



**PUBLIC SERVICES AND PROCUREMENT CANADA  
ENVIRONMENTAL SERVICES – WESTERN REGION**

# **Operations and Maintenance Manual Resolute Bay Landfill Remediation Project, Resolute Bay, Nunavut**

**PSPC Project R.095508.001**

**Final Report**

March 10, 2020

DOJV Project No. P2017-06

# Executive Summary

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Dillon Consulting Ltd. and Outcome Consultants Inc in joint venture (DOJV) was contracted by Public Services and Procurement Canada (PSPC) Environmental Services to compose an Operations and Maintenance Manual (O&M Manual) for the Resolute Bay Airport Landfill. Work by DOJV was conducted according to the Terms of Reference *Specifications and Remedial Supervision – Resolute Bay Airport Landfill Remediation – Resolute Bay, Nunavut* dated December 2017. Work was completed under the Northern Contaminated Site Environmental Clean-up Work/Services Supply Arrangement EW699-170520-003 and in accordance with the Nunavut Water Board (NWB) Water License (WL) 1BR-RBL1419. This document is intended to abide to the requirements set out in the Nunavut Water Board (NWB) Water License (WL) 1BR-RBL1419.

The Resolute Bay Airport is five kilometres northwest of the Inuit hamlet of Resolute, adjacent to Resolute Bay on Cornwallis Island, Nunavut. Two historical landfills are located on the site and were previously identified along with a vehicle storage area (also referenced as metal storage area) as Areas of Environmental Concern (AEC) based on activities, historical and present, associated with the airport and local community. For reporting purposes, the AECs are referenced as the solid waste landfill (AEC 1), historical landfill (AEC 2), and the vehicle/metal storage area (AEC 3).

Site remediation is complete and took place over a two-year period from 2018 to 2019. The remedial objectives at the site included the removal of physical hazards (i.e., slope stabilization and capping at the landfills and debris removal), consolidation of waste and debris, off-site disposal of materials deemed hazardous by the NWB WL and the containment and control of contaminants in the surface water pathways prior to leaving the site and ultimately, discharging to receiving water bodies.

With remediation completed, operations and maintenance (O&M) activities will begin as outlined in this document. The goal of this O&M Manual is to ensure that during the lifespan of monitoring activities, the current and future risks to human health & environment are negligible from a physical standpoint. This will be achieved by ensuring that all design intents are met, and by reevaluating risks during each monitoring event. The O&M Manual will be implemented immediately after the completion of construction.

The O&M Manual consists of specific monitoring elements, with descriptions of methodology and action levels based on observed impacts. The elements of the plan are as follows:

- Natural environment monitoring to assess trends in the use of the site by wildlife;
- Maintenance and visual monitoring of landfill covers to assess performance and stability;
- Operational monitoring of the surface water swales including surface water/seep monitoring to address the potential for instability from surface drainage impacts.

# Table of Contents

<b>Executive Summary</b>	<b>i</b>
<b>1.0 Introduction</b>	<b>5</b>
1.1 Purpose of the Manual .....	5
<b>2.0 Site Background</b>	<b>7</b>
2.1 Site Identification .....	8
2.2 Overall Site Description.....	8
2.1.1 Regional Setting .....	8
2.1.2 Climate and Weather .....	9
2.1.3 Geological Setting .....	9
2.1.4 Demography.....	9
2.1.5 Lines and Other Property Lines.....	9
<b>3 Operation and Maintenance of Solid Waste Landfill (AEC 1)</b>	<b>11</b>
3.1 Site Description .....	11
3.2 Summary of Implemented Remediation Strategy .....	11
3.3 Remedial Design and Risk Management.....	11
3.3.1 Remedial Design.....	11
3.3.2 Risk Management .....	12
3.4 Operation & Maintenance Evaluation, Procedures and Reporting .....	12
3.4.1 Complete Visual Inspection Report.....	13
3.4.2 Stability Assessment .....	16
3.4.3 Operation and Maintenance Severity Rating.....	16
3.4.4 Recommendations .....	19
<b>4 Operation and Maintenance of Historical Landfill (AEC 2)</b>	<b>20</b>
4.1 Site Description .....	20
4.2 Summary of Implemented Remediation Strategy .....	20
4.3 Remedial Design and Associated Risks .....	20
4.3.1 Remedial Design.....	20
4.3.2 Associated Risks .....	20
4.4 Operation & Maintenance Evaluation, Procedures, and Reporting .....	21
4.4.1 Complete Visual Inspection Report.....	21
4.4.2 Stability Assessment .....	23

4.4.3	Operation and Maintenance Severity Rating.....	24
4.4.4	Recommendations .....	25
<b>5</b>	<b>Operation and Maintenance of Vehicle Storage Area (AEC 3)</b>	<b>27</b>
5.1	Site Description .....	27
5.2	Summary of Implemented Remediation Strategy .....	27
5.3	Remedial Design and Associated Risks .....	27
5.3.1	Remedial Design.....	27
5.3.2	Associated Risks .....	27
5.4	Operation and Maintenance Procedures.....	27
5.4.1	Complete Visual Inspection Report.....	27
5.4.2	Stability Assessment .....	30
5.4.3	Operation and Maintenance Severity Rating.....	30
5.4.4	Recommendations .....	32
<b>6</b>	<b>Action levels are to be separated into unique sections for operational and maintenance features.</b>	
	<b>Spills &amp; Discharges - Contingency &amp; Emergency Response Plan</b>	<b>33</b>
<b>7</b>	<b>Monitoring Plan</b>	<b>36</b>
7.1	Water Quality.....	36
7.1.1	Testing Parameters: .....	36
7.1.2	AEC 1 Monitoring Wells .....	37
7.1.3	AEC 2 Monitoring Wells .....	37
7.1.4	AEC 3 Monitoring Wells .....	38
7.2	Site Stability.....	38
<b>8</b>	<b>Reporting Procedures</b>	<b>39</b>
8.1	Annotated Drawings on Tabloid Paper, indicating all visual inspection features.....	39
8.2	Photographic Records .....	39
<b>9</b>	<b>References</b>	<b>40</b>
<b>10</b>	<b>Closure</b>	<b>42</b>

## Appendices

- A Drawings
- B Design Tables
- C Field Templates

## Tables

TABLE 1: GENERAL AEC 1 VISUAL INSPECTION MATRIX.....	14
TABLE 2: SITE SPECIFIC AEC 1 RISKS VISUAL INSPECTION MATRIX.....	15
TABLE 4: SEVERITY RATINGS OF AEC 1 OPERATIONAL FEATURES.....	16
TABLE 5: SEVERITY RATINGS OF AEC 1 MAINTENANCE FEATURES .....	18
TABLE 6: ACTION LEVELS FOR AEC 1 LANDFILL MONITORING OR REHABILITATION .....	19
TABLE 7: GENERAL AEC 2 VISUAL INSPECTION MATRIX.....	22
TABLE 8: AEC 2 SITE SPECIFIC RISKS VISUAL INSPECTION MATRIX.....	23
TABLE 9: SEVERITY RATINGS OF AEC 2 OPERATIONAL FEATURES.....	24
TABLE 10: SEVERITY RATINGS OF AEC 2 MAINTENANCE FEATURES .....	25
TABLE 11: ACTION LEVELS FOR AEC 2 LANDFILL MONITORING .....	26
TABLE 12: GENERAL AEC 3 VISUAL INSPECTION MATRIX.....	29
TABLE 13: SEVERITY RATINGS OF AEC 3 OPERATIONAL FEATURES.....	31
TABLE 14: SEVERITY RATINGS OF AEC 3 MAINTENANCE FEATURES .....	31
TABLE 15: ACTION LEVELS FOR AEC 3 MONITORING .....	32
TABLE 16: AEC 1 MONITORING WELL LOCATIONS.....	37
TABLE 17: AEC 2 MONITORING WELL LOCATIONS.....	37
TABLE 18: AEC 3 MONITORING WELL LOCATIONS.....	38

## Figures

FIGURE 1: FLOW CHART OF OPERATION AND MAINTENANCE ACTIVITIES BY AEC AS PER THE ASMRP .....	6
FIGURE 2: SITE IDENTIFICATION INFORMATION .....	8
FIGURE 3: FLOW CHART OF RESPONSE ORGANIZATION.....	35

## 1.0 Introduction

### 1.1 Purpose of the Manual

Dillon Consulting Ltd. and Outcome Consultants Inc in joint venture (DOJV) were contracted by Public Services and Procurement Canada (PSPC) Environmental Services to develop an Operations and Maintenance Manual for the Resolute Bay Landfill Remediation Program, as a requirement of the Water Licence (NWB Amended Renewal Water Licence No. 1BR-RBL1929).

The purpose of this manual is to assist responsible bodies with the proper operation and maintenance of remediated works during the post closure phase of the project lifecycle. This manual is intended to work as a companion document to the Long-Term Monitoring Plan (prepared under separate cover), and focuses on geophysical parameters and operational design features for the continued operation of the remediated works. In contrast, the Long-Term Monitoring Plan emphasizes chemical parameters for ensuring the protection of the natural environment and that the intent of the remedial design is being achieved.

DOJV prepared the manual in accordance with the “Guidelines for the preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996” as referenced in the Water Licence. The general body of the manual is reflected as such:

- 1) Introduction
- 2) Site Description
- 3) Operation and Maintenance of AEC 1
- 4) Operation and Maintenance of AEC 2
- 5) Operation and Maintenance of AEC 3
- 6) Spills & Discharges – Contingency & Emergency Response Program
- 7) Monitoring Program
- 8) Reporting

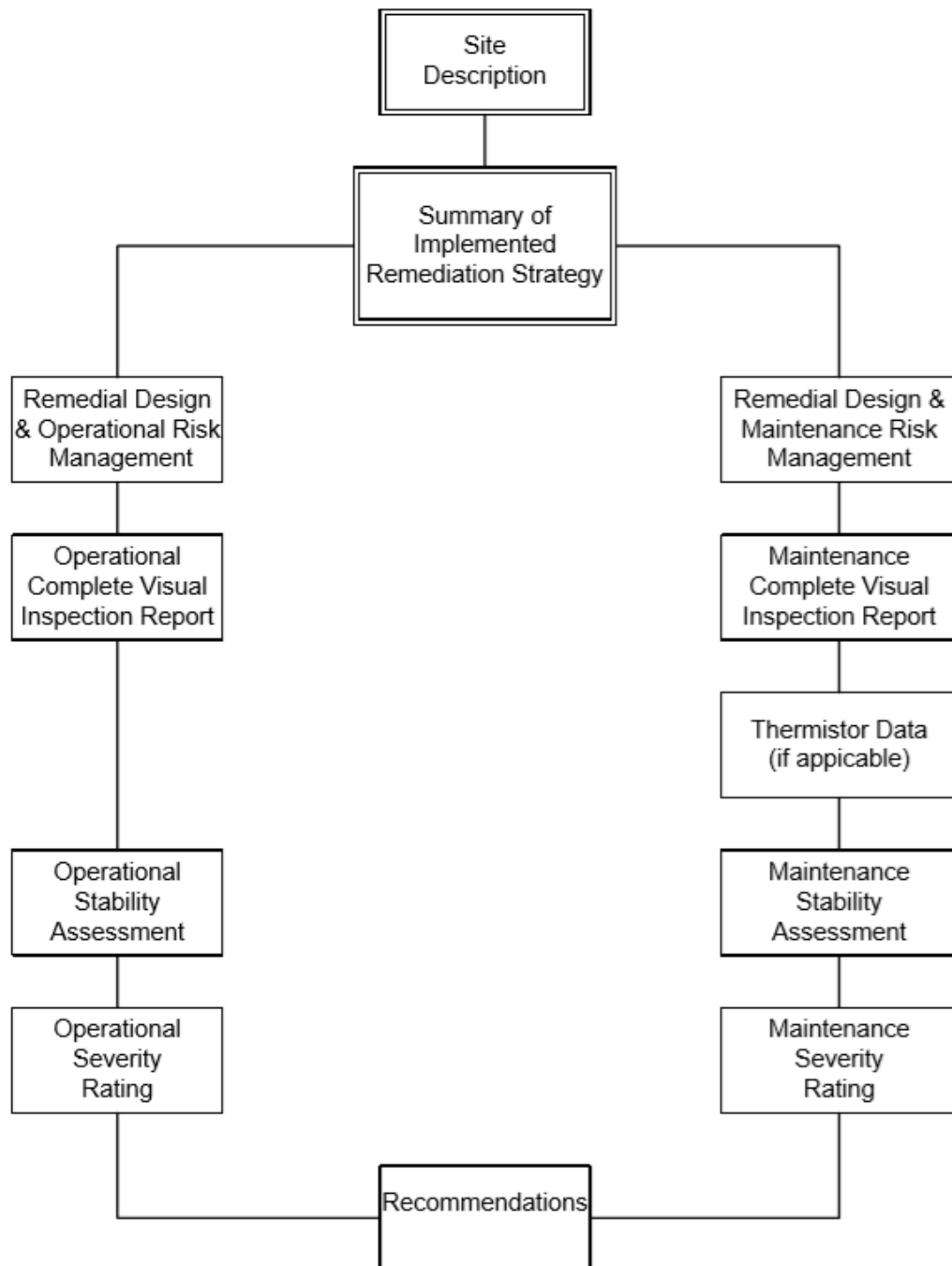
Appendix A – Figures

Appendix B – Design Tables

Appendix C – Field Templates

For each AEC, the Operation and Maintenance activities follow the elements presented in Figure 1 from the general guidelines set by the “Abandoned Military Site Remediation Protocol, 2008” (ASMRP).

FIGURE 1: FLOW CHART OF OPERATION AND MAINTENANCE ACTIVITIES BY AEC AS PER THE ASMRP



## 2.0 Site Background

The Resolute Bay Airport is five kilometres northwest of the Inuit hamlet of Resolute, adjacent to Resolute Bay on Cornwallis Island, Nunavut. Cornwallis Island is in the Qikiqtaaluk Region of Nunavut. Three Areas of Environmental Concern (AECs) were previously identified based on activities, historical and present, associated with the airport and local community. Two historical landfills referred to as the solid waste landfill (AEC 1), historical landfill (AEC 2) and a former vehicle storage area (AEC 3), are located on the site. AEC 3 is also referred to as the metal storage area. Two inactive soil land treatment units (LTUs) and a buried Asbestos waste pile owned by TC are also located onsite, however, these features were not included in the present Remediation scope of work nor covered within this O&M Manual. The sites cover an approximate area of 2025 hectares.

The Resolute Bay airport was originally constructed by the Royal Canadian Air Force and has been in operation since 1949 (PSPC, 2017). Transport Canada, on behalf of the Government of Canada, took ownership of the property in 1964 and continued operations until July 1, 1995. From July 1, 1995 to April 1, 1999 the Government of Northwest Territories had ownership and operations continued under the Arctic Airport Division of the Department of Transportation. The Government of Nunavut has owned the property since April 1, 1999.

Environmental audits and environmental site assessments have occurred at the Site since 1993. investigations between 1993 and 2005 were undertaken by TC. TC engaged PSPC since 2009 to assist with delineation of contaminants of concern, the development of remediation action plans for the site, and development of remediation specifications to tender for remediation contractor services.

A Phase II/III ESA was completed by Franz Environmental Inc. (Franz) in March of 2010 and provided a conceptual remedial option plan (RAP). An informal RAP was later produced by Franz during the 2011-2012 fiscal year. The accepted design included an aggregate capping solution without an impermeable geomembrane. A data gap assessment was completed on the AECs by Franz in 2013-2014. The data gap assessment identified an adjacent municipal sewage lagoon which was a concern for overflowing effluent, a past contributor to leachate production at AEC-1. The sewage lagoon is owned by the Government of Nunavut and as such is not included in the project scope. Two landfills and a single metal storage area are located on the site and were previously identified as Areas of Environmental Concern based on activities, historical and present, associated with the airport and local community.

During the 2014-2015 government fiscal year, PSPC purchased and mobilized 26 marine shipping containers, 10 Liquid hazardous waste containers and 5 solid hazardous waste containers to site in anticipation of remedial activities.

DOJV was retained by PSPC during FY 2017-2018 to review and modify the existing remediation designs to provide an achievable scope of work that could be contracted and completed by the end of the FY 2019-2020.



The contract was awarded to Kudlik Construction Ltd under contract EW699-182827/A, in June 2018. Construction work began in Summer 2018 and is was completed in the Summer 2019.

## 2.1 Site Identification

Site information is presented in Figure 2below.

FIGURE 2: SITE IDENTIFICATION INFORMATION

Site Characteristic	Description
FCSI No. of Contaminated Site	N0017003
DFRP Number	NA (site is administered by Nunavut)
Exact Site Name as listed in IDEA	Old Landfill/Main Drum Cache
Site Address (street address, municipality, province/territory)	Resolute Bay, Nunavut
Reporting Organization	Transport Canada
Legal description or metes and bounds:	Lot 1001, Quad 58 F/11, Plan 77590, Resolute Bay, Nunavut with adjacent areas
Approximate Site area	2025 hectares
Centre of site coordinates (in lat/long or UTM)	74.716944 N, 94.969444 W

## 2.2 Overall Site Description

### 2.2.1 Regional Setting

The site is located on the southwestern edge of Cornwallis Island in the high arctic. Cornwallis Island is roughly in the centre of the Canadian arctic, north of the Arctic Circle. Resolute is accessible year-round by air and for three months in the summer by boat (Geological Survey of Canada, 1958).

Cornwallis Island is affected by plate tectonics, but this has not resulted in the formation of mountains. Instead, the island is relatively flat, with a maximum elevation of approximately 400 metres above mean sea level (Geological Survey of Canada, 1958).

The island is characterized by plains topography with relatively small hills and ridges, with intervening broad valleys.

### 2.1.2 Climate and Weather

The Resolute CARS weather station is approximately 2.5 km south of the landfill. Climate normals for the weather station indicate that the weather is typical of the high arctic: only June, July and August have average daily temperatures above zero. The highest temperature recorded at the station before 2010, the period for which climate normal data is available, was 18.5°C.

The site is in the polar desert as indicated by annual precipitation of 161.2 mm, approximately 2/3 of which falls as snow. On average, there are only four days a year with rainfall of more than 5 mm.

### 2.1.3 Geological Setting

The site is on the boundary between two geologic units, separated by the sharp gradient that passes through AEC 1. The “upper site,” i.e., the eastern portion of the site and the majority of the airport lands, consists of argillaceous and dolomitic limestone, calcereous shale and calcisilite, and shallow to deep subtidal outer shelf ramp.

The lower site area, between the upper site and the bay, consists of medium to thick-bedded light grey to yellow-brown dolostone as well as dolomitic limestone, minor flat pebble conglomerate, and local stromatoporoid bioherms in semi-arid to arid subtidal to supratidal settings (Natural Resources Canada, 2015).

Site overburden “is a mix of angular cobbles and boulders with variable amounts of sands and gravels, all a result of bedrock fracturing and weathering” (SENE and Franz, 2013) with local pockets of silt also noted.

The site is in the zone of continuous permafrost. Permafrost was encountered in previous investigations at depths between 0.4 and 1 metres (SENE and Franz, 2013).

### 2.1.4 Demography

According to the Federal Contaminated Sites Inventory (FCSI) record for the site, there are five residents within a 1 km radius of the site; 131 within a 5 km radius of the site, and 312 within a 10 km radius of the site.

### 2.1.5 Lines and Other Property Lines

The Resolute airport is legally described as Lot 1001, Quad 58 F/11, Plan 77590 (Public Works and Government Services Canada, 1994). The total area of the site is 2,025 hectares. The work areas

described in this report do not map directly onto the property – as noted above, AEC 3 is on Territorial land slightly outside the airport property boundaries.

## 3 Operation and Maintenance of Solid Waste Landfill (AEC 1)

### 3.1 Site Description

AEC 1 is a solid waste landfill developed in the 1960s and 1970s that has not been in official use since 1995. It is located on airport property approximately 2 km north of the north end of the airstrip.

### 3.2 Summary of Implemented Remediation Strategy

The RAP identified remedial objectives at the site as: (i) the removal of physical hazards (i.e., slope stabilization and debris removal and/or capping), (ii) consolidation of waste and debris, and (iii) the containment and control of contaminants in the surface water pathways that may discharge to receiving water bodies.

Specifically, the following remedial work was completed:

- Regrading, cutting/filling, and excavation of the non-stable soil and non-hazardous waste material located at the slope face to achieve the designed 3H:1V slope;
- Segregating contaminated soil and hazardous material unearthed during slope stability activities, packaging, and transporting the material to a licensed disposal facility off-site;
- Filling voids with borrow material to stabilize the slope;
- Constructing an aggregate cover over the top and slope of the landfill;
- Constructing drainage swales to direct surface water around the landfill; and
- Upgrading or maintaining roads as necessary.

### 3.3 Remedial Design and Risk Management

#### 3.3.1 Remedial Design

The AEC1 landfill design was based on a soil barrier cover design. The soil barrier was placed and compacted during construction. The barrier construction along with the predicted ambient environment leads to the formation of permanently frozen ground over time (permafrost aggradation). The presence of permafrost within the soil barrier cover has the added benefit of reducing infiltration by an order of magnitude of three to five times<sup>1</sup> in comparison to a similar soil without permafrost present, thereby reducing the potential for leachate generation. Drainage swales were constructed to redirect surface water along the perimeter of the landfill from entering onto the surface of the landfill, thereby reducing the potential for landfill leachate production.

<sup>1</sup> Cold Regions Cover System Design Technical Guidance Document”, MEND Report 1.61.5c (July, 2012)

For AEC1, previous conceptual landfill designs had a minimum of 1.0m total aggregate fill thickness to be placed, with the top 0.2 m being coarse fill. However, based on test pitting information carried out prior to construction and further analysis, it was found acceptable to have a reduced fill thickness for the final landfill design based on the possibility for change in material types and the overall landfill geometry (shallow top cover). The final implemented design used a 1.1m aggregate thickness on side slopes including a 0.3m Type 1 coarse layer. The top surface of the landfill was relatively flat and therefore capped with 0.6m of Type 2 fine aggregates. The installed landfill uses the Type 2 fine aggregates to avoid direct surface runoff contact, reduce water infiltration, promote permafrost aggradation, and reduce leachate generation. A sufficiently high degree of saturation of the barrier layer below the active zone was added to maintain the reduced infiltration capacity (voids within soil profile filled with ice, once frozen). Fine-textured soils were used since they have higher capillary suction, and field capacity (water content of a soil when gravity drainage ceases). The landfill top was sloped to 2% for positive drainage and side slopes cut and filled to a 3H:1V slope for improved slope stability. The cut and fill of side slopes was implemented to reduce safety risks of additional hauling and placement.

### 3.3.2 Risk Management

The following is all related information during the Design and Development phase of the project last updated on January 17, 2019. *Table 1 in Appendix B* describes design features, issues, feasibility, and rational behind decisions. The following risks are interpreted from the design phase segregated based on the risk type and integrated into the site operation and maintenance:

#### Operational Risks:

- Ensuring landfill cover thickness is thicker than active layer. (min 1.0m)
- Snow cover duration
- Sun exposure
- Surface temperature
- Wind
- Surface water drainage and potential percolation into landfill cap
- Ensuring a sufficiently high degree of saturation of the barrier layer below the active zone
- Runoff diversion

#### Maintenance Risks:

- Surface drainage and municipal sewage lagoon overflow.

The sewage lagoon is owned by the Government of Nunavut and as such is not included in the project scope. Although any overflow, or general issue relating to the sewage lagoon is not the responsibility of Transport Canada, the sewage lagoon does pose a potential maintenance risk to the AEC 1 remedial works.

### 3.4 Operation & Maintenance Evaluation, Procedures and Reporting

The operation and maintenance evaluation and procedures will be conducted in a format that provides the desired AMSRP reporting results. The report results are as follows with the associated procedures described below:

3.4.1

### Complete Visual Inspection Report

A field assessor will inspect the physical integrity of the capped areas at the site. The inspection will be conducted using photographs, sketches, and other notes.

A field assessor will make observations of the presence or absence of visual items in the table below. Operation and maintenance features will be distinguished from one another as shown, meanwhile general observations will be distinguished from site specific risk observations by means of separate tables.

The General Visual Inspection Matrix was largely adapted from the ASMRP *Table 7.2*.

TABLE 1: GENERAL AEC 1 VISUAL INSPECTION MATRIX

Observation Parameter	Operational Feature	Maintenance Feature	Observations from Previous Report	Current Observations
Settlement	✓			
Erosion	✓			
Frost Action	✓			
Animal Burrows		✓		
Vegetation	✓			
Staining		✓		
Vegetation Stress	✓			
Seepage Points	✓			
Exposed Debris		✓		
Condition of Monitoring Instruments		✓		
Grades/ Topography	✓			
Distance to downgradient surface water bodies	✓			
Distance to freshwater/marine habitat and habitat usage	✓			
Terrestrial Habitat		✓		
Land Uses		✓		
Debris		✓		

Site specific risks will also be visually inspected for, to the extent possible:

TABLE 2: SITE SPECIFIC AEC 1 RISKS VISUAL INSPECTION MATRIX

Observation Parameter	Operational Feature	Maintenance Feature	Observations from Previous Report	Current Observations
Ensuring landfill cover thickness	✓			
Snow cover, including measured depth	✓			
Sun exposure	✓			
Surface temperature	✓			
Wind effects	✓			
Surface Drainage	✓			
Municipal Sewage Lagoon Overflow		✓		
potential percolation into landfill cap	✓			
Ensuring a sufficiently high degree of saturation of the barrier layer below the active zone	✓			
Runoff Diversion	✓			

A field assessor is to take measurements of any feature noted. In subsequent years, A field assessor will compare all previously-identified features with current conditions. The field assessor will take photographs and make note of the location and direction of the photos so that they can be re-created in each year of the monitoring program.

Visual observations may be compiled in a table format.



### 3.4.2 Stability Assessment

Further to a Visual Inspection, the Stability Assessment serves to provide an analysis of the current status of the AEC. The stability assessment was adapted from the AMSRP, although, the extent of the assessment protocol should only be limited to physical characteristics. The assessment will serve to analyze established risks. This will be done by comparing current observations to previous observations and/ or baseline conditions. From this comparison, appropriate severities and action levels will be concluded as identified in following sections. Any additional risks identified should also be established in this section to be implemented for future operation and maintenance activities.

The Stability Assessment will include the following:

- A general interpretation of findings
- A comparison to between previous conditions and/or baseline conditions and as-built drawings
- Expected findings
- Any additional risks identified and its impact

Based on the above criteria, the severity of each observation should be established as part of the analysis. Tables in the following sections are for the evaluation of analyzed observations. Operational and Maintenance features are to be evaluated based on separate matrices.

### 3.4.3 Operation and Maintenance Severity Rating

The following tables are to be used for interpreting the severity level of operational features. The following tables were adapted from *Table 4.1* of the AMSRP Volume 2. *Table 4* represents a *Severity Rating of Operation Features*, meanwhile *Table 5* represents a *Severity Rating for Maintenance Features*.

TABLE 3: SEVERITY RATINGS OF AEC 1 OPERATIONAL FEATURES

Severity Rating	Description
Not observed	No issues identified
Acceptable	Noted features are of little consequence. The landfill is performing as designed. Minor deviations may be observed, such as isolated areas of erosion or settlement, drainage system is performing well.

Severity Rating	Description
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include an increase in number or size of features of note, such as differential settlement, erosion or cracking; drainage systems are showing increased sedimentation reducing surface flow. No significant impact on landfill stability to date, but potential for failure is assessed as low or moderate.
Significant	Significant or potentially significant changes affecting landfill stability, such as significant changes in slope geometry, significant erosion, or differential settlement; scarp development, collapsed or slumped surface water drainage systems. The potential for failure is assessed as imminent.
Unacceptable	The stability of the landfill is compromised to the extent that waste materials are exposed in areas of erosion, or differential settlement, cap is not functional and/or slope failure, surface water is not draining as designed with overflows or breakouts.

TABLE 4: SEVERITY RATINGS OF AEC 1 MAINTENANCE FEATURES

Severity Rating	Description
Not observed	No issues identified
Acceptable	Noted features are of little consequence. The landfill is performing as designed. Minor deviations may be observed such as terrestrial habitat use on the landfill, surface debris from non-project related landfill activities, or visual changes noted in the sewage lagoon.
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include an increase in number or size of features of note, such as small animal burrows on the landfill caps or slopes, sewage lagoon overflow, signs of tampering, or significant amounts of debris on-site. No significant impact on landfill stability to date, but potential for failure is assessed as low or moderate.
Significant	Significant or potentially significant changes affecting landfill stability, such as large animal burrows on the landfill caps or slopes, sewage lagoon overflow impeding near AEC1, or significant amounts of debris heaving the landfill. The potential for failure is assessed as imminent.
Unacceptable	The stability of the landfill is compromised to the extent that waste materials are exposed in areas of erosion, the landfill cap is not functional and/or slope failure. Observations may include sewage lagoon overflow onto the landfill.

3.4.4

Recommendations

Based on the analyses and perceived severity ratings, a set of recommendations for each operation and maintenance activity will be given. The following action matrix below which was adapted from the ASMRP will be used as guide for creating recommendations. Once the severity of observations is established, recommendations should be further elaborated on, either in the current section, or as part of a separate document as seen appropriate.

TABLE 5: ACTION LEVELS FOR AEC 1 LANDFILL MONITORING OR REHABILITATION

Severity Rating	Action
Not observed	Monitoring to continue as planned
Acceptable	Monitoring to continue as planned
Marginal	Analyze potential causes of instability. Continue monitoring plan with any potential recommendations for future operation and maintenance.
Significant	Assess current and future impact to implemented remedial works, develop a remedial plan.
Unacceptable	Develop and Implement a site-specific remedial plan (in coordination with the LTM).

Action levels are to be separated into unique sections for operational and maintenance features.

## 4 Operation and Maintenance of Historical Landfill (AEC 2)

### 4.1 Site Description

AEC 2 is a historic landfill that operated between 1947 and 1996. The landfill was used by the military, Transport Canada, and other airport tenants. It is 0.5 km immediately west of the airstrip and in close proximity to restricted access airport activities.

### 4.2 Summary of Implemented Remediation Strategy

The Conceptual RAP identified remedial objectives at the site such as the removal of physical hazards (i.e., slope stabilization and debris removal and/or capping), consolidation of waste and debris, and the containment and control of contaminants in the surface water pathways prior to leaving the site and ultimately, discharging to receiving water bodies.

Specifically, the following remedial work was completed:

- Consolidation of non-hazardous wastes from AEC 2 within AEC 1;
- Regrading the top and embankment of the landfill to direct surface water away from the slope face; and
- Constructing surface drainage swales to promote drainage from existing culverts and to redirect surface water away from the top of the former landfill.

### 4.3 Remedial Design and Associated Risks

#### 4.3.1 Remedial Design

The AEC2 landfill design was based on a barrier cover design. Surface debris was removed from AEC 2 and brought to AEC 1 if non-hazardous. Hazardous materials were packaged and shipped off-site. The implemented design has a cap and slopes graded, using a cut/fill approach, with aggregates used to fill in voids or low spots on the top to promote surficial flow.

#### 4.3.2 Associated Risks

The following is all related information during the Design and Development phase of the project. *Table 2 in Appendix B* describes design features, issues, feasibility, and rational behind decisions. The following risks were interpreted from the design phase for AEC 2 or similar features from AEC1:

**Operational Risks:**

- Permafrost Degradation
- Snow cover duration
- Sun exposure
- Surface temperature
- Wind
- Surface water drainage and potential percolation into landfill cap
- Runoff diversion

**Maintenance Risks:**

- N/A

## 4.4 Operation & Maintenance Evaluation, Procedures, and Reporting

### 4.4.1 Complete Visual Inspection Report

A field assessor will inspect the physical integrity of the capped areas at the site. The inspection will be conducted using photographs, sketches, and other notes.

A field assessor will make observations of the presence or absence of visual items in the table below. Operation and maintenance features will be distinguished from one another as shown, meanwhile general observations will be distinguished from site specific risk observations by means of separate tables.

The General Visual Inspection Matrix was largely adapted from the ASMRP *Table 7.2*.

TABLE 6: GENERAL AEC 2 VISUAL INSPECTION MATRIX

Observation Parameter	Operational Feature	Maintenance Feature	Observations from Previous Report	Current Observations
Settlement	✓			
Erosion	✓			
Frost Action	✓			
Animal Burrows		✓		
Vegetation	✓			
Staining		✓		
Vegetation Stress	✓			
Seepage Points	✓			
Exposed Debris		✓		
Condition of Monitoring Instruments		✓		
Grades/ Topography	✓			
Distance to downgradient surface water bodies	✓			
Distance to freshwater/marine habitat and habitat usage	✓			
Terrestrial Habitat		✓		
Land Uses		✓		
Debris		✓		

Site specific risks will also be visually inspected for to the extent possible:

TABLE 7: AEC 2 SITE SPECIFIC RISKS VISUAL INSPECTION MATRIX

Observation Parameter	Operational Feature	Maintenance Feature	Observations from Previous Report	Current Observations
Permafrost Degradation	✓			
Snow cover duration	✓			
Sun exposure	✓			
Surface temperature	✓			
Wind	✓			
Surface water drainage and potential percolation into landfill cap	✓			
Runoff Diversion	✓			
Permafrost Degradation	✓			
Snow cover duration	✓			

A field assessor is to take measurements of any feature noted. In subsequent years, A field assessor will compare all previously-identified features with current conditions. The field assessor will take photographs and make note of the location and direction of the photos so that they can be re-created in each year of the monitoring program.

Visual observations may be compiled in a table format.

#### 4.4.2 Stability Assessment

Further to a Visual Inspection, the Stability Assessment serves to provide an analysis of the current AEC. The stability assessment was adapted from the AMSRP, although, the extents of the assessment protocol should only be limited to physical characteristics. The assessment will serve to analyze established risks. This will be done by comparing current observations to previous observations and/ or baseline conditions. From this comparison, appropriate severities and action levels will be concluded in



following sections. Any additional risks identified should also be established in this section to be implemented for future operation and maintenance activities.

The Stability Assessment will include the following:

- A general interpretation of findings
- A comparison to between previous conditions and/or baseline conditions and as-built drawings
- Expected findings
- Any additional risks identified and its impact

Based on the above criteria, the severity of each observation should be established as part of the analysis. Tables in the following sections are for the evaluation of analyzed observations. Operational and Maintenance features are to be evaluated based on separate matrices.

#### 4.4.3 Operation and Maintenance Severity Rating

The following tables are to be used for interpreting the severity level of operational features. This tables were largely adapted from *Table 4.1* of the AMSRP Volume 2. *Table 4* represents a *Severity Rating of Operation Features*, meanwhile *Table 5* represents a *Severity Rating for Maintenance Features*.

TABLE 8: SEVERITY RATINGS OF AEC 2 OPERATIONAL FEATURES

Severity Rating	Description
Not observed	No issues identified
Acceptable	Noted features are of little consequence. The landfill is performing as designed. Minor deviations may be observed, such as isolated areas of erosion or settlement.
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include an increase in number or size of features of note, such as differential settlement, erosion or cracking. No significant impact on landfill stability to date, but potential for failure is assessed as low or moderate.
Significant	Significant or potentially significant changes affecting landfill stability, such as significant changes in slope geometry, significant erosion, or differential settlement; scarp development. The potential for failure is assessed as imminent.
Unacceptable	The stability of the landfill is compromised to the extent that waste materials are exposed in areas of erosion, or differential settlement, cap is not functional and/or slope failure.

TABLE 9: SEVERITY RATINGS OF AEC 2 MAINTENANCE FEATURES

Severity Rating	Description
Not observed	No issues identified
Acceptable	Noted features are of little consequence. The landfill is performing as designed. Minor deviations may be observed such as terrestrial habitat use on the landfill, or surface debris from non-project related landfill activities.
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include an increase in number or size of features of note, such as small animal burrows on the landfill caps or slopes, signs of tampering, or significant amounts of debris on-site. No significant impact on landfill stability to date, but potential for failure is assessed as low or moderate.
Significant	Significant or potentially significant changes affecting landfill stability, such as large animal burrows on the landfill caps or slopes, or significant amounts of debris heaving the landfill. The potential for failure is assessed as imminent.
Unacceptable	The stability of the landfill is compromised to the extent that waste materials are exposed in areas of erosion, the landfill cap is not functional and/or slope failure.

#### 4.4.4

### Recommendations

Based on the analyses and perceived severity ratings, a set of recommendations for each operation and maintenance activity will be given. The following action matrix below which was adapted from the ASMRP will be used as guide for creating recommendations. Once the severity of observations is established, recommendations should be further elaborated on, either in the current section, or as part of a separate document as seen appropriate.

TABLE 10: ACTION LEVELS FOR AEC 2 LANDFILL MONITORING

Severity Rating	Action
Not observed	Monitoring to continue as planned
Acceptable	Monitoring to continue as planned
Marginal	Analyze potential causes of instability. Continue monitoring plan with any potential recommendations for future operation and maintenance.
Significant	Assess current and future impact to implemented remedial works, develop a remedial plan.
Unacceptable	Develop and Implement a site-specific remedial plan (in coordination with the LTM).

Action levels are to be separated into unique sections for operational and maintenance features.

## 5 Operation and Maintenance of Vehicle Storage Area (AEC 3)

### 5.1 Site Description

AEC 3, the historical vehicle storage area, is a metal storage area previously used for vehicle and airport metal waste storage. It is northwest of the Resolute Airport airstrip and 2.75 km north-west of AEC 1. It is an inactive area on Territorial property directly adjacent to the northern Resolute Airport property limit.

### 5.2 Summary of Implemented Remediation Strategy

The Conceptual RAP identified remedial objectives at the site such as the removal of physical hazards (i.e., slope stabilization and debris removal and/or capping), consolidation of waste and debris, and the containment and control of contaminants in the surface water pathways prior to leaving the site and ultimately, discharging to receiving water bodies.

Specifically, the following remedial work was completed:

- Consolidation of non-hazardous wastes from AEC 3 within AEC 1;
- Excavate and dispose of approximately 179 m<sup>3</sup> of PHC- and metals-contaminated soil at a licenced disposal facility; and
- Backfill and re-grade excavations with approved borrow material.

### 5.3 Remedial Design and Associated Risks

#### 5.3.1 Remedial Design

The remedial design called for a backfill and surface grading of Type 2 material following the removal of surface non-hazardous waste materials to AEC 1. Any hazardous materials were packaged and transported offsite for disposal at a licensed facility. *Table 3* summarized in *Appendix B* describes design features, issues, feasibility, and rational behind decisions.

#### 5.3.2 Associated Risks

There were no additional risks identified in addition to typical construction activities.

### 5.4 Operation and Maintenance Procedures

#### 5.4.1 Complete Visual Inspection Report

A field assessor will inspect the physical integrity of the backfilled and graded areas at the site. The inspection will be conducted using photographs, sketches, and other notes.

A field assessor will make observations of the presence or absence of visual items in the table below. Operation and maintenance features will be distinguished from one another as shown, meanwhile general observations will be distinguished from site specific risk observations by means of separate tables.

The General Visual Inspection Matrix was largely adapted from the ASMRP *Table 7.2*.

TABLE 11: GENERAL AEC 3 VISUAL INSPECTION MATRIX

Observation Parameter	Operational Feature	Maintenance Feature	Observations from Previous Report	Current Observations
Settlement	✓			
Erosion	✓			
Frost Action	✓			
Animal Burrows		✓		
Vegetation	✓			
Staining		✓		
Vegetation Stress	✓			
Seepage Points	✓			
Exposed Debris		✓		
Condition of Monitoring Instruments		✓		
Grades/ Topography	✓			
Distance to downgradient surface water bodies	✓			
Distance to freshwater/marine habitat and habitat usage	✓			
Terrestrial Habitat		✓		
Land Uses		✓		
Debris		✓		

Site specific risks will also be visually inspected for to the extent possible:

A field assessor is to take measurements of any feature noted. In subsequent years, A field assessor will compare all previously-identified features with current conditions. The field assessor will take photographs and make note of the location and direction of the photos so that they can be re-created in each year of the monitoring program.

Visual observations may be compiled in a table format.

#### 5.4.2

### Stability Assessment

Further to a Visual Inspection, the Stability Assessment serves to provide an analysis of the current AEC. The stability assessment was adapted from the AMSRP, although, the extents of the assessment protocol should only be limited to physical characteristics. The assessment will serve to analyze established risks. This will be done by comparing current observations to previous observations and/ or baseline conditions. From this comparison, appropriate severities and action levels will be concluded in following sections. Any additional risks identified should also be established in this section to be implemented for future operation and maintenance activities.

The Stability Assessment will include the following:

- A general interpretation of findings
- A comparison to between previous conditions and/or baseline conditions and as-built drawings
- Expected findings
- Any additional risks identified and its impact

Based on the above criteria, the severity of each observation should be established as part of the analysis. Tables in the following sections are for the evaluation of analyzed observations. Operational and Maintenance features are to be evaluated based on separate matrices.

#### 5.4.3

### Operation and Maintenance Severity Rating

The following tables are to be used for interpreting the severity level of operational features. This tables were largely adapted from *Table 4.1* of the AMSRP Volume 2. *Table 4* represents a *Severity Rating of Operation Features*, meanwhile *Table 5* represents a *Severity Rating for Maintenance Features*.

TABLE 12: SEVERITY RATINGS OF AEC 3 OPERATIONAL FEATURES

Severity Rating	Description
Not observed	No issues identified
Acceptable	Noted features are of little consequence. Performing as designed. Minor deviations may be observed, such as isolated areas of erosion or settlement.
Marginal	Physical/environmental surface grading performance appears to be deteriorating with time. Observations may include an increase in number or size of features of note, such as differential settlement, erosion or cracking.
Significant	Significant or potentially significant changes affecting site regrading such as significant differential settlement or water erosion features. Regrading is not consistent with remedial design.
Unacceptable	Significant settlement or erosion.

TABLE 13: SEVERITY RATINGS OF AEC 3 MAINTENANCE FEATURES

Severity Rating	Description
Not observed	No issues identified
Acceptable	Noted features are of little consequence. Minor deviations may be observed such as planned grading settlement.
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include settlement or erosion



Severity Rating	Description
Significant	Significant or potentially significant changes such as significant settlement affecting permafrost, active layer or site water drainage.
Unacceptable	Backfilling and grading is not performing as designed.

#### 5.4.4

#### Recommendations

Based on the analyses and perceived severity ratings, a set of recommendations for each operation and maintenance activity will be given. The following action matrix below which was adapted from the ASMRP will be used as guide for creating recommendations. Once the severity of observations is established, recommendations should be further elaborated on, either in the current section, or as part of a separate document as seen appropriate.

TABLE 14: ACTION LEVELS FOR AEC 3 MONITORING

Severity Rating	Action
Not observed	Monitoring to continue as planned
Acceptable	Monitoring to continue as planned
Marginal	Analyze potential causes of instability. Continue monitoring plan with any potential recommendations for future operation and maintenance.
Significant	Assess current and future impact to implemented remedial works, develop a remedial plan.
Unacceptable	Develop and Implement a site-specific remedial plan (in coordination with the LTM).

6

## Action levels are to be separated into unique sections for operational and maintenance features. Spills & Discharges - Contingency & Emergency Response Plan

This section is intended to describe the measures to be used to prevent, warn of, prepare for, respond to, and recover from any emergency that may cause harm to the environment or danger to human life or health. As a result, DOJV has prepared a Spills Discharge Contingency and Emergency Response Plan.

Planning for an emergency is imperative due to the remoteness of the site.

To prevent any spills or discharges, the following procedures will be followed by on-site personnel during the Monitoring Program:

- Ensure staff are familiar with regulations
- Always ensure equipment is shut 'Off' when not required
- Seal all outlets of fuel storage containers
- Ensure there is no smoking or open flames in the vicinity
- All equipment that may be parked for two hours or more, will have a haz-mat/drip tray under it or be sufficiently diapered
- Leaky equipment shall be repaired immediately
- Report any spills immediately to the site lead
- No fueling on-site

The flow chart depicted in *Figure 3* identifies the response. An immediately reportable spill (Major Spill) is defined as a release of a substance that is likely to be an imminent environmental or human health hazard or meets or exceeds the maximum volumes. It must be reported to the Nunavut 24-Hour Spill Report Line at 867-975-8130. Any spills less than these quantities (Minor Spill) will be tracked and documented by DOJV. Information about minor spills will be communicated to the project management team during monthly reports and immediately upon request of an Authority Having Jurisdiction. In all cases, discussions with the Project Team will be initiated to confirm and document the level of effort required.

Following reporting of the spill to the Project Lead, the Project Lead will report spills to the NWT 24-Hour Spill Line as necessary.

The emergency procedure for initial actions, that will be followed, are listed as:

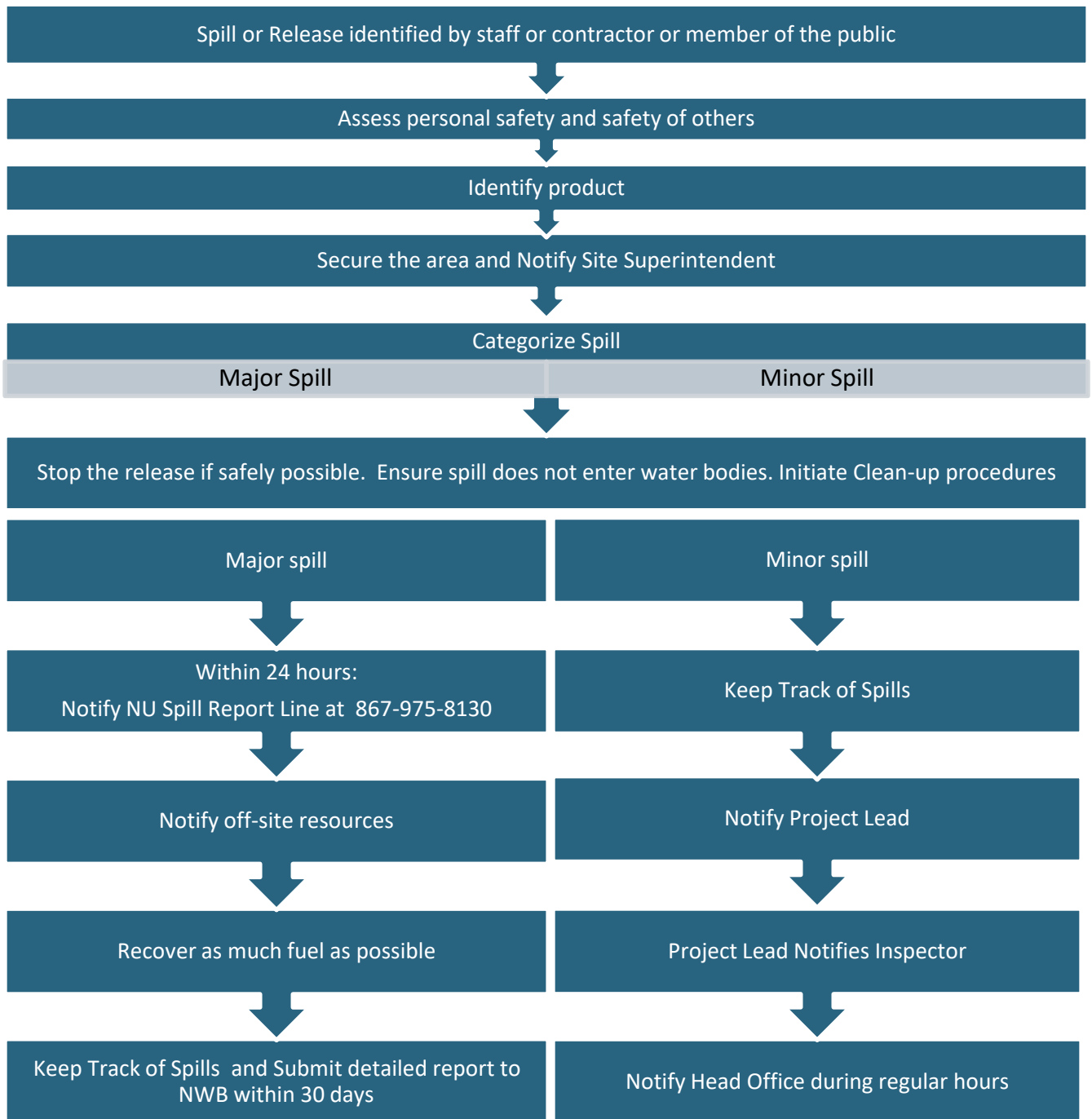
- Ensure safety of all personnel
- Wear appropriate PPE
- Assess spill hazards and risks

- Remove all sources of ignition
- Stop the spill if safely possible e.g. shut of pump, replace cap, tip drum upward, patch leaking hole. Use the contents of the nearest spill kit to aid in stopping the spill if it is safe to do so
- No matter what the volume is, notify the Project Lead
- Contain the spill – use contents of spill kits to place sorbent materials on the spill, or use shovel to dig dike to contain spill. Methods will vary depending on the nature of the spill

#### Procedures for Containing and Controlling a Spill

- Initiate spill containment by first determining what will be affected by the spill.
- Assess speed and direction of spill and cause of movement (water, wind, and slope).
- Determine best location for containing spill, avoiding any water bodies.

FIGURE 3: FLOW CHART OF RESPONSE ORGANIZATION



## 7 Monitoring Plan

The schedule, data collection and reporting for Operations & Maintenance and Long-Term Monitoring (provided under separate cover) will work in conjunction to create the Monitoring Program. The Operations and Maintenance activities will serve to observe and analyze physical parameters related to site operations, whereas, the Long Term Monitoring Plan will serve to provide an overall evaluation including the analysis of Water Quality (chemical) parameters.

The proposed Monitoring Program schedule is that monitoring will be conducted in years 1, 3, 5, 7, 10, 15, 20 and 25. Monitoring can be scheduled after year 10 as deemed necessary; however, the current LTM duration is assumed to be 25 years. The actual inspection years may vary slightly. The LTM is scheduled to begin in 2020.

The main purpose of the proposed program is to ensure no contamination pathways are observed following the implemented designs. Additionally, it must be confirmed that adequate permafrost aggregation in the AEC 1 landfill is present, and that the function of the two landfills meet design intents in terms of stability.

As such, the Monitoring Plan will focus on two main parameters:

1. Water Quality – Reported as part of the Long Term Monitoring Plan
2. Site Stability – Reported as part of the Operations and Maintenance Report

For site stability, observational parameters are to be analyzed immediately for variances from as-built drawings and compared accordingly. Recommendations will be summarized in the Operations and Maintenance Report, and categorized by specific AEC, as outlined in the O&M manual.

Due to the remote nature of the site, method and frequency of the O&M activities will work in conjunction with the Long-Term Monitoring Plan and any Remedial Plans that have been developed.

Monitoring is scheduled to commence in 2020. This visit will prioritize data collection for baseline conditions following remedial works, as well as the observation of differential landfill cap settlement.

### 7.1 Water Quality

The following section outlines the required water quality testing parameters as per the NWB Amended Renewal Water License No. 1BR-RBL-1929. The following is a summary of the current testing parameters and monitoring wells that have been installed at each AEC with the associated discharge point nomenclature. For more information on the sampling methods, effluent quality limits, action levels, and general requirements for chemical parameters, please refer to the Long Term Monitoring Plan.

#### 7.1.1 Testing Parameters:

As per the Water License, the following chemical parameters will be tested as shown below, at locations outlined in Section 7.1 *Monitoring Wells*.

- pH
- Total Suspended Solids (TSS)
- Nitrate – Nitrite
- Total Phenols

- Total Hardness
- Sodium
- Magnesium
- Chloride
- Total Copper
- Total Iron
- Total Mercury
- Total Zinc
- Total Aluminum
- Total Cobalt
- Polycyclic Aromatic Hydrocarbons (PAH)
- Benzene, Toluene, Ethylbenzene, Xylene (BTEX)
- Conductivity
- Ammonia
- Nitrogen
- Oil and Grease (visual)
- Sulphate
- Total Alkalinity
- Potassium
- Calcium
- Total Cadmium
- Total Chromium
- Total Lead
- Total Nickel
- Total Phosphorous
- Total Manganese
- Total Arsenic
- Total Petroleum Hydrocarbons (TPH)

### 7.1.2 AEC 1 Monitoring Wells

The following monitoring wells have been installed at AEC1:

TABLE 15: AEC 1 MONITORING WELL LOCATIONS

Well ID	Northing	Easting	Elevation	AEC	Description
RBL-1	8295630	441147	66.2	AEC 1	Monitoring Well installed up-gradient of the Solid Waste Landfill
RBL-2	8295551	440943	52.2	AEC 1	Monitoring Well installed down-gradient of the Solid Waste Landfill
RBL-3	8295608	440901	51.5	AEC 1	Monitoring Well installed down-gradient of the Solid Waste Landfill

Well ID numbers are as per NWB Amended Renewal Water License No. 1BR-RBL-1929. In the event there is a discharge from AEC 1, a monitoring well with the well ID RBL 4 is to be installed at the discharge point and daily discharge volumes are to be recorded as per the Water License.

The X,Y,Z coordinates are represented under UTM Zone 15N and are confirmed by survey method.

### 7.1.3 AEC 2 Monitoring Wells

The following monitoring wells have been installed at AEC1:

TABLE 16: AEC 2 MONITORING WELL LOCATIONS

Well ID	Northing	Easting	Elevation	AEC	Description
RBL-5	8292509	441662	53.1	AEC 2	Monitoring Well installed up-gradient of the Historic Landfill
RBL-6	8292566	441420	42.7	AEC 2	Monitoring Well installed down-gradient of the Historic Landfill

RBL-7	8292634	441384	43.2	AEC 2	Monitoring Well installed down-gradient of the Historic Landfill
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Well ID numbers are as per NWB Amended Renewal Water License No. 1BR-RBL-1929. In the event there is a discharge from AEC 2, a monitoring well with the well ID RBL 8 is to be installed at the discharge point and daily discharge volumes are to be recorded as per the Water License.

The X,Y,Z coordinates are represented under UTM Zone 15N and are confirmed by survey method.

#### 7.1.4

#### AEC 3 Monitoring Wells

The following monitoring wells have been installed at AEC1:

TABLE 17: AEC 3 MONITORING WELL LOCATIONS

Well ID	Northing	Easting	Elevation	AEC	Description
RBL-10	8296242	440493	43.8	AEC 3	Monitoring Well installed up-gradient of the Vehicle Storage Area (Site 1)
RBL-11	8296265	440383	41.6	AEC 3	Monitoring Well installed down-gradient of the Vehicle Storage Area (Site 1)
RBL-12	8296335	440450	42.6	AEC 3	Monitoring Well installed down-gradient of the Vehicle Storage Area (Site 1)
RBL-14	8296449	440682	55.4	AEC 3	Monitoring Well installed up-gradient of the Vehicle Storage Area (Site 2)
RBL-15	8296468	440635	52.7	AEC 3	Monitoring Well installed down-gradient of the Vehicle Storage Area (Site 2)

Well ID numbers are as per NWB Amended Renewal Water License No. 1BR-RBL-1929. In the event there is a discharge from AEC 3 – Site 1, a monitoring well with the well ID RBL 13 is to be installed at the discharge point. In the event there is a discharge from AEC 3 – Site 2, a monitoring well with the well ID RBL 16 is to be installed at the discharge point and daily discharge volumes are to be recorded as per the Water License.

The X,Y,Z coordinates are represented under UTM Zone 15N and are confirmed by survey method.

## 7.2

### Site Stability

As a requirement for the Renewal Water License Renewal No. 1BR-RBL-1929, site stability will be analyzed as part of the Monitoring Program. Site stability should be broken out by AEC and analyzed as outlined in the Operations and Maintenance Manual's sections 3 through 5. *Figure 1* of this Document outlines the general procedures for analyzing site stability.

## 8 Reporting Procedures

### 8.1 Annotated Drawings on Tabloid Paper, indicating all visual inspection features

For each site visit, annotated drawings on tabloid paper should indicate all noteworthy features identified. Annotations shall include the following information:

- Approximate 3D position (in table format)
- Reference to relevant photos
- A unique identifier or point number

### 8.2 Photographic Records

For documentation of on-site photos, the photo log template from Appendix C is to be used. The following will ensure that the following are captured:

- Area of Environmental Concern
- Provide a Unique Identifier
- Description
- Photo Direction
- Date

See *Appendix C* for a Photo Log Template.

All photos should be included in a separate appendix when compiling future Operation and Maintenance Reports.

Any noteworthy observations should also have approximate GPS locations for inclusion in the section “Annotated Drawings on Tabloid Paper, indicating all visual inspection features”.



## 9 References

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## Closure

This report was prepared exclusively for the purposes, project, and site location outlined in the report. The report is based on information provided to, or obtained by Dillon-Outcome as indicated in the report, and applies solely to site conditions and the regulatory and planning frameworks existing at the time of the site supervision. Dillon-Outcome's report represents a reasonable review of available information and environmental monitoring efforts within an established work scope and schedule.

This report was prepared by Dillon-Outcome for the sole benefit of our client. The material in it reflects Dillon-Outcome's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon-Outcome accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust that this information is satisfactory for your requirements.

Sincerely,

**DILLON-OUTCOME JOINT VENTURE**



Mark Mathews, B.Eng  
Junior Professional



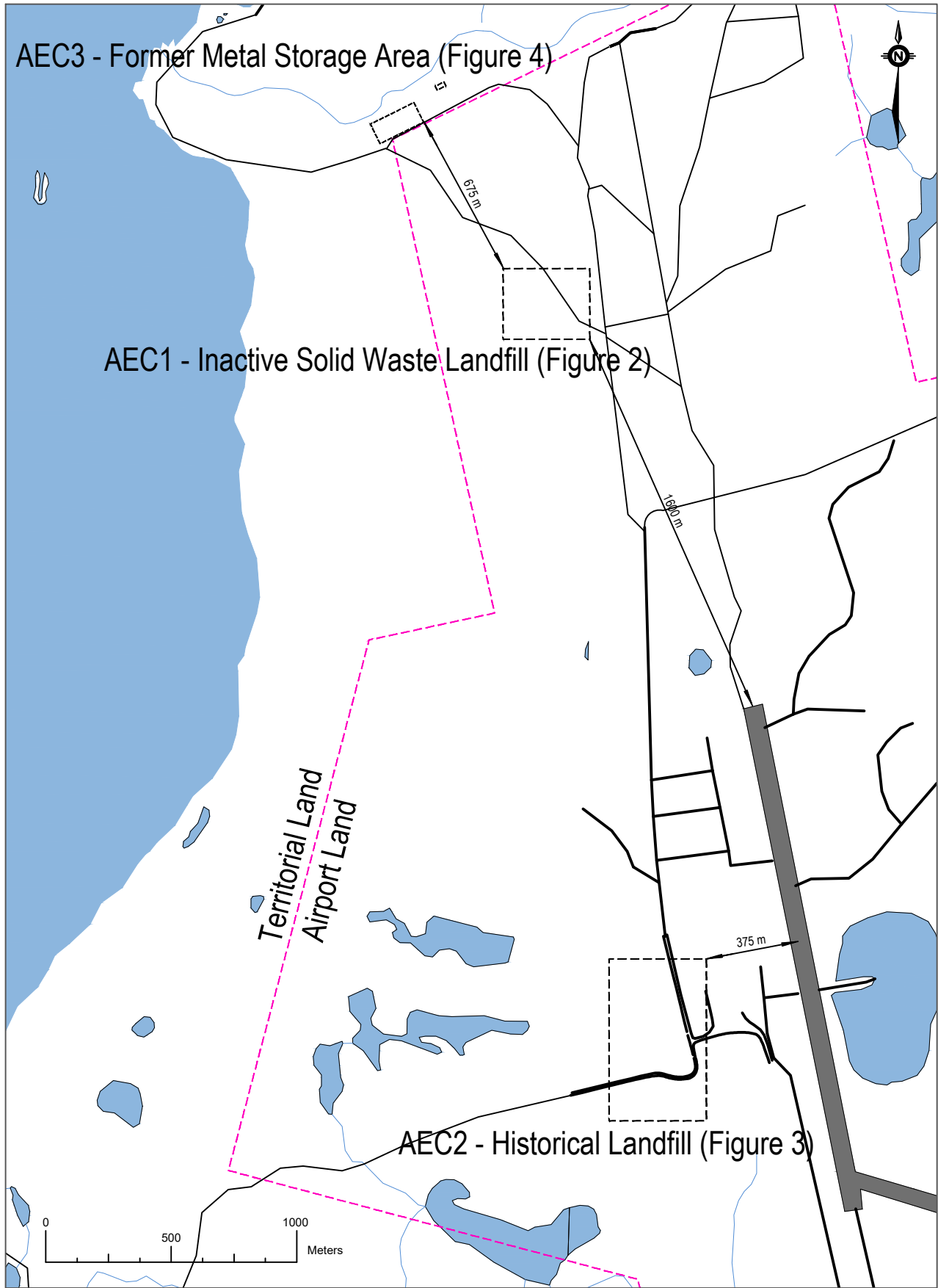
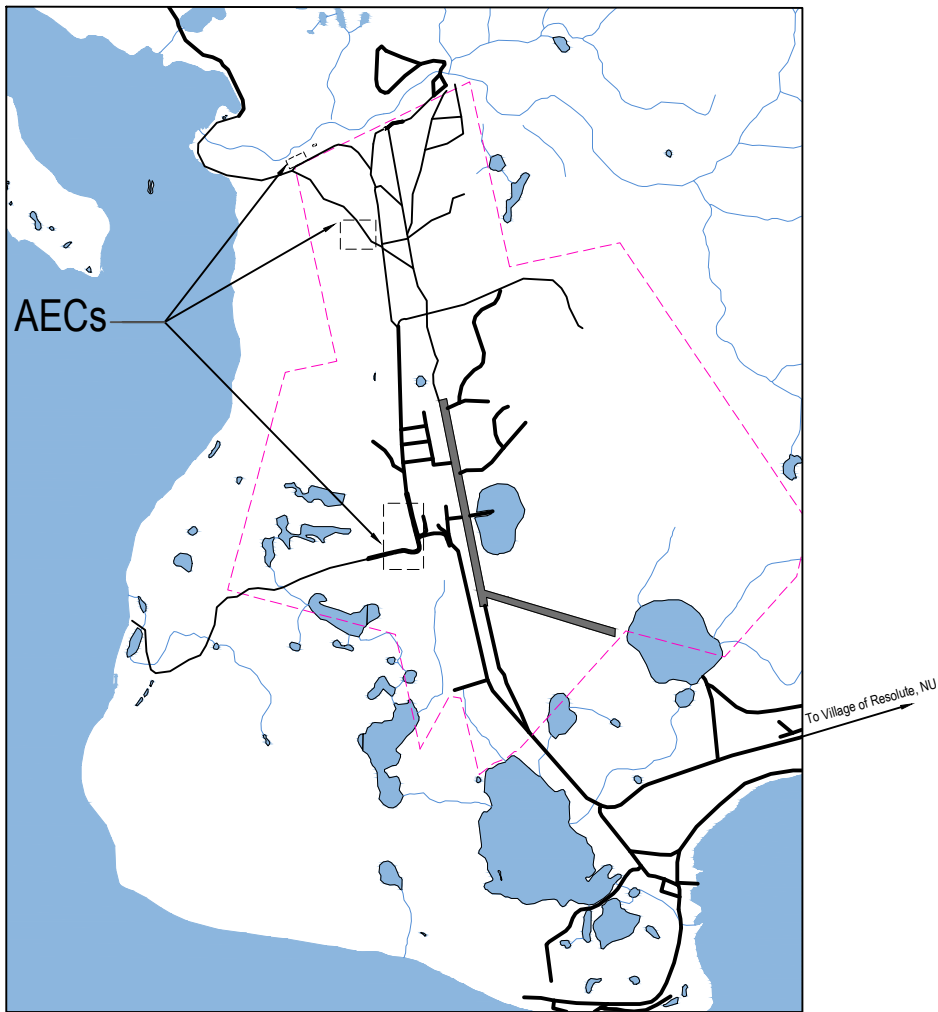
Steve Livingstone, M.Sc., P.Geo  
Senior Professional



Michael Billowits, MSc.(Eng), P.Eng.  
Engineer of Record  
President, Outcome Consultants Inc.

# Appendix A

## *Figures*



NOTES:  
[ ] - Adapted from Preliminary Design prepared by  
Arcadis Canada Inc. on behalf of Public Works &  
Government Services Canada (March 2016)

LEGEND:  
[ ] Airport Property Line  
[ ] Area of Environmental Concern (AEC)



PROFESSIONAL SEALS

DO NOT SCALE DRAWINGS

04		
03		
02		
01		
revision		date

Do not scale drawings.  
Verify all dimensions and conditions on site and immediately  
notify the Departmental Representative of all discrepancies.

A	Detail No. No. du detail
B	drawing no. - where detail required dessin no. - ou detail exige
C	drawing no. - where detailed dessin no. - ou detaille

project title  
titre du projet  
RESOLUTE BAY NUNAVUT  
PWGSC for TRANSPORT CANADA  
REMEDIATION OF RESOLUTE  
BAY AIRPORT LANDFILLS

drawing title  
titre du dessin  
SITE LOCATION

drawn by  
dessiné par C. SADLER

designed by  
conçu par J. MAUCHAN

approved by  
approuvé par M. BILLOWITS

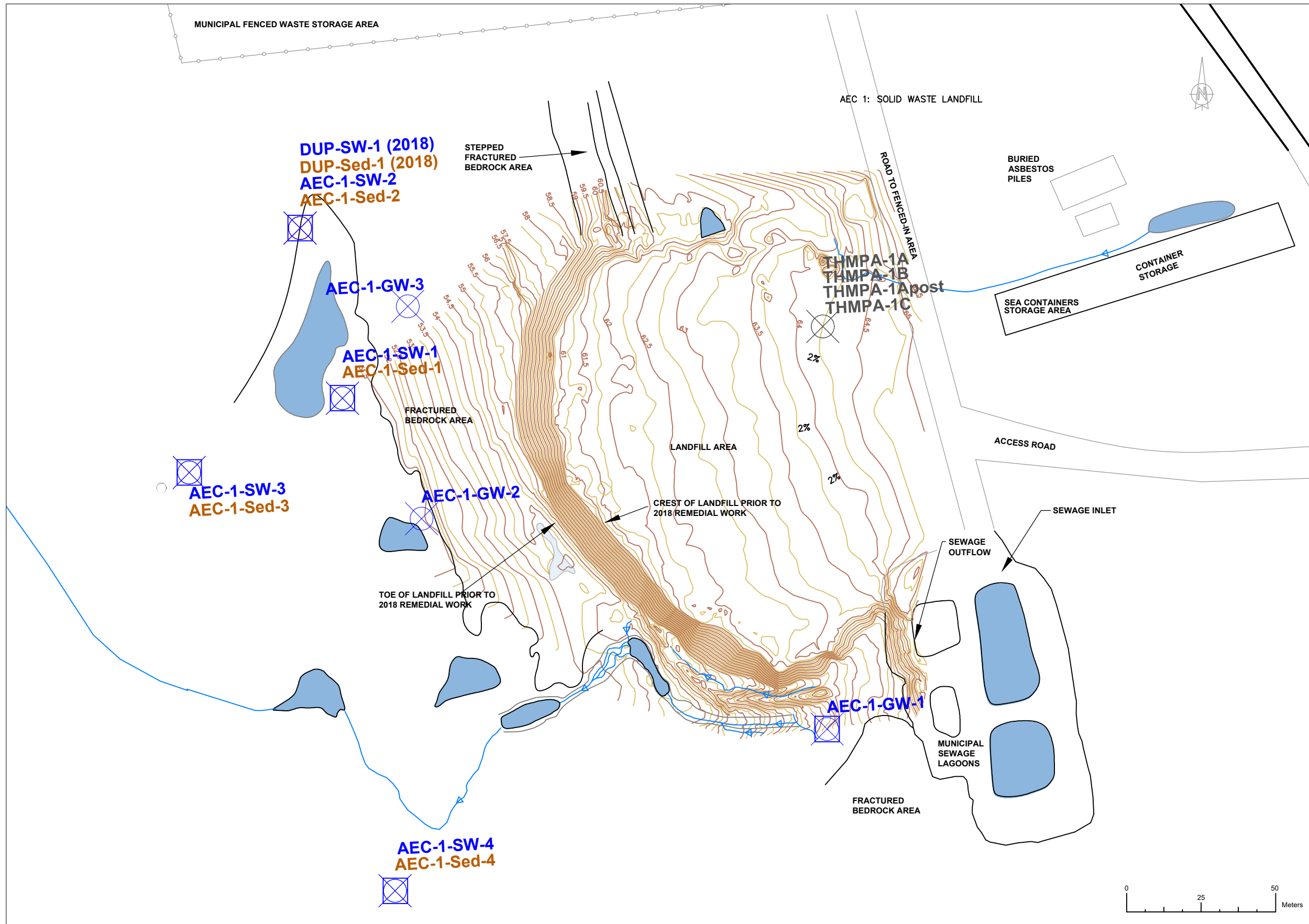
bid  
offre N. ROBINSON project manager  
administrateur de projets

project date  
date du projet MARCH 2020

project no.  
no. du projet R.095508.001

drawing no.  
dessiné no. Figure 1

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 metres



#### NOTES:

- Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)
- Protected and maintained municipal fenced waste storage area. Kudlik Construction provided public access throughout work.
- Protected, maintained and left buried Asbestos piles As-1a
- Protected and maintained sewage lagoons. Kudlik Construction provided public access throughout work
- Buried Asbestos Piles were not disturbed during work
- (2018) and (2019) Indicate year that sample was collected.

#### LEGEND:

- Major Topographic Contour
- Minor Topographic Contour
- Topographic Elevation (approx. metres above sea level)
- Surface Water Drainage Pathway
- Surface Flow Direction
- Water
- Road
- Photo Number and Location
- Buried Asbestos Piles
- Sample collected in 2018
- THMPA - Temporary Hazardous Materials Processing Area (soil Sample)
- SW - Surface Water Sample
- SED - Sediment Sample
- GW - Groundwater Sample
- DUP - Duplicate Sample
- Sample collected in 2018 and 2019
- Sample collected in 2019



#### PROFESSIONAL SEALS

#### DO NOT SCALE DRAWINGS

04		
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02		
01		
revision		date

Do not scale drawings.  
Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

A	Detail No.
B	drawing no. - where detail required
C	drawing no. - where detailed

project title	RESOLUTE BAY NUNAVUT
titre du projet	PWGSC for TRANSPORT CANADA
drawing title	REMEDATION OF RESOLUTE BAY AIRPORT LANDFILLS
titre du dessin	

AEC1 Construction Monitoring Sample Locations

drawn by  
dessiné par C. SADLER

designed by  
conçu par J. MAUCHAN

approved by  
approuvé par M. BILLOWITS

bid offre N. ROBINSON project manager  
administrateur de projets

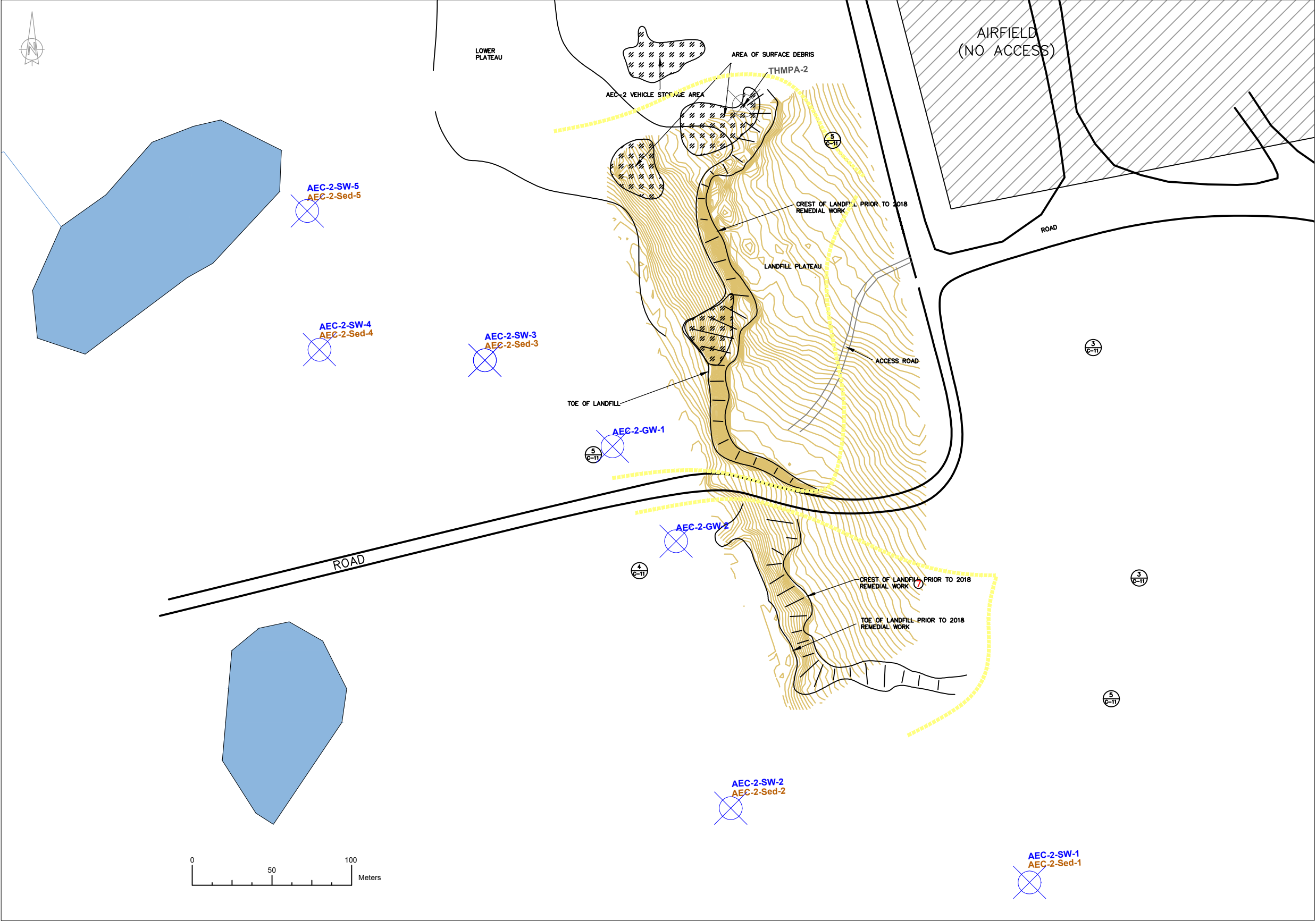
project date  
date du projet MARCH 2020

project no.  
no. du projet R.095508.001

drawing no.  
dessiné no. Figure 2



AEC 2 – HISTORICAL LANDFILL



Public Works and  
Government Services Canada

Travaux publics et  
Services gouvernementaux Canada

Notes:  
[1] – Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)

LEGEND:

— Major Topographic Contour

— Minor Topographic Contour

Topographic Elevation (approx. metres above sea level)

Airfield

Surface Waste

Road

Embankment

Sample collected by DOJV in 2018 and 2019

THMPA – Temporary Hazardous Materials Processing Area (soil Sample)

SW – Surface Water Sample

SED – Sediment Sample

GW – Groundwater Sample

DUP – Duplicate Sample

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PROFESSIONAL SEALS

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A

B drawing no. – where detail required  
dessin no. – ou détail exigé

C

C drawing no. – where detailed  
dessin no. – ou détaillé

project title  
titre du projet

RESOLUTE BAY  
PWGSC for TRANSPORT CANADA  
NUNAVUT

REMEDATION OF RESOLUTE  
BAY AIRPORT LANDFILLS

drawing title  
titre du dessin

AEC2 Construction Monitoring Sampling Locations

drawn by  
dessiné par

C. SADLER

designed by  
conç par

J. MAUCHAN

approved by  
approuvé par

M. BILLOWITS

bid  
offre

N. ROBINSON

project manager  
administrateur de projets

project date  
date du projet

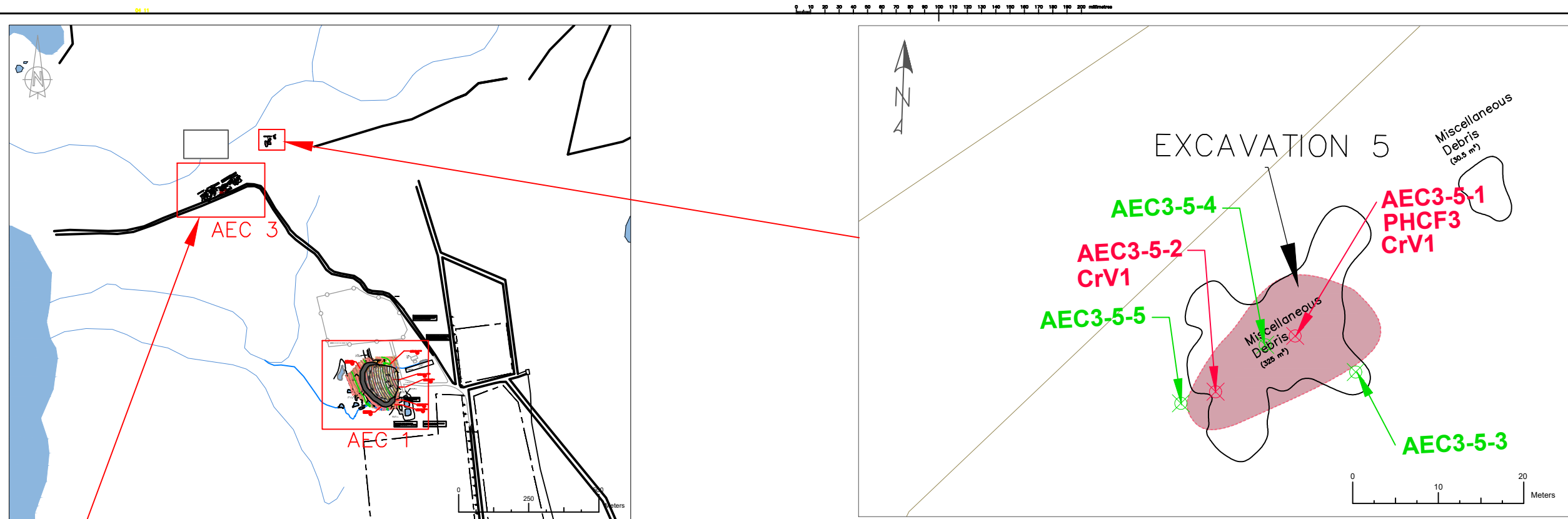
MARCH 2020

project no.  
no. du projet

R.095508.001

drawing no.  
dessiné no.

Figure 3



Public Works and Government Services Canada  
Travaux publics et Services gouvernementaux Canada

Notes:

- Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)

LEGEND:

- Major Topographic Contour
- Minor Topographic Contour
- Topographic Elevation (approx. metres above sea level)
- Airfield
- Surface Waste
- Road
- Embankment
- 2019 Soil Sample Below Criteria
- 2019 Soil Sample Above Criteria

THMPA - Temporary Hazardous Materials Processing Area (soil sample)  
SW - Surface Water Sample  
SED - Sediment Sample  
GW - Groundwater Sample  
DUP - Duplicate Sample

PROFESSIONAL SEALS

DO NOT SCALE DRAWINGS

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revision		date

Do not scale drawings. Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

A Detail No. No. du détail  
B drawing no. - where detail required dessin no. - où détail exigé  
C drawing no. - where detailed dessin no. - où détaillé

project title  
titre du projet

RESOLUTE BAY NUNAVUT  
PWGSC for TRANSPORT CANADA

REMEDATION OF RESOLUTE BAY AIRPORT LANDFILLS

drawing title  
titre du dessin

AEC3 SOIL EXCAVATION LOCATIONS

drawn by  
dessiné par

C. SADLER

designed by  
conçu par

J. MAUCHAN

approved by  
approuvé par

M. BILLOWITS

bid  
offre

N. ROBINSON

project manager  
administrateur de projets

project date  
date du projet

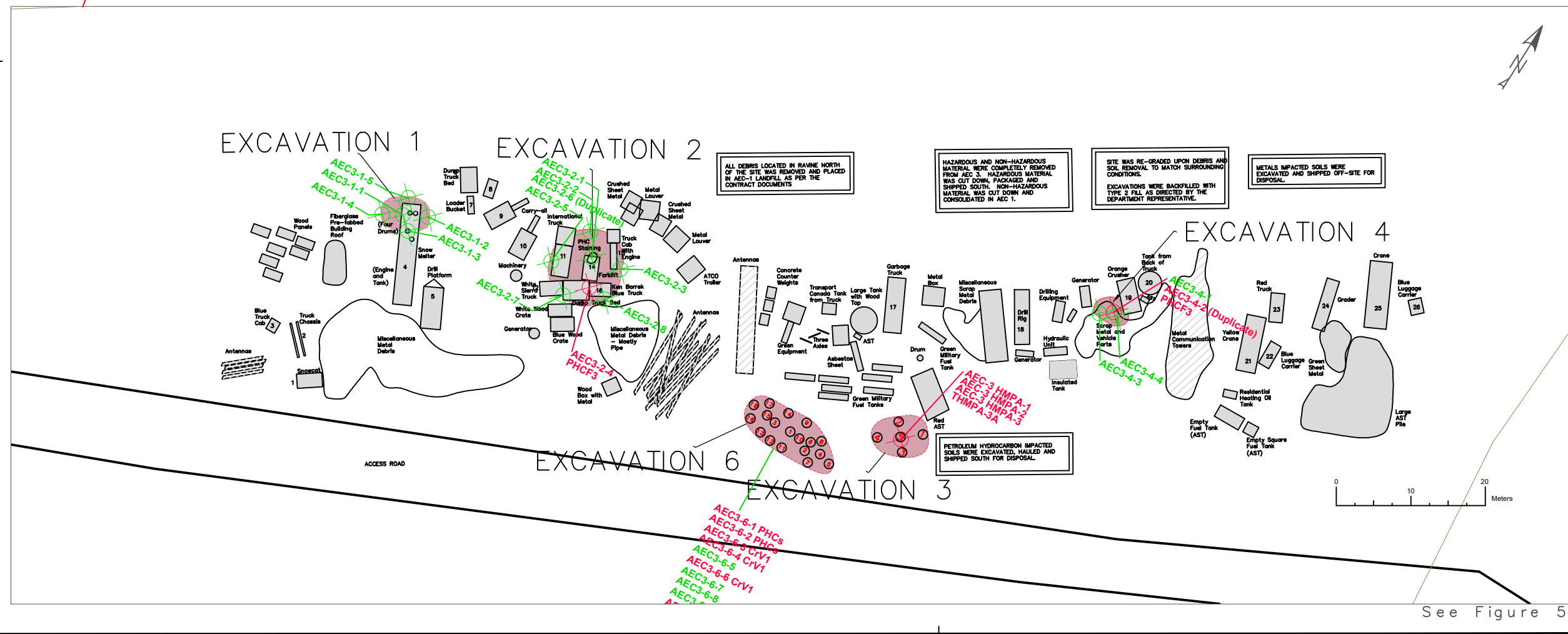
MARCH 2020

project no.  
no. du projet

R.095508.001

drawing no.  
dessiné no.

Figure 4



See Figure 5



0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 metres

EXCAVATION 1

EXCAVATION 2

EXCAVATION 4

EXCAVATION 6

EXCAVATION 3

ALL DEBRIS LOCATED IN RAVINE NORTH OF THE SITE WAS REMOVED AND PLACED IN AEC-1 LANDFILL AS PER THE CONTRACT DOCUMENTS

HAZARDOUS AND NON-HAZARDOUS MATERIAL WERE COMPLETELY REMOVED FROM AEC 3. HAZARDOUS MATERIAL WAS CUT DOWN, PACKAGED AND SHIPPED SOUTH. NON-HAZARDOUS MATERIAL WAS CUT DOWN AND CONSOLIDATED IN AEC 1.

SITE WAS RE-GRADED UPON DEBRIS AND SOIL REMOVAL TO MATCH SURROUNDING CONDITIONS. EXCAVATIONS WERE BACKFILLED WITH TYPE 2 FILL AS DIRECTED BY THE DEPARTMENT REPRESENTATIVE.

METALS IMPACTED SOILS WERE EXCAVATED AND SHIPPED OFF-SITE FOR DISPOSAL.

PETROLEUM HYDROCARBON IMPACTED SOILS WERE EXCAVATED, HAULED AND SHIPPED SOUTH FOR DISPOSAL.

Public Works and Government Services Canada  
Travaux publics et Services gouvernementaux Canada

Notes:

- Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)
- All Non-hazardous debris moved to AEC1 landfill.
- All Hazardous Materials transported off-site for disposal.

LEGEND:

- Major Topographic Contour
- Minor Topographic Contour
- Topographic Elevation (approx. metres above sea level)
- Airfield
- Surface Waste (removed)
- Road
- Embankment
- 2019 Soil Sample Below Criteria
- 2019 Soil Sample Above Criteria
- 2019 Excavation Area

THMPA - Temporary Hazardous Materials Processing Area (soil Sample)  
SW - Surface Water Sample  
SED - Sediment Sample  
GW - Groundwater Sample  
DUP - Duplicate Sample



PROFESSIONAL SEALS

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- A Detail No. No. du détail
- B drawing no. - where detail required dessin no. - ou detail exigé
- C drawing no. - where detailed dessin no. - ou détaillé

project title  
titre du projet  
RESOLUTE BAY NUNAVUT  
PWGSC for TRANSPORT CANADA

drawing title  
titre du dessin  
REMEDIATION OF RESOLUTE BAY AIRPORT LANDFILLS

AEC3 EXCAVATIONS

drawn by  
dessiné par  
C. SADLER

designed by  
conçu par  
J. MAUCHAN

approved by  
approuvé par  
M. BILLOWITS

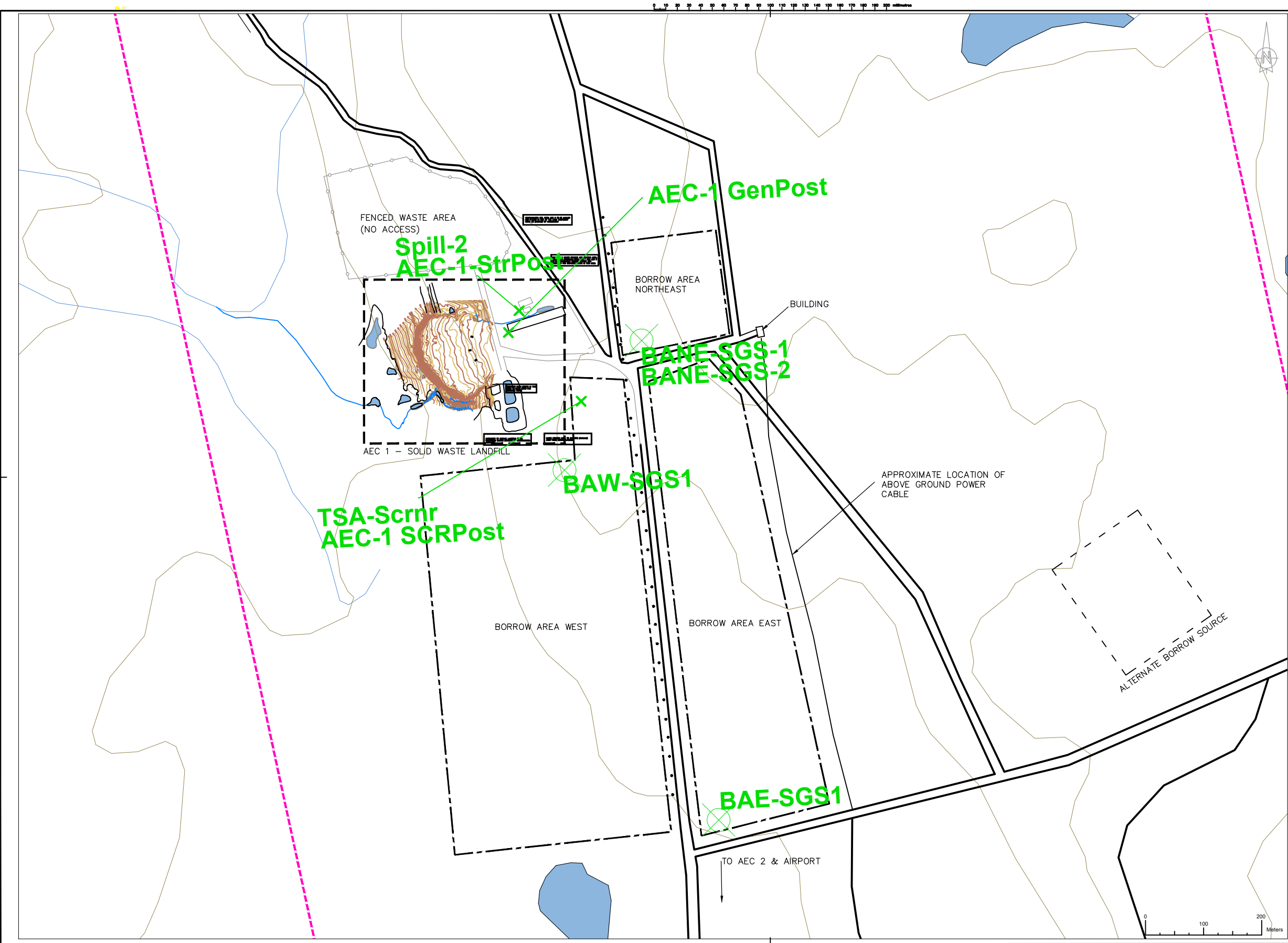
checked by  
vérifié par  
N. ROBINSON project manager  
administrateur de projets


project date  
date du projet  
MARCH 2020

project no.  
no. du projet  
R.095508.001

drawing no.  
dessiné no.  
Figure 5








Public Works and  
Government Services Canada  
Travaux publics et  
Services gouvernementaux Canada

NOTES:


Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)

LEGEND:

- Major Topographic Contour (Background - from NTS)
- Major Topographic Contour
- Minor Topographic Contour
- Topographic Elevation (approx. metres above sea level)
- Surface Water Drainage Pathway
- Water
- Borrow Source Area
- Property Boundary
- Area Identification
- Road
- Fenced Area
- Hydro Pole
- Sample collected in 2018
- Sample collected in 2019
- THMPA - Temporary Hazardous Materials Processing Area (soil Sample)
- SW - Surface Water Sample
- SED - Sediment Sample
- GW - Groundwater Sample
- DUP - Duplicate Sample



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PROFESSIONAL SEALS

DO NOT SCALE DRAWINGS

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revision		date

Do not scale drawings.  
Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

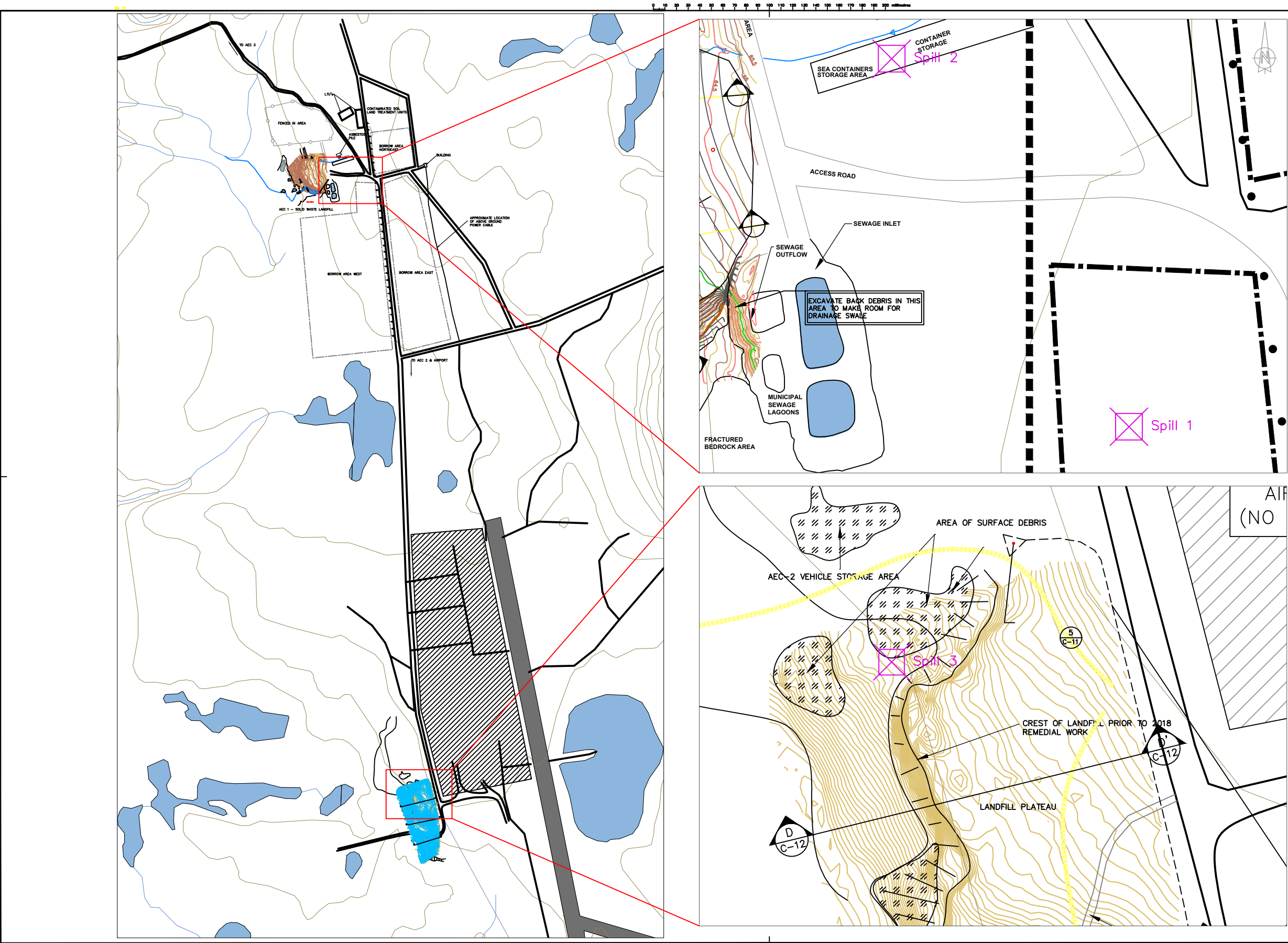
A	Detail No.
B	drawing no. - where detail required
C	drawing no. - where detailed


project title	RESOLUTE BAY	NUNAVUT
titre du projet	PWGSC for TRANSPORT CANADA	
drawing title	REMEDIAL OF RESOLUTE BAY AIRPORT LANDFILLS	
titre du dessin	BORROW AREAS	

drawn by	C. SADLER	
designe par		
designed by	J. MAUCHAN	
conc par		
approved by	M. BILLOWITS	
approuve par		
bid offre	N. ROBINSON	project manager
		administrateur de projets

project date	MARCH 2020
date du projet	
project no.	R.095508.001
no. du projet	
drawing no.	Figure 7
dessin no.	








Public Works and  
Government Services Canada  
Travaux publics et  
Services gouvernementaux Canada

NOTES:


- 1 - Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)
- 2 - Spills were cleaned up by Kudlik as per their Spill Contingency Plan.
- 3 - Spill locations were sampled by DOJV

LEGEND:

- Water
- Fenced Area
- Major Topographic Contour (Background - from NTS)
- Major Topographic Contour
- Minor Topographic Contour
- Topographic Elevation (approx. metres above sea level)
- Surface Water Drainage Pathway
- Borrow Source Area
- Property Boundary
- Area Identification
- Spill Location and sample location
- Sample collected in 2018
- Sample collected in 2019
- THMPA - Temporary Hazardous Materials Processing Area (soil Sample)
- SW - Surface Water Sample
- SED - Sediment Sample
- GW - Groundwater Sample
- DUP - Duplicate Sample
- Road
- Hydro Pole



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CONSULTING



outcome  
CONSULTANTS

PROFESSIONAL SEALS

DO NOT SCALE DRAWINGS

revision	date
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Do not scale drawings.  
Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

A	Detail No.
1	No. du detail
B	drawing no. - where detail required
C	dessin no. - ou detail exige
D	drawing no. - where detailed
E	dessin no. - ou detaillé

project title	titre du projet
RESOLUTE BAY PWGSC for TRANSPORT CANADA	NUNAVUT

drawing title	titre du dessin
REMEDIAL OF RESOLUTE BAY AIRPORT LANDFILLS	

drawn by	dessiné par
C. SADLER <td></td>	

designed by	conç par
J. MAUCHAN <td></td>	

approved by	approuvé par
M. BILLOWITS <td></td>	

bid	offre
N. ROBINSON <td></td>	

project manager	administrateur de projets

project date	date du projet
MARCH 2020	

project no.	no. du projet
R.095508.001	

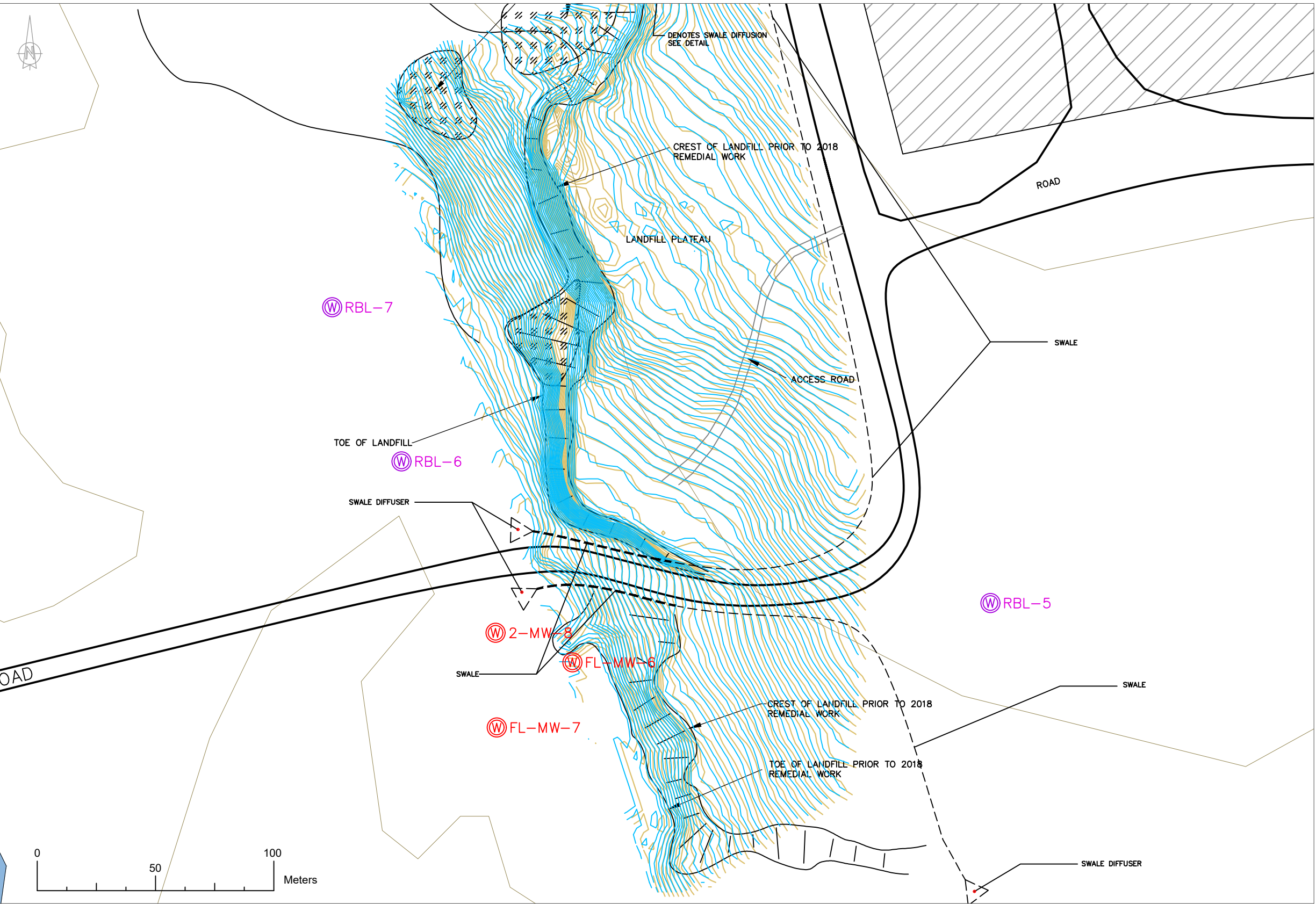
drawing no.	dessiné no.
Figure 8	





0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 metres

AEC 2 – HISTORICAL LANDFILL



Public Works and  
Government Services Canada  
Travaux publics et  
Services gouvernementaux Canada

Notes:  
- Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)

- LEGEND:**
- Major Topographic Contour
  - Minor Topographic Contour
  - Topographic Elevation (approx. metres above sea level)
  - Airfield
  - Surface Waste
  - Road
  - Embankment
  - Sample collected in 2018
  - Sample collected in 2019
  - Monitoring Well installed in 2019
  - Existing Monitoring Well
  - THMPA – Temporary Hazardous Materials Processing Area (soil Sample)
  - SW – Surface Water Sample
  - SED – Sediment Sample
  - GW – Groundwater Sample
  - DUP – Duplicate Sample



PROFESSIONAL SEALS

DO NOT SCALE DRAWINGS

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revision		date

Do not scale drawings. Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

- A Detail No. No. du detail  
B drawing no. – where detail required dessin no. – ou detail exigé  
C drawing no. – where detailed dessin no. – ou détaillé

project title  
titre du projet  
RESOLUTE BAY  
PWGSC for TRANSPORT CANADA NUNAVUT  
REMEDATION OF RESOLUTE BAY AIRPORT LANDFILLS

drawing title  
titre du dessin  
AEC2 MONITORING WELLS  
INSTALLED IN 2019

drawn by  
dessiné par C. SADLER

designed by  
conçu par J. MAUCHAN

approved by  
approuvé par M. BILLOWITS

bid  
offre N. ROBINSON project manager  
administrateur de projets

project date  
date du projet MARCH 2020

project no.  
no. du projet R.095508.001

drawing no.  
dessiné no. Figure 10



Public Works and Government Services Canada  
Travaux publics et Services gouvernementaux Canada

Notes:

- Adapted from Preliminary Design prepared by Arcadis Canada Inc. on behalf of Public Works & Government Services Canada (March 2016)

**LEGEND:**

- Major Topographic Contour
- Minor Topographic Contour
- Topographic Elevation (approx. metres above sea level)
- Airfield
- Surface Waste
- Road
- Embankment
- Sample collected in 2018
- Sample collected in 2019
- Monitoring Well installed in 2019
- THMPA – Temporary Hazardous Materials Processing Area (soil Sample)
- SW – Surface Water Sample
- SED – Sediment Sample
- GW – Groundwater Sample
- DUP – Duplicate Sample

PROFESSIONAL SEALS

DO NOT SCALE DRAWINGS

revision	date
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02	
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Do not scale drawings. Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

A Detail No. No. du detail  
 B drawing no. – where detail required dessin no. – ou detail exigé  
 C drawing no. – where detailed dessin no. – ou détaillé

project title  
 titre du projet
 RESOLUTE BAY NUNAVUT  
PWGSC for TRANSPORT CANADA

drawing title  
 titre du dessin
 REMEDIATION OF RESOLUTE BAY AIRPORT LANDFILLS

drawn by  
 dessiné par C. SADLER

designed by  
 conçu par J. MAUCHAN

approved by  
 approuvé par M. BILLOWITS

bid  
 offre N. ROBINSON
 project manager  
administrateur de projets

project date  
 date du projet MARCH 2020

project no.  
 no. du projet R.095508.001

drawing no.  
 dessin no. Figure 11

## **Appendix B**

### ***Field Template***



## TEMPLATE 1: PHOTO LOG TEMPLATE

<p style="text-align: center;"><b>Insert Photo</b></p>
--

**Photo AEC and Point**

Example: "AEC1-1"

(For non- AEC's, use  
"General")

**Date**

Example: December 12,  
2019

**Description**

Example: "Sediment  
Runoff Observed at East  
AEC1 Slope"

**Viewing Direction**

Example: "NE"

Alternatively, embedding the date and viewing directed on the photo is acceptable. A description and photo point using the Photo Log Template would still be required.