Nunami Stantec
P.O. Box 188
RANKIN INLET, Nunavut
X0C 0G0

November 20, 2019

City of Iqaluit
Building 901 (City Hall) Nunavut Drive
Iqaluit, NU X0A 0H0

Attention: **Matthew Hamp, Department of Engineering and Sustainability**

Dear Matthew,

Reference: **Iqaluit Wastewater Treatment System**
Existing Lagoon Action Plan November 2019 Update

PLAN UPDATE

The June 2018 Action Plan was updated in August 2019 and is again updated in November 2019.

BACKGROUND

The City of Iqaluit has requested Nunami Stantec review the potential timeline and develop an action plan to temporarily divert flow to the existing lagoon to allow the improvements to be implemented to the existing Wastewater Treatment Plant (WWTP). The diversion is necessary as the current Headworks within the WWTP will require a complete shutdown for up to 4 months to replace the existing components with new and improved equipment in order to provide additional capacity to meet the growing needs of the City.

The City's lagoon has been in operation since the mid-1970's, with some upgrades and desludging being completed in 1991. In the late 1990's, the City endeavored to build a mechanical treatment facility capable of secondary treatment but following a series of problems, the design-builder abandoned the project. Following a facility evaluation in 2002, a remedial plan was developed, and a new design for a primary and secondary facility was produced. However, lack of funding allowed only the primary treatment portion (Phase 1) to be completed and the secondary treatment was put on hold.

Following completion of Phase 1, future use of the lagoon was identified as a provisional treatment process in the event that the wastewater treatment facility needed to be bypassed. This objective remains with a specific requirement for the current project to provide a treatment process for a four-month flow diversion that is required to build the new plant. The intent is also to incorporate the lagoon, as previously intended as a provisional treatment process in the overall treatment system.

LAGOON COMPONENTS

Lagoon Characteristics

The available piping systems to the lagoon incorporate a combination septage dump station and diversion chamber which allows both the septage and gravity flow from the City's system to be directed to the lagoon on a provisional basis.

Based on the limited information available, the lagoon volume is reported to be 56,000 m^3.

The outlet from the lagoon, based on 1991 as-builts, consists of piped discharge controlled by a valve chamber; the elevation of the discharge is 5.6 metres, which is approximately 2 metres above the bottom of the lagoon. The lagoon is not lined and several features such as a French drain, and an overflow spillway, were incorporated into the design of the lagoon to maintain the geotechnical stability of the system. The discharge point of the outlet directs the flow to the same channel that the current WWTP outfall discharges to and which ultimately releases to Koojesse Inlet.

The lagoon provided successful treatment of sewage for decades, and although it may be undersized for the current quantity of flow, it is anticipated that it will continue to function as a treatment facility and for the four-month shutdown, provide a reasonable level of treatment.

See Appendix A for the 1991 as-built drawings.

Current Sludge Volume

It is understood that the most recent desludging of the sewage lagoon occurred in 1991. The lagoon remained in full operation until 2006 at which time the mechanical primary treatment system was commissioned at the current WWTP. Since 2006, the lagoon has been utilized for short periods during process upsets at the WWTP.

No information is available on the current quantity of sludge accumulated, and as discussed later, a sludge survey will be performed to establish the volume.

LAGOON ACTION PLAN

In order to ascertain the expected performance of the lagoon while diverting all the City's flow, the following action is recommended:

1. Performance Test

Flow will be diverted to the lagoon for a period of two weeks in early July, at which time samples will be taken from the piped discharge outlet. This should provide a reasonable expectation of the results that can be achieved during the anticipated four-month diversion, while the new WWTP primary treatment system is constructed and commissioned.

Meanwhile, the City has increased their testing frequency of effluent from the existing mechanical primary treatment system, and the results can be compared.

Update: Results from the sampling program are summarized in letter of January 24, 2019 and is included in Appendix B.

2. Desludging

With the quantity of sludge unknown, it is recommended that a sludge survey be performed this year, which would establish the elevation of the sludge "blanket" in the lagoon and the density of the sludge blanket. The benefit will be:

- The sludge accumulation quantity can be better established for future desludging requirements.
- The available volume for accumulation of solids while diverting the sewage flow to the lagoon can be more reasonably established. Based on the current quantity of solids collected at the WWTP, a retention time can be established and an approximation of the reduction of TSS and COD estimated based upon hydraulic retention time.

Update: Sludge Survey performed, and report is included in Appendix C.

Following confirmation that the lagoon is acceptable for the four-month diversion, construction of the new WWTP can proceed with desludging of the lagoon taking place in 2019 (see the following timeline). Various methods exist for the desludging of the lagoon. Some common methods include:

- *Mechanical Removal of Sludges* - This involves decanting the lagoon, continued dewatering of accumulated liquids and removing the sludge by mechanical means. The in place dewatered sludge is typically hauled to a landfill site for disposal.
- *Pumping and Dewatering of Sludge* – In this method, a barge mounted solids handling pump is utilized to pump the solids to a dewatering system, while the liquid remains in the lagoon. Dewatering methods can typically be by centrifuge, or more suitable to this operation, the use of Geotubes. Geotubes are essentially a large filter sock whereby, the solids are encapsulated within the fabric, while allowing the liquids to drain out. Once the tube is full, and the water has drained, the solids can be excavated and hauled to the landfill. Iqaluit also has the advantage that the tube can be put through a freeze/thaw season, providing further dewatering and more importantly, a reduction in pathogens.
- *Disposal of Sludge* – The City is currently developing a solids management plan which will determine the ultimate disposal option, and which may include utilizing the sludge as organic cover/mix material for the landfill.

Should indication be that the lagoon will not be able to accommodate the four-month diversion, efforts may be necessary to expedite the desludging efforts, and desludge prior to the needed diversion.

Update: Desludging completed in October 2019 and sludge currently dewatering in geotubes stored in lined containment area adjacent lagoon and which drains to lagoon. Based on an estimated dewatered solids content of 20%, the volume is anticipated to be approximately 4,700 m3. The final quantity results are included in Appendix D.

3. Decanting of Existing Lagoon

It has been suggested that the City may want to consider decanting the existing lagoon prior to the temporary four-month diversion. This is not considered prudent at this time as:

- Recent test results of the effluent discharge from the existing mechanical primary treatment provides indication that the performance is lacking and would not provide the same level of treatment as the lagoon itself, should the decanted liquid be sent there.
- It may be more beneficial overall to decant and desludge the lagoon upon completion of the new mechanical primary treatment as more reliable and increased treatment of the decanted liquid can be provided as compared to the current system.

Therefore, it is recommended to decant the existing lagoon following the desludging efforts in 2019 (see the following timeline).

Update: Pond Decanted October 2019

4. Public Awareness

Although the lagoon has been in intermittent operation for the past decade, the additional flow may cause increased odours. To combat the production of additional odours, the lagoon should be monitored for any surface exposure of the solids themselves. Maintaining a liquid cover will assist in reducing the odours.

In addition, the diversion is planned for fall 2018 and with freezing occurring, the ice cover will also provide a reduction in odours.

However, should exposed solids be witnessed, it is suggested that the available liquid be circulated by pump to dissipate exposed sludges.

In addition, the City may want to consider providing signage at known access points to deter public access. Currently no such measures are in place.

Update: Lagoon warning signs have been placed around the existing lagoon

5. Stakeholder Notification

The relevant regulatory organizations will be kept informed of:

- Schedule of events
- Planned procedures being undertaken
- Temporary diversion test results
- Sludge survey results
- Treatment levels achieved during the four-month diversion

In addition, the City may want to inform the residents, through the City's website, of the anticipated use of the lagoon while the new WWTP is being constructed. If presented in a positive light, i.e. that is necessary for the completion of a state of the art, complete mechanical treatment plant, it should be viewed as favourable.

LAGOON TIMELINE OF ACTIVITIES (UPDATED NOVEMBER 2019)

There are several steps in reaching the completion of integrating the lagoon into the temporary and permanent overall treatment system. The anticipated timeline is:

Date	Original Planned Date	Actual or New Planned Date
Prepare and Approve Lagoon Action Plan	June 2018	June 2018
Performance Test (two weeks)	July 2018	July 2018+
Perform Sludge Survey	August 2018	September 2018
Quantify Anticipated Treatment Results	August 2018	September 2018
Inform Stakeholders	September 2018	September 2018
Install Public Access Deterrents	September 2018	Installed November 2019
Divert Flow to Lagoon	October 2018	July 2018
Monitor Lagoon	October 2018 to January 2019	July 2018 to March 2019
Return Flow to New Primary WWTP	January 2019	March 2019
Prepare Desludge Documents for Pricing	February 2019	May 2019
Obtain Pricing & Award	March 2019	August 2019
Shipping of Geotubes	July 2019	August 2019
Commence Dewatering of Sludge	August 2019	September 2019
Complete Dewatering of Sludge	September 2019	October 2019

Date	Original Planned Date	Actual or New Planned Date
Decant Lagoon & Evaluate Condition	September 2019	October 2019
Prepare Lagoon Operations Manual	October 2019	November 2019
Lagoon in Operation for Plant Upset Conditions	October 2019	October 2019
WWTP Commissioned	November 2019	February 2020
Geotube Freeze Thaw Dewatering	Winter 2019/2020	
Excavate and Transport Dewatered Solids to Landfill for use as an organic cover material (options being evaluated)	August 2020	

We trust this meets your current requirements and should you have any questions, please contact the undersigned.

Sincerely,

Nunami Stantec

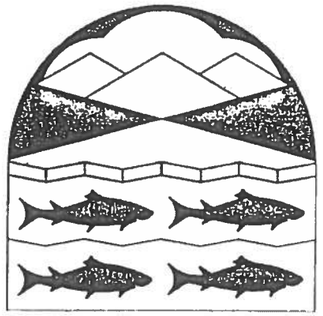
Glenn Prosko, P.Eng.
Senior Project Manager
Phone: (780) 969-3258
Glenn.Prosko@stantec.com

Attachment: None

cc. Charles Kretch, Derin Boz, Colliers

APPENDIX A

1991 Lagoon As-builts



TOWN OF IQALUIT

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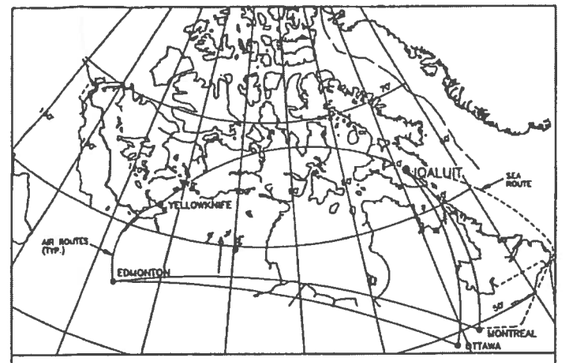

LOCATION PLAN
N.T.S.

IQALUIT - N.W.T. - CANADA

LAGOON RECONSTRUCTION AND DRAINAGE IMPROVEMENTS

RECORD DRAWINGS

CONTRACT No.

THIS IS A
PHOTO-REDUCTION
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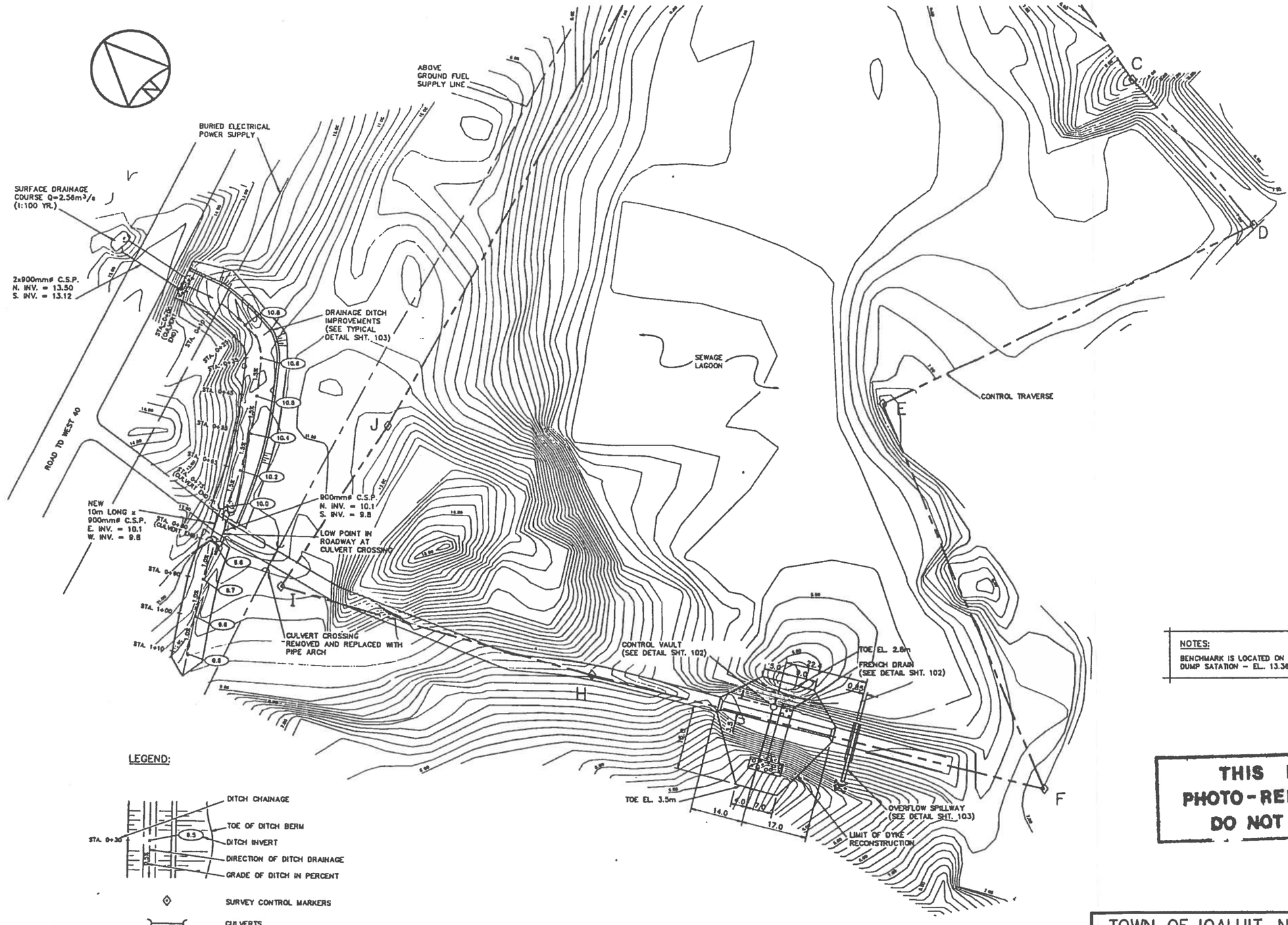
Kenneth R. Johnson
M.A.Sc., MCIP, P.Eng.
Planner & Engineer
www.cryofront.com

UMA Engineering Ltd.
Engineers, Planners & Surveyors



NOTES:

BENCHMARK IS LOCATED ON CONCRETE SLAB OF SEWAGE DUMP SATATION – EL. 13.366m.

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PERMIT

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 007
UMA ENGINEERING LTD

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0	91	07	24	FOR REVIEW	ME	KRJ	JVA	KRJ	KRJ

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ENGINEER

REGISTERED PROFESSIONAL ENGINEER N.W.T.

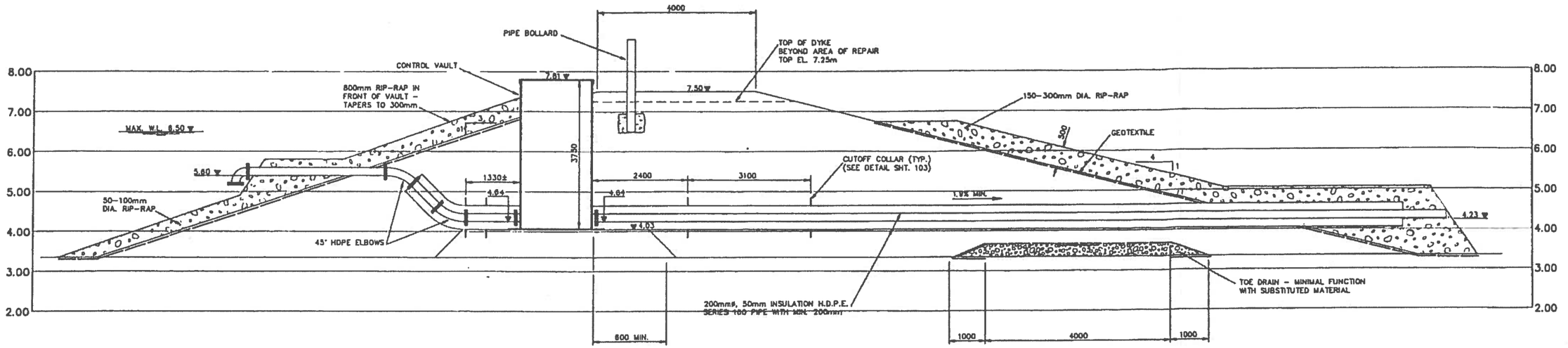
TOWN OF IQALUIT, N.W.T.

LAGOON RECONSTRUCTION AND DRAINAGE IMPROVEMENTS

OVERALL SITE PLAN AND GRADING

uma 8202 - 4396 - 03 EDMONTON

CODE	DRAWING	REV
CD-00-47-A1	101	2



DYKE RECONSTRUCTION

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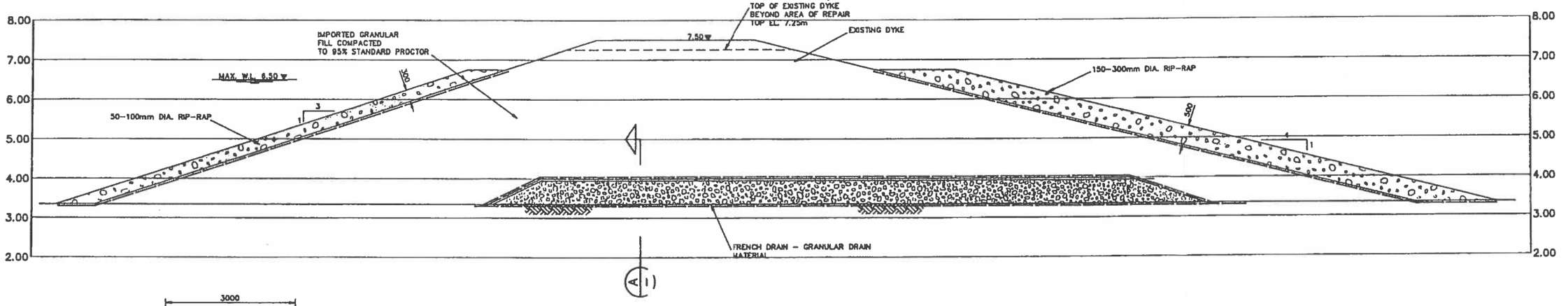

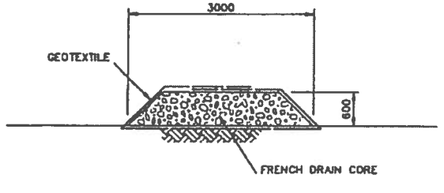

SECTION A

SCALE 1:50

FRENCH DRAIN (MINIMAL FUNCTION WITH SUBSTITUTED MATERIAL)

SCALE 1:50

NOTE: IMPORTED GRANULAR FILL CLASS D2 NOT UTILIZED ABOVE ELEVATION OF FRENCH DRAIN. MATERIAL WITH LARGER FINES COMPONENT SUBSTITUTED BY TOWN OF IQALUIT. DESIGN SLOPES OF 4:1 (EXTERIOR) AND 3:1 (INTERIOR) ACCOMMODATE THIS MATERIAL.

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PERMIT NUMBER
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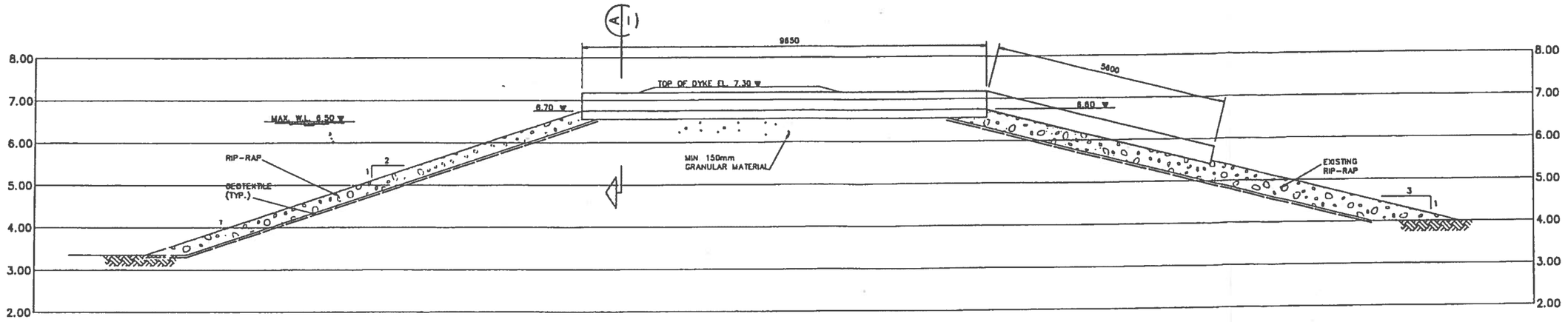
TOWN OF IQALUIT, N.W.T.

LAGOON RECONSTRUCTION
AND DRAINAGE IMPROVEMENTS

SECTIONS & DETAILS

CODE	DRAWING	REV
	100	2



SECTION THROUGH OVERFLOW SPILLWAY

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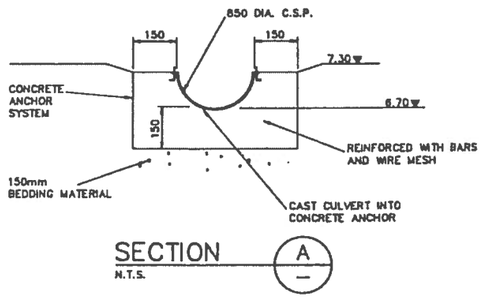
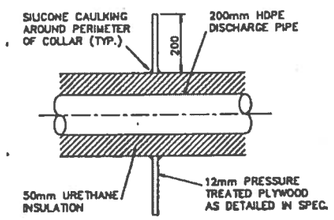
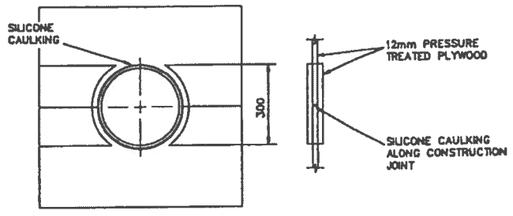


SECTION A — A

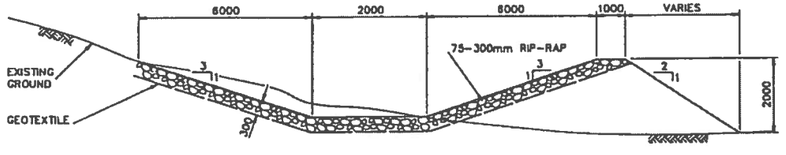
N.T.S.





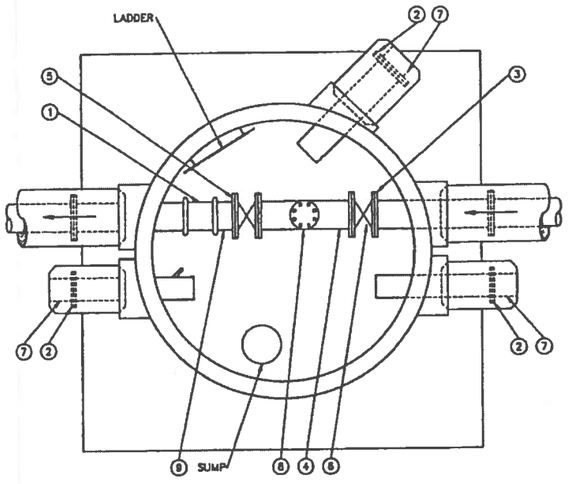
CUTOFF COLLAR DETAIL

N.T.S.



DITCH X-SECTION DETAIL

N.T.S.



REFERANCE

1. VICTAULIC SPOOL PIECE
2. BLIND FLANGE - GALVANIZED
3. VICTAULIC STYLE #741 FLANGE - GALVANIZED
4. FLANGE SPOOL PIECE - GALVANIZED
5. PINCH VALVE
6. 200 KNIFE GATE VALVE (200 CWP CRANE)
7. MASTIC COATED P.U. INSUL. PLUG
8. TEE WITH BLIND FLANGE
9. FLANGE BY VICTAULIC SPOOL PIECE

CONTROL VAULT

N.T.S.

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PERMIT NUMBER P 007
UMA ENGINEERING LTD.

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REGISTERED PROFESSIONAL ENGINEER

TOWN OF IQALUIT, N.W.T.

LAGOON RECONSTRUCTION AND DRAINAGE IMPROVEMENTS

SECTIONS AND DETAILS

CODE	DRAWING	REV
OD-90-47-A1	103	2

APPENDIX B

Sampling Program Evaluation

Nunami Stantec
P.O. Box 188
RANKIN INLET, Nunavut
X0C 0G0

NUNAMI STANTEC

September 19, 2018

City of Iqaluit
Building 901 (City Hall) Nunavut Drive
Iqaluit, NU X0A 0H0

Attention: **Matthew Hamp, Department of Engineering and Sustainability**

Dear Matthew,

Reference: **Iqaluit Wastewater Treatment System**
Existing Sewage Lagoon Performance Review

BACKGROUND

Nunami Stantec, in cooperation with the City of Iqaluit, previously prepared the potential timeline and developed an action plan to temporarily divert flow to the existing lagoon to allow the improvements to be implemented to the existing Wastewater Treatment Plant (WWTP). See letter of June 6, 2018. The diversion is necessary as the current Headworks within the WWTP will require a complete shutdown for up to 4 months to replace the existing components with new and improved equipment in order to provide additional capacity to meet the growing needs of the City. A technical review of the lagoon action plan was performed by CIRNAC, in which their comments and recommendations were implemented into the updated action plan (See letter of August 10th, 2018).

A future use of the lagoon was identified more than a decade ago as a provisional treatment process in the event that the wastewater treatment facility needed to be bypassed. This objective remains with a specific requirement for the current project to provide a treatment process during the needed diversion to build the new plant. The intent is also to incorporate the lagoon, as previously intended, as a provisional treatment process in the overall treatment system.

As per the action plan, a test diversion to the lagoon was undertaken and the results of that testing and the sludge survey performed, and the anticipated level of treatment is summarized in this letter.

LAGOON ACTION PLAN UPDATE

The previously prepared Action Plan is updated as follows:

Event	Planned Date	Actual Date
Prepare and Approve Lagoon Action Plan	June 2018	June 2018
Performance Test (two weeks)	July 2018	August 2018
Perform Sludge Survey	August 2018	September 2018
Quantify Anticipated Treatment Results	August 2018	September 2018
Inform Stakeholders	September 2018	September 2018

Event	Planned Date	Actual Date
Install Public Access Deterrents	September 2018	
Divert Flow to Lagoon	October 2018	
Monitor Lagoon	October 2018 to January 2019	
Divert to Newly Commissioned WWTP (Primary Treatment)	January 2019	
Prepare Desludge Documents for Pricing	February 2019	
Obtain Pricing & Award	March 2019	
Shipping of Geotubes	July 2019	
Commence Dewatering of Sludge	August 2019	
Complete Dewatering of Sludge	September 2019	
Decant Lagoon & Evaluate Condition	September 2019	
Prepare Lagoon Operations Manual	October 2019	
Lagoon in Operation for Plant Upset Conditions	October 2019	
WWTP Commissioned (Secondary Treatment)	November 2019	
Geotube Freeze Thaw Dewatering	Winter 2019/2020	
Excavate and Transport Dewatered Solids to Landfill for use an organic cover material	August 2020	

LAGOON COMPONENTS

Lagoon Characteristics

The available piping systems to the lagoon incorporate a combination septage dump station and diversion chamber which allows both the septage and gravity flow from the City's system to be directed to the lagoon on a provisional basis.

Based on the survey performed, the normal operating volume of the lagoon is estimated to be 25,000 m^3.

The outlet from the lagoon, based on 1991 as-builts, consists of piped discharge controlled by a valve chamber; the elevation of the discharge is 5.6 metres, which is approximately 2 metres above the bottom of the lagoon. The lagoon is not lined and several features such as a French drain, and an overflow spillway, were incorporated into the design of the lagoon to maintain the geotechnical stability of the system. The discharge point of the outlet directs the flow to the same channel that the current WWTP outfall discharges to.

The lagoon provided successful treatment of sewage for decades, and it is anticipated that it will continue to function as a treatment facility and provide a reasonable level of treatment for the four-month shutdown.

Current Sludge Volume

It is understood that the most recent desludging of the sewage lagoon occurred in 1991. The lagoon remained in full operation until 2006 at which time the mechanical primary treatment system was commissioned at the current WWTP. Since 2006, the lagoon has been utilized for short periods during process upsets at the WWTP.

The sludge survey has been performed and the results are:

- Volume Pond – 20,436 m^3
- Volume Sludge – 1,597 m^3
- Volumetric Sludge Percentage – 7.8%

LAGOON PERFORMANCE

The testing was undertaken over a 2-week period in July and August. Both the influent and effluent were tested.

Performance Test Results

The results of the recent testing are as follows:

Date	Sample	BOD (mg/L)	TSS (mg/L)
Sewage Lagoon			
July 27, 2018	Influent	134	124
	Effluent	24	58

August 2, 2018	Influent	59	148
	Effluent	33	64
August 7, 2018	Influent	173	176
	Effluent	60	72

SUMMARY - average BOD removal was 64%, while average TSS removal was 57%.

Above presented data shows an average calculated effluent TSS:BOD rate of 1.9, which indicates good lagoon treatment performance. TSS:BOD rates close to 1 indicate poor treatment or short-circuiting, with untreated wastewater mixing with the effluent while rates less than 1 indicate old sludge solubilization and release of soluble BOD. Rates above 2 are due to algal overgrowth and high loss of sludge particles with the effluent.

And in comparison, the most recent results of testing of the Wastewater Treatment Plant are as follows:

Date	Sample	BOD (mg/L)	TSS (mg/L)
Wastewater Treatment Plant			
November 30, 2017	Influent	146	300
	Effluent	151	164
January 24, 2018	Influent	237	244
	Effluent	202	208
March 8, 2018	Influent	223	188
	Effluent	182	168
March 15, 2018	Influent	322	284
	Effluent	300	324

SUMMARY - average BOD removal was 9%, while average TSS removal was 15%.

As seen, the Wastewater Treatment Plant which consists of primary treatment only, has been performing poorly. The sewage lagoon has by far outperformed the WWTP and a much higher level of performance can be anticipated during the diversion.

Theoretical Lagoon Performance

Even though the TSS removal during the winter months when the diversion to the lagoon will be accomplished is expected to be higher than the TSS removal obtained during testing over the summer months, for worst case scenario conditions the TSS average removal of 57% is used to estimate the solids that will stay in the lagoon during a four-month wastewater diversion period. The estimation follows:

Current WWTP Flow to be Diverted to the Lagoon:	3,326 m^3/day
Influent Wastewater TSS:	149 ppm or g/ m^3 (using the TSS average obtained during summer testing)
Total Influent Solids to lagoon:	497 kg/day
Total Expected Days of Flow Diversion to Lagoon:	120 days
Total Quantity of Solids to be Diverted to Lagoon:	59,602 kg
Estimated TSS Removal Expected:	57% (same obtained during summer testing for worst case scenario)
Solids Expected to Settle in Lagoon for 120 Days:	33,973 kg
Typical Sludge Density:	1,100 kg/m^3
Volume of Solids to Settle in Lagoon for 120 Days:	31 m^3
Total Lagoon Volume from Survey:	20,436 m^3
Current Volume of Solids in Lagoon from Survey:	1,597 m^3
Current Volumetric Solids Percentage in Lagoon:	7.8%
Total Solids Volume in Lagoon after 120 Days:	1,628 m^3
Volumetric Solids Percentage in Lagoon after 120 Days:	8.0%

The estimation shows that the volumetric solids increase in the lagoon over a period of 4 months would be only 0.2% which wouldn't present any issues for the lagoon operation.

The top water elevation registered in the lagoon survey is 5.9 meter. Therefore, the lagoon will be able to receive approximately 0.6 more meters of water depth to reach the maximum water elevation of 6.5 meters registered on the lagoon design drawings. Considering a total lagoon storage volume of approximately 25,000 m^3 at maximum water level in the lagoon, the hydraulic retention time could be estimated as follows:

Estimated Total Lagoon Storage Volume:	25,000 m^3
Total Solids Volume in Lagoon after 120 Days:	1,628 m^3
Total Water Volume in Lagoon after 120 Days:	23,372 m^3
Current WWTP Flow to be Diverted to the Lagoon:	3,326 m^3/day
Lagoon Hydraulic Retention Time (HRT):	7 days.

This HRT is congruent with calculations developed during previous years for the lagoon. Therefore, effluent BOD during the winter months wouldn't be expected to be above 160 mg/L (Refer to performance Evaluation of Primary Sewage Lagoon in Iqaluit, N.W.T. by Ken Johnson and John Cucheran). A BOD effluent at that level, will provide a BOD removal of approximately 30% based on a BOD influent of 232 mg/L as measured from the testing developed during the summer months, which is much better than the current BOD removal obtained by the WWTP of 9%.

SUMMARY

Based on the recent test diversion to the lagoon and the current performance of the wastewater treatment plant, it is anticipated that the lagoon will provide a much higher level of treatment both at the beginning and end of the diversion.

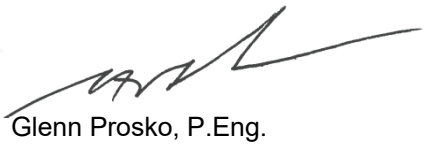
Please note again that the wastewater treatment plant cannot be upgraded without the interrupting flow to the plant for the 4-month period. The headworks is receiving a complete upgrade with increased robustness, capacity, and redundancy. In addition, the Contractor Kudlik Construction, anticipates that a shutdown of nearer to 2-months will be required, however, we have based our analysis on a 4 months period in the event that a longer contingency period is required.

We recommend that the diversion proceed and trust this meets your current requirements.

Should you have any questions, please contact the undersigned.

Sincerely,

Nunami Stantec



Glenn Prosko, P.Eng.
Senior Project Manager
Phone: (780) 969-3258
Glenn.Prosko@stantec.com

Attachment: Lagoon test summary results
Sludge Survey Report

cc. Eslam Maher, Colliers

Appendix A

Lagoon Sample Results

CADUCEON ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B18-22323

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 30-Jul-18
DATE REPORTED: 08-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: 110126045 - Iqaluit WWTP
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Test F - Influent	Test F - Discharge		
			Sample I.D.		B18-22323-1	B18-22323-2		
			Date Collected		27-Jul-18	27-Jul-18		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
BOD	mg/L	3	SM 5210B	30-Jul-18/O	134	24		
Total Suspended Solids	mg/L	3	SM 2540D	01-Aug-18/O	124	58		
Conductivity @25°C	µmho/cm	1	SM 2510B	30-Jul-18/O	329	225		
pH @25°C	pH Units		SM 4500H	30-Jul-18/O	7.28	7.69		
Nitrite (N)	mg/L	0.1	SM4110C	01-Aug-18/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	01-Aug-18/O	< 0.1	< 0.1		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	01-Aug-18/O	15.2	8.46		
o-Phosphate (P)	mg/L	0.01	MOEE 3366	01-Aug-18/O	1.09	0.79		
Phosphorus-Total	mg/L	0.01	E3199A.1	31-Jul-18/K	3.13	1.60		
Aluminum	mg/L	0.01	SM 3120	31-Jul-18/O	0.18	0.13		
Antimony	mg/L	0.0005	EPA 200.8	30-Jul-18/O	< 0.0005	< 0.0005		
Arsenic	mg/L	0.0005	EPA 200.8	30-Jul-18/O	0.0006	< 0.0005		
Barium	mg/L	0.001	SM 3120	31-Jul-18/O	0.017	0.015		
Beryllium	mg/L	0.002	SM 3120	31-Jul-18/O	< 0.002	< 0.002		
Cadmium	mg/L	).000070	EPA 200.8	30-Jul-18/O	0.000198	0.000090		
Chromium	mg/L	0.002	SM 3120	31-Jul-18/O	< 0.002	< 0.002		
Cobalt	mg/L	0.005	SM 3120	31-Jul-18/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	31-Jul-18/O	0.220	0.046		
Iron	mg/L	0.005	SM 3120	31-Jul-18/O	0.416	1.56		
Lead	mg/L	0.0001	EPA 200.8	30-Jul-18/O	0.0023	0.0011		
Lithium	mg/L	0.01	SM 3120	31-Jul-18/O	< 0.01	< 0.01		
Manganese	mg/L	0.001	SM 3120	31-Jul-18/O	0.066	0.111		
Mercury	mg/L	0.00002	SM 3112 B	02-Aug-18/O	0.00003	< 0.00002		
Molybdenum	mg/L	0.01	SM 3120	31-Jul-18/O	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	31-Jul-18/O	< 0.01	< 0.01		
Selenium	mg/L	0.005	EPA 200.8	30-Jul-18/O	< 0.005	< 0.005		
Silver	mg/L	0.0001	EPA 200.8	30-Jul-18/O	< 0.0001	< 0.0001		

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON™ ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B18-22323

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 30-Jul-18
DATE REPORTED: 08-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: 110126045 - Iqaluit WWTP
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Test F - Influent	Test F - Discharge		
			Sample I.D.		B18-22323-1	B18-22323-2		
			Date Collected		27-Jul-18	27-Jul-18		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Strontium	mg/L	0.001	SM 3120	31-Jul-18/O	0.066	0.056		
Thallium	mg/L	0.0003	EPA 200.8	30-Jul-18/O	< 0.0003	< 0.0003		
Tin	mg/L	0.05	SM 3120	31-Jul-18/O	< 0.05	< 0.05		
Titanium	mg/L	0.005	SM 3120	31-Jul-18/O	0.005	< 0.005		
Uranium	mg/L	0.0003	EPA 200.8	30-Jul-18/O	< 0.0003	< 0.0003		
Vanadium	mg/L	0.005	SM 3120	31-Jul-18/O	< 0.005	< 0.005		
Zinc	mg/L	0.005	SM 3120	31-Jul-18/O	0.411	0.037		
Total Coliform	cfu/100mL	1	MOE E3371	30-Jul-18/O	5300000	20000		
Fecal Coliform	cfu/100mL	1	MOE E3371	30-Jul-18/O	860000	30		

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON™ ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B18-23373

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 07-Aug-18
DATE REPORTED: 14-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Test F
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Test F Influent	Test F Discharge		
			Sample I.D.		B18-23373-1	B18-23373-2		
			Date Collected		02-Aug-18	02-Aug-18		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
BOD	mg/L	3	SM 5210B	09-Aug-18/O	59	33		
Total Suspended Solids	mg/L	3	SM 2540D	09-Aug-18/O	148	64		
Conductivity @25°C	µmho/cm	1	SM 2510B	08-Aug-18/O	358	307		
pH @25°C	pH Units		SM 4500H	08-Aug-18/O	7.00	7.43		
Nitrite (N)	mg/L	0.1	SM4110C	08-Aug-18/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	08-Aug-18/O	< 0.1	< 0.1		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	09-Aug-18/O	19.4	12.9		
o-Phosphate (P)	mg/L	0.01	MOEE 3366	09-Aug-18/O	1.25	0.83		
Phosphorus-Total	mg/L	0.01	E3199A.1	10-Aug-18/K	3.78	2.15		
Aluminum	mg/L	0.01	SM 3120	09-Aug-18/O	0.27	0.11		
Antimony	mg/L	0.0001	EPA 200.8	08-Aug-18/O	0.0010	0.0005		
Arsenic	mg/L	0.0001	EPA 200.8	08-Aug-18/O	< 0.0005	< 0.0005		
Barium	mg/L	0.001	SM 3120	09-Aug-18/O	0.024	0.017		
Beryllium	mg/L	0.002	SM 3120	09-Aug-18/O	< 0.002	< 0.002		
Cadmium	mg/L	).000015	EPA 200.8	08-Aug-18/O	0.000161	0.000085		
Chromium	mg/L	0.002	SM 3120	09-Aug-18/O	< 0.002	< 0.002		
Cobalt	mg/L	0.005	SM 3120	09-Aug-18/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	09-Aug-18/O	0.258	0.093		
Iron	mg/L	0.005	SM 3120	09-Aug-18/O	0.591	1.22		
Lead	mg/L	0.00002	EPA 200.8	08-Aug-18/O	0.00273	0.00086		
Lithium	mg/L	0.01	SM 3120	09-Aug-18/O	< 0.01	< 0.01		
Manganese	mg/L	0.001	SM 3120	09-Aug-18/O	0.077	0.113		
Mercury	mg/L	0.00002	SM 3112 B	13-Aug-18/O	0.00003	< 0.00002		
Molybdenum	mg/L	0.01	SM 3120	09-Aug-18/O	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	09-Aug-18/O	< 0.01	< 0.01		
Selenium	mg/L	0.001	EPA 200.8	08-Aug-18/O	< 0.005	< 0.005		
Silver	mg/L	0.0001	EPA 200.8	08-Aug-18/O	< 0.0001	< 0.0001		

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON™ ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B18-23373

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 07-Aug-18
DATE REPORTED: 14-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Test F
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Test F Influent	Test F Discharge		
			Sample I.D.		B18-23373-1	B18-23373-2		
			Date Collected		02-Aug-18	02-Aug-18		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Strontium	mg/L	0.001	SM 3120	09-Aug-18/O	0.069	0.074		
Thallium	mg/L	0.00005	EPA 200.8	08-Aug-18/O	< 0.0003	< 0.0003		
Tin	mg/L	0.05	SM 3120	09-Aug-18/O	< 0.05	< 0.05		
Titanium	mg/L	0.005	SM 3120	09-Aug-18/O	< 0.005	< 0.005		
Uranium	mg/L	0.00005	EPA 200.8	08-Aug-18/O	< 0.0003	< 0.0003		
Vanadium	mg/L	0.005	SM 3120	09-Aug-18/O	< 0.005	< 0.005		
Zinc	mg/L	0.005	SM 3120	09-Aug-18/O	0.795	0.056		
Total Coliform	cfu/100mL	1	MOE E3371	08-Aug-18/O	1860000	940000		
Fecal Coliform	cfu/100mL	1	MOE E3371	08-Aug-18/O	1020000	41000		

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B18-23562

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 09-Aug-18
DATE REPORTED: 16-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Test F
P.O. NUMBER:
WATERWORKS NO.

Test Samples were improperly labeled.
Left column is effluent sample
Right column is influent sample

Client I.D.					Test F Influent	Test F Discharge		
Sample I.D.					B18-23562-1	B18-23562-2		
Date Collected					07-Aug-18	07-Aug-18		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
BOD	mg/L	3	SM 5210B	10-Aug-18/O	60	173		
Total Suspended Solids	mg/L	3	SM 2540D	10-Aug-18/O	72	176		
Conductivity @25°C	µmho/cm	1	SM 2510B	09-Aug-18/O	320	421		
pH @25°C	pH Units		SM 4500H	09-Aug-18/O	8.02	7.10		
Nitrite (N)	mg/L	0.1	SM4110C	09-Aug-18/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	09-Aug-18/O	< 0.1	0.1		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	09-Aug-18/O	11.8	21.0		
o-Phosphate (P)	mg/L	0.01	MOEE 3366	09-Aug-18/O	0.76	1.89		
Phosphorus-Total	mg/L	0.01	E3199A.1	13-Aug-18/K	2.36	3.77		
Aluminum	mg/L	0.01	SM 3120	13-Aug-18/O	0.09	0.24		
Antimony	mg/L	0.0001	EPA 200.8	09-Aug-18/O	< 0.0005	< 0.0005		
Arsenic	mg/L	0.0001	EPA 200.8	09-Aug-18/O	< 0.0005	< 0.0005		
Barium	mg/L	0.001	SM 3120	13-Aug-18/O	0.014	0.019		
Beryllium	mg/L	0.002	SM 3120	13-Aug-18/O	< 0.002	< 0.002		
Cadmium	mg/L	).000015	EPA 200.8	09-Aug-18/O	0.000129	0.000234		
Chromium	mg/L	0.002	SM 3120	13-Aug-18/O	< 0.002	< 0.002		
Cobalt	mg/L	0.005	SM 3120	13-Aug-18/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	13-Aug-18/O	0.107	0.225		
Iron	mg/L	0.005	SM 3120	13-Aug-18/O	0.855	0.896		
Lead	mg/L	0.00002	EPA 200.8	09-Aug-18/O	0.00121	0.00335		
Lithium	mg/L	0.01	SM 3120	13-Aug-18/O	< 0.01	< 0.01		
Manganese	mg/L	0.001	SM 3120	13-Aug-18/O	0.101	0.130		
Mercury	mg/L	0.00002	SM 3112 B	14-Aug-18/O	< 0.00002	0.00012		
Molybdenum	mg/L	0.01	SM 3120	13-Aug-18/O	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	13-Aug-18/O	< 0.01	< 0.01		
Selenium	mg/L	0.001	EPA 200.8	09-Aug-18/O	< 0.005	< 0.005		
Silver	mg/L	0.0001	EPA 200.8	09-Aug-18/O	< 0.0001	0.0001		

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

CADUCEON™ ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B18-23562

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 09-Aug-18
DATE REPORTED: 16-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Test F
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Test F Influent	Test F Discharge		
			Sample I.D.		B18-23562-1	B18-23562-2		
			Date Collected		07-Aug-18	07-Aug-18		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Strontium	mg/L	0.001	SM 3120	13-Aug-18/O	0.065	0.066		
Thallium	mg/L	0.00005	EPA 200.8	09-Aug-18/O	< 0.0003	< 0.0003		
Tin	mg/L	0.05	SM 3120	13-Aug-18/O	< 0.05	< 0.05		
Titanium	mg/L	0.005	SM 3120	13-Aug-18/O	< 0.005	0.005		
Uranium	mg/L	0.00005	EPA 200.8	09-Aug-18/O	0.00036	0.00045		
Vanadium	mg/L	0.005	SM 3120	13-Aug-18/O	< 0.005	< 0.005		
Zinc	mg/L	0.005	SM 3120	13-Aug-18/O	0.050	0.123		
Total Coliform	cfu/100mL	1	MOE E3371	09-Aug-18/O	28000000 [1]	12000000		
Fecal Coliform	cfu/100mL	1	MOE E3371	09-Aug-18/O	3100000	1900000		

1 . duplicate = 20000000 cfu/100 ml

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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CADUCEON™ ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G72049 **REPORT No. B18-24879**

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 21-Aug-18
DATE REPORTED: 30-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Test F
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Sewer Lagoon Decant			
			Sample I.D.		B18-24879-1			
			Date Collected		18-Aug-18			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
BOD	mg/L	3	SM 5210B	22-Aug-18/O	41			
Total Suspended Solids	mg/L	3	SM 2540D	22-Aug-18/O	69			
Conductivity @25°C	µmho/cm	1	SM 2510B	21-Aug-18/O	351			
pH @25°C	pH Units		SM 4500H	21-Aug-18/O	7.35			
Nitrite (N)	mg/L	0.1	SM4110C	21-Aug-18/O	< 0.1			
Nitrate (N)	mg/L	0.1	SM4110C	21-Aug-18/O	< 0.1			
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	22-Aug-18/O	15.7			
o-Phosphate (P)	mg/L	0.01	MOEE 3366	22-Aug-18/O	0.95			
Phosphorus-Total	mg/L	0.01	E3199A.1	24-Aug-18/K	4.12			
Aluminum	mg/L	0.01	SM 3120	28-Aug-18/O	0.08			
Antimony	mg/L	0.0001	EPA 200.8	22-Aug-18/O	< 0.0005			
Arsenic	mg/L	0.0001	EPA 200.8	22-Aug-18/O	< 0.0005			
Barium	mg/L	0.001	SM 3120	28-Aug-18/O	0.017			
Beryllium	mg/L	0.002	SM 3120	28-Aug-18/O	< 0.002			
Cadmium	mg/L	0.000015	EPA 200.8	22-Aug-18/O	0.000387			
Chromium	mg/L	0.002	SM 3120	28-Aug-18/O	0.011			
Cobalt	mg/L	0.005	SM 3120	28-Aug-18/O	< 0.005			
Copper	mg/L	0.002	SM 3120	28-Aug-18/O	0.109			
Iron	mg/L	0.005	SM 3120	28-Aug-18/O	0.654			
Lead	mg/L	0.00002	EPA 200.8	22-Aug-18/O	0.00236			
Lithium	mg/L	0.01	SM 3120	28-Aug-18/O	< 0.01			
Manganese	mg/L	0.001	SM 3120	28-Aug-18/O	0.136			
Mercury	mg/L	0.00002	SM 3112 B	24-Aug-18/O	< 0.00002			
Molybdenum	mg/L	0.01	SM 3120	28-Aug-18/O	< 0.01			
Nickel	mg/L	0.01	SM 3120	28-Aug-18/O	0.02			
Selenium	mg/L	0.001	EPA 200.8	22-Aug-18/O	< 0.005			

NOTE: Bacteria passed acceptable holding time upon arrival at Lab.

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

CADUCEON™ ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G72049 **REPORT No. B18-24879**

Report To:

City of Iqaluit
PO Box 460,
Iqaluit NU X0A 0H0
Attention: Maria Karveli

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 21-Aug-18
DATE REPORTED: 30-Aug-18
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Test F
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.		Sewer Lagoon Decant			
			Sample I.D.		B18-24879-1			
			Date Collected		18-Aug-18			
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Silver	mg/L	0.0001	EPA 200.8	22-Aug-18/O	< 0.0001			
Strontium	mg/L	0.001	SM 3120	28-Aug-18/O	0.077			
Thallium	mg/L	0.00005	EPA 200.8	22-Aug-18/O	< 0.0003			
Tin	mg/L	0.05	SM 3120	28-Aug-18/O	< 0.05			
Titanium	mg/L	0.005	SM 3120	28-Aug-18/O	< 0.005			
Uranium	mg/L	0.00005	EPA 200.8	22-Aug-18/O	0.00041			
Vanadium	mg/L	0.005	SM 3120	28-Aug-18/O	< 0.005			
Zinc	mg/L	0.005	SM 3120	28-Aug-18/O	0.148			
Total Coliform	cfu/100mL	1	MOE E3371	21-Aug-18/O	560000			
Fecal Coliform	cfu/100mL	1	MOE E3371	21-Aug-18/O	16000			

NOTE: Bacteria passed acceptable holding time upon arrival at Lab.

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

APPENDIX C

2018 Sludge Survey

LAMBOURNE ENVIRONMENTAL Ltd.
51 Belich Crescent, Red Deer County T4S 2K5 Ph. (403) 348-8298 Fax (403) 348-8290

September 18, 2018

Iqaluit, NU
Attn: Sandra Rousseau

Dear Sandra,

On behalf of Lambourne Environmental Ltd. and our colleagues at Hydrasurvey Ltd. I am pleased to present you with the enclosed survey report. I trust that you will find the information provided useful in assessing the current state of the lagoon at Iqaluit.

Lambourne Environmental is a full-service Lagoon Desludging and Disposal company. We have been meeting the lagoon cleaning needs of Western Canada for 25 years. We pride ourselves on planning and executing projects to the satisfaction of all our stakeholders.

Should you have any questions regarding the survey report please contact Andrew Ambrocichuk at 780-328-9102 or myself.

Thank you for the opportunity to serve you. If you have any questions or would like to further discuss the potential desludging and disposal work for this project we would be more than happy to help and come up with a solution.

Yours truly,
Lambourne Environmental Ltd.

David Linsley, B.Sc.
General Manager

SLUDGE SURVEY REPORT

IQALUIT, NU WASTEWATER LAGOON

Location: Iqaluit, NU

Name of Lagoon(s): Iqaluit Wastewater Lagoon

Client: Lambourne Environmental

Client Contact: David Linsley

Report prepared by: A. Ambrocichuk

Surveyors: A. Ambrocichuk, S. Gay, B. Buryn

Date(s) of Survey: 06/09/18 – 07/09/18

Map Grid Reference: Datum: WGS84, Projection: UTM, Zone 19N

Revision Number: 1

Report Print Size: 11x17”

Figure 1 Plan overview of Iqaluit, NU Wastewater Lagoon

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
Revision	1
Sheet	1

FIGURES, TABLES, APPENDICES SUMMARY

List of Figures

List of Tables

Appendices

	Name	Date
Prepared by:	AA	17-09-2018

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HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
Revision	1
Sheet	2

EXECUTIVE SUMMARY

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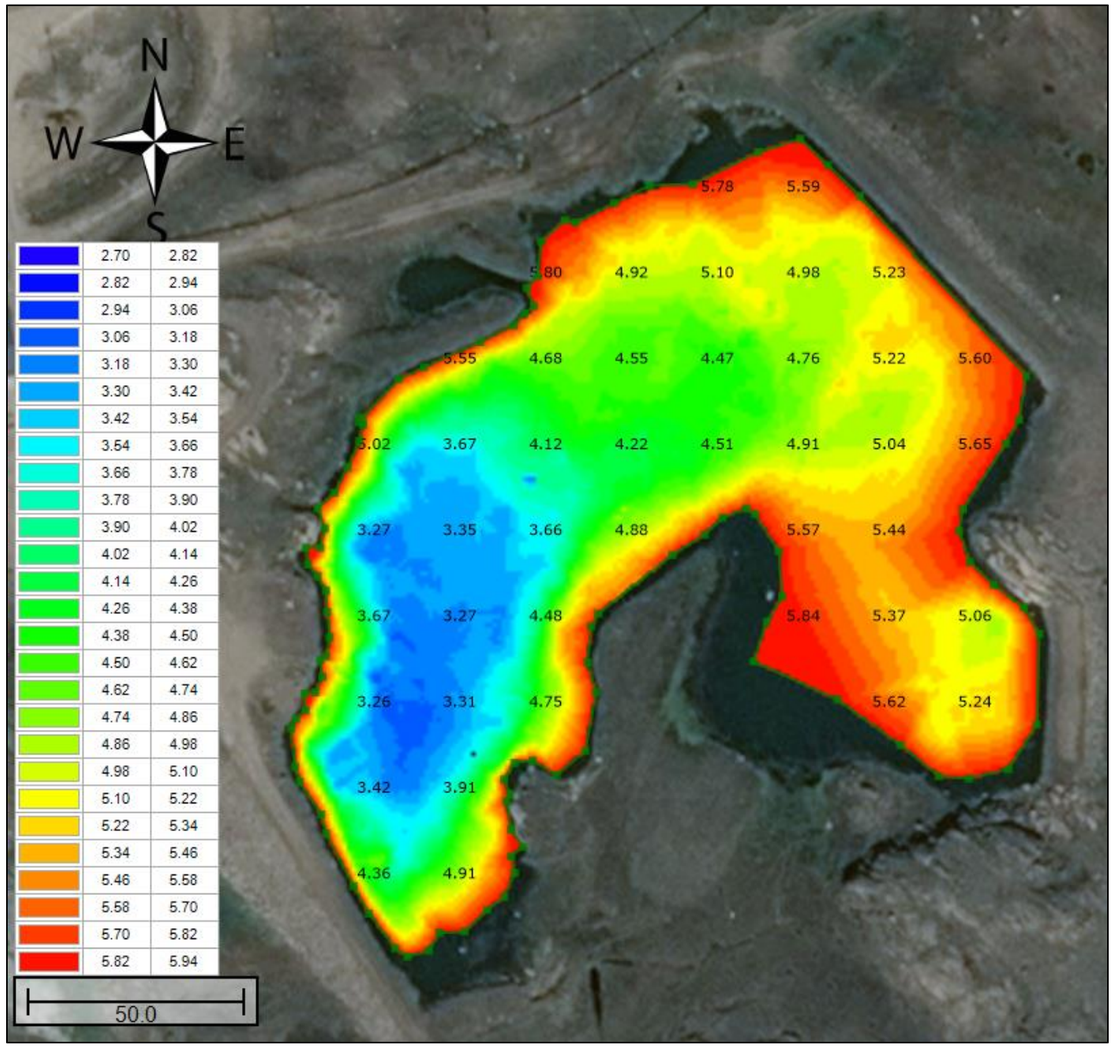

Figure 2 Iqaluit lagoon top of sludge elevations (m)

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Prepared by:	AA	17-09-2018

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HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
Revision	1
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EXECUTIVE SUMMARY CONTINUED

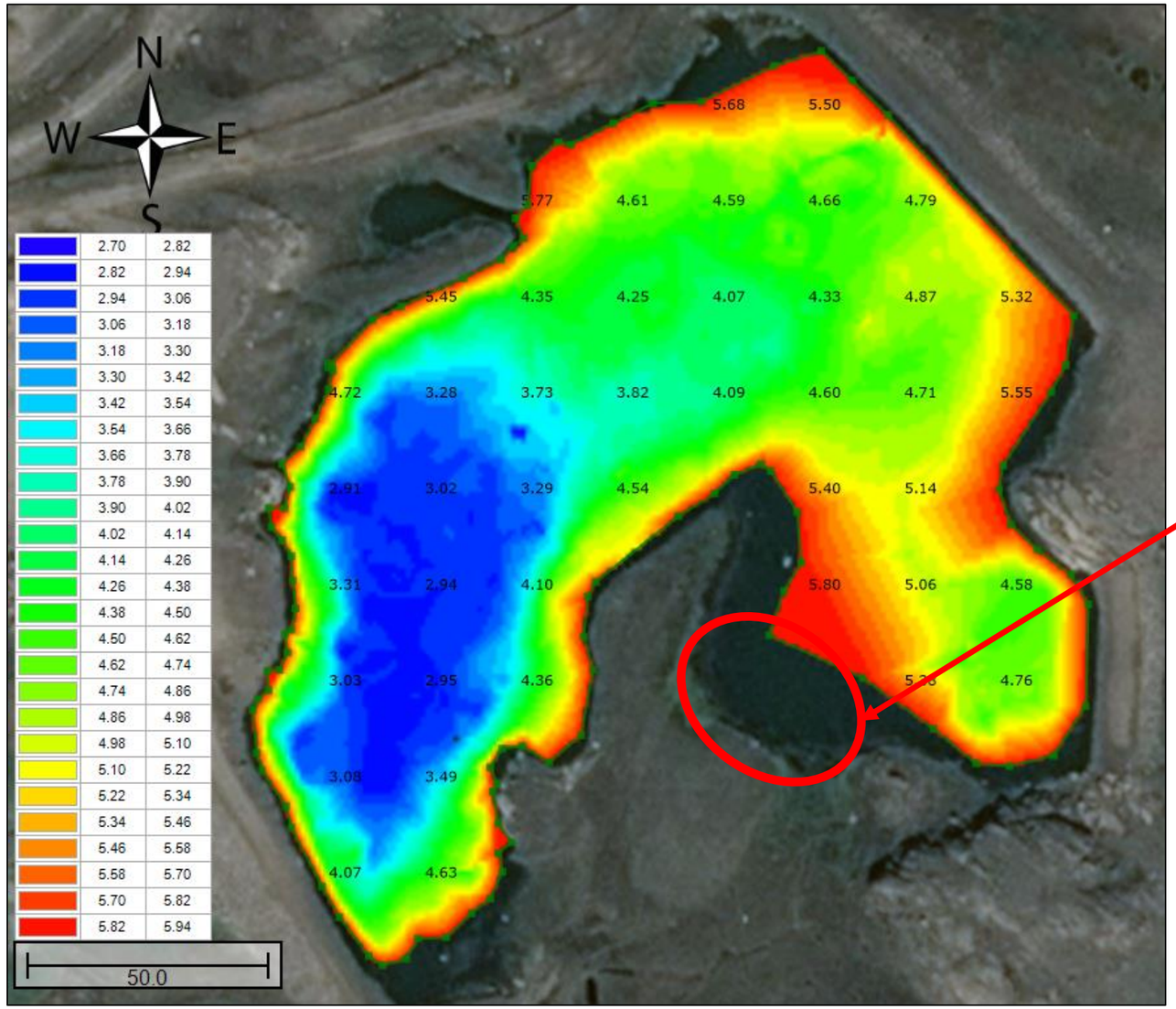

Figure 3 Iqaluit lagoon bottom profile elevations (m)

- Iqaluit lagoon water elevation at the time of survey was 5.9m and appeared to be well below the high waterline, exposing accumulated sludge along the shoreline. The image below shows the sludge beach as identified by the red circle in the CAD drawing to the left. Boat access to determine the depth of this sludge was not possible due to the extremely shallow beach.

This is not a legal or engineered survey document
Matrix depths and elevations are interpolated from field measurements
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Survey data collected on September 6-7, 2018
Report any discrepancies in this report to Hydrasurvey Ltd.
Do not modify or use this report for purposes other than which it is intended

	Name	Date
Prepared by:	AA	17-09-2018

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HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
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Sheet	4

EXECUTIVE SUMMARY CONTINUED

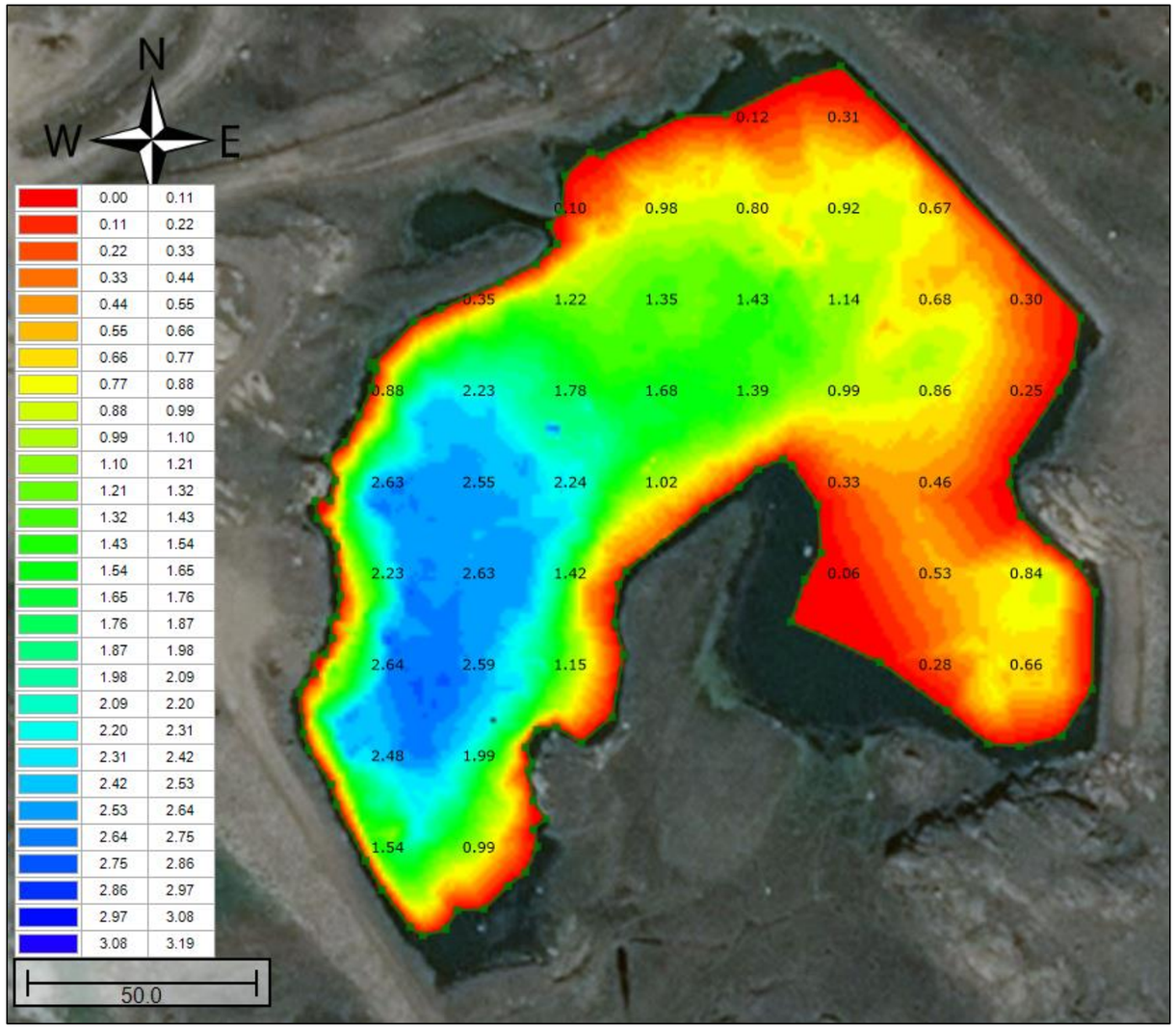

Figure 4 Iqaluit lagoon depths to top of sludge (m)

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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EXECUTIVE SUMMARY CONTINUED

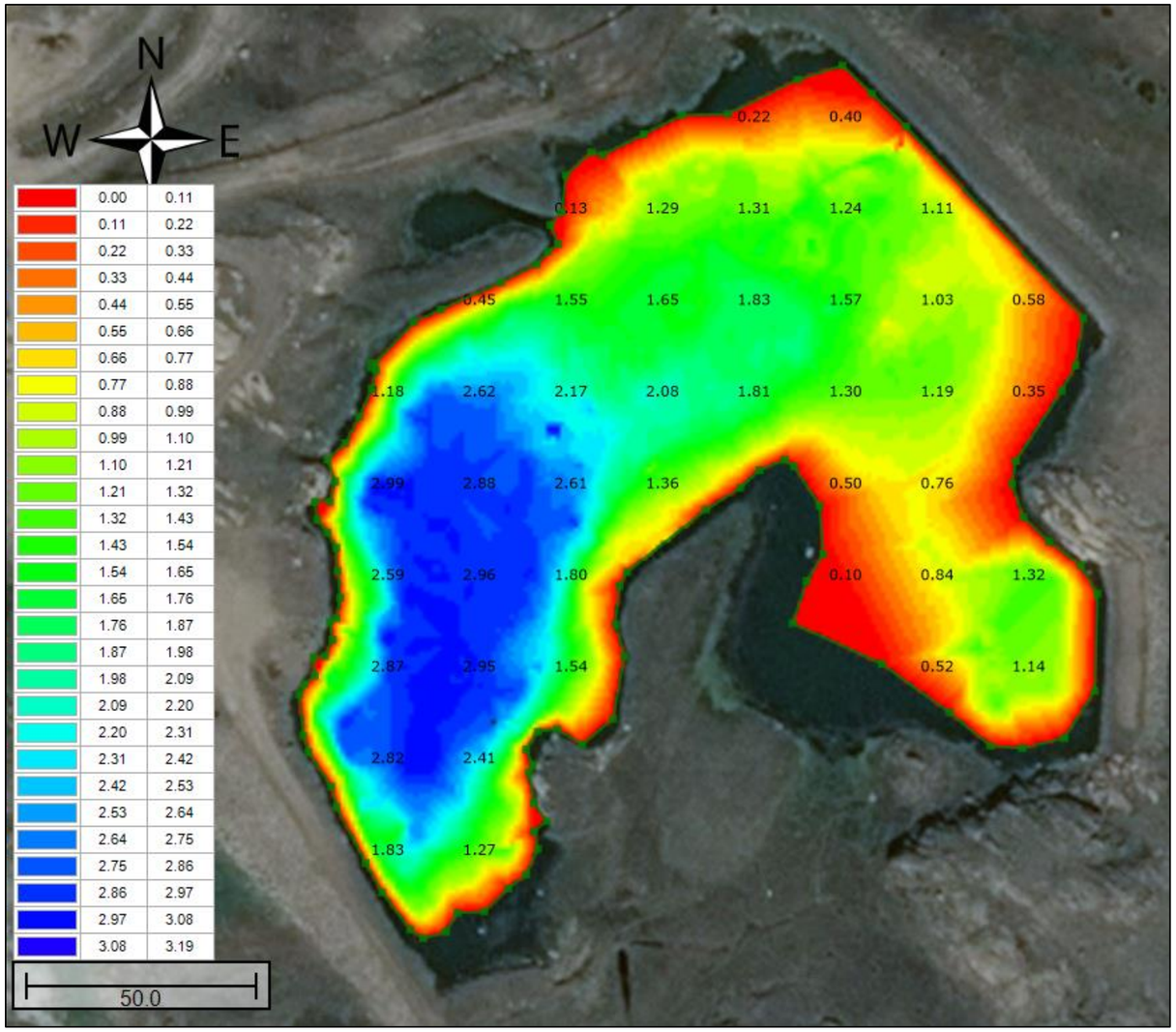

Figure 5 Iqaluit lagoon bottom profile depths (m)

	Name	Date
Prepared by:	AA	17-09-2018

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HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
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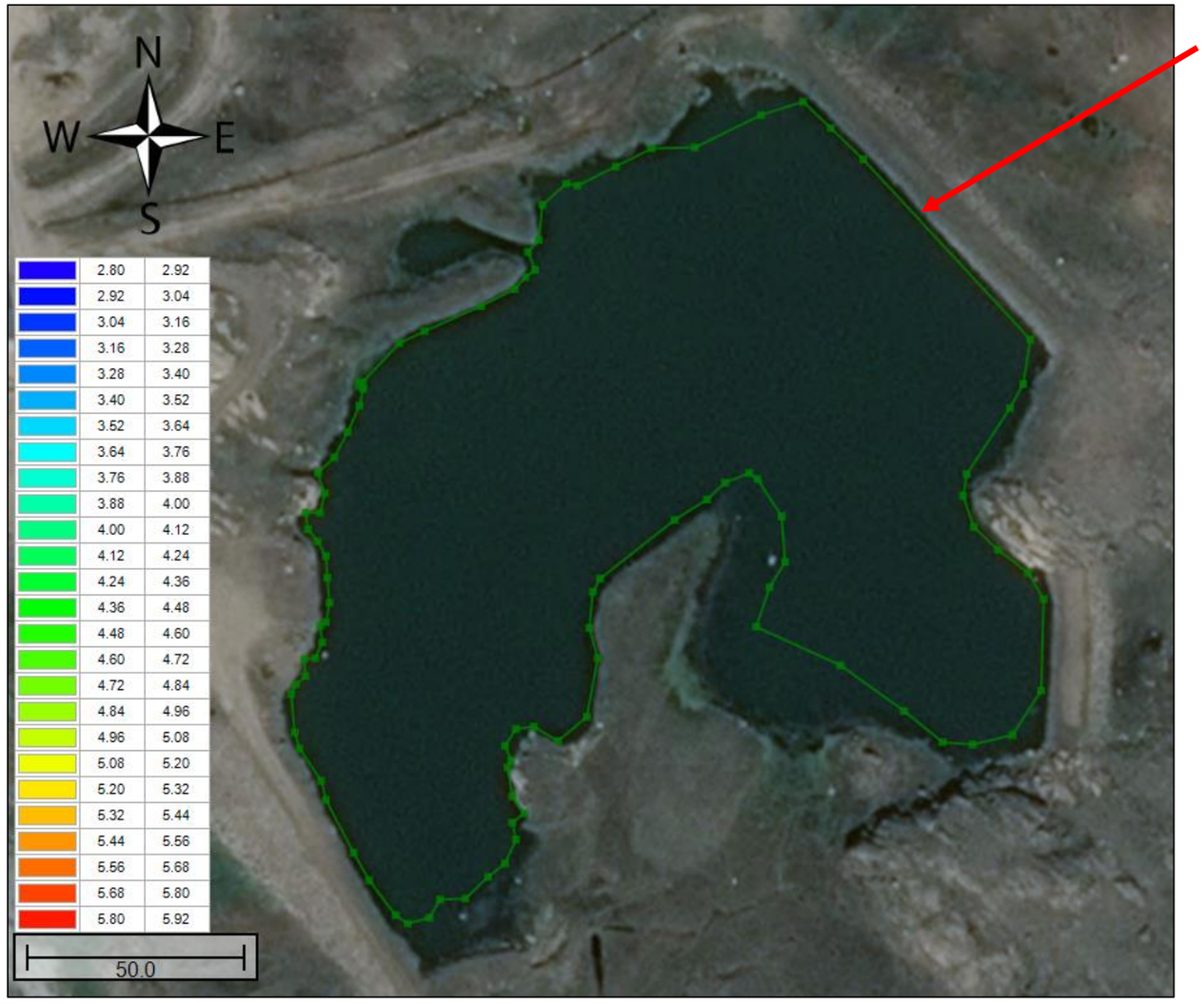
EXECUTIVE SUMMARY CONTINUED



Green line represents location of shoreline at the time of survey

Figure 6 Iqaluit lagoon shoreline as marked with RTK GNSS at the time of survey (m)

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HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey	
Project Number	18027	
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EXECUTIVE SUMMARY CONTINUED

ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths and elevations with the lagoon liner. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry weight.

IQALUIT LAGOON:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) = **5,220 m^3**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) = **1,597 m^3**

TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) = **316 m^3**

Figure 8 Iqaluit lagoon estimated sludge volume

LAGOON HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY (WATER LEVEL @ 5.9 m) = **20,436 m^3**

Figure 7 Iqaluit lagoon hydraulic capacity

Table 1 Iqaluit Lagoon Stage Volumes at Present Sludge Loading

Stage	Depth (m)	Volume (m^3)	Area (m^2)
1	0.0	20436	17605
2	0.5	12624	13502
3	1.0	7116	8231
4	1.5	3715	5230
5	2.0	1565	3515
6	2.5	189	1765

A NOTE ON VOLUME CALCULATIONS

Estimates of sludge quantity and pond hydraulic capacity are provided in this report. It is important to note that reported sludge volumes are based on pond depths measured by the sub-bottom profiler or infrared sludge interface detector and verified using manual checks. Sludge volumes are calculated using software that creates interpolations between the sounding lines measured in the field. As such the volume of sludge calculated in this report will vary from what is actually found in the field. The volumes shown in this report should be used as guidelines for planning maintenance desludging or dredging and should not be assumed to be exactly accurate. By choosing to use the sludge volume estimates provided in this report the user agrees to indemnify and hold Hydrasurvey harmless of any additional charges resulting from underestimated or overestimated sludge volumes.

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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Revision	1
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SLUDGE SURVEY DETAILED FINDINGS – TOP OF SLUDGE 3D IMAGE

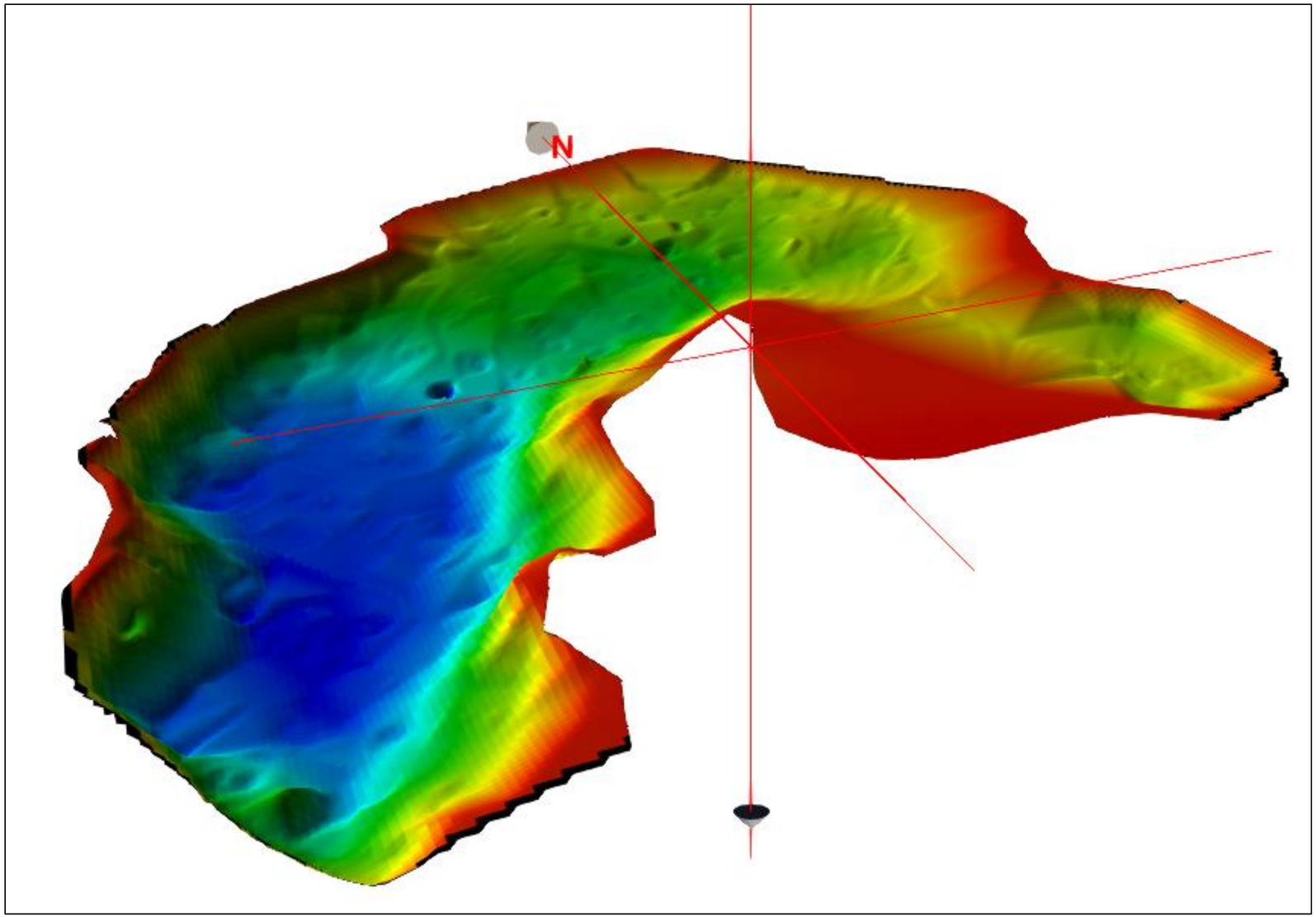

Figure 9 Iqaluit Lagoon 3D isometric image of top of sludge looking north east

	Name	Date
Prepared by:	AA	17-09-2018
Unless otherwise specified all dimensions are in meters		

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
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SLUDGE SURVEY DETAILED FINDINGS – SURVEY IMAGES

Figure 12 The north east corner of the Iqaluit Lagoon at the influent location was full of sludge. A portion of this area was not accessible by boat due to the extremely shallow beach that has formed. This influent area was in constant operation during the survey.

Figure 11 Exposed riprap and shoreline along the east dyke of the lagoon

Figure 10 The low waterline exposed a large beach at the south west corner of the Iqaluit lagoon

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HYDRASURVEY

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SLUDGE SURVEY DETAILED FINDINGS – ECHOGRAM SAMPLE

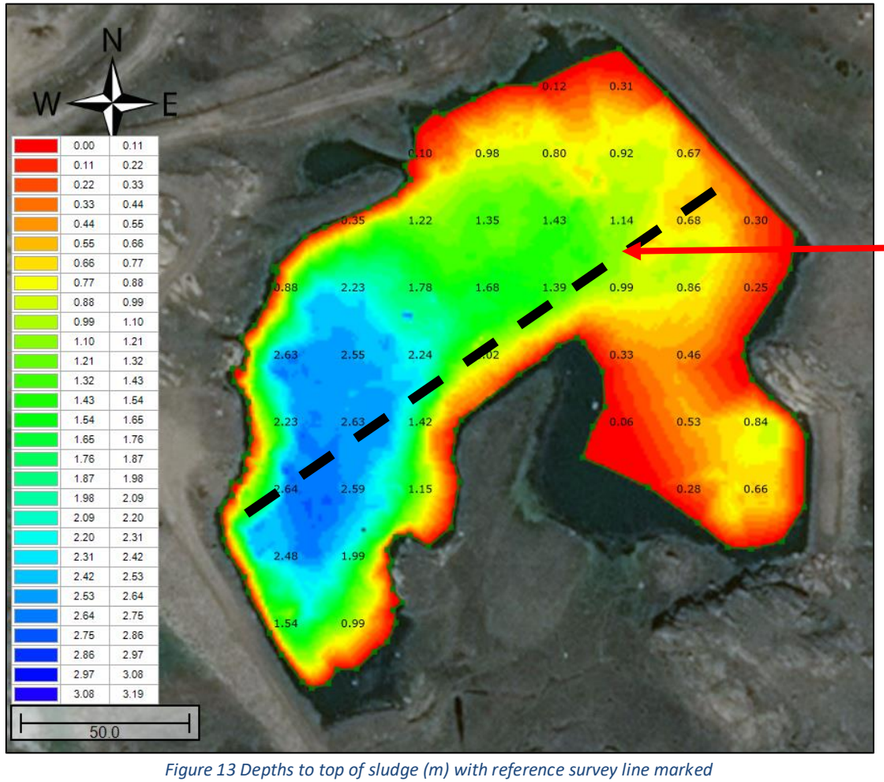

Figure 13 Depths to top of sludge (m) with reference survey line marked

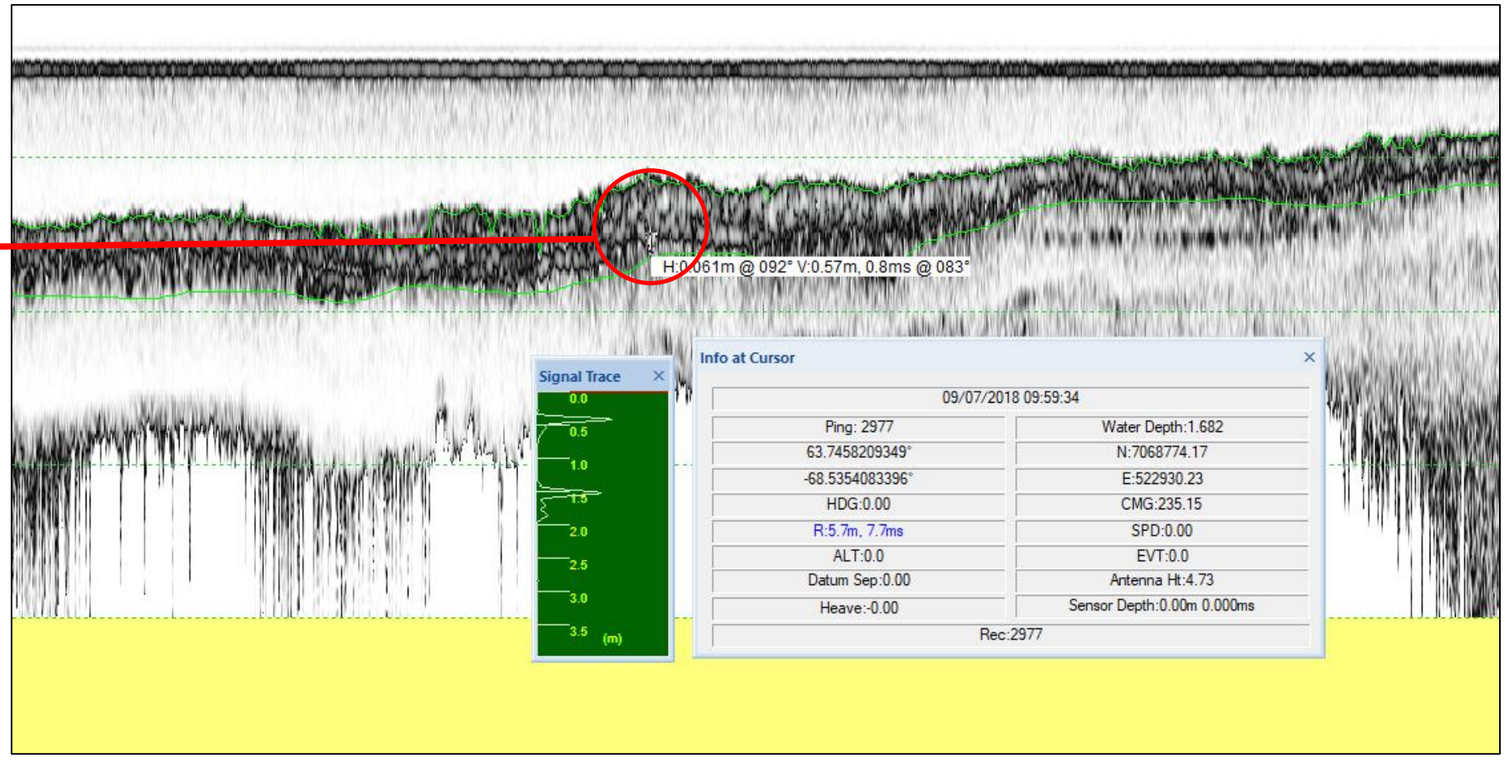

Figure 14 Echogram showing accumulated sludge on bottom

- The sub-bottom profiler echogram image above represents the cross section (elevation) view of the black line in the figure to the left. The red circle shows the accumulated sludge on top of the lagoon bottom. At this point the sludge is measured at 0.57 m thick.
- Hydrasurvey used the sub-bottom profiler to survey all boat accessible areas of the Iqaluit lagoon.

	Name	Date
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HYDRASURVEY

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SURVEY METHODOLOGY

Hydrasurvey uses sub-bottom profiling technology and RTK GNSS positioning to map both the top of sludge and lagoon bottom. Hydrasurvey uses both an infrared sludge interface detector and a sludge judge to correlate actual field measurements with acoustic reflectors measured using the sub-bottom profiler. In very shallow (< 0.5 m) water depths Hydrasurvey uses an infrared sludge interface detector with RTK GNSS positioning to measure the sludge blanket. Hydrasurvey also collects sludge samples and tests them for total solids and total volatile solids for computation of dry material volumes.

Sludge Survey Equipment:

Vessel: Inshore survey vessel (Commercial grade inflatable) outfitted with survey system mount and electric motor

Positioning: RTK Base and Rover GNSS system

Sonar: Mutli-frequency sub-bottom profiler (High Frequency at 100kHz, Low Frequencies at 15kHz, 12kHz, 10kHz, 8kHz, 6kHz, 5kHz and 4kHz)

Sound Velocity: Portable sound velocity profiler (temperature, depth, conductivity)

Sludge measurement devices: Infrared sludge interface detector, sludge judge and Ekman grab sampler

Survey line spacing	10 m
Survey speed	3 km/hr
Number of manual sludge measurements	6
Number of sludge samples taken	1
Number of sound velocity profiles taken	2
Average sound velocity in the lagoons	1445.65 m/s
Sub-bottom profiler transducer settings	HF: 100kHz, LF: 8kHz
Transducer draft (below waterline)	0.23 m
GPS antenna height (above waterline)	1.43 m
Lagoon water elevation during survey	5.9 m
Number of planned survey lines	37 lines
Approximate total distance of survey lines	4.5 km

Table 2 Sludge Survey Details

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
Revision	1
Sheet	12

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Visit: https://helpx.adobe.com/acrobat/using/enable-3d-content-pdf.html for more information.

Scale Up

Scale Down

HYDRASURVEY

3D scene of Iqaluit wastewater lagoon. Note 3D pdfs are in Beta and are to be used for reference purposes only. Do not scale from this drawing.		
Map Projection: UTM WGS84 Z19 (m)	Company: Hydrasurvey Ltd.	Area: Iqaluit Wastewater Lagoon
Date: September 06, 2018	Chief Surveyor: A. Ambrocichuk	Vessel: Hydraboat 1

CERTIFICATE OF ANALYSIS

REPORTED TO	Hydrasurvey Ltd. 9715 - 76 Street Edmonton, AB T6C 2L1		
ATTENTION	Andrew Ambrocichuk	**WORK ORDER**	8090632
PO NUMBER		**RECEIVED / TEMP**	2018-09-10 09:46 / NA
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36
PROJECT INFO			

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO 17025:2005 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry

It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve

Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

If you have any questions or concerns, please contact me at jshanko@caro.ca

Authorized By:

Jennifer Shanko, A.Sc.T.
Account Manager

TEST RESULTS

REPORTED TO	Hydrasurvey Ltd.	**WORK ORDER**	8090632
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36

Analyte	Result	RL	Units	Analyzed	Qualifier
Iqualuit S1 (8090632-01) | Matrix: Solid | Sampled: 2018-09-06					
General Parameters					
Solids, Total	**30.6**	0.1	% wet	2018-09-17	
Solids, Volatile	**19.8**	0.1	% dry	2018-09-17	

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Hydrasurvey Ltd.	**WORK ORDER**	8090632
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36

Analysis Description	Method Ref.	Technique	Location
Solids, Total in Solid	SM 2540 G (2011)	Gravimetry	Kelowna
Solids, Volatile in Solid	SM 2540 G (2011)	Gravimetry	Kelowna

Glossary of Terms:

RL	Reporting Limit (default)
% dry	Percent (dry weight basis)
% wet	Percent (as received basis)
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Hydrasurvey Ltd.	**WORK ORDER**	8090632
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS)**: A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS)**: A second aliquot of sample is fortified with with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8I0647										
Duplicate (B8I0647-DUP1)	**Source: 8090632-01**			Prepared: 2018-09-17, Analyzed: 2018-09-17						
Solids, Total	29.9	0.1	% wet		30.6			2	7.5	
Solids, Volatile	20.4	0.1	% dry		19.8			3	9	
Reference (B8I0647-SRM1)				Prepared: 2018-09-17, Analyzed: 2018-09-17						
Solids, Total	68.6	0.1	% wet	69.3		99	80-120			

LAMBOURNE ENVIRONMENTAL Ltd.
51 Belich Crescent, Red Deer County T4S 2K5 Ph. (403) 348-8298 Fax (403) 348-8290

September 18, 2018

Iqaluit, NU
Attn: Sandra Rousseau

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Yours truly,
Lambourne Environmental Ltd.

David Linsley, B.Sc.
General Manager

SLUDGE SURVEY REPORT

IQALUIT, NU WASTEWATER LAGOON

Location: Iqaluit, NU

Name of Lagoon(s): Iqaluit Wastewater Lagoon

Client: Lambourne Environmental

Client Contact: David Linsley

Report prepared by: A. Ambrocichuk

Surveyors: A. Ambrocichuk, S. Gay, B. Buryn

Date(s) of Survey: 06/09/18 – 07/09/18

Map Grid Reference: Datum: WGS84, Projection: UTM, Zone 19N

Revision Number: 1

Report Print Size: 11x17”

Figure 1 Plan overview of Iqaluit, NU Wastewater Lagoon

	Name	Date
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HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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FIGURES, TABLES, APPENDICES SUMMARY

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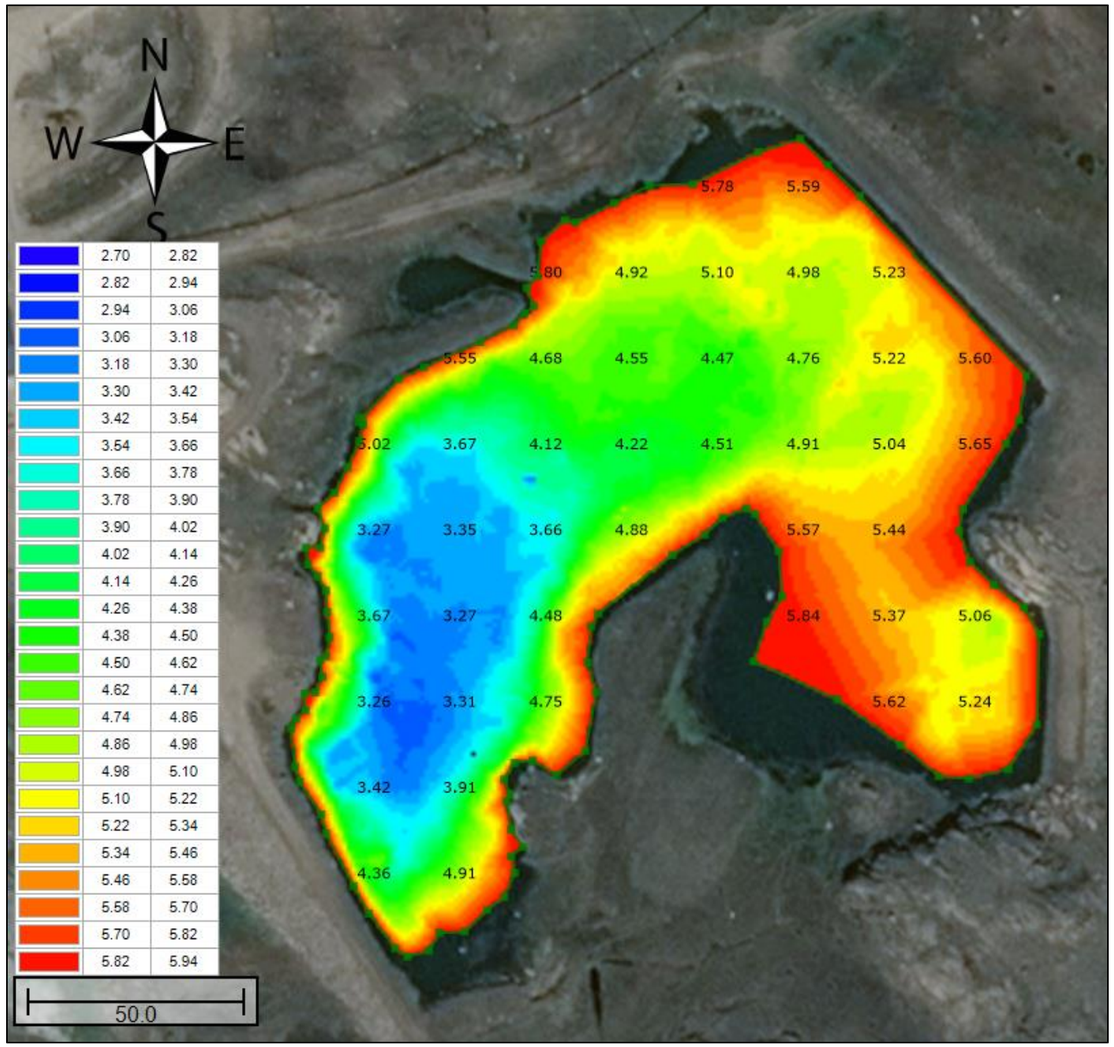

Figure 2 Iqaluit lagoon top of sludge elevations (m)

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Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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Revision	2
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EXECUTIVE SUMMARY CONTINUED

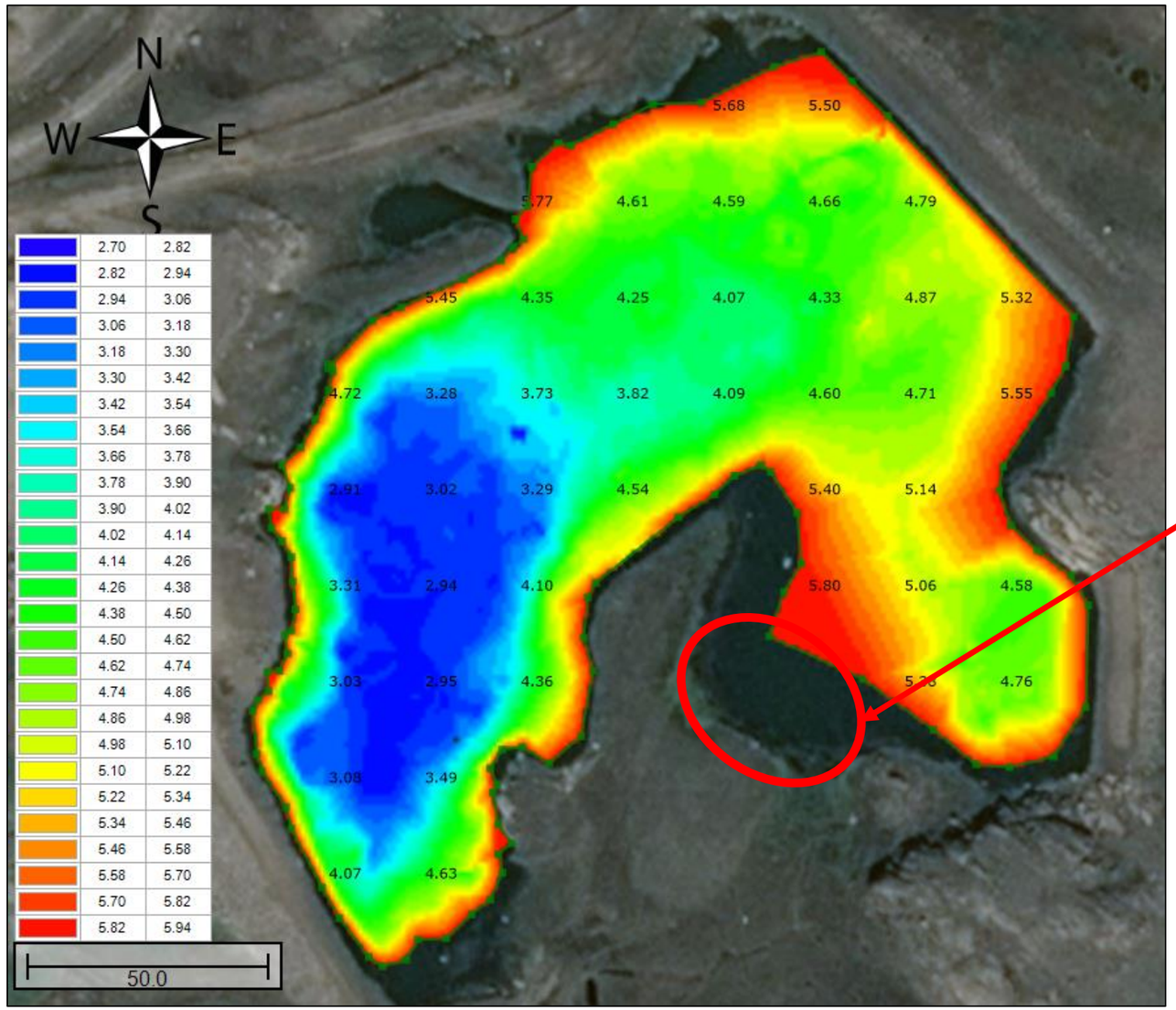

Figure 3 Iqaluit lagoon bottom profile elevations (m)

- Iqaluit lagoon water elevation at the time of survey was 5.9m and appeared to be well below the high waterline, exposing accumulated sludge along the shoreline. The image below shows the sludge beach as identified by the red circle in the CAD drawing to the left. Boat access to determine the depth of this sludge was not possible due to the extremely shallow beach.

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Project Number	18027
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Sheet	4

EXECUTIVE SUMMARY CONTINUED

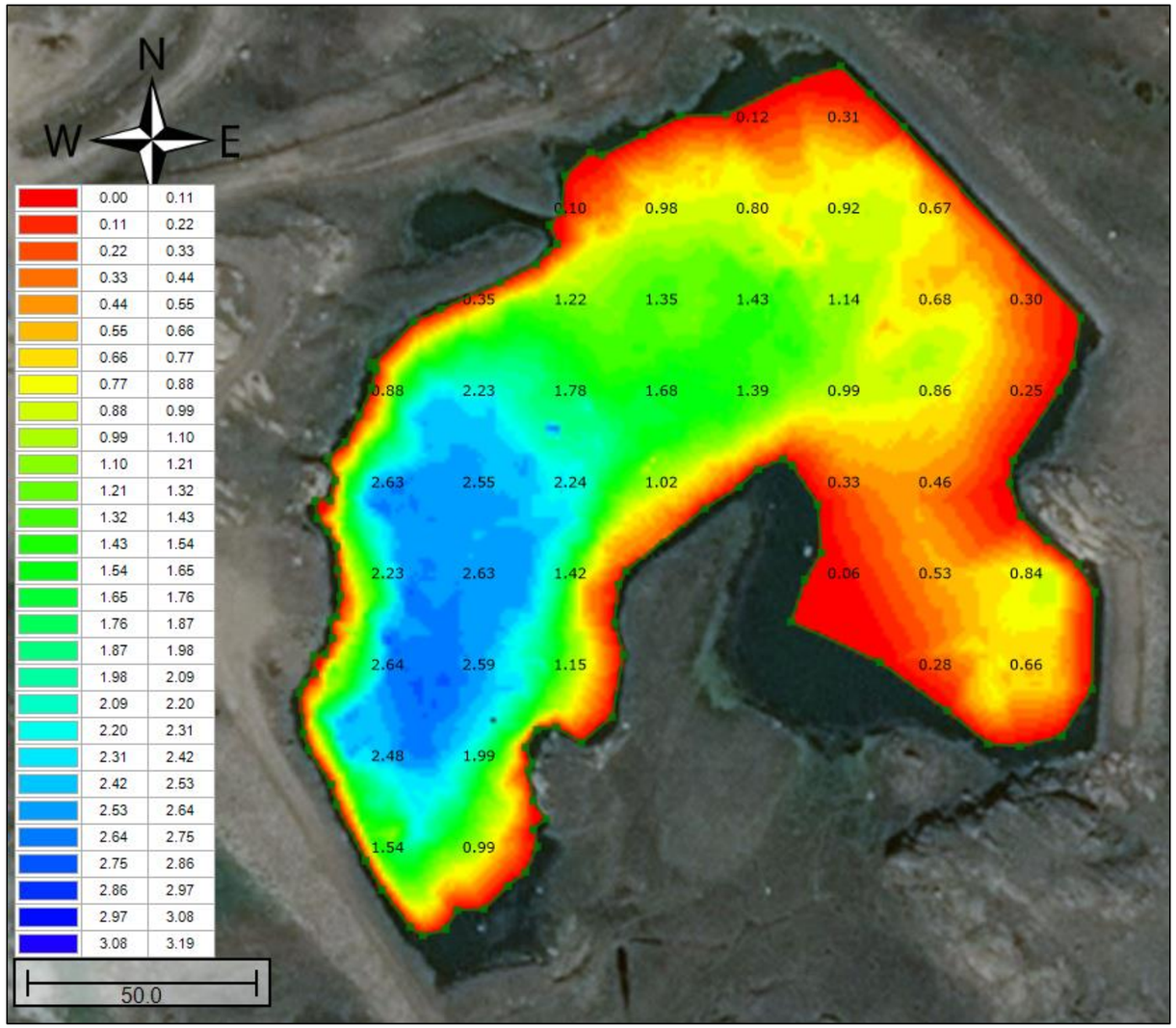

Figure 4 Iqaluit lagoon depths to top of sludge (m)

	Name	Date
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HYDRASURVEY

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EXECUTIVE SUMMARY CONTINUED

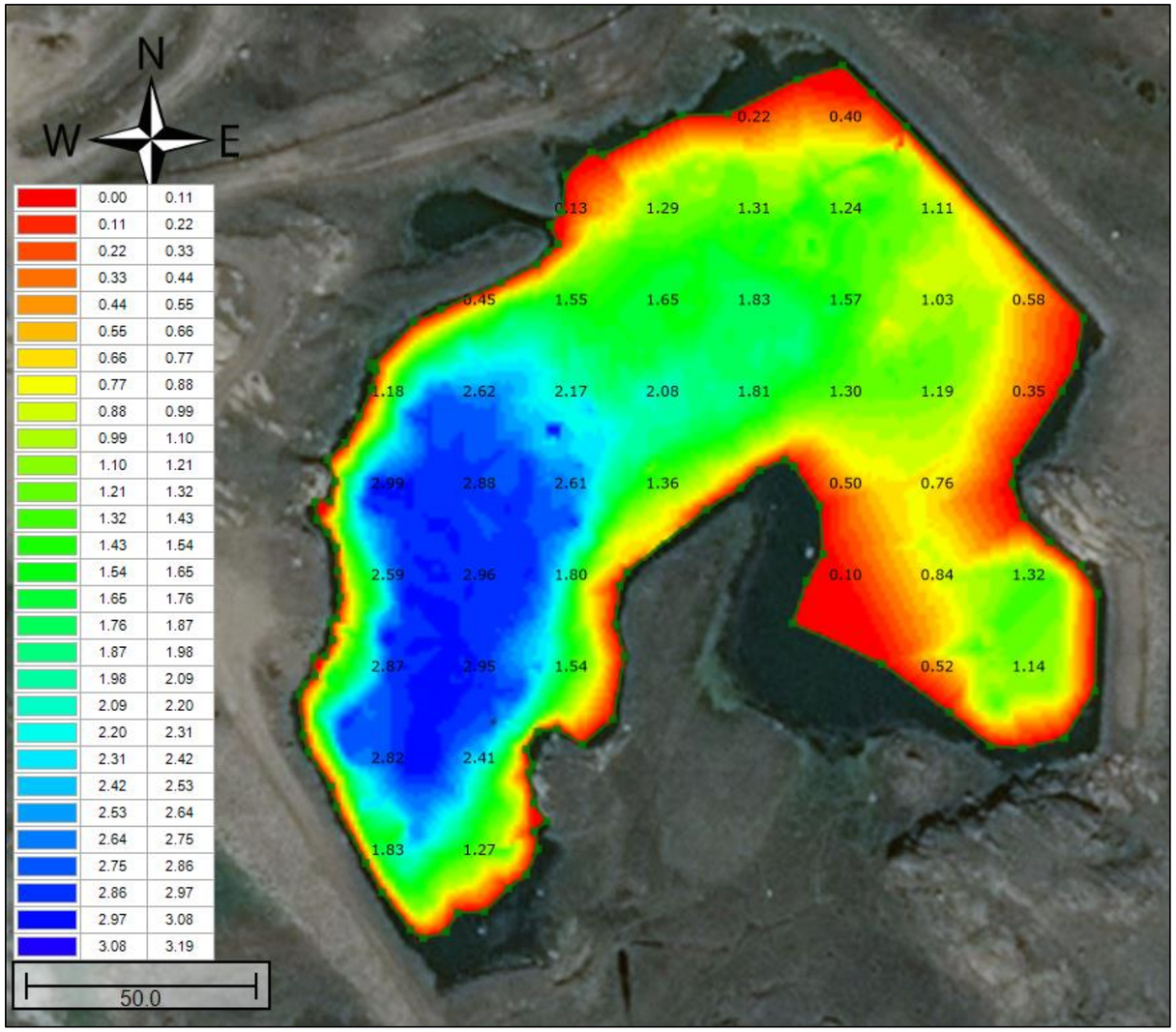

Figure 5 Iqaluit lagoon bottom profile depths (m)

	Name	Date
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HYDRASURVEY

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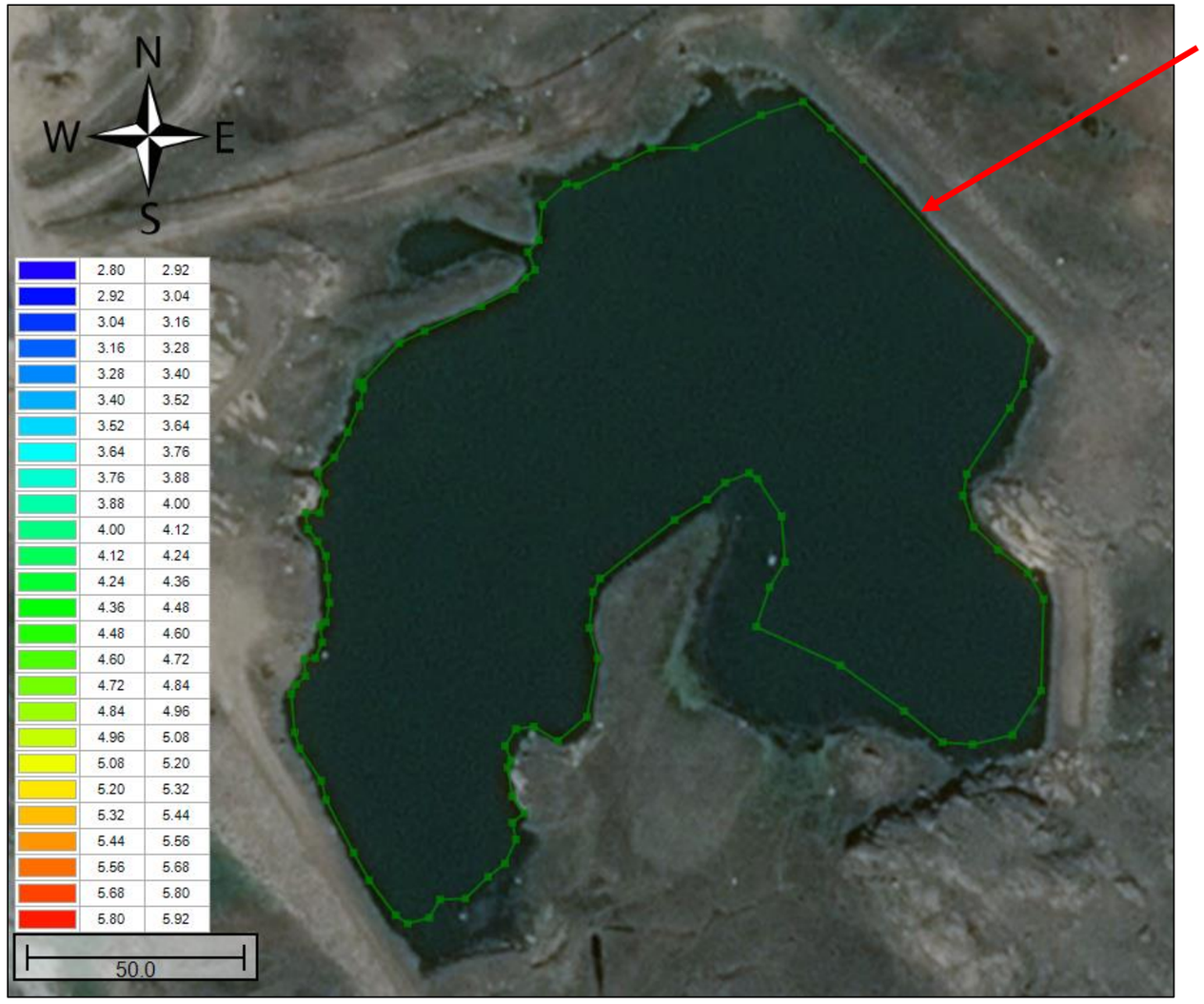
This is not a legal or engineered survey document
Matrix depths and elevations are interpolated from field measurements
Depths are relative to water level at the time of the survey
Survey data collected on September 6-7, 2018
Report any discrepancies in this report to Hydrasurvey Ltd.
Do not modify or use this report for purposes other than which it is intended

EXECUTIVE SUMMARY CONTINUED



Green line represents location of shoreline at the time of survey

Figure 6 Iqaluit lagoon shoreline as marked with RTK GNSS at the time of survey (m)

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
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EXECUTIVE SUMMARY CONTINUED

ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths and elevations with the lagoon liner. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry weight.

IQALUIT LAGOON:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) = **5,220 m^3**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) = **1,597 m^3**

TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) = **316 m^3**

Figure 8 Iqaluit lagoon estimated sludge volume

LAGOON HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY (WATER LEVEL @ 5.9 m) = **20,436 m^3**

Figure 7 Iqaluit lagoon hydraulic capacity

Table 1 Iqaluit Lagoon Stage Volumes at Present Sludge Loading

Stage	Depth (m)	Volume (m^3)	Area (m^2)
1	0.0	20436	17605
2	0.5	12624	13502
3	1.0	7116	8231
4	1.5	3715	5230
5	2.0	1565	3515
6	2.5	189	1765

A NOTE ON VOLUME CALCULATIONS

Estimates of sludge quantity and pond hydraulic capacity are provided in this report. It is important to note that reported sludge volumes are based on pond depths measured by the sub-bottom profiler or infrared sludge interface detector and verified using manual checks. Sludge volumes are calculated using software that creates interpolations between the sounding lines measured in the field. As such the volume of sludge calculated in this report will vary from what is actually found in the field. The volumes shown in this report should be used as guidelines for planning maintenance desludging or dredging and should not be assumed to be exactly accurate. By choosing to use the sludge volume estimates provided in this report the user agrees to indemnify and hold Hydrasurvey harmless of any additional charges resulting from underestimated or overestimated sludge volumes.

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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SLUDGE SURVEY DETAILED FINDINGS – TOP OF SLUDGE 3D IMAGE

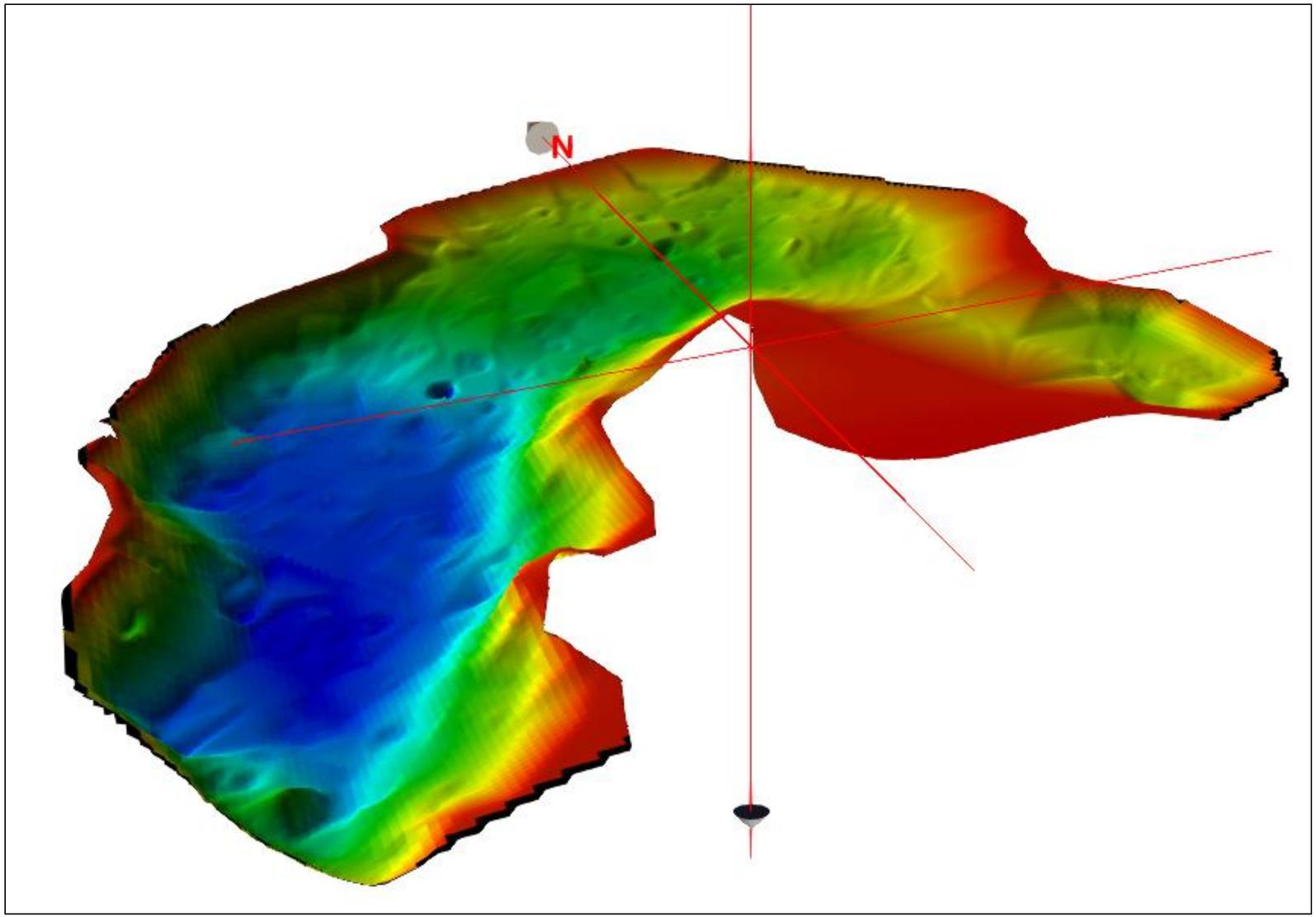

Figure 9 Iqaluit Lagoon 3D isometric image of top of sludge looking north east

	Name	Date
Prepared by:	AA	17-09-2018
Unless otherwise specified all dimensions are in meters		

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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SLUDGE SURVEY DETAILED FINDINGS – SURVEY IMAGES

Figure 12 The north east corner of the Iqaluit Lagoon at the influent location was full of sludge. A portion of this area was not accessible by boat due to the extremely shallow beach that has formed. This influent area was in constant operation during the survey.

Figure 11 Exposed riprap and shoreline along the east dyke of the lagoon

Figure 10 The low waterline exposed a large beach at the south west corner of the Iqaluit lagoon

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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SLUDGE SURVEY DETAILED FINDINGS – ECHOGRAM SAMPLE

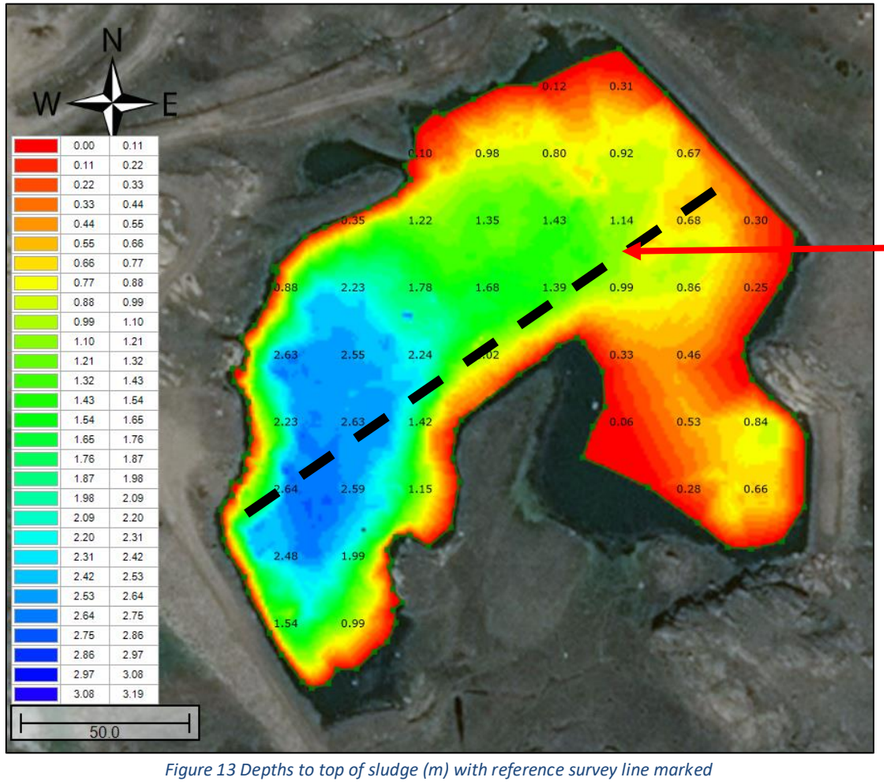

Figure 13 Depths to top of sludge (m) with reference survey line marked

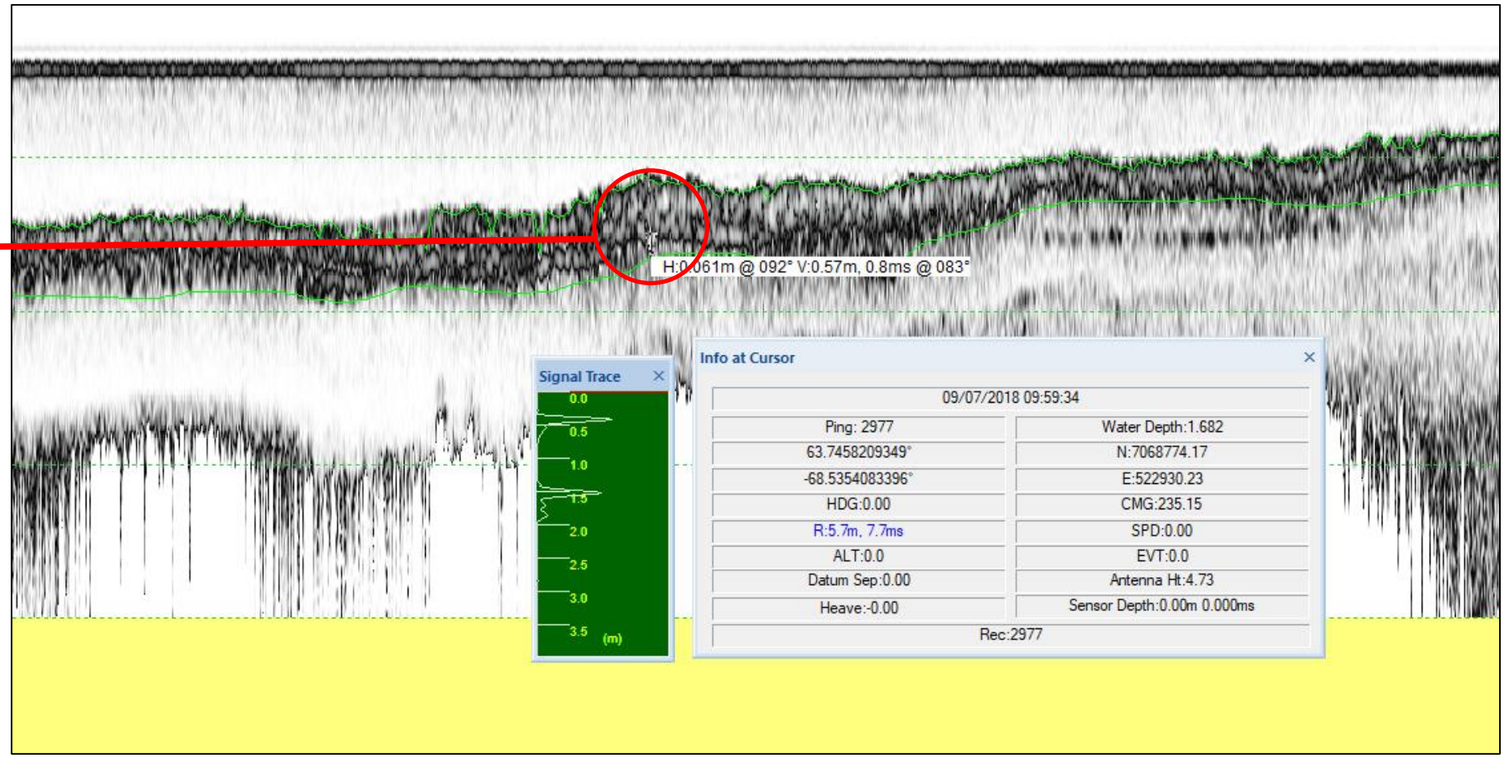

Figure 14 Echogram showing accumulated sludge on bottom

- The sub-bottom profiler echogram image above represents the cross section (elevation) view of the black line in the figure to the left. The red circle shows the accumulated sludge on top of the lagoon bottom. At this point the sludge is measured at 0.57 m thick.
- Hydrasurvey used the sub-bottom profiler to survey all boat accessible areas of the Iqaluit lagoon.

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
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SURVEY METHODOLOGY

Hydrasurvey uses sub-bottom profiling technology and RTK GNSS positioning to map both the top of sludge and lagoon bottom. Hydrasurvey uses both an infrared sludge interface detector and a sludge judge to correlate actual field measurements with acoustic reflectors measured using the sub-bottom profiler. In very shallow (< 0.5 m) water depths Hydrasurvey uses an infrared sludge interface detector with RTK GNSS positioning to measure the sludge blanket. Hydrasurvey also collects sludge samples and tests them for total solids and total volatile solids for computation of dry material volumes.

Sludge Survey Equipment:

Vessel: Inshore survey vessel (Commercial grade inflatable) outfitted with survey system mount and electric motor

Positioning: RTK Base and Rover GNSS system

Sonar: Mutli-frequency sub-bottom profiler (High Frequency at 100kHz, Low Frequencies at 15kHz, 12kHz, 10kHz, 8kHz, 6kHz, 5kHz and 4kHz)

Sound Velocity: Portable sound velocity profiler (temperature, depth, conductivity)

Sludge measurement devices: Infrared sludge interface detector, sludge judge and Ekman grab sampler

Survey line spacing	10 m
Survey speed	3 km/hr
Number of manual sludge measurements	6
Number of sludge samples taken	1
Number of sound velocity profiles taken	2
Average sound velocity in the lagoons	1445.65 m/s
Sub-bottom profiler transducer settings	HF: 100kHz, LF: 8kHz
Transducer draft (below waterline)	0.23 m
GPS antenna height (above waterline)	1.43 m
Lagoon water elevation during survey	5.9 m
Number of planned survey lines	37 lines
Approximate total distance of survey lines	4.5 km

Table 2 Sludge Survey Details

	Name	Date
Prepared by:	AA	17-09-2018

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey
Project Number	18027
Revision	2
Sheet	12

CERTIFICATE OF ANALYSIS

REPORTED TO	Hydrasurvey Ltd. 9715 - 76 Street Edmonton, AB T6C 2L1		
ATTENTION	Andrew Ambrocichuk	**WORK ORDER**	8090632
PO NUMBER		**RECEIVED / TEMP**	2018-09-10 09:46 / NA
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36
PROJECT INFO			

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO 17025:2005 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry

It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve

Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

If you have any questions or concerns, please contact me at jshanko@caro.ca

Authorized By:

Jennifer Shanko, A.Sc.T.
Account Manager

TEST RESULTS

REPORTED TO	Hydrasurvey Ltd.	**WORK ORDER**	8090632
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36

Analyte	Result	RL	Units	Analyzed	Qualifier
Iqualuit S1 (8090632-01) | Matrix: Solid | Sampled: 2018-09-06					
General Parameters					
Solids, Total	**30.6**	0.1	% wet	2018-09-17	
Solids, Volatile	**19.8**	0.1	% dry	2018-09-17	

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Hydrasurvey Ltd.	**WORK ORDER**	8090632
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36

Analysis Description	Method Ref.	Technique	Location
Solids, Total in Solid	SM 2540 G (2011)	Gravimetry	Kelowna
Solids, Volatile in Solid	SM 2540 G (2011)	Gravimetry	Kelowna

Glossary of Terms:

RL	Reporting Limit (default)
% dry	Percent (dry weight basis)
% wet	Percent (as received basis)
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Hydrasurvey Ltd.	**WORK ORDER**	8090632
PROJECT	Cell 2A	**REPORTED**	2018-09-17 15:36

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS)**: A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS)**: A second aliquot of sample is fortified with with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8I0647										
Duplicate (B8I0647-DUP1)	**Source: 8090632-01**			Prepared: 2018-09-17, Analyzed: 2018-09-17						
Solids, Total	29.9	0.1	% wet		30.6			2	7.5	
Solids, Volatile	20.4	0.1	% dry		19.8			3	9	
Reference (B8I0647-SRM1)				Prepared: 2018-09-17, Analyzed: 2018-09-17						
Solids, Total	68.6	0.1	% wet	69.3		99	80-120			

APPENDIX D

2019 Sludge Removal Quantity

SUMMARY TABLE	
No Client :	Kudlik 90678
Project	IQALUIT Lagoon
Estimated volume	5220 m3
Estimated BDT	1600
Project manager	René Couture

	DATE		VOLUME PUMPED (m3/day)	COMPOSITE SAMPLE VOLUME AVERAGE (mL)	AVERAGE OF WATER IN SAMPLE (ml)	AVERAGE WEIGHT OF SAMPLE (gr)	AVERAGE DENSITY OF SLUDGE	AVERAGE SOLID % OF SLUDGE SAMPLE	AVERAGE SOLIDE % OF SLUDGE SAMPLE COMPOSITE	TOTAL BDT/DAY	TOTAL POLYMER/DAY (KG)	AVERAGE POLYMER (KG/m3)	POLYMER KG/BDT
	29-09-2019		1048	11 500	11047	453	1,00	9,74	0,39	4,00	22,00	0,02	5,50
	30-09-2019		1162	11 500	10964	536	1,00	10,36	0,48	5,59	22,00	0,02	3,94
	01-10-2019		1135	11 500	10991	509	1,00	10,65	0,48	5,36	22,00	0,02	4,10
	02-10-2019		1168	11 500	10928	572	1,00	10,65	0,53	6,19	22,00	0,02	3,55
	03-10-2019		1129	11 500	10544	956	1,00	12,84	1,06	11,84	22,00	0,02	1,86
	04-10-2019	#	1241	11 517	10804	713	1,00	10,34	0,64	7,95	22,00	0,02	2,77
	05-10-2019	#	0	0	0	0	1,00	0,00	0,00	0,00	0,00	0,00	0,00
	06-10-2019		826	10 000	8775	817	1,00	32,41	2,68	31,76	80,00	0,10	2,52
	07-10-2019		870	9 500	7125	1567	1,02	35,57	5,90	74,56	128,00	0,15	1,72
	08-10-2019		928	11 740	8460	2933	1,01	38,45	8,74	107,61	174,00	0,19	1,62
	09-10-2019		1097	12 060	7820	3733	1,04	37,73	11,05	131,15	186,00	0,17	1,42
	10-10-2019		934	11 700	8433	3067	1,03	37,66	9,75	88,38	132,00	0,14	1,49
	11-10-2019		361	11 000	10550	450	1,00	2,78	0,04	0,45	0,00	0,00	0,00
	12-10-2019										0,00		
	13-10-2019										0,00		
	TOTAL		**11899**	**135017**	**116442,17**	**16305**				**474,84**	**832**	**0,86**	
	AVERAGE/DAY		**915,31**	**10385,90**	**8957,09**	**1254,19**	**1,01**	**19,17**	**3,21**	**36,53**	**55,47**	**0,07**	**2,35**

DATE	BDT / BAGS					
	1	2	3	4	5	
29-sept-19	4,00					
30-sept-19	5,59					
01-oct-19	5,36					
02-oct-19	6,19					
03-oct-19	11,84					
04-oct-19	7,95					
05-oct-19	0					
06-oct-19	31,76					
07-oct-19	74,56					
08-oct-19	107,61					
09-oct-19	78,35	52,8				
10-oct-19		88,38				
11-oct-19		2,35				
TOTAL	333,21	143,53	0,00	0,00	0,00	476,74

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-11	**Précédent**	11 539									
	08:00	11 725	186	10000	10000	9500	500	1,00	3,54	0,18	0,33
	10:00	11 900	175	12000	12000	11600	400	1,00	2,01	0,07	0,12
	12:00		0				0	0,00		0,00	0,00
	14:00						0	0,00		0,00	0,00
	16:00						0	0,00		0,00	0,00
	18:00						0	0,00		0,00	0,00
			361,00	11000,00	11000,00	10550,00	450,00	1,00	2,78	0,04	0,45

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-10	**Précédent**	10 605									
	08:00	10 812	207	10000	10200	7800	1200	1,02	37,33	4,39	9,27
	10:00	11 005	193	12000	12500	9200	3300	1,04	38,62	10,20	20,50
	12:00	11 203	198	12000	12200	9500	2700	1,02	37,84	8,37	16,86
	14:00	11 300	97	12000	12300	8600	3700	1,03	35,88	10,79	10,73
	16:00	11 425	125	12000	12400	8000	4400	1,03	38,64	13,71	17,71
	18:00	11 539	114	10000	10600	7500	3100	1,06	37,66	11,01	13,31
			934,00	11333,33	11700,00	8433,33	3066,67	1,03	37,66	9,75	88,38

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-09	**Précédent**	9 508									
	08:00	9 660	152				1200	0,00		0,00	0,00
	10:00	9 870	210	12000	12600	8100	4500	1,05	38,62	13,79	30,41
	12:00	10 075	205	12000	12400	7900	4500	1,03	37,84	13,73	29,09
	14:00	10 225	150	12000	12300	8100	4200	1,03	35,88	12,25	18,84
	16:00	10 436	211	12000	12400	8000	4400	1,03	38,64	13,71	29,89
	18:00	10 605	169	10000	10600	7000	3600	1,06	37,66	12,79	22,91
			1097,00	11600,00	12060,00	7820,00	3733,33	1,04	37,73	11,05	131,15

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-08	**Précédent**	8 580									
	09:00	8 580	0				1200	0,00		0,00	0,00
	10:00	8 685	105	10000	10000	9000	1000	1,00	38,62	3,86	4,06
	12:00	8 993	308	12000	12100	8500	3600	1,01	36,58	10,88	33,80
	14:00	9 146	153	12000	12200	8100	4100	1,02	37,89	12,73	19,81
	16:00	9 350	204	12000	12100	8300	3800	1,01	39,35	12,36	25,42
	18:00	9 508	158	10000	12300	8400	3900	1,23	39,81	12,62	24,53
			928,00	11200,00	11740,00	8460,00	2933,33	1,01	38,45	8,74	107,61

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-07	**Précédent**	7 710									
	07:00	7 915	205	10000	10000	8000	1200	1,00	35,20	4,22	8,66
	10:00	8 220	305	10000	10000	8000	2000	1,00	34,60	6,92	21,11
	11:30	8 375	155	8000	8300	5300	3000	1,04	36,58	13,22	21,26
	14:00	8 580	205	10000	10 400	7200	3200	1,04	35,88	11,04	23,54
	16:00		0				0	0,00		0,00	0,00
	18:00						0	0,00		0,00	0,00
			870,00	9500,00	9675,00	7125,00	1566,67	1,02	35,57	5,90	74,56

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
	Précédent	6 884									
	09:00	6 884	0				0	0,00		0,00	0,00
	10:00	6 884	0				0	0,00		0,00	0,00
2019-10-06	11:30	7 142	258	10000	10 000	9100	900	1,00	30,65	2,76	7,12
	14:00	7 354	212	10000	10 000	8900	1100	1,00	30,24	3,33	7,05
	16:00	7 560	206	10000	10000	8600	1400	1,00	33,45	4,68	9,65
	18:00	7 710	150	10000	10000	8500	1500	1,00	35,29	5,29	7,94
			826,00	10000,00	10000,00	8775,00	816,67	1,00	32,41	2,68	31,76

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-05	**Précédent**	1									
	08:00	1	0	0	0	0	0	0,00	0,00	0,00	0,00
	10:00	1	0	0	0	0	0	0,00	0,00	0,00	0,00
	12:00	1	0	0	0	0	0	0,00	0,00	0,00	0,00
	14:00	1	0	0	0	0	0	0,00	0,00	0,00	0,00
	16:00	1	0	0	0	0	0	0,00	0,00	0,00	0,00
	18:00	1	0	0	0	0	0	0,00	0,00	0,00	0,00
			0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-04	**Précédent**	5 643									
	08:00	5 822	179	9000	9000	8550	450	1,00	10,00	0,50	0,90
	10:00	6 030	208	12000	12100	11300	800	1,01	10,81	0,71	1,50
	12:00	6 244	214	12000	12000	11250	750	1,00	10,50	0,66	1,40
	14:00	6 463	219	12000	12000	11200	800	1,00	10,35	0,69	1,51
	16:00	6 675	212	12000	12000	11275	725	1,00	10,26	0,62	1,31
	18:00	6 884	209	12000	12000	11250	750	1,00	10,12	0,63	1,32
			1241,00	11500,00	11516,67	10804,17	712,50	1,00	10,34	0,64	7,95

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
	Précédent	4 514									
	08:00	4 675	161	9000	9000	8400	600	1,00	12,03	0,80	1,29
	10:00	4 880	205	12000	12000	10988	1012	1,00	12,24	1,03	2,12
2019-10-03	12:00	5 079	199	12000	12000	10885	1115	1,00	12,35	1,15	2,28
	14:00	5 275	196	12000	12000	10992	1008	1,00	11,05	0,93	1,82
	16:00	5 490	215	12000	12000	11222	778	1,00	14,58	0,95	2,03
	18:00	5 643	153	12000	12000	10779	1221	1,00	14,79	1,50	2,30
			1129,00	11500,00	11500,00	10544,33	955,67	1,00	12,84	1,06	11,84

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-02	**Précédent**	3 346									
	08:00	3 504	158	9000	9000	8425	575	1,00	10,04	0,64	1,01
	10:00	3 706	202	12000	12000	11488	512	1,00	10,22	0,44	0,88
	12:00	3 903	197	12000	12000	11511	489	1,00	10,96	0,45	0,88
	14:00	4 109	206	12000	12000	11403	597	1,00	10,67	0,53	1,09
	16:00	4 333	224	12000	12000	11388	612	1,00	10,96	0,56	1,25
	18:00	4 514	181	12000	12000	11354	646	1,00	11,02	0,59	1,07
			1168,00	11500,00	11500,00	10928,17	571,83	1,00	10,65	0,53	6,19

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-10-01	**Précédent**	2 211									
	08:00	2 360	149	9000	9000	8504	496	1,00	10,04	0,55	0,82
	10:00	2 558	198	12000	12000	11566	434	1,00	10,22	0,37	0,73
	12:00	2 755	197	12000	12000	11500	500	1,00	10,96	0,46	0,90
	14:00	2 957	202	12000	12000	11489	511	1,00	10,67	0,45	0,92
	16:00	3 144	187	12000	12000	11453	547	1,00	10,96	0,50	0,93
	18:00	3 346	202	12000	12000	11433	567	1,00	11,02	0,52	1,05
			1135,00	11500,00	11500,00	10990,83	509,17	1,00	10,65	0,48	5,36

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
2019-09-30	**Précédent**	1 049									
	08:00	1 204	155	9000	9000	8601	399	1,00	10,60	0,47	0,73
	10:00	1 422	218	12000	12000	11458	542	1,00	9,98	0,45	0,98
	12:00	1 615	193	12000	12000	11493	507	1,00	10,32	0,44	0,84
	14:00	1 802	187	12000	12000	11406	594	1,00	10,88	0,54	1,01
	16:00	2 031	229	12000	12000	11427	573	1,00	10,15	0,48	1,11
	18:00	2 211	180	12000	12000	11401	599	1,00	10,25	0,51	0,92
			1162,00	11500,00	11500,00	10964,33	535,67	1,00	10,36	0,48	5,59

Client	**Kudlik 90678**
Project	**IQALUIT Lagoon**
Volume	**5220 m3**
Estimated BDT	**1600**
Responsable:	**René Couture**

	HOURS	FLOW METER TOTALISER	VOLUME PUMPED (m3/h)	SAMPLE VOLUME (mL)	WEIGHT OF SAMPLE (gr)	WATER IN SAMPLE (ml)	WEIGHT OF SLUDGE IN SAMPLE (gr)	DENSITY OF SLUDGE	SOLIDE % OF SLUDGE SAMPLE	SOLIDE % OF SLUDGE SAMPLE COMPOSITE	BDT
	Précédent	1									
	08:00	142	141	9000	9 000	8500	500	1,00	10,15	0,56	0,80
	10:00	332	190	12000	12 000	11750	250	1,00	9,84	0,21	0,39
2019-09-29	12:00	532	200	12000	12 000	11545	455	1,00	9,75	0,37	0,74
	14:00	727	195	12000	12 000	11660	340	1,00	8,79	0,25	0,49
	16:00	902	175	12000	12 000	11340	660	1,00	10,05	0,55	0,97
	18:00	1 049	147	12000	12 000	11487	513	1,00	9,87	0,42	0,62
			1048,00	11500,00	11500,00	11047,00	453,00	1,00	9,74	0,39	4,00