
SCALE: AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE ISACHSEN
SITE LOCATION PLAN

SHEET NO. 700

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

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8801200 8801100 8801000

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SCALE 1:1,500

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

NOTE:
AERIAL FROM ARCGIS EARTH.

CAPE ISACHSEN NORTH
DISTURBED AREA
SAMPLE AREA 100
SEE DRAWING 702

CAPE ISACHSEN OLD FOOTING
SAMPLE AREA 200
SEE DRAWING 703

LIMITS OF
HIGH RESOLUTION
IMAGERY/CONTOURS

DRILL
SUMP

CI-SW-SUMP

CAPE ISACHSEN EAST
DISTURBED AREA
SAMPLE AREA 400
SEE DRAWING 705

CI-SW-BKGND

WELLHEAD

CI-002

CAPE ISACHSEN WELLHEAD
SAMPLE AREA 300
SEE DRAWING 704

CI-000

CI-001

10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

CAPE ISACHSEN
SURVEYED LIMITS

PROJECT NO. 21-2370

SHEET NO. 701

494190 494205 494220 494235 494250 494265 494280 494295

8801220 8801205 8801190 8801175

5m 4 3 2 1 0 5 10m

SCALE 1:300

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

- METALS IMPACT ZONE
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
CONTOURS BASED ON RTK SURVEY AND DRONE PHOTOGRAMMETRY AT 0.5m INTERVAL.
AERIAL FROM DRONE.

CI-101
CI-104
CI-103
CI-GEOTECH 1
CI-102
SIGN

6.7 6.6 6.5 6.4 6.9 6.8 7.1 7.0 6.0 5.9 5.8

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DATE: OCTOBER 2022
SCALE: AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE ISACHSEN
CAPE ISACHSEN NORTH DISTURBED AREA
SAMPLE AREA 100

SHEET NO. 702

494160 494200 494240 494280

8801160 8801120

0 5 10 15 20m
SCALE 1:400

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

- METALS IMPACT ZONE
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
CONTOURS BASED ON RTK SURVEY AND DRONE PHOTOGRAMMETRY AT 0.5m INTERVAL.
AERIAL FROM DRONE.

CI-201
CI-204
CI-200
CI-202
CI-203
CI-SW-SUMP
CA-SW-QA/QC1

Debris to be collected and removed from site

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\21270 PIONEER SITES\CAPE ISACHSEN\CAPE ISACHSEN 213N.DWG
PLOT DATE: 2022-10-13 @ 3:53:36 PM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB

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DATE: OCTOBER 2022	
SCALE: AS SHOWN	

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO.: 21-2370

CAPE ISACHSEN
CAPE ISACHSEN OLD FOOTING
SAMPLE AREA 200

SHEET NO.: 703

494220 494230 494240 494250 494260 494270

8801090

8801080

8801070

6.0

CI-301

CI-300

CI-302

WELLHEAD

ANARCTIC SIGN

CI-304

CI-303

2.5m 1.5 0.5 0 1 2 3 4 5m

SCALE 1:150

LEGEND:

- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

- METALS IMPACTED ZONE
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
CONTOURS BASED ON RTK SURVEY AND DRONE PHOTOGRAMMETRY AT 0.5m INTERVAL.
AERIAL FROM DRONE.

Debris to be collected and removed from site

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\21370 PIONEER SITES\CAPE ISACHSEN\CAPE ISACHSEN 713N.DWG
PLOT DATE: 2022-10-19 @ 3:55:09 PM PLOT SCALE = 1:1 PLOT STYLE: DILLON.CTB

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DATE: OCTOBER 2022
SCALE: AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE ISACHSEN
CAPE ISACHSEN WELLHEAD
SAMPLE AREA 300

SHEET NO. 704

8801070 8801100 8801130 8801160

494340

494370

5m 4 3 2 1 0 2 4 6 8 10m
SCALE 1:250

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

- METALS IMPACTED ZONE
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
CONTOURS BASED ON RTK SURVEY AND DRONE PHOTOGRAMMETRY AT 0.5m INTERVAL.
AERIAL FROM DRONE.

CI-400
CI-403
CI-401
CI-402
SIGN

LOW LEVEL BORON IMPACT

Shredded drums to be collected and removed from site.

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2PI, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\21370 PIONEER SITES\CAPE ISACHSEN\CAPE ISACHSEN Z19N.DWG
PLOT DATE: 2022-10-19 @ 3:37:21 PM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE ISACHSEN
CAPE ISACHSEN EAST DISTURBED AREA
SAMPLE AREA 400

SHEET NO. 705

5.0 Kristoffer Bay Remedial Action Plan

5.1 Executive Summary

The Kristoffer Bay site is designated NB043 in the Northwest Territories/Nunavut contaminated site database and its federal contaminated site inventory number is 00024264. The site is located on the southern tip of a southwestern pointing peninsula on southern Ellef Ringnes Island, about 420 km northwest of Resolute Bay and 70 km southeast of the Isachsen High Arctic Weather Station. Kristoffer Bay is a former Panarctic Oils Ltd. drilling site where the B-06 exploration well was drilled, and a drill camp was established. There is no airstrip associated with Kristoffer Bay.

The main features of the Kristoffer Bay site are the B-06 Wellhead, which is surrounded by a concrete foundation, a second potential wellhead located about 70 m upland to the northwest of the B-06 Wellhead marker, a debris field upland of the suspected second wellhead and a suspected drill sump located to the northeast of the B-06 Wellhead. Panarctic was active at Kristoffer Bay in 1973 and 1974. The Site covers an area of about 200 m on a northwest-southeast axis by 100 m on a southwest-northeast axis. The Phase III ESA (DOJV 2022a) of Kristoffer Bay was carried out in the summer of 2022 via soil sampling and chemical analysis at two APECs and assessing the observable debris:

- APEC 1 B-06 Wellhead Area
- APEC 2 Upland Area

The soil analytical results were first compared to generic CCME soil quality guidelines for agricultural land use and then assessed in a Human Health and Ecological Risk Assessment (HHERA) to analyze whether the concentrations of contaminants would constitute acceptable or unacceptable risks to the actual receptors at the Site. At APEC 1, centered at the B-06 Wellhead, a zone of petroleum hydrocarbon (PHC) and polycyclic aromatic hydrocarbons (PAH) impacted soil was detected with a radius of about 5 m on each side of the wellhead and delineated by a second set of test pit locations. The PHC and PAH contaminated soil volume compared to generic guidelines was estimated at 52 m^3.

In the upland area, a shallow deposit of angular rock chips appears to be drill cuttings and was found to be contaminated with in benzene, toluene, ethylbenzene, and PHC-F2, and metals (arsenic, nickel and selenium) with a volume of 3 m^3. Also an area of boron (hot water soluble) exceedance of CCME agricultural guidelines was found upgradient of the second potential wellhead with a volume of 8 m^3.

The surface water sample collected from a location downstream of the well sump and washout at the suspected second wellhead had no petroleum hydrocarbon detected.

The HHERA's conclusions were that the parameter concentrations found in soil are not a concern for human or ecological receptors, thus there is no risk-based requirement for remediation of soil at Kristoffer Bay.

There was no hazardous building material (lead paint, asbestos) or waste fuel found at the Site.

There is wide-spread drilling related debris scattered at the site with a greater concentration at the north end of the Site. It was probably buried after the completion of drilling but is becoming exposed due to erosion. Items found include two crushed drums, drill rod, several drill heads, couplers, heavy duty chain, plywood. Only the exposed material has been estimated. A total of 10 m^3 of metal debris is present, with an estimated weight of 30 tonnes.

A summary of all waste streams at Kristoffer Bay is given below.

Table 5-1– Summary of Waste Streams at Kristoffer Bay Requiring Remediation

Waste Stream	Quantity
Contaminated Soil	None
Non-hazardous debris	Metal drilling debris 10 m^3 / 30 tonnes
Waste fuel	None
Drums	two exposed waste drums, included in the non-hazardous debris

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. The evaluation criteria were consistent for the options analysis for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Available; iv) Reduction of Environmental Liabilities; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as either favourable, neutral or unfavourable, according to the degree to which the criterion was satisfied. The objective is to develop a solution which is protective of the environment and does not require on-going monitoring or maintenance, i.e., a "walk-away" solution.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option for Kristoffer Bay consists of:

- Collection of non-hazardous debris into 1 m^3 soil bags. All of this waste would be transported to the Isachsen HAWS where a waste transfer station would be established. It would require about 30 sling loads by helicopter.

- Once the waste from Kristoffer Bay has all been transferred to Isachsen HAWS it would be transferred to fixed-wing aircraft and flown to Resolute Bay for onward transportation.
- From Resolute Bay, the wastes would be transported by sealift for metal recycling or final disposal at licensed waste disposal facilities in the South.

Remediation at Kristoffer Bay would be done in a single phase of work over about 8-10 days during the summer work season of 2023. There is usually one sealift visit to Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be “walk-away”, with no on-going monitoring requirements or liability.

5.2 Introduction

5.2.1 Objectives

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of: i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project.
- Recommend optimal scheduling of work such that the entire Pioneer Bundle can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

5.3 Background of Kristoffer Bay Site and Features

The Kristoffer Bay site is designated NB043 in the Northwest Territories/Nunavut contaminated site database and 00024264 in the FCSI. The site is located on the southern tip of a southwestern pointing peninsula on southern Ellef Ringnes Island, about 420 km northwest of Resolute Bay and 70 km southeast of the Isachsen High Arctic Weather Station. Kristoffer Bay is a former Panarctic Oils Ltd. drilling site where the B-06 exploration well was drilled, and a drill camp was established to support and staff drilling of the exploration well and other test holes, both over water and on land. There is no airstrip associated with Kristoffer Bay. Kristoffer Bay site is centred at approximately 78° 15' 4.1" N latitude and 102° 32' 35.4" W longitude. See Figure 800 for the site location. See Figure 800 for the site location.

The Phase I ESA for the site (WESA 2012f) revealed that Panarctic applied to lease land at the Kristoffer Bay on April 5, 1974 as a drilling site to explore and prove oil and gas reserves. The site consists of the former Panarctic Kristoffer Bay B-06 exploration well, a suspected sump and disturbed areas. Through interviews the Phase I ESA found that the drill camp was a tracked mobile camp.

The Phase II ESA field work (WESA 2012f) was done concurrently to the Phase I site visit on July 7, 2011. The sampling program for the site consisted of five soil samples (plus duplicate and background samples) and one groundwater sample. Sampling work was centred at the B-06 well marker. Four of the samples were taken at the well marker and one was at the outflow of the suspected drill sump. Soil impacted by hydrocarbons was found adjacent to, and downgradient of, the well marker. A sample of drilling mud collected adjacent to the well marker had antimony, arsenic, chromium (VI) and molybdenum concentrations that exceed site criteria.

A groundwater sample collected downgradient of the well marker had aluminum, cadmium, chromium, copper, fluoride, iron, lead, mercury, nickel, sulphate, thallium, uranium and zinc concentrations that exceed site criteria. Delineation was not achieved at any of these locations.

The Phase III ESA (DOJV 2022a) at Kristoffer Bay, grouped the features and impacts previously identified into two APECs and completed a detailed sampling program with the aim of delineating the known impacted areas and collecting enough information to complete a HHERA. The areas targeted in the Phase III ESA were:

- APEC 1 B-06 Wellhead Area
- APEC 2 Upland Area

Sediment and surface water samples were also collected and analyzed, and the scattered debris was investigated for quantity and to determine if there was any hazardous waste. Field work for the Phase III ESA was carried out over four visits on June 25, 26, 30 and July 3, 2022. The results of the Phase III ESA for contaminated soil assessment and waste material classification are contained in the following sections.

5.3.1 Physical Setting and Site Reconnaissance

A ground-level site reconnaissance of the Kristoffer Bay site was the first task performed. The Site is on a peninsula with the water bodies of Dome Bay to the west and Kristoffer Bay to the east. It is on the southern flank of a talus ridge which rises to the north. The site has the ocean on the south side and is bordered by a stream in a heavily eroded channel to the east. The site slopes very gently to the east and is traversed by minor dry streambeds and one larger washout at its north side, all of which drain to the east. The B-06 Wellhead is on the southern side of the Site, surrounded by a square concrete foundation of about 3m by 3m. The area around the Wellhead is identified as APEC 1 in this investigation.

To the northeast of the B-06 Wellhead is a depression may have been its drill sump. It was dry at the time of the site visit. Seventy metres to the northwest of the B-06 Wellhead there is a steel pipe (with no identification) protruding from the ground which may be a second wellhead or test hole. This pipe is in a washout channel that widens at it progresses to the east before joining the stream. The widened area of this washout was extensively investigated in this investigation because it had evidence of hydrocarbon impact (sheen on water in the test pits and odour in the soil).

There is widespread, partially exposed metallic debris across the site including drill rods, drill heads and couplers, heavy chains. Only two partially buried drums were observed; there were no intact drums and no waste fuel observed at the site. There was no evidence indicate were the drill camp would have been located during the time that the well(s) were drilled. WESA, 2012c interviewed a person with knowledge of the drilling activity at Kristoffer Bay who indicated that it was a tracked vehicle camp (cat train).

The physical hazards present at this Site are the partially buried metal objects including cables, drive chains, drill rods and crushed drums found in the upland area of the Site (APEC 2).

5.3.2 Site Access Conditions

Reconnaissance flights over Kristoffer Bay were completed by Kenn Borek Air in July 2021 and it was too wet and soft to land. There was no identifiable fixed-wing landing strip identified in the 2021 reconnaissance flight. The ground reconnaissance conducted in 2022 found no indication of an established landing strip either. The Site has uneven ground and is traversed by washouts. It is doubtful that fixed-wing landings could be accomplished at the Site. It was thus determined that the best means of accessing Kristoffer Bay was by helicopter from the Isachsen weather station. The flying time from the Isachsen weather station to Kristoffer Bay in an AStar 350 B2 helicopter is about 25 minutes each way.

5.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the APECs at the Kristoffer Bay via soil sampling and inventorying the other waste streams.

5.3.4 Impacted Soil Assessment

Soil sampling was carried out by manually dug test pits. Test pits were dug to refusal on permafrost or as deep as possible if permafrost was not encountered. Bedrock was not encountered in any test pit at Kristoffer Bay.

The approach in planning the test pit locations was to target the previously identified contaminated soil locations, plus any areas that Dillon-Outcome felt were data gaps to be filled, with a set of inner and stepped-out test pits around the APEC. APECs were sampled on the up and down-gradient sides. The stratigraphy observed in each test pit was logged in terms of soil type, evidence of contamination (staining or odour) presence of debris, moisture, water inflow, and colour. A total of 27 environmental test pits, three geotechnical test pits and four background test pits were conducted at Kristoffer Bay.

The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the Human Health and Ecological Risk Assessment (DOJV 2022b). The results of both assessments are summarized below.

5.3.4.1 Impacted Soil Quantities by Generic Guidelines

The generic guidelines used to screen for soil exceedances were:

- **Soil – BTEX, metals and PAH:** CCME Soil Quality Guidelines, Agricultural Land Use, coarse-grained soil, shallow soil (<1.5 metres);
- **Soil – Petroleum Hydrocarbons:** CCME Canada-Wide Standards for Petroleum Hydrocarbons, Tier 1, Agricultural land use, coarse-grained soil, Eco soil contact, more than 10 m from aquatic habitat.

Agricultural land use was deemed appropriate given CCME agricultural/wildland use is defined as "Land on which the primary activity is related to the productivity capability of the land and includes lands that provide habitat for wildlife and birds".

Background Soil Testing: There were four background test pits dug and sampled: KB000, KB001, KB002 and KB003.

KB000 and KB001 were about 75 m to the west and upgradient of the Wellhead(s). KB002 was about 50 m to the northwest of the debris field and KB003 was on the ridge 300m upgradient of the Site. Figure 802 shows the locations of all four background samples. All four were non-detect for BTEX and PHC. The only metal parameter to exceed the CCME Agricultural Guidelines was boron at 5.8 mg/kg compared to a CCME agricultural guideline value of 2 mg/kg at KB000. Some PAH components were detected in samples KB000, KB001 and even KB003. Although not expected to be present in background samples, the boron and PAH levels establish a baseline that will be used to compare to the samples taken from the suspected impacted areas. Only background sample KB002 had no PAH detections.

The background chemistry results show that although naturally occurring boron may exceed CCME Agricultural Guidelines, the background soil in this location is not otherwise anomalously mineralized and has no petroleum hydrocarbon contamination.

APEC 1 Wellhead (Area 100): Ten test pits (KB100 SURF to KB104B) were completed to investigate for contamination at the Panarctic B-06 Wellhead. The previous study found PHC and metals impact at the Wellhead but did not achieve delineation. Test pits KB100 SURF and KB101 were within the foundation walls which surround the wellhead marker. KB100 SURF was in the top 10 cm of soil to establish concentrations for comparison to dermal contact guidelines. It had no BTEX or PHC exceedances. Test pit KB101 went to a depth of 0.3 m and encountered water at 0.25 m. It had exceedances of PHC F2 and F3. The first series of step-out test pits (KB102, 103, 104, 105) were PHC-impacted. All had PHC F2 and F3 exceedances, with KB102, KB104 and KB105 also having PHC-F1 exceedance and KB105 also having an ethylbenzene exceedance. The highest PHC concentrations were at KB103 and KB104 in the northeast and southeast directions (east is the down-gradient direction).

The second set of stepped out test pits were 3-4 m farther from the Wellhead than the first, and none had any PHC, BTEX metals or PAH exceedances. The impacted area thus is delineated horizontally to lie completely inside the second set of stepped-out test pits. It is shown on Figure 803 and interpreted to have an area of 70 m^2. Water was found at a depth of 0.25m in the test pit inside the foundation where the soil level was about 0.5 m below the surrounding grade. Assuming the contamination goes no deeper than the water table that establishes a 0.75 for the contamination and a volume of 52 m^3.

APEC 2 Upland Area (Area 200): The Upland Area includes a zone of suspected drill cuttings at KB200 and the suspected second wellhead and the washout downgradient of it.

KB200 was in the centre of an area of black angular rock chips which were assumed to be drill cuttings spread on the surface from the well drilling operation. The depth extent of this material was 0.16 m.

Chemical results show that these cuttings exceed CCME Agricultural Guidelines in benzene, toluene, ethylbenzene, and PHC-F2, and metals (arsenic, nickel and selenium). The highest exceedance factor was 7 for benzene. The rest of the exceedance factors were less than 2, thus this area is not heavily contaminated. A circular area of diameter 5 m has been assigned giving an area of 20 m^2 and a depth of 0.16 m, giving a volume of 3 m^3 of PHC and metals impacted soil around KB200.

KB201 was directly at the vertical pipe (suspected second wellhead), and it was sampled at two depths (0.0-0.25) coarse light brown sand, and (0.25-0.37) fine mix of light and dark sand possible smearing. The results showed detection of PHC F2 and F3 in the shallow sample, without any exceedances, and no detection of PHC or BTEX in the deeper sample. This zone was pursued in an up-gradient direction and KB203 was placed 15 m up-channel. It reported presence of benzene, xylenes and PHC-F2 without any exceedances. The only exceedance was in boron (17 mg/kg compared to 2 mg/kg). The area around KB203 is interpreted to be impacted in boron. The soil surface had a white dusty appearance. A circle of diameter of 5 m around KB203 has been assigned giving an area of 20 m^2 and a depth of 0.4 m, giving a volume of 8 m^3 of boron impacted soil.

Downstream of this vertical pipe, the washout channel widened, and ten test pits were dug (KB204 to KB204SE1) to trace the suspected hydrocarbon impact as evidenced by sheen on water infiltration in the test pits and odour. The results indicate that PHC-F2 was detected at KB204 but below Guidelines at all of the step-out test pits. Thus, this washout is not contaminated above Guidelines.

The suspected sump was investigated with a test pit samples KB-205 (and duplicate) and KB-OUTWASH, at the point where the suspected sump drains towards the steam to the east. KB-205's duplicate had detection of PHC-F2 and F3 below Guidelines, while KB205 was non-detect. KB-OUTWASH had PHC-F2 and F3 detected below Guidelines but boron marginally over Guidelines (2.7 mg/kg compared to 2 mg/kg). There was only a marginal boron exceedance identified at the suspected drill sump and since the boron concentration was less that that found in a background test pit it is not inferred to be an anthropogenic contamination.

A summary of the contaminated soil volume estimates at the APECs at Kristoffer Bay and the degree of certainty in the delineation is provided below.

Table 5-2 - Kristoffer Bay Impacted Soil Areas

Defined Area	Surface Area of Impact (m^2)	Depth or height (m)	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
APEC 1 – Wellhead Area	70	0.75	52	PHC & PAH	Good horizontal delineation; bounded Vertical delineation assumes stops at water table
APEC 2 – Upland Area					
Around KB200	20	0.16	3	BTE, PHC-F2, metals	Fair, contamination associated with drill cuttings, visually identified.
Around KB203	20	0.4	8	boron	Possibly natural but 3 x levels found in background sample
Totals	**110 m^2**		**63 m^3**	**52 m^3 PHC, PAH 3 m^3 BTE, PHC and metals 8 m^3 boron**	**Range: Low to Fair.**

There is a total of approximately 63 m^3 of impacted soil.

5.3.4.2 Impacted Soil by Site Specific Human Health Risk Assessment

The Human Health Risk Assessment (HHRA) results indicated there is negligible potential for human health risk at Kristoffer Bay site. This conclusion is supported by consideration of the various conservative assumptions and approaches used in the HHRA, which results in what are believed to be conservative estimates of potential exposure and risk. Whereas the generic CCME guideline levels for PHC are based on the vapour inhalation pathway, the absence of buildings allows for an evaluation using the direct contact guideline for human health. Only three of the four inner set of test pits at the J-06 Wellhead had PHC concentrations over the direct contact pathway value, and all soil samples were composited over the depth of 0 to 0.3 m with the deeper part of the sample containing the hydrocarbon content. The maximum concentration of PHC F2 of 9600 mg/kg was at KB103 and exceeds the component value of 6800 mg/kg for residential land use by 1.4-fold. The soil sample of only surface soil was below the generic guidelines for PHC. Given the minimal area and fact that it is not present at the surface there is no PHC risk to human health. There are no other PHC exceedances for human health endpoints.

5.3.4.3 Ecological Risk Assessment

The Ecological Risk Assessment (ERA) was done conducted in a similar fashion to the HHRA. It concluded that the likelihood of potential risk to soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible given the limited habitat, site conditions and size of the Site. PHCs are readily metabolized by vertebrates so do not tend to accumulate in tissues of birds and mammals. PHCs also are not readily absorbed into and accumulated into plant tissues. Therefore, the food ingestion pathway does not tend to result in high exposures of PHCs for wildlife populations.

5.3.4.4 Conclusions of the HHERA

The likelihood of potential risk to outdoor site visitors, terrestrial vegetation and soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible. There is no human or ecological trigger for soil remediation at Kristoffer Bay.

5.3.5 Hazardous and Non-Hazardous Waste

An inventory of hazardous and non-hazardous building materials was conducted.

No painted wood or electrical transformers were observed anywhere at the site.

All of the debris observed was non-hazardous. There was wide-spread drilling related debris scattered at the site with a greater concentration at the north end of the Site. It was likely buried at the completion of drilling but is becoming exposed due to erosion. Items found include two crushed drums, drill rod, several drill heads, couplers, heavy duty chain, plywood. Only the exposed material has been estimated.

The descriptions and volumes are presented below.

Table 5-3 Debris Volumes and Descriptions by APEC at Kristoffer Bay

Debris Area	Type of Debris	Estimated Volume (m^3)
APEC 1 – Wellhead Area	None, assuming the well marker and foundation remain in place	0
APEC 2 – Upland Area	Two crushed drums, drill rod, several drill heads, couplers, heavy duty chain.	10
Totals		**10 m^3**

The total observed volume of non-hazardous waste is on the order of 10 m^3. The drill rod was 3m long and would require on-site cutting in order to remove from the Site. Using a volumetric weigh of 3 tonnes per cubic metre for unconsolidated scrap steel, an estimated weight of the debris is 30 tonnes.

5.3.6 Waste Fuel and Drums

There were no intact drums found at Kristoffer Bay and there is no waste fuel at the Site. The crushed/shredded drums are included in the debris volumes.

5.3.7 Summary of Waste Streams

A summary of all waste streams at Kristoffer Bay requiring remediation is given below.

Table 5-4 Summary of Waste Streams at Kristoffer Bay Requiring Remediation

Waste Stream	Quantity
Contaminated Soil (PHC, PAH or metals)	None
Non-hazardous debris	10 m^3/ 30 tonnes
Waste fuel	None
Drums	Two exposed crushed drums, included in the non-hazardous debris

5.4 Remedial Options Analysis by Waste Stream

5.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were weighted evenly in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the

numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given in order to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 420 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are “walk-away” with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation component of this project has not yet taken place, and the stakeholders’ opinions on the integrated option which is the output of the remedial options analysis have not been heard.

5.4.2 Non-Hazardous Waste Debris

There is a total of 10 m^3 of non-hazardous debris at Kristoffer Bay comprised of metal with a total weight estimated at 30 tonnes. Metal waste is widespread at the Site with a greater concentration at the north end of the Site. Items found include some crushed drums, drill rod, several drill heads, couplers, steel cable and heavy-duty chain.

Options for managing the non-hazardous debris are:

1) Consolidation on-site: All the non-hazardous waste would be consolidated at a single location at the Site and left on-site. Most, but not all, of the exposed waste is in the debris field on the north side of the Site. Waste which has been moved into the washouts or found elsewhere would be collected and brought to the north side of the site. This would have to be done using manual labour only and it would not be possible to achieve any reduction of volume by crushing without heavy equipment. This material is not contaminated and therefore would not create impacted leachate. The metal would continue decomposing over time. The HHERA has concluded that there is no environmental risk, so this evaluation criterion is neutral for each of the options. A moderate degree of physical hazard would be present to wildlife, the appearance would still look like a waste site. It would constitute an unlicensed waste disposal area and have on-going liability.

2) Burial of waste on-site. This option is a variation on option 1, in which the consolidated wastes would be consolidated in the north end of main debris field and trenches would be manually dug to 1 m depth in the sand and the material would be placed in the trenches and buried. Additional labour and time would be required compared to option 1. The physical hazard would be removed, and the visual appearance of the site would improve. Buried waste would still constitute an on-going liability as it would remain a waste site and Territorial approval would have to be obtained.

3) Off-site disposal of all non-hazardous debris: All debris would all be removed from Kristoffer Bay for eventual disposal of out of Territory. The crushed drums and other metal waste would be collected by hand and either put into 1 m^3 soil bags or slung out as-is. The steel waste at this site is not as low density as at Cape Isachsen and an average density of 3 T per cubic metre has been assigned. The total debris volume is about 10 m^3 and total weight is 30 T. About 30 sling load trips back to Isachsen HAWS would be required.

The three options for management of non-hazardous debris have been evaluated and the results are tabulated below.

Table 5-5 Evaluation of Options for Non-Hazardous Debris at Kristoffer Bay

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Consolidation On-Site	Neutral	Favourable	Favourable	Unfavourable	Unfavourable	Neutral (0)
Burial of Waste On-site	Neutral	Neutral	Neutral	Unfavourable	Neutral	Unfavourable (-1)
Off-site Disposal of all Non-hazardous Debris	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	Favourable (+1)

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

For the Consolidating On-site Option, the Reduction of Environmental Risk score is seen as a neutral because there is no chemical contamination associated with this waste stream; it is non-leachable solid waste. It does not rate a favourable score because there is some physical risk to wildlife with leaving it on-site. The Value to the Crown score for this option is favourable as it is the lowest cost option. Its Resources Required are the least, thus its score is favourable; the labour requirement would simply be manually dragging the metal waste to the north side of the Site where most of it is located. No burial or air lift is involved, contrary to the other options. Reduction of liability however is unfavourable. Since debris would be left on-site it would constitute a waste disposal site and have some on-going monitoring requirements and may not receive Territorial approval. Regarding Local Benefits, although there would be local labour involved in this option it's the physical appearance of consolidated debris would not be consistent with traditional values. The overall score for this option is neutral (0).

The Burial of Waste On-site option scores neutral on Reduction of Environmental Risk because there is no chemical contamination associated with this waste stream. Is also scores neutral in the Value to the Crown (cost) criterion because it is intermediate in cost between options 1 and 3. The labour content is high and it would have the longest on-site duration because the trenching and burial work would all be manually done but it avoids the helicopter transportation of waste to Isachsen HAWS and onward transportation out of Territory, so its Resources Required are neutral compared to option 3. In terms of Reduction of Liability, it scores unfavourably like option 1, because with buried wastes, Kristoffer Bay would remain a waste disposal site with ongoing monitoring requirements, i.e. not a "walk-away" solution. In terms of Local Benefits, it is also neutral because the physical appearance would be improved compared to present, but burial would only be shallow given the manual labour, and erosion and freeze-thaw cycles might bring the waste to the surface once again. The Burial of Waste On-site option's overall score is unfavourable (-1).

The Off-site Disposal of all Non-hazardous Debris option scores favourably under Reduction of Environmental Risk because all chemical and physical risk would be removed from the Site. For Value to the Crown, it scores unfavourably due to having the highest cost of the three options. It scores also unfavourably under Resource Requirements because it not only requires significant labour on-site, but it will also require about 30 helicopter sling loads to Isachsen. With a round trip time of 1.25 hours, this will burn about 38 drums of fuel. From the Reduction of Liability perspective, it does achieve the "walk-away" objective and is therefore favourable. In terms of Local Benefits, it not only has a high labour content, but it also leaves a site with no limitations on its future land use. Overall, this option scores the most favourably (+1).

The optimum waste management solution for the non-hazardous waste at Kristoffer Bay is thus to collect and transport from the Kristoffer Bay site to Isachsen for transfer to Resolute Bay and then out of the Territory for disposal or recycling.

5.4.3 Waste Drums

The remedial options for the crushed or shredded fuel drums have been accounted for under non-hazardous waste.

5.4.4 Integrated Remedial Plan

The only waste stream requiring management at Kristoffer Bay is non-hazardous debris.

The on-site work at Kristoffer Bay would be completed in a single phase of work over about 6 or 7 days during the summer work season of 2023. Good weather would be required for multiple roundtrips per day slinging waste to Isachsen HAWS. The activities will consist of freeing the partially buried steel objects, cutting of steel that is over 1 m long using torches, collection of all non-hazardous debris into 1 m^3 soil bags. It would be transported to the Isachsen HAWS in about 30 sling loads by helicopter. Each round trip would have a cycle time of about 1 hour and 15 minutes. Refuelling would be needed every other round-trip.

Once the waste from Kristoffer Bay has all been transferred to Isachsen HAWS it would be transferred to fixed-wing aircraft and flown to Resolute Bay for onward transportation by sealift.

From Resolute Bay, the wastes would be transported to the South by sealift for metal recycling or final disposal at licensed waste disposal facilities. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be "walk-away", with no on-going monitoring requirements or liability.

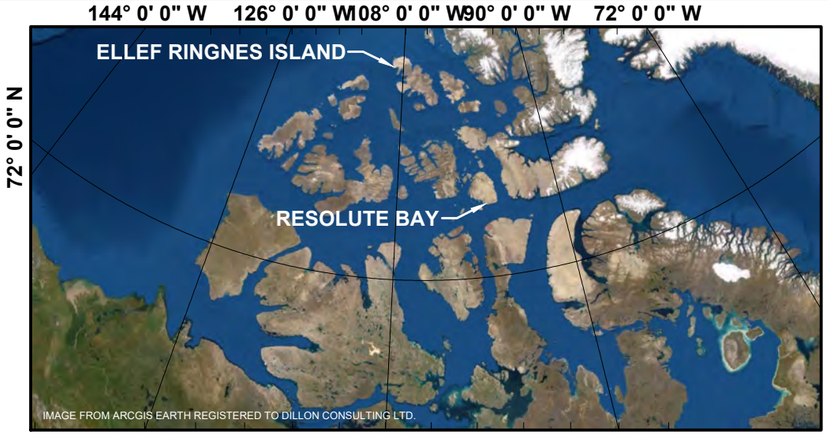
5.5 Scope of Work for Proposed Remedial Solution

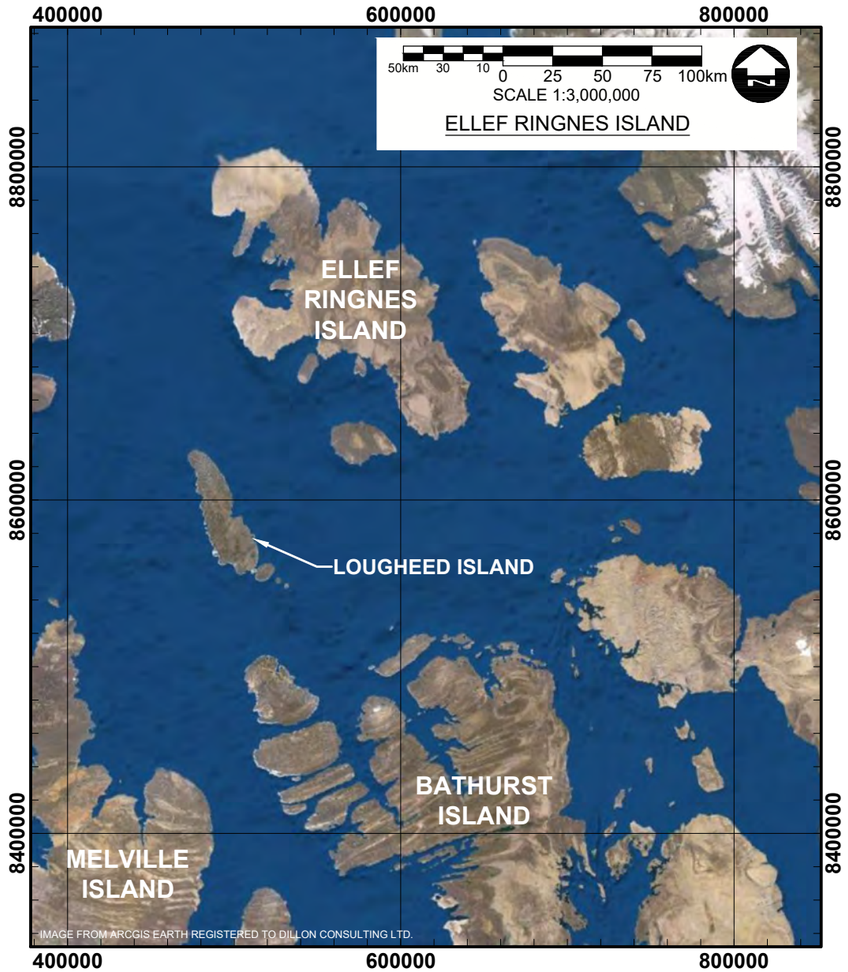
The scope of work required to implement the work resulting from the preferred remedial option has been resolved into a Work Breakdown Structure (WBS) included in Appendix A and has been packaged with three other 'small' sites in the Pioneer High Arctic Bundle. The WBS describes in a graphical form the work that will be required of a contractor for this site within the overall contract. The WBS contains four deliverables for work supporting all of the sites in the contract: BOPC1: Balance of Project Costs, 1: Project Meetings, 2 Health, Safety and Environment, 3 Logistics, Transportation and Facilities, and 4 Kristoffer Bay Remediation.

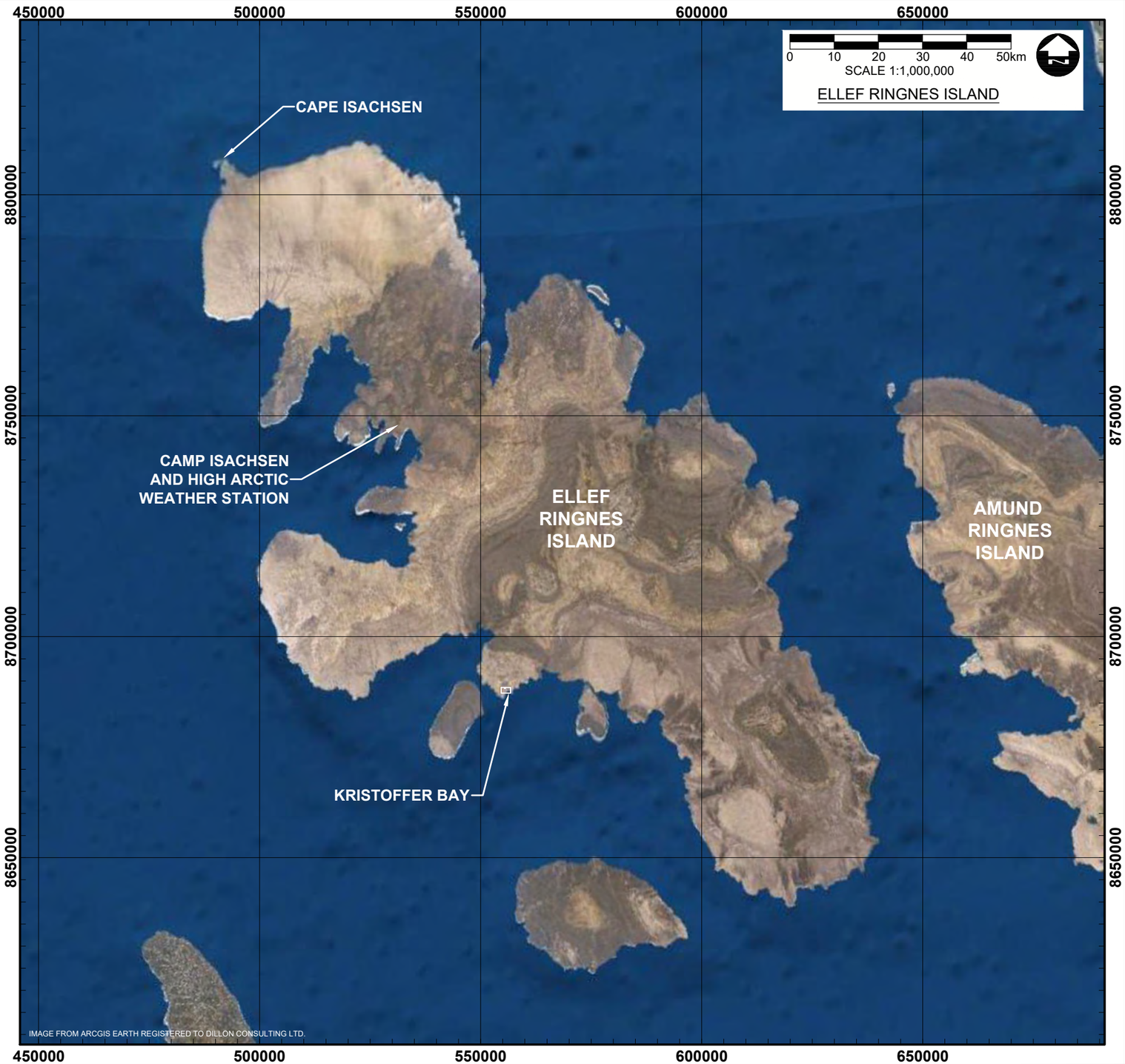
The on-site work at Kristoffer Bay would be completed in a single phase of work over about 6 or 7 days during the summer work season of 2023. On-Site activities will be the freeing partially buried steel objects, cutting of steel that is over 1 m long using torches, collection of all non-hazardous debris into 1 m^3 soil bags. It would be transported to the Isachsen HAWS in about 30 sling loads by helicopter. Each round trip would have a cycle time of about 1 hour and 15 minutes. Refuelling would be needed every other round-trip.

Once the waste from Kristoffer Bay has all been transferred to Isachsen HAWS it would be transferred to fixed-wing aircraft and flown to Resolute Bay.

From Resolute Bay, the wastes would be transported by sealift for metal recycling or final disposal at licensed waste disposal facilities in the South. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be "walk-away", with no on-going monitoring requirements or liability.







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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

KRISTOFFER BAY
SITE LOCATION PLAN

SHEET NO. 800

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\21370 PIONEER SITES\KRISTOFFER BAY\KRISTOFFER BAY Z1GN.DWG
PLOT DATE: 2022-10-20 @ 12:32:12 PM PLOT SCALE 1:3 PLOT STYLE: DILLON.CTB

554750 555000 555250 555500 555750 556000 556250 556500

8688250 8688000 8687750 8687500

KB-SW-UP
8688321.736mN, 555420.735mE, 37.016m

GENERAL SAMPLE AREA
SEE DRAWING 802

100m 75 50 25 0 50 100 150 200m
SCALE 1:5,000

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

NOTE:
AERIAL FROM ARCGIS EARTH.

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FILENAME: C:\CAD\21370 PIONEER SITES\KRISTOFER BAY\KRISTOFER BAY 21IN.DWG
PLOT DATE: 2022-10-20 @ 12:33:02 PM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

KRISTOFFER BAY
SURVEYED LIMITS

SHEET NO. 801

555600 555700 555800 555900 556000

8687700

8687600

8687500

20 16 12 8 4 0 10 20 30 40 50m
SCALE 1:1200

LEGEND:
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- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
AERIAL FROM DRONE.

KB-003
KB-SW-BKGD
KB-GEO-003
Metal debris to be collected and removed from site
KB-002
DEBRIS FIELD
SIGN
SAMPLE AREA 200 APEC 2
UPLAND AREA
SEE DRAWING 804
SUSPECTED SECOND WELLHEAD
WASHOUT
SUSPECTED DRILL SUMP
KB-OUTWASH
LIMITS OF HIGH RESOLUTION IMAGERY/CONTOURS
KB-001
KB-GEO-002
KB-SW-DOWN
KB-SED-001
KB-000
SIGN
KB-GEO-001
SAMPLE AREA 100 APEC 1
WELLHEAD AREA
SEE DRAWING 803

555600 555700 555800 555900 556000

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

KRISTOFFER BAY
GENERAL SAMPLE AREA

SHEET NO. 802

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FILENAME: C:\CAD\21370 PIONEER SITES\KRISTOFFER BAY\KRISTOFFER BAY 21-370.DWG
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8687565 8687560 8687555 8687550

PHC, BTEX, AND METALS IMPACT

PHC AND PAH IMPACT

KB-102-B

KB-103

KB-102

KB-103-B

PANARCTIC WELLHEAD B-06

KB-100-SURF

KB-101

WELL FRAME

KB-104

KB-105

KB-104-B

KB-105-B

SIGN

12.0 11.9 11.8 11.7 11.6

0 1 2 3 4 5m
SCALE 1:100

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

- METALS IMPACT ZONE
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
CONTOUR INTERVAL 0.1m AND 0.5m (DERIVED FROM RTK SURVEY AND DRONE PHOTOGRAMMETRY)
AERIAL IMAGE FROM DRONE COMPOSITE

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

KRISTOFFER BAY
SAMPLE AREA 100 APEC 1
WELLHEAD AREA

SHEET NO. 803

555780 555800 555820 555840 555860 555880 555900 555920

8687640 8687620 8687600 8687580

0 5 10 15 20m
SCALE 1:400

LEGEND:
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- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

- METALS IMPACTED ZONE
- HYDROCARBON IMPACTED ZONES
- PERMAFROST DEGRADATION

NOTE:
CONTOUR INTERVAL 0.1m AND 0.5m (DERIVED FROM RTK SURVEY AND DRONE PHOTOGRAMMETRY)
AERIAL IMAGE FROM DRONE COMPOSITE

SIGN
KB-202
KB-201
KB WELLHEAD WEST
KB-203
BORON IMPACT
KB-204-N1
KB-204-N2
KB-204
KB-204-E1
KB-204-E2
KB-204-E3
KB-204-E4
KB-204-NE1
KB-203
KB-204-E5
KB-204-SE1
SUSPECTED DRILL SUMP
KB-OUTWASH
KB-GEO-002
PHC, BTEX, AND METALS IMPACT
KB-200
KB-103-B

11.0 10.5 12.5 12.0 11.5 13.0

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

KRISTOFFER BAY
SAMPLE AREA 200 APEC 2
UPLAND AREA

PROJECT NO.: 21-2370
SHEET NO.: 804

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6.0 Remedial Work Plan

The seven sites comprising the Pioneer High Arctic Bundle represent a large amount of site remediation work at high Northern latitudes with short work seasons. The work requires Regulatory permits to be applied for and in place before it can commence, remote camps to be mobilized for the workers, terms of reference and specifications to be drafted and contracts to be tendered, all for successful implementation. Remediation of the seven Pioneer Sites has been grouped in to two packages for procurement and implementation. This Remedial Action Plan details the Small Site Package, which includes four of the seven Pioneer High Arctic sites with smaller scopes and waste quantities for their remediation.

6.1 Small Site Package (2023)

This package includes Playfair Point, Pioneer Island, Cape Isachsen and Kristoffer Bay. Work at Cape Isachsen and Kristoffer Bay would be staged from the Isachsen HAWS. The Playfair Point and Pioneer Island sites would be staged from Resolute Bay. These four sites mostly have non-hazardous debris; Playfair Point is the only site with drums and waste fuel. This contract is envisaged to be tendered in the first quarter of 2023/24 and implemented in the 2023 work season. The work breakdown structure for activities comprising the Small Site Package is included in Appendix A.

6.1.1 Regulatory Requirements

The current land use permit with the Lands Administration Branch of CIRNAC for the Isachsen Weather station allows DOJV to use the site for habitation in support of environmental site assessment activities. It must be amended to allow DOJV to use the site as a temporary transfer station for waste from the two sites on Ellef Ringnes Island. It is planned that all of the waste would be flown out before the end of the 2023 season, but being permitted to hold it for one year would be prudent, in case the 2023 season closes early due to bad weather. The population of a Contractor's work team, fuel caching for helicopter use and temporary storage of waste from Cape Isachsen and Kristoffer Bay are expected to trigger only an amendment and not a change from the current Class B Land Use Permit. DOJV will manage the regulatory correspondence for amendment of the Land Use Permit. The Nunavut Planning Commission (NPC) has been informed of the planned additional activity at Isachsen.

Little or no water will be used at these four sites however renewal of the approval for Use of Waters Without a License at Isachsen will have to be secured by DOJV from the Nunavut Water Board.

A Notice of Project must be filed by the contractor with the Nunavut Workers Safety & Compensation Commission (WSCC) and that will be the responsibility of the Contractor.

A health and safety and environmental protection plan will be required from the contractor to submit to the project authority. A dedicated Medic will be required to be on the work team.

6.1.2 Camp Requirements

Accommodation for the Contractor's crew while working on the two sites on Ellef Ringnes Island will be at the temporary camp at Isachsen HAWS in 2023. Both the Pioneer Remediation Project and ECCC's Isachsen Site Assessment Project are planning to use the camp and must communicate while planning their 2023 field programs to ensure that the teams can share the accommodation at the Isachsen field camp.

6.1.3 Logistics

A logistics plan will be a requirement from the successful remediation contractor. It will have to include:

- Mobilizing a work team and helicopter support team to Isachsen HAWS
- Operation over a sufficient duration to remove all waste from Cape Isachsen and Kristoffer Bay to Isachsen HAWS by helicopter
- Removal of all relocated wastes from Isachsen to Resolute Bay by fixed-wing aircraft
- Mobilizing a work team to Resolute Bay to perform work at Playfair Point and Pioneer Island
- Removal of all wastes from Playfair Point and Pioneer Island to Resolute Bay by fixed-wing aircraft
- Temporary storage of wastes at Resolute Bay
- Shipment of wastes out of Territory by sealift
- Certification of disposal of all waste types.

6.1.4 Schedule

The schedule in the form of a Gantt chart for all activities related to the Small Site Package is included in Appendix A.

7.0 Limitations and Closing Remarks

Dillon-Outcome has completed this Remedial Action Plan of four of the Pioneer High Arctic Bundle Sites in Nunavut based on the findings of site visits conducted in field season during 2021 and 2022 with the standard of care generally expected of environmental consultants for a study of this nature.

This RAP has been prepared for the use of the Government of Canada and may be shared with third party uses (contractors and other stakeholders).

Changes to the physical setting of the Site, surrounding area and applicable guidelines and regulations governing contaminated sites in Nunavut have the potential to influence the interpretation presented in this RAP.

Sincerely,

DILLON-OUTCOME JOINT VENTURE

Don Plenderleith, M.Sc., P.Eng (NU).
Environmental Division Manager

8.0 References

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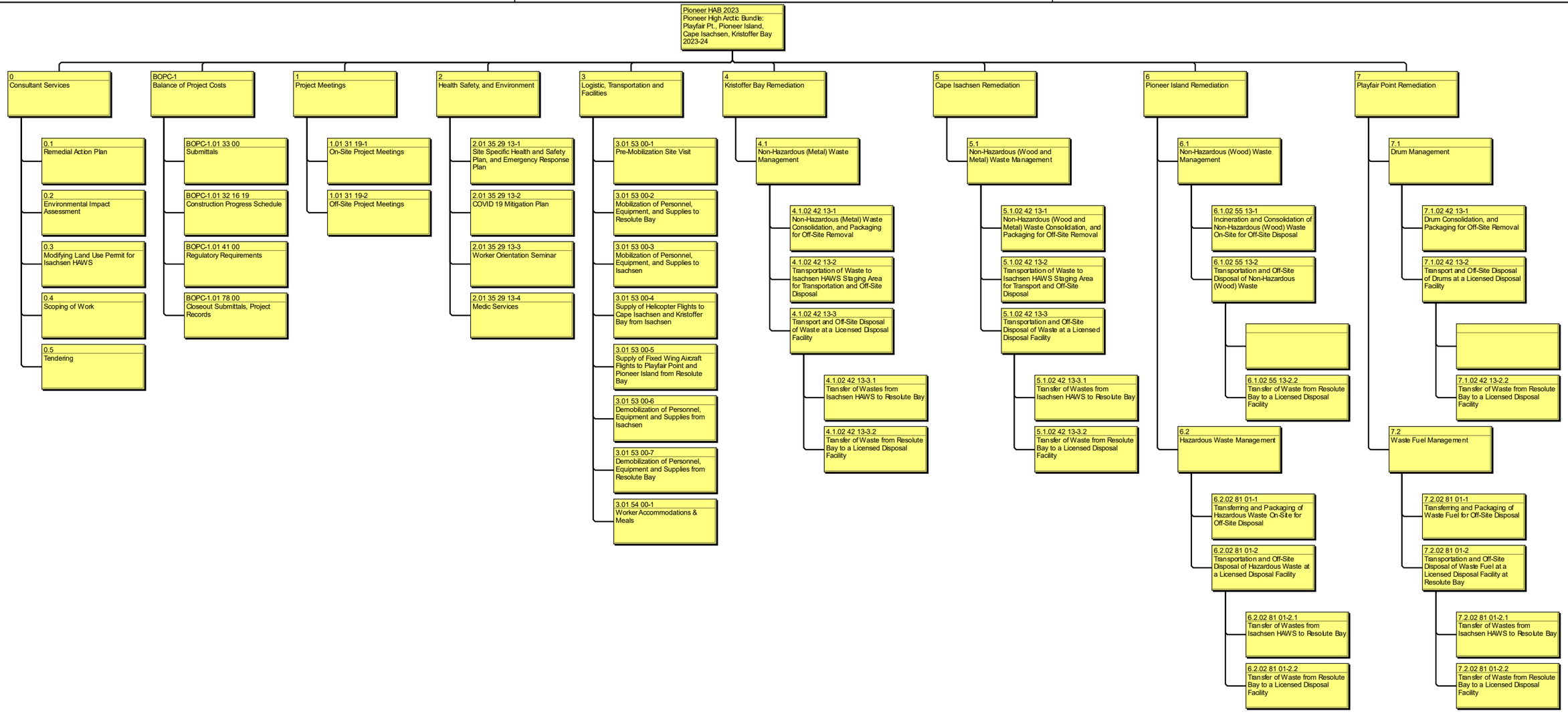
Water and Earth Sciences Associates Ltd. (WESA), *Integrated Phase I and Phase II Environmental Site Assessment of Cape Ahnighito, Nunavut,* WESA, February 2012 (WESA 2012d)

Water and Earth Sciences Associates Ltd. (WESA), *Integrated Phase I and Phase II Environmental Site Assessment of Cape Isachsen, Nunavut,* WESA, February 2012 (WESA 2012e)

Water and Earth Sciences Associates Ltd. (WESA), Integrated Phase I and Phase II Environmental Site Assessment of NB048 Kristoffer Bay Nunavut, WESA, February 2012 (WESA 2012f)

Appendix A

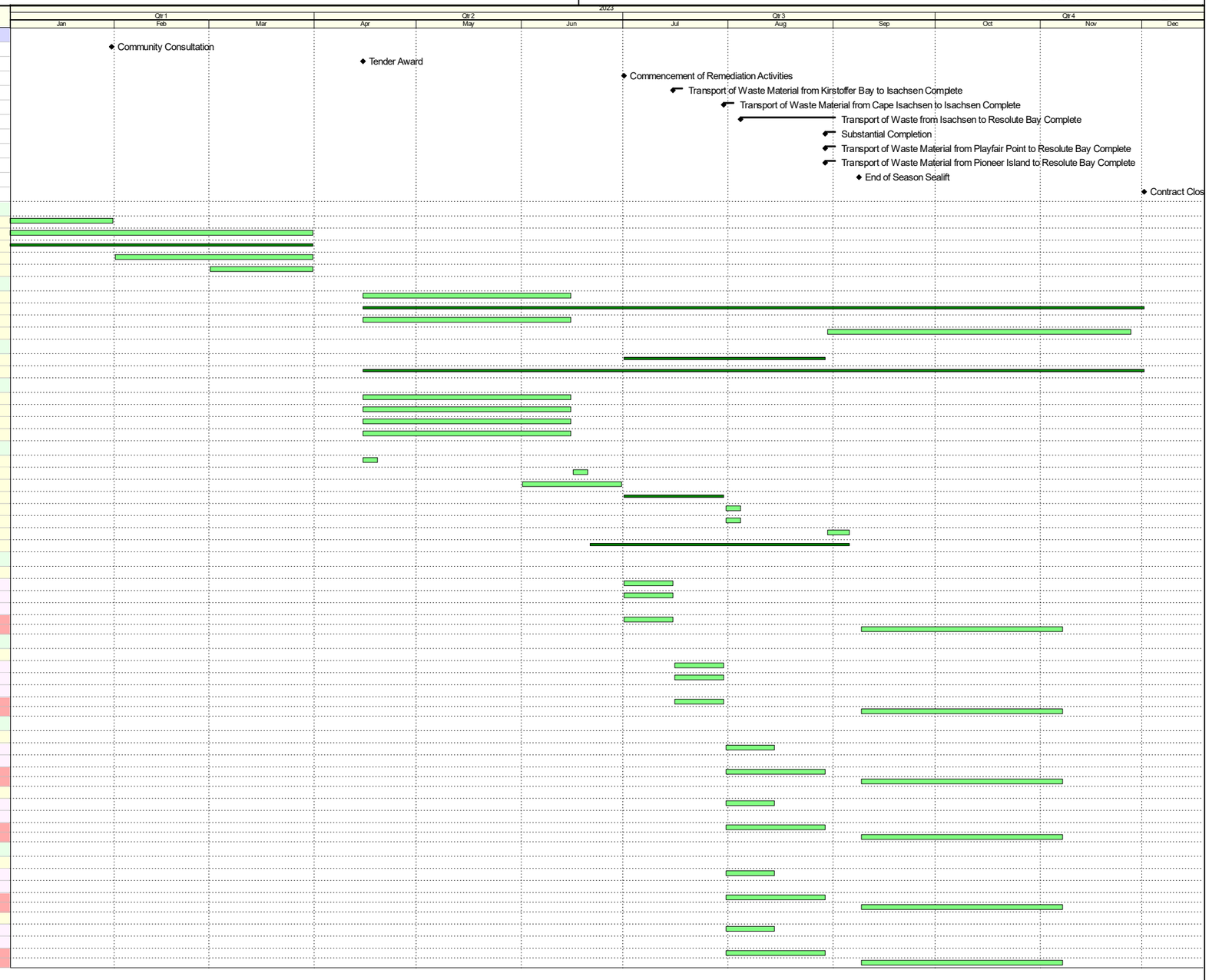
WBS and Schedule Small Site Package (2023)


Pioneer HAB 2023
Pioneer High Arctic Bundle: Playfair Pt., Pioneer Island, Cape Isachsen, Kristoffer Bay 2023-24
0
Consultant Services
0.1
Remedial Action Plan
0.2
Environmental Impact Assessment
0.3
Modifying Land Use Permit for Isachsen HAWS
0.4
Scoping of Work
0.5
Tendering
BOPC-1
Balance of Project Costs
BOPC-1.01 33 00
Submittals
BOPC-1.01 32 16 19
Construction Progress Schedule
BOPC-1.01 41 00
Regulatory Requirements
BOPC-1.01 78 00
Closeout Submittals, Project Records
1
Project Meetings
1.01 31 19-1
On-Site Project Meetings
1.01 31 19-2
Off-Site Project Meetings
2
Health Safety, and Environment
2.01 35 29 13-1
Site Specific Health and Safety Plan, and Emergency Response Plan
2.01 35 29 13-2
COVID 19 Mitigation Plan
2.01 35 29 13-3
Worker Orientation Seminar
2.01 35 29 13-4
Medic Services
3
Logistic, Transportation and Facilities
3.01 53 00-1
Pre-Mobilization Site Visit
3.01 53 00-2
Mobilization of Personnel, Equipment, and Supplies to Resolute Bay
3.01 53 00-3
Mobilization of Personnel, Equipment, and Supplies to Isachsen
3.01 53 00-4
Supply of Helicopter Flights to Cape Isachsen and Kristoffer Bay from Isachsen
3.01 53 00-5
Supply of Fixed Wing Aircraft Flights to Playfair Point and Pioneer Island from Resolute Bay
3.01 53 00-6
Demobilization of Personnel, Equipment and Supplies from Isachsen
3.01 53 00-7
Demobilization of Personnel, Equipment and Supplies from Resolute Bay
3.01 54 00-1
Worker Accommodations & Meals
4
Kristoffer Bay Remediation
4.1
Non-Hazardous (Metal) Waste Management
4.1.02 42 13-1
Non-Hazardous (Metal) Waste Consolidation, and Packaging for Off-Site Removal
4.1.02 42 13-2
Transportation of Waste to Isachsen HAWS Staging Area for Transportation and Off-Site Disposal
4.1.02 42 13-3
Transport and Off-Site Disposal of Waste at a Licensed Disposal Facility
4.1.02 42 13-3.1
Transfer of Wastes from Isachsen HAWS to Resolute Bay
4.1.02 42 13-3.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
5
Cape Isachsen Remediation
5.1
Non-Hazardous (Wood and Metal) Waste Management
5.1.02 42 13-1
Non-Hazardous (Wood and Metal) Waste Consolidation, and Packaging for Off-Site Removal
5.1.02 42 13-2
Transportation of Waste to Isachsen HAWS Staging Area for Transport and Off-Site Disposal
5.1.02 42 13-3
Transportation and Off-Site Disposal of Waste at a Licensed Disposal Facility
5.1.02 42 13-3.1
Transfer of Wastes from Isachsen HAWS to Resolute Bay
5.1.02 42 13-3.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
6
Pioneer Island Remediation
6.1
Non-Hazardous (Wood) Waste Management
6.1.02 55 13-1
Incineration and Consolidation of Non-Hazardous (Wood) Waste On-Site for Off-Site Disposal
6.1.02 55 13-2
Transportation and Off-Site Disposal of Non-Hazardous (Wood) Waste
6.1.02 55 13-2.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
6.2
Hazardous Waste Management
6.2.02 81 01-1
Transferring and Packaging of Hazardous Waste On-Site for Off-Site Disposal
6.2.02 81 01-2
Transportation and Off-Site Disposal of Hazardous Waste at a Licensed Disposal Facility
6.2.02 81 01-2.1
Transfer of Wastes from Isachsen HAWS to Resolute Bay
6.2.02 81 01-2.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
7
Playfair Point Remediation
7.1
Drum Management
7.1.02 42 13-1
Drum Consolidation, and Packaging for Off-Site Removal
7.1.02 42 13-2
Transport and Off-Site Disposal of Drums at a Licensed Disposal Facility
7.1.02 42 13-2.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
7.2
Waste Fuel Management
7.2.02 81 01-1
Transferring and Packaging of Waste Fuel for Off-Site Disposal
7.2.02 81 01-2
Transportation and Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility at Resolute Bay
7.2.02 81 01-2.1
Transfer of Wastes from Isachsen HAWS to Resolute Bay
7.2.02 81 01-2.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility

Pioneer High Arctic Bundle: Playfair Pt., Pioneer Island, Cape Isachsen, Kristoffer Bay 2023-24

data date: 01-Jan-23

Activity ID	Activity Name	At Completion Duration	Start	Finish
Pioneer High Arctic Bundle: Playfair Pt., Pioneer Island, Cape Isachsen, Kristoffer Bay 2023-24		335	01-Jan-23	01-Dec-23
PHAB-3010	Community Consultation	0		31-Jan-23*
PHAB-3060	Tender Award	0		15-Apr-23*
PHAB-3490	Commencement of Remediation Activities	0	01-Jul-23*	
PHAB-3620	Transport of Waste Material from Kirstoffer Bay to Isachsen Complete	0		15-Jul-23
PHAB-3630	Transport of Waste Material from Cape Isachsen to Isachsen Complete	0		30-Jul-23
PHAB-3660	Transport of Waste from Isachsen to Resolute Bay Complete	0		04-Aug-23
PHAB-3900	Substantial Completion	0		29-Aug-23
PHAB-3640	Transport of Waste Material from Playfair Point to Resolute Bay Complete	0		29-Aug-23
PHAB-3650	Transport of Waste Material from Pioneer Island to Resolute Bay Complete	0		29-Aug-23
PHAB-3120	End of Season Sealift	0		08-Sep-23*
PHAB-3510	Contract Closeout	0		01-Dec-23*
Consultant Services		90	01-Jan-23	31-Mar-23
Remedial Action Plan		31	01-Jan-23	31-Jan-23
Environmental Impact Assessment		90	01-Jan-23	31-Mar-23
Modifying Land Use Permit for Isachsen HAWS		90	01-Jan-23	31-Mar-23
Scoping of Work		59	01-Feb-23	31-Mar-23
Tendering		31	01-Mar-23	31-Mar-23
Balance of Project Costs		231	15-Apr-23	01-Dec-23
Submittals		62	15-Apr-23	15-Jun-23
Construction Progress Schedule		231	15-Apr-23	01-Dec-23
Regulatory Requirements		62	15-Apr-23	15-Jun-23
Closeout Submittals, Project Records		90	30-Aug-23	27-Nov-23
Project Meetings		231	15-Apr-23	01-Dec-23
On-Site Project Meetings		60	01-Jul-23	29-Aug-23
Off-Site Project Meetings		231	15-Apr-23	01-Dec-23
Health Safety, and Environment		62	15-Apr-23	15-Jun-23
Site Specific Health and Safety Plan, and Emergency Response Plan		62	15-Apr-23	15-Jun-23
COVID 19 Mitigation Plan		62	15-Apr-23	15-Jun-23
Worker Orientation Seminar		62	15-Apr-23	15-Jun-23
Medic Services		62	15-Apr-23	15-Jun-23
Logistic, Transportation and Facilities		144	15-Apr-23	05-Sep-23
Pre-Mobilization Site Visit		5	15-Apr-23	19-Apr-23
Mobilization of Personnel, Equipment, and Supplies to Resolute Bay		5	16-Jun-23	20-Jun-23
Mobilization of Personnel, Equipment, and Supplies to Isachsen		30	01-Jun-23	30-Jun-23
Supply of Helicopter Flights to Cape Isachsen and Kristoffer Bay from Isachsen		30	01-Jul-23	30-Jul-23
Supply of Fixed Wing Aircraft Flights to Playfair Point and Pioneer Island from Resolute Bay		5	31-Jul-23	04-Aug-23
Demobilization of Personnel, Equipment and Supplies from Isachsen		5	31-Jul-23	04-Aug-23
Demobilization of Personnel, Equipment and Supplies from Resolute Bay		7	30-Aug-23	05-Sep-23
Worker Accommodations & Meals		77	21-Jun-23	05-Sep-23
Kristoffer Bay Remediation		130	01-Jul-23	07-Nov-23
Non-Hazardous (Metal) Waste Management		130	01-Jul-23	07-Nov-23
Non-Hazardous (Metal) Waste Consolidation, and Packaging for Off-Site Removal		15	01-Jul-23	15-Jul-23
Transportation of Waste to Isachsen HAWS Staging Area for Transportation and Off-Site Disposal		15	01-Jul-23	15-Jul-23
Transport and Off-Site Disposal of Waste at a Licensed Disposal Facility		130	01-Jul-23	07-Nov-23
Transfer of Wastes from Isachsen HAWS to Resolute Bay		15	01-Jul-23	15-Jul-23
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	09-Sep-23	07-Nov-23
Cape Isachsen Remediation		115	16-Jul-23	07-Nov-23
Non-Hazardous (Wood and Metal) Waste Management		115	16-Jul-23	07-Nov-23
Non-Hazardous (Wood and Metal) Waste Consolidation, and Packaging for Off-Site Removal		15	16-Jul-23	30-Jul-23
Transportation of Waste to Isachsen HAWS Staging Area for Transport and Off-Site Disposal		15	16-Jul-23	30-Jul-23
Transportation and Off-Site Disposal of Waste at a Licensed Disposal Facility		115	16-Jul-23	07-Nov-23
Transfer of Wastes from Isachsen HAWS to Resolute Bay		15	16-Jul-23	30-Jul-23
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	09-Sep-23	07-Nov-23
Pioneer Island Remediation		100	31-Jul-23	07-Nov-23
Non-Hazardous (Wood) Waste Management		100	31-Jul-23	07-Nov-23
Incineration and Consolidation of Non-Hazardous (Wood) Waste On-Site for Off-Site Disposal		15	31-Jul-23	14-Aug-23
Transportation and Off-Site Disposal of Non-Hazardous (Wood) Waste		100	31-Jul-23	07-Nov-23
Transfer of Wastes from Isachsen HAWS to Resolute Bay		30	31-Jul-23	29-Aug-23
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	09-Sep-23	07-Nov-23
Hazardous Waste Management		100	31-Jul-23	07-Nov-23
Transferring and Packaging of Hazardous Waste On-Site for Off-Site Disposal		15	31-Jul-23	14-Aug-23
Transportation and Off-Site Disposal of Hazardous Waste at a Licensed Disposal Facility		100	31-Jul-23	07-Nov-23
Transfer of Wastes from Isachsen HAWS to Resolute Bay		30	31-Jul-23	29-Aug-23
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	09-Sep-23	07-Nov-23
Playfair Point Remediation		100	31-Jul-23	07-Nov-23
Drum Management		100	31-Jul-23	07-Nov-23
Drum Consolidation, and Packaging for Off-Site Removal		15	31-Jul-23	14-Aug-23
Transport and Off-Site Disposal of Drums at a Licensed Disposal Facility		100	31-Jul-23	07-Nov-23
Transfer of Wastes from Isachsen HAWS to Resolute Bay		30	31-Jul-23	29-Aug-23
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	09-Sep-23	07-Nov-23
Waste Fuel Management		100	31-Jul-23	07-Nov-23
Transferring and Packaging of Waste Fuel for Off-Site Disposal		15	31-Jul-23	14-Aug-23
Transportation and Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility at Resolute Bay		100	31-Jul-23	07-Nov-23
Transfer of Wastes from Isachsen HAWS to Resolute Bay		30	31-Jul-23	29-Aug-23
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	09-Sep-23	07-Nov-23



Remaining Level of Effort
Remaining Work
Milestone
Float Bar

Page 1 of 1

outcome CONSULTANTS

Date	Revision	Checked	Approved
12-Dec-22	Preliminary Schedule	M.Mathews	D.Plenderleith

Appendix B

Waste Fuel Test Results

Petro Laboratories Inc.

1295 Matheson Blvd. East, Mississauga, Ontario, L4W 1R1 Tel: (905) 361-2388 Fax: (905) 361-2411
E-mail: petrolab@gmail.com

Laboratory Report

Outcome Consultants Inc.
151 Holland Ave., Suite 200
Ottawa, Ontario
K1Y 0Y2

Lab no.: 16556-1 ,2
Date report: Sept 15, 2021
Sample in: Sept 2, 2021
P.O. no.: 2021-10

Attn: Don Plenderleith

Re : Pioneer Sites
Two liquid samples from Drums for testing.

TESTS	RESULTS
Lab No.	**16556-1**
Sample ID	**Playfair West Drum #2**
Date	**Aug 4,2021**
1. Flash Point ,°C ASTM D93	22
2. PCB's in ppm ASTM D4059	<1
3.Total Chlorine, in ppm ASTM D808	570
4. Appearance (Visual)	Clear Liquid
5. Specific gravity ASTM D289	0.7708
6. Viscosity, cst @40°C ASTM D445	1.02
7. pH (water fraction) Electrode	Not Applicable to solvent
8. Infra- Identification FTIR scan	Spectrum similar to gasoline mixture
9. Metals in ppm by ICP	
Cadmium	<1
Lead	<1
Chrominum	<1
10. Water, % volume	0

Remarks: The samples are both volatile solvent mixed with gasoline.

Tested by: PS./ S.I. (chemist)

Approved by: James Szeto

Memebr of ASTM
JS:LN

James Szeto, B.Sc.
Chief chemist

Appendix C