devon

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Calgary, AB T2P 4H2
Phone: (403) 232-7100

Water Register: N7L1-1777

October 30, 2006

N.W.T Water Board
PO Box 1326
Yellowknife, NT
X1A 2N9

Attention: Mr. Gordon Wray

Dear Mr. Wray:

Re: Devon Itiginkpac F-29 Sump Assessment

As indicated previously (April 2006) Devon has retained the services of Kiggiak-EBA to assist in the assessment and future planning for the F-29 drilling sump. Attached is a copy of Kiggiak-EBA's report for the F-29 site. In June (June, 29, 2006) the NWT Water Board requested further information concerning Devon's 2005 F-29 Sump Monitoring Program Report. The attached report provides an assessment of the site based on data acquired from Devon's monitoring program, and addresses the questions posed by the NWT Water Board in June.

Devon continues to monitor the F-29 sump and recently (September 2006) completed an EM survey and download of ground temperature data. Devon is currently contemplating next steps for the F-29 location in association with the well partner (Shell Canada).

Devon apologizes for the timing of this submission and invites comments with respect to the Kiggiak- EBA report.

Sincerely,
DEVON CANADA CORPORATION

Peter Millman
Environmental Advisor
Tel: (403) 232-7294
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peter.millman@devoncanada.com
attachments: 2

Report / Plan in document holder

KIGGIAK - EBA

1777

ITGINKPAK F-29 SUMP REMEDIATION PLAN

Submitted To:

DEVON CANADA CORPORATION

Prepared by:

KIGGIAK-EBA CONSULTING LTD.
CALGARY, ALBERTA

Project No. KE1037/1100118

OCTOBER 2006

KIGGIAK - EBA

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1.0 INTRODUCTION

This report reviews the extent of salt contamination adjacent to the sump at the Itiginkpak F-29 well site, and provides recommendations for remediation of the area and for re-establishing containment of drilling wastes in the sump. It has been prepared by Kiggiak-EBA Consulting Ltd. (Kiggiak-EBA), an Inuvialuit company, with technical support by EBA Engineering Consultants Ltd. (EBA). Devon Canada Corporation (Devon) is the operator of the site, at which it drilled an exploration well in early 2003.

The Itiginkpak F-29 site is located, as indicated on Figure 1, approximately 38 km west-northwest of Inuvik, in the Mackenzie Delta. This location is approximately 7.5 km off of the winter road route between Aklavik and Inuvik, and about 71 km by ice-road from Inuvik (the winter road route is subject to change due to early season ice conditions). Figure 2 provides a recent topographic survey of the site area showing the sump at the west end of the lease. The sump is approximately 70 m from the nearest channel bank, and a similar distance from a small lake to the south.

In the years following well completion, Devon has been monitoring the site, including recording ground temperatures from thermistor strings, conducting shallow electromagnetic geophysical (EM) surveys, and surface water chemical testing. This monitoring indicates that potassium chloride salt contamination from the drilling wastes is spreading from the sump in several areas and off the lease to the southwest. Section 3.0 of this report describes the areas of contamination and basis for this interpretation.

As a consequence of these observations, the Northwest Territories Water Board, which has been receiving copies of Devon's monitoring reports, in January 2006 directed Devon to "submit a plan for the reclamation of water and soils impacted by migration of contaminants from the F-29 drilling waste sump … (including) provisions for ongoing monitoring of the site once the reclamation work is completed…". The following report is intended to address the first of these requirements.

2.0 ACTIONS INITIATED

Kiggiak-EBA was retained in May 2006 to prepare a reclamation (remediation) plan for the F-29 sump. Initially, this included a review of site monitoring reports (References 1 to 6) and Water Board correspondence with Devon. The review also considered observations and notes prepared by EBA (2003) which had been retained to observe the sump excavation, to provide geotechnical guidance for the closure of the sump, and to provide and install three thermistor cables at the site.

In June 2006, this report's authors visited the site to obtain a first-hand appreciation for the layout and condition of the sump, and to consider alternate remediation options. Photograph 1 and Photograph 2 provide an indication of conditions at the site in June 2006. At that time, samples were taken from the ponds and wet areas around the sump. These were submitted to ALS Laboratory Group for salinity analyses and the results have been reported separately to Devon. Copies of that data are also enclosed in Appendix A with an assessment of the potential severity of the impact of the salt contamination, prepared by one of EBA's senior environmental specialists.

Kiggiak-EBA subsequently commissioned Inukshuk Geomatics Ltd. (Inukshuk) to conduct a detailed topographic survey of the site which was required for planning drainage repairs, setting grades for remediation works, and to allow quantity calculations for contracting the remediation works. The results of that survey which was completed on July 29, 2006 are illustrated on Figure 2.

Essis Ltd. have recently completed an EM survey of the site for Devon and a report is being prepared. Devon have indicated that Kiggiak-EBA will be asked to review the 2006 data obtained by Essis when the report is available.

3.0 SITE CONDITIONS

3.1 LEASE DESCRIPTION

The lease is located on an island in the Mackenzie Delta. Taylor Channel is on the north side of the lease and there is a small lake to the south of it. In this part of the Delta, the maximum surface elevation is less than 5 m and the lease area is only about 2 m above the summer channel level. The west end of the lease is relatively flat with a slight slope to the southwest. A low, southwest trending swale, which originally provided drainage for the west end of the lease, was blocked by the sump and now contains ponded water.

Most of the lease, which was cleared of trees, shows a healthy level of natural re-vegetation since 2003. The sump area, however, is generally bare and shows the imprint of a dozer's tracks. Grading work done to improve drainage from the cap and from the pond on the east side of the sump by Devon in 2005 probably stripped away any natural re-vegetation that may have existed from these areas.

Figure 2 indicates that the sump cap is about 0.2 m to 0.8 m above the level of the surrounding site. EBA 2003 reports that it was initially built-up by 1.5 m to 2.0 m above level grade. The extent to which this loss of relief results from thaw and settlement of ice-rich cap backfill, or from thawing of the icy layers and ground ice in the cover (below ground portion of the cap) that Devon put over the drilling wastes, or from grading work by Devon in 2005, is not clear.

Ground temperature monitoring reported in Newpark, 2005 indicates that seasonal thaw reaches about 1.5 m below grade in disturbed areas (Newpark Area C) and 0.9 m in the naturally re-vegetated areas of the lease (Newpark Area A). Furthermore, the average annual ground temperature appears to be between -3°C and -4°C. In this temperature range, the drilling wastes, which originally were dry mixed with zeolite, may contain unfrozen pockets of saline-rich water.

3.2 SALT CONTAMINATION

Figure 3, interpreted from the EM surveys conducted by Essis and reported by Newpark in 2005, indicates the extent of three areas of concern. Chemical analyses of soil and water samples (IEG, 2005) show that the primary contamination and contributor to the high apparent conductivity values is potassium chloride (salt). Potassium chloride is a significant component of the buried drilling wastes.

The September 2003 EM survey, conducted by Essis, shows an area of anomalously high apparent conductivity that is approximately 12 m wide between the south end of the sump and the southern lease boundary. Apparent conductivity is generally a measure of the electrical properties of water in the soil pores and more saline soil-water mixes will have higher apparent conductivity values. The 2003 survey did not extend off-lease to identify whether the apparent contamination had spread beyond the lease boundary.

A similar survey conducted in September 2005 by Essis shows the area of apparent contamination between the sump and southern lease boundary had grown to 25 m wide. In the 2005 survey, the plume of inferred contamination can be traced southwesterly to about 80 m off the lease, although the most significant concentrations appear to extend only about 15 m beyond the lease boundary. An area of dead or distressed tree growth is evident in photos of the area adjacent to the lease.

EM surveys across the pond that has formed in the blocked swale on the east side of the sump, suggest that ponding may have impacted the permafrost containment zone adjacent to the sump. A small pocket of elevated apparent conductivity has developed in the pond, suggesting the possible escape of some of the unfrozen saline-rich water associated with the drilling wastes.

A third area of concern that is similarly indicated by high apparent conductivity measurements made by Essis first appeared in the September 2005 EM survey. It is located adjacent to the north (or northwest) corner of the sump. Regrading work by Devon in the summer of 2005 may have something to do with the recent development of this area of high apparent conductivity.

4.0 INTERPRETATION OF SUMP GEOMETRY

In order to appreciate grading recommendations and fill areas outlined below, it is necessary to clearly indicate our understanding of the geometry of the sump. This is somewhat difficult because there are no reports of a proper sump perimeter survey nor are there as-build drawings of the sump cap. The source of the "sump outline" which appears on all the Essis EM survey drawings and which is shown on Figure 3 is unknown. From site pictures and comments in EBA 2003, the as-built geometry of the sump and condition of the backfill are interpreted to have been as follows:

a) The sump cap was placed to 1.5 m to 2.0 m above surrounding grade.

b) The crest (outer top edge) of the backfill was 2 m to 3 m outside the perimeter of the excavation.

c) Sideslopes of the backfill were graded to approximately 3H:1V.

d) The soil cover, (over the drilling wastes up to ground level) was placed in 0.5 m thick lifts, which were each flooded and allowed to freeze-back, before proceeding with the next lift.

e) Pictures, in Newpark 2003, suggest the excavation was approximately 5 m deep, except for the area of the access ramp, which was located in the northeast corner.

f) Devon reports that the drilling wastes (cuttings) were dry-mixed with zeolite to decrease the mobility of salts and heavy metals, and these were placed at least 3.5 m below grade.

g) Verbal reports suggest the drilling wastes had a maximum depth of 1.5 m in the bottom of the sump. There are also reports that the bottom of the pit containing the frozen drilling wastes was flooded and allowed to freeze (i.e., the ice-cover), before the soil cover was placed. This was done to encapsulate the drilling wastes in ice.

h) Although the original ground elevations were not surveyed for the sump area, Inukshuk's survey (Figure 3) suggest the average pre-construction grade near the north end of the sump was approximately at Elevation 4.2, near the middle it was approximately at Elevation 4.1, and near the south end it was approximately at Elevation 4.0.

i) The east pond area does not appear on project photos in Newpark 2003 to be as deep as it is in Inukshuk's 2006 survey. Likely the area has settled by as much as 0.5 m due to deeper thaw resulting from the ponded water.

Figure 4 schematically shows the interpreted cross-section of the sump, as it was first completed. The outline of the sump excavation, presented on Figure 3, has been determined conservatively by working back from the toe of the fill, which is reliably distinguishable on the ground and on Inukshuk's surveyed topography. As a minimum, the edge of the excavation should be approximately 6.0 m inside the toe of the fill. [Calculated as 1.5 m (the minimum height of fill) x 3 (for 3H:1V sideslopes) + 1.5 m (for the minimum distance that the crest is reported to have been outside the excavation)]. The following recommendations assume the edge of the sump excavation conservatively is only 5.0 m inside the limits of the fill.

5.0 REMEDIATION REQUIREMENT

For the sump to contain partially unfrozen drilling wastes with saline-water pockets, several remediation design criteria must be satisfied, as follows:

- The sump must have a sufficiently thick soil cap (>1.5 m above surrounding ground level) that it does not thaw through to allow surface water into the sump or to release drilling waste fluids.
- The area of contaminated cap soils in the north half of the sump (see Figure 3) should be covered by a similar 1.5 m of thaw-stable fill, because it could thaw more deeply than uncontaminated cap soils.
- The surface of the cap must be graded to drain properly; otherwise ponding will cause it to thaw more deeply. (Ponded water acts as a heat source and promotes deeper thaw.) A top slope of 2.5% is recommended to promote runoff.
- Seasonal thaw (the active layer) in the containment zone around the perimeter of the sump must not extend deeper than the top of the ice cap, which is interpreted to be about elevation 2.8 m.

Some other requirements that must be incorporated in the remediation design include:

- providing a drainage path for water ponding on the east side of the sump;
- protecting the sump cap from erosion caused by drainage;
- removing salt contaminated soils within the active layer along the southwest side of the sump;
- confining in situ salt contaminated soil in the area north of the sump and in the east pond area by covering with sufficient soil (>1.5 m) that it becomes encapsulated in permafrost; and
- establishing a cover of grasses over the sump and adjacent disturbed areas to help resist erosion and improve (cool) the ground temperature regime.

6.0 REMEDIATION RECOMMENDATIONS

6.1 SUMP CAP

The proposed remediation work on the sump cap is intended to re-establish a frozen seal over the cover soils and drilling wastes.

Essis 2005 clearly indicates that the north central part of the cap has been contaminated with salts and Drawing 1 indicates that the thickness of the cap has declined substantially from its original height of 1.5 m to 2.0 m above grade. For this to have occurred, requires:

a) thawing of about 4.5 m of non-saline cap and cover soils and its consolidation, which is not supported by the thermistor monitoring data;

b) thawing of saline-rich drilling wastes and the flood-cover water and subsequent displacement of unfrozen saline drilling fluids into and through the backfill; or

c) removing considerable material during regrading activities in 2005.

A plausible interpretation is that some of the drilling wastes or water with which it was flooded have partially thawed as they warmed up to average ground temperatures. This would occur at ground temperatures that would not thaw the non-saline cover and cap soils. Subsequently, some of that saline-rich water has been displaced by the weight of the backfill and it may have mixed into the backfill.

To create a new cap that will prevent the ingress of precipitation and promote proper drainage, a new cap should be placed over the existing cap to a height of at approximately 1.5 m above the thinnest part of the existing cap. The surface of the new cap cover should be sloped at a minimum 2.5% grade to promote runoff. The cap should extend to cover the entire existing cap fill area and extend at beyond the original sump boundaries in areas where contamination has been identified. The sideslopes of the fill should be trimmed to 2.5H:IV. Except where confined by the lease boundaries. Figure 5 shows recommended design grades and design sections. This would require approximately 3,500 m^3 of in-place fill plus allowances for bulking and consolidation.

It is recommended that the new cap cover be constructed of pit-run granular fill, such as the material which can be obtained from the Navy Road Pit in Inuvik. The pit-run should be free from significant snow, ground-ice, large frozen lumps, and boulders. It should be placed in thin (< 0.20 m) lifts, and track-packed.

6.2 EAST-SIDE POND

The proposed remediation work on the east side of the sump is intended to raise the confining permafrost table to about elevation 4.0 m which would be higher than the normal high water level of the pond.

To push the ponded water away from the sump, the west end of the pond should be filled for a distance of 10 m from the interpreted original edge of the sump excavation, or about 5 m wider than the cap fill outlined above. The fill should not be allowed to block either outlet from the pond. It should extend the length of the sump and have a height of at least 1.5 m above the pond outlet level (to elevation 5.4 m). Final sideslopes on the fill in this section should be 2H:1V. Before the fill is placed, pond ice should be removed from the fill area. The pond ice, which could have a low level of salinity, can be wasted at the east end of the lease. The berm can be constructed of pit-run granular fill, sourced and placed as described above.

These recommendations recognize that some ponding will remain in the area on the east side of the proposed fill area. This ponding will be far enough from the edge of the sump that a secure containment barrier is maintained.

A second assumption is that the contaminated active layer soils, shown near the south end of the pond on Figure 3, can be left in-place and mostly will be immobilized when buried under 1.5 m or more of frost-stable capping soil.

6.3 SOUTH-SIDE CONTAMINATION

Salt contaminated near surface soils should be removed to a depth of about 1.0 m below grade during the winter of 2007 from the area indicated on Figure 3. Contaminated soils from between the sump and southwestern lease boundary (an area of approximately 25 m x 8 m) should be ripped, excavated, loaded in trucks, and hauled to Inuvik for disposal. The southwestern edge of the excavation should be the lease boundary.

The resulting excavation should be backfilled with Inuvik (Navy Road Pit) pit-run which must be handled uniquely to ensure that it will provide containment to at least 1.5 m above the level of drilling wastes. The back-fill must be placed in 0.20 m lifts, water-saturated, and track-packed or tamped with by a backhoe. The lifts should be placed several hours apart to allow them to freeze. The actual time required should be adjusted according to air temperature. This will be a difficult winter construction task which must be well planned in advance.

The sump cap should be extended in this area to cover the excavation zone to the extent possible without blocking drainage. The south edge of the new cap should have a top elevation as indicated on Figure 5 and it should extend from about 5.0 m beyond the west edge of the sub-cut area around the southeast end of the sump. The toe of the new cap should be placed about 1.0 m from the lease boundary and the south facing slope may need to be as steep as 2H:IV to allow for a drainage path between the berm and the lease boundary. The south-side berm should be wrapped around the southeast corner of the sump to meet the east-side berm, and must not impede drainage from the pond at the 4.1 m elevation level.

These recommendations do not include remediation of the soils and distressed (dead) vegetation which are located beyond the lease boundary in a southwesterly direction. The plume of saline contamination appears on EM mapping (Essis, 2005) to extend to about 80 m off the lease. It should be left to attenuate naturally which should occur after its source has been cut-off by the measures described above. This is further discussed in Appendix A.

6.4 NORTH-SIDE CONTAINMENT

With the apparent collapse of the north half of the sump cap (or removal of some of the cap during the 2005 re-grading effort) and the contamination of some of the cap soil, it is prudent to ensure that perimeter containment is maintained. Remediation measures, which include extending the new cap to cover the area of concern identified in 2005, are recommended to ensure that permafrost does not thaw to below the level of the original ground.

6.5 DRAINAGE AND EROSION CONTROL

Drainage from the east-side pond and runoff from the sump cap will be directed northward into the ditch at about the 3.9 m level or southwesterly into the natural swale at about the 4.1 m level. Hydraulic and/or thermal erosion is possible in both areas, until they become re-vegetated. Consequently, it is recommended that a stockpile of 100 m^3 of clean, quarry rock or coarse gravel is placed on the lease to provide a source of erosion resistant fill for remediation, should it be required. The stockpile should be configured to allow deep seasonal thaw and internal drainage if it is not to be ice-bonded when needed.

7.0 RECOMMENDATIONS FOR CONSTRUCTION CONTROL

The remediation plan presented above requires planning, care and good workmanship if it is to be successful. Alternately, the suggested minimum fill thicknesses should be increased to provide a more conservative insulating soil cap.

Some of the critical areas to control during construction include the following:

- inspect the fill being loaded for trucking at the pit, to minimize the amount of snow, ground ice, large boulders, and materials that are not suitable for the site;
- strip snow and ice from the areas where fill is to be placed;
- prepare the work site with a protective ice pad, except where fill is to be placed;
- retain surveyors to stake cut areas, to set the toe and crest lines for filling, and to set grades;
- place the fill in thin lifts and track-pack;
- install thermister cables to allow monitoring of the effectiveness of the remedial works (the existing thermister cables are not expected to survive the remedial works); and
- complete an as-built survey.

8.0 CLOSURE

Recommendations provided herein are intended to cut-off the escape of saline-rich seepage from the Itiginkpak F-29 sump and to re-establish permafrost containment. The proposed approach is based on the use of natural materials and relies on local ground temperature measurements from 2003 to 2005. If there are any questions regarding these recommendations, please contact the undersigned.

Respectfully submitted,
Kiggiak-EBA Consulting Ltd.

REGISTERED PROFESSIONAL ENGINEER
NEIL R. MacLEOD
LICENSEE
N.W.T.
Oct 20, 2006

REGISTERED PROFESSIONAL ENGINEER
E.M. GROZIC
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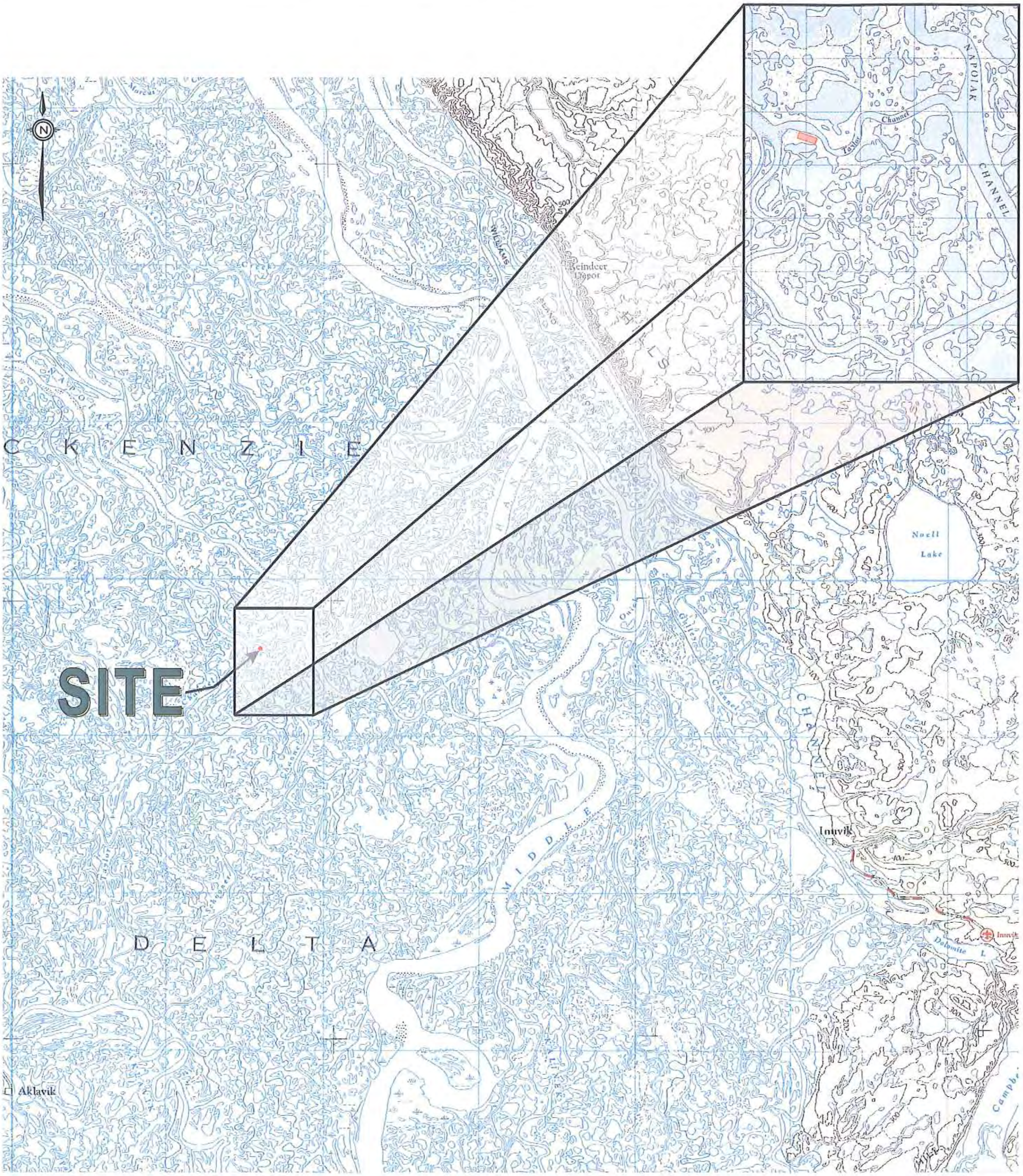
PERMIT TO PRACTICE
KIGGIAK-EBA CONSULTING LTD.
Signature
Date 20 October 2006
PERMIT NUMBER: P 0449
The Association of Professional Engineers, Geologists and Geophysicists of the NWT / NU

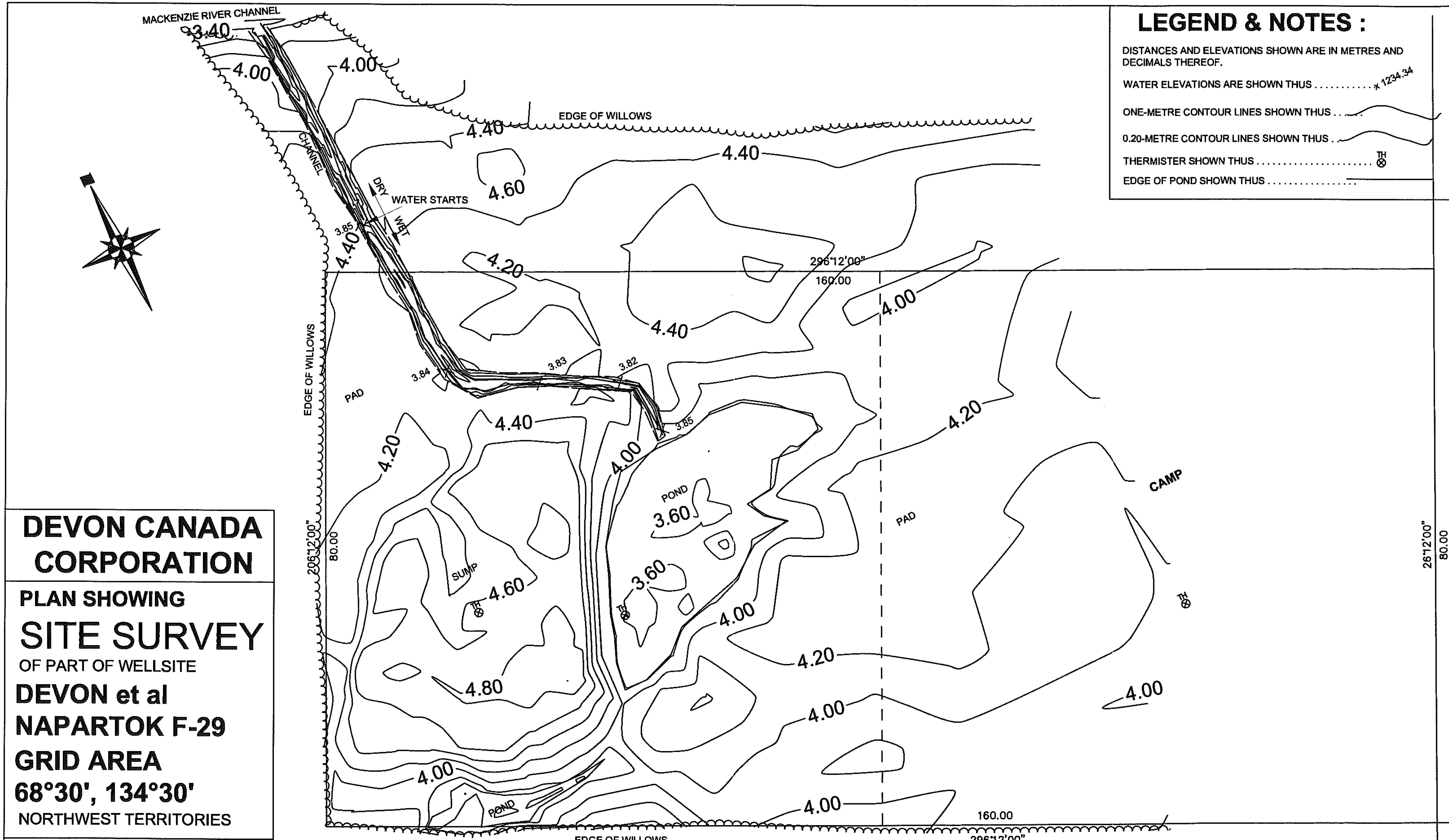
REFERENCES

1. Newpark Environmental Services (2003): Devon Itiginkpak F-29 Drilling Waste Disposal Summary
2. Newpark Environmental Services (2004): Itiginkpak F-29 Site Investigation and Downloading of Temperatures.
3. Newpark Environmental Services (2005): Itiginkpak F-29 Site Investigation and Downloading of Temperatures.
4. Essis Ltd. (2003): Environmental Imaging to Investigate Subsurface Conditions at the F29 Sump Location.
5. Essis Ltd. (2005): Environmental Imaging to Investigate Subsurface Conditions at the F29 Sump.
6. IEG Environmental (2005): Report for the Devon Canada Itiginkpak (F-29) Sump Assessment.
7. EBA Engineering Consultants Ltd. (2003): Letter of May 22, 2003 addressed to Devon Canada Corporation. Subject: Observation of Sump Excavation and Closure, Nepartok F-29 Drill Site, Mackenzie Delta NWT

FIGURES



EBA Engineering Consultants Ltd.	CLIENT: DEVON CANADA CORPORATION	PROJECT: ITIGINKPAK F-29 SUMP REMEDIATION
DWN. ANS / CHKD. NRM		TITLE: SITE LOCATION PLAN
EBA JOB NO. 1100118	FILE: 1100118-fg1.cdr / REVISION NO. 1	DATE: August 30, 2006 / Figure 1



DEVON CANADA CORPORATION

PLAN SHOWING

SITE SURVEY

OF PART OF WELLSITE

DEVON et al NAPARTOK F-29 GRID AREA 68°30', 134°30'

NORTHWEST TERRITORIES

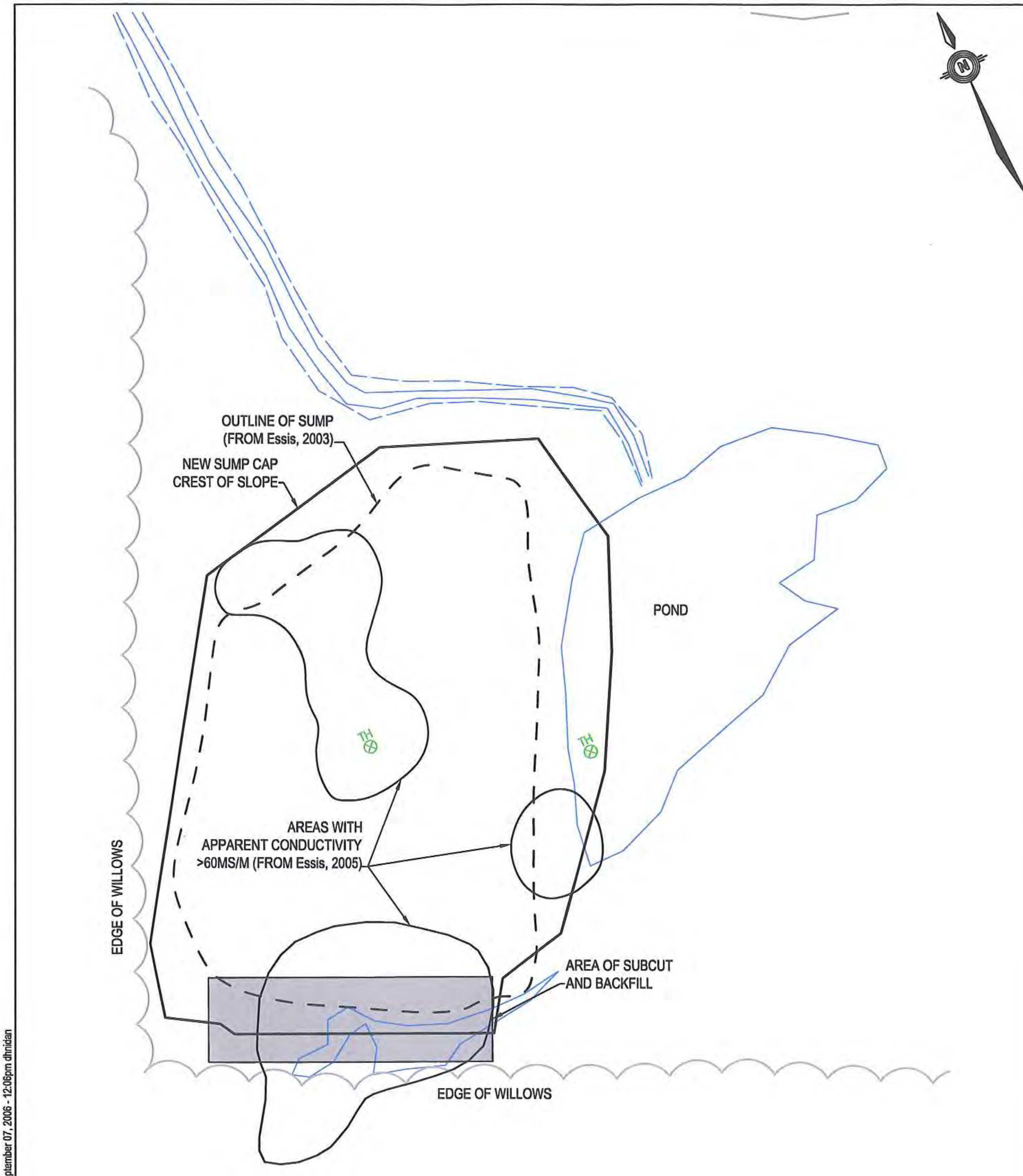
INUKSHUK Geomatics Inc.
300-6940 FISHER ROAD S.E.
CALGARY, ALBERTA T2H 0W3
PH (403) 253-8101
WWW.CHALLENGERGEOMATICS.COM
Email: calgary@chalgeo.com

10 5 0 10 20 metres

SCALE 1 : 500

FIGURE 2

Drawn by: KP	Scale: 1:500	Drawing: 35016_SITE SURVEY	
Checked by: RR	Date: Sep 07, 2006 - 12:08pm		
REV No. 0	Description:	Date: -/-/-	By: -



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		AREAS OF CONTAMINATED SOILS ON LEASE			
	EBA Engineering Consultants Ltd.	PROJECT NO. 1100118	DWN ANS	CKD NRM	REV 0
		OFFICE EBA-CALG	DATE August 30, 2006		Figure 3

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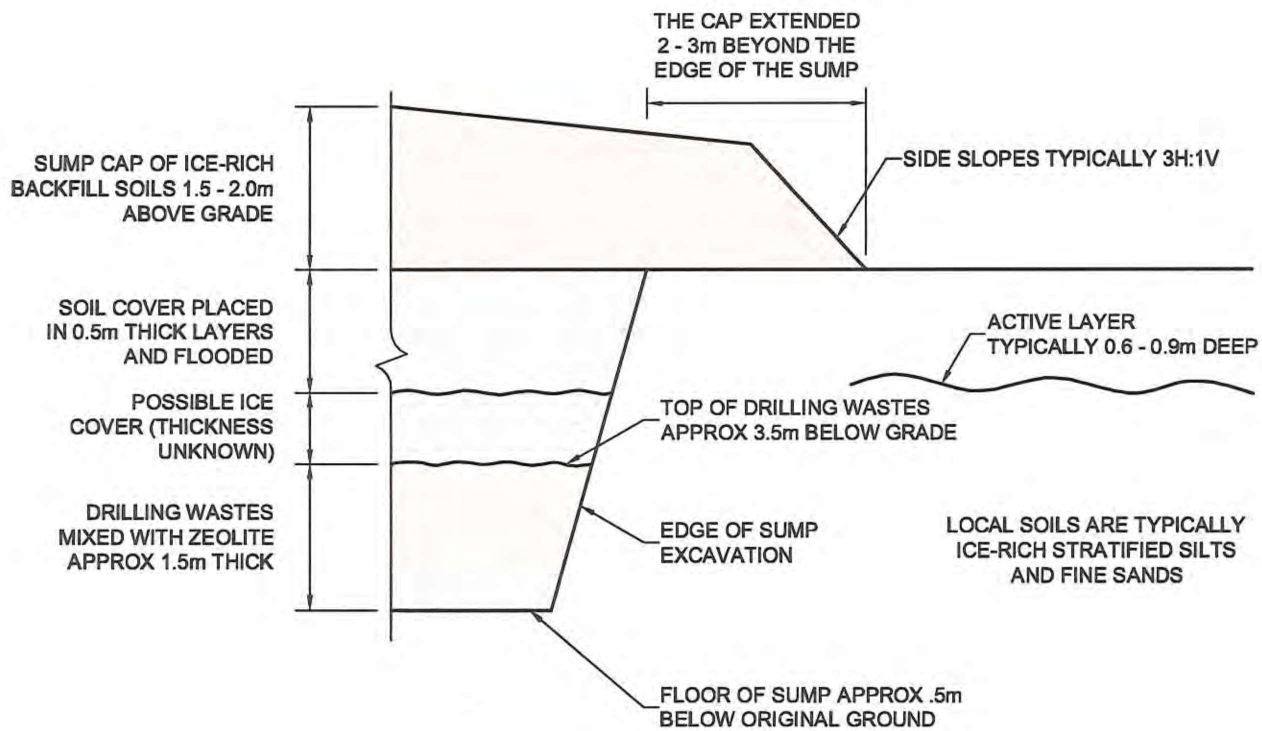

INTERPRETED CROSS-SECTION
N.T.S.

CLIENT

DEVON CANADA CORPORATION

EBA Engineering Consultants Ltd.

ITIGINKPAK F-29
SUMP REMEDIATION

INTERPRETED CROSS-SECTION OF THE ORIGINAL SUMP

PROJECT NO.	DWN	CKD	REV
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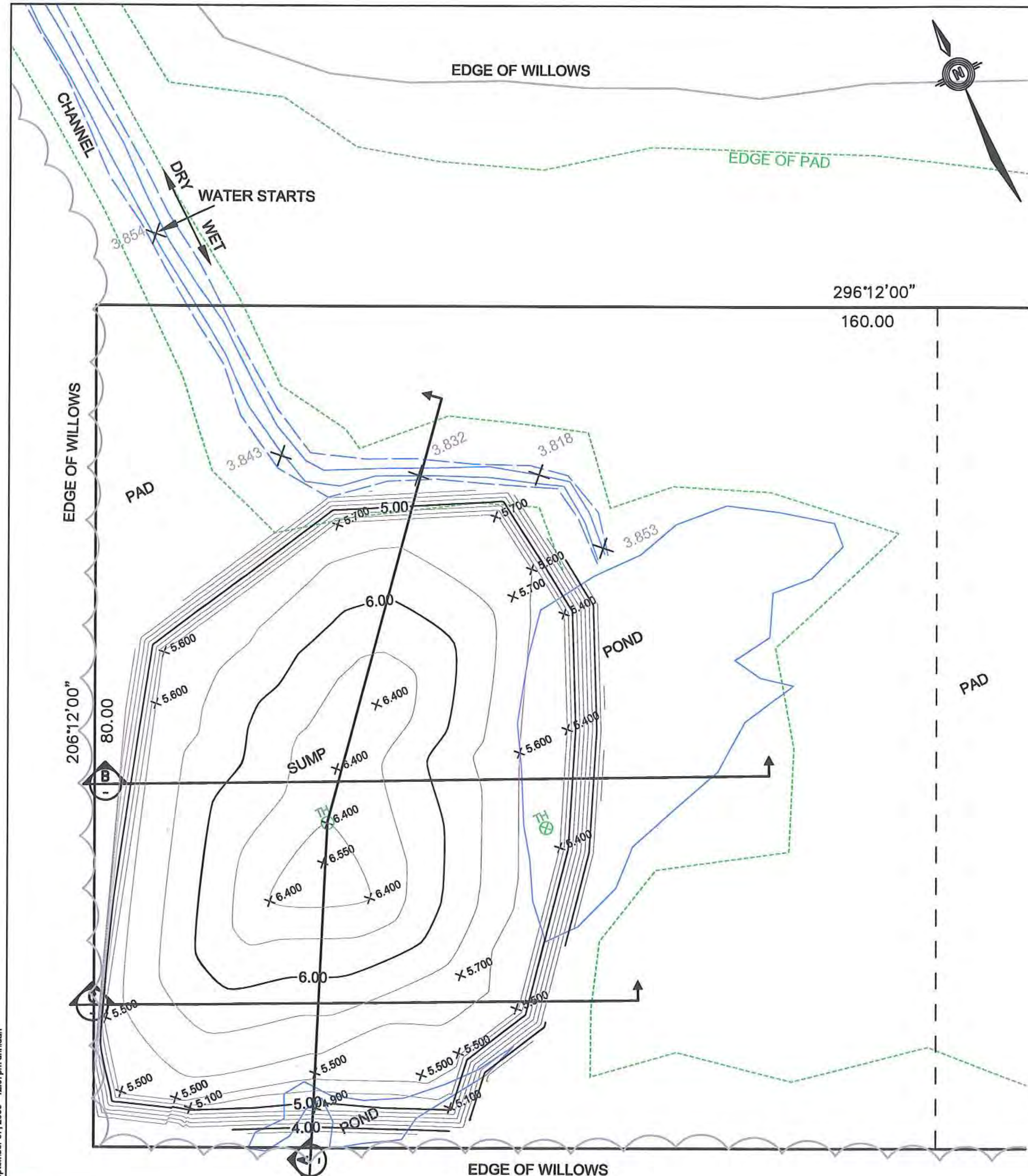
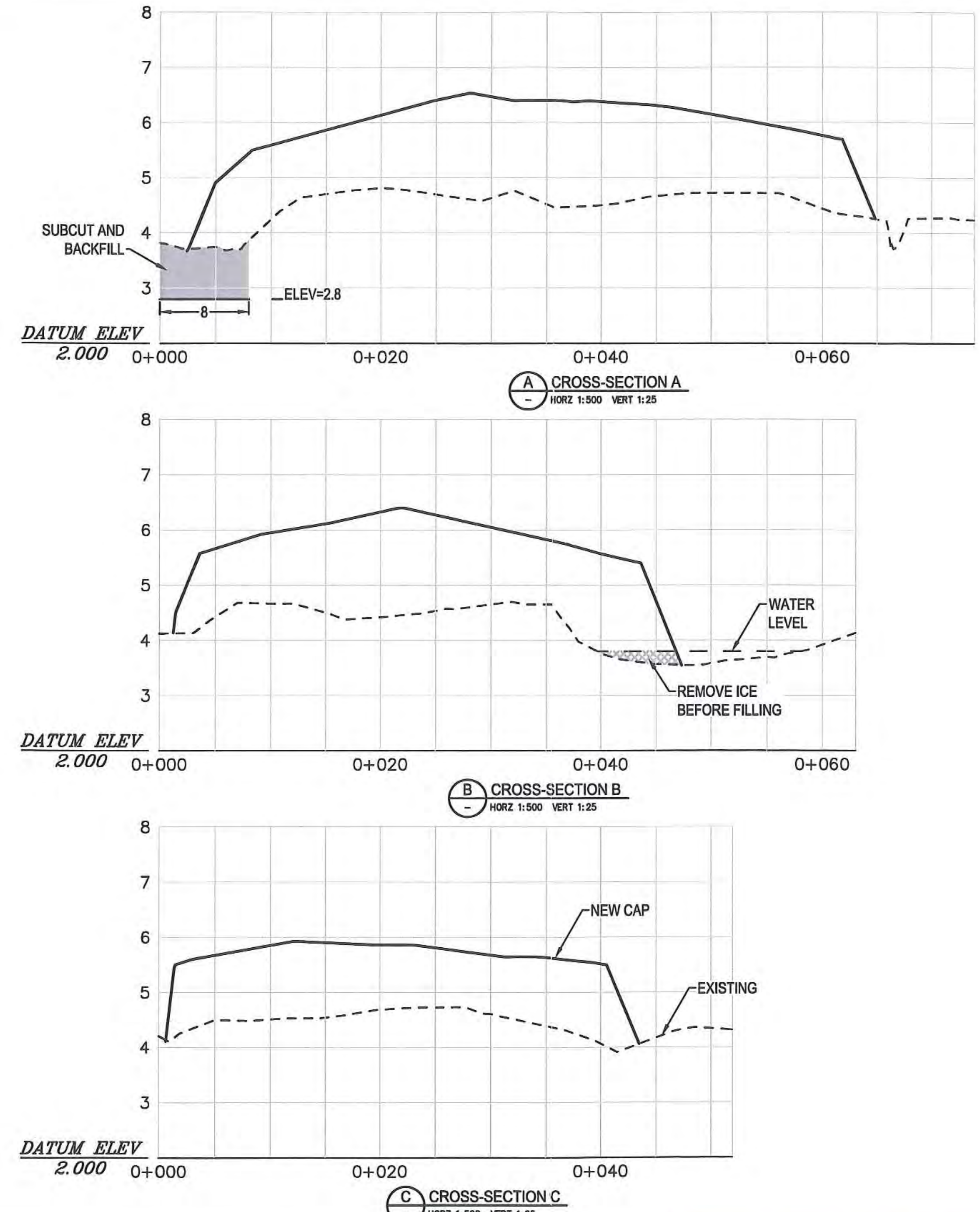
OFFICE	DATE
EBA-CALG	August 30, 2006

Figure 4





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CLIENT

DEVON CANADA CORPORATION

ITIGINKPAK F-29
SUMP REMEDIATION

DESIGN SECTIONS FOR
NEW SUMP CAP

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
1100118	ANS	NRM	0
OFFICE	DATE		
EBA-CALG	August 30, 2006		

Figure 5

PHOTOGRAPHS

Photo 1 Itiginkpak F-29 Lease and Sump Area – June 16, 2006 (viewed southward)

Photo 2 Itiginkpak F-29 Sump Cap and Edge of East Pond (viewed northward)

Photo 1
Itiginkpak F-29 Lease and Sump Area – June 16, 2006 (viewed southward)

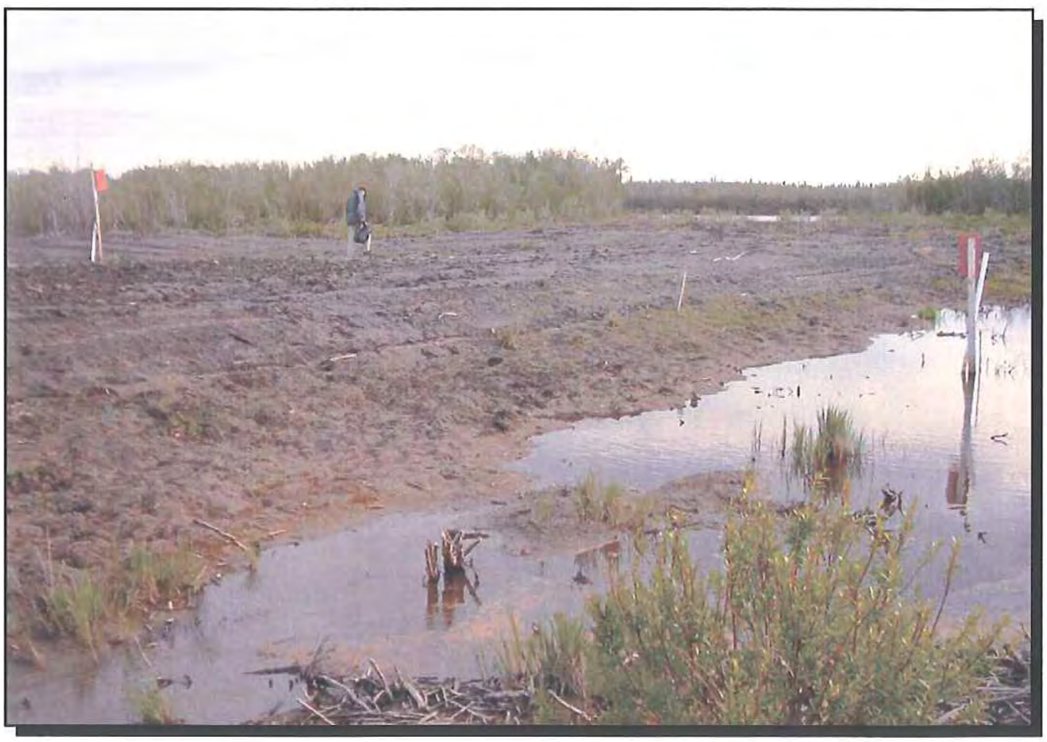


Photo 2
Itiginkpak F-29 Sump Cap and Edge of East Pond (viewed northward)

APPENDIX

APPENDIX A SEVERITY OF SALT IMPACTS (AUGUST 30, 2006 MEMO)

TO: Neil MacLeod., M.Sc., P.Eng.
Ed Grozic, M.Eng., P.Eng.
Kiggiak-EBA Consulting Ltd.
Northern Oil and Gas Services

DATE: August 30, 2006

FROM: Kathryn Bessie, P.Ag.
Senior Soil Scientist,
EBA Engineering Consultants
Environmental Services

FILE: 1100118

SUBJECT: **Severity of Salt Impacts**
Devon Itiginkpak F-29 Sump, Remediation Plan

1.0 INTRODUCTION

As part of Kiggiak-EBA's work scope described in our May 16, 2006 letter, we committed to: "Assess the severity of brine-based (salt) contaminated soil around the sump and identify necessary remedial measures, including the extent to which salt contaminated soil surrounding the sump should be removed or can be left in place." This memo provides that assessment based on background information supplied by the client, including the following:

- EBA, 2003. Observations of Sump Excavation and Closure, Nepartok F-29 Drillsite, Mackenzie Delta, NWT, Prepared by EBA Engineering Consultants Ltd., May 2003, file 1100023
- Essis Ltd., 2003. Environmental Imaging to Investigate Subsurface Conditions at the Itiginkpak F-29 Sump, September 30, 2003. Directed by Newpark Environmental Services.
- Essis Ltd., 2005. Environmental Imaging to Investigate Subsurface Conditions at the Itiginkpak F-29 Sump, October 18, 2005. Directed by Newpark Environmental Services.
- IEG Environmental, 2005. Report for the Devon Canada, Itiginkpak F-29 Sump Assessment, September 2005.
- Newpark Environmental Services, 2003. Drilling Waste Disposal Summary Devon Itiginkpak F-29.
- Newpark Environmental Services, 2004. Site Investigation and Downloading of Temperatures, Devon Itiginkpak F-29, September 2004.
- Newpark Environmental Services, 2005. Site Investigation and Downloading of Temperatures, Devon Itiginkpak F-29, September 2004.
- Correspondence between Devon and the Northwest Territory Water Board; and
- Pictures and file notes during sump construction and backfill.

2.0 ASSESSMENT

Severity and Extent of Off-Lease Salt Impact

The ecosystem off-lease has been impacted by salts from the drilling sump, specifically potassium chloride salts. There is a linear area with dead willows that has not been measured, but appears to be substantially smaller than the off-lease area of higher conductivity shown by Essie 2005 (approximately 5 m wide and 80 m long or 400 m^2). The impacted area follows an existing surface water drainage pathway southwest of the lease. Whether the number of willows impacted and size of area have grown has not been monitored. Salt seepage appears to be increasing in severity immediately adjacent to the sump based on an interpretation of the three continuous years of non-intrusive conductivity surveys.

Salt concentrations within this area exceed CCME guidelines for Parkland land use of electrical conductivity (EC) of 2.0 dS/m and sodium adsorption ratio (SAR) of 5.0, referenced in the IEG 2005 report. The EC in 2005 sampling for the area south of the sump and extending off-lease were greatest closest to the source ranging at various depths above the permafrost between 12.00 dS/m to 20.90 dS/m (BH004). Salt concentrations generally decrease the further the sample location is from the source with concentrations at BH005 of about 6 dS/m. In the middle, the EC concentrations are lowest at the surface (between approximately 6 dS/m to 10 dS/m) and highest along the permafrost interface (approximately 0.7 cm below ground surface) with concentration from about 12 dS/m to 25 dS/m. This distribution indicates the salts are moving laterally and are not from a surface spill. The concentrations from samples in the center of the cap were highest at the surface (about 4 dS/m to 12 dS/m) and decreased with depth.

The type of introduced salt south of the sump is primarily potassium chloride, which corresponds to main salts in the drilling waste and is one of the more mobile salts. Whereas in the center of the cap area there are other elevated cations (including magnesium and sodium) possibly influenced by the addition of cement or other compounds during sump stabilization, or other less soluble salt additives to the drilling waste.

Based on the photographs of the site and ecological area, the predominant vegetation species appear to be willow (*Salex sp.*) and sedges (*Carex sp.*), with some black spruce further from the site (*Picea Mariana*).

Electrical conductivity less than 2 dS/m are usually considered as non-saline and have no affect on vegetation growth. EC in the range of 2 to 4 dS/m are often rated as fair for plant growth; 4 dS/m to 8 dS/m as poor for plant growth and greater than 8 as undesirable[1];. Other categorizations recognize that some species are tolerant to EC even up to about 32 dS/m^2. Other regulations take the approach of using sodium and chloride toxicities to evaluate impact[3]. One can also use the approach of using control soil concentrations in naturally saline and sodic areas or tolerance of the specific vegetation to set site-specific guidelines.

Although there is extensive information on salt tolerance of agricultural vegetation, there is less for wetland and forest vegetation. Just from a brief look, one would assume that the willows would start to regenerate when EC's are less than 4 dS/m to 8 dS/m. However, there are some much higher EC's reported for some species of willows from one document reviewed [4]. For mature black spruce, the upper tolerance for brine spill was reported as 7.11 dS/m. Forest nurseries find conifer

[1] Alberta Environment. 2001. Salt Contamination Assessment & Remediation Guidelines.
[2] Breisler, E et.al. 1982. Saline and Sodic Soils, Principles-Dynamics-Modeling
[3] Bright, D.A. and J. Addison. 2002. Derivation of matrix Soil Standards for Salt under the British Columbia Contaminated Sites Regulation; Environment Canada & Health Canada.and 2000 Draft. Priority Substances List, Assessment Report, Road Salts (Draft)
[4] Alberta Environment. 2000. Acceptable Salinity, sodicity and pH values for Boreal Forest Reclamation.

germination affected by EC greater than 2 dS/m. Alaska willow (*Salix alaxensis*) and short-capsuled willow (*Salix brachycarpa*) EC tolerances in a study on Tanana River in interior Alaska were reported as 14.39 dS/m to 31.24 dS/m, which is much higher than the low to moderate tolerances considered for willows[5]. Awned sedge by Athabasca River in Alberta was the only sedge species reported on and it had an EC tolerance reported as 8.2 dS/m.

It is beyond the scope of this memo to set site-specific guidelines. The memo's purpose is to indicate the EC level at which one might expect to see the willow vegetation start to re-grow. The assessment is based upon a few select references and the authors experience assessing and remediating salt spills over the last 25 years in wetlands, boreal forest and agricultural soils in Alberta and northern BC.

There is likely a 400 m^2 area that contains soils currently above an EC of 4 dS/m to 8 dS/m. This area is subject to a flushing action every spring/summer. If the source was removed, one would expect the salts concentration to be flushed within a reasonable time period and the willows to start to revegetate. This prediction, however, should be confirmed by monitoring. Salts tend to migrate as a slug in soils with high water content, so cutting the dead willows off at ground level and monitoring new growth or further kill off should be conducted, as well as continuing the annual EM surveys, soil sampling and sump temperature monitoring.

Additional Water Analysis from July 2006 Site Visit

Four grab samples of the ponded water around the sump were collected and analyzed for salinity 2006. A figure showing the approximate location of the samples and the laboratory data is attached.

Previous water samples were collected by IEG (2005). Background water samples had a maximum electrical conductivity of 0.374 dS/m and chlorides of 14.9 mg/L. Whereas, the East Pond had slightly elevated maximum EC of 1.370 dS/m and chlorides of 322 mg/L. There are no CCME freshwater aquatic life guidelines for either of these parameters.

The 2006 water samples also had EC and chlorides greater than the background, but were in the same general low range as the previous samples for the east ponds, with ECs ranging about 0.7 dS/m and chlorides about 118 mg/L. The north pond area was slightly higher values than these. The South (southwest) Pond, which connects to the off-lease area, had higher concentrations with an EC of 5.420 dS/m (5420 uS/cm) and chlorides of 1960 mg/L.

3.0 REMEDIATION PLAN RECOMMENDATIONS

If the source of salt contamination was cut-off at the lease edge by increasing the thickness and area of the sump cap, allowing the area to remain frozen at higher grades, there would be left only a minor amount of area off-lease with salt contamination.

[5] Alberta Reclamation Research Technical Advisory Committee. 1989. Manual of Plan Species Sujitability for Reclamation in Alberta, 2nd Ed. RRTAC report 89-4.

It seems reasonable to expect that as long as the source is stopped on-lease, the residual salts left in place off-lease should be able to dissipate with time.

These recommendations are based upon an assumption that the client wishes only to stabilize the sump area and control off-lease releases of salt, and that removal of the entire sump is not an option being considered at this time.

4.0 CLOSURE

This assessment is based on data from others and is limited by the scope of work referenced in the introduction. It should be considered preliminary and is limited by the accuracy and amount of the data reviewed. Additional site monitoring data is expected in fall of 2006 and, at that time, this assessment should be re-evaluated. For further limitations refer to EBA's General Terms and Conditions.

I trust that the above is adequate as input for the engineering design for stabilizing this sump. Should you have any questions, please contact the undersigned.

Sincerely,
EBA Engineering Consultants Ltd.

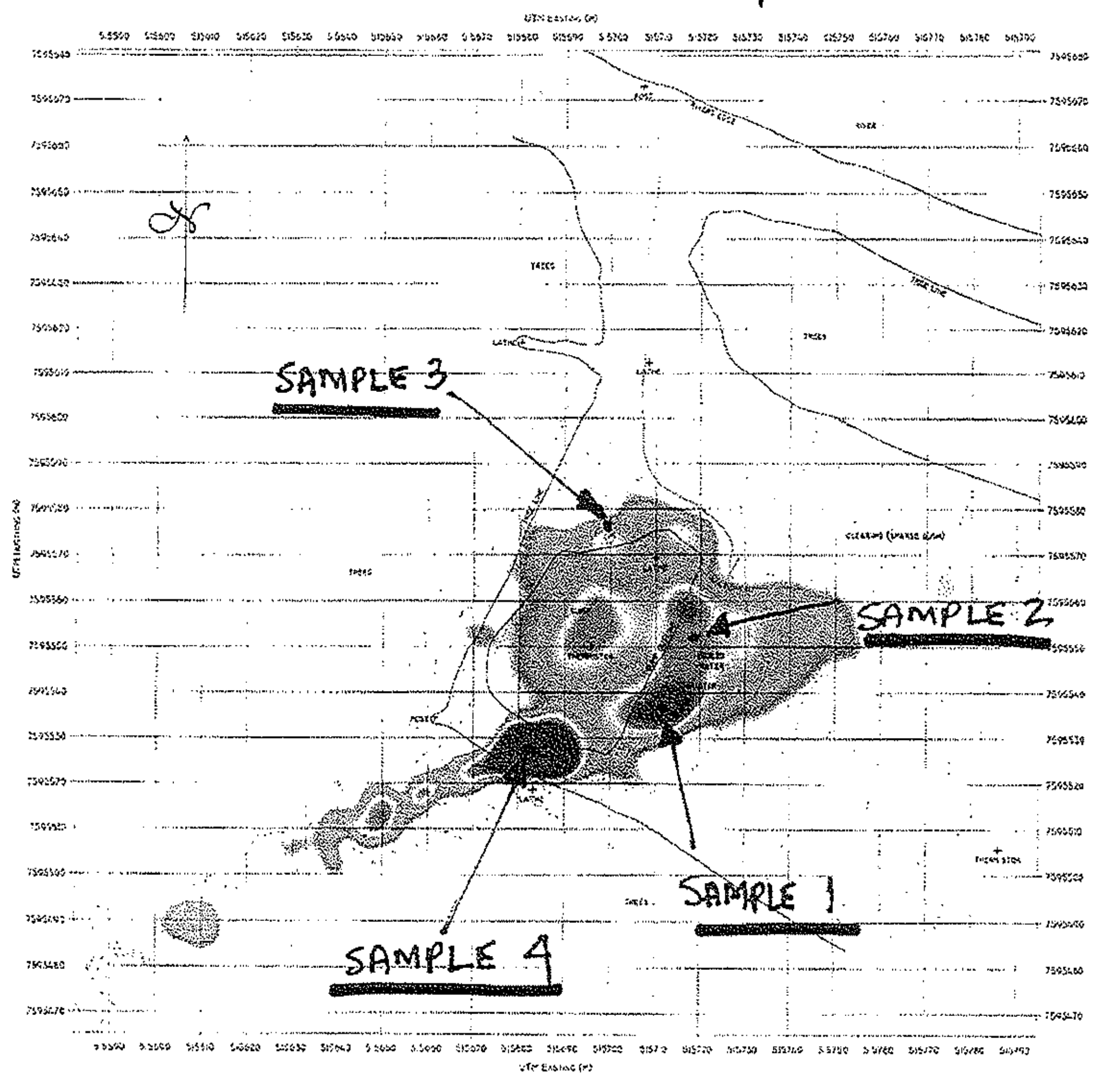
K Bessie

Kathryn Bessie, P.Ag. Oct 20, 2006
Senior Soil Scientist
MERUS Environmental Services
EBA Engineering Consultants Ltd.
Direct Line: 403.723.6865
kbessie@eba.ca

/kdb

EBA JOB NO. 1100118

ROUTINE WATER + SALINITY



[redacted]

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COC #095892

Pg 1 of 1

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COMPANY: EBA ENGINEERING CONSULTANTS LTD

CONTACT: ED GROZIC

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PHONE: 723-6858 FAX: 203-3301

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JOB # 1100118

PO / AFE:

LSD: DEVON ITIGINKPAK F-29 SUMP

QUOTE #

ANALYSIS REQUEST

SAMPLE ID	SAMPLING LOCATION	SAMPLED BY / DATE / TIME	SAMPLING METHOD	SAMPLE TYPE	BASIC WATER SALINITY									HAZARDOUS? (Y/N)	NUMBER OF CONTAINERS	HIGHLY CONTAMINATED? (Y/N)	LAB SAMPLE #
SAMPLE # 1	EAST POND	ENG 16/06/06	GRAB		\									N	1	N	1
SAMPLE # 2	EAST POND	EMG 16/06/06	— " —		\									N	1	N	2
SAMPLE # 3	NORTH POND	EMG 16/06/06	— " —		\									N	1	N	3
SAMPLE # 4	SOUTH POND	EMG 16/06/06	— " —		\									N	1	N	4

NOTES & CONDITIONS:

1. Quote number must be provided to ensure proper pricing.
2. Turnaround times will vary dependent on complexity of analysis & Lab workload at time of submission. Please contact the Lab to confirm turnaround time.
3. All hazardous samples submitted must be labeled to comply with WHMIS and TDG regulations. This must include the nature of the hazard, as well as a contact name & phone number that the Lab can contact for further information.

NOTE: Failure to properly complete all portions of this form may delay analysis.

GUIDELINES / REGULATIONS	SPECIAL INSTRUCTIONS / NATURE OF HAZARDOUS MATERIAL	SAMPLE CONDITION
		☐ FROZEN ☒ COLD ☐ AMBIENT — MEAN TEMPERATURE 9°C

RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:	SAMPLE CONDITION ACCEPTABLE UPON RECEIPT? (Y/N)
EMGrozic	19/06/06	Clyde		
RELINQUISHED BY:	DATE & TIME:	RECEIVED BY: [signature]	DATE & TIME: June 19/06	

REFER TO BACK FOR SAMPLING INFORMATION & REGIONAL LOCATIONS

WHITE - REPORT COPY, PINK - FILE COPY, YELLOW - CLIENT COPY

REVISED MAY 2003

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

ANALYTICAL REPORT

EBA ENG CONSULTANTS LTD
ATTN: ED GROZIC

115, 200 RIVERCREST DR SE

CALGARY AB T2C 2X5

Reported On: 29-JUN-06

Lab Work Order #: **L401405** **Date Received:** **19-JUN-06**

Project P.O. #: N/A
Job Reference: 1100118 DEVON ITIGINPAK F-29 SUMP
Legal Site Desc:
CofC Numbers: 095892

Comments:

APPROVED BY: ______________________________

MONICA GIBSON
Project Manager

ALS Canada Limited
Environmental Division
Part of the ALS Laboratory Group
Bay 2, 1313-44 Ave. N.E., Calgary, AB T2E 6L5
Phone: +1 403 291 9897 Fax: +1 403 291 0298 www.alsglobal.com
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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L401405-1 SAMPLE #1 EAST POND								
Sampled By: ENG on 16-JUN-06								
Matrix: WATER								
Basic Water Salinity								
Chloride (Cl)	116		0.1	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
Conductivity (EC)	802		3	uS/cm		22-JUN-06	JF	R412421
Sulphate (SO4)	6.1		0.5	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
TDS (Calculated)	521		1	mg/L		23-JUN-06		
pH	8.0		0.1	pH		22-JUN-06	JF	R412421
SAR								
Calcium (Ca)	91.7		0.5	mg/L		29-JUN-06	RAZ	R414441
Potassium (K)	26.6		0.1	mg/L		29-JUN-06	RAZ	R414441
Magnesium (Mg)	30.6		0.1	mg/L		29-JUN-06	RAZ	R414441
Sodium (Na)	17		1	mg/L		29-JUN-06	RAZ	R414441
SAR	0.4			SAR		29-JUN-06	RAZ	R414441

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L401405-2 SAMPLE #2 EAST POND								
Sampled By: ENG on 16-JUN-06								
Matrix: WATER								
Basic Water Salinity								
Chloride (Cl)	118		0.1	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
Conductivity (EC)	780		3	uS/cm		22-JUN-06	JF	R412421
Sulphate (SO4)	4.7		0.5	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
TDS (Calculated)	507		1	mg/L		23-JUN-06		
pH	8.0		0.1	pH		22-JUN-06	JF	R412421
SAR								
Calcium (Ca)	92.4		0.5	mg/L		23-JUN-06	HSC	R413088
Potassium (K)	28.2		0.1	mg/L		23-JUN-06	HSC	R413088
Magnesium (Mg)	30.8		0.1	mg/L		23-JUN-06	HSC	R413088
Sodium (Na)	17		1	mg/L		23-JUN-06	HSC	R413088
SAR	0.4			SAR		23-JUN-06	HSC	R413088

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L401405-3	SAMPLE #1 NORTH POND								
Sampled By:	ENG on 16-JUN-06								
Matrix:	WATER								
Basic Water Salinity									
	Chloride (Cl)	393		0.1	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
	Conductivity (EC)	1860		3	uS/cm		22-JUN-06	JF	R412421
	Sulphate (SO4)	160		0.5	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
	TDS (Calculated)	1210		1	mg/L		23-JUN-06		
	pH	8.2		0.1	pH		22-JUN-06	JF	R412421
SAR									
	Calcium (Ca)	202		0.5	mg/L		23-JUN-06	HSC	R413088
	Potassium (K)	139		0.1	mg/L		23-JUN-06	HSC	R413088
	Magnesium (Mg)	53.9		0.1	mg/L		23-JUN-06	HSC	R413088
	Sodium (Na)	52		1	mg/L		23-JUN-06	HSC	R413088
	SAR	0.8			SAR		23-JUN-06	HSC	R413088

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L401405-4	SAMPLE #4 SOUTH POND								
Sampled By:	ENG on 16-JUN-06								
Matrix:	WATER								
Basic Water Salinity									
	Chloride (Cl)	1960		0.1	mg/L	20-JUN-06	21-JUN-06	LHH	R412094
	Conductivity (EC)	5420		3	uS/cm		22-JUN-06	JF	R412421
	Sulphate (SO4)	19.0		0.5	mg/L	22-JUN-06	22-JUN-06	LHH	R412629
	TDS (Calculated)	3520		1	mg/L		23-JUN-06		
	pH	7.9		0.1	pH		22-JUN-06	JF	R412421
SAR									
	Calcium (Ca)	365		0.5	mg/L		29-JUN-06	RAZ	R414441
	Potassium (K)	764		0.1	mg/L		29-JUN-06	RAZ	R414441
	Magnesium (Mg)	111		0.1	mg/L		29-JUN-06	RAZ	R414441
	Sodium (Na)	164		1	mg/L		29-JUN-06	RAZ	R414441
	SAR	1.9			SAR		29-JUN-06	RAZ	R414441

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Preparation Method Reference(Based On)	Analytical Method Reference(Based On)
CL-CL	Water	Chloride (Cl)		APHA 4110 B-Ion Chromatography
EC-CL	Water	Conductance (EC)		APHA 2510 B-electrode
PH-CL	Water	pH		APHA 4500 H-Electrode
SAR-CALC-CL	Water	SAR		APHA 3120 B-ICP-OES / CSSS 18.4-Calc.
SO4-CL	Water	Sulfate (SO4)		APHA 4110 B-Ion Chromatography
SOLIDS-TDS-CALC-CL	Water	TDS (Calculated from EC)		APHA 1030 F - 0.65*EC

** Laboratory Methods employed follow in-house procedures, which are generally based on nationally or internationally accepted methodologies.

Chain of Custody numbers:

095892

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
CL	ALS LABORATORY GROUP - CALGARY, ALBERTA, CANADA		

GLOSSARY OF REPORT TERMS
Surr - A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior but not normally detected in enviromental samples. Prior to sample processing, samples are fortified with one or more surrogate compounds. The reported surrogate recovery value provides a measure of method efficiency. The Laboratory control limits are determined under column heading D.L.
mg/kg (units) - unit of concentration based on mass, parts per million
mg/L (units) - unit of concentration based on volume, parts per million
< - Less than
D.L. - Detection Limit
N/A - Result not available. Refer to qualifier code and definition for explanation

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
UNLESS OTHERWISE STATED, SAMPLES ARE NOT CORRECTED FOR CLIENT FIELD BLANKS.
Although test results are generated under strict QA/QC protocols, any unsigned test reports, faxes, or emails are considered preliminary.

ALS Laboratory Group has an extensive QA/QC program where all analytical data reported is analyzed using approved referenced procedures followed by checks and reviews by senior managers and quality assurance personnel. However, since the results are obtained from chemical measurements and thus cannot be guaranteed, ALS Laboratory Group assumes no liability for the use or interpretation of the results.

ENVIRO-TEST Routine Water Chemistry Report

L401405

Lab ID	Sample ID	Lab ID	Sample ID

ALS LABORATORY GROUP SOIL SALINITY CONVERSION

L401405

Lab ID	Sample ID			
L401405-1	SAMPLE #1 EAST POND			
Sample Date: 16-JUN-06				
Matrix: WATER				
	Result mg/L	% Sat	Meq/L	Dry Soil mg/kg
Calcium (Ca)	91.7	0	4.58	
Potassium (K)	26.6	0	0.68	
Magnesium (Mg)	30.6	0	2.52	
Sodium (Na)	17	0	0.73	

Lab ID	Sample ID			
L401405-3	SAMPLE #1 NORTH POND			
Sample Date: 16-JUN-06				
Matrix: WATER				
	Result mg/L	% Sat	Meq/L	Dry Soil mg/kg
Calcium (Ca)	202	0	10.07	
Potassium (K)	139	0	3.56	
Magnesium (Mg)	53.9	0	4.44	
Sodium (Na)	52	0	2.28	

Lab ID	Sample ID			
L401405-2	SAMPLE #2 EAST POND			
Sample Date: 16-JUN-06				
Matrix: WATER				
	Result mg/L	% Sat	Meq/L	Dry Soil mg/kg
Calcium (Ca)	92.4	0	4.61	
Potassium (K)	28.2	0	0.72	
Magnesium (Mg)	30.8	0	2.53	
Sodium (Na)	17	0	0.73	

Lab ID	Sample ID			
L401405-4	SAMPLE #4 SOUTH POND			
Sample Date: 16-JUN-06				
Matrix: WATER				
	Result mg/L	% Sat	Meq/L	Dry Soil mg/kg
Calcium (Ca)	365	0	18.23	
Potassium (K)	764	0	19.53	
Magnesium (Mg)	111	0	9.12	
Sodium (Na)	164	0	7.12	

"Calculations are as per:
Methods of Analysis for Soils, Plants and Waters
Homer D. Chapman and Parker F. Pratt
University of California, Riverside, Cl.
August, 1961."

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

ALS Laboratory Group Quality Control Report

Workorder: L401405 Report Date: 29-JUN-06

Client: EBA ENG CONSULTANTS LTD
115, 200 RIVERCREST DR SE
CALGARY AB T2C 2X5

Contact: ED GROZIC

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-CL	Water							
Batch R412094								
WG458050-2 DUP		**L401031-2**						
Chloride (Cl)		11.2	11.0		mg/L	1.1	13	20-JUN-06
WG458050-3 DUP		**L401405-2**						
Chloride (Cl)		118	119		mg/L	0.88	13	21-JUN-06
WG458050-1 LCS								
Chloride (Cl)			98		%		90-111	20-JUN-06
WG458050-4 MS		**L401405-2**						
Chloride (Cl)			92		%		84-108	21-JUN-06
EC-CL	Water							
Batch R412421								
WG459123-1 LCS								
Conductivity (EC)			98		%		90-108	22-JUN-06
PH-CL	Water							
Batch R412421								
WG459123-1 LCS								
pH			7.0		pH		6.9-7.2	22-JUN-06
SAR-CALC-CL	Water							
Batch R413088								
WG459966-4 DUP		**L401405-2**						
Calcium (Ca)		92.4	92.5		mg/L	0.15	13	23-JUN-06
Magnesium (Mg)		30.8	30.9		mg/L	0.38	13	23-JUN-06
Potassium (K)		28.2	27.8		mg/L	1.2	13	23-JUN-06
Sodium (Na)		17	17		mg/L	0.39	13	23-JUN-06
WG459966-3 IRM		**SALSTD-CL**						
Calcium (Ca)			105		%		86-124	23-JUN-06
Magnesium (Mg)			96		%		85-120	23-JUN-06
Potassium (K)			95		%		73-124	23-JUN-06
Sodium (Na)			99		%		84-117	23-JUN-06
WG459966-1 LCS								
Calcium (Ca)			99		%		96-114	23-JUN-06
Magnesium (Mg)			96		%		91-109	23-JUN-06
Potassium (K)			95		%		92-110	23-JUN-06
Sodium (Na)			99		%		92-110	23-JUN-06
WG459966-2 MB								

ALS Laboratory Group Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAR-CALC-CL	Water							
Batch R413088								
WG459966-2 MB								
Calcium (Ca)			<0.5		mg/L		0.5	23-JUN-06
Magnesium (Mg)			<0.1		mg/L		0.1	23-JUN-06
Potassium (K)			0.3	A	mg/L		0.1	23-JUN-06
Sodium (Na)			<1		mg/L		1	23-JUN-06
WG459966-5 MS		**L401405-2**						
Calcium (Ca)			100		%		84-120	23-JUN-06
Magnesium (Mg)			98		%		85-111	23-JUN-06
Potassium (K)			92		%		87-108	23-JUN-06
Sodium (Na)			104		%		81-119	23-JUN-06
Batch R414441								
WG461717-10 DUP		**L401405-1**						
Calcium (Ca)		91.7	90.7		mg/L	1.1	13	29-JUN-06
Magnesium (Mg)		30.6	30.2		mg/L	1.2	13	29-JUN-06
Potassium (K)		26.6	26.6		mg/L	0.13	13	29-JUN-06
Sodium (Na)		17	16		mg/L	1.5	13	29-JUN-06
SO4-CL	Water							
Batch R412094								
WG458050-2 DUP		**L401031-2**						
Sulphate (SO4)		15.9	16.1		mg/L	1.2	13	20-JUN-06
WG458050-3 DUP		**L401405-2**						
Sulphate (SO4)		4.7	4.9	J	mg/L	0.2	2	21-JUN-06
WG458050-1 LCS								
Sulphate (SO4)			96		%		91-110	20-JUN-06
WG458050-4 MS		**L401405-2**						
Sulphate (SO4)			98		%		87-115	21-JUN-06
Batch R412629								
WG459242-2 DUP		**L402416-4**						
Sulphate (SO4)		45.5	44.7		mg/L	1.9	13	22-JUN-06
WG459242-3 DUP		**L402531-3**						
Sulphate (SO4)		18.1	18.3		mg/L	0.93	13	23-JUN-06
WG459242-5 DUP		**L402710-1**						
Sulphate (SO4)		265	266		mg/L	0.52	13	23-JUN-06
WG459242-1 LCS								
Sulphate (SO4)			98		%		91-110	22-JUN-06
WG459242-4 MS		**L402531-3**						

ALS Laboratory Group Quality Control Report

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-CL		Water							
Batch	**R412629**								
WG459242-4	**MS**		**L402531-3**						
Sulphate (SO4)				109		%		87-115	23-JUN-06

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Legend:

Limit	99% Confidence Interval (Laboratory Control Limits)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Qualifier:

RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.
A	Method blank exceeds acceptance limit. Blank correction not applied, unless the qualifier "RAMB" (result adjusted for method blank) appears in the Analytical Report.
B	Method blank result exceeds acceptance limit, however, it is less than 5% of sample concentration. Blank correction not applied.
E	Matrix spike recovery may fall outside the acceptance limits due to high sample background.
F	Silver recovery low, likely due to elevated chloride levels in sample.
G	Outlier - No assignable cause for nonconformity has been determined.
J	Duplicate results and limit(s) are expressed in terms of absolute difference.
K	The sample referenced above is of a non-standard matrix type; standard QC acceptance criteria may not be achievable.