REPORT FOR THE ENCANA CORPORATION UMIAK N-16 2006 SUMP MONITORING PROGRAM

G. W. 6
E. A. 1
W. RES. 1
NWDO 0/L6.
FILE 1
1797

NORTHWEST TERRITORIES WATER BOARD
DEC - 5 2006
YELLOWKNIFE, NWT

Submitted To: **Northwest Territories Water Board**
P.O. Box 1500. Goga Cho Building
Yellowknife, NT X1A 2R3

Water Licence: **N7L1-1797**

Licencee: **EnCana Corporation**

Submitted by: **Sandra Marken**

Year Reported: **2006**

1 Introduction

This is the third annual sump monitoring report for the Umiak N-16 Sump Monitoring Program. Two years of the required five year monitoring program has been completed. The monitoring program is scheduled to conclude in 2009. The information in this report is required under *Part H Conditions Applying to Abandonment and Restoration of the Northwest Territories Board Licence N7L1-1797* for the EnCana Corporation Umiak N-16 Drilling Program.

This Sump Monitoring Program follows the *Protocol for the Management of Drilling Waste Disposal Sumps* – Inuvialuit Settlement Region NWT (NWT Water Board 2006), and includes:

1. Visual assessment of the sump site;
2. Temperature data logging at four thermister locations;
3. Electromagnetic (EM) survey; and
4. Soil and water sampling.

Site visits during 2006 to the Umiak N-16 sump included:

- May 31, 2006 – by Kavik-AXYS and EnCana representatives to download thermister data from the previous winter and to conduct a general visual assessment of the site.
- September 13, 2006 – by an ESSIS Environmental SubSurface Imaging Solutions Ltd. (ESSIS) representative to conduct the 2006 EM survey.
- September 16, 2006 – by Kavik-AXYS representatives to conduct the final download of the thermisters during 2006 and obtain soil and water samples to investigate potential elevated soil and water anomalies identified in the 2005 and 2006 EM surveys.

This report herein documents the results of these site visits and data monitoring activities.

2 Methods

The methods for monitoring the N-16 sump follow the Protocol for the Management of Drilling Waste Disposal Sumps – Inuvialuit Settlement Region NWT (NWT Water Board 2006). In addition, the monitoring program was augmented, based on feedback from the NWT Water Board (NWT Water Board, June 19, 2006), requesting the following:

- Soil samples to be collected in concert with EM surveys to help interpret the results of the EM Surveys from 2005 and 2006.
- Provide the chemical characteristics of the deposited sump wastes and an interpretation as to the condition of the waste within the sump, keeping in mind that the EM surveys indicate that the waste has migrated outside the sump confines.

Other items requested at that time were reported on September 06, 2006 (EnCana 2006).

2.1 Visual Assessment

Visual assessments were conducted by Kavik-AXYS representatives during all visits in 2006 to document conditions on the general physical structure of the sump including: settlement, vegetation concerns and vigor, presence or absence of ponding, erosion, stress or tension cracks. These visual assessments were conducted both from the air and on the ground. A general photo log of the sump and surrounding area is located in Appendix A.

2.2 Temperature

During 2004 four thermisters were installed in and surrounding the Umiak N-16 sump. The thermisters were initially installed to depths of 14 meters including sensors located at depths of 0.5, 0.75, 1.0, 1.5, 3.0, 4.5, 6.0, 7.5, 9.0, 10.5, 12.0 and 14.0 meters below grade as required under NWT Water Licence No. N7L1-1797. However, it was estimated that the sump settled approximately 0.45 m during the first growing season and the thermister depths within the sump were adjusted to 0.05, 0.3, 0.55, 1.05, 2.55, 4.05, 5.55, 7.05, 8.55, 10.05, 11.55, 13.55 meters below grade. Control data was collected from Thermister 1726. Thermisters 1725, 1727 and 1728 were located in the sump (Figure 1).

Temperatures were recorded twice daily at 0000 and 1200 and averaged for each month. Graphs illustrating the averaged data for each depth of the thermisters from September 01, 2005 to August 31, 2006 are located in Appendix B. Raw data for each thermister is located in Appendix C.

2.3 Electromagnetic Survey

Essis Ltd. conducted electromagnetic surveys on September 13, 2006 using a Geonics EM31 and EM38 ground conductivity meters. These instruments were used to identify the lateral extents of ion-rich regions which may reflect ion migration from the sump to the surrounding areas and help identify requirement for additional sampling. Readings from the EM38 approximate measurements of the top 1.5 m (shallow) of topsoil while the EM31 approximates measurements of the top 5 m (deep) of topsoil. Results of the EM survey are located in Appendix D.

2.4 Soil Sampling

The purpose of the soil and water investigation conducted on September 16, 2006 was to identify, or confirm the absence of potential migration of sump constituents into adjacent areas as identified in the EM surveys.

Soil samples were obtained utilizing a hand driven Dutch auger. All soil samples were removed directly from the auger by hand using clean latex gloves. Every effort was made to eliminate the possibility of cross contamination between soil samples. Samples were inspected for colour, visual staining, odour, and any other anomalous characteristics that may be related to environmental contamination. Samples requiring salinity analysis were retained in a laboratory issued zip-lock containers for analysis. Each sample intended for hydrocarbon or organic chemical analysis was retained in a 250 ml glass jar, ensuring no head space was evident within the jar to retain the integrity of the samples.

A minimum of ten (10) potential soil sample locations were identified by referencing the 2005 EM survey drawing and the 2006 EM field survey drawing provided by ESSIS prior to the site investigation. The locations generally included:

- one (1) background sample at each sump (from a control area) up gradient from the sump at a point where a migration path has not been identified;
- two (2) samples near the centre of the sump;
- two (2) or three (3) samples in the centre of the areas where migration has been observed; and
- the remaining samples were used to delineate the lateral extent of the migration.

For salinity analysis, two discreet soil samples were obtained from each sample location in the sump cap at intervals of approximately 0.4 cm or until the auger was rejected by the permafrost. Samples obtained in the areas adjacent to the sump were a composite of all material within the corehole. Hydrocarbon samples were a composite of the top 0.8 cm of the sump cap or until rejection of the auger by permafrost. Samples were submitted to ALS Laboratories (ALS) and tracked using a chain of custody process to verify which samples require laboratory analysis. All samples were stored in coolers under suppressed temperature conditions until submission to the laboratory. See Tables 1 and 2 for the tabulated salinity and hydrocarbon results and Figure 1 for location of sample points. See Appendix E for the certified laboratory results from ALS.

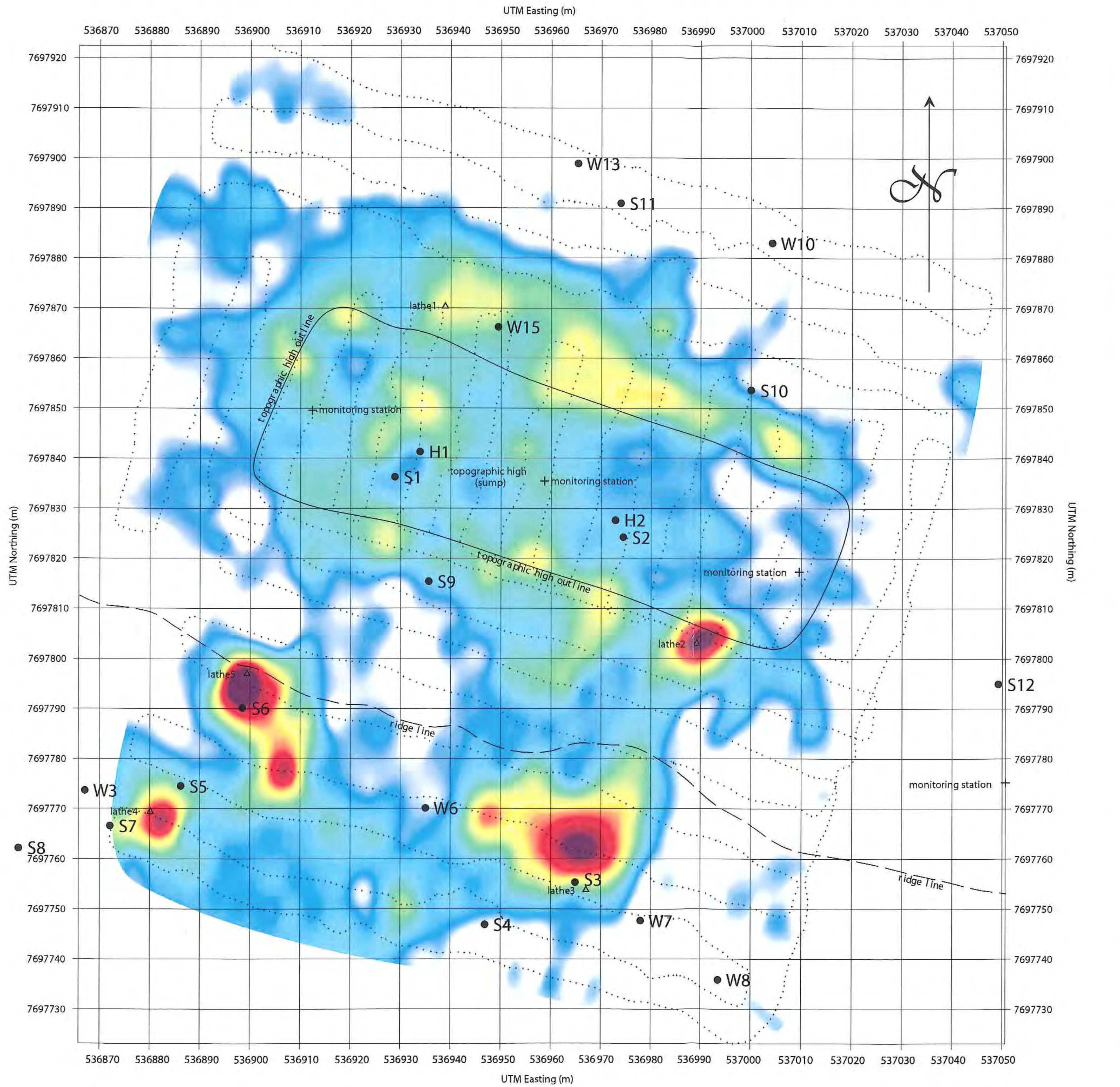
2.5 Water Sampling

During the site visit, an electrical conductivity (EC) meter was utilized to field test anomalies observed within the surficial water in and around the sump. At locations where potential migration paths were observed and the EC meter detected elevated concentrations of ionic activity, water samples were obtained at arm's length, stored in a laboratory issued 500 ml plastic jar and submitted to ALS Laboratory for salinity analysis. A background sample of surficial water (N16-W10) was obtained up gradient of the sump, in a location not anticipated to be effected by migration from the sump. See Table 3 for tabulated salinity water results and Figure 1 for locations of sample points. See Appendix E for the certified laboratory results from ALS.

2.6 Guideline Selection

The guidelines used to compare the results from the soil and water sampling programs includes the Canadian Council of Ministers of the Environment's (CCME) Soil and Water Quality Guidelines for:

- Soil salinity for residential and parkland;
- Soil hydrocarbon for residential and parkland; and
- Water for freshwater and aquatic life.



Site Location Map

Comments

The colour image reveals the 'Apparent Conductivity Distribution' on site. The term 'Apparent Conductivity' implies that conductivity measurements do not linearly relate to actual soil conductivities.

The presented EM data should be used qualitatively to select targets for vertical (depth) geophysical profiling or soil sampling. Geophysical results are only conclusive after correlation to soil sample data (ground–truthing). The depth response of the electromagnetic (EM) field varies from surface to a unique depth, the 'skindepth' of that particular EM signal. The skindepth of any EM signal is strongly influenced by overall soil conductivity. Since soil conductivity varies randomly, the apparent conductivity distribution does not represent data from any particular depth.

Posted features are surveyed using DGPS. A positional accuracy of several decimeters is generally possible. Positional accuracy diminishes near larger buildings and other satellite–obstructing features.

Technical Summary

Geophysical Specifications

Instrument:	Geonics EM38
Measured Quantities:	Quadrature in mS/m Inphase in ppt, Hs/Hp
Primary Field Source (Tx):	Self–Contained Dipole Tx
Receiver (Rx):	Self–Contained Dipole Rx
Intercoil Spacing:	1.0 m
Operating Frequency:	14.6 kHz
Conductivity Ranges:	10 – 1000 mS/m

Positioning (DGPS) Specifications

GPS Rover:	Trimble Pathfinder Power
GPS Base:	Trimble 4000ssi Dual
Data S/A Corrections:	Post–Processed Differential
Coordinate Projection:	Universal Transverse Mercator (UTM)
UTM Rover Zone:	08
Datum:	North American Datum 1927 (NAD27–NWT)
Base Coordinate:	SOPAC, Inuvik, NWT X: 560870E Y: 7577533N Elev.: 51.22 m (HAE)

Legend

- Topographic High
- Monitoring Station
- Lathe
- Ridge Line
- Geophysical Measurement Stations

4 6 8 10 12 14 16 18 20
Apparent Conductivity
(mS/m)

Map 1/2	Scale = 1:850	September 2006	Job No.: 1651 01

Lateral Conductivity Distribution (EM38) & Site Features

Umiak N16 Sump

REDUCED VERSION

Client: EnCana

Directed by: KAVIK-AXYS Inc.

Produced by: Essis

Figure 1

Approved: ____________

Created: ____________

PERMIT TO PRACTICE
ESSIS LTD.

Signature ____________

Date ____________

PERMIT NUMBER: P 6825
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Table 1 **Umiak N-16 Sump - Soil Sampling Salinity Results**

			Sample ID	N16-S1	N16-S1	N16-S2	N16-S2	N16-S3	N16-S4	N16-S5	N16-S6	N16-S7	N16-S8	N16-S9	N16-S10	N16-S11	N16-S12 (Control)
			Depth (m)	0.0-0.40	0.40-0.92	0.0-0.40	0.40-0.86	0.0-0.39	0.0-0.35	0.0-0.44	0.0-0.35	0.0-0.46	0.0-0.48	0.0-0.42	0.0-0.44	0.0-0.46	0.0-0.42
Parameters	**Units**	**Detection Limits**	**Guidelines[1]**														
Chloride (Cl)	mg/L	20	-[4]	40	30	40	30	220	30	180	490	2290	110	110	30	30	50
Calcium (Ca)	mg/L	5	-	169	194	173	167	72	19	75	174	823	49	72	36	30	26
Potassium (K)	mg/L	2	-	7	10	7	28	75	5	32	32	433	8	4	7	6	9
Magnesium (Mg)	mg/L	3	-	47	55	40	37	34	8	24	74	169	19	26	12	10	13
Sodium (Na)	mg/L	2	-	42	38	33	34	39	14	31	54	154	21	31	17	14	24
SAR	SAR	N/A[2]	5	0.7	0.6	0.6	0.6	1.0	0.7	0.8	0.9	1.3	0.7	0.8	0.6	0.6	0.9
Sulphate (SO4)	mg/L	6	-	303	452	410	389	48	16	38	103	151	30	192	35	31	32
Saturation	%	0.1	-	56.0	35.3	46.0	32.0	400	370	296	40.0	105	172	180	144	383	176
pH in Sat.[3] Paste	pH	0.1	6 to 8	6.5	7.3	6.5	7.3	4.7	4.7	5.1	4.5	5.1	5.0	5.0	4.5	4.7	4.3
Conductivity Sat.[3] Paste	dS/m	0.03	2	1.03	1.28	1.06	1.16	0.99	0.22	0.81	1.83	7.44	0.54	0.74	0.28	0.28	0.31
MUST PSA % > 75um	%	1	-	44	75	75	85	N/A	29	N/A	77	16	N/A	N/A	N/A	N/A	N/A
Organic Matter	%	1	-	11	5	2	2	75	81	51	11	<0.1	60	31	40	80	74
% Sand	%	1	-	79	85	81	87	N/A	72	N/A	82	5.3	N/A	N/A	N/A	N/A	N/A
% Silt	%	1	-	15	10	15	10	N/A	22	N/A	14	16.8	N/A	N/A	N/A	N/A	N/A
% Clay	%	1	-	6	5	4	3	N/A	6	N/A	4	77.4	N/A	N/A	N/A	N/A	N/A
Foreign Matter (>1.70 mm)	%	0.1	-	N/A	N/A	N/A	N/A	<0.1	N/A	<0.1	N/A	N/A	<0.1	<0.1	<0.1	<0.1	<0.1
Coarse Fiber (>1.70 mm)	%	0.1	-	N/A	N/A	N/A	N/A	13.4	N/A	6.9	N/A	N/A	3.8	7.3	6.8	13.3	8.1
Medium Fiber (0.85-1.70 mm)	%	0.1	-	N/A	N/A	N/A	N/A	18.0	N/A	7.3	N/A	N/A	9.5	14.9	17.3	23.3	20.3
Fines (<0.85 mm)	%	0.1	-	N/A	N/A	N/A	N/A	66.7	N/A	81.9	N/A	N/A	86.8	77.6	75.8	62.5	70.4

NOTES:
1. CCME. 1999 (Update 2003). Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, MB. For Residential and Parkland (Highlighted cells exceed criteria).
2. N/A - Not Applicable
3. Sat. – Saturated
4. (-) No guideline

Table 2 Umiak N-16 Sump - Soil Sampling Hydrocarbon Results

Parameters	Units	Detection Limits	Guidelines[1]	N16-H1	N16-H2
			Sample ID	N16-H1	N16-H2
			Depth (m)	0.0-0.8	0.0-0.8
Benzene	mg/kg	0.005	0.5	<0.005	<0.005
Toluene	mg/kg	0.01	0.8	<0.01	<0.01
Ethylbenzene	mg/kg	0.01	1.2	<0.01	<0.01
Xylenes	mg/kg	0.01	1.0	<0.01	<0.01
F1 (C6-C10)	mg/kg	5	260	<5	<5
F1-BTEX	mg/kg	5	-[3]	<5	<5
F2 (C10-C16)	mg/kg	5	900	10	10
F3 (C16-C34)	mg/kg	5	800	120	200
F4 (C34-C50)	mg/kg	5	5600	74	130
Total Hydrocarbons (C6-C50)	mg/kg	5	-	200	340
Chromatogram to baseline at nC50	-	N/A[2]	-	NO	NO
% Moisture	%	0.1	-	17	9.9

NOTES:
1. Canadian Council of Ministers of the Environment (CCME). 2001. *Canada Wide Standards for Petroleum Hydrocarbons (PHC) in Soil.* Winnipeg, MB. For Residential and Parkland (Highlighted cells exceed criteria).
2. N/A - Not Applicable
3. (-) No guideline

Table 3 Umiak N-16 Sump - Water Sampling Salinity Results

Parameters	Units	Detection Limits	Sample ID / Guidelines[1]	N16-W3	N16-W6	N16-W7	N16-W8	N16-W10 (Control)	N16-W13	N16-W15
Chloride (Cl)	mg/L	0.1	-[3]	153	33.3	378	389	16.0	35.0	217
Calcium (Ca)	mg/L	0.5	-	34.7	9.9	68.9	207	12.5	21.5	113
Potassium (K)	mg/L	0.1	-	21.9	2.4	120	50.1	0.7	2.4	52.9
Magnesium (Mg)	mg/L	0.1	-	19.2	6.1	27.3	89.9	5.8	9.1	43.5
Sodium (Na)	mg/L	1	-	19	12	42	74	8	12	36
Ion Balance	%	N/A	-	106	145	93.9	99.8	167	148	104
TDS (Calculated)	mg/L	N/A	-	253	68	665	1280	56	100	683
Hardness (as $CaCO_3$)	mg/L	N/A	-	166	50	284	887	55	91	461
Nitrate+Nitrite-N	mg/L	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10
Nitrate-N	mg/L	0.05	13	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10
Nitrite-N	mg/L	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sulphate (SO_4)	mg/L	0.5	-	5.6	<0.5	29.2	343	<0.5	0.6	143
pH	pH	0.1	6.5-9.0	5.6	6.0	5.4	7.7	5.9	6.5	7.6
Conductivity (EC)	uS/cm	3	-	587	170	1390	2290	131	213	1250
Bicarbonate (HCO_3)	mg/L	5	-	<5	9	<5	254	26	38	157
Carbonate (CO_3)	mg/L	5	-	<5	<5	<5	<5	<5	<5	<5
Hydroxide (OH)	mg/L	5	-	<5	<5	<5	<5	<5	<5	<5
Alkalinity, Total (as $CaCO_3$)	mg/L	5	-	<5	7	<5	208	21	32	129

NOTES:
1. CCME. 1999 (Update 2003). Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, MB. For Freshwater Aquatic Life (Highlighted cells exceed criteria).
2. N/A - Not Applicable
3. (-) No guideline

3 Results

3.1 Visual Assessment

Visual assessments during 2006 revealed no evidence of ponding, erosion, stress, tension cracks on the cap or surface of the sump. There was no evidence of settling within the sump. Vegetation establishment on the sump cap has been moderate with clusters of vegetation growth (See Photo 1 in Appendix A). Vegetation surrounding the sump cap showed no visual signs of stress (Photo 2 in Appendix A). Permafrost depths were between 0.86 and 0.92 on the sump cap and ranged between 0.35 and 0.48 m in the areas adjacent to the sump (see depths of samples in Table 1). There was very little moisture contained in the active layer of the sump cap.

3.2 Temperature

Thermister 1728 was identified as corrupted when the data from the thermisters was downloaded during the initial site visit in May 2006. Therefore, no data was available for Thermister 1728 during the 2005/2006 monitoring period. The thermister was sent to the distributor to be repaired. The distributor attempted to extract data from the logger but was unsuccessful. The thermister has subsequently been repaired and reattached. Logging of data was reinstated on September 16, 2006. New data from 2006/2007 will be generated for the 2007 Annual Sump Monitoring Report.

Thermisters 1725 and 1727 located in the sump showed a greater degree of clustering of the temperatures in the active layer and shallow permafrost, between 0.00 m and 1.05 m than that of the control thermister (1726). Depths exceeding 4.0 m had temperature profiles between the control and the sump thermisters. Generally, the control thermister data reveals a greater degree of consistency in the thermal regime in the depths between 0.0 m and 4.5 m below grade.

3.3 Electromagnetic Survey

Results of the 2006 EM38 and EM31 surveys (Appendix D) showed decreasing response amplitudes along the axis of the sump as compared to the two previous years. As in previous years, drilling wastes appear to be concentrated in the western portion of the sump. The 2006 EM surveys indicate a wider dispersion of elevated conductivity around the sump; however, hot spots recorded in 2005 are slightly reduced in magnitude in 2006. Two new hot spots were identified this year in an area south west of the sump not surveyed in previous years.

3.4 Soil Sampling

Based on the 2005 and 2006 EM survey results, twelve (12) soil sample locations were chosen to characterize and delineate potential impacts from the sump (Figure 1). The salinity analysis revealed that soil samples N16-S6 and N16-S7, designed to investigate the high ionic anomalies southwest of the sump, have the highest concentrations of general salinity parameters. Sample N16-S7 was the only sample to have electrical conductivity concentrations that exceeded CCME guidelines. pH for all samples located off the sump cap (including background) had values that were not within the acceptable CCME guideline range, likely a response to naturally occurring low pH in the peaty substrate that surrounds the sump. All other samples were within CCME guidelines. Soil samples N16-S3, N16-S5 and N16-S9 were located to investigate other EM survey anomalies and migration paths on the south side of the sump. These samples had slightly elevated salinity parameters above background conditions. Generally, all the other samples on the south and north perimeter of the sump had values that approximate background conditions for the area.

Two samples from the sump were submitted to the lab for hydrocarbon analysis. Hydrocarbons were detected in both samples; however, they were under CCME guidelines. A background hydrocarbon sample was not obtained during the site visit due to the absence of mineral topsoil located within the vicinity of the sump.

3.5 Water Sampling

Seven (7) water samples were obtained and forwarded to the lab for salinity analysis based on the results of the field screening (see Figure 1 for locations). There was no surface water observed on the cap of the sump. Water samples N16-W3, N16-W7 and N16-W8 were located to investigate anomalies identified in the EM survey on the south side of the sump. Water sample N16-W15 was located to delineate the northern extent of the anomalies identified in the EM survey. These samples had elevated electrical conductivity, potassium and chloride values. Water samples N16-W6 and N16-W13 approximated background conditions. The pH levels for four of the seven samples were not within acceptable CCME guidelines including the background sample, likely due to the acidic nature of the surrounding peatlands.

4 Discussion

Results of the EM38 and EM31 surveys and the soil and water sampling program suggests that ionic concentrations have migrated from the sump into the adjacent areas. The EM38 survey showed elevated electrical conductivity responses extending north and south from the sump and appears to be concentrated in the lower topographical regions. Within these hotspots, elevated levels of potassium and chloride identified in the soil and water sampling program verified that these elevated anomalies likely originate from the sump. However, only one soil sample had elevated parameters that exceeded CCME guidelines that are not a result of background conditions (S16, with a conductivity reading of 7.44 dS/m, above CCME guideline of 2 dS/m).

One possible explanation for the mechanism causing migration of sump contents is that the elevated salts in the sump result in a lower freezing temperature than the surrounding environment. As the surrounding area freezes up in the fall, pressure is exerted on the sump, which may remain unfrozen for a longer period of time. Water, high in salt concentration, is then squeezed up and out of the sump, migrating to adjacent topographically low areas. It appears that over time, salts may have continued to move out of the sump, resulting in lower EM38 readings in the sump and a few areas of high salt concentration and EM38 readings in low lying areas adjacent to the sump. Gradual dissipation of these hot spots is apparent, through natural dilution and equilibrium processes.

Vegetation on the sump cap and the surrounding area did not indicate signs of stress due to regional elevated salinity results; however, the assessment did not occur during the optimum time of year to assess vegetation health.

Revegetation has not fully covered the sump cap after three growing seasons since the initial reclamation. Revegetation has been sparse on the sump cap, limited to isolated clusters. Vegetation growth may be limited due to the coarse grain topsoil and lack of surface organics, limiting the moisture availability. Due to the coarse granular material composing the topsoil and the high wind potential, wind erosion may be a concern over the long-term management of the sump. However, significant wind erosion was not observed during the site visit.

Comparing the temperature graphs for each of the thermisters over the previous year, the temperature regime in the thermisters has appeared to be stabilized in the lower permafrost. In the active layer and the upper permafrost, there is a greater variability in the sequences of the graphs as the active layer in the sump is more sensitive to seasonal climatic variations than the control thermister. This could be a result of the coarse grained nature of the sump cap and the limiting water retaining capability of the soil. Water has a much higher specific heat than air, allowing climate variations of the atmosphere to have a greater effect on the temperature in the soil of the sump cap than the water saturated organic horizons that surround the sump. In addition, the sump cap lacks an insulating organic layer at the surface allowing the cap to thaw and freeze more quickly and to a greater extent then the surrounding tundra, and resulting in an active layer that is considerably deeper than that of the surrounding area.

5 Recommendations

The following is a summary and proposed dates of recommendations for the Umiak N-16 sump during 2007. These recommendations are in addition to requirements outlined in *Part H Conditions Applying to Abandonment and Restoration of the Northwest Territories Board Licence N7L1-1797* for the EnCana Corporation Umiak N-16 Drilling Program:

- Seed and fertilize the cap of the sump as necessary (April-June 2007).
- A visual assessment to document general stress to vegetation during the growing season (June-August 2007).
- A follow up soil and water assessment in conjunction with the 2007 EM Survey (September 2007).

Vegetation establishment has not been adequate to stabilize the cap of the sump and substantially inhibit the potential for erosion into the surrounding area. The sump cap should be fertilized and/or revegetated with an ENR approved seed mix as required in April-June 2007 in conjunction with the spring 2007 sump assessment and thermister download. Seed should be broadcast at the time of year when temperature and moisture regimes are at the optimum level to promote germination. Special care shall be taken to ensure seeds are buried in the sump cap and that the existing vegetation is not disturbed. Vegetation should be re-assessed during the fall 2007 site visit. If additional seeding is required, an ENR approved cover crop, designed to stabilize the cap during the short-term, have a finite life expectancy and be out competed by native vegetation should be considered.

As part of the overall visual assessment, special attention to vegetation health should occur in areas of high salinity concentrations. The assessment must occur during the growing season (June-August 2007) to adequately document evidence of stress to vegetation. The results will be compared against the surrounding vegetation.

The analytical results from the soil and water sampling assessment and the EM surveys indicate that elevated parameters outside the sump are likely the result of migration of ionic concentrations located within the sump. However, generally the concentrations are located in isolated areas. If there is no or limited additional migration of sump constituents in the future then a natural attenuation of these elevated parameters may occur. A follow up assessment of soil and water chemistry during the fall 2007 assessment in conjunction with the required EM survey is recommended to monitor any further changes surrounding the sump. EM38 readings indicate that the sump cap concentrations are low and should not provide a future source of compounds that would impact the surrounding area.

It appears that the deep permafrost within the sump has stabilized and is responding to climatic changes similar to the control thermister. The shallow permafrost and active layer within the sump has not stabilized to the same level as the control thermister. With this being the second year of a five-year monitoring program, and temperature monitoring proceeding until 2009, no additional thermal monitoring is recommended.

6 References

Candian Council of Ministers of the Environment (CCME). Update 2001. *Petroleum Hydrocarbons in Soil – Canada-Wide Standards*. Winnipeg, MB.

Candian Council of Ministers of the Environment (CCME). Update 2003. *Canadian Environmental Quality Guidelines: Summary Table*. Winnipeg, MB.

EnCana Corporation. 2006. *Sump Monitoring and Information Requests from the Water Board.* Calgary, AB.

Environmental Studies Research Funds (ESRF). *Drilling Waste Management Recommended Best Practices.* Canada.

Northwest Territories (NWT) Water Board. 2006. *Protocol for the Monitoring of Drilling-Waste Disposal Sumps.* Yellowknife, NWT.

Northwest Territories (NWT) Water Board. June 19, 2006.,*Water Register N7L1-1797 Umiak N-16 Sump Monitoring Program.* Yellowknife, NWT.

Appendix A Site Photos

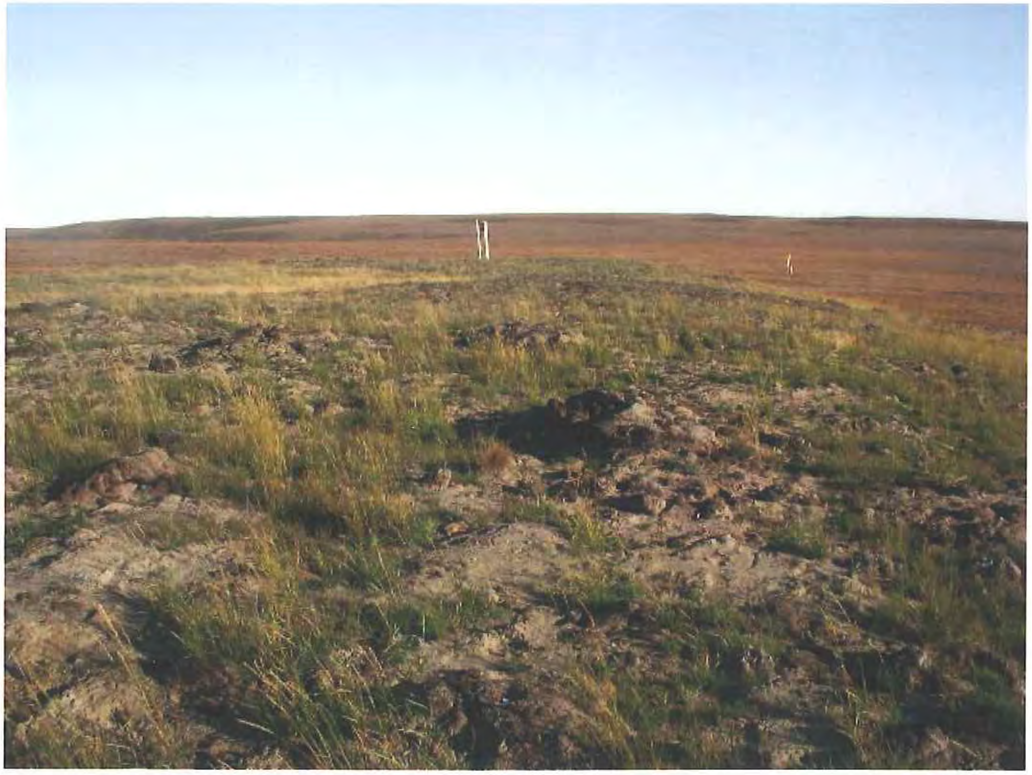
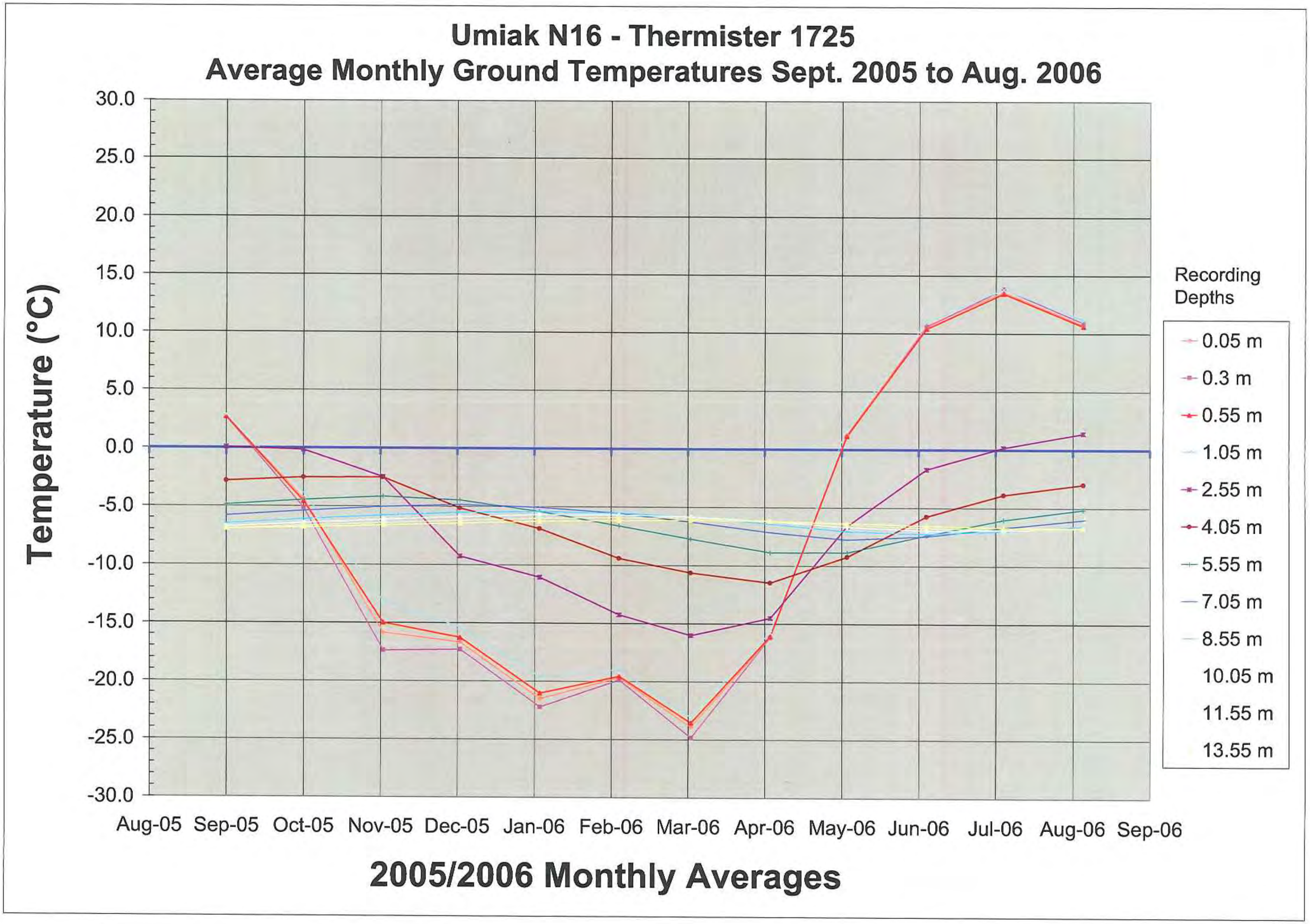


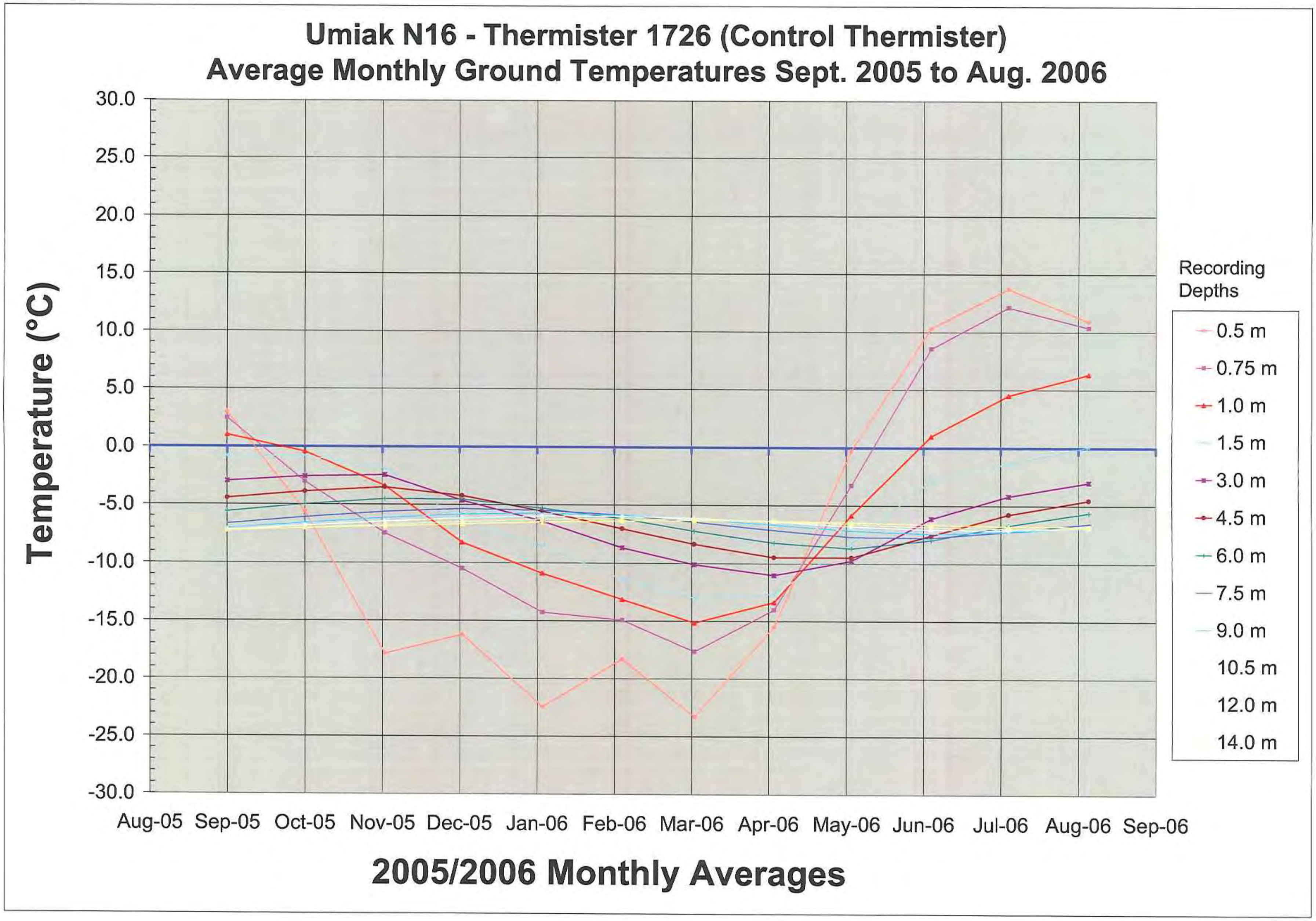
Photo 1: Vegetation establishment on the sump cap (September 16, 2006).

Photo 2: Representative photo of the general surrounding vegetation and ponding along the south perimeter of the sump (September 16, 2006).

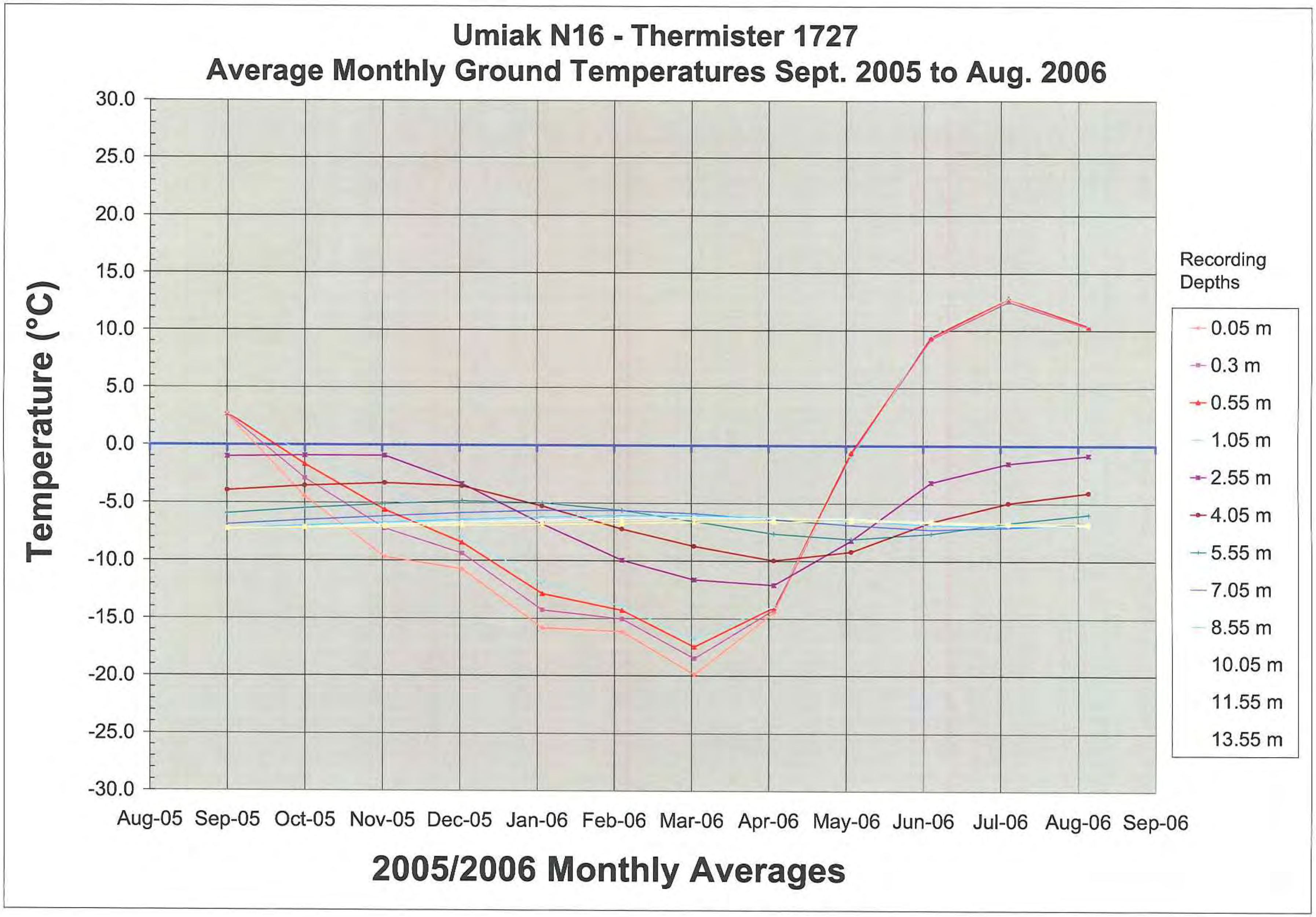
Appendix B Thermister Temperature Graphs



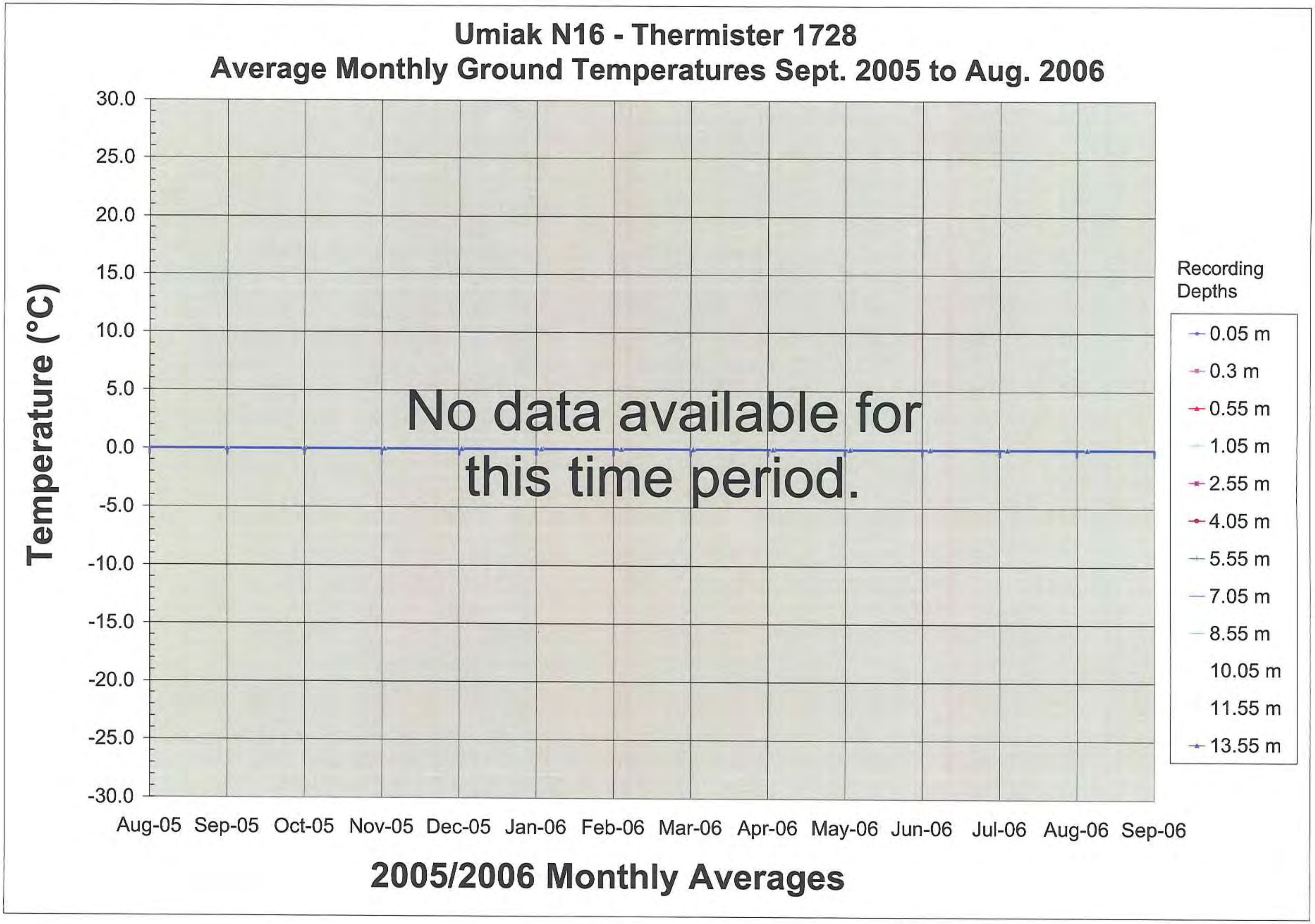
Umiak N16 - Thermister 1725
Average Monthly Ground Temperatures Sept. 2005 to Aug. 2006
Temperature (°C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
Aug-05 Sep-05 Oct-05 Nov-05 Dec-05 Jan-06 Feb-06 Mar-06 Apr-06 May-06 Jun-06 Jul-06 Aug-06 Sep-06
2005/2006 Monthly Averages
Recording Depths
0.05 m
0.3 m
0.55 m
1.05 m
2.55 m
4.05 m
5.55 m
7.05 m
8.55 m
10.05 m
11.55 m
13.55 m



Umiak N16 - Thermister 1726 (Control Thermister)
Average Monthly Ground Temperatures Sept. 2005 to Aug. 2006
Temperature (°C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
Aug-05 Sep-05 Oct-05 Nov-05 Dec-05 Jan-06 Feb-06 Mar-06 Apr-06 May-06 Jun-06 Jul-06 Aug-06 Sep-06
2005/2006 Monthly Averages
Recording Depths
0.5 m
0.75 m
1.0 m
1.5 m
3.0 m
4.5 m
6.0 m
7.5 m
9.0 m
10.5 m
12.0 m
14.0 m



Umiak N16 - Thermister 1727
Average Monthly Ground Temperatures Sept. 2005 to Aug. 2006
Temperature (°C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
2005/2006 Monthly Averages
Recording Depths
0.05 m
0.3 m
0.55 m
1.05 m
2.55 m
4.05 m
5.55 m
7.05 m
8.55 m
10.05 m
11.55 m
13.55 m



Umiak N16 - Thermister 1728
Average Monthly Ground Temperatures Sept. 2005 to Aug. 2006
Temperature (°C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
No data available for this time period.
Aug-05 Sep-05 Oct-05 Nov-05 Dec-05 Jan-06 Feb-06 Mar-06 Apr-06 May-06 Jun-06 Jul-06 Aug-06 Sep-06
2005/2006 Monthly Averages
Recording Depths
0.05 m
0.3 m
0.55 m
1.05 m
2.55 m
4.05 m
5.55 m
7.05 m
8.55 m
10.05 m
11.55 m
13.55 m