Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

REMEDIATION AND RECLAMATION ACTION PLAN
FORMER AKLAVIK POWER PLANT
68° 13’ 6.24” NORTH AND 135° 0’ 21.24” WEST
AKLAVIK, NORTHWEST TERRITORIES

Report Prepared for:
NORTHWEST TERRITORIES POWER CORPORATION

Prepared by:
MATRIX SOLUTIONS INC.

June 2017
Edmonton, Alberta

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INTRODUCTION

The Northwest Territories Power Corporation (NTPC) has retained Matrix Solutions Inc. to test a method of soil remediation at its former electricity generation plant in Aklavik, Northwest Territories. This bio-augmentation trial is licensed by the Inuvialuit Water Board under Licence No. N3L8-1838. Part G, Item 1 of this licence requires NTPC to submit a Remediation and Reclamation Action Plan for the Project to the Board for approval at least 5 days prior to mobilization. Mobilization to construct the treatment cell is scheduled for July 5, 2017.

Although the results of the remediation trial will not be known until it is finished in 2018 or 2019, Matrix has prepared this plan to address the licence requirement to submit a Remediation and Reclamation Action Plan before mobilizing to the site. It is expected that the plan will need to be updated once the results of the bio-augmentation trial have been evaluated, since the outcome of the treatment trial will determine subsequent remediation options for the site as a whole.

SITE DESCRIPTION

Location:	The site is a former power station situated in the hamlet of Aklavik, Northwest Territories, located on the Peel Channel of the west side of Mackenzie River Delta (Figure 1), approximately 100 km south of the Beaufort Sea and 55 km west of Inuvik. The site legal description is Lots 58, 58A, and 58B, LTO 33, CLSR 40355.
Land Use:	The current land use is industrial. Surrounding land uses are residential to the north and commercial to the west. There is public land located south of the site (Anglican Church cemetery). Areas to the east are undeveloped.
Physical Features:	The site topography is flat, sloping gently to the southeast. Peel Channel bends around the south side of Aklavik. The distance between the channel shores to the east and the south of the site is approximately 250 m. A layer of gravel and clay fill covers most of the site, underlain by the original topsoil and clayey silt (Figure 2); the depth to permafrost is approximately 1.2 to 2.1 m below ground surface (bgs).

BACKGROUND

The site historically had a power plant that used bunker C and fuel oil (diesel) to generate electricity. Former infrastructure included the powerhouse, an aboveground diesel storage tank (AST), and an office. Remaining infrastructure includes a concrete dock used to support the original generator, a smaller concrete pad, and a chain-link fence around the perimeter.

Contaminants of concern onsite are petroleum hydrocarbons (PHCs), polycyclic aromatic hydrocarbons (PAHs), and metals.

The site has been the subject of four environmental site assessments (ESA; Figure 3):

- A July 1997 Phase II ESA (EBA 1998) included digging 16 test pits; analytical results suggested that most of the soil impacts were downslope (to the south of) of the former AST. This observation was based on the highest total PHC concentrations at the south property line, including 96,000 parts per million (ppm) at a depth of 0.6 m bgs from a test pit south of the former AST, and 39,000 ppm at a depth of 0.3 m bgs from a test pit located between the former AST and the concrete dock.
- A groundwater assessment in 2002 (Golder 2002) included digging five test pits (to a depth between 1.8 and 2.2 m bgs) and installing five groundwater monitoring wells (Golder 2002). The well farthest to the north had no detectable PHCs, while other wells on the site had benzene, toluene, ethylbenzene, and PHC fraction 2 (F2; $C_{>10}$-C_{16}) concentrations higher than the applicable Canadian Council of Ministers of the Environment guidelines.

- A Phase III ESA in June 2003 to July 2003 (Biogenie 2004) included soil sampling from an additional 22 test pits and 8 manual boreholes offsite in the cemetery, plus groundwater sampling of the 5 wells (Biogenie 2004). The assessment concluded that an estimated 2,720 m^3 of hydrocarbon-impacted soils was present on NTPC's property at an average depth of 1.8 m bgs. Limited data suggested that site soils were also impacted with PAHs higher than the *Environmental Guidelines for Contaminated Site Remediation* (NWT ENR 2003) for residential/parkland land use.
- In August 2015, Matrix collected soil samples using hand augers to a depth of 1 m. The investigation found levels of hydrocarbons and metals above the *Environmental Guidelines for Contaminated Site Remediation* guidelines (NWT ENR 2003). Impacts in the south portion of the site were consistent with the historical location of the generator and included PHC fraction 3 ($C_{>16}$-C_{34}; 3,280 to 42,300 mg/kg) and fraction 4 ($C_{>34}$; 7,710 to 25,800 mg/kg) and metals (copper, nickel, and zinc) consistent with historical fuel spillage and engine wear. Impacts in the north section of the site were characterized by elevated levels of F2 (1,660 to 22,700 mg/kg) indicative of diesel.
- Arsenic levels exceeded the guidelines at multiple locations; this is attributable to imported gravel from a nearby quarry and is not considered a contaminant of concern.

PREVIOUS AND CURRENT REMEDIATION ACTIVITY

2003:	• Remediation activities were undertaken following a June 2003 release of heating oil associated with the former power plant site office (Golder 2003).
2004:	• Offsite remediation within the cemetery area was completed in 2004 (Biogenie 2005).
2007:	• The excavation of additional offsite soils was completed in 2007 (Biogenie 2008). • Attempts were made to remediate the excavated soils within a biopile on a treatment pad, but remediation criteria were not met after one season of treatment.
2017:	• Beginning in July 2017, Matrix will construct a treatment cell (Figure 4) to test bio-augmentation using a proprietary BioReclaim™ solution. • Actively growing, specialized microbial strains of the *Pseudomonas* genus in the augmentation solution will be applied to soils within the treatment cell to degrade PHCs. *Pseudomonas* bacteria are known to be effective at degrading PHCs even in cold temperatures, and they produce a surfactant molecule (rhamnolipid) that enhances bio-augmentation. • Construction, operation, and monitoring of this treatment cell are the activities licensed under the Inuvialuit Water Board under Licence No. N3L8-1838.

REMEDIATION AND RECLAMATION ACTION PLAN

The action plan for this site is as outlined below. Since the method used for soil remediation will be contingent on whether the bio-augmentation trial shows success at the Aklavik site, this plan will need to be updated once results of the trial have been evaluated in 2018 or 2019.

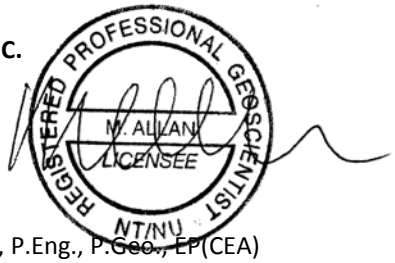
1. Remediate the soil
   - If bio-augmentation works, the treatment cell will continue to be used to process soils. Confirmatory sampling will be conducted in conjunction with soil treatment to affirm when no further impacted soils remain for treatment, and to affirm when sufficient treatment has been done in the treatment cell. As treated soil tests clean, it will be used to backfill excavations. Based on the size of the treatment cell and the amount of impacted soil estimated to require treatment, soil remediation by this method may take 5 or more years to complete.
   - If bio-augmentation does not work sufficiently well, NTPC will assess other remediation options such as excavation and replacement, thermal desorption, and/or in situ chemical oxidation. The soil remediation method that provides the best combination of technical feasibility, cost effectiveness, suitability for site conditions, safety, and other concerns will be selected and proposed to the Inuvialuit Water Board. The timeline for remediation will depend on the technology ultimately selected. Regardless of the chosen method, confirmatory sampling will be conducted to establish when remediation is complete.
2. Demolish concrete dock and slabs
   - While soil remediation is going on, NTPC will evaluate potential opportunities to reuse or recycle the concrete dock and slab (e.g., as excavation backfill, granular material, or riprap). The acceptable level of residual PHCs within the concrete and the maximum allowable size of concrete pieces will be determined and evaluated. If reuse/recycling is not deemed allowable or feasible, disposal options will be identified.
   - The concrete will be broken into smaller pieces to enable removal for reuse/recycling or disposal, as appropriate. Since the dock has proven resistant to breaking with traditional excavating equipment, a qualified explosives contractor may be approached to assist with this task.
   - The concrete pieces will be loaded and transported to the chosen reuse/recycling or disposal location.
3. Remove site infrastructure
   - Soil treatment cell components (e.g., polyethylene liner, thermistors, wiring), the water treatment system (e.g., tanks, pumps, and piping), the perimeter chain-link fence, and any other infrastructure remaining onsite will be dismantled and reused/disposed elsewhere as appropriate.
4. Reclaim the surface
   - Remediation activities will disrupt the ground surface. As work progresses, spot grading will be done to provide drainage and maintain a trafficable surface. Once soil remediation is complete and infrastructure is removed, any areas requiring further grading will be addressed.
   - If required to support future commercial/industrial use, gravel will be imported and spread upon the graded surface.

CLOSURE

This Remediation and Reclamation Action Plan has been prepared to comply with Part G, Item 1 of Inuvialuit Water Board Licence No. N3L8-1838. Since the licensed project is one that will test a bio-augmentation method of soil remediation, the outcome of the trial will determine subsequent remediation of the site as a whole. Consequently, the foregoing plan will warrant review and updating once the results of the bio-augmentation trial have been evaluated in 2018 or 2019.

If you have any questions or concerns regarding this plan, please contact Margaret Allan at 780.989.8343.

MATRIX SOLUTIONS INC.



Margaret Allan, M.Eng., P.Eng., P.Geo., EP(CEA)
Principal Engineer

June 26, 2017

Reviewed by

Scott McIntyre, B.Sc., E.I.T.
Remediation Engineer

MA/rsm
Attachments: Figure 1. Site Location Map
Figure 2. North-South Cross-section A-A'
Figure 3. Site Plan Showing Historical Information
Figure 4. Plan View of Biotreatment Cell and Water Treatment

REFERENCES

Biogenie S.R.D.C. Inc. (Biogenie). 2008. *Final Remediation, Aklavik NTPC Power Plant, Aklavik, Northwest Territories.* Report prepared for Northwest Territories Power Corporation. March 2008.

Biogenie S.R.D.C. Inc. (Biogenie). 2005. *Site Remediation, Anglican Cemetery, Aklavik, Northwest Territories.* Report prepared for Northwest Territories Power Corporation. Quebec, Quebec. January 2005.

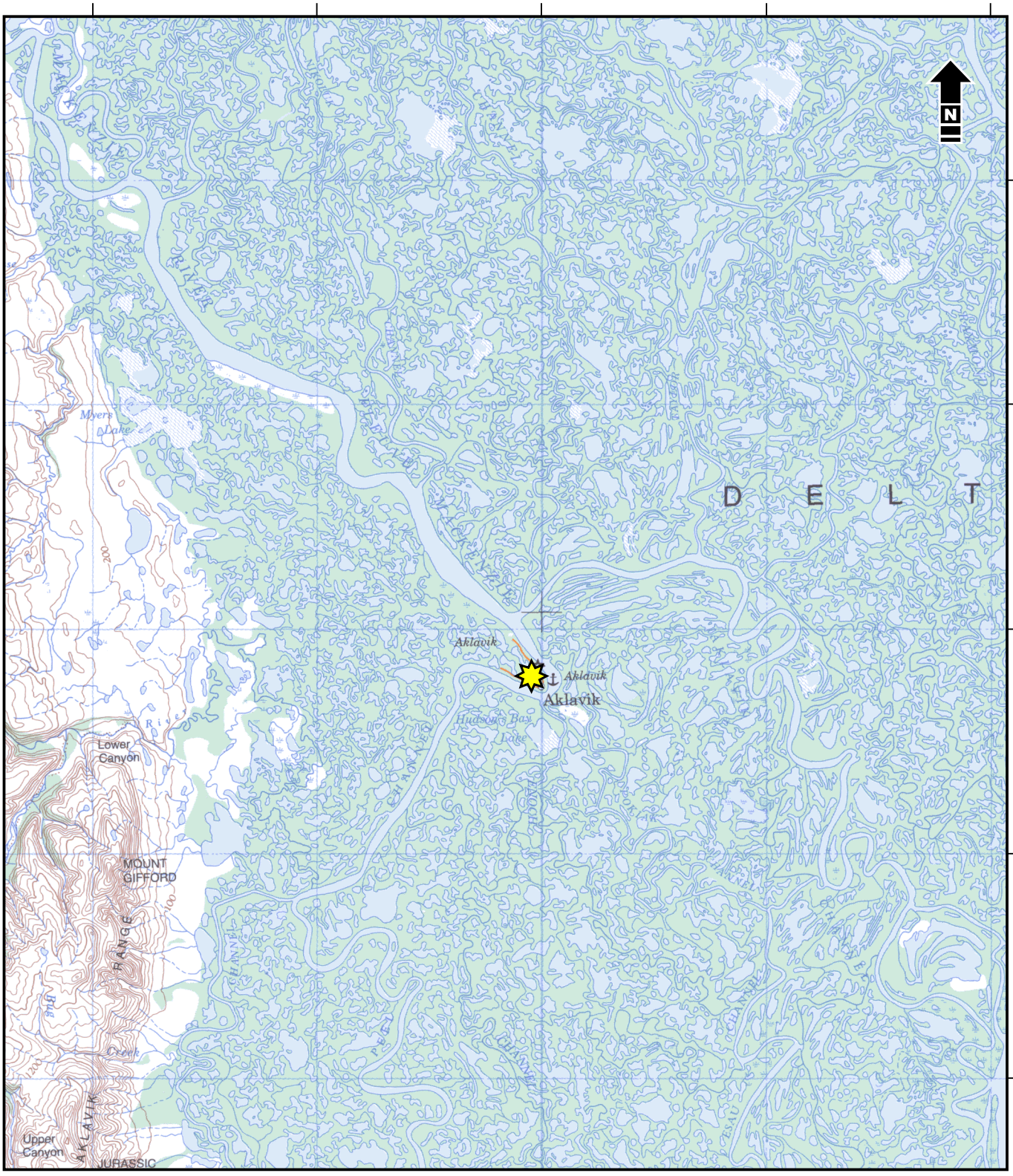
Biogenie S.R.D.C. Inc. (Biogenie). 2004. *Phase III Environmental Site Assessment, NTPC Powerplant, Aklavik, Northwest Territories.* Report prepared for Northwest Territories Power Corporation. Sainte Foy, Quebec. February 2004.

EBA Engineering Consultants Ltd. (EBA). 1998. *Phase II Environmental Site Assessment, NTPC Power Plant, Aklavik, NT*. Report prepared for Northwest Territories Power Corporation. April 1998.

Golder Associates Ltd. (Golder). 2003. *Corporate Generating Site Aklavik, NT*. Prepared for Northwest Territories Power Corporation. October 2003.

Golder Associates Ltd. (Golder). 2002. *Groundwater Monitoring Program – Aklavik*. Prepared for Northwest Territories Power Corporation. October 2002.

Northwest Territories Environment and Natural Resources (NWT ENR). 2003. *Environmental Guideline for Contaminated Site Remediation*. November 2003. http://mvlwb.com/sites/default/files/documents/Environmental-Guideline-for-Contaminated-Site-Remediation.pdf



Site Location

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Northwest Territories Power Corporation
Lot 58, 58A and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

Site Location Map

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-LP-16	D. Felske	M. Allan	J. Kern

Figure 1

Reference: 107 B (Aklavik), Edition 1.1, UTM Zone 08, NAD83

1:250,000 metres
2,500 0 2,500 5,000

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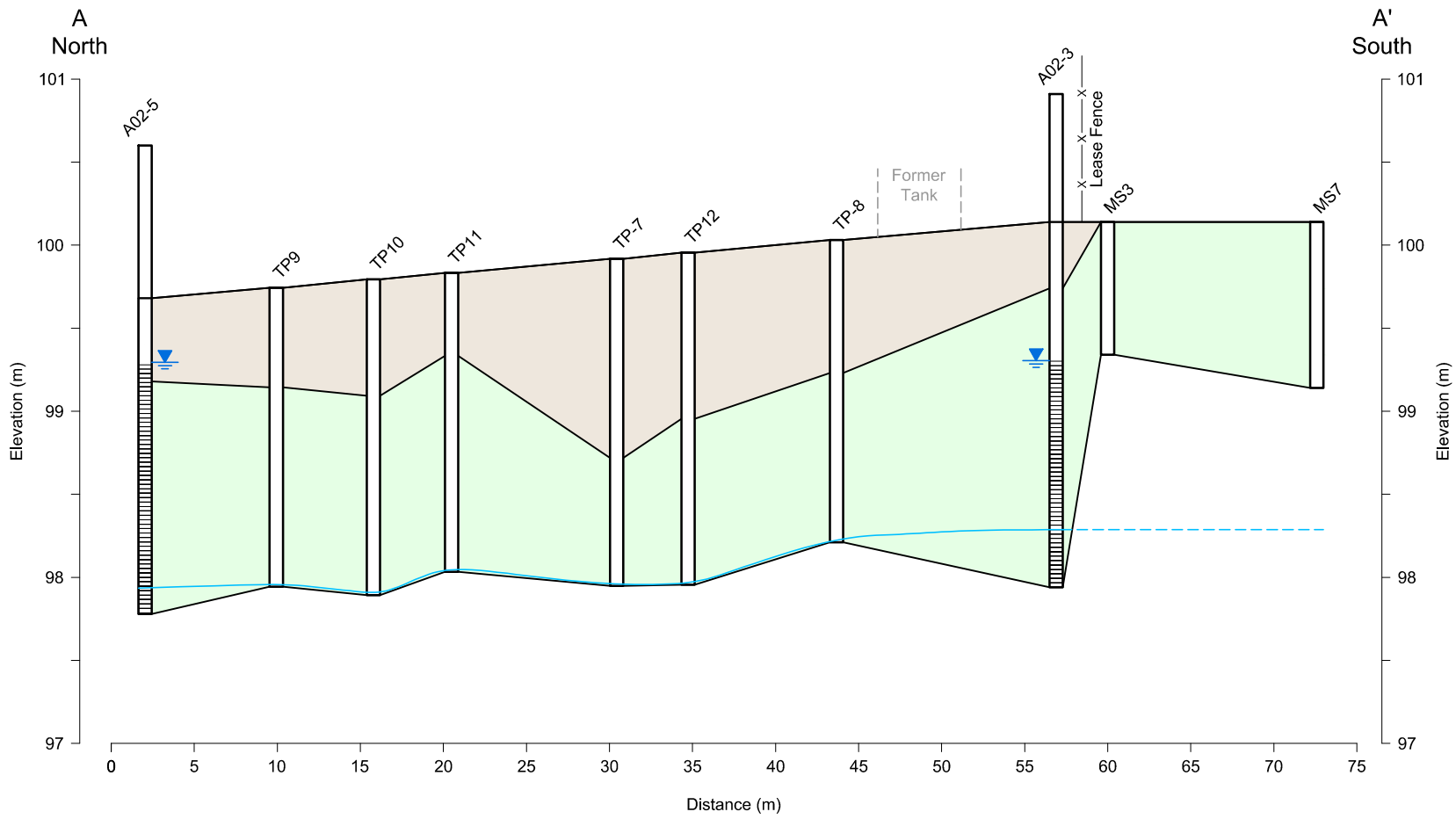

Fill

Silt

Permafrost - July 1, 2003

Permafrost Inferred - July 1, 2003

Monitoring Well

Groundwater Elevation (m) August 2002

Screened Interval

Test Pit

1:40 metres

0.4 0 0.4 0.8

Vertical Scale

1:400 metres

4 0 4 8

Horizontal Scale

Reference:

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Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

North - South Cross-section A - A'

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-SP-15	S. Pluim	M. Allan	E. Rugayan

Figure 2

Plot 1:1 = Tabloid (L)

Easting (m)

499740 499750 499760 499770 499780 499790 499800 499810 499820 499830 499840 499850

Northing (m)

7567250 7567240 7567230 7567220 7567210 7567200 7567190 7567180 7567170 7567160

Hvatum Rd

Gardlund Rd

Gate

Aklavik Anglican Cemetery

Former Powerhouse

Former Pad

Former Pad

Office

Former Gravel Stockpile

Former Biopile (~180 m^3)

Tank 71102

Blower

Log Shed

Dock

Lot 58

Lot 58A

Lot 58B

2008 Excavation

2004 Excavation

2003 Excavation

2003 Excavation

D1

D2

D3

A

A'

A02–5 A02–4 A02–3 A02–2 A02–1

15–H1 15–H2 15–H3 15–H4 15–H5 15–H6 15–H7 15–H8 15–H9 15–H10 15–H11 15–H12 15–H13 15–H14 15–H15 15–H16

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20 TP21 TP22

TP–1 TP–2 TP–3 TP–4 TP–5 TP–6 TP–7 TP–8 TP–9 TP–10 TP–11 TP–12 TP–13 TP–14 TP–15 TP–16

MS1 MS2 MS3 MS4 MS5 MS6 MS7 MS8

SSC–1 SSC–2 SSD–1 SSE–1 SSE–2

N

- Monitoring Well
- Hand Auger
- Former Pile (Removed 2015)
- Test Pit (EBA - 1998)
- Hand Auger (Golder - June 2003)
- Test Pit (Biogénie - July 2003)
- Manual Borehole (Biogénie - July 2003)
- Grave Site
- Fence
- Former Site Feature
- Estimated Limits of Contamination
- A—A' Cross-section

Reference:
Historical site information referenced from Request for Proposals (RFP No. 21511) Soil Remediation Project report provided by Northwest Territories Power Corporation.

1:400 metres
4 0 4 8
UTM83-08

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Site Plan Showing Historical Information

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-SP-15	S. Pluim	M. Allan	E. Rugayan

Figure 3

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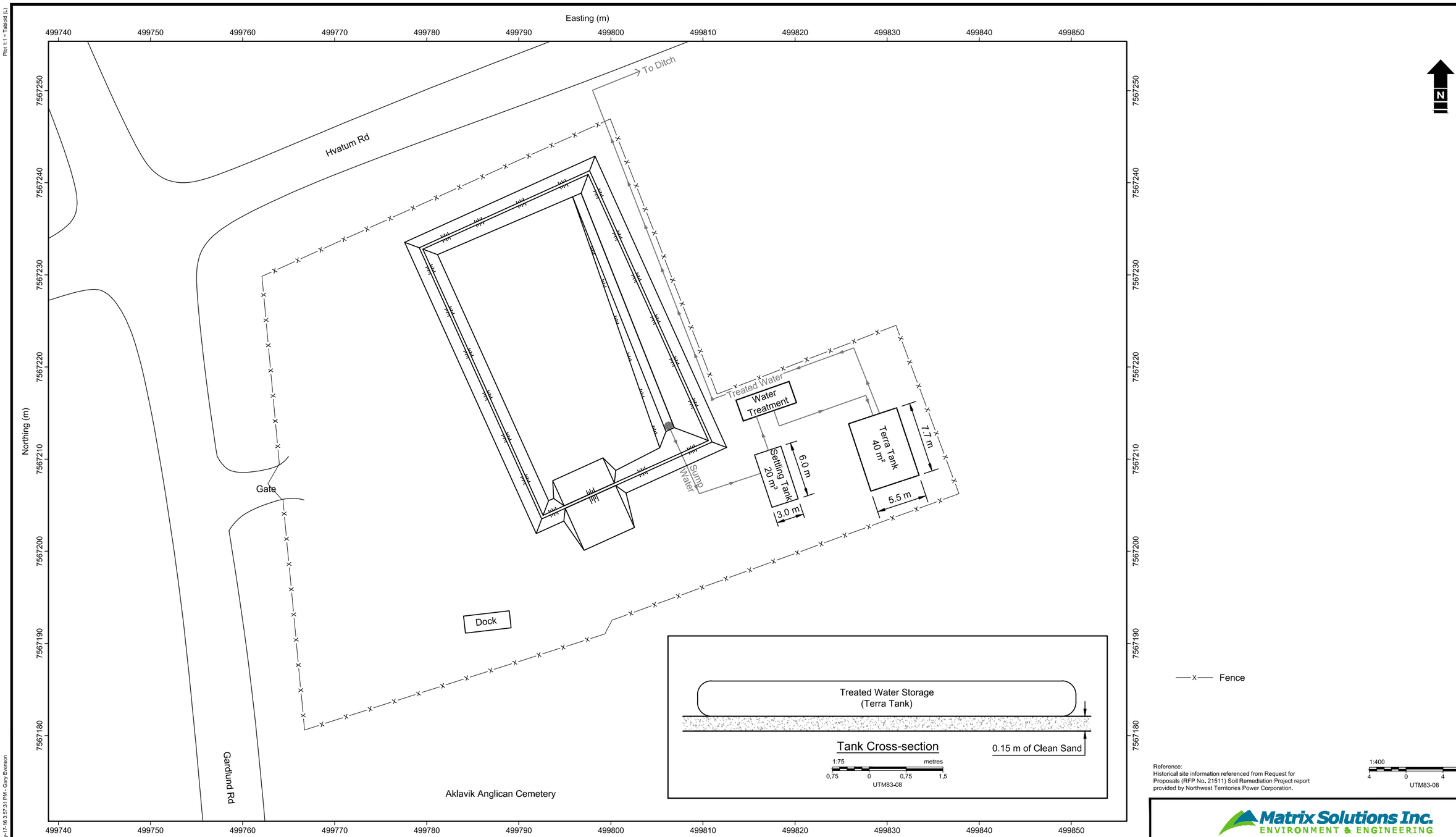
Plot 1:1 = Tabloid (L)



Notes:
Drawing(s) must be used in conjunction with the attached report, Remedial Action Plan dated April 18, 2016 and is subject to the limitations and conditions stated in the report.

STAMP

Permit to Practice No.: L3176

REVISION					
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
1		Issued for Review			

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Northwest Territories Power Corporation
Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

Plan View of Biotreatment Cell and Water Treatment

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-SP-15	D. Felske	M. Allen	J. Kern

Figure 4